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One Less Nuclear Power Plant (OLNPP)

Reframing Urban Energy Policy

Challenges and Opportunities in the City Seoul

SEOUL METROPOLITAN GOVERNMENT

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Celebrating the Achievements and Fruits of One Less Nuclear Power Plant (OLNPP)

The biggest threat faced by the world is climate change. Incidents caused by extreme weather events worldwide are threatening the very survival of mankind. By 2030, the world will need at least 50 percent more food, 45 percent more energy and 30 percent more water, according to U.N. estimates. That is, if we maintain the current consumption and production patterns, we will need two more planets by 2030 and three more by 2050.

Although there is an urgent need for concerted global efforts to address climate change, the international response has been lukewarm. Recognizing the importance of the issue of climate change, Seoul has launched a long-term plan to step up its global responsibility and play its part in global efforts against climate change. Through its flagship policy "One Less Nuclear Power Plant", the Seoul Metropolitan Government (SMG) is taking the initiative in promoting new and renewable energy generation and energy efficiency, taking steps in its pursuit of responding to climate change and energy crisis.

In November 2013, Seoul has gained its strong ally, Seoul International Energy Advisory Council (SIEAC). Over the past five years, various suggestions and comments made by the SIEAC along with the OLNPP Executive Committee have been the driving force behind reaching the goal of reducing energy consumption by 2 million TOE in June 2014, six months ahead of schedule. Such achievements gave our city confidence in meeting the ambitious goals for OLNPP Phase 2 – spreading the three core values of energy self-reliance, energy sharing and energy participation across our society. Also, our city's efforts to respond to climate change have garnered international recognition and awards, including the UN Public Service Award, the World Green Building Council (WGBC) Government Leadership Awards and the Earth Hour City Challenge (EHCC) of World Wildlife Fund (WWF).

Through the Seoul International Energy Conference (SIEC) and annual SIEAC Advisory Meetings over the past four years, the OLNPP has continuously been evolving and the expert insight and advice from the SIEAC and OLNPP Executive Committee members became the foundation for the SMG to establish and implement a world-renowned energy policy. Also, it gave a significant boost to the establishment of Seoul Energy Corporation.

This book 'Reframing Urban Energy Policy: Challenges and Opportunities of the City of Seoul' is published to express our appreciation of the hard work and dedication of our SIEAC members. I believe that the substantial achievements made possible thanks to the full support of SIEAC should not be limited to Seoul, but be available to countries around the world. This book will help cities and nations trying to respond to climate change to learn a lesson from the OLNPP and make a significant progress in tackling the common challenge of climate change.

The energy sector should also be mindful of the long-held axiom that as civilization advances, we need more efforts to control ourselves. Acknowledging the tremendous efforts of SIEAC and OLNPP Executive Committee members for Seoul's energy policy, my citizens and I would like to dedicate this book to them with our deep appreciation.

Thank you.

Park Won Soon

Mayor of Seoul, Seoul Metropolitan Government

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Walt Patterson

Chair of the Seoul International Energy Advisory Council

Walt Patterson, Chair of the Seoul International Energy Advisory Council, is Associate Fellow in the Energy, Environment and Development Programme at Chatham House in London, UK, and a Visiting Fellow at the University of Sussex. Born in Canada, he has lived in the UK since 1960. A postgraduate nuclear physicist, he has been actively involved in energy and environment since the late 1960s.

Keeping The Lights On: Towards Sustainable Electricity is his thirteenth book. He has also published hundreds of papers, articles and reviews, on topics including nuclear power, coal technology, renewable energy, energy systems, energy policy and electricity. He has been specialist advisor to two Select Committees of the UK House of Commons, an expert witness at many official hearings, a frequent broadcaster and advisor to media, and speaker or chair in conferences around the world. He has been awarded the Melchett Medal of the Energy Institute. The Scientific American 50 named him 'energy policy leader' for his advocacy of decentralized electricity.

His current project for CH and the Sussex Energy Group is 'Managing Energy: Rethinking The Fundamentals'. Walt Patterson On Energy, www.waltpatterson.org, is an online archive of his work since 1970. For information and readers' comments on Electricity Vs Fire, see www.waltpatterson.org/news.htm.

Urban Challenge, Urban Opportunity

Walt Patterson (Chair of Seoul International Energy Advisory Council)

We are living in the century of the city. Even within the lifetimes of our grandparents, most people on earth lived in the countryside, in rural areas and villages. Within the past century, however, people all over the world have been leaving the countryside and moving into cities. According to the World Bank, by 1960 nearly 34 per cent of the world's people were living in cities. By 2015 that proportion had risen to 54 per cent, and the trend is relentlessly upward. Moreover, 23 per cent now live in cities of over one million people. The metropolitan areas of the largest cities can now number upwards of 30 million – more than the population of four out of five entire countries in the

world. Cities of over 5 million are commonplace. Even the largest cities, such as Shanghai, Sao Paolo and Djakarta, are still growing rapidly.

People move to cities because they see advantages - jobs, amenities and other attractions. But even a modest-sized city needs decision-making and governance. The vast settlements, the 'megacities', now burgeoning on every continent make enormous demands on civic governance. Human activity in cities, especially employment, differs markedly from rural activities. Cities are sprawling arrays of physical infrastructure - buildings, roads, bridges, docks, water pipes, sewers, electricity, gas and rail networks – that must be erected, maintained, repaired, upgraded and replaced. People in cities need shelter, food, water, sanitation, drainage and waste management. All require intensive organization.

Daily life in cities includes an endless variety of jobs, but unlike rural life city life rarely includes the critically-essential activity of food production. Cities have to bring in most of the necessary food, as well as water and materials, often from far outside the city. Goods and people must be moved, into and out of the city and within it, in millions of journeys every day. To feed a concentrated crowd of millions, bringing food from beyond the city limits, delivering and distributing it, is a staggering undertaking. But it is only one of the many activities, also including industry, commerce, education and health-care, essential for the citizens of a liveable megacity.

This presents a daunting challenge, and many cities are now failing to meet it. Far too many urban buildings are flimsy, poorly designed and badly built, even in wealthy areas, to say nothing of ever-expanding slums. Inadequate buildings give inadequate shelter, not only from winter cold but more and more from summer heat. Making such buildings even habitable, never mind comfortable, requires active heating and cooling, usually by burning fuels, either directly or to generate the requisite electricity. Congested streets are crammed with traffic, strangling mobility. Vehicle exhausts, also from burning fuels, combine with fumes from domestic and industrial fires to make city air toxic, unbreathable. A city needs enormous quantities of water, for drinking, for cooking, for industry, for cleaning and sanitation. But many cities are unable to deliver water of the right quality where it is needed, and then dispose of it effectively after use. Urban waterways are all too often polluted and foul. City air and city water, essential for life, may actually endanger it.

As if such local problems were not sufficiently alarming, cities also face, often in concentrated form, a mounting array of problems now affecting the entire planet. The central cause is climate change. Greenhouse gases, particularly carbon dioxide produced by fire, are inexorably raising the average temperature at the earth´s surface. The polar icecaps are shrinking. Glaciers are melting. The oceans are expanding. Rising sea-levels may engulf the low-lying coastal areas that include many of the world´s best-known cities – New York, Sydney, Rio de Janeiro, Hong Kong, the list of cities in jeopardy could fill pages.

Although normal sea levels are not yet flooding cities, storm surges have already overwhelmed sea defences in many places, as the overheated atmosphere makes hurricanes and typhoons fiercer and more frequent. Rainfall, too, has become frighteningly intense, producing devastating floods in many different places, inundating settlements and drowning their inhabitants. Yet even as some places suffer from too much water, others suffer from too little. Droughts lasting years have dried out some of the world´s wealthiest regions, such as California, Texas and New South Wales, to say nothing of poorer areas in Africa and Asia. Droughts turn vegetation into tinder, feeding wildfires that sweep down on cities with relentless fury, overwhelming efforts at control.

The loss of snow-cover in the Himalayas may not at first appear an urban issue – but Himalayan snow provides the water-supply for hundreds of millions of people in cities along the Ganges and the Indus. Carbon dioxide from the fire of burning fuels, much of it in city buildings, industry and transport, is absorbed in the oceans. It turns seawater acidic, dissolving the shells of sea-creatures at the base of the entire oceanic food-chain, threatening a major source of protein and an essential component of urban food-supply worldwide.

Faced with such a battery of problems, some cities are breaking down, the lives of their citizens growing ever grimmer. Other cities, however, are fighting back. City governments have one crucial advantage: they are close to key problems. They can study them at first hand, right on their doorsteps, and work out how best to tackle them. Local problems may offer local solutions. An enlightened city government can get to grips with urban problems directly and in detail. It can enlist and support the active involvement of its citizens in programmes to address the problems, and in doing so to improve their own daily lives. The very density of cities, properly addressed, can be an advantage rather than a disadvantage. It can facilitate more efficient provision of food, water and energy services, and enable easier mobility between home, work and leisure.

Cities, moreover, may also hold the key to tackling the unprecedented global challenge of climate change. National governments have been wrangling since 1988 about how to meet this challenge. After a quarter-century of largely ineffectual negotiations, in December 2015 197 national governments at last came together in Paris to sign an agreement undertaking to limit atmospheric carbon dioxide emissions, to keep global temperature rise to below 2 degrees Celsius. But the national commitments thus far on offer will not meet this criterion. The process between national governments is encouraging, but much too slow. National government involvement, long on rhetoric but lacking actual action, still falls far short of meeting the climate challenge.

Many city governments, however, recognize that cities bear heavy responsibility for creating the global climate threat. Cities still rely on fire to make inadequate buildings habitable, to power urban industry and vehicular transport, and to generate much of the electricity for city lighting, motors, refrigeration and electronics. Enlightened city governments understand that both their local problems and the global

problems arise from the same cause. Fire, from burning fossil fuel, produces not only the emissions that poison local urban air, but also those perturbing global climate.

Much of this fuel-burning fire is wasteful and unnecessary, used to compensate for inefficient infrastructure and other inefficient hardware. Cities also rely too much on electricity generated with fire, burning coal or natural gas, or with the even more violent phenomenon of nuclear fission. Planners too often consider fire-based electricity cheap, even as the emissions from fire suffocate their citizens and upset the climate. Fortunately, however, cities and other electricity users now have another option - fire-free renewable electricity from wind, sunlight and moving water. Renewables are growing steadily and dramatically cheaper and more reliable, and their use is expanding rapidly in many parts of the world.

City governments acknowledge and welcome the opportunity this offers. Civic leadership can reduce the use of fire and fuel, by upgrading buildings and improving efficiency of other assets – passive measures with long-term value, eliminating wasteful supply. Civic leadership can also replace fire-based traditional electricity with fire-free renewable electricity. Such measures have fostered active and fruitful cooperation between city and other local governments around the world.

As far back as 1990, for example, local leaders created the Interna-tional Council for Local Environmental Initiatives, ICLEI, now known as Local Governments for Sustainability, drawing together upwards of 1500 cities, towns and regions. In 2004 three international organizations came together to found an umbrella group called United Cities and Local Governments, UCLG, now thought to be the largest local government organization in the world. In 2005, the mayors of some twenty megacities joined forces to work together at city level to combat the mounting threat of climate disruption. The network, originally designated C20, has since been renamed the C40 Cities Climate Leadership Group. Even that label is now a serious understatement, with more than 80 large cities, such as Beijing, Los Angeles and Mexico City, already affiliated. Every year the network surveys its members, to identify the powers that city governments have over water, energy, transport, waste management, urban measurement and planning, as well as finance and economic development. The network keeps a record of civic action plans and programmes to combat climate change, sharing information and technical expertise. It has already catalogued nearly 10 000 actions, with plans for continued expansion.

As the C40 website states: "City mayors are directly accountable to their constituents for their decisions, and are more nimble than state and national elected officials to take decisive action—often with immediate and impactful results. What our cities do individually and in unison to address climate change can set the agenda for communities and governments everywhere."

At the Paris conference in December 2015, under the aegis of ICLEI, C40 and UCLG, the mayor of Paris welcomed more than

1000 mayors and other local officials from five continents to a summit that closed with the "Paris City Hall Declaration". It pledged to "advance and exceed the expected goals of the 2015 Paris Agreement to be reached at COP21 to the full extent of our authorities," and to "support ambitious long-term climate goals such as a transition to 100% renewable energy in our communities, or a 80% greenhouse gas reduction by 2050". It asserted that cities can reduce greenhouse-gas emissions by up to 3.7 gigatons by 2030, equivalent to nearly a third of the difference between national commitments and the 2-degree Celsius threshold that stands as the current global goal.

Many of the requisite policies and measures are already in practical use in some leading cities. But they could be adopted much more widely, and implemented more effectively, accelerating the progress toward fully sustainable cities, including megacities. The example of Seoul, the Seoul Municipal Government led by Mayor Park Won Soon, and the vigorous and committed citizens of Seoul, can be a beacon for other megacities. The World Wide Fund for Nature (WWF) chose Seoul from among 167 contestants as its Global Earth Hour Capital 2015. Mayor Park, president of ICLEI and chair of the World Mayors Council on Climate Change, has been awarded the 2016 Gothenburg Prize for Sustainable Development. As described in detail in subsequent chapters of this book, the success of Seoul´s energy strategy, One Less Nuclear Plant Plan, renamed Seoul´s Sustainable Energy Action Plan, is a spectacular demonstration of how much a city can achieve, and how rapidly. We, the members of Mayor Park´s Seoul International Energy Advisory Council, are proud to be a part of it.

Yet Seoul is only one city among many. Working together, the world´s cities are on the march, toward a better, brighter future. The urban challenge is also an urban opportunity, not only for city dwellers around the world but for the planet we all share.

Ahn, Byung-ok
Head Director of Institute for Climate Change Action

Dr. Ahn, Byungok is the head of the Institute for Climate Change Action (ICCA), a nongovernmental organization providing research, analysis and commentary covering climate change and energy issues.

From 1991 to 2002 he has spent time in Germany and researched applied ecology at the University of Duisburg-Essen. After earning a Doctoral degree in Germany, he returned to Korea to join the Korea Federation for Environmental Movement (KFEM), the biggest environmental NGO in Asia with about 40,000 members. In 2007, he was selected as the Secretary General of KFEM and was involved in various environmental and societal issues in the country.

In 2010, he stayed in Japan for 2 months as a fellow of the Asia Leadership Fellow Program (ALFP) supported by Japan Foundation and International House of Japan. Recently, he provides theoretical and practical foundations for climate and energy policy for a sustainable future and lectures in diverse fora: universities, public policy workshops and training of civil society groups. Since 2012, He has worked as a co-chairman of the Executive Committee for One Less Nuclear Power Plant since 2012.

An Era of Transition, From Nations to Cities

Ahn, Byung-ok (Head, Institute for Climate Change Action)

In the history of civilization, the 21st century will be recorded as a special period of transition. That is because the world is transitioning rapidly from the age of fossil fuels to the age of renewable energy. The rate of change we are experiencing now is estimated to be several tens to hundreds of times faster than the transition from the Stone Age to the Bronze Age. The '100% Renewable Energy' society, relying only on renewable energy, was regarded as 'a pure imagination by those still believing that the earth is flat' until very recently. But now, '100% renewable energy' is the most attractive term referred to by not only environmental activists but also government representatives, heads of

local governments and corporate CEOs. What are the reasons that the age of 100% renewable energy is being accepted as a reality, not a dream?

First, the reality of the energy market has changed. The total investment in renewable energy in 2015 reached a record high of about US$286 billion worldwide. This is more than double the sum of investments made in coal and gas power generation combined in 2015.

According to the World Nuclear Industry Status Report in 2016, 2015 was a year of unexpected outcome for the nuclear industry in that ten new 9-gigawatt nuclear power plants started their operation amidst a prolonged recession. Nuclear energy generation was increased by 31 TWh between 2014 and 2015, while renewable energy production rose by 7 times more, or by 250TWh during the same period.

The 'BP Energy Outlook 2035' released recently by BP P.L.C. corroborates that the global energy mix is on a steady trend of decarbonization.

The report estimates that by the 2030s the demand for crude oil will increase in the plastic and textile industries, not in automobiles, trucks and aircraft.

This is a new trend, completely different from the past. Of course, coal and oil still dominate the energy market, and for the time being they will. But it is clear that there is no future for fossil fuels in the face of the catastrophic impacts of climate change. The Paris Agreement, which came into effect on November 4, 2016, would not have been possible without a shift in the pursuit of a low-carbon economy in a variety of areas including technology, finance and markets. In that sense, the Paris Agreement is a victory for both diplomacy and the market. Participation by dozens of global companies including Google, Microsoft, Siemens, IKEA and BMW in the '100% Renewable Energy Alliance' demonstrates that renewable energy and low carbon technologies have already emerged as a strong player in the global market.

Second, the rapid decline in renewable energy prices is also a factor in accelerating the era of 100% renewable energy. Prices of coal, oil and natural gas have virtually remained unchanged for the past 65 years, but PV equipment prices have shown a rapid decline. Recently, the economies of scale due to the construction of large-scale solar power plants are estimated to have led to an additional 20% drop in prices. On the other hand, the cost of nuclear energy and fossil fuels are increasing day by day, reflecting their actual social and environmental costs. Looking at the changes in power generation prices since the second half of 2014, onshore wind has fallen by 2.4% and solar power by 5.4% while gas and coal power have increased. The cost of nuclear power generation in the United States is three times that of wind, solar, and small hydro power. In Europe, the Middle East and Africa, coal-fired power generation costs are 15% higher than onshore wind power. It will not be long before solar and wind power generation will produce electricity at a cheaper price than all other modes of electricity generation anywhere in the world.

Third, the battery technology that can overcome the intermittency

of renewable energy is worth nothing. As solar and wind power are greatly affected by weather conditions, supply stability has been a stumbling block. In addition, in most cases, surplus power had to be discarded. However, the phenomenal development of the energy storage system (ESS) technology is changing the landscape of the energy market. Energy storage devices such as lithium batteries combine with renewable energy to open the way for the prevention of surplus power loss. As in the case of other products, this technology secures inventory and supplies electricity only when needed. Additionally, it cannot be overlooked that the development of information and communication technologies has reduced the social utility of centralized thermal power generation and nuclear power generation, and that distributed renewable energy more closely matches the needs of energy prosumers. Being able to overcome spatial limitations is another advantage unique to renewable energy. Most notably, photovoltaics can generate electricity in moving objects ranging from cars, airplanes, ships to even clothing, bags and watches worn by people. This is consistent with the technical characteristics of the Hyper-connected Society, in which people, objects, and data are all connected.

Both nuclear energy and climate change are representative risk factors that threaten the survival of human civilization. Nuclear energy can be compared to the sword of Damocles in Greek mythology. The reason is that the use of nuclear energy is unstable and dangerous like Damocles, seated under a sword that hangs by a single hair of a horse's tail without knowing when the weapon will fall off onto his head. Climate change resembles the life of Princess Cassandra of the Trojan Kingdom. Cassandra prophesied that Troy would be destroyed by Odysseus during the Trojan war if a huge horse left by the Greek army could be sneaked into the city. But she was believed by no one. Even her father King Priam thought that Cassandra had gone insane. Eventually, Troy fell and many were killed as she had predicted.

The disaster that occurred at the Fukushima nuclear power plant in Japan in 2011 proves that the hair that sustains the sword right above our heads could be cut off at any time. The "myth of safe nuclear energy" completely collapsed with an alarming understanding that a massive nuclear disaster transpired again within 25 years after the Chernobyl disaster. The prospect that the world before and after Fukushima will be different is becoming a reality in many parts of the world. Switzerland opened a ministerial meeting right away and decided to shut down all five of its reactors under operation by 2034. In Italy, a referendum was held three months after the Fukushima disaster, and up to 94 percent of participants voted against the government's plans to resume nuclear power generation.

Even France, which relies heavily on nuclear energy for about 77% (63GW) of its total electricity demand, made a shift in its energy policies. The French government has enacted the 'Law on Energy Transition for Green Growth' that aims to reduce the proportion of nuclear energy to 50% of the power generation mix and to increase the proportion of renewables to 32% by 2025.

Germany is the country that draws the most attention worldwide.

The country is carrying out an ambitious plan to shut down all 17 nuclear power plants by 2022, while maintaining its goal of reducing GHG emissions.

The 'Intergovernmental Panel on Climate Change (IPCC)' plays the part of prophet Cassandra. According to the 'Global Carbon Budget' presented by the 5th IPCC Report, accumulated GHG emissions must not exceed the threshold of one (1) trillion tons (790 billion tons of CO2) if the world wants to limit the rise of the average temperature of the globe to less than 2 degrees Celsius compared to that of the pre-Industrial Revolution era. Given that accumulated emissions are around 600 billion tons thus far, only about 400 billion tons of GHG (240 billion tons of carbon dioxide) can be emitted by humans if they want to avoid the catastrophe of climate change.

The Paris Agreement sets forth various long-term goals to be achieved in the second half of the 21st century, such as keeping the average global temperature rise far below the 2°C level, preferably up to 1.5°C where possible, compared to the pre-industrialization era, and striking a balance between the amount of anthropogenic GHG emissions and the amount of GHG emissions eliminated by sinks of greenhouse gases. To keep the global average temperature rise at below 2°C, global greenhouse gas emissions should be reduced by 40-70% compared to 2010 by 2050. Countries have submitted their emissions reduction goals in their respective 'Intended Nationally Determined Communications (INDCs).' When the figures in the documents are taken together, temperature rise by global warming is still expected to be between 2.7 to 3.7 degrees Celsius compared to the pre-industrial level, even if all parties achieve their targets. That is an improvement compared to the current emissions which are expected to raise the global temperature by 4 to 5 degrees Celsius. Yet it also means that there exists a significant gap between the aggregate of national targets proposed by countries and the worldwide goal of limiting the rise of global temperature between 1.5 to 2 degrees Celsius. Therefore, the parties to the Paris Agreement need to take bolder measures to reduce GHG emissions starting in 2025 or 2030.

That is why the role of cities worldwide is so important. The country-led response to climate change is destined to become a 'competition' rather than 'cooperation,' and 'burden sharing' rather than 'opportunity sharing.' This is attributable to historical and socioeconomic differences between countries, such as emissions, cumulative emissions, reduction abilities, ability to pay, and economic structure. Developing countries with a strong desire for economic growth through industrialization are more likely to accept the regulation of global greenhouse gas emissions as a "Kick away the ladder" strategy being employed by developed countries. Developed countries perceive inflows of low-priced products made in countries with loose GHG emissions regulations as a burden because they threaten their domestic businesses' price competitiveness.

By contrast, city networks serve as a buffer against national conflicts. There is competition among cities. Yet the way in which cities interact with each other is largely based on co-operation within

horizontal networks. On top of that, the city is a proper space to carry out experiments of diverse alternative energy systems that help overcome the risks of both nuclear energy and climate change. For this reason, the role of non-state actors, such as cities, is expected to become more important in the new climate regime that will be launched under the Paris Agreement. In fact, cities have implemented climate change response and energy conversion well before countries have. The point is well corroborated by the fact that thousands of cities worldwide have joined Local Governments for Sustainability (ICLEI), the C40 Climate Leadership Group (C40), United Cities and Local Governments (UCLG), and the Global Covenant of Mayors for Climate & Energy.

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Urban Energy System in the Changing World

Allan Jones

President of International Energy Advisory Council

Allan is owner of Allan Jones Energy and Climate Change, an energy and climate change consultancy working both in the UK and overseas. Allan is also President/ Chair of the International Energy Advisory Council (IEAC) and a Member of the Seoul International Energy Advisory Council (SIEAC) advising the Seoul Metropolitan Government on its energy and climate change policies and strategies. The IEAC is a 'not for profit' company registered in the USA and provides independent advice to governments and other organisations who want to implement decisive steps towards a 100% renewable energy future. The IEAC's energy experts, analysts and consultants have collectively advised more than 200 governments and organisations in 27 countries as well as more than 50 international organisations.

The SIEAC provides expert advice to the Seoul Metropolitan Government on its 'One Less Nuclear Power Plant' plan which was initiated by the Mayor of Seoul following the Fukushima nuclear disaster in 2011. Phase 1 of the plan displaced 23 TWh of centralised energy generation (equivalent to the Wolsong Nuclear Power Plant - Units 1 and 2) through a combination of energy efficiency and decentralised energy, saved 14 TWh of oil and liquefied natural gas consumption and reduced greenhouse gas emissions by 6 million tonnes between 2012 and 2014. Phase 2 of the plan is currently under way and will generate economic benefits of KRW 1.5 trillion (USD 1.5 billion) and create 34,000 new green jobs. The programme of works includes 320 MW of solar PV, 230 MW of fuel cells, 12,000 buildings energy efficiency retrofits, 8 million LED lights and 150,000 members joining the City's car sharing scheme.

Allan was Chief Development Officer, Energy and Climate Change at the City of Sydney (2009-2014) and a Board member of Australia's National Climate Change Adaptation Research Facility (2010-2013). Prior to his Sydney appointment Allan was Chief Executive Officer of the London Climate Change Agency (2004-2008) and prior to that Woking Borough Council's Director of Thameswey Ltd in the UK.

Allan's role at the City was to deliver the City's Green Infrastructure Plan, including trigeneration, renewable energy, advanced waste treatment and decentralised water and major building energy efficiency retrofits, LED street lighting and solar PV projects on the City's own buildings and operations. During his appointment the City reduced Council's overall greenhouse gas emissions by 25% from 2009 to 2014 years as well as setting in place the green infrastructure to supply 100% of the City's local government area electricity, heating and cooling demands from renewable energy resources and to reduce greenhouse gas emissions by 70%, both by 2030.

The National Climate Change Adaptation Research Facility (NCCARF) was established with funding of $56.2 million and is based at Griffith University studying how Australia can adapt to the impacts of climate change such as more frequent and severe droughts, floods and sea level rise. NCCARF comprised Australian and Queensland Governments and 8 universities bringing together 5,500 practioners that led to over 150 research reports on every aspect of climate change adaptation.

During his time in London Allan set up and ran the London Climate Change Agency (LCCA) and contributed to the development of the energy and climate change

elements of the London Plan, Mayor's Climate Change Action Plan and the Mayor's Climate Change Statutory Duty as well as developing and implementing decentralised energy and renewable energy projects in London. Allan also established the London ESCO, a public/private joint venture energy services company between the LCCA and EDF Energy to catalyse the ESCO market in London.

During his time at Woking, Allan reduced CO2 emissions by 77.5% from 1990 levels to 2004 and undertook ground breaking work on energy and water efficiency, trigeneration and renewable decentralised energy systems, advanced waste treatment technologies, alternative fuels for transport and fuel cells. Under Allan, Woking installed 81 private wire decentralised energy systems, nearly 10% of the UK's total installed solar PV and the first fuel cell CHP in the UK. Allan was also instrumental in establishing Thameswey Ltd and Thameswey Energy Ltd, the Council's energy and environmental services company and energy services company, respectively.

Allan is a Fellow of the Institution of Engineering and Technology and was appointed a Member of the British Empire in 1999 for services to energy and water efficiency and was instrumental in Woking Borough Council gaining the Queen's Award for Enterprise: Sustainable Development 2001 in the development of Local Sustainable Community Energy Systems, the only local authority ever to receive a Queen's Award for Enterprise.

Urban Energy System in the Changing World

Allan Jones MBE (President of International Energy Advisory Council)

Introduction

The world's first public electricity supply was not powered by fossil fuels but by renewable energy in the Surrey town of Godalming in the UK. In 1881, Godalming Borough Council decided to replace the existing coal gas fuelled public lighting with a new form of energy called electricity. A small hydro-electric plant was installed on the nearby River Wey which supplied electricity to lighting in both the streets and houses of Godalming town centre.

This was followed by Edison, who in 1882 opened the world's

first steam powered electricity generating station at Holborn Viaduct in London, where he contracted with the City of London to provide street lighting. In time, Edison went on to supply other consumers with electric lighting.

Later in 1882, Edison opened the Pearl Street Power Station in New York City supplying consumers in the First District. Both the London and New York electricity systems were supplied with direct current (DC). Today, the Godalming, London and New York systems would be called decentralized energy where generation is close to energy demand.

However, by the end of the 1880's alternating current (AC) systems were introduced in Europe and the USA. This would go on to form the incumbent command and control centralized energy systems that we know today. Very large fossil fuel and nuclear energy power plants could be located many miles from energy demands in cities supplied by high voltage transmission and distribution networks. Centralized energy power stations are very inefficient losing two thirds of their generated energy into the atmosphere in the form of waste heat via huge cooling towers but this did not matter to the early energy entrepreneurs as electricity was king.

Later on, concern was voiced about the greenhouse gas and pollutant emissions from fossil fuel power stations, particularly from coal fired power plants, and their impact on climate change and human health and following the Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011) nuclear accidents/disasters safety concerns grew about nuclear power plants.

The energy industry business model also changed from the small municipal or consumer owned generation and consumption, called prosumer today, to large monolithic state or privately owned energy companies, either deriving revenue from what is perceived as 'back-door taxation' from state owned utilities or as dividends from privately owned utilities.

Although energy has been deregulated in most countries there has, in practice, been little competition between utilities and very little benefits passed on to the consumer. Electricity regulation has been designed to support and incentivize centralized energy and by default, disincentivize energy efficiency and decentralized energy.

However, since the 1990's there has been a progressive move away from the command and control centralized energy business model and towards new local municipal energy companies and individual or community owned local energy generation business models where energy efficiency plays a much bigger role than in the incumbent centralized energy system.

With concern about climate change and local pollution and the availability of small scale clean generation technologies at economic cost we are now seeing the rise of the prosumer which will have profound impacts on the centralized energy business model similar to the impact of the digital revolution.

This section sets out a number of examples of urban energy policy where cities and other urban areas have adopted and implemented

innovative and sometimes extraordinary measures to tackle climate change and gain energy independence from the grid.

Woking, UK

Background

Woking is a large town in Surrey, England located 37km south-west of central London. The local authority, Woking Borough Council, serves a population of nearly 100,000. The original Woking, today known as Old Woking, dates back to the 8thcentury and was recorded in the Doomsday Book in 1086 with one of the owners as King William the Conqueror.

With the coming of the railway from London to the south coast and south-west of England in 1838, modern Woking was built between the Basingstoke Canal and Woking Railway Station becoming the new centre of population rather than Old Woking. Today, the Borough comprises Woking town centre and a number of villages. Woking claims a number of firsts: the first crematorium, the first mosque and one of the first public electricity supplies in the UK, all in 1889. IBM UK, Formula One motor manufacturer McLaren and WWF also have their headquarters in Woking. However, Woking's claim to fame today is its achievements in decentralized energy and tackling climate change.

The Council is recognised as the most energy efficient local authority in the UK and gained the Queen's Award for Enterprise: Sustainable Development 2001 in the development of Local Sustainable Community Energy Systems, the only local authority ever to receive a Queen's Award for Enterprise. How did this happen?

Energy Efficiency Policy

In 1990, the Council adopted an Energy Efficiency Policy which was the catalyst for all that Woking has since achieved. Following the adoption of the Policy the Council implemented a series of sustainable energy projects from 1990 to 2004, including the UK's first trigeneration project, first local authority private wire residential decentralized energy systems, largest domestic solar PV/cogeneration installations, first stationary fuel cell system and first public/private joint venture Energy Services Company (ESCO). The initial target was to reduce energy consumption by 20% from 1990 to 1995 but was achieved one year early so the Council increased the target to a 40% reduction in energy consumption by 2000.

Woking Borough Council Achievements to March 2007

Reduction in energy consumption	51%
Reduction in water consumption	44%
Reduction in CO2e emissions	80%
Supply from decentralized energy	98%
Energy efficiency improvement of the Borough's housing stock	33%

Source: Woking Borough Council (2008)

With the surpassing of its energy and climate change targets in 2000 the Council began to prioritise the reduction of greenhouse gas emissions in the Borough's private sector housing and commercial building stock as well as transport. Although the Council had implemented energy efficiency in private sector housing stock as part of its tackling fuel poverty programs and connected private sector buildings to its decentralized energy networks a more comprehensive climate change framework for the whole of the Borough was needed, particularly for new development.

Private Wire Decentralized Energy Networks

A key feature of the Woking decentralized energy system was private wire networks that enabled electricity to be supplied at a lower price than grid electricity. More than 80 private wire networks were installed taking advantage of the exempt licensing regime in the UK which enabled the Council to generate, distribute and supply electricity directly to itself and to other consumers over private wire networks. However, although the exempt licensing regime removed the regulatory barriers to generating and supplying electricity to non-domestic consumers it limited the generation and supply of electricity to domestic consumers to 1MWe (about 1,000 households) per generation site. This regulatory barrier was overcome in Woking by ensuring that no more than 1,000 households were connected to each of the cogeneration, trigeneration or renewable energy sites. Hence, the large number of private wire decentralized energy networks in Woking.

All decentralized energy systems are interconnected to the local public wires distribution network and incorporates thermal storage and back-up gas fired boilers to provide continuous electricity, heating and cooling services.

The mechanism that was employed to trade electricity to the Council and other consumers was an enabling agreement for exempt supplier operation developed jointly with the region's public wires distribution network operator. The agreement brought together all decentralised energy sites into a common local electricity trading system balancing imports and exports between the sites across the local public wires distribution network. In other words, any standby and top up electricity required by one generating site or group of generating sites was supplied by surplus electricity exports from another generating site or group of generating sites instead of each generating site operating in isolation to other generation sites with their own individual standby and top up and export agreements.

For example, this enabled the Woking Town Centre trigeneration stations to be switched off at midnight but still able to supply heat fired absorption cooling to nightclubs operating until the early hours of the morning from thermal storage whose heat had been generated and stored from electricity generated earlier in the day. Electricity supplied to Woking Town Centre overnight came from surplus electricity generated in the Council's leisure and swimming pool complexes where thermal energy was required to maintain the thermal energy and humidity balance of the buildings but much less electricity was

required during closing hours. Similar reverse energy profiles were matched across the Borough through the selection of different energy generating plant and energy demand profiles to minimize or eliminate the import of electricity from or export to the national grid. Additional targeted energy efficiency measures were also implemented to achieve the right energy balance.

The House of Lords Science and Technology Committee Inquiry into the Practicalities of Renewable Energy identified the principle of the Energy[1] after its visit to view the Woking decentralised energy system in 2004. In other words, the private wire networks were considered to be the LANs and the local public wires distribution network was considered to be the WAN.

Thameswey

In 1999, the Council established a wholly owned energy and environmental services company called Thameswey Ltd which in turn established a public/private joint venture energy services company with a Danish energy company in 2000 called Thameswey Energy Ltd. Thameswey Energy Ltd enabled the Council to take forward the innovative and unique decentralized energy services concept that the Council had so successfully employed over the previous 10 years at a small-scale level using local authority finance to a large-scale level using primarily private finance. The Council owns the intellectual property in Thameswey and the Thameswey registered trademarks. Thameswey Energy Ltd designs, finances, builds and operates large scale decentralized energy schemes which enabled the Council to increase its decentralized energy generation capacity by 800% from 2000 to 2004.

Thameswey Ltd is the Council's holding company which has enabled the Council to operate outside the Council's local government area and to develop further companies, including Thameswey Solar Ltd to implement solar energy throughout the Borough, Thameswey Housing Ltd to provide affordable housing throughout the Borough and Thameswey Central Milton Keynes Ltd which supplies Milton Keynes (population 256,000) central business district via a decentralized energy network.

Climate Change Policies

In 2002, the Council adopted a Climate Change Strategy to reduce greenhouse gas emissions for the whole of the Borough by 60% from 1990 to 2050 and by 80% from 1990 by 2080. Key features of the Strategy was climate change adaptation and a new 'environmental footprint' target for new development and land use which set the objective to reduce greenhouse gas emissions by 80% compared to the previous land use in 1990. For example, if the previous land use was a factory and was to be replaced by housing the emissions of the new housing had to 80% less than the emissions of the factory. For a greenfield site the emissions would have to be reduced by 100% as the

1 *Internet House of Lords Science and Technology Committee Inquiry into Renewable Energy: Practicalities Volume 1 Report 1 Appendix 11*

previous land use would be deemed to be zero emissions.

In 2015, the Council adopted Woking 2050 to replace its Climate Change Strategy as the Council's new climate change and sustainability strategy. A key change with the new strategy was to reduce greenhouse gas emissions by 80% from 1990 to 2050. By 2013, Woking's emissions for the whole of the Borough had been reduced by 36% from 1990 levels.

London, UK

Background

The Greater London Authority (GLA) consists of a directly elected Mayor of London and an elected 25-member London Assembly with scrutiny powers. It shares local government powers with 32 London Boroughs and the City of London Corporation. The GLA Functional Bodies comprise Transport for London (TfL), Mayor's Office for Policing and Crime, London Fire and Emergency Planning Authority and GLA Land and Property, an arms-length company which replaced the London Development Agency (LDA) in 2012. In addition, the London Legacy Development Corporation was established in 2012 to replace the Olympic Park Legacy Company.

With a population of around 8.7 million people London's energy consumption is responsible for around 40 million tonnes of greenhouse gas emissions a year. London is a growing city and its population is predicted to increase to 9.4 million people by 2021. This growth represents both a challenge and an opportunity to transform the way the city works and ensure it moves to a low carbon development path. London, as a large and wealthy world city, has taken the commitment to lead and show by example in taking action to avert catastrophic climate change. Key drivers to achieve this ambitious objective are political leadership and effective partnerships on the ground. Successive Mayors of London have made addressing the causes of climate change one of their main priorities of London strategies and have set ambitious targets and policies for both mitigating and adapting to climate change.

Congestion Charge and Low Emission Zone

The road transport sector in London accounts for around 20% of greenhouse gas emissions, 50% of nitrous oxides (NOx) emissions and 66% of particulates (PM10), London also has one of the worst traffic congestion and is amongst the worst polluted cities in Europe with over 1,000 premature deaths a year due to poor air quality. Tackling road transport congestion and pollution is therefore a priority policy area for the Mayor of London.

Introduced in 2002, the Congestion Charge is currently £11.50 ($US14.85) per day within the charge zone which covers the area within the London Inner Ring Road (City of London and Westminster). Registered vehicles which emit 75g/km or less of carbon dioxide (CO2) and meet the Euro 5 standards for air quality, all-electric cars and some plug-

in hybrids are exempt from the Congestion Charge which has seen an increase in the number of such vehicles. In the first year of operation traffic was reduced by 25% and traffic CO2 emissions was reduced by 16.4% with NOx) and PM10 emissions reduced by 13.4% and 15.5%, respectively, in the charge zone. The original exemption for internal combustion only vehicles was 100g/km but was replaced by the new CO2 emissions and Euro 5 air quality standard in 2013 to curb the growing problem of diesel vehicles. To date, there are no internal combustion-only vehicles that meet the new standard and NOx and PM10 emissions have been reduced by 17.3% and 23.8%, respectively.

The Congestion Charge scheme cost £163 million ($US210 million) to build and £115 million ($US150 million) a year to operate. Net revenues to TfL is currently £172.5 million ($US225 million) a year (2014/15). Annual profits are reinvested into the public transport network, primarily on low emission buses. TfL currently has 1,700 hybrid buses, 50 all-electric buses and 8 hydrogen fuel buses in service (2016). TfL is also replacing fossil fuel diesel with biodiesel derived from London's waste fats and oils with almost 3,000 renewably fuelled buses in operation (2016) which reduces 21,000 tonnes of CO2 emissions a year in addition to the reduction of 48,000 tonnes of CO2 emissions a year as a result of the introduction low emission buses such as hybrids. By 2020, all double deck buses operating in central London will be hybrid and all single deck buses will be zero emission (at point of use). This strategy will reduce NOx emissions by 95% by 2020.

Introduced in 2008, the Low Emission Zone covers most of Greater London within the M25 motorway. Diesel heavy goods vehicles (HGV's), coaches and buses that do not meet European emission standards relating to PM10 are charged £200 ($US260) per day and non-compliant heavy light goods vehicles (LGV's) are charged £100 ($US130) per day.

Plans are currently under way to place further curbs on diesel vehicles to improve air quality in the Congestion Charge zone with the introduction of the Ultra-Low Emission Zone (ULEZ) in 2020. All cars, motorcycles, vans, minibuses, buses, coaches and HGV's will need to meet new exhaust emissions standards or pay a daily charge. The daily charge for non-compliant vehicles will be £130 ($US170) for motorcycles, cars, vans and minibuses and £1,000 ($US1,300) for HGV's, coaches and buses. The ULEZ daily charges are in addition to the Congestion and Low Emission Zone charges.

London Plan

The London Plan is the statutory spatial development strategy for the Greater London area that is written by the Mayor of London and published by the GLA. The regional planning document was first published in 2004, substantially revised and republished in 2008 and again in 2011 with minor alterations in 2016. The London Plan 2016 is currently in effect until 2031.

Chapter 5 of the London Plan covers London's response to climate change in which the Mayor is committed to making London a world leader in tackling climate change with policies that will support

the delivery of the Mayor's vision for London and the objectives set out in the London Plan. In particular, that London should be a city that becomes a world leader in improving the environment locally and globally, taking the lead in tackling climate change, reducing pollution, developing a low carbon economy and consuming fewer resources and using them more effectively.

An energy assessment is required for each planning application referred to the Mayor, setting out how the London Plan climate change mitigation and energy policies will be met within the development. Specifically, applicants are required to set out how the planning applications apply the energy hierarchy. The GLA measures the success of its London Plan policies through regular monitoring reports.

Key Energy and Climate Change Policies in the London Plan

1. Reduce London's CO2 emissions by 60% below 1990 levels by 2025
2. Planning decisions based on the following energy hierarchy:
   - Be lean: use less energy
   - Be clean: supply energy efficiently
   - Be green: use renewable energy
3. Sustainable design and construction
4. Retrofitting
5. Decentralized energy networks: 25% of London's heat and power to be generated by decentralized energy systems by 2025
6. Decentralized energy in development proposals in accordance with the following hierarchy:
   - Connection to existing heating and cooling networks
   - Site wide cogeneration/trigeneration network
   - Communal heating and cooling
7. Renewable energy: A 20% reduction in CO2 emissions through the use of on-site renewable energy generation
8. Innovative energy technologies:
   - Uptake of electric and hydrogen fuel cell vehicles
   - Hydrogen supply and distribution infrastructure
   - Uptake of advanced waste conversion technologies such as anaerobic digestion, gasification and pyrolysis
9. Reduce the impact of the urban heat island effect
10. Urban greening
11. Green roofs and walls
12. Flood risk management
13. Water use and supplies
14. Waste net self-sufficiency by 2026

Source: Greater London Authority (2016)

Monitoring the London Plan Climate Change Mitigation and Energy Policies

Year	2010	2011	2012	2013
Stage II planning applications	112	118	171	174
Number of dwellings in development	28,181	32,051	55,879	43,178
Estimated domestic floor area (million m^2)	2.0	2.2	3.9	3.0
Non-domestic floor area (million m^2)	2.2	1.5	2.3	2.3
CO_2 emission reductions compared to 2010 Building Regulations (percent)	33	33	36	36
CO_2 emission reductions compared to 2010 Building Regulations (tonnes pa)	35,598	41,136	59,817	49,474
Dwellings connected to heat networks	27,000	31,000	53,000	41,097
Proposed cogeneration capacity (MWe)	28	17	29	25
Solar PV panels (m^2)	22,500	49,000	87,000	71,354

Source: Greater London Authority (2014)

For 2013, the London Plan monitoring reports shows that around £17 million ($US25 million) of investment in cogeneration, £103 million ($US135 million) of investment in heat network infrastructure supplying 41,000 homes and £13 million ($US17.5 million) of investment in solar PV and other renewable energy technologies had been made, achieving a 36% reduction in CO2 emissions over and above the UK Building Regulations requirements. Over the 4 year period more than 150,000 new dwellings were connected to district heating networks, around 100MWe of cogeneration was installed and 230,000 m^2 of solar PV had been installed due to the London Plan policies.

Mayor's Energy Strategy

The Mayor's Energy Strategy was published at the same time as the London Plan 2004. Although the Strategy was non-statutory it did assist planners and developers in determining compliance with the London Plan 2004.

For renewable energy, the Strategy did not require a specific target for each development but a London target to generate at least 665GWh of electricity and 280GWh of heat, from up to 40,000 renewable energy schemes by 2010 and set specific targets for particular renewable energy technologies. In practice, GLA planners negotiated around the 'Merton Rule' of 10% of the development's energy needs being met from on-site renewable energy.

For cogeneration, the Strategy adopted a target to double London's 2000 cogeneration capacity by 2010.

For climate change, the Strategy adopted a target to reduce CO2 emissions by 60% below 2000 levels by 2050.

The Strategy also introduced the concept of energy services and Energy Services Companies (ESCO's) to help deliver these targets. Woking Borough Council was an active consultee on the draft Strategy and examples of the work of Woking and Thameswey are detailed in the Strategy.

London Climate Change Agency

As part of the Mayor's 2004 election manifesto was a commitment to establish a climate change agency for London. There was a

recognition that although the Mayor had implemented robust policies and strategies on decentralised energy and climate change, which would be further developed during his second term in office, delivery of these policies and strategies remained at risk without a body to stimulate, develop, enable and/or deliver projects on the ground.

In particular, there was no engineering or climate change technical resource to advise and work with the GLA Group, London Boroughs, property developers/owners and consultants to help deliver the Mayor's targets. In addition, there was also market failure in that there were no ESCO's operating in London to design, finance, build and operate decentralised energy systems which were long-term projects, typically financed and operated over 25 to 35 years.

Following his re-election, the Mayor of London established the London Climate Change Agency (LCCA) in 2006 to transform London into a leading low carbon sustainable city. The LCCA was established as a municipal company to develop and implement projects in the sectors that impact on climate change, especially in the energy, water, waste and transport sectors.

LCCA Projects

1. Centre of Climate Change and Engineering Excellence
2. Policy and Strategy – Mayoral, central government and Stern Review
3. Demonstration Projects:
    - London Transport Museum Solar PV Roof
    - City Hall Solar PV Roof
    - Palestra and Wind Turbines
4. Better Buildings Partnership
5. Green Concierge Scheme Pilot
6. Renewable Gases and Liquid Fuels
7. LDA Development Projects Climate Change Advice and Support
8. Thames Barrage Renewable Energy/Flood Prevention Study
9. LED Lighting
10. South Kensington Carbon Reductions Project
11. Energy Efficiency Revolving Fund
12. Macro Decentralized Energy and Low Carbon Zones Development
13. Removal of the Regulatory Barriers to Decentralized Energy
14. London ESCO

Source: London Climate Change Agency (2008)

London ESCO

The LCCA procured a private sector partner for the London ESCO via a competitive negotiated procedure tendering process. Nine major energy and utility companies tendered for this, including two international oil companies and a large US energy services company. EDF Energy plc won the tender and the London ESCO Ltd was established in 2006.

The London ESCO was established as a public/private joint venture ESCO between the LCCA Ltd (19% shareholding) and EDF Energy (Projects) Ltd (81% shareholding) to design, finance, build and operate local decentralised energy systems for both new and existing development. Investment in ESCO projects is in the same shareholding proportions but because of the 20% equity, 80% loan project finance formula the LCCA's equity investment is always covered by the LCCA's share of the project fee, however large the ESCO project is.

The London ESCO project portfolio covered around 50 potential short, medium and long term decentralised energy projects with an investment value of £200 million ($US260 million) in projects reducing CO2 emissions by 310,000 tonnes a year. The decentralised energy and energy services markets were catalysed by the establishment of the London ESCO which saw the ESCO market in London increasing from having no ESCO players in 2006 to having twelve ESCO players in 2007.

London's 25% Decentralised Energy (DE) by 2025 Target

DE installed by 2008	205MWe
DE under construction from 2008	63MWe
DE new development consented to 2017	349MWe
DE further capacity required from decentralised energy	583MWe
Total	1,200MWe

Mayor's Climate Change Action Plan

The Mayor's Climate Change Action Plan was published in 2007 following a detailed analysis of London's greenhouse gas emissions and the action that would be required to avoid catastrophic climate change. This implies a target of stabilising London and UK emissions at 60% below 1990 levels by 2025. However, 50% of this target was dependant on additional action by central government such as action on aviation, carbon taxes and the removal of the regulatory barriers to decentralised energy.

In order to deliver this target, the Action Plan set out the actions that would be needed to tackle London's CO_2 emissions in the following sectors:

- Emissions from existing homes
- Emissions from existing commercial and municipal activity
- Emissions from new build and development
- Emissions from energy supply
- Emissions from ground transport
- Emissions from aviation

In addition, the Mayoral Group was also required to reduce its emissions of around 226,000 tonnes of CO_2 a year, 0.5% of London's total emissions, through its own direct activity on the 'show by doing' principle as the Mayor cannot expect others to reduce emissions if the Mayoral Group does not aggressively reduce its own emissions.

Of the sector emissions energy supply is by far the biggest. In 2007, London's centralised energy caused emissions of 35 million tonnes of CO_2 a year, 75% of London's emissions. This is set to increase by 15% by 2025 (compared to 2006 under the business as usual scenario. Hence, the importance of the LCCA developing the decentralised energy and ESCO markets.

Climate Change Mitigation and Energy Strategy

Under the GLA Act 2007 the Mayor is now subject to a statutory duty to address climate change and issue a climate change mitigation and energy strategy and an adaptation to climate change strategy. The new climate change duty was sought and obtained from central government by the first Mayor of London and made law in May 2008. This was the first time that any politician in the world had a statutory duty to tackle climate change.

The Mayor's Climate Change Mitigation and Energy Strategy was published in 2011 and focuses on reducing CO_2 emissions to mitigate climate change, securing a low carbon energy supply for London, and moving London to a thriving low carbon capital. The scale of the challenge that London faces in reducing CO_2 emissions is significant, but achievable. In 2008, London emitted 44.71MtCO_2, which is 8.5% of the UK's total CO_2 emissions. This is approximately equal to London's CO_2 emissions in 1990, having fallen from a peak in 2000 when the GLA was established. Nearly 80% of CO_2 emissions originate from energy supply to, and energy use in, buildings and transport accounts for 22% of London's CO_2 emissions.

The Mayor's CO_2 Emissions Reduction Targets in London

Target Year	Target CO_2 Emissions Reduction on 1990 Levels
2015	20%
2020	40%
2025	60%
2050	80%

Source: Greater London Authority (2011)

Better Buildings Partnership

In 2008, the LCCA established the London Better Buildings Partnership (BBP) as a not for profit company limited by guarantee between the LCCA and 20 landlords who owned 60% of London's commercial property and were responsible for 33% of London's greenhouse gas emissions. Membership of the BBP currently comprises 27 major property owners including the Crown Estate.

The principle behind the BBP was to identify and target major landlords to adopt the same targets and actions as the Mayor of London. Major landlords are in competition with each other in attracting and retaining anchor tenants and they cannot afford for their competitors to gain an advantage over them. Energy ratings such as Energy Disclosure and Green Star ratings are used to differentiate the energy and environmental ratings between buildings and therefore incentivize tenants to occupy the highest rated buildings since their energy and water costs will be lower.

The number of landlords targeted was the point where the number of properties owned by landlords started to taper off into smaller number of properties owned by many smaller landlords. In this way, resources could be more effectively applied to a smaller number of very large landlords who collectively were responsible for a significant proportion of London's emissions and who also had a vested interest in competing with other major landlords to attract and retain anchor tenants who wanted to occupy low carbon buildings and therefore, avoid the costs of voids or empty properties.

Licence-Lite

As a national regulatory instrument the exempt licence regime was also available to London. However, although the exempt licence supply regime worked well for non-residential buildings and residential buildings for Woking with a population of nearly 100,000 by ensuring that no more than 1,000 households were connected to each decentralised energy system this was not really practical for a metropolitan city like London with a population of 8.7 million.

Following lobbying by the LCCA the Government published a call for evidence for the review of barriers and incentives to distributed electricity generation in 2006. The LCCA's submission[2]

to the Distributed Energy Review included detailed evidence of regulatory market failure which showed that decentralised energy was economically penalised by electricity regulation. This resulted in the establishment of the Government's Distributed Energy Working Group to remove the barriers to distributed energy that may exist within the electricity market and the electricity licensing arrangements. The LCCA was appointed a member of the Working Group.

The Working Group's work culminated in the concept of 'virtual private wire'over public wire networks and the recognition that what was needed to remove the regulatory barrier was a new'stripped down'supply licence to operate over the public wires distribution network rather than the transmission network where most of the costs and barriers to distributed energy existed.

Any imports or exports traded with the national grid would be grandfathered, ie, managed by parties to the grid balancing and settlement agreement. In other words, the existing licensed utilities would contract with the decentralised energy generators similar to the enabling agreement for exempt supplier operation developed in Woking. The new 'stripped down' licence was enacted by the Electricity Supply Licence Modification 2009.

Following the enactment of the new Electricity Supply Licence Modification the Mayor through the GLA obtained a 'stripped down' electricity licence from the regulator (called Licence-Lite) and procured by competitive tender the third party licensed electricity supplier to act as the grandfather for the London scheme. A tender process for the Licence-Lite generating capacity was also undertaken by the Mayor. The intent of the London scheme is to aggregate decentralised energy

2 *London Climate Change Agency Submission to the Ofgem Distributed Energy Review 2007*

in the London Boroughs, government buildings, other public sector and private sector to supply selected commercial and public sector consumers in London. Licence-Lite increases the financial value of decentralised electricity generation by 30% which incentivizes more decentralised energy. Phase 2 of Licence-Lite will include residential electricity generation and supply, thereby creating a separate electricity market for decentralised energy in London.

Energy for Londoners

As part of the new Mayor's 2016 election manifesto was a commitment to establish 'Energy for Londoners', a not-for-profit company to provide a comprehensive range of energy services to help Londoners generate more low carbon energy and increase their energy efficiency, support local and community energy enterprises, and buy clean energy generated across the city, using it to power GLA and TfL facilities.

Sydney, Australia

Background

Sydney was the first European settlement in Australia with the arrival of the First Fleet in 1788. The City of Sydney was established in 1842 and today, is the local government area (LGA) covering the Sydney central business district and surrounding inner city suburbs of the greater metropolitan area of Sydney, New South Wales. The Lord Mayor is directly elected while the nine other Councillors are elected by the proportional voting method. The current Lord Mayor has been in office since 2004.

The City of Sydney is the state capital of New South Wales. Sydney is Australia's global city and international gateway with world-renowned tourist attractions and sustained investment in cultural infrastructure and facilities. The City of Sydney is also the nation's economic powerhouse representing around 25% of New South Wales gross domestic product (GDP) and around 8% of Australia's GDP. However, the City is also recognised as the nation's leading environmental performer and one of the world leaders in tackling climate change.

Sustainable Sydney 2030

Sustainable Sydney 2030 is the vision and strategic plan for the City of Sydney to make Sydney a green, global and connected city by 2030. The full spectrum of interested individuals and groups were consulted on Sustainable Sydney 2030 over a period of 18 months making it the most extensive engagement process in the City's history. Of key significance to energy and climate change was that 90% of respondents wanted urgent action on climate change. Sustainable Sydney 2030 was adopted by Council in 2008 and provided the mandate for the Lord Mayor and Council to deliver the 10 targets to make Sydney more sustainable by 2030.

Key Energy and Climate Change Targets in Sustainable Sydney 2030

1	The City will reduce greenhouse gas emissions by 70% below 2006 levels by 2030
2	The City will meet 100% of electricity demand by local generation
3	The use of public transport for travel to work will increase to 80% by 2030
4	At least 10% of City trips will be made by bicycle and 50% by walking by 2030

Source: City of Sydney (2008)

As 80% of Sydney's greenhouse gas emissions come from coal fired power plants the 70% reduction in greenhouse gas emissions could not be delivered without replacing coal fired centralized energy generation with low or zero carbon decentralized energy generation. Therefore, the 100% local electricity demand would need to be met principally by decentralized energy - 70% from trigeneration and 30% from renewable electricity generation by 2030.

Green Infrastructure Plan

A key objective in Sustainable Sydney 2030 was to prepare a Green Infrastructure Plan. Central to achieving this was the objective was to develop a Green Infrastructure Plan comprising five Master Plans as follows:

- Decentralized Energy Master Plan : Trigeneration;
- Decentralized Energy Master Plan : Renewable Energy;
- Decentralized Energy Master Plan : Advanced Waste Treatment;
- Decentralized Water Master Plan; and
- Energy Efficiency Master Plan

In addition, a Climate Change Adaptation Strategy would support and take into account the Green Infrastructure Plan as climate change mitigation and adaptation should be integrated holistically since the green infrastructure that a city needs to function must also be resilient and adaptable to climate change.

Trigeneration Master Plan

Based on the energy efficiency target in Sustainable Sydney 2030 the Trigeneration Master Plan was the first decentralised energy master plan to be developed and adopted by the City in 2013. The reason for this is that city energy demands are very high in relation to their geographical area and for a city like Sydney those energy demands have very high air conditioning or cooling demands, particularly in summer. The Trigeneration Master Plan forecast what the energy demands would be by 2030 on a 'business as usual' basis to ensure that the Master Plan adopted catered for the 2030 energy demand.

The Trigeneration Master Plan broke the city down into energy demand layers and geographical areas to determine the heating and hot water demands and how much of the electric cooling demands could be converted to heat fired absorption cooling demand. This would have the double benefit of significantly reducing electricity

consumption and peak power by switching from electric cooling to thermal cooling. This in turn enabled more local electricity generation from the need for additional waste heat to supply both heating and cooling demands. The Master Plan was then developed into Low Carbon Zones for energy dense inner city areas, hot spots outside the inner city areas (eg, university campuses, etc) and the remainder of the city which would be mainly low rise suburban areas where domestic energy systems would be more appropriate.

The Trigeneration Master Plan showed that 70% of the City's electricity demands and 100% of the City's heating and cooling demands could be met by trigeneration and reduce the City's GHG emissions by 31.9%.

Although the initial fuel for the trigeneration network would be natural gas to enable the economic development of the heating and cooling network infrastructure the City resolved in 2012 that by 2030 renewable gases from waste and other renewable energy resources would replace fossil fuel natural gas in the trigeneration systems enabling them to provide carbon free electricity as well as carbon free heating and cooling. The renewable gas resources necessary to deliver this outcome would be included in the Renewable Energy Master Plan.

Renewable Energy Master Plan

The Renewable Energy Master Plan was the second decentralized energy master plan to be developed and adopted by the City in 2013. The Renewable Energy Master Plan established that no more than 18.2% of the city's electricity demand could be met by renewable electricity generation, primarily solar PV. The reason for this is that cities have very high energy demands and tall buildings whose roofs are small in comparison to the number of energy consuming floors, small geographical area in relation to the city's energy demands and over-shadowing is more of an issue in cities.

Therefore, the City needed to make up the balance of the 30% renewable electricity generation required from outside the city. However, the City did not want to include renewable electricity generation from Queensland or Victoria or even outback New South Wales whose electricity could never reach Sydney so the City developed a proximity principle that would only include renewable electricity generation within 250km of the city. In practice, enough renewable electricity generation could be sourced within 100-150km of the city to more than make up the 30% renewable electricity generation target. This would also avoid or minimize the very high cost of grid upgrades or reinforcements.

The second stage of the Renewable Energy Master Plan was to identify renewable gas resources derived from waste both inside and within 250km of Sydney. The renewable gas resources identified comprised virtually all forms of waste that are not otherwise recycled, such as from residential and commercial waste, sewage and landfill. Beyond the city, renewable gases can also be sourced from livestock manure, agricultural stubble and husks from crops or non-native

forestry off-cut waste. Energy crops and native woodlands were specifically excluded from the Master Plan to avoid any potential land use conflicts with food crops and destruction of native woodlands.

The only exceptions to this were oil Mallee crops which play an important role in long-term sustainable farming in low rainfall areas to decrease the salinity levels of the land and bushland fire hazard reduction materials to reduce the current fire hazard reduction burn-offs, with consequential air pollution and adverse health impacts, and the risk of accidental bushfires.

Producing renewable gas from bioenergy, either by anaerobic digestion or gasification, converting into a sustainable natural gas for injection into the gas grid for pipelining into the city enables typically 80% of the primary renewable energy resource to be recovered compared with typically only 20% for electricity only generation connected into the electricity grid. The renewable gas resources identified in the Master Plan are all within economic proximity to the gas grid.

The Renewable Energy Master Plan the City of Sydney identified that the total residual municipal solid waste (MSW) and commercial and industrial (C&I) waste resource available in New South Wales within 250 km of the City's LGA but excluding the City's LGA was around 3.7 million tonnes a year, forecast to grow to 4.6 million tonnes a year by 2030. This was more than enough renewable gas resource required by the City for both trigeneration and other gas uses. Advantages for other local authorities in utilising local advanced waste treatment and renewable gas grid injection plants to meet the City of Sydney's renewable gas demand would be the virtual elimination of non-recyclable waste going to landfill and the avoidance of the landfill levy which would save local authorities $177 million ($US135 million) a year and businesses $252 million ($US190 million) a year.

Advanced Waste Treatment Master Plan

The Advanced Waste Treatment (AWT) Master Plan was the third decentralized energy master plan to be developed and adopted by the City in 2014. The AWT Master Plan was a subset of the Renewable Energy Master Plan for the renewable gas resources available from the MSW collected by the City and from the C&I waste collected by city business waste contractors. The AWT Master Plan also provided the environmental and financial data to build an advanced waste treatment facility for the City's own MSW and C&I waste.

The AWT Master Plan demonstrated that the diversion of MSW from landfill would increase from 61% in 2012 to 92% by 2030 and the diversion of C&I waste to landfill would increase from 49% in 2012 to 94% by 2030. Total recycling of MSW and C&I waste would therefore, increase from 52% in 2012 to 94% by 2030. This would reduce greenhouse gas emissions across the City's LGA by 7% below 2006 levels by 2030. The City and the City's LGA businesses would also save in the region of $3.9 million ($US3 million) and $18.7 million ($US14.25 million) a year, respectively, in the landfill levy. In addition, using advanced gasification as part of the advanced waste treatment

would produce more than enough renewable gas to supply the City of Sydney's own trigeneration and other gas uses.

The AWT Master Plan also included indicative financial analysis for a plasma gasification advanced waste treatment facility with renewable gas grid injection over its 35 year life based on two scenarios - one at 100,000 tonnes of waste a year and one at 150,000 tonnes a year, showed that both scenario facilities would be in profit by Year 9 with a slightly better profit for the 100,000 tonnes of waste a year scenario.

Delivering a 100% Renewable Energy Sydney by 2030

Decentralized Energy Master Plan	Electricity	Heating & Cooling	Gas	Reduction in GHG Emissions
Trigeneration	70%	100%	-	31.9%
Renewable Energy	30%	-	100%	37.5%
Advanced Waste Treatment	Inc. above	Inc. above	Inc. above	5.2%
Total Renewable Energy	100%	100%	100%	74.6%

Source: City of Sydney (2014)

Taken together, the Trigeneration, Renewable Energy and Advanced Waste Treatment Master Plans would enable 100% of the City's electricity, heating and cooling demands to be met by 100% renewable energy resources and reduce 2006 greenhouse gas (GHG) emissions by 74.6% by 2030.

Other Master Plans

The 2003-10 drought brought home the impacts of taking water for granted. With a rising population and growth in development it was predicted by Sydney Water that there would be at least a 30% shortage in water supply to Sydney by 2030. The Decentralized Water Plan adopted by the City in 2012 showed that the shortfall in water supply could be addressed by reducing water demand by 10% through a water efficiency program and by a recycled water network supplying 30% of Sydney's water demand. The Master Plan also showed that by displacing remote centralized energy power plants with local decentralized energy plants would reduce water demand from coal fired power plants cooling towers, equivalent to 22% of the City's LGA 2030 potable and non-potable water demand.

The Energy Efficiency Master Plan adopted by the City in 2015 showed that the 18% reduction in greenhouse gas emissions through energy efficiency measures target in Sustainable Sydney 2030 could be increased to a 33% reduction in greenhouse gas emissions target through an aggressive program of modern energy efficiency measures.

CitySwitch Green Office Program

In 2005, the City joined the CitySwitch Green Office and set up a support program for commercial tenants. Tenants have a critical role to play since they influence up to 50% of the energy use in commercial office buildings. The CitySwitch program is a partnership between local and state governments that supports office-based businesses

to significantly improve day-to-day energy and waste efficiency, reduce operational costs, create value for employees and foster their commitment to environmental sustainability.

The CitySwitch program also enabled the City to educate tenants and proselytise energy efficiency ratings and emissions reductions and the impact that tenants could have in incentivizing landlords to improve the energy efficiency of both the landlord's and tenanted parts of their buildings, particularly at new or renewal of or break clause lease contract points, to create the pressure for landlord action.

The Sydney CitySwitch Green Office currently comprising 106 tenancies occupying 19% of the city's office space have improved their NABERS rating from 3.8 to 4.1 from 2006 to 2014 and reduced greenhouse gas emissions by 58,400 tonnes pa.

Better Buildings Partnership

In 2011, the City established the Sydney Better Buildings Partnership (BBP) with 13 major landlords who own 50% of the city's commercial floor space. The BBP now has 16 members who collectively reduced greenhouse gas emissions in their property portfolio by 45% and reduced energy bills by $30 million ($US22.5 million) a year since 2006. The BBP programme of works led to a significant growth in energy efficiency, trigeneration, low-carbon heating and cooling networks, renewable energy, water efficiency, recycled water and waste minimi-sation.

Similar to the BBP in London the City identified where the number of properties owned by landlords started to taper off into smaller number of properties owned by many smaller landlords. For Sydney, this was 13 major landlords that the City needed to convince to join the BBP and adopt the same energy and climate change targets as the City using Energy Disclosure and NABERS energy ratings as the driver to improve the energy performance of their buildings.

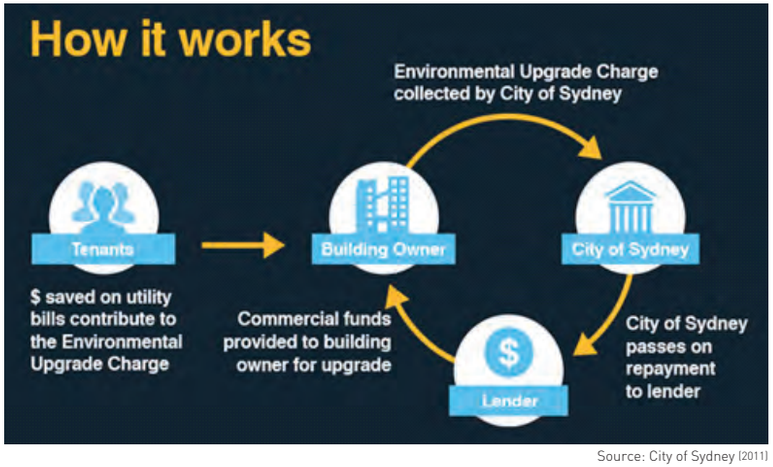
Environmental Upgrade Agreements

In 2011, the City introduced Environmental Upgrade Agreements (EUA's) in its LGA taking advantage of amendments to the New South Wales (NSW) Local Government Act 1993 to overcome the barriers to implementing energy efficiency and environmental upgrade works in commercial and multi-residential buildings.

The first barrier is access to capital for larger projects with longer term paybacks and the second barrier is the split incentive between landlords and tenants where if the landlord was to invest in projects in the tenanted part of the property the tenant would receive the financial savings, not the landlord. EUA's enable the establishment of an innovative financing mechanism through the EUA's to assist building owners to gain access to commercial finance at a lower cost and at the scale and in the timeframes needed to progress cost effective energy efficiency and environmental upgrade works. EUA's also overcome the split incentive between landlord and tenant as most leases provide for proportional pass-through of local council rates and charges which is used as the basis of the scheme.

The City worked with NSW Government to introduce EUA legislation[3] and the City was the first local authority to take advantage of this with a $26.5 million ($US20 million) trigeneration scheme serving phase 1 of the new Central Park development. To date 4 EUA's with a total value of $30.4 million ($US23 million) have been signed and a further 7 EUA's are currently being implemented or negotiated for energy efficiency works of the order of $2-3 million ($US1.5-2.25 million) each.

Environmental Upgrade Agreements



Source: City of Sydney (2011)

City of Sydney Projects

The City is implementing Sustainable Sydney 2030 at two levels – one at the local government area level and one at the City's own buildings and operations level. 'Show by doing' is an important principle since the City cannot expect others to do what it is not prepared to do itself on its own buildings and operations. Although the City had implemented a number of energy and climate change projects prior to 2008 it was important for the City to not only deliver the Sustainable Sydney 2030 energy and climate change targets for its own buildings and operations but also to deliver these targets at a more accelerated rate than its residents and businesses in the City's LGA to show environmental leadership.

In support of this approach the City decided to implement four major carbon reducing projects - Building Energy Efficiency Retrofits to 45 of the City's major buildings, LED Street Lighting to replace 6,448 street lights with LED's, Solar PV on 31 buildings and the Town Hall Precinct Trigeneration project.

City of Sydney Major Projects on its Own Buildings and Operations

Project	Energy Savings	Water Savings	Reduction in GHG Emissions
Building Energy & Water Efficiency Retrofits	15.5%	21.8%	15.0%
LED Street Lighting	5.5%	-	5.3%
Solar PV	3.0%	-	3.3%
Trigeneration	3.1%	-	3.0%
Total	27.1%	21.8%	26.6%

Source: City of Sydney (2016)

3 *New South Wales Government Environmental Upgrade Agreements*

The four major carbon reducing projects were installed from 2011 to 2016 and reduced greenhouse gas emissions by 26.6% below the City's carbon footprint in 2006.

Carbon Neutral Sydney

Following adoption of Sustainable Sydney 2030 the City adopted a strategy for carbon neutrality by first reducing emissions and then offsetting emissions. The strategy places reducing emissions through undertaking projects first and then offsets the remaining emissions so that each year the reduction in emissions through undertaking projects increases and the offsetting of emissions through carbon offsets reduces. From a standing start in 2008 it was important for the City to demonstrate that it was taking action against climate change, meeting public and staff expectations, showing leadership and reducing costs through energy savings.

Prior to 2008 the City offset its emissions by buying Green Power. However, this policy cost $2 million ($US1.5 million) a year and the City's total emissions was actually increasing up and until 2008. Green Power is very expensive, it does not reduce the City's emissions, it does not incentivize carbon reducing action on the ground and there are more cost effective carbon offsets available. Therefore, in 2010 the City resolved to replace the City's Green Power purchase contract with a Renewable Energy Fund of up to $2 million a year that was to be used for renewable energy projects on the City's own buildings and operations.

The City also resolved that the City's Renewable Energy Certificates were to be retired so that it was counted as additional renewable energy in Australia and not counted as part of the Federal Government's low renewable energy target. The City's remaining emissions was to be offset by more cost effective alternative accredited carbon offsets so that the City remained carbon neutral. The City's carbon offsets are procured by competitive tender each year. The City also resolved that its first renewable energy project would be a $2 million program of works to install solar PV on more than 30 of its buildings. The new renewable energy policy was made retrospective back to 2009.

Percentage of Emissions the City Offsets through Purchasing Carbon Neutral Credits

Total tCO_{2e}	2006	2007	2008	2009	2010	2011	2012	2013	2014
Green Power	8,163	41,901	43,569	0	0	0	0	0	0
Offsets	3,564	12,574	10,826	51,736	50,030	48,336	46,701	43,945	40,769
Totals	11,727	54,475	54,395	51,736	50,030	48,336	46,701	43,945	40,769
% of CO_{2e}	22%	100%	100%	100%	100%	100%	100%	100%	100%

Source: City of Sydney (2015)

The City's emissions in the table above comprise:

Scope 1: Gas, fleet fuel and so on.

Scope 2: Electricity emissions.

Scope 3: Emissions from flights, taxis, contractors fuel and events.

In 2008, the City of Sydney became the first local authority in Australia to be certified as carbon neutral under the National Carbon Offset Standard.

By 2016, the City had reduced its greenhouse gas emissions on its own buildings and operations by 27% and across the City's local government area by 19% below the 2006 baseline. Also in 2016, the City released its Environment Action Plan 2016-2021 which includes a plan that targets 50% renewable electricity through working with the City's business and resident groups to sponsor large scale renewable energy projects to supply the City of Sydney local government area.

Urban Community Renewable Energy

Community renewable energy has become the renewable energy phenomenon of the 21st century. In Denmark, nearly 50% of domestic electricity demand and 80% of thermal energy demand is owned by the customers themselves in one form or the other. In Germany, 88% renewable energy generation is owned by customers, either as individuals or as cooperatives. The rapid roll out of renewable energy in Germany is five times the installed nuclear capacity which will be completely phased out by 2022. Community renewable energy is one of the fastest growing markets in the USA with 27 states having legislation that allows community renewable energy schemes. For example, there are more than 1,500 wind farms owned by farmers, ranchers, landowners, consumer-owned utilities, school districts, universities and native tribes.

The various types of community renewable energy schemes comprise:

- Community Owned Renewable Energy
- Third Party Ownership
- Energy Services Model
- Landowner Pools
- Municipal Owned Renewable Energy
- State Shared Renewable Energy Programs
- Ecobonds

However, whilst it may be readily understood how community renewable energy works in rural areas it may not be readily understood how community renewable energy works in cities and other urban areas. The following examples set out the variety of innovations that were employed to implement community renewable energy in cities and other urban areas.

Copenhagen, Denmark

Around 150,000 households are co-owners of a local wind turbine. It was the ownership model rather than the tariff structure that led to the success of wind energy in Denmark. It was the key factor behind the high public acceptance that wind energy projects enjoyed and it enabled a much faster deployment, since large numbers of

people were involved in the sector that generated tremendous goodwill towards wind energy.

The Middelgrunden wind farm in Copenhagen Harbour became operational in 2000 and comprises twenty 2MW wind turbines with a hub height of 64 metres and a rotor diameter of 76 metres supplying 4% of the electricity requirements of Copenhagen. The offshore wind farm is 3.5km from Copenhagen harbour and highly visible from the 11th century city with its historic and modern buildings.

The Middelgrunden wind farm is 50% owned by the Copenhagen utility and 50% owned by a community cooperative with 8,650 members. Each cooperative share consists of 1,000kWh/year of electricity and was sold for 4,250 DKK ($US640). The number of shares sold was based on 50% of 81GWh/year with 90% of 89GWh/year guaranteed production providing a rate of return of 7.5% after depreciation.

Poundbury, UK

The Poundbury renewable gas grid injection plant is owned and operated by JV Energen, a joint venture between local farmers and the Duchy of Cornwall established to provide a renewable energy solution for the Duchy's urban development at Rainbarrow Farm, Poundbury, Dorset. Founded in 1337 the Duchy of Cornwall is a crown body principally responsible for managing the land and properties of the eldest son of the reigning British monarch – currently HRH Prince Charles, who was consulted at every stage of the project and who opened the project in 2012.

Rainbarrow Farm is situated on Duchy of Cornwall land outside of the village of Poundbury and was built as part of the Prince of Wales's sustainable community designs for the town. The town of Poundbury is expected to be fully completed by 2025 when it will house approximately 5,000 people and provide 2,000 jobs in the factories, offices and general facilities across the site. Poundbury is already home to 2,000 people and provides employment for 1,600 people and is home to 140 businesses. The renewable gas grid injection plant supplies renewable gas for up to 56,000 homes in Poundbury and the local surrounding area via the national gas grid.

The Poundbury renewable gas grid injection plant uses around 41,000 tonnes of maize, grass and potato waste grown by local farmers as well as organic waste from nearby factories, including chicken manure, Dorset Cereals and the House of Dorchester Chocolate Factory. The waste is digested in an anaerobic digester which produces biogas with 96% methane content which is upgraded and converted into biomethane and injected into the natural gas grid as a substitute natural gas by Southern Gas Networks who own and operate the Southern Region gas distribution network.

The plant also has the capacity to produce 23,000 tonnes of liquid and 8,000 tonnes of solid, renewable fertiliser a year. The digestate is used by local farmers in place of inorganic feedstock to significantly increase food production in arable crops and grass production for cattle.

Hannover, Germany

Founded in the 13th century, Ronnenburg is 8km south-west of Hannover. Five farmers from the area of Ronnenburg, who have been working together for some time in a machine cooperative, jointly established Biogas Ronnenburg GmbH or "BiRo" for short. In 2007, each farmer made an equal contribution of 20% towards the investment costs and substrate supply with annual contracts with additional farmers on the growing of maize substrate. The harvest is organised by BiRo, procurement and settlement is carried out via weighing scales at the biogas facility and silage is billed on site. Harvest and transport is invoiced to the growers.

The biogas facility runs on maize and wheat grain substrate. Fertiliser from the biogas facility is used on the fields in the immediate vicinity.

The farmers produce maize silage on their fields, store it in their own biogas facility and generate raw biogas. Operations at the biogas facility are undertaken by the five farmers. As the farmers own 100% of both the agricultural land and the biogas facility, they earn their money either during substrate growing and/or biogas selling.

The raw biogas is sold to Stadtwerke Hannover, owned by the City of Hannover, who upgrade the biogas to biomethane or substitute natural gas on site and inject the renewable gas into the gas grid to supply the cogeneration plants supplying Hannover's decentralised energy network. Ronnenburg is one of four renewable gas grid injection plants that supply the Hannover decentralised energy network.

Graz, Austria

Austria's second largest city Graz is served by a city-wide decentralised energy or district heating network supplied by two large gas fired cogeneration plants for winter operation located 20 km from the city centre, one gas fired cogeneration and one gas fired boiler plants in the city for summer operation and waste heat from a local steelwork plant all year round. The decision to implement a decentralised energy network in Graz was taken following a referendum in 1978 to shut down the local Zwentendorf nuclear power plant.

Graz Energie is a municipal owned utility responsible for distributing 70% of the city's electricity, together with district heating, gas and water. Two other utilities distribute the remaining 30% of electricity. In 1997, the Graz Energy Agency was established to promote energy efficiency and renewable energies and is jointly owned by the City of Graz (47.5%), Graz Energie (47.5%) and Steierische Ferngas (the regional gas transmission company) (5%)

The City of Graz plan for thermal energy is to deliver a 100% renewable system by 2050, as follows:

District Heating

	2010	2050
Fossil Fuels	60%	0%
Waste Heat	35%	50%
Solar Thermal	5%	50%

Source: City of Graz (2007)

To deliver this target will require 85,000-95,000 m^2 of solar thermal collector arrays by 2050.

The Graz Energy Agency was responsible for developing and procuring the energy services model using Energy Services Companies (ESCOs) for large scale solar thermal projects injecting renewable heat into the decentralised energy/district heating network. German ESCO S.O.L.I.D was successful in developing the first four large scale solar thermal projects at Graz based on a design, finance, build, operate and maintain model.

Each solar thermal system is connected to the district heating network via a buffer station. Some systems are mounted on the rooftops of occupied buildings, such as Berliner Ring, with the surplus solar heat exported into the district heating network. Other systems are mounted on industrial buildings, such as the AEVG, or ground mounted, such as Wasserwerk Andritz where most, if not all of the solar heat is exported into the district heating network. Heat is sold to consumers via Graz Energie for the same price as fossil fuel heat under an Energy Performance Contract with the ESCO.

Hamburg, Germany

Hamburg is the second largest city in Germany and the eighth largest city in the European Union. The population of the City of Hamburg is 1.8 million people, while the Hamburg Metropolitan Region has a population of 5 million inhabitants.

In common with the rest of Germany, the City's climate change target is to comply with the Energiewende (Energy Transition or Energy Turnaround) which is to reduce greenhouse gas emissions by 40% by 2020 and by 80-95% by 2050 below 1990 levels. The Energiewende target for energy is to phase out nuclear energy by 2022 and to supply 33% of its electricity from renewable energy by 2020, at least 50% by 2030 and 80% by 2050. By 2015, Germany had reduced its carbon emissions by nearly 28% below 1990 levels and generated nearly 33% of Germany's electricity requirements from renewable sources.

Prior to 1997, the electricity, gas and district heating grids were owned by the City of Hamburg but between 1997 and 2002 the grids were privatised and sold to major European energy companies. However, following dissatisfaction with increasing energy prices, the public's growing opposition to coal and nuclear fired power plants which mainly supplied Hamburg and the private utilities failure to install any meaningful renewable energy capacity led to the City in 2008, deciding to establish its own community energy utility.

Hamburg Energie was established in 2009 as a 100% municipal owned energy company supplying renewable energy and gas to Hamburg consumers. By the end of 2009 Hamburg Energie had built its first large scale solar PV project, acquired 25.1% each of the local electricity, gas and district heating grids and established Hamburg Energie Solar to assist Hamburg residents and businesses to install their own solar projects. Investment in rooftop solar PV was 15% equity and 85% debt finance with equity provided by Hamburger citizens in the form of a solar bond issued by the City of Hamburg.

By 2012, Hamburg Energie had become the second largest energy supplier in the city and the City's proactive approach to municipal owned renewable energy had gained high public support. In 2013, Hamburg electors voted in a referendum for the City of Hamburg to re-municipalize the electricity, gas and district heating grids despite a well-funded campaign from private utilities and others for a no vote. Key factors in the yes vote was the desire to reduce energy costs, increase renewable energy and the fact that the private utilities generated electricity from predominantly coal and nuclear power plants. Following the referendum Hamburg Energie bought back the electricity grid in 2014 and is currently in negotiations to buy back the gas and district heating grids by 2018/19.

Since local grid network charges were the largest components in energy bills, City analysts had calculated that if profits in the local grids was reduced by 50% and the remaining profits recycled into building renewable energy consumers energy bills could be reduced at the same time as making renewable energy more economical and therefore, accelerating the uptake of local renewable energy.

California, USA

As renewable energy becomes increasingly cost-competitive with fossil or nuclear fuel electricity sources, more and more Americans are turning to renewable sources to meet their energy needs. Hundreds of thousands of home and business owners across the United States have invested in renewable energy and are generating their own electricity. However, the majority of residential and commercial energy consumers in cities and other urban areas cannot install renewable energy systems on their own property for a number of reasons.

In 2013, Governor Brown signed into law SB 43, the California Shared Renewable Self-Generation Program that enables utility customers – local governments, businesses, schools, homeowners and renters to access affordable renewable energy. The Act allows energy utility customers who are incapable of generating their own renewable energy on site using solar PV, wind turbines or other forms of renewable energy generation, to obtain renewable energy from an off-site renewable energy facility. Additionally, the new law removed the regulatory barriers that were deterring schools and local governments from pursuing off-site solar opportunities.

Whilst rooftop solar has been a runaway success for homeowners able to take advantage of the California Solar Initiative, at least 75% of households cannot participate because they are renters and do not own their own roofs, they do not have strong enough credit, or their roofs are too small or do not receive enough sunlight. Similarly, for businesses, 70% of whom rent or lease their facilities.

Despite their inability to utilise renewable energy, these utility customers continue to pay into solar and renewable energy programs that fail to benefit them financially. SB 43 now allows all California households and businesses the ability to voluntarily buy up to 100% renewable energy from a shared facility in their local utility's area and receive a credit for the generation/supply portion on their utility bill.

The program works, as follows;

- First, a renewable energy developer builds a shared renewable energy plant and signs up investors or subscribers who choose how much electricity they want to offset.
- Next, the shared renewable energy project generates electricity and sends it to the grid. The volume is then tracked by the utility.
- Finally, the utility gives an energy bill credit to the investor or subscriber (in $/kWh), which is then subtracted from their monthly utility bill.

California Shared Renewable Self-Generation Program

Source: California Shared Renewables (2013)

SB 43 is estimated to provide 6,500 new Californian jobs on top of the 43,000 Californians already employed in the industry. The in-state economic value is estimated to be $2.65 billion as a result of the initial 600MW program alone.

Allowing customers to invest in a system off-site simplifies the process of selecting renewable energy. These community renewable energy facility arrangements come in many different forms. A congregation could power their homes by sharing the electricity generated by a solar system on their church's roof. A school campus could invest in a portion of a system located at a different school to power their entire campus.

For example, SolarShares offers residents of the City of Sacremento the opportunity to buy shares in its solar farm. The electricity generated by each customer's shares appears as a credit on his or her energy bill. Typically, customers make savings on average of $4-$50 a month, depending on the month and sunshine throughout the year.

Shared renewable energy generation must be as close as possible to the investors consuming the renewable electricity to avoid or minimise distribution network augmentation and to maximise the embedded benefits of the scheme.

The Vote Solar Initiative estimates that more than 20,000 residential ratepayers will take advantage of the pilot program. In addition, local governments, schools, businesses and the military are likely to take advantage of the new legislation.

One Less Nuclear Power Plant : A Case Study of Seoul Megacity

Ahn, Byung-ok (Head, Institute for Climate Change Action)

History of Seoul, Changes in Perspective[1]

Seoul is a basin-shaped city located in the midwestern part of the Korean peninsula at 37° 34 N and 126° 59 E. While the Hangang River flows east-west across the center, the city is surrounded by Bukhansan Mountain (837m), Gwanaksan Mountain (629m), Dobongsan Mountain (740m), Suraksan Mountain (428m) and Buramsan Mountain (510m). The east-west distance is 36.78 km, the north-south distance is 30.3 km, and the overall area is approximately 605.25 km^2. Seoul was the capital of the Joseon Dynasty for 500 years and is now the capital of the Republic of Korea.

It is difficult to identify exactly at what time in history the city of Seoul was formed. According to archaeological research and excavation results, it is clear that groups of people lived in what is now Seoul and its surrounding areas such as Incheon, Bucheon and Yongin, along the Hangang River, in prehistoric times. The time is estimated to have been around 4000 BC when the small tribal states formed at this time were agricultural society centered on shell mounds, dolmens and tumuli, stoneware and earthenware.

It was around 2000 years ago that Seoul took shape as a city when it became the capital of the Baekje Kingdom (18 BC – 660 AD), one of three ancient kingdoms of the Korean peninsula. The Seoul area was then called 'Wiryeseong'. After the Silla Kingdom unified the three kingdoms in 668 AD, the present-day Seoul area was renamed 'Hanyang-gun'. Afterward, the name 'Hanyang' was used as the capital of the Joseon Dynasty (1392-1910).

According to records, the population of Seoul was 103,328 in 1428, the 10th year of King Sejong's reign who was the fourth monarch of the Joseon Dynasty. If people living just outside the walls were included, the total number of Hanyang residents was about 110,000. The population of Seoul stood at 200,000 for almost 200 years from the 1660s; however, it began to increase toward the end of the 19th century as the country opened its doors to the outside world.

1 *Selected from the Seoul Statistical Yearbook published by the city of Seoul in 2016.*

When Korea was annexed by Japan in 1910, Seoul was renamed as 'Gyeongseong'. Seoul became a city with a population of about 730,000 in 1936. After Korea was liberated on August 15, 1945, the city was officially named the present name 'Seoul'. The word 'Seoul', originally a common noun meaning 'capital city', was used for a long time by Koreans. In 1946, Seoul was promoted to a special city and placed under the direct control of the central government. Its population was about 1.4 million then.

On June 25, 1950, the Korean War broke out, which lasted for three years. Most of the capital city's urban infrastructure was completely destroyed. In 1953, the armistice agreement was signed, and Seoul began to rise again as the capital city of a war-torn country. In the 1960s, the spatial structure of Seoul metropolitan city began to shift from a mono- to a multi-nuclear spatial structure in line with its rapid population growth, industrialization, and increased demand for public services. As the city area expanded, Seoul constructed an expansive transportation network to facilitate the smooth flow of people and goods within its boundaries. The completed radial and circular street network system linked Seoul to its rapidly-expanding suburbs, resulting in formation of a vast metropolitan area. As of the end of 2016, the city of Seoul with an area of 605.20 km^2 was composed of 25 districts and 424 dongs (neighborhoods). By area, Seoul accounts for only 0.6% of the country. By population, it is home to 10 million people or 20% of the country's total population, making it the 6th most crowded megacity in the world in terms of population density (Table 1).

[Table 1] **Top 10 Largest Cities in the World Ranked by Population Density**

Ranking	City	Country	Population (persons)	Area (km^2)	Population density (person/km^2)
1	Mumbai	India	14,350,000	484	29,650
2	Kolkata	India	12,700,000	531	23,900
3	Karachi	Pakistan	9,800,000	518	18,900
4	Lagos	Nigeria	13,400,000	738	18,150
5	Shenzhen	China	8,000,000	466	17,150
6	Seoul	South Korea	10,000,000	605	16,530
7	Taipei	Taiwan	5,700,000	376	15,200
8	Chennai	India	5,950,000	414	14,350
9	Bogota	Colombia	7,000,000	518	13,500
10	Shanghai	China	10,000,000	746	13,400

Source: City Mayors Statistics (partially modified)

The population of Seoul grew from one million in 1953 to 10 million in 1988 and to 11 million in 1992. According to the resident registration statistics released by the Ministry of Interior, the resident population of Seoul was 9,995,784 as of the end of May 2016, dipping below the 10 million mark for the first time in 28 years. The major causes of population decline were high housing costs and low fertility rates. While the resident population in Seoul has declined, the daytime population who commute to Seoul during the day for work, school, or services is still high. As of 2015, people using the subway and buses in the city per day were 7,234,000 and 4,403,000, respectively. As of

the end of May 2016, the Seoul population accounted for 19.37% of the nation's total population. The city's population accounted for one-quarter (24.6%) of the nation's population in 1992. It dropped below the 20% mark for the first time in 2013 (19.8%) and further declined to 19.7% in 2014 and 19.4% in 2015.

The population structure of Seoul has also changed. Since the year 2000, the rate of working age population has steadily decreased while the percentage of elderly population has increased. From 2005 to 2014, the population aged 0-14 years declined by 26.3% while those aged 65 and over increased by 66.0%. The total fertility rate decreased steadily from 3.05 in 1970 to 1.26 in 1998, making Seoul an ultra-low birthrate society (total fertility rate dropping below the 1.3 mark). The proportion of the population aged 65 or older in the total population increased from 6.3% in 2003 to 11.8% in 2014.

As the population grew and the number of one- or two-person households increased, the number of housing units in Seoul rose steadily. For 10 years between 2005 and 2014, the number grew by 501,347 (13.9%) from 3,102,000 to 3,603,000. As a result, the housing supply rate increased from 93.7% in 2005 to 97.9% in 2014 (Table 2).

[Table 2] Changes in the Number of Houses and the Housing Supply Rate in Seoul

Classification	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of houses (1,000)	3,102	3,151	3,173	3,231	3,258	3,400	3,449	3,498	3,548	3,603
Housing supply rate (%)	93.7	94.1	93.2	93.6	93.1	97.0	97.1	97.3	97.5	97.9

In terms of house types, apartment units accounted for 44.7% (1,613,000), single houses, 35.1% (1,265,000), multi-family houses, 15.5% (556,000), townhouses, 4.0% (142,000) and residences within non-residential buildings, 0.7% (24,000) as of 2014. As of the end of 2016, the road ratio in Seoul was 22.66% and the number of registered cars was 3,093,930.

Seoul's average daily electricity consumption was 91,291 MWh in 2001. It jumped to 124,333 MWh in 2015, up by 36.2% in 10 years. The average daily use of oil decreased by 30.8% over 10 years, from 195,000 barrels in 2001 to 135,000 barrels in 2015, as alternative demands increased and prices rose. The average daily use of city gas decreased by 2.4% from 11,681,000 m^3 in 2001 to 11,402,000 m^3 in 2015.

Observing Seoul through Energy Issues

Status of Final Energy Consumption

In 2014, the major national energy sources were petroleum (48.1%), electricity (19.2%) and coal (16.6%), in terms of consumption. In Seoul, the share of coal consumption was very low at 0.7%, with oil (41.5%), city gas (27.7%), and electric power (25.7%) accounting for almost 95% of total energy consumption. Since the late 1990s, city gas and electricity consumption have increased significantly with the share of oil gradually declining in Seoul. The proportion of city gas has remained

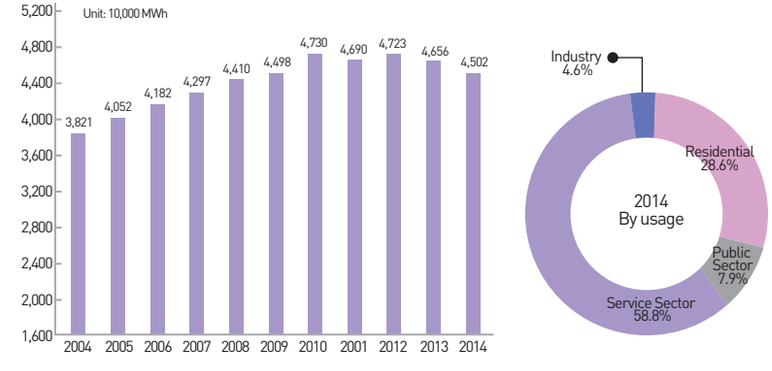
steady at around 30% since 2000. The share of electricity increased from 21% in 2003 to 25.7% in 2014. In 2014, whereas the share of coal consumption was 16.6% nationwide, it was only 0.7% in Seoul. This illustrates that electrical power consumed in Seoul is supplied mostly by thermal power plants located outside of Seoul. Meanwhile, the consumption of new and renewable energy in Seoul nearly tripled from 2003 to 2014 (the SMG, 2017a).

The total energy consumption in Seoul has stood at the 15 million TOE level for the past few years. It is a sharp contrast to the steady increase in energy consumption nationwide. In 2014, Seoul consumed 7.1% of the nation's total energy. Nationwide, the industrial sector is the largest energy consumer whereas residential, commercial and transportation sectors consume 83% of the total energy available in Seoul. Energy consumption by the industry has increased steadily over the past 10 years nationwide, while it has declined recently in Seoul. In Seoul, residential and commercial sectors are the biggest energy consumers. Yet their energy consumption is declining: in 2014 it was 8.107 million TOE, a 7.1% decrease from the previous year. In 2014, the transportation sector registered a 2.5% decline over the previous year in energy consumption at 4.406 million TOE, whereas the energy consumption by the public sector jumped by 13.5% in 2014 over the previous year. The total energy consumption in Seoul has stood at the 000 TOE level for the past few years.

Status of Power Consumption

Electricity consumption in Seoul has declined since peaking at 47.3 million MWh in 2010 (Fig. 1). In 2014, electricity consumption in Seoul was 45.02 million MWh, down 3.3% from the previous year.

[Figure 1] Changes in Power Consumption and Percentage of Consumption by Use in 2014 in Seoul



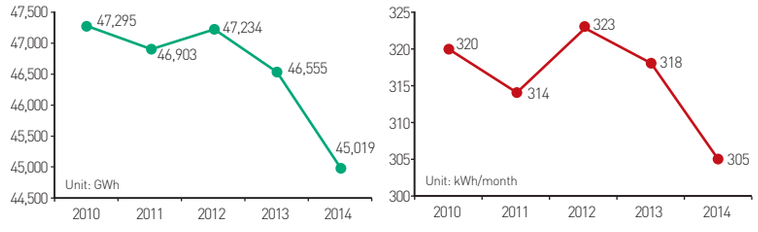
Source: the SMG, 2015b

In 2014, the share of electricity consumption by usage in Seoul was as follows: 83.1% for residential and commercial, 9.4% for the public sector and other, 4.6% for industry, and 2.8% for transportation. By contrast, industrial and residential/commercial sectors were the largest energy consumers across the country at 55.4% and 38.2%, respectively. In 2014, total power consumption in the country increased 0.6% from the previous year while Seoul registered a 3.3% decrease in the area during the same period. The situation is

the result of various efforts that the Seoul Metropolitan Government (SMG) made during the period to reduce power demand in the city.

Over five years from 2010 to 2014, Seoul's electricity consumption was the highest at 47,295 GWh in 2010, and the lowest at 45,019 GWh in 2014. Monthly electricity consumption per household was the highest at 323 kWh in 2012 and the lowest at 305 kWh in 2014 (Fig. 2).

[Figure 2] Seoul's Total Electricity Consumption (left) and Monthly Household Electricity Consumption (right)



Source: the SMG, 2017a

Status of Power Generation Facilities and New & Renewable Energy

As of 2015, Seoul had a total power generation capacity of 781 MW, including 612 MW of thermal power and 169 MW of new and renewable energy. Most of the city's power is generated from thermal power plants (78%), but the proportion of new and renewable energy is rapidly increasing. In 2015, the electricity that could be produced by the city's power generation facilities was 2,476 GWh, equivalent to 5.5% of the total power consumption of Seoul (45,381 GWh).

The increase of new and renewable energy generation facilities is remarkable. Solar photovoltaic, fuel cell, and geothermal related facilities have expanded particularly impressively. Heat production using waste has been actively carried out as well. New and renewable energy production rose nearly fourfold from 78,000 TOE in 2003 to 293,000 TOE in 2014. Still, the output of new and renewable energy in Seoul was only 2.6% of the national production in 2014, and it accounted for a mere 1.9% of the city's total energy consumption. However, the proportion of solar cells, which was 0.1% in 2003, jumped to 4.2% in 2014. By contrast, the fact that bioenergy and waste energy account for 89% indicates that there are many obstacles to be overcome in Seoul down the road. (SMG, 2017a).

One Less Nuclear Power Plant - "Citizens are Energy"

A Blueprint for Urban Energy Conversion Prepared Together with Citizens

The SMG launched the One Less Nuclear Power Plant (OLNPP) initiative against the following four major backgrounds: The first was the disaster that happened at the Fukushima Daiichi Nuclear Power Plant in Japan on March 11, 2011. The Fukushima nuclear power plant disaster was an unfortunate event that vividly revealed that humans can never completely control the risks associated with nuclear energy. The nuclear safety myth collapsed with the shock that another nuclear disaster took place 25 years following the Chernobyl disaster in 1986. The recognition that large cities such as Seoul should take the

lead in scrapping the existing electricity policy based on nuclear power plants and instead dramatically expanding the production of clean and safe energy has led to the birth of the OLNPP initiative in the city.

The second was the rolling blackouts that occurred on September 15 of the same year. It reminded citizens of the urgent need of energy transition in big cities like Seoul. In Seoul, most of its power is supplied from outside. Citizens recognized that the function of the whole city might be paralyzed in the event of a major power outage. The repercussions of the rolling blackouts had much to do with the OLNPP consistently maintaining as its core value 'energy self-sufficiency' since inception.

The third was the conflict over the construction of high-voltage transmission cable towers in Miryang in southern Korea and the sense of responsibility that Seoul citizens have developed for energy issues through the incident. The conflict between Miryang City in South Gyeongsang Province and the Korea Electric Power Corp. (KEPCO) was over the location of the 765 kV high voltage power cables and towers. The conflict escalated for a few reasons including the unilateral decision and actions to construct the towers without residents' consent, KEPCO's refusal to lay power lines underground for financial reasons, and sacrifice forced on rural population for power supply to urban centers. Through media coverage of the conflict, citizens of Seoul began to realize that their electricity was produced elsewhere at their compatriots' expense.

The final background was citizens' awareness of their city's role in the struggle to fight climate change. In modern cities full of asphalt and concrete, nature no longer exists in its pristine form. In that sense, cities could be "a space where men have declared their victory in a long confrontation with nature" as mentioned in "The End of Nature" by the American journalist Bill McKibben. Nevertheless, cities deserve keen attention because more than half of the world's population lives there. They use 75% of the world's energy and emit about 80% of its carbon dioxide. Therefore, urban energy conversion is a necessity, not a choice, to respond to climate change. The OLNPP initiative has been widely recognized as an effective means of mitigating climate change.

Mayor Park Won Soon, who took office in October 2011, started to gather opinions of citizens and experts based on the abovementioned backgrounds and perspectives. From January to April 2012, the SMG held 16 meetings with the Policy Advisory Group of Hope and civic groups and came up with a draft, which was reviewed at 'the OLNPP Policy by Listening Forums' on February 21, 2012 and 'the Policy Hackathon' on April 16, 2012. Particularly, the policy hackathon was participated by more than 400 citizens, who presented a total of 109 new ideas, including 'disclosure of energy use by large buildings' and 'creation of exclusive streets for public transportation and pedestrians.'

The SMG set up governance organizations devoted to public-private partnerships for the successful promotion of the OLNPP initiative. They are 'Citizens' Commission' and 'Executive Committee',

both of which are composed of representatives of businesses, academia, culture, religion, education and civil society. They not only serve as a window for communication between the public and the private sectors, but also check progress and present concrete measures to further invigorate the initiative. (Table 3) shows the main functions of the 'OLNPP Citizens' Commission' and 'the OLNPP Executive Committee.'

[Table 3] Main Functions of the OLNPP Citizens' Commission and the OLNPP Executive Committee

OLNPP Citizens' Commission	•Leading the policy paradigm shift from an energy saving city to an energy production city •Determining policy directions for the OLNPP initiative •Reviewing the OLNPP initiative action plans and their revisions and making overall adjustments
OLNPP Executive Committee	•Consultation on the overall promotion plan of the OLNPP initiative •Consultation on the OLNPP action plans and development and planning of new OLNPP programs •Invigoration of private sector-initiated OLNPP programs •Evaluation and supplementation of the OLNPP initiative programs

In order to provide adminstrative support to the public-private partnership governance, the SMG created new teams called "OLNPP General Management Team" and "Energy Citizen Cooperation Division (currently Energy Efficiency Promotion Division)", and secured institutional basis through the amendment of 'the Seoul Special City Energy Ordinance.'

Goals and Achievement of OLNPP Phase 1

The goal of OLNPP Phase 1 was to produce or save 2 million TOE of energy equivalent to the power generation of a nuclear power plant by 2014 through the production of new and renewable energy, energy conservation and energy efficiency together with citizens. The initiative also aimed at raising the city's electricity self-sufficiency rate from 2.95% in 2011 to 5% by 2014 and to 20% by 2020. To achieve its goal, the OLNPP initiative set up 10 core programs, 21 policy issues, and 78 projects in 6 major areas including the expansion of new and renewable energy production.

Many citizens participated in new and renewable energy production, energy efficiency and energy conservation. As a result, the goal of producing and saving 2 million TOE by the end of 2014 was achieved in June 2014, six months ahead of schedule. Among the three areas of energy production, efficiency and conservation, the most remarkable achievement was made in the field of energy conservation (about 910,000 TOE), in which citizens actively participated, by achieving 190% of the targeted volume (480,000 TOE). On the other hand, energy efficiency and energy production achieved only 63% and 78% of their targets at about 870,000 TOE and about 260,000 TOE, respectively (Table 4).

[Table 4] Goals and Achievements of the OLNPP Initiative by Area

Unit: 1,000 TOE

Classification	Goals	Achievements			
		Total	2012	2013	June 2014
Total	2,000	2,040	331	921	788
Energy production	410	260	35	78	147
Energy efficiency	1,110	869	145	328	396
Energy conservation	480	911	151	515	245

Planting Sunlight Trees on Rooftops and Verandas

The expansion of new and renewable energy production failed to reach its target because it was difficult to secure sites necessary for the installation of new power generation facilities due to the spatial conditions of Seoul. The SMG, however, made great efforts to make institutional improvements such as rent reduction for public land, easing of restrictions on the installation in parks and development-limited areas, and the introduction of Seoul-type FIT (feed-in tariffs). In cooperation with the Seoul Metropolitan Office of Education, the SMG changed its policy towards a more demand-oriented approach, such as increasing the use of school rooftops for solar panel installation and charging rent for use of public land based on the installed capacity, thereby significantly reducing the economic burden of new and renewable energy producers. In order to encourage citizens' participation, the SMG surveyed the rooftops of all buildings and houses in Seoul and published 'the Seoul Sunlight Map', which provides information on the possibility of the installation of solar power plants with their potential output. As a result, solar power generation facilities increased from 22.6 MW in 2011, prior to the launch of the OLNPP initiative, to 70.5 MW by the end of 2014.

Lighting, Architecture and Transportation - Creating Smart Systems

The energy efficiency sector is divided into lighting, architecture, and transportation. In the area of lighting, 6.79 million LED lights were installed with the help of low-interest rate loans and special purpose companies (SPCs) making initial investments and recovering their costs over time through citizens' reduced energy bills. In cooperation with Korea Finance Corporation, the SMG replaced all the lights (430,000) in 243 subway stations in Seoul with LED lights without using its own funds.

Buildings tend to consume the largest amount of energy in Seoul. To cut down on energy demand of the building sector, the SMG further enhanced its 'Green Building Design Criteria' applied to its review of applications for the construction of new buildings in the city. As a result, the energy efficiency requirement of new buildings with a surface area of more than 3,000 m^2 has strengthened to Level 2 or above. For existing buildings, the SMG has extended the BRP (building retrofit project) loan program to residential units and raised the loan limit to 2 billion won per building (15 million won per housing unit). In addition, it lowered the interest rate from 2.5% in 2012 to 2% in 2013 and to 1.75% in 2014 to reduce initial investment costs.

In the transport sector, the SMG expanded the car-sharing

program and increased the number of transit parking lots to promote the use of public transportation. On public holidays, it reduced the operation of city buses by 3% to save fuel consumption. It is also worth noting that the SMG has expanded the exclusive median bus lane network and implemented bus route rationalization to cut down on energy waste caused by congestion in the city center. The SMG has provided the training in eco-friendly driving for city bus drivers who drive further distance and attached eco-driving devices to their steering wheels. It has also installed exhaust gas reduction devices in old diesel cars or paid subsidies for their early scrapping.

Energy Conservation, the Champion of the OLNPP Initiative

The membership of the Eco-Mileage System jumped from 480,000 in February 2012 to 1,700,000 in 2014. The culture of energy conservation quickly spread both at home and work. The Eco-Mileage System was awarded the UN Public Service Award for its excellence in 'promoting innovative mechanisms for citizen participation in policy making' in 2013. 'Energy Clinics' that visit households for free energy consultation, 'Energy Guardian Angels Corps' of more than 20,000 participants that drive energy conservation in schools and homes, and 'Good Stores' that compel energy conservation in the commercial sector all have played the role of a messenger for the OLNPP through sharing energy conservation tips and spreading energy saving practices. The greatest achievement in the energy conservation sector was in seeing the potential for energy issues.

Reduction of Both Energy Consumption and GHG Emissions

The achievement of the OLNPP initiative can be confirmed by the reduction in actual energy use in Seoul, including electricity, gas, and oil. It is true that energy use cannot be attributed entirely to the effect of the OLNPP initiative because it can increase or decrease depending on natural or economic conditions, including temperature fluctuations. However, compared to other cities in the country, such as Daegu, Gwangju and Daejeon, with an energy consumption structure similar to that of Seoul because of their comparable social and economic environment, it is clear that the OLNPP initiative has brought about remarkable results (Table 5). From 2011 to 2014, the nation's electricity consumption grew 4.9%, while Seoul's electricity consumption declined 4.0% (Fig. 3). During the same period, electricity consumption per household dropped only in Seoul among the country's four major cities, pointing to the effect of the OLNPP initiative in terms of energy conservation.

[Table 5] **Changes in Electricity Usage Nationwide and Seoul, Daegu, Gwangju and Daejeon from 2011 to 2014**

Unit: GWh

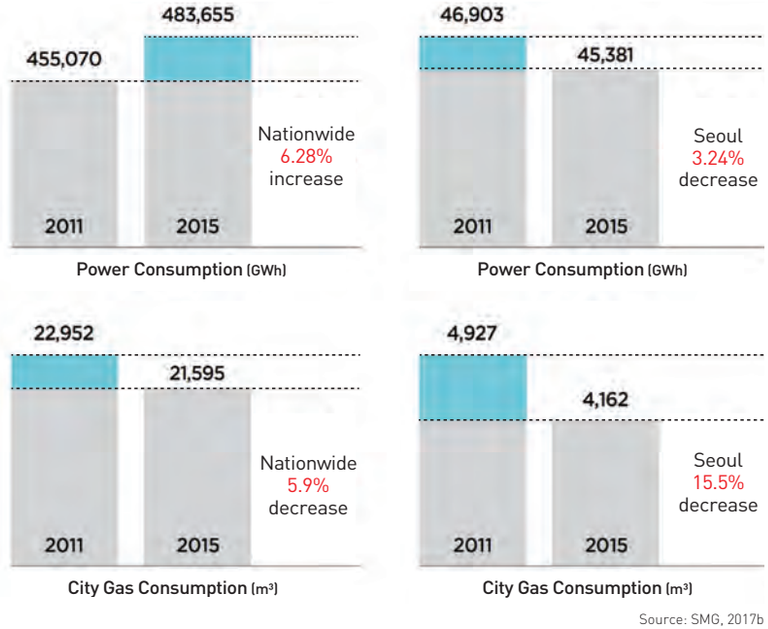
Classification	2011	2012	2013	2014	Rate of change ('11–'14)
Nationwide	455,070	466,593	474,849	477,592	4.9
Seoul	46,903	47,234	46,555	45,019	-4.0
Daegu	14,822	14,955	15,080	14,859	0.2
Gwangju	8,047	8,131	8,274	8,197	1.9
Daejeon	9,060	9,160	9,225	9,103	0.5

Source: SMG, 2014a

In Seoul, city gas consumption declined by 13.5% between 2011 and 2014, registering a far higher reduction rate than the other cities. The consumption of city gas, either for residential and commercial use or for combined heat and power plants, has been on a steady decline since 2011.

Changes in energy consumption patterns have also led to the reduction of GHG emissions. Analysis results indicate that a total of 5,635,000 tons of greenhouse gas emissions were reduced during the two years of the first phase of the OLNPP initiative. The quantity is equivalent to the effect of creating 5,211 km² of a forest which is 1,158 times as big as Yeouido (4.5 km²) in Seoul.

[Figure 3] Comparison of Electric Power and City Gas Consumption in Korea and Seoul



Source: SMG, 2017b

One Less Nuclear Power Plant Phase 2 – 'Seoul Sustainable Energy Action Plan'

Values and Goals of 'Seoul Sustainable Energy Action Plan'

After successfully completing Phase 1 of the OLNPP initiative, the SMG announced Phase 2 of the initiative by the name of 'Seoul Sustainable Energy Action Plan' on August 20, 2014. 'Seoul Sustainable Energy Action Plan' pursues an energy producing city, a city that remains safe amid a power crisis, and a city that coexists with other regions. As in Phase 1, 'Seoul Sustainable Energy Action Plan', the second phase of the OLNPP initiative sought to envisage main directions and promotion methods together with citizens. Citizens' opinions were collected through social fiction contests, Policy by Listening Forums, and online surveys. The Executive Committee took the lead in reviewing the values, policy goals, and detailed tasks to be pursued and carried out during Phase 2 of the OLNPP initiative. The SMG made efforts to reflect the opinions of domestic and international experts such as members of the Seoul International Energy Advisory Council (SIEAC).

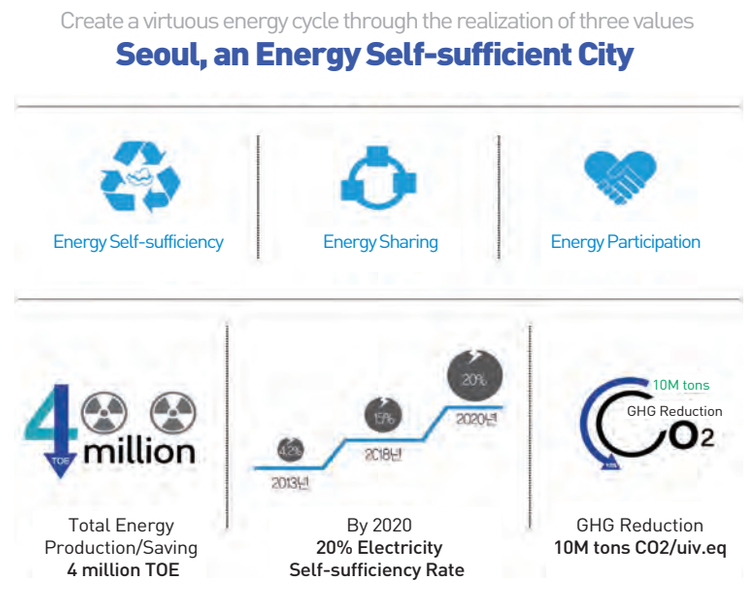
The second phase project has succeeded the first phase but it is an advanced form of Phase 1 in that it seeks to fundamentally change the structure of energy production and utilization through improvement of unreasonable energy legislation and enhancement of institutional support. Phase 2 emphasizes that the ultimate goal of the OLNPP initiative is the realization of a city where citizens actively act not just

as energy consumers but also as energy producers and the citizens' practices of energy conservation and wise energy use are becoming a part of their culture. In addition, 'Seoul Sustainable Energy Action Plan' has launched Seoul Energy Corporation to solve issues caused by the absence of a specialized integrated enforcement agency (OLNPP Citizens' Commission, Executive Committee and SMG, 2014).

'Seoul Sustainable Energy Action Plan' has declared that 'self-sufficiency', 'sharing', and 'participation' are the core values of Phase 2 of the OLNPP initiative. Energy 'self-sufficiency' is aimed at building a city that takes responsibility for the negative impacts associated with energy consumption by lowering its external dependence on energy supply. The goal of 'Seoul Sustainable Energy Action Plan' is the realization of a safe city that produces sustainable energy by itself in preparation for an energy crisis, and a smart city that supports the development of the energy industry and creates jobs in the local area. Energy 'sharing' can be realized in the process of sharing energy saved by citizens with neighbors and future generations, and pursuing energy co-prosperity through cooperation with regions where natural conditions are favorable for expanding new and renewable energy. Energy 'participation' is an expression of the willingness to practice 'energy democracy' by strengthening energy governance in which citizens become the key players from the establishment to the completion of energy policies.

'Seoul Sustainable Energy Action Plan' aims to increase the city's electricity self-sufficiency rate from 4.2% in 2013 to 20% by 2020. By achieving this goal, Seoul will be able to produce and save 4 million TOE by 2018, equivalent to the power generated by two nuclear power plants, while reducing greenhouse gas by 10 million tCO_{2eq} (Fig. 4).

[Figure 4] Policy Goals of One Less Nuclear Power Plant Phase 2
'Seoul Sustainable Energy Action Plan'



The Four Major Policies of the 'Seoul Sustainable Energy Action Plan'

A City of Distributed Energy Generation

According to 'Seoul Sustainable Energy Action Plan,' the SMG started to distribute mini-solar panels (250W) for apartment balconies

in earnest so that everyone could participate in electricity production given the reality of many high-rise apartments in Seoul. Starting with 2.5 MW in 2014, the SMG plans to supply 2.5 MW or more every year and establish a total of 19.25 MW of mini-photovoltaic power stations by 2020. Since 2015, the SMG has arranged for citizens to buy mini-solar panels from supermarkets and install them in their residences on their own.

At the same time, the SMG launched 'Seoul Solar Power Generation Citizens' Fund' which allows citizens to invest directly and earn economic profit. The solar power investment product launched on August 10, 2015 with an aim to raise 8.25 billion won. With a total of 1,044 applicants, the fund became fully subscribed in just five days. The SMG built a total of 4.24 MW photovoltaic power plant in four locations such as Jichuk, Gaehwa, Dobong, and Godeok train service depots. The annual revenues generated from the fund are distributed to investors at a rate of 4%, and the rest is donated to the energy vulnerable.

The SMG also makes institutional efforts to strengthen the city's energy self-reliance by getting involved in the planning stage of various facilities that consume energy. Previously, the SMG's 'Environmental Impact Assessment Criteria' required that at least 10% of total energy consumed by a new building with a floor area of 100,000 m^2 or more be supplied from new and renewable energy sources. The SMG raised the threshold to 12% in September 2014 and to 14% in 2015. Furthermore, the SMG is institutionally preparing to increase the ratio to 20% by 2018.

Efficient Lower Energy Consumption Social Structure

'Seoul Sustainable Energy Action Plan' places emphasis on the energy demand management of buildings. In order to alleviate initial investment costs for insulation and window replacement for existing buildings and houses, the SMG provides a total of 15 billion won in the form of low-interest loans (at an annual interest rate of 1.45% starting from January 2016) every year. In addition, the SMG supports energy designers who completed its programs to offer customized energy diagnostic service to homes and small shops.

The SMG is also promoting institutional improvement that will obligate taking energy efficiency into consideration at the earliest stages of building design and urban planning. The SMG plans to upgrade the deliberation standards for environmental impact assessment for new large-scale buildings. It will require the application of energy saving technology and improvement of facility efficiency for general buildings. By 2023 at the latest, it will apply 100% zero energy design standards. Aside from this, the SMG is promoting a policy requiring the disclosure of information related to the energy performance of buildings at 'Seoul Real Estate Information Plaza' upon the sale or rent of buildings.

The goal of the lighting sector is to replace all the lighting fixtures in the public sector (about 2.2 million) with LEDs by 2018 and about 78% of all the lighting fixtures in the private sector (34.68 million) with LEDs

by 2020. In the transportation sector, programs being implemented by the SMG include car sharing, expanding the number of streets dedicated to pedestrians, revitalizing bicycle use, and subsidizing the scrapping of old diesel cars.

The goal of Eco Mileage, a representative program of energy conservation, is to increase the number of registered members to 2.8 million by 2018 and save a total of 1 million TOE. In 'Seoul Sustainable Energy Action Plan,' the SMG revised the method for calculating energy savings. One out of 4 categories including electricity and city gas had been selected for assessment, but starting in 2016, 2 categories were subject to evaluation with electricity savings calculations mandatory.

Quality Energy Jobs through Innovation

In order to revitalize the energy business of the private sector, 'Seoul Sustainable Energy Action Plan' supports the foundation of social enterprises and the activities of cooperatives. The goal is to have a total of 70 social enterprises and cooperatives to engage in the energy sector by 2018. To upgrade its support for residents at 'Youth Startup Center,' willing to start a new business in the energy sector, the SMG has delegated the task to Seoul Business Agency (SBA) for more professional assistance. The SMG plans to raise and operate 148 billion won by 2018 as a Startup Fund designed to support small business owners who are yet to consolidate their business base despite their excellent business items. In order to support green SMEs whose growth is slow because of difficulties in business environment, the SMG supports 1-2% of the interest on the market loan.

It is also important to have a system that can support from start-up to cultivation of manpower to market development. The SMG plans to establish a green cluster in G-Valley in Gasan and Guro, the largest new and renewable energy cluster, as a pilot project and then expand regional clusters in six additional locations throughout the city, including Mapo and Nowon, by 2018. The SMG plans to support 45 R&D projects by 2018 to develop green energy technologies and create jobs.

Among various programs that can increase jobs in the energy field, the two most effective programs include nurturing energy technicians in high schools and training energy designers who can diagnose and consult on energy use in homes and small- and medium-size buildings. To nurture 2,000 energy technicians in high schools by 2018, the SMG plans to support their acquisition of qualifications and employment through the provision of equipment and the development of educational materials. The SMG is seeking to secure the budget and train over 700 energy designers by 2018.

Warm Energy Sharing Community

In order to provide a system to guarantee citizen's fundamental energy rights, 'Seoul Sustainable Energy Action Plan' is in the process of surveying the actual conditions of the energy poor, establishing 'Energy Welfare Charter,' legislating the 'Energy Welfare Ordinance,'

and creating the 'Energy Welfare Fund'. With a goal of 100,000 citizens participating in fundraising, the 'Energy Welfare Fund' is to serve as an 'energy welfare platform' that donates part of the profit generated from the city's energy production and saving efforts such as solar PV systems, LED lights, and BRP (Building Retrofit Program) to the energy poor.

The representative energy welfare project of 'Seoul Sustainable Energy Action Plan' is BRP targeting the city's low-income housing and social welfare facilities such as senior centers. The BRP project for low-income housing targets 1,100 households by 2018. The BRP project for social facilities such as senior centers will be done on 150 locations by 2018. The action plan also supports insulation improvement and repair work for public rental housing built more than 15 years ago.

The 'Energy Self-sufficient Villages' plan aims to build a total of 200 such villages by 2018. A total of 55 energy self-sufficient villages are in operation including 7 villages designated in 2012 such as Sipjaseong and Seongdaegol, and 24 villages in 2016. A total of 75 villages will be operational by the end of 2017. The energy saving community building project is increasing its efficiency through public contests and assessments of energy conservation among apartment complexes.

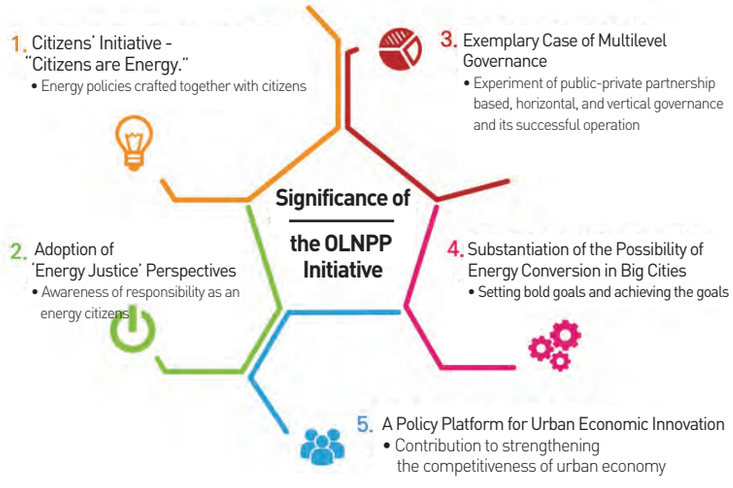
Significance of the OLNPP Initiative and Future Challenges

Performance and Significance

Since the full-fledged implementation of the OLNPP initiative, energy consumption has decreased in Seoul in all fields such as electric power, city gas, and oil. The achievements of Seoul have different meanings from those of other cities in the developed world. Most of the cities in foreign countries have more advantageous geographical and social conditions than Seoul. They are rich in renewable energy sources such as hydroelectric power, wind power, and biomass. Their central governments play a strong support role. Seoul, on the other hand, is severely constrained by spatial conditions to expand its renewable energy sources combined with a lack of support from the central government.

The reason for the success of the OLNPP initiative despite such restrictions is that the SMG has placed a high priority on citizens' participation in the initiative, from planning to execution, as shown in the slogan "Citizens are Energy" (Fig. 5). The term 'Seoul Sustainable Energy Action Plan' includes two critical elements. First, it means that 'acting' together with citizens to produce energy and trying to use it wisely is the mandate of a modern city. Second, it also means that the city's energy related actions must be 'sustainable' for the welfare of not only its current residents but also its future generations and the residents of the rest of the country.

[Figure 5] Significance of the OLNPP Initiative



The OLNPP initiative differs from the energy policies of the city's previous administrations and many other cities in the country. 'Citizens' Initiative' is the first pillar supporting the OLNPP initiative: Citizens actively participate in setting and implementing energy policies. The second pillar is 'Energy Justice' based on the sense of responsibility of the metropolis that depends on external energy. When the OLNPP initiative was launched, Seoul's electricity self-sufficiency rate was only 2.95%. More than 97% of the power consumed in the city was sourced from the outside through a long-distance power grid. As the conflict on the construction of the power grid in Miryang shows, concentration of power generation facilities and power transmission over long distances to mega cities eventually entail excruciating social conflicts. Therefore, the current SMG set a policy goal of raising the electricity self-reliance rate reflecting the values that it treasures, such as 'energy justice' and 'urban ethics'.

The third significance of the OLNPP initiative is the exemplary energy governance. The OLNPP is evaluated as having actively strengthened governance based on public-private partnership represented by the Citizens' Commission and the Executive Committee, vertical governance with the city's autonomous districts, and horizontal governance with other local governments in the country. In November 2016, the SMG signed a friendly exchange agreement with the city of Samcheok in Gangwon Province to promote partnership in the field of new and renewable energy, drawing keen attention as it is the city's first attempt to expand its energy governance to a win-win model with other local governments.

The fourth significance of the OLNPP initiative is that the SMG established ambitious goals and achieved them, proving that mega cities can carry out energy conversion successfully. Thus, representatives of many municipalities at home and abroad have visited Seoul to learn more about the OLNPP initiative. In particular, local governments and civil society in Taiwan and Hong Kong have expressed great interest in the roles of citizen participation and public-private partnership based governance in achieving the goals of the OLNPP initiative.

The fifth significance of the OLNPP initiative is the experi-

mentation of a policy platform designed to innovate urban economies through the OLNPP initiative. Energy is the cornerstone of an urban economy. Therefore, a city's energy conversion should be recognized as a matter of which economic system to choose rather than a simple choice of energy source. The OLNPP initiative is a powerful means of enhancing Seoul's urban competitiveness.

Future Challenges

Although the OLNPP initiative is recognized as a successful policy both at home and abroad, there are also many challenges to be solved. The biggest challenge is whether the ultimate values of the initiative including 'citizen initiative' and 'energy justice' take root in the municipal administration to the extent that the values will sustain even under different municipal leadership. Therefore, 'sustainability' is a key measure to determine the destiny of the initiative in the long term. From the perspective of sustainability, the OLNPP initiative faces three major challenges.

First, Seoul has to overcome the transformation trap'. The trap refers to the inability to resolve political, social, and economic contradictions typical of transition societies (Marc Saxer, 2016). Although the OLNPP initiative has emphasized 'citizen initiative' from the conceptualization phase, it is hard to say that even after four years, the top-down policy promotion method has been overcome. In a society with high diversity and mobility, top-down policy promotion is likely to encounter resistance at the point of conflict of interests and hinders the development of the initiative into an institutional and social plan. Regardless of whether the initiative has to change its name or not, it is necessary for citizens with diverse interests to change their perspectives of the initiative if its vision and values are to have sustainability. Energy is a 'livelihood issue' for citizens, and the initiative needs to be approached in terms of urban economy, industry and jobs rather than municipal politics. In addition, it is necessary to reinforce the strategic alliance through the redefinition of the stakeholders of the initiative while paying close attention to who ultimately reaps the benefit of the transition.

Second, the fence of the OLNPP initiative has to be installed 'deeper and wider'. A city's energy conversion cannot be completed simply by replacing nuclear energy and fossil energy with renewable energy (Lee Gang-joon, 2015). The depth of the fence is determined by 'energy citizenship.' 'Energy citizenship' is formed in the process of recognizing social contradictions and implementing alternatives to solve the issues through the prism of energy. In this context, citizens' participation represented by energy designers, 'Energy Guardian Angels Corps', and 'Good Stores' that save energy need to be reinterpreted from the perspective of 'energy citizenship'. Installing the fence 'wider' means that Seoul should further specify and deepen the responsibilities that it perceives. The 'Joint Declaration on Regional Energy Conversion' by the heads of four municipalities in the country, suggested by the SMG and announced on November 24, 2015, can be regarded as the beginning of solidarity between local governments

through energy conversion. When the 'energy win-win' project being promoted by Seoul and Samcheok succeeds, it will become a breakthrough in the country's energy conversion efforts.

Third, it is necessary to gradually turn from the 'stand-alone' strategy to the 'permeation' strategy. The OLNPP initiative is a comprehensive policy covering all energy sectors, but some consider that it is loosely connected to transportation, urban planning and urban regeneration. In the early stages of policy promotion, it is inevitable to establish an identity through 'stand-alone' approaches. However, given the interconnectedness and complexity of energy issues that are intertwined with a city's economy, spatial structure, infrastructure and culture, the most important task for innovative energy policies is to figure out a 'transition pathway' while embracing the city's numerous components. Therefore, the SMG's recent attempts to link urban regeneration projects with the OLNPP should be further strengthened and expanded to other fields as well.

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2

Energy Service and efficiency

Mycle Schneider

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Mycle Schneider works as independent international analyst on energy and nuclear policy.

Mycle Schneider is the Convening Lead Author and Publisher of the annual World Nuclear Industry Status Report. He is a Founding Board Member and Spokesperson of the International Energy Advisory Council (IEAC), USA, and the Coordinator of the Seoul International Energy Advisory Council (SIEAC) that advises the Seoul Metropolitan Government, South Korea. In 2007, he was appointed as a member of the International Panel on Fissile Materials (IPFM), based at Princeton University, USA. Between February 2010 and June 2011, he acted as Lead Consultant for the Asia Clean Energy Policy Exchange, implemented by IRG, funded by USAID, with the focus of developing a policy framework to boost energy efficiency and renewable energies in six Asian countries.

Between 2004 and 2009 he has been in charge of the Environment and Energy Strategies Lecture of the International Master of Science for Project Management for Environmental and Energy Engineering at the Ecole des Mines in Nantes, France.

From 2000 to 2010 he was an occasional advisor to the German Environment Ministry. In 2006-2007 he assessed nuclear decommissioning and waste management funding issues on behalf of the European Commission. In 2005-2006 he was appointed as nuclear security specialist to advise the UK Committee on Radioactive Waste Management (CoRWM). 1998-2003 he was an advisor to the French Environment Minister's Office and to the Belgian Minister for Energy and Sustainable Development. He directed the energy information service WISE-Paris between 1983 and 2003.

Mycle Schneider has given evidence or held briefings at national Parliaments in 14 countries and at the European Parliament. He has given lectures or had teaching appointments at 20 universities and engineering schools in ten countries. Mycle Schneider has provided information and consulting services to a large variety of clients including the European Commission, the European Parliament's General Directorate for Research, Oxford Research Group, the French National Scientific Research Council (CNRS) and the French Institute for Radiation Protection and Nuclear Safety (IRSN), the International Atomic Energy Agency (IAEA), Heinrich-Böll-Foundation, Greenpeace International, International Physicians for the Prevention of Nuclear War (IPPNW), UNESCO and Worldwide Fund for Nature (WWF).

Media representatives from around the world have inquired for his information, advice or complete features including many TV and radio stations, electronic and print media. Mycle Schneider is co-editor of International Perspectives on Energy Policy and the Role of Nuclear Power, Multi Science Publishing, UK, 2009.

In 1997 he was honoured with the Right Livelihood Award ("Alternative Nobel Prize").

The Intelligent Energy Services Approach

Mycle Schneider (Head, Mycle Schneider Consulting)

On the fringes of a Chernobyl Tenth Anniversary event in 1996, I was invited for dinner to a beautiful traditional restaurant in the Ukrainian capital Kiev. Wood-woven lamps with a cloth-lining above each table, equipped with good, old Edison lightbulbs, provided warm light and generated a cozy atmosphere. Except for one lamp, which had one of these compact fluorescent lightbulbs sticking out of the lampshade and delivering aggressive, white light. The restaurant owner meant well, replacing a century-old technology by an energy-savings device.

That's exactly what the Thai national parliament administration did on a big scale a decade later. It replaced incandescent lightbulbs in the entire building. The country has been perceived as one of the forerunners of implementing energy efficiency labeling and the parliament was considered a beautiful example of success. I witnessed the outcome speaking at a conference in parliament. Generally, too little and too white light, cold and uncomfortable, plunged the people representatives' building into an odd atmosphere. Hard to imagine carrying out efficient work in such an unwelcoming lighting environment.

More recently, in October 2013, a research associate of the Science Policy Research Unit at Sussex University in the United Kingdom, an internationally renowned energy research team, interviewed me via skype on the perspectives of nuclear power. Every 15 minutes, his screen went black, as his office was plunged into the dark. I wondered what was going on. My interviewer explained that the office lighting was connected to an infrared movement sensor. So, if my interview partner did not move for a certain amount of time, the lights automatically switched off... to save electricity.

What do these three lighting stories from different time periods and various parts of the world have in common? The attitudes and choices were driven by the only desire to save electricity, forgetting about the actual purpose of delivering the service of lighting in a restaurant, a parliament building and a computer workspace. The specific needs are very different in the three cases. The restaurant's cozy atmosphere is crucial to its success. The general equipment with compact fluorescent lightbulbs would have been a perfect recipe to

empty the place. It can hardly be the purpose to save a few kilowatt-hours at the price of bewildering customers. Every country would like to have well-designed operating conditions in parliament that render the working environment particularly efficient. The ergonomics of computer work-places are complex, as people often spend countless hours sitting behind screens. Appropriate lighting is crucial to make this work. It is also a difficult task as the screens are themselves a lighting source and mastering the contrast with the surrounding space is a challenge.

How do we get this right? Let's start by redefining the objectives of progressive energy policy as providing intelligent energy services to everyone. To make them intelligent, energy services shall be:

- affordable and just—basic energy services need to be accessible or distributed to everyone;
- clean and sustainable—the delivery of energy services shall protect the environment and not restricting options for future generations;
- reliable—access to basic energy services needs to be guaranteed at all time;
- efficient and user-friendly—practical implementation of solutions designed to closely follow people's needs and possibilities is key.

What are basic energy services? People don't need kilowatt-hours, barrels of oil or cubic-meters of gas, people need cooked food, heat and cold, lighting, communication, mobility and motor force. Thinking about daily life, every aspect having to do with energy falls into one of these six categories. The challenge is to provide these services with respect to the four criteria spelled out above.

Cooked Food

> The control of wood fires
> for cooking arguably is the
> fundamental transformation
> that made humans distinct
> — from other primates[1]

Over three billion people rely on traditional biomass (such as wood and agricultural waste) and coal for cooking. Most of these communities still cook on highly inefficient open fires or rudimentary stoves.[2] About four-fifths of the food we consume is cooked, and every human being has the fundamental right to cooked food. Cooking is the most elementary of energy services, and still, hardly any energy policy strategy ever addresses the issue specifically and effectively. Worse, cooking represents also a very major health issue, especially for women

1 *R. Wrangham, "Catching Fire: How Cooking Made Us Human", Basic Books, 2010.*
2 *Practical Action, "Poor people's energy outlook 2016", September 2016.*

and children exposed to toxic pollutants from incomplete combustion. It has been estimated that, in 2010, 3.5 million premature deaths in the world were attributable to air pollution from cooking with solid fuels. After high blood pressure, household air pollution is considered the second most important risk factor for women worldwide, and in many poor regions, it is de facto the highest risk factor for women.[3]

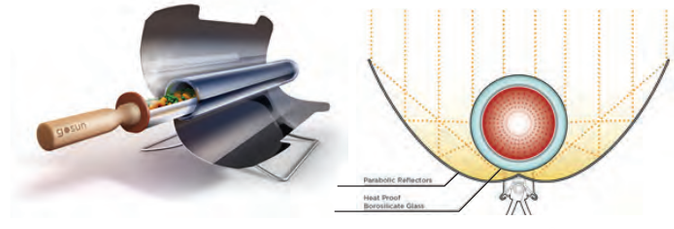
There are many ways to cook food, depending on the primary energy used, the stove technology and the meal you would like to prepare. Solid, liquid or gaseous fuels can be used as well as solar heat, or a combination of various systems. In our 19th century log cabin in the Canadian bush, we have the luxury of a combined wood-propane stove (see Figure 1) and a brand-new fuel-free solar cooker (see Figure 2). On a hot summer evening, no point in making a fire and heating up the house, we use propane, and during the day, the sun feeds our brand-new solar stove. When the evenings get chilly, the wood stove provides wonderfully comfortable heat with the eye-catching fire visible through the window of the firebox.

3 *Kirk R. Smith, et al., "Energy and Human Health", Annual Review of Public Health, 2013*

[Figure 1] **Combined Wood-Propane Stove**

Source: www.elmirastoveworks.com

[Figure 2] **Modern Solar Stove**



Source: www.gosunstove.com

Especially in Asian countries, cooked rice is synonym to daily basic food supply and electric rice cookers are a common feature. In 2013, a Thai 5th grader from Bangkok[4] ran a simple experiment to compare four different ways to cook 350 milliliters of brown rice: an electric rice cooker, an electric stove-top, the same stove-top but with rice that had soaked in water overnight and a sweater to maintain the heat after the water had come to the boiling point, and a simple

4 *I admit, her parents are senior energy experts.*

solar oven. The results were convincing: Soaking the rice and using insulation—a properly designed insulated box would significantly increase the effect—achieves the same effect in about the same time at about one third of the power consumption as the electric rice cooker. Of course, the solar oven does it for free, but it takes significantly longer. Modern solar ovens like the go-sun (see Figure 2 above) achieve similar cooking time results in full sun as an electric stove top.

Energy efficiency and cooking time are only two of a list of criteria. Some like their rice sticky others dry, some want white others brown rice, boiled or steamed... "Rice culture is complex and elastic", as a specialized website puts it.

It is important to understand people's needs and wishes in order to design policy and to educate about the phenomenal choice of cooking options and their respective advantages and disadvantages.

Heat and Cold

People need to stay warm in winter and cool in summer. The feeling of temperature depends on many parameters including humidity, air flow, the ambient medium (at same temperature water feels cooler than air as the conductivity of water is higher), the environment (whether heat or cold is reflected or stored nearby) and individual perception. Unfortunately, heating and cooling is often applied in collective environments in a way that makes people uncomfortable, too hot in winter, too cold in summer. It is surprising that the managements of public places like hotels, restaurants, conference rooms and public transport often don't seem to have any idea of what people perceive as comfortable temperature.

More importantly, there are many people that cannot afford to make it themselves comfortable. Energy poverty is a severe and highly underestimated phenomenon even in the world's richest countries. In 2010, a young Scottish mother of a six-year-old son told the BBC:

"On a daily basis, I've had to make decisions on whether to heat my house or whether to feed my son."

Since then, energy poverty has significantly worsened in the U.K. Thousands of people die in so-called industrialized countries from sicknesses triggered from poor thermal insulation, too hot in summer, too cold in winter. The term "Excess Winter Deaths" has become a statistical unit, EWDs. In 2015, there were an estimated 44,000 EWDs in England and Wales alone, the highest level since 1999.[5] If much of the increase has been attributed to the flu virus and most of the deaths involved people over 75, an estimated 9,000 people died from respiratory and other diseases caused by insufficient heating.[6] In total, an estimated 13 million people live in conditions of fuel poverty, spending more than 10 percent of the household income for heating. In France, about 11 million people or 19 percent were living in households that complained about "being cold" in the winter

5 http://www.bbc.com/news/health-34919149
6 http://www.bbc.com/news/uk-35862763

of 2013 — an increase of 73 percent since 1996 — because they could not pay for appropriate heating, or because insulation and heating systems did not provide "thermal comfort". About one third of the housings are equipped with electric space heating, massively boosted until recently to get rid of some of the kilowatt-hours generated by the overbuilt nuclear program. Many households went bankrupt, unable to cope with ever rising electricity and gas bills. And summers can get too hot, especially for vulnerable people. The heatwave of 2003 led to the premature death of an estimated 15,000 people in nuclear France. In Germany, heating and power costs have doubled on average since 2000. Between 8 and 10 percent of the households, up to about 4 million people are living in energy poverty. Many spend more than 30 percent of total household expenditures for energy services and the expression of a "second rent" has come up.[7]

What a devastating failure of energy policy, when the richest countries on earth are incapable of keeping millions of poor people warm in winter and cool in summer.

Appropriate building standards are key. Today, buildings can be designed and built so they need little or no active heating or cooling systems, at little or no extra cost (see for example Passive House Institute at passiv.de/en/). But standards are not enough, performance needs to be systematically audited to make sure that housing infrastructure has been built to standards. The renewal rate of buildings is much too slow to address the issue, so retrofitting needs to be massively and deeply implemented. Homes guaranteeing thermal comfort not only provide the minimum environmental condition to stay healthy, they obviously also increase general well-being dramatically, and, as side effects, reduce household spending, energy consumption and greenhouse gas emissions.

Great progress has been made in the development of methodologies to significantly improve efficiency of the existing housing stock, not only for individual homes but also for entire districts (see for example the SINFONIA Project at www.sinfonia-smartcities.eu/en/project). "Cool Roofs" in the U.S. have demonstrated that by simple means, like the choice of color and material, thermal input into buildings can be dramatically reduced at limited cost.

There are countless highly efficient active heating and cooling systems that are affordable and respect the environment. The use of solar energy for space- and water-heating has greatly advanced. Solar district heating has made an impressive jump in Denmark over the past year, when the total surface of collectors has increased by 62 percent to reach 1.3 million square meters.[8] Collective solar heating is particularly attractive in cities, where urban heating infrastructure already exists and solar thermal collectors replace fossil fuel boilers. Modern biomass-based heating systems are reaching efficiency levels similar to gas or oil central heating facilities.

7 *DIW, "Auf der Suche nach Energiearmut: Eine Potentialanalyse des Low-Income-High-Costs Indikators für Deutschland", 2015.*

8 *http://planenergi.eu/activities/fjernvarme/solar-heating/*

Lighting

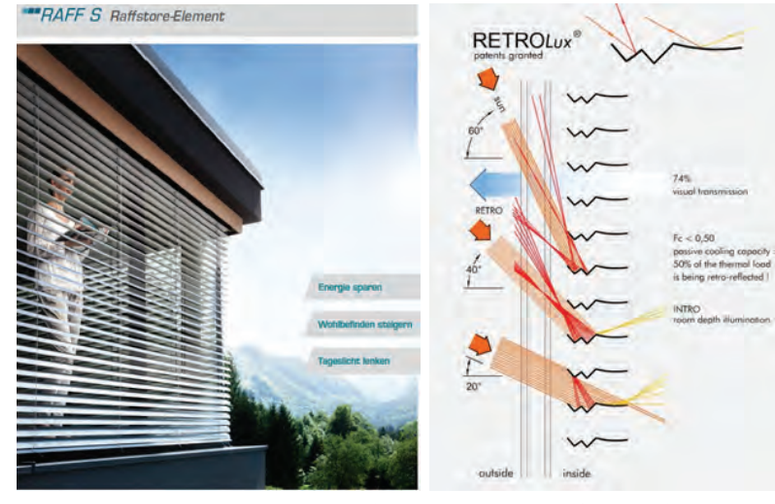
> So it would seem that having access to natural daylight is a necessity if you are to have a happy and productive workforce and therefore, should be considered in the design of any building.[9]

The best lighting source for human well-being is the sun. A major literature review by the Lighting Research Center in New York for the U.S. Department of Energy stated: "Electric light sources can be constructed to closely match a spectrum of daylight, but none have been made that mimic the variation in light spectrum that occurs with daylight at different times, in different seasons, and under different weather conditions."[10]

There are many positive aspects of daylight,[11] including the following:

- Psychologically, daylight and a view are much desired, and therefore increase the happiness factor.
- Daylight does have a greater probability of maximizing visual performance than most forms of electric lighting because it tends to be delivered in large amounts with a spectrum that ensures excellent color rendering. People that see better work better, they make less mistakes and increase productivity.

[Figure 3] **Light Transparent Blinds Keep Heat Out**



Sources: Schlotterer, "Raffstore S", www.schlotterer.at/Retro SolaR; "RETROLux", 2017

- Physiologically, daylight is an effective stimulant to the human visual system and the human circadian system, the body's internal time clock. Exposure to bright light during the day and little or no light at night will accurately entrain the circadian system, which has a direct beneficial effect on the performance of both visual and non-visual tasks.
- Exposure to daylight has positive effects on health, provided intensity is well managed. Windows that provide a view out

9 http://www.kestrelaluminium.co.uk/2016/11/15/the-impact-of-natural-light-on-wellbeing/

10 Peter Boyce, Claudia Hunter, and Owen Howlett, "The Benefits of Daylight through Windows", Lighting Research Center, Rensselaer Polytechnic Institute, New York, 12 September 2003,

11 The following is based on the excellent overview with numerous links to further literature: Kevin Van Den Wymelenberg, "The Benefits of Natural Light—Research supports daylighting's positive effect on building performance and human health", 19 March 2014; see http://www.archlighting.com/technology/the-benefits-of-natural-light_o

as well as daylight, can reduce stress and hence reduce the demand for health services. Daylight reduces the incidence of health problems caused by the rapid fluctuations in light output typical of electric lighting. Benefits of daylight exposure of school children include a decrease in dental decay (cavities), improved eyesight, increased growth, and improved immune system.[12] Daylight can also have a positive impact on certain illnesses (especially skin sicknesses like psoriasis and eczema).

- A wall containing windows or a roof with skylights cost more to construct and maintain than one without. These costs are generally offset by reductions in building operating costs, namely reduced electricity consumption for lighting and cooling. In addition, the value of the building increases.
- Daylighting of a conventionally windowless retail space can have a very positive effect on sales. A sales assessment over an 18-month period of 108 Walmart stores, all very similar in design, except that two thirds had skylights and one third had not, came to an amazing result: All other things being equal, an average non-sky-lit store reached on average 40 percent higher sales with the addition of skylights, with a range between 31 percent and 49 percent.[13]

12 *L. Edwards and P. Torcellini, "A Literature Review of the Effects of Natural Light on Building Occupants", National Renewable Energy Laboratory, July 2002.*

13 *"Skylighting and Retail Sales—An Investigation into the Relationship Between Daylighting and Human Performance", Condensed Report, August 20, 1999, HESCHONG MAHONE GROUP*

The last point highlights a key aspect. While energy savings have originally often triggered interest in retrofitting buildings with daylighting, the combined effects of increased well-being, physically and mentally, better viewing and thus significant productivity gains dwarf the economic effect of saving kilowatt-hours—even if the combination with daylight-sensing controls can reduce energy used for electric lighting by 20 percent to 60 percent. As a comprehensive 1999 study on "Skylighting and Retail Sales"[14] points out:

> A building that promises 1 percent higher productivity is likely to be far more interesting to an owner than a building that is guaranteed to use 10 percent less energy.

This is, of course, also true for our children's learning environment. Extensive studies have demonstrated that absenteeism drops and learning capacities increase significantly in day-lit schools. A study of Canadian schools reported that students had an attendance increase of 3.2 to 3.8 more days per year than the students in traditional fluorescent lighting schools.[15] In 1999, Heschong Mahon reached the following conclusion of what remains probably the largest study on daylighting effects in schools to date, based on the evaluation of about 2,000 classrooms and 21,000 students:

14 *idem.*

15 *according to L. Edwards and P. Torcellini, "A Literature Review of the Effects of Natural Light on Building Occupants", National Renewable Energy Laboratory, July 2002.*

Controlling for all other influences, we found that students with the most daylighting in their classrooms progressed 20 percent faster on math tests and 26 percent on reading tests in one year than those with the least. Similarly, students in classrooms with the largest window areas were found to progress 15 percent faster in math and 23 percent faster in reading than those with the least. And students that had a well-designed skylight in their room, one that diffused the daylight throughout the room and which allowed teachers to control the amount of daylight entering the room, also improved 19-20 percent faster than those students without a skylight.

Daylighting systems start with the choice of colors on walls, ceilings and furniture, which can reduce the need for artificial lighting by over one quarter. Obvious options are windows, transparent doors and roofs. Skylights are increasingly popular. Less known are simple light-shelves that, fixed on the outside, keep the sun out, and, on the inside, reflect sunlight to the ceiling, to sophisticated blinds—letting light in, keeping thermal load out (see Figure 3)—and highly complex mirror systems that reflect sunlight into shaded spaces between towers (see Figure 4). Sun channels or sun tubes can bring daylight into windowless rooms.

The One Central Park high-rise building in Sydney, Australia, is a superb example of combining optimized daylighting with intelligent, high-efficient LED lighting by night.

[Figure 4] **One Central Park-Reflecting Sun-and Project LED-Lights Between Towers**

Sources:

Left: Simon Wood, http://www.verticalgardenpatrickblanc.com/realisations/sydney/one-central-park-sydney;
Right: Murray Fredericks, http://www.arcspace.com/features/ateliers-jean-nouvel-/one-central-park/

Communication

The internet revolution has profoundly changed our communication tools and habits. It has also significantly influenced social behavior and traditional development patterns. In many countries, the landline stage has simply been skipped and people go straight to mobile phones. That is certainly true for much of the African continent. When my son came back from a six-month long trip through several west-African countries, he was struck by the fact that even the poorest people seem to have a mobile phone. Many had several SIM-cards, and used them according to the most favorite tariff for the destination

of the call or the type of usage. What struck me, was that my son reported that people often had to go or drive for kilometers to get their phones charged by some people that had made it a business. Collective solar charging stations, like the Solar Pump (see Figure 5), charge anything from a cell phone to a computer and even bicycle batteries. Small, solar mobile phone chargers are available for between less than $10 to over $100 (see Figure 6).

My colleague Alan Meier illustrates in a dedicated chapter how energy services are increasingly web-based and delivered or managed through the internet (see Chapter 2-4). Communication through the internet is not only increasing the means of communication. The digital world is consuming considerable amounts of energy and can save a lot of it, while increasing the service level.

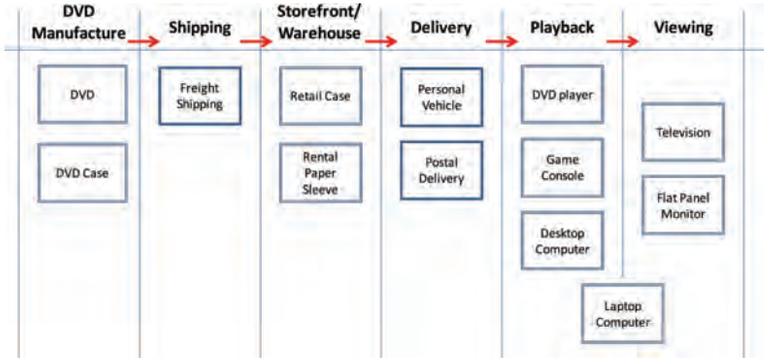
[Figure 5] Solar Multipurpose Charging Station

[Figure 6] Solar Mobile Phone Charger

Sources:
Left: http://yolkstation.com
Right: http://www.ecofriend.com/solar-pump-charging-station-to-charge-your-gadgets-on-the-go.html

The system comparison of various means to view a film, on DVD (see Figure 7) or by streaming (see Figure 8), provides an interesting example. The energy consumption — and thus indirect greenhouse gas emissions — of DVD viewing is stemming from the manufacturing, shipping, storing, delivery, the embedded energy consumption in playback and viewing devices as well as their own energy efficiency.

[Figure 7] System Diagram of DVD Viewing

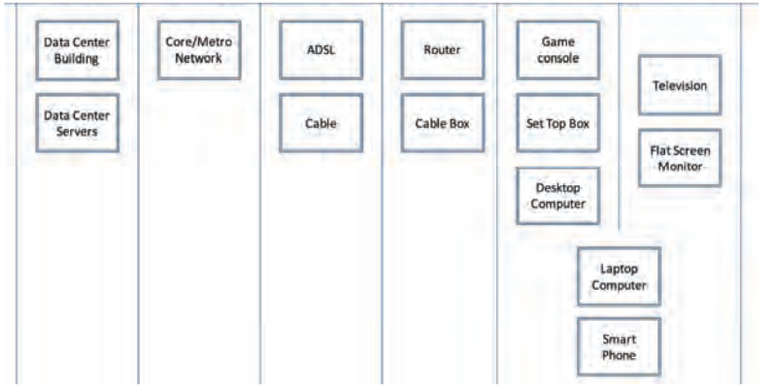


Source: Arman Shehabi et al. "The energy and greenhouse-gas implications of internet video streaming in the United States", Environmental Research Letters, Volume 9, Number 5, 28 May 2014.

In the case of streaming, the energy is consumed in the data centers, the transmission, access networks, and the viewer's equipment, from router to viewing equipment, whether television, computer or smart phone.

What is better from an energy consumption and emissions point of view, streaming or DVD viewing? There are very little differences between streaming and mail options to obtain a purchased or rented

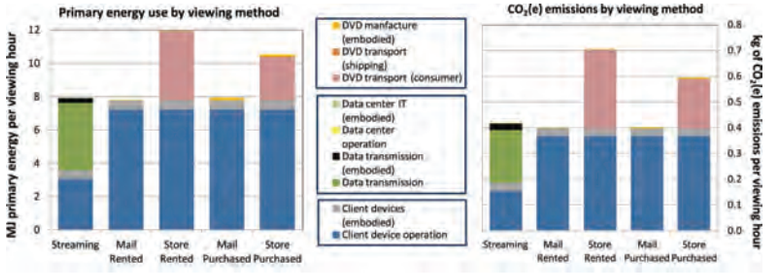
[Figure 8] System Diagram of Streaming



Source: Arman Shehabi et al. "The energy and greenhouse-gas implications of internet video streaming in the United States", Environmental Research Letters, Volume 9, Number 5, 28 May 2014.

DVD. Consumption and emissions increase substantially in the DVD case, when the consumer himself is transporting the object between the shop or a rental store and his home (see Figure 9).

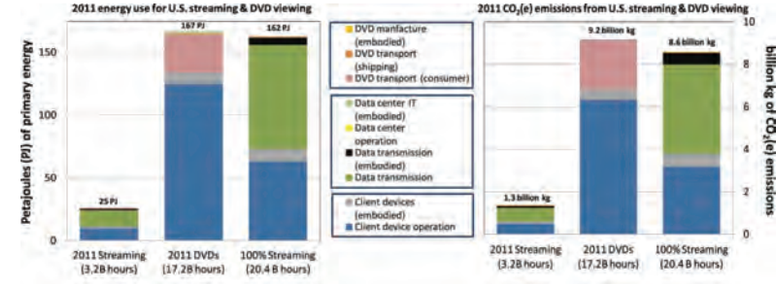
[Figure 9] Energy Consumption and Greenhouse Gas Emissions Streaming vs. DVD-Viewing-1



Source: Arman Shehabi et al. "The energy and greenhouse-gas implications of internet video streaming in the United States", Environmental Research Letters, Volume 9, Number 5, 28 May 2014.

Considering the viewing practice and electricity mix in the U.S. in 2011, the vast majority (87 percent) of consumption/emissions is due to the viewing of DVDs. According to this estimate, shifting all DVD viewing to streaming would reduce energy consumption by 30 petajoules (1015 joules)[16] and emissions by 2 billion kilograms (see Figure 10). The savings would be very large and correspond to the annual power consumption of about 200,000 U.S. households or 2 million households in the European Union.

[Figure 10] Energy Consumption and Greenhouse Gas Emissions Streaming vs. DVD-Viewing-2



Source: Arman Shehabi et al. "The energy and greenhouse-gas implications of internet video streaming in the United States", Environmental Research Letters, Volume 9, Number 5, 28 May 2014.

The problem in this study is that is does not take into account the difference in broadcasting quality. The service is not identical between the two options. While the DVD option in general provides a much

16 25 PJ + 167 PJ = 192 PJ vs. 162 PJ for all streaming

higher resolution picture, the streaming option has other advantages like time saving, mobility and flexibility. It depends what people are looking for. Likely, a different mix between streaming and the use of a solid film (or sound) support—but still a mix—would result from an optimized service offer and consumer attitude.

Information and Communication Technologies (ICT) have found their way into most of the appliances and machines we use. Microchips help operate, command and control small and large systems. How much energy computing uses is often difficult or impossible to assess, but generally less than they help saving. Stanford Professor Jonathan Koomey and colleagues write:

> For example, many clothes washers are equipped with sensors and computer technology that improve the service being delivered and save both motor and hot water energy in amounts many times larger than the electricity used by the computing equipment. Automobile engines are almost all computer controlled nowadays, which gives them higher efficiency and lower emissions than they would otherwise have. Data centers and the information services they deliver enable structural changes that increase efficiency throughout the economy.[17]

17 Jonathan G Koomey, H. Scott Matthews, and Eric Williams, "Smart Everything: Will Intelligent Systems Reduce Resource Use?", The Annual Review of Environment and Resources, Vol. 38, October 2013 pp. 311-343. [http://arjournals.annualreviews.org/eprint/wjniAGGzj2i9X7i3kqWx/full/10.1146/annurev-environ-021512-110549]

The energy efficiency of computer calculations—measured in computations per kilowatt-hour—has made extraordinary and very regular progress, doubling every 1.6 years from the mid-1940s to 2009. This makes it a 13-orders-of-magnitude improvement over the period. And significant progress is, if not certain, still possible. This does not say anything about task efficiency, standby power consumption or battery performance, all factors that impact the service level of the device, all significantly improved over time with no end in sight.

Koomey et al. list 15 capabilities and services that ICT enables or greatly improves:

1. Near-zero marginal cost of reproduction and distribution
2. Quicker publishing
3. Easier sharing of data
4. Quicker review of technical material
5. Easier ordering and distribution
6. Direct feedback from suppliers to consumers (and vice versa)
7. Indirect feedback from consumers to suppliers (through data collection)
8. Collaboration among users
9. Access to information 24 hours per day
10. Universal searching
11. Easier and more widespread public access to technical information
12. Dematerialization of products and services

13. Improving measurement and verification of processes

14. Improving the speed and accuracy of analysis

15. Enabling more rapid institutional change

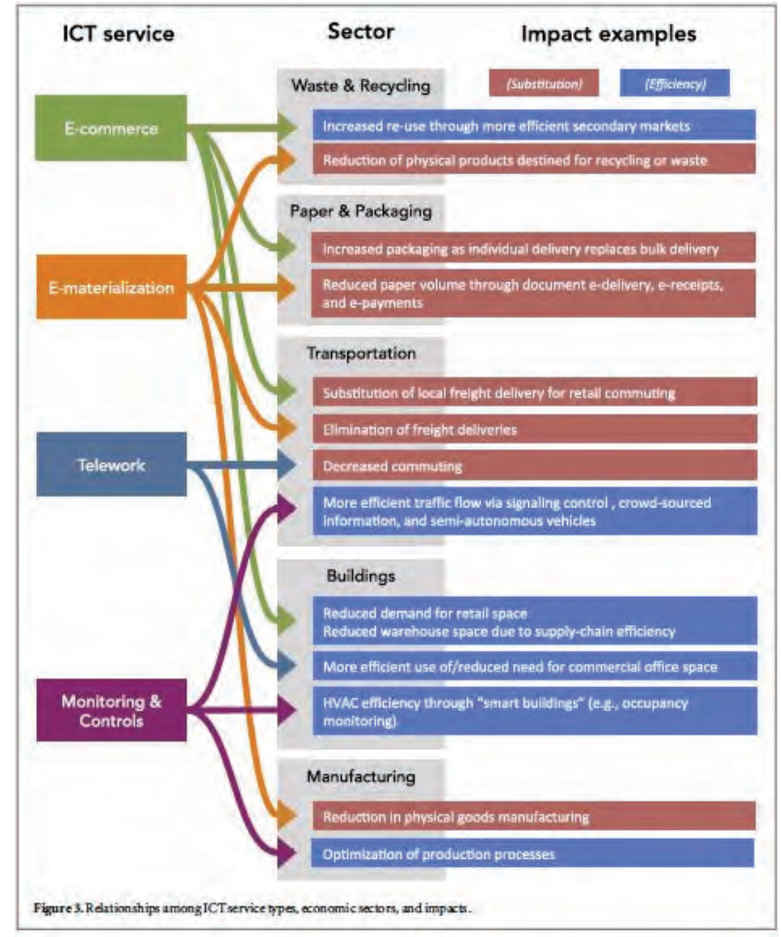
[Figure 11] **Cell-Phone Controlled Smart Bulb**

Source: The Wire Cutter, "The Best Smart LED Light Bulbs", 10 February 2017
[http://thewirecutter.com/reviews/best-smart-led-light-bulbs/]

Many of these services have the potential to positively impact the economy, the environment and the level of well-being. But as the dematerialization of services, for example, often entails great benefits, sometimes social consequences outweigh the positive effects and it remains crucial to assess performance holistically to make the right choices.

The following illustration (see Figure 12), elaborated by Nathaniel C. Horner and colleagues of the Climate and Energy Decision Making

[Figure 12] **Impacts of Information & Communication Technologies (ICT)**



Sources: Nathaniel C. Horner et al., "Known unknowns: indirect energy effects of information and communication technology", Environ. Res. Lett. 11, 2016.

Center, Carnegie Mellon University, illustrates a series of examples on how ICT services can influence various sectors, either by improving efficiency or by substituting physical performance by electronic service.

Mobility

> The surest way to improve mobility is to reduce the demand for private motor vehicle use, promote walking for short trips, cycling and local transit for medium-length trips, and regional transit for longer trips.[18]

Traditionally, mobility services are labelled 'transports', shipping goods or people over distance. In fact, the term mobility is more appropriate as the task is rather moving 'things', whether objects, services or people from A to B. The first question should be, if there is an expressed need to move things from A to B, what is available or needed at B that is not available or needed at A?

A decade ago, there were two bicycle stores in the 30,000-population city in the suburbs of Paris, France, where I live. Today, there is none. As I don't have a car and I don't have the time to establish my own home bike-repair, whenever my bike breaks down beyond a flat tire, I need to borrow a car—I don't own one—load my bike and drive to the next repair shop. Is this logical? Efficient? Certainly not. Fortunately, there are some young, enthusiastic people that just started a non-profit bike-repair in-town. I'm proud to have been their first customer.

In constantly growing urban areas people move daily over millions of person-kilometers from home to work, from work to shopping, from home to friends, leisure and vacation.

People, objects or services are shipped from A to B either because the service is not available at B at all, or not in the same quality or at the same price (not only in the monetary sense) as in A. The mobility debate is however limited mainly to the question of transport mode rather than to the purpose itself. City planners compare modal options how to get from A to B, by car, by bike, by tram, by subway, or by bus. Rarely, or too late, they ask the basic underlying question: why do people want to go from A to B? Are there any means to bring B to A, or, at least closer to A? Are there means to get the same service from C, already closer to A or providing even superior service?

I have visited a small community in Austria that succeeded in maintaining a cheese factory and a restaurant in town by collectively deciding to support the establishments. The cheese factory was modernized with local subsidies, it integrated a brand-new shop and a beautiful meeting room to service local clients. The move kept the jobs in the community, reduced transport needs and increased the service level at the same time. And, of course, energy consumption and emissions dropped.

Often urban development boosts mobility needs, rather the opposite of what should be the goal to begin with. In Paris La Défense, planners have created the largest business district in Europe with 3.5 million square meters (37.5 million sq. ft.) of office space and 180,000 employees in over 500 large companies. But living space, shops, restaurants and cafés have only been added by and by and remain

18 *Global Designing Cities Initiative/National Association of City Transportation Officials, "Global Street Design Guide", Island Press, October 2016.*

far below requirements. Currently, only about 40,000 people are living in the area and 500 new homes are added per year. The high concentration of office space created a huge need for urban transport and the local trains to La Défense are notoriously overcrowded (see Figure 13). One million people take the main east-west connection (RER A) every day, and the capacities are more than saturated. As in many other cities, problem-solving attempts have been focused on raising transport capacities—more trains, longer trains, in combination with tramway, buses, cars, etc.—rather than improving conditions that render mobility obsolete. Transport capacities are always finite, whatever mode is favored.

[Figure 13] **RER A in Paris—Chronically Overcrowded**

Source: Le Point, 2008

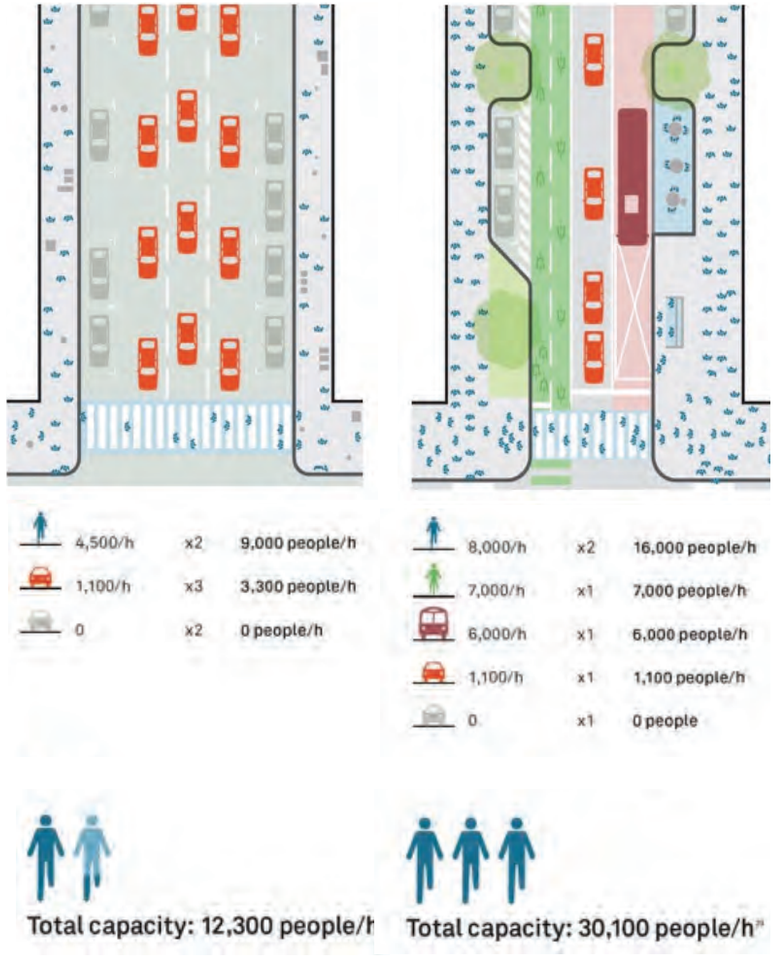
Urban planning always should put people first and define targets that increase well-being and happiness factor. Energy consumption and pollutant emissions will fall automatically if the response strategies are intelligent. The balanced re-densification of service offer, from housing to leisure, from job-offers to shopping opportunities, allows to reduce distances that bring (back) in walking and biking as strategic mobility options. The Seoul Metropolitan Government's Sustainable Energy Action Plan rightly defines the objective as to "establish transport culture by prioritizing pedestrians and bicycles". However, the goals and pace of implementation could be significantly more ambitious.

Opening-up and widening the walking and cycling options has multiple benefits. The pre-conditional push-back of the individual combustion car significantly reduces space use, municipal investment needs, energy consumption and air pollution.

The capacities of car-oriented streets and multimodal streets are very different. The following two diagrams (see Figure 14) from the Global Street Design Guide illustrate the potential capacity of the same street space when designed in two different ways. In the first example, most of the space is allocated to personal motor vehicles, either moving or standing. The second shows a multi-modal street that radically reduces the space allocated to individual cars—without banning them—and redesigns space in a people oriented way: increasing access to services, reducing air pollution, raising visual attractiveness with trees and cafés, and allowing for higher people density in a higher quality environment. The flow capacity in this example increases by a factor of 2.5 to over 30,000 people per hour, most of them pedestrians and bike riders.

The Global Street Design Guide, developed jointly by the Global Designing Cities Initiative and the US National Association of City Transportation Officials is a wonderful toolbox for urban planners laying out basic principles applicable anywhere.

[Figure 14] Car-oriented Versus Multi-modal Street



Source: Global Designing Cities Initiative/National Association of City Transportation Officials, "Global Street Design Guide", Island Press, October 2016.

Motor Force

The first energy luxury of mankind was the use of the animal for traction and transport. Indeed, the energy efficiency of man—the capacity to transform absorbed calories into work energy—is much greater than in the case of working animals like horses and cows. Mankind has used simple machines for thousands of years, but it is the steam engine that provided the key ingredient of the industrial revolution. Today, motorized machines — increasingly electricity driven — have invaded every single aspect of society, from toothbrush to tunnel drilling machine, from kitchen robot to car factory. The combination of sensors, electronics and communication technologies allows for an unprecedented level of services in all areas of life.

And yet, daily life is full of examples, where the use and implemen-tation of motor force are not based on thorough service-need assessment and cost-benefit evaluation.

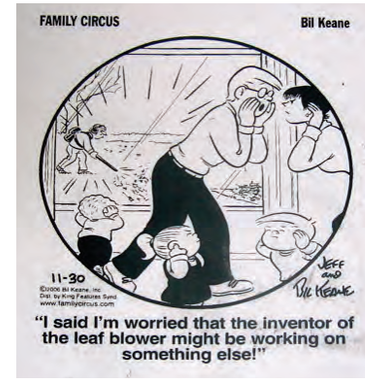
In the early 1980s, a French development project financed and installed a solar pumping system in rural western Africa. To the great surprise and dismay of the project management, only a few months after the successful inauguration, they found the facility destroyed. The women of the surrounding villages — the very group of people that had profited most from the pump, as they did not have to carry water from the well anymore — had smashed the installation to pieces. It took a while to find out what happened. The women felt they had been robbed of their main meeting point, where they used to chat and

exchange local news. The French "development assistants" had no idea of the social and cultural background of "the well".

Source: homesteaddreamer.com

In the U.S., it took a "Right to Dry" movement, a "Drying for Freedom" film documentary and a "National Hanging-Out Day" to convince legislators in various states, including Colorado, Florida, Hawaii, Maine, Utah and Vermont, to introduce legislation outlawing the ban of clotheslines. Further 13 U.S. states, including California, have had "solar access laws" for a long time, that are now being re-interpreted as allowing for a "solar clothes-drying device"— clothesline or drying racks. In many cities and residential areas in Canada and the U.S., it remains prohibited to dry clothes outside in sun and wind. Households have been forced to use drying machines, especially in the 300,000 private residential communities housing some 60 million people, "because many people viewed it as an eyesore, not unlike storing junk cars in driveways, and a marker of poverty that lowers property values", as the New York Times put it.[19] Drying clothes outside has in fact many advantages. It is healthier, as the sun kills bacteria; safer, as dryers cause more than 12,000 residential fires in the U.S. annually; air-dried cloth smells and feels better; saves a lot of energy, as American households use between four percent and over ten percent of their annual power consumption to dry clothes (more than to cool food); and obviously, it avoids all the emissions that come with electricity generation.

There are many machines that seem to miss the service point. "We nominate the leaf blower as one of the worst inventions ever", Californian company Terra Nova Ecological Landscaping states on its website.[20] Many cities in the U.S., including large cities like Los Angeles, have leaf blower bans in place for decades. The two Californian cities Belvedere and Berkeley banned blowers as early as 1987 and 1991 respectively.



Source: homesteaddreamer.com

In other countries, blower bans remain the exception. Graz, second largest city in Austria, has outlawed the use of the noisy machines in 2014. In Germany, the same year, the attempt to prohibit blower use failed in Bavarian parliament, but their use in the country is limited to certain hours during weekdays. In most countries, there is no specific legislation, and the use of leaf blowers is simply regulated by general

19 New York Times, "Debate Follows Bills to Remove Clotheslines Bans", 10 October 2009.

20 http://www.terranovalandscaping.com/services-dim/

restrictions on noise.

Noise pollution is highly detrimental to human well-being, and can lead to serious health problems, from hearing impairment to psychological disorders, evere stress symptoms and cardiovascular problems. Blowers also whirl up fine dust, cause exhaust pollution and consume energy, mostly gasoline. The use of a much cheaper rake or broom takes longer, but provides exercise in fresh air, contributing to the fitness of the tree-owner. The benefits of machine use always need to be weighed against nuisances and costs.

Some Guiding Principles

The definition of principles for the successful implementation of energy policy is a challenge. The following attempt is not meant to provide a comprehensive list of ingredients, but rather a selection of basic principles that should orient energy policy.

People First!

Energy policy shall serve the people first. Well-being needs to be put into the center of attention. Well-being and the happiness factor are well-studied fields. Research results in these fields need to be integrated into the approach on energy services. What's the point of "energy access", a plug in the wall, an oil tank in the basement, if people are too poor to pay for power and oil? The challenge is to make sure that people have access to cooked food, that they are warm in winter and cool in the summer, that lighting is efficient at work and at home, that shopping, leisure and social services are in reach, that information and communication options keep developing and that machines take over human force wherever benefits outweigh costs.

Assessing Energy Service Needs

The first of a long list of recommendations that the Seoul International Energy Advisory Council (SIEAC) formulated for Seoul Mayor Park Won-soon and his Municipal Government over the past three years was:

> To identify service demand and to make an explicit goal of providing all its citizens of Seoul with intelligent energy services—affordable, sustainable, reliable and user-friendly. People need service security for cooked food, heating and cooling, lighting, mobility, communication and motive force, not kilowatt-hours, barrels of oil, or cubic meters of gas.

It is indispensable to develop a deep understanding of people's service needs to formulate intelligent and effective energy policy strategies. This approach is still lacking in Seoul just as in most cities.

Developing Master Plans

Energy strategies should be co-constructed (in the sustainable

development sense) based on scenarios illustrating which options lead where that are debated openly with the various components of civil society. Goals are defined qualitatively and quantitatively and intermediate goalposts are defined. Master planning is an appropriate tool for the purpose as illustrated in cities like Sydney, Australia. Seoul has developed a far-reaching participatory process, but could improve implementation conditions with the elaboration of master plans.

Prioritizing Passive Energy Solutions

Passive energy concepts optimize the potential to cover energy services needs before adding primary energy sources to the system. Appropriate insulation reduces or even eliminates the need for active heating or cooling systems. Modern, super-efficient windows can achieve a positive thermal balance, gaining more heat than they lose and avoiding cooling needs through proper shading. A white roof can reduce or even eliminate the need for air-conditioning. Daylight harvesting should be optimized as a first step towards efficient and comfortable lighting. Prioritizing walking and biking over motorized modal mobility concepts — whatever the primary energy and energy carrier for the motors are — always pays off. But remember that prioritizing one option does not necessarily mean excluding another option.

Setting Ambitious Standards and Norms

Standards and norms, whether in the agro-food industry, the building sector, transport or communication, are an indispensable first step that can trigger a dynamic of rapid improvement. In many cases, it is crucial that any substantial work on infrastructure — like retrofitting insulation and efficiency measures in existing homes or industrial plants — is optimized in one go. People won't do it twice, so the first time needs to be the right one.

Boosting Education and Training

All regulation is useless if the full implementation chain is not guaranteed. That means education and training on all levels of society need a very major overhaul. What are technological improvements worth if the people that are supposed to apply them have no idea how they work. In the age of LEDs, most people — including interior architects and craftsmen that are supposed to design and implement the systems — still don't know what a lumen is. Regulators are generally ignorant (yet) when it comes to profit of the vast opportunities that properly designed micro-grids can offer. Universities and engineering schools should play a much bigger role. They are the ideal places to develop, design, demonstrate, implement full-scale innovative energy systems and provide continuous education.

Getting Sequencing Right

Any roof has a limited surface. The higher population density, the smaller the roof surface per capita. The roof is a formidable collector of resources, from daylight to rain water, from solar heat to solar

power. These options will compete with one another, not only in terms of usable surface but also in terms of necessary capital investment. It is therefore important to carefully assess, which is the right sequence of implementation according to a clear catalogue of decision-making criteria.

Prioritizing Local Over National Schemes

The detailed analysis of energy service needs is particularly valuable on the local level. And the shorter the distance, the higher the efficiency of delivery and the lower the losses in the system, whether it is food production and processing, heat and cold or power generation and distribution. Optimizing local systems first, then complementing with resources drawn from larger distances. Adapting regulations that allow for balancing of heat/cold and electricity needs through connections between neighbors, communities, cities. Clustering micro-grids before tapping into interregional power grids.

Rendering Auditing Compulsory

Only qualified independent auditors can find out whether the requirements of standards are met in practice. The most energy efficient building design or industrial retrofitting concept is worthless if implementation is sloppy.

Combining Services

Many of the smartest energy service solutions are combining individual services. Combined Heat and Power (CHP) or cogeneration facilities recover and re-inject waste heat from power plants into urban heating or industrial heat use. Trigeneration systems add chillers to cogeneration systems and make use of waste energy to generate cool water or air. The cook stove that heats the house has been around for centuries. Modern lighting systems, passive and active, generate less heat — in other words, they contribute to cooling. Computing generates heat that can be usefully put to work for space heating.[21] Energy harvesting, that is the recovery of energy generated as a side-effect of a specific activity, is attracting increasing attention. Body heat from travelers is systematically recovered at Stockholm train station to heat a building. A Tokyo railway station has generated power via piezoelectric tiles for over ten years. In 2014, California commissioned a study into large-scale road-based applications of the system. In brief, the technical possibilities are endless.

21 The concept has been successfully implemented on a large scale by Paris-based company QarnotComputing.

Dilip Limaye

President, SRC Global Inc.

Mr. Limaye is President and CEO of SRC Global Inc. and is internationally recognized as a pioneer and an entrepreneur with over 40 years of experience in energy efficiency (EE), renewable energy (RE), and energy service companies (ESCOs). He is a senior advisor and consultant to the World Bank, Asian Development Bank, IFC, IEA, UNEP, UNDP, USAID and other donor agencies on financing and implementation of clean energy to mitigate climate change impacts. His recent work has focused on financing and implementation clean energy in buildings and has included a Guidebook on EE financing for China and the development of a UNEP Guidebook on Financing Sources for Climate Change Mitigation. He was the co-author of two recent books published by the World Bank, one on financing performance contracting projects in public buildings, and the other on leveraging commercial financing for clean energy projects in Asia. He has edited or co-authored eight other books and has presented over 40 technical papers at international conferences.

He has extensive experience in energy efficiency in buildings and industry. He recently completed a major project funded by the Asian Development Bank to identify, develop and implement energy efficiency options in buildings in the Pacific nations. As part of this project, he co-authored a Guidebook on Energy Efficiency in Public and commercial Buildings. He was also a co-author of a major World Bank report on Scaling Up Energy Efficiency in Buildings in Eastern European countries.

He has served as a Board Member of A-Power Energy Generation Systems, the largest alternative energy company in Asia, and Board Chairman of Photonix Solar, a solar PV company, and Online Energy Manager, an international energy efficiency technology company. He graduated from IIT-Bombay and was awarded the President of India Gold Medal. He has a Master's degree in Engineering from Cornell University and has conducted doctoral studies in international business at the University of Pennsylvania's Wharton School and in alternative energy at Drexel University. He has also completed the Executive Program on Global Climate Change and Economic Development at Harvard University.

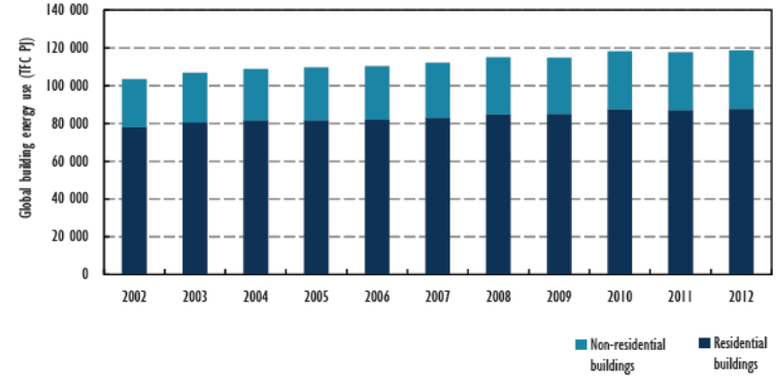
Building Energy Efficiency: Technologies and Business Models

Dilip R. Limaye (President, SRC Global Inc.)

INTRODUCTION

Buildings consume about 40 percent of the world's total energy consumption and are therefore major sources of worldwide greenhouse gas (GHG) emissions.[1] The need for commercial buildings (health, education, leisure, and government, among others) increases as populations, economies and incomes grow, and developing country growth outpaces OECD growth in those categories. In addition, with the trend towards increased urbanization, particularly in developing countries, a large number of new buildings will be constructed, and most of these will last for well over 30 years. In residential buildings, with rising incomes and a natural preference for comfortable indoor air temperatures, air conditioning use is increasing rapidly. As consumers invest in air conditioning and other new energy-using appliances, residential energy consumption will increase further. Global energy use in buildings has increased by about 20% in the last ten years, as shown in Figure 1 and the trends mentioned above are likely to lead to substantial growth in building energy consumption and it is estimated that energy consumption in buildings will double by the year 2050 unless substantial efforts are devoted to improving energy efficiency in buildings.[2]

[Figure 1] Global Growth in Building Energy Consumption, 2002-2012



1 *International Energy Agency, World Energy Outlook, Paris, 2015*

2 *Energy Information Administration, International Energy Outlook - 2016, Washington, DC, 2016*

Major Energy end uses in buildings

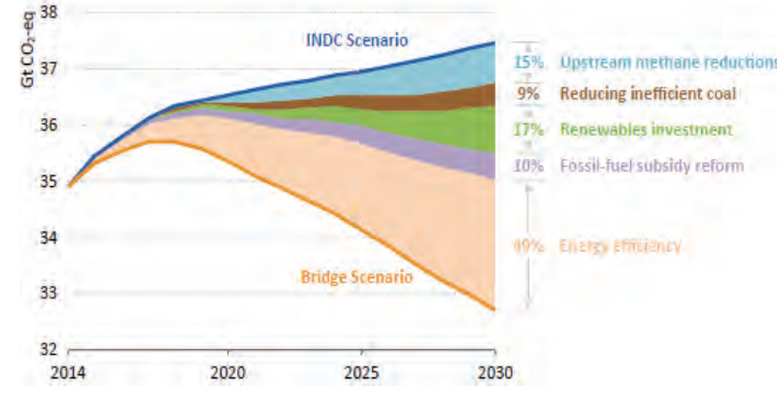
The major energy end-uses in buildings are:

- Lighting
- Air conditioning
- Space heating
- Refrigeration
  - – Water heating
  - – Cooking
  - – Computers and office equipment
  - – Appliances
  - – Electronics
  - – Other miscellaneous devices.

Importance of energy efficiency

Energy efficiency has been recognized as the most cost-effective option for mitigating climate change. In 2009, the parties to the U.N. Framework Convention for Climate Change (UNFCCC) agreed to the long-term goal of holding the increase in global average temperature below 2°C relative to pre-industrial levels (the "450 parts per million (ppm) scenario"),[3] and that deep cuts in global greenhouse-gas emissions are required to achieve this. Measures to improve energy efficiency (EE) were estimated account for a very large portion (57%) of the abatement through 2030.[4] In 2015, the parties agreed to develop Intended Nationally Determined Contributions (INDCs), leading to the development of IEA's INDC scenario.[5] IEA then developed a near-term strategy, building on available technology and five proven policy measures, which are developed and illustrated in a "Bridge Scenario" (see Figure 2), that represents an important first step to move the energy world towards a path consistent with the achievement of the 2°C scenario.

[Figure 2] **Contribution of Energy Efficiency in Mitigating Climate Change**



Source: Adapted from International Energy Agency, World Energy Outlook.

3 UNFCCC, Basic Facts and Figures, https://unfccc.int/essential_background/basic_facts_figures/items/6246txt.php

4 International Energy Agency, World Energy Outlook - 2009, Paris, 2010.

5 International Energy Agency, World Energy Outlook: Special Report of Energy and Climate Change, 2015

As shown in Figure 2, among the policy measures considered, energy efficiency will contribute by far the most (49%) of the GHG reductions. Improved EE in buildings is likely to make a major contribution to the needed GHG abatement.

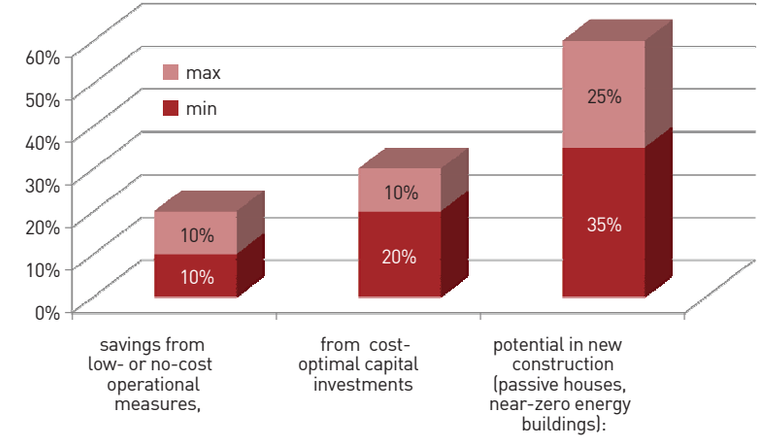
Energy Efficiency Opportunities in Buildings

Both existing buildings and new construction are often inefficient. Reasons for inefficiency may include:

- Poorly insulated building envelope
- Inefficient windows and doors
- Infiltration of outside air
- Poorly designed heating, ventilation and air conditioning (HVAC) equipment
- Poor maintenance of energy-using equipment
- Use of inefficient lighting devices and insufficient use of daylighting
- Inefficient office equipment
- Poor control of installed mechanical equipment.

Building energy efficiency can be improved by implementing a wide range o measures. The potential for energy efficiency improvement can be as much as 60% (see Figure 3). Potential energy reduction from the low- or no-cost measures can be between 10% and 20%, and investments in the medium cost measures can reduce energy by about 20-30%. Other cost-intensive measures can reduce building energy use up to 35-60% and can readily be adopted in newly constructed buildings or during comprehensive thermal modernization.[6]

[Figure 3] Potential for Improved Energy Efficiency in Buildings



Source : World Bank, Energy Efficiency in Public Buildings, Washington, DC, 2013

Benefits Of Energy Efficiency

Implementation of energy efficiency options in buildings in developed as well as developing countries has demonstrated that

6 *World Bank, Energy Efficiency in Public Buildings, Washington, DC, 2013*

energy efficiency can be a very attractive option for:

- reducing building operating costs and freeing up budgets for other investments
- mitigating the impact of energy price increases and volatility
- reducing air and water pollution from energy supply and use
- slowing the growth in energy consumption, thereby helping to increase system reliability and reduce need for new energy supplies
- improving local environmental quality
- mitigating global climate change impacts
- contributing to job creation and economic development
- capturing lost EE opportunities in new construction.

Typical energy-efficient technologies and measures for buildings

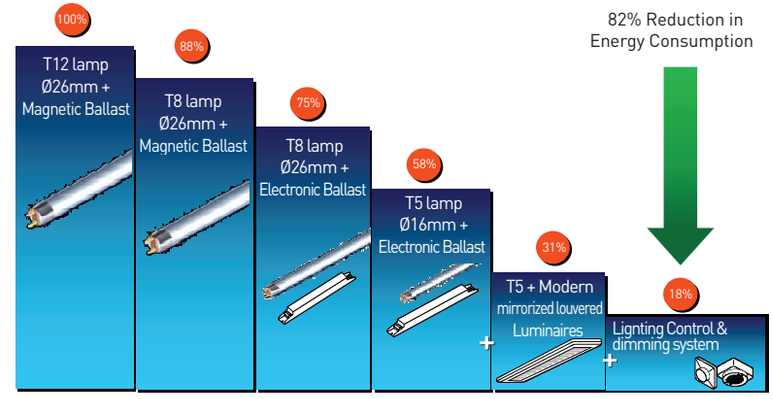
Simple housekeeping measures

A wide range of options is available for improving energy efficiency in buildings. Some of the simplest measures are low-cost or no-cost measures referred to as "good housekeeping". These include reviewing and modifying operating procedures for energy equipment, removing redundant lighting fixtures, switching off unnecessary loads (e.g. lights, office equipment), and information and awareness raising of building maintenance personnel.

Lighting

There has been enormous improvement in lighting technologies in the last two decades. An example of improving lighting efficiency is shown in Figure 4, which shows that by combining measures such as electronic ballasts, T-5 lamps (and now LEDs), improved luminaires, and lighting controls, there can be a reduction of 82% compared to T-12 lamp with a magnetic ballast, which is commonly used in many existing buildings.

[Figure 4] Example of Improving Lighting Efficiency



Source: IIEC, Guidebook on Building Energy Use, prepared for the Asian Development Bank, Manila, 2014.

There are many other emerging lighting technologies that can provide significant savings in lighting energy consumption (see Figure 5)

[Figure 5] Emerging Lighting Technologies

Application in general lighting	Energy saving through innovative lamp technologies			~savings / lamp / year*
Street lighting	Mercury vapor	~40%	High-pressure sodium lamp	220 kWh / 110 kg CO_2
Office & Industry Lighting	Fluorescent lp. w. halophosphate phosphor	~65%	New T5 fluorescent w/ electronic control & light management	180 kWh / 90 kg CO_2
Shop lighting	3 Standard Halogen lamps	~80%	New Ceramic metal halide lamps	500 kWh / 250 kg CO_2
Hospitality Spotlighting	Low voltage halogen reflector	~30%	Dichroic Halogen lamp with infrared coal technology	60 kWh / 30 kg CO_2
Household lighting (private)	Standard Incandescent	~80%	Compact fluorescent	50 kWh / 25 kg CO_2
		~30%	Halogen Energy-Saver	18 kWh / 9 kg CO_2
Lighting design	Low voltage halogen reflector	~50%	White LED Module COINlight OSTAR	45 kWh / 22 kg CO_2

Source: Wolfgang Grigor, Towards a New Culture of Lighting, Presentation to the World Bank, Washington, DC, 2012

Building Envelope Measures

The design and construction of the building envelope affects both energy consumption and the comfort and productivity of occupants. Common problems in many countries include leaky windows, glare from inappropriately oriented or un-shaded windows, excessive heat gain, and uninsulated walls and roofs.

Technologies that can provides substantial gains in energy efficiency include:[7]

- high levels of insulation in walls, roofs and floors to reduce heat losses in cold climates and heat gains in warm climates
- high-performance windows, with low thermal transmittance for the entire assembly
- highly reflective surfaces in hot climates, including both white and "cool-colored" roofs and walls
- properly sealed structures to ensure low air infiltration rates, with controlled ventilation for fresh air.

Building Energy Management Systems

Building energy management systems (BEMS) are computer-based control systems that control and monitor a building's mechanical and electrical equipment such as heating, ventilation, lighting, etc. Sometimes referred to as building management systems (BMS), they connect the building services plant back to a central computer to allow automatic control of on/off times, temperatures, humidity etc. Cables connect the plant through a series of hubs called "outstations" around the building back to a central supervisor computer where building operators can control the building. Software provides control functions, monitoring, alarms and allows the operators to optimize building performance. BEMS are a critical component to managing energy demand, particularly in large complex buildings and multi-building sites.[8]

The advantages of a BEMS include:

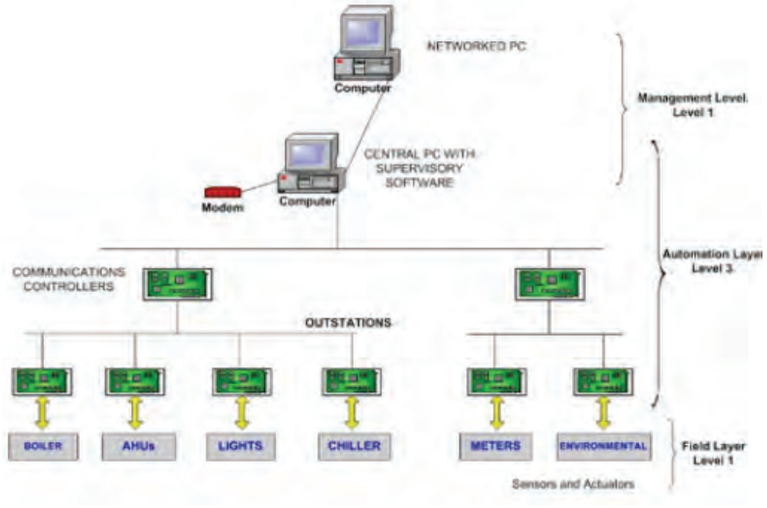
7 *International Energy Agency, Technology Roadmap: Energy Efficient Building Envelope, Paris, 2013.*

8 *The Energy Institute, Building Energy Management Systems, https://www.energyinst.org/filegrab/?ref=3120&f=EI%2FEIBI+9.5*

- It provides energy analysis, management and control information.
- It enables equipment, air conditioning, lighting, etc. to be switched on and off automatically.
- It optimizes space heating within the building.
- It allows monitoring of equipment status and environmental conditions.

A typical structure is shown in Figure 6.

[Figure 6] **Typical structure of BEMS**



Source: Sustainable Energy Authority of Ireland[9] Technical Guidance: Building Energy Management Systems.

9 *Sustainable Energy Authority of Ireland, Technical Guidance: Building Energy Management Systems. http://www.seai.ie/Your_Business/Technology/Buildings/Technical_Guidance/BEMS/#BEMSn*

Replacing Inefficent Equipment

The efficiency of energy-using equipment (such as chillers, boilers, motors, pumps and refrigeration equipment) varies considerably. Replacing inefficient equipment with efficient counterparts can lead to significant energy savings. Table 1 shows typical efficiencies of a range of energy equipment.

[Table 1] **Equipment Efficiencies**

List of Equipment	Low Efficiency	Baseline Efficiency	High Efficiency
Air Dryers	50%	75%	94%
Air Handling Unit	50%	75%	92%
Boiler	50%	75%	96%
Chillers	50%	75%	90%
Compressor	25%	50%	75%
Cooling Tower	50%	75%	90%
Fans / Blowers	25%	65%	80%
Furnaces	50%	75%	90%
Heat Exchanger	10%	75%	90%
Heat Pumps	25%	75%	90%
Motors	50%	75%	98%
Pump	25%	65%	80%
Refrigeration Eqpt.	50%	75%	94%

Source: The World Bank

Heating and Cooling Systems

Efficiency of heating and cooling systems can be improved by measures such as:

- Replacing inefficient equipment with high-efficiency equipment
- Installing effective controls
- Reducing losses from uncontrolled air leaks in the building envelope
- Using high efficiency motors and variable speed drives in air handling equipment
- Using advanced technologies such as:[10]
  - Solar heating and cooling
  - District cooling systems
  - Geothermal heating
  - High efficiency absorption cooling
  - Renewables-based cooling systems

Daylighting and Passive Solar Systems

Daylighting is the practice of using natural sunlight through placement of windows or other openings and reflective surfaces so that during the day natural light provides effective internal lighting, thereb0y maximizing visual comfort. Daylighting saves energy by reducing the use of electric lighting.[11]

10 Renewable Heating and Cooling European Technology Platform: http://www.rhc-platform.org/

11 International Energy Agency, Daylighting in Buildings, Paris, 2010.

An illustrative example of daylighting is shown in Figure 7.

[Figure 7] **Example of Daylighting**

Source: Integrated Design Lab, Puget Sound

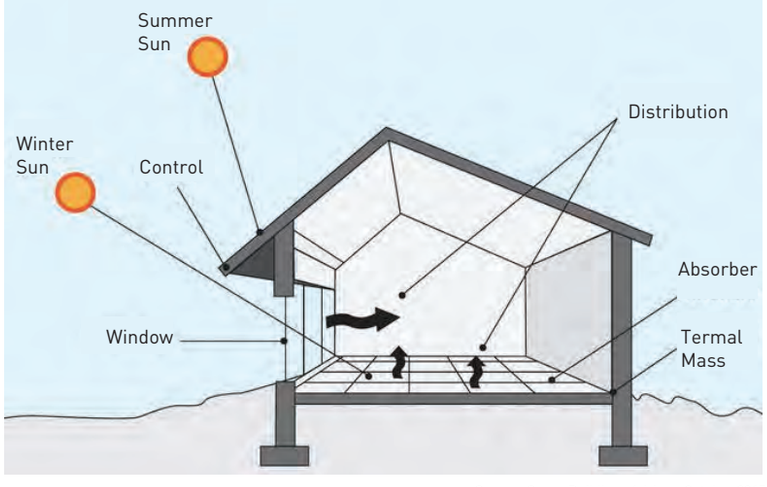
Since the amount of daylight varies in intensity and quality at different times of the day, the design of the building needs to consider how much variation is desirable or can be tolerated. Lighting requirements can be very strict for certain uses, e.g. in museums, but are more flexible in most applications. To provide good lighting there are three factors that should always be considered: the quantity of light, quality of light, and its distribution.

Passive solar design refers to the use of the sun's energy for the heating and cooling of buildings. In this approach, the windows, walls, and floors of a building take advantage of natural energy characteristics created by exposure to the sun to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the

summer. Passive solar systems are simple, have few moving parts, require minimal maintenance, and require no mechanical systems.

Operable windows, thermal mass, and thermal chimneys are common elements found in passive design. Operable windows are simply windows that can be opened. Thermal mass refers to materials such as masonry and water that can store energy for extended time. Thermal mass will prevent rapid temperature fluctuations. An illustration of passive solar design is provided in Figure 8.

[Figure 8] **Illustration of Passive Solar Design**

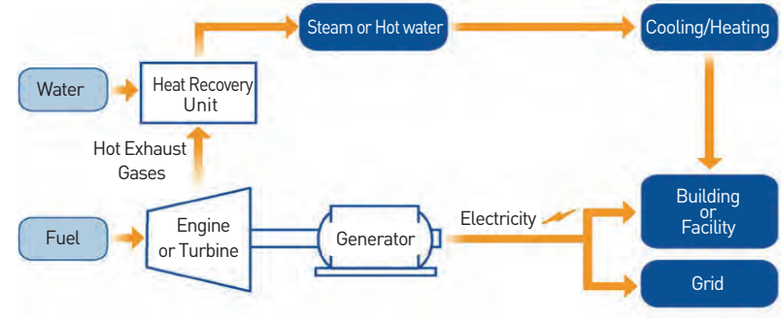


Source: Green Buildings Advisor, October 2015

Cogeneration and Trigeneration

Cogeneration technologies (also known as combined heat and power or CHP) produce two forms of energy (generally electricity and thermal energy) from a single fuel source such as natural gas or biomass. In buildings, cogeneration can achieve energy savings of 20 to 40% by utilizing the heat energy that is normally wasted in the electricity generation process.[12] An illustration is provided below.

[Figure 9] **Schematic Illustration of Cogeneration**



Source: U.S. EPA, Combined Heat and Power Partnership

Cogeneration can offer the following benefits:

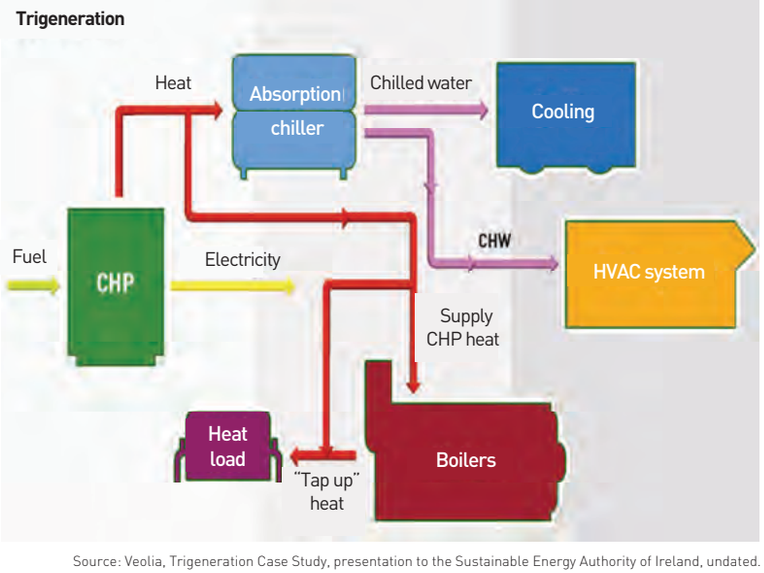
- Reduced GHG emissions to the environment
- Cost savings
- Decentralized forms of electricity generation, where plants are designed to meet the needs of local consumers, providing high efficiency, avoiding transmission losses, and increasing system flexibility.
- Improved security of energy supply.

12 *Cogen Europe, http://www.cogeneurope.eu/what-is-cogeneration_19.html*

Trigeneration is an advanced form of cogeneration which produces three forms of energy (generally electricity, hot water, and chilled water) from a single energy source. In such a system, a cogeneration plant producing heat and power is combined with an absorption chiller. Heat from the cogeneration plant is partly used to produce cooling with the absorption chiller. The system can use steam or low pressure hot water depending on the model. The cooling works best with steam and is generally used for air conditioning purposes.

The viability of such a system will depend on the mix and timing of the requirements for heat, cooling and electricity. A schematic illustration is shown in Figure 10.

[Figure 10] Schematic Illustration of Trigeneration



Source: Veolia, Trigeneration Case Study, presentation to the Sustainable Energy Authority of Ireland, undated.

Renewable Energy Systems and Net Zero Energy Buildings

Buildings can also benefit from the installation of renewable energy systems, including:

- Rooftop solar photovoltaic (PV) systems for generation of electricity on site
- Solar thermal systems for providing hot water
- Rooftop wind energy systems for on-site electricity generation.

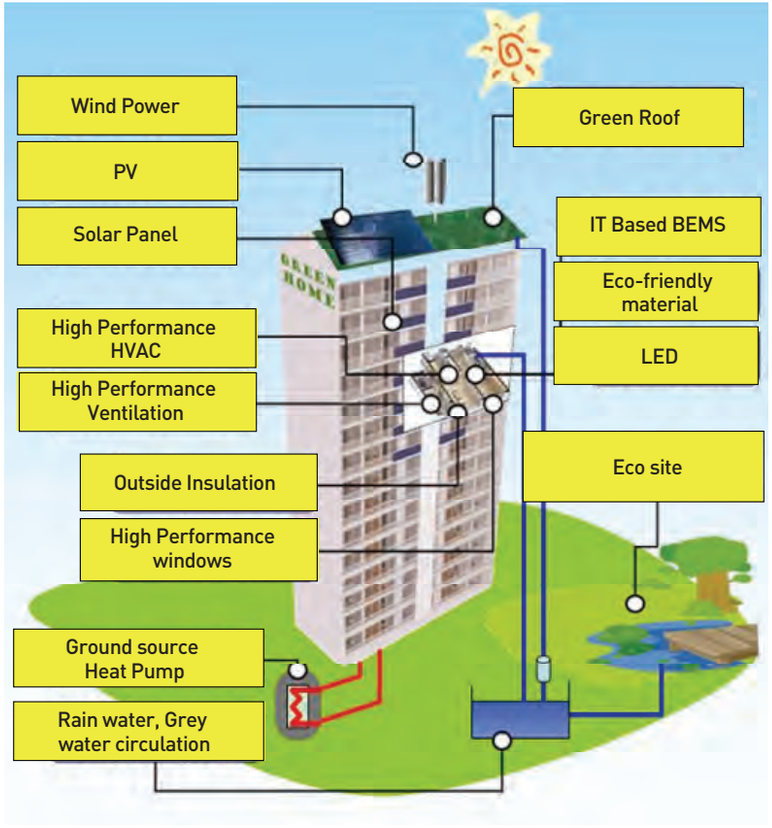
The option of generating energy on site, combined with daylighting, passive solar, and energy-efficient equipment have led to the movement towards net zero energy buildings (NZEBs).

The NZEB:

- Produces as much energy as it consumes
- Produces and exports at least as much emissions-free renewable energy as it uses from emission-producing energy sources
- May use a combination of technologies, such as:
- Advanced daylighting & passive solar
- Natural ventilation
  - Advanced glazing systems
  - Rooftop or building-integrated solar PV
  - Wind energy systems
  - Cogeneration (CHP)
  - Ground source heat pumps

The technologies that can be used for NZEB are illustrated in Figure 11.

[Figure 11] Technologies for a Net Zero Energy Building



Source: Korea Energy Management Corporation

The long-term advantages of NZEBs, including lower environmental impacts, lower operating and maintenance costs, better resiliency to power outages and natural disasters, and improved energy security, have led to increasing interest on the part of building owners to meet such a target for their buildings.

Barriers to Implementation

While there are many opportunities for saving energy in buildings, and commercial cost-effective technologies are available, the actual implementation of energy efficiency in buildings has been far less than the potential due to many important barriers.[13] These barriers have generally been classified into four types: (i) Legal and regulatory barriers; (ii) Institutional barriers; (iii) Limited implementation capacity; and (iv) Financing barriers.

Of these, financing barriers are perhaps the most important and present many challenges. The most important financing barriers faced in implementing energy efficiency in buildings include the following:[14]

- Limited availability of internal funds for investments in energy efficiency (EE)
- Lack of perceived incentives for investing in EE projects.
- Small project size leading to high transaction costs.
- Limited knowledge and understanding on the part of banks and financial institutions (lenders) regarding the benefits of EE projects.
- Risk perceptions - lenders generally perceive EE projects as

13 *See, Jas Singh, Dilip R. Limaye, Brian Henderson, and Xiaoyu Shi, Public Procurement of Energy Efficiency Services: Lessons from International Experience. World Bank, Washington, DC, 2010: and Dilip Limaye, DSM Financing Annex: Financing DSM and Energy Efficiency Programs in China. Washington, DC: USAID ECO-Asia Clean Development and Climate Program, 2010.*

14 *Jas Singh, Dilip Limaye, and Kathrin Hofer, Scaling Up Energy Efficiency in Buildings in the Western Balkans, The World Bank, Washington, DC, 2012.*

being more risky than their other conventional lending

- Requirement for collateral or balance sheet financing - Lenders usually require high levels of collateral or strong borrower balance sheets to provide financing.
- Limited experience with "project financing" for EE projects.
- Poor communication between lenders and project developers.

Innovative financing mechanisms are needed to overcome these barriers.

Addressing the Barriers

While some building owners have funded energy efficiency (EE) projects in their buildings using their own funds, the competing demands for internal funds generally lead to lower priority for EE projects and limit the amount of funding available for such projects. Equipment suppliers have sometimes provided financing for the equipment purchase; but such financing is limited only to the specific equipment and is limited to a short term (generally up to one year). National and local governments as well as donor agencies have provided financing for many EE projects to promote and enhance the knowledge, understanding and experience with these projects, but such funding has usually been program-specific and therefore of limited duration. Similarly, NGOs, Foundations and others have financed a limited number of pilot and demonstration EE projects.

There have been many efforts to encourage energy service companies (ESCOs) to implement EE projects using the performance contracting approach and ESCOs have been responsible for providing or arranging financing for the projects. Also, there have been efforts to encourage commercial financial institutions to more actively participate in financing EE projects either directly or in collaboration with ESCOs.[15] Despite substantial efforts devoted by governments and donor agencies to these approaches, the available financing for EE projects has generally been limited, and there has been increasing recognition that more sustainable financing mechanisms need to be developed and implemented.

Government ROLE VERSUS MARKET ROLE

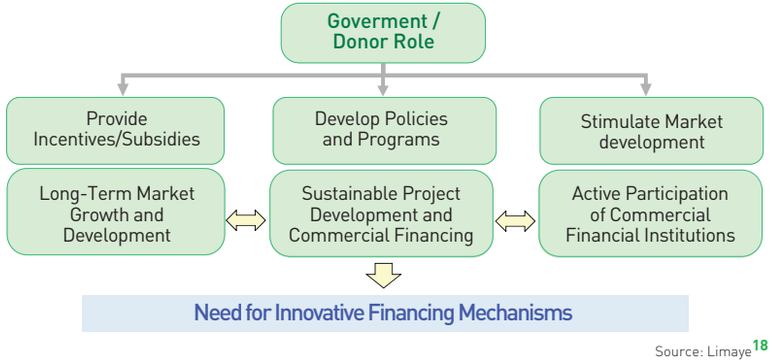
Governments (in many cases with support from international donor agencies) have developed many policy and regulatory instruments to overcome the barriers and facilitate the scaling up of investments in energy efficiency projects in buildings. Governments have adopted a wide range of initiatives to overcome the barriers to large-scale implementation of energy efficiency (EE). These have included legislative and regulatory measures, fiscal incentives, information and

15 *Dilip Limaye, Kathrin Hofer and Jas Singh, Fostering the Development of Energy Services Markets. World Bank, Washington, DC, 2016.*

communication programs, and financing in the form of grants.[16]

However, governments and donors have concluded that, while grant financing of EE projects can be an important and useful first step for implementing EE projects, the availability of such financing is limited and grants are neither a long-term nor a sustainable solution. While government initiatives can facilitate the financing and implementation of EE projects in buildings, the scaling of investments to meet the long-term needs requires the facilitation of sustainable project development and commercial financing approaches.[17] The long-term growth and development of the market for delivering EE financing and implementation services requires the active participation of commercial banks and financial institutions. Figure 12 illustrates this.

[Figure 12] Government/Donors vs. Market Roles in Scaling Up Energy Efficiency Investments



Source: Limaye[18]

16 *Xiaodong Wang, et al, Leveraging Commercial Financing for Clean Energy in East Asia, The World Bank, Washington, DC, 2010.*

17 *Dilip R. Limaye, Lessons Learned from Innovative Financing of Energy Efficiency Programs, Presentation to the Asia Clean Energy Forum, Regulatory and Policy Dialog, Manila, June 2011.*

18 *Ibid.*

Business Models for financing and implementation

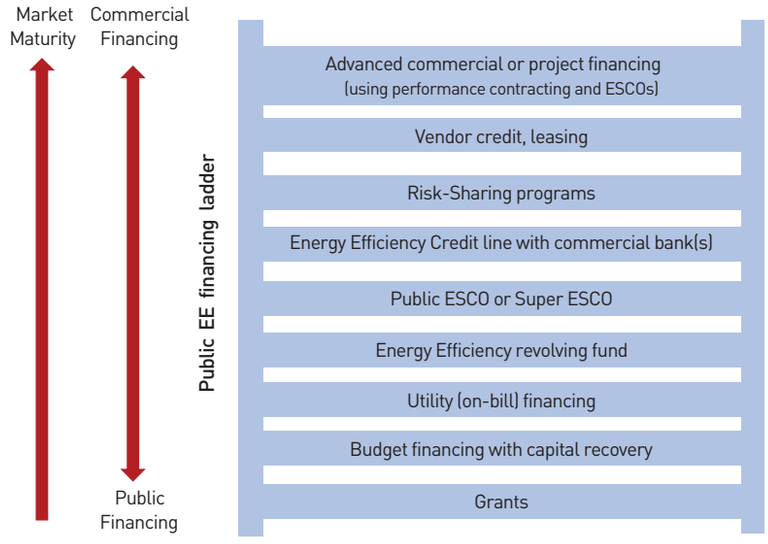
To obtain such leveraging of commercial financing, many countries have developed and implemented a range of financing and delivery mechanisms beyond grant financing, either to enhance the financial leverage of public funds or to gain access to commercial funding for building EE projects. Examples include the following:

- Budget financing with capital recovery for public buildings - financing by the Ministry of Finance (MOF) or a parent budgeting agency with repayments in the form of reduced future budgetary outlays
- Utility on-bill financing of EE investments
- Establishment of an EE revolving fund
- Establishment of an EE credit line for financing through existing financial institutions
- Creation of a risk-sharing facility, such as a partial credit guarantee program, to reduce the risk of commercial loans for EE projects
- Establishment of a public or super ESCO
- Leveraging commercial financing using energy service companies (ESCOs) under the energy saving performance contracting (ESPC) approach.

Figure 13 illustrates these options in the form of a "financing

ladder" for building EE projects, moving from reliance on public (bottom) to commercial (top) financing. The figure also shows the increasing need for maturity of the commercial financing markets as we move up the ladder.

[Figure 13] Financing Ladder for Building Energy Efficiency Projects



Source: Jas Singh, Dilip Limaye, and Kathrin Hofer, Scaling Up Energy Efficiency in Buildings in the Western Balkans, The World Bank, Washington, DC, 2012.

Three of the business models using the schemes from Figure 13 for financing and implementation of building EE projects are briefly discussed below.

Energy Efficiency Revolving Fund

An energy efficiency revolving fund (EERF) is a special purpose fund established for financing energy efficiency projects. An EERF has been demonstrated to be an attractive option for scaling up EE financing in buildings. Under a typical EERF, financing is provided to energy users to cover the initial investment costs of EE projects; some of the resulting savings are then used to repay the EERF until the original investment is recovered, plus interest and service charges. The repayments can then be used to finance additional projects, thereby allowing the capital to revolve and creating a sustainable financing mechanism.[19]

Some funds have been established by donor agencies such as the World Bank.[20] Others have been created by national governments such as in Thailand.[21] In the U.S., electricity regulators have established Public Benefit Funds using the public benefit charge (PBC) mechanism.[22] Because EE projects have low paybacks, capturing the cost savings and reusing them for new investments creates an efficient source of sustainable financing.

A typical structure of an EERF is shown in Figure 14.

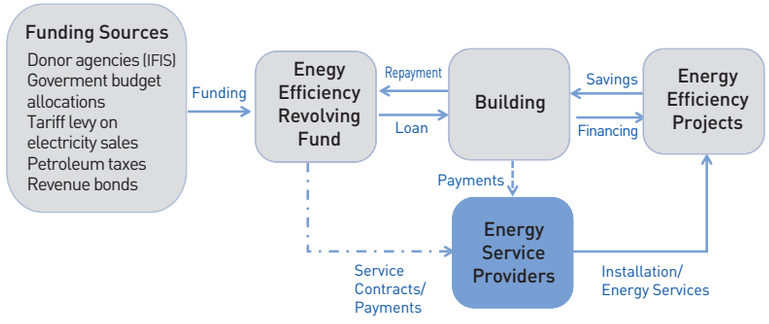
19 *World Bank, Guidance Note: Energy Efficiency Revolving Funds. Washington, DC, 2014.*

20 *For example, the World Bank helped establish the Bulgarian Energy Efficiency Fund and the Armenia Renewable Energy and Energy Efficiency Fund.*

21 *Thailand established the ENCON Fund to finance energy efficiency projects.*

22 *A public benefit charge (also known as a system benefit charge) is a regulatory mechanism that imposes a levy on electricity sales and uses the funds from such a levy to finance energy efficiency programs.*

[Figure 14] Typical Structure of Energy Efficiency Revolving Fund



Source: World Bank, Guidance Note: Energy Efficiency Revolving Funds. Washington, DC, 2014

One of the advantages of an EERF is that it can serve the needs of different types of buildings by offering a range of financing products and "windows," such as the following: World Bank, Guidance Note: [23] (i) debt financing; (ii) energy services; (iii) credit or risk guarantees; and (iv) forfaiting.[24]

EERFs can help demonstrate the commercial feasibility and viability of EE projects, provide a credit history for the building owners borrowing the funds, and help build capacity among service providers such as auditors, installers, construction management firms, and energy service companies (ESCOs). Thus, an EERF can help lay the groundwork for increased commercial financing as the market evolves.

23 *Energy Efficiency Revolving Funds. Washington, DC, 2014.*

24 *Forfaiting refers to the purchase of receivables from an energy efficiency project in which the payment stream lasts over a period of many years. Forfaiting is useful in situations where an ESCO is using its own equity for project financing. The EERF may purchase the future cash flow stream from the ESCO thereby releasing the ESCO funds for financing additional projects.*

Energy efficiency Credit Line

An EE credit line is a financing mechanism under which funds are provided to commercial banks and financial institutions (lenders) to provide debt financing of EE projects. The major purpose of such a credit line is to increase the funding available from these lenders for debt financing of public sector energy efficiency project investments.[25] The funding sources for the credit line may be governments and multilateral or bilateral financial institutions. The funds provided to lenders are often leveraged with additional funds provided by the lenders to increase the total amounts available for debt financing.

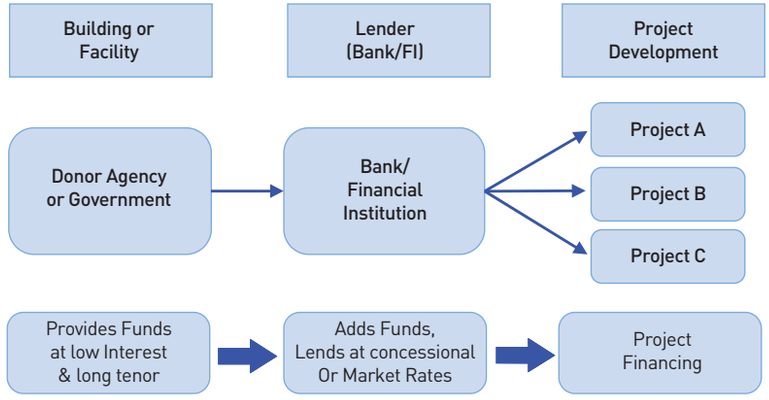
Dedicated EE credit lines address many of the issues related to insufficient lending by banks and financial institutions for EE projects. By establishing a credit line and providing funding, a credit line can help overcome some of the barriers to commercial financing. Most EE credit lines also have a technical assistance component to build lender capacity relative to EE project financing. The best examples of EE credit lines are the Sustainable Energy Finance Facilities (SEFFs) established in many European countries by the European Bank for

25 *Dilip R. Limaye, Energy Efficiency Credit Lines: A Synthesis Paper. Prepared for the Sustainable Energy Department, The Wold Bank. Washington, DC, 2013*

Reconstruction and Development (EBRD).[26]

Figure 15 shows the typical structure of a credit line.

[Figure 15] Illustrative Structure of Energy Efficiency Credit Line



Sources: Limaye[27]

EE credit lines can address the following types of barriers:

- Limited interest on the part of building owners to use internal financing for EE projects
- Lack of liquidity in the financial markets for commercial debt financing of EE projects
- Perception of high financial risks of energy efficiency projects among lenders
- Inadequate expertise and capacity among lenders to understand the financing needs of EE projects
- Relatively high transaction costs for processing EE project financing transactions.

Public or Super ESCO

To scale up financing and implementation of EE projects, some countries have taken a more active role in developing and promoting a public or a "super" ESCO for EE project implementation in the public sector. Such entities are wholly or partly owned by the government. Often this is done to promote ESCOs in general, examples being China (pilot EMCs created by the World Bank in Beijing, Shandong, and Liaoning), Poland (MPEC), and Ukraine, where the public UkrESCO was established.[28] Such public ESCOs were typically formed when the local ESCO markets were nascent and some public effort was deemed necessary to catalyze them. The advantage of a public ESCO is that there is often no competitive process required for project development since a public agency is simply contracting with another public entity.

The super ESCO is a special type of public ESCO. Established by the government, it functions as an ESCO for the public sector (hospitals, schools, municipal utilities, government buildings, and other public facilities) while also supporting the capacity development and project development

26 EBRD, Sustainable Energy Finance Facilities, http://seff.ebrd.com/index.html
27 Ibid.
28 World Bank, Energy Services Market Development, Washington, DC, 2014.

activities of existing private sector ESCOs. The government capitalizes the super ESCO with sufficient funds to undertake public sector ESPC projects and to leverage commercial financing.

A primary function of the super ESCO is to facilitate access to project financing by developing relationships with local or international financial institutions. The super ESCO may also provide credit or risk guarantees for ESCO projects, or act as a leasing or financing company to provide ESCOs and/or customers with EE equipment on lease or on benefit-sharing terms.[29]

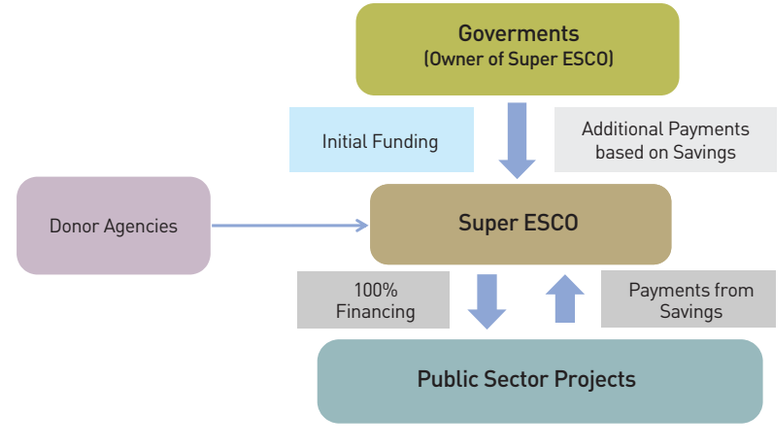
A super ESCO can be uniquely positioned to overcome many of the barriers faced by smaller ESCO companies. With its size and credibility as a public institution, a super ESCO has the capacity both to support the growth of a nation's private domestic ESCO business and to finance EE projects.

Figure 16 illustrates the structure of a super ESCO.

A national super ESCO could be entirely publicly owned or established as a public-private partnership (PPP). It would be designed to serve the needs of public as well as private buildings. An appropriate role for the super ESCO is to implement public sector projects and engage private ESCOs as contractors for the implementation (such as installation, commissioning and performance monitoring). thereby helping build their capacity. The super ESCO may also arrange financing for small private ESCOs to help them implement projects in the private sector.

29 Limaye, Dilip R., and Emily S. Limaye. 2011. "Scaling Up Energy Efficiency: The Case for a Super ESCO." Energy Efficiency Journal 4:133–144

[Figure 16] Typical Structure of a Super ESCO



Source: Limaye[30]

Examples of super ESCOs include the New York Power Authority (NYPA) in the United States, Fedesco in Belgium, Fakai Super ESCO in China, and Energy Efficiency Services Limited (EESL) in India, arguably the most successful super ESCO.

performance contracting and ESCOs

Performance contracting refers to energy efficiency implementation services offered by private ESCOs under energy saving

30 Limaye, Dilip R., "Scaling Up Energy Efficiency: The Emerging Model of the Super-ESCO." Presentation at the IFC International ESCO Financing Conference in Johannesburg, South Africa, May 2013.

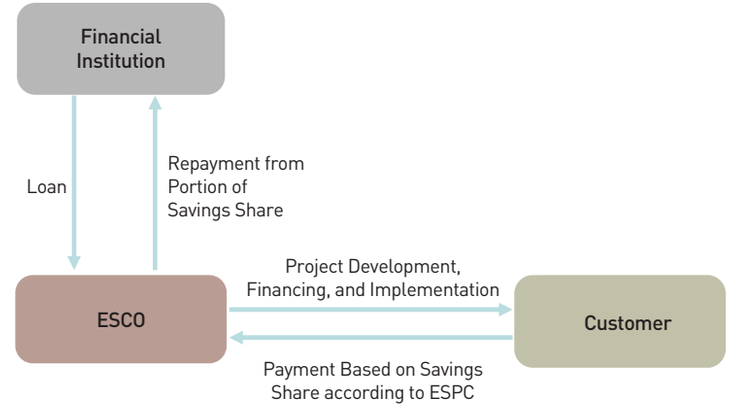
performance contracts (ESPCs). These have the following key attributes:[31]

- ESCOs offer a complete range of implementation services, including design, engineering, construction, commissioning, and maintenance of EE measures, and monitoring and verification of the resulting energy and cost savings.
- ESCOs provide or arrange financing (often 100 percent) and undertake contracts under which the payments to the ESCO are less than the cost savings from the project.
- Under the performance contract, ESCOs offer specific performance guarantees for the entire project and generally guarantee a level of energy and/or cost savings.
- Most of the technical, financial, and operational risk is assumed by the ESCO, thereby substantially reducing the risks to the energy user.

ESCOs have successfully offered financing and implementation services for scaling up energy efficiency in many countries. In the United States, Canada, Japan, Korea, China, and Thailand, the most commonly used ESCO business models are shared savings and guaranteed savings, while in Europe the most common model is the outsourced energy management.[32]

Under the shared savings model, an ESCO provides or arranges for most or all needed financing to implement the energy efficiency project. The agreement between the ESCO and building owner specifies how cost savings are shared, measured, and verified through a predetermined measurement and verification (M&V) protocol. The building owner does not invest in the project but receives a share of the energy cost savings during the contract period and 100 percent of the savings after it, allowing for a positive cash flow for the duration of the project (Figure 17).

[Figure 17] **Shared Savings Model**



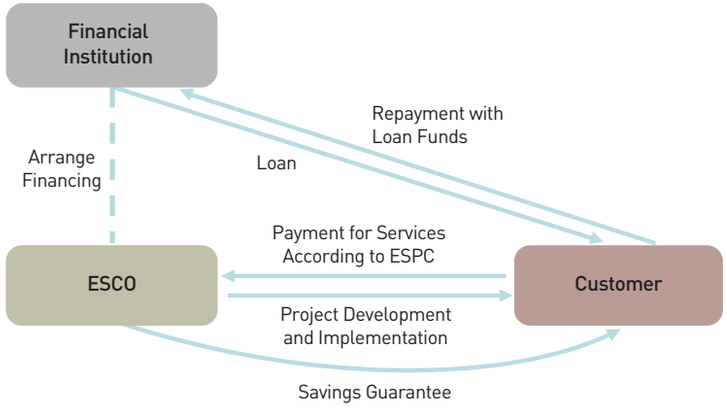
Source: World Bank[33]

31 *SRC Global Inc. A Strategic Framework for Implementation of Energy Efficiency Projects for Indian Water Utilities. Report prepared for the Public-Private Infrastructure Advisory Facility. Washington, DC, 2005.*

32 *World Bank. Guidance Note: Energy Services Market Development. Washington, DC, 2014.*

33 *Ibid.*

[Figure 18] **Guaranteed Savings Model**

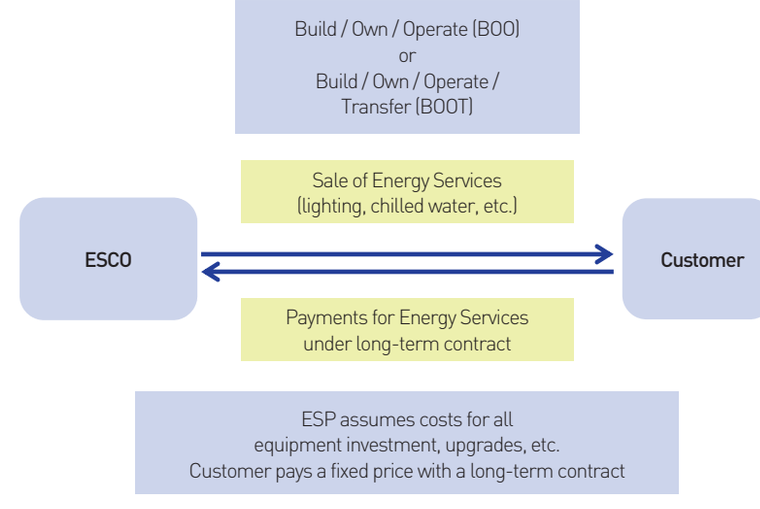


Source: World Bank[34]

Under the guaranteed saving model, the building owner borrows the needed funds to finance the project and puts the loan on its balance sheet. The ESCO provides a performance guarantee and specifies the M&V approach. Payments are made by the host facility to the ESCO once project performance guarantees are satisfied (Figure 18). The loan is repaid by the host facility out of the energy cost savings.

The outsourced energy management model, most commonly used in the European Union, is also referred to as energy performance management contracting or energy supply contracting. In this approach, the ESCO takes over the operation of energy-using equipment, pays for equipment upgrades, repairs, and related expenses and sells the energy output, such as steam, heating, cooling, and lighting, to the host facility under a long-term contract at an agreed price (Figure 19). The ownership of equipment ultimately remains with the ESCO (build-own-operate model) or is transferred to the customer (build-own-operate-transfer model).

[Figure 19] **Outsourced Energy Management Model**



Source: World Bank[35]

34 *Ibid.*

35 *Ibid.*

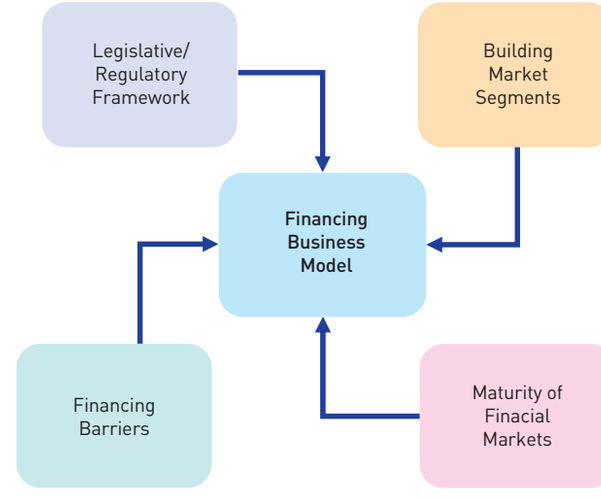
concluding Remarks

This paper has highlighted the benefits of improving energy efficiency in buildings and pointed out the wide range of technologies that are available to substantially reduce energy consumption in buildings. Despite the recognition of the importance and benefits of EE in buildings and the range of available technologies for improving energy efficiency, the implementation of EE projects in buildings has been rather limited and falls far short of the potential. There are many barriers to scaling up implementation of EE projects. Financing barriers are among the most challenging and difficult to overcome.

International efforts to address the financing barriers to implementation of EE in buildings have led to the development and deployment of a wide range of financing and implementation business models, some of which have been summarized herein. The applicability, suitability and benefits of the different business models depends on a set of local factors as shown in Figure 20:

- Existing legislative and regulatory framework
- Financing barriers
- Building market segments
- Maturity of the financial markets.

[Figure 20] Selecting the Financing Business Model



Source: Dilip R. Limaye, Lessons Learned from Innovative Financing of Energy Efficiency Programs, Presentation to the Asia Clean Energy Forum, Regulatory and Policy Dialog, Manila, June 2011.

Thus, to select the most appropriate business model, it is important to develop information on the requirements and constraints posed by laws and regulations, develop information on the building market segments and their needs, identify the major financing barriers hindering implementation, and assess the status of existing financial markets in terms of the understanding of lenders regarding EE and their willingness and interest of lenders to finance EE projects. Such information can facilitate the selection of the most appropriate financing and implementation business model.

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Professor at Myongji University

Lee Myeong Ju is working as an Associate Professor for Department of Architecture, Myongji University and has a German Architect Certificate (Dipl.-Ing. Architektin), German Passive House Design Certificate (Zertifizierte Passivhaus Planer), and German Passive House Engineer (Zertifizierte Passivhaus Handwerker) certificate. In February 2017, she obtained the degree of Doctor of Public Administration and now is working on policy studies as well as zero energy building design. Since September 2013, she has been working a R&D project manager for "Zero Energy Housing Model Development & Demonstration Complex Establishment" (KRW 44.2 billion) supported by Ministry of Land, Infrastructure, and Transport, and has been a head of Zero Energy Design Center, Myongji University for 4 consecutive years. In June 2009, he established ZED Architects Co., Ltd. as an in-university venture business of Myongji University with the support from Small and Medium Business Administration, and has been taking the position of head of affiliated Zero Energy Technology Institute as a practice-oriented professor serving for practices and research.

Making Buildings Efficient:
Energy Savings through BRPs in Seoul

Lee Myeong-ju
(Prof. of Myongji Univ. and Director of IT & Zero Energy Architecture Center)

Significance of Buildings in GHG and Energy Policies

Making Buildings Energy-efficient, an Important Means to Achieve GHG Reductions and Low Energy Consumption

At the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) held in December 2015, the Paris Agreement was adopted to deal with the measures that will be taken in response to climate change from 2020 onward. Under the new climate regime dictated by the Paris Agreement, all Parties have the obligation to submit their voluntary

reduction commitments or Intended Nationally Determined Contributions (INDC) and to make efforts to achieve them. Korea has submitted an INDC pledging to cut its greenhouse gas emissions by 37% from BAU (business-as-usual) levels by 2030.

GHG reductions and low energy consumption are like two sides of a coin. The total amount of GHG emissions in Korea (as of 2013) is 694.5 million tons of CO2e, of which the energy sector accounts for the largest share with 606.2 million tons of CO_{2e}, or 87.3%. Since the energy sector is such a major GHG emitter, the Korean government's policy to reduce GHG emissions needs to focus on the energy sector. Different policies are being promoted in various fields to reduce GHG emissions and cut down on energy consumption. One of the efficient ways to achieve policy goals with little burden on the national economy, including industries, is to enhance the energy performance of buildings.

In Korea, the share of the building sector in total final energy consumption is 24.8% (as of 2012), which is relatively low compared to the industrial sector (54.0%). In developed countries where the manufacturing sector is declining, energy consumption in residential and commercial buildings is on the rise.

The proportion in Korea is expected to rise to 40% comparable to the level of many developed countries. In the case of Seoul, where the proportion of manufacturing is low, residential and commercial buildings account for 54% of the total energy consumption. Once the energy performance of buildings is improved, the effect may be steadily icreme.[1] In terms of economic effects, if the government provides KRW 10 billion for the green remodeling project every year, it is predicted that about KRW 200 billion of private investment will be induced and 2,800 jobs will be created.[2]

There are around 7 million buildings in Korea of which residential buildings account for 65% (4.6 million units) and commercial buildings 17% (1.22 million units). Seventy-five percent of them are over 10 years old; 67% over 15 years old; and 58% over 20 years old. The proportion of buildings over 30 years old has reached 36%. There are still many buildings that were completed when the concept of the building energy performance itself was not established well. According to the Ministry of Land, Infrastructure and Transport, the total energy saved through green remodeling of existing buildings is equivalent to 1.7 times the capacity of new power plants, and annual energy savings amount to about 7% of residential and commercial power consumption.[3]

Diverse Policy Considerations Needed to Improve Building Energy Performance

Efforts to improve the energy performance of buildings require policy considerations from various perspectives. The policy approach should vary depending on whether the target is existing buildings or

1 *Lee Myeong-ju, A Study on the Optimization Model of Korean-style Zero Energy Apartment Complex, Climate Change Collaboration Course at Sejong University, Feb. 2017*

2 *Lee Tae-sik, Revitalization of the Building Market through Green Remodeling, Architecture, Vol. 59, No. 07, 2015*

3 *Ibid.*

new ones. More emphasis will be placed on policies that reflect market principles to guide the owners of existing buildings whereas for new construction, energy efficiency of buildings can be improved through phases of strengthening policies such as design standards and energy performance standards. However, at the implementation stage for both existing and new, various design and construction technologies such as energy simulation, energy load minimization design technique, high-efficiency equipment and materials selection, optimization of complex energy system connected with renewable energy, and BEMS (Building Energy Management System) should be reviewed in a comprehensive way with the total energy savings in mind.

What is even more important is how the various component technologies, which should be considered for building energy performance improvement, can be deployed and implemented in the process of strategic and effective policy making. The Building Retrofit Project (BRP), a core project in the "One Less Nuclear Power Plant" initiative by the Seoul Metropolitan Government (SMG) in April 2012, is a very meaningful and interesting role model. Under the model, measures taken at the municipal level to improve buildings' energy performance were formulated into systematic policies, implementation was validated through achievements and empirical data, thereby leading the way in proactively improving relevant institutions.

The BRP (Building Retrofit Project) in the One Less Nuclear Power Plant

The BRP in One Less Nuclear Power Plant (OLNPP) Phase 1

The OLNPP is a practical energy policy taking into account the energy supply and demand situation in Seoul and the characteristics of the region. The SMG announced the first phase of the OLNPP on April 26, 2012, not long after its fifth mayor elected by popular vote was sworn in. The first phase set up 23 policy tasks and 71 projects in six major areas in which the BRP for residential and commercial buildings was included as one of the six major areas.

BRP (Building Retrofit Project) refers to a project that identifies and improves inefficient and wasteful factors in order to make upgrades in energy conservation and utilization efficiency in the housing and building sector. The OLNPP Phase 1 contains a variety of building energy efficiency projects including (i) loan financing projects, (ii) public sector BRP projects such as social welfare facilities, (iii) high-efficiency LED lighting fixture distribution, and (iv) analysis and disclosure of actual energy consumption by energy-guzzling buildings.

The OLNPP Phase 1 provided loans amounting to KRW 54.9 billion to private BRP projects at an annual interest rate of 1.75%. BRP was carried out at 59 social welfare facilities and 72 school facilities in the public sector and at over 20,000 houses and buildings in the private sector.

The loans provided by the SMG support up to 100% of the

incurred costs for improvements in the energy efficiency of houses and buildings, including the utilization of insulated windows, insulation materials, and LED lighting. The loan ceiling is KRW 15 million for a house and KRW 2 billion for a building. Payback for the loan payments can be made in installment payments for up to eight years. What is noteworthy about the loans is that their interest rate, loan amounts, and borrower qualifications are all improving. The interest rate dropped to 2% from 2.5% in January 2013, to 1.75% in 2014, and to 1.45% in 2016 to minimize the burden on citizens. The support scope was originally limited to owners of houses and buildings, but in August 2013, was extended to contractors and tenants as well. The support ceiling was originally 80% of the project cost, but it increased to 100% in 2014. Notably, in February 2013, the SMG signed a business agreement with a major window manufacturer to cut down on the price of windows supplied to BRP sites thereby providing relief to the citizens.

The SMG conducted an energy performance improvement project for 59 social welfare facilities under the premise that the public sector should play a leading role in the promotion of BRP in the city. In addition to improving energy performance, the city's BRP also has a greater implication of creating a pleasant residential environment through the enhancement of insulation performance and the replacement of windows. Therefore, the city's BRP for welfare facilities can be defined as a policy that provides a healthy environment for users who are not only the socially vulnerable but also the underprivileged in personal health. Moreover, the SMG actively promoted its BRP at 72 schools in order to promote space and energy welfare of young children.

The LED streetlight supply, one of the SMG's representative projects, has supplied 6,790,000 LEDs in total including 430,000 LED lights of those used to improve the lighting of 243 subway stations. The SMG's LED lighting replacement project is highly significant given the fact that it was launched when LED distribution was in its infancy in Korea. Its positive impact on the industry is significant in that the public sector took the lead in formulating and expanding the initial LED market through market-leading purchasing initiatives. Most importantly, in order to relieve the initial burden of switching to expensive LED lighting, the SMG established a special purpose corporation (SPC) with the Korea Finance Corporation and introduced a new method in which they make investments first and then get citizens/organizations to pay back their debts annually with their electricity savings.

In addition, the SMG has analyzed and disclosed the energy consumption status of 423 energy-guzzling buildings, which has motivated the building owners to make intensive improvement efforts.

The BRP for OLNPP Phase 2

The OLNPP Phase 2 announced in August 2014 pursues institutionali-zation and social structural change for policy sustainability as a whole, which is also reflected in the BRP. Not only for existing buildings but also for new buildings, energy efficiency

enhancement is being sought through strengthened standards and regulations. Particularly, its goal goes beyond energy saving buildings, but now aims to realize zero energy for new buildings. Furthermore, the scope of efficient energy amount and management system has extended from individual buildings to the whole city, including new concepts such as restructuring into low-energy-type urban space and building low-energy-type compact cities within the metropolis. In other words, as the building-level BRP initiative became institutionalized in the second phase, the perspective has expanded to a future-oriented direction with a consideration for more macroscopic urban space.

It is obvious that the direction and policy contents of the second phase reflect on the limitations demonstrated from the first phase. The BRP initiative during the OLNPP Phase 1 indicated that some meticulous strategies were required to reinforce the initiative promotion conditions so that the BRP would not end with the achievement of some quantitative targets but continue as the mega city's long-term commitment.

First, in order to convert the BRP initiative into a more sustainable commitment, it was necessary to incorporate it into various systems such as evaluation criteria and guidelines. Second, it was necessary to establish criteria and a legal basis for the accurate building energy diagnosis as part of the BRP for existing buildings. Third, the residential BRP had been limited to reinforcement of insulation and replacement of windows, entailing improvements to only a part of the architectural structure. Therefore, design manuals that would cover entire buildings of different purposes had to be prepared and supplied to citizens. Fourth, a demonstration model was required because the citizens could not readily perceive the results of BRP projects due to lack of such demonstrations. Lastly, a system was needed to enable energy production and efficiency review from the urban planning stage.

Emphasis on Improvements in Building Energy Efficiency through Institutional Arrangements

The second phase BRP focused on establishing institutional basis in which deliberation standards were strengthened for large-scale development projects and large buildings, with a total area of 100,000 m^2 or larger each, subject to environmental impact assessment. The introduction of BEMS became mandatory starting in 2016, and the installation of LED lighting was required as follows: 70% in 2014, 90% in 2016, and 100% in 2018.

[Figure 1] A bird's eye view drawing of the country's first zero-energy housing complex in Nowon

In order to strengthen the design standards for civilian buildings, the SMG aimed at revising the "Seoul Green Building Design Standards" to complete the realization of zero energy for new buildings in stages: 50% in 2014, 60% in 2016, and 100% in 2023. In order to develop design and construction technologies for zero energy housing complexes, the SMG joined forces with the central government and the autonomous districts to commission an R&D project to create a zero energy housing demonstration complex in Nowon-gu District by 2017. It will be a 121-household apartment complex that is 100% self-sufficient in top five energy types consumed in residential buildings, namely heating and cooling, hot water supply, ventilation and lighting. The complex will produce 420 MWh per year through solar panels of the total capacity of 410 kW. By offsetting electric bills in a single contract, the complex will be able to achieve net-zero final energy, net-zero primary energy, net-zero carbon dioxide, and net-zero energy costs.

The central government is making it obligatory to implement a passive design by 2017 and achieve zero-energy for new buildings by 2025 according to the plan that the Ministry of Land, Infrastructure and Transport announced for early activation of zero energy buildings in 2014. The SMG is showing stronger commitment to making it mandatory to achieve zero energy for new buildings by 2023, two years earlier than the central government. Such an active stance of the SMG is encouraging in the sense that the new zero-energy architecture technology enables convergence of various technologies in building materials, machinery and control systems, and renewable energy in the course of improving energy efficiency and at the same time can create synergies among relevant industries through system distribution.[4]

For public buildings, the SMG reinforced the "Seoul City Evaluation Standards for Construction Technologies in the Energy Section of Public Facilities" to increase the proportion of the complex energy system linked to new and renewable energy from 11% to 25% by 2020 and make it compulsory for public service buildings of 3,000 m^2 or more to implement Building Energy Management Systems (BEMS) starting in April 2014. In December 2015, the SMG carried out a project to build BEMS for the first time at Seoul Metropolitan Seobuk Hospital. As a follow-up measure, the SMG got its real-time data transmitted to the Korea Energy Agency for regular analysis of energy saving effects. The SMG plans to continue expanding the initiative to Boramae Hospital, Seoul Medical Center, and Seoul Metropolitan Seonam Hospital among others. BEMS is a new technology being introduced without national standards for different building purposes and different energy sources and facility systems. The SMG therefore plans to gradually expand it based on a pilot operation and periodic analysis while taking the lead in introducing the system.

One of the points to note in Phase 2 is the attempt to approach the building energy problem in the urban planning stage such as in the district-unit plan. "The Seoul Metropolitan City Guidelines on

4 Lee Myeong-ju, A Study on the Optimization Model of Korean-style Zero Energy Apartment Complex, Climate Change Collaboration Course at Sejong University, Feb. 2017

the Review of Eco-Friendliness of Urban Management Plans" have been overhauled so that planners must present ways, at the urban management planning stage, to reduce the energy demand of buildings and supply new and renewable energy to buildings. Effectiveness aside, the efforts to link energy issues to city planning itself is significant.

Representative Examples of the Seoul BRP Initiative: Performance Measurement and Institutionalization

This paper will look at specific examples of the 'Seoul BRP Initiative' that can offer considerable implications for benchmarking by other municipalities or suggest future development directions of the 'BRP' in the country.

Monitoring of Energy Saving Effects of the BRP Loan Program

The SMG has used a loan program as one of the key means of the Seoul 'BRP' initiative to promote energy efficiency improvement for many houses and buildings. To ensure sustainability and scalability of the project, it is necessary to verify whether building energy performance has actually improved. The SMG carried out "BRP Energy Reduction Effect Monitoring," through an external research service provider, to analyze the energy savings and reduced costs of 46 houses and 54 buildings that had participated in the SMG's BRP project from 2012 to 2014, and to investigate citizen's satisfaction level and identify their complaints, if any.

The analysis of the improvement effects of 46 houses monitored indicates that electric power consumption decreased by 1.7% and fuel consumption by 17.4% compared to those before improvement. There was a 10.5% reduction in total energy use after the improvement. The analysis of the improvement effects of 54 buildings monitored shows that electricity consumption decreased by 5.7% and fuel consumption plunged by 19.5% due to the improvement. The total energy savings reached 6.6%.

The survey on the citizens using the loan showed a high level of satisfaction at 79.1 out of 100 points. Most of the respondents pointed to the low interest rate as reason for their satisfaction. In terms of the achievements of the initiative, 64% of the surveyed subjects mentioned energy cost reduction, 27% creation of a comfortable indoor environment, and 8% increased building asset value. The results demonstrate that the 'BRP' has led to improvements in not only energy conservation but also other values such as residents' comfort.

However, although it is meaningful to analyze the effect of the financing program which is one of the most important energy efficiency measures in the SMG's BRP program, there are some roadblocks for future performance measurement and monitoring as the report itself suggests.

First, it is difficult to set standards because of a lack of data on the BRP applicants' building usage and their energy utilization patterns. Second, there remains a possibility that the margin of error range

between energy simulation values and actual measurements can be significant because there is no building usage profile for each type of building. Third, it is not possible to distinguish the outlet power used by home appliances and top five energy types used in buildings from the total monthly electricity usage, and equally difficult to distinguish heating, hot water, and cooking through the monthly usage of thermal energy sources such as city gas. Fourth, it is difficult to accurately measure the percentage of the contribution of partial improvement of houses and buildings to their total energy consumption. Considering these limitations, it is necessary to seek ways to measure energy usage separately through the installation of HEMS or BEMS even for small buildings for precise analysis.

The Demonstration Effects of the Lighthouse Project

Acknowledging the limitations identified in the loan program monitoring process, the SMG launched the Seoul City Lighthouse Project separately from the loan program. It is a 'BRP demonstration model' in which the SMG cooperates with its autonomous districts to make large-scale improvements in the energy performance of public buildings widely used by local residents, and carries out HEMS-based monitoring. The SMG has named it the Lighthouse Project with the goal of presenting a positive image of the 'BRP' to the local community as its representative model. In addition to the improvement of energy performance itself, the Pilot Project has expanded its scope to improvements in convenience facilities and aging facilities used by children and seniors in particular.

It is analyzed that as a result of the BRP for the Lighthouse Project, the energy efficiency level of existing low energy efficiency buildings has improved considerably. Previously, the results of the structural safety assessment indicated that the Seocho-gu Village of the Arts Senior Center and Nowon-gu Doam Senior Center were grade C while the Jung-gu Jungrim Childcare Center was grade B. Notably, asbestos was detected in the childcare center. The building energy efficiency improvement project expanded to asbestos removal, structural reinforcement, retrofit piping and electrical wiring improvement, and indoor and outdoor environmental improvements according to the facility users' input. It is estimated that the top five building energy requirements of the senior facility can be reduced by 60% in Seocho-gu 61% for the Nowon-gu facility and 40% for the Jung-gu facility as a result of the implementation of the 'BRP.'

Demonstration Case 1: Seocho-gu Village of the Arts Senior Center

Location: 44-16, 323-gil, Nambusunhwan-ro, Seocho-gu, Seoul **Size:** Two-story building
Floor area: 119.52 m² **Building area:** 72.62 m²
Main materials: Aluminum louvers, triple pane windows, heat recovery ventilation systems
PV power systems: 2.0 kW

Building cost: 157 million + 33 million electricity & telecom

Post-improvement: Feb. 2016

Pre-improvement: Jan. 1990 (completed)

Demonstration Case 2: Nowon-gu Doam Senior Center

Location: 126-na-gil, Deongneung-ro, Nowon-gu, Seoul
Size: Two-story building with one basement floor
Floor area: 371.18 m² **Building area:** 134.98 m²
Main materials: Basalt tiles, EIFS, triple pane windows, heat recovery ventilation systems
PV power systems: 3.0 kW

Building cost: 227.7 million + 47.35 million electricity & telecom

Post-improvement: May 2016

Pre-improvement: Jan. 1978 (completed)

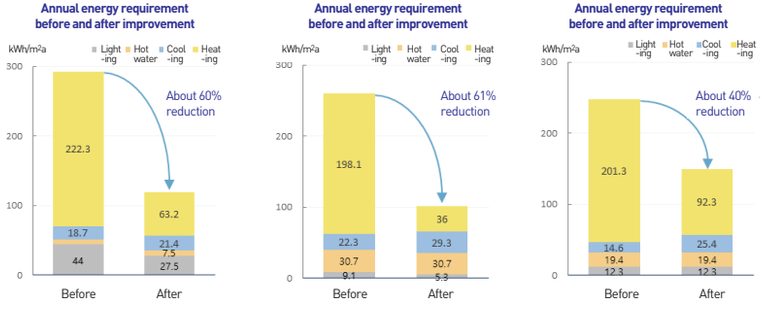
Demonstration Case 3: Jung-gu Jungrim Childcare Center

Location: 62-12, Mallidong 1-ga, Jung-gu, Seoul **Size:** Three-story building with a basement floor
Floor area: 518.05 m² **Building area:** 143.66 m²
Main materials: colored glass, EIFS, triple pane windows, heat recovery ventilation systems
PV power systems: 4.5 kW

Building cost: 288 million + 69.6 million electricity & telecom

Post-improvement: Apr. 2016

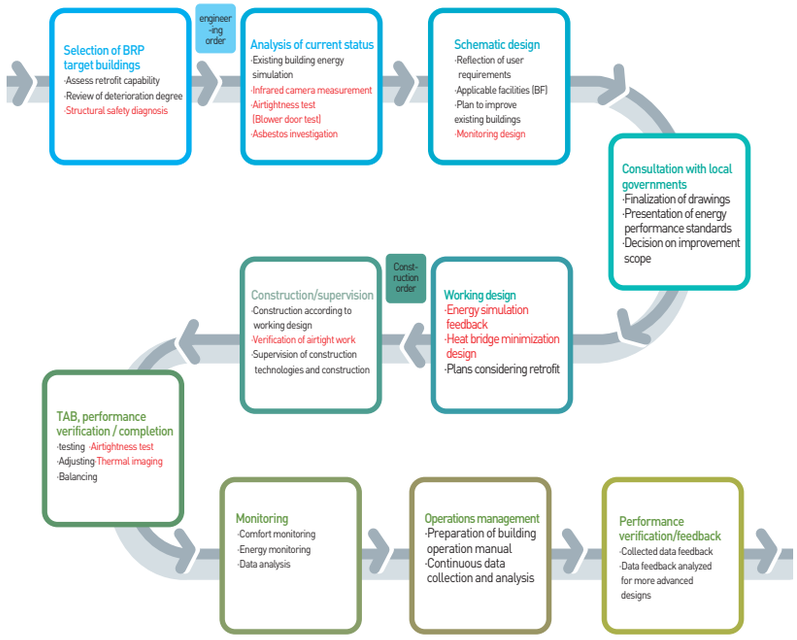
Pre-improvement: Oct. 1998 (completed)



Seocho-gu Village of the Arts Senior Center | Nowon-gu Doam Senior Center | Jung-gu Jungrim Childcare Center

BRP Design and Construction Manual - Small Facilities for Children and Seniors

The SMG has produced and distributed the 'Manual on Energy Saving Remodeling Design and Construction Technologies' on the basis of the BRP designs developed through the Lighthouse Project. The manual is intended for departments responsible for the management of welfare facilities and public facilities to refer to in their partial improvement work of deteriorated facilities within their budgets. It is also designed for ordinary citizens to take part in the BRP easily.



The manual includes energy saving design technology, comfort enhancement design technology, construction management technology, new & renewable energy installation technology, and energy saving effect analysis along with their specific examples. The design and construction manual is based on the experiences of designers and builders in remodeling two senior centers and one daycare center. It also provides a checklist for things that must be reviewed. The most important items in the checklist are the grounds for BRP building selection and the items that must be inspected in buildings. The building inspection process should be carried out with due caution as it involves the simultaneous review of energy performance improvements, convenience facility improvements and deteriorated facility improvements.

[Table 1] The BRP Checklist

Stages	Tasks	Major Review Items
Planning	BRP building selection	Project goals/building usage/layout conditions/external conditions/internal conditions/ utilization status
		Decision of work scope (construction scope) to maximize building value
		Analysis of expected effects of the BRP selection
Building Surveys	Check for existence of drawings and prepare a drawing list	Check for existence of BRP building drawings
	Structural safety analysis	Diagnosis of existing buildings by specialists in structural safety diagnosis

Stages	Tasks	Major Review Items
Building Surveys	Asbestos investigation	Survey of asbestos removal sites by asbestos investigation organizations
	Field surveys	Field surveys to secure basic data (drawings, actual measurements, deterioration degree, facilities, equipment, user feedback, etc.)
	Equipment check	Check energy sources and equipment
	Feedback from clients and users	Collect feedback from clients and users and determine budget-based improvement priorities
	Check annual energy consumption	Predict annual energy consumption based on energy consumption records
	Airtightness tests	Measure airtightness of existing buildings
	Heat bridge measurement	Measurement of heat bridge sites (infrared camera, structural heat bridge)
	Building energy simulation (current state)	Energy simulation depending on the current state
Basic and Working Design	Review of related legislation	Review of legislation according to building usage
	Decision on BRP scope of target buildings	Design/construction scope considering the current state
	Establish building energy performance goals	Establish improvement goals depending on energy efficiency grade certification, etc.
	Set the budget and work scope	Set the budget and work scope according to the design
	Application of energy saving technical factors to buildings	Insulation / windows / air-tightness / heat recovery ventilation facilities / external shade / lighting / high-efficiency facilities
	Plans for amenity improvement factors	Improvement plans according to the Act on Promotion of the Transportation Convenience and user feedback
	Plans for improvement factors of deteriorated buildings	Improvement plans considering the building deterioration degree and user opinions

Stages	Tasks	Major Review Items
Basic and Working Design	Monitoring plans	Plans according to whether monitoring device is installed
	Plans for new and renewable energy	Quantity calculation and design according to new and renewable energy application
	Prepare detail drawings	Prepare detail drawings about major BRP parts and parts in need of structural reinforcement
	Building energy simulation (plan)	Implementation of simulation according to building plans
Const-ruction	Selection of contractors and supervisors	Selection of contractors and supervisors capable of comprehensive management and coordination
	Drawing review meetings	Work schedules and materials delivery plans according to drawing reviews
	Check needs for design modification	Review of design modification needs according to consultation among relevant parties
	Construction preparation	Check on interior condition remodeling, furniture movement, and fixtures storage
	Structural safety diagnosis / demolition	Implementation of demolition according to structural safety diagnosis results
	Masonry work	Masonry work considering airtightness/ insulation
	Insulation work	Proper insulation work to realize targeted insulation performance
	Window installation	Proper installation for planned window performance
	Airtightness work	Airtightness work to realize building airtightness performance and review of major parts
	Heat recovery ventilation installation	Mechanical ventilation system installation work
	New & renewable energy system installation	Work related to new & renewable energy facilities

Stages	Tasks	Major Review Items
Const-ruction	Monitoring system installation	Panels, screen size, data, installation locations
	Airtightness tests	Review of completed building airtightness performance (post-improvement)
	Infrared camera measurement	Review of completed building heat bridge performance (post-improvement)
Operation & Manage-ment	Preparation of building maintenance guidelines and user education	Operation guidelines and user education according to BRP building characteristics

Improvements in Energy Diagnosis Standards for Public Buildings

The revision of the energy diagnosis standards for public buildings under the SMG's control was carried out to provide more detailed energy diagnosis criteria than the central government's regulations so that the SMG can perform effective energy diagnosis for its public buildings while expanding the horizon of its BRP initiative. Public buildings in Korea with more than 3,000 m² are subject to energy diagnosis according to the Regulation on Promotion of Rationalization of Energy Use by Public Agencies (Notice of the Ministry of Trade, Industry and Energy). The purpose is to evaluate and improve the energy performance of buildings through energy diagnosis. However, due to the limitations of the energy diagnosis system, the results of energy diagnosis did not lead to energy efficiency improvement. The SMG has set up its own energy diagnosis standards that have classified energy diagnosis items more elaborately.

At the energy diagnosis stage, diagnosis content became more specific as in pre-investigation, field diagnosis, analysis and report documentation. Numerous energy diagnosis items were classified into energy demand, energy requirement, and items that reduce the primary energy requirement for better understanding. Specifically, the report of the energy diagnosis result is divided into general status, diagnosis result summary, detailed improvement items and attachments so that the diagnosis items are described in detail and the diagnosis improvement proposals are described accurately. The 'Energy Diagnosis Standards for Public Buildings of the SMG' was enacted and implemented in January 2017 after being reviewed at expert consultation meetings and by related SMG departments and affiliated institutions. It is expected that through the implementation of the diagnosis standards, energy diagnosis for large-scale buildings will become more effective and lead to an increased number of BRP commitments.

Policy Discussion Forum entitled "Architecture and Cities: Planting Energy"

In December 2015, a Policy Discussion Forum was held at the Seoul City Hall conference room on the subject of "Architecture and Cities, Planting Energy." The forum was attended by more than 200 people including Mayor Park Won Soon and representatives from the OLNPP Executive Committee, architecture/urban planning/energy related academic circles, associations and businesses. The keynote speech was made on the topic of "Architecture and Cities: Planting Energy." Discussions were held in various areas such as ▲Architectural

design and energy ▲Improvement plans for energy efficiency systems of new and existing buildings ▲The BRP initiative observed at work sites ▲Marketability of the BRP initiative ▲Significance of improving the energy diagnosis system ▲Urban design and energy systems ▲ Urban regeneration and energy efficiency ▲Expansion of energy supply for urban renewal activation zones.

The particular Policy Discussion Forum is mentioned here as an important policy case of the SMG because of not only the forum title and the keynote speech but also the significance of the above-mentioned discussion topics. Just when the whole world is headed toward a new climate regime a new climate regime, the forum has drawn the concepts of 'architecture' and 'cities.' It contained the future-oriented goal of 'planting energy,' which can be construed as the city administration's declaration to minimize blind spots in the city's efforts to improve the energy efficiency of individual buildings and to accelerate its 'expansion into urban space' as being pursued in the OLNPP Phase 2. It also means that interest is now being shifted to areas that require more serious and intense efforts, including architectural design, energy, urban regeneration and BRP. Based on the various recommendations drawn up at the forum, 30 institutional improvements were proposed.[5]

5 http://m.pmnews.co.kr/a.html?uid=15400

Conclusion

Cooperation Needed between Housing & Architecture, Urban Planning, and Urban Regeneration Bureaus

This paper is an overview of Seoul's 'BRP' efforts being promoted through its OLNPP Project. In short, Seoul is promoting BRP with visions in a very delicate manner despite it being a municipality without the legislative power and its rather weak BRP market. The following six obstacles to green remodeling pointed out at the Study on the Inhibiting Factors of Green Remodeling Project in Korea Lee Chang-jae, Ahn Yong-han, A Study on Barriers of the Green Remodeling Project in Korea,[6] are applicable to the city's BRP efforts: (1) High initial investment cost, (2) A delay in payback (a protracted payback period), (3) A lack of government policies and incentives, (4) A lack of awareness of green remodeling among building owners and developers, (5) Restrictions by national policies and regulations, and insufficient standards, and (6) A lack of awareness of green remodeling among society members.

Given the obstacles, various measures included in the city's BRP policies are highly valuable. It is seeking to offset the high initial investment costs and the protracted return on investment through long-term financing at low interest rates. It is also commendable that the BRP results are demonstrated through the implementation of

6 Journal of Spring Academic Conference, Architectural Institute of Korea, Vol.36, No.1, April 30, 2016

the Lighthouse Project, which raises the public awareness of BRP and allows for its diffusion. The SMG is also seeking institutional improvement in various aspects at the municipal level although not entitled to legislate.

However, there are concerns that these efforts and approaches are made in silos and not shared throughout the SMG. The OLNPP is promoted by the Climate & Environment Headquarters of the Seoul Metropolitan Government. The focus is placed on its own undertakings, yet it will be difficult to achieve outstanding results without the active involvement of the Housing & Architecture Bureau. The clock is ticking, and there is still no word of the Housing & Architecture Bureau pursuing major policy tasks related to the BRP in the housing and construction sector. Furthermore, the collaboration with Urban Planning and Urban Regeneration, sought by the OLNPP Phase 2, must be achieved no matter how difficult it is. There has yet to be meaningful progress in this regard. I hope that this project will be more effectively carried out through close communication between departments to share the vision of one less nuclear power plant set up by the climatic environment headquarters in Seoul as a whole.

The OLNPP being promoted by the SMG is a highly exemplary initiative. This initiative contains the values and philosophies that Seoul's energy policies should pursue. It has also presented specific implementation means in a systematic and comprehensive manner. It is no exaggeration to say that Seoul has been leading the country's 'BRP' efforts for over five years. There is still a long way to go. The initiative must evolve into policy commitments that will certainly lead to not only the development of high-efficiency materials and equipment technology but also the enhancement of technological convergence with information technologies. It should also create a business model in which market principles work. Integration of the BRP initiative with urban planning and urban regeneration should be more aggressively pursued. Though it may sound a bit trivial to some, it is also necessary to build up information and empirical data related to the city's 'BRP' initiative.

There is an Asian phrase 'Wisan Ilgwe (爲山一簣) which means that whether you can succeed in building a mountain rests on the last batch of soil. Hopefully all the citizens of Seoul will show their support and dedication to the OLNPP and the entire world also can come together under the city's vision.

Alan K. Meier
Senior Scientist, Lawrence Berkeley National Laboratory

Alan Meier is a Senior Scientist at Lawrence Berkeley National Laboratory and an Adjunct Professor at the University of California Davis Energy Efficiency Center. At LBNL, he leads the Electronics, Lighting, and Networks group. Meier's research has focused on understanding how energy is transformed into useful services and then how to obtain those services with less energy. Meier also studies energy use of consumer electronics, energy test procedures for appliances, and international policies to promote energy efficiency. He played a significant role in global actions to reduce standby power use in appliances. Recently, Meier's research has focused on reducing the energy use of the Internet of Things.

Delivering Energy Services Through the Web: California's Experiences

Alan Meier (Senior Scientist, Lawrence Berkeley National Laboratory)

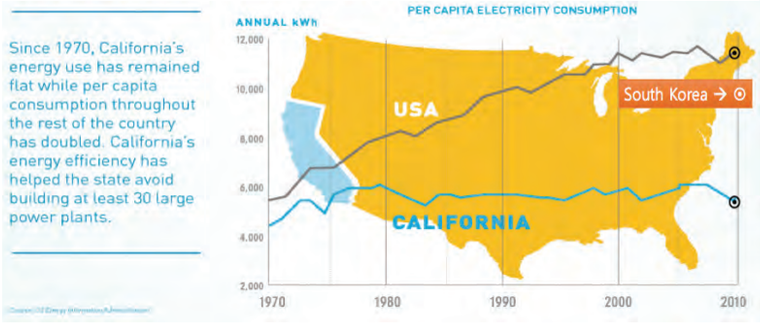
California's experiences delivering energy services through the web are directly relevant to Seoul's own attempts to apply advanced information technologies to saving energy, creating a higher quality of life, and ensuring a more sustainable city.

California's Per-Capita Electricity Use Has Been Constant for 40 Years

To understand why California's experiences are important, let's

first look at California's electricity use. Figure 1 shows the electricity use per person over the last 40 years for California and the USA.

[Figure 1] Why Energy Efficiency Matters



For comparison, Korea's per-capita electricity use is also shown. Korea's per-capita electricity use is lower than the US but higher than California. California's electricity use has always been a little lower than the national average, but the first important change occurred after the first oil embargo in the mid 1970s. Electricity use in the USA continued to rise while California's electricity use"took a right turn"and remained flat. In fact, electricity use per person has been about the same for over 40 years.

If California had followed the US trend, the state would have needed another 30 power plants, most of which would have been nuclear powered. Note also that the 40 years covered some periods of high economic growth, yet the per-capita consumption barely changed. There are several explanations for CA's exceptional performance, but the state's policies to use electricity more efficiently certainly played a role.

Now the challenge is for California (and the world) to make a second right turn (and reduce) electricity use in order to achieve our climate targets. The question I will address is, will the rise of the Internet economy and web-delivered services be part of the solution? I want to explore that question by presenting some examples.

New Web Services Insert Themselves Between Traditional Appliances and Occupants

What are"services", Here"services"means the things that directly contribute to our health, welfare, productivity, and pleasure. Thus, services, are things like thermal comfort, food, mobility, hygiene, and illumination. Put another way, people don't want air conditioners and cars; they want the coolness and mobility that these devices give us.

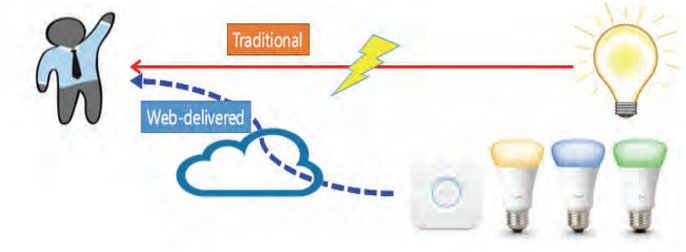
A web-delivered service is the delivery or management of the service through the Internet. This"management"typically involves the use of much more information.

The traditional way services are delivered are through appliances. So a light bulb gives you illumination, a car gives you transportation, and a heater makes you warm. But the web-delivered version participates in — some might say "disrupts"— this relationship between an appliance and the service. This disruption becomes clear with some examples where energy plays an important role.

Lighting Services

Lights are an appliance that provide illumination. That's the traditional situation described in Figure 2.

[Figure 2]



The occupants have a switch that allows them to turn the light on or off. However, some companies have changed this relationship by inserting a remote control with a connection to the Internet. (The lightning bolt represents the web-based disruption.)

Now a web-based service can control the light. If the lights are LEDs, then the controller can adjust both the intensity and color of the lights. Consumers often buy these lights to provide greater comfort and convenience rather than to save energy.

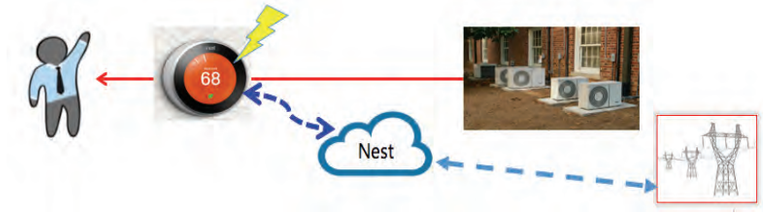
Still, LEDs are much more efficient than most older lighting systems, so energy savings are almost certain to occur. However, we must not forget that the remote control draws some standby power. One California study demonstrated that the standby energy consumption will be greater than the electricity used for lighting when the lights are on for less than a few hours per day.

Internet-Connected Thermostats Deliver Thermal Comfort

We use heaters and air conditioners to provide thermal comfort. Recently several companies have appeared to help manage the temperatures in American homes. The largest company is a California-based firm called Nest (which Google subsequently acquired). How does the thermostat work?

The relationship between the Internet connected thermostat, the cloud, and thermal comfort is shown in Figure 3.

[Figure 3]



The thermostat is connected to the Internet through a Wi-Fi connec-tion in the home. A complex set of algorithms — all residing in the Cloud — select the best combination of temperatures for that specific home. These take into account the home's thermal

performance, the outside temperature, and if the occupants are at home. The goals are to give the occupants maximum comfort and convenience while saving energy.

Already 6 million Internet-connected thermostats have been installed and the number is growing 20% each year. While people generally buy them for comfort and convenience, these thermostats also reduce heating and cooling costs up to 15%.

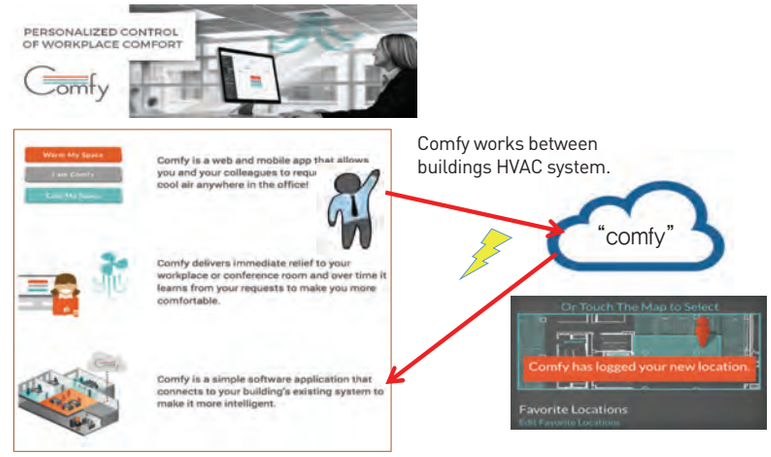
The dashed line to the electricity grid is increasingly important to both the utility, the thermostat vendor, and the customer. Sometimes these thermostat vendors work in partnerships with the electric power companies. If there is a shortage of electricity for a few hours, Nest and other vendors may adjust the inside temperatures of thousands of homes to save electricity. Of course, these adjustments are only made with the permission of the occupants, who typically receive rebates.

This is an excellent example of how new web-based companies are inserting themselves between the traditional providers – in this case the air conditioner companies and the utilities – and the customers to provide new, energy-saving services and conveniences.

Office Thermal Comfort and Productivity

How many of you have felt hot or cold in your office and been unable to do anything about it? Now, several web-based services allow office workers to complain via an app or website. Figure 4 shows one app called Comfy, receives your complaint, and then adjusts the building's heating and cooling system to make you more comfortable.

[Figure 4] **Office Thermal Comfort & Productivity**



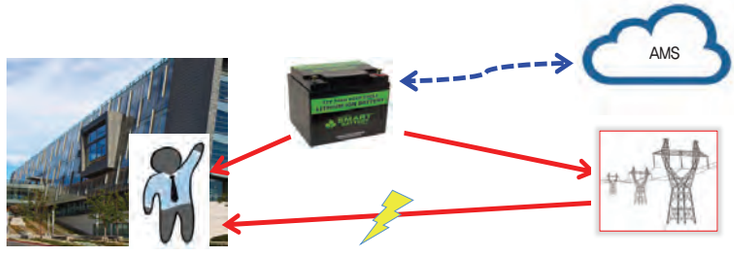
Of course, it requires the participation of building owners and the installation of some hardware. The primary objective of this system is to provide more comfort, but it can also help the building manager operate his system more efficiently and save energy. Here again, a web-based entity has inserted itself into the delivery of energy-related services.

Energy Storage Services

California was one of the first regions to allow companies to

sell electricity storage as part of its electricity market operated by the grid operator. The goal is to develop energy storage to complement electricity generated by renewable sources like wind and solar. The details of this program are complicated, but the outcome is a kind of market for energy storage. This electricity can be made quickly available when clouds obscure the sun or the wind suddenly stops blowing. Several companies, such as Advanced Microgrid Solutions, have entered this market. They install large batteries in commercial buildings. They sell the electricity to the building or the utility depending on the price of electricity that hour as illustrated in Figure 5.

[Figure 5]



Companies like AMS don't save electricity but they do reduce electric demand and enable greater use of renewables. In this way, they have inserted themselves between the electric power company and the consumer.

Ride-Sharing and Other Web-Based Mobility Services

Ride-sharing apps like Uber are now being used around the world. California was the birthplace of Uber and many other apps, and new ones keep appearing. Each seeks to provide slightly different transportation services. Most of these mobility solutions are web-based services that insert themselves between the private automobile and the consumer as illustrated in Figure 6.

[Figure 6]

These services should save energy, money, and resources because the private car sits idle 95% of the time and occupies valuable real estate. Unfortunately, there has been very little evidence that these promised benefits have occurred. We have seen evidence that young people are beginning to change their opinions regarding purchases of cars – and even getting a drivers license – so perhaps the true impact will not be revealed for a few years.

Few Web Services Use Smart Meters

Almost every home in California has a smart utility meter, that is, a meter capable of communicating with the electricity utility company. The meter makes it possible to read consumption remotely, charge tariffs that change over a day or year, and perform many cost-saving administrative services (like remotely switching on and off electricity). Ten years ago experts expected the smart meter would be the foundation of many home energy services. That did not occur. Instead, the smart meter has become a kind of technological dead end. Why did that happen?

Most web-services abandoned the smart meter because the electric power company controlled the communications. Also, each utility – there are more than 20 in California alone – had slightly different rules governing data access, security, and privacy. As a result, the web-based companies could not scale-up and make a single solution that applied to the whole world (which companies could do with the Internet).

Still, the smart meter will play a vital role in the future grid. When electricity supplies are intermittent, the cost of generation will fluctuate. We need a means of conveying that constantly-varying price signal to consumers and charging them when electricity supplies are scarce. That's what a smart meter will do. But it won't be the hub of many web-delivered services.

In California, however, the utilities use the smart meter and the web to show how your home's energy use compares to other similar homes in your neighborhood. My home's energy use is shown in Figure 7.

[Figure 7]

When this information is carefully presented, it encourages consumers to reduce their energy 5%. It's not a large amount of electricity but these programs are still worthwhile because the cost of these programs is very small.

Conclusions

California has been very active in developing new energy-related services that are delivered via the web. The examples illustrate the ways in which these new services insert themselves between the traditional provider — the light bulb, the air conditioner, the car — and the energy consumer. In this way they disrupt traditional relationships between energy-using appliances and the end user. But the evidence of energy savings varies widely. It's strong in some cases but non-existent in others. So it will take more time to move from anecdotes to economy-wide evidence.

Song Sang-seok
Secretary General of Networks for Green

Mr. Song Sang-seok, Secretary-General of Green Transport, has worked as a member of 'the Environmental Health Subcommittee for the Citizens Committee for Green Seoul,' 'the Seoul Commission on Sustainable Development,' 'the Executive Committee for One Less Nuclear Power Plant,' 'the Climate and Air Quality Subcommittee of the Private Environmental Policy Council under the Ministry of Environment,' and 'the Low-Carbon Vehicle Supply Promotion Committee under the Ministry of Environment.'

Green Transport Strategies in Seoul: Achievements and Tasks

Song Sang-seok (Secretary General, Green Transport Movement)

The Current State of Transportation in Seoul

The population of Seoul is steadily decreasing, however the number of registered vehicles is increasing year by year. It was back in 2005 that more than 50 percent of the city's households had ownership of one or more passenger cars. As of 2015, the number of registered vehicles in Seoul stands at approximately 3,056,000, of which passenger cars account for 83.7%, or 2,560,000.

In terms of modal share (as of 2014), public transportation accounts for 66.0% and passenger cars 22.8%. The share of public

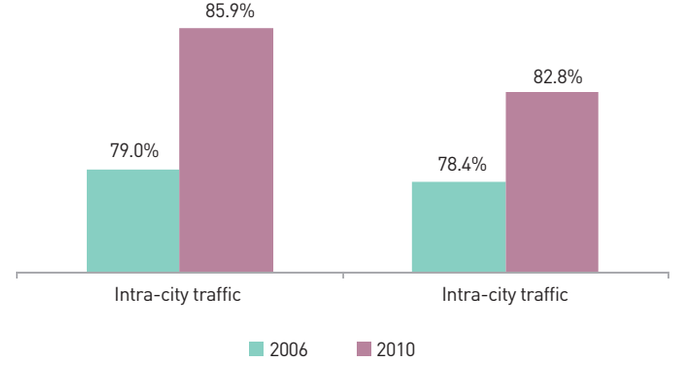
transportation has been increasing but not significantly, and the share of passenger cars has been decreasing but again, not significantly.

[Table 1] **Major Transportation Indices in Seoul**

Classification		Unit	2010	2011	2012	2013	2014	2015
Population & Traffic Status	Population	1,000	10,575	10,529	10,442	10,388	10,369	10,297
	Traffic volume	1,000/ day	31,156	31,885	32,150	32,516	32,689	
	Modal shares							
	• Mass transit	%	64.3	65.1	65.6	65.9	66.0	
	(Bus)		(28.1)	(28)	(27.4)	(27.1)	(27.0)	
	(Subway)		(36.2)	(37.1)	(38.2)	(38.8)	(39.0)	
	• Cars		24.1	23.5	23.1	22.9	22.8	
	• Taxis		7.2	7	6.9	6.8	6.8	
	• Others		4.4	4.4	4.4	4.4	4.4	
	Registered vehicles (number of cars)	1,000 units	2,981 (2,434)	2,978 (2,443)	2,969 (2,448)	2,974 (2,463)	3,014 (2,511)	3,056 (2,560)
	Average driving speed	km/h	24 (17)	...	...	26.4 (18.7)	25.7 (17.4)	25.2 (17.9)
Transportation Infrastructure	Total road length	km	8,142	8,148	8,174	8,197	8,214	8,215
	Road ratio	%	22.02	22.06	22.24	22.32	22.42	22.43
	Total subway length	km	316.9	316.9	327.1	327.1	327.1	331.6
	Total bus-only lane length	km	100.4	114.3	115.3	115.3	117.5	119.3
	Total bike lane length	km	844.6	804.2	666.0	707.6	724.6	775.9
	Total parking spaces	1,000 spaces	3,404	3,595	3,584	3,760	3,822	3,877
	Parking ratio (residential areas)	%	114.2 (96.6)	120.8 (98.3)	120.7 (99.1)	126.4 (99.8)	126.8 (101.1)	126.9 (100.3)

According to a survey conducted by the Green Transport Movement about passenger vehicles in September 2012, 81.1% of the city's traffic comprise of passenger cars, of which more than 80% are single-occupant. Roads are mostly occupied by passenger cars whose modal share stands at a mere 20%. Furthermore, the trend is yet to be reversed.

[Figure 1] **Seoul's Single Occupation Vehicle Ratio - SMG's press release** (18 Feb. 2013)



The average driving speed of passenger cars at 17.9 km/h as of 2015 falls even below that of buses at 19.5km/h, illustrating the severe traffic congestion of the city. We might as well claim that Seoul is at least 10 years behind on its need to work on the traffic demand management.

[Table 2] Changes in the Average Traffic Speed in Seoul

(Unit: km/h)

Description		1995	2005	2006	2007	2008	2009	2010	2013	2014	2015
Cars	Total	21.7	22.9	22.9	23.4	24.4	24.0	24.0	26.4	25.7	25.2
	Down town	18.3	14.0	14.4	14.4	16.7	16.0	17.0	18.7	17.4	17.9
	Suburb	21.9	23.5	23.5	24.0	24.9	24.5	24.5	26.6	26.0	25.4
Buses		18.8	17.6	17.9	19.6	19.7	19.6	19.8	20.0	19.6	19.5

The Bus Rapid Transit (BRT) was introduced to Seoul in July 2004 as part of the overhaul of the city's bus system. The exclusive median bus lane system launched in 2004 expanded considerably from 57.1 km in 2005 to 119.3 km in 2016. However, the increase has slowed down since 2010.

The total length of the subway system in Seoul, the main means of public transportation, is 331.6 kilometers as of 2016. Currently the focus is being placed on the extension of existing lines instead of planning new ones.(table 3)

[Table 3] Average Daily Ridership of Mass Transit in Seoul

(Unit: 1,000 persons/day)

Description	Bus			Subway			Total
	City Bus	Shuttle Bus	Total	Rides	Transfers	Total	
2005	4,538	927	5,464	4,538	2,295	6,833	12,297
2006	4,651	1,007	5,659	4,530	2,291	6,821	12,479
2007	4,583	1,020	5,602	4,529	2,336	6,865	12,467
2008	4,617	1,047	5,664	4,588	2,366	6,955	12,619
2009	4,613	1,077	5,690	4,652	2,446	7,098	12,788
2010	4,599	1,124	5,723	4,807	2,527	7,334	13,056
2011	4,652	1,152	5,804	4,931	2,642	7,573	13,377
2012	4,580	1,168	5,748	4,995	2,677	7,672	13,420
2013	4,548	1,200	5,748	5,099	2,752	7,851	13,599
2014	4,574	1,222	5,796	5,183	2,850	8,034	13,830
2015	4,404	1,196	5,600	5,122	2,863	7,985	13,585
2016	4,280	1,212	5,492	5,113	2,886	7,999	13,491

* Seoul subway lines 1-9 (including phase 2 of Line 9), Seoul city/red/shuttle buses, on the basis of card tags
* Subway transfers include cases where a passenger gets off at a station of a different subway line

The ridership of buses and subways which account for 66% of the total modal share in Seoul showed a steady increase until 2014 and a slight decrease in 2016. It indicates that there is a limit to expanding the use of public transportation through public transportation support policies unless they are backed by traffic demand management policies on passenger car traffic.

[Table 4] Changes in Traffic Volume in Seoul

(Unit: 1,000 units/day)

Classification	Bi-directional	Inflow	Outflow	Change over the previous year
Total (90 points)	6,627,269	3,375,340	3,251,929	170,675 (2.6%)
Downtown (24)	1,252,084	645,733	606,350	-3,139 (-0.3%)
City boundaries (22)	1,785,635	878,100	907,535	199,542 (12.6%)
Main roads (32)	2,405,847	1,221,697	1,184,150	-2,441 (0.1%)
Bridges (12)	1,183,702	629,810	553,893	-23,288 (-1.9%)

Changes in traffic volume in Seoul indicates that as of 2015, the traffic volume in the city center is decreasing slightly while continuing to increase at the city boundaries due to urban expansion following the development of new satellite cities and the population migration to the metropolitan area. This suggests that the traffic demand management of Seoul may not thrive based solely on its unilateral effort. Instead, Seoul must develop and promote its policies in association with surrounding municipalities.

Achievements and Limitations of Seoul's Transportation Policies from the Perspective of the One Less Nuclear Power Plant (OLNPP) Project

Achievements of Seoul's Energy Saving Policies in Transportation & Logistics

Outline of Transportation Sector of the OLNPP Project Phase 1

- Operation of car sharing ('Nanum-Car') service
- Creation of the Sinchon Public Transport-only Area
- Expansion of the Weekly No Driving Day Program for large buildings
- Expansion of Car-free Days
- Creation of pedestrian streets (car-free streets)
- Discouragement of driving in downtown Seoul
- Continuous infrastructure improvement for increased mass transit ridership
- Enhanced enforcement of anti-idling regulations
- Expansion of the eco-friendly driving culture

The transportation sector accounts for 31% of Seoul's energy use. Phase 1 of the One Less Nuclear Power Plant (OLNPP) Project implemented nine major projects, including the expansion of the Nanum-Car service, in the transportation sector.

According to a report by the Seoul Metropolitan Government (SMG) on the achievements of its OLNPP Project Phase 1, the SMG promoted its car-sharing project with an aim to gradually shift the citizens' perception of passenger cars from 'ownership' to 'joint use.'

The city offers a variety of benefits to 200,000 car-sharing service members including priority assignment of long-term parking permits for public parking lots and financial subsidies for the purchase of electric vehicles, in which a total of 1,250 vehicles are operating. In order to discourage the entry of vehicles into the downtown area, the SMG promoted the increase of traffic inducement charges and expanded the membership of the weekly No Driving Days system to buildings. In addition, the SMG has organized "carless street" events under specific themes for each of its major streets. It has also helped increase the number of daily bicycle riders to 500,000. The SMG has actively promoted the eco-friendly driving culture in an effort to reduce energy waste caused by bad driving habits. To create its user-friendly public transportation infrastructure, it has expanded the exclusive median bus lane by 14.7 km in three major routes and built three additional transfer facilities.

Meanwhile, the 2014 Seoul Energy White Paper also introduced policies that the SMG promoted to conserve energy in the transportation sector. The Paper says that the number of automobiles in Seoul continued to increase until 2010 when the trend started to reverse, and that energy consumption in the transportation sector peaked in 2008 at 494 million TOE followed by a decline thereafter.

[Table 5] **Energy Consumption in Transportation Sector in Seou**

(Unit: 1,000 TOE)

Consumption	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Description	4,612	4,625	4,292	4,674	4,870	4,942	4,857	4,846	4,631	4,576	4,517

Source: Yearbook of Regional Energy Statistics 2014

The SMG has implemented five projects, including the distribution of eco-friendly electric vehicles, to conserve energy in the transportation sector. To accelerate the distribution of eco-friendly electric vehicles, the SMG supported the market price difference with gasoline vehicles.

Energy Saving Projects in Transportation Sector

- Distribution of eco-friendly electric vehicles
- Implementation of weekly no driving days
- Reduction of emissions of diesel vehicles in operation
- Promotion of public transportation
- Promotion of Nanum Car (car-sharing) service

As a result, a total of 941 electric cars were supplied up until 2014. As of 2015, the subsidy amounted to KRW 43 million per unit (15M by the central government and 28M by the SMG) when bought by the SMG and its affiliated corporations, KRW 30 million per unit (30% by the central government and 70% by the SMG) when bought by autonomous districts, and KRW 22.5 million per unit (15M by the central government and 7.5M by the SMG) when bought by car-sharing services. The SMG distributed a total of 498 electric motorcycles up until 2014 through support measures identical to those offered for four-wheeled electrical vehicles – making up for the price difference with gasoline motorcycles. In addition to the subsidy paid by the SMG, electric cars that are

classified as Type 1 low emission vehicles are entitled to various benefits granted to low emission vehicles. Electric vehicles are exempt from a total of KRW 1.3 million in taxes - individual consumption tax and education tax – until 2015. They are entirely exempt from environmental improvement charges, which amounts to KRW 570,000 per year depending on the displacement and also entirely exempt from traffic-congestion charges at Namsan Tunnels #1 and #3. They also receive a 50% discount in public parking lots in Seoul and Gyeonggi-do, and an 80% discount in subway transit parking lots.

Seoul's Weekly No Driving Day Program enables its citizens to designate one weekday for not driving. It is designed to contribute to cutting down on energy consumption, mitigating traffic congestion and reducing air pollution. It started using paper stickers in 2003, which was then switched to electronic tags in July 2007. As of December 2014, a total of 757,000 cars have joined the voluntary movement. The SMG is providing various incentives to encourage citizens' active participation. The incentives include a 5% reduction in automobile taxes, a 50% reduction in traffic-congestion charges at Namsan Tunnels #1 and #3, and a maximum of 30% discount on parking fees in public parking lots. Moreover, the incentives go as far as providing benefits for Resident Priority Parking, including priority parking permits and priority monthly passes. Car insurance premiums are discounted by 8.7% (OBD-equipped vehicles) as well.

As part of the special measures to improve the atmospheric environment in the Seoul metropolitan area, the SMG joined forces with the Ministry of Environment to promote projects such as the installation of exhaust gas reduction devices, conversion to LPG engines and inducement of early scrapping for a total of 278,000 old diesel cars from 2005 to 2014. The SMG estimates that it not only saved energy but also contributed to improving the air quality in Seoul through the projects which will be continued in the future.

[Table 6] **Seoul City's Old Diesel Vehicle Emission Reduction Project**

(Unit: No. of vehicles)

Classification	Promotion of Low Emission Vehicles								
	total	~ 2007	2008	2009	2010	2011	2012	2013	2014
Budget (100M) (City) (National)	7,607 (3,782) (3,782)	3,212 (1,585) (1,585)	948 (474) (474)	893 (446) (446)	800 (400) (400)	570 (285) (285)	472 (236) (236)	456 (228) (228)	256 (128) (128)
Total (vehicles)	278,187	106,474	36,099	34,866	30,825	24,114	16,401	17,256	12,152
LPG conversion	126,426 (45.4%)	73,625	16,452	14,027	7,922	2,074	961	7,738	3,627
Installation of emission reduction devices	88,311 (31.7%)	26,398	9,796	11,709	17,461	14,961	7,617	277	92
Accelerated vehicle retirement	63,006 (22.6%)	6,451	9,851	9,130	5,442	7,079	7,823	8,797	8,433
Installation of three-way catalytic converters	527 (0.2%)	-	-	-	-	-	-	378	149
PM-NOx simultaneous reduction device	106 (0.04%)	-	-	-	-	-	-	62	44
Replacement of construction machinery engines	143 (0.1%)	-	-	-	-	-	-	4	139

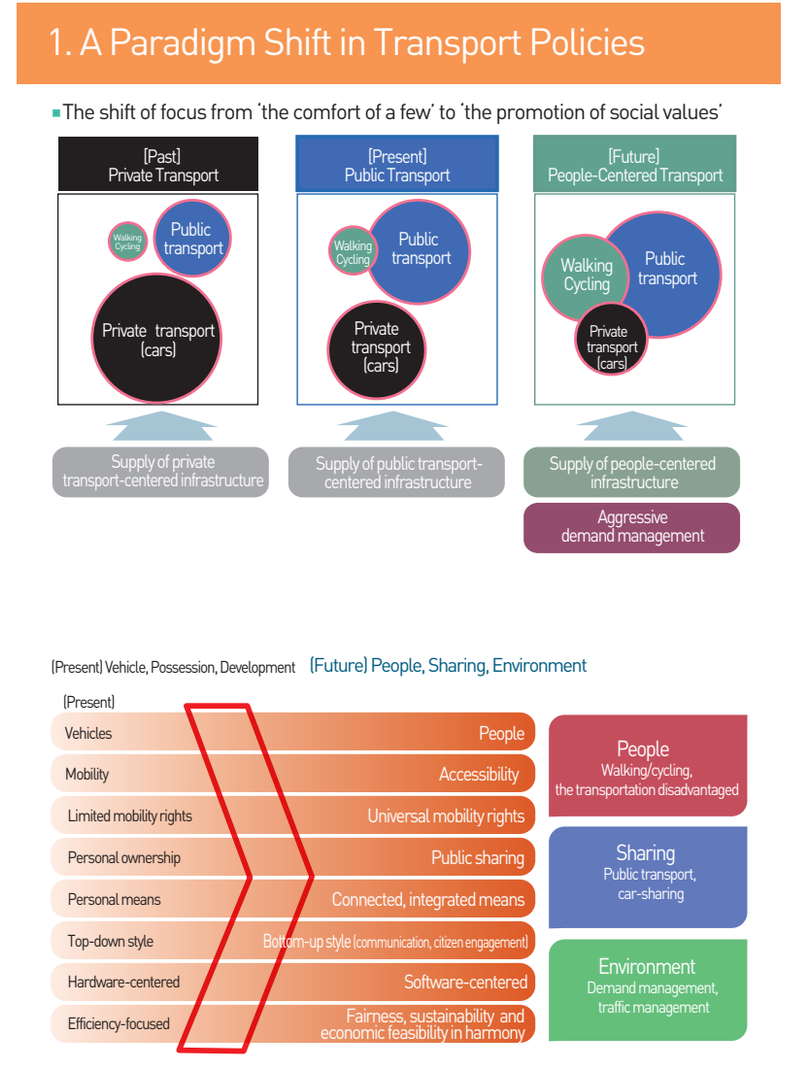
Source: Air Quality Management Division, SMG

Regarding the SMG's efforts to increase mass transit ridership and expand the Nanum-Car (car-sharing) service, they are in line with the projects described in the OLNPP Phase 1 report.

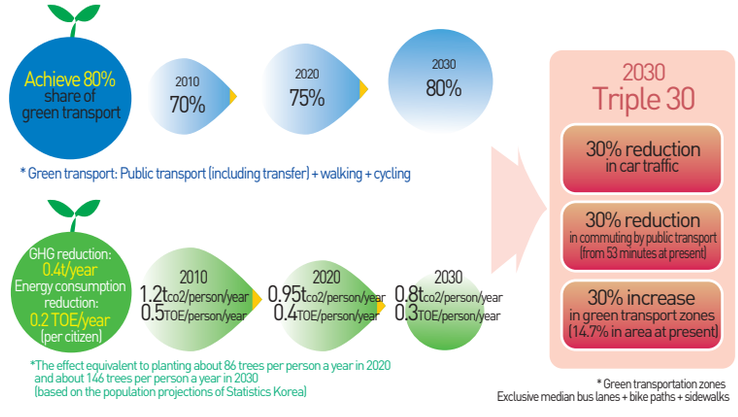
Limitations on Seoul's Energy Saving Policy Promotion in the Transportation Sector

As part of the promotion of the second phase of its urban transportation improvement plan, the SMG established a basic plan called "Seoul Traffic Vision 2030" in May 2014. This 20-year plan is the city's highest-level plan in the transportation sector, dominating all its improvement plans on the city railway, sidewalks, roads and public transportation as a whole. 'Seoul Traffic Vision 2030' has shifted the focus from private transport to people-centered transport prioritizing walking and bicycling, among others. The 2030 goals include a 30% reduction in car traffic, car traffic, subsequently followed by a 30% reduction in commuting time by public transportation (from 53 minutes at present), and a 30% increase in green transportation zones (from 14.7% at present).

Seoul Traffic Vision 2030



3. Goals of Seoul Transport Policies



4. Major Policies of Seoul Traffic Vision 2030

The fact that the SMG continues to work to shift its policy focus to green transportation is obvious from its Seoul Urban Master Plan (2030 Seoul Plan) and Seoul Mid-term Municipal Fiscal Plan (2017-2021) as well as its annual plans and budgets which are highly relevant to the promotion of transportation policies.

[Table 7]

Core Issue	Goals	Planned Indices	2013	2020	2030
A community-based city with stable housing and convenient traffic	Promotion of urban renewal for work-life balance in space	Jobs-housing balance index (the lowest zone: northeastern Seoul)	71	77	90
	Creation of a green transport environment where citizens can live comfortably without private cars	Green transportation ratio	70%	75%	80%
	Securing stable, affordable housing for everyone	Public rental housing ratio	5%	10%	12%

Source: Seoul Urban Master Plan (2030 Seoul Plan)

Seoul is in the process of shifting its transportation policy focus. The SMG's 2017 plan and budget indicate that its transportation policy keyword for the year is the realization of "The Walking City Seoul." However, only KRW 75.1 billion or 4% of the city's total road and transportation budget is set to be directly invested in the activation of green traffic, implying that the city's transportation policy shift is yet

to be reflected in its specific projects.

[Table 8] **Seoul's Major Policies and Budget in Transportation Sector in 2017**

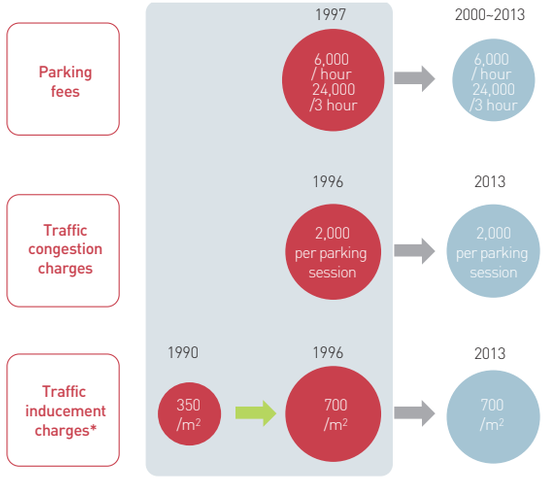
Main Goals	Major Projects	Budget (Unit: 100M)
Securing space encouraging citizens to walk	Expansion of pedestrian streets	14
	Creation of model car-free streets as landmarks for districts	11
	Expansion of Seoul Trail and improvements in its maintenance	42
Realizing a 'walkable' city	Expansion of crosswalks to protect pedestrians' walking rights	26
	Creation of a special historical and cultural space near Sejong-daero	174
	Connection of Seoullo 7017 and restructuring of roads within the Seoul City Wall premises	38
Expanding safe pedestrian infrastructure	Creation of 20 pedestrian priority streets	22
	Expansion of pedestrian environment improvement zones	31
	Improvements in traffic safety facilities including jaywalking prevention facilities	44
Boosting the walking rights of the transportation disadvantaged	Improvements in child protection zones and visual safety information infrastructure for children's safety	18
	Expansion of braille tile sections and lowering curb heights	22
Promotion of cycling linked to public transport	Citywide expansion of 'Seoul Bike' public bicycle service linked to public transport	243
	Expansion of cycling routes and safety facilities	66

As a result of examining the traffic policies promoted by the SMG. It has clearly shifted the focus of its transportation policies from private cars to public transportation, pedestrians and green transportation, and yet the achievements of such policy shift have been very limited thus far. A good example is the city's public transportation. In 2004, the SMG reorganized the city's bus service, its flagship public transportation service. Yet various indicators show that the changes in the share of the city's public transport system remains insignificant.

It is worth noting that although the SMG has continuously invested in infrastructure and services for buses and subways, the ratio of switching from passenger cars to public transportation or green traffic is not significantly large. This is due to the fact that the policy for restricting the use of passenger cars is not so effective, and in effect motorists are not giving up on their private transport.

It is easy to see the reason if one considers the SMG's policies designed to discourage the use of passenger cars in the city. For one, parking fees in Seoul are very low compared to other cities in the developed world. So they are not so effective in discouraging motorists from driving downtown.

[Figure 2] Changes in Charges after Policy Introduction



* Traffic inducement charges are levied upon buildings of over 3,000m²

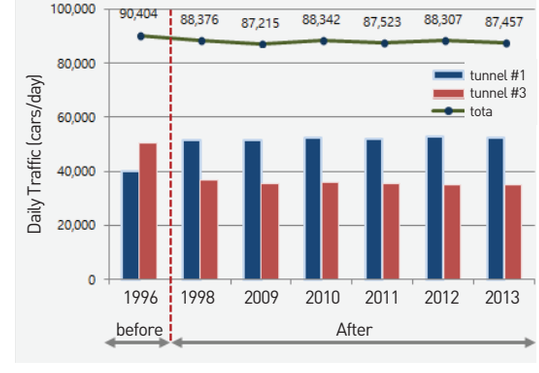
Public parking fees have not been raised since 1997. The fees are as low as one-sixth of the amount in comparison to some major cities in other countries. Traffic congestion fees began to be charged at Namsan Tunnels #1 and #3 in 1996 in a vain attempt to curb passenger car use. The traffic volume was mildly affected in the beginning, however there has been hardly any notable impact on the traffic volume since then. The main reason is that the tolls have not reflected inflation over the years. In a research study, the Seoul Institute has claimed that the tolls of KRW 2,000, the amount set in 1996, should be raised to KRW 6,580 when inflation is reflected.

[Figure 3] Comparison of Parking Fees between Seoul and Global Cities

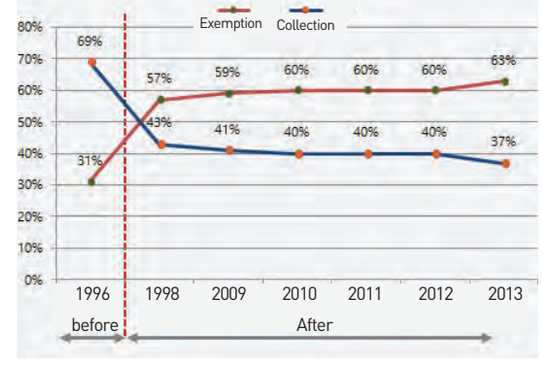
(US $: month)

Source : PARKING RATE SURVEY 2011, Colliers International

[Figure 4] Changes in Traffic Volume



[Figure 5] Changes in Collection/Exemption Ratios



Before the policy implementation, 69% of the drivers paid tolls whereas 31% were exempted entirely or partially. Now 63% are exempted entirely or partially whereas only 37% pay tolls in full. This raises serious questions about the effectiveness of the traffic congestion charges itself. The SMG has made it possible to raise the traffic inducement charge, which is imposed on major facilities that cause additional traffic demand, from KRW 700 to 1,000 per square meter. Still, the measure has limitations to suppress traffic demand in a considerable way.

The SMG actively promotes car-sharing, but its impact will not be significant, unless it can absorb the existing car ownership demand in a notable way. In other words, the city's overall passenger car use will increase unless existing motorists get rid of their cars to use the car sharing service. Therefore, it is necessary to strongly discourage citizens from using their private cars in the city while the SMG continues to promote public transport and the car sharing service as an alternative means of transportation.

[Figure 3] **Current State of Alleys Where Resident Preferred Parking is Implemented**

The parking rate in Seoul stands at 126% whereas that of the city's residential areas is 100%, implying that parking in those particular areas could be problematic. The SMG runs a resident-preferred parking permit system for the city's alleys, with the side effect being the supposedly safest alleys turning into not-so-safe parking lots. In fact, the area right in front of citizens' residences is exposed to fatal traffic accidents as pedestrian safety accidents frequently occur in alleys. It is important to change the city's major streets into pedestrian-friendly spaces through the launch of the Seoullo 7017 Project and the expansion of Toegye-ro sidewalks, public transportation preferred streets and car-less streets. Likewise, it is critical to transform alleys into pedestrian-centered spaces.

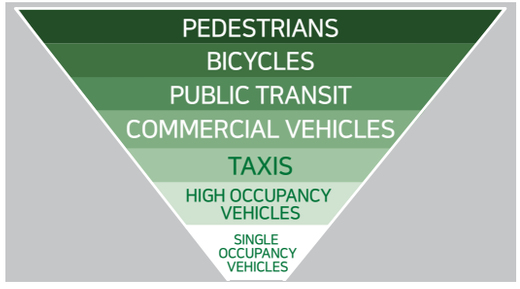
The SMG recently announced a policy of gradually replacing the Weekly No Driving Day System with the Car Mileage System so as to

reduce motorists' driving in a more significant way. It is necessary to examine the effectiveness of such a private car driving restraint policy in terms of fairness from the perspective of green transportation users. The SMG offers benefits to motorists who reduce their driving through the Weekly No Driving Day System and the Car Mileage System while offering virtually nothing to those who have switched from driving to green transportation such as public transportation and cycling. In other words, it is not fair to first compensate motorists who have reduced their driving instead of those who have completely switched to green transportation. It is deemed more reasonable to impose penalties such as congestion charges and parking fees on motorists while providing incentives like tax breaks to green transportation users.

Suggestions to Promote Green Transport in Seoul

Comprehensive Approaches Required for Traffic Demand Management, Green Transport Promotion, and Air Quality Improvement

[Figure 5] Priority of Sustainable Urban Transport Policies



In order to revitalize green transport, it is necessary to establish and promote comprehensive transportation policies that will strike a balance between closely linked policies to promote public transportation, cycling and walking while discouraging driving private cars. In other words, policies intended to make driving private cars inconvenient are closely linked to policies that promote green transportation such as public transportation and cycling. So all these issues should be addressed interactively and not independently. When establishing transportation policies, priority should be set in the order of pedestrians, bicycles, public transportation and passenger cars.

Recently, the SMG has announced the designation of a Green Transportation Promotion Area inside the Seoul City Wall as a way to promote green transport in the city. In connection with this, it has also announced that it will designate some main streets in the city center such as Jongno as exclusive public transportation areas while carrying out a road diet for other main streets including Toegye-ro as part of the city's efforts to restructure its urban space. It can be seen as part of the SMG's endeavors to manage the city's traffic demand by restructuring the road space and limiting the means of use instead of enlarging or strengthening its traffic congestion charge system. The SMG needs to look into the possibility of linking the approaches with other alternatives while promoting them as planned. One example is the Low Emission Zone (LEZ) being carried out in more than 200 cities around the world. One of the city's chronic environmental problems is its micro dust pollution. In the transportation sector, fine dust caused

by diesel vehicles is the most serious problem. Therefore, it will be necessary to take comprehensive approaches, instead of dealing with traffic demand management and air quality improvement separately, so that the city's Green Transport Promotion Areas and Urban Space Restructuring inside the Seoul City Wall can be closely linked to the LEZ initiative that bans the operation of polluting vehicles.

Strengthen Communication and Cooperation with 'Citizens,' the Main Actors in Improvements in the Walking Environment

Starting with the enactment of the Basic Ordinance on Securing the Right to Walk and Improvement of the Walking Environment in 1997, the SMG declared the "Pedestrian-Friendly Seoul" in 2013 and the "Walkable City Seoul" in 2016 as part of its continued efforts to expand pedestrians' rights. The SMG has created squares for people to gather in front of City Hall and in Gwanghwamun. It has expanded sidewalks through a road diet campaign. Citizens can now cross streets instead of using overpasses and underground walkways. Cheonggyecheon Stream and Plaza have been given back to pedestrians. The city's exclusive pedestrian streets are gradually expanding.

However, there is a hidden problem here. The upgrades of the pedestrian environment have been focused on the improvement of main streets. What about the pedestrian environment in alleys where ordinary citizens spend most of their time? While the right to walk has been extended on main roads, the situation has remained unchanged in alleys. The priority is still placed on securing more parking spaces than walking and community spaces. In order to make the 'Walkable City Seoul' a success, it is necessary to reorganize alleys that account for about 77% of the city's roads as pedestrian priority spaces. Improvements of alleys should be based on citizen engagement rather than authorities' directions or the interests of some major buildings nearby. It is becoming a reality that improvements made in the pedestrian environment without residents' consent or demand are scarcely effective. It is necessary to set up an organization like a 'Public-Private Working Group to Improve the Pedestrian Environment' in order to promote upgrades in alleys together with residents. It can be a very good example of a public-private partnership. Citizens from other regions can also be expected to actively take part in the efforts. It is time to allocate the budget for improvements in the pedestrian environment promoted by residents.

Active Measures Needed to Secure Traffic Safety in Alleys

The SMG has increased the city's safety budget designed for the maintenance and repairs of deteriorated infrastructure such as subways and bridges by 10.7% (KRW 136.3 billion) in an effort to assuage citizens' safety concerns. A budget of KRW 176.1 billion will be spent on the replacement of deteriorated subway cars and facilities. It has allocated KRW 411.2 billion to the maintenance and repairs of roads and bridges. How much does it spend on the improvement of citizens' safety in their daily lives?

In 2014, 56% of traffic fatalities in Korea occurred in alleys. The fatality rate of pedestrians in Seoul was 54% (214 out of 400 deaths). among which 53% accounted for fatalities in roads that were less than 13 meters wide. The most effective way to secure pedestrians' safety is the reduction of the speed limit in alleys. The pedestrians' fatality rate is 80% at a vehicle speed of 50 km/h. It drops to 20% at a vehicle speed of 30 km/h. The issue of 'alleys' has not been addressed officially. Some parts of alleys (e.g. school zones and senior citizen protection zones) are subject to speed limits, which ends up confusing both drivers and pedestrians.

Another problem with alleys is the sheer number of cars that are parked. In 2014, the number of cars exceeded that of parking spaces made in alleys. However, not all excess cars can find a place to park in a building rather than on streets. Japan began to implement the garage certificate system some 60 years ago and alleys in Japan look totally different from those in Korea.

It is necessary to prepare for a continuous discussion on the speed limit and parking in alleys to secure traffic safety. It is time to launch a pilot project for alleys designated at the dong level (the smallest administration unit) or a city block and to restart the discussion on the introduction of the garage certificate system.

Safety Must be Secured to Promote Cycling as Daily Transport Mode

Bicycles are the most environmentally friendly means of transport. As the awareness of fine dust increases, so does the social awareness of environmental and personal health issues. Thus, an increasing number of people are riding bicycles.

The SMG continues to invest heavily in the construction of bicycle infrastructure. Yet verification is needed to prove that the investments have led to increased bicycle ridership (the total length of the city's bike path rose by 16.5%, from 666 km to 775.9 km, between 2012 and 2014). The expansion of safe bicycle infrastructure (KRW 6.6 billion) including connecting bicycle roads is deemed an undertaking that raises cyclists' satisfaction with a relatively small amount of money.

Construction of new bike paths or significant improvements of existing paths should be preceded by a careful analysis of bicycle usage (big data) in the areas. Priority should be placed on areas leading to schools and subway stations so that students and commuters can safely ride bikes.

The number of the city's public bikes called Ttareungyi, whose pilot operation began with 440 bikes, has increased to 5,600 in 2016. In 2017, KRW 24.3 billion, a sizable amount of money, will be spent on the expansion of public bikes. Despite being a charged system, the number of service users stands at 200,000, indicating that there is a strong demand for bicycles in the city. As the number of bicycles increases, the cost per unit will decrease, but the total maintenance cost will continue to increase. Clearly, it is time to consider the expansion of the service. However, the SMG should be prepared to brace for the increasing burden of operating costs (the burden is set to increase just like the subsidy for city buses). There are benefits of transferring between public

bikes and mass transit. The benefits need to be extended to the riders of personal bikes who transfer to the subway system. Although initial implementation will be difficult, the effect of expanding bicycle use will be higher than the current incentive for public bike riders.

In addition to the quantitative expansion, qualitative aspects should be emphasized as well. An analysis on cycling accidents in Seoul over a period of five years from 2011 to 2015 has revealed that a total of 17,463 accidents occurred, resulting in 18,356 injuries and 138 deaths. The number of accidents in 2011 was 2,861. It increased to 4,062 in 2015, or a 29% increase over a five year span between 2011 and 2015. It would be very difficult to raise the share of bicycle transportation to 10% by 2020 if bike riding remains a risk as serious as it is now. In the final analysis, however, bike commuting is a way to create a safe road environment while helping create a wonderful bike culture in Seoul. The SMG needs to continue to place its policy focus in that direction.

3

Towards Energy Prosumer Cities

Choi Seung-kook

Executive Director of Solar-Wind Energy Co-op

Mr. Choi Seung-kook, executive director of Solar-Wind Energy Co-op and the Federation of Seoul Citizens Power Generation Cooperatives, has worked for green movements and energy conversion all his life. Also, acting as chief of the production subcommittee for One Less Nuclear Power Plant, Seoul's energy governance organization, he has taken the lead in promoting energy conversion at the level of the Seoul Metropolitan Government.

Mr. Choi has actively participated in environmental movements for more than 20 years since he established Green Korea United, Korea's representative environmental organization, in 1991 and fulfilled his role as its Secretary-General from 2007 to 2011. In the year 2000 in the midst of a global energy crisis, he founded "Korea NGO's Energy Network," in cooperation with more than 260 civic groups and served as its first Secretary-General and Co-representative.

He has engaged in various activities for the activation of public-private governance as vice chairman of Seoul Energy Committee, manager of Citizens Committee for Green Seoul, a member of the Presidential Commission on Sustainable Development, a member of the Central Environmental Preservation Advisory Committee, a member of the Public-Private Environmental Policy Council (Ministry of Environment), a member of the Prior Environmental Review Committee (Ministry of Environment), an environmental policy advisor for the Environment and Labor Committee (National Assembly), and chief of the Eunpyeong-gu Policy Evaluation Advisory Committee.

Mr. Choi has made ceaseless efforts to successfully resolve significant environmental issues in modern Korea. Specifically, he has played a leading role in enacting the Act on Preserving Baekdudaegan Mountains, the Framework Act on Energy, and the Framework Ordinance on Energy, and designating Wangpi Stream as an ecological landscape preservation area, producing significant results. He has also taken part in protesting against the four-river project and the construction of new nuclear power plants, nuclear waste sites, power line towers, a highway that cuts through Mt. Bukhansan, Donggang River Dam, and Naerincheon Stream Dam, sparing no efforts to prevent wrong national projects from destroying eco-systems and causing pain to local residents.

From 2008 to 2010, Mr. Choi presented diverse opinions and alternatives as a regular columnist for the Kyunghyang Shinmun and the Naeil Shinmun to raise awareness on environmental issues and to shift the paradigm of Korean society.

He is currently focusing on an energy conversion initiative led by the Solar-Wind Energy Co-op to overcome nuclear and climate crises and to establish a regional energy-distributed system. To this end, he is also adding fresh air to institutional reforms to lead the Korean government to have more interest and make more investment in renewable energy.

Seoul's Experiments for Solar Power Generation:

Together or Separately through Energy Cooperatives and Apartments' Mini PVs

Choi Seung-kook (Executive Director, Solar & Wind Energy Cooperative)

Introduction

Seoul's Dream towards a Sunlight City

Energy is hardly an easy issue to address in Seoul, inhabited by ten million people accounting for 20 percent of the country's total population. Seoul produces little energy on its own therefore depends mostly on energy produced by nuclear or thermal power plants situated in other regions of the country. Consequently, its residents are being threatened by climate change or fear of radiation. They must also confront the issue of energy justice associated with the pain being suffered by fellow compatriots over the construction of power towers not to mention the discomfort of those residing around power plants in the other parts of the country.

Seoul, however, has begun to make changes. It envisions to transform itself from a mere energy consumer to a solar energy producer, to significantly raise its overall energy self-sufficiency rate. Such a dream has resulted in the city's launch of the 'Make Seoul a City of Sunlight' project, which naturally begins with the construction of sunlight (solar) power generating systems.

The Seoul Metropolitan Government (SMG) has announced the "One Less Nuclear Power Plant" initiative which included "Make Seoul a City of Sunlight" to increase its electricity self-sufficiency rate from 4.2 percent as of 2013 year-end to 20 percent by 2020. Solar power generation is the driving force behind energy production in the One Less Nuclear Power Plant Project. Seoul plans to install 200MW capacity of solar power generation by 2020. In order to achieve the goal, the SMG has presented various policy proposals such as the introduction of Seoul-type feed-in tariffs (FIT),[1] improvements in the rent standard for solar power plants, the implementation of Climate Change Fund financing, and subsidies for mini PVs supporting as much as 50 percent of the installation fee.

1 *Feed-in Tariff: Often referred to as subsidy for difference in tariff, but feed-in tariff (FIT) is more accurate than the former one considering the purpose of the system.*

Energy Conversion and Solar Power Generation

Seoul strives to increase its energy self-sufficiency rate largely due to the necessity of energy conversion. Mankind is required to make radical changes in the traditional energy supply and demand system through energy conversion because of the impact of climate change being confirmed on a daily basis and the danger of nuclear power generation demonstrated by the Fukushima nuclear disaster. "Energy conversion refers to processes involved in the replacement of traditional non-sustainable energy sources such as fossil fuels and nuclear power with renewable energy sources, the shift from large-scale centralized energy supply to small-scale distributed energy supply, and the establishment of a sustainable energy system by reducing energy consumption or improving energy efficiency."[2]

Countries around the world depend on renewable energy sources such as solar and wind power to achieve energy conversion. For instance, the European Union (EU) is planning to cover 20% of its primary energy needs with renewable energy by 2020. Germany that has decided to cease the operation of all its nuclear power plants by 2022 obtained 32% of its energy from renewable energy sources such as solar and wind power in 2015 with the goal of raising the rate to 55% by 2035.[3]

2 *Choi Seung-kook, 2016, A Study on the Plan of Promoting Solar Power Generation for Energy Transition, University of Seoul, pp. 8-9*

3 *Choi Seung-kook, 2016, A Study on the Plan of Promoting Solar Power Generation for Energy Transition, University of Seoul, p. 2*

In contrast, the Korean government's target for new and renewable energy[4] by the year 2035 is 11% and does not look too promising. While the central government's commitment to energy conversion through increased renewable energy supply remains weak, the efforts of urban centers with concentrated populations and industries towards energy conversion have become all the more crucial for the country's success in overcoming its current energy crisis.

Seoul is hopeful that the "Make Seoul a City of Sunlight" project that advocates the spread of solar PV systems throughout the mega city will be a feasible solution. Considering how Seoul is a densely populated area home to 10 million people and how it has preserved rich historical and cultural heritage serving as Korea's capital for more than 600 years, solar power has the biggest potential of all possible renewable energy sources in the city.

The 'voyage' towards becoming a Sunlight City has progressed as planned. It is true that the SMG has been confronted with obstacles in expanding its solar power generation due to the outdated energy policy of the previous administrations. Nonetheless, the city of Seoul strives to overcome the hindrance. The SMG has laid the groundwork for energy conversion by establishing a Seoul-type FIT system, launching an aggressive site-renting policy, providing loans for the installation of PV systems, and financing the installers of mini PVs. On the other

4 *Instead of setting goals for renewable energy, Korea sets goals for new and renewable energy and monitors progress made in new energy (waste energy, hydrogen energy, fuel cell, coal gasification and liquefaction) and renewable energy (solar power, solar thermal energy, wind, geothermal, tidal power, and microhydropower) together.*

hand, energy citizenship is on the rise as an increasing number of citizens are joining energy cooperatives or installing solar PVs to produce energy for themselves.

The Emergence of Energy Cooperatives

The Emergence of Energy Cooperatives

In Korea, energy conversion is being promoted in two directions. One is the anti-nuclear movement and the other is the renewable energy movement. The former is based on traditional anti-nuclear campaigns. The latter is a new movement advocating specific solutions designed to achieve a nuclear-free society, and is given the name of an energy independence movement.

Most energy cooperatives in Korea were established between 2012 and 2013. It is directly related to the occurrence of the Fukushima Daiichi nuclear disaster in 2011. To those who were conscious of energy problems in the country, denuclearization was no longer just an ideal but a mandate that had to be realized in the shortest time possible. They arrived at a consensus of specific energy alternatives customized for their local communities. It led to the emergence of energy cooperatives which installed solar PVs and promoted energy conversion. The movement coincided with the country's legislation of support for cooperatives as a whole. The establishment of cooperatives was simplified and thus the energy cooperative boom ensued.

Energy cooperatives in Europe including Germany produce renewable energies such as solar and wind power while striving to streamline their countries' relevant legislation. Korea's energy cooperatives, however, focus on solar power generation. They also concentrate on institutional improvements related to photovoltaic power generation. This is the reason why most of Korea's energy cooperatives refer to themselves as solar power cooperatives. In fact, only the 'Sun & Wind Energy Cooperative' uses 'energy cooperative' in its name among the country's citizen participatory cooperatives. The other cooperatives have 'solar power coop' in their names, including Seoul Citizen's Solar Power Coop, Won Solar Power Coop, Hansalim Solar Power Coop, and Gyeongnam Solar Power Coop.

The phenomenon points to the limited number of renewable energy sources available in Korea other than solar power. Nevertheless, use of the term "solar power coop" instead of "energy cooperatives" in the organizations' names inevitably restricts the scope of their activities. The organizations should refer to themselves as energy cooperatives because they are charged with presenting diverse alternatives to nuclear power and playing key roles in streamlining the country's relevant legislation and raising the awareness of citizens.

Current Status of the Energy Cooperatives

Energy cooperatives are divided into two groups according to their purposes. The first group is citizen participatory energy cooperatives set up by multiple individuals to promote energy

conversion. The second group is business-oriented energy cooperatives established by companies according to the Framework Act on Cooperatives. According to the Act, a cooperative can be set up by five persons or more. Following the cooperative boom in Korea, businesses involved in the production of renewable energy united forces to form cooperatives which constitute the second group of cooperatives. The first group of cooperatives were set up by organizations involved in various energy-related activities to promote energy conversion that centers on solar power generation following the Fukushima nuclear disaster. As a matter of course, many of these cooperatives are being established in accordance with the Act, and so they maintain the characteristics of enterprises. Yet, in essence, they are similar to social enterprises or energy conversion advocacy groups.

Approximately 40 energy cooperatives are operating in Korea at the moment. More than 20 are located in Seoul, and nearly half of them are operating as citizen participatory cooperatives. In the rest of this paper, I would like to focus on the citizen participatory energy cooperatives with the belief that it is desirable to use small-scale, distributed renewable energy through the local residents' participation. Therefore, the citizen participatory energy cooperatives which best suits the model have a crucial role to play.

The total number of people participating in energy cooperatives nationwide is estimated to be close to 10,000. Most of the cooperatives have around 300 members each. Table 1 below summarizes the current status of cooperatives that directly or indirectly participate in the activities initiated by the National (Seoul) Citizen Power Generation Cooperatives Association.

[Table 1] **Current Status of Citizen Participatory Cooperatives (as of Dec. 2016)**

Name	Members	Main Activities	Power Plants	Est. Date
Solar & Wind Energy Cooperative	270	Solar power generation, energy conversion, institutional improvements	288kW/ 4 units	Apr. 19, 2013
Neighborhood Solar Power Coop	500	Solar power generation, energy conversion, education & training	100kW/ 3 units	Dec. 15, 2012
Seoul Citizen's Solar Power Coop	300	Solar power generation, energy conversion, institutional improvements	112kW/ 2 units	Nov. 26, 2012
Won Solar Power Coop	470	Solar power generation, energy conversion, education & training	800kW/ 22 units	July 14, 2013
Gangnam Solar Power Coop	50	Solar power generation, energy conversion, community service	156kW/ 3 units	Jan. 10, 2013
Nowon Solar & Wind Power Generation Cooperative	1,145	Solar power generation, education on climate change	30kW/ 1 unit	Feb. 16, 2013
Geumcheon Solar Power Coop	50	Solar power generation	50kW/ 1 unit	Dec. 27, 2012
Hansalim Solar Power Coop	1,390	Solar power generation, energy conversion	500kW/ 3 units	Dec. 26, 2012
Ansan Citizen's Solar Power Coop	650	Solar power generation, energy conversion, education & training	1,496kW/ 13 units (including those under installation)	Dec. 12, 2012
Suwon Citizen's Solar Power Coop	270	Solar power generation, energy conversion, education & training	695kW/ 9 units	Feb. 2013
Seongnam Solar Power Coop	80	Solar power generation, education & training	28.8kW/ 1 unit	July 17, 2013
Gyeongnam Solar Power Coop	240	Solar power generation	120kW/ 2 units	Jan. 9, 2013
Incheon Solar Power Coop	387	Solar power generation, energy conversion	150kW/ 2 units	Feb. 5, 2013
Bucheon Citizen's Solar Power Coop	30	Solar power generation, energy conversion	40kW/ 1 unit	July 16, 2013

Activities of the Energy Cooperatives

Installation and Operation of Solar Power Plants

The most important activity of the cooperatives is sunlight (solar) power generation. Cooperatives began by recruiting members and raising funds. Based on local communities, most associations recruited local residents and school officials as their members. They worked hard to secure funds required to install solar power plants. When the cooperatives began their operations in 2013, the cost of installing a solar power plant per kW was about 2.5 million won, so they had to raise more than 250 million won to build a 100 kW power plant. While the financing process for the Climate Change Fund became simplified in 2015, it had been difficult to meet the financing terms before then since most cooperatives had to depend on their members' contributions to install solar power plants.

Cooperatives that succeeded in securing funds had to overcome another unexpected obstacle — securing space to install their solar power plants. It turned out to be unfounded optimism that there would be sufficient room for solar power plants in mega cities surrounded by numerous buildings when most energy cooperatives were established in Korea. In reality, it was a challenge to find places to install PV systems. The buildings owned by businesses were not accessible at all and few schools were willing to cooperate. The last resort in Seoul was the rooftops of public buildings owned by the SMG among others or the land of public institutions such as water purification plants. In Seoul, the mayor's strong commitment backed up by the dedicated efforts of the members at the Dept. of Green Energy made it possible to conduct a survey on all the buildings owned by the SMG and find space to install PVs. Yet the space was far from enough to meet the demand of power generation businesses due to various constraints such as difficulties in grid connection.

Another hurdle was the plunge in solar prices that began in 2014. Most notably, the price of solar power dropped to 70 won per kW as a result of an RPS bid in the first half of 2015, striking a heavy blow to power generation companies including cooperatives. The price reduction reached 68% compared to that of the second half of 2011 prior to the introduction of RPS. Building solar PVs therefore meant generating financial loss.

Still, cooperatives are accelerating their installation of solar power plants to achieve their larger goal of energy conversion. The number of power plants run by each cooperative varies, but with some exceptions, each cooperative operates two or three power plants. The Won Solar Power Coop funded largely by Won-Buddhism runs a total of 22 commercial power plants (including 100 household units) nationwide — the largest number of plants run by any cooperative in the country. The Ansan Citizen's Solar Power Coop reached a milestone by exceeding 1MW in total electricity production including those in the process of installation. The Suwon Citizen's Solar Power Coop, a social enterprise fully supported by the municipal government of Suwon, also operates a sizable solar power plant. Also worth noting are the Hansalim Solar Power Coop and the Solar & Wind Energy

Cooperative. The former is characterized by the active participation of the members of the Hansalim Cooperative and the latter by the active participation of diverse cooperatives, the public and progressive political party members in the Eunpyeong area that have concurred on the cause of energy conversion.

As shown in Table 1 above, the size of the power plants installed and operated by citizen participatory energy cooperatives is still very small, producing just a few megawatts of energy, compared to the cooperatives running solar and wind power plants in Germany and the U.K and elsewhere. Nonetheless, these cooperatives are currently playing an important role in leading Korea's energy conversion, especially in terms of the expansion of renewable energy across the country. They are also very significant in that they develop energy citizens interested in energy conversion and participate in various energy related activities.

System Improvement Activities

The installation and operation of solar power plants are the most important tasks for energy cooperatives, which however also put considerable emphasis on activities designed to achieve the country's institutional improvements with respect to energy conversion. In Seoul, the efforts to make institutional improvements have taken two directions. One is designed to institutionalize necessary systems and support measures for photovoltaic power generation at the municipal level, and the other is aimed at streamlining the central government's systems.

Energy cooperatives in Seoul have sought for practical ways to further enhance the SMG's support for solar power generation and those engaged in the business. The most impressive achievement thus far has been the expansion of the Seoul-type FIT. While promoting the One Less Nuclear Power Plant Project, the SMG introduced a Seoul-type FIT system designed to support 50 won per kW for a period of five years up to 50kW for each plant site. However, PV prices plummeted by half compared to 2013, causing solar power generation entities to face a serious crisis in 2014. Representatives of energy cooperatives met with Mayor Park Won Soon on August 6, 2014 and demanded the expansion of the Seoul-type FIT system. It was agreed at the meeting to increase the limit of support per site to 100kW and increase the amount of support to 100 won per kW, which have played a central role in helping small power generation companies in Seoul to continue building solar power plants in the municipality which gets less sunlight compared to other regions.

The energy cooperatives operating in the city also continue their efforts to increase the effectiveness of the SMG's Climate Change Fund. The SMG has financed the installation of solar power plants through the Fund. It was, however, almost impossible for small-scale power generation companies to receive financing because the financing terms were difficult to meet - for instance, RPS bidding results were asked as collateral. Thus, the representatives of the city's cooperatives held meetings with the mayor on October 17, 2013 and August 6,

2014 and continued to hold consultation meetings with the officials of Seoul Climatie and Environment Headquarters. As a result, the RPS collateral requirement was eliminated from their financing conditions, their loan ceiling was increased, and their financing terms were simplified. With these changes, the Climate Change Fund has become a major source of financing for power generation companies.

In addition, space rental prices have been lowered through negotiations between the SMG and the cooperatives so that the roofs of public buildings owned by the SMG can be leased to them more actively. All SMG buildings that can accommodate solar PV systems have been surveyed and their rooftops have been leased to small-scale power generation companies and cooperatives in a proactive manner. Furthermore, cooperatives have contacted the Seoul Metropolitan Office of Education to promote the installation of solar power plants in schools throughout the city. However, despite the great prospect of the installation of solar power plants ranging from 50 to 100kW on their rooftops, most schools in the city are reluctant to install them and thus being a significant hurdle to the expansion of solar power in the municipality. The city's energy cooperatives are seeking solutions in various ways with the Seoul Metropolitan Office of Education so that superintendent Cho Hee-yeon can realize his campaign promise to install solar PVs at school.

Cooperatives have worked to make institutional improvements designed to convert the central governments' energy policy, placing priority on the re-introduction of the standard price purchase system (FIT system) for photovoltaic power generation. The National (Seoul) Citizen Power Generation Cooperatives Association (hereinafter the 'Association'), which is a federation of energy cooperatives, have regarded the central government's replacement of the FIT system with the RPS (Renewable Portfolio Standards) as the biggest obstacle to the promotion of solar power generation in the city and continued to strive for the re-introduction of the FIT system.

In the first half of 2015 when the solar energy bid prices plummeted, the Association held press conferences and rallies to urge the central government to abolish the RPS system, having defined the situation as the crisis of the entire solar PV business in the country. It also organized an 'Energy Conversion Response Team (hereinafter the 'Response Team')' that would focus on activities designed to bring about changes in the energy policies of the central government.

[Table 2] **Solar Price Trends following the Introduction of the RPS**

(Unit: Won)

Description Time: REC	2H2011	1H2012	1H2013	1H2014	1H2015	1H2016
REC Price (average)	219,777	156,634	136,095	112,591	70,707	86,477
SMP/kW	145.21 (Dec.)	183.92 (July)	149.72 (May)	143.79 (May)	81.99 (July)	68.78 (May)

Source: Choi Seung-kook, Choi Geun-hee, 2016, A Study on the Plan of Promoting Solar Power Generation for Energy Transition, Journal of the Korean Urban Management Association, Vol. 29, No. 3, p. 286

The Response Team has conducted research to identify problems of the RPS system and figure out their remedies. Following three

rounds of discussions based on the Team's findings, the Association had finalized its position as follows: "Solar PV prices plummeted due to the limitations of the RPS system, and thus the government needs to make fundamental changes in its renewable energy policies. First of all, the government absolutely needs to reintroduce the FIT system to reinvigorate the country's small-scale PV business. While it reintroduces the FIT system for small-scale solar PVs of 100 kW or less, the government can maintain the RPS system for bigger PVs. The cost incurred with the re-introduction of the FIT system should be reflected in the electricity bill while the Korea Electric Power Corporation (KEPCO) builds the grid-based infrastructure and reduces the system integration cost. It is also necessary to supplement the current RPS system in the transitional period until the FIT system has been reintroduced. The supplementary measures should include the introduction of a minimum price guarantee for solar power, a large increase in the purchase of small volumes, solutions to the surplus quantities, the mitigation of system integration costs, and the elimination of imported wood pellet co-firing from REC quantities."[5]

In order to reflect this position in the central government's policies, the Response Team worked actively to persuade the National Assembly in August and September 2015 before the Assembly's regular session for the year began. The Team met with the chairman of the National Assembly's Trade, Industry and Energy Committee and other committee members of the ruling and opposition parties to explain the necessity of system improvements and helped them point out the problems of the RPS system and the necessity of the reintroduction of the FIT system to the government officials during the year's regular parliamentary inspection of national affairs. As a result of these efforts, Rep. Lee Won-wook and Rep. Kim Han-pyo questioned the limitations of the RPS system, requested the re-introduction of the FIT system for small-scale solar PVs, and raised the difficulties faced by small-scale power generation companies including energy cooperatives during the parliamentary inspection of national affairs. Following this, a round table discussion took place between the Director of the Office of Energy and Resources at the Ministry of Trade, Industry and Energy and representatives of energy cooperatives. At the discussion, the Ministry made a commitment to seek ways to reinvigorate the installation of small-scale PV systems, reduce grid linkage costs, and decrease the number of imported wood pellet co-firing. Significant changes began to be made in the bidding market in the second half of 2015. An unscheduled bidding was held in the second half of 2015 and it resulted in the additional purchase of 183MW of photovoltaic power. In 2016, the price of photovoltaic power began to recover.

The Response Team completed its organizational activities in 2015 and changed its name to the 'Institutional Improvement Committee' in 2016 and has since focused on bringing about changes in the government's energy policies. As soon as the 20th National Assembly convened in 2016, the Committee promoted the revision of

5 *The National Citizen Power Generation Cooperatives Association, 2015, A Report on the Activities of the Energy Response Team*

the 'Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy' centering around the re-introduction of the FIT system. In addition to the re-introduction of the FIT system for small PV systems of 100kW or less, the Committee has vigorously engaged in efforts to make institutional improvements including a bill worked out with Rep. Hong Ik-pyo to reflect costs incurred with the FIT reintroduction in electricity bills and offer financial support for grid linkage with KEPCO.

Meanwhile, energy cooperatives have analyzed problems with the current RPS system and strived to improve it until the reintroduction of the FIT system. As a result, the ratio of small solar PVs in the RPS bidding market has grown and the proportion of imported wood pellet co-firing, pointed out as a serious problem, has been greatly reduced in the RPS target. Furthermore, though not complete yet, changes have been made to the cost calculation method for the grid linkage with KEPCO.

Local Community Energy Conversion Movement: Educational Activities, Energy Conservation Campaigns in Daily Life. etc.

One of the roles of energy cooperatives that must not be overlooked is the energy conversion movement carried out with citizens. Through diverse educational programs, hands-on experience programs and leadership cultivation programs on various topics such as energy conservation, expansion of renewable energy, and linkage between urban regeneration and energy, citizens will be able to heighten their energy sensitivity, reach consensus on the necessity of energy conversion, and grow into 'energy citizens'. Most of these educational programs are carried out by the citizen participatory energy cooperatives.

Energy cooperatives launch various energy conservation campaigns and publicity activities among cooperative members and local residents. In association with local governments, they offer energy consulting services through a program called Energy Clinic, and steadily carry out campaigns on Energy Day and publicity activities for local residents.

Mini PVs, the Seoul-type Solar Power Plant

Mini PVs, Experiment Gone Unnoticed

Mini PVs attracted the attention of the public in the summer of 2016 in line with the sudden increase in power usage due to the record high temperatures. However, few had anticipated such popularity of the mini PVs.

Mini PVs refer to micro PVs (around 250W per unit) that can be easily installed in the verandas of apartments or town houses. The product is the outcome of intense studies on how citizens themselves can generate electricity easily so as to become energy producers instead of mere energy consumers.[6] The idea was to install mini power plants

6 *Choi Seung-kook, 2016, A Study on the Plan of Promoting Solar Power Generation for Energy Transition, University of Seoul, p. 52*

on the verandas of apartment since there are limits to the installation of PVs on the residential rooftops in a mega city like Seoul that has a high density of apartment buildings. In short, the plants can be regarded as "Seoul-type sunlight power plants."

It was in 2013 that the SMG launched the mini PV project. "The SMG launched the mini PV installation trial project with a total of 50 households in Seoul and organized a citizen evaluation team to collect information on electricity generation capacity, installation conditions, and feedback from the team."[7] Based on the results of the pilot project, the SMG aims to install a total of 40,000 mini PVs on apartment verandas by 2018 through financial support of up to 50% of the installation cost. As of 2016, the installation of a mini PV cost 640,000 won. The SMG has been offering a subsidy of 310,000 won per unit. It has been providing an additional 100,000 won per unit if more than 20 households applied for the installation at the same time. The SMG promotes the PV installation in a variety of ways. Additionally, 13 districts including Guro-gu, Yangcheon-gu, Songpa-gu, Nowon-gu and Seocho-gu provide an additional subsidy of 50,000 or 100,000 won per unit.

Despite such efforts, the SMG suffered substantial difficulties with the mini PV project in the beginning. A 300W mini PV generates electricity that can power a two-door refrigerator, which is not so impressive by any standard, while a household has to pay 300,000 won per unit for the installation fee. The project did not progress as well as expected in the beginning. In addition, citizens had a negative image about mini PVs, which was another obstacle. Rumors spread among apartment residents that apartment prices would drop because of the deterioration of the aesthetics of the apartment buildings and that PVs would generate electromagnetic waves. There were even cases in which some households had to give up on the installation due to the objections of their neighbors.

Thus, only 2,826 households installed mini PVs on their verandas until the end of June 2015 in Seoul despite the SMG's full effort for promotion.

Seoul's Experiment that Thrived in a Crisis

The mini PV project however had a turning point in an area that few had seen coming. In 2016, Korea suffered the hottest summer on record. Sweltering conditions continued. Air conditioners and electric fans sold out. The highest power consumption record was broken each day. Citizens had to pay electricity bills that had increased exponentially.

It was the mini PVs that attracted keen interest among apartment dwellers under such circumstances. The electricity that a mini PV produced was not much. Yet its role turned out to be considerable when the progressive electricity rate combined with increased electricity consumption. Word of mouth grew about the advantages of

7 *Baek Jong-hak & Yoon Sun-jin, 2015, The Mini-PV Project as a Strategic Niche for One Less Nuclear Power Plant of Seoul and Changes in Energy Citizenship, Seoul Studies, Vol. 16, No. 3, p. 95*

mini PVs. Inquiries about the PVs poured in so much that members of the SMG's Department of Green Energy could do nothing else. PV businesses were swamped with PV installation orders. As a result, toward the end of the summer in September, 2016, more than 9,500 households had installed veranda-type mini solar PVs.

To sum up, Seoul's mini PV project aimed at installing Seoul-type sunlight power plants in households was launched in 2013 and had a turning point in 2016 amid an energy crisis due to the massive heat wave during the summer.

Current Status of the Distribution of Mini PVs

There have been slight adjustments in the SMG's definition of its mini PVs. Firstly, the mini PVs were limited to those installed on apartment verandas. The scope was extended to include 3kW PVs installed in individual houses in 2015 and PVs larger than 3kW installed in buildings of various types in 2016. In accordance with the changes, the official term was changed from "mini PVs" to "mini solar power plants" in 2015. The support targets are now divided into veranda type (200W~1kW), residential type (1~3kW) and building type (over 3kW).[8] Nevertheless, this paper focuses on veranda-type mini PVs.

It has been confirmed that the Seoul mini PVs have far exceeded the 10,000 unit mark and reached 13,346 at the end of 2016. Most notably, a total of 8,311 veranda-type mini PVs were installed in 2016 alone, accounting for more than 62% of the accumulative total, with most of them installed during the second half of the year.

[Table 3] The Current Status of the Distribution of Veranda-type Mini PVs by District

District	2014	2015	2016	Total
Nowon-gu	466	672	2,287	3,425
Yangcheon-gu	57	426	442	925
Guro-gu	91	410	316	817
Seongbuk-gu	119	237	493	849
Mapo-gu	66	110	540	716
Dobong-gu	55	111	475	641
Songpa-gu	53	176	334	563
Gangdong-gu	106	41	340	487
Geumcheon-gu	90	39	325	454
Dongdaemun-gu	79	159	287	525
Dongjak-gu	74	54	331	459
Yeongdeungpo-gu	39	91	177	307
Seodaemun-gu	28	72	329	429
Seocho-gu	37	29	333	399
Eunpyeong-gu	58	102	84	244
Gangbuk-gu	41	88	115	244
Seongdong-gu	40	25	262	327
Gwanak-gu	50	60	128	238
Jungnang-gu	33	58	178	269
Gangseo-gu	70	94	106	270
Jongno-gu	36	77	75	188
Jung-gu	10	42	137	189
Gangnam-gu	30	29	191	250
Gwangjin-gu	24	39	6	69
Yongsan-gu	25	17	20	62
Total	1,777	3,258	8,311	13,346

Source: Green Energy Division, Seoul Metropolitan Government

8 *Choi Seung-kook, Park Gyu-seop and Lee Sang-hoon, 2016, A Plan to Invigorate Solar PVs to Make Seoul a City of Sunlight, Seoul Citizen Power Generation Cooperatives Association, p. 35*

[Table 4] **Current Status of Subsidy Payments by District Offices for Veranda-type Mini PVs in 2016**

Ser. No.	Districts	Budget (KRW)	Individuals/ Groups	Indiv. Subsidy	Payment Methods
1	Jung-gu	4M	Individuals	110K	Deposit into individuals' bank account
2	Seongdong-gu	10M	Individuals	100K	-
3	Dobong-gu	30M	Individuals	100K	-
4	Nowon-gu	50M	Individuals	50K	-
5	Mapo-gu	50M	Individuals	100K	-
6	Yangcheon-gu	40M	Individuals	100K	-
7	Guro-gu	30M	Individuals	100K	-
8	Seocho-gu	62.7M	Individuals	100K	-
9	Songpa-gu	30M	Groups (10 households)	50K	-
			Groups (20 households)	100K	
10	Gangdong-gu	10M	Groups (10 households)	50K	Deposit into individuals' bank account
11	Yeongdeungpo-gu	15M	Individuals	100K	-
12	Dongjak-gu	15M	Individuals	100K	-
13	Seodaemun-gu	10M	Individuals	100K	-

Source: Seoul Citizen's Solar Power Coop, Choi Seung-kook, Park Gyu-seop and Lee Sang-hoon, 2016, A Plan to Invigorate Solar PVs to Make Seoul a City of Sunlight.

As can be seen in the two tables above, the mini PVs have been installed in the order of Nowon-gu, Yangcheon-gu, Guro-gu, Seongbuk-gu, Mapo-gu and Dobong-gu in terms of the number of units installed. All districts except for Seongbuk-gu has paid pay subsidies at the district level. This means that even though the SMG is offering subsidies, the cost for a veranda-type mini PV system is not low enough to appeal to citizens.[9] Fortunately, more districts are planning to provide subsidies for the installation of mini Pvs in 2017, which is expected to further boost the spread of mini PVs in Seoul.

Nowon-gu has a much higher number of mini PVs installed as compared to other districts. The reason for this is that the district office has offered an additional district-level subsidy since the inception. The installation in the district showed a dramatic increase in the second half of 2016, in particular, as the Seoul Housing & Communities Corporation (SH) donated mini PVs to new rental apartments in the area during the period. In the case of rental apartments in Nowon-gu, it is confirmed that there is no financial burden on tenants because the entire installation fee is covered by the subsidies offered by the SMG, the district office and the SH.

Energy Cooperatives, Mini PVs, and Emergence of Energy Citizens

The activities of the energy cooperatives and the distribution of apartments' mini PVs began with different objectives and have been promoted in different ways. Yet they are two roads leading to the same

9 *Choi Seung-kook, Park Gyu-seop and Lee Sang-hoon, 2016, A Plan to Invigorate Solar PVs to Make Seoul a City of Sunlight, Seoul Citizen Power Generation Cooperatives Association, pp. 36-37*

goal of 'energy conversion through solar power generation.'

The main focus of energy cooperatives is commercial solar power plants with a capacity of 30 to 100 kW. Yet the organizations also invest considerable effort in expanding the mini PVs throughout the city. The Seoul Citizen's Solar Power Coop is the leader of energy cooperatives in the country. It has worked as a veranda-type mini PV installer since 2014. It has thus far installed 3,174 mini PVs, accounting for 38 percent of the total of 8,311 mini PVs set up in Seoul. Overall, energy cooperatives have installed a total of 5,257 mini PVs accounting for around 63 percent of the total mini PVs installed across the city: the Hae Dream Cooperative and the Green Dream Cooperative have installed 1,627 and 456 mini PVs, respectively. Other participatory energy cooperatives, such as the Solar & Wind Energy Cooperative, have joined hands with the Seoul Citizen's Solar Power Coop to engage in the spread of mini PVs in their respective areas.

[Table 5] **Current Status of Installation of Mini PVs by Provider**
(as of Dec. 31, 2016)

Classification	Total	Seoul Citizen's Solar Power Coop	Kyoungdong Solar Energy	Micro Power Station	Hyundai SDW Industrial	Green Dream Cooperative	Hae Dream Cooperative
Installation	8,311	3,174	2,121	672	261	456	1,627
Ratio (%)	100	38.2	25.5	8.1	3.1	5.5	19.6

Source: Seoul Citizen's Solar Power Coop

The statistics point to the fact that the installation of apartments' mini PVs — the Seoul-type sunlight power plants — has achieved impressive results due to the active participation and efforts of energy cooperatives in the city.

Another common feature of energy cooperatives and the mini PV installation project is the cultivation of energy citizens fostering energy citizenship. "Energy Citizenship is citizens' moral character and personality of considering it their right and duty to learn and reflect on energy — related issues in order to make their participation in energy-related decisions relevant — on the basis of the recognition of their rights to participate in energy-related decisions - and to actively take part in energy problems faced by the society in which they live."[10] Energy citizens armed with such virtues grow into major players in their communities in terms of anti-nuclear and energy conversion movements. It is these leaders that play the central role in diverse energy conversion activities at the community level.

Analysis data released in the United Kingdom where energy cooperatives are quite active reveal that, "Energy cooperatives have provided the information and education necessary for the formation of new and active energy citizenship and played a central role in providing a reliable interpretation of community energy on the basis of daily experiences of local residents. Energy cooperatives

10 Baek Jong-hak & Yoon Sun-jin, 2015, The Mini-PV Project as a Strategic Niche for One Less Nuclear Power Plant of Seoul and Changes in Energy Citizenship, Seoul Studies Vol. 16, No. 3, p. 94

have also provided social learning opportunities for local residents to reflect on the patterns of energy production and consumption in their communities and discuss whether they can make changes in the patterns to make them more sustainable and friendly to their communities."[11] Energy cooperatives operating in Korea also provide energy-related education and information in their communities, initiate discussions on various topics instrumental in forming sustainable communities, and take necessary actions on the results.

The Voyage towards Sunlight City Must Continue

It should be understood that the journey to make Seoul a City of Sunlight through the activities of energy cooperatives and the expansion of apartments' mini PVs has only just begun. There are quite a few obstacles to overcome in order to make the voyage successful.

In order for citizen participatory energy cooperatives to steadily lead the energy conversion movement, the cooperatives should be financially self-sufficient. To that end, the problem of unstable solar power prices should be first solved. Solar power prices have been plummeting over the past five years threatening the viability of small power generation companies, including cooperatives, until the second half of 2016 when the prices shot up in the spot market, baffling solar power producers. The prices of solar power are so unstable that power generators say that they feel as if they are gambling rather than bidding in the market. In order to overcome the problem, top priority should be placed on institutional improvements such as the re-introduction of the FIT system and plans for lowering excessive grid linkage costs should be urgently worked out.

In addition, "it is necessary to offer consultation on the establishment and operation of cooperatives and help with activist training so that energy cooperatives can settle and become operational in due course. Support measures need to be worked out in the contexts similar to village enterprises and social enterprises in order for the cooperatives to secure space and personnel as early as possible."[12]

In order to overcome the difficulties of securing solar power plant sites, which is a chronic problem for cooperatives, prompt action needs to be taken to acquire school building rooftops for the installation of solar power plants. It is necessary to offer sufficient incentives to schools that rent their building rooftops and to completely remove their burden of post-installation management of the space. Furthermore, it is urgently required to make it mandatory to link school remodelling or roof waterproofing work with the installation of solar power plants.

Along with these changes in the external environment, energy cooperatives should strive to deepen their association with their

11 Lee Jeong-pil & Han Jae-gak, 2014, Implications of Community Energy and Energy Citizenship in Energy Conversion in the U.K., ECO 2014, Vol. 18, No. 1, pp. 102-103

12 Choi Seung-kook, 2016, A Study on the Plan of Promoting Solar Power Generation for Energy Transition, University of Seoul, p. 145

communities. Although energy cooperatives operate on the basis of citizens' participation, their membership hovers at around 300 people per cooperative. It is therefore necessary that they embrace more local residents, play a central role in regional energy conversion movements, and expand the installation of sunlight power plants.

The record heat waves of 2016 changed the perspective on mini PVs. The number of households that have installed mini PVs has risen dramatically. Although the project is now in full swing, there remains numerous problems that are yet to be resolved.

Veranda-type mini PVs can be installed in most apartments, so it has a great potential for expansion in Seoul. Therefore, it is important to investigate all apartment complexes and make a list of all the apartments where it is possible to install mini PVs. After that, it is necessary to secure the consent of residents through apartment management offices or tenant representatives, which is not as easy as it sounds. Therefore, it is crucial to launch promotions and intensive education designed to improve the awareness of current housing management and certified housing managers.

In addition, ways to lower the installation fee of apartments' mini PVs should be sought. It is true that the SMG relieved the household's burden of the installation fee by significantly increasing its subsidy with additional subsidies from its district offices in 2017, improved financial support alone is not likely to change citizens' perception on solar PVs. Therefore, while the City Government subsidies 50% of the installation fee, it needs to ensure that the unit costs of production and installation are reduced, thereby reducing actual installation costs.

Installation requests tend to occur intensively in the summer. Due to installers' shortage of manpower, delays often occur and the quality of post-installation service might deteriorate, which serves as an obstacle to the spread of mini PVs in Seoul. Thus, mini PV installers should equip themselves with a system that can guarantee quicker installation while trying to reduce sources of complaints from consumers by putting forward a post-installation service manual that covers services provided to those who have moved after mini PVs are installed in their apartment.

At the 4th Seoul International Energy Conference held in November 2016, Mayor Park Won Soon proposed a policy of one solar power plant for each household. 2017 will mark the 3rd anniversary of the launch of the One Less Nuclear Power Plant project. Concrete implementation plans should be put forth in 2017 to turn the mayor's proposal at the conference into reality. One of the easiest things to consider is to maximize the spread of residential mini PVs. Yet it is true that a number of individual houses in the city are not suitable for the installation of mini PVs. Still every household in Seoul can take part in the city's sunlight (solar) power generation by joining energy cooperatives as members. Those citizens who cannot install mini PVs in their residences can still participate in the city's solar power generation by taking part indirectly in the solar power generation initiated and run by cooperatives that they join. In the end, it is expected that energy cooperatives and the mini PV project will

play a key role for the success of the One Solar Power Plant for Each Household Project proposed by Park Won Soon.

The challenge to turn Seoul, a city with a population of 10 million, into a City of Sunlight is not an easy feat to accomplish. No one can expect the great experiment to succeed only through the activities of energy cooperatives or the effects of the apartments' mini PV installation project. However, it is a fact that the number of citizens equipped with energy citizenship, who are shifting from mere energy consumers to energy producers through the activities of energy cooperatives and the installation of apartments' mini PVs, is on the rise. I am therefore fully confident that the municipality's journey towards a Sunlight City deserves a great deal of optimism from people inside and outside its perimeters.

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Achieving a Democratic and Sustainable Energy Future:

Energy Justice and Community Renewable Energy Tools at Work in the OLNPP Strategy

John Byrne and Yun Sun-Jin[1]

Introduction

Launched in 2011, United Nations' Sustainable Energy for All (SE4all – see World Bank, 2017) initiative aims to realize three objectives: (1) ensure universal access to modern energy services; (2) double the global rate of improvement in energy efficiency; and (3) double the share of renewable energy in the global energy mix. These objectives are also included as sub-goals of the 7th target of the UN Sustainable Development Goals (SDGs) on "affordable and clean energy" (see United Nations General Assembly, 2015). Realizing the SE4all and SDG agendas will require the world community to address the challenges of energy availability and affordability. Energy services must be accessible to all citizens at prices that everyone can afford if the shift to sustainable energy is, in fact, "for all."

Not all countries have significant accessibility deficits, but all countries — including those in the wealthy world — have difficulty meeting the requirement of affordable energy services for all. Indeed, as discussed below, a growing movement exists to address significant and, in some cases, widening inequality in affordable energy.

A key commitment of the One Less Nuclear Power Plant (OLNPP) strategy adopted by Seoul Metropolitan Government is 'energy welfare'.[2] While energy services are available to almost every Korean family, more than 15% of households can struggle to make bill payments during harsh winters or high temperatures. In Seoul, an

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2 The term used by OLNPP has the approximate meaning of 'energy fairness,' 'energy equity' and 'energy justice' employed by researchers and some countries in characterizing a social condition or metric for unaffordable energy services for sizable segments of a society (Hall et al., 2013; Sovacool et al., 2017). It is intended to address the condition of 'fuel poverty' — a commonly used term in Europe — and 'energy poverty' (frequently used in the US). In this regard, OLNPP planning and policy seeks to remove unequal burdens among members of a society to enjoy needed energy services. It does this by a mixture of national and local programs that lower fuel payments and, additionally, lower energy losses (by the application of energy efficiency strategies).

estimated 10.3 percent of total households are classified as energy-poor (Jin 2009). Nearly 70 percent of the families in the lowest income decile pay more than 17 percent of their income for energy services, while the average across deciles is much lower (less than 5 percent — see Byrne et al., 2015). Seoul Metropolitan Government (SMG) has given high priority to the goal of energy affordability for all of its citizens so that no one is denied the opportunity to participate in and enjoy the basic services of daily life necessary to be a citizen.

In addition to addressing energy welfare needs of its citizen, the City must also enable everyone to participate in the shift to the sustainable energy future envisioned in its OLNPP strategy. This includes access to renewable energy options (especially solar electric power). To meet this goal (which is likewise included in the worldwide SE4all and SDG agendas), the City has devised an initiative called 'renewable energy sharing,'[3] which can empower low- and moderate-income households to enjoy the benefits of sustainability. Again, though, affordability must be included in the strategy and, in this respect, energy welfare and renewable energy must be coproduced as part of a more democratic approach to pursuing One Less Nuclear Power Plant.

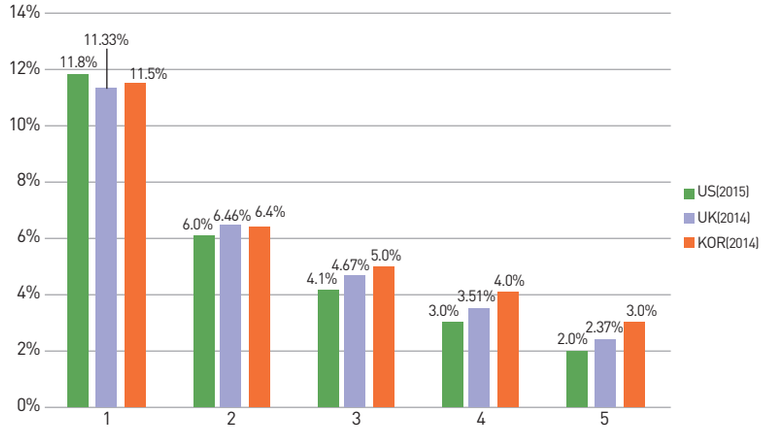
This chapter examines the opportunities and challenges of energy welfare and renewable energy sharing as principles to guide City policy and planning. A review of international efforts to address both principles via policy tools is conducted, focusing on the US and UK as best-practice examples. This international review is then used to benchmark South Korea's and Seoul's efforts, with attention given to both qualitative and quantitative dimensions of impact. Finally, additional strategies that might be considered for inclusion in the OLNPP framework are offered.

A Review of International Efforts to Address the Energy Welfare & Renewable Energy Sharing Challenges When Building a Sustainable Energy Future

Studies show that energy affordability is a problem for the world community, including wealthy countries (Jannuzzi & Goldemberg, 2012; Teller-Elsberg et al., 2016). A useful comparison is to consider the income effort needed to purchase basic energy services (including electricity and heating) in the US, UK and South Korea. The countries show a similar pattern of unequal burden by income quintile (Figure 1): the 'energy poor' (typically, the lowest income quintile) must dedicate 2.5 times as much of its income to meet basic energy needs compared to middle income families (i.e., the 3rd quintile) and 4-6 times as much as wealthy households.

3 *Again, a variety of terms are used internationally to capture this policy purpose. From 'community clean energy development' to 'local sustainable energy planning,' the aim is to empower households, neighborhoods, and communities to identify energy service needs and to meet them with local, renewable energy options in combination with energy conservation. This approach is often regarded as an effort democratize energy governance (van der Schoor & Scholtens, 2015; Moss & Becker, 2014).*

[Figure 1] Share of income needed to pay energy bills (heating fuel & electricity) by income quintile: Comparison of U.S., U.K. and Korea



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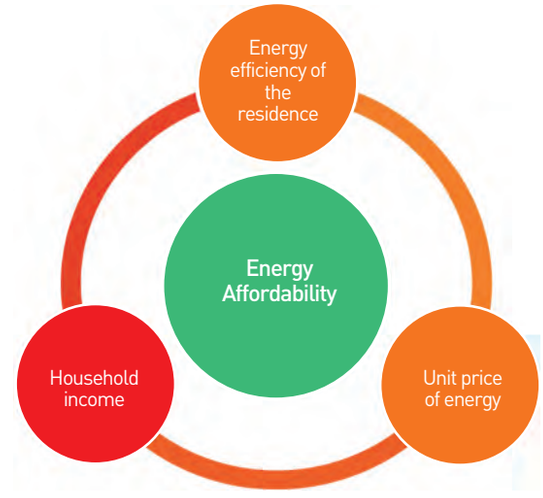
Basic energy needs become unaffordable when the interplay of family income, energy prices and home energy and equipment efficiency causes a family to spend a substantially higher share of their family earnings than the majority of households (see Figure 2 and Table 1).

[Figure 2] Factors Affecting Energy Affordability



Source: Presentation at the 2014 Seoul International Energy Conference. "Sustainable Energy for All Citizens of Seoul," presented by Drs. John Byrne and Sun-Jin Yun with research assistance from CEEP Ph.D. candidates Joohee Lee and Jeongseok Seo.

Acting on the energy welfare challenge

Improving energy affordability typically involves a two-prong strategy that, on the one hand, offers payment assistance for fuel and services, and on the other, strives to lower energy waste in homes and key appliances needed by families for daily life. The US, UK and South Korea have adopted versions of this two-prong strategy.

[Table 1] **Policies to Address Energy Poverty: Korea Compared to US & UK**

	U.S.	U.K.	Korea
Terms commonly Used	Energy Burden	Fuel Poverty	Energy Poverty
Definition of Energy-Poor Households	•A household with a 10% energy burden.	•Household spending at least 10% on heating	•A household spending more than 10% of the total income on energy expenses.
National Programs	•Weatherization Assistance Program: Since 1976 •Low-Income Home Energy Assistance Program: Since 1981	•Warm Front Scheme : 2000-12 •Affordable Warmth Grants : Since 2013 •Winter Fuel Payment: Since 2000	•Weatherization program: Since 2007 •Energy Bill Discount & Fuel Payment Program: Since 2010

Source: Prepared by CEEP Ph.D. candidate Joohee Lee from these sources: U.S. Department of Health and Human Services, 2005; U.S. Department of Health and Human Services, 2017; Energy UK, 2017; UK Government, 2017; Korea Electric Power Corporation, 2013.

In the case of the US, the fuel payment policy prong has been in place since 1981 when the Low Income Home Energy Assistance Program (LIHEAP) passed into law. It combines payment for emergency needs and a portion-of-bill monthly payment for qualifying households (see Table 1, above). Each year about 8.5 million households are served from an eligible population of 35 million families. Funding has varied between US$3.5-4.0 billion per year recently and has had high Congressional vote support (meaning that a substantial majority of members of the US House and Senate have vote for its appropriation). Program scope widened from a focus on heating needs to include year-round energy needs; now about 72% of LIHEAP funds address heating needs (include emergencies), while about 13% assist households with cooling needs (again, including emergencies), and the remainder covers program administration. The average annual household benefit is more than US$500 (Byrne et al., 2014).

The country's weatherization effort dates back to 1976. The annual number of families annually served is approximately 150,000 households (including those in single — and multi-family housing, and owners as well as renters). Funding each year is over $930 million (including US$50 million in matching state and local contributions). The program has similar vote support to LIHEAP. Average expenditure per household is estimated to be more than US$6,000 with a bill savings-to-investment ratio of 2.6 (when health and environmental benefits, the ratio climbs above 4.0 — see Byrne et al., 2014; ACEEE, 2014).

A defining attribute of the US LIHEAP and WAP programs is that implementation and administration are performed by local, non-profit community agencies. Funds flow from the federal government to state agencies and then to more than 900 community agencies nationwide. Contributions from states and local governments and charities are also part of the fabric of the US system.

The percent of eligible households served by both US programs is less than needed to end energy poverty and there currently is no policy proposal of federal and local commitments that can promise to meet this goal.

Comparable data were not available to the authors for the UK case regarding the country's fuel payment and weatherization

initiatives. But the two-prong strategy guides the UK's effort to address energy poverty in a manner similar to that of the US. A notable difference is that the UK relies on central government organized public private partnerships to administer its programs rather than the US scheme of relying on non-profit community agency networks (Byrne et al., 2014; Northern Ireland Housing Executive, 2016).

At least an infrastructure of energy efficiency tools exists in both societies to tackle energy welfare needs. Its inadequacy to significantly ameliorate the problem is recognized by each country's policy analysts, who point to the very low funding levels of programs (Byrne et al, 2014). But efforts have been given to introduce fuel payment support and energy efficiency as tools of energy justice.

Acting on the renewable energy sharing challenge

The same cannot be said for efforts by the US and UK to assure that economically vulnerable households have access to clean energy tools that can empower them to be 'prosumers,' that is, energy decision makers who can govern both the amount of their energy use and the sources of its supply.

Renewable energy is an essential tool to create a sustainable future for all societies. But it should also be recognized that renewable energy systems, if properly designed, elevate the energy user to a decision maker and this, in turn, opens the possibility for families and communities to become less dependent on energy institutions which many believe they cannot influence. Locations, types and sizes of power plants (for example) are chosen without decisive community involvement and the role of the public is typically limited to paying the prices needed to secure capital investments and cover the costs of plant operations, fuel payments, and billing systems that tell us how much we owe.

There are examples in the US of initiatives to tackle this problem. The federal government and several state and local governments in the United States have an array of renewable energy (mostly solar PV) programs to help low-and moderate-income (LMI) households alleviate their energy burden.

At the federal level, the 2013 President's Climate Action Plan set forth a target of deploying 300MW of installed capacity of renewable energy technologies (so-called Renew300 Initiative), focusing on solar PV, at federally assisted housing by 2020. Through this program, the federal government partners with affordable housing developers to install solar PV on the rooftops of public housing or multi-family assisted housing administered through the U.S. Department of Housing and Urban Development (HUD) (The White House, 2015). Others include the U.S. Department of Energy's SunShot Prize: Solar in Your Community Challenge, which offers $5 million in cash prize and technical assistance over 18 months to selected teams to develop projects or business models including community solar (U.S. DOE, 2016a), and the 2016 Clean Energy Savings for All Initiative, which sets forth a specific goal of making 1 GW of solar PV available to LMI neighborhoods by 2020 (The White House, 2016). The USDOE also maintains an assistance

team under its SunShot initiative called Community and Shared Solar, which is intended to facilitate the efforts of state and local governments to address the need for renewable energy sharing (U.S. DOE, 2016b).

There are also several programs to support low- and moderate-income families at state or local levels. For example, the District of Columbia launched an Affordable Solar Program through its DE Sustainable Energy Utility, which was recently renamed Solar for All. The program helps low-income residents to install solar PV at no cost and aims to cut the electric bill of at least 100,000 qualifying households by at least 50% by December 31, 2032 (DDOE, 2017, p. 4). Through the Mass Solar Loan Program, Massachusetts state government offers loans to any households in their jurisdiction who apply for the program to install PV on their houses. This program offers a carveout for low-income families with financial incentives, including interest rate buydowns by 1.5% and a 30% reduction in loan principal (Massachusetts Clean Energy Center, 2017). California's Multifamily Affordable Solar Housing (MASH) program provides eligible low — and moderate — income households with a cash incentive ($1.10/kWh to $1.80/kWh) for up-front costs of PV installations (CPUC, 2015). For this effort, the state annually allocates $65.2 million solely for low-income public housing.

Compared to the scale and history of its low- and moderate-income fuel payment and energy efficiency improvement programs, national policies in the UK to promote renewable energy development for energy poor households are modest. Although the UK's Green Deal initiative provides households with low-interest loans for renewable projects, program eligibility criteria are steep for low-income families (Koh, et al., 2013). When a feed-in tariff was implemented in 2010, tariff rates were attractive enough for companies to provide households with affordable solar panels (Clarke, 2013). In recent years, however, reductions in tariff rates have left energy poor communities without attractive opportunities to take advantage of renewable energy technologies. The National Energy Action's Technical Innovation Fund can be used to assist families in fuel poverty to install unconventional technologies such as renewable-powered heating but to date, the number of households using the option is small (National Energy Action, 2016).

Local-level projects are under development in the UK. In December 2016, London's Borough of Camden Council launched a pilot program, '24/7 Solar,' which is designed to reduce energy bills of families at risk by installing solar PV (with storage) on rooftops (London Borough of Camden Council, 2016). This project is partly funded by the NEA. Northern Ireland's housing authority (the Housing Executive) has recently developed a solar PV scheme for energy poor households in partnership with the private sector. Through this program, more than 1,000 homes have installed solar PV systems generating electricity that is saving equivalent of $25 per month per household on average (Northern Ireland Housing Executive, 2016). While also modest in scale, local-level efforts are seen as promising.

For the US and UK, the purchase of renewable energy and the

governance role it can give to a family is mostly treated as a private matter. Families are expected to enter renewable energy markets and seek to buy what they can afford. For families with modest incomes, the ability to buy capital equipment or incur debt to own renewable energy systems is obviously much lower than that for middle or upper income households, creating the prospect of renewable energy evolving as an elite service and failing to address energy justice concerns.

International experience: promising but inadequate

Overall, the US and UK cases underscore the need for policy attention to the problem of energy poverty. Efforts to design a democratic response to energy poverty have been more successful in the case of the energy welfare challenge, where an infrastructure of fuel payment and weatherization programs has been in place for decades. This promising response to the problem has established its policy importance but neither country is investing in the key tool of weatherization at a rate necessary to promise an end to this aspect of energy injustice. Making renewable energy an attractive option to families most at risk of energy poverty is a recent goal with, so far, a small footprint. The build-out in the US is larger at the national and local levels but it must receive much more investment to provide a serious choice for at-risk households.

The Case of Seoul

Who are the energy vulnerable?

Article 16-2 of the Energy Act in South Korea authorizes the Government to undertake actions support universal supply of energy to all citizens. Actions anticipated by the Energy Act include:

1. Supply of energy to vulnerable classes in energy use, especially low-and moderate-income households
2. Improvements in the energy efficiency of housing occupied by vulnerable classes.
3. Other matters leading to improvements in the energy welfare of vulnerable classes.

In addition, Article 4-5 requires that "the State, local governments and energy suppliers shall contribute to the universal supply of energy to every citizen, including the poor." Additional to this national statement of policy responsibility, the city of Seoul is governed by its Energy Ordinance which requires "the city government to contribute to the universal supply of energy to all citizens including the energy poor with the assistance of local districts and energy utilities." As well, Seoul's energy planning authority includes an obligation to address energy poverty. And the city can mobilize its Climate Change Fund to support the energy-vulnerable based on Article 4 of the ordinance creating the fund.

According to Article 1-7 of the Energy Ordinance of Seoul, the

energy-vulnerable are those who are eligible for National Basic Living Security benefits, as well as any household in the second lowest income class specified in the Energy Act. The 2nd National Basic Energy Plan defines the energy-vulnerable as those who spend more than 10% of their income on energy. For Seoul this means approximately 10.3% of all households (about 610,000 households composed of 1.36 million people) are to receive policy attention.

Energy welfare policies, plans and programs

Lower level income households tend to rely on energy options such as relatively cheap LPG or kerosene. Most do not have access to town gas infrastructures and family appliances are relatively energy-inefficient because of modest family purchasing power. Thus, relative spending on energy expenses is around 2.3 times that of the middle quintile household and nearly 4 times that of the upper quintile (see Figure 1. above).

The SMG clearly recognizes the basic energy rights of all citizens and tries to guarantee them. It prepared a Citizens' Charter for Basic Energy Rights and Energy Welfare Ordinance to expand the responsibilities of the Seoul government to act on this pressing problem. The "Seoul Sustainable Energy Action Plan" includes specific actions to support the city's energy poor through energy welfare projects. A distinctive feature of the SMG approach is to act on the problem as a community-wide one with citizens sharing their saved energy with the energy-vulnerable (Seoul Metropolitan Government, 2014).

To implement this policy perspective, Seoul has organized several projects and has sought to integrate national projects into the City's program infrastructure. Energy welfare projects carried out by the SMG can be classified into three categories (Seoul Metropolitan Government, 2014):

- Programs implemented by the Climate and Environment Division which can be further classified into –
  - Projects involving public support (especially fuel vouchers and the distribution of LED lamps to replace conventional lighting)
  - Private resource networking projects which engage the business sector and citizens in assistance to households that can include technical and financial support and draw support from Seoul's energy welfare civil fund
  - Projects conducted by a newly created government workforce which ensures that energy welfare needs of energy vulnerable families is leaned (for example, through surveys and outreach activities) and these needs are then communicated to the government for action
- Programs implemented by the Social Welfare Division which focus on emergency funding support and assistance to enable, repair or maintain Korean ondol (underfloor heating) strategies
- Programs implemented by the Bureau of Housing and Construction, in which house repairs and energy efficiency improvements of government-subsidized rental units are targeted.

South Korea's central government mainly relies on centrally administered energy voucher and fuel payment systems managed by the government-owned "Korea Energy Foundation." Local governments have not been encouraged to work on energy welfare initiatives customized to address local circumstances. In response, SMG has undertaken important efforts to realize its own energy welfare policies. It plans to enact a Charter of Basic Energy Rights and an Energy Welfare Ordinance to complement existing local laws and to the gap left by the central government's energy welfare policy system. SMG has pledged to promote residential energy efficiency improvement and solar power expansion projects for the energy poor. This includes offering its own energy vouchers and direct subsidies of renewable energy project costs. SMG has also undertaken the pioneering step of trying to connect citizen involvement in building a sustainable energy transition which includes sharing the benefits of energy efficiency and renewable energy use with the energy-vulnerable. SMG has created a workforce energy welfare social workers, who conduct regular surveys among the energy-vulnerable and give advice, in order to enhance the capacity of all citizens to participate in a sustainable energy future.

Representative examples of energy welfare through energy sharing projects under OLNPP

Citizens' Energy Welfare Fund (Climate and Environmental Headquarters, 2017) SMG created an Energy Welfare Fund based on citizen contributions of energy savings to be shared with energy-vulnerable families. Citizens have been deeply involved in the creation, operation, and distribution of the Energy Welfare Fund since 2015. Sharing comes in several forms, including citizen donations of a portion of bill savings generated from the conservation of energy and generation of energy services from renewable energy. This sharing process takes advantage of City promotions of solar power, LED lights, Building Retrofits Program, and Eco-Mileage projects. The Citizens Council composed of 100 citizens has launched fund raising initiatives to complement these government-supported efforts. SMG is mobilizing citizen participation with a goal of 100,000 sharing members by 2018 and 200,000 by 2020. The donation target from all efforts is 1.7 billion KRW (Korean won) and 3 billion KRW, respectively. The Fund is being used to improve energy efficiency and replacement of inefficient appliances of the energy-poor. In 2016, 754 million KRW was collected through efforts by more than 27,000 citizens.

Beyond simply supplying energy vouchers and quick-fix weatherization strategies (such as wallpapering and replacement of floor mats) which are the foci of central government efforts, a City-supported initiative is forming to improve the energy efficiency of the energy-vulnerable through the replacement of balcony windows, elevators, security lights, and boilers with high energy-efficient products. This deep-retrofit approach will pay significant dividends because housing performance is often quite low for those at risk of energy poverty. In addition, this effort can in some cases abate energy-related environmental and health problems and reduce national energy insecurity by lowering demand

for energy imports.

The SMG-created Fund commits the city to these important initiatives while also enabling it to assure basic energy benefits — including emergency aid for heating costs. Plans are in place to target the new programs to the specific needs of single-parent households, households with handicapped members, and the city's poorest households.

ENURI Program: Supporting Energy Welfare and Renewable Energy Sharing through Shared Savings from Participating Businesses (Climate and Environmental Headquarters, 2017)

SMG is creating vehicles for the mobilization of its business community to support energy welfare and renewable energy sharing programs. In a manner similar to the Citizens Energy Fund, SMG is asking companies to donate to a share of energy cost savings from energy-efficiency improvements and the generation of renewable energy (which lowers their utility bills to a fund that helps to lower energy bills) to projects which help the energy poor. This program connects the principles of corporate social responsibility with energy welfare and renewable energy sharing. However, this approach is not a simple donation but sharing of energy saved through sustainable energy investments of companies. More than 25 company donations were made during 2015-16. Specific examples include: participating company donation support of products to protect community child welfare centers from winds, cool roof painting for poor communities, PV installation for the energy-vulnerable communities, insulation retrofits for older homes, etc. These activities can stimulate a sharing culture and contribute to energy justice. Also, this project can help companies to become involved in the citywide OLNPP effort without costly regulation.

Seoul's innovations are promising and welcome. Of course, as with the situation internationally, we will need more policy creativity and we will need to learn better how to produce results at a large scale.

Possible Steps to Strengthen the OLNPP Strategy to Meeting Energy Welfare and Renewable Energy Sharing Challenges

The strategies reviewed in the US, UK, and Seoul can ameliorate the problem of energy inequality but they can also leave certain problems unaddressed. For example, the fuel payment programs in all three societies mainly subsidize utilities and fuel companies, rather than reducing energy costs per se for at-risk households. These subsidies represent income for the conventional energy structure that is failing to meet the needs of a sustainable energy future and can offer little hope, by themselves, of making the energy system of the future more democratic and fair.

Energy vouchers and fuel payments leave intact an underlying social inequality, namely, that the most economically vulnerable

households often occupy the poorest performing homes because better, including more energy-efficient, housing is unaffordable to families. While weatherization assistance can contribute lower costs, no national program is currently funded to a level that would result in a significant reduction in energy poverty. Additionally, weatherization programs too often sacrifice savings for ease of administration. Specifically, there is a tendency to adopt technical 'one-size-fits-all' solutions, ignoring different energy consumption patterns, demands and needs depending on a household's situation. To accommodate lower program costs per project (thereby increasing the number of families served when program funds are small), weatherization assistance can too often focus on 'low-hanging fruit' options that create immediate but relatively small reductions in energy use, leaving at-risk households with enduring problems of high heat and air conditioning losses, inefficient water heating systems, unaddressed building envelope issues, and inefficient appliances. Unless we 'dig deeper,' families are left with increasingly more costly living conditions, growing threats to family health in some instances, and disproportionate environmental burdens.

We offer below strategies to address three key problems in the hope of strengthening the impact of the OLNPP strategy.

Redirecting investment toward sustainable energy development

There is an evident need in the near term for modern society to address energy poverty by making conventional energy services affordable. Cutting energy voucher or fuel payment programs would be morally wrong and socially irresponsible.

At the same time, underinvestment in sustainable energy options lengthens the time spent sending funds to the energy system we intend to replace. As noted above, energy vouchers and fuel payments do not change the underlying conditions of energy poverty. Rather, they simply provide income to the conventional energy system so that the energy poor have access to its services.

How can we address this problem? SMG has created an innovative platform for an answer with the launch of the Citizens' Energy Welfare Fund (CEWF). Our suggestion is to expand this effort in three ways. First, the platform could be encouraged to pursue specific annual targets tied to concrete goals of energy poverty reduction — for example, a reduction of 20% by 2020 in energy poverty (measured by the ratio of income share needed by the middle and lowest income quintiles to meet basic energy service needs).[4] Second, perhaps with management support from the newly created Seoul Energy Corporation, the Fund could be managed as a mutual bank or credit union in which members own and govern the assets — namely, the deposits of members. If the City deposited funds for at least some of its energy welfare and renewable energy sharing initiatives in the CEWF and citizens placed some of their savings in the Fund as well, this would create a continuing investment vehicle to support democratic, energy-fair sustainable energy projects. Vehicles of this kind exist in other countries but they

4 *An annually produced version of Figure 1 could be helpful in stating and measuring this goal.*

often lack a sovereign investor like a city. Further, OLNPP's success to date in attracting exceptionally high levels of participation of other programs, if marshalled to transform CEWF into a community institution, could leverage the creditworthiness of SMG deposits to enable the Fund to become a viable driver for sustainable energy development. Third, current efforts to involve the business community in the OLNPP initiative might be expanded to include encouragement of company deposits in the Fund with the commitment to dedicate a portion of the business deposits each year to projects designed to hasten the shift among business energy equipment and services to ones consistent with sustainable energy development. With South Korea's recent adoption of a policy on socially responsible investment, this would furnish companies with an attractive compliance opportunity.

These steps create an opportunity to organize the sizable investment capacity needed to meet several of the ambitious energy welfare and renewable energy sharing goals of OLNPP.

Overcoming the one-size-fits-all tendency in implementing weatherization and community renewables strategies

A key feature of sustainable energy development is its reliance on distributed energy-supply, energy-saving and energy-storage approaches. This feature is a strength because it means that energy development can be built according to community choices and needs. Hopes for democratic governance of the energy system, moreover, depend upon this feature. But the democratic, distributed model can also be seen as complicated and planners can sometimes look for ways to standardize decision structures and program implementation. A practical example of this tension is the struggles countries have undergone in building significant weatherization and community renewables programs. The challenge has been as a technical one and planners look for ready-made, 'one-size-fits-all' solutions. Such a development path can compromise the key benefit of sustainable energy development, namely, its ability to recognize and respond appropriately to different energy consumption patterns and demands depending on a household's or a community's situation.

A practical solution to this problem can be found in US experience — a responsive system built to rely on a network of over 900 community-based, non-profit organizations who managed over US$900 million of annual investments in deep-retrofit weatherization of low- and moderate income housing. OLNPP has already been busy building the rudiments of community-based agency networks to perform regular energy needs assessments. This could be expanded to include the management and implementation of the City's own weatherization program.[5]

This approach would have an important advantage for local economic development. By a partnership of (a) community non-profit agencies representing each of the City's 25 administrative divisions

5 *Using the US system as an example, CMEJ (Citizens for Environmental Justice), with the assistance of the Center for Energy and Environmental Policy, University of Delaware launched the first city-based weatherization initiative in Seoul in 2006.*

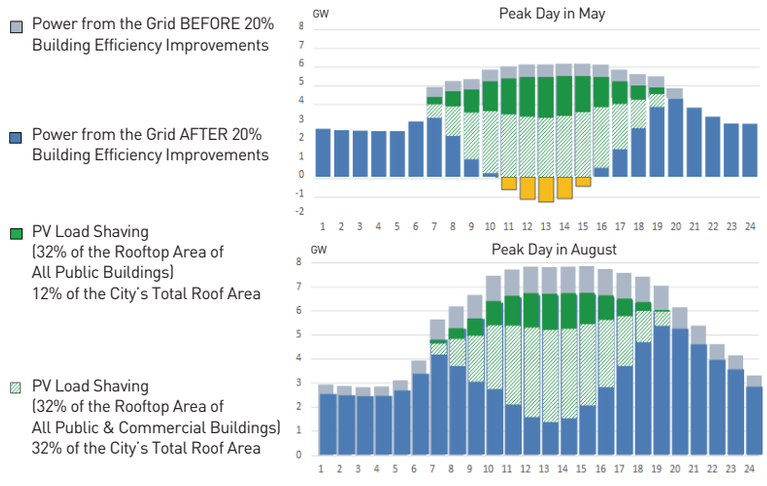
(and perhaps additional agencies to represent many of the 200 or so sub-administrative divisions) with (b) associations of local building contractors, renewable energy installers, and engineering firms (as states in the US like Massachusetts and New York have done), a sustainable energy development network can be organized and coordinated with CEWF playing its expanded role as sustainable energy investor. This would replace the 'one-size-fits-all' model with a 'made-to-suit' or 'made-to-order' approach. This solution has the singular advantage of empowering a key feature of the network model: local job creation. Organized in this manner, the City's weatherization and community renewable generation projects can be expected to create 4-5 times as many jobs as investments in conventional energy use (Byrne et al., 2015). This benefit would, in turn, spur an even more rapid transition to the sustainable energy future that OLNPP envisions. The added jobs would strengthen local economies, leading to higher investment rates in the CEWF, and thereby fostering increased investment in an energy future that citizens desire. OLNPP's aim to realize energy justice could be captured in an "End to Energy Poverty" Initiative as an economic development as well energy campaign.

Renewable energy – from an elite option to a democratic option

Finally, SMG can also take practical steps to remove barriers to renewable energy use by building access to options for community renewable energy services, rather than depending on private transactions in a market to own individual renewable energy technology. By combining the expanded CEWF function with a sustainable development network, it is possible for SMG to think about its buildingscape as an infrastructure for renewable energy development for all communities. One configuration of this infrastructure is the use of rooftops to host solar power plants across the buildingscape.

This strategy is under active investigation for the City. Using Seoul's actual rooftop real estate, the country's current retail electricity prices, the city's hourly and daily receipt of insolation, current solar electric power installation costs in the South Korean market, and current national and city policy incentives, the technical potential for a nearly 1.0 GWp network of solar power plants has been identified using 30% of the rooftop real estate of public and commercial buildings only and a capacity topping 3.8 GWp if 30% of all of the City's rooftop area hosts solar power facilities (Byrne et al., 2016, Table 3.). To realize this transformative case, an additional policy incentive would be needed if a 12-15 year payback is to be achieved (Byrne et al., 2017). Estimation of the policy incentive is underway.

[Figure 3] Seoul as a Solar City



Sources: Load data supplied by KEPCO. Estimates by (https://sam.nrel.gov).
Note: Published in Byrne et al. (2015)

As shown in Figure 3, this project would indeed be transformative. During midday hours in months such as May, Seoul Solar City (SSC) could actually export electricity from its community-based, distributed plant network. During the typical peak period of electricity use for this vertical city (which usually occurs in August), over 75% of its peak load could be served by the Solar City plant network. Overall, SSC offers the promise of providing more than 60% of the daylight needs of the cut annually, and nearly one-third of its all-hours annual need.

In the near term, community renewable energy projects could be hosted by public buildings which can serve as test beds (see the solid green area of Figure of 3. for technical potential). Pricing models per kWh delivered by this public buildings-based network could be designed which allow the cost of investment to be paid from infrastructure bonds sold to enable the project. A share of the output of the system hosted on public buildings could be dedicated to reducing the cost of electricity to low- and moderate-income households. Utilizing the Seoul Energy Corporation to design and organize investment, a Solar Power for Prosperity Campaign can be launched in phases which includes an effort to significantly lower electricity poverty, and perhaps end its existence, in the city. Locating the test bed plants in neighborhoods that include at-risk communities, this test bed approach could, as well, create needed jobs and local economic development.

Conclusion

On the one hand, the right to basic energy services must be embraced by modern society. On the other, protection of the right to basic energy services must be pursued in a manner that observes the carrying capacity of the environment. This means any society's intention to plan an energy transition needs to be measured by metrics of justice as well as sustainability (Byrne et al., 1998; Agyeman et al., 2003).

SMG's OLNPP expressly takes responsibility for meeting the twin challenges of energy welfare and renewable energy sharing in its Phase 1 and 2 plans. SMG has created promising tools to realize its goal of an energy-sustainable and energy-fair Seoul, including the

CEWF, its impressive framework for citizen participation (Lee et al., 2014), the launch of the Seoul Energy Corporation, the creation of ENURI to spur business participation, the multi-dimensional program development and implementation it has employed, and the ordinances passed to bind the city to goals of justice and sustainability.

More actions are needed, as OLNPP's recent report recognizes (Seoul Metropolitan Government, 2014; Climate and Environmental Headquarters, 2016). We hope that suggestions offered in this chapter for additional policy, organizational, and institutional efforts can assist this highly ambitious plan for Seoul prove helpful.

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4

Energy Governance and Participation

Manfred Fischedick
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Governance as a Key Agenda in Local (Low Carbon) Energy System Transition

Prof. Dr. Manfred Fischedick
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Introduction

As cities representing more than half of the global population are the origin of around 60 % of current global energy consumption and more than 70% of energy related greenhouse gas (GHG) emissions local (low carbon) energy system transition pathways play a major role for wining the fight against climate change and for reducing fossil fuel based energy demand. In the future it is expected that energy and carbon footprint of cities will even increase as a consequence of further urbanisation and economic growth. Considering the forward-pressing

problems like climate change that's why local (low carbon) energy system transition is of utmost meaning and appropriate governance structures are needed to pave the way accordingly and to take action. In other words cities should be and have to be the heart of shaping sustainable energy infrastructures in the future.

Context for shaping energy system transition pathways

Local energy system transition pathways have to be considered in the context of ongoing and upcoming trends like urbanisation, digitalisation, connectivity and economic as well demographic developments. Ideally, they are intertwined with efforts to minimize risks and vulnerability of cities and build up a resilient and worth living city. Thus, more challenges and tasks than just reduction of CO2-emissions have to be considered and even contradicting or competing priorities might occur. In addition, even with respect to climate issues there is a dual challenges situation with mitigation and adaptation being both relevant.

While today around 50% of global population lives in cities, until 2050, over 70% of the world population will live in cities. Mega cities, developing country mega cities in particular, are key for our carbon future. But it is worth to note, that it is not only about the mega cities, but about cities with less then 750.000 inhabitants where the majority of the people are living and contribute to global greenhouse gas emissions. However, mega cities and particularly capitals like Seoul play an important role to showcase appropriate solutions and to provide holistic concepts for a local low carbon energy system transition. Cities are the brains of our economies and centres of creativity and power. Therefore they are not only part of the problem, but also central part where the solution comes out or has to come out. Cities as clusters of innovation, although depending on the legal constitution of the countries, having different possibilities to act concerning pro-active reduction of energy related emissions. Not at least they can act on the demand side and the promoting of energy efficiency.

Cities are very often main driver and forerunner for significant changes on the national level, cities networks - national and international - boost the federal government for more progressive and ambitious commitments and action. Moreover, if action is constrained at the national level, cities can be crucial arenas of climate action as they are often more flexible and it is more feasible for individual/group leadership to make a difference in them than at a national/federal level. cities can be seen as ideal real laboratories and learning arenas for low carbon energy system transition. In cities socio-technical texture of modern societies can be found but with lower grade of complexity in comparison to countries – transformation processes can be realized much faster.

What was already partly visible at the last international climate conferences (i.e. COP 21 in Paris and COP 22 in Marakkech), the "driver seat" for appropriate climate policy making might probably be shifted from the national level more and more to regional and locally based policy

making.

The diffusion of climate change action at city level is already widespread. Following to the Urban Climate Change Governance Survey (UCGS), based on results from 350 cities worldwide, seventy-five percent of the cities report activity in both greenhouse gas mitigation and climate adaptation (Aylett, 2014).[1] Moreover, city commitments to climate change frequently outstrip their national counterparts in terms of ambition and coverage. Often city initiatives are driven by other targets (particularly improvement of local air quality), supported by expected co-benefits (e.g. regional economic impulses, job effects) and not at least backed by their citizens. Table 1 shows selected examples of city related climate change activities.

[Table 1] **Overview of a selection of urban climate change activities**

Region	City	Actions
Global	100% renewable energy movement	Dynamic movement of so-called 100% renewable energy cities/regions. Throughout the world, cities or regions pursue 100% renewable energy supply.
Africa	Cape Town	The 'One Million Climate Jobs!' social movement brings together labour officials, community activists and environmentalists to stimulate green job creation at large scale.
Asia	Shanghai, China	While dominated by hierarchical governance, Shanghai has positioned itself as a leader in experimentation with low- or no-emission public transportation, particularly buses.
East Asia	Seoul, Korea	One Less Nuclear Power Plant Initiative: innovative energy solution-searching effort equal to replacing one nuclear power plant.
Europe	Collection of Dutch, German, and Scandinavian cities	Cities pursue aggressive carbon-neutral emission profile by 2020 or 2025 and provide in addition long-term strategies to become carbon neutral by 2025.
Middle America	Mexico City, Mexico	Actively exchanges best practices with other cities.
North America	Portland, OR, USA	Full-scale reconceptualization of the urban form.
	Los Angeles, CA, USA	World's largest LED streetlight retrofit program.
	New York, NY, USA	Climate justice agenda includes actions on healthcare access, high-speed internet access, and addressing racial and ethnic disparities.
South America	Manizales, Colombia	Multiple risk exposure conditions accelerate shift to prevention, resilience, and vulnerability reduction (as opposed to emergency response).
	Quito, Bogota, Curiciba	Pioneering cities for bus rapid transit systems

Sources: Bulkeley & Schroeder, 2012; Bartlett & Satterthwaite, 2016; Reckien, et al., 2014; Francesh-Huidobro, 2016; Bond, 2012[2]

1 *Aylett, A. (2014). Progress and challenges in urban governance of climate change — results of a global survey. Cambridge, MA: MIT. Retrieved from http://www.urbanclimatesurvey.com/*

2 *Bulkeley, H., & Schroeder, H. (2012). Global cities and the politics of climate change. In P. Dauvergne, Handbook of Global Environmental Politics (249-262). Cheltenham, UK: Edward Elgar Publishing Ltd.; Bartlett, S., & Satterthwaite, D. (2016). Cities on a finite planet: towards transformative responses to climate change. New York, NY: Routledge.; Francesh-Huidobro, M. (2016). Climate change and energy policies in Shanghai: A multilevel governance perspective. Applied Energy, 164 (15), 45-56.; Bond, P. (2012). Politics of climate justice - Paralysis above, movement below. Scotsville, South Africa: University of KwaZulu Natal Press.; Reckien, D et al. (2014). Climate change response in Europe: what's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries. Climatic Change, 122, 331-340. doi:10.1007/s10584-013-0989-8*

In addition to city specific initiatives more and more (transnational) municipal networks (e.g., C40, ICLEI, Covenant of Mayors, European Green Capital) organize a systematic experience exchange and aim for mutual efforts.

Framework for the provision of city related solutions

For the provision of suitable solutions at city level minimum two major steps are necessary. First, to get a better understanding of the city as a socio-technical systems, of the relevant actors, the decision routines, the specific challenges and targets. Secondly, to identify appropriate key elements (strategies) that can contribute and enable a low carbon energy system transition.

Understanding urban systems as necessary prerequisite

Better understanding urban systems comprises various factors and facts finding routines, amongst others: development and interpretation of greenhouse gas inventories (and monitoring systems), implementation of structural and institutional analysis, identification of real needs of citizens and enterprises, analysis of past/future trends (incl. elaboration of real-term transformation experience).

Successful city planning instruments rely on the structure and quality of the available set of data and insights. As normally in cities long lasting investments are predominant (e.g. in infrastructure, in building envelops), the reflected time span has to be long enough and very often has to comprise decades. As a consequence, there is a need to deal with uncertainties and to handle them in a proper way. Due to the long-term horizon discussion of lock-in risk and path-dependencies (lost opportunities and danger of 2nd best solutions) is relevant as well.

Understanding of a city as a system means understanding of complexity. It is much more than just the specification of spatial patterns, but the question of what constitutes cities and what drives the decision makers has to be understood: this includes aspects like intertwined processes and complex decision making processes in cities, socio-technical and socio-cultural interactions, economic impacts, direct and indirect feedbacks/feedforwards.

With respect to governance policy input output analysis is an important element of the systems approach to learn more about the internal constitution of the city and its position from the multi-level perspective (i.e. international — national — regional — local level). In general, cities are part of a vertical and horizontal multi-level governance system. Growing urban agglomerations and inter-linkages between urban centres and hinterland require creative approaches of regional cooperation (horizontal multi-level governance).

Thus, a holistic approach is needed for shaping low carbon energy system transition processes including long term thinking, multi-problem analysis, regional cooperation, stakeholder oriented and not at least participatory approaches.

Key elements for enabling energy system transition

Even having understood that low carbon energy system transition needs an holistic approach and that the specific characteristic and constitution of cities significantly matters various key elements can be identified from a more general perspective that can enable or at least contribute to a low carbon development at city level . They can be seen as kind of building blocks for specification of appropriate city related strategies. Before describing or at least listing major elements it should be noted that no one-size fit all solution exists, but a sample of different strategy elements have to be chosen comprising technological options as well as those addressing consumer behaviour and governance structures respectively principles. The following elements should be mentioned here, the list not being meant as complete catalogue of options:

- Energy efficiency: Increasing energy efficiency as major element when delivering transport and building services (e.g. heating and cooling) in urban energy systems: energy service oriented approach needed to harness full potential – start with thinking about the real demand of people before providing not suitable (technical) solutions
- (Local) renewable energies: Renewable energy options are often limited in urban areas, but can nevertheless make an important contribution to cover the cities energy demand (e.g. rooftop photovoltaics, municipal solid waste, sewage and wastewater gas) and at the same time can help to reduce energy dependency and to improve (energy) resilience as well as to provide economic value at the local level. To extend the renewable energy option in cities cross-city cooperation and particularly cooperation with the "Hinterland (surroundings)" is recommendable.
- City planning as important element for shaping the future of the urban energy system: compact and dense urban areas very often build the basis for implementation of sector specific mitigation options (e.g. public transport, district heating) – local policy makers do have the levers to shape city structures (e.g. regulatory land-use planning, enforcement of building codes)
- Participation: involve people and industry as part of solution – define appropriate actor roles, create implementation culture, implement public campaigns to raise awareness. Establish collaborative governance principles – use appropriate instruments of participation etc.
- Acknowledge diversity of the cities and urban societies: find an appropriate transition pathways that fits with the specific conditions in the city and build upon the specific character "Eigenart" of the city (i.e. the socio-cultural and spatial diversity of the city)
- Leadership/championship: find right leader/champion; provide room/flexibility/space for leadership
- Goal oriented policy and implementation pathways: setting of suitable milestones, conduct transparent monitoring, combine long-term vision with clear implementation strategy, multi-

objective planning (consider sustainability challenges beyond the carbon issue: waste, water, air quality, mobility, biodiversity, living standards)

- Impact analysis and integration of results into decision-making frameworks: identify socio-economic impacts and reflect co-benefits (e.g. the benefits of low carbon transport goes generally beyond CO2-emissions reduction, smart mobility solutions help to improve air quality and if combined with infrastructure changes and a shift to more bicycle and pedestrian based mobility not at least the quality of living)
- Building awareness and nurture culture for low carbon living: motivation for sustainable consumption and production patterns
- Provision of better baseline information and decision assisting tools: provide adequate tools for the planning and discussion process (from GHG inventory to scenario modelling)
- Address GHG emissions within as well as outside city boundaries: consider induced emissions along the whole supply chain, make use of regional cooperation while applying GHG mitigation options
- Find proper mix of mitigation options: make use of complementarity of different options and consider system interactions between the options and right places for implementation: consider technological options and behavioural change,
- Reflect context: reflect the institutional, cultural, structural, social and political context when assessing the available options and provide suitable framework conditions accordingly
- Transformative science approach: engage scientists in the solution finding process including transformative science approaches as mean to make use of broader set of competences (co-creation of solutions with civil society, conceptualisation of real-laboratories)
- Cross-sector approach: Break silos within the governance structures and stress cross-sector perspectives and common approaches
- Test and learn: Acknowledge the lack of a blueprint and set up real laboratories within the city as concrete experimental areas (focus on specific elements to be learned)
- Smart governance:
  - Avoid policy fragmentation and aim for appropriate multi-level governance approach
  - Reflective governance: pick up learning's from experimentation within the city[3] (including specific real-laboratory approaches) and learn from others (internal and external knowledge partnerships, support of (trans-regional) civil-society networks) and adapt and further develop policy mix
- Flexibility: anticipate change (of drivers and decision environment/

3 *A survey in 100 cities found a long history of successful experimentation at city level as a feature of urban response to climate change (including social and technical forms of experimentation) across different world regions and sectors and as a key tool to open up new political spaces for governing climate change. (V.C. Broto, H. Bulkley: A survey of urban climate change experiments in 100 cities, Global Environmental Change 23 (2013), 92-102*

landscape) and amend adaptation and mitigation pathways and underlying management systems accordingly

- Focus on transformational rather than incremental solutions: i.e. actions need to be embedded in and contributing to a long-term transformational strategy rather than piecemeal (to avoid the lock-in)

Following the recently published report from the German Advisory Council on Global Change (WBGU)[4] "Humanity on the move – unlocking the transformative power of cities" particularly the establishment of collaborative governance structures plays an crucial role "It is not only the normative compass that demands that all sections of the urban society should take part in shaping the transformation process. Without the necessary approval and support of the population, even local governments with comprehensive decision-making powers and sufficient financial resources would fail to meet the challenges of the transformation process.

To achieve this, it is necessary to establish collaborative governance structures. This involves strengthening arenas for public discourse in cities wherever feasible, using instruments of participation, and facilitating participatory processes in local governments. In highly regulated contexts, particularly in mature and in quickly growing, planned cities, it is necessary to create spaces for experimentation and development for trying out different forms of sustainable living. Where such spaces already exist, cities should consider how they can be supported. The transformative effect of civil-society and municipal activities can be reinforced by connecting them with scientific expertise. For this it is expedient to set up transdisciplinary research centres at the urban and regional level." (WGBU 2016).

4 *German Advisory Council on Global Change (WBGU) "Humanity on the move — unlocking the transformative power of cities" particularly the establishment of collaborative governance structures plays an crucial role, Berlin, 2016*

Practise examples for smart energy governance and participation

Reflecting the various options at the city level amongst others particularly appropriate energy governance structures (including smart management principles) and participatory approaches play a decisive role to shape a low carbon energy system. With the Climate Protection Plan Process North Rhine Westphalia (regional level) and the Innovation City Ruhr (city level) following two good practice examples are described that have proven to be successful under the German conditions. They present experience from the regional respectively city level and stand for specific approaches. Although based on rather specific transformation history and implementation conditions, both examples provide various opportunities for transfer of findings and tools.

Climate Protection Plan Process North Rhine Westphalia: good practice at the regional level for participation

North-Rhine Westphalia (NRW) is home to one of the most important industrial regions in Europe, and the first German state to have adopted its own Climate Protection Law, which binds the state to reducing its GHG emissions. NRW emits about a third of German GHG emissions (305 MtCO2eq in 2012) or about 7% of the EU's GHG emissions. Its total emissions are equivalent to those of Spain. The state is therefore key for meeting national and European climate targets.

The state is particularly important in this context due to the structure and extent of its economy and constitution of the energy sector. A backbone of its economy is a large energy-intensive material producing industry. It accounts for more than 10% of the energy intensive industries of the EU28, making NRW one of the largest industrial regions in Europe. 40% of the German industrial electricity demand arise in NRW's large energy consuming companies, e.g. the steel, aluminium and chemical industry. The state's energy sector is dominated by extensive hard coal and lignite mining as well as coal-fired power production. About 30% of Germany's electricity supply is based in NRW (70 % coal-based, 90% fossil-based). A climate-friendly transformation of the state and in particular of its energy intensive industry would therefore significantly contribute to compliance with European and national climate targets. Beyond that, NRW could also serve as a role model for the transformation of other industrial regions in Europe and worldwide, which are characterized by large energy-intensive industries and corresponding challenges for sustainability transitions.

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In order to set a legal framework for regional climate protection measures and to contribute to national and European climate targets, NRW adopted its own Climate Protection Act. The Act obligates the state government to reduce GHG emissions by at least 25% until 2020 and by at least 80% until 2050 compared to 1990 levels (Landtag

Nordrhein-Westfalen 2013).[5] It mandates the development of a Climate Protection Plan which shall initiate a dialogue process with stakeholder involvement to break down the state-wide GHG reduction targets into sector-specific sub-ordinate targets (Vallentin et al.[6] 2016). Stakeholders in the main GHG emitting sectors (e.g. industry and energy) were involved in six working groups throughout the years 2013 and 2014 in the development of climate protection strategies, measures and in the modelling of scenarios for GHG reduction pathways (Lechtenböhmer et al. 2015a, Fischedick et al. 2015, MKULNV NRW 2014).[7]

Transformation background of NRW

NRW is a state driven by external and internal factors with compre-hensive experience in transformation and adaptation of structures. Within NRW the Ruhr district is of particular interest and meaning for shaping a low carbon energy system as being the industrial power house of the state. As such, for understanding not only the options for NRW, but the German energy transition in sum ("Energiewende") the Ruhr district and its transformation history is of central economic, social and environmental importance.

The Ruhr district compromises 11 cities and 4 counties and is Germany's largest urban conglomerate. It is named after the river Ruhr that crosses the south of the region from east to west. With a population of 5 million (2015), a local GDP of €152 billion (2012) and a labour force of 1.7 million (2012) it is one of Europe's largest industrial clusters.

What is now an urban agglomeration, was 200 years ago a rural area of small settlements. Having had a population of about 200,000 in the early 19th century, it rose to 4 million before World War I and to 6 million in the 1950s. The massive increase in labour force promoted a rapid increase of the output of coal and steel. During the 1920s-1940s the output of steel of the Ruhr district exceeded the total of steel production in Great Britain. In the 1930s every 6th ton of steel consumed worldwide was produced in the Ruhr district. The production peaked in the 1950s when more than one million people were employed in the steel and coal industry. This represented roughly 70% of the whole labour force of the Ruhr district. The Ruhr industry not only helped Germany to become one of the most industrialized countries but also was the armour factory in both world wars. After World War II it provided the resources for the German rapid economic recovery ("Wirtschaftswunder").

5 *Landtag Nordrhein-Westfalen (2013): Gesetz zu Förderung des Klimaschutzes in Nordrhein-Westfalen. Gesetz- und Verordnungsblatt (GV NRW) Ausgabe 2013 Nr. 4 vom 6.2.2014, Düsseldorf.*

6 *Vallentin, D., Fischedick, M., Knoop, K., Mersmann, F., Mölter, H., Schneider, C., Schüwer, D., Tschache, B., Wäger, J., Zeiss, C. (2016): An industrial region in transition. Energy and climate policy in North Rhine-Westphalia. Available online: http://www.theclimategroup.org/_assets/files/ETP-NRW-briefingMay2016_EN.pdf (accessed on 04.08.2016).*

7 *Lechtenböhmer, S., Schneider, C., Yetano Roche, M., Höller, S. (2015): Re-Industrialisation and Low-Carbon Economy — Can They Go Together? Results from Actor-Based Scenarios for Energy-Intensive Industries in the German State of North Rhine Westphalia. Energies, 8: 11404-11429; Fischedick, M., Richwien, M., Lechtenböhmer, S., Zeiss, C., Espert, V. (2015): Klimaschutzpläne und -gesetze — partizipationsorient ierte Instrumente vorausschauender Klima- und Standortpolitik. Energiewirtschaftliche Tagesfragen, 65 (5): 18-21; Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen (MKULNV NRW) (2015): Klimaschutzplan Nordrhein-Westfalen. Klimaschutz und Klimafolgenanpassung. Düsseldorf*

The economic decline of the Ruhr district began in the 1960s when world market prices for coal and steel fell below the production costs of the Ruhr industry. New mines in North-America and East Europe supplied the markets with cheap coal mined near surface, while the average mining depth in the Ruhr in 1960 was 650 meters. The global and national energy mix (demand)also began to shift from coal to oil. The results were large-scale closures of factories and mines. Between 1960 and 1990 the Ruhr district lost more than half a million jobs in the rapidly declining coal and steel industry. Even though the massive German economic growth during the 1960s partly compensated the job losses, it could not prevent an unemployment rate of 15% in the region in the 1980s and a massive emigration of citizens (Reicher 2011).[8]

In order to mitigate this development, both the state government and the federal government started to support the mining industry with subsidies. The German coal industry was funded with €295 billion (in 2008 prices) in total between 1950 and 2008 (Meyer/Eidems 2009).[9] The largest share went to the Ruhr district. Simultaneously, the state started to invest in higher education, establishing five universities and 16 universities of applied science. As of 2012 around 223,000 students were enrolled in these universities.

Green markets have matured to a core element of the Ruhr district's economic development strategy. According to the economic development agency of the Ruhr district (WMR 2016)[10] green manufacturing and recycling industries in the so-called lead market "Energy and Resource Efficiency" have grown continuously, often more rapidly than the dynamic green industrial sector in in the rest of Germany. The overall turnover of more than 6,000 companies of this lead market in the Ruhr district amounted to almost 64 billion € in 2013 supporting about 79,000 jobs.

Green markets have also become a central element of the economic strategy for the rest of North-Rhine Westphalia. Between 2009 and 2012 the sector has grown by 15.6% (compared to 11.4 in the rest of Germany). In 2012 around 1500 patents were allocated in green sectors with the highest share originating from the Ruhr District. Between 2009 and 2012 exports of NRW's green sector have expanded by 26% reaching a volume of 8.54 billion € equivalent to 2.1% of the global market share. Between 2009 and 2012 the employment in the NRW eco-industries increased by 5.4%.

Four pillars of climate protection in NRW : participation as underlying principle

The four pillars of Climate Protection in North-Rhine-Westphalia are:

8 *Reicher, Christa; Kunzmann, Klaus R.; Polívka, Jan; Roost, Frank; Utku, Yasmine; Wegener, Michael (Eds.), 2011: Schichten einer Region — Kartenstücke zur räumlichen Struktur des Ruhrgebietes (Berlin: Jovis).*

9 *Meyer, Bettina; Schmidt, Sebastian; Eidems, Volker, 2009: Staatliche Förderungen der Atomenergie im Zeitraum 1950–2008. FÖS-Studie im Auftrag von Greenpeace; at: <http://www.foes.de/pdf/90903-Subventionen_Atom kraft_Endbericht-3%20li.pdf> (April 2014).*

10 *WMR, Wirtschaftsförderung Metropole Ruhr, ed. (economic development agency of the metropolitan area Ruhr) 2015: Wirtschaftsbericht Ruhr 2014. Essen: Wirtschaftsförderung Metropole Ruhr*

- The Climate Protection Starting Programme (CPSP), which was launched in 2011 and has contributed to the implementation of a variety of relevant climate protection measures.
- The Climate Protection Act (CPA), which was adopted by the NRW Parliament in January 2013 setting legally binding targets.
- The KlimaExpo (KE), which act as internal and external exposition platform for NRW
- The Climate Protection Plan (CPP), which will be adopted by the NRW Parliament to specify strategies and actions for short- and long-term sectoral and regional climate protection and adaption.

1) The Climate Protection Starting Program

End of 2012 the NRW government launched the Climate Protection Starting Program to support core climate change mitigation measures of communities, companies and private households. The program offers grants and loan schemes. For example, the program has provided annually 150 million € for energy efficiency in buildings and in total 250 million € for combined heat and power (CHP) projects. Other measures include a climate change mitigation initiative for communities and an electricity saving initiative for low income households.

2) NRW Climate Protection Act

In June 2011 the state government of North Rhine-Westphalia decided that by 2020 it would reduce its greenhouse gas emissions by at least 25 % and by 2050 by at least 80 % below 1990 levels. After the NRW state parliament (Landtag) passed the "Act on the Promotion of Climate Protection" in January 2013, for the first time in German history emissions reduction targets became legally binding — here at the state level as frontrunner. In addition to emission targets the act also defines adaptation targets.

3) KlimaExpo

In 2014, the government of North Rhine-Westphalia launched the initiative "KlimaExpo.NRW" as an exposition for innovative projects in the areas of climate change mitigation and adaptation. Until 2022, KlimaExpo.NRW will feature different formats of events that highlight the economic opportunities of climate change mitigation and adaptation for North Rhine-Westphalia and the state's potential for technological and social innovations in these areas. The KlimaExpo.NRW is not only a showcase but also a laboratory for new ideas and innovation. The initiative will present successful projects to a broad audience in order to motivate citizens, companies and cities and communities to become an active part in the low-carbon transition process.

4) NRW Climate Protection Plan

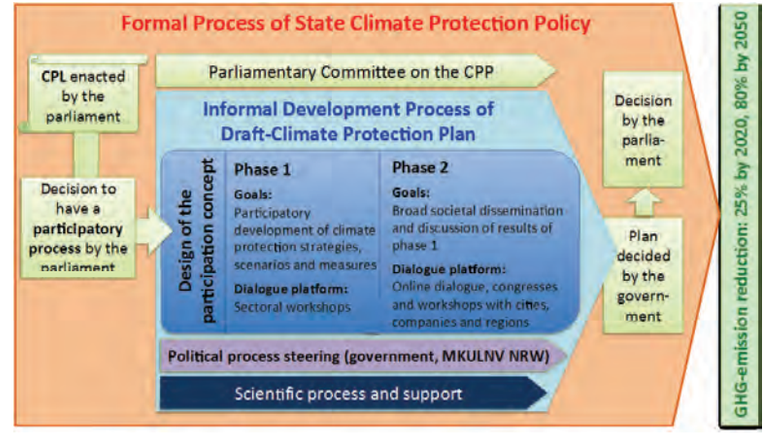
The Climate Protection Law mandated the development of a Climate Protection Plan (CPP) which breaks down the state-wide reduction targets into sectors and timeframes and which envisaged strong actor participation (Fischedick et al. 2015, Vallentin et al. 2016). The

comprehensive participation of all state-wide actor groups is central to the strategy. Actors in the six main GHG emitting sectors were involved over 2013 and 2014 in the development of climate protection measures, strategies and the identification of sectoral potentials of climate protection via scenario development (Lechtenböhmer et al. 2015, Fischedick et al. 2015, MKULNV NRW 2014).

The embedding of an informal process of policy making (actor participation) into a formal political process (parliamentary process) is the specific characteristic of climate policy in NRW (cf. figure 1). The combination of legal binding climate protection targets and a participatory process for the development of strategies and measures for the achievement of these targets constitutes an innovative approach to climate policy. The understanding of its formal/informal structure is of far reaching interest not only for the in-depth description of the specific case of climate policy in a populous and highly industrialised region such as NRW. It also highlights a possible pathway for future innovative modes of governance which are deemed as essential for the realisation of sustainable transition targets in general. There is a growing consensus within the scientific community that conventional formal ways of policy making, which are often characterised as top-down and state driven, have to the complemented by innovative, informal modes of governance.

The formal process of NRWs state climate protection policy and the embedding of the participatory process for the development of the process is shown below. In Figure 1 the legal entities and their responsibilities, the phases of the participatory process and the role and responsibility of science are schematically presented.

[Figure 1] Structure of the combined formal/informal process of climate policy making in NRW



The formal political framework firstly has the function to speak out a clear mandate to the actors of the participatory process, which defines the scope and tasks of the dialogue process. Secondly, it should transfer the dialogue results into the formal-legislative process of decision making as collectively mandatory policy measures cannot be declared by informal participation but only by democratically legitimised authorities (Renn et al. 2013).[11] With regard to contemporary climate policy in NRW, the enactment of the Climate Protection

11 *Renn, O., Köck, W., Schweizer, P.-J., Bovet, J., Benighaus, C., Scheel, O., Schröter, R. (2013): Die Öffentlichkeit an der Energiewende beteiligen. Grundsätze und Leitlinien für Planungsvorhaben. GAIA, 22 (4): 279 – 280.*

Law is the pivotal starting point of the policy process and functions as its formal political guard rail: the law requires that the discourse in climate policy in NRW focuses its discussions on the question of how climate protection shall be conducted and not the question whether climate targets should be introduced at all. In line with the drafting and enactment of the Climate Protection Law, it was mandated that an informal, participatory process should be embedded into the formal political process. By means of this informal process, strategies and operational climate protection measures for the achievement of the legal binding climate protection goals should be developed.

From the beginning it was envisaged that the political and participatory process should be accompanied by scientific expertise. A collaborative team in the interplay between economy, policy, the civil society, research and the public at large was set up with the aim to co-create solution-oriented knowledge with high societal relevance.

In total 1,200 actors where directly involved in the course of the dialogue process (not including the participants of a state-wide online dialogue). The Climate Protection Plan was drafted in the so far largest participatory, multi-stakeholder process ever conducted in Germany. The first part of the informal development process of the CPP organized in six sectoral working groups included about 400 actors and lasted for about one and a half years. In the field of climate mitigation[12] this phase had two distinct objectives:

- the discussion of climate protection strategies and their quantification via scenario building (time frame 2050) and
- the development of concrete, operational climate protection measures (time frame 2020).

The second phase of the informal policy process aimed at a broad, target group oriented participation of the general public in order to specify and — if necessary — adjust the climate protection measures developed in the first phase by the working groups. Citizens were involved by means of an online dialogue and on-site dialogue formats. Additionally, congresses and workshops directed at cities and municipalities, companies and specific regions were organised as discussion platforms.

The key outcome of the informal process was the participatory development of a proposal of climate protection measures which was handed over to the state government of NRW and a set of scenarios describing concrete pathways to achieve the climate protection targets of the state. The government thereafter consolidated these process results in a draft CPP which in 2015 entered the formal political process of law enactment and was decided upon by the State Parliament in December 2015.

Added value of the process

With the process of the development of the climate protection plan, the government of NRW decided to intensively engage relevant

12 Mitigation is in the focus of interest of this paper. Besides mitigation, the CPP had a second track of participatory policy making in the field of climate adaptation. Based on the existing adaptation strategy of NRW, operational measures were discussed in four workshops with about 30 actors each.

stakeholders already in the development phase. After following and steering the process over more than two years, several added values could be detected:

- better understanding of the stakeholder family being relevant for the implementation of ambitious climate protection policy and the specific role of the actors (including interaction between each other);
- significantly improved knowledge base about mitigation potentials and suitable scenarios for the state level (scenario corridor as orientation mark for the assessment of options for action);
- sound foundation and stakeholder assessment for the selection and implementation of mitigation measures (policy instruments) — multi-stakeholder perspectives provides an overview about pro's and con's of different policy instruments;
- lighthouse effect beyond NRW for similar participatory processes abroad;
- highly productive discussion atmosphere and culture within the working groups as solid basis fro cross-stakeholder cooperation and activities as well as better understanding of position (background, potentials and motivation) of each stakeholder
- raising awareness on different perspectives by stakeholders
- confidence building between stakeholders and ministries, especially between industry and Ministry for the Environment;
- better chance to implement mitigation measures if jointly developed with the relevant stakeholders;
- starting point for further in-depth dialogues with stakeholders (e.g. industry-science dialogue).

Innovation City Ruhr: good practice at the city level for smart management structures and cross-sector cooperation

In NRW respectively the Ruhr area Innovation City Ruhr has become a showcase and real-life laboratory for low-carbon governance mobilizing resources from business, municipalities, research and civil society to manage a low-carbon transition in an urban context of a highly industrialized region.

Innovation City aims at a low-carbon transition of entire city quarters. As such it is an important real-life experiment not only for governance in NRW but the entire German energy transition ambitions. In 2010, a regional institutional entrepreneur consisting of private and public companies (the Initiativkreis Ruhr, cf. box 1) launched the Innovation City Ruhr competition. Sixteen cities participated.

After a multi-stage selection process with an independent jury, Bottrop was nominated to be the InnovationCity Ruhr. The city of Bottrop won the award with a the convincing presentation of a blueprint for the governance of an ambitious low-carbon transition process. Innovation City Bottrop aims at halving CO_2 emissions by 2020 (compared to 1990 levels) in an area of 25 square kilometers and 14,500 buildings and 70,000 thousand inhabitants. The targeted area includes several neighborhoods which represents in many ways the cultural and socio-economic diversity of the Ruhr district. By 2020 the city plans an exemplary application of a number of innovations

in energy efficiency, application of renewable energy generation, decentralized power generation and electric mobility.

For the jury it was convincing, that, among other things, the selected pilot area comprises some typical regional characteristic (regarding social structure, building stock, energy supply system). Therefore a high transferability can be assumed. In addition, it was promising that Bottrop had a good network and a close co-operation of business, administration and politics (including the highly engaged mayor). For the jury it was also important, that the public was already actively involved during the application phase and the formulation of the strategy. As such participatory elements play an important role in the concept. Finally, the jury was convinced by the holistic approach in Bottrop's' application. Targeting on a broad range of fields of application and implementation, rather than a focus on individual projects (lighthouse projects).

[Box 1] **Initiativkreis Ruhr – a specific organisation in the Ruhr area**

The Initiativkreis Ruhr is an association of around 70 leading companies and institutions of the Ruhr District. They employ around 2,25 million people worldwide and generate a global turnover of around 630 billion €. representatives with a leading function in these companies can become member of the Initiativkreis Ruhr on a personal capacity. The honorary membership is unsalaried and approved by the general assembly. The institution is a non-incorporated association with its headquarters in the city of Essen with the purpose of fostering Corporate Social Responsibility (CSR). Operations of the association are implemented by the limited liability company Initiativkreis Ruhr and other associated companies such as the limited liability company Innovation City Management.

Bottrop develops its solutions bottom-up, through collaboration between science, business, municipal and state administrations, civil society as well as the general public. Target groups are divided into two categories:

- municipal and other larger institutions and
- consumers.

Management, Planning and Financing

The InnovationCity Management Company (ICM), funded in 2011, controls the entire process of the project (ICM). ICM is set up as a limited liability company borne by five public and business shareholders which support the company with staff, financial resources and know-how. ICM manages the overall transition process and its almost 300 individual projects. Currently, the core team consists of 25 employees. With an innovative concept for the modernization of city quarters, IC Bottrop solves quarter-specific problems and supports municipal utilities as well as energy suppliers with the development of new sales and business models. ICM is financed on the basis of a public-private partnership with EU-Structural Funds and regional, municipal as well as corporate investments and RTD funds.

The constellation with the central actor "ICM" can be described as an institutional innovation. By establishing this institution, the entire process management is not tied to the conventional municipal structures. This results in a higher degree of independence, goal orientation and flexibility. The ICM's strong institutional network of

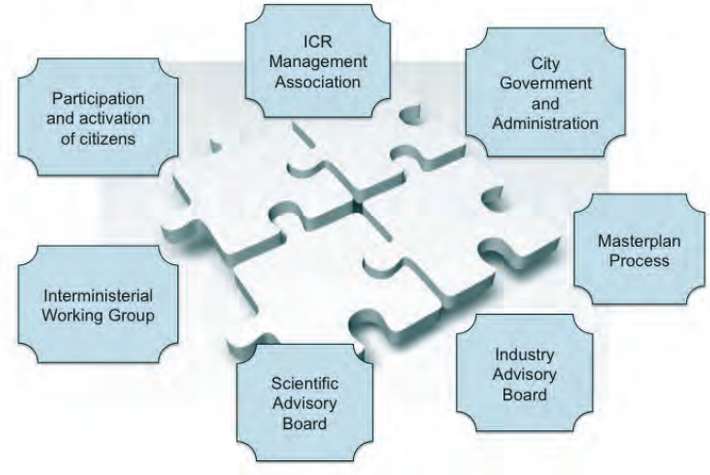
actors from private sector, politics, administration, science and civil society has played a decisive role in the success of the project.

Another crucial element of the overall process is the elaboration of a master plan, which combines a comprehensive potential analysis resulting in the derivation of an appropriate project catalogue. The master plan forms the basis for many of the implementation projects in the model area. In April 2014 the master plan has been endorsed by the city council and now functions as the basis for the general urban development in the pilot area.

This "script" for the low-carbon transition considers different technological, social and economic aspects of implementation and the participation of the citizens of Bottrop. 200 measures of the masterplan have already been implemented or are in the process of being implemented. Measures address sectors such as housing, energy, mobility, infrastructure and work. In the housing sector activities focus primarily on the energetic refurbishment of homes, including three ambitious demonstration projects, which aim at transforming energy-consuming homes into energy-plus dwellings (which generate rather than consume energy). The "CHP 100" creates 100 combined heat and power plants. Current research and development activities aim at integrating the single CHP into a virtual power plant. Other measures include the development of cycle paths and advanced low-carbon mobility concepts. In addition to technological and infrastructure projects other support actions aim at improving the quality of life, urban gardening or school education.

The two basic elements ICM and master plan (especially in their combination) go beyond common climate mitigation concepts and represent a unique feature for the InnovationCity.

[Figure 2] Institutional elements of the Innovation City approach



By 2015 the measures and projects have resulted in an absolute terms in a reduction of CO2-emissions of about 100,000 tons, which is equivalent to a 38%-reduction compared to 2010 emission levels. Central for the success of innovation city is the particularly the progressive strategy for refurbishment of the building stock. The Innovation City Bottrop is with an annual energetic modernization rate of more than 3% far above the national modernization rate of about 1%. In the pilot area 16% of building owners have implemented modernisation measures of one sort or another in the first half of the project.

Key for this remarkable success is a multi-stage communication approach. All house-owners in the pilot area have access to free consulting services. Until end of 2015 2,100 persons have used these services. In the target area about 56% of the advised persons have actually implemented modernization measures in their dwellings.

The consultancy service is combined with financial support measures of the municipality which allows direct financial support for energetic modernization activities of building owners. Depending on the type of building and the potential for CO2-reductions a financial support of up to 25% can be realized. Between April 2014 until September 2015 111 individuals have applied for a total financial support of 3,58 Mio. The city has already accepted grants with a total volume of €. 2,6 Mio. €. 382,000 € have already been invested. This is equivalent to an average support quota of almost 15%.

Impacts on the private sector and employment

Innovation City Bottrop does not only aim for significant reduction of CO_2-emissions but touches other areas that are critical for a vibrant and resilient city. This includes:

- creation of new high quality jobs and regional economic value
- promotion of the private sector development and
- improvement of quality of live (e.g. through improved air quality, participation – civil society involvement)
- protect the city for future threats (e.g. adaptation measures with respect to climate change)

With respect to job creation and regional economic value the strategy of the city has been successful so far. All governmental and non-governmental stakeholder have already invested 183 Mio. Euro in the low-carbon transition until 2020 will invest in total more than 290 Mio. About 110 Mio. Euro have been invested in the private sector. In addition, 26 Mio. Euro have been invested in services and consumption. Over the total transition period the employment increase will result in 924 person-years. The indirect employment effects will result in 276 man-years. Thus in total, Innovation City Bottrop will result in 1,200 man-years of additional employment, which is equivalent to about 300 jobs.

Roll out

Before its end in 2020 Innovation City Bottrop has already turned out to be a success story attracting interest among many national and international stakeholders of the global low-carbon transition. Therefore, the regional government of NRW has decided to finance with European Structural Funding a diffusion process involving other 20 urban quarters, the so-called Innovation City Roll Out.

During a three months preparatory phase a jury has selected 20 city quarters. They have been chosen in order to be representative for the Ruhr District related to aspects such as urban development, consumption and production patterns and demography.

In July 2016 the concept phase has begun to lay the conceptual basis for the reduction of CO_2-emissions in the urban quarters. The

conceptualization for each quarter which will be implemented in close cooperation with the municipalities. Depending on the urban target area it will most likely take six months. The quarter concepts are based on different modules: In addition to the analysis of basic characteristics, planners develop the energetic refurbishment and energy supply concepts. In parallel the roll out is prepared with a concept for communication and activation of stakeholders.

The conceptualization phase ends with contracts between the stakeholders in the quarters aiming at implementing the conceptualized measures in the framework of an integrated quarter development. This will eventually lead to the implementation phase.

There is evidence for a successful learning process which was necessary for effective collaboration between the different actors involved in the project. There is no single instrument that is crucial for the project, but the fundamental principles of communication and co-operation. This includes a strong commitment of all participants involved in the project as well as networking activities. InnovationCity is based on specific, hardly reproducible starting conditions, both the persons involved and the available financial resources. For the roll out, the question is how similar results can be achieved under less optimal conditions.

Knowledge Transfer

The roll-out aims at initiating transition towards low-carbon development trajectories in 20 selected urban quarters. In addition it lays the foundation for monitoring real-life laboratories to enable policy-learning and adaptive governance. Therefore, a broad regional knowledge-transfer and diffusion process is integrated in the roll-out. All relevant stakeholders of the region and the city quarters will meet at regular roundtables in order to exchange information on failures, experiences and best practice. The roundtables will also invite interested stakeholders from other municipalities of the Ruhr district, governmental and non-governmental organisations, science as well as expert institutions and funding agencies. This network creates also an opportunity for other cities (at national and international level) but also different stakeholders like development agencies to participate in the policy-learning.

Conclusion

Mobilising urban potentials require an appropriate national (supporting) government structure. Vice versa implementation strategies at city level and related activities have to pave the way to achieve global and national targets while enabling the highly important reflection of specific institutional, social, cultural, structural and political framework.

A significant part of the energy efficiency potentials and the deployment potential of renewable energies might remain untapped without a supporting national (or in the German case even European) policy

framework. Energy and CO_2-taxes, feed in tariffs or auctioning systems are only some examples of suitable supporting instruments. Nevertheless and besides the significant role of national governance structures over the last decades cities have shown important leadership and very often even a pioneer role in implementing appropriate strategies addressing climate change issues.

A shift is already underway from the nation-state basis of policy design to more regional and locally based policy design. Local and regional levels of policy design are or can be motivated by very different political drivers. The concrete measures and investments they promote can shape a climate policy landscape better focused on sustainability than following a top-down principle. Sub-national policy design efforts have increasingly positioned themselves as drivers of appropriate climate policy formulation.

In the paper selected regional activities in North Rhine Westphalia, the energy and industry heart of Germany, have been described in detail underlining the formulated hypothesis. In that context it became obvious that smart governance and management structures as well as participatory approaches are crucial for a successful implementation of GHG mitigation measures. The participative governance is a key component of the NRW transition management. The participation of citizens, research, business and municipalities in the development and promotion of climate protection policies increases ownership among stakeholders and shapes new networks and actor coalitions. The state government plays more and more a moderating role supported by research, which supported the process with evidence, including modelling, scenario-building.

In order to motivate stakeholders to become an active part in the low-carbon transition process the government of NRW supports innovation with showcase and demonstration activities such as the Klima.Expo or the Innovation City Ruhr (Bottrop) and with broad participatory approaches as the Climate Protection Plan where more than 400 different stakeholders representing the portfolio of relevant institutions have been involved to formulate climate protection scenarios and to assess policy instruments from a multi-stakeholder perspective.

Originally launched with a competition by an exclusive institutional hybrid of industrialists and public institutions (Initiativkreis Ruhr), Innovation City Ruhr (Bottrop) has become an innovative public-private partnership for climate change mitigation, adaptation and the improvement of living conditions at the city level. It has set ambitious goals for the low-carbon transition of a total city quarter and implements the transition with a mix of research and development as well as demonstration of technological and social innovations.

From a governance perspective not only the initiation by industry actors but also the innovative implementation and management structures (Innovation City Management) and public-private financing is probably unique as well as the broad participatory approach. It seems to be worth to analyse and research how these successful elements can be transferred into different regions around the world.

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Researcher of Energy & Climate Policy Institute

Ms. Lee Yu-jin, a regional energy policy researcher and lecturer, has authored a number of related books, based on the belief that a regionally distributed energy policy should be promoted in the era of nuclear-exit and peak oil. In 2011, she participated in formulating Seoul's policies for One Less Nuclear Power Plant as a member of the Hope Policy Advisory Committee and is now working as General Manager of the Executive Committee for One Less Nuclear Power Plant. She has taken part in regional energy planning in Gyeonggi-do, Daegu, Jeonju, Suncheon, Wanju-gun, and Nowon-gu and is currently fulfilling her role as policy advisor. She also ran for the 19th National Assembly in 2012 as co-chairperson of Green Party Korea, which has been promoting nuclear-exit and energy conversion as its goals. She has authored [Climate Change Story], [Community Energy! It's Our Hope], [How to Use Solar and Wind Energy], and [Transition Town].

Energy Citizen as a Critical Actor in Seoul's Energy Governance

: The Seoul Energy Governance Network Connected with its Citizens, Villages, Autonomous Districts, Local Governments, the Central Government and the International Community

Lee Yu-jin
(Chief Officer of Executive Committee of the One Less Nuclear Power Plant Project)

Mayor Park Won Soon of Seoul has revolutionized the mega city's administration. Under the banner of "Citizens are the Mayor," the 5th and 6th administrations of the Seoul Metropolitan Government (SMG) elected by popular votes have institutionalized citizens' participation and governance in its policy making and implementation. Governance in this context refers to public-private partnership in all processes of governing. According to the "Seoul Metropolitan Government Basic Ordinance on the Revitalization of the Governance of Public-Private Partnerships" (Ordinance No. 6317) enacted on September 29, 2016, the governance refers to "the municipal administration methods and systems in which

the private sector and the SMG jointly determine, enforce and evaluate policies designed to solve social problems."[1] Article 3 of the ordinance stipulates that the basic principles for revitalizing the governance of public-private partnerships should include participants' voluntary engagement and a horizontal cooperative relationship; expansion of the awareness that the governance of public-private partnerships process itself is an important value; and building mutual trust between the private sector and the municipal government.

Through the governance institutionalization process, the SMG establishes policies through participatory and deliberative processes, determines policies on the basis of citizens' opinions collected through Cheongchaek (policy by listening) forums and surveys, and expands a policy feedback process based on reports prepared jointly by public and private sectors following the completion of policy implementation and evaluation. An increasing number of citizens agree that policy performance is important in municipal administration, yet the governance process itself is as critical, if not more. The Park Won Soon administration, the 6th popularly voted city government, places top priority on the governance of public-private partnerships where the 'One Less Nuclear Power Plant (OLNPP)' project is considered a representative success case of such governance.[2] On April 26, 2012, the SMG announced and enacted the OLNPP project aimed at reducing 2 million TOE equivalent to the capacity of one nuclear power plant through energy conservation and production of new and renewable energy. Furthermore, on August 20, 2014, the SMG announced the launch of the 'One Less Nuclear Power Plant 2 — Seoul Sustainable Energy Action Plan' following the initial achievement. As a result, the SMG raised the city's energy self-sufficiency rate from 2.9 percent in 2011 to 5.5 percent in 2015. The SMG achieved its goal although the OLNPP project was a challenging task under the central government-led energy generation and distribution regimes. Behind it were energy citizens who were aware of energy issues and active in taking relevant actions. In the area of energy, there is no significant change in the municipal budget size between the previous administration (the 4th popularly elected city government) and the current one (the 5th and 6th popularly elected city government) (Lee Gang-jun, 2015). A considerable part of the achievement is attributable to citizens' energy conservation. Therefore, the major factor in the success of the city's OLNPP project was the change in the city's energy policy operation methods, i.e. the change in the city government's governance. (Lee Ju-heon, 2016).

Based on my experiences in participating in the initial planning and implementation of the OLNPP initiative as one of the city's energy citizens, I would like to analyze the formation, expansion, achievements and challenges of the city's energy governance and sum up the roles that the city's energy citizens have played in its success so far. This paper first describes the process in which the OLNPP

1 *Ordinance No. 6317 of Seoul Special City enacted on September 29, 2016*

2 *On November 27, 2016, 'the Joint Governance Seoul Citizens Conference' was held at Sejong University in Seoul with the participation of more than 1,200 citizens, and the OLNPP initiative was featured as a successful case.*

initiative was established and the relevant governance was formed. Secondly, it recounts the accomplishments that the city's energy governance has achieved through its ever-expanding network along with the contributions that the city's energy citizens have made in the process. Lastly, this paper explores the implications of the city's energy governance and discusses its future challenges.

The OLNPP Policy Formulation and Governance Establishment Processes

Running for the city's by-election in 2011, Park Won Soon, the current mayor, presented an energy platform based on alternatives to the Fukushima nuclear power plant accident in Japan and the massive September 15th blackouts in Seoul. At a campaign pledge review meeting, then-mayoral candidate Park said, "Seoul should not keep forcing other areas to bear the burden of producing energy and sending it to Seoul. Seoul should find ways to achieve 'regional win-win' in the energy sector." After the election, Mayor Park Won Soon organized the Policy Advisory Group of Hope and ordered its Environment and Culture departments to prepare new energy policies. Climate and Environment Headquarters, the Policy Advisory Group of Hope, and civic groups held a total of 15 meetings from January to February 2012 and came up with the draft of the OLNPP initiative. At a subsequent meeting of the Policy Advisory Group of Hope, the initiative goal of reducing 2 million TOE through energy conservation, improved efficiency and increased energy production and the initiative name of "the OLNPP" were set. Detailed policies and action plans were drafted by the SMG's relevant units. The draft was carefully reviewed by citizens at a policy discussion workshop held on February 21 and a mega town hall meeting held on April 16. More than 400 citizens participated in discussions about various topics at the town hall meeting. The focus was placed on strengthening regulations concering building energy consumption, developing programs aiming to raise citizens' awareness about the issue and expanding photovoltaic power systems suitable for the city.

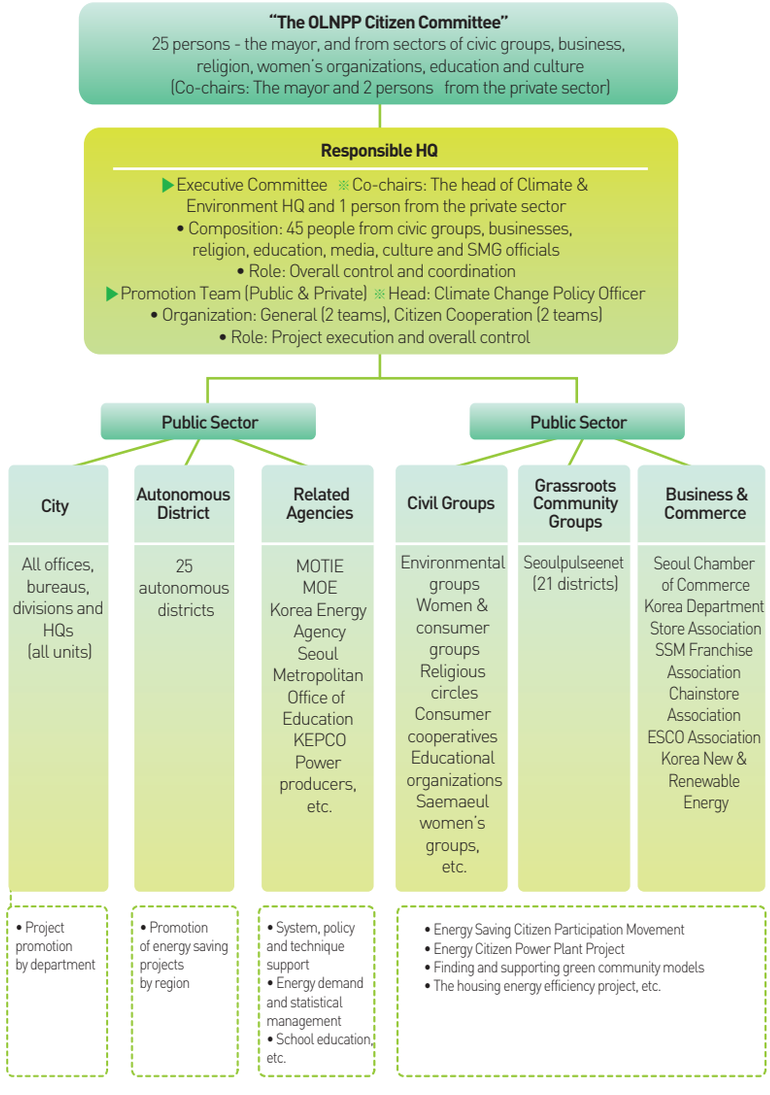
However, the OLNPP initiative establishment process was not entirely smooth. Climate & Environment Headquarters had no prior experience in establishing energy policies that took on so much significance. Communication with the civil society was not active during the previous administrations (the 3rd and 4th city administrations), thus it was not easy to bring its leaders to the table for discussion in the first place. There emerged differences of opinions between the SMG and the Citizen Advisory Group about issues such as 'hydrogen fuel cell' and 'electric car'. There was also a concern that if the initiative was named 'OLNPP,' the central government might be passive in providing support and communicating to the city government. However, consensus was reached after a number of meetings and adjustments. The SMG built the policy framework for the OLNPP initiative and then started to discuss how to organize working groups. Climate &

Environment HQ enhanced its energy administration organization by launching new units such as 'OLNPP Coordination Team,' 'Green Energy Division.' and 'Energy Citizen Cooperation Department (currently Energy Citizen Cooperation Division).' The citizen members of the Citizen Advisory Group for Hope also proposed the establishment of Seoul Energy Corporation as a control tower for the effective promotion of the OLNPP initiative. After much discussion, the OLNPP initiative governance was composed of Citizen Committee, Executive Committee, and the responsible HQ as shown in (Figure 1). The Citizen Committee is made up of 25 members from civil society, business, religion, women's organizations, education, and cultural sectors as well as the mayor. It serves as the highest decision-making body.

The core of the OLNPP governance is the Executive Committee. In August 2012, 'the Seoul Metropolitan City Energy Ordinance' was amended to create the basis for its establishment and operation.[3] Composed of 45 members, the Executive Committee advises on policies and project implementation, develops new projects, actively promotes citizen-led OLNPP programs, and evaluates and supplements projects (the SMG, 2014). During the Phase 1, the Executive Committee had four subcommittees in the areas of energy conservation, energy efficiency, energy production and citizen communication. The committee members had in-depth discussions on the roles, status, authority and operations of the committee itself. They raised a question, "What role should the Executive Committee play to make the OLNPP initiative a success?" in order to define their respective responsibilities in line with the committee's authority and roles. As a result, it was determined to hold subcommittee meetings on a monthly basis, to have relevant SMG officials attend the meetings, and have the discussion results sent to the SMG administrative units immediately. It was also decided to establish General Subcommittee that would review and coordinate what was discussed among four subcommittees. According to the decision, the Executive Committee composed of diverse stakeholders in both public and private sectors was granted the actual decision-making authority so that it could make policy decisions through its members' joint planning, implementation and accountability. From 2012 to 2013, the OLNPP initiative governing body held a total of 41 meetings including two Citizen Committee meetings, 11 Executive Committee meetings, and 28 subcommittee meetings.

3 The Seoul Metropolitan City Energy Ordinance, Article 12 (5) ⑤: "In order to promote the committee's tasks efficiently, an executive committee can be established and operated to execute and evaluate projects under public and private cooperation.

[Figure 1] The OLNPP Governance Promotion System



The city's energy governance further deepened in the policies adopted for "the OLNPP Phase 2 –Seoul Sustainable Energy Action Plan" launched in 2014. As the key player in policy making, the OLNPP Executive Committee prepared a comprehensive plan through 23 meetings and 1 forum held by four subcommittees. The committee discussed potential values of the city's energy policies, including self-sufficiency, participation, justice, and sharing and put to a citizen's vote to select self-sufficiency, sharing and participation as the three core energy values. The determination of the values and policy goals of the initiative by popular vote was an experiment of the city-level democracy: The SMG asked questions to citizens about energy issues and found solutions to them (Ahn Byeong-ok, 2016). The three core values of "Seoul Sustainable Energy Action Plan" includes 'participation' to emphasize the city's citizen-led energy governance. Upon the launch of Phase 2 of the OLNPP initiative, the Executive Committee restructured itself into the four subcommittees of Production, Efficiency, Industrial Jobs, and Community Welfare. Since then, the Executive Committee has assessed the implementation of the detailed policies of the Seoul Sustainable Energy Action Plan called "Energy Saving Cities, Seoul", conducted policy consultation and system improvement activities, and co-hosted the 'Seoul Energy Forum' regularly with the SMG. From 2014 to 2016, the Executive Committee held a total of 69 meetings.

In February 2017, the third Executive Committee was launched with the subcommittees of Production, Efficiency, Education Jobs, and

Community Welfare, and the ratio of the youth in the organizations has increased. The Executive Committee members voluntarily engage in various activities including promotion, lectures, research, institutional improvement, and citizen engagement regarding the OLNPP initiative at home and abroad. What drives the active engagement of citizens as well as the committee members are the values and ethical directions that the initiative pursues, including the presentation of sustainable energy policies, the possibility of creating alternative energy solutions at the level of local governments, and the commitment to fulfilling the city's responsibility as a huge energy consumer.[4] The OLNPP initiative has presented social and moral values, which has resulted in facilitating the establishment of governance with efficient communication amongst its actors. Consensus on the values that policies pursue has raised the level of policy dramatically. Compliance and created a large number of policy support groups inside and outside, resulting in a high level of policy expandability(Lee Ju-heon, 2016). Lee Gang-joon (2015) attributed the high achievement in the field of energy conservation campaign to citizen's active participation in governance, despite the decrease in the energy and climate budget to the range of 76% of the former city administration's budget. He also referred to the establishment of Energy Citizen Cooperation Division and the increase of the governance support budget as the causes of the increased citizens' participation in energy conservation and production activities.

4 *On November 26, 2016, a presenter at the 'Seoul Citizens' Governance Conference' commented on the OLNPP initiative, "I've never seen a local government's policy that excites me so much. It perfectly coincides with my value orientation, and so I've spent time and energy helping the initiative to succeed." (Lee Yoo-jin, 2016).*

The Achievements of Network Governance and the Roles of Energy Citizens

The OLNPP governance is connected to citizens, villages, autonomous districts, local governments, central government, and international society like as a network under the leadership of its Executive Committee. The governance began with the city administration and citizens sit around a table together in 'equal' capacity[5] to discuss issues over time and put decisions into action in a timely manner. The process of sharing ideas and bringing them into an action takes time, but the citizens who participate in the process take the lead in implementing the ideas. They in effect reinforce the city government's administrative power. Now let us look into the achievements that the city has made through energy governance and the roles that energy citizens have played in the process.

Emergence and Growth of Energy Citizens – Citizens are Energy

The most successful area in the OLNPP Initiative Phase 1 was energy conservation through citizen participation. The number of

5 *Lee Ju-heon (2016) defined it "a cooperative operating system based on horizontal cooperative relationship." Such a framework can enhance the accessibility of various participants.*

energy-saving citizens increased thanks to various programs such as the Energy Conservation Program Contest, the Energy Self-Sufficiency Village Project, and the Energy Conservation Competition. While engaging in various contest programs, citizens grow up to be advocates who not only participate in competition but also fully understand, support and promote the OLNPP initiative through education and practice. They are called energy citizens with energy citizenship who hold themselves accountable for the consequences of their energy consumption and the overall climate change.

Eco-Mileage, a citizen participatory energy saving program, has more than 1.8 million individual and group members. Members can earn mileage for saving electricity, water, or city gas to pay apartment maintenance fees, charge T-money, or use as credit card points. The emergence of energy citizens can also be confirmed through eco-mileage policies. Citizens have begun to donate their incentives to the energy poor. Citizens donate their eco-mileage to the Seoul Energy Welfare Citizens' Fund to help the energy disadvantaged pay for their air conditioning and heating or insulated wallpaper construction. Citizens donated 55.689 million won worth of eco-mileage to the Fund until December 2016. The fact that the number of citizens donating their incentive to energy welfare is increasing means that the city's energy citizenship is growing.

The policies open to energy citizens include 'Energy Clinics', 'Energy Guardian Angels' whose more than 20,000 members take the lead in saving energy at home and school, and 'Good Stores' that practice energy conservation. The SMG has also introduced the energy designer system for energy diagnosis and consulting in home, school, and commercial sectors. Citizens hired as energy designers provide customized energy diagnosis and consulting service to shops, small buildings, religious facilities, kindergartens and jjimjilbang (public sauna) facilities. The designers studied the use of incandescent lamps in traditional markets and have become involved in the LED replacement project for the locations. Based on their field experiences, they have established Energy Cooperative and continue with their contributions to the cause.

The number of households participating in solar power generation, including 'Veranda Solar Power,' reached 22,000 as of December 2016. An increasing number of citizens have become 'energy farmers' in this mega city through the Citizen Sunlight Fund, the Energy Cooperative, Energy Supermarkets, and Energy Self- Sufficient Villages. Citizens invested a total of 8.25 billion won in the Citizen Sunlight Fund launched in August 2015. A total of 1,044 people (69% from Seoul and 31% from other regions) joined the fund on that day. The SMG has built a 4.25 MW solar power plant in each of the city's four train depots in Jichuk, Gaehwa, Dobong and Godeok with the donated funds. Energy Cooperatives are most active in Seoul, a home to the OLNPP initiative (Yoon Sun-jin, Sim Hae-young, 2015). The reason is that, in addition to the impact of the Fukushima disaster, the SMG has created systems in which citizens can easily participate in energy production, including the introduction of the Seoul-type FIT and the reduction of

rent for public land used for PV power generation. Various civil groups such as Solar and Wind Energy Coop, Our Neighborhood Solar Power Coop, and Seoul Citizens' Solar Power Coop continue to find sites, gather members, and install PV stations. The number of citizens that install mini PV stations and work as members of energy cooperatives to join the cause of energy conversion in Seoul is on the rise.

Expanding Energy Self-Sufficient Villages through Autonomous Districts' Governance

In 2012, the SMG launched the 'Energy Self-Sufficient Village' project for the first time among the country's local governments. The resident-led energy self-sufficient village campaign was carried out in Buan, Sancheong, Imsil, and Yeondaedo Island. But it was in Seoul that the campaign became a municipal project for the first time. An energy self-sufficient town can be defined as "a village that achieves environmental, economic and social sustainability by arranging for its energy-conscious community to increase its energy independence" (Lee Yu-jin, 2016b). The village community plays the leading role in promoting 'energy independence' or 'energy conversion'. The energy self-sufficient village project began in 2012 with 7 villages, and it has since increased to 55 (as of December 2016).

'Seongdaegol Energy Self-Sufficient Village' was built by 'energy citizens' who played a central role in linking their activities to the growth of their autonomous district's energy governance. Through their three-year energy-related activities, the residents have come to believe that the autonomous district's governance should be connected with the sustainability of their energy self-sufficient village. From the perspective of the residents, it is Dongjak-gu District that influences their daily lives more significantly than the SMG. The residents proposed that Dongjak-gu establish an energy governance organization. On September 22, 2015, an energy council (composed of 15 heads of self-governing resident committees, 3 representatives of energy self-sufficient villages, and 5 representatives of environmental groups) was launched. On November 5, 2015, the energy council held "the Dongjak-gu Energy Conference for GHG Emissions Reduction and Energy Self-Sufficiency Improvement" with the participation of more than 100 residents. In collaboration with government officials, Seongdaegol residents have organized the council and planned and carried out the pre-training of the residents' self-governing body chairpersons, held conferences, and had a meeting with their district head. As shown in (Figure 2), the Seongdaegol residents played a role in establishing the energy governance of their autonomous district through the energy council that connects the energy-independent village, heads of 'tongs' and 'bans', the resident center and the district.

[Figure 2] The Energy Governance Connecting the Village - Resident Center - Dongjak-gu – the SMG

The establishment of the energy council in Dongjak-gu is being benchmarked by other districts in the city. Kim So-young, representative of Seongdaegol Energy Self-Sufficient Village has participated in the OLNPP initiative as a member of the Executive Committee. She has led the review of the Dongjak-gu case and the expansion of the district governance in the Community Welfare Subcommittee. The SMG has helped autonomous districts to hold OLNPP conferences, energy self-sufficient village forums and tong and ban head training sessions. With a long-term perspective, the SMG encourages its districts to form public-private councils participated by local authorities (district offices and residents' self-governing bodies) and private organizations, and support their budget through the 'City-District Collaboration Project.'

[Figure 3] **Establishment of Local Energy Governance based on Energy Self-Sufficient Villages in Seoul**

The more energy self-sufficient villages districts have, the more active they are in energy governance. Of 25 autonomous districts in Seoul, Seodaemun-gu has the most energy-independent villages with 11, followed by Dongjak-gu, Gangdong-gu, and Guro-gu with 5 each. Seodaemun-gu has established governance with emphasis placed on energy self-sufficient villages. It has hired an official devoted to the affairs related to energy self-sufficient villages and the Energy Self-Sufficient Village Council. Seodaemun-gu holds Energy Self-Sufficient Village Council meetings regularly. The villages join hands to host festivals and carry out projects. Gangdong-gu has adopted a 'preliminary energy self-sufficient village' system and is implementing incubation policies. It has appointed the residents of Sipjaseong Village and Seongnae Kolon Apartment 2-cha as members of the Energy Committee. The OLNPP Executive Committee has accepted the Dongjak-gu case as a model for district-level energy governance and extended the model to all the other districts in the city. This was possible because residents could participate in the OLNPP Executive Committee and freely provide feedback. Energy citizens' ideas put forth at Executive Committee meetings are adopted as the SMG's policies which in turn affect the daily lives of citizens in a particular district or the entire city.

Declaration of Regional Energy Conversion – the SMG leading the Establishment of Regional Energy Cooperative Body

In August 2015, the OLNPP Executive Committee discussed the issue of cooperation with other municipalities in order to achieve the goal of the 'Seoul Sustainable Energy Action Plan.' In June of that year, Gyeonggi-do announced its policy goal to increase its energy

independence rate from 29.7% to 70% by 2030 through demand management and expansion of renewable energy in its 'Energy Self-Reliance Declaration 2030.' Chungcheongnam-do also announced a new policy aimed at producing additional new and renewable energy equivalent to the electricity generated by 3.3 thermal power plants. Through discussions at the Executive Committee, the SMG prepared to declare a 'Joint Declaration on Regional Energy' with Gyeonggi-do, Chungcheongnam-do and Jeju-do. Consultations and coordination were needed until the heads of the four local governments were able to announce their energy policies and sign a joint agreement. The draft of the 'Joint Declaration on Regional Energy' was prepared by the Executive Committee. The four local government representatives completed the declaration through mutual consultation.

On November 24, 2015, the heads of Gyeonggi-do, Seoul, Chungcheongnam-do and Jeju Special Self-Governing Province made a joint declaration on 'regional energy conversion'. It is safe to say that it was quite significant in terms of the country's regional energy policies that the heads of four local governments gathered, emphasized the necessity of energy decentralization, and pledged to cooperate with one another. The Joint Declaration called for: 1) replacing nuclear power and coal power plants by enhancing energy self-sufficiency through demand management and renewable energy production; 2) promoting the formation of a council with the central government to foster distributed energy and new energy industries; and 3) making such efforts become regular through the 'Regional Energy Forum'. The proclamation made it clear that the signatories were against nuclear and coal-based power generation and called for the enhancement of energy decentralization and the expansion of distributed energy. The signatories had in common that they possessed a strong commitment to energy conversion and their local governments established and promoted energy plans aimed at raising their 'energy self-sufficiency rate'.

The SMG is playing a role in establishing an energy cooperation system between local governments in Korea. In 2016, it played a central role in hosting a seminar participated by research institutes in the four local governments. The seminar held in November under the theme of "One Year After the Declaration of Regional Energy Conversion, How Far Has Energy Decentralization Progressed?" became a valuable opportunity for participants to share the current status and seek mutual cooperation. The SMG is also cooperating with the 'Local Government Council for Energy Policy Conversion' which is participated by all 25 districts. On November 1, 2016, the SMG signed a mutual cooperation agreement with Samcheok City in Gangwon-do regarding new and renewable energy. Mayor Park Won Soon is striving to build cooperative energy governance with a range of other local governments in the country: He advocated building solar power plants in Samcheok, Miryang and Gyeongju with the funds of the Regional Win-Win Fund at the inauguration ceremony of Seoul Energy Corporation. He has published the OLNPP manual and distributed it nationwide as part of his devotion to the cause.

Seoul's Energy Policies Adopted as National Policies - Governance Proposal to Improve Energy Policies and Systems

The OLNPP initiative has infused the local governments' energy policies with vitality. It has demonstrated that local governments can establish and implement energy policies tailored to their local characteristics and increase their energy self-sufficiency rates. The SMG has introduced many successful programs such as the mini solar power generator, the Seoul-type FIT, the rent reduction (5% of official land price → 20,000 won for less than 100kW and 25,000 won for over 100kW), energy self-sufficient villages, the LED power-saving support system, and the BRP, becoming a benchmark target for other local governments throughout the country. The mini solar power generator has expanded to the city's 24 districts as of 2016. It was adopted as a central government policy in 2017. The Ministry of Trade, Industry and Energy announced in its 'Measures to Boost the New and Renewable Energy Supply' that it would pay 25% of the generator price as a national subsidy, in addition to the local government's 50% subsidy, in order to spread mini solar power generators nationwide. A local government's policy being adopted as the central government' policy is an example of bottom-up policymaking.

In cooperation with the Executive Committee, the SMG has produced a booklet with proposals for improvements in the country's environmental policies and systems and distributed it to the Ministry of Trade, Industry and Energy and the National Assembly since 2015. Institutional improvement ideas in the major energy sector include the following: (1) Relaxation of regulations on PV station location conditions in restricted development zones for the expansion of renewable energy production, (2) Re-introduction of small PV FIT system, (3) Elimination of excessive cost required by linkage with small power generation facility, (4) Simplification of power generator net metering and expansion of net metering targets, (5) Increase of subsidy for cogeneration plants, (6) Unification of gas tariffs for distributed power sources and power generation, (7) Expansion of energy audit targets among large energy consumers, and (8) Addition of inspection items to the energy management standards in the building sector. The SMG is proposing to form an energy council between the central government and itself for close cooperation to bring about institutional improvements. In November 2016, the Mayor of Seoul proposed to switch the country's energy policies centered on fossil energy and nuclear power while referring to the heat wave and the 5.8 magnitude earthquake in Gyeongju, and to shut down and safety-check nuclear power plants in the earthquake-hit areas, suspend the construction of new nuclear power plants, shut down old nuclear power plants, and adopt the policy of 1 PV station per household. The head of a local government is strongly urging the central government to switch its energy platform.

Collaboration with International Community and Offshore Expansion - Export of the OLNPP Initiative to Taiwan

As the OLNPP has drawn international attention and Mayor Park Won Soon has served as chairman of ICLEI (Local Governments

for Sustainability), the SMG has come to build an international energy governance. The city's Eco-mileage System won the 2013 United Nations Public Service Award for citizen participation, expansion of energy-saving culture, and reduction of energy consumption. In November 2013, the SMG was awarded the 'Climate Action Leadership Award' by the World Green Building Council. In 2014, the SMG was awarded the 'World Best City Award for Action against Climate Change' presented by the World Wildlife Fund (WWF) and ICLEI. Based on such international recognition, the city of Seoul successfully hosted ICLEI World Congress 2015 in Seoul. In November 2013, the SMG commissioned 10 global energy experts as advisors at the 4th Seoul International Energy Conference. The Seoul International Energy Advisory Council (SIEAC) has submitted the "Recommendation for Seoul toward the City of Self-reliance in Energy Services." It has held the Seoul International Energy Conference every year since 2013.

Meanwhile, Hong Kong and cities in Taiwan and China are adopting the OLNPP policy as well. Taiwan, in particular, has been actively benchmarking the OLNPP initiative as a successful case of energy demand management after deciding to halt the construction of Unit 2 of nuclear power plant No. 4. Representatives of local governments and civic activists have visited the SMG. Taiwanese media have reported a great deal about the OLNPP initiative. The members of the OLNPP Executive Committee have been invited to Taiwan for interviews and lectures. New Taipei City has an active sisterhood relationship with Seoul.

At the General Assembly of the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, France in 2015, the American business magazine Forbes featured an article on the Seoul OLNPP initiative. In the article entitled "Seoul Presenting a New Way to Reduce Nuclear Power Plants," Forbes introduced, in detail, Mayor Park Won Soon's speech reiterating, "Our vision is to have Seoul citizens produce energy themselves and consume energy efficiently." CNN introduced the city's Weekly No-Driving Day Campaign and Air Quality Information Disclosure System in its coverage of the C40 Cities Climate Leadership Group (C40). NHK introduced mayor Park Won Soon as one of the four 'world's mayors with unique individuality' and as a mayor playing a significant role in solving common tasks faced by many major cities around the world. In 2016, Mayor Park Won Soon was awarded the 'Gothenburg Award for Sustainable Development.'

Seoul Energy Corporation – A New Energy Governance Partners

In November 2016, the SMG launched Seoul Energy Corporation (SEC) to effectively enforce its energy policies. Based on the SH Corporation's Collective Energy Business Group, the SEC seeks to expand new and renewable energy sources including incinerators, sewage heat and biomass, and carry out various energy efficiency projects. According to the results of a survey, 70.8% of the respondents agree to the necessity of SEC and regarding the reasons, 29.5%

referred to the stronger implementation of energy policies, 27.7% cited the expansion of collective energy supply, 17.2% mentioned the stabilization of heating costs, and 12.8% pointed to local reinvestment of business profits. As for a public corporation's conditions for success, 42.2%, 21% and 19.1% referred to management transparency, public interest, and citizen welfare, respectively, as the most important condition.

The OLNPP Executive Committee formed the 'SEC Establishment Governance Committee' to take charge of the preparations for the SEC launch in 2016. Eventually, SEC launched SEC Citizen Committee composed of more than 50 people with the goal of 'working with citizens'. It implies that citizens participate in setting business goals, implementing plans and making achievements and take responsibility for the results. SEC will carry out the SMG's energy self-sufficiency policies and implement GHG emissions reduction while playing a role in creating new industries and jobs. SEC will create Energy Welfare Fund with part of its profits to support the energy poor. Thus, in Seoul, the SMG, SEC and citizens are ready to work as a team in a full-fledged collaboration towards the common goal of energy conversion. Seoul has secured SEC as its energy governance.

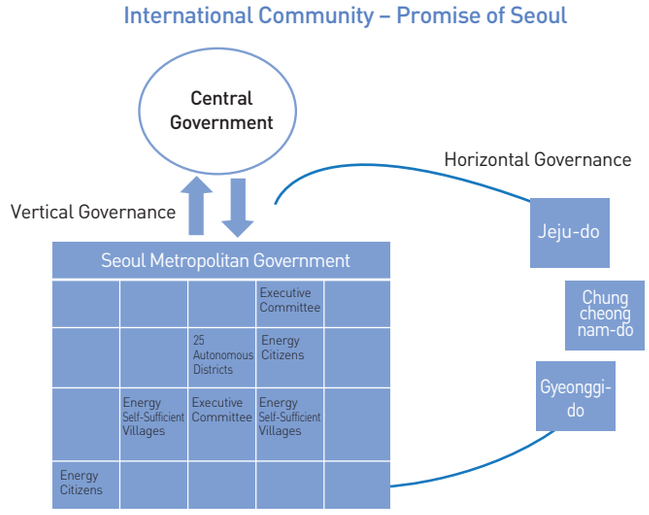
Implications of the OLNPP Initiative Governance

Seoul energy governance is based on a structure in which various stakeholders including key players like SMG and the Executive Committee and all those that constitute the infrastructure, superstructure, and horizontal structure of the governance are interconnected like a net for constant communication and cooperation. The infrastructure is buttressed by energy citizens who participate in setting and implementing the OLNPP policies. With energy citizens, energy self-sufficient villages and district-level governance being tightly connected with one another, the OLNPP achievements continue to expand. Based on the horizontal structure, the SMG continues to promote the country's energy decentralization through the establishment of regional energy governance with Gyeonggi-do, Chuncheongnam-do and Jeju-do. Based on its infrastructure plus its horizontal support structure, the SMG works with the central government, its superstructure, for institutional and organizational improvements including the establishment of energy councils while enhancing its bonding with the international community through ICLEI and the Seoul International Energy Advisory Council. The structure of the SMG's energy governance is illustrated in (Figure 4).

The SMG has formed a broad yet robust network of energy governance with its citizens, villages, autonomous districts, local governments, the central government, and the international community. It has raised the significant issues of 'regional energy', 'energy democracy', 'energy decentralization' and 'energy conversion' in the country and promote its expansion. Most notably, Mayor Park Won Soon advocated nuclear phase-out and energy conversion in the

Seoul International Energy Conference 2016. At the inauguration ceremony of SEC, he announced the city's 'win-win energy' policy in front of the residents of Miryang, Yeongdeok, Yeonggwang and Samcheok whom he had personally invited. He continues to emphasize the direction and the necessity of energy conversion. The Seoul energy governance plays a role in bonding citizens and relevant stakeholders who agree to the necessity of energy conversion. The bond serves as a driving force behind the city's efforts for energy conversion.[6]

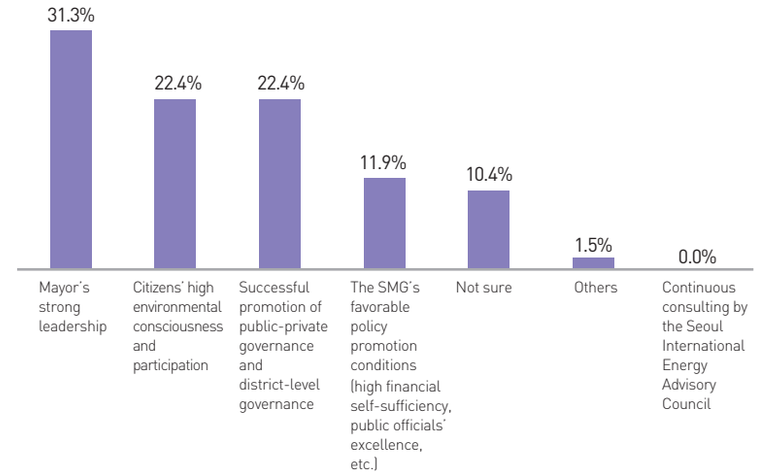
[Figure 4] The Seoul Energy Governance Structure



Source: Kim Ha-na (2016, p. 342)

6 *Catholic priest Kim Jun-hwan of the Miryang 765kV Transmission Tower Opposition Committee said at his congratulatory address for the launch of Seoul Energy Corporation, "It's really comforting to hear that the SMG understands the pain of Miryang. I envy the SMG's policies. I am disheartened. The SMG can implement such policies. Why can't the central government?"*

[Figure 5] The Most Critical Success Factor for the OLNPP (Seoul Sustainable Energy Action Plan)



The assessment of Seoul energy governance is also confirmed by the results of a survey conducted by the Institute for Climate Change Action.[7] As for the most important success factor of the OLNPP (Seoul Sustainable Energy Action Plan), 31.3% pointed to 'the mayor's solid leadership', 22.4% cited 'citizens' high environmental consciousness and participation,' 22.4% referred to 'the successful promotion of public-private governance and district-level governance,' and 11.9% mentioned 'the SMG's favorable policy promotion conditions (high financial self-sufficiency, public officials' excellence, etc.) (Figure 5). In sum, the mayor's leadership and citizen engagement have joined forces to

7 *A questionnaire survey for the evaluation and direction setting of the Seoul Metropolitan Government's Energy Comprehensive Measures (including the OLNPP project), including an executive committee for reducing the number of nuclear power plants (an online questionnaire based on self-filling questionnaires from January 16 to 20, 2017).*

create a synergistic effect through public-private governance. 58.2% of the respondents answered positively about the SMG's communication with citizens and its energy governance efforts - 19.4% said 'very good' and 38.8% 'good.'

The following implications can be drawn from the achievements made by Seoul Energy Governance. First, the mayor's leadership played a role in the stable operation of energy governance in Seoul. The energy governance was possible because the mayor had keen interest in the OLNPP initiative on which it placed top priority. As one of the current city administration's 10 core projects, the OLNPP initiative has been a major consideration in the Seoul Municipal Administration Evaluation Workshop participated by the mayor. In the evaluation workshop held in December 2012 for the year's second half, Mayor Park urged the Climate & Environment HQ to set up a plan for widespread innovation and active citizen participation, saying that the 'OLNPP' initiative was not progressing as fast as it should be. Since then, the SMG and the OLNPP Executive Committee have boosted collaboration.

Second, governance was able to work properly because the OLNPP Executive Committee is equipped with enforcement and decision-making functions and holds regular meetings while the SMG's Energy Efficiency Promotion Division provides direct support for energy citizens' activities. The fact that the Executive Committee gather regularly and their discussion results are instantly sent to the city's administrative organization contributes to the stabilization of the governance. Over time, the members of the executive committee have deepened their understanding of the municipal policies, which in turn has further increased their contribution. Energy Efficiency Promotion Division provides citizens with growth opportunities through education and other support means by implementing a variety of civic participation policies.

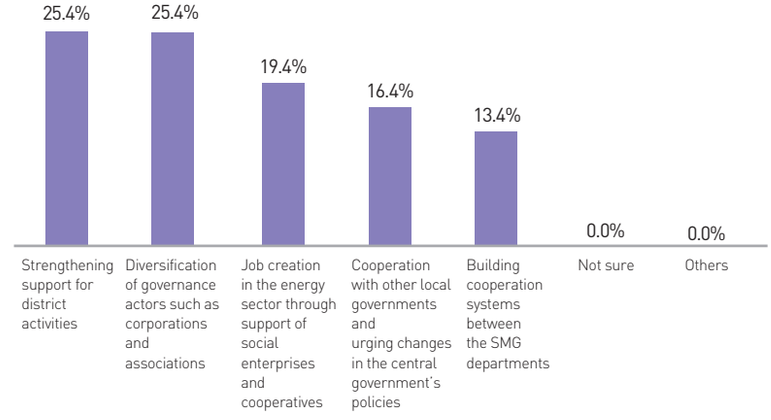
Third, the emergence and growth of energy citizens have stimulated the development of the city's energy policies. The OLNPP's strengths such as sustainability, ethicality, equity, fairness, and the vision for and values of energy conversion have led to the increasing voluntary participation of citizens as well as the Executive Committee members. In line with the citizens' growth, new experiments have been attempted. Examples include the launch of a 'power-saving plant' in Seongdaegol energy self-sufficient village, the increase of wages for security guards of Doosan Apartment in Seongbuk-gu with saved electricity bills for public space, and the installation of a mini PV system in a security guard room in scorching summer. Such attempts have contributed to promoting the OLNPP initiative citywide. The outcome so far has been made possible through energy citizens who have done more than just trying to meet the quantitative energy goals. It was the result made by those who have asked themselves questions and tried to find answers as to how to reduce energy consumption and with whom to share the outcome.

Challenges Facing the OLNPP Initiative Governance

The Seoul energy governance has been promoted by both public and private sectors from the planning stage to the implementation and evaluation stages. However, the process has not been easy. For five years from 2012 to 2017, public officials in charge of the OLNPP initiative have changed many times — 4 heads of Climate & Environment HQ, 4 heads of Environmental Policy Division, and numerous public servants under them. The SMG has been in a situation in which it is difficult to internalize governance experiences. In addition, it is difficult to carry out quantitative evaluation of governance. So there is a limit to the objectification of governance performance whose processes are important. Ahn Byeong-ok, chairperson of the Executive Committee, presented the future direction of energy governance — 'to be deeper and wider' — at the Environmental Policy Evaluation Conference held in the second year of the current city administration.

According to a survey conducted by Institute of Climate Change Action about what is most needed to strengthen the governance system of the OLNPP 2 – Seoul Sustainable Energy Action Plan, 25.4% answered 'enhancement of support for district activities,' 25.4% pointed to 'diversification of governance actors including corporations and associations,' 19.4% cited 'energy sector employment by supporting social enterprises and cooperatives,' 16.4% referred to 'cooperation with other local governments and request for changes in the central government's policies' and 13.4% selected 'building cooperation systems between relevant departments within the SMG'. (Fig 6). As for priority, respondents chose cooperation with autonomous districts, more diverse participation of stakeholders, energy jobs creation, cooperation with other local governments and the central government, and inter-departmental governance, in that order. From the survey results, the future challenges of the OLNPP initiative can be illustrated as follows:

[Figure 6] **Feedback on the Question of What's Needed Most to Enhance Governance**



First, autonomous districts must establish governance similar to the OLNPP Executive Committee. The SMG must help districts build up their energy governance by providing them with administrative and financial support for their energy policy establishment and enforcement. Gyeonggi-do financially supports the establishment of

local energy plans in its 31 cities/counties. In Seoul, it is necessary for 25 autonomous districts to set up their energy plans in a way that the citywide energy self-sufficiency goal of 20% by 2020 is reflected in the districts' energy goals. It is also a good way to build regional energy centers to enhance the districts' efficiency in policy enforcement. For instance, Nowon-gu, Gangbuk-gu, Seongbuk-gu and Dobong-gu are discussing the construction of a regional energy center in Northeastern Seoul.

Second, more diverse citizens should participate in energy governance. This is the reason why young people and company-related people were recruited for the 3rd term Executive Committee. In addition, restoring the functions of the Citizens' Committee that has not been operational since 2015, is also a challenge to meet. By using the social influences of the committee members, it will be possible to secure publicity and social diffusion effects, which are considered to be shortfalls of the OLNPP initiative.

Third, jobs creation must be realized in the energy sector in conjunction with social enterprises and cooperatives. This is linked to the sustainability of the SMG's energy policies. In order for policies to sustain when the city's leadership changes, the number of people who actually represent the related fields must increase. To that end, development of the energy economy and industry must be promoted. What sets 'Seoul Sustainable Energy Action Plan apart from the plan for the OLNPP initiative Phase One is this aspect — revitalizing the energy industry and creating jobs in the sector. To that end, fiscal and manpower support is necessary as well as efforts to expand the relevant infrastructure. At the same time, it is also necessary to find out how well citizens are prepared to work in the sector in terms of skills and capabilities. Careful observations must be made about whether there is an educational base for energy citizens to grow, whether there are enough job opportunities for trained energy citizens, and whether energy citizens have built a network and cooperate with one another systematically. Job creation in the energy sector requires policies, technologies, and financial and human infrastructure that can make efficiency improvement and accelerate the growth of renewable energy business. Cultivating skilled labor is important for energy efficiency and renewable energy technologies to maintain market confidence.[8] It is necessary to discuss what kind of policies the SMG should develop to enable energy citizens to have energy jobs in stages.

Fourth, the SMG must concentrate on the shift of national policies through cooperation with other local governments. The biggest barrier to the realization of the vision of 'Seoul Sustainable Energy Action Plan' is institutional arrangements. To overcome the obstacle, it is important to establish governance with both the central government and other local governments. The SMG must pursue improvements in the central government 's energy policies through cooperation between local governments. It should also continue to enhance its horizontal regional energy network. To establish a regional energy regime, local

8 *Yoo Jeong-min (2014), 'Proposals about Seoul Energy Conversion Policies,' Environmental Justice, issue report (Apr. 2014)*

governments must acquire rights to making and enforcing various policies such as demand management and supervision, expansion of distributed energy, adjustment of energy mix, energy pricing, and the ownership and operation of power grids. To gain such authority, however, the SMG must be able to persuade its stakeholders including the central government to extend support and reach consensus.

Fifth, the SMG energy governance requires inter-departmental collaboration. The OLNPP initiative is related to a broad range of areas such as urban planning, residential environment, spatial structure, economy, infrastructure and culture. In particular, the attempt to link the city renewal projects with the OLNPP initiative should be strengthened. However, in reality, nothing is more difficult than inter-departmental collaboration in government offices. In order to boost interdepartmental cooperation, the SMG must be equipped with a system that incentivizes inter-departmental projects by precisely measuring the outcome of cooperation. Collaboration will work even better if each department's contributions are fairly measured and recognized in the assessment of collaboration results.

The SMG is evaluated as successfully conducting its energy governance that it has established with the citizens. The most important point in governance is that all participants have to sit around a table and start to talk having while maintaining an equal level of power. Governance can be sustained when participants continue to share their knowledge, ideas, and time with one another on the basis of mutual respect until they can resolve problems. The core values of the SMG's energy policies - 'self-reliance', 'sharing', and 'participation' - will be supported by even more citizens as the problems and limitations of the current energy system become more evident over time. In fact, the SMG's energy policies attracted particularly keen attention in 2016 due to the earthquake of 5.8 magnitude in Gyeongju, a heat wave, rising electricity rates, and fine dust across the country.

Governance is a process of constant consultation to find alternatives. 2017 marks the fifth year of the launch of the OLNPP initiative. The national energy policies will also have a fundamental shift in 2017 through the 8th Basic Plan for Long-term Electricity Supply and Demand and the2nd National Basic Plan for New and Renewable Energies 2018. Standing at such a crossroad, the SMG needs to concentrate on the governance again in order to solve all the associated problems while expanding the scope of achievements of Seoul energy governance. Seoul energy governance is alive in its energy citizens' daily lives. It is time to systematically gather their five-year experiences and build up 'a wider, deeper' energy governance. Let's join forces to create an even more tightly knit energy governance network in Seoul.

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Kim Hye-ae
Director of Seoul Energy Dream Center

Kim Hye-Ae is director general of Seoul Energy Dream Center, which Seoul's iconic zero-energy building and a space for civic learning on environment and energy.

After graduating from department of sociology at Hanyang University in 1989, Kim founded Korea's representative environmental civic group, the Green Korea United in 1991.

After 16 years as an environmental activist, Kim came to realize the importance of education, thereby established the Green Education Center in 2007 to begin environmental education in earnest.

Leveraging her field experience, Kim has served as policy advisor to the central government and the Seoul city government, and with the arrival Mayor Park Won-Sun, has been very active in making Seoul more sustainable in many ways, one of which is sitting on the Committee on One Less Nuclear Power Plant.

Today, as co-founder of the Green Korea United, Kim is focused on her role an active civic movement leader, and through Seoul Energy Dream Center, is committed to promoting home and abroad Seoul's best practices on environmental and energy policies.

Building Energy Citizenship through Education and Practice in Seoul

Kim Hye-ae
(Head of Seoul Energy Dream Center & Co-representative of Green Korea United)

Necessities and Requirements for the Creation of Energy Citizenship

In recent years, our lives have been under the direct impact of climate change. Since the Fukushima Daiichi nuclear disaster in Japan, Korea has also suffered from earthquakes around nuclear power plants in Gyeongju. Thus, the public's awareness of environmental problems including climate change and energy problems is rapidly expanding in Korea. At present, more than 90% of the population think that climate change and environmental problems are serious and that action is

necessary. However, despite the high level of awareness, only a few are taking action. Why is this?

According to a survey conducted by an environmental group in Seoul on the ''Awareness of Environmental Education' among the citizens of Seoul, only 50% of the 587 respondents were either interested (23.3%) or very much interested (26.6%). The rest responded with neutral (35%) or were not interested. Also, 34.7% of the respondents said that they have not received any sort of environmental education. By age group, people in their 20s and 30s demonstrated a lower level of interest in environmental education compared to older age groups. They also paid less attention to environmental issues in the community and the world.

Seoul, one of the world's largest metropolises, consumes the largest amounts of energy and resources per capita in the world. In that sense, Seoul dwellers are accountable, for the environmental degradation. However, in reality, environmental policies are always put on the back burner in the face of various urban problems, such as political struggles, housing problems, unemployment, infrastructure deterioration and poverty. Notably, 'environmental education' is given the lowest priority in budgeting and HR allocation.

This is true not only in the city administration but also in the city's educational administration. More than 90% of school teachers in the city think environmental education is necessary. Yet the selection rate of environmental subjects is only 4.9% in middle schools and 16.4% in high schools. The reason is that such subjects are not helpful in the college entrance examination.

Mayor Park Won Soon, who emphasizes communication and governance, has created and launched various policies designed to raise the importance of an environmental administration and encourage citizen participation in the metropolis through diverse initiatives such as 'Creation of Urban Villages' and 'One Less Nuclear Power Plant'. The situation has significantly improved, but there are still a few obstacles to overcome.

Education for sustainable development (ESD), spread throughout the world, focuses on the consideration of future consequences, the concept of generations, and integration.

The education is predicated on the idea that human beings cannot overcome the impending global environmental crisis solely based on their advanced material civilization and technologies and that they must seriously consider the future of the globe and find the right direction to pursue. The education also underscores that the future reality of humanity's descendants not be hampered by the present generation. To that end, the present generation must look carefully at the amount of earth resources they may tap into in order to save as much as possible. It calls for fundamental changes in lifestyle. In addition, it is necessary to consider ecological (nature), economic and social issues in an integrated way to realize a sustainable society. It is impossible to realize a sustainable society if mankind overlooks environmental issues inherent in socioeconomic aspects or socioeconomic issues in resolving environmental issues.

'Energy citizenship,' in its true sense, must be capable of understanding these characteristics and fuse them internally. It would be difficult to achieve its objectives if efforts are focused on the resolution of superficial problems or a partial approach is taken on these imminent issues.

The biggest reason for the success of the 'One Less Nuclear Power Plant Policy' was that it guaranteed the active policy seminars participation of citizens. Behind the success were numerous large and small public hearings, policy seminars, education sessions and creative activities linked to events in local communities (urban villages) as well as various detailed policies that had been proposed, determined and promoted by citizens themselves, without which the municipal government alone would not have been able to achieve.

The reason that the city's goal of raising its energy self-reliance rate from less than 5% to 30% over a period of 10 years does not sound farfetched is because the number of citizens fortified with genuine "citizenship" has been on the rise.

The Characteristics and Achievements of the SMG's Energy (Environment) Education

The Seoul Metropolitan Government (SMG) established the first 'Ordinance on Environmental Education Support' among nationwide regional municipalities (2008), followed by the 1st Environmental Education Plan (2013-2015) and the 2nd Environmental Education Plan (2016-2020) in line with the National Comprehensive Plan for Environmental Education under its vision: "Foster citizens taking actions to realize a sustainable society." The SMG has promoted environmental education in the areas of ecology, resource circulation, water, and climate change in accordance with the conditions of each class and locality.

The environmental and energy education that the SMG has offered thus far can be summed up in the following three categories:

First, the SMG education has expanded and revitalized climate change and energy-related educational spaces and programs.

Education programs in conjunction with its main policy task of 'One Less Nuclear Power Plant' have been active in particular. The SMG has created new educational spaces such as the Seoul Energy Dream Center, the One Less Nuclear Power Plant Information Center, and the Nowon Eco Center. It has revitalized on-site energy education by using eco-friendly vehicles called 'Haero' and 'Haeyo' built by renovating trucks. The SMG has also strengthened its education of energy citizens.

Second, the SMG has revitalized its green career education and appropriate technology education. It runs the 'Green Mentor School' featuring green career experiences led by environmental professionals and holds workshops on making appropriate technology products. It has also created jobs related to energy education such as 'energy doctors' and professionals of 'Energy Welfare Social Cooperatives.'

In addition, the SMG has trained lecturers of energy education and strengthened capacity building programs so that they can effectively serve as environmental and energy educators.

Third, the SMG supported and ran various environmental education programs. It has provided environmental education opportunities for all age groups, from toddlers to the elderly, and provided education on various topics including climate change, nature experience, water, fine dust, and resource circulation. The SMG has upgraded the city's nature-experiencing facilities and installed new environmental education facilities such as eco-schools.

Through these efforts, Seoul has accomplished more than before. For instance, the SMG has supplemented or revitalized environmental education at schools through 'Energy Guardian Angel Corps' activities and energy classes run by professionals. It has also broadened the scope of its socio-environmental education despite its ample programs and human resources by awarding projects to private entities and providing support. Over the past five years, more than 20,000 people have participated in 38 education programs launched in this fashion.

Also, the SMG has cultivated 'Green Leaders' who can work in the city's 25 districts, leading to the enhancement of environmental activities at the local level. The leaders have formed a critical human network in spreading the One Less Nuclear Power Plant Project to local communities. However, the biggest contributor to the citywide expansion of the One Less Nuclear Power Plant Project and the active engagement in it at the local level has been the resident environmental education based on the village community movement such as the energy independent village. Environmental communities such as eco villages existed in Seoul before the implementation of the resident environmental education. However, a remarkable expansion has been made in resident education at the local level only after Seoul city began to support a larger number of energy-independent villages each year.

On the one hand, the citizens of Seoul have benefited from environmental education following the creation of special environmental education and exhibition spaces such as the Seoul Energy Dream Center, the Nowon Eco Center, and the One Less Nuclear Power Plant Information Center in the city. All exhibition halls offer free admission and all interactive education programs are also free of charge except when expenses for materials arises. The educational spaces are specialized through customized exhibition contents and diverse interactive programs coupled with highly qualified commentators and instructors. The facilities are particularly popular among schools and family groups, visited by tens of thousands of people each year.

Educational Programs and Practices to Promote the One Less Nuclear Power Plant Initiative

The One Less Nuclear Power Plant Policy has been promoted with emphasis placed on new and renewable energy production, energy conservation and efficiency, energy sharing and community

development. The most successful sector has been 'saving and efficiency.' This means that although development of policies or technologies is a major factor, it is impossible to achieve policy goals without citizens' participation and practice. The SMG exceeded its original policy goals because there have been a wide range of education, experimentation and active participation in schools, homes, businesses, communities (urban villages) and the civil society.

Education at School

Environmental education at schools in Seoul can be roughly divided into three levels.

The first level is 'the production and distribution of environmental teaching materials.' In fact, the environmental education at schools cannot be fully implemented through the efforts of SMG alone, since the Seoul Metropolitan Office of Education is in charge of public education in the metropolis area. Thus, close cooperation with the Office of Education is vital. Collaborating with the Office of Education, the civil committee members of the Seoul Environment Committee published an environmental science textbook series called 'Hwanirang Gyeongirang' for elementary schools and distributed it nationwide. The contents of the textbook series are linked to the current elementary school curriculum, so as to allow integrative implementation into an existing class by teachers as easy as possible.

The Seoul Environment Committee also published and distributed another environmental textbook series called 'Exploring Green Treasures' following the success of 'Hwanirang Gyeongirang.'

[Figure 1] **Environmental textbook series called 'Hwanirang Gyeongirang' for elementary schoolchildren**

The second level is the 'Energy Guardian Angel Corps' activities. The SMG has promoted the formation and operation of the 'Energy Guardian Angel Corps,' which practices energy conservation at schools and at homes and engages in various community services, in order to promote environmental practices in schools. The corps is set up at primary and secondary schools on a voluntary basis. At present, the corps is organized in more than 500 schools across the metropolis with over 20,000 students serving as energy guardian angels. The activities of the corps are supported by competent professional NGOs. To maximize operational efficiency, hub schools are designated for each district. The guardian angels receive a variety of education. Their major activities include monitoring cases of energy waste; practicing energy conservation efforts in homes, schools and communities; engaging in energy conservation experiences; and participating in

energy conservation contests. The Energy Guardian Angels Corps activities have turned out to be a good energy education opportunity not only for students, but also for their teachers and parents.

The third level is the 'Green Campus' activities. The SMG launched the 'Green Campus' project in 2013 with the aim of contributing to the spread of an energy saving culture by participating members of the university and creating a sustainable campus in connection with education for future generations and communities. The city has promoted 'Green Campus Promotion Project' as a municipal subsidy project through public contests. The SMG brought together universities and civil society to jointly carry out the project, thereby expanding it to a wider level. Universities participating in this project set up short-term and mid- to long-term energy conservation road maps along with detailed action plans. They install and run energy conservation experience centers and power saving stations. The schools also carry out educational programs for university members and promote energy education and conservation projects in association with neighboring communities.

The universities appoint Green Campus Publicity Ambassadors among their students in order to promote the Green Campus project and the One Less Nuclear Power Plant Project. The universities' activities include participation in the publicity of the SMG's energy policies including the One Less Nuclear Power Plant Project, citizen-oriented campaigns, energy welfare projects, Seoul Green Campus College Student Forums, energy and environmental education customized for youth and citizens, on-campus energy conservation, campus activities related to the creation of the Green Campus, and community projects in urban villages near the school.

The universities participating in the Green Campus Project number 34 (out of more than 50 universities in Seoul) as of 2016. They have established a network called the 'Seoul Green Campus Council'. Since universities are one of the sectors that consume a huge amount of electricity in the city, the Green Campus Project could produce a very significant outcome in energy conservation.

[Figure 2] **Member Universities of the Seoul Green Campus Council**

Source: Yoon Sun-jin, 'One Less Nuclear Power Plant Project of Seoul,' a PPT presentation

Operation of Professional Educational Institutions

As mentioned in the above, the space for special exhibition on energy and the environment is playing a big role. At present, there are five major exhibition and educational facilities in Seoul. There are numerous small and medium sized halls and thematic exhibition halls operated by the city's district offices across the city, which will not be mentioned in this paper.

The Seoul Energy Dream Center is one of the leading energy exhibition halls that have been built and fully funded by the SMG. It is also the first zero-energy building of any public structure in the city. It is an energy exhibition and education institution constructed through technical cooperation between the SMG and Germany. Since its opening in December 2012, over 80,000 students and citizens have visited and received education at the center each year. It is operated through consignment to a private organization and is housed in a three-story building (1st floor: energy specialized exhibition hall, 2nd floor: climate change special exhibition hall).

Most notably, the World Cup Park, where the Energy Dream Center is located, was a landfill site for 15 years. It is therefore a very symbolic space when it comes to the city's environmental protection efforts. There are many environment-related facilities in the vicinity such as a resource recovery facility, the District Heating Corporation, hydrogen stations, and a fuel cell power plant. The SMG runs educational programs (eco-tour) tapping into the facilities. The Dream Center goes beyond zero net energy to achieve the status of energy-plus building every year. The World Green Building Council has ranked the center's building as the third among public buildings in the Asia-Pacific region with its "Green Building Award." The building itself is recognized as a model for excellent energy education. The building has many passive elements such as triple pane windows, insulation, a courtyard, and exterior electric blinds The building has many passive elements that increase the energy efficiency by up to 70%, such as necessary energy is covered by solar and geothermal heat.

In addition to educating through exhibition tours and hands-on programs, the center runs professional energy and architectural education programs customized for children, builders and energy experts. It plays an important role in the city's energy education. In addition, many foreign visitors (public officials, journalists, etc.) visit the center to witness the city's excellent energy policies. In 2016, more than 2,000 overseas visitors were deeply impressed with the city's One Less Nuclear Power Plant Project.

[Figure 3] Seoul Energy Dream Center and its Visitors

Source: Website of Seoul Energy Dream Center (www.seouledc.or.kr)

The second is the 'One Less Nuclear Power Plant Information

Center.' Located on the first floor of Seoul City Hall Seosomun Building, it serves as a promotional and educational center for the city's One Less Nuclear Power Plant Project. The center is built on a small area in the most efficient way using recycled wood, waste glass bottles and flooring materials taken from closed schools in rural areas.

The center offers information on the energy status of Seoul's 25 districts including the level of energy consumption as well as visual education on energy. The center also runs hands-on educational programs. The center plays an important role in publicizing the One Less Nuclear Power Plant Project to City Hall visitors.

Last year, 15,000 people visited the center and participated in 210 training sessions.

[Figure 4] Entrance to the One Less Nuclear Power Plant Information Center and the Inside of the Exhibition Hall

Source: Website of the One Less Nuclear Power Plant Information Center (http://energy.seoul.go.kr)

The third space to introduce is the 'Nowon Eco Center.' It was built by the Nowon-gu and opened in February 2012 as a specialized energy exhibition hall. The center is also designed as a zero-energy building. It has installed and operated solar thermal, photovoltaic, geothermal and waste heat recovery systems. The center is located in a densely populated apartment complex area. It is visited by many students and families thanks to its high accessibility. Last year, over 36,000 people participated in more than 1,000 educational sessions. Participatory programs such as "Everyone's Garden" are quite active.

As a passive house, the entire building serves as a training ground. Diverse educational programs are offered on a variety of topics such as energy, climate change, ecology, woodworking, recycling, and cuisine on a monthly basis. In addition, it plays the role of an eco-friendly resident base center through the operation of small group activities on child care, eco-friendly living and eco-learning. It activates residents' participation projects and public-private partnership projects.

[Figure 5] Nowon Eco Center and Student Participation

Source: Website of Nowon Eco Center (ecocenter.nowon.kr)

The fourth is the 'Geumcheon Eco Center' launched in 2010. It does not have its own building It does not have its own building but is housed in the Geumcheon-gu Office Building. The district office building is equipped with geothermal and photovoltaic facilities and green walls which serve as great sources of environmental education for visitors. Using the district office as an eco center not only reduces the budget but also encourages a large number of citizens to participate

in the center's programs.

The Geumcheon Eco Center provides citizens and students with a variety of interactive programs led by professional lecturers. The most representative education program is the 'Bangapda Geumcheon Eco-classroom' which was attended by more than 8,000 participants last year in 250-300 sessions. The center also operates the Geumcheon Eco Center Exploration Program and on-site climate classes. It is distinctive in that its educational programs are customized for seniors and multicultural students who seldom have opportunities to take part in such educational programs elsewhere. Other district offices in Seoul may use this as a benchmark case to operate eco-centers inside their buildings.

In addition to the Nowon Eco Center and the Geumcheon Eco Center, 'Dobong Environment Class' is another environmental education facility run by a district office in Seoul. It is the oldest educational facility in the city among those run by the city's municipal institutions. Dobong-gu District built the facility and commissioned its operation to a private institution in 2003. Its main features include ecology programs, an audiovisual classroom, a nature learning center, and a natural environment classroom. Recently, it has focused on renewable energy education. In addition to its own educational programs, the center also supports teacher training and group activities joined by environmentally-aware students and citizens to form connections between the society and environmental education. The center also plays a central role in fostering green leaders in the community through the organization and support of homemakers active in environmental protection.

Citizens, Environmental Education in the Local Community and Practice

Eco-mileage is the representative citizen engagement project promoted by the SMG. The program is aimed at empowering citizens to voluntarily save energy and increase participation through incentives for energy conservation as well as various public relations activities. The initiative was launched in 2009, followed by the start of Eco-mileage Program in 2011. As of January 2017, eco-mileage members number 1.9 million, representing almost one in five citizens in the city. In addition to the substantial effects of energy saving, the initiative is evolving into a 'Participation and Sharing' project as it is now linked to the support projects such as helping the energy-poor and planting trees to stop desertification. In addition to the substantial effects of energy saving, the initiative is becoming a 'Participation and Sharing' project as it is now linked to the support of people living in energy-deficient areas and forestation efforts in deserts.

The SMG won the United Nations Public Service Award for this initiative in the 'Promotion of Citizen Participation' category.

The second most active local activity in Seoul is 'Promise of Seoul: Civic Action Team.' "The Seoul Commitment to Climate Change, Promise of Seoul" was created to promote the "Energy Saving City Seoul, Reducing 1 Ton of CO_2 per person" initiative. It was the city's policy goal that was announced by Mayor Park Won Soon to the entire world on the occasion of the ICLEI World Congress 2015 that

took place in Seoul. Under the goal of fulfilling the responsibilities of Seoul as a leading city in tackling environmental and climate change issues,, the initiative is the promise of the citizens to reduce 10 million tons of CO_2 by 2020. 'Civic Action Team' is organized to promote the initiative and operated at the district level. Team members receive green leader training in basic, intensive and professional levels. Afterward, they engage in a variety of activities. In May of 2016, the citywide Committee of Civic Action Teams was launched and held the opening ceremony where members shared information on their district-level activities and consolidated their commitment to the cause.

The third successful civic education in Seoul is 'Haero-Haeyo, a Movable Energy Playground.'

The movable energy playground refers to a renovated truck equipped with a PV power station as well as teaching materials. The movable playground visits schools and villages for young citizens to engage in various experiential programs and learn about the One Less Nuclear Power Plant Project while playing.

The playground features the 'Haero' and 'Haeyo' brother-sister characters that dream of running on carbon-zero solar energy. It also offers training through PV-powered visual education. Visitors can also experience making juice using a bicycle generator. To date, the movable energy playground initiative has provided energy education to more than 16,000 people in more than 100 schools (448 classes) and 50 communities.

Eco-mileage


Promise of Seoul, Civic Action Team


Movable Energy Playground

Education through Village Communities (Energy-independent Villages)

The SMG supports the voluntary activities of residents who are willing to create energy self-supporting villages, thereby helping to build a foundation that aims for long-term energy independence in communities. Launched in 2012 as part of the city's village community support project, the initiative designated and supported 55 energy independent villages, including apartment houses and single-family homes until 2016.

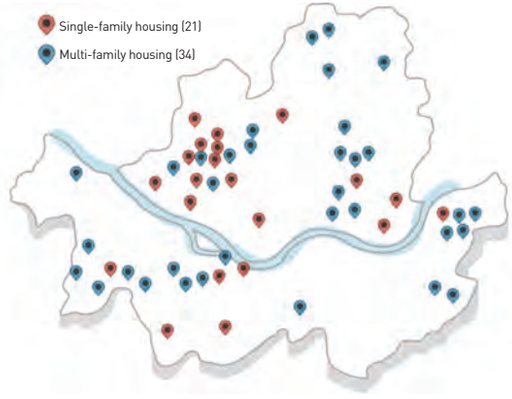
Based on the awareness of the problem of climate change and energy crisis, the participants of the initiative take the lead in energy saving and efficiency and increase the production of new and renewable energy to minimize the external energy demand and maximize their energy independence. It is one of the city's initiatives that backs up its One Less Nuclear Power Plant Initiative in the most effective way. Most notably, a village network is formed naturally through the process of setting up an organization at the community level and cooperating with administrative departments (district offices and resident centers), local companies, local schools, and civic organizations.

Over the span of the three years that the SMG provides support,

local residents organize, educate themselves, secure households that will lead energy conservation and practice, and hold various regional events. During that period, communities build up a basis for their energy independence.

Fifty-five energy self-reliant villages set goals customized for their households and housing structure. Through education and practice, they make improvements in various areas including energy, environment, child education and living conditions. In the process, the mega city is able to revive its weakened community spirit. Creating your own organization and working for tis leads to greater satisfaction than participating in a handful of education, practice or campaign opportunities. The energy independent village initiative is an ideal type of sustainable education striving for integration, inter-generational cooperation, and consideration for the future. The SMG plans to increase the number of energy independent communities from 55 to 100 by 2018.

[Figure 6] Map of Seoul Energy Independent Villages as of 2016



Network Construction and Activities related to Environmental Education

In recent years, environmental education-related organizations have formed consortiums to share relevant information, to exchange programs and human resources, and to create and promote joint programs.

In 2015, the Korean Network of Environmental Education Facilities (KEEF), a nationwide consortium of environmental education related exhibition halls, was launched. So far, 12 exhibition and education facilities have joined the consortium. As a national consultation body, the network carries out collaborative projects to exchange contents of each member organization and to enhance the effectiveness of their educational efforts. Excellent interactive programs are selected as joint commitments to be promoted nationwide. The network also contributes to improving the quality of educators through the exchange of lecturers among member organizations.

The environmental education groups and organizations located in the city of Seoul constitute the Seoul Environmental Education Network (SEEN) to enhance the effectiveness of the energy and environmental education that used to be promoted in dispersion and to provide more professional and systematic education. The SEEN routinely cooperates with the SMG to plan and implement the city's comprehensive environmental education plan and various events such as the Environmental Education Hanmadang, Earth Day, and civic education programs. It has become a good example of the SMG's governance, one of its key administrative directions.

Future Direction and Major Challenges

As pointed out at the beginning, the reality is that Korean citizens' environmental awareness and commitment to implement eco-friendly measures nationwide is relatively low compared to other countries more advanced in the environmental protection. Moreover, the central government still has little interest and willingness to engage in environmental policies, which makes the prospect dim for the overall social environment.

Yet, the SMG has raised questions proactively, coming up with advanced policies, gathering the wisdom of citizens and promoting the One Less Nuclear Power Plant Project successfully.

However, there remains a number of regarding citizen education and practice.

First of all, it is necessary to establish its own philosophy and concepts as to what the goal of 'Seoul-type' energy education should be. There is an important task at hand to grow into a city with advanced energy policies by overcoming high energy consumption, the SMG's conflict with central government policies, and the lack of cooperation from education authorities. The challenges may not be overcome in a year or two. Yet as it has done thus far, the SMG will have to lay the foundation and strive to solve the issues one by one. The SMG is expected to reach its goals in the not-so-distant future.

To that end, the city of Seoul may consider the following suggestions.

First, a 'Seoul Environmental Education Center' should be established to promote a comprehensive environmental education in the areas of energy and climate change. This is also something to be pursued by a comprehensive environmental education plan. Currently, the Seoul Energy Dream Center plays that role, but the investment for budget and manpower is called for more integrated and sustainable education.

Second, in order to revitalize environmental education at schools, energy and environmental education should be made mandatory from elementary to secondary levels in a systematic manner. For this purpose, environmental education specialists should be stationed at the Seoul Metropolitan Office of Education. This is a task that can be solved through cooperation between the SMG and the Office of Education.

Finally, substantial cooperation and mutual support with the 25 district offices in Seoul should be strengthened. However good a policy may be, its effectiveness would be compromised without cooperation from lower administrative units, such as dongs and gus.

Also, to take a step forward, a systematic process needs to be established to train leaders. At present, there are a lot of complaints from participants about the fact that there is no virtual difference among beginner, intermediate and advanced courses.

On top of that, each district office should set up a department or hire a specialist devoted to environmental education. A number of consultation meetings with officials in charge of environmental

education in district offices so far have indicated that the offices mostly do not have environmental education departments or specialists and even when they do, the specialists do not work exclusively on this.

In addition, the district offices do not feel strongly attracted to the environmental education contents and related policies proposed by the SMG. Beyond incentive schemes providing little motivation, the SMG needs to create conditions that encourage public servants to produce policies with creativity and enthusiasm and to promote them with local actors in a more enthusiastic way.

Conclusion

There is an old saying that goes, "If you want to go fast, go alone. If you want to go far, go together."

It means that the wisdom of many can result in greater achievements compared to that of a few outstanding individuals. It is never easy for a mega city with more than 10 million residents like Seoul to become energy-independent and expect its residents to adapt to eco-friendly lifestyles. However, our dream can come true because a collective wisdom may be sought from more people in Seoul.

I long for the day when a growing number of Seoul citizens who are considerate of, communicate and empathize with others will contribute to a green future - for Seoul, for Korea and for the world.

The beginning towards that journey looks very promising.

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Conclusion

Seoul's Sustainable Energy Action Planning:
Lesson for Cities

| John Byrne, Yun Sun-jin |

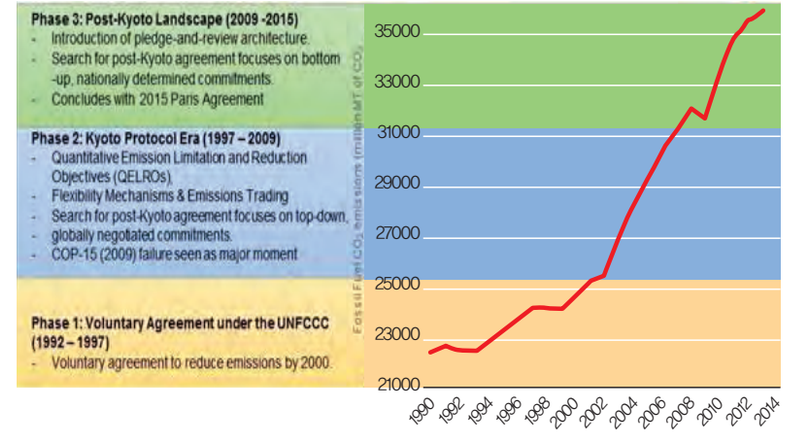
Seoul's Sustainable Energy Action Planning: Lesson for Cities

John Byrne and Yun Sun-Jin[1]

Despite 21 years of negotiations, parties to the UN Framework Convention on Climate Change (UNFCCC) have not found a path to sustained carbon reduction. This fact (depicted in Figure 1.) led to rethinking in Paris of the policy architecture guiding global efforts. The lifeworld is in critical danger due to our inaction.

1 Dr. Byrne is chairman of the Foundation for Renewable Energy and Environment (FREE) and distinguished professor of energy and climate policy, Center for Energy and Environmental Policy (CEEP), University of Delaware. Dr. Yun is professor of energy and environmental policy, in Seoul National University's Graduate School of Environmental Studies. The authors wish to thank Dr. Job Taminiau, research principal at FREE and Ph.D. candidates Jeongseok Seo and Joohee Lee (CEEP) for their significant research assistance in the preparation of this chapter.

[Figure 1] **Per capita CO_2 emissions under UNFCCC negotiations**



source: Boden & Marland (2016). Global CO_2 emissions from fossil-fuel burning, cement manufacture, and gas flaring: 1751-2013. Carbon Ditoxide Information Analysis Center (CDIAC)

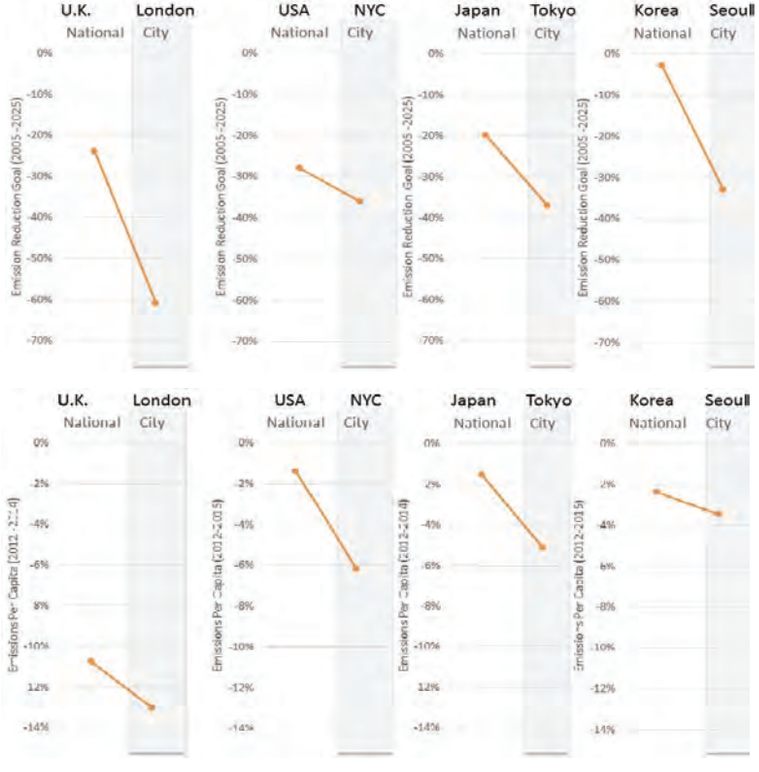
In the wake of the 21-year policy failure at the global level, a key decision was made in Paris to open policy thinking to include 'sub-national' parties as possible drivers for change (Byrne and Lund, 2016; and Taminiau and Byrne, 2015). In their ambition and performance, cities are proving that sub-national actors can surpass their national counterparts in actions to lower greenhouse gas emissions (see Figures 2a. and 2b.). This includes Seoul, which has a more aggressive plan to cut its greenhouse emissions faster and deeper than the national government; and its performance to date outpaces that of the national government.

The Seoul Sustainable Energy Action Plan initiative[2] exemplifies

2 Also known by its operational name, One Less Nuclear Power Plant (OLNPP).

the sort of sub-national leadership expected in the Paris Accords. The election of Mayor Park Won-soon to lead ICLEI — the world's largest consortium of local governments dedicated to environmental stewardship — confirms Seoul's rising international importance in climate-sensitive innovation. Its bold decarbonization policies deserve the international attention Seoul is now enjoying and (as we discuss below) the support of the city's citizens and businesses it has attracted.

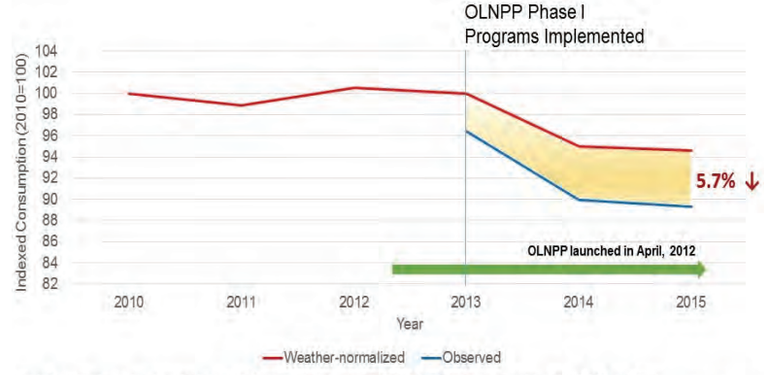
[Figures 2a and 2b] **Comparison of city and national plans and realizations to reduce CO_2 emissions.**



Source: Byrne, J. (2017). "Climate Policy without the US Government, presentation at the Global Leaders Forum, Johns Hopkins University, April 25, 2017.

Preliminary analysis by the authors suggests that the City of Seoul in just a few short years (2013-15) has reduced citywide consumption of electricity and natural gas by 5.7% (see Figure 3). By any measure, this is a significant achievement.

[Figure 3] **The OLNPP Effect**



Note: Regression analyses were run to predict LNG and electricity consumption over 2013-2015. The following equations are the results of the analyses:
- For electricity, $C_{electricity} = 293.0736 + 0.1295*HDD + 0.3282*CDD - 13.9232*D$ ($R^2 = 74\%$) where HDD and CDD are heating degree days and cooling degree days in Seoul and D represents a dummy variable when HDD>CDD is 1.
- For LNG, $C_{gas} = 164.36 + 0.86*HDD$ ($R^2=95\%$) where HDD is heating degree days in Seoul.

Data sources: Seoul Statistics, KOSIS, Korea City Gas Association

Source: Byrne (2016) Conference proceedings of the Seoul International Energy Conference 2016, Seoul City Hall, Seoul, November 1, 2016. Based on research carried out by Dr. Yun Sun-Jin (Seoul National University), Dr. Job Taminiau (Foundation for Renewable Energy and Environment) and PhD candidates Jeongseok Seo and Joohee Lee.

Seoul Metropolitan Government has established departmental responsibilities for the new thrust, set up an inter-departmental team to pursue integrated planning, and has launched the Seoul Energy Corporation — a government-owned entity to pursue clean energy opportunities in all end-use sectors with short- and long-term plans to build out the city's intended sustainable future. A three-year budget

(2014-16) of nearly 2.2 trillion KRW[3] (1.9 billion USD) has been dedicated to a suite of programs (SMG, 2014) that, by international standards, attract exceptionally high participation — over 1 million residents of the city have joined one or more programs (Byrne, 2016; and Lee et al, 2014). A recent survey found that 71% of citizens were familiar with OLNPP and 59% evaluated the city's efforts positively (SMG, 2014a).

To date, GHG emission reductions are roughly 8.2 million tons, or 0.2 tons lower per capita on average — in only 5 years of program implementation (OLNPP, 2017b). While much more is needed for Korea to climb down from its annual release of 11.8 tons of CO_2 per person (6th highest among OECD countries) to realize the equitable and sustainable per capita rate of 3.3 tons per person per year (OECD Data; Byrne et al, 1998).[4]

In addition to OLNPP's environmental impact, numerous economic benefits have been experienced by the city's citizens. Over 20,000 jobs have been created by OLNPP's programs, leading to a regional economic dividend of approximately 1.3 trillion KRW (1.1 billion USD – SMG, 2014b). It is little wonder that, to date, 11 cities in the c0ountry have sought SMG's assistance in setting up their own sustainable energy planning system (OLNPP, 2017c).

Notice should also be taken of the creative actions by Seoul Metropolitan Government (SMG) and its citizens and businesses.

3 This includes private investment attracted by the OLNPP programs of approximately 1.0 trillion KRW (nearly 900 million USD) (see Byrne, 2016).

4 Seoul's per capita emission is approximately 4.58 tons in 2013 (SMG, 2016), the result of the fact that most industry is located beyond the city's jurisdiction. If the OLNPP emission effect is allocated to Seoul alone, this represents a decline to about 3.78 tons.

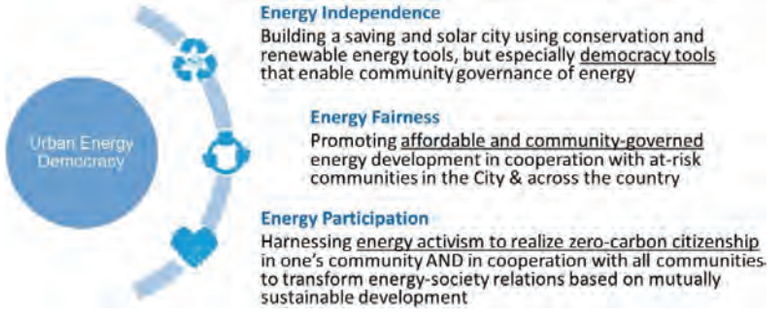
These include the creation of a Citizens' Energy Welfare Fund to ensure that the new energy-society relationship being built in the city is inclusive — sustainable energy for all (SE4ALL). The city's outreach to the business community through its unique ENURI program offers an interesting vehicle for cities to consider as they seek participation from this sector which can be critical to success in certain areas (SMG, Climate and Environment Division, 2017). And a very inventive effort has been made to learn directly from citizens and communities about the workings — good and not so good — of the OLNPP process. Vehicles like the Citizens' Congress, OLNPP Listening Workshops, and the establishment of the OLNPP Citizens Council — all are a testament to the vigorous engagement of Seoul's civil society underlying OLNPP.

There is a record of accomplishment and innovation to be found in the Seoul Sustainable Energy Action Plan process. The high level of transparency and community based governance has earned the initiative an enviable level of trust and attracted significant and ongoing participation among citizens and businesses.

Of course, challenges lie ahead. The City needs to find a way to more systematically invest in energy productivity of its built environment. Similarly, it needs to take advantage of Seoul's immense rooftop real estate (over 180 million m^2 — see Byrne et al, 2016) as the host for a transformative distributed solar power plant conservatively estimated to be able to satisfy 60% of the city's daylight electricity needs (Byrne, 2016). A vertical city surrounded by mountains on three sides must look within its boundary to find renewable energy opportunity.

Finally we offer thoughts on how the City might operationalize the three principles driving its idea of urban energy democracy: independence, fairness, and participation.

[Figure 4] Lessons from and for Seoul

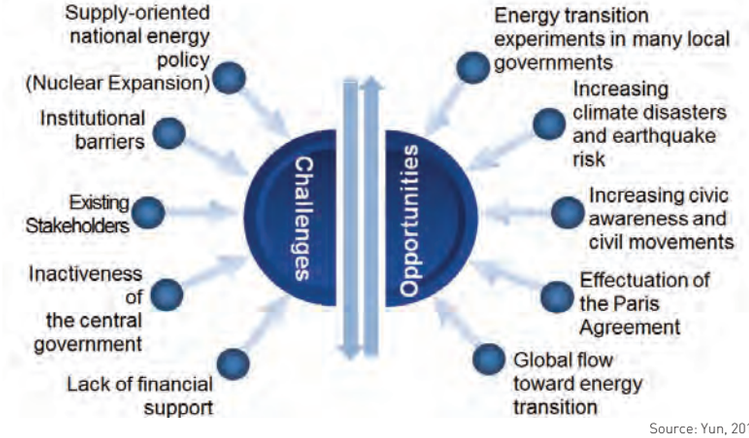


Source: Byrne, 2016. Conceptualization was a team effort of Dr. Yun Sun-Jin, Dr. Job Taminiau, and PhD candidates Jeongseok Seo and Joohee Lee.

The ambition of OLNPP is striking and the results to date are impressive. For exactly this reason, we think SMG just might be able to realize its distinctive philosophy of urban energy democracy. We hope our brief comments in Figure 4. prove modestly helpful as SMG tackles this very large task.

The target year of the second phase of the OLNPP is 2020. In order to achieve its goals, many challenges including supply-oriented national energy policy, institutional barriers against energy alternatives and a decentralized energy system, resistance from stakeholders supporting the existing conventional energy system, inactiveness of the central government, lack of financial support, and so on, need to be contested. However, there are opportunities which boost a more active approach to OLNPP. Those are energy transition experiments in many local governments in South Korea as well as international cities, increasing climate disasters and earthquake risk, increasing civic awareness and civil energy transition movements, global, national and local efforts to implement the Paris Agreement, the global shift to sustainable energy, and so on. If there are more concerned citizens and enterprises driven by continued successes of the OLNPP, the sustainable energy transition will gain momentum.

[Figure 5] Challenges to and Opportunities for Seoul's OLNPP



Source: Yun, 2017

The success of the OLNPP cannot be confined to the boundary of Seoul, domestically and internationally. If Seoul succeeds, large cities will have a means to live in the greenhouse and humanity may have a chance to end climate risk. We wish the City all the best.

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OLNPP

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