Final Report for APN LCI PROJECT
Project Reference Number: LCI2013-05CMY(R)-Jupesta

Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan

Low Carbon Initiatives Framework

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

The concept of "green growth" has been connected to the "green economy for sustainable development and poverty reduction", which is the first theme of the Rio+20. The Asia Pacific region, where the world's major population and economic growth is, can show the global impact of sustainable development, partly due to the fact that this region includes an advanced economy such as in Japan and key emerging economies such as China and Indonesia. The UN declared that half the population was living in cities in 2008 and that this percentage would increase to 60% by 2030. Thus the low carbon city is a starting point to make cities and human settlements inclusive, safe, resilient and sustainable; one of the 17 Sustainable Development Goals. Against this background, this project explored a new funding mechanism with engagement of many stakeholders' such as public private partnerships. This project also can be used as guidance on how cities in selected countries can play a key role in the green growth agenda, by stimulating growth through smart investment in urban infrastructure, i.e. by building a physical infrastructure, by financial and tax incentives, energy supply, and heightening society's awareness of a sustainable lifestyle.

Keywords: green investment, infrastructure, Japan, China, Indonesia

Objectives

To build a low carbon city, the following components must be incorporated:

1. Measures to reduce GHG emission such as energy efficiency and the provision for cleaner energy in energy mix in the master plan.
2. Measures that can generate economic benefits, income, and jobs in a low carbon city, by creating innovative systems of `non-fossil fuel energy based` society.
3. Provision of a financial scheme to attract investment; this financial institution should comply with other development institutions besides being able to reduce risks and lower barriers such as upfront cost and institutional regulations.

This study primarily looked at the role of a new business model to sustainably scale up infrastructure and raise the importance of local governance to facilitate low carbon city development through technology transfer and foreign investments, and innovative entrepreneurships. This study examined the problems, actors, institutions, networks and provides solutions (policy recommendation) to scale up the creation of low carbon cities. Since there is no one single solution to sustainability issues, the cities' problems and also the solutions can differ from those applicable to other cities due to geographic, economic, social, technical and political conditions. A lot of study has already been conducted in those cities. Most of those studies looked from the supply side to measure the technology to promote low carbon cities. In contrast to those studied, we tried to complement the previous studies by using an approach from the demand side. The goal was to scale up the upfront green investment to bring the highest multiple benefits that can be generated in human well-being indicators (social, economic, and environment). This study is not a long term assessment over multiple years, but provides basic guidelines for tailor made investment in low carbon cities; these guidelines might be adapted for other cities; e.g. how much investment is needed for the city of Jakarta for adopting prevention of air pollution by using catalytic converters in all vehicles. The return is not only clean air but also reduces the health cost due to a decrease of outdoor pollutants from vehicles. This leads the improvement of human well-being.

Amount received and number years supported

The Grant awarded to this project was:

US$ 45,000 for Year 1:

US$ 38,700 for Year 2:

Activity undertaken

This study was spanned two years and involved an assessment of the selected cities from the current state into the sustainable low carbon state. The first year has been spent on a preliminary study based on the researchers' expertise. The working package 1 was a conceptual framework and indicator development and was conducted to conceptualize the city from sustainable development perspectives. The institutional analysis is useful as an analytical framework to define the concept of a low carbon city based on human wellbeing and planet centered development. The parameters used in this study were based on human well-being indicators adopted from the UNEP Green Economy Concept, which includes well-being and social equity[1]. Well-being indicators refer to green jobs in a low carbon or in green industries which are understood as productive, secure, respecting labor rights, providing an adequate income, offer social protection and include social dialogues, union freedom, collective bargaining and participation. Social equity indicators refer to overall measure of human and social development such as poverty alleviation, equity, social inclusiveness and inclusive wealth. A sustainable city should develop not only for the rich, but also must serve the poor. In general, this indicator is connected to the Sustainable Development Goals in the Framework of the post 2015 Development Agenda. Working package 1 was led by Dr. Manu Mathai and has been supported by Kiki Kartikasari from Bogor Agriculture University.

The working package 2 utilized a cost-benefit assessment to measure the environmental impact of green investment, e.g.: energy efficiency in buildings, etc. The method of cost-benefit aims to measure the energy, cost and GHG emissions balances at city level and to identify in which sector the GHG emissions could be cut. The study has been conducted by using two case studies (i.e. Shanghai case and Jiangsu case) for analysis. The final result of this study has identified the opportunities for removing existing barriers. This working package has been led by Dr. Ping Jiang supported by Dr. Wan Xin Li.

The working package 3 was used to visit financial institutions and learn from new funding mechanisms under new business models (joint ventures, spin off, private public partnerships, etc.). The risk analysis has been conducted to create a new business model for green investment, which is needed to create green jobs. Green job creation was considered since cities can be seen as an opportunity for job creation. A risk analysis has been conducted to measure the impact of investment in a green infrastructure (e.g.: monorail for public transport in Jakarta, low carbon building in Shanghai and public space in Yokohama), to indicate the range of investment required and show how to leverage the funding resources by public private partnership. This working package was led by Ms. Wakiyama and was supported by Dr. Jupesta.

Working package 4 integrated a top down assessment method to measure the impact policy intervention for the new investment options on new patterns of production and consumption at city level. This top down model was created to examine a new policy intervention and its impact on an entire energy system. The integrated assessment analysis combined the socio-economic and environmental impact of green investment under different scenarios. This working package was led by Dr. Rizaldi supported by Dr. Gelang, Dr. Toni and Dr. Lukytawati. All these studies were led by people who previously have conducted similar studies and discussed those with all team members. The midyear result has been delivered at a public forum to discuss results and receive feedback. The final result has been reported at a policy workshop and involved policy makers and other stakeholders. The first year's result have been disseminated at meetings in the respective countries involving all stakeholders (academic, industries and policy makers). The final result of this study was to identify the opportunities for removing barriers.

[1] UNEP (2012), Measuring Progress toward an Inclusive Green Economy.

Results

In the first year, several workshops to discuss and engage stakeholder's participation have been held in Jakarta, Shanghai, Yokohama and Beijing. In the second year, three main results were presented at a session named "Foot printing and low carbon urban infrastructure development" at UGEC's 2nd conference on November 6th -8th 2014 in Taipei under the same name as the project: Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan. The speakers were Dr. Gelang Dewi from Indonesia, Dr. Ping Jiang from China and Ms. Wakiyama from Japan. Further, the conference papers together with other research outcomes related with this project already published as an edited book by Dr. Jupesta and Ms. Wakiyama by MacMillan publishers. The shorter version will be published as policy report. Apart from several peer reviewed papers, all the project outcomes will be published by December 2015 as a book by Palgrave Macmillan.

Relevance to the APN Goals, Science Agenda and to Policy Processes

The methodology used this project was intended to provide policy recommendations by making suggestion on the impact of policy intervention in terms of new mechanism in city infrastructure. This study did not look from one side only, but looked from both sides: bottom up by holding stakeholders interview in the first year and also top down by a policy modeling assessment in the second year. As mentioned in part one of the summary, the cities are responsible for 90% of global population growth, 80% of the wealth creation and 60-80% of the global energy consumption as well as global GHG emissions. A low carbon city might be an effective way to pursue sustainable development. Green industries, green jobs and green investment are key issues for the sustainable development to pursue environment protection without sacrificing economic development. Cities also have become one of seven critical issues in Rio+20 which need to be tackled to pursue sustainable development. In this study, we have involved different stakeholders (policy makers at national and city level, civil society and industries), since we proposed a bottom up governance approach. The stakeholders' dialogues have already been held in each country with support from local policy makers (city government). UNU-IAS has a well-established relationship with the Yokohama city government; similarly, the Indonesian and Chinese partners have a good relationship with Jakarta and Shanghai city governments. This study was a frontier study for Green Investment in the chosen cities. It was expected that this study gave a valuable contribution to policy makers due to its policy relevance and also would bring added value to other stakeholders' (community, industries and academics) on how to pursue Green Investment at city scale. We will use this two-year APN funded project to propose an advanced research project with funding from the respective countries /cities (China/Shanghai, Indonesia/Jakarta and Japan/Yokohama) and/or from other regional cooperation (e.g.: APEC, ASEAN, etc.).

Self-evaluation

We are very pleased that the project not only produced important research which may help policy makers to design cities to be inclusive and low carbon, but we have also fostered closer collaboration between partners. For example, Dr. Manu Mathai (UNU), an Indian national, has explores the institutional framework towards Low Carbon city for Jakarta. Hopefully, this experience is useful when he returns to his home country, India. Further, the young scientist Kiki Kartikasari has been actively involved which has resulted in a peer reviewed publication together with Dr. Mathai.

Potential for further work

We intend to continue this APN project by applying for two years project funded by the Toyota Foundation (2016-2018). This further project expected for the continuation of knowledge sharing between China, Japan and Indonesia researchers.

Publications (please write the complete citation)

List of Edited Book:
Jupesta, J., Wakiyama, T. (2015). Low Carbon Urban Infrastructure Investment in Asian Cities, Palgrave Macmillan Publisher.

List of book chapters:
Chapter 1. Introduction. **Joni Jupesta, Takako Wakiyama,** Ambiyah Abdullah
Chapter 2. Risk Analysis for Low Carbon City Development in Yokohama, **Takako Wakiyama,** Ambiyah Abdullah, **Joni Jupesta**
Chapter 3. Analysis on the Economic Policies to Promote the Development of Green Buildings in China**, Ping Jiang**, Xiao Hu, Jiajia Zheng, Yun Zhu, Xing Sun, Shuo Gao.
Chapter 4. Low Carbon City Scenario for DKI Jakarta Towards 2030**, Retno Gumilang Dewi,** Iwan Hendrawan, Ucok Siagian, **Rizaldi Boer, Lukytawati Anggraeni, Tony Bakhtiar**
Chapter 5. Assessment of the impacts of low carbon investment on renewable energy for development of low carbon future in Yokohama city, **Takako Wakiyama,** Ambiyah Abdullah, **Joni Jupesta**
Chapter 7. Conclusion. **Joni Jupesta** and **Takako Wakiyama**

List of Peer Reviewed Scientific Articles:
Mathai, M. V., & Kartikasari, K. (2015). Institutional Framework for Low-Carbon Urban Infrastructure Investment: Some Evidence and Lessons from DKI Jakarta, Indonesia. Journal of Comparative Asian Development, 0(0), 1–31. http://doi.org/10.1080/15339114.2015.1059056

Jiang P., Hu X.,Sun X., Gao., Zheng J., Zhu Y. (2015): Analysis of economic incentive policies in promoting the development of green buildings in China, Habitat International (under review).

List of Op-eds:
Jupesta J. (2015). Green investment in Asian cities: Lessons from the People's Republic of China, Indonesia, and Japan, ADBI Blog: http://www.asiapathways-adbi.org/2015/01/green-investment-in-asian-cities-lessons-from-the-peoples-republic-of-china-indonesia-and-japan/

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http://www.eastasiaforum.org/2013/12/14/illuminating-japans-energy-future/

Wakiyama T., Jupesta J. (2013)*:* Green Investment in Asian Cities, in Urbanization and Global Environment Changes (UGEC) Viewpoints Issue No.9 July 2013.
http://ugec.org/docs/ugec/viewpoints/Viewpoints9-July2013.pdf

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Joni Jupesta, Takako Wakiyama, Manu Verghese Mathai ,Ping Jiang, Wan Xin Li, Rizaldi Boer, Retno Dewi Gumilang, Toni Bakhtiar , Lukytawati Anggraeni (2015): Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan. APN Policy Brief, September 2015.

Joni Jupesta, Takako Wakiyama, Manu Verghese Mathai ,Ping Jiang, Wan Xin Li, Rizaldi Boer, Retno Dewi Gumilang, Toni Bakhtiar , Lukytawati Anggraeni, (2015): Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan. APN Science Bulletin, March 2015

Joni Jupesta, Takako Wakiyama, Manu Verghese Mathai ,Ping Jiang, Wan Xin Li, Rizaldi Boer, Retno Dewi Gumilang, Toni Bakhtiar , Lukytawati Anggraeni (2014): Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan. APN Science Bulletin, March 2014.

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TECHNICAL REPORT

Preface

This report is the product of a two-year APN project, *Low-Carbon Urban Infrastructure Investment in Asian Cities: Shanghai, Jakarta and Yokohama*, which explored a new funding mechanism for urban infrastructure investment that engages multiple stakeholders in public-private partnerships. The project involved several researchers from UNU-IAS, the Institute for Global Environmental Strategies (IGES), Fudan University (China) and Bogor Agriculture University (Indonesia). This report aims to showcase the role that cities can play in the green growth agenda by making smart urban infrastructure investments in low-carbon buildings and other types of physical infrastructure, by using financial incentives and taxes, by fostering renewable energy supplies and by raising societal awareness of sustainable lifestyles.

Table of Contents

1.0 Introduction

The concept of "green growth" is tied to the "green economy for sustainable development and poverty reduction", the first theme of the Rio+20 United Nations Conference on Sustainable Development (UNCSD). Furthermore, formulating strategies for making cities and human settlements inclusive, safe, resilient and sustainable has emerged as one of the 17 Sustainable Development Goals. To effectively achieve green growth, developing a low-carbon society should occur at multiple levels: international, regional, national and subnational. The Asia-Pacific region, the site of rapidly growing populations and economies, can show the global impact of sustainable development, partly because this region includes a key advanced economy, Japan, and two key emerging economies, China and Indonesia.

The UN concluded that 50% of the world's population lives in cities (2008) and that this percentage will increase to 60% by 2030. Furthermore, cities account for 90% of the population growth, 80% of the wealth creation and 60-80% of the energy consumption and GHG emissions across the globe. Thus, it would be most effective to begin building a low-carbon society by developing low-carbon cities. Across Asia, several approaches have previously been employed to develop low-carbon cities, particularly in the transportation, building and waste management sectors. Several cities in Japan, China and Indonesia have already invested in initiatives aimed at developing low-carbon/green cities. Cities require intensive urban infrastructure development to accommodate rapid and substantial growth. However, as a result of the financial constraints on local governments, funding urban infrastructure projects has become a critical issue. Plans to overcome these constraints may prove critical to achieving low-carbon development pathways.

Against this background, this report, which is based on the APN-funded project, explores a new funding mechanism that engages numerous stakeholders in public-private partnerships. The private and public sectors should work hand in hand to foster green investment. As economic and political power has shifted to cities and megacities, particularly in the Asia Pacific region, local economic development has been successfully employed in numerous cities as a strategy to address issues involving uneven growth and extreme poverty (SDSN, 2013). Cities also play a critical role in national growth and in generating environmental externalities. Cities account for 70% of all public direct investment and 50% of all public procurement. Moreover, cities offer economies of scale for measures designed to address climate change adaptation (OECD, 2014).

This research project uses explorative qualitative and quantitative approaches to define, measure and monitor green investment at the city scale in Jakarta, Yokohama and Shanghai and in certain slum areas in India. Several methods were applied in this study, including risk analysis, cost-benefit analysis, integrated assessment modelling, input-output analysis and comparative analysis.

Chapter 2 examines the effect of feed-in tariff (FIT) and other renewable energy investment policies; we examine variations in expected returns and risks under different FIT conditions. We also study investment returns and risks by examining net present value (NPV) and internal rate of return (IRR) measures using the discount cash flow (DCF) method. The DCF method is used as an investment analysis and evaluation model. NPV estimates future cash flows, and IRR can determine investment benefits by estimating the rate of operating revenues against investment. Larger revenues from business gains and faster returns from revenues result in higher IRR. In the case of solar photovoltaics (PV), IRR values that exceed 10% before tax and 7-8% after tax are preferred.

Chapter 3 presents a combined qualitative and quantitative analysis. The qualitative methods used in the study include literature and comparative analyses. Information was identified and collected, and the necessary comparisons were made by means of the literature review. First, main international green codes (i.e., LEED, BREEAM and CASBEE) are presented, China's Green Standards (i.e., the Evaluation Standards of Green Building) are introduced – and green building development trends in China are described – in the literature review. Research objectives, questions and frameworks are reasonably determined from the results of the literature analysis. The goal of employing quantitative methods is to quantify the incremental costs of green buildings and to compare the relation between subsidies and incremental costs. The incremental costs of green buildings per unit floor area can be calculated using the initial cost and unit floor area of a sample building.

The results presented in chapter 4 were generated from the ExSS (Extended Snap Shot) ExSS (Extended Snap Shot) nonlinear programming model, which uses the GAMS (General Algebraic Modeling System) v 23.3 that is supported by various technical, economic and social parameters (Dewi et al., 2010 and Dewi, 2012). The back-casting method was engaged first to determine a set of desirable goals and then to determine how to achieve these goals, which involved (i) setting a framework, including the base year (2005) and target year (2030), the environmental target, the target area, and the number of scenarios; (ii) describing and quantifying socioeconomic assumptions; (iii) exploring energy technologies to achieve low-carbon targets; (iv) estimating GHG emissions for the base and target years; and (v) analysing low-carbon measures that can achieve low-carbon city targets. The projection scenarios developed in this study include business as usual (BaU) and mitigation scenarios; BaU scenarios envision development paths and associated GHG emissions without considering mitigation efforts, whereas mitigation scenarios envision development paths to achieve low-carbon city targets.
Chapter 5 wrap three case into concluding remarks and way forward for relevancy of the research outcomes into global changes.

2.0 Japan Case: Yokohama city

In recent years, numerous cities have formulated climate change and low-carbon action plans and have increased their annual budgets to accommodate such plans that complement the increased funds provided by national and subnational governments at the prefecture and city levels. For instance, beginning in 2014, the regional green new deal fund (renewable energy installation promotion fund) was created at the prefecture and city levels to enhance the deployment of environmentally friendly technologies and projects, including renewable energy and energy-efficient technologies.

In the case of Yokohama, the size of the climate change action funds grew from 1.108 billion yen in 2008 to 5.111 billion yen in 2013 (MOEJ, 2014). Yokohama is a government ordinance–designed city with a population of 3.7 million and boasts the second largest urban population in Japan after Tokyo. This city has experienced trends involving population growth and increased total CO_2 emissions. Total CO_2 emissions generated from Yokohama in 2010 reached 18.841 million t-CO_2. Shares of total emissions by sector are as follows: energy conversion (18.8%), industry (14.8%), households (23.1%), commercial sector (19%), transportation (21.6%), and the waste sector (2.8%) (Figure 2.1). Household emissions represent the largest share among the other sectors and have a high rate of increasing CO_2 emissions. Household emission sources include electricity (60.7%) and city gas (26.8%). The commercial sector also shows the highest degree of basic year emissions rate increases among the sectors due to an expansion of total office building floor space (a 42.5% increase from 1990 levels), and 72.1% of all emissions are generated from electricity and 20.5% are generated from city gas sources. Yokohama has promoted renewable energy use to combat global warming and to achieve the targets set by the city government (City of Yokohama, 2011).

However, there are various challenges to increase the amount of renewable energy including installation barriers of renewable energies and risks for investments. The risks faced by electricity producers and investors in electricity market are price risk, technical risk, quantity risk, regulation risk and financial risk. Policy can control quantity risk, the price risk, and regulation risk. However, these risks could be mitigated by policies. For instance, price risk in the long term can be reduced, to some extent, by the introduction of FIT. In order to facilitate the dissemination of renewable energy, policy option such as tax deductions and financial support system is also necessary to make sure that invest return can be generated in the shorter period. Therefore, for the promotion of renewable energy supply, electricity market reform, innovative financing scheme and further low carbon policies play a key role to mitigate low carbon investment risks and make renewable energy investment more attractive to investors. In Japan, FIT was introduced in 2012 after the Fukushima nuclear accident to accelerate renewable energy. After FIT was introduced, the installed capacity of solar PV was increased up to 11.857 GW in 2 years from July 2012 to July 2014. This paper examines the risks and returns of renewable energy investment in Yokohama city.

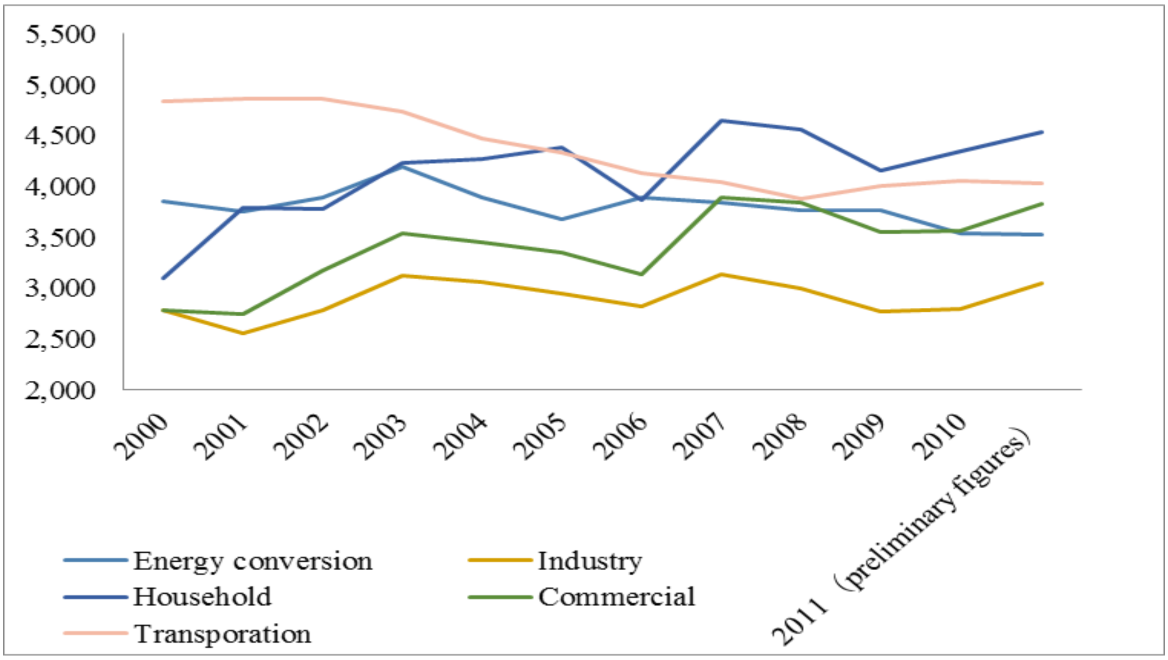


Figure 2.1. Yokohama total energy consumption levels

Source: City of Yokohama, Climate change policy headquarters[2]

2.1. Methodology

To analyse the effects of Feed in Tariff (FIT) and other policies on renewable energy investments, we examine the differences between expected returns and risks under various FIT conditions. The NPV can be used to estimate future cash flows, and the IRR can be used to determine investment benefits by estimating operating revenue rates against investments.

The NPV of the renewable energy project was determined as follows:

[2] http://www.city.yokohama.lg.jp/ondan/plan/ghgemissions/

$$NPV = \sum_{t=1}^{T} \frac{CF^t}{(1+i)^t} - I \text{............ (1)}$$

Where CF is the cash flow of solar PV and where I is investment, i is the interest rate and t is time.

However, IRR is calculated by determining the discount rate through which NPV becomes 0 (equation (2)). In other words, the interest rate return on investment is plus or minus 0. A comparison between the interest rate and the IRR of the discount rate can serve as an indicator of investment decisions.

$$NPV = I - \sum_{t=1}^{T} \frac{CF^t}{(1+irr)^t} = 0 \text{............ (2)}$$

Although NPV and IRR can be used to assess future investment returns, NPV calculations are designed to serve as projections of only one scenario and of one possible future expectation. However, in the business world, there are numerous components of future cash flow uncertainty. Thus, we use Monte Carlo discount cash flow simulations and estimate the stochastic distribution of NPV and IRR by assessing the uncertainty, risk and return levels of a project investment.

2.2 Results & Discussion

Household

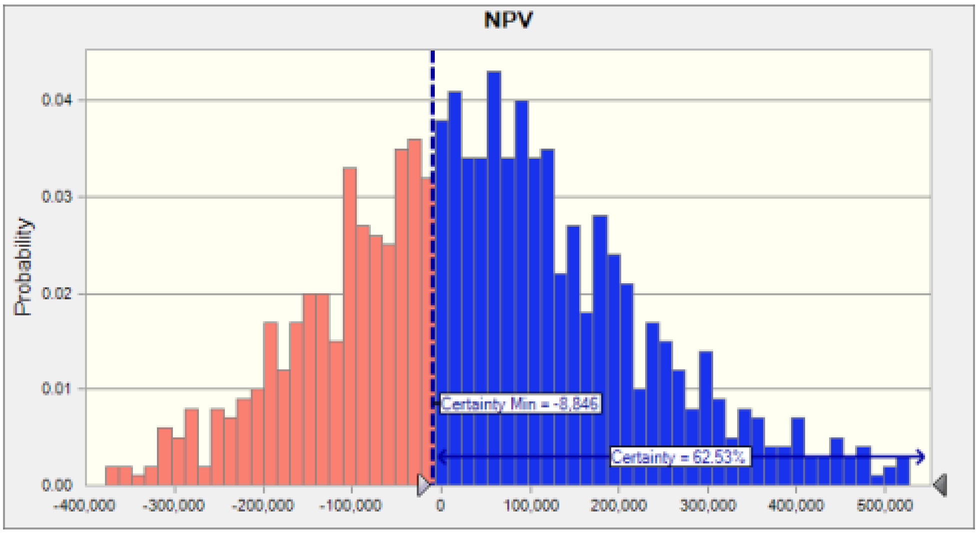
The analysis results show that to mitigate solar module investment costs while minimizing risk, a longer provision term of 20 years of fixed FIT prices proves effective. In the base case with a 20-year FIT cash flow calculation, cash returns will begin in August of 2027, 14 years from initial investment. Risk and return ranges can be generated from solar insolation rate probabilities in a range from 1.70 to 6.18 kw/m² with future electricity use and price changes. In addition, NPV and risk ranges are affected by the FIT fixed price. For a 2013 fixed FIT price of 38 yen/Kwh, the probability of achieving returns is 40%, which is more than 10% lower than the 2012 price of 42 yen/kWh fixed FIT rate (Table 2.1). Thus, to reduce risk and increase returns, there must be either solar PV construction cost reductions or the high fixed FIT rates must be maintained.

Table 2.1 Monte Carlo Simulation results: Household IRR and NPV forecast values

	Forecast values			
	38 yen/Kwh (2013)		42 yen/Kwh (2012)	
	IRR	NPV	IRR	NPV
Base Case	0.33%	187,027	0.33%	198,316
Mean	0.25%	5,664	0.27%	49,442
Median	0.25%	262	0.27%	41,471
Mode	---	---	0.20%	-108,629
Standard Deviation	0.07%	175,836	0.07%	170,740
Variance	0.00%	30,918,202,919	0.00%	29,152,279,231
Skewness	-0.0867	0.1895	0.0503	0.3641
Kurtosis	2.85	2.86	3.04	3.30
Coeff. of Variability	0.3004	31.04	0.2638	3.45
Minimum	0.02%	-460,845	0.06%	-377,833
Maximum	0.46%	613,071	0.51%	737,412
Range Width	0.44%	1,073,916	0.45%	1,115,244
Mean Std. Error	0.00%	5,560	0.00%	5,399

Source: Author

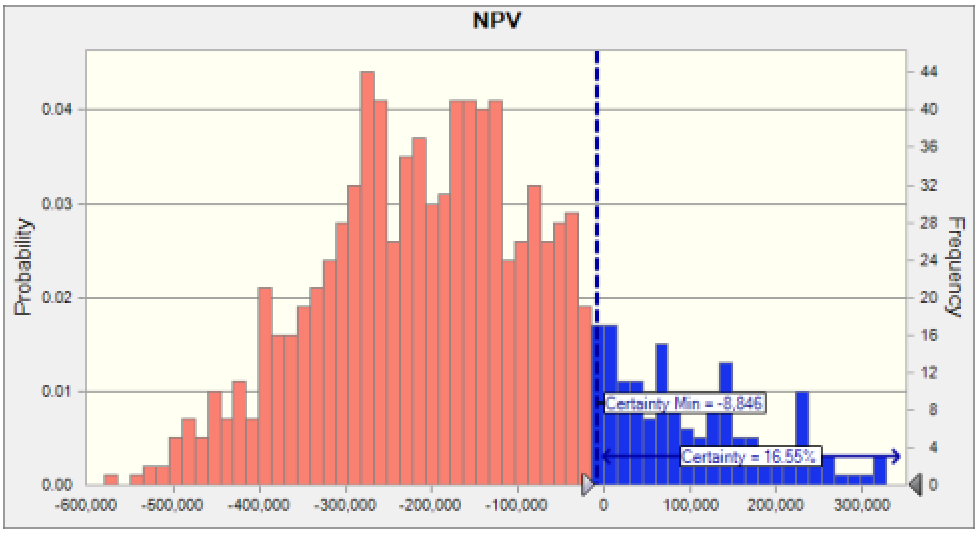
Figure 2.3. Household NPV distribution for FIT of 40 yen/kWh for a 20-year period



Source: Author

However, when the FIT mechanisms continue for only 10 years and the other 10 years do not include fixed FIT prices, the IRR is reduced to 0.31% in the base case. In the simulation analysis, the range of risks and potentials is 0.17% for the mean, -0.07% for the minimum and 0.48% for the maximum. As for NPV, a household can acquire 145,073 yen in profits over 20 years in the base case. Risks and returns range from -579,417 to 623,701, and the mean is recorded at -158,426 yen (Figure 2.3 and 2.4). Only a probability of 10% can generate returns. However, if a household continues to use solar PV for personal electricity purposes, investment gains will grow. Although profits may not be returned, there are benefits to reducing electricity fees for electricity usage and CO_2 emissions (the same effects found for the 20- and 10-year FIT scenarios). The accumulated CO_2 emissions for 4.62 KW of installed capacity over 20 years are expected in a range of 34,094 to 37,770 t-CO_2, and accumulated electricity fees decline over 20 years range from 1.929 million to 3.479 million yen by means of household FIT system installation.

Figure 2.4. Household NPV distribution with a FIT of 42 yen/kWh over 10 years



Source: Author

Commercial sector

The commercial cash flow analysis results show that the IRR base case for investing in 50 kW of solar PV falls below the 3% discount rate of 2.2% and 2.1% for both immediate and normal amortizations (Table 2.2). In the simulation, the IRR value exceeds the discount rate by more than 20% and by less than 20% in the cases of immediate amortization and normal amortization, respectively. In terms of NPV, immediate amortization ranges from roughly -6.36 million to 5 million and normal amortization ranges from -6.81 million to 4.24 million, although the base case presents a negative value (Figure 2.5). The probability of generating positive revenues over 20 years is 20% in the case of immediate amortization and 10% in the case of normal amortization. However, the tax policy effects differ across company financial conditions and cash flow balances. In addition, with 100% immediate amortization effects, initial year taxes can be reduced, and it is notable that amortization rates are zero after the initial year, thus increasing taxes.

We also analyse the impact of fixed FIT price changes. We compare the FIT prices of 40 yen/kWh, 36 yen/kWh and 32 yen/kWh for 2012, 2013 and 2014, respectively. The results show that IRR in the base case is reduced to 0.7% at the 36 yen/kWh FIT rate with normal amortization (2.1% for the 40 yen/kWh FIT rate). When the FIT rate is reduced to 32 yen/kWh, the IRR value is -0.8% in the base case. In the simulation, the IRR value exceeds 3% in 40 yen/kWh with more than 10% probability, but the probability value declines to less than 10% at 36 yen/kWh. Thus, FIT system installation and construction must be limited. For the NPV, although the 40 yen/kWh simulation ranges from (6,628,302) to 3,037,176 yen, this range is smaller under 36 yen/kWh, from (8,693,496) to 97,576 yen.

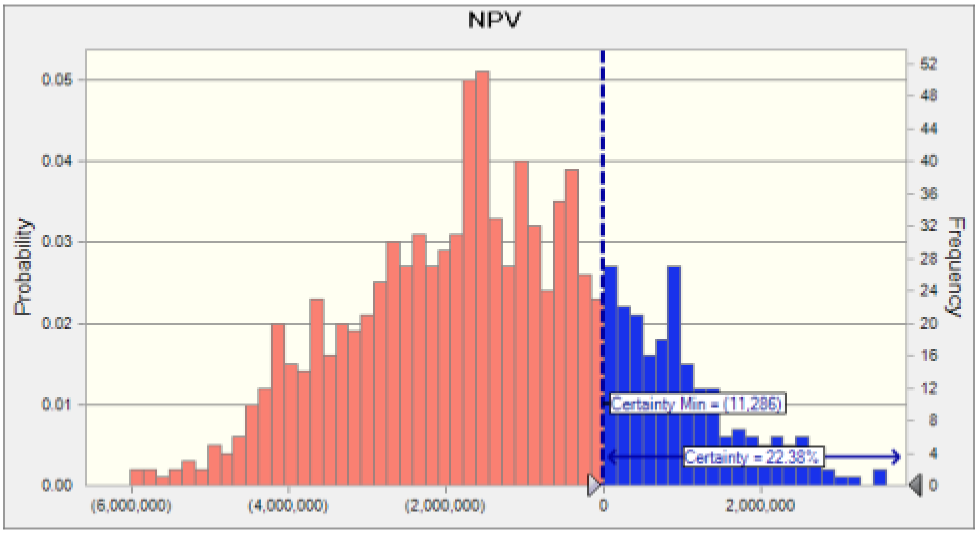
However, the economic and environmental effects of solar PV installation are considerable. Total electricity generation levels for a solar PV installed capacity of 50 kW range from 877,913 to 1,342,964 kWh over 20 years and can therefore offset electricity use. CO_2 reductions over 20 years can be achieved within a range of 407,351 to 623,135 t-CO_2.

Table 2.2 Monte Carlo Simulation results: IRR and NPV forecast values

	IRR		NPV	
	Immediate amortization	Normal amortization	Immediate amortization	Normal amortization
Certainty level	99.50%	99.10%	22.40%	19.00%
Certainty range	from 0.0% to +∞	from 0.0% to +∞	from (11,286) to +∞	from (98,353) to +∞
Entire range	from -0.5% to 5.3%	from -0.6% to 5.1%	from (6,364,099) to 5,059,357	from (6,813,591) to 4,243,291
Base Case	2.2%	2.1%	(1,571,330)	(1,854,628)
Mean	2.3%	2.1%	(1,374,009)	(1,675,100)
Median	2.3%	2.1%	(1,448,119)	(1,725,384)
Standard Deviation	0.9%	0.9%	1,770,053	1,685,965
Skewness	0.0354	-0.0099	0.0877	0.0646
Kurtosis	2.82	2.92	2.80	2.85
Coeff. of Variability	0.3952	0.4056	-1.29	-1.01
Minimum	-0.5%	-0.6%	(6,364,099)	(6,813,591)
Maximum	5.3%	5.1%	5,059,357	4,243,291
Range Width	5.8%	5.8%	11,423,456	11,056,883
Mean Std. Error	0.0%	0.0%	55,974	53,315

Source: Author

Figure 2.5. NPV distribution for 20-year immediate amortization for a FIT of 40 yen/kWh



Source: Author

Challenges

After the Fukushima earthquake, discussions of renewable energy sources emerged in Japan. The FIT system was implemented in July of 2012, and installed capacity levels of renewable energy have rapidly increased since that time, particularly in the case of non-residential solar power generation installation. However, total hydro, wind, solar and geothermal electricity generation levels reached only 0.097 trillion kWh[3] in 2014. The renewable energy ratio is at 10%, which is almost the same as 2010. In addition, the installed capacity acceleration rate declined in 2014 because of limitations in the current FIT system, electricity management issues and transmission and distribution network system maintenance challenges (METI, 2014). To further promote renewable energy installation while increasing the ratio of renewables in the electricity energy system, Japan must identify ways of mitigating risks resulting not only from prices and quantities but also from the FIT system and policy changes.

However, there are various challenges to promote renewable energy investment. These are rooted in emerging discussions on future electricity equilibria, on energy trade-offs between fossil fuel and nuclear and renewable energy sources and on prioritization concerns. In addition, solar power generation involves issues of voltage suppression. If individual electricity generation stations transmit higher voltage electricity than electricity companies, voltage levels across regions will increase and break down power conditioner functioning in a manner that reverses electricity flows. Addressing this connection problem would involve building additional infrastructure, such as output control systems, storage batteries and power grid enhancements, to avoid limiting renewable energy installation via connection capacities[4;5].

The Japanese FIT system shows that although policies such as FIT schemes can mitigate price risks, policy and regulation changes can increase renewable energy investment risks and the uncertainties and returns generated from renewable energy operations.

2. 3 Conclusions

This analysis shows that solar energy sources will enjoy an increase in the probability of returns over 20 years for both the household and commercial sectors, which will depend, however, on the rate of FIT schemes and on installation costs. If module prices are reduced to one-half of current levels, 97.64% profits and 2.48% risk reductions can be expected per household. For the commercial sector, in cases of normal amortization with FIT prices of 36 yen/kWh, the IRR value increases 11.2% in the base case, and according to the simulation analysis, even the minimum IRR value (7.6%) exceeds the 3% discount rate. With regard to NPV values, the base case is 9.217 million yen, and in the simulation, the range varies from 5.317 million to 14.319 million yen. With regard to the 10-year economic and environmental benefits of solar PV installation, 1,579 kg-CO_2/kWh may reduce CO_2 emissions by generating 4,237kW of household electric power.

The Yokohama case study results can be used to guide policies employed in other cities and countries. Risks and returns from renewable energy investments are heavily dependent on FIT rates, solar module prices and solar PV usage periods. If households continue to use solar PV for personal electricity use, investment gains will increase. Although profits may not return, there are benefits in

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[3] Calculated from electricity power generation statistics published by the Agency for Natural Resources.
[4] METI, Agency for Natural Resources and Energy, 2014. This is an operational review of feed-in tariffs that are designed to maximize the introduction of renewable energy (Japanese)
http://www.meti.go.jp/press/2014/12/20141218001/20141218001-B.pdf.
[5] METI 2015. METI promulgated a relevant notice to the ordinance to amend some of the renewable energy special measures and law enforcement regulations (Japanese).
http://www.enecho.meti.go.jp/category/saving_and_new/saiene/kaitori/dl/150122_press.pdf

terms of electricity fee reductions and declines in CO_2 emissions, which are the same as those found for both the 20- and 10-year FIT scenarios. For the commercial sector, in comparing tax policies, we found that tax policy effects depend on company financial conditions. Recently, although FIT rates have declined in Japan, total solar module costs have declined over a matter of years, which may shorten return periods while increasing renewable energy investment and operation returns. However, we are also aware of limitations within FIT systems, frameworks and policies (e.g., regulation changes). Although FIT schemes are believed to mitigate price risks while delivering on long-term government promises, when such beliefs are in question, policy changes to FIT systems may be used to adjust market conditions in a country.

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3.0 China Case: Shanghai city & Suzhou city

Green building promotion has become a major issue of building development in the context of low-carbon sustainability since the 1990s. In recent years, various countries have formed their own green building assessment systems for supporting green building development based on local realities. The "Evaluation Standards of Green Building" (hereafter referred to as "the Green Standards") went into force in China in 2006 (Ministry of Construction of China, 2006), which indicates that China has taken formal steps to promote green building development.

Two main types of buildings (i.e., residential and public buildings) are addressed under the Green Standard. The Green Standard present the following six measures for assessing standards under its evaluation system: land saving, outdoor environments, energy saving and energy performance, water saving and utilization, material saving and utilization, and indoor environment quality and operations management. Each category includes various items. A total of 40 items are allocated to resident buildings, and 43 are dedicated to public buildings. Green buildings are divided into three levels/grades (i.e., one-, two- and three-star) based on the number of standard items met. Tables 3 and 4 provide information on residential and public building evaluation standards presented in the Green Standards (Ministry of Construction of China, 2006).

Table 3.1 General Green Standard's requirements for residential buildings

	General requirements (40 items)					
Level/ Grade	Land-saving and outdoor environments	Energy saving and utilization	Water saving and utilization	Material saving and utilization	Indoor environmental quality	Operations management
★	4	2	3	3	2	5
★★	6	3	4	4	3	6
★★★	7	4	6	5	4	7

Table 3.2 General Green Standard's requirements for public buildings

Level/ Grade	**General requirements (43 items)**					
	Land-saving and outdoor environment	Energy saving and utilization	Water saving and utilization	Material saving and utilization	Indoor environmental quality	Operations management
★	3	5	2	2	2	3
★★	5	6	3	3	4	4
★★★	7	8	4	4	6	6

When residential or public buildings meet the standards presented in the tables above, green building labels/certificates can be issued. Green labels include one green label/certificate for the design stage and another green label/certificate for the operational stage (Fig. 3.1). The green design label is awarded for the completed design of a project that meets the standards, and the green operations label is awarded for a project that meets the standards after at least one year of operation.

(a) Three-star green label for the operation stage (b) Three-star green label for the design stage

Fig. 3. 1 Three-star green labels for buildings in China

Furthermore, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development of China (MOHURD) jointly presented the "Action on Accelerating the Implementation of the Development of Green Building in China (hereinafter referred to as "the Action")" in 2012 (Ministry of Finance and the Ministry of Housing and Urban-Rural Development, 2013). The Action states that economic incentive policies, standards and evaluation systems improvements, and technological development processes should be addressed when promoting green building development in China. The Action requires that all new public buildings receiving government investments (at any level) must meet the Green Standards after 2014. The Action also presents a plan for creating 1 billion m^2 of new green building space in 2015 and for increasing the green building share to 30% of all new buildings by 2020. By December 31, 2013, 1,446 buildings were officially identified as green buildings (both green design and green operations), and the total green building area covered 162.7 million m^2. Among these buildings, 1,342 cover an area of 150 million m^2, and 92.8% of all green buildings were certified as green buildings at the design stage. A total of 104 buildings covering an area of 12.8 million m^2 (representing 7.2% of all green buildings) were awarded green labels at the operation stage.

A subsidy scheme is also set in place under the Action, which only awards subsidies to green operation buildings. The average subsidy awarded by the central government is 45 yuan[6]/m^2 for

[6] The reference exchange rate between yuan (i.e. CNY) and USD is: 6.27 yuan =1 USD.

two-star green buildings and 80 yuan/m^2 for three-star green buildings in China. In addition to the central government's subsidy scheme, local governments also sometimes issue their own subsidy schemes to promote the development of local green buildings (Table 3.3).

Table 3.3 Subsidy schemes of five provinces and cities in China for green buildings.

City/Province	Subsidy scheme
Shanghai	Average 60 yuan/m^2 for two- and three-star green buildings. Maximum of six million yuan for a single project.
Tianjin	Maximum of 10% of project investment for the green building subsidy.
Xi'an	5 yuan/m^2 for one-star green buildings, 10 yuan/m^2 for two-star green buildings and 20 yuan/m^2 for three-star green buildings.
Shandong	15 yuan/m^2 for one-star green buildings, 30 yuan/m2 for two-star green buildings and 50 yuan/m^2 for three-star green buildings.
Jiangsu	15 yuan/m^2 for one-star green buildings, 25 yuan/m^2 for two-star green buildings and 35 yuan/m^2 for three-star green buildings.

Under current policies covering green buildings, including economic policies, green building quantities and areas have increased significantly since 2008 (Fig. 2). By the end of 2013, 704 projects had been awarded green building certificates, and the total green building floor area covered 86.9 million m^2. There are 648 green building projects (79.3 million m^2) at the design stage and 56 green building projects (7.6 million m^2) at the operation stage. Compared to 2012 levels, the number of green buildings increased by 81.0%, and the total floor area increased by 112.3%. The number of one-star green buildings increased by 90.1%, and the corresponding floor area increased by 143.2%. The number of two-star green buildings increased by 115.6%, and the corresponding floor area increased by 121.4%. The number of three-star green buildings increased by 10.6%, and the corresponding floor area increased by 19.4% (The Eleventh Session of the China, 2014).

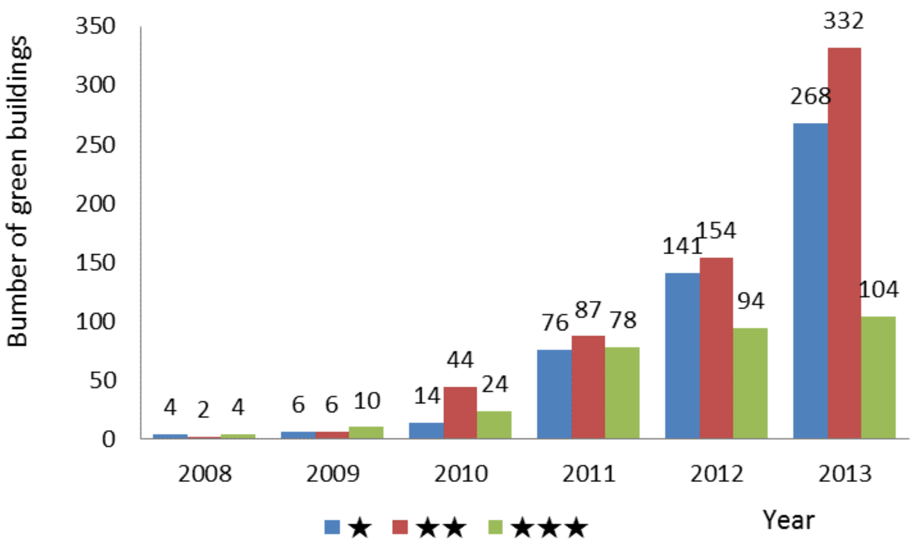

Fig. 3. 2 Numbers of green buildings in China between 2008 and 2013

Of the 704 green buildings identified, 61 were approved by the Science and Technology Promotion Centre of the Ministry of Housing and Urban-Rural Development. A total of 180 green buildings were approved by the City Science Studies of China. The remaining 463 green buildings were approved by local authorities. Green buildings have been built in 28 provinces and cities throughout China since 2008 (Fig. 3.3) (Chinese Construction News and Tianjin Daily, 2013).

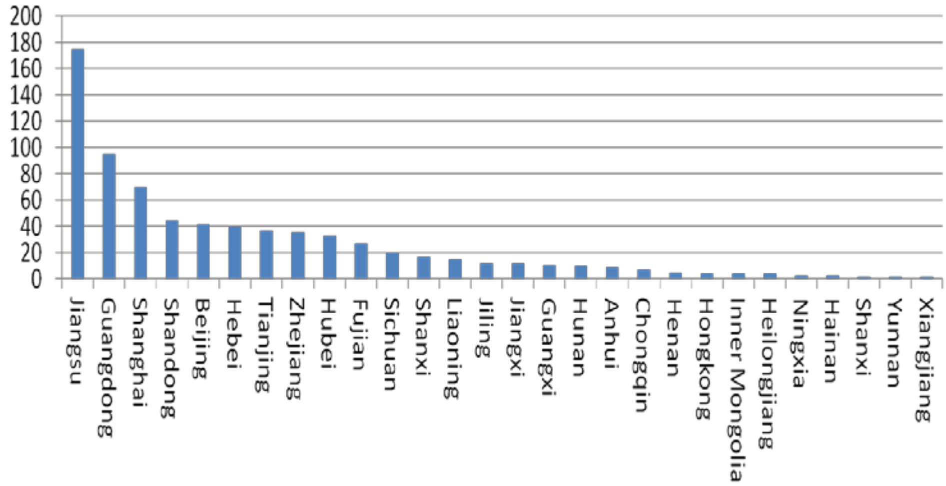

Fig. 3. 3 Number of green buildings in 28 Chinese provinces and cities from 2008-2013

However, this expansion of new green buildings represents a much smaller trend compared to recent overall building sector growth trends in China. For instance, the total new constructed building area was 3,892 million m^2 in 2003, but the total constructed green building area (including all one-, two- and three-star green buildings) covered 83 million m^2, accounting for only 2% of the total building area in 2003 (National Bureau of Statistics of China, 2014; The Eleventh Session of the China, 2014). This paper seeks to answer the following questions: What led to the current green building situation? What barriers and problems are there in green building development? How can solutions be worked out to overcome these barriers? Our research methods are designed to answer these questions.

3.1 Methodology

In comparison to “normal” buildings, green buildings can maximize resource conservation (e.g., savings on energy, water, and materials), facilitate environmental protection and reduce pollution while also ensuring the healthful, comfortable and efficient use of space for occupants over the entire building life cycle (Chinese Construction Ministry, 2006). Green buildings have thus had a positive external impact by reducing energy consumption and water use levels, reducing pollution levels, and by improving indoor and outdoor environments at different life cycle stages (Liu, 2006). Green building construction and operation costs, which are mainly borne by developers, are typically higher than those of other buildings because of the nature of positive external benefits. However, most external benefits are enjoyed by occupants, not by developers. In turn, developers are presented with few incentives to develop green buildings. To address this situation, policies such as subsidies, tax exemptions and other economic incentives should be designed and implemented to comprehensively support green building design, planning, land use, material development, construction, operation, maintenance, renovation and demolition over the life cycle.

A total of 104 green buildings are selected as research samples in this study to explore the economic incentives for green building development in China. The cities of Suzhou and Shanghai are used as case studies for assessing local economic policies. In particular, data from the following sources are used: the Chinese Society for Urban Studies (CSUA), the China Green Building Council (CHINAGBC), and the China Association of Building Energy Efficiency (CABEE). The 104 samples are located in 22 Chinese provinces and cities. The data also include information on building names, building types, identified green star features, floor areas, initial investment costs and operational cost savings.

We conduct both qualitative and quantitative analyses. The qualitative method employed in the study involves a literature review and comparative analysis. Information collection, identification and comparisons are conducted by means of a literature review. First, major international green codes (i.e., LEED, BREEAM and CASBEE) are presented, China's Green Standards (i.e., the Evaluation Standards of Green Building) are introduced, and green building development conditions in China are described in the literature review. Our research objectives, questions and framework are formed based on the literature analysis.

The quantitative method is designed to quantify the incremental cost of green buildings and to also compare the relationship between subsidies and incremental costs. Green building incremental costs per unit of floor area can be determined from the initial cost and floor areas of the sample buildings. The equation used is:

$$Ci = Co/S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Where Ci is incremental cost (yuan/m^2), Co is the initial cost (yuan), and S is the floor area (m^2).

The total green building subsidy for the two case studies (i.e., Suzhou and Shanghai) is calculated using the equation below:

$$St = Sc + S_L \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Where St is the total subsidy (yuan), Sc is the central government subsidy (yuan), and S_L is the local government subsidy (yuan).

For Suzhou, the local subsidy is the sum of subsidies from the Jiangshu provincial government and Suzhou municipal government. For Shanghai, the local subsidy is equal to the municipal government subsidy. To further identify differences between two- and three-star green buildings, the quantitative analysis also examines reasons behind differences in the quantity of design- and operation-stage green buildings within the sample.

3.2 Results & Discussion

To promote energy conservation and green building development, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development issued a policy entitled the "Action of Accelerating the Development of Green Building in China" in 2012 (Wang, 2013), which provides subsidies for two- and three-star green buildings in the Chinese building sector. The following subsidy scheme is employed: 45 yuan/m^2 for two-star green buildings and 80 yuan/m^2 for three-star green buildings (MOHURD, 2013).

Using Equation (1) and data for the 104 sample buildings, the average incremental costs for green public and residential buildings are presented in Table 3.4.

Table 3.4 Average incremental costs of green buildings in China

Building type	Green building level	Average incremental cost (Unit: yuan/m²)
Public	One-star	25.32
Public	Two-star	82.71
Public	Three-star	337.69
Residential	One-star	42.85
Residential	Two-star	103.03
Residential	Three-star	110.91
Average incremental cost of two-star green buildings		93
Average incremental cost of two-star green buildings		224

According to the Action, average national subsides for green buildings are established as follows: 45 yuan/m^2 for two-star green buildings and 80 yuan/m^2 for three-star green buildings. Based on the study results, actual incremental costs in China are 93 yuan/m^2 for two-star green buildings and 224 yuan/m^2 for three-star green buildings. Clearly, central government subsidies (i.e., Ministry of Finance and the Ministry of Housing and Urban-Rural Development of China) do not cover real incremental costs. Instead, current national subsidies cannot effectively encourage and support green building development in China. In addition to the national subsidy scheme, local governments issue and implement subsidy schemes in cities and provinces. The total subsidies for green buildings are required to integrate national and local government subsidies. To further evaluate local green building economic incentive policies, we present two case studies and a corresponding analysis.

Following the Action, a series of local economic incentive policies were issued by local provincial and city governments in 2012. Subsidies under local policies differ based on local climatic conditions and economic development patterns in provinces and cities.

Based on the quantity of green buildings in different cities among the 104 sampled buildings, Suzhou and Shanghai are ranked first and second, respectively, insofar as having the largest number of identified green buildings is concerned. Therefore, two cities are examined as case studies for exploring subsidy schemes of green building development at the local level.

Case 1: Suzhou

Jianshu province, where Suzhou is located, issued the “Building Energy Management Measures of Jiangsu Province". The policy outlines the following subsidy standards for green buildings: 15 yuan/m^2 for one-star green buildings, 25 yuan/m^2 for two-star green buildings and 35 yuan/m^2 for three-star green buildings in Jiangsu province (Feng, 2013). At the same time, Suzhou established its own municipal subsidy procedure entitled the “Green Building Implementation Plan”. Under this plan, the following subsidy procedure is employed: 15 yuan/m^2 for two-star green residential buildings, 25 yuan/m^2 for two-star green public buildings, 35 yuan/m^2 for three-star green residential buildings and 50 yuan/m^2 for three-star green public buildings.

The total subsidy for green buildings in Suzhou is thus equal to the total subsidy amount from the central, Jiangsu provincial and Suzhou municipal governments. Moreover, total subsidies for green buildings in Suzhou are determined using Equation (2): 95 yuan/m^2 for two-star green buildings (i.e., 45 + 25 + 25 =95 yuan/m^2) and 140 yuan/m^2 for three-star green buildings (i.e., 80 + 35 + 25 = 140 yuan/m^2).

Based on the results of Equation (1), real incremental costs of green buildings in Suzhou are: 41 yuan/m^2 for two-star green buildings and 246 yuan/m^2 for three-star green buildings. The total subsidy (i.e., 95 yuan/m^2) covers the incremental cost of two-star green buildings. However, the total subsidy (i.e., 140 yuan/m^2) does not cover the incremental cost of three-star green buildings.

Case 2: Shanghai

Shanghai was the first Chinese city to implement the Green Standards. The country's first green building label was awarded to a Shanghai building in 2008. A total of 94 green building labels were issued between 2008 and 2013. According to the Shanghai municipal government's policy titled "Supporting the Building Energy-saving Projects in Shanghai", subsidies for both two- and three-star green buildings amount to 60 yuan/m^2 (Liu, 2006). After adding central government subsidies using Equation (2), the total subsidy amounts to 105 yuan/m^2 for two-star green buildings (45 + 60 = 105 yuan/m^2) and 140 yuan/m^2 for three-star green buildings (80 + 60 = 140 yuan/m^2).

Based on the results of Equation (1), real incremental costs of green buildings in Shanghai are: 41 yuan/m^2 for two-star green buildings and 381 yuan/m^2 for three-star green buildings. Therefore, as in Suzhou, the total subsidy (i.e., 105 yuan/m^2) covers the incremental cost of two-star green buildings, but the total subsidy (i.e.140 yuan/m^2) does not cover the incremental cost of three-star green buildings.

A comparison between subsidies and incremental costs for the two cities is presented in Fig. 3.4.

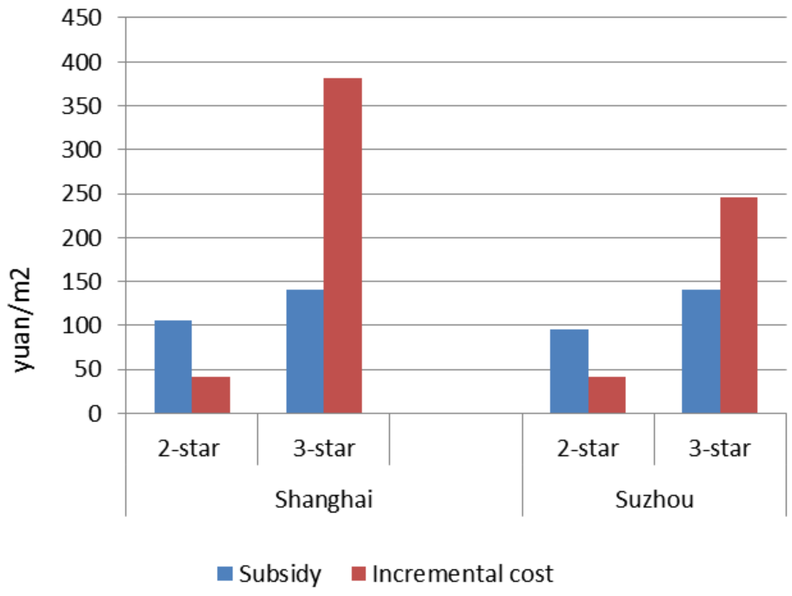

Fig. 3. 4. Subsidies and incremental costs of green buildings in Shanghai and Suzhou

3.3 Conclusions

China is the largest energy consumer and emitter of carbon emissions in the world. The building sector is one of the most energy-intensive sectors in China. Energy conservation and environmental protection have been become central priorities of the national sustainable development strategy, and green building promotion constitutes a key task as part of this strategy.

Green buildings have had positive external benefits (e.g., energy and water saving, pollution reduction, indoor and outdoor environmental improvements) over their life cycles. However, building developers cannot enjoy all the potential external benefits and must bear incremental costs. This form of market failure must be mitigated, mainly through economic policies. Subsidies have formed an integral part of Chinese central and local government strategies to promote green building development. In this study, 104 green buildings in 28 provinces and cities are used as research samples to explore the incremental costs of green buildings and for drawing comparisons between current subsidies. In conducting an additional analysis at the local level, Shanghai and Suzhou are taken as case studies. From the study results, we find that total subsidies in Shanghai and Suzhou are sufficient for two-star green buildings, but are insufficient to encourage the development of three-star green buildings at both the national and local levels, which suggests that it would be costly for developers to build three-star green buildings, but that it would be profitable for them to build two-star green buildings.

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4. Indonesia Case

DKI Jakarta, the capital city of Indonesia, is one of megacities in the world with 10 million population living in 662 km^2 of land area and 6,977 km^2 of sea area [Widodo, 2013]. The city is a coastal city (± 40% of land area is bleow sea level), located in a tropic region with dry and rainy seasons. Several rivers flowed accross the city, combined with low topography make Jakarta prone to flooding from swollen rivers in the wet season and high sea tides. In addition, lack of water level control infrastructure, deforestation in surrounding area of DKI Jakarta, and complex socio-economic problems indirectly contribute to triggering a flood event. This situation makes the city vurnerable to the impact of climate change, especially the rise of sea level and rainfall intensity. The term 'city' is used to represent Province of DKI Jakarta.

The population of this city grew 1%/year during 2005-2010. Economically, the city contribute significantly to national economy; with the GDP around 396 trillion rupiah (at constant price 2000) in 2010, DKI Jakarta acounts to 17% national GDP. The GDP grew 6.5%/year during 2005-2010. The main contributor of the city's GDP is tertiary industry/commercial (73%) and secondary industry or manufacturing (15%) [Widodo, 2013]. The city is caracterized as having high motorized vehicle (cars and motorcycles) density, limmited public transport infrastructure. Population growth, economic charactristics, and transportation condition lead to the high GHG emission level, i.e. 3.84 ton CO_2e per capita (2005), of which energy sector accounted for 89% of total GHG emission. As comparison, at the same year, national GHG emission is 3.01 ton CO_2e per capita. [RAD GRK DKI Jakarta, 2012]

This report presents results of a modeling study concerning Low Carbon City Scenario for DKI Jakarta Towards 2030. The study aims to identify development paths that will bring DKI Jakarta becomes Low Carbon City in 2030. Since energy sector accounts for 89% of total GHG emission of DKI Jakarta, the study focusses in energy sector. Particular emphasise is to be given to the selection of energy technologies that are aplicable for achieveing Low Carbon City. The results of the study may be used as the infomartion base of DKI Jakarta in preparing its development strategies, policies, and plans

4.1 Methodology

The tool used in this research is non-linear programming model ExSS (Extended Snap Shot) using GAMS (General Algebraic Modeling System) v 23.3 supported by various technical, economic and social parameters (Dewi et al., 2010 and Dewi, 2012).

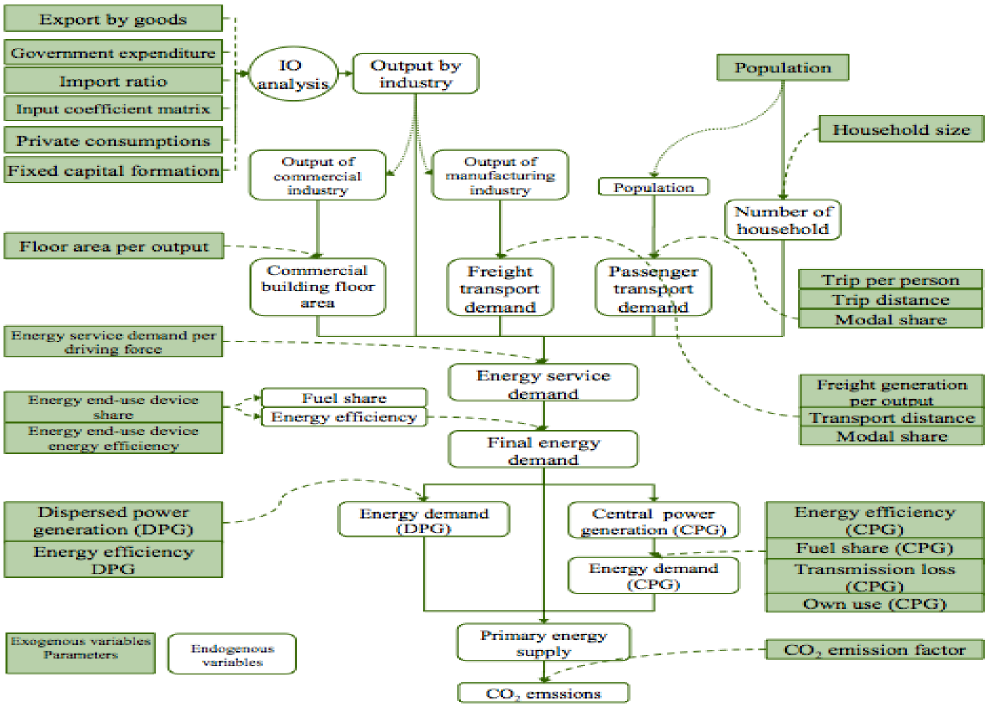

Figure 4.1 Overview of calculation system of Extended Snapshot Tool (Dewi et al., 2010)

The method based on back casting approach is developed with sets of desirable goal first and then seek the way to achieve it, namely (i) setting of framework: base year (2005) and target year (2030), environmental target, target area, and number of scenarios; (ii) describing and quantifying of socio economic assumptions, (iii) exploring energy technologies for low carbon measures; (iv) estimating the GHG emission in the base year and target year; and (v) analyzing low carbon measures that can achieve low carbon city target. Projection scenarios developed in this study are business as usual (BaU) and mitigation scenarios. The BaU scenario envisions development paths and the associated GHG emission without considering mitigation efforts. The mitigation scenario is developed to envision the development paths to achieve low carbon city.

During the last decade, the city's population grew 1% p.a and the ecnomy grew 6.5% p.a., therefore, projection (2005-2030) uses assumption that the population will continue to grow at the same rate (1% p.a) and the ecnomy will grow at slightly higher rate (7% p.a). Figure 2 presents population by age group and GPD output in 2005 and 2030. It can be seen in the figure, the main contributor of the city's economy is tertiary industry (commercial) followed by secondary industry (manufacture). Commercial sector will growth at faster rate compare to other sectors and therefore the share of this sector increases from 66% (2005) to 71% (2030). Although this sector has high share in GDP output, the energy intensity of commercial sector is lower than other sectors. Therefore, the increasing final energy demand of commercial sector is assumed not as high as other sector.

Projection for both BaU and mitigation scenarios use the same socio economic indicator assumptions. All assumptions of socio economic indicator used in this study is summarized in Table 4.1. As can be seen in the table, the city's population increases 1.3 times, GDP increases 5 times, passenger transport demand increases 3.9 times, and freight-transport demand increases 3.8 times. All of these parameters are eventually will affect the projection of energy demand and the associated GHG emission.

Table 4.1 Socio-economic variable (input parameters to ExSS Modeling)

Socio Economic Parameter	**Base year 2005**	**Target year 2030**	**Ratio 2030/2005**
Population, Million	8.9	11.4	1.3
Number of household, Million	2.2	2.85	1.3
GDP (at constant price 2000), trillion IDR	474	2,347	5
GDP per capita, million IDR	53	206	3.9
Gross output, trillion IDR			
- Primary	5.2	18.8	3.6
- Secondary	305	1,250	4.1
- Tertiary (commercial/floor area)	594	3,367	5.3
Passenger-transport demand, billion psg. km	49	192	3.9
Freight-transport demand, billion ton km	15.8	61	3.8

In this study, the mitigation scenario is limited to energy technology options that can achieve Low Carbon City. Other options that can lead to the GHG emission reduction, such as change of lifestyle, are not considered in this study. In developing these energy technology options, the author uses mitigation options in RAD GRK of DKI Jakarta as reference. The options are limited to the GHG emission reduction from energy consuming activities, i.e. transportation, industrial, commercial and residential sectors.

4.2 Results & Discussion

Energy demand of DKI Jakarta increases significantly, particularly due to increasing activity in transportation and industry. The final energy consumption in 2005 is 6.67 MToe (5.5% of total energy consumption of Indonesia). Future energy of the city depends on population growth, economic development, transport demand generation, and energy technology mix that will be deployed in the future. The energy supply corresponds to future energy demand and decision of energy mix and technology to supply future energy demand. The level of future GHG emissions is determined by the magnitude of energy activities (both in demand side and supply side) and technology mix used in energy activities. The ExSS modeling simulation showing snapshots of population, GDP, energy demand, and GHG for base and target year is presented in Figure 4.2 and Table 4. 2. The snapshots of parameters in Figure 3 are presented as ratio of its future values (2030) as compared to the level of base year (2005).

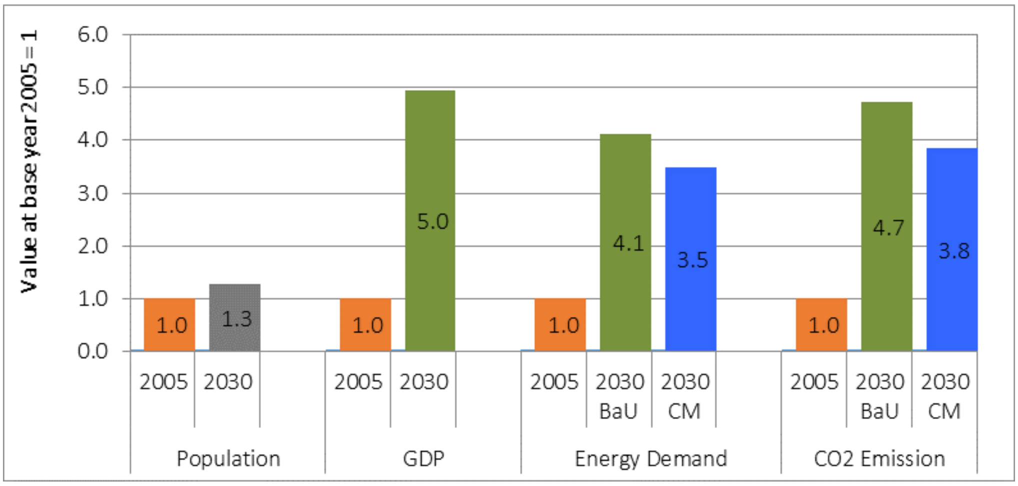

Figure 4.2 Future value of Population, GDP, Energy, and CO_2 emission

Table 4. 2 Estimation of scenario quantification for base year (2005) and target year (2030)

Parameter	**Base Year (2005)**	**BaU 2030**	**CM 2030**
Energy Demand (ktoe)	6,672	27,537	23,224
- Passenger transport	1,701	6,875	5,235
- Freight transport	625	2,403	2,194
- Residential	1,518	5,705	5,299
- Industrial	2,337	9,303	7,766
- Commercial	491	3,252	2,730
Energy Demand/Capita (toe/cap)	0.7	2.4	2.0
Energy Intensity (toe/million IDR)	14	12	10
GDP Growth Rate	6.5%	6.9%	6.9%
Energy Demand Growth Rate		6.1%	5.3%
Energy Elasticity		0.9	0.8
CO2 emission (kton-CO2)			
- Total Sectoral Energy	**29,992**	**141,534**	**115,235**
Passenger transport	5,272	21,313	13,735

Parameter	Base Year (2005)	BaU 2030	CM 2030
Freight transport	1,917	7,369	5,389
Residential	8,834	41,118	36,410
Industrial	8,749	35,645	29,288
Commercial	5,219	36,089	30,413
- All Type of Energy	**29,992**	**141,534**	**115,235**
Coal	4	15	13
Oil	10,062	37,349	26,437
Gas	4,750	18,763	16,732
Electricity	15,176	85,407	72,053
Carbon Intensity			
- Ton CO2 per capita	3	12	10
- Ton CO2 per million IDR	63	60	49

The snapshot of final energy demand under BaU and CM projections of energy demand (by type and by sector) in 2030 are presented in Figure 4.3, while snapshot of energy supply mix and corresponding sectoral GHG emission are presented in Figure 4.4. Snapshot of final energy demand in DKI Jakarta shows that under BaU scenario the final energy demand during 2005-2030 is estimated to increase 4.1 times from 6.67 mtoe (5.5% of total energy consumption of Indonesia) to 27.54 mtoe while the primary energy supply during 2005-2030 will increase from 11.29 mtoe to 49.2 mtoe. Under mitigation scenario (CM), in the same period, the demand is estimated to increase 3.5 times from 6.67 mtoe to 23.33 mtoe while the primary energy supply mix will increase from 11.3 mtoe to 41.53 mtoe. The level of the future GHG emission from energy sector is determined by the magnitude of activities in both demand and supply sides of energy sector and technology mix used in the sector. Under the BaU, the GHG emission associated with energy used in both sides will increse from 30 kton CO_2e (2005) to 143 kton CO_2e (2030), with major contributor are power generation (61%), transportation (20%), industry (14%), residential (5%), and commercial (0.4%). Under the mitigation scenario, the GHG emission level will be 26 million ton CO2 in 2030, it is lower than BaU level for the same year. The GHG emission level associated with energy used in both demand and supply sides in the base year, under the BaU, and under the mitigation scenarios is presented in the right hand side of Figure 5.

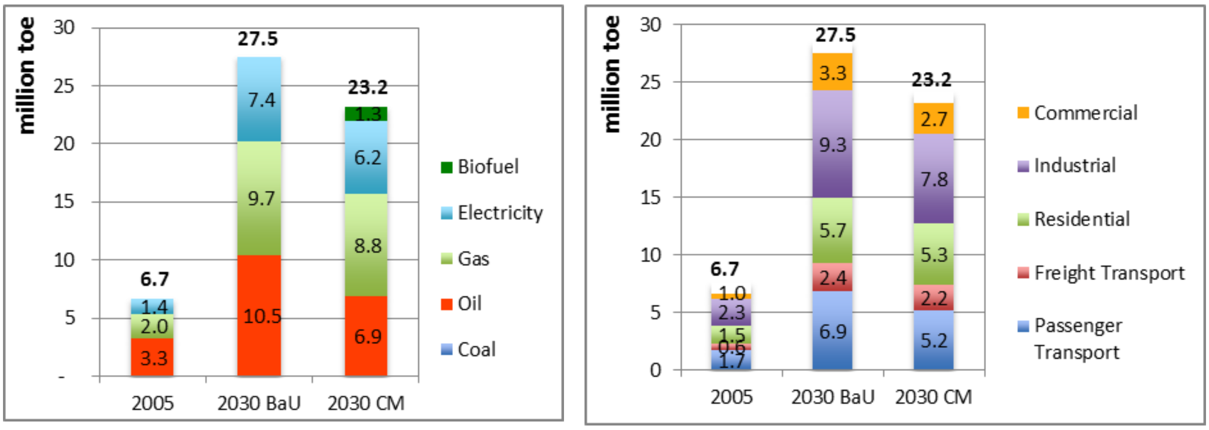

Figure 4.3 Snapshot of final energy demand of the city (by energy type and sector)

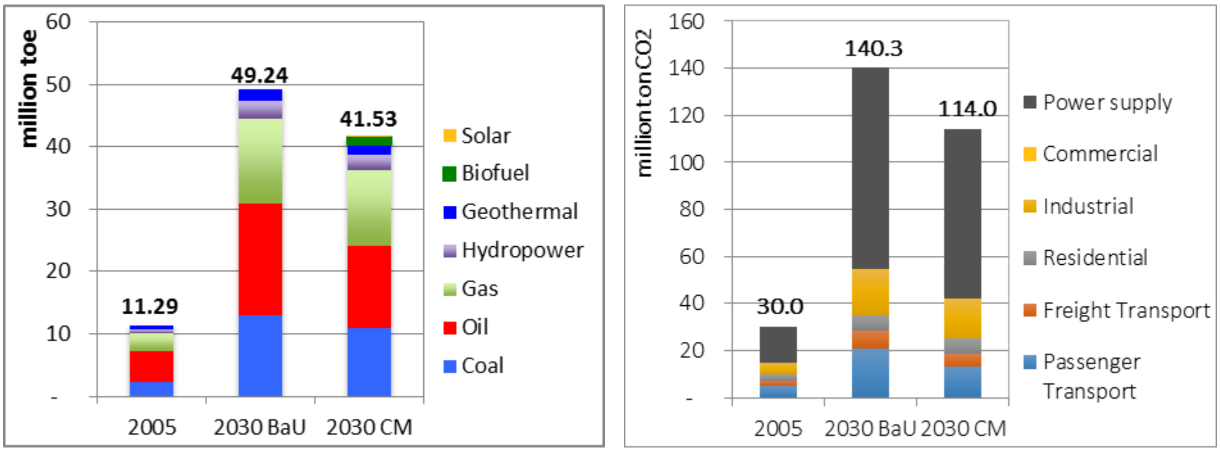

Figure 4.4 Snapshot of energy supply mix and corresponding sectoral GHG emission

The share of sectoral consumption by type of energy during 2005-2030 will slightly change, i.e. all sectors will decrease except commercial sector that will increase from 7% to 12%.

Mitigation scenario (CM) in energy development path of DKI Jakarta has been explore using Provincial RAD GRK of DKI Jakarta (2012) as reference. This development is expected will bring DKI Jakarta become Low Carbon City in the future. The detail of GHG emissions reduction from each mitigation measures is summarized in Figure 4.5. As can be seen from Figure 4.5, main GHG emission reductions are resulted from implementing end use energy efficiency measures in industry, non-government building and residential sectors and implementing fuel switching in transport sector.

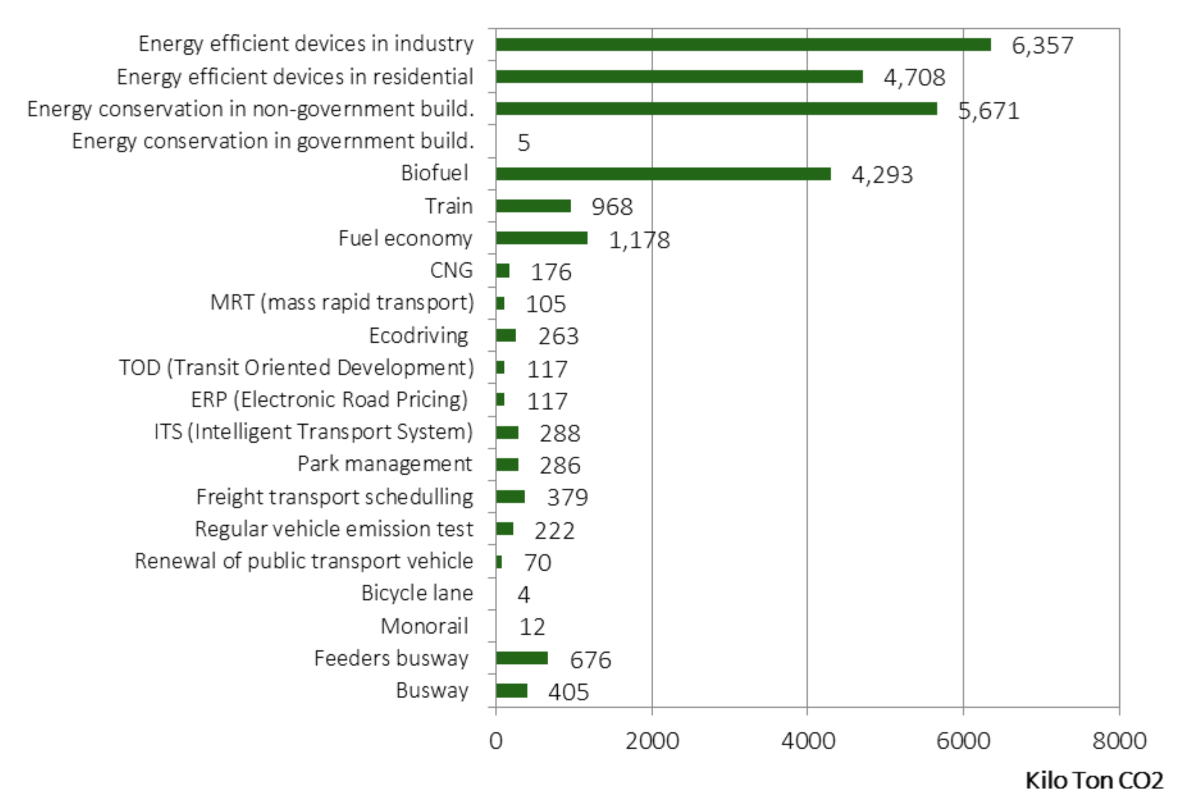

Figure 4.5 Breakdown of GHG emissions reduction achieved in 2030

4.3 Conclusions

1. Modeling using ExSS GAMS has been implemented to explore development path of DKI Jakarta that will lead to development with low carbon emission in energy sector in 2030. This development is expected will bring DKI Jakarta become Low Carbon City in the future. As of now, there is no specific definition in terms of number of Low Carbon City.
2. GDP growth used in this modeling results in increase of GDP in 2030 by 5 times compared to 2005. There is also shift in sectoral GDP product, where the share of commercial (tertiary industry) will increase from 66% to 71%. This is in line with the expectation that capital city like DKI Jakarta will rely more on commercial sector as compared to manufacturing industry and other sector. It should be noted that energy intensity in commercial sector as not as high as in manufacturing industry sector. And therefore such shift will lead to less energy demand growth rate. The type of energy used in this sector is mainly electricity.
3. Mitigation actions for DKI Jakarta has been explore using Provincial RAD GRK of DKI Jakarta (2012) as reference. The selected mitigation actions results in emission reduction 26 million ton CO_2 in 2030 compared to emission in BaU. This reduction is equivalent to 19% of BaU level in 2030. As comparison the RAD target is 30%. Although in term of percentage of reduction resulted from the mitigations used in the study is lower than that of RAD, in term of the magnitude of the GHG emission reduction it is similar to the RAD target. The difference in term of percentage is probably due to higher BaU resulted in this study, which is caused by higher economic growth assumption compared to that used in the RAD.
4. The dominant sector that has potential emission reduction is industry sector followed by transport, commercial and residential. By specific type of measures, the main contributor to emission reduction is implementing end use energy efficiency measures in industry, non-government building and residential and implanting fuel switching in transport.

4.4 References

[1] Dewi et.al. (2010), Low Carbon Society Scenario toward 2050: Indonesia Energy Sector, Kyoto University.
[2] Dewi, R.G. (2012), Indonesia Low Carbon Development Strategy Scenario 2050: Energy Sector, *Thai Environmental Engineering Journal*, p. 63-67.
[3] Provincial RAD GRK of DKI Jakarta (2012), Governor Regulation of DKI Jakarta No. 131/ 2012, Jakarta Indonesia.
[4] Widodo, N. (2013), *Jakarta Dalam Angka (Jakarta in Figures)*, BPS Statistics of DKI Jakarta Province, Jakarta, Indonesia.

5.0 Concluding Remarks and Way Forward

5.1 Concluding Remarks

This report presents several case studies on green infrastructure in Asian countries, i.e., China, India, Japan and Indonesia[1]. The following methodologies were utilized: risk analysis, cost-benefit analysis, and integrated assessment modelling. Cities are central to achieving low-carbon development targets. Green infrastructure adoption in cities will require transformations in technology, governance and funding. Several cities in the China, Indonesia, and Japan have invested in green city initiatives. Among others, the Low-carbon Urban Infrastructure Investment Project for China, Indonesia, and Japan, funded by the Asia-Pacific Network for Global Change Research (APN), attempts to address pathways to green infrastructure investment in these countries at the city level, which is also referred to as a form of smart investment. Through this type of investment, economic growth and GHG emission reductions can be achieved at the city level.

With regard to China, the author proposes the following policy recommendations for the city of Shanghai (which are in line with pathways to achieving low-carbon city targets):

(i) The Chinese central government and relevant local governments must update current economic incentive policies. The protocol for approving green buildings must be simplified, and costs must be reduced.

(ii) The energy performance contract may serve as a good tool for involving private businesses.

(iii) Carbon trading and carbon taxes can be adopted as part of economic incentive policies to promote green building development. Carbon trading schemes such as the Clean Development Mechanism (CDM) can help developers overcome investment barriers, as costs and risks associated with employing technologies and knowledge can be reduced significantly. Investors can pay off initial extra costs within a manageable risk range by selling carbon reduction credits granted for implementing green building projects. In fact, different partners such as developers, energy companies, and even real estate management companies can enjoy benefits under carbon trading mechanisms of China's building sector.

In Japan, Yokohama represents a government ordinance–designated city that displays increasing trends in terms of population and energy consumption levels. In 2007, the city established an execution plan for global warming countermeasures; based on that plan, the city established a 25% reduction target for total GHG emissions by the 2020 fiscal year from 1990 levels as a midterm target and an 80% reduction target for 2050. To achieve these targets, the city initiated a series of activities using various financing methods focused on household and commercial energy consumption reduction. The case demonstrates that although feed-in-tariffs (FIT) and tax policies can help a company mitigate investment risk and achieve returns from business involving renewables, it is dependent not only on the rate of the FIT and on installation costs but also on the framework of the FIT system. Thus, to promote renewable energy investment, further financing mechanisms and incentive mechanisms and a thorough review of the FIT system is needed.

In Indonesia, industrial energy efficiency levels, among others, have resulted in the most significant cuts to GHG emissions in the Jakarta metropolitan area. From an institutional analysis perspective, energy efficiency strategies are insufficient when confronted with a need for more fairness in the pursuit of well-being, which places considerable demands on shared societal resources. As for the Asian region, lessons learned from the three cities show that unplanned and unstructured urban growth will lead to significant economic, social, and environmental costs. Low-carbon infrastructure in cities may be funded through low-carbon technology incentives (e.g., solar PV), by fostering clean development mechanisms and by adopting energy efficiency measures through both market mechanisms and/or policy interventions, as in the cases of Yokohama, Shanghai and Jakarta.

5.2 Way Forward

Studies of cities are becoming more important due to rapid urbanization rates, particularly in the Asia-Pacific region. Infrastructure investments of US$ 90 trillion by 2030 have become the focus of governments and development funding agencies. Two sustainability agendas created in 2015 are highly relevant to low-carbon infrastructure investments: the post-2015 development agenda and the COP 21 of the UNFCCC. The post-2015 development agenda to be developed in September of 2015 in New York will reaffirm the central role of cities as the focus of one of the 17 goals to achieving sustainable development targets by 2030. Low-carbon technology partnerships will also be on the agenda of the 21st COP of the UNFCCC meeting to be held in December of 2015 in Paris. This book will serve as an overview of green investment activities prior to 2015 and will support opportunities for developing further sustainable development goals and low-carbon technology partnerships.

5.3 References

United Nations, Division for Sustainable Development, UN-DESA. Open Working Group on Sustainable Development Goals. http://sustainabledevelopment.un.org/owg.html

J. Jupesta. 2011. Green Economy Transition in Indonesia. *Our World Magazine,* United Nations University. 17 October. http://ourworld.unu.edu/en/green-economy-transition-in-indonesia

APN. Low Carbon Urban Infrastructure Investment: Cases of China, Indonesia, and Japan. http://www.apn-gcr.org/resources/items/show/1919

Appendix

Conferences/Symposia/Workshops
Agenda/Programme (including title, date and venue)
Participants list (comprising contact details of each participant, including organisation, address, phone number, fax number, and email address)

List of Conference Presentations:

July 25th 2013: **Jupesta J.:"** Low Carbon Urban Infrastructure Investment: Case of China, Indonesia and Japan "on APN's Interactive Session at LoCARNet 2nd Annual Meeting, Yokohama, Japan.

October 29th 2013: **Jiang P**.: "Promote the development of green building" on Workshop on Climate Change and Urban Growth at Fudan Tyndall Centre, Fudan University, Shanghai. China

December 5th 2013**: Mathai M.V.:** "Complementary Policy Perspectives for Governing Low Carbon City Development" on International Symposium on Realizing Low Carbon Cities in North-East Asia: Bridging science, Policy and Promoting Cooperation" at CASS, Beijing, PR China.

December 19th 2013: **Dewi R.G.:** Scenarios of GHG emission projection and mitigation strategies for industry and transportation sectors in DKI Jakarta" on Workshop Scenario Development towards Low and Climate Resilience City at Jakarta, Indonesia.

December 19th 2013: **Boer R.:** Challenges toward climate resilience city for DKI Jakarta" on Workshop Scenario Development towards Low and Climate Resilience City, at Jakarta, Indonesia.

December 15th 2014**:** Siagian U., **Dewi R.G., Boer R.,** Fitri, Anisa, and Iwan**;** GHG Emission for BaU and Mitigation Scenario for Transport Sector of DKI Jakarta" on workshop "Progress and Challenges in Developments towards Low Carbon and Climate Resilience City", Bogor, Indonesia.

December 15th 2014**: Boer R.:** Promoting an Integrated Knowledge Based Low-Carbon Development Policy Making in Asia" on workshop "Progress and Challenges in Developments towards Low Carbon and Climate Resilience City", Bogor, Indonesia.

List of Poster Sessions:

July 23rd-24th 2013: Green Investment in Asian Cities (Yokohama, Jakarta and Shanghai), International Forum for Sustainable Asia and Pacific (ISAP), Yokohama, Japan.
http://www.iges.or.jp/isap/2013/en/index.html

April 10th 2013: Green Investment in Asian Cities (Yokohama, Jakarta and Shanghai), Inter Governmental/ Scientific Planning Group Meetings at Asia Pacific Network for Global Change Research (APN-GCR), Kobe, Japan.
http://www.apn-gcr.org/2013/04/17/18th-igmspg-meetings-convened-in-kobe-japan/

List of Workshops organized/related with APN project:

July 25th 2013: Public Forum APN's Interactive Session at LoCARNet 2nd Annual Meeting, Yokohama, Japan organized by APN.
http://lcs-rnet.org/past/meetings_locarnet/2013/07/2nd_annual_meeting_of_the_locarnet_in_yokohama_japan.html

July 25th 2013: APN Policy Workshop organized by UNU-IAS. Presentation from Working Group 1 (Mathai et. al.), WG 2 (Wakiyama and Jupesta), WG3 (Jiang et. al.) WG4 (Boer et. al.)

October 29th 2013: Workshop on Climate Change and Urban Growth at Tyndall Center, Shanghai, PRC organized by Fudan University, China.
http://tyndallcentre.fudan.edu.cn/en/Show.aspx?info_lb=586&info_id=2506&flag=536

December 5th -6th 2013: International Symposium on Realizing Low Carbon Cities in North-East Asia: Bridging science, Policy and Promoting Cooperation at Beijing, PRC organized by UNESCAP-CASS.
http://www.ias.unu.edu/sub_page.aspx?catID=35&ddlID=2876

December 15th -16th 2013: Workshop on Scenario Development towards Low and Climate Resilience City, at Jakarta, Indonesia, organized by CCROM Bogor Agriculture University, Indonesia.

Funding sources outside the APN

N/A

List of Young Scientists

The Young scientists/students involved in the project titled "Analysis on the Economic Policies to Promote the Development of Green Buildings in China" are:

1. ***Xiao Hu****, Fudan Tyndall Centre of Fudan University/China*
2. ***Jiajia Zheng****, Fudan Tyndall Centre of Fudan University/China*
3. ***Yun Zhu****, Fudan Tyndall Centre of Fudan University/China*
4. ***Xing Sun,*** *Fudan Tyndall Centre of Fudan University/China*
5. ***Shuo Gao,*** *Fudan Tyndall Centre of Fudan University/China,*

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