Part II
Bridging the Gap Between Modeling and Real Policy Development

Chapter 6
Designing a National Policy Framework for NAMAs

Lessons Learnt from Thailand

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Abstract This section presents lessons learnt from Thailand in climate policy design. Thailand has filled the gap between modelling analyses and climate policy development in its Nationally Appropriate Mitigation Action (NAMA). Thailand's mitigation pledge under NAMA framework was successfully designed and communicated to UNFCCC in COP20. The integrated assessment modelling analysis plays an important role in the development of Thailand NAMA. Consensus building was derived from several discussions among stakeholders of NAMA implementation. Criteria for selection of greenhouse gas countermeasures were based on cost optimization by using a module of the Asia-Pacific Integrated Model called 'AIM/Enduse', abatement costs, co-benefits and feasibility of implementation. In addition, economic feasibility of countermeasures in NAMA actions was also assessed. Then, NAMA implementation has been prepared based on assumptions concerning limitations of resources, capital requirement, timing and appropriateness for Thailand.

Since 2012 Thailand's mitigation pledge to UNFCCC has been prepared on the basis of domestic appropriate measures. Co-benefits of NAMAs are also assessed, and they reveal positive aspects of GHG mitigation under NAMA framework. Results found that Thailand has high potential of GHG emission reduction by both domestically supported NAMAs and internationally supported NAMAs about 23–73 million tonnes CO_2 per year in 2020 or approximately accounted for 7–20 % in 2020 of the total GHG emissions. The NAMA actions include measures in (1) renewable electricity, (2) energy efficiency, (3) biofuels in transportation and (4) environmental sustainable transport system. These GHG countermeasures are in line with the national policy and plans of ministries of energy and transport in order to avoid the conflict between climate policy and policies of the related ministries. Results of cost optimization, co-benefits, economics and appropriateness are also necessary for communication among policymakers, administrators, academic researchers and the public on consensus building.

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Finally, to ensure the quantified GHG reduction in 2020 and the transparency of Thailand's NAMA implementation, the measurement reporting and verification (MRV) process is required. The MRV process of these NAMAs needs cooperation among related ministries. These lessons learnt from Thailand, when modified as needed, can be a 'good practice' of climate policy design.

Keywords Thailand NAMA • Integrated assessment modelling • Renewable energy • Energy efficiency • Co-benefits of GHG Mitigation • AIM/Enduse

Key Message to Policymakers

- Thailand successfully developed its Nationally Appropriate Mitigation Action (NAMA).
- Integrated assessment modelling helps in climate policy development.
- Consensus building is necessary among stakeholders' concerns.

Lessons learnt from Thailand can be a 'good practice' of climate policy design.

6.1 Introduction

Within the climate change framework, there is a gap between modelling analyses and policy development, and whether national climate policy incorporates such modelling analyses depends on several factors. This section introduces a good example of a means to fill in this gap. Through discussion with the climate change focal point and related agencies, Thailand succeeded in reflecting the modelling analysis in actual policy development. Thailand's scenario studies on Nationally Appropriate Mitigation Action (NAMA) and NAMA roadmap development have been highly successful. This approach can be adopted by other regions as a 'good practice' of climate policy design and modified as needed according to local conditions.

6.2 NAMA and CO_2 Mitigation Strategy

Climate change and greenhouse gas (GHG) mitigation are two key global issues, with a growing list of countries adding them to agendas within United Nation Framework Convention on Climate Change (UNFCCC) discussions. Further, the Conference of Parties (COP) has decided on appropriate implementations and GHG mitigation targets for developing countries. The 'Nationally Appropriate Mitigation

Action (NAMA)' concept was first introduced in the 'Bali Action Plan' in COP13 in 2008 and, for developing countries, involves submission of GHG mitigation targets at the request of COP. In other words, the targets are only GHG mitigation 'pledges' (Decision 1/CP.13 'Bali Action Plan', Decision 1/CP.16 'Cancun Agreements', Decision 2/CP.17 in Durban and Draft, Decision -/CP.18 'Doha Climate Gateway'). Moreover, developing countries are welcome to propose their actions and targets for GHG mitigation under the voluntary basis of the UNFCCC. As of October 2012, 54 countries had proposed mitigation pledges that included NAMA implementation. Thailand communicated its NAMA pledge to UNFCCC in COP20 in Lima (Dec. 2014).

In the convention-track decision, developing countries agree to take on NAMAs, supported by technology and finance, based on their goal as being 'aimed at achieving a deviation in emissions relative to 'business-as-usual' emissions in 2020'. Developed countries are urged to raise ambition levels of their targets 'to a level consistent with' the latest recommendations of the Intergovernmental Panel on Climate Change (IPCC). Developed countries have been requested to prepare 'low-carbon development strategies or plans', and so have developing countries.

The term 'NAMAs' refers to any national climate policy that leads to reduction in greenhouse gas (GHG) emissions in developing countries. The mitigation pledges communicated to UNFCCC by signatory countries of NAMA agreements can be classified into four main groups: (1) NAMA concept, (2) NAMA plan, (3) NAMA implementation and (4) NAMA submitted to the UNFCCC's NAMA registry. Thailand's NAMAs are in line with national sustainable development plans and are aimed at achieving GHG emissions reduction relative to 'business as usual' emissions in 2020, resulting in GHG mitigation. NAMAs have impacts that can be measured, reported and verified (MRV) and comprise two types in Thailand: (1) domestically supported NAMAs and (2) internationally supported NAMAs. Both types require MRV processes to verify actual emission reductions and to provide transparency of the processes. In 2014, Thailand constructed a national strategy 'Roadmap to Thailand NAMAs 2020' with clear targets to set up benchmarks and orient emission reductions activities. In December 2014, the country announced its NAMA pledge with a GHG reduction target in the range of 7–20 % in COP20 in Lima. The pledge communicated to UNFCCC was approved by the cabinet, the national climate change committee and NAMA subcommittee and stakeholder consultations. As this pledge has no legal binding for the country, the final NAMA pledge process only needed approval at the cabinet level (see Fig. 6.1), and if it were legally binding, it would have required parliamentary approval, in accordance with the constitution. In such case, the Department of Treaties and Legal Affairs of the Ministry of Foreign Affairs would be involved. If the post-2020 mitigation pledge involves legal binding, the domestic processes leading up to communication to UNFCCC will require more time.

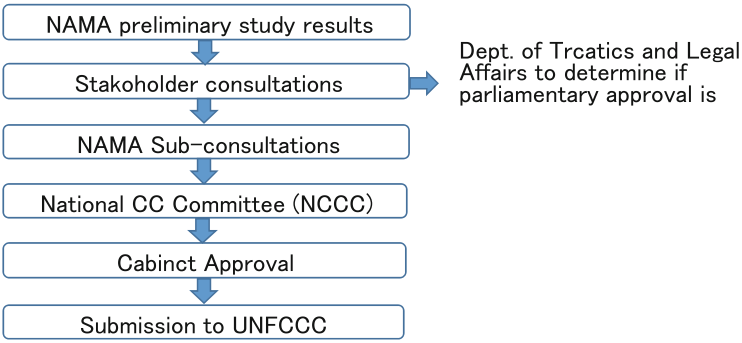

Fig. 6.1 National NAMA approval process of Thailand

6.3 Implementation of a Climate Change Mechanism in Thailand

In 2012, the first study by Thailand Greenhouse Gas Management Organisation (TGO) showed that Thailand has a high potential for GHG emissions reduction, via both domestically and internationally supported NAMAs, to the tune of about 23–73 million tonnes CO_2 per year by 2020 or approximately 7–20 % of the total GHG emissions for 2020. The calculated abatement costs of NAMAs vary in the range 0–1000 USD/t-CO_2. However, these CO_2 reduction actions are voluntarily for Thailand. In order to convey its intent as regards being a main supporter for climate change reduction and GHG mitigation in SE Asia, Thailand has to be ready for the coming strategies in the proposed NAMAs. The TGO working group and the Ministry of Energy found that the national sectoral approach actions are composed of:

1. Alternative Energy Development Plan (AEDP) 2012–2021 (updated in May 2012)
2. Energy efficiency measures in industrial and building sectors, according to the act on energy conservation passed by the Ministry of Energy
3. Biofuel promotion in the transport sector under AEDP
4. The mass transit system, termed 'environmental sustainable transport system', by the Office of Transport and Traffic Policy and Planning (OTP)

Thailand's mitigation pledge to UNFCCC has been prepared on the basis of these measures since 2012. In addition, co-benefits of NAMAs are also assessed, and they reveal positive aspects of GHG mitigation under the NAMA framework. The MRV process of these NAMAs requires cooperation among the related ministries.

6.3.1 Success of Clean Development Mechanism (CDM) Projects in Thailand

As of January 2012, TGO reported that the number of CDM projects issuing CERs had increased to ten, with a total CO_2 reduction of 1.05 Mt-CO_2. However, as developing CDM projects up to the issuance of CERs takes much time, it is recommended that Thailand's NAMA process be made more flexible and simplified to reduce the overall processing time and that other developing CDM projects be switched to register in the NAMA category. It is anticipated that Thailand will fast-track projects under NAMAs. As of December 2014, 222 Thai CDM projects had received the letter of approval (LoA), accounting for a cumulative GHG reduction of 12.72 Mt-CO_2. Of these, however, only 151 projects had been registered by the CDM Executive Board (CDM-EB) (with a cumulative GHG reduction of 7.25 Mt-CO_2), and only 43 projects had received issuance of certified emission reductions (CERs) (equal to 6.92 Mt-CO_2).

6.4 Overview of Energy, Environment and Socio-Economic Factors

6.4.1 Thailand's Energy Sector

Thailand is the second largest economy in the Association of Southeast Asian Nations (ASEAN) and is categorised as a middle-income developing country. Since recovering from the Asian financial crisis in 1997, its economy has shown significant growth, rising to 224 billion USD in 2012 and growing on average at 4.07 % annually. Medium-term economic projections point to Thailand maintaining this growth rate (about 4 % annually), and one report ('Thailand Power Development Plan 2010', published by Ministry of Energy, Thailand) quotes a figure of 4.27 % for 2012–2030.

The population of Thailand expanded 2.4 times during 1960–2012 and reached 66.8 million in 2012. Two decades ago the average annual population growth rate dropped to 0.74 % and then to 0.46 % in the most recent decade. The urban population was reported as 34.4 % in 2012. Accompanying the expected gradual economic growth, infrastructure development, increased access to modern energy and high-income generation will lead to increased urbanisation in future; thus, the urban population is forecasted to rise to 60 % by 2050.

6.4.2 Primary Energy Supply and Final Energy Consumption

Behind Indonesia, Thailand is the second largest energy consumer in ASEAN and consumed over 70.5 Mtoe in 2011, amounting to just over 20 % of regional demand. Of this, 70 % was due to transport and industrial sectors, with the transport sector being the largest energy consumer in 2011 (25,466 ktoe), closely followed by the industrial sector (24,966 ktoe). The residential sector is the third (16,551 ktoe). Over the last two decades, the highest average annual growth rate in energy demand was recorded in the industrial sector at 6.78 %, followed by transport and residential sectors at 5.16 % and 3.1 %, respectively.

In terms of fuel mix, as shown in Fig. 6.2, petroleum products dominate the total final energy consumption (TFEC) at 47 %, followed by electricity at 18 %. The dependency on fossil fuels is significant, as petroleum products, coal and its products and natural gas amounted to 63 % of TFEC in 2011.

As regards total primary energy supply for the world, it doubled from 1973 to 2011. Figure 6.3 gives a comparison of fuel mix in 1973 and 2011. According to the figures, fossil fuels have maintained their dominance since the 1970s. Except for the increase in nuclear share, from 0.9 % in 1973 to 5.1 % in 2011, none of the non-fossil fuel shares exhibit significant increases, though some of them have higher incremental factors, such as solar PV and wind power. In addition, the contribution of oil to total primary energy supply (TPES) dropped from 46 to 31.5 %, whilst natural gas and coal increased to 21.3 % and 28.8 % in 2011, from 16 % and 24.6 % in 1973, respectively.

In 2011, TPES in Thailand was recorded at 127.9 Mtoe, whilst still only 0.97 % of the world and 8 % of Asia excluding China attained this figure due to an average annual growth rate of 6.74 % since 1990. As with the global statistics, oil has the major share in the fuel mix of TPES at just above 36 %, followed by natural gas at 32 % and biomass at 16.2 % in 2011. The natural gas share has grown considerably due to its increased use in power generation. On the other hand, growth in energy from coal has been restricted due to its environmental concerns in Thailand and had a share of about 12.3 % of TPES in 2011. However, the percentage for fossil fuels in TPES stood at about 85 % in 2011.

6.4.3 Thailand's GHG Emissions

In 2000 Thailand emitted about 229 Mt-CO_2eq, most of which is due to the power sector. It is followed by transport and industry sectors, each accounting for 44.4 and 30.3 Mt-CO_2, respectively. Figure 6.4 shows sectoral shares of CO_2 emissions in 2000 and in particular shows that the energy sector is the biggest CO_2 emitter, accounted for 69.57 % of the total. The share of CO_2 emissions in the agricultural

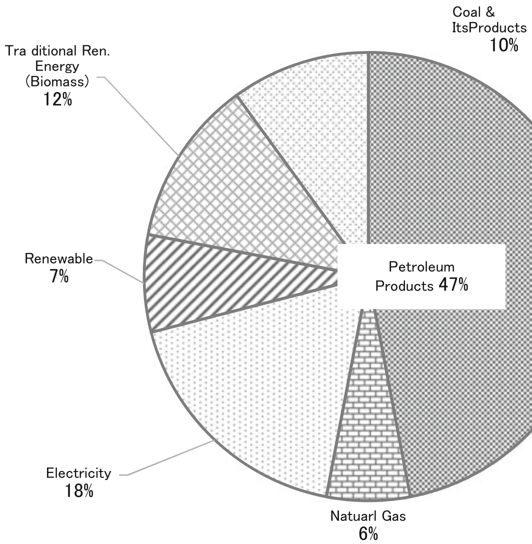

Fig. 6.2 Total final energy consumption by fuel type in 2011

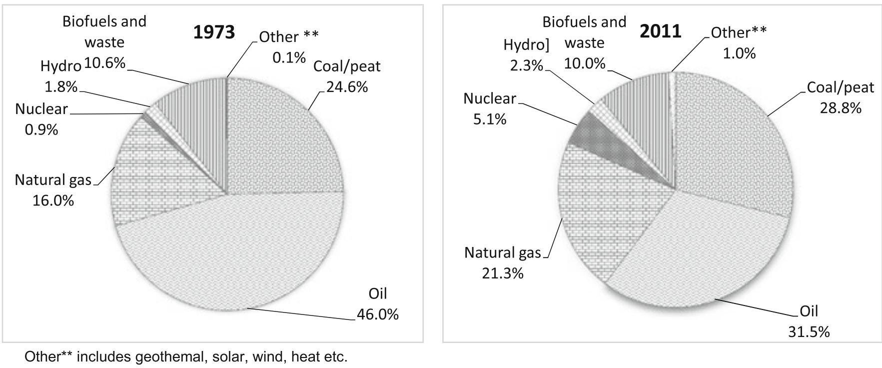

Fig. 6.3 Global fuel share of TPES for 1973, 2011

sector is about 22.64 %. The forestry sector and carbon sequestration result in CO_2 absorption of 3.44 %.

The trend in Thailand's GHG emissions shows an increase—in 1992 total CO_2 emissions stood at about 100,033 kt-CO_2, which then increased to 194,853 in 2009, and accounted for an average increase rate of 2.33 % per annum. The biggest CO_2-emitting sector is the power sector, which was responsible for 41,838 kt-CO_2 in 1992, and 81,797 in 2009, and accounted for an average increase rate of 5.14 % per annum. This is followed by the industrial, transport and building sectors, which accounted for average annual increase rates of 1.66 %, 2.00 % and 2.98 %, respectively.

In 2011, CO_2 emissions of 206.4 Mt-CO_2 were recorded, a contribution of only 0.66 % to the global figure. However, CO_2 increased by 202.4 % over the last two

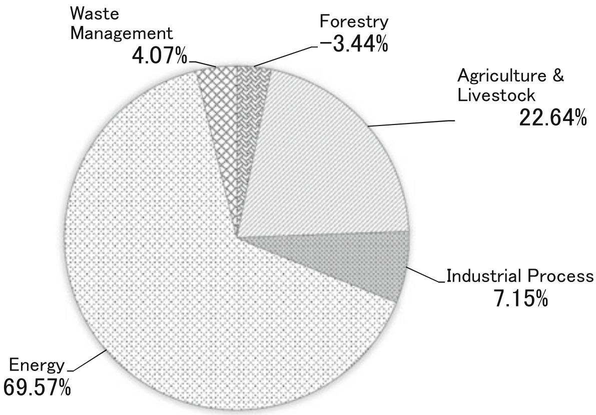

Fig. 6.4 Breakdown of CO_2 emissions by sector in 2000 (Source: Thailand's Second National Communication, ONEP 2011)

decades. Of the total, 41.8 % came from the power sector in 2011, and second was transport at 28.52 % (58.87 Mt-CO_2). However, although the emission quantity is still comparatively small, emissions from residential and commercial sectors have the highest average annual growth rate of 5.35 %, followed by the industry and the power sectors of 4.47 % and 3.89 %, respectively. A fuel-wise comparison of carbon emissions shows that by far oil is the largest emitter and was responsible for about half of CO_2 emissions for 2011. Due to its high use in power generation, natural gas has also incurred considerable emissions (about one third of the total) followed by coal (about one fifth).

In the energy sector, the energy conversion processes in electricity power plants are the chief contributor to CO_2 emissions, which are followed by combustion processes in industry and transportation. During 2002–2010, the corresponding CO_2 emissions increased by 30.03 %, 18.78 % and 12.47 % in the power, industry and transport sectors, respectively. Therefore, it is recommended that related policy measures in GHG mitigation in the energy sector be focused on energy conversion processes and fossil fuel combustion processes in industry and transportation sectors. Thus, for Thailand's NAMA, the first study focused on power generation, industry and waste to energy activities.

6.4.4 Other Air Pollutant Emissions

NO_x emissions in 2011 stood at 971 kt-CO_2 and during the period 1994–2011 increased by about 83 %. The transport sector is the major NO_x emitter in Thailand and in 2011 was responsible for 307 kt-CO_2, an approx. 31.6 % share of the total. However, power, manufacturing and others (agricultural, construction and mining) also emitted considerable amounts.

With regard to SO_x emissions, the figures dropped considerably during the period 1994–2011, from 1326 kt in 1994 to 552 kt in 2011. Since the power sector is responsible for the highest SO_x emissions, desulphurisation retrofits in power plants have decreased SO_x emissions drastically. However, in 2011 the power sector emitted the highest amount at about 55 %. More than 96 % of SO_x emissions in 2011 were produced from the power and manufacturing sectors.

6.5 Relationship Between Thailand's Energy Policy and Climate Change

The energy policy of the Ministry of Energy of Thailand has three main strategy aims: energy security, promotion of alternative energy and increased energy efficiency in the enduse sectors, as follows:

1. The energy security strategy aims at development and promotion of endogenous energy resources to satisfy domestic consumption. It includes cooperation with nearby countries in the development of energy sources and utilisation of renewable energy resources such as small hydroelectricity generation, development of nuclear power and utilisation of clean coal technologies.
2. The alternative energy strategy was announced by the Thai government as a national agenda in 2008. Promotion and utilisation of alternative energy supplies include biofuels, biomass, biodiesel and waste to energy. In addition, renewable electricity generation from solar, wind and hydro has been targeted in the 15-year Alternative Energy Development Plan (AEDP) of the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy. The first 15-year AEDP plan made in 2011 is divided into three periods: 2008–2011, 2012–2016 and 2017–2022. This plan will result in cumulative energy savings of 19,799 ktoe by 2022 and will account for 20 % of total final consumption in 2022.
3. The increased energy efficiency strategy of DEDE aims at targeting energy savings in the residential, industrial, commercial and transport sectors. It includes promoting awareness and understanding of energy conservation, providing financial incentives to the private sector in retrofits of energy equipment for energy savings, peak load cutting in the commercial sector and R&D on minimum energy performance standards, building energy codes and mass transit systems. Efficient use of energy results in less investment in the energy supply (DEDE, 2009).

6.5.1 Revised Alternative Energy Development Plan: AEDP 2012–2021

As mentioned above, the first AEDP is divided into three subperiods and aims to promote renewable electricity generation such as biomass power, biogas power,

Table 6.1 Potential of renewable power generation in the AEDP plan

Renewable energy	AEDP plan (MW)[a] 2008–2011	AEDP plan (MW)[a] 2017–2022	Revised in 2012[b] 2021 (MW)
Solar	55	500	3000
Wind	115	800	1800
Wastes to energy	78	160	400
Biomass	2600	3700	4800
Small hydro	165	324	324
Biogas	60	120	3600
Others	–	–	3
Total	3073	5604	13,927

Source: [a]DEDE (2010)
[b]DEDE (2012)

small hydropower, solar power, wind power and waste to power. In January 2012, DEDE increased the target of 2012 AEDP to 25 % by 2021. To achieve this target in the revised AEDP plan, Ministry of Energy has provided financial support and mechanisms to promote renewable electricity generation in the form of 'adders' on the top of buy-back rates. Adders of different renewable energy sources will be given by different rates. The concept of these incentives is to make the renewable energy investment yield sufficient profits within given lifetimes under specified economic criteria. The target of renewable electricity generation in its first AEDP plan was 5604 MW, in which biomass power will share about 3700 MW and will account for 66 % of the total capacity by 2022 (see Table 6.1).

In 2012, the National Energy Policy Committee (which includes the prime minister) announced the revised AEDP plan. Total renewable power generation was to be 13,927 MW in 2021 with expected annual energy generation of 63,035 GWh in 2021. The largest share of power capacity will be represented by 4800-MW from biomass electricity generation (see Table 6.1).

6.5.2 *Thailand's 20-Year Energy Efficiency Development Plan*

In 2011, the Ministry of Energy announced the 20-Year Energy Efficiency Development Plan (EEDP). This plan aims at cutting off overall energy intensity and total final energy consumption by 25 % and 20 %, respectively, in 2030. The main sectors targeted are transport and industry (EPPO 2011). EEDP will provide both mandatory actions and voluntary support to promote energy efficiency. The mandatory actions will comply with the 1992 Energy Conservation Act (ENCON Act) and the revised 2007 ENCON Act and minimum energy performance standards including energy labelling. The main form of support to promote energy efficiency is financial, such as incentives for measures proven to enable energy savings, incentives to promote the use and production of energy devices that comply with minimum energy performance standards and incentives to promote high energy efficiency vehicles.

6.5.3 Thailand Power Development Plan (PDP) 2010–2030

The Thailand Power Development Plan is the government-approved development pathway of the power sector for the period 2010–2030. Two objectives have been accomplished by developing this plan. First, the future peak power demand and the total energy demand have been forecasted. Second, a roadmap for power generation expansion to meet forecasted demand has been developed. The PDP 2010 plan has been revised several times for a variety of reasons and changes in national energy circumstances. The first revision was made since the peak demand in 2010 was significantly higher than as forecasted and capacity addition of independent power producers (IPPs) was lower than planned due to delays in plant construction. Then, due to lowered public acceptance for nuclear power as a result of Japan's Fukushima incident, a second revision was prepared. The third and latest revisions were prepared based on three key issues: (1) to adopt forecasted power demand results, (2) to include the guidelines given in the revised Alternative Energy Development Plan (AEDP 2012–2021) and (3) to place more emphasis on energy security.

In PDP2010 Revision 3, to forecast power demand, energy saving programmes and energy efficiency promotions have been considered at a success rate of only 20 %, in accordance with MoEN's (Ministry of Energy) 20-Year Energy Efficiency Development Plan 2011–2030. According to the forecasts, the peak generation requirement in 2030 is 52,256 MW, and net energy generation requirement is 346,767 GWh. These figures have been set as the baseline for preparation of the PDP. In addition, the following features can be highlighted. One of the considerations taken into account was keeping the reserve margin at the level of 20 % higher than the peak demand due to risk in the natural gas supply sources in western Thailand. In addition, diversification of fuel has also been considered to reduce the natural gas dependency. Another consideration was to maintain the share of nuclear power below the 5 % margin. In the plan, a capacity of 2000 MW has been planned for nuclear in 2026. Increasing the share of renewable power generation by 5 % from the level proposed in its PDP Revision 2 has been taken into account. In the PDP 2010 plan, adding 14,580 MW of renewable power capacity has been planned for the system, 9481 MW coming from domestic sources and 5099 MW via purchases from neighbouring countries. Promotion of cogeneration and increasing the power purchased from it were another assumption made, with cogeneration accounting for 6476 MW of capacity addition. In addition, 25,451 MW from combined cycle power plants and 8623 MW thermal power capacity, including 4400 MW of coal, have been added for the period 2012–2030. Altogether, 55,130 MW of new capacity has been added for 2012–2030, whilst 16,839 MW of capacity has been retired. At the end of 2030, net operating capacity stands at 70,686 MW for 2030.

6.5.4 Environmental Sustainable Transport System

The 'environmental sustainable transport system' was proposed and developed by the Office of Transport and Traffic Policy and Planning (OTP). The actions, which mainly involve a modal shift, fuel economy improvement and sustainable mass transit system, started in 2012. However, due to the long lead time for construction, this sustainable system is not due to be fully operational until after 2020.

6.6 AIM/Enduse Modelling of Thailand's Energy System

The methodology used to develop Thailand's NAMAs is based on a bottom-up tool, the 'AIM/Enduse' model. The Asia-Pacific Integrated Model (AIM) was developed by the National Institute for Environmental Studies (NIES) of Japan as the first and only integrated assessment model specific to Asia and was used to evaluate policy options on sustainable development particularly in the Asia-Pacific region (Kainuma et al. 2003). AIM/Enduse is a bottom-up optimisation model comprising a detailed technology selection framework within a country's energy-economy-environment system. It can analyse mitigation scenarios by using both the AIM/Enduse model and AIM/Enduse tools. In the model, 'energy technology' refers to a device that provides a useful energy service by consuming energy. Energy service refers to a measurable need within a sector that must be satisfied by supplying an output from a device. It also can be defined in either tangible or abstract terms; thus, 'service demand' refers to the quantified demand created by a service; i.e. service outputs from devices satisfy service demands. The AIM/Enduse leader in Thailand is Prof. Ram M Shrestha, who has developed and analysed climate policies for several Asian countries, as well as Thailand.

In this study, the structure of AIM/Enduse for Thailand's reference energy system was created using socio-economic assumptions obtained from related agencies such as the Office of the National Economic and Social Development Board (NESDB), Electricity Generating Authority of Thailand (EGAT 2010) and DEDE (see Fig. 6.5). Then, the selected CO_2 countermeasures are analysed. The AIM family tools could handle the problems in both general equilibrium and partial equilibrium modelling. Thus, the AIM/Enduse tool is highly suitable for analyses of CO_2 countermeasures in Thailand's NAMAs. Results from the AIM/Enduse modelling for Thailand's energy system show that final energy consumption by economic sectors in the BAU will increase from 71,491 ktoe in 2005 to 113,384 ktoe in 2020 (see Fig. 6.6).

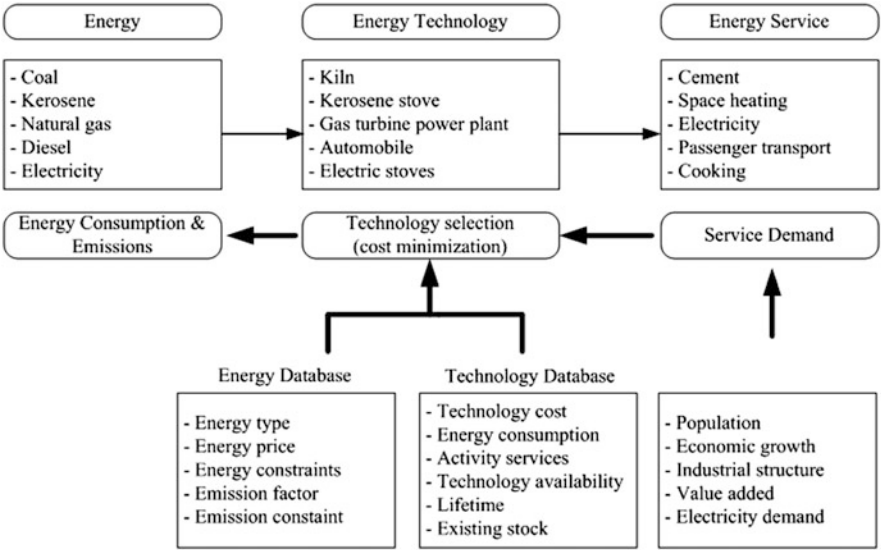

Fig. 6.5 Structure of AIM/Enduse for modelling of Thailand's NAMAs

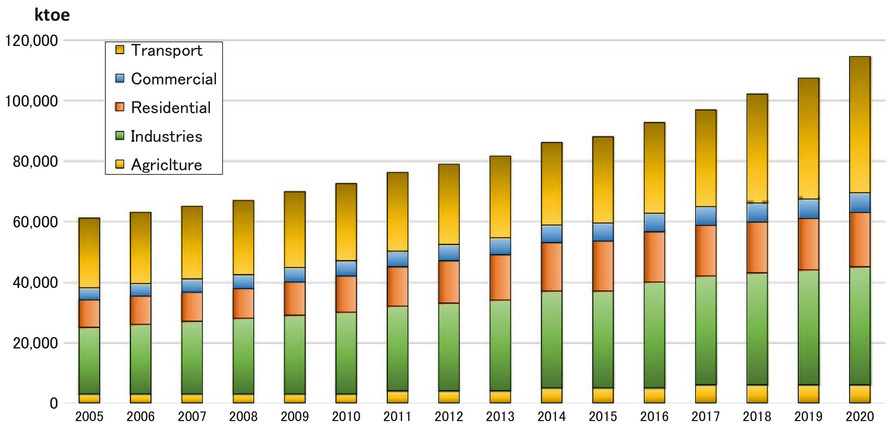

Fig. 6.6 Final energy consumption by economic sector in BAU

The steps of modelling analyses of Thailand's NAMAs are as follows: (1) reviews of national policy measures related to CO_2 countermeasures, (2) data collection and verification, (3) data processing, analyses and modelling by the AIM/Enduse tool, (4) development of CO_2 emissions as baseline in the business-as-usual (BAU) scenario, (5) analyses of CO_2 countermeasures and (6) discussion and conclusion on CO_2 countermeasures under NAMAs (Limmeechokchai et al. 2013).

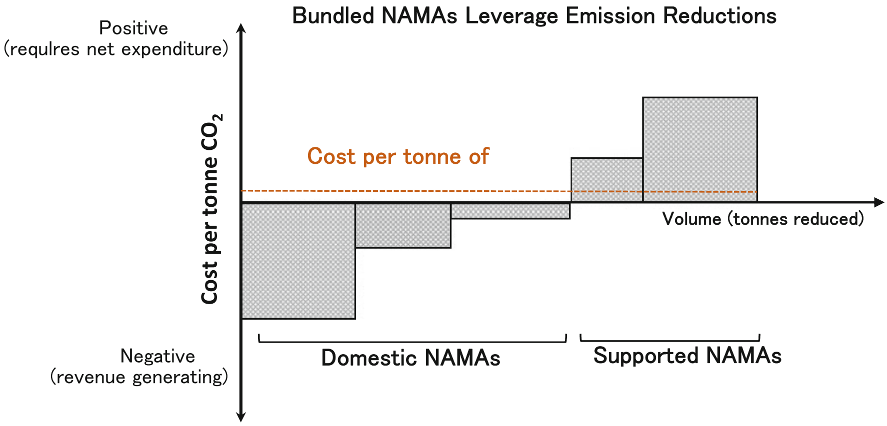

Fig. 6.7 Criteria to selection of Thailand's NAMAs

6.7 Designing a National Policy Framework for Thailand's NAMAs

6.7.1 Criteria/Selection of CO_2 Countermeasures

In the analyses of CO_2 countermeasures (CMs) for Thailand's NAMAs, the abatement costs of selected countermeasures from the national policies and plans, including their economic feasibility, were estimated. The selected countermeasures with appropriate abatement costs were proposed as measures for Thailand's NAMAs (see Fig. 6.7). The proposed countermeasures for Thailand's NAMAs were also assessed for their economic feasibility.

6.7.2 Domestically vs. Internationally Supported NAMAs

The CO_2 countermeasures (CMs) obtained from the AIM/Enduse analyses can be classified into two types:

1. Domestic NAMAs performed voluntarily by the Thai government, sinceCO_2 abatement costs are not excessive and the CO_2 CMs could utilise domestic technologies and know-how
2. Internationally supported NAMAs which have high abatement costs and need support, technology transfer, know-how and capacity building from developed countries

Table 6.2 Internal rates of return (IRR) of CO_2 CMs in renewable power generation

NAMAs	CO_2 countermeasures (CMs)	Incremental abatement costs (\$/t-CO_2)	IRR with adders/FiT (%)	IRR without adders/FiT (%)
Domestic NAMAs	Biogas power	0.02	14.0	8.8
	Small hydropower	0.69	11.7	5.4
	Biomass power	2.67	11.3	4.0
Internationally supported NAMAs	Wind power	51.88	10.8	1.5
	Solar power	102.81	9.0	n.a.

Note: Thailand implemented incentives for renewable electricity generation in its ‘adder’ scheme in 2008 and ‘feed-in Tariff’ scheme for solar PV in 2012

6.7.3 Economic Assessment of Domestic and Internationally Supported NAMAs

In addition to the incremental abatement costs of CO_2 countermeasures, the internal rate of return (IRR) of each identified CO_2 CM has been analysed. Table 6.2 presents the IRRs of CO_2 CMs for renewable power generation. The CO_2 CMs with high incremental abatement costs tend to have low IRRs, such as the IRRs of wind and solar power without incentives or ‘adders’ of only 1.5 % and −5.5 %, respectively. When the adders are taken into account, the IRRs of wind and solar power increase to 10.8 % and 9.0 %, respectively. Therefore, both wind and solar power should be considered as internationally supported NAMAs and since need international support to promote the nationwide use of such technologies as CO_2 countermeasures.

On the other hand, renewables powered by biogas, small hydro and biomass have low incremental abatement costs of 0.02, 0.69 and 2.67 US\$/t-CO_2, respectively. In addition to incremental abatement costs, their IRRs without adders are 8.8 %, 5.4 % and 4.0 %, respectively. When 2011 adders are taken into account, their IRRs increase to 14.0 %, 11.7 % and 11.3 %, respectively (see Table 6.2). These IRRs are sufficient and result in financial viability for the renewable power producers in Thailand. Therefore, biogas, small hydro, and biomass power must be classified as domestic NAMAs in Thailand.

For the waste-to-energy sector, from the IRR point of view the MSW of local landfill technology is the best CO_2 countermeasure. However, the identified four MSW technologies show negative IRRs. The IRRs without 2011 adders for MSW-Local landfill, MSW-INC, MSW-BD and MSW-Controlled landfill are −1.3 %, −4.5 %, −6.0 % and −8.0 %, respectively (see Table 6.3). The corresponding incremental abatement costs are 32.85, 140.63, 164.73 and 395.32 US\$/t-CO_2, respectively. When adders were taken into account, their IRRs increase to 11.0 %, 9.0 %, 9.0 % and 10.0 % for MSW-Local landfill, MSW-INC, MSW-BD and MSW-Controlled landfill, respectively. Therefore, all CO_2 countermeasures in

Table 6.3 Internal rates of return (IRR) of CO_2 CMs in the waste-to-energy sector

NAMAs	CO_2 countermeasures (CMs)	Incremental abatement costs (\$/t-CO_2)	IRR with adders (%)	IRR without adders (%)
Internationally supported NAMAs	MSW (local landfill)	32.85	11.0	n.a.
	MSW (incinerator)	140.63	9.0	n.a.
	MSW (digesters)	164.73	9.0	n.a.
	MSW (controlled landfill)	395.32	10.0	n.a.

the waste-to-energy sector will be considered as internationally supported NAMAs since they need financial incentives, technology transfers and capacity building.

For energy efficiency (EE) countermeasures, the payback periods of EE lighting, EE cooling and EE motors in industry were calculated (see Table 6.4). It was found that payback periods of the proposed countermeasures for EE NAMAs in industry are satisfactory. Their short payback periods for business investment are only 3.0–3.5 years. These results are consistent with the stakeholder consultation.

6.8 Framework for Thailand's NAMAs

6.8.1 NAMA Pledge to UNFCCC

Thailand is assessed as having a high potential for GHG mitigation from both domestically supported NAMAs and internationally supported NAMAs, up to 72.99 Mt-CO_2. Of this, 23.33 Mt-CO_2 will be from domestically supported NAMAs and 49.66 Mt-CO_2 internationally supported, as shown in Table 6.5. Figure 6.8 shows the potential CO_2 reduction from Thailand's NAMAs in 2020.

With respect to the potential for GHG mitigation from these measures in 2020, Thailand will be able to provide a draft mitigation pledge as a NAMA concept. Such information includes the base year and the potential of GHG mitigation when compared with the GHG emissions in the target year, 2020.

Thailand's mitigation pledge as a NAMA concept was finalised in 2013. However, more analysis needs to be conducted on the policies in different sectors as well as examples of mitigation pledges submitted by other countries, e.g. China, India, Indonesia, Brazil, Mexico and Chile before drafting Thailand's NAMA policies for the UNFCCC. This step is conceptually important in the development of NAMAs for the implementation phase. It is also beneficial to the country in terms of international financial support for the internationally supported NAMAs.

In conclusion, the total appropriate GHG mitigation by NAMA measures in the energy sector under domestically and internationally supported NAMAs in 2020 will be about 73 Mt-CO_2, accounting for 20 % from the total GHG emissions

Table 6.4 Payback period of energy efficiency (EE) measures in industry

EE in industry	CO_2 countermeasure	Payback period
Domestic NAMAs	EE lighting	3.5 years
	EE cooling	3.0 years
	EE motors	3.0 years

Table 6.5 Proposed CO_2 countermeasures for Thailand's NAMAs in 2020

NAMAs	CO_2 countermeasures	CO_2 reduction in 2020 (kt-CO_2)
Domestically supported NAMAs	RE power	2568
	EE industries	4762
	Building codes	5909
	Transport/ethanol (AEDP 2012)	5069
	Transport/biodiesel first Gen (AEDP 2012)	5022
	Subtotal	23,330 kt-CO_2
Internationally supported NAMAs	RE power (high abatement costs)	13,456
	EE industries (high abatement costs)	9743
	Transport/biodiesel second Gen (AEDP 2012)	14,459
	Environmental sustainable transport (OTP)	12,000
	Subtotal	49,658 kt-CO_2
Total domestic and supported NAMAs		72,988 kt-CO_2
Total emissions in 2005		192,724 kt-CO_2
Total emissions in BAU2020		367,437 kt-CO_2

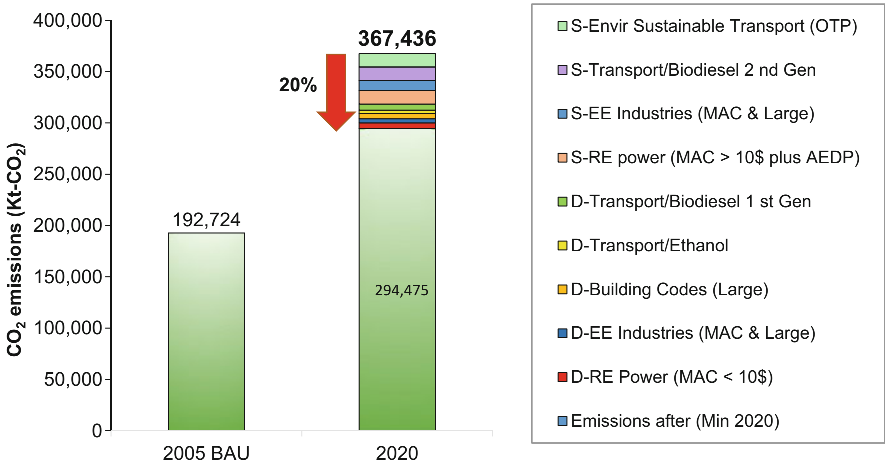

Fig. 6.8 Potential of CO_2 reduction in Thailand NAMA 2020

estimated in the 2020 BAU, where the measures should be explained according to NAMA that:

> Thailand will lower CO_2 emissions by 20 % when compared to the BAU 2020 level.

The potential to reduce the GHG emissions by domestically supported NAMAs is one important measure which could demonstrate the effort Thailand is making as a developing country involved in global GHG mitigation, but, naturally, different countries have different limitations and motivations in developing domestically supported NAMA actions.

A further development in domestically and internationally supported NAMAs is to group NAMAs together, i.e. create ‘Bundled NAMAs’. For example, the Power Development Plan (PDP), waste to energy plan, increased energy efficiency in industrial and building sectors plan, promotion of bioenergy in the transport sector plan and increased energy efficiency in the transport sector plan could be combined as a bundle of NAMAs under Thailand’s NAMAs, which would demonstrate the importance of GHG emission reductions and funding sources. Thailand has considered carrying out further studies on the environmental impacts in other dimensions, sustainable development and financial availability of the government funds to achieve the 2020 GHG mitigation target.

6.8.2 Seeking Financial Support

In Thailand, it is found that there are two sources of domestic funds for the GHG mitigation in energy sector. The first is the ‘Energy Conservation Promotion Fund’ (ENCON Fund), which was established by the energy conservation act to provide financial support for the implementation of energy security and the development of renewable energy. It is responsible for funding efficiency improvements, renewable and alternative energy development, R&D projects, human resources development, public education, campaigns and environmental projects. The ENCON Fund is currently focused more on projects that follow the Thailand 20-Year Energy Efficiency Development Plan 2011–2030 (EEDP) and Thailand 10-Year Alternative Energy Development Plan 2012–2021 (AEDP) but not the climate change issue.

The second fund is the ‘Energy Service Company Fund’ (ESCO Fund), which is supported by the Ministry of Energy. Its objective is to encourage private investment in renewable energy and energy efficiency projects. The ESCO Fund is financed by the ENCON Fund to encourage six kinds of investment: (1) equity investment, (2) ESCO venture capital, (3) equipment leasing, (4) credit guarantee facility, (5) technical assistance and (6) assistance for renewable energy projects in selling carbon credits. Due to its benefits, ESCO would appear to be a very worthy mechanism for the domestically supported NAMA plan.

However, as investments for projects tend to be very high, more funds should be provided to help operators. Such projects warrant further study, though procedures for requesting assistance from the ENCON Fund are still very strict and complex due to the limited and discontinuous nature of the fund, which affects motivation and which in turn is why implementation of NAMAs does not go according to plan or may not achieve the targets. Therefore, implementation of NAMAs will have to rely on funding and capacity building from international sources, such as the Green Climate Fund (GCF). It also needs the cooperation of developed countries such as Germany, despite the presence of limitations, complexity and difficulty in accessing the funds. The funding for GHG mitigation actions in Thailand has very high potential of necessity in the near future since domestic funds are not sufficient and there exist barriers for domestic funding.

In addition to RE and EE NAMA actions, Thailand's transport master plan, the 'environmental sustainable transport system', which is a capital intensive plan proposed by the Office of Transport and Traffic Policy Planning (OTP), will also require international support. However, due to the long lead times of the transport system, this system will contribute less in the NAMA 2020 period but will play a key role in GHG reduction potential post-2020.

6.9 Building Consensus Among NAMA Stakeholders in Thailand

During 2012–2013, several NAMA workshops were carried out among stakeholders of GHG emitters in the power, industry and waste to energy and transport sectors to identify the appropriate GHG mitigation measures and potential in Thailand. As regards Thailand's NAMA stakeholder workshops, the steps in organising stakeholder workshops by ONEP (2014) and TGO (2014) during 2012–2013 are as follows:

1. Organising the workshops and work with experts in related GHG mitigation sectors in order to prepare GHG mitigation potential and mitigation plans in the power, industrial, transport and waste to energy sectors, including preparation of related documents to cover the issues discussed in the workshops
2. Collection of Q&A and discussed issues in the workshops from stakeholders of power, industries, transport, waste to energy, ministerial officers, NGO and private sectors
3. Summary report submitted to the policymakers in the related ministries

Barriers to Thailand's NAMAs have been identified in the stakeholder workshops, including barriers to support for CO_2 countermeasures (CMs). The identified CO_2 CMs under NAMAs show that Thailand and other developing countries have taken the responsibility to prepare voluntary mitigation in the low-carbon development plans toward helping, together with developed countries, to solve global climate issues. However, Thailand and other developing countries require capacity-building assistance in preparing CO_2 CMs under NAMAs. Further, developed countries need to provide support for developing countries in terms of capacity building, technology transfers of CO_2 CMs and financial support.

It was agreed on by the stakeholders that Thailand needs to analyse the policies of all involved agencies, the structure of the organisations involved, the existing energy policies related to GHG emission measures and the barriers to implementing GHG mitigation actions in renewable electricity generation and energy savings in industry, building and transport sectors.

The implementation of GHG mitigation actions within the renewable electricity generation sector and the energy savings in the industry and building sectors can be performed using two approaches—'project-based NAMAs' and 'sectoral-based NAMAs'. Both approaches have to be analysed for the amount of GHG reductions which will involve related organisations during implementation and MRV process. Thailand intends to set up an organisation or group responsible for the follow-up of NAMA implementation and NAMA MRV that will assume the role of 'Thailand NAMA coordinator'.

On the other hand, Thailand has yet to familiarise itself with the 'sectoral-based NAMAs' since most of the actions are nonmarket mechanisms where the structure and process of the GHG mitigation actions are set up by the government, e.g. adders and feed-in tariff scheme for electricity generation from renewable energy (solar, wind, hydro and biomass), which have different types of energy sources, NAMA methodology and NAMA MRV measures. The sectoral-based NAMAs can be adapted for use with other policies in the energy sector, e.g. measures to promote energy efficiency, whilst energy savings in the building and industrial sectors will have different NAMA methodologies and NAMA MRV processes.

6.10 Co-Benefits of Thailand's NAMAs

6.10.1 Energy Security Aspect

Co-benefits of GHG mitigation actions in Thailand NAMAs in terms of energy security have been assessed. The co-benefit aspects under consideration are of the following indicators: (1) Diversity of Primary Energy Demand (DoPED), (2) Net Energy Import Dependency (NEID), (3) Net Oil Import Dependency (NOID), (4) Net Gas Import Dependency (NGID) and (5) Non-Carbon-based Fuel Portfolio (NCFP), along with four co-benefits, which are (1) oil import intensity (OII), (2) gas import intensity (GII), (3) energy intensity (EI) and (4) carbon intensity (CI).

Results from analyses of energy security show that CO_2 countermeasure implementations under Thailand's NAMAs are able to increase national energy security since Thailand's NAMAs are related to the promotion of renewable electricity generation, which will also reduce the use of fossil fuels in electricity generation and increase the energy efficiency in the industrial and building sectors. In the case of a GHG reduction of 20 % in 2020, the indicators for DoPED and

NEID will be increased by 2.66 % and 10.56 %, respectively, whilst the indicators for NOID and NGID will be decreased by 3.65 % and 3.62 %, respectively, when compared to BAU for 2020. From the increase in renewable energy, the CO_2 emissions can be reduced, which will result in an increased NCEP indication of 18.99 %.

In addition, the indicators on OII and GII will be decreased by 8.14 % and 8.35 %, respectively. Furthermore, the indicators on energy intensity and carbon intensity in the case of a GHG reduction of 20 % in 2020 will be decreased by 17.9 % and 18.3 %, respectively, when compared to BAU.

Therefore, promoting the use of renewable energy can increase the energy security indices and GHG mitigation in Thailand. In general, Thailand still has many kinds of useful renewable energy resources which have high potential to be utilised because Thailand is an oil-importing country, so it is important that the government give more attention to promote the renewable energy resources to replace the imported fossil fuels (Limmeechokchai et al. 2014).

6.10.2 Environmental Aspect

Thailand NAMA implementation will directly result in decreased fossil fuel consumption. Consequently, a large amount of GHG emissions will be mitigated. In addition, other gases from combustion of fossil fuels will be mitigated as well. Transport NAMA actions will directly improve local and city air quality. It was also found that Thailand's NAMA actions will result in not only decreased CO_2 emissions, but also decreased CO, NO_x and SO_2 emissions.

6.10.3 Economic Aspect

The GHG countermeasures in Thailand's NAMAs have been assessed in terms of macroeconomic effects by using the input-output table. Results show that investment from the economic sector in Thailand's renewable energy power plants can be increased, which will cause an increase in the domestic production when compared to the 2020 BAU scenario. It also means an increase in investment for biomass and hydropower plant power generation, despite the fact that domestic production will be decreased due to solar and wind power projects. However, decreasing GDP in 2020 will come from investment of the private and public consumption sectors due to imported commodities resulting from the import of renewable technologies such as solar PV and wind turbines. Employment in the country will increase in 2020 as a result of increased activity in electricity production from domestic biomass.

Results of macroeconomic analyses based on increased energy efficiency of motors and lighting in the industrial sector show no economic stimulus, which will decrease the GDP by 1.25 billion Baht, increase the imported commodities by 1.19

billion Baht and increase the investment of the private and public consumption sector in implementing new motors by 0.83 billion Baht. However, the energy efficiency measures will help decrease the import of fossil fuels and gain more benefit when compared to the decreased GDP and also increase Thailand's energy security.

The analysis covering increased energy efficiency of cooling systems via installation of insulators for building envelopes and of lighting systems via upgraded light bulbs in the building sector shows that there is no increase in economic stimulus, which will decrease the GDP by 18.59 billion Baht, decrease the value of exports by 6.84 billion Baht and decrease the value of imports by 0.49 billion Baht. Moreover, the increased energy efficiency will decrease the private and public consumption sectors by 6.67 billion Baht and domestic production by 18.59 billion Baht. This means Thailand can reduce the amount of imported fossil fuels, which will outweigh the reduced GDP. This also increases Thailand's energy security.

6.10.4 Social Aspect

It is evident that the EE NAMA actions in the residential and commercial building sector will result in reduced energy cost for households and building owners. The social aspect of Thailand's NAMA actions has been assessed as savings per household and saving per unit of electricity consumption of buildings. In the NAMA case of a 20 % CO_2 reduction in 2020, it was found that the annual electricity bill saving per household will be around 60 USD. This social aspect of co-benefits shows the positive impact of Thailand NAMA actions, and finally it helps readily adopt EE NAMA actions.

6.11 Layout of Roadmap to Thailand NAMA 2020

To achieve a GHG reduction of 7–20 %, as Thailand communicated in its mitigation pledge to UNFCCC in Lima COP20, the Office of Natural Resources and Environmental Planning and Policy (ONEP) under MONRE proposed a roadmap to Thailand's 2020 NAMAs (see Fig. 6.9). This roadmap includes both domestically and internationally supported NAMAs (ONEP 2014). If GHG countermeasures implemented under Thailand's NAMA roadmap during 2014–2020 successfully clear the MRV processes, the higher GHG mitigation target of 20 % in 2020 will be achieved easily. However, the NAMAs still need support in terms of capacity building, financing, technology transfer and removal of EE barriers (Asayama and Limmeechokchai 2014).

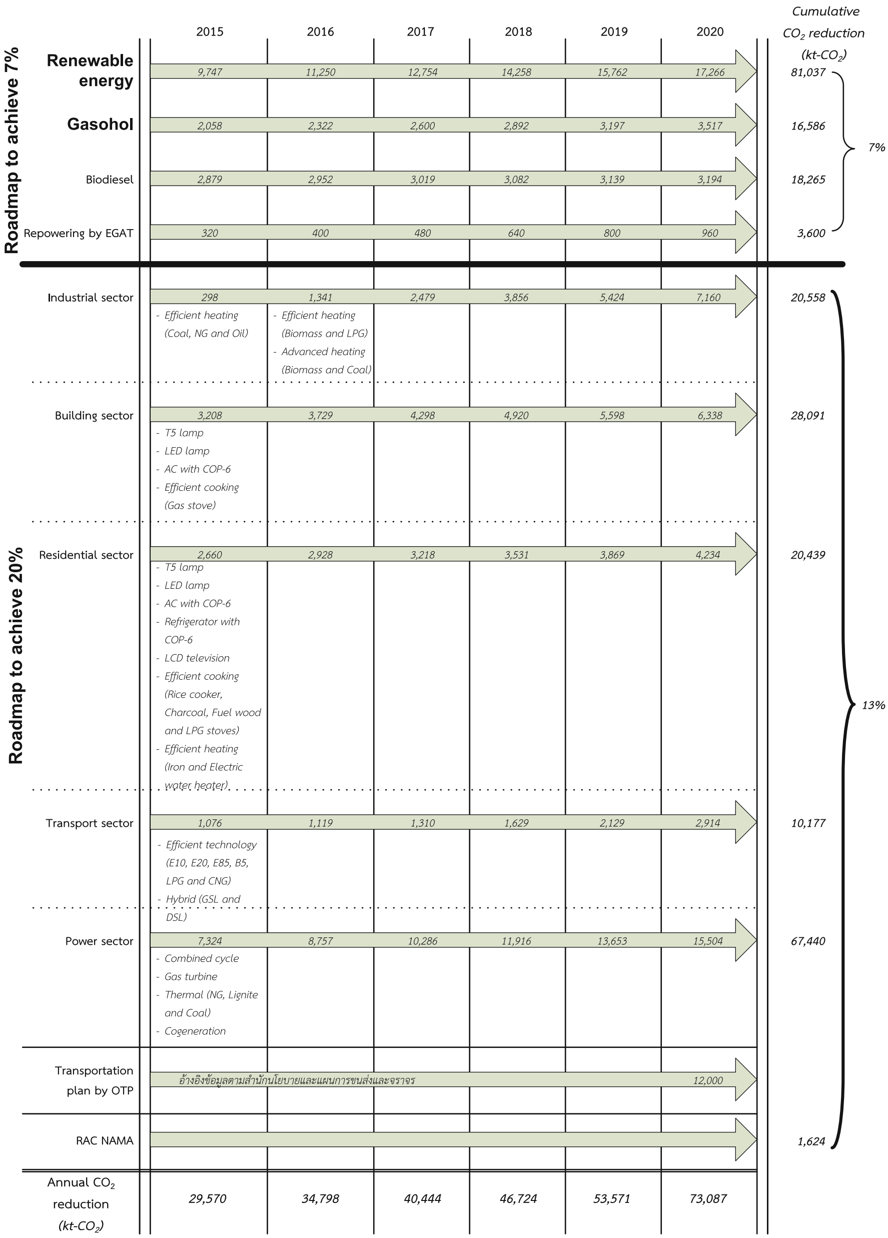

Fig. 6.9 Roadmap to Thailand's 2020 NAMAs

6.12 MRV of Thailand's NAMAs: The Road to Success

Thailand has prepared a NAMA roadmap in relation to the estimated GHG emission reductions. The MRV process under Thailand's NAMA actions complies with the UNFCCC process; thus, it will not cause more barriers to the NAMA MRV or the procedure according to the mitigation actions for both project-based NAMAs and policy-based NAMAs. Before pushing ahead with the projects, meetings with stakeholders must be held. These meetings need to be arranged by the agencies responsible for the MRV process, and MRV guidelines for each project need setting. This can be done by the working group and coordinator from the department of energy and climate change and by the working groups on GHG mitigation in the energy sector from the Ministry of Energy, together with the working groups from the Ministry of Energy and MONRE.

It was found that strategies for reduced GHG emissions from the use of renewable energy for electricity generation, increased energy efficiency in buildings and energy savings in industries are high priorities under Thailand's NAMA actions. However, for the NAMA actions to be achieved successfully, the organisations and the MRV process have to be developed at the same time as the NAMA action.

For the RE NAMA actions, the MRV process requires cooperation among ONEP, TGO, Ministry of Energy (Department of Alternative Energy Development and Efficiency), Energy Regulatory Commission (ERC) and Energy Policy and Planning Office (EPPO) (see Fig. 6.10a, b). These agencies will be responsible for NAMA MRV so that NAMA actions will be achieved to meet the targets of the AEDP plan and the targets for GHG emission reductions following the NAMA actions.

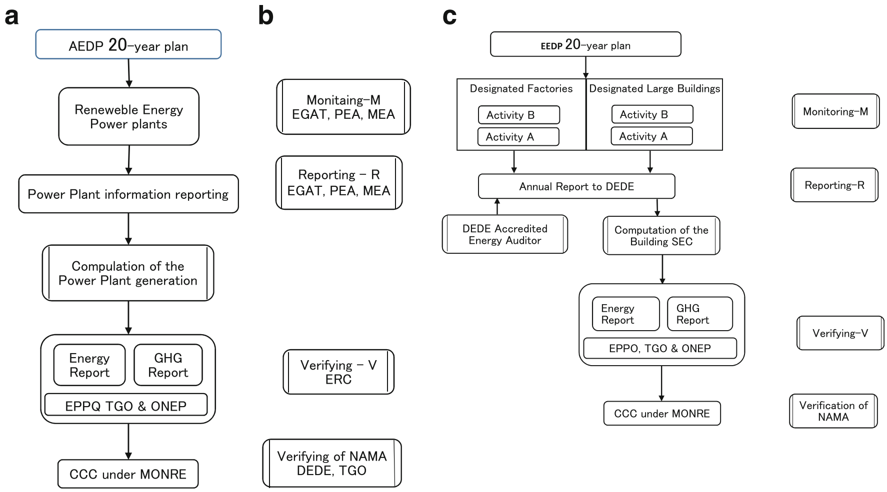

Fig. 6.10 MRV processes of domestically supported NAMAs (**a**) MRV of RE power generation (**b**) MRV of substitution of biofuels for fossils (**c**) MRV of energy efficiency in buildings and industries

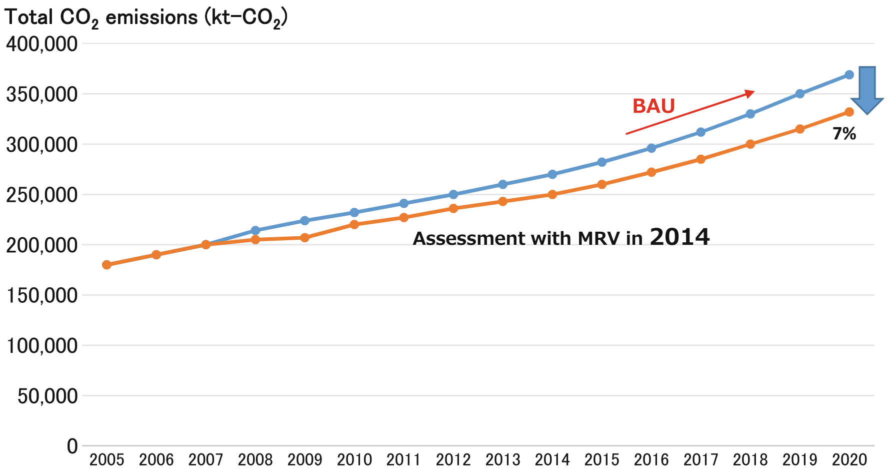

Fig. 6.11 Success of MRV process for domestically supported NAMAs

For the EE NAMAs, the actions are related to energy efficiency in industry and buildings. The MRV process requires cooperation among TGO and the Ministry of Energy (Department of Alternative Energy Development and Efficiency) (see Fig. 6.10c). These agencies will be responsible for NAMA MRV so that NAMA actions will accomplish the targets in energy conservation in industry and buildings and the targets for GHG emission reductions.

Finally, in October 2014, the ONEP revealed roadmap to Thailand's NAMAs. It shows that the domestic MRV processes of both RE and EE NAMAs already achieve a CO_2 reduction of 7 % (Fig. 6.11).

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Chapter 7
'Science to Action' of the Sustainable Low Carbon City-region

Lessons Learnt from Iskandar Malaysia

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Abstract This paper outlines the lessons learnt through the multidisciplinary 'Science-to-Action' approach to formulating, mainstreaming and implementing the *Low Carbon Society Blueprint for Iskandar Malaysia 2025* (LCSBP-IM2025). Iskandar Malaysia (IM) is a rapidly developing urban region in southern Peninsular Malaysia that was institutionalised in 2006 with a view to spurring Malaysia's economic growth up to 2025. In pursuing rapid economic growth to become a developed, high-income nation by 2020, Malaysia is conscious of its global responsibility in environmental protection and global climate change mitigation, hence the country's commitment to reducing its carbon emission intensity of GDP by up to 40 % by 2020 based on the 2005 level. Being a premier economic region in Malaysia, IM seeks to develop a low carbon society (LCS) and lead the way to cutting its carbon emission intensity by up to 58 % by 2025 based on the 2005 level through the implementation of the LCSBP-IM2025.

The LCSBP-IM2025 is the outcome of an internationally funded joint research under the SATREPS programme that brings together Universiti Teknologi Malaysia (UTM), Kyoto University, Japan's National Institute for Environmental Studies (NIES), Okayama University and the Iskandar Regional Development Authority (IRDA), in a unique 'academia-policymaker' partnership, towards crafting an LCS pathway to guide and sustainably manage the projected rapid development in IM up to 2025. To that end, a multidisciplinary research team that comprises the above research institutions and IRDA, led by UTM, has been set up. A methodology has

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been developed to formulate IM's future LCS scenarios, propose LCS actions to achieve the LCS scenarios, quantify the GHG emission reduction potential of the proposed LCS actions and continuously engage local stakeholders in a series of focus group discussions (FGDs).

The project has been a great success from its official commencement in July 2011, which saw the LCSBP-IM2025 being launched at UNFCCC's COP 18 in Doha in November 2012 and officially endorsed by the Malaysian Prime Minister in December the same year. In November 2013, the *Iskandar Malaysia Actions for a Low Carbon Future* was launched, outlining ten priority projects selected from the LCSBP-IM2025's 281 programmes for implementation in IM in 2013–2015; the projects are now at various stages of implementation, yielding real impacts on IM's progression towards its LCS goal.

The project offers valuable lessons especially in advancing *scientific research* on LCS into *policymaking* and, importantly, into *real actions* (hence, Science to Action). These include the importance of having strong highest-level government support, aligning LCS actions to higher-level development priorities, taking policymakers on-board the research team, continuously actively engaging local communities and stakeholders through FGDs and overcoming science-policy and disciplinary gaps that emerged. What is clearly evidenced by the LCSBP-IM2025's success is that developing countries, with good synergy between highly committed local research institutions and policymakers, subject to adequate international funding and technological assistance from developed nations, are capable of crafting and putting in place implementable LCS policies that eventually contribute to mitigating global climate change through real cuts in GHG emissions while still achieving a desired level of economic growth.

Keywords Low carbon society (LCS) • Science to Action (S2A) • Iskandar Malaysia • Low carbon society blueprint • Academia-policymaker partnership • Extended Snapshot Tool (ExSS) • GHG emission mitigation • Green growth • Urban region • Lessons learnt

Key Messages to Policymakers

- Low carbon society is the way forward to strong, sustainable cities and regions.
- Internationally funded joint research on LCS is essential to developing countries.
- Good scientific research is cornerstone to effective implementation of LCS policies.
- Policies supported by science are effective for realising GHG emission reduction.
- Highest-level government support greatly expedites LCS science to LCS actions.

7.1 Introduction

Malaysia, like most other rapidly urbanising ASEAN countries, though not a significant source of emissions of greenhouse gases (GHG), has taken actions to address climate change through various environmental, economic and social initiatives over the years. In 2009, Malaysia voluntarily set a target for GHG reduction of up to 40 % in terms of energy intensity of GDP by 2020 compared to 2005 levels. Following that, a series of national-level key policies aiming at guiding the nation towards addressing climate change holistically, ensuring climate-resilient development, developing a low carbon economy and promoting green technology have been formulated. These include the *National Policy on Climate Change* (MNRE 2009), *National Green Technology Policy* (KeTTHA 2009a), *National Renewable Energy Policy and Action Plan* (KeTTHA 2009b) and the *Green Neighbourhood Planning Guideline* (JPBDSM 2012), among others. These are important in providing a framework for achieving Malaysia's broader sustainable development goals, while the country elevates itself to become a high-income nation by 2020 (PEMANDU 2010). At the national level, the Malaysian Government is positioning the ecosystem, value system and supply chain to create a vibrant low-carbon economy. Apart from national mitigation and adaptation strategies for addressing the impact of climate change, there is a need to also look into regional and local resilient policies to reduce GHG emissions, especially in major cities and economic development corridors involving many urban conurbations. It is indeed at the regional and local levels that climate change policies may be operationalised and see their effects.

The International Energy Agency estimates that urban areas currently account for two thirds of the world's energy-related GHG emissions, and this is expected to rise to about 74 % by 2030 (World Bank 2010). Cities especially in developing countries with rapid population growth and economic development are consuming vast natural resources, generating enormous amounts of wastes and emitting large volumes of GHGs. Despite the fact that cities are the main carbon emission contributors, experts largely agree that cities nonetheless offer the greatest opportunity for mitigating climate change. City-based climate change policies are proven to be effective and efficient, feasible and relatively easy to deliver as compared to national climate change policies. Many cities, predominantly in developed countries, have established action plans and road maps to tackle climate change issues. However, difficult challenges lie ahead of cities in developing and transition nations in Asian regions, including Malaysian cities, where urban population is high and growing fast, economic growth is rapid and general awareness of climate change is relatively low; there appears to be an observable lack of knowledge, experience and urgency in mitigating climate change at the city and regional levels.

In line with the Malaysian Government's objectives to strengthen economic competitiveness and improve quality of life, and its aspiration for promoting green economic growth and greater sustainability, Iskandar Malaysia (IM), a rapidly developing economic corridor established in 2006, sets out to be the first urban region in Malaysia to formulate and implement a city-regional level climate change action plan – the *Low Carbon Society Blueprint for Iskandar Malaysia 2025* (LCSBP-IM2025). Optimistically, the LCSBP-IM2025, being perhaps among the first few city-regional level climate change action plans in developing countries, does not only benefit IM in laying out a clear sustainable development pathway for the urban region but also other Malaysian and Asian cities and regions through the sharing and dissemination of good practice and experiences gained in drawing up the Blueprint for implementation. The purpose of this paper is to outline the experiences gained and lessons learnt through the multidisciplinary 'Science to Action' (science to policy to implementation) approach to drawing up and mainstreaming the LCSBP-IM2025 for implementation in IM.

7.1.1 About Low Carbon Society Blueprint for Iskandar Malaysia 2025

The *Low Carbon Society Blueprint for Iskandar Malaysia 2025* is a written document that presents comprehensive climate change mitigation policies and detailed strategies to guide the development of Iskandar Malaysia towards becoming 'a strong and sustainable metropolis of international standing' in 2025, in line with the urban region's development vision. The LCSBP-IM2025 incorporates various related national policies, the *Comprehensive Development Plan for South Johor Economic Region 2006–2025* (CDP) (Khazanah Nasional 2006) and 24 Iskandar Malaysia blueprints towards transforming IM into a sustainable, low carbon metropolis that is built on solid economic foundations (for more details on the policy context and framework of the Blueprint, see Sect. 7.2). The LCSBP-IM2025 provides and explains technical details of carbon mitigation options (with specific measures and programmes) for implementation in IM. It is aimed at coordinating and guiding the implementation of a total of 281 programmes organised under 12 low carbon society (LCS) policy actions in IM in order to lead the urban region towards achieving a targeted 50 % reduction in GHG emission intensity of GDP by 2025 based on the 2005 level.

7.1.2 Low Carbon Society (LCS)

The concept of low carbon society (LCS) is the fundamental philosophy that underpins the formulation of the LCSBP-IM2025. LCS is an emerging theory and is defined as (Skea and Nishioka 2008, p. S6):

> A society that takes actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within the society are met.

> A society that makes an equitable contribution towards the global effort to stabilise atmospheric concentrations of carbon dioxide and other greenhouse gases (GHGs) at a level that will avoid dangerous climate change through deep cuts in global emissions.
>
> A society that demonstrates high levels of energy efficiency and uses low carbon energy resources and production technologies.
>
> A society that adopts patterns of consumption and behaviour that are consistent with low levels of GHGs emission.

The ideology of LCS emphasises 'people' – the society – as the source of, and at the same time, solution to, climate change. It highlights existing human activities as the main contributors to global GHG emissions and therefore calls for efforts of the current society in all sectors to shift their mass consumption behaviour and lifestyle to a new consumption pattern that poses less harm to the environment. Low carbon society is a new society that consumes relatively low amounts of resources (raw materials, energy and water) in minimising GHG emissions to avoid adverse effects of climate change. Despite the fact that the concept stresses on social reform for better environmental system, it does not compromise the attainment of robust economic growth and maintenance of high quality of life. In this light, there are two fundamental aspects of LCS in leading societies towards reducing GHG emissions:

1. 'Decoupling' of economic activities, urban growth and urban transportation from intense resource and energy consumption and GHG emissions towards minimising the environmental impacts of increased economic activities and transportation (see Li 2011; UNEP 2011, 2014)
2. Exploration for attainment of potential social, environmental and economic 'co-benefits' arising out of climate change policies, which have been found to be highly pertinent to effective implementation at the local city level and to getting greater political acceptance of the policies (see de Oliveira et al. 2013; Seto et al. 2014)

In realising LCS, various 'soft' and 'hard' infrastructure developments/improvements are needed to encourage communities to change their preferences and behaviours to the practice of green lifestyles. 'Soft' infrastructure includes intangible elements that comprise of awareness, education, governance, institutions, legislation and finance. On the other hand, 'hard' infrastructure refers to physical elements that include the urban form, land use structure, transportation system, technology, building design and utilities (see Fig. 7.1). Specific strategies for low carbon society transformation for one city will be different from another city with respect to their geographic, economic, political and sociocultural contexts.

7.1.3 Iskandar Malaysia (IM) in Brief

Iskandar Malaysia, previously known as the South Johor Economic Region (SJER) and the Iskandar Development Region (IDR), is a visionary economic region in the

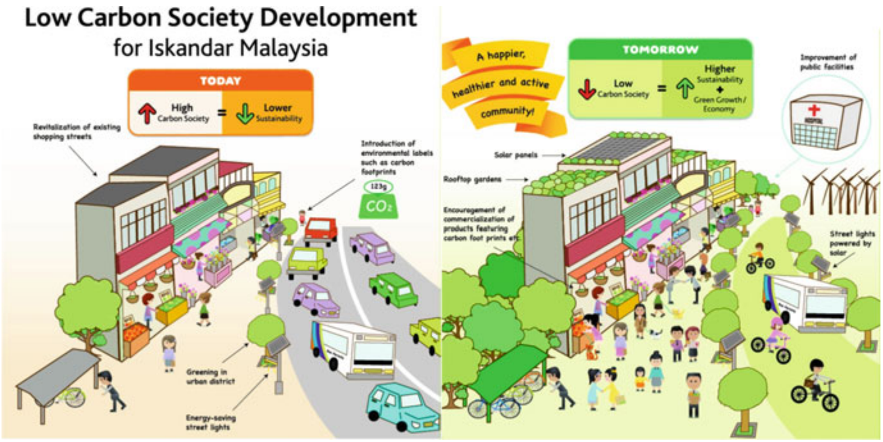

Fig. 7.1 Schematic representations of social-environmental-economic transformations involving changes in lifestyle and technology that will bring about a low carbon society in Iskandar Malaysia (Source: IRDA 2014)

southern tip of Peninsular Malaysia. The region with the size of 221,634 ha (2,216.3 km^2) was established in 2006 as one of the catalyst development corridors to spur growth of the Malaysian economy into the first quarter of the twenty-first century. In the macro-regional context, IM is strategically located at the southern-most tip of Mainland Asia to tap on a vast and burgeoning market of about 0.8 billion people within a 6-hour flight radius (Fig. 7.2).

Envisioned to be ‘a strong and sustainable metropolis of international standing’ and set to become an integrated global node that synergises with growth of the Global City State of Singapore and the Riau-Batam Region of Indonesia, it has been projected that IM will be sustained by a rapid annual gross domestic product (GDP) growth of 7–8 % that will almost quadruple the GDP of the urban region to MYR141.4 billion in 2025. The urban region is expected to experience a concomitant rapid population growth, with Iskandarians more than doubling from 1.35 million in 2005 to about 3 million by 2025 (Khazanah Nasional 2006).

As shown in Fig. 7.2, five flagship zones have been established as the main economic growth centres with their respective niche sectors in IM. These flagship zones have been envisaged to both further strengthen and value-add to the urban region’s existing economic clusters as well as to diversify and develop targeted strategic growth sectors.

In terms of local administration, IM covers the entire Districts of Johor Bahru and Kulai and three subdistricts of Pontian. The administrative jurisdiction of the urban region falls under five local authorities (which are also the respective local planning authorities (LPAs) for their areas), namely, the Johor Bahru City Council (MBJB), Johor Bahru Tengah Municipal Council (MPJBT), Pasir Gudang Municipal Council (MPPG), Kulai Municipal Council (MPKu) and Pontian District Council (MDP) (see Fig. 7.3). In addition to traditional state and local

Fig. 7.2 Geographic location of Iskandar Malaysia within the Southeast Asian region and the five flagship zones in Iskandar Malaysia (Source: Adapted from http://www.iskandarmalaysia.com.my/)

administrative institutions, towards expediting and ensuring effective implementation and materialisation of development plans and policies in IM, the Iskandar Regional Development Authority (IRDA) has been set up under the Iskandar Regional Development Authority Act, 2007 (Act 664). Under this Parliamentary Act, IRDA which is co-chaired by the Malaysian Prime Minister and Johor State *Menteri Besar* (literally the 'Chief Minister') holds the statutory functions of planning, promoting, coordinating and facilitating development and investments in IM.

As Iskandar Malaysia undergoes very rapid physical-spatial development and economic growth, it becomes highly essential that the social and environmental impacts of its rapid expansion and economic growth are mitigated, guided by a holistic LCS blueprint that will fit into the existing development planning and institutional framework presently at work in the urban region.

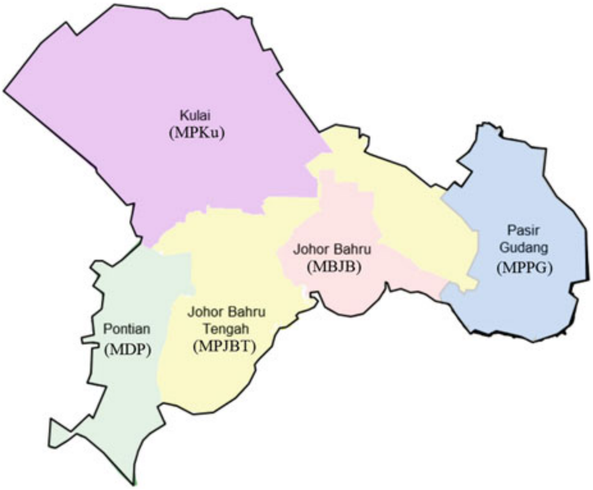

Fig. 7.3 Municipal jurisdictions within the Iskandar Malaysia economic corridor (Source: Adapted from Khazanah Nasional 2006)

7.2 Integrating Low Carbon Society Blueprint into Existing Policy Framework

Since its inception in 2006, development in Iskandar Malaysia has been governed by various policies, plans and guidelines at the national, state and local levels. Specifically, IM has a statutory Comprehensive Development Plan (CDP) that is provided for under the Iskandar Regional Development Authority Act, 2007 (Act 664) and a series of 24 blueprints covering various development aspects of the urban region (see Fig. 7.4, column 2); the blueprints gain statutory status by means of adoption by the Johor State Planning Committee (SPC) under the Town and Country Planning Act, 1976 (Act 172). The main function of the CDP and blueprints is to provide a development coordination framework by which all government entities within Iskandar Malaysia are to legally abide under Act 664.

At the same time, IM is also home to five local planning authorities (LPAs) that hold the traditional statutory role of planning and regulating development and use of land within their administrative areas under Act 172. The LPAs come under the *Johor Bahru District and Kulai District Local Plan 2020*, which is the statutory plan provided for under Act 172 for guiding and regulating land use and development in the Johor Bahru and Kulai Districts (which jointly cover most of Iskandar Malaysia) (Fig. 7.4, column 3). The Local Plan is required by law to take cognisance of and provide clear spatial articulation to higher-level development policies, including the *Johor State Structure Plan 2020*, the *National Physical Plan-2* as well as other general development policies (Fig. 7.4, column 4). Most LPAs also enact their respective development policies and planning guidelines that have to be in line with the Local Plan. However, reducing energy and carbon emission intensity of rapid growth has to date not been an agenda of these plans and policies.

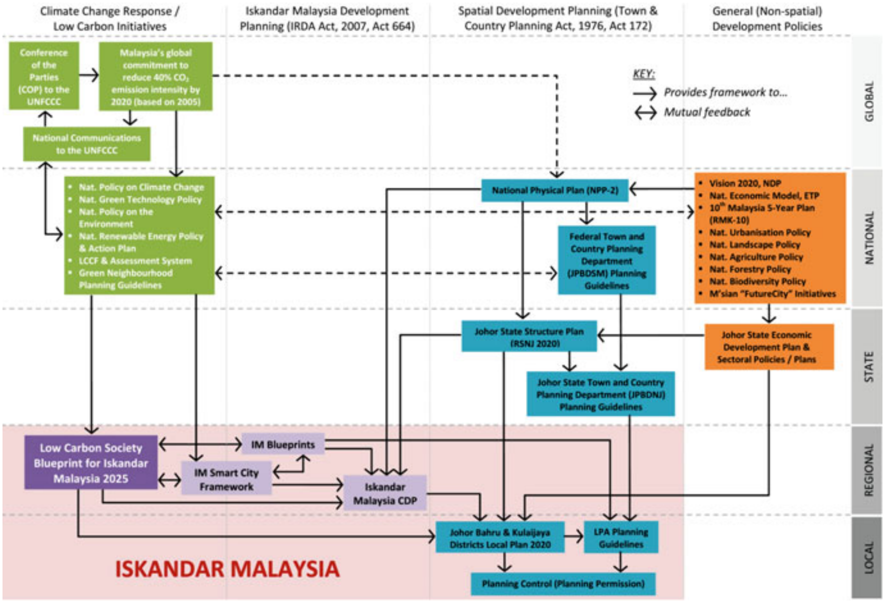

Fig. 7.4 Policy context of the LCSBP-IM2005 which serves as the critical link between global and national climate change initiatives and policies and local development planning policies and regulation mechanisms (Source: UTM-Low Carbon Asia Research Centre 2013a, p. 3–4)

Since the honourable Prime Minister of Malaysia made the pledge of voluntary reduction of the country’s carbon emission intensity at COP 15 in 2009, a series of national-level climate change responses and low-carbon initiatives have emerged in the forms of policies, framework and guidelines (Fig. 7.4, column 1). However, these policies and guidelines have yet to find their way into the lower-level development policies, plans and guidelines that are more effective and detailed in guiding and regulating physical-spatial development but are hitherto largely ‘carbon blind’.

Being a premier economic corridor in Malaysia, it is only appropriate that IM leads the way in contributing to honouring the country’s pledge to reduce its carbon emission intensity by 40 % (based on 2005 emission levels) by 2020. It is in this light that the *Low Carbon Society Blueprint for Iskandar Malaysia 2025* is formulated to provide the crucial policy link between the country’s global and national climate change responses (Fig. 7.4, column 1) and Iskandar Malaysia’s regional- and local-level development plans and policies. To that end, the Blueprint sets a GHG emission intensity reduction target of 50 % by 2025, based on the 2005 emission level. The target would be achieved through implementing 12 LCS actions set under three main themes: *Green Economy*, *Green Community* and *Green Environment*. The Blueprint also takes special cognisance of the recently launched Iskandar Malaysia Smart City Framework that sets out the general characteristics of

IM as a smart city, which include elements of reducing carbon emission and emphasis on development of ICT infrastructure.

Once adopted by the SPC, the Blueprint shall provide a statutory policy framework for the CDP, which is currently under review, and serve as the 'umbrella blueprint' for the existing 24 IM blueprints which need to be progressively revised to incorporate relevant LCS policies and strategies. As required under Act 664, these would subsequently trickle down to the *Johor Bahru District and Kulai District Local Plan 2020* and various LPA planning guidelines and take effect through the granting of planning permissions to future developments in IM (Fig. 7.4, pink box).

7.3 Policy Design for Low Carbon Society Blueprint in Iskandar Malaysia

7.3.1 Science-to-Policy Approach to Designing the LCSBP-IM2005

The LCSBP-IM2025 is developed from a unique 'academia-policymaker' partnership with the involvement of various stakeholders (local communities; NGOs; businesses and industries; Federal, State and local authorities) along the way. The application of well-tested scientific modelling to inform LCS policies and the promotion of green technologies and industries in the Blueprint towards achieving industrial growth and social well-being and transforming governance are in line with the recent 'Science to Action' (S2A) initiatives championed by the Malaysian Prime Minister (New Partnership for Climate Resilient Development 2014).

Through S2A, the government aims to intensify the application of science and technology as a key pillar of the nation's development and the *rakyat's* (people's) well-being. In the context of the LCSBP-IM2025, the application of science and technology is in the area of climate change mitigation, environmental protection and urban planning for urban-regional development. It involves the joint efforts between four research institutions from Malaysia (Universiti Teknologi Malaysia) and Japan (Kyoto University, National Institute for Environmental Studies (NIES) and Okayama University) and also a regional development authority (Iskandar Regional Development Authority) that is responsible for coordinating and enabling development in the Iskandar Malaysia region (see Fig. 7.5).

The overall process as shown in Fig. 7.5 begins with the usual information gathering, analysis and contextual appraisal of current development, carbon emission and policy scenarios in Iskandar Malaysia. This informs the setting of IM's LCS goals and carbon emission reduction target in 2025. These then feed into an iterative process of formulating policy actions, measures and programmes and testing them via the *Asia-Pacific Integrated Model* (AIM) against the achievement of set goals and targets. The AIM is a suite of scenario-based quantitative

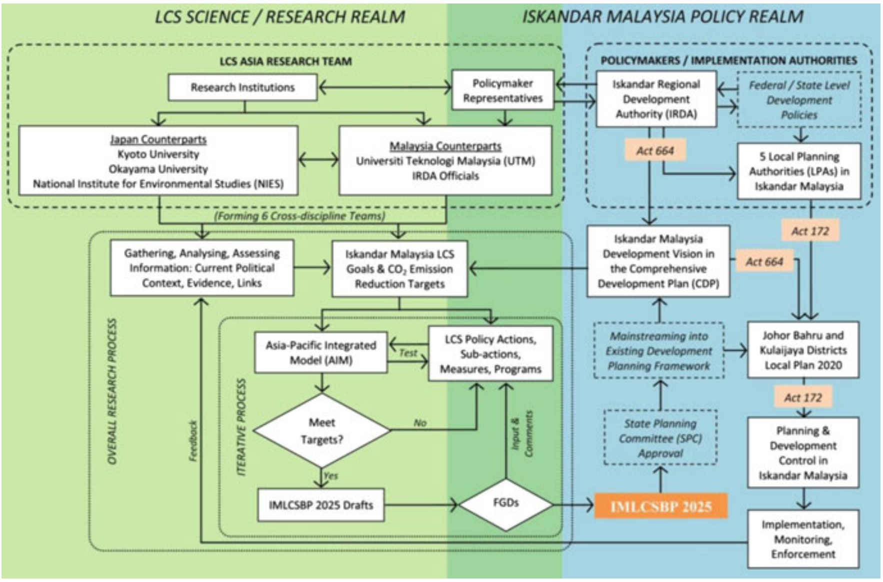

Fig. 7.5 The science/research-policymaking model that emerged from the formulation of the LCSBP-IM2025 and mainstreaming of the Blueprint into the existing development planning institutional framework (Source: UTM-Low Carbon Asia Research Centre 2013a, p. 0–6)

accounting tools that are able to both forecast multiple-scenario GHG emissions and then 'backcast' based on the selected GHG emission reduction scenario to guide timely implementation of policies and allocation of resources in order to achieve the emission reduction target. The AIM has been widely used in many countries and is recognised by the Intergovernmental Panel on Climate Change (IPCC), an international leading body for the assessment of climate change. The main tool used to forecast GHG emissions of different scenarios in IM – the Extended Snapshot tool (ExSS) – will be explained in more detail below (see Sects. 7.3.2 and 7.3.3).

Stakeholder participation is built into the process at this stage through a series of focus group discussions (FGDs) where proposed actions, measures and programmes are scrutinised by stakeholders and their opinions are gathered and fed back into the policy formulation process. A total of five rounds (nine sessions) of FGDs have been held until the final draft of the Blueprint was ready for consideration for approval by the State Planning Committee (SPC) and subsequent mainstreaming (see UN-Habitat 2012) into the existing development planning framework for implementation.

The LCSBP-IM2025 is therefore formulated based on scientific and quantitative modelling that incorporates cyclical input and feedback from various stakeholders, resulting in practical and feasible LCS policies with improved public acceptance, corporate buy-in and eventual policymaker adoption and implementation of the policies. The Blueprint thus exemplifies effective sustainable development policymaking that is scientifically based and institutionally context sensitive. The holistic and integrated features of the Blueprint are shaped by six interrelated multidisciplinary expert groups from Malaysia and Japan, covering the aspects of Land Use and Scenario Integration; Transportation and Air Quality; Energy Systems; Sustainable Waste Management, Education and Consensus Building and regional development planning and governance (IRDA).

7.3.2 Creating LCS Scenarios – The Extended Snapshot (ExSS) Tool

This section explains the procedure and methodology of the Extended Snapshot tool (ExSS) in GHG emissions accounting that informs the design of GHG emission mitigation options for Iskandar Malaysia. ExSS is developed by Kyoto University and the National Institute for Environmental Studies (NIES), Japan, and was first launched in 2006 (Ali et al. 2013). It is a static accounting model with simultaneous equations and the ability to project consistent socio-economic variables, energy demand and supply and CO_2 emissions from energy consumption in a particular future year based on a set of future assumptions of development and energy technologies. The tool quantifies economic growth and changes in industrial structure; demography; changes of lifestyles in terms of consumption pattern and energy service demand; transport volume and structure; and low carbon measures that include energy-efficient devices and buildings, renewable energy, modal shift to public transport and fuel mix in power generation (see Gomi et al. 2010).

The methodology for creating LCS scenarios builds on the idea of 'backcasting', which begins with the setting of a desirable LCS goal followed by iterative explorations of possible options to achieve the goal using ExSS. Figure 7.6 summarises the overall process of the method which comprises seven steps.

1. Setting the framework

Framework of an LCS scenario includes a target area, a base year, target year(s), environmental targets and a number of scenarios. The base year provides the base scenario against which the target year scenario is compared. The target year should be far enough to realise the required change and yet near enough to capture with reasonable clarity the development vision and future scenarios in the target area. In the preparation of the LCSBP-IM2025, 2005 is selected as the base year, while the target year of IM's LCS scenario has been set as 2025. For the environmental target, CO_2 from energy use is opted for because it is expected to be a main source of GHG emissions in IM in 2025.

2. Descriptions of socio-economic assumptions

Before conducting the quantitative estimation, the qualitative future image of the target area's development is narrated. It is essentially an image of demography,

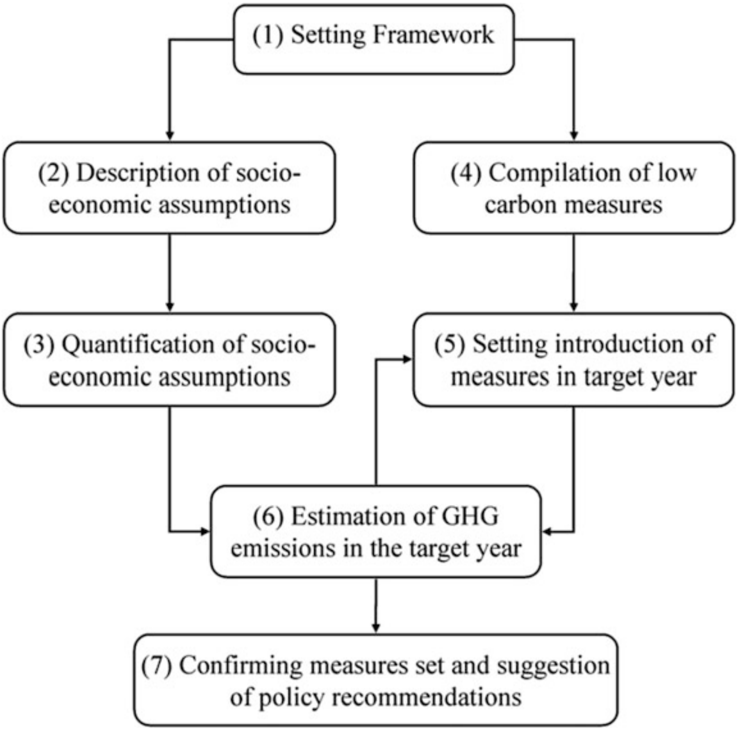

Fig. 7.6 Creating LCS scenarios, overall process (Source: Gomi et al. 2010, p. 4786)

lifestyle, economy and industry, land use, transportation, technology available, its diffusion level and so on. For the purpose of LCSBP-IM2025, Iskandar Malaysia's Comprehensive Development Plan (CDP) and various State and local official economic and development planning documents have the main sources on which future scenarios of IM are based.

3. Quantification of socio-economic assumptions

To provide 'snapshots' of estimated energy use and GHG emissions based on the future image of IM in Step (2), values of exogenous variables and parameters are set. These are then input into ExSS which then calculates various socio-economic indices of the target year, including population, GDP, output by industry, passenger and freight transport demand.

4. Compilation of low carbon measures

The next step involves the compilation of countermeasures (CM) which are expected to be available in the target year, for example, high-energy-efficiency devices, transport structure change such as public transport, use of renewable energy, energy-saving behaviour and carbon sink. Technical data are required to estimate their effects on reducing GHG emissions. For the purpose of the LCSBP-

IM2025, the technical data used have been based on those from a preceding study in Japan's Shiga Prefecture due to limited availability of IM-specific information and, importantly, similarity in the industrial structure and population size of the Shiga and IM regions.

5. Setting introduction of countermeasures

Technological parameters related to energy demand and CO_2 emissions, in short energy efficiency, are defined at this stage. Since there can be various portfolios of the measures, it is crucial that appropriate criteria are chosen, for example, cost minimisation, acceptance to stakeholders (through FGDs), realistic levels of technological development and their diffusion rates.

6. Estimation of GHG emission in the target year

Based on the socio-economic indices and assumptions of countermeasures' introduction set in Steps (3) and (5), GHG emissions are finally calculated using ExSS. If the resultant GHG emissions meet the preset reduction target, the correspondent combinations of countermeasures are selected for policy proposal in the next step. Otherwise, Step (5) will be repeated where countermeasures and technological parameters are reset until the GHG reduction target is achieved.

7. Proposal of policies

Policy set to introduce the countermeasures defined is proposed. Available policies depend on the context of the municipality, region or country which they are aimed at addressing. ExSS can calculate emission reduction potential for each countermeasure. Therefore, it can show the reduction potential of measures which especially need to be prioritised. It can also identify measures which have high reduction potential and are therefore important.

7.3.3 *Structure of Extended Snapshot (ExSS) Tool*

The Extended Snapshot tool is a key component of the aforementioned Asia-Pacific Integrated Model (AIM) developed by Kyoto University and NIES, Japan. It is a modelling tool to assess future energy consumption, power generation, technology diffusion, transportation, industrial outputs, residential and commercial activities and waste generation and GHG emissions, coupling with predetermined socio-economic, industrial and demographic scenarios in a particular future year (the target year).

Figure 7.7 shows the simplified internal working and data structure of the ExSS tool, which comprises four modules (driving forces, energy service demand, primary energy supply and GHG emissions) with input parameters, exogenous variables and variables between modules. ExSS is a system of simultaneous equations. Given a set of exogenous variables and parameters, solution is uniquely defined. In this simulation tool, only CO_2 emissions from energy consumption are calculated.

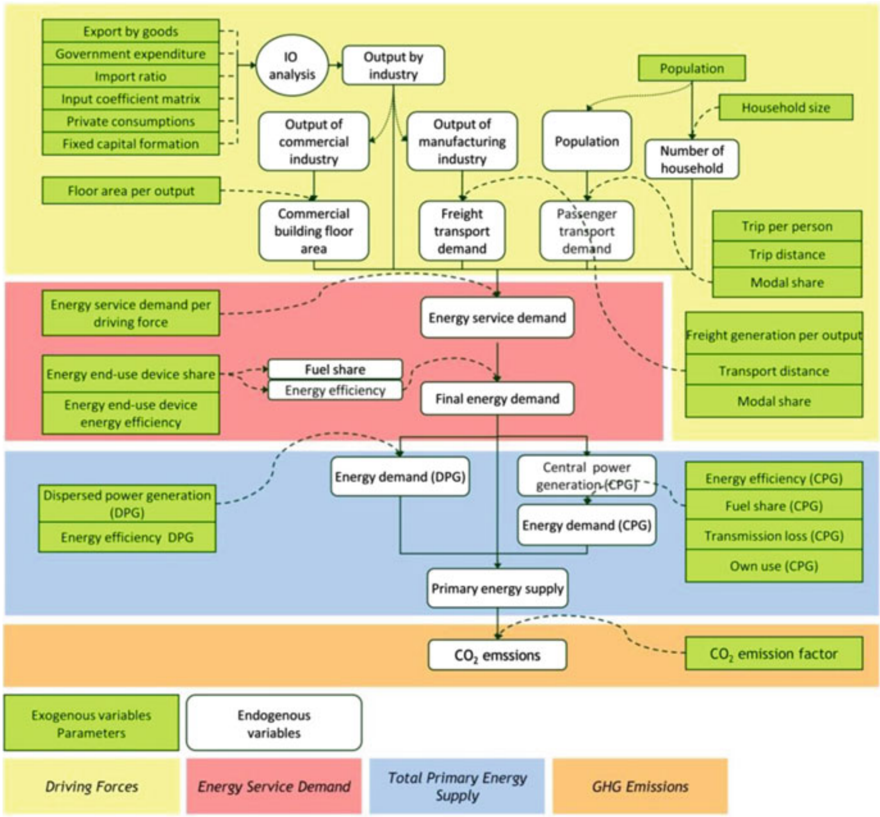

Fig. 7.7 Structure of the ExSS tool (Source: Adapted from Gomi et al. 2010)

In many LCS scenarios, exogenously fixed population data are used. However, people migrate more easily, when the target region is a relatively smaller area such as a state, district, city or town. Population is decided by demand from outside of the region, labour participation ratio, demographic composition and relationship of commuting with outside of the region.

To determine output of industries, the 'export-base' input-output approach is combined in line with the theory of regional economics. Industries producing export goods are called basic industries. Production of basic industries induces other industries, i.e. nonbasic industries, through demand of intermediate input and consumption of their employees. A number of workers must fulfil labour demand of those productions. Given assumptions of where those workers live and labour participation ratio, population living in the region is computed. This model enables us to consider viewpoints of regional economic development to estimate energy demand and CO_2 emissions. For future estimation, assumption of export value is especially important if future development of the target region is expected to (or desired to) be led by particular industries, such as automotive manufacturing or petrochemical industries.

Passenger transport demand is estimated from the population and freight transport demand, which is taken as a function of output by manufacturing industries. Floor area of commercial activities is determined from output of tertiary (service) industries. Other than driving force, activity level of each sector and energy demand by fuels are determined with three parameters: energy service demand per driving force, energy efficiency and fuel share. Diffusion of countermeasures changes the value of these parameters and so GHG emissions.

The estimated results of the future socio-economic indicators and energy demand in 2025 are based on the modelling of the socio-economic variables and energy balance table in 2025. Most of the socio-economic indicators and energy balance table for Iskandar Malaysia are obtained from official and published statistics and secondary sources. Assumptions are used where information for macroeconomic analysis is not available for the Iskandar Malaysia region (see Ho et al. 2010).

7.4 GHG Emissions in Iskandar Malaysia

This section presents GHG emission results for Iskandar Malaysia as simulated via the Extended Snapshot tool (ExSS). As mentioned earlier, to quantify GHG emissions in Iskandar Malaysia, a range of parameters (demography, economic growth, industry structure, energy, technology, transportation and land use) from Iskandar Malaysia's CDP, the 24 Iskandar Malaysia blueprints and other official documents are considered in the ExSS modelling. Three scenarios have been generated from the simulation:

1. 2005 – base year scenario
2. 2025 business as usual (BaU) scenario – target year with the development according to the CDP and existing development and environmental policies, without additional carbon mitigation measures
3. 2025 countermeasure (CM) scenario – target year with the development according to an assumed improvised CDP that adopts carbon mitigation options from the low carbon society blueprint

Based on the simulation result from the ExSS model, GHG emissions of Iskandar Malaysia in 2005 have been estimated to be 11.4 $MtCO_2eq$, and the value is projected to almost triple to 31.3 $MtCO_2eq$ in the 2025 BaU scenario (Fig. 7.8). With the introduction of the proposed 12 LCS actions (see Sects. 7.4.1 and 7.4.2) and their correspondent implementation programmes from the LCSBP-IM2025, increment of GHGs emission has been projected to slow down significantly, leading to an estimated emission level of 18.9 $MtCO_2eq$ for the 2025 CM scenario. As the industry sector is the key component in supporting the fast-growing region of IM, the sector will remain the highest emission sector contributing to between 35 and 53 % of the total GHG emissions in IM for all three base year (2005), 2025 BaU and 2025 CM scenarios.

	2005	2025	2025 /2005
Population (1000)	1,353	3,000	2.22
Household (1000)	303	706	2.33
GDP (Bill. RM)	35.7	141.4	3.96
Gross output (Bill. RM)	121.4	438.9	3.61
Primary industry	1.5	2.4	1.59
Secondary industry	86.2	274.0	3.18
Tertiary industry	33.7	162.5	4.82
Passenger transport demand (Mill. passenger-km)	9,565	59,524	6.22
Freight transport demand (Mill. ton-km)	8,269	26,054	3.15

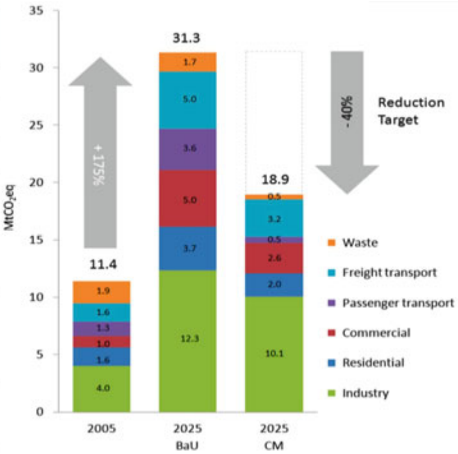

Fig. 7.8 Socio-economic scenario, GHG emission for base year (2005), business as usual (BaU) and countermeasure (CM) scenarios in 2025 (Source: UTM-Low Carbon Asia Research Centre 2013b, p. 1)

The result indicates that full implementation on the Blueprint's LCS programmes would potentially bring about a 58 % reduction of GHG emission intensity (over GDP) in 2025 compared to the 2005 level and a 40 % emission reduction in absolute terms from 2025 BaU (Fig. 7.8). This achievement is higher than the national commitment of 40 % voluntary carbon intensity reduction by 2020 and the Blueprint's initial target of 50 % reduction in intensity.

7.4.1 Structure of GHG Emission Mitigation Options

The LCSBP-IM2025 provides a sustainable green growth road map with 12 policy actions to move Iskandar Malaysia towards achieving its vision of a 'strong, sustainable metropolis of international standing' by 2025. The integration of two competing goals – 'strong' and 'sustainable' – in a single development vision poses great challenges to IM's growth policies and development planning. On the one hand, the urban region needs to develop a prosperous, resilient, robust and globally competitive *economy* (the 'strong' dimension); on the other (the 'sustainability' dimension), it needs to nurture a healthy and knowledgeable *society* that subscribes to low-carbon living and at the same time develop a total urban-regional *environment* that enables rapid economic growth but reduces growth's energy demand and carbon emission intensity. This calls for a holistic and integrated approach, involving policies and strategies on *Green Economy*, *Green Community* and *Green Environment* (Fig. 7.9), to decouple rapid growth from carbon emission in IM. Meeting this challenge has been the primary goal and underlying philosophy of the LCSBP-IM2025. Essentially, the Blueprint comprises two principal components:

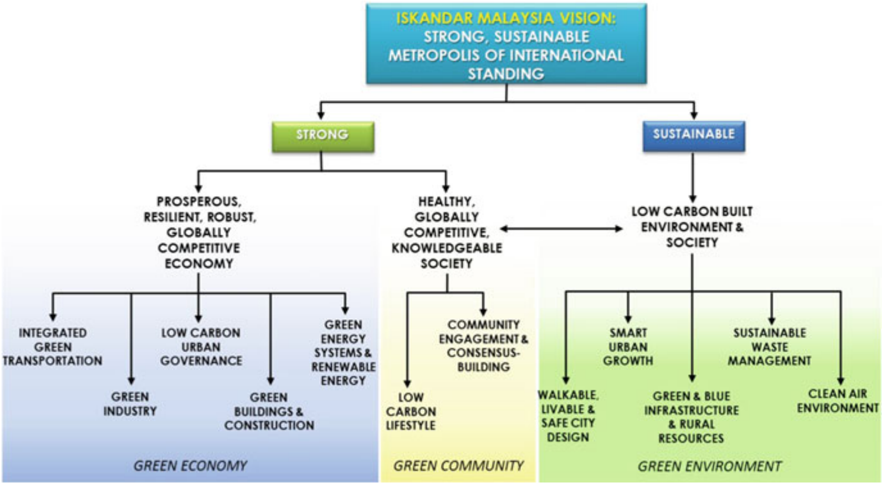

Fig. 7.9 Development of framework and scoping for LCSBP-IM2025 based on Iskandar Malaysia's development vision

Fig. 7.10 'Work breakdown structure' (WBS) approach (Source: UTM-Low Carbon Asia Research Centre 2013a, p. 0–7)

1. Narrative on growth scenarios, policies, measures and programmes to achieve a minimum targeted 50 % reduction in carbon emission intensity by 2025 based on the 2005 level. Under this first component, 12 LCS Actions have been identified under the three themes: Green Economy, Green Community and Green Environment. To provide a clear framework for effective implementation of the policies, the 'work breakdown structure' (WBS) approach has been adopted where each of the 12 LCS Actions is collapsed into subactions and, in turn, into measures and detailed programmes (Fig. 7.10). A total of 281 LCS programmes have been identified for implementation in Iskandar Malaysia up to 2025 to meet

the GHG reduction target that has been set. For details of the 12 policy actions, subactions, measures and programmes (totalling some 400 policy items), readers are referred to the Full Report and Summary for Policymakers (SPM) of the Blueprint (UTM-Low Carbon Asia Research Centre 2013a, b).

2. Scenario-based modelling and projection of carbon emission reductions achievable using ExSS (see Sect. 7.3.2). With the implementation of the 281 LCS programmes identified in the Blueprint, a 58 % reduction in carbon emission intensity, from 319.33 tCO2eq/MYR1mil in 2005 to 133.66 tCO2eq/MYR1mil in 2025, has been projected for Iskandar Malaysia, which is higher than the 50 % reduction targeted at the outset.

7.4.2 GHG Emission Mitigation Options

As mentioned above, 12 mitigation options have been identified to lower carbon emissions of Iskandar Malaysia and transform the society of IM into a low carbon society. These have been organised under the three themes following the triple bottom line (TBL) of sustainable development, namely, Green Economy, Green Community and Green Environment. Collectively these 12 policy actions can potentially deliver a total of 12,758 ktCO_2eq direct emission reduction in 2025, accounting for a 40 % emission cut back from 2025 BaU. Table 7.1 shows the CO_2 reduction potential of each LCS Action. Three actions: *Action 5* (*Green Energy System and Renewable Energy*), *Action 6* (*Low-Carbon Lifestyle*) and *Action 1* (*Integrated Green Transportation*) jointly contribute to 57 % of total emission reduction; policymakers should pay more attention to these three actions and highlight them as higher-priority countermeasures that would help IM to cut carbon emission significantly.

7.5 Beyond Science and Policymaking: Implementing the LCSBP-IM2025

The LCSBP-IM2025 was prepared with its eventual implementation in mind from the outset. After its completion and launching at the UNFCCC's 18th Conference of the Parties (COP 18) in Doha, Qatar in November 2012 and its subsequent endorsement by the Prime Minister of Malaysia (who is also a Co-Chairman of IRDA) in December 2012 (Fig. 7.11), IRDA and the research team immediately looked into priority projects for implementation in Iskandar Malaysia for the 2013–2015 period. A series of intensive workshops were conducted between June and September 2013 and concluded in the formulation of the *Iskandar Malaysia Actions for a Low Carbon Future* (IRDA 2013), which outlines seven (7) specific Action-based projects plus three (3) special area-based projects (see Sect. 7.6.2) selected from the 281 programmes in the LCSBP-IM2025 for immediate implementation.

Table 7.1 Twelve mitigation options to lower the carbon emissions of Iskandar Malaysia

Mitigation options	Reduction[a] (ktCO2eq)	Percentage (%)
Green Economy	**6,937**	**54 %**
Action 1 Integrated Green Transportation	1,916	15 %
Action 2 Green Industry	1,094	9 %
Action 3 Low Carbon Urban Governance[b]	–	–
Action 4 Green Building and Construction	1,203	9 %
Action 5 Green Energy System and Renewable Energy	2,725	21 %
Green Community	**2,727**	**21 %**
Action 6 Low-Carbon Lifestyle	2,727	21 %
Action 7 Community Engagement and Consensus Building[b]	–	–
Green Environment	**3,094**	**25 %**
Action 8 Walkable, Safe and Livable City Design	263	2 %
Action 9 Smart Urban Growth	1,214	10 %
Action 10 Green and Blue Infrastructure and Rural Resources	392	3 %
Action 11 Sustainable Waste Management	1,224	10 %
Action 12 Clean Air Environment[c]	–	–
Total	**12,758**[c]	**100 %**

Source: UTM-Low Carbon Asia Research Centre 2013a, p. 0–5

[a]Contribution to GHG emission reduction from 2025 BaU to 2025 CM.

[b]Actions 3, 7 and 12 do not have direct emission reduction, but their effect is included in other Actions

[c]Since contribution of Action 10 includes carbon sink by forest conservation and urban tree planting, the total contribution of the 12 Actions is greater than difference of the GHG emissions between 2025 BaU and 2025 CM

Fig. 7.11 Launching of the LCSBP-IM 2025 at COP 18 (November 2012) and the Blueprint's endorsement by the Prime Minister of Malaysia (December 2012)

7.5.1 *Selection of Priority Projects*

The ten projects have been prioritised for implementation based on their institutional readiness (e.g. continuation of or extension to existing initiatives), relatively higher CO_2 reduction potential and lower implementation barriers, which include

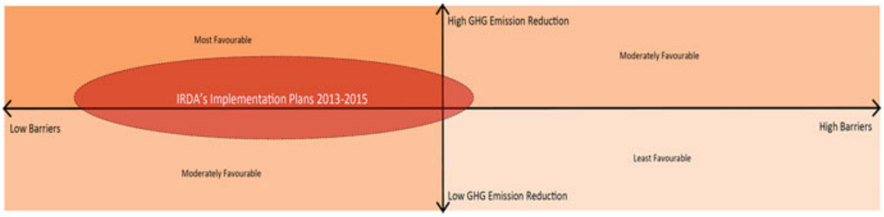

Fig. 7.12 Selection of priority LCS projects for implementation in 2013–2015 based on their relatively higher emission reduction potential and lower implementation barriers (Source: UTM-Low Carbon Asia Research Centre 2013c)

aspects of costs, human capital, institutional and legislative framework, society readiness (public acceptance), private sector buy-in and technology availability. Conceptually, these projects, when plotted in a four-quadrant plot along the axes of emission reduction potential and implementation barriers (Fig. 7.12), fall within the centre-upper-left region of the plot.

Another fundamental criterion underlying the selection of the ten implementation projects is that they should collectively cut across evenly all three main themes – Green Economy, Green Community and Green Environment – and the 12 LCS Actions of the Blueprint. To that end, a 'Project versus LCS Action mapping' exercise has been carried out, which shows a well-distributed coverage of all three main themes and ten out of 12 Actions of the Blueprint by the ten projects (Fig. 7.13). Successful implementation of these projects will be highly essential as positive demonstrations to the local and business communities in IM that will potentially boost their confidence, acceptance, ownership and support of the other LCS programmes in the Blueprint.

7.5.2 *Selected Projects for Implementation in IM (2013–2015)*

This section provides a summary of the ten projects that have been selected out of the 281 LCS programmes in the LCSBP-IM2025 and shows how actions supported by science can be, and are being, used to enable and realise reduction in carbon emissions in IM. For details of each project, readers are advised to consult the *Iskandar Malaysia Actions for a Low Carbon Future* booklet (IRDA 2013) from which the following project summaries have been extracted. The ten projects may be divided into seven specific LCS Action-based projects and three special area-based projects, as follows:

Seven specific Action-based projects:

1. Integrated Green Transportation – Mobility Management System
2. Green Economy Guidelines

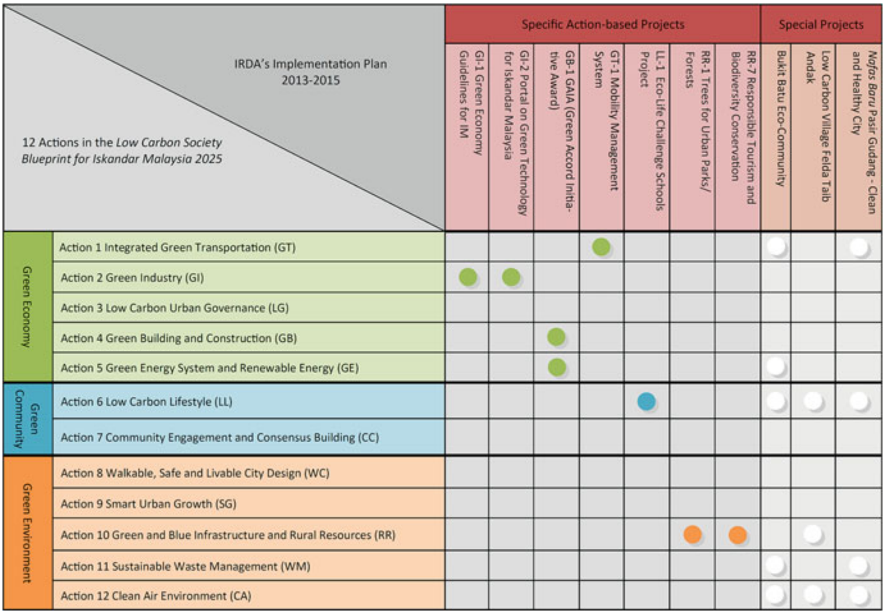

Fig. 7.13 Project versus LCS Action mapping exercise that shows even coverage across the Blueprint's three main themes and 12 Actions by the ten selected projects (Source: UTM-Low Carbon Asia Research Centre 2013c)

3. Eco-life Challenge Schools Project
4. Portal on Green Technology
5. Trees for Urban Parks
6. Responsible Tourism Development and Biodiversity Conservation
7. GAIA (Green Accord Initiative Award)

Three special area-based projects:

8. Bukit Batu Eco-Community
9. Low Carbon Eco Village FELDA Taib Andak
10. Special Feature: Smart City – Nafas Baru Pasir Gudang – Green and Healthy City

1. Integrated Green Transportation – Mobility Management System

The Iskandar Malaysia Mobility Management System (IMMMS) promotes sustainable transport and manages the demand for car use by changing travellers' attitude and behaviour. MMS coordinates information, services and activities to optimise the effectiveness of urban transportation. It is an innovative approach in managing and delivering coordinated and inclusive transportation services to customers, including the elderly, people with different abilities and low-income population. It is an online platform accessible through computers and smart phones, connecting citizens to the various modes of travelling within Iskandar Malaysia.

Project components include route and schedule information; trip/journey planner and travel optimisation; current travel conditions, alerts and avoidance; real-time transit arrival information; user travel analysis and system analysis.

2. Green Economy Guidelines

The Green Economy Guidelines look into areas of procurement, operations and supply chain management for businesses in order to minimise their impacts on the environment. The guidelines call for the government to look into the prospect of developing, adapting and revising current policies to support green growth through tax breaks, reducing perverse incentives and promoting and rewarding good practices for going green. Once the guideline is fully adopted by the various sectors within IM by the end of 2015, it will help to enhance the region's economic growth in tandem with environmental protection and conservation, supported by a green workforce and informed communities which generate positive impacts towards achieving IM's vision as well as contributing to GHG emission reduction in the region.

3. Eco-life Challenge Schools Project

The Children's Eco-life Challenge project (ELC) is an eco-household accounting project designed for students. The project is recommended as a supplement to the existing formal curriculum as a form of contextual learning, promoting systems-thinking and encouraging students to apply knowledge and skills learnt to real-life context. Through ELC, students monitor their own behaviour pattern as well as their families' in moving towards a low carbon lifestyle. Aspects included in ELC are energy consumption, waste generation and management, travel choice, frugal consumption and use of renewable resources. In 2013, the first batch of 22 Iskandar Malaysia-based UNESCO Associated Schools Project Network (ASPnet) primary schools participated in the inaugural ELC competition; the champion school was sent on an educational trip to Kyoto. The number of participating schools increased to 80 in 2014, and all 198 primary schools in IM (with a student population of over 184,000) are expected to be included under the ELC project in 2015. The complete Eco-life Challenge module and lesson plan are scheduled for a 2015 roll-out in IM. Updates on the implementation of the ELC project can be found at http://www.sustainableiskandar.com.my.

4. Portal on Green Technology

The Green Portal is a website and online platform where local communities, the government, private businesses, developers, investors and the wider public can access information related to green technology and the natural environment in IM. The portal is a one-stop virtual centre providing the latest news and information on green technology and LCS related topics, strategies, policies and guidelines. The portal also serves as a platform for promoting green employment and facilitating networking of a 'carbon literate' workforce to meet the growing needs of local, national and international green industries, notably those located within IM. The portal contains both historical and recent information on the natural environment such as policies on spatial/land use, shoreline planning, energy and waste management which will improve the knowledge of viewers and industry practitioners in both green technology and natural environment. The Green Portal is hosted in IRDA's current IM website at http://www.iskandarmalaysia.com.my/.

5. Trees for Urban Parks

'Trees for Urban Parks' aims to increase green lungs in urban areas in IM; enhance places for people to visit, exercise, recreate and socialise; and create habitats for attracting birds and small animals back into urban settings. The project calls for the retention as well as reintroduction of endemic tree species in urban parks and urban forests in IM. Key strategies to that effect include effective enforcement of the Trees Preservation Order (TPO) under the Town and Country Planning Act, 1976 (Act 172), promoting and encouraging planting of endemic trees among developers and monitoring and annual reporting of endemic tree planting. To begin with, IRDA has carried out a fairly comprehensive inventory of tree and plant species that are endemic to Johor and particularly to IM. Currently proposed tree planting programmes cover *Hutan Bandar MBJB* (MBJB Urban Forest) and *Taman Merdeka* in the Johor Bahru City limits.

6. Responsible Tourism Development and Biodiversity Conservation

Responsible tourism and biodiversity conservation inherently bring about simultaneous economic, social and ecological benefits and as such are candidate priority projects for advancing IM's LCS goal. Defining characteristics of responsible tourism are environmental education, community-led projects and promotion of resilient local economy. Building on the success of the first and second Eco-tourism Summits in 2012 and 2013, IRDA successfully led local communities and villagers in *Kampung Sungai Melayu* to actively champion the conservation of local natural resources (e.g. mangrove forests, grounds of migratory birds) and involve in sustaining and improving their economic livelihood. Starting as an IRDA-led project focusing on birding, taking advantage of the September–March migratory bird season, the annual project has taken its own momentum. Local communities are beginning to take stronger responsibility and pride in their natural environment, viewing it more than just a source of livelihood. IRDA now looks into transmitting the success formula to other coastal communities in IM.

7. GAIA (Green Accord Initiative Award)

The Green Accord Initiative Award or GAIA recognises and awards worthy companies and businesses in Iskandar Malaysia that have pioneered green and low carbon principles in their operation. While most companies comply with required environmental regulations or social requirements, some companies have initiated to look beyond regulatory compliance. This effort includes working with local communities in sectors of health and well-being, alleviating poverty, conserving the environment, and reducing carbon footprints. In this initial phase, GAIA will be looking specifically at green building development and companies that have adopted efficient energy system and implemented renewable energy approaches.

GAIA will be awarded to worthy development projects and buildings that have met local and international codes on green buildings, especially building design, and the application of green technology in their construction. GAIA is a soft incentive that will be tied to local and international rating tools such as Malaysia's Green Building Initiative (GBI), Japan's CASBEE and Singapore's Green Mark as well as other known assessment tools (e.g. LEED and BREEAM) to evaluate and recognise green buildings in Iskandar Malaysia. Work towards developing GAIA assessment criteria began in 2013 with the assessment tool being finalised in 2014. Evaluation begins in 2015 and will be conducted through collaborations with industry players and in consultation with all relevant parties in IM.

8. Bukit Batu Eco-Community

The Bukit Batu Eco-Community project aims to demonstrate how village communities whose current economic base predominantly revolves around oil palm and rubber plantations can achieve higher-value economic development within a low carbon society framework. The project seeks to improve villagers' lifestyle and financial status in and around the Kulai District in a sustainable manner via local employment, entrepreneurship and business co-ownership. The development emphasises the adoption of appropriate green technologies and various LCSBP-IM2025 recommendations to become a showcase model for other rural communities with rapidly urbanising contexts in IM. The initial phase of the proposed Eco-community of 1,214 hectares sits on a 4-ha site that is strategically located at the first exit of the North–South Expressway to IM, about 40 km northwest of Johor Bahru City. The first-phase development, funded via IRDA's Social Project Fund (SPF), comprises a business and marketing centre for local SMEs to market their products and services. Apart from yielding economic gains, the centre also provides various training, mindset change and social development programmes for the village communities. Environmentally, the centre will have the first rural green building that attempts to generate electricity from solar, wind and biomass sources; implement rainwater harvesting and promote 3R and green transportation.

9. Low Carbon Eco Village FELDA Taib Andak

Low Carbon Eco Village FELDA Taib Andak is a pioneer project that began in 2012 under Action 7 of the LCSBP-IM2025 to develop a model for low carbon community that incorporates the application of low carbon mitigation measures, such as energy-saving practices, use of oil palm biomass, 3R (reduce, reuse and recycle), production of green goods and reducing private transportation use. A key emphasis of the project is active community involvement in formulating and subsequently implementing a 12-action low carbon village blueprint towards promoting a low carbon lifestyle within the rural community. Successful programmes to date include organic waste composting, bamboo plantation, provision of recycling bins in each residential block, use of bicycles, social awareness programme and zero open burning. Continuous engagements with the community and regular monitoring of project implementation will be carried out by FELDA (Federal Land Development Authority), IRDA and Universiti Teknologi Malaysia.

10. Special Feature: Smart City – Nafas Baru Pasir Gudang – Green and Healthy City

Nafas Baru literally means 'new breath'. It is a programme mooted by IRDA together with *Majlis Perbandaran Pasir Gudang* (MPPG, Pasir Gudang Municipal Council) to rejuvenate Pasir Gudang to become a Green and Healthy City by 2025. Nafas Baru is in line with both the LCSBP-IM2025 and the *Iskandar Malaysia Smart City Framework*. The objective is to create 'smarter residents' in terms of resource planning and management through community actions where residents, the municipal council, industries and others work towards transforming Pasir Gudang into a clean, green, healthy and vibrant city.

With the aim of reducing carbon emission intensity by focusing on the three LCSBP-IM2025 pillars: Green Economy, Green Community and Green Environment, four (4) main initiatives have been identified to be implemented in the 2013–2015 period:

1. Green Industry

The green industry programme aims to make the existing industries in Pasir Gudang 'greener', low carbon and environmentally friendly without compromising their production and profit. As a start, ten industries of various types, sectors and sizes have been selected as pilot projects in which participating industries receive assistance to gauge their current status and readiness to adopt green industry initiatives. This will provide the basis for developing industry-specific low-carbon action plans.

2. Green Community Programme

This initiative aims to promote green community and green lifestyles among residents of Pasir Gudang through increasing the level of public awareness of climate change issues and LCS and encouraging them to live a lower-carbon lifestyle. Awareness campaign and teach-in programmes have already started, which focus on strategic aspects that are directly relevant to Pasir Gudang, including energy efficiency, 3R, composting, tree planting, smart travel choices, walking and cycling.

3. Integrated Solid Waste Management (Waste to Energy)

This programme seeks to enhance the implementation of the Integrated Solid Waste Management Blueprint 2009 in the Pasir Gudang area through developing an integrated and sustainable framework for managing solid wastes generated in the area. This is achieved through nurturing a participative and actively engaged public that is motivated to manage solid wastes in an environmentally and socially responsible manner; institutionalising a social and industrial solid waste management 'preferential framework' in the order of eliminate, reduce, reuse and use of advanced treatment and disposal technologies; and developing recycling and treatment technologies capable of generating beneficial by-products with zero or minimal emission.

4. Carbon Sequestration through the Trees Preservation Order (TPO)

This initiative aims to arrest and gradually reverse the decline in the carbon stock in trees in Pasir Gudang. To begin with, MPPG has identified 250 trees to be gazetted under the Trees Preservation Order (TPO) under the Town and Country Planning Act, 1976 (Act 172). The trees, covering 19 species with an age range of 8–30 years, have significant characters of being large and healthy, rare and unique and having substantial aesthetic, historic or tourism value. IRDA and MPPG are now working to price tag TPO gazette trees by identifying their carbon sequestration and monetary values, which will serve as a guide to future tree planting and urban landscape design in Pasir Gudang towards contributing to carbon emission reduction in Iskandar Malaysia.

7.6 Lessons Learnt

The Low Carbon Society Blueprint for Iskandar Malaysia 2025 is the first of its kind in Malaysia and, in the sense of its urban-regional scale application, perhaps among the few pioneering examples in Asia. The completion of the LCSBP-IM2025 and its launching at COP 18, Doha, in November 2012, are a major milestone in the *Project of Development of Low Carbon Society Scenarios for Asian Regions* that is sponsored by the Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST) under the Science and Technology Research Partnership for Sustainable Development (SATREPS) programme. The virtually no-time-gap selection and actual implementation of ten projects that collectively put ten of the Blueprint's 12 LCS Actions into *real action* in IM in the 2013–2015 period (see Sect. 7.5 above) are another significant achievement of the project. The project which officially commenced in July 2011 offers many valuable lessons especially in advancing scientific research on LCS into policymaking and, importantly, into actual implementation of the policies. A discussion of the key lessons learnt in the project is thus important and is in line with the objectives of the project under the SATREPS framework, which include the development of a methodology for creating LCS scenarios that are appropriate to Malaysia's context and dissemination of the methodology in the form of training programmes to other Asian countries. This section expands on the lessons identified in the project discussed in two earlier papers (see Ho et al. 2013a, b) and adds new revelations further gained since then.

The SATREPS funding framework necessitated at the outset of the project the setting up of a high-level Joint Coordinating Committee (JCC) that comprises top officials of key Malaysian Federal and Johor State government agencies that are relevant to the LCS project and their Japanese counterparts to oversee the implementation and review the progress and achievements of the project. It is found that this set-up indirectly boosts the government agencies' awareness of, and to some degree their commitment to, and buy-in of, the idea of LCS in urban and regional development. This may be important for the long-term advancement of the LCS agenda in the country, with strong endorsement from the central government, which potentially results in more effective GHG emission reduction.

In order to ensure LCS research that leads to effective LCS policies which are able to meet current policy needs, fulfil policymakers' expectations and fit into the wider policy framework, it is essential that a good inventory and understanding of existing policies across all government levels on economic and social development, environmental protection and climate mitigation are gained, in particular in terms of their interrelationship and of identifying policy gaps which the research should be designed to fill (see Fig. 7.4). Good understanding of the legal-institutional framework is also crucial to determine the form of LCS policies to be prepared, whether it should be a stand-alone policy or mainstreamed into existing policies (see UN-Habitat 2012), which influences the research process. In the case of the LCSBP-IM2025, a stand-alone LCS policy was prepared and subsequently mainstreamed into the local planning mechanism. In the final analysis, LCS research should be *policy oriented*, aiming at providing objective scientific evidences and concrete support for good LCS policies, which are in turn *research informed* and *evidence based*. Such integration and synergy potentially benefit both the research and policymaking sides, overcoming the situation of lack of communication between researchers and policymakers (UNCTAD Virtual Institute 2006) and building mutual trust between them, which opens up to more collaboration opportunities in the future for the creation of meaningful, implementable and effective LCS policies.

To also ensure that the LCSBP-IM2025 reflects as much as practicable the needs, concerns and aspirations of the entire IM communities, which potentially leads to higher level of awareness and ownership of the Blueprint and greater support for the implementation of the LCS programmes among the communities, it is learnt that continuous inclusive engagement of various stakeholders in IM through a series of focus group discussions (FGDs) is highly effective. FGDs have been designed into the research process at multiple stages where research findings and policy proposals were exhibited and actively discussed with stakeholders that range from Federal, State and local government agencies; industries; local businesses; civil societies, residents' associations and specific community groups; and various local NGOs and NPOs. Each FGD yielded useful feedback and opinions that were fed into the evolving policy proposals, which were fielded again in the subsequent FGD for further scrutiny by the stakeholders. Effectiveness of the FGDs is evidenced through the progressive improvement and refinement to each subsequent draft LCSBP-IM which began with 7 LCS Actions initially and expanded to 8, 10, 11 and the final 12 LCS Actions that provide the mainframe for the 281 LCS programmes to be implemented.

As the research progressed, an ever presence of 'science-policy gaps' was felt in terms of timescale (e.g. long-term versus short-term gains), priority (e.g. economic feasibility and budgetary concerns over social and ecological impacts) and practical considerations (e.g. institutional capacity and human capital to translate research into policy) between policymakers and researchers. While not all gaps were able to be patched as well as intended, it is learnt that having policymakers (committed IRDA officials) on-board the research team (see Fig. 7.5) helped significantly in identifying these issues as they cropped up and in promptly finding middle grounds. The inclusion of IRDA officials in the research team effectively brings the 'science/ research realm' into the 'policy realm' and vice versa. This, to our knowledge, is rather uncommon; the more common research practice would be to periodically consult policymakers at several stages of the research process in which the policymakers' role tends to be advisory (reviewing and providing input, feedback, critique, etc.) instead of being continuously actively involved in shaping and conducting the research itself as in the case of the LCSBP-IM research.

It is further found that 'disciplinary gaps' exist even among academic researchers from different professional (e.g. social science versus pure science and engineering) and academic-cultural (e.g. Malaysian and Japanese research cultures and use of terminologies) backgrounds. An example of such a gap is the initial disagreement between planners who tended to take a more holistic and integrated view of policies and their interrelationship and engineers who tended to be precise about the boundaries and need for mutual exclusiveness between policies to avoid double counting in quantitative modelling of GHG emissions. Research team members need to be prepared to put in extra efforts and time to communicate and understand the other side's standpoint and smooth over any conflicts that arise. While disciplinary gaps are perhaps inevitable, it is found that working over them gives rise to perspectives and solutions that otherwise would not be thought of, thus leading to more creative and inclusive policymaking.

Effective communication of research evidences is vital; research evidences need to be communicated in straightforward languages, readable and graspable to policymakers who normally have very limited time. Furthermore, proposed policies need to 'appeal' to policymakers through, among others, identification of 'quick win' and 'low-lying fruits' programmes; emphasising social, health, air quality and environmental co-benefits of LCS programmes that will lead to potential public cost saving and greater public acceptance; outlining clearly direct implementation, resource allocation and benefit/cost implications; and showing sensitivity to institutional capacity and needs.

Towards ensuring high levels of buy-in from the government that result in speedy implementation of the LCS policies, it is learnt that strategic positioning and aligning of the policies in relation to the country's highest level, top priority policies are essential. In the case of the LCSBP-IM2025, the Blueprint emerged to be the first concrete policy that effectively and positively responds to the Prime Minister's COP 15 pledge to reduce the Malaysia's carbon emission intensity of GDP by 40 % by 2020 based on the 2005 emission level; the LCSBP-IM2025 demonstrates a potential reduction in emission intensity of GDP by 58 % in Iskandar Malaysia by 2025, based on the 2005 level. This translated into a highprofile endorsement of the Blueprint by the Prime Minister in December 2012, a month after the Blueprint's launch at COP 18. In addition, the LCSBP-IM2025 is also aligned to the Prime Minister's recent 'Science to Action' (S2A) initiative (see Sect. 7.3.1).

Another possible reason behind the almost immediate adoption and implementation of the LCSBP-IM2025 in IM in 2013 may be the status of the Co-Chairmen of IRDA, who are the country's Prime Minister and the Johor State's *Menteri Besar* (literally the Chief Minister). While this may be a given advantage in Iskandar Malaysia, in that IRDA's Co-Chairmen are statutory in nature under the IRDA Act, 2007 (ACT 664), the lesson learnt here is that it pays to have the top and most powerful politicians presiding over the area in which an LCS policy is to be implemented.

Apart from getting strong support from the highest level of the government, having strong leadership and committed officials at the local agency level who believe in the importance of scientific research in good policymaking is indispensable. Importantly for the LCSBP-IM2025, implementation agency level leadership and officials also consistently show deep commitment to advancing the LCS agenda in Iskandar Malaysia and are willing to engage with research institutions to see to it that good LCS policies are put in place. Through this, IM gets the benefits of having high-quality research backing of its LCS policy from Universiti Teknologi Malaysia, with strong expertise and technical support from Kyoto University, NIES and Okayama University.

Lastly, what worked well in Iskandar Malaysia may not necessarily work equally well in other urban regions. It is hoped that this sharing of lessons learnt in carrying LCS research through into policies and on-the-ground implementation, nonetheless, offers useful initial reference points for possible replication and/or adaptation in other countries or urban regions aiming to pursue a similar sustainable, low carbon growth path. No two urban regions or cities are the same; each will have to carve out its own model of LCS in relation to its specific economic, sociocultural, ecological and legal-institutional contexts. What is clearly evidenced by the successes of the LCSBP-IM2025 thus far is that developing countries, subject to adequate international funding and research and technological assistance from developed nations, and with good synergy between highly committed local research institutions and policymakers, are capable of crafting and putting in place implementable low carbon society policies that will eventually contribute to mitigating global climate change through real cuts in GHG emissions while still achieving a desired level of economic growth.

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Part III
Best Practices and Recommendations in Each Sector to Make It Happen