ERIA Discussion Paper Series

Engendering Liveable Low-Carbon Smart Cities in ASEAN as an Inclusive Green Growth Model and Opportunities for Regional Cooperation[§]

S. KUMAR[#]

Asian Institute of Technology

September 2015

Abstract: *This paper discusses the status, opportunities, and modalities for engendering liveable low-carbon smart cities in ASEAN as an inclusive green growth model and the opportunities for regional cooperation. Rapid economic growth and increases in urban population in the Association of Southeast Asian Nations (ASEAN) cities will require the consumption of a huge amount of resources which will damage the local and global environment and produce an enormous amount of waste if not handled appropriately. Such environmentally unsustainable growth undermines public health and safety, comfort and liveability, and more importantly is a barrier to achieving global targets for emission reduction. Transforming cities to make them liveable through low-carbon green growth will not only increase the comfort for the city dwellers by improving liveability, but also minimise greenhouse gas (GHG) emissions. Already, initiatives have been taking place in ASEAN to encourage cities to promote green growth through practicing environmental sustainability. Such initiatives are often implemented on a project basis, which are short term and lack a sustaining impact in the region. A well-constructed, city-level, and market-driven framework that allows for participation of all stakeholders and that has a built-in monitoring and evaluation system with well-thought-out measurable indicators to track performance would be useful to systematically transform ASEAN cities. Regional cooperation, such as through facilitating knowledge sharing, has a role to play in strengthening low-carbon green growth development in the region. Therefore, during 2015–2025, the ASEAN Socio-Cultural Community (ASCC) will provide an excellent opportunity to spearhead such activities in a systematic and consistent manner, be a model, and show the world the benefits of low-carbon city development.*

***Keywords*:** Smart cities, climate change, green growth, ASEAN
JEL Classification: Q4, Q3, Q28,Q5

[§] This research was conducted as a part of the project of the Economic Research Institute for ASEAN and East Asia (ERIA) and the ASEAN Secretariat 'Framing the ASEAN Socio-Cultural Community (ASCC) Post 2015: Engendering Equity, Resiliency, Sustainability and Unity for One ASEAN Community'. The author thanks Dr Anis Zaman for his help. The opinions expressed in this paper are the sole responsibility of the author and do not reflect the views of ERIA or the ASEAN Secretariat.

[#]Author's contact details: S. Kumar. kumar@ait.ac.th Asian Institute of Technology, Klong Luang, Pathumthani 12120, Thailand.

1. Background

Cities are the powerhouses of economy that drive wealth, innovation, and social inclusion, and provide economic opportunities. Cities are increasingly being chosen as habitats because of their ability to deliver a better life for the dwellers, offer more income opportunities, and provide access to better education and health services. In this process, cities consume large resources and also create significant adverse effects, for example, air pollution, greenhouse gas (GHG) emissions, and health issues. Therefore, it is important that cities are made and/or developed to be smart and liveable. Smart liveable cities need to possess sustainability characteristics including low-carbon impact, community oriented and/or responsive development, economic development, and increased social cohesion.

As urbanisation increases, cities will continue to use increasing amounts of land and energy (Lehmann, 2014; Dhakal, 2009), consume large quantities of raw materials, and produce more waste. There is, thus, a need for innovative and comprehensive strategies that are capable of managing the future cities by increasing demographic and structural changes more effectively. Integrated urban development with focus on energy, water, and the urban microclimate will be the appropriate approach to deal with future growth in cities (Lehmann, 2014).

Many ASEAN member states have developed strategies for green growth and formulated initiatives to achieve the transformation from a conventional economy to a low-carbon development. These strategies focus on improving both environmental performance and well-being of citizens, whilst fostering a thriving economy (OECD, 2014a, Jacob *et al*., 2013). For example, Thailand's vision for 2027 outlines, 'people live and enjoy a safe and sound environment' and 'processes of production are environmentally sound, and food and energy are secure (NESDB 2011).' Indonesia's long-term development plan 2005–2025 aims to 'improve the management of natural resources and the environment to support the quality of life', recognising that 'the long-term sustainability of development will face the challenges of climate change and global warming which affect activities and livelihoods (OECD 2014a).' Wawasan Brunei 2035 (Brunei Darussalam's national vision) envisages 'an environmental strategy that ensures the proper conservation of our natural

environment and cultural habitat. It will provide health and safety in line with the highest international practice (DEPD 2010).' Myanmar envisages becoming a modern, developed, and democratic nation that makes the most of its 'latecomer's advantage' to achieve green growth by 2030. Whilst national level initiatives are in place to achieve a low-carbon economy and to safeguard the environment and its people, coordinated, long-term, integrated city-level approaches to transform cities into creative and liveable places with green growth strategy is essential.

The ASEAN Socio-Cultural Community (ASCC) Blueprint aims to address the region's aspiration to lift the quality of life of its peoples by setting out concrete and productive actions that are people-centred and socially responsible. Whilst reviewing the progress of the implementation of the blueprint at the ASCC council during the 25th ASEAN Summit held at Bagan, Myanmar on 30 September 2014, it was noted that 'The primary goal of the ASCC is to contribute to the realisation of the ASEAN Community that is people-centred and socially responsible, with a view to achieving enduring solidarity and unity amongst the nations and peoples of ASEAN, by forging a common identity and building a caring and sharing society which is inclusive and harmonious where the well-being, livelihood, and welfare of the peoples are enhanced.'

The ASCC Blueprint has a greater role to play in transforming ASEAN cities into liveable and low-carbon growth centres for the region. These roles would include (i) providing technical, financial, and policy support to improve the transformational capacities of cities, (ii) facilitating the exchange of knowledge and best practices amongst cities, (iii) building institutional capacities of cities to effectively making their journey towards low-carbon development, (iv) increasing the awareness of the city stakeholders about the benefits of green growth without compromising the future economic prosperity, and (v) demonstrating regional leadership in sustainability of cities.

This paper discusses how urban systems in ASEAN could be transformed in the face of population growth through the development of appropriate infrastructure and policy instruments. Taking into consideration the ASEAN vision from the ASCC Blueprint and ASEAN regional agreements on the development of a sustainable environment and directions for economic growth in member states, this paper

examines the viability of green growth in the ASEAN cities and suggests policy directions for the cities to be used as guidelines, especially post 2015.

The paper first takes a look at the economic growth in the ASEAN region and reviews the challenges of cities to support such growth for long-term sustainability. Section 3 discusses the opportunities and identifies approaches to decouple emission intensity from economic development. Section 4 then reviews strategies and actions that enable cities to become more resilient, facilitate low-carbon development, improve the well-being of the citizens, and take lessons of relevant strategies and policies appropriate and applicable to ASEAN nations and cities. Section 5 focuses on the importance and roles of regional cooperation amongst ASEAN member states to strengthen the low-carbon initiatives in the region. Finally, the paper proposes recommendations and provides a set of indicators to track performance.

2. ASEAN Cities and Their Challenges

2.1. Status

The ASEAN region has been one of the world's most dynamic and fastest growing regions in recent decades (ADB, 2009). Cities in Southeast Asia are growing twice as fast as the rest of the world. The population of ASEAN will increase from 631 million to 739 million in 2035 (Table 1). Most member states (for example, Brunei Darussalam, Cambodia, the Lao People's Democratic Republic, Malaysia, and the Philippines) will have high average annual growth rates that will be more than the world average of 0.98 percent (OECD, 2014b). It is expected that in 2030, as much as 70 percent of the population of ASEAN member states will be living in cities (World Bank, 2014).

Table 1: Population Outlook of ASEAN Member States (in millions)

Population in millions	2015	2025	2035
Brunei Darussalam	0.44	0.50	0.56
Cambodia	15.09	16.80	18.10
Indonesia	254.16	275.58	291.69
Lao PDR	6.70	7.50	8.09
Malaysia	30.92	35.55	39.89
Myanmar	50.31	53.67	55.93
Philippines	101.94	118.94	135.86
Singapore	5.50	6.01	6.52
Thailand	72.31	74.87	76.52
Viet Nam	93.83	101.04	106.04
TOTAL	**631.00**	**690.00**	**739.00**

Source: OECD (2014b).

The ASEAN cities would need to address threats to their future growth including increased energy demand, traffic congestion, poor air quality, urban heat island effect, waste management, and water and food security as well as health-related hazards. The future urbanisation in ASEAN cities will require a paradigm change to decouple urban-driven growth from resource exploitation and exhaustion. The patterns of resource exploitation currently fuelling urban development and the inefficiencies that underpin such systems, pose challenges to the delivery of cost-effective and affordable services and the realisation of environmental sustainability.

The continued economic growth will lead to a more energy intensive lifestyle as people are able to purchase vehicles, household appliances, and other energy consuming devices as disposable income increases, which will further increase energy demand in the region. In the business-as-usual (BAU) scenario, the per capita energy demand at the national level is projected to continue to increase from 1.45 tons of oil equivalent (TOE) per person in 2011 to 2.26 TOE per person in 2035 (ERIA, 2014). The economic growth will give rise to the demand for increased infrastructure (for example, energy, water, and waste) and other amenities to support the growing needs of the population and industrial and commercial development. As

cities are the main driver of economic growth, ASEAN cities will need to decouple economic growth from the natural resource depletion and environmental degradation to ensure a long-term sustainable future.

2.2. Low-carbon cities

Cities are responsible for more than 70 percent of global energy-related carbon dioxide (CO_2) emissions. Low-carbon green growth is a pattern of development that helps decouple economic growth from carbon emissions, pollution, and resource use. Specifically, low-carbon green growth entails (i) using less energy and improving resource efficiency, (ii) protecting and promoting the sustainable use of natural resources, (iii) designing and disseminating low-carbon technologies and business models, and (iv) implementing policies and incentives which discourage carbon intensive practices (ADB and ADBI, 2012). These principles are overarching across global, regional, national, and local contexts, and also apply in the city context as well. Ideas applied by some cities to define the concept of smart, liveable cities are given in Box 1.

Box 1: What is a liveable, smart, and low-carbon city?

Various definitions explain liveable, smart, and prosperous cities that aim for green growth and/or low-carbon development.

- The City of Sydney defines a liveable and thriving city as the place where (i) the environment matters, (ii) the economy thrives, (iii) art and culture are encouraged and supported, and (iv) people feel at home, connected to the local community, and the wider world (City of Sydney, 2014a).
- The City of Toronto aims to achieve an ambitious 2050 target of lowering emissions by 80 percent that will benefit everyone. It focuses on developing a liveable, prosperous city that embraces the green economy, a city where people spend less time commuting, less money on energy costs and the fallout of extreme weather events, and breathe cleaner air (City of Sydney, 2014a).
- The Organisation for Economic Development and Co-operation (OECD) defines green growth in cities as fostering economic growth through urban activities that reduce environmental impact, ensure efficient consumption of natural resources, and the protection of ecosystem services (OECD, 2014b).

- The Malaysian initiative defines a low-carbon city as a city that comprises societies that consume sustainable green technology, green practices, and emit relatively low-carbon or GHG as compared with present day practices to avoid the adverse impacts on climate change (KeTTHA, 2011).

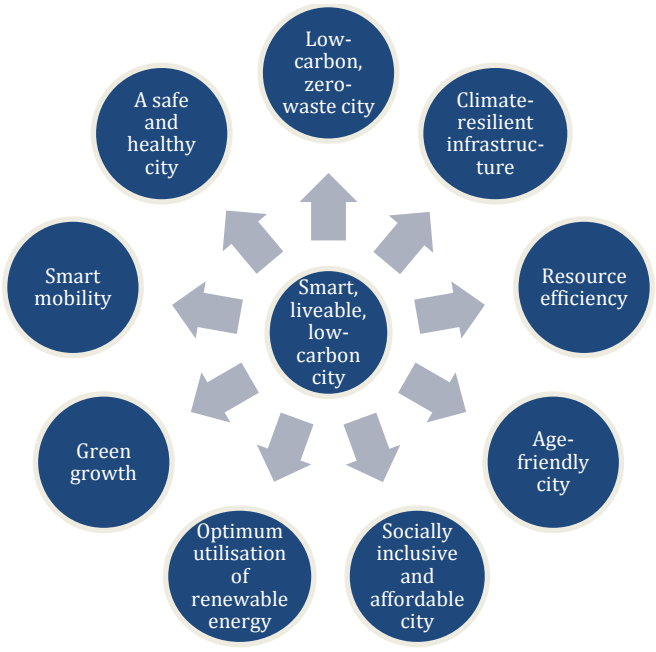
In a smart liveable urban setting, city precincts need to generate a good share of their power themselves, locally and on-site. Implementing zero-energy and plus-energy buildings is a useful and doable approach to this end. The provision on renewable energy systems in buildings and green urban transformation is becoming a major planning focus in cities.

The provision of open spaces in city precincts is a major planning issue to make the city liveable. For example, it is recommended that a minimum 30 to 40 percent of the area should be dedicated to public green space to maximise open space whilst allowing for higher densities. These public green spaces can come in all sizes, from intimate small gardens, to urban farming and community gardens, to more formal parks, to meadows and urban forests – all reintroducing biodiversity into the built environment (Lehmann, 2014).

Information communication technologies and green infrastructure are likely to be critical in transforming urban settings to become more sustainable. Smart cities commonly comprise green buildings and low-carbon precincts that minimise pollution and environmental damage, reuse rainwater, and treat and recycle waste water on-site, they do not dump waste materials off-site but reuse them as much as possible, and they reduce energy needs by maximising energy efficiency and optimising the use of renewable energy resources.

In summary, for the purpose of this paper, smart liveable cities are those that have smart infrastructure and governance systems to support low-carbon development, provide a liveable environment that supports the comfortable living of its dwellers, and foster inclusive economic development through social integration and regional cooperation. Figure 1 provides an illustration of the characteristics of a smart liveable city. Case studies of liveable low-carbon cities are provided in Appendix A.

Figure 1: Characteristics of a Smart Liveable City



Source: Author's compilation.

Transforming cities to become more compact (that is, making them resource efficient) and be capable of using less energy, not only helps to reduce GHG emissions and address the impacts of climate change, but also brings improvements in liveability and well-being for city dwellers. Effective planning and implementation of green urban transformation requires the input of policymakers, power suppliers, researchers, architects and planners, and citizens.

2.3. Why focus on cities for low-carbon development?

Besides the reasons described above, the compelling reasons, post 2015, for ASEAN to promote smart, liveable, low-carbon cities in the ASCC context, include:

a) Cities, as drivers of the economies of nation states, can play a primary role in showcasing improvements in the quality of the life and the living environment, thus being models for the community as a whole. Many of the concepts are linked (for example, promoting clean energy utilisation can reduce local pollution and greenhouse gas emissions, create new jobs and

creative employment), promoting a smart city concept goes beyond activities in a particular sector.

b) City based local policies that promote green and/or liveable concepts can be more easily implemented (and explored) before making it national, helping in the assessment of impacts and challenges. These complement national policies.

c) City administrators (for example, mayors) could administer issues that are inter-sectoral, compared to national ones that may be sector based. This is an important consideration for adopting innovative policies, standards, and measures. The case of New York, where the former Mayor Bloomberg initiated many policies and measures is an example.

d) Being inter-sectoral, the involvement of stakeholders can be more easily done (local councillors, local universities, industries, non-governmental organisations (NGOs), civil society, amongst others) – closer to the ground and reality. This would promote deeper and committed stakeholder involvement in participatory decision making, ensuring success in the implementation of policies and measures. The interaction of local stakeholders addressing local issues to make cities greener, more liveable, and smarter for the benefit and/or growth of the cities would see more enthusiasm. This would also bring closer working relationships between the private sector, research and educational institutions, NGOs, and the community.

e) The exchange of ideas and learning possibilities can be more quickly adapted at city-to-city level, leading to improvements across ASEAN at a faster pace – geared to promoting economic growth and improving living quality.

2.4. Low-carbon pathway for ASEAN cities

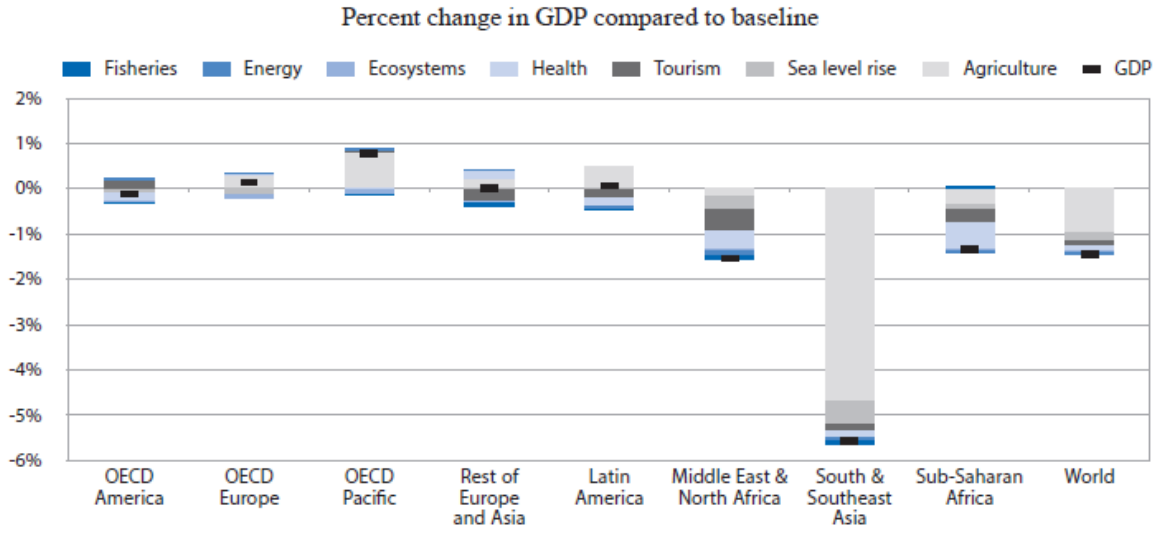
Southeast Asian countries are highly reliant on natural resources like oil, gas, minerals, and wood. According to OECD (2014a):

- Climate change could result in a gross domestic product (GDP) loss for the ASEAN region of more than 5 percent by 2060 due to a reduction in agricultural losses and a rise in sea levels. Coastal cities are already facing high economic losses due to climate change in the order of millions of dollars, which could climb to US$6 million by 2050.

- Air pollution in many Southeast Asian cities is now well above the World Health Organization guidelines.

Figure 2 compares the economic loss from climate change in the South and Southeast Asian region compared with other regions of the world. It is thus important for the Southeast Asian countries to follow green growth to meet the challenges of economic and social development in the short term whilst safeguarding longer-term economic performance and human well-being.

Figure 2: Estimated Drop in Economic Output from Climate Change by 2060



Note: GDP = gross domestic product, OECD = Organisation for Economic Co-operation and Development.

Source: OECD (2014a).

a) The need for a low-carbon pathway for future development in the ASEAN region has been highlighted in a number of policies and plans. These include:

b) ASEAN Vision 2020 which states that 'A clean and green ASEAN with fully established mechanisms for sustainable development to ensure the protection of the region's environment, the sustainability of natural resources and the high quality of life of its peoples' (ASEAN, 2009b).

c) The ASCC Blueprint represents the human dimension of ASEAN cooperation and upholds ASEAN commitment to address the region's aspiration to lift the quality of life of its peoples. The blueprint is a complete framework that aims to address a number of issues of the region, including promoting quality living standards in ASEAN cities and urban areas. This aims to ensure cities

and urban areas in ASEAN are environmentally sustainable, whilst meeting the social and economic needs of the people (ASEAN, 2009a).

d) The Nay Pyi Taw declaration informs about consolidated elements of the ASEAN community's post-2015 vision, which include '… inclusive, sustained and equitable economic growth, as well as sustainable development, consistent with the United Nation's (UN) post-2015 development agenda' (ASEAN, 2014).

These policies and strategies have elements that support developing low-carbon smart cities. This includes ensuring environmentally sustainable development, fostering inclusive economic growth, encouraging green growth, and meeting the socio-economic needs of the people.

Some ASEAN cities, in collaboration with various organisations, have already taken up a number of initiatives (Box 2). For example, the status of implementation of the ASCC Blueprint (as of September 2014) indicates under the category 'Characteristic Element' title, Ensuring Environmental Sustainability, one of the major thrusts is promoting quality living standards in ASEAN cities and urban areas with an objective to ensure cities and urban areas in ASEAN are environmentally sustainable, whilst meeting the social and economic needs of the people.

Box 2: Summary of ASEAN Initiatives (compilation of ASCC Matrix)

- ASEAN Initiative on Environmentally Sustainable Cities (AIESC) commenced in 2005, addresses air, water, and land pollution in 25 participating cities.
- Clean Air for Smaller Cities project, supported by GIZ, helps nine smaller cities from Cambodia, Indonesia, the Lao PDR, Philippines, Thailand, and Viet Nam to develop clean air action plans.
- The knowledge sharing workshop held in 2011 in Jakarta facilitated sharing of knowledge and experiences on sustainable urban planning, for example, transportation, greening buildings, and waste management. This workshop was supported by ASEAN–United States (US) Technical Assistance and Training Facilities.
- Local Governments for Sustainability (ICLEI) supported the development of emissions inventory and the use of a monitoring software system in Yogyakarta City (Indonesia). This pilot project is expected to demonstrate and share the emission management system with other ASEAN cities.
- CityLinks Pilot Partnership programme between the US and ASEAN is an 18-month programme aimed at strengthening urban climate resilience and adaptation in selected cities in ASEAN member states through sharing experiences of US cities on environmental sustainability with ASEAN cities. Two cities – Chiang Rai (Thailand) and Legazpi city (Philippines) have been chosen to participate in the first round of experience sharing with two US cities.
- Information sharing workshops are being held under the Environmentally Sustainable Cities programme (workshops were held in Jakarta in 2010, in Kitakyushu in 2011, in Siem Reap in 2012, in Ha Noi in 2013, and in Surabaya in 2014).
- The ASEAN Environmentally Sustainable Cities (ESC) Model Cities Programme is being implemented in 14 cities to promote the development of ESC in ASEAN countries through strengthening national ESC frameworks and building capacity of local governments. With regional funding, ASEAN should consider a long-term programme delivered to 100 cities by 2025.
- Key indicators for environmentally sustainable cities have been developed through a rigorous process in collaboration with ASEAN member states. These 23 indictors are now being tested for their effectiveness in cities.
- To encourage environmental sustainability and to recognise the initiatives taken by the cities, ASEAN has developed an award programme. In 2014, awards have been given to 10 cities and another six cities have been given certificates of recognition.

3. Designing Low-Carbon Cities

Low-carbon liveable city design is to be undertaken through an integrated framework that involves city operations and planning, and the city's services to the community. Various frameworks and methodologies exist, with different but closely related themes that have been successfully tested and implemented to achieve the outcome in transforming cities. For example, the Urban-Low Emissions Development Strategy (LEDS) methodology for the development of green climate cities, jointly developed by ICLEI and UN-Habitat (ICLEI, 2011), includes:

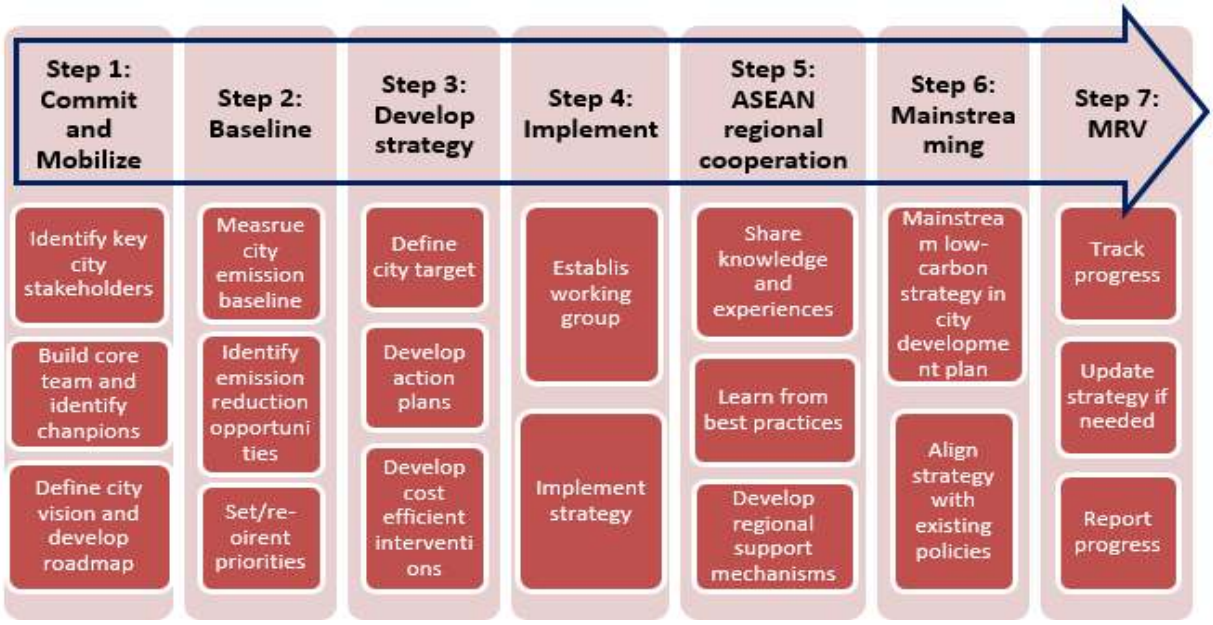
1) baselining performance and visioning a low emission future;
2) developing a GHG inventory. Examples of GHG inventory development tools are provided in Appendix B;
3) identifying and assessing priority solutions;
4) developing cost investment proposals and implementing of low-hanging fruit;
5) measuring, reporting, and verifying emissions commitments, actions, and reductions at national level; and
6) mainstreaming and integrating low emission planning and development criteria into existing city planning process.

The Low Carbon City Framework of Malaysia focuses on four interrelated aspects that are conducive to transforming to a low-carbon liveable city: urban environment, urban transportation, urban infrastructure, and building. The framework aims for a 40 percent reduction in GHG reduction in GDP per capita from cities by 2020 (in alignment with the national goal) and involves the following seven steps:

- identifying areas of concern;
- identifying priorities (low-hanging fruits that are easy to implement);
- developing cost efficient interventions;
- engaging a wider range of communities;
- measuring, reporting, and verifying:
- mainstreaming activities in line with green technology policy; and
- supporting government efforts towards achieving the 40 percent CO_2 reduction goal.

Summarising the above-mentioned framework and taking into consideration the ASEAN context, the ASEAN framework for liveable low-carbon city development is proposed in Figure 3.

Figure 3: Proposed ASEAN Framework for Liveable Low-carbon City Development



Source: Author's compilation.

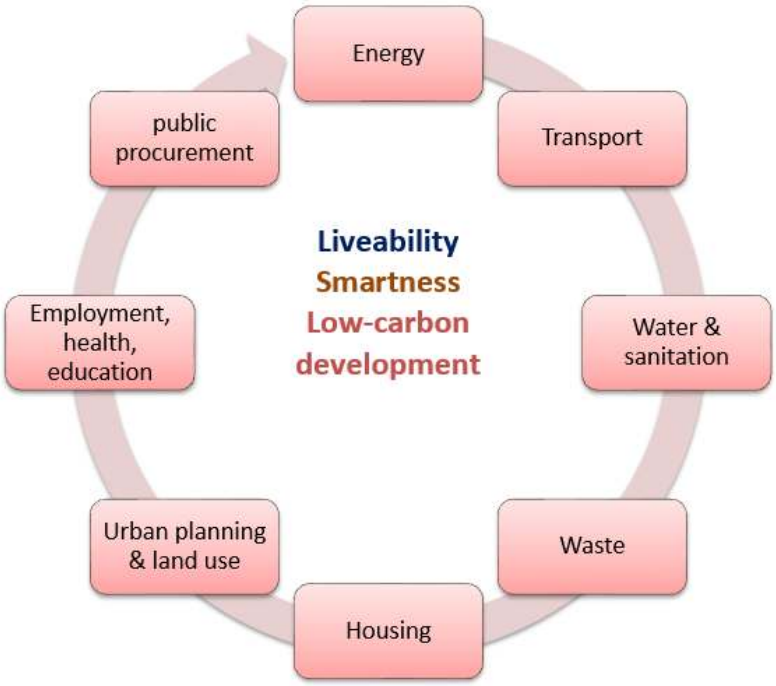
Though the framework is self-explanatory, some of the steps including key interventions that would be appropriate for ASEAN cities are discussed in the following section, along with examples of best practices in the region.

3.1. Making cities smart and liveable

The transformation of cities requires the development and implementation of interrelated interventions on preferred sectors as identified by the stakeholders. The choice of sectoral intervention is often based on the sectoral scenario analysis that is undertaken during the planning exercise. Such interventions vary in a great deal, for example, Masdar City in the United Arab Emirates has been built on 10 pillars of sustainability, which include energy, waste, transport, water, natural resources, and food.

The Urban-LEDS framework, suggests development of interventions and/or actions in eight interrelated areas (Figure 4) (Bland, 2013). Similar areas for interventions have also been highlighted in the Malaysian Low Carbon City Framework (KeTTHA, 2011).

Figure 4: Areas for Intervention in a Liveable Low-carbon Smart City



Source: Author's compilation.

The City of Auckland's plan to become a thriving green sustainable city consists of five areas of intervention – energy, transport, waste, built environment (roads, buildings, parks, amongst others) and food, agriculture, and natural carbon sink (Auckland Council, 2014). Whilst the choice of sectors and type of sectoral interventions vary depending on socio-economic and geographical location of the city, most common sectors that will need transforming in a typical city in the ASEAN region are discussed below. Examples of other cities in terms of technologies and plans are presented in Appendix C.

3.2. Decoupling emission intensity from economic growth

Conventionally, economic growth has a strong relation to emissions because higher growth usually requires greater use of energy. Economic growth has been regarded as the most influential factor for the rise in emissions in Tokyo, Seoul, Beijing, and Shanghai over the past decade (Droege, 2011). However, recent technological advancements provide substantial opportunities to decouple economic growth from emission intensity. This can be achieved by a number of strategies, including:

- Renewable energy. Increasing the use of renewable energy technologies can be done by encouraging on-site power generation and by increasing renewable energy in the energy generation mix (more in section 3.3).
- Energy efficiency. Improving energy efficiency, particularly, in the commercial, residential, and industrial sectors. High-energy efficiency will eliminate or partially offset the increased energy demand caused by increased economic activities (more in section 3.3).
- Rapid transit system. An increase in economic activities will require more people living and working in cities, which, in turn, will increase the demand for mobility and lead to increased GHG emissions. The introduction and/or expansion of rapid transit systems will reduce the number of cars on the road (more in section 3.5).
- Sustainable waste management. Cities also need to minimise waste generation through practicing sustainable production and consumption.

The cities that are moving towards zero net emissions strategies (for example, Melbourne) or low-carbon cities (for example, Sydney, Toronto, and Tokyo) have developed measures to encourage green growth by breaking the link between economic development and emission intensity.

3.3. Transforming the energy sector

One major change that is essential to achieving a low-carbon economy or city is to change the way energy is generated and/or used. As energy is the major source of GHG emissions, it is crucial to reduce energy-related emissions. This can be achieved a number of ways:

a) **Renewable energy**. Energy generation in a smart city requires the application of innovative and/or smart and renewable technologies, which will need to be explored and prioritised. Over recent years, the cost of renewable energy has significantly fallen, and in many cases, is comparable with conventional technologies. Many cities in transition to a low-carbon future are considering installing solar photovoltaic (PV) systems on large buildings (City of Sydney, 2014a; City of Melbourne, 2014). Innovative technologies, such as trigeneration is also being explored (City of Sydney, 2014a). The development of a renewable energy target is also important to ensure continuous and long-term implementation of renewable energy development and more importantly to facilitate the development of a market dynamics through building an enabling environment for entrepreneurship development. Many ASEAN nations have developed renewable energy plans, for example, Indonesia – 17 percent by 2020 and Thailand – 25 percent by 2021. However, to achieve smart and liveable city status, it is important to set city-level targets, which will need to be independent of national targets.

b) **Energy efficiency**. Energy efficiency is an integral part of a smart city energy management strategy, as this helps to reduce the overall city's energy demand and investment in energy generation. Energy efficiency can be applied to building, industry, transport, and residential and commercial sectors. Melbourne aims to implement a range of energy efficient measures in buildings, transport, industries, and residential buildings through the development and implementation of city-level energy efficiency policies and plans (City of Melbourne, 2014). There has been good progress in energy efficiency improvement by individual ASEAN nations as well as in the region as a whole. The ASEAN Energy Efficiency and Conservation Sub-Sector Network, which started in 2010, aims to reduce energy intensity of the region by at least 8 percent by 2015 compared to the 2005 level (ACE, 2014). There are also individual country-level targets for energy efficiency improvement. These include 26 percent GHG emission reduction by 2020 through various measures including energy efficiency and 25% reduction in final energy consumption in Thailand by 2030 compared to the base year 2010. As with

renewable energy, energy targets also need to be set at city levels to achieve a smart liveable city.

3.4. Urban planning and land use

As cities grow, the demand for infrastructure (buildings, roads) also grows. This infrastructure causes rising temperatures, resulting in a lack of comfort for dwellers, increasing the demand for energy, and increasing GHG emissions. Cities can play a key role in urban development and can make a difference in promoting sustainable urban development by incorporating appropriate policies in housing and other establishments under their jurisdiction. One of the important areas to consider in relation to sustainable urban development is the urban heat island (UHI) effect. The UHI is one of the major problems of the 21st century posed to human beings as a result of urbanisation and industrialisation. The large amount of heat generated from urban structures as they consume and re-radiate solar radiation and from the anthropogenic heat sources, are the main causes of UHI (Rizwan *et al*., 2008). The impacts of UHI are manifold – increased energy consumption, increased evaporation and water consumption, elevated emissions of air pollutants and greenhouse gases, poor human health and lack of comfort, impaired water quality, and risks to public health (Anisuzzaman, 2014). Green buildings and low-carbon precincts minimise pollution and environmental damage. They reuse rainwater and treat and recycle wastewater on-site. They do not dump waste materials off-site, instead they are reused as much as possible. They reduce their energy needs by using the maximum low-embodied energy insulation possible. Low-carbon precincts of green buildings have good natural ventilation, use low-energy lighting and electrical appliances, and make use of passive and active solar power. Low-carbon precincts have reduced embodied energy by using mainly locally sourced low energy materials from sustainably managed, renewable, or recycled sources, with minimal use of imported materials (Lehmann, 2014).

Various measures are implemented to improve the comfort level of built-up areas and reduce the heat related energy demand in buildings and precincts. The City of San Francisco in 2008 established green building requirements for new residential and commercial buildings, as well as renovations to existing buildings. This was done by amending the building codes of California's Building Standards Commission (City

of San Francisco, 2014). The Rio Tinto naturescape building at Kings Park Botanic Gardens in Perth, Western Australia is a good example of sustainable green building that features earth-berming construction, green roof, onsite power generation, and passive solar design with sufficient ventilation (Robertson, 2011).

3.5. Sustainable transport system

As cities grow, the demand for transportation of both people and materials also grows. Increased vehicles give rise to a number of problems for cities including increase in GHG emissions, local air pollution, congestions, and lack of comfort. The World Bank notes that when the annual income per capita falls between US$3,500 and US$8,500, cities tend to experience faster motorisation rates (Xue and Zhang, 2014). Table 2 shows that many ASEAN cities fall in this range, indicating the importance of developing a sustainable transport city.

The question is how to develop a sustainable transport city. The key concept of a sustainable transport city is to reduce per capita transport energy use, which can be achieved by:

a) Reducing vehicle kilometre travelled (VKT). VKT per person is strongly related to the urban design and is inversely related to urban density. In a smart and low-carbon city, VKT should be minimum. VKT per person increases with distance from the central business district (CBD) in large cities. For example, in Sydney, the VKT varies from below 11 kilometre (km) in the inner city suburbs to over 30 km towards the fringes.
b) Transit-oriented development (TOD). TOD is a mixed-use residential and commercial area designed to maximise access to public transport and often incorporates features to encourage transit ridership. TOD addresses the growing problems of peak oil and climate change by creating dense, walkable communities connected to a train line that reduce the need for driving thus reducing transport related emissions. A TOD city should have a number of components including walkable design with pedestrians as the highest priority, train stations as prominent features of two centres; places of office, residential, retail, and civic uses are in close proximity of residential area; include the easy use of bicycles, scooters, and rollerblades as daily support transportation system; reduced and managed parking inside a 10-minute walk

to the town centre and/or train station. TOD can improve the quality of life and encourage a healthier, pedestrian-based lifestyle with less pollution.

Table 2: Asian Megacities – Area, Population, and Per Capita GDP

Metropolitan	Land area (km^b)	Population in 2010 (thousand)	GDP per capita (US$)
Bangkok[a]	7,762	11,970	3,893
Jakarta[a]	13,601	24,100	2,349
Metro Manila[a]	4,863	21,420	1,796
Ho Chi Minh[a]	2,095	7,163	1,032
Kuala Lumpur[b]	243	1,720	20,837
Yangon[c]	10,171	4,350	238
Ha Noi[d]	1,979	6,451	
Phnom Penh[e]	678	1,501	769
Bandar Seri Begawan[f]	5,765	203	25,914
Vientiane[g]	3,920	795	1,302

Note: Population as of 2010 and per capita GDP in 2005 US dollars.

Source:
a. Acharya (2013).
b.http://statistics.gov.my/portal/index.php?option=com_content&view=article&id=536&Itemid=111&lang=en&negeri=W.P.Kuala%20Lumpur
c. http://www.citypopulation.de/Myanmar.html
d. http://www.vietnamonline.com/az/hanoi-population.html
e. http://www.phnompenh.gov.kh/phnom-penh-city-facts-99.html
f. http://www.citypopulation.de/Brunei.html
g. www.jica.go.jp/project/english/laos/009/materials/pdf/pamphlet_01.pdf

Bangkok is moving towards becoming a TOD city. The city has transformed its transport system from its water-based transportation modes to highways and railways. Mass rail transit is now the core component of urban transport policy and capital investment. The city has now connected most urban areas with over 86 kms of railway through a massive 61 stations. A further 98.62

kms and 62 stations are under construction. It also expected to develop an additional 330 kms and 246 stations, extending the whole urban rail system to more than 500 kms. Recent trends in housing development show more condominium projects than individual houses (Ratanawaraha and Chalermpong, 2014).

Singapore is a densely populated metropolis, with more than 5 million inhabitants living on 710 km^2 of land (CLC, 2014). Singapore has proved that it is possible to achieve high liveability, even though it is one of the most densely populated places on the earth (it received a liveability score of just below 90 out of 100 [Economist, 2014]). Central to this achievement is the city's efficient transportation system, which didn't occur overnight. Since the 1970s, Singapore's government has supported planning along public transit routes, with the result that the city is now far along in its TOD (Jander, 2014). Singapore has successfully developed an integrated approach to TOD through its mass rapid transit (MRT) system and high density land use development (Seetharam *et al*., 2010). The MRT has limited the need for highway expansion and supported the development of planned new towns instead of urban sprawl.

c) Building rapid transit systems. Rapid transit is a public transport system, especially built for busy cities that face inadequate road infrastructure and have high peak-time congestion, is fast and segregated from common traffic on the road. These systems are able to transport high numbers of passengers per unit of time compared to other vehicles, particularly in comparison with passenger cars. They are not only efficient and can reduce cost of travel and save GHG emissions, but also they are safe and reduce the number of accidents. Various rapid transit systems are available in the world, for example, mass rapid transit (MRT) that commonly use railways and bus rapid transit (BRT) that use special buses.

   EMBARQ is the World Resource Institute signature initiative for sustainable transport and urban development, operating through a global network of centres in Brazil, China, Mexico, and Turkey. It helps to improve the quality of life in cities worldwide through learning from local experiences and

implementing that globally(WRI 2014a). EMBARQ has been researching and implementing various rapid transit systems around the world.

One of the solutions is a BRT, a city-based, high-speed bus transit system in which buses operate for a significant part of their journey within a fully dedicated right of way lane to avoid traffic congestion. BRT can reduce travel time by millions of hours for commuters. For example, researches have shown that BRT users in Istanbul, Turkey can save 28 days per year by shifting from other transport modes to the BRT. Similarly, commuters in Johannesburg saved an estimated 9 million eight-hour work-days between 2007 and 2026. In addition, BRT results in GHG reduction, local air pollutant emissions reduction, improvement in traffic safety, and increase in physical activities of commuters (King, 2013).

(d) Alternative fuels for transportation. Use of alternative fuels has significant potential of reducing GHG emissions from transportation sector. Technologies include use of bio-fuel, increase in electric vehicles, and switching to liquefied natural gas (LPG) or compressed natural gas (CNG) from oil and diesel. Ho Chi Minh City has obtained remarkable achievements in the past 10 years through the creation of different types of bus routes such as night buses, bus routes for students and workers, which are made up of government supported bus routes as well as privately supported bus routes. Ho Chi Minh City is now running 28 CNG powered buses operating from 5 am to 9 pm with about 320 trips per day and 12,000 passenger turnover per day. Preliminary assessments show that CO_2 emissions have decreased by 20 percent, mono-nitrogen oxides has decreased by 57 percent, carbon monoxide has decreased by 63.5 percent, and Hydrocarbon (HC) has decreased by 63 percent. Not only have Particulate Matter (PM) and black smoke decreased by 100 percent, but there is no longer a bad smell in the roads and the noise level has decreased by about 3 decibels (dBA) (Luu, 2014).

3.6. Improving resource efficiency through waste minimisation

Smart cities need to consider the reconfiguration of their infrastructure that can change the flow of resources through cities, and their use, consumption, and disposal.

Decoupling resources and/or materials flows from economic growth is increasingly being considered to build smart and compact cities. Retrofitting urban infrastructure or building new infrastructure that is more resource efficient and taking into account the long-term flows of strategic resources can help achieve this. Resource efficiency can be improved by treating outputs from one use, as inputs to another would help cities increase resource productivity and adapt to a future of resource limitations and climate uncertainty. For example, resource efficient systems could reduce water demand by up to 80 percent (UNEP, 2013).

Cities should develop infrastructure and policies that help reduce imports of resources as well as exporting waste. In regards to reducing imports of resources, cities need to develop infrastructure and policies to facilitate reduction of three key resources – food, energy, and water. Lehmann (2014) notes that in future citizens will need to produce energy and food on-site on their own properties. Examples of measures include production of food locally, for example, by encouraging homestead gardening and changing food habits, restricting water use, and building infrastructure to recharge groundwater.

The increased amount of waste generation is adversely affecting lifestyle, polluting the local and global environment, and consuming energy. In order to reduce waste generation cities should not only practice sustainable consumption but should reuse waste. Lehmann (2014) notes that 'we should stop using the word 'waste' and replace it with terms like 'opportunity materials' or 'misallocated materials''. In Sri Lanka, Matale is soon to become the country's first 'zero-waste' city. Thanks to the leadership of its mayor, the city has developed partnerships with non-governmental organisations and received funding from an international donor. Implementation of an innovative, pro-poor approach to solid waste management with a series of integrated resource recovery centres is underway in Matale. Adopting the eco-efficiency perspective of seeing waste as a resource has created green jobs for the urban poor, means that the town's households have their solid waste collected and that the municipal government has saved money and land from being turned into an open dumpsite (Lehmann, 2014). Yokohama, one of the largest cities in Japan with 3.65 million population, is moving towards 'zero waste'. The city successfully demonstrated reduction of its waste by 38.7 percent between 2001 and 2007. This has been achieved by the active role of the city government who inspired citizens and

businesses to join a 3R campaign to reduce, reuse, and recycle materials that had previously been seen as waste. This led to closing of two incinerators that saved US$1 billion in maintenance and operating costs. In addition, the city government has been able to raise money by selling materials collected in recycling (Lehmann, 2014).

3.7. Building urban resilience

Urban resilience is typically defined as the ability of a city or urban system to withstand a wide array of shocks and stresses – as such, climate change is understood as one of many stresses that cities face (Leichenko, 2011). In the context of cities, resilience translates into a new paradigm for urbanisation and influences the way we understand and manage urban hazards, as well as urban planning in general (Jha *et al*., 2013). With increasing population, ageing infrastructure, and lack of capacity to mitigate various shocks and stresses, including that of climate change, cities are becoming more vulnerable. For example, ASEAN cities are facing increasing risks of disasters from climate change such as large-scale floods in Thailand and tropical storms in the Philippines that have been tragic reminders of the devastation, economic and social damage, and loss of human lives.

Building resilience cannot be a 'one size fits all' methodology, rather it is a process known as 'learning by doing' where stakeholders' participation is centre to the success. Resilience is an iterative process that allows for ongoing assessment of vulnerability and implementation of interventions that build on each other. Whilst vulnerability assessment is an important part of building city resilience to changing climate, it should not be a one-off exercise, rather an ongoing effort to review the understanding and vulnerability that would allow the city stakeholders to assess the efficacy of resilience building actions, as well as to address circumstances and events as they arise (Friend *et al*., 2013).

To measure resilience, multiple dimensions are proposed but the basic dimensions found in the literature are economic, social, institutional and/or organisational, and physical. Many indicators developed for assessing community resilience therefore focus on the ability of the built environment to withstand disasters or to sufficiently provide infrastructure and public facilities to support basic needs during emergency events. Sustainability assessment tools for the assessment at the community scale including housing have recently been developed to measure the

sustainability of urban projects, which consist of multiple buildings and other issues beyond building scale. The rating tools for community scale have multiple indicators, which are classified into four to six categories covering environmental, economic, and social dimensions of sustainability. Appendix D presents some rating tools available for the assessment.

4. Strengthening Regional Cooperation

Effective regional and international cooperation are central to effective approaches to GHG emissions reduction. For ASEAN this is important, as around 26 percent of the region's total trade takes place amongst member countries (OECD, 2014a). The cities that are the biggest emitters in ASEAN have an essential role to play in promoting the regional green economy, and are well positioned to use regional cooperation to advance the uptake of low-carbon technologies in a cost-effective way. ASEAN cities can share knowledge and learning, and implement regional initiatives to overcome the cost barrier by a cost-sharing approach. Regional cooperation can also provide a common ground for learning and sharing experiences, and the relatively less advanced cities can learn about new technologies and innovative policy instruments.

Cooperative action in the region would be in the political interest of all governments, as:

a) ASEAN nations have a wider area of business and economic interests including trans-boundary business and commercial activities. A region-wide push on energy efficiency, technology, investment, and deforestation is essential to add credibility to voluntary pledges and national targets without losing economic competitiveness.
b) Given the scale of investment required and the deterioration of public finance in many countries, cooperation, consultation, and coordination amongst governments in the region can leverage private sector capital.
c) As far as progress in global climate deals, it will take time to come up with and implement a global measure. Thus, it would be useful for ASEAN to

develop regional actions to demonstrate and provide the international community with experiences and lessons for increased financial and technical assistance to ASEAN.

The following regional-level actions for accelerating low-carbon green growth would be appropriate for ASEAN.

Regional energy partnership. The ASEAN member states should promote a regional partnership on renewable energy. This would include setting up national targets and appropriate feed-in tariffs (FIT) and renewable energy portfolio standards. Whilst some member states have already set up targets, such as Indonesia, Malaysia, and Thailand, it is important that all states fulfil this requirement to ensure regional harmony. Governments also need to promote partnerships to work towards setting up applicable national energy efficiency standards and apply them to a limited but critical range of energy-intensive industrial and consumer goods and buildings. Various programmes are underway in different ASEAN countries (for example, the Philippines, Thailand, and Malaysia) to develop standards and ratings of energy appliances and implement them in the commercial and residential sectors. However, regionally consistent standards and ratings are essential to stop cross-border propagation of non-standard products.

Private sector participation. Active participation by the private sector is essential to ensure a long-term market-driven approach to building a low-carbon economy. Cities should implement capacity development programmes to create an enabling policy and legal environment to attract private sector investment in low-carbon infrastructure development. ASEAN governments, regional organisations, and research institutions should work together to develop large-scale integrated smart city demonstration projects to increase awareness, test concepts, and develop mechanisms suited to local and regional contexts. The private sector can be encouraged to participate in transforming liveable cities through their corporate social responsibility (CSR) efforts.

Technology transfer. ASEAN should develop a common knowledge management and learning centre to share experiences and lessons learned on advanced low-carbon technologies and smart city growth mechanisms. City governments should consult with regional development organisations to encourage support in promoting climate technology transfer and diffusion, helping ASEAN member states and cities learn

from each other. ASEAN should forge a free trade agreement within the ASEAN region for high-impact green and low-carbon technologies and services.

National level policies and regulations in terms of fossil fuel use and subsidies can also help in the move towards low-carbon cities.

Box 3: Energy Efficiency Programme Singapore

The Energy Efficiency Singapore Programme is a key market-based strategy in mitigating emissions and addressing climate change. It focuses on supporting research and development (R&D), raising awareness, promoting the adoption of energy-efficient technologies and measures, as well as building capabilities and expertise. For example, Singapore's Building and Construction Authority introduced Green Mark standards for both non-residential and residential buildings in early 2008. Singapore has shifted towards the use of less carbon intensive fuels, principally natural gas. The Singapore government has built its first liquefied natural gas (LNG) receiving terminal on Jurong island and has been in operation since May 2013. . Efforts in promoting renewable energy such as biomass and solar energy are focused currently on R&D. Singapore is also one of the few countries in the world that incinerates almost all of its solid waste. The electricity from the incineration plants contributes 2 percent–3 percent to Singapore's energy supply. Moreover, Singapore is increasing the energy efficiency of its transport sector by improving and promoting the use of public transport. The government plans to achieve a target of 70 percent of commuters using public transport during rush hours by 2020. A vehicle quota system and electronic road pricing are already used to reduce traffic congestion. A green vehicle incentive scheme to encourage the use of hybrid and compressed natural gas vehicles introduced a discount of 40 percent for purchase from their market value.

Source: (ADB, 2013) and (Bell 2015).

5. Recommendations

The development of a smart liveable city and fostering a low-carbon economy is an integrated approach that needs commitment from city executives, active participation of public and private sectors, flowing of private sector investment, and cross-sectoral implementation of best practices and green and/or smart technologies

and services. ASEAN member states are already implementing measures pertaining to green growth and development of a low-carbon economy. However, a complete and well-constructed approach to develop a smart liveable city that fosters low-carbon development is absent in the ASEAN region. The first technical workshop on 19–20 January 2015 in Jakarta raised the following questions:

a. how ASEAN should be by 2025 in a smart-city context, with the implication on suggested outcomes and targets and outcome statements; and
b. what are the feasible and appropriate cases or examples especially in the ASEAN region of 'good practices' or 'good initiatives' that provide insights for upscaling to the regional level.

The following recommendations are aimed at improving the regional efforts to transforming ASEAN cities to make them liveable and foster a low-carbon economy both at national and regional levels.

5.1. Specifics

5.1.1. Upscaling existing programmes and activities

A number of initiatives are already in place in ASEAN to promote smart and low-carbon cities, both through local city-based initiatives as well as in collaboration with external agencies (institutions, cities, and governments). These have been highlighted and presented in Section 2. However, keeping in mind that (i) ASEAN cities are growing in terms of population, geographical area, and numbers, (ii) cities are the mainstay of a nation's economy, and (iii) cities contribute significantly to pollution and GHG emission, these existing initiatives, post 2015 need a significant boost in terms of increasing the number of cities being involved in such activities, as well as the number of activities to be undertaken, which would be city specific (such as industrial city and tourism city). It is suggested that by 2025, (say), at least 100 cities in the ASEAN region need to be involved and/or active in promoting low-carbon initiatives from the existing ASEAN Initiative on Environmentally Sustainable Cities (AIESC) of the current 25 cities.

5.1.2. Develop simple and robust scorecards for cities based on compilation of activities, results, good practices, and lessons learnt

Techniques and methods to estimate the emission and addressing them (mitigation) have been discussed in Section 3, and the examples from ASEAN and elsewhere have also been discussed. Cities in the ASEAN region are also recognised for their efforts. However, it is not clear how many of these efforts are being made aware to all the cities in the region. It is suggested that a detailed compilation of the various activities conducted, the results obtained through these activities, the good practices observed that could be easily replicated and upscaled, and the lessons learnt from 'failed' initiatives be carried out and shared and disseminated across the ASEAN region to all cities. It is important to emphasise the role of cities in their contribution to the economy as well as environmental problems, which necessitate that all cities have the knowledge to initiate and carry out activities they deem fit. Developing ASEAN city indicators that measure low-carbon and/or smart cities (some are listed in section 5.4) will be useful to develop scorecards that provide the impetus and incentives for cities to promote low-carbon growth.

5.1.3. Initiate city-based working groups to promote the smart city concept

In order to promote the smart city concept, it is imperative that city-based working groups are formed which are composed of local partners – local governments, NGOs, the private sector, universities, and civil society members. Such groups will help in developing plans and activities that are inclusive, and a bottom up approach to growth and improving living standards. This will also ensure the smooth implementation of initiatives, as well as the development of local level policies. It is not clear whether the local community is well represented in decision making towards low-carbon development in cities, and so it is suggested to form such working groups. These groups could share lessons from their work with the 'new cities' interested in low-carbon development.

5.1.4. Encourage development and implementation of local and/or city level 'green and/or smart' policies

Many, if not all, policies towards low-carbon development (such as promotion of renewable energy, energy efficiency, and building codes) are national-level policies that are applicable to the country as a whole. City-level (or even ward level) local

policies and standards can be developed and implemented in concurrence with the national policies. It is suggested to encourage cities to initiate local policies towards low-carbon development that can also serve as a prototype for expansion and upscaling.

In order to introduce and carry out these recommendations, the following should be taken into account, either in the process or as an implementation mechanism.

5.2. Actions

5.2.1. Acceptance by city authorities

For the success of any city-based strategy, it is imperative that the city authorities fully support the initiative. Without their support, no low-carbon city initiative will work and succeed. It is therefore not surprising that top administrators of cities spearhead activities. In the 'actions towards low-carbon cities' project involving 10 cities in Asia, the top administrators were directly involved, which resulted in achieving the project objectives in time (Kumar *et al*. 2013). This is evidenced in other city-based activities in other programmes in the ASEAN region as well.

5.2.2. Policies and strategies

Good governance and a sound understanding of the local context should govern green growth. Moreover, the policies need to be people-centred and allow the affected stakeholders to participate in and contribute to decision-making processes. Policies that contribute to green growth whilst improving the quality of life, include the following items (i.e. Establishing building codes and Sustainable waste management) (OECD 2014a).

5.2.3. Establishing building codes

Improving energy efficiency of buildings is a cost-effective measure to reduce energy demand and to reduce GHG emissions. Setting a mandatory building code is an effective way to achieve building energy efficiency. Specifying energy efficiency standards for new buildings and retrofitting requirements for old and existing buildings would significantly contribute to GHG reduction for the cities. Such building codes would compensate for the large increase in building energy demand that would arise from the massive increase in the ASEAN urban population by 2030. Building codes exist in some ASEAN countries, for example, Malaysia, the Philippines, Singapore, and Thailand. However, a regional guideline on developing

building codes and adjusted to reflect local context would be more effective. Such codes would help benchmarking of standards for energy efficiency of buildings and appliances in the region.

5.2.4. Sustainable waste management

Increasing city populations together with poor knowledge in waste management practice amongst the citizens in ASEAN cities is a major threat to making cities liveable and improving both the local and global environment. Sustainable waste management that involves environmentally appropriate treatment of organic waste, and recycling and recovering of non-organic waste would significantly reduce GHG emissions, clean the local environment, and create jobs. ASEAN cities can leverage the low labour cost in the region to make such interventions cost effective. Any voluntary initiative to sustainable waste management is unlikely to be effective and thus would need some form of policy directives at the city level. The ASEAN Socio-Cultural Community (ASCC) can play a part, for example, by developing guidelines for sustainable waste management.

5.3. Regional cooperation

ASEAN cites are in a fortunate position due to their proactive regional groups and associations. These bodies can play an important role in strengthening the efforts of transforming cities. For example:

- *Technical, financial, and policy support*. Technical, financial, and policy support is required to improve the transformational capacities to cities. The ASCC would need to build-in provisions for rendering such support to cities. For example, technology transfer programmes can be conducted at city, national, and regional levels under the leadership of ASCC.
- *Knowledge sharing*. ASEAN cities can learn from each other about their experiences of transformation, best practices of specific interventions, amongst others. The ASCC would be in a better position to facilitate the exchange of ideas and knowledge amongst the cities. Regional knowledge sharing workshops with the participation of a wide range of stakeholders including government, the private sector, and the community would enhance the learning process of transforming cities.

- *Building institutional capacity*. The region comprises cities of various sizes and types. Institutional capacities to implement sectoral interventions and to enforce policy measures also vary. Many cities lack the institutional capacity to develop policy measures, develop cost-effective sectoral interventions, establish appropriate indicators, and mainstream low-carbon measures into the city development plan. The ASCC can help improve the institutional capacity of cities by providing training and other capacity building events such as study tours.
- *Awareness programmes*. Targeted education programmes would help cities and their stakeholders to learn about the benefits of liveability and low-carbon development. In particular, they would help to eliminate the misconception that low-carbon development and green growth would restrict the city's future economic prosperity.
- *Regional leadership*. The ASCC's role in cumulative improvement of liveability and low-carbon development of ASEAN cities would position itself as a regional leader.
- *Harmonisation of regional initiatives*. The ASEAN region benefits from a number of groups and associations, for example, the Economic Research Institute for ASEAN and East Asia (ERIA) and the ASEAN Centre for Energy (ACE). These bodies have been working on initiatives including energy conservation, sustainable energy generation, and supporting economic growth. However, these are being done in isolation without taking advantage of collaborative strength. Cumulative efforts in addressing cross-cutting themes would further improve the regional initiative of city transformation. For example, ACE could implement energy efficiency programmes in the region with the involvement of cities to become more effective. Such programmes should take into account and align with the city development plan and work in harmony with other regional groups to facilitate an integrated approach to liveable low-carbon city development.

5.4. Development of city-level GHG emissions inventory

The development of an emissions inventory is the first step to initiate low-carbon development. Baselines will allow the establishment of a target and help to develop measures to reduce emissions. Several tools are available to help cities prepare their emission inventories. For example, ICLEI supported Yogyakarta City and piloted the use of emission software HEAT+. Two other software are discussed in Appendix B. A regional programme to support the inventory development needs to be done. For example, a target of city-level inventory development in 100 cities by 2025 could be established.

GHG inventory development will require capacity building of city staff (and other stakeholders). There are highly-skilled training organisations in the region (for example, the Asian Institute of Technology) that offer capacity development in the whole spectrum of emission accounting and action plan development.

5.5. Development of a knowledge management platform

On a regional scale, sharing lessons, experiences, and good practices with other cities that are in transition of transforming to low-carbon green growth, is a value addition. This not only encourages and provides clear lines to the cities in their endeavours for transformation but also it eliminates the reinvention of the wheel by just implementing those that have been successful elsewhere. This can be implemented in a number of ways as listed below (or a combination of all of them).

- Develop a regional website, either by the ASEAN secretariat or other regional organisations, where cities will share their best practices, policies, lessons learned, and stories about leadership.
- Conduct regional workshops, study tours, and courses on a regular basis where participants participate in discussions and visit low-carbon facilities, amongst other activities. The city governments should be encouraged to ensure their staff participate in these programmes and implement lessons learnt.

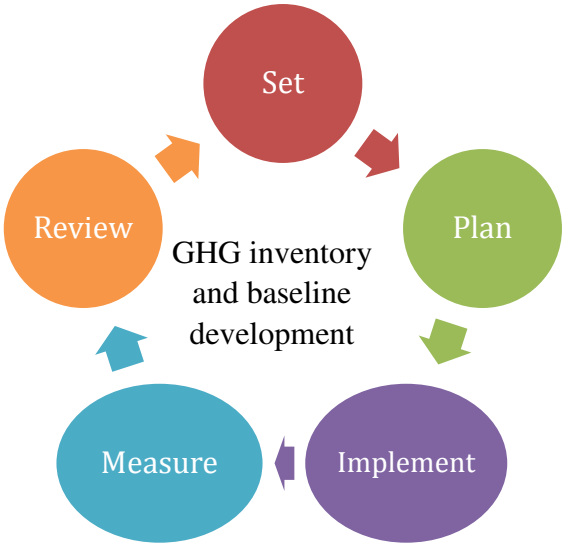
As discussed earlier, some initiatives to bring together city leaders and operational staff are already taking place. However, these are mostly occurring on a

project basis. A regional long-term initiative needs to be put in place to allow ongoing and regular knowledge sharing opportunities. Such programmes, for example, can target (i) develop a regional low-carbon liveable city information sharing website, (ii) conduct bi-annual knowledge sharing workshops until 2025, and (iii) develop a low-carbon academy to allow city staff (and other stakeholders) to enrol (10 enrolment per year up to 2025) for a short courses on practical-oriented low-carbon city development. Note that such an academy does not need to be a stand-alone institute, rather it can be housed in a university to minimise the cost.

5.6. Emission reduction plan and strategy

As discussed earlier, setting up an emission reduction target is essential for cities to achieve a low-carbon economy. To be effective, such targets should be long term, be continually improved over time, and adaptable to a changing world rather than rely on strategies that have been created in the present to remain effective in the future. Therefore, emission reduction is a cyclical process (Figure 6) and involves the following:

Figure 6: Carbon Emission Reduction Strategy model



Source: Author.

a) **Set**. Create targets that are quantifiable and have specific timeframes.
b) **Plan**. Identify appropriate solutions to be implemented in order to achieve target.
c) **Implement**. Put the solutions into practice.
d) **Measure**. Record the actual effect of the solution.
e) **Review**. Gauge the progress towards the target and make an assessment on the effectiveness of the solutions and the strategy.

5.7. International collaboration

Strategic ties with more developed cities, for example the leading low-carbon and/or green growth cities in Europe, the United States, and Australia would have significant benefits for ASEAN cities to learn the success factors as well as obtaining practical guidance on city transformation. Such initiatives are already occurring in ASEAN, for example, the collaboration of Chiang Rai (Thailand) and Legazpi city (Philippines) with two US cities under the City Links Pilot Partnership programme (Box 2).

It is suggested that a long-term collaboration programme focusing on sharing information, exchanging ideas, and technical assistance with cities outside ASEAN should be developed. Collaboration at programme-level, for example, with renowned and successful programmes in Europe, should also be considered. Recently, the Indian government announced a programme for 100 low-carbon cities – ASEAN may find it useful to collaborate with this programme for mutual benefits.

5.8. Mainstreaming green growth in city development plans

Mainstreaming green growth objectives into city development plans is vital to encourage cross-sectoral participation and ensure the availability of budgets for the green growth transition. However, there are challenges to integrate green growth strategies into city development plans. For example, city development plans are usually done on short- to medium-term scale (1 to 5 years) whilst green growth needs longer-term planning, say 20 years. Often green growth strategies require an upfront cost and investment and there may not be an immediate benefit. This requires green

growth strategies to adopt a long-term perspective and consider the well-being of future generations, whilst also considering the distribution of costs and benefits across all stakeholders in the short term. For example, the green growth strategies of Cambodia and Viet Nam have targets and a schedule for implementation in the short, medium, and long term (OECD, 2014a). An Asian Development Bank working paper on the development of an integrated framework of urban development provides an operational framework that begins with an assessment of a business-as-usual (BAU) scenario to develop a smart liveable city (Sandhu and Singru, 2014). The framework provides three core elements that are required for an integrated urban development: (i) ensuring economic competitiveness through, for example, the development of low-carbon smart infrastructure and the development of private entrepreneurship, (ii) conserving natural resources and implementing low-carbon technologies such as by introducing renewable energy generations, and (iii) improving the equity (for example, building resilience). Favourable policy instruments (for example, fiscal incentives), good governance and appropriate institutional mechanisms, and engagement of stakeholders in the decision-making process enable the successful implementation of integrated urban development.

5.9. Low-carbon development indictors

Shifting to a low-carbon economy through the implementation of green growth needs to be accompanied by a reliable set of measurement tools to help policy evaluation, performance monitoring, and raise a city's profile of green growth amongst the public and policymakers. Once the low-carbon target has been set, the city can then set sector-level measurable indicators to establish specific goals and measure progresses.

(Baeumler *et al*., 2012)((??)) notes that low-carbon city development indicators focus on four different but overlapping objectives – sustainable cities, green cities, eco-cities, and low-carbon cities. These indictors attempt to define benchmarks to determine whether or not cities have reached this particular goal.

A set of green growth indicators has been proposed, which are based on (i) European green city index, (ii) Leadership in Energy and Environmental Design

(LEED) for neighbourhood development, and (iii) list of low-carbon indicators that were used for Chinese cities (Table 3).

Table 3: Measurable Indicators for the Development and Monitoring of a Low-carbon Liveable City

Measurement area	Measurable indicators	ASEAN relevance
GHG emissions	• Emissions per capita and emission intensity	Relevance of these indicators to ASEAN visions is demonstrated by overarching plans and/or strategies. For example, the ASCC Blueprint states the ASEAN vision 'D.5. Promoting quality living standards in ASEAN cities/urban areas'. Planned actions under this vision include working towards initiatives such as Low Carbon Society, Compact Cities, Eco-cities and Environmentally Sustainable Transport (ASEAN, 2009a).
Energy	• Energy consumption per capita • Energy intensity • Share of renewable energy in generation mix	
Green buildings	• Energy consumption per square meter in commercial and residential buildings • Number of certified green buildings • Minimum building energy efficiency • District heating and cooling • On-site renewable energy sources • Solar orientation for building blocks	
Sustainable transport	• Share of green transport mode trips • Percentage of citizens walking, cycling, or taking public transport • Percentage of citizens travelling by public transport • Length of public transport network • Existence of congestion reduction policies • Reduced parking footprint • Transportation demand management	
Land use	• Compact development • Mixed use neighbourhood centre • Walkable streets • Access to open space or recreational facilities	

Note: ASEAN = Association of Southeast Asian Nations, ASCC = ASEAN Socio-Cultural Community, GHG = greenhouse gas.
Source: Adapted from Baeumler *et al*. (2012).

The indicators listed in Table 3 focus on the key sectors that can contribute to emission reductions in cities. These quantitative indicators need to be complemented with qualitative indicators that focus on regulatory and enforcing mechanisms, for example, policies, regulations, and standards. Singapore has developed different indictors (below) to measure its liveability status (CLC, 2014) which have some similarities that are listed in Table 3.

- **Community well-being**. Home ownership rates; number of people living and working in the central area; percentage of people satisfied with the living, working, and leisure environment in Singapore; measures of building safety and quality, that is construction quality assessment system.
- **Built environment**. Percentage of users satisfied with the parks, number of projects that aim for Green Mark certification (green building rating system), park provision ratio (hectares per 1,000 population), number of days in a year where the pollutant standards index (PSI) is in the good range, number of air and water pollutants in a year, utilisation rate of state land.
- **Transportation**. Traffic congestion at peak hours, percentage of public transport ridership, customer satisfaction levels for public transport.
- **Water and sanitation**. Minimisation of unaccounted for water, access to sanitation, level of domestic water consumption per capita, water that meets the World Health Organization drinking water quality guidelines, access to clean drinking water sources.
- **Waste**. Recycling rate.
- **Energy**. Energy consumption levels

Work in these metrics needs to be done comprehensively in close consultation with the city authorities.

6. Conclusions

Major cities (capital and major business and tourist cities) in the ASEAN region need to improve their liveability to serve as home to a growing population. Huge economic growth also needs to be supported by low-carbon urban development to reduce greenhouse gas emissions and to combat climate change. Improvement of liveability conditions and transformation to low-carbon development pathways require a holistic approach that involves well-constructed interventions to sectoral scopes. ASEAN leaders have set visions for the development of sustainable cities and improvement in resource efficiency, which are reflected in a number of regional policy documentations.

The realisation of the ASEAN vision of sustainable city development is a complex and long-term process that requires strong commitment at city and national level, and mobilisation of resources. The development of low-carbon cities requires conducive policies and strategies formulated by the government. It also requires collaboration and cooperation from the private sector for it to be 'market driven'. In addition, collaboration from foreign partners, who are seeking to share technologies and knowledge of green technologies, is also important. A strong awareness campaign programme is required to educate stakeholders and the community. City-level decision-making processes will need to involve all levels of stakeholders including national governments, the research community, practitioners, non-governmental organisations, and the private sector. Engendering liveable low-carbon smart city for the ASEAN region will need to address the following:

- City leaders should advocate for national policy adjustment to support cities initiatives of low-carbon development.
- Cities need to first start the process of measuring their emissions, that is, the development of an emission inventory. Whilst national-level emission inventories have been developed for some countries, a city-level emission inventory is generally absent. Focus should be given on using a consistent framework of emission accounting to ensure cross-border applicability of emission data.
- Consider the development of a knowledge management centre to share experiences and lessons learned to maximise regional cooperation. This will help cities to learn from each other and to implement best practices without the need for reinventing the wheel.
- City-level targets should take into consideration of any existing national and/or regional targets and policies to avoid any conflict in the longer term. Such targets and policies may also include national commitments to the Millennium Development Goals.
- Low-carbon green growth initiatives should be linked with wider food security, energy security, and water security to maximise the benefits of city transformation and ensure alignment with the overall development agenda.

Investing in cities towards a low-carbon and smart city concept by ASEAN could lead to the following benefits:

- In terms of implementation, considering the geography and mandate of the city authorities, initiatives will be easier to implement. Results and impacts (clean air, improvement in living standards, growth in local economy, amongst others) will be evident to the people.
- Many of the initiatives may not need new funds, but could be reallocated within the existing budgetary expenses, for example, replacing non-energy efficient lamps with energy efficient ones. Involving the private sector could bring in funds through CSR, whilst universities could attract research funding from various sources.
- Promote closer working within the city context and encourage a sense of ownership of activities leading to good governance.
- Promote economic development within the city and its environs, and contribution to the national GDP. Introducing low-carbon development in small and medium-sized cities could help invigorate the local economy, and reduce migration to mega cities.
- Smart city promotion has multiple benefits including reducing local pollution, mitigating GHG emissions, increasing income levels, improving quality of life, greater economic development, and increased social cohesion.
- Cities contribution to GHG emission reduction can assist the global agenda of mitigating emissions.

References

Anisuzzaman, M. (2014), *Development of a Framework for Local Governments to Enhance Adaptive Capacity to Climate Change*. Perth, Australia: Murdoch University. Available at: http://researchrepository.murdoch.edu.au/23333/ (accessed 5 January 2015).

Australian Broadcasting Corporation [ABC], (2014), Melbourne named world's most liveable city. *ABC News*. Available at: http://www.abc.net.au/news/2014-08-19/melbourne-worlds-most-liveable-city-for-the-fourth-year-running/5681014 (accessed 4 January 2015).

ACE (2014), *ASEAN Energy Efficiency Development and Its Associated Activities*, ASEAN Centre for Energy. Available at: http://www.aseanenergy.org/media/documents/2014/06/03/a/s/asean_energy_efficiency_development.pdf (accessed 27 November 2014).

ADB (2013), *Low-Carbon Green Growth in Asia: Policies and Practices*, Available at: http://www.adbi.org/book/2013/01/25/5459.low.carbon.green.growth.asia.exec.summary/ (accessed 9 January 2015).

ADB (2009), *The Economics of Climate Change in Southeast Asia: A Regional Review*, Manila: Asian Development Bank. Available at: http://www.adb.org/publications/economics-climate-change-southeast-asia-regional-review (accessed 27 December 2014).

ADB-ADBI (2012), *Policies and practices for low-carbon green growth in Asia*, Philippines: Asian Development Bank and Asian Development Bank Institute. Available at: ipcc-wg2.gov/njlite_download2.php?id=9689.

ASEAN (2009a), *ASEAN Socio - Cultural Community Blueprint*, Available at: http://www.asean.org/communities/asean-socio-cultural-community (accessed 30 December 2014].

ASEAN (2009b), *Fourth ASEAN State of the Environment Report 2009*, Association of Southeast Asian Nations. Available at: http://www.asean.org/resources/publications/asean-publications/item/fourth-asean-state-of-the-environment-report-2009-2 (accessed 30 December 2014).

ASEAN (2014), *Nay Pyi Taw Declaration on Realisation of the ASEAN Community by 2015*, Association of Southeast Asian Nations. Available at: http://www.asean.org/news/asean-secretariat-news/item/nay-pyi-taw-declaration-on-the-asean-community-s-post-2015-vision.

Auckland Council (2014), Auckland Energy Resilience and Low Carbon Action Plan. Available at: http://www.aucklandcouncil.govt.nz/en/planspoliciesprojects/plansstrategies/theaucklandplan/energyresiliencelowcarbonactionplan/Pages/home.aspx (accessed 15 January 2015).

Baeumler, A., E. Ijjasz-Vasquez, and S. Mehndiratta (2012), *Sustainable Low-Carbon City Development in China*, World Bank Publications.

Bell, J., (2015), 'Trafigura and Singapore LNG sign strategic deal to utilise excess storage capacity', Available at: http://www.txfnews.com/News/Article/5074/Trafigura-and-Singapore-LNG-sign-strategic-deal-to-utilise-excess-storage-capacit (accessed 1 July 2015).

Bland, S., (2013), Urban-Low Emission Development Strategies. Available at: http://locs4africa.iclei.org/wp-content/uploads/2013/11/5_Steven-Bland_Low-Emission-Dev-Strategies.pdf (accessed 22 January 2015).

City of Melbourne (2014), *Zero Net Emissions - City of Melbourne*, Melbourne, Australia: The City of Melbourne. Available at: http://www.melbourne.vic.gov.au/Sustainability/CouncilActions/Pages/ZeroNetEmissions.aspx (accessed 4 January 2015).

City of San Francisco (2014), Green Building Ordinance | Department of Building Inspection. Available at: http://sfdbi.org/green-building-ordinance (accessed 5 January 2015).

City of Sydney (2014a), Sydney 2030 - Green/Global/Connected. Available at: http://www.sydney2030.com.au/ (accessed 4 January 2015).

City of Sydney (2014b), Trigeneration. Available at: http://www.cityofsydney.nsw.gov.au/vision/towards-2030/sustainability/carbon-reduction/trigeneration (accessed 5 January 2015).

City of Toronto (2014), *TAF 2015-2020 Strategic Directions: Charting the Voyage to a Low Carbon City*, Toronto, Canada. Available at: www.toronto.ca (accessed 4 January 2015).

CLC, (2014), *Liveable sustainable cities - a framework*, Centre for Liveable City, Singapore Government. Available at: http://www.clc.gov.sg/documents/books/CLC_CSC_Liveable_&_Sustainable_Cities.pdf (accessed 15 January 2015).

DEPD (2010), *Brunei Darussalam | Millennium Development Goals and Beyond: Revisited*, Brunei Darussalam: Department of Economic Planning and Development. Available at: http://www.depd.gov.bn/mdg/Downloads/Brunei%20Final%20MDG%202nd%20Report.pdf (accessed 25 June 2015).

Dhakal, S., (2009), 'Urban energy use and carbon emissions from cities in China and policy implications', *Energy Policy*, 37(11), pp.4208–4219.

Droege, P. (2011), *Urban Energy Transition: From Fossil Fuels to Renewable Power*, Elsevier.

ERIA (2014), *Energy Outlook and Analysis of Energy Saving Potential in East Asia | ERIA*, Indonesia. Available at: http://www.eria.org/publications/research_project_reports/FY2013/No.19.html (accessed 27 December 2014).

Friend, R., J. Henceroth, and S. Reed (2013), *How is building resilience different from all other programs? Experience from promoting urban climate change resilinece*, Institute for Social and Environmental Transition-International (ISET-International). Available at: http://www.i-s-e-t.org/images/pdfs/Resilience%20Discussion%20Paper_131218.pdf (accessed 6 April 2014).

GIZ (2014), Regional Programme 'Cities – Environment – Transport.' Available at: https://www.giz.de/en/worldwide/14509.html (accessed 30 December 2014).

ICLEI (2014), Global Protocol for Community-Scale GHG Emission Inventories (GPC). Available at: http://www.iclei.org/our-activities/our-agendas/low-carbon-city/gpc.html (accessed 4 January 2015).

ICLEI (2011), South African Project Overview. Available at: http://www.kznenergy.org.za/wp-content/uploads/2013/10/URBAN-LEDS-Brochure_ICLEI-1.pdf (accessed 22 January 2015).

Jacob, K., P. Kauppert, and R. Quitzow (2013), *Green Growth Strategies in Asia: Drivers and Political Entry Points*, Friedrich Ebert Stiftung. Available at: library.fes.de/pdf-files/iez/10403.pdf

Jander, M. (2014), Transit Oriented Development: 5 Leading Cities. Available at: http://www.ubmfuturecities.com/author.asp?section_id=234&doc_id=525744 (accessed 13 January 2015).

Jha, A. K., T. W. Minner, and Z. Stanton-Geddes (2013), *Building urban resilience : principles, tools, and practice*, Washington DC, USA: The World Bank. Available at: http://econ.worldbank.org/external/default/main?pagePK=64165259&theSitePK=469372&piPK=64165421&menuPK=64166093&entityID=000356161_20130308155433 (accessed 8 January 2015).

KeTTHA (2011), *Low Carbon Cities Framework and Assessment System*, Kementerian Tenaga, Teknologi Hijau dan Air. Available at: http://esci-ksp.org/wp/wp-content/uploads/2012/04/Low-Carbon-Cities-Framework-and-Assessment-System.pdf (accessed 22 January 2015).

King, R., (2013), 4 Ways Cities Benefit from Bus Rapid Transit (BRT). Available at: http://www.wri.org/blog/2013/12/4-ways-cities-benefit-bus-rapid-transit-brt (accessed 7 January 2015).

Kumar, S. *et al*., (2013), *Action towards Resource-efficient and Low Carbon Cities in Asia - Experiences and Highlights*, Thailand: Asian Institute of Technology. Available at: http://lcc.ait.asia/general_publication_detail.php?pubID=11 (accessed 2 January 2015).

Lehmann, S. (ed.) (2014), *Low Carbon Cities: Transforming Urban Systems* 1 edition. Abingdon, Oxon; New York, NY: Routledge.

Leichenko, R. (2011), 'Climate change and urban resilience', *Current Opinion in Environmental Sustainability*, 3(3), pp.164–168.

Luu, V.H. (2014), 'CNG buses in Ho Chi Minh City, Vietnam', Available at: http://www.greengrowth.org/?q=initiatives/cng-buses-ho-chi-minh-city-vietnam (accessed 15 January 2015).

NESDB (2011), *THE ELEVENTH NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT PLAN (2012-2016)*, National Economic and Social Development Board. Available at: http://eng.nesdb.go.th/Portals/0/news/plan/eng/THE%20ELEVENTH%20NATIONAL%20ECONOMIC%20AND%20SOCIAL%20DEVELOPMENT%20PLAN(2012-2016).pdf (accessed 25 June 2015).

OECD (2014a), *Towards Green Growth in Southeast Asia*, Paris: Organisation for Economic Co-operation and Development. Available at: http://www.oecd-ilibrary.org/content/book/9789264224100-en (accessed 12 January 2015).

OECD (2014b), *Urban Green Growth in Dynamic Asia: A Conceptual Framework*, Available at: http://www.oecd.org/greengrowth/urban-gg-dynamic-asia.htm (accessed 28 December 2014).

Queensland Government (2014), Yeerongpilly Transit Oriented Development. Available at: http://www.dsdip.qld.gov.au/local-area-planning/yeerongpilly-transit-oriented-development.html (accessed 8 January 2015).

Ratanawaraha, A. and S. Chalermpong (2014), Towards Transit-Oriented Development in Bangkok: Evidence and Challenges. Available at: www.ash.harvard.edu/.../Asia_Public_Policy_Forum_2014_Paper.pdf

Rizwan, A.M., L.Y.C. Dennis, and C. LIU (2008), 'A review on the generation, determination and mitigation of Urban Heat Island', *Journal of Environmental Sciences*, 20(1), pp.120–128.

Robertson, K. (2011), Kings Park centre to provide underground education. *PerthNow*. Available at: http://www.perthnow.com.au/news/western-australia/kings-park-centre-to-provide-underground-education/story-e6frg13u-1226120471443 (accessed 5 January 2015).

Sandhu, S. C. and R. N. Singru (2014), *Enabling GrEEEn Cities: An Operational Framework for Integrated Urban Development in Southeast Asia*, Available at: http://wcm.adb.org/sites/default/files/publication/149685/southeast-asia-wp-9.pdf (accessed 13 January 2015).

Seetharam, K., B. Yuen, and Y. Kuan (2010), *Developing Living Cities: From Analysis to Action*, World Scientific.

Sharifi, A. and A. Murayama (2013), 'A critical review of seven selected neighborhood sustainability assessment tools', *Environmental Impact Assessment Review*, 38, pp.73–87.

Songdo (2014), Songdo International Business District. Available at: http://www.songdo.com/ (accessed 5 January 2015).

The Economist (2014), The best places to live. *The Economist*. Available at: http://www.economist.com/blogs/graphicdetail/2014/08/daily-chart-13 (accessed 15 January 2015).

UNEP (2013), *City-Level Decoupling: urban resource flows and the governance of infrastructure transitions*, United Nations Environment Programme. Available at: http://www.unep.org/resourcepanel/Publications/City-LevelDecoupling/tabid/106135/Default.aspx (accessed 8 January 2015).

World Bank (2014), Energizing Green Cities: Solutions to Meet Demand and Spark Economic Growth. Available at: http://www.worldbank.org/en/news/feature/2014/02/18/energizing-green-cities-solutions-to-meet-demand-and-spark-economic-growth (accessed 2 January 2015).

WRI (2014a), *Cities At Large: EMBARQ Helping cities make sustainable transport a reality*, World Resources Institute. Available at: http://www.wricities.org/sites/default/files/Cities-at-Large-web.pdf (accessed 1 July 2015).

WRI (2014b), Launch of First Global Standard to Measure Greenhouse Gas Emissions from Cities. Available at:

http://www.wri.org/news/2014/12/release-launch-first-global-standard-measure-greenhouse-gas-emissions-cities (accessed 4 January 2015).

Xue, L. and H. Zhang (2014), Low-carbon and sustainable transport in Qingdao: A strategic study. *EMBARQ*. Available at: http://www.embarq.org/research/publication/low-carbon-and-sustainable-transport-qingdao-strategic-study (accessed 7 January 2015).

Appendix A: Case Studies of Low-carbon Cities

A. City of Toronto

Goal/target: Reduce GHG emissions by 80 percent by 2050

Approach: The city has set out ambitious but clear goals and developed bold measures to achieve this emission reduction target. These include:

- **Public Investment**: The city is investing $20 million to green Toronto's homes and businesses with innovative projects like shared geo-thermal systems and green roofs.
- **Building bike/walk paths**: Doubling the city-wide bike network to 1,000km by 2012.
- **Financial incentives**:
    - Up to $100,000 per installation for green and cool roofs on industrial and commercial buildings.
    - $62 million has been allocated to offer zero-interest financing for renewable energy and energy efficiency upgrades to not-for-profit and government buildings.
- **Mass rapid transit**: Construction/expansion of North America's largest mass rapid transit system, which will add 120 km of modern light rail public transit.
- **Building retrofitting**: Upgrading over 500 city facilities and buildings to be energy efficient, plus an additional 1,000 inefficient apartments will be retrofitted to make them energy efficient.
- **Increasing tree canopy**: Doubling the city's tree canopy by 2050.
- **Awareness**: Public reporting of harmful chemical use.
- **Smart vehicles**: Increasing the use of hybrid electric vehicles.
- **LED technology**: Over 2,000 traffic lights to be converted to LED technology.
- **Green standards**: Financial incentives are available to implement made-in-Toronto concept to designing environmentally friendly buildings and landscapes.

The city is on its path towards becoming a world-leading low-carbon city. By 2011, Toronto had reduced greenhouse gas emissions by 22 percent, exceeding its 2012

target of a 6 percent reduction in greenhouse gas emissions compared to 1990 (the Kyoto target) despite rapid growth in population in the city since 1990. This puts Toronto firmly on a path to achieving its 2020 target of 30 percent reduction (City of Toronto, 2014).

B. City of Melbourne

Melbourne has been named the world's most liveable city for the fourth year in a row, by the Economist Intelligence Unit's liveability survey of 140 cities (ABC, 2014).

Goal/target: The city planned to become a carbon neutral city and to be one of the world's most sustainable cities. The zero net emissions by 2020 strategy, initially planned in 2003, outlines the detailed plan to achieving this goal and the progress made so far.

Approach: The city has identified six focus areas where it can achieve the most effective and viable greenhouse gas emissions reductions and has set out clear, ambitious objectives for each of the focus areas (City of Melbourne, 2014). These are:

a) **Council operations and leadership:** Maintain carbon neutrality and reduce greenhouse gas emissions by 10 percent by 2018 (baseline year 2010–2011).
b) **Commercial buildings and industry:** Increase the average National Australian Built Environment Rating System (NABERS), or equivalent, rating or commercial buildings to four by 2018. This roughly equates to an average increase in energy efficiency of 40 percent per building.
c) **Residential buildings:** Melbourne will establish a baseline and develop a long-term target in the first year of implementation plan
d) **Stationery energy supply:** 25 percent of electricity from renewable sources by 2018.
e) **Transport and freight:** Increase the percentage of all trips using low emissions transport from 51 percent in 2009 to 60 percent in 2018.
f) **Waste management:** Decrease waste to landfill per resident by five percent by 2018. Melbourne to trial seven precinct waste solutions by 2018.

C. Songdo International Business District, South Korea

The Songdo International Business District is being developed on 1,500 acres of reclaimed land along Incheon's waterfront, 40 miles from Seoul and 7 miles from Incheon International Airport (Figure A1). The estimated annual GHG emissions from this high-density city energy use will be 260,000 tonnes of CO_2 equivalent (tCO_2-e) based on 65,000 residents. This compares to 780,000 tCO_2-e GHG emissions from a typical low-density development. All the buildings of Songdo city are LEED certified, this reduces GHG emissions from building energy use by about 300 percent (250,000 tCO_2-e compared with typical case of 674,000 tCO_2-e) compared to typical buildings. The smart transport system and mobility infrastructure will reduce transport related GHG emissions by about 80,000 tCO_2-e.

Figure A1: Top Elevation of Songdo IBD

Source: Songdo (2014).

Highlights of the Songdo IBD master plan are:

- The 68-story northeast Asia Trade Tower, which will stand as the Republic of Korea's tallest building and most advanced corporate centre.
- The architecturally stunning Songdo Convensia, operating as Incheon's primary convention centre, is the Republic of Korea's largest column-free interior space.

- 600 acres of open space including a 100-acre central park, providing a beautiful place of refuge and relaxation for those who live and work in the city.
- The Incheon Arts Centre, a cultural complex housing a concert hall, opera house, museum of Asian contemporary art, a music conservatory, design school, artist in residence housing, and a library.
- The Jack Nicklaus Golf Club Korea features an 18-hole championship golf course, a full clubhouse and a fitness centre situated on a 228 acre site, which will also include luxury villas and condominiums.
- Public and private schools including the Chadwick International School for students from kindergarten to high school, offering a state-of-the-art learning environment and international perspectives to prepare them for leading post-secondary schools around the world.

Songdo International City Hospital, planned to boast the latest in medical diagnosis and treatment technologies. Partners such as 3M and Microsoft will also participate in the development of this world-class healthcare facility.

Appendix B: Greenhouse Gases Inventory Tools

Various tools are available in the public domain (for free) to assist with city-level emissions accounting, tracking performance over time, and streamlining the reporting process. Below is a brief discussion of some commonly used tools.

Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

Developed in collaboration with the World Resources Institute, C40 Cities, and ICLEI, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) offers a robust and clear framework that builds on existing methodologies for calculating and reporting city-wide GHG emissions. The GPC requires cities to measure and disclose a comprehensive inventory of GHG emissions and to total these emissions using two distinct but complementary approaches. One approach captures emissions from both production and consumption activities taking place within the city boundary, including some emissions released outside the city boundary. The other approach categorises all emissions into 'scopes' depending on where they physically occur. Separate accounting of emissions physically released within the city boundary should be used for aggregation of multiple city inventories in order to avoid double counting (ICLEI, 2014). The GPC is divided into three main parts:

- **Part I** introduces the GPC reporting and accounting principles, sets out how to define the inventory boundary, specifies reporting requirements, and offers a sample reporting template.
- **Part II** provides overarching and sector-specific accounting and reporting guidance for sourcing data and calculating emissions, including calculation methods and equations.
- **Part III** shows how inventories can be used to set mitigation goals and track performance over time, and shows how cities can manage inventory quality.

The GPC has been piloted in a number of cities with great success (WRI, 2014). These include:

- **Guangzhou, China** is using the GPC to analyse its greenhouse gas emissions trends and design a roadmap towards emission peak. WRI China provides training and technical advice to Guangzhou to apply the GPC.

- **Johannesburg, South Africa** conducted its first ever city-wide GHG inventory using the GPC to establish a 2007 baseline. Total greenhouse gas emissions were estimated at 26.5 million tons of CO_2 emissions, 71 percent of which was from electricity use. Johannesburg is now using this evidence to create a detailed climate action plan.
- **Rajkot, India** and seven other Indian cities – home to almost 11 million people – set up their very first GHG inventories using beta versions of the GPC. The GPC guidance has helped Rajkot (one of the GPC pilot cities) plan and implement actions to achieve its 14 percent CO_2 emissions reduction target by 2016 (based on 2011 base year).
- **Rio de Janeiro, Brazil** conducted GHG inventories for 2005 and 2012 as part of the GPC pilot programme. With these results, Rio implemented a series of low-carbon transport, waste management, forestry, and energy efficiency projects. So far these actions have avoided 378,000 tons of CO_2 emissions.
- **Wellington, New Zealand** participated in the GPC pilot programme to develop a GHG inventory for the Wellington region (including Wellington city and seven other cities) as part of its new climate change action plan to lower GHG emissions by 30 percent by 2030 and 80 percent by 2050 (from 2001 levels).

The ASEAN cities involved in the GPC framework are classified into:

- GPC pilot cities: Georgetown and Iskandar (Malaysia), and Nonthaburi and Phitsanulok (Thailand)
- GPC beta version users: Balikpapan and Semarang (Indonesia) and Johor Bahru (Malaysia)

Bilan Carbone™

Developed by the French Environment and Energy Management Agency (ADEME), Bilan Carbone™ (carbon balance) is a tool to calculate the GHG emissions to assess the direct and indirect emissions produced by the different activities of all the stakeholders in a territory. The Bilan Carbone™ module is made up of a series of spreadsheets with associated utility manuals. A spreadsheet is used to calculate emissions, compare emissions between different years, and assess the potential of

various emission reduction actions. The associated utilities assist users in calculating the emissions in road transport, the cooling gas leaks from refrigeration and air conditioning systems, and simulating 'what is at stake economically' over the entire range of activities studied. Over 2,000 Bilan Carbone™ diagnostics have been conducted in France and the tool is being adapted in the rest of the world. These include:

Paris: Paris encompasses 3,000 hectares of green space, receives 30 million tourists annually, and accounts for 10 percent of the national GDP. The carbon balance study took into account the major fluxes of consumption or movements: energy use, mobility of people and merchandise, consumption of Parisians and visitors, and production of waste, amongst others.

Three major sectors account for 80 percent of all the emissions through the use of energy: energy consumed in buildings, transport of people, and transport of merchandise. Such estimations have been useful for the city authorities to provide the right direction in setting policies that helps Paris to achieve resource efficiency and environmental sustainability, and in meeting the Kyoto Protocol obligations.

The Bilan Carbone™ tool was used in seven cities of Southeast Asia to estimate GHG emissions of cities. The tool helped the city administrators to estimate the GHG emissions by the municipalities and to develop measures to reduce the emissions (Kumar et al., 2013). The tool was further used to estimate the emissions of tourism related activities in Chiang Mai (Thailand) and Hue City (Viet Nam).

Appendix C: Case Studies of Technologies and Plans

A. Yeerongpilly Transit Oriented Development

The 14-hectare Yeerongpilly Transit Oriented Development (TOD) site is located alongside the Brisbane River, approximately 6 kilometres from the Brisbane central business district. It adjoins the Queensland Tennis Centre and Mirvac Tennyson Reach development to the west and Fairfield Road and the Beenleigh to Gold Coast railway line to the east. A pedestrian overpass across Fairfield Road provides easy access between the site and the Yeerongpilly train station. The benefits of the proposed Yeerongpilly TOD include:

- more efficient use of existing land and infrastructure
- housing options, including a mix of housing types and sizes to suit different lifestyles and help accommodate Brisbane's growing urban population
- new local employment opportunities
- convenience of local retail within walking distance
- convenient location close to public transport helping to reduce traffic congestion and provide a sustainable alternative to private car usage
- enabling more active lifestyles through new public spaces, recreational facilities, cyclist and pedestrian friendly streets, parks, and plazas
- better pedestrian accessibility between the Queensland Tennis Centre and the Yeerongpilly railway station

The proposed site is susceptible to flooding, therefore, this site requires new buildings to have habitable floor levels at least 500 millimetres above the interim residential flood level for development.

Source: Queensland Government (2014).

B. Trigeneration for Sydney Town Hall

As part of Sydney's plans to reduce GHG emissions by 70 percent by 2030, the city is planning to install a low-carbon trigeneration plant that will produce low-carbon local power, heating, and cooling for Sydney Town Hall and the neighbouring Town Hall House where over 1,500 city people work. Hundreds of lights, printers, computers, air conditioners, and the city's electric vehicle fleet will be powered by the plant.

Trigeneration at Town Hall will help achieve a 3 percent reduction in the city's organisational carbon pollution, and help to reduce greenhouse gas emissions over the project life. It will deliver infrastructure to improve energy efficiency at the Town Hall by up to 20 percent, compared with energy from the grid. The city has received grant funding from the Commonwealth Government for the project under the 'Community Energy Efficiency Programme.'

The trigeneration refers to 3 simultaneous outputs from the gas-fired engines, low-carbon electricity, hot water to heat buildings, and chilled water to cool buildings. A trigeneration engine runs on natural or renewable gases producing low-carbon electricity. The engine, which is about the size of a shipping container, generates heat that is captured to make hot water. Hot water can be converted to chilled water for air-conditioning by a secondary piece of equipment called an absorption chiller. Hot water or chilled water, called thermal energy, can be distributed to nearby buildings through a network of underground pipes.

Trigeneration is more than twice as efficient as coal-fired power stations that produce around 80 percent of Sydney's electricity – heat by-products created at coal-fired power stations are wasted, but trigeneration captures and uses them for air-conditioning, heating, and hot water services.

Source: City of Sydney (2014b).

Appendix D: Rating Tools

Table D.1 presents the general characteristics of six well known rating tools: the Leadership in Energy and Environmental Design for Neighbourhood Development (LEED-ND), BRE Environmental Assessment Method for Community (BREEAM Community), Comprehensive Assessment System for Built Environment Efficiency-Urban Development (CASBEE-UD), Green Building Index (GBI Tool for Township), Green Star-Communities, and Pearl Community.

Table D.1 Characteristics of the Selected Tools for Assessing Sustainability at Community Scale

Tool	Country of origin	Rating scale	Users
BREEAM Community	United Kingdom	Outstanding (≥85%) Excellent (≥70%) Very good (≥55%) Good (≥40%) Pass (≥25%) Unclassified (<25%)	Developers, professionals, planners, politicians, and communities
LEED-ND	United States	Platinum (80-100) Gold (60-79) Silver (50-59) Certified (40-49)	Private developers, neighbours, citizens, and community
CASBEE-UD	Japan	Excellent (<0.5) Very good (0.5-1.0) Good (1.0-1.5) Fairly poor (1.5-3.0) Poor (≥3	NA
GBI for Township	Malaysia	Platinum (≥86) Gold (76-85) Silver (66-75) Certified (50-65)	Project teams, owners, developers, and contractors
Green Star-Community	Australia	4 star rating(>45) 5 star rating(>60) 6 star rating(>75)	Federal government, state government, local governments, developers, financiers, and consumers

Pearl Community	Abu Dhabi	1 pearl (all mandatory credits) 2 pearl (≥55) 3 pearl (≥75) 4 pearl (≥100) 5 pearl (≥125)	NA

Note: NA = not available.

Source: (Sharifi & Murayama 2013).

These tools could be used to develop sustainability indicators considering low-carbon and resilience of buildings and communities.

ERIA Discussion Paper Series

No.	Author(s)	Title	Year
2015-57	S. KUMAR	Engendering Liveable Low-Carbon Smart Cities in ASEAN as an Inclusive Green Growth Model and Opportunities for Regional Cooperation	Sep 2015
2015-56	Shandre THANGAVELU	Services Productivity and Trade Openness: Case of ASEAN	Aug 2015
2015-55	Lili Yan ING and Chandra Tri PUTRA	Imported Inputs in Indonesia's Product Development	Aug 2015
2015-54	Cassey LEE	The Objectives of Competition Law	Aug 2015
2015-53	Burton ONG	Competition Law and Policy in Singapore	Aug 2015
2015-52	Robin SAKAMOTO	Investing in Higher Education, and Its Potential Impact on Research and Development for Technological Upgrading, Innovation, and Competitiveness	Aug 2015
2015-51	Xiao JIANG and Jose CARABALLO	The Employment Effects of GVCs on Asian Countries and the Phenomenon of Value-Added Erosion	Aug 2015
2015-50	Mun-Heng TOH	Singapore's Participation in Global Value Chains: Perspectives of Trade in Value-Added	July 2015
2015-49	Ben SHPEHERD	Developing Domestic and Export Markets and Levelling Up Trade in Value-Added: Lessons Learnt	July 2015
2015-48	Siwage Dharma NEGARA	How Labour Market Policies Affect Innovation and Trade Competitiveness	July 2015
2015-47	Hank LIM, Bernard AW, LOKE Hoe Yeong	AEC Scorecard Phase IV: Furthering the Implementation of the AEC Blueprint Measures The Singapore Country Report	June 2015

No.	Author(s)	Title	Year
2015-46	Saowaruj RATTANAKHAMFUSumet ONGKITTIKUL Nutthawut LAKSANAPUNYAKULNichamon THONGPAT Natcha O-CHAROEN	Thailand Country Study ASEAN Economic Community Blueprint Mid-term Review Project	June 2015
2015-45	Koji KUBO	Evolving Informal Remittance Methods of Myanmar Migrant Workers in Thailand	June 2015
2015-44	Philippa DEE	Monitoring the Implementation of Services Trade Reform towards an ASEAN Economic Community	May 2015
2015-43	Shandre THANGAVELU	FDI Restrictiveness Index for ASEAN: Implementation of AEC Blueprint Measures	May 2015
2015-42	Rully PRASSETYA and Ponciano S. INTAL, Jr.	AEC Blueprint Implementation Performance and Challenges: Standards and Conformance	May 2015
2015-41	Ponciano INTAL Jr.	AEC Blueprint Implementation Performance and Challenges: Trade Facilitation	May 2015
2015-40	Fukunari KIMURA, Tomohiro MACHIKITA, and Yasushi UEKI	Technology Transfer in ASEAN Countries: Some Evidence from Buyer-Provided Training Network Data	May 2015
2015-39	Dionisius NARJOKO	AEC Blueprint Implementation Performance and Challenges: Services Liberalization	May 2015
2015-38	Kazunobu HAYAKAWA, Nuttawut LAKSANAPANYAKUL, Shujiro URATA	Measuring the Costs of FTA Utilization: Evidence from Transaction-level Import Data of Thailand	May 2015
2015-37	Kazunobu HAYAKAWA,	Government Strategy and Support for Regional	May

No.	Author(s)	Title	Year
	Nuttawut LAKSANAPANYAKUL, Pisit PUAPAN, Sastra SUDSAWASD	Trade Agreements: The Case of Thailand	2015
2015-36	Dionisius A. NARJOKO	AEC Blueprint Implementation Performance and Challenges: Non-Tariff Measures and Non-Tariff Barriers	May 2015
2015-35	Kazunobu HAYAKAWA, Tadashi ITO, and Fukunari KIMURA	Trade Creation Effects of Regional Trade Agreements: Tariff Reduction versus Non-tariff Barrier Removal	Apr 2015
2015-34	Kazunobu HAYAKAWA, Tadashi ITO	Tarrif Pass-through of the World-wide Trade: Empirical Evidence at Tarriff-line Level	Apr 2015
2015-33	Kazubobu HAYAKAWA, Nuttawut LAKSANAPNYAKUL, and Shujiro URATA	Firm-level Impact of Free Trade Agreements on Import Prices	Apr 2015
2015-32	Ponciano INTAL, Jr.	AEC Blueprint Implementation Performance and Challenges: Investment Liberalization	Apr 2015
2015-31	Emily Christi A. CABEGIN	The Challenge of China and the Role of Deepening ASEAN Integration for the Philippine Semiconductor Industry	Apr 2015
2015-30	Venkatachalam ANBUMOZHI, Alex BOWEN and Puthusserikunnel Devasia JOSE	Market-Based Mechanisms to Promote Renewable Energy in Asia	Apr 2015
2015-29	Venkatachalam ANBUMOZHI	Low Carbon Green Growth in Asia: What is the Scope for Regional Cooperation?	Apr 2015
2015-28	Tan LI and Larry D. QIU	Beyond Trade Creation: Free Trade Agreements and Trade Disputes	Mar 2015

No.	Author(s)	Title	Year
2015-27	Mai Anh NGO	Exporting and Firm-Level Credit Constraints – Evidence from Ghana	Mar 2015
2015-26	Sunghoon CHUNG, Joonhyung LEE, Thomas OSANG	Did China Tire Safeguard Save U.S. Workers?	Mar 2015
2015-25	Esther Ann BØLER, Beata JAVORCIK, Karen Helene ULLTVEI-MOE	Globalization: A Woman's Best Friend? Exporters and the Gender Wage Gap	Mar 2015
2015-24	Tristan Leo Dallo AGUSTIN and Martin SCHRÖDER	The Indian Automotive Industry and the ASEAN Supply Chain Relations	Mar 2015
2015-23	Hideo KOBAYASHI and Yingshan JIN	The CLMV Automobile and Auto Parts Industry	Mar 2015
2015-22	Hideo KOBAYASHI	Current State and Issues of the Automobile and Auto Parts Industries in ASEAN	Mar 2015
2015-21	Yoshifumi FUKUNAGA	Assessing the Progress of ASEAN MRAs on Professional Services	Mar 2015
2015-20	Yoshifumi FUKUNAGA and Hikari ISHIDO	Values and Limitations of the ASEAN Agreement on the Movement of Natural Persons	Mar 2015
2015-19	Nanda NURRIDZKI	Learning from the ASEAN + 1 Model and the ACIA	Mar 2015
2015-18	Patarapong INTARAKUMNERD and Pun-Arj CHAIRATANA and Preeda CHAYANAJIT	Global Production Networks and Host-Site Industrial Upgrading: The Case of the Semiconductor Industry in Thailand	Feb 2015
2015-17	Rajah RASIAH and Yap Xiao SHAN	Institutional Support, Regional Trade Linkages and Technological Capabilities in the Semiconductor Industry in Singapore	Feb 2015
2015-16	Rajah RASIAH and Yap Xiao SHAN	Institutional Support, Regional Trade Linkages and Technological Capabilities in the Semiconductor Industry in Malaysia	Feb 2015
2015-15	Xin Xin KONG, Miao ZHANG and Santha	China's Semiconductor Industry in Global Value Chains	Feb

No.	Author(s)	Title	Year
	Chenayah RAMU		2015
2015-14	Tin Htoo NAING and Yap Su FEI	Multinationals, Technology and Regional Linkages in Myanmar's Clothing Industry	Feb 2015
2015-13	Vanthana NOLINTHA and Idris JAJRI	The Garment Industry in Laos: Technological Capabilities, Global Production Chains and Competitiveness	Feb 2015
2015-12	Miao ZHANG, Xin Xin KONG, Santha Chenayah RAMU	The Transformation of the Clothing Industry in China	Feb 2015
2015-11	NGUYEN Dinh Chuc, NGUYEN Ngoc Anh, NGUYEN Ha Trang and NGUYEN Ngoc Minh	Host-site institutions, Regional Production Linkages and Technological Upgrading: A study of Automotive Firms in Vietnam	Feb 2015
2015-10	Pararapong INTERAKUMNERD and Kriengkrai TECHAKANONT	Intra-industry Trade, Product Fragmentation and Technological Capability Development in Thai Automotive Industry	Feb 2015
2015-09	Rene E. OFRENEO	Auto and Car Parts Production: Can the Philippines Catch Up with Asia	Feb 2015
2015-08	Rajah RASIAH, Rafat Beigpoor SHAHRIVAR, Abdusy Syakur AMIN	Host-site Support, Foreign Ownership, Regional Linkages and Technological Capabilites: Evidence from Automotive Firms in Indonesia	Feb 2015
2015-07	Yansheng LI, Xin Xin KONG, and Miao ZHANG	Industrial Upgrading in Global Production Networks: Te Case of the Chinese Automotive Industry	Feb 2015
2015-06	Mukul G. ASHER and Fauziah ZEN	Social Protection in ASEAN: Challenges and Initiatives for Post-2015 Vision	Feb 2015
2015-05	Lili Yan ING, Stephen MAGIERA, and Anika WIDIANA	Business Licensing: A Key to Investment Climate Reform	Feb 2015
2015-04	Gemma ESTRADA, James ANGRESANO, Jo Thori LIND, Niku MÄÄTÄNEN, William MCBRIDE, Donghyun PARK, Motohiro SATO, and Karin SVANBORG-SJÖVALL	Fiscal Policy and Equity in Advanced Economies: Lessons for Asia	Jan 2015

No.	Author(s)	Title	Year
2015-03	Erlinda M. MEDALLA	Towards an Enabling Set of Rules of Origin for the Regional Comprehensive Economic Partnership	Jan 2015
2015-02	Archanun KOHPAIBOON and Juthathip JONGWANICH	Use of FTAs from Thai Experience	Jan 2015
2015-01	Misa OKABE	Impact of Free Trade Agreements on Trade in East Asia	Jan 2015

http://www.eria.org/publications/discussion_papers/FY2014/
http://www.eria.org/publications/discussion_papers/FY2013/
http://www.eria.org/publications/discussion_papers/FY2012/
http://www.eria.org/publications/discussion_papers/FY2011/
http://www.eria.org/publications/discussion_papers/FY2010/
http://www.eria.org/publications/discussion_papers/FY2009/
http://www.eria.org/publications/discussion_papers/FY2008/