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APEC Low-Carbon Model Town Project: Progress and Prospect - Focusing on Low-Carbon Building -

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Abstract: This paper discusses APEC's Low-Carbon Model Town (LCMT) project from its inception, to the completed phases, through to the planned phases. The LCMT project aims to combine various components such as energy-efficient buildings, transport and power systems to create communities that affordably reduce energy use and carbon emissions while creating pleasant living conditions.This project is applicable as a case study on promoting sustainable cities in developing countries.

Key words: low-carbon building, sustainable cities, low-carbon town indicators

1. Introduction

The Asia Pacific Economic Cooperation (APEC) is a framework of economic cooperation among countries and territories (they are called 'economies[1]' in APEC) in the Asia and Pacific region. APEC was established in 1989 with 12 economies as the founding members: Australia, Brunei Darussalam, Canada, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Thailand and the United States. Since then, China, Hong Kong, China and Chinese Taipei joined in 1991. Mexico and Papua New Guinea followed in 1993. Chile acceded in 1994. And in 1998, Peru, Russia and Viet Nam joined, taking the full membership to 21 [1].

Energy has been one of the major fields of cooperation in APEC. In the APEC region, energy consumption is rapidly increasing in tandem with urbanisation progress, both of which are due to economic development in the APEC region. Since fossil fuels remain the major energy resources in the region, increasing energy consumption is posing a higher risk of climate change. Accordingly, a low carbon society is becoming more and more necessary for the region. The region needs to improve energy efficiency and promote renewable energy not only at economy (national) level but also at town/city level in the face of rapid urbanisation.

On 19 June 2010, at the 9th Meeting of APEC Energy Ministers in Fukui, Japan, the Ministers launched the APEC Low-Carbon Model Town (LCMT) Project. In their 'Fukui Declaration - Low Carbon Paths to Energy Security: Cooperative Energy Solutions for a Sustainable APEC', the Ministers included the following statement:

> 'Introduction of low-carbon technologies in city planning to boost energy efficiency and reduce fossil energy use is vital to manage rapidly growing energy consumption in urban areas [2].'

They therefore launched the LCMT Project 'to present successful models for coordinated usage of advanced low-carbon technologies.'

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[1] APEC uses the term 'economy' to describe members instead of nation or country, to include economies such as Hong Kong and Chinese Taipei which are separate economic entities.

The LCMT project aims to combine various components such as energy-efficient buildings, transport and power systems to create communities that affordably reduce energy use and carbon emissions while creating pleasant living conditions. The LCMT Project consists of three activities:

a) Developing and refining the 'Concept of Low-Carbon Town in the APEC region' (Concept) by APEC experts (LCMT Study Group A);
b) A feasibility study of low carbon development for each case study town by consultants hired by the APEC Secretariat; and
c) A policy review of low carbon development policy of each case study town by APEC experts (LCMT Study Group B).

Since 2011, one town/city in the Region was chosen as the case study town that year's phase. The case study towns represent various types of town/city in the Region:

1) Yujiapu, Tianjin, China in Phase 1 (2011) focused on the greenfield development of central business districts (CBD) of a large city;
2) Samui Island, Thailand in Phase 2 (2012) focused on the development on an island resort;
3) Da Nang, Viet Nam in Phase 3 (2013) focused on the redevelopment of an existing city;
4) San Borja, Lima, Peru in Phase 4 (2014) focused on a residential area in a city;
5) Bitung, Indonesia in Phase 5 (2015) focused on an industrial area in a city; and
6) Mandaue, the Philippines in Phase 6 (2016) is focusing on formulating low-carbon development plans in cooperation with neighbouring cities.

Phase 7 in 2017 will plan to address a low-carbon development plan in inland region with high demand for heating and cooling system.

As an omnipresent component of low carbon town (LCT) developments, 'Low Carbon Buildings' are focused on in this paper, alongside the various components of LCT.

2. Low Carbon Building in 'The Concept of Low-Carbon Town in the APEC Region'

2-1. Low Carbon Building in the First Edition of the Concept

In October 2011, the Asia Pacific Energy Research Centre published the First Edition of 'The Concept of Low-Carbon Town in the APEC region', 'Low Carbon Buildings' was identified as one of demand side measures for low carbon town development along with 'Low Carbon Urban Structure', 'Energy Management Systems' and 'Low Carbon Traffic'.

The 'Concept' provides 'Low Carbon Building' as follows:

> In office and commercial buildings, a lot of electricity and heat energy are used for air conditioning, lighting, office automation (OA) equipment, and hot water supply. The same applies to residential buildings, although on a different scale. When evaluating the low carbon buildings measures, it is advisable to follow the following three steps as it will lead to more efficient and cost effective CO_2 reductions.
>
> > 1st Step: Reduce heat load into the building through rooftop greenery and improvement of the heat insulation of the windows, etc.
> > 2nd Step: Deploy passive energy design such as natural lighting and natural ventilation.
> > 3rd Step: Improve energy efficiency in air conditioning, lighting equipment, etc.
>
> There are plenty of reduction measures within each step. It is necessary to examine the most

appropriate combination of measures considering the use, targeted CO_2 reduction amount, construction cost etc. of the intended buildings [3].

Then the 'Concept' explains necessary considerations in each step:

i) Reduction heat load in the building

Evidence shows that heat energy demand for cooling/heating and electricity use for lighting depends greatly on the structure of the building, its outer environment and the use of the building.

In order to reduce CO_2 emissions associated with the building, the first step is to consider measures that will create a comfortable work and living environment in the building without using too much energy, in other words, the measures which will reduce the energy load of the building.

ii) Adoption of passive energy design

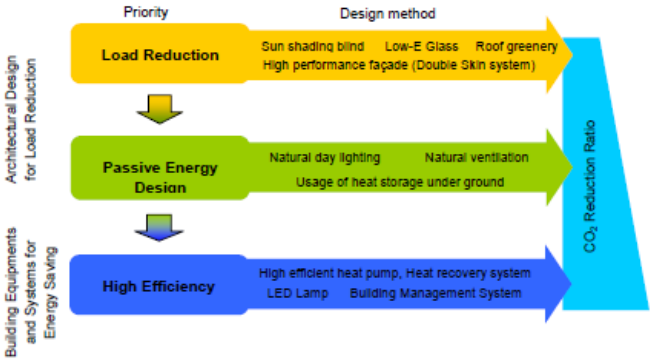
It can be effective to adopt passive forms of environment-friendly technology, which makes use of sunlight, solar heat, wind, rainwater and geological conditions to adjust the indoor environment. For example, it may suit to construct buildings that maintain comfortable room temperature by adopting sun shading blinds and cooling with outside air, and ensures the brightness and clean air by utilising daylight and natural ventilation respectively.

iii) Improvement of equipment efficiency

Energy use in the building can be reduced by adopting high efficiency equipment for functions such as air conditioning, lighting, office automation, hot water supply [3].

At the end of 'Low Carbon Buildings' section, the 'Concept' shows a schematic design flow of low carbon building in Figure 5 [3].

Figure 5 Schematic design flow of low carbon building



Appendix 2 'Low Carbon Measures Along with Cases Examples' is an attachment of the 'Concept'. As for Low Carbon Building, six types of case examples are enumerated: 'Sunlight shading and thermal insulation', 'Façade engineering', 'Natural ventilation', 'Daylight use plus lighting system', 'Hybrid of natural ventilation plus air conditioning' and 'High-efficient heat source plus heat storage'.

Though the First Edition 'Concept' was intended to be a comprehensive guideline for LCT development, it was influenced by the on-going LCT project in Yujiapu, Tianjin, China. And so it focused on green field development in a large city such as Yujiapu.

2-2. Low Carbon Building in the Second Edition of the Concept

During following Phases, the 'Concept' has been refined taking into account of a different type of LCT development in each Phase. As for low carbon building, one paragraph was added in the Second Edition published in October 2012 to explain the first step, '1) Reducing heat load in buildings':

Compared to large-scale businesses and commercial buildings, large hotels, or high-rise residential complexes, it will be difficult for small- and medium-sized resort hotels

> (comprised of cottage-type buildings) and low- and medium-rise housing to introduce centralized energy supply systems (e.g., DHC, central heat sources, central hot-water systems, etc.) Here, the further introduction of highly efficient equipment and facilities—such as high-efficiency air conditioners, heat-pump water heaters, and latent heat recovery-type water heaters—plays a very important role in reducing a building's CO_2 emissions.
> In addition, for small buildings, reinforcing insulation by using rooftop greenery, solar reflectance paint on roofs, etc., as well as use of natural energies (such as natural ventilation and natural lighting) will amplify the effectiveness of CO_2 reduction methods and should be actively introduced [4].

This revision reflects experiences in Samui Island, Thailand in Phase 2, where there are many small- and medium-sized resort hotels and low- and medium-rise housing.

Also in the Second Edition, 'Sunlight shading and thermal insulation' in Appendix 2 'Low Carbon Measures Along with Cases Examples' was changed to 'Sunlight reflection, shading and thermal insulation' in order to include high solar reflectance paint for roof surfaces. This change is based upon advice from a Japanese expert in paint industry.

2-3. Low Carbon Building in APEC Low-Carbon Town Indicator System

The guideline of low carbon buildings and its case examples in the Concept remained intact in the Third Edition in Phase 3 [5]. However, the refinement process of the Concept itself has largely changed since Phase 3 with the inclusion of APEC Low-Carbon Town Indicator (LCT-I) System. According to the Final Report of Feasibility Study for the LCT-I System by APEC LCMT Phase 3 Task Force Japan which is established to assist the refinement process, the purpose of the LCT-I System is defined as follows:

> … ways to review and develop low carbon cities still vary significantly from economy to economy, making it difficult for the project to achieve overall progress in the region. In order to facilitate and support the overall progress of the project in the region, indicators (standards), which practically manage CO_2 emissions at the municipal level, need to be developed, disseminated, and widely used.
>
> Our country [quoter note: Japan], which is advanced and has long experience in the field of energy saving, could contribute to the further development of the APEC LCMT project by taking the initiative in developing a CO_2 (energy-originated CO_2) management method for cities.
>
> In light of the above, we propose that a new management indicator system should be developed for the APEC LCMT project, which aims to promote the development of low carbon towns across the region, by leveraging the LCMT concept and the results of the past feasibility studies [6].

As a part of the LCT-I System, indicators for low carbon building were considered. The Final Report of Feasibility Study during Phase 3, three items were proposed for introducing indicators of low carbon building: 'Energy-saving construction', 'Building insulation' and 'Energy efficiency of building equipment'. As for Energy-saving construction, 'Ratio of buildings certified as green buildings to total buildings in the district (%)' could be an indicator. For Building insulation, 'Thermal performance standard' could be measured. And Energy efficiency of building

equipment could be evaluated by 'Reduction rate of energy use'.

Appendix 4 'Low Carbon Town Indicators (Preliminary Study Results)' of the Fourth Edition of the Concept published in November 2014 proposed to maintain the same structure of indicators for low carbon building [7]. The Phase 5 Task Force Japan and Study Group A carried out further surveys, discussions with experts of indexation/standardization and sensitivity analyses of indicators in test cases. The draft of the LCT-I System Guideline was published as Appendix 5 of the Fifth Edition of the Concept. The LCT-I System was designed as simple as possible and adopted five point scale considering the user-friendliness. The assessment areas of the LCT-I System is comprehensive (see figure below) and include both quantitative and qualitative indicators

[13].

Among 23 Tier 3 indicators, two of them are categorized under Buildings (Tier 2), namely, 'Energy Saving Construction' and 'Green Construction'. The indicators target to promote the installation of energy-saving equipment (hardware) such as heat insulation and natural energy utilization as well as the development of certification system and guidelines (software) of low carbon buildings through the assessment. The First Edition of LCT-I System will be published as one of the deliverables in Phase 6.

3. Low Carbon Building in Case Study Town in Each Phase

3-1. Yujiapu, Tianjin, China in Phase 1 (2011)

Yujiapu Central Business District (CBD)/Financial District Development Project in Tianjin, China was selected as a case for the APEC LCMT Project Phase 1.

The Phase 1 Study Group B which in charge of policy reviews for LCT development described the Project as follows:

> Yujiapu Financial District (YFD) will become the heart of the Tianjin Binhai New Area (TBNA) Financial regulation pilot zone by attracting world class financial institutions and creating an innovative environment to facilitate the implementation of China new financial regulations.
>
> The Financial District is also expected to set up a new standard for the sustainable development and construction of cities in Asia by adhering to the development concept of green building and low-carbon city.
>
> YFD covers an area of 3.86 million sq m, surrounded by rivers at its east, west and south. The total building size is 9.50 million sqm [8].

The review team emphasised the importance of 'green building' as stated in the executive summary.

> At least twelve buildings in Phase I of the Yujiapu CBD area are planned to get the certification of green building, a highly commendable feat. It is recommended, however, that given that green buildings are highly encouraged in this area and in the development of the low carbon town, such green building requirements should be clearly stipulated in

each building contract to guarantee that their design and construction meets the minimum requirements of the new buildings [8].

The team also appreciated a plan to utilise advanced technology in commercial buildings, but with the reservation for residential sector.

> The use of motion sensors and other advanced technology for controlling electricity demand in commercial buildings is an interesting and cutting edge concept. Such technology in conjunction with energy efficiency awareness campaigns for the general public should see a reduction in energy use.
>
> However, it is recommended that a well thought out plan is put forth with regards to the supply and demand balance of electricity across the board even in the residential sector, specifying the type of technology that may be introduced there (i.e. smart grids) focused on green field development of central business districts (CBD) of a large city [8].

3.2 Samui Island, Thailand in Phase 2 (2012)

Samui Island (in Thai, Koh Samui) was chosen as the case town for APEC LCMT Phase 2 and described by the Phase 2 Study Group B as follows:

> Koh Samui is a small island situated in the Gulf of Thailand and located in Suratthani Province, approximately 750 km to the south of Bangkok. Whilst the island's population is small at approximately 54 000 registered people and unregistered population of about 6 times of the registered population, tourists number up to 1.1 million annually. Given the islands main industry is tourism and the large number of visitors travelling to Koh Samui annually, the island is making great strides in achieving low-carbon status [9].

As mentioned above in 2-2, the Samui Island case drew attention to small- and medium-sized resort hotels and housing. As per resort hotels, the review team recommended a green building benchmark. The Policy Review team also raised the issue of retrofitting of old buildings which was unnoticed in Phase 1 for Yujiapu as it was a green field project.

> Given the number of hotels and resorts on the island there is plenty of potential to develop or adopt a green building benchmark that identifies facilities that have achieved efficient use of energy and water, this will be beneficial to hotels and resorts as well as they look at marketing their respective properties as eco-friendly. The option of retrofitting some of the old buildings on the island to make them low-carbon should also be considered [9].

3.3 Da Nang, Viet Nam in Phase 3 (2013)

Da Nang was chosen as the case town for APEC LCMT Phase 3 and described by the Phase 3 Study Group B as follows:

> Da Nang is the biggest city in central Viet Nam. It is located between Hanoi and Ho Chi Minh City at 759km and 960km respectively. As of 2011, the population of Da Nang 951,684 people, which is growing as industrialisation draws more people to the area. Da Nang is shifting its economic structure away from agriculture and toward industry and services. Its main industries are frozen fish, textiles and garments, cement, automobile tyres, and leather goods. However, more technical industries are rapidly growing in the area, which include electrical equipment, information technology component parts, machinery, ship building, manufacturing and assembling automobiles and bicycles, and beer and dairy beverages. Tourism

is also a growing economic sector in Da Nang and is one of Viet Nam's national tourist sites [10].

The Phase 3 Study Group B gave a portrait of Da Nang and produced 75 recommendations for implementation, compared to 32 and 82 recommendations in Phase 1 and Phase 2 respectively. The recommendations in Phase 3 were grouped by high, medium and low order urgency level for the first time.

Among 9 recommendations related to low carbon buildings, 3 recommendations listed below are classified high urgency level which can be implemented in short term but at low cost.

> **Recommendation 33:** Develop an evaluation criteria for low carbon building design.
> **Recommendation 34:** Promote energy efficiency standards for all non-residential buildings.
> **Recommendation 37:** Publish a policy paper to promote low carbon building deployment and financing [10].

It is noteworthy that the review team has paid attention to a financing issue in Recommendation 37. This seems because the Da Nang project, as a redevelopment of an existing city, inevitably involves small and medium local enterprises who usually have difficulties in financing investment to buildings.

3.4 San Borja, Lima, Peru in Phase 4 (2014)

San Borja was chosen as the case town for APEC LCMT Phase 4 and described by the Phase 4 Study Group B as follows:

> San Borja is one of the 49 districts of Lima City in Peru. San Borja is bordered by the districts of San Luis and La Victoria to the north, Santiago de Surco to the east and south, Surquillo to the southwest and San Isidro to the west. San Borja, established as unique district in 1983, covers 9.96 km^2 and is 170 meters above sea level. In 2011, San Borja´s population was 111 808 people comprising approximately 36,000 households. In 2012 the population was 112 562 people. The majority of the population is between 20 and 50 years (52%) and is comprised of 55% female and 45% male. Peru is one of the fastest growing economies in South America with the urbanisation rates increasingly rapidly. San Borja reflects this trend, making low carbon development an essential goal for the local government [11].

The review team made 50 recommendations for implementation with grouping of high, medium and low order urgency level, similarly to the Phase 3 review team. Among 7 recommendations related to low carbon building, 4 recommendations listed below are to be classified high urgency level.

> **Recommendation 16**: Establish a San Borja Green Building Task Force under the 'LCT-Community Planning Council'.
> **Recommendation 17:** Establish a Mandatory San Borja Green Building Code.
> **Recommendation 20:** Develop a San Borja-centric sourcebook for green buildings suited to Lima's climate conditions.
> **Recommendation 21:** Establish a Comprehensive Capability Program [11].

The background of Recommendation 16 on a new organisation seems to be a large number of property owners to be consulted with by San Borja municipality government since this district is mainly a residential area.

3.5 Bitung, North Sulawesi, Indonesia in Phase 5 (2015)

Bitung was chosen as the case town for APEC LCMT Phase 5 and described by the Phase 5 Study Group B as follows:

> Bitung City is located strategically on the Minahasa Peninsula in the north-east of the Sulawesi Island in Indonesia and covers a total land area of around 313.5 km^2 (31 350 ha). In 2014, Bitung's population was 202 204 people, showing an average annual growth rate (AAGR) of 2.2% from the 2006 population level of 169 562 people. The port City of Bitung is expected to be an international hub port as it sits at a strategic geographical location in international trade routes. The plan is supported by the central government with the designation of Bitung Special Economic Zone (SEZ). Bitung SEZ will entail significant amount of energy. Currently, Bitung City is dependent on diesel generators and hydro power plants for most of its energy demand [12].

Among 8 recommendations related to low carbon buildings, 2 recommendations listed below are classified high urgency level.

> **Recommendation 25**: Increase the capacity of local government on low-carbon buildings by learning experiences from other low-carbon towns.
>
> **Recommendation 26**: Set a clear and more ambitious target for photovoltaic (PV) installation and prioritisation among relevant building sectors.

The recommendations are made to accelerate Bitung SEZ's plan to install photovoltaic (PV) panel in all types of buildings and to introduce other energy-saving equipment including LED lighting, Building Energy Management System (BEMS), low emission glasses, natural lighting system, etc.

4. Future of APEC LCMT Project

APEC LCMT Project has entered its sixth year in 2016. In its Phase 6, the Concept is expected to complete refinement and the Sixth Edition of the Concept will be the Final Edition. The First Edition of the LCT-I System will also be released as a separate document of the Concept. Feasibility study for the case study town, Mandaue City is underway in Phase 6. Mandaue City is located in the middle-eastern coastal region of Cebu Province in the Philippines. There is a plan called 'Mandaue 20/20' consists of Integrated Development of Green Growth Areas including green building program, Green Loop to restore river and Metro Public Transport System. The interconnectivity of Mandaue City, Cebu City and Lapulapu City will be focused to identify the possible low-carbon measures that are taken in cooperation with neibouring cities. Low carbon buildings will be analysed accordingly.

In parallel with the implementation of Phase 6, the preparatory stage of Phase 7 has already started. Phase 7 plans to address a low-carbon development plan in inland region with high demand for heating and cooling system. In order to increase the number of LCT in the APEC region, LCMT Symposium will be held for the capacity building of the central and local government officials of developing APEC economies. The Concept and the LCT-I System will fully be utilized as an education tool in the Symposium. Thus, APEC LCMT project is entering a dissemination stage from a survey and research stage.

5. Conclusion

APEC LCMT Project is in the middle of Phase 6 and preparing for Phase 7. From Phase 7, the Project will move on to disseminate LCT throughout the APEC Region by promoting the application of the LCT-I System to towns/cities which plan to become low-carbon. It is strongly hoped that the Project will

continue to serve APEC member economies and act as a catalyst for rapid urbanisation that is also low carbon compatible.

*This paper is an updated version of the original paper which was prepared for the conference proceedings of the 10th Energy Forum 2015 on Advanced Building Skins in Bern, Switzerland.

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