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

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1. Introduction

This paper discusses APEC's LCMT project from its inception, to the completed phases, through to the planned phases. This project is applicable to the Advanced Building Skins Conference as a case study on promoting sustainable cities in developing countries.

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.

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.'

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:

[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.

a) Developing and refining the 'The Concept of Low-Carbon Town in the APEC region' (the 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; and
5) Bitung, Indonesia in Phase 5 (2015) is focusing on an industrial area in a city.
Phase 6 in 2016 will plan to address formulating low-carbon development plans in cooperation with neighbouring cities.

For the reference of architects, 'Low Carbon Buildings' are focused on in this paper, alongside the various components of low carbon town (LCT) developments.

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

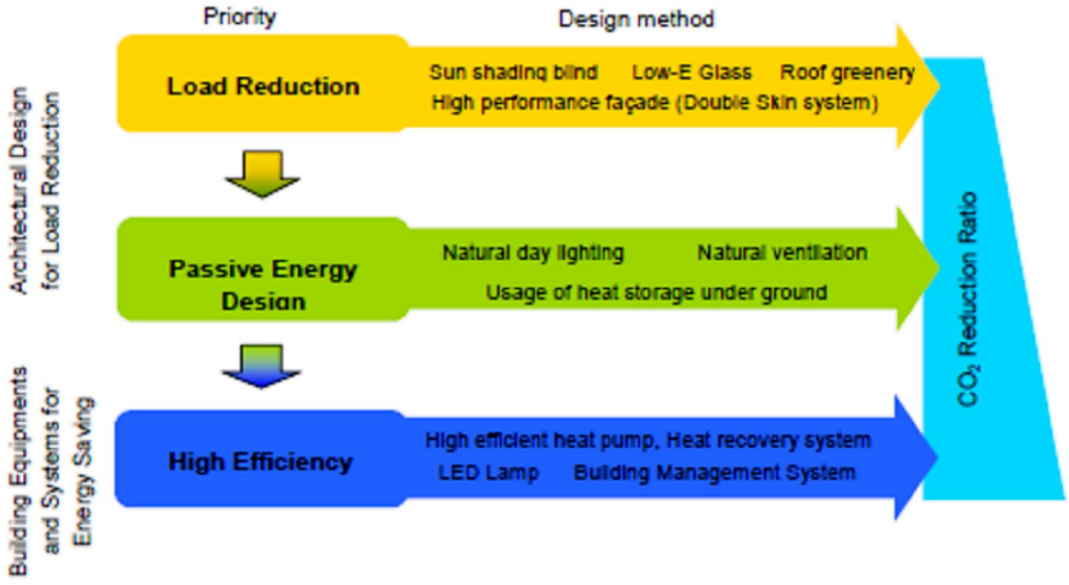
Evidence shows that heat energy demand for cooling/heating and electricity use for lighting depends greatly on the structure of the building, its outer environment and the use of the building.
In order to reduce CO_2 emissions associated with the building, the first step is to consider measures that 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 attached to 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 low carbon town (LCT) development, it was influenced by the then 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

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 APEC LCT-I System by APEC LCMT Phase 3 Task Force Japan which is established to assist the refinement process, the purpose of the APEC 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 anew that a 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 APEC LCT-I System, indicators for low carbon building has been under consideration 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 which is in charge of refining the Concept are now working hard to finalise the APEC LCT-I System including indicators for low carbon building. They are carrying out further surveys, discussions with experts of indexation/standardization and sensitivity analyses of indicators in test cases.

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 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)

Though the Phase 4 Study Group B has yet completed its policy review report, they depict the case study town, San Borja, as follows in their draft:

> 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 is planning to make 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.

4. Future of APEC LCMT Project

APEC LCMT Project has entered its fifth year in 2015. In its Phase 5, the Concept is expected to complete refinement with finalisation of the APEC LCT-I System. The finalised APEC LCT-I System will include established indicators for low carbon building. Feasibility study for the case town, Bitung is also close to completion. Bitung situates on the northern coast of the island of Sulawesi in Indonesia. The Indonesian Government has plans to make Bitung an international hub port for the eastern part of Indonesia. A special industrial zone next to a new port facility will be developed, which will be occupied mainly by marine product processing industries. Since the target area of Bitung LCT project is the industrial zone, low carbon industrial buildings or low carbon factories will be discussed in LCT planning.

In parallel with the completion stage of Phase 5, the preparatory stage of Phase 6 has already started. Mandaue city in Cebu Island, the Philippines, is chosen as a candidate for the case study town for Phase 6. Phase 6 plans to address formulating low-carbon development plans in cooperation with neighbouring cities. Mandaue's LCT plan in cooperation with neighbouring Cebu City and Lapu-Lapu City will be developed and studied through a feasibility study and policy review. Low carbon buildings will be analysed accordingly.

In relation with the Concept, disseminating the APEC LCT-I System will be an important task for Study Group A after finalising the APEC LCT-I System itself. APEC energy officials have already started to consider a new format for future LCMT Project. APEC LCMT project is entering a dissemination stage from a survey and research stage.

5. Conclusion

APEC LCMT Project is completing its 5th Phase and will soon establish its Concept with the APEC LCT-I System. After the establishing the APEC LCT-I System, the Project will move on to disseminate LCT throughout the APEC Region, promoting the application of the APEC 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.

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