Asia-Pacific
Economic Cooperation

APEC Low Carbon Model Town Project Phase 1

Policy Review for

Yujiapu CBD, Tianjin, China

Final Report

September 30, 2011

Report for the APEC Energy Working Group

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PREFACE

The APEC Low Carbon Model Town (LCMT) Project seeks to promote low-carbon technologies in city planning in order to manage rapidly growing energy consumption and greenhouse gas emissions in urban areas of the APEC region. 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 first phase of the LCMT Project has developed an initial version of the "The Concept of the Low Carbon Town in the APEC region" and provides a feasibility study and policy review of a planned low-carbon urban development in Yujiapu CBD. The key objectives of the project are;

1) To develop the "The Concept of the Low Carbon Town in the APEC region", which is intended to be a guidebook to the principles and implementation of low carbon urban design;

2) To assist in the implementation of the concepts in selected Low Carbon Towns by providing feasibility studies and policy reviews of these planned urban development projects;

3) To share best practices and real-world experiences of low carbon design with planners and policymakers throughout the APEC region.

This report presents the findings of Policy Review for Yujiapu CBD Development Project in Tianjin, China.

The primary accountability of each policy review is shared by the economy being reviewed and the Review Team. The Policy Review in Tianjin, China was conducted by a team of ten experts (see Appendix A) who visited Tianjin from 30 August to 1 September 2011.

During the visit, the Review Team had comprehensive discussions with representatives and experts from government agencies, private and state companies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions, especially National Energy Administration and Tianjin Innovative Finance Investment Company (TIFI) who organised the event.

EXECUTIVE SUMMARY

The Yujiapu Financial district is an impressive new development of a proposed financial centre in the heart of an existing urban setting. The city is also the site of a significant effort to address a number of current urban problems including climate issues. Yujiapu Central Business District (CBD)/Financial District Development Project in Tianjin, China was selected as a case for the APEC LCMT Project Phase 1. A team of experts met to conduct policy review on the current and proposed efforts with respect to a number of key issues regarding application of low carbon measures.

Yujiapu Financial District

- 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 sq m.

There is a strong commitment to low carbon technology and its application in the low carbon town development in Yujiapu, Tianjin, China. This commitment extends from the highest level of government (the Central Government) to the Tianjin Local Government. This is reflected by the comprehensive design and plans of the Yujiapu area that incorporate innovative low carbon technologies. The recommendations made in this report are intended to help improve a project that is already developing very well.

The Review Team was pleased to note that there is strong communication between the Chinese Central Government and Local Tianjin Government. This is critical in setting coordinated long term low carbon and carbon emission reduction goals in the development stages of the project and also as the low carbon town evolves in the future. Whilst it is admirable that the central and local governments are making concerted efforts to set coordinated low carbon and carbon emission reduction targets, it is recommended that a local agency (counterpart organisation) in Tianjin / Yujiapu is assigned and

recognized for the co-ordination of this important endeavour so that the work can be carried out efficiently and handled with ease as the target setting becomes more complex.

Whilst the transportation system management plan is comprehensive and impressive; it is recommended that careful thought be given to the management of freight demand. The role of freight is a very important component to consider given its overall impact on traffic flow and carbon emission.

Given land constraints it is reassuring to see that Yujiapu is considering the development of underground space as part of its urban expansion. The inclusion of a pedestrian walk, utility tunnel and pass way for underground vehicle carriageway for loading/unloading, parking, etc. is indicative of a well thought out design. In order to gain maximum benefits from such an investment it is important that such facilities are made attractive to the general public. It is therefore recommended that the design for such underground space includes the necessary ventilation and day lighting for a pedestrian walk.

The review team found that eight district heating and cooling systems (DHC) have been designed for the Yujiapu central business district (CBD) area and will cover about 72.9% of the floor area. An ice storage system will also be employed to further balance the peak and off-peak electricity requirements to make full use of the characteristics of this business oriented area. In order to guarantee the function of the DHC system during its entire life; it is recommended that the measurement and verification (M&V) process is undergone before the DHC is put into operation and it is also suggested that a professional energy service company (ESCO) is employed to operate this system as necessary.

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.

The review team found that overall urban design in this low carbon town is a transit oriented development. It seems that the micro-climate concept is employed to help the overall urban design to plan the arrangement of buildings and green corridors to reduce environment temperature in the Yujiapu CBD area. It is recommended that in order to attract more investment for this long-term low carbon town development plan and integrate the micro-climate concept into the urban design, incentives should be provided by the government, as developers may be put off micro-climate technology due to its high cost. If incentives are planned to be offered they should be made clear and publicized so that developers are aware.

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).

The basic concept employed by the Yujiapu CBD is to build a semi-permanent “builders’ home” for the entire construction workforce and “manager home” for the management team members during their involvement in this project. A “Low-carbon Construction Guideline” and monitoring and tracing mechanism have been developed for this project. However, there can be more improvement by considering sea transportation for construction material and preparing the construction guideline for underground space.

It is great to see Yujiapu CBD has employed the system integration concept to design and plan the water supply and treatment system. It is also good to consider the ecology in the water environment. However, it is recommended that rain water collection can be designed with a sunken plaza type in mind. The employment of information and communication technologies (ICT) to centralize the water management would be more effective in dealing the water problems for this area.

RECOMMENDATIONS

GOALS TO REDUCE CO_2 EMISSIONS AND LOW CARBON INDEX SYSTEM

Recommendation 1 *Further the coordination between Local Community-Level Goals and Sector-Level Goals*

Recommendation 2 *Further the clarification of Sector-Level Goals by examining the applicability of various advanced low-carbon technologies and unique local conditions.*

Recommendation 3 *Assign a local agency in Tianjin / Yujiapu (counterpart organization) as the monitoring/reviewing agency for the co-ordination of this low carbon town development.*

Recommendation 4 *Display the both CO_2 targets and actual emissions prominently at the exhibition centre or at other landmarks of Yujiapu for helping create common understanding for stakeholders.*

Recommendation 5 *Develop a Virtual Exhibition and material which displays not only the goal for this low carbon town but, progress and achievements and can also be distributed to other economies.*

Recommendation 6 *Clarify the Carbon/Energy audits methodology for benchmarking purposes.*

TRANSPORTATION SYSTEM

Recommendation 7 *Clarify a road pricing plan and the parameters and key indicators of the model that would be used to support the plan.*

Recommendation 8 *Deal with connectivity in a rigorous scientific fashion by making correct estimation of the substantial traffic flow from surrounding areas into the Yujiapu CBD area.*

Recommendation 9 *Conduct a detailed plan to deal with the role of freight and its impact on the overall traffic flow and carbon usage.*

Recommendation 10 *Plan some accommodation (parking spaces) for irregular electric vehicles not just automobiles.*

Recommendation 11 *Enrich the overall transportation plan with Evacuation and emergency routes.*

UNDERGROUND SPACE

Recommendation 12 *Consideration and arrangement of the ventilation and smoke exhaust for the underground space with reference from the heat island analysis.*

Recommendation 13 *Arrange more close cooperation between the underground space development and the heat island analysis and DHC system.*

REGIONAL COOL AND HEAT SUPPLY ENERGY SYSTEM

Recommendation 14 *Provide regulation (such as M&V guidelines, underground trench, etc.) or incentives (government subsidies) for the employment of a DHC system.*

Recommendation 15 *Identify the interface or responsibility/risk for all involved parties needs to be more clearly identified. .*

Recommendation 16 *Monitor and calibrate the sensing & metering infrastructure/devices for providing accurate and sufficient data can be provided.*

Recommendation 17 *Consider high temperature difference in DHC system to reduce the energy requirement.*

ENERGY SAVING BUILDING

Recommendation 18 *Consider the certification of green building as a necessary condition in the contract, to constrain the behaviour of the developer.*

Recommendation 19 *Consider some measures as an incentive to the owner of the building so higher standards of green buildings can be met.*

Recommendation 20 *Conduct the regulation/guideline for carrying out the testing and verification of a new building.*

Recommendation 21 *Set up and improve a mechanism for the review of the electricity and heat consumption information.*

HEAT ISLAND ANALYSIS APPLICATION

Recommendation 22 *Identify incentives offered for the development of the building with consideration/employment of the micro-climate concept or other high-efficient system/facilities.*

Recommendation 23 *Propose the guidelines or criteria for solving the conflict between the results from the micro-climate concept and the real distribution of building arrangements.*

ENERGY EFFICIENCY MANAGEMENT SYSTEM

Recommendation 24 *Develop a well thought out plan with regards to the supply and demand balance of electricity across the board and the type of technology that can be introduced there (i.e. smart grids).*

Recommendation 25 *Implementation of education campaigns and policies on the benefits of energy efficiency to alter human behaviour on energy conservation and the employment of new technology.*

Recommendation 26 *Expand close cooperation between the energy service company (ESCO) and the Energy Management System (EMS) or DHC to raise energy efficiency and create a beneficial situation.*

Recommendation 27 *Expand the existing EMS to the Area Energy Management System (AEMS) and combine with security systems or other smart management concepts to form the basis of a smart home or community.*

LOW CARBON CONSTRUCTION

Recommendation 28 *Consider shipping the material due to the close location of the Yujiapu area to the delivery port.*

Recommendation 29 *Evaluation of low carbon construction for the underground space construction work.*

REGIONAL WATER SYSTEM

Recommendation 30 *Consider collecting Rain water by sunken plaza.*

Recommendation 31 *Set up a centre to monitor the quality and flow of drinking water, rainwater system, and even river water information etc.*

Recommendation 32 *Make good use of gray water reuse based on a balance between the construction and material cost and the gain of the water reuse and energy saving by delivery within short distance.*

PART 1: BACKGOUND INFORMATION

The background information contained in this report has been contributed by China. This information is intended to provide some context to the recommendations of the Policy Review Team. It covers from the policy in the central and local government. The detail design concern and law/regulations for the low carbon town development is also included. The monitoring and reporting mechanism is also specified. Finally, the status of this LCMT is explained.

1. Policy on low carbon development

1.1 National policy and strategy for the low carbon development

At present, the Chinese government makes great efforts on developing the low carbon pilot work, including: making the low carbon development plan, making the auxiliary policy that supports the low carbon green development, hastening the establishment of the industry system characterised with low carbon emission, establishing the green house emission data statistics and management system, positively advocating the low carbon green life and consumption ways to mobilize the positiveness of different sides, accumulating the work experience that guides different areas and industries separately ,promoting the realisation of China's green house gas emission action aim. The current policy targets the pilot city, the project that meets the requirement and is listed in the execution method statement will be supported according to the available policy. The project that is not covered in the current policy will be given the comprehensive award according to the project investment, local investment and energy saving efficiency. The project that has been given the award will be given the comprehensive award. The provincial government and local government need to arrange the capital for modelling.

1.2 National target for low carbon development

The Chinese government has promised that the unit GDP green gas emission will decrease by 40% or 45% by 2020.

During the 12th Five-year Development Plan (2011-2015) Low carbon economy development targets for 2015 can be summarized as follows.

- non-fossil fuel usage accounts for 11.4%in total primary energy consumption
- reduce energy consumption -16% per unit of GDP
- reduce CO_2 emission -17% per unit of GDP
- reduce NOx emission -10% per unit of GDP
- reduce SO2 emission -8% per unit of GDP
- reduce water use -30% per unit of industrial value add

2. Master plan of low carbon town development in Tianjin area

2.1 Overall low carbon development in Tianjin

Tianjin Municipal Party Committee and Municipal Government are paying more attention to the green development to continuously strengthen the work intensity, hasten the change of development and make some positive achievements around -high level industry, self innovative and eco

–agreeable living . Firstly, enlarge the industry structural adjustment intensity. Secondly, enlarge the energy saving, consumption reduction intensity. Thirdly, enlarge the utilization and development intensity of the clean energy and recycled energy. Fourthly, enlarge the low carbon economy construction carrier intensity. Fifthly, enlarge the arrangement of low carbon pilot working. Sixthly, intensify the low carbon development ability construction.

2.2 Development plan for this low carbon town (Yujiapu CBD, Tianjin, China)

Based upon this, in June 2010, the Yujiapu Financial District Development Project was selected as a first case for the APEC LCMT Project. With their pioneering initiative, Yujiapu CBD is hoped to explore an applicable and alternative approach to the establishment of low carbon town, and meanwhile, provide useful experience and assistance to other member economies, promoting the concept of low carbon within the region. The overall design overview is shown in Figure-1.

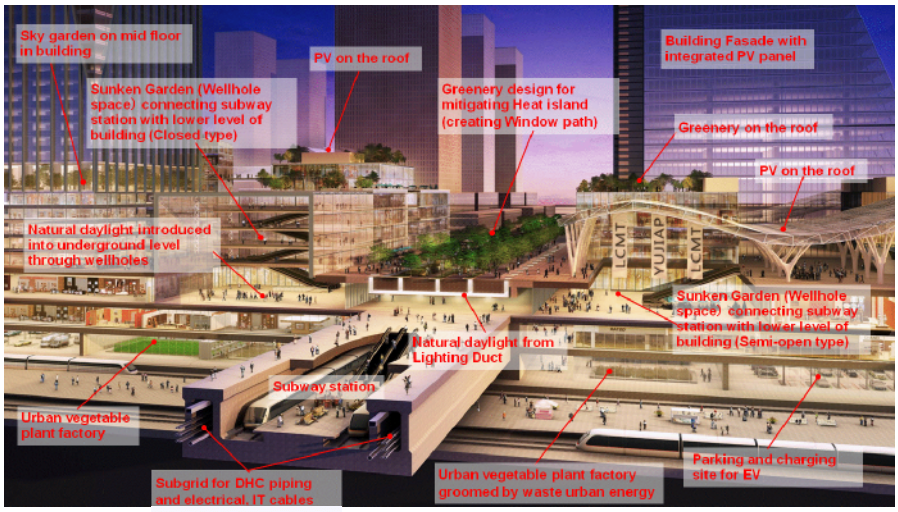

Figure-1 Design overview of Yujiapu CBD

2.3 Organizational structure

The development of this low carbon town is carried out by Tianjin Innovative Finance Investment Co. Ltd (TIFI), under the supervision of Tianjin Municipal Government and Binhai New Area Government.

2.4 Index for this low carbon town development

As shown in the Figure-2, the direct target in 2020 (mid-term) for real carbon reduction is 30% (which is over 50% CO_2/GDP) and 50% in 2030.

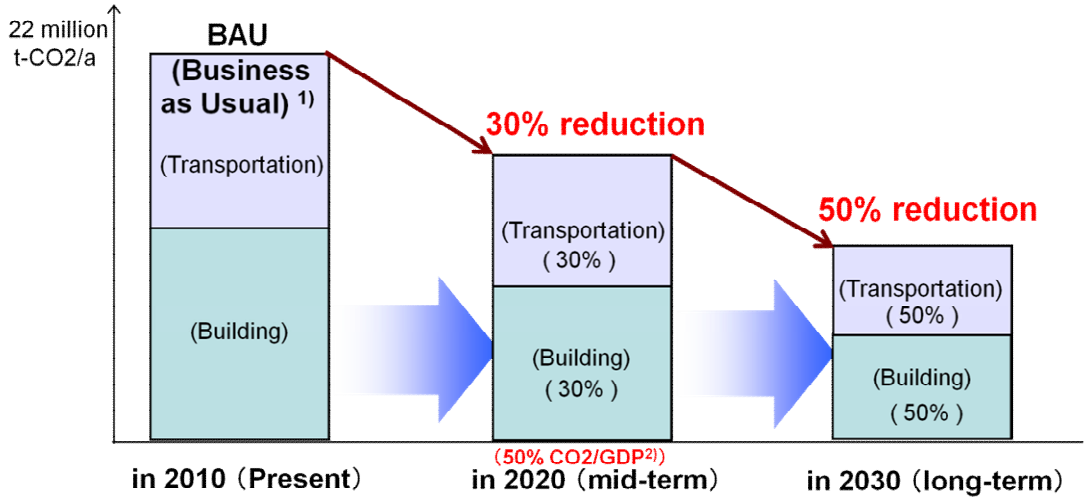

Figure-2 Target for carbon reduction in this low carbon town

3. Supporting Measures and Design Consideration

3.1 Transportation system

Yujiapu Financial District adheres to the concept of “advocate public transportation, encourage walking”. It planned and designed 4 subway lines to provide a convenient and efficient public transportation system, as well as a high-speed train line connecting Beijing to Tianjin. At the same time, a slow-transport system is being designed. Underground shopping malls and a myriad of underground spaces all linked seamlessly to facilitate travel, reduce the use of motor vehicles and the fossil energy consumption and provide the financial district with a low-carbon green transportation environment. The overall design concept and transportation can be shown in figure-3 and Figure-4.

The feature of this arrangement can be summarized as following.

- Cooperated with the overall urban design to employ the transit oriented development concept
- Maximization of the prioritization of public transport not only to travel inside this area but also the travelling between residential districts outside the area and business offices inside the area.
- Emphasizes the use of bike paths, walking paths, and pedestrian walkways through the detailed plan of underground space.
- Utilizes the efficient road network to reduce the use of personnel vehicle.

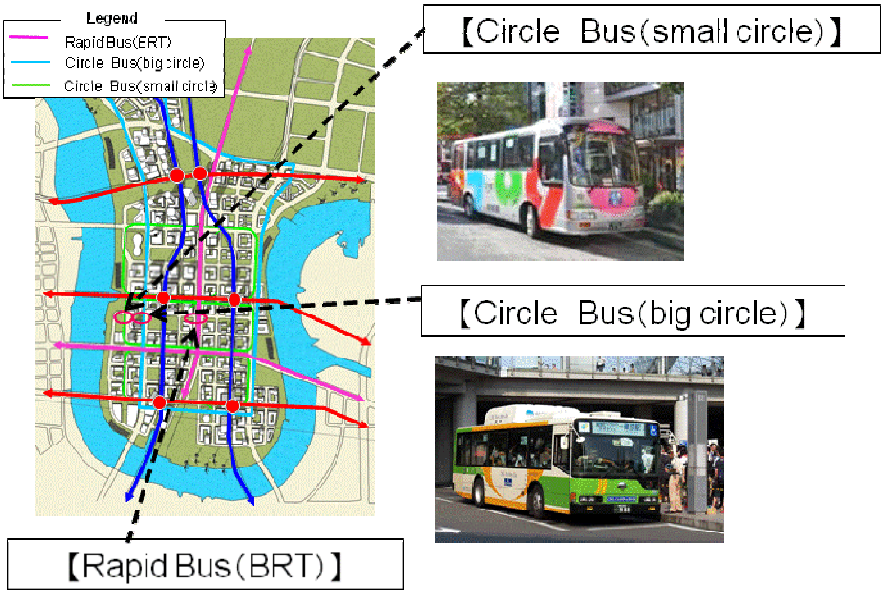

Figure-3 Concept and arrangement of transportation system

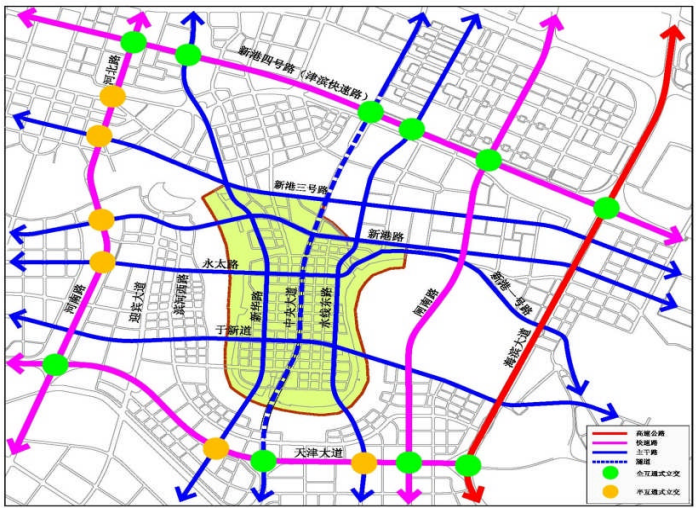

Figure-4 Overall external transportation connection for Yujiapu CBD area

3.2 Heat island analysis and building design

With the support of the Binhai New Area Government, TIFI undertook research regarding the key technologies of low-carbon towns, carefully analyzing urban microclimate simulations, building optimization, and road and green space layout, so as to reduce the area's carbon levels and building energy consumption. The multi-peak arrangement for the overall urban design can be shown in Figure-5.

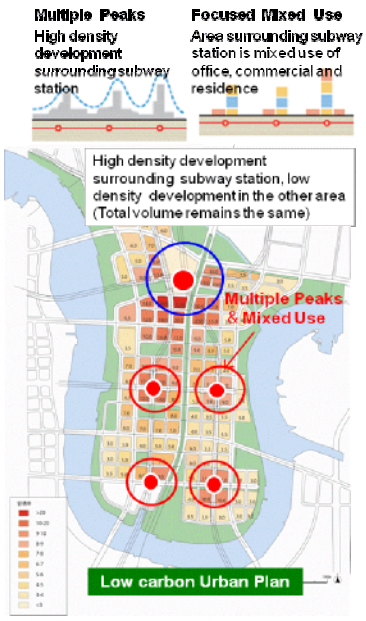

Figure-5 Multiple peaks and mixed use arrangement in Yujiapu CBD

3.3 Energy Management and DHC system

TIFI organized a study of energy management systems, and had numerous exchanges and communication with domestic and international energy management companies. TIFI also innovated in an energy investment model. TIFI now have signed a strategic cooperation agreement with France's Suez Energy. The two sides will jointly invest in the starting area's energy centres and professionally manage their operations. Through this bilateral cooperation, advanced energy management technologies and concepts for the full implementation of Yujiapu Financial District's energy management will be introduced. The design approach can be shown in Figure-6 and possible cases in our study can be summarized in Table-1.

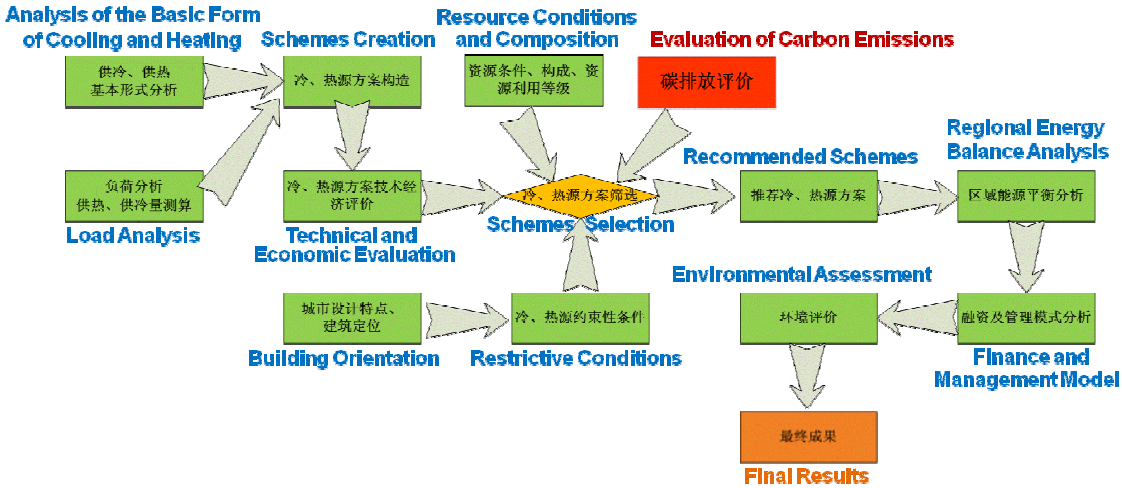

Figure-6 The design approach for the DHC system in Yujiapu CBD area

Table-1 Possible cases of the DHC in Yujiapu CBD

	Generating Hot water	Generating Chilled water	Notes
CASE1	Hot water by waste heat from local electricity power plant	Absorption Refrigerator using hot water by waste heat using hot water by waste heat	
CASE2	Hot water by waste heat from local electricity power plant	Electrical Turbo type Refrigerator with Ice thermal storage 1)	Same systems with current Master Plan
CASE3	Hot water by waste heat from local electricity power plant	Electrical Turbo type Refrigerator with Water thermal storage 1)	Popular in Japan as high efficient system
CASE4	Hot water by waste heat from local electricity power plant	Absorption Refrigerator using hot water by waste heat with Co-generation system 2)	Co-generation system supplies electrical power and waste heat
CASE5	Hot water by waste heat from local electricity power plant	Electrical Turbo type Refrigerator with Water thermal storage, and Co-generation system	

TIFI have organized a panel of experts to form an investigation and analysis team for the purpose of studying Yujiapu Financial District's geothermal resources, sewage resources, river resources and urban energy supply. Currently a special technical scheme has already been adopted in the starting area, using power plant residual heat and ice storage technology. Later phases of construction will be based on building and construction features to use natural gas and other clean energies such as power plant residual heat and energy from waste, among others, to provide low-carbon heating and cooling to the buildings.

3.4 Underground space

The subway development will be taken as a leader in underground space construction, linking the key areas of the peninsula from the point, line to surface, building an underground space of great depth

and high intensity. Active connection is to promote the efficient use of underground space and form a network of underground space development and utilization system. The existing and planned underground space will be integrated and sorted out systematically and connection will be enhanced (as shown in Figure-7). The "E" shape represents a pedestrian walk, whilst the double "C" shape represents a utility tunnel (also for the DHC system), some of the space is also reserved for some pass way for underground vehicle carriageway (such as loading/unloading, parking, etc.).

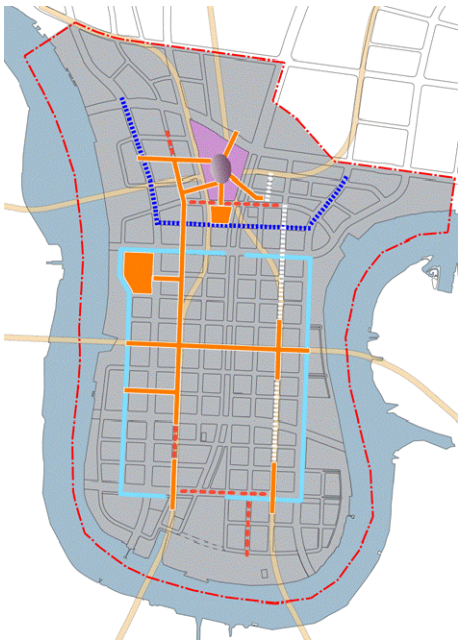

Figure-7 Underground space arrangement

3.5 Low carbon construction

For the whole process of low carbon town, TIFI have launched a low-carbon construction technologies research and compiled low-carbon construction guidelines to provide guidance for the construction and design. TIFI also improve their personnel's low-carbon awareness and make every effort to reduce carbon emissions during the construction process. Meanwhile, TIFI integrated the construction period of Yujiapu Financial District to develop a project called the "builders' home". It's located within Yujiapu Financial District, with Yongtai road to the north, and the Haihe River to the south. Out of a total area of 70,000 sqm, the constructed area represents 37,000 sqm, divided into 12 groups, it includes 10 workshop groups, 1 public support group and 1 management group, each group is located on two stories. It's different from traditional temporary buildings since each individual building has its

own foundations, enhancing the safety of the structure. It provides a comfortable living environment for construction staff, but also professional management, long-term turnover, it helps saving energy and lowers the material costs of building process.

In order to employ the low carbon construction during the development of Yujiapu CBD area, the "Low-carbon Construction Guideline for Yujiapu Financial District in Tianjin (Trial)" was published to set the criteria for the entire management team and construction company. The guidelines cover: (a) Management organization and responsibility, (b) Environment quality maintenance, (c) Material resources consideration, (d) Water resource consideration, (e) Energy conservation and renewable energy, and (f) Construction site regulations.

3.6 Water management system

The design criteria and guideline for water supply and management system can be seen in Figure-8 and the features of this system can be summarized as following.

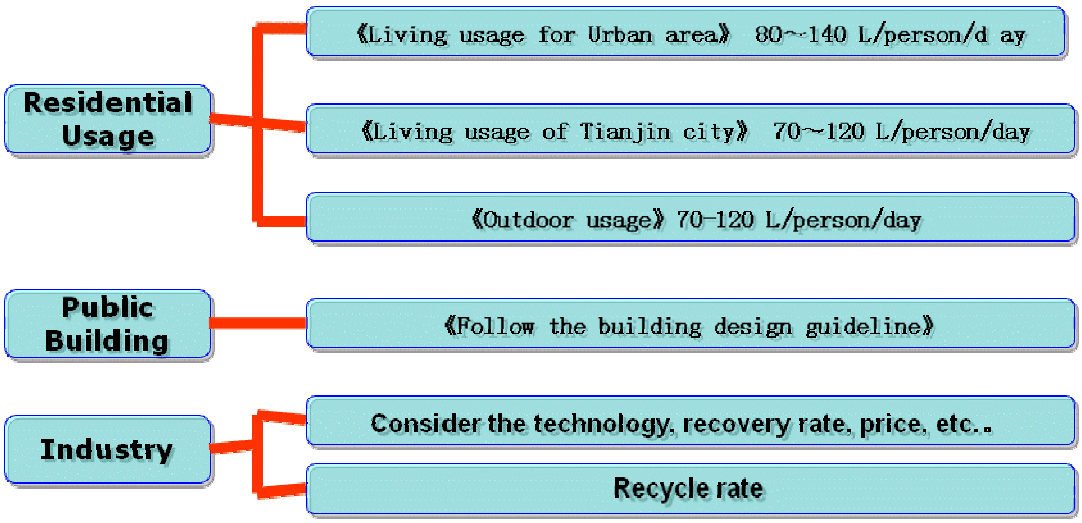

Figure-8 Design criteria and guideline for water system

- Utilize the new type eco-protection piping material, improve the life of the system, energy-saving, protect the underground water
- Utilize the energy saving appliance, set the small-type water treatment system
- Improve the rainwater utilization rate through many kinds of measures (including the collection and the utilization of the rainwater at the construction site)

- Storage the preliminary rainwater, process, and prohibit the pollution of Hai He River
- Utilize the permeable pavement and increase the rainwater penetration, self-restraint ground water
- Utilize the energy saving pump facility in the water drainage pump
- Locate many kinds of water resource allocation to ensure the high quality water supply

4. Status of this low carbon town development

4.1 Progress of this low carbon town

With the support of China's National Energy Administration and all relevant departments of Tianjin City and Binhai New Area, TIFI focus on in-depth studies in the aspects of energy structure optimization, renewable energy, energy efficiency, etc. TIFI base itself on the overall planning to determine the technical route to a low-carbon town. At the same time, TIFI focus on low-carbon town construction and operations management combined with industrial restructuring - the whole process required to build a comprehensive low-carbon demonstration town.

4.2 Problem and solution faced during the development period

The development of the low carbon town mentions many factors relating to industry and many kinds of professional technologies, the policy of the government needs to be further confirmed, made clear, and operated. The technology progress depends on the general technology level and production ability of the society, many researches cannot be focused on one region or one enterprise, APEC should intensify its platform role, and promote the flow of the low carbon technology and low carbon capital.

5. Summary Remarks

Being a case for the APEC LCMT Project Phase1 not only allowed Yujiapu Financial District Development Project to improve the level of its construction skill, but also increased their visibility and provided more opportunities and cooperation platforms of far-reaching significance. Yujiapu CBD expects more support from APEC in the future.

PART 2: REVIEW TEAM REPORT

This part of the report presents the Policy Review Team's conclusions and recommendations

1. GOALS TO REDUCE CO2 EMISSIONS AND LOW CARBON INDEX SYSTEM

1.1. Findings

The National Goals as published in the 12th Five-year Development Plan (2011-2015), the low carbon economy development targets contain very clear and definitive targets concerning 'sustainability' issues which cover the area of energy and carbon reduction; specifically the plan sets the 2015 targets of key issues as follows :

- non-fossil fuel usage account for 11.4%in total primary energy consumption

- reduce energy consumption -16% per unit of GDP

- reduce CO_2 emission -17% per unit of GDP

- reduce NOx emission -10% per unit of GDP

- reduce SO2 emission -8% per unit of GDP

- reduce water use -30% per unit of industrial value add

These targets are reconfirmed in the medium term and longer term low carbon development goals which were discussed during the policy review process in Yujiapu, Tianjin.

Furthermore the 12th Five-year Development plan also contains several issues of major significance to the low carbon development i.e.:-

- Provincial and Sector Targets Deployed with Monitoring of progress, these goals will be made available in the coming months.
- Low Carbon Pilot cities (8: Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang and Baoding) and Low Carbon Pilot provinces (5 : Guangdong, Liaoning, Hubei, Shaanxi and Yunnan), supporting fiscal measures and incentives have been announced. It is expected that a major policy push will favour the adoption of advanced technology solutions for new energy development and also energy efficiency.
- The government will be implementing 'Performance Accountability' with established measurements to monitor the progress.
- Investment in energy efficiency technology,
- Increased use of non-fossil fuels consumption with a target to reach 11.4% share of total energy consumption by 2015.
- New emission reduction targets for carbon dioxide, nitrogen dioxides and sulfur oxides.
- Promote green consumption
- Introducing 'Carbon emission trading market'.

The observations and findings from this component of the policy review can be summarized and explained as follows:

The above mentioned government targets are very important and is central to the success of low carbon development. It is also noted that Yujiapu and Tianjin city are promoted as the central theme of this national policy and that after the announcement of both APEC (June 2010) and the People's Congress of China (March 2011), the policy commitment from the national level is firm and that the local government and the planning, administration and construction work of Yujiapu exhibit a high level of policy alignment and strong communication between levels of government in this regard.

For the medium term, the 40-45% reduction of carbon intensity by 2020 as the national goal based on the 2005 baseline is very impressive. With the best available policy measures, technology advancement and the prevailing socio-economic trends, China will be able to meet the stated goals. This has been delegated to Tianjin and Yujiapu (through their own plans) to set the target of reducing carbon intensity by 50% by 2020 which will require 30% real reduction in both the transportation and industry sectors. The target will be increased to a50% reduction by 2030.

Yujiapu CBD will be a milestone of low carbon town development; containing many innovative solutions in an 'integrated' manner, adopting wide-ranging advanced technology.

Data on monitoring and reporting are still scant; this is understandable as it is still in initial stages of project implementation. The study conducted proposes to set a carbon reduction target as a primary aim and then to use 6 direct indexes and 28 indirect indexes to reflect the progress and the success of the implementation.

The indirect index will reflect the two approaches in the low carbon developments i.e.:-

- Load Reduction Approach (14 indexes), covering the reduction of carbon emissions through new area energy production, the utilization of renewable and untapped energy, resource recycling and reuse (water, waste, raw materials) and pollution abatement measures.
- Value Increase Approach (14 indexes), covering the environment (green areas, biodiversity catchment areas, reduction of heat island effects) transportation (mass transit, walking street, convenient connectivity) and business-friendly atmosphere (safety, security, enhanced economic activities and advanced information technology).

It was found during the site visit that the Exhibition Centre is an excellent showcase for the project, providing graphic details of modern urban planning and the future outlook of Yujiapu when fully developed.

It was also found that the 'builders' home' - central and modern housing facilities have been provided for the construction workers during their stay on the construction site. This is a commendable 'sustainable practice' where human values are very well respected.

It was apparent that a comprehensive study of the 'low carbon development' has been prepared for the area; showing political commitment to the development goals. It was also noted that urban planning of Yujiapu will promote the low carbon development in China for years to come and will be a good example for other economies to learn from the best practice.

1.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of low carbon goal and index setting.

(1) It is recommended that Local Community-Level Goals should be further coordinated with Sector-Level Goals.

It is essential for Local Community-Level Goals to be further coordinated with Sector Level Goals, since maximisation of reduction in CO_2 emissions depends on how to integrate various low-carbon-measures in various sectors, especially in the transport and building sectors.

(2) It is recommended that the way to achieve Sector-Level Goals should be further clarified by examining applicability of various advanced low-carbon technologies and unique local conditions.

It is valuable to further clarify how to achieve Sector-Level Goals by examining what kind of combination of advanced low-carbon technologies/measures will result in maximization of reduction in CO_2 emissions, carefully considering unique local conditions and specific characteristics of each area.

(3) With National Reform and Development Committee (NDRC)/National Energy Administration (NEA) as the National Monitoring / Review Agency; it is recommended that a local agency in Tianjin / Yujiapu (counterpart organization) be assigned and recognized for the co-ordination of this important endeavour.

It is also suggested that a local university or research lab be approached to actively participate in the program as this will help the monitoring and reporting measures first hand.

(4) It is desirable that both CO_2 targets and actual emissions be displayed prominently at the exhibition centre or other landmarks of Yujiapu as this will help create common understanding for stakeholders.

The display should also include other pollutant emissions such as particulate matters, nitrogen oxides and sulphuric oxide. Highlights of innovative solutions and carbon footprint displays should be made more prominent.

(5) A virtual exhibition should be developed; showing goals, progress and achievements of this low carbon town development.

Information availability in English will help ease international understanding and acknowledgment. There have been so many lessons learnt and excellent examples that should to be made available to other economies.

(6) Carbon/Energy audits and methodology will need to be clarified; (in English) for benchmarking purposes.

In a new concept of 'Low Carbon Development'; the importance of MRV (Measurement, Reporting, and Verification) is of high priority. It is recommended that a local university or research organization be appointed to help co-ordinate this function. The APEC LCMT project will also contribute in this respect as Yujiapu CBD will be the first of its kind. The proper MRV measures will help transfer the developmental concept and lessons learnt to other APEC economies and beyond to embark on the 'low carbon' future with more confidence, therefore ensuring the success of this very important program.

2. LOW CARBON TOWN TRANSPORTATION SYSTEM

2.1. Findings

The idea of low carbon town is an extension of the various global efforts to improve the quality of urban life while at the same time rebased on the information presented it is proposed that the new development project will consists of 3.86 sq km of urban development.

The observations and findings from this component of the policy review can be summarized and explained as follows:

(1) Yujiapu Transportation Plan

As described in the presentation, the Yujiapu Transportation Plan is based on several key design principles. These include:

- Balanced Regional Development
- Transport and Land Use;
- Transport and Environment
- Transport subsystem

- People Foremost
- Efficiency and Convenience
- Good Accessibility
- Multi Mode Choice
- Good Feasibility
- Green Transport
- Public Transport Priority
- Pedestrian Priority
- Traffic Integration

In addition, the Transport system planners also included the following additional planning concepts into their overall approach:

- Intensive land use, good land use structure, change the trip generation and distribution
- Change the travel habit, reduce the demand of the car use
- Develop the sustainable transport mode of the walk, the cycling, the bus, the metro
- Parking management and charging
- Implement traffic demand control
- Reduce the fuel consumption
- Reduce the carbon emission of the urban transport system

In general, these concepts are consistent with the ideas and concepts expressed in policy statements of the other policy entities offered by various governmental groups. In short, these principles constitute best practices in accordance with the general principles accepted today in the urban planning and transit oriented development (TOD) circles.

(2) Implementation Strategies

The planners offered four distinct strategies to be able to meet these policy principles namely:

- Transit oriented development
- Prioritization of public transport
- Prioritization of pedestrian Traffic
- Development of an efficient road network
- Encourage the use of electric vehicles
- Parking control

The overall plan is designed to reduce carbon emissions considerably. The proposed plan is expected to reduce emissions by 30% over the proposed time period as shown in Figure-9.

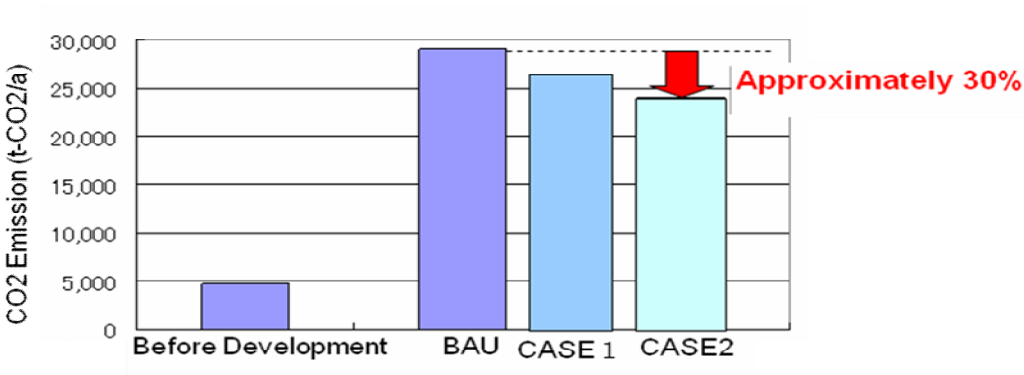

Figure-9 Carbon reduction under different scenarios

The planners also offered more specific areas, such as modal distribution, and have offered the following breakdown of the proposed traffic usage as shown in Figure-10, where it is clear that the predominant mode is that of pedestrian traffic followed by use of the bus and metro:

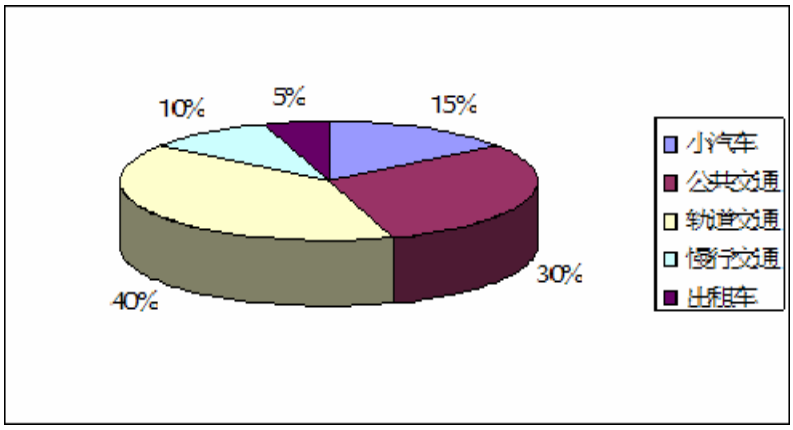

Figure-10 Traffic usage distribution

(3) Transit Oriented Development

The materials submitted to the review team specify that the development and construction will emphasize the “integration of the hub-station” and transfer points to maximize the interconnectedness of the various modes. The presenters emphasized that they will be trying to ensure that the transfer stations for the metro and the bus lines will be highly interconnected and limit or minimize the amount of walking between the different modes.

(4) Orientation towards Public Transport

The materials submitted to the review team emphasized the maximization of the prioritization of public transport. The surface transportation system will emphasize the combination of bus and Metro (as shown in Figure-11). The system will also emphasize the convenience of the transfer between the two modes. For example, the use of greater bus rapid transit could result in a reduction in carbon of 14%.

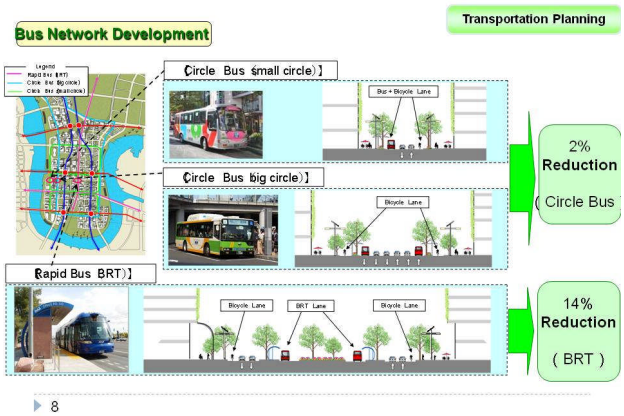

Figure-11 Overall transportation arrangement

(5) Prioritize the use of Non-motorized Transport

The proposed transport plan also emphasizes the use of bike paths, walking paths, and pedestrian walkways. Bike path and bike rental services would be readily available throughout the community. Presenters emphasized the fact that access to various services and other modes of transport would be limited to at most a distance coverable in a five minute walk. Encouraging more bicycle usage is thought to contribute to a 3% reduction in carbon.

(6) Use of Automobiles

The planners state that the “efficiency of care use is part of sustainable transport” and offer the policy of road use pricing and controlled access. Efforts will be made to provide parking management and road pricing. Car park pricing, decreasing the availably of parking spaces and providing car park sharing schemes are all techniques that will contribute to decreased automobile usage. The use of electric vehicles alone is thought to be able to contribute to a total of 3% reduction in carbon usage.

(7) Efficient Road Network

Another strategy of the transportation plan is to utilize the efficient road network. The use of road pricing combined with traffic planning is projected to result in an overall 10% reduction in carbon emissions. The main road consists of “Four vertical and four horizontal roads” while the secondary trunk road consists of “Three vertical and four horizontal” tributaries (Figure-12).

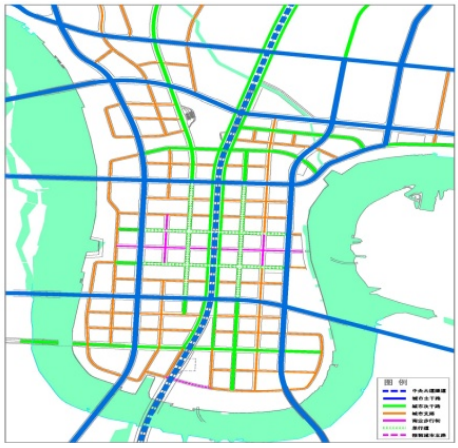

Figure-12 Major road transportation system

(8) Summary of Carbon Reduction Targets

The overall summary of the transportation related carbon targets predicts a 30% reduction over time in the carbon emissions as shown in Figure-13.

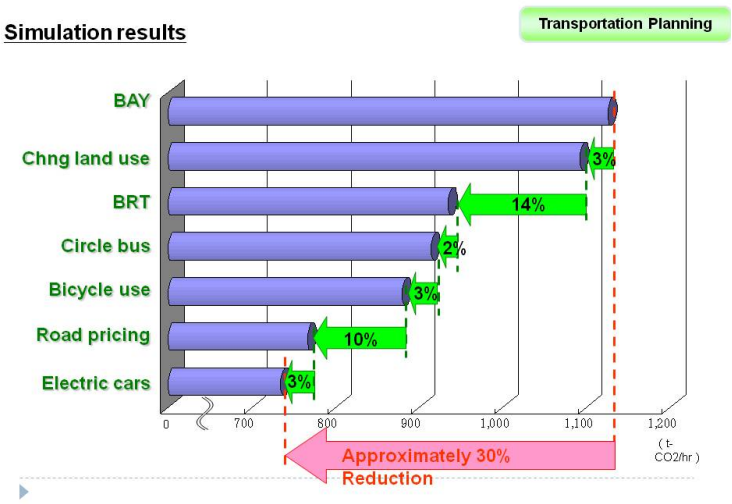

Figure-13 The carbon reduction by each measures

(9) Review Team Assessment of Transportation Planning Principles

Taken together these planning principles are consistent with best practices in place in other major metropolitan areas that have attempted to develop sustainable low-carbon urban setting and low-carbon transport.

Based on the review of the materials, the actual physical inspection, and the presentations from experts it appears that the Yujiapu project represents the best practices of low carbon urban planning and development that we have seen in a number of years.

2.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of transport development.

(1) The planners noted that there would be a road pricing plan. However, it was unclear what the parameters and key indicators of the model that would be used to support the plan might be. This is an essential part of the overall intervention and needs to undergo careful scrutiny.

(2) The traffic system is designed to interconnect with other key routes from the greater metropolitan area into the city. Based on anecdotal evidence the traffic flow from the surrounding areas is substantial. Nevertheless, it would be good to get a correct estimate. Figure-14 below depicts the connections between the other cities, the Tianjin City Centre, the airport, the port and the other districts. As can be seen there is a need to ensure that the connectivity is dealt with in a rigorous scientific fashion.

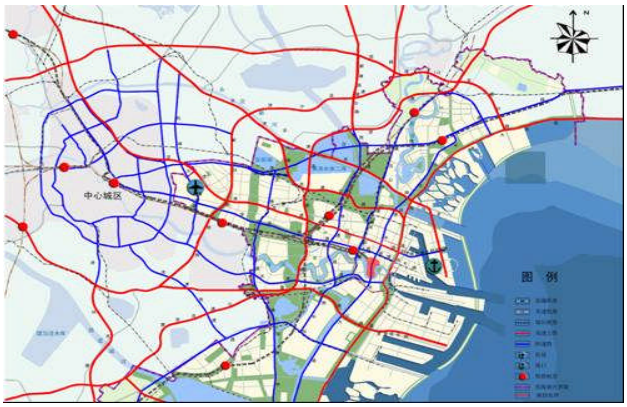

Figure-14 External transportation arrangement

(3) Another key point that was not discussed in detail during the presentation was the role of freight demand. Unfortunately, other metropolitan and urban areas have not dealt with sufficient barriers

that will determine the role of freight and its impact on the overall traffic flow and carbon usage. It is imperative that the issues surrounding freight be given some thought with regards to the incorporation of the role of freight into the overall plan. While it is expected to be small, the unintended consequence of not having a plan could add significantly to the amount of carbon consumed. The effects of diesel dwell time idling and blockage are significant. The planners may wish to include some additional pricing plans to better control the movement of freight in the urban setting so as to maximize the movement of freight in an off-duty time period.

(4) Another key dimension that could be addressed in the plan is the placement and utilization of electric charging stations throughout the setting. While the most straight forward would clearly be the parking structures, it is imperative that these charging stations also be available at the surface as well. Moreover, it is suggested that there be some accommodation for irregular electric vehicles not just automobiles.

(5) The plan would not be complete without the inclusion of evacuation and emergency routes. There are two types, one for more immediate day to day activity and then for large scale catastrophes. In addition to this the planning for day to day regular energy vehicles will decrease the likelihood of congestion occurring from routine accidents or larger scale problems as well.

3. UNDERGROUND SPACE

3.1. Findings

Construction of underground space is one of the ways for urban expansion when there is land limitation; it can create more value and increase green area in the ground surface for urban development. The observations and findings from this component of the policy review can be summarized and explained as follows:

(1) The underground space development is based on a rail transit system to connect all the buildings and major recreation areas, businesses, and offices areas. It also provides the space for an underground trench to accommodate the piping system of different utilities (includes the piping for DHC system). It can provide a comfortable and well accessible underground pedestrian network which can avoid the cold and heat, rain, sand, wind from tall buildings, traffic pollution and other adverse conditions. It also provides easy maintenance for the different utility systems that are accommodated in the underground trench.

(2) The underground space in Phase I of Yujiapu Financial Zone (Phase I) will cover around 1.0 km^2

(about 80% of the blocks) with total underground floor area estimated to be 89,000m^2. It provides easy connection (walking distance) to the major public transit facilities. This arrangement has formed an underground pedestrian network which can reduce the ground traffic load and improve the use of the public transportation system and necessary underground vehicle transport (such as, parking garage, unloading space, etc.).

(3) In order to minimize the negative impact resulting from the enclosed underground space, such as a depressing environment that lacks any sense of direction, several open spaces are designed to provide the necessary ventilation and day lighting. This can increase the attractiveness or desire for people to use the underground pedestrian system.

(4) The design and arrangement of the underground space and pedestrian walkway is based on the development of a subway system. It means that the subway system development will be taken as a lead role in the underground space construction. The overall design of the underground space is connected with each major subway or transit station or recreation site to form a network of underground space and provide convenient access for people's activities or requirements.

(5) The underground space development has been extensively designed and constructed in the Yujiapu CBD area. The model creates benefits through the extension of space availability and supports the different ground surface activities. However, it also introduces some problems for people's safety, such as, ventilation, poor indoor air quality, smoke exhaust, etc.

3.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the underground space development and usage.

(1) The consideration and arrangement of the ventilation and smoke exhaust for the underground space should be approached with much caution and involve detailed planning. The reference from the simulation results of overall heat island analysis for the flow and thermal field in this area can most likely provide some useful suggestions for the location and orientation of each open space.

The heat island analysis can provide the thermal and flow field variation/distribution in this development area. With these macro simulation results in mind, the arrangement of the open space and fresh air inlet can be carefully selected to avoid any unnecessary blockage by surrounding buildings or the influence of outdoor weather conditions. This will benefit the natural ventilation and day lighting system design and arrangement to reduce the energy consumption for indoor air change and lighting.

Another application needed for the employment of heat island analysis is the arrangement of an emergency smoke exhaust system to ensure the safety of the underground space.

(2) The design and arrangement of the underground space development needs to be in more close cooperation with the heat island analysis and DHC system.

Heat island analysis can provide the thermal and flow variation/distribution. This information can provide the necessary reference for the arrangement of open space or inlet/outlet of air. The underground space development can also conveniently provide the arrangement of piping and facilities of the DHC system that are employed in this area. In order to fully use all resources and reduce carbon emissions during development and construction, close cooperation between the construction of underground space and the DHC system is necessary to shorten the construction period and provide the maximum economic benefit for the overall development. Another advantage of the underground space is to provide easy access for the future maintenance or facility replacement requirement. Review team would like to strongly suggest that the underground space development should be under close cooperation with other items (such as heat island analysis, DHC, etc.) so that there is an integrated design and construction process of the underground space.

4. REGIONAL COOL SUPPLY AND HEAT SUPPLY ENERGY SYSTEM

4.1. Findings

The overall development theme in this low carbon town is a transit oriented development. The multiple peaks and mixed use concept were employed to concentrate the office, retail, business, and residential areas around either a main train station or subway stations. There are a total of five peaks in this Yujiapu CBD area. This kind of development model will result in a high-density building arrangement. This can also introduce more compact development and create the opportunity for a high-efficient energy usage facility or arrangement, such as a DHC with AEMS.

The observations and findings from this policy review on regional cool supply and heat supply energy system can be summarized and explained as follows:

(1) The heating is supplied by the thermal power plant located about 22 km from the Yujiapu CBD. The supply capacity is 7,200 MW and can cover about 13 million m^2 of floor area. The cooling will be supplied by the electricity power unit with ice storage system.

(2) Eight district energy systems were designed in this area. They will cover about 72.9% of the floor area as shown in Figure-15.

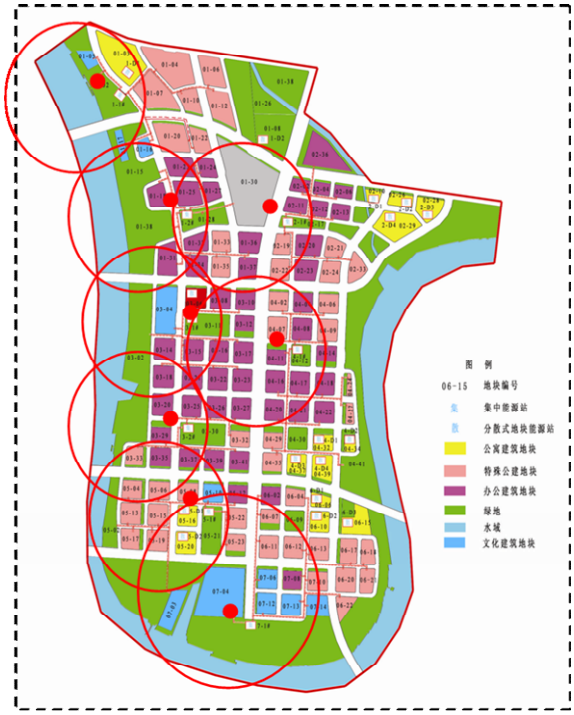

Figure-15 Arrangement of 8 district energy system

(3) According to the results from numerical simulation and calculation, this kind of design can reduce the equipment requirement for the same cooling and heating capacity by 20~25% with 10% of energy efficiency improvement.

(4) However, the DHC system is a complex system with high technology intensity. It involves design, construction, operation, and life cycle maintenance. It also requires the close cooperation of each item or involved party. The uncertainty that is caused by its operation needs more experienced and professional engineers to monitor or exercise immediate judgment and action to minimize its effect. On the other hand, the user and general public need to be educated on the system in order to boost their confidence of the system.

(5) The decision to employ the DHC system only for business and office buildings (or larger users) and not for single users is an appropriate choice.

(6) The Life Cycle Assessment (LCA) was employed for equipment and material evaluation to consider the carbon foot print. It demonstrates that the developer's ambitions for the low carbon development.

4.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the regional cool supply and heat supply energy system.

(1) The employment of the DHC is a good choice. It can increase overall energy efficiency in comparison with the dispersed or single unit through the employment of high efficient equipment and introduction of a professional ESCO to operate and maintain this system. In order to provide a good development environment for the DHC system, regulation (such as M&V guidelines, underground trench, etc.) or incentive (government subsidy) may be needed.

The DHC system is a complex technology and requires equipment integration work. It needs the support from government and needs to be understood by the user. In order to operate the DHC system more smoothly, two important issues are suggested for your consideration before the implementation of the DHC system in this new development area. One is to construct all the necessary piping inside the underground common trench together with the construction and development of underground space to save construction cost and time. This also provides easy access for future maintenance and replacement requirements. The other is to set up the M&V process and guidelines. This can ensure proper construction and meet the function requirements after the system starts to operate. The contents of the M&V process and guidelines should cover the process from design to operation and maintenance (i.e., the entire life of the system). This means that close cooperation and discussion between system designer, constructor, and operator is necessary. Review team strongly suggests the cooperation or introduction of ESCO or a similar mechanism with the employment of the DHC system..

(2) In order to operate the DHC system more efficiently, the cooperation between energy service/supply company and user is required. The interface or responsibility/risk for all involved parties should be identified more clearly.

A high performance DHC system should commence after the detailed analysis of the cooling and heating load variation not only in different buildings/blocks but also during the year to account for different weather conditions (i.e., transient loading variation is required). However, there are many parameters (such as weather, population density, occupation rate, activities, etc.) that will affect the performance of the DHC system. It is also hard for construction/operation companies to handle/respond to each parameter appropriately or in a timely manner. In order to avoid any unnecessary misunderstandings between the involved parties, the responsibility/risk matrix should be identified very clearly to all the involved parties so that the risk can be shared during the entire life of its operation.

(3) The regular monitoring and calibration period for sensing & metering infrastructure/devices is needed to be identified and defined more clearly. This can provide accurate and sufficient data for the DHC system to operate more stably and efficiently. This should also avoid any unnecessary disputes between the operation company and user regarding the necessary charge.

The charging system is the motivation/driver for the sustainable operation of the DHC system. In order to get the exact data to calculate the amount of usage for each user, the flow meter, temperature indicator, and other necessary detect devices should be installed properly. The regular inspection and calibration for each measurement device by a third party is also required. This can ensure the accuracy of all the data collected from these devices and the calculation results can be trusted. This can also garner the confidence and trust from the user and moderate any conflict between the parties.

(4) The high temperature difference in chilling water can be considered in this system to reduce the energy requirement.

In order to make full use of the characteristics of the ice storage system employed in this DHC system, some of the new technology (such as low-temperature chiller water, high-temperature difference, low temperature supply air, etc.) can be considered for the design of the air conditioning system.

5. ENERGY SAVING BUILDING IN

5.1. Findings

The energy consumption of buildings is around 30~40% of total energy consumption and creates about 40% of carbon dioxide emissions. It has also been found that more than one-fifth of the present energy consumption can be saved by applying new technology/material and by introducing more ambitious standards to either new or existing buildings. The improvement of building energy efficiency is an issue that has been studied and analyzed by many economies all over the world.

The building code or regulations will be the key factor to guide the building design and meet the target of carbon reduction. However, the energy codes still need the cooperation of the infrastructure development, such as code training, software tools for building design and code compliance, energy efficiency testing and rating of construction materials and facilities/equipment to create enough impact for changing the philosophy of building design and construction practices.

Furthermore, for the analysis of building energy consumption and carbon emissions, the concept of the LCA should be adopted. It is found that the energy consumption or carbon emissions during the

buildings' entire life are much higher than that during the construction of a new building. For the LCA, we need to consider a building from the choice of material (i.e., raw material, extraction through materials processing, manufacture, distribution, etc), and building function such as, (operation, repair/retrofit and maintenance, etc) to disposal treatment (e.g., disposal, recycling, etc). This will cover the building construction material, appliance, furniture, decoration, etc. Therefore consideration is not only given to the building's exterior design but also its sustainability and whole life performance. It was also found that keeping the building in an optimal condition and high performance operation is an important issue for the building sector. This will therefore introduce necessary regular inspections and auditing after the building is functional. In 2006, the Chinese government issued the evaluation standard of green building, that puts forward the concept of green building in its life cycle, it can save resources (energy , water , land, material), as well as protect the environment and reduce pollution, providing people with cleaner air, efficient use of space, and aesthetically pleasing architecture. They also set the standard of the green building, from 1 star to 3 stars. It is found that all twelve buildings in the start up area is planned to get the certification of green building, four of them to achieve at least the grade of 1 star, five of them to achieve the grade of 2 stars, three of them to achieve the highest grade of 3 stars, and part of the building plans to reach the Leadership in Energy and Environmental Design (LEED) certification level. The buildings in Yujiapu CBD area can provide a good example for other economies. The energy efficiency buildings in Yujiapu CBD set a good precedent for green buildings in China.

The Tianjin Binhai new area international financial conference hotel is planned to be a demonstration project, involving the integration of advanced design ideas and technology, including: building envelope, self shading, solar photovoltaic panels, outdoor permeable surface, advanced air-conditioning system technology, high-efficient lighting system, light-piping system and renewable-energy charge piles. Annual energy consumption is predicted to be approximately 15,440,000kWh. The gross energy consumption will be 70% ~ 80% of the typical energy-saving value approved by the National Standard. Annual CO_2 emissions are assumed to be reduced by 1.93 million kg, which is around 10kg per unit of floor area (m^2). Correspondingly, according to the information from TIFI, the use of advanced technology will increase the construction cost from 150 to 300 RMB per square meter.

The observations and findings from this component of the policy review can be further summarized and explained as following:

(1) The urban design in this low carbon town (Yujiapu CBD), has set the multiple peaks and mixed use concept as the guideline for the building arrangement. The building design also considers the

architecture perspective of the building load reduction, and equipment/system side for energy conservation. The measures and advanced technologies adopted in the building design can be classified into three categories: (1) load reduction, (2) natural energy, and (3) high-efficient equipment/system.

(2) With the benefit of advanced technology for energy saving, the cost is comparably higher than normal level. Based on the estimated cost of 150 RMB per square meters, it is predicted that the 12 buildings in Phase I development of Yujiapu CBD area will increase the construction costs from 100 million RMB to 300 million RMB. The increased cost may raise issues with regards to the owner's willingness to accept the design concept.

(3) There could be a difference between estimated energy savings and actual energy savings. Therefore, how to guarantee the level of actual energy savings is the more important issue in the next stage.

5.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement for future construction works.

(1) Consider the certification of green building as a necessary condition in the contract, to constrain the behaviour of the developer.

The certification of green building should be an essential requirement for buildings in the development of the overall low carbon town. It is suggested that the owner of the buildings conduct an agreement with TIFI to guarantee their design and construction can meet the standards of green buildings.

(2) Consider some measures as an incentive to the owner of the building for higher standards of green building to be met.

The incentive can be classified into the following categories.

- Building floor area ratio
- Building construction coverage rate
- Interest rate for loan
- Tax deduction
- Others

(3) The regulation/guideline for carrying out the testing and verification of a new building is necessary for both constructor and user.

Building commissioning will influence the performance of a new building after the construction work is finished. The regulation/guideline for carrying out the testing and verification of a new building is necessary for both constructor and user. The mechanism should be set up by government or the responsibility authorized to a professional organization. The building commissioning can include the following items: (a) Specification of the material employed, (b) Performance of the appliance, (c) Equipment/system performance, (d) Energy consumption measurement, (e) Air quality inside the building, (f) Others.

(4) A mechanism for the review of the electricity and heat consumption information for each building should be set up and improved.

With the help of an energy management system, energy statistics and monitoring and evaluation of every building need to be strengthened. In the case of significant differences between the expected consumption and actual situation, the owner should analyze the reason and take action to remedy it. The government should also set up a regular assessment or auditing mechanism to monitor the long-term performance of the building. The publication of the energy performance of each building can be used for peer evaluation amongst similar buildings.

6. THE PLAN FOR THE LOW CARBON TOWN HEAT ISLAND ANALYSIS APPLICATION

6.1. Findings

Yujiapu CBD is designed as a business and financial centre. The day population is about ten times of that of the night population. This means that transportation is an important factor for energy consumption and also provides the convenience for people to travel between home and office. As shown in the feasibility study and presentation, the subway station is located in the centre of a high density development area. It is also found that the micro-climate concept is employed to help the overall urban design to plan the arrangement of buildings and green corridors to reduce environment temperature. This can also reduce the cooling load requirement and create a more comfortable living environment.

It is found that overall urban design in this low carbon town is a transit oriented development. The multiple peaks and mixed use concept were employed to concentrate the office, retail, business, and residence around either main train stations or subway stations. There are a total of five peaks in this Yujiapu CBD area. This can introduce more compact development and result in a high-efficient energy

usage facility or arrangement, such as DHC system with AEMS. It also provides a more convenient and comfortable living environment for people who live or work in this area.

However, the overall urban design will face the challenge of the implementation of the results from heat island analysis (micro-climate). There is often some conflict between theoretical results and the actual situation. In order to solve this problem, guidelines or a professional committee will need to handle this kind of issue. This can provide some coordination/arbitration between the theoretical and real situation. It can also help to ascertain what kind of content should be employed in this development area and derive the maximum benefit amongst the different participating units and create a more eco-environment for people to stay in this area.

The other observations and findings from this policy review on heat island analysis application can be summarized and explained as follows:

(1) The building arrangement will affect the thermal flow field (micro-climate) in the urban area. It will also have direct influence on the cooling load requirement and air quality. Heat island analysis has already been employed to analyze the effect in the Phase I plan. The results will be employed to provide improvement to the Phase I construction work and offer suggestions for the future phases of development.

(2) As per our understanding, Yujiapu CBD is one of the portions in the overall development plan for Binhai New Area of Tianjin. The detailed development plan is supervised by the Tianjin City Government in order to maintain its consistency with the long term development goal and requirement of Tianjin City.

(3) However, the detailed process or criteria for the application of heat island analysis is not quite clear at this time. This is probably due to the unclear knowledge of any incentives provided by the government or developer. Another reason is that the heat island analysis performed at this stage is still in its preliminary study. The coverage area or intensive analysis needs to expand in order to derive more valuable suggestions with regards to future urban design.

6.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further implementation of the heat island analysis concept.

(1) In order to attract more investment for this long-term low carbon town development plan and integrate the micro-climate concept into the urban design, any incentives offered for the development of the building with consideration/employment of the micro-climate concept or other

high-efficient system/facilities should be identified more clearly.

The incentives can be similar to those mentioned in the section regarding the employment of energy saving buildings.

(2) Thermal flow analysis on a macro- scale (micro-climate concept) can provide the basic information for performing the urban design. However, the conflict between the results from the micro-climate concept and the real distribution of building arrangements has always existed. In order to solve this problem, the guidelines or criteria for the final urban design need to be proposed and specified clearly. The guideline can include weighted factors, weight can be based on the importance of each factor to Yujiapu CBD and Tianjin City, some such factors may include; energy, economy, finance, transportation, function, living environment, etc.

A comprehensive and detailed urban design will set a good foundation for the future and long-term low carbon town development. Heat island analysis (micro-climate concept) will provide the necessary information for carrying out real urban design, especially for building location and orientation. It can also provide different simulation scenarios for people to understand and compare town arrangements including, buildings, corridors, green areas. Through the employment of the micro-climate concept, it can not only save energy consumption in the long term but also create a more eco-friendly environment for people to live or work in. In order to attract the developer to carry out a detailed heat island analysis before proceeding to urban design, incentives should be provided by the government. Therefore, review team suggests that China can consider the current situation and enhance policy programs and regulations to highlight incentive programs for developers so that they are attracted to low carbon development projects and will consider investing in such projects.

The adoption of the micro-climate concept may introduce some conflict with the full usage of existing land area under development. Therefore, the decision, procedure or criteria should be identified or published by the adoption of a weighting factor for some of the key parameters. This can not only shorten the length of time it takes to create the urban design but also make a big contribution to the sustainability of the new development area.

7. LOW CARBON TOWN ENERGY EFFICIENCY MANAGEMENT SYSTEM

7.1. Findings

As mentioned in the previous report, eight energy supply and management centres with DHC system are planned in the Yujiapu CBD area. High-rise buildings are also located in this area that will have high occupation density during the day time. It is estimated that the average plot ratio (or building floor area ratio) is about 10.

Large scale public buildings (LSPBs) consume about 25% of energy consumption of urban buildings; these LSPBs only represent around 4% of urban buildings in China. It is also estimated that building energy consumption is the major energy consumption component in the Yujiapu CBD area; it is therefore a very important factor with regards to the reduction of carbon emissions in Yujiapu.

As shown in Figure-16, the AEMS will play an important role in the smart community to balance and adjust the requirement of both demand and supply. The overall energy conservation concept is to have green buildings with high-efficient envelop material, high-efficient cooling/heating devices, and high-efficient lighting devices, etc. The building energy management system (BEMS) can be employed to optimize the energy consumption for a single building in order to get a healthy and comfortable living environment with minimum energy requirements. The employment of a city grid and renewable energy (such as photo voltaic, wind power, etc.) with the smart grid can manage electricity supply more stably and also provide high-quality electricity to this area. With optimization of both demand and supply, AEMS can adjust the system more dynamically and accurately through the employment and assistance from energy information communication technology (EICT). The energy storage device can be acted as a buffer to stabilize the entire energy consumption system in this area.

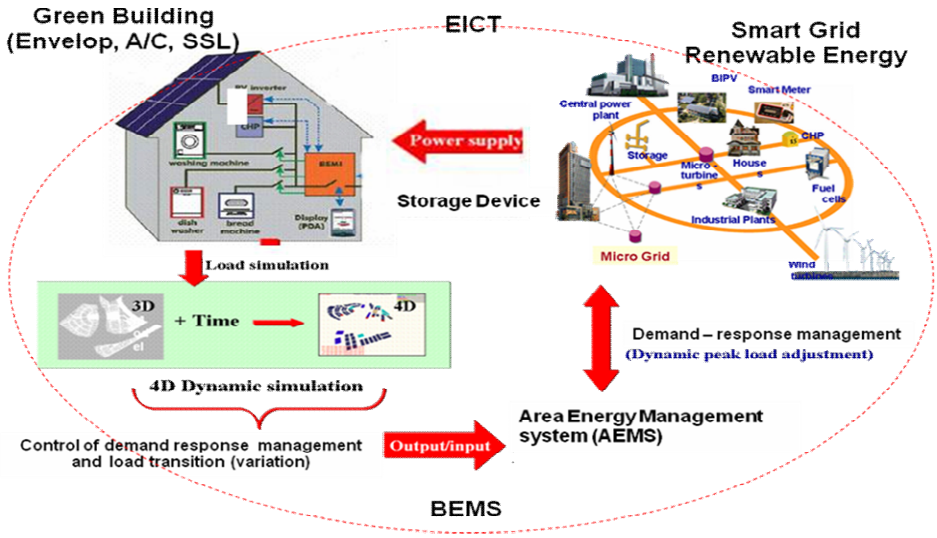

Figure-16 Application of area energy management system in smart community

The observations and findings from this component of the policy review can be summarized and explained as follows:

(1) It is found that Yujiapu's priorities in terms of energy efficiency seem to, in order of importance be; heating and cooling, underground pumps, air conditioners, ventilators-pipelines, and lighting systems.

(2) Thanks to the Er Ge (report company), Yujiapu seems to have a state of the art and unique monitoring system for energy demand in commercial buildings at their disposal. This monitoring system can collect and analyze the energy consumption and system performance of each major equipment/facility to help the management team focus on the priority areas of energy demand.

(3) The employment of the system is estimated to result in energy savings of 26.6% in the existing buildings. This is higher than our expectation for the system to employ this kind of management system without doing any equipment/system adjustment or replacement. This may be due to improper system design (such as over capacity design) or operation. More detailed analysis and evaluation should be performed in order to understand more clearly the advantages/benefits of the EMS.

(4) The energy management system seems to be only employed on the demand side to manage energy consumption for buildings in the Yujiapu CBD area.

7.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement in future EMS development and implementation.

(1) The use of motion sensors and other advanced technology for controlling electricity demand in commercial buildings is an interesting concept. However it will be good to see a well thought out plan with regards to the supply and demand balance of electricity across the board even in the residential sector and the type of technology that can be introduced there (i.e. smart grids).

The employment of an EMS system should cooperate with the sensing, metering, and control devices. Human behaviour is also a major parameter that affects the outcome of the EMS. Therefore, the adoption of a proper device with optimum function, taking into account human behaviour should be considered carefully. However, in this high building density and occupation density area, each building cannot be treated as a single unit. Consideration of all Yujiapu CBD area is required. This will push the requirement for the AEMS to dynamically manage supply and demand at the same time. This way, it is possible to reach a win-win situation (i.e., reduce energy consumption and carbon emissions, and create a high-quality living environment without the sacrifice of stable energy supply). The operation of the system is vital to increase energy efficiency.

(2) The implementation of education campaigns and policies aiming to make the public more aware of the benefits of energy efficiency may be useful to alter human behaviour and thus work in tandem with the management of energy demand through technology and reduce wasting of energy and reduce energy demand further. This will introduce the requirement for operator training and human education.

Education and training regarding the operation of the system is needed not only for the operator but also for the general population living or working in this area. Without the understanding and support from the human element of Yujiapu, the EMS cannot manage buildings to reach and exhibit the optimum function.

(3) ESCO can expand its close cooperation with the EMS or DHC to raise energy efficiency and create a beneficial situation.

The integration of EMS (or AEMS in the future) with the DHC system is highly sophisticated. The monitoring and operation of this kind of system can introduce the requirements of a professional engineer or company. The introduction of ESCO into this low carbon town can not only lead to the sharing of investment risk between all the involved parties but can also lead to the cooperation between

the Yujiapu local government and a professional company for the management of this complex energy supply and demand system.

(4) It is highly recommended to expand the existing EMS to the AEMS. In the future it is also suggested that thought be given to the combination of the AEMS with security systems or other smart management concepts to form the basis of a smart home or community.

The concept of a low carbon town or smart community may not only meet the minimum carbon emission requirements but also provide an eco-living environment for people to live or work in this area. The EMS can handle a single building's energy consumption in a reasonable way. The AEMS can expand the energy management (both demand and supply) to the entire Yujiapu area. If the AEMS can be combined with building security systems in the future, there will be more benefit to the operation companies and individual users.

8. LOW CARBON CONSTRUCTION

8.1. Findings

The Yujiapu CBD is a long-term development and construction project, the construction company and workers will vary in different stages of the project, as there will be a need to fulfil the changing requirements. The basic concept employed by the Yujiapu CBD is to build a semi-permanent "builders' home" for the entire construction workforce and "manager home" for the management team members during their involvement in this project. It is not only to provide a comfortable living environment but also to reduce the construction of temporary housing. The temporary accommodation will be in tact until the completion of the project after which it will be converted into green spaces.

The observations and findings from this component of the policy review can be summarized and explained as follows:

(1) A "Low-carbon Construction Guideline for Yujiapu Financial District in Tianjin (Trial)" was published to assist the entire management team and construction company. The guidelines cover: (a) Management organization and responsibility, (b) Environment quality maintenance, (c) Material resources consideration, (d) Water resource consideration, (e) Energy conservation and renewable energy, and (f) Construction site regulations.

(2) The developers for the Yujiapu CBD also set up a management organization and process to monitor all progress and achievements of the low carbon construction. The organization and process can been shown in Figure-17.

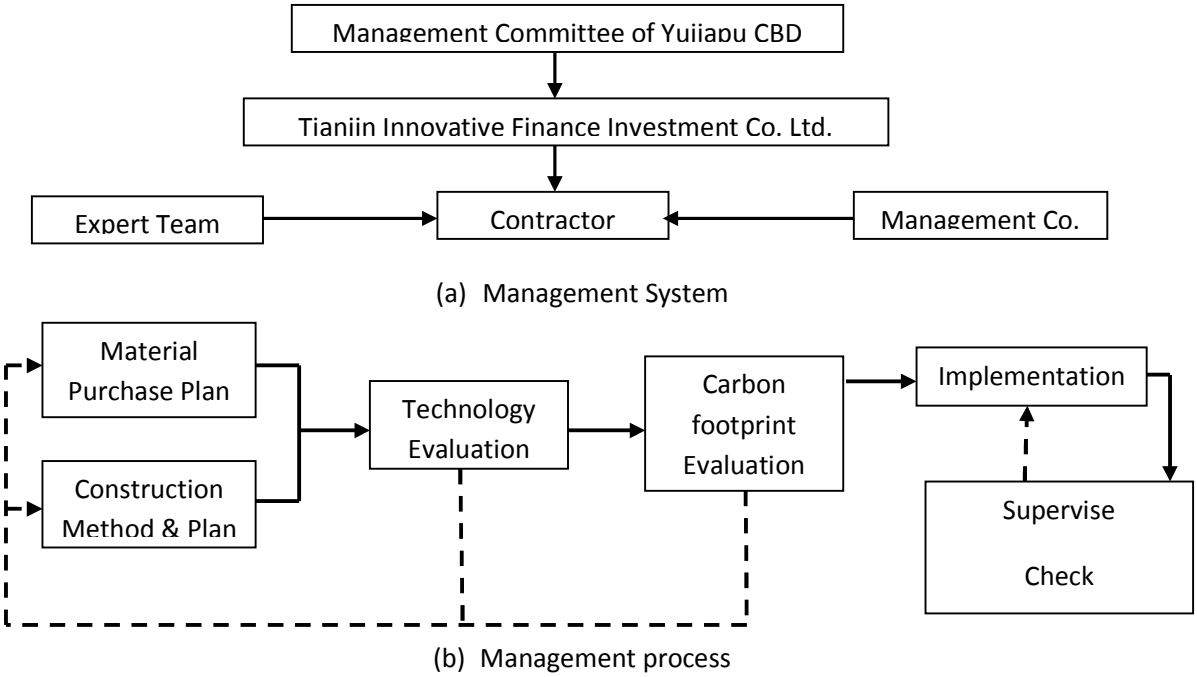

Figure-17 Low carbon construction management organization and process

(3) The goals and measures for the low carbon construction are very clearly identified in a simple way - 128501. It means: (a) 100% of integrated and digital management, (b) 20% of energy consumption reduction for the entire construction works, (c) 80% of factory building components, (d) reduce at least 50% of material loss for the construction works, (e) zero pollution in the surrounding environment, and (f) waste generation rate is less than 1%.

(4) It seems that during the construction process of this low carbon town, measures have been taken in terms of dust control and soil contamination prevention. This will prevent the health impacts that could affect the general Yujiapu population and construction workers who work on the this area.

(5) Training programs on low carbon technology for construction workers is a great step forward and will prove useful not only for this project but also for future low carbon town developments in China and even within other APEC economies. Yujiapu CBD's achievement in terms of the development of a training program/mechanism can be duplicated and used in other economies.

(6) Collaboration between the Yujiapu local government and universities within China also demonstrates current and further commitment to low carbon technology in the Yujiapu region.

(7) In order to reduce the transportation energy consumption for all the material or facilities applied in

this low carbon town development, a supply chain with a distance less than 500km was set up for the major construction materials suppliers.

(8) There is a good management and assessment mechanism in place for the construction workers and managers. This is important for the evaluation of the workers skills and monitoring of the progress of the project.

8.2. Recommendations

Based on the above observation and findings, the following suggestions and recommendations can be applied for further improvement in future construction work.

(1) The consideration of material delivered by ship can also be considered due to the good location of the Yujiapu area.

To set up a material supply chain less than 500 km is a good way to minimize energy consumption and carbon emissions due to ground transportation by truck or train. However, the Yujiapu CBD area is very near the ocean with a good harbour nearby. By considering the carrying/transporting capacity and energy consumption per unit weight, surface transportation by ship or cargo vessel is probably more competitive than ground road transportation by truck. The overall evaluation and calculation should be considered more carefully in order to choose the most economic mode of material transportation.

(2) The evaluation of low carbon construction is also needed for the underground space construction works.

As shown in the presentation, the underground space is a very unique characteristic in the Yujiapu CBD. It does not only increase the space availability in the limited land area but also provides easy/convenient access for people to travel in the area under any weather conditions. However, the underground construction work is quite different to the ground construction work. There are more issues that need to be considered, such as ventilation, lighting, safety, access, etc. A special version and guideline for underground construction is also most likely needed to address the above important issues.

(3) It is valuable to share achievement and information for low carbon construction work to all of the economies in the APEC region.

The Yujiapu CBD has set up a very good model for low carbon construction work. Information availability in English will help international interests. There are so many lessons learnt and excellent examples that should be made available to other economies. The access to the “Low-Carbon Construction Guidelines for Yujiapu Financial District in Tianjin” could provide helpful information for the international community if an English version can be made available.

9. REGIONAL WATER SYSTEM

9.1. Findings

As far as the low carbon town is concerned in water consideration, the topic can be classified by the following several items:

- Increase water recycle usage;
- Decrease water loss, decrease energy consumption;
- Integration of data, shared information, improve efficiency
- Protect environment, make the best use of water ecology

The plan of the Yujiapu CBD area relating to water consideration is well arranged with some policies already been put into action.

The observations and findings from this component of the policy review can be summarized and explained as follows:

(1) Set target of various water resource recycle

It is very important to set a target for action. Tianjin is a city where there is a water shortage. The condition will be more serious as the economy develops. This problem can be mitigated through increasing the water recycling rate. In Yujiapu, different sources of water, namely, gray water, sewage water and rain water, will be recycled to a certain degree in different times of the year. Because of the short review period, technology wasn't discussed in detail, the target should be adjusted taking into account water recycling and the technologies employed as shown in Table-2.

Table-2 Target for the water management system

Year	Gray water	Sewage water	Rain water
2020	40%		15%
2030	80%	30%	30%

(2) Water supply and drainage (Common ditch; Separate system)

As for the drinking water supply, since the pipe is not covered with the heavy earth, it can reduce the pipe system damage greatly. For example the pipe joint won't be easily collapsed by freeing from the uneven settle force. The leakage point can be easily found by "open view" and call for a timely repair as well. Therefore the water leakage can be substantially decreased. Furthermore, changing pipe and routine maintenance won't need to result in the digging of the road anymore. As for the separate

system, on one hand, rainwater can be reused directly or through a primary treatment; on the other hand, domestic wastewater is not diluted which is good for the microorganism system in the wastewater plant; and the less volume of water to pump the plant, the less energy used (Figure-18).

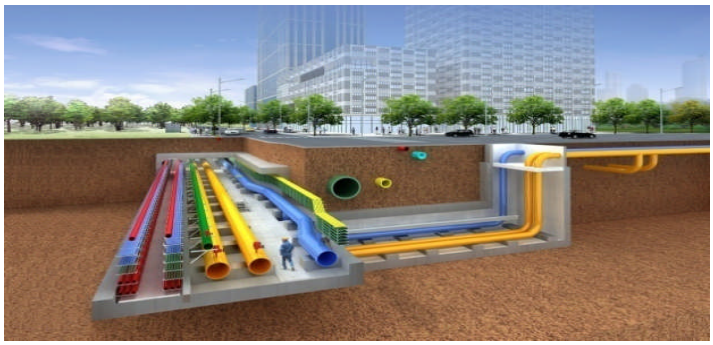

Figure-18 Piping arrangement

(3) Rain water storage and usage

There are two ways to store rain water: naturally and manually. Usage of a green roof at some homes and land green coverage by 1/4 can hold much rainwater. In some places, use of permeable brick and concrete is mentioned, so the water is permeated into the ground, and does not flow away (as shown in Figure-19). A big underground storage tank is planned as well to collect the rainwater from the city.

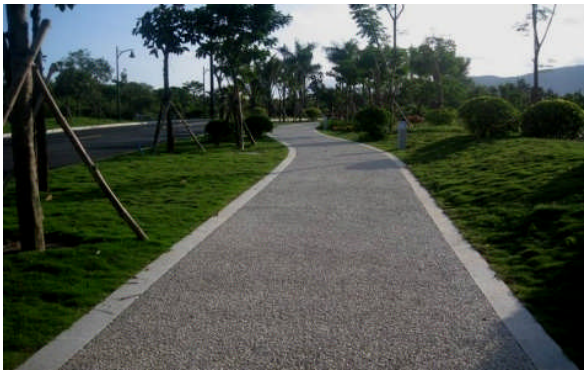

Figure-19 Green area design for water storage

(4) New material & new technology

As far as the water delivery is concerned, the pipe with smooth inner surface will reduce the energy loss by a low friction coefficient, and the common ditch will make the plastic pipe usage practical;

variable frequency drive, sensors and software as a whole is employed to increase the pump efficiency in the CBD building, which will provide large electricity savings. This practice, as a reference, will be important to the future design and operation for the high building group in Yujiapu.

Figure-20 New material for underground piping

(5) Construction site

Water saving and reuse is put into effect in the builder's home, and wastewater pollution prevention is adopted as well. Since the builder's home will be used for 10 years, total effect is considerable.

(6) Ecology with water

It was good to see that the Yujiapu plan took a comprehensive approach to the water environment. Ecology with water improves the value and aesthetic. There is wetland opposite the River Haihe, boat trips can be utilized here as they are a pleasant leisure activity and will add to the business centre. The massive space of green land on the riverbank could contain some artificial water spectacle to add to the aesthetics of the town.

9.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the regional water supply system development and usage.

(1) Rain water collection by sunken plaza

Figure-21 shows a demo of Rotterdam city in Netherland at the pavilion of Shanghai expo 2010. The Plaza is a leisure place for citizens on sunny days; and can also be a big storage tank during the storm rain period. There're some holes connected to the city drainage pipe or ditch (with valves control).

When the rain stops, the water can then flow to the collection tank. In Yujiapu centre zone, among those buildings, if this plaza can fit and match with the surroundings, the benefits can be as follows:

- Rainstorm storage
- Multi-land usage
- Reduce infrastructure cost

Figure-21 Sample of water storage tank design with the plaza

With an additional “buffer tank” of the sunken plaza, the planning rain water storage tank can be smaller; both the size of the pump and the pipe can be reduced as well.

(2) Central water centre (Supervisory Control and Data Acquisition & VIDEO)

It’s very useful to set up a centre for the control of wastewater discharge, which can operate the system safely, efficiently and reliably. However the centre can be multifunctional to cover more water service in Yujiapu. Except for wastewater discharge control, the monitoring of the quality and flow of drinking water, rainwater system, and even river water information etc. can be centralized. The concept for the employment of ICT in the water management can be shown in Figure-22. If necessary, it can be put together with the video system for water assets supervision.

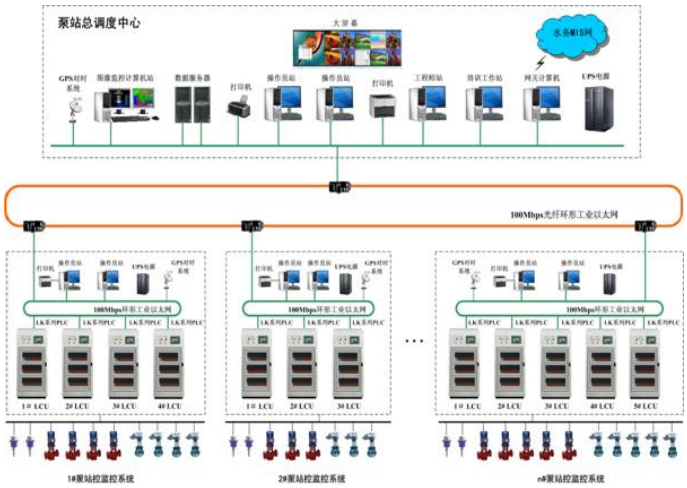

Figure-22 Information communication system for water management structure

(3) Gray water usage (supplementary point)

Considering the gray water reuse it is important to clarify whether it is an individual water recycle system (such as pipe, collection tank, treatment facilities etc) or a combined system with other water systems. The solution should be thought through carefully to get a balance between the construction and material costs and the gains from the water reuse and energy savings through the delivery within short distance.

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Dr. Patric Sherry, Associate Professor& Executive Director, National Centre for Intermodal Transportation, University of Denver, United States.

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Appendix B: Organisations, Officials and Experts Consulted

National Energy Administration, PRC

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Tianjin Development and Reform Commission

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Energy Research Institute, National Development and Reform Commission

Ms. HU Runqing, Associate Research Fellow, Architecture Centre for Renewable Energy Development

Tianjin Innovative Finance Investment Company

Mr. LI Bo, Chairman of the board

Mr. JIA Liang, General Manager

Mr. ZHAO Tong, Vice General Manager

Mr. YANG Haisong, Header of General Office

Ms. LI He, Office Worker

China Architectural Design & Research Group

Mr. WU Deshen, Adviser General Engineer

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Dr. Shinji Yamamura, Executive General Manager, Principal Consultant

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Mr. Fumihiko Kakehi, Consultant

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