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APEC Guidebook
on Quality of Infrastructure Development
and Investment

Committee on Trade and Investment

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Purpose

(1) Purpose

A rapid growth in infrastructure development and investment is expected in many parts of the APEC region in line with economic growth and urbanization trends. The shortage of budget available for infrastructure development in member economies result in the tendency of procuring infrastructure at the lowest possible initial cost in many cases. Sometimes, however, this has led to a higher-than-expected overall cost due to the lack of consideration of maintenance and operation costs, long-term durability, safety (including resilience to natural disasters), or environmental factors.

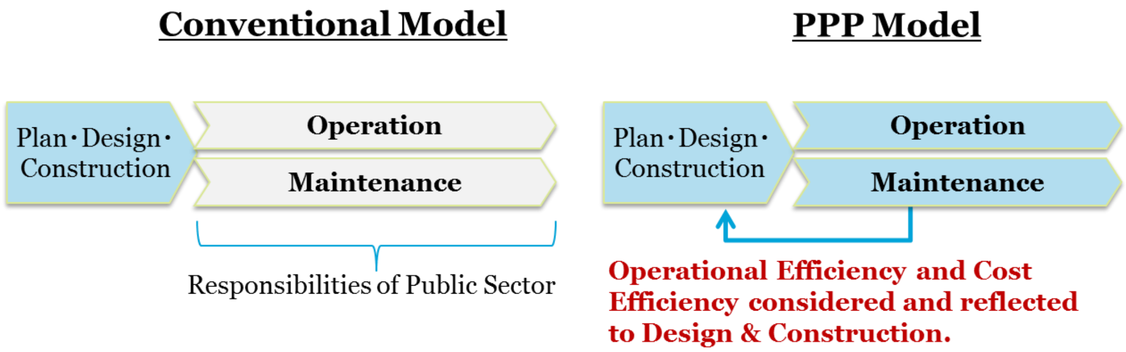
Against this backdrop, the 21st APEC Economic Leaders' Declaration in 2013 recognized in addition to the initial price of procurement the importance of consideration of lifecycle cost (including performance and durability) and environment, elements such as safety and maintainability at the outset of procuring infrastructure ("quality of infrastructure"), and also the importance of enhancing the governments' ability to plan infrastructure projects based on the above and on comprehensive and holistic considerations.

This Guidebook shares further details of these common recognitions with government officials and other stakeholders in the APEC economies that are engaged in infrastructure development and investment, so that such common recognitions are actually applied to projects.

Given the fact that APEC economies include those of diverse levels of capacity and experience in infrastructure projects, this Guidebook may be put into practice in an incremental manner taking into account their diverse circumstances. By making use of this Guidebook as a practical, non-binding reference, it is expected to foster governments' expertise in infrastructure projects, and ultimately improve the quality of infrastructure in APEC economies.

(2) Scope of infrastructure projects

This Guidebook covers various fields of infrastructures in general, such as power generation, water system, and railway transportation[1]. The coverage of this Guidebook encompasses two fundamental models in infrastructure procurement, namely the "Conventional Model" and the "PPP (Public Private Partnerships) Model. The distinctive difference between the two is the aim of the models. While the former aims to procure "Facilities/Built Infrastructures"[2], the latter aims to procure "Services" through infrastructures.



The PPP model, which covers all aspects of an infrastructure project, often provides a useful reference to highlight quality issues in infrastructure, in terms of the way in which Life Cycle Cost, environmental impacts and safety is considered. Therefore, references are made to PPP in various parts of this Guidebook.

However, it should be noted that, while the PPP Model is an effective means to realize "quality of infrastructure", references to PPP in this Guidebook can also be applied to the Conventional Model. It is understood that the application to the Conventional Model of concepts and/or methods described therein is also effective.

[1] This Guidebook also intends to cover social sectors such as health and education sectors.
[2] Typical examples include procuring equipment or device, and commissioning design or construction.

Section.1 How to define the quality of infrastructure projects

1.1 Nature and quality of infrastructure projects

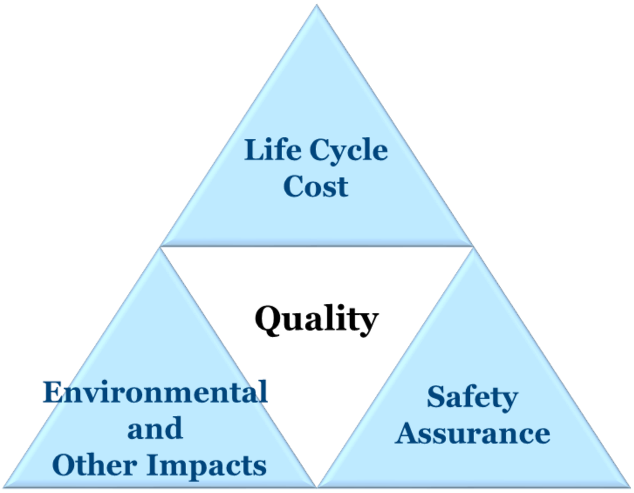
(1) Nature of infrastructure projects

Infrastructure projects such as power generation, water system, and railway transportation or waste disposal projects support the basic life of the general public. These infrastructures are expected to provide stable and sustainable public services on a long-term to a large number of beneficiaries.

(2) Quality of infrastructure projects

In light of the above, when discussing qualities of infrastructures at large, we should take into consideration the three key elements of Quality, namely, Life Cycle Cost (LCC), Environmental and Other Impacts and Safety Assurance as referred to in Fig.1. By doing so, the quality of service throughout the life of the subject infrastructure starting from the designing stage to the end of maintenance and operation stage is satisfactorily secured.

Figure1.
Three three key elements of Quality



[Case Example：Failure to maintain project's long-term quality]

- A power generation project awarded to a contractor proposing the lowest price. As a result, delay to the construction period occurred and also the required power output was not achieved.
- A PPP project focused too much on price aspects and lesser concern to, project management aspect thereby led to the loss of a user's life.

1.2 Method for securing quality

For securing quality, appropriate actions at each step (design, engineering, construction, operation, maintenance) are needed.

(1) Technologies and construction management

Appropriate designing and engineering are keys to securing the expected quality of infrastructures, in terms of LCC, compliance with environmental and other standards and safety assurance. Superior construction technologies and effective construction management are also essential to realize satisfactory results in each of these stages up to the completion of construction.

(2) Operation and maintenance

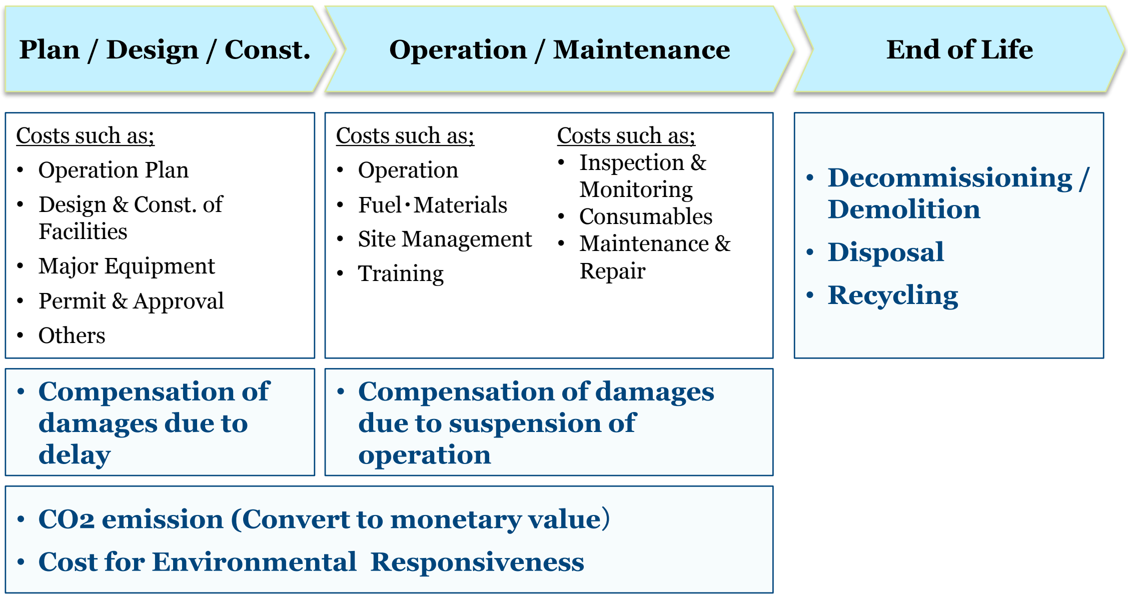
Needless to say appropriate operation and maintenance are also essential to maintaining the quality and the performance of infrastructure on mid- to long-term. A detailed operation and maintenance program should be developed and implemented with an adequate organizational structure. In this respect, application of preventive maintenance and advanced renewal technologies are also important to realize the longer service life of infrastructure.

1.3 Embody the three key elements for quality of infrastructure project

(1) Life Cycle Cost reduction

LCC includes initial investment, and cost of maintenance and operation along with the necessary cost for renewal. Moreover, cost of demolition and disposal at the end of the life of a project is also to be included. From the point of a sustainable long-term operation, cost of minimizing opportunity loss and environmental impacts which can be converted into monetary terms (e.g. CO_2 emission) should also be taken into consideration. It is important that a widely recognized method based on objective criteria be applied to the LCC calculation.

Figure2. Cost conponets to be considerd under LCC Model



Following Case Example illustrates how CO2 emission may be converted into monetary terms.

[Case Example : Environmental impact calculated as cost in the EU rule]

- *Considerations of vehicles' environmental cost were specified under the EU Directive: "DIRECTIVE 2009/33/EC: The promotion of clean and energy-efficient road transport vehicles"*

CO_2 emission: 0.03-0.04 EUR/kg
NOx emission: 0.0044 EUR/g
Particulate matter emission: 0.087 EUR/g

* Cost per unit was established in 2007

(2) Environmental and other impacts

Introduction of higher level environmental standards serves to enhance environmental sustainability. Instead of merely satisfying the current standard, it is meaningful to apply a standard that goes beyond the economy's existing environmental standards, with due consideration of sustainability for future generation, if possible. In setting the standards applicable to the project, objective numerical targets setting higher goals to the extent possible is also encouraged. In this respect, applying superior environmental technologies (e.g. reutilization of a large variety of resources) becomes an important consideration in evaluating qualities of infrastructures.

If the project expects to receive financing from multilateral development banks, public export credit agencies in OECD countries or private financial institutions which adopts “Equator Principles”, considerations of environmental and other impacts are generally required, based on appropriate standards, for example IFC’s Performance Standards and EHS Guidelines. Even for cases where multilateral development bank funding is not sought, appropriately integrating such considerations in infrastructure project planning is also key to ensuring the viability and social acceptability of the planned infrastructure, thereby reducing the overall project risk.

(3) Safety assurance

Safety assurance is an important aspect throughout the period of construction, maintenance and operation. In order to secure a safe environment for all personnel, as well as welfare for the neighborhood and region including resilience to natural disaster, measures utilizing superior technologies such as seismic or fire prevention technologies are becoming more and more important for infrastructure projects. Failure to integrate disaster proofing in the design and construction of the infrastructure can also lead to increased and otherwise avoidable project risks.

Section.2 How to realize the quality of infrastructure projects

2.1 Process for developing infrastructure projects

The overall process for implementing an infrastructure project with quality is depicted below and the contents of this Guidebook are outlined in line with a typical project process.

- At the 1st Stage, a feasibility study is conducted to identify the necessary quality of an infrastructure project and select a project implementation method, considering Value for Money and other factors.
- At the 2nd Stage, the procurement stage, the details of required service level of infrastructure, qualification and evaluation criteria of bidders are identified to secure quality, upon which competing proposals are invited.
- During the 3rd and 4th Stages, a selected contractor provides design and construction work and operation and maintenance services under the contract. The contract execution is monitored and appropriately managed.
- At the 5th Stage, ex-post evaluation stage, the project is evaluated from a qualitative perspective at the mid-period and at the end of the project.

Figure 3 illustrates these processes and relevant sections of this Guidebook are specified under “Reference.”

Figure3. Process for developing infrastructure projects

Stage	Task	Reference
1st Stage Feasibility Study	● Define the Quality of infrastructure ● Select procurement method ● Value for Money test	2.1
2nd Stage Procurement	● Define the service level ● Pre qualification ● Proposal Evaluation	2.2 2.3 2.4 3.1
3rd Stage Construction	● Manage the private company or SPC ● Monitor EPC activity	2.5 2.6 Appendix
4th Stage Operation & Maintenance	● Manage the private company or SPC ● Monitor O&M activity	
5th Stage Ex-Post Evaluation	● interim appraisal ● Final evaluation	2.7

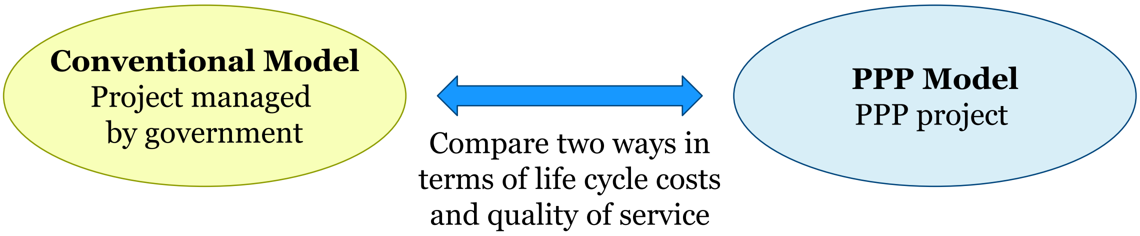
2.2 Select procurement method and Value for money test for decision-making

As the general public ultimately bears the cost of infrastructure projects, an implementation method with the highest value for money (VFM)[3] for tax payers should be selected in view of key elements of quality.

Typically, VFM test is conducted to identify whether the project is to be conducted under the conventional model or the PPP model by comparing the value of an infrastructure project implemented through both models. Furthermore, when the conventional model is selected, VFM for a project is measured among different conventional models such as individual commissioning, design-build, EPC, etc. The calculation should consider not only the total cost throughout the life of the project, but also the level of service so that the real value for taxpayers can be appropriately compared.

[3] Impact of an investment made. A concept of assessing project from both the aspect of cost and outcome. For example, the lifecycle cost for a project by the public and the private sectors will be compared for making the decision to implement a project using the PPP model. The party with the lower cost will be selected. If the cost is the same, the party that can improve the quality of service will be selected.

Figure4. Assess VFM



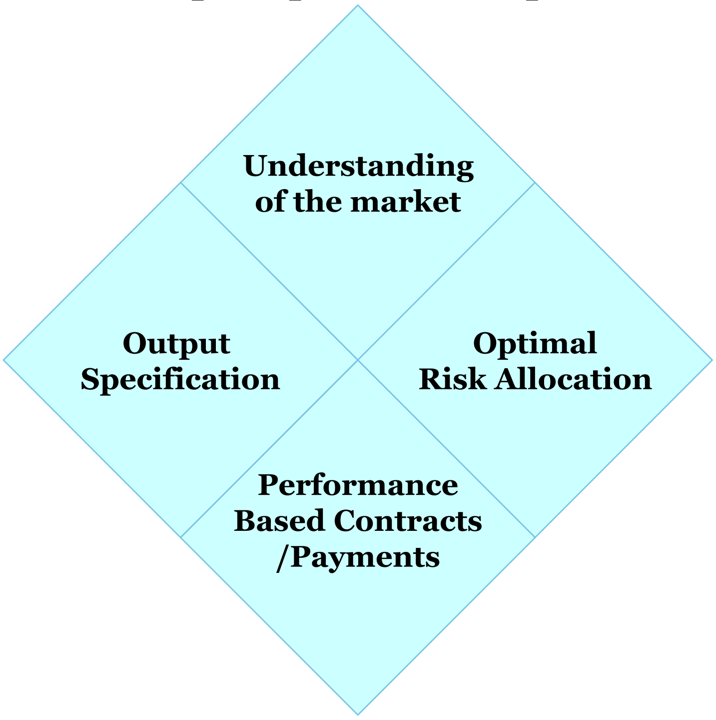
The procurement method is not always purely selected by VFM. Limited availability of public or private funds can be a killing factor for a project implementation under conventional or PPP model. In addition, urgent needs of infrastructure may not be met under PPP model in certain circumstances. Moreover, the capacity to undertake the assessment of appropriate options of procurement is required.

2.3 Basic concept of procurement procedures for infrastructure projects

There are four basic concepts to be considered when planning the procurement of infrastructures, i.e. understanding of the market, principle of output specification, optimal risk allocation and performance based contracts and payments.

By satisfying all four, a competitive environment can be achieved and as a result, a high-quality infrastructure project can be realized.

Figure5.
Basic concept on procurement procedures



(1) Understanding of the market

To have adequate understanding of the market is a key for determining the appropriate procurement method for the subject infrastructure. Market soundings in a way of dialogues and/or hearings with prospective private sector entities at each stage of the project implementation process (stages from planning through final procurement) are encouraged so that real capacities and capabilities as well as deeper understanding of their behaviors that is useful to determine the appropriate procurement method can be gained by the procuring agencies.

It is important to set a fair and transparent environment when conducting dialogues and/or hearings. Such environment will attract and encourage a large number of prospective private sector entities to participate and lead to creating a competitive procurement environment.

(2) Principle of output specification

Output specification which is a standard practice in PPP aims to utilize the private sector's knowhow and promote their innovation. Thus, it is important to leave details of the specification to the private sector's discretion rather than the procuring agency inputting detailed specification, restricting flexibility on the part of the private sector.

(3) Optimal risk allocation

Risks should be allocated between the public and private sector by taking account of the principle of "risk shall be borne by those who can best manage the risk." Sufficient attention should be paid, as excessive risk-bearing by the private sector may lower its motivation to enter into the market and could result in the failure of a project[4].

(4) Building appropriate incentives

Appropriate incentives under a performance based approach should be built to enhance the private sector's motivation to operate the project efficiently. Examples of such incentives include an independent remuneration structure that promotes efforts by the private sector contractor, allows auxiliary projects that provide opportunities for additional revenue sources for the private sector other than public services. As another example to motivate the private sector's participation, a proposal system under which the private sector proposes its own ideas on project implementation is observed in some APEC economies[5]. It is noted that excessive pursuit of profit from business other than the core public service provided by the infrastructure is not desirable from the nature of the infrastructure projects.

2.4 Defining the service level for Infrastructure project

As has been described earlier, infrastructure projects are expected to provide stable and sustainable public services on a long-term to a large number of beneficiaries. Thus, a procuring agency needs to identify the expected outcome, relevant project's service level and quality to be achieved with output specification.

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4 Demand risk, currency risk and land acquisition risk are often considered as major risks of infrastructure projects.

5 Methods including the Swiss Challenge and bonus point methods. Swiss Challenge requires a public authority which has received an unsolicited proposal for a public project to publish the bid and invite third parties to match or exceed it. The key is to consider the appropriate implementation method by paying attention to transparency and fairness.

Defining the service level in this way as a part of the contract can serve to securing efficient implementation of the project. Incorporating a provision that imposes a penalty for failure to meet the service level (e.g. reduction in fees) facilitates the contractors to maintain specified service level and discourage them to terminate the contract without justifiable reason.
The method statements for achieving compliance with the specified service level should also be included in the proposal to be submitted. This will help evaluating the contractor's ability appropriately.

2.5 Importance of appropriate screening

(1) Basic components of screening

Screening is necessary in two stages: the screening of the qualification of prospective proponents; and the screening of the proposals submitted by proponents. Each step can be further broken down into details on a case-by-case basis, but neither can be eliminated from the point of ensuring qualities, in principle.

The screening should always follow a fair and transparent process, based on applicable international rules or standards (e.g. WTO's Agreement on Government Procurement, World Bank procurement guidelines).

(2) Concept of qualification screening

For qualifications (pre-qualification), requirements should be determined for measuring the necessary capacities and track records appropriate to the nature of the project[6]. For the purpose of evaluation, track records should be accompanied by objective evidence. It is also important to require evidence through which actual performance on the proponents' track records can be confirmed rather than just a list of projects undertaken by the bidder. Furthermore, it is useful to adopt official certification or public standard or certification by third party.

However, an overly strict screening process may prevent new entries and ruin other efforts to create a competitive environment, which should be reviewed carefully on a case-by-case basis.

[6] Examples of "nature of the project" may include sector, scale, scope of work etc.

[Sample qualification criteria]

- Track record showing appropriate scale and years elapsed
- Track record indicating past projects implemented on schedule and with quality
- Track record without environmental destructions
- Track record without issues on safety

(3) Concept of proposal evaluation

When evaluating proposals, it is desirable that the evaluation criteria take into account the LCC, service level to be achieved and environment and safety aspects of the quality of infrastructure. In order to perform an appropriate evaluation, these factors should be proposed in line with the project scheme or required technology available so that feasibility can be assessed appropriately. A well-balanced assessment of financial and technical factors is also important (e.g. application of the comprehensive assessment method, combining finance and quality evaluation).

[Example: proposal evaluation criteria on a water treatment plant project]

Qualitative Evaluation (50Points)	1. Durability of building 2. Schedule 3. Flexibility of the process to handle changes in flow rates and water chemistry 4. Flexibility of the Project to manage by-pass events. 5. Expandability of the Plant 6. Ability of the plant to consistently achieve the legislation and Guidelines 7. Financial hedging strategies 8. Recourse, Guarantees during the Work and Operations 9. Recourse, Guarantees and/or insurance for environmental risks 10. Financial Commitments 11. Financing Plans
LCC Evaluation (Risk Adjusted Net Present Value) (50Points)	• LCC have to include Development cost, Operating cost, Capital maintenance cost, etc. • The procuring agency may make adjustments it deems appropriate to reflect risks associated with each Proponent proposal.

2.6 Contract management for Infrastructure project

For an infrastructure project, the procuring agency's task is not complete at the selection of a private contractor. For both the Conventional and PPP Models, the project ownership of the public sector remains important and the public sector must always monitor the execution of the contract.

In order to do so, regular reports from an operator must be fully reviewed and timely instructions need to be provided in order to improve the situation in case any issues arise. Appropriate contract management can be achieved by appropriate reporting requirement and incentives and/or penalties schemes for the contractor.

2.7 Ex-post evaluation

Ex-post evaluation is conducted at the mid-term and the end of the project period from the qualitative perspective, such as LCC, environmental and other impacts, project schedule, and compliance with the service level of the project. This evaluation compares the costs, benefits and other impacts predicted at the planning stage and those of actuals at the evaluation stage and aims at drawing lessons learned and recommendations for more effective and efficient implementation of projects.

The evaluation is undertaken by the procuring agency or the promoting organization.

Section.3 Other initiatives by the procuring agency

3.1 Considerations on financing for the PPP method

(1) Understanding of risks of a project

In general, investors identify risks such as the procuring agency's credit risk, political risk and demand risk when implementing a project through the PPP method. The impact of foreign exchange risk also cannot be ignored when foreign investors participate. It is important to define these risks comprehensively at the outset.

(2) Application of appropriate countermeasures for risks

In order to appropriately implement a PPP project, it is important to gain a comprehensive understanding of these risks and to implement risk mitigation measures, in addition to determining risk allocation to parties that can best control the risk.

Appropriate risk allocation depends on the economic situation of the APEC economies. An economy's policy on how to respond to risks should be determined by referring to the measures taken in other economies to mitigate the impact of risks.

[Finance formulation initiatives]

- A mechanism was established in Indonesia for providing government guarantee to cover government performance risk etc.
- The public sector bears foreign exchange risk in many IPP*1 projects and this can be transferred to users in the form of a hike in power rates.
- Tajikistan's power generation project provides VGF2 (Viability Gap Funding) to secure profitability.

*1: Project that only generates and sells power to electric power companies.

*2: A structure for covering the gap between investment and return. For example, for a project that earns usage fees, if profit cannot be secured by fee alone, compensation will be provided until profitability can be secured.

3.2 Concept of institutional structures for project implementation

(1) Basic concept of the organization structure

In implementing a project, both the skill and amount of required resource for an implementation team at the procuring agency should be examined and well arranged. Expertise required of the team member include profound understanding of technical and business aspects of the project, knowledge on procurement procedures, private financing, contracts and legal matters.

(2) Direction for developing the organization structure

The project implementation team should have a wide range of roles. Establishing a multi-layered institutional framework, including a promoting organization as an apex agency in the economy among other relevant agencies, a specialist team within the procuring agency, and an implementation support system, helps to promote smooth implementation of infrastructure projects. A well-organized promoting organization, such as a PPP center or an inter-agency body that focuses on infrastructure project, are instrumental in strengthening the capacity of government, including formulation of infrastructure development plan, project selection, designing, financing, implementation, supervision and long-term contract management.

[Sample organization structure]
In the UK, an organization in charge was established within the HM Treasury for promoting the PPP. Partnerships UK was also established to support ordering parties. Partnerships UK in turn made an investment to establish 4 Ps (currently reorganized into Local Partnerships) for supporting ordering parties at local governments. At these organizations, experts in the areas of finance, accounting, legal affairs and business have been appointed and seconded from accounting/consulting/law firms and/or financial institutions to provide advice on guidelines and project implementation.

Partnerships UK has since been reorganized as Infrastructure UK now. Infrastructure UK is a unit within the HM Treasury that works on the UK's long-term infrastructure priorities and secures private sector investment. They are responsible for coordinating and simplifying the planning and prioritization of investment in UK and for improving infrastructure.

Appendix (1) Key matters for the power sector

Power supply projects directly contribute to the well-being of lives of people as well as promoting economic activities in the APEC economy, and aim to provide a stable power supply of good quality to meet the demand of the economy.

(1) Importance of technologies and construction management

Mid- to long-term qualities can be maintained and secured at power facilities such as power plants, by ensuring construction and commissioning on schedule and stable operation at the time of commencement and during the operation period.

Power generation projects are one of the infrastructure facilities that greatly impact people's life and economic activities. A delay in power supply caused by a delay in the start of operation, frequent failures or power cuts due to unstable operation will have negative impacts on people's life. This will slow down economic activities, give a bad impression on foreign tourists/investors, and have a negative impact on the economic growth of the economy.

Thus, these circumstances should be avoided by placing priority on mid- to long-term quality. In order to do so, it is necessary for the construction management team to confirm proven records of bidders as well as the proposed system, including whether key equipment had been installed smoothly and on schedule during construction and continued in operation stably in an environment in other economies.

(2) Appropriate operation and maintenance

Same as construction management, maintenance is another key element in the stable operation of facilities. As the operation of power facilities cannot stop, these must be maintained while in operation. From the point of long-lasting assets, facilities should go through inspections systematically for aging and necessary parts should be renewed appropriately.

(3) Factors to be considered in the procurement of power infrastructure

i. Curtailing Life Cycle Cost

Judgments should be made based not only on the initial investment cost of the plant, but also on maintenance cost such as the renewal cost arising from the operation or the deterioration of the plant. In addition, the cost of fuel throughout the project period should be considered for fuel burning power plants, such as coal or gas. Required initial investment is relatively high for plants utilizing new technology with high generating efficiency, but this may possibly be off set with the cost of fuel owing to the efficient consumption rate at such plants when considering total cost required for the entire project period (including maintenance and repair costs).

In such cases, facilities will be procured based on the following:

- Durability (mechanical equipment, measuring instruments such as meters, facilities such as electric cables), e.g. quality will not deteriorate, performance will not decline, lower failure rate, etc.
- Sustainability, such as disaster prevention and earthquake resistant (e.g. power plant, power grid)
- Repair, renewal and long-lasting facilities based on the plan developed by asset management
- Utilization of the latest technology

Also, a delay in the start of operation of the plant may require the use of an alternative power source and lead to an increase in fuel cost. For avoiding such a situation, construction works should be completed according to the original schedule under the contract through effective construction management and delivery control. Thus, confirming past performance records during the qualification screening process becomes an important factor.

ii. Environmental impacts

In order to contribute to a sustainable society, projects are required to apply environmentally-friendly technology as much as possible. If power generation is accompanied by heavy environmental burden, it may cause health hazards and pollution lawsuits through the spread of environmental contamination. By applying technologies with high environmental performance in advance to respond to environmental issues, negative impacts on top priority matters such as people's lives, safety and health, can be avoided. Despite negative images of coal-fired power plants in the past, plants applying newly invented highly efficient technology are capable of reducing the emission of CO_2 and NOx drastically and contribute to easing environmental burden.

iii. Safety assurance

Safety of employees and residents in the neighboring region must be secured when constructing and operating power plants. The accident rate for a power plant's construction, operation and maintenance also should be considered. In the procurement of a power plant, it is important to confirm that there are technologies in place that secure the plant's safety (e.g. control system for stable operation). The training of personnel engaging in appropriate operation and control are also keys to securing safety.

Appendix (2) Key matters for the water and sewage sector

Water is a limited resource on Earth. Furthermore, drinking water is essential for human life. Appropriate use in daily life and domestic activities, maintenance of a sustainable water cycle and securing of appropriate water quality needs to be prioritized. Thus, when detailed project plans for water infrastructure are developed, it is important to take account of possible challenges that might result from urbanization in the mid- to long-term as well as to be in line with a master plan for urban development. Moreover, securing an adequate level of water quality requires appropriate water facilities from the intake to the discharge such as water treatment plants, distribution networks, and pumping stations.

(1) Importance of technologies and construction management

Construction technologies and control are key factors in developing facilities. Mid- to long-term quality can be maintained in water and sewage facilities through appropriate construction technology and management. The same applies to distribution pipelines, and focus should be given on securing water quality, water volume and pressure as well as on the features of the land and fluctuations in demand when developing water distribution networks and sewage pipes. In addition, emphasis should be placed on construction technologies and control for preventing water leakage.

It is for the above reason that construction technology and capabilities should be appropriately assessed.

(2) Appropriate operation and maintenance

In addition, it is indispensable that the facilities developed must be operated, maintained and controlled appropriately and that they are used as lifelines on a long-term. From the point of long-lasting assets, facilities should go through inspections systematically for aging and be renewed appropriately by applying new technologies.

(3) Factors to be considered in the procurement of water and sewage infrastructure

i. Curtailing Life Cycle Cost

Judgments should be made based not only on the initial investment cost of the plant, but also on maintenance cost such as the renewal cost arising from the operation or the deterioration of the plant. In addition, for the water and sewage sector, appropriate technology and facilities should be introduced by considering raw water quality (input) and the required water quality (output).

In such cases, facilities will be procured based on the following:

- Durability (mechanical equipment such as pumps, measuring instruments such as meters, facilities such as water pipes), e.g. quality will not deteriorate, performance will not decline, low failure rate, etc.
- Sustainability, such as disaster prevention and earthquake resistant (e.g. water and sewage treatment plant, distribution pipelines)
- Repair, renewal and long-lasting facilities based on the plan developed by asset management
- Utilization of the latest technologies such as the existing pipe renovation method (e.g. pipeline)
- Utilization of the environmental technology such as the digestion gas generating system

Also, a delay in the commencement of operation of the plant may negatively affect to the life of residents. For avoiding such a situation, construction works should be completed according to the original schedule under the contract through effective construction management and delivery control. Thus, confirming past performance records in construction management during the qualification screening process is important.

ii. Environmental impacts

An economy or region's environmental and water standards must be complied with. From the perspective of long-term environmental burden, it is recommended to apply a treatment method exceeding the prevailing standards, if possible. This will not only lead to the conservation of water resources and contribute in the reduction of treatment cost on the mid- to long-term, but will also reduce social costs required for measures to address epidemics or pollution.

In order to ensure water availability and quality in the long term, an integrated water basin management approach is required. It includes paying particular attention to the cumulative environmental impacts (urban water use, industrial, extractive sector, agriculture, etc) at the water basin level to integrate these considerations in infrastructure design.

In order to contribute to a sustainable society, the latest environmental technologies (e.g. effective use of waste water, gas, heat or hydraulic power generated) should be applied.

iii. Safety assurance

Focus should be placed on water quality, considering the impact on public health for which the establishment of an appropriate monitoring system will be required.

Attention should be paid to control water quality and residual chlorine concentration within the water plant, and to manage these also at the distal end water supply.

A thorough safety control at water and sewage plants is a priority, and the latest monitoring technology should be applied for control.

Safety during construction is another important aspect, and impact on workers and local residents should be sufficiently considered.

Appendix (3) Key matters for the railway sector

As a major public means of transportation, the railway is a method for transporting a large number of residents smoothly and safely. Moreover, the railway is critical for economic growth and expansion due to its role in alleviating traffic congestion and responding to environmental issues in cities with growing population, or as infrastructure that supports the increase in the flow of people and cargo. Thus, it is fundamental that trains are operated on time, safety of users is thoroughly ensured, and operation of mass transportation is always stable.

(1) Importance of technologies and construction management

In order to meet the above mentioned purpose, reliable design and construction technology and control for railway facilities are important. Without appropriate construction, mid- to long-term quality of facilities cannot be achieved. In addition, quality will need to be prioritized in the procurement of rolling stock and signaling system by selecting products with no defect.

(2) Appropriate operation and maintenance

In developing the railway network, not only the maintenance of facilities, but also an operation and maintenance system realized through the appropriate education and training of railway staff are important.
From the point of long-lasting assets, facilities should go through inspections systematically for aging and be renewed appropriately.

(3) Factors to be considered in the procurement of railway infrastructure

i. Curtailing Life Cycle Cost

Judgments should be based on the initial investment cost of rolling stocks, controlling systems, stations, tunnels, elevated bridges and rail, but also on maintenance cost such as utility cost for the operation and renewal cost arising from deterioration.

In such cases, facilities will be procured based on the following:

- Durability (mechanical equipment, traffic signal control system), e.g. quality will not deteriorate, performance will not decline, low failure rate, etc.
- Sustainability, such as disaster prevention and earthquake resistant (e.g. Station, engine terminal, overhead contact line)
- Repair, renewal and long-lasting facilities based on the plan developed by asset management
- Technology such as technologies of prolonged life7 should be applied to repairs and renewals, with an aim to reduce the long-term life cycle cost.

Also, a delay in the commencement of operation of the railway system may negatively affect to the life of residents. For avoiding such a situation, construction works should be completed according to the original schedule under the contract through effective construction management and delivery control. Thus, confirming past performance records of construction management during the qualification screening process is important.

ii. Environmental impacts

In order to contribute to a sustainable society, projects should engage in reducing CO_2 emissions and energy-saving through the effective use of environmental technology when constructing facilities or maintaining rolling stocks. Resource saving throughout the entire railway system, such as energy-saving operation, application of materials that are superior in terms of recycling and introduction of long-lasting technology for parts that need to be replaced regularly, shall be also prioritized in future.

iii. Safety assurance

Securing the safety of users is the top priority. The operation system relating to safety assurance, other control systems, and operating structure should not be judged based on the cost alone, but on whether safety can be sufficiently secured.
When building facilities, a high level of safety should be ensured at the designing and construction phase through appropriate interface of a total system including engineering, and system integration.

In particular, areas and regions where disasters such as an earthquake are likely to occur, sufficient measures will be taken on both the facilities (e.g. antiseismic technology) and

[7] e.g. Preventive maintenance, fiber-reinforced polymer

operation (e.g. BCP/Business Continuous Plan).

Appropriate construction and management technology will be applied to tracks (including maintenance and regular inspections) in mountainous areas. In addition to the tangible aspects, hard infrastructure, human resource development and training are crucial for safety control. The intangible aspects, soft infrastructure, such as technical transfer (knowhow on operation management), inspection and maintenance, manual on repair and staff education are considered as an important factor.