A Study on Smart Communities in the APEC Region

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APERC
Asia Pacific Energy Research Centre

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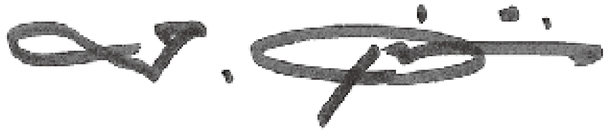
Foreword

Following the Asia-Pacific Economic Cooperation's mission of promoting economic prosperity in a sustainable way, many economies are promoting more efficient energy utilization with advanced technologies including smart technologies in order to reconcile their growing energy needs with lower carbon emissions. This movement presents an opportunity for upgrade their energy infrastructure. This research report reviews smart community projects and backgrounds of economy to identify the expectations and challenges for the related smart technologies in the APEC Region.

This report categorizes respective economies' smart community projects by responsible entities, purpose, focused technologies and so on. The knowhow and technologies, acquired through smart community demonstration projects, should be suited to the regulations and market structures in the respective economies for future continuous penetration and utilisation. The report reviews the market situation and project summary of selected economies to understand the characteristics of the economy and the future penetration potential of element technologies.

This report consists of two main parts. The first part can be read in to acquire an understanding of overviews of smart community projects in the Asia-Pacific region, electricity business in selected economies and prospects of dissemination of element technologies related to smart communities. The second part shows one of the outcomes of demonstration projects for smart grid system integration.

This report is the work of the Asia Pacific Energy Research Centre. It is an independent study, and does not necessarily reflect the view of or policies of the APEC Energy Working Group or individual member economies. Hopefully, this research report will become a cornerstone of the establishment of information exchange and international collaborative activities designed to accelerate smart community development, leveraging APEC's economic and cooperative strengths.



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Executive Summary

In order to promote economic growth with upgrade of infrastructure, APEC economies have expanded demonstration projects of Smart Community which focused on technical and urban development. Many economies have been putting efforts to effectively integrate advanced smart technologies; however, the goals of those projects slightly differ in each economy, because of the various backgrounds of APEC economies. This report firstly reviews the current smart community across the APEC region discussing the perspective smart technologies with consideration on the economic status and energy market structure. Secondly, this report summarises the major results of demonstration projects, which focus on the integration of variable renewables with smart technologies.

A variety of projects is ongoing in the APEC region.

More than 130 smart community-related projects are ongoing in the APEC region (Section1). Our survey shows that China and United States are the leading economies, in terms of the number of demonstration projects followed by Canada and Australia. The overview of the projects across the region also highlights that each economy has slightly different objectives and definitions of 'smart community', mainly due to economy specific status of energy system and energy/environmental policy. In general, matured APEC economies, such as United States and Japan, focus on improving existing energy infrastructure for reliable energy supply, efficient energy use and variable renewables' integration as well as developing and promoting advanced new technologies, while projects in developing economies include green field developments of low-carbon districts.

Smart technologies and knowhow should be suited to the market system in each economy for future continuous penetration.

The electricity business regulations and market situation in major APEC economies vary economy by economy (Section2). The knowhow and technologies acquired through smart community demonstration projects should be suited to the regulations and market structures in the respective economies, for future continuous penetration and utilisation. This report categorises respective economies' smart community projects by responsible entities, purpose, focused technologies and so on (Section3). The information above--electricity market situation and project summary—is useful to understand the characteristics of respective economies and the future penetration potential of element technologies.

Smart Grid System Contributes to Integrating Variable Renewables.

Smart technologies are expected to incorporate the fluctuations of intermittent power output from renewable energy. Some demonstration projects of these technologies including EV and storage shows that participating in the frequency regulation service market using EV storage batteries is technologically feasible (Section4). However, the regulation service market is designed on the premise of using conventional energy sources, such as fossil fuel thermal power and hydropower (including conventional) generation. Therefore, it is necessary to modify the market design to enable participation of storage batteries. The smart grid system integration depends not only on technological development but on the design of the market structures as well as regulations.

1 Overview of the Current Status of Smart Community Demonstration Projects in the APEC Region

The following is an overview of smart community-related demonstration projects being planned or implemented in the APEC region. By identifying the outline of individual projects and challenges for smart communities in individual regions and economies, this report reviews the status of the dissemination of elemental technologies of smart communities for the future and their benefits, including energy-conservation and electricity-saving effects.

This chapter outlines the following representative smart community-related projects in the APEC region.

Table 1-1 Major Smart Community-Related Projects and Policies in the APEC Region

Country	No.of Major Projects	● National Energy Policy ● Smart community related policy, etc
Australia	10	・ Energy White Paper ・ Smart Grid, Smart City Programme
Brunei Darussalam	2	・ RKN 2012-2017 ・ N/A
Canada	11	・ Federal Sustainable Development Act, FSDA ・ Canadian Smart Grid Standards Roadmap
Chile	4	・ National Energy Strategy 2012-2030 ・ N/A
People's Republic of China	16	・ 12th Five-Year Plan (2011-2015) ・ New-Type Urbanization Plan (2014-2020)
Hong Kong, China	3	・ 12th Five-Year Plan (2011-2015) ・ N/A
Indonesia	6	・ National Energy Policy （2014） ・ the Metropolitan Priority Area for Investment and Industry
Japan	6	・ Strategic Energy Plan (2014) ・ the Conference on the Next-generation Energy and Social System
Republic of Korea	5	・ 2nd National Energy Basic Plan (2014) ・ National Smart Grid Roadmap
Malaysia	4	・ Tenth Malaysia Plan (10th MP) ・ N/A
Mexico	4	・ Estrategia Nacional de Energía 2013-2027 ・ National Group for Smart Electricity Networks
New Zealand	7	・ New Zealand Energy Strategy 2011-2021 : NZES ・ Smart Grid Forum
Papua New Guinea	1	・ Development Strategic Plan 2010-2030, DSP 2010-2030 ・ N/A
Peru	5	・ PROPUESTA DE POLITICA ENERGETICA DE ESTADO PERU 2010-2040 ・ N/A
The Philippines	5	・ Philippine Energy Plan: PEP2012-2030 ・ National Renewable Energy Program
Russia	5	・ Energy strategy of Russia up to 2030 ・ N/A
Singapore	3	・ National Energy Policy Report ・ N/A
Chinese Taipei	6	・ Framework of Sustainable Energy Policy (2008) ・ Master Plan of Smart Grid
Thailand	5	・ the 11th National Economic and Social Development Plan ・ Thailand Smart Grid Development
The United States	15	・ N/A ・ American Recovery and Reinvestment Act
Viet Nam	7	・ Power Development Master Plan 7 ・ N/A

Below, we explain the details of the projects and policies in individual economies.

1.1 Australia

(1) Outline of Energy Policy

In 2009, the government of Australia started the Smart Grid, Smart City programme, to which it allocated AUD100 million in budget funds, in order to demonstrate smart grid technologies at the commercial level. Under this programme, relevant parties made investments totalling AUD490 million. This programme was implemented in the 2010–2013 period, and the benefits brought by relevant technologies were analysed. Subsequently, the programme was extended and implemented in the 2013–2014 period. An analysis of the programme's benefits revealed that the introduction of smart metres through cooperation between a consortium led by Ausgrid and relevant companies with the participation of 30,000 households could reduce energy consumption expenditure by as much as AUD28 billion over the next 20 years.[1]

(2) Major Smart Community Projects

A) The Smart Grid, Smart City Programme

- **Time period**: 2010–2014
- **Total budget**: Approximately AUD100 million
- **Project partners**: Ausgrid (one of the three New South Wales electricity distribution entities), IBM Australia, GE Energy Australia, Grid Net, CSIRO, TransGrid, Energy Australia, Landis+Gyr, Sydney Water, Hunter Water, the University of Newcastle, the University of Sydney, Lake Macquarie City Council and the City of Newcastle.
- **Objective and results**: The project evaluates a data communication network, an IT system, monitoring and control technologies on the grid side, the demand-side trend, distributed power sources and storage batteries within the grid, and electric vehicles for the purpose of comprehensively examining smart grids.
- **Technologies**: Battery, automation of power distribution, distributed power supply, IT, reactive power control equipment, smart metre, EV
- **References**:
  - https://ich.smartgridsmartcity.com.au/Main/Final-Report/ARUP_SGSC-Executive-Report-National-Cost-Benefit-A.aspx

B) The Future Grid Research Programme

- **Time period**: 2013–2015
- **Total budget**: Approximately AUD13 million
- **Project partners**: The University of Sydney, CSIRO, the University of Newcastle, the University of Queensland, and the University of New South Wales

[1] https://ich.smartgridsmartcity.com.au/Main/Final-Report/ARUP_SGSC-Executive-Report-National-Cost-Benefit-A

- **Objective and results**: The project evaluates system stability, grid plans, optimisation of electricity and gas usage, economic benefits and costs of network building, and political techniques and regulations intended to promote a shift to low carbon usage for the purpose of studying the development and optimisation of grids from the technological, economic and political viewpoints.
- **Technologies**: Battery, EMS, PV, etc.
- **References**:
  - http://www.futuregrid.org.au/

C) King Island Renewable Energy Integration Project

- **Time period**: 2010–2014
- **Total budget**: Approximately AUD18 million
- **Project partners**: Hydro Tasmania
- **Objective and results**: The project is expanding the use of renewable energy in order to reduce dependence on diesel fuels and is cutting greenhouse gas emissions for the purpose of integrating renewable energy sources on King Island. The project aims to develop a world-leading power system on King Island. KIREIP will result in the use of renewable energy for over 65% of the island's energy needs, and will reduce CO_2 emissions by more than 95%. The unique part of this system is the integration of technologies. Although the renewable generation sources are mature (wind, solar, bio diesel), the enabling and storage technologies are new and emerging, and the method by which these technologies are being used and integrated is world leading.
- **Technologies**: Power station upgrade, biodiesel trial, energy storage, wind energy, diesel–UPS flywheel system, smart grid
- **References**:
  - http://www.kingislandrenewableenergy.com.au/
  - http://www.smartgridimpact.com/index_download.html#map

D) Alice Solar City

- **Time period**: 2008–2013
- **Total budget**: Approximately AUD42 million
- **Project partners**: Power and Water Corporation, Northern Territory Government (NTG), Arid Lands, Environment Centre (ALEC), Northern Territory Chamber of Commerce and Industry (NTCCI), and Tangentyere Council
- **Objective and results**: The project analyses the effects of pricing that reflects costs associated with the introduction of technologies related to PV power generation, energy

efficiency and smart metres.

- **Technologies**: PV, smart metre, solar thermal water heater
- **References**:
  - http://www.alicesolarcity.com.au/research-and-reports
  - http://www.smartgridimpact.com/index_download.html#map

E) Townsville Queensland Solar City

- **Time period**: 2009–2013 (Ongoing)
- **Total budget**: Approximately AUD15 million (including AUD5 million from the Queensland Government through the Department of Mines and Energy)
- **Project partners**: Australian Government
- **Objective and results**: The Townsville Queensland Solar City project is part of the Australian Government's leading-edge Solar Cities programme. The project conducts trials for a range of initiatives that aim to reduce wasteful energy usage, increase solar energy usage and cut greenhouse gas emissions by more than 50,000 tonnes. One of the trials is the installation of 2,500 electricity smart metres for homes and businesses.
- **Technologies**: Smart metre, PV
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.townsvillesolarcity.com.au/

F) Synergy Advanced Metering Proof

- **Time period**: 2009
- **Total budget**: Approximately AUD4.5 million
- **Project partners**:
- **Objective and results**: The Thornlie and Canning Vale Advanced Metering Proof of Concept study involved an investigation and behavioural trial of advanced metring solutions as a means of helping customers manage their electricity consumption habits. The study aims to revolutionise the way households consume energy and monitor their energy use. The study included multiple channels of communicating with customers including through an in-home display, an interactive website, email and SMS to encourage behavioural change.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.parliament.wa.gov.au/parliament/pquest.nsf/3b051e205914713c4825718e00186cc2/5254ce49ba21f25fc8257674002955a3?OpenDocument

G) Country Energy Intelligent Network

- **Time period**: From 2008 (Ongoing)
- **Total budget**: N/A
- **Project partners**: around 10,000 customers in regional New South Wales
- **Objective and results**: The Intelligent Utility Network is a digital, open standards-based network of sensors, metring, communications, computer processors, and analytics which connects an entire utility company – from power plant to plug. These connected systems provide a utility with near real-time data and information to better manage the grid infrastructure, enabling fewer and shorter power outages, improved customer service, and the ability to source and deliver power more efficiently, including renewable energy. Country Energy is demonstrating day-to-day intelligent network applications for around 10,000 customers in regional New South Wales.
- **Technologies**: Smart metre, EMS
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.computerworld.com.au/article/212861/country_energy_set_deploy_australia_first_intelligent_utility_network/

H) Blacktown Solar City

- **Time period**: 2007–2013
- **Total budget**: AUD37 million
- **Project partners**: Blacktown local government
- **Objective and results**: The Blacktown Solar City project focused on giving residents and businesses in the Blacktown local government area the education and tools they need to use energy more wisely and reduce energy consumption and associated emissions. By employing solar power, smart metres, energy efficiency and new approaches to electricity pricing and financing, this project provided cost effective energy solutions and reduced greenhouse gas emissions. It also provided valuable information that has the potential to help shape future energy markets and policy across different levels of government.
- **Technologies**: PV, smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.endeavourenergy.com.au/wps/wcm/connect/EE/NSW/NSW+Homepage/communityNav/Supporting+the+community/Blacktown+Solar+City

I) Adelaide Solar City

- **Time period**: 2007–2013
- **Total budget**: AUD3.9 million over three years
- **Project partners**: Australian Government, customers in the cities of Salisbury, Tea Tree Gully, Playford and Adelaide
- **Objective and results**: The programme combines solar power, smart metring, energy efficiency and cost reflective pricing to conduct a trial of a range of innovative energy solutions. It is being executed in the cities of Salisbury, Tea Tree Gully, Playford and Adelaide as part of the Australian Government's AUD94 million Solar Cities programme.
- **Technologies**: PV, smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.metropolis.net.au/metropolis/About-Metropolis/projects/ASC.html

J) Victoria Smart Meter Roll-out

- **Time period**: 2009–2013
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: In Victoria, the main objectives of the deployment of smart metres are to improve the information management and to give clients the tools necessary to reduce their electricity consumption.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - https://www.ewov.com.au/publications-and-media/news-hot-topics/hot-topic-archive/end-of-the-smart-meter-rollout

Under smart community-related projects in Australia, the central government plays the leading role in implementing various programmes. A broad range of initiatives, mainly technologically high-level initiatives using smart metres and ICT, are being implemented from the viewpoint of urban development, development on islands and enhancement of grids. In particular, the projects in Australia are promoting initiatives intended to improve energy efficiency, with a view to reducing energy expenditure.

(3) References

- https://ich.smartgridsmartcity.com.au/
- Ausgrid (2014), “Smart Grid, Smart City: Shaping Australia’s Energy Future”

1.2 Brunei

(1) Outline of Energy Policy

Brunei enjoys a stable economy and a high level of income due to the production of abundant amounts of oil and natural gas. It also owns and manages huge amounts of overseas assets. On the other hand, in order to move its economy away from excessive dependence on energy resources, the economy has aimed to achieve economic diversification under successive five-year national development plans.

In January 2008, the government of Brunei launched a long-term national vision called "Wawasan Brunei 35[2]." In order to realise this vision, in April 2012, the government of Brunei launched the 10th National Development Plan (RKN 2012–2017), which covered the five years from 2012. Based on this plan, the government allocated BND6.5 billion in budget funds to 682 projects. The 10th National Development Plan centres on (a) education, (b) quality of life, (c) improvement of the business environment, (d) development of the private sector, (e) good governance and (f) sustainable infrastructure.

Aside from the oil and natural gas industries, there are no large-scale industries or companies in Brunei, so recipients of the benefits of smart communities are limited to the non-industrial sector, mainly ordinary households. Therefore, smart community-related policies focus on studies on how to use renewable energy in that sector.

(2) Major Smart Community Projects

A) Demonstration Project for Solar Photovoltaic Power Generation

- **Time period**: 2008–2013 (Completion and start of operation of the facilities are scheduled for 2010; a demonstration test will be conducted for three years thereafter.)
- **Total budget**: JPY1.5 billion (borne fully by Mitsubishi Corporation)
- **Project partners**: Mitsubishi Corporation, the government of Brunei
- **Objective and results**: Mitsubishi Corporation conducted a demonstration test and operational evaluation, including comparison of multiple solar cell modules under the weather conditions of Brunei, for three years from 2010 in cooperation with the Energy Department under the Prime Minister's Office of Brunei and the Department of Electrical Services. Data and knowhow concerning the operation and maintenance of power generation facilities and human resource development acquired through this demonstration test will be used for future dissemination and practical use of PV power generation.
- **Technologies**: PV
- **References**: http://www.mitsubishicorp.com/jp/ja/ir/ar/2013/operations/energy/project.html

[2] http://www.bedb.com.bn/why_wawasan2035.html

B) **UBD | IBM Centre Demonstration Project**

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: UBD (Universiti Brunei Darussalam), IBM
- **Objective and results**: Six projects – Consumer and Grid Friendly Homes, Crop Modeling, Economic Dispatch, Green Community Project, Solar PV Performance Modeling, Short Term Wind Energy Forecast – are now being implemented.
- **Technologies**: PV, wind, biomass, EMS, pico smart grid system (PSGS), etc.
- **References**:
  http://202.93.211.141/current-projects.html

Smart community projects in Brunei focus on the use of renewable energy. Recently, Brunei government officials have been actively participating in international seminars related to smart communities. Through such activities, Brunei is expected to study the introduction of smart communities as part of urban infrastructure development with reference to successful cases of such activities in neighbouring Asian economies by taking advantage of its strong domestic finances. It is expected to promote smart communities for the convenience of residents using AEMS, HEMS, EV, etc.

(3) References

- http://www.asahi.com/eco/TKY200808130424.html

1.3 Canada

(1) Outline of Energy Policy

The energy policy of the federal government of Canada is based on three basic principles: (1) being market-oriented, (2) attaching importance to the judicial powers and the role of provincial governments and (3) intervening in the market process as necessary. In particular, the federal government’s energy policy has placed emphasis on sustainable development in recent years. On the other hand, specific measures are determined by provincial governments and municipalities. In addition, as Canada has vast areas of land, one notable feature of the economy is the strong need for storage of electricity and heat in regions remote from metropolitan areas and so there is high interest in micro-grids. The Smart Grids Standards Advisory Committee (SGSAC), which is co-chaired by the Standards Council of Canada and the Canadian Electricity Association Federal Energy Regulatory Commission, is responsible for giving strategic advice, providing information and issuing instructions for the implementation of the Canadian Smart Grid Standards Roadmap[3].

[3] http://www.scc.ca/en/about-scc/publications/roadmaps/canadian-smart-grid-standards-roadmap

Among provincial governments, Ontario Province is highly interested in the dissemination of renewable energy, and thus is concurrently promoting the introduction of smart metres and the establishment of smart grids.

(2) Major Smart Community Projects

A) Ontario's Smart Metering Initiative

- **Time period**: 2004–2011
- **Total budget**: CAD1 billion
- **Project partners**: DOE, OEB (Ontario Energy Board), IESO (Independent Electricity System Operator), Canadian Niagara Power, ENWIN Utilities, London Hydro SAP
- **Objective and results**: The project was intended to introduce smart metres into all households and small and medium-size enterprises in Ontario Province. It aimed to introduce 4.5 million smart metres by the end of 2011, as well as the introduction of electricity pricing by time zone. It also aimed to renew an aged power transmission and distribution network and to build a smart grid to introduce renewable energy and reduce energy consumption.
- **Technologies**: Smart metre, AMI, MDM, etc.
- **References**:
  - http://www.energy.gov.on.ca/en/archive/annual-report-results-based-plan-2010-2011/
  - http://www.ieso.ca/Pages/Ontario's-Power-System/Smart-Grid/Ontario's-Smart-Metering-Network.aspx
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

B) Drake Landing Solar Community (DLSC)

- **Time period**: From 2007
- **Total budget**: USD5.50 million
- **Project partners**: CANMET Energy SAIC Canada, United Communities, Sterling Homes Ltd, ATCO Gas, Town of Okotoks, Climate Change Division, Atlantic Region, Environment Canada, IFTech International, Enermodal Engineering Ltd, Bodycote Materials Testing Canada Inc, EnerWorks Inc, Nu, Sunbow Consulting Ltd, Hurst Construction Management Inc, Howell-Mayhew Engineering Inc
- **Objective and results**: DLSC is heated by a district system designed to store abundant solar energy underground during the summer period and distribute the energy to each home for space heating needs during winter period.
  - Establishing the largest subdivision of R-2000 single-family homes in Canada, each being 30% more efficient than conventional housing
  - Fulfilling 90% of each home’s space heating requirements from solar energy thus

reducing dependency on fossil fuels

- **References**
  - ➢ http://www.dlsc.ca/about.htm

C) Smart Metering Programme

- **Time period**: 2011–2014
- **Total budget**: CAD930 million
- **Project partners**: BC Hydro, the government of British Columbia Province, Corix Utilities, Capgemini, SAP, Bit Stew Systems, Clevest Solutions
- **Objective and results**: The project aimed to introduce 1.8 million smart metres to replace older ones by the end of 2012. After the introduction of metres, the project intended to develop applications for general households. The renewal of ageing power generation, transmission and distribution systems and the use of metre information were also under consideration.
- **Technologies**: Smart metre, development of applications
- **References**:
  - ➢ http://www.bchydro.com/energy-in-bc/projects/smart_metering_infrastructure_program.html
  - ➢ http://www.smartgridimpact.com/index_download.html#map

D) Hydrogen Assisted Renewable Power

- **Time period**: 2009–2010
- **Total budget**: N/A
- **Project partners**: BC Hydro, General Electric (GE) and Powertech, Sustainable Development Technology Canada (SDTC)
- **Objective and results**: The programme aimed to produce hydrogen and store energy by using hydropower and to reduce the fuel consumption of diesel power generators by utilising a micro-grid system using fuel cells. It will reduce Bella Coola's annual diesel consumption by 200,000 litres -- lowering greenhouse gas emissions by 600 tonnes annually --, and provide storage for run-of-river power, so the electricity can be used when the community needs it most.
- **Technologies**: Micro grid system, hydrogen, FC, storage
- **References**:
  - ➢ https://www.bchydro.com/news/press_centre/news_releases/2009/bella_coola_ghg_reduction.html

E) Installation of Next-generation Meters

- **Time period**: 2011–2017
- **Total budget**: USD100 million
- **Project partners**: Hydro Quebec, the government of Quebec Province, Landis-Gyr, SAP
- **Objective and results**: The project aims to introduce 3.9 million smart metres by the end of 2017. In line with the introduction of AMI, Hydro Quebec will build a data management system. The project will promote the replacement of ageing electricity metres and the dissemination of smart metres.
- **Technologies**: AMI
- **References**:
  - http://www.hydroquebec.com/residential/customer-services/next-generation-meters/

F) Hydro One Smart Meter Rollout

- **Time period**: 2006–2010
- **Total budget**: $112 million[4]
- **Project partners**: Hydro One
- **Objective and results**: After successfully completing the pilot project and incorporating lessons learned, Hydro One staff began the work of safely and efficiently deploying AMI infrastructure across the province. The project's total target is to install 1.3 million metres, and currently over 1.2 million metres are installed. Hydro One and its project partners are not just planning for the smart network of the future, they are developing it today through a series of smart grid initiatives. These initiatives are employing numerous smart network and smart home technologies enabled by an integrated combination of standards-based mesh radio and state-of-the-art WiMax wireless technology, including: distribution station and security monitoring; mobile work dispatch and accomplishment reporting; automated vehicle location safety monitoring; emergency management vehicle communications; time-of-use rate pilot project in combination with real-time energy monitors; automated two-way communicating home thermostats; and in-home two-way real-time energy monitors.
- **Technologies**: AMI infrastructure, communication and transport infrastructure development
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - ISGAN, Smart Grid Project Catalogue Part 1, by project main application, 2013

[4] Note that the references report the budget of the project in '$', but do not specify whether it is USD, CAD or other currency.

G) EPCOR

- **Time period**: 2009–2011
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: Three DA (Distribution Automation) circuits were installed in 2009. Work on four new DA circuits started in 2010, to be completed in 2011. An additional six DA circuits are planned for installation in 2011 as EPCOR continues to work to improve reliability on behalf of customers. EPCOR has a total of 284 circuits but many of them may not be suitable for DA, such as underground circuits that are not subject to lightning strikes or falling trees. DA is designed to minimise outages and lead to quicker identification of faulted areas and faster repairs. In the event of a failure in the grid, DA can identify and isolate the failure, restoring power to most customers within one minute. This permits crews to work at locations where there may be actual damages, such as downed wires or a blown transformer that suffered a lightning strike.
- **Technologies**: DA circuits
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://corp.epcor.com/about/Documents/EPCOR-Corporate-Responsibility-Report-2009.pdf

H) Toronto Hydro Smart Meter Rollout

- **Time period**: 2005–2012
- **Total budget**: CAD900 million (EUR697 million)
- **Project partners**: N/A
- **Objective and results**: Toronto Hydro used eMeter's Energy IP to enable them to accomplish a full-scale rollout of Advanced Meter Infrastructure (AMI) and smart metres to enable TOU pricing, with simultaneous upgrading of existing related infrastructure with limited customer complaints or inquiries. Toronto Hydro deployed Energy IP in 2008 to serve as an Operational Data Store (ODS) to handle the data from the AMI system, provide a virtualised interface to the centralised MDM/R, and to perform customer presentment data management and demand response programme management. The value of the benefits of the smart metre rollout was calculated by Constellation Consulting at about CAD1.25 billion (EUR1.16 billion) assuming the successful introduction of Time of Use (ToU) rates and full consumer engagement. The estimated implementation costs for the smart metring rollout is approximately CAD900 million (EUR697 million).
- **Technologies**: eMeter, AMI

- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.ey.com/Publication/vwLUAssets/Utilities_Unbundled_8_May_2010/$FILE/Utilities_unbundled_8_May_2010.pdf

I) GridSmartCity (Burlington, Ontario)

- **Time period**: From 2009 (Ongoing)
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: GridSmartCity™ by Burlington Hydro integrates electricity production, delivery and consumption to produce a more efficient, reliable and responsive system with a lower environmental footprint. The Smart Grid uses sensors and monitors and combines them with advanced communications and computer analytics to improve the ability to incorporate renewable power generation from the sun and wind and new technologies such as electric vehicles. It also uses smart metres, time differentiated prices and in-home energy management devices to help consumers to better understand their electricity use and enable them to control usage to manage electricity cost.
- **Technologies**: EV, PV, smart metre, wind power generation
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - https://www.burlingtonhydro.com/your-community/projects.html

J) PowerShift Atlantic

- **Time period**: N/A
- **Total budget**: $32 million[5]
- **Project partners**: New Brunswick Power
- **Objective and results**: The impact of the virtual power plant (VPP) solution is assessed by comparing the differences in generation utilisation and the associated production costs by evaluating the system with, and without, the VPP. This will be used to determine: peak reduction, additional RES hosting power in the grid/maximum power load and estimated reduction of CO_2.
- **Technologies**: Aggregation (demand response, VPP), smart network management, integration of DER, integration of large-scale RES
- **References**: ISGAN, Smart Grid Project Catalogue Part 1, by project main application, 2013

[5] Note that the reference reports the budget in '$', but does not specify whether it is USD, CAD or other currency.

K) Zone de Réseau Interatif

- **Time period**: N/A
- **Total budget**: $25.6 million[6]
- **Project partners**: Hydro-Québec Distribution, Mitsubishi Motors
- **Objective and results**: The agreement between Hydro-Québec and Mitsubishi calls for testing of up to 30 all-electric iMiEV type vehicles. The goal of the project is to better understand charging and driving behaviours, as well as charging infrastructure needs at 120 V/15A, 240V/15–30A, and direct current charging (50kW).
- **Technologies**: Electric vehicles and Vehicle2Grid applications, smart metre
- **References**: ISGAN, Smart Grid Project Catalogue Part 1, by project main application, 2013

Smart community-related projects in Canada are mainly led by provincial governments, aiming to promote the introduction of smart metres accompanying the modification of ageing facilities and to make use of metre information. Canada has vast areas of land, so it is difficult to develop economy-wide infrastructure. As a result, one notable feature of the Canadian projects is the utilisation of micro-grids as autonomous energy systems in remote regions in particular.

(3) References

- http://cleantech.nikkeibp.co.jp/report/smartcity2012/
- http://www.iea-isgan.org/

1.4 Chile

(1) Outline of Energy Policy

The Energy Ministry announced a new energy policy called "National Energy Strategy 2012–2030" in February 2012. The six pillars of the strategy are: improvement of energy efficiency, promotion of introduction of non-conventional renewable energy sources, roles of traditional renewable energy sources, strengthening of domestic transmission systems, enhancement of competitiveness and diverse and sustainable development. Relevant items under the new energy policy are as follows, which include "Facilitating Connection for Small Generators and Intelligent Networks" related to smart communities.

- Enhancement of transmission systems[7]
  - Speeding-up of procedures for granting electricity concessions
  - Creation of utility corridors – regulatory reform

[6] See footnote5.
[7] http://kallman.com/shows/iftenergy_2012/pdfs/Energy-for-the-Future-Chile's-National-Energy-Strategy-2012-2030-English.pdf

        - Deregulation related to transmission systems and transformer substations
        - Facilitating connection for small generators and intelligent networks
    - Promotion of competition
        - Creation of independent electricity system operation centres that will replace the existing economic load dispatch centres
        - Ensuring secure and economical distribution of electricity
        - Promotion of renewable energy power generation by households – net metring
- International transmission systems
    - Participation in a project implemented by Colombia to connect transmission systems with those of central and South American economies (Peru, Bolivia and Ecuador)

(2) Major Smart Community Projects

A) Santiago District Smart City Development

- **Time period**: 2012–2020
- **Total budget**: USD40 million
- **Project partners**: The government of Chile
- **Objective and results**: 1) Co-design of technology solutions to improve local and municipal services; 2) Co-creation of a roadmap for scaling up the adoption of technology solutions to support local and municipal services; 3) Co-creation competition (i.e., open challenge) with local stakeholders (e.g., universities, enterprises, civil society, local and municipal government) to develop technology solutions for local and municipal services, and 4) Co-creation of a strategic plan for the development of a local technology-innovation lab for local and municipal services with the ecosystem

- **Technologies**: Adoption of LED lighting, HEMS, traffic control system, smart metre
- **References**: http://cityminded.org/santiago-chile-ingredients-smart-city-10307

B) Huatacondo District Micro Grid Development

- **Time period**: N/A
- **Total budget**: CLP300 million
- **Project partners**: Centro De Energia (an organisation within the University of Chile)
- **Objective and results**: The project introduces renewable energy into micro grids.
    - Benefits:
        - PV: 22.68kW + 1kW
        - Wind: 3kW
        - Storage battery: 30kVA

- ✧ Renewable energy accounts for 75% of the energy provided in the project area.
- ✧ Diesel fuel consumption is reduced by 50%.

- **Technologies**: PV, wind, lead-acid storage battery
- **References**: http://www.centroenergia.cl/ce-fcfm/?page_id=1004

C) Introduction of PV Power Generation into Educational Facilities in the El Romeral Region

- **Time period**: 2012
- **Total budget**: N/A
- **Project partners**: Centro De Energia (an organisation within the University of Chile)
- **Objective and results**: The project aimed to introduce PV power generation into educational facilities in regions unconnected to grids.
  - ➢ Benefits:
    - ✧ Introduction of 14 PV modules (3.2kW)
    - ✧ Lead-acid battery (640Ah)
    - ✧ Backup diesel (3.2kW)
- **Technologies**: PV, lead-acid storage battery
- **References**: http://www.centroenergia.cl/ce-fcfm/?page_id=1922

D) "Smart City Gran Concepcion" Activity

- **Time period**: 2014
- **Total budget**: N/A
- **Project partners**: World Bank (ICT Unit),
- The government of Chile (MTT)
- **Objective and results**: The project aims to develop and operate a workshop package with a view to smart city development.
  - ➢ To achieve two goals: (A) to improve local and municipal service delivery by introducing open innovation and ICT tools; and (B) to lay the framework for the development of a local and sustainable innovation ecosystem in Gran Concepcion.
- **Technologies**: Workshops and discussions incorporating the design thinking technique
- **References**: http://blogs.worldbank.org/ic4d/smart-city-gran-concepcion-activity-launched-chile

In 2014, a study council on the introduction of technologies necessary for promoting smart cities and services in future was established under the leadership of the government of Chile, Chilean telecommunications companies and international banks. Currently, a project intended to disseminate renewable energy is ongoing. In the future, demonstration and full-fledged dissemination of comprehensive, advanced smart communities, including renewable energy usage, may be promoted.

(3) References

- Gobierno de Chile, "National Energy Strategy 2012–2030"

1.5 People's Republic of China

(1) Outline of Energy Policy

The Xi government of the People's Republic of China has set forth a "new-type urbanisation" policy and has announced that it will develop infrastructure, including energy, IT communications and traffic systems, and will concurrently reform social systems, including the social security system and the family registration system, in order to promote green and smart new-type urbanisation. In March 2014, the government of China announced the New-Type Urbanisation Plan (2014–2020), advocating the goal of raising the proportion of residents in urban areas to 60% (the current proportion is approximately 53.7%) by having around 100 million people with rural family registration settle permanently in urban areas by 2020.

Land, urban and real estate development is also an important element of smart community development in China, and names like "low-carbon cities," "green cities," "green communities" and "smart cities" are widely used. Almost at the same time as the start of implementation in 2010 of the 12th Five-Year Plan (2011–2015), five provinces and eight cities across the economy were selected for implementation of low-carbon model city projects under the leadership of the National Development and Reform Commission of China. In March 2012, the Ministry of Science and Technology announced the 12th five-year plan for smart grid development, presenting goals and specific measures regarding important elements of the smart grid such as grid paralleling and storage technologies related to renewable energy, long-distance power transmission technology, technology related to automation of power distribution and micro-grids, and smart metres and application technologies. Subsequently, under the leadership of the National Development and Reform Commission and central government ministries and agencies, such as the Ministry of Housing and Urban-Rural Construction, the scope of demonstration was expanded through such programmes as low-carbon model cities, low-carbon model communities and smart model cities, and the standard for evaluating low-carbon model cities and smart cities is being established.

Encouraged by the central government's policy, regional governments formulated urban development plans including low-carbon city and eco-city plans one after another, resulting in the creation of too many such plans. While the central government is preventing uncontrolled development of low-carbon cities and smart cities by regional governments, the New-type Urbanisation Plan (2014–2020), announced in 2013, set forth the policy of promoting such cities.

Therefore, in the future, the construction of low-carbon cities and smart cities is expected to proceed further in China. The low-carbon model community programme being implemented by the National Development and Reform Commission aims to build some model communities by the end of 2020 by selecting 1,000 places nationwide as low-carbon models.

As there are a very large number of smart community-related demonstration projects in China, major projects in terms of the total budget are described below.

(2) Major Smart Community Projects

A) Caofeidian International Eco-city

- **Time period**: Short term (2008–2010), medium term (2011–2020), long term (2020 and beyond)
- **Total budget**: Total investment budget of approximately CNY5 trillion
- **Project partners**: SWECO of Sweden (urban development plan), Caofeidian International Eco-city Investment Co Ltd, Caofeidian Jiaxiang Real Estate, Beijing Golden Tech, Nomura Research Institute, Nikken Sekkei, Daiwa House Industry, Sharp
- **Objective and results**: The project aims to build a Japan-China cooperation community in the project area and to encourage Japanese companies to set up operations there. Currently, Japanese companies such as Nomura Research Institute (development strategy), Nikken Sekkei (planning), Daiwa House Industry (real estate development) and Sharp (HEMS) are participating in the eco-city development project. The project aims to achieve an energy saving rate of 65% for newly-built houses and 50% for public buildings; build city-wide networks of pedestrian and cycling roads; meet more than 60% of the annual hot water demand with solar thermal water heaters; and achieve a 100% utilisation rate of renewable energy including wind and PV power generation, solar thermal and geothermal heat.
- **Technologies**: HEMS, water treatment and usage, traffic control system, wind power generation, PV
- **References**:
  - http://en.tswstc.gov.cn/
  - http://www3.ntu.edu.sg/TCTforum/ppt/DrLinPeng.pdf

B) Sino-Singapore Guangzhou Knowledge City

- **Time period**: until 2030
- **Total budget**: Approximately CNY18 billion
- **Project partners**: Sino-Singapore Guangzhou Knowledge City Investment and Development Co Ltd (joint venture of the government of Guangzhou City and SingBridge International

Singapore), Sino-Singapore Guangzhou Knowledge City Investment and Development Co Ltd, SingBridge International Singapore, Ascendas of Singapore, Hitachi Ltd (energy management, renewable energy, IT platform, provision of solutions in such fields as next-generation transportation), ABB of Switzerland, Siemens of Germany and Philips of the Netherlands

- **Objective and results**: Sino-Singapore Guangzhou Knowledge City is a city being co-developed by the governments of China and Singapore. It aims to create a centre of advanced manufacturing and services industries by introducing and using ITC technologies and attracting personnel in the high-technology field and make it an environment-friendly city by introducing renewable energy and green buildings.
- **Technologies**: ICT, EV, environment-friendly town design, geothermal, bio gas, PV, micro-hydropower, CHP, public transport system, green buildings
- **References**: http://www.ssgkc.com/

C) Yujiapu Financial District

- **Time period**: 2010–2020
- **Total budget**: N/A
- **Project partners**: The city government of Tianjin, Tianjin Innovative Financial Investment Company, SOM of the United States, Nikken Sekkei, Honeywell of the United States, etc.
- **Objective and results**: This project, which is the first low-carbon model city project in the Asia-Pacific Economic Cooperation (APEC) region, aims to create a low-carbon central business district (CBD). Its goal is reducing CO_2 emissions by 30% by 2030 compared with 2010. Deployment of an energy efficiency steward by Yujiapu Innovative Service Center Co Ltd saves a monthly average of 50,000kWh, and results in a monthly average of 50 tons less carbon, and a monthly energy cost of over CNY40,000, with an average energy-saving rate of 23.4%. Planned deployment of a regional-grade energy efficiency steward at Yujiapu will help reduce the energy consumption of relevant architectural structures by more than 20%.
- **Technologies**: EV, green buildings, recycling, renewable energy, transport systems, IGCC
- **References**:
  - http://www.tifi.com.cn/
  - http://apecenergy.tier.org.tw/database/db/ewg47/3/1_Yujiapu_Financial_District_Low_Carbon_Town_Index_System.pdf

D) Shanghai Pudong New Area

- **Time period**: Until 2015 (during the 12th Five-Year Plan)
- **Total budget**: Investments totalling CNY30 billion are planned (90% of which will be

private capital)

- **Project partners**: The Economic and Information Commission of the Pudong New Area Economic, Pudong Station of Shanghai branch of China Telecom, Shanghai Pudong Development Bank, Xuntu Digital, Shanghai E&P International, etc.
- **Objective and results**: The project aims to check and monitor energy consumption at 366 major public buildings by using the Internet of Things (IoT) and industrial IoT. It will build a smart public transport system that provides real-time traffic information to residents. Smart medicine will promote a shift to electronic medical data (2.38 million cases have already been shifted to electronic data) and expand the introduction of electronic services, including automated reception, automated accounting and automated report printing, at hospitals. An e-government system will be introduced in order to reduce the time spent on administrative procedures.
- **Technologies**: Smart transportation, vehicle-to-vehicle communication network cloud computing
- **References**: http://www.spc.jst.go.jp/news/120205/topic_1_05.html

E) Smart Community Demonstration Test in Gongqingcheng City, Jiangsu Province

- **Time period**: Fiscal 2011–2013 (preliminary survey period was until the end of November 2011)
- **Total budget**: Preliminary survey: approximately CNY30 million; demonstration project: approximately CNY3 billion (The budgets for the preliminary survey and the project itself may vary depending on the budget status.)
- **Project partners**: Toshiba Corporation, Toshiba Solutions Corporation, Toshiba (China) Co Ltd, Smart Communications Inc, Itochu Corporation, Itochu (China) Holding Co Ltd, NTT DoCoMo
- **Objective and results**: The project aimed to establish an advanced smart community model for small and medium-size cities.
- **Technologies**: PV, charging infrastructure system, storage battery

F) Jinzhou City Smart Community Project

- **Time period**: 2012–2015
- **Total budget**: N/A
- **Project partners**: Toshiba Corporation
- **Objective and results**: The project aims to promote a model city for use of new energy sources, energy conservation and environmental preservation.
- **Technologies**: BEMS

- **References**: http://www.kankyo-business.jp/news/002746.php

G) Yangzhou Smart Grid Demonstration

- **Time period**: 2010–2012
- **Total budget**: USD2 billion
- **Project partners**: GE
- **Objective and results**: The project aims to disseminate technologies across China as in other economies by presenting a model case of city development to the economy.
- **Technologies**: Next-generation smart grid and railway, and provision of financial services using IT
- **References**:

http://www.elp.com/articles/2010/04/ge-opens-yangzhou-smart-grid-demonstration-center-in-china.html

H) Sanxiang Intelligent Substation

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: CSG (China South Powergrid)
- **Objective and results**: Wide-area information monitoring and control; a multi HVDC coordinating and control system developed by CSG has also been put into operation.
- **Technologies**: Grid management system
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - Yanshan Yu et al., The Smart Grids in China—A Review, Energies 2012, 5, 1321–1338; doi:10.3390/en5051321

I) Smart Grid in Shanghai World Expo

- **Time period**: 2010
- **Total budget**: N/A
- **Project partners**: Government of China
- **Objective and results**: Shanghai World Expo was the first official presentation of the "low carbon" concept Expo. There was a large-scale implementation of solar energy, new energy vehicles, smart grid, and an LED lighting demonstration. The Smart Grid Demonstration Project was located in the World Expo Park. A 110kV intelligent substation in B1 of the State Grid Pavilion supplied electric power for the whole Park. With a low-carbon and green concept, this substation used a ground source heat pump, heat collection, ice storage and

other new technologies* to achieve energy recycling. The entire demonstration zone included nine model projects and four demo projects.

- **Technologies**: Heat pump, heat collection, ice storage
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - https://www.sgiclearinghouse.org/Asia?q=node/2547&lb=1

J) Power Information Collection System

- **Time period**: 1990s
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: Pilot construction of power information collection system encompassing loading management and metre reading technologies*
- ***Technologies**: Smart metre
- **References**: http://www.smartgridimpact.com/index_download.html#map

K) Distributed Power Supply Pilot Project

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: 863 programmes of distributed power supply in Fushan
- **Technologies**: Distributed power system
- **References**: http://www.smartgridimpact.com/index_download.html#map

L) Sino-Singapore Tianjin Eco-city

- **Time period**: 2011–2020 (Ongoing)
- **Total budget**: N/A
- **Project partners**: Residents in Tianjin
- **Objective and results**: The Smart City Project in Sino-Singapore Tianjin Eco-city was started in April 2010 and will be a 30km^2 eco-city accommodating 350,000 residents along with business parks. The city will be divided into seven distinct sectors – Lifescape, Eco-Valley, Solarscape, Urbanscape, Windscape, Earthscape and Eco-Corridors.
- **Technologies**: PV, wind power generation system
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.tianjineco-city.com/en/

M) Smart Meter Upgrade Project

- **Time period**: 2010–2015 (Ongoing)
- **Total budget**: N/A
- **Project partners**: State Grid Corporation of China (SGCC)
- **Objective and results**: Thirty-six million smart metres have been installed as of 2011. State Grid Corporation of China (SGCC) plans to install over 300 million smart metres by the end of 2015.
- **Technologies**: Smart metre
- **References**: http://www.smartgridimpact.com/index_download.html#map

N) The Longgang Renewable Energy Application

- **Time period**: N/A (Ongoing)
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: The Longgang renewable energy application base was built to experiment on developing renewable power and connecting it to the grid.
- **Technologies**: N/A
- **References**: http://www.smartgridimpact.com/index_download.html#map

O) Intelligent Network Distribution

- **Time period**: N/A (Ongoing)
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: Automatic distribution management system with technical features of remote management, remote signal and remote control
- **Technologies**: Automatic distribution management system
- **References**: http://www.smartgridimpact.com/index_download.html#map

P) Macau AMI Pilot Project

- **Time period**: 2012–2013
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: AMI Pilot Project in Macau
- **Technologies**: AMI
- **References**: http://www.smartgridimpact.com/index_download.html#map

Smart city projects are listed below.

Table 1-2 List of Smart City-related Projects in China

Beijing	Dongcheng District, Chaoyang District, Beijing City, the future of technology, Beijing Lize financial business district, Beijing Economic and Technological
Tianjin	Jinnan District, Tianjin Eco City, Wuqing, Hexi District
Shanghai	Shanghai Pudong New Area
Chongqing	Nan'an District of Chongqing Municipality, Chongqing Two Rivers Area, Yongchuan District, Jiangbei District
Hebei	Shijiazhuang City, Langfang, Handan City, Qinhuangdao City, Qian'an City, Qinhuangdao Beidaihe District, Tangshan Caofeidian District, Tangshan City
Shanxi	Taiyuan, Changzhi, Ping Lu District, Shuozhou, Yangquan, Datong City, Jincheng, Shuozhou Huairen
Inner Mongolia Autonomous Region	Wuhai, Hulunbeir Erdos, Baotou Shiguai District
Heilongjiang Province	Zhaodong, Zhaoyuan County, Daqing, Jiamusi City Huanan County, Qiqihar, Mudanjiang City, Anda
Jilin	Liaoyuan City, Panshi City, Siping City, Yushu, Changchun High-tech Industrial Development Zone, Fusong Baishan City, Jilin Chuanying search
Liaoning Province	Shenyang Hunnan New District, Dalian City of eco-technology innovation, Yingkou City, Zhuanghe, Dalian general Bay Area
Shandong Province	Dezhou, Weihai, Dongying City, Shouguang City, Xintai City, Changyi, fat city, Jinan West Park, Yantai City, Qufu City, Jining City, Laoshan District,
Jiangsu Province	Wuxi, Changzhou, Zhenjiang, Taizhou City, Nanjing Hexi New City (Jianye), Suzhou Industrial Park, south of Yancheng District, Kunshan Huaqiao
Anhui Province	Wuhu, Huainan, Tongling City, Yuhui District Bengbu, Fuyang City, Huangshan City, Huaibei City, Hefei High-tech Industrial Development Zone,
Zhejiang Province	Wenzhou, Jinhua City, Zhuji City, Hangzhou City, Zhenhai, District of Hangzhou City, Hangzhou Xiaoshan District, Ningbo City (including Haishu
Fujian	Nanping City, Cangshan District, Pingtan comprehensive experimental zone, Putian City, Quanzhou Taiwanese Investment Zone
Jiangxi Province	Pingxiang City, Nanchang Honggutan, Xinyu City, camphor City, Gongqingcheng, Shangrao city Wuyuan
Henan Province	Zhengzhou City, Hebi City, Luohe City, Jiyuan City, Xinzheng City, New Luoyang, Xuchang City, Wugang, Lingbao
Hubei Province	Wuhan, Wuhan riverbank area, Huanggang, Xianning City, Yichang City, Xiangyang
Hunan Province	Zhuzhou City, Shaoshan, Zhuzhou Yunlong demonstration area, Parker Town, Liuyang City, Changsha Great River pilot area, Yueyang City, Yueyang Tower
Guangdong Province	Zhuhai City, Panyu District, Guangzhou City, Luogang District, Guangzhou, Shenzhen, Ping Shan District, Foshan City Shunde District, Foshan City
Guangxi Zhuang Autonomous Region	Nanning, Liuzhou (including Yufeng District), Guilin, Guigang
Hainan	Wanning City
Yunnan Province	Kunming Wuhua, Honghe Hani and Yi Autonomous Prefecture, Mengzi City, Honghe Hani and Yi Autonomous Prefecture Mile City
Guizhou Province	Tongren City, Liupanshui City, Wudang District of Guiyang City, Guiyang, Zunyi City (including Renhuai, Meitan County), Bijie City, Kaili City,
Gansu Province	Lanzhou, Jinchang City, Silver City, Longnan City, Dunhuang City
Sichuan Province	Ya'an City, Wenjiang District, Chengdu Pi County, Mianyang, Suining, Chong City
Tibet Autonomous Region	Lhasa, Nyingchi
Shaanxi Province	Xianyang City, Yangling Agricultural Hi-tech Industries Demonstration Zone, Baoji, Weinan, Yan'an City
Ningxia Hui Autonomous Region	Wuzhong City, Yinchuan, Shizuishan (Dawukou area included), Yinchuan Yongning County
Xinjiang Uygur Autonomous Region	Korla City, Kuitun City, Urumqi, Karamay, Yining

Source: Compiled from the National Smart City Pilot Project List, prepared by the Ministry of Housing and Urban-Rural Construction of China.

(3) References

- National New-Type Urbanization Plan (2014–2020)
- Ministry of Housing and Urban-Rural Construction of China (2013), "National Smart City Pilot Project List"

1.6 Hong Kong, China

(1) Outline of Energy Policy

In the Five-Year Plan (12th plan, 2011–2015), which is the pillar of the national economic plan, China is advocating the scientific formulation of urban plans centering on the development of transport, communication and electricity infrastructure, etc. as an urbanisation policy. Smart community plans in China are part of the urbanisation strategy. Based on the above, the Hong Kong Special Administrative Region is striving to realise smart communities by implementing the following measures.

- Adoption of the New Digital 21 Strategy (smart Hong Kong, smart living)
- Development of green buildings (ordinance concerning energy efficiency of buildings)
- Promotion of green transport (trial green transport fund, etc.)
- Setting of the target for carbon intensity reduction

In addition, Hong Kong, China is actively implementing the following projects by taking advantage of having the second highest dissemination rate of smart phones and its strength in electronic infrastructure, including an advanced and extensive settlement system using non-contact type smart cards, in order to establish its position as an international high-tech city in Asia.

(2) Major Smart Community Projects

A) Global Expansion of an Urban Smart Transport System

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Mitsubishi Corporation
- **Objective and results**: The project aims to develop a model for collaboration between EV, EV bus and charting systems that can be applied to other regions.
- **Technologies**: EV, EV bus, charging system
- **References**: https://www.mitsubishi.com/mpac/j/monthly/ichioshiback/monthly05.html

B) Smart City Plan in Hong Kong, China

- **Time period**: 2014–2015
- **Total budget**: *USD77.9 million (the infrastructure portion of the total budget of the

government of Hong Kong, China in fiscal 2014)

- **Project partners**: The government of Hong Kong, China
- **Objective and results**: The project aims to enhance the competitiveness of the City of Hong Kong
- **Technologies**: Development of communication infrastructure
- **References**: http://www.budget.gov.hk/2014/eng/highlights.html

C) Hong Kong AMI Pilot Project

- **Time period**: From 2012
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: This is a 4,500-metre pilot project. The project will link cellular-enabled metres and data collection and management software with grid routers and connected grid management systems.
- **Technologies**: Smart metre
- **References**: http://www.smartgridimpact.com/index_download.html#map

Regarding the implementation of smart community projects, in 2013, the central government of China announced 90 locations designated as trial cities for such projects, in which more than USD10 billion will be invested over the next three years. Hong Kong, China, which is one of those cities, is making progress in the field of urban development using the smart community project through the enhancement and improvement of urban infrastructure including communication infrastructure – an area of strength for Hong Kong, China – while making use of technologies and capital provided by foreign companies, such as Siemens, Schneider Electric and Hitachi Ltd.

(3) References

- 12th Five-Year Plan (2011–2015)

1.7 Indonesia

(1) Outline of Energy Policy

As for Indonesia's energy policy, the "Presidential Regulation on National Energy Policy" was established in January 2006. The policy emphasised reducing dependence on oil and shifting to gas and coal. Meanwhile, a new draft national energy policy approved by the parliament in January 2014 aims to continuously increase renewable energy and reduce dependence on oil. With regard to the implementation of a long-term national development plan for 2005 to 2025, the government also formulated the "Masterplan for Acceleration and Expansion of Indonesia's Economic Development"

(MP3EI)[8]. The Metropolitan Priority Area for Investment and Industry (MPA) Master Plan, which is part of the MP3EI, was drafted as an action plan related to Jakarta in order to resolve various problems in the Jakarta metropolitan area, including serious traffic congestion and air pollution, and an increase in greenhouse gas emissions resulting from growth in energy demand. There are projects related to smart communities and urban development in particular that are being implemented based on this plan.

(2) Major Smart Community Projects

A) Development of a Kitakyushu City-type Low-carbon, Eco-city Model in Surabaya City, Indonesia

- **Time period**: 2012–2013
- **Total budget**: JPY80 million
- **Project partners**: NTT Data, Nippon Steel & Sumikin Engineering, Fuji Electric, Kitakyushu City, Surabaya City
- **Objective and results**: The project aims to turn cities and industrial zones into low-carbon ones with high added value. With a view to creating business opportunities for Japanese companies, the project proposes the introduction of systems that create high added value, low-carbon systems and eco-city systems (cogeneration, recycling, etc.) into urban areas and industrial zones in Surabaya, which has had a close relationship with Kitakyushu City for many years.
- **Technologies**: Cogeneration, recycling technology, smart metre, EMS
- **References**:
  - http://www.meti.go.jp/meti_lib/report/2012fy/E002999.pdf

B) Project on Low-Carbon City Planning in Surabaya

- **Time period**: Fiscal 2012–2016
- **Total budget**: Approximately JPY13 billion to JPY14 billion
- **Project partners**: Institute for Global Environmental Strategies, Kitakyushu City (Kitakyushu Asian Center for Low Carbon Society), NTT Data Institute of Management Consulting Inc, ALMEC Corporation, Hitachi Zosen Corporation, AMITA Corporation, Matsuo Sekkei, Nishihara Corporation
- **Objective and results**: The project is examining the possibility of reducing greenhouse gas (GHG) emissions in major energy consumption sectors in Surabaya City in order to explore the possibility of forming a specific large-scale JCM project in the city. In the field of energy,

8 http://www.indonesia-investments.com/projects/government-development-plans/masterplan-for-acceleration-and-expansion-of-indonesias-economic-development-mp3ei/item306

the project aims to save energy used in buildings and to provide heat and electricity to industrial zones, and in the field of transportation, it aims to improve the operation of public transport systems, tax service, etc. and promote a shift to highly efficient vehicles.

- **Technologies**: CHP, LED, BEMS, etc.
- **References**:
    - http://www.env.go.jp/earth/coop/lowcarbon-asia/project/data/FY2013_FS05/FY2013_FS05_EN_V1.pdf

C) Building of Smart Communities on Indonesian Islands

- **Time period**: 2011–2012
- **Total budget**: N/A
- **Project partners**: Meidensha Corporation
- **Objective and results**: The project proposes a micro-grid system to the national electricity company (PLN) in order to introduce renewable energy into remote islands. Meidensha Corporation also proposes a joint operation with the national electricity company.
- **Technologies**: PV, EMS, battery
- **References**:
    - http://www.meti.go.jp/meti_lib/report/2011fy/E002968.pdf

D) Development of a Smart and Eco-industrial Zone Model in the Suryacipta Industrial Zone

- **Time period**: Fiscal 2012–2016
- **Total budget**: Approximately JPY3.5 billion
- **Project partners**: NEDO, Ministry of Energy and Mineral Resources (MEMR), Sumitomo Corporation, Fuji Electric, Mitsubishi Electric, NTT Communications
- **Objective and results**: The project aims to save energy and provide high-quality electricity by making use of Japanese electric power infrastructure technology. It will verify both the technological and business validity of this business model and will continuously expand the business after confirming its usefulness.
- **Technologies**: Automated power distribution system, uninterruptible power supply, voltage stabiliser, etc.
- **References**:
    - http://www.nedo.go.jp/news/press/AA5_100213.html

Japanese companies have been involved from the commercialisation stage; smart community-related projects are being implemented mainly based on capacity building support provided by the ADB.

E) Green Cities: A Sustainable Urban Future in Indonesia

- **Time period**: Undecided
- **Total budget**: USD1 million
- **Project partners**: Regional governments, urban development companies, etc.
- **Objective and results**: The project aims to build a green city design system in Indonesia (including not only development of infrastructure but also provision of services). It also aims for comprehensive management of cities based on systematic urban design.
- **Technologies**: N/A
- **References**: http://www.adb.org/projects/46380-005/main

F) Renewable Energy Development

- **Time period**: 2005–2011
- **Total budget**: USD1 million
- **Project partners**: The government of Indonesia, local governments and local residents
- **Objective and results**: The project aims to develop new energy sources on Indonesian islands. It also aims to secure and provide power by building small and medium-size hydropower generation facilities and geothermal power generation facilities. It will operate and manage three small hydropower generation facilities and conduct commercial operation of two geothermal power generation facilities, and develop and operate three hydropower generation facilities.
- **Technologies**: Small hydro
- **References**: http://www.adb.org/projects/34100-013/main

In addition to the abovementioned smart community projects, there are a large number of urban development plans. In Indonesia, there are low-carbon city models including waste treatment, and smart community and smart city development plans implemented from various viewpoints, including urban development intended to invite industries and the development of islands. There are also diverse initiatives utilising the knowledge acquired through preceding projects in cooperation with Japanese companies and local governments and human resource development in Indonesia.

(3) References

- NEDO, "Basic Survey toward Realizing Smart Community Urban Plans in Cities in the Neighborhood of the Indonesian Capital," 2013
- Master Plan for the Acceleration and Expansion of Indonesia's Economic Development

1.8 Japan

(1) Outline of Energy Policy

Regarding smart communities in Japan, the Strategic Energy Plan[9], which was decided by the Cabinet in 2014, stipulates the following: "A smart community is a community of a certain scale in which various consumers participate and one which has created a new social system. The new social system, while utilising a distributed energy system, including renewable energy and cogeneration, comprehensively manages energy supply and demand of the distributed energy system through an energy management system using IT, storage battery and other technologies so as to optimise use of energy and incorporates life support services, including the provision of care for elderly people." In light of this, it can be said that the objective of smart communities in Japan is to change lifestyles[10] by further disseminating renewable energy and making active use of ICT (information and communication technologies).

As smart community demonstration projects are cited in the Strategic Energy Plan that was decided by the Cabinet in 2014, they are being implemented mainly by the Agency for Natural Resources under the Ministry of Economy, Trade and Industry. Currently, large-scale demonstration projects are under way in four locations in Japan (Yokohama City, Toyota City, Keihanna-gakken City and Kitakyushu City) (referred to hereafter as the Four Major Demonstration Projects). In addition, the government has designated environmental future cities (11 locations) and environmental model cities (23 locations) and is promoting the development of environment-friendly cities in the broad sense of the term, including smart communities. (The environmental future city project is characterised as one of the 21 National Strategic Projects under the New Growth Strategy in 2010.) In Japan, smart community development is expected to proceed as part of urban development.

(2) Major Smart Community Projects

A) The Yokohama Smart City Project (YSCP)

- **Time period**: 2010–2014
- **Total budget**: JPY74 billion
- **Project partners**: City of Yokohama, Advanced Energy System for Sustainability, Urban Renaissance Agency, Marubeni Corporation, Yokohama Smart Community, Accenture, NTT DoCoMo, NTT Facilities, Orix, Orix Auto Corporation, Sharp, JX Nippon Oil & Energy, Sumitomo Electric, Sekisui House, Sony Energy Devices, Daikyo Astage, Taisei, Tokyo Gas, Tokyo Electric Power, Toshiba, Nissan, JGC Corporation, J-SYS, NEC, Nomura Real Estate

[9] http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf
[10] Compiled with reference to the website of Japan Smart City Portal.

Development, Panasonic, Hitachi, Misawa, Mitsui Fudosan, Mitsui Fudosan Residential, Mitsubishi Estate, Meidensha

- **Objective and results**: The project aims to develop smart city models based on cooperation between citizens, private companies and cities and to disseminate successful models nationwide and abroad.
- **Technologies**: PV power generation, storage battery, CEMS, HEMS, BEMS, FEMS, EV, charging infrastructure, storage battery SCADA

  *4,000 detached houses and condominiums, four business buildings, three commercial buildings, eight condominium buildings, one large factory, 25 demand response (DR)-capable EVs (including six charging- and discharging-capable EVs; two charging stations installed with PV storage batteries)
- **References**: http://jscp.nepc.or.jp/yokohama/

B) The Toyota City Low-carbon Society Verification Project (Smart Melit)

- **Time period**: 2011–2014
- **Total budget**: JPY22,720 million
- **Project partners**: Toyota City, Aichi Prefecture, Nagoya University, Aisin, Eneres, KDDI, Circle K, Sharp, Shinmei Industry, Sumitomo Electric, Secom, Systems Engineering Consultants, Chubu Electric Power, Denso, Toshiba, Toho Gas, Toyota, Toyota Industries Corporation, Toyota Smile Life, Toyota Tsusho, TTRI, Toyota Home, DI, Toyota Auto Body, Central Nippon Expressway, Meitetsu, HP, Hitachi, Fujitsu, Mitsubishi Corporation, Yazaki, Yamato Transport, Yamaha, BMW Group, BMW Japan
- **Objective and results**: With attention focused on the household sector (households and transportation), the project identifies medium-term technological challenges while keeping in mind what the situation of households will be like 10 years later in a society where grid parity has been achieved due to the dissemination of PV power generation. The project aims to build a low-carbon society in which the overall optimum can be measured on a community-by-community basis without blindly raising social costs.
- **Technologies**: PV, biomass, heat energy, CEMS, HEMS, EV/PHV/FC buses, ITS
- **References**: http://jscp.nepc.or.jp/toyota/

C) The Keihanna Eco City Next-generation Energy and Social Systems Demonstration Project

- **Time period**: 2010–2014
- **Total budget**: JPY13,572.8 million
- **Project partners**: Kyoto Prefecture, Kizugawa City, Tanabe City, Seika, Kansai Science

City, Kansai Economic Federation, Kyoto Center for Climate Actions, Urban Renaissance Agency, Enegate, i-Energy WG, Osaka Gas, Omron, Kansai Electric Power, Keihanna Interaction Plaza, Sharp, Doshisha Yamate Sustainable Urban City Council, Unisis, Mitsubishi Motors, Mitsubishi Heavy Industries, Mitsubishi Corporation, Mitsubishi Electric, Fuji Electric, Furukawa Electric, Furukawa Battery, Enesis

- **Objective and results**: The project is implementing demand response through collaboration between CEMS, HEMS, BEMS and the EV charging management centre and is demonstrating the energy saving and CO_2 reduction effects. Regarding the EV charging management system, the project demonstrates the peak shift effect by guiding users to specific charging stations and charging times based on the location of EVs and the amount of electricity remaining in the storage battery. Regarding V2X, the project demonstrates the usage of EV storage batteries for adjusting power supply and demand within factories. These achievements will be commercialised as a "Keihanna eco-city model" and be used for the recovery of cities in the Tohoku region, and will be disseminated to other economies.
- **Technologies**: CEMS, HEMS, electricity DR, BEMS, EV management system, V2X
- **References**: http://jscp.nepc.or.jp/keihanna/index.shtml

D) The Kitakyushu Smart Community Project

- **Time period**: 2010–2014
- **Total budget**: JPY16,334 million
- **Project partners**: Azbil, Aeon, Aeon Delight, Iwatani, Uchida Yoko, Orix, Human Media Creation Center/Kyushu, Kyuhen, Saibu Gas, JX Nippon Oil & Energy, Johnson Controls, Sharp, Nippon Steel & Sumitomo Metal, Nippon Steel & Sumikin Engineering, NS Solutions, Sekisui, Softbank Telecom, Daiwa House, Denso, TOTO, Toppan Printing, Toyota Motor, Toyota Industries, Toyota Tsusho, Toyoda Gosei, Nippon Steel & Sumikin Texeng, IBM Japan, Japan Telecom Information Service, Higashida Clinic, Fuji Electric, Furukawa Electric, Furukawa Battery, FamilyMart, Hokosha, Honda, Mitsubishi Heavy Industries, Yaskawa, Yaskawa Information Systems
- **Objective and results**: The project aims to indicate what local energy management should be like and build a desirable social structure in a low-carbon society by reforming lifestyles, business styles and the style of town building.
- **Technologies**: PV, wind, thermal energy, CEMS, BEMS, HEMS, EV, lifestyle, data centre, network
- **References**: http://jscp.nepc.or.jp/kitakyushu/index.shtml

E) Kashiwa-No-Ha Smart City

- **Time period**: 2005–2030
- **Total budget**: The total budget is undecided as the project is ongoing.
- **Project partners**: Hitachi, Mitsui Fudosan, University of Tokyo, Hewlett-Packard Japan, e-solutions, Itochu, Kokusai Kogyo Group, SAP AG, NTT Communications, LG CNG, JX Nippon Oil & Energy, Shimizu Corporation, Sharp, Tsuneishi Holdings, Nikkei Sekkei, NTT, Future Design Center, Mitsui Fudosan, Mitsui Home, Azbil
- **Objective and results**: The project aims to realise a safe, secure and sustainable smart city by implementing three initiatives – an environmental-symbiotic city, a city of health and longevity, and a city of new industry creation – through collaboration between public institutions, such as universities and research institutions, private companies such as Mitsui Fudosan and Hitachi, and the government, including administrative agencies.
- **Technologies**: AEMS, BEMS, EV, PV, storage battery
- **References**: http://www.kashiwanoha-smartcity.com/

F) Fujisawa Sustainable Smart Town

- **Time period**: From 2008
- **Total budget**: The total budget is undecided as the project is ongoing.
- **Project partners**: Panasonic (representative company), Ain Pharmaciez, Accenture, Gakken Cocofump Holdings, Social Welfare Corporation Camellia of the Koyama Healthcare Group, Culture Convenience Club, Sunautas Corporation, Alsok, Dentsu, Tokyo Gas, Nihon Sekkei, PanaHome NTT East, Sumitomo Mitsui Trust Bank, Mitsui & Company, Mitsui Fudosan, Mitsui Fudosan Residential, Yamato Transport
- **Objective and results**: With the concept of "Bringing energy to life," the project set the overall goal of reducing CO_2 emissions by 70% (compared with 1990), usage of water for living needs by 30% (compared with facilities and equipment used in small communities in 2006), increasing the renewable energy utilisation rate to more than 30% and securing three days of lifeline services in emergencies.
- **Technologies**: AEMS, GEMS, EV, PV, storage battery
- **References**: http://fujisawasst.com/

Japan is demonstrating and evaluating advanced technologies and services related to DR mainly under the abovementioned Four Major Demonstration Projects. There are expectations that based on the results of these projects, the public and private sectors will cooperate in actively advancing into emerging economies mainly in East Asia (India, Southeast Asian economies, China, etc.) through the promotion of feasibility studies and foreign demonstration projects and that

Japanese-developed smart community systems will be disseminated abroad in the future through economic diplomacy by government leaders, the provision of appropriate platforms and enhancement of governmental support tools.

(3) References

- The website of "Future City" Initiative: http://future-city.jp/
- Strategic Energy Plan (2014)

1.9 Korea

(1) Outline of Energy Policy

In Korea, it is widely recognised that smart grids play a role in creating new industries. The economy aims to increase its share of the global smart grid market to 30% and plans to export technologies that have undergone domestic demonstration tests to other economies. Since the government announced a comprehensive package of measures to promote smart grids, Korea has set forth the policy and roadmap for promoting smart grids and communities, including information technologies, as a national strategy. In 2010, it announced the National Smart Grid Roadmap, which describes the business outlook in three stages for the period up to 2030. In November 2011, a law was put into force governing the promotion of building and usage of smart grids (Smart Grid Law). This law stipulates that the government should formulate and implement a plan for promoting the smart grid business every five years. The government announced the first basic plan for smart grids on 18 July 2012. The plan covers general matters necessary for promoting the building and use of smart grids, including: medium- and long-term policy goals and policy direction, development, demonstration, dissemination, management and use of technologies, standardisation, bills for industrial promotion, investment, training of professional personnel, advance into foreign markets, international cooperation, protection of information, securing of safety and institutional improvements.

The details of the roadmap in the period up to 2030 are as described below. In the roadmap, it is estimated that technological development assistance worth a total of 27,050 billion won will be necessary in the period up to 2030.

- First stage (2010–2012)

  Conduct demonstration tests regarding wide-area, remote surveillance of power grids, electric vehicles, introduction of micro-grids, diversification of pricing, and sales of renewable energy.
- Second stage (2013–2020)

  Expand various systems to urban areas, incorporate distributed power sources such as micro-grids into grids, promote electricity sales transactions, disseminate electric vehicles nationwide, enhance electricity pricing and new market entries, and proceed with electricity management at buildings and factories.

- Third stage (2021–2030)

Expand the abovementioned businesses nationwide, increase the use of technologies, and integrate technologies in each field, including the building of integrated smart grids and zero-energy buildings.

(2) Major Smart Community Projects

A) The construction of a Smart Grid Test-bed in Jeju Island

- **Time period**: 2009–2013
- **Total budget**: JPY18.7 billion
- **Project partners**: KEPCO, SKEnergy, SKTelecom, GSCaltex, KT, LG, Hyundai Heavy Industries, POSCON, KPX
- **Objective and results**: The project provides an ideal environment for testing distributed power sources and micro-grid technology. By 2030, sustainable power generation using renewable energy will start. A total of 168 companies are participating in this project and 6,000 households are also involved. The project will optimise energy usage by using renewable energy and energy storage technology. It is being implemented to demonstrate technologies and systems, including IT technologies, smart grids, introduction of renewable energy, and usage of next-generation transport systems and smart houses, for a variety of purposes.
- **Technologies**: EV, charging infrastructure, EMS, smart metre, smart grid-related technologies, PV, wind, transportation infrastructure
- **References**:
  - http://www.smartgrid.or.kr/10eng3-1.php

B) U-City Project

- **Time period**: 2004–2020
- **Total budget**: USD30 billion
- **Project partners**: POSCO E&C, Cisco System, 3M, United Technologies
- **Objective and results**: The project is implementing urban development, including smart buildings, cogeneration and energy management systems; creates next-generation transport systems, including the use of car sharing; and promotes health and welfare. As part of urban development, the project is enhancing the attractiveness of cities through town building featuring improvement of relevant transport systems and promotion of health and welfare.
- **Technologies**: Smart metre, energy management system, CHP, etc.

- **References**:
  - http://www.gsma.com/connectedliving/wp-content/uploads/2012/08/cl_busan_08_121.pdf

C) **Smart Seoul 2015**

- **Time period**: 2011–2015
- **Total budget**: KRW850 billion
- **Project partners**: Seoul City
- **Objective and results**: The project aims not only to introduce smart technologies and develop information restructure, including Wi-Fi spots, but also to strengthen relationships between citizens and communities. The project promotes the dissemination of smart devices and smart metres and analyses the benefits (ICT infrastructure, integration of frameworks of urban plans and smart consumers are three pillars of the project).
- **Technologies**: Smart metre, security camera, etc.
- **References**:
  - https://itunews.itu.int/En/4148-Smart-Seoul.note.aspx
  - http://www.itu.int/dms_pub/itu-t/oth/23/01/T23010000190001PDFE.pdf
  - http://www.eshiraz.ir/shares/emun/emun-adm/FAZ-2-3/Seoul%20Egov_civil%20services_part3.pdf
  - http://pc.nikkeibp.co.jp/article/column/20110811/1034726/

D) **Daegu-Gyeongbuk High-tech Medical Cluster**

- **Time period**: 2011–2030
- **Total budget**: KRW4,600 billion
- **Project partners**: Samsung Electronics, LG Electronics
- **Objective and results**: The project is implementing demonstration tests of the medical tourism business and smart care service. It aims to turn the region into a world-class research centre by concentrating medical complexes there. As part of the vision of making the region a hub of a world-class advanced medical industry, the project will build an advanced medical complex. With a view to turning the region into a world-class research centre, the project will conduct research and development related to next-generation medical technologies intended to incorporate IT in particular.
- **Technologies**: ICT, smart care technology
- **References**:
  - http://www.city.gamagori.lg.jp/uploaded/attachment/19411.pdf
  - http://english.mw.go.kr/front_eng/jc/sjc0108mn.jsp?PAR_MENU_ID=1003&MENU

_ID=1003100401

➢ http://techon.nikkeibp.co.jp/article/NEWS/20111114/201579/?rt=nocnt

E) 10 Power IT Project (Seoul)

- **Time period**: 2005–2012
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: Korea embarked on a strategic technology development programme in 2005 and selected 10 projects, which have since been systematically implemented. The implementation of these projects was connected with the Smart Grid Initiative. The Power IT Programme is expected to develop the electric power and electrical industries.
- **Technologies**: Communication infrastructure development
- **References**:
  - ➢ http://www.smartgridimpact.com/index_download.html#map
  - ➢ http://www.smartgrid.or.kr/Ebook/10POWER_IT_PROJECTS.PDF

A notable feature of demonstration projects in Korea is the building of smart grids and networks taking advantage of information technologies, as exemplified by the project on the Cheju Island. Korea plans to use smart grids to create technologically sophisticated industrial cities by applying knowledge acquired through these projects to urban development projects.

(3) References

- Nikkei BP, http://cleantech.nikkeibp.co.jp/report/smartcity2012/
- KSGI (Korea Smart Grid Institute), "Korea's Smart Grid Roadmap"

1.10 Malaysia

(1) Outline of Energy Policy

Based on the National Energy Policy, which was announced in 1979, Malaysia set the following three policies regarding the supply and use of energy and the environment.

- ➢ Securing a safe and efficient energy supply by developing domestically-owned renewable and non-renewable energy resources.
- ➢ Reducing wasteful energy consumption and unproductive energy usage by promoting efficient use of energy.
- ➢ Minimising adverse effects on the environment.

By establishing various laws and regulations as well as the economy's strategies based on the above policies, Malaysia is implementing energy policy measures. In addition, Malaysia has set a medium-term economic development plan called the Malaysia Plan and is implementing policies concerning renewable energy and energy conservation. The current 10th Malaysia Plan (2011–2015) calls for (i) strengthening incentives for investment in renewable energy and (ii) increasing the renewable energy power generation capacity to 985MW by 2015. Smart community projects in Malaysia are being implemented in connection with this plan.

TNB, a state-run electric power company, has announced a long-term strategy as outlined below.

- TNB's 25-year Electricity Technology Roadmap (TRM), with the purpose of modernising the electricity supply industry in Malaysia
- TRM focuses on four main goals:
  - Reliable and efficient delivery system
  - Intelligent power-delivery systems
  - Value-added electricity products and services
  - Enhanced environmental management

The details of major smart community-related projects are described below.

(2) Major Smart Community Projects

A) Smart City Development in Kuala Lumpur and Kuantan

- **Time period**: Fiscal 2014–2016
- **Total budget**: JPY6.2 billion
- **Project partners**: Panasonic
- **Objective and results**: The project aims to improve the residential comfort of houses and residential areas by using cutting-edge technologies and to make use of up-to-date IT technologies that make it possible to choose convenient electricity that suits environmentally-oriented life styles.
- **Technologies**: Smart condominiums
- **References**:
  - http://www.nikkei.com/article/DGXNZO70435540W4A420C1FFE000/

B) Iskandar Development Plan (joint project with the government of Singapore)

- **Time period**: Fiscal 2006–2025
- **Total budget**: MYR100 billion
- **Project partners**: The government of Malaysia, the government of Singapore, Mitsui & Co
- **Objective and results**: The project will create an attractive city through land development,

sales and leasing as well as infrastructure development in the Medini area.

- **Technologies**: EV bus, system of energy management of a group of buildings, surveillance system linked to security cameras, light-emitting diode (LED) lighting
- **References**:
  - https://www.mitsui.com/jp/ja/release/2013/1200422_4689.html

C) Smart Grid Test Systems

- **Time period**: 2010–2015
- **Total budget**: N/A
- **Project partners**: Tenaga National Berhad, Sarawak Energy Berhad, Sabah Electricity Senderian Berhad
- **Objective and results**: Smart Grid Test Systems as demonstration projects. Three sites have been identified for Smart Grid Test Systems: Bayan Lepas (an industrial area), Bukit Bintang (a commercial centre) and Medini (a green field area). These three areas have been chosen for the SCADA-DA test bed.
- **Technologies**: PHEV, CHP, ICT, AMI, storage, charging stations LED, automation
- **References**:
  - http://www.ewh.ieee.org/soc/pes/malaysia/images/KeyNote%20PECON2010/Mohd%20Yusof%20Rakob%20-%20Planning%20for%20TNB%20Smart%20Grid.pdf

D) Smart Grid Pilot Project

- **Time period**: From 2014
- **Total budget**: MYR2 million (USD590,000)
- **Project partners**: Tenaga National Berhad
- **Objective and results**: A global smart grid communications company that is developing end-to-end solutions for the utility's first integrated smart metre and smart grid project, and is installing 1,000 smart metres in Putrajaya and Malacca. The initiative for the smart grid scheme is intended to meet the rising energy consumption and demand in Malaysia which is projected to increase by 5% per year over the next five years, and is likely to double in the next 20 years.
- **Technologies**: Smart metre
- **References**:
  - http://www.tnb.com.my/tnb/application/uploads/newsclips/3c21d3d4d4089509c73559110c8b6a97.pdf
  - http://themalaysianreserve.com/main/news/corporate-malaysia/5584-aia-annualised-new-premium-broke-rm1b-in-2013

- http://www.tnb.com.my/tnb/application/uploads/newsclips/cbb13b89d615714e051d5db08f430ae7.pdf"

Under the national energy policy, Malaysia is considering diversification of power sources, including the use of renewable energy, and promotion of energy conservation to deal with an increase in domestic energy consumption due to further economic development and prevent global warming. Accordingly, under the Malaysia Plan, the economy is planning smart city development as part of a large-scale urban development project in order to promote the dissemination of renewable energy and energy conservation. Thus, Malaysia is using advanced technologies related to smart communities and smart grids as techniques to build new towns, so the dissemination of such technologies will become important in the field of urban development.

(3) References

- Nikkei BP, http://cleantech.nikkeibp.co.jp/report/smartcity2012/
- http://onlineapps.epu.gov.my/rmke10/img/pdf/en/chapt6.pdf
- Mohd Yusof Rakob, “Planning for Smart Grid in TNB System,” PECon2010

1.11 Mexico

(1) Outline of Energy Policy

In Mexico, a strategy called the Estrategia Nacional de Energía 2013–2027, which was announced in February 2013, forms the basis of the current energy policy. This strategy rests on the principle of achieving energy security, economic efficiency, environment-friendliness and sustainability. In relation to smart communities, the development of smart grids is regarded as important and for which CFE is responsible. Smart grids are expected to improve the efficiency and reliability of the electric power sector and the stability of the power transmission and distribution sector through the installation of data collection devices on electric power networks and the usage of the collected data. Smart grids are also expected to contribute to decision making and prediction of future demand. In addition, in Mexico, the dissemination of smart grids is expected to promote renewable energy, mitigate environmental impact and reduce transmission power losses.

Meanwhile, the “2do Informe de Labores 2013–2014” cites the following points with regard to the Programa Nacional de Infraestructura. ‘Strategy 2.7 Develop distribution quality electricity, thus reducing losses in the supply and increasing service coverage. One of the most important challenges for the electricity sector is to increase the efficiency, availability, reliability and security of systems distribution of electricity, which involves, among others, network deployment of the smart grid. ’

Moreover, as a smart grid-related organisation, the National Group for Smart Electricity Networks (REI in Spanish) was established at the federal government level, including the sector’s head

(SENER), the regulator (CRE) and the state-own utility (CFE). The aim is to promote the orderly integration of renewable energy. The REI Group has internal guidelines for its operations and by September 2014 was drawing up its annual work plan.

(2) Major Smart Community Projects

A) Guadalajara Ciudad Creativa Digital

- **Time period**: From 2012
- **Total budget**: N/A
- **Project partners**: Guadalajara city, IBM
- **Objective and results**: The Guadalajara project is serving as a test bed to develop best practices and a pool of talent that can be used in cities throughout Mexico. To speed up that process, the project is embracing revolutionary, and often complementary, technologies such as the Internet of Things (IoT), smart grid, e-health and augmented reality, to name a few. All of the above will help provide the people of Guadalajara with clean water, nutritious food, and affordable energy, housing and transportation, etc.
- **Technologies**: IT, communication infrastructure development, traffic control system, e-Health
- **References**:

  Smart City, Smart Future: Guadalajara, Mexico, IEEE Smart Cities:
  http://smartcities.ieee.org/articles-publications/smart-city-smart-future-guadalajara-mexico.html
  Ciudad Creative Digital:
  http://www.carloratti.it/FTP/CCD/files/CCD_brochure.pdf#page=1&zoom=auto,-199,595

B) Macrobus Bus Rapid Transit (BRT) in Guadalajara

- **Time period**: 2012–2017
- **Total budget**: USD749.25 million-
- **Project partners**: Center for Sustainable Transport Mexico (CTS-Mexico)
- **Objective and results**: Improved efficiency, mode switching, integration with feeder lines for efficient transport trips of customers by combining fine-density feeder lines with high-capacity trunk routes, load increase or change in occupancy, reduction of the existing fleet of buses through public transit re-organisation. This is an integral part of the BRT project.
- **Technologies**: BRT
- **References**:

  Macrobus Bus Rapid Transit in Guadalajara http://esci-ksp.org/project/macrobus-bus-rapid-transit-in-guadalajara-mexico/

C) SCADA System Based on OSI's Monarch

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Open Systems International, Inc (OSI), Automatización y Tecnología Mexicana SA de CV (Atemex), División de Distribución Noroeste of CFE (Northwest Division)
- **Objective and results**: Supply their next-generation SCADA system based on OSI's Monarch (Multi-platform Open Network ARCHitecture) platform, intended for the distribution centre in the city of Culiacan, in the Mexican state of Sinaloa.
- **Technologies**: GUI, dynamic tabular display subsystem, advanced alarm management system, real-time and historical trending, communications front-end processor, historical information system and data archiving, inter-control centre communications protocol, calculation & scripting subsystem
- **References**:
  Mexico's National Electricity Commission (CFE) Chooses OSI Technology for Mexico's Northwest Region Distribution Network:
  http://www.osii.com/news-and-events/media-coverage.asp?display=detail&id=181

D) Mexico City's First AMI Smart Grid Project

- **Time period**: From 2011
- **Total budget**: USD250 million
- **Project partners**: Elster, CFE, The Secretaria de Energia (SENER), Mexico's Federal Energy Ministry
- **Objective and results**: The Comision Federal de Electricidad (CFE) has already deployed automated metre infrastructure (AMI) systems in 14 of Mexico's 16 service areas. The Secretaria de Energia (SENER), Mexico's Federal Energy Ministry, and the CFE are implementing a smart grid pilot project in different areas of Mexico City. SENER and CFE will use the EnergyAxis pilot project as a benchmark for evaluating the advantages of Elster's Smart Grid Technologies for potential future deployments. By demonstrating AMI features such as remote metre reading in hard-to-reach areas, energy usage monitoring, remote connect/disconnect, load management and AMI-DA (distribution automation) convergence in voltage monitoring, the Elster project will expand CFE's Smart Grid initiatives even further. CFE will use the project to showcase AMI benefits including system improvements, increased productivity, reduced outages, more accurate readings, improved operational

efficiencies related to fewer truck rolls and service calls, and a reduction in non-technical losses.

- **Technologies**: AMI
- **References**:
  Comision Federal de Electricidad (CFE) Selects Elster for Mexico City's First AMI Smart Grid Project
  http://www.intelligentutility.com/article/11/04/comision-federal-de-electricidad-cfe-selects-elster-mexico-citys-first-ami-smart-grid-project
  http://www.smartgridimpact.com/index_download.html#map

(3) References

- Secretaria de Energia, "Estrategia Nacional de Energía 2013–2027"
- SEP (Secretaria de Educacion Publica), "2do informe de labores 2013–2014"

1.12 New Zealand

(1) Outline of Energy Policy

The government of New Zealand announced a new energy strategy (New Zealand Energy Strategy 2011–2021: NZES) titled "Developing our energy potential" in August 2011. As major policy targets, this strategy cites the following points.

The government's goal is for New Zealand to make the most of its abundant energy potential, for the benefit of all New Zealanders. This will be achieved through the environmentally-responsible development and efficient use of the economy's diverse energy resources, so that:

- The economy grows, powered by secure, competitively-priced energy and increasing energy exports.
- The environment is recognised for its importance to the New Zealand way of life.

The government has set the goal of providing 90% of all electricity through renewable energy by 2025. As a specific measure, the government is striving to enhance heat insulation of houses and increase the use of clean heat through a programme called "Warm Up New Zealand" (Heat Smart Programme) to improve energy efficiency in particular. Regarding the smart grid, the Ministry of Business, Innovation and Employment, with the support of the Electricity Networks Association, established the Smart Grid Forum in 2014. This forum, which brings together industry, government and academia, including regulatory authorities, policymaking officials and consumers, is advocating the vision of using smart grid technology in order to contribute to the improvement of productivity in New Zealand and the interests of consumers.

(2) Major Smart Community Projects

A) Demand Response Management

- **Time period**: 2013 (First phase)
- **Total budget**: N/A
- **Project partners**: Vector, Counties Power, Vodafone NZ, Nelson Marlborough District Health Board, Simply Energy, Trustpower, Refining New Zealand, Callaghan Innovation
- **Objective and results**: The objectives of the market programme were to:
  - confirm operation of DRMS including:
  - successful offering of DR up to at least 100MW
  - coordination of providers with DRMS and between load types
  - understanding of interaction with other demand side regimes such as interruptible load
  - determine the natural price points for different DR providers
  - help determine the next steps of embedding DR in the NZ context
- **Technologies**: Demand response, etc.
- **References**:
  - https://www.transpower.co.nz/projects/demand-response-project/demand-response-programme-2013

B) The Blue Skin Community Energy Project

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Akina Foundation, Lottery Grants Board, United Way New Zealand, COGS, Bendigo Valley Foundation, and many others
- **Objective and results**: Blueskin Power aspires to have achieved the following by 2020. Families and individuals in Blueskin Communities will:
  - Be free of fuel poverty, with warm, comfortable, energy efficient homes.
  - Own the means to generate sufficient local renewable energy to meet the communities' needs.
  - Be linked to each other, and within each community, by a comprehensive walking-cycling network.
  - Provide 'open-door' education to promote and teach others of the achievements.
- **Technologies**: Wind power, solar PV, etc.
- **References**:
  - http://www.blueskinpower.co.nz/

C) The Powerco Smart House Pilot Programme

- **Time period**: 2014 (at least two years)
- **Total budget**: N/A
- **Project partners**: PowerCo
- **Objective and results**: Three houses have been designed to capture future potential household scenarios based on the dynamic market and technological landscape. These houses are fully interactive with PowerCo's information networks, and test three market hypotheses about how consumers will behave going forward.
- **Technologies**: Remotely controlled infra-red heating, remote controlled radiator/storage, remotely controlled heat pump, gas fire heating, gas central heating/water, insulation & down-lights, alternate PV set-up, solar controller, bathroom heat/fans, baseline testing, fridge/freezer/laundry, energy storage, cooking options
- **References**:
  - http://www.ieadsm.org/Files/Tasks/Task%2024%20-%20Closing%20the%20Loop%20-%20Behaviour%20Change%20in%20DSM,%20From%20Theory%20to%20Policies%20and%20Practice/Publications/Subtask%202_PowerCo_NZ_case%20study_small.pdf

D) The Warm Up New Zealand Programme

- **Time period**: 2009–2014
- **Total budget**: NZD100 million
- **Project partners**: Energy Efficiency and Conservation Authority (EECA)
- **Objective and results**: Budget 2013 allocated NZD100 million of operating funding over three years to the Warm Up New Zealand: Healthy Homes programme, targeting low-income households for home insulation, particularly households occupied by children and/or the elderly. Warmer, drier homes provide real benefits to New Zealanders. As well as energy efficiency gains, insulating homes reduces health risks caused by cold, damp housing such as respiratory illnesses and serious diseases like rheumatic fever.
- **Technologies**: House insulation
- **References**:
  - http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/homes/insulation-programme

E) Contact Energy SmartConnect

- **Time period**: 2012–2015
- **Total budget**: N/A
- **Project partners**: N/A

- **Objective and results**: Contact Energy's smart metres are designed to allow households to benefit from the introduction of smart appliances and from pricing plans which enable customers to choose to use electricity when it is most cost effective. They have the capability to support in-home displays and will be able to communicate with smart appliances in the future with the use of a simple plug-in module. By 2015, up to 350,000 Contact Energy customers will have the SmartConnect service.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.contactenergy.co.nz/aboutus/findoutabout/smartconnect-faq

F) Unison Smart Grid Project

- **Time period**: Announced in 2012 (Planned)
- **Total budget**: N/A
- **Project partners**: Unison, Silever Spring Networks
- **Objective and results**: Unison's smart grid roll-out is expected to deliver improved reliability and service for consumers, provide enhanced management of power grid assets, and enable greater overall energy efficiency.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.silverspringnet.com/article/silver-spring-networks-selected-by-unison-for-new-zealand-smart-grid-deployment/#.VTCxOdLtlBc

G) Mercury Energy Smart Meter Deployment

- **Time period**: From 2008
- **Total budget**: N/A
- **Project partners**: Mercury Energy, more than 300,000 Mercury Energy customers
- **Objective and results**: More than 300,000 Mercury Energy customers will receive a high-tech smart metre, through a metring services provider. The new metres record usage in 30-minute periods, meaning that information for bills will always be accurate and up to date and this information could also be used to help customers manage their power consumption.
- **Technologies**: Smart metre, AMI
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - https://www.sgiclearinghouse.org/Oceania?q=node/2598&lb=1

(3) References

- Ministry of Energy and Resources, “New Zealand Energy Strategy 2011–2021”
- EECA: http://www.eeca.govt.nz/
- Ministry of Business, Innovation and Employment: http://www.med.govt.nz/
- New Zealand Smart Grid Forum:
  http://www.med.govt.nz/sectors-industries/energy/electricity/new-zealand-smart-grid-forum

1.13 Papua New Guinea

(1) Outline of Energy Policy

The Department of National Planning and Monitoring formulated the “Medium Term Development Plan 2011–2015, MTDP 2011–2015” and the “Development Strategic Plan 2010–2030, DSP 2010–2030” in 2010. As a major goal, the MTDP 2011–2015 aims to ensure that all households have secure and reasonable access to energy and that electricity is generated and transmitted in sufficient volume to meet future energy demand. As challenges related to implementation, the MTDP 2011–2015 cites the following points.

- A shortage of investments necessary for maintaining and managing existing facilities
- The need for private companies to make investments in order to secure necessary installed capacities
- Improvement of inefficient operation of power generation facilities

Meanwhile, DSP2010–2030 places emphasis on the development of energy resources and the improvement of power grids in particular and cites an estimate that capital investment that will meet demand, which is expected to increase five-fold by 2030, will become necessary. As a means to meet the demand, DSP2010–2030 advocates “an electricity super-corridor” programme.

The electricity super-corridor will be a power network extending across various economic areas. This programme aims to create a network that gives towns, cities and regions access to electricity. The economy also anticipates future exports of electricity, including exports of electricity to Australia and Indonesia using the hydropower potential of the Purari River.

(2) Major Smart Community Projects

A) Construction of an e-Learning system in Papua New Guinea

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: The government of Papua New Guinea, ZTE corporation
- **Objective and results**:

- ➢ Provide a nationwide telecommunication network using WiMax technology
- ➢ Build 89 schools all over the economy
- ➢ Provide remote education systems and courseware

- **Technologies**: Communication infrastructure development, e-learning

(3) References

- Medium Term Development Plan 2011–2015, MTDP 2011–2015

1.14 Peru

(1) Outline of Energy Policy

In November 2010, the Ministry of Energy and Mines announced an economy's basic energy policy called "Propuesta de Politica Energetica de Estado Peru 2010–2040." Reference materials attached to the policy announcement cited nine points as Peru's energy policy goals. Under the goal of maximising energy efficiency in terms of both production and consumption, expectations for smart technologies were expressed. Specifically, "achieving automated supply-demand management through a system using smart technologies, thereby contributing to the improvement of energy system efficiency" and "improving energy efficiency through the use of autonomous, distributed energy" were cited as policy guidelines.

(2) Major Smart Community Projects

A) Smart City Feasibility Survey

- **Time period**: Fiscal 2014 (June to December)
- **Total budget**: N/A
- **Project partners**: Nikken Sekkei Research Institute, Hitachi Consulting (USA)
- **Objective and results**: The projects will build a low-carbon model town.
- **Technologies**: PV, wind power generation, EMS, use of ICT in the security sector
- **References**:

  http://www.nikken-ri.com/news/2014/plfjb40000002hrc-att/press.pdf#search='%E3%83%9A%E3%83%AB%E3%83%BC+%E3%82%B5%E3%83%B3%E3%83%9C%E3%83%AB%E3%83%8F+%E3%82%B9%E3%83%9E%E3%83%BC%E3%83%88'

B) Sustainable Urban Transport

- **Time period**: 2015–2025
- **Total budget**: USD6.5 billion
- **Project partners**: The government of Peru, Protransporte, Cofide, Transitemos, Iniclativa Aire Limpio, giz, KFW, British Embassy Lima, World Resources Institute, LEDS, BID, CAF

- **Objective and results**: 1) Integrated public mass transportation system in the Lima Metropolitan Area and Callao, 2) Development of non-motorised transport, 3) Institutional development to improve urban transport management (autonomous authority), 4) Modernisation of the public transport vehicle fleet (scrapping system), 5) Control and mitigation of GHG emissions by the vehicle fleet (fuel economy standard and labelling system), 6) National Programme: Support to local governments in terms of sustainable urban transport
- **Technologies**: Traffic management system

C) The Economics of Low Carbon, Climate Resilient Cities

- **Time period**: 2009–2030
- **Total budget**: N/A
- **Project partners**: The government of Peru, British Embassy Lima, University of Leeds, Centre for Low Carbon Futures, IDB, INTE-PUCT, ESRC Economic & Social Research Council, Centre for Climate Change Economics and Policy
- **Objective and results**: This study aims to provide an evidence base for Lima-Callao, and to use this to examine whether there is an economic case that can be used to secure investments in energy and water efficiency and in low-carbon, climate resilient development in the city. The more specific aim is to provide prioritised lists of the most cost- and carbon/water-effective measures that could realistically be adopted across the energy, housing, commercial, transport, industry, waste and water sectors within the city.
- **Technologies**: Solar photovoltaics, bus rapid transit, solar hot water
- **References**:
  - http://www.climatesmartcities.org/sites/default/files/ELCC%20Lima%20Report%20Full%20English.pdf

D) Arequipa Region

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Arequipa Region (25 large customers, 200 customers)
- **Objective and results**: SEAL in Arequipa, where the nature of the terrain makes metre reading complicated and costly, is running a pilot project at 25 large customers that employs both terrestrial and satellite data transmission. The pilot project will be expanded to more than 200 customers. SEAL expects to recoup its project investment in under a year.
- **Technologies**: Smart metre
- **References**: http://www.smartgridimpact.com/index_download.html#map

E) Electro Sur Medio Smart Meter Project

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Electro Sur Medio, large clients in Pisco and Ica
- **Objective and results**: Electro Sur Medio launched a 75-point pilot project using cellphones as modems in Pisco and Ica for monitoring losses at substations and monitoring large clients.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.metering.com/smart-metering-taking-off-in-latin-america/

(3) References

- Propuesta de Politica Energetica de Estado Peru 2010–2040, http://www.minem.gob.pe/descripcion.php?idSector=6&idTitular=2300

1.15 The Philippines

(1) Outline of Energy Policy

The Philippine Department of Energy announced the latest energy plan, called "Philippine Energy Plan: PEP2012–2030," in December 2012. In particular, this plan calls for programmes in the power generation sector, including competition in retail sales, open access, mutual collaboration between grids, spot market, renewable energy market, promotion of local electrification and adaptation to smart grid technology. In addition, from the perspective of promoting renewable energy, the National Renewable Energy Programme, which was launched in July 2011, set renewable energy goals for the period up to 2030. In particular, the programme set the milestone goals of completing demonstration tests of smart grids and concentrated solar thermal power generation by 2015 and achieving grid parity by 2020. Also, expectations for the use of biofuels and electric vehicles as an alternative fuel policy in the transportation sector are high. In particular, in an electric vehicle programme, a demonstration project related to the introduction of e-trike is being implemented with the support of the ADB (the details are to be described later).

(2) Major Smart Community Projects

A) Clark Green City

- **Time period**: 2014–2019 (First phase)
- **Total budget**: PHP3.8 billion
- **Project partners**: Bases Conversion and Development Authority (BCDA), (Centios, Cisco)

- **Objective and results**: Building a ‘Green City’ at the 36,000 hectare portion of the Clark Special Economic Zone in Pampanga will cost approximately PHP200 billion. The green metropolis will be a mix of industrial, institutional and commercial areas, which will apply green technologies* by adapting a Green Building System. Renewable energy from sustainable sources will be used by all facilities and buildings in Clark Green City, which is half the size of Metro Manila
- ***Technologies**: Water supply system, including a water treatment plant, renewable energies
- **References**:
  - http://www.greencityclark.com/

B) Davao City Public Safety and Security Command Center (PSSCC)

- **Time period**: N/A
- **Total budget**: Approximately PHP120 million
- **Project partners**: Davao City, IBM, etc.
- **Objective and results**: Davao City is the largest city in the Philippines in terms of land area and is considered the business capital of the Southern Philippines. Today, with enhanced public safety operations using advanced and smarter technologies, it is well positioned to become a premier socio-economic and tourism hub in the Asia-Pacific region. The Public Safety and Security Command Center (PSSCC) will integrate city operations into a single system and use advanced technologies to enhance public safety operations in the city.
- **Technologies**: GPS, GIS data utilisation, CCTV
- **References**:
  - http://www.davaocity.gov.ph/psscc/Home/home.aspx
  - https://www-03.ibm.com/press/us/en/pressrelease/38152.wss
  - http://newsbytes.ph/2013/06/09/davao-city-formally-unveils-p120-m-ibm-smarter-city-project/

C) Orga Smart Grid System Trial

- **Time period**: From 2012
- **Total budget**: N/A
- **Project partners**: Meralco, Orga Systems
- **Objective and results**: In the Orga Smart Grid System Trial project, 40,000 customers will be connected. Meralco provides dynamic smart metring innovations. A tiered prepaid electricity scheme based on a centralised real-time billing solution will be offered.
- **Technologies**: Smart metre
- **References**:

- ➢ http://www.smartgridimpact.com/index_download.html#map
- ➢ http://www.orga-systems.com/media-center/press-releases/details/article/meralco-and-orga-systems-bring-smart-grid-roll-out-to-philippines/

As described above, in addition to projects in which Japanese companies have been involved from the commercialisation stage, smart community-related projects are being implemented mainly based on capacity building support provided by the ADB.

D) Mitigation of Climate Change through Increased Energy Efficiency and the Use of Clean Energy

- **Time period**: 2011–2014
- **Total budget**: USD1.1 million
- **Project partners**: Industries, foreign investors, etc.
- **Objective and results**: The project will improve the efficiency of air conditioners and refrigerators. It aims to encourage households to reduce energy expenses by learning about reasonable and energy efficient choices.
- **Technologies**: N/A
- **References**:
  - ➢ http://www.adb.org/projects/43207-012/main

E) Market Transformation through Introduction of Energy-Efficient Electric Vehicles Project

- **Time period**: Until 2018
- **Total budget**: USD504 million
- **Project partners**: Philippine companies involved in parts of electric vehicles, the government
- **Objective and results**: The project aims to reduce CO_2 emissions through the use of alternatives to fossil fuels in the transportation sector by triggering market reform, such as the use of electric three-wheelers. It will deploy 100,000 e-trikes nationwide to replace the same number of traditional gasoline-powered three-wheelers, reducing the transportation sector's annual petroleum consumption by 2.8% (equivalent to 89.2 million litres) and CO_2 footprint by 79%.
- **Technologies**: Electric three-wheeler
- **References**:
  - ➢ http://www.adb.org/projects/43207-013/main
  - ➢ https://www.doe.gov.ph/programs-projects-alternative-fuels/299-the-e-trike-project

As a national energy policy, the Philippines is promoting the dissemination of renewable energy and developing grid connections as infrastructure. The economy is also working to develop alternative fuels in the transportation sector, and there are high expectations for the expansion of the domestic power grid and dissemination of EVs. Programmes using information technology and energy conservation technology are being implemented as specific smart community-related projects in order to develop green and safe cities. Another major feature is that a large-scale demonstration project for E-trike, or electric three-wheelers, is being implemented.

(3) References

- DOE, Philippine Energy Plan (PEP) (2012–2030)
- DOE, Renewable Energy Plans and Program (2011–2030)

1.16 Russia

(1) Outline of Energy Policy

Russia is a major producer of fossil fuels: it has the world's second largest reserves of natural gas and coal and the seventh largest oil reserves. Russia has until now implemented its energy policy backed by sufficient domestic reserves of fossil fuels. However, under the Energy Strategy for Russia for the Period up to 2030[11], which was formulated in 2009, Russia aims to shift from the traditional resource-dependent model to a technological innovation model. Moreover, the strategy calls for efficient management of national projects based on technological innovation in order for the energy sector to support economic development. As a major policy goal, the strategy aims to achieve sustainable economic development, improve people's living standards and raise Russia's economic status by making maximum and efficient use of energy resources and the potential of the energy sector.

The following are the details of major smart community projects being implemented in Russia.

(2) Major Smart Community Projects

A) Skolkovo District Smart City Development

- **Time period**: 2014–2015
- **Total budget**: USD300 million
- **Project partners**: Panasonic, Ernst&Young, Cisco and Russian Academy of Science
- **Objective and results**: The project aims to create future cities by using knowledge concerning communication technology, bio-engineering, nuclear engineering and the aerospace industry.

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[11] http://www.energystrategy.ru/projects/docs/ES-2030_(Eng).pdf

- **Technologies**: Communication infrastructure development, electronic monitoring
- **References**:
  - http://news.panasonic.net/archives/2012/0829_13036.html

B) Belgorod District Smart City Development

- **Time period**: From 2009
- **Total budget**: N/A
- **Project partners**: San Diego Gas & Electric Company, the city of San Diego, Belgorodenergo, (the Belgorod region energy company) and the Belgorod Regional Administration, Northern Arctic Federal University
- **Objective and results**: The project aims to reduce CO_2 emissions through efficient use of electricity.
- **Technologies**: Smart metre, electronic monitoring, model houses for demonstration of HEMS, traffic control system
- **References**:
  - http://www.undp-eeb.ru/index.php?option=com_content&view=article&id=35%3A2012-01-20-20-05-39&catid=4&Itemid=37&lang=en

C) Tomsk District Smart City Development

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Tomsk Polytechnic University
- **Objective and results**: Urban development using high technology, healthcare and education
- **Technologies**: Well-balanced usage of hydropower generation, gas combined power generation and nuclear power generation (curbing CO_2 emissions), communication infrastructure development, smart metre
- **References**: http://res-eff.tpu.ru/en/

D) Novokuzneck's Smart Meter Project

- **Time period**: 2010
- **Total budget**: N/A
- **Project partners**: The city of Novokuzneck, Iskraemeco
- **Objective and results**: In the southern part of Russia, the city of Novokuzneck has been using Iskraemeco electronic metres since 2010. Around 8,000 smart metres are installed in multi-apartment buildings across the town. Along with smart metres, the buildings are using

Iskraemeco MDM software, SEP2W.

- **Technologies**: Smart metre
- **References**: http://www.smartgridimpact.com/index_download.html#map

E) PermEnergo Pilot Project

- **Time period**: 2011
- **Total budget**: N/A
- **Project partners**: Interregional Distributive Grid Company of Urals and Volga (IDGC URAL), customer in Perm region
- **Objective and results**: The PermEnergo pilot project falls under a federal programme called "Count. Save. Pay.", a key part of Russia's plan for infrastructure modernisation, and has attracted the personal interest of former President Medvedev. PermEnergo is part of a smart grid initiative by Interregional Distributive Grid Company of Urals and Volga (IDGC URAL), the business that manages distribution companies for the Perm, Sverdlovsk, Chelyabinsk, and Kurgan regions of Russia. Over two million households are serviced by IDGC URAL companies. The company intends to replace and install approximately 50,000 intelligent metres in the Perm region and integrate them into a unified ACS. The company expects that the new technology will save its customers up to 20% of their electricity usage while lowering its operating costs and improving the overall efficiency of the grid.
- **Technologies**: Smart metre
- **References**:
  - http://www.smartgridimpact.com/index_download.html#map
  - http://www.smartmeters.com/echelon-in-russion-pilot/

Most of the smart community-related projects in Russia are implemented as infrastructure development projects, such as urban development and installation of smart metres. One notable feature about these projects is that Russia is conducting a study on plans for creating more advanced future cities than the ones envisioned in other economies, not only by using advanced technologies in the fields of EMS and communication, but also by combining technologies in various fields, including bio-engineering, nuclear engineering, aviation, healthcare and education. At the moment, Russia is facing difficulty engaging in joint projects with other economies because of economic sanctions imposed by other economies due to the Ukraine issue. Therefore, in the short term, Russia may consider the feasibility of implementing smart community projects alone.

(3) References

- Energy Strategy (2009) Energeticheskaia strategiia Rossii na period do 2030 godu (Energy

strategy of Russia up to 2030)

1.17 Singapore

(1) Outline of Energy Policy

In 2007, Singapore announced the National Energy Policy Report. In particular, the "Energy for Growth Section" of the report set forth the following four points as basic policy objectives and stipulated that various measures will be implemented in line with these policy objectives: (i) economic competitiveness, (ii) energy security, (iii) environmental sustainability and (iv) industrial development. Singapore is actively introducing and using renewable energy sources, mainly PV power generation, by taking advantage of its geographical feature, that is, the long hours of sunlight particular to tropical regions. Moreover, building of smart communities in Singapore is an extension of the introduction and use of PV power generation and other renewable energy sources, and it centres on urban development projects making effective use of renewable energy, as shown by major smart community-related projects described below.

(2) Major Smart Community Projects

A) IES (Intelligent Energy System) Pilot Project

- **Time period**: 2010–2013
- **Total budget**: Approximately SGD30 million
- **Project partners**: Energy Market Authority (EMA), Accenture, ST Electronics, Nanyang Technological University
- **Objective and results**: The project aims to improve management of demand through smart grids and promote energy efficiency improvement, the introduction of distributed-type renewable energy and electric vehicles, etc. For consumers, the project presumably brings such merits as an improvement of the quality of services and products and the capability to actively manage energy consumption, pricing and CO_2 emissions. Specifically, the project will implement demonstration tests concerning three fields: smart metres, demand response management systems and management of power provided by multiple power sources. The project, to be implemented mainly at Nanyang Technological University (NTU), will also include multiple sites such as the neighboring CleanTech Park at Jalan Bahar and selected residential, commercial and industrial buildings, encompassing about 4,500 smart metres.
- **Technologies**: Smart metre, DMS, PV, EV, AMR, AMI, etc.
- **References**:
  - http://app.nccs.gov.sg/%28X%281%29S%28h2hsgj45etuvjf45dyec4hit%29%29/news_details.aspx?nid=91&AspxAutoDetectCookieSupport=1
  - http://www.smartgridimpact.com/index_download.html#map

B) Pulau Ubin Project

- **Time period**: 2013–2014
- **Total budget**: N/A
- **Project partners**: Energy Market Authority (EMA), Agency for Science, Nissan Motor, Keppel Energy
- **Objective and results**: The project aims to verify the effectiveness of the introduction of micro-grids in Singapore by demonstrating the possibility of supplying electricity through micro-grid infrastructure on Ubin Island.
- **Technologies**: PV, DMS, OMS, battery, SCADA, etc.
- **References**:
  - http://www.ema.gov.sg/Pulau_Ubin_Micro-grid_Test_Bed.aspx

C) Punggol Eco-Town- The Sustainable Waterfront Town

- **Time period**: 2011–2015, from 2015 onwards
- **Total budget**: N/A
- **Project partners**: HDB Building Research Institute, Housing & Development Board, Singapore, Panasonic, the Energy Market Authority (EMA), the Economic Development Board (EDB)
- **Objective and results**: The project aims to develop and demonstrate total energy solutions that combine energy creation, storage and management at public condominiums.
- **Technologies**: PV, battery, EMS, IHD (in home displays), etc.
- **References**:
  - http://news.panasonic.com/press/news/official.data/data.dir/jn110801-1/jn110801-1.html

As Singapore does not have domestic resources, it actively seeks foreign investments in order to boost its industries. The Economic Development Board plays the central role in the provision of preferential corporate tax treatment and protection of intellectual property in order to encourage companies to set up businesses in Singapore. The abovementioned smart community-related projects are part of these efforts. Regarding individual projects, Singapore is considering improving efficiency and stability through optimum management of all systems, and information technology systems in particular.

(3) References

- Ministry of Trade and Industry (2007), "National Energy Policy Report - Energy for Growth"

1.18 Chinese Taipei

(1) Outline of Energy Policy

Chinese Taipei's policy concerning smart communities is based on the Sustainable Energy Policy Framework, which was formulated in 2008, and is implemented as part of the building of an energy-saving, low-carbon society advocated under the framework. In addition, at a national energy conference held in 2009, Chinese Taipei adopted a plan concerning the promotion of smart grids and infrastructure and six action plans.

As a result of rapid urbanisation, the location of the main economic bloc is shifting from the economy to cities, and individual cities make decisions concerning planning and implementation of smart community programmes. There are the following two main trends: (i) energy conservation and CO_2 emission reduction; and (ii) enhancement of welfare services. Technologies related to (i) include smart grids (next-generation power transmission networks), the smart EV system and smart recycling system. Technologies related to (ii) meet citizens' various needs, including residential safety, and healthcare comfort and convenience, and they include the following.

- Residential safety: Disaster management and alarm systems and smart house security and reporting systems
- Healthcare: Remote medicine network, healthcare monitoring system and medical emergency call system for remote regions
- Comfort and convenience: Collaborative education platform, electronic settlement system, smart transportation, cloud service, Internet of Things (IOT)

In September 2012, Chinese Taipei announced the Smart Grid Master Plan, which included investments totalling four billion dollars in six implementation areas by 2030[12]. Described below are major smart community-related projects being implemented in Chinese Taipei.

(2) Major Smart Community Projects

A) Global Dissemination of an Urban Smart Transport System

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Mitsubishi Corporation
- **Objective and results**: EV, EV bus, development of a model network of charging systems that can be applied to various cities
- **Technologies**: EV, EV bus, charging system

12 http://2013twfr.weebly.com/uploads/1/8/5/2/18521992/__4-4_smart_home_energy_management_system_with_renewable_and_storage_energy_-_ht_yang.pdf

- **References**: http://www.meti.go.jp/press/2012/11/20121105001/20121105001-
  http://www.mitsubishi-motors.com/publish/pressrelease_jp/corporate/2011/news/detail4476.html

B) Building of Smart Cities in Taichung, Kinmen County, and Bade City, Taoyuan County

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: Taichung, Kinmen County, and Bade City, Taoyuan County
- **Objective and results**: Urban development using information technology
  - Taichung: "U-Speed Taichung"
    - Administrative efficiency will drastically improve following the consolidation of the county and city.
    - Broadband network: The WiMax coverage rate will expand to 80%.
    - Implementing an i-Park test in the Taichung City Precision Machinery Innovation Technology Park, construction of a database
    - Promoting application of smart energy conservation
  - (Taoyuan)
    - E-Taoyuan (2009): e-government
    - M-Taoyuan (2010): Mobile broadband network (30 WiMax base stations, 121 Wi-Fi facilities), relevant applications
    - I-Taoyuan (2011): Smart and green buildings, etc.
- **Technologies**: Broadband, Wi-Fi, cloud services
- **References**:
  - http://www.nikkei.com/article/DGXNASFK2600Z_W3A620C1000000/?df=2
  - http://www.nikkei.com/article/DGXNASFK2600Z_W3A620C1000000/?df=2
  - http://www.intelligentcommunity.org/index.php?src=news&refno=1137&category=Community&prid=1137

C) Residential Time-of-Use Power Pricing on Smart Grid

- **Time period**: 2010–2011
- **Total budget**: TWD30 billion
- **Project partners**: Taiwan Power Company
- **Objective and results**: A strategy for implementing a feasible system for residential time-of-use power pricing. Three major targets will be achieved in this study as follows:
  1. To compile the experiences of foreign enterprises in implementing power price strategies by deploying smart grids, including in the United States, France, Italy, Sweden, Singapore,

Korea, and Japan, and to analyse the similarities and differences among them for reference;

2. To comprehend the opinions of residential users on the current time-of-use metre power price system by questionnaire survey, interview and other available research approaches, and to design the residential time-of-use power price strategy and scheme for the AMI of the smart grid based on the outcomes of the survey;
3. To conduct a benefit assessment of the impact of the residential time-of-use power price system on Taipower Company and society as a whole.

- **Technologies**: AMI
- **References**: http://www.taipower.com.tw/UpFile/DownloadFile/%E6%99%BA%E6%85%A7%E9%9B%BB%E7%B6%B2(Smart%20Grid)%E4%B8%8B%E4%BD%8F%E5%AE%85%E6%99%82%E9%96%93%E9%9B%BB%E5%83%B9%E7%A0%94%E8%A8%82%E7%AD%96%E7%95%A5%E4%B9%8B%E7%A0%94%E7%A9%B6.pdf

D) New Taipei City Smart City Project

- **Time period**: N/A
- **Total budget**: N/A
- **Project partners**: New Taipei City
- **Objective and results**: Development of public LAN in public spaces, Taipei Far Eastern Telecom Park (Tpark), Xizhi economic and trade zone, Golden Corridor of Industry, smart green community, central China smart green community, municipal e-counters, etc. NTPC's government has succeeded in attracting nearly USD10 billion of investment in eight developments focused on such growth areas as ICT, digital media, biotech, green energy and logistics.
- **Technologies**: Broadband, Wi-Fi, cloud services, EV, renewables
- **References**:
  - http://www.intelligentcommunity.org/index.php?src=news&refno=1139&category=Community&prid=1139
  - http://www.japandesk.com.tw/pdffile/205p3-4.pdf

E) Demo Site of Smart Grid and AMI in Penghu

- **Time period**: 2013–2015
- **Total budget**: TWD240 million
- **Project partners** BOE, MOEA
- **Objective and results**: The first demo site for promoting AMI, micro grids, advanced power

distribution, smart home and building energy management, and electric vehicle energy supply management. Although the economy's first site, it is at a world level and will definitely reach a certain size. Penghu is being promoted as a benchmark world-class low-carbon island. In 2015, the target of reducing carbon emissions by 50% compared to 2005 will be reached, by when renewable energy will supply more than 50% of the total energy demand. The growth rate of electricity consumption will be decreased by 7%, and per capita carbon emissions will be reduced to 2.1 tons per year. The demo site shows the investment pattern on large-scale wind turbine under prefectural stake.

- **Technologies**: AMI, micro grid, advanced power distribution, smart home and building energy management, and electric vehicle energy supply management
- **References**:
  - http://www.moea.gov.tw/Mns/populace/news/News.aspx?kind=1&menu_id=40&news_id=3437
  - http://www.ee.ncu.edu.tw/~linfj/PDF/Development%20of%20Smart%20Grid%20in%20Taiwan%202012.pdf

F) ITRI Pilot Project

- **Time period**: From 2010
- **Total budget**: N/A
- **Project partners**: N/A
- **Objective and results**: ITRI is implementing AMI demonstrations for the domestic industry and regulation development. Government funding for the AMI pilot project was secured, and the involvement of 300–500 customers is planned. The pilot includes a basic functional test that may contribute to AMI regulation and standards in Chinese Taipei. The communication architecture and system interfaces will also be evaluated.
- **Technologies**: AMI
- **References**: http://www.smartgridimpact.com/index_download.html#map

From the above, it appears that many industries are involved in smart community plans in Chinese Taipei and that Chinese Taipei is promoting domestic industries while cooperating with foreign companies through these plans. In addition, in terms of enhancement of welfare services, Chinese Taipei is not only dealing with energy environmental problems but also considering increasing value added to services.

(3) References

- "Sustainable Energy Policy Framework," 2008

1.19 Thailand

(1) Outline of Energy Policy

In Thailand, on 14 February 2013, the Energy Policy and Planning Office (EPPO) of the Ministry of Energy of the central government announced the "Thailand Smart Grid Development[13]" programme, which sets out the process of development. In this process, a strategy and roadmap will be formulated in the short term, R&D on relevant technologies will be implemented in the medium term, and a smart grid will be expanded nationwide in the long term. A state-owned regional power distribution company called PEA formally announced the PEA smart grid policy on 10 March 2011, which calls for investments totalling 400 billion baht (approximately USD13 billion) over the next 15 years in a project to introduce a smart grid nationwide. In the first phase of the smart grid development under the PEA's 11th National Economic and Social Development Plan, projects worth 13,465 million baht are under consideration. The PEA will implement the smart grid development projects (phase 1) in Chiang Mai Province, Nakhon Ratchasima Province, Phuket Island and Pattaya City in Chonburi Province between 2013 and 2017. The budget of the projects is estimated at 4,860 million baht.

(2) Major Smart Community Projects

A) Amata Science City

- **Time period**: 2012–2017
- **Total budget**: N/A
- **Project partners**: The Japan Research Institute, Toshiba, NTT Data, Itochu, SMBC
- **Objective and results**: The Japanese partners will cooperate with Amata, the largest developer of industrial zones in Thailand, in making investments and formulating a master plan. In particular, they will help to introduce BEMS and provide anti-flood and other systems because of the proximity of a river.
- **Technologies**: BEMS, anti-flood and other systems
- **References**:
  - http://www.amata.com/site/inside.php?m=locations&p=6&sub=69

B) Low-Carbon Town Development Project in Koh Samui

- **Time period**: 2012–2027
- **Total budget**: N/A
- **Project partners**: Hitachi
- **Objective and results**: A regional energy plan for islands will be formulated and implemented. One of the objectives is to change lifestyles through regional energy

[13] http://www.cigre-thailand.org/tncf/events/smartgrid_15feb2013/smart_grid_policy_progress.pdf

management.

- **Technologies**: EV, HEV, fuel cell vehicle, EV charging station
- **References**:
  - http://aperc.ieej.or.jp/publications/reports/lcmt/Policy_Review_for_Koh_Samui_Thailand.pdf

C) Smart Grid in Pattaya City, Chonburi

- **Time period**: 2013–2015
- **Total budget**: THB1.485 billion
- **Project partners**: PEA
- **Objective and results**: This is a regional-level demonstration project that is part of the PEA's smart grid demonstration programme. Smart metres will be installed in all areas within the relevant region and smart grid facilities will be installed at three transformer substations.
- **Technologies**: Smart metre, battery, PV, automation, ITC, EV, power supply, EV
- **References**:
  http://thailand.ahk.de/fileadmin/ahk_thailand/Projects/Smart_Grid/Presentation/Smart_Grid_Drivers_22_Sept.pdf

D) Nakhon Nayok Province Smart City Project

- **Time period**: 2014–2015
- **Total budget**: USD21.1 million
- **Project partners**: Nakhon Nayok Province, True Corp
- **Objective and results**: The project aims to improve public services by developing wide-area communication networks and to enhance the competitiveness of provinces by making regional cities more competitive.
- **Technologies**: Communication infrastructure development
- **References**:

http://www.futuregov.in/articles/2013/mar/14/thailands-smart-city-steps-network-progress/

E) Smart Thai

- **Time period**: From 2011
- **Total budget**: N/A
- **Project partners**: The government of Thailand
- **Objective and results**: Operated by Wade Thai, Smart Thai is a 30-month European Union-funded project. It aims to improve the sustainable economic and social development

of Thailand through the efficient delivery of sustainable, economic and secure electricity using Smart/Intelligent Grid systems (SIGS) based on EU models and technologies. The specific objective of the Project is also to transform the generation, transmission and distribution network of Thailand by enhancing the capacity of Thai private and public sector organisations to introduce and promote SIGS, thereby contributing to the national development goals of Thailand related to the environment, climate change and energy security.

- **Technologies**: Smart/Intelligent Grid Systems (SIGS)
- **References**: http://www.smartgridimpact.com/index_download.html#map

In Thailand, in addition to a development plan formulated by the central government, PEA, a regional electric power company, formulated a specific roadmap for smart grids and is implementing a project. Presumably, the PEA is considering implementing more advanced infrastructure development in regions within Thailand by accumulating experiences through such activities as introducing smart technologies at the power distribution level, in addition to inviting industries and implementing development projects on islands.

(3) References

- Ministry of Energy (2013), “Thailand Smart Grid Development”
- PEA (2013), “The 11th National Economic and Social Development Plan (2012–2016)”

1.20 The United States

(1) Outline of Energy Policy

President Obama is advocating the use of renewable energy and energy conservation, which are expected to contribute to the fight against climate change, technological innovations in US industries, job creation and growth. Specific measures for this purpose include infrastructure investments that contribute to smart grid development by combining the improvement of power transmission networks and information and communication technology, the promotion of advanced vehicles and reduction of public transport systems’ dependence on oil. The Obama administration cited promoting the use of renewable energy electricity, curbing electricity demand and modernising power transmission infrastructure as its policy for the electricity sector that takes into account the fight against climate change.

In particular, the Obama administration places emphasis on power transmission networks because the infrastructure project for building the networks creates jobs and because smart grids that realise real-time, interactive control through information and communication technology contribute to energy conservation. Policy measures related to smart grids and communities include several relevant programmes that were launched under the Energy Independence and Security Act (EISA) and are now being implemented under the American Recovery and Reinvestment Act (ARRA). The two major projects are the Smart Grid Investment Grants (SGIG)[14] and the Smart Grid Demonstration Project (SGDP)[15], which are being implemented by the DOE. In addition, a variety of other projects related to power transmission and distribution networks are being implemented under the grant programme, including the Renewable and Distributed Systems Integration (RDSI) Programme[16] and Smart Grid Workforce Training and Development[17].

These are five-year programmes that are operated by the Office of Electricity Delivery and Energy Reliability within the DOE. While the SGIG focuses on improving the performance of power transmission networks by disseminating existing smart grid technologies and equipment, the SGDP focuses on developing new smart grid technologies and energy storage technologies, with a view to evaluating future practicality[18].

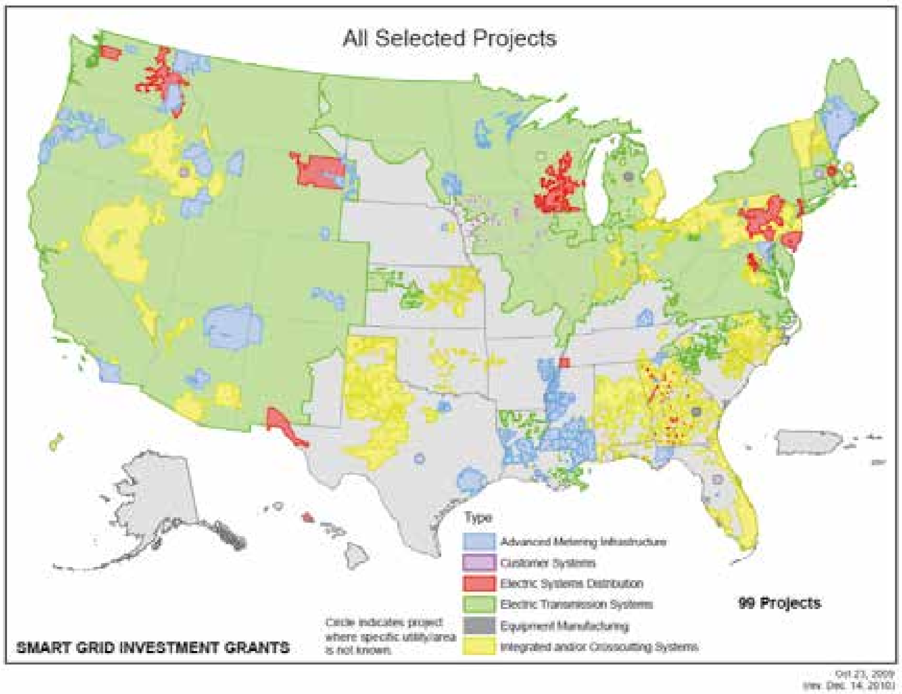

Figure 1-1 Smart Grid Investment Grant Programme

[14] There are 99 SGIG projects with a total budget of about USD8 billion. The federal share is about USD3.4 billion.
[15] The program consists of 32 projects in two areas: Smart Grid Regional Demonstrations (16 projects) and Energy Storage Demonstrations (16 projects). The total budget for the 32 projects is about USD1.6 billion; the federal share is about USD600 million.
[16] Including the cost share of recipients, the combined budget of the nine projects exceeds USD100 million. The projects from ATK, Chevron, and MonPower did not receive any funds provided through the American Recovery and Reinvestment Act.
[17] USD100 million was designated for workforce training.
[18] https://www.smartgrid.gov/recovery_act/project_information

Source: Smart Grid Investment Grant Programme

Described below are representative demonstration projects related to smart communities and smart grids.

(2) Major Smart Community Projects

A) SmartSacramento Project (Sacramento Municipal Utility District (SMUD))

- **Time period**: From 2011
- **Total budget**: approximately USD308 million
- **Project partners**: California State University Sacramento, State of California's Department of General Services, County of Sacramento, Los Rios Community College District, Elk Grove Unified School District, the Sacramento City Unified School District
- **Objective and results**: The objectives are reducing metre-related costs and power distribution loss costs, improving service reliability, reducing greenhouse gas emissions, standardising pollution emission amounts and reducing fuel usage by trucks.
- **Technologies**: Smart metre, EV, automation of power distribution, smart network management, aggregation (demand response, VPP), smart customer and smart home, electric vehicles and Vehicle2Grid applications, advanced metring infrastructure (AMI) and distribution automation systems
- **References**
  - https://www.smartgrid.gov/sites/default/files/pdfs/project_desc/SMUD%20Project%20Description%2008-08-2013%20with%20PEP%20addendum%20and%20revise....pdf
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

B) Smart Grid Project

- **Time period**: 2009–2015
- **Total budget**: approximately USD640 million
- **Project partners**: CenterPoint Energy Houston Electric (CEHE), LLC
- **Objective and results**: (i) Automating metre reading, (ii) reducing use of trucks, (iii) enabling residential and commercial customers to effectively manage and control their electricity usage and (iv) improving distribution system efficiency and reliability
- **Technologies**: AMI, customer system, power distribution system
- **References**:
  - https://www.smartgrid.gov/sites/default/files/pdfs/project_desc/CenterPoint%20Houston%20Project%20Description_20131209.pdf

C) Research Development and Demonstration of Peak Load Reduction on Distribution

Feeders Using Distributed Energy Resources for the City of Fort Collins

- **Time period**: 2008–2013
- **Total budget**: approximately USD12 million
- **Project partners**: Fort Collins Utilities, Colorado State University, Advanced Energy Brendle Group, Eaton Corporation, InteGrid Laboratory, New Belgium Brewing Spirae, Inc, Woodward Governor Company, Larimer County Eaton
- **Objective and results**: The project aims to reduce the peak load by 20–30% and demonstrate the maximum export and import volume in a state of deliberate isolation and the benefit of concentrating distributed energy resources (DER) of participating regions.
- **Technologies**: PV, micro-turbine, dual fuel CHP system, wind turbine simulator, plug-in hybrid vehicle, fuel cell
- **References**:
  - https://www.smartgrid.gov/sites/default/files/pdfs/project_desc/NTO2876_RDSI%20Fact%20Sheet%20FortCollins_3.0.pdf

D) Beacon Power 20MW Flywheel Frequency Regulation Plant

- **Time period**: 2010–2015
- **Total budget**: approximately USD52 million
- **Project partners**: Hazle Spindle LLC, Beacon Power LLC, PJM Interconnection, PPL Electric Utilities, George J Hayden Inc
- **Objective and results**: The project aims to demonstrate flywheel technology. It also explores commercial feasibility and quantifies the scale of smart grid energy storage technology.
- **Technologies**: Flywheel
- **References**:
  - https://www.smartgrid.gov/sites/default/files/pdfs/project_desc/OE0000200_Fact%2520Sheet_Beacon%2520Power%2520Jul2013_3.0%5B1%5D_0.pdf

E) Smart Grid Demonstration Site in Los Alamos County

- **Time period**: 2009–2013
- **Total budget**: Approximately JPY4.8 billion (approximately JPY3.0 billion at the Los Alamos site and approximately JPY1.8 billion at the Albuquerque site)
- **Project partners**: New Energy and Industrial Technology Development Organization, Toshiba Corporation, Kyocera Corporation, Accenture, Itochu Corporation, Itochu Techno-Solutions Corporation, NTT Facilities, Cyber Defense Institute, Sharp, NGK Insulators, NEC, Hitachi

- **Objective and results**: The project will demonstrate superior technologies cultivated in Japan (large storage batteries for grids, energy management systems, etc.) in order to expand the introduction of new energy and promote energy conservation, will promote participation in activities to standardise smart grids, the conceptualisation of which is progressing rapidly in economies around the world, and will disseminate Japanese smart grid-related technologies abroad.
- **Technologies**: PV, control of large storage batteries for power grids, demand response
- **References**: http://jpn.nec.com/press/201209/20120918_01.html

F) Smart Grid Project in Boulder, Colorado State ("SmartGridCity," or SGC)

- **Time period**: From 2008
- **Total budget**: N/A
- **Project partners**: Accenture, citizens of Boulder City
- **Objective and results**: The project aims to build a smart grid on a citywide scale for the first time in the world.
- **Technologies**: Smart metre, infrastructure related to plug-in hybrid electric vehicles (PHEV)
- **References**:

http://www.accenture.com/SiteCollectionDocuments/jp-ja/PDF/industry/Utilities/Accenture_Smartgrid_Energyforum_128.pdf

G) gridSMART (SM) Demonstration Project

- **Time period**: N/A
- **Total budget**: approximately USD149 million
- **Project partners**: AEP Ohio
- **Objective and results**: The demonstration area includes 150 square miles including approximately 110,000 metres and seventy distribution circuits. AEP Ohio will implement Smart Grid technology over fifty-eight 13-kV circuits" from ten distribution stations and twelve 34.5-kV circuits from six distribution stations. Included in this project is a redistribution management system, integrated volt-VAR control, distribution automation, advanced metre infrastructure, home area networks, community energy storage, sodium-sulphur battery storage, and renewable generation sources.
- **Technologies**: Smart network management, smart customer and smart home, integration of DER, smart metring, aggregation (demand response, VPP), electric vehicles and Vehicle2Grid applications, advanced metring infrastructure (AMI) and distribution automation systems
- **References**:

- ISGAN (2013), Smart Grid Project Catalogue Part 1

H) Pacific Northwest Division Smart Grid Demonstration Project

- **Time period**: N/A
- **Total budget**: approximately USD178 million
- **Project partners**: Battelle Memorial Institute
- **Objective and results**: More than 20 types of responsive smart grid assets will be tested across six regional and utility operational objectives at 15 unique distribution sites operated by 12 utilities across five states and three climatic regions. A base of smart grid technology serving more than 60,000 customers will be installed, validated and operated. The demonstration will develop a single integrated Smart Grid incentive-signalling approach and will test and validate its ability to continuously coordinate the responses of Smart Grid assets to meet a wide range of operational objectives. It will also use distributed control to mitigate wind integration problems. Micro-grid islanding will also be evaluated for its potential to enhance reliability for customers and relieve energy demand.
- **Technologies**: Smart network management, integration of DER, integration of large-scale RES, advanced metring infrastructure (AMI) and distribution automation systems
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

I) Smart Grid Project

- **Time period**: N/A
- **Total budget**: approximately USD330 million
- **Project partners**: Southern Company Services, Inc
- **Objective and results**: This project involves integrated upgrades of the distribution, transmission, and grid management systems. Major efforts include automation of major parts of the distribution system, automation of selected transmission systems, and new equipment for many substations.
- **Technologies**: Smart network management, distribution and substation automation
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

J) Smart Grid Deployment

- **Time period**: N/A
- **Total budget**: approximately USD551 million
- **Project partners**: Duke Energy Carolinas, LLC

- **Objective and results**: The project involves large-scale deployments of AMI and distribution automation in Ohio and Indiana, a pilot deployment of AMI and distribution automation in Kentucky, and deployment of distribution automation in North and South Carolina. The project includes pilot programmes for electricity pricing including time-of-use rates, peak-time rebates, and critical-peak pricing. Customers in these pilot programmes use home area networks, web portals, and direct load control devices to reduce their electricity consumption and peak demand. Distribution automation equipment will be installed on 1,926 out of 4,741 circuits.
- **Technologies**: Smart metring, smart customer and smart home, aggregation (demand response, VPP), smart network management, advanced metring infrastructure (AMI) and distribution automation systems
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

K) Smart Grid Project

- **Time period**: N/A
- **Total budget**: approximately USD227 million
- **Project partners**: EPB
- **Objective and results**: The project is implementing two-way communications and metring expected to: (1) enable customers to view their energy consumption at their convenience through systems such as web portals, (2) provide time-based rate programmes to customers, (3) provide information and tools to improve outage management, and (4) reduce operating and maintenance costs
- **Technologies**: Smart metring, smart customer and smart home, aggregation (demand response, VPP), smart network management
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

L) Energy Smart Florida

- **Time period**: N/A
- **Total budget**: approximately USD579 million
- **Project partners**: Florida Power & Light Company (FPL)
- **Objective and results**: This project is deploying advanced metring infrastructure (AMI), distribution automation, new electricity pricing programmes, and advanced monitoring equipment for the transmission system. AMI supports two-way communication between FPL and its three million consumers receiving smart metres, providing detailed information about

electricity usage and the ability to implement new electricity pricing programmes. New distribution automation devices expand the functionality of FPL's distribution system to increase reliability, reduce energy losses, and reduce operating and maintenance costs.

- **Technologies**: Smart metring, smart customer and smart home, aggregation (demand response, VPP), smart network management
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

M) Enhanced Demand and Distribution Management Regional Demonstration

- **Time period**: N/A
- **Total budget**: approximately USD68 million
- **Project partners**: National Rural Electric Cooperative Association
- **Objective and results**: This project is demonstrating smart grid technologies with 27 cooperatives in 11 states across multiple utilities, geographies, climates, and applications including low density areas, low consumer income areas, and service areas prone to natural disasters. NRECA will conduct studies on advanced volt/volt-ampere reactive control for total demand.
- **Technologies**: Smart metring, smart network management, aggregation (demand response, VPP), smart customer and smart home
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

N) Positive Energy Smart Grid Integration Programme

- **Time period**: N/A
- **Total budget**: USD293 million
- **Project partners**: Oklahoma Gas and Electric (OG&E)
- **Objective and results**: The programme aims at reducing peak loads, overall electricity use, and operating and maintenance costs while increasing the efficiency, reliability, and power quality of the distribution system. The programme implements secure wireless communications to: (1) allow smart metre customers to view their electricity consumption data through a personalised web site, and (2) allow OG&E to manage, measure, and verify targeted demand reductions during peak periods. The new systems capture metre information for billing and implement new customer pricing programmes and service offerings. The project deploys a more dynamic distribution management system, automated switching, and integrated voltage and reactive power control (IVVC) that reduces line losses, reduces operating costs, and improves service reliability.

- **Technologies**: Smart metring, smart network management, aggregation (demand response, VPP), smart customer and smart home, advanced metring infrastructure (AMI) and distribution automation systems
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

O) SmartGrid Programme

- **Time period**: N/A
- **Total budget**: USD16.2 million
- **Project partners**: Talquin Electric Cooperative
- **Objective and results**: The project is implementing two-way communications to: (1) enable customers to view their energy consumption at their convenience through customer systems and web portals, (2) provide time-based rate programmes to customers, (3) provide information and tools to improve outage management, and (4) reduce operating and maintenance costs. The project is also installing automated distribution grid equipment expected to: (1) enhance the reliability and quality of electric delivery, and (2) reduce operating and maintenance costs.
- **Technologies**: Smart metring, smart network management, aggregation (demand response, VPP), smart customer and smart home, advanced metring infrastructure (AMI) and distribution automation systems
- **References**:
  - ISGAN (2013), Smart Grid Project Catalogue Part 1

Projects being implemented under the Smart Grid Demonstration Programme are listed below.

Table 1-3 Smart Grid Demonstration Programme in the United States

Title	States	Award Amount ($)	Total Project Value ($)
AEP Ohio (gridSMARTSM Demonstration Project)	Ohio	75,161,246	148,821,823
Amber Kinetics, Inc. (Flywheel Energy Storage Demonstration)	California	3,694,660	7,457,591
Aquion Energy (Sodium-Ion Battery for Grid-level Applications)	Pennsylvania	5,179,000	10,359,827
Battelle Memorial Institute (Pacific Northwest Division Smart Grid Demonstration Project)	Washington	88,821,251	177,642,503
Beacon Power (20 MW Flywheel Frequency Regulation Plant)	Massachusetts	24,063,978	52,415,000
CCET (Technology Solutions for Wind Integration)	Texas	13,516,546	27,075,457
City of Painesville, Ohio (Vanadium Redox Battery Demonstration Program)	Ohio	4,243,570	9,462,623
Consolidated Edison Company of New York, Inc. (Secure Interoperable Open Smart Grid Demonstration Project)	New York	45,388,291	92,388,217
Detroit Edison (Advanced Implementation of Energy Storage Technologies)	Michigan	4,995,271	10,877,258
Duke Energy Business Services (Notrees Wind Storage Demonstration Project)	North Carolina	21,806,226	43,612,464
East Penn Manufacturing Co. (Grid-Scale Energy Storage Demonstration Using UltraBattery Technology)	Pennsylvania	2,543,523	5,087,269
Kansas City Power and Light (Green Impact Zone SmartGrid Demonstration)	Missouri	23,940,112	49,830,280
Ktech Corp (Flow Battery Solution for Smart Grid Renewable Energy Applications)	New Mexico	4,764,284	9,528,568
Long Island Power Authority (Long Island Smart Energy Corridor)	New York	12,496,047	25,293,801
Los Angeles Department of Water and Power (Smart Grid Regional Demonstration)	California	60,280,000	120,560,000
National Rural Electric Cooperative Association (Enhanced Demand and Distribution Management Regional Demonstration)	Virginia	33,932,146	67,864,292
New York Power Authority (Evaluation of Instrumentation and Dynamic Thermal Ratings for Overhead Lines)	New York	720,000	1,440,000
New York State Electric and Gas (Advanced Compressed Air Energy Storage)	New York	1,394,453	2,942,265

NSTAR Electric and Gas Corporation (Automated Meter Reading-Based Dynamic Pricing)	Massachusetts	2,362,000	4,877,989
NSTAR Electric and Gas Corporation (Urban Grid Monitoring and Renewables Integration)	Massachusetts	5,267,592	10,591,934
Oncor Electric Delivery Company (Dynamic Line Rating)	Texas	3,471,681	7,136,552
Pacific Gas and Electric Company (Advanced Underground Compressed Air Energy Storage)	California	25,000,000	355,938,300
Pecan Street Project Inc (Energy Internet Demonstration)	Texas	10,403,570	24,657,078
Premium Power (Distributed Energy Storage System)	Massachusetts	6,062,552	12,514,660
Primus Power Corporation (Wind Firming EnergyFarm)	California	14,000,000	46,700,000
Public Service Company of New Mexico (PV Plus Battery for Simultaneous Voltage Smoothing and Peak Shifting)	New Mexico	2,305,931	6,113,433
Seeo Inc (Solid State Batteries for Grid-Scale Energy Storage)	California	6,196,060	12,392,122
Southern California Edison Company (Irvine Smart Grid Demonstration)	California	39,621,208	79,242,416
Southern California Edison Company (Tehachapi Wind Energy Storage Project)	California	24,978,264	49,956,528
SustainX Inc. (Isothermal Compressed Air Energy Storage)	New Hampshire	5,396,023	13,046,588
The Boeing Company (Boeing Smart Grid Solution)	Missouri	8,561,396	17,172,844
Waukesha Electric Systems Inc (Fault Current Limiting Superconducting Transformer)	Wisconsin	10,239,411	20,478,822

Source: Compiled from the Smart Grid Demonstration Program (SGDP).
https://www.smartgrid.gov/recovery_act/overview/smart_grid_demonstration_program

(3) References

- DOE, "Smart Grid Investment Grant Program"
  https://www.smartgrid.gov/recovery_act/overview/smart_grid_investment_grant_program
- DOE, "Smart Grid Demonstration Program"
  https://www.smartgrid.gov/recovery_act/overview/smart_grid_demonstration_program
- ISGAN (2013), Smart Grid Project Catalogue Parts 1 and 2

1.21 Viet Nam

(1) Outline of Energy Policy

Viet Nam announced the goal of increasing the proportion of electricity generated through renewable energy from 3.5% in 2010 to 4.5% in 2020 by giving priority to the use of renewable energy sources for power generation based on the Power Development Master Plan 7 (PDP7), which was formulated in July 2011. In addition, under the 8th Five-Year Plan for Socio-Economic Development (2006–2010), which was formulated in 2006, Viet Nam set the national goal of becoming a middle-income economy by 2010 and becoming an industrialised economy by 2020, recognising the importance of promoting science and technology for achieving the goal. Accordingly, Viet Nam is considering expanding the use of renewable energy and promoting high-tech industries and building smart communities as part of the science and technology policy. Viet Nam also aims to achieve a stable power supply within service areas by using smart grid technology. The details of major smart community-related projects being implemented in Viet Nam are as follows.

(2) Major Smart Community Projects

A) New Town and High-tech Park Smart Community Development

- **Time period**: 2012–2016
- **Total budget**: USD1.5 billion
- **Project partners**: Toshiba, Toshiba Solutions, Nippon Koei, Azusa Sekkei, ESPAD Environmental Space Planning & Architectural Design, SMBC
- **Objective and results**: Japanese companies present a comprehensive proposal covering the formulation of plans for building a smart community within the park, system construction, and management and recovery of funds, and implement the plans together with developers. Through this, they implement a system model integrating processes concerning smart community development from formulation of plans to recovery of funds, and disseminate the model widely in and outside Japan.
- **Technologies**: Construction of systems for smart community development

B) Binh Duong New City Development

- **Time period**: 2012–2020
- **Total budget**: USD1.2 billion
- **Project partners**: Becamex Tokyu (65% owned by Tokyu Corporation and 35% owned by Becamex)
- **Objective and results**: The project aims to export a town building package by taking advantage of the knowhow acquired through the Tama Den-en City. It will build a city that uses a smart grid and raise the value of real estate. A cost-benefit analysis of energy

conservation will be conducted through a feasibility study.

- **Technologies**: Smart metre, energy conservation equipment, EMS, power failure-proof storage batteries, etc.
- **References**:
  - http://www.becamex-tokyu.com/
  - http://www.tokyu.co.jp/ir/upload_file/library_06_02/9005_2010060914253103_P06_.pdf
  - http://www.meti.go.jp/meti_lib/report/2014fy/E003878.pdf

C) Ha Noi Software Technology Park

- **Time period**: Scheduled to be completed in 2016
- **Total budget**: N/A
- **Project partners**: Hanel Limited Company, Sai Dong Urban Investment and Development JSC, Toshiba (feasibility study)
- **Objective and results**: This urban development project aims to create a cluster of software-related companies in order to achieve industrial and economic development for Ha Noi City.
  - Reducing the environmental impact of common infrastructure, including water and electricity infrastructure
  - Improving energy efficiency of buildings and reducing costs
  - Creating smart houses: comfort, safety and convenience
  - Toshiba is conducting a feasibility study on optimising city management and increasing the value of real estate.
- **Technologies**: EMS, PV, battery, smart metre, etc.
- **References**:
  - http://www.meti.go.jp/meti_lib/report/2012fy/E003006.pdf

In addition to the abovementioned projects in which Japanese companies have been involved from the commercialisation stage, there are smart community-related projects implemented mainly based on capacity building support provided by the ADB.

D) Green Cities: A Sustainable Urban Future in Southeast Asia

- **Time period**: 2013–2015
- **Total budget**: USD870,000
- **Project partners**: Regional governments, urban development companies, etc.
- **Objective and results**: The project provides technical assistance related to green city action

plans in Viet Nam (at the moment, assistance is provided to two cities). It also aims to build the capacity of stakeholders and regional governments involved in green city development.

- **Technologies**: N/A
- **References**:
  - http://www.adb.org.projects/46474-001/main

E) Ha Noi and Ho Chi Minh City Power Grid Development Sector Project

- **Time period**: 2012–2015
- **Total budget**: USD744,000
- **Project partners**: Regional governments, local companies, etc.
- **Objective and results**: The project provides technical assistance related to power generation and transmission in Viet Nam (assistance is provided to two cities). It also aims to develop power generation and transmission systems.
- **Technologies**: N/A
- **References**:
  - http://www.adb.org/projects/46391-002/main

F) Transmission Efficiency Project (TEP)

- **Time period**: 2014 (approval) to 2019
- **Total budget**: approximately USD731 million
- **Project partners**: National Power Transmission Company (NPT)
- **Objective and results**: The development objective of the Transmission Efficiency Project for Viet Nam is to improve the capacity, efficiency, and reliability of electricity transmission services in selected parts of the electricity transmission network in the territory of the borrower. The project is comprised of three components. The first component, enhancing transmission infrastructure, will finance transmission lines and substations at voltage levels of 220kV and 500kV. The second component, developing a smart grid network, will support modernisation of monitoring, control, and protection equipment in 500kV and 220kV substations to improve the reliability of the interconnected power system as a whole and of some bulk-supply points in the distribution network. The third component, capacity building, will contribute to the gradual development of the national power transmission company (NPT) to become an independent transmission company with revenues from the application of performance-based regulations in the transmission sector and support efficient reform of the overall power sector.
- **Technologies**: N/A
- **References**:

- http://www.worldbank.org/projects/P131558?lang=en

G) Distribution Efficiency Project

- **Time period**: 2012 (approval) to 2018
- **Total budget**: USD800 million
- **Project partners**: Vietnam Electricity (EVN), Ministry of Industry & Trade (MOIT)
- **Objective and results**: The development objectives of the Distribution Efficiency Project are to improve the performance of Viet Nam's power corporations (PCs) in providing quality and reliable electricity services, and to reduce greenhouse gas emissions through demand side response and efficiency gains. There are three components to the project. The first component is system expansion and reinforcement. The second component is introduction of smart grid technologies in distribution. The third component is technical assistance and capacity building. Technical assistance to and capacity building of the Electricity Regulatory Authority of Vietnam (ERAV) will also be provided.
- **Technologies**: N/A
- **References**:
  - http://www.worldbank.org/projects/P125996/distribution-efficiency-project?lang=en

In addition to these smart community projects, there are a large number of urban development plans. Under these projects, more specific studies will be conducted on the introduction of technologies related to smart communities and smart grids. Viet Nam, which has been maintaining economic development, is promoting smart community-related projects in order to develop new cities as residential areas and to develop regions and cities integrated with industries.

(3) References

- Power Development Master Plan 7 (2011)

2 Electricity Business in the Selected APEC Economies Where Smart Community Demonstrations are Ongoing

The knowhow and technologies, acquired through smart community demonstration projects, should be suited to the energy situation in the respective economies for future continuous penetration and utilisation. Therefore, this chapter outlines the business regulations and market situation in the major APEC economies for the consideration of future smart community projects outlook.

2.1 Australia

(1) Regulatory Framework

As Australia has a federal system, there are federal- and state-level regulations. The federal government is responsible for regulating interstate matters, including the wholesale electricity market, the transmission sector, electricity distribution pricing and the retail sector excluding pricing. Meanwhile, state governments are responsible mainly for regulating retail pricing. The Australian Energy Regulator (AER), which is under the Australian Competition and Consumer Commission (ACCC), equivalent to a federal fair trade commission, functions as an energy-related regulatory agency. The AER is responsible for the national electricity market (NEM), economic regulations concerning the power transmission and distribution sector within the NEM, and regulation of the retail sector excluding pricing.

The Australian Energy Market Commission (AMEC) is responsible for formulating and reviewing rules concerning the NEM and the natural gas market as an independent agency, and it also presents policy recommendations to the Standing Council of Energy and Resources (SCER), which is comprised of energy ministers of the federal and regional governments.

(2) Wholesale Market (incl. ancillary services)

The electricity supply system can be broadly divided into the eastern region, which is comprised mainly of the NEM, the state of Western Australia, and the Northern Territory. The NEM plays a particularly important role as a wholesale electricity market. Currently, six eastern regions – Queensland, New South Wales, Victoria, South Australia, Tasmania and the Australian Capital Territory (ACT) – are participating in the NEM and are engaging in the electricity business. The Australian Energy Market Operator (AEMO) operates and manages the NEM. The states participating in the NEM appoint executives of AEMO as its major shareholders. In addition to calculating spot prices and making price adjustments between market participants, AEMO is also responsible for maintaining the supply-demand balance and disclosing various indexes to the market. Among participants in the NEM are power generators, network service providers, users and traders. There are day-ahead markets for energy and ancillary services.

Table 2-1 Outline of the NEM

Participating jurisdictions	Qld, NSW, Vic, SA, Tas, ACT
NEM regions	Qld, NSW, Vic, SA, Tas
Installed capacity	48 321 MW
Number of registered generators	317
Number of customers	9.3 million
NEM turnover 2012–13	$12.2 billion
Total energy generated 2012–13	199 TWh
National maximum winter demand 2012–13	30 491 MW[1]
National maximum summer demand 2012–13	32 539 MW[2]

MW, megawatts; TWh, terawatt hours.

1 The maximum historical winter demand of 34 422 MW occurred in 2008.

2 The maximum historical summer demand of 35 551 MW occurred in 2009.

Source: AER (2013), State of the Energy Market 2013

(3) Retail Market

As of April 2013, in all states of Australia except for the states of Western Australia and Tasmania, the retail market, including for household users, was fully liberalised. In the states of Western Australia and Tasmania as well, the scope of liberalisation has gradually been expanded. Users with annual electricity usage of 50,000kWh or more have been covered by liberalisation in the state of Western Australia since January 2005 and in the state of Tasmania since July 2011. The AER has pointed out that in the state of Victoria, where liberalisation started earlier than anywhere else within the NEM area, moves to re-integrate power generators and retailers to promote market concentration and mitigate the risk of retail electricity price volatility are becoming prominent. More specifically, while there are around 20 companies which have a retail supply license in each state, three companies – AGL Energy, Origin Energy, Energy Australia – hold a combined share of 76% in the NEM area. As for the reintegration of power generation and retail sales, these three companies together own a majority (58%) of the power generation plants that have started operating since 2007. Similar moves are spreading among other companies. The customer switching rate of suppliers is the highest in the state of Victoria, which has been promoting liberalisation ahead of other regions; in

2012, the switching rate there reached 30%.

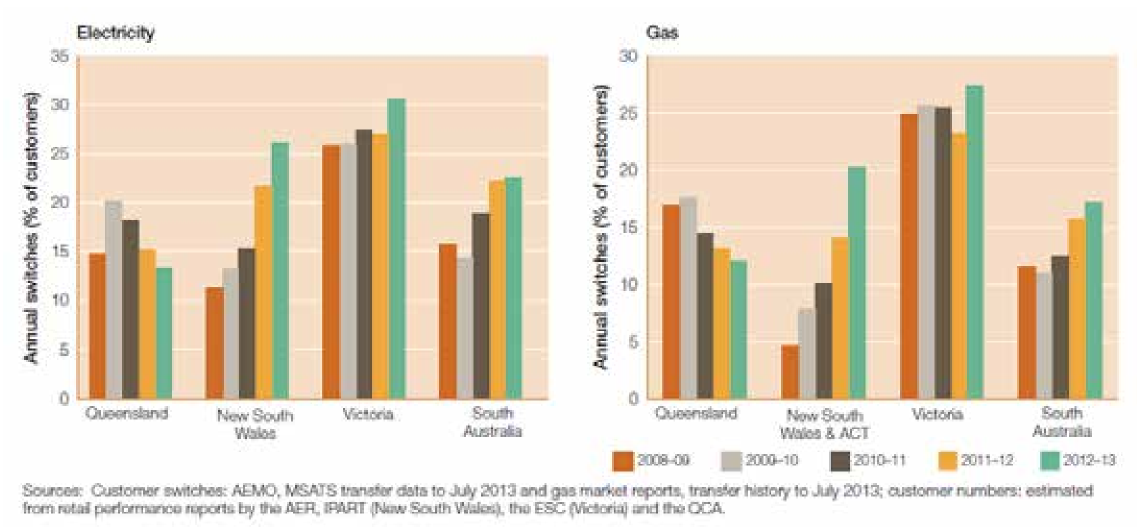

Figure 2-1 Customer Switching of Energy Retailers, as a Percentage of Small Customers

Source: AER (2013), State of the Energy Market 2013

http://www.aer.gov.au/publications/state-of-the-energy-market-reports

2.2 People's Republic of China

(1) Regulatory Framework

In China, as a result of the electricity system reform at the end of 2002, the National Energy Administration under the National Development and Reform Commission and the State Power Management Commission became the main regulatory organisations in the electricity sector. The National Development and Reform Commission formulates policies concerning the energy sector in general. Regarding the electricity sector, the Power Industry Department is responsible for such work as approving electricity pricing (wholesale and retail pricing) and the construction of large-scale power generation plants and power transmission and transformer facilities. The State Power Management Commission was responsible for directly supervising power companies, complementing the functions of the National Development and Reform Commission, which controls wholesale electricity transactions and issues electricity business licenses. However, the State Power Management Commission was integrated into the National Energy Administration as a result of the organisational reform in June 2013, and thus the authorities over the licensing of distribution of and changes in electricity supply service areas, the issuance of electricity supply licenses and the issuance of electricity business licenses were transferred to regional offices of the National Energy Administration.

As for the outline of the current regulation of the electricity business in China, the authority over the issuance of local licenses belongs to regional offices of the National Energy Administration. The

National Energy Administration conducts examinations and presents proposals with regard to power transmission fees and costs, and the National Development and Reform Commission grants final approval for electricity prices, power transmission fees and the construction of power generation plants, while the State Council approves oil and gas prices. The National Development and Reform Commission and the National Energy Administration jointly conduct examinations regarding various prices.

(2) Wholesale Market (incl. ancillary services)

In China, some initiatives to liberalise the electricity market have been implemented on a trial basis. However, primarily, two power transmission and distribution companies (State Grid Corporation of China and China Southern Power Grid[19]) purchase electricity from five major power generators (China Huaneng Group, China Datang Corporation, China Huadian Corporation, China Guodian Corporation and China Power Investment Corporation), and then electricity is supplied to users exclusively through regional power grid companies, and provincial power transmission and city and county level power distribution companies under the control of the major power companies. Provincial power companies are responsible for power supply in individual service areas and they issue power supply instructions to most power generation plants. Power interchange between provincial power companies is managed by regional power grid companies and China Southern Power Grid. State Grid Corporation of China manages power interchange between regional power grid companies. Under this structure, power generation and power transmission/distribution are separated. However, power transmission and distribution companies are also responsible for retail sales, so this is similar to a vertically integrated system, with only power generation separated.

[19] These two companies are state-owned and are subject to supervision by the State-owned Assets Supervision and Administration Commission, an organisation within the State Council. The service area of State Grid Corporation of China is divided into five grids companies: North China Grid, Northeast China Grid, East China Grid, Central China Grid and Northwest China Grid.

Figure 2-2 Supply Areas of Large Power Grid Companies
Source: State Grid Corporation of China

As a result of the electricity system reform in 2002, the State Power Management Commission, which was the organisation responsible for supervising the electricity sector at that time, prepared a "Guiding opinion concerning the construction of regional electricity markets," "Basic rules on the operation of electricity markets," "Rules on electricity market management" and "Standard of technical support system functions for the electricity market," and it developed markets and conducted trials of direct transactions between power generators and users and wholesale bidding in the northeastern region, the eastern region and the southern region. The trials are ongoing in all these regions. Regarding ancillary services, power generators are required to meet the specifications necessary for providing the services. Final ancillary services are provided after the examination of the characteristics and status of power generation plants based on instructions from grid operators under a vertical integration structure.[20]

(3) Retail Market

Retail electricity sales are undertaken exclusively by county level power distributors, so liberalisation regarding the selection of retail companies has not proceeded in China. Wholesale and

[20] China Electric Power Research Institute (2012), Study on Ancillary Services and Grid Connection Standardisation for Integrating Renewable Energy into Chinese Smart Grid

retail electricity prices are determined at the provincial level in accordance with pricing systems regulated by the central government, so both supply and pricing are regulated. In December 2004, the central government introduced a coal-electricity price link system, under which electricity prices may be revised in accordance with changes in coal prices, but the central government has the discretion regarding whether or not the system may be applied. Electricity price revision has been conducted seven times by 2011 based on the coal-electricity price link system or for reasons such as resolving losses incurred by power companies. As coal prices sometimes showed significant movements after 2008, it became difficult to keep the balance between coal and electricity prices and between the management of coal companies and that of power companies. Therefore, regarding prices, the State Council showed signs of flexibility such as leaving pricing to the discretion of companies. For example, regarding coal for power generation, the State Council abolished the twin pricing system comprised of priority contract prices and market prices and announced a policy under which coal companies and power generators determine prices based on voluntary consultations. There is a tendency that electricity prices for non-industrial and agricultural users are high in economically developed regions while they are kept low in other regions. As for future reform of retail electricity pricing, a progressive increase system was introduced in July 2012 for prices of electricity for living needs nationwide on a trial basis except for the Tibet and Xinjiang Uyghur Autonomous Regions.

2.3 Japan

(1) Regulatory Framework

In Japan, general electric utilities with a vertically integrated structure which have a regional monopoly are responsible for supplying power to meet general needs in the supply areas for which they have obtained a license. When supplying power, power companies need to obtain approval from the Minister of Economy, Trade and Industry with regard to electricity prices and supply terms.

Since 1995, the Electricity Business Act has been gradually revised with regard to the regulation of the electricity business. In 1995, the principle of competition was introduced into the power generation sector and pricing regulations were revised. As a result of the revision in 1999, the retail sector was partially liberalised and new entry using power companies’ networks was permitted. As a result of the revision in 2003, behaviour regulations were introduced, the Japan Electric Power Exchange (JEPX) was established, basic rules concerning grid operation were formulated, and the Electric Power System Council of Japan (ESCJ), a neutral organisation for dispute settlement, was established.

In response to the debate on the revision of the energy system that was prompted by the Great East Japan Earthquake and the nuclear accident at Fukushima Daiichi Nuclear Power Station in 2011, a study is being conducted on new measures to be taken in the electricity business. There is a roadmap that envisions the establishment of a wide-area grid operation organisation and a shift to a new regulatory organisation by 2015, full liberalisation of retail sales, the creation of a new mechanism to ensure supply capacity and an hour-ahead market by 2016, and the abolition of retail price regulation and legal separation of the power transmission and distribution sectors by 2018–2020.

(2) Wholesale Market (incl. ancillary services)

In response to the decision to establish a private, voluntary wholesale electricity exchange, made at a meeting of the Electricity Industry Committee in 2003, the JEPX was established in November of the same year. In order to secure trading volume, the Electricity Industry Committee considered whether or not to impose obligations on existing power companies with regard to bidding on the exchange. Although the committee decided not to obligate power companies to input power sources, the companies voluntarily expressed their views on initial input. In April 2005, a market that mediates day-ahead spot electricity trading and forward transactions was opened. In the hour-ahead market, transactions are conducted through a system under which one price is set for one auction in each trading time zone, while in the forward market, forward contract transactions are conducted on a bilateral basis. Ancillary services are provided by general electric utilities, with the costs recovered widely from users in the form of retail supply fees and consigned supply fees.

In the debate on the electricity system reform, the opinion was expressed that in order to enhance the transparency of ancillary service costs, measures should be taken to create an ancillary market in which power sources used for ancillary services are procured and to enable the grid operation sector to provide the services using power sources procured through the market.

(3) Retail Market

In March 2000, liberalisation regarding the selection of suppliers started with respect to special high-voltage power users (with contracted electricity usage of 2,000kW or more). Subsequently, the scope of liberalisation was expanded to users with contracted electricity usage of 50kW (as of 2014). As a result, the liberalised sector accounts for approximately 63% of the overall electricity demand. In the liberalised sector, the number of new entrants has been increasing. As of June 2014, Power Producers and Suppliers (PPS) held a combined share of 5.65%.

Under the policy for future electricity system reform, the details of frameworks for relevant systems are being designed with a view to starting full liberalisation regarding small-scale consumers, including households, in 2016 and abolishing regulated pricing around 2018–2020.

2.4 Korea

(1) Regulatory Framework

At the same time as the establishment of the Korean Power Exchange (KPX) in April 2001, the Korean Electricity Commission (KEC) was established as an independent regulatory organisation in order to facilitate a smooth shift to a competitive market and ensure that the market functions properly. The KEC consists of the chair and eight commissioners. Under the KEC are the Competition and Regulation Division, the Competition Planning Division, the Market Management Division, the Grid Operation Division and the Consumer Protection Division. The main missions of the KEC are (i) enforcing the standard for the operation of the electricity market and licensing of power companies (issuance of business licenses), (ii) promoting fair competition, (iii) protecting consumers' interests, (iv) monitoring the electricity market and (v) overseeing affairs related to the realignment of the electricity business. Meanwhile, the Ministry of Trade, Industry and Energy (MOTIE) is responsible for the energy policy for the whole of Korea, and it formulates power source development plans, forecasts demand and regulates pricing in the electricity sector.

(2) Wholesale Market (incl. ancillary services)

As a result of the electricity market reform, KEPCO's power generation division was divided and the KPX was established at the same time. The wholesale market is a mandatory market based on a cost base pool operated by the KPX, and basically, all power generators participate in it. Meanwhile, KEPCO's power transmission division is responsible for operating power grids in Korea. Based on the power generation volume for each hour estimated by the KPX on the previous day, KEPCO selects power generators with low power generation cost from among pre-registered generators and issues operation orders to the selected generators. However, participation by IPPs which concluded electricity trading contacts with KEPCO before the establishment of the KPX and renewable energy power generators is discretionary. While some renewable energy power generators are participating in the KPX, the government provides compensation to make up for the difference between their supply costs and the average transaction price on the KPX. In 2011, the trading volume on the KPX amounted to 462.4 billion kWh, accounting for 97.9% of the overall domestic power supply volume. The KPX plays the main role in providing ancillary services, with expenses paid according to the characteristics of power generation plants participating in bidding.

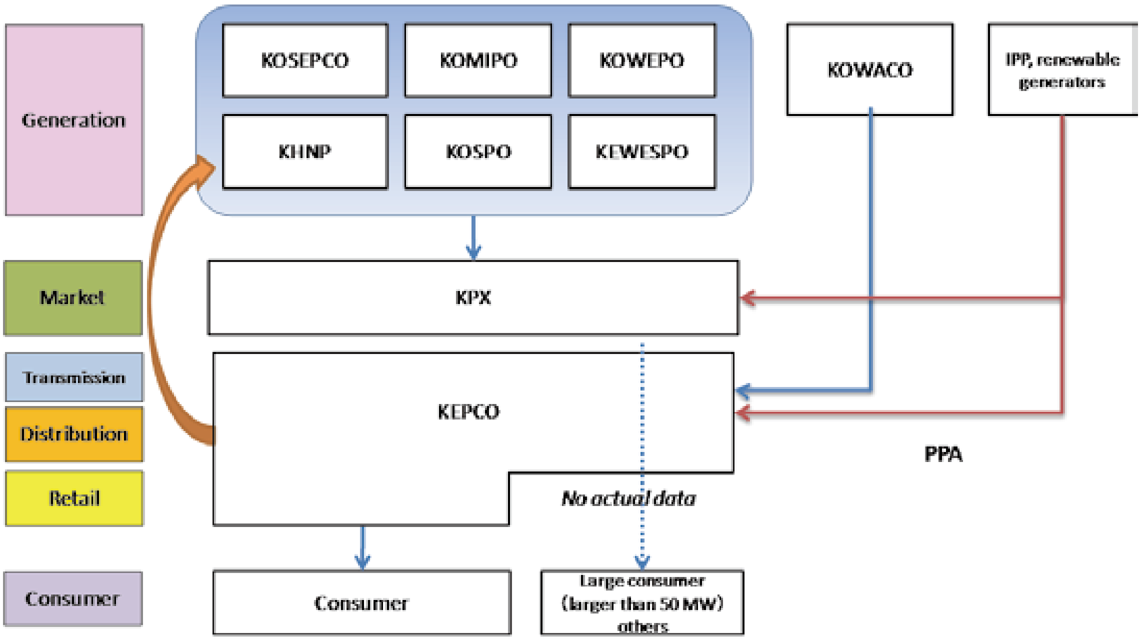

Figure 2-3 Electricity Business System in Korea (as of the end of July 2013)

Source: Adapted from reference materials prepared by Korea Electric Power Corporation and "Electricity Business in Foreign Countries," published by Japan Electric Power Information Center Inc

(3) Retail Market

As for the retail sector, although a single buyer system under which KEPCO is basically the exclusive buyer is in place, large-scale consumers and Community Energy Systems (CES) may purchase electricity directly from the KPX. Small-scale consumers such as households purchase electricity from KEPCO.

In the power generation sector, electricity rates reflect market prices through the wholesale market. On the other hand, KEPCO's retail prices are subject to approval, which means that price revisions require approval from MOTIE. Between 2002 and 2013, electricity rates were revised eleven times. As KEPCO is chronically reporting losses, Korea is considering introducing a fuel cost adjustment system to resolve the problem of the rising electricity purchase cost (fuel price rise), which is the main cause of KEPCO's losses.

2.5 The United States

(1) Regulatory Framework

In the electricity business in the United States, the federal government has regulatory authority over interstate transactions, while state governments have jurisdiction over other matters in principle. As for power supply, the Federal Energy Regulatory Commission (FERC) regulates interstate transactions, and state public utility commissions regulate intra-state transactions. The North

American Electric Reliability Corporation (NERC), an organisation appointed by the FERC, formulates standards for grid reliability. The major matters over which the FERC has authority are as follows.

- Regulation of power transmission based on supply cost and interstate wholesale electricity transactions
- Review of certain mergers and acquisitions and corporate transactions by private electricity companies
- Review of electricity transmission projects under limited circumstances
- Licensing and inspection of private, municipal and state hydroelectric projects
- Protection of the reliability of the high voltage intestate transmission system through mandatory reliability standards managed by the NERC

Although public utility commissions' roles and regulatory scope vary from state to state, their general roles are as follows.

- Licensing of private electricity companies' business activities, including pricing and accounting
- Regulation concerning construction and safety of power generation, transmission and distribution facilities except for nuclear power plants
- Licensing of construction of power generation facilities

In order to promote further competition in the wholesale electricity market, the FERC issued Orders 888 and 889 in 1996, obligating electricity companies to separate the functions of the power transmission and generation divisions and to open transmission lines to third-party users. At the same time, the FERC also obligated electricity companies to establish information networks so as to ensure non-discriminatory use of transmission lines. The FERC Order 888 recommended the establishment of Independent System Operators (ISOs) to ensure the efficiency of grid operation and neutrality, and several ISOs were established. The ISOs include ones that were established as successors to existing tight power pools, such as ISO New England (ISONE), New York ISO (NYISO) and PJM-ISO. In December 1999, the FERC issued Order 2000, requiring electricity companies to establish wide-area grid operation organisations called Regional Transmission Organisations (RTOs) in order to complement the deficiencies of ISOs. In the United States, seven ISOs/RTOs have been established to date. Of them, ISO-NE, PJM, MISO and SPP have been approved as RTOs by the FERC.

(2) Wholesale Market (incl. ancillary services)

The Energy Policy Act of 1992 defined an Exempt Wholesale Generator (EWG), which is an

Independent Power Producer, as a new category of power producer exempt from application of the regulations under the Public Utility Holding Company Act. As a result, EWGs engaging in power generation for the purpose of wholesale sales are permitted to own and operate power generation facilities and sell electricity without restriction within the limits of business arrangements and geographic area of activity, resulting in virtual liberalisation of the wholesale electricity market across the United States.

The current wholesale electricity market in the United States is divided into two types, depending on the region. One is a bilateral transaction-based market in which electricity transactions are negotiated directly between suppliers and power supply plans are formulated through non-organised individual transmission line owners. This type of market is the mainstay in the Southeast, Southwest, mountainous regions in the West, and the Northwest. The other is an organised transaction market which is operated by an ISO which operates and controls all transmission facilities in a specific broad area and a broad grid operator such as an RTO. This type of market is the mainstay in the Northeast, the mid-Atlantic region, Midwest, Texas and California. In most states in these regions, retail competition has been introduced. Around two-thirds of all electricity supplied in the United States is consumed in the regions covered by the ISOs/RTOs.

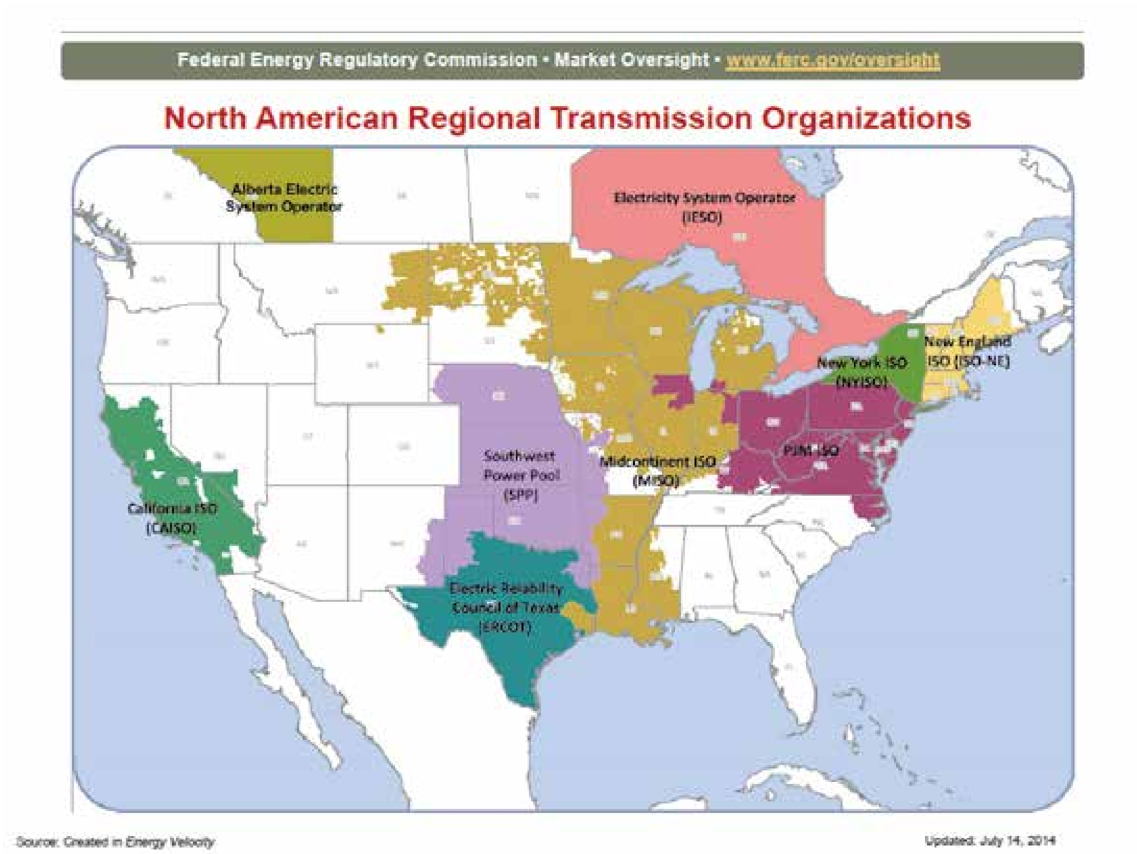

Figure 2-4 ISOs/RTOs

Source: http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html

In most of the US regions where ISOs/RTOs have been established, the electricity market consists of the capacity market, the day-ahead market, the real time market and the ancillary service market. Retailers are required to secure supply capacity equivalent to the demand size plus reserves in advance. The capacity market is a place where supply capacity is traded to adjust capacity surpluses and shortages. The supply capacity thus secured is required to participate in the day-ahead market.

(3) Retail Market

The liberalisation of the retail market is implemented on a state-by-state basis, and electricity supplied to final consumers is either purchased from the wholesale market (Independent Power Producers and organised wholesale electricity market), generated by electricity companies themselves, or obtained through a mix of these two in all states, regardless of liberalisation. In regulated states where the retail market has not been liberalised, electricity companies are subject to the traditional rate of return regulation enforced by state regulatory authorities. Retail users cannot select alternative suppliers. Most of these electricity companies have a vertical integration structure under which they own power generation, transmission and distribution facilities.

The liberalisation of the retail electricity market and the introduction of competition have been implemented on a state-by-state basis, and at first, laws and regulations concerning liberalisation were enacted in 24 states and Washington D.C. at the peak time. However, due to the impact of the electricity crisis in the early 2000s, liberalisation plans have been reviewed. More specifically, following an electricity crisis in the state of California in 2000–2001, this state suspended retail competition in September 2001, while the states of Arkansas and New Mexico abolished liberalisation laws that had been enacted, and the states of Oklahoma and West Virginia postponed the implementation of liberalisation indefinitely. As of October 2013, full liberalisation of retail sales was in place in 13 of the 50 US states and in Washington D.C. In six other states – Oregon, Nevada, Montana, Virginia, Michigan and California – partial liberalisation limited to large-scale consumers is in place. In the state of California, liberalisation of retail sales for users other than households was resumed in 2010, but the ceiling on the liberalisation quota has been set at the level before the suspension of liberalisation. In 2008, the state of Michigan revised the liberalisation law and implemented an irregular liberalisation limiting the liberalisation quota to 10% of electricity companies' electricity sales volume in the previous year.

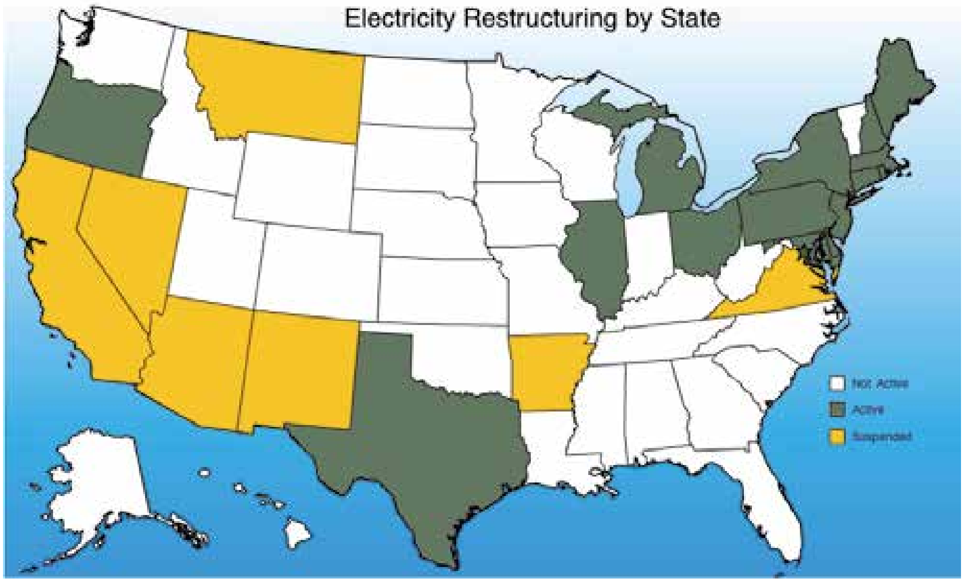

Figure 2-5 US States where the Electricity Market Has Been Liberalised

Source: http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html

Switching of suppliers from major electricity companies in states where the market has been liberalised has made significant progress, particularly in the household user market. In many liberalised states, until the mid-2000s, price caps or price freezes were in place for users who did not switch suppliers. However, following the lifting of the freeze and a shift to market prices, there was an increase in the number of retail suppliers entering the household user market, and this is presumably one of the factors behind the rise in the switching rate. The supplier switching rates regarding major electricity companies are as shown below.

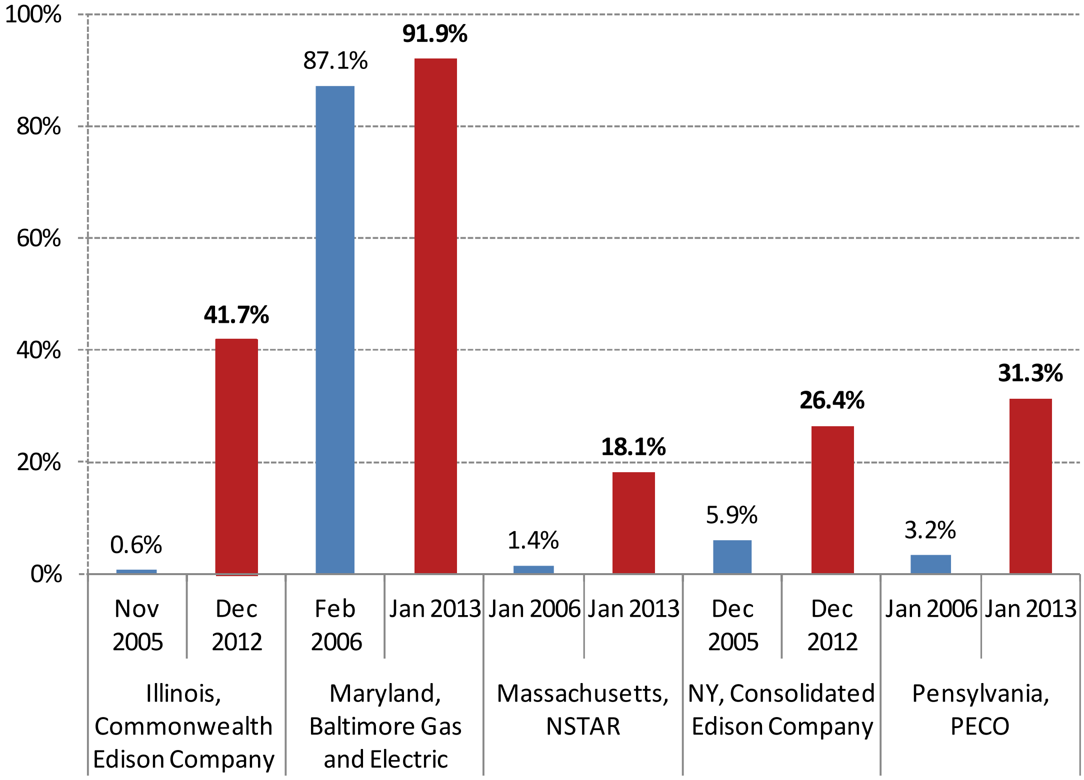

Figure 2-6 Switching Rate regarding Major US Electricity Companies

Source: Compiled from the Japan Electric Power Information Center, "Electricity Business in Foreign Countries Vol. 1 (I)"

2.6 Thailand

(1) Regulatory Framework

In Thailand, the Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA) mainly undertake the electricity business: the EGAT is responsible for power generation and transmission, the MEA is responsible for power distribution in urban areas (Bangkok, Nonthaburi and Samut Prakarn), and the PEA is responsible for power distribution in rural areas. In addition, Very Small Power Producers (VSPPs), which include renewable energy power generators and CHP energy power generators with capacity of 10MW or less, have been allowed to sell electricity to the MEA and PEA since 2006. While deregulation concerning new entry into the power generation sector has been proceeding in Thailand, the EGAT has a monopoly over power transmission and the MEA and PEA have a monopoly over power distribution. The Energy Regulatory Commission (ERC) regulates and supervises these businesses. The ERC is an organisation established on the basis of the Energy Industry Act (EIA), enacted in 2007, in order to supervise and monitor the energy industry in general. Regarding the electricity business, the ERC has jurisdiction over the management of a power source development fund and the issuance of business licenses and electricity price regulation, among other matters. Other relevant administrative organisations include the DOE, which oversees the energy sector, enforces regulation of energy resource prices and ensures fair transactions in the energy business; the EPPO, which is responsible for energy policy and planning; and the DEDE, which is responsible for ensuring efficiency of power transmission and distribution.

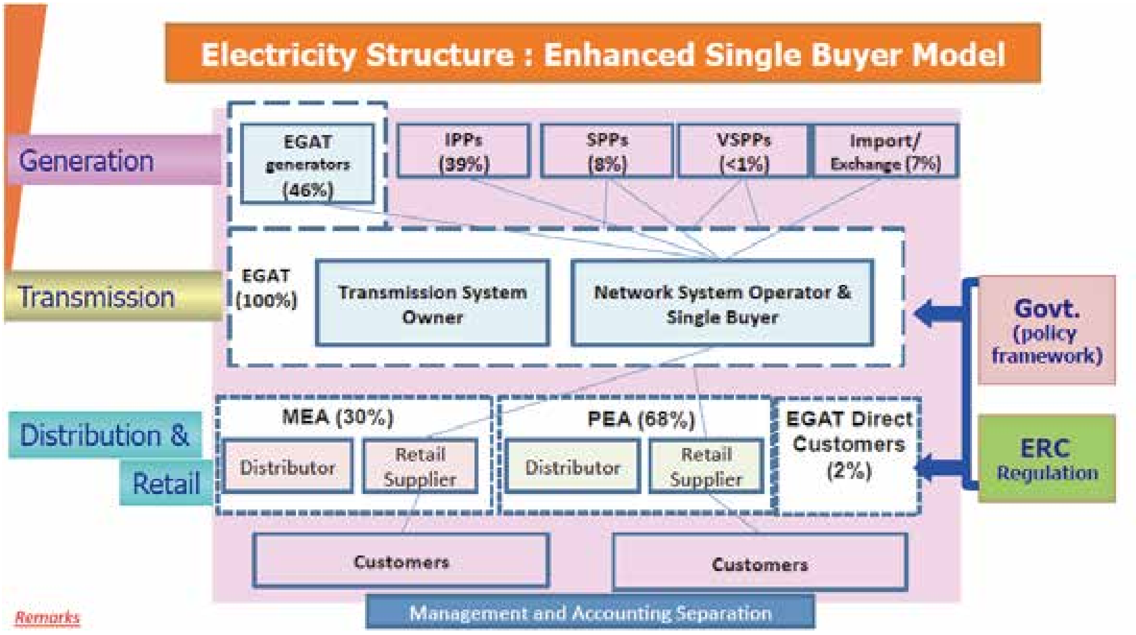

Figure 2-7 Electricity Business Structure in Thailand

Source: Direk Lavansiri (2014), "ERC's Role to Enhance Power Supply Security," 12 February 2014

(2) Wholesale Market (incl. ancillary services)

As for the wholesale electricity market, following the Asian currency crisis in 1997, a full liberalisation plan modelled on the UK liberalisation, including the creation of an electricity pool market and the division and privatisation of the EGAT, was considered, but the plan did not go ahead because of opposition from ordinary citizens. Later, an electricity pool plan was abandoned under the Thaksin government, thus bold market reforms have not been carried out. Therefore, as for the electricity business structure, power generators, including the EGAT, sell electricity to the EGAT, which in turn supplies electricity to the MEA and PEA at wholesale prices regulated by the EPPO[21]. Wholesale prices applied by power generators to the EGAT, which is the single buyer, are determined through auctions under a pricing system based on the type of power generation, the power trading volume, the contract period and other contract terms. The cost of ancillary services is calculated by the EGAT, which is the single buyer and grid operator, in accordance with the pricing regulations, and is paid to power generators as part of the cost of power generation.

[21] In addition, SPPs may sell electricity directly to general customers.

(3) Retail Market

The MEA and PEA account for most of the retail sales, with a small volume of electricity sold directly by the EGAT. Retail electricity prices are regulated by the ERC, and price revisions are subject to approval from the National Energy Policy Council (NEPC). The MEA and PEA use the same retail pricing system except for some pricing menus. Although they use the same pricing system, there is a difference in supply cost between urban and rural areas due to differences in demand density and the number of poor households exempted from having to pay electricity fees. Therefore, subsidies paid to the MEA and PEA based on national policy are used to make adjustments.

3 Prospects and Effects of Dissemination of Element Technologies Related to Smart Communities in the APEC Region

As compiled in Chapter 1, smart community-related projects vary by economy in the APEC region, and the definition of the term also differs when including those projects being carried out in the form of a smart grid project or smart city project. This chapter categorises respective economies' smart community projects and compiles their stances and purposes. In addition, the positioning of smart community projects and the technologies expected to be introduced in each economy are examined in light of the status of the energy market in major economies.

3.1 Outline of Smart Community Projects in the APEC Region

There are many economies in the APEC region and their ethnic composition, governance system and economic situation vary significantly. The sizes, responsible entities and purposes of smart community-related projects reflect the characteristics of respective economies. Specifically, in the United States and Canada, each state or province takes the initiative in carrying out projects by utilising subsidies of the federal government, whereas in Korea and Japan, the central government leads pioneering demonstration projects in designated areas. In China and Indonesia, the central government plays a major role in some projects for utilising ICT and other smart technologies from the viewpoint of urban development involving local governments.

This section roughly categorises actual smart community-related projects according to whether the economy adopts a federal system and the objectives of each project. The results are as shown in the following table.

Table 3-1 Outline of Smart Community-related Projects in the APEC Region

	Purpose	Outline	Technology	Country	Others
Central Government	Industrial competitiveness	Enhance Industrial competitiveness through demonstration project	EMS, IT	Japan, Republic of Korea, Chinese Taipei, Singapore	Many technologically advanced demonstration project(including smart care)
	City infrastructure	Central government takes initiative to develop city infrastructure	EV, Transportation, Water, Recycle, Renewable energy	China, Indonesia, Malaysia, Thailand, Russia, Vietnam ,etc	Technologies focus on the city infrastructure
	Energy network infrastructure	Development of infrastructure based on the national energy master plan	Renewable energy, Transportation, IT infrastructure, Telecommunication	Chile, Mexico, Peru, Philippines	Development of infrastructure (including Electrification)
Local government	Upgrade of existing infrastructure	Central government makes vision and local governments promote their business considering each situation	AMI, Battery, Renewable energy, etc	U.S., Australia, Canada, China	Modernization of transmission line, Development of islands
International organization	General Infrastructure, Capacity building	International organization support capacity building and development of infrastructure	Transpiration, Renewable energy, Energy efficient appliances	Indonesia, Philippines, Vietnam, China, etc	Development of renewable in island, capacity building of smart technologies.

For descriptive purposes, the table shows the categorisation mainly based on whether each project is led by the central government or a local government. Furthermore, projects led by the central government are divided into three groups depending on their purposes. Together with projects led by a local government and those supported by an international organisation, all projects were classified into five categories in total.[22] The following characteristics can be pointed out for each category.

(1) Projects Led by the Central Government (for enhancing industrial competitiveness, etc.)

Economically matured regions where the central government plays a major role in governance include Japan, Korea, Chinese Taipei and Singapore. Demonstration projects being carried out in these regions characteristically utilise highly advanced IT. Specifically, four projects in Japan and one project in Cheju, Korea, aim to develop and introduce advanced technologies under the initiative of the central government, by attempting to create a comprehensive energy management system in certain specified areas, promote utilisation of electric vehicles and renewable energy, and develop a demand response system. Furthermore, Korea is also considering the introduction of smart technologies in medical fields and has been working to raise its industry and technology levels through information technology. These economies are carrying out smart community-related projects with the aim of improving domestic technological capacity and enhancing industrial competitiveness.

(2) Projects Led by the Central Government (for developing city infrastructure, etc.)

Regions with high economic growth potential where the central government has great authority include China, Indonesia, Malaysia, Thailand and Viet Nam. They have been promoting smart community or smart city-related projects. In these regions, efforts have been made to develop infrastructure and integrate industries in expectation of further economic growth. In such context, projects in these regions are more focused on the development of smart cities. The central government characteristically plays a major role in drawing up a framework for advanced urban development, and the utilisation of IT and the introduction of smart technologies have been promoted for enhancing the efficiency of society as a whole, by methods such as seeking more efficient use of energy and the creation of an efficient transportation system for mitigating congestion and an environmentally-friendly resource circulating system in targeted areas.

[22] Projects supported by the administration or domestic or foreign public financial institutions were assumed for categorisation, but the survey revealed that there are also projects mainly led by private companies or NPOs aiming to increase the use of renewable energy and energy conservation on a local level.

(3) Projects Led by the Central Government (for developing energy network infrastructure, etc.)

In economies other than those mentioned above, due to their economic situation and insufficient infrastructure, the urgent issue is the development of infrastructure for delivering energy nationwide prior to promoting efficient use of energy through advanced technologies. Economies of South America, such as Mexico, Chile and Peru, and also the Philippines face the need to promote rural electrification and develop energy networks for improving people's living. Therefore, in these regions, smart grid projects for developing energy networks and micro-grid projects free from large-scale systems have been promoted. They commonly seek means to effectively develop inadequate social capital and infrastructure by utilising more efficient technologies.

(4) Projects Led by a Local Government (for various purposes such as for upgrading existing infrastructure)

Economically matured regions where a federal system is adopted and where local governments such as state governments and provincial governments have great authority include the United States, Canada, Australia and China. As a geographical feature, these economies have vast land areas and state governments and provincial governments are vested with great authority. This also applies to their promotion of smart community-related projects. For example, in the United States, respective states carry out independent demonstration projects by utilising the subsidy programme established under the American Recovery and Reinvestment Act (ARRA) enacted by the federal government. Also in Australia and Canada, states and provinces are carrying out distinctive projects, and play a central role and promote diverse smart community projects depending on the circumstances of respective areas, ranging from progressive initiatives utilising various types of technologies to modernisation of transmission lines and development of islands.

(5) Projects Led by an International Organisation

In addition to the abovementioned projects led by the central government or a local government, there are projects supported by international financial institutions such as the World Bank and ADB aiming to contribute to energy conservation and reduction of CO_2 emissions. Examples include the transmission line enhancement project in Viet Nam supported by the World Bank and the electric three-wheeler project in the Philippines supported by the ADB. Projects supported by international financial institutions are not limited to those for hardware development but include technical and institutional ones for personnel training and awareness-raising activities with the aim of promoting the development of IT, renewable energy, advanced transportation systems, etc., as seen in many projects for capacity building supported by the ADB.

As explained above, projects called smart community projects, smart grid projects or smart city projects have different purposes depending on the circumstances of each economy and region, and the technologies expected to be introduced differ accordingly. Therefore, a longer-term issue is to properly ascertain what technologies will be disseminated in projects under way or under consideration, in light of the state of affairs in respective economies, and what should be done to facilitate the dissemination of other technologies, and to seek solutions for the challenges thus ascertained.

3.2 Prospects of Dissemination of Element Technologies Related to Smart Communities in Respective Economies

As indicated in Section 3.1, purposes and expectations of smart communities and smart cities vary by economy and technologies collectively referred to as smart technologies have been developed and utilised in various manners accordingly. This section compiles the definitions and concepts of terms such as smart grid and smart community. Then, categories of smart projects shown in Table 3-1 will be reexamined in terms of purposes and related technologies.

(1) Types of Smart Projects

In smart community-related projects, the smart grid concept is often proposed in western economies. There is no clear universal definition of smart grid, but according to the US Act[23] and definition by the EU[24], smart grid is the concept of modernising the electric grid. More specifically, smart grid aims to achieve total optimisation by way of power system control and utilisation of communication technology in order to expand the targeted scope to include projects to increase the construction of small-scale distributed power facilities, such as photovoltaic power facilities, wind power facilities, and combined heat and power facilities, through the modernisation of power systems, as well as projects to improve power system stability through the diffusion of power storage units, IT-based home appliances and electric vehicles.

In contrast, the concept of a smart city or smart community aims to make people's lives more convenient and flexible through the utilisation of infrastructure consisting of smart grids, not limited to electric power systems[25]. This includes matters relating to the expansion of social services that contribute to the improvement of living standards, such as streamlining of the transportation sector,

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[23] The purport of the Act and the characteristics of smart grids are described as follows: It is the policy of the United States to support the modernisation of the economy's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid (Energy Independence and Security Act of 2007, Title XIII--Smart Grid, Sec. 1301. Statement of Policy on Modernisation of Electricity Grid).

[24] Smart Grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety (Source: ERGEG, "ERGEG position paper on Smart Grids – An important dimension for cost-efficient investments, June 2010).

[25] https://www.smart-japan.org/english/index.html

enhancement of medical and nursing care services and disaster prevention measures. Streamlining of the transportation sector and disaster prevention measures require improvement of energy efficiency and business continuity planning (BCP), and are closely related to the energy sector in particular. Initiatives with these purposes include projects to develop smart cities in China and other economies that are positioned as a part of urban development projects, and smart community projects in Japan, Korea and northern European economies that are positioned as part of their efforts for developing new industries.

Additionally, there is the concept of micro grid, which may be understood as a narrowly defined smart grid. Based on the abovementioned classification, micro-grid projects have two aspects, that is, they aim to develop infrastructure through the electrification of areas without electricity and also aim to improve living standards by enabling people to use electricity.

Types of smart projects are depicted as follows.

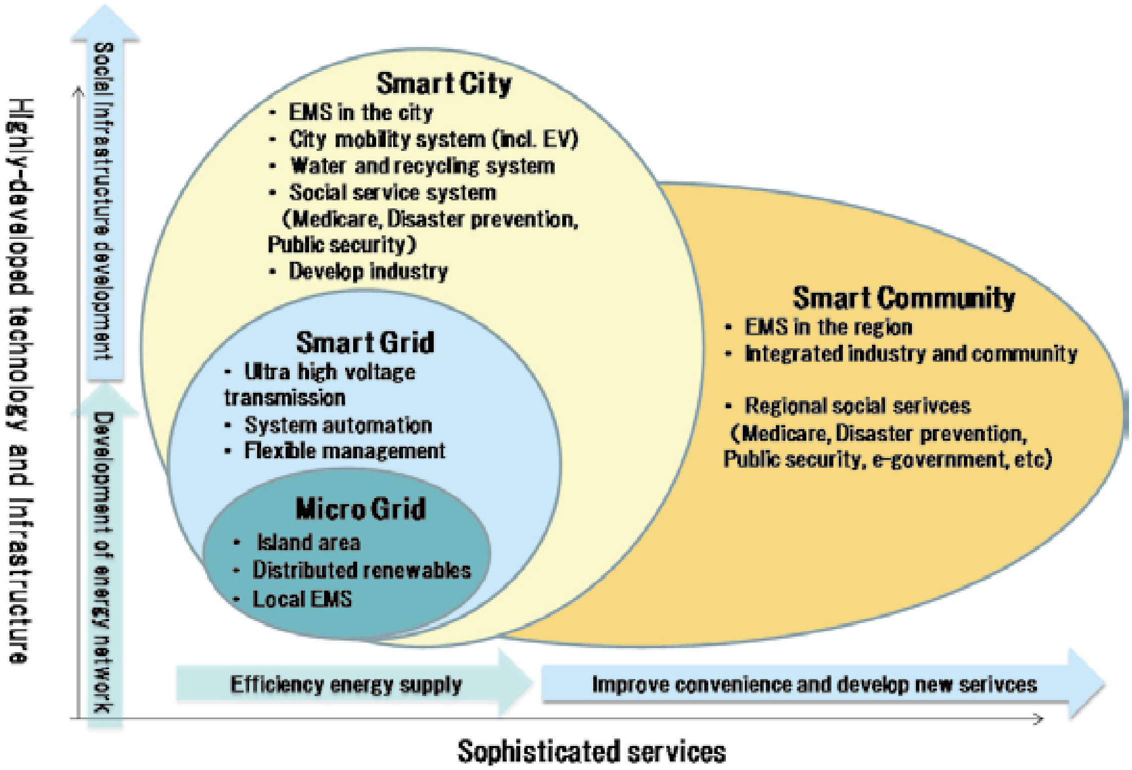

Figure 3-1 Types of Smart Projects

(2) Types of Smart Projects and Element Technologies in the APEC Region

In projects with titles including the term “smart city” that are carried out for urban development in the APEC region, the focus is mainly placed on technologies for building an area-wide transportation system or recycling system to introduce EMS or EVs, etc. In the case of transmission line development projects, smart grid technologies for reducing losses or increasing power system stability are prioritised to promote distribution automation and development of batteries. In the case of smart community projects for improving services on a regional level or micro-grid projects on islands or in areas with isolated power systems, much importance is placed on technologies for developing communication infrastructure, integrating EMS for each household or region, or utilising renewable energy. The following table shows types of smart projects newly categorised based on Table 3-1 in terms of purposes and related technologies (the WEF also categorises smart grid projects by their archetype[26]).

Table 3-2 Outline of Smart Community-related Projects in the APEC Region

Type	Outline	Technology	Country	Infrastructure
Advanced smart community	Demonstration of advanced smart community service with ICT	EMS, ICT	Japan, Republic of Korea, Chinese Taipei, Singapore	Well developed
Smart grid	Update of transmission network	AMI, Battery, Renewable energy, etc	U.S., Australia, Canada, China	Old and aging
Smart city	Development of city and industry at green field	EV, Transportation, Water, Recycle, Renewable energy	China, Indonesia, Malaysia, Thailand, Russia, Vietnam ,etc	Not fully developed of terminal network
Smart community and Micro grid, etc	Development of network infrastructure in undeveloped area and remote area from backbone network	Renewable energy, Transportation, IT infrastructure, Telecommunication	Chile, Mexico, Peru, Philippines	Undeveloped backbone network and rural electrification

In short, smart projects may be categorised based not only on their respective titles but also on technologies to be introduced depending on the level of infrastructure development and the degree of maturity of each economy and region. In tandem with the advancement of IT and other technologies, infrastructure in each economy and region is expected to mature in stages through micro-grid projects and smart city projects. Furthermore, a smart city project in which a package of technologies necessary for providing advanced services is introduced in an area without sufficient electricity infrastructure may bring about rapid development and modernisation of infrastructure. For

[26] The World Economic Forum categorizes them into seven key smart grid archetypes. They provide logical groupings for implementation architectures. They are intended to crystallise the differences in drivers; it is recognized that, within one geography, multiple priorities will be at play and, in this instance, multiple archetypes will apply.
1. Aging Infrastructure (e.g. New York)
2. Island Networks (e.g. Singapore)
3. Concentrated Intermittent Renewables (e.g. US Midwest)
4. Developing Economy (e.g. Mumbai, Rio de Janeiro)
5. Hi-tech Manufacturing (e.g. Silicon Valley)
6. Distributed Generation and Storage (e.g. Flanders, Belgium)
7. Enhanced Resilience (e.g. New Orleans, North-east China)
(WEF (2009), Accelerating Smart Grid Investments))

sustainable development of smart community-related projects, non-structural efforts must be made in addition to those for advancing technologies or other structural efforts. It has been pointed out that in order to ensure the expected effects of smart technologies, market design and appropriate rules need to be discussed rather than only focusing on the outcome of various demonstrations and research on element technologies in the United States and other economies. This means that regardless of how advanced technologies, such as EVs and HEMS, are developed, they are unlikely to be used without markets and rules necessary for introducing a demand response system and for utilising batteries.

Considering the dissemination of advanced technologies to be the result of various demonstration projects in the APEC region, it is necessary to consider how to ensure their sustainable use and try to offer political incentives to further promote demonstration projects and make required market reforms.

3.3 Barriers to Entry of Element Technologies Related to Smart Communities and Forecasts

Each economy and region has a unique business system and regulatory system for its energy market and electricity market, and so it is necessary to properly ascertain the current status of each market and regulatory system before considering policies for promoting the introduction of smart technologies.

For example, in the United States, where electricity markets are liberalised in some states, there are diverse markets, such as the energy market, capacity market and ancillary services market, with the potential for further expansion of new services through competition among business operators. In such circumstances, batteries and EVs may not only function as energy storage units or transportation equipment; new uses of such smart technologies may be devised, focusing on the frequency adjustment function of batteries or on the energy storage function of EVs, thus fulfilling the potential of smart technologies. As various demonstration projects have revealed the problems of commercialising individual technologies, it is also necessary to consider proper markets and to incorporate solutions for such problems.

This section examines forecasts of electricity markets, regulations, smart community projects and related technologies in the United States, Japan, China and Thailand.

Table 3-3 Smart Community-related Projects and Power Business System in the APEC Region

Economy	Structure	Market	Technology	Type
United States	Unbundled (in some States)	Liberalised (in some States)	AMI, battery, renewable energy	Smart grid
Japan	Vertically	Liberalised	EMS, ICT	Advanced smart

	integrated (to be unbundled)	(in high voltage)		community
China	Unbundled (State owned)	Regulated	EV, transportation, water, recycling, EMS, renewables	Smart city
Thailand	Unbundled (State owned)	Regulated	EV, battery, EMS	Smart grid, Smart city

(1) The United States

A) Domestic power situation and ongoing smart community-related projects[27]

Most of the ongoing smart technology-related demonstration projects in the United States are being carried out under the American Recovery and Reinvestment Act (ARRA) enacted in 2009. Subsidies under the ARRA are provided for smart grid projects based on the Energy Independence and Security Act of 2007, which was enacted in 2007 and specifies new medium-term guidelines for the economy's energy policy as a whole. This Act calls for support for modernisation of the economy's electricity transmission and distribution system is to be supported in order to maintain a reliable and secure electricity infrastructure, and projects focusing on infrastructure development have been promoted. It has been pointed out that the electricity transmission and distribution system is less efficient in the United States than in European economies, and that the outage time is longer and the transmission and distribution loss rate is higher than in Japan, Germany and France.

In light of this situation, President Obama announced as follows in October 2009: "The largest single energy grid modernisation investment in US history, funding a broad range of technologies that will spur the economy's transition to a smarter, stronger, more efficient and reliable electric system. The end result will promote energy-saving choices for consumers, increase efficiency, and foster the growth of renewable energy sources like wind and solar"[28]. The combined effect of the investments announced that support for smart grid projects under the ARRA will enhance the reliability and stability of the power system and reduce economic losses by avoiding power outages that cost USD150 billion a year. The investment is also important for promoting the introduction of renewable energy in remote rural areas, achieving clean economic growth, and investing in infrastructure for the 21st century.[29] Thus, the major purpose of ongoing smart projects in the United States is to update the transmission and distribution infrastructure. In short, the United States prioritises smart projects for infrastructure development, and the introduction of smart grid-related

27 https://www.smartgrid.gov/future_grid

28 https://www.whitehouse.gov/the-press-office/president-obama-announces-34-billion-investment-spur-transition-smart-energy-grid

29 http://energy.gov/articles/president-obama-announces-34-billion-investment-spur-transition-smart-energy-grid

technologies is expected to be promoted according to the categorisation in the preceding section.

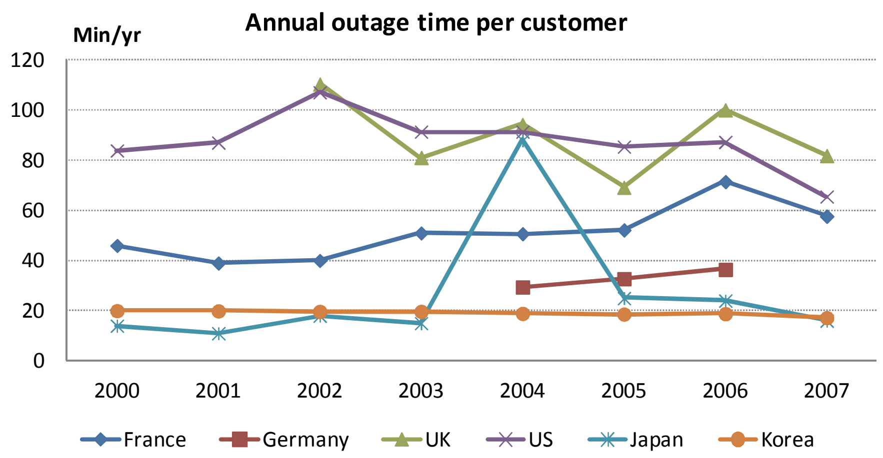

Figure 3-2 Outage Time per Customer

Source: Created based on ANRE (2011), "Energy White Paper 2010"

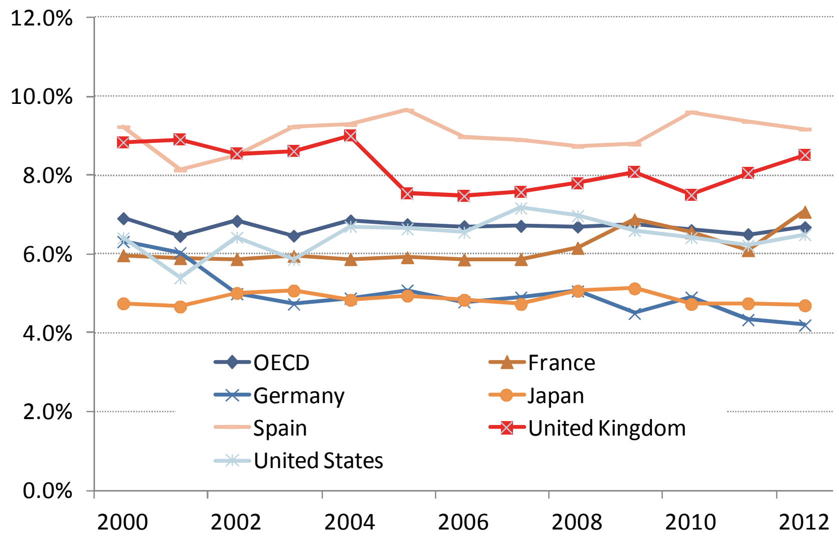

Figure 3-3 Comparison of Transmission and Distribution Loss Rates

Source: Created based on DOE/EIA, "International Energy Statistics"

In the medium and long term, renewable energy is expected to spread and responses to such trends are also necessary, such as mitigation of system congestion by each RTO. The following figures show changes in congestion charges in the PJM and NYISO areas. In the PJM area, congestion charges started to decrease in the mid-2000s, but system congestion may increase in the future due to unevenly located power facilities. In the NYISO area, congestion charges were higher in 2013 than in 2012 and this increase is attributed to higher costs for dispatches for mitigating congestion. DR technologies and other smart technologies may be one way of mitigating system congestion.

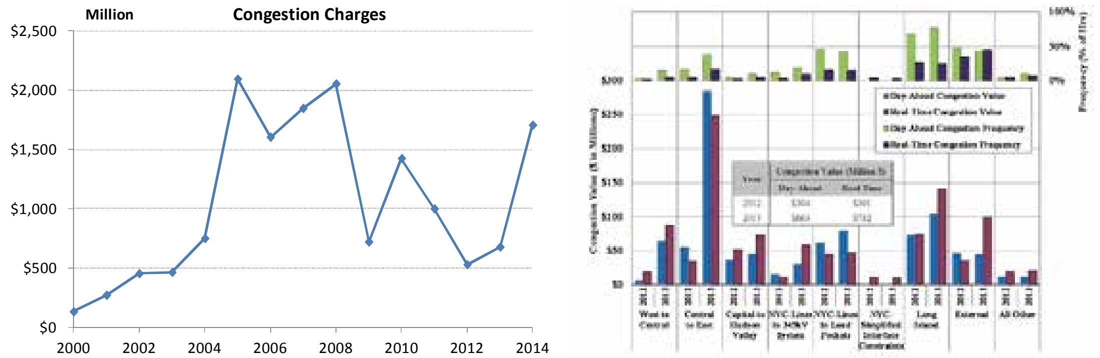

Figure 3-4 Changes in Congestion Charges (Left: PJM Area; Right: NYISO Area)

Source: Created based on yearly editions of Monitoring Analytics, LLC, State of the Market Report for PJM; Potomac Economics, 2013 State of the Market Report for the New York Isomarkets

Note: Data for 2014 in the left figure are for January to September 2014.

B) Electricity market and smart technologies

In the United States, power generation and power distribution and transmission are separated in some states and the business system centred on RTOs and ISOs has been established across states. As the introduction of renewable energy is expected to expand in respective areas, system operators face an urgent need to stabilise their system. System operators, such as PJM, NYISO, MISO, ERCOT and CAISO, are encouraging utilisation of advanced technologies while operating various electricity markets. The following are an example relating to demand response as a good way of utilising markets, and an example relating to batteries in the future.

- An example relating to demand response

In the United States, the FERC is vested with the authority to assess demand response under the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007, and the FERC issued Order 719 (promulgated in October 2008) with regard to wholesale electricity markets, which requires RTOs and ISOs to receive bids for ancillary services from demand response resources as well as from power generation and other resources. Furthermore, Order 745 (promulgated in March 2011) provides for the payment of cost by demand response resources participating in the day-ahead and real-time wholesale energy market.[30] Meanwhile, state governments have endeavoured to build demand response-related infrastructure while receiving subsidies from the Department of Energy, and have promoted demand response programmes based on their authority to approve power rates. In California, for example, the Loading Order was introduced in 2003 and power companies planning to develop new power sources are required to develop their supply capacity by making efforts to decrease electricity consumption, reduce demand during peak periods through demand

[30] However, at present only PJM actually applies this Order in its business.

response and meet new generation needs first with renewable and distributed generation resources and then with clean fossil-fuelled generation.

Under such circumstances, further utilisation of demand response technologies has been discussed in the United States, and incentive-based demand response programmes, in which programme sponsors request load reduction or reject load under agreements concluded with consumers, have been widely adopted. One of the areas where demand response programmes have been actively promoted by RTOs and ISOs is the PJM area, but such programmes are also widely adopted in and around Florida, where wholesale electricity markets are not developed. Therefore, the development of wholesale electricity markets is not always effective for promoting demand response programmes.

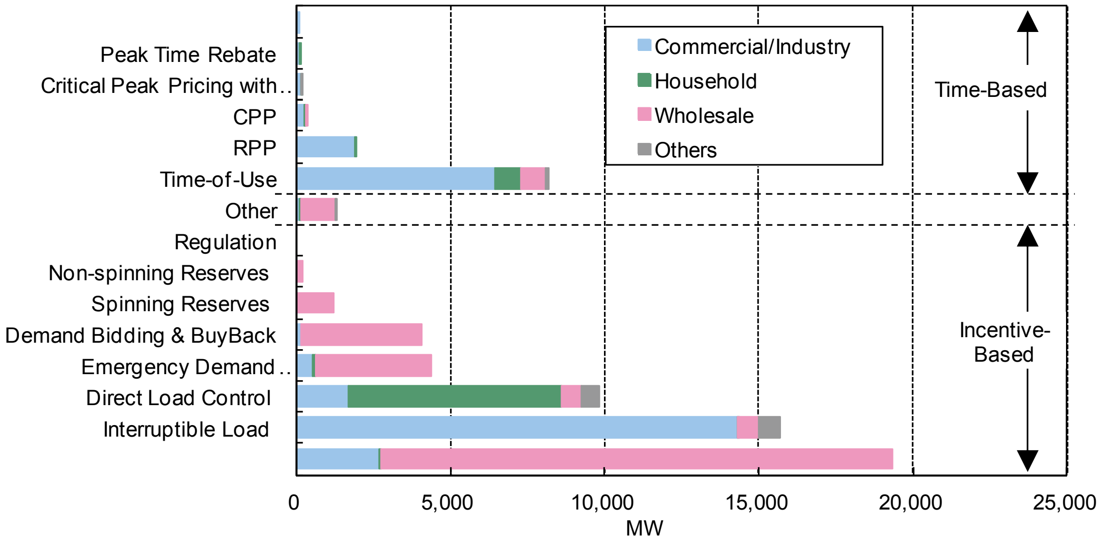

Figure 3-5 Introduction of Demand Response Programmes by Type

Source: FERC, "2012 Assessment of Demand Response and Advanced Metering Staff Report" (December 2012)

As the figure shows, most of the introduced demand response programmes are incentive-based. This may be because demand response providers can surely expect reduced power demand by aggregating consumers and offering services to guarantee power demand reduction to RTOs and ISOs.

In the United States, the development of markets and institutional design for enabling dissemination has served to expand the introduction of demand response programmes. In the future, time-based demand response programmes, which face uncertainty, will also be adopted through systemic revision and the dissemination of EMS technology that enables direct load control and other smart technologies that can remove such uncertainty.

- An example relating to batteries

California announced its policy to increase the percentage of renewable energy in the state's electricity mix to 33% by 2020, reduce greenhouse gas emissions to the 1990 levels by 2020, increase distributed power generation, and reach 1.5 million zero emission vehicles (ZEVs) in use by 2025. Measures to achieve such goals have been discussed. In particular, there is concern about the stability of the power system due to ageing and closure of existing thermal power plants and the diffusion of photovoltaic power generation. The following figure created by the CAISO shows power demand curves up to 2020. Measures are required for responding to demand drops during the daytime and significant demand increases in the evening.

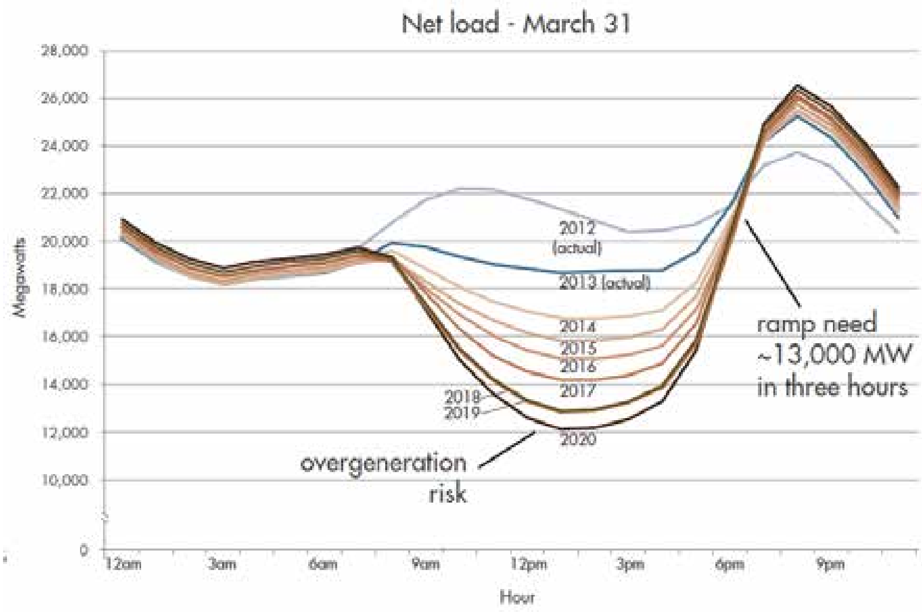

Figure 3-6 The Duck Curve Shows Steep Ramping Needs and Overgeneration Risk

Source: CAISO, "Fast Facts"

CPUC, "Energy Storage" http://www.cpuc.ca.gov/PUC/energy/electric/storage.htm

As a countermeasure, California quantitatively clarified the required capacity of energy storage facilities and has worked to facilitate investment in power distribution infrastructure, thereby strengthening energy networks. Specifically, California Assembly Bill 2514 (enacted in 2010) requires electricity retailers to achieve the goals by the end of 2020. This bill applies to various types of energy storage facilities, including mechanical, thermodynamic and chemical storage facilities, and diverse technologies such as those for EVs, flywheel batteries and heat storage tanks are expected to be developed and adopted.

- Electricity market and smart technologies

AMI and smart metres are likely to spread as part of the infrastructure through demonstration projects under the SGIG and the SGDP based on the ARRA. Therefore, efforts for reinforcing the contribution of AMI and EV-related technologies in the electricity market will facilitate the diffusion of new equipment and devices. For that purpose, the significance and potential of each technology need to be clarified by RTOs or under Federal Orders issued by the FERC in accordance with circumstances in respective regions, as in the case of demand response programmes and batteries. Short-term measures have been taken for the utilisation of new technologies in the market, but RTOs now consider longer-term adequacy in addition to short-term demand and supply of electricity. Such trends suggest that the potential of demand response in both wholesale markets and retail markets, as well as the potential of the capacity market, are considered and that their institutional positioning is being clarified, and this may expand the dissemination of smart technologies and lead to equipment development in the long term.

It is required that Federal Orders define fundamental indicators and technologies and promote harmonisation as necessary to help economy-wide diffusion of technologies that have been independently established by respective RTOs.

C) Future developments

In ongoing power grid modernisation projects under the ARRA and other policy packages, the structural priority may shift from the enhancement of efficiency of large-scale power systems to the optimisation of operation of subordinate power systems. More specifically, smart grid technologies are expected to be increasingly used in higher-level power systems whereas technologies related to DR, batteries, EVs, etc. will be utilised more in terminal systems. However, there is also a possibility of bottom-up diffusion of distributed power generation, including photovoltaic power generation for home use, and that of AMI and other measuring devices. Accordingly, the roles of RTOs and ISOs and technology development and dissemination in these sectors will become increasingly significant.[31] Continuous efforts need to be made for disseminating smart grid technologies that can provide new investment opportunities to replace investment in existing large-scale power transmission and distribution, and this is also expected to ensure the economic performance of technologies related to batteries and EVs, etc. and further disseminate such technologies. With regard to smart community-related projects and expansion of services, the key may be the development of applications in accordance with the growth of IT ventures mainly on the West Coast, uncovering new needs, and structural integration. However, there is a risk that technologies are localised to fit individual retail markets and rules have been developed specific to each state or region, and therefore nationwide measures are required.[32]

[31] In Hawaii, where the power system is rather small in scale and renewable energy has been widely disseminated, such cases of bottom-up diffusion are already observed and corresponding measures are being discussed.

[32] In relation to demand response, for example, standardisation of regulations for wholesale markets has been discussed with the cooperation of RTOs, while matters concerning retail markets are under the jurisdiction of state governments.

(2) Japan

A) Domestic power situation and existing smart community-related projects

In Japan, smart grid projects have been promoted from a different perspective than those in the United States. Japan's transmission and distribution infrastructure is highly efficient, among the best in the world in terms of outage time and transmission loss. Whereas discussions centre on smart grid technologies in the United States, Japan is promoting advanced smart community projects.

Specifically, the Master Plan for the Demonstration of Next-Generation Energy and Social Systems was established on 11 August 2010 and four locations were designated. The demonstration projects at these four locations mainly focused on the following.[33] "Operational experiments in these cities will be conducted for a five-year period from 2010 to 2014, and will verify elements ranging from technologies for the realisation of the smart grid and smart cities to related mechanisms and business models. Specifically, the subjects to be verified include ways to make power use visible, the control of home electronic devices, hot water systems, etc., demand response, which involves the adjustment of energy demand that is encouraged from the supply side, the linking of EVs and homes, the optimal design of energy storage systems, EV charging systems, and transport systems. The projects seek to create Community Energy Management Systems (CEMS) that will bring all of these together and optimise energy use for the community as a whole."

The following year, the Great East Japan Earthquake struck and revealed that the current power system has limits in that its stability is maintained only by adjusting demand and accommodation capacity between the eastern part and the western part of the economy. Therefore, the objective of creating a disaster-resilient system and providing services that will contribute to economic revitalisation was newly incorporated in smart community projects, and so such efforts are expected to be made in demonstration projects.

Accordingly, the smart projects that are now being carried out in Japan place emphasis on what content should be incorporated in a system centring on energy management specific to each area. Thus, there are higher expectations for technologies related to smart communities and smart cities than those for macroscopic technologies related to smart grids.

Meanwhile, the commencement of the feed-in tariff system in 2012 led to the rapid introduction of renewable energy generation, revealing the capacity limit of the power system. In response, the Ministry of Economy, Trade and Industry established a working group of experts and clarified the amount of power produced by renewable energy generation, or by intermittent generation in particular, that the current power system can accept. As measures to increase such capacity, flexible output control for power generation facilities, building of a wider-area power system, and utilisation of interconnected power lines are being discussed. Smart technologies related to batteries, etc. are expected to support such measures and expand the possibilities, and smart grid-related technologies

[33] http://jscp.nepc.or.jp/article/jscp/20120817/319944/

are also expected to enable wide-area highly-efficient system operation.

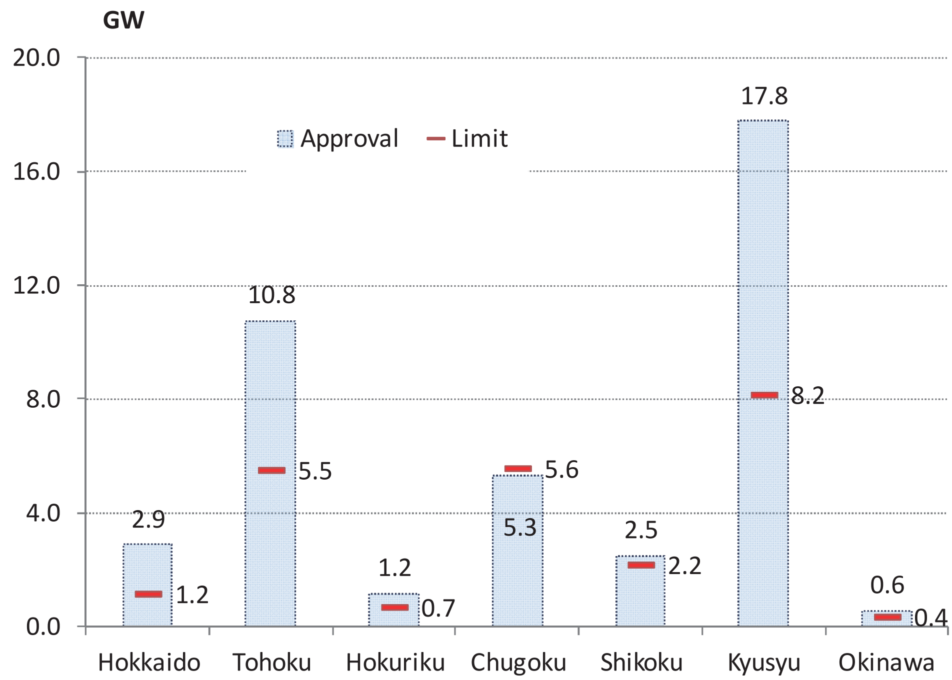

Figure 3-7 Acceptable Limit of Power by PV Generation and Amount Approved under the FIT System

Source: Created based on ANRE, New Energy Subcommittee (2014)

B) Electricity market and smart technologies

In Japan, vertically integrated general electric utilities that have a local monopoly are obliged to supply power in their respective regions. Regarding utilisation of the electricity market, the transaction volume on the JEPX was limited, especially before the Great East Japan Earthquake. However, the transaction volume has been increasing thanks to voluntary efforts in the private sector and under the instruction of the Ministry of Economy, Trade and Industry after the earthquake, and the ministry concluded that the market has been revitalised to some extent. Discussions are under way on policies to further revitalise and utilise the power of the market to diversify services by means such as through the development of a real-time market and ancillary services market.

Electricity system reforms are currently the subject of much attention: it is planned to introduce a license system and to fully liberalise the electricity market in 2016 and to implement legal unbundling in 2020. Such changes in the business environment will also require Japanese electric power suppliers, which have developed high-quality electrical grid infrastructure under an integrated power generation and transmission system, to take a different approach to investment. The key is whether the new system is designed to continue attracting stable investment in infrastructure development.

A report by the Expert Committee on the Electricity System Reform published in February 2013 describes the direction of the electricity system reforms and identifies the following issues: i) utilisation of markets (revitalisation of wholesale electricity markets, etc.); ii) wide-area and neutral power transmission and distribution (expansion of wide-area operation, implementation of legal unbundling); iii) measures to ensure load capacity for stable power supply (new mechanism to ensure load capacity, creation of an hour-ahead market and real-time market, market-linked mechanism of imbalance settlement, mid- and long-term measures to ensure load capacity); and iv) other system reforms (regulatory organisation, self-wheeling, etc.). Technologies to support these are expected to be introduced from now on, and so the introduction of smart metres and other equipment for ascertaining real-time power demand and supply is likely to be promoted.

One particular issue identified in the report is the roles of the Organisation for Cross-regional Coordination of Transmission Operators (OCCTO) and the negawatt market; the System Design Working Group has been discussing relevant technologies for this issue as a priority. The OCCTO will encourage transmission and distribution companies, which have so far made and implemented their infrastructure development plans by only considering the demand and supply balance within their respective areas, to draw up plans that take into account other companies' power supply plans, thus identifying concrete problems. In addition, incorporating the concept of DR in long-term equipment planning, as is being discussed in the United States, may facilitate forward-looking utilisation of DR and dissemination of related technologies. The negawatt market is also a promising solution to the imbalance in liberalising electricity markets, for which EMS and other related technologies will be helpful.

Ahead of the market development and system reform as mentioned above, power companies have announced deadlines for introducing smart metres, which suggests that smart metres will steadily become part of the infrastructure. Market development for utilising the potential of such infrastructure is urgently needed.

Table 3-4 Smart Metre Introduction Plan

		Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyusyu	Okinawa
HV		2016	Finished	Finished	2016	Finished	2016	2016	2016	Finished	2016
LV	Start	2015	2014 First half	2014 First half	2015 Jul	2015	-	2016	2014 Second half	2016	2016
	End	2023	2023	2020	2022	2023	2022	2023	2023	2023	2024

Source: Smart Meter Institution Subcommittee, ANRE

In Japan, frameworks for respective markets with the objective of reforming the electricity system are now being developed; the future trends need to be watched.

C) Future developments

Electricity system reforms are now under way in Japan, and the key is how to encourage the use of technologies to ensure the stability of systems both in the power generation sector and the retail sector. The issue of how to overcome system constraints due to increasing renewable energy generation has also been attracting attention.

Smart metres will be installed for all consumers by the mid-2020s, but if the fragmentation of markets and technologies is not eliminated, it may be impossible to fully utilise diverse technologies, such as demand response technologies and EVs on the consumer side and dispatchable distributed generation networks on the power company side.

The abovementioned demonstration projects in Kitakyushu City, Toyota City, Yokohama City and Keihanna Science City are being carried out in closed communities by related parties in a unified manner with the support of respective local governments. These demonstration projects are more like technology demonstrations carried out jointly with the current administration; they are not intended to prove whether technologies related to demand response and V2G (Vehicle to Grid), etc. may be commercialised under common rules in the nationwide market to meet common needs. In order to disseminate these technologies more widely, the negawatt market and capacity market, which are now being discussed as part of the system reforms, will need to play a significant role.

We must also monitor the progress of smart community projects in Japan utilising such technologies as distributed CHP and community energy management in relation to seeking market-based economic efficiency, creating a disaster-resilient energy system and offering services that will contribute to economic revitalisation.

(3) People's Republic of China

A) Domestic power situation and ongoing smart community-related projects

In China, power demand has been increasing significantly since the beginning of this century in tandem with accelerating economic growth, and there has been an urgent need to develop electric power sources to meet the increasing demand. In addition to coal-fired power generation, which has been the major electric power source, the government announced a policy of increasing facilities for gas-fired power, nuclear power, wind power and photovoltaic power generation in the future. However, the imbalanced distribution of resources and energy transportation are problems inherent to the Chinese energy system. In China, natural gas is transported from inland or from other economies in the west to places of demand in the eastern coastal areas, and the same structure also applies to the electricity supply system. Thermal power plants that use coal produced inland, wind power plants that are constructed inland where wind conditions are favourable, and inland water resources have been utilised with the aim of connecting the whole economy through a project to transport power generated in the west to the eastern part, and a project to exchange power between the south and the north. Such economy-wide initiatives will have to be strengthened further.

Figure 3-8 Outline of Chinese Electricity System and Problems in Grid Networks

Source: Created based on State Grid Corporation of China (2014), White Paper on Green Development, http://www.sgcc.com.cn/ywlm/projects/

The State Grid Corporation of China[34] plans to develop a large-scale electricity system and construct highly efficient 1000kV transmission lines and a large number of UHV transmission lines. The Corporation considers "robust smart grids" to be the key for integrating the state's energy systems and has set the goals of constructing large-scale power plants in the power generation sector, building a special high-voltage grid in the power transmission sector, liberalising the power transformation and distribution sector, and introducing smart metres and building a two-way communication network in the retail sector. Highly efficient power transmission and distribution technologies are expected to be introduced mainly in these fields.

Big cities such as Beijing and Shanghai, which are the major centres of demand, now face problems such PM2.5 pollution and serious traffic congestion due to population increase. In particular, there is severe atmospheric pollution in cities and only 17 out of 471 cities larger than *hsien* satisfied air quality level 1 in 2010.[35] To resolve these problems and to enhance energy efficiency, China aims to increase the efficiency of city systems and thereby improve the

[34] The Smart Grid Construction Plan compiled by the State Grid Corporation of China in March 2010 set up the following overall objectives: 1) Optimal distribution of resources, 2) Stable operation of grids, 3) Development of renewable energy, 4) Improvement of services to consumers, and 5) Improvement of services through interactive communications.

[35] Japan Electric Power Information Center (2014) "Electric Power Business in Foreign Countries Volume 1 (part 2)"

environment and energy system, and is promoting smart city projects.

Thus, China is endeavouring to develop higher-level power system infrastructure by utilising smart grid technologies and to promote smart city-related projects on the demand side, taking into consideration the stabilisation of energy systems, power resource development and achievement of a low-carbon society. Related technologies are expected to be disseminated both in higher-level power systems and subordinate power systems.

B) Electricity market and smart technologies

In China, a regional grid corporation and provincial power corporation in each province exclusively supply power to consumers via distribution companies in respective city or *hsien* under their jurisdiction. The authority to grant permission for the allocation and change of business areas, the authority to grant licenses for supplying power, and the authority to grant licenses for the electricity business are delegated to the regional bureaus of the Bureau of Energy. Furthermore, the creation of electricity markets by region is now being discussed, and it is expected that transport, electricity and city infrastructure will be developed uniformly with local administration, electricity markets suited to the characteristics of respective regions will be created, and related technologies will be introduced in such processes.

A project under way in Tianjin[36] aims to reduce CO_2 emissions by 50% by 2030 by efficiently and integrally utilising diverse technologies centred on low-carbon construction, low-carbon indicators, low-carbon transport, low-carbon finance, low-carbon energy, etc., mainly through EMS covering the entire city. The project will also serve as a model low-carbon city and the city government is playing the central role. On the other hand, market-linked initiatives may be difficult as the reform of the electricity market is still under discussion. Nevertheless, the project has set social and economic targets, which include creating an innovative city with a low-carbon economy, leading carbon finance and carbon trading.

The 12th five-year plan (2011–2015) published by the Chinese government in March 2011 called for the creation of an emissions trading market,[37] and in October 2011, the National Development and Reform Commission (NDRC) issued a notice on the development of an emissions trading model project to seven major local cities: Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen. In response, each local government has been making preparations, such as establishing system rules, setting up emission caps for targeted companies, making an allocation plan, preparing

[36] http://www.tifi.com.cn/en/51.html?5
http://apecenergy.tier.org.tw/database/db/ewg47/3/1_Yujiapu_Financial_District_Low_Carbon_Town_Index_System.pdf

[37] Ministry of the Environment (2012) "Outline of Emissions Trading System in China"
http://www.env.go.jp/earth/ondanka/det/os-info/mats/cn20121025.pdf

a registry and developing trading platforms. Tianjin city and other cities may focus on reducing CO_2 emissions in their existing or planned smart city projects, and may include the creation of intercity emissions trading platforms as an objective of their projects.

The roadmap of the NDRC aims to commence pilot projects for the carbon market in 2013, complete the basic framework for the carbon-trading market in 2015, and operate the carbon-trading system nationwide during the period of the 13th five-year plan (2016–2020). Depending on how reforms of the electricity market progress in China, smart projects may be incorporated into preceding initiatives to develop a carbon-trading market as part of CO_2 emissions reduction measures. In the process, smart community-related technologies, centring on those for energy conservation and low-carbon power supply, may be disseminated widely.

C) Future developments

China’s electricity business structure consists of government-managed or publicly-managed large-scale power generation corporations and power transmission corporations that cover the whole economy, and provincial power distribution corporations in respective provinces. Under this structure, smart city projects and smart community projects for urban development have been carried out in the demand sector, while smart grid projects using large-scale, sophisticated facilities have been promoted in the power transmission sector including the economy’s grid, focusing on the development of 1000kV ultra-high-voltage transmission lines.

Meanwhile, smart city projects in demand areas are likely to promote the dissemination of EVs and EMS in accordance with the needs of respective provinces, resulting in localisation of such technologies. Accordingly, the central government needs to standardise criteria, create a platform for a carbon-trading market, and promote electricity market reform for fulfilling adjustment functions. Furthermore, while promoting reforms of the electricity market to create a more flexible market, it is necessary to change the rate system, which is currently controlled by the central government, to enable electricity charges to be set flexibly depending on regional circumstances. If electricity market reform progresses favourably, technologies relating to DR and batteries and other ICT may be further disseminated for flexible operations for achieving peak-shaving, etc. based on a price signalling strategy, covering wider areas beyond where smart city projects are now being carried out.

(4) Thailand

A) Domestic power situation and ongoing smart community-related projects

In Thailand, the Power Development Plan 2010 Revision 3 (PDP2010R3) published by the government in June 2012 predicts that power demand will double from that in 2011 by 2030, and that it is indispensable to develop power generation facilities and transmission facilities. At present, coal-fired power generation is the main type, but the Thai people are environmentally conscious and it is difficult to construct new coal-fired facilities. The PDP forecasts the potential of hydropower, thermal power (gas-fired power, in particular), nuclear power and renewable energy generation. Regarding hydropower, as large-scale development is difficult domestically, the possibility of small hydro development and joint projects with Laos and other neighbouring economies is being considered. As for thermal power, the focus is on replacement with gas-fired power. The setting of targets for nuclear power has been delayed due to the accident at Fukushima Daiichi NPP, while the plan for renewable energy is scheduled to be revised upward. Furthermore, the PDP has produced plans for reinforcing domestic distribution systems, including rural electrification, and for developing systems for importing electricity from Laos, Malaysia, Myanmar and China.

Due to the difficulty of increasing coal-fired power facilities within the economy as mentioned above, Thailand needs to develop other power sources and strengthen collaboration with other economies in the medium to long term. Furthermore, rural electrification and expansion of renewable energy are required domestically and therefore smart grid technologies will be indispensable in developing efficient infrastructure both in higher-level power systems and subordinate power systems. The Provincial Electricity Authority (PEA) has officially announced the PEA Smart Grid Policy to expand the scope and content of smart grid projects in three stages through carrying out demonstration projects in the power distribution sector in islands and specific areas.

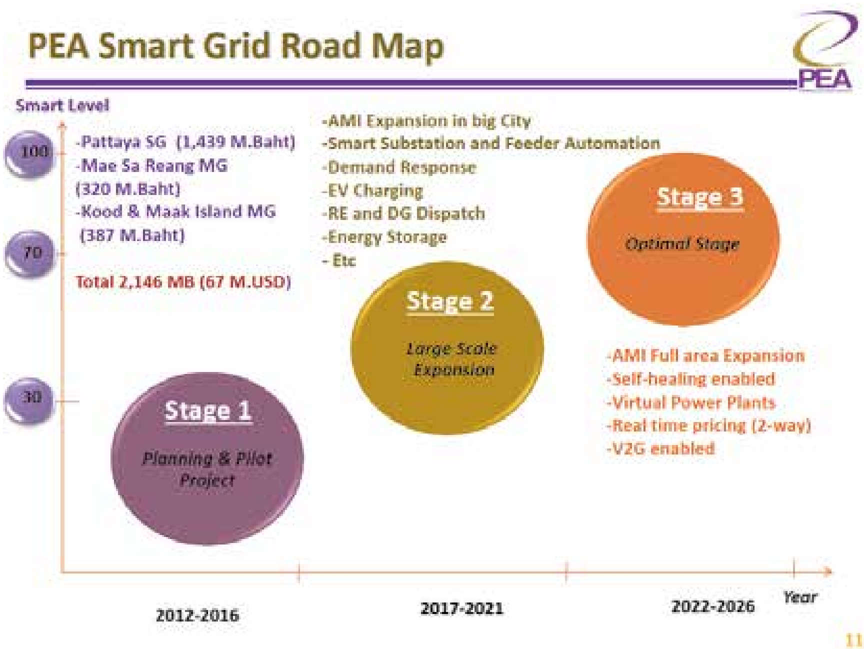

Figure 3-9 PEA Smart Grid Road Map

Source: PEA (2014), Smart Meter – PEA Smart Grid Project in Pattaya

B) Electricity market and smart technologies

In Thailand, the electricity industry is unbundled and deregulation for allowing new entry is now under discussion in the power generation sector. In contrast, the power transmission sector is monopolised by the publicly-managed EGAT and the power distribution sector is managed by the publicly-managed MEA and PEA. The Thai government clearly positions the smart grid strategy as part of its energy strategy and the PEA draws up plans and carries out projects to utilise advanced technologies in the power distribution sector such as projects for automating power distribution to stabilise the system, while promoting rural electrification.

Thailand has a single buyer system with no electricity wholesale market and electricity rates are regulated. Such cost-based electricity rates ensure stable procurement of funds, and stable investment is expected to continue as power demand increases. As market-based pricing is not adopted at present, whether new services and technologies are introduced depends on the transaction rules of the EGAT. However, one option is that used in Korea, under which the government-managed KEPCO integrally operates power systems while adopting a single buyer system and introducing the concept of DR in KPX (electricity wholesale market).[38] Also in Thailand, how markets are utilised under the monopolistic system will affect the future introduction of smart technologies or technologies particularly close to consumers.

C) Future developments

The PEA plays the central role in the current smart grid strategy and the focus is on technologies for automating power distribution, etc. Therefore, it is expected that the development of advanced infrastructure, mainly transmission networks, will be steadily promoted and demand response technologies and EVs may be utilised under the initiative of the PEA as technologies that contribute to stabilising networks.

Meanwhile, the usage of demand response technologies by private companies for business may be affected by the policies of the Energy Regulatory Commission (ERC) and by a fundamental review of the electricity rate system, concerning matters such as how to differentiate rates between the MEA and the PEA under the instruction of the government. For further utilisation of smart technologies, it may be necessary to create and utilise an electricity market to ensure transparency in the electricity rate system and introduce competition.

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38 http://www2.schneider-electric.com/corporate/en/press/press-releases/viewer-press-releases.page?c_filepath=/templatedata/Content/Press_Release/data/en/shared/2015/01/20150119_energy_pool_speeds_up_its_growth_in_asia_signing_today_a_business_star.xml

3.4 Energy/Power-Saving Effect through the Dissemination of Element Technologies Related to Smart Communities in Each Economy

Many of the projects listed in Chapter 1 are under way or under consideration, but the resulting energy-saving effect, CO_2 emissions reduction effect and economic effect have seldom been fully reviewed. While it is difficult to clarify the energy-saving effect and power-saving effect from this survey, a proper quantitative analysis of the introduction of technologies related to smart communities, smart cities and smart grids is given below.

As this chapter has shown, projects including the term “smart” in their title are being carried out with various purposes depending on respective economies’ status, level of infrastructure development and energy market structure, in consideration of what is necessary at present and in the future. Therefore, when evaluating the effects of introducing smart community-related technologies, it is necessary to consider the circumstances of the relevant economy.

Specific matters to be evaluated include the degree of maturity of the energy network infrastructure, regulations on the energy market, and economic conditions,[39] and it is necessary to classify smart technologies that are introduced preferentially in light of these aspects and evaluate their effects. For example, in economies like Japan where the grid infrastructure has been developed, the widespread introduction and dissemination of smart grid technologies will not yield additional energy-saving effects which can be expected in other economies. Furthermore, due to the absence of relevant markets, demand response technologies and batteries installed at consumers’ homes are unlikely to produce an energy-saving or peak-shaving effect. In order to evaluate the future energy-saving effect of smart technologies in Japan, infrastructure level and electricity market forecasts also need to be taken into consideration; technologies that are expected to be introduced are those related to EMS, batteries, and control of EVs by fully utilising ICT, rather than smart grid technologies.

In this manner, when forecasting the energy-saving effect and CO_2 emissions reduction effect of smart technologies in a certain economy, its infrastructure status, social situation, market trends and regulatory trends must be taken into account and the possibility of introducing relevant technologies must be examined. Then, the energy- and power-saving effect of introducing element technologies related to smart communities should be evaluated and accumulated in light of the results of individual demonstration projects now being carried out in the economy.

[39] In addition to these, whether local governments have strong power or the central government has centralised power, and the degree of urbanisation of the economy will affect the forecast of future introduction of smart technologies.

4 Smart Grid System Integration

4.1 Integration of Renewable Energy Generation Systems

There are various constraints in the integration of renewable energy generation systems, but this section compiles output fluctuations and constraints due to ramp rates of respective power sources.

(1) Example of the Bonneville Power Administration

The Bonneville Power Administration (BPA), which is engaged in the power transmission business in the northwestern area of the United States, has introduced 4,782MW of wind power generation. The BPA publicises actual and estimated wind power generation, actual hydropower generation and actual thermal power generation every five minutes. The BPA has almost approached its limit of expanding wind power generation and seems to even suppress output. Actual wind generation output from January to March 2014 is as shown in Figure 4-1. During this period, output fluctuated from 0MW to 4,319MW (90% of installed capacity), and the average availability was 24%.

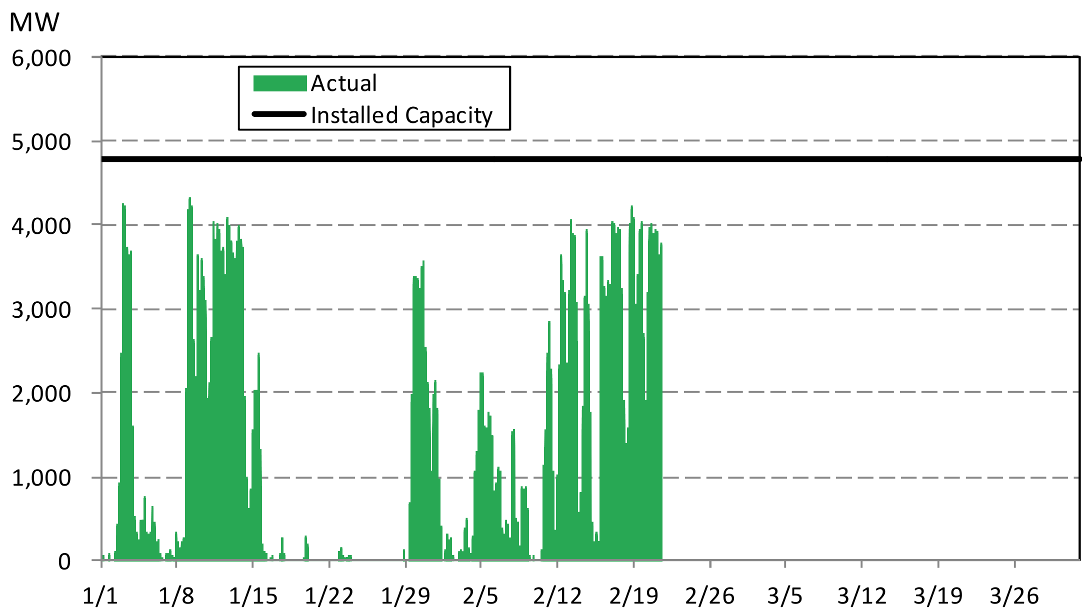

Figure 4-1 Actual Wind Generation Output in BPA

Source: Bonneville Power Administration

The BPA is a balancing authority responsible for maintaining the demand and supply balance and is obliged to minimise area control errors (ACE), which are represented as follows.

$ACE = (NI_A - NI_S) - 10B\,(F_A - F_S) - I_{ME}$

where:

- NI_A is net interchange (actual)

- NI_S is net interchange (scheduled)
- B is balancing authority bias
- F_A is frequency (actual)
- F_S is frequency (scheduled)
- I_{ME} is interchange (tie line) metring error

The major task is to equalise scheduled output and actual output in the interconnection within the relevant area, which means to maintain the difference between generation output and demand within the area so as to match import and export plans.

Additionally, the BPA, as a balancing authority, is obliged to ensure a certain level of reserve margin, for which it uses thermal power generation and hydropower generation. When using thermal power generation to ensure the reserve margin, the BPA cannot suppress the output of thermal generation below the reserve requirement. In the BPA area, when the output of thermal generation can no longer be suppressed, that of wind generation is suppressed.

Figure 4-2 shows the distribution of load, output of wind generation, output of thermal generation, and net load (load − output of wind generation) in 2014. The net load becomes almost the same level as the output of thermal generation during certain time zones as seen on 23 May 2014 in Figure 4-3. At this time of the year, power demand is relatively small in the BPA area, but the output of thermal generation was suppressed to a level close to the reserve requirement thanks to the increased output of wind generation. Under such circumstances, when the output of thermal generation can no longer be suppressed, that of wind generation is suppressed.

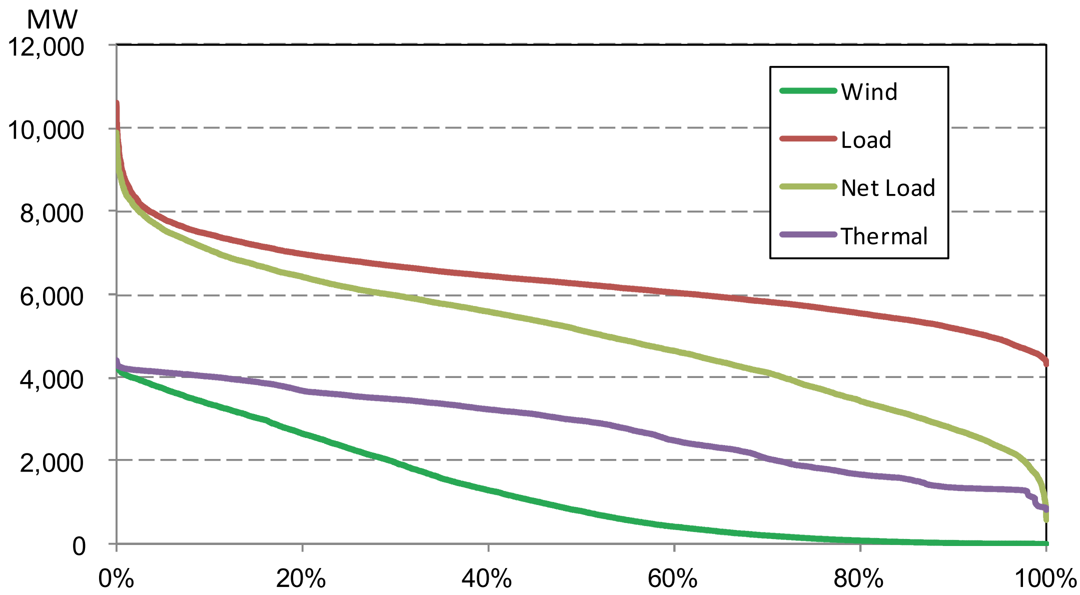

Figure 4-2 Distribution of Demand and Generation Output

Source: Bonneville Power Administration

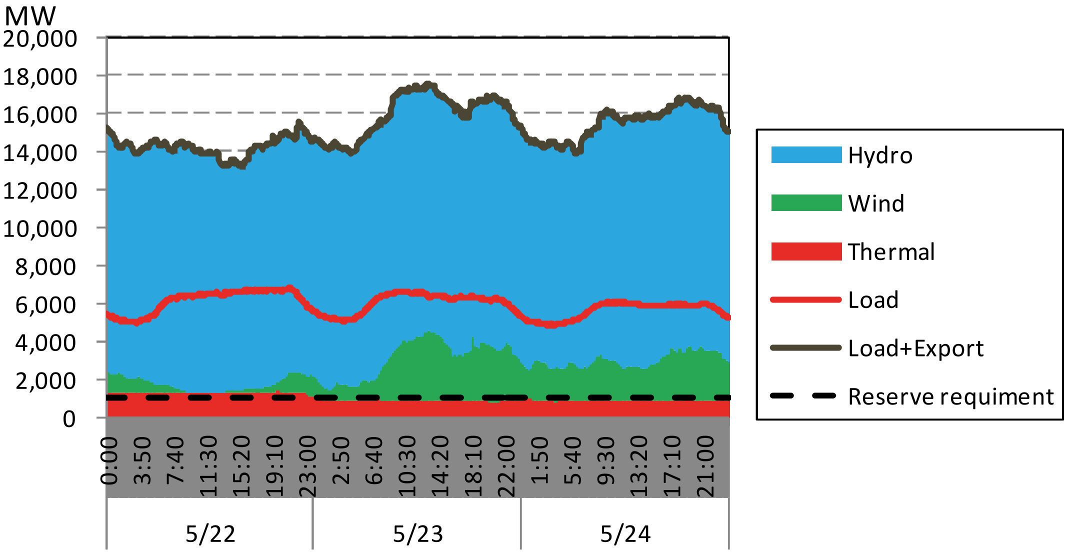

Figure 4-3 Demand and Supply Balance in BPA (22–24 May 2014)

Source: Bonneville Power Administration

During 28–30 May 2011, as shown in the figure below, the output of thermal generation was suppressed at the minimum level without any room for further suppression, resulting in the suspension of wind generation. The BPA is implementing a smart grid project with the aim of mitigating such demand and supply constraints.

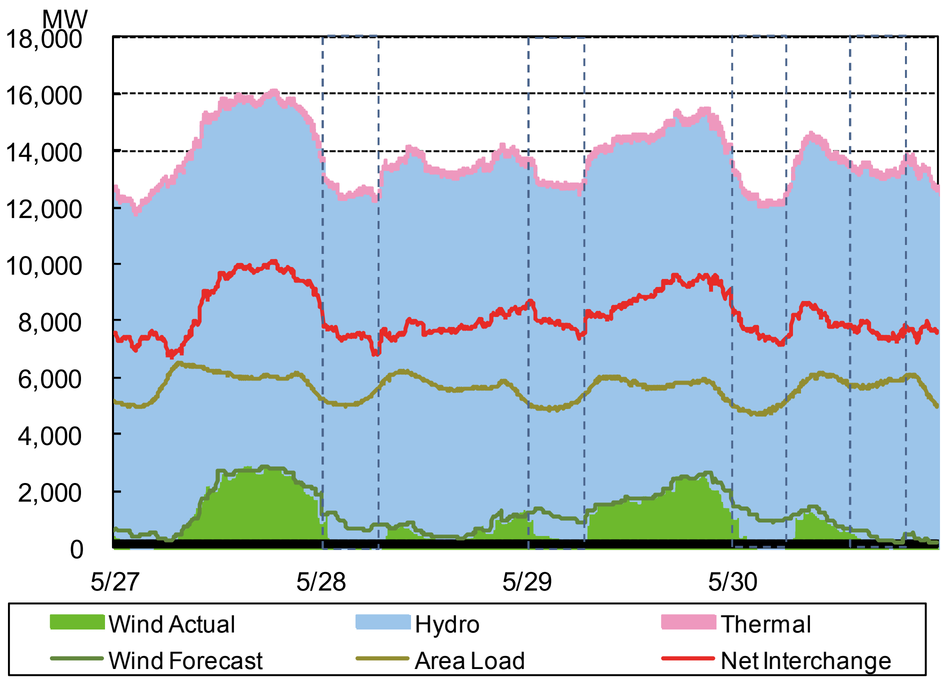

Figure 4-4 Demand and Supply Balance in BPA (27–30 May 2011)

Source: Bonneville Power Administration

(2) Example of 50 Hertz Transmission

Fifty Hertz Transmission, which is a power transmission company covering the eastern part of Germany, has introduced 13,048MW of wind power generation, which significantly affects demand and supply operations. Figure 4-5 shows the situation in January 2014; it can be observed that the output of wind generation significantly fluctuated from 10MW to 10,628MW.

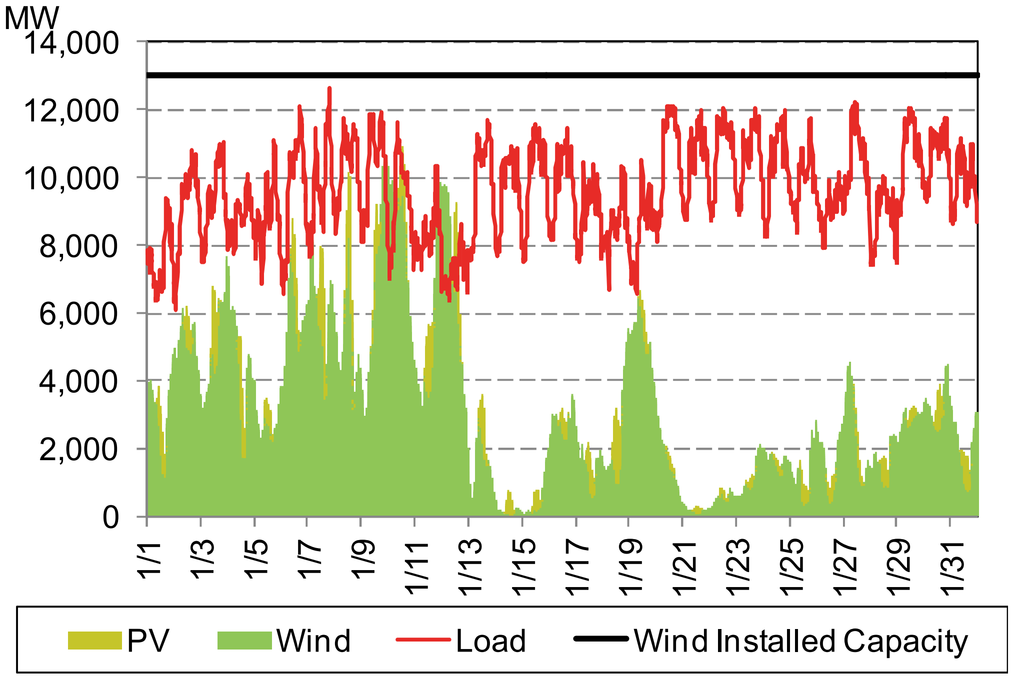

Figure 4-5 Actual Output of Wind Generation and PV (January 2014)

Source: 50 Hertz Transmission

Figure 4-6 shows the distribution of the load, output of wind generation, output of other generation, net load (load − output of wind generation) and reserve requirement in 2014. The output of other generation becomes almost the same level as the reserve requirement during certain time zones as seen on 24 December 2014 in Figure 4-7. The output of other generation represents the overall output of power generation in 50 Hertz Transmission's area except the output of wind generation, and includes the output by a number of generators that do not constitute the reserve margin. Therefore, the reserve margin required for demand and supply operations may not have been fully secured during this period, suggesting that the output of wind generation was suppressed.

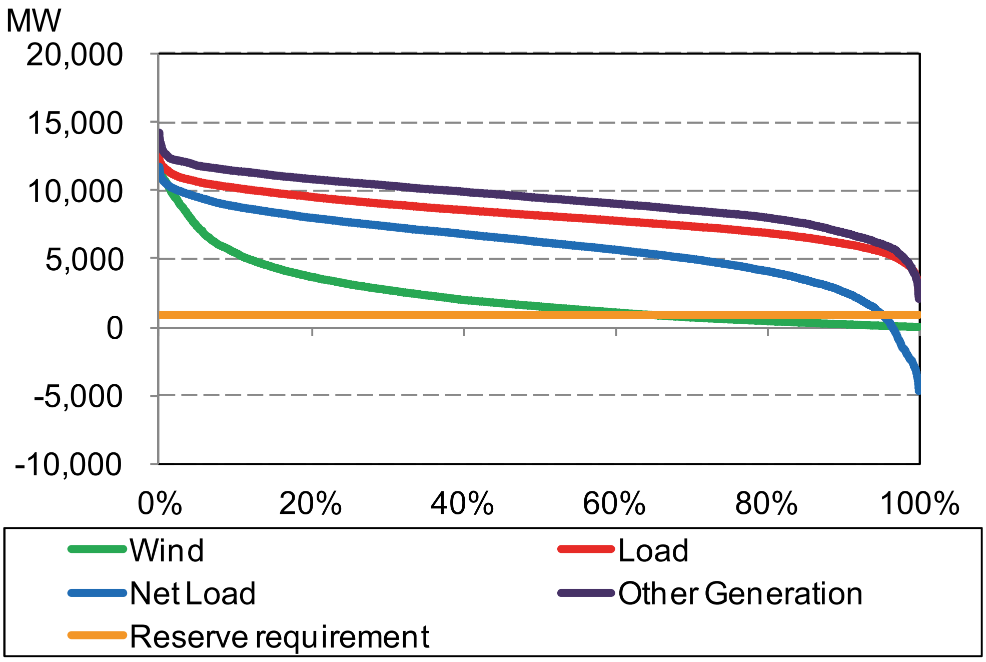

Figure 4-6 Distribution of Demand and Generation Output

Source: 50 Hertz Transmission

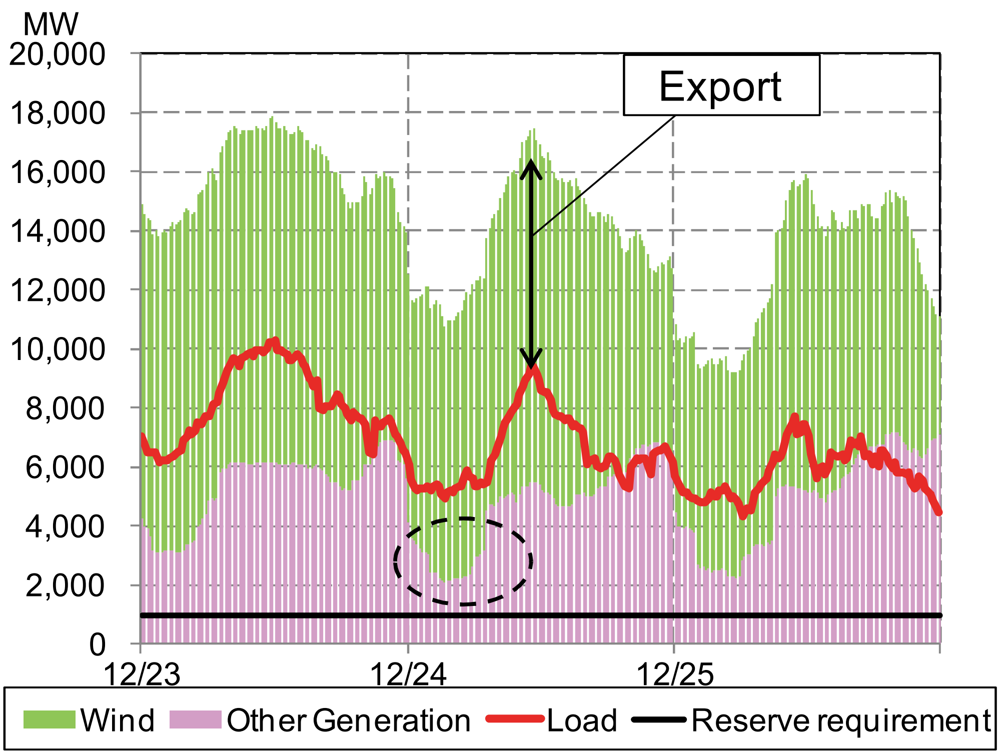

Figure 4-7 Demand and Supply Balance in 50 Hertz Transmission (23–25 December 2014)

Source: 50 Hertz Transmission

Here, the effect of wind power generation on maintaining the demand and supply balance is analysed. When the output of wind generation is as planned in advance, the demand and supply balance within the area can be maintained by adjusting the output of other generation sources and exports and imports. Therefore, the degree of forecast errors of the output of wind generation and their influence on the overall demand and supply balance will be evaluated. Figure 4-8 shows forecast errors of the load, output of wind generation and output of PV generation in January 2014. Errors in load forecast, which greatly affect the maintenance of demand and supply balance, were larger than forecast errors of the output of wind generation and output of PV generation.

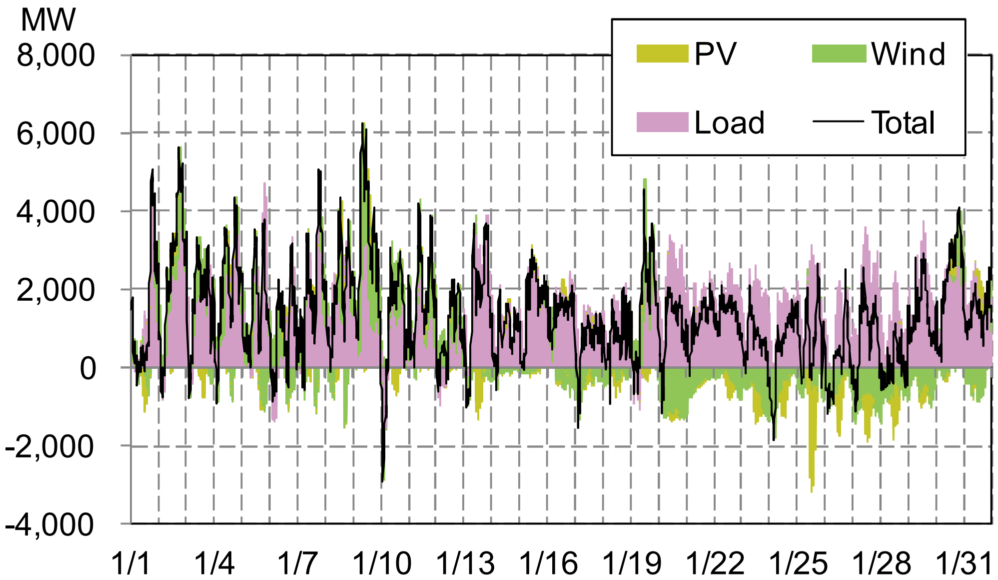

Figure 4-8 Forecast Errors of Load, Output of Wind Generation and Output of PV Generation

Source: 50 Hertz Transmission

However, forecast errors may be dealt with if they have certain patterns. Figure 4-9 shows the hourly distribution of forecast errors of load in January 2014. Errors tended to be smaller during night-time hours and larger during the day. When forecast errors are positive, errors throughout the day may be dealt with by operating standby power plants, while when forecast errors are negative, they may be handled by suspending the operation of the relevant power plants.

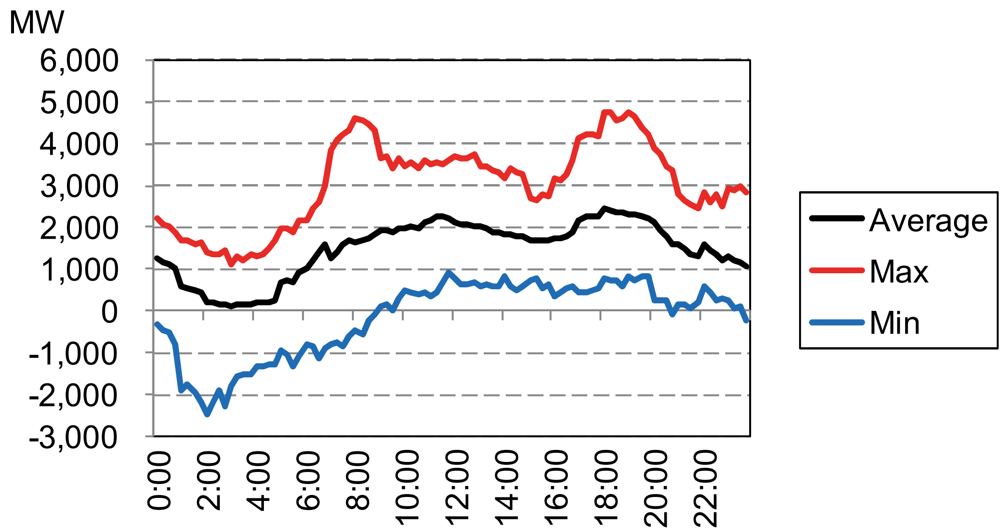

Figure 4-9 Distribution of Forecast Errors of Load

Source: 50 Hertz Transmission

On the other hand, Figure 4-10 shows the hourly distribution of forecast errors of the output of wind generation in January 2014. Forecast errors are close to zero on average but fluctuate randomly in both the positive and negative directions.

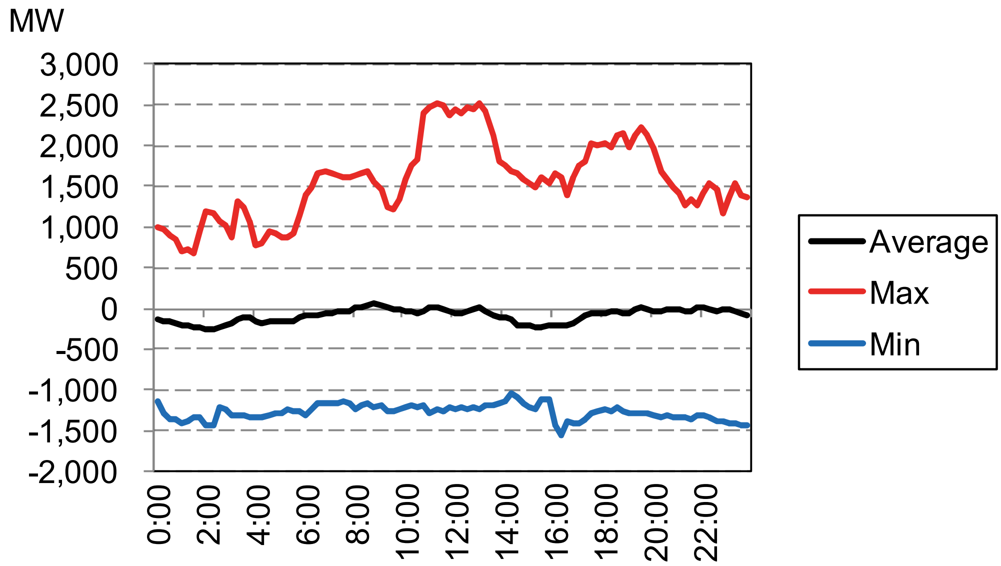

Figure 4-10 Distribution of Forecast Errors of Output of Wind Generation

Source: 50 Hertz Transmission

When forecast errors fluctuate randomly in this manner, certain constraints arise in maintaining the demand and supply balance through the alteration of operational schedules. In the case of thermal power generation, it takes several hours to resume the operation of plants that use some types of power sources. If there are many such facilities within the system, it will be difficult to maintain the supply-demand balance and there is no choice but to use wind power generation for output suppression. Table 4-1 shows the ramp rates of respective power sources. Open cycle gas turbine (OCGT) plants can quickly resume operation, but plants using other types of power sources typically require several hours.

Table 4-1 Ramp Rates of Respective Power Sources

		Mini Stable output	Ramp rate (%/min)	Lead time, warm (h)
Firm RE	Reservoir hydro	5%-6%	15%-25%	<0.1h
	Solid biomass	-	-	-
	Biogas	-	-	-
	Solar CSP/STE	20%-30%	4%-8%	1h-4h
	Geothermal	10%-20%	5%-6%	1h-2h
Dispatchable non-RE	Combustion engine bank CC	0%	10%-100%	0.1h-0.16h (6min-10min)
	Gas CCGT inflexible	40%-50%	0.8%-6%	2h-4h
	Gas CCGT flexible	15%-30%	6%-15%	1h-2h
	Gas OCGT	0%-30%	7%-30%	0.1h-1h
	Steam turbine (Gas/Oil)	10%-50%	0.6%-7%	1h-4h
	Coal inflexible	40%-60%	0.6%-4%	5h-7h
	Coal flexible	20%-40%	4%-8%	2h-5h
	Lignite	40%-60%	0.6%-6%	2h-8h
	Nuclear inflexible	100%	0%	na
	Nuclear flexible	40%-60%	0.3%-5%	na

Notes: CC: combined cycle, CSP: concentrated solar power, STE: solar thermal energy
Source: IEA, "The Power of Transformation – Wind, Sun and The Economics of Flexible Power Systems," 2014

(3) Difference in Ramp Rates and Responses to Renewable Energy Output Fluctuations

As shown in Table 4-1, the minimum stable output and ramp rate vary by type of power source. The minimum stable output is the minimum output required for maintaining the operation of generators and the ramp rate represents the response capacity towards instructions on output fluctuations.

Figure 4-11 shows forecast errors of the output of wind generation and output changes by unit time (1 hour and 30 minutes) of the BPA from January to March 2014. How does a power transmission company make adjustments by using its reserve margin in order to deal with such output changes?

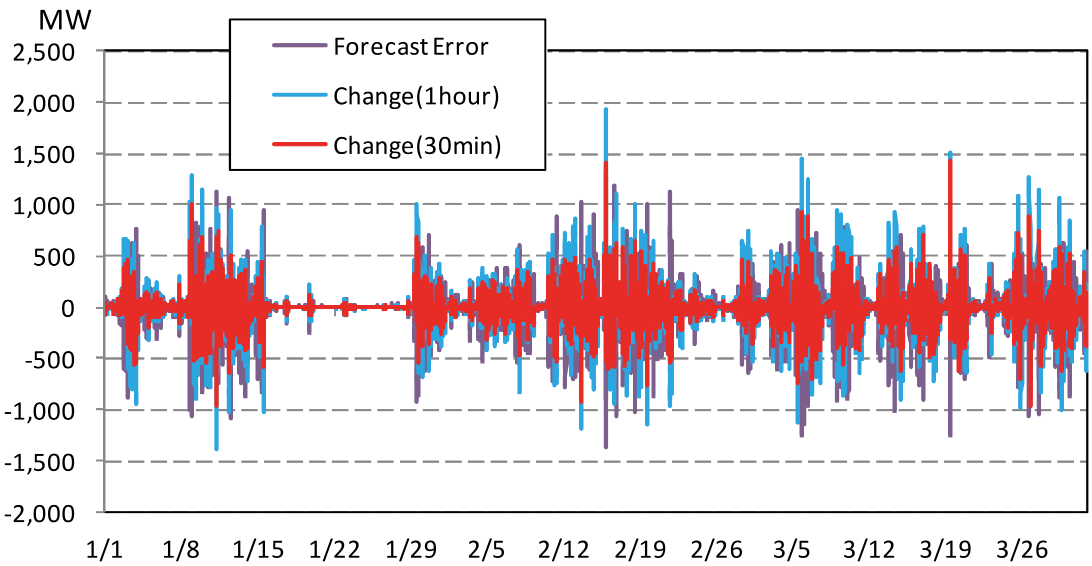

Figure 4-11 Forecast Errors of Output of Wind Generation and Output Changes by Unit Time
Source: Bonneville Power Administration

The definitions of frequency control reserves to be used by power transmission companies for dealing with rapid fluctuations in demand and supply vary as shown in Table 4-2. Various frequency control reserves from primary ones to tertiary ones are envisaged, but the following is the calculation of the capacity of thermal power generation required to increase output from the minimum state by 100MW in 5, 10 and 15 minutes (see Figure 4-12).

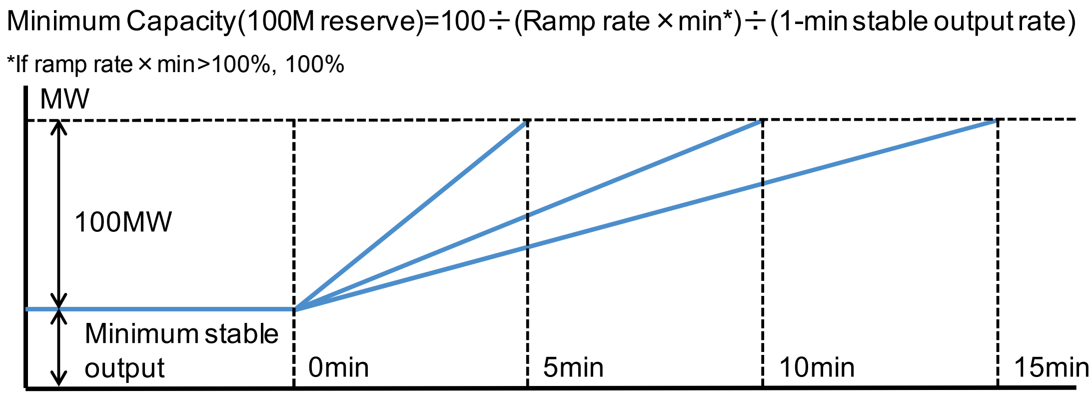

Figure 4-12 Concept Regarding Minimum Capacity Required to Increase Output by 100MW

Table 4-2 Types of Frequency Control Reserves in Japan, the United States and European Economies

<table>
<tr><th></th><th>Primary Frequency Control Reserves</th><th>Secondary Frequency Control Reserves</th><th colspan="5">Tertiary Frequency Control Reserves</th></tr>
<tr><td rowspan="2">PJM</td><td rowspan="2">Frequency Response
(30s(no recommendation))
(±0.36Hz)(Obligation)</td><td colspan="5">Operating Reserve(Biggest unit)</td><td rowspan="2">Reserve beyond 30 minutes</td></tr>
<tr><td>Regulation(5m)(0.7% of Peak demand)(Marginal Pricing)</td><td>Spinning Reserve(10m)</td><td colspan="3">Quick Start Reserve(10m)</td></tr>
<tr><td rowspan="3">CAISO</td><td rowspan="3">Frequency Response
30s(no recommendation))
(±0.36Hz) (Obligation)</td><td colspan="4">Operating Reserve</td><td colspan="2" rowspan="3">Replacement Reserve and Supplemental Energy</td></tr>
<tr><td>Regulation(10m)</td><td colspan="3">Contingency Reserve</td></tr>
<tr><td colspan="2">Spinning Reserve(10m)</td><td colspan="2">Non-Spinning Reserve(10m)</td></tr>
<tr><td>Germany</td><td>Primary Reserve (5s) (±0.2Hz) (663MW)</td><td>Secondary Reserve(5m) (over 2,000MW)(Pay as Bid)</td><td colspan="3">Minutes Reserve(15m) (3% of Peak demand) (Pay as Bid)</td><td colspan="2">Hours Reserve and Emergency Reserve</td></tr>
<tr><td rowspan="2">France</td><td rowspan="2">Primary Reserve(30s)
(±0.5Hz) (700MW) (Obligation)</td><td rowspan="2">Secondary Reserve (5m) (500-1,000MW) (Pay as Bid)</td><td colspan="5">Tertiary Reserve</td></tr>
<tr><td colspan="2">Rapid 15 Minutes Reserve(15m)</td><td colspan="3">Complementary 30 Minute Reserve(30m)</td></tr>
<tr><td rowspan="2">Great Britain</td><td>Operating Reserve</td><td rowspan="2">N.A.</td><td colspan="2">Operating Reserve(5m)</td><td colspan="3">Contingency Reserve(5m-120m)</td></tr>
<tr><td>Response
Primary/Secondary
High Frequency (10s, 30s)
(±0.2Hz, ±0.5Hz) (Obligation)</td><td>Fast Reserve(2m)</td><td>Fast Start(5m)</td><td colspan="2">Short-term operating reserve(5m-120m)</td><td>BM Start-Up
(Warming and Hot Standby)</td></tr>
<tr><td>Spain</td><td>Primary Reserve(±0.8Hz)(30s-15m) (1.5% of Peak demand)</td><td>Secondary Reserve(100s-15m) (Av. 500MW)</td><td colspan="5">Tertiary Reserve(15m-2h)</td></tr>
<tr><td>Sweden</td><td>FCR-N(±0.1Hz, 3m) and FCR-D(-0.3Hz, -0.5Hz, 30s) (559MW)</td><td>N.A.</td><td colspan="5">Manual Frequency Restoration Reserves(FRR-M)(15m)and Automatic Frequency Restoration Reserves(FRR-A)(2m) (Biggest unit(weekly))(1,220MW)</td></tr>
<tr><td>Japan</td><td>Spinning Reserve(10s)
(no band, but target:
±0.2Hz)(3% of Peak demand)</td><td>Operating Reserve (10m)(5% of Peak demand)</td><td colspan="5">Cold Reserve (no recommendation)</td></tr>
</table>

Notes: FCR-N: Frequency Containment Reserves for normal operating band, FCR-D: Frequency Containment Reserves for disturbances
Sources: NERC, "NERC IVGTF Task 2.4 Report- Operating Practices, Procedures, and Tools," 2011/3 and others

In the case of reservoir hydropower generation with a high ramp rate, the minimum capacity required to increase output by 100MW is around 100MW, while in the case of lignite-fired power generation with a low ramp rate, as much as 5,556MW is required to achieve a 100MW output increase in five minutes.

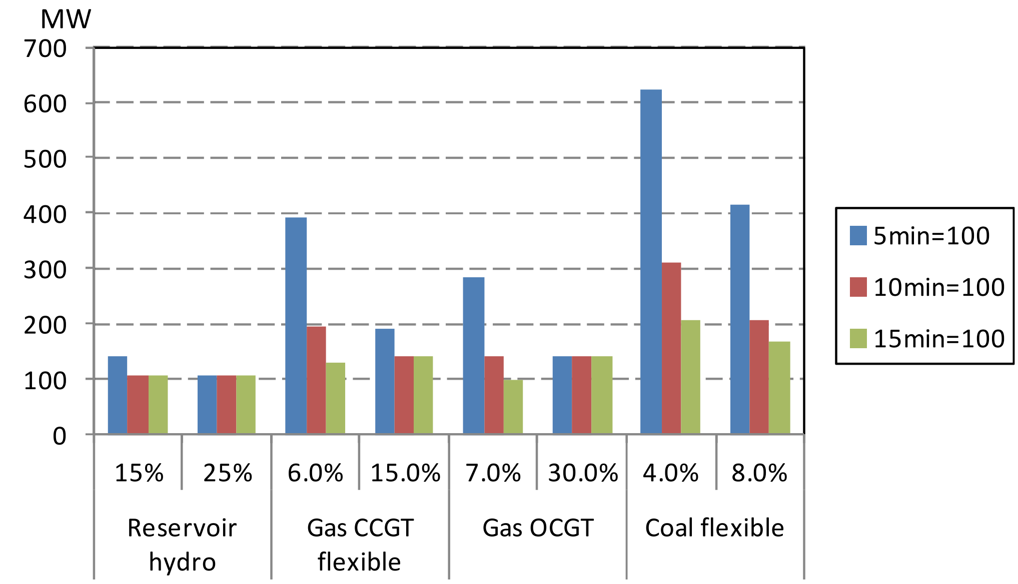

Figure 4-13 Case of Flexible Generation

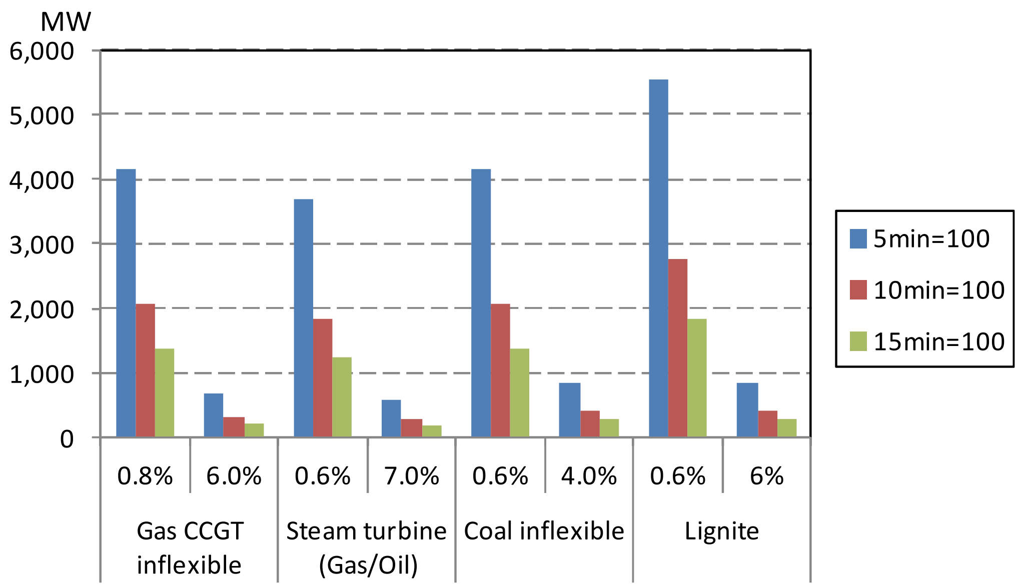

Figure 4-14 Case of Inflexible Generation

Each power source has constraints relating to ramp rate and minimum output, and when many inflexible power sources, such as coal-fired power generation, are linked in the system, the minimum output constraint of intermittent renewable energy generation becomes larger.

On the other hand, when many reservoir hydropower facilities and gas-fired power facilities with a high ramp rate exist in the system, the flexibility of the system is high and the capacity to accept renewable energy generation increases accordingly. In this manner, how much intermittent renewable energy generation can be introduced depends on the characteristics of the composition of power sources in respective areas.

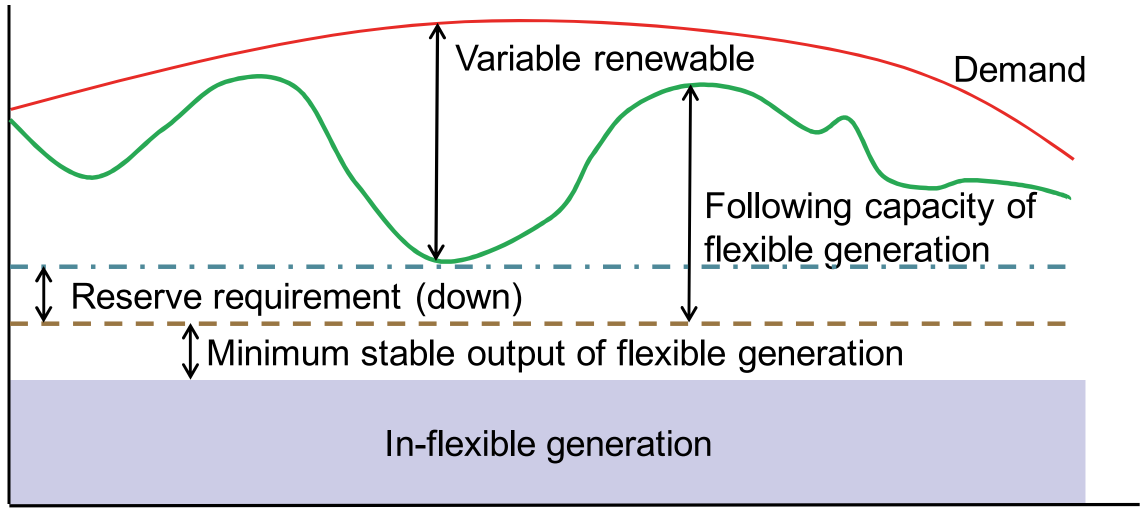

Figure 4-15 Case of Flexible Generation

4.2 Grid Integration of EVs

Two-way grid integration making use of the storage battery function of electric vehicles (EVs) is under consideration in various regions. In particular, methods such as using EVs as reserves for ancillary services and using them to contribute to voltage stability in the wholesale market are under consideration. However, as there is no market for electricity for voltage stability in many cases, using EVs as reserves for ancillary services is the main method under consideration.

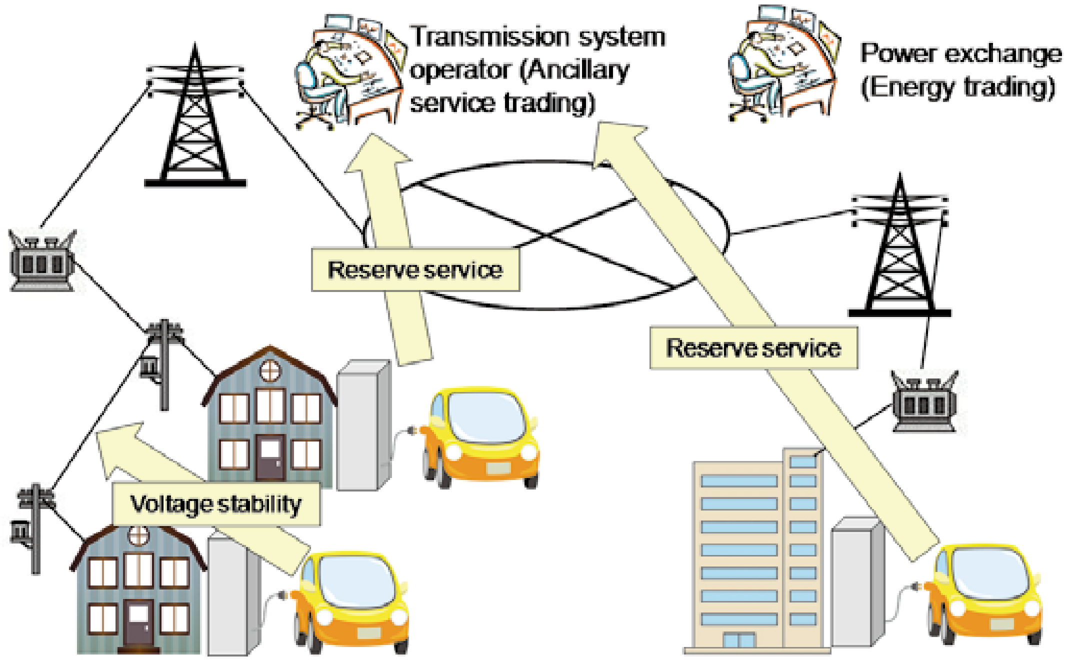

Figure 4-16 Concept of Grid Integration of EVs

The University of Delaware is identifying challenges and considering measures to resolve them in a comprehensive manner, including electrical engineering, mechanical engineering, software systems, economics and the market. In 2003, Pepco Holdings Inc (PHI), an electricity company in the state of Pennsylvania, commissioned the University of Delaware to conduct a theoretical analysis of the vehicle-to-grid (V2G) system in the service area of PJM Interconnection, a wide-area grid organisation in the Northeast, in view of initiatives in the State of California and other regions to introduce EVs and hybrid vehicles and the possibility of effective use of storage batteries installed on such vehicles. As a result of designing the V2G concept for the Mid-Atlantic region through these initiatives, the University was able to obtain funds from various sources including Google and to conduct further research and development. In October 2007, PHI, PJM and the University of Delaware succeeded in developing eBOX, which is capable of receiving signals from PJM's power supply instruction system. Subsequently, the University jointly conducted a demonstration research with PJM, the results of which were summarised in "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System"[40]. Later, the University published "A comparison of two GIV mechanisms for providing ancillary services at the University of Delaware,"[41] which explained the analysis of its participation in PJM's frequency regulation service market through the use of storage batteries installed on EVs with the support of partners such as NRG Energy, AC Propulsion, BMW, AutoPort, EVGrid, and JM Interconnection. Below, after

[40] http://www.udel.edu/V2G/resources/test-v2g-in-pjm-jan09.pdf

[41] http://www.udel.edu/V2G/resources/Vandael-TwoGIVMechanisms2013.pdf

explaining the key points of the PJM market, we will mainly discuss the abovementioned two papers.

PJM is a wide-area grid operation organisation managing supply and demand through the capacity market, the energy market and the ancillary service market. The flow of wholesale electricity transactions conducted by PJM is as shown in Figure 2-5. The University of Delaware studied mainly the effects and economic cost of transactions using EV storage batteries in transactions in the frequency regulation service market. This market is for reactive supply capacity which is obtainable within five minutes upon issuance of an order from PJM. The output of supply capacity participating in the market is required to be adjusted in accordance with frequency regulation signals issued by PJM every two to four seconds. Figure 4-17 shows the output values indicated by frequency regulation signals. It is necessary to follow the signal indication in order to keep the maximum capacity for frequency regulation service within the range of minus 1 to plus 1.

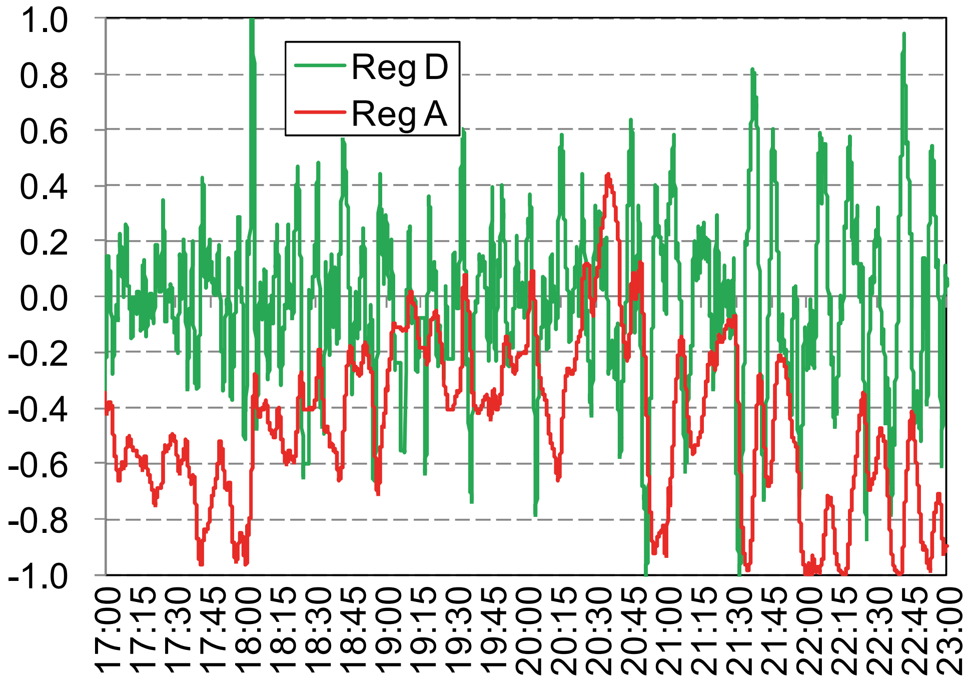

Figure 4-17 Frequency Regulation Signals Issued by PJM

Source: PJM Interconnection

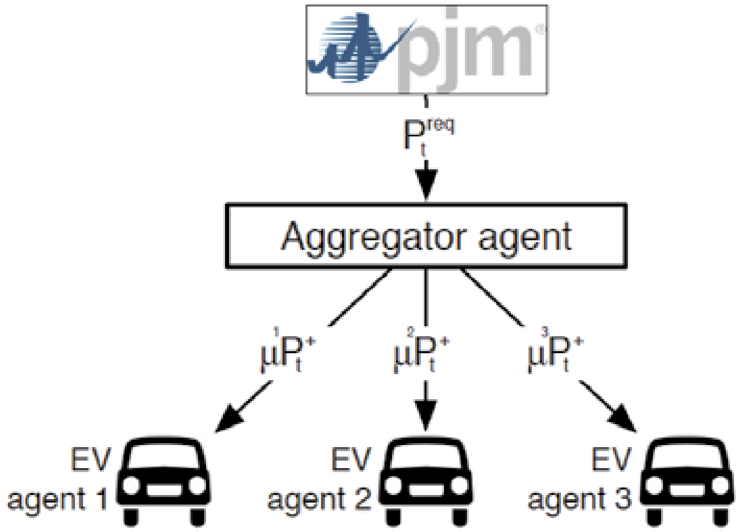

Figure 4-18 Relationship between PJM and Aggregator

Source: University of Delaware, "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System," November 2008

In a test conducted in 2007, the response of an EV equipped with a storage battery with a voltage of 355V and a generation capacity of 35kWh to frequency regulation signals was examined. Figures 4-19 and 4-20 show the key results. It was found that while the response to frequency regulation signals was sometimes not good at high discharge rates, the batteries mostly responded well to the signals.

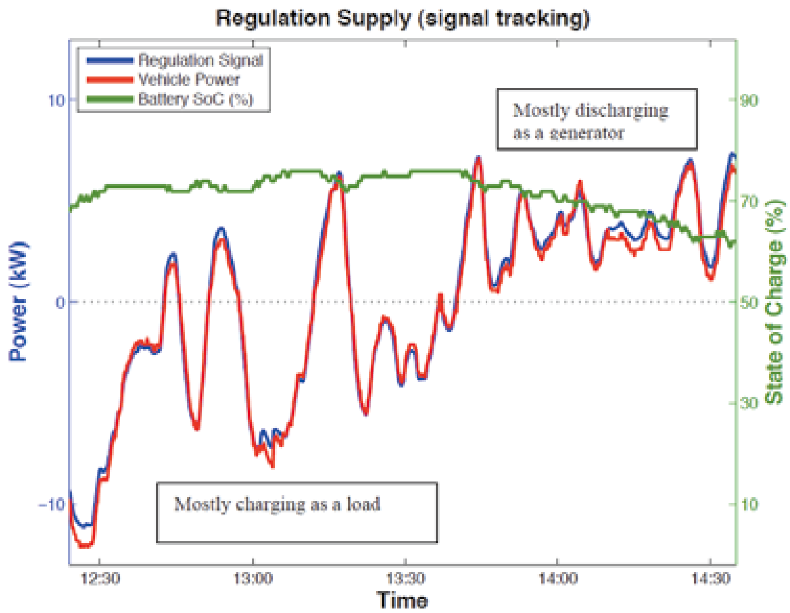

Figure 4-19 Example of Response during Daytime Hours

Source: University of Delaware, "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System," November 2008

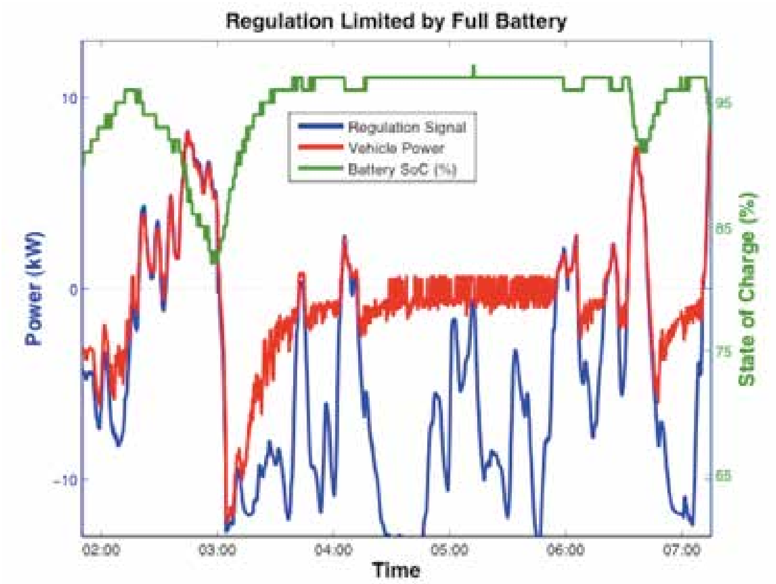

Figure 4-20 Example of Response during Daytime Hours

Source: University of Delaware, "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System," November 2008

Many electricity companies in California offer time-zone pricing. Consequently, charging at residential charging stations is often concentrated in off-peak zones in which the applicable electricity rate is relatively low. However, at private and public charging stations to which time-zone pricing is not applicable, the timing of charging apparently depends on the periods of activity. In particular, residential charging in San Diego and San Francisco starts at midnight in most cases, so it is presumed that most EV owners there implement charging according to the electricity pricing menu. It should be noted that no particular problem has arisen in terms of voltage or frequency stability because the installed capacity is small.

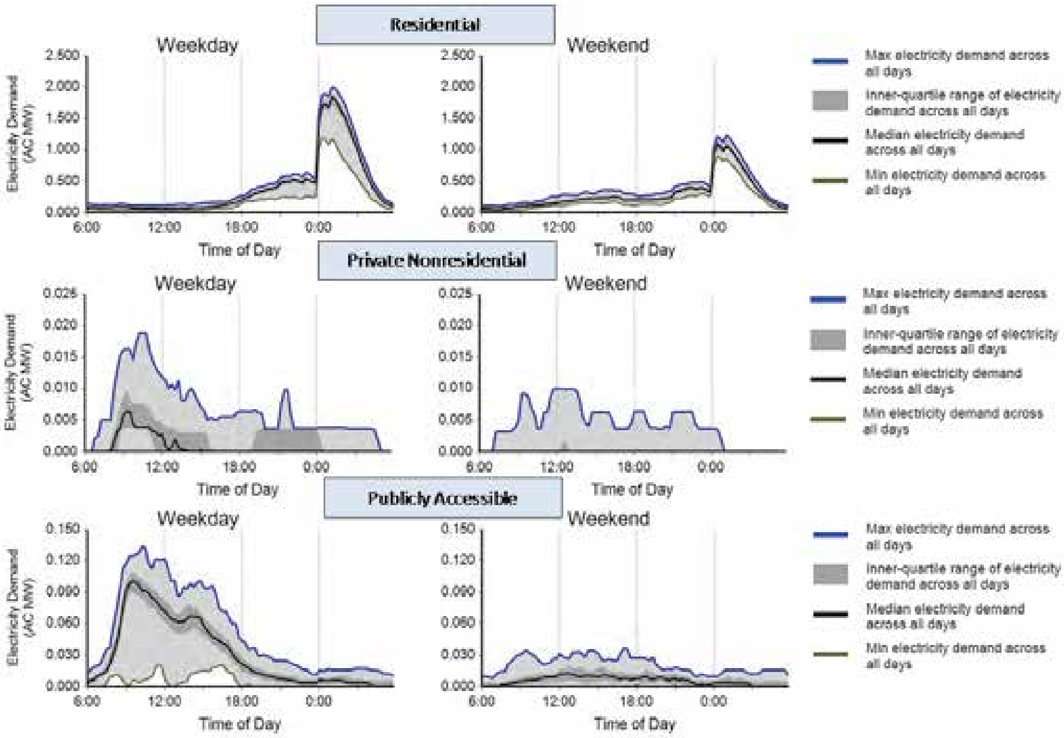

Figure 4-21 Example of EV Charging Pattern (San Francisco)

Note: April–June 2013

Source: The EV Project, “Q2 2013 Report – The EV Project”

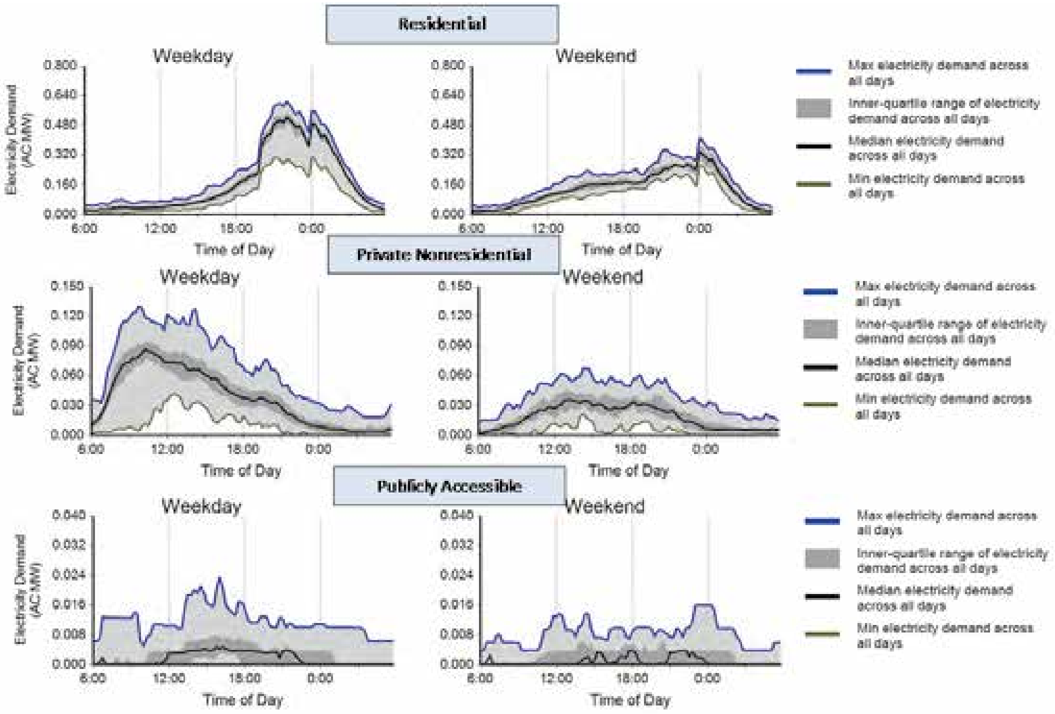

Figure 4-22 EV Charging Pattern (Los Angeles)

Note: April–June 2013

Source: The EV Project, “Q2 2013 Report – The EV Project”

The demonstration test conducted by the University of Delaware, which is advanced in studies on V2G, showed that participating in the frequency regulation service market using EV storage batteries is feasible technologically. However, the response capability of storage batteries deteriorates in early morning hours when the charging rate is high. It is possible to supplement the supply capacity by secondary use of EV storage batteries, thereby increasing the value of the batteries as a supply capacity. Still, as the reliability of storage batteries as a supply capacity cannot be secured without a certain number of EVs, it is necessary to encourage greater participation as a wide-area initiative. At a minimum, it may be essential for each transmission and distribution company to develop a V2G programme. To broaden the geographical scope of the V2G initiative, government involvement is indispensable (such as the V2G promotion initiative in California).

Usually, the frequency regulation service market is designed on the premise of using conventional energy sources such as fossil fuel thermal power and hydropower generation. Therefore, it is necessary to modify the market design as PJM has done in order to enable participation by storage batteries, which respond well to regulation signals in the short term but whose sustainability is low.

5 References

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6 Mission Report
(Report on Participation in APEC Workshop on Smart DC Power Opportunity for Community)

1. Date: 10–11 November 2014
2. Location: Chiang Mai Rajabhat University, Chiang Mai, Thailand
3. Participants: Representatives from APEC economies, university officials, companies involved in businesses related to direct current (DC) electricity, Provincial Electricity Authority of Thailand, Thai government officials, etc.
4. Key Points

   i) The APEC Workshop on Smart DC Power Opportunity for Community was held to coincide with a meeting on new energy sources. Given the expected increase in the use of PV, the adoption of direct current (DC) power transmission would reduce losses arising from the conversion between alternating current and direct current, as LED lighting and electrical equipment such as TVs use DC electricity. This demonstration project focuses on the efficient use of electricity by creating a DC community using DC equipment. The project is based on the principle that using DC electricity without conversion is more efficient.

   ii) In the workshop, in addition to sharing information on a smart DC community, discussions were held in small groups on expansion of the DC community from the viewpoints of policy, subsidy, technological strategy, etc. The following day, the results of the discussions were shared among all participants.

5. Key Points of Individual Sessions

Session 1. Overview on Smart Grid Systems for the Community Level

- In the ASEAN region, there is a strong need for an international grid in order to utilise various economies' resources. Challenges include setting economy targets, enacting laws, harmonising standards and securing finance for projects.
- The Provincial Electricity Authority of Thailand (PEA) is implementing a smart grid programme in three locations.

Session 2. Best practice for Community Power Systems in the APEC Region

- In the United States, federal budget funds are used to support many micro-grid projects.
- In some parts of the APEC region, grid interconnection is insufficient, and DC has an advantage in that DC facilities can be installed there together with PV and other power supply facilities. Expectations are also rising for EVs as DC equipment.
- In Thailand, a project to integrate renewable energy into a smart grid is under way at the

University of Phayao.

- As Viet Nam is lagging behind in developing low-voltage grids, the economy is implementing a smart power distribution project in the Cau Giay district of Ha Noi and a project to improve the operation of the Dich Vong distribution and transformer substation. Viet Nam aims to realise smart power distribution by improving regulation facilities and installing PV and DC facilities as backups.

Session 3. The Challenges and Barriers for DC Community Power Systems Development and Implementation

- On both the supply and demand sides, DC-capable facilities, including PV facilities, are increasing. Partly as a result, unnecessary power losses are arising from AC/DC conversion. There is a plan to develop an economy-wide grid first and regional grids subsequently.
- The cost of regulating a DC network may be as small as one tenth that of an AC network. An increasing number of facilities for commercial buildings are DC-capable, and such facilities are highly efficient.
- A DC solar power system costs 20% more than an AC system. However, the additional cost may be offset if the system is installed at a new building.
- While the debate on standards is ongoing at the IEC and the IEEE, there are challenges in terms of technology and technological certification.
- The challenges for DC networks are policy-related ones, rather than technological ones that require improvements of equipment. It is necessary to create a DC market.

Session 4. Group Breakout: Overall Roadmap for DC Community Power Development in the APEC Region

- Discussions were held in three groups, one for technological standards, one for policies and subsidies, and one for technological development and dissemination strategy.

Session 5. Opportunities for DC Community Power Systems in the APEC Region

- Technological development and cost reduction of PV will promote the dissemination of DC networks.
- A combination of smart grid and DC, which has an advantage in terms of energy conservation and other matters, can be achieved through the integration of various technologies. This combination will contribute to the reduction of ancillary services and development of off-grid mini-networks. DC will contribute to the expansion of household systems combined with PV.

- A major challenge is the low level of awareness among relevant people. Other challenges include misunderstanding of technologies, low level of technology, priority given to existing facilities, sunk costs, and a lack of policy support.
- The Chiang Mai World Green City (CWGC) started in 2009. It consists of a smart community, highly efficient buildings and seminar halls made of natural materials, etc. It uses various technologies, including DC micro-grid, AC micro-grid, PV, HP, a recycled plastic walkway and bio gas derived from waste. DC equipment uses up to 30% less energy on average than AC equipment. The energy conservation rate is 33% for air conditioners, 27% for refrigerators, 16% for TVs and 30% for lighting equipment. The CO_2 reduction effect is around 2,000 tons over a 15-year period compared with the business-as-usual (BAU) case. The use of renewable energy and environmental management produce particularly large reduction effects.
- It is expected that through this workshop, the concept will evolve further, triggering a sequence of processes, including growth of public awareness, implementation of demonstration projects, provision of policy incentives, drafting of standards, setting of policies and dissemination in the market.

Session 6. Group Presentation on Road Map for DC Community Power Development in the APEC Region

Regarding technologies and standards:

- It is necessary to promote exchanges of information between relevant parties and outreach initiatives, introduce existing sites, develop standards, devise solutions and provide systems. In addition, in order to develop global standards, it is necessary to use an existing framework for cooperation and create a forum for exchanging information among major players.

Regarding policy and finance:

- Raising awareness among policymakers: To promote programmes at the economy and local levels as well as in non-electrified areas and to identify merits and benefits, such as reliability improvement.
- Policy measures: Cost reduction, tax credits, feed-in-tariff (FIT) programme, environmental policy incentives. The creation of subsidy programmes and R&D funds will be considered. Carbon credits, employment and GDP.
- Barriers: A lack of political leadership and a lack of awareness about the importance of the merits of regional DC grids. It is necessary to send clear messages with regard to education, technological development plans and financial resources.

Technological development and dissemination strategy:

- Develop a dissemination strategy by clarifying the objectives of R&D through a combination of education, awareness-raising and technological innovation.

APEC DC Smart Grid Workshop Wrap-up

- Expectations for DC smart grid-related workshops organised by APEC
- Expectations for the development of a database and implementation of activities to raise awareness about DC networks under APEC's leadership
- Necessity of platforms for research and exchanges of information concerning DC smart grids

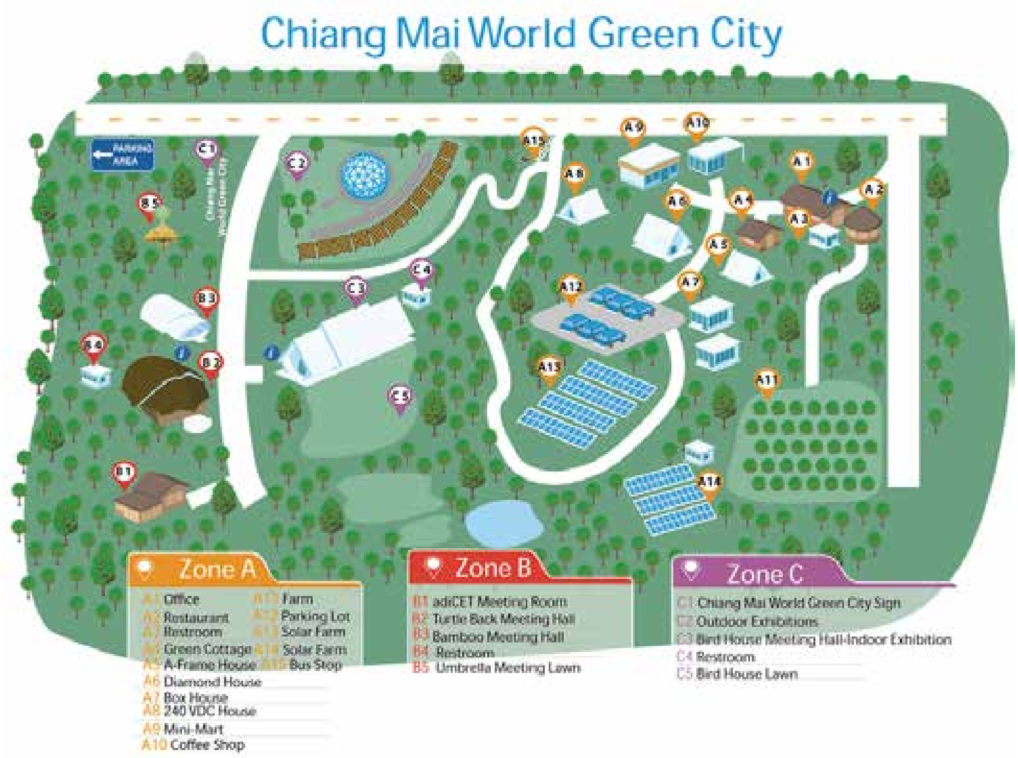

Figure 6-1 PEA Smart Grid Road Map

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