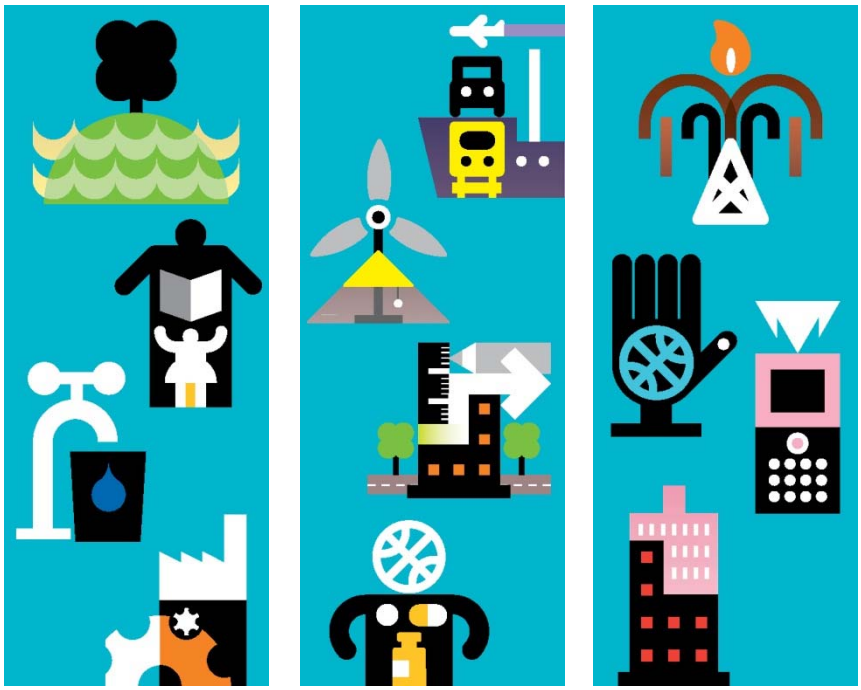


Overview of Electricity Markets in Overseas Jurisdictions

April 2015

Electrical and Mechanical Services Department

Mott MacDonald

Overview of Electricity Markets in Overseas Jurisdictions

April 2015

Electrical and Mechanical Services Department

Electrical and Mechanical Services Department
Government of Hong Kong Special Administrative Region

Mott MacDonald, 20/F AIA Kowloon Tower, Landmark East, 100 How Ming Street, Kwun Tong, Kowloon, Hong Kong
T +852 2828 5757 F +852 2827 1823 w W www.mottmac.com

Contents

Acronyms

ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AEMO	Australian Energy Market Operator
AREP	Affiliated Retail Energy Provider
ATSI	American Transmission Systems, Inc.
AUD/AU$	Australian Dollar
BETTA	British Electricity Trading and Transmission Arrangements
CAGR	Compound Annual Growth Rate
CAISO	California ISO
CCGT	Combined-Cycle Gas Turbine
CCL	Climate Change Levy
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
CEGB	Central Electricity Generating Board
CfD	Contracts for Differences
CI	Customer Interruptions
CLP	CLP Power Hong Kong Limited
CM	Capacity Mechanism
CML	Customer Minutes Lost
COAG	Council of Australian Governments
CPF	Carbon Price Floor
CPI	Consumer Price Index
CPS	Carbon Price Support
CPUC	California Public Utilities Commission
CREZ	Competitive Renewable Energy Zones
DASR	Day – Ahead Scheduling Reserve
DECC	Department of Energy and Climate Change
DEOK	Duke Energy Ohio/Kentucky
DNOs	Distribution Network Operators
DPCR-5	Distribution Price Control Review 5
DRP	Demand Response Programme
DSR	Demand Side Response
DWR	Department of Water Resources
EKPC	Eastern Kentucky Power Cooperative
EIM	Energy Imbalance Market
EILS	Emergency Interruptible Load Service
EMA	Energy Market Authority
EMC	Energy Market Company Pte Ltd
EMR	Electricity Market Reform

EMSD	Electrical and Mechanical Services Department
ENB	Environment Bureau
EPS	Emission Performance Standards
ERCOT	Electric Reliability Council of Texas
ERS	Emergency Response Service
ETS	Emission Trading Scheme
EU	European Union
EUA	European Carbon Allowance
FERC	Federal Energy Regulatory Commission
FID	Final Investment Decision
FiT	Feed in Tariff
FRRS	Fast Regulation Reserve Service
FTRs	Financial Transmission Rights
GB	The Great Britain
GBP	Great Britain Pound
GDP	Gross Domestic Product
GW	Gigawatt
HEC	Hongkong Electric Company Limited
HHI	Herfindahl-Hirschman Index
HPC	Hinckley Point C
HSFO	High Sulphur Fuel Oil
IIS	Interruptions Incentive Scheme
ISO	Independent System Operator
kV	Kilovolts
kW	Kilowatts
kWh	Kilowatt hour
LCF	Levy Control Framework
LCPD	Large Combustion Plant Directive
LNG	Liquefied Natural Gas
LOLE	Loss of Load Expectation
LOLP	Loss of Load Probability
LMP	Locational Marginal Pricing
LSEs	Load-Serving Entities
MCE	Ministerial Council on Energy
MMU	Market Monitoring Unit
MSCP	Market Surveillance and Compliance Panel
MSSL	Market Support Service Licensee
MW	Megawatt
MWh	Megawatt hour
ncm	normal cubic metre
NEM	National Electricity Market

NEMMCO	National Electricity Market Management Company
MSSL	Market Support Service Licensee
NEMS	National Electricity Market of Singapore
NETA	New Electricity Trading Arrangement
NG	National Grid
NIE	Northern Ireland Electricity
NP	National Power
NSHB	North of Scotland Hydro Board
Ofgem	Office of Gas and Electricity Markets
ORDC	Operating Reserve Demand Curve
PG	PowerGen
PG&E	Pacific Gas & Electric
PJM	PJM Interconnection LLC
PSO	Power System Operator
PTC	Production Tax Credit
PTE	Panel of Technical Experts
PUB	Public Utilities Board
PUCT	Public Utility Commission of Texas
PURA	Public Utility Regulatory Act
RECs	Regional Electricity Companies
REP	Retail Energy Provider
RET	Renewable Energy Target
RIIO	Revenue(=)Incentives(+) Innovation(+)Outputs
RO	Renewable Obligation
ROCs	Renewable Obligation Certificates
RPI-X	Retail Price Index -X
RPM	Reliability Pricing Model
RPS	Renewable Portfolio Standards
RSI	Residual Supply Index
RTEP	Regional Transmission Expansion Plan
RTO	Regional Transmission Operator
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCA	Scheme of Control Agreement
SCE	Southern California Edison
SCED	Security Constrained Economic Dispatch
SDG&E	San Diego Gas & Electric
SIR	System Inertial Response
SGD	Singapore Dollar
SGX	Singapore Exchange
SRMC	Short Run Marginal Cost

SSE	Scottish and Southern Energy
SSEB	South of Scotland Electricity Board
TETCO M-3	Texas Eastern, zone M-3
TPS	Three Pivotal Supplier
TSO	Transmission System Operator
TWh	Terawatt hour
UK	The United Kingdom
US	The United States
USA	The United States of America
USEP	Uniform Singapore Energy Price
VOLL	Value of Lost Load

Executive Summary

Australia

Prior to the liberalisation process, the supply of electricity in Australia was provided by vertically integrated, state-owned utilities meeting customer demands of individual states and territories.

The liberalisation process in Australia started in the mid-1980s in response to emerging concerns about the inefficiency of the state-owned electricity industry; the response, at that time, was to introduce some reforms at state level with the objective of strengthening the management and control arrangements for the electricity industry. Then in the early 1990s, the emerging neo-liberal ideology and globalisation process created an enormous pressure on the Australian electricity industry – and in other state controlled sectors – to undertake more radical reforms. The reform of the electricity industry became an integral part of the main reform program introduced by the Australian government; and as part of it, several agreements were reached between various state governments in Australia to reform their electricity industries. **The main objective of this reform was to increase competition in the industry and provide greater choice for end-use electricity consumers**.

Even though the federal government has taken a large stake in power sector regulation, the electricity market is still regulated through a combination of state and federal legislation. To ensure proper coordination among different governmental levels, the sector is steered by the Council of Australian Governments[1] (COAG) which provides the ground for political agreements between the different stakeholders.

A key part of the reform in the electricity industry came with development of the National Electricity Market (NEM) in 1998, which comprised New South Wales, Victoria, Australian Capital Territory, Queensland and South Australia (and included Tasmania in 2005). The establishment of the NEM was the result of extensive consultation and collaboration between the states and the electricity industry. The reforms also included the unbundling of the vertically integrated state-owned electricity authorities into separate generation, transmission, distribution and retail sales sectors in each State.

The Australian Energy Market Operator (AEMO) is responsible for aggregating and dispatching supply to meet demand in the NEM in the lowest cost manner available. In addition to the electricity market, AEMO runs the gas market in Australia. AEMO was created with the objective of strengthening the national character of energy market governance by drawing together under one operational framework the responsibility for electricity and gas market functions, NEM system operations and national transmission planning.

Retail competition was introduced in 2003 in the states of Victoria, New South Wales, Queensland and South Australia, and regulated at state level. Currently, all states in Australia, (except Victoria, South Australia and New South Wales) apply some form of retail price regulation for electricity supplied under a standard retail contract, applying either a building block approach (bottom-up process) or a benchmark of retail cost index. Australian governments agreed to review the continued use of retail price regulation and to remove it if “effective competition” can be demonstrated. The Australian Energy Market Commission

[1] The COAG is the peak intergovernmental forum in Australia and its members are the Prime Minister, State and Territory Premiers and Chief Ministers and the President of the Australian Local Government Association.

(AEMC) continuously assesses the effectiveness of retail competition in each state; however, state and territory governments make the final decisions on this matter.

Since the implementation of the NEM, wholesale prices have been in the range of 20 to 60 AU$/MWh (at real prices from January 1998). From the analysis performed, it appears that the NEM provides cost reflective prices in electricity markets (gas prices and carbon scheme) and this is consistent with the expected outcome of the reform process undertaken by the country. At retail level, the trend in prices shows a significant increase over the past five years with network costs being the key price driver, followed by the introduction of green policies (carbon price and renewable energy promotion) – both of them regulated activities.

In terms of operational efficiency, considering that competition provides, in theory, strong incentives to operational efficiency across market participants and the fact that the NEM is reaching good level of competition at the wholesale and retail markets, means that operational efficiency should have improved.

Currently, the retail sector in the NEM remains fairly competitive; three retailers – AGL Energy, Origin Energy and Energy Australia – jointly supplied 77% of small electricity customers in southern and eastern Australia in 2012–13. The existence of a contestable market provided small private retailers (mostly new entrants) the possibility of gaining market share during 2012-2013. This is in line with the objective of the power sector reform in providing customer choice. However, the retail competition has not led to increased customer satisfaction and their complaints have been increasing.

In terms of system reliability, it is observed that the liberalisation process did not have an impact on the overall reliability of the system.

From our review, there appears to be a general consensus in Australia across federal and state governments that while a good level of competition has been achieved, this should be further pursued and improved; this is particularly important for gentailers[2], as they have the possibility of exercising market power. It has also been agreed that the liberalisation process needs to be carefully considered and barriers removed as long as there is an agreement on the benefits for the society in pursuing further market development.

At wholesale level, the NEM shows good level of competition and, while adjustments are required to mitigate market power of some market players (mainly fine tuning, from improvements in the transmission grid for bottleneck prevention to regulatory changes for ensuring barriers are not raised in market competition), we can conclude the objective of the reform process has been achieved. At retail level, we can reach to the same conclusion in Victoria, South Australia and New South Wales, and to a reasonable extent in Queensland and Australian Capital Territory. Tasmania is still lagging to achieve a competitive environment at retail level but it is important to highlight that Tasmania was the last state to join the NEM therefore, it lags on below the learning curve compared the rest of the states.

Despite the initial unbundling of generation, transmission, distribution and retail activities, the NEM is currently observing a process of vertical integration between generation and retail activities. This could be

[2] Gentailers are power companies that have both generation and retail business

seen as a contradiction within the market design: unbundling was implemented to promote competition, but the market rules have allowed generators and retailers to re-bundle. While there is a natural economic incentive for this (allowing generators and retailers to hedge risks), the process can easily lead to a raising in barriers for competition, allowing the gentailers to exercise market power and prevent new entrants into the market. In fact, the regulator has noted a number of cases in which market power has been exercised, though this has not been observed on a continuous basis. The different government bodies (regulators and competition authorities) will need to maintain a strict monitoring on gentailers activities to prevent these companies exercising market power.

Singapore

Prior to 1995, the Public Utilities Board (PUB) owned and managed power generation, distribution and retailing. This structure served Singapore adequately for three decades.

In 1995, the government of Singapore introduced the first reform of the electricity industry when it corporatized the electricity undertakings of the PUB. **The main objective of the reform was to gradually introduce competition in electricity generation and retail so that Singapore would have an electricity market that allows market forces rather than central planning to drive investment, production and pricing decisions**.[3]

Consistent with the government policy, the liberalisation process was gradually introduced. A key milestone took place in 2003 when the National Electricity Market of Singapore (NEMS) was formed under a new legal and regulatory framework by the Energy Market Authority (EMA) and the Energy Market Company Pte Ltd (EMC). The NEMS handles the purchase and sale of electricity, serving as a trading platform for electricity.

In 2004, the EMA imposed "vesting contracts" (special financial contracts)[4] on the three largest generators (Senoko Energy, PowerSeraya and Tuas Power Generation) as a condition of their electricity licences. The vesting contracts were designed to reduce the market power of the large players with pricing provisions intended to reflect the economics of new generation plant. The vesting contract level allocated to each generator diminishes as the market power of that generator is reduced. Vesting contracts are still in place, although EMA has recently determined to lower the vesting contract level from the current 40% of the total demand to 30% for first-half 2015 and 25% for second-half 2015 and 20% for 2016[5].

In addition, EMA has been gradually introducing further contestability to the retail market by reducing the eligibility threshold of non-residential users. However, household customers are still non-contestable and remain on the regulated tariff.

---

[3] EMA (2010) - Introduction to the National Electricity Market of Singapore.

[4] With the vesting contracts, generation companies are committed to selling a specified amount of electricity (viz the vesting contract level) at a specified price (viz the vesting contract price). This removes the incentives for generation companies to exercise their market power by withholding capacity to push up spot prices in the wholesale market. [Source: https://www.ema.gov.sg/Licensees_Electricity_Vesting_Contracts.aspx]

[5] Source: EMA (2014). Review of the Vesting Contract Level for the Period 1 January 2015 to 31 December 2016 – Final Determination Paper.

EMA is also promoting the introduction of a Demand Response Programme (DRP) to enhance competition in the wholesale electricity market. The DRP will allow customers with flexible electricity demand to voluntarily reduce their demand, in exchange for a reduction in the electricity prices as a result of their actions.

Also, EMA together with the Singapore Exchange (SGX) was preparing to launch the first electricity derivative (future) market in Asia by the end of 2014. This market was finally launched on 1 April 2015 and the product to be traded is the Uniform Singapore Energy Price[6] (USEP) Quarterly Base Load Electricity Futures. The objective of the electricity futures market is to provide market participants with a tool to manage their risk exposures and prevent the need of vertical integration between generators and retailers. Potential new participants to the electricity market can also use the futures market to back fixed price contracts for consumers with an appetite for low risk electricity price contracts.

Changes in the generation mix (replacing more expensive oil with comparatively more economical natural gas) driven by market competition, combined with stable LNG prices in the region, have helped to exert downward pressure on wholesale electricity prices in Singapore; thus, enabling contestable consumers to purchase more competitive retail packages. Therefore, the government strategy of developing wholesale competition together with further reliance on natural gas as a source to maintain industrial competitiveness appears to be paying off.

Electricity tariffs for non-contestable consumers are regulated by the EMA and are updated quarterly to reflect changes in the cost of power generation. Considering that regulated prices follow the trends in wholesale prices, non-contestable consumers have also benefitted from competition. In addition, they have also benefited from lower grid charges (in both nominal and real terms) for which we can consider the government has made reasonable efforts to promote efficiency in regulated activities.

Considering that competition, in theory, provides strong incentives for operational efficiency across market participants, the fact that the NEMS is reaching good level of competition at the wholesale and retail markets means that operational efficiency should have improved.

The introduction of contestability at retail level has brought significant changes to the market shares of retailers companies over the last decade; while the retail market is served by six retailers as in 2003, their market share has changed quite substantially (at least in terms of electricity sales). Despite the lack of information to develop a more detailed analysis, this trend in customer choices appears to show that market forces are driving customers decisions, in line with the objectives of the government for the liberalisation of the power sector.

Finally, in terms of system reliability, the fact that Singapore was able to improve reliability levels in its grid leads us to infer that the development of competition and efficiency at retail and wholesale markets has not affected the reliability of the grid.

The reform process in Singapore is in the process of moving towards full retail market liberalisation (EMA has recently taken decisive steps in the retail market to reduce the eligibility threshold level allowing retail

[6] The USEP is the weighted-average of the nodal prices at all off-take nodes as calculated by the Energy Market Company.

companies to access an increasing amount of customers); and, the government is working on introducing further tools in an effort to increase competitive behaviour of market participants.

The reform program introduced by the government is largely achieving its objective, as the market reforms have introduced enough incentives for market participants to invest in more efficient forms of power generation (increasing the share of natural gas combined-cycle gas turbine (CCGT) and replacing expensive diesel / oil generation). This change in the generation profile affected prices at wholesale and retail levels providing end customers a share on the improvements in efficiency.

Retail competition has changed the market share of retail companies which would imply that customers are benefitting from better commercial offers (either in terms of cheaper energy and/or better services). However, the contestable market is an area in which EMA needs to improve monitoring activities (or at least to make more transparent the monitoring results) in order to understand whether customers have enough information to maximise the benefits of retail competition. It should be noted that full contestability to all retail customers has not yet completed and vesting contracts are still in place, reflecting the possible risk in the market reform.

A key issue in the Singapore electricity sector is the lack of public available information over the contestable market. Currently, EMA does not provide analysis, information or monitoring activities on commercial offers of retailers for contestable consumers; there are also no price comparison tools for customers as observed in other countries. Additionally, while there appears to be a certain level of vertically integration between generators and retails, we were not able to find out any analysis or monitoring of the potential threat of this activity on new entrants and market competition.

United Kingdom

Prior to the reform, all power generation plus the transmission grid in England and Wales were run by the Central Electricity Generating Board (CEGB). Distribution and supply were integrated activities undertaken by 12 regional Electricity Supply Boards who had monopoly status and provided a supply to all consumers in their own geographical areas. All utilities were publicly owned and run.

The approach to electricity sector reform in the UK, albeit broadly consistent, was undertaken slightly differently in Scotland, Northern Ireland and in England and Wales, reflecting the pre-existing industry structure (and the strength of regional lobbies). The overall approach was driven by the Conservative Government which was pursuing an agenda of widespread privatisation and reform throughout all utility sectors. **One of the main philosophical drivers was the belief that competition between privately-owned, profit-driven organisations would drive down costs and increase the efficiency of the utility sectors, as well as relieving some pressure on the State treasury.**

The Electricity Act 1989, primary legislation which applied to the whole of Great Britain (Scotland, England and Wales), restructured the industry, provided for its privatisation, introduced wholesale and retail competition and established a new independent regulatory body to oversee the industry throughout GB. The Act clearly defined the separate roles of policy maker, regulator and service providers.

Under the Act, the CEGB in England and Wales was broken up. The thermal generation assets were split into two generation companies, PowerGen and National Power, which were corporatised and floated. The nuclear assets were vested in a new public company, Nuclear Electric, which together with the Scottish nuclear assets was floated as British Energy several years later. The 12 regional Electricity Supply Boards were also corporatised and privatised as Regional Electricity Companies (RECs).

In 1990, the Electricity Pool was established, which provided a compulsory spot market for wholesale electricity and set a half hourly market price which paid all generators the marginal price, thereby low cost generation made potentially excessive profits. In 2001, the Pool was abolished and replaced by a wholesale market in which generators and suppliers were free to strike bilateral contracts for physical delivery of wholesale electricity. It was thought that bilateral contracts would be struck closer to cost rather than marginal price, reducing the excessive profit for low cost generation.

Retail competition was introduced gradually, with largest customers (consuming >1MW) being eligible for competitive supply first and the consumption limit on eligibility being reduced in stages. From 1990 consumers over 1MW had access to competitive supply; in 1994, consumers over 100kW and between 1998 and 2000 all retail consumers became eligible.

With over 60% of the customers having never switched supplier, there are widespread concerns that the retail market is uncompetitive, and the Office of Gas and Electricity Markets (Ofgem), the sectors regulator, has referred the sector to the Competition in Markets Authority (CMA) for an investigation, following Ofgem's 2014 'State of the Market Assessment' report. The CMA will investigate which areas of the market are not functioning and will report on findings over the course of 2015.

In 2013 the government introduced the Energy Act 2013, which implements major changes under the Electricity Market Reform (EMR) programme. The main aspects of the reform are the Contracts for Difference (CfD) and the Capacity Market, which effectively turns the government into a central energy and capacity procurer, with the energy market playing a much reduced role. The CfD, which gives a close to fixed price of energy for low carbon generators, is being implemented to spur investment in renewable and nuclear capacity in order to achieve renewable and carbon emissions reduction targets. The capacity market will pay existing and new firm generation capacity and demand side response in order to ensure medium and long term capacity adequacy.

In the initial form of the liberalised wholesale market, only three generating companies existed. The concentration of generating assets in a small number of companies suppressed competition. As of May 2014 the Big 6 companies together own just over half the current installed generating capacity, with the remaining capacity own by independents and other international companies, a significant amount of which is renewable capacity. The retail market has seen much less significant changes than the wholesale market. There have been no major shifts in market shares between companies, but there has been a small but significant gain of market share by smaller suppliers since January 2013.

Electricity prices, in both the wholesale and retail markets, have increased since the early 2000's. These increases are attributable to gas price increases and the introduction of carbon pricing and green policies. It is likely that electricity prices would have increased without liberalisation as the underlying generation costs have increased.

As the wholesale market is considered to be competitive, we would expect that there would be strong incentives to improve the operational efficiency of the market. However, Ofgem reported in 2014[7] that competition in the retail market is weak due to market segmentation and possible tacit co-ordination between incumbent suppliers. Therefore, we cannot guarantee that operational efficiency at the retail market is maximised.

United States

California

At the beginning of the 1990's, California was in the middle of a major state-wide recession, with high unemployment rates and companies being pushed away to other states due to high electricity prices. In 1995, because of expensive investments in nuclear power and high-priced contracts for power, California consumers paid the highest rates in the western continental United States (the average rate of about 99 USD/MWh)[8]. **The state's governor believed that a new market system would lower prices by encouraging competition among existing and new wholesale and retail suppliers and by reducing regulation**.[9]

The reforms required the utilities to become transmission and distribution companies, divesting themselves of generators, with the divested generators only able to sell power to a state-managed power exchange. The grid would be operated by an Independent System Operator (ISO). The distribution companies retained retail responsibilities but retail competition was part of the reform process as well. Under the reform arrangements, the supply-side of the market was largely deregulated while the retail market was strongly regulated during the transitional stages of the reforms by the California Public Utilities Commission (CPUC) putting in place controls on retail prices.

In 2000/2001, there was a sustained period of high and volatile electricity prices at wholesale level that was not reflected on retail tariffs due to caps on tariffs. As a consequence, a major utility (Pacific Gas and Electric) went bankrupt and rolling blackouts resulted. Multiple factors contributed to the system failures, including a drought that reduced the level of hydroelectric power available to serve customers, unexpected outages at nuclear power plants, high natural gas prices, and strong demand for power. A further factor was California's heavy reliance on short-term markets which made it vulnerable to market manipulation.

As a consequence of the crisis, further reforms in the Californian power market were put on hold. Transitional arrangements were implemented with the Department of Water Resources (DWR) signing several Power Purchase Agreements (PPAs) to procure electricity for the utilities. In 2003, the utilities resumed some procurement of power for their customers and the DWR reduced the cost of the long-term contracts through renegotiation. Further to this, market developments in California over the past years were aimed to improve the deployment of renewable energy sources, which is an indirect way of introducing competition at wholesale and retail levels without changing the current market structure.

---

[7] March 2014 report, 'State of the Market Assessment', Ofgem - https://www.ofgem.gov.uk/ofgem-publications/86804/assessmentdocumentpublished.pdf accessed 21/01/2015

[8] Weare, Christopher (2003). The California electricity crisis: causes and policy options

[9] World Bank (2001) - The California Experience with Power Sector Reform Lessons for Developing Countries.

Considering that wholesale prices were at a low level during the first years of the pool market in California, excluding the crisis period – between mid-2000 to mid-2001 – the effects of the reform had virtually no impact in lowering electricity price. At retail level, the objectives of the reform were not met and retail consumers have not yet observed a general decrease in prices.

The fact that about one third of total generation (i.e. utility owned generation) is not participating in the market but follows a regulatory review process and that there is no retail competition, implies that the effects of the reform process had a limited impact in the overall enhancement of operational efficiency.

The analysis of the power system reliability performance indicators provides no evidence to consider that the liberalisation process produced a structural break on reliability of electricity supply to customers. However, during the 2000/2001 crises, the electricity system did experience rolling blackouts due to tight supply, strong demand, market manipulation, etc.

California has been operating a hybrid combination of regulated / non-regulated market for 16 years; while the wholesale electricity market behaves competitively, the retail market continues to be fully regulated under direct control of CPUC and we have found no indications at the time of preparing this report that the Government has plans to introduce further competition at retail level.

Based on this, the preliminary condition required to foster competition at retail level would be to reach a political consensus in California that promoting retail competition would be beneficial for the society. Nonetheless, we were not able to find any indication that California has the political will (or that it is being currently analysed) to foster further liberalisation measures than the ones already implemented.

PJM

PJM Interconnection, founded in 1927, administers competitive wholesale markets across 13 states and the District of Columbia. PJM is the Regional Transmission Operator (RTO) and is regulated by the Federal Energy Regulatory Commission (FERC). FERC (Order 2000) established goals and principles for RTO market design. Among these goals are: eliminating discriminatory access to competitively priced electricity, encouraging new suppliers' entry into the market, promoting efficient and reliable operations, and fostering economically efficient investment in generation and transmission facilities.

PJM introduced an energy spot market in 1998 and daily and monthly capacity markets in 1999. It implemented a day-ahead energy market[10] in 2000 and a revised capacity market[11] in 2007. There are also a synchronized reserve market and a day-ahead scheduling reserve market. The 2007 capacity market is based on PJM's Reliability Pricing Model (RPM) which provides long-term price signals, consistent with the PJM's Regional Transmission Expansion Planning process, for supply-side capacity resources and demand-side capacity obligations.

[10] Day-ahead markets allow participants to trade energy and revise their position the day before operation. Introducing a day-ahead market gives participants opportunities to trade based on more relevant demand and availability information, allowing for more efficient market outcomes.

[11] Capacity markets provide payment to firm capacity, and is used as a mechanism to ensure supply security.

PJM, as a very mature market, has a wide range of instruments to provide competitive incentives to market participants; in this sense, there are no (to our knowledge) current plans to introduce further markets or instruments to further promote competition in PJM. Nonetheless, the dynamic nature of power markets and specifically in the PJM area – where the size of the market is enlarging – require constant fine-tuning of the markets in order to ensure they continue to provide competitive outcomes in the future. In this sense, even though PJM has reached its intended results, small regulatory improvements across the different markets can keep improving market outcomes, achieving greater cost effective services to its consumers.

Implementing those changes in market regulation requires work and coordination among PJM Board, stakeholders and the FERC. PJM operates on an independent basis, and has introduced small changes in market rules and regulation in order to enhance competitive results. The conditions that allow PJM to operate in competitive basis are:

- The existence of FERC as regulatory body;
- The existence of PJM acting as Independent System Operator (operate the assets but do not exercise ownership on them);
- Unbundled market participants;
- Low regional congestion problems (even though local congestion problem exists and may create room to provide incentive for exercising market power by some market participants);
- Continuous monitoring process, tests and procedures that allows mitigating the exercise of market power by stakeholders; and
- The availability of proper amount of information to ensure market transparency

Texas

Prior to reforms which came in to force at the retail level in 2002, the electric industry in Texas consisted of a mixture of investor-owned utilities, generation and transmission cooperatives, distribution cooperatives, river authorities, and municipally owned utilities. Generating plants owned by non-utilities produced approximately 10% of the consumption.

Liberalisation of the electricity market came into force in 2002 with industrial and political support for reforms. In its scope of competition report in 1999, the Public Utility Commission of Texas (PUCT) recognised that regulated utilities were overearning due to declining costs for utilities and stable prices. Plans to de-regulate the sector were announced in 1999 with the expressed intention of bringing down the costs of electricity for consumers.

A key component of the Texas deregulation system was the setting up of a Regional Transmission Operator (a role assigned to the State agency called the Electric Reliability Council of Texas (ERCOT)) to ensure open access to the transmission system. ERCOT also administers the competitive wholesale (day-ahead and real-time) market, ancillary service market and the retail market.

Wholesale electricity prices in the ERCOT are driven by gas price and local climate conditions. Increasingly, wind availability will become a significant driver of electricity price as wind capacity continues to increase. While wholesale prices increased (in real terms) in the period between 2002 and 2008, they decreased subsequently and the prices in 2013 are about the same level of those observed at market

liberalisation in 2002. While prices have not decreased from 2002 – following the objectives of the liberalisation process – they reflect marginal generation costs and follow the trend of natural gas prices.

A similar trend could be observed in retail prices. While the retail electricity price increases show de-regulation of the retail market did not meet the stated intentions of reducing the electricity price, it appears to be clear that prices reflect the market conditions affecting the power sector.

Considering that competition, in theory, provides strong incentives for operational efficiency across market participants and that the information analysed shows that both wholesale and retail markets in ERCOT performed competitively, then the operational efficiency should have improved in both markets.

Market liberalisation has increased customer choices in Texas and customers have been actively searching for better commercial opportunities. More recently, switching rates started to decline and, according to the information analysed, this may be caused by retail markets reaching high maturity levels.

In terms of system reliability, the analysis of power system performance provides no evidence to consider that the liberalisation process produced a structural break on reliability of electricity supply to customers. However, there is concern currently about the long term generation supply adequacy as power prices are not high enough to spur investment in new generation. A number of reforms, such as the Operating Reserve Demand Curve (ORDC), which artificially increases electricity prices when operating reserves drop, and easing of electricity price caps, are currently being implemented.

Texas is one of the most active regions of those reviewed in this study in terms of introducing further tools to promote market development. ERCOT and PUCT have followed the guidelines for market development provided years ago which shows that there is political willingness in the State to pursue effective development of competition in the power sector.

The degree of vertical integration between generators and retailers in the Texan market is unclear as the market monitoring activities appear to consider only specific sections of the market (i.e. retail and generation) and do not consider the market as a whole. Such vertical integration can lead to a reduction in market liquidity and competition (in retail and/or generation) where vertically integrated utilities with market power have the possibility of raising economic barriers to the entry.

Lessons for Hong Kong

Introducing competition in the electricity markets in the jurisdictions under the study had mixed outcomes, with some of them not meeting their intended objectives at the time of liberalisation.

Where markets have reached a reasonable level of competition, we observed that market prices follow the fundamentals of power sector. However, this does not necessarily mean that competition will decrease electricity prices *per se* for end customers as there are many factors affecting the final price of electricity (including the market structure before the liberalisation). In fact, electricity tariffs in the jurisdictions under study have mostly been on the rising trend, due to, e.g. the rising fuel prices and network costs, costs driven by green measures, etc.

A general consensus among the society has been a key ingredient for the introduction of liberalisation reforms on the countries under analysis. It provided the institutions with the necessary mandate and power to introduce the required changes in the existent structures. In Hong Kong, the government has been studying the possibility of introducing competition in the power market trying to determine the extent of benefits and implications from liberalisation processes across the world. However, the special characteristics of Hong Kong and its power sector require that the decision process must be carefully evaluated and the public's aspirations duly considered before introducing any type of reform.

To develop a power market requires the existence of a "critical mass" of companies to ensure enough liquidity in the market; certainly, this cannot be guaranteed with only CLP and HEC participating in the market. One potential alternative would be to allow Mainland China companies to act as market participants in the wholesale market; however, this will require cooperation and coordination at government level between Mainland China and the Hong Kong Special Administrative Region. A detailed study should be conducted to ascertain that such arrangement would not bring unacceptable negative impact to the overall electricity supply reliability in Hong Kong.

The Singapore case presents many similarities to the case in Hong Kong, in terms of geographical space limitations, high reliability requirements to the system, vertically integrated utility prior to the reform. However, in Singapore, the utility was state owned before unbundling and liberalisation process, whereas in Hong Kong the two utilities are privately owned. Any reforms to introduce a competitive market would need to respect these companies' rights given by law.

As in the case of the early reforms in the UK, market power would need to be considered in Hong Kong due to the existence of just two utilities. Regulators would need to consider requirements to unbundle existing utilities in order to develop a competitive wholesale market; such unbundling should have to be made in accordance with the law in Hong Kong and in respect of the private property of the existing utilities.

PJM has developed a successful competitive wholesale market because of a number of conditions that have been satisfied. So far, Hong Kong has the Environment Bureau with regulatory and monitoring power on the two electricity supply companies operating in Hong Kong under the Scheme of Control Agreements. All the rest of the conditions appear not to be currently available; those of particular importance are:

- The inexistence of third party access to the grid (including all secondary regulation);
- The fact that only two market participants exists today (which would require forcing the unbundling of these companies to promote competition);
- Limited interconnection capacity between Hong Kong and Mainland China (if this is required to boost competition at wholesale level and if Mainland China is considered an appropriate source of supply); and
- The issue of enough interconnection capacity between the two existing systems as one of the preconditions for market development, in order to ensure price signals are not distorted by congestion issues.

1 Introduction

1.1 The objective of the present study is to provide the Government of the Hong Kong Special Administrative Region with a review of the process of electricity market liberalisation in a number of countries, with a focus on:

- Restructuring processes undertaken, their rationale and perceived benefits
- Current status and future plans
- Outcomes of the electricity market development

1.2 The geographical coverage of the study comprises the following countries:

- Australia (Section 2)
- Singapore (Section 3)
- United Kingdom (Section 4)
- United States, selected states (Section 5)

1.3 For each country under analysis, we provide a wide-ranging review, analysis and assessments, encompassing;

- Arrangements of the electricity market prior to the reform;
- Reasons to introduce competition, and the intended objectives and expected benefits to be achieved by the market liberalisation;
- Review of the reform process;
- Current market status and recent trends in market development;
- Outcomes of the electricity markets in terms of tariffs, operational efficiency, reliability of electricity supply and customer choices versus the intended objectives for market liberalisation; and
- Circumstances or conditions that may be required for market liberalisation to achieve its intended results and the availability of those conditions in Hong Kong.

2 Australia

2.1 Arrangements Prior to the Reform

2.1.1 Prior to the liberalisation process, the supply of electricity in Australia was provided by vertically integrated, state-owned utilities meeting customer demands of individual states and territories.

2.1.2 The liberalisation process in Australia started in the mid-1980s in response to emerging concerns about the inefficiency of the state-owned electricity industry; the response, at that time, was to introduce some reforms at state level with the objective of strengthening the management and control arrangements for the electricity industry.

2.1.3 This initial (soft) reform led to significant productivity gains; nonetheless, the emerging neo-liberal ideology and globalisation process which started in the early 1990s created an enormous pressure on the Australian electricity industry – and in other state controlled sectors – to undertake more radical reforms.

2.2 The Reform Process

2.2.1 The reform of the electricity industry became an integral part of the main reform program introduced by the Australian government (the so called microeconomic reform); and as part of it, several agreements were reached between various state governments in Australia to reform their electricity industries. **The main objective of this reform was to increase competition in the industry and provide greater choice for end-use electricity consumers.**

2.2.2 A key part of the reform in the electricity industry came with development of the National Electricity Market (NEM) in 1998. The establishment of the NEM was the result of extensive consultation and collaboration between the states and the electricity industry. The reforms also included the unbundling of the vertically integrated state-owned electricity authorities into separate generation, transmission, distribution and retail sales sectors in each State.

2.2.3 The NEM delivers electricity to market customers on an interconnected power system that stretches more than 4000 km from Port Douglas in Queensland to Port Lincoln in South Australia, and includes a sea-bed cable between Victoria and Tasmania[12]. The NEM comprises five regions that are based on State boundaries, Tasmania becoming the fifth region of the NEM in 2005. Western Australia and Northern Australia do not participate in NEM due to geographical and cost factors.

2.2.4 The National Electricity Market Management Company (NEMMCO) was established in May 1996 to implement, administer and operate the wholesale NEM, but it was replaced in 2009 by the Australian Energy Market Operator (AEMO). AEMO is responsible for aggregating and dispatching supply to meet demand in the lowest cost manner available. In addition to the physical wholesale

[12] Western Australia and the Northern Territory do not participate in the NEM due to geographical and cost factors.

market, retailers may also contract with generators through financial markets to better manage any price risk associated with trade on the spot market.

2.2.5 Further to the specific activities as Market and System Operator, AEMO has other core functions that can be grouped into the following areas:

- Gas Markets Operator
- National Transmission Planner
- Transmission Services
- Energy Market Development

2.2.6 Even though the federal government has taken a keen interest in power sector regulation, the electricity market is still regulated through a combination of state and federal legislation. To ensure proper coordination among different governmental levels, the sector is steered by the Council of Australian Governments[13] (COAG) which provides the ground for political agreements between the different stakeholders.

2.2.7 AEMO was created by the COAG and developed under the guidance of the Ministerial Council on Energy (MCE). The objective at the time of creation was to strengthen the national character of energy market governance by drawing together under one operational framework the responsibility for electricity and gas market functions, NEM system operations and national transmission planning.

2.2.8 The restructuring phases of Australia electricity market is highlighted in the table below:

Table 2.1: The Electricity Industry Restructuring in Australia

Date	Key Changes
5th May 1997 (NEM1 stage1)	The interstate wholesale electricity trading market began between New South Wales, Victoria and the Australian Capital Territory (ACT). Although the trading among the states exists but the security of power system is still the responsibility of the individual states.
October 1997 (NEM1 stage2)	All the regulations of the National Electricity Code [14] will be enforced but exceptional to market rules and system security which will continue under the functions of the states.
The original program for the phased introduction of the NEM included three phases; NEM1, NEM2 and NEM3. Due to rapid implementation of the national electricity market in NEM1 phase, NEM2 was abandoned	
October 1997 (NEM pilot)	Participation of Queensland in the national electricity market. Queensland will operate its own electricity system based on arrangements specified in the code since the state is not connected to the national grid
1998 (NEM3)	National Electricity Market commenced operation and involved the separation of the previously vertically integrated supply chain of generation, transmission, distribution and supply. South Australia generators will enter the market as full participants.
May 2005	Tasmania joined the NEM as a participating jurisdiction, introducing a contestable wholesale market to be followed by phased introduction of retail competition.

[13] The COAG is the peak intergovernmental forum in Australia and its members are the Prime Minister, State and Territory Premiers and Chief Ministers and the President of the Australian Local Government Association.

[14] See the National Electricity Code at the National Electricity Code Administrator website here: http://www.neca.com.au/TheCode/index.html

Date	Key Changes
2005	The Australian Energy Market Commission (AEMC) established by the COAG to oversee the nation's main energy markets including making rules to govern the electricity and natural gas markets
2005	The Australian Energy Regulator (AER) regulates energy markets and networks under national energy market legislation and rules
2009	Australian Energy Market Operator (AEMO) manages the market, taking over the activities developed by the NEMMCO
2012	AER started to take regulatory functions in the retail market as part of the National Energy Customer Framework ('Customer Framework') that aims to put the market into a single federal framework and to streamline the way that energy retail markets are regulated.

2.2.9 Currently, the Customer Framework is being implemented in ACT, New South Wales, South Australia and Tasmania. Queensland has just passed the Law (approved in September 2014) and will start the implementation in July 2015 and Victoria is yet to implement it. Western Australia and Northern Territory are not expected to implement this scheme.

2.2.10 The Customer Framework does not allow AER to set retail energy prices (this competence remains with state regulatory bodies), but AER provides a price comparison website, Energy Made Easy, to help customers find the best energy offers for their needs. The website also provides a benchmarking tool for households to compare their electricity use with that of similar households, and information on the energy market, energy efficiency and consumer protections.

2.2.11 Other AER roles in the retail market regulation (where the Customer Framework has been implemented) include:

- monitoring and enforcing compliance with obligations in the Retail Law, Rules and Regulations;
- reporting on performance of the market and energy businesses, including energy affordability and disconnection of customers for non-payment of energy bills;
- assessing authorisation applications from businesses that want to become energy retailers, and exempting businesses from authorisation requirements;
- approving policies that energy retailers must implement to assist customers facing financial hardship and looking for help to manage their energy bills; and
- administering a retailer of last resort scheme, which protects customers and the market if an energy retailer fails.

Green Policies

2.2.12 The introduction of green policies (renewable energy promotion, carbon pricing, etc.) had a significant impact of the generation mix in the NEM over the last years. The two main green policies at national level are: the Renewable Energy Target (RET) scheme and the Carbon Price scheme (recently replaced by a Direct Action Plan).

2.2.13 The Renewable Energy Target scheme (introduced in 2001 and expanded in 2007) aims to achieve 20% share for renewable energy in Australia's electricity mix by 2020. It requires

electricity retailers to source a proportion of their energy from renewable sources developed after 1997. Retailers comply with the scheme by obtaining renewable energy certificates created for each megawatt hour of eligible renewable electricity that an accredited power station generates, or that eligible solar hot water or small generation units generate. Certificates from large and small scale projects have traded at around 30−40 AU$/MWh throughout 2013.

2.2.14 In 2012, the Australian Government introduced a Carbon Price scheme as the central tool for its Clean Energy Future Plan. The plan targeted a reduction in carbon and other greenhouse emissions to at least 5% (below 2000 levels) by 2020. The scheme placed a fixed price on carbon for three years, starting at 23 AU$/CO2 tonne emitted. An emissions trading scheme was expected to replace the fixed price on 1 July 2015, whereby the market would determine the price, however, in 2014, the Carbon Price scheme was repealed and replaced by a Direct Action plan, whereby the government will pay for emissions abatement activity in Australia. The new plan is for a AU$1.55 billion Emissions Reduction Fund to provide incentives for abatement activities across the Australian economy, with funding provided to least cost sources of abatement (as determined through a reverse auction). It also includes funding for urban tree planting and rooftop solar installations.

Retail Market Reform

2.2.15 Retail competition was introduced in 2003, although the regulatory framework and methodologies differ between state and territory jurisdictions.

2.2.16 Currently, all states in Australia, except Victoria, South Australia and New South Wales, apply some form of retail price regulation for electricity supplied under a standard retail contract, applying one of these two alternatives:

- Building block approach: the regulator determines efficient cost components (like wholesale costs, retail operating costs and regulatory obligations) and passes through other regulated costs (like network costs). The regulator uses these costs to determine a maximum revenue requirement to be reflected in the prices that the retailer charges. Determinations typically cover a number of years, but some cost components are adjusted annually. Separate pass through provisions cover unexpected costs which are approved by the regulator. Tasmania and Queensland use this approach.
- Benchmark of retail cost index: the regulator determines movements in benchmark costs to calculate annual adjustments in retail prices. The Australian Capital Territory (ACT) uses this approach.

2.2.17 In an effort to fulfil with the objectives of the power sector reform, Australian governments agreed to review the continued use of retail price regulation and to remove it if “effective competition” can be demonstrated. With this objective in mind, the AEMC continuously assesses the effectiveness of retail competition in each state, to advise whether to remove price regulation and, if so, how. State and territory governments make the final decisions on this matter.

2.2.18 According to the AEMC, effective competition requires “effective participation of customers and retailers”[15]. The studies developed by AEMC assess whether customers are aware, informed and engaged, and whether retailers are competing to provide the products customers want.

2.2.19 The studies achieve this objective by examining a number of different indicators that highlight both the behaviour of retailers and the responses of customers; they include:

- customer switching behaviour;
- ability of suppliers to enter the market;
- independent rivalry within the market;
- differentiated products and services;
- price and profit margins; and
- the exercise of choice by customers.

2.2.20 The criteria used in AEMC reviews are:

- the level of customer activity in the market;
- barriers to retailers entering, expanding or exiting the market;
- the degree of independent rivalry;
- customer outcomes; and
- retailer outcomes.

2.2.21 Together, the criteria are referred to as the "competitive market indicators" which AEMC has used to structure its assessment of retail competition. So far, the AEMC has concluded from the following studies:

- Victoria and South Australia (2008): the AEMC found that competition was effective in both markets.
  - Victorian Government removed retail price regulation in 2009 and South Australia in 2013.
- ACT (2011): the AEMC found ineffective competition in small customer market because customers were unaware of their ability to switch retailers.
  - ACT Government decided to retain price controls for at least another two years.[16]
- New South Wales (2013): the AEMC found that competition was effective in energy retail markets, with substantial discounts being offered from the regulated price.
  - NSW government removed price regulation in July 2014.

2.2.22 In Queensland, the Government committed to removing electricity retail price regulation in south east Queensland by July 2015, so long as appropriate consumer protection and engagement policies are in place; for instance, introducing time of use incentives, addressing the cost impact on local bonus scheme for solar PV, reforming price structure to promote the reduction of peak demand.

[15] AEMC – Retail Competition Review 2014 Final Report

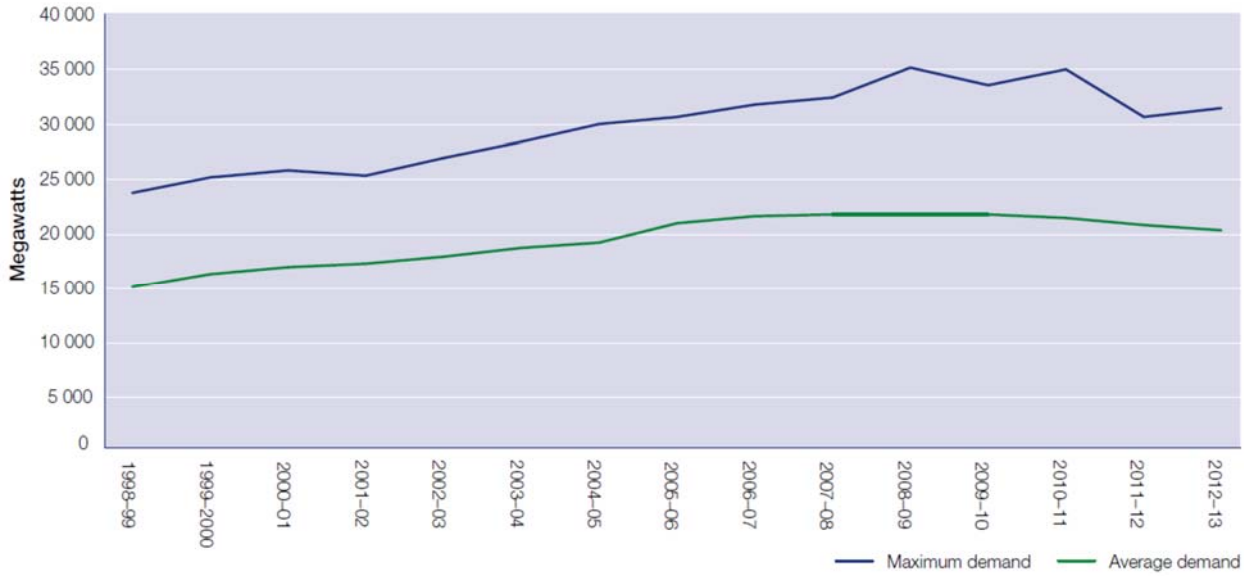
[16] Price control remains effective at the time of preparing this report. In July 2014 the ACT State Regulatory Body approved regulated tariffs for small consumers until 2017.

2.3 Market Development

Wholesale Market

2.3.1 Electricity demand in the NEM peaked in 2008 – 2009 and again in 2010 – 2011 but it has severely corrected since then (see Figure 2.1); the impact of such correction has been so important that the Australian Energy Market Operator (AEMO) has revised its demand forecast downwards twice in 2013.

Figure 2.1: Maximum and Average Electricity Demand in NEM



Source: AER (2013) – State of the energy market

2.3.2 The current trend in the electricity demand has been caused by a number of factors, for instance:

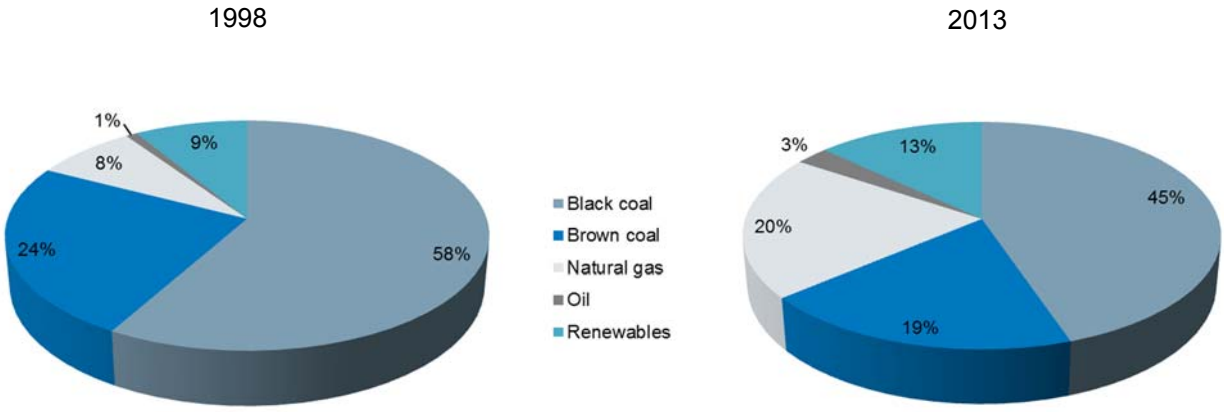
- Long-term price elasticity which make consumers responsive to higher electricity costs through:
  - Direct reductions in consumption;
  - Implementation of energy efficiency measures
  - Promotion of self-generation (Solar PV or Solar Water Heaters)
- Moderate economic growth and weaker energy demand from the manufacturing sector.
- Mild weather over 2013 and 2014.

2.3.3 Such correction in demand has prompted a surplus of more than 2,000 MW on the generation side since 2012. Generation companies have reacted by reducing capacity; some plants have been retired while some others operate only during summer, when the peak demand occurs.

2.3.4 The supply side in the NEM (which accounts for most of Australia) is largely represented by coal generation (black and brown); by the end of 2013, 54% of the total installed capacity was coal based generation; followed by natural gas (20%) and hydropower (17%). Wind generation still represents a small fraction with a 6% share of the total installed capacity in the NEM- but it is increasing its share on yearly basis.

2.3.5 The effect of the green policies, combined with the cost reductions observed in many renewable technologies, changed the competitiveness of generation technologies (Figure 2.2). Coal generation is being replaced by a combination of renewable energy sources (mostly hydro and wind) backed with flexible natural gas.

Figure 2.2: Change in Generation Mix since 1998 (% of electricity generation)



Source: BREE - Australian Energy Statistics (2014)

Retail Market

2.3.6 Currently, Australia's retail energy markets appear to be highly concentrated with three retailers accounting for more than 90% of electricity market share in four of the six jurisdictions (Queensland, New South Wales, Victoria and South Australia). In addition, substantial vertical integration exists between retailers and generators.

2.3.7 The three retailers – AGL Energy, Origin Energy and Energy Australia – are the leading companies in southern and eastern Australia. The three jointly supplied 77% of small electricity customers and over 85% of small gas customers in 2013. However, their combined market share fell by 2% between 2012 and 2013, mainly as a result of competition from smaller retailers in the New South Wales and Victorian electricity markets.

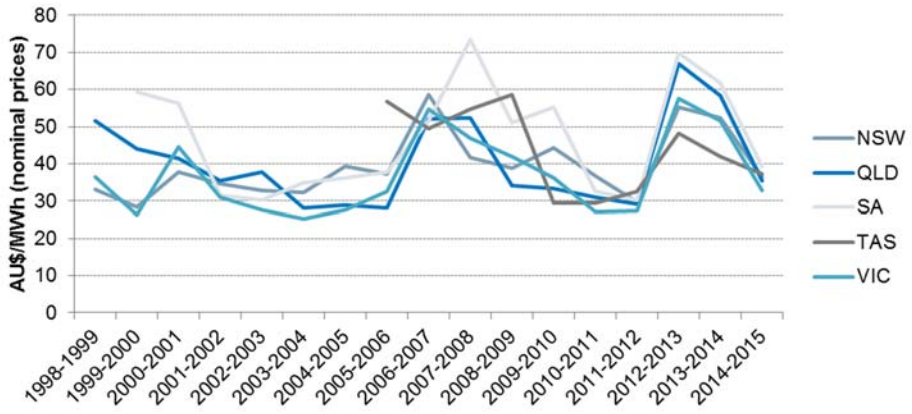
2.4 Outcomes of the Electricity Market

Electricity Tariffs

Wholesale Market

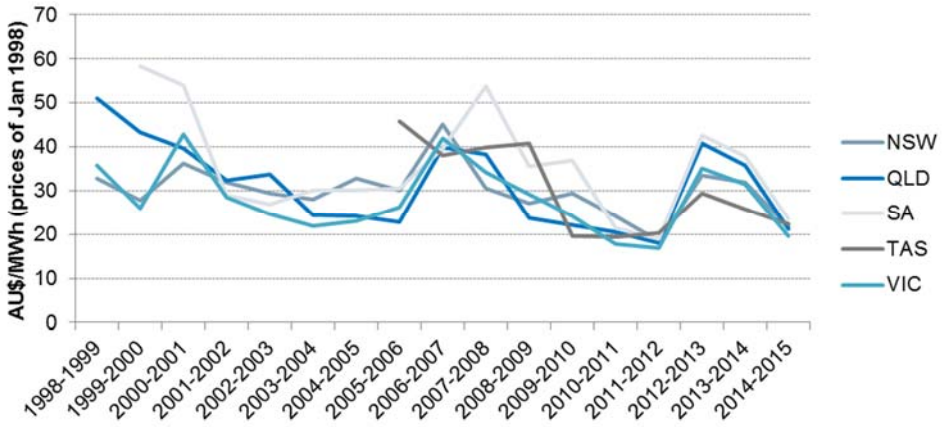
2.4.1 Since the implementation of the NEM, wholesale prices have been in the range of 20 to 60 AU$/MWh (at real prices from January 1998). A decrease in electricity prices was observed during the first years of NEM functioning until they started to increase at the end of 2006. Prices peaked during 2007 – 2008 and then decrease following the global financial meltdown. A new peak was observed in 2012 – 2013 coincidental with the introduction of Carbon Price scheme. However, the trend changed after the scheme was repealed (see Figure 2.3 and Figure 2.4).

Figure 2.3: Average Annual Prices in the NEM (AU$/MWh in nominal prices)



Source: Mott MacDonald based on AEMO data

Figure 2.4: Average Annual Prices in the NEM (AU$/MWh in prices of January 1998)



Source: Mott MacDonald based on AEMO and World Bank data (Australia GDP Deflator)

2.4.2 From the analysis performed, it appears that the NEM provides cost reflective prices in electricity markets (gas prices and carbon scheme) and this is consistent with the expected outcome of the reform process undertaken by the country. Furthermore, the changes observed in the generation mix show that market participants respond to market incentives of supplying electricity with the most cost efficient technology.

Retail Market

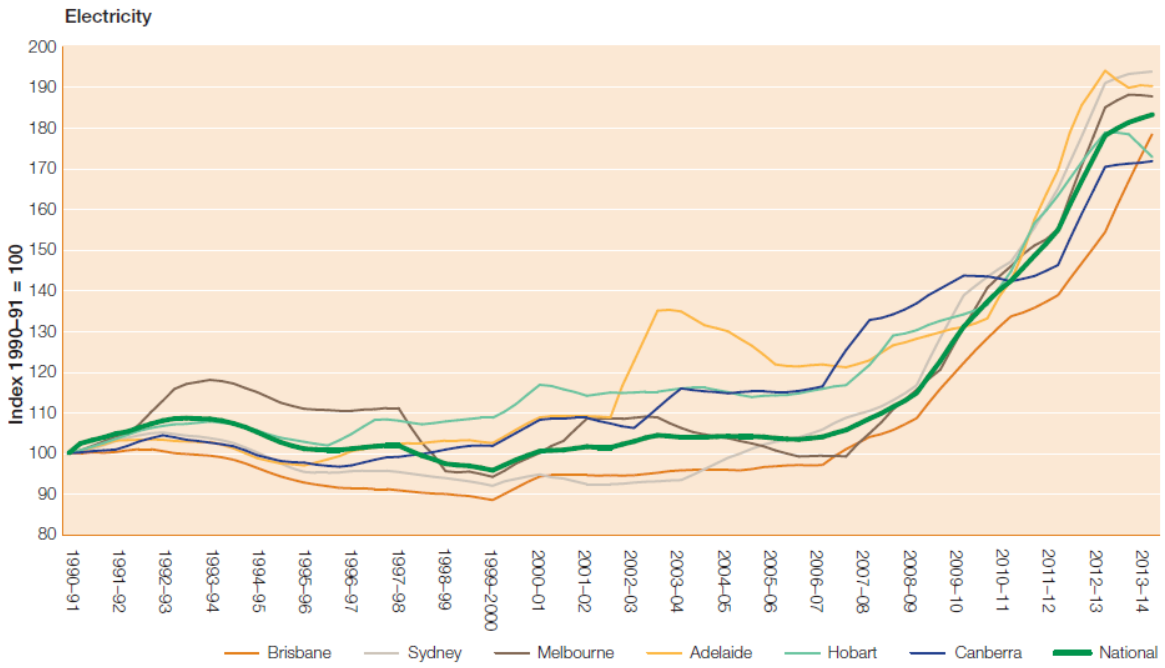
2.4.3 Retail electricity tariffs in Australia varies across states; due to the low population density, the cost of using transmission and distribution networks to transport electricity is the largest component of electricity bills (approximately 36% to 57%), followed by wholesale energy costs (21% to 27%) and retailer costs (10% to 15%).[17]

2.4.4 Figure 2.5 shows the changes in real energy prices for metropolitan households since 1991, using the electricity component of the Consumer Price Index. According to this index, electricity prices rose nationally over the five years to 2012−13 by 64% in real terms (87% nominal terms), with prices moderating (flattening) to 2013/14.

2.4.5 The trend in retail electricity prices shows that liberalisation of wholesale and retail services did not have an immediate impact on retail prices; there has however been a significant increase over the past five years with network costs being the key price driver, followed by the introduction of green policies (carbon price and renewable energy promotion).

[17] Values for the period 2010 – 2013.

Figure 2.5: Retail Price Index (inflation adjusted) – Australian Capital Cities



Source: AER (2014) – State of the energy market

Operational Efficiency

2.4.6 Except in the case of Tasmania, all other States participating in the NEM have full retail contestability, so all consumers can enter into a contract with the retailer of their choice. Considering that competition, in theory, provides strong incentives to operational efficiency across market participants, then the fact that the NEM is reaching good level of competition at the wholesale and retail markets, means that operational efficiency should have improved.

2.4.7 In the case of natural monopolies (like transmission and distribution), the regulatory bodies should ensure that transmission and distribution companies have enough incentives to maximise the operational efficiency.

2.4.8 In the case of the NEM, AER determines allowances for each network to cover efficient operating and maintenance expenditures based on load densities, the scale and condition of the network, geographic factors and reliability requirements. In assessing operating expenditure forecasts, the AER considers relevant cost drivers, including load growth, expected productivity improvements and changes in real input costs for labour and materials.

2.4.9 The AER operates a national incentive scheme for transmission and distribution companies to improve the efficiency of operation and maintenance expenditure in running their networks. These

incentives are aligned with those provided through the AER's service target performance incentive scheme, to encourage business decisions that balance cost and service quality.

2.4.10 The scheme allows a company to retain efficiency gains (and to bear the cost of any efficiency losses) for five years after the gain (loss) is made. In the longer term, the businesses share efficiency gains or losses with customers through price adjustments, passing on 70% of the gain or loss.

Increase in Customer Choices

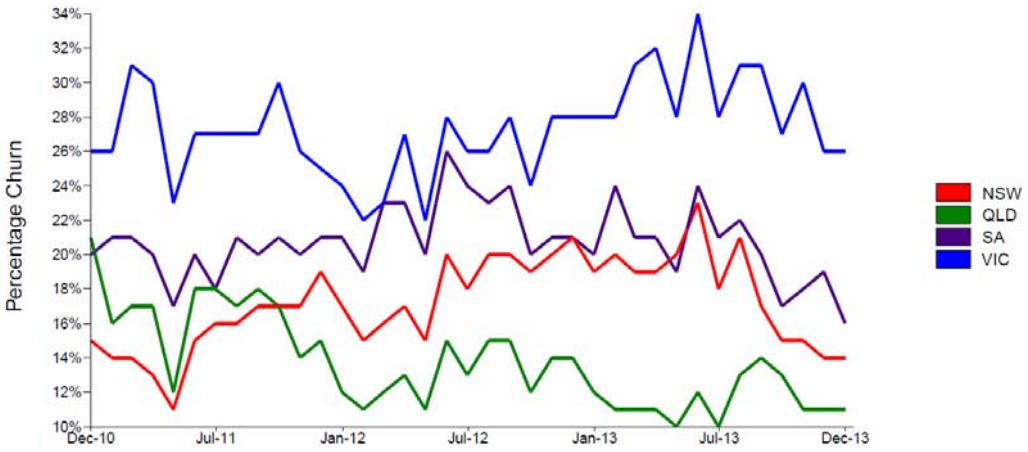
2.4.11 In line with the overall goal of the electricity sector reform, the development of competition at retail level brought the possibility to end use customers of selecting their retailing company; the number of retailers steadily increased over the years, following the introduction of full retail contestability in most states.

2.4.12 Currently, the retail sector in the NEM remains fairly competitive with three retailers – AGL Energy, Origin Energy and Energy Australia – jointly supplying 77% of small electricity customers in southern and eastern Australia in 2012–13.

2.4.13 The existence of competition is possible thanks to a contestable market comprised of small private retailers (mostly new entrants) that gained market share during 2012-2013. In Victoria, which is the region with the most diverse market structure, small private retailers supplied 27% of electricity customers in 2013.

2.4.14 This level of contestability in the retail market mitigates the possibility of individual retail companies to exercise market power on end users. Nonetheless, this process takes time as it requires consumers to be informed on the commercial opportunities in order to be able to make a rational selection of the provider. The AEMO publishes switching data measuring the number of customer switches from one retailer to another. Figure 2.6 sets out annual switching data.

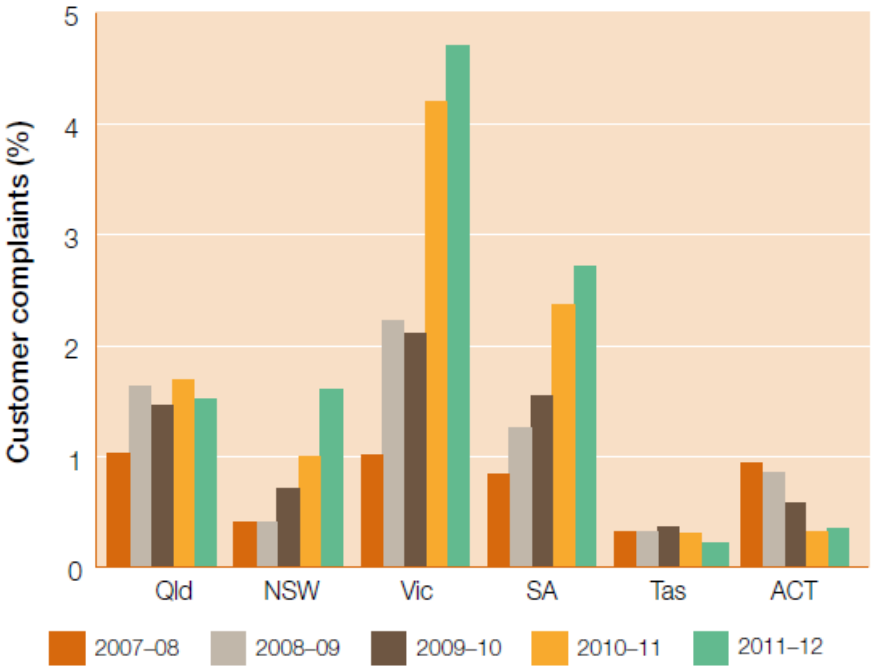
Figure 2.6: Customer Switching of Electricity Retailer (annualised transfer rate)



Source: AEMO (Dec 2013) - NEM Monthly Retail Statistics

2.4.15 The increase in retail competition has not led to increased customer satisfaction and the complaints have been increasing in most states (see Figure 2.7).

Figure 2.7: Rising Trend of Customer Complaints 2007 to 2012



Source: 'State of the Energy Market 2013', AER

Vertical Integration

2.4.16 Recent trends in Australia show a significant integration between generators and retailers to form “gentailers”. This type of vertical integration responds to a natural trend for both generators and retailers to internally hedge price risks, reducing their need to participate in secondary markets.

2.4.17 However, a decline in the trading volume on the secondary markets generates a reduction in its liquidity, posing a potential barrier to entry and expansion by generators and retailers that are not vertically integrated, and allowing gentailers to exercise market power in both wholesale and retail markets.

2.4.18 Across the NEM, three companies - AGL Energy, Origin Energy and EnergyAustralia - have significant market share in both generation and retail markets. The three businesses:

- Control 36% of generation capacity (15% in 2009).
- Control 45% of new generation capacity commissioned or committed since 2009.
- Jointly supply 77% of energy retail customers.

2.4.19 In addition, the Queensland and Tasmanian governments own joint distribution−retail businesses. The ACT Government has ownership interests in both the host energy retailer and distributor. The AER applies jurisdictional ring fencing guidelines to distribution businesses.

2.4.20 The existence of “gentailers” does not imply, as such, that these companies will be able to exercise market power on its consumers; however, since they have the possibility to control supply and demand, the possibility of such companies exercising market power largely increases. As a matter of fact, AER has already recognised that in some states, gentailers are exercising market power (even though not on continuous basis).

2.4.21 In order to mitigate the possibility of such market power exercise, the AER must keep a close monitoring of the operations of these companies while ensuring customers receive enough information to select the best commercial offer available. The AER’s role in national retail regulation is to:

- provide an energy price comparator website for small customers;
- authorise energy retailers to sell energy, and grant exemptions from the authorisation requirement (for example, to retirement villages and caravan parks that onsell energy);
- approve retailers’ policies for dealing with customers facing hardship;
- administer a ‘retailer of last resort’ scheme, to protect customers and the market if a retail business fails;
- report on retailer performance and market activity, including energy affordability, disconnections and competition indicators (such as Herfindahl–Hirschman index (HHI) and residual supply index (RSI)); and,
- enforce compliance with the National Energy Retail Law and its supporting rules and regulations.

System Reliability

Generation Reliability

2.4.22 The AEMC Reliability Panel is the body in charge of defining the reliability standard for the NEM and the standard is the expected amount of energy at risk of not being delivered to customers because of insufficient available capacity.

2.4.23 According to AER[18], the current reliability standard is: *"that no more than 0.002% of customer demand in each NEM region should be unserved by generation capacity per financial year, allowing for demand side response and imports from interconnectors".* This standard has been breached only twice (during the heat-waves in 2009 that greatly affected Victoria and South Australia. In that year, the unserved energy reached 0.0032% in South Australia and 0.004% in Victoria).

Transmission Network Reliability

2.4.24 Reliability standards for transmission networks are regulated and monitored at a State level in Australia. This causes some complications at the time of trying to analyse the general trends in transmission network reliability.

2.4.25 According to the information analysed, it appears that the transmission networks in the NEM deliver high rates of reliability with transmission outages usually causing less than three minutes of unsupplied energy in New South Wales, Victoria and South Australia; and nine minutes of unsupplied energy in Tasmania.

Transmission Reliability Standards

2.4.26 In 2013, the AEMC developed a national framework for expressing, setting and reporting on transmission reliability. Though the scheme still relies on State Regulatory Bodies, the framework includes the possibility of delegating to AER the responsibility of setting the reliability standards within a specific State.

2.4.27 The methodology used in the framework is based on an economic assessment of the Value of Customer Reliability (VCR) and community consultation. The Value of Customer Reliability represents, in dollar terms, the willingness of customers to pay for the reliable supply of electricity[19]. In September 2014, AEMO finalised the estimation the VCR, the values are presented in the table below.

[18] AER (2013) – State of the energy market

[19] Internationally, this concept is also referred as the Value of Lost Load (VOLL)

Table 2.2: NEM-level VCR Results

Customer Class	Residential	Agriculture	Commercial	Industrial	Direct customers	NEM wide
VCR (AU$/kWh)	25.95	47.67	44.72	44.06	6.05	33.46
VCR (US$/kWh)	22.80	41.88	39.29	38.71	5.32	29.40
VCR (HK$/kWh)	176.87	324.90	304.80	300.30	41.23	228.05

Source: AEMO (2014) – Value of Customer Reliability Review

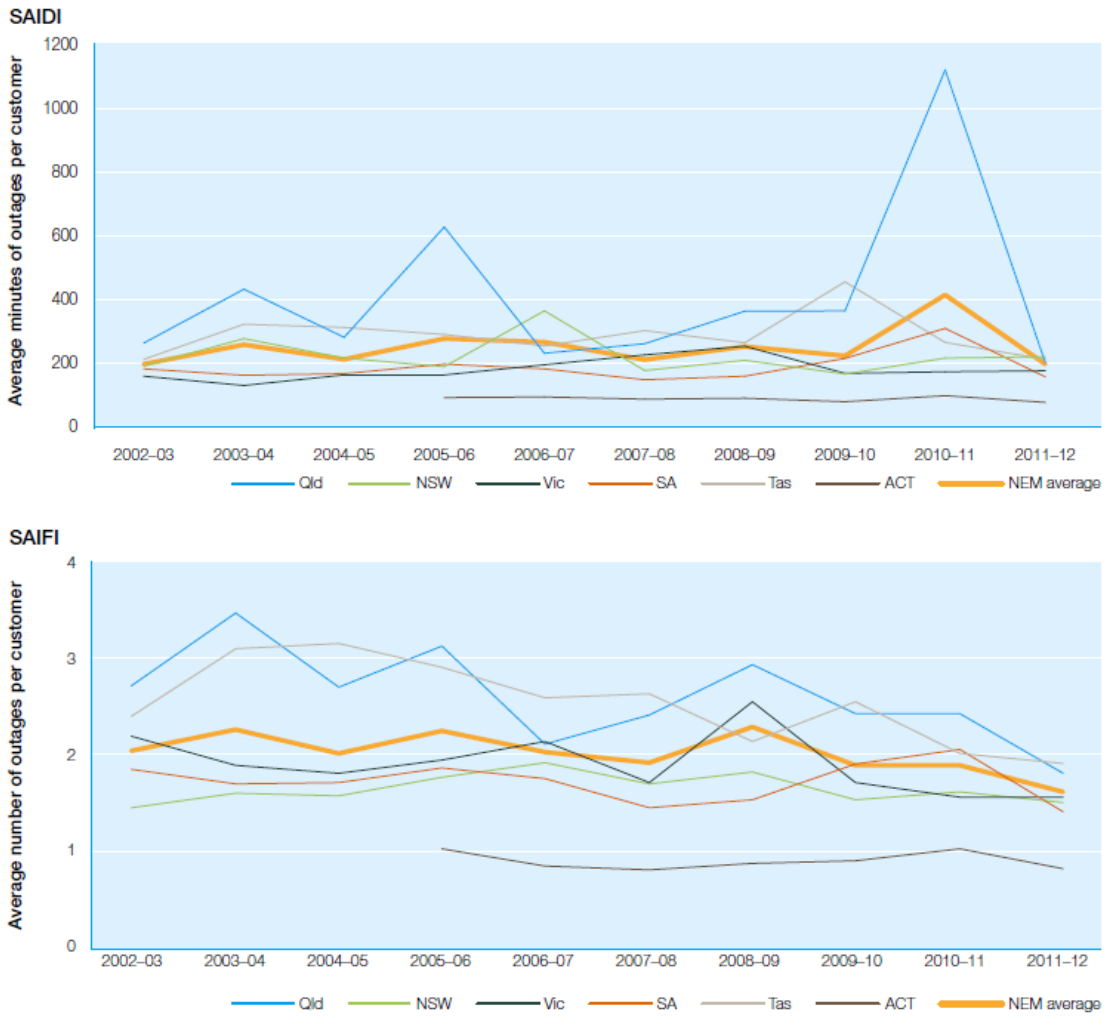
2.4.28 These values will help State Regulatory Bodies in determining the need of increasing the reliability level in the transmission system; basically, there is a need to increase the reliability of the system if the marginal cost of increasing the security is lower than the Value of Customer Reliability.

Distribution Network Reliability

2.4.29 Distribution outages account for over 95% of electricity outages in the NEM; therefore it is key that distribution companies have enough incentives to maintain an adequate level of outages.

2.4.30 Figure 2.8 presents historical data on the average duration (SAIDI) and frequency (SAIFI) of outages experienced by customers in different States. Queensland experiences significant variations in performance, partly because its large and widely dispersed rural networks make it more vulnerable to outages than are other NEM jurisdictions. For instance in 2010-2011, the state was severely affected by extreme weather conditions with heavy flooding in the south and Cyclone Yasi in the north which pushed SAIDI values to over 1100 minutes.

Figure 2.8: System Reliability



Source: AER (2013) – State of the energy market

2.4.31 SAIDI data indicate electricity networks in the NEM delivered reasonably stable reliability outcomes over the past years. Across the NEM, a typical customer experiences around 200−250 minutes of outages per year, but with significant regional variations.

2.4.32 The SAIFI data show the average frequency of outages was relatively stable between 2002−03 and 2011−12, with energy customers across the NEM experiencing an outage around twice a year. The average frequency of outages in 2011−12 was reduced or stable relative to that of the previous year in all jurisdictions. Queensland and South Australia recorded the largest reductions in outage frequency.

2.4.33 These results show that the reform process of the power industry in Australia did not present a negative effect on the reliability of power supply.

2.5 Market Liberalisation Determinants

2.5.1 Australia is in the process towards full market liberalisation; its wholesale market has matured and its retail market is becoming more competitive. However, the government has decided to maintain a close monitoring on market evolution before introducing further liberalisation.

2.5.2 Also, the power sector is in transition process to federal regulation, which requires political consensus and coordination at different government levels. While a lot of progress has been observed in recent years, there are still some areas in which federal regulation needs to be developed.

2.5.3 In our view there is a general consensus in Australia across federal and state governments that while a good level of competition has been achieved, this should be further pursued and improved: this is particularly important for gentailers, as they have the possibility of exercising market power. It has also been agreed that the liberalisation process needs to be carefully considered and barriers removed as long as there is an agreement on the net benefits (value for money) for the society in pursuing further market development.

2.5.4 At wholesale level, the NEM shows good level of competition and, while adjustments are required to mitigate market power of some market players (a broad range of fine-tunes, from improvements in the transmission grid for bottleneck prevention to regulatory changes for ensuring barriers are not raised in market competition), we can conclude the objective of the reform process has been achieved. At retail level, we can reach to the same conclusion in Victoria, South Australia and New South Wales, and to a reasonable extent in Queensland and ACT. Tasmania is still lagging to achieve a competitive environment at retail level but it is important to highlight that Tasmania was the last state to join the NEM therefore, it falls below the learning curve compared the rest of the states.

2.5.5 Despite the initial unbundling of generation, transmission, distribution and retail activities, the NEM is currently observing a process of vertical integration between generation and retail activities. This could be seen as a contradiction within the market design: unbundling was implemented to promote competition, but the market rules have allowed generators and retailers to re-bundle. While there is a natural economic incentive for this (allowing generators and retailers to hedge risks), the process can easily lead to a raising of barriers to competition, allowing the gentailers to exercise market power. In fact, the regulator has noted a number of cases in which market power has been exercised, though this has not been observed on a continuous basis. The different government bodies (regulators and competition authorities) will need to maintain a strict monitoring on gentailers activities to prevent these companies exercising market power.

2.5.6 In the case of Hong Kong, there are no “state and federal” issues but there could be “Hong Kong and Mainland China” should a future wholesale market would consider allowing Mainland China companies to participate in the market.

2.5.7 To develop a power market requires the existence of a “critical mass” of companies to ensure enough liquidity in the market; certainly, this cannot be guaranteed with only CLP and HEC participating in the market. One potential alternative would be to having Mainland China companies to act as market participants in the wholesale market; however, this will require cooperation and coordination at government level between Mainland China and the Hong Kong Special Administrative Region. A detailed study should be conducted to ascertain that such arrangement would not bring unacceptable negative impact to the overall electricity supply reliability in Hong Kong.

2.5.8 Under the different approaches to promote efficiency and cost reflectiveness in the power sector, the Australian government took the political decision of promoting market outcomes results - rather than centralized regulation – where competition could be effectively promoted (wholesale and retail levels). It was this political will that provided the institutions with the necessary power to introduce the required changes in the existent structures. In Hong Kong, the government has been studying the possibility of introducing competition in the power market, trying to assess the extent of benefits and implications from liberalisation processes across the world. However, the special characteristics of Hong Kong and its power sector requires that the decision process must be carefully evaluated before building the necessary consensus to introduce any type of reform.

2.5.9 Finally, Australian regulatory bodies have firmly adopted the “cost – benefit analysis” principle to guide infrastructure investments in the power sector. The regulators understand that increasing the reliability level in the network is: expensive, costly for electricity users and naturally promoted by utilities; in this sense, they limit the quest for further system reliability on the willingness to pay of the consumers for such reliability. We understand that a high level of system reliability is important in Hong Kong but it would be important to make clear and transparent that ensuring high system reliability comes at a cost.

3 Singapore

3.1 Arrangements Prior to the Reform

3.1.1 Prior to 1995, the Public Utilities Board (PUB) owned and managed power generation, distribution and retailing. This structure served Singapore adequately for three decades.

3.1.2 However, in the mid-1990s the Government concluded that the regulated system should be liberalised. The government calculated that a competitive market would likely reduce energy costs for large industrial users, thereby ensuring Singapore's continued competitiveness, particularly for the energy-intensive semiconductor and chemical industries - cornerstones of Singapore's industrial strategy.

3.2 The Reform Process

3.2.1 In 1995, the government of Singapore introduced the first reform of the electricity industry when it corporatized the electricity undertakings of the PUB. **The main objective of the reform was to gradually introduce competition in electricity generation and retail so that Singapore would have an electricity market that allows market forces rather than central planning to drive investment, production and pricing decisions**.[20]

3.2.2 In 1998, the government introduced the second phase of the reform with the introduction of a wholesale electricity market (the Singapore Electricity Pool) to facilitate the trading of electricity between generators and SP Services Ltd in a competitive environment. The companies participating in the market were almost exclusively state-owned (all part of the Temasek Holding); nonetheless, it provided the next step in the market reform strategy.

3.2.3 In 2000, following a comprehensive review process, the government decided to take a major step in power sector deregulation by:

- Introducing the unbundling, at ownership level, of contestable and non-contestable segments of the electricity industry;
- Establishing a system operator and market operator (under PUB);
- Establishing a real-time wholesale market; and
- Starting the liberalisation of the retail market.

Simultaneously, the Government decided to restructure the gas industry to put in place a competitive market framework to complement the liberalisation of the electricity industry.

3.2.4 In 2001, the Government established a new statutory body, the Energy Market Authority of Singapore (EMA), under the Ministry of Trade and Industry, with the overall responsibility for regulating the electricity and gas markets. Also, the system operation functions were transferred from PUB to EMA, and EMA formed the Energy Market Company Pte Ltd (EMC) to operate wholesale electricity market.

[20] EMA (2010) - Introduction to the National Electricity Market of Singapore.

3.2.5 In 2002, the EMC became operational. In 2003, the National Electricity Market of Singapore (NEMS) was formed under a new legal and regulatory framework by EMA and EMC. The NEMS handles the purchase and sale of electricity, serving as a trading platform for electricity.

3.2.6 In June 2003, consumers with average monthly consumption of 20,000kWh and above became contestable. The size threshold for consumers to be contestable was lowered again in December 2003, allowing consumers with average monthly consumption of 10,000 kWh and above to become contestable. The objective of those measures was to introduce competition at retail level.

3.2.7 In 2004, EMA imposed "vesting contracts"[21] (special financial contracts) on the three largest generators (Senoko Energy, PowerSeraya and Tuas Power Generation) as a condition of their electricity licences. The vesting contracts were designed to reduce the market power of the large players with pricing provisions intended to reflect the economics of new generation plant. The vesting contract level allocated to each generator diminishes as the market power of that generator is reduced. Vesting contracts are still in place, although EMA has recently determined to lower the vesting contract level from the current 40% of the total demand to 30% for first-half 2015 and 25% for second-half 2015 and 20% for 2016[22].

3.2.8 In December 2008, the divestment of Temasek's 3 gencos was completed.

3.2.9 In 2014, the Energy Market Authority (EMA) of Singapore has taken two steps forward in providing commercial and industrial consumers more choices to select their electricity providers by reducing the contestability (eligibility) threshold of average monthly electricity consumption from:

- 10000 kWh to 8000 kWh in April 2014; and
- 8000 kWh to 4000 kWh in October 2014.

3.2.10 This means that non-residential consumers with an average monthly consumption of 4000 kWh are eligible now to select their electricity retail company. In meeting the contestability threshold, EMA allows the consumers to aggregate their demand across different electricity accounts, something that was not permitted before.

3.2.11 EMA estimates that these measures will allow more than 76,000 accounts to be eligible for retail contestability, an increase from 12,600 accounts at the beginning of 2014.

[21] With the vesting contracts, generation companies are committed to selling a specified amount of electricity (viz the vesting contract level) at a specified price (viz the vesting contract price). This removes the incentives for generation companies to exercise their market power by withholding capacity to push up spot prices in the wholesale market. [Source: https://www.ema.gov.sg/Licensees_Electricity_Vesting_Contracts.aspx]

[22] Source: EMA (2014). Review of the Vesting Contract Level for the Period 1 January 2015 to 31 December 2016 – Final Determination Paper.

3.2.12 The contestability threshold will be lowered to 2000 kWh from July 2015. This further reduction is expected to bring an addition of about 13,500 more contestable customers. Full contestability market (including residential customers) will also be developed in the future.

Demand Response Programme

3.2.13 EMA is also promoting the introduction of a Demand Response Programme (DRP) to enhance competition in the wholesale electricity market. The programme is expected to start working in 2015 after regulatory and market changes are introduced.

3.2.14 The DRP will allow customers with flexible electricity demand to voluntarily reduce their demand, in exchange of a reduction in the electricity prices as a result of their actions. This will enhance competition in marginal price as these participants will compete against the most expensive generators in the system; for each settlement period the market operator will have to decide whether it is cheaper to dispatch one additional plant or to reduce the demand on flexible participants. The objective of the DRP is to change the shape of the load curve by reducing peak demand or by avoiding price spikes when the generation supply is at the limit of availability.

3.2.15 The expected benefits of the programme are:

- Providing an additional option for consumers to participate in the National Electricity Market of Singapore (NEMS) through demand side bidding and to manage their electricity usage in response to price signals.
- Reducing the wholesale electricity prices during peak periods as more expensive generation units need not be scheduled to run.
- Promoting more efficient investments in the NEMS as DRP is expected to reduce ‘peaks’ in electricity consumption. In the long term, this reduces the need to invest in expensive generation units that are only run infrequently to meet ‘peak’ demand.
- Providing an additional resource to improve system reliability as consumers reduce consumption in response to high prices during periods when supply capacity is tight (e.g. due to unplanned outages or gas disruptions).

3.2.16 The DRP will be open for all contestable consumers who are able to offer a reduction in electricity consumption of at least 0.1MW (per half hour). Contestable consumers can participate on an individual basis, through electricity retailers or through licensed load providers known as “Demand Response Aggregators” who are able to aggregate the demand of multiple consumers into a larger tranche.

3.2.17 The initial proposal by EMA is that consumers can submit demand bids, indicating their willingness to reduce their electricity demand at different price points (similar to how generators offer their capacity into the market). Participating consumers will share one-third of the savings due to the reduction in electricity prices as incentive payments. However, at the time of preparing this report, it is pending to development of the final algorithm to be used in the NEMS.

Electricity Futures Market

3.2.18 EMA together with the Singapore Exchange (SGX) was preparing to launch the first electricity derivative (future) market in Asia by the end of 2014. This market was finally launched on 1 April 2015.

3.2.19 The product to be traded is the Uniform Singapore Energy Price[23] (USEP) Quarterly Base Load Electricity Futures, to be traded on SGX-Derivatives Trading platform and cleared on SGX-Derivatives Clearing house.

3.2.20 The contract is a standard, cash-settled futures contract listed as contract quarters (i.e. January to March, April to June, July to September, and October to December), with the following specifications:

- Position Limits: 1,000 lots net long or net short in all contract quarters combined.
- Price Limits: No price limit (Unless otherwise prescribed by SGX).
- Last Trading Day: To be the last business day of the contract quarter.
- Final Settlement Price: The Final Settlement Price is the arithmetic average of all half-hourly USEP prices in the expiring contract quarter, rounded to two decimal places.
- The final settlement will be in cash.

3.2.21 The objective of the electricity futures market is to provide market participants in the Singapore electricity market with a tool to manage their risk exposures and prevent the need of vertical integration between generators and retailers. Potential new participants to the electricity market can also use the futures market to back fixed price contracts for consumers with an appetite for low risk electricity price contracts.

3.3 Market Development

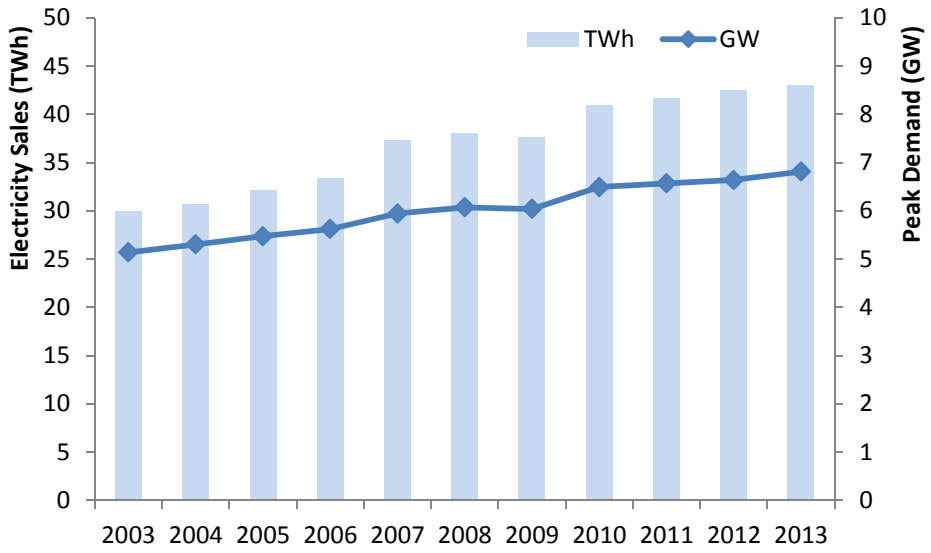
Wholesale Market

3.3.1 After more than a decade of functioning, the wholesale power market in Singapore is consolidating while continuing expanding; the development of LNG for power generation, and eventually for trading, is helping the country to maintain its strategic position as energy hub in the region.

3.3.2 Power demand maintained the growth trend over the past ten years with an average increase in peak demand of 2.9% per year (Figure 3.1). This trend in the demand keeps pushing the supply to maintain expansions and investments plans in the country.

[23] The USEP is the weighted-average of the nodal prices at all off-take nodes as calculated by the Energy Market Company.

Figure 3.1: Electricity Sales and Peak Demand



Source: Mott MacDonald based on EMA and IEA information

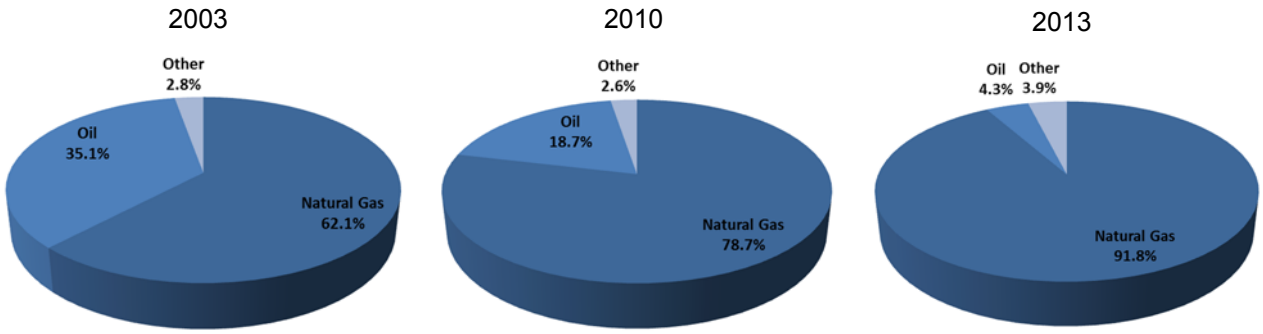
3.3.3 Singapore is highly dependent on fossil fuels for power generation; therefore, diversification of the supply mix was a key priority for the government over the last years. However, switching fossil fuels in a cost effective way basically means replacing more expensive oil with comparatively more economical natural gas as the input source in power generation.

3.3.4 Following these premises, the Singapore government took the strategic decision of relying in Liquefied Natural Gas (LNG) as a source of:

1. Reducing generation costs; while
2. Diversification of natural gas sources (compared to piped gas, traditionally supplied from Malaysia or Indonesia)

3.3.5 In early 2013, the government-funded LNG terminal commenced operations, allowing Singapore to supply more than 90% of its electricity with natural gas (Figure 3.2). This change in the fuel mix over the last decade had a significant effect in mitigating the impact of oil prices in the electricity tariffs.

Figure 3.2: Fuel Mix for Generation



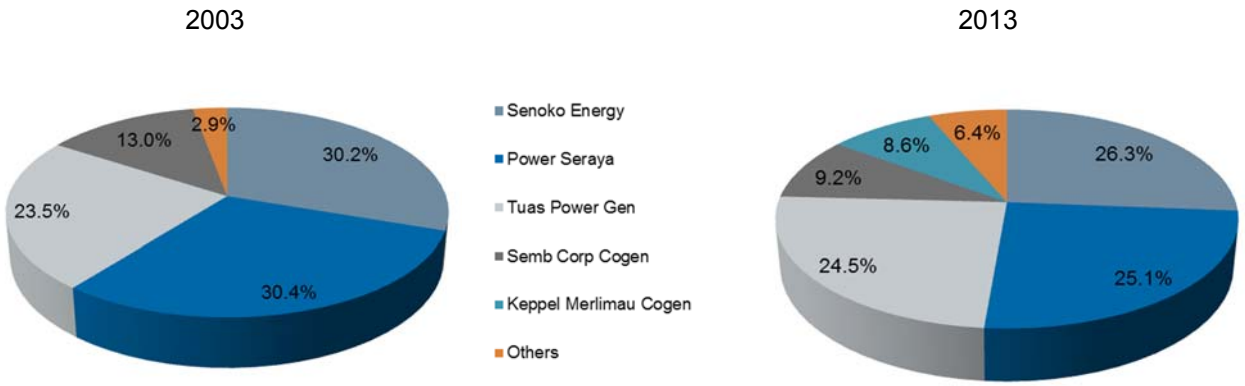
Source: EMA – Singapore Energy Statistics

3.3.6 In addition to the changes in the fuel mix, the supply side is facing an increase market competition with 1,961MW of new generation capacity added to the system in 2013. This includes:

- 220MW from ExxonMobil;
- 840MW from Keppel Merlimau Cogen;
- 101MW from TP Utilities; and
- 800MW from PacificLight Power.

3.3.7 Changes in market development across time has reduced the market share of two of the main incumbents: YTL PowerSeraya (from 30.4% to 25.1%), Senoko Energy (from 30.2% to 26.3%) while gaining new entrants, as shown in Figure 3.3.

Figure 3.3: Market Share of Generation Companies (Based on Scheduled Generation)



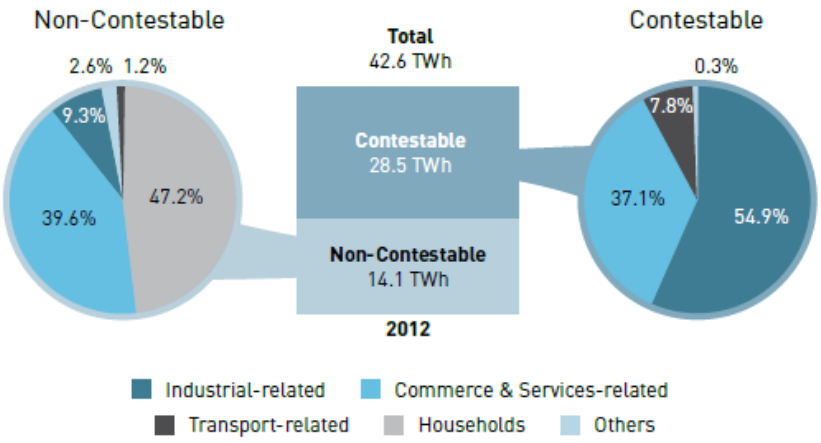
Source: EMC – NEMS Market Reports 2003 and 2013

Retail Market

3.3.8 Contestable (eligible) consumers accounts for 66.9% of electricity sales in 2012, while the remaining 33.1% is attributed to non-contestable (regulated) consumers. However, contestability market is increasing as EMA has further relaxed the eligibility threshold level in 2014 as explained in Section 3.2.9.

3.3.9 In 2012 among contestable consumers; industry-related and commerce & services-related consumers accounted for 54.9% (or 15.6 TWh) and 37.1% (or 10.6 TWh) of total electricity sales to contestable consumers respectively. Another 7.8% or 2.2 TWh of such sales were attributed to the transport-related sector.

Figure 3.4: Electricity Sales by Contestability and Sector in 2012



Source: EMA – Singapore Energy Statistics 2013

3.3.10 Electricity sales to non-contestable consumers were mostly made to households (47.2% or 6.6 TWh), while another 39.6% (or 5.6 TWh) of sales were attributed to the commerce & services-related sector. The industry-related sector accounted for another 9.3% (or 1.3 TWh) of non-contestable electricity sales.

3.4 Outcomes of the Electricity Market

3.4.1 The government's objective when liberalising the power sector was for market forces, rather than central planning, to drive investment, production and pricing decisions. Introducing market competition would likely reduce energy costs for large industrial users, thereby ensuring Singapore's continued competitiveness.

3.4.2 This general strategy for the power sector was further complemented by the government's commitment to rely on natural gas as the main input source for power generation; and to diversify

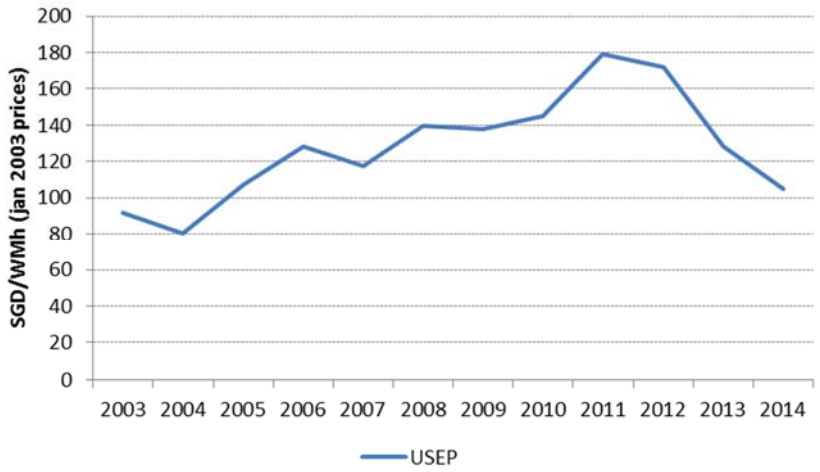
its natural gas supply sources to enhance competition in the power sector while improving security of supply.

Wholesale Prices

3.4.3 Annual average electricity prices at wholesale level (USEP) increased 14%, on a real basis, from 2003 to 2014 – at an average rate of 1.2% per year (see Figure 3.5); even considering that electricity demand has grown at an average rate of 2.9% per year during the same period.

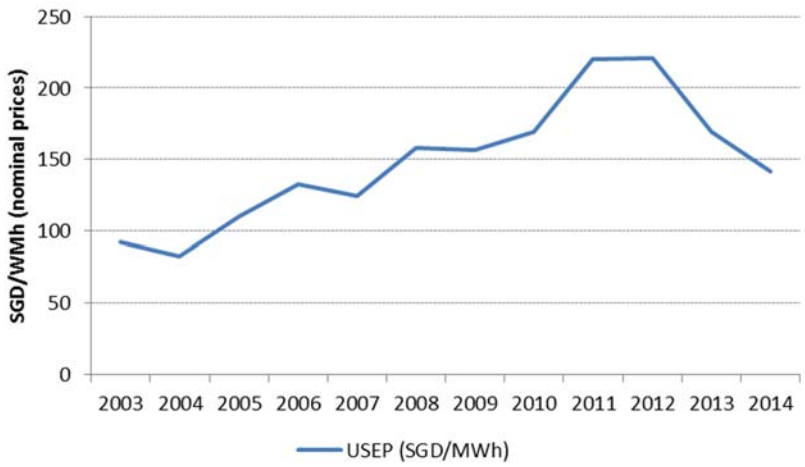
3.4.4 Changes in the generation structure driven by market competition, combined with stable LNG prices in the region, have helped to exert downward pressure on electricity prices in Singapore, with wholesale electricity prices dropping by 22% and 36% in 2013 and 2014, respectively, compared to 2012; thus, enabling contestable consumers to purchase more competitive retail packages (see Figure 3.7). Therefore, the government strategy of developing wholesale competition together with further reliance on natural gas as a source to maintain industrial competitiveness appears to be paying off.

Figure 3.5: Annual Average Nodal Prices (USEP) in Singapore (SGD/MWh) in Prices of January 2003



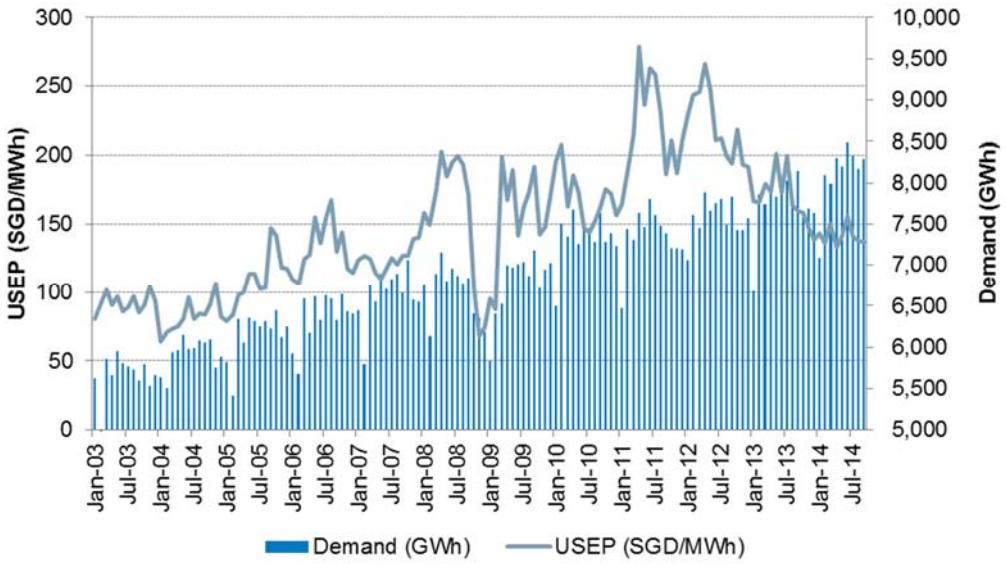
Source: Mott MacDonald based on EMC and World Bank (CPI index) data

Figure 3.6: Annual Average Nodal Prices (USEP) in Singapore (SGD/MWh) in Nominal Prices



Source: Mott MacDonald based on EMC data

Figure 3.7: Average Nodal Prices (USEP) and Electricity Demand in Singapore



Source: Mott MacDonald based on EMC data

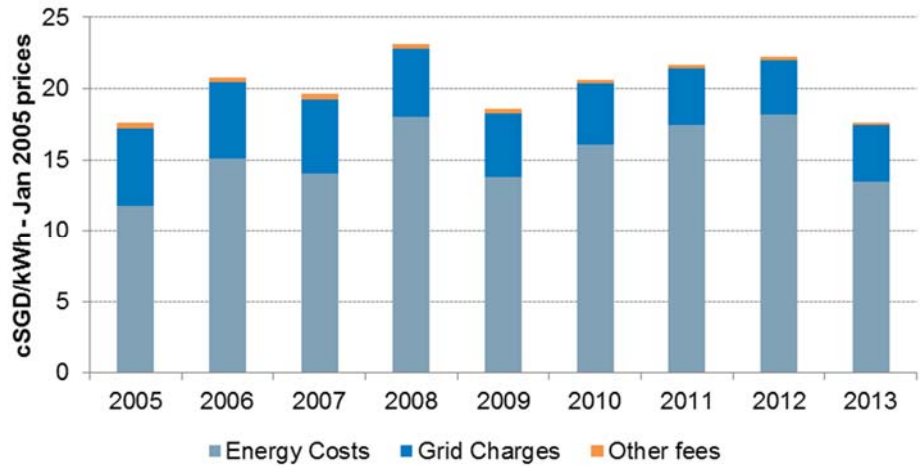
Electricity Tariffs

3.4.5 Electricity tariffs for non-contestable consumers are regulated by the EMA and are updated quarterly to reflect changes in the cost of power generation.

3.4.6 Distribution costs are low as the distribution area is small, so generation costs make up the majority of the electricity tariff. Therefore, the electricity tariffs are pegged to LNG price over the previous three months. With the introduction of liquefied natural gas (LNG) for power generation, the average natural gas price is pegged to the weighted average forward prices of high sulphur fuel oil (HSFO) and dated Brent prices through commercial gas contracts.

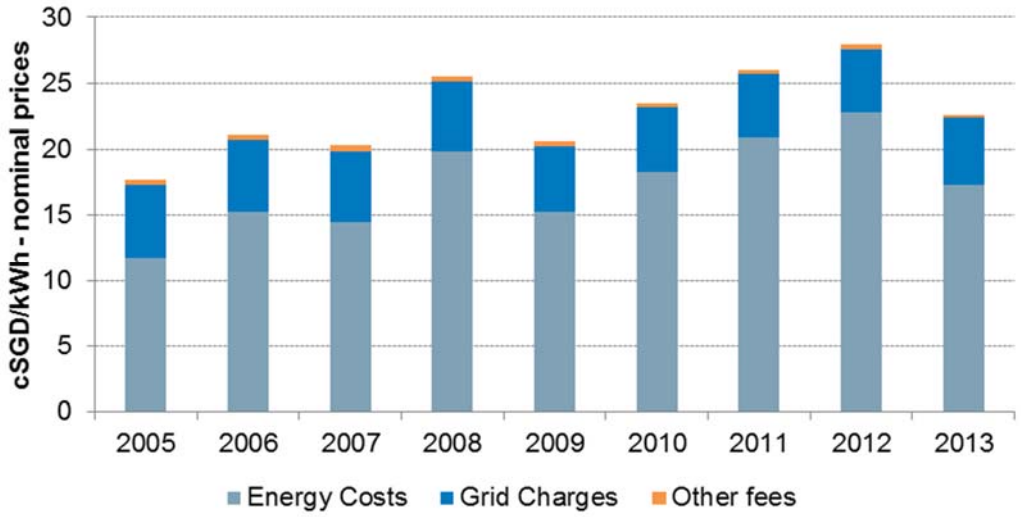
3.4.7 Figure 3.8 below presents the evolution of the regulated tariffs for residential customers in Singapore at prices of January 2005 (real basis); as it can be observed, in real terms, low voltage tariffs have fluctuated between 18 to 22 cSGD/kWh over the period from 2005 to 2013.

Figure 3.8: Low Voltage Electricity Tariff (cSGD/kWh) in Prices of January 2005



Source: Mott MacDonald based on EMA and World Bank (CPI Index) data

Figure 3.9: Low Voltage Electricity Tariff (cSGD/kWh) in Nominal Prices

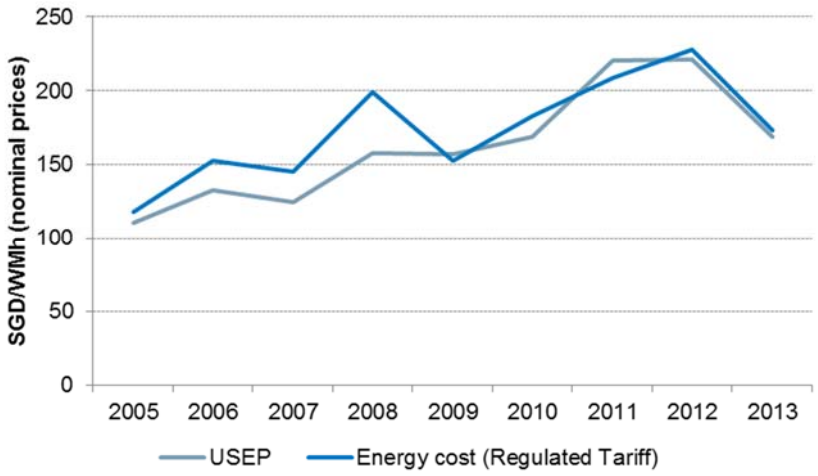


Source: Mott MacDonald based on EMA data

3.4.8 The composition of electricity tariffs in Singapore can be categorized into three main components, namely energy costs (paid to the generation companies), grid charges (paid to SP PowerAssets) and other fees, which includes market support services fees (paid to SP Services), market administration and power system operation fees (paid to EMC and PSO). In 2013, energy costs accounted for some 78% of total electricity tariffs, while 21% was attributed to grid charges and the 1% remaining to other fees.

3.4.9 Considering that regulated prices follow the trends in wholesale prices (see Figure 3.10), non-contestable consumers have also benefitted from the competitive market outcome explained in the previous section.

Figure 3.10: USEP prices versus Energy Component of the Regulated Tariff



Source: Mott MacDonald based on EMC and EMA data

3.4.10 There are no regulated tariffs for contestable consumers (other than the regulated charges for the use of the transmission / distribution network and other administrative charges). Contestable customers have the possibility of either registering themselves as market participant in the NEMS or to sign a contract with a retailer.

3.4.11 For those customers participating directly in the NEMS, the electricity price they face is the nodal price arising from NEMS market; while for contestable customers contracting with a retailer, the electricity price will depend on the terms negotiated with the retailer. Unfortunately, EMA does not publish information on the prices or margins negotiated by retailers.

Operational Efficiency

3.4.12 In order to ensure the market operates efficiently, the NEMS is supervised by a Market Surveillance and Compliance Panel (MSCP). The panel identifies market rule breaches and assesses market operations for efficiency and fairness.

3.4.13 In its 2013 Annual Report, the MSCP concluded that: *"The Market Surveillance and Compliance Panel (MSCP) is generally satisfied with the state of compliance in the National Electricity Market of Singapore (NEMS) in 2013. Only six cases of rule breach required determinations from the MSCP. The number of gate closure violations was relatively flat from the previous year and did not create any significant market impact."*[24]

[24] MSCP Annual Report 2013.

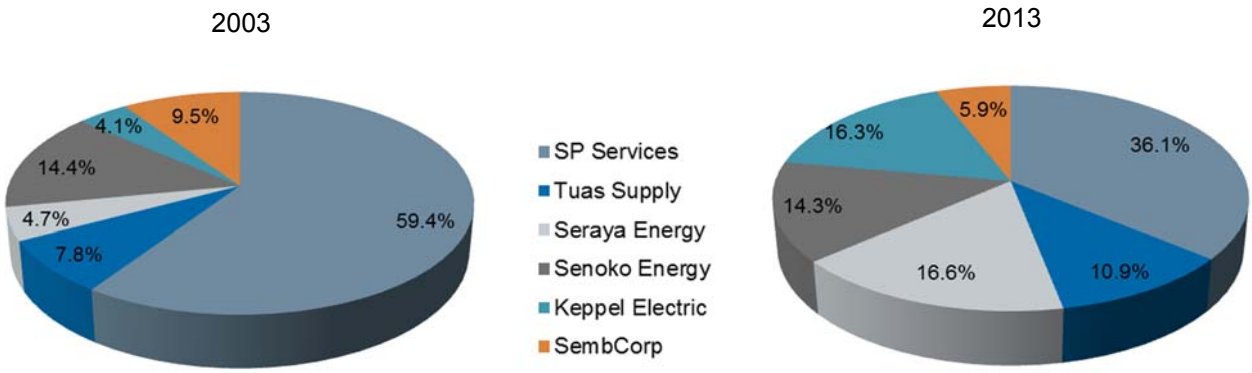
3.4.14 Considering that competition, in theory, provides strong incentives to operational efficiency across market participants, then the fact that the NEMS is reaching good level of competition at the wholesale and retail markets, means that operational efficiency should have improved.

Increase in Customer Choices

3.4.15 The retail market in Singapore is dynamic and this trend is expected to increase in the future as the number of contestable customers increases over time.

3.4.16 The introduction of contestability at retail level has brought significant changes to the market shares of retailers companies over the last decade. While the retail market is served by six retailers as in 2003, their market share has changed quite substantially; Singapore Power Services (which act as Market Support Service Licensee (MSSL) providing electricity at regulated tariffs) has significantly lost market share to other competitors (from 59.4% in 2003 to 36.1% in 2013). Similarly for SembCorp, its market share has also dropped from 9.5% to 5.9% in the same period of time. Seraya Energy and Keppel Electric have increased their share by more than 3 times, from 4.7% and 4.1% to 16.6% and 16.3% respectively. Tuas Supply has also increased its market share but at a more moderated rate, from 7.8% in 2003 to 10.9% in 2013. Finally, Senoko Energy was the only retailer to maintain almost unchanged its market share (14.3%) (see Figure 3.11).

Figure 3.11: Annual Market Share of MSSL and Retailers (based on Energy Consumption)



Source: EMC – NEMS Market Report 2013

3.4.17 Unfortunately, there is no public information on the client distribution by retailer in order to compare whether the changes in the market shares by consumption are triggered by a substantial switch rate between customers.

Reliability of Electricity Supply

3.4.18 As part of its regulatory powers, EMA has put in place strict performance targets on SP PowerAssets Ltd (the transmission company) to ensure that electricity is delivered reliably with a high quality of service (see Table 3.1).

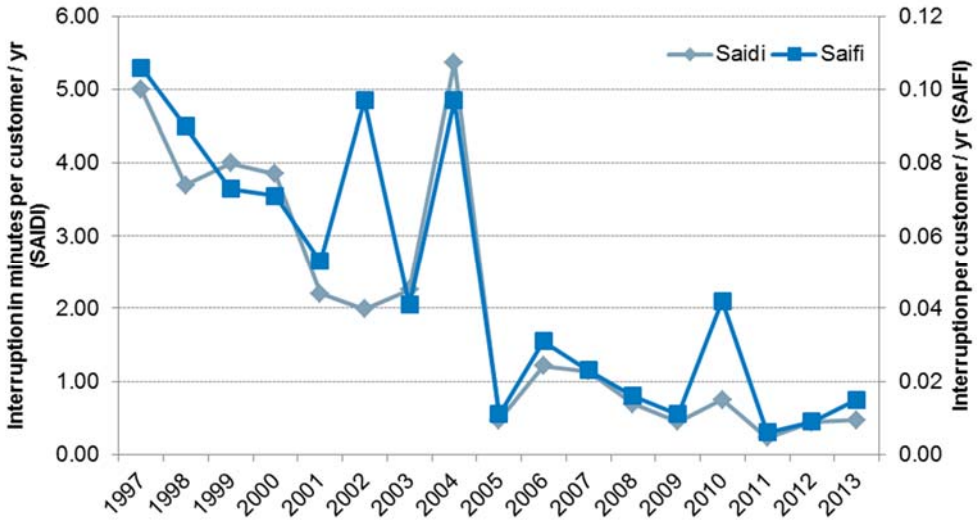
Table 3.1: Performance Standards for SP PowerAssets Ltd

Service Dimension	Service Indicator	Service Standard	Performance Target (%)
Availability of Supply	Minimum advance notice for planned interruption of electricity supply	7 calendar days	95
Reliability of Supply	Number of power failure incidents* caused by failure of, damage to, or operation of Licensee's equipment or cables	0	100
Restoration of Supply	Time taken to restore electricity supply for each power failure due to failure of, damage to, or operation of Licensee's equipment or cables rated at 22kV and below	3 hours 2 hours	100 90
Quality of Supply	Time taken to rectify voltage complaint or limit violation	2 calendar days	95
	Time taken to correct a voltage complaint that requires network reinforcement	6 months	99
	Number of voltage dip incidents* due to failure of, damage to, or operation of Licensee's equipment or cables	0	100
Providing Supply	Time taken to implement electrification scheme requiring new substations after take-over of substation (up to 22kV)	10 weeks	90
	Time taken to implement service connection requiring cable installation work, after premises to be supplied with electricity is ready to receive cable	6 weeks	90
Customer Contact	Time taken to reply to a written enquiry or complaint	7 working days	95
Metering Services	Time taken to attend to meter problem at site upon notification	8 calendar days	95

Source: EMA webpage

3.4.19 Tight performance target and regulation has ensured that Singapore's electricity grid maintained its status as one of the most reliable in the world and this has not been affected by the introduction of competition at wholesale and retail levels. Proof of this is the excellent track record of SAIDI and SAIFI values in the country (see Figure 3.12).

Figure 3.12: Historical Evolution of SAIDI and SAIFI



Source: Mott MacDonald based on Singapore Power and EMA information

3.4.20 While there is a clear political will on having substantial amount of reliability in the power system; unlike the case of Australia, we were not able to find public available information on the socio-economic rationale for selecting that specific quality level by the regulator and / or an economic estimation (or cost benefit analysis) of the impact of such quality level in the electricity bill for the society.

3.4.21 It is most probable that the effective implementation of the Demand Response Programme will provide information to the EMA on the appetite of customers for interruptible electricity service. Based on this concept, EMA may find it easier to estimate the value of lost electricity for the consumers and be able to have an economic benchmark to determine an efficient reliability level.

3.4.22 Nonetheless, the fact that Singapore was able to improve reliability levels in its grid enables us to infer that the development of competition and efficiency at retail and wholesale markets has not affected the reliability of the grid.

3.5 Market Liberalisation Determinants

3.5.1 From its inception in 1995, the liberalisation process of power in Singapore took substantial amount of time and efforts to be developed and implemented. The reform process was

characterised by a gradual introduction of competition in order to ensure the transition to competition was properly managed.

3.5.2 This reform process was constantly backed by a strong political will to foster competition at wholesale and retail level, following the underlying principle that the market, rather than a centralised body, would lead to efficient investments in the power sector.

3.5.3 The reform process in Singapore is in the process towards full retail market liberalisation (EMA has recently taken decisive steps in the retail market to reduce the threshold level allowing retail companies to access an increasing amount of customers) and the government is working in introducing further tools for market players in an effort to increase competitive behaviour of market participants (for example, future markets and the Demand Response Programme).

3.5.4 The reform program introduced by the government is achieving its objective, as the market reforms have introduced enough incentives for market participants to invest in more efficient forms of power generation (increasing the share of natural gas CCGT and replacing expensive diesel / oil generation). This change in the generation profile affected prices at wholesale and retail levels providing end customers a share on the improvements in efficiency.

3.5.5 Retail competition has changed the market share of retail companies which would imply that customers are benefitting from better commercial offers (either in terms of cheaper energy and/or better services). However, the contestable market is an area in which EMA needs to improve monitoring activities in order to understand whether end customers have enough information to maximise the benefits of retail competition (or if the monitoring activity exists, provide more information on the monitoring results). It should be noted that full contestability to all retail customers has not yet completed and vesting contracts are still in place, reflecting the possible risk in the market reform.

3.5.6 The Singapore case presents many similarities to the case in Hong Kong, in terms of geographical space limitations, high reliability requirements to the system, vertically integrated utility prior to the reform. The process in Singapore required substantial political will and a detailed roadmap on how and when to introduce further layers of competition / reforms in order to ensure competitive outcomes are achieved without affecting the reliability of the system and preserving the rights of different market participants. This could be of reference value to Hong Kong.

3.5.7 The introduction of LNG has promoted competition and investments in power generation. By promoting the development of strategic power generation infrastructure (i.e. the LNG terminal) and facilitated third party access, the government of Singapore has helped to develop competition in the electricity market.

3.5.8 In Hong Kong, the government has been studying the possibility of introducing competition in the power market trying to assess the extent of possible benefits and implications in the electricity market from liberalisation processes across the world. However, the special characteristics of

Hong Kong and its power sector requires that the decision process must be carefully evaluated before building the necessary public consensus to introduce any type of reform.

3.5.9 Also, while EMA and EMC adequately perform monitoring at the wholesale level, identifying areas of improvement and working on resolving them; we observe little public information on monitoring commercial activities at retail level. For instance, as a difference to the Australian case for instance, EMA has not put adequate effort in to inform and make publicly available a tariff comparison tool that would allow small customers (with little experience on power market functioning) to understand and independently assess commercial offers from different retailers with potential negative implications for competition.

3.5.10 Ensuring end customers receive the benefits of effective competition at retail level is as important as guaranteeing competition at wholesale level; there is little point in having a transparent wholesale market if its benefits are diluted downstream at retail level.

3.5.11 Transparency is key for adequate competitive market functioning, therefore, in order to maintain the objectives of liberalisation process, the government of Singapore needs to take a step forward in providing accessibility to information – obviously providing an adequate protection level for commercially sensitive information – allowing different players to be able to analyse, comment and provide ideas on how markets can be improved to reach further competition. Currently, there is no public available information on commercial offers of retailers, nor are there any price comparison tools and, if there is market monitoring conducted, this information is not publically accessible. Additionally, while there appears to be a certain level of vertically integration between generators and retailers, we have not seen any analysis or monitoring of the potential for this to create barriers for new entrants and prevent effective competition.

3.5.12 In Hong Kong, we observe some similar issues in terms of accessing information on the power market. Information on the annual tariff reviews, SCA review, development plans, etc is currently provided by the power companies to the Panel of Economic Development and made public subsequently. Enhancing the access to information can be explored to allow stakeholders to better evaluate the performance of the HEC and CLP.

4 United Kingdom

4.1 Arrangements Prior to the Reform

England & Wales

4.1.1 Prior to the reform, all thermal and nuclear generation plus the transmission grid in England and Wales were run by the Central Electricity Generating Board (CEGB). Distribution and supply were integrated activities undertaken by 12 regional Electricity Supply Boards who had monopoly status and provided a supply to all consumers in their own geographical areas. All utilities were publicly owned and run.

Scotland

4.1.2 Prior to reform in the UK, there were two vertically-integrated public Boards in Scotland – the North of Scotland Hydro Board (NSHB) and the South of Scotland Electricity Board (SSEB). Each company provided generation, transmission, distribution and supply services in their respective geographical areas (north of Scotland and south of Scotland). Each company effectively operated as a supply monopoly in its own area, although there was close cooperation with one another through the Joint Generating Agreement, which effectively established an economic despatch Scotland-wide (as NSHB owned mostly hydro generation plus some gas, SSEB had mostly coal and nuclear assets were held separately). The SSEB supplied approximately twice the volume of NSHB, but NSHB covered twice the land mass.

Northern Ireland

4.1.3 Under the Electricity Supply (Northern Ireland) Order 1972, all of the previously disparate electricity companies were integrated to form the Northern Ireland Electricity Service, subsequently renamed Northern Ireland Electricity (NIE), which undertook all generation, transmission, distribution and supply as a vertically-integrated public company.

Approach & Objective

4.1.4 The approach to electricity sector reform in the UK, albeit broadly consistent, was undertaken slightly differently in Scotland, Northern Ireland and in England and Wales, reflecting the pre-existing industry structure (and the strength of regional lobbies). The overall approach was driven by the then Conservative Government which was pursuing an agenda of widespread privatisation and reform throughout all utility sectors. One of the main philosophical drivers was the belief that competition between privately-owned, profit-driven organisations would drive down costs and increase the efficiency of the utility sectors, as well as relieving some pressure on the State treasury.

4.2 The Reform Process

Early reform – the compulsory pool

4.2.1 The Electricity Act 1989, primary legislation which applied to the whole of Great Britain (Scotland, England and Wales), restructured the industry, provided for its privatisation, introduced wholesale and retail competition and established a new independent regulatory body to oversee the industry throughout GB. The Act clearly defined the separate roles of policy maker, regulator and service providers.

4.2.2 Under the Act, the CEGB in England and Wales was broken up. The thermal generation assets were split into two generation companies, PowerGen (PG) and National Power (NP), which were corporatised and floated. The nuclear assets were vested in a new public company, Nuclear Electric, which together with the Scottish nuclear assets was floated as British Energy several years later. The 12 regional Electricity Supply Boards were also corporatised and privatised as Regional Electricity Companies (RECs).

4.2.3 Whilst the RECs retained monopoly distribution rights within their geographical area, the supply (retail) activity was gradually opened up to competition. The transmission assets and the system operation activity were vested in a new company called the National Grid Company which was originally owned by the 12 RECs and subsequently floated. Since 2002, the TSO role of National Grid has been extended to cover the whole of Great Britain.

4.2.4 Further primary legislation in 2000, driven by European Directives, required the legal separation of the REC's distribution (wires) activities from their supply (retail) activities in order to facilitate greater retail competition. There has subsequently been significant integration (mergers and acquisitions) between distribution companies (in pursuit of economies of scale) and there are now only 7 separately owned distribution companies in the UK. The supply sector has also seen both horizontal and vertical integration (with generators). The supply activity is now carried out by 6 major supply/generation companies, with considerable foreign investment.

4.2.5 Under the original reform model, generators in England and Wales sold all their output into a compulsory Pool and the 12 RECs (and any independent suppliers or very large customers) were required to buy their wholesale electricity requirements from it. The Pool was run by a Market Operator which in turn was owned by market participants. Prices in the Pool were set each half hour by the marginal plant on the system. To this price was added a component to cover the cost of system services and another component to cover 'capacity' costs. Suppliers paid the composite price for their entire demand. Generators competed to provide plant in each half hour. In order to hedge the volatility of half-hourly Pool prices, suppliers and generators concluded bilateral financial instruments known as Contracts for Differences (CfDs), which effectively fixed prices for given periods.

4.2.6 During its early years, the Pool was dominated by the price-setting plant of NP and PG (nuclear was a price-taker only) and wholesale prices did not fall as expected. In the mid-1990s, in response to market power concerns, NP and PG each agreed to divest further plant in return for which the two companies were permitted to purchase Regional Electricity Companies. The 1990s also saw the emergence of new independent gas-fired generators, the investors in which were often consortiums of the RECs. However these tended to be base-load plant and hence did not provide competition at the margin to set the Pool price.

British Electricity Trading Arrangements

4.2.7 In 2001, the Pool was abolished and replaced by a wholesale market called the New Electricity Trading Arrangements (NETA) in which generators and suppliers were free to strike bilateral contracts for physical delivery of wholesale electricity. The idea was that bilateral trading would reduce the amount of rent that low cost generators could receive by removing the pay-at-margin pool. A balancing market was put in place to allow market participants to buy and sell their residual requirements and provides the grid operator with access to electricity to balance the system. This market arrangement was extended to Scotland in 2005 to form the British Electricity Trading and Transmission Arrangements (BETTA). There are now multiple generators and suppliers in the GB market and the wholesale arrangements are considered competitive. Regulation of the competitive markets is largely through GB-wide competition/anti-trust legislation but specific restrictions in the Generation Licence also apply.

Retail Market

4.2.8 Retail competition was introduced gradually, with largest customers (consuming >1MW) being eligible for competitive supply first and the consumption limit on eligibility being reduced in stages. From 1990 consumers over 1MW had access to competitive supply; in 1994, consumers over 100kW and between 1998 and 2000 all retail consumers became eligible. It is estimated that over 50% of consumers have switched supplier at least once. Retail prices to captive customers were subject to regulatory price control. The last supply price control was lifted in 2002 once the regulator Ofgem considered that retail competition provided customer with sufficient protection.

4.2.9 During the 1990's, a number of new and independent suppliers entered the market to supply the big consumers, but the most effective competition to the regional RECs in their own territory came from other RECs from other areas. As the market has developed, independent suppliers have largely been swallowed by the large, integrated generation-supply companies; the one or two that remain tend to operate in niche markets such as 'green' products.

Network Regulation

4.2.10 In 2008, Ofgem undertook a review of the traditional incentive approach of RPI-X. The recommendation of the review was to implement a new regulatory approach which incentivised performance. The new approach is called RIIO, which stands for Revenue = Incentives +

Innovation + Outputs. RIIO is to be applied to electricity & gas transmission (RIIO-T1), electricity distribution (RIIO-ED1) and gas distribution (RIIO-GD1)[25]. RIIO-ED1 is not yet under way, but will start on 1st April 2015 and end 31st March 2023. The distribution business is still under the RPI-X regulatory approach (see below).

4.2.11 RIIO-T1 is the first transmission price control review, which started in 2013 and is due to finish in 2021. RIIO works by setting a number of objectives on safety, reliability, availability, customer satisfaction, connections, environmental, and wider works. The regulated company can then gain bonuses or receive penalties based on their performance against the objectives. For example, regulated companies can receive up to 1% of allowed revenue for performance on developing customer satisfaction and stakeholder engagement. RIIO-T1 is still in its early stages and the extent of its success is yet to be determined.[26]

4.2.12 Distribution companies are regulated by Ofgem under the incentive approach of RPI-X. The revenue that each company is allowed to recover through its use of system tariffs is effectively capped at a level considered by the regulator as being sufficient to cover the reasonable costs of operation and investment as well as a return. Any cost savings made by the company during the control period is retained to provide an incentive for efficiency savings. Cost savings in the region of 20-30% were made by the RECs in the first period of the distribution price control (1990-1995/6). Since the early price controls, the design of incentives has become increasingly complex, encouraging distribution networks to improve the quality of supply and make their networks more accessible to small scale generation as well as incentivising continued efficiency improvements.

Electricity Market Reform

4.2.13 In late 2010, then energy minister Chris Hulme, made speech that admitted that then existing market arrangements would not be up to the challenge of achieving UK's carbon targets while also meeting its energy needs affordably and securely. Hulmes' statement echoed Ofgem's project discovery review which had come to a similar conclusion and had also mapped out several alternative market arrangements. The government published the White Paper outlining its view on 12 July 2011[27]. While the whole programme was presented as Electricity Market Reform (EMR), it was not so much about reforming market *per se,* but rather overlaying a series of interventions which effectively moved from a comparatively free market to a managed one. And the explicit assumption was that this was required to deliver a sustainable, secure and affordable energy system. The Energy Act of 2013 eventually laid the legislative foundation for EMR.

4.2.14 The key instruments of EMR are:

[25] RIIO-GD1 is out of the scope of this report

[26] See https://www.ofgem.gov.uk/ofgem-publications/53599/1riiot1fpoverviewdec12.pdf for the final proposals by Ofgem for RIIO-T1, accessed 20/01/2015

[27] Planning our Electric Future: A White Paper for Secure, Affordable and Low-carbon Electricity.

- Carbon price support (CPS) – a rising minimum carbon price, often called the carbon price floor (CPF). The EU Emissions Trading Scheme (ETS), which puts a price of carbon on electricity generation, has historically been low. The new CPS (only applied in the UK), was implemented in order to guarantee a rising carbon price and so assist in achieving carbon reduction targets;
- Contracts for differences (CfD) - long term government procured and backed off-take contracts for new low carbon generation. The CfD will replace the Renewables Obligation to give greater certainty for project revenues and is also available for new nuclear generation and carbon capture and storage projects;
- Capacity mechanism (CM) – payments to otherwise unsupported generators for making capacity available at times of system stress. There is currently concern about the short- and medium- term resource adequacy, given a large proportion of new capacity is wind (non-firm capacity) and the expectation of coal plant closure. The CM is being introduced in order to ensure resource adequacy;
- Emission performance standards (EPS) – tough CO_2 emission standards that effectively prohibit new coal generation, unless fitted with Carbon Capture and Storage (CCS). This has been put in place to achieve carbon reduction targets.

Carbon Price Support (CPS)

4.2.15 CPS was put in place in April 2013 – which ensures a certain minimum carbon price in the GB by topping up the European carbon allowance (EUA) price, applied through the existing Climate Change Levy (CCL) mechanism (a set of taxes on energy use to businesses). Measures have been put in place to largely exempt energy intensive sectors, and reduce the burden to industry so as to minimise the impact on GB competitiveness. However, domestic users pay the full impact. CPS is under the direct control of the Treasury rather than the Department of Energy and Climate Change (DECC). In 2012 and 2013, Government (DECC) had outlined a projection showing the carbon price floor (CPF) rising steadily at 2 GBP/tonne a year up to 2020 and 4 GBP/tonne a year thereafter, however under political pressure regarding “green taxes”, the government decided to freeze the CPF level for four years from 2014/15. This early intervention has acted to undermine the effectiveness of the CPS, which was intended to signal a long term view on the value of carbon. The government is hoping that reforms in the EU’s emission trading scheme (ETS) (primarily designed to reduce the number of allowances) will lead to drive a substantial increase in allowance prices, so reducing the need for the CPS.

Contracts for Differences (CfD)

4.2.16 The CfDs are a financial instrument (a two-way swap) which provides a long term (15 year+) fixed price for the output of new low carbon generation (nuclear, renewables and CCS). It replaces the current Renewable Obligation (RO) mechanism, whereby qualifying renewable generation secures a top-up price (via Renewable Obligation Certificates [ROCs]) versus the wholesale market price and extends support to nuclear and CCS. There will be a short period of parallel running when new renewable generators can choose between ROC and CfD support, but from 2017, only CfDs will be offered. There will be, however, arrangements to grandfather ROC

support for those taking ROCs. As with the ROC mechanism, the strike prices in the CfDs are banded by technology so as to allow differentiation, with about 12 different renewable technologies. A set of strike prices for renewables was published in late 2013 for 2014 to 2019. All these prices were projected to decrease over time, though generators will lock in a fixed price. However, these strike prices set the maximums achievable because at a late stage in the planning process UK government was forced to introduce an auction mechanism by the European Union, in order to comply with EU's competition and state aid guidelines. An auction mechanism has been rapidly put together and the first CfD auctions are scheduled in early 2015. The auctions will be grouped into two categories – mature renewable technologies and less proven technologies - instead of individual technology bands.

4.2.17 Contracts for nuclear and CCS are being progressed separately under the so-called FID (final investment decision) enabling path, effectively being negotiated on a bilateral basis. This applies to Hinckley Point C (HPC) being backed by EdF, Drax's coal CCS and SSE/Shell's Peterhead gas CCS projects. Eventually, it is government's intention that all CfD prices would be subject to a competitive auction.

4.2.18 The contract terms for the CfDs are generally regarded as attractive to investors. Strike prices are being offered a level which is matched to the RO+ market support levels with a small discount reflecting the assumed saving in cost of capital from having a fixed price contract. Full inflation protection is being offered, and there is no gain-share mechanism for re-financing gains, both of which will have pleased investors.

Capacity Mechanism (CM)

4.2.19 This is an arrangement by which National Grid (NG) can contract for generating capacity or demand reduction to be made available at a future period. Contracts will be auctioned on an annual basis if the NG estimates there will be a shortfall in capacity needed to comply with its reliability standard of 3 hour loss of load expectation (LOLE). Both new capacity and existing capacity is eligible to bid into the auction, which will establish a clearing price in £/kW a year for each auction. New plant will be allocated a 15-year contract at the clearing price, while legacy plant will be offered the price for one year. Generators will then be paid according to the price on the basis of the capacity they make available in periods of system stress. Generators already benefitting from CfD, RO or feed-in-tariff support will not be eligible for capacity payments. Secondary auctions, may be run a year ahead of scheduled delivery in order to allow fine tuning.

4.2.20 The first auction was run in December; concluded on 18th December 2014. The auction awarded capacity agreements for 49 GW, clearing at a price of £19.40/kW/year. Only 2,600 MW (5%) were for new build projects, with the remainder for existing, refurbishing and Demand Side Response (DSR) capacity market units. The auction has received criticism for awarding contracts for many plants, such as nuclear, that would continue to operate without the capacity payments. In addition the 9.2 GW of coal were awarded contracts – which could undermine carbon reductions

objectives. Only 174MW of DSR was awarded, and DECC is facing legal challenges by Tempus Energy on its decision not to allow unproven DSR to compete for longer term contracts[28].

4.2.21 Looking forward it is unclear whether there will be an increased demand for peakers in the medium term. Much will depend on when and how strongly the UK downward demand trend reverses and also on the future contribution of DSR and interconnectors. DSR is allowed in the first auction, but its proponents argue that the current rules discourage its participation and are calling for rule changes. Interconnectors are not eligible to participate in the first auction, but will be able to in successive ones. Existing interconnectors will compete as price takers, however new interconnectors may compete as price setters and be eligible for 15 year contracts. With European wholesale prices generally well below those in UK, there is strong prospect that interconnectors will undercut new CCGTs.

Emission Performance Standards (EPS)

4.2.22 This is a minimum CO_2 emission standard for new generation plant that is set at 450 gCO_2 per normal cubic metre (ncm). This is sufficient for new gas plant, but is too tough for unabated coal plant, whose emissions are about double this level. Initially, this EPS was to be applied to existing plant as well, however this was amended as Government was concerned that forcing off existing coal would jeopardise energy security. Also, it was argued that applying the EPS to existing coal plant would not be required since high carbon price – guaranteed by the CPS mechanism - would force coal plants out of merit. However, the extent of the current fuel price advantage of coal versus gas, and the freeze on the CPS means that coal plants are still in merit and are running ahead of gas and consequently increasing CO_2 emissions.

4.2.23 Another term which is mentioned alongside the EMR instruments is the **Levy control framework (LCF),** although this had existed before the EMR was devised. The LCF is the mechanism by which the Treasury tries to keep control of costs of various interventions on electricity consumers. It provides a guideline for the amount of money that the electricity industry can burden consumers through the main renewable and energy efficiency support measures – including CfD, RO, FiT[29], etc. Its importance is that in principle the Treasury may constrain the amount of funding for CfDs or other support instruments, although in practice there is room to flex the cap. Note however that the LCF excludes the capacity payments, as well as additional transmission and balancing costs associated with bringing on new generation plants. Also, it excludes the costs of the CPS, which are not reported in any of the EMR impact analyses.

4.2.24 With the first CfD auctions approaching there have been several revisions in what the Government is saying is available under the LCF, but the general feeling of the renewable

[28] See Energy Spectrum 12th January 2015 (Issue 456) – published by Cornwall Energy

[29] Current arrangements for renewables support are the RO and Feed in Tariff (FiT). The RO rewards renewable generators with tradable certificates on top of the market price, and is targeted at medium to large sized (generally above 5MW) generators. The FiT pays a guaranteed price per kWh and is targeted at the residential and small business market, generally for installations of less than 5MW.

developer community and lenders is that the allocated budgets are too small to allow the UK to achieve its renewable generation targets. A number of developers and lenders are now rethinking whether to continue with potential projects, given that the tight LCF, with a lower than expected fund, now suggest extremely fierce competition for CfDs.

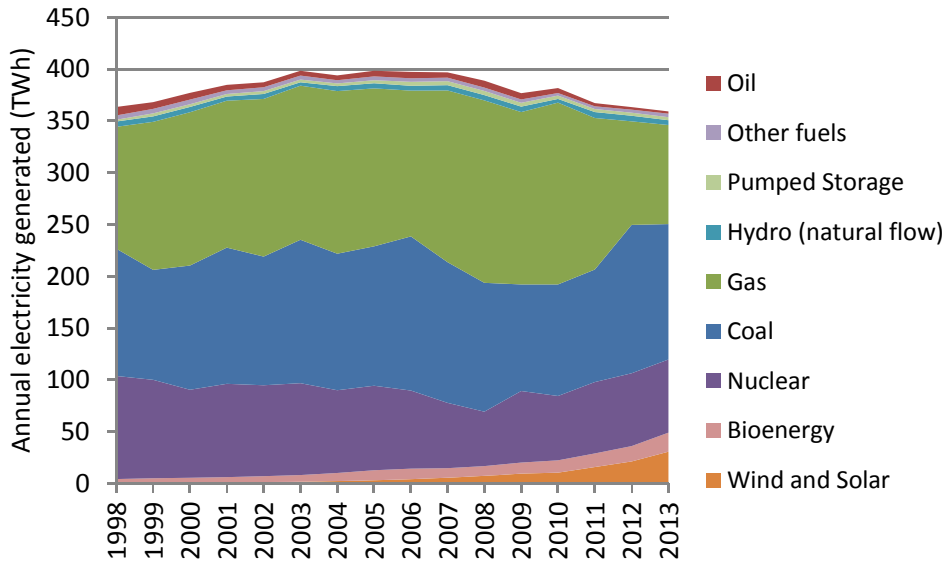
4.3 Market Development

Generation

4.3.1 The generation mix is dominated by a combination of coal, gas and nuclear; supported by a small but increasing share of renewables – mainly bioenergy and wind (see Figure 4.1). Oil is used as a fuel for peaking power plants due to its expense and flexibility. Coal and gas struggle for dominance, with the relative shares determined by the fuel price spread. Coal has experienced resurgence since a low in 2008[30], though with the combination of the CPS, Large Combustion Plant Directive (LCPD) and capacity market, coal generation is likely to drop in the future. Nuclear and renewables should continue to make gains in market share as the UK strives to meet its carbon reduction targets.

4.3.2 Overall generation requirements have continued to fall post 2010 and into 2014, as the economy has struggled to recover from the 2007-08 financial crisis.

Figure 4.1: Annual UK Generation Mix by Fuel Type in TWh: 1998 to 2013



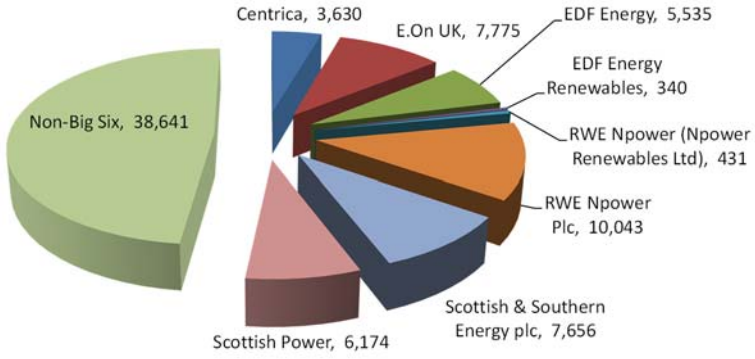
Source: Energy Statistics, Department of Energy and Climate Change.

[30] The US shale gale, which depressed US gas prices, also depressed coal demand – this loosened the global coal market, improving the economics of coal generation compared to gas generation in the UK.

Market Power

4.3.3 In the initial form of the liberalised wholesale market, only three generating companies existed. The concentration of generating assets in a small number of companies suppressed competition. However, in 2001 to 2002, Centrica, EDF, E.ON and RWE entered the UK market. The Big 6 companies (Centrica, E.On UK, EDF Energy, RWE Npower, SSE and Scottish Power) together own just over half the current installed (as of May 2014) generating capacity, with the remaining capacity being owned by independents and other international companies, a significant amount of which is renewable capacity (see Figure 4.2).

Figure 4.2: Installed Capacity by Company, 2014 (MW)

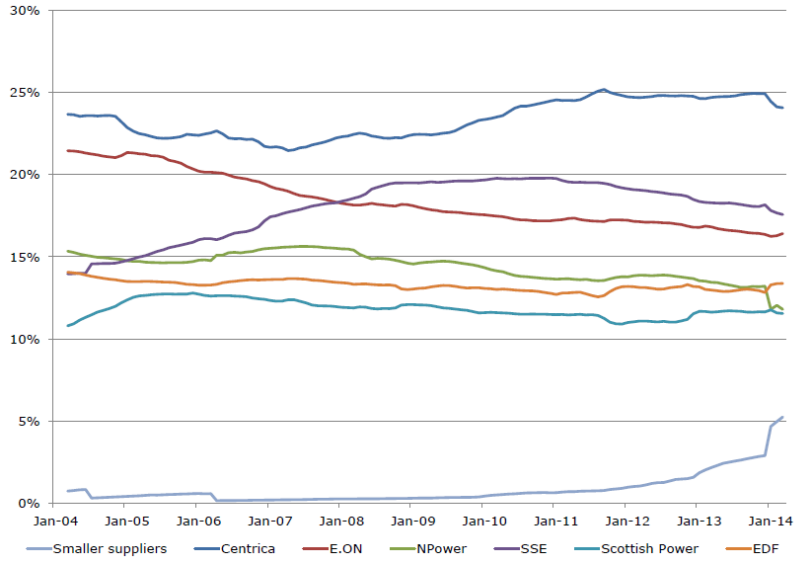


Source: DECC, 2014

Retail Market

4.3.4 The retail market has seen much less significant changes than the wholesale market. There have been no major shifts in market shares between companies (apart from a switching of position between E.On and SSE); the big six suppliers still provide well over 90% of non-business customers (see Figure 4.3). Very recently, there has been a small but significant gain of market share by smaller suppliers since January 2013.

Figure 4.3: Retail Market, Supplier Share



Source: Ofgem, 2014

4.3.5 In their March 2014 report, 'State of the Market Assessment', Ofgem states,

"In summary, we have found weak competition between incumbent suppliers. This arises from market segmentation and possible tacit co-ordination. While we might expect competitive pressure from consumers or new suppliers, we have also found barriers to entry and expansion (including vertical integration) and weak customer pressure."

4.3.6 Here Ofgem points to market segmentation and possible tacit co-ordination between incumbent suppliers as reasons for the poor competition in the retail market. One of the key issues in the retail market is the 'stickiness' of a significant proportion of domestic consumers. This could be due to an issue of trust in the industry: Ofgem report that in 2013, 43% of customers did not trust energy suppliers and lack of understanding of the market: 54% of customers said they understood the range of tariffs 'not very much' or 'not at all'. Lack of customer switching eases the pressure of competition on incumbents, as they have less incentive to offer competitive pricing if their customers do not switch. This being said, with continued media focus on the sector, and the small but rapid jump in market share of smaller suppliers, there are signs that retail competition may increase in the future.

4.4 Outcomes of the Electricity Market

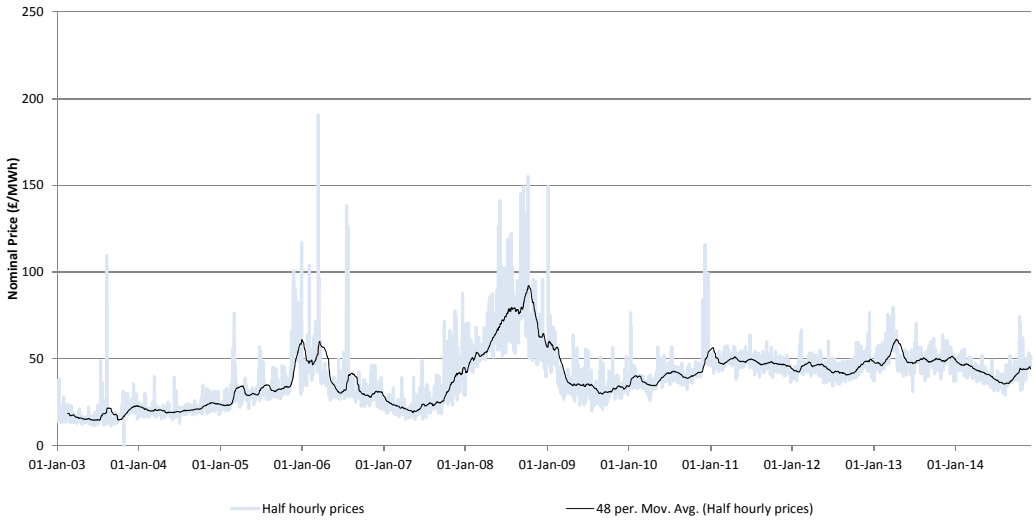
Electricity Tariffs

Wholesale Market

4.4.1 Power in the UK is traded through either bilateral contract, through brokers, or through an exchange. The majority of the volume is traded through bilateral forward contracts, the terms of which are confidential. The APX Group administers the UK Power Exchange: while the volumes traded on this exchange are a small proportion of the total, the prices should be reflective of the wider market. Here we show half hourly and daily average spot market prices for the UK Power Exchange since January 2003 (see Figure 4.4).

4.4.2 Over the period, there has been general upward trend, riding from an average of £18/MWh in 2003 to an average of £48/MWh in 2011 – an average annual growth rate of 13% (whereas the annual average CPI rate was about 3% in the same period). The driving force behind the wholesale electricity price is the price of gas, which is the marginal fuel in the UK. The peak in January 2006 and at the end of 2008 was due to peaking gas prices. The levelling off since 2011 is due to the loosening of global energy markets, brought about by a combination of weak demand and increased supply (particularly from the US).

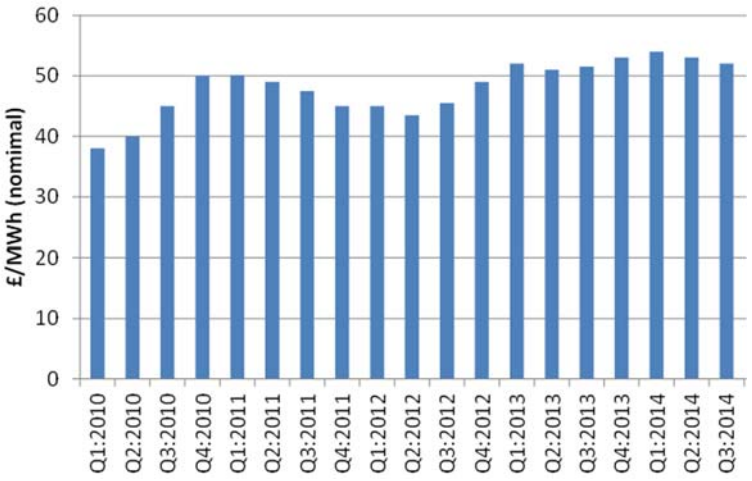
Figure 4.4: UK wholesale prices since January 2003



Source: APX Group, 2014

4.4.3 UK wholesale power prices, as measured by the annual forward contract, have moved in a band between 40-60 GBP/MWh in since 2010, with a gradual upward drift (see Figure 4.5). In April 2013, when the Government introduced a Carbon Price Support, carbon has again become a significant secondary factor, although its impact is small where gas is the price setter. At 16 GBP/tCO_2, this provides an uplift of about 6-7 GBP/MWh versus 1.5-2.0 GBP/MWh from the EU emission trading scheme.

Figure 4.5: GB Annual Baseload Power Forward Price by Quarter 2010-2014: GBP/MWh



Source: Bloomberg

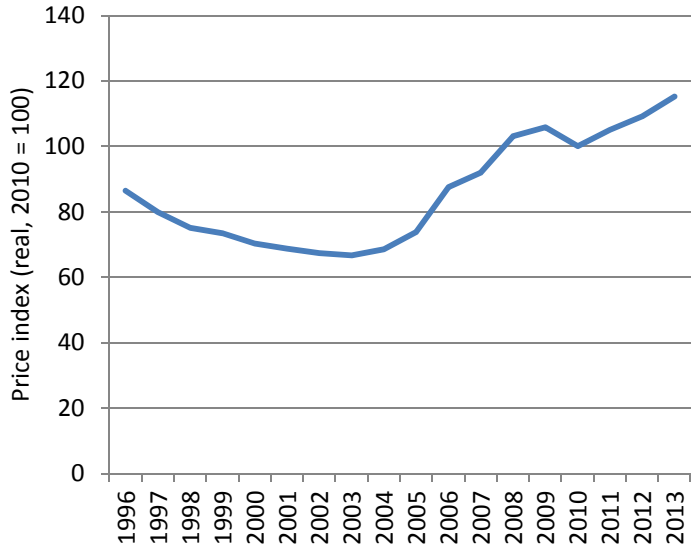
4.4.4 While power prices have continued to be driven by gas there has been a marked shift in the generation mix since 2010 as coal generation has increased successively at the expense of gas, and renewables have also seen an increasing contribution. Prior to 2010, power generation from coal had been on a declining trend. What has driven this reversal has been a relative decline in the coal price versus gas price, such that clean dark spreads[31] have been well over 10 GBP/MWh, while clean spark spreads have rarely touched 5 GBP/MWh and have often been below 3 GBP/MWh. Clean dark and spark spreads are the variable cost margins (coal and gas) generators make after deducting carbon costs. Both these margins are well below the level required to trigger new investment, which is indicative of a general over supply in the generation market in recent years. This is also reflected by the significant numbers of plant put into mothballs (~4GW) or closed (~7GW) during 2010-2013.

Retail Market

4.4.5 There has been a general upward drift in prices (see Figure 4.6), which is largely attributable to increases in gas prices. Additionally, green policies, particularly the Renewables Obligation, have increased costs for suppliers, which pass through into the retail price. As production and other costs have increased, it is likely that costs for consumers would have increased similarly in the same period if in the absence of a market.

[31] A spread is the difference between two values, in this case it is the difference between the fuel cost (including the cost of carbon if it is a 'Clean' spread) and electricity price, where dark spread refers to coal and spark spread refers to gas. Spreads need to be above a certain threshold (about 10-12 GBP/MWh for clean spark spread and above 20 GBP/MWh for clean dark spreads) to spur investment, as the spread needs to cover all fixed costs and provide a return on the investment.

Figure 4.6: Retail Electricity Price (real, indexed 2010 = 100)



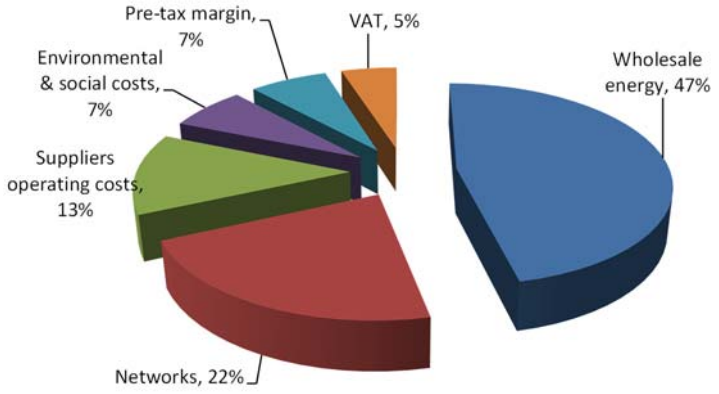
Source: DECC, Domestic Energy Price Indices (GDP Inflator) 2014

4.4.6 The average household dual fuel bill has increased from 2009 to 2012 by 13% (Figure 4.7). Ofgem reports a further 6% increase in 2013. This 19% increase compares with a general inflation of 13%, indicating a real increase of 6% from 2009 to 2013. The chart shows a big increase in company profits since 2009, however the companies point out that 2009 was poor performing year for retail and such low margins were not sustainable. The companies have argued that much of the increase in recent years has been due to environmental and social obligations. And indeed, Figure 4.8, which provides a breakdown of an average household bill for March 2014, shows that environmental and social charges account for the same share as the suppliers' pre-tax margins.

Figure 4.7: GB Annual Dual Fuel Household Bill 2009-2012

Source: Sate of the market assessment, Ofgem, 2014

Figure 4.8: Breakdown of GB Household Electricity Bill: March 2014



Source: Ofgem, 2014

4.4.7 On occasions announcements of retail price increases and company earnings statements have triggered protests from consumer lobbies and politicians. This has been reinforced by continuing survey reports showing that many customers do not trust their suppliers, do not understand their tariffs and bills, are scared to change supplier and generally feel they are getting poor service.

4.4.8 In 2012, Ofgem conducted its own Retail Market Review (RMR) and concluded that customers had low trust of suppliers and found tariffs complicated and that it was unclear that suppliers were acting competitively. In 2013, the government acted to reduce number of tariff offers that each supplier can make to four, including obligation on each supplier to inform customers of their least cost option, if customer requests this.

4.4.9 Following public outcry at retail price rises in 2013 even as wholesale prices were falling; Government said it would force suppliers to provide a one-off rebate of £12 a customer. This is now being implemented for the 2014/15 financial year (just ahead of the General Election).

4.4.10 Meanwhile, Ofgem, acting with support from the Office of Fair Trading, recommended in spring 2014 that the major electricity suppliers be subject to a broad investigation by the Competition and Markets Authority (CMA), the UK's primary Competition body. This investigation is now underway and is expected to present its findings sometime around the General Election in 2015.

4.4.11 On 24th July 2014, the CMA published a paper[32] detailing the reasons for the investigation, on the basis of Ofgem's referral, and the questions it would seek to answer. In this paper, the CMA sets out four 'theories of harm' of potential distortions in the market, which it will test over the investigation. The four theories of harm are:

- "Theory of harm 1: Opaque prices and/or low levels of liquidity in wholesale electricity markets create barriers to entry in retail and generation, perverse incentives for generators and/or other inefficiencies in market functioning.
- Theory of harm 2: Vertically integrated electricity companies harm the competitive position of non-integrated firms to the detriment of customers, either by increasing the costs of non-integrated energy suppliers or reducing the sales of non-integrated generating companies.
- Theory of harm 3: Market power in electricity generation leads to higher prices.
- Theory of harm 4: Energy suppliers face weak incentives to compete on price and non-price factors in retail markets, due in particular to inactive customers, supplier behaviour and/or regulatory interventions."

4.4.12 Between May to June 2015, the CMA is expected to publish provisional findings and possible remedies, with the final report expected after November. It is unclear what the CMA will recommend, however there is a general expectation that some measures will be taken to provide greater separation between generation and supply, and also greater transparency in electricity pricing.

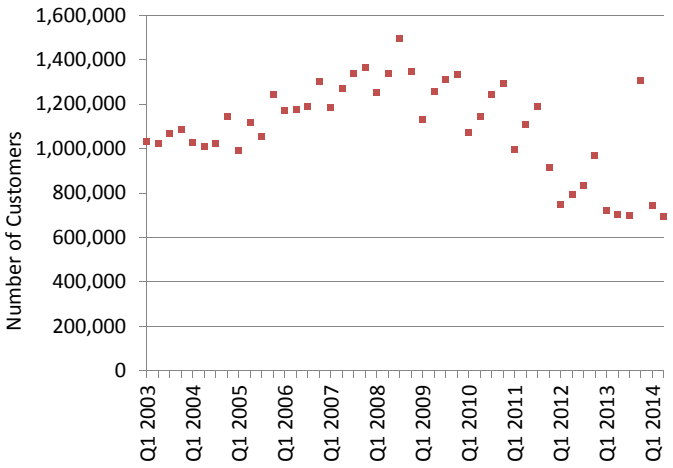
Customer Choices

4.4.13 A large proportion (62%) of customers has never switched from their legacy supplier, and a significant minority (about 15%) of customers have only switched once. This means that the

[32] "Energy Market Investigation: Statement of Issues" available here: https://assets.digital.cabinet-office.gov.uk/media/53cfc72640f0b60b9f000003/Energy_Issues_Statement.pdf accessed 20/01/2015

competitive section of the supply market is less than 25% of customers – and only about 12% of customers switched in 2012. In fact, customer switching has decreased since 2008, apart from an anomalous spike in late 2013 when there was an increased media focus on the energy sector (see Figure 4.9).

Figure 4.9: Number of Customers Switching Each Quarter



Source: Ofgem, 2014

4.4.14 Ofgem highlights that a key barrier to competition in the retail market is a lack of trust in energy suppliers in their March 2014 report 'State of the Market Assessment', causing customer disengagement from the market,

"Moreover, a total of 43 per cent of consumers did not trust energy suppliers to be open and transparent in their dealings with them in 2013… nearly one in five consumers (18 per cent) said they 'completely' distrusted energy suppliers in this regard.

[…]

Lack of trust and poor supplier conduct which further reduced the confidence of some customers to engage in the market and contributed to the permanent disengagement of others."

4.4.15 Ofgem also found evidence of low levels of customer satisfaction. Only 51-52 per cent of customers said they were satisfied with their supplier, and customer complaints have increased by more than 50 per cent since the beginning of 2011.[33]

[33] Source: March 2014 report, 'State of the Market Assessment', Ofgem, paragraph 1.16

Operational Efficiency

4.4.16 Operational efficiency is something which is not monitored directly in the generation and retail businesses at least from the regulatory side, since these activities are assumed to be subject to competitive pressures.

4.4.17 In 2012, Bloomberg New Energy Finance analysed the level of competition on the wholesale generation market[34], using the Herfindahl index. The Herfindahl index is the sum of the squares of the percentage of market share held by all companies in the sector. The index ranges from 0 to 1 (with 1 being a complete monopoly), with 0.1 being the upper limit of what is considered to be a competitive market. Bloomberg reported that Herfindahl index dropped from almost 0.2 in 1995 to around 0.08 in 2000 (due to EDF sell-off of Eggborough power station), and is currently at around 0.1.

4.4.18 As the wholesale market is considered to be competitive, we would expect that there would be strong incentives to improve the operational efficiency of the market. However, as discussed in Section 4.3.3, Ofgem reports that competition in the retail market is weak. Therefore, we cannot guarantee that operational efficiency at the retail market is maximised.

4.4.19 The regulator takes a keen interest in the operational efficiencies of the transmission and distribution businesses, through its setting of price (allowable revenue) controls. This tends to happen mainly on a cyclical basis, when price controls are reviewed.

4.4.20 The current price control, the Distribution Price Control Review 5 (DPCR-5) was set for the period 2010-2015 and expires in April 2015. For the DPCR-5, Ofgem set an allowed revenue for each of the 14 monopoly Distribution Network Operators (DNOs), taking into consideration the cost of capital, regulatory asset value, excluded services, taxation and pensions.

4.4.21 After the DPCR-5 expires, Ofgem will implement its so-called RIIO framework, which is a fundamental break from the DPCR regulatory mechanism. RIIO stands for Revenue(=)Incentives(+) Innovation(+)Outputs, and is a new performance based model for setting the network companies' price controls which will last eight years. RIIO involves an extension in obligations on distribution network operators with revenues much more strongly linked to performance including stronger incentives on reliability.

Reliability and Security of Electricity Supply

Reliability

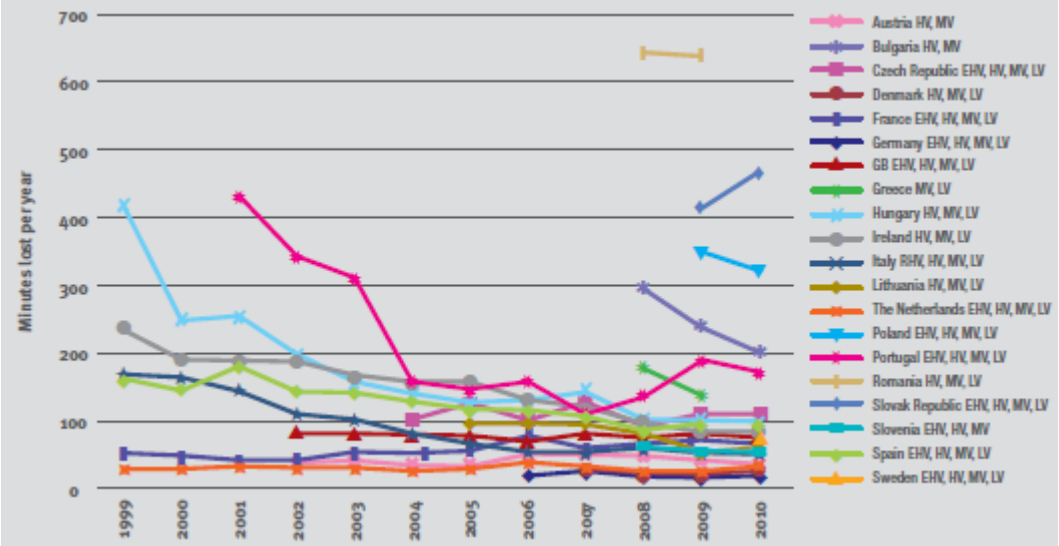
4.4.22 There are various complicated measures which make allowance for extent of underground cables versus overhead, voltage distribution, line length, weather, natural hazards, tree growth, etc.

[34] See http://www.greenpeace.org.uk/sites/files/gpuk/Big-Six-Investment-Trends.pdf accessed 12.12.2014

These measures are also adjusted to take account of the extra demands on distribution network operators in terms of connections to new load and embedded generators and obligations to improve the environmental performance of equipment, such as replacing those using SF6. These measures tend to show an improvement in reliability.

4.4.23 Two measures, which provide a clearer indicator of supply reliability, are the number of Customer Interruptions (CI) and Customer Minutes Lost (CML). These measures are equivalent to SAIFI and SAIDI, covering frequency and duration of outages. Between 2002 and 2010, according to Ofgem CI and CML performance improved by 17% and 25% respectively, largely as a result of a closer monitoring by the regulator coupled with financial incentive, under the Interruptions Incentive Scheme (IIS). The IIS is still running in the current price control. These figures put GB in the middle of the European network utilities – see Figure 4.10. UK is comparable with France and Spain but Austria, Germany, the Netherlands all perform significantly better.

Figure 4.10: Minutes Lost per Year in European Utilities 1999-2010 (GB has red line with triangle)



Source: Power distribution in Europe – facts and figures, Eurelectric, 2013

Security of Supply

4.4.24 There is widespread concern among industrial power users, and many in the power sector itself that supply margins are becoming extremely tight and are anticipating that brown outs, if not black outs, are imminent. However, National Grid is not unduly concerned. It is certainly true that margins are falling and LOLE is rising. In 2014 de-rated plant margin is estimated to be over 4%. While this looks low, it is above the level that ruled during 2003-06. And while for the winter of 2014/2015, LOLE is the highest for 7 years, at 1.6 hours, it is still comfortably within 3 hour target NG/DECC are using for setting capacity requirements in the capacity market. Even so, NG has put in place special transitional measures for Supplementary Balancing Reserve and DSR that

can be called upon in the three years before the first capacity mechanism contracts become effective.

4.4.25 Interconnectors were only considered at float (ie zero contribution to supply or demand) in NG's assessment. However, the view of a number of independent advisors (such as the Panel of Technical Experts [PTE]) is that a more appropriate assumption is that interconnectors would provide a net contribution to security. Under EU pressure, the CM is to be modified so that interconnectors will be allowed to directly participate in the CM. It is thought that this will bring forward a greater contribution from existing interconnectors as well as new interconnectors. The government has also agreed a new regulatory regime for new interconnectors called the "cap and floor" which will guarantee revenues for developers. So far five interconnector projects have been granted such support, with a combined capacity of 6.5 GW. These include two new links to France (IFA2 and FAB link), one to Ireland (Greenlink), and one each to Norway (NSN) and Denmark (Viking link). With these links on this would take GB's interconnection to over 10 GW, about 17% of current peak demand.

4.4.26 While the UK had excess generation capacity before the reform, and significant new capacity has been added at the initial stage of the reform, the reserve level has subsequently dropped and there is now concern over the adequacy of supply in the future. Ofgem forecasts that the capacity margin may drop to around 2% in 2015-16, and the regulator had to introduce various measures to encourage investment in generation capacity[35].

4.4.27 It is clear that the market reforms have not been successful in achieving adequate levels of capacity margin, as evidenced by the implementation of the Capacity Market and the National Grid's transitional arrangements.

4.5 Market Liberalisation Determinants

Wholesale

4.5.1 In the early years of the compulsory pool market, competition in the market was weak because of the concentration of generating capacity in the hands of few (three) generators. Through combination of mergers, acquisitions and sell-offs, the Big Six energy companies own just over half the generating capacity, with the remainder owned by smaller companies and independents. Market power would need to be considered in Hong Kong due to the existence of just two power companies. Unlike the UK prior to privatisation and market reform, the two power companies in Hong Kong are owned by private investors. Regulators would need to consider requirements to break-up or sell-off some of the generating capacity in order to develop a competitive wholesale market.

[35] See Electricity Capacity Assessment Report 2014, Ofgem, p.5

4.5.2 The UK government's efforts to rebalance the wholesale electricity market largely rests on whether budget for the support of programme is politically acceptable, which in turn will depend on the state of economy, the costs of low carbon technology and general public support for the UK's government's green ambitions.

4.5.3 However, the government's decision to underwrite new generation capacity through the CfD and capacity mechanisms effectively means the UK has moved to a state managed market, with government taking decisions on procurement through its auction allocations and budgetary caps. The capacity market itself may end up paying a significant share of station fixed costs, which along with the increased contribution from low variable cost generation, is likely to lead to weakening energy wholesale prices. At the same time wholesale energy prices are expected to become more volatile especially as variable renewables play an increasing role in the market.

Retail

4.5.4 Ofgem reports that there is currently weak competition due to low customer trust and participation, and due to the extent of vertical integration. The Government does not have a real programme; it is waiting on the CMA inquiry. Notwithstanding any surprising recommendations from this inquiry, Government is hoping that a few tactical rule changes will encourage more vigorous competition among suppliers and innovation in service provision, especially in relation to energy efficiency services.

4.5.5 The near term outlook may also be impacted by the General Election scheduled for 7th May 2015 since the main political parties have different focuses. The main differences are that Labour is likely to be more interventionist in terms of setting restraints and even price caps on retail prices. However, it is possible that the CMA may recommend some major changes, such as full unbundling of generation and retail which may lead Labour to revise its plans.

4.5.6 The UK case shows the importance of customer engagement and trust in the retail market for it to deliver the expected. If retail liberalisation is to occur in Hong Kong, efforts must be taken to properly inform consumers of their choice, and the procedures and tariff options should be simple in order to encourage switching.

Security of Supply

4.5.7 Due to the implementation of the CM, GB should not encounter significant and extended risks in terms of security of supply. National Grid points out that significant negative margin risks are likely only when extreme weather events (worse than a 1 in 20 winter, and 1 in 20 low wind) are combined with severe conventional plant outages. In regards to security of supply, an energy only market appears to have been undesirable because of the need for price spikes in an energy only market to incentivise new capacity build. It is unclear whether this would have held true if additional support for renewables, which distorts the market, had not been required to meet carbon reduction and renewable energy targets. If a volatile energy market would be undesirable

in Hong Kong, a capacity payment mechanism, such as a capacity market, could be an appropriate tool to ensure security of supply.

Networks

4.5.8 The outlook for future performance on network reliability is less clear although there is clearly scope for GB distribution companies to improve their performance on CI and CML levels versus the better performing European operators. Much will depend on whether the current incentive arrangements and the new RIIO framework will provide strong enough incentive to overcome the challenges of accommodating substantial amounts of distributed generation. Using performance based regulation may well create a more efficient incentive environment – effort should be made to monitor the progress of RIIO to determine its success and applicability to Hong Kong.

5 United States

5.1 Overview

5.1.1 Around 1900 electricity was provided mainly by vertically integrated utilities, providing generation, transmission, and distribution. However, many businesses (non-utilities) generated their own electricity. Utilities operated in designated exclusive franchise areas, usually municipalities. Since monopolies were subject to the Sherman Antitrust Act of 1890 and subsequent legislation, regulation of the utilities was carried out by State public service commissions.

5.1.2 However, utilities sought to undermine the regulatory regime by forming interstate holding companies to control the state level utilities, necessitating the introduction of controls at the federal level of Government in the form of the Public Utility Holding Company Act of 1935. Under the provisions of this Act, holding companies were regulated by the Securities and Exchange Commission, and utilities which were involved in interstate electricity wholesale marketing or transmission were regulated by the Federal Power Commission. In 1977, the Federal Power Commission was replaced by the Federal Energy Regulatory Commission (FERC).

5.1.3 The USA's national policy is to provide a regulatory framework that encourages competition in wholesale power markets. The electricity industry is now regulated both at the state and federal levels, with FERC the primary regulatory authority.

5.1.4 There are differences between regions in the way the regulatory regimes have evolved, including differences in industry structure, mix of ownership, sources of generation and also in consumption patterns. Some regions have organized spot markets administered by a Regional Transmission Operator (RTO) or an Independent System Operator (ISO), and others rely on bilateral contracting between wholesale sellers and buyers.

5.1.5 In terms of retail supply, some 20 states have regulatory arrangements that allow competition in electricity supply to some if not all retail customers at prices set in the market. Some 30 states continue to provide electricity to retail customers mainly or exclusively under traditional regulated monopoly utility service franchises.

5.1.6 In the following sections we present the experience of California, Texas and PJM. California and Texas represent good examples of how state regulation has led to different market models; while PJM is one of the largest ISO in the world with a large set of market-based instruments to promote competition at wholesale level.

5.2 California

Arrangements Prior to the Reform

5.2.1 In the 1990s, there were three main incumbent investor-owned vertically integrated utilities in California: Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric. Together they had a market share of approximately three quarters of the total electricity sales at

that time. The rest of the market was covered by small municipal companies or other privately-owned small utilities providing local services.

5.2.2 The market is regulated by the California Public Utilities Commission (CPUC), which was established in 1911 to regulate privately owned utilities including electric and gas companies.

The Reform Process

5.2.3 At the beginning of the 1990's, California was in the middle of a major state-wide recession, with high unemployment rates and companies being pushed away to other states due to high electricity prices. In 1995, because of expensive investments in nuclear power and high-priced contracts for power, California consumers paid the highest rates in the western continental United States (the average rate of about 99 USD/MWh)[36]. The state's governor believed that a new market system would lower prices by encouraging competition among existing and new wholesale and retail suppliers and by reducing regulation.[37]

5.2.4 The reforms, introduced in late 1990s, required the utilities to become transmission and distribution companies, divesting themselves of generators, with the divested generators only able to sell power to a state-managed power exchange. The grid would be operated by an Independent System Operator (ISO) viz. California ISO (CAISO) which is a non-profit organization governed by an advisory board of representatives of grid users. The distribution companies retained retail responsibilities but retail competition was part of the reform process as well.

5.2.5 The market continued to be regulated by the CPUC. In relation to energy, CPUC's mission is to promote reliable, safe and environmentally sound energy services at the lowest reasonable rates for California electricity consumers. In particular it has the following roles:

- to regulate transmission rates;
- to enhance the design and operation of California's wholesale market;
- to engage in transmission planning and policy initiatives and proceedings; and
- to ensure the State's electric reliability.

5.2.6 Under the reform arrangements, the supply-side of the market was largely deregulated while the demand side of the market was strongly regulated during the transitional stages of the reforms by the CPUC putting in place controls on retail prices.

5.2.7 The divestment of generating plant was achieved through a mixture of mandatory orders and financial incentives. In 1997, California Assembly Bill 1890 (AB 1890) authorized the CPUC to mandate plant divestment to mitigate market power. CPUC directed two of the three investors-owned utilities, Southern California Edison Company and Pacific Gas and Electric Company, to

[36] Weare, Christopher (2003). The California electricity crisis: causes and policy options

[37] World Bank (2001) - The California Experience with Power Sector Reform Lessons for Developing Countries.

submit voluntary plans to divest at least 50% of their fossil-fuel generating resources for approval by the CPUC. The financial incentive for companies to divest generating plant was that, during a four-year transition period, stranded costs could be recovered from existing customers through a "competition transition charge" with the implied risk that further divestments could be mandated by the CPUC after the four year period without allowing the recovery of stranded costs.

5.2.8 Another feature of the reforms was that the wires businesses had to allow any generator open access to the transmission system under terms, conditions and prices set by the CPUC. CPUC sets these tariffs after periodic cost of service reviews in which the actual costs for providing the service are reviewed by the regulator.

5.2.9 In 2000/2001, there was a sustained period of high and volatile electricity prices at wholesale level that was not reflected on retail tariffs due to tight tariff regulation. As a consequence, a major utility bankrupted (Pacific Gas and Electric) and rolling blackouts resulted. Multiple factors contributed to the system failures, including a drought that reduced the level of hydroelectric power available to serve customers, unexpected outages at nuclear power plants, high natural gas prices, and strong demand for power.

5.2.10 A further factor was California's heavy reliance on short-term markets which made it vulnerable to market manipulation. The high dependence on the spot market arose from the CPUC requiring California's investor owned utilities to divest a substantial portion of their generation assets, whilst not allowing them to enter into long-term power purchase agreements with the new owners[38].

5.2.11 The crisis abated when some factors, such as natural gas prices moved back to their pre-crisis levels, and in addition the State entered into long-term contracts to purchase power to stabilise the market and to make good supplies that Pacific Gas and Electric, amongst others, were in no financial position to procure themselves. These long-term contracts accounted for approximately 30% of total consumption. A decision by CPUC in 2002 allowed the State to be fully reimbursed for its purchase of power by collections from the receipts from the retail customers' bills of the three major California electric utilities (the previous incumbents).

5.2.12 As a consequence of the crisis, further reforms in the Californian power market where put on hold. Transitional arrangements were made, with the Department of Water Resources (DWR) signing several Power Purchase Agreements (PPAs) to procure electricity for the utilities. In 2003, the utilities resumed some procurement of power for their customers and the DWR has reduced the cost of the long-term contracts through renegotiation. The portfolio of long-term contracts peaked in 2004 at 12.8 GW, falling to 10GW in 2007 and then falling significantly after 2010 with less than 300MW in the 2012-2015 period.

5.2.13 Further to this, market developments in California over the past years were aimed to improve the deployment of renewable energy sources, which is an indirect way of introducing competition at wholesale and retail levels without changing the current market structure. Renewable energy,

[38] See: http://www.eia.gov/electricity/policies/restructuring/california.html

being generally more expensive and more capital intensive than conventional (gas and coal) generation, requires intervention in the market. However, the introduction of renewables can reduce the market share of incumbents and provide pathways for new entrants. In this way, renewables policy can indirectly encourage competition. Additionally, some policies encourage uptake of small scale renewables for self-consumption; this – though marginally – indirectly introduces competition at the retail and wholesale level.

5.2.14 Changes in the wholesale market due to renewables can be attributed to the introduction of Renewable Portfolio Standards (RPS). The RPS imposes a binding cap of 33% Renewable Electricity Standard and applies to all electricity retailers in the state including publicly owned utilities, investor-owned utilities, electricity service providers, and community choice aggregators. All of these entities must adopt the new RPS goals of

- 20% of retails sales from renewables (excluding large hydropower) by the end of 2013,
- 25% by the end of 2016, and
- 33% requirement being met by the end of 2020.

5.2.15 Based on this promotion mechanism, renewable energy generators obtain revenues from two different sources: firstly, for the electricity sales in the wholesale market; and secondly, for the sales of renewable energy certificates to electricity retailers. This mechanism promotes the entrance of new participants in the wholesale market, enhancing competition.

5.2.16 In parallel, at retail level, the CPUC's California Solar Initiative moved the consumer renewable energy rebate program for existing homes from the Energy Commission to the utility companies under the direction of the CPUC. This incentive program provides cash back for solar energy systems of less than one megawatt to existing and new commercial, industrial, government, non-profit, and agricultural properties. Also, the Energy Commission's New Solar Homes Partnership offers incentives to encourage solar installations, with high levels of energy efficiency, in the residential new construction market for investor-owned electric utility service areas. This mechanism, to a limited extent, introduces indirect competition at retail level as end users are offered the alternative to switch – at least partially – electricity provider (from the utility to own generation) if the investment in self-generation provides a levelised cost of electricity below the retail price charged by the utility.

ISO Energy Imbalance Market

5.2.17 Some restructuring process has also occurred at ISO level, with CAISO launching an Energy Imbalance Market (EIM) together with PacifiCorp[39] in October 2014. The objective of the EIM is to increase visibility of interconnected systems to more accurately balance resources, by allowing interconnected balancing authorities to participate in the CAISO real-time market.

[39] PacifiCorp is an electricity utility in the west USA, with 1.8 million customers and 10.5 GW of conventional and renewable generation capacity.

5.2.18 The EIM is expected to bring down costs by allowing non-ISO transmission owners to benefit from calling on lower priced and a wider array of electricity resources to meet demand. It will also achieve efficiencies by leveraging geographical diversity to fine-tune electricity flows during times of under- or over-generation of energy.

5.2.19 The model does not include the obligation of market participants to become a transmission member in the ISO; EIM partners use the ISO real-time energy service as they need. Participants pay a usage fee as they go, but considering the CAISO is a non-profit organization, fees are calculated to cover the additional costs of providing the service and, thus, expected to be low.

5.2.20 Since the EIM has been launched in October 2014, the market will initially operate between CAISO and PacifiCorp but it will start accepting further market participants in 2015.

Long Term Capacity Market

5.2.21 California has a clear objective to promote substantial penetration of renewable energy in the system (33% target for 2020) and the CAISO understands that achieving this target will require the development of new firm generation capacity to ensure grid integration of renewable energy sources is smoothly implemented.

5.2.22 While the CAISO Department of Market Monitoring in its latest annual report did not indicate any material negative impact to prices as a result of new renewables coming onto the grid. They noted that new wind and solar power increases the need for complementary flexible and fast-ramping resources dispatchable by the ISO to integrate intermittent energy efficiently and reliably. Based on this, the report champions the idea of developing a longer-term procurement process and a well-designed centralized capacity market to foster flexible capacity[40].

Market Development

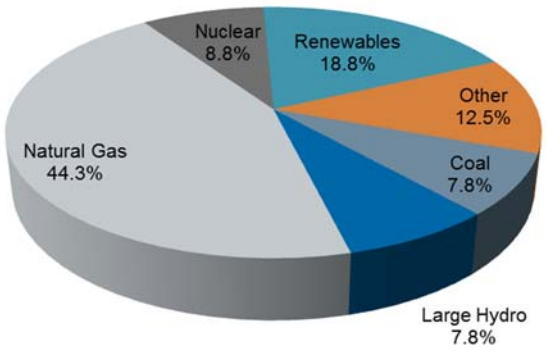
Wholesale Market

5.2.23 In 2013, about 70% of the electricity consumed in California is generated from within the state, with the other 30% coming from generators in the Pacific Northwest and Southwestern U.S.

5.2.24 Of the total electricity supplied to California, the majority (44.3%) is generated by natural gas power plants, followed by renewables (18.8%), nuclear (8.8%), coal and large hydro (7.8% each); the 12.5% remaining corresponds to electricity sources which cannot be confirmed (see Figure 5.1).

[40] CAISO (2013) – Annual state of the grid

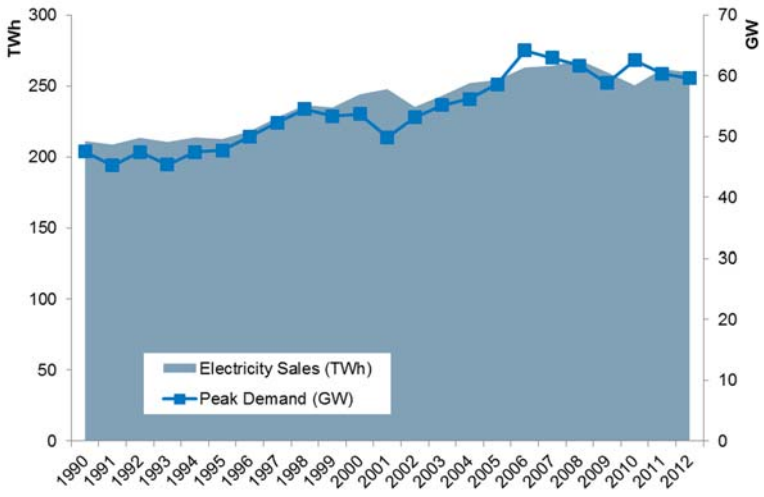
Figure 5.1: Generation Mix in California Power Market (% of electricity generation) (2013)



Source: Mott MacDonald based on California Energy Almanac

5.2.25 Electricity and peak demand in the state shows signs of saturation, as growth rates over the last decade are in the range of 1% (CAGR[41]) on both electricity and peak demand (see Figure 5.2). Also, energy efficiency plans and demand response programs promoted by CPUC and other stakeholders have played a significant role in maintaining this trend in demand. This was particularly relevant in 2012 with the closure of San Onofre nuclear power plant, demand response programmes introduced during summer that year (combined with mild temperatures) allowed to maintain peak demand substantially below the all-time peak demand of summer 2006 (64.1 GW).

Figure 5.2: Peak Demand and Electricity Sales in California



Source: Mott MacDonald based on California Energy Almanac and EIA data

[41] Compound Annual Growth Rate

Retail Market

5.2.26 On the retail services, California is served by about 75 load-serving entities (LSEs). These are broken down as:

- Investor-Owned Utilities - 6
- Publicly Owned Utilities - 48
- Rural Electricity Cooperatives - 4
- Native American Utilities - 3
- Other Electricity Service Providers - 14

5.2.27 Nonetheless, a large majority of consumers in the state are served by one of the three largest investor owned utilities – Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). These "big three" procure electricity from a combination of their own generating assets and the wholesale market and then sell electricity to residential, commercial, and industrial consumers at retail rates that are regulated by CPUC. The rest of the state is served by smaller, municipally owned utilities that are not subject to regulation by the CPUC due to their public nature.

5.2.28 In the retail market, prices are determined by a cost of service regulation model under which a utility earns an amount of revenue equal to the cost of providing electricity plus a negotiated "fair" rate of return on its investments and capital assets. Both the costs and the rate of return are determined through a rate case process involving the CPUC, which takes place approximately every three years. Cost of service regulation establishes a direct link between the costs incurred by a utility and the rates that consumers pay.

Outcomes of the Electricity Market

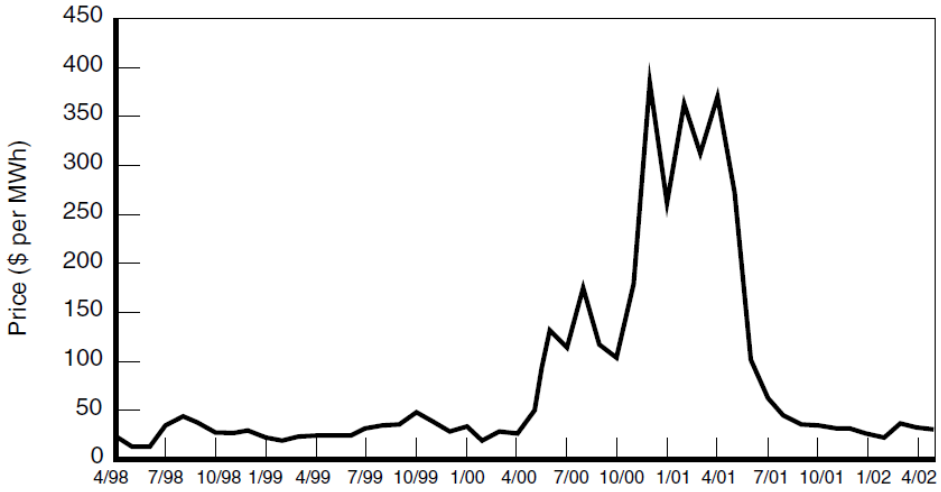
5.2.29 The main objective of the reform process was to lower prices by encouraging competition among existing and new wholesale and retail suppliers and by reducing regulation.

5.2.30 In addition, CPUC mission is to provide reliable, safe and environmentally sound energy services at the lowest reasonable rates for California's electricity consumers. Following CPUC mission, it can be inferred that the development of competitive market should be the way of providing "the lowest reasonable rates" for the consumers. Nonetheless, the effects of the California crisis in early 2000 left a bitter taste on CPUC quest for liberalisation.

Electricity Prices

5.2.31 Considering that wholesale prices were at the level of 50 USD/MWh during the first years of the pool market in California (established in 1996 when the Electric Utility Industry Restructuring Act (Assembly Bill 1890) became law), excluding the crisis period – between mid-2000 to mid-2001 – the effects of the reform had virtually no impact in lowering electricity price (see Figure 5.3 and Figure 5.5).

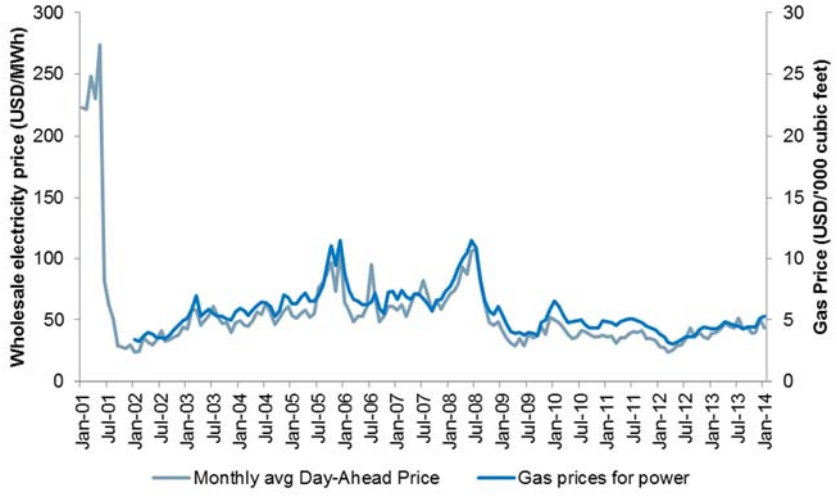
Figure 5.3: Average Wholesale Electricity Prices in California (1998–2002)



Source: Weare, Christopher (2003). The California electricity crisis: causes and policy options

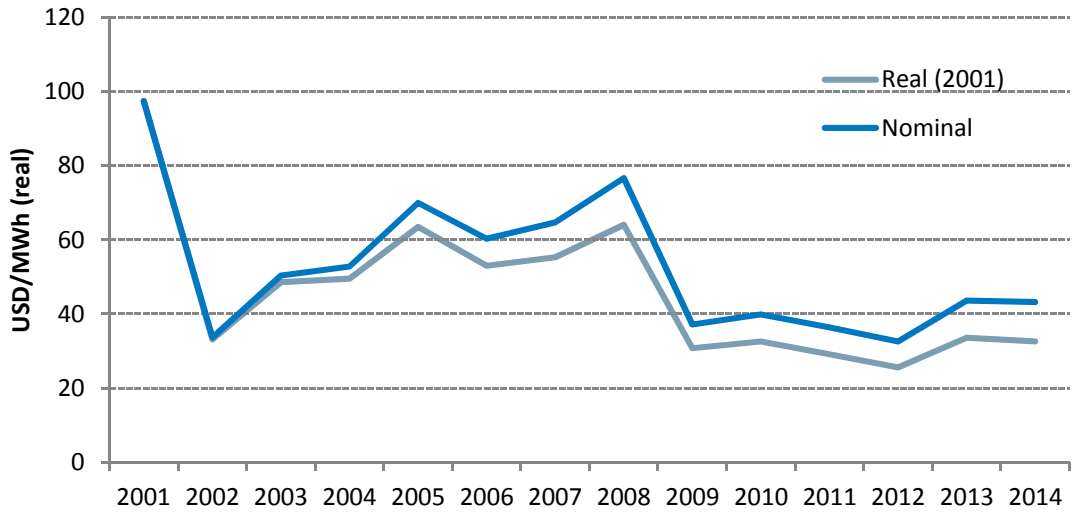
5.2.32 In the wholesale market, prices are largely linked to natural gas as this technology is usually the marginal one (see Figure 5.4). Developments in shale gas and other unconventional technologies (combined with low growth in demand) over the past years have maintained domestic gas prices in California at 2001 levels, and this has contributed to wholesale electricity prices in the range of 30 - 50 USD/MWh since 2009 (as observed before the crisis), even in real terms (see Figure 5.5, USA GDP deflators were used to calculate real values, source: California Energy Almanac).

Figure 5.4: Average Wholesale Electricity and Gas Prices in California (2001 - 2014)



Source: Mott MacDonald based on EIA information

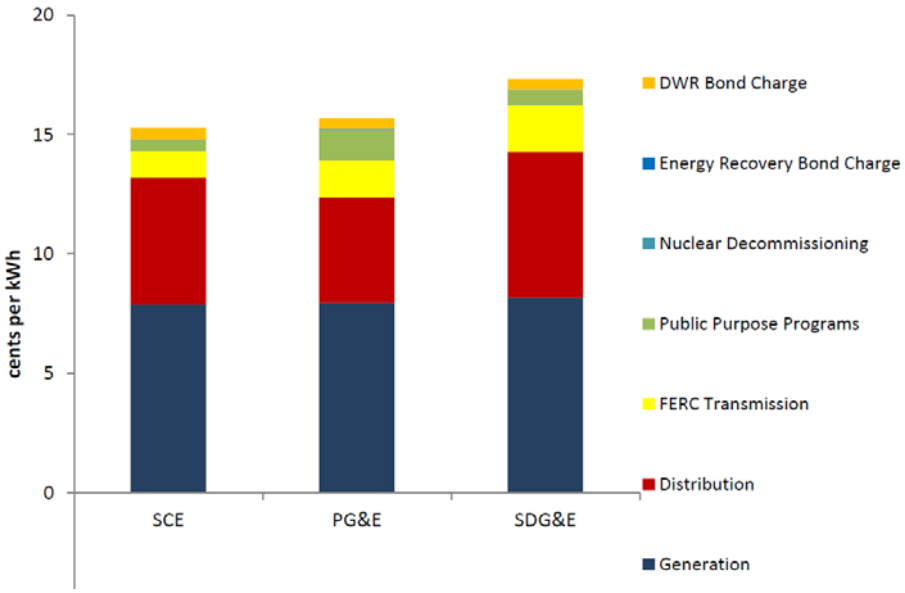
Figure 5.5: Average Annual Wholesale Generation Prices (real and nominal)



Source: Mott MacDonald based on EIA information

5.2.33 Generation costs generally account for approximately 50% of the electricity rate (see Figure 5.6). However, in the case of California, generation costs are a mix of utility owned generation (regulated as cost centres) and power purchased at the wholesale market. Electricity and fuel purchases in the wholesale market are reviewed by the CPUC, to the extent deemed reasonable, and passed through the revenue requirements without any profit or mark-up for the utility.

Figure 5.6: 2013 Rate Components

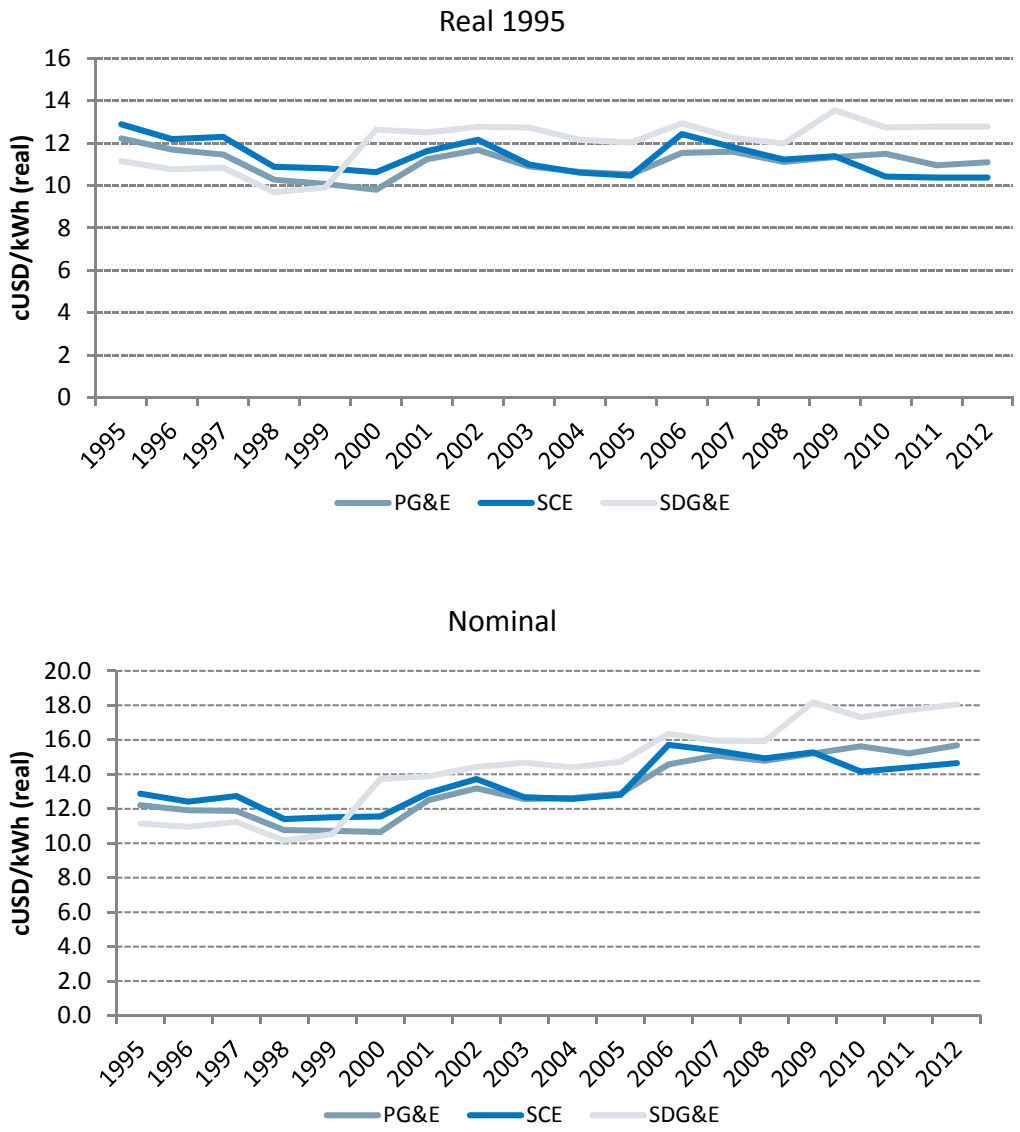


Source: CPUC (2014) – Electric and gas utility cost report

5.2.34 Further to the generation costs, transmission and distribution cost is the second largest component of the electricity tariff with a share in the range of 40% to 45%. The rest of the components correspond to different programs and the repayment of the bond created to finance utilities during the 2001 crises (DWR bond).

5.2.35 In real terms (netting off the effects of inflation) residential electricity tariffs in California have almost remained unchanged since 1995 (see Figure 5.7 – real 1995 prices calculated using USA GDP deflator, source: California Energy Almanac).

Figure 5.7: Residential Electricity Tariffs in California (in real and nominal cUSD/kWh)

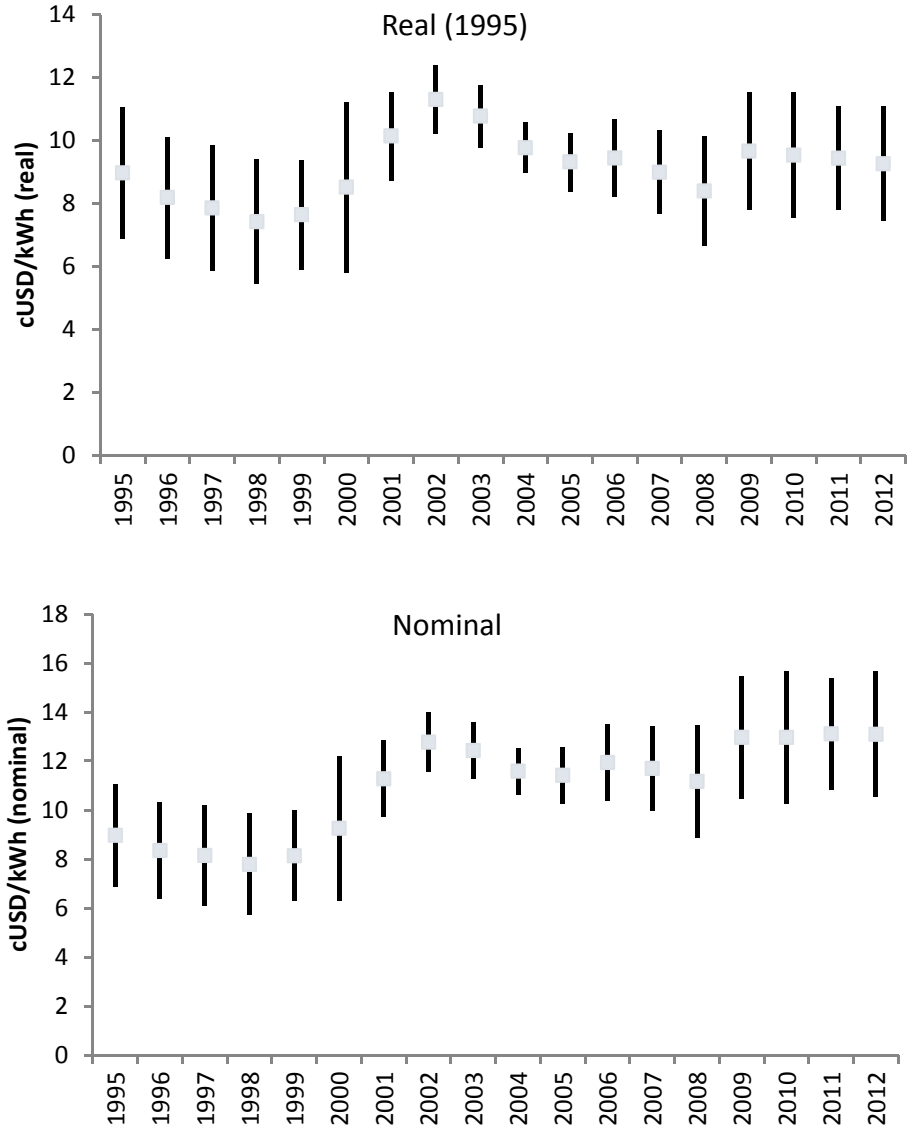


Source: Mott MacDonald based on California Energy Almanac data

5.2.36 A similar trend could be observed in the case of non-residential electricity tariffs (see Figure 5.8 – 1995 real prices calculated using USA GDP deflator, source: California Energy Almanac). This was of particular importance on late 1999 to early 2001 (California energy crisis), as the retail tariffs were not able to pass-through the generation prices paid in the wholesale market causing the bankruptcy of PG&E in April 2001 and leaving the other utilities in serious financial problems. As the figure shows, the effects of the crisis where reflected in the tariffs with one year lag (price

peak for non-residential tariffs registered in 2002) as the CPUC allowed utilities to transfer to the end customers the financial costs of the rescue program developed as part of the crisis.

Figure 5.8: Non-residential Electricity Tariffs (Average and max-min range) (in real and nominal cUSD/kWh)



Source: Mott MacDonald based on California Energy Almanac data

5.2.37 All in all, at retail level, the objectives of the reform were not met and retail consumers have not yet observed a general decrease in prices. This is because consumers are still paying some of the consequences of the California crisis.

Enhancement in Operational Efficiency

5.2.38 For the generation participating in the wholesale electricity market, according to the information reviewed from CPUC and CAISO[42], the ISO markets continued to perform efficiently in 2012, with wholesale energy prices over the year coming in about equal to the prices that the ISO Department of Market Monitoring estimates would result under highly competitive conditions. About 97% of the system load was scheduled in the day-ahead energy market, which contributed to the competitive market outcomes. This result shows that despite the initial mistakes in the design of the market model, the wholesale market has been able to present competitive behaviour, in line with CPUC mission for the power sector.

5.2.39 Further to this, the EIM is the most recent tool introduced in California to enhance the operational efficiency of the transmission system. The EIM will optimize available energy supplies by providing frequent and automatic dispatching, taking into account resources across the entire region.

5.2.40 Integral to advancing clean and efficient power supplies is sharing a broader array of resources within the West to take advantage of geographic differences that produce new efficiencies. The expected benefits of EIM include:

- Enhancing situational awareness;
- Identifying and dispatching resources faster after a grid event; and
- Assisting with renewables integration.

5.2.41 Based on this, we understand that the effects of the reform process had a limited impact in the enhancement of operational efficiency as about one third of total generation (i.e. utility owned generation)[43] is not benchmarked in the market but follows a regulatory review process.

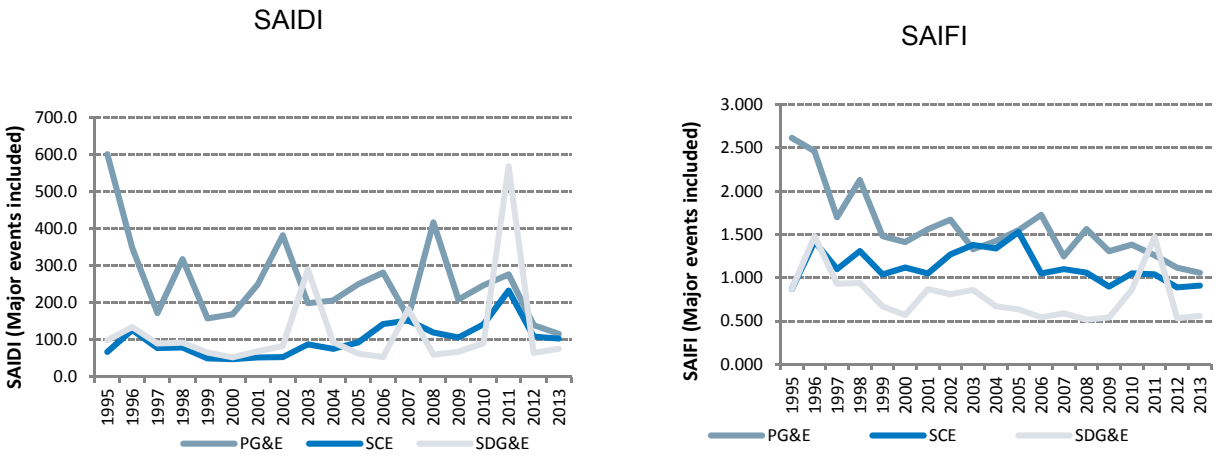
Reliability of Electricity Supply

5.2.42 The reliability of the grid in California is usually hindered by natural events like earthquakes, bush fires and flooding that affects different parts of the State across the year.

[42] See Memo on Market Monitoring Report from Eric Hildebrandt, Director, Department of Market Monitoring (11/12/2013) available: http://www.caiso.com/Documents/DepartmentMarketMonitoringReport-Memo-Dec2013.pdf accessed 21/01/2015

[43] See CPUC "Electric and Gas Utility Cost Report" (April 2014) available at http://www.cpuc.ca.gov/NR/rdonlyres/E1804568-DF65-48A4-A00B-EB6D9AF63E4D/0/AB67CostReport2014.pdf - accessed 21/01/2015

Figure 5.9: Historical Evolution of SAIDI and SAIFI in Key Utilities in California



Source: Mott MacDonald based on Annual Electric Reliability Reports (2013)

5.2.43 Figure 5.9 presents the evolution of SAIDI and SAIFI values[44] for the three largest utilities in California. In SAIFI terms, the average number of outages per customer has been decreasing for PG&E and SCE over the last twenty years; even though, they are still far from the reliability level provided by SDG&E. On SAIDI terms, however, the three utilities present more consistent reliability levels in the range of 100 to 200 minutes of outages per year.

5.2.44 In terms of the impact of the reform process, we have no evidence to consider that the liberalisation process produced a structural break on reliability of electricity supply to customers. Note that while the 2000/2001 crisis was primarily financial; the electricity system did experience rolling blackouts due to tight supply, strong demand, market manipulation, etc.

Increase in Customer Choices

5.2.45 In 1996, as part of the reform process, the CPUC introduced the possibility of retail competition. However, the possibility of developing competition was seriously hindered by the existence of highly regulated tariffs which provided little incentives to consumers to switch operator. After 8 months of being implemented only 1.1% customers switched consumers and retailers abandoned the idea of competing in the market.

5.2.46 Currently, there are no choices for the consumer to change supplier in California and we were not able to identify in the information analysed any proposal that would support the introduction of competition at retail level.

[44] Values include outages from Transmission, Distribution and Generation, with major events included

5.2.47 The only initiative that could introduce, to a limited extent, further consumer choices at retail level are the CPUC's California Solar Initiative and the Energy Commission's New Solar Homes Partnership described in Section 5.1.16.

5.2.48 Therefore, in terms of the objectives of the reform process, the liberalisation process failed to introduce choices for customers to select their electricity providers.

Market Liberalisation Determinants

5.2.49 California has been operating a hybrid combination of regulated / non-regulated market for 16 years; while the wholesale electricity market behaves competitively, the retail market continue to be fully regulated under direct control of CPUC and we have found no indications at the time of preparing this report that the Government has plans to introduce further competition at retail level.

5.2.50 Based on this, the preliminary condition required to foster competition at retail level would be to reach a political consensus in California that promoting retail competition would be beneficial for the society. Nonetheless, we were not able to find any indication that California has the political will (or that it is being currently analysed) to foster further liberalisation measures than the ones already implemented.

5.2.51 On the other hand, over the last decade, political and regulatory trends in California have aimed towards climate change and emission reductions as sustainability issues have taken preference over liberalisation as the paradigm to solve in the power sector and this is where the regulatory attention is being directed. Nonetheless, as an indirect effect of such policies, the development of renewable energy and demand response have contributed to increase competition at wholesale level and, also very marginally at retail level (with net metering and other programmes).

5.3 PJM[45]

The Reform Process

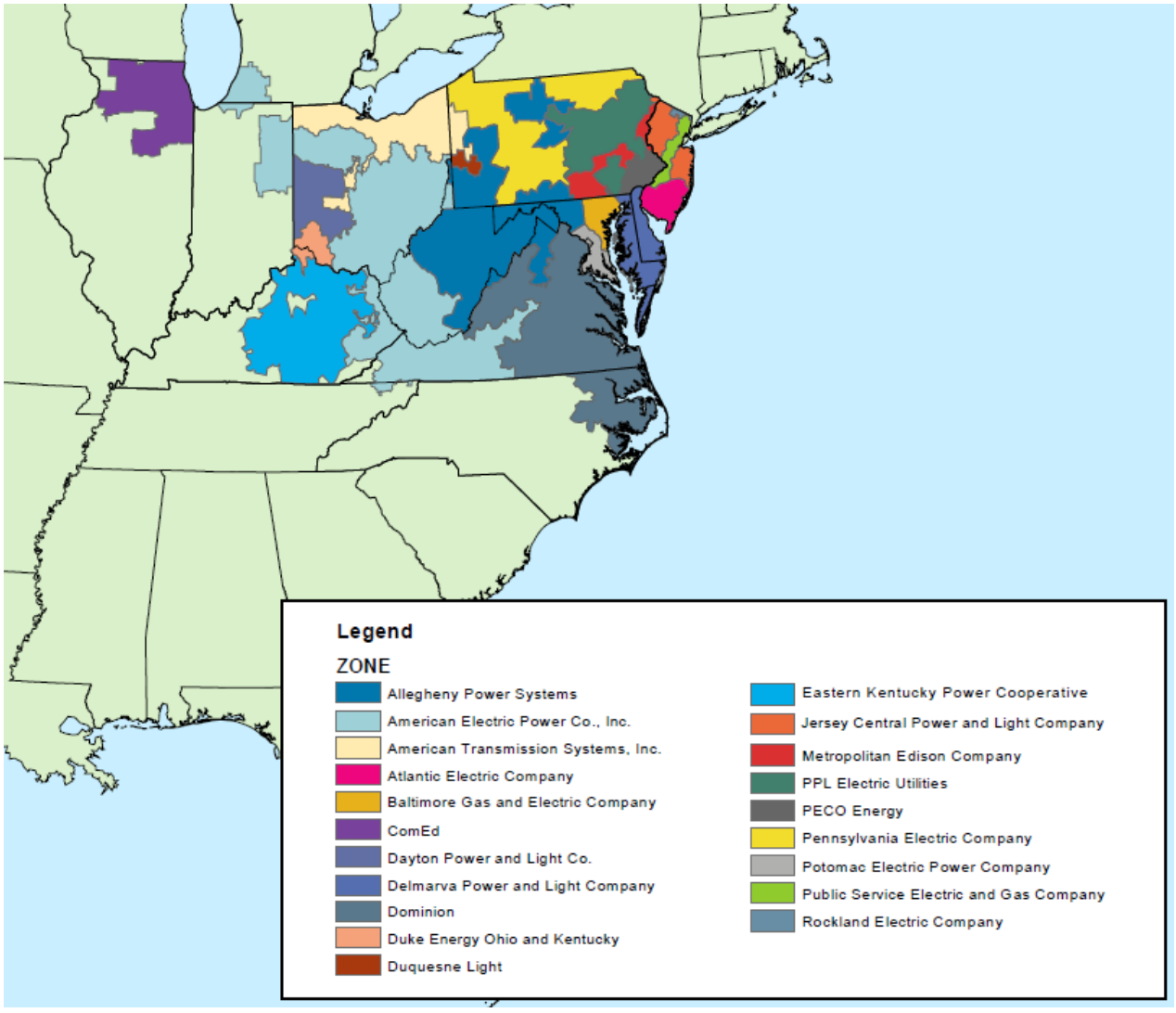
5.3.1 PJM Interconnection, founded in 1927, administers competitive wholesale markets across 13 states and the District of Columbia. PJM is the Regional Transmission Operator (RTO) and is regulated by the Federal Energy Regulatory Commission (FERC). FERC (Order 2000) established goals and principles for RTO market design. Among these goals are:

- eliminating discriminatory access to competitively priced electricity,
- encouraging new suppliers' entry into the market,
- promoting efficient and reliable operations, and
- fostering economically efficient investment in generation and transmission facilities.

45 The analysis of PJM did not include the retail sector because this is regulated at state level in each of the 14 the jurisdictions in which PJM provides transmission services.

FERC gives RTOs considerable discretion in how they design their markets to satisfy these goals, consistent with region specific needs. PJM serves a number of transmission zones in the Eastern USA (see Figure 5.10).

Figure 5.10: Transmission Zones Served by PJM



Source: PJM

5.3.2 To ensure adequate transmission capacity, PJM develops transmission plans in collaboration with the Transmission Owners and other stakeholders. The coordinated outcome is published in an annual Regional Transmission Expansion Plan (RTEP) and PJM designates one or more of the Transmission Owner(s), as appropriate, to construct, own and finance projects in the Plan.

Transmission tariffs are set by PJM and these have to be approved by FERC, but regulatory approval for project financing is at the Transmission Owner level.

5.3.3 PJM introduced an energy spot market in 1998 and daily and monthly capacity markets on in 1999. It implemented a day-ahead energy market[46] in 2000 and a revised capacity market[47] in 2007. There are also a synchronized reserve market and a day-ahead scheduling reserve market. The 2007 capacity market is based on PJM's Reliability Pricing Model (RPM) which provides long-term price signals, consistent with the PJM's Regional Transmission Expansion Planning process, for supply-side capacity resources and demand-side capacity obligations.

5.3.4 PJM coordinates the buying, selling and delivery of wholesale electricity through day-ahead and real-time markets. The day-ahead market is a forward market which uses locational marginal pricing to reflect the value of the energy at the specific location and time it is to be delivered. Prices are calculated each hour for the next operating day based on generation offers, demand bids and scheduled bilateral transactions. The real-time market is a spot market in which current locational marginal prices are calculated at five-minute intervals based on actual grid operating conditions.

5.3.5 PJM is a limited liability company without stock holders. It is managed by a Board which is constituted as an independent body. The Board is advised by member committees on which each member/customer has a representative, but PJM operates independently from its members. There are over 550 members and five member categories: transmission owners, generators, distributors, marketers and large consumers. Members fund PJM on a prorated basis to their MWh throughput/traded.

5.3.6 A Market Monitoring Unit (MMU) was established in 1999 (accountable to FERC and PJM Board) with the following goals:

- to develop/modify market rules to facilitate competition;
- to limit returns to market power;
- to provide incentives to competitive behaviour; and
- to make the exercise of market power more difficult.

5.3.7 PJM's goal is to provide competitive power markets which would lead to achieving the highest efficiency in the power sector. According to the information we have reviewed from the 2013 Monitoring Results for PJM Markets (see Table 5.2), PJM markets are currently meeting that goal on reasonable basis.

5.3.8 PJM, as a very mature market, has a wide range of instruments (i.e. the spot market, day-ahead market, capacity market and reserves market, as described above) to provide competitive

[46] Day-ahead markets allow participants to trade energy and revise their position the day before operation. Introducing a day-ahead market gives participants opportunities to trade based on more relevant demand and availability information, allowing for more efficient market outcomes.

[47] Capacity markets provide payment to firm capacity, and is used as a mechanism to ensure supply security.

incentives to market participants; in this sense, there are no (to our knowledge) current plans to introduce further markets or instruments to further promote competition in PJM. Nonetheless, the dynamic nature of power markets and specifically in the PJM area – where the size of the market is enlarging – require constant fine-tuning of the markets in order to ensure they continue to provide competitive outcomes in the future.

5.3.9 There are still areas in different parts of PJM where more transparency is required in order to permit markets to function effectively. This is specifically important on energy uplift charges[48] where information sources are notably opaque.

5.3.10 Table 5.1 summarises key areas in which the latest monitoring report for the market status requests PJM to introduce changes in.

Table 5.1: Areas of Regulatory Improvement

Area	Issues in need of Regulatory improvement
Energy Market	Roles of PJM and the transmission owners in the decision making process to control for local contingencies need to be clarified and transparent.
Capacity Market	Improvements in the definition of Capacity Resource and Demand Response would help to clarify and provide proper incentives for market participation Demand Response should be obliged to provide capacity year round and not on exceptional time (i.e. summer) as currently happens.
Demand Response	The characteristic of Demand Response units should be modified in order to incentivize them to provide further flexibility of demand side. Demand Response should face the same offer cap ($ 1000) as energy offers. Also, they should provide nodal location on grid.
Ancillary Services Market	Regulation market should consistently apply marginal benefit factor throughout optimization, assignment, and settlement.
Financial Transmission Rights Market	Market design is prone to provide cross subsidies across Financial Transmission Right (FTR) marketplace participants (including geographic cross subsidies).

Source: Mott MacDonald based on Monitoring Analytics - State of the Market Report for PJM (2013)

Wholesale Market Development

5.3.11 PJM operates a centrally dispatched, competitive wholesale electric power market that in 2014 has an installed generating capacity of 183 GW, 879 members which provide electricity to more than 61 million customers in Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

[48] Energy uplift charges are paid by PJM to market participants providing operating reserves (ancillary services) in order to ensure the reserves are not provided at a loss to the provider. See http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2014/2014q2-som-pjm-sec4.pdf for more information, accessed 21/01/2015

5.3.12 PJM coordinates and directs the operation of the transmission grid and plans transmission expansion improvements to maintain grid reliability in this region. To achieve these tasks, PJM operates:

- Energy Market (day ahead and real time) as Locational Marginal Pricing (LMP);
- Reliability Pricing Model (RPM) Capacity Market;
- Regulation Market;
- Synchronized Reserve Markets;
- Day – Ahead Scheduling Reserve (DASR) Market; and
- Long Term, Annual and Monthly Balance of Planning Period Auction Markets in Financial Transmission Rights (FTRs).

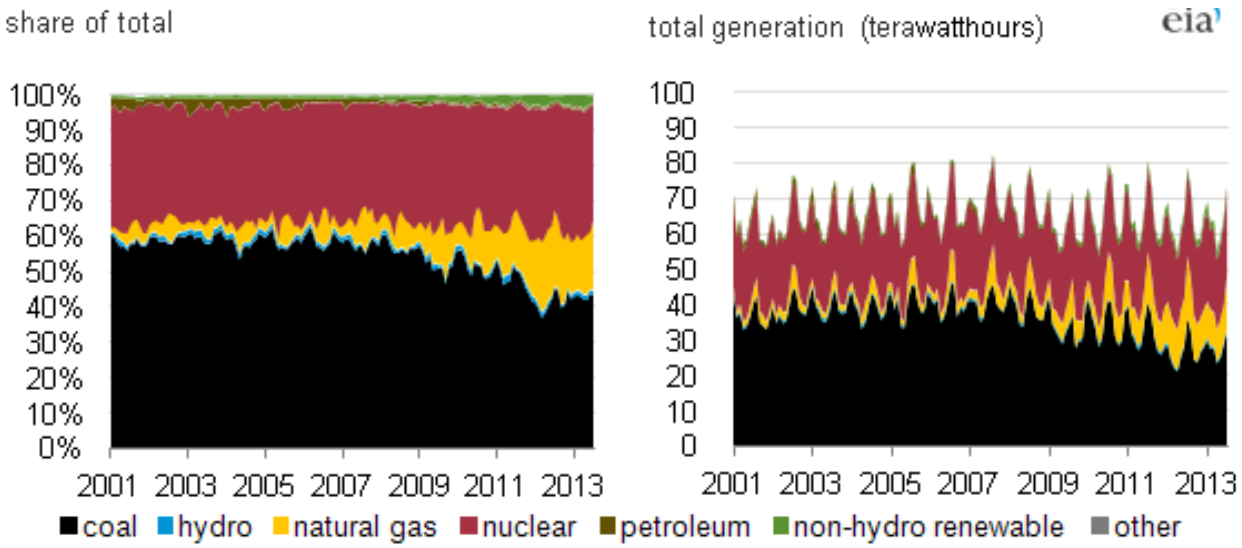
5.3.13 All these markets were introduced by PJM on or before 2008. Since then, relevant changes in the PJM have been:

- Integration of the American Transmission Systems, Inc. (ATSI) Control Zone (2011).
- Integration of the Duke Energy Ohio/Kentucky (DEOK) Control Zone (2012).
- Integration of the Eastern Kentucky Power Cooperative (EKPC) (2013).

PJM Supply Side

5.3.14 In the PJM region, the decline in natural gas prices led to an increase in the use of natural gas for power generation, but coal and nuclear remain as the main sources of electricity.

Figure 5.11: Fuel Shares of Total Electricity Generation in PJM Area (Mid-Atlantic)

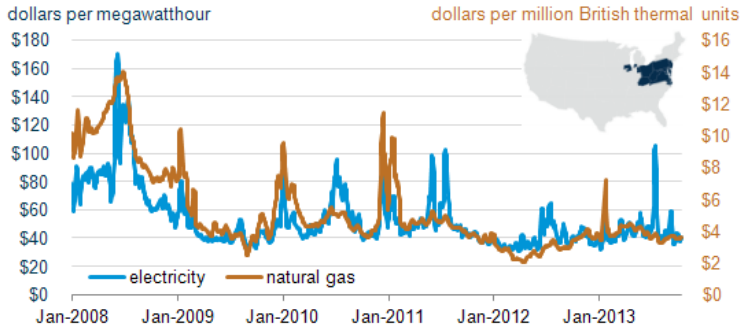


Source: EIA Electricity Monthly Update

5.3.15 Although natural gas-fired units do not make up a majority of the generation units in this region, these units often set the wholesale electricity price. Natural gas generation is usually the marginal

technology, so the wholesale power price in the PJM system generally moves with the natural gas price on any given day (see Figure 5.12).

Figure 5.12: Spot Electricity and Natural Gas Prices in PJM Area (Mid-Atlantic)[49]

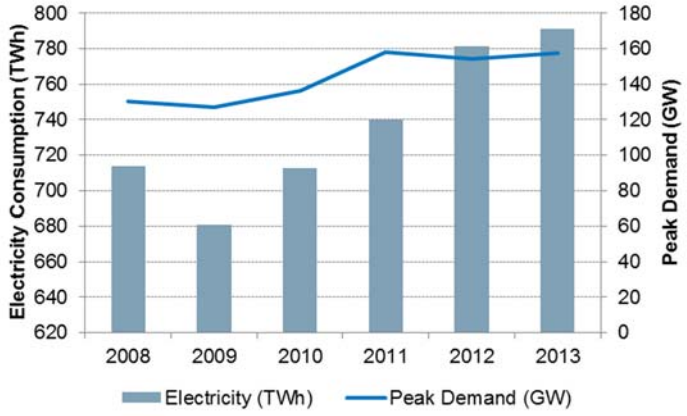


Source: U.S. Energy Information Administration based on SNL Energy

PJM Demand Side

5.3.16 Currently, electricity consumption in PJM accounts for approx. 790 TWh (2013), following a positive growth trend as presented in the figure below.

Figure 5.13: Evolution of Electricity Demand in PJM



Source: Mott MacDonald based on PJM data

5.3.17 Analysing the demand side in PJM is not as straightforward as it appears because we need to take into account the fact that PJM is a dynamic market which has been enlarging (bringing new

[49] Note: Data are the rolling seven-day average. The electricity price is PJM West, and the natural gas price is the TETCO M-3 zone.

market participants) over the past years. According to a recent PJM study[50], excluding the impact of new transmission systems joining PJM, total peak demand remains practically unchanged; this could be explained by the fact that energy efficiency and demand response measures outweigh the positive effects of GDP growth and low electricity prices in the region over the last years.

Outcomes of the Electricity Market

5.3.18 Every quarter and year end, Monitoring Analytics LLC performs an independent analysis of the state of the PJM markets assessing their competitiveness, including market structure, market performance and participant behaviour. More specifically, the assessment covers the following topics:

- Market structure:
  - Characteristics: Assesses the ownership structure of the market. Uses a three pivotal supplier (TPS) test to measure of market structure. The TPS measures market participants by combining the ownership of assets, the relationship between ownership among multiple entities and the market demand and it does so using actual market conditions reflecting both temporal and geographic granularity. Market shares and the related Herfindahl-Hirschman Index (HHI) are also used for measuring the market structure.
  - Output provided: competitive or not competitive.
- Participant behaviour:
  - Characteristics: refers to the actions of individual market participants
  - Output provided: competitive, mixed or not competitive.
- Market performance:
  - Characteristics: refers to the outcome of the market. Market performance reflects the behaviour of market participants within a market structure, mediated by market design.
  - Output provided: competitive or not competitive.
- Market design:
  - Characteristic: assesses the rules under which the entire relevant market operates, including the software that implements the market rules. Market rules include the definition of the product, the definition of marginal cost, rules governing offer behaviour, market power mitigation rules, and the definition of demand.
  - Output provided: effective, mixed or flawed.

5.3.19 Table 5.2 provides the results of the monitoring assessment for 2013, as it can be seen, the overall result is that PJM markets presented competitive behaviour over the past year. Nonetheless, the monitoring authority was able to determine key areas in which need enhancement in order to improve the competitiveness of this market.

[50] http://www.eia.gov/conference/2014/pdf/presentations/sotkiewicz.pdf

Table 5.2: 2013 Monitoring Results for PJM Markets

Market	Overall Market Result	Market Structure (Aggregated market)	Market Structure (Local market)	Participant behaviour	Market Performance	Market design
Energy market	Competitive	Competitive	Not Competitive	Competitive	Competitive	Effective
Capacity market	Competitive	Not Competitive	Not Competitive	Competitive	Competitive	Mixed
Regulation market	Competitive	Competitive	N/A	Competitive	Competitive	Flawed
Synchronised reserve	Competitive	Not Competitive	N/A	Competitive	Competitive	Mixed
Day-ahead scheduling reserve market	Competitive	Competitive	N/A	Mixed	Competitive	Mixed
FTR auction market	Competitive	Competitive	N/A	Competitive	Competitive	Mixed

Source: Mott MacDonald based on Monitoring Analytics - State of the Market Report for PJM (2013)

5.3.20 Further to the pure monitoring analysis, Monitoring Analytics is bounded to provide recommendations on how to overcome the issues that prevents markets to behave truly competitive. A summary highlighting the areas of the market which need improving is presented in Table 5.1.

Market Liberalisation Determinants

5.3.21 PJM has a high liberalisation level in the wholesale power sector. The introduction of several markets allowed PJM to foster competitive market outcomes across the different stages in power sector operation and dispatch (day-ahead, real time balancing, ancillary services, and capacity payments).

5.3.22 Nonetheless, due to the intrinsic characteristic of power, electricity markets require constant regulatory polishing in order to ensure participants receive proper incentives to offer cost effective services. In this sense, even though PJM has reached its intended results, small regulatory improvements across the different markets can help improving market outcomes, achieving greater cost effective services to its consumers.

5.3.23 Implementing those changes in market regulation requires work and coordination among PJM Board, stakeholders and the FERC. PJM, operating on an independent basis, has been able to introduce small changes in market rules and regulation in order to enhance competitive results.

5.3.24 The conditions that allow PJM to operate in competitive basis are:

- The existence of FERC as regulatory body;

- The existence of PJM acting as Independent System Operator (operate the assets but do not exercise ownership on them);
- Unbundled market participants;
- Low regional congestion problems (even though local congestion problem exists and may create room to incentivise market power exercised by some market participants);
- Continuous monitoring process, tests and procedures that allows mitigating the exercise of market power by stakeholders; and
- The availability of proper amount of information to ensure market transparency

5.3.25 So far, Hong Kong has the Environment Bureau with regulatory and monitoring power on the two electricity supply companies operating in Hong Kong under the Scheme of Control Agreements. All the rest of the conditions appear not to be currently available; those of particular importance are:

- The inexistence of third party access to the grid (including all secondary regulation);
- The fact that only two market participants exists today (which would require forcing the unbundling of these companies to promote competition);
- Interconnection capacity between Hong Kong and Mainland China (if this is required to boost competition at wholesale level); and
- The issue of enough interconnection capacity between the two existing systems as one of the preconditions for market development, in order to ensure price signals are not distorted by congestion issues.

5.3.26 Additionally, increased interconnection (as seen in the interconnected PJM system) with the Mainland China market may increase the development potential for the Hong Kong electricity market through possible participation in a larger regional market.

5.4 Texas

Arrangements Prior to the Reform

5.4.1 Prior to reforms which came in to force at the retail level in 2002, the electric industry in Texas consisted of a mixture of investor-owned utilities, generation and transmission cooperatives, distribution cooperatives, river authorities, and municipally owned utilities. Generating plants owned by non-utilities produced approximately 10% of the consumption.

5.4.2 The Public Utility Commission of Texas (PUCT) regulated all aspects of electricity supply in line with the Public Utility Regulatory Act (PURA). PUCT set the standards for electric service, authorized utilities to invest in new facilities such as power plants, transmission lines, or other equipment necessary to meet their obligation to provide service to all customers, and set the rates for electric service.

5.4.3 Liberalisation of the electricity market came into force in 2002 after period of industrial and political support for reforms. In its scope of competition report in 1999, the PUCT recognised that

regulated utilities were overearning due to declining costs for utilities and stable prices. **Plans to de-regulate the sector were announced in 1999 with the expressed intention of bringing down the costs of electricity for consumers.**

The Reform Process

5.4.4 The 2002 deregulation established separate retail providers, power generators and transmission and distribution companies, with the following functions:

- Retail providers sell electricity to residential and business customers.
- Power generators own and operate power plants, and sell this power wholesale to retail providers, who package the power with transmission and delivery service for sale to retail customers. Retail providers are not permitted to own power plants; however, they can be affiliated with a power generation company.
- The delivery of the electricity through network assets is provided by local Transmission and Distribution Service Providers, who are also responsible for consumer meters and meter reading.

5.4.5 Most areas of the state are open to competition, but electric cooperatives and city-owned utilities have the option to decide whether or not their customers can participate in competition. The Panhandle, El Paso, the Golden Triangle and the far northeast corner of the state remain outside those areas where deregulation is mandated.[51]

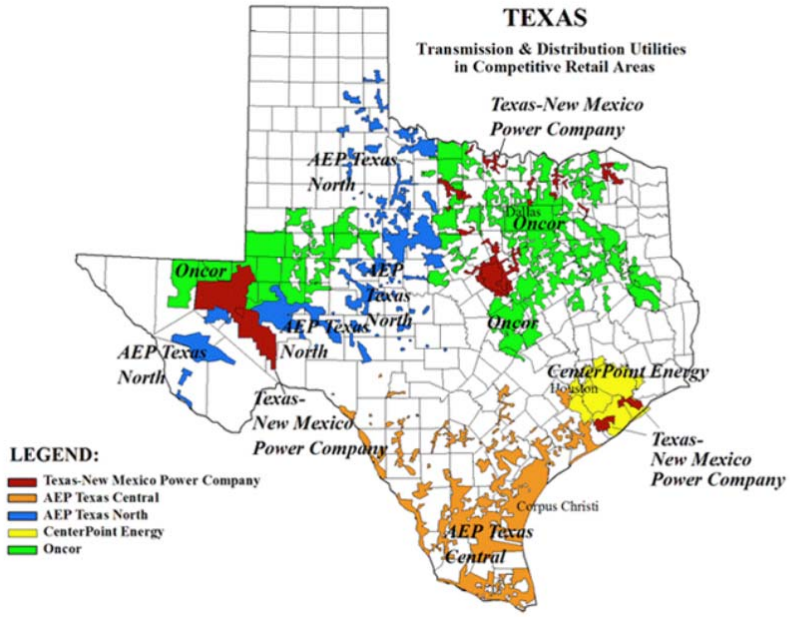
5.4.6 A key component of the Texas deregulation system was the setting up of a Regional Transmission Operator (a role assigned to the State agency called ERCOT) to ensure open access to the transmission system. The Electric Reliability Council of Texas (ERCOT) became the Independent System Operator (ISO) for the majority (about 85% of demand) of the power grid in Texas in 2001. ERCOT also administers the competitive wholesale (day-ahead and real-time) market, ancillary service market and the retail market.

Retail Market Reform

5.4.7 In 2002, the retail electricity market was opened up to competition. Since then, customers in deregulated area (see Map 5.1) have had a choice of switching to a competitive Retail Energy Provider (REP) or staying on the previous regulated tariff with the utilities Affiliated Retail Energy Provider (AREP) i.e. the incumbent.

[51] See http://historyofderegulation.tcaptx.com/chapter/appendix-a-senate-bill-7-key-components/ accessed 2/12/2014

Map 5.1: Deregulated Electricity Areas in Texas



Source: PUCT

5.4.8 Some areas were not deregulated because they did not meet the Public Utility Regulatory Act (PURA) established competition criteria:

1. a sufficient number[52] of interconnected utilities in the power region are under the operational control of an independent organization;
2. a generally applicable tariff guarantees open and non-discriminatory access to transmission and distribution facilities in the region; and
3. no person owns and controls more than 20% of the installed generation capacity located in or capable of delivering electricity to the region.

5.4.9 The PUCT introduced the 'price to beat' concept which set a floor price for the AREPs. New entrants could charge lower than the price to beat, allowing them to gain market share. This stopped the AREPs from protecting their initial market share at the beginning of deregulation. In January 2007, the previous incumbents were allowed to compete with new entrants.

5.4.10 In 2011, the PUCT adopted a new rule in order to enhance customer protection, prohibiting REPs from knowingly providing prepaid service to critical care and chronic condition residential customers. Also included in the rule is the requirement of use of an advanced meter to ensure consumers are billed for actual consumption. In 2012 an additional amendment was made to

[52] 'Sufficient number' is unspecified by the PURA

provide a mechanism to determine if prepaid rates were no higher than the price charged by the provider of last resort (as required by the Public Utility Regulatory Act (PURA)).

Wholesale Market Reform

5.4.11 In 2010, ERCOT underwent significant reforms of the wholesale energy market, introducing Locational Marginal Pricing (LMP), moving from a zonal market (of four regions) to a nodal market (of over 4000 nodes). The step is the culmination of the process which was started in 2003, when the PUCT ordered ERCOT to develop a nodal wholesale market design. The objective of the transition to LMP was to increase market efficiency by providing locational signals for new investment and thereby significantly reducing wholesale prices. The PUCT reports that the nodal market has improved the price signals, transmission efficiencies and the direct assignment of local congestion costs[53].

5.4.12 The overall effect is thousands of different prices, taking into account the internal constraints of the transmission system, as opposed to a small number of zoned prices. Map 5.2 shows the pricing contours (of one specific price interval) for both a zonal estimate (on the left) and the fully nodal pricing solution (on the right). The nodal market gives a much higher level of granularity than zonal which improves the efficiency of dispatch, reduce overall prices and provide pricing signals for the investment of transmission and for the location generation that takes into account grid constraints.

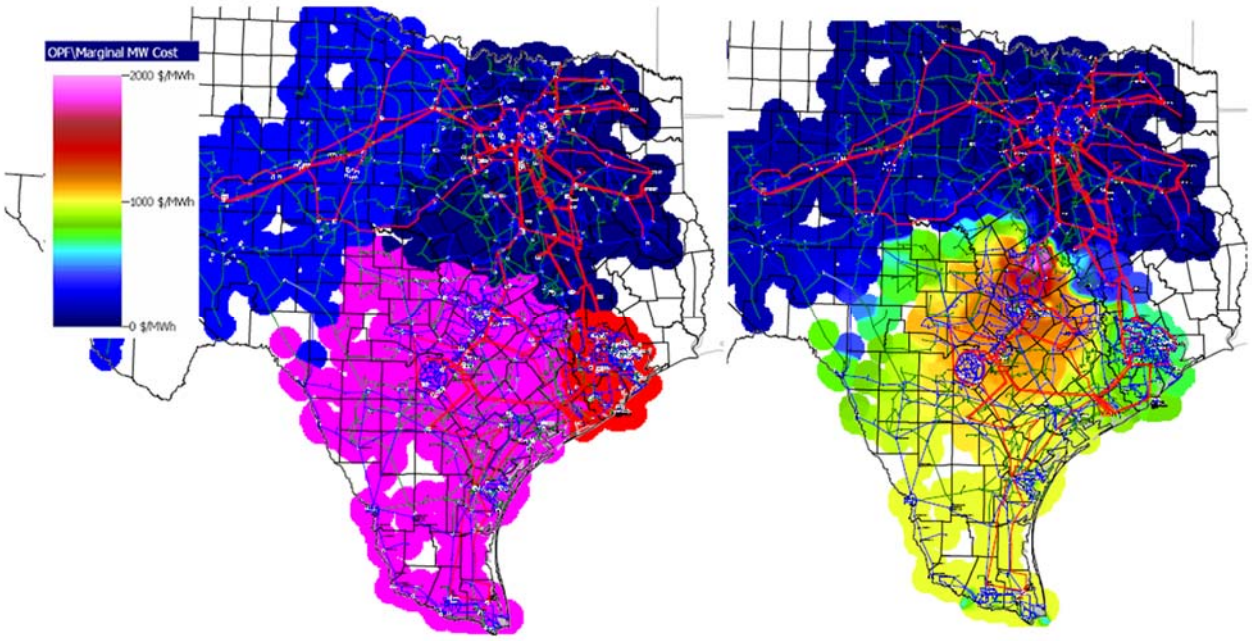
5.4.13 The benefits of LMP are to:

a. reduce wind curtailment by providing more efficient power plant scheduling;
b. incentivise transmission development to connect areas with large differences in price; and,
c. incentivise investment of generation in areas with the greatest need (i.e. the highest prices).

5.4.14 However, introducing LMP can cause problems of reduced market liquidity and increased market power. This is because the constraints limit the range of potential generators and buyers can trade with, for instance, a relatively isolated node where one generation company owns most of the assets may be vulnerable to market power abuse.

[53] See https://www.puc.texas.gov/industry/electric/reports/scope/2013/2013scope_elec.pdf accessed 06.11.2014

Map 5.2: ERCOT Zonal Vs Nodal (LMP) Grid Representation

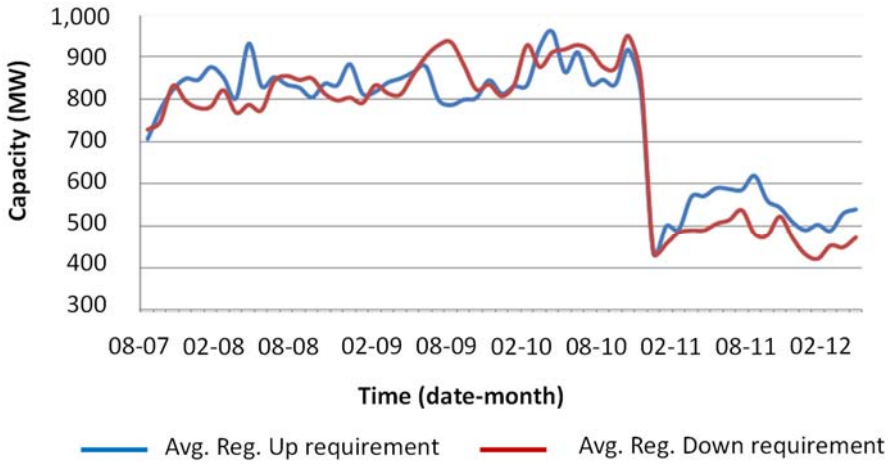


Source: PUCT

5.4.15 Also included in the reform was the introduction of Day Ahead co-optimisation of the energy market and ancillary service markets and the reduction of dispatch times from 15 minutes to 5 minutes with the introduction of the Security Constrained Economic Dispatch (SCED) optimiser (SCED is used by ERCOT to optimise dispatch of power generation at the nodal level based on demand, availability and cost curves subject to transmission constraints). ERCOT reports that the reforms have improved dispatch efficiency and unit commitment.

5.4.16 As a result of these reforms, the average regulation requirement has been significantly reduced (see Figure 5.14 for the Trend of Monthly Average Regulation requirement in 2010), which should result in system wide cost savings. Regulation Requirement is needed for arresting frequency excursions, held by ERCOT in order to stabilise system frequency. The move closer to real time market closure (from 15 minutes to 5 minutes) allows participants to refine their positions closer to dispatch time, therefore reducing the need for ERCOT to use regulation services to balance the system. The reforms reduced the average regulation requirement from between 700 and 950 MW to between 400 and about 600 MW.

Figure 5.14: Trend of Monthly Average Regulation Requirement in 2010



Source: ERCOT

5.4.17 ERCOT is also considering reforming its ancillary services market to introduce new products of System Inertial Response (SIR) and Fast Regulation Reserve Service (FRRS). These reforms are meant to address some of the specific challenges of increasing wind generation, such as short term active power balancing[54], in a synchronously independent system.[55]

5.4.18 In an attempt to remedy declining levels of resource adequacy[56], two specific reforms have been introduced. The first is to ease the cap on energy market price and the second is to introduce the Operating Reserve Demand Curve (ORDC).

5.4.19 Caps on energy market price were increased from 3,000 USD/MWh to 4,500 USD/MWh (in 2012), to 5,000 USD/MWh in 2013 and a further increase to 7,000 USD/MWh in the summer of 2014 with plans to increase again to 9,000 USD/MWh in 2015. The low prices seen in recent years, due to low Short Run Marginal Cost (SRMC) wind plants and cheap gas, has not been enough to bring on new gas capacity. The intention of the increases is to address resource adequacy concerns by providing greater incentives for the deployment of new capacity in order to secure resource adequacy.

5.4.20 The ORDC is a price adder, or availability payment, paid to generators based on reserve availability, loss of load probability (LOLP) and value of lost load. When demand increases to a level where the level of operating reserve available diminishes, the LOLP increases and the ORDC price adder increases accordingly (see Figure 5.15) up to a maximum of Value of Lost

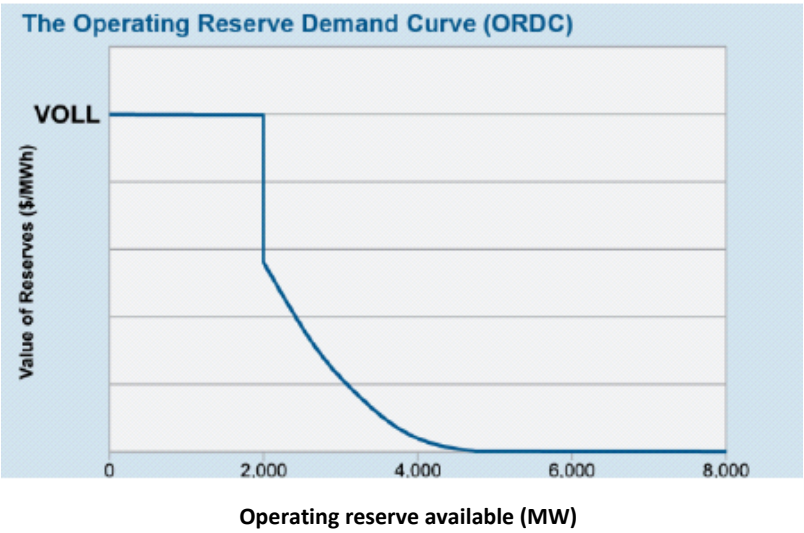
[54] For more detailed discussion on the specific challenges of wind integration, please see the Mott MacDonald report 'RE-Integration' here http://iea-retd.org/wp-content/uploads/2015/01/Report-Volume-I-Main-Report.pdf accessed 19.01.2015

[55] See ERCOTs concept paper on Ancillary Service Re-think

[56] Also called capacity margin

Load (VOLL) when operating reserves decrease to 2GW or less. The adder should provide incentives for the development of new flexible and reliable generation and smooth out price spikes due to energy scarcity.

Figure 5.15: Operating Reserve Demand Curve



Source: ERCOT (2014)

5.4.21 The Emergency Response Service (ERS), formerly the emergency interruptible load service (EILS), has undergone a number of reforms to improve its effectiveness. The service is available to ERCOT to allow it reduce the demand of participating customers (usually large loads or aggregators of smaller loads) during emergencies where capacity is insufficient. The service has been deployed twice – during the extreme weather conditions in February and August 2011.

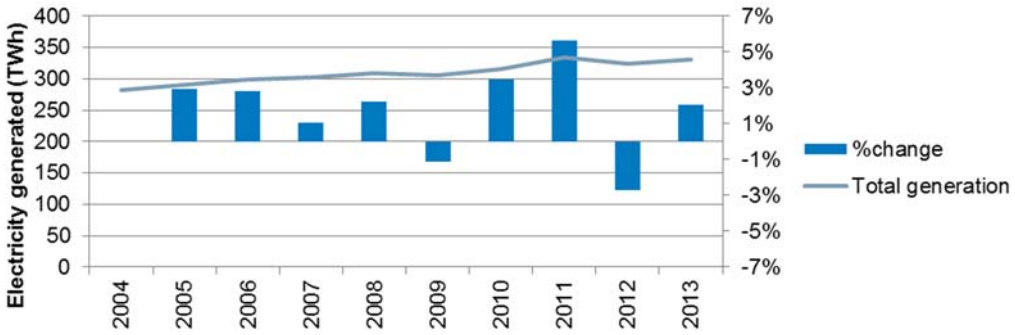
5.4.22 Recent amendments to the service in March 2012 have expanded the scope of the service. ERCOT has flexibility to change the duration of contract periods and adopt new payment mechanisms (as opposed to just the pay-as-bid as when introduced). Additionally, the deployment criterion (i.e. the maximum time from instruction the provider has before reducing demand) was relaxed from 10 minutes to 30 minutes.

Market Development

5.4.23 The ERCOT wholesale market has continued to grow throughout most of the preceding decade, from 280 TWh generated in 2004 to 330 TWh generated in 2013 (see Figure 5.16), leading to an average annual growth rate between 2004 and 2013 of 1.8%. The electricity generation dropped only in two years (2009 and 2012). The high growth in electricity generation in 2011 (and

following drop in 2012) was due to extreme weather conditions – high temperatures experienced in the summer of 2011 cause the increase in demand from air-conditioning.

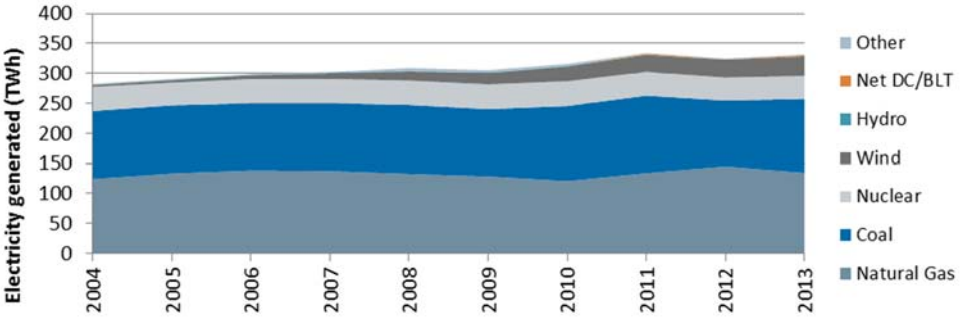
Figure 5.16: ERCOT Electricity Generation (TWh)



Source: ERCOT (2014)

5.4.24 The major shift in electricity generation has been the growth of wind energy. The Production Tax Credit (PTC) and Competitive Renewable Energy Zones (CREZ) have together incentivised significant development of wind generation in Texas (see Figure 5.17) with wind making up 10% of total electricity generated in 2013, up from 1% in 2004.

Figure 5.17: ERCOT Generation by Technology (TWh)



Source: ERCOT (2014)

5.4.25 In the ERCOT area, the top three power generators (on a capacity basis) – Luminant Generation Company LLC, NRG Texas Power LLC, and Calpine Corporation – together own 42% of the power generation capacity[57] (see Table 5.3).

[57] Total capacity is approx. 81 GW

Table 5.3: Top 5 Power Generation Companies by Capacity in 2014

Rank	Company	Capacity (MW)	% of total capacity
1	LUMINANT GENERATION COMPANY LLC	13,629	17%
2	NRG TEXAS POWER LLC	11,767	14%
3	CALPINE CORPORATION	8,359	10%
4	KIOWA POWER PARTNERS LLC	3,134	4%
5	FPLE FORNEY LLC	1,789	2%

Source: Mott MacDonald and PUCT, 2014

5.4.26 Eighteen companies, representing about 70% of capacity, own at least 1,000MW. The remaining 30% of capacity is owned by 78 smaller power generation companies.

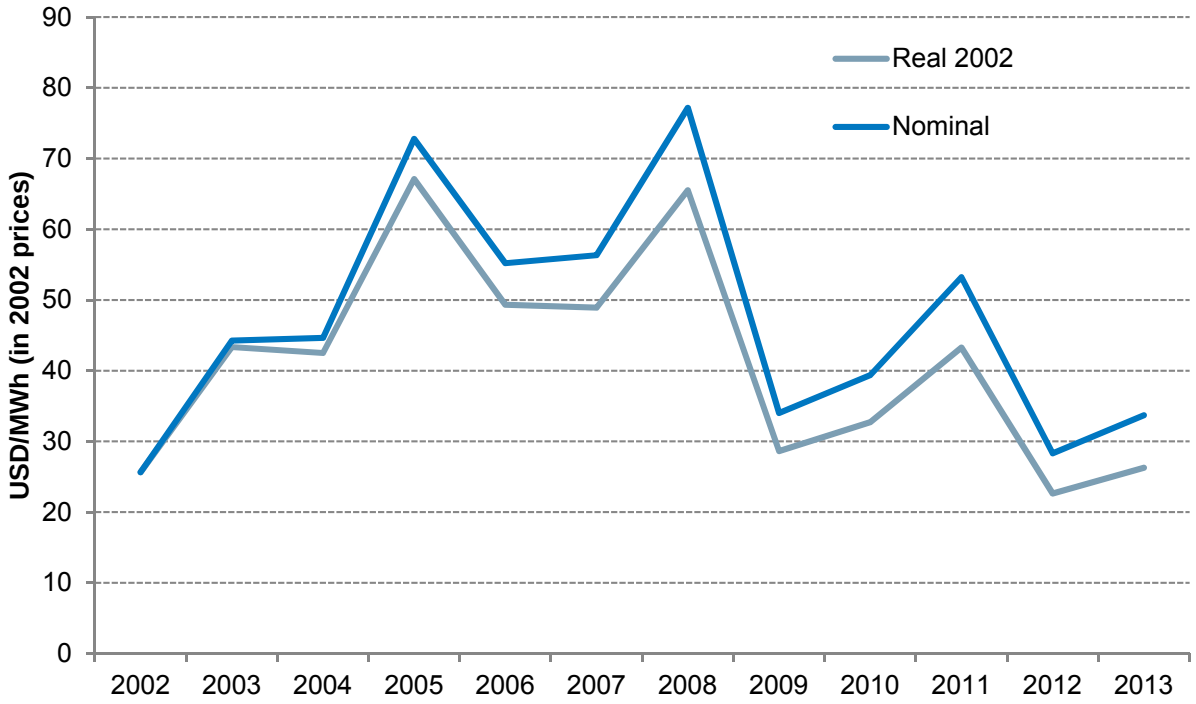
5.4.27 The extent of unbundling between the generation, distribution and retail companies is unclear; for instance, the largest generator: Luminant Generation Company LLC, the largest retailer: TXU Energy Retail Company LLC, and a distribution company: Oncor Electric Delivery Company LLC, are all subsidiaries of Energy Future Holdings. PUCT commissions studies on retail and generation market competition while ERCOT also commissions studies on generation market competition. However, these studies do not discuss the issue of vertical integration. We are not aware of any studies that have been conducted to investigate the impact of vertical integration on competition.

Outcomes of the Electricity Market

Wholesale Tariffs

5.4.28 The resulting electricity prices in the ERCOT wholesale market are driven by gas price (because gas is the marginal generating technology) and local climate conditions (the high prices in 2005 were due to hurricane Ike affecting the Texas and 2008 due to the financial crisis that affected commodity prices) (see Figure 5.18 - real prices in 2002 $ calculated using USA GDP deflator, source: California Energy Almanac). Increasingly, wind availability will become a significant driver of electricity price as wind capacity continues to increase.

Figure 5.18: Average Wholesale Electricity Prices in ERCOT from 2002 to 2013 (real 2002 and nominal US$/MWh)



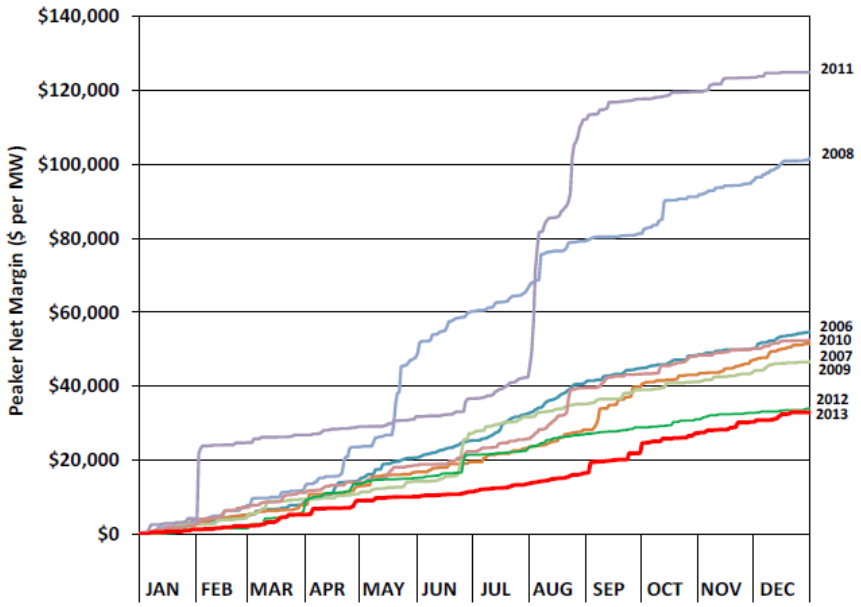
Source: ERCOT and Potomac Economic, reports from 2002 to 2014

5.4.29 At wholesale level, electricity prices increased (in real terms) in the period between 2002 and 2008 and then they corrected (decreased) showing that prices in 2013 are at the same level of those observed at market liberalisation in 2002. While prices have not decreased – following the objectives of the liberalisation process to reduce costs for consumers – they reflect the trend in marginal generation costs (follow the trend of natural gas prices).

5.4.30 The Independent Market Monitor report to ERCOT[58] explains that the 'Peaker Net Margin' (the hypothetical annual net revenue of a peaking unit) has been too low in recent years to justify investment in new peaking capacity. The report states that required net revenue to satisfy annual fixed costs of a new gas turbine ranges from $80,000 to $105,000 per MW-year. However, in the period between 2006 and 2013, only the years 2008 and 2011 achieved this, and the other eight years were well below (see Figure 5.19). Indeed, 2012 and 2013 had the lowest levels of peaker net margin.

[58] '2013 State of the market Report for the ERCOT Wholesale Electricity Markets' (2014)

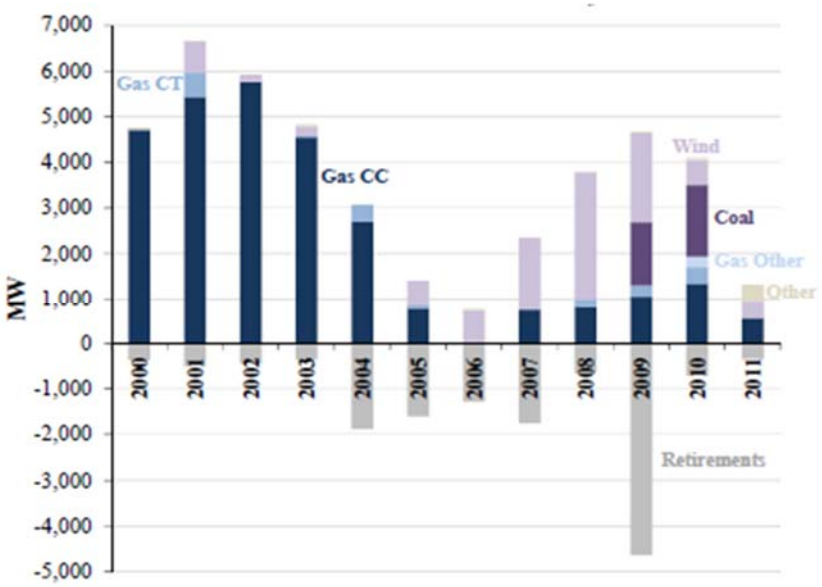
Figure 5.19: Peaker Net Margin



Source: ERCOT and Potomac Economics, 2014

5.4.31 As a result, there has been relatively little investment in firm capacity (see Figure 5.20) causing concern about the ability of the market to deliver the required investment in new capacity. Also, structural changes in the composition of the electricity supply in ERCOT have caused recent concerns about resource adequacy as well.

Figure 5.20: Investment and Retirements in ERCOT

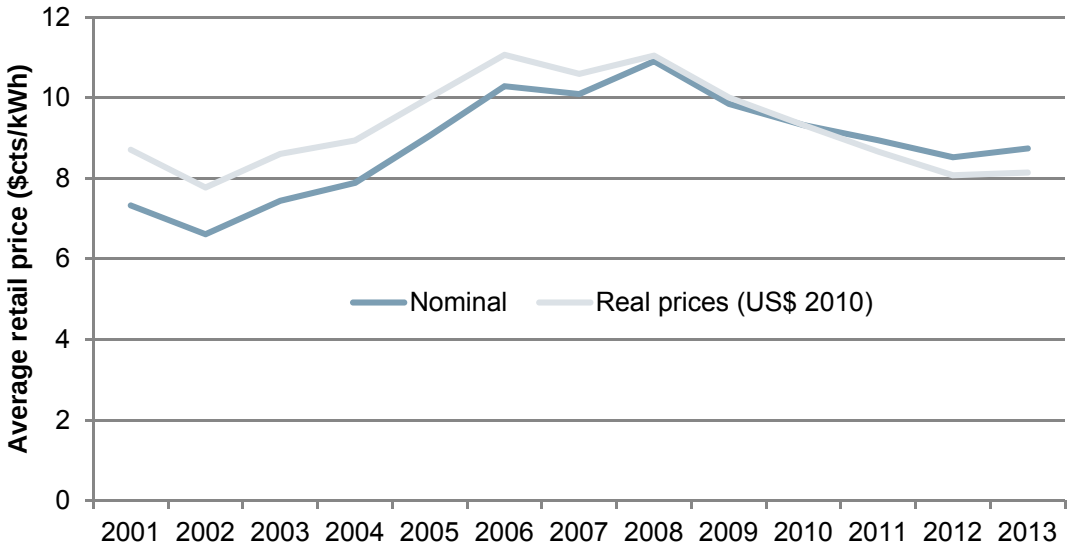


Source: Brattle Group, 2012

Retail Market

5.4.32 Average retail prices in Texas increased significantly, approximately 40% in real terms (see Figure 5.21), during the period 2002 to 2008, but currently remain lower than their peak experienced in the summer of 2008, standing at 8.14 cUSD/kWh in July 2014 (in prices of 2010 using CPI as the deflator). The retail electricity price increases show de-regulation of the retail market did not meet the stated intentions of reducing the electricity price. However, this is against a backdrop of rapidly increasing gas prices (during the period 2002 to 2008, gas prices increase 250%).

Figure 5.21: Average Retail Electricity Prices in Texas (in prices of 2010)



Source: EIA, 2014, and Mott MacDonald

Operational Efficiency

5.4.33 Every two years, the PUCT publishes its report 'The Scope of Competition in the Electric Markets in Texas' – the most recent one of which was published in January 2015. The report is favourable, and commends the market in achieving a high level of competitiveness:

"The Texas retail market, under the Commission oversight, remains the national leader in competitive residential, commercial, and industrial offerings, with the highest number of competitors and product variety in the country"

5.4.34 Furthermore, every year, an Independent Market Monitor for the ERCOT Wholesale Market prepares a report on the state of ERCOT wholesale electricity markets. In its most recent version[59], the report specifically states that: *"The ERCOT wholesale market performed competitively in 2013"*

5.4.35 Due to the strength of competition in both markets, the operational efficiency should have improved in theory, as a well-functioning market provides rewards for high levels of operational efficiency. However, there is an under-analysed issue of the effects of vertical integration, which could influence the competitive operation of the markets.

[59] Potomac Economics (2014) - 2013 STATE OF THE MARKET REPORT FOR THE ERCOT WHOLESALE ELECTRICITY MARKETS.

Increase in Customer Choices

5.4.36 In 2013, the PUCT stated in its 'The Scope of Competition in the Electric Markets in Texas':

"Customers in every competitive area of Texas have enjoyed many choices in electric providers and products. Customers have been able to choose from a variety of fixed, variable, prepaid or postpaid products and around 60 renewable products with 100% renewable content."

In January 2015, the PUCT reinforced the above statement, saying:

"Since the publication of the 2013 Scope of Competition Report, the number of retail electric providers (REPs) and competitive offers has remained stable"

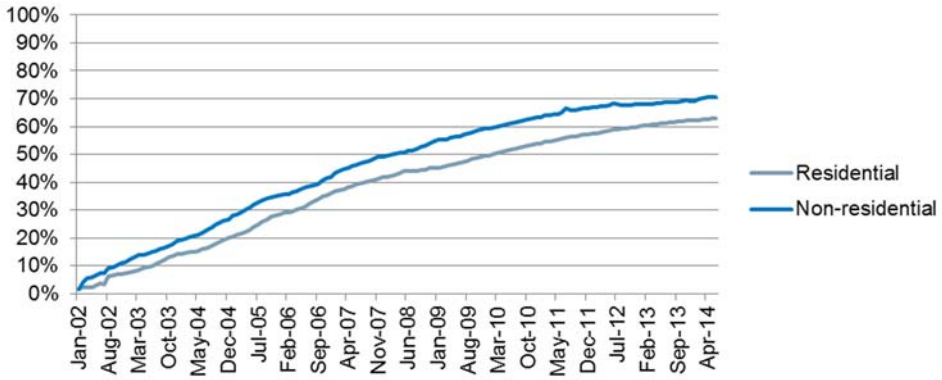
5.4.37 By September 2014, there were 114 REPs providing service to customers in ERCOT. These are spread over service territories, but there is still a significant amount of choice for customers in each area (see Table 5.4), with each provider offering around 5 different residential tariffs; these tariffs can be compared using the webpage created by PUCT "Power to Change" (by entering the customer's postal code, the webpage provides a tariff comparison of the retailers in the area), promoting informed and transparent tariff selection.

Table 5.4: Number of REPs by Service Area in 2014

Transmission and Distribution Utility	# of REPs Serving Resid. Cust. (Incl. affiliated REPs)	Number of Residential Products
Oncor	46	255
CenterPoint	44	257
AEP TCC	45	234
AEP TNC	40	225
TNMP	41	211
Sharyland	27	114
Source: PUCT, 2015, "Scope of Competition in the Market"		

5.4.38 By June 2014, 63% of residential and 70% of non-residential customers had switched to an REP (see Figure 5.22). This means that the competitive retail market is now a significant size of the total electricity sales. However, the rate of customers switching to a competitive REP appears to be slowing for both residential and non-residential customers.

Figure 5.22: Percentage of Customers Switching to an REP



Source: ERCOT, 2014

Reliability of Electricity Supply

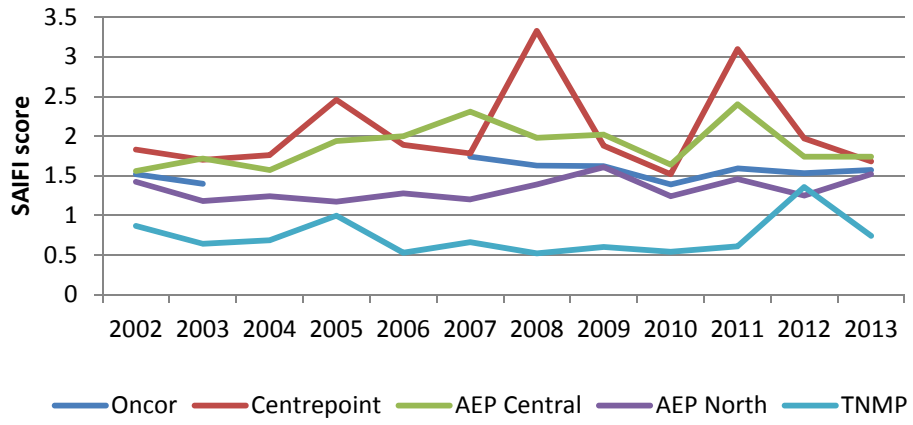
5.4.39 Utility companies are required to report their reliability of supply indicators of System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) to the PUCT. The PUCT's Substantive Rule 25.52 on Reliability and Continuity of Service specifies that utilities must report SAIFI and SAIDI by type of interruption (forced, scheduled, outside causes and major events). In addition, the order specifies standards, unique to each utility and based on past performance, and requires that the SAIFI and SAIDI should not exceed 5% of the system wide standard.[60]

5.4.40 SAIFI (see Figure 5.23) and SAIDI (see Figure 5.24) in Texas are heavily influenced by extreme weather events. The peak experience in 2011 for most utilities is possibly due to the extreme weather events in February and August of that year. In 2008, Texas experienced the most destructive hurricane in its history: Hurricane Ike. It hit southeast Texas and caused the SAIDI for Centrepoint to increase to 8804. Hurricane Rita in 2005 made landfall on the Texas Louisiana border.

5.4.41 Discounting the impacts of storms and extreme weather events, there does not appear to be any significant change in SAIFI or SAIDI since the liberalisation of the markets.

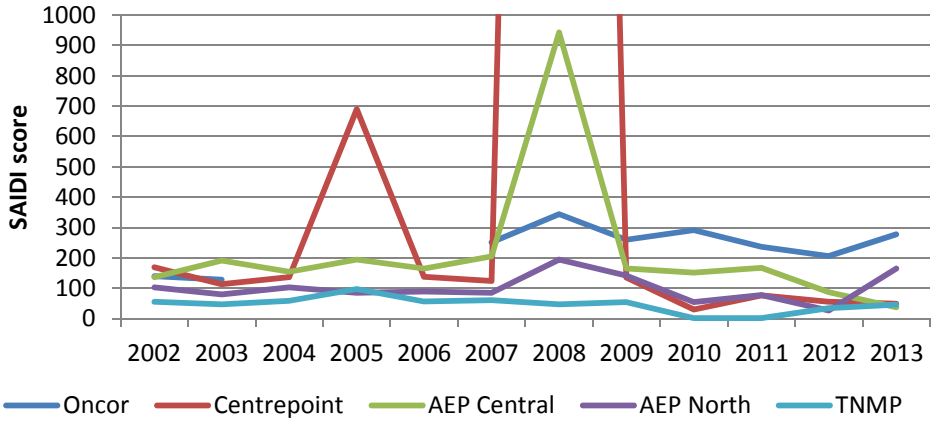
[60] See https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.52/25.52.pdf accessed 07.11.2014

Figure 5.23: SAIFI for Utilities in Competitive Supply Areas



Source: PUCT (2014), (Notes: Records for Oncor from 2004 to 2006 are not available)

Figure 5.24: SAIDI for Utilities in Competitive Supply Areas



Source: PUCT (2014), (Notes: 2008 value for Centrepoint is 8804. Records for Oncor from 2004 to 2006 are not available)

Market Liberalisation Determinants

5.4.42 Texas is one of the most active regions in this study in terms of introducing further tools to promote market development. ERCOT and PUCT have followed the guidelines for market development provided years ago which shows that there is political willingness in the State to pursue effective development of competition in the power sector.

5.4.43 The recent introduction of nodal prices will open the door to new challenges as companies may now have tools to perform market power at nodal level. Monitoring activities from ERCOT and

PUCT are key to understand the introduction of new regulatory updates in the future to mitigate this market power (if applicable), as it has been happening in other power markets, for instance in PJM.

5.4.44 Moving from zonal to nodal prices required substantial efforts in terms of studies, regulation, system implementation, etc.; also, the fact that Texas has some issues with installing new capacity has positively cooperated to achieve this fundamental change in the market, as nodal prices provides clearer price signals compared to zonal prices. However, the move to nodal pricing may present greater opportunity for market participants to exercise market power, as access to the market is constrained by the geographical transmission limitation of the power network.

5.4.45 The degree of vertical integration between generators and retailers in the Texan market is unclear as the market monitoring activities appear to consider only specific sections of the market (i.e. retail and generation) and do not consider the market as a whole. Such vertical integration can lead to a reduction in market competition and exercise of market power if vertically integrated utilities have the possibility of raising economic barriers to the entry competition (in either retail or generation side) or by reducing liquidity in the long term energy markets.

5.4.46 There is concern on the little investment in firm capacity and the declining levels of resource adequacy, which may have adverse impact on long term supply reliability.