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IEE JAPAN

Joint Project between NITI Aayog and Institute of Energy Economics Japan (IEEJ)

Report on Assessing the Natural Gas Demand in Japan till 2040

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List of Abbreviations

AWEO – Asia/World Energy Outlook

BCM – Billion Cubic Metres

BP – British Petroleum

CAGR - Compound annual growth rate

CCT - Clean Coal Technology

EIA – Energy Information Administration

EPIC – Energy Policy Institute at University of Chicago

GDP - Gross domestic product

GHG – Green House Gas

GW – Gigawatt

IEA – International Energy Agency

IEEJ – Institute of Energy Economics Japan

IEO – International Energy Outlook

IESS - Indian Energy Security Scenario

INDCs - Intended Nationally Determined Contributions

LNG - Liquefied Natural Gas

MMBTU – Million Thermal British Units

Mtoe – Million Ton of Oil Equivalent

MTPA – Million Tons per Annum

PPAC – Petroleum Planning and Analysis Cell

RE – Renewable Energy

SOI – Statement of Intent

TWh – Terawatt hour

WEPS+ - World Energy Projection System Plus

Acknowledgments

My special thanks to Shri Anil Kumar Jain, Additional Secretary (Energy, Climate Change & Overseas Engagements), NITI Aayog who has been the major driving force behind this project. His firm grip on the subject of Energy, especially natural gas was a constant source of valuable inputs for me throughout the project. Also, I would like to acknowledge Shri Harendra Kumar, Joint Advisor, NITI Aayog who has provided able leadership to this project.

Moreover, I must appreciate the cooperation received from the Institute of Energy Economics Japan (IEEJ) while working on this project. I acknowledge the efforts of Ms. Pooja Vijay and Abhishek Sood at Energy Policy Institute at the University of Chicago (EPIC) – India for providing inputs with regards to World Energy Projection System (WEPS) modeling.

Abstract

As per the Statement of Intent (SOI) signed between NITI Aayog and Institute of Energy Economics Japan (IEEJ), one of the important topics was to assess the natural gas demand of India and Japan and analyze the impact of increased penetration of gas on the overall energy scenario of India and Japan.

This report aims to arrive at the natural gas demand in Japan until 2040 and analyze in detail the impact on energy mix, electricity mix, installed capacity, per capita emissions, and emissions intensity. (Refer report 'Assessing the Natural Gas demand in India' which captures natural gas scenario in India- by Ripunjaya Bansal). The World Energy Projection System Plus (WEPS+) model has been used to arrive at the final results of this report. This price-consumption equilibrium model has been developed by the United States Government's Energy Information Administration (EIA**).**

Post Fukushima tragedy in 2011 in Japan, its reliance on LNG imports have increased as it had to shut down its nuclear power plants for power generation. Moreover, Japan has been the world's largest importer of LNG with imports of 85 MTPA in 2015. The ushering in of new reforms in Japan in the gas retail sector from 1st April, 2017 strives to increase the competition in gas retail markets. This move of the government will completely open up the retail gas market which is pegged at 2.4 trillion yen a year where any number of companies could enter the retail market and the consumers could actually chose their suppliers. These reforms aim to secure natural gas supply by expanding and improving pipeline networks, lowering gas prices by promoting market competition and increasing consumer choice and business opportunities in the gas sector and will also allow third party access to pipelines.

This exercise tells us that the energy demand of Japan has saturated and is largely expected to remain constant till 2040. However, there could be a change in energy mix and electricity mix of Japan depending upon its decision, whether to bring nuclear on stream and how the global fuel prices would impact the consumption behaviour in Japan. Finally, a comparison is also done between the results of WEPS+ and Asia/World Energy Outlook (AWEO) of IEEJ in order to understand the reasons for variations.

I. Introduction:

Policymakers must decide which energy fuel sources and technologies to prioritise in a way that simultaneously drives economic growth and encourages sustainable development. In line with the global goal of moving towards cleaner fuel choices, this study aims to understand the role that natural gas can play in the future energy mix of Japan. Using energy modeling and analysis, various scenarios were created to reflect realistic changes in global natural gas prices, domestic fossil fuel market regulations and renewable energy penetration to finally arrive at the natural gas demand in Japan till 2040. The results of this analysis provide insights on how the above mentioned factors affect Japan's energy and electricity mix and emission pathways until the year 2040. These results can assist Japan to formulate appropriate policies to achieve its desired energy pathways.

Japan is a highly energy efficient economy which started focussing on energy efficiency in a big way as early as 1970's. The primary energy consumption of Japan has decreased at (-) 1.23% CAGR from 2004 to 2015. And as evident from figure 1, the last 5 years has seen a gradual constant decline in primary energy consumption. This trend is likely to continue in the future and Japan's energy consumption would largely remain constant.

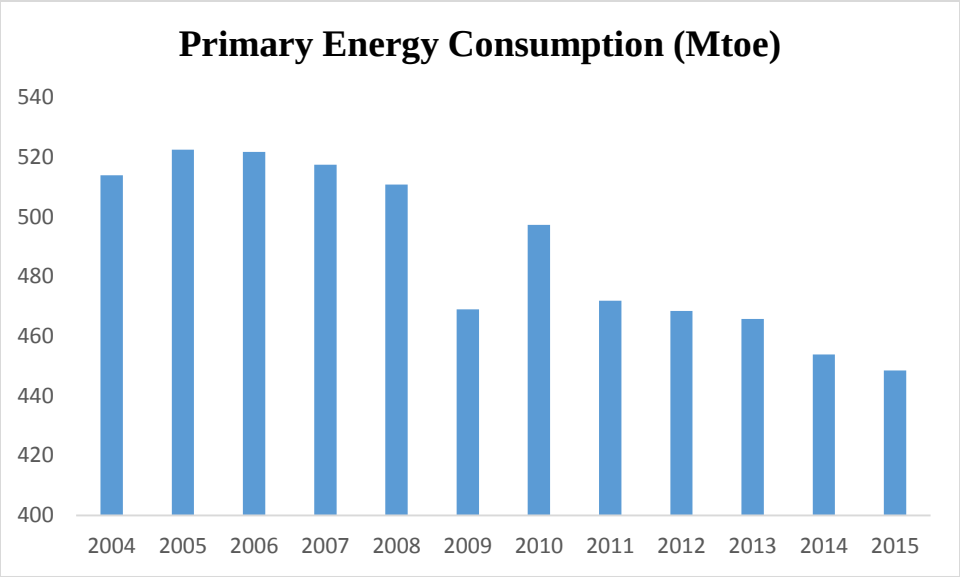

Figure 1

II. Role of Natural Gas in Japan:

Following the removal of nuclear power after the Fukushima incident in 2011, Japan has become increasingly dependent on fossil fuel imports. Since 2012, less than 9% of the country's energy demands have been met by domestic resources. The Japanese government has chosen natural gas

as its fuel of choice for power generation to substitute the lost nuclear generation. Almost a quarter of its primary energy consumption (Figure 2) and 40% of its electricity generation comes from gas. It is also evident from figure 2 that the share of nuclear in the energy mix is just 0.2% in 2015 which was 13% in 2004.

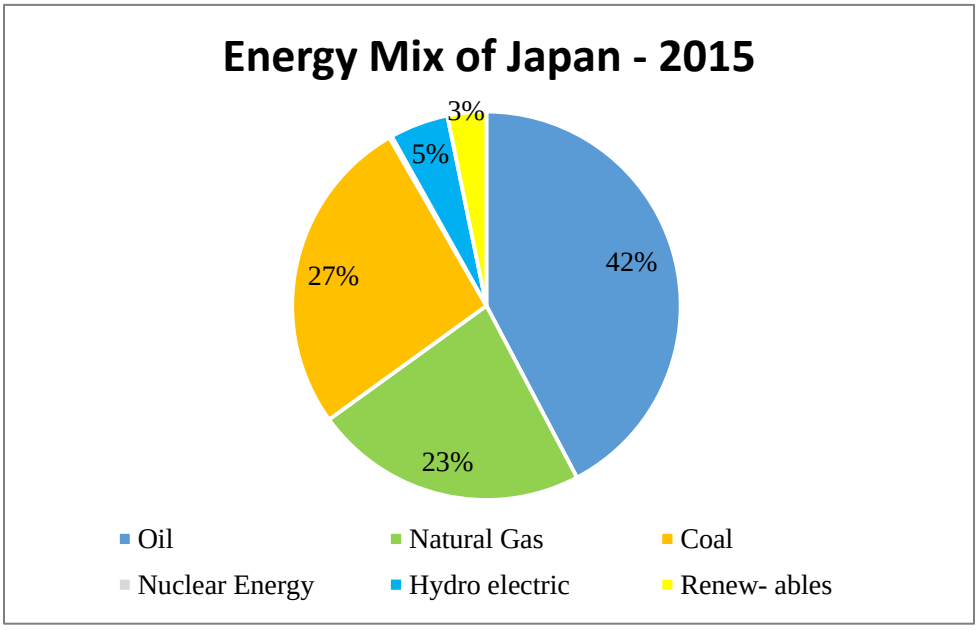

Figure 2 – Source: BP Statistics 2016

68% of the gas was used for power generation in 2014. The Figure 3 gives a break-up of the natural gas consumption across different sectors in 2014.

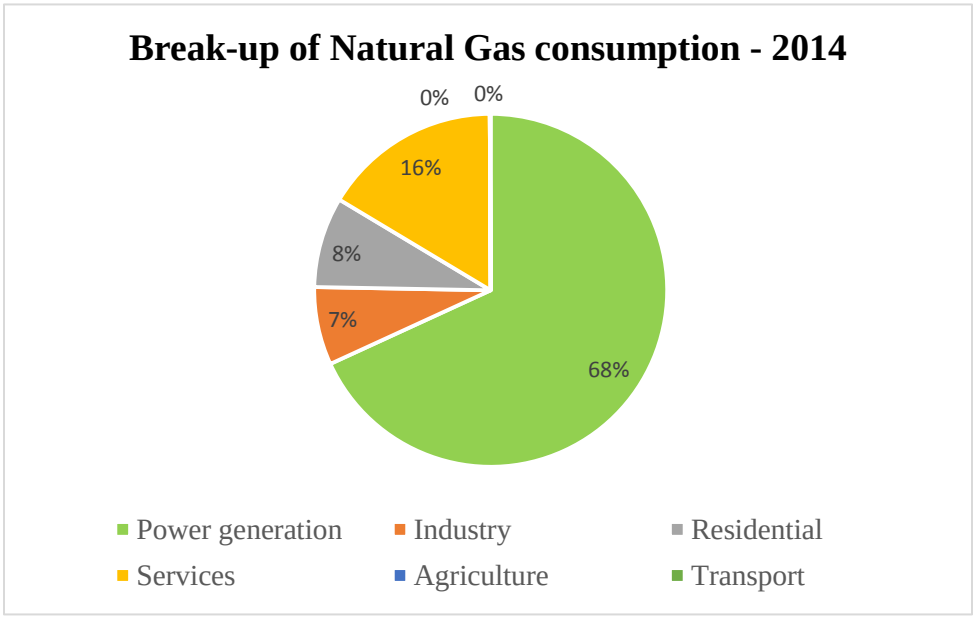

Figure 3 – Source: IEA

Figure 3 makes it clear that gas is not consumed in the agriculture sector of Japan and transport sector consumed a mere 0.1 BCM of gas in 2014 which is just negligible in comparison with the total consumption of 130 BCM in 2014.

Insufficient indigenous natural gas resources have made Japan the world's largest importer of Liquefied Natural Gas (LNG). Japan accounted for 37% of the global share of LNG imports between 2012 and 2014, with imports of 85 MTPA in 2015. The Japanese government plans to restart its nuclear capacity, which may push down the demand for LNG. However, decommissioning of aging plants will once again push the demand for LNG up after 2020. Thus, even if Japan's nuclear generation increases again, LNG will continue to play an important role in the country's energy sector.

III. Natural Gas Pricing in Japan:

Japan has an open gas market with no Government regulations on pricing. This leads to the gas prices in Japan being governed by international market prices unlike India, which is still in the midst of reforming its gas sector and moving towards a more market determined price. The Asian gas prices have been historically linked to Japanese Crude Cocktail (JCC) prices which led to high gas prices, especially until 2014. However, post declining of crude oil prices after mid-July, 2014, the global LNG prices have softened and spot purchases have even touched a low of $5/mmbtu in the last couple of years.

The Government of Japan has introduced a new major gas reform which has come into force from 1st April 2017 which seeks to introduce more competition in the retail gas market which was controlled by three major city gas suppliers - Tokyo Gas, Osaka Gas and Toho Gas. This move of the Government would completely open up the retail gas market which is pegged at 2.4 trillion yen a year where any number of companies could enter the retail market and the consumers could actually choose their suppliers. These reforms aim to secure natural gas supply by expanding and improving pipeline networks, lowering gas prices by promoting market competition and increasing consumer choice and business opportunities in the gas sector and would also allow third party access to pipelines.

IV. Modeling Approach, Scenarios and Assumptions:

World Energy Projection System Plus (WEPS) +, which is an economic optimization model has been used to arrive at the final results for this exercise. This model is developed by the U.S Energy Information Administration (EIA) and is used by them to produce the International Energy Outlook (IEO), which annually provides insights into the global energy scenario.

The role of natural gas in Japan seems to chiefly depend on two factors; restoration of nuclear energy and economic viability of natural gas in Japan. Japan has a free or unregulated market for natural gas, and therefore global markets will primarily influence the extent of LNG imports. Natural gas will also have to compete with alternatives such as renewables and coal, however,

the latter is cheaper to import than LNG, but then coal is a more polluting and less efficient fuel than gas. Keeping this in mind, the following scenarios take into consideration international natural gas prices, nuclear energy capacity and the penetration of renewables in Japan and try to capture how the energy scenario of Japan would vary depending on different scenarios. The following are the 5 scenarios.

I. Base Case:

Japan's energy scenario will be based on business as usual trends and policy measures. Japan's official 2030 Renewable Energy targets of 80 GW shall be met.

II. High Nuclear Share:

A majority of Japan's nuclear installed capacity in operation before the 2011 Fukushima incident will be restarted. It is envisaged that this will result in 40 GW of installed nuclear capacity by 2030. Japan's renewable targets of 80 GW by 2030 shall also be met in this scenario.

III. High Gas Prices:

This scenario seeks to understand the impact of a 50% increase in natural gas prices over and above the gas prices in Base case on the natural gas demand in Japan and finally on its energy mix. Nuclear capacity shall grow based on current policy measures and 2030 renewable energy targets shall be met.

IV. Low Gas Prices:

This scenario seeks to understand the impact of a 50% decrease in natural gas prices in comparison with the gas prices in base case on the natural gas demand and energy mix. Nuclear capacity shall grow based on current policy measures and 2030 renewable energy targets shall be met.

V. Low RE Achievement:

This scenario assumes that Japan's renewable energy targets are not met by 2030, but instead met in 2040. Nuclear capacity and oil and gas markets shall function as usual. Table 1 summarises the different scenarios.

	Scenarios	Nuclear Energy in 2030	Market Price of Natural Gas	Renewable Target Achievement year
I	Base Case	Determined by model	Determined by model	2030
II	High Nuclear Energy	40 GW	Determined by model	2030
III	Low Natural Gas Price	Determined by model	50% lower than Base Case	2030
IV	High Natural Gas Price	Determined by model	50% higher than Base Case	2030

V	Low RE	Determined by model	Determined by model	2040

Table 1: Modeling Scenarios for Japan

Macroeconomic Assumptions:

- GDP is assumed to grow at a CAGR of 1.4% between 2012-40
- Population decreases from 127.5 million in 2012 to 110 million in 2040
- The share of manufacturing would largely remain constant – 18% in 2012 to 19% in 2040
- The urbanization would increase from 92% in 2012 to 97% in 2040.

V. Pricing Assumptions for Natural Gas and Coal:

Since, WEPS+ is an economic optimization model, the pricing assumptions of natural gas and coal would play a very important role to arrive at the end results for different scenarios. The price projections for gas and coal have been derived through the WEPS model.

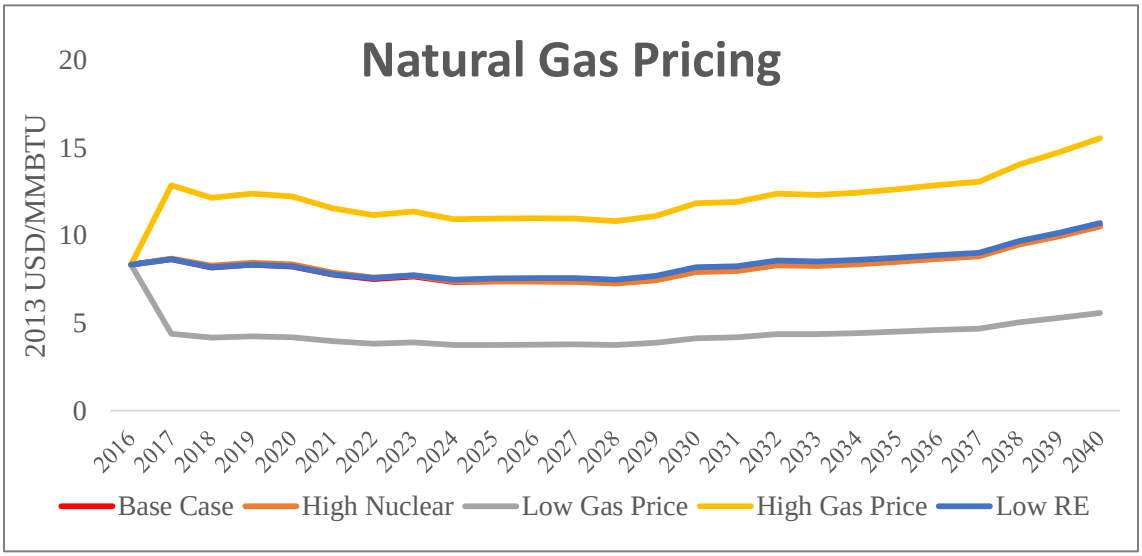

Figure 4

Figure 4 projects the price of natural gas in Japan until 2040. Natural gas prices in 2016 are taken to be 8.6 (2013) USD/MMBTU, which increases to 15.6 (2013) USD/MMBTU in the High Gas Price case and reduces to 5.6 (2013) USD/MMBTU in the Low Gas Price case. The High Nuclear, Low RE and Base Case scenario trend line for natural gas prices are similar to each other and lie between the Low and High Gas Price scenarios.

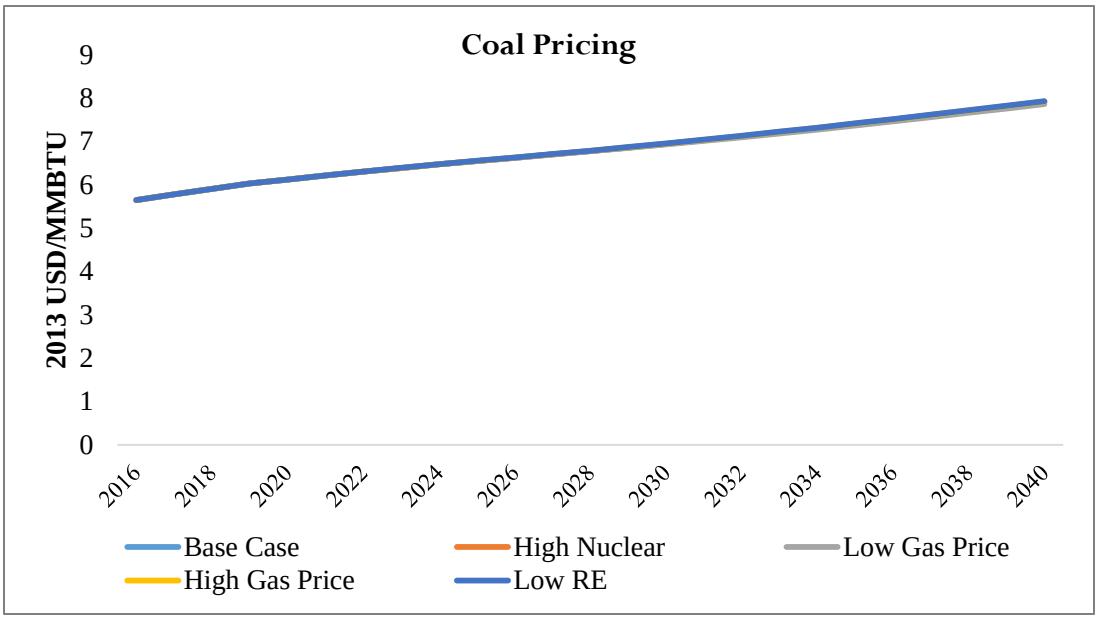

Figure 5

The Figure 5 gives the pricing assumptions for coal. Coal prices in 2016 are considered to be $5.6/mmbtu which would rise to $7.9/mmbtu, but are likely to remain constant across different scenarios.

	Natural Gas (2013 USD/MMBTU)	Coal (2013 USD/MMBTU)
2016	8.3	5.6
2040 Base Case/Low RE/High Nuclear	10.5-10.7	7.9
2040 Low Gas Price	5.6	7.9
2040 High Gas Price	15.6	7.9

Table 2

The Table 2 gives a summary of the natural gas and coal prices in 2016 and 2040 in different scenarios.

VI. Results Derived from WEPS+ Modeling Exercise for Japan:

1. Primary Energy Demand:

The primary energy demand of Japan would largely remain constant as Japan is a highly efficient and a developed economy. The primary energy demand would rise from 6045 TWh in 2015 to 6866 TWh in 2040. It is envisaged to rise at a CAGR of 0.46% from 2012-40.

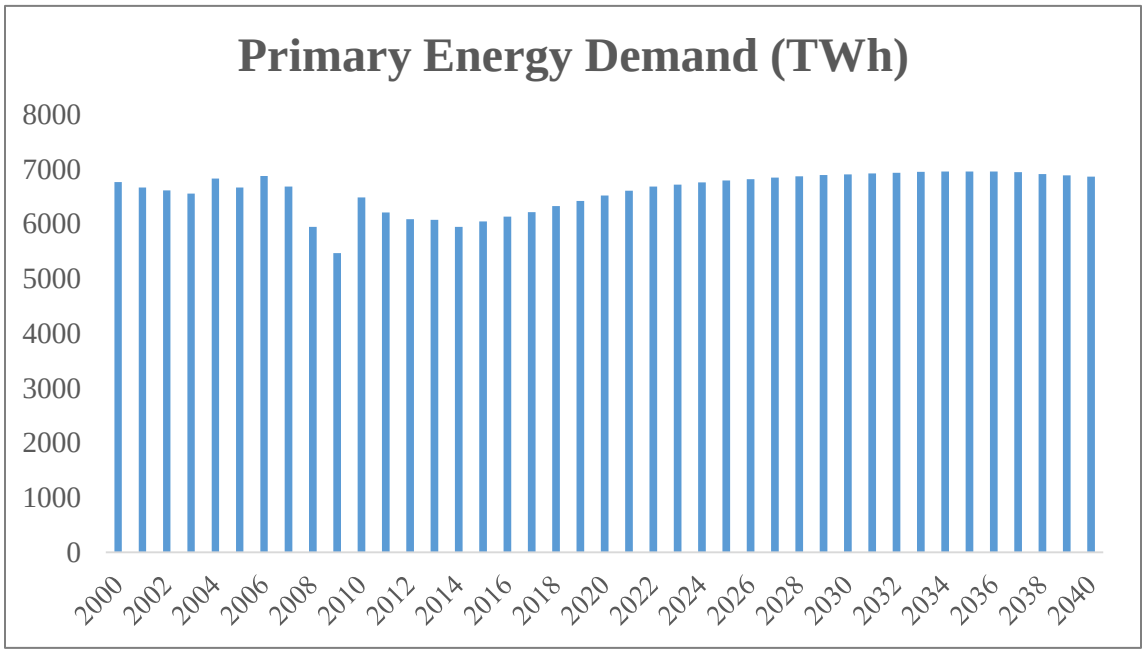

Figure 6

Figure 6 gives the Primary Energy demand of Japan until 2040. As explained above, Japan's primary energy requirement is likely to remain flat until 2040, it is the energy mix that would change depending upon the energy path that Japan follows.

2. Primary Energy Mix:

A quarter of Japan's primary energy requirements was fulfilled by natural gas in 2015. The Figure below gives the energy mix of Japan in 2040 in various scenarios. It is well evident that the share of renewables does not vary much across different scenarios and remains in the range of 14%-15% in 2040. The share of nuclear in energy mix would rise to 9% in 2040 in High Nuclear scenario in comparison with other scenarios in which the share remains at 6% in 2040 because the installed capacity of nuclear plants is 33 GW in high nuclear scenario in 2040, whereas it is 25 GW in 2040 in other scenarios. Moreover, the share of natural gas is higher in Low Gas price scenario with 34% in 2040, in comparison with other scenarios where the share varies between 31%-33%. This is so because the price of natural gas in Low Gas price scenario comes out to be $5.6/mmbtu (refer Table 2), which is quite lower than other scenarios.

It is to be noted that, even in the High Gas price scenario, where the price of natural gas is as high as $15.6/mmbtu, the share of gas in energy mix does not fall below 31% indicating Japan's power to absorb high prices.

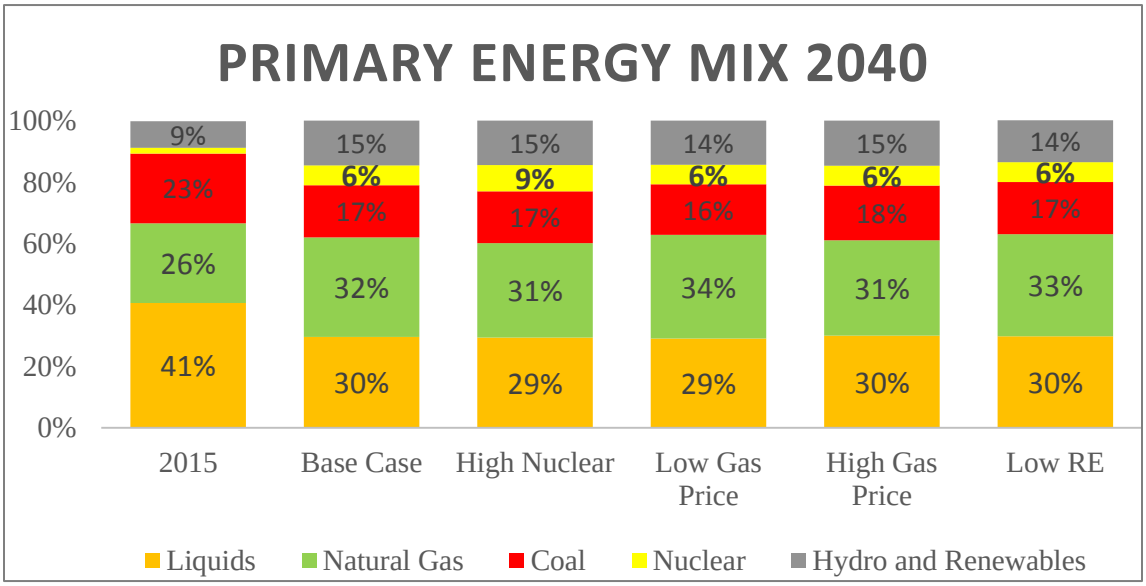

Figure 7

3. Final Energy (Delivered Energy) Demand:

Figure 8 gives the final energy demand of Japan till 2040. Since, the primary energy demand does not increase much till 2040 (0.46% CAGR from 2012-40), the final energy demand would also follow that trend. The final energy demand was 5078 TWh in 2015, which would become 4957 TWh in 2040 i.e. largely constant. However, the sectoral share of energy consumption would change over the years. The share of industry declines from 47% in 2015 to 41% in 2040, and that of transport also slightly decreases from 21% in 2015 to 19.7% in 2040. This is so because, there would be higher penetration of energy efficiency measures in Industry and Transport sectors.

The share of residential sector increases from 13% in 2015 to 16% in 2040 because of increased urbanization in Japan. Also, the share of commercial sector also increases from 18% in 2015 to 23% in 2040 due to increased economic activity.

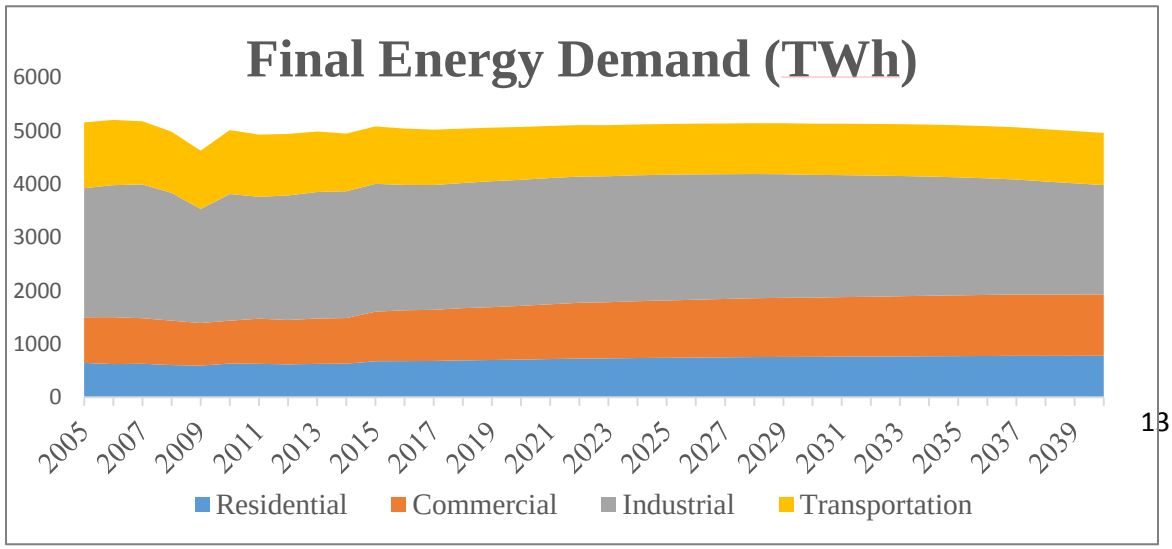

Figure 8

4. Installed Capacity:

Figure 9 gives the total installed capacity for electricity generation in Japan. It rises from 264 GW in 2015 to 348 GW in 2040, unlike India, where we see a 4 to 5 times increase in the installed capacity (refer Report – Overall Energy Scenario of India until 2040). The installed capacity of Japan largely remains constant in 2040 across different scenarios, but the capacity mix would vary depending upon different scenarios. The solar installed capacity would increase from 33.5 GW in 2015 to 71 GW in 2040, whereas the installed capacity of wind would increase from 2.7 GW in 2015 to 9 GW in 2040.

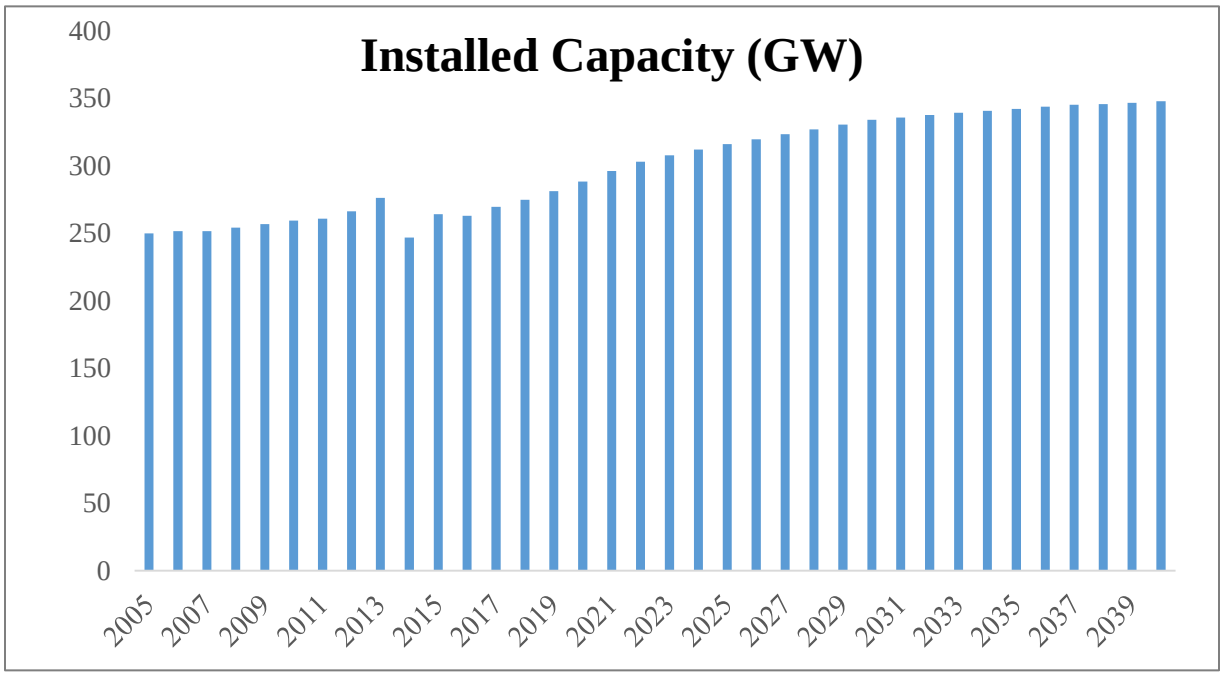

Figure 9

5. Installed Capacity Mix:

Figure 10 below gives the break-up of installed capacity in 2040. The natural gas based installed capacity would rise from 92 GW to 120-130 GW in 2040 in different scenarios. Since, the natural gas prices remain low in Low Gas price scenario, the installed capacity is quite high in this scenario at 128 GW in 2040. The natural gas based capacity is lowest in the High Nuclear scenario (120 GW in 2040) because the nuclear fired power plants would displace the gas based plants in this scenario. The decommissioning of the old nuclear power plants would reduce the installed capacity from 40 GW to 33 GW in 2040 in High Nuclear scenario. The total installed capacity is 348 GW in 2040 in all scenarios, except the Low Renewable Energy (RE) scenario, in which the RE based capacity is at 82 GW in 2040 in comparison with 90 GW in other scenarios because the Low RE scenario assumes that the 80 GW RE target of Japan is met by 2040, which should have been met by 2030 as is the case in other scenarios. The installed capacity of nuclear

is highest in High nuclear scenario with 33 GW in 2040 in comparison with 25 GW in other scenarios. Moreover, the capacity of oil and coal fired power plants reduce from 2015 to 2040 in all the scenarios.

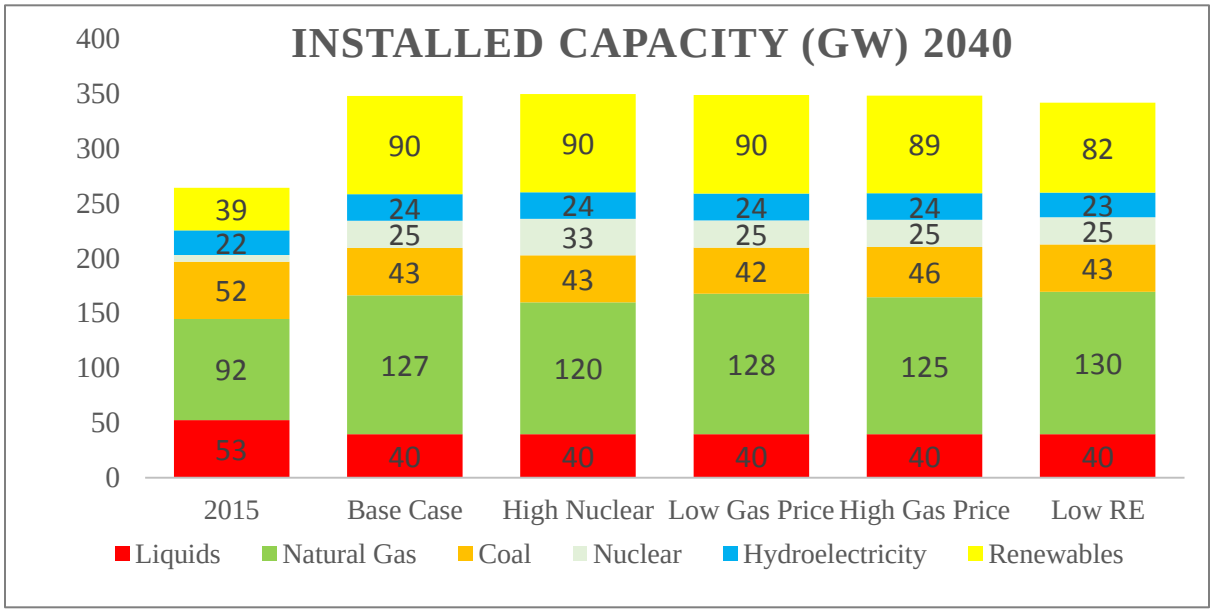

Figure 10

6. Electricity Generation:

Figure 11 shows the electricity generation of Japan till 2040. The electricity generation would grow at a CAGR of 1.32% from 2012-40 and would become 1396 TWh in 2040 from 968 TWh in 2012. Japan has one of the World's most efficient coal fired plants and is a leader in the field of clean coal technology.

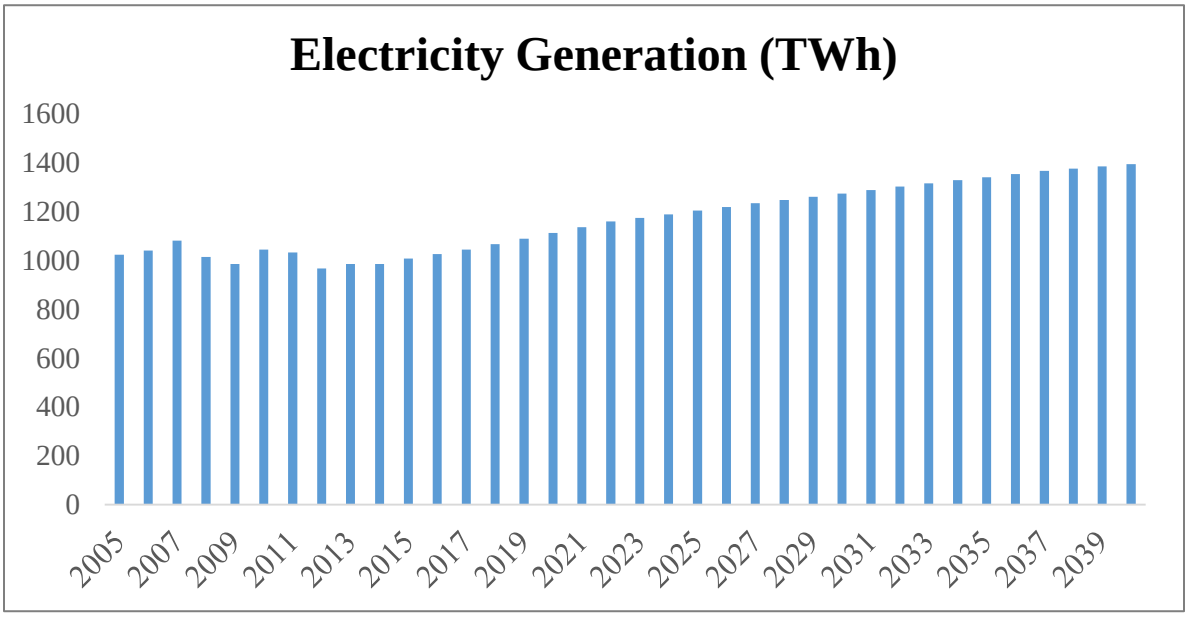

Figure 11

7. Electricity Generation Mix:

Figure 12 gives the electricity mix of Japan in 2040. The majority of electricity in 2040 is projected to be generated from natural gas ranging between 47-53%, which is a higher share than what Japan had in its electricity mix of 2015 (39%). The share of coal fired power plants would reduce from 29% in 2015 to 17%-19% in 2040 which is in line with the Government's agenda of reducing their coal fired plants. Nuclear power accounts for 14% of the electricity generation in 2040 in High Nuclear scenario, whereas the share remains at 10% in 2040 in other scenarios. The share of electricity generation from wind and solar would rise to 5% and 8% in 2040 from 0.5% and 2% in 2015 respectively. Moreover, the share of RE in electricity mix would increase from 6% in 2015 to 14%-15% in 2040.

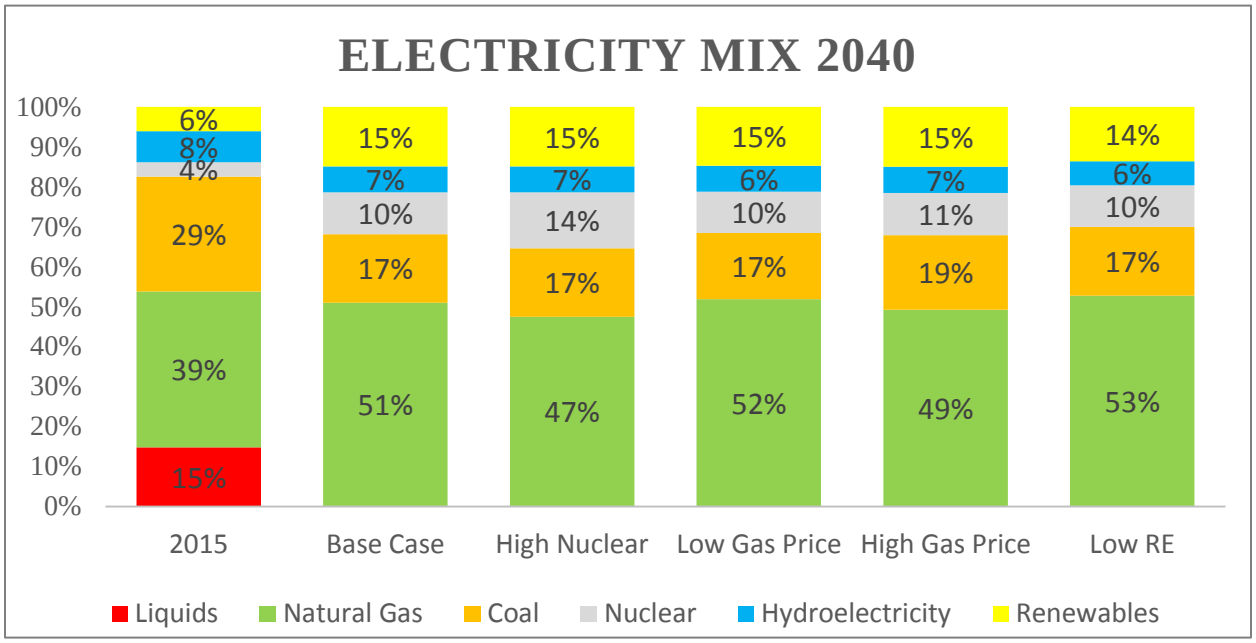

Figure 12

8. Natural Gas Demand in Japan:

Figure 13 gives the sectoral consumption of natural gas in 2040. Natural gas in Japan is primarily used to produce electricity in 2040. When the cost of natural gas goes down in the Low Gas price scenario in comparison with base case, the commercial sector's gas consumption increases by about 24%, power sector by only 2% and residential by 1.4%. The use of natural gas in the power sector does not deviate much because the installed capacity of natural gas power plants does not vary significantly with change in prices. However, it appears that non-electricity energy use in the commercial and residential sector is affected more by changes in the cost of natural gas. The total natural gas consumption is highest in the Low Gas price scenario at 218 BCM in 2040 as the price of natural gas in this scenario is lowest. Whereas, the gas consumption is lowest in High Gas price and High Nuclear scenario with consumption levels of 196-197 BCM in 2040.

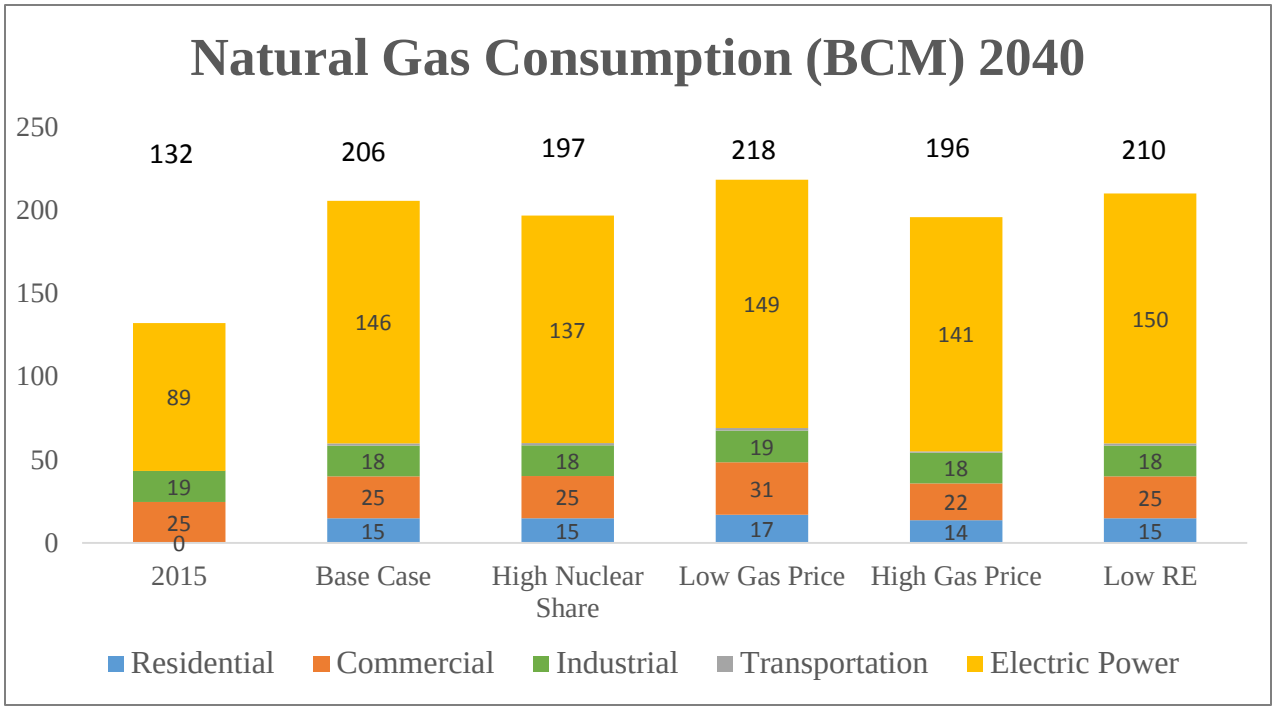

Figure 13

9. GHG Emissions by Japan[1]:

Figure 14 below gives the energy related GHG emissions by Japan till 2040. The GHG emissions would be lowest in the High Nuclear scenario as in this scenario, the electricity generated from natural gas fired power plants is lowest in comparison with other scenarios. Moreover, the highest carbon intensive pathways are the low gas and high gas price scenarios, which are 1.5 % more carbon intensive than the base case. The high gas price results in increased use of coal plants, which causes higher carbon emissions compared to the base case. In the low gas price scenario, despite there being a reduced coal consumption by coal based power plants, there is also lower generation of electricity from carbon free sources like hydro and nuclear, leading to higher emissions from natural gas based power plants.

It is to be noted that the INDCs target of Japan is to reduce the GHG emissions by 26% by 2030 from 2013 levels. However, this study envisages only a 5% reduction in emissions in high nuclear scenario by 2030 from 2013 levels, whereas in other scenarios, the reduction is only 2-4%.

[1] This study takes into account only energy related emissions. In Japan, energy related emissions account for 90% of the total emissions.

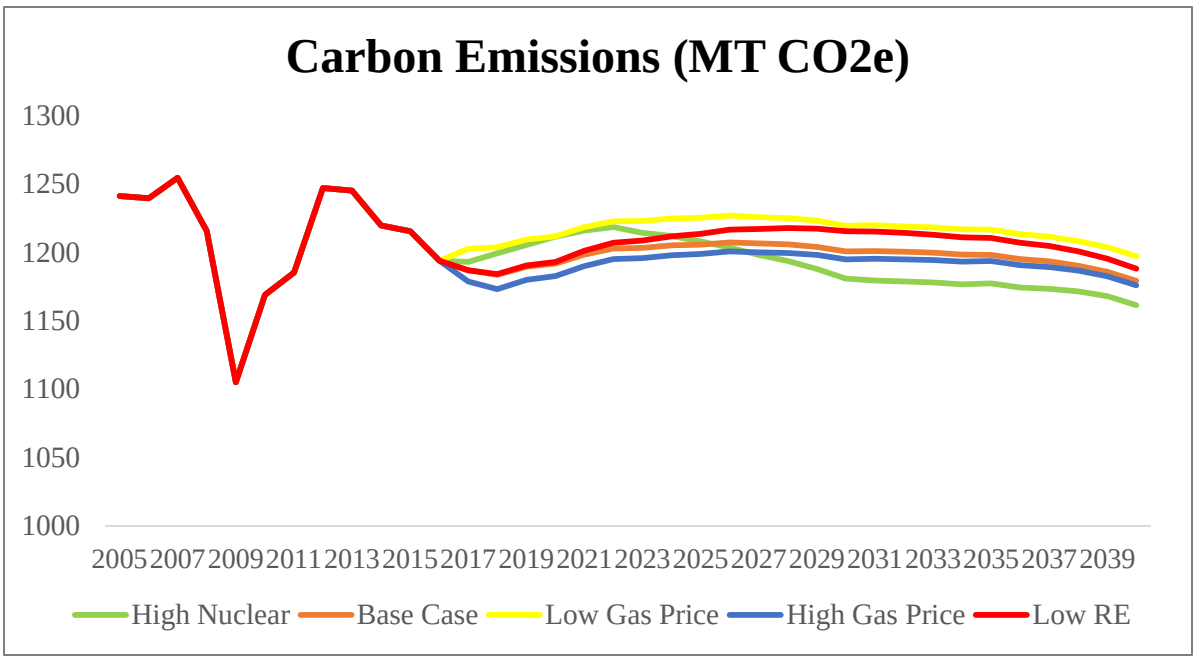

Figure 14

10. Emissions Intensity:

Figure 15 gives the emissions intensity of Japan till 2040. The reduction in emissions intensity is quite similar in all the scenarios. It reduces by 31% by 2040 from 2015 levels.

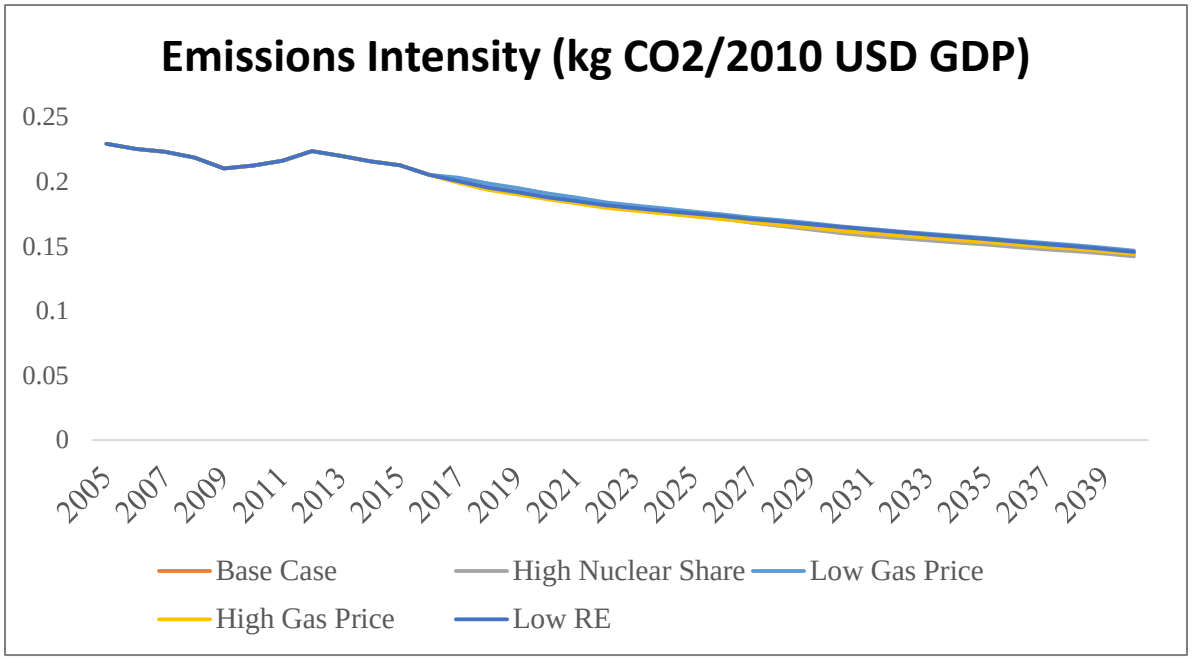

Figure 15

VII. Comparison of the results from WEPS+ and Asia/World Energy Outlook[2]:

The outputs of WEPS+ from this study have been compared with the results in the Asia/World Energy Outlook (AWEO) 2016 (IEEJ, 2016). The AWEO is an annual report prepared by the Institute of Energy Economics, Japan (IEEJ) which studies the scenario of energy sector for Asian countries. We have chosen to compare our results with AWEO as IEEJ, being the premier energy think tank in Japan would have robust insights on the national energy pathways of Japan.

1. Comparison of Macroeconomic Assumptions:

- WEPS+ considers a GDP growth of 1.4% CAGR from 2012-40, whereas the AWEO 2016 considers a GDP growth rate of 1% CAGR from 2012-40.

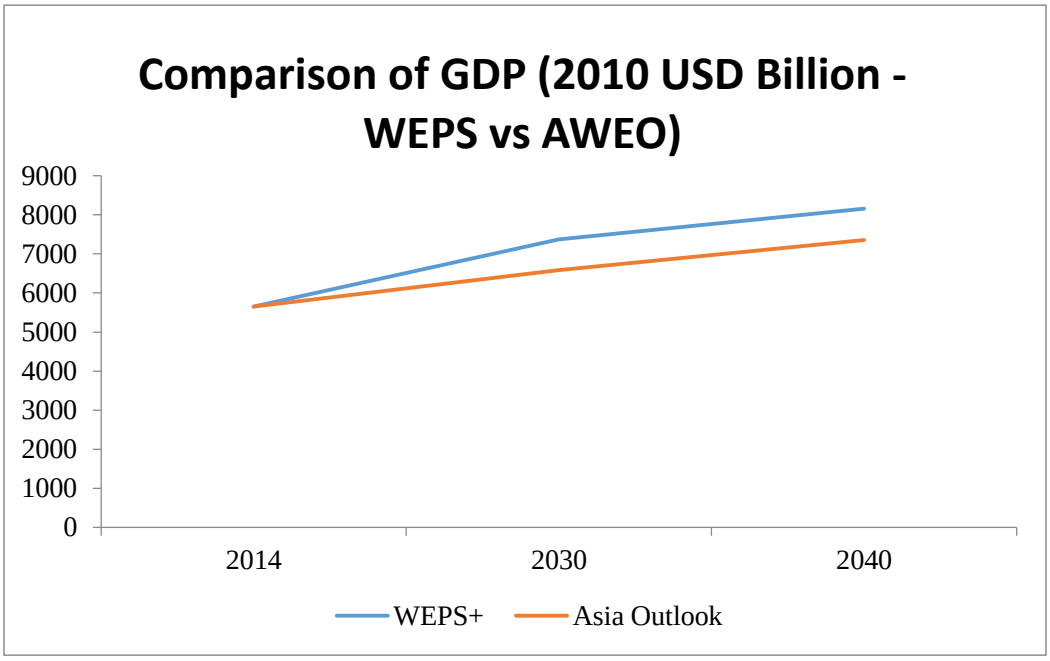

Figure 16

[2] This report compares the base case of WEPS+ modeling exercise and reference case of Asia Energy Outlook 2016.

- The population as per the WEPS+ model is assumed to be 110 million in 2040, whereas the AWEO assumes a slightly higher population of 114 million in 2040.

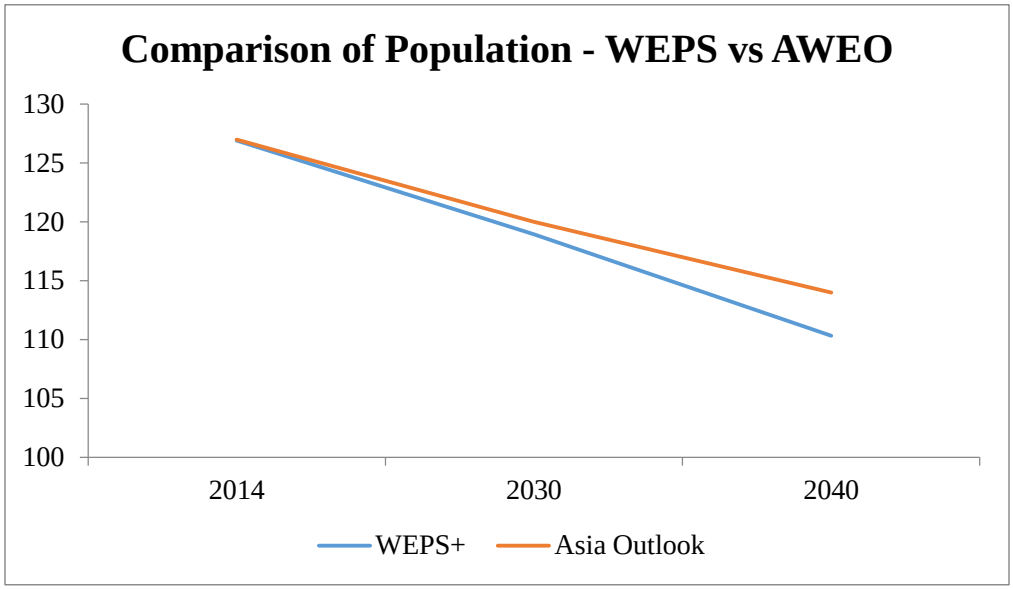

Figure 17

2. Comparison of Primary Energy Demand:

There is a 40% difference in primary energy demand (Figure 18) between the two studies – i.e. the primary energy demand in AWEO 2016 is envisaged to be 40% lesser in 2040 in comparison to what is envisaged in WEPS in 2040. This is primarily due to the decreased GDP growth rate in AEO (1% CAGR from 2012-40) in comparison with WEPS (1.4% CAGR from 2012-40).

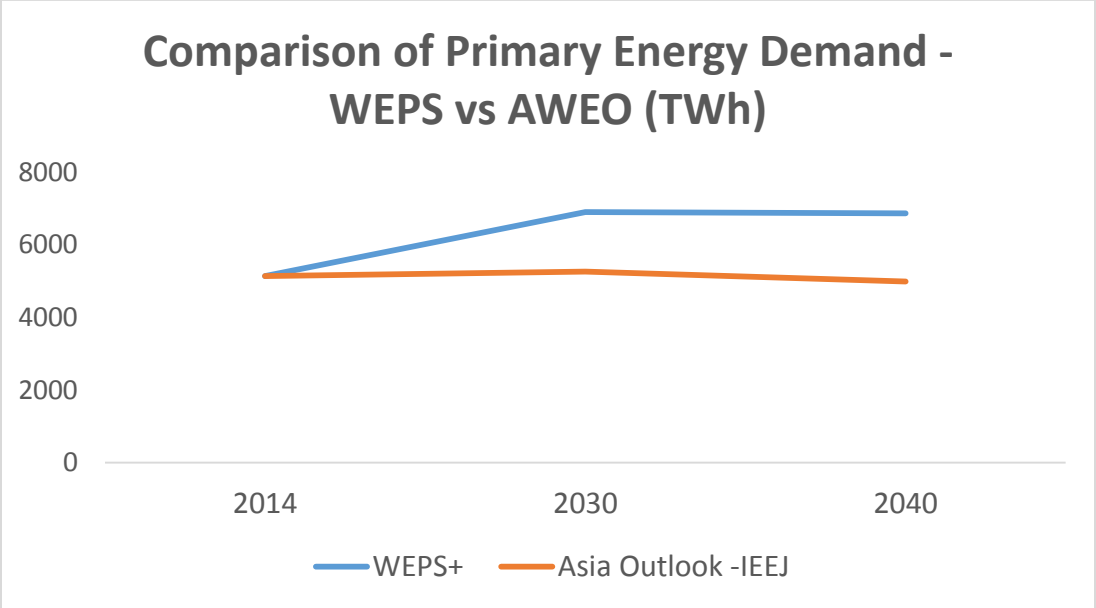

Figure 18

3. Comparison of Primary Energy Mix in 2040:

Figure 19 gives the comparison of primary energy mix in 2040 between the two studies. The primary energy mix of the two studies also varies as the primary energy does. The share of natural gas is 8% higher in WEPS in 2040 when compared to AWEO and that of coal is 8% lower in WEPS in 2040 in comparison with AWEO. The prime reason for the difference is that AWEO might assume that it would be cheaper to import coal than natural gas due to which the share of coal is higher in AWEO when compared to WEPS in 2040. Similarly, WEPS envisages a higher share of renewables in energy mix i.e. 15% in 2040 in comparison with 9% in AWEO in 2040. This is so because, AWEO might have weighed heavily on the fact that Japan does not have enough land for renewables.

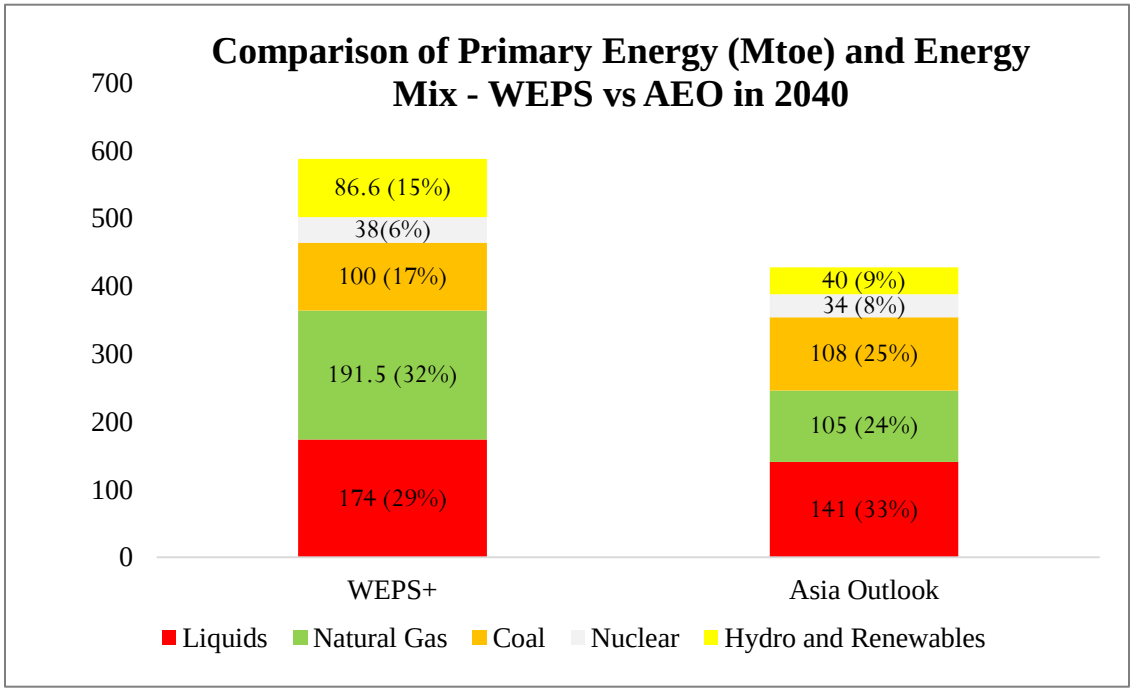

Figure 19

4. Comparison of Electricity Generation (TWh) and Electricity Mix in 2040:

Figure 20 compares the Electricity Generation and Electricity Mix in 2040 for WEPS and AWEO. A trend similar to the energy mix is also seen in the electricity mix when the results from WEPS and AWEO are compared. The share of natural gas in electricity generation is around 14% higher in WEPS in 2040 when compared with AWEO and the share of coal in electricity mix is 9% lower in WEPS in 2040 when compared to AWEO. The primary reason for the difference is that the AWEO would have assumed that it would be cheaper to import coal than natural gas due to which the share of gas in electricity generation is lower in AWEO in comparison with WEPS.

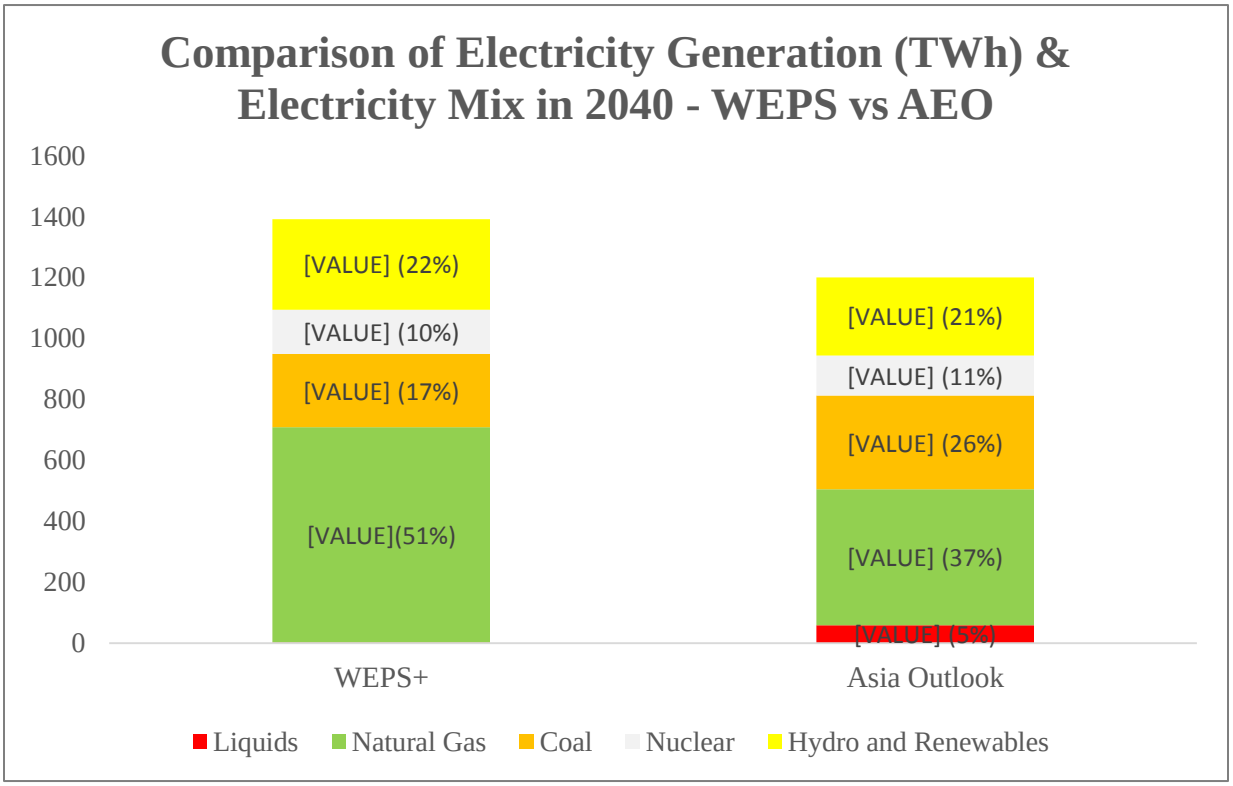

Figure 20

5. Comparison of Per Capita Emissions:

Figure 21 gives a comparison of per capita emissions for WEPS and AWEO. The per capita emissions are higher in WEPS exercise because it assumes a higher GDP growth rate which results in more energy usage than AWEO. Therefore, there is 17% increase in per capita emissions in WEPS in 2040 when compared with AWEO.

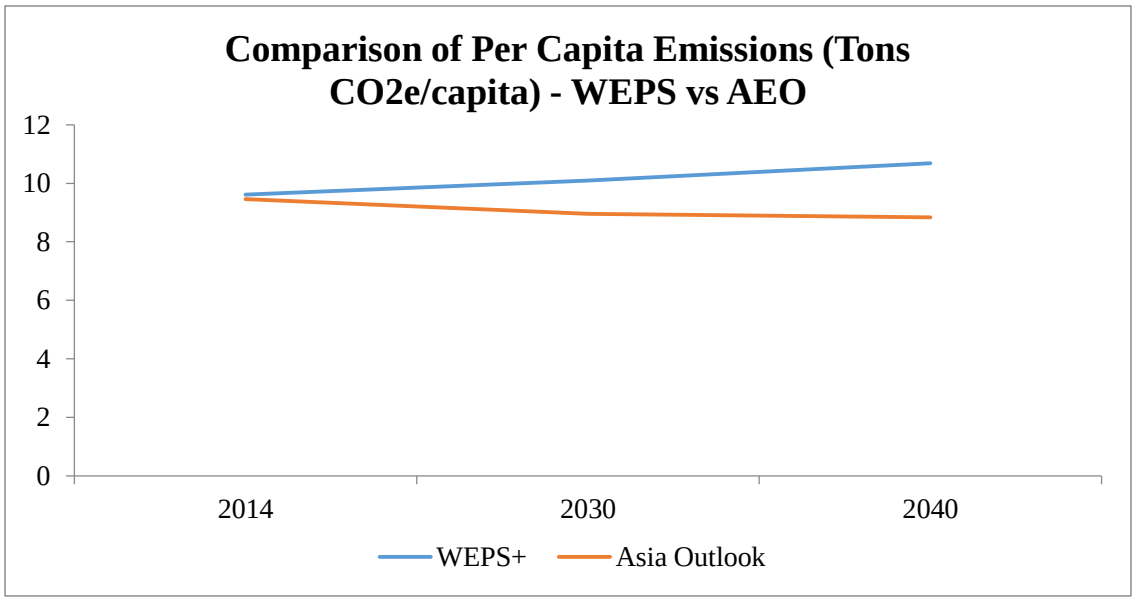

Figure 21

VIII. Key Takeaways:

It can be inferred from the above exercise that the energy demand of Japan has largely saturated as it is a highly efficient and developed economy. Even in 2040, the rise in primary energy demand is marginal, i.e. a CAGR of 0.46% from 2012-40. However, there is a scope of varying energy and electricity mix for Japan depending on the pathway it chooses to meet its future energy requirements.

The above will largely depend on two key factors – whether Japan will be able to reinstate its nuclear power fleet and the impact of international prices of LNG, coal and crude oil. It is really commendable to see how Japan has managed its energy needs, when it imports 92% of its primary energy requirement. This was also the case when the global crude oil and natural gas prices were at their peak in 2012 to mid-2014. Japan has been focusing on Energy Efficiency which forms the cornerstone of their energy strategy and has helped them to absorb the volatile prices of primary fuels. Apart from above, following are the key takeaways:

1. The share of nuclear in the energy mix of Japan has fallen down from a high of 14% in 2010 to negligible in 2015 because the entire nuclear fleet of Japan was almost shut down post Fukushima tragedy in March, 2011.

2. The prices of primary energy sources i.e. coal, oil and gas (imported as LNG) are market determined depending on International market prices and Government does not interfere with the prices. The Government also introduced new reforms in the gas retail sector (came into force on 1st April, 2017) in order to increase the competition which is likely to result in lower gas prices for consumers and giving them the choice to choose their suppliers and expanding the pipeline infrastructure along with an aim to secure natural gas supplies.

3. The primary energy mix of Japan is not envisaged to change much in 2040. There are little variations in different sources of energy in the final energy mix in 2040 in different scenarios. (refer Figure 7)

4. Industrial sector would continue to account for a major share in the final energy demand (47% in 2015 to 41% in 2040) as manufacturing accounts for around a quarter of share in GDP of Japan. Whereas, the share of residential and commercial sector would gradually increase from 13% to 16% and 18% to 23% from 2015-40 respectively. And the share of transport would slightly decline from 21% in 2015 to 19.7% in 2040.

5. Japan is much likely to bring its nuclear capacity on-stream and the share of nuclear in electricity mix is likely to be in the range of 10%-14% depending on the scenario. But, natural gas would continue to play an important role in Japan's electricity mix and its share is likely to rise from 39% in 2015 to 47%-53% in 2040 depending on the scenarios.

6. Japan is already the world's largest LNG importer with 85 MT of imports in 2015 and the demand for natural gas is going to increase by 2040. The table below gives a brief summary on Natural gas scenario of Japan:

Natural Gas Demand in Japan		
Parameter	**2015**	**2040 (Ranges)**
Natural Gas Demand (BCM)	**132**	**196-218**
Share of natural gas in energy mix	**26%**	**31%-34%**
Share of natural gas in electricity mix	**39%**	**47%-53%**

Table 3

7. The emissions of Japan are likely to remain flat between 2015 and 2040 (around 1200 MT – refer figure 14). However, Japan has a target to reduce its emissions by 26% by 2030 from 2013 levels as committed at COP 21, the modeling exercise suggests that it would be difficulty for Japan to meet its targets. The highest reduction of 5% over the target period (2013 to 2040) is envisaged in high nuclear scenario, whereas the reduction in other scenarios is in the range of 2%-4%. The per capita emissions of Japan are likely to rise marginally, from 9.5 tons CO_2e/capita in 2015 to 10.7 tons CO_2e/capita in 2040 and 10.2 tons CO_2e/capita in 2030.

IX. References:

BP. 2016. “BP Statistical Review of World Energy 2016”. London: British Petroleum

EIA. 2015. “Japan: International Energy Data and Analysis, U.S Energy Information Administration, January 2015”. United States: EIA, Government of the United States

EIA. 2016. “World Energy Projection System Plus: Commercial Module, August 2016”. United States: EIA, Government of the United States

IEA. 2016. “Energy Policies of IEA Countries: Japan 2016 Review”. Paris: International Energy Agency

IEA. 2016. “World Energy Outlook 2016”. Paris: International Energy Agency

IEEJ. 2014. “Economic and Energy Outlook of Japan for FY2015, The Institute of Energy Economics, Japan, December 2014”. Tokyo: IEEJ

IEEJ. 2016. “Asia/World Energy Outlook 2016, Executive Summary, The Institute of Energy Economics, Japan”. Tokyo: IEEJ

PPAC. 2016. “Domestic Natural Gas Price October 2016 – March 2017”. New Delhi: PPAC, Ministry of Petroleum and Natural Gas, Government of India

The Oxford Institute for Energy Studies. 2012. “Natural Gas in India: Liberalization and Policy”. Anil Kumar Jain, University of Oxford, The Oxford Institute for Energy Studies

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