

## **Outcome of the modelling results on Overall Energy Scenario of Japan**

Uni-variate & Multivariate modelling of Auto-Regressive Integrated Moving Average (ARIMA) Model and Macroeconomic model structure have been used for projecting overall energy scenario of Japan. The reference scenario (policy as usual) and advanced technology scenario (energy efficient technology policy) has been considered for the projections. These scenarios have been created by assuming following macro-economic indicator of the Japan.

- GDP: 1.4% (CAGR) Growth 2012-2047,
- Population: 1.2 Billion (2012) - 1.05 Billion (2047),
- Urbanization: 92% (2012) - 97% (2047)
- Share of Manufacturing: 18% (2012) – 20% (2047).

**Primary Energy Consumption:** In Japan Primary Energy Consumption (PEC) will decrease from 442 Mtoe to 429 Mtoe during 2014-2047 in reference scenario (RS), while PEC will be 395 Mtoe in 2047 in advance technology scenario (ATS). Therefore, there will be 8% less consumption of primary energy in Japan in ATS as compare to reference scenario from 2014-2047.

Further, oil & coal will be major contributor in primary energy, as there share will be 31% to 33% and 23% to 25% in PEC of Japan in advance & reference scenario in 2047. Share of natural gas will be 18% to 25% in PEC of Japan in 2047. Meanwhile, nuclear energy share will increase from 0% to 8-14% in PEC from 2014-2047 in ATS. The renewable energy contribution will be 8% to 11% by 2047.

**Final Energy Consumption (Sources):** Final Energy Consumption (FEC) by sources (i.e. coal, oil, natural gas, electricity and renewable energy) will decrease from 296 Mtoe to 279 Mtoe during 2014-2047 in reference scenario (RS), while it will be 248 Mtoe in advance technology scenario (ATS). Therefore, there will be 16% less consumption of final energy in ATS and 8% less consumption in reference scenario from 2014-2047.

Further, oil & electricity sources will be major contributor in FEC till 2047, as there share will be 40% to 42% and 34% in FEC of Japan in advance & reference scenario in 2047. Share of natural gas will remain i.e. 12% in FEC in 2047 under both scenario. Meanwhile, share of coal will be 9% & renewable energy will be 2% in 2047 in FEC under ATS.

**Final Energy Consumption (Sectors):** Industry and Buildings will consume 33% to 35% energy from 2014-2047 under ATS & RS. Meanwhile, the share of transport sector in energy consumption will be 19% to 24% during same period in same scenario.

**Fossil Fuel Energy Vs Clean Energy:** The share of fossil fuel energy will decrease from 95% to 82% during 2014-2047 under reference scenario, while it is projected to be 73% in 2047 under ATS. Moreover, clean energy share will increase from 5% to 18% from 2014-2047 under reference scenario and 27% in 2047 under ATS. It may be mentioned that under INDC commitment, Japan Government has given target of 48% share of clean energy (22% to 24% nuclear energy & 22% to 24% renewable energy) by 2030.

**Power Generation Mix:** The natural gas based power generation will decrease from 41% to 37% during 2014-2047 under reference scenario and 26% in 2047 under ATS, while coal based generation will decreased from 34% to 26% under reference scenario and 22% under ATS during same period. Meanwhile, oil based generation will drastically reduce from 11% to 5% under both scenario during 2014-2047.

The nuclear based generation will increase from 0% to 20% and renewable based generation will increase from 7% to 18% under ATS. The nuclear based generation however, will depend on local residence response and nuclear safety issues which are challenged in different courts of the Japan.

Japan will save 1203 Twh energy during 2014-2047 in reference scenario and 1059 Twh energy during same period in ATS due to energy efficiency and demand side measurements.

**Power Generation Mix Scenario:** Future of nuclear energy is uncertain due to great earthquake in Japan in 2011 and Japan has recently started renewable energy installation. Under new feed in tariff policy for renewable energy in Japan, Japan has started picking up renewable energy realization path. Therefore, to observe the nuclear energy and renewable energy response in total power generation mix scenario of Japan, three power generation mix scenario has been created.

**Scenario-1: High Renewable Low Nuclear Scenario:** Under this scenario renewable energy is projected to increase from 15% to 21% during 2014-2047 and nuclear energy 0% to 11% under reference scenario, while under ATS, renewable energy is likely to increase to 30% and nuclear energy 20% in 2047.

**Scenario-2: High Nuclear Low Renewable:** Under this scenario nuclear energy has been projected to increase from 0% to 21% and renewable energy is likely to decrease from 15% to 11% during 2014-2047 under reference scenario, while under ATS, renewable energy is projected to decrease to 20% and nuclear energy to increase to 30% in 2047.

***In both scenario 1 & 2,*** thermal energy contribution is projected to reduce from 85% to 68% during 2014-2047 under reference scenario and to 50% under ATS during the same period.

**Scenario-3: Moderate Nuclear and Moderate Renewable:** Under this scenario, equal share of renewable energy and nuclear energy has been assumed i.e. 0% to 30% nuclear energy and 15% to 30% (renewable energy) during 2014-2047 under reference scenario and 0% to 31% nuclear energy and 15% to 31% renewable energy during same period under ATS. Therefore, thermal energy contribution is projected to reduce from 85% to 40% during 2014-2047 under reference scenario while, thermal energy contribution under ATS will reduce to 38% by 2047 under ATS.

***Scenario 3 is close to INDC target of power generation mix scenario of Japan.***

**Energy Self Sufficiency:** The energy self sufficiency of Japan will increased from 7% to 11% in reference scenario during 2014-2047 and 15% in ATS. However, Japan will not be even 25% energy self-sufficient by 2047. Japan has given a lot of focus on renewable energy and energy efficiency in its energy policy 2014 and it is aiming to achieve 25% energy sufficiency by 2030. Japan is also exploring next generation fuels to become more energy self-sufficient in future.

**Emission:** There will be 26% emission reduction in 2047 from 2013 base level in reference scenario and 35% emission reduction during the same period under ATS. However, under INDC commitment, Japan has given 26% emission reduction target in 2030 from 2013 base level which seems to be in synergy with ATS. Due to energy efficiency and demand side management, it is possible that Japan may not only achieve 26% emission reduction target but even surpass it.