

# JAPAN

- Japan's primary energy demand is expected to grow at an annual rate of 0.5 percent over the outlook period.
- The oil dependency of the economy will decrease from 50 percent in 2002 to 42 percent in 2030. Natural gas and nuclear will increase their share to replace oil in the energy mix.
- CO<sub>2</sub> emissions in 2010 from energy consumption are projected to be about 10 percent higher than the Kyoto target.

## RECENT ENERGY TRENDS AND ENERGY POLICY

In parallel with Japan's recovery from a decade long recession in the 1990s, energy consumption has increased at 1.4 percent per year between 2001 and 2004, at a slightly faster rate than that of the previous decade of 1.0 percent. In spite of the faster growth, the energy elasticity to GDP was lower at 0.82 in recent years, compared with that of 1.1 over the past decade. The lowering of GDP elasticity is as a result of the introduction of advanced technologies, and improvements in operational efficiency in the energy transformation, transportation and end-use sectors.

Between 2001 and 2004, the trend of energy consumption growth has shown substantial differences by source. Oil declined yearly at 0.4 percent due to the continued fuel switching efforts by the electricity and industry sectors. Natural gas increased by 2.9 percent per year, driven mainly by the industry sector for use in on-site cogeneration systems. Nuclear declined at an annual rate of 4.1 percent due to the suspension of operations for safety inspections in 2003 and 2004.<sup>57</sup> Among the energy sources, coal, the main fuel for electricity generation, has increased at the fastest annual growth rate of 5.7 percent, due partly to the electricity companies' increased coal consumption to make up for the loss from nuclear power generation, and partly to reduce generation costs amid a deregulation of electricity industry.

The increase in energy consumption growth, combined with the rise in the use of coal for electricity generation, has resulted in higher CO<sub>2</sub> emissions over recent years. Between 2001 and 2004, CO<sub>2</sub> emissions from the energy sector have increased annually at 2.0 percent, compared with that of 0.7 percent during the 1990s. Japan has ratified the Kyoto Protocol, and is committed to reduce CO<sub>2</sub> emissions to 6 percent below that of the 1990

emissions level between 2008 and 2012. In 2004, Japan's CO<sub>2</sub> emissions from the energy sector have already surpassed that of its 1990 emissions level by 15 percent.

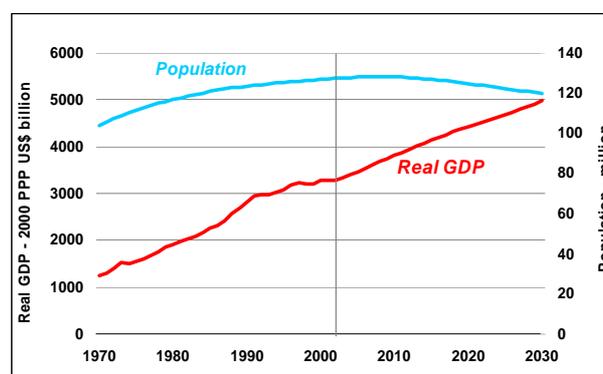
Therefore, meeting the Kyoto target will be a difficult challenge for the economy as a whole. The challenge may be even greater for the electricity industry which is currently undergoing market liberalisation. Rising LNG prices, in parallel with rising crude oil prices in the future will make it difficult for the electricity industry to curb CO<sub>2</sub> emissions as carbon intensive coal has become the preferred option due to its cost competitiveness.

## ENERGY DEMAND DRIVERS

Over the outlook period, Japan's economy is expected to grow at an annual rate of 1.5 percent. The near-term growth to 2015 is expected to be fast at 1.8 percent per year, driven by growth in the services sector.

Population is projected to contract by an average rate of 0.2 percent per year (2002-2030), compared with the growth of 0.4 percent between 1980 and 2002. The population started to decline in 2005, and the declining trend is expected to continue towards the end of the outlook period.

Figure 44 GDP and Population



Source: Global Insights (2005)

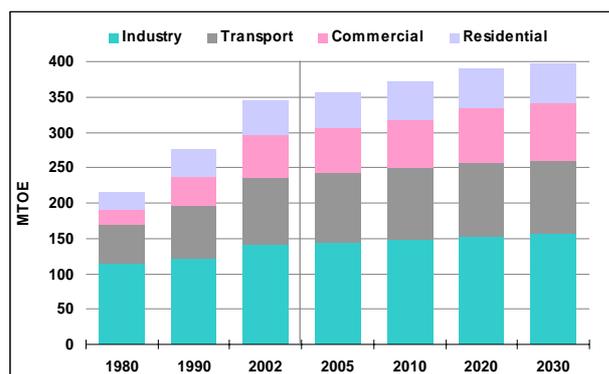
<sup>57</sup> In 2002, Tokyo Electric Power Company (TEPCO) was found to have falsified their safety reports in the later half of 1980s and during 1990. The incident has led to the suspension of operation of about 17 nuclear units for several months starting at the latter half of 2003.

## OUTLOOK

### FINAL ENERGY DEMAND

Over the outlook period, final energy demand is projected to grow at 0.5 percent per year, compared with annual growth in the previous two decades of 2.2 percent. The commercial sector is expected to grow at the fastest rate of 1.0 percent per year through 2030, followed by residential at 0.5 percent, industry at 0.4 percent and transport at 0.4 percent.

Figure 45 Final Energy Demand



Source: APERC Analysis (2006)

### Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 0.4 percent until 2030, lower than the 1.0 percent observed over the past two decades. The shift of industry structure from an energy-intensive to non-energy-intensive structure<sup>58</sup> and the sluggish growth in materials production is expected to lower the projected growth in energy demand in the sector. Japan's business community's strong measures for energy conservation, such as the "Keidanren (Japanese Business Federation) Voluntary Action Plan on Environment"<sup>59</sup> are also expected to contribute to reducing energy demand growth. Consequently, energy intensity<sup>60</sup> in the industrial sector is projected to decline at an average annual rate

<sup>58</sup> Industrial sector's share to total value of output declined from 36 percent in 1980 to 30 percent in 2002, while that for the service sectors increased from 65 percent to 70 percent. Over the outlook period, the share of the industrial sector is projected to decline further to 29 percent in 2030, whereas that for the service sectors will rise to 71 percent, and that the share of energy-intensive-industries within industrial value-added will also decline from 23 percent in 2002 to 22 percent in 2030..

<sup>59</sup> The plan is aimed at reducing CO<sub>2</sub> emissions by industry and transformation sectors below their 1990 levels in 2010 by setting reduction targets in each industry category. The reduction targets in energy consumption through voluntary actions by industries are: iron and steel by 10 percent; chemicals by 10 percent; paper and pulp by 10 percent; and cement by 3 percent.

<sup>60</sup> The amount of energy needed to produce a dollar's worth of industrial sector's value added.

of 1.1 percent, reaching 102 toe per US\$ million in 2030 from 140 toe per US\$ million in 2002.

Petroleum products are projected to maintain the largest share of industrial energy demand throughout the outlook period, but with a declining share, from 50 percent in 2002 to 44 percent in 2030. The decline is as a result of the gradual substitution of fuel oil by natural gas and slow growth of naphtha demand.<sup>61</sup> By contrast, natural gas is projected to represent the highest growth rate of 2.1 percent per year, the share increasing from 7 percent in 2002 to 12 percent in 2030. Robust growth in natural gas demand is expected as more industries install modern gas-turbine cogeneration systems (combined heat and electricity) to comply with the CO<sub>2</sub> emissions reduction target. Coal demand is projected to decline by 0.1 percent per year as crude steel production, the main consumer of coking coal, is projected to decline by 0.4 percent over the outlook period. Electricity, the second-largest energy source for the industrial sector, is likely to increase its share from 26 percent in 2002 to 30 percent in 2030 as non-energy-intensive industries such as mechanical and IT industries utilise more electrical equipment. The share of renewable energy is projected to remain fairly constant at 2.0 percent over the outlook period. Biomass, which is largely used in cogeneration, particularly by the paper and pulp industry, will account for almost all of the demand for renewable energy.

### Transport

Over the outlook period, energy demand in the transport sector is projected to grow at an annual rate of 0.4 percent per year, compared with the previous two decades at 2.5 percent per year. Near term growth to 2010 is projected to be faster at 1.1 percent, slowing down to 0.2 percent between 2010 and 2020. Due to the decline in population, transport energy demand is expected to reach its peak sometime in 2025 and decline thereafter by an annual rate of 0.1 percent to the end of outlook period.

Energy demand for road transport is projected to increase by an annual rate of 0.2 percent, maintaining the largest share at around 78 percent of the total transport energy demand. Gasoline for passenger vehicles is expected to increase by 0.5 percent per year, compared with that of 2.6 percent in the

<sup>61</sup> Between 1980 and 2002, production of ethylene increased at an annual rate of 2.5 percent, and Japan is currently posted as the world's second-largest producer of ethylene with a production capacity of about 7.2 million tonnes per year. However, future production of ethylene is projected to increase slowly from the current 7.4 million tonnes to 7.6 million tonnes by 2010, then stay at that level through 2030. This would result in the slow growth for naphtha demand as a feed stock for ethylene production.

previous two decades. The stock of passenger vehicles will reach the highest level of 62 million units in 2013, and then decline at an annual rate of 0.3 percent to the end of the outlook period. Despite declining passenger vehicle stocks, gasoline demand per passenger vehicle is expected to increase slightly by an annual rate of 0.2 percent. Vehicle efficiency improvement will be offset by the increasing share of large-sized vehicles, and reducing share of medium-sized vehicles. Demand of diesel for freight trucks is expected to decline annually at 0.2 percent (2002-2030). Continued improvements in operational efficiency by freight truck owners, combined with slow economic growth towards the end of the outlook period will result in the aforementioned decline in diesel demand.

**Residential and Commercial**

Japan’s residential energy demand is expected to grow annually at 0.5 percent, at a slower rate compared with the previous two decades of 3.0 percent per year. Since the energy mix in the residential sector has already been diversified, not much difference is expected from the current situation over the outlook period. Since 1990, electricity has accounted for the largest share in total residential energy demand due to the increase in the household ownership of electric appliances such as air conditioners, refrigerators and televisions. As the total number of households is expected to reach the highest level in 2015 and decline thereafter, electricity demand is projected to grow at 0.6 percent per year, which is a slower rate than the 3.8 percent annual growth rate observed during the past two decades. Among the energy sources, natural gas is expected to grow the fastest at 1.3 percent per year in the total residential energy demand.

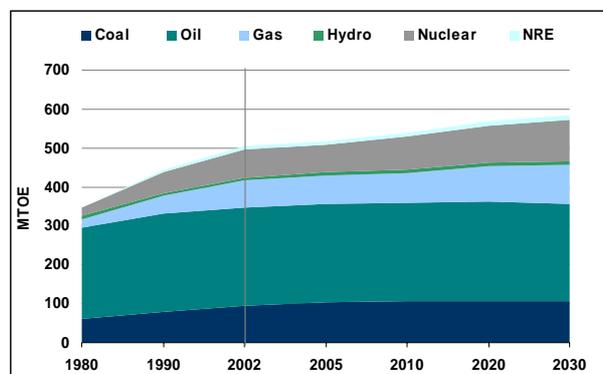
Reflecting the slow growth in floor space and implementation of energy efficiency programmes in the commercial sector, energy demand for the commercial sector is expected to grow at an annual rate of 1.0 percent, a significantly slower rate than the previous two decades at 5.0 percent per year. Electricity is projected to grow by 1.5 percent annually, supported by the increase in demand for cooling and lighting in commercial buildings. Natural gas is expected to grow at the fastest rate of 1.8 percent per year, replacing diesel oil as a feedstock for standby generators in commercial buildings.

**PRIMARY ENERGY DEMAND**

Japan’s primary energy demand is projected to grow at an annual rate of 0.5 percent through 2030. New and renewable energy is expected to grow at the fastest rate of 2.1 percent per year. However, the share in total primary energy demand is projected to

remain small at around 2.0 percent. Nuclear will be the second fastest growing energy source, at an annual rate of 1.4 percent, followed by natural gas at 1.3 percent, and coal at 0.4 percent. Demand for oil is projected to decline at an annual rate of 0.1 percent through 2030.

*Figure 46 Primary Energy Demand*

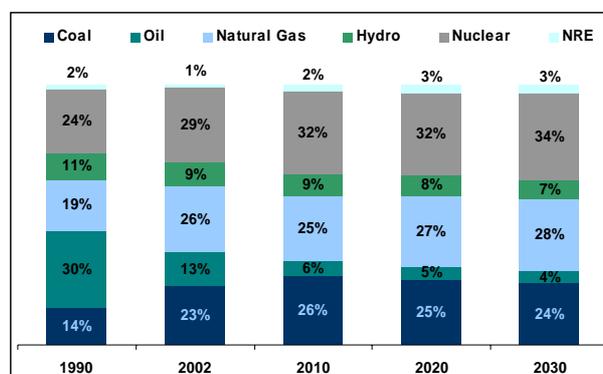


Source: APERC Analysis (2006)

**ELECTRICITY**

Electricity demand is expected to increase by an annual rate of 0.9 percent over the outlook period. Electricity demand from the commercial sector is expected to show the fastest growth at 1.5 percent per year, followed by industry at 0.9 percent and residential at 0.6 percent.

*Figure 47 Electricity Generation Mix*



Source: APERC Analysis (2006)

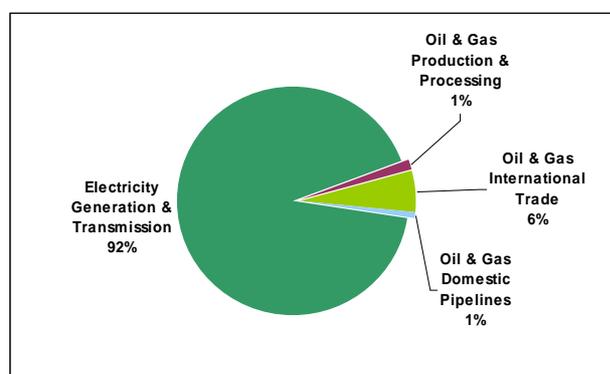
In conjunction with the economy’s energy policy goal to reduce energy imports, the share of nuclear in the electricity generation mix is projected to increase from 29 percent in 2002 to 34 percent in 2030 with an estimated addition of 12 GW of installed capacity. The share of coal in 2030 is expected to be around 24 percent, compared with 14 percent in 1990, as electricity companies favour coal over other energy sources due to cost competitiveness. The share of natural gas in the electricity generation mix is expected to increase from 26 percent in 2002 to 28 percent in 2030. Electricity generation from new and

renewable sources is expected to grow the fastest at a rate of 5.2 percent per year, but the share will remain low at around 2 to 3 percent. The share of oil is expected to decline from 13 percent in 2002 to 4 percent in 2030.

### INVESTMENT REQUIREMENTS

To meet the projected growth in energy demand, Japan will have to develop energy infrastructure with a total investment of between US\$116.5-141.8 billion over the outlook period. The majority of the investment requirements are expected to be allocated to the development of electricity generation and transmission infrastructure, accounting for about 92 percent of total investment requirements in the same period.

Figure 48 Investment Requirements

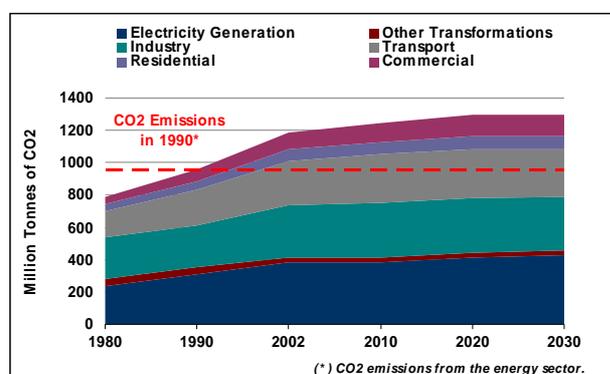


Source: APERC Analysis (2006)

### CO<sub>2</sub> EMISSIONS

CO<sub>2</sub> emissions from the energy sector are projected to increase from 1,186 million tonnes of CO<sub>2</sub> in 2002 to 1,294 million tonnes of CO<sub>2</sub> in 2030. The electricity and industry sectors are the biggest contributors, together accounting for 52 percent of total incremental growth in CO<sub>2</sub> emissions between 2002 and 2030.

Figure 49 CO<sub>2</sub> Emissions by Sector



Source: APERC Analysis (2006)

## MAJOR ISSUES

### OIL SUPPLY SECURITY

After the two oil shocks in 1973 and 1980, Japan has implemented policy measures to diversify energy sources away from oil, diversify energy import supply sources, and improve energy efficiency to restrain energy demand growth. As a result of these policies, Japan has successfully reduced the share of oil in total primary energy demand from 77 percent in 1973 to 50 percent in 2002. Over the outlook period, the share of oil is projected to decline further to 42 percent by 2030.

Despite oil's declining share in the primary energy mix, dependence on the Middle East is expected to rise as imports from Asia - such as Indonesia and Malaysia - decline. As an option to diversify crude oil supply sources, the government has been negotiating with Russia to import oil from Angarsk. Japan has encouraged local private companies to get involved in upstream oil development projects overseas. To facilitate the establishment of a private internationally competitive upstream exploration and development company, government has undertaken the public listing of INPEX, a formerly government owned company.

### DEREGULATION OF THE ENERGY INDUSTRY AND MEETING THE KYOTO TARGET

Japan's energy industry has been undergoing a major transformation since deregulation of the oil industry started in 1985 and the electricity and gas industry in 1995. About 40 percent of the electricity market is open to competition, and about 45 percent of the gas market has been liberalised as of 2006. The oil market has been completely liberalised since 1994. As a result of liberalisations, energy industries are trying to improve their operational efficiency, and find sources that can reduce supply costs.

Coupled with the competitive pressures to reduce costs, the energy industry in Japan is also faced with the difficult challenge of meeting the Kyoto target. The challenge is expected to be greater for the electricity industry as carbon intensive coal has become the fuel of choice in the near-term, due to its cost competitiveness against LNG. Over the outlook period, CO<sub>2</sub> emissions from electricity generation alone are likely to increase by about 30 percent by 2010, compared with that of the 1990 level.

## IMPLICATIONS

Japan seeks to simultaneously achieve the energy policy goals of: 1) enhancement of energy security, 2) improvement of economic efficiency of energy

supply and 3) protection of environment. It is a challenging task for Japan's energy industry as these policy goals often contradict each other.

Japan's energy industry may have to find the most cost effective options to diversify energy sources away from the Middle East and to improve the economic efficiency of energy supply. However, the discussion with Russia on the oil supply from Angarsk through pipeline seems primarily driven by the goal to enhance energy supply security rather than the improvement of economic efficiency. Policy makers would have to continue making efforts to place all the options for energy supply sources on the table, and involve stake holders, including energy industries in the neighbouring economies, to harmonise various institutional interests.

In addition, Japan's energy industry is faced with a challenge to meet the Kyoto target. As the marginal cost of emissions reduction in Japan is rising in parallel with increases in energy prices, the energy industry will have to find other options aside from measures adopted in the domestic market. These would include emissions trading, and overseas GHG emissions reduction projects such as Joint Implementation and Clean Development Mechanism.

## REFERENCES

- APERC (2005). *APEC Energy Overview 2005*. Tokyo.
- EDMC (2005). *Handbook of Energy & Economic Statistics in Japan*. The Institute of Energy Economics, Japan. Tokyo.
- EDMC (2006). *APEC Energy Database*. Energy Data and Modelling Center, Institute of Energy Economics, Japan. Website: [www.ieej.or.jp/apec](http://www.ieej.or.jp/apec).
- Ministry of Economy, Trade and Industry (2005). *Japan's Energy Demand and Supply Outlook*. (in Japanese)