

# CHINESE TAIPEI

- Chinese Taipei's primary energy demand is projected to grow at 2.4 percent annually; owed mainly to growth in the industry and transport sectors; high dependence on energy intensive industries has made it difficult for the economy to decouple energy consumption from economic growth.
- Chinese Taipei is expected to expand the utilisation of renewables and import more coal and natural gas as a result of the constraints placed on the economy by the Non-Nuclear Homeland policy.
- Energy security (high dependence on oil imports), lack of investment in infrastructure development to meet high energy demand, increasing CO<sub>2</sub> emissions, and the quest for alternative fuels to replace nuclear will remain the economy's major areas of concern over the outlook period.

## RECENT ENERGY TRENDS AND ENERGY POLICY

Chinese Taipei's primary energy consumption grew annually at 5.9 percent, from 83.1 Mtoe in 2000 to 98.6 Mtoe in 2003, mainly as a result of increased consumption of natural gas and coal in the electricity sector. Natural gas consumption increased from 5.5 Mtoe in 2000 to 7.2 Mtoe in 2003 and likewise coal consumption increased from 29.4 Mtoe in 2000 to 36.1 Mtoe in 2003.

Chinese Taipei is a net importer of fossil energy with an import dependency of 98 percent in 2004. With scarce indigenous energy resources, the economy is only able to produce natural gas, which accounts for less than 10 percent of the economy's total natural gas consumption.

Before the completion of the Formosa Petrochemical Corporation's refinery in 2000, Chinese Taipei had imported a significant amount of refined petroleum products. However with the expansion and upgrade of its refining capacity, the economy has been transformed into a net exporter of petroleum products.

In order to supply natural gas to the Taiwan Power Company's Datan Power Station, the economy is set to construct an LNG receiving terminal in Taichung. Chinese Taipei has allowed independent power producers (IPP) to participate in power plant investment. Eight IPP projects have been completed as of 2004. In 2001, Chinese Taipei set up the ultimate goal of establishing a "Non-Nuclear Homeland Policy" and declared the construction of two advanced light water reactors to be commissioned in 2009 as the last nuclear power plants permitted in the economy.

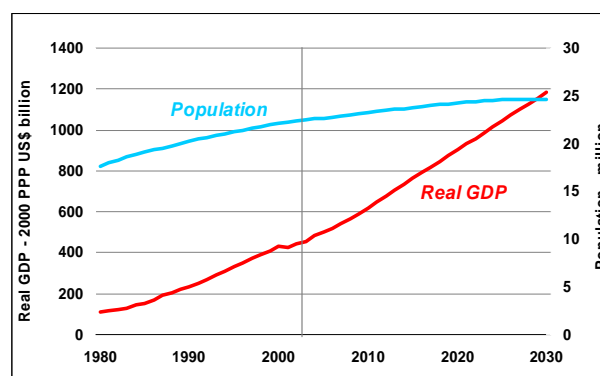
The Energy Commission, which was established in 1979 under the Ministry of Economic Affairs (MOEA), was legalised and became the Bureau of Energy when the Constituent Act of the Bureau of Energy was promulgated in 2004. The Bureau

currently takes the responsibility of formulating and implementing national energy policy. The "Renewable Energy Development Law", "Petroleum Administration Law", "Natural Gas Business Law", and "Electricity Act" are to be set up to create a better energy business environment in the future.

## ENERGY DEMAND DRIVERS

Chinese Taipei's GDP is projected to grow annually at 3.6 percent over the outlook period to reach US\$1,184 billion in 2030, compared with growth of 6.5 percent per year from 1980 to 2002. The services sector will account for the largest share of GDP at 66.3 percent, followed by the industrial sector (32.9 percent) and the agricultural sector (0.8 percent) in 2030.

Figure 104 GDP and Population



Source: Global Insights (2005)

The population of Chinese Taipei is expected to increase at a slow rate of 0.3 percent annually, from 22 million in 2002 to 25 million in 2030. Due to changes in lifestyle, the urbanisation level is expected to experience a declining trend from 79 percent in 2002 to 76 percent in 2030 as people move from urban to rural areas.<sup>101</sup>

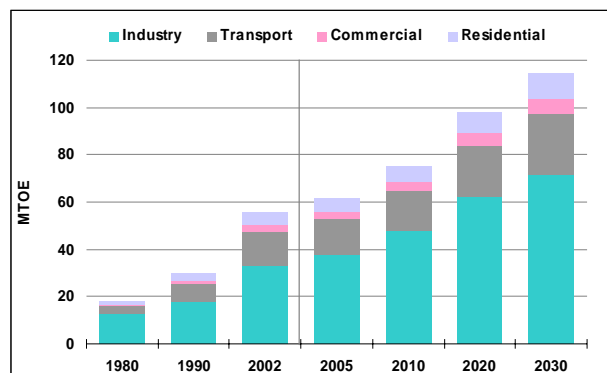
<sup>101</sup> APERC estimate

## OUTLOOK

### FINAL ENERGY DEMAND

Total final energy demand is projected to grow at 2.6 percent annually from 55.5 Mtoe in 2002 to 114.4 Mtoe through 2030. The industrial sector will account for the largest share at 63 percent, followed by transport (22 percent), residential (9 percent) and commercial (6 percent). Demand for electricity is projected to increase at 3.5 percent annually.

Figure 105 Final Energy Demand



Source: APERC Analysis (2006)

#### Industry

Energy demand in the industry sector is projected to grow at an average annual rate of 2.8 percent, lower than the average annual growth of 4.6 percent over the past two decades. The shift in structure of the industry sector, from energy-intensive to non-energy-intensive industries<sup>102</sup>, as well as improvements in energy efficiency will lead to the lower projected growth in energy demand in the sector. Currently, Chinese Taipei's main industries are electronics and petrochemicals. The petrochemical industry accounts for 53 percent of total industrial energy demand, thus making the industrial sector highly energy-intensive. Faster projected growth in the electronics and IT industries compared with the petrochemical industry<sup>103</sup> will result in the comparatively lower growth rate for industrial energy demand, particularly in the latter part of the outlook period. Consequently, energy intensity<sup>104</sup> in the industrial sector is expected to

<sup>102</sup> As a result of expansion of petrochemical and metallurgy industries, the share of energy-intensive industries to industrial value-added increased from 27.7 percent in 1980 to 33 percent in 2002. Over the outlook period, this share is projected to decline to 30.1 percent in 2030 as Chinese Taipei develops non-energy-intensive industries such as electronics and IT.

<sup>103</sup> The electronics and machinery industries are expected to grow at 4.7 percent per year over the period to 2030, while petrochemical industries are expected to grow at 3.5 percent.

<sup>104</sup> The amount of energy needed to produce a dollar's worth of industrial sector's value added.

decline at an average annual rate of 0.9 percent, reaching 188 toe per US\$ million in 2030 from 240 toe per US\$ million in 2002.<sup>105</sup>

By fuel, petroleum products are projected to maintain the largest share throughout the outlook period, although declining slightly to 51 percent in 2030 from 53 percent in 2002. Demand for naphtha as a feedstock for ethylene production is projected to lead the growth in industrial oil demand.<sup>106</sup> The share of electricity is likely to increase from 24 percent in 2002 to 31 percent in 2030 as further use of new and high-tech precision equipment would result in greater demand for electricity. In addition coal is expected to increase slowly at 1.9 percent per year, compared with 5.5 percent growth in the previous two decades, as a result of a slowdown in crude steel production.<sup>107</sup> On the other hand, the share of natural gas is projected to remain constant at 2 percent.

#### Transport

During the past decade, Chinese Taipei's transportation energy consumption has grown at an annual rate of 6.5 percent – an almost one to one ratio with the annual growth of GDP. Along with economic development, improvement in living standards, and upgrades in transportation infrastructure, energy consumption of all the transport sub-sectors has exhibited substantial annual growth. For example, air transport registered the fastest growth at 8.0 percent, followed by road at 4.9 percent, rail at 4.5 percent, and marine at 2.6 percent between 1990 and 2002. With growth in all sub-sectors, the economy's per capita transport energy consumption has increased from 0.37 toe per person in 1990 to 0.6 toe per person in 2002.

Over the outlook period, transport energy demand is expected to grow at about 2.2 percent per year. Growth will be mostly driven by the energy demand for air transport, which accounts for 63 percent of total incremental growth. Exports of high value added manufacturing products, and increase of direct air travel between Chinese Taipei and Mainland China will spur the growth in energy demand for air transport. To accommodate the expected rise in air

<sup>105</sup> Over the last two decades, energy intensity in Chinese Taipei's industrial sector followed a U-shaped curve, falling until 1993 to reach 157 toe per US\$ million and gradually increasing thereafter to 240 toe per US\$ million in 2002.

<sup>106</sup> Over the outlook period, industrial naphtha demand is projected to grow at 3.5 percent per year reflecting the robust growth in ethylene production growing at 3.7 percent.

<sup>107</sup> It is assumed that the production of crude steel will grow slowly at 2.5 percent per year over the period to 2030, compared with 7.9 percent between 1980 and 2002.

transport for both the passenger and freight sub-sectors, Chinese Taipei is considering the construction of a new airport close to the centre of Taipei, and expansion of freight handling capacity at Kaoshiung airport.

Energy demand for road transport is projected to grow by 1.1 percent per year, slower than the rate observed historically. As Chinese Taipei's population is expected to peak sometime in 2025, it is projected that the number of passenger vehicles would only grow moderately. Mass transit rail-systems are expected to gradually replace demand for buses and passenger vehicles for city travel, just as high-speed railway system will continue to replace the demand for passenger vehicles for inter-city travel. Subsequently, gasoline demand is expected to grow annually at 2.0 percent during the first half of the outlook period, but slow down to 0.6 percent per year thereafter. By contrast, diesel demand for freight trucks is expected to grow at a constant rate of 1.0 percent per year, due to the growth of high value added manufacturing products, and the expansion of petrochemical industries favouring trucks as the main mode of transport.

#### Residential and Commercial

Consistent with the income growth and the improvement in living standards, the energy demand of the residential sector is expected to grow at 2.6 percent per year over the outlook period. The main energy source for the residential sector in Chinese Taipei is electricity, growing at 3.2 percent per year to account for 74 percent of total energy demand in 2030, due to the high ownership level of electric appliances. Demand for LPG is projected to grow slowly at 0.8 percent annually and account for the second largest share at 15 percent in 2030 from 25 percent in 2002, mainly in areas not covered by the natural gas pipeline network.<sup>108</sup> By contrast, natural gas is projected to grow at an annual rate of 2.2 percent as LPG is replaced.

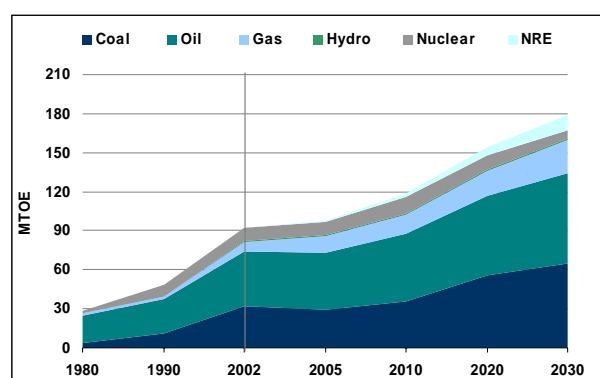
Chinese Taipei's commercial energy demand is mainly driven by annual growth of 2.9 percent in the services sub-sector, much slower compared with the 8.5 percent annual growth rate in the past three decades. As in the residential sector, electricity is the main energy source for the commercial sector. During the outlook period, demand for electricity is expected to grow at the fastest rate of 3.4 percent per year, as a result of the increase in demand for cooling

and lighting in commercial buildings. Similarly, natural gas demand is projected to increase at 2.7 percent annually, maintaining a share of around 6 percent throughout the outlook period. Petroleum products are expected to grow at a slow rate of 0.6 percent annually, with the share in total commercial energy demand declining from 21 percent in 2002 to 11 percent in 2030.

#### PRIMARY ENERGY DEMAND

Total primary energy demand is projected to grow at an annual rate of 2.4 percent, from 92.4 Mtoe in 2002 to 178.6 Mtoe in 2030. Oil will remain the dominant fuel at 39 percent, followed closely by coal (36 percent), natural gas (14 percent), NRE (7 percent) and nuclear (4 percent) in 2030.

Figure 106 Primary Energy Demand



Source: APERC Analysis (2006)

Among the fossil fuels, oil will grow from 41.6 Mtoe in 2002 to 69.6 Mtoe in 2030, with an annual growth rate of 1.9 percent. Growth will be spearheaded by the anticipated construction of a new 300,000 b/d refinery in Yunlin by the Chinese Petroleum Corporation by 2014. Coal will remain a major fuel input for electricity generation, accounting for the largest share in electricity generation at 59 percent. Natural gas demand is projected to grow annually at 4.5 percent to reach 25.2 Mtoe in 2030 as a result of increased utilisation of natural gas for electricity generation. To meet supply, Chinese Taipei plans the construction of additional LNG receiving terminals.

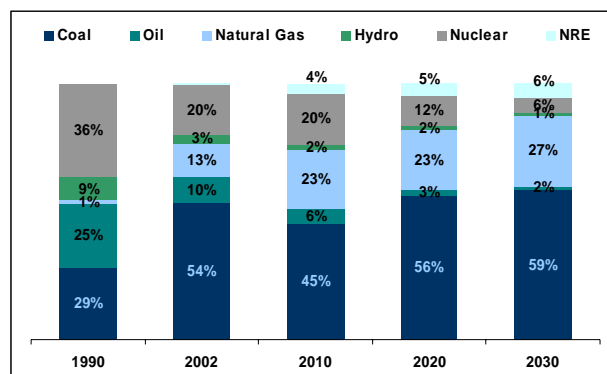
The share of NRE, which includes biomass, bagasse, wind, solar, and geothermal, in the economy's primary energy mix is projected to increase significantly from 0 percent in 2002 to 7 percent in 2030. On the other hand, the share of nuclear will remain stagnant at 11 percent from 2002 to 11 percent in 2010 and decline thereafter; reaching 4 percent by 2030, due to Chinese Taipei's Non-Nuclear Homeland policy.

<sup>108</sup> In 2001, the percentage of households connected to the natural gas pipeline network was 20 percent. Those not connected used bottled LPG, which is primarily used for cooking and water heating. By 2030, it is projected that the percentage of households connected to the network would reach almost 60 percent.

## ELECTRICITY

In 2030, total installed capacity will reach 86 GW, the majority of which will be thermal at 81 percent – consisting of coal (51 percent), natural gas (28 percent) and oil (2 percent) – followed by hydro (7 percent), NRE (7 percent), and nuclear (4 percent).

Figure 107 Electricity Generation Mix



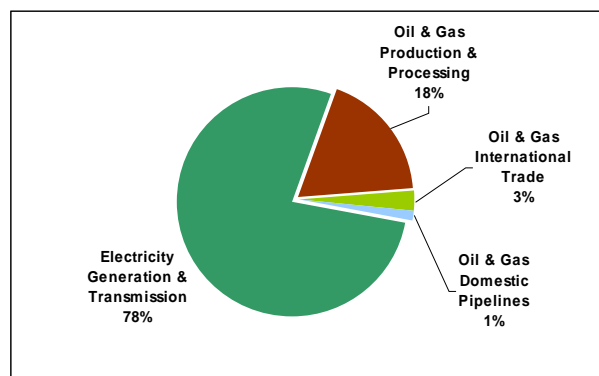
Source: APERC Analysis (2006)

Total electricity generation is projected to increase from 199 TWh in 2002 to 438 TWh in 2030, with an annual growth rate of 2.8 percent. Due to cost competitiveness, the share of coal will increase from 54 percent in 2002 to 59 percent in 2030. Oil will be replaced by natural gas, the share of which is projected to decrease from 10 percent in 2002 to 2 percent in 2030. Likewise, the share of nuclear will decrease from 20 percent in 2002 to 6 percent in 2030 as units reach retirement age and are decommissioned. However, the share of natural gas will increase significantly from 13 percent in 2002 to 27 percent in 2030, in part due to environmental considerations. The share of hydro is projected to be the smallest, decreasing from 3 percent in 2002 to 1 percent in 2030, due to the concern of perceived negative impacts to the environment. Nevertheless, as a result of government policy to promote the development of renewables, the share of renewables will increase from 0 percent in 2002 to 6 percent in 2030.

## INVESTMENT REQUIREMENTS

The total investments necessary to finance Chinese Taipei's energy infrastructure requirements are expected to reach between US\$ 104-125 billion by 2030. The majority of the investment, US\$ 83-97 billion will be required for electricity generation and transmission. Investments in more coal and natural gas-fired power plants will be required to replace oil and nuclear power plants. New refinery capacity, transport and distribution facilities, including storage and LNG terminals will make up the downstream oil and gas investment requirements at between US\$ 21-28 billion.

Figure 108 Investment Requirements

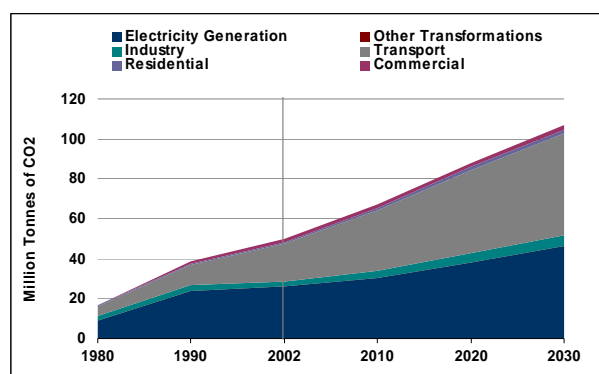


Source: APERC Analysis (2006)

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

Total CO<sub>2</sub> emissions from the energy sector are projected to increase from 266 million tonnes of CO<sub>2</sub> in 2002 to 515 million tonnes of CO<sub>2</sub> in 2030. The increase is mainly driven by the continued use of coal in electricity generation, despite the offset from decreasing oil utilisation and increasing the use of less carbon intensive natural gas, renewables and hydro.

Figure 109 CO<sub>2</sub> Emissions by Sector



Source: APERC Analysis (2006)

## MAJOR ISSUES

### NON-NUCLEAR HOMELAND POLICY

Notwithstanding the government policy to discontinue utilisation of nuclear for electricity generation, the economy will start the commercial operation of two new advanced light water reactors in 2009, the last nuclear power plants to be built within the economy.

Over the outlook period, the nuclear capacity will reach a peak of 7,844 MW in 2010, and as older plants decommissioned the capacity will gradually decrease to 3,651 MW in 2030. Therefore, the share of nuclear in the electricity generation mix will decline significantly, from 20 percent in 2002 to 6 percent in 2030. Subsequently, to meet future demand for electricity, the share of other fuels will have to

increase. For example, the share of renewables is expected to increase from 0 percent in 2002 to 6 percent in 2030.

#### REDUCING THE ECONOMY'S HIGH ENERGY INTENSITY

The energy intensity of Chinese Taipei is currently relatively high compared with other industrialised APEC economies with limited energy resources such as Japan, mainly as a result of the economy's high reliance on heavy industry to support economic growth. Therefore to decouple the energy demand from economic growth will remain a major challenge in the future.

#### ENHANCEMENT OF ENERGY SECURITY

Over the outlook period, due to the economy's lack of indigenous energy resources, Chinese Taipei is expected to remain an energy importer, importing almost all of the economy's oil requirements. To minimize the impact of oil supply disruptions, Chinese Taipei maintains an oil stockpile of no less than 90 days supply. The economy has also tried to diversify its energy supply mix by switching from oil to natural gas, coal and renewable energy. In addition, it has started to secure international joint venture agreements to acquire captive supply sources.

To ensure the continued supply of domestically produced petroleum products, Chinese Taipei is expected to construct a new refinery in 2015, replacing an existing refinery that is due to be phased-out.

An LNG facility is also expected to be constructed, starting operation in 2008, in anticipation of the growth in demand for natural gas for electricity generation.

#### IMPLICATIONS

With limited domestic energy resources, the security of energy supply is one of the most important issues in energy policy. The Non-Nuclear Homeland policy which limits the utilisation of nuclear energy also puts additional constraint on the economy in terms of diversification of energy supply sources. This implies that to meet increasing energy demand, Chinese Taipei will have to look to alternative energy sources to replace nuclear energy, with coal and natural gas, both higher emitters of CO<sub>2</sub> emissions being the most likely energy sources utilised. The planning for optimal energy mix among fossil fuels and renewables poses a great challenge for the future energy industry development.

To decouple energy consumption and GDP growth, the service sector needs to be

promoted/expanded and changes in the structure of the industry sector to a structure that is less energy intensive should be addressed. For example, promoting knowledge-based industries such as the Green Silicon Island proposal could be one way to reduce energy intensity and foster a less energy intensive economy.

Nevertheless, energy will continue to be an essential element of economic activities and the stability of energy supply will continue to be an important aspect of government policy. The establishment of international stockpiling through regional cooperation could be an important way of stabilising domestic energy supply, as could the acquisition of equity in international energy resource developments by the national oil company be another method through which stability of energy supply could be strengthened.

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