6 INDUSTRIAL SECTOR ENERGY DEMAND

BUSINESS-AS-USUAL INDUSTRIAL DEMAND

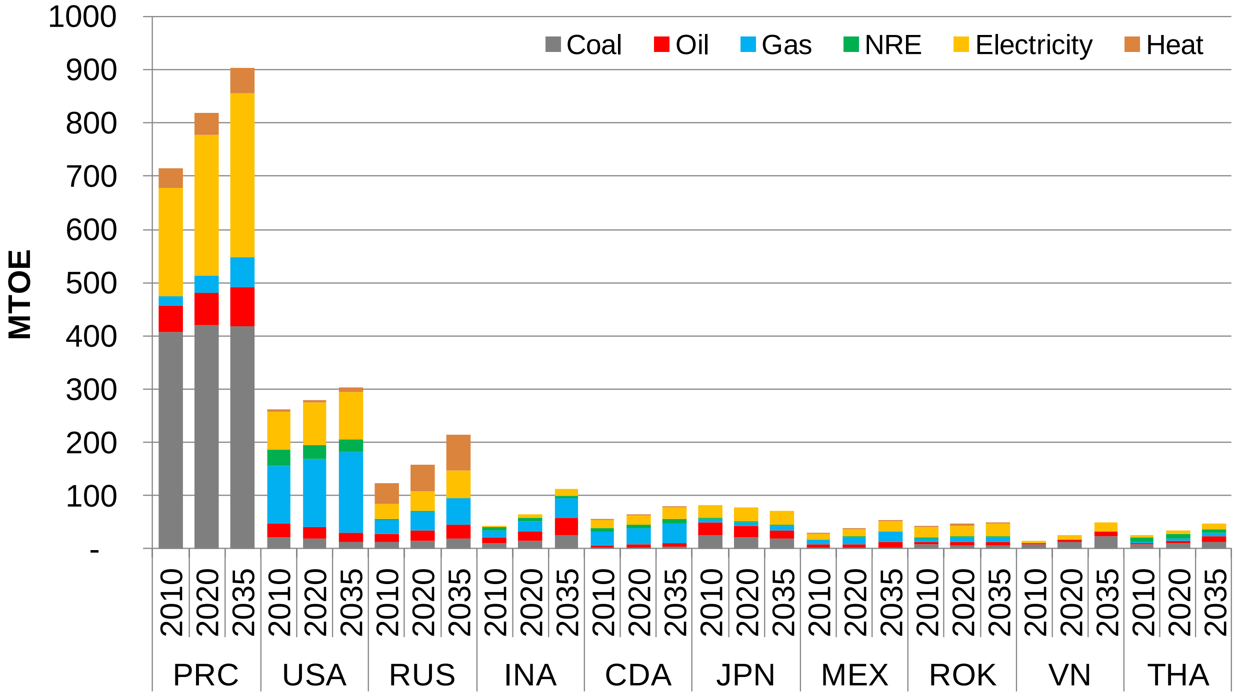
The APEC region's total industrial energy demand in a business-as-usual (BAU) scenario is projected to grow at an annual rate of 1.3% during the outlook period 2010–2035. This is roughly in line with the APEC region's projected total final energy demand annual growth rate of 1.5% over the same period. It translates to an industrial energy demand level of 2 029 million tonnes of oil equivalent (Mtoe) in 2035, up from 1 481.7 Mtoe in 2010.

Industrial Sector Demand by Economy

Figures 6.1 and 6.2 show the projected industrial demand by energy source for each APEC economy during the outlook period 2010–2035. Clearly, the mix of energy sources used varies significantly across the region. The large difference between the vertical axis scales in the two graphs demonstrates the vast difference in energy consumption in the industrial sector between the large and small economies.

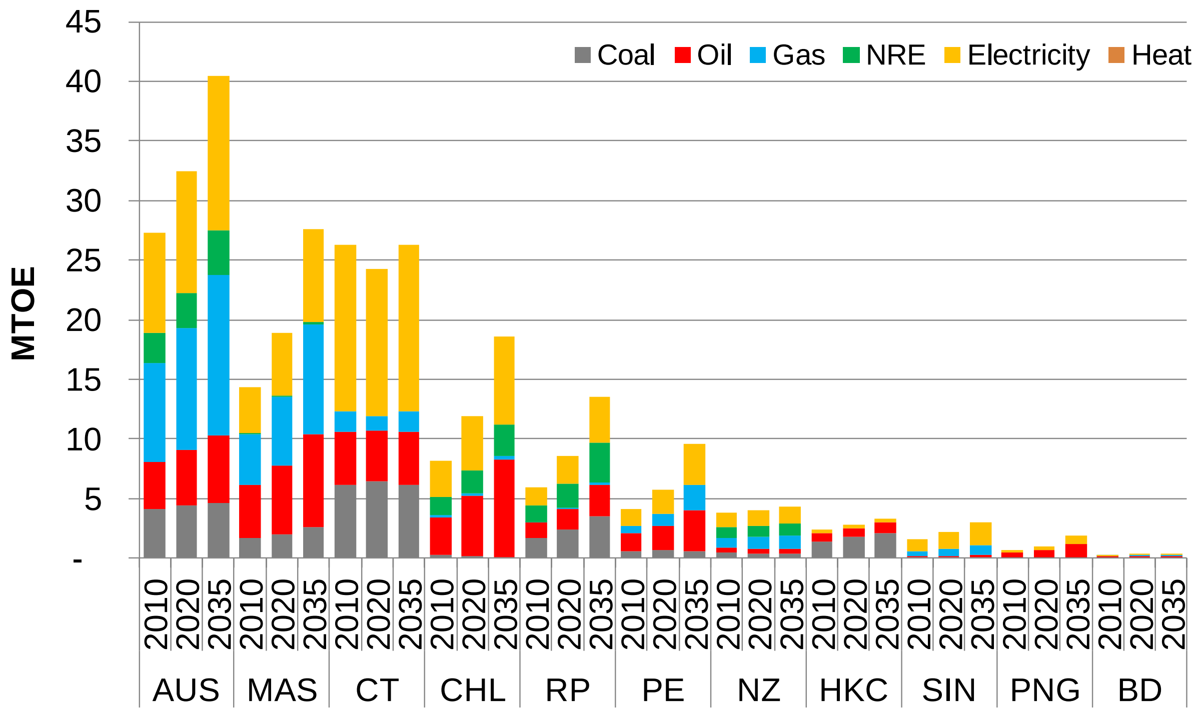
The three economies expected to have the highest industrial energy demand during the outlook period are China, the United States (US) and Russia, in that order. The combined industrial energy demand of these economies is projected to represent more than 70% of the APEC region's total industrial demand between 2010 and 2035. China will have the highest industrial demand in the region—902.8 Mtoe in 2035—which alone represents 44% of the APEC region's total industrial demand. US industrial demand level on the other hand is expected to have about 16% of the APEC region's total industrial demand throughout the period.

Figure 6.1: Final Industrial Energy Demand by Energy Source, Larger Economies



Source: APERC Analysis (2012)

Figure 6.2: Final Industrial Energy Demand by Energy Source, Smaller Economies

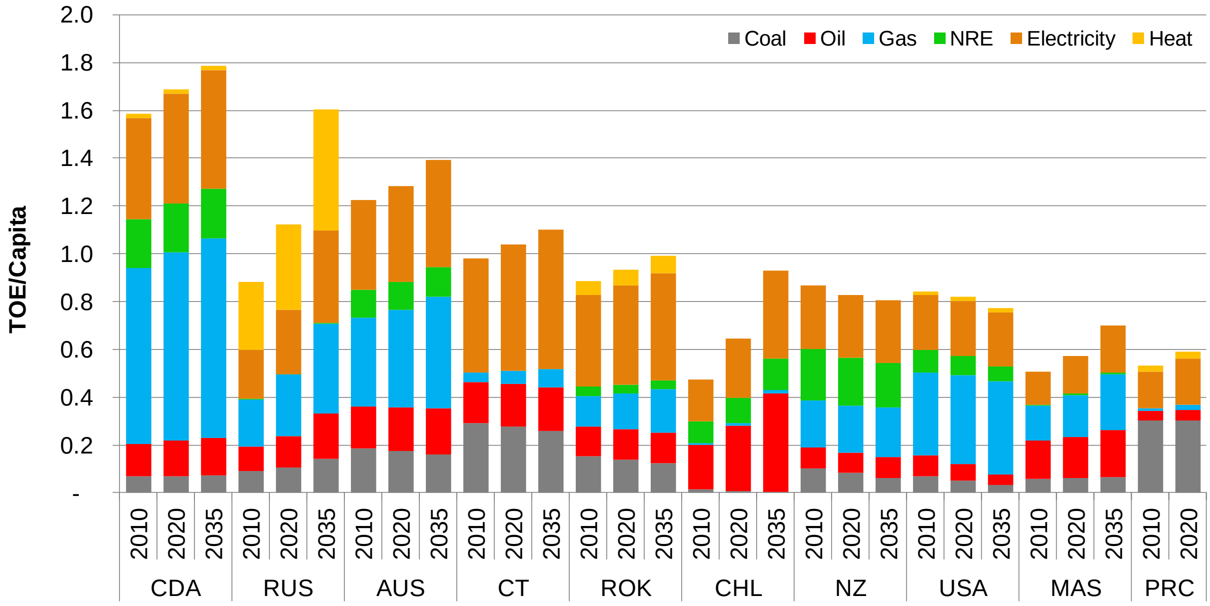


Source: APERC Analysis (2012)

Per Capita Industrial Sector Energy Demand by Economy

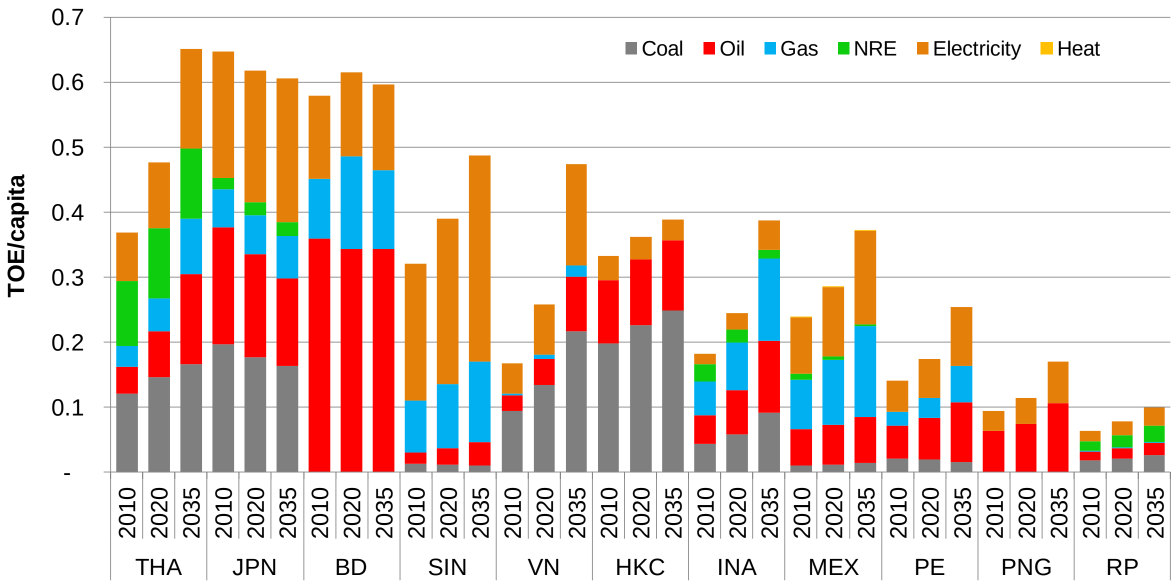
As seen in Figures 6.3 and 6.4, in 2035 Canada, Russia and Australia will have the highest per capita industrial sector energy demand, in that order. With their abundant resources and low population densities, it is likely energy-intensive industries will dominate the industrial structure of these economies over the next 25 years. Chinese Taipei and Korea will also continue to have energy-intensive industries as a core of their economies, albeit fully dependent on imported resources. While oil will continue to be used in moveable industrial applications, growth in industrial demand will be increasingly dominated by a demand for gas, electricity, and (in Russia) district heating ('heat') as the required delivery infrastructures are developed.

Figure 6.3: Per Capita Industrial Sector Energy Demand by Energy Source, Highest Demand Per Capita Economies



Source: APERC Analysis (2012)

Figure 6.4: Per Capita Industrial Sector Energy Demand by Energy Source, Lowest Demand Per Capita Economies



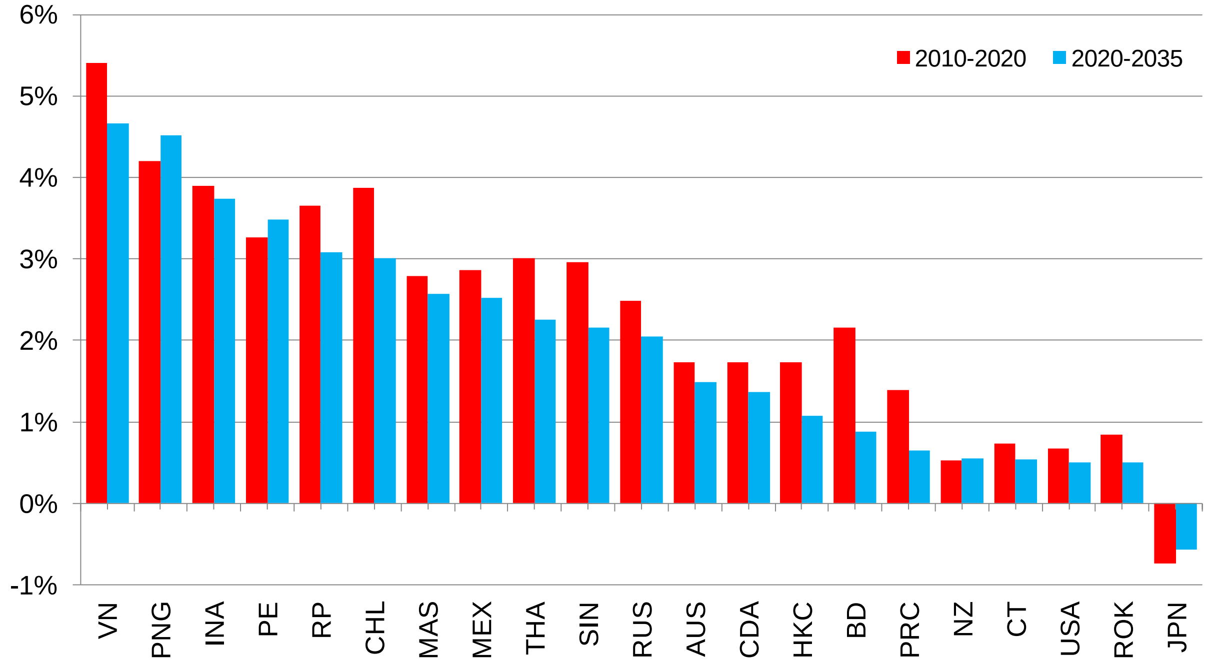
Source: APERC Analysis (2012)

Industrial Sector Growth in Energy Demand by Economy

As shown in Figure 6.5, industrial energy demand is expected to grow most rapidly in APEC's developing economies, other than China. These high levels of growth can be attributed to the rapid industrial development of these economies. Although China's economy is expected to grow rapidly, it is already heavily industrialized and it is likely to have a growth rate more akin to a mature economy.

In the mature economies, industrial demand growth will be slower, as overall economic growth will be slower. These economies will exhibit a structural shift away from energy-intensive industries toward higher value-added industries and services. In particular, Japan's industrial demand is projected to decline by 0.6% over the outlook period, from the 2010 level of 82.9 Mtoe down to 70.7 Mtoe by 2035. This will be the result of Japan's relatively slow economic growth accompanied by an explicit policy of structural change (METI, 2010).

Figure 6.5: Annual Percentage Growth Rates in Industrial Sector Energy Demand by Economy



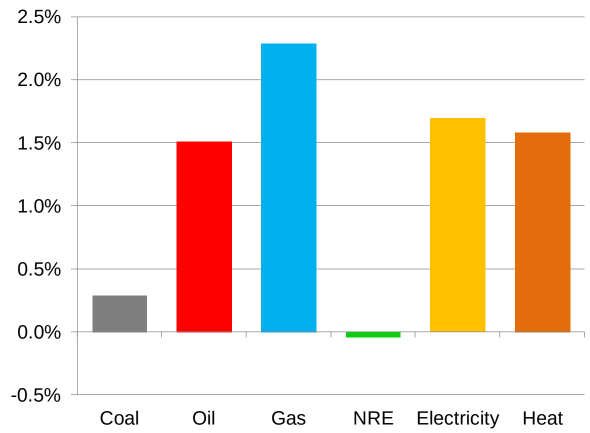
Source: APERC Analysis (2012)

Industrial Sector Growth in Energy Demand by Energy Source

As shown in Figure 6.6, gas is projected to grow the fastest among the energy sources at about 2.3% from 2010 to 2035. This translates to energy demand levels of 231.1 Mtoe in 2010 and 406.8 Mtoe in 2035. Gas is clean, easy to use and energy efficient for many industrial applications. As discussed in Chapter 12, gas will be available in abundant quantities in many APEC economies.

Electricity comes in second with 1.7% growth. It is the only energy source that can generally be used to power electronic and many types of mechanical equipment. Oil comes in third at 1.5%; although oil is expensive, it is the only energy source that can be used with many types of moveable equipment.

Figure 6.6: Annual Percentage Growth Rates in Industrial Demand by Energy Source, 2010–2015



Source: APERC Analysis (2012)

APERC's model projects negative growth for new renewable energy (NRE) in the industrial sector. NRE in the industrial sector consists mainly of biomass used in the pulp and paper and, to a lesser extent, food processing industries, where biomass is a production by-product. Although it is possible new applications for the direct use of NRE in industry may be developed, these are not reflected in APERC's models as there is little encouraging information to go on as yet. Industry can, of course, more easily use NRE indirectly in the form of electricity.

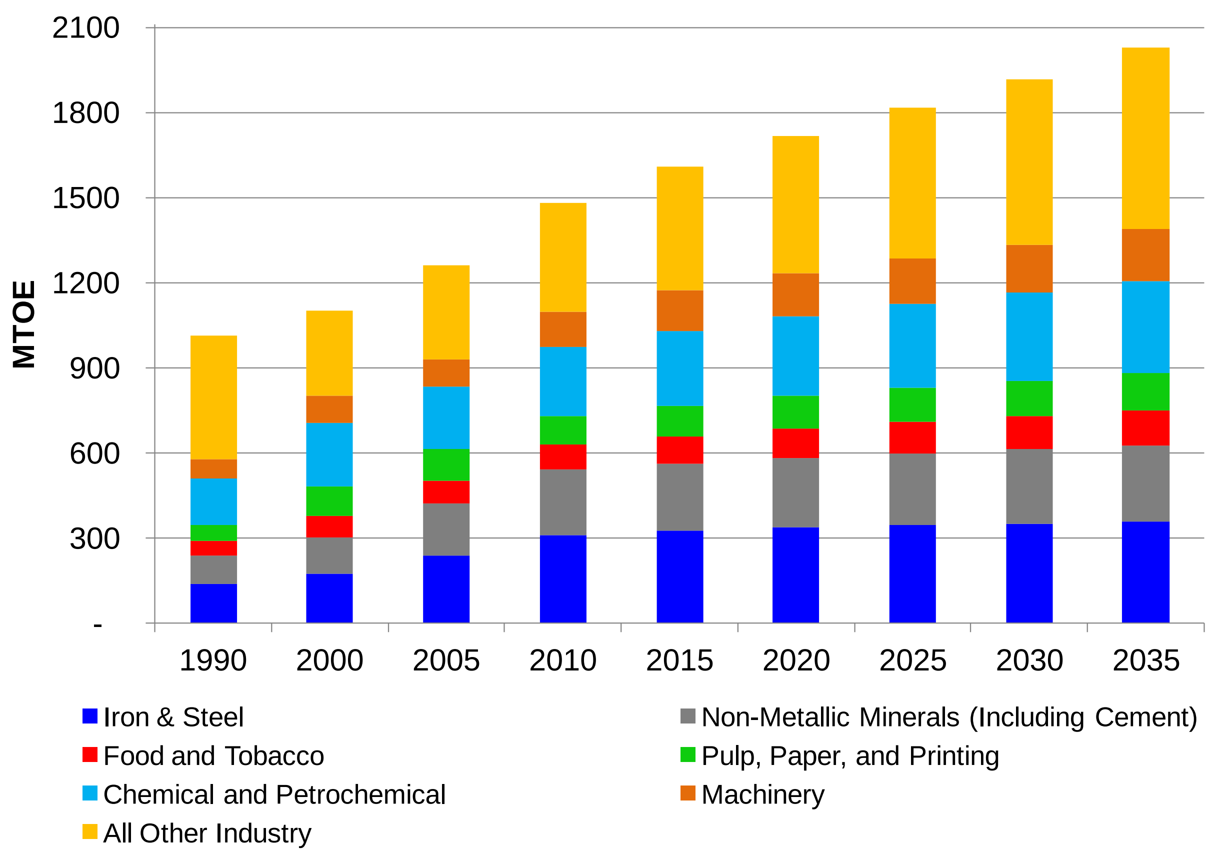
Coal consumption in industry is also projected to grow slowly. It will be used mainly in heavy industrial facilities that either technically need coal or can afford the personnel and equipment needed to manage its use. As discussed above, these industries are likely to grow slowly in many APEC economies. In addition, it is worth noting that 78% of the industrial coal demand in the APEC region in 2010, and 74% in 2035, is in China. China is an economy with an intensive focus on improving industrial energy efficiency (see the sidebar 'Industrial Energy Intensity, China and the United States' at the end of this chapter).

APEC's Energy Demand by Industry Type

Figure 6.7 shows APEC's projected industrial energy demand by industry. Over the outlook period, APEC's developing economies will reach a more mature stage of development. Industries supplying the materials necessary for basic infrastructure, such as steel and cement, will make way for high-tech industries. Thus, the region's industry structure will become less energy intensive. The growth rate of industrial energy consumption will gradually slow, while most of the increase in industrial energy demand will occur in the less energy-intensive industries.

Some economies do not collect data on energy demand by specific industries. This means the 'All Other Industry' category includes not only energy demand by industries other than the six specifically listed in Figure 6.7, but also energy demand in economies where industrial energy demand is not broken out by specific industry.

Figure 6.7: APEC's Final Industrial Energy Demand by Industry Type

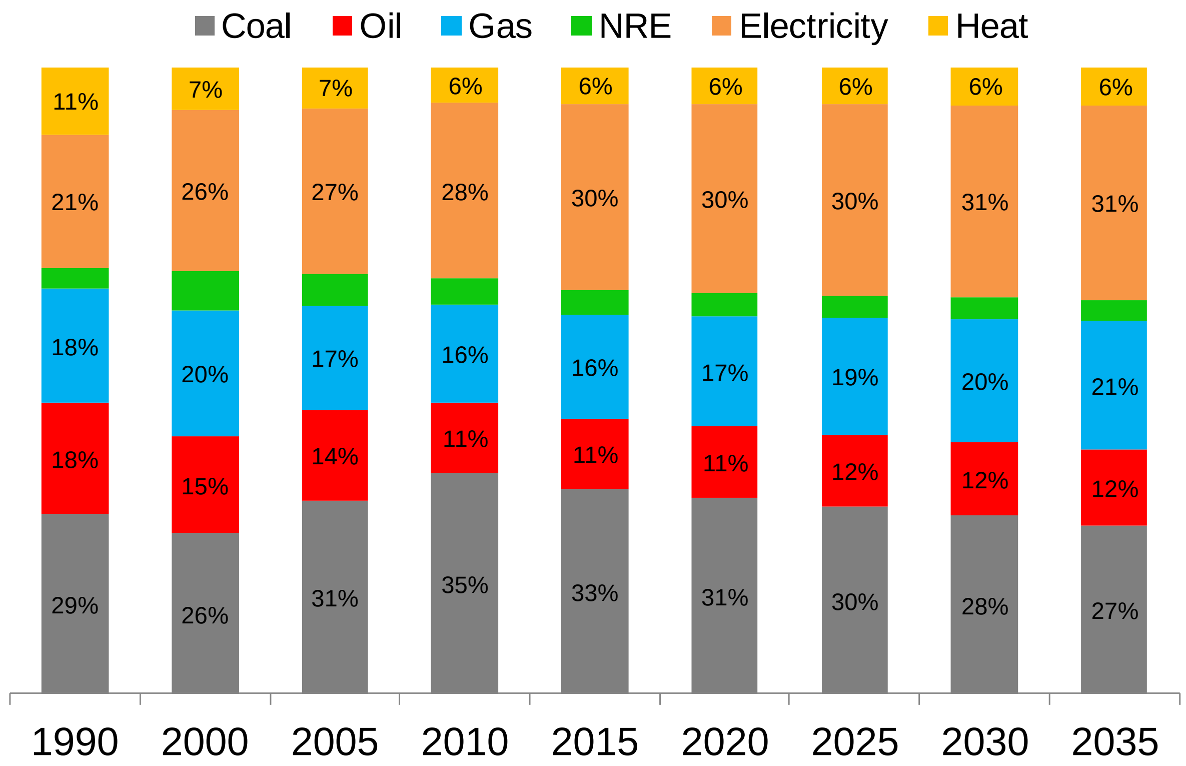


Source: APERC Analysis (2012)

Industrial Sector Market Shares by Energy Type

Figure 6.8 shows the projected market shares for each energy type in the industrial sector. Coal will lose some of its share in the energy mix to natural gas and electricity as the heavy industries intensively using coal, such as iron and steel and cement, reach saturation. Gas and electricity will replace coal as high quality energy sources for high-tech industries. Oil products including liquefied petroleum gas (LPG) will gradually be replaced by gas and electricity pending the development of their delivery networks. NRE will decline modestly unless technologies are developed for its extensive direct use in industry.

Figure 6.8: APEC's Final Industry Energy Demand, Percentage Share by Fuel Source



Source: APERC Analysis (2012)

APERC'S INDUSTRIAL SECTOR ENERGY DEMAND MODEL AND HOW IT WORKS

APERC's industrial demand models are based on an econometric approach. That is, equations are specified relating energy demand to other 'dependent' variables such as industry output and energy prices. The coefficients of the equations are then estimated statistically, based on historical data. Given the projections of the dependent variables, one could then use the estimated equations to make projections of future energy demand.

APERC was fortunate to have access to a database of potential dependent variables and their projected future values over the outlook period compiled by IHS Global Insight (Global Insight, 2012). IHS Global Insight is one of the world's leading economic data and forecasting services. Global Insight's database covered 19 of the 21 APEC economies (all but Brunei Darussalam and Papua New Guinea). For the remaining two economies, basic data on historical and projected GDP was available from the US Department of Agriculture, Economic Research Service (USDA ERS, 2012).

Ideally, one would build an industrial energy demand model that is consistent across industries and economies. However, due to data limitations, this was not feasible. Since the data limitations in many ways shaped the model, they deserve noting.

Data on total industry energy demand by type of energy is available from the IEA's World Energy Statistics (IEA, 2011) for all APEC economies except Papua New Guinea. The level of detail varies greatly. For some economies, data on specific industries may be available only for certain industries or for certain types of energy (such as electricity). The data also varies greatly in quality, and in some cases there were values that appeared questionable.

Global Insight provided an extensive database of historical and projected sales by specific industries in each economy. In some cases, APERC researchers modified the projected values to reflect their knowledge of policies and resource constraints that Global Insight may not have considered. Global Insight also provided historical and projected macroeconomic data on each economy, including GDP, employment, and various price indexes.

Data on historical energy prices is available from the IEA publication Energy Prices and Taxes (IEA, 2012a) and other sources. However, the level of coverage varies greatly by economy. Even where coverage is good, it does not necessarily give a clear picture of what is happening to the energy prices faced by individual industrial customers. These energy prices may depend on where the customer is located within the economy, the precise energy product used, and what type of tariffs, regulations, taxes, or contractual conditions apply.

Because of these data limitations, each economy had to be modelled individually. Ideally, at least seven specific industries would be modelled in each economy: iron and steel; chemicals and petrochemicals; non-metallic minerals (including cement); machinery; food and tobacco; pulp, paper and printing; and all other. But, for some economies, it was necessary to further aggregate industries. Also, the models had to be customized to the quality of the data available. What worked for one economy did not necessarily give satisfactory results for another.

In general, APERC focused on modelling energy intensities (that is E/Y, where E = energy consumption and Y = industry sales) for each economy, specific industry, and energy type. Energy intensity was generally modelled as changing over time, with changes in energy prices, and with the growth of the industry or the economy. If one can formulate a projection of energy intensity, it is simply a matter of multiplying it by projected industry sales to obtain a projection of energy demand. The merit of this approach is that it can be used to analyze future changes in industrial structure and energy intensity separately.

A risk of using any econometric model is that coefficients obtained through econometric analyses only show the historical trend, while innovative technology may bring a drastic change in the future. Thus, the energy intensity model is built combining results of econometric analyses and supplementary studies on sub-sector energy trends in each economy. Shifts in the choice of energy types among those available also had to be considered separately.

INDUSTRIAL ENERGY INTENSITY, CHINA AND THE UNITED STATES

As part of the process of developing the industrial energy demand models described above, APERC did some comparisons between industrial energy intensities in APEC's two largest economies, China and the United States (US). The results raise some interesting questions about the competitiveness of the two economies. A summary of the results is shown in Table 6.1.

Table 6.1: Energy Intensity in China and the United States

	Energy Intensity (kilogram oil equivalent/USD)		
	1990	2009	2010
Iron and steel			
China - Based on 2005 Real USD	0.897	0.381	0.368
United States - Based on 2005 Real USD	0.184	0.239	0.200
China - Based on 2005 PPP USD	0.377	0.160	0.155
Chemical and petrochemical			
China - Based on 2005 Real USD	0.696	0.186	0.168
United States - Based on 2005 Real USD	0.157	0.133	0.136
China - Based on 2005 PPP USD	0.293	0.078	0.071
Non-metallic minerals			
China - Based on 2005 Real USD	3.446	0.693	0.580
United States - Based on 2005 Real USD	0.130	0.309	0.334
China - Based on 2005 PPP USD	1.451	0.292	0.244
Machinery			
China - Based on 2005 Real USD	0.371	0.030	0.029
United States - Based on 2005 Real USD	0.020	0.025	0.024
China - Based on 2005 PPP USD	0.156	0.013	0.012
Food and tobacco			
China - Based on 2005 Real USD	0.457	0.055	0.049
United States - Based on 2005 Real USD	0.017	0.044	0.047
China - Based on 2005 PPP USD	0.193	0.023	0.021
Paper, pulp and printing			
China - Based on 2005 Real USD	0.777	0.113	0.102
United States - Based on 2005 Real USD	0.044	0.081	0.089
China - Based on 2005 PPP USD	0.327	0.048	0.043
Others			
China - Based on 2005 Real USD	0.379	0.059	0.052
United States - Based on 2005 Real USD	0.071	0.022	0.023
China - Based on 2005 PPP USD	0.160	0.025	0.022
Total			
China - Based on 2005 Real USD	0.638	0.118	0.106
United States - Based on 2005 Real USD	0.069	0.054	0.056
China - Based on 2005 PPP USD	0.268	0.050	0.045

Sources: *World Energy Statistics* 2011 © OECD/IEA 2011, Global Insight (2012) and The World Bank (2008)

For each specific industry, the first row labeled "China – Based on 2005 Real USD" shows energy intensity in China, measured as kilograms of oil equivalent per 2005 real US dollars (USD) of sales. To get the sales figures, sales in real 2005 Chinese Yuan (CNY) were converted to 2005 real USD at the 2005 CNY to USD exchange rate. The second row labeled "US – Based on 2005 Real USD" shows the comparable figures for the US.

It can be seen that, in 1990, every Chinese industry was far more energy intensive than its US counterpart. However, between 1990 and 2009, China's industrial energy intensities decreased dramatically in every industry. This improvement probably reflects both the huge scale of industrial development and modernization that took place in China over this period, as well as China's comprehensive and assertive policies for promoting industrial energy efficiency. For a description of these policies, see the APEC study Understanding Energy in China: Geographies of Energy Efficiency (APERC, 2009).

What happened to energy intensity for US industry during this period depended on the specific industry—for some industries it went down, but for others it went up. Overall, the gap between China's industrial energy intensities and those of the US narrowed considerably. Because 2009 was a year of deep recession in the US, especially for energy-intensive industries, figures are also shown for the year 2010, based on the International Energy Agency's (IEA's) statistics that became available shortly before the release of this outlook (IEA, 2012b). Compared to 2009, the 2010 results show a continued decline in energy intensity in China and a mixed impact on energy intensity in the US.

There is another way to do the comparison between China and the US. The third row labeled "China – Based on 2005 PPP USD" shows energy intensity in China measured as kilograms of oil equivalent per 2005 purchasing power parity (PPP) USD of sales. To get these sales figures, sales in real 2005 CNY were converted to 2005 USD at the 2005 PPP rate. The PPP rate tells how many CNY it would take in China to buy the same amount of goods and services as one USD would buy in the US. The World Bank has compiled data on 2005 PPP rates for most economies (The World Bank, 2008).

When comparing energy intensities across economies, PPP is arguably superior to using exchange rates. Ideally, any comparison of energy intensities between two economies would compare the energy required to produce identical goods and services in both economies. However, the goods produced by the same industry in two economies will never be identical, so a perfect comparison is impossible. Since PPP dollars are calculated to buy the same amount of goods in every economy, using them to calculate energy intensities should provide a better approximation to the energy required to produce identical goods.

In 2005, CNY 1 was worth 2.375 times more when converted to USD at PPP rates compared to when converted at market exchange rates. That is, one CNY would buy 2.375 times more in China than it would buy if it was converted to USD at the market exchange rate and the dollars spent in the US. Therefore, to convert the Chinese energy intensities from a real 2005 USD basis to a PPP 2005 USD basis, one can simply divide by 2.375. Of course, no adjustment is needed to the energy intensities for the US, since by definition one USD in the US always has a purchasing power parity of one USD.

Comparing the US energy intensities in the second row to the Chinese energy intensities based on PPP values in the third row, we see that China's industrial energy intensities in 2009 are actually lower than those for the US in every industry except 'Others'. In 2010, China's energy intensity is lower in every industry. It would thus appear that China has already surpassed the US in the efficiency by which its industry uses energy, at least when energy intensity based on PPP is used as the measure.

Many factors can distort comparisons of energy intensities between economies. We have already mentioned the impact of the different mix of goods produced in the two economies. There are also issues related to the types of energy used (electricity, for example, can be used more efficiently than coal) and the quality of the data. Nevertheless, this data suggests that by using energy more efficiently, China's industry may be gaining a competitive advantage over US industry. This development should be of concern to both policymakers and industrial managers in the US.

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