CHILE

- *Through promotion of energy efficiency and construction of LNG import terminals, Chile has responded in an effective and environmentally responsible fashion to the natural gas crisis of the early 2000s, which was precipitated by Argentina's restrictions on gas exports to Chile.*
- *Looking forward, however, the business-as-usual outlook suggests that Chile will face additional challenges, with CO_2 emissions more than doubling and oil imports rising 72% over the 25-year outlook period.*
- *Chile may have significant shale gas resources; however, further investigation is required to determine its economic viability there.*

ECONOMY

Chile is one of three Latin American members of APEC. The economy lies in South America, with Peru to the north and Bolivia and Argentina to the east. It is 4300 kilometres long and on average 175 kilometres wide; the total land area is 756 950 square kilometres. Chile is divided into 15 regions, which form the economy's first level of administration. Each region is headed by a governor appointed by the President. Regions are divided into provinces (the second level of administration), also each headed by a governor appointed by the President. There are 54 provinces in total. Provinces are further divided into communes, which are governed by municipalities.

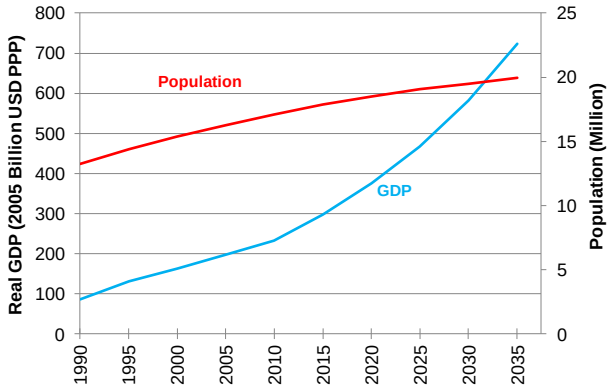
Chile has a greatly varied climate, covering at least seven major climatic subtypes. Temperatures are influenced by oceanic currents: in the south and centre, the Antarctic current produces cooler temperatures, while towards the north temperatures rise due to the effect of tropical currents. Average temperatures in central Chile range between summer peaks of 20°C and winter lows of 8°C. The climactic diversity causes regional differences in energy consumption patterns, such as use of air conditioning in the north, compared to demand for heating in the south.

Chile's population is projected to grow at an average annual rate of 0.6% over the outlook period, reaching over 20 million by 2035. Almost all of the 2035 population (99%) are expected to be living in urban areas—mainly in big cities such as Santiago, Valparaiso–Viña del Mar and Concepción.

In 2010, GDP per capita was USD 13 644 (in 2005 PPP) and during the outlook period, Chile's GDP growth is expected to be moderate, with an average annual growth rate of 4.6%. GDP in 2035 is estimated at USD 724 billion at 2005 USD PPP (or USD 36 259 per capita). This assumes continued expansion of the manufacturing industry, which has been a substantial contributor to Chile's GDP; the mining sub-sector, specifically copper, is also expected to continue to grow.

Chile's economy is based on five key areas: rich mineral resources, agriculture (which takes advantage of the wide variety of climatic conditions), rich fishing grounds, industry, and financial services. Chile has a market-oriented economy characterized by a high level of foreign trade, with export markets balanced among Europe, South America, North America and Asia. Chile has 25 trade agreements in place (MRE, 2008, p. 18), and is an active participant in international organizations such as the Asia-Pacific Economic Cooperation (APEC), the World Trade Organization (WTO), Southern Common Market (Mercado Común del Sur or Mercosur), European Free Trade Association (EFTA), Central American Common Market (CACM) and Latin American Energy Organization (Olade).

Figure CHL1: GDP and Population



Sources: Global Insight (2012) and APERC Analysis (2012)

Broken down by economic sectors, Chile's GDP in 2010 was composed of agriculture and mining (21%), manufacturing and industry (22%) and services, transport and communications (57%) (BCL, 2012). Copper extraction accounts for 92% of the mining GDP, and is one of the pillars of the Chilean economy; it attracts significant foreign private investment, since its production is well developed and oriented to exports.

There are four major energy demand sectors in Chile: industry, mining, transportation, and 'other' (residential, commercial and public) (APEC, 2009). The industry and mining sectors together used 37% of the 2009 final energy demand; this was driven by two subsectors in particular: copper, and pulp and paper. The major energy sources consumed in these sectors are petroleum products, biomass, and electricity.

The transport sector is also a major energy user, consuming 31% of the final demand. Chile's particular geography, high urbanization and low population density (in most centres other than greater Santiago) create the conditions for frequent long journeys. Road transportation is the predominant mode, accounting for 80% of the transport energy demand. Maritime and air transport together make up most of the remaining energy use, while the rail share of the transport energy demand is minimal, representing less than 1%.

In the medium and long term, vehicle sales growth is expected to be sustained by rising incomes and low prices. Light vehicle ownership will increase substantially from around 1.8 million cars in 2009 to 6.6 million cars in 2035. Most of the cars sold in Chile are made in Asia or elsewhere in South America by American and European automakers. There is no longer any automotive production in Chile—the last remaining local assembly plant in Chile, a General Motors plant in Arica that assembled pick-up trucks, closed in mid-2008.

Historically the railways have been important in Chile, but they now play a relatively small part in the economy's transport system. Rail's declining importance, including for freight transportation, is expected to continue through the outlook period.

Chile employs a concessions or public–private joint investment system to finance the construction, development and improvement of transport infrastructure such as highways, airports and urban transportation systems. The system is administered by the Ministry of Public Works (MOP). Between 1993 and 2008, USD 11.5 billion was invested in new, upgraded highways (such as Highways 5, 68, 78 and 57) as well as road maintenance and improvement of urban transportation, especially in Santiago (such as the Metro de Santiago bus system). By 2009, Chile had a total 81 000 km of roads, of which 21% was paved (MOP, 2009).

The 'other' sector, which covers the residential, commercial and public sub-sectors, consumed 28% of Chile's final energy demand in 2009; 79% of this use was in the residential sector. New renewable energy (NRE) accounts for 46% of total final energy consumption in the residential sub-sector—mostly of biomass for heating and cooking (APERC, 2009).

ENERGY RESOURCES AND INFRASTRUCTURE

Chile has limited domestic fossil energy resources. It is largely dependent on international energy markets, which means the economy is exposed to considerable risk in terms of security of supply and price fluctuations. The economy does produce some conventional energy resources, including crude oil, natural gas, coal, and renewable energy sources such as hydro, wind and biomass. Chile is considered to have three major domestic energy resources: wood/biomass for heating and electricity generation; water for hydroelectricity generation; and natural gas from the Magallanes region.

Chile's estimated proven crude oil reserve in January 2009 was 150 million barrels (equivalent to about 20 Mtoe) located mostly in the southern Magallanes region (Oil & Gas Journal, 2011). In 2009, production was 0.72 Mtoe (about 14 000 barrels/day), including gas liquids. By comparison, Chile's 2009 total primary oil supply was 15.6 Mtoe. Limited local production means dependency on imports is substantial and growing. The government-owned Empresa Nacional del Petróleo (ENAP) and privately owned GEOpark are the major oil producers and refiners in the economy. ENAP operates all three refineries in Chile, the largest of which is the 113 400 barrels/day Bio-Bio refinery, located south of the capital Santiago (ENAP, 2009).

Chile's natural gas production comes from onshore and offshore facilities in the Magallanes region. Proved reserves of natural gas were 98 billion cubic metres (or about 88 Mtoe) in 2011 (USEIA, 2011). However, Chile had limited gas production of about 1.5 Mtoe in 2009 (IEA, 2011). The economy is a net importer of natural gas, with imports accounting for 44% of the economy's total natural gas supply in 2009. There are indications Chile may have significant resources of shale gas (see Volume 1, Table 12.2), but utilization of this resource is not included in APERC's business-as-usual (BAU) projection because the initial studies on shale gas in the Magallanes region only began in 2009 and information is still incomplete.

Historically, Chile's main source of imported gas was Argentina, but Chile has faced restrictions on imports imposed by that economy since 2004 (see the 'Energy Policies' section below). Given the limited domestic gas production, Chile is pursuing other

sources of imports in the form of liquefied natural gas (LNG). Two major LNG import facilities commenced full-scale operation in 2011. The first, located in Quintero Bay, has a total installed capacity of 5 million cubic metres per day. The second facility in Mejillones, in northern Chile, has an installed capacity of 2.5 million cubic metres per day. Both these terminals will be expanded in the future.

Natural gas distribution is carried out by eight companies: Metrogas, Gasvalpo, Innergy, GasSur, Intergas, Gasco Magallanes, Distrinor, and Lipigas. The biggest, Metrogas, supplies industrial and residential customers in Santiago. In Valparaíso City distribution is by Gasvalpo. In the south, Innergy handles industrial distribution while residential distribution is the responsibility of GasSur and Intergas. In the far south, industrial and residential distribution is by Gasco Magallanes. In the north, Distrinor supplies Antofagasta city and Lipigas distributes within Calama city.

Chile's recoverable coal reserves were estimated at 700 million tonnes in 2008 (CNE, 2008a), or 136 years of coal supply at 2005 demand levels. Domestic coal production is in two regions: Bio-Bio in Golfo de Arauco, and Pecket and Isla Riesco in Magallanes. Production of coal is expected to reach 5–6 million tonnes.

In terms of electricity generation potential, Chile is rich in hydropower energy sources. Chile's total electricity generation in 2009 was 60.7 TWh, with 51% of this coming from thermal power plants run on coal (25%), oil (20%) or gas (6%). The rest was almost all hydro (IEA, 2011). Public utilities accounted for 91% of total electricity generation, while the remainder was generated by independent producers.

Chile's electricity grid is made up of two main systems. The Central Interconnection System (SIC) supplies 90% of the population while the Northern Interconnection System (SING) provides electricity to northern regional consumers including the mining companies located there. The two grids are not connected. In addition, there are two smaller systems serving a very small proportion of the population; these are the Aysen Interconnection System and the Magallanes Interconnection System.

Renewable energy (hydro, wind, biomass and biogas) contributed 76% of Chile's domestic energy production in 2009 (7339 ktoe). Biomass in the form of wood is the largest source of domestic energy production (50% of total indigenous production and 70% of energy from renewable sources) with most wood used in the residential sector. The second largest renewable energy contributor is hydro. In 2009 Chile produced 2228 ktoe (25 990 GWh) of hydropower, which was 22% of total indigenous energy production. Chile also has a modest potential supply of biogas from biomass treatment of waste products such as poultry dung and urban solid waste. Chile began some production of biogas in 2009, producing a total of 6.9 ktoe (12 million cubic metres) (MINERGIA, 2010). Biofuels are just starting to emerge in the automotive sector.

No other energy sources, such as nuclear or geothermal, are currently being employed, although the potential of geothermal and photovoltaic resources in Chile's energy mix is promising.

ENERGY POLICIES

Chile's approach to the energy sector is based on the development of a free market economy. Since 1990, the economy has distinguished itself as a world leader in liberalizing the energy sector.

Chile's energy policy priority is to reduce the economy's dependence on energy imports and the associated exposure to supply shocks, which are heightened by the growing energy demand. A significant event in Chile's recent history, that has deeply influenced its subsequent energy policies, was the gas crisis that began in 2004. The background on the crisis is that in 1995, in an effort to diversify its energy supply, Chile signed a gas integration protocol with Argentina to set up a supply of competitively priced imported gas. The agreement led Chile's private sector to invest heavily in the economy's natural gas infrastructure. The gas share in Chile's power generation rose from 1% in 1996 to 33% in 2004. However, in 2004, Argentina began to unilaterally reduce energy exports, with severe impact on the gas trade with Chile, even cutting off gas exports completely in some periods during 2007 and 2008 (IEA, 2009).

In early 2012, the Chilean Government through its Ministry of Energy issued the National Energy Strategy 2012–2030 (ENE for its Spanish acronym). This document sets out long-term policy and objectives for the energy sector. It focuses on electricity issues, and on the supply of clean, competitively priced and reliable energy to Chile, to support the economy's development and to sustain economic growth. The ENE established six main goals (MINERGIA, 2012):

1. Economy-wide promotion of energy efficiency
2. Promotion of non-conventional renewable energy
3. Expansion of hydropower generation to reduce dependence on energy imports

4. A new institutional focus on electricity transmission
5. Modifications to the electricity market to make it more competitive
6. Development of electricity interconnections with neighbouring economies.

As the ENE was issued by the President and his Cabinet, it can be expected that most measures and targets in the strategy will be enforced, although there are certain parts of the ENE that depend on further regulation or legal modification, and so are less certain.

On the planning side, the ENE proposes the creation of power utility corridors that will be listed as facilities of 'national interest', improving small power producers with access to the grid, and the use of smart grid technology to promote the expansion of distributed generation.

On the operational side of the electricity sector, the ENE calls for more independence for existing independent power system operators in each of the two major electricity systems. This is to bring more even-handed treatment to all power producers. There is policy to introduce net metering into the Chilean market, so that families and small businesses have incentive to install renewable energy technologies with the possibility of being paid by the utility for surplus energy fed to the grid. In addition, the ENE proposes the development of electricity interconnections with Chile's neighbours, particularly with Argentina, while also advancing efforts with Peru, Bolivia and Ecuador. This is with the intent of preventing supply disruption.

Chile's oil and gas sector is centred on the National Petroleum Agency (ENAP), the government-owned company created in 1950 and unchanged by 1990s liberalization. ENAP presently controls the bulk of oil production and refining in the economy, supplying about 70% of Chile's oil product demand through an extensive network for transportation, storage and distribution of crude oil, natural gas and refined products (ENAP, 2011). Despite Chile's limited hydrocarbon resources, the economy has always aspired to securing energy supply and self-sufficiency. For this reason, ENAP carries out exploration and production activities overseas, including in Ecuador, Argentina and Egypt. Technically, Chile's oil and gas industry is open to private companies, but in practice few investors participate due to the economy's limited resources.

In the case of coal, domestic production is limited, accounting for little more than 5% of Chile's coal demand in 2010 (MINERGIA, 2010). The Isla Riesco project in the south of Chile is expected to significantly increase the domestic supply, with its annual output of approximately 6 million tonnes of coal. It is expected to start operation in the first half of 2013 (Mina Invierno, 2012a, 2012b).

Energy efficiency has become central to Chile's work towards its key goal of reducing dependence on imported fossil fuels. The government's dual approach in recent years—increasing the share of electricity produced from hydro and new renewable energy (NRE) sources while reducing demand growth through energy efficiency—has been strengthened through the ENE published in 2012.

The Energy Efficiency Agency (AChEE) is responsible for the promotion and enhancement of efficient energy use in the economy. This agency includes representatives of the Ministries of Finance and Energy and is responsible for implementing Chile's Action Plan on Energy Efficiency 2020 (PAEE 2020), which is listed as the first goal of the ENE. The main target of PAEE 2020 is a 12% reduction in the forecast energy demand for 2020, roughly equivalent to 1122 MW of capacity.

The Chilean Government through AChEE is carrying out several major projects in these areas:

- *Transport Sector.* One program was carried out in 2011, replacing 144 buses older than 20 years with new, energy-efficient units. Other lines of action are currently in 'pre-development': developing efficient driving workshops; providing incentives for improving energy efficiency standards and technological upgrades in existing vehicles; fostering implementation of economy-wide energy efficiency management; and developing information mechanisms to promote purchase of energy-efficient vehicles.
- *Residential, Commercial and Public Sectors.* Action in these sectors is at the planning stage. The plans include a pilot project for water heaters replacement; specialized training in energy efficiency management; the inclusion of energy efficiency criteria for new buildings; a special program to carry out energy efficiency measures in public buildings; and an energy efficiency certification scheme for current buildings.
- *Industry and Mining Sectors.* There are three projects in planning in these energy-intensive sectors. They include implementation of energy management systems through the implementation of the international standard ISO 50.001; promotion of and training in cogeneration; and the development of an economy-wide list of top-quality energy advisors.

- *Business Development.* Four programs are underway, including energy audits and diagnosis.
- *Measurement and Verification.* AChEE's project management, training and monitoring software are included in this area.
- *Education and Training.* This covers several projects with wide application, including strengthening energy efficiency research and innovation in higher education institutions, and increasing people's awareness of energy efficiency issues.

In terms of electricity production from renewable energy, new legislation proposed in April 2008 aims to provide an incentive for increased use of new renewable energy (NRE) in the economy's electricity systems. Law 20.257 (the Law of Non-Conventional Renewable Energy) took effect in 2010 (CNE, 2008b) and establishes that any new power supply contract (new consumption or new supply to existing consumption) must include at least a percentage of self-generated or outsourced NRE. The share starts at 5% for the period 2010–14 and gradually builds up to 10% of total energy production by 2024.

Since the ENE's publication in 2012, renewable energy has become a higher priority, and it is expected that its share in the Chilean electricity matrix will rise in the short and long term. The ENE proposes various strategies in support of this, such as improving bidding mechanisms; expanding hydropower generation; developing a geo-referenced atlas to provide accurate information that can support investment; implementing financing schemes; and developing and implementing differentiated policies for individual technologies, which will address specific technical and economic issues.

In addition, from May 2012 one of the six sectoral committees of Chile's Economic Development Agency (CORFO) has been exclusively devoted to energy issues. The Renewable Energy Centre is in charge of supporting access to finance, supporting project development, strengthening networking and stimulating innovation in the NRE area (CORFO–CER, 2012).

In Chile, prices for petroleum-based fuels are set by market conditions across all stages of the value chain, including retail sales at service stations. However, specific excise taxes (IEC in Spanish) are charged on transport fuels (gasoline, diesel, LPG and CNG). Although Chile does not employ direct energy subsidies, a mechanism was introduced in February 2011 to reduce uncertainty about domestic prices for oil products. This is the government's Consumers' Protection System for Volatility in International Oil Prices Volatility (SIPCO). Under this system, a price band is determined around the average price of a fuel over the past five months. If the price of the fuel rises or falls outside this band, the excise tax is varied to counteract the price change. Thus, significant variations in price are absorbed into the IEC excise tax system and consumer risk is minimized (CNE, 2012).

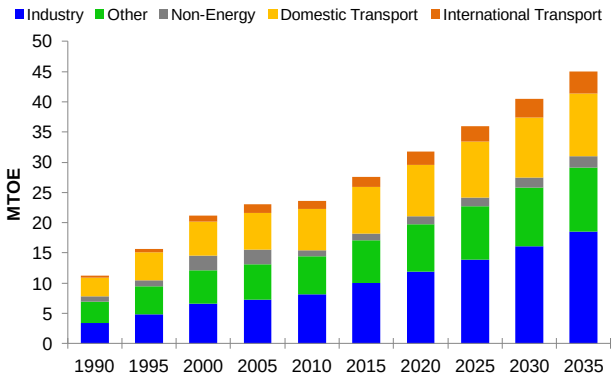
Chile is a signatory to the United Nations Framework Convention on Climate Change (1995), and ratified the Kyoto Protocol in 2002. In 2006, the government published a National Strategy on Climate Change to promote action in that area. In December 2008, to complement the strategy, Chile published the National Action Plan on Climate Change 2008–12. This action plan assigns institutional responsibilities for adapting, mitigating and strengthening Chile's response to climate change (CONAMA, 2008).

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

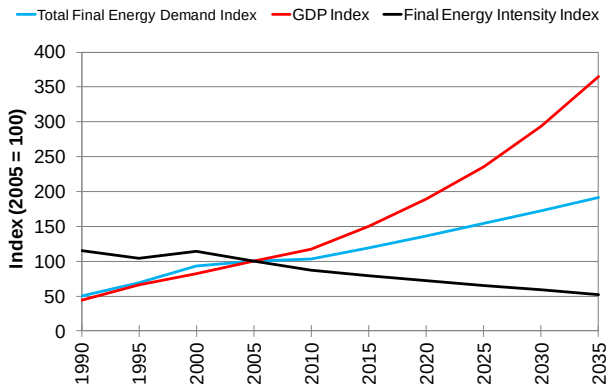
Chile's final energy demand (excluding the international transport sector) is expected to grow 88% over the outlook period, rising from 22.3 Mtoe in 2010 to 41.9 Mtoe by 2035 under business-as-usual (BAU) assumptions. By 2035 the sector with the greatest energy demand will be industry (44%), followed by 'other' (residential, commercial, and agriculture) with 26%, domestic transport with 25%, and the remaining 5% accounted by non-energy use.

Figure CHL2: BAU Final Energy Demand



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Figure CHL3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Energy demand in the Chilean industrial sector is expected to grow almost 130% over the outlook period, rising from 8.1 Mtoe in 2010 to 18.6 Mtoe by 2035. By 2035, the largest share of this demand will be for oil products (predominantly diesel) at 44%, followed by electricity at 39%. Renewable energy sources, mostly biomass in the pulp and paper industry, are expected to be the third major energy source for the sector with 14%, while coal is bound to account for less than 1%. The use of natural gas, mainly in the mining and petrochemical industries, is expected to remain minimal, with little change from 2010 levels (about 1% in 2035). While Chile's historically restricted gas supplies might have discouraged a more rapid expansion of natural gas in the industrial sector, this may change with the availability of more gas in the form of LNG. Our industrial gas projections could, therefore, be conservative.

Transport

Energy demand in Chile's domestic transport sector is expected to increase 52%, rising from 6.8 Mtoe in 2010 to 10.4 Mtoe in 2035. As with most economies, by 2035 the bulk of the sector's energy demand is expected to be met by petroleum-based fuels (gasoline and diesel) with 94%. Biofuels, gas (CNG) and electricity (for electric cars) could account for the remaining 6% of the transport sector demand in 2035.

Chile's light vehicle fleet is expected to double by 2035. Composition of the fleet at the end of the outlook period is expected to be mostly conventional gasoline and diesel-powered cars (81%), with conventional hybrid cars at 8%, plug-in hybrids at roughly 4%, CNG cars at 3%, and the remainder made up by LPG cars, motorcycles and and hydrogen fuel cell cars. With a current ownership level of less than 200 vehicles per 1000 people, Chile's vehicle ownership is far from saturation and is projected to grow steadily in line with the economy's increasing population, urbanization rate and per capita income.

Energy use in the transport sector will grow more slowly than light vehicle ownership. This reflects slower growth in energy demand for heavy vehicles and other transport modes, along with increasingly efficient vehicles.

Other

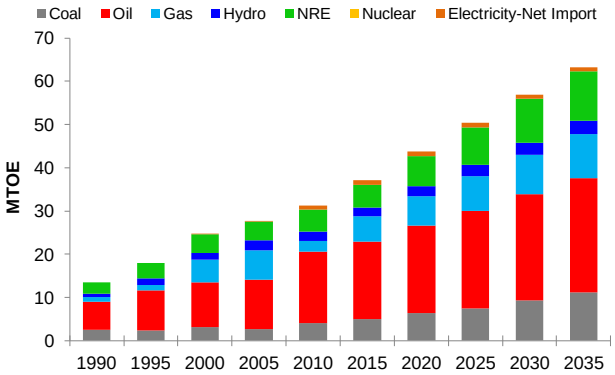
Energy demand in the residential, commercial and agriculture subsectors is expected to grow 76% in the outlook period, rising from 6.3 Mtoe in 2010 to 11.1 Mtoe by 2035. Projections indicate that all energy sources in this combined sector will experience a fairly similar growth over the period (expanding around 140% on the 2010 amount) with the exception of renewable energy, which is expected to remain flat.

PRIMARY ENERGY SUPPLY

Chile's primary energy supply is projected to double over the outlook period, from 31.3 Mtoe in 2010 to 63.6 Mtoe in 2035. Among the fossil fuels, natural gas will experience the largest growth, increasing four times from 2.5 Mtoe in 2010 to 10.3 Mtoe in 2035. This assumption is based on the planned expansion of the current LNG import terminals. The energy supply from petroleum products will grow 61%, rising from 16.6 Mtoe in 2010 to 26.7 Mtoe in 2035, while coal supply will grow 177% by 2035, reaching more than 11.2 Mtoe.

New renewable energy (NRE) supply is projected to more than double from 5.0 Mtoe in 2010 to 11.4 Mtoe in 2035—exceeding coal's share to become the second largest energy source in Chile's primary energy mix. The growth of NRE will be mainly driven by electricity generation demand growth.

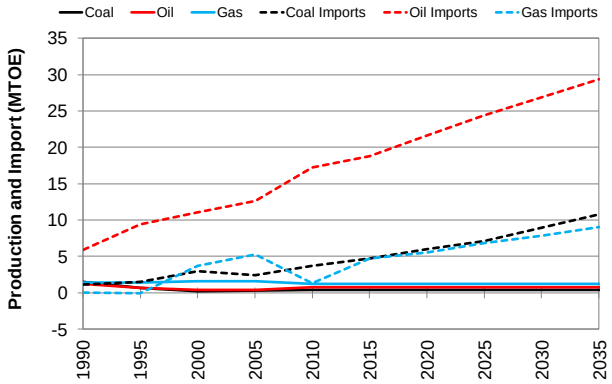
Figure CHL4: BAU Primary Energy Supply



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Oil will remain dominant, accounting for 42% of Chile's total primary energy supply in 2035, and will be predominantly used in transport and industry. Oil imports are expected to rise by about 72%, rising from 17.2 Mtoe in 2010 to 29.6 Mtoe in 2035. Without taking into account the possible impact of the Isla Riesco project on the domestic coal supply, coal imports are expected to reach 10.8 Mtoe in 2035, nearly triple its 2010 figure. Significant growth of gas imports is expected, increasing almost seven times over the outlook period from 1.3 Mtoe in 2010 to 9.1 Mtoe in 2035, as a result of the expansion of Chile's LNG terminals.

Figure CHL5: BAU Energy Production and Net Imports

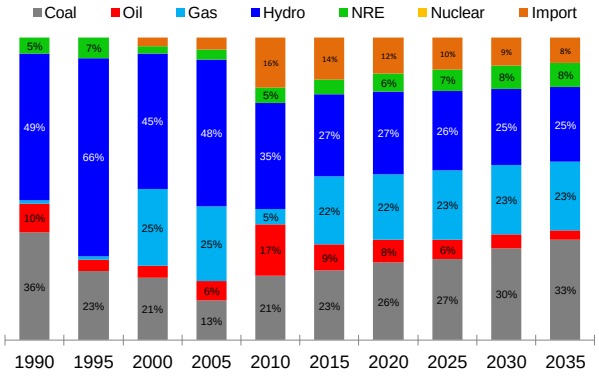


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

ELECTRICITY

Total electricity generation in Chile is projected to grow 119% over the outlook period, increasing from 60 TWh in 2010 to 131 TWh in 2035. Coal-fired technology is expected to become a more important source, supplying 36% of the electricity generated in 2035, followed by hydro (27%) and natural gas (25%). Natural-gas-fired generation will have the largest increase, growing more than eight times in comparison to 2010 levels. At the same time, electricity generation from NRE is expected to more than triple. The increase in the use of gas for electricity generation reflects greater ability to import LNG following the expansion of the current import terminals.

Figure CHL6: BAU Electricity Generation Mix

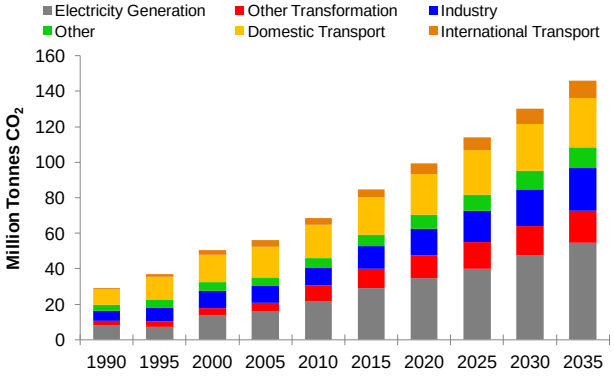


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

CO_2 EMISSIONS

Chile's total CO_2 emissions are projected to more than double over the outlook period, reaching 14 million tonnes of CO_2 in 2035 (including international transport) compared to nearly 69 million tonnes of CO_2 in 2010. By 2035, CO_2 emissions from the electricity generation sector are estimated to account for 37% of this (around 55 million tonnes), followed by domestic transport (19% or 28 million tonnes), and industry (16%, 24 million tonnes).

Figure CHL7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

The decomposition analysis reported in Table CHL1 shows GDP growth (at 4.6% per year) underlies much of the projected CO_2 emissions increase. The impact of this economic growth is partly offset by a reduction in the energy intensity of GDP of 1.6% per year, reflecting a shift toward less energy-intensive industry and greater energy efficiency economy-wide.

Table CHL1: Analysis of Reasons for Change in BAU CO_2 Emissions from Fuel Combustion

(Average Annual Percent Change)

	1990-2005	2005-2010	2005-2030	2005-2035	2010-2035
Change in CO_2 Intensity of Energy	-0.6%	1.8%	0.5%	0.4%	0.2%
Change in Energy Intensity of GDP	-0.6%	-1.0%	-1.4%	-1.5%	-1.6%
Change in GDP	5.6%	3.3%	4.4%	4.4%	4.6%
Total Change	4.4%	4.1%	3.4%	3.2%	3.1%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

With its efforts to promote energy efficiency and LNG imports, Chile has responded effectively to the security of supply challenges posed by the gas crisis, and has done so in an environmentally responsible fashion. Looking ahead, however, Chile's rapidly growing CO_2 emissions and increasing dependency on imported oil in the BAU scenario suggest additional challenges will need to be addressed in the future.

ALTERNATIVE SCENARIOS

To address the energy security, economic development, and environmental sustainability challenges posed by the business-as-usual (BAU) outcomes, three sets of alternative scenarios were developed for most APEC economies.

HIGH GAS SCENARIO

To understand the impacts higher gas production might have on the energy sector, an alternative 'High Gas Scenario' was developed. The assumptions behind this scenario are discussed in more detail in Volume 1, Chapter 12. The scenario was built around estimates of gas production that might be available at BAU prices or below, if constraints on gas production and trade could be reduced.

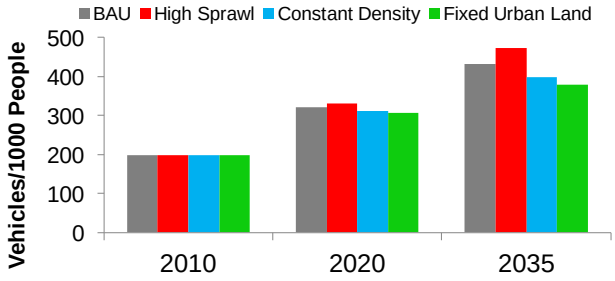
Significant increases in Chile's domestic gas production would require Chile to have significant unconventional natural gas potential. An analysis by the United States Energy Information Administration estimated that Chile has 64 Tcf (1600 Mtoe) of technically recoverable shale gas (see Volume 1, Table 12.2). However, further investigation will be required before the economic viability of this gas can be confirmed. Therefore, the High Gas Scenario was not run for Chile and Figures CHL8–CHL10 are not included here.

ALTERNATIVE URBAN DEVELOPMENT SCENARIOS

To understand the impacts of future urban development on the energy sector, three alternative urban development scenarios were created: 'High Sprawl', 'Constant Density', and 'Fixed Urban Land'. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Figure CHL11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. The difference between the scenarios is significant, with vehicle ownership about 10% higher in the High Sprawl scenario compared to BAU in 2035, and about 13% lower in the Fixed Urban Land scenario. This means that better urban planning will have a direct impact on vehicle ownership in the long run.

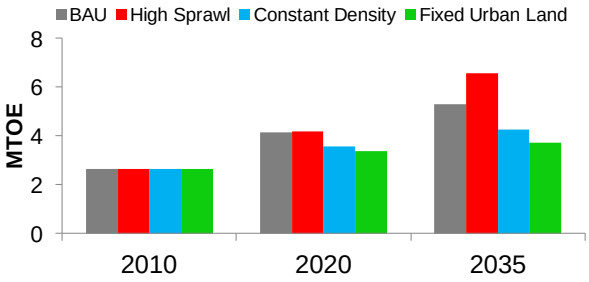
Figure CHL11: Urban Development Scenario – Vehicle Ownership



Source: APERC Analysis (2012)

Figure CHL12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. Light vehicle oil consumption would be 31% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 26% lower in the Fixed Urban Land scenario.

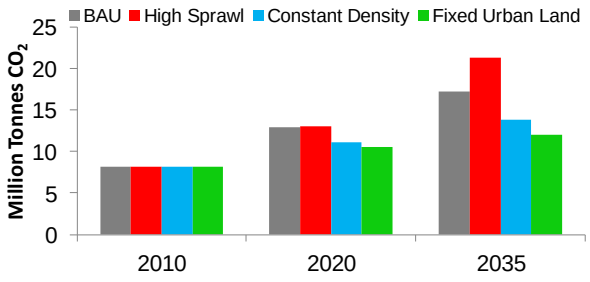
Figure CHL12: Urban Development Scenario – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure CHL13 shows the change in light vehicle CO_2 emissions under BAU and the three alternative urban development scenarios. The impact of urban planning on CO_2 emissions is similar to the impact of urban planning on energy use, since there is no significant change in the mix of fuels used under any of these scenarios. Light vehicle CO_2 emissions would be 31% higher in the High Sprawl scenario compared to BAU in 2035, and about 27% lower in the Fixed Urban Land scenario.

Figure CHL13: Urban Development Scenario – Light Vehicle CO_2 Emissions



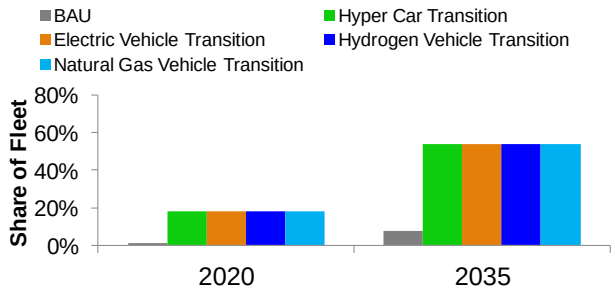
Source: APERC Analysis (2012)

VIRTUAL CLEAN CAR RACE

To understand the impacts of vehicle technology on the energy sector, four alternative vehicle scenarios were developed: 'Hyper Car Transition' (ultra-light conventionally-powered vehicles), 'Electric Vehicle Transition', 'Hydrogen Vehicle Transition', and 'Natural Gas Vehicle Transition'. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Figure CHL14 shows the evolution of the vehicle fleet under BAU and the four Virtual Clean Car Race scenarios. By 2035, the share of alternative vehicles in the fleet reaches about 55% compared to about 8% in the BAU scenario. The share of conventional vehicles in the fleet is only about 45%, compared to about 92% in the BAU scenario.

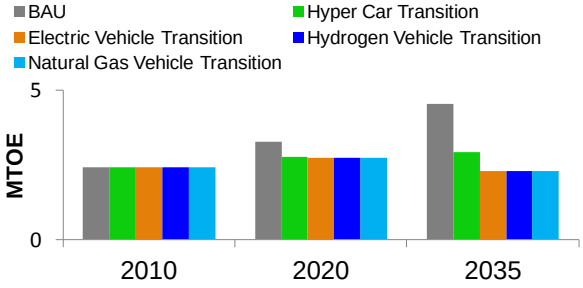
Figure CHL14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure CHL15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by about 50% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to the BAU scenario by 2035. The drop is large as these alternative vehicles use no oil. Oil demand in the Hyper Car Transition scenario is also significantly reduced compared to BAU—down 35% by 2035—even though these highly efficient vehicles still use oil.

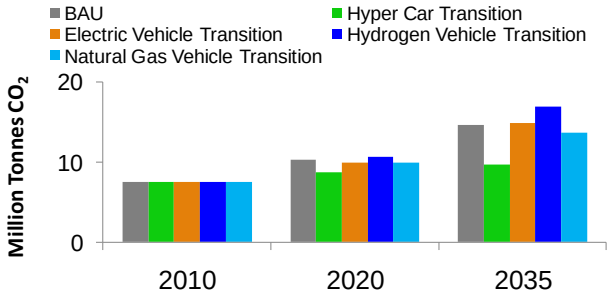
Figure CHL15: Virtual Clean Car Race – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure CHL16 shows the change in light vehicle CO_2 emissions under BAU and the four alternative vehicle scenarios. To allow for consistent comparisons, in the Electric Vehicle Transition and Hydrogen Vehicle Transition scenarios the change in CO_2 emissions is defined as the change in emissions from electricity and hydrogen generation. The emissions impacts of each scenario may differ significantly from their impact on oil consumption, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

Figure CHL16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

In Chile, the Hyper Car Transition scenario is the clear winner in terms of CO_2 emissions reduction, with emissions reduced by 34% compared to BAU in 2035. The Natural Gas Vehicle Transition scenario offers lower emissions reduction (7% compared to BAU), reflecting the lower emissions of natural gas compared to oil. The Electric Vehicle Transition scenario offers no significant emission reduction in Chile. This is probably because coal will be the largest marginal source for electricity generation in Chile in 2035, and coal combustion produces more CO_2 emissions than oil or natural gas combustion. The Hydrogen Vehicle Transition scenario offers no emission benefits, in fact producing 15% more CO_2 compared to BAU in 2035.

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