PERU

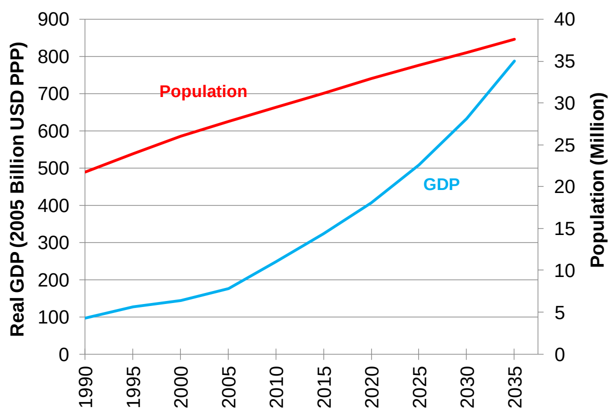
- *Although Peru is expected to remain a net gas exporter into the future, there is some uncertainty whether long-term production from the Camisea gas project will meet the economy's demand and export commitments, especially in the final years of the outlook period.*
- *The expected reduction in hydropower's contribution to electricity production, as fossil fuel use rises, will be the fastest growing source of CO_2 emissions over the outlook period.*
- *Peru has considerable potential for improving its energy efficiency; however, this will require the expansion of effective large-scale measures into the more energy-intensive sectors such as transport and electricity generation.*

ECONOMY

Peru is a developing economy in South America and one of the three APEC Latin American economies. It has a land area of around 1.28 million square kilometres along the Pacific coast of the continent, bordering Ecuador and Colombia to the north, Brazil and Bolivia to the east, and Chile to the south. Peru's economic resources and climatic conditions are diverse; its climate zones range from tropical humidity in the Amazon rainforests, dry and cold in the Peruvian Andes' highlands, to hot and humid along the coast. Its complex biodiversity has led to Peru being listed as one of the 12 mega-diverse economies in the world (UNEP, 2002).

Peru is politically divided into 25 regions and the Lima Municipality, which is considered an autonomous region containing Lima, the capital city. With roughly nine million people, Lima is also the economy's largest urban and financial centre and is ranked fifth among Latin American urban centres (UN, 2008), containing 31% of the total Peruvian population (INEI, 2011b). Other important cities in the economy are Arequipa, Trujillo and Chiclayo.

Figure PE1: GDP and Population



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

Peru's urbanization in recent decades has been rapid, with an annual growth rate of 2.1% since 1990. As of 2010, around 77% of Peru's population is considered urban, while 22% is still living in rural areas (UN, 2009). Peru's population, close to 29.5 million, is expected to grow at an average annual rate of 1%, reaching 37.6 million people in 2035.

Peru's economic growth since 2000 has been significant, with its GDP in constant currency terms increasing at an average annual rate of 5.7% from 2000 to 2010. Peru is the seventh largest economy in Latin America and the fifty-first in the world (IMF, 2011).

The main contributor to the economy is the services sector, which accounts for nearly 62% of Peru's GDP, followed by industry with 24% and agriculture with the remaining 14% (INEI, 2011a). The Peruvian economy is expected to grow considerably between 2010 and 2035, with GDP increasing at an annual average rate of 4.8%.

Growth in GDP per capita is expected to be less dynamic, with a projected annual growth rate of 3.7% over the same period, to reach almost USD 21 000 by 2035. Although Peru is considered a 'High Human Development' economy, placed eightieth in the world and eighth in Latin America on the basis of the United Nations' Human Development Index, the economy faces major challenges in terms of improving quality of life for its people. These challenges include increasing the proportion of the population with access to water and sanitation (Peru's rate is among the lowest in Latin America), as well as reducing the proportion of the urban population living in slums (currently about one-third) (UNDP, 2011; UN, 2008). In spite of some success in poverty reduction in the five years to 2011, Peru still struggles to improve general conditions, with 31% of its population considered poor and 10% considered extremely poor (INEI, 2011b).

Peru is a commodity export economy, with minerals, natural gas, fish and produce accounting for nearly 78% of its total exports. The mining sector is critical to the Peruvian economy, as it constitutes 4.3% of GDP, provides 61% of exports and is a key destination for foreign direct investment in the economy, attracting 23% of the total (INEI, 2011a; MINCETUR, 2011; Proinversión, 2011). Peru is the world's top producer of silver, second of copper and zinc, third of tin, fourth of lead and mercury and sixth of gold (MINEM, 2010c).

After mining, the energy (oil and gas) industry is the most important in Peru, accounting for almost 1.4% of its GDP, making up almost 10% of its exports and representing 16% of the total foreign direct investment (INEI, 2011a; MINCETUR 2011; Proinversión, 2011). The remainder of Peruvian exports are mainly agricultural and fishing products.

Owing to Peru's diverse geography and climate, the economy is also exposed to several natural hazards. Earthquakes, tsunamis, volcano activity, droughts, and floods are not uncommon. In particular, Peru has been affected by the periodic climatic phenomena known as 'El Niño' and 'La Niña'—this sudden increase (El Niño) or decrease (La Niña) of equatorial ocean water temperature approximately every five years—that give rise to abnormal rainfall patterns that can go way above or below the norm, with severe economic consequences. The Peruvian Government estimated the economic losses caused in 1997 and 1998 by El Niño at over USD 3.5 billion (INDECI, 2010; NASA, 2011).

Transport systems in Peru are insufficient to keep up with demand growth and there are few options other than road transport, which is the dominant mode. Air transport infrastructure is limited, with most passenger and freight traffic going through Lima airport. The rail network is also fairly limited, and most traffic is for freight only. Water-based transportation is only employed in the Amazon river areas (MTC, 2005; MTC, 2011a).

The economy's road infrastructure comprises a total of 126 000 kilometres of roads maintained by three levels of government (central, state and local). The overall quality is poor, with less than 20% of Peruvian roads being paved (MTC, 2011c). In rural and poor areas such as in the Andes mountains, the roads' poor quality, or their absence, hinders economic growth by isolating populations from access to social centres and markets. With the help of the World Bank, a road construction program for the economy's poorest areas was implemented from 1995 to 2011. It is estimated that 3.5 million people benefited from this program, which included the construction of rural vehicle roads, pedestrian paths and fluvial corridors in the Amazon region (WB, 2010).

Bus services are the main public transport option across Peru, and small-sized vans (combis) and minibuses (micros) provide most of the conventional passenger service in Lima. The informality and disorganization prevalent in their operations is not only responsible for their general inefficiency, but also for significant emissions (MTC, 2007). In the city of Lima, however, the 2010 introduction of an urban train line and a bus-rapid-transit (BRT) corridor (with vehicles operating on compressed natural gas) has significantly reduced the number of conventional vehicle commuter trips.

Peru's total vehicle fleet reached 1.8 million units in 2010, with nearly two-thirds of these in the Lima region (MTC, 2011b). In a move to benefit Peruvian families, car purchases were boosted in the 1990s by reducing import restrictions. This facilitated the importing of used cars, which has had an impact on the economy's vehicle fleet's renewal rate and average age—the fleet is considered old, with an average age of 17 years.

With no domestic vehicle manufacturers, all Peruvian vehicle sales come from imported stock, whether new or used. Most used units come from Japan and South Korea, requiring special facilities (CETICOs) to convert the right-wheeled Asian cars to the Peruvian left-hand-drive mode (BBVA, 2010).

In 2001, the government set maximum allowable vehicle emissions limits, calculated according to the vehicle's technology and fuel. The license required to import a vehicle now has stricter conditions applying to used cars, such as gasoline-fuelled vehicles not being older than five years, and diesel vehicles not being older than two. These criteria have reduced used car sales as well as their share in the economy's total car sales, falling from 83% in 2001 to 20% by 2010 (MTC, 2011a). By the end of 2012, the removal of the fiscal benefits granted to some CETICOs in combination with the reduction of taxes on the sales of new cars seems likely to reduce further the share of used cars into the Peruvian car fleet over the next few years (Gestión, 2013).

ENERGY RESOURCES AND INFRASTRUCTURE

Peru possesses a variety of natural resources, including a range of energy sources. Proved energy reserves total 582 million barrels of crude oil (1.24 billion barrels if natural gas liquids (NGL) are included), 0.35 trillion cubic metres of natural gas, 21.4 million tonnes of coal and 1800 tonnes of uranium located in the Puno region (MINEM, 2010a; MINEM, 2011). Of particular significance, the economy's natural gas reserves are the largest in South America after Brazil and Argentina (OGJ, 2011).

Peru produced 72 700 barrels per day (B/D) of crude oil and 84 500 B/D of NGL in 2010 (MINEM, 2010a). The economy's oil-refining capacity, which totals 213 300 B/D, is spread across six refineries (Conchán, El Milagro, Iquitos, La Pampilla, Pucallpa and Talara) (Petroperu, 2011; Repsol, 2011). Production of petroleum products in 2010 reached 74 620 million barrels, with gasoline and diesel making up half of the total output. Peru is a net oil importer. Not only is the domestic production insufficient to meet domestic demand, but most crude produced is of extra-heavy type, which cannot be processed in many of Peru's refineries. Of around 55 million barrels of total crude oil processed in Peru's refineries in 2010, the proportion of indigenous feedstock was 36%, while the remaining 64% was imported, mainly from Ecuador and Nigeria (MINEM, 2010a).

In contrast with its modest oil profile, Peru is considered a major South American gas producer. The Camisea project is the economy's major gas production area and is by far the most important energy project ever undertaken in Peru (Pluspetrol, 2011). This project began with the San Martín and Cashiriari gas fields, commonly known as 'Block 88', in the Ucayali basin in south-eastern Peru along the Camisea River. Although they were discovered in the 1980s, it was not until 2000 that a 30-year production contract was signed between the government and production companies, with development starting in 2004. In 2010 Peru produced around 7.2 billion cubic metres (255.6 billion cubic feet) of natural gas, a remarkable increase of 108.4% over the previous year. This was mainly due to the addition of Block 56 to the project; this block's output represented almost 40% of total production (MINEM, 2010a).

Although the initial aim of the Camisea project was to provide natural gas for domestic use, gas production increased rapidly since 2004, which has allowed the development of a liquefied natural gas (LNG) export market (MINEM, 2010a; PlusPetrol, 2011). In 2010, Peruvian LNG exports from its Melchorita plant amounted to 3.59 bcm, representing approximately half of Peru's total production (Perupetro, 2011).

Coal production in Peru is limited and the economy is a net importer. Peru's coal needs are met by 87% imports and 13% domestic production. Reserves amount to about 21 million tonnes and are located in the La Libertad, Ancash and Lima regions, with nearly all of them (95%) of anthracite type; bituminous coal makes up the rest (MINEM, 2011).

Peru's electricity infrastructure is based on the National Interconnected System (SEIN for its acronym in Spanish), which covers most of Peru—SEIN was created by interconnection of Peru's northern and southern power grids in 2001. There are also isolated power systems in areas where an extension of SEIN is not technically or economically feasible. Roughly 20% of the Peruvian population still lacks of access to electricity (MINEM, 2010d).

Of Peru's total installed power capacity of 8612 MW in 2010, about 85% goes into public service via SEIN and 15% is used by on-site power systems isolated from the main grid, servicing municipalities and private users (MINEM, 2010b). Several private companies participate in electricity generation, transmission and distribution on SEIN and a remarkable proportion of the economy's electricity generation is based on hydroelectricity (approximately 46%). The rest comes from thermal power plants, which are fuelled by natural gas (33% of total electricity production), diesel and fuel oil (19%) and coal (2%). Increasing gas production and availability in recent years has stimulated gas use within thermal plants.

New renewable energy (NRE) sources for electricity generation, such as biomass and wind, represent only 0.3% of the total capacity (MINEM, 2010b, 2010d). However, the Ministry of Energy and Mines' (MINEM) projections for Peru's NRE-based power generation are promising. The potential contributions are estimated at 77 GW from wind energy and 60 GW from biomass. In addition, while there has been no formal assessment of geothermal energy potential in Peru, initial studies suggest sufficient resources to allow power generation projects. At the same time, potential resources of hydropower (which is not counted as a 'new' renewable energy source) has been estimated at 177 MW.

Peru's SEIN system has one international link with Ecuador. While further interconnections with electricity networks in Brazil and Colombia are planned in the near future, interconnection with Chile and Bolivia is prevented by the use of different frequencies in their electricity systems (MINEM, 2010d).

ENERGY POLICIES

In Peru, the Ministry of Energy and Mines (MINEM) is responsible for development of energy policies and for guidance of the energy sector, as well as for addressing mining policies and issues. This reflects the major importance of these two sectors to the Peruvian economy.

MINEM is responsible for environmental issues concerning energy and mining activities. Through its different departments, the ministry covers all major areas of influence in the energy sector, oversees their activities and promotes investment to achieve sustainable development across the economy. In addition to MINEM, an autonomous regulatory organization created in 1996, Organismo Supervisor de la Inversión en Energía y Minería (Osinergmin) is in charge of setting electricity tariffs and gas transportation rates. Its goal is promoting efficiency in the power and gas sectors at the lowest possible cost for the customer.

In November 2010, MINEM issued Peru's Energy Policy Proposal 2010–2040. The goal of the policy is to meet Peru's energy demand in a safe, sustainable, reliable and efficient way, supported by planning, research and technological innovation. Its main objectives are achieving a diversified and competitive energy matrix with emphasis on renewable energy and energy efficiency; a competitive energy supply; universal access to energy supply; the highest possible efficiency levels in the energy production and utilization systems; self-sufficiency in energy production; and developing an energy sector with minimal environmental impact and low carbon emissions, as part of sustainable development (MINEM, 2010e).

In particular, the policy strives to develop the natural gas industry and extend its use in the residential, commercial, transport and industrial sectors as well as for efficient power generation. It also calls for strengthening institutions involved in the energy sector and joining regional energy markets in order to achieve Peru's long-term vision (MINEM, 2010e).

As Peru's economy has become gradually more open, free-market mechanisms such as competition and private operation have been implemented in industries such as mining, electricity, hydrocarbon and telecommunications. Several new laws have established a regime where domestic and foreign investments are subject to equal terms and this has encouraged foreign companies to participate in almost all economic sectors. Overall, Peru aims to ensure proper conditions to attract and retain investment by granting foreign investors equal treatment with Peruvians. Most activities are unrestricted, and there are a variety of schemes available under which investment can be made.

Under this regime, oil and gas upstream activities in Peru are conducted by private companies under licence or on service contracts granted by the government. In addition to MINEM, the government-owned company Perupetro is in charge of assessing the technical aspects of the contracts granted. The government guarantees that the tax law in effect on the agreement date will remain unchanged throughout the contract term. Under a licence contract, the investor pays a royalty; whereas under a service contract, the government pays remuneration to the contractor. In both cases, the distribution of the economic rent (either as royalty or remuneration) is determined using two methodologies: production scales and economic results (Ernst & Young, 2011).

Before Camisea came online, Peru had developed only the Aguaytía gas field in its central region and some others in the northern department of Piura. Camisea, as one of the biggest gas reserves in South America and source of nearly all (more than 95%) of the natural gas in Peru, has been the basis of major development of the domestic natural gas industry (Osinergmin, 2008; MINEM, 2010a). The development is based on a model that aims for an open market with free competition in the production sector—with some government-set goals that participating companies have to meet. There is some government regulation of the transport and distribution activities, especially regarding tariffs (Osinergmin, 2008).

Electricity is a major issue within Peru's energy profile. When economic reforms began in 1992, one of the main targets of the Peruvian Government was the liberalization of the market to create an efficient, competitive and reliable electricity sector. This sector is now divided into three areas: generation, transmission, and distribution, with many private and government-owned power utilities participating in all of them. By law, electric energy dispatch and planning are carried out by the Electric Energy Operation and Dispatch Committee (COES for its Spanish acronym), which is a private and independent operator. To foster efficiency and competition, the legal framework prevents the participating companies from creating trusts and monopolies.

Peru's policies in the electricity sector have these objectives:

- reducing the economy's exposure to price volatility and helping ensure that consumers receive more competitive electricity tariffs
- reducing administrative intervention in generation price determination to promote market solutions
- creating effective competition in the generation market

- introducing a mechanism of compensation between SEIN and the isolated systems so that prices in the separate systems incorporate the benefits of natural gas production while reducing their exposure to the volatility of fuel markets.

Under this framework, there are regulated and non-regulated electricity prices, depending on the size of individual demand. 'Free' users are exempt from regulated prices due to their large demand (usually equal or more than 2500 kWh on their maximum annual demand), while users under 2500 kWh are subject to the regulated prices scheme.

Peru also has policy goals to increase use of renewable energy sources and support their development. The government aims to diversify renewable-based electric generation from the current significant reliance on hydropower. Modifications to the regulatory framework in 2008 added new features, including a five-year target for the share of domestic power consumption generated from renewable energy sources (excluding hydropower plants larger than 20 MW installed capacity); a firm price guaranteed for up to 20 years for successful bidders for energy supply contracts; and priority in dispatch and access to networks.

To achieve the renewable energy policy goals, MINEM established open auctions for renewable energy supply in order to ensure competitive conditions for electricity generators and customers. The first auction, finished in March 2010, added 411 MW in renewable energy capacity to SEIN; this was awarded in 26 projects using wind, solar, biomass or mini-hydro (Osinergmin, 2011b). From a second auction, open in the second half of 2011, another 210 MW of capacity was added to SEIN. This consists of 102 MW small hydro, 90 MW wind power, 16 MW solar and 2 MW biomass from urban waste (Osinergmin, 2011a).

In regard to biofuels, Peru's regulatory framework also establishes a mandatory fuel blending of 7.8% of bioethanol in gasoline (this mix is known as gasohol) and 5% of biodiesel in traditional diesel (this mix is known as diesel B5).

Although Peru does not use nuclear energy for power generation, a government-run nuclear program has been in operation since 1975. In late 2009, Peru's Nuclear Energy Institute (IPEN, for its acronym in Spanish) presented its Institutional Strategic Plan 2010–2016. This plan encompasses three main objectives, including the promotion of power generation based on nuclear energy (IPEN, 2009). In addition, Peru's Energy Policy Proposal 2010–2040 considers nuclear energy development as an integral part of the economy's energy matrix in the long term.

To promote energy efficiency, in 2009 MINEM published a Referential Plan for the Efficient Use of Energy 2009–2018. This document outlines the actions required in each sector to achieve the economy's energy efficiency goals. The key goal is to reduce energy consumption by 15% from 2007 levels by 2018, through implementation of energy efficiency measures.

Subsequently, in May 2010, the Peruvian Government created the General Directorate of Energy Efficiency (DGEE) within the Vice-Ministry of Energy (through Supreme Decree No. 026–2010–EM). DGEE serves as the technical regulatory body in charge of the proposal and assessment of energy-efficient use and production, and non-conventional renewable energy issues. It also leads the economy's energy planning, and is in charge of developing the National Energy Plan, which must incorporate actions for electricity sector development, in line with economy-wide development policies and the 2010–2040 Energy Policy framework.

Energy prices in Peru are partially subsidized. To strengthen macroeconomic development, the Peruvian Government created the Fund for Price Stabilization of Oil-derived Fuels in 2004. This aims to avoid price increases for final consumers resulting from high volatility in international oil prices. Using this mechanism, the government sets upper and lower price limits for producers and importers, to ensure the price stays within that range in spite of changing market conditions. In the case of fluctuations that drive the price above the limit, the difference is covered by the fund, through transfers to producers and importers; in the opposite situation, these parties will pay to the fund the difference between the actual price and the band's lower limit (El Peruano, 2010). As of early 2012, the fund was still operating, with considerable benefit for retail LPG, regular gasoline (84 and 90 octane), gasohol, diesel B5 and industrial fuel oil used for power generation (El Peruano, 2012).

As one of the economies most vulnerable to climate change, Peru has looked forward to implementing an effective and sustainable strategy for adapting and mitigating its effects. After the United Nations Climate Change Conference of Parties (COP16) held in Cancun, Mexico in late 2010, Peru submitted its Nationally Appropriate Mitigation Action (NAMA), which proposes to reduce the economy's emissions by working towards several objectives. These objectives include reduction to zero of net deforestation of natural or primary forests;

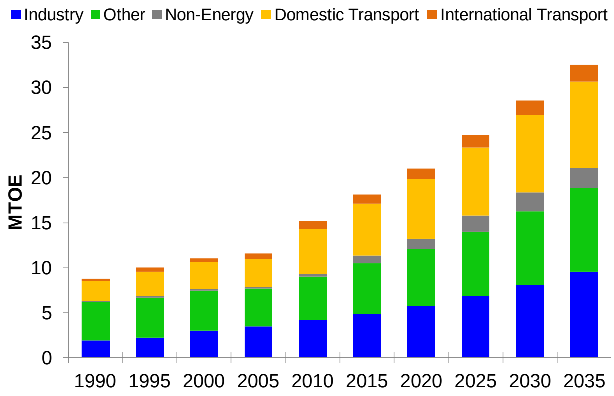
modification of the current energy grid, so that renewable energy (nonconventional energy, hydropower and biofuels) represents at least 33% of the total energy use by 2020; and implementation of measures to reverse the inappropriate management of solid waste (UN–FCCC, 2011).

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

Peru's final energy demand (excluding the international transport sector) is expected to grow at an average rate of 3.1% per year, from 14.3 million tonnes of oil equivalent (Mtoe) in 2010 to 30.6 Mtoe by 2035 in the business-as-usual (BAU) scenario. In the long term, the most significant change is expected in the industry sector, which will expand its energy demand 130%, rising to 9.6 Mtoe in 2035. In 2035 the domestic transportation and industry sectors are expected to share the lead with a 31% share each, closely followed by the 'other' sector with 30%, and non-energy with 7%.

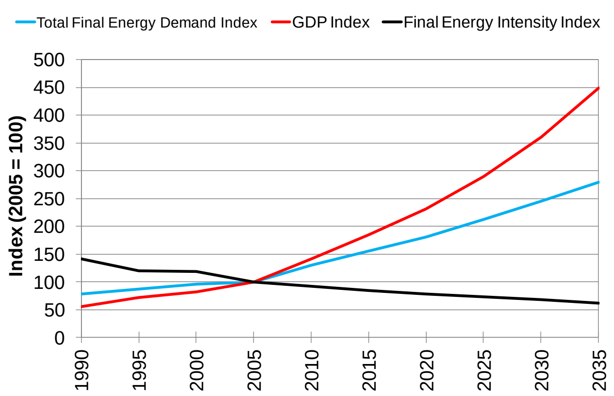
Figure PE2: BAU Final Energy Demand



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

From 2005 to 2035, Peru's final energy intensity is expected to decline considerably, by 38% in comparison to 2005 levels.

Figure PE3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Reflecting its energy-intensive nature, Peru's industrial energy demand is expected to increase at an average annual rate of 3.4% from 2010 to 2035. Gas demand is expected to experience the biggest increase over the outlook period, growing 243% from 2010, followed by electricity (141%) and oil (128%), while coal use is expected to slightly decrease (4%) in the same period.

Projections indicate that fuel shares in 2035 will remain fairly similar to 2010. The main changes are an increase in gas from 15% to 22% and decrease in coal from 15% to 6%. Although the share of natural gas in the Peruvian industrial energy demand is expected to grow, this will ultimately depend on the development of distribution networks to reach potential customers beyond Lima, which currently stands as the most important market. Energy intensity in this sector is expected to decrease by 38% from 2005 to 2035.

Transport

As in other developing economies, Peru's transport energy demand remains the largest of the final-use sectors. Due to a projected expansion of the economy's total vehicle fleet by nearly 250% from 2010 to 2035, it is expected that energy demand in this sector will grow 92% in the same period (equivalent to an annual average growth of 2.6%). By 2035, energy demand will reach 9.6 Mtoe (11.5 Mtoe if international transport is included).

Road transport is expected to account for nearly all the transport demand, with oil-based fuels (gasoline, diesel and LPG) being the dominant energy sources. Biofuels demand is also expected to increase based on the growth of oil-based fuels, given Peru's mandatory blending of gasoline with bioethanol and diesel with biodiesel. Development of other fuels and/or technologies in this sector seems unlikely and is not considered in the projection.

Some of the main factors that will affect the transport energy demand in the outlook period are:

- the expiration of import licenses for used cars, which will make for greater efficiency in the vehicle fleet as more new cars are sold—and which could ultimately promote the introduction of new technologies
- the building and expansion of CNG infrastructure and the success of the current CNG projects, such as the Lima BRT corridor
- aggressive transport policies that could call for construction of new mass transportation systems

- tighter environmental standards that might allow development of new technologies or setting of higher biofuels blending targets.

Other

Reflecting the increased urbanization in Peru in the outlook period, energy demand growth in the 'other' sector (which covers residential, commercial and agriculture use) is expected to be moderately rapid, with an annual average growth of 2.6% reaching 9.3 Mtoe by 2035.

Electricity is the source expected to experience the fastest growth in 'other' sector demand (162%), closely followed by oil (mainly as LPG, 158%) and natural gas (138%). As Camisea gas production rises, natural gas and its by-product LPG are expected to increase their availability. While natural gas distribution grids are expected to expand in Lima and Callao replacing existing LPG and electricity demand there, in turn LPG's greater distribution is expected to replace demand for less convenient fossil fuels (such as coal and kerosene) or non-commercial biomass.

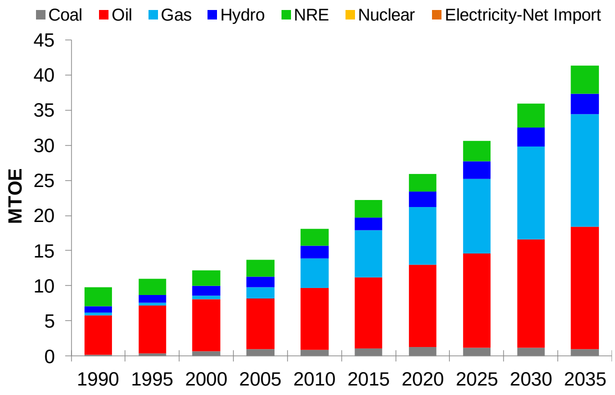
In contrast, the demand growth in the 'other' sector for new renewable energy (NRE) is expected to be much lower. As non-commercial biomass is still widely used in Peruvian households for heating and cooking purposes in the form of firewood, dung and yareta (a dried moss-type plant), it is likely demand will decrease as more convenient energy options become available. Other commercial NRE sources such as solar may also come into production but on a small scale.

Nonetheless, the expected decrease in energy intensity in the 'other' sector will be greater than in Peru's industry and transport sectors. Under the legal framework set by the Peruvian Reference Plan for the Efficient Use of Energy, several programs will operate until 2018, including replacement of incandescent bulbs by high-efficiency lamps, replacement of traditional electric boilers by solar technology in households, and replacement of stoves running on firewood and kerosene by new appliances based on natural gas and LPG. As a result, energy intensity in the 'other' sector is expected to improve significantly, decreasing 51% from 2005 to 2035.

PRIMARY ENERGY SUPPLY

Peru's primary energy supply is projected to increase by 129% in the outlook period, rising from 18.0 Mtoe in 2010 to 41.3 Mtoe in 2035. Fossil fuels (coal, oil and gas) are expected to remain the main energy sources, mainly due to the anticipated expansion in domestic supply of natural gas, with their combined share of the primary supply expected to increase from 77% in 2010 to nearly 84% in 2035. The remainder of the energy supply will come from hydro and NRE. While gas supply growth is expected to grow most rapidly, increasing 282% from 2010 to 2035, growth from coal will be the lowest, expanding 15.1% in the same period.

Figure PE4: BAU Primary Energy Supply

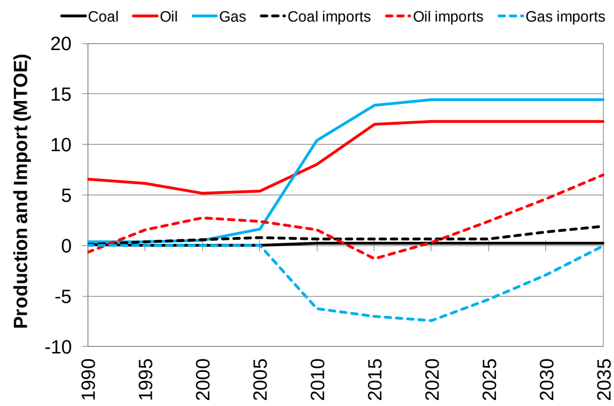


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Under BAU assumptions, Peru is expected to continue as a net gas exporter based on its proven natural gas reserves, production and demand. However, as the Peruvian Government's production forecasts are restricted to a 10-year span, gas production beyond that period is somewhat uncertain. In this regard, the assumptions made in this Outlook are that gas output will peak in 2016, and will be sustained around that level until 2035. The projection therefore indicates gas imports will be required in the last years of the outlook period to meet growing demand and whether gas imports are needed or not will ultimately depend on Peru's capacity to strengthen its exploration and production and maximize Camisea's output.

Projections indicate that Peru will remain an oil importer throughout the outlook period. Given its scarce oil reserves and limited production in comparison to expected demand, net oil imports are expected to grow 352%. In addition, since no major coal mining projects seem likely in the near future, coal imports will continue to be required to meet most of its demand.

Figure PE5: BAU Energy Production and Net Imports



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

From 2005 to 2035 Peru's primary energy intensity will decrease by 33%. This is of special importance to Peru's energy security given its role as a growing oil importer.

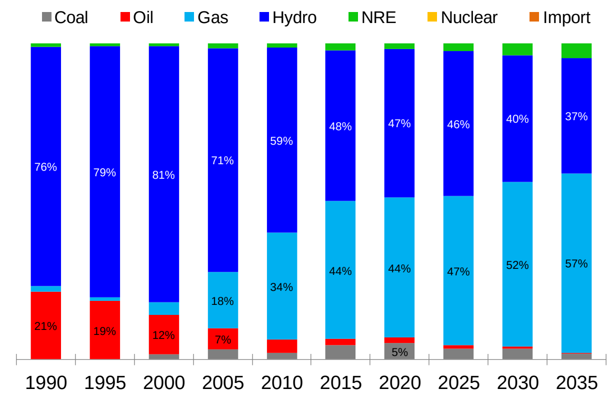
ELECTRICITY

Electricity generation is projected to increase at an annual average growth rate of 3.7% from 2010 to 2035, reaching 92 TWh by 2035. As shown in Figure PE6, while the hydrocarbon share of the power generation mix in 2010 amounted to 40%, by 2035 it is expected to represent as much as 60% of total generation, with hydroelectricity and a much smaller share of NRE making up the remainder.

The increase in gas production is expected to support considerable growth in combined-cycle power technologies. In this case, power generation based on gas is projected to grow significantly, increasing 320% from 2010 to 2035, followed by coal (125%) and hydro (56%). Demand for oil-based fuels such as diesel and fuel oil is expected to decrease 87% by 2035, as the use of these fuels for electricity generation will largely be limited to areas where gas distribution or hydropower is unavailable.

The Peruvian Government's efforts to raise the NRE contribution to the electricity generation mix will pay off in the long term. With an expected remarkable growth of 740% over the outlook period, NRE-based generation technologies will be the fastest growing energy source. The NRE share of total generation is expected to increase from 1% in 2010 to 5% by 2035. The mostly likely NRE development will be wind and biomass-fuelled power plants.

Figure PE6: BAU Electricity Generation Mix



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

This projection does not consider any growth in international trade in electricity with Peru's neighbours. With only one existing arrangement with Ecuador, further discussions in progress on interconnections with Brazil and Colombia will influence Peru's future electricity supply.

CO_2 EMISSIONS

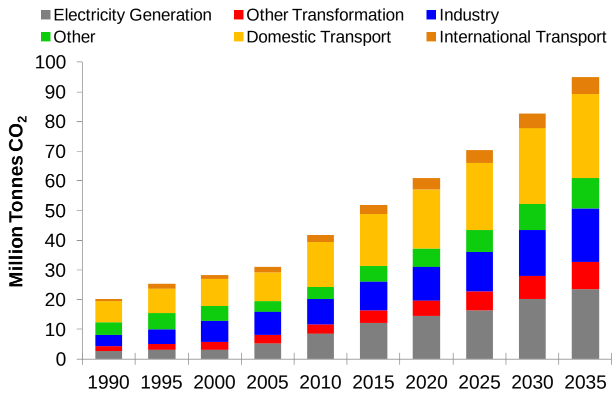
CO_2 emissions associated with the energy sector in Peru are projected to grow 128% from 2010 to 2035, from 41.8 million tonnes of CO_2 equivalent to 95.1 million tonnes of CO_2 equivalent. In 2035, final-use energy sectors are expected to make up most of these emissions (59%), followed by electricity generation (25%), refineries and energy sector own-use (10%) and international transport (6%).

Owing to the expected increase in natural gas use, especially in power generation, the projection indicates that oil's share of total emissions will decrease, from 68% in 2010 to 60% in 2035, coal will reduce from 8% to 4% and the gas share will grow from 24% to 36%.

Even though Peru is seeking to diversify its power generation mix by promoting NRE and replacing fuel oil and diesel power plants, the expected reduction in hydropower contribution and increasing reliance on gas-fired technologies is expected to raise the share CO_2 emissions from electricity generation between 2010 and 2035 from 20% to 25%.

In terms of final-use sectors, the largest increases in emissions from 2010 to 2035 are expected to be in the 'other' sector (157%), industry (110%) and domestic transport (86%).

Figure PE7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

Table PE1 shows that from 2010 to 2035, Peru's emissions will grow at about 3.3% per year. This will mainly be driven by GDP growth of 4.7% per year, offset declining energy intensity of GDP (improved energy efficiency and a shift to less energy-intensive industry) of 1.3%. The CO_2 intensity of energy will remain unchanged.

Table PE1: 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	0.5%	0.4%	0.1%	0.0%	0.0%
Change in Energy Intensity of GDP	-1.6%	-1.3%	-1.2%	-1.3%	-1.3%
Change in GDP	4.0%	7.2%	5.3%	5.1%	4.7%
Total Change	2.9%	6.2%	4.0%	3.8%	3.3%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Although the Camisea project has helped Peru to achieve gas self-sufficiency and become a significant player in the international gas market scene as the only source of LNG exports in South America, the long-term evolution of the project is unclear. It is uncertain whether Peru will be able to continue to satisfy domestic demand and international export contracts.

There would appear to be an opportunity to develop policies to improve Peru's energy efficiency, especially in the final demand sectors, given expected large increases in consumption and emissions. Energy intensity improvements implemented by the Peruvian authorities would provide numerous advantages to the economy. Energy security enhancement, reduction of growth in oil imports, maximization of gas value, increased productivity and ultimately, greater reductions in CO_2 emissions are some of the benefits Peru could gain by developing more ambitious energy efficiency policies.

ALTERNATIVE SCENARIOS

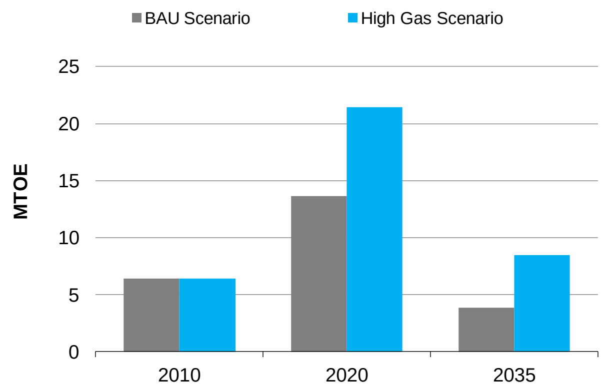
To address the energy security, economic development, and environmental sustainability challenges posed by the business-as-usual (BAU) outcomes, three sets of alternative scenarios were developed for most APEC economies including Peru.

HIGH GAS SCENARIO

To understand the impacts higher gas production might have on the Peruvian energy sector, an alternative 'High Gas Scenario' was developed. The assumptions behind this scenario are discussed in more detail in Volume 1, Chapter 12.

This scenario was built around estimates of gas production that might be available at BAU scenario prices or below, if constraints on gas production and trade could be reduced. As shown in Figure PE8, under the High Gas Scenario gas production in Peru would be 121% larger in 2035 than under BAU.

Figure PE8: High Gas Scenario – Gas Production



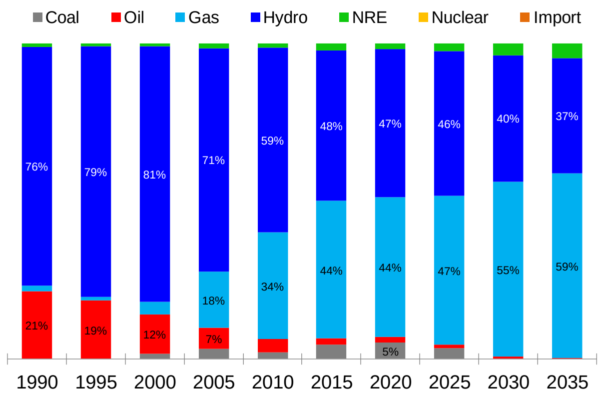
Source: APERC Analysis (2012)

Assumptions about gas production were based on information provided by Peru's MINEM on the total gas reserves (proved, probable and possible) from Blocks 56, 57, 58 and 88 of the Camisea gas project. While the BAU scenario only considers the development of proved gas reserves, the High Gas Scenario includes the probable reserves potential, resulting in much higher gas production. The High Gas Scenario assumptions also incorporate additional gas output from Block 58 coming online by 2025.

Under this High Gas Scenario, additional gas consumption in each economy will depend not only on the economy's own additional gas production, but also on the gas market situation in the APEC region. Irrespective of the significant investments required to develop the gas potential at Camisea, higher gas consumption in Peru's domestic market entails considerable expansion in the pipeline network to reach consumption centres beyond Lima. For this reason, it is probable that some portion of the additional gas production will be allocated for exports through Peru's LNG plant, which may be expanded in the future.

The High Gas Scenario assumes that the main use for the additional gas production will be in the electricity generation sector as a replacement for coal. The effects of a larger gas contribution to Peruvian electricity generation are presented in Figure PE9. Since the BAU electricity generation mix shown in Figure PE6 already included a significant increase in gas-based electricity generation, raising it to 57% of total generation and replacing most coal generation by 2035, the gas share under the High Gas Scenario is only slightly larger. By 2035 gas would account for 59% of the total electricity generation mix in Peru, completely eliminating coal-based generation.

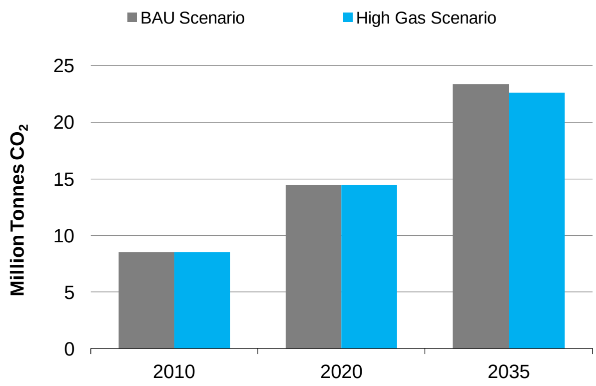
Figure PE9: High Gas Scenario – Electricity Generation Mix



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

As gas has roughly half the CO_2 emissions of coal per unit of electricity generated and the expected increase in the gas-based electricity generation is very moderate in comparison with BAU, CO_2 emissions would only reduce 3% in 2035. Figure PE10 shows this CO_2 emissions reduction.

Figure PE10: High Gas Scenario – CO_2 Emissions from Electricity Generation



Source: APERC Analysis (2012)

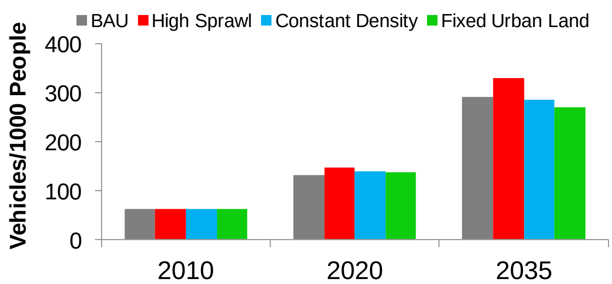
ALTERNATIVE URBAN DEVELOPMENT SCENARIOS

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

Figure PE11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. By 2035, the High Sprawl scenario shows an increase of 14% compared to BAU, while the Constant Density and Fixed Urban Land scenarios showed a reduction of 2% and 7%, respectively.

In developing economies like Peru, the impact of urban planning tends to be relatively small. As vehicle ownership is still far from the saturation level, it will grow rapidly irrespective of urban planning. However, it should be noted that after 2035, there might still be significant impacts.

Figure PE11: Urban Development Scenarios – Vehicle Ownership

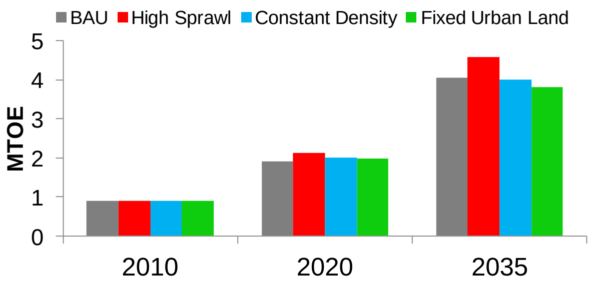


Source: APERC Analysis (2012)

Figure PE12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The results are similar to Figure PE11, with the highest variation being the

13% increase in 2035 compared to BAU occurring under the High Sprawl scenario, while the Constant Density and Fixed Urban Land scenarios showed a reduction of 1% and 6%, respectively..

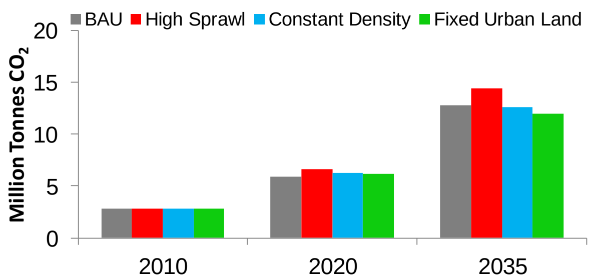
Figure PE12: Urban Development Scenarios – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure PE13 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.

Figure PE13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO_2 Emissions



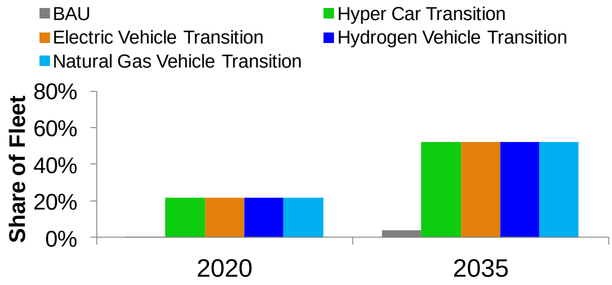
Source: APERC Analysis (2012)

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 PE14 shows the evolution of the vehicle fleet under BAU and the four 'Virtual Clean Car Race' scenarios. By 2035 the share of the alternative vehicles in the fleet reaches around 52% compared to about 4% in the BAU scenario. The share of conventional vehicles in the fleet is thus only about 48%, compared to about 96% in the BAU scenario.

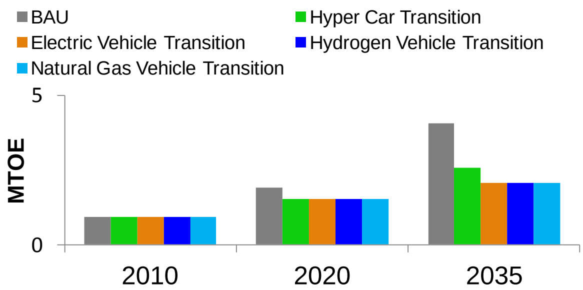
Figure PE14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure PE15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 49% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to BAU 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 37% by 2035—even though these highly efficient vehicles still use oil.

Figure PE15: Virtual Clean Car Race – Light Vehicle Oil Consumption

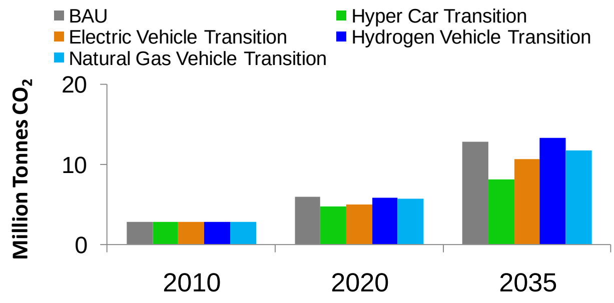


Source: APERC Analysis (2012)

Figure PE16 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 impact of each scenario may differ significantly from their oil consumption impact, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

In Peru, the Hyper Car Transition scenario appears to be the best option in terms of CO_2 emissions savings, with an emissions reduction of 36% compared to BAU in 2035. The next best reductions are the Electric Vehicle Transition (17%) and Natural Gas Vehicle Transition (8%) scenarios. Although hyper cars consume conventional fuels, their efficiency levels would significantly reduce the amount of fuel required. In Peru, electric vehicles would also offer significant reductions because natural gas-fired generation would probably be the marginal source of the electricity. The Hydrogen Vehicle Transition scenario offers the least benefits, and in fact actually increases CO_2 emissions by 4% compared to BAU in 2035. Although hydrogen vehicles have little direct carbon impact, hydrogen fuel production is energy intensive, entailing significant indirect CO_2 emissions.

Figure PE16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

REFERENCES

BBVA (Banco Bilbao Vizcaya Argentaria – Research) (2010), Peru: Automobile Market Outlook, www.bbvaresearch.com/KETD/fbin/mult/automobile_market_outlook_peru_tcm348-259266.pdf?ts=832012

El Peruano (2010), *Decreto de Urgencia No. 027-2010*, www2.osinerg.gob.pe/preciosreferencia/TarPreciosBanda/Decreto_UrgenciaN°027-2010.pdf

— (2012), *Decreto de Urgencia No. 005-2012*, www.mef.gob.pe/index.php?option=com_docman&task=doc_download&gid=8761&Itemid=100599&lang=es

Ernst & Young (2011), *Global Oil and Gas Tax Guide 2011*, June 2011, www.ey.com/oilandgas

Gestión (El Diario de Economía y Negocios de Perú) (2013), *La venta de autos nuevos alcanzó nuevo récord*, gestion.pe/economia/venta-autos-nuevos-marco-nuevo-record-2012-2055795

Global Insight (2012), *World Industry Services*, retrieved from IHS Global Insight Data Service.

IEA (International Energy Agency) (2011), *World Energy Statistics 2011,* retrieved from OECD/IEA CD-ROM Service.

IMF (International Monetary Fund) (2011), *World Economic Outlook Database*, September 2011, www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx

INDECI (Instituto Nacional de Defensa Civil del Perú) (2010), *Atlas de Peligros del Perú 2010*, www.indeci.gob.pe/atlas_10/index_final2.html

INEI (Instituto Nacional de Estadística e Informática) (2011a), *Información Económica*, www.inei.gob.pe/web/aplicaciones/siemweb/index.asp?id=003

— (2011b), *Perú en cifras. Indicadores Demográficos—Población*, www.inei.gob.pe

IPEN (Instituto Peruano de Energía Nuclear) (2009), *Plan Estratégico Institucional 2010–2016,* www.ipen.gob.pe/site/transparencia/transp_2012/plan_org/pei2010_2016.pdf

MINCETUR (Ministerio de Comercio Exterior y Turismo) (2011), *Cierre 2010 Exportaciones*, www.mincetur.gob.pe/newweb/Default.aspx?tabid=2315

MINEM (Ministerio de Energía y Minas) (2010a), *Anuario de Hidrocarburos 2010*, www.minem.gob.pe/publicacion.php?idSector=5&idPublicacion=403

— (2010b), *Anuario Estadístico de Electricidad 2010*, www.minem.gob.pe/publicacion.php?idSector=6&idPublicacion=405

— (2010c), *Anuario Minero 2010*, www.minem.gob.pe/publicacion.php?idSector=1&idPublicacion=382

— (2010d), *Perú Sector Eléctrico 2010*, Documento Promotor, www.minem.gob.pe/publicacion.php?idSector=6&idPublicacion=52

— (2010e), *Propuesta de Política Energética de Estado 2010–2040*, www.minem.gob.pe/prepublicacionesSectorDown.php?id=99

— (2011), *Balance Nacional de Energía 2010*, www.minem.gob.pe/publicacion.php?idSector=12&idPublicacion=418

MTC (Ministerio de Transportes y Comunicaciones) (2005), *Plan Intermodal de Transporte 2004–2023*, www.mtc.gob.pe/portal/logypro/plan_intermodal/principal.html

— (2007), *Especificaciones Técnicas para la conservación de Carreteras*, *Diagnóstico del Sector Transporte*, http://transparencia.mtc.gob.pe/idm_docs/normas_legales/1_0_2951.pdf

— (2011a), *Estadísticas de transportes*, www.mtc.gob.pe/estadisticas/index.html

— (2011b), *Parque vehicular estimado según departamento o región 2002–2011*, www.mtc.gob.pe/estadisticas/archivos/ESTADISTICA items/1-TRANSPORTES/4.CARRETERO/3.A.2.xls

— (2011c), *PPPs and CREMA contacts on National Roads*, www.proviasnac.gob.pe/Archivos/file/Documentos de Interes/NRN PERU RTT engl %28jun2011%29.pdf

NASA (US National Space Aeronautics and Space Administration – Earth Observatory) (2011), *El Niño, La Niña, and Rainfall*, earthobservatory.nasa.gov/Features/WorldOfChange/enso.php

OGJ (Oil & Gas Journal) (2011), *Worldwide Report,* Pennwell, Houston, USA, 5 December.

Osinergmin (Organismo Supervisor de la Inversión en Energía y Minería) (2008), *Regulación del Gas Natural en el Perú*, www2.osinerg.gob.pe/Infotec/GasNatural/pdf/Regulacion Gas Natural Peru.pdf

— (2011a), *Acta de Adjudicación de la Segunda Subasta de Suministro de electricidad con Recursos Energéticos Renovables*, www2.osinerg.gob.pe/EnergiasRenovables/contenido/Actas/Acta-Adjudicacion y Buena Pro.pdf

— (2011b), *Resultados Primera Subasta*, www2.osinerg.gob.pe/EnergiasRenovables/contenido/Resultado1raSubasta.html

Perupetro (La Agencia Nacional de los Hidrocarburos) (2011), Embarques de gas natural para fines de exportación, www.perupetro.com.pe/RelacionExportacion/relacion.jsp

Petroperú (2011), *Instalaciones*, www.petroperu.com.pe/portalweb/Main.asp?Seccion=74

PlusPetrol (2011), *Proyecto Camisea*, www.pluspetrol.net/camisea.html

Proinversión (Agencia de Promoción de la Inversión Privada) (2011), *Inversión extranjera directa en Perú por sector de destino*, www.proinversion.gob.pe/0/0/modulos/JER/PlantillaStandard.aspx?ARE=0&PFL=0&JER=1744

Repsol (2011), *Refinería La Pampilla*, www.repsol.com/pe es/corporacion/complejos/refineria-la-pampilla/

UN (United Nations) (2008), *State of the World's Cities 2010/2011: Bridging the Urban Divide,* United Nations Human Settlement Program, www.unhabitat.org/pmss/getElectronicVersion.aspx?nr=2917&alt=1

— (2009), *World Urbanization Prospects: The 2009 Revision Population Database*, esa.un.org/unpd/wup/unup/

UNDP (United Nations Development Programme) (2011), *Human Development Report 2011*, hdr.undp.org/en/media/HDR 2011 EN Complete.pdf

UNEP (United Nations Environment Programme) (2002), *Cancun Declaration of Like-Minded Megadiverse Countries*, www.pnuma.org/deramb ing/CancunDeclaration.php

UN–FCCC (United Nations Framework Convention on Climate Change) (2011), C*ompilation of information on nationally appropriate mitigation actions to be implemented by Parties not included in Annex I to the Convention,* unfccc.int/resource/docs/2011/awglca14/eng/inf01.pdf

WB (The World Bank) (2010)*, Peru Rural Road Program: Bringing Access to the Rural Poor,* siteresources.worldbank.org/NEWS/Resources/PeruRuralRoadProgram4-11-10.pdf