Technical Report:

Commercial Opportunities in the Peruvian Energy Sector

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Executive Summary

As the third largest country in South America with a rapidly growing economy and vast natural resources, Peru offers large opportunities for development in the renewable energy, natural gas and energy efficiency sectors. Peru economy has grown at an average 5.9% annually over the past decade, and is currently the fastest growing economy in South America. Its economy is expected to continue to grow at a rate of 3.5-4.3% annually for the next three years.

Peru's largest sectors are mining and industry, and the country contains large reserves of metals such as gold, silver, copper, lead, and zinc. It also has vast natural gas and hydro resources, which are being developed, and renewable resources such as solar, wind, and geothermal that have yet to be exploited.

Peru's energy matrix is largely based on oil and natural gas, which together make up 79% of the country's Total Primary Energy Supply (TPES). Peru's electricity demand has grown steadily with its economy, increasing by 81% over the last ten years. In 2016, the peak electricity demand in Peru's interconnected national grid (SEIN) reached 6,492 MW. Electricity generation is largely based on natural gas and hydropower, which accounted for 47% and 46% of total generation, respectively, in SEIN in 2016. Renewable resources, such as small hydro (<20 MW), solar and wind represented 4.9% of electricity generation in 2016.

Peru's renewable energy sector has grown significantly in the past eight years, with 33 solar, wind, small hydro and biomass projects entering the national grid since 2009, for a total installed capacity of 602 MW. There are currently 35 renewable energy projects in development, totaling an additional 733 MW that is expected to come online by 2020. Peru's investment promotion agency, Proinversion, expects growth rates of 3-5% in non-conventional renewables by 2025. Future investments of US$ 8.8 billion would be needed to increase renewable energy (excluding large hydro) to 20% of the total electricity generation by 2040, according to ProInversion.

Solar and wind are the fastest growing renewable energy sectors, and Peru currently has an installed capacity of 96 MW of solar and 232 MW of wind power. A total of $1.5 billion has been invested in the two sectors from 2008-2017. The hydropower sector is the most developed in Peru, having been the major source of electricity for the country until the development of the natural gas sector in 2004. The biomass sector is relatively small, with a total of three projects and 31 MW coming online since 2010. To date, no geothermal projects have been constructed in Peru.

The opportunities for solar are diverse, with potential in large grid connected projects, mid sized off grid projects in mining and industry and small scale pv systems for rural electrification. Wind has also been attracting foreign investors in Peru, with the majority of projects being large scale grid connected wind farms. The prices for solar ($48.09/MWh) and wind ($37.79/MWh) energy set in Peru's fourth renewable energy auction in 2015 were some of the lowest prices seen in Latin

America at the time.

The hydro industry is considerably more developed than other renewable sources (historically, Peru's main source of electricity was hydro) in Peru, with 4,700 MW of large hydro and 230 MW of small hydro installed. Opportunities in the small hydro sector in Peru are mainly in providing services for hydropower plants and hydroelectric companies.

In the geothermal sector, there is high potential (resources are estimated at 2,860 MW), but no geothermal projects have moved beyond the exploration phase in Peru. Several foreign companies have concessions to explore the country's potential, but high exploration and investment costs have delayed development of the sector.

The growth of the natural gas sector in Peru began with development of the Camisea Gas fields in 2004, which are expected to bring $23 billion in benefits to the county over the 33 year life. Between 2004 and 2016, the share of natural gas in electricity generation has more than quadrupled, growing from 10% to 47%. In 2016, US$ 334.6 million was invested in oil and gas exploration, with US$ 46.95 million spent on exploration and US$ 287.65 million on exploitation.

Peru is now the third largest producer of natural gas in South America, producing 14 billion m^3 in 2016. In 2013, 30% of Peru's domestic natural gas was used for electricity generation, 11% for industry, 6% for transport and 53% was exported, mainly to Mexico as well as Asian and European markets. A negligible amount (<1%) is used in the residential sector.

In Peru's National Energy Plan 2014-2015, it is predicted that natural gas will be used to generate 6,891 MW of electrical energy by 2025, representing a 53% increase in production since 2013. The annual growth of the sector is estimated to be 4.6% for 2017.

The upstream opportunities in the natural gas sector involve the exploration of Peru's 18 sedimentary basins with hydrocarbon exploration potential, only three of which have been exploited.

The midstream opportunities in the sector include the Southern Gas Pipeline, and US$7 billion project that will transport liquid natural gas from the Camisea Fields to the southern regions of Peru. The project, which is just over 35% completed, was returned to the Peruvian government last year, and an international bidding process is expected to open in early 2018 to find international investors to continue the project.

The downstream opportunities include upgrading liquid hydrocarbon plants, such as diesel and petroleum which mainly serve as Peru's backup electricity reserve, to natural gas as well as converting single cycle power plants to combined cycle.

The energy efficiency industry in Peru is in its early stages of development. Energy management and the implementation of energy efficiency measures are still relatively uncommon practices.

The major opportunities are in the mining, industry and residential sectors and include upgrading to high efficiency lightings and motion sensors, installing variable frequency motor drives and improving the efficiency of heating and cooling processes in processing plants. However, the market has yet to develop to the low cost of energy and a lack of technical expertise and financing options. Energy efficiency companies with experience conducting investment grade energy audits and providing turnkey solutions are needed to help develop the sector.

Peru's major industry events provide an opportunity to make connections with the main players in the energy and mining sectors. Business in Peru is highly dependent on personal relationships and local connections, and negotiations and deals are often made at social or industry-related events. Partnering with a local company with technical expertise and a legal counselor is an effective approach for foreign firms looking to enter the market.

1.0 Introduction

Peru is the third largest country in South America, with a population of 31.48 million and a GDP of US$189 billion in 2015 (World Bank, 2017). It is extremely biodiverse, and its habitats include the Pacific coastal region to the west, the tropical Amazon basin in the east, and the Andes Mountain range stretching from north to south. It contains an abundant supply of natural resources, and is among the world's highest producers of gold, copper, silver, lead, zinc and tin. Its energy resources include vast amounts of natural gas and hydro that have allowed Peru to meet its growing electricity demand and renewable sources such as solar, wind, biomass and geothermal that remain to be developed.

According the International Monetary Fund, Peru is a "rising star" as an emerging market with strong growth and low vulnerability. Peru is leading regional economic growth in South America, and its economy is expected to continue to grow at a rate of 3.5-4.3% annually for the next three years. Strong economic growth and careful financial management have made Peru an attractive place for investments. From 2005 to 2015, Peru recorded the lowest annual inflation rate at a regional level (3.0%), and its Standard and Poor credit rating is BBB+ with positive outlook. Peru's major sectors by private investment are mining, hydrocarbons, electricity, industry and infrastructure (ProInversión, 2017).

Peru's rapid development has led to an increase in electricity demand of 81% between 2006 and 2016 (MINEM, 2015). In Peru's interconnected grid (SEIN), peak electricity demand reached 6,492 MW in 2016 (COES, 2016) and if Peru maintains current growth rates, it is expected to reach to 15,822 MW by the year 2030. The majority of Peru's electricity generation comes from hydro and natural gas, which account for 45.8% and 46.5% of total generation in SEIN, respectively (COES, 2016). Renewable resources, including small hydropower, represent 4.9% of total electricity generation.

Within SEIN, electricity use is dominated by the industrial (including mining) sector, which accounted for 51% of total electricity consumption in 2015 (MINEM, 2015). The expansion of this sector and overall growth in Peru's electricity market creates an opportunity to diversify Peru's electricity mix. Renewables, including solar, wind, small hydro, biomass, geothermal, and tidal power could fill this demand, considering that Peru's ample renewable resources have largely been unexplored.

The following report presents the current situation and prospects of Peru's renewable energy and natural gas sector. It describes the legal and regulatory framework that promotes energy development, the main players in the energy market and the social and environmental challenges caused by the growth of the energy sector. It also analyzes the results of the last 4 renewable energy auctions, and energy prices and tariffs in the electricity market. The report concludes by describing the main entry barriers for sustainable energy development, the future of energy in Peru, and recommendations for Peru's energy sector.

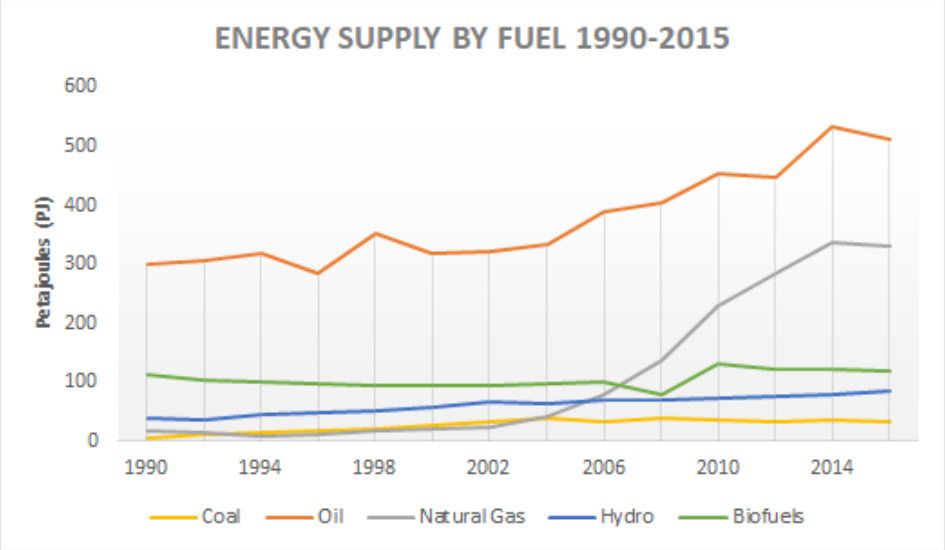
2.0 Current Status of Peru's Energy Sector

Energy Sector

Energy Supply

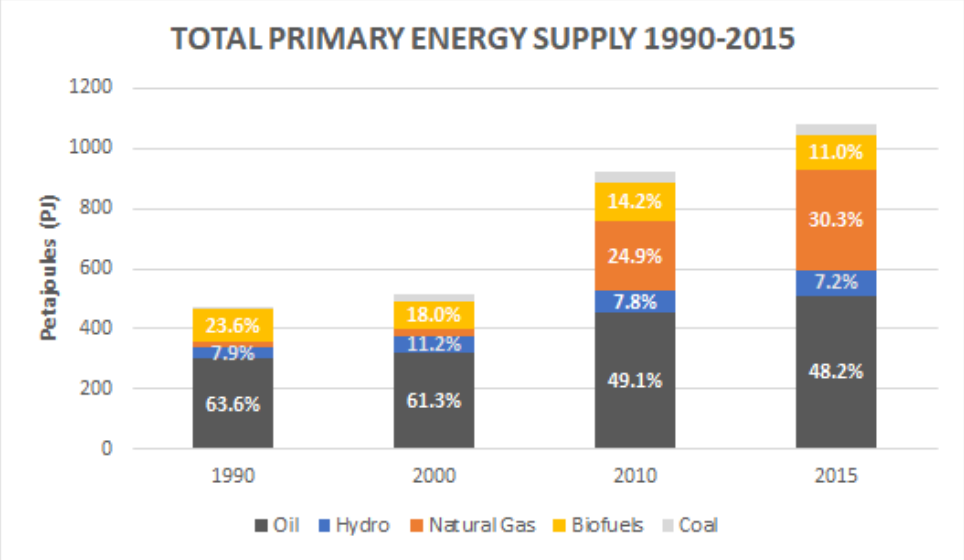
Peru's high rate of economic growth has resulted in a significant increase in energy demand. To meet this demand, Peru' has increased its Total Primary Energy Supply (TPES) by 153% over the past 25 years, from 408 Petajoules (PJ) in 1990 to 1,030 PJ in 2015. Figures 1 and 2 illustrate the growth of Peru's energy supply from 1990 to 2015.

Figure 1: Energy Supply by Fuel



Source: International Energy Agency (IEA) 2017

Figure 2: Total Primary Energy Supply



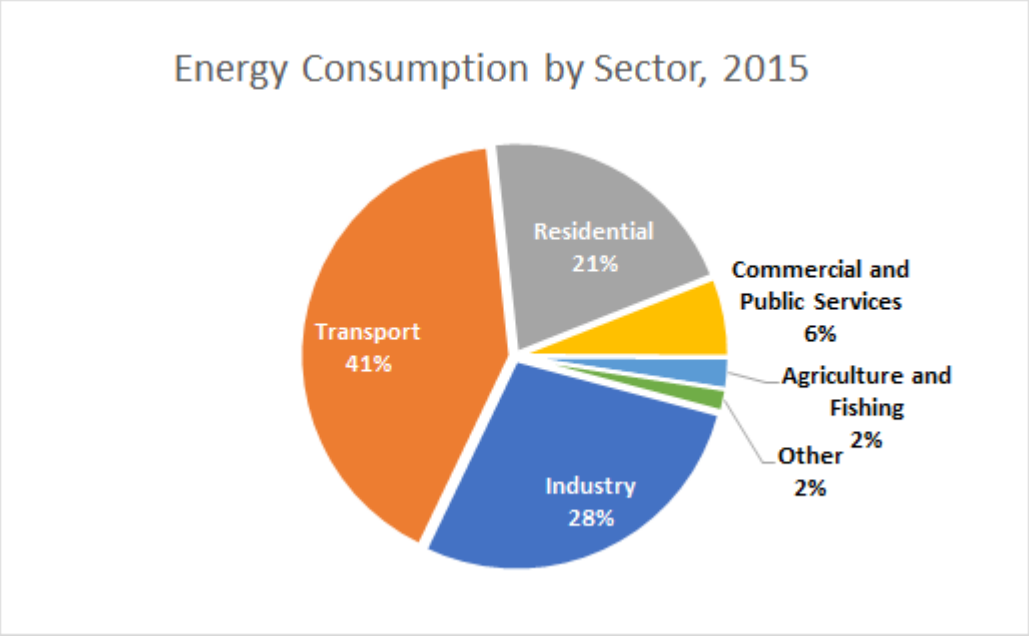
Source: International Energy Agency (IEA) 2017

Peru's Total Primary Energy Supply (TPES) is dominated by fossil fuels (oil, natural gas, coal), which accounted for 80.8% of its total energy supply in 2015. Natural gas has seen the largest growth since 2000, increasing its total supply from 21 PJ to 330 PJ in 2015, and approaching oil as the largest energy source. Oil supply (production and importation) has also experienced sustained growth over the past 20 years, while hydro, biofuel, and coal sectors have experienced moderate growth. Additionally, there has been a small influx of renewables into the energy sector (not shown in Figures 1 and 2) since 1998, and energy production from renewables grew from 0.3 PJ in 2008 to 4.1 PJ in 2015. However, at 0.4%, renewables represent a very small portion of the total energy supply.

Energy Consumption

Peru's energy consumption is dominated by the transport and industry sectors, which together account for 69% of the total energy consumption, followed by the residential sector at 21% and the commercial and public services sector at 6%. Figure 3 below shows a breakdown of Peru's energy consumption by sector in 2015.

Figure 3: National Energy Consumption 2015



Source: International Energy Agency (IEA) 2017

Electricity Sector

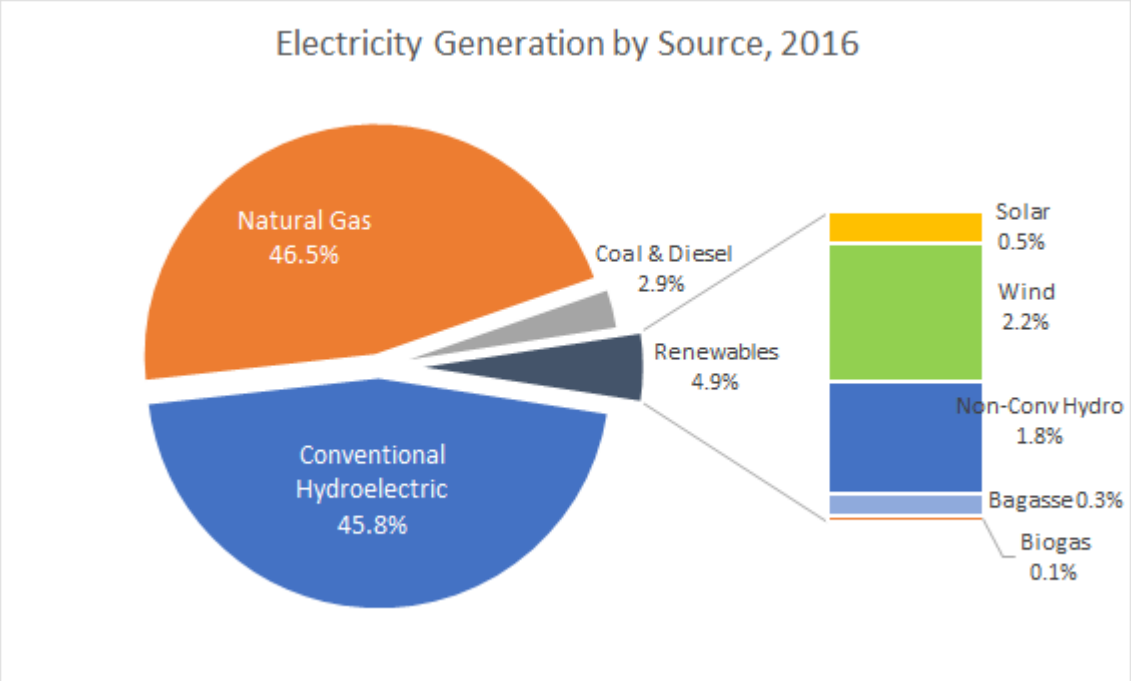
Electricity Generation

Peru's total electrification rate covers 93% of the population, with 7% (2.2 million) remaining without electricity, based on the most recent estimates by MINEM in 2015 (MINEM-DGER, 2015). Peru's Ministry of Energy and Mines (MINEM) aims to achieve 99% electrification by 2025. Peru's Interconnected Grid (SEIN) covers 88.8% of the Peru's total population, with the difference being covered by isolated systems (such as the city of Iquitos).

A 600 km, 220 kV transmission line from Moyobamba to Iquitos has been proposed to integrate Iquitos into SEIN. However, the project has faced major delays and is unlikely to be constructed in the next 6 years due to high costs (more than US$600 million) and a failure to meet MINEM's requirements in its environmental impact report. This creates an opportunity in Iquitos to develop renewable projects, which has resources for small hydro, solar and biomass. Iquitos is currently powered by a 80 MW oil-powered thermal power plant, inaugurated in November of 2017.

In the Interconnected Grid, Peru's electricity generation is dominated by the hydroelectric and thermal (fossil fuel) energy sectors, with natural gas accounting for 46.5% of generation (22,471 GWh), hydropower for 45.8% (22,133 GWh), and renewables for 4.9% (2,368 GWh) in 2016 (COES, 2016). Figure 4 below shows the breakdown of electricity production by sector for 2016.

Figure 4: National Electricity Generation 2016



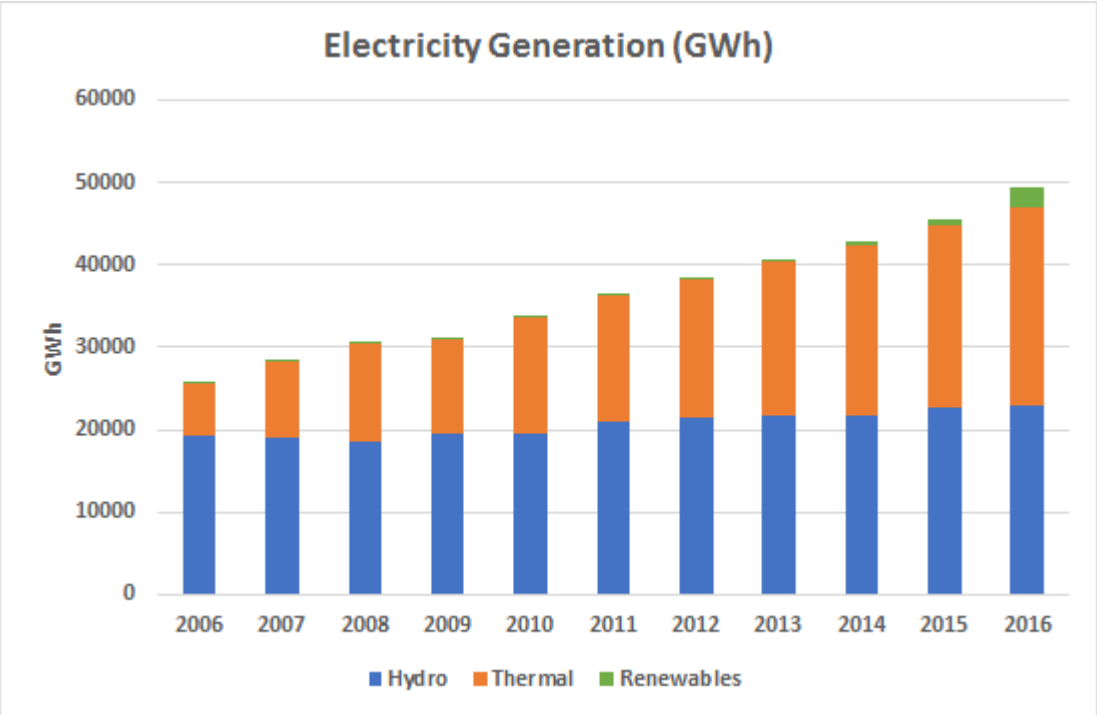
Source: Annual Operation Report 2016 SEIN, COES SINAC

It is worth noting the difference between conventional and non-conventional hydroelectric generation. Conventional hydroelectric generation refers to hydroelectric systems greater than 20 MW, and is generally not considered renewable. Non-conventional hydro, which refers to hydro systems smaller than 20 MW, is included in the renewables category.

Before 2008, MINEM did not differentiate between conventional and nonconventional hydroelectric generation. In 2008, Legislative Decree 1002 was passed, setting the guidelines for renewable energy and separating conventional hydro (>20MW) from non-conventional hydro (<20 MW). As a result, the conventional hydroelectric category in Figure 4 includes some hydroelectric plants smaller than 20 MW that had been built before 2008. The non-conventional hydro category (1.8%) represents small hydro plants installed after 2008.

In the past 10 years Peru's total electricity generation has almost doubled, increasing from 25,614 GWh in 2006 to 48,326 GWh in 2016 (MINEM, 2015; COES, 2016). This represents an increase of 22,712 GWh, or 89% over 10 years. The average annual rate of increase of electricity generation over the same time period was 6.6%. Figure 5 below summarizes the historical electricity production from 2006 to 2016.

Figure 5: National Electricity Generation 2006-2016



Sources: Evolution of the Electrical Sector 1995-2015, MINEM
Annual Operation Report 2016 SEIN, COES SINAC

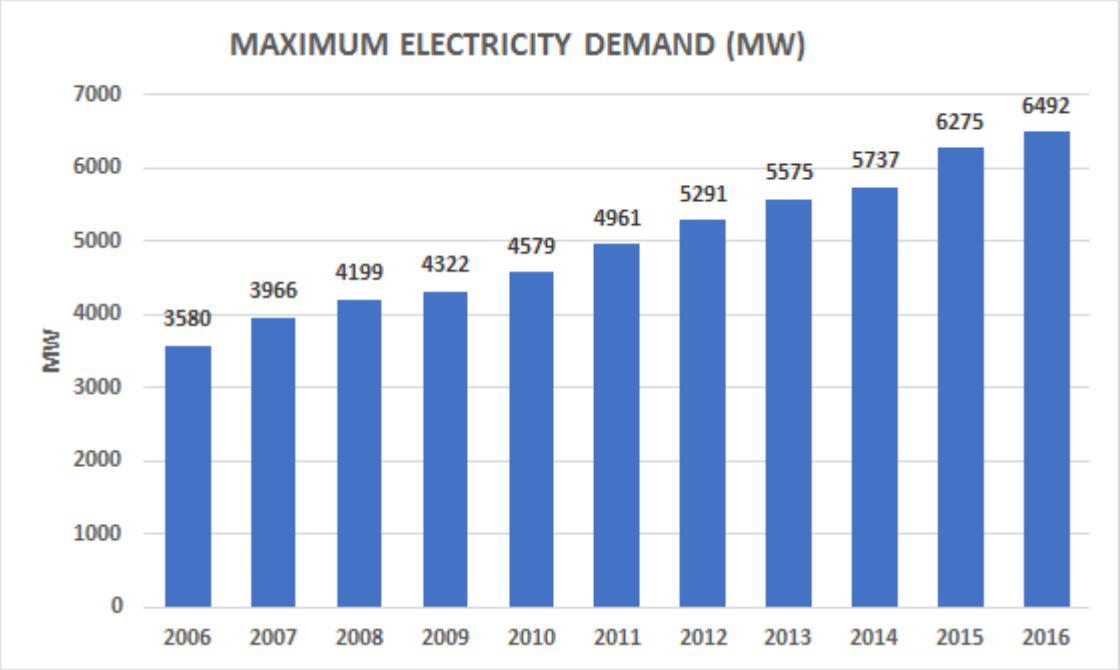
The share of thermal power in electricity generation has grown significantly since the

development of the Camisea Gas fields in 2004. Between 2004 and 2016, the share of natural gas in Peru's electricity generation has more than quadrupled, growing from 9.9% in 2004 to 46.5% in 2016. As a result of the natural gas development, the share of hydroelectric energy in electricity generation dropped from 76% in 2004 to 50% in 2016 (COES, 2016).

Maximum Electricity Demand (Power Demand)

Between 2006 and 2016, Peru's maximum electricity demand in SEIN increased from 3,580 MW to 6,492 MW, an increase of 2,912 MW (81%) over ten years (Proinversión 2017). The average annual increase in maximum demand during this time period was 6.4%. Figure 6 below illustrates the growth in Peru's maximum electricity demand from 2006 to 2016.

Figure 6: Growth of Maximum Electricity Demand in SEIN, 2006-2016



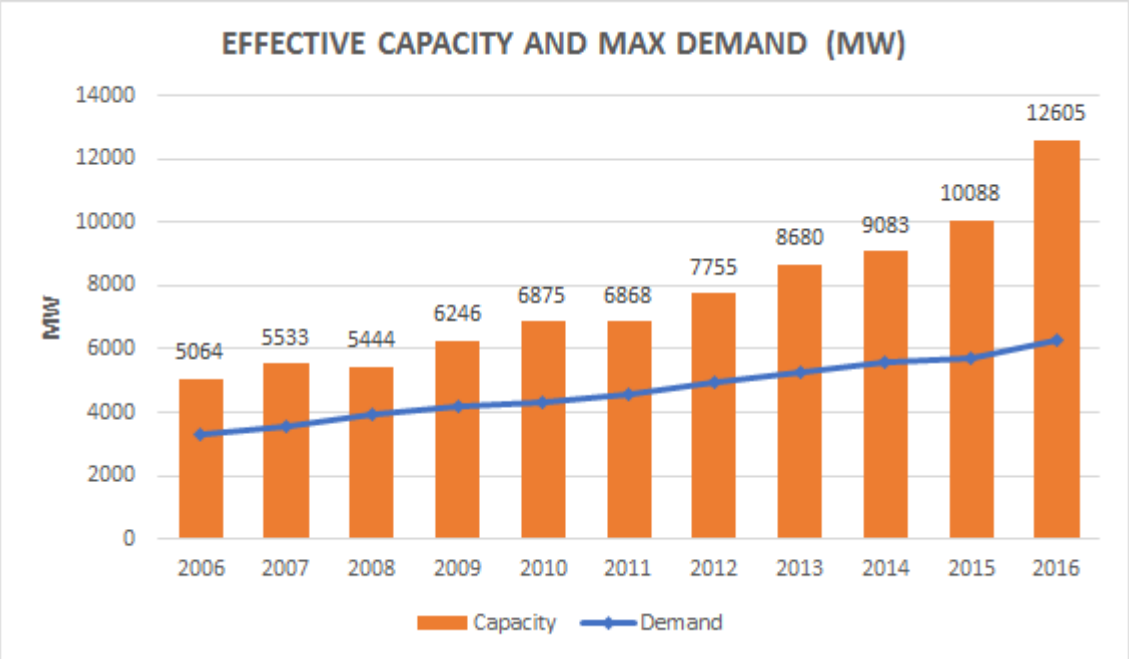
Sources: Evolution of the Electrical Sector 1995-2015, MINEM
Annual Operation Report 2016 SEIN, COES SINAC

From 2015 to 2016, electricity demand increased by 217 MW (3%). By 2025, MINEM expects demand to reach between 9,500 MW and 12,300 MW, based on the current GDP growth scenarios (MINEM, 2014).

Effective Capacity (Power Supply)

As the demand for electricity has increased, Peru has continued to add power capacity to meet this demand. Figure 7 illustrates the growth of effective capacity, or power supply, and maximum demand from 2006-2016.

Figure 7: Growth of Effective Power Capacity 2006-2016



Sources: Evolution of the Electrical Sector 1995-2015, MINEM
Annual Operation Report 2016 SEIN, COES SINAC

From 2006 to 2016, effective capacity has increased by 7,540 MW, a rate of 9.4% annually. Over this time period, the annual rate of increase of effective capacity (9.4%) has exceeded the rate of increase of maximum demand (6.4%), ensuring that the growing demand for energy is met.

In the past year (2015 to 2016), effective capacity has increased by 2,516 MW (25%), due to a number of large hydroelectric (~1100 MW) and thermoelectric plants (~1300 MW) coming online, as well as the 97 MW Tres Hermanas wind park.

MINEM has stated that the optimum reserve capacity in SEIN should be at least 40%. In 2016, Peru's energy reserve was 36% in dry season and 57% in wet season in available energy (SIDEC, 2016). Available energy includes a capacity factor for hydropower capacity that varies between wet season and dry season, and the cold reserve is not considered in the calculation of the energy reserve.

A cold reserve of 1,333 MW of diesel fuel, called 'Nodo Energetico del Sur', has been installed in 2016 (COES, 2016) in the southern part of Peru for use in emergency cases. It is expected that with the projected arrival of the Southern Gas Pipeline in 2023, the diesel fuel cold reserve will be replaced by natural gas from Camisea.

Construction for the Southern Gas pipeline (Gasoducto Sur Peruano) began in May 2015, and the US$7 billion pipeline is just over 35% completed. In January 2017, Peru's finance ministry cancelled the contract to build the pipeline as a result of investigations of the project's main

stakeholder, Brazilian company Odebrecht, paying US$29 million in bribes in Peru (Post, 2017). A new deal will take at least one year to complete, and any deal is likely to include changes to the project, according to legal experts.

3.0 Government Policies

Renewable Energy

In 2008, MINEM passed Legislative Decree 1002, establishing Peru's first target for Renewable Energy Development. It stated that by 2013, 5% of Peru's total electricity consumption in the interconnected grid should come from non-conventional renewable energy sources. Small hydro was not included in the 5% to support further development of solar, wind, biomass, tidal, and geothermal energy.

As of December 2017, the 5% target has not yet been reached. In 2016, generation from renewable sources including small hydro reached 4.9%. Not including small hydro, renewables account for 3.2% of Peru's total electricity generation.

Natural Gas

Government policy has been favourable towards natural gas, seeing it as an opportunity to diversify its energy use and reduce its dependence on oil imports (Ernst & Young, 2017). The primary uses of the gas are: electric power generation, heavy industry, transportation, and residential and commercial with power generation being the largest user (World Bank, 2010).

In the National Energy Plan 2014-2025, it is predicted that natural gas will be used to generate 6,891 MW of energy in 2025 representing a 53% increment in production since 2013. In terms of contribution to the electrical energy matrix however, thermoelectric generation will fall from 57% to 48%. These predictions assume an average annual national growth of 4.5% (MINEM, 2014).

National Energy Policy of Peru

The National Energy Policy of Peru, 2010-2040 (*Política Energética Nacional del Perú 2010-2040)*, contains 9 policy objectives, including the following objectives regarding renewable energy and natural gas:

> **Objective 1:** To have a diversified energy matrix, with an emphasis on renewable sources and energy efficiency
>
> **Objective 4:** To improve the efficiency of the use of energy and of the energy production chain.
>
> **Objective 6:** Develop an energy sector with minimal environmental impact and low carbon emissions within a framework of sustainable development

Objective 7: Develop the natural gas industry and its use in residencies, transportation, trade and industry as well as efficient power generation.

The policy is 6 pages in length, and although it promotes renewable energy (conventional and non-conventional) participation in the energy matrix, it does not indicate clear or quantifiable targets that are supposed to be designated in the National Energy Plan. With the arrival of the Southern Gas Pipeline now delayed until at least 2023, The National Energy Policy of Peru needs to be revised with specific and quantifiable objectives for renewable energy participation in Peru's energy matrix.

National Energy Plan

In April 2014, MINEM published the National Energy Plan 2014-2025, which sets a target of 60% generation from renewable energy by 2025. However, this target includes 55% generation from large hydro, which already accounted for 45.8% of generation in 2016 in SEIN. It also restates the 5% generation target set for non-conventional renewables in 2008, and does not provide any further guidelines on the integration of renewables in Peru's energy mix.

Regarding natural gas, the report reiterates the ongoing government objectives to develop the natural gas sector and its use for domestic electricity production, industry and transportation purposes throughout the country, reducing Peru's dependency on oil importations. The report sets out a target to assess and redesign the process of obtaining the permits required by the oil and gas industry in order to promote sustainable investment in oil and gas exploration.

Additionally, The National Energy Plan 2014-2025 outlines a series of energy efficiency (EE) objectives and plans, which aim to reduce national energy demand by 14.8% of the predicted value for 2025 (based on an annual national growth prediction of 4.5%). The general aims are summarized as follows: to create a culture where economic growth and environmental conservation are in balance; improve transparency in the energy market; cooperate with international partners to develop EE projects; to promote the forming of energy service companies and encourage the efficient use of energy in remote communities.

By sector, the exact plans for the years 2014 - 2025 include the installation of:

Residential - 7 million energy efficient lightbulbs, 1 million solar water heaters, 0.5 million high efficiency wood stoves

Public - 850,000 energy efficient lightbulbs

Manufacture and services - 511 upgraded liquid hydrocarbon boilers, 30,000 efficient motors, promotion of cogeneration, 8 million energy efficient lightbulbs

Transport - Diesel to natural gas vehicle conversions

Additional - Energy efficiency labeling, minimum efficiency of some household items, education of energy efficiency across all levels of education.

National Renewable Energy Plan

Although a National Renewable Energy Plan is mandated by Peruvian Law under Legislative Decree 1002, which was passed in 2009, a plan has yet to be published. A National Renewable Energy Plan is needed to create a long term vision for renewables in Peru. Peru needs to implement long term renewable energy targets and create mandatory goals for renewable energy integration. A long term plan is also vital in encouraging investors to build foundations in Peru.

If Peru developed a National Renewable Energy Plan, it could be used to drive renewable energy auctions in Peru, which are currently subject to fluctuations in the energy market and don't have a fixed timeline or set of goals. The plan could also be applied to make technology specific decisions within auctions. For example, a National Wind Energy Plan could be applied to integrate 5,000 MW of wind power in the next five years, with a plan to auction 1,000 MW each year until the goal is met.

United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on 9 May 1992 with a primary objective to stabilize greenhouse gas emissions. Since then, a number of important environmental policies have been made through the same framework, notably the 1997 Kyoto Protocol and 2016 Paris Agreement. The signing of major new agreements and protocols occurs at the annual Conference of the Parties (COP).

At COP21 (Paris, 2016), a near global consensus was reached; 196 of the participating countries, including Peru, signed a document committing them to reduce their emissions with the aim of keeping global temperature rise this century well below 2 degrees celsius above pre-industrial levels. The agreement went into effect 5 October 2016, and its period of implementation is from 1 January 2021 to 31 December 2030, with the option for updates every 5 years.

Peru is responsible for 0.3% of the global emissions, of which approximately half is generated through land use, land-use change and forestry sector activities (LULUCF). The exact mitigation targets for Peru are set out in the Intended Nationally Determined Contribution (iNDC) Document, published in 2015 and are as follows:

- *The Peruvian iNDC envisages a **reduction of emissions equivalent to 30%** in relation to the Greenhouse Gas (GHG) emissions of the projected Business as Usual scenario (BaU) in 2030.*
- *The Peruvian State considers that a 20% reduction will be implemented through domestic investment and expenses, from public and private resources (non-conditional proposal),*

and the remaining 10% is subject to the availability of international financing and the existence of favorable conditions (conditional proposal).

Along with mitigation targets, Peru set out a series of **adaptation** goals within its iNDC Document. These are a series of aims to increase Peru's resilience against the negative impacts of climate change. Indeed, Peru possesses seven of the nine characteristics recognized by the UNFCCC to deem a country as "particularly vulnerable" to the impacts of climate change. In accordance with the most recent available scientific information, five sectors/systems were identified as the most at risk to the negative impacts of climate change. In priority order, highest to lowest, they are the following: Water (Water resources), Agriculture, Fishery, Forestry and Health.

An additional five areas where action must be taken in order to address adaptation effectively are: disaster risk management, resilient infrastructure, poverty and vulnerable populations approach, gender approach and promotion of private investmentment in climate change adaptation.

On 6 December 2016, The National Adaptation Plan (Plan Nacional de Adaptación, 2016) was released. It outlined detailed measures ranging from the promotion of drought resistant crops to engaging the local indigenous communities in the conservation of forests and jungles to meet the adaptation goals of the iNDC Document.

4.0 Renewable Energy

Market Trends

Peru's renewable energy sector has grown from less than 1MW to 602 MW in the past 8 years, with the entry of 33 solar, wind, small hydro and biomass projects into the national grid since 2009. There are currently 35 renewable energy projects in development, totaling an additional 733 MW that is expected to come online by 2020. The solar and wind sectors are experiencing the fastest growth in Peru, and offer the largest opportunities in the renewable sector.

The opportunities for solar are diverse, with potential in large grid connected projects, mid sized off grid projects in mining and industry and small scale pv systems for rural electrification. Wind has also been attracting foreign investors in Peru, with the majority of projects being large scale grid connected wind farms. The prices for solar ($48.09/MWh) and wind ($37.79/MWh) energy set in Peru's fourth renewable energy auction in 2015 were some of the lowest prices seen in Latin America at the time.

The hydro industry is significantly more developed than other renewable sources (historically, Peru's main source of electricity was hydro) in Peru, with 4,700 MW of large hydro and 230 MW of small hydro installed. Opportunities in the small hydro sector in Peru are mainly in providing

services for hydropower plants and hydroelectric companies.

In the geothermal sector, there is high potential (resources are estimated at 2,860 MW), but no geothermal projects have moved beyond the exploration phase in Peru. Several foreign companies have concessions to explore the country's potential, but high exploration and investment costs have delayed development of the sector. In the biomass sector, 31 MW of projects have been developed through concessions granted in renewable energy auctions.

Peru's investment promotion agency, Proinversion, expects growth rates of 3-5% in non-conventional renewables by 2025. Future investments of US$ 8.8 billion would be needed to increase renewable energy (excluding large hydro) to 20% of the total electricity generation by 2040, according to ProInversion.

Within Latin America, Mexico's recent renewable energy auction in November announced record low prices of $19.48/MWh for solar and $17.70/MWh for wind energy. The prices seen in Mexico provide price reference points for Peru's next renewable energy auction, which being evaluated for 2018, although MINEM has yet to announce the official dates.

Market Size

Peru's total renewable energy investments are estimated at US$2.7 billion since the beginning of the first renewable energy auction in 2009, averaging US$389 million per year between 2009 and 2016 (Osinergmin, 2015a). Peru's solar and wind energy industries are dominated by international companies, which controlled 100% of the investments in the solar and wind sectors in the auction market. The total investments for the solar and wind power sectors are estimated at US$754 million and US$841 million, respectively (Osinergmin, 2015a). A national company has yet to win a concession for a solar or wind project during the renewable energy auctions.

The biomass and small hydro sectors are controlled by national companies. National companies account for 100% of investments in the biomass sector, which are estimated at US$58 million (Osinergmin, 2015a). The investments in the small hydro sector are estimated at US$1.07 billion, with 94% of investments controlled by national companies (Osinergmin, 2015a).

Potential

The table below shows summarizes the resources available for each type of renewable energy technology, along with the capacity installed the percentage of the resource currently utilized.

Table 1: Renewable Energy Sources, 2016

Renewable Energy	Installed Capacity MW	Potential MW	Percent of resource utilized
Hydroelectric (conventional ≥20MW)	4,224	70,000	6.4%
Hydroelectric (non-conventional <20MW)	230		
Wind	233	20,500	1.1%
Solar	96	25,000*	0.4%
Biomass	31	450*	6%
Geothermal	0	3,000	0%
Total	**4,814**	**118,950**	**4.0%**

*These numbers are referential, no official studies have been conducted to estimate the potential (in MW) for solar and biomass

Source: Evolution of the Electrical Sector 1995-2015, MINEM; Peru: Renewables Readiness Assessment 2014, IRENA

As shown above, Peru's renewable energy sources are greatly underutilized. Peru's largest renewable energy source, hydropower, only reaches 6.4% of its total potential. This number is

much lower when considering only non-conventional renewable energy sources. Wind (1.1%), geothermal (0%), and solar (0.4%) all utilize less than 2% of their potential. Peru's total renewable energy potential is estimated at 118,950 MW, more than 18 times the country's maximum electricity demand in 2016 (6,492 MW).

Solar

As of the end of 2017, Peru's total grid-connected solar capacity was 96 MW, and is expected to reach 280 MW by 2018. Including projects from the last energy auction (to be completed in 2018), a total of US$797 million has been invested in solar projects from 2008-2017. US$597 million of investments were in large scale projects through energy auctions and US$200 million in rural electrification.

Market Trends

The solar market holds the most diverse set of opportunities for Dutch companies interested in investing Peru's renewable energy market, in both large scale grid-connected projects, mid size off grid systems and small scale rural systems.

Large scale grid-connected projects are awarded through renewable energy auctions, which have been held every two years since 2009. Four 20 MW grid connected projects came online in 2012, and one 16 MW project in 2014, all awarded through Peru's first and second energy auctions. The solar farms are located in the southern provinces of Arequipa, Tacna, Moquegua and Ica, and the total investments for the five projects were US$380 million.

In the fourth energy auction held in 2015, Enel won the concession for the largest solar project in the Andean region, its 145 MW Rubi solar plant in Moquegua. The project is expected to be completed by March 2018, with investments of US$165 million. The bids during the fourth auction averaged $48.09/MWh, the lowest prices for large scale solar PV in South America at the time. The next renewable energy auction is being evaluated for the second half 2018, according to ministry officials.

The off grid market is another large opportunity for Dutch companies. Large scale mines, industrial facilities and agriculture (100 kW- 2 MW) without grid connections rely on expensive diesel generators to power their facilities. Solar PV is significantly cheaper than diesel, and offering these facilities a clean source of power and opportunity to save on their energy costs is an attractive solution.

Rural electrification also offers an opportunity for small scale solar PV. Peru' goal of reaching 99% electrification by 2021 involves the installation of small scale pv systems for remote households without grid access, with planned investments of $385 million by 2021. The last off grid energy auction was held in 2013, with a concession of 200,000 small systems granted to the Italian Tozzi Group. The timeline for the next off grid energy auction has yet to be announced.

Resources

Peru's solar resources are some of the highest in the world, receiving 2,050-2,550 kWh/m^2 of solar irradiance per year (Meteonorm, 2016).

In June 2003, MINEM published the *Solar Energy Atlas for Peru (Atlas de Energía Solar del Perú)*, detailing the available solar resources in Peru. Table 2 below shows the regions with the highest solar potential in Peru.

Table 2: Regions with High Solar Potential

Region	Average Daily Solar Energy kWh/m^2
Arequipa	6.08
Ica	5.50
Moquegua	6.04
Piura	5.54
Tacna	5.83
Tumbes	5.67

Source: Solar Energy Atlas for Peru

Peru's solar resource varies per region, with the highest levels annual averages reaching 6.5-7.0 kWh/m^2 per day in areas of the southern coast and the lowest dropping to 4.5-5.0 kWh/m^2 per day in the northern Amazon near Ecuador (MINEM, 2003). By comparison, the highest annual averages in the Netherlands reach 3.0-3.5 kWh/m^2, on the western coast (Solar GIS, 2014). A map of Peru's solar resources is shown in Appendix 1.

Key Companies

The major players in Peru's grid connected solar market are Spanish company Solarpack, which has invested US$232 million, and Italian company Enel, which has invested US$165 million. In the off grid market, the main player is Italian company Tozzi Green, which has invested a total of US$150 million in small scale systems since 2015.

The major companies in the sector, by investments, are shown below.

Table 3: Main Players in the Solar Sector

Company	Country	Investments (million USD)	Installed Capacity (MW)	Projects
Solarpack	Spain	US$232	56	3
Enel Green Power	Italy	US$165	145*	1
Tozzi Green	Italy	US$150	26.4* (off grid)	1
T-Solar	Spain	US$147	40	2
ENGIE	France	US$52	40*	1

**to be installed* *Source: Osinergmin, 2015a, internal calculations*

Installed Projects

Since 2012, 5 large scale grid-connected solar photovoltaic systems have been installed in Peru, for a total of 96 MW. The projects were concessioned through renewable energy auctions held every two years since 2008. All large scale grid-connected projects are located in the southern coast, in districts of Arequipa, Tacna and Moquegua. The total investments in grid-connected projects are $380 million.

In the off grid market, Ergon Power SAC (a subsidiary of Italian company Tozzi Green) has installed 6,000 small scale (120 W) systems to users without a connection to the grid. The concession was granted through an off-grid renewable energy auction held in 2013. Ergon aims to install a total of 200,000 systems by 2019, with investments of $300 million.

A summary of Peru's installed projects is shown in Table 3 below.

Table 3: Installed Solar PV Systems

Project	Developer/ Operator	Region	Size (MW)	Operational Since	Investments (million USD)
Repartición Solar	T-Solar (Spain)	Arequipa	20	Jul 2012	73.5
Majes Solar	T-Solar (Spain)	Arequipa	20	Jul 2012	73.6
Tacna Solar 20TS	Solarpack (Spain)	Tacna	20	Oct 2012	94.6
Panamericana Solar	Solarpack (Spain)	Moquegua	20	Dec 2012	94.6
Moquegua FV	Solarpack (Spain)	Moquegua	16	Dec 2014	43.0

Source: Osinergmin, 2015a

Projects in the Pipeline

The current projects in the pipeline are Central Solar Rubi, a 145 MW solar farm and Intipampa, a 40 MW solar farm, both located in the district of Moquegua in southern Peru. The two projects were concessioned in the last energy auction in 2015.

CS Rubi is being constructed by Enel Green Power Peru, a subsidiary of Italian energy company Enel, and when completed will be the largest solar power plant in the Andean region. It is currently 71% completed and the commercial startup date for the plant is March 2018. Total investments for the project are US$ 165 million.

Intipampa is being developed by French company ENGIE (Enersur is the Peruvian subsidiary) and is currently 31% completed. Construction is expected to be completed in December 2020 and investments for the project are US$ 52.3 million. The details of the two projects are summarized in the table below.

Table 4: Solar Projects in Development

Project	Developer	Price offered (cts USD/kwh)	Power to be installed (MW)	Estimated investments (million USD)	Date for commercial start-up
CS Rubi	Enel Green Power Perú	47.98	144.48	$165	31.03.2018
Intipampa	Enersur	48.50	40.00	$52.3	31.12.2017

Wind

At the end of 2017, Peru's total grid-connected wind capacity was 232 MW, and is expected to reach 392 MW by March 2018. Including the projects to be completed in 2018, between 2008 and 2017, a total of US$733 million has been invested in wind projects in Peru. With a total wind resources estimated at 20,500 MW, only 1.9% of Peru's wind resources have been exploited.

Market Trends

The wind sector holds large opportunities for Dutch companies looking to invest in large scale grid connected projects or provide services to companies installing utility scale projects.

Like solar, large scale grid-connected wind projects are awarded through renewable energy auctions. Between 2014 and 2016, four projects came online, for a total of 232 MW. Spanish based Cobra Group owns two of the wind farms located in Ica, and U.S. company ContourGlobal the other two, one in located in Piura, and the other in La Libertad. The investments for the four projects totaled US$515 million.

In the latest energy auction in 2015, three projects were awarded for a total of 162 MW. The largest project, the 126 MW Nazca wind farm in Ica, was won by the Italian company Enel, now one of the main players in Peru's renewable energy market. The average bid price in the last auction was $37.79/MWh, one of the lowest prices seen in Latin America. The projects awarded in the 2015 auction are expected to come online in March 2018.

Renewable energy auctions offer the largest opportunity for Dutch companies looking to enter Peru's wind market, and the next renewable energy auction is being evaluated for the second half 2018, according to ministry officials. Off grid generation is also an opportunity to enter the market. Large scale mines, industrial facilities and farms that rely on expensive diesel generators need a cheaper source of electricity, and areas with high wind potential could offer a significantly lower price of energy.

Peru's offshore wind resources have yet to be evaluated, and its offshore potential is unknown. According ministry officials, the development of offshore wind is not a priority because Peru has onshore wind potential that has yet to be developed.

Resources

The regions of Peru with the highest wind energy potential lie along the coastline, and in the Andes Mountains. In these regions, wind speeds approach up to 8-11 m/s. A map of the average annual wind speeds at 100m is shown in Appendix 2.

In 2016, MINEM published the *Wind Atlas for Peru* (*Atlas Eólico del Perú*), which estimated Peru's overall potential for wind energy generation at 28.4 GW, with 20.5 GW considered technologically feasible for development. MINEM did not include off-shore wind potential in its study. Table 4 below shows the regions with the highest wind energy potential.

Table 4: Regions with High Wind Potential

Region	Total Potential MW	Usable Potential MW
Amazonas	417	129
Ancash	816	708
Arequipa	1,176	1,020
Cajamarca	1,173	891
Ica	5,295	2,280
La Libertad	1,185	921
Lambayeque	9,114	7,017
Lima	618	429
Piura	8,601	7,098

Source: Wind Atlas for Peru, MINEM, 2016

The highest resources are in Lambayeque and Piura on the northern coast, and Ica on the southern coast. Seasonally, the highest wind resource is available during the winter months (May-Nov) and the lowest in the summer months (Dec-April). This complements well with the availability of water for hydropower, which is highest in the summer and lowest in the winter.

Key Companies

To date, all large scale wind projects have been concessioned through renewable energy auctions. The companies with the greatest investments in the sector are U.S. based ContourGlobal, which has completed two projects with US$343 million in investments and Spanish company Cobra Group, which also has two projects and investments of US$247 million. New players which entered the market during the most recent auction are Italy's Enel and Spain's Grenergy with US$166 million and US$52 million in investments, respectively.

The major companies in the sector, by investments, are shown in the table below.

Table XX: Main Players in the Wind Sector

Company	Country	Investments (million USD)	Installed Capacity (MW)	Projects
Contour Global	U.S.	US$343	112	2
Cobra	Spain	US$247	128	2
Enel Green Power	Italy	US$166	126*	1
Grenergy	Spain	US$52	36*	2

*to be installed

Installed Projects

As of December 2017, Peru has installed four large scale grid connected wind projects installed, for a total installed capacity of 232.7 MW. All five projects were concessioned through renewable energy auctions. The projects are located in the districts of Ica, Piura and La Libertad. The total investments in grid connected projects are US$515 million.

A summary of Peru's installed projects is shown in the table below.

Table 5: Installed Wind Energy Systems

Project	Developer/ Operator	Region	Capacity MW	Investments million USD	Operational Since
Marcona	Cobra (Spain)	Ica	31	US$ 75	Apr 2014
Cupisnique	ContourGlobal (US)	La Libertad	81	US$ 172	Aug 2014
Talara	ContourGlobal (US)	Piura	31	US$ 71	Aug 2014
Tres Hermanas	Cobra (Spain)	Ica	97	US$ 197	Mar 2016

Source: thewindpower.net, 2017

Projects in the Pipeline

The current projects in the pipeline are the 126 MW Nazca wind farm located in Ica in southern Peru, and two 18 MW wind farms, Huambos and Duna in Cajamarca on the northern coast. The two projects were concessioned in the last energy auction in 2015.

CE Parque Nazca is being constructed by Enel Green Power Peru, a subsidiary of Italian energy company Enel, and when completed will be the largest wind power plant in the country. It is expected to be completed by the end of March 2018 and total investments for the project are US$166 million.

PE Huambos and PE Duna are being developed by Spanish company Grenergy, and are expected to be completed by the end of December 2018. The investments for each project were US$26 million. The details of the three projects are summarized in the table below.

Table 4: Wind Projects in Development

Project	Developer	Price offered (cts USD/kwh)	Capacity (MW)	Energy awarded (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
CE Parque Nazca	Enel Green Power Perú	37.83	126.00	573.00	US$166	31.03.2018
PE Huambos	Grenergy	36.84	18.40	84.60	US$ 26	31.12.2018
PE Duna	Grenergy	37.79	18.40	81.00	US$ 26	31.12.2018

Source: Osinergmin

Hydro

The hydro sector is the most developed in Peru, having been the major source of electricity for the country until the development of Camisea and the entry of natural gas in 2004. However by Peruvian law, only hydropower plants smaller than 20 MW are considered renewable. A total of 230 MW of small hydro has been awarded since the first auction in 2009, with investments reaching $1.2 billion (including projects to be completed in by 2020).

Market Trends

The hydroelectric industry is significantly more developed than other renewable sources, and the opportunities in the small hydro sector in Peru are in large scale grid connected projects and for companies that provide services for hydropower plants and hydroelectric companies.

Small hydro projects are awarded through renewable energy auctions held on average every two years. 21 projects and 290 MW of small hydro have come online since the first energy auction in 2009, and 28 projects (360 MW) are currently in development. The market is quite diverse with 32 different companies (mostly Peruvian) winning concessions for 45 projects in the past four auctions.

In the last renewable energy auction held in 2015, six projects were awarded for a total of 60 MW. The largest project is the 20 MW Ayanunga hydroelectric plant in Huanuco being developed by Enel, also one of the major players in the solar and wind markets in Peru. The average bid prices were $43.86/MWh, and the projects are expected to be completed by the end of 2020.

Since the hydroelectric market is more developed than other renewable markets, there are large opportunities in offering services to the existing hydroelectric facilities. Technologies and services that improve the operations of existing plants, such as improved monitoring and efficiency, leak detection and automatic warning systems are desired services.

Renewable energy auctions also offer an opportunity to enter Peru's hydro market, and the next renewable energy auction is being evaluated for the second half 2018, according to ministry officials.

Resources

In March 2011, MINEM published the *Hydroelectric Potential Atlas for Peru* (*Atlas del Potencial Hidroeléctrico del Perú*), estimating Peru's total small (1-20 MW) and medium (20-100 MW) hydropower potential at 98,460 MW, with 69,445 MW considered feasible for development. The study only provided a combined potential estimate for small to medium size plants, and did not provide an estimate for each category individually. Hydropower less than 1 MW was not included in the study. A map of the annual average rainfall in mm is shown in Appendix 3.

The greatest potential for small and medium sized hydro projects are in the districts of Cusco in the southern Andes, Loreto in the northern Amazon, and Madre de Dios in the southern Amazon. Table 6 shows the regions with the highest hydropower potential.

Table 6: Regions with High Hydropower Potential

Region	Total Potential MW	Usable Potential MW
Amazonas	3,385	2,635
Ancash	4,199	2,891
Arequipa	2,692	1,933
Ayacucho	2,133	2,119
Cajamarca	3,981	3,680
Cusco	14,653	9,056
Huánuco	6,958	5,221
Junín	5,064	3,550
La Libertad	2,810	2,228
Lima	2,829	2,160
Loreto	11,570	9,085
Madre de Dios	12,816	8,122
Puno	6,416	4,639
San Martin	7,496	4,289
Ucayali	4,076	2,399

Source: Hydroelectric Potential Atlas for Peru, MINEM 2011

As mentioned in the previous section, Peru hydropower potential varies throughout the year based on the precipitation rates. The highest potential occurs in the summer (Dec-April), and

lowest in the winter (May-Nov).

Key Companies

The small hydro sector contains a large number of different players (32 different companies for 45 small hydro projects). The companies with the largest investments are shown in the table below, but there is no company with greater than a 6% share of the market.

The companies with the greatest investments are Peruvian companies Sinersa and Empresa de Generación Eléctrica (EGE) Junin. Sinersa has completed two projects with investments of US$69.4 million and EGE Junin has two projects with investments of US$66.7 million. Hidroelectrica Santa Cruz and U.S. based Duke Power are also major players, with investments of US$57.3 million and US$32.5 million, respectively.

The major companies in the sector, by investments, are shown in the table below.

Table 16: Main Players in the Hydro Sector

Company	Country	Investments (million USD)	Installed Capacity (MW)	Projects
Sinersa	Peru	US$69.4	29	2
EGE Junin	Peru	US$66.7	40	2
Hidroelectrica Santa Cruz	Peru	US$57.3	29	4
Duke Power EGE Nor	U.S.	US$32.5	16	2

Source: Osinergmin

Installed Projects

To date, Peru has installed twenty one grid connected small hydro (<20 MW) projects, with a total installed capacity of 230 MW. All projects were concessioned through the renewable energy auctions, and the projects are located in the regions of Ancash, Cajamarca, Junin, Lima, La Libertad and Piura.

Because of the major construction and permitting requirements, hydroelectric projects have faced larger delays than other renewable energy projects. Of the 26 concessions granted in the first two auctions, 17 projects have been completed.

A summary of recently (since 2014) installed projects is shown in the table below. A full list of all twenty one projects is shown in Appendix 4.

Table XX: Recently Installed Small Hydro Projects

Project	Developer/ Operator	Capacity MW	Investments million USD	Operational Since
Runtanullo III	EGE Junin	20	US$ 31.1	22.11.2014
Runtanullo II	EGE Junin	20	US$ 35.6	24.12.2014
Canchayllo	EGE SAC	5.0	US$ 10.0	31.12.2014
Chanchay	Sinersa	19.2	US$ 49.1	04.08.2016
Rucuy	Rio Baños	20	US$ 42.0	09.08.2016
Potrero	Empresa Electrica Agua Azul	19.9	US$ 46.0	29.04.2017
Yarucaya	Huaura Power Group	17.5	US$ 37.2	17.08.2017

Projects in the Pipeline

There are currently six small hydro projects in development from the last energy auction, and 22 from previous auctions. The projects in the last auction totaled of 60 MW and US$ 129 million in investments.

Enel is developing two projects, the 20 MW Ayanunga hydroelectric plant in Huanuco and the 0.7 MW Her 1 project in Lima. The investments for Ayanunga and Her 1 are $48.3 million and $3.2 million, respectively. Both projects are already under construction, and are expected to be completed in 2018.

A consortium of Peruvian companies, Consorcio Hidroeléctrico Sur Medio, is developing two projects in Ayacucho, the 15.55 MW Kusa hydro plant and the 14.51 MW Alli hydro plant. The investments for Kusa and Alli are US$ 26.9 million and US$ 29.5 million respectively. Both projects are still in the development phase, and construction is expected to be completed by the end of 2020.

Another consortium of Peruvian companies, Consorcio Hydrika 6, is developing the 8.9 MW Hydrika 6 plant in Ancash. The investment for the project is US$ 21 million, and it is expected to be completed by April 2019.

Table XX: Small Hydro Projects in Development

Project	Developer	Price offered (cts USD/kwh)	Power (MW)	Annual energy (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Her 1	Enel Green Power Perú	58.20	0.70	4.66	US$ 3.2	30.06.2018
Ayanunga	Enel Green Power Perú	43.98	20.00	131.65	US$ 48.3	31.12.2018
Hydrika 6	Consorcio Hydrika 6	45.90	8.90	60.00	US$ 21	17.04.2019
Kusa	Consorcio hidroélectrico Sur Medio	45.40	15.55	72.53	US$ 26.9	31.12.2020
Alli	Consorcio hidroélectrico Sur Medio	45.40	14.51	69.32	US$ 29.5	31.12.2020

Biomass

As of December 2017, the total installed biomass capacity in Peru is 31 MW, and is expected to reach 36 MW by 2018. Including the projects scheduled to be completed in 2018, total investments in the sector are $58.2 million since 2008. Peru's total biomass resources are estimated at 450 MW.

Market Trends

The biomass sector is relatively small in Peru. The current projects have all been awarded through renewable energy auctions, with a total of three projects and 31 MW coming online since 2010. The two biogas plants, Huaycoloro (4.8 MW) and La Gringa (3.2MW), installed in 2010 and 2011, generate electricity from the methane produced by Lima's largest landfill, Huaycoloro. The third facility, Paramonga 1, is a 23 MW bagasse power generation plant in Lima. The investments for the three projects totaled US$47 million.

The current projects commissioned during the last auction in 2015 are two 2.4 MW thermoelectric biomass plants, CT Huaycoloro II and CT Callao. Both plants use biogas produced by solid waste to generate electricity. The plants are expected to be completed by the end of 2017 and the total investments for the projects were US$ 2.5 million each.

Renewable energy auctions offer the largest opportunity for Dutch companies looking to enter Peru's biomass market, and the next renewable energy auction is being evaluated for the second half 2018, according to ministry officials.

Resources

In 2013, the *Energy Potential of Biomass Residuals in Peru* (*Potencial Energético de la Biomasa Residual en el Perú*) was published, providing an estimate of the energy potential for biomass in Peru. The study was based on national agricultural and forestry production statistics from 2003 to 2011. It concluded that waste from both the agricultural and forestry sectors, which amounts to 10,247,670 metric tons annually, has the potential to generate 2,993,506 toe (tonne of oil equivalent), or 125 PJ per year. Table 8 below shows the energy potential for each region.

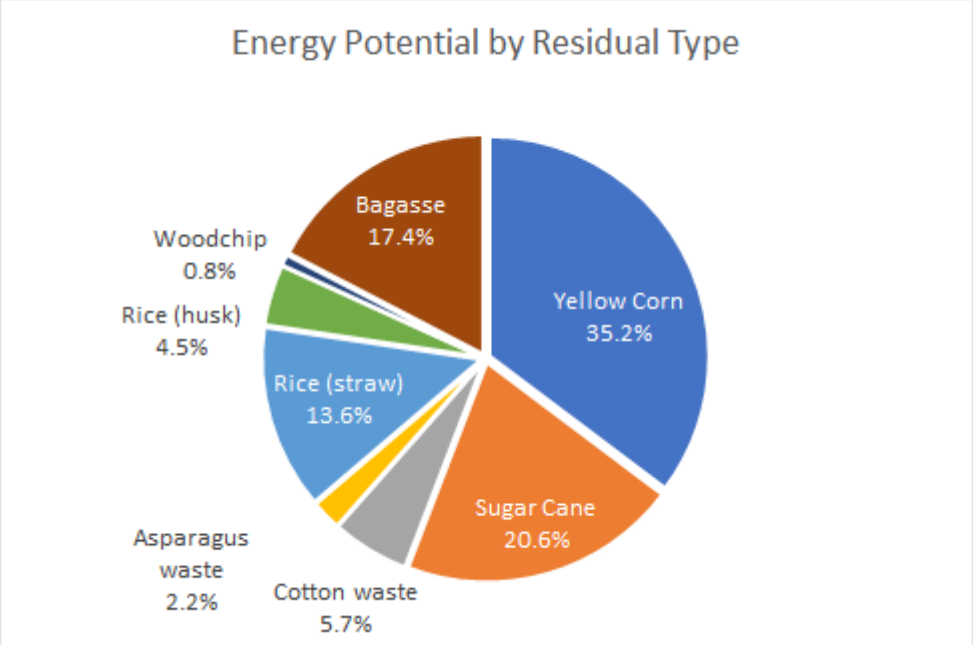
Table 8: Biomass Potential per Region

Region	Energy Potential (tonne of oil equiv)
Ancash	148,001
Cajamarca	88,682
Ica	186,577
La Libertad	777,646
Lambayeque	499,979
Lima	387,378
Piura	349,061
San Martin	212,563

Source: Energy Potential of Biomass Residuals in Peru, Assureira and Assureira, 2013

The greatest sources of energy from biomass in Peru come from yellow corn leaves, sugar cane (leaves and buds), bagasse, cotton waste, rice husks, rice straw and asparagus waste. The percentage of energy potential for each type of residual is shown in Figure 9 below.

Figure 9: Sources for Biomass Energy



Source: Energy Potential of Biomass Residuals in Peru, Assureira and Assureira, 2013

For the generation of electric power, the most important bioenergy resource is biogas, generated by the anaerobic decomposition of plant and animal waste. Used residues include bagasse, rice husk, forestry waste, grain chaff, and remains from the poultry, beef cattle and pig farming.

Key Companies

The biomass sector is controlled by Peruvian companies. The major players are Peruvian companies Paramonga, which has invested US$31 million, Petramas, which has invested US$16 million and Energia Limpia, which has invested US$11.2 million.

The major companies in the sector, by investments, are shown below.

Table XX: Main Players in the Biomass Sector

Company	Country	Investments (million USD)	Installed Capacity (MW)	Projects
Paramonga	Peru	US$31	23	1
Petramas	Peru	US$16	8	2
Energia Limpia	Peru	US$11.2	4*	2

Installed Projects

As of February 2017, Peru's total installed biomass capacity is 31 MW, operated by the three projects run by Peruvian companies Petramas and Paramonga. The biogas projects include Petramas' Huaycoloro and La Gringa plants, both of which generate electricity from methane produced by Lima's largest landfill, Huaycoloro. Paramonga operates a 23MW bagasse cogeneration power plant in Lima that generates electricity from the residues from its sugar operations. The projects are summarized in Table 9 below.

Table 9: Installed Biomass Capacity

Project	Developer/ Operator	Region	Technology	Size MW	Operational Since
Paramonga 1	Paramonga	Lima	Bagasse	23.0	Mar 2010
Huaycoloro	Petramas	Lima	Biogas	4.8	Oct 2011
La Gringa	Petramas	Lima	Biogas	3.2	Sep 2015

Source: Annual Operation Report 2016 SEIN, COES SINAC

Projects in the Pipeline

The current projects in development are two 2.4 MW thermoelectric biomass plants, CT Huaycoloro II and CT Callao located in Lima and Callao. Both plants use biogas produced by solid waste to generate electricity. Both plants are currently under construction, and are expected to be completed by the end of 2017. The total investments for the projects were US$ 2.5 million each. The details of the two projects are summarized in the table below.

Table XX: Biomass Projects in Development

Project	Developer	Price offered (cts USD/kwh)	Power (MW)	Energy Awarded (GWh/year)	Investment (USDm)	Commercial Start-up Date
CT Callao	Empresa Concesionaria Energía Limpia	77.00	2.40	14.50	US$ 2.5	31.12.2017
CT Huaycoloro II	Empresa Concesionaria Energía Limpia	77.00	2.40	14.50	US$ 2.5	31.12.2017

Geothermal

Market Trends

Peru has significant geothermal energy in its Andean volcanic belt. The country has an estimated geothermal potential of 2,860 MW. Because resource exploration and development is higher risk and more expensive than other types of renewables, the geothermal market is less developed than other sectors. Additionally, many of the geothermal resources are located in protected indigenous areas and national parks.

As of December 2017, no geothermal projects have been constructed in Peru. Several foreign companies have concessions to explore the country's potential, and 30 projects have been authorized for the exploration phase. The projects are located in Moquegua, Ayacucho, Arequipa, Puno and Pasco. Philippine company Energy Development Corporation (EDC) has invested $11 million to develop the Achumani geothermal field in Arequipa.

Japan International Cooperation Agency (JICA) has also invested in developing Peru's geothermal sector, assisting in the preparation of the 2012 Geothermal Master Plan. No geothermal projects have been presented in Peru's four renewable energy auctions, but EDC hopes that energy will be allocated in the expected upcoming auction in 2018. Without any projects in the exploitation phase, there is an opportunity for Dutch companies to provide technical experience and support to Peru's geothermal sector.

Resources

Peru is located within the Pacific Ring of Fire, a geologically and volcanically active region that stretches from the southern tip of South America up through the coast of North America, across the Bering Strait and down through Japan and New Zealand. In Peru, the subduction of the Nazca plate beneath the South American plate results in active volcanoes and high levels of geothermal activity in the Andes Region. From 2010 to 2012, under the financial assistance from the Japan International Cooperation Agency (JICA), MINEM contracted a Japanese engineering firm to conduct a study on the geothermal potential for power generation in Peru. The study divided Peru into 6 major geothermal areas (see Appendix 4), with 61 different geothermal sites, and estimated the total geothermal potential to be 2,860 MW.

Table 7: Geothermal Potential Areas

Geothermal Area	Potential MW
Cajamarca-La Libertad	193
Callejón de Huaylas	236
Churin	125

Central	32
Eje Volcanico Sur	1,597
Cusco-Puno	524
Other (Northern Peru)	152

Source: The Master Plan for Development of Geothermal Energy in Peru, Matsuda and Lima, 2015

As shown in the table above, the regions with the most abundant geothermal potential are found in the south, in Cusco-Puno and Eje Volcano Sur.

Key Companies

The companies that have been granted concessions for exploration are listed in the table below.

Company	Project	Location	Culm Est Phase I (2 years)
ANDES POWER PERÚ S.A.C	TUTUPACA	Tacna	19-mar-2013
ECO ENERGY S.A.C	GERONTA II	Ayacucho	20-may-2013
	UMACUSIRI I	Ayacucho	20-may-2013
	UMACUSIRI II	Ayacucho	20-may-2013
	GERONTA I	Ayacucho	20-may-2013
	PINAYA I	Puno	5-feb-2013
	PINAYA II	Puno	5-feb-2013
	PINAYA III	Puno	20-may-2013
	PINAYA IV	Puno	13-dic-2014
	PINAYA V	Puno	13-dic-2014
	PINAYA VI	Puno	19-dic-2014
EDC Energía Verde Perú SA (previously HOT ROCK PERÚ S.A.)	TURU	Arequipa Cusco	6-dic-2013
	ACHUMANI	Arequipa	28-oct-2014
	HUISCO	Ayacucho	16-feb-2015

GEOTÉRMICA QUELLAAPACHETA PERÚ S.A.C	QUELLAAPACHETA	Moquegua	7-abr-2013
MAGMA ENERGÍA GEOTÉRMICA PERÚ S.A	LORISCOTA	Arequipa Puno	14-abr-2013
	CRUCERO	Moquegua Puno	14-abr-2013
	PASTO	Tacna Moquegua	16-jul-2013
	SARA SARA	Ayacucho	15-sep-2013
	PANEJO	Moquegua	15-sep-2013
	ATARANI	Tacna Moquegua	23-sep-2013
	SUCHE	Tacna	1-dic-2013
	TUTUPACA NORTE	Tacna Moquegua	1-dic-2013
	PINCHOLLO LIBRE	Arequipa	8-jul-2015
ENEL GREEN POWER PERÚ S.A.	CARMEN	Ayacucho	8-feb-2015
	CHILATA	Moquegua	20-abr-2015
EMX GEOTHERMAL PERÚ S.A.C	TAMBOCHACA	Pasco	27-abr-2015
	PUMAHUIRI	Ayacucho	27-abr-2015
	SENGATA	Ayacucho	27-abr-2015
	COROPUNA	Arequipa	27-may-2015

In February 2012, Energy Development Corporation (EDC), a Philippine geothermal energy company, in partnership with Australia-based Hot Rock Limited (HRL) entered in a partnership to co-develop the Quellaapacheta and Chocopata projects in southern Peru. Quellaapacheta is located in the Mariscal Nieto Province, and Chocopata in the Espinar Province, both part of the Eje Volcano Sur Geothermal Area.

The two companies set up subsidiaries within Peru to conduct further studies. In September 2012, EDC announced that after conducting primary studies for Chocopota, it would not be proceeding with the project. As of February 2017, no further announcements have been made for the Quellaapacheta project.

Barriers for Renewable Energy Development

Natural Gas Development

The Peruvian government and private development investments have led to strong growth of the natural gas sector over the past decade. The government has subsidized natural gas extraction from Block 88 of Camisea, leading to artificially low prices for natural gas because the pricing does not include exploration costs. The low price of natural gas creates barriers for renewable energy sources, who are forced to compete on a non-level playing field (IFC, 2011).

The price of energy is expected to rise in the next 5-10 years when the Southern Gas Line enters into operation, and when the sources from Camisea are depleted in 20-30 years. Natural gas extraction from other areas will be much more expensive because it will include the full cost of exploration.

Additionally, natural gas is well positioned in the Peruvian electricity market, representing 46.5% of electricity generation in SEIN in 2016. Natural gas companies exert influence in energy forums by trying to impede the entry of renewable energy into the market. Common arguments made by natural gas companies against the entry of renewables into the market include that renewables will raise the tariff to end users, renewables are not necessary because of Peru's oversupply of electricity and that their intermittency creates difficulties for the grid operator.

Oversupply of Electricity in SEIN

From 2006 to 2016, the annual rate of increase of the effective capacity (9.4%) exceeded the rate of growth of maximum demand (6.4%). With a number of large hydroelectric and thermal plants coming online in 2016, the effective capacity (12,605 MW) greatly exceeded the maximum demand (6,492 MW). In 2016, Peru's energy reserve was 36% in dry season and 57% in wet season in total available energy. Available energy includes a capacity factor for hydropower capacity that varies between wet season and dry season, and the cold reserve is not considered in the calculation of the energy reserve.

Peru's oversupply of electricity is likely to decrease investment in new generation within Peru's interconnected grid. The current supply of electricity is expected to last until 2021 (OBG, 2016). In a ratings report released in October 2016, the financial ratings company Fitch stated that "Capacity has outpaced demand due to the economic slowdown, with low metal prices and stalled projects affecting energy demand during the last two years" and "a prolonged period of oversupply with low spot prices is likely to discourage new investments,"

Participation of Renewables in SEIN

D.L. 1002 sets the participation of non-conventional renewables in the grid at 5% of the total energy consumption. This figure was expected to increase in 2013, however a new target still has not been set. When the projects from the fourth auction come online, Peru is expected to reach

the 5% target. It is possible that greater participation of renewables in the national grid will not occur until a new participation target is determined.

Prima

Renewable energy projects awarded through RER auctions are compensated at the end of each year for their awarded energy through a fee in the regulated user's electricity tariff, known as *prima* (as discussed in section 7). Prima was initially created to support the development of renewable energy development when renewables first entered the market in 2009, and prices were not competitive with conventional energy. However, over the past 9 years, renewable energy prices have dropped significantly, and are now competitive with conventional energy prices (as shown by the results of the last RER auction).

As a result, Prima is no longer necessary for renewable energy development. Under the current system further development of renewables results in charges being directly applied to the end user. Prima needs be removed as a transmission charge, but RER still needs to be given firm power within the grid to compete with conventional energy technologies.

Firm Capacity (Potencia Firme)

Firm capacity is the guaranteed (power) capacity a plant can deliver to the electrical system during a period of maximum electricity demand (peak hours). Currently, RER technologies are assigned a firm capacity equal to zero.

After the first two RER auctions, Supreme Decree N° 024-2013-EM was passed, indicating that COES must propose the calculation procedure of firm power for renewables and that any modification must be approved by Osinergmin. However, to date no firm power has been set for renewables.

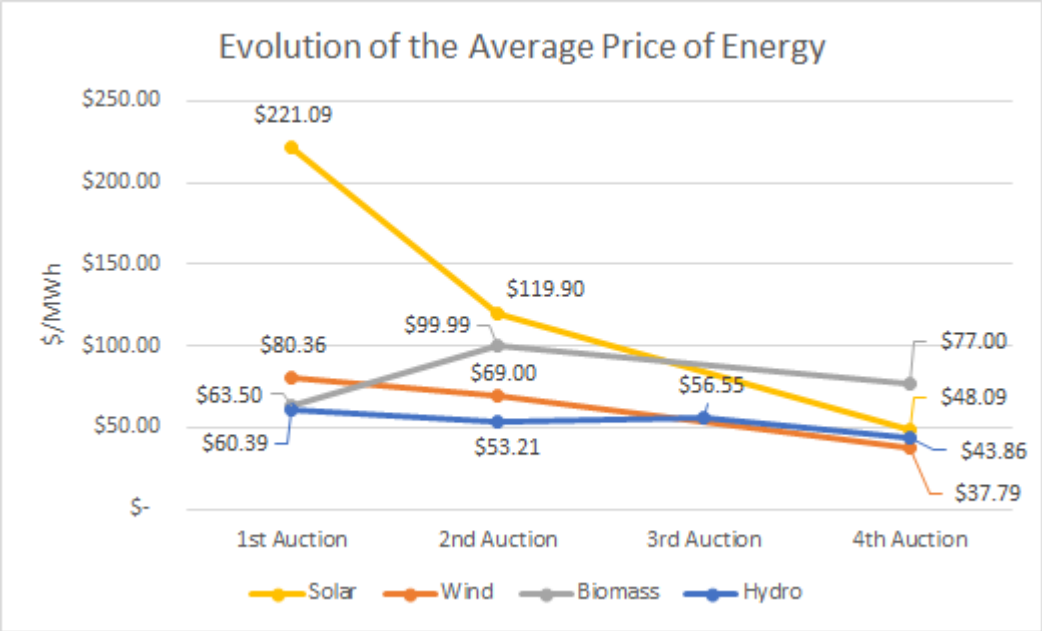
Without firm power, RER technologies cannot compete on an equal footing with conventional technologies because they cannot charge for power (they can only charge for energy) to cover their investment costs. Currently, renewable energy generators rely on the prima, which is charged to end users through the transmission tariff to cover their investment costs.

Opportunities

Grid Connected Energy Auctions: Solar, Wind, Hydro, Biomass and Geothermal

Peru's Renewable Energy Auctions, known as *subastas*, generally take place every two years. During the auctions, the major government projects for utility-scale solar, wind, small hydro, biomass. Although eligible, geothermal energy has yet to be included in Peru's RER auctions,

The most recent renewable energy auction took place in 2015, and since the first auction in 2009 the average price of energy, especially for solar and wind, has decreased significantly. The trends in the average price of energy by technology are shown in Figure 18 below.



The prices for solar ($48.09/MWh) and wind ($37.79/MWh) energy set in the fourth auction were at the time record low prices for these technologies. The projects for solar and wind ranged from 18 MW to 145 MW, and project investments were from US$26 million to US$165 million. The next auction is being evaluated for 2018, although MINEM has yet to announce the official dates.

Because of the scale of the projects (between US$2.5 and US$160 million), energy auctions are recommended for larger companies. Companies interested in participating directly in auctions should read through section 12 which gives a detailed analysis of the auction process in Peru.

For mid-sized companies not interested in bidding directly on projects but instead providing services to larger companies, the main entry point would be to contact the key companies/main players in each renewable energy sector. The main players are listed in the 'key companies' section for each technology. Additionally a list of all auction projects (and companies is listed in Appendix 9).

EnerTek and the Peruvian Renewable Energy Society (SPR) can provide support contacting companies if needed. Another opportunity to make connections or offer services is during Peru's major industry related events listed in Section 7, which majority of the main players in the sector attend.

Off Grid Generation in the Mining Industry: Solar, Hydro and Wind

Off grid energy is the one of the largest untapped markets in Peru, and the Mining and Industry sectors represent a large opportunity to implement renewable energy technologies, especially solar, wind and hydro.

Many mines and industries have constructed their own hydroelectric facilities or have short term PPAs (<5 years) with hydro and gas generators for less than $40/MWh. Some mines and manufacturing facilities also rely on power from diesel generators, which is costly and inefficient.

The expected growth in electricity demand for the mining sector in 2018 is estimated at 2 GW. The table below shows some of Peru's major mines and industrial facilities, and their electricity demand in the free market. A full list of major mining and industrial companies is provided in Appendix 7.

Mine/Industrial Facility	Company	Demand in the Free Market (MW)
Volcan	Volcan Compañia Minera	84.00
Yanacocha	Buenaventura	60.00
Cerro Verde		200.00
Cement Factory	Cemento Andino	26.00
Antamina	Compañia Minera Antamina	150.00
Antapaccay	Compañia Minera Antapacay	76.00
Milpo	Compañia Minera Milpo S.A.A	27.00
Barrick Misquichilca	Barrick Gold Corporation	25.00

A long term solar, wind or hydro PPA (10-20 years) could be an attractive option for mining or industrial facilities, which have large areas of land that can be used for generation. These companies are interested in reliable, cheap sources of energy, and electricity costs in the mining

sector typically account for 30% of operation costs. Mining companies also collect detailed energy consumption and meteorological data for their environmental impact and compliance requirements, and this data can be used in the feasibility studies for renewable projects.

Potential barriers are that solar and wind have a firm capacity (potencia firma) of zero in Peru's grid, so solar and wind PPA contracts cannot be signed with mines that have a grid connection to SEIN (the national grid). Although a revised definition of firm capacity has been proposed, it has not yet been approved by MINEM. Hydro is granted firm capacity in SEIN.

The best way to enter the market and establish connections with major players in the mining sector is during the major industry events, such as PeruMin and Expo Mina. The major industry events are listed in Section 7. EnerTek and the Peruvian Renewable Energy Society (SPR) can also provide support contacting companies directly.

Rural Electrification: Solar and Small Hydro

In the National Rural Electrification Plan 2016-2025, MINEM states that it plans to reach its goal of 99% electrification and provide electricity to 3.3 million people in rural areas by 2025 (MINEM has since announced that it expects to reach this target by 2021). MINEM expects investments from 2016 to 2025 to be US$1.27 billion. A breakdown of these investments is shown in the Table 19 below.

Table 19: Expected Future Investments in Rural Electrification

Project	Investment Millions US$
Transmission Lines	130.6
Rural Electrical Systems	644.1
Small Hydropower Plants	18.3
Solar PV Systems	385.6
Electrical Companies	92.3
Total	**1,271**

Source: National Rural Electrification Plan 2016-2025

The expected US$385.6 million and US$18.3 million in investments in solar PV and small hydropower represent an opportunity for Dutch companies to enter the rural electrification market. Although rural electrification through renewables has mostly focused on PV systems, MINEM is also looking for solutions with hydro in the Andes and wind in the northern and central coasts.

The last off grid energy auction was held in 2013, with a concession of 200,000 small solar PV systems granted to Ergon Power SAC (a subsidiary of Italian company Tozzi Green), with an investment of approximately $200 million.

MINEM is planning to call for a new off-grid energy auction in next few years for 150,000 PV systems to reach its goal of 500,000 additional off-grid PV systems. The auction will likely call for mobile systems which can be moved to higher areas where the villagers spend the night.

Dutch companies interested in entering the rural electrification market could either provide services to Ergon Power or submit bids for the next off grid auction. The sector offers future opportunities for companies offering services for small pv systems such as plug and play and mobile systems.

Distributed Generation: Solar, Hydro and Wind

Electricity demand is not evenly distributed in Peru. Distribution within SEIN is divided by region into the Central, Northern and Southern Zones. There is a strong concentration of power plants in the Central Zone, due to greater access to resources such as water and natural gas in the region, and a high demand for energy. There are also better facilities for transmission lines. The Central Zone has an energy surplus and supplies energy to Northern and Southern Zones, which have energy deficits. Table 17 below shows the available energy and demand in 2016.

Table 17: Energy Flow in the Interconnected Grid, 2016

Region	Available Energy GWh	Energy Demand GWh	Difference GWh
North	5,598	6,822	-1,224
Central	58,570	29,680	28,890
South	4,475	11,774	-7,269

Source: Osinergmin, internal calculations

In 2016, the southern zone had the largest energy deficit, and received more than 60% of its energy from the central zone. The northern zone also had an energy deficit, though it is much smaller than the southern zone, and only requires about 20% of its energy from the central zone. The central zone, on the other hand, had an energy surplus almost double its total energy demand.

With high wind and hydro resources in the north and solar resources in the south, there is a large opportunity to develop renewables these two regions, both on and off-grid. Developing renewables in the north and south would have significant benefits for these two regions by reducing energy dependence on the central region, avoiding congestion in transmission lines and improving regional energy security.

Dutch companies planning on bidding in future grid connected (and off grid) energy auctions should consider regional energy needs (shown in the table above) in addition to the energy resources available in each region (described in the 'resources section' for each technology).

Feed In Tariff: Solar

Article 2 of Legislative Decree 1221 states that renewable energy generators who are connected to the grid can inject their surplus energy, or feed into the grid, as long as this does not affect the safety of the distribution system.

Although this decree was passed in September 2015, the specific regulation governing distributed generation and feeding into the grid has not yet been published.

The Peruvian government is currently working on regulations to allow small producers of renewable energy, such as rooftop solar systems, to feed their excess energy into the grid, and the law may be released in 2018. After the feed in tariff law (known as the distributed generation law in Peru) is passed, the return on investment for small scale solar systems will increase significantly in Peru, and should provide large opportunities in residential solar market.

Geothermal Development

The geothermal sector is largely underdeveloped, and has high potential in Peru, with 2,860 MW of resources available. With concessions only having been granted for exploration (not for exploitation), no geothermal facilities have been constructed in Peru. The lack of development in the sector provides an opportunity for Dutch companies to provide much needed technical expertise, experience and financing.

Geothermal is seen a long term opportunity in Peru because of the time and investments needed to develop the resource. Barriers such as the high cost of resource exploration and development result in higher prices than renewables such as solar and wind. Additionally, some of Peru's geothermal resources are located in national parks or protected areas that make development in such areas difficult. The main player in the sector, Philippine company EDC, has invested $11 million since 2012, and has yet to move past the exploration phase.

Geothermal energy has the advantage of being a constant source of energy, unlike solar, wind and hydro, which are intermittent. It could also be used as to heat homes or power mining activities, which are both needs in the southern Andes where the geothermal resources are located.

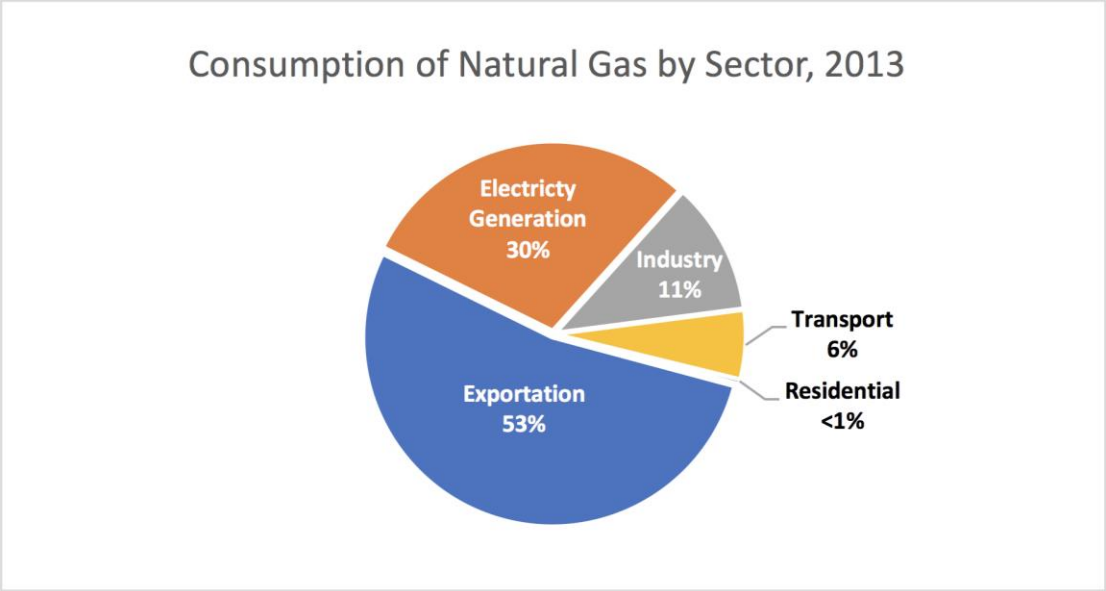
There is also a possibility that geothermal will be included in the next renewable energy auction. Companies interested in pursuing geothermal opportunities are encouraged to contact the major players in Peru's geothermal sector (listed in the Geothermal section) such as EDC. The Peruvian Renewable Energy Society (SPR) can also provide support to companies looking to enter the sector.

5.0 Natural Gas

Peru's efforts to develop natural gas began to gain traction in 1999 with the enactment of the Law Nº 27133 - 'Law of Promoting the Development of Natural Gas Industry'. This stated the development of the natural gas industry – exploration, production, pipeline transport and distribution to end-user markets – was in the national interest.

Peru is now the third largest producer of natural gas in South America. In 2013 Peru consumed 314.1 MMSCFD (million standard cubic feet daily) of natural gas for electricity generation, 120.2 MMSCFD in industry (including electricity generation for direct consumption), 62.59 MMSCFD for transportation, 3.76 MMSCFD for residential use and exported 567 MMSCFD. Around two thirds of the exports are to Mexico, and the rest to Asian and European markets based on highest demand. The relative contributions of the sectors is shown in Figure XX.

Figure XX



Source: Plan Energético Nacional 2014-2025

Market Trends

With strong political support, investment friendly regulations being introduced and large investments in exploration already done, growth in Peru's exploitation of natural gas is likely to continue to increase in the coming years and subsequently the market size will grow.

In the National Energy Plan 2014-2015, it is predicted that natural gas will be used to generate 6,891 MW of electrical energy by 2025, representing a 53% increase in production since 2013. In terms of contribution to the electrical energy matrix, however, thermoelectric generation is expected to fall from 57% to 48%. These predictions assume an average annual national growth of 4.5% (MINEM, 2014).

Key factors that will determine the growth of the market are: exact gas reserve quantities in the Camisea fields, electricity demand from the mining sector, the introduction of a grid connection with Chile, legislative frameworks on exploration and extraction and changes to the price of natural gas.

Market Size

Extraction, Transportation and Refinery

In 2016, US$ 334.6 million was invested in oil and gas exploration in Peru with US$ 46.95 million spent on exploration and US$ 287.65 million on exploitation. According to Peru's Central Bank (BCRP), this represented 14.2% of all new investments in the country in 2016. The annual growth of the sector is estimated to be 4.6% for 2017 (ProInversión, 2017).

As shown in Table 10, the majority of gas reserves are located in the Camisea region, approximately 500 km southeast of Lima, on the eastern slopes of the Andes in the region of Cusco. Discovered in 1989 and beginning production in 2005 (Ernst & Young, 2017), a study commissioned by the Inter-American Development Bank (IDB) estimates that the Camisea project alone will bring about $23 billion in benefits to Peru over its 33 year life (APOYO Consultoría, 2007).

Table 10: Electricity Generation from Natural Gas Reserves in 2016)

Reserve	Electricity Generation	
	GWh	%
Natural Gas Camisea	21324.5	94.96%
Natural Gas Aguaytia	368.5	1.64%
Natural Gas Malacas	651.7	2.90%
Natural Gas Las Isla	112.5	0.50%

Total	**22457**	**100%**

Source: Annual Operation Report 2016 SEIN, COES SINAC

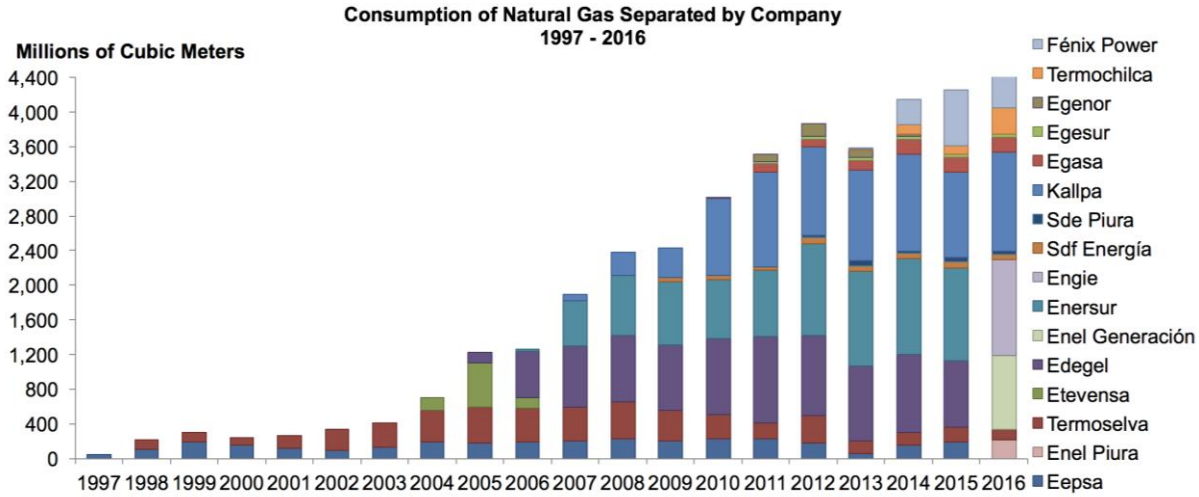
Energy Generation

The five largest thermoelectric power operators (Kallpa, Engie, Enel Generación, Fenix Power and Termochilca) accounted for 91% of the total thermoelectric generation in 2016. Between them, they have active totals in Peru of US$ 8,686 million and invested US$ 320.8 million into their projects in 2016 (Apoyo y Asociados, 2016).

Key Companies and Installed Projects

Figure XX shows the increasing consumption of natural gas for energy production between 1997 and 2016. It is worth noting that two of the five largest producers changed their names in 2016: Enersur and Edegel are now called Engie and Enel Generación Perú, respectively. The increased production of the Camisea fields, a consistent stream of new plants, and the completion of plant upgrades have maintained consistent growth in the sector.

Figure XX: Consumption of Natural Gas Separated by Company 1997 - 2016



Source: Annual Operation Report 2016 SEIN, COES SINAC

Table XX shows production, installed capacity and financial investments of the five largest thermoelectric plant operators in 2016. A full table of all 12 natural gas power plants operators including their gas consumptions and plant efficiencies is shown in Appendix 9.

Table XX: Electricity Production, Installed Capacity and Investments for Natural Gas Plant Operators in 2016

Operator	Production (% of total) GWh	Installed Capacity MW	Investments in 2016 Million USD	Active Totals Million USD
Kallpa	6,015 (26.79%)	1,062	US$ 21	US$ 721
Engie (previously Enersur)	5,843 (26.02%)	2,530	US$ 59	US$ 2,270
Enel (previously Edegel)	3,898 (17.36%)	1,486	US$ 189	US$ 4,612
Fénix Power	3,582 (15.95%)	570	US$ 21	US$ 839
Termochilca	1,106 (4.92%)	201.5	US$ 32	US$ 246

Sources: Annual Operation Report 2016 SEIN, COES SINAC, Clasificación de Empresas, Apoyo y Asociados 2016

Projects in the Pipeline

Table XX shows a selection of extraction, transportation and refinery projects in process from 2016-2018. These projects, as well as any future projects, will benefit from the already existing infrastructure of the Camisea Project, such as gathering systems and the Malvinas' gas separation plant, in order to deliver gas and liquids to the coast through TGP's (Transportadora de Gas del Perú S.A.) pipelines.

The modernisation of the Talara Refinery is a government subsidised project costing around $US 3.5 billion. The aim is to improve the refinery capacity and the infrastructure of the site. Técnicas Reunidas was awarded the Engineering, Procurement and Construction (EPC) contract for the refinery modernisation in May 2014. As of June 2017 the project was 60.5% complete.

Both the Talara and Pampilla Refinery modernizations are due to be completed in 2018. In contrast, as of January 2017, the Southern Gas pipeline was only 37.6% completed with no contract in place for it completion.

In addition to Southern Gas pipeline project, a complete overhaul is proposed for the Northern Pipeline, which has recently suffered several high profile leaks. The project is to ensure its maintenance, sustainability and enhance its infrastructure (Ernst & Young, 2017).

Furthermore, the Peruvian government is studying the possibility of connecting the Camisea gas reservoirs with the central and northern regions of the country (probably through Cusco), in order to satisfy the increasing demand for natural gas in the northern region of the country.

Exploration contracts are usually broken into sections of 2D and 3D seismic mapping, followed by exploratory drilling. The Australian gas company Karoon has exploration rights for Block Z-38 located offshore of the northern tip of Peru. Awarded in October 2016, the firm has a 3 year exploration contract, estimated at around US$ 20 million, comprising 2D and 3D seismic data acquisition from the site. The 2D seismic acquisition is proposed for the first half of 2018.

Block 58 is located in the Cusco region near Peru's largest gas block of Camisea, from which gas is exported to Mexico. The block's capacity is enough to increase Peru's total gas reserves by 27.7%, according to government figures. It is expected that the Chinese state-owned CNPC will drill 60 exploratory wells in the Block before the end of 2018.

Table XX: Extraction, Transportation and Refinery Projects 2016–2018

Project	Contractor	Estimated investment* US$	Expected Completion Date
Talara Refinery Modernization	Técnicas Reunidas	3,545 million	2018
La Pampilla Refinery Modernization	Repsol	1,000 million	2018
Southern Gas pipeline	To be determined	To be determined	2022 (estimate)
Northern Peruvian Oil Pipeline overhaul	To be determined	1,900 million	To be determined
Northern and Central Pipeline connection to Camisea	To be determined	3,300 million (estimate)	To be determined
Block Z-38 exploration and development	Karoon	3,000 million	2019
Block 58 exploration	CNPC	1,300 million	2023

*Investment reflects the grand total of the projects, regardless of their beginning and/or ending date. Source: Ernst & Young, 2017

Potential and Opportunities

There is great potential and a large number of opportunities for the natural gas industry in Peru. From upstream projects of exploration and extraction, midstream transportation and refinery projects to downstream energy production. A great way to explore the opportunities, make connections in the industry and gain market exposure, is through the trade fairs and conferences listed in Section 7.

Upstream

Peru has 18 sedimentary basins with hydrocarbon exploration potential. Only three of them have been exploited, indicating that a large amount of hydrocarbon potential has not been explored, especially in the jungle and coastal regions (Ernst & Young, 2017).

Under Peru's 1993 Organic Hydrocarbons Law (Ley N° 26221, La Ley Orgánica de Hidrocarburos (LOH)), oil and gas deposits are state property and may be explored and exploited under a licensing agreement with Perúpetro, the state entity in charge of awarding (including contracting third parties by means of joint ventures) and supervising oil blocks.

Indeed, Perúpetro is currently working on a more competitive Exploration & Exploitation (E&E) framework which is aimed to attract new sustainable investments with broad business, technological, social and environmental support. As part of this reform, Perupetro is establishing 54 areas for Contracts and/or Technical Evaluation Agreements (Ernst & Young, 2017). These contracts represent opportunities for oil and gas exploration companies looking to work in Peru.

To follow this opportunity, make direct contact with Perupetro to stay up-to-date with opportunities and changes in policy relating to the contracting of exploration contracts. It is recommended to work with a local engineering consultancy (for example Amec Foster Wheeler or A.C.I. Proyectos) which has experience with contracting and permitting oil and gas projects in Peru.

Midstream

The biggest midstream project currently in progress is the Southern Gas pipeline. This pipeline, once completed, will transport liquid natural gas from the Camisea Fields to the southern regions of Peru. Due to issues with the primary stakeholder, Brazilian company Odebrecht, the concession has been returned to the Peruvian Government, along with all the assets involved in the project. An international bidding process is expected to open in early 2018 to find international investors to continue the project (Ernst & Young, 2017). The large demand for natural gas in the southern regions of Peru comes from the residential sector as well as the large scale petrochemical and energy projects, both the ones already running, and planned future projects. The Southern Gas Pipeline represents opportunities for pipeline construction, consultancy for permitting and licensing, as well as environmental, geological and social impact

studies. Works may come from projects auctioned by Petroperu or through subcontracts once the Engineering, Procurement and Construction (EPC) contract has been awarded. Projects in the residential sector may also become available once the arrival date for the gas is confirmed.

ProInversion, the government agency for the promotion of the private industry in Peru, is an important point for information about access to the Peruvian Market and government tendered projects. Registering interest with them is good starting point. Perupetro advertises their contracts and bidding procedures through their website however the knowledge of a consultancy firm with bidding experience in the Peruvian oil and gas sector would be a valuable asset.

Downstream

Access to gas in the southern Peruvian Region is a bottleneck for many upgrade and installation projects. The completion date of the Southern Peruvian Pipeline is still unknown and so to is the exact quantity of proven gas reserves in the Camisea; it is likely that exploration companies are waiting for the government to increase gas prices before declaring exact quantities. These two factors represent uncertainties that are currently limiting investment in downstream projects.

The interconnection of Peru and Chile's electricity grids would ensure greater demand and profitability of electricity generation in southern Peru. A proposed 220kV transmission line which would connect the city of Tacna in the South of Peru and Arica in the north of Chile and could transport 300 MW of power. This would likely increase investment downstream activities. The project could come online by 2020, according to Chile's energy minister (BN Americas, 2016).

The key parties involved are the Peruvian Ministry of Energy and Mines and Ministry of Energy Chile. These two parties will be issuing contracts for the preliminary studies and following constructions works. Government tendered projects and works will be released through ProInversion.

Upgrading Liquid Hydrocarbon Plants to Natural Gas

The substitution of natural gas for liquid hydrocarbon generation is an attractive substitution. Energy production from natural gas produces about 30% fewer emissions than oil (AS-COA, 2010). Peru is still heavily relies on diesel, residual fuel oil (RFO) and high viscosity petroleum for its cold reserve, which serves as a backup electricity generation source. In 2016 the total energy produced from combustible liquids was 254.8 GWh with diesel alone representing 1.06% of the thermoelectrically generated electricity in 2016. Indeed, Engie Energy, which operates the largest cold reserve running on diesel has said that when the gas from the Southern Gas pipeline arrives they intend to upgrade their plant to run on gas (Oil & Gas Year, 2015). The other operators running liquid hydrocarbon plants are Samay, Egasa, SDF Energia, Enel Generacion, Enel Piura, Cerro Verde, Shougesa, Planta Eten, ElectroPeru, IEP and San Gaban.

Plant upgrades are commissioned directly by the plant owers. A good opportunity to make connections within the industry and to sell natural gas services and equipment is at trade fairs, especially FIGAS Expo, which has importation agreements that allow foreign equipment to be imported for display, bypassing costs and delays that otherwise might be incurred.

Upgrading Natural Gas Plants from Simple-Cycle to Combined-Cycle

Table XX shows the generation technologies used in the thermoelectric plants in Peru and reference values of plant efficiencies. It is interesting to note the large difference in efficiencies between gas turbine and combined cycle gas turbine plants. Modernising simple-cycle gas turbine plants to combined-cycle offers improved fuel efficiency and reduced operational costs.

Table XX: Technologies Used for ThermoElectric Energy Production in 2016 and reference values for plant efficiency

Technology Type	Energy Produced GWh	Participation %	Efficiency %
Gas Combined Cycle	18 038.6	75.1	up to 58%
Gas Turbine	4 704.5	19.59	up to 39%
Steam Turbine *	1 022.9	4.26	39 to 47%
Diesel	254.8	1.06	38 to 44%
Total	**24 020.8**	**100**	**-**

** 772.89 GWh (3.2% participation) from coal*

Source: Annual Operation Report 2016 SEIN, COES SINAC, Efficiency in Electricity Production, EurElectric and VGB, 2003

Siemens has received an order to upgrade Termochilca's simple-cycle plant to combined-cycle operability. This work, due to be completed in 2018, will increase the plant's power output by around 100 MW while reducing CO2 emissions by 30 percent (Power Engineer, 2016).

Uncertainties in energy demand and total gas reserves in the Camisea, combined with the low price of gas in Peru are obstacles for the proliferation of combined cycle generating technology. With changes to the price of gas (controlled by the government), or the interconnection of Peru and Chile's electrical grids, the demand for plant modernisations will increase.

Similar to the opportunities listed in the 'upgrading liquid hydrocarbon plants to natural gas' section, this opportunity could be followed by networking at trade fairs, especially FIGAS.

6.0 Energy Efficiency

The energy efficiency industry in Peru is in its early stages of development and energy management and implementation of energy efficiency measures are still comparatively uncommon practices (IFC, 2009. Carbon Trust, 2016).

Market Potential

Assessing the size and potential of the energy efficiency (EE) market in Peru is difficult, due to its relative infancy. A report published by the Carbon Trust in 2016, *Enhancing Private Sector Engagement in Energy Efficiency in Peru,* estimated that low cost energy efficiency measures have the potential to save Peruvian businesses around US$ 1 billion (12% of energy costs). This estimate does not include potential savings in the residential and transport sectors, as well as potential grid efficiency improvements, and it is likely that potential savings are much greater.

A report conducted by The World Bank, *Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers*, compared energy efficiency measures in various countries and gave each country an energy efficiency score. The indicators used and the scores achieved by Peru, 4 other Latin American countries and the Netherlands can been found in Appendix 10. The report highlights the scope for growth of the EE sector in Peru, which is awarded an average score of 31/100, the 5th lowest score of the 13 Latin American and Caribbean countries evaluated. The score indicated a lack of policies for energy efficiency rating and certification systems, building codes, incentives such as carbon pricing and institutions offering financing mechanisms as areas for improvement.

Government funded public entities are starting to embrace EE, however, and there has been talk of revised regulation regarding EE policies being released shortly by the Ministry of Energy and Mines. Several large public entity and privately funded EE projects have already been completed, and more are in the pipeline. They are detailed in the *Current Projects* and *Projects in the Pipeline* sections.

Key Institutions and Companies

In terms of multilateral entities and key large scale projects, it is worth mentioning the following (IFC, 2011):

1. **Peru 2021** is a private non-profit organization whose mission is to train and mobilize business leaders to incorporate social responsibility into the management of their companies.
2. **Green Energy Consultancy and Services** is a leading company in the identification, design, and management of projects, studies, advising and businesses in the fields of energy efficiency, renewable energy, climate change and environmental issues. With over 15 years in the Peruvian and regional market, its staff promote the implementation of innovative solutions that allow customers to incorporate sustainable good practices and climate management in their companies, products, projects and services.
3. The **International Finance Corporation** (**IFC**) has a Sustainable Energy Finance program that seeks to increase access to financing for sustainable energy projects, including renewable energy and energy efficiency.
4. The **Inter-American Development Bank** (**IDB**) is supporting a project with FONAM (National Fund for the Environment) to promote the use of clean technologies and energy efficiency in small and medium enterprises (SMEs). Additionally, in combination with COFIDE on a scheme called Energy Savings Insurance (ESI), which aimed to offer insurance, guaranteeing SMCs financial returns through energy savings in case of noncompliance on the part of the contractor.
5. **Latin American Development Bank** (Corporación Andina de Fomento (CAF)) has created the Special Financing Program for Clean, Alternative Energy and Energy Efficiency Projects (PROPEL) to try to address problems of access to long-term financing currently faced by small and medium-scale energy projects.
6. The **Peru Development Bank (COFIDE),** whose mission is to promote sustainable and inclusive development in Peru, has a program called BIONEGOCIOS with its own funds and with two lines of international credit. It invests in energy efficiency and renewable energy projects directly, and also supports funding the associated technical assistance.
7. The **Fondo MiVivienda (FMV)** is the development bank for the real estate and construction sectors in Peru. One of its projects, Bono MiVivienda Sostenible (BMS), promotes bioclimatic housing, energy efficient technologies (LED lighting and natural gas) and efficient water use in the homes that it finances. As of December 2016, the FMV had accredited 12 housing projects through its BMS scheme.
8. **MGM Innova Group**, a private investment body based in Miami, USA provides integrated solutions (technical, financial and environmental) that contribute to the mitigation and adaptation of climate change. They focus on socially responsible investments in the energy efficiency and renewable energy sectors in Latin America and the Caribbean. In 2018 they started using Green Energy, a local peruvian engineering consultancy, to

identify projects in Peru and to attract attention towards Peru for future investments.

Market Barriers

Some of the barriers hindering the growth of the energy efficiency market in Peru:

1. **Insufficient energy audit companies**, especially those capable of providing investment grade economic-financial analyses of energy efficiency projects. Green Energy identified over 30 energy efficiency companies in the country, only 5-6 with such an expertise. This is a major barrier identified by Green Energy according with its experience in advising COFIDE (the Peruvian development bank) in technical aspects of energy efficiency and renewable energy projects.
2. **Lack of technical expertise**, including equipment installation specialists, consultants, project financial evaluators and Energy Services Companies (ESCOs) to provide turn-key efficiency upgrades and to assume financial risk of energy efficiency upgrades.
3. **Low energy prices**, which do not encourage the efficient use of energy.
4. **Relatively cheap natural gas**, slowing the conversion of single-cycle gas or diesel plants to combined-cycle plants.
5. **Lack of financing options**, and insufficient interest of commercial banks in funding energy efficiency projects: mostly due to lack of information on the subject, concern about the risks, and lack of technical support.
6. **Trade barriers to import,** due to weak regulation and legislation regarding energy efficiency technologies and innovations.

General factors that commonly inhibit the development of energy efficiency projects that are also applicable in Peru:

1. **Rational purchasing:** users can be reluctant to invest in efficient machinery and technology because they do not take into account all economic aspects of the purchase (greater focus on initial investment than long term energy and maintenance costs).
2. **Irreversible investments**: investments in energy efficiency savings are often irreversible, since they are not likely to be recovered if they do not turn out to be profitable.
3. **Uncertainty in energy prices**: potential changes in the price of energy affect savings and therefore lower the trust in the economic evaluations of EE measures.
4. **Energy efficiency measures not a priority**: since energy savings and efficiency measures are not usually core activities for most companies, they are normally postponed for actions of greater interest (for example, investing in a new production line).

(Source: Assessment of the Peruvian Market for Sustainable Energy Finance, International Finance Corporation)

Current Projects

Listed in Table XX are current projects that are in need of financing, or have completed an energy audit but are lacking a comprehensive economic-financial study (Green Energy, 2017).

Table XX: List of EE projects in Development

Sector	Description	Current Status
Brickmaking	Efficient tunnel oven, fueled with biomass and solar energy for administrative areas	Financing has been approved: US$ 2.7 million (US$ 2.18 million of leasing and US$ 0.52 million of working capital)
Brickmaking	Efficient tunnel ovens, improving efficiency and productivity improvements	Looking for financing of US$ 20 million for 4 tunnel ovens
Plastics	Injection equipment and efficient refrigeration systems. The injection equipment is already operating with a savings of approx 30% and an improvement in productivity of approx 50%.	Financing was approved for equipment (US$ 350,000). Looking for finance of US$ 490,000 for 2 more pieces of machinery.
Fishing	Efficient Boilers	Looking for financing of US$ 1.5 million for 3 efficient boilers
Animal Waste	Biodigester to generate electricity, treatment lakes to eliminate the problem of contamination	Looking for financing of US$ 736,000
Hotels	Concentrated Solar Power (CSP) for a hotel. Currently using LPG for the heating system. The CSP will supply around 90% of the current consumption.	Looking for financing of US$ 400,000
Agriculture	Solar Pumping	Looking for financing of US$ 42,600 for a pilot installation of 6 hectares

Sources: COFIDE, Green Energy

Projects in the Pipeline

In this section several future projects are presented that are parts of larger projects, led mainly by public entities.

Table XX: List of Future EE Projects

Sector	Description	Objectives and Goals
Higher Education	EE and RE projects on university campuses (Red del Compromiso Climático de las Universidades Peruanas)	Implementation of EE and RE projects on university campuses as technology examples for the students and energy savings measures. Investment of US$ 10 million. Average energy savings of 30% and annual greenhouse gas emission reductions of 17,000 tons of CO_2
Office Buildings	Program of EE in offices and shopping centers in the district of San Isidro, Lima	Approximate area of the offices: 1,497,333 m^2. Approximate area of shopping centers 436,106 m^2. A potential savings of at least 20% in energy and 30% of in water consumption has been calculated.
Public Buildings	Solar photovoltaic installation on public buildings (MINAM)	The goal of the first phase is to install 100 systems, with a total value of approx. US$ 2 million (with an average system size of 2 kW). This energy is to be used for lighting and in the offices. EE measures will be implemented simultaneously.

Sources: COFIDE, Green Energy, Ministry of Energy and Mines

Potential and Opportunities

In 2006, the Ministry of Energy and Mines concluded that energy efficiency and co-generation markets applying ESCO methodology could represent an investment potential of almost US$ 2 billion (MINEM, 2006) and could mitigate 10% to 15% of CO_2 emissions until 2025. (CAF, 2016)

In an analysis performed by Green Energy, 12 sectors were identified as having potential for the development of renewable energy and energy efficiency projects. These were fishing, agriculture, animal waste, public buildings, residential buildings, shopping centres and associated services, cement production, mining/mineral processing, textiles, street lighting, small to medium sized companies in general and energy transmission and distribution.

Latin American Development Bank (CAF), by applying its own methodology, identified 7 potential opportunities to implement EE measures in Peru. They are listed in Table XX below.

Table XX: Table of EE opportunities as identified by CAF

Measure	Description	Total investment (MM USD)*	CO_2 emissions mitigation (MM $kgCO_2$) **
Switch to CFL light bulbs	Replace incandescent bulbs of 75W (working life of 1000 h) with CFL bulbs of 23W (working life 10,000h)	0.32	1.7
Installation of occupancy sensors in hotels	Sensors to control air conditioning units, heat pumps and lights in hotels that operate 12 months a year	5.2	1.1
Switch to LED lights	Replace 53W halogen bulbs (equivalent to 75W incandescent) with LED of 10W	1.0	1.8
Installation of variable frequency motor drivers	Variable frequency system for asynchronous motors	127.8	210.6
Implementing the standard *ISO 50001: Energy management*	Obtaining the certificate *ISO 50001: Energy management*, on behalf of industries	76.6	1,050
Tube Insulation	Thermal insulation that improves the energy efficiency of the tubes, reducing the heat losses and CO_2 emissions	647.6	257
Recuperation or	Installation of efficient ovens for the	852.1	758.9

generation of heat for cooling, drying, cooking, melting, etc	casting, cooking, drying, ect. in industries		

Source: Energy efficiency in Peru: Identification of opportunities. CAF, May 2016.

(*) Total potential investment financeable by CAF in Peru (**) Conversion ratio: 0,5 kgCO2/kWh

In addition to the measures listed above, there is an opportunity regarding energy auditing. The vast majority of Peruvian companies have not conducted and energy audit in their buildings or industrial processes, or considered energy efficiency measures in the design and management of their facilities. Offering energy audit services, with the ability to form economic-financial analyses of energy efficiency measures and make "bankable" energy diagnostic reports may offer good returns. However the ability to act on EE measures depends on confidence in the analysis and the availability of credit, both of which have historically been poor.

To enter the EE market in Peru and follow up on any of the opportunities listed, it is advised to perform a detailed study of Peruvian EE market. The report should include market analysis of the key sectors and the financial opportunities associated. An engineering consultancy firm like EnerTek or another firm with experience in Peru could perform this.

7.0 Market Entry

The Doing Business program, funded by the World Bank, gives a general comparison between the 190 assessed nations for the 'ease' of starting a business, getting credit and other metrics associated with corporate activities abroad. Table XX shows the scores of Peru and the Netherlands for a few selected measures. The Doing Business Score is calculated by normalizing the country rank to a scale of 0 - 100, where 0 represents the lowest performance (rank 190) and 100 represents the best (rank 1).

Table XX: Objective Measures of Business Regulations for Peru and the Netherlands

Topics	**Doing Business Score (0-100)**	
	Peru	**Netherlands**
Starting a Business	83.39	94.28
Getting Credit	80.00	45.00
Paying Taxes	65.81	87.59
Trading Across Borders	71.45	100.00
Overall	**69.45**	**76.03**

Some Topics are omitted from this table and maybe found at the Doing Business Website. The 'Overall' score is an average of all topics measured. Source: Doing Business - The World Bank

Accessing the Peruvian Market

Local Partners

Business in Peru is highly dependent on personal relationships and local connections; negotiations and deals are often made at social or industry-related events. Peruvian companies prefer to contract services with people they already have a connection with, or have been recommended by someone they trust. Partnering with a local company with technical expertise and a legal counselor is often an effective approach for small to medium sized foreign firms to enter the market.

Below is a list of the local partners and organizations that could provide support for Dutch companies looking to enter the market.

Table XX: Local Support Partners

Company/Organization	Sector(s)
EnerTek SAC	Consultancy renewables, energy efficiency
Amec Foster Wheeler or A.C.I. Proyectos	Legal, financial and engineering consultancy
Embassy of the Netherlands	All sectors
PetroPeru	Natural gas
Sociedad Peruana de Energias Renovables (SPR)	Renewable, energy efficiency
Sociedad Nacional de Minería, Petróleo y Energía (SNMPE)	Oil, mining and natural gas
Sociedad Peruana de Hidrocarburos (SPH)	Hydrocarbons

Table XX: Partner Contacts

Company/Organization	Contact	Email
EnerTek SAC	Ravi Sahai	rsahai@enertekglobal.com
Amec Foster Wheeler or A.C.I. Proyectos		
Embassy of the Netherlands	Synara Sanchez	Synara.SanchezSotomayor@minbuza.nl
PetroPeru	--	webmaster@petroperu.com.pe
Sociedad Peruana de Energias Renovables (SPR)	Juan Coronado	contacto@spr.org.pe
Sociedad Nacional de Minería, Petróleo y Energía (SNMPE)	--	postmaster@snmpe.org.pe

Sociedad Peruana de Hidrocarburos	--	informes@sphidrocarburos.com

Trade Fairs, Exhibitions and Forums

The main trade fairs, exhibitions and forums related to the renewable energy and natural gas industries in Peru and from around South America are listed in Table XX.

Table XX: Major Industry Events in the Peruvian Energy Sector

Event	Sectors	Main Players	Description	Frequency
PeruMin Sept. 2019, Arequipa	Mining	The Institute of Mining Engineers of Peru (IIMP), Ministry of Energy and Mines (MEM)	A display of the latest mining technology and provide effective solutions to the main problems in the Peruvian mining sector	Biennial
ExpoMina 12-14th Sept. 2018, Lima	Mining	Mine operators, mine equipment companies, mining engineering consultancies	Latest developments in equipment, supplies, services and machinery for the mining companies	Annual
ExpoEnergia 7-8 March 2018, Lima	Mining, Energy and Heavy industries	Mine operators, mining and energy engineering firms, logistical and administration companies and energy generation plant operators.	A commercial platform that connects providers and clients of technologies and services relating to mining, energy generation and heavy industry sectors.	Annual
PENREC (Peruvian Renewable Energy Conference) June 2018, Lima	Renewable Energy	Clean energy developers, Offtakers, EPC Contractors, Consultants, Government Stakeholders, Installers and Integrators	An opportunity to develop your business network in Peru and raise your brand awareness. Information about policy, finance and development of the RE sector.	Annual
Pacific Alliance Energy	Energy	Energy regulators, public sector leaders, investors and	To promote the evolution of the energy sector in Peru, Chile,	Flexible Dates

Forum Date: TBC (Last held in Sept. 2017 in Colombia)		financiers	Colombia and Mexico through exploring new opportunities in the market	
FIGAS Expo 25-27 Oct 2018 Lima	Natural Gas (NG) and Liquid Petroleum Gas (LPG)	Environmental service companies, exploration & production, gas processing, generators and transportation	Market opportunity for the sale of a broad range of equipment and services for the NG sector.	Biennial

Local Branch

There are many different options available to foreign companies looking to enter the Peruvian Market. It is possible to form a Peruvian corporation (Sociedad Anónima (S.A.)), a Limited Liability Company (Sociedad de Responsabilidad Limitada (S.R.L)), a Public Corporation (Sociedad Anónima Abierta (S.A.A.)) or a branch (Sucursale). According to Doing Business 2017, Peru ranks 54th out of 190 countries in terms of ease of starting a company and doing business, and 3rd in Latin America.

Financial and Legal Information

Local Finance

Technology risk and inexperience with renewable energy and energy efficiency projects have historically made local financiers reluctant to invest in this sector. With limited involvement of local banks, Peru has been forced to rely on international organizations, like the Inter-American Development Bank and the World Bank, to develop large-scale renewable energy projects. This has limited the sector's growth. As new renewable energy and energy efficiency projects become more common, local financiers are expected to extend the credit lines available to future investments (International Trade Administration, 2014).

The Marcona and Tres Hermanas wind parks (129 MW, completed in 2015) offer examples of international financing for large scale renewable energy projects in Peru. The projects, developed by Spanish based Cobra Group was financed by a US$ 207 million senior loan granted by US ExIm, Proparco, FMO, DEG, Natixis and Hyundai Power Private Special Asset Unit Trust, and US$ 20 million to the subordinate loan granted by Development Bank of Latin America (CAF).

For small to medium scale projects, the Global Climate Partnership Fund (GCPF) provides financing options for renewable energy and energy efficiency projects in South America. GCPF focuses on financing projects for SMEs, private households, and small corporates/project finance in developing countries, primarily in cooperation with local financial institutions.

Large scale natural gas projects tend to funded via foreign financial institutions, or in the case of the exploration and development of Block 58, foreign governments. (Works within Block 58 have been contracted to the Chinese state-owned CNPC.) All exploration, refinery and transportation contracts are issued in partnership with PetroPeru, which is financed from Peruvian state reserves. For small to medium sized natural gas projects, funding usually comes from private companies and contractors which will be involved in the construction and operation of the new service.

Taxation

The legal framework governing foreign investments in Peru is based on equal treatment for all investors, local or foreign. Foreign investments are allowed, without restrictions, in most economic activities and given stable free access to foreign currency, and freedom to repatriate profits, dividends and royalties (Deloitte, 2014). The principal rules governing investment in Peru are established in the Peruvian Constitution, the Foreign Investment Promotion Law (Legislative Decree N° 662) and Framework Law for Private Investment Growth (Decree Law N° 757).

The Peruvian Tax Regime comprises: Income Tax, Value Added Tax, Temporary Net Assets Tax, Customs Duties, Municipal Taxes as well as Financial Transaction Tax and Social contributions. Ernst and Young (Ernst and Young, 2017a), Deloitte (Deloitte, 2014) and PFK (PFK, 2015) have published comprehensive tax guides for Peru. Their tax guides are referenced with a website link to the full reports, and should be referred to for more detail on the tax system in Peru.

Trade Agreements

In 2016, the Netherlands exported US$ 314 million worth of products to Peru. The largest sectors were chemicals, machinery and mechanical appliances and food products (World Integrated Trade Solution, 2016).

Peru provides open access for foreign investors and companies in all sub sectors of the energy market. It enforces non-discriminatory practices for foreign investors and companies and the legal system guarantees protection of private property, free competition, free repatriation of profits, and full access to national and international financing (ProInversión, 2017).

The EU (including the Netherlands), together with Ecuador, Colombia and Peru, signed the Protocol of Accession of Ecuador, a bilateral free trade agreement, which entered into force on 1 May 2017 (European Commission, 2017). The protocol outlines a broad range of objectives including: the liberalisation of trade in goods and services; the application of the agreed provisions regarding customs and trade facilitation, standards, technical regulations and conformity assessment procedures; and the principle of free competition.

A base rate importation duty (a percentage cost of the item value) is set for importations from the EU entering Peru. Across many products this is 0, for example gas turbines, solar panels and

wind turbines, and negotiations are taking place to remove the tariffs for the remaining products. Engineering services are subject to no market access restrictions and therefore receive Peruvian national treatment (European Commission, 2017).

Corruption

According to the Global Competitiveness Report 2015-16 produced by the World Economic Forum, based on a survey of businesspeople, corruption is considered as the third most important obstacle to doing business in Peru, surpassed only by inefficient government regulations and restrictive labour regulations (World Economic Forum, 2015).

The scandal of the Southern Gas Pipeline, involving the Brazilian construction conglomerate Odebrecht, embroiled political elites from Peru and throughout Latin America. In response, the Peruvian judicial system has taken a series of measures to remove the impunity for corruption, including being willing to prosecute ex-presidents.

Indeed, Decree-Law 1243 (22 October 2016) modified the Criminal Code to broaden the civil disqualification penalty for public officials by introducing definitive civil disqualification measures following corruption, preventing public officials convicted of corruption from holding a position in state or federal governments (Lexology, 2017).

Further positive regulatory changes have come as Peru has endeavoured to join the Organisation for Economic Cooperation and Development (OECD). The measures taken amend Peru's anti-corruption laws to comply with the OECD's standards.

Furthermore, in October 2016, under a newly elected President Kuczynski, an anti-corruption programme to fight endemic corruption was launched showing strong intent from the current government to reduce corruption and in so doing so secure membership to the OECD.

Notwithstanding, in the private sector on small to medium sized projects the influence of corruption is very small, and business in Peru functions similar to in Europe where projects and contractors are selected through open, unbiased competition. Working with a trusted local partner or trade organization is recommended to help navigate the Peruvian business environment.

8.0 Active Dutch Companies in Peru

The table summarizes the major services of the Dutch companies working in Peru, organized by sector.

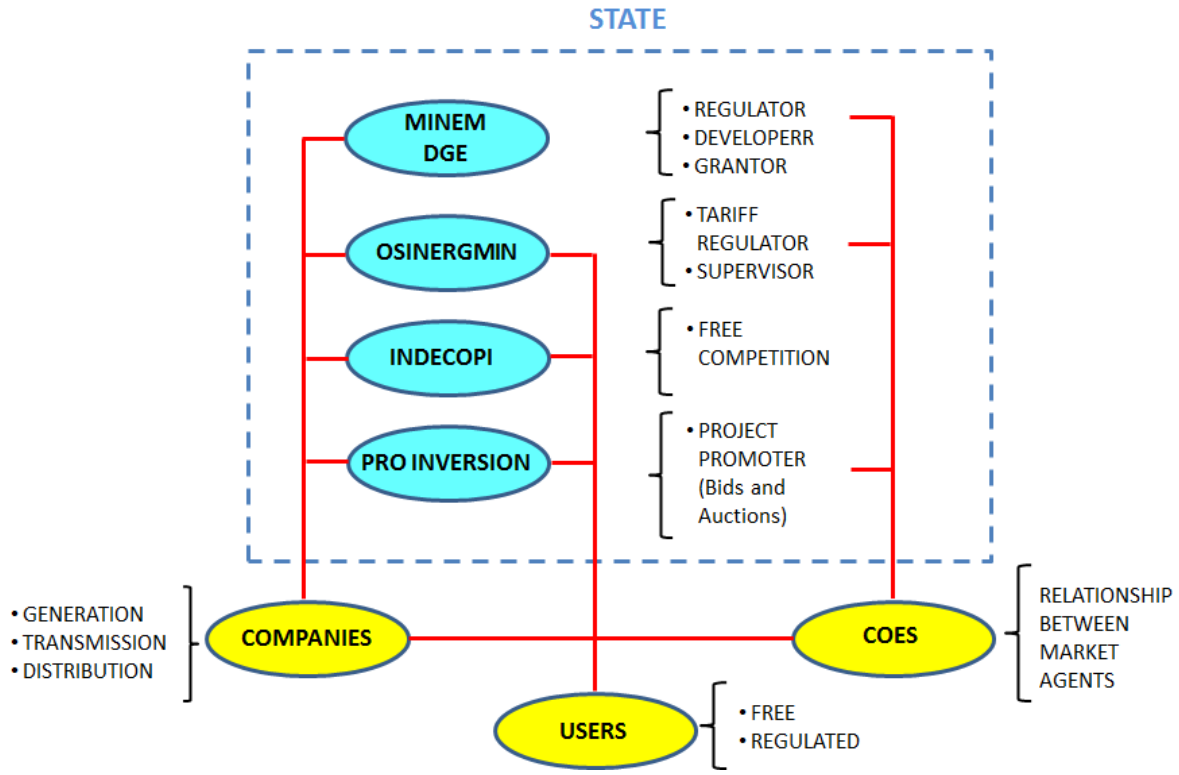
Table XX: Dutch Companies in Peru

Sector	Company	Services
Solar	Kipp & Zonen	Solar radiation measurement instruments
Biomass Biogas	Nijhuis Industries	Wastewater to biogas conversion
Natural Gas	Kuehne + Nagel	Oil/gas/maritime logistics
	Van Beest	Manufacturer and supplier of shackles
Offshore	Boskalis	Maritime infrastructure/maritime services, offshore wind
Gridtech	ELEQ Steenwijk	Manufacturer of electrotechnical applications for protecting/measuring/connecting electrical energy
Consultancy	Arcadis	Consultancy and engineering firm
	DNV GL	Quality assurance and risk management for maritime, oil/gas, renewables
	Ecofys	Energy and climate consultancy firm
	Royal Haskoning DHV	Engineering and consultancy in wind/tidal/geothermal/biomass/hydropower
	Witteveen + Bos	Consultancy and engineering firm on water, infrastructure, sustainability, construction

9.0 Structure of the Electricity Sector

The electricity sector in Peru is governed by four main government entities (MINEM, Osinergmin, Indecopi and ProInversíon), the national grid coordinator (COES), electricity companies (Generation, Transmission and Distribution) and electricity consumers (Free and Regulated Users). The relationship between the main industry players in the Peruvian electricity market are shown in Figure 10 below.

Figure 10: Interaction between Main Industry Players



Source: MINEM - Ministry of Energy and Mines

Government Entities

DGE-MINEM *(Dirección General de Electricidad)*, the National Electricity Office of the Ministry of Energy and Mines (MINEM) is responsible for granting concessions to carry out electricity related activities and setting policies and regulations for electricity sector.

OSINERGMIN *(Organismo Supervisor de Inversión en Energía),* the Energy and Mining Investment Supervisory Body, supervises and regulates activities in the energy and mining sectors, including renewable energy. It also determines electricity tariffs, which must comply with existing regulations. Osinergmin is in charge of running the Renewable Energy Auctions that have taken

place every two years since 2009.

INDECOPI *(Instituto de Defensa de la Competencia y la Propiedad Intelectual)*, the National Institute for the Defense of Competition and Intellectual Property, ensures compliance with market laws to protect consumer and entrepreneurial interests by preventing restrictive practices and maintaining free and fair competition.

PROINVERSIÓN *(Agencia de Promoción de la Inversión Privada del Perú)*, the Promotion Agency of Private Investment of Peru, promotes the investment of private companies in Peru to boost Peru's competitiveness and sustainable development. It is an agency recognized by investors and by the population as a strategic ally for the development of investments in Peru. In recent years it has promoted auctions for energy generation from large hydroelectric plants such as Chaglla and Cerro del Águila (almost 1,000 MW), contributing to an electricity supply that is already in excess.

National Coordinator

COES *(Comité de Operación Económica del Sistema)*, the Committee for Economic Operation of the Electrical System, coordinates the operation of the national grid at a minimum cost. COES also plans the development SEIN transmission lines. It is comprised of professionals from the generation, transmission, distribution companies and free users of SEIN who cooperate to guarantee a reliable electricity supply.

Power Companies

GENERATION COMPANIES produce electrical energy (conventional or non-conventional) which is transported through transmission lines and delivered to a SEIN Substation. From the substation, the electricity is delivered to free or regulated users which have an Energy Sale Contract or PPA with the generation companies. The main generation companies in Peru are Engie, Enel Generación Peru, ElectroPeru, Kallpa and Fenix Power, which accounted for 64% of the national market in 2015 (Osinergmin, 2015b).

TRANSMISSION COMPANIES transport electrical energy through transmission lines in medium (1-36 kV) or high voltage (36-220 kV). Generation companies and SEIN users pay transmission companies a toll to send and receive their electricity. The main transmission companies are Abengoa Perú, Consorcio Transmantaro and Red de Energía del Perú (REP), which controlled 88% of the national market in 2015 (Osinergmin, 2015b).

DISTRIBUTION COMPANIES distribute electric energy through low and medium voltage distribution lines to industrial users, regulated, and domestic users. The main distribution companies are Luz del Sur, EdelNor and Distriluz which accounted for 81% of the market in 2015 (Osinergmin, 2015b).

A list of all generation, transmission and distribution companies and their market share is provided in Appendix 6.

Electricity Customers

FREE USERS are large energy consumers connected to SEIN, with a maximum electricity demand greater than 2.5 MW. Free users are not subject to price regulation for energy or power.

REGULATED USERS are small to medium sized energy users connected to SEIN, with a maximum electricity demand less than or equal to 200 kW. Regulated users are subject to price regulation for the energy or power they consume.

For users whose maximum electricity demand is between 200 kW and 2.5 MW, they can choose to be a Regulated User or a Free User. These requirements and conditions are detailed in Supreme Decree No. 022-2009-EM (*Decreto Supremo Nº 022-2009-EM*).

Regional Governments and Associations

DREM *(Dirección Regional de Energía y Minas),* is the regional entity of the Ministry of Energy and Mines in each of the 25 regions in Peru. Each DREM office is responsible for granting concessions for generation projects (500 kW to 10 MW) and managing energy plans and policies within its region. DREM offices also prepare the regional statistics for the energy and mining sectors.

SNMPE *(Sociedad Nacional de Minería Petróleo y Energía)*, the National Association of Mining, Oil and Energy, is a non-profit business organization that advocates for mining, energy and hydrocarbon interests and is an important player in the energy sector and the government.

THE ENGINEERING COLLEGE OF PERU *(Colegio de Ingenieros del Perú)*, the professional school of collegiate engineers of Peru has a national presence in the energy sector and organizes events, forums and exhibitions on relevant issues.

AFIN *(Asociación para el Fomento de la Infraestructura Nacional),* the Association for the Promotion of National Infrastructure, is a trade association consisting the main public infrastructure companies in the energy, transport, telecommunications, health and sanitation sectors. Publishes a bulletin every 15 days on economic, legal and new investments in Peru. Also promotes the development of renewable energies.

Peruvian Society of Renewable Energy *(Sociedad Peruana de Energias Renovables)* is a non-profit civil association that brings together companies and organizations committed to the development of non-conventional renewable energies. Its mission is to encourage the development of electric power generation in Peru from renewable resources.

EITI (Extractive Industries Transparency Initiative) is a global coalition of governments, companies and civil society that is working together to improve openness and accountable

management of revenues from natural resources. The initiative aims to allow citizens to be informed about how much profit their country is making from the extraction of natural resources. Peru joined the EITI in 2005, becoming the first latin american country to do so.

MINAM (Ministry of the Environment) is the nation's environmental authority, the overseeing entity of the National Environmental Management System (SNGA), and a part of the Executive Branch. Its main functions are focused in promoting environmental sustainability by preserving, protecting, recovering and securing the environment, ecosystems and natural resources.

Petroperu is a state-owned company of private law that carries out exploration, exploitation, transport, and refining activities.

SPH (Sociedad Peruana de Hidrocarburos) is the main hydrocarbons guild in Peru. Founded in 2013, it groups the main companies dedicated to exploration and exploitation activities in the country.

10.0 Energy Prices and Tariffs in the Electricity Market

Energy Prices

The energy price includes the investment and operation and maintenance costs for each technology, and is expressed in dollars per megawatt-hour (US$/MWh). Energy prices according to Osinergmin and the latest auctions for each technology in Peru are shown in the table below.

Table 14: Energy Prices by Technology

No.	Technology	Energy Price (US$/MWh)
1	Gas Turbine (Combined Cycle)	20-22
2	Gas Turbine (Single Cycle)	30-36
3	Wind	38
4	Coal	38
5	Small Hydro	44
6	Solar	48
7	Large Hydro	55-65
8	Diesel Engine	250-300

Source: Osinergmin

Although the lowest energy prices are for natural gas, it is worth noting that the costs for natural gas are subsidized by the government and do not include exploration costs. Nevertheless, renewable energy prices are now competitive with prices of conventional technologies. Energy generation from wind is now the same price as coal, with small hydro and solar following close behind. The prices for hydroelectric vary, depending on the size and specifications of the project.

The most expensive generation is diesel, which is often used in the industrial and agricultural applications as an energy reserve or where a grid connection is not available such as the mining, manufacturing, and agriculture sectors. Because of the high cost of diesel generation, these sectors present a large opportunity for renewable generation.

Electricity Market (SEIN)

The Peruvian electricity market consists of four principal submarkets: the Spot Market, the Free Market, the Regulated Market and the Auction Market.

The **Spot Market,** also known as the marginal market, refers to the transactions between generators based on the variable cost of energy. The price of energy on the Spot Market varies every 15 minutes and depends on the variable energy cost of the last generating unit dispatched by COES. The unit or generation plant that sets the Spot Price is known as "marginal unit".

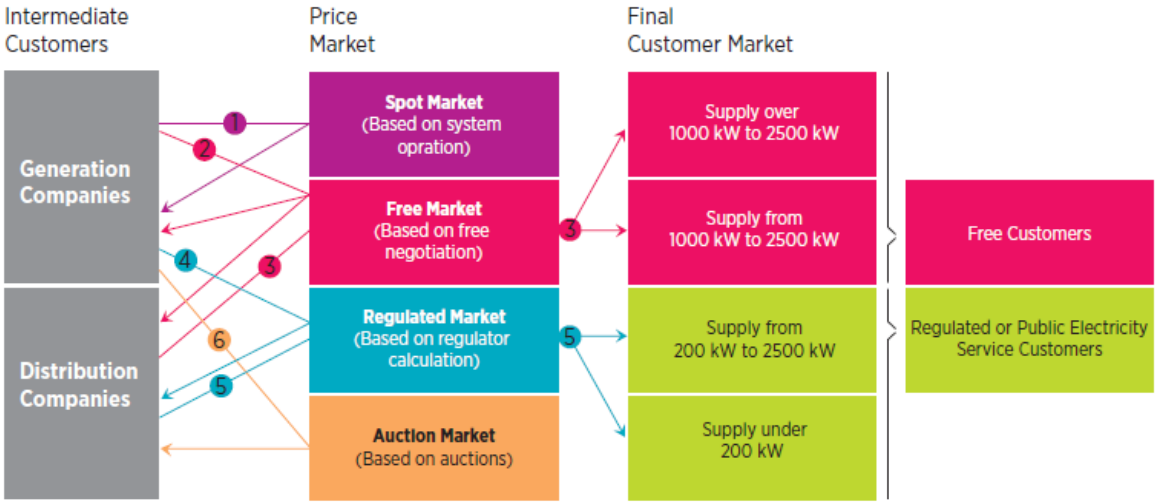
The **Free Market** refers to free negotiations between the generation and distribution companies and between distribution companies and final customers (with a demand greater than 2.5 MW). Customers with a maximum power demand between 200 kW and 2.5 MW can choose between the free market and regulated market.

In the **Regulated Market,** generation companies negotiate with distribution companies based on a price ceiling set by Osinergmin. Distribution companies then sell the electricity to consumers with a power demand less than 200 kW.

The **General Auction Market** is set through auctions and is available to generation companies selling electricity awarded to distribution companies in energy auctions. Renewable Energy Auctions, as described in Section 6 are a submarket within the General Auction Market.

Figure 20 below illustrates the interactions between the market players and submarkets in Peru's electricity system.

Figure 20: Electricity Market

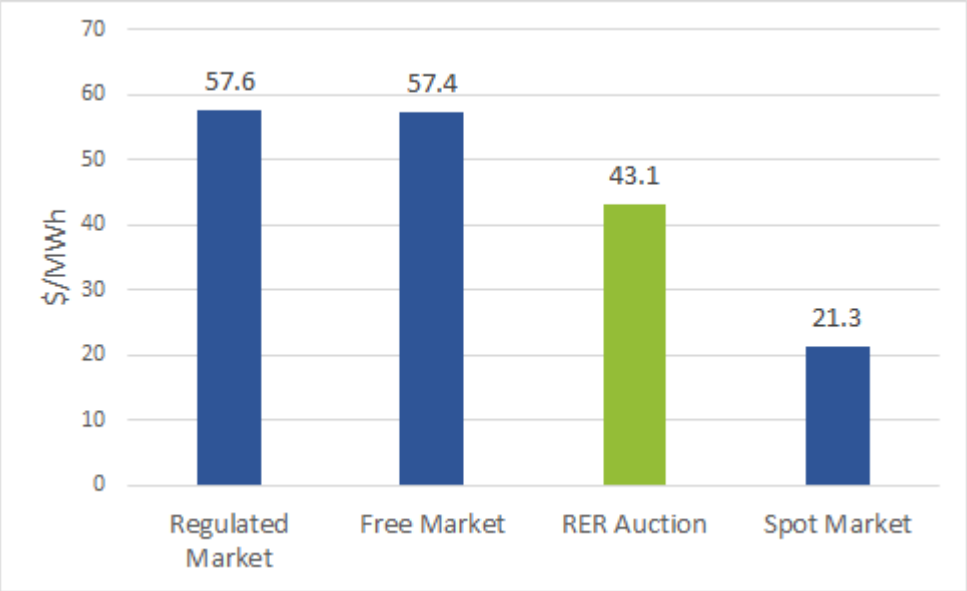


Source: Peru: Renewables Readiness Assessment 2014, IRENA

Market Prices

To compare the price of electricity between the Regulated Market, Free Market, RER Auction Market and Spot Market, the generation prices for each submarket in 2015 are shown in Figure 21 below. The generation prices shown are combined price of energy and power (also known the monomic price).

Figure 21: Market Prices (Generation Only), 2015



Source: Osinergmin

The price of electricity in the renewable energy auctions is now lower than the conventional price of energy in the free market and the regulated market. Although natural gas generation is still cheaper than renewables due to government subsidies, the price of generation for other types of energy, such as large hydro and coal bring up the cost of energy in the free and regulated market, causing higher prices in the regulated and free market.

At an average of US$43.1/MWh, the average generation cost at the latest RER auction was 34% lower than the price for regulated users and 33% lower than the price for free users.

The lowest price of electricity is still on the spot market because energy on the spot market is sold inexpensively between generators when there is oversupply in the grid.

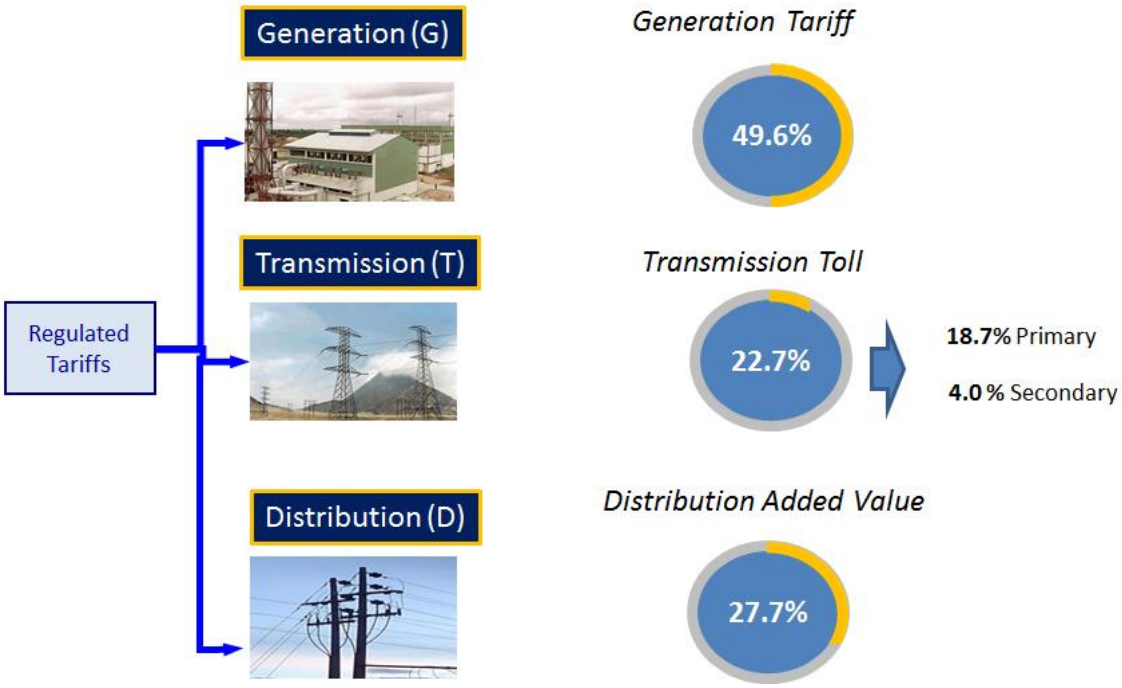
Tariffs

Regulated prices, or tariffs, are set by Osinergmin and contain 3 components: the Generation Tariff, Transmission Toll, and Distribution Charges. These charge are shown below.

- Generation Tariff: Also known as the generation price or monomic price, it is the combined price of energy and power. It is determined by averaging the prices of the long-term contracts signed between generation and distribution companies (following the completion of energy tenders) with the prices of free users at generation level.
- Transmission Toll: The charges for the use of the high voltage transmission system. It consists of the primary transmission charge and the secondary transmission charge.
- Added Value of Distribution (VAD): The charges for the use of the distribution system in medium (1-36 kV) and low voltage (220V-440V).

Figure 22 below shows each percentage of each component in the regulated price for domestic consumers. The tariffs shown below are an average of the regulated prices paid by consumers in 2016.

Figure 22: Components of Electricity Tariffs

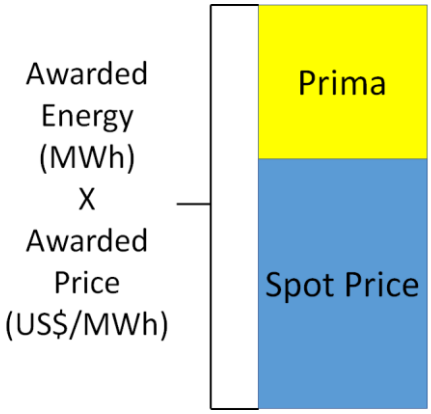


Source: Osinergmin

As shown in the figure above, more than 50% of the electricity tariff paid by end users at the domestic level comes from transmission and distribution costs. Generation accounts for the other 50%.

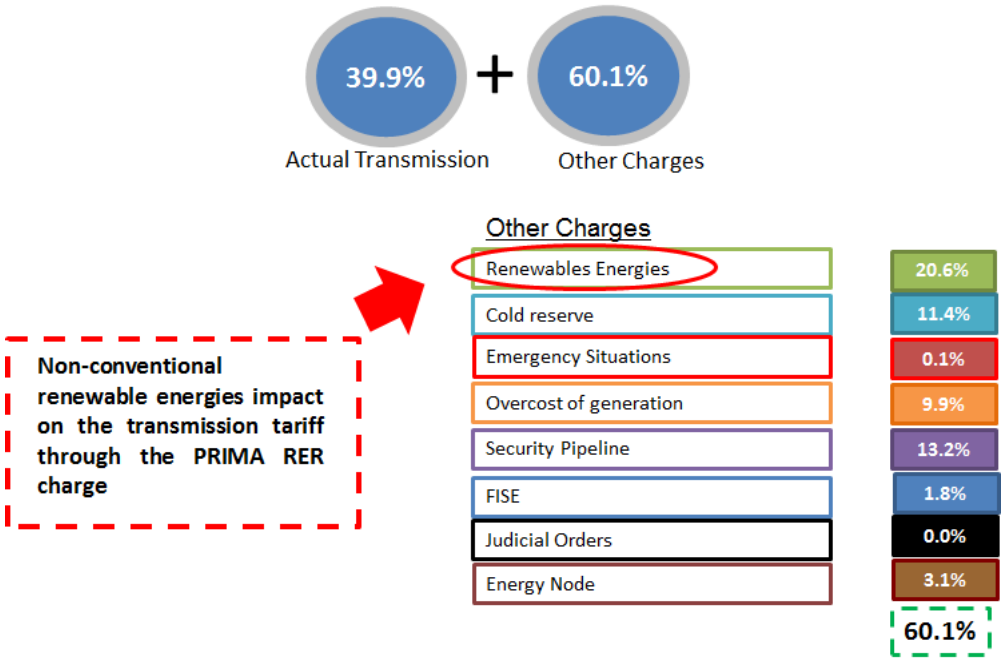
Prima

Renewable energy generators awarded projects through RER auctions receive the initial payment for their delivered energy based on the marginal price (or spot price) of electricity at the time of generation. According to Legislative Decree 1002, the generators are then compensated annually for the difference between the payment received based on the spot market price and the expected payment (based on the awarded price in the auction). This compensation is known as *prima*, and is paid for by end users through a charge in the transmission toll. A diagram of the payment for renewable energy generators is shown below.



In recent years, Osinergmin has been adding several fees within the transmission toll to pay for the *prima*, and other investments including transmission lines, isolated systems, the Southern Gas Pipeline, Electrical Social Compensation (FOSE), rural electrification, Social Inclusion (FISE), etc. These fees account for more than 60% of the total transmission fee. An average of the fee allocation paid by domestic users in 2016 is shown in Figure 23 below.

Figure 23: Transmission Fee



Source: Osinergmin

11.0 Legal Framework and Regulatory Environment

Since 1997, Peru has issued a variety of legal standards and regulations to promote investments in renewable energy. The first regulation was the Organic Law of Geothermal Resources which laid the groundwork for exploration of geothermal resources in the Peruvian subsoil. Following the signing of the Peru-US Free Trade Agreement (FTA) in April 2006, new regulations have been drafted and published to encourage investment in renewables. The relevant regulations are shown in the table below, with an explanation provided for each regulation.

Table 10: Renewable Energy Standards and Regulations

No.	Regulation	Year
1	***Ley Nº 26848*** *Ley Orgánica de Recursos Geotérmicos (p. 29/07/1997)*	1997
	Law Nº 26848 Organic Law of Geothermal Resources (p. 29/07/1997)	
	Summary: Promotes investments in geothermal exploration and exploitation, establishing the criteria for obtaining authorizations, concessions, rights and obligations to ensure efficient use of geothermal resources.	
2	***Decreto Legislativo Nº 1002*** *Promoción de la inversión para la generación de electricidad con el uso de energías renovables (p. 02/05/2008)*	2008
	Legislative Decree Nº 1002 Legislative Decree for the Promotion of Investments in Renewable Energies for Electricity Generation (p. 02/05/2008)	
	Summary: Promotes the use of renewable energy through the diversification of Peru's energy matrix. Declares the development of new electric generation through renewables a matter of national interest in order to protect Peru's natural environment and move toward energy security. Indicates that every five (5) years, MINEM will establish a target percentage of the national electricity consumption that should be generated from renewable energy (not including hydroelectricity). This percentage was set at 5%, to be revised again in 2013. In 2013, Peru did not meet its 5% renewables target, and a new percentage has not yet been declared.	
	Decreto Supremo N° 012-2011-EM *Nuevo Reglamento de la Generación de Electricidad con Energías Renovables*	

3	*(e. 22/03/2011, p.23/03/2011). Reemplaza al Reglamento original (Decreto Supremo 050-2008-EM).*	2008, 2011
	Supreme Decree N° 012-2011-EM New Regulation for the Generation of Electricity by Renewable Energy. Replacement of the original Supreme Decree 050-2008-EM	
	Summary: Establishes the necessary provisions for the application of D.L. 1002 to promote electricity generation through renewable resources. Assigns a Firm Power equal to ZERO for Solar, Wind and Tidal technologies and establishes the procedures that will be proposed by COES to OSINERGMIN. Presently, there is no agreement within COES to propose a firm power different from Zero because COES represents all the generators of the country, mainly hydro-thermal.	
4	***Decreto de Urgencia 019-2008*** *Declaran de interés nacional la implementación y aplicación de la tecnología alternativa de calefacción "Sistema pasivo de recolección de energía solar de forma indirecta" denominada "Muro Trombe" (p.05/06/2008)*	2008
	Urgent Decree 019-2008 Promotion of the national interest in the implementation and application of the alternative heating technologies, the so called "Passive system for the indirect collection of solar energy" or the "Trombe Wall" (p.05/06/2008)	
	Summary: This norm empowers the National Training Service for the Construction Industry, SENCICO, to train and apply techniques for the installation of the "Trombe Wall" in the high Andean areas, which have been identified as affected by the "Friaje" phenomenon in the central highlands of the country. The "Friaje" is a cold weather phenomenon which causes very low temperatures that affects thousands of vulnerable people each year.	
5	***Osinergmin N° 200-2009-OS/CD*** *Procedimiento sobre Hibridación de Instalaciones de Generación Eléctrica que Utilicen Recursos Energéticos Renovables*	2009
	Osinergmin N° 200-2009-OS/CD Procedure on Hybrid Electricity Generation Facilities using Renewable Energy Resources	
	Summary: Is applicable when a Renewable Energy Resource (RER) technology used in a hybrid system has obtained Adjudicated Energy in the RER auctions promoted by DL 1002. Hybrid renewable energy systems are systems that combine one or several renewable energy sources in a generation plant. Renewable sources	

	combined with non-renewable sources are not considered hybrid systems.	
6	***Decreto Supremo Nº 056-2009-EM*** *Disponen adecuar competencia de los Gobiernos Regionales para el otorgamiento de concesiones definitivas de generación con recursos energéticos renovables (p. 11/07/2009)*	2009
	Supreme Decree Nº 056-2009-EM Allocation of adequate competencies to Regional Governments to award definitive concessions for electricity generation through renewable energy resources (p. 11/07/2009)	
	Summary: Specifies that regional governments are responsible for granting authorization for electricity generation of installed power plants between 500 kW and 10 MW, if the RER project is within their region. The purpose is to reduce the workload of the Ministry of Energy and Mines.	
7	***Decreto Supremo Nº 019-2010-EM*** *Aprueban nuevo reglamento de la Ley N° 26848, Ley Orgánica de Recursos Geotérmicos. (p. 08/04/2010)*	2010
	Supreme Decree Nº 019-2010-EM Approval of a New Regulation of the N° 26848 Act, Organic Law for Geothermal Resources. (p. 08/04/2010)	
	Summary: Organizes and elaborates on the articles of Law 26848 which regulate the development Peru's geothermal resources. Replaces previous regulations from 2006, 2008 and 2009 (DS No. 072-2006-MS, DS No. 016-2008-MS, and DS No. 009-2009-MS).	
8	***Decreto Supremo N° 031-2012-EM*** *Modifican los artículos del Decreto Supremo N° 009-93-EM y del Decreto Supremo N° 012-2011-EM, relativos al marco regulatorio que regula el otorgamiento de las concesiones de generación hidráulica RER.*	2012
	Supreme Decree N° 031-2012-EM Modification of Supreme Decree N° 009-93-EM and Supreme Decree N° 012-2011-EM, the regulatory framework governing the awarding of concessions for the generation of hydroelectric energy.	
	Summary: Clarifies that hydroelectric projects that are intentionally being developed with a capacity equal to or less than 20 MW to take advantage of the RER regime in the same river basin where a hydroelectric project of greater	

	capacity could be developed will not be considered RER projects. The purpose is to ensure the efficient and rational use of river basins in the future as conflicts have arisen over this issue in the past.	
9	***Decreto Supremo Nº 020-2013-EM*** *Aprueban Reglamento para la Promoción de la Inversión en Áreas no Conectadas a Red (p.27/06/2013).*	2013
	Supreme Decree Nº 020-2013-EM Approval of the Regulation for the Promotion of Investment in Off-grid Areas (p.27/06/2013).	
	Summary: Establishes the necessary provisions for the application of DL1002 to improve the quality of life of populations living in off-grid areas through the development of RER's for electricity generation. These RER's are to be developed via auctions of photovoltaic systems paid by all users through the electricity tariff.	
10	***Decreto Supremo N° 024-2013-EM*** *Modifican el Reglamento de la Ley de Promoción de la Inversión para la Generación de Electricidad con el uso de Energías Renovables y el Reglamento de la Ley de Concesiones Eléctricas. (p. 06/07/2013)*	2013
	Supreme Decree N° 024-2013-EM Modification of the Regulations of the Law for the Promotion of Investment in Electricity Generation by Renewable Energies and the Law of Electric Concessions (p. 06/07/2013)	
	Summary: This regulation was modified to improve the administrative procedures of the RER auctions after the first two auctions. It indicates that COES must propose the calculation procedure of Firm Power for renewables and that any modification must be approved by Osinergmin.	
11	***Decreto Legislativo N° 1221-2015*** *Decreto Legislativo que mejora la regulación de la distribución de electricidad para promover el acceso a la energía eléctrica en el Perú.*	2015
	Legislative Decree N° 1221-2015 Legislative Decree improving the regulation of electricity distribution to promote access to electrical energy in Peru.	
	Summary: Establishes that regulated users with renewable non-conventional electricity generation or cogeneration can use the electricity for their own consumption or	

	can inject their surplus into the distribution system. Indicates that the respective regulation will be published 4 months from Sep 2015. As of Feb 2017 (17 months later), the regulation has not yet been published.	

Financial and Fiscal Incentives for Renewables

In addition to the regulations that promote investments in renewable energy listed in Table 9 above, financial and fiscal incentives have also been established that promote renewable energy development. Three Legislative Decrees that offer financial incentives to support renewable energy development are listed below.

Legislative Decree N.° 1002-2008

Legislative Decree N.º 1002-2008 declares that power generation through renewable energy is a priority in the interconnected grid (SEIN), which means that renewables will always be in operation (supplying energy to the grid) for the duration of 20 year PPA project life. This allows investors a legal guarantee to recover their investment in the minimum amount of time possible.

The decree also guarantees the investor an energy price, in US$/MWh (known as an adjudicated tariff) for 20 to 30 years (scaled). This price is covered by the marginal market, also known as the spot market, in which the price of energy varies every 15 minutes based on the energy cost of the last generating unit. In the case that the marginal market price is lower than the awarded PPA amount, the difference is covered by consumers through a fee in their electricity tariff, known as the *prima* (discussed further in section 7).

Lastly, the decree provides a simplified process to obtain environmental and technical permissions (such as an environmental impact study) to obtain the definitive concession for RER projects, which differs from the regular and established legal framework in the law governing electrical concessions.

Legislative Decree N.° 1058-2008

Article 1 of Legislative Decree N.° 1058-2008, entitled 'The Promotion of Investment in Energy Generation with Water Resources and with other Renewable Resources', is a tax benefit aimed exclusively at promoting investments in all Renewable Energies (wind; solar; geothermal; biomass; hydro, all sizes; and tidal energy).

The article states that energy companies using renewable resources can utilize an accelerated depreciation rate for corporation tax (impuesto a la Renta) of 20%. Since 2008, any Peruvian or foreign investor operating a power plant using renewable resources has the option to apply a maximum annual global depreciation rate of 20% to machinery, equipment and civil works. The accelerated depreciation stipulated by this norm is a benefit offered for renewables sources only.

In comparison, Article 39 of the TUO (Texto Único Ordenado - Ordered Unique Text) of the Corporate Tax Law (Ley del Impuesto a la Renta) sets the depreciation rate applicable for buildings and constructions at 5% annually.

Legislative Decree N.° 977-2007

Article 2, subparagraph c) of Legislative Decree N.° 977 states that any favourable tax exonerations, tax incentives or tax benefits will have a validity of no more than six (6) years. Any exoneration, incentive or tax benefit granted without setting a duration of validity, will by default have a six (6) year duration of validity. In the case of Legislative Decree N.° 1058 listed above, this means that as a tax benefit, the accelerated 20% depreciation rate is only valid for six (6) years from the beginning of operations.

Natural Gas Standards and Regulations

Under Peru's 1993 Organic Hydrocarbons Law, oil and gas deposits are state property and may be explored and exploited under a licensing agreement with Perúpetro, the state entity in charge of awarding and supervising oil blocks. With this law in effect, exploration surged, revealing Peru's vast hydrocarbon wealth. In 2008 a combination of events lead to severe energy shortage in Peru: a drought affecting the hydro plants' production, a sudden increase in demand from the mining sector and a worldwide hike in oil prices. The government policy and law making then focused on supporting a diversified energy matrix including further support for hydrocarbon exploration as well as midstream infrastructure.

(Osinergim powerpoint) **And Lax...doc in downloads**	***Ley Nº 27133*** *Ley de Promoción del Desarrollo de la Marco Normativo de la Masificación del Gas Natural (p. 3/06/1999)*	1999
	Law Nº 27133 Law of Promoting the Development of Natural Gas Industry (p. 3/06/1999)	
	Summary: This Law aimed to establish specific conditions for promoting the development of the natural gas industry, promoting competition and encouraging diversification of energy sources to increase the reliability of energy supply and competitiveness of the country's productive apparatus.	
http://www.equilibrium.com.pe/Enersurset16.pdf	***Ley N° 25844*** *Ley de Concesiones Eléctricas*	?2000?
	Ley de Concesiones Eléctricas: El Decreto Ley N°25844	
	y sus modificatorias rigen la actividad en el sector eléctri- co del país, el mismo que se encuentra compuesto de tres grandes segmentos: generación, transmisión y distribución. A partir de octubre del 2000, el sistema eléctrico está con- formado por un solo Sistema Eléctrico Interconectado Na- cional	

	(SEIN), además de existir algunos sistemas aisla- dos.	
http://www.equilibrium.com.pe/Enersurset16.pdf	***Ley N° 28832*** *Ley para asegurar el desarrollo eficiente de la generación eléctrica (p. 23/07/2006)*	2006
	Ley N° 28832 Law to ensure the efficient development of electricity generation (p. 23/07/2006)	
	This law modifies different articles of the Law of Concessions (Ley de Concesiones, N° 25844), to establish as one of its primary objectives the generation of electricity in a form that reduces the Peruvian system's vulnerability to price fluctuations and through this achieve a reduction in the risks of power shortages and as well ensure the final consumer a more competitive tariff by encouraging greater competition in the market.	
	***Decreto Legislativo N°* 063-2005-EM (28/12/2005)**	2005
	Legislative Decree Nº 063-2005-EM	
	Summary: from the Ministry of Energy and Mines, which reiterated some aspects of natural gas distribution and commercialization to promote mass-scale consumption in the automotive, residential and industrial sectors.	
EY	***Decreto Legislativo N°* 1292 (p. 31/12/2016)**	2016
	Legislative Decree No. 1292 (p. 31/12/2016)	
	Summary: At the end of 2016 the Government issued this Legislative Decree in which it has declared the necessity to modernize and reorganize Petroperu. In the same legislation, Petroperu has been authorized to contract third parties by means of joint ventures, services contracts, among other forms, regarding the management and operation of its current projects and the future ones (while still maintaining its favourable status as a public entity.) To that extent, it has allowed Petroperu to authorize the necessary investments and expenses to the adequate performance of the operation to Northern Peruvian Oil Pipeline over-haul to ensure its maintenance, sustainability and its infrastructure enhance. Furthermore, Petroperu is now authorized to organize and carry social responsibility activities through the Regime called Construction work for Taxes, according to Law No. 29230.	
	Ley 29969 (Diciembre 2012),	2012

	Disposiciones a fin de promover la industria del Gas Natural	
	Law 29969 (December 2012), Disposiciones a fin de promover la indústria del Gas Natural.	
	Summary: En el Art. 3 se faculta a las empresas de distribución de electricidad de propiedad del Estado, a ejecutar programas de masificación de gas natural, incluyendo la distribución en el ámbito de su concesión, conforme a la normatividad vigente.	
https://engie-energia.pe/wp-content/uploads/2015/09/ENGIE-0316-AAI.pdf , http://www.equilibrium.com.pe/Enersuset16.pdf	***Decreto Legislativo N°1221 - 2015 (p. 25/09/2015)*** *Decreto Legislativo que mejora la regulación de la distribución de electricidad para promover el acceso a la Energía Eléctrica en el Perú*	2015
	Decreto Legislativo N°1221 - 2015 (p. 25/09/2015) Legislative decree to improve the regulation and the distribution of electricity to promote access to electrical energy in Peru	
	This legislative decree modifies decree No 25844, Ley de Concesiones Eléctricas. Some of the modifications related to generation are: 1) a limit of 30 years for concessions from tender and 2) distributors are obligated to guarantee their demand for 24 months. Furthermore the decree establishes conditions for the generations of energy from non conventional renewable energies and hybrid systems.	

Financial and Fiscal Incentives for Natural Gas

Under Peru's 1993 Organic Hydrocarbons Law (Ley N° 26221, La Ley Orgánica de Hidrocarburos (LOH)), oil and gas deposits are state property and may be explored and exploited under a licensing agreement with Perúpetro, the state entity in charge of awarding (including contracting third parties by means of joint ventures) and supervising oil blocks. Petroperu was created under the directions of Law N° 26223 and N° 26224 (link) with its role most recently updated under Legislative Decree No. 1292 (see above).

To this extent the exploration of oil and gas is subsidized by the government, as its status as state entirety provides a series of fiscal and legislative advantages. As such, the cost of exploration of gas is not reflected in its consumer price. (link)

One such example of the financial incentives received by Petroperu can be seen in the financial structuring of the Talara Refinery, a PetroPeru run entity. In accordance with the Law Nº 30130, the plant has a guarantee from the Peruvian Government for US $ 200 million per year up to a maximum US $ 1,000 million. (link)

Peru's efforts to develop natural gas began to gain traction in 1999 with the enactment of the Law Nº 27133 - Law of Promoting the Development of Natural Gas Industry (described above). This stated the development of the natural gas industry – exploration, production, pipeline transport and distribution to end-user markets – was in the national interest. According to this law, the end goal in developing a natural gas supply chain was to better supply the domestic market with energy.

In November 2010, the Ministry of Energy and Mines officially released Peru's National Energy Policy 2010-2040, reiterating the objective of developing the natural gas sector and its use for domestic, electricity, industry and transportation purposes throughout the country. (link)

Following that, the 'National Energy Plan 2014 - 2025' states that among other incentives, formalities for obtaining permits required by the oil activity should be assessed, redesigning them based on investment promotion for sustainable oil exploration. (link)

Commercial Contracts and Power Purchase Agreements

A PPA (Power Purchase Agreement) is a financing mechanism which allows regular users or free consumers (mines, industries, agricultural users) to utilize the benefits of renewable energy generation without investing in renewable projects (consumers are only buying the electricity). The PPA, as a contractual mechanism, has been used by large energy generators for many years as a method to finance renewable and non-renewable energy assets.

In a PPA, the "Seller" (owner of the property) signs a long-term contract with the "Buyer" that obliges the buyer to pay a predetermined amount for three components

- firm power in US$/kW-month,
- energy during peak hours in US$/MWh
- energy during off-peak hours in US$/MWh

that will be delivered by the renewable energy (hydro, solar, wind, biomass, etc) project. The duration of this contract varies depending on the type of technology used, but is typically between 10 and 20 years. The interest rate of the PPA is either fixed or variable and is determined by a formula based on the consumer price index (PPI), the dollar and inflation.

In Peru, as in other countries, the promoters and developers of renewable energy projects use PPA's to attract private investors to invest in renewable energy. The individual investors determine the value of the PPA based on the type of project, the price of delivered energy, the credit rating of the contractual counterpart, risks associated with the project and other contractual details.

The following factors are considered in the signing of a PPA:

1. **Price of Energy:** Unit of measurement is US$/MWh. There are different prices for energy delivered between 18:30 – 23:30, and energy outside of peak times between 23.31 – 18:29
2. **Price of Power:** Unit of measurement is US$/kW-month, it should be converted to US$/MWh by multiplying by a value of 1.388.

The combination of sum of the price of energy and power in the same units uses a monomic price of US$/MWh.

3. **Price Formula:** Known as scaling or the polynomic formula, this formula allows the prices and tariffs of the contract to be updated over time. Generally, the PPA contracts are indexed to the Consumer Price Index (PPI) or the U.S. consumer price index, Peruvian inflation, the value of the US dollar or the price of natural gas. In some cases, the formula for price updates of PPA's considers the price of fuel in the U.S. In the case of renewable energy contracts won by public auction in Peru, the updating factors considered are the producer price index (PPI) or the WPSSOP3500 (Finished Goods Less Food and Energy) index. The price formula is updated annually if the combination of its components vary

by more than 5%.

4. **Power and Minimum Energy:** This is an important consideration for PPA contracts. If the consumer commits to consuming a determined quantity of energy represented by a load diagram, the generator will impose a limit on the minimum power for the consumer so as not to lead to hardships for the generation company. A minimum power clause of 80% is generally included. Some renewable energy generators offer a lower limit to differentiate themselves from the competition. In the case of RER auctions, there is also a commitment to minimum energy generation by the generation company seeking the concession. If the minimum energy generation is not met, the generation company could be subjected to a reduction in the minimum energy generation commitment or be fined.
5. **Point of Supply:** Also known as the Delivery Bar or the Collection Bar, Point of Supply refers to the location at which the energy generated will be supplied, or collection location when the energy is bought by the buyer. The location is generally a medium or high-voltage energy substation. For RER contracts, the delivery bars are listed and have the capacity to supply electricity to every electrical substation. Each RER project should consider the energy losses between the generation location and the bar of delivery when evaluating the commitments for electricity delivery.

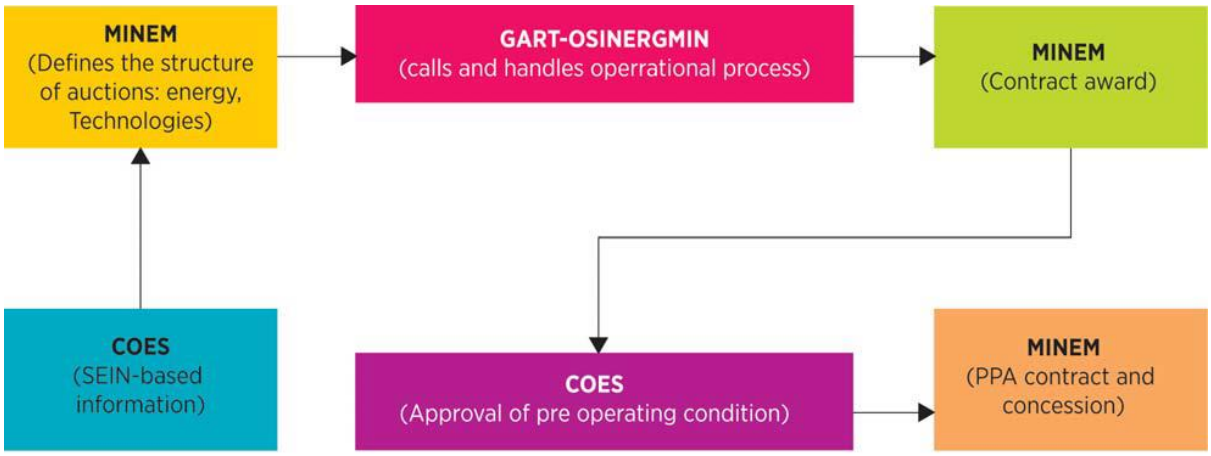
12.0 Renewable Energy Auctions (Grid Connected)

Between 2008 and 2016, Peru conducted four Renewable Energy Auctions, awarding a total of 66 projects, 1,623 MW, and 6,140 GWh/yr in solar, wind, biomass and small hydro generation. Geothermal and tidal technology are also eligible, but have not yet participated in any renewable energy auctions.

Process

The renewable energy auctions are managed by MINEM, OSINERGMIN and COES. The interaction between the three agents is shown in Figure 14 below.

Figure 14: Renewable Energy Auction Design



Source: Peru: Renewables Readiness Assessment 2014, IRENA

For each tender, MINEM determines the total amount of energy (in GWh/yr) to be auctioned, known as the *required energy*. An amount of the total required energy is allocated to each renewable energy technology. The allocated amounts are a result of recommendations from the grid operator, COES, which considers the current infrastructure and the power injection points in the grid.

After the energy requirements are determined, OSINERGMIN establishes an auction committee with representatives from MINEM and COES. The committee sets the maximum energy price, known as the *ceiling price*, for each technology, which is kept confidential.

When the bids have been received, the Auction Committee evaluates the bids based on the offered price of energy (US$/MWh or cents US$/kWh) and the total amount of energy offered (MWh or GWh).

The Auction Committee performs the following steps for each technology to select bids (Mwenechanya, 2013):

1. Bids are sorted by offered price, starting with the lowest. Bids that exceed the maximum price are rejected.
2. If the total energy offered in the bids is less than the required energy, the Committee accepts all bids.
3. If the bids offered exceed the required energy, the Committee may accept partial bids, or call for a second round of the auction.

A diagram illustrating the bid selection process for a sample wind power project is shown in Appendix 7.

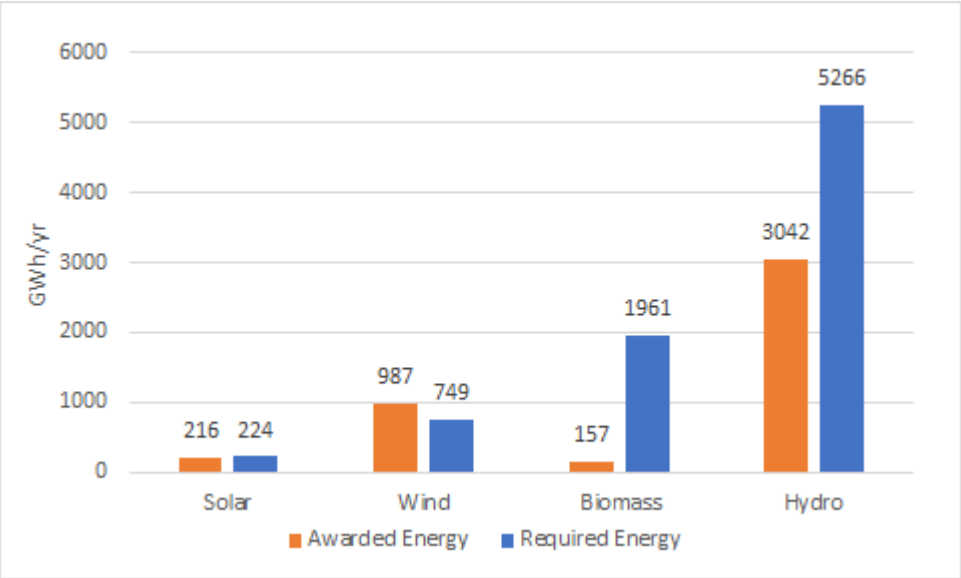
After the bids are selected, PPA contracts are awarded and concessions are granted to the winning projects. Successful projects have a guaranteed annual income. This income is determined by multiplying the bid price or energy tariff (in US$/MWh) by the annual awarded energy (expressed in MWh or GWh) to determine the project's guaranteed annual income.

A typical RER auction in Peru takes about four months from the time that the auction is announced to the signing of project agreements. The stages of the auction are summarized in Appendix 8.

First Three Auctions

Between 2009 and 2013, Peru held three renewable energy auctions. A total of 53 projects and 4,402 GWh/yr were awarded. A summary of the results is shown in Figure 15 below.

Figure 15: Results, Auctions 1-3



Source: Osinergmin, 2015a

In the first three auctions, five projects were awarded for solar PV (216 GWh/yr), four for wind (987 GWh/yr), three for biomass (157 GWh/yr), and forty one for small hydro (3,042 GWh/yr). All solar, wind and biomass projects awarded in the first three auctions are in currently operation. The majority of hydro projects are also in operation, although not all awarded projects were constructed.

Total investments for the first three auctions reached nearly US$2.2 billion, US$1.25 billion for biomass, solar and wind projects, and US$974 million for hydroelectric projects (Osinergmin, 2015a). All solar and wind projects were awarded to international companies, who outbid national companies. The majority of biomass and small hydro projects, however, were won by national companies.

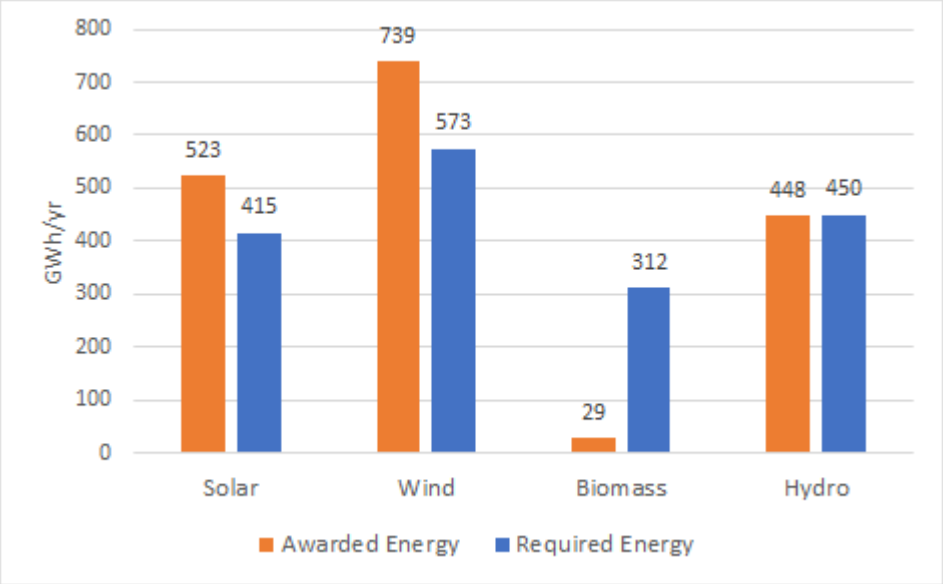
A list of the projects awarded in the first three auctions is provided in Appendix 9.

Fourth Auction

The fourth renewable energy auction took place in 2015. MINEM called for a total of 1750 GWh/yr of energy, distributed by technology as follows: 415 GWh/yr for solar, 573 GWh/yr for wind, 125 GWh/yr for agricultural biomass, 125 GWh/yr for forestry biomass, 62 GWh/yr for urban biomass and 450 GWh/yr for small hydropower.

13 and 430 MW of projects were awarded to supply a total of 1740 GWh of renewable energy per year. The results of the fourth auction are shown in Figure 16 below.

Figure 16: Results, Fourth Auction

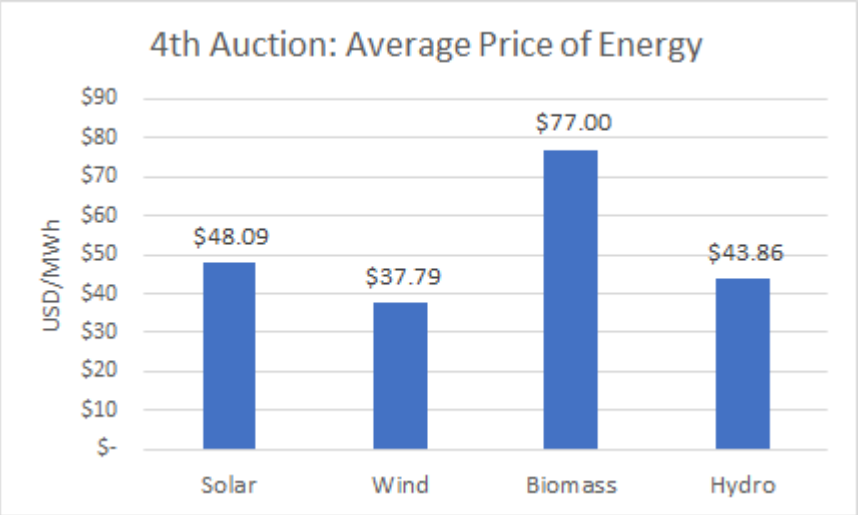


Source: Osinergmin, 2016

Two projects were awarded for solar PV (523 GWh/yr), three for wind (739 GWh/yr), two for urban biomass (29 GWh/yr) and six for small hydro (448 GWh/yr). The percentage of required energy that was awarded for each technology was 126% for solar, 129% for wind, 9% for biomass and 99.6% for hydro.

The average price of energy for awarded projects was US$43.11/MWh, a 24% decrease in price from the third auction. The awarded prices of energy continued to drop significantly for solar and wind, as technology has improved and solar and wind prices have decreased worldwide. Figure 17 below illustrates the average awarded price of energy for each technology.

Figure 17: Average Price of Energy, Fourth Auction



Source: Osinergmin, 2016

The average awarded prices for solar (US$48/MWh) and wind (US$38/MWh) decreased by 60% and 45%, respectively, from the second auction (no solar, wind or biomass projects were awarded in the third auction), while the average awarded price for small hydro (US$43/MWh) decreased by 22% from the third auction. The average awarded price for biomass (US$77/MWh) decreased by 23% from the second auction.

The prices for solar and wind in the fourth auction were the lowest in South America at the time. As a reference, prices contracted in 2015 in Brazil, considered one of the most competitive renewable energy markets in the world, were at the equivalent of US$51/MWh for wind and US$74.7/MWh for solar PV (35% and 55% higher, respectively) (Lee, 2016).

A list of the projects awarded in the fourth auction is provided in Appendix 9.

Auction Trends

Since the first auction in 2009, Peru has contracted a total of 66 projects, 1,263 MW and 6,140 GWh/yr of renewable energy. A summary of the results of Peru's four energy auctions are shown in Table 12 below.

Table 12: Summary of Auction Results

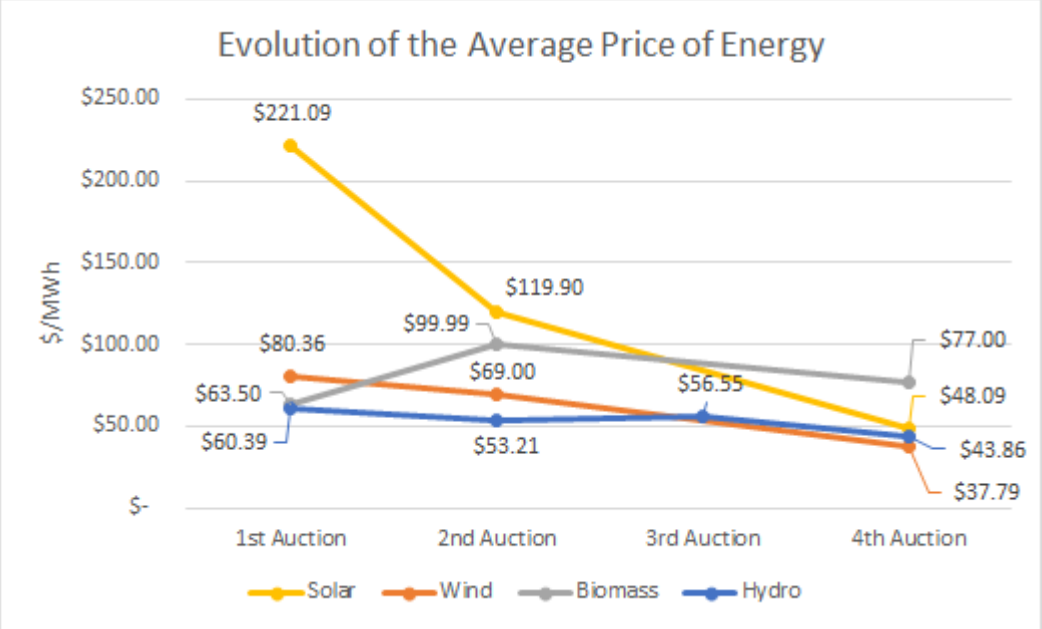
Technology	No. of Projects	Power Awarded (MW)	Energy Awarded (GWh/yr)
Solar	7	281	739
Wind	7	394	1,726
Biomass	5	33	186
Hydro	47	555	3,490
Total	**66**	**1,263**	**6,141**

Source: Osinergmin, 2015a

The majority of awarded projects have been for hydropower, which accounts for 57% of the total energy awarded, in GWh/yr. Wind and solar projects represent 28% and 12% of total awarded energy, respectively, and biomass the remaining 3%.

Between the first auction in 2009 and the final auction in 2015, the average price of energy, especially for solar and wind, has decreased significantly. The trends in the average price of energy by technology are shown in Figure 18 below.

Figure 18: Evolution of the Average Price of Energy, by technology

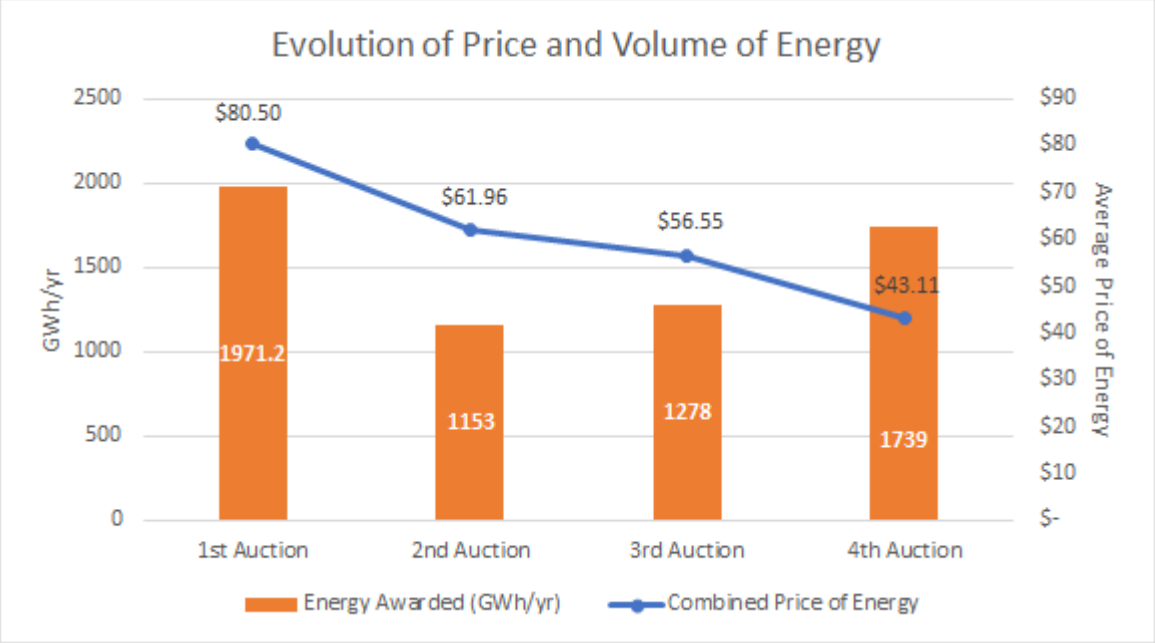


Source: Osinergmin, 2015a

Between the first and fourth auctions, the price of solar has dropped from US$221.09/MWh to US$48.09/MWh, a decrease of 78%. Wind power has also experienced significant price reductions, decreasing from US$80.36/MWh in the first auction to US$37.79/MWh in the fourth auction, a reduction of 53%. Hydropower, a more established technology, experienced a moderate price reduction from US$60.39/MWh to US$43.86/MWh, a decrease of 27%. The price of energy for biomass varies greatly by the type of technology (biogas, bagasse, etc) awarded. As a result, the price of biomass has increased and decreased over the span of four auctions, based on the technology that was awarded in each auction.

The combined average price of renewable energy (an average of the prices of solar, wind, small hydro and biomass) has steadily decreased for each auction. The evolution of the combined average price of energy and the total energy awarded for each auction is shown in Figure 19 below.

Figure 19: Evolution of Combined Price of Energy



Source: Osinergmin, 2015a

Between the first auction in 2009 and fourth auction in 2015, the average combined price of energy has almost halved, decreasing from US$80.50/MWh to US$43.11/MWh, a reduction of 46%. The average decrease in energy price between auctions was 19% .

In the fourth auction, the prices for renewable energy dropped below the prices paid for conventional energy in Peru. The average price paid by regulated users in SEIN was US$57.6/MWh, which is 26% higher than the average price of energy in the fourth renewable energy auction (US$43.11/MWh).

Grid Infrastructure

Peru's current transmission system in the interconnected grid has been optimised for conventional power plants. Currently there is one 220 kV line that connects the Central Zone (Tumbes) with the Southern Zone (Moquegua), and two 220 kV lines that connect the Central Zone with the Northern Zone. There is also one 500 kV line that connects Trujillo in the Northern Zone with Moquegua in South. A new 500 kV transmission line is under construction between the central and south zones, and is expected to be completed in October 2017. Peru also has a 220 kV transmission line connected to Ecuador. A map of Peru's transmission lines is shown in Appendix 10.

Capacity of Renewables in SEIN

A report published by COES in August 2015, entitled the *Study of the Maximum Capacity of Non Conventional Generation (Wind and Solar PV) to be Installed in SEIN (Estudio de la Máxima Capacidad de Generación no convencional (Eólica y Solar Fotovoltaica) a ser instalada en el SEIN),* estimated the maximum amount of solar PV and wind energy that could be installed in SEIN by 2018.

The estimated maximum capacity values are based on the ability of the transmission system to handle additional generation from renewable sources, considering the various constraints on the system (voltage, current, angular displacement, etc.). The findings are summarized in Table 13 below.

Table 13: Grid Capacity for Solar PV and Wind

Technology	Installed Capacity 2017 MW	Expected Capacity 2018 MW	Maximum Capacity 2018 MW
Solar PV	96	240	1076
Wind	233	359	580
Total	329	599	1656

Source: Study of Maximum Capacity of Non conventional Generation, COES, 2015

The third column, Expected Capacity 2018, is based on the projects awarded in the fourth auction that are expected to come online in 2018, the 144.5 MW Rubi Solar PV and the 126 MW Parque Nazca Wind park. Even after the projects form the last auction come online, the electrical grid can still accommodate a higher injection from renewable resources. The Total Expected Capacity, 599 MW, is less than half the Total Maximum Capacity of 1,656 MW. Based on the expected installations for 2018, solar PV will reach 22% of maximum capacity and wind 62% of maximum capacity allowed in SEIN.

A more detailed table with the capacity for each zone (north, central, and south) is shown in Appendix 11.

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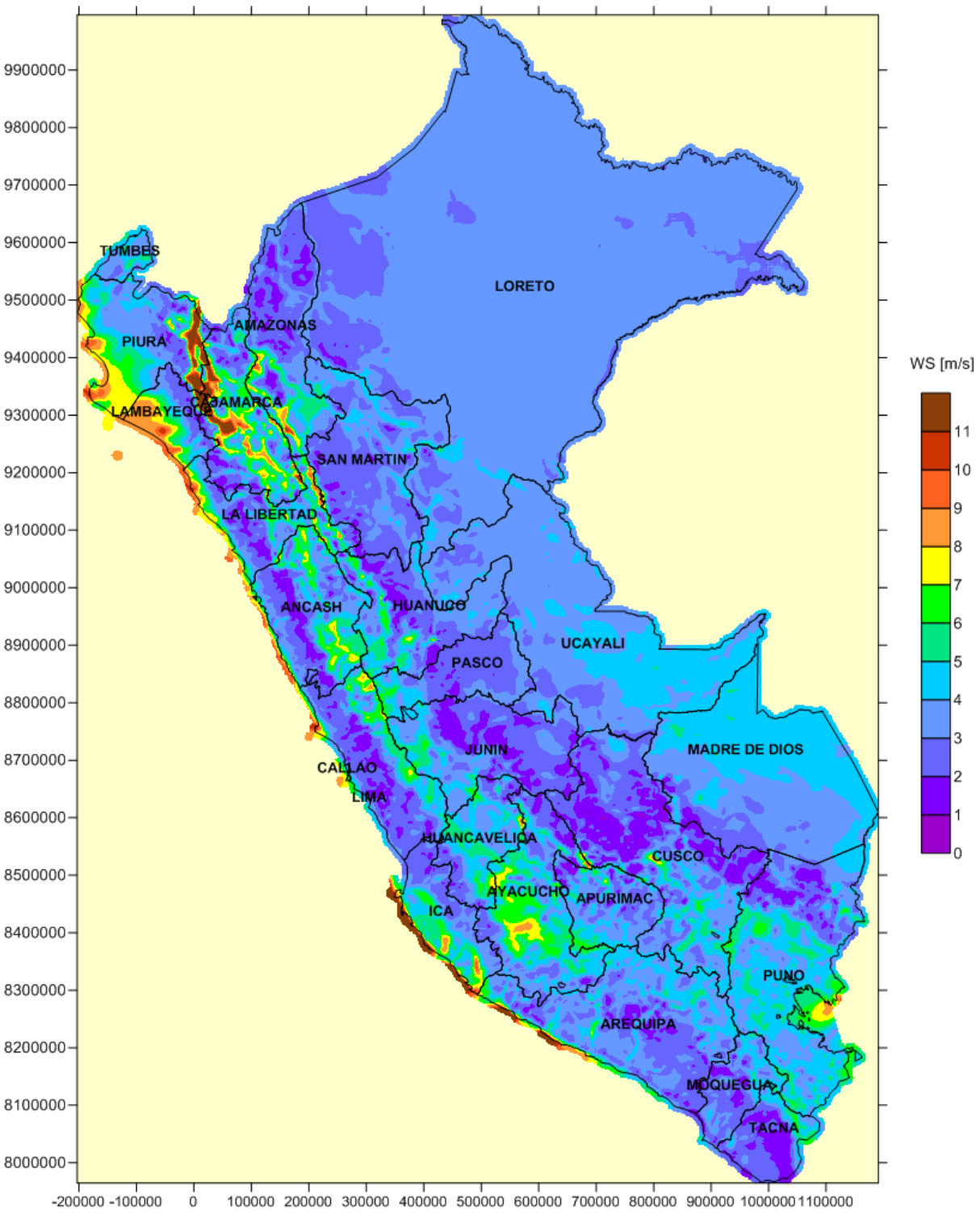
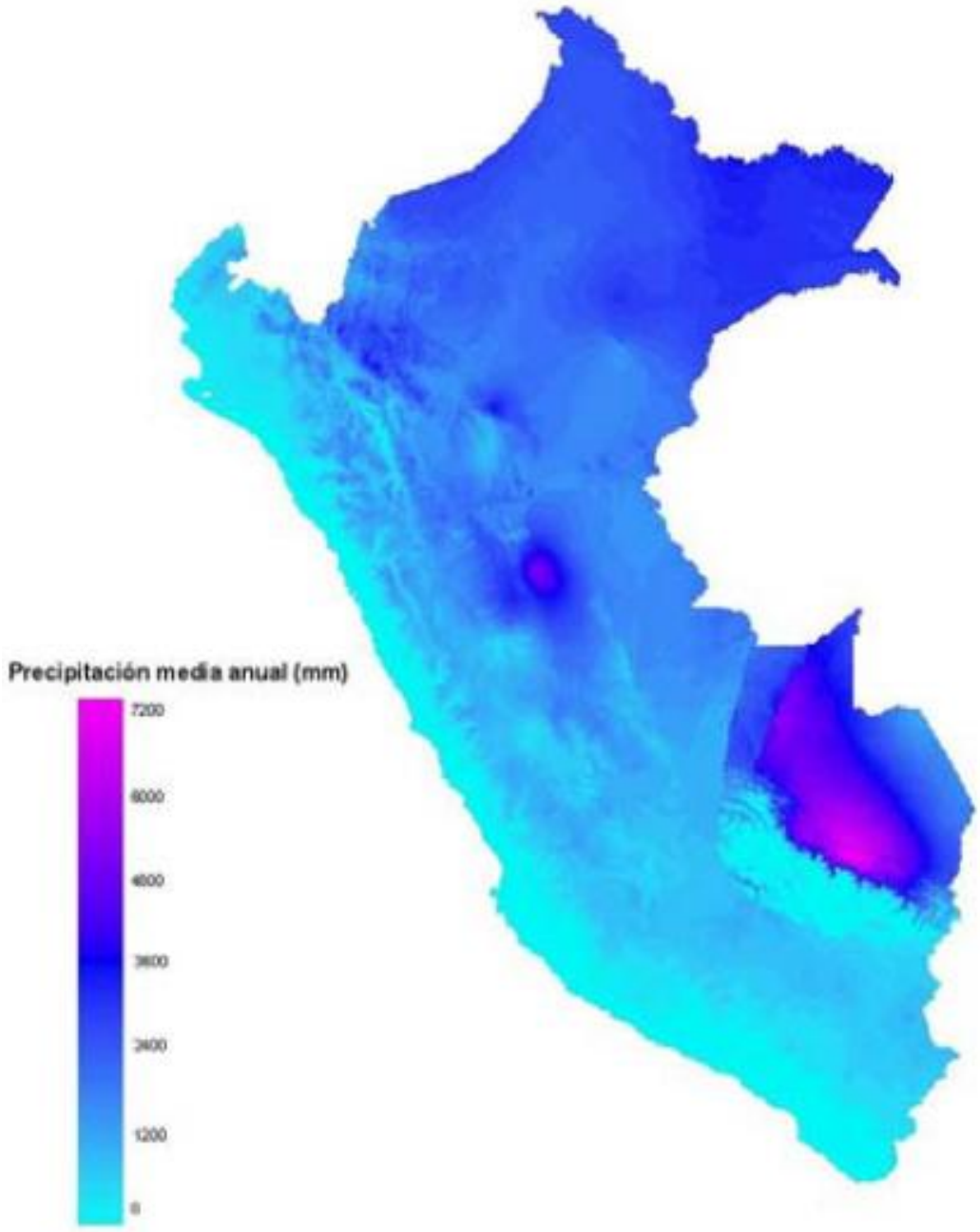
Appendix 1: Global Horizontal Irradiation, kWh/m^2

Appendix 2: Average Annual Wind Speeds at 100m



Source: Wind Atlas for Peru, MINEM, 2016

Appendix 3: Average Annual Precipitation (mm)



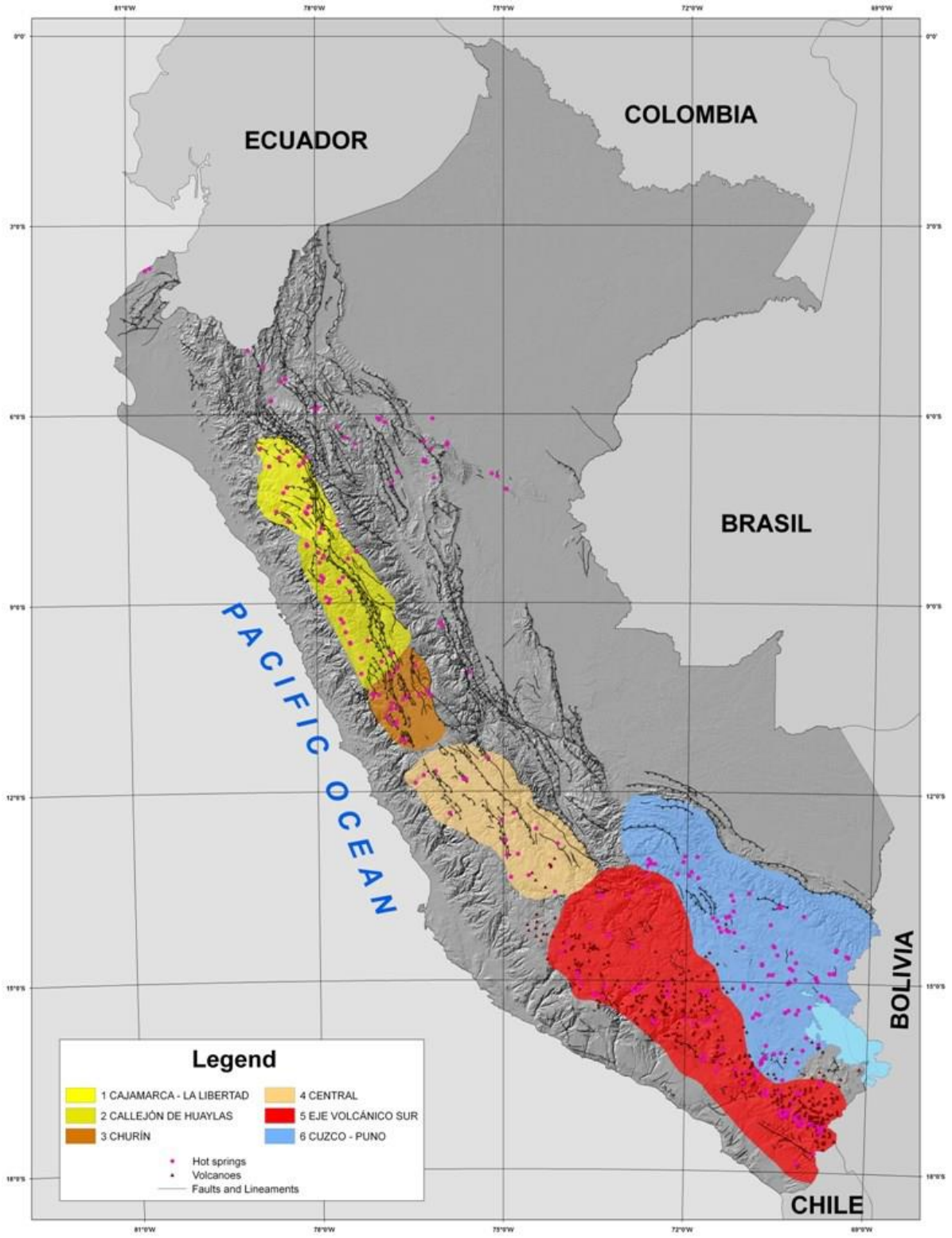
Source: Hydroelectric Potential Atlas for Peru, MINEM 2011

Appendix 4: List of Installed Small Hydroelectric Projects

Project	Developer/ Operator	Region	Capacity MW	Investments million USD	Operational Since
Carhuaquero IV	Duke Energy EGENOR	Cajamarca	10	US$20.3	22.05.2008
Caña Brava	Duke Energy EGENOR	Cajamarca	6.0	US$12.2	19.02.2009
Poechos II	Sinersa	Piura	10	US$20.3	27.05.2009
Santa Cruz I	Hidroelectrica Santa Cruz	Ancash	6	US$12.2	29.05.2009
La Joya	Generadora Energia SAC	Arequipa	9.6	US$19.4	01.10.2009
Santa Cruz II	Hidroelectrica Santa Cruz	Ancash	7.0	US$13.2	01.07.2010
Roncador	Maja	Lima	4.0	US$ 8.2	01.04.2010
Purmacana	Santa Rosa	Lima	2.0	US$ 2.8	18.03.2011
Pias I	Ayepsa	La Libertad	12.6	US$ 27.5	04.01.2012
Huasahuasi I	Hidroelectrica Santa Cruz	Junín	8.0	US$ 17.4	15.02.2012
Nueva Imperial	Hidrocañete	Lima	4	US$ 7.5	20.04.2012
Huasahuasi II	Hidroelectrica Santa Cruz	Junín	8.0	US$ 14.5	05.05.2012
Yanapampa	Yanapampa	Ancash	4.1	US$ 9.0	23.02.2013
Las Pizarras	Rio Doble	Cajamarca	18	US$ 39.6	30.04.2013
Runtanullo III	EGE Junin	Junín	20	US$ 31.1	22.11.2014
Runtanullo II	EGE Junin	Junín	20	US$ 35.6	24.12.2014
Canchayllo	EGE SAC	Junín	5.0	US$ 10.0	31.12.2014
Chancay	Sinersa	Lima	19.2	US$ 49.1	04.08.2016

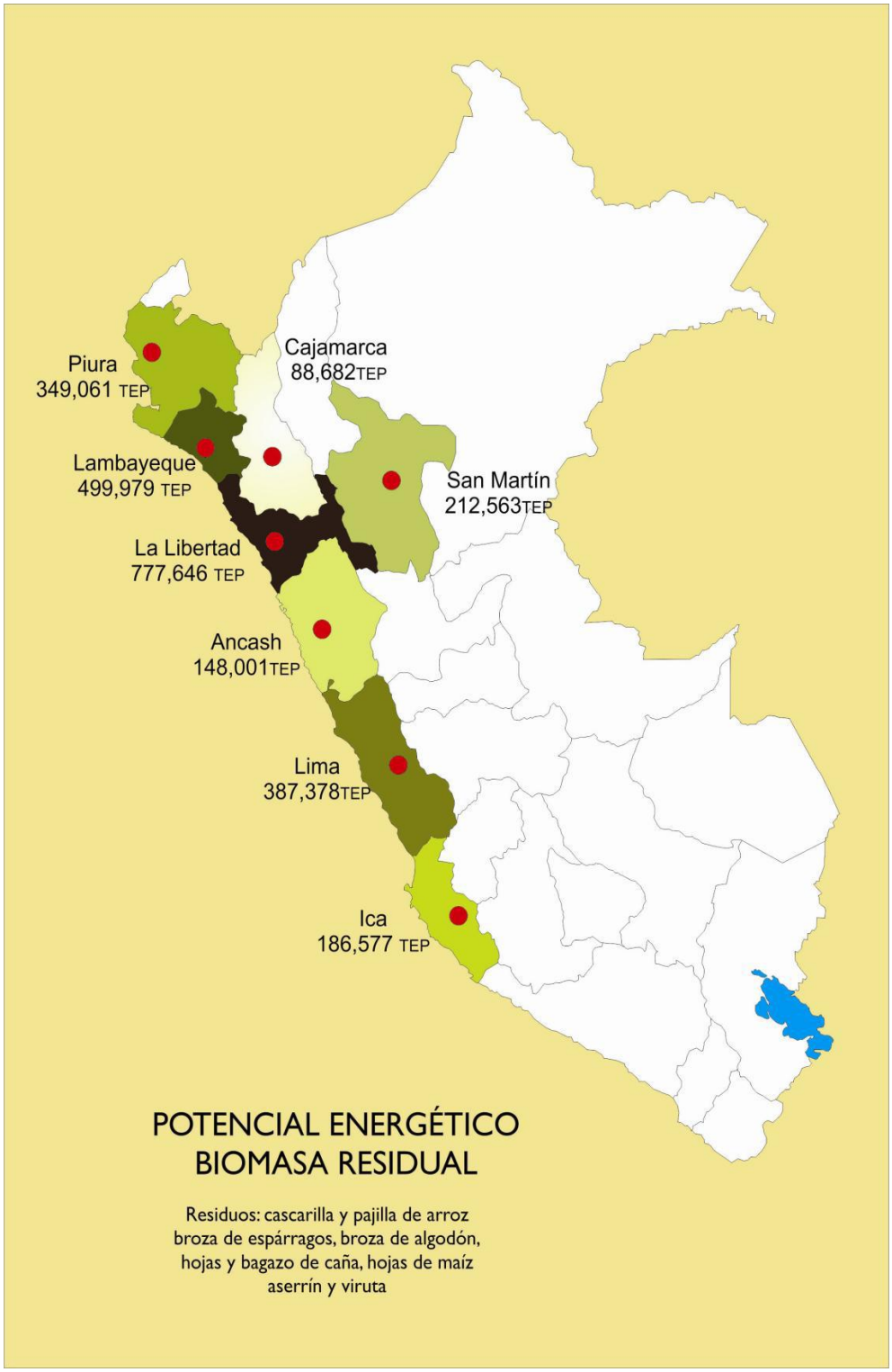
Rucuy	Rio Baños	Lima	20	US$ 42.0	09.08.2016
Potrero	Empresa Electrica Agua Azul	Cajamarca	19.9	US$ 46.0	29.04.2017
Yarucaya	Huaura Power Group	Junín	17.5	US$ 37.2	17.08.2017

Appendix 5: Geothermal Map of Peru



Source: Simplified Map of the Geothermal Regions of Peru, Vargas and Cruz, 2010

Appendix 6: Biomass Potential by Region



Source: Energy Potential of Biomass Residuals in Peru, Assureira and Assureira, 2013

Appendix 7: Major Mining Companies in Peru

Company	Project	Region
Barrick Gold	Lagunas Norte	La Libertad
Buenaventura	Yanacocha (joint owned)	Cajamarca
	Cerro Verde (joint owned)	Arequipa
Doe Run Peru	Cobriza	Huancavelica
Hudbay Peru	Constancia	Cusco
Marcobre (Minsur)	Mina Justa	Ica
Milpo Andina	Atacocha	Pasco
	El Porvenir	Pasco
	Cerro Lindo	Ica
Minera Antamina	Antamina	Ancash
Minera Antapaccay (Glencore)	Antapaccay	Cusco
Minera Atacocha	Atacocha	Pasco
	Santa Barbara	Pasco
Minera Cerro Verde	Cerro Verde	Arequipa
Minero Horizonte	Parcoy, Culebrillas and Untuca	La Libertad
Minera Las Bambas	Las Bambas	Apurímac
Minera Los Quenuales (Glencore Xstrata)	Iscaycruz	Lima
	Yauliyacu	Lima
Minera Miski Mayo (Vale)	Bayóvar	Huánuco
Minera Poderosa	Jimena, Glorita, Choloque and Atahualpa	La Libertad
Minera Raura	San Miguel de Cuari	Huánuco

Newmont Mining	Yanacocha (joint owned)	Cajamarca
	Conga	Cajamarca
Rio Tinto	La Granja	Cajamarca
Shougang Hierro Peru	Marcona	Ica
Southern Peru Copper	Toquepala	Tacna
	Cuajone	Moquegua
	Tia Maria	Arequipa
Volcan	Alpamarca	Junin
	Cerro de Pasco	Pasco
	Chungar	Pasco
	Yauli	Junin

Appendix 8: Power Companies

Participation of Generation Companies in the National Electrical Grid, First Semester 2016

No.	Generation Company	Market Share
1	ENGIE ENERGÍA PERÚ S.A (EX ENERSUR S.A)	21.25%
2	EDEGEL S.A.A	16.02%
3	ELECTRICIDAD DEL PERÚ S.A - ELECTROPERÚ S.A	11.42%
4	KALLPA GENERACIÓN S.A	9.77%
5	FÉNIX POWER PERÚ S.A.	5.50%
6	DUKE ENERGY EGENOR S. EN C. POR A.	4.18%
7	STATKRAFT PERÚ SA	3.90%
8	EMPRESA DE GENERACIÓN ELÉCTRICA AREQUIPA S.A - EGASA	2.77%
9	TERMOCHILCA S.A	2.49%
10	TERMOSELVA S.R.L	2.38%
11	COMPAÑÍA ELÉCTRICA EL PLATANAL S.A - CELEPSA	2.31%
12	EMPRESA ELÉCTRICA DE PIURA S.A - EEP S.A	1.75%
13	CHINANGO S.A.C	1.71%
14	ENERGÍA EÓLICA S.A	1.63%
15	EMPRESA CONCESIONARIA DE ELECTRICIDAD DE UCAYALI S.A - ELECTRO UCAYALI S.A	1.51%
16	EMPRESA DE GENERACIÓN HUANZA S.A.	1.44%
17	EMPRESA DE GENERACIÓN ELÉCTRICA MACHUPICCHU S.A - EGEMSA	1.24%
18	EMPRESA DE GENERACIÓN ELÉCTRICA SAN GABÁN S.A - SAN GABÁN	1.18%
19	SHOUGANG GENERACIÓN ELÉCTRICA S.A.A - SHOUGESA	0.89%
20	LUZ DEL SUR S.A.A	0.88%
21	PLANTA DE RESERVA FRÍA DE GENERACIÓN DE ETEN S.A - PLANTA ETEN	0.85%
22	SDF ENERGÍA S.A.C	0.69%
23	EMPRESA DE GENERACIÓN ELÉCTRICA DEL SUR S.A - EGESUR	0.56%

24	SAMAY I S.A.	0.34%
25	SINDICATO ENERGÉTICO S.A - SINERSA	0.34%
26	PANAMERICANA SOLAR S.A.C	0.32%
27	PARQUE EÓLICO MARCONA S.A.C	0.30%
28	ELÉCTRICA SANTA ROSA S.A.C	0.29%
29	HIDROELÉCTRICA HUANCHOR S.A.C	0.28%
30	GTS MAJES S.A.C	0.27%
31	GTS REPARTICIÓN S.A.C	0.27%
32	EMPRESA ELÉCTRICA RÍO DOBLE S.A - ERD	0.19%
33	AGRO INDUSTRIAL PARAMONGA S.A.A	0.14%
34	EMPRESA DE GENERACIÓN ELÉCTRICA DE JUNÍN S.A.C	0.14%
35	SDE PIURA S.A.C	0.11%
36	PETRAMÁS S.A.C	0.10%
37	GENERADORA DE ENERGÍA DEL PERÚ S.A - GEPSA ENERGÍA	0.09%
38	HIDROELÉCTRICA SANTA CRUZ S.A.C	0.09%
39	AGUAS Y ENERGÍA PERÚ S.A	0.08%
40	TACNA SOLAR S.A.C	0.05%
41	HIDROCAÑETE S.A	0.05%
42	EMPRESA DE GENERACIÓN ELÉCTRICA CANCHAYLLO S.A.C - EGECSAC	0.04%
43	ELÉCTRICA YANAPAMPA S.A.C	0.04%
44	MAJA ENERGÍA S.A.C	0.03%
45	EMPRESA CONCESIONARIA ENERGÍA LIMPIA S.A.C	0.03%
46	MOQUEGUA FV S.A.C	0.03%
47	SOCIEDAD MINERA CERRO VERDE S.A.A	0.03%
48	PROYECTO ESPECIAL CHAVIMOCHIC	0.02%
49	EMPRESA DE INTERÉS LOCAL HIDROELÉCTRICA CHACAS S.A - EILHICHA S.A	0.01%

Participation of Transmission Companies in the National Electrical Grid, First Semester 2016

No.	Transmission Company	Market Share
1	CONSORCIO TRANSMANTARO S.A	34.94%
2	RED DE ENERGÍA DEL PERÚ S.A - REP	32.05%
3	ABY TRANSMISIÓN SUR S.A	13.43%
4	ATN S.A	5.67%
5	RED ELÉCTRICA DEL SUR S.A - REDESUR	3.85%
6	INTERCONEXIÓN ELÉCTRICA ISA PERÚ S.A	3.20%
7	ETESELVA S.R.L	1.95%
8	TRANSMISORA ELÉCTRICA DEL SUR S.A - TESUR S.A	1.82%
9	ETENORTE S.R.L	1.30%
10	EMPRESA DE TRANSMISIÓN CALLALLI S.A.C	0.44%
11	POMACOCHA POWER S.A.C	0.38%
12	CONSORCIO ENERGÉTICO DE HUANCAVELICA S.A - CONENHUA	0.33%
13	EMPRESA DE TRANSMISIÓN GUADALUPE S.A.C	0.22%
14	PROYECTO ESPECIAL OLMOS TINAJONES - PEOT	0.22%
15	COMPAÑÍA TRANSMISORA NORPERUANA S.R.L	0.20%

Participation of Distribution Companies in the National Electrical Grid, First Semester 2016

No.	Distribution Company	Market Share
1	LUZ DEL SUR S.A.A	28.72%
2	EMPRESA DE DISTRIBUCIÓN ELÉCTRICA DE LIMA NORTE S.A.A - EDELNOR S.A.A	27.30%
3	EMPRESA REGIONAL DE SERVICIO PÚBLICO DE ELECTRICIDAD ELECTRONORTEMEDIO S.A - HIDRANDINA S.A	8.74%
4	ELECTRONOROESTE S.A - ENOSA	6.10%
5	ELECTROCENTRO S.A	4.84%
6	SOCIEDAD ELÉCTRICA DEL SUR OESTE S.A - SEAL	4.68%
7	EMPRESA DE SERVICIO PÚBLICO DE ELECTRICIDAD DEL NORTE S.A. - ELECTRONORTE S.A	3.84%
8	ELECTRO DUNAS S.A.A	3.69%
9	ELECTRO SUR ESTE S.A.A	3.54%
10	ELECTRO ORIENTE S.A	3.30%
11	ELECTROSUR S.A	1.67%
12	EMPRESA CONCESIONARIA DE ELECTRICIDAD DE UCAYALI S.A - ELECTRO UCAYALI S.A	1.42%
13	CONSORCIO ELÉCTRICO VILLACURI S.A.C - COELVISAC	1.25%
14	ELECTRO PUNO S.A.A	0.27%
15	EMPRESA DE ADMINISTRACIÓN DE INFRAESTRUCTURA ELÉCTRICA S.A - ADINELSA	0.23%
16	EMPRESA MUNICIPAL DE SERVICIOS ELÉCTRICOS DE TOCACHE S.A - ELECTRO TOCACHE	0.21%
17	EMPRESA MUNICIPAL DE SERVICIOS ELÉCTRICOS DE UTCUBAMBA S.A.C - EMSEU	0.09%
18	SERVICIOS ELÉCTRICOS RIOJA S.A - SERSA	0.07%
19	ELECTROPANGOA S.A - EPASA	0.02%
20	EMPRESA DE SERVICIOS ELÉCTRICOS MUNICIPAL DE PATIVILCA S.A.C - ESEMPAT	0.01%

21	EMPRESA DE SERVICIOS ELÉCTRICOS MUNICIPALES DE PARAMONGA S.A - EMSEMSA	0.01%
22	EMPRESA DISTRIBUIDORA Y COMERCIALIZADORA DE ELECTRICIDAD SAN RAMÓN DE PANGOA S.A - EDELSA	0.01%

Appendix 9: Annual Natural Gas Electricity Production

Natural Gas Energy Production ordered by plant and operator in 2016

Operator	Plant	Production GWh
AIPSAA	C.T. PARAMONGA	86
	Total	86
AURORA	C.T. MAPLE ETANOL	0.5
	Total	0.5
CERRO VERDE	C.T. RECKA	24.3
	Total	24.3
EDEGEL (2)	C.T. SANTA ROSA	796.8
	C.T. VENTANILLA	2 533.0
	Total	3 329.8
EEPSA (2)	C.T. MALACAS	554.5
	C.T. RESERVA FRÍA DE GENERACIÓN PLANTA TALARA	26.8
	Total	581.3
EGASA	C.T. CHILINA	28
	C.T. MOLLENDO	25.3
	C.T. PISCO	539.9
	Total	593.1
ECELIM	C.TB. LA GRINGA V	19.9
	Total	19.9
EGESUR	C.T. INDEPENDENCIA	139.9
	Total	139.9
ELECTROPERÚ	C.T. TUMBES	3.2
	Total	3.2
ENEL GENERACIÓN	C.T. SANTA ROSA	156.6
	C.T. VENTANILLA	458.4
	Total	615
ENEL PIURA	C.T. MALACAS	97.1
	C.T. RESERVA FRÍA DE GENERACIÓN PLANTA TALARA	1.1
	Total	98.2
ENERSUR (1)	C.T. CHILCA 1	1 034.2
	C.T. ILO1	73.4
	C.T. ILO2	125.8
	C.T. RESERVA FRÍA DE GENERACIÓN PLANTA ILO	38.2
	Total	1 271.7
ENGIE	C.T. CHILCA 1	4 638.2
	C.T. CHILCA 2 (6) (18)	170.5
	C.T. ILO1	136.4
	C.T. ILO2	647
	C.T. RF PLANTA ILO	61.7
	C.T. NODO ENERGÉTICO PLANTA ILO (NEPI) (17)	29.3
	Total	5 683.2
FÉNIX POWER	C.T. FÉNIX	3 581.8
	Total	3 581.8
INFRAESTRUCTURAS Y ENERGÍAS DEL PERÚ	C.T. RESERVA FRÍA PUERTO MALDONADO (9)	0.3
	C.T. RESERVA FRÍA PUCALLPA (8)	2.5
	Total	2.8

KALLPA	C.T. KALLPA	5 695.5
	C.T. LAS FLORES	319.3
	Total	6 014.8
PETRAMAS	C.TB. HUAYCOLORO	31.3
	Total	31.3
PLANTA ETEN	C.T. RESERVA FRIA DE GENERACION ETEN	7.7
	Total	7.7
SAMAY	C.T. PUERTO BRAVO (7)	136.1
	Total	136.1
SAN GABÁN	C.T. TAPARACHI	1.4
	Total	1.4
SDE ENERGÍA	C.T. TABLAZO	112.5
	Total	112.5
SDF ENERGÍA	C.T. OQUENDO	198.7
	Total	198.7
SHOUGESA	C.T. SAN NICOLÁS	13.3
	Total	13.3
TERMOCHILCA	C.T. SANTO DOMINGO DE LOS OLLEROS	1 105.8
	Total	1 105.8
TERMOSELVA	C.T. AGUAYTIA	368.5
	Total	368.5
TOTAL		24 020.8

(1) From 29.03.2016 the company ENERSUR S.A. changed its public name to ENGIE ENERGÍA PERÚ S.A..
(2) From 09.11.2016 the company EDEGEL S.A.A. changed its public name to ENEL GENERACIÓN PERÚ S.A.A.
(6) The start of commercial operation of the unit TG41 of the plant C.T. Chilca 2 was at 00:00 on the 06.05.2016 (COES/D/DP-502-2016)
(7) The start of commercial operation of C.T. Puerto Bravo was at 00:00 on 26.05.2016 (COES/D/DP-570-2015)
(8) The start of commercial operation of C.T. Reserva Fría de Generación - Planta Pucallpa was at 00:00 on the 28.07.2016 (COES/D/DP-807-2016)
(9) The start of commercial operation of C.T. Reserva Fría de Generación - Planta Puerto Maldonado was at 00:00 on the 28.07.2016 (COES/D/DP-808-2016)
(17) The start of commercial operation of C.T. Nodo Energético Planta Ilo (NEPI) was at 00:00 on the 22.10.2016 (COES/D/DP-1093-2016)
(18) The start of commercial operation of the combined cycle at C.T. Chilca 2 was at 00:00 on the 16.12.2016 (COES/D/DP-1285-2016)
Source: Source: Annual Operation Report 2016 SEIN, COES SINAC

Appendix 10: Electricity Production, Fuel Consumption and Efficiency for Natural Gas Plant Operators in 2016

Operator	Plants	Production GWh	Participation %	Consumption Millions of m3	Participation %	Efficiency kWh/m3
Kallpa	C.T. Kallpa, C.T. Las Flores	6,014.80	26.79	1,135.60	24.21	5,296.77
Engie (previously called Enersur)	Chilca 1&2, Ilo1&2, Planta Ilo, Nepi	5,842.90	26.02	1,113.50	23.74	5,247.40
Enel Generación Perú S.A.A. (previously called Edegel)	C.T. Santa Rosa, C.T. Vetanilla	3,897.70	17.36	849	18.1	4,591.16
Fénix Power	C.T. Fénix	3,581.80	15.95	638.9	13.62	5,605.76
Termochilca	C.T. Santo Domingo De Los Olleros	1,105.80	4.92	305.7	6.52	3,617.11
ENEL PIURA	C.T. Malacas C.T., Reserva Fría De Generación, Planta Talara	651.7	2.9	209.1	4.46	3,116.52
EGASA	C.T. Chilina C.T., Mollendo, C.T. Pisco	539.9	2.4	176.8	3.77	3,053.64
TERMOSELVA	C.T. Aguaytia	368.5	1.64	130.2	2.78	2,829.76

SDF ENERGÍA	C.T. Oquendo	198.6	0.88	58.3	1.24	3,409.44
EGESUR	C.T. Independencia	139.9	0.62	33	0.7	4,233.80
SDE PIURA	C.T. Tablazo	112.5	0.5	39.7	0.85	2,830.30
Total		**22,454.10**	**100**	**4,689.80**	**100**	

Source: Annual Operation Report 2016 SEIN, COES SINAC

Appendix 11: National Energy Efficiency Scores

A report conducted by The World Bank in 2016, *Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers*, compared energy efficiency measures in various countries and gave each country an energy efficiency score using the following indicators:

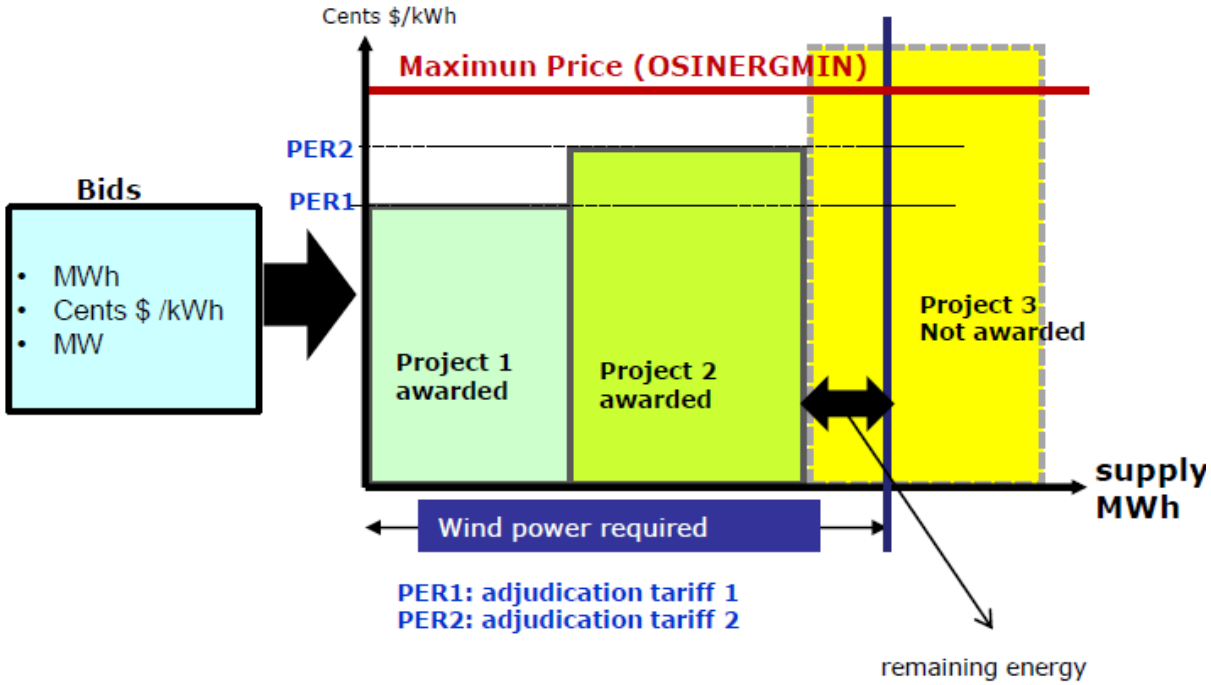
1. National energy efficiency planning
2. Energy efficiency entities
3. Information provided to electricity consumers
4. Incentives from electricity rate structures
5. Incentives and mandates: large consumers
6. Incentives and mandates: public sector
7. Incentives and mandates: utilities
8. **Financing mechanisms for energy efficiency**
9. Minimum energy efficiency performance standards
10. **Energy labeling systems**
11. **Building energy codes**
12. **Carbon pricing and monitoring**

Country	Mean	Indicators											
		1	2	3	4	5	6	7	8	9	10	11	12
Peru	**31**	75	57	67	48	33	50	4	0	42	0	0	0
Bolivia	**37**	33	71	57	56	22	0	50	83	17	50	0	0
Colombia	**51**	92	86	63	37	78	0	17	92	42	83	20	0
Ecuador	**55**	67	86	63	67	61	25	71	83	67	67	0	0
Mexico	**78**	67	100	58	81	100	75	88	83	94	83	37	74
Netherlands	**76**	100	100	94	67	89	88	0	100	83	50	73	73

≥67 33<x<67 ≤33

Source: Regulatory Indicators for Sustainable Energy, The World Bank 2016

Appendix 12: Bid Selection Process



Source: Renewable Energy in Peru, Molinelli, Osinergmin, Presentation 2011

Appendix 13: Sample RER Auction Schedule

Step	Activity	Actor
1	Announcement of Auction	MINEM
2	Approval of Bidding	MINEM
3	Call for Bids	Osinergmin
4	Registration and sale of bidding documents	Osinergmin
5	Questions and Comments by Participants	Participants
6	Publication of Final Bidding Documents	MINEM
7	Submission of Bids	Participants
8	Evaluation of Technical Proposals	Committee
9	Publication of List of Bidders	Committee
10	Awarding of Contracts	Committee
11	Signing of Agreements	MINEM+Winners

Source: Renewable Energy in Peru, Molinelli, Osinergmin, Presentation 2011

Appendix 14: RER Auctions Projects

1st Auction: Solar, Wind and Biomass Projects

Technology	Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Energy awarded (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Biomass	Agro Industrial Paramonga	**Paramonga1 ***	5.20	23.0	57.0	115.0	31.0	31.03.2010
Biomass	PETRAMAS S.A.C.	**Huaycoloro**	11.00	4.0	73.0	28.3	10.5	06.12.2011
Wind	PARQUE EÓLICO MARCONA S.R.L. (COBRA PERÚ)	**Marcona**	6.56	32.0	53.0	148.4	61.1	21.03.2014
Wind	ENERGIA EOLICA S.A.	**Talara****	8.70	30.0	46.0	119.7	101.0	03.09.2014
Wind	ENERGIA EOLICA S.A.	**Cupisnique*** **	8.50	80.0	43.0	302.0	242.0	03.09.2014
Solar	Solarpack	**Panamericana^**	21.50	20.0	28.9	51.0	94.6	31.12.2012
Solar	T-Solar	**Majes Solar^^**	22.25	20.0	21.5	37.6	73.6	31.10.2012
Solar	T-Solar	**20T Solar^^^**	22.30	20.0	21.4	37.4	73.5	31.10.2012
Solar	Solarpack	**Tacna Solar 20T**	22.50	20.0	26.9	47.2	94.6	31.10.2012

**Paramonga 1 Cogeneration Power Plant / **Talara Power Station / ** Cupisnique Wind Power Station*

^Panamericana Solar / ^^Majes Solar 20T / ^^^20T Solar Distribution

1st Auction: Hydroelectric Projects

Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Energy awarded (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Hidroeléctrica Santa Cruz S.A.C	Santa Cruz I	5.5	6.00	65	29.5	12.2	29.05.2009

Hidroeléctrica Santa Cruz S.A.C	Santa Cruz II	5.5	6.50	66	33.0	13.2	01.07.2010
Hidrocañete S.A.	Nueva Imperial	5.6	3.97	81.4	25.0	7.5	20.04.2012
Eléctrica Yanapampa S.A.C	Yanapampa	5.6	4.13	77.4	28.0	9.0	23.02.2013
Hidroeléctrica Santa Cruz S.A.C.	Huasahuasi II	5.7	8.00	70.5	42.5	14.5	05.05.2012
Hidroeléctrica Santa Cruz S.A.C.	Huasahuasi I	5.8	7.86	70	42.5	17.4	18.04.2012
SINERSA	Chancay	5.9	19.20	85	143.0	36.2	31.12.2015
Sindicato Energético S.A	Poechos II	5.9	10.00	75	50.0	20.3	27.05.2009
Maja Energía S.A.C.	Roncador I	6.0	2.0	88.9	14.1	4.1	01.04.2010
Maja Energía S.A.C.	Roncador II	6.0	2.0	88.9	14.1	4.1	11.12.2010
Generadora de Energía S.A.C	La Joya	6.0	9.60	65	54.7	19.4	01.10.2009
Generadora de Energía del Perú	Angel I	6.0	19.95	75	131.0	23.1	31.12.2017
Generadora de Energía del Perú	Angel II	6.0	19.95	75	131.0	21.5	31.12.2017
Generadora de Energía del Perú	Angel III	6.0	19.95	75	131.0	25.1	31.12.2017
Eléctrica Santa Rosa S.A.C	Pumacana	6.0	1.80	71.3	9.0	2.8	18.03.2011
Hidro Energía SAC	Shima	6.4	5.00	75	32.9	N/A	30.09.2012
Duke Energy Egenor	Carhuaquero IV	7.0	10.00	76	66.5	20.3	22.05.2008
Duke Energy Egenor	Caña Brava	7.0	6.00	41	21.5	12.2	19.02.2009

Eléctrica Río Doble S.A.	Las Pizarras	6.4	18.00	67	85.0	39.6	30.04.2013

2nd Auction: Solar, Wind and Biomass Projects

Technology	Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Energy awarded (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Biomass	Consorcio Energía Limpia	**La Gringa V**	10.0	2.0	8.0	14.0	5.1	29.06.2015
Wind	Consorcio Tres Hermanas - Cobra Perú S.A	**Tres Hermanas***	8.9	90.0	52.0	415.8	185.7	31.12.2015
Solar	Moquegua FV SAC	**Moquega FV**	11.99	16.0	30.5	43.0	43.0	31.12.2014

2nd Auction: Hydroelectric Projects

Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Annual energy (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Aldana Contratistas*	Canchayllo	4.74	3.73	77	25.16	10.0	31.12.2014
Arsac Contratistas**	Huatziroki I	4.76	11.08	75	72.27	23.2	04.03.2016
Peruanas Renovables^	Manta	5.20	19.78	74	127.50	18.4	-
Renovables de los Andes	RenovAndes H1	5.39	19.99	90	150.00	54.3	31.10.2016
Andes Corporating Generation	8 de Agosto	5.39	19.00	90	140.00	46.0	15.02.2016
Andes Corporating Generation	El carmen	5.59	8.40	76	45.00	27.0	15.02.2016
Empresa de Generación Junín	Runatullu III	5.65	20.00	80	120.00	31.1	22.11.2014

3rd Auction: Hydroelectric Projects

Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Annual energy (GWh/year)	Estimated investment (USDm)	Date for commercial start-up
Huaura Power Group S.A.	Yarucaya	5.05	16.50	115.0	32.7	31.12.2016
Empresa electrica Agua Azul S.A.	Potrero	5.18	19.90	134.2	47.8	31.12.2016
International Business and Trade LLC Sucursal del Perú	Hydrika 5	5.39	10.00	57.9	21.9	17.01.2018
International Business and Trade LLC Sucursal del Perú	Hydrika 3	5.39	10.00	50.8	30.6	21.06.2018
International Business and Trade LLC Sucursal del Perú	Hydrika 2	5.45	4.00	20.0	8.2	06.02.2018
Andean Power S.A.	Carhuac	5.48	20.0	97.0	30.0	07.11.2018
International Business and Trade LLC Sucursal del Perú	Hydrika 1	5.49	6.60	35.6	22.4	01.07.2018
International Business and Trade LLC Sucursal del Perú	Hydrika 4	5.55	8.00	44,8	18.6	02.06.2018
Empresa de Generación Junín	Runatullu II	5.59	19.00	80.0	35.6	24.12.2014
Hidroélectrica Karpa S.A.C.	Karpa	5.57	19.00	115.0	53.8	23.12.2016
Empresa de Generación Eléctrica Canchayllo	Colca	5.69	12.05	70.2	26.5	16.12.2018

S.A.C.						
Eléctrico Zaña S.A.C.	Zaña 1	5.75	13.20	80.9	32.3	29.12.2018
Empresa de Generación Eléctrica Canchayllo S.A.C.	Chilcay		12.01			
Empresa de Generación Eléctrica Canchayllo S.A.C.	Huasicancha		6.25			
Hidroélectrica Laguna Azul S.R.L.	Laguna Azul	6.20	20.00	130.0	60.0	12.12.2018
Nueva Esperanza Energy S.A.C.	Chaupiyacu		11,70			
Empresa de Generación Eléctrica Santa Lorenza S.A.C.	Santa Lorenza I	6.48	18.70	140.0	41.7	31.12.2017

4th Auction: Solar, Wind and Biomass Projects

Technology	Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Energy awarded (GWh/year)	Estimated investment (USDm)	Provisional date for commercial start-up
Biomass	Empresa Concesionaria Energía Limpia S.A.C.	**CT Callao**	77.00	2.00	83	14.50	-	31.12.2020
Biomass	Empresa Concesionaria Energía Limpia S.A.C.	**CT Huaycoloro II**	77.00	2.00	83	14.50	-	31.12.2020
Wind	Enel Green Power Perú S.A	**CE Parque Nazca**	37.83	126.00	52	573.00	-	31.03.2018
Wind	GR Paino S.A.C.	**PE Huambos**	36.84	18.00	54	84.60	-	31.12.2020
Wind	GR Taruca S.A.C	**PE Duna**	37.79	18.00	51	81.00	-	31.12.2020

Solar	Enel Green Power Perú S.A.	**CS Rubi**	47.98	144.48	33	415.00	-	31.03.2018
Solar	Enersur	**Intipampa**	48.50	40.00	31	108.40	-	31.12.2020

4th Auction: Hydroelectric Projects

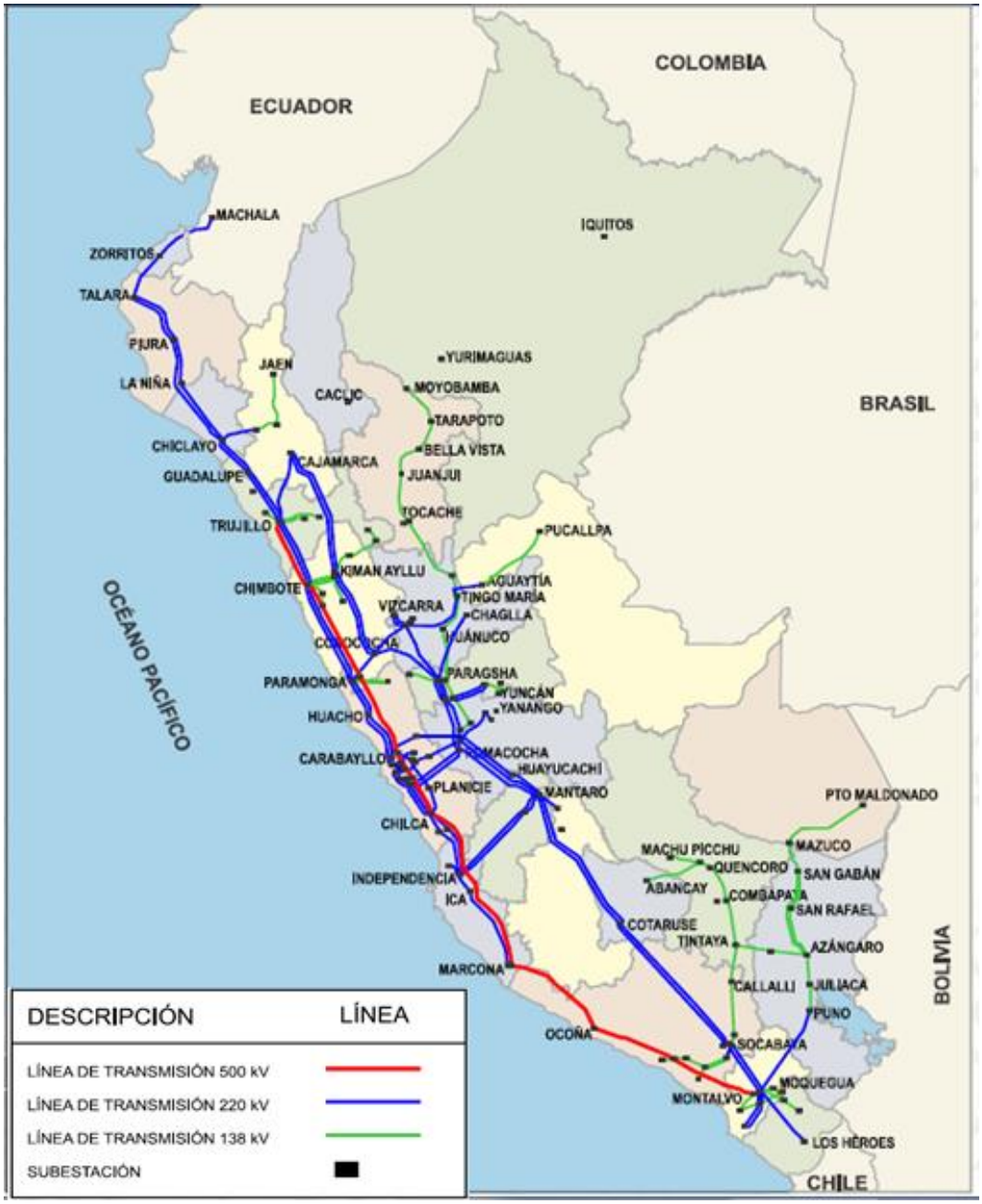
Bidder	Project	Price offered (cts USD/kwh)	Power to be installed (MW)	Plant factor (%)	Annual energy (GWh/year)	Estimated investment (USDm)	Provisional date for commercial start-up
Empresa de generación eléctrica río baños S.A.C.	**Rucuy**	40.00	20.00	63.00	110.0	-	31.12.2020
Enel Green Power Perú S.A.	**Ayanunga**	43.98	20.00	75.00	131.65	-	31.12.2018
Consorcio hidroélectrico Sur Medio	**Kusa**	45.40	15.55	53.00	72.53	-	31.12.2020
Consorcio hidroélectrico Sur Medio	**Alli**	45.40	14.51	55.00	69.32	-	31.12.2020
Consorcio Hydrika 6	**Hydrika 6**	45.90	8.90	77.00	60.00	-	31.12.2020
Edegel S.A.A.	**Her 1**	58.20	0.70	76.00	4.66	-	31.12.2020

Sources:

Concession contracts for the supply of energy with renewable energy resources- Auctions, Osinergmin, 2015

Notarized Minutes of Awards, Fourth Auction, Osinergmin 2016

Appendix 15: Map of Transmission Lines



Source: Opportunities for Renewables in Electricity and Heat Supply for the Peruvian Industry Sector, Estela, Presentation 2016

Appendix 16: Capacity in SEIN for Renewables

Region	Site	Voltage kV	Capacity Allowed MW	Total Capacity Per Area MW	Total Capacity in SEIN MW
North	Zorritos	220	150	**720**	**1656**
	Talara	220	430		
	Pariñas	220	230		
	Piura Oeste	220	540		
	La Niña	220	600		
	Chiclayo Oeste	220	500		
	Felam	220	270		
	Guadalupe	220	550		
	Cupisnique	220	340		
Central	Huacho	220	350	**332**	
	Ica	220	150		
	Marcona	220	300		
	Tres Hermanas	220	12		
	Ocoña	500	500		
South	San Jose	500	500	**604**	
	Montalvo	500	500		
	Socabaya	220	340		
	Santuario	138	140		
	Reparticion	138	85		
	Majes	138	80		
	Toquepala	138	0		

	Aricota 2	138	0		
	Camaná	138	90		
	Ilo3	138	20		
	Los Héroes	220	70		

Source: Study of Maximum Capacity of Non-conventional Generation, COES, 2015

Appendix 17: Power Capacity by Zone

Region	Power Demand MW	Power Capacity MW
North	806	1,460
Central	4,298	7,866
South	1,460	2,753

Source: Grid Manager Osinergmin, Personal Communication, March 5, 2017

Appendix 18: Glossary

AWARDED ENERGY: In renewable energy auctions, the amount of energy awarded to each winning project in GWh/yr. This is the amount of energy that the project is expected to generate and deliver to the national grid each year.

AWARDED TARIFF: Also known as the awarded price of energy, the awarded tariff is the price of energy, in US$/MWh that is guaranteed to the generator who has won a project in the renewable energy auction. The tariff (in US$/MWh) is multiplied by the annual awarded energy (usually expressed in GWh) to determine the project's guaranteed annual income.

CAPACITY FACTOR: The ratio of the actual energy output of a power plant over a period of time to the maximum possible energy output. The maximum energy output is calculated by multiplying the facility's nameplate capacity by the number of hours in a year (8760).

COES: The Committee for Economic Operation of the Electrical System, it manages the operation of the national electric grid, SEIN.

CONVENTIONAL ENERGY: Energy generated from nonrenewable sources such as oil, coal and natural gas. Hydroelectric plants greater than 20 MW are also considered conventional energy.

DEFINITIVE CONCESSION: The right to generate electricity (conventional or non-conventional) granted by the relevant authority (MINEM or DREM) according to the regulations established by the Electric Concessions Law.

EFFECTIVE POWER: Actual electric generation capacity of a generation facility determined under specific measurement conditions prescribed by COES.

EXTRA HIGH VOLTAGE: Voltages greater than or equal to 220 kilovolts (kV).

FIRM CAPACITY: Also known as firm power, it is the guaranteed (power) capacity a plant can deliver to the electrical system during a period of maximum electricity demand (peak hours). The calculation of firm capacity within SEIN is defined by COES, which assigns a zero firm capacity to non-conventional renewables such as solar, wind and tidal energy (Supreme Decree N° 012-2011-EM), because renewable resources such as sunlight and wind are available intermittently.

FREE USERS: Large energy consumers connected to SEIN, with a maximum electricity demand greater than 2.5 MW. Free users are not subject to price regulation for energy or power.

HIGH VOLTAGE: 36-220 kilovolts (kV)

HYBRID GENERATION SYSTEMS: Energy systems which combine different types of renewable energy systems (e.g., wind and solar, or wind and hydro) or one type of renewable energy with a

fossil fuel (e.g., solar and diesel generator). Under Peruvian Law, only systems that combine non-conventional renewable sources are considered hybrid systems.

INSTALLED POWER: Maximum possible electric generation capacity of a generation facility

LOAD CURVE: Also known as the load profile, a load curve is a chart showing a consumer's demand for electricity over time. Electrical demand (in kW or MW), is shown on the y-axis and time is shown on the x-axis.

MARGINAL MARKET (SPOT MARKET): Transactions between generators based on the variable cost of energy. The price of energy on the Spot Market varies every 15 minutes and depends on the variable energy cost of the last generating unit dispatched by COES. The unit or generation plant that sets the Spot Price is known as "marginal unit".

MEDIUM VOLTAGE: 1-36 kilovolts (kV).

NON-CONVENTIONAL ENERGY: Energy sources that are renewable and have a minimum environmental impact, such as solar, wind, biomass, geothermal, tidal and small hydro (less than 20 MW)

PRIMA: Renewable energy generators awarded projects through RER auctions receive the initial payment for their delivered energy based on the marginal price (or spot price) of electricity at the time of generation. Generators are then compensated annually for the difference between the payment received based on the spot market and the expected payment (based on the awarded price in the auction). This compensation is known as *prima*, and is paid for by end users through a charge in the transmission toll.

REGULATED USERS: Small to medium sized energy users connected to SEIN, with a maximum electricity demand less than or equal to 200 kW. Regulated users are subject to price regulation for the energy or power they consume.

SEIN: The National Interconnected Electric System (*Sistema Eléctrico Interconectado Nacional*), the national electric grid of Peru.

SUBSTATION: Electrical stations that transform voltage from high to low or vice versa voltage for transmission