Asia-Pacific Economic Cooperation

APEC Oil and Gas Security Exercise in Peru

Lima, Peru

6-8 November 2017

APEC Energy Working Group

May 2018

Asia-Pacific
Economic Cooperation

APEC Oil and Gas Security Exercise in Peru

Lima, Peru
6 – 8 November 2018

Final Report

Energy Working Group

May 2018

APEC Oil and Gas Security Exercise in Peru: EWG 05 2016S

Produced by:

Asia Pacific Energy Research Centre (APERC)
Institute of Energy Economics, Japan
Inui Building, Kachidoki 11F, 1-13-1 Kachidoki
Chuo-ku, Tokyo 104-0054 Japan
Tel: (813) 5144-8551
Fax: (813) 5144-8555
E-mail: master@aperc.ieej.or.jp (administration)
Website: http://aperc.ieej.or.jp/

For:

Asia-Pacific Economic Cooperation Secretariat
35 Heng MuiKeng Terrace, Singapore 119616
Tel: (65) 68 919 600
Fax: (65) 68 919 690
E-mail: info@apec.org
Website: http://www.apec.org

APEC#218-RE-01.8

PREFACE

The Asia Pacific Energy Research Centre (APERC) has been conducting the Oil and Gas Exercise since 2013 following the APEC Energy Ministers' directive (10th APEC Energy Ministerial Meeting) in St. Petersburg in June 2012 to pursue regional cooperation on supply emergency response through workshops and exercises. Such directive intends to aid APEC economies to improve policy response and measures in dealing with or resolving any magnitude of energy supply disruption based on their respective domestic conditions.

APERC held the first two oil and gas security exercises (OGSE) in 2013 – the Joint Southeast Asian Exercise in Bangkok, Thailand, and the Indonesian Exercise. In November 2015, APERC officially launched the Oil and Gas Security Initiative (OGSI) expanding the program related to supply security consisting of three pillars, one of which is the OGSE. The Philippines hosted the 3rd OGSE and the first under the OGSI in December 2015. Finally, on March 2017, Australia was host to the 4th OGSE, which was a regional capacity building with the participation of other APEC economies – Indonesia, the Philippines and Thailand.

This report presents the outcome of the OGSE in Peru (the 5th exercise) jointly organised by APERC and the Peruvian government through the Ministry of Energy and Mines on 6-8 November 2017. The OGSE in Peru was a 'blind' type exercise, in which participants were briefed about hypothetical supply disruptions without prior notice. The report contains the Peruvian participants' responses to the two hypothetical emergency scenarios formulated, one for oil and another for gas. The report analyses thoroughly the comments and recommendations provided by the Expert Review Team for each scenario. This feedback aims to improve Peru's response measures, policies, plans, procedures and communication strategies to better face supply emergency situations.

The first day was devoted to the general presentation of the APEC OGSE, as well as the APEC Exercise Model Procedure (OGS-EMP). Later on, the Peruvian government presented their energy planning policy and approach to energy security. In the afternoon session, the first hypothetical supply disruption scenario was presented for crude oil and oil products. Participants discussed the possible impacts and actions to be taken and presented to the Review Expert Team their responses. In the second day, a separate disruption scenario was presented for gas supply. Likewise, the Peruvian participants started a discussion on how to minimize the effects of such disruption in the natural gas sector. After the participant's presentation of their responses, the Review Expert Team provided their assessment and recommendations for both scenarios.

Six invited experts formed the Expert Review Team to assess, comment and provide recommendations to the Peruvian participants' responses on the presented emergency scenarios for oil and gas. The Team was composed by representatives of the Latin American Energy Organisation; the Inter American Development Bank (IADB); Economic Research Institute for ASEAN

and East Asia (ERIA); the Japan Oil, Gas and Metals National Corporation (JOGMEC); the Department of Energy of the United States; and the Institute for the Sciences of Nature, Territory and Renewable Energies at the Pontifical Catholic University of Peru (INTE - PUCP).

Through the conduction of OGSE, APERC envisions that those APEC economies who have not yet conducted regular emergency exercises consider doing such to strengthen their emergency preparedness system to address and mitigate the impacts of supply disruptions. The response measures should be continuously improved through the conduct of exercises to make systems more resilient to any supply crisis. APERC is committed to carrying on this activity as long as the Energy Ministers and the APEC economies still see the value of this program in improving resilience and mitigating the impact of any supply emergency. APEC economies are also encouraged to hold (or continue to hold) their own supply emergency exercises to further strengthen their policies, institutional arrangements and mechanisms, and response measures on supply disruption.

The Expert Review Team and APERC wish to thank all the participants and delegates who engaged with the team for discussions, particularly to the General Direction for Energy Efficiency and the General Direction for Hydrocarbons at the Ministry of Energy and Mines of Peru. This effort for energy security in the APEC region would not have been possible without their collaboration.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS

Bbl	Barrel
Bbbl	Billion Barrel
Bcm	Billion Cubic Metre
Bcf/y	Billion Cubic Feet per Year
Bcm/y	Billion Cubic Metre per Year
BPO	Business Processing Outsourcing
Cm	Cubic Metre
GWh	Gigawatt-Hour
Kbbl	Thousand Barrel
Kbbl/d	Thousand Barrel per Day
km	kilometre
Kt	Kilo Tonne
KWh	Kilowatt-Hour
Mbbl	Million Barrel
Mbbl/d	Million Barrels per Day
Mboe	Million of Barrels of Oil Equivalent
Mmscfd	Million Standard Cubic Feet per Day
Mcm/d	Million Cubic Metre per Day
Mmt	Million Metric Tonne
Mtoe	Million Tonne of Oil Equivalent
MW	Mega-Watt
Tcf	Trillion Cubic Feet
Tcm	Trillion Cubic Metre
TWh	Terawatt-Hour

ACRONYMS

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
ASEAN	Association of South East Asian Nations
CCGT	Combined Cycle Gas Turbine
CNG	Compressed Natural Gas
COES	Electric System Economic Operations Committee
EMM	Energy Ministerial Meeting
ERIA	Economic Research Institute for ASEAN and East Asia
EWG	Energy Working Group

FSRU	Floating Storage Regasification Unit
GDP	Gross Domestic Product
HHI	Herfindahl-Hirshman Index
IADB	Inter-American Development Bank
IEA	International Energy Agency
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEM	Ministry of Energy and Mines of Peru
NGV	Natural Gas Vehicle
OGSE	Oil and Gas Security Exercise
OGSI	Oil and Gas Security Initiative
OGSN	Oil and Gas Security Network
OLADE	Latin American Energy Organization
OSINERGMIN	Supervisory Agency for Investments in Energy and Mining
PPP	Purchasing Power Parity
SEIN	National Integrated Electrical System
USD	US Dollar

LIST OF FIGURES AND TABLES

FIGURES

TABLES

EXECUTIVE SUMMARY

Peru is one of the two APEC members located in South America. With a growing population of 30 million inhabitants, Peru experienced average annual GDP growth of 4.8% between 2000 and 2015. This promising economic trend is expected to continue in coming years. However, economic inequality is still a challenge and around 22% of the population live under the poverty line, most of them without access to modern forms of energy.

As a consequence of rapid economic growth, Peru's energy demand has been growing steadily since 2003 and is expected to follow the promising economic expansion prospects. The Peruvian economy relies heavily on oil and gas consumption. Demand for these fuels is expected to continue growing at very high rates. In this context, a secure and diversified supply of oil and gas is indispensable for Peru's economic growth and development.

Peru's total primary energy supply doubled from 2000 to 2015 from around 12 million tons of oil equivalent (Mtoe) to more than 24 Mtoe. Oil is the dominant fuel but followed closely by natural gas, especially in recent years. Peru's oil demand growth has been driven mainly by the transport sector, which represents around 70% of total oil consumption, followed by the industrial and buildings sector with 16% and 13%, respectively. In terms of oil products, diesel is by far the most consumed fuel with more than 50% of the total share, mainly utilised in road transport.

Peru is an oil producer but a net crude oil and oil products importer. Peru's crude production covers only around 20%-30% of local refinery intake, with the rest covered by imports. Ecuador is by far the main source of crude imports for Peru with around 50%, followed by Colombia, Nigeria, Brazil, the US, and others with shares lower than 10%.

Peru has seven refineries with a joint capacity of 200 thousand barrels per day (Kbbl/d). La Pampilla is the biggest refinery which receives about 90% of its input from oil imports and produces more than half of domestically refined oil products. Peruvian refining capacity is not enough to meet oil products demand. As a result, not only does Peru import crude oil but also oil products. Peru is a net diesel importer, a net fuel oil and jet fuel exporter and produces just enough gasoline to meet local demand. More than 80% of Peruvian refined product imports come from the US. Peru's crude oil and product stocks are limited and have been below the equivalent of 20 days of consumption over the last 5 years.

Peru's gas demand has grown strongly since the development of the Camisea field started in 2004. In 2015, gas consumption was six times higher than in 2005, with almost 70% of its share destined for power generation. Gas fired power generation capacity surpassed hydropower capacity in 2009, becoming Peru's largest source of generation, with more than 60% of the total share. Gas consumption in the industrial sector has also experienced a similar growth trend.

Production at the Camisea field has allowed Peru not only to meet growing domestic demand but also to become an LNG exporter. Since 2012, more than 95% of Peru's total gas production comes from the Camisea field. In order to bring this gas to Lima, and other main urban centres, the 730-kilometre long Camisea gas pipeline was built, traversing the Andes Mountains, and then up north to Peru's central region, where the bulk of gas-fired power generation infrastructure is located. The Camisea pipeline is the main gas pipeline in Peru, transporting more than 98% of the gas produced in Peru from the Camisea field to industrial users, power generation plants and LNG exports.

In 2012, the Peruvian Government published its most relevant energy security legislation, the Law to Ensure Energy Security and Promote the Development of the Petrochemical Industry. It mandates diversification of energy sources, reduction of external dependence and an increase in energy supply chain reliability. The law also instructs the construction of specific infrastructure projects such as complementary pipelines to the Camisea gas pipeline, as well as an LNG import regasification terminal. Nevertheless, the law has not been fully implemented and much effort to remains to achieve the detailed projects specified in it.

The OGSE in Peru was a 'blind' type exercise, in which participants are briefed about hypothetical supply disruptions without prior notice. The goal is to make a realistic approach to a possible emergency response with limited time and information.

The first stage of the exercise was an oil emergency scenario in which Peru's largest refinery, La Pampilla, was severely damaged by an 8.8 magnitude earthquake. A total and abrupt shutdown of the refinery was assumed, with a total loss of production of fuel products and around 50% of stock products. Repairing the damage was assumed to take at least 2 months. The main impact was in the Lima region where around 40% of the gasoline and 30% of diesel consumption is produced in the La Pampilla refinery. Most of Peru's vehicle fleet and transport fuels demand is concentrated in Lima and its surroundings. The participants' response included importing extraordinary oil products cargoes, bringing fuel products from the Talara refinery for limited time, clearing major highways and roads to transport oil products from other refineries or terminals, rationing demand and canceling non-essential activities.

Based on the responses of the participants, the Expert Review Team provided a series of recommendations for a possible disruption on oil supply. The recommendations included:

- working closely with refinery owners to find ways of supplying lost production;
- co-ordinating with traders to import additional gasoline and diesel through existing channels;
- teaming up with PetroPeru to run more crude oil at their refineries;
- releasing the obligatory 15-day inventory;
- determining the feasibility of liquid fuel rationing;

- setting up an organisation responsible for monitoring and holding oil products emergency stocks;
- establishing a joint oil stockpiling company with the private sector;
- actively promoting joint stockpile measures among companies to increase stock capacity in the private sector;
- enhancing ethanol production and planning energy rationing programs for each refinery.

The second stage of the exercise comprised a gas supply disruption scenario, independent of the oil disruption scenario. In this stage, it was assumed that a landslide fractured the Camisea gas pipeline, which transports more than 95% of Peru's natural gas production, stopping all gas flows. It was also assumed that repairing the pipeline and normalising flows would take around 3 weeks. Without gas, about 60% of total power generation capacity would be out of service. Additionally, industrial and residential users would face natural gas shortages, while LNG exports would be totally interrupted.

The participants' responses included assuring there were no other fractures or leaks in the pipeline, maximising hydropower generation, dispatching as much as possible power plants fuelled by oil and coal, importing as much electricity as possible from Ecuador, rationalising power demand with the exception of vital facilities, suspending all LNG export cargoes, using gas available in the LNG exports plant facility and maximising the use of LPG as a substitute fuel.

For the gas scenario, the Expert Review Team provided the following recommendations as a result of the participants' answers:

- diversifying power generation sources to reduce gas dependency, especially by promoting renewable sources like solar, wind, bio-thermal and geothermal;
- conducting a thorough analysis for building a Floating Storage and Regasification Unit (FSRU) to import gas;
- reactivating the construction of the *Gasoducto Sur Peruano* gas pipeline;
- considering infrastructure planning and investment strategies to improve flexibility on gas supply in pre- and post-disruption scenarios;
- finding a long-term agreement to use Peru LNG's liquefaction plant storage capacity in emergency cases and
- reviewing regulations and incentives to attract capital and technology from investors willing to bet on Peru's hydrocarbon exploration, production and general industry development and;
- As a last resource measure, Peru's government should determine the feasibility of electricity rationing in a prioritised and ordered way.

The Expert Review Team provided other valuable recommendations to enhance Peru's energy security and to improve preparedness for sudden shocks and emergencies in energy supply. The team recommended establishing a robust database with power generation installed capacity,

reserve margin, main supply routes, energy demand estimates of essential services, stocks levels on a real-time basis as well as collecting data on oil and gas demand, crude production, crude oil and product import volumes, refined volumes for each refinery, sales, and pipelines, ports and land tankers capacity. The team also recommended setting up a task force to develop an emergency operation and determining entities that will be responsible for: coordinating information; communicating with the public; analysing and determining the extent of the emergency; providing overall coordination of emergency relief efforts; mandating restrictive policies and soliciting international support.

In conclusion, while Peru has a relevant and detailed Energy Security Law, energy security policy and a long-term planning approach seem new to Peru. Participants emphasised that Peru has been focusing on supply security, mainly, if not exclusively, by infrastructure development. Peru relies heavily on both crude oil and product imports, with most of their capacity concentrated in coastal areas vulnerable to earthquakes and floods. Regarding gas, more than 95% of total production comes from the Camisea field. Almost all of this gas is transported by a single gas pipeline and is used to provide around 45% of Peru's electricity. Therefore, the Peruvian oil and gas sectors are severely exposed to supply disruptions, especially natural disasters. It does not appear that Peru has a well-structured emergency management organisation in place, particularly involving disruptions on oil and gas supply. The exercise exposed that Peruvian authorities did not have very clear management procedures, communication strategies, and responsibility distribution during an emergency scenario.

While the recommended measures, as well as other risk management and disaster preparedness plans and actions, involve considerable investments, recovery and emergency costs without preparedness are not only costlier but could also be catastrophic. The Expert Review Team highlights the importance of energy security and recommends the Government to consider it as a top priority of sustainable and responsible development of Peru. Finally, the Expert Review Team sincerely hopes that this Oil and Gas Security Exercise contribute positively to enhance energy security in Peru.

1. BACKGROUND AND ENERGY SITUATION IN PERU

Objectives and scope of the exercise

Energy Security has been a serious concern confronting the region with energy demand continuously increasing to fuel economic growth and development. Such concern will be at the forefront of energy cooperation in the APEC region throughout the 21st century.

Against this backdrop, the Eleventh Energy Ministerial Meeting (EMM 11) held in Beijing, China in 2014 gave further direction to strengthen capabilities and systems for oil and gas emergency response of the APEC member economies. The Ministers also instructed once again the Energy Working Group, including through APERC, to continue cooperation on emergency response to assist economies strengthen emergency response measures and policies based on their respective domestic circumstances in collaboration with the International Energy Agency (IEA), Association of South East Asian Nations (ASEAN), the Economic Research Institute for ASEAN and East Asia (ERIA) and other international organisations. In response to the Ministers' directive, the Oil and Gas Security Initiative (OGSI) was launched covering three pillars, namely: Oil and gas Security Exercise (OGSE), and Oil and Gas Security Network (OGSN), and Oil and Gas Security Studies (OGSS). The OGSE aims at:

1. Investigating domestic system for emergency preparedness in each APEC economy;
2. Developing possible scenarios of oil and gas emergency situations;
3. Obtaining necessary information and analyses by mobilising capable experts in the APEC region;
4. Testing the effectiveness of the APEC Oil and Gas Security Exercise Model Procedure.

Further, APERC has drafted the APEC Oil and Gas Security Exercise Model Procedure (EMP), which provides a step-by-step approach for oil and gas emergency exercises to promote and guide economies in developing and implementing their respective emergency exercises.

Based on this background the APEC Oil & Gas Security Exercise in Peru, conducted by APERC and the Ministry of Energy and Mines (MEM) of Peru, covered both oil and gas supply emergency scenarios. Emergency scenarios were presented separately - the first scenario was on oil and the second was on natural gas. The exercise was conducted in Lima, Peru, from 6-8 November 2017. The emergency exercise results were reviewed and evaluated by the APEC Energy Working Group (EWG) in its 55th meeting held in Hong-Kong in May 2018.

Demographic and economic backgrounds

Peru is a constitutional republic located on the west central coast of South America, bordered by the Pacific Ocean, with Chile to the south, Ecuador and Colombia to the north, and Brazil and Bolivia to the east. With a land area of 1.3 million square kilometres (km2), Peru is divided into three main geographical regions: the coast to the west, the mountain region (Andes Mountains) and the Amazonian region (Selva). Peru is divided into 25 political departments (administrative regions).

Source: turismo.org

Figure 1- Map of Peru

In 2014, Peru had a total population of about 30.97 million, an increase of 1.3% from the previous year (ESTO, 2017). In 2015, approximately 22% of Peru's population was considered poor and 4.1% extremely poor (INEI, 2015a). The major population centre of Peru is Lima, with 9 million people, nearly one-third of the total population (INEI, 2015b). The urbanisation rate in Peru is 76% (INEI, 2011). GDP (PPP, Constant 2011) stands at USD 369.23 billion in 2015, while the Peruvian GDP per capita was recorded at USD 11,767 (PPP, Constant 2011) (WB, 2017). Peru achieved its highest economic growth in 2008 since 2000, coinciding with high oil prices recorded that year (Figure 1).

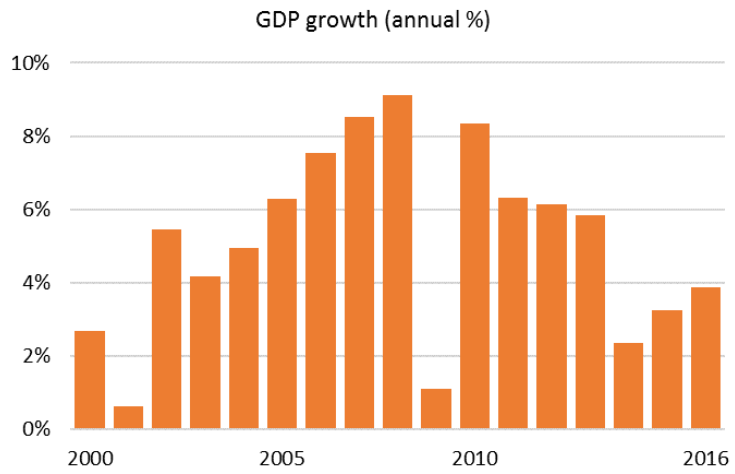


Figure 2: Major cities, economic growth and populations in Peru

Source: WB, 2017

Since 1990, Peru's economy has been driven by its internal demand, mainly private investments, exports and domestic consumption. Peru has a market-oriented economy, and in 2015, its key segments were services (49%), manufacturing and construction (18%), and mining (12%) (BCRP, 2015). Between 2000 and 2015, the average annual growth rate (AAGR) was 4.8%, higher than the level reached in 2014 (2.4%), due to the deceleration of emerging economies and global uncertainty. This resulted in negative growth rates in private and public investments (-4.4% and -7.5%, respectively), and a reduction in the private consumption growth rate from 4.1% in 2014 to 3.4% in 2015 (BCRP, 2015).

Mining is especially important for the economy, since Peru is a major global producer of several metallic and non-metallic minerals, ranking third in silver, zinc, copper and tin, fourth in lead, and sixth in gold (USGS, 2016). Consequently, mineral exports have consistently accounted for a significant share of the export revenues, contributing as much as 55% in 2015 (BCRP, 2015). During 2015, around 20% of the USD 24 billion of foreign direct investments were destined to the energy, oil and transport sectors (Proinversion, 2015).

Total Primary Energy Supply and final energy consumption

Peru's total primary energy supply (TPES) in 2014 was 22.78 million tonnes of oil equivalent (Mtoe), increasing 5.9% from 2013, due to the increasing production of natural gas. By energy source, in 2014, almost half (10 Mtoe) of the TPES was from oil, 32% from natural gas (7.22 Mtoe) and 4% from coal (0.841 Mtoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others constituted the remainder at 21% (4.69 Mtoe) (ESTO, 2017).

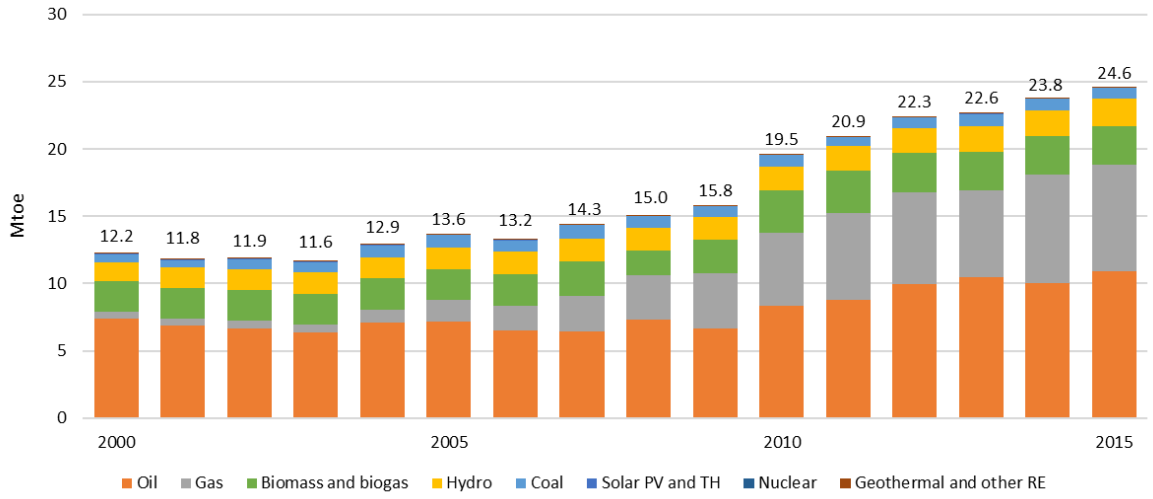


Figure 3: Peru's Total Primary Energy Supply

The proven gas reserves of the economy were 0.4 Tcm in 2016, and are expected to increase to 0.8 Tcm by 2025, based on the information from the Ministry of Energy and Mines (MEM) (MEM, 2014). The Camisea gas field, the largest in Peru, is located 500 km from Lima, in the region of Cusco. Production at the Camisea field has allowed Peru not only to meet growing domestic demand but also to become an LNG exporter. Since 2012, more than 95% of Peru's total gas production comes from the Camisea field. In order to bring gas to Lima, and other main urban centres, the 730-kilometere long Camisea gas pipeline was built, traversing the Andes Mountains, and then up north to Peru's central region, where the bulk of gas-fired power generation plant is located. The Camisea pipeline is the single most important gas pipeline in Peru, transporting more than 98% of the gas produced in Peru from the Camisea field to industrial users, power generation plants and LNG exports.

The Camisea field was initially aimed at satisfying the domestic demand for natural gas. However, as production levels have increased at an average annual rate of 63% since 2004, excess supply was destined to exports with the construction of the Peru LNG Melchorita liquefaction plant. Peru's LNG exports amounted to 8.1 billion cubic metres (Bcm) (BCRP, 2015).

Peru's proven coal reserves are around 9.9 million tonnes (Mt) with about 95% consisting of anthracite and the remainder with bituminous coal. The majority of the reserves are located in the La Libertad, Ancash and Lima departments. Peru is a net importer of coal, with 80% of its coal demand in 2014 being met by imports and 20% by domestic production (MEM, 2014).

In 2014, Peru's electricity generation totalled 45 515 gigawatt-hours (GWh), a 5.1% increase from the 43 295 GWh generated in 2013. Of that total, electricity generated from hydropower constituted the maximum share of 49% (22 196 GWh), thermal plants accounted for 49% (22 330 GWh) and the remainder was generated from other sources such as biomass and wind (ESTO, 2017).

In the other energy sectors different types of biomass, such as firewood, vegetable coal, dung and yareta (a moss-type plant dried and then burned) are used for heating and cooking. In 2015, the renewable sources used for energy supply included firewood (38%), hydropower (48%) and the remainder was from other biomass sources (MEM, 2015).

Final energy consumption in Peru decreased by -0.5% in 2014, reaching 17.60 Mtoe. Transportation represented 42% of the final energy consumption in 2014 and barely decreased 0.1% since 2013 to reach 7.31 Mtoe. The share of the industrial sector was 28%, while the combined other residential, commercial and agricultural sectors consumed 29%. Accordingly, oil products dominated the total energy consumption in 2014 with 55%, the majority of which was consumed as diesel, gasoline and liquefied petroleum gas (LPG) (MEM, 2015). Electricity constituted 31% of the total end-use energy demand, while gas and coal accounted for the remaining 9% and 4%, respectively (ESTO, 2017).

1.2 Oil Demand and Supply

1.2.1 Oil Demand

In 2014, Peru's final demand for oil products was equal to 9.72 million tonnes of oil equivalent (Mtoe), this represents an increase of around 40% compared to 2004 when final oil demand was 7.03 Mtoe. The transport sector is the biggest oil consumer in Peru with around 70% of total oil consumption in 2014. In 2004, however, the transport sector's oil consumption share was 54%, this increase shows that Peru's oil demand growth has been driven mainly by the transport sector. The industry sector's oil consumption decreased slightly from 1.9 Mtoe to 1.6 Mtoe from 2004 to 2014, this is explained, mainly, by an increase of gas consumption in the sector. On the other hand, oil consumption in the residential sector has actually increased by around 0.3 Mtoe, keeping its same share during the same 10-year period. This reflects an increase in liquefied petroleum gas (LPG) for cooking and water heating.

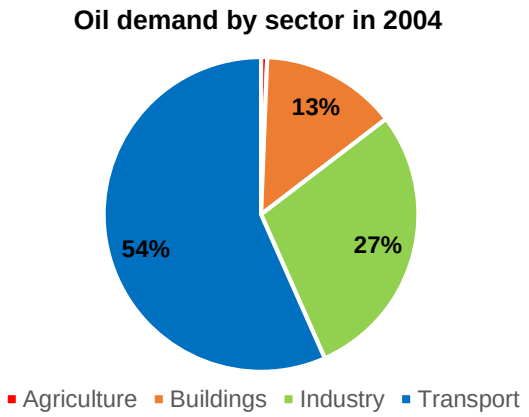


Figure 4: Oil demand by sector in 2004

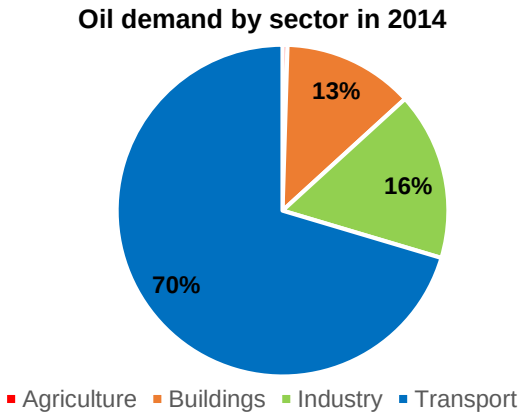


Figure 5: Oil demand by sector in 2014

Given that the transportation sector prevails Peru's oil demand, it is not surprising that diesel and motor gasoline are the most consumed oil products, accounting together for more than 60% of the total. Nevertheless, the preponderance of diesel alone, accounting for more than half of total oil consumption, is a particularity of the Peruvian transportation sector. This is especially striking when compared to the relatively low consumption of motor gasoline. The explanation behind this may be the fact that most of freight transport is done with diesel-powered heavy trucks as well as the bulk of public transportation buses; plus, diesel prices are lower than gasoline ones.

In the industrial sector, despite a substitution effect *vis-à-vis* natural gas, fuel oil keeps a substantial but declining share of consumption in the sector. Meanwhile, the residential sector consumes heavily LPG, mainly for cooking and water heating.

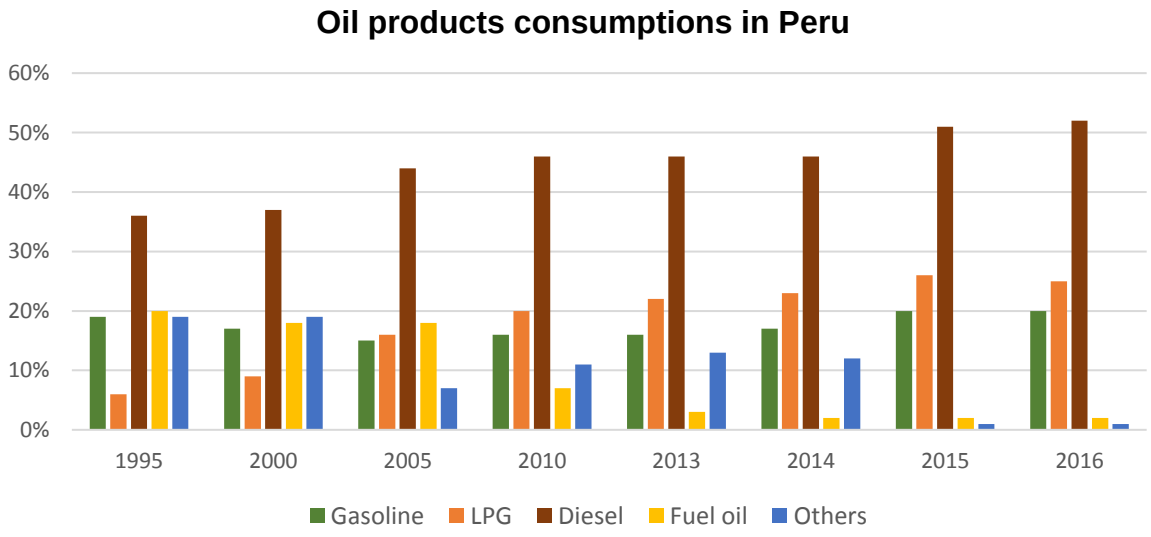


Figure 6: Oil products consumptions in Peru

Source: ESTO (2017)

1.2.2 Oil Supply

Since 2013, Peru's crude oil production has been able to meet roughly around 20%-30% of local refinery intake. Peru relies on crude oil imports to use the rest of its refining capacity. However, Peruvian refining capacity is not enough to meet oil products demand. As a result, Peru also has to import oil products, mainly diesel.

Based on the monthly data collected by the APEC Energy Statistics and Training Office (ESTO), crude production in December 2016 declined to 1.19 million barrels or by nearly 40% since January 2015. Consequently, Peruvian crude oil imports have increased, raising at a fast rate its crude oil import dependency (Figure 7).

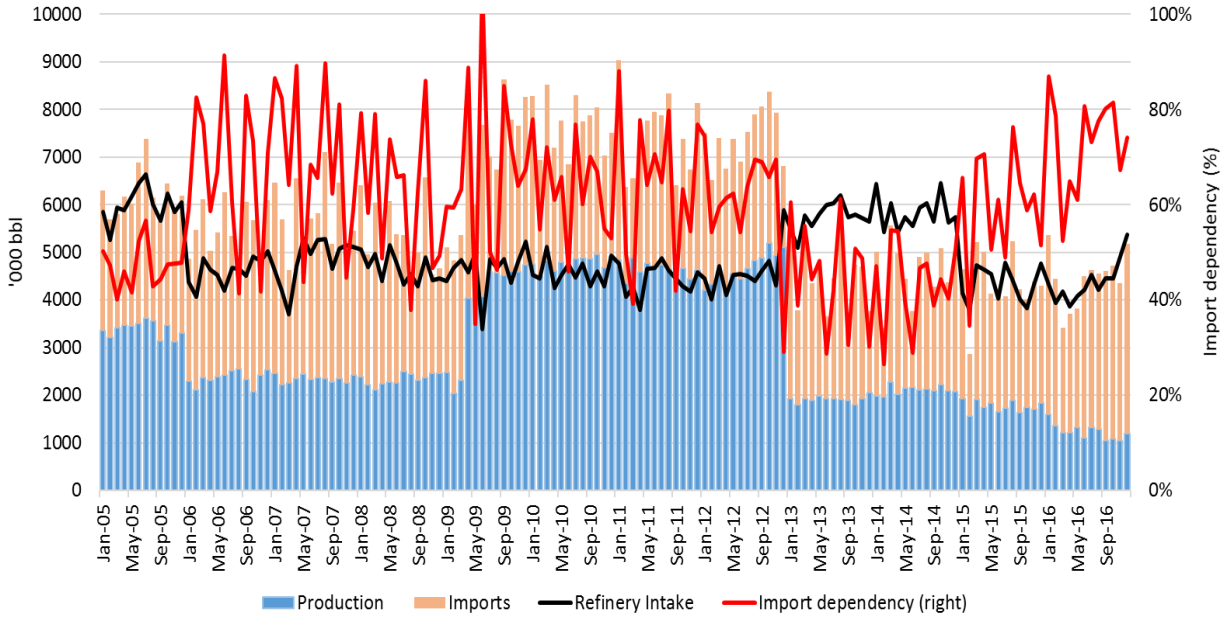


Figure 7: Monthly crude oil production, imports and import dependency 2005-16

Source: ESTO (2017)
Note: Import dependency calculation was based on total imports over refinery intake.

South American neighbours, led by Ecuador, have been the major source of Peru's crude oil imports. Ecuador and Colombia made a combination of more than 60% of crude oil sources. Based on Herfindahl-Hirshman Index (HHI), which measures the degree concentration, the diversity of crude oil imports sources improved in 2016 as Peru started to import oil from the US in large volume (Figure 8).

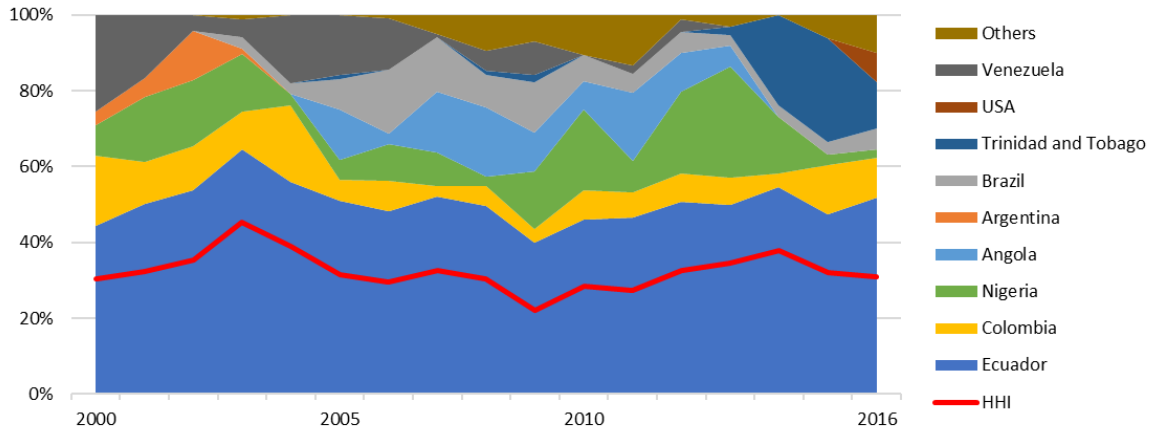


Figure 8: Peru's crude oil import sources 2000-16

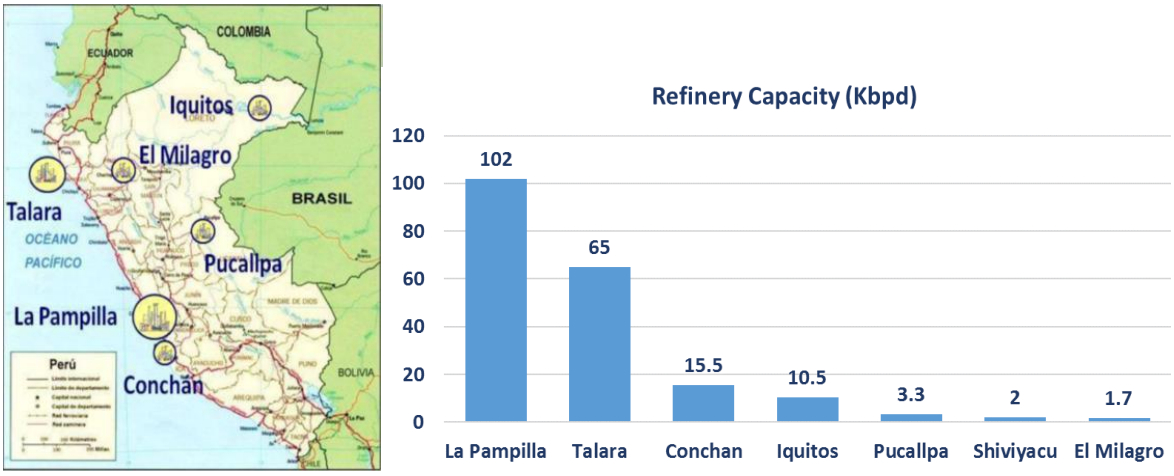
Source: UN *Comtrade* and APERC analysis (2017).

1.2.3 Oil products supply

Refinery capacity

Peru has seven refineries with a combined capacity of 200 thousand barrels per day. The largest and most important of which is the La Pampilla refinery, which processes about 51% of Peru's crude oil into gasoline, diesel, aviation fuel and fuel oil (Figure 9).

Figure 9: Peru's refining capacity by location and capacity



Source: Osinergmin and Repsol (2017)

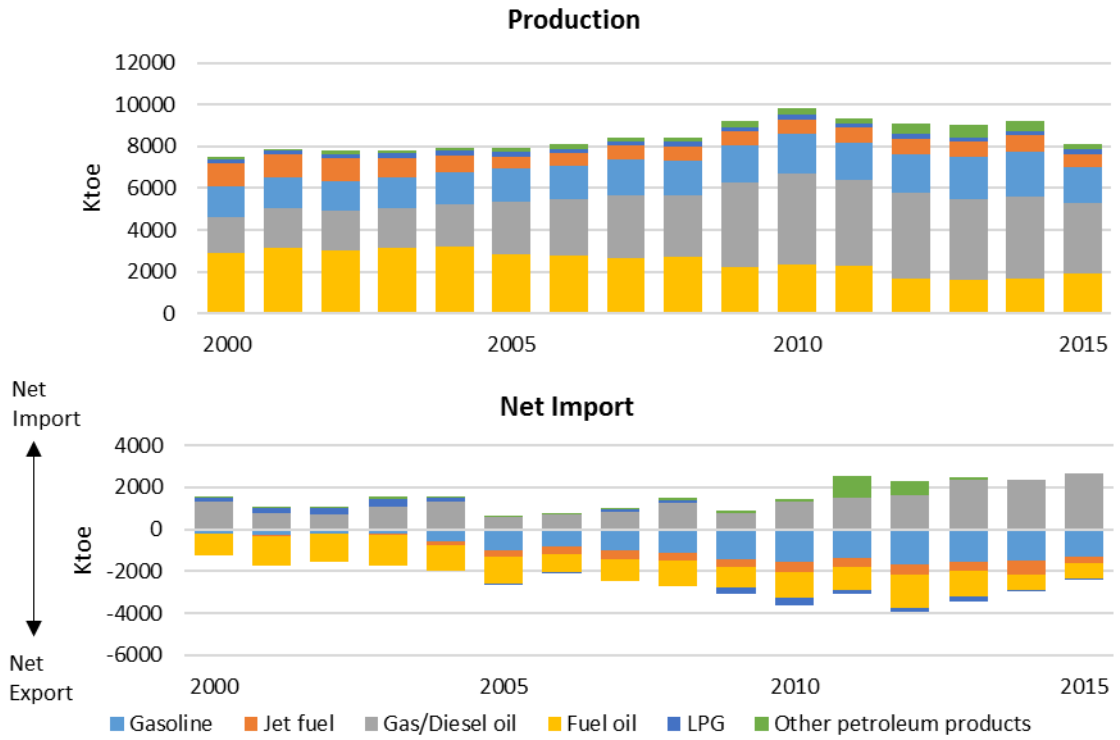
While all in-land refineries (Iquitos, Pucallpa and El Milagro) used indigenous crude production, the coastal refineries imported most of the crude oil. The La Pampilla refinery imported more than 90% of the refinery input from multiple sources, mainly Ecuador, Brazil, Nigeria, Colombia and

Trinidad & Tobago. As for the Talara refinery, the second biggest in Peru, more than 60% of the crude oil input came from domestic production.

Refinery production & imports

Based on data from the Joint Oil Data Initiative (JODI), Peru is a diesel net importer. Conversely, Peru is a fuel oil and jet fuel net exporter. Peru generally produced just enough gasoline to meet local demand (Figure 10).

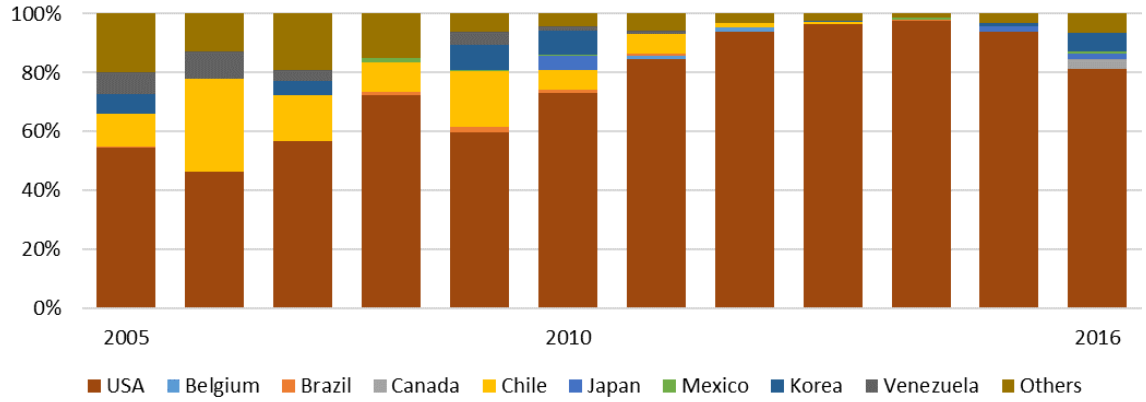
Figure 10: Oil products output and net imports, 2000-15



Source: ESTO (2017)

The US has been, increasingly, the major import source for oil products in Peru, reaching above 90% from 2012 to 2015 (Figure 11).

Figure 11: Oil products import sources, 2005-16

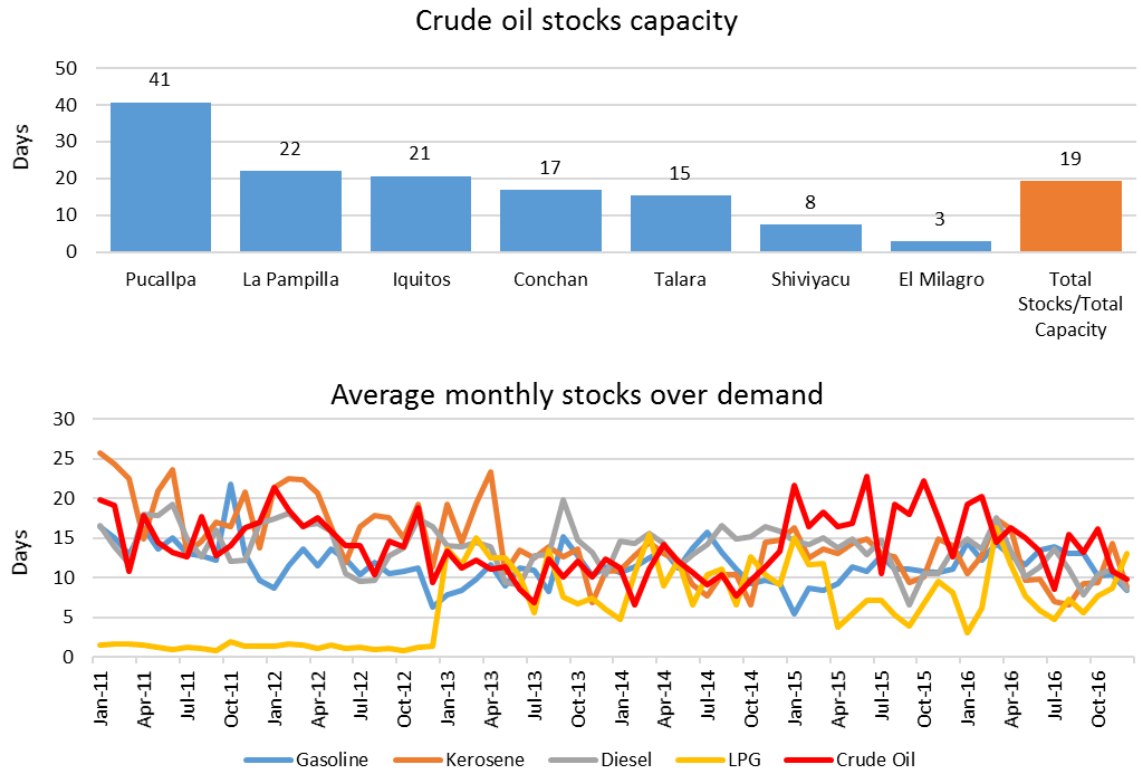


Source: UN Comtrade (2017)

Oil product stocks

Each refinery holds different levels of crude oil stocks. The Pucallpa refinery which is a small complex located in the Central East region has the highest stock level, measured by days, while the biggest refinery, La Pampilla, has roughly half of it (Figure 12). In general, Peru's petroleum products stocks are limited and have recently not been above the 15-days consumption needs. Crude oil stocks have been slightly higher, reaching the 20-days mark in 2015. Although, in comparison, the International Energy Agency member must have, at least, 90 days of equivalent oil products. Moreover, diesel, the most consumed oil fuel in Peru, has had periods when stocks go as down as seven days.

Figure 12: Crude oil stocks in days and ratio between closing stocks and demand, 2015-16



Source: Osinergmin and ESTO (2017)

1.3 Gas Demand and Supply

1.3.1 Gas Demand

Peru's gas demand has grown dramatically in the past 10 years. In 2005, gas demand was barely above one Mtoe, predominantly driven by power generation. As a response to the abundant domestic gas production due to the exploitation of the Camisea field, gas demand followed the trend and more than doubled by 2007. Peru's gas demand in 2015 grew almost by six times compared to 2005 levels, with almost 70% of its share destined to power generation. Gas consumption in the industrial sector has also experienced a similar growth trend.

Conversely, consumption in the residential sector has not grown as fast, mainly due to a lack of access to the fuel in several regions due to the limited gas transmission capacity. A characteristic feature in Peru is the energy consumption fast growing rate in the transport sector, nevertheless, natural gas-fired vehicles share is still very small when compared to diesel or gasoline fired vehicles.

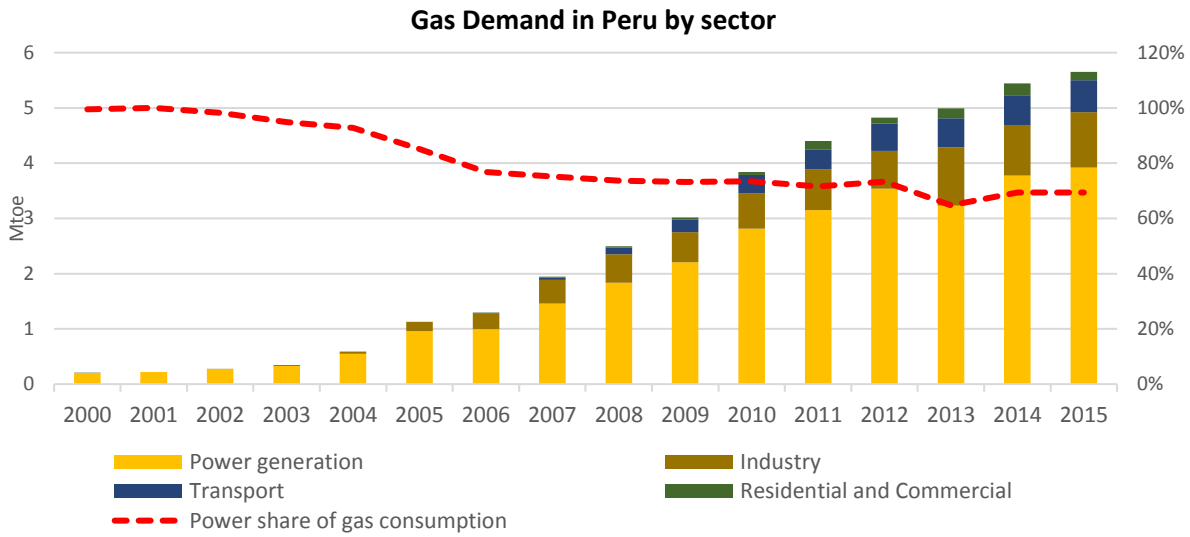


Figure 13: Gas Demand by Sector (2000-15)

As mentioned, power generation is the main driver of Peru's domestic demand, resulting in several additions of gas-fired power plants. In fact, gas-fired power generation capacity surpassed hydropower capacity in 2009, becoming Peru's largest source of power generation, as shown in figure 14.

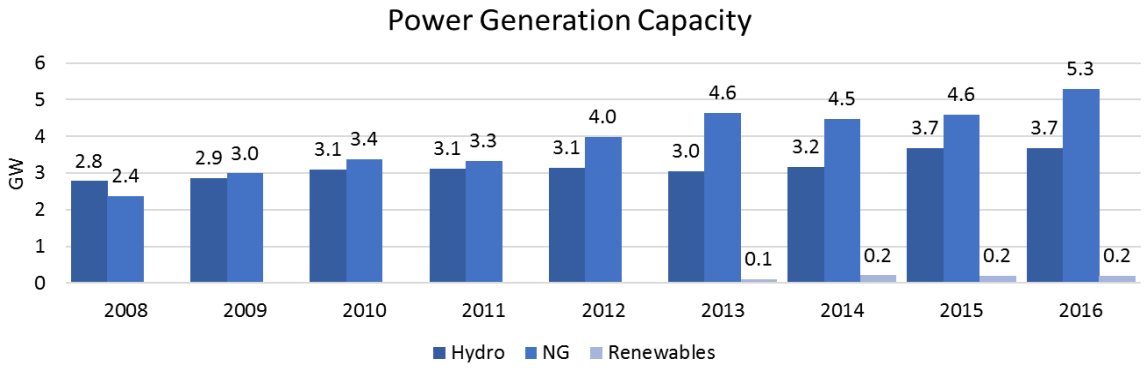


Figure 14: Power generation capacity by source 2008-16

Source: Osinergmin

1.3.2 Gas Supply

Peru's gas production grew very rapidly in the past decade, from 81 million standard cubic feet per day (Mmscfd), in 2005, to 1326 Mmscfd, in 2015. The reason of this growth relies in one of the

milestones in the Peruvian energy sector, the discovery and exploitation of the Camisea gas field, located in the Cusco region. While the field was discovered in the late 1980's, it only started production in 2004. Production has been growing ever since up to becoming the predominant source of Peru's natural gas. In 2015, almost the totality of gas produced in Peru came from the Camisea field.

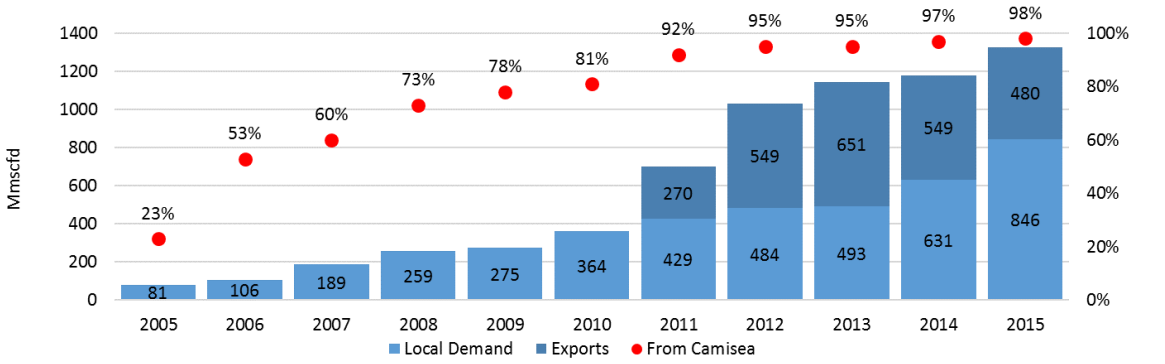


Figure 15: Gas production, local demand, exports and share from the Camisea field.

Source: Osinergmin (2017)

In order, to take the Camisea field's gas to Lima, and other main urban centres, the Camisea gas pipeline was built and became operational in 2004. The 730-kilometeres long Camisea gas pipeline takes gas from the Cusco region to the coast, traversing the Andes Mountains, and then up north to Peru's central region, where the bulk of gas-fired power generation plant is located. The Camisea pipeline is the single most important gas pipeline in Peru, transporting more than 98% of the gas produced in Peru from the Camisea field to industrial users, power generation plants and compromised LNG exports.

A natural gas liquids (NGL) pipeline runs parallel to the gas pipeline between Camisea and Ica, it is mostly used for Liquefied Petroleum Gas (LPG) production. Moreover, due to the excess production from the Camisea gas field, Peru started exporting gas in 2011, when the Melchorita LNG plant became operational. The Melchorita liquefaction plant, located in the Ica region, is the only LNG export terminal in South America with a capacity of 920 MMSCFD (Figure 16). Peru's main LNG destinations are Mexico, Spain and France.

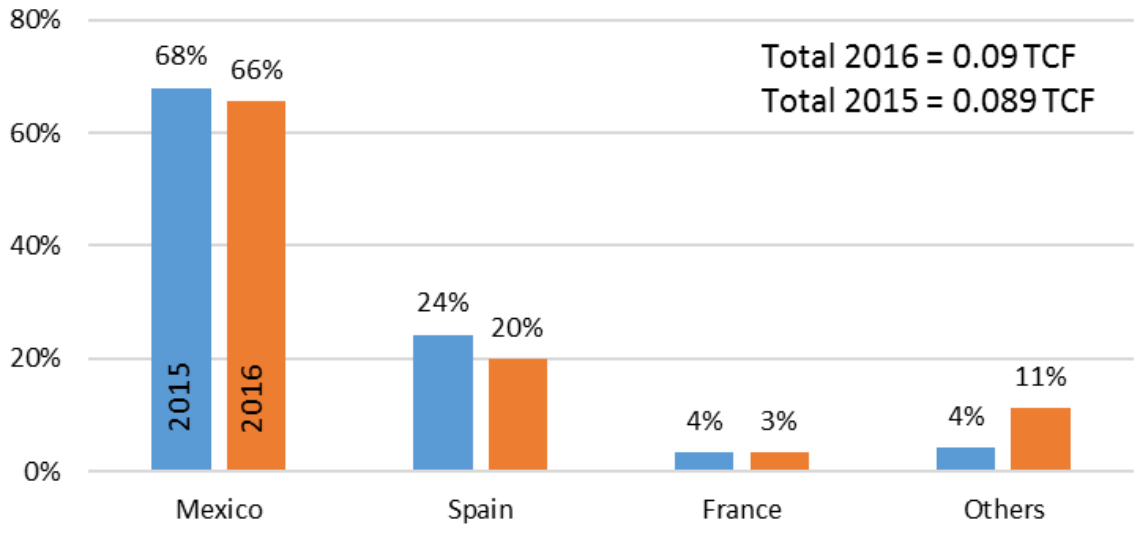


Figure 16: Peru LNG exports by destination 2015-16

Source: Osinergmin

1.3.3 Peru's Electricity System

In 1992, the Peruvian Government issued the Electric Power Concession Law which promoted competition and efficiency in electricity generation, transmission and distribution of electricity. This law allows the setting of electricity rates based on marginal costs and free market forces. In this context, the government enabled incentives and conducted biddings to stablish a spot market. The law also modified the functions held by the Electric System Economic Operations Committee (COES— *Comité de Operación Económica del Sistema Interconectado Nacional*), which is a private, independent operator and planner for the electricity system; and adjusted the legal framework for transmission prices. Finally, large electricity customers were allowed to negotiate directly with generation and distribution companies.

Peru's main electricity system, the National Integrated Electrical System (SEIN), is supplied, almost evenly, by hydropower and gas-fired power plants. Since 2012, the SEIN is also fed with solar, wind and biomass sources. In 2013, the SEIN accounted for 85% of the installed power in Peru and 93% of the total energy generation (MEM, 2013). In 2013, there were 38 power generation companies —63% private and the rest state-owned companies. In the same period, there were eight transmission and 21 distribution companies (52% private and 48% state-owned companies) (OSINERGMIN, 2013).

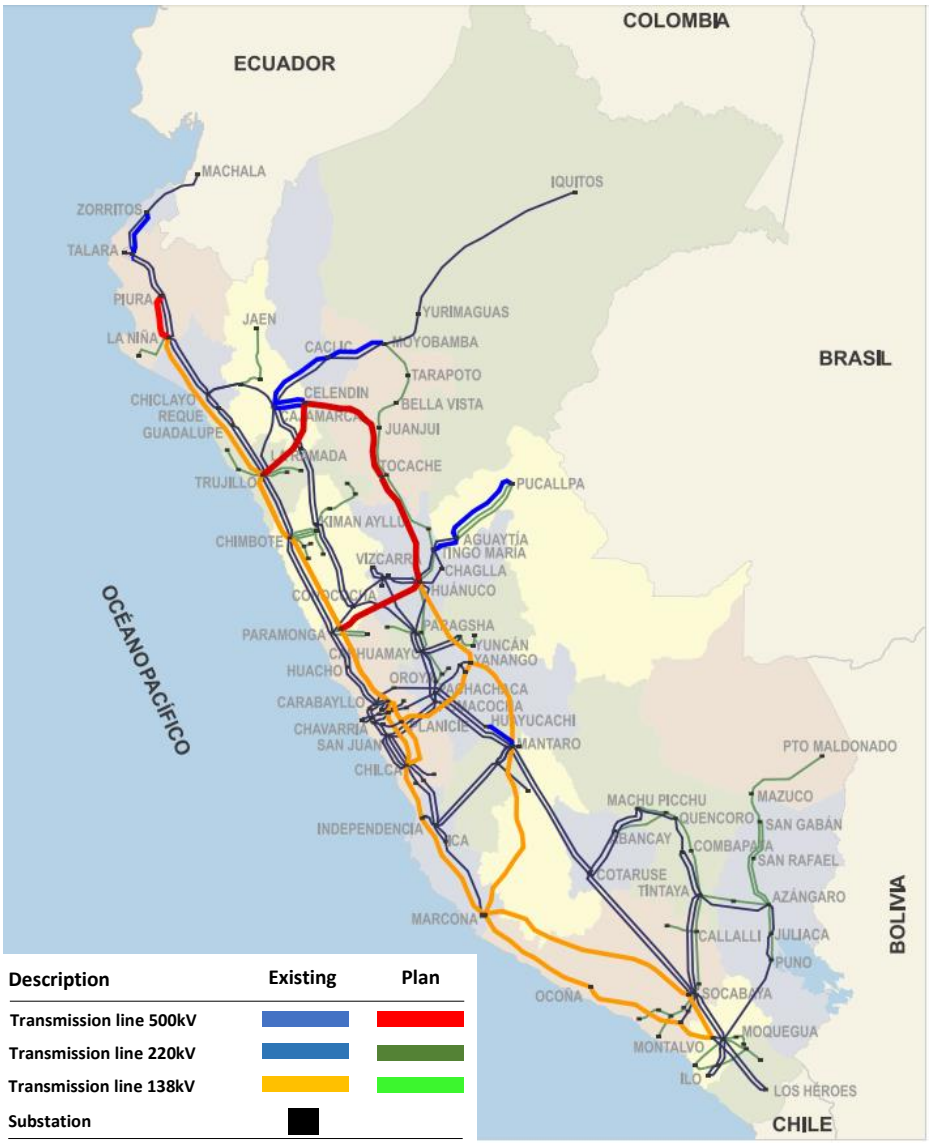


Figure 17: Peru's Electrical System and Expansion Plans.

Source: COES, 2017

As already mentioned, thermal power generation capacity surpassed hydropower capacity in 2009 and became the leading capacity since then. In terms of power generation capacity by fuel, natural gas has more than 60% of the total share, with a minimal participation of diesel and fuel oil. (Figure 18).

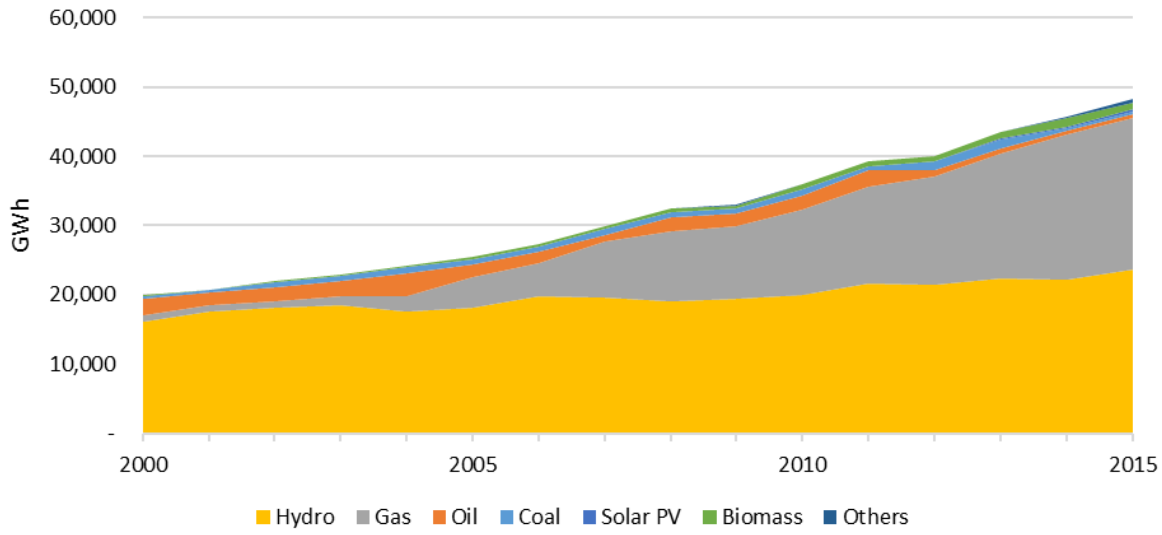


Figure 18: Peru's Power Generation by Source, 2000-15

Source: IEA (2017)

1.4 Institutional Structure and Emergency Measures

1.4.1 Peru's Energy Policy

Peru's Ministry of Energy and Mines (MEM) is responsible for the formulation and evaluation of energy and mining policy. The MEM is also responsible for environmental issues concerning energy and mining activities. The Ministry is divided in two: the Vice-Ministry of Energy and the Vice-Ministry of Mines. Through its general directorates (electricity, rural electrification, hydrocarbons, energy efficiency, mining, energy-environmental issues and mining-environmental issues), the Vice-ministry of Energy covers the major areas of influence in the sector, overseeing its activities and promoting investments to achieve sustainable development.

In addition to the MEM, the Supervisory Agency for Investments in Energy and Mining (OSINERGMIN) is Peru's autonomous regulatory agency, created in 1996. OSINERGMIN is responsible for setting electricity tariffs and gas transportation rates. Its goal is to promote efficiency in the power and gas sectors at the lowest possible cost for the customer by designing and implementing effective regulations.

The government published the National Energy Plan 2014–25 (MEM, 2014) detailing the policies and objectives to guide the energy policy of the economy. According to the plan, Peru's overarching goal is to have a reliable, continuous and sufficient energy system that can support sustainable development, in part by promoting investments in infrastructure (transport, refinery and production) and exploration. The National Energy Plan's main goals are (MEM, 2014):

- To provide energy security and universal access to energy supply; and
- To develop energy resources under a social and environmental perspective.

Under the same plan, the government also set energy efficiency goals, focusing on:

- Establishing new labelling rules for electrical appliances, water heaters, lighting, electric engines and boilers;
- Promoting an energy efficiency culture;
- Establishing an exclusive means for the public transportation system;
- Maximising the use of natural gas in power generation;
- Promoting the substitution of LPG and diesel to natural gas; and
- Striving to maintain energy prices in real terms, avoiding price distortions.

At the same time, the Energy Plan considers the expansion of gas pipelines to cover the entire coastal region. This is expected to increase by 2025, natural gas consumption up to a goal of 35% of final energy demand.

One of the aspirational goals under this plan is to improve the electrification rate to 99% by 2025, through the implementation of the Social Energy Inclusion Program. The program intends to increase electricity coverage to cover 2.2 million people, living in isolated regions, by expanding the electricity grid and providing access to non-conventional energy sources (Table 1). Further, the Social Energy Inclusion Fund aims to provide 1.2 million low-income families access to LPG through discount coupons. Finally, the distribution of improved cookstoves aims to encourage a more efficient use of traditional biomass among low-income families. These improved cookstoves are 50% more efficient in the consumption of traditional biomass, reducing CO2 emissions and respiratory diseases (APERC, 2017).

Table 1: Energy social inclusion indicators of Peru, Energy Plan 2014–25

	2013	2016	2025
Electricity Access (% population)	90.3	95.8	99.0
LPG Discount Coupons (Families)	645 000	1 200 000	1 200 000
Improved Cookstoves (Families)	72 000	144 000	500 000

Source: MEM (2014).

Seeking to become an energy hub in the South American region, Peru is encouraging energy integration projects with Ecuador, Colombia and Chile in electricity, Brazil in hydropower, and Bolivia in gas. Peru has electricity interconnections with Ecuador through two transmission lines (500 kilovolts (kV) and 220 kV). Agreements with Bolivia intend to support transportation of its gas to the LNG terminal in Peru. Additionally, Peru and Bolivia are undertaking studies in electricity to assess the potential of interconnecting their power systems to jointly supply electricity to Chile.

1.4.2 Energy markets and investment

The Peruvian economy became more market-oriented following structural reforms in the 1990s, resulting in the privatisation of the mining, electricity, hydrocarbons and telecommunications industries. Several laws established a regime under which domestic and foreign investments are subject to equal terms, and this has encouraged foreign companies to participate in almost all economic sectors. In 1999, Peru passed the Law for Promotion of Natural Gas Industry Development (Law 27133), which established specific conditions to promote the development of the natural gas industry (El Peruano, 1999).

In recent years, Peru has expanded and streamlined the available investment schemes, with a particular focus on areas involving exports, infrastructure and services to the population. As such, investments in oil and gas upstream activities are conducted under licenses or service contracts granted by the government through the MEM. Some of the conditions in upstream and downstream activities are summarised in Table 2.

Table 2: Investments required according to the Energy Plan 2014–25

Upstream Activities	
Exploration	Authorisation up to seven years.
	The Ministry of Energy and Mines can extend it up to three additional years.
Exploitation	Maximum 30 years for crude oil.
	Maximum 40 years for non-associated natural gas and condensates.
Downstream Activities	
Transportation	Conducted by ships or pipelines.
	Concession up to 60 years.
Refinery	Authorised by the General Directorate of Hydrocarbons (Ministry of Energy and Mines).
Distribution	Liquid hydrocarbon and similar hydrocarbon by-products require authorisation from the Ministry of Energy and Mines.

Source: E&Y (2014).

The increasing energy demand and the abundance of natural gas will challenge the economy to increase energy investments to meet future energy infrastructure requirements. Peru's Energy Plan forecasts that USD 50 billion investments will be required in the energy sector, given the expected rapid GDP growth rates.

1.4.3 Energy efficiency

In 2000, the government passed the Law for the Promotion of the Efficient Use of Energy (Law 27345). Consistent with this legislation, the Peruvian Government promoted energy-saving measures in the public sector, such as replacing less-efficient incandescent lamps with compact fluorescent lamps and acquiring equipment with energy efficiency labels.

In 2009, the MEM presented the Benchmark Plan for Efficient Use of Energy from 2009 to 2018. The plan aims to reduce energy consumption by 15% from the 2007 levels by 2018 through energy efficiency measures. The plan includes an analysis of energy efficiency in Peru and identifies sector programs that could be implemented to achieve the proposed targets. Actions outlined in the plan include lighting systems, boilers and engines replacement, as well as the implementation of labelling schemes for computers. To date, the implementation of the plan has been delayed due to a shortage of audit firms and lack of incentives for the mains stakeholders.

In May 2010, the Peruvian Government created the General Directorate for Energy Efficiency (DGEE), within the Vice-Ministry of Energy, as the technical regulatory body, proposing and assessing energy efficiency. The DGEE also leads the energy planning of the economy, and is responsible for developing the National Energy Plan.

1.5 Energy Security Policy

In 2012, the Peruvian Government published the Law to Ensure Energy Security and Promote the Development of the Petrochemical Industry (29970). It states that energy security becomes a matter of high interest in Peru and mandates the diversification of energy sources, the reduction of external dependence and an increase in the energy supply chain reliability. The law also mandates the construction of specific infrastructure projects such as parallel pipelines to the Camisea gas pipeline and the Camisea products pipeline, as well as an LNG imports regasification terminal.

Moreover, Peru is expected to become more dependent on both crude oil and oil products imports as the rapid growth of the transport sector increases the demand. To address this challenge, the government is overhauling the existing facilities of the Talara refinery so that heavy oil can be refined domestically. The project, with a cost of around USD 3.5 billion, is expected to increase the refinery capacity from 65 to 95 thousand barrels per day (Kbbl/d).

The government is also encouraging state-owned companies to become more active in hydrocarbons exploration and production projects. The government is reducing the time required to obtain exploration permits and facilitating communication with local communities to help reduce protests against exploration and production of extractive activities.

1.5.1 The Peruvian Southern Gas Pipeline (GSP)

As already stated, almost the totality of gas production in Peru is transported by a single pipeline, the Camisea Gas Pipeline. As a way to diminish the vulnerability of depending on a single gas transport system and provide other regions access to this fuel, the Peruvian government conceived the construction of an alternative gas pipeline transporting the Camisea field's gas to the South of Peru. The Peruvian Southern Gas Pipeline project involves the transport of gas produced in the Cusco region to the southern coastal city of Ilo through a 1,000km, 32-inch diameter pipeline system divided into three sections. The project originally had as potential clients, thermal power plants, a petrochemical complex, industry and residential users.

The Peruvian Government awarded in 2014 the contract to a consortium integrated by Brazilian company Oderbrecht and Spaniard Enagas. The construction started in 2015. However, on January 2017, the Peruvian government ended the contract, after the consortium failed to meet its financial deadline.[1] The consortium lost trust from banks financing the construction due to the ongoing investigation on alleged corruption cases of Oderbrecht in Brazil, Colombia, Mexico, Peru and other countries. The construction of the pipeline had at that moment a general progress of around 40%.[2] Companies such as Sempra showed initial interest an acquiring the gas pipeline and continue its construction but withdrew from negotiations arguing the government's "inability to provide necessary assurances that the concession would not be canceled due to alleged legal violations by the seller."[3]The Peruvian government will start a new bidding process and expects the contract to be awarded to a new consortium in early 2019 and only after that, construction works will restart.

1.6 Natural disasters in Peru

1.6.1 Earthquakes and tsunamis

More than half of APEC members including Peru, are located in the ring of fire – a string of volcanoes and sites of seismic activity around the edges of the Pacific Ocean (Figure 19). Roughly 90% of all earthquakes occur along the Ring of Fire, and the ring is dotted with 75% of all active volcanoes on Earth.

[1] https://elcomercio.pe/economia/negocios/gobierno-pone-concesion-gasoducto-sur-peruano-160547

[2] http://rpp.pe/economia/economia/gobierno-oficializo-fin-del-contrato-del-gasoducto-sur-peruano-con-odebrecht-noticia-1031322

[3] http://www.ogj.com/articles/2017/01/peru-to-cancel-natural-gas-pipeline-contract.html

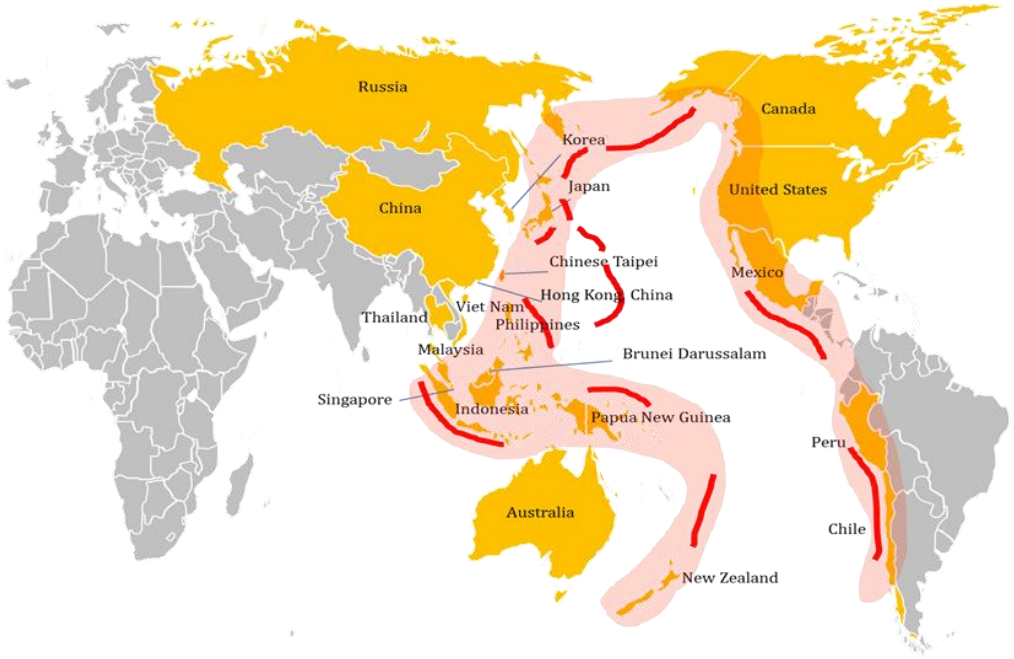


Figure 19: The Ring of Fire, an area prone to earthquakes and volcanic eruptions

Source: APERC (2016)

Since 2000, more than 100 earthquakes with magnitude above 5.5 have hit Peru. In 2007, an 8 magnitude earthquake struck the central coast, just west of the major city of Pisco. It killed nearly 600 people. On July 2017, an earthquake with a magnitude of 6.4 struck off the coast of Peru. However, the earthquake did not cause fatalities.

In addition to the devastating earthquakes, there have been tsunamis due to strong tremors. Data from the US National Centers for Environmental Information (NCEI) showed that two big tsunamis happened in 2001 and 2007 with maximum water heights reaching 8.8 metres and 10.05 metres, respectively (NCEI, 2017). Both of the tsunamis were caused by earthquakes with magnitude of 8.4 and 8.0, accordingly.

A report from New Zealand Society for Earthquake Engineering (NZSEE) that visited the affected areas during the earthquake-tsunami incident, shows there were no damage to major distribution networks while a storage facility for oil and other liquids was less affected (NZSEE, 2008).

1.6.2 Heavy rains and mudslide

From January to March 2017, Peru was hit with extremely heavy rains. This record downpours caused rivers to overflow, triggering landslides and leaving thousands homeless. This disaster forced the government to declare a “state of emergency” in the affected regions.

An unusual bout of heavy rains powered by El Niño conditions have drenched parts of Peru with 10 times more rainfall than normal, causing rivers to overflow, and mudslides to destroy roads, houses and farms. More than 70 deaths have been attributed to the flooding, which has isolated hundreds and displaced thousands (The Atlantic, 2017).

2. First Stage of oil and gas supply emergency: Oil emergency scenario

2.1. Background

The La Pampilla refinery is the largest refining complex in Peru. It is located in the Port of Callao, near Lima, and is owned by Spanish company Repsol. The La Pampilla refinery has a total capacity of 102 thousand barrels per day (Kbbl/d), consisting of two atmospheric distillation units: Distillation Unit 1 with 34 Kbbl/d capacity; Distillation Unit 2 with 73 Kbbl/d capacity; and 2 vacuum distillation units with 27 Kbbl/d and with 26 Kbbl/d, respectively.

This refinery contributes to about 51% of Peru's refining capacity. The La Papilla refinery produces, mainly, LPG, gasoline, diesel, jet fuel, fuel oil and asphalts. The refinery is located in a seismic area, close to the Pacific coast. On top of that, there is no major pipeline connecting it with other major infrastructure like Talara refinery, the second largest in Peru.

2.2 Oil products demand in the past years

Diesel makes roughly 45% of oil product demand followed by LPG with slightly above 20% and gasoline with below 20%. Over a 24-month period, oil product demand in Peru has increased by 27%, from 6302 Kbbl/d to 8003 Kbbl/d.

Transport recorded the highest share in oil demand with 65% of total oil products demand, followed by industry 15% and residential 10%. Based on Peru's National Energy Plan 2014-2025, oil demand is expected to increase at 2.5%/year.

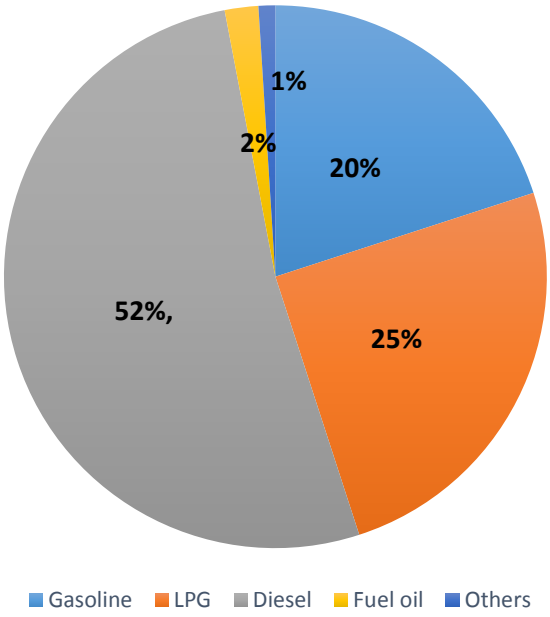


Figure 20: Oil products consumption in Peru, 2016

A further breakdown in transport sector shows that the Central Coast region concentrates most of the private and public transportation vehicles in Peru (65%). Nearly 40% of gasoline demand and 29% of diesel demand in this region is supplied by the La Pampilla refinery (Figure 21).

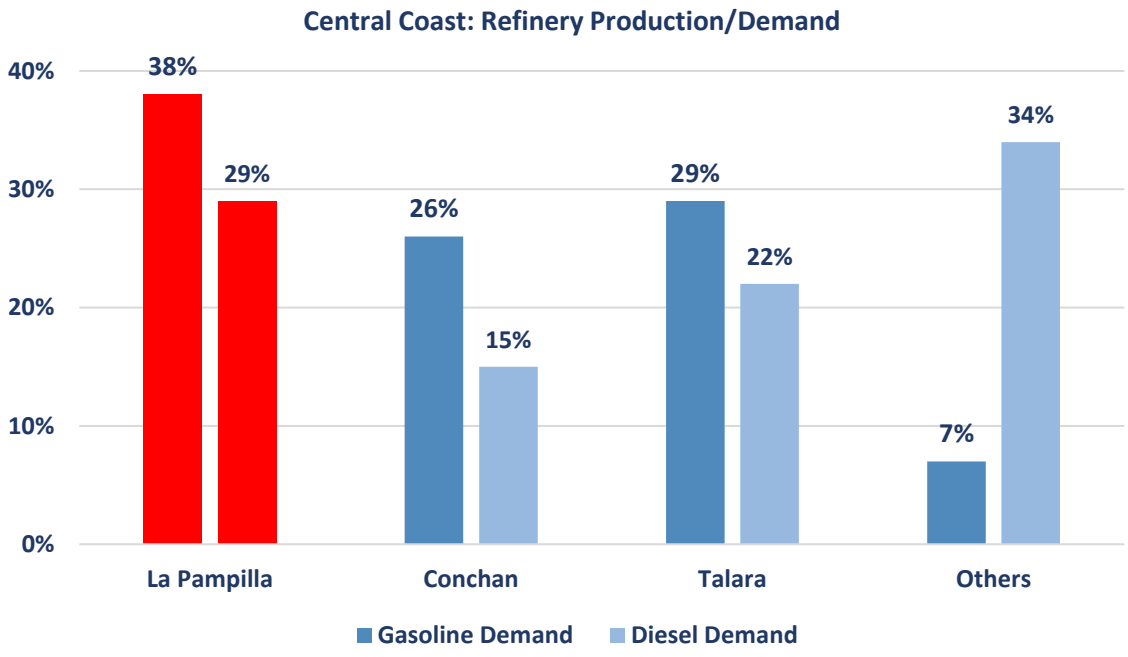


Figure 21: Central coast oil products supply and demand by refinery, 2015

Source: Osinergmin

2.3 The Emergency situation assumptions

Peru's central coast region, where Lima is located, was hit by an 8.8 magnitude earthquake. The earthquake was followed by a tsunami, leaving heavy damage to key infrastructure (Panamericana Highway and main avenues in Lima and the Constitutional Province of Callao) (Figure 22).

- Because of the earthquake and tsunami, the La Pampilla refinery has completely stopped operations due to damages caused by both, the earthquake and the tsunami.
- With a total and abrupt shutdown of the La Pampilla refinery, expected cargoes of crude oil will have to be either diverted or postponed.
- The main impact will be in the central coast region where around 40% of the gasoline and 30% of the diesel consumed are produced in the La Pampilla refinery.
- This will have very severe consequences since most of the vehicle fleet and transport fuels demand is concentrated in Lima and its surroundings.
- Distillation Units 1 and 2 were heavily damaged after the earthquake and tsunami. This resulted in a total loss of production of fuel products and around 50% of stock products. Based on the results of the last inspection, the repair of the damaged Distillation Units 1 and 2 facilities is expected to take at least 2 months and, at least, 3 weeks for vacuum distillation units.
- The only refinery that could absorb additional crude oil processing would be the Talara refinery, but only up to 65 000 b/d.
- Alternative supply routes have to be identified to cover the central coast demand during the time the La Pampilla refinery is shut down.

Figure 22: Earthquake epicentre and tsunami affected area, 2008-16

Source: APERC Scenario and Google Map

2.4 The Response

The participants assessed the level of supply shortages resulting from the earthquake and the tsunami as a severe case for an emergency, mainly due to lack of supply alternative. The Peruvian participants acknowledged that La Pampilla supplies 40 % of gasoline and 30% of diesel in Peru, affecting more Lima where the biggest fuel demand is located and that the alternative largest refinery is located in Talara, more than 1,000 km north of Lima.

The participants noted the transportation sector was the most affected. They also assessed the integrity of energy supply in Peru, focusing on alternative refining complexes not affected by the earthquake. A contingency fund was mentioned by some participants, although this could not be confirmed during the exercise, to procure oil products from other producers during the domestic supply disruption.

The response included the following actions:

- Assessing the integrity of the affected refinery as well as other refining complexes;
- Importing extraordinary oil products cargoes by ship;
- Review basic services first, such as hospitals and food distribution;
- Rationalising demand.
- Cancelling non-essential activities – such as school and university classes in order to reduce oil consumption.
- The government should use contingency fund, in order to buy oil products.

- Using production from the Talara refinery as reserve. Although the Talara refinery has its own market and with less capacity than the La Pampilla, the refinery may able to increase production more than normal for emergency purposes, even by sacrificing quality over quantity.
- Buying oil products from Chile.
- Clearing major highways and roads that were damaged. This is especially important in order to transport oil products from other refineries or terminals.
- Allocating personnel and fuel for machinery needed to clear the highways and other obstacles;
- Important institutions such as the army have individual contingency plans. To have numbers that can help to measure disaster relieved.

3. The Second Stage of the oil and gas supply emergency: The gas emergency scenario.

3.1 Background

From January to March 2017, Peru was hit with extremely heavy rains. This record downpours caused rivers to overflow, triggering landslides and leaving thousands homeless. This disaster forced the government to declare a "state of emergency" in the affected regions.

An unusual bout of heavy rains powered by El Niño conditions have drenched parts of Peru with 10 times more rainfall than normal, causing rivers to overflow, and mudslides to destroy roads and farms. More than 70 deaths have been attributed to the flooding, which has isolated hundreds and displaced thousands (The Atlantic, 2017).

3.2 The Camisea Gas Pipeline

The Camisea gas pipeline connects Peru's biggest gas field, Camisea, in the Cusco region to the coast in Ica, mainly for an export liquefaction plant (Peru LNG), and then to Lima, predominantly for power generation.

The Camisea gas pipeline cross multiple regions - Cusco, Ayacucho, Huancavelica and Lima- before arriving at the Melchorita Peru LNG export terminal and then continuing Peru's capital city (Figure 23). Roughly 30% of the pipeline is located in Huancavelica, one of the most affected regions by the flood. A natural gas liquids (NGLs) pipeline runs parallel to the gas pipeline between Camisea and Ica. The Melchorita Peru LNG liquefaction plant, located in the Ica region, is the only LNG export terminal in Peru with a capacity of 920 Mmscfd.

Figure 23: The Camisea gas pipeline

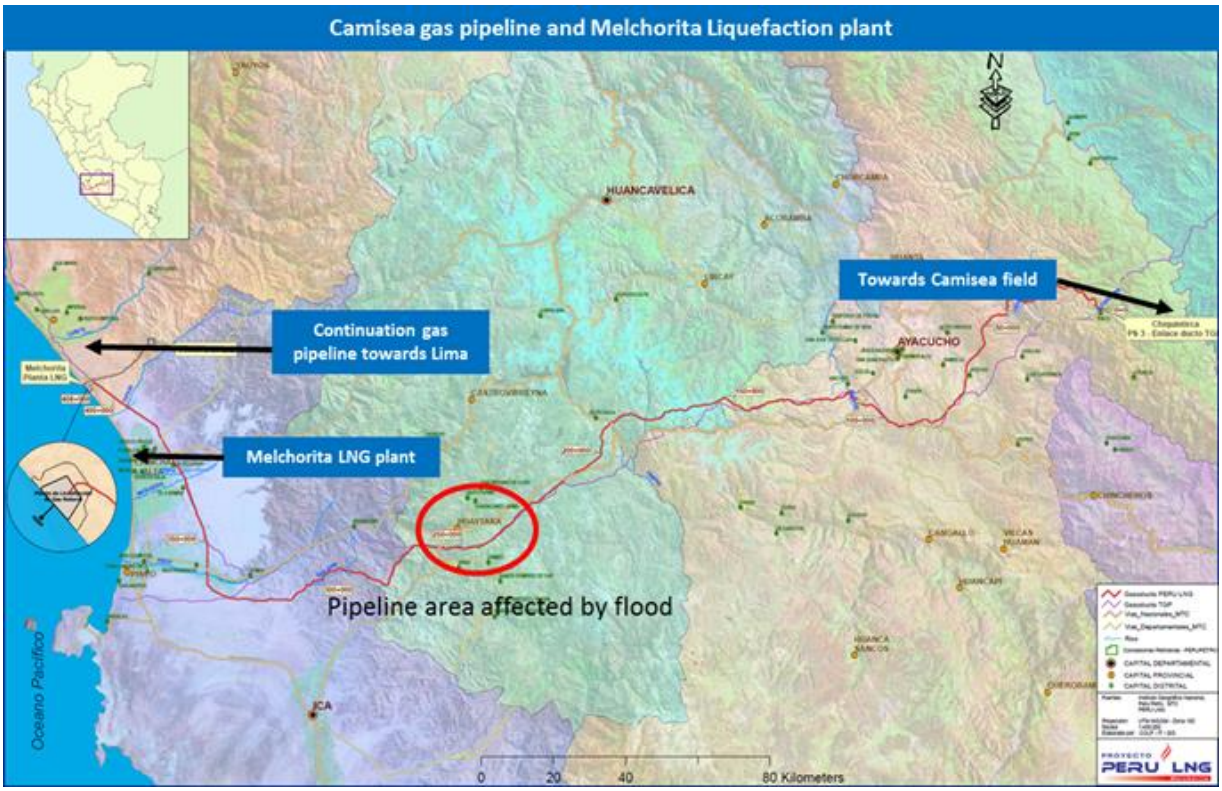
Source: Osinergmin

3.3 The Emergency situation assumptions

As in early 2018, once again heavy rainstorms hit Peru, triggering another emergency. This time, the extraordinarily strong rains caused a massive landslide, also known as *huaico*, that destroyed everything in its path in the Huancavelica region, where the Camisea gas pipeline traverses.

This landslide fractured the Camisea gas pipeline, which transports more than 90% of Peru's natural gas coming from the Camisea field (Figure 24).

Figure 24: Camisea gas pipeline affected by the landslide



Source: APERC Scenario

- As a consequence of the broken pipeline, Transportadora de Gas del Peru (TGP), the pipeline operator, reported that all natural gas flows have completely stopped. The lack of natural gas would put Peru's energy sector in a critical state.
- At the same time, the repair team cannot reach the damaged area due to safety concerns as heavy rains are still happening. Repairing of the pipeline and the normalisation of the natural gas flows might take around 3 weeks, depending on the extent of the damage.
- The impossibility to transport the Camisea's field gas to the Ica region and to Lima has two immediate implications:
- The shut-down of about 50% of total power generation capacity. Even by turning on oil-fuelled power plants into the grid, blackouts are expected. Additionally, industrial and residential users in Lima will face, at least partial, shortages of natural gas; and
- LNG exports from Melchorita's liquefaction plant will be totally interrupted.

3.4 The Response

The participants assessed the damage level of the gas pipeline caused by the landslide due to unusual heavy rains. As Peru relies heavily on the gas supply from the Camisea gas field (98% of gas production), the participants also assessed this scenario as a severe case for emergency as it cut off

practically all gas supply for domestic use in power generation, industry, commercial and residential sectors, and LNG export. The participants also assessed the lack of flexibility of fuel options of the current gas power plants. They also expected public panic and possible electricity blackouts.

The participants' responses were around these main actions:

- Assuring other sections of the Camisea pipeline or other gas pipelines have no fractures or leaks.
- Maximising as much as possible hydropower generation.
- Turning on to maximum capacity all power plants fuelled by oil and coal.
- Importing as much electricity as possible from Ecuador.
- Rationalising power demand and leaving only vital facilities like hospitals and water plants with uninterrupted power supply.
- Suspending all LNG export cargoes.
- Using whichever volumes are available in the Peru LNG Melchorita liquefaction plant storage tanks to send it to power generation facilities.
- Using and importing as much LPG as possible as a substitute for natural gas, especially for commercial users.

4. GENERAL OBSERVATIONS AND RECOMMENDATIONS FROM THE EXPERT TEAM

For this exercise, APERC formed an expert team composed of six specialists on energy security from other APEC economies. The list of the experts can be found at **Annex III**. Around 30 Peruvian representatives from relevant agencies and companies participated in the exercise, engaging in productive discussions about energy security in Peru. The participants gave their responses on both scenarios presented, in which hypothetical supply disruptions on the oil and gas sector were assumed. Taking the participants' responses and the Peruvian energy sector characteristics, the Review expert team provided the following recommendations:

4.1 Pre-emergency preparation

1. Peru should to carefully redesign its emergency management organisation, particularly involving disruptions in oil and gas supply.

2. It is important for the government to establish a robust database with almost real-time data in order to take more informed decisions during emergency periods. This database should include information on available infrastructure such as:

    - Power generation installed capacity, reserve margin and spinning reserve margin.
    - Main supply routes (e.g. sea/pipelines) and secondary supply routes (e.g. land tankers).
    - Energy demand estimates of essential services such as hospitals, search and rescue, reconstruction services, etc.
    - Keep tracking inventory or stocks levels on a real-time basis as well as data on oil and gas demand at least twice a month. The data should also include crude production, crude oil and products import volumes, refined volumes for each refinery, sales, and stock levels in each terminal; and
    - Have a complete database of pipelines, ports and land tankers capacity.

4.2 Institutional arrangement

3. It was not clear if Peru has any inter-ministerial or coordinating body to involve key ministries and agencies for oil and gas emergency responses.

4. There was confusion on which agency should be responsible for supervising and enforcing the oil and gas distribution during the emergency period.

5. Limited data, lack of information, and regulations hinder finding the best measures to reduce demand during emergencies. Instead, lack of coordination and miscommunication may lead to public panic and sudden surges in fuel prices.

6. Constant cabinet shifts due to political changes and the lack of a public career in the Ministry of Energy and Mines affect the institutional quality and governance of the sector. This is reflected in a lack of continuity on policies and long-term energy planning.

7. A clear emergency protocol, with short and long-term measures, needs to be in place. Although Peru has an emergency response system embedded into the National Civil Defence System, or *Sistema Nacional De Defensa Civil* (SINADECI), it is not clear the role which each institution is to play when an emergency struck. SINADECI was established as part of the efforts of the government to mitigate big scale natural disasters effects.

8. The Ministry of Energy and Mines should:

    - Set up a task force to develop an emergency operation like the U.S. FEMA or U.S. Office of Electricity's emergency management office
    - Engage private industry, governmental organisations, and non-governmental organisations to establish lines of communication that could be utilised during emergencies
    - Determine entities that, during the emergency, will be responsible for:
        - Co-ordinating information;
        - Communicating with the public and making press releases;
        - Performing supply analysis to determine the extent of the emergency ;
        - Providing overall coordination of emergency relief efforts;
        - Clearing highways;
        - Coordinating private and government organisations contributions;
        - Mandating restrictive policies like odd/even rationing or rolling blackouts;
        - Soliciting aid from other governments and international support.
        - Reviewing marine or import laws to assure they do not interfere with the emergency response effort.
        - Assessing:
            - the damage to refinery or pipeline facilities,
            - the ability to import additional refined products,
            - the ability to import additional gas and electricity
            - the ability to reduce demand (liquid fuels, electricity or gas)
        - Purchase additional liquid fuel to supply the public.
        - Make the decision to reduce demand.
        - Relax diesel sulphur regulations where technically possible
    - Co-ordinate government efforts with non-governmental organisations and industry.

9. Besides having short and long-term measures, Peru needs to have a contingency plan for each sector and fuel, with a complete risk analysis and review of possible impacts. An economy-wide level energy planning should include scenarios that consider disaster or emergency events.

10. The government should establish clear roles and responsibilities for agencies involved in emergency responses, with a specific organisation taking the lead, probably the Ministry of Energy and Mines.

11. The Ministry of Energy and Mines or the designated leading organisation should involve other stakeholders (industry, government and non-governmental organisations) in their emergency protocol making process.

12. Peru's energy security law (29970) mandates power generation diversification, redundancy and the construction of specific infrastructure projects. However, after more than 4 years of its enactment, only a few of the law stipulations have been fulfilled. The Ministry of Energy and Mines should take action to accomplish effectively an enhancement of Peru's energy security.

13. Further regulations, other than the energy security law, should delimit responsibilities and actions to take in order to control energy supply and demand during emergencies.

4.3 Communication strategy

14. When energy emergencies happen, governments should inform the public with clear and accurate data on the degree of supply disruption and the impacts on fuel consumption. The main purpose of an effective communication strategy is providing the public assurances and certainty in order to avoid panic and chaotic situations.

15. During an emergency, it is crucial that the leading institution becomes the official and only interlocutor with the public. This can be the Ministry of Energy and Mines of Peru or other institution that is better suit the role. The goal is to avoid confusion and miscommunication that could lead to uncertainty and panicking.

16. To establish an effective working communication strategy, the government needs to engage private industry, other government ministries and agencies, and non-governmental organisations. Moreover, clear communication is also essential among actors coordinating emergency response measures.

4.4 Supply measures

4.4.1 Oil supply emergency

17. Based on the participant's responses to the oil supply emergency scenario, the Review Expert Team recommended some steps that need to be taken such as:

    - Requesting relevant stakeholders co-operation, like industry and big consumers;
    - Working closely with refinery owners to find ways of supplying lost production;
    - Co-ordinating with oil product traders that are currently importing 80 MBD of products (mostly diesel) to engage them in helping to import additional gasoline and diesel through existing channels;
    - Co-ordinating with PetroPeru, the state-owned oil and gas company, to determine if additional crude could be run at their refineries;
    - Releasing the obligatory 15-day inventory requirement to enable refined products to be available in an interim period;
    - Determining the feasibility of liquid fuel rationing (like odd/even rationing);

18. When disasters struck, the government should make an early assessment of the damages on infrastructure.

19. Peru should encourage increasing domestic crude oil production and trying to reduce oil imports if market conditions are favourable.

20. The current government's policy promoting ethanol usage on top of gasoline and biodiesel is a right move. However, a thorough evaluation should be done about the net effects on Peru's energy sector, in accordance with the biofuels law. Despite challenges in long-term ethanol storage, Peru should be able to secure domestic ethanol production.

21. The private sector needs consider an increase in stock levels and allocate them strategically. Currently, Peru has oil product stocks for around 10 days of normal consumption, while crude oil stocks level is around 20 days. These levels are insufficient to respond to a major oil supply disruption.

22. Peru should set up an organisation responsible for monitoring and holding oil products stocks on behalf of the government which can only be used during emergencies. This inventory should be separated from private stockpiles. Once the emergency protocol is triggered, after all private sector's fuel stocks are depleted, the government stock can be used as a last resort measure. The main purpose of this stock is enhancing Peru's energy security, providing a signal of reliability and preparedness to the public

23. As a complementary measure to establishing an oil stockpile agency, the government can do so through a different approach by setting up a joint oil stockpiling company with the private sector, as is the case in Japan. More than two oil companies or relevant company can set up an oil joint stockpile company to increase capacity in the private sector.

24. Japan's experience is to provide very low bank interest under government loan guarantees to the private sector for purchasing crude oil that will be used for additional stocks can be another option for Peru to follow. In Japan, the private sector usually has stocks for around 45-days operation, but the petroleum stockpile act requests the private sectors hold additional stocks for at least 70 days including 45-day operation stocks.

25. Reasonable stock volumes levels should be decided according to each sub-region consumption patterns. A detailed sub-regional research in oil consumption levels should be conducted.

26. Plan energy emergency rationing programs for each refinery, prioritising the most consumed fuels in the respective region, in order to have enough stocks to face supply disruptions.

4.4.2 Gas supply emergency

27. Diversifying power generation sources. Currently, Peru relies on gas to generate 60% of its electricity supply. On top of this high dependency on gas, almost all gas is transported by a single major pipeline, as a result, the power sector faces high risks of failure and vulnerability to disruptions. Promoting actively power generation with other sources such as solar, wind, bio-thermal and geothermal is crucial for Peru's energy security and should a top priority for energy policy.

28. Analyse the feasibility of building a Floating Storage and Regasification Unit (FSRU) to import gas. This will help to secure gas deliveries, in case of supply disruption. A small volume liquefied plant, LNG tank lorries, bulk storage tanks, satellite system are proven technologies that should be considered as alternatives.
29. Reactivate the construction of a second major gas pipeline (*Gasoducto Sur Peruano*) from the production area to other consumption areas, as part of long-term security measures. Despite high in investment, this initiative will help Peru to have a more secured system.

30. Peru needs to take into consideration infrastructure planning and investment strategies to improve flexibility on gas supply in pre- and post-disruption scenarios; these issues should be included in the long and medium-term energy plan.

31. The Ministry must find an agreement in which Peru LNG's liquefaction plant storage capacity can be used in emergency cases.

32. New tools like the energy planning platform being developed currently by Peru's Ministry of Energy and Mines will be key to run extreme scenarios, assess its consequences and propose alternatives to make the existing infrastructure more resilient.

33. It is important to update the National Energy Plan, involving the private sector and academia, in order to set clear short- and long-term energy security policy objectives. It is also necessary to review the sector's regulations, in particular, those related to investment incentives to attract capital and technology from investors willing to bet on Peru's hydrocarbon exploration, production and general industry development.

34. In extreme cases and given the high dependency on natural gas for power generation, Peru needs to introduce dual fuel power generators. Alternative fuels like diesel or fuel oil should be readily available on-site to replace gas in case of gas interruption happened.

35. As a last resource measure, determine the feasibility of electricity rationing in an ordered way (rolling blackouts, demand reduction by closing schools or government).

4.5 Demand measures

36. Peru needs to consider a fast and reliable fuel switch option to meet demand when facing supply disruptions. Liquefied petroleum gas (LPG) can be a good alternative fuel in case of emergency. Due to its relative easiness to transport during emergencies, having an LPG stockpile may help to alleviate some of fuel supply constraint during any major disaster.

37. Fuel quality and standards relaxation should be introduced during oil supply disruption. This standard relaxation allows oil companies to import a wider selection of crude oil products during a specific and clear period.

38. Energy savings and conservation programs need to be expanded to all economic sectors in order to reduce global energy consumption.

4.6 Regional cooperation

39. Stablish potential bi-lateral reciprocal emergency cooperation mechanisms between Peru and its neighbours Chile, Ecuador, Colombia, Brazil and Bolivia, for energy supply during emergencies.

40. Take advantage of the supports of regional organisations such as the Latin American Energy Organization (OLADE) or the Organization for American States (OAS) should be able to help these economies to establish a broad and functioning emergency framework.

41. Develop cooperation agreements with APERC and APEC member economies to learn from the best international practices.

4.7 Data

42. Oil production and acquisition data should be collected at least twice a month instead of on a monthly base. If possible, data acquisition on a weekly base would be even better. The government and policy makers should have more precise data on crude production, crude and oil products import volumes, refined volumes per refinery, sales amount, and stock levels in each terminal.

43. Given the seismicity in the coastal region, a study of tsunami's possible effects should be conducted. The simulation should include possible damages and setup of counter measures to mitigate its damage including evacuation method. Japan conducted such studies in several regions after the 2011 Great East Japan Earthquake.

4.8 General recommendations

44. Peru must have clear procedures and protocols to be followed during emergency response operations in every relevant energy facility such as refineries, importing terminals, power plants, etc.

45. The Ministry of Energy and Mines together with OSINERGMIN should conduct similar security exercises, which are essential to prepare the government and relevant industries for emergencies. They should be conducted on a regular basis. Decision makers at the highest level need to be present in this type of workshops

46. Similarly, energy policy officials should be trained in risk prevention and response actions in emergency situations.

5. CONCLUSION

Despite the existence of an Energy Security Law and the relatively high vulnerability of some fields of the Peruvian energy sector, such as diesel production, natural gas transport and power generation, the relevance of energy security and an energy emergency response approach need to be further strengthened in Peru's planning. During the exercise, although participants generally agreed there is a need for long-term planning and emergency response preparedness, they emphasised that Peru has been focusing supply security, mainly, if not exclusively, by infrastructure development.

In the oil sector, Peru relies heavily on both crude oil and product imports. Crude oil and product imports should be strategically diversified. Ecuador is the main source of crude oil imports while the US dominates, to an even higher degree, oil product imports. More than half of domestic refining capacity is concentrated in a single complex, La Pampilla. On the other hand, Peru's government is expanding the Talara Refinery with 90 Kbbl/d of installed capacity. This new complex will be in operational by 2020. However, almost all of Peru's import facilities and refineries are located on the Peruvian coast, in which earthquakes and floods are common.

Regarding the gas sector, the Camisea field is responsible for around 95% of Peru's natural gas production and 60% of Peru's LPG production. Both natural gas and LPG are transported via a couple of pipelines and is used to provide around 45% of Peru's electricity. Therefore, these sectors are severely exposed to any disruptions, particularly in the Amazonian region, where there are no other transport alternatives and access to the region is extremely complicated. Until now, these disruptions have been treated by the Peruvian government as supply emergencies and reacting by dispatching cold reserve turbines -strategically built for addressing these impasses-, halting natural gas exports, and immobilizing LPG stocks.

Although the participants in the exercise were aware of the existing regulations to deal with emergencies in the energy sector, Peru has to carefully redesign its emergency management organisation, particularly involving disruptions in oil and gas supply. The exercise also exposed that Peruvian authorities did not have a clear responsibility distribution during an emergency scenario. Much of the conversation and questions were focused on what Peru has done wrong in the past and what Peru should do in the future. There was little conversation on what the government should and can do to avert the exercise crisis.

The Ministry of Energy and Mines along with other Peruvian institutions should consider establishing a brand-new governmental organisation that is responsible for emergency response in the oil and gas sector. Perhaps, Peruvian decision-makers should consider an extension of the functions of the recently created Reconstruction Authority for this purpose. In any case, this organisation should have clear and long-term responsibilities and it should involve other relevant stakeholders like industry, government, and non-governmental organisations. It is crucial to update

the National Energy Plan to include an energy security approach, in order to set clear short and long-term objectives.

While the recommended measures, as well as other risk management and disaster preparedness plans and actions, involve considerable investment, recovery and emergency losses without preparedness are not only greater but could also be catastrophic. The benefits of governments investing in energy security are translated in a responsible use of public finances, safe access to energy and an improved quality of life.

The Expert Review Team highlights the importance of energy security and recommends the Government consider it as a top priority for the sustainable and responsible development of Peru's energy sector.

REFERENCES

APERC (Asia Pacific Energy Research Centre) (2016), *Policy Success Factors for Geothermal Electricity Development in The APEC Region* http://aperc.ieej.or.jp/file/2016/2/12/Policy_Success_Factors_for_Geothermal_Electricity_Development_in_the_APEC_Region.pdf

—— (2017), *APEC Energy Overview 2016*, http://aperc.ieej.or.jp/publications/reports/energy_overview.php

BCRP (Banco Central de Reserva del Perú) (2015), *Memoria Anual 2015*, www.bcrp.gob.pe/publicaciones/memoria-anual/memoria-2015.html

COES (2017), *Actualización Plan de Transmisión 2017 – 2026*, http://www.coes.org.pe/Portal/Planificacion/PlanTransmision/ActualizacionPTT

El Peruano (1999), *Ley para la Promoción del Uso de Gas Natural Industrial, Ley No. 27133*, www2.osinerg.gob.pe/MarcoLegal/docrev/LEY-27133-CONCORDADO.pdf

ESTO (Energy Statistics and Training Office, APERC) (2017), *APEC Energy Database*, http://www.egeda.ewg.apec.org/

E&Y (Ernst & Young) (2014), *Global Oil and Gas Tax Guide 2014*, www.ey.com/GL/en/Industries/Oil---Gas

INEI (Instituto Nacional De Estadistica E Informatica) (2011), *Perú: Estimaciones y Proyecciones de Población Urbana y Rural por Sexo y Edades Quinquenales, Según Departamento 2000-2015*, http://proyectos.inei.gob.pe/web/biblioineipub/bancopub/Est/Lib0844/index.htm

— (2015a), Evolución de la Pobreza Monetaria en Perú, https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1347/libro.pdf

— (2015b), Cifras de Pobreza, www.inei.gob.pe/media/cifras_de_pobreza/np_057-2015-inei.pdf

MEM (Ministerio de Energía y Minas) (2013), *Balance Nacional de Energía 2013*, http://www.osinerg.gob.pe/newweb/uploads/GFH/Balance%20de%20Energia%20en%20el%20Peru%202013.pdf

—— (2014), *Plan Estratégico Nacional 2014–2025*, http://www.minem.gob.pe/minem/archivos/2ResEje-2014-2025%20Vf.pdf

NCEI (National Centers for Environmental Information) (2017), *Significant Earthquake Database* https://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=1&d=1

NZSEE (New Zealand Society for Earthquake Engineering Inc) (2008), *The Pisco (Peru) Earthquake of 15 August 2007, NZSEE Reconnaissance Report, June 2008*, http://www.nzsee.org.nz/db/Bulletin/Archive/41(3)0109.pdf

OSINERGMIN (Organismo Supervisor de la Inversión en Energía y Minería) (2012), *Gerencia Adjunta de Regulación Tarifaria – GART. Energías Renovables*, www2.osinerg.gob.pe/EnergiasRenovables/EnergiasRenovables.html

—— (2013), *Reporte Trimestral de Monitoreo del Mercado Eléctrico. Segundo Semestre del 2013 Año 2 – Nº 4 – Noviembre 2014,* http://www.osinergmin.gob.pe/seccion/centro_documental/Institucional/Estudios_Economicos/Reportes_de_Mercado/RSMME_II_2013.pdf.

Proinversion (Peruvian Private Investment Promotion Agency) (2015), https://www.proinversion.gob.pe/RepositorioAPS/1/0/JER/PRESENTACION_PAIS/PPT_Por%20que%20invertir%20en%20Peru_INGL%C3%89S.pdf

The Atlantic (2017), *Peru Suffers Worst Flooding in Decades,* https://www.theatlantic.com/photo/2017/03/peru-suffers-worst-flooding-in-decades/520146/

UN Comtrade (2017), UN Comtrade Database, https://comtrade.un.org/data/

USGS (United States Geological Survey) (2016), *Minerals Information*. http://minerals.usgs.gov/minerals/

WB (World Bank) (2017*), World Bank Open Data*, https://data.worldbank.org/

ANNEX I: AGENDA

OIL AND GAS SECURITY EXERCISE IN PERU
THREE (3) DAYS PROGRAM AGENDA

Day 1 (Monday, 6 November 2017)	
8:30 (30”)	Registration
9:00 (10”)	Welcome Remarks by Peru’s Director General for Hydrocarbons – Mr. Norvic Chicchon Ugarte
9:10 (10”)	Opening Remarks by APERC President - Mr. Takato Ojimi
9:20 (15”)	Introduction of Participants
9:30 (10”)	Photo Session
9:40 (15’’)	Coffee Break
Session 1	
9:55 (15”)	Presentation on the whole schedule for the exercise case study by APERC - Dr. Kazutomo Irie
10:05 (10”)	Presentation on the Exercise Model Procedure (EMP) – Mr. Diego Rivera Rivota
10:15 (45”)	Presentation on the Preliminary Protocol of Oil and Gas Security by Peru’s Energy Planning Specialist, Mr. Henry Garcia
10:50 (60”)	Q & A
12:00 (60”)	Lunch Break
Session 2	
13:00 (20”)	Introduction of the Oil Supply Emergency Scenario by APERC including Q/A - Mr. Izham Shukor
13:20 (120”)	Discussion among Peruvian’s Stakeholders on the Response to the Oil Supply Emergency Scenario
15:20 (15”)	Coffee Breaks
15:35 (45”)	Presentations on the Response to the Oil Supply Emergency Scenario by the Coordination Officials of Peru
16:20 (60”)	Q & A, and Discussion on the Responses to the 1st Scenario
17:20	Closing of Day 1
Day 2 (Tuesday, 7 November 2017)	
8:30 (30’’)	Registration
Session 3	
9:00 (15”)	Presentation on the schedule for Day 2 by APERC - Dr. Kazutomo Irie
9:15 (15”)	Introduction of the Gas Supply Emergency Scenario by APERC including Q/A - Mr. Diego Rivera Rivota
9:30 (120”)	Discussion among Peruvian’s Stakeholders on the Response to the 2nd Stage of the Oil and gas Emergency Scenario
10:00 (15”)	Coffee Break
10:15	Continuation of Discussion
11:30 (30”)	Presentations on the Response to the Gas Supply Emergency Scenario by the Coordination Officials of Peru
12:00 (30”)	Questions/Answers and Discussion on the response to the 2nd Scenario
12:30 (60”)	Lunch Break
Session 4	
13:30 (60”)	Tentative Evaluation of the Exercise by Expert Review Team and time for experts to wrap-up.
14:30 (30’’)	Tentative Evaluation of the Exercise by Peruvian’s Stakeholders
15:00 (60’’)	Questions/Answers and Discussion on the Exercise
16:00 (15’’)	Final Remarks from Director General for Energy Efficiency – Javier Campos Gavilan
16:15 (15’’)	Closing Remarks by APERC President - Mr. Takato Ojimi
Farewell Dinner	
Day 3 (Wednesday, 8 November 2017)	
The Ministry of Energy and Mines will arrange a site tour to the Melchorita Peru LNG Export Plant for the Expert Review Team.	
09:00 (135”)	Transport from the Novotel in San Isidro to Melchorita.
11:30 (120’’)	Guided visit to the Melchorita Peru LNG Export Plant.
13:30 (135’’)	Transport from Melchorita back to the Novotel in San Isidro.

ANNEX II: LIST OF PARTICIPANTS FROM PERU

	Name	Organisation	Position
1	**Norvic Chicchon**	Ministry of Energy and Mines (MEM)	Director General for Hydrocarbons
2	**Javier Campos Gavilan**		Director General for Energy Efficiency
3	**Claudia Espinoza Zegarra**		General Directorate for Energy Efficiency
4	**Cristina Condezzo Alarcon**		General Directorate for Energy Efficiency
5	**Freddy Garcia**		General Directorate for Energy Efficiency
6	**Gianina Ibarra**		General Directorate for Energy Efficiency
7	**Felix Bernabel**		General Directorate for Energy Efficiency
8	**Roman Armando Uribe Calampa**		General Directorate for Hydrocarbons
9	**Rafael Hinope Navarrete**		General Directorate for Hydrocarbons
10	**Hector Bonilla Garayar**		General Directorate for Energy Efficiency
11	**Roberto Mendoza**		General Directorate for Energy Efficiency
12	**Manuel Heredia**		General Directorate for Energy Efficiency
13	**Jimmy Lopez Aquino**		General Directorate for Electricity
14	**Isabel Jauregui Zuniga**		Civil Defence
15	**Adolfo Medina Rodriguez**	Ministry of Transport	General Direction for Civil Air Transport
16	**Kelly Montoya Jara**	CENEPRED	Urban Planning Specialist
17	**Ana Montenegro Alfaro**	Peru Petro	Planning and Management Control Unit
18	**Ronald Orellana Pacuar**	COES	General Auditor
19	**Jose Hugo Tezen Campos**	National University of Callao	Mechanic Engineering Faculty Dean
20	**Juan Victor Loaiza Alvarez**	Cusco Regional Government	Regional Director of Energy and Mines
21	**Jaime Eduardo Mejia Cobos**	OEFA	Evaluation Direction
22	**Jesus Santeliz**	Transportadora de Gas del Peru	Technical Operations Coordinator
23	**Fredy Efrain Alvarado Nato**	Talara refinery	Maintenance Head
24	**David Lemor**	Peru LNG	Corporate Affairs Director
25	**E. Flores**	Petroperu	-

ANNEX III: EXPERT REVIEW TEAM

Name	Organisation	Position
Experts from APEC economies		
Ms. Sylvia Larrea	Inter-American Development Bank (IADB)	Lead Energy Specialist
Dr. Phoumin Han	Economic Research Institute for ASEAN and East Asia (ERIA)	Energy Economist
Mr. John Powell	Office of Liquid Fuels Analysis, U.S. Department of Energy	Director
Ms. Martha Vides Lozano	Latin American Energy Organization (OLADE)	Senior Hydrocarbons Specialist
Mr. Pedro Gamio	Institute for the Sciences of Nature, Territory and Renewable Energies (INTE - PUCP)	Professor and Researcher
Mr. Hiroaki Maruyama	Japan Oil, Gas and Metals National Corporation (JOGMEC)	Project Director
APERC		
Mr. Takato Ojimi	APERC	President
Dr. Kazutomo Irie	APERC	General Manager
Mr. Diego Rivera Rivota	APERC	Researcher
Mr. Muhamad Izham Abd Shukor	APERC	Researcher