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# Economic Watch

## Peru

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Análisis Económico

Peru
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# Peruvian electricity sector

## Short-term risks?

- **3,500 MW of capacity will be added to Peru's electricity system between 2012 and 2016**

  This new capacity will be sufficient to meet the additional 2,000 MW we forecast it will be demanded until that date.

- **However, there may be a short-term deficit given that 75% of this new supply will not come on-stream before 2014**

  Under adverse hydraulic conditions, the reserve margin would not be sufficient to cover system losses and to handle any unexpected failures in the generating units.

- **Deficiencies in the electricity transmission infrastructure are another short-term bottleneck**

  At present, there is congestion in the transmission to the North and South of the country during peak hours, but we expect to be corrected as new facilities come on-stream this year.

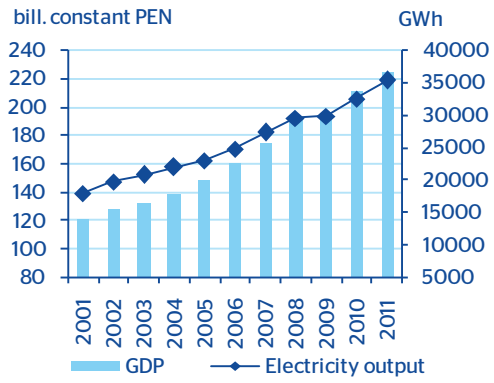
- **Prices could be used more actively to improve electricity demand distribution throughout the day, and to encourage investment**

  Increased price differentials between peak and off-peak demand could incentivize more efficient energy use, and could attract supply to meet peak demand.

- **Going forward, the pace of electricity infrastructure investment needs to be maintained**

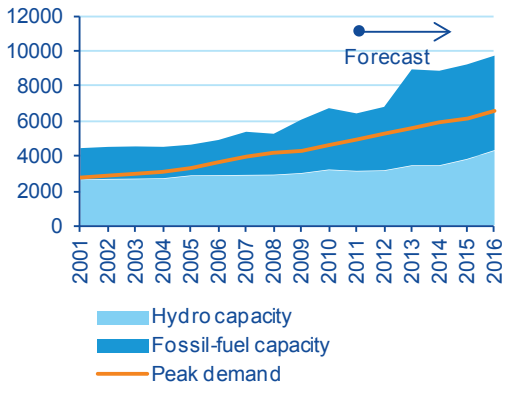
  Given the length of time such installations require, continuous work on generating and transmission capacity is needed so that these difficulties are not repeated in future.

Chart 1
**GDP and electricity production (bllion 1994 PEN, GWh)**




Source: COES, MINEM

Chart 2
**Effective capacity and peak demand (MW)**




Source: COES, MINEM and BBVA Research Peru

# Electricity demand has doubled over the last ten years as a result of economic growth

Over the last ten years (2002-2011), the Peruvian economy has grown at an average of 6.4% per year, resulting in electricity demand doubling over this period (chart 1). However, electricity generating infrastructure has not expanded at the same pace, with effective output increasing by only 43% over the same period. This has reduced system reserves (from 57% in 2001 to 13.5% in December 2012) and resulted in more intensive use of existing capacity, increasing the risk of plant failures.

Furthermore, over 80% of new capacity has been installed in the centre of the country (as a result of the availability of natural gas near Lima since 2004). This has increased transmission demands, increasing congestion on electricity transmission lines to the north and south. Thus, in February the Ministry of Energy and Mining declared an "exceptional situation" in the electricity system, enabling the tension of existing lines to be increased above normal tolerance levels. However, this also increases the volume of losses and reduces the quality of the energy distributed by the system.

## New generating capacity will be sufficient to meet demand until 2016

Based on our economic growth assumptions, we forecast that electricity demand will increase by around 2,000 MW (chart 2) until 2016. This increase will easily be covered by the new power stations currently under construction, which have combined generating capacity of over 3,500 MW. However, around 75% of this new infrastructure will only start to come on stream since the second half of 2013. Therefore, we need to differentiate between the situation in the short term (2012- 2013) and in the medium term (2014-2016).

## The reserve margin is currently lower than advisable

In April, the operating reserve margin (ORM - the difference between actual generating capacity and peak demand) for the interconnected national electricity system (SEIN) was 11.6%.

Table 1
**ORM in April 2012**

| Capacity definition | MW |
|---|---|
| Installed capacity: generating capacity under ideal conditions | 6,746 |
| (-) Losses due to actual facility conditions | |
| Effective capacity: the real supply capacity | 6,444 |
| (-) Hydro capacity losses (due to lack of water) | |
| (-) Fossil-fuel generating capacity losses (due to unavailability of fuel) | |
| (-) Planned plant maintenance | |
| Actual capacity: real-time energy supply capacity | 5,710 |
| 11.6% ↕ ORM: should cover { - Transmission and distribution losses; - Power station breakdowns | |
| Peak demand: the highest load on the system | 5,049 |

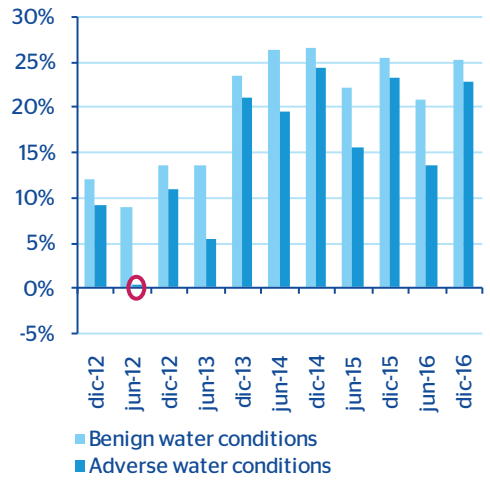
Source: BBVA Research

Is this level high or low? Under ideal conditions, the ORM should be sufficient to cover transmission and distribution losses and any breakdowns in the system. According to available figures, losses from the transmission and distribution system may be as high as 10% of the system load. This only leaves the remaining 1.6% (less than 100 MW) of the ORM to cover generating unit breakdowns. With 16 generating units with capacity over 150 MW, and with a failure indicator (FIF - the unplanned unavailability factor) calculated as around 3% (11 days per year) by the regulator (Osinergmin), there is a 50% likelihood of a breakdown at one of these power stations on any given day. If there was a breakdown at a typical natural-gas power station (around 180 MW), the system would be in deficit resulting in power outages. This situation would be even more serious in the even of an unexpected breakdown at the Mantaro power station, the largest in the country, with 671 MW of effective capacity. Whilst the regulator has set a target reserve margin of 32.7% for 2008-2012, the reference point used for this ratio was a generating capacity similar to effective output. Making the appropriate adjustments (mainly, lower capacity due to anticipated hydro conditions), we estimate that the ORM should be between 20% and 25% (1,000 to 1,250 MW) for the system to offer reasonable levels of security and reliability.

## There will be an electricity shortfall if there are adverse water conditions in 2012 and 2013

The electricity sector faces the greatest difficulties from June to August (the dry season) due to water shortfalls. During this period, the actual capacity (AC) of hydro power stations is significantly lower -between 10% and 20%- than in the months with the highest rainfall (December to April), depending on how dry conditions are. Taking this information into account, we estimate that the ORM will be between 9% and 0% in the middle of this year (June to August), depending on whether hydro conditions are benign or severe, respectively. In the former case, there would be a risk from generating failures; whilst in the latter, the system would not be able to cover any transmission or distribution losses. This would result in energy rationing or expensive imports from Ecuador, with the situation being even worse in the event of a breakdown.

Chart 3
Reserve Margin 2011-2016
Percentage of Actual Output




Source: COES, Osinergmin and BBVA Research Peru

Table 2
Main electricity generation projects
Installed capacity (MW)

| Project | Start of operations | Capacity (MW) | Type[1] |
|---|---|---|---|
| Kallpa IV | 2012 | 292 | CC fossil-fuel plant |
| Machu Picchu II | 2013 | 192 | Hydro |
| Huanza | 2013 | 91 | Hydro |
| Fénix | 2013 | 520 | CC fossil-fuel plant |
| Chilca Uno TG4 | 2013 | 270 | CC fossil-fuel plant |
| Ilo - cold reserve | 2013 | 564 | Dual fossil-fuel |
| Quitaracsa I | 2014 | 112 | Hydro |
| Cheves | 2014 | 168 | Hydro |
| Sto. Domingo Olleros | 2014 | 200 | SC fossil-fuel plant |
| Santa Teresa | 2015 | 98 | Hydro |
| Chaglla | 2016 | 406 | Hydro |

1/ CS = simple cycle; CC = combined cycle.
Source: APOYO, Osinergmin

This situation will begin to ease towards the end of this year as the Kallpa combined cycle plant comes on stream, adding 292 MW of capacity to the system. In addition, a number of smaller hydro and fossil-fuel power stations will come on stream in the first half of 2013, with total installed capacity of over 300 MW. These new plants will enable the system to cover the approximate 400 MW increase in demand in 2013. However, the ORM will remain below recommendable levels in the dry season (between 5% and 13%, depending on rainfall), leaving us exposed to system failures, especially if water conditions are adverse. We should note here that the probability of the

dry season being severe this year and next is increasing as a result of the El Niño phenomenon, resulting in heavy rains in the north of the country but drought in the centre and south of the Peruvian Andes, where 85% of hydro capacity is installed.

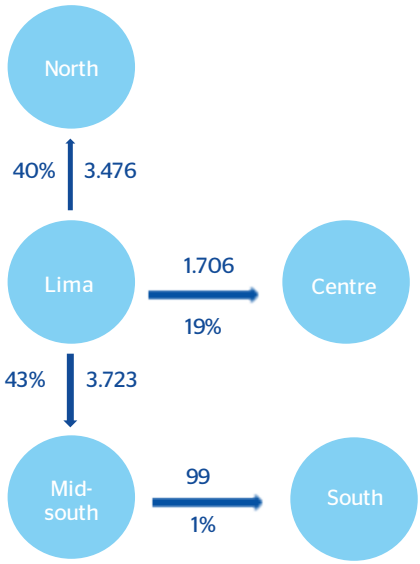
This situation would largely be alleviated if work to complete the first stage of the TGP natural gas pipeline is completed in the first quarter of 2013. This first stage will increase capacity by 120 million cubic feet per day. If 80% of this is used for electricity generation, this will add 400 MW of new capacity from the Fénix power station. However, the pipeline has faced a number of obstacles (mainly changes to its route and security issues) which could delay it coming into operation until 2014.

On the other hand, more could be done to increase efficient use of available infrastructure by encouraging higher electricity demand outside peak periods. Whilst we have seen some improvements to the distribution of demand over the last 10 years (the average ratio of minimum to maximum demand increased from 58% in 2002 to 63% in 2011), this could actually have been due to supply side restrictions. Therefore, there are still some additional gains to be made from a larger differential between peak and off-peak electricity prices, as the current ratio is only 85% for residential customers.

## Electricity transmission: an additional short-term bottleneck

Electricity supply in some parts of the country is also hampered by transmission line (TL) deficiencies. For example, the Lima Mid-south transmission line (the Campo Armiño – Cotaruse TL) suffered from congestion 43% of the time in 2011. There were similar problems with the transmission line from Lima to the north (Chimbote 1 – Trujillo Norte TL). This suggests that these lines were always overloaded during peak hours, resulting in service outages and requiring electricity imports from Ecuador (5,729 MWh in 2011). Whilst the cost of imported electricity is higher than domestic output, this demonstrates the importance of having in place the infrastructure and operational mechanisms to make use of this option in emergencies. Therefore work needs to continue on improving interconnections with other neighboring countries.

Chart 4
Congestion on main transmission lines in 2011 (hours per year)




Spurce: COES, BBVA Research Peru

Table 3
Transmission Projects Portfolio 2012-2014

| Project | Location | Start of operations | Km | Kv |
|---|---|---|---|---|
| Carhuamayo-Carhuaquero line | North | 2012 | 697 | 220 |
| Centre - Mid-north transmission upgrade | North | Dec-12 | 515 | 500 |
| Centre - Mid-south - South interconnection upgrade | South | 2013 | 1.600 | 500 |
| Pomacocha - Carhuamayo line | North | 2013 | 110 | 220 |
| Talara-Piura system upgrade | North | 2013 | 102 | 220 |
| Trujillo-Chiclayo line | North | 2014 | 304 | 500 |
| Machu Picchu-Abancay-Cotaruse line | South | Undefined | 402 | 220 |
| Tintaya-Socabaya line | South | Undefined | 207 | 220 |

Source: APOYO

## The impact of generation and transmission deficits on electricity prices for end users will be minimal

Peru currently operates a system of electricity prices based on calculation of "idealized costs". This calculates generating prices as though there were no natural gas or transmission deficit, with users being charged the costs of running the highest cost power stations (or importing energy from Ecuador) through a temporary charge. This process has a type of price discrimination towards fossil-fuel generators, under which each of them is paid according to their variable costs. To the extent that electricity deficit this year and next is attributable to unavailability of natural gas (the natural gas pipeline is currently close to full capacity and it will not be possible to use some of the fossil-fuel capacity that comes on stream in 2013) and transmission line congestion, the application of these "idealized costs" will result in moderate and temporary increases in end-user prices

## Work on new generating and transmission infrastructure should result in fewer problems from 2014

The outlook for generation and transmission in the electricity market appears more favorable from 2014. By 2014, both stages of the expansion of the natural gas pipeline to Lima should be operational, increasing supply by 390 million cubic feet per day, enabling both the Fénix (521.5 MW) and Santo Domingo Olleros (197.6 MW) power stations to generate electricity. In addition, a number of hydroelectric power stations are currently under construction, with combined capacity of over 1,000 MW; these will come on-stream in 2015-2016, covering demand and raising the ORM above 20% since 2014. However, in the event of severe adverse weather conditions, the ORM could fall below 20% in the dry season in 2015 and 2016.

On the transmission side, a number of projects are underway to upgrade transmission between the centre and north of the country. However, there could still be obstacles facing transmission to the south. For example, no completion date has been defined for the Machu Picchu – Cotaruse TL as part of its original route has been declared a protected area, and its new route (and cost) has not yet been defined.

## Installing electricity infrastructure is a lengthy business, so work needs to get going now on these new investments

In order to maintain the momentum of electricity infrastructure investment, the obstacles to transmission line installation need to be overcome as quickly as possible. In addition, ProInversión (the body responsible for promoting investments in public infrastructure) tender processes should be carried out taking into account the length of time involved in completing electricity infrastructure projects (over four years for a hydroelectric power station). Furthermore, the authorities must also make provisions to avoid any further environmental or safety obstacles arising. This must take into account that the ORM will be under 20% in 2015 and 2016 if weather conditions are adverse, and below 20%, even under normal conditions, since 2017 onwards, if no additional investments are made.

Another aspect that must be considered is that the completion of the pipeline to the south could lead to power stations being built in this area, contributing to decentralize installed capacity and decreasing demand for transmission to the south, reducing congestion and losses. This would also decrease the risks of interruptions to the unique natural gas pipeline currently available.

Furthermore, a larger differential between peak and off-peak prices could provide an incentive to improve the distribution of demand and attract supply of generating units to cover peak demand. Moreover, the idealized costs systems should not be used unrestrictedly, but only for temporary situations so as to achieve its purpose of avoiding excessive short-term price volatility, so that in the medium term prices reflect the costs resulting from infrastructure scarcity and, thus, encourage investment.

Accelerating investment could avoid future electricity deficits in the country; and this would have a positive impact on the country's potential future growth.

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