PEER REVIEW ON ENERGY EFFICIENCY IN PERU

May 2011

Report endorsed by the APEC Energy Working Group

CONTENTS

PREFACE

According to the guidelines for the APEC Peer Review on Energy Efficiency (PREE), the objectives of the PREE, endorsed by APEC leaders at their 2007 meeting are to:

- share information on energy efficiency performance as well as on policies and measures for improving energy efficiency
- provide opportunities for learning from the experience of other economies and for broadening the network among energy efficiency policy experts
- explore how energy efficiency goals on an overall and/or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstances of each economy
- monitor progress towards attaining energy efficiency goals on an overall and/or sectoral basis and implementing action plans, if such goals and action plans have been already formulated at the time of the review
- provide recommendations for voluntary implementation on how implementation of action plans could be improved with a view to achieving energy efficiency goals.

Two activities are undertaken as part of the PREE:

a) **Peer Reviews** of volunteer member economies

b) The **Compendium** of energy efficiency policies of APEC member economies based on either the APEC voluntary PREE or energy efficiency aspects of the IEA Energy Policy Review.

This report presents the results of a peer review of energy efficiency policies conducted in Peru. Peru volunteered to undertake a peer review.

The primary accountability for each peer review is shared by the economy being reviewed and the Review Team. The peer review in Peru was conducted by a team of eight experts (see Appendix A) who visited Peru from 8 to 12 November 2010.

During the visit, the Review Team had comprehensive discussions on energy efficiency with representatives and experts from government departments and private and state companies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions, especially the representatives of the Ministry of Energy and Mines who organised the event.

EXECUTIVE SUMMARY

In Peru, the organisation responsible for the formulation and evaluation of energy–mining policies is the Ministry of Energy and Mines (MINEM), which has two sub-ministries: the Vice-Ministry of Mines and the Vice-Ministry of Energy. MINEM also has responsibility for environmental issues in relation to mining and energy activities. The Peruvian Government, through the Vice-Ministry of Energy, has actively pursued energy efficiency since the 1980s and 1990s, when it created the Energy and Environment Centre (CENERGIA) and the Energy Conservation Project (PAE). PAE was created in 1994 and was the basis of a strong energy conservation campaign run by the government; after international awards and good results, in 2001 PAE was converted from a temporary project to a permanent program and it is still continuing.

In 2000, the Technical Energy Bureau of MINEM worked in the National Energy Useful Balance of 1998. This document updated the structure of the energy demand matrix and allowed to elaborate the annual net energy balance. The document concluded that the energy efficiency of the economy in 1998 was 34% due to the high consumption of wood. This document was the base of the Referential Energy Plan and the Energy Policy and Alignments released in 2001, for the period 2001-2015.

As part of the continuing strategy to improve the energy efficiency in the economy, the government of Peru developed a legal and regulatory framework covering the planning and implementation of the energy policy strategy. In 2000, the government passed the Law for the Promotion of Efficient Use of Energy (Ley de Promoción del Uso Eficiente de la Energía), Law No. 27345. This law has the objective that efficient use of energy is declared of national interest in order to assure energy supply, protect consumers, promote national economy competitiveness, and reduce negative environmental impacts. After publication of Law No. 27345, in 2002 the Peruvian government developed the Long-Term Policy Guidelines for Energy Sector which contains the Vision, Objectives, Strategic Guidelines, and the medium and long-term Policy tools for the energy sector.

The Review Team was impressed of the efforts taken by the Peruvian government to improve the energy efficiency in the economy. Special attention was the development of the Energy Efficiency Referential Plan 2009 – 2018 in late 2009, the creation of the General Directorate of Energy Efficiency (Dirección General de Efficiencia Energética – DGEE) in May 2010, the proposal to create the Energy Efficiency Centre (Centro de Eficiencia Energética – CEE), and the development of a Proposed National Energy Policy for 2010 – 2040 which is being used as a guideline document for DGEE.

The Review Team evaluates that creation of DGEE as the government office with responsibilities to formulate energy efficiency policy is a very positive step as one can clearly regard the DGEE as the government office directly responsible for developing energy efficiency policy, energy planning and the promotion of renewable energy and energy efficiency programs. Also, the proposal to create the CEE by Peruvian government has been an important step for the implementations of the energy policies developed by DGEE. At the same time, significant policy and program development related to energy efficiency also takes place within other government offices responsible for transport, housing, environment, etc. These institutions, as well as local government, need to work cooperatively to achieve

a common energy efficiency vision and objectives. However, the Review Team found that there is no sufficient common ground among these institutes, while all of them recognized the value of energy efficiency to some degree.

The Peruvian government has recognized that there is some lack of cohesiveness among the Ministries and organizations on the function of energy efficiency policy formulation and program implementation. The Review Team found that building public support for energy efficiency measures and programs initiated by the government, organizations and enterprises is a critical action to create that energy efficiency culture in the entire economy. With respect to financing investments in energy efficiency, the Review Team found that two Peruvian financing organizations do not clearly focus on energy efficiency per se; the one focuses on major energy efficiency infrastructure projects while the other focuses on fuel substitution and Energy Service Companies (ESCOs); the Review Team recommends that creating a parallel agency to both organizations to finance only energy efficiency projects in all sectors should provide the needed assistance and incentives for the building of a strong energy efficiency in Peru.

Also, the Review Team identified that it is important to focus on energy efficiency in transport sector. The use of energy in this sector is the largest one and with a high increase of natural gas consumption. The government of Peru well understands that transport sector has a high energy efficiency improvement potential by the use of clean fuels and the construction of rapid transit system. However, high dependency of petroleum products is still a challenge in the economy. The Peruvian government has focused the robust use of natural gas in the economy because of the high natural gas proven reserves as well as the implementation of several high-performance programs such as the implementation of standards and labelling for vehicles, improve traffic management, etc. However, more coordination of energy efficiency policies among relevant ministries (of energy, transport, environment and finance) should be promoted in order to manage high energy demand in future.

Finally, the recommendations made by the Review Team are aimed to strengthen the weakest links in the existing policy and programs of Peru. The energy efficiency Review team’s recommendations cover:

- EE related to institutional context;
- EE goals, targets, and strategy;
- Energy data collection and monitoring;
- Policy measures in industry sector;
- Policy measures in electricity sector;
- Policy measures in commercial and residential sector;
- Policy measures in transport sector;
- EE appliances and equipment; and
- EE related research and development.

RECOMMENDATIONS

Institutional Context

Recommendation 1 *The Government of Peru should constantly and consistently show leadership for policy-making and policy-coordination.*

Recommendation 2 *The Government of Peru should provide a proposed autonomous energy efficiency centre with a clear and strong mandate (e.g. a mandate to encourage effective implementation and evaluation of energy efficiency improvement programmes in all sectors, a mandate to compile and analyse relevant energy end-use data and to provide advice to the MINEM and other relevant Ministries on the development of energy efficiency policy/programmes). The Government of Peru should also provide this proposed autonomous centre with stable and sufficient resources to implement effective long-term energy efficiency improvement programmes.*

Energy Efficiency Goals, Targets and Strategy

Recommendation 3 *Integrate energy efficiency plans and policies across the General Directorate of Energy Efficiency (DGEE).*

Recommendation 4 *Create a Government Energy Management Program to integrate energy efficiency plans and policies across all Ministries.*

Recommendation 5 *Develop and Implement a National Action Plan for Energy Efficiency*.

Recommendation 6 *Create a pathway with annual timelines to meet the stated energy efficiency targets.*

Recommendation 7 *Set up a process for annual reviews of the energy efficiency target in the Referential Plan and include all sectors as part of the plan to increase the target over time.*

Recommendation 8 *Create a national public education and awareness campaign for energy efficiency. Tie in important national overarching goals in the message.*

Recommendation 9 *Create an energy efficiency framework that is focused on the low-income people of Peru.*

Recommendation 10 *Create an energy efficiency educational program for the school children of Peru (K-12 and university).*

Recommendation 11 *Create an economic environment for utilities to provide energy efficiency services to the people and businesses of Peru.*

Recommendation 12 *It is recommended that the project to create the Energy Efficiency Center should work as a parallel agency to PROINVERSION to finance only energy efficiency projects in all sectors.*

Energy data collection and monitoring

Recommendation 13 *Develop a set of energy efficiency indicators for economic sectors and sub-sectors.*

Recommendation 14 *Define the data needs, energy data, economic data, according to the energy efficiency indicators needs.*

Recommendation 15 *Create a legal mechanism to empower the government to obtain energy end-use data from all energy users in the economy as well as to spread the burden of data collection among the government agencies.*

Recommendation 16 *Carry out factorisation or indexation techniques on the indicators to remove the non-energy factors as well as to create economy-wide indicators by aggregation.*

Recommendation 17 *Develop an analytical energy efficiency monitoring framework. The analytical framework should help to be a communication tool for policy makers and energy users in the efforts to improve energy efficiency.*

Recommendation 18 *Publish, periodically, energy efficiency monitoring reports and disseminate the reports to stakeholders.*

Industry Sector

Recommendation 19 *The Peruvian Government should develop a comprehensive National Action Plan of Energy Efficiency in order to show the pathway to achieve energy efficiency target in industry sector and to provide common understanding among stakeholders what to be done and when to be done.*

Recommendation 20 *It is recommended to develop energy efficiency comprehensive strategies to industry sector in Peru through mandatory and voluntary measures, as well as to enforce the requirement to have EE managers.*

Recommendation 21 *The MINEM need to establish stable and secured funding source and mechanism, as well as to consider establish a special purpose fund which may be called "Energy Conservation Promotion Fund" to move the Action Plan forward. MINEM should also look for external funding sources and from private or public investment fund to mobilize some capital for energy efficiency project. It is therefore suggested that public fund (Energy Conservation Fund) should be used to initiate and leverage private sector's investment.*

Recommendation 22 *In the light of the establishment of General Directorate of Energy Efficiency and the proposal to create the new Energy Efficiency Centre, strategic positioning and clear responsibilities must be assigned. It is recommended that the recently created DGEE and the project to create the EE Centre, the DGEE should take the role of policy maker while EE Centre takes the responsibility of implementing agency. Also, it is highly recommended that capacity building in both organizations is extremely vital.*

Electricity Sector

Recommendation 23 *It is recommended that further effort be made to reduce the T&D losses and at the same time improve the thermal power plant efficiency. Audit and assessment can be conducted to identify the existing power plant efficiency and areas for improvement.*

Recommendation 24 *It is recommended that the Peruvian Government to institutionalise the legal framework within the electricity market and delivery sector. Amongst others:*

- *Regulators/OSINERGMIN together with COES to be given more power to specify and enforce EE related laws and regulation*

- *Energy projects should embed EE related requirements and specifications (as part of National Policy)*

Recommendation 25 *There is opportunity to translate the proposed demand reduction to real action plan with active involvement from OSINEGMIN/COES/transmission-distribution operator/customers through the following:*

- *Utility should also play their roles to promote and encourage Energy Efficiency*
- *Rebates and incentives to customers implementing EE projects and utilising efficient equipment*
- *Establish funding mechanism to support EE programs and initiatives*

Recommendation 26 *Proper planning is recommended for DG and RE interconnection together with rural electrification projects to ensure optimised asset utilisation, network expansion and reinforcement thus minimising network losses. This can also be linked to other initiatives towards achieving supply and load controllability, energy efficiency and Smart Grid.*

Recommendation 27 *It is recommended that the regulator enforces the requirement to have EE managers for certain type and size of electricity consumers. Thus, it is necessary to have in place a national program to develop the required competent people in EE.*

Commercial and Residential Sector

Recommendation 28 *It is recommended to conduct detailed studies on energy efficiency status in order to obtain indicators of the efficient use of energy of each economy's sector.*

Recommendation 29 *It is highly recommended to improve the energy efficiency campaign programs, incorporate energy efficiency subjects in education materials and provide effective training related to technical, financial and economic fields.*

Recommendation 30 *The Peruvian government should implement monitoring and evaluation of policies in order to establish the steps towards the next stage as well as to provide an indicator of the efficiency benchmarking*.

Recommendation 31 *It is recommended the delegation of tasks and authority of the ministries concerned.*

Recommendation 32 *It is necessary to develop and implement mandatory energy efficiency standards and seek for its international harmonization.*

Recommendation 33 *Competence development of energy managers and energy auditors.*

Recommendation 34 *It is highly recommended to develop minimum energy performance standards as a priority action in the commercial and residential sector.*

Recommendation 35 *Create efficiency program for low-income communities.*

Transportation Sector

Recommendation 36 *It is recommended that Ministry of Energy and Mines through DGEE and the Ministry of Transport and Communications should work together to develop medium and long-term planning programs.*

Recommendation 37 *The Government of Peru should develop a roadmap for the introduction of new transport technologies such as HYBRID cars as one of the alternatives to reduce the future high dependency of natural gas in the sector.*

Recommendation 38 *The MINEM, MET, MTC and MINAM should develop and implement programmes with National and International Banks in order to promote the financing of new vehicles (for mass transportation such as taxis and freights) at local and regional level for lower income drivers.*

Recommendation 39 *Government should regulate the transport (taxis and freight drivers) in order to achieve best energy efficiency practices and incentives for car drivers.*

Recommendation 40 *To follow-up on the construction of public transport such as "Metropolitano" under the Bus Rapid Transit (BRT) scheme, the electric transport of the Electric Train Lima (Metro) and others and provide more information to final users about their benefits and advantages.*

Appliances and Equipment

Recommendation 41 *MEPS should be based on energy performance of shipped products in the Peruvian domestic stock (international references shall be established on a particular energy performance that is not native to Peru). We strongly recommend that Universities or Research Institutes support to establish technical level of MEPS, these levels should consensus with all stakeholders.*

Recommendation 42 *The government of Peru should seek legal mechanisms necessary to ensure and, at the same time to comply with its constitution, to establish mandatory energy efficiency standards based on the environmental benefits involved in their implementation.*

Recommendation 43 *Peru should be supported by universities or laboratories to perform studies with measurements, surveys and statistical data to determine, where efforts should be concentrated; it is required to achieve the set goals. Efforts in Peru should be centralized, it is necessary that all efforts and past experiences to focus on the newly established office to have a starting point and new goals.*

Recommendation 44 *The international experience indicates that mandatory standardization programmes encourages market transformation, for example, the impact of mandatory standards programme on the Mexican electricity system has been significant; in terms of capacity, it has reduced the need for total generating capacity of 3440 MW, or 6.4% of capacity installed in 2005.*

Recommendation 45 *Peru could determine the mechanisms for standard monitoring compliance and therefore should implement an infrastructure (laboratories network) for compliance verification and monitoring and surveillance to verify compliance with the standards.*

Recommendation 46 *The energy saving campaigns should be addressed to recommend better energy-use habits for major energy-consuming equipment as was done in 1995. These campaigns should be permanent to encourage a savings culture, despite people tend to forget that these campaigns have become habits and habits form a culture.*

Energy Efficiency Related Research and Development

Recommendation 47 *It is highly recommended that CONCYTEC should be an independent organisation, separate from the Ministry of Education, in order to have better management autonomy and provide institutional strengths.*

Recommendation 48 *The International Cooperation Programmes should be strengthened in order to achieve more financing and investment for R&D programmes with high priority in Universities and Research Centres.*

Recommendation 49 *The Peruvian Government should increase its gross domestic expenditure in Science Research and Technology Development.*

Recommendation 50 *It is highly recommended to establish National Institutes in areas such as Hydrocarbons (e.g. Petroleum and Natural Gas) and Electricity/Renewable Energy in order to strengthen research and development in specific areas with the formation of Postgraduate professionals with Master and Ph.D. degrees.*

Recommendation 51 *It is recommended to establish a National Researchers System (Sistema Nacional de Investigadores) to be dependent from CONCYTEC in order to incentivize high quality professionals and reduce the "brain-drain" from Peru.*

PART 1: BACKGOUND INFORMATION

The background information contained in this report has been contributed by Peru. This information is intended to provide some context to the recommendations of the PREE Team. The first section discusses the trends in Peru's energy consumption. The second section provides information on Peru's energy efficiency institutions, current policies and objectives and energy efficiency programs.

1. STATISTICS, FORECASTS AND TRENDS IN ENERGY CONSUMPTION

1.1. Peru's Energy Balance in 2008

1.1.1 The primary energy consumption (energy supply)

Net Primary Energy Consumption

The gross internal supply of primary energy is considered as an aggregated of the total production as well as the variation of inventories and imports; deducting the unused energy and exports.

In 2008, the primary energy internal gross supply was at 761,422 Terajoules (TJ) showing a growth of 1.9% with respect to last year. Commercial energy represented 86% of the total internal gross supply, as shown in Table 1. This table shows an important increase of natural gas (including natural gas liquids), which increased by 21.6% with respect to 2007.

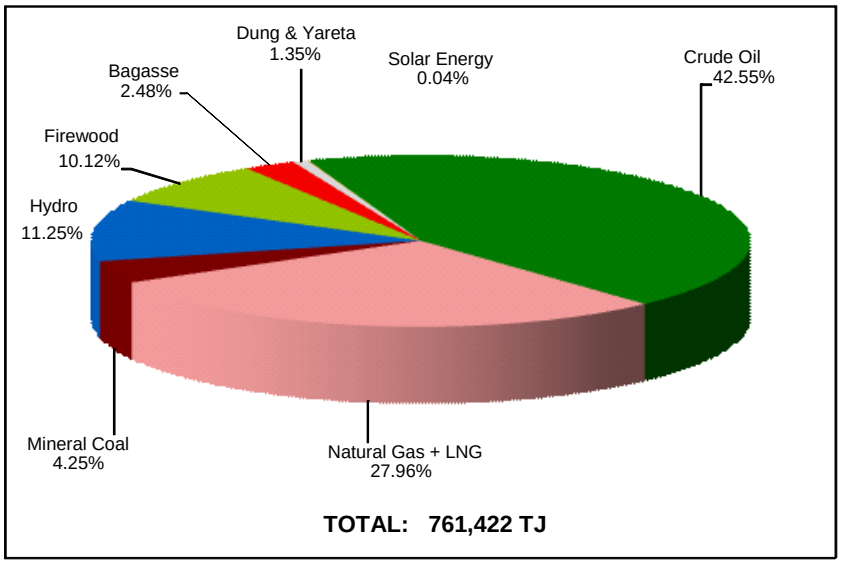
Table 1. Primary Energy Consumption (TJ)

SOURCE	2007	2008	GROWTH RATE (%)
Commercial Energy			
Crude Oil	335 892	323 983	-3.5
Natural Gas + LNG	175 161	212 930	21.6
Mineral Coal	34 557	32 372	-6.3
Hydro Energy	87 926	85 637	-2.6
Subtotal	**633 537**	**654 922**	**3.4**
Non Commercial Energy			
Firewood	86 455	77 029	-10.9
Bagasse	15 629	18 870	20.7
Dung & Yareta	11 047	10 299	-6.8
Solar Energy	295	302	2.4
Subtotal	**113 425**	**106 500**	**-6.1**
TOTAL	**746 962**	**761 422**	**1.9**

Sources: General Directorate of Hydrocarbons (DGH)
General Directorate of Electricity (DGE)
General Directorate of Mines (DGM)

In Peru, crude oil is the dominant energy resource; Peru's total primary energy consumption had a share of 42.5% in 2008. Natural gas and liquids is the second largest component, representing 27.9% in the same year. The increase of the natural gas share has been possible by the high production of Camisea natural gas project. The third-largest component was the hydro energy with 11.2% in 2008. On the side of non-commercial energy, Peru has high firewood consumption for cooking purposes; consumption of this energy source represented 10.1% in 2008, however it had a decrease of 10.9% between 2007 and 2008. This decrease was due to the implementation of social health programs in rural regions. Bagasse showed the highest increase among the non-commercial energy achieving at 20.7% between 2007 and

2008. Use of bagasse was increased in agro-industry and own-electricity generation consumption at the end of 2008.



Source: DGH, DGE, DGM

Figure 1. Share of Internal Gross Energy Supply

Destination of Primary Energy Consumption

The primary energy internal gross supply has two destinations: transformation centres and direct consumption. In 2008, 686,886 TJ were destined to the transformation centres, of which 365,974 TJ were processed in crude oil refineries and 212,930 TJ in gas plants, representing 53.3% and 30.9% of total primary energy destined to transformation centres, respectively.

On side of power plants, they transformed 102,764 TJ (83.3% of hydro energy, 10.2% of coal and the remaining by bagasse). From this energy transformed, 92% was used for the electricity generation and the remaining 8% for own supply.

Similarly in 2007, no coke was produced from mineral coal in 2008; because the coke industry stopped coke operation's plant by DOE RUN. On the other hand, 5,218 TJ of firewood was used in vegetable charcoal production.

Table 2. Destination of Primary Energy Consumption (TJ)

DESTINATION	2007	2008	GROWTH RATE (%)
Transformation Centers	620 780	644 805	3.9
Direct Consumption	126 182	116 617	-7.6
TOTAL	**746 962**	**761 422**	**1.9**

Source: DGH, DGE

Table 3. Distribution of Primary Energy to Transformation Centres (TJ)

DESTINATION	2007	2008	GROWTH RATE (%)
Refineries	**335,892**	**323,983**	**-3.5**
Gas Plants	**175,161**	**212,930**	**21.6**
Power stations	**103,801**	**102,674**	**-1.1**
Hydro Energy	87,926	85,637	-2.6
Bagasse	5,948	6,622	11.3
Mineral Coal	9,927	10,415	4.9
Coke Industry & Blast Furnaces	**0**	**0**	
Mineral Coal	0	0	
Coal Industry	**5,925**	**5,218**	**-11.9**
Firewood	5,925	5,218	-11.9
TOTAL	**620 780**	**644 805**	**3.9**

Source: DGH, DGE

1.1.2 The secondary energy consumption

In 2008, production of secondary energy was 696,804 TJ, where 82.4% was produced in crude oil refineries and gas plants. The remaining secondary energy produced corresponds to electricity generation with 17.0% and charcoal, industrial gas and coke with 0.6%.

For production of secondary energy, transformation losses accounted with 110,228 TJ, which were contemplated by 3,255 TJ from furnaces, 2,207 TJ from coal heaters, 6,717 from crude oil refineries, 86,632 TJ from electricity plants and 11, 417 TJ from electricity plants for own consumption. On the hand of exports and imports, Peru had a total secondary energy exports of 130,494 TJ (principally hydrocarbons as industrial oil and gasoline) which increased by 13.4% from previous year, while total imports was of 85,398 TJ (91.5% of hydrocarbons and 8.5% of coke) showing a higher increase of 36.3% between 2007 and 2008.

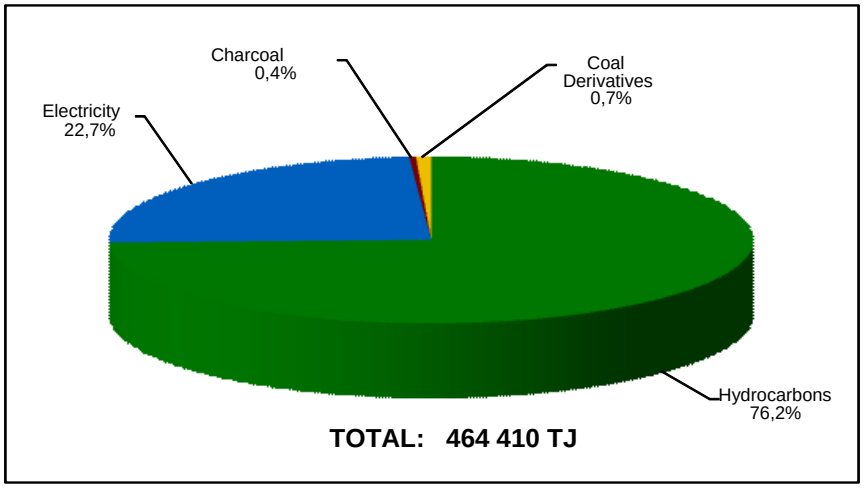
Own consumption of secondary energy was of 36,461 TJ which 94.7% corresponds to hydrocarbon derivates and coal and the remaining to electricity. On the side of transmission and distribution losses of electricity, Peru had total losses of 9,543 TJ in 2008.

Table 4. Final Secondary Energy Consumption (TJ)

SOURCE	2007	2008	GROWTH RATE (%)
Hydrocarbons	290 059	353 750	22.0
Electricity	96 824	105 247	8.7
Charcoal	2 370	2 087	-11.9
Coal Derivatives	3 604	3 326	-7.7
TOTAL	**392 857**	**464 410**	**18.2**

Source: DGH, DGE

Peru's total final secondary energy consumption was 464 410 TJ, showing an increase of 18.3% respect to previous year. As shown in Figure 2, Peru is a net secondary energy consumer of hydrocarbons, with 76.2% of the total share.



Source: DGH, DGE

Figure 2. Share of Final Secondary Energy Consumption

1.1.3 Total final energy consumption

In 2000, a national wide survey on energy consumption was carried out in order to obtain a disaggregated analysis of Peru's economy sectors. Results from the survey were used to measure the structure of economy's sectors.

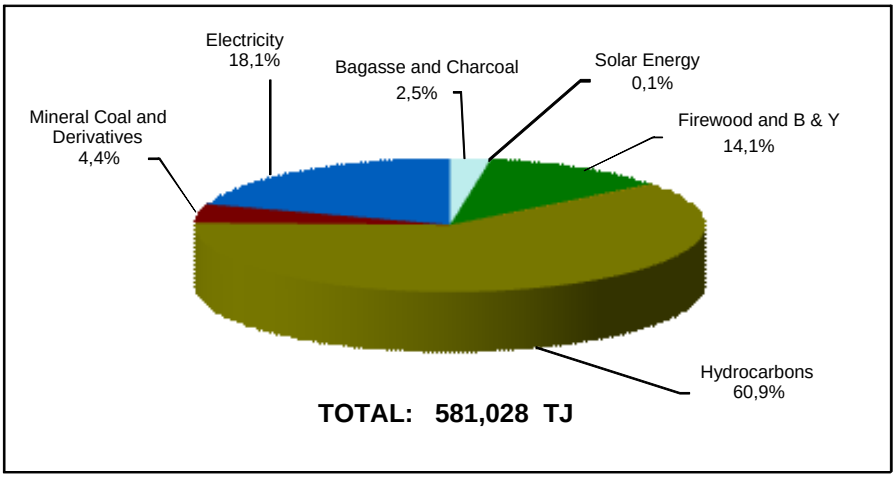
In 2001, an energy demand update methodology was elaborated with the support of the Canadian Cooperation, which enabled to relate the energy's share of the year 2000 with some included data such as the Gross Domestic Product (GDP), Motor Vehicle Fleet and Population.

The information sources of the National Energy Balance are the Central Reserve Bank of Peru (Banco Central de Reserva del Perú) and the Ministry of Transport and Communications (MTC), respectively. The information for population statistics comes from the Statistics and Information National Institute (Instituto Nacional de Estadísticas e Informática – INEI) and the 2007 National Census.

Regarding the oil products and natural gas consumption, information is compiled from the sales reported by the oil companies in the General Directorate of Hydrocarbons (Dirección General de Hidrocarburos – DGC) of the Ministry of Energy and Mines (MINEM). In the case of electricity consumption, information is compiled from the sales reported by the power companies in the General Directorate of Electricity (Dirección General de Electricidad – DGE).

Total Final Energy Consumption by Source

In 2008, total final energy consumption was 581,028 TJ, showing an increase of 8.6% with respect to previous year. This increase was possible due to an increase of petroleum products and natural gas consumption. From the total, 60.9% corresponded to oil, natural gas and coal, 14.1% to firewood and dung & yareta, 18.1% to electricity, 4.4% to mineral coal and its derivatives, 2.5% to bagasse and charcoal and 0.1% to solar energy as shown in Figure 3.



Source: Sector's Companies, DGH, DGE, and estimated data.

Figure 3. Share of Final Energy Consumption by Source

Among petroleum products, diesel oil increased robustly between 2007 and 2008, showing an annual growth of 22.9% due to increased vehicle seals in the internal market and imports of used vehicles. On the other hand, for the third consecutive year, a high annual growth rate of natural gas consumption was shown (36.3%). This robust consumption of natural gas was determined by transport sector because the conversion of vehicles that use gasoline or diesel to natural gas, as well as the dynamic behaviour of industry sector. On the side of biomass use, bagasse consumption increased by 27.2% between 2007 and 2008; this increase was possible by increased consumption in agro-industry sector and for own-use electricity generation.

In Peru, electricity consumption increased by 8.7% between 2007 and 2008. This increase was motivated by the increased use of electricity in industry sector, mining and metallurgical, residential and commercial sectors. In 2008, the largest electricity consumption sectors were the industry and mining and metallurgical sectors.

Total Final Energy Consumption by Sectors

In Peru, energy consumption by sectors is divided in five groups: residential, commercial and public (RCP); transportation; farming, agro-industry and fishing; industry and mining; and non-energy use. Among the energy-use sectors, transportation sector was the highest energy consumer, showing a robust increase of 21.7% from 2007 to 2008. This increase was shown by the imports of vehicles and

sales in the internal market. The second largest energy consumption sector was the industry and mining with an increase of 3.1%, finalizing with 167,967 TJ. On the other hand, the RCP sectors had a decrease of 1.9% between 2007 and 2008; it was possible by the reduction of firewood, charcoal and kerosene consumption.

Table 5. Total Final Energy Consumption by Source (TJ)

SOURCE	2007	2008	GROWTH RATE (%)
Mineral Coal	24 630	21 957	-10.9
Firewood	80 530	71 812	-10.8
Dung & Yareta	11 047	10 299	-6.8
Bagasse	9 623	12 248	27.2
Solar Energy	295	302	2.4
Coke	1 331	1 612	21.1
Charcoal	2 370	2 087	-11.9
Liquefied Gas	38 369	43 622	13.7
Gasoline	39 265	44 169	12.5
Jet Fuel	25 724	27 156	5.5
Diesel Oil	131 588	161 781	22.9
Fuel Oil	43 865	35 861	-18.2
Non-Energetic from oil and gas	4 790	10 612	121.6
Natural Gas	22 410	30 548	36.3
Industrial Gas	2 273	1 714	-24.6
Electricity	96 824	105 247	8.7
TOTAL	**534 933**	**581 028**	**8.6**

Source: Sector's Companies, DGH, DGE, and own estimations.

Among the sectors, transport is the highest consumer of energy with a share of 36.2%; this behaviour has been the result of the increase of vehicle sales in the internal market and imports. Also, high increase of natural gas consumption has been one of the drivers, by the conversion of LPG, gasoline and diesel vehicles to natural gas use. The second largest energy consumer sector is the industry and mining & metallurgical sectors together; in 2008 these sector had a share of 28.9%. In the same year, the third largest sector was the residential, commercial and public sector showing 28.6% of share.

Table 6. Total Final Energy Consumption by Sectors (TJ)

SECTOR	2007	2008	GROWTH RATE (%)
Residential Commercial and Public	169 394	166 189	-1.9
Transportation	173 499	210 093	21.1
Farming, Agro-industry and Fishing	18 387	18 434	0.3
Industry and Mining	162 988	167 967	3.1
Non-Energetic	10 665	18 344	72.0
TOTAL	**534 933**	**581 028**	**8.6**

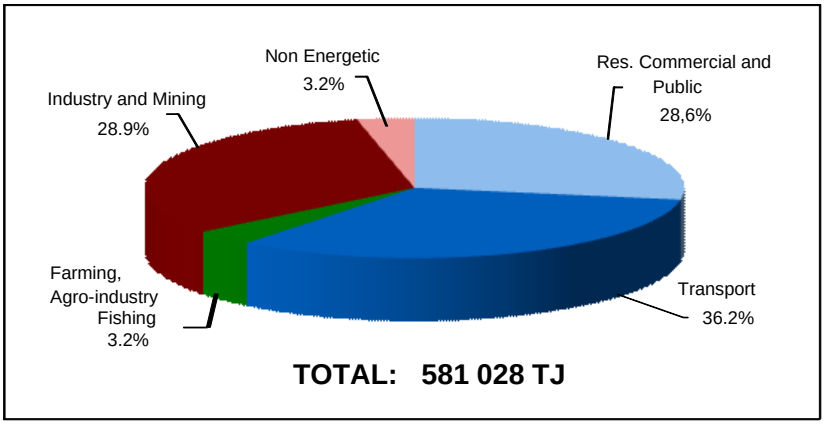
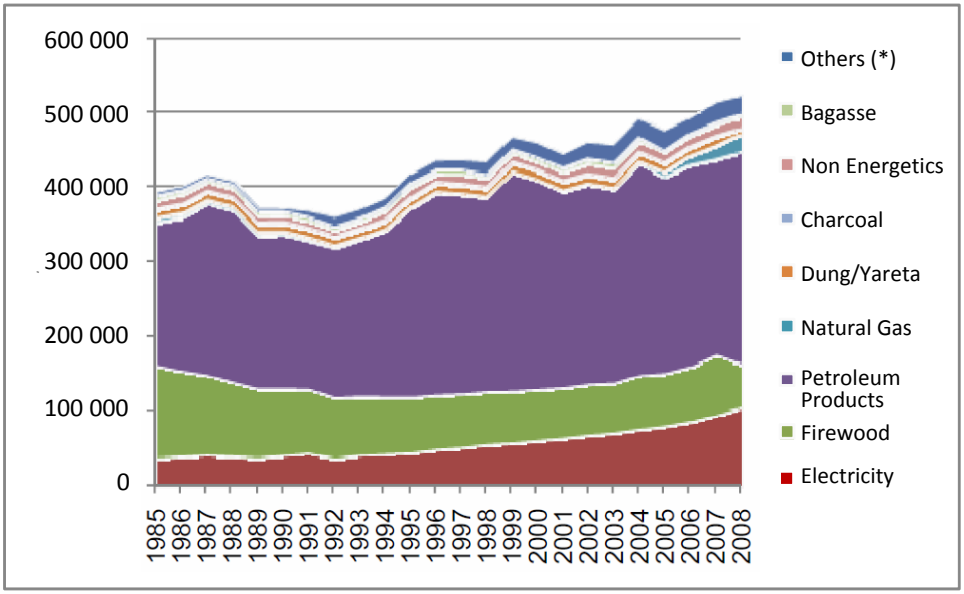


Figure 4. Share of the Final Energy Consumption by Sectors

1.1.4 Historical trends by energy source

In Peru, energy consumption has been characterized through the years by the dependency of petroleum products, which has been recently replaced by natural gas. As shown in Figure 5, from final energy consumption in Peru during the period of 1985 and 2008, use of petroleum products have the largest share. On the other hand, during the same period, electricity consumption has increased strongly from 38,367 to 106,947 TJ (an increase of 178.7%). On the other hand, consumption of firewood has slowed down because of replacement by natural gas for cooking and use of electricity for water heating in rural areas. During the period of 1993 and 2003, however, natural gas consumption has reduced drastically



(*) Mineral Coal and derivatives
Source: Energy Matrices from 1985 to 2008

Figure 5. National Final Energy Consumption (TJ)

In the case of firewood consumption, which is used in great quantities especially in rural areas, trend has decreased slowly during the period 1985 and 2008. Meanwhile, some Kerosene consumers started shifting to LPG but in rural areas firewood was still used for cooking as shown in Figure 5.

During the 1985 – 2008 period, the final energy consumption annual growth rate increased by 1.24% and the Gross Domestic Product by 2.99%. The elasticity Consumption - GDP for the same period was at 0.4. This shows that GDP increase is higher compared to energy consumption, which demonstrates that processes are more efficient; therefore, the economy is more efficient.

1.1.5 Historical trends by sectors

Residential and Commercial Sectors

The annual growth rate for energy consumption in the residential and commercial sectors decreased by 0.26% during the 1985 – 2008 period. Firewood is still predominant in the consumption structure, being mainly used for cooking with efficiency close to 10%. Electricity and LPG demand have increased its participation in this sector by 25% and 16%, respectively, while kerosene consumption has decreased drastically during 2004 – 2008 due to an increase in the Excise Tax – Impuesto Selectivo al Consumo (I.S.C.) added to kerosene in the last years. Finally, the quick use of natural gas in residential and commercial sectors is lower compared to the industrial and transport sectors.

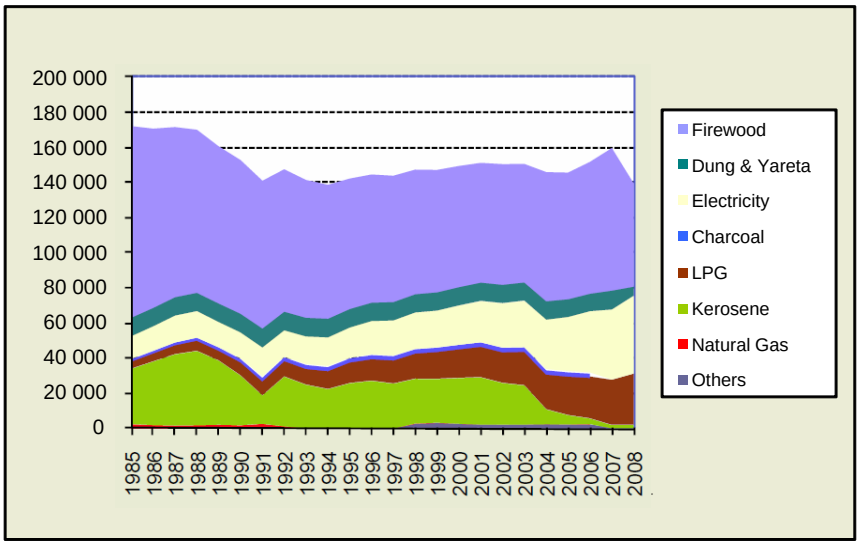


Figure 6. Energy Consumption – Residential and Commercial Sectors (TJ)

Public Sector

During the 1985 – 2008 period, energy consumption in public sector decreased by 0.6% annually, a lower demand of turbo was recorded in this sector. Additionally, it is important to point out that diesel consumption has decreased during this period.

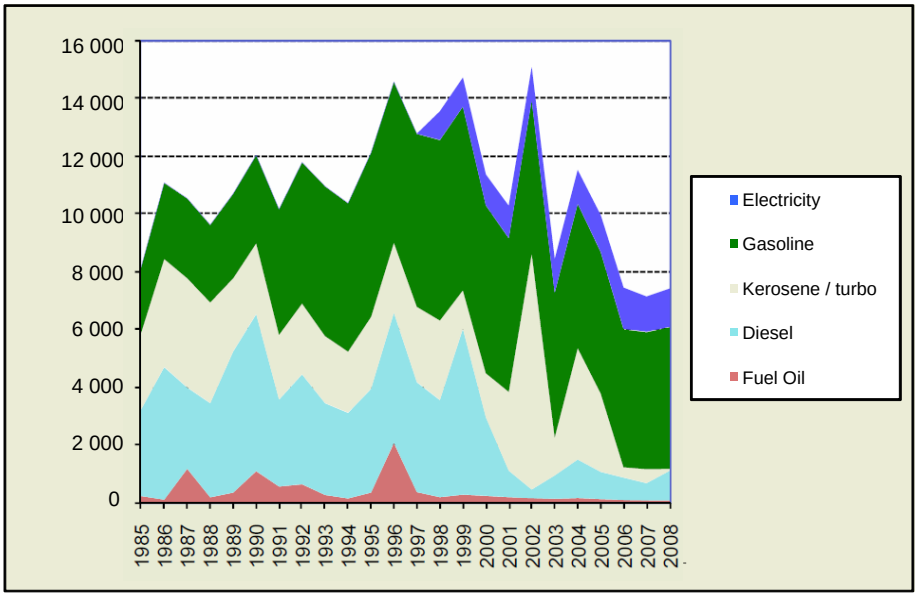


Figure 7. Energy Consumption – Public Sector (TJ)

Transport Sector

During the 1985 – 2008 period, energy consumption in the transport sector increased with an annual growth rate of 2.64%. Due to stand out penetration of diesel in road transport, fuel consumption has a stable growth. Additionally, industrial fuel consumption for ship fleets decreased within the consumption structure of this sector.

LPG and natural gas sources have penetrated this sector but they do not stand out at present because the amount of energy consumed is too low compared to the consumption of other hydrocarbons.

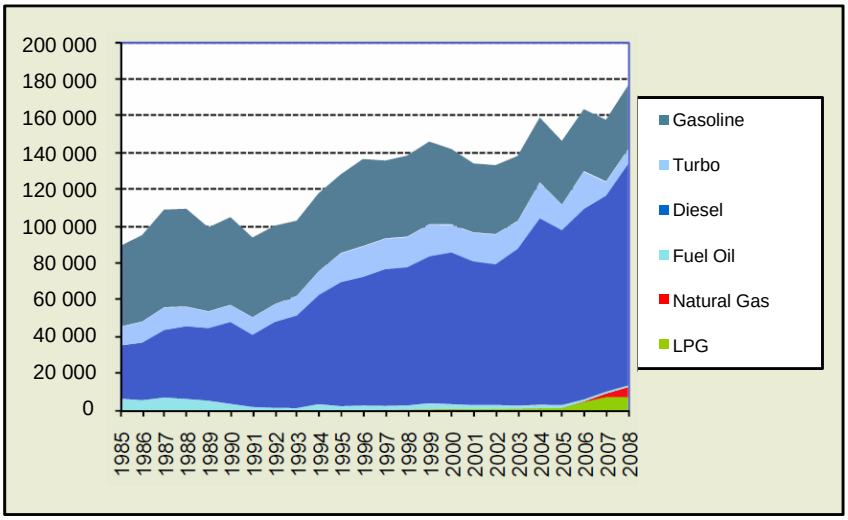


Figure 8. Energy Consumption – Transport Sector (TJ)

Farming and Agro-Industry Sector

During the 1985 – 2008 period, energy consumption in the farming sector and the agro-industry decreased to an average annual rate of 2.19%. Bagasse consumption is still predominant in this sector for the generation of steam in boilers for the sugar producing processes as a substitute of hydrocarbons.

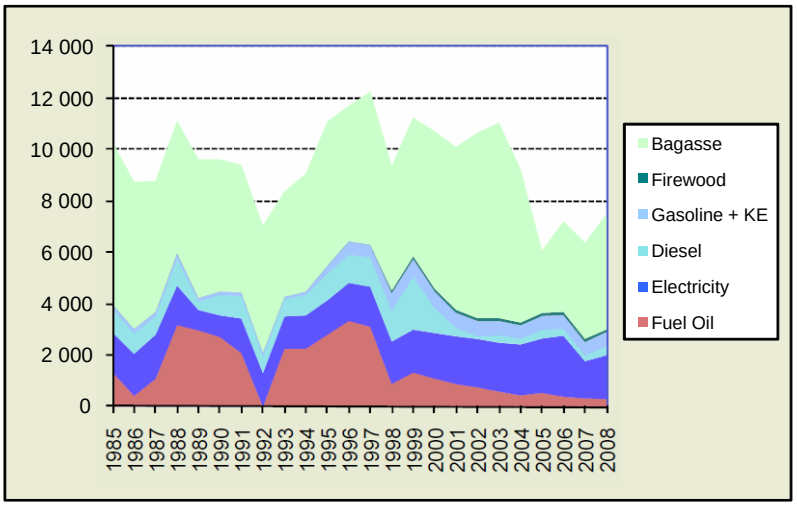


Figure 9. Energy Consumption – Farming and Agro-Industry Sector (TJ)

Fishing Sector

During the 1985 – 2008 period, final energy consumption in the fishing sector had an annual growth rate of 1.75%, industrial fuel was in great demand in this period. For this energy balance, the electricity consumption was obtained from the State Electricity Office (Dirección General de Electricidad), based on information from the electricity companies. It is important to point out that since the year 2003, natural gas has been used in the northern part of the economy.

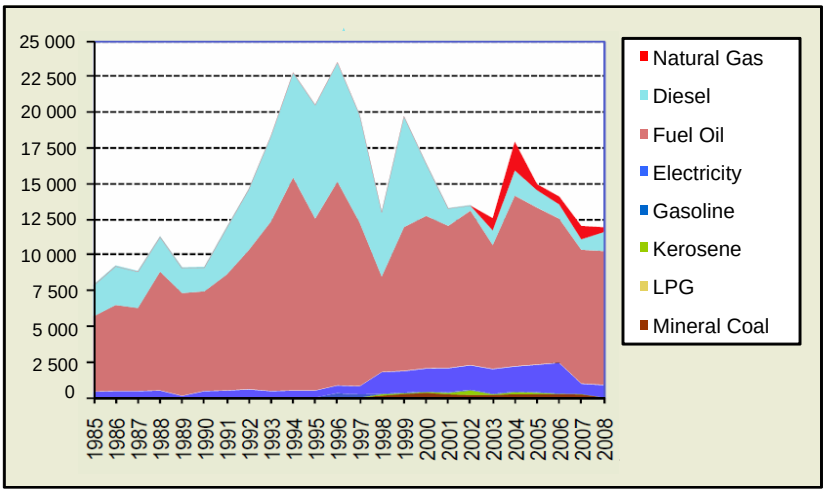


Figure 10. Energy Consumption – Fishing Sector (TJ)

Mining - Metallurgical Sector

During the 1985 – 2008 period, the energy consumption annual growth rate in this sector was 1.83%. Diesel, industrial fuel and electricity were the energy products with greater participation as shown in Figure 11. It is important to point out the penetration of the Camisea Gas, but it is still incipient in this sector.

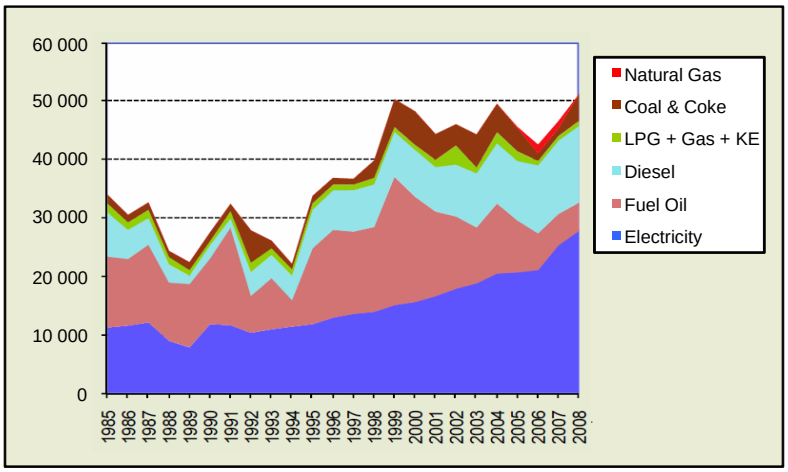


Figure 11. Energy Consumption – Mining Metallurgical Sector (TJ)

Industrial Sector

During the 1985 – 2008 period the consumption of final energy in this sector increased by an average annual rate of 2.71%, as shown in Figure 12. It can be said that the country is in the process of industrialization, since the last 10 years, energy consumption in this sector has increased by 6.53% annually. This sector is quite diversified as regards to energy consumption, given that it uses the entire national energy basket, where the following stand out: mineral coal, electricity and industrial fuel. Meanhwile, natural gas which was used since 2004, represented 16.7%. share of the sector in 2008

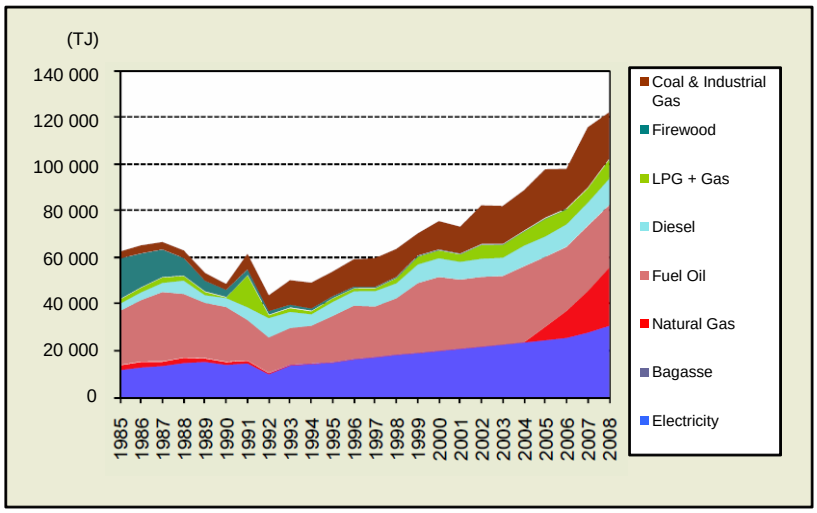


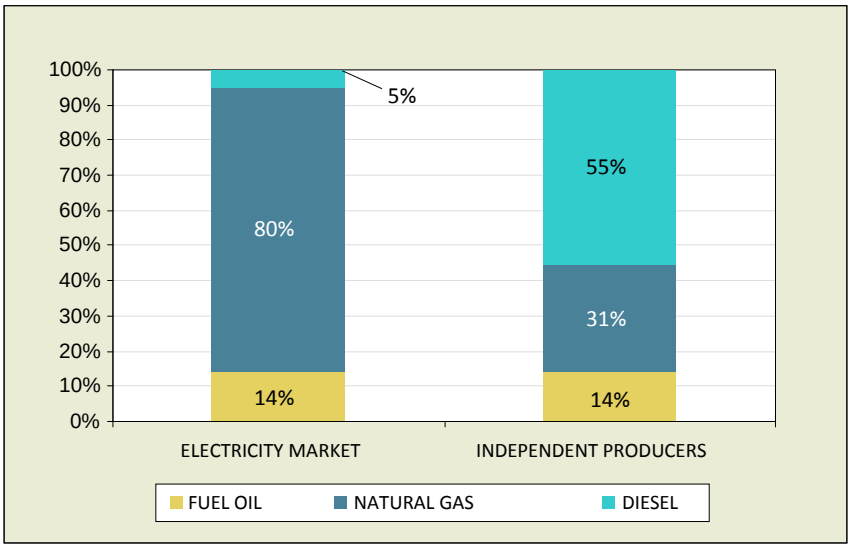
Figure 12. Energy Consumption – Industrial Sector (TJ)

1.1.6 The Electricity Sector in Peru

The sources of primary energy used for electricity generation in Peru are hydro, mineral coal, and bagasse. In 2008, primary energy consumption as hydro, mineral coal and bagasse were destined to transformation centres for electricity generation and commercialized in the electric market and own-use. A total of 23,850 GWh of hydro, 344 thousand tons of mineral coal and 1,055 thousand tons of bagasse were consumed for electricity generation.

On the side of secondary energy resources for electricity generation purposes in Peru, majority came from natural gas and petroleum products. Among the petroleum products, diesel 1, diesel oil and fuel oil are considered. In 2008, total consumption of petroleum products for electricity generation was 711 thousand cubic meters (tcm), while total consumption of natural was 2,471 million cubic meters (mcm). A high dependency of natural gas for electricity generation is shown in Peru, having a 76.1% of its participation among the hydrocarbons as shown in Figure 13 (80% in the electric market and 31% by independent producers). During the same year, a robust annual increase of all hydrocarbons were presented in comparison to 2007, finalizing with an increase of 95.6% fuel oil, 49.9% diesel oil and 25.7% natural gas, respectively.

In Peru, the infrastructure of the electric sector is established by the Interconnected Electric System (Sistema Eléctrico Interconectado – SEIN) and small Isolated Systems (Sistemas Aislados – SSAA) in rural areas. These systems are operated by electric enterprises for the electricity commercialization for three disintegrated activities: generation, transmission and distribution. The enterprises in the Peruvian electric market are private and public.



Source: OPIC, DGE – MEM

Figure 13. Fuel Consumption Structure by Type of Service

In 2008, total installed generation capacity was 7,158 MW, which was confirmed by 45% of hydropower plants and 55% by thermoelectric plants. From the total capacity, 5,585 MW came from plants with an installed capacity higher than 20 MW and distributed in hydropower plants (2,927 MW) and thermoelectric plants (2,658 MW); among the thermoelectric plants, 6 power plants use natural gas as fuel and totalized an installed capacity of 1,719 MW. On the side of total electricity production, Peru had 32,903 GWh, where 59% came from hydro plants and 41% from thermoelectric. From the total electricity produced, 30,622 GWh corresponds for the electric market and 2,281 GWh for own-producers purposes; an annual growth rate of 9.9% was reached between 2007 and 2008 as shown in Table 7.

Table 7. Electricity Production Growth (GWh)

YEAR	POWER STATIONS		TOTAL	GROWTH RATE (%)
	ELECTRICITY MARKET	INDEPENDENT PRODUCERS		
2007	28 200	1 743	29 943	9.9
2008	30 622	2 281	32 903	

Source: DGE – MINEM

Peru has an interconnected system with transmission lines of 220 kV, 138 kV and 60 kV which is operated almost in total by the SEIN. Also, Peru has the purpose to have 500 kV transmission lines in the short-term. A total transmission line in Peru is the 9,347 km.

On the side of total electricity losses (transmission and distribution), Peru had total losses of 2,652 GWh, an increase of 4.4% respect 2007. On the other hand, in 2008 the own-consumption of electricity was of 530 GWh showing an increase of 7.4% in comparison to 2007.

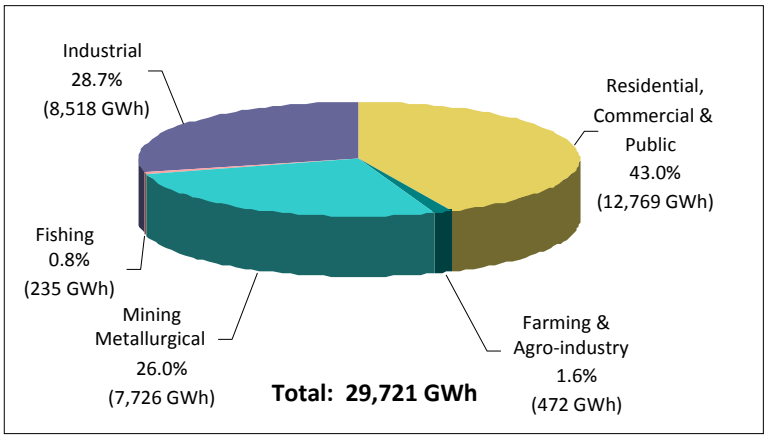


Figure 14. Final Electricity Consumption by Sectors

In 2008, Peru had a total final electricity consumption of 29,721 GWh, having an increase of 10.4% with respect to 2007. This final consumption was prominent in the residential, commercial and public sectors (RCP) having a total share of 43%; the second largest electricity consumer is the industry sector with

29% of share, while the metal-metallurgical sectors showed a share of 26% of the total. Together, these three sectors accounted for 98% share of the total electricity consumed in 2008 as shown in Figure 14.

1.1.7 The energy-economy-environment indicators

The economy indicators are basically used to evaluate the economic growth of a country. The Gross Domestic Product (GDP) is the main indicator to measure the production of goods and services in an economy. However, this indicator does not provide information about the other components of a sustainable development.

The United Nations Development Program (UNDP) presented a new integrated index (Human Development Index – HDI), which allows to measure the achievements of a country in terms of life expectancy, education and per-capita GDP. The HDI includes a variety of social, economic and political aspects which have an impact in the quality of human life.

The environmental aspects, the state of the environment, tendencies and policies and their links with the social and economic aspects, especially within a sustainable development framework have received and continue receiving more attention from national and international authorities. At the same time, important efforts are being carried out to design and implement indicators and indexes that will enable to measure and monitor environmental variables and their relation with the social and economic aspects of a sustainable development.

These indicators are obtained from two sources: the United Nations Development Program UNDP and the Economic-Energy Information System SIEE – OLADE. It I important to point out that SIEE has the year 1995 as a base year for the Gross Domestic Product (GDP). Table 8 shows the main macroeconomic indicators of Peru from 1995 to 2008.

Table 8. Socioeconomic and Energy Information of Peru

	FINAL CONS. (TJ)	POPULATION 10^3 HAB.	GDP 10^6 US$ 1995	INTENSITY (TJ/10^6 US$ 1995)	GDP PER CAPITA	CONSUMPTION PER CAPITA	HDI *
1995	420 050	23 690	53 643	7,83	2,26	17,73	0,729
1996	438 614	24 038	54 984	7,98	2,29	18,25	0,732
1997	439 105	24 392	58 723	7,48	2,41	18,	0,739
1998	436 637	24 750	58 430	7,47	2,36	17,64	0,737
1999	470 414	25 113	58 955	7,98	2,35	18,73	0,743
2000	462 885	25 482	60 515	7,65	2,37	18,17	0,747
2001	446 811	25 857	60 646	7,37	2,35	17,28	0,752
2002	463 391	26 236	63 599	7,29	2,42	17,66	0,752
2003	459 664	26 622	66 187	6,94	2,49	17,27	0,762
2004	495 003	27 013	69 356	7,14	2,57	18,32	0,767
2005	479 181	27 410	73 864	6,49	2,69	17,48	0,773
2006	496 054	27 812	79 551	6,24	2,86	17,84	0,788
2007	517 400	28 221	86 631	5,97	3,07	18,33	0,806
2008	525 787	28 635	95 121	5,53	3,32	18,36	0,816

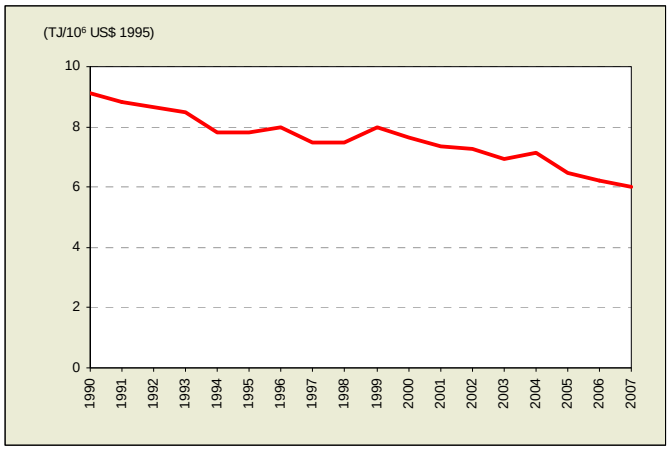
Source: Economic-Energy Information System SIEE-OLADE, PNUD

* HDI 2008 Estimate

Energy Intensity of Peru

The energy intensity is an indicator that measures the energy productivity within an economy process. It can also be defined as the quantity of energy needed to produce a US $ of Gross Domestic product (GDP). In Peru, the evolution of this indicator during the period 1990 – 2008 is shown in Figure 15.

This indicator is practically stable in the period 1994-1999, but, from year 2000, this indicator has a sustained decrease reflecting improvement in the country's productivity.

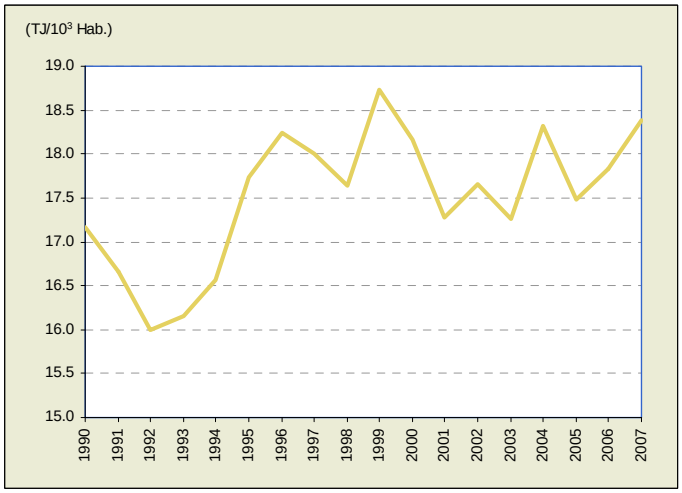


Source: Economic-Energy Information System SIEE OLADE

Figure 15. Energy Intensity in Peru

Energy Consumption per Inhabitant

In the year 2008, the energy consumption per inhabitant was of 18.5 TJ/10^3 Hab. The evolution of this indicator during the period 1990 - 2008 is shown as follows.

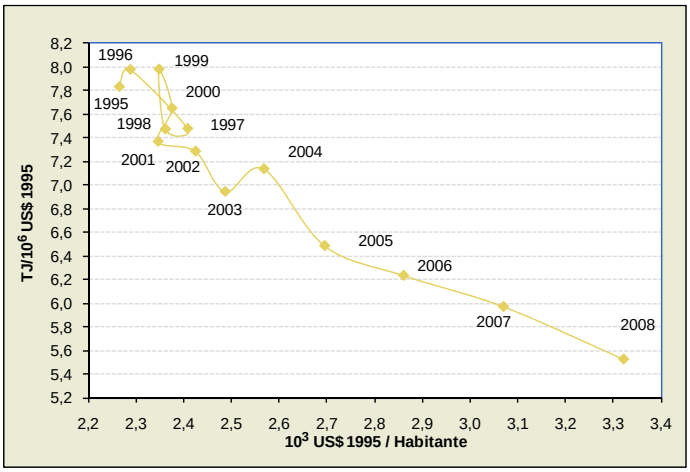


Source : Energy Matrix from 1990 to 2008

Figure 16. Energy Consumption per Inhabitant in Peru

The Energy Path

The energy path graphically represents the variations experienced because of the energy intensity of the internal economic activity (energy offered by each GDP unit) in relation to the economy system evolution, measured by the GDP per capita. In Figure 17, the energy path evolution is shown for the period 1995 – 2008.



Source: Economic-Energy Information System SIEE OLADE

Figure 17. Energy Path in Peru

The energy path of the economy, in the period 1995-2001 is random, with an annual growth rate of 2% of GDP, since 2001 it moves towards the right and downwards presenting increasing rates being of 8.9% in 2008.

Environmental Indicators

The emissions of commercial energy are presented but emissions of commercial sources such as wood, yareta and vegetal coal are not considered. For the calculation of emissions, the use of methodology of the Intergovernmental Panel on Climate Change (IPCC), a tool developed by the Latin American Energy Organization (OLADE) which take into account the emission coefficients from the former National Environmental Commission (CONAM), now Ministry of the Environment (MINAM), and published them in the First National Communication on Climate Change and the National Green-house Gases Inventory.

The method uses reported values according to the energy activity, developed by energy source and these are considered by its pollution factor of each pollutant. From this methodology, emissions like carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrogen oxides (NO_X), Sulphur oxides (SO_X) and particles are obtained.

In Peru, CO_2 emissions during the periods 1985 – 2008 increased from 14.7 to 24.3 million tons, such emissions comes from different commercial energy use. Specifically, liquid hydrocarbons are the most extensive pollutant which generates CO_2 emissions. The transport sector activities have the most CO_2 intensive emissions showing total emissions of 12.3 million tons at the end of 2008. The second largest

CO_2 pollutant sector is the industry sector; emissions have increased robustly with around 2.8 million tons in 1992 to around 7.0 million tons in 2008. On the side of CO_2 emission intensity (emission of CO_2 per energy consumed), Peru has maintained between 41 and 49 thousand kg of CO_2 per TJ consumed as shown in Figure 18; at the end of 2008 the economy presented a CO_2 emission intensity of 46.5 thousand kg per TJ. This constant behaviour of CO_2 emission intensity has been a result of several energy efficiency measures in the economy, especially during the periods of 1999 – 2003 and 2004 – 2007.

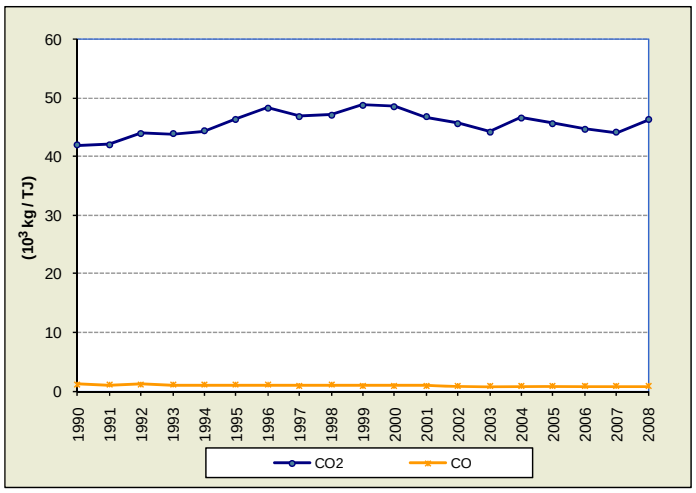


Figure 18. Carbon Emission Intensity in Peru 1990 - 2008

On the side of carbon monoxide (CO) emission in Peru, its level increased from 0.39 million tons in 1985 to 0.42 million tons in 2008. The transport sector has been the major contributor of CO pollutant. As regards CO emissions intensity, Peru shows a constant emission intensity of 2 thousand kg per energy consumed as shown in Figure 18.

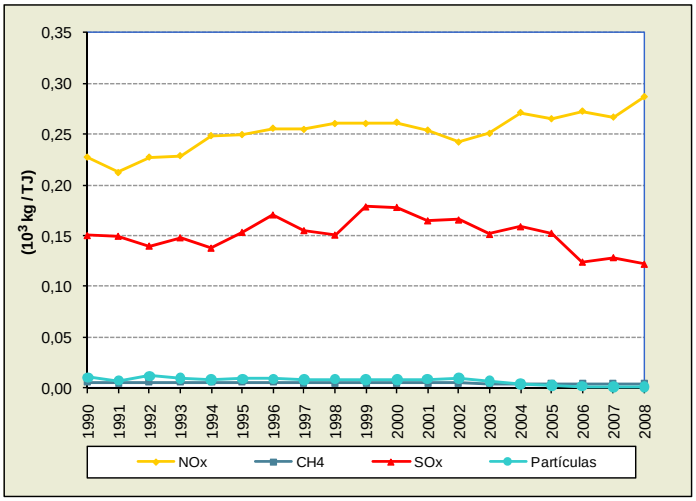


Figure 19. Emission Intensity of NO_X, CH_4, SO_X and Particles

While methane (CH_4), nitrogen oxides (NO_X) and sulphur oxides (SO_X) have small contribution as compared with CO_2,, their emission levels however, have increased moderately during the period 1985 – 2008. Specifically, CH_4 and NO_X emissions have increased from 1.91 kilo-tons in 1985 to 2.44 kilo-tons in 2008, and from 74.1 kilo-tons in 1985 – 150.63 kilo-tons in 2008, respectively. The transport sector is the most CH_4 and NO_X pollutant contributor. On the side of SO_X emissions, its level has shown an increase from 54.5 kilo-tons in 1985 to 64.1 kilo-tons in 2008; those emissions came mostly from industrial and metal-metallurgical sectors.

As shown in Figure 19, the emission intensity of NO_X is the largest contributor due to the increased consumption of hydrocarbon fuels in the transport sector with its low energy efficient vehicles which are commercialized in Peru.

2. ENERGY EFFICIENCY INSTITUTIONS, POLICIES AND MAJOR PROGRAMS

2.1. Institutional Framework

The Executive Decree Nº 026-2010-EM of 28 May 2010, creates the General Directorate of Energy Efficiency (GDEE) as a line body of the Ministry of Energy and Mines. GDEE depends on the Vice-Ministry of Energy as shown in Figure 20.

GDEE is the technical regulatory body in charge of proposal and assessment of energy efficiency and non-conventional renewable energy policies, the promotion of an efficient use of energy formation, as well as the lead of energy planning.

Figure 20. Organization of the Vice-Ministry of Energy, Peru

The new DGEE has defined five pillars for the energy efficiency as shown in Figure 21, and explained as follows:

Education:

- To develop an energy efficiency culture (at all education levels)
- Local experience regarding energy saving programs in the MINEM
- Agreement between Ministry of Education and MINEM
- The “Energy Savings Day” was established as national day on 21 October

Renewable energy:

- Potential of renewable energy at national level
- Local use of renewable energy such as biomass (biodigesters), solar (heaters), rural electrification with hybrid technology, etc.

Regulations:

- Developing of energy efficiency labelling regulations for engines, eco-efficient buildings, appliances, etc. (INDECOPI)

Technology:

- Efficient lighting (use of LED technology)
- Fuel switching in transport sector
- Intelligent traffic lights
- Smart grid

Market:

- Good environment for business
- Private investments
- Establishment of Energy Service Companies (ESCOs)
- Participation of financing institutions such as COFIDE, Inter-Development Bank and so on
- International cooperation
- Other economic incentives

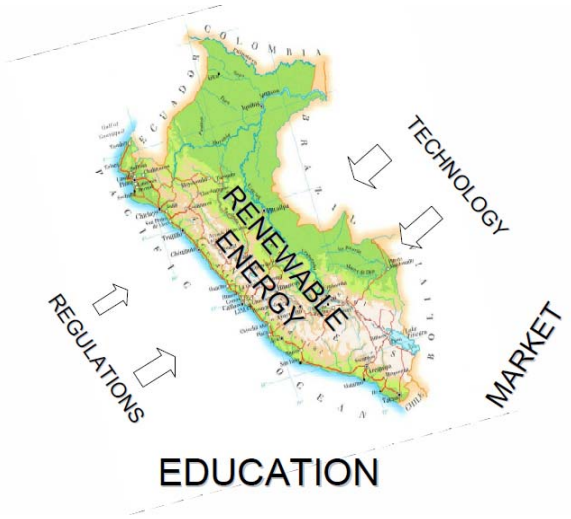


Figure 21. The five pillars of energy efficiency in Peru.

2.1.1 Institutions and Organizations

The GDEE is the only institution in charge with energy efficiency policies in the economy. Nevertheless, there are other institutions and organizations that carry out energy efficiency activities:

- **Public and private universities:** Research and development. Universidad de Ingeniería, Pontificia Universidad Católica del Perú, Universidad Nacional Agraria La Molina, Universidad del Santa, Universidad San Agustín de Arequipa, among others.
- **National Institute for the Defense of the Consumer and Private Property (INDECOPI):** Energy efficiency standards.

2.1.2 Government Laws, Decrees, Acts

The legal and regulatory framework regarding energy efficiency is as follows:

- Law Nº 27345 – Efficient Use of Energy Promotion Law of 8 September 2000
  - Efficient use of energy is declared of national interest in order to assure energy supply, protect consumers, promote national economy competitiveness, and reduce negative environmental impacts.
  - The Ministry of Energy and Mines is the authority responsible for the promotion of efficient use of energy: It promotes the creation of a culture towards energy efficiency; market transparency regarding efficient processes, technologies and services; international cooperation projects for the development of efficient use of energy; elaborates and executes referential energy efficiency programs; promotes the establishment of ESCOs; coordinates the development of energy efficiency policies with other public and private sectors; and promotes the efficient consumption of energy carriers in isolated and remote areas.
- Consumer's information rights on energy consumption of devices, appliances and equipment (energy efficiency label)
- By virtue of the Law Nº 27345 – Executive Decree Nº 053-2007-EM of 23 October 2007
  - Title I: Aim, legal framework, scope, policy
  - Title II: Efficient use of energy culture
  - Title III: Sectoral programs of efficient use of energy
  - Title IV: Planning and diffusion of efficient use of energy
  - Title V: Information rights
  - Title VI: Opportunities and development capacity
- Executive Decree Nº 034-2008-EM of 19 June 2008 – Energy saving measures for the public sector.

- Ministerial Resolution Nº 038-2009-MEM/DM of 20 January 2009 – Approved energy consumption indicators and monitoring methodology.
- See Annex Nº 1: List of approved energy efficiency national standards (voluntary).

2.2. Energy Policy

The energy policy is led by the Ministry of Energy and Mines. The Ministry elaborated the "Long-Term Policy Guidelines for Energy Sector" work document (September 2002) containing the Vision, Objectives, Strategic Guidelines, and the medium and long-term Policy Tools for the energy sector, based on the Integral Study of Energy, developed by the Technical Office of Energy.

2.2.1 The Peruvian energy policy guidelines

Vision: Developing an efficient energy system, covering the basic energy needs of the population, contributing to the economic growth, for a better social equity and with a controlled environmental impact.

General objective 1: Covering the energy basic requirements of the population, both in quantity and quality, thus diminishing the social and regional asymmetries; making possible the development of productive activities, and improving the population's living conditions.

- **Specific objective 1.1:** To cover energy requirements for basic heat uses of the population and diminish biomass dependency of the supply.
- **Specific objective 1.1:** To expand the national electricity supply, especially in rural areas and in isolated and frontier communities.

General objective 2: Achieving a well-balanced situation between the final consumption structure, supply infrastructure characteristics, and the availability of natural energy resources in the country.

- **Specific objective 2.1:** To reverse the current situation of the Hydrocarbons Trade Balance.
- **Specific objective 2.2:** To achieve improvements in the development of the natural gas industry, generating greater energy matrix diversity, a greater energy auto-sufficiency level and a lower energy supply cost, and lower pollution levels by way of emissions/discharges.
- **Specific objective 2.3:** To consolidate the electricity sector reform, in order to achieve a greater competitiveness.
- **Specific objective 2.4:** To achieve improvements in the use of potential renewable resources.

- **Specific objective 2.5:** To promote efficient use of energy and of productive, service and residential sectors.
- **Specific objective 2.6:** To achieve important advances in the environmental care by reducing the pollution load of emissions/discharges into the atmosphere, natural water sources and soils, in the production, transport and final use of energy.
- **Specific objective 2.7:** To achieve a greater coherence of tax tools with energy policies, especially regarding fuel prices structure.
- **Specific objective 2.8:** To foster competition development in the fuel market, in order to avoid price fixing practices.

2.2.2 The Energy Referential Plan to 2015

The Energy Referential Plan shows the situation of the energy sector and the projections of the demand, supply, investments and commercial balance to be able to plan up to the year 2015. The results of the projections shall not be seen as finished products, but as part of the continuous dynamic process aimed at the search for integral-natured solutions for the Peruvian energetic system problems.

2.3. Energy Efficiency Referential Plan 2009 - 2018

In September 2009, the government of Peru through MINEM organised a workshop on efficient use of energy where the Referential Plan for the Efficient Use of Energy 2009–2018 was approved. This is the main instrument to achieve the economy's energy efficiency goals through action plans proposed for each sector. The plan includes an analysis of energy efficiency in Peru, identifying sector programs that could be implemented to achieve the proposed targets.

The Regional Governments were represented by the Regional Presidents, Regional Managers, or officials appointed to this effect, and the Energy and Mines Regional Offices as well as State Electricity office representatives, being a total of 45 participants. As a result of the workshop, the following recommendations were put forward:

- Reinforce the strategic alliances with other economy sectors to promote electrical safety, energy efficient use and environment care.
- Develop tax benefits for private companies operating with efficient technologies.
- Strengthening of the Energy and Mines Regional offices (DREMs) to be able to implement a Referential plan.
- The inclusion of renewable energies in accordance with the geography and climate realities in the regions.
- Mining and Energy Sectors shall commit to being role models of efficiency.

Objective

The objective is to reduce consumption by 15% until the year 2018 in relation to the projected demand for that year, without affecting production and neither services of the different economy sectors nor the comfort of the residential sector (see Figure 22).

If the different projects mentioned below are implemented, the behavior of the energy demand would be as shown in the following graphic.

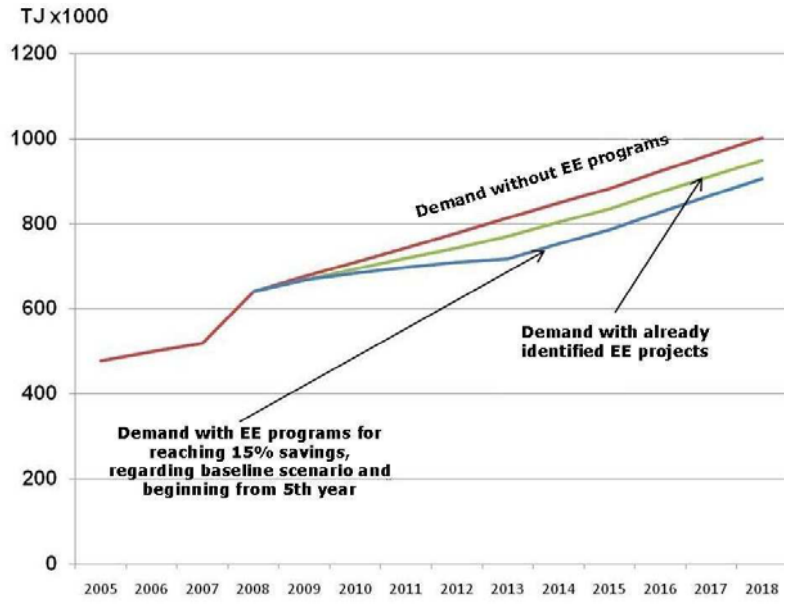


Figure 22. Evolution of energy demand, with and without energy efficiency programs of all sectors 2009 - 2018

2.3.1 Mission and Vision of the Referential Plan

Mission

Promote the implementation of energy efficiency actions in all consumption sectors through good practices and the use of efficient technology, improve competitiveness and contribute to the sustainable development of the economy.

Vision up 2018

Vision 1 – As a Sector: International prestige institution which guides and coordinates the efficiency programs at a multi-sectoral level, contributes to ensure energy supply at competitive prices and reduces the energy-environmental impact, preserves natural resources and improves competitiveness in the country for an optimal positioning in the worldwide market.

Vision 2 – As a Country: That the consumptions within the productive and service sector, for each product unit or service rendered, should be approximately the same as those of competitive countries; that the transport sector, be similar to those of countries with a terrestrial infrastructure and traffic comparable to ours; and that the population in general have an efficient energy use culture and be aware of the implications of the risks of environmental effects of consumption of energy sources and put into practice a new model of sustainable development and cooperate to development y to the welfare of the country.

Human Resources: Highly Specialized professionals in energy efficiency, motivated and proactive.

Organization: An Administration which answers to the Vice-Ministry of Energy, with lines of communication and defined authority.

Organization Culture: Job environment and organizational culture that promote teamwork, tendency to sincerity, quality and excellence as well as great communication at an inter-sectoral and international level.

Physical Infrastructure: Comfortable surroundings, efficient use of energy consumption model, using cutting edge technology, as well as renewable energies.

2.3.2 Sectoral Programs

Concerning the generation of this Referential Plan, it should be pointed out that:

a) The Referential Plan has been generated for the 4 sectors which the regulation indicates: residential, productive and public services, and transport. The improvements of efficiency have been calculated from then demand point of view.

b) An important definition, is having established the 15% energy savings goal for the 2009 -2018 Referential Plan forecast, the cumulated energy savings demand is projected at 372.71 PJ during the forecast period of analysis as shown in Table 9. This would be accomplished with all activities that are proposed in the present Referential Plan, having quantified only a part of the actions within the projects have need established in following chapters, which would indicate the progress as well as to meet new alternatives as a contingency of the possible unachieved 15% of savings through the mentioned activities. As a precedent, in 2008 the European Union has just set the goal of 20% savings until 2020, in spite of the fact that they have been carrying out energy saving programs in the same way.

c) The present Referential Plan will indicate tendencies and shall be updated in the measure that more recent data becomes available, if the economy persuades to have more precise results and convert them into a representative Referential Plan. In any event, carrying out of these data update studies must be at the top of the agenda as a permanent task at the start of the development of this Referential Plan.

d) In the present document, the term “efficiency” and “savings” are used indistinctly, and this is so due to the fact that any efficiency measure results in a reduction of consumption or energy savings by product or service unit, which is why the use of this term should not be understood as seeking the reduction of consumption “per se”, but greater effectiveness will lead to savings that will optimize the consumption in every sectors.

e) In this study, a detailed analysis will be carried out, which will comprise the energy situation within the country, inasmuch as in the 2007 Energy Balance, the yearbooks of the “Dirección General de Electricidad” – General Directorate of Electricity, of the “Dirección General de Hidrocarburos” – General Directorate of Hydrocarbons, of OSINERGMIN, among others, there is a description of what has been going on in the sector during the last few years, which is why its repetition in the present document will be reiterative in other respects, the present Referential Plan is concluded, it should form part of the Energy Referential Plan that is being put together by the MINEM and for which is being carried out the aforementioned analysis.

f) Reduction of the CO_2 emissions that will be produced as a consequence of the energy efficiency projects have been quantified, in order to have an estimate of the carbon certificates, which could be sold through MDL mechanisms or within the voluntary market, and serve as financial improvers for its implementation.

g) The EFIEMISION V.1 Program has been designed to estimate the savings of the present Referential Plan. The said software will be published in the “Sistema Interactivo de Eficiencia Energética (SIEE)” – Energy Efficiency Interactive System (EEIS) and will be available to the general public.

Residential sector

A series of objectives and actions have been proposed in order to form an efficient use of energy culture within the population, seeking that the present one, as well as the new generations, become responsible users and cooperate towards sustainable development by way of increasing efficiency, through the improvement of consumption habits and the selection of adequate electrical equipment and appliances, as well as the intense use of renewable energies, efficient architecture, in accordance with the climatic conditions of each region.

In this sector, we have initially identified 4 important projects that can be implemented and are referred to the substitution of 1 million traditional kitchen stoves for improved and more efficient units, modernization of all the residential sector’s lighting (mainly, the substitution of all incandescent lamps for energy saving lamps), the improvement of consumption habits of the population and the substitution of 100 000 electric water heaters for solar ones. Still pending, among the most important, the calculation of the impacts of the replacement of refrigerator door seals, the substitution of kerosene kitchen stoves for LPG or natural gas ones, the labeling of household electrical appliances and those that derive from other actions as proposed in this chapter.

Table 9. Energy demand reductions with energy efficiency programs

SECTORS	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
1. Reductions with energy efficiency programs (TJ x 1000)											
Residential Sector	2.76	4.84	8.57	13.96	18.92	18.92	18.92	18.92	18.92	18.92	143.65
Productive and Services Sector	3.77	7.67	11.56	16.46	17.95	17.95	17.95	17.95	17.95	17.95	147.16
Public Sector	0.05	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.95
Transport Sector	1.15	2.39	3.76	5.23	6.80	8.48	10.24	12.20	14.27	16.43	80.95
TOTAL	**7.73**	**15.00**	**23.99**	**35.75**	**43.77**	**45.45**	**47.21**	**49.17**	**51.24**	**53.40**	**372.71**
2. Emissions reductions (x 1000 tCO_2/year)	779	1499	2362	3468	4262	4381	4506	4645	4791	4945	35638
3. Annual economic savings ($x10^6$ US$)	121	231	347	490	571	612	655	703	754	807	5291
4. Incomes through carbon certificates ($x10^6$ US$)	8	14	20	27	30	30	30	30	30	30	249
5. Required investments ($x10^6$ US$)	97	100	124	185	98	14	14	14	14	14	674

Productive and Service sector

In this sector, the government of Peru will promote the optimization of energy consumption with the objective of improving competitiveness within the productive and service sectors, in order to face in the best of conditions, the competition that will be generated in the coming years as a consequence of the free trade commerce and the globalization of the world economy.

With this purpose in mind, a series of actions have been proposed in this chapter, having being calculated the impact that the projects referring to the substitution programs of 30000 electric motors, operation improvement of 60% the economy's boilers, the stimulation of cogeneration use and the use of efficient lighting (replacement of T12 fluorescents for T8 ones, substitution of electromagnetic ballasts for electronic ballasts and the total elimination of incandescent lamps). In addition, it has been proposed to expedite the use of cogeneration technology, which can introduce 196 MW into the system as referred in Table 11.

Within the medium and long-term, financial mechanisms for the achievement of the objectives of the present Referential Plan should be implemented.

Public sector

The aim is to achieve the energy's modernization of the public infrastructure through the improvement of its energy consumption taking into account that such infrastructure are similar by surface units, worker and/or beneficiary and/or user for similar climates, and carry out the necessary actions to maintain it in time.

In this sector, the first step that has been projected is the modernization of lighting, through the substitution of traditional T12 fluorescents for T8 ones, substitution of electromagnetic ballasts for electronic ballasts and the total elimination of incandescent lamps, as well as other measures as mentioned in the Referential Plan.

Although the savings projected are modest in comparison to those of other sectors, the goal is to show that the public sector (specifically the Peruvian State) can be seen as an example model and to be as a guideline with multiplier effect to the rest of Peru's energy sector.

Transport sector

In this sector, the aim is to reduce the consumption of combustible, by travelled distance units within urban transport, through information campaigns and other regulatory measures in order to achieve an efficient conduction and management of the vehicular traffic, which in other countries have originated savings of approximately 10%.

The savings originating from an education campaign for drivers and companies has been quantified, to achieve an efficient conduction and adequate management from the energetic point of view, as well as the impact that it would produce in the extreme case of a 1 day per week vehicular restriction in order to reduce traffic jams, which represent an annual loss of 500 million dollars in operative costs and person-hours.

Table 10. Annual energy savings by sources in 2018 (TJ x1000)

Sector	Residential				Productive & Services				Public	Transport	Total	%
Program	Cooker	Lighting	Water heaters	Consumption habits	Engines	Boilers	Lighting	Cogeneration	Lighting	Efficient driving		
Biomass savings	16.53										16.53	30.97
Fuel savings						8.75		5.95		16.43	31.13	58.31
Electricity savings		0.8	1.16	0.41	1.4		1.84		0.1		5.71	10.73

Table 11. Electricity demand reductions by sectors (MW)

SECTORS	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1. RESIDENTIAL										
Efficient lighting	109	113	116	121	121	121	121	121	121	121
Electrical water heaters	0	0	0	0	0	0	0	0	0	0
Consumption habits improvement	20	40	60	80	80	80	80	80	80	80
2. PRODUCTIVE & SERVICES										
Engine substitution	20	40	60	80	103	103	103	103	103	103
Cogeneration	20	40	80	160	196	196	196	196	196	196
Efficient lighting	27	70	95	95	95	95	95	95	95	95
2. PUBLIC										
Efficient lighting	3	6	6	6	6	6	6	6	6	6
TOTAL	**199**	**309**	**417**	**542**	**601**	**601**	**601**	**601**	**601**	**601**

PART 2: REVIEW TEAM REPORT

This part of the report presets the PREE Team's conclusions and recommendation about energy efficiency policies and programs in Peru.

1. INSTITUTIONAL CONTEXT

1.1. Critique

Well-organised institutional structures are crucial to the successful development and implementation of energy efficiency policies. To achieve effective cross-sector improvement in energy efficiency requires very close coordination among relevant government agencies at various levels on regular basis.

The Review Team acknowledged that the Ministry of Energy and Mines (MINEM) is the authority responsible for promotion of efficient use of energy, based on Efficient Use of Energy Promotion Law No. 27345 (2000-09-08) and that the General Directorate of Energy Efficiency (DGEE) was created in the MINEM based on Executive Decree No.026-2010-EM in May 2010.

The Review Team evaluates that creation of DGEE as the government office with responsibilities for energy efficiency policy making is a very positive step as one can clearly regard the DGEE as the government office directly responsible for developing energy efficiency policy, energy planning and promotion of renewable energy and energy efficiency programs.

At the same time, significant policy and program development related to energy efficiency also takes place within other government offices responsible for transport, housing, etc. These institutions, as well as local government, need to work cooperatively to achieve a common energy efficiency vision and objectives.

The Review Team was informed that a proposal to create Energy Efficiency Centre which would be responsible for implementing demonstration projects is under consideration.

The Review Team evaluates that the creation a proposed Energy Efficiency Centre with responsibilities for implementing demonstration projects is a very positive step in the right direction, as this proposed institutional framework, in general terms, is consistent with institutional arrangements made in other parts of the world.

It is important that a proposed Energy Efficiency Centre should have:

- a clear mandate to act – linked to empowering legislation objectives;

and

- provide adequate funding for energy efficiency activities.

***Legislative mandate*.** International experience suggests that effective energy efficiency centres/agencies require a strong mandate established through legislation. Such mandate is important for several reasons. First energy efficiency improvements require long term commitment. A legislative mandate provides long term support despite shorter term changes in political, economic and market operating environment. Second, a legislative mandate also provides the agency with necessary authority to conduct its business (for example, to collect data). Third, such a statutory mechanism helps connect energy efficiency policy to broader policy frameworks. The government of Peru should consider

establishing energy efficiency legislation (based on experience in New Zealand, Japan and Chile, for example) that provides a proposed Energy Efficiency Centre a strong mandate.

Funding. Obviously there is a need to provide a proposed Energy Efficiency Centre with stable and sufficient resources to implement effective long term energy efficiency policies and programs.

1.2. Recommendations

Recommendation 1 *The Government of Peru should constantly and consistently show leadership for policy-making and policy-coordination.*

More Inter-Ministry Cooperation at various levels by developing sector-level goals, strategies and action programmes as well as consistently reviewing the results of various action programmes in all sectors is essential to maximise energy saving in integrated manner.

Recommendation 2 *The Government of Peru should provide a proposed autonomous energy efficiency centre with a clear and strong mandate (e.g. a mandate to encourage effective implementation and evaluation of energy efficiency improvement programmes in all sectors, a mandate to compile and analyse relevant energy end-use data and to provide advice to the MINEM and other relevant Ministries on the development of energy efficiency policy/programmes). The Government of Peru should also provide this proposed autonomous centre with stable and sufficient resources to implement effective long-term energy efficiency improvement programmes.*

It is essential that the institutional arrangements relating to energy efficiency clearly identify objectives, provide a mandate to act and provide stable funding and resources for energy efficiency activities.

2. ENERGY EFFICIENCY GOALS, TARGETS AND STRATEGY

2.1. Critique

The PREE review team is extremely pleased to see that the Government of Peru has embarked on a very strong and nationally focused energy efficiency program. Through a number of recently enacted laws, decrees and resolutions (many discussed in the previous section), Peru has established a solid institutional framework and has initiated a strategic focus on energy efficiency as a major means to meet its current and future energy needs.

The energy efficiency strategy being pursued by the Government of Peru is driven in large part by three key national goals; 1) to reduce its significant dependence on imported energy, particularly oil, 2) to meet the basic energy needs of its population, and 3) to enhance its economic growth and productivity. These goals are all critical to the economy's long term viability and national security and can lead to a continuing prosperity over time.

During our meetings with senior government officials, it was noted that although Peru had a history of energy efficiency, from 1998 through 2008, very little was done in a concerted or integrated fashion –

energy efficiency during that time was comprised mainly of independent actions.[1] The Efficient Use of Energy Promotion Law[2], enacted in late 2008, set the vision for the resurgence of a national energy efficiency plan. This vision sees energy efficiency as a critical piece in the national interest and one which can ensure energy supply, protect consumers, promote economic competitiveness, and reduce adverse environmental impacts[3]. Overall, the laws and decrees since then have been established to create a "culture" of energy efficiency throughout the economy.

To further move along this pathway the General Directorate of Energy Efficiency (DGEE) was created by Executive Decree in July of 2010 and it reports directly to the Vice Minister for the Ministry of Energy and Mines (MINEM). The DGEE is charged with critical tasks to accelerate efficiency, such as the:

- Promotion of energy efficiency
- Creation of a Peruvian culture of energy efficiency
- Coordination of energy efficiency policies with the public and private sector

In addition, an *Energy Efficient Use Referential Plan for 2009 – 2018* was produced by MINEM in late 2009. The Referential Plan resulted in numerous recommendations, such as

- Reinforce strategic alliances with other sectors to promote energy efficiency
- Provide tax incentives for companies to use efficient technologies
- Implement the plan through, and strengthen, MINEM's regional offices
- Commit MINEM to be an energy efficient role model

Most importantly, the Referential Plan set a target to reduce Peru's energy consumption by 15% by 2018 (from the 2007 baseline). It also set a Sectoral Vision (for residential, productive, public and transport) as well as an economy-wide Vision for energy efficiency

The MINEM has also developed a Proposed National Energy Policy for 2010 – 2040 which is being used as a guidance document for DGEE. In addition the PREE team was informed[4] that by mid-2011, a new energy plan highlighting energy efficiency will be developed.

Currently, the DGEE is establishing its Directorate. This major undertaking of creating a new Directorate, while implementing many of the key policies, goals, programs and strategies noted above, is a Herculean task. DGEE's Human Resource capacity today stands at 14, with a plan to increase to 15 in 2011. The Directorate itself has a three-fold mission;

1) Energy Planning,

[1] Discussion with Director General Luis Haro of the DGEE, 11-11-10
[2] Law N° 27345 (2000-09-08)
[3] Review on Energy Efficiency in Peru – Background Information, MINEM, September 2010, pg. 36
[4] op. cit. Luis Haro, 11-11-18

2) Efficiency and Alternative Sources, and

3) Promotion of energy efficiency.

DGEE's budget of $1 million (USD) is very small in light of the scope of its current and future activities. Considering that this Directorate has only been in existence since July of 2010, it has accomplished much but has much more to do to meet its vision and strategic goals and targets.

DGEE and MINEM also plan to create a "Centre of Excellence for Energy Efficiency" in Peru[5]. This Centre would be created in conjunction under the auspices of the Energy and Climate Partnership of the Americas, hosted in June 2010 by U.S. Energy Secretary Steven Chu, which brought together ministers and stakeholders from the 34 Summit of American countries to launch or join new initiatives that would accelerate the world's transition to clean energy technologies[6]. Through the *Low Carbon Communities of the Americas* program in USDOE's Office of Energy Efficiency and Renewable Energy, the National Renewable Energy Laboratory was provided US$1,000,000 to assist countries in the western hemisphere. Peru's MINEM was awarded US$100,000 to launch the proposed Center for Energy Efficiency as a regional organization that would be geared to drive transformational energy efficiency technologies throughout the Andean region. The work could include a variety of objectives: identifying and sharing best-practice policies, providing the economies with information on emerging policy trends, and identifying opportunities for policy coordination across similar economies.

The PREE Team recognizes the excellence of the work accomplished so far by a small Directorate in a very short time. In addition to the discussions with MINEM and DGEE, the team also held discussions with other Ministries, Directorates, other government agencies and private organizations. The various government organizations included, for example, the Ministry of the Environment, the DG for Electricity, DG for Hydrocarbons, COFIDE, OSINGERMIN, Ministry of Transportation, Ministry of Education, INDECOPI, etc. While all recognized the value of energy efficiency to some degree, it is apparent that there is no common ground among these organizations. A very clear message on energy efficiency must be developed and spread among all of these organizations in order to ensure a transformational change within the economy following the five pillars that DGEE has created on Education, Renewable Energy, Regulation, Technology, and Market (see Figure 21 in Chapter 2, Part 1); each agency of the government must undertake its own actions, policies, and programs with energy efficiency as a top priority.

One means to achieve a more consistent and government wide message would be the creation of a Government Energy Management Program. Such program would serve to integrate energy efficiency plans and policies across all Ministries and other relevant federal government organizations. By taking the lead on coordinating policies and actions across all ministries, the government of Peru will drive the energy efficiency culture throughout the entire Peruvian government.

The foundational strategy of a specific government energy management program is that can leverage the benefits of energy-saving actions within a government by stimulating broader changes in both the

[5] Minister Pedro Sánchez of MINEM, discussion, 08-11-10

[6] Discussion with USDOE's Gary Ward, Director of the Office American Affairs, November 24, 2010.

demand and supply sides of the market. The government sector's purchasing power alone offers a powerful non-regulatory means to stimulate demand for energy-efficient products and services. Domestic suppliers of energy-related products and services are then encouraged to introduce more energy-efficient products and services as a real and vibrant market for energy efficiency emerges from the government actions[7].

Government *Leadership by Example* is a powerful tool to transform the energy efficiency marketplace in the economy. The active participation and visibility of the government can move the markets in energy efficiency. Other APEC economies, e.g. the United States, Philippines, Malaysia, have government energy management programs that run from very comprehensive to less comprehensive, but all using government leadership as a means to transform efficiency throughout the economy.

For example, in October 2004, through an Administrative Order, the Philippine government institutionalized the Government Energy Management Program (GEMP), which aims to reduce government energy consumption by 10% through the implementation of energy efficiency and conservation measures in government facilities and projects for a minimum 3-year period, beginning in January 2005. Under the Eighth Malaysia Plan (2001-2005) a new energy efficiency initiative was implemented and called the "Energy Management Program in Government Buildings." This program is aimed at improving energy efficiency in government buildings and facilities in Malaysia, and is seen as a vehicle for government leadership on energy efficiency[8].

In general, a well implemented in-house government energy management program is more cost-effective than a series of decentralized activities. Governments are major purchasers of energy-using equipment, and can thus be a key agent of market transformation if they direct this purchasing power towards efficient products[9].

By creating a government wide energy management program, Peru's Government can implement a sound, cost-effective energy management program and initiate the type of investment practice that will enhance the nation's energy security and environmental stewardship[10], thereby meeting a number of its goals and leading the entire economy on the way to meeting its efficiency target.

The PREE review team also notes that it is an important step for a government to establish a strong base of energy efficiency policies and programs that can lead the economy to reduce its energy consumption while continuing to increase its productivity. A number of economies have established a national energy efficiency action plan to guide them along the pathway to a clean and sustainable energy future.

The United States developed a comprehensive National Action Plan for Energy Efficiency over the past few years. The development of this plan was under the auspices of the US Department of Energy and

[7] See, http://www.usaid.gov/our_work/economic_growth_and_trade/energy/publications/projects/mexico_peps.pdf
[8] See, Promoting an Energy Efficient Public Sector website; http://www.pepsonline.org/
[9] Ibid.
[10] See, http://www1.eere.energy.gov/femp/

the Environmental Protection Agency, but relied heavily on both private sector and non-governmental input throughout the entire process.

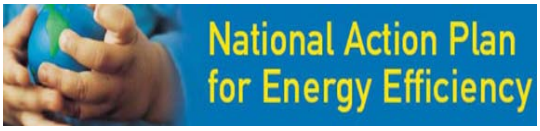


Figure 23. US National Action Plan for EE logo

A Leadership Group of nearly 60 nationally known energy organizations were brought together to lead the development of this forward looking plan. Even today as the plan meets many of its goals the private sector and non-governmental representatives are still working together diligently with the government to move it forward; while it is evolving, the Leadership Group is updating the plan through 2025.

Chile, recently established its own National Action Plan for Energy Efficiency. That plan was based in large part on the results of APEC's Peer Review of Energy Efficiency program.

Figure 24. Chile's National Action Plan for EE logo

Chile's actions in that plan make a powerful statement as to how important a well developed and executed plan can help an economy's overall energy future. In fact, the Alliance to Save Energy awarded Chile with the Americas 2010 EE Visionary Award.

- Chile's commitment and outstanding contributions to the advancement of energy efficiency
- The establishment of an energy efficiency information labeling program,
- The institution of South America's first residential energy efficiency building code,
- The development of the National Action Plan for Energy Efficiency, and
- The development of an autonomous energy efficiency agency to guide implementation efforts in the country.

The PREE team believes that Peru is headed in the same direction and a national action plan could serve as the roadmap that could drive the economy to its destination.

Though it is critical to a national action plan, even if one is not developed, it is necessary for Peru to create an energy efficiency pathway of policies and programs for the economy to follow. The pathway also needs to have annual timelines to meet the stated energy efficiency targets and which can be used by Peru to measure its progress. The reason that this is important is that it is necessary to ensure that the government is able to determine whether targets will be met on time, or whether more aggressive actions/measures are needed. The Preliminary Energy Savings Potential study provides gross annual savings numbers in the four sectors but not the actions or measures to achieve them.

One way that Peru could ensure that it is travelling along the path it develops is to set up a process for annual reviews of the energy efficiency target in the Referential Plan. This will enable the government to continually take stock of where they are, what progress has been made, and what further policies and programs (or targets and goals) set forth in the strategic plan need to be modified or enhanced. Additionally, this annual review also provides the government an opportunity to include all sectors of the economy as part of the plan to increase the energy efficiency target over time. By reviewing the target annually and evaluating progress, Peru will likely be able to ratchet up the target over time. By including all sectors, there will be more flexibility across a broader spectrum as additional sectors can contribute to meeting higher targets.

The PREE team recognizes that part of any national strategy on energy efficiency must include a viable public awareness campaign. Informing the public as to the benefits of reducing energy consumption through energy efficiency is critical to imbuing a “culture” of energy efficiency that Peru has set as one of its national goals. Creating a national public education and awareness campaign for energy efficiency through a variety of media is one means to accomplish this. Tying in other important national overarching goals into the message can help create that culture.

Building public support for energy efficiency measures and programs initiated by the government and enterprises is a critical action to create that energy efficiency culture. While educating the public (and enterprises) on the cost savings from efficiency, national goals such as energy security (reducing liquid fuel imports) and Greenhouse Gas reductions (due to energy efficiency actions) will resonate well with the public and get them to become more efficient as a matter of national pride. Creating a public education and awareness campaign should also be viewed as a continuing program, to get results both in the short term, but also over the long term. And parts of a public education campaign can be tied directly into product labelling policies and programs that are discussed in a later section of the report.

Along with a long term public awareness program, the PREE review team recognizes the importance of educating children about energy, particularly energy efficiency. In order to meet Peru’s goal of creating a culture of energy efficiency throughout the economy, it is necessary to create an energy efficiency educational program for the school children of Peru, both K-12 and at the university level. Like the program that was developed in Peru between 1994 and 2000, the development and implementation of an educational program on energy efficiency (including curriculum and demonstrations) will provide children with the basic knowledge and benefits of being energy efficient. This will help the DGEE meet

its requirement to “create a Peruvian culture of energy efficiency” as children will carry the energy efficiency message home to parents.

As the PREE review team has found in other economies, it is critical to provide the institutional and regulatory framework that allows the provision of energy efficiency services and programs to be a viable business operation for the utilities. For example, in order for the utilities to embrace energy efficiency fully, they need to be able to achieve a return on investment that is equal to (or greater than) the return they achieve on generating electricity. Historically, if a utility’s only source of revenue has been based on generating kWh, then providing energy efficiency services and programs can reduce that revenue stream. Consequently it is necessary for the government to create an economic environment for utilities that provides a return and incentive to provide energy efficiency services to the people and businesses of Peru. The utility industry in Peru can be a significant partner in delivering massive amounts of energy efficiency if the proper regulatory schemes are in place. In this regard, DGEE considers that it is not convenient that OSINERGMIN assumes the responsibility to promote politics or reforms on energy efficiency due to this institution is in charge of supervising the private investment in energy and mining as well as in charge of the regulation of electric tariffs.

In looking at financing investments in energy efficiency in Peru, the PREE review team found mixed results. For example, in order to meet long-term energy efficiency goals, it is critical to have a financing stream for investments. The PREE review team had discussions with two financing organizations that exist today. However, neither of these organizations focuses on energy efficiency per se; one (PROINVERSION) focuses on major energy efficiency infrastructure projects, while the other (COFIDE) focuses on fuel substitution and Energy Service Companies (ESCOs). Nonetheless, the existence of both organizations provides the infrastructure and the experience of financing investments in energy, which lays the basic framework for financing energy efficiency investments. Creating a parallel agency to PROINVERSION or COFIDE to finance only energy efficiency projects in all sectors could jump start a major energy efficiency investment program in the economy. By having this new entity focus solely on financing energy efficiency projects, the needed assistance and incentives for the building of a strong energy efficiency industry in Peru can be achieved.

Another area of interest to the PREE review team is in the area of energy efficiency policies and programs that can benefit the low-income population of the economy. This can be an overlooked segment of an economy, but their needs for more energy efficiency do exist and the cost savings associated with energy efficiency in the building they live in and the appliances or lighting they use can be a critical factor to their well being. Therefore, creating an energy efficiency framework of policies and programs that is focused on the low-income people of Peru should be a goal of the overall energy efficiency strategy for the economy. Like expanding to all sectors of the economy to meet the Referential Plan efficiency target, expanding energy efficiency policies to focus on the low-income and/or rural community will allow more flexibility to meet the target while protecting a vulnerable segment of the economy and meeting an important social goal.

2.2. Recommendations

Recommendation 3 *Integrate energy efficiency plans and policies across the General Directorate of Energy Efficiency (DGEE).*

This will ensure a common strategic plan and coordinated actions will be shared among the various Directorates in the Ministry.

Recommendation 4 *Create a Government Energy Management Program to integrate energy efficiency plans and policies across all Ministries.*

By taking the lead on coordinating policies and actions across all ministries will drive the energy efficiency culture throughout the entire Peruvian government. *Leadership by Example* is a powerful tool to transform the energy efficiency marketplace in the economy.

Recommendation 5 *Develop and Implement a National Action Plan for Energy Efficiency*.

Using the current foundation of plans, policies, and programs to serve as a framework, Peru can develop a comprehensive economy-wide energy efficiency plan that will help transform the efficiency marketplace and meet its efficiency targets.

Recommendation 6 *Create a pathway with annual timelines to meet the stated energy efficiency targets.*

This is necessary to ensure that the government is able to determine whether targets will be met on time, or whether more aggressive actions/measures are needed. The Preliminary Energy Savings Potential study provides gross annual savings numbers in the four sectors but not the actions or measures to achieve them.

Recommendation 7 *Set up a process for annual reviews of the energy efficiency target in the Referential Plan and include all sectors as part of the plan to increase the target over time.*

By reviewing the target annually and evaluating progress, Peru will likely be able to ratchet up the target over time. By including all sectors, there will be more flexibility across a broader spectrum that can contribute to meeting higher targets.

Recommendation 8 *Create a national public education and awareness campaign for energy efficiency. Tie in important national overarching goals in the message.*

This is a critical action that will build public support for energy efficiency measures and programs initiated by the government and enterprises. While educating the public (and enterprises) on the cost savings from efficiency, national goals such as energy security (reducing liquid fuel imports) and Greenhouse Gas reductions (due to energy efficiency actions) will resonate well with the public and get them to become more efficient as a matter of national pride.

Recommendation 9 *Create an energy efficiency framework that is focused on the low-income people of Peru.*

Like expanding to all sectors of the economy to meet the Referential Plan efficiency target, expanding energy efficiency policies to focus on the low-income and/or rural community will allow more flexibility to meet the target while protecting a vulnerable segment of the economy and meeting an important social goal.

Recommendation 10 *Create an energy efficiency educational program for the school children of Peru (K-12 and university).*

Like the program that was developed in Peru between 1994 and 2000, the development and implementation of an educational program on energy efficiency (including curriculum and demonstrations) will provide children with the basic knowledge and benefits of being energy efficient. This will help the DGEE meet its requirement to "create a Peruvian culture of energy efficiency" as children will carry the message home to parents.

Recommendation 11 *Create an economic environment for utilities to provide energy efficiency services to the people and businesses of Peru.*

The utility industry can be a significant partner in delivering massive amounts of energy efficiency if the proper regulatory schemes are in place. OSINERGMIN is also a critical player in this area as it can promote the types of policies, regulations, and reforms that would place energy efficiency on the same financial basis as generation.

Recommendation 12 *It is recommended that the project to create the Energy Efficiency Centre should work as a parallel agency to PROINVERSION to finance only energy efficiency projects in all sectors.*

In order to meet long-term energy efficiency goals, it is critical to have a financing stream for investments. The project to create the Energy Efficiency Center should help as a financing agency, similar to PROINVERSION (which finances major energy infrastructure projects), or COFIDE (which is promoting fuel substitution and some ESCO projects) but which would focus only on financing energy efficiency projects could provide the needed assistance and incentives for the building of a strong energy efficiency industry in Peru.

3. ENERGY DATA COLLECTION AND MONITORING

3.1. Critique

MINEM collects data on energy consumption such as primary energy supply, energy transformations and final energy use. The energy data were reported, annually, in the form of energy balance report with the breakdown of the type of fuels. The report provides the state of energy supply and use as well as energy transformations in Peru. Basically, the report provides an indication on the efficiency of the energy system such as the efficiency of primary energy transformation into final energy and the distributions efficiency. The report also provides data on selected sectors final energy use according to type of fuels.

Economy-wide energy efficiency indicator such as Total Final Energy Consumption/ Gross Domestic Product ratio was available from the existing data collected by MINEM. From the data provided by MINEM to the PREE team, the energy intensity value has improved from 7.83 TJ/one million of 1995 US$ in 1995 to 5.53 TJ/ one million of 1995 US$ in 2008, improving at an average 2.6% annually. The intensity could provide an indication of the state of energy efficiency improvement in Peru.

To further enhance energy data collection and monitoring, MINEM issued a ministerial resolution. The Ministerial Resolution No 038-2009-MEM/DM is a guide on energy consumption indicators and monitoring methodology for key economic sectors. Under the ministerial resolution, the MINEM is responsible to develop a system to collect data and establish energy consumption indicators as well as monitoring.

3.2. Recommendations

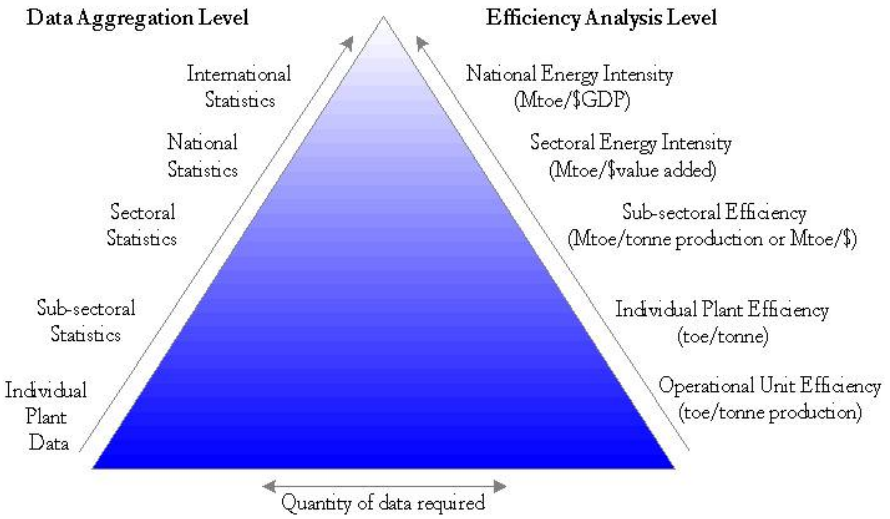
The economy-wide energy efficiency indicators like primary energy supply to final energy ratio and final energy consumption to GDP ratio are good to depict the overall energy system efficiency and economic efficiency of energy use but not enough to tell how the actual technical energy efficiency improvements in various economic sectors and sub-sectors are performing. Understanding energy use at various economic sectors and sub-sectors is very important. By knowing how energy is used and the energy drivers, the Peruvian Government can plan effective and efficient energy efficiency improvement strategy and measures. The understanding on energy use needs energy and energy-use related economic data as well as techniques to analyse the data.

The Peruvian Government should establish a set of energy efficiency indicators which covers various economic sectors and sub-sectors to monitoring and understand the real improvement of energy efficiency in the economy. Energy efficiency indicators will measure ‘how well’ energy is used in the production of useful outputs. In this regard, the indicators should have criteria such as ability to convey information clearly, developed on sound scientific basis, cost effective to develop and relevant to energy efficiency program’s targets.

Energy and economic data collection are important components in indicators development. The data collection needs should be developed together with the indicators development plan. The types of data needed are defined by the indicators developed. The collections of energy end-use data are an expensive activity and require massive resources. There are situations where energy end-use data cannot be obtained from users, especially from commercial and industrial users. The data are treated as classified information by the users for various reasons.

The Peruvian should create a legal mechanism to improve energy end-use data. The mechanism must be able to reduce the resources need in data collection by decentralising the data collection efforts among government agencies with the responsibility to improve energy efficiency in the economy as well as to provide a legal mean to the Government to obtain the data from energy users.

Energy efficiency indicators must be able to reflect economy-wide efficiency improvement. Economy-wide energy efficiency indicators can be developed by aggregating the sectoral and sub-sectorals indicators. To aggregate the sectoral and sub-sectorals indicators, which vary in units of measurement; factorisation or indexation technique can be used. The factorisation or indexation techniques will also help to eliminate the non-energy factors of the indicators such as structural and activity effects. The indicators with the elimination of non-energy factors are useful for Peruvian government to understand clearly the underlying factors of energy efficiency improvement. The relationship between energy efficiency indicators at various levels and aggregation is depicted in the Figure 24. The influence of non-energy factors is depending on level of aggregation, decline as the level of aggregation decreases (moving down the pyramid in the Figure 25).



(Source: Phylipsen et al, 1998.[11])

Figure 25. Energy Efficiency Indicator Pyramid

The monitoring of energy efficiency improvement at various economic sectors and sub-sectors requires substantial human capacity and infrastructure to gather data, manage database, perform analysis, prepare and disseminate reports. As such, it is important for Peruvian Government to develop an analytical framework to monitor energy efficiency improvement programs.

The framework should be structured in such a way that data collection, analysis and reporting involved all stakeholders responsibile to promote energy efficiency in the economy. This will help spread the responsibility of reporting to various stakeholders and can avoid the burden of reporting to only certain agencies. However, a focal agency should be designated to coordinate the efforts among agencies. The

[11] Phylipsen, GJM, K.Block and E.Worrel. (1998). *Handbook on International Comparisons of Energy Efficiency in the Manufacturing Industry*. Department of Sciency, Technology and Society. Utrecht University.

focal agency also should be responsible to prepare and publish in periodical manner the monitoring reports.

It is important for the Peruvian Government to convey the achievement of energy efficiency programs to various stakeholders and energy users in the economy. The information will instil confidences among energy users on the Peruvian Government's commitment to improve energy efficiency in the economy. The confidences will attract more and wider participation of energy users to participate and support the energy efficiency efforts. As such, wider dissemination of energy efficiency improvement monitoring efforts is necessary.

Summary of recommendations are:

Recommendation 13 *Develop a set of energy efficiency indicators for economic sectors and sub-sectors.*

Recommendation 14 *Define the data needs, energy data, economic data, according to the energy efficiency indicators needs.*

Recommendation 15 *Create a legal mechanism to empower the government to obtain energy end-use data from all energy users in the economy as well as to spread the burden of data collection among the government agencies.*

Recommendation 16 *Carry out factorisation or indexation techniques on the indicators to remove the non-energy factors as well as to create economy-wide indicators by aggregation.*

Recommendation 17 *Develop an analytical energy efficiency monitoring framework. The analytical framework should help to be a communication tool for policy makers and energy users in the efforts to improve energy efficiency.*

Recommendation 18 *Publish, periodically, energy efficiency monitoring reports and disseminate the reports to stakeholders.*

4. POLICY MEASURES – INDUSTRY SECTOR

4.1. Critique

Industry sector has always been a major energy consuming sector in the Economy for Peru. The recent statistics show that energy demand in this sector has been accounted for 28 to 30% of total energy consumption and is expected to increase at the rate of 4% annually. The major challenge for this sector is that in the past decade energy intensity increased from 1.0 TJ/million USD (1997) to 1.29 TJ/million (2005). If the trend continues, the energy demand will rise significantly and the country will need to invest for many new power plants and associated facilities and will have to depend on imported fuels even more. This would, certainly, aggravate the energy security situation as well as the industrial competitiveness in the global market.

Peruvian government, especially Ministry of Energy and Mines, is aware of such emerging problems. The Energy Efficiency Referential Plan has been developed with a focus on industry, residential, public and transportation sector. The key target of the Plan during 2009 - 2018 is set out to reduce energy consumption by 15% compared to the baseline projection (BAU case). Some activities and projects have also been identified such as improvement of energy performances in motors, boilers, and lighting systems. Standards and labelling is expected to be the key measure to achieve such ambitious goal.

However, the review team found that little implementation was actually carried out for Industry Sector. Some notable achievement, among other things, was the ESCO study conducted during 2002 – 2006 which recommended energy efficiency projects with a very nice financial return. Nevertheless, none of the recommended projects were implemented. Another work with real progress was the setting of energy standards for industrial equipment such as motors and boilers. A few standards have been officially announced, but there are no promotional or regulatory activities to ensure the widely recognition of the standards. Many industrial entrepreneurs as well as energy service companies are not aware of such standards.

The review team feels that even though the EE Referential Plan set a clear target, action plan must be prepared and appropriate financial and human resources must be arranged in order to achieve the target. Some projects were identified but many times they could not secure necessary budgets. As a result, little work has been done to improve energy efficiency in Industry Sector. The review team is also concerned that there are no mechanisms to monitor the implementation, evaluate the effectiveness of promotional measures, or report the outcomes of the Referential Plan. Without such mechanism, it would be extremely difficult for the Ministry of Energy and Mines to manage and carry out the Preferential Plan as expected.

4.2. Recommendations

Recommendation 19 *The Peruvian Government should develop a comprehensive National Action Plan of Energy Efficiency in order to show the pathway to achieve energy efficiency target in industry sector and to provide common understanding among stakeholders what to be done and when to be done.*

Below are few recommendations in making a good plan, but not limited to, such as :

a) Conduct energy efficiency potential survey: It is important to make a plan from reliable data. A survey should be conducted to estimate the magnitude of energy savings potentials in each industrial subsector. The study can also serve as a development of benchmark in energy usage in industries and help understand the needs to improve energy efficiency which could be as simple as practicing good energy management or as difficult as changing production processes. The study should also recognize the differences between technical potential and market or investment potentials which can then be a good material to develop necessary measures to enhance energy efficiency for the target group.

b) Investment Need Assessment / Barriers: Even though some energy savings can be achieved by good energy management and housekeeping practices, investment may be needed to attain higher energy efficiency on industrial production process. Investment needs and barriers must be estimated and understood in order to set appropriate budgets and measures. Possible measures include tax incentives, soft-loan program, investment subsidies.

c) Training Need Assessment: capacity building is also essential to raise industrial energy efficiency. It is advisable to evaluate current overall competency of industry personnel in energy management or energy conservation techniques, in order to quantify the training needs and develop suitable training programs, possibly, ranging from basic energy management training to specific advanced energy saving technologies. Training need assessment should be focused on sectors with great energy demand and great energy saving potentials.

d) Clear Target; Milestones: With the results of energy saving potentials, investment and capacity needs assessments, Ministry of Energy and Mines should consider set out a clear target and create a strategic roadmap including milestones for a short, medium, and long term goals. The targets should address tangible outputs such as investment magnitude in energy efficiency projects or number of personnel trained in each training program, or indicate the impacts from all measures using energy saving or energy intensity as quantitative indicator.

e) Action Plan and Budget requirement: DGEE should then develop action plan to reach such targets. Sufficient budgets and resources including human resources should be allocated accordingly. The plan should also identify all major risks involved and preventive measures must be carried out to ensure the successful implementation of the Action Plan.

f) Appoint Responsible Agencies (DGEE; EE Center) job assignment must be clear among responsible agencies. One possible scenario could be that DGEE would be tasked as a policy maker and monitoring body, while the proposal to create the EE Center should be appointed as an implementing agency.

g) Monitoring and Evaluation Scheme: It is very important, but in many cases overlooked, to develop a comprehensive monitoring and evaluation scheme for the Action Plan. The M&E scheme should include not only the implementation results of the Action Plan but also the advancement of EE technologies and economic situation to be able to review the Plan and the Target in time and avoid any wasteful activities as well as retool strategies as needed.

Recommendation 20 *It is recommended to develop energy efficiency comprehensive strategies to industry sector in Peru through mandatory and voluntary measures, as well as to enforce the requirement to have EE managers.*

Mandatory measures are suitable for assure basic energy management activities to be conducted in large energy consuming industries and voluntary measures provide incentives or to build capacity to industrial energy users to enable them in project implementation. Mandatory components should be include: mandatory energy audit for large energy users; EE standards for major industrial equipment;

energy management standard; dedicated person for energy management; report monthly energy consumption on annual basis; specific energy consumption / benchmark; and energy saving target and plan to be developed for each industry. On the other hand, voluntary components should include: capacity building / training; incentive for EE projects (Grant/Subsidy); tax incentives; soft loans / co-investment program; promotion / awareness campaign; voluntary agreement; EE awards / show cases; and research & development. All programs should be designed to assist industrial users and they should be co-related to avoid overlapping and conflicting among themselves.

Recommendation 21 *The MINEM need to establish stable and secured funding source and mechanism, as well as to consider establish a special purpose fund which may be called "Energy Conservation Promotion Fund" to move the Action Plan forward. MINEM should also look for external funding sources and from private or public investment fund to mobilize some capital for energy efficiency project. It is therefore suggested that public fund (Energy Conservation Fund) should be used to initiate and leverage private sector's investment.*

Mandatory or voluntary measures require a sizable budget for implementation as subsidy money, technical assistance, promotion campaign or administrative work. Since the work plan may continue year after year, long-term and flexible funding should be secured. The Fund could be established by collecting so called "energy conservation tax" from the sale of final commercial energy including electricity, gasoline, diesel, fuel oil, natural gas, etc. Surcharge from factories do not comply with mandatory component could also serve as additional income of the Fund. For the subject of energy efficiency and conservation which can help mitigate risk of climate change, there are quite a few funding agencies available. Global Environmental Facility, The World Bank's Clean Technology Fund, IADB Clean Energy Fund, Cool Earth Initiative by Japan, just to name a few. Many EE funds are available and ready to invest in many forms – project financing; debt financing; equity financing; ESCO- financing model. EE investment in industry sector could require a large amount of money. Cooperation with local financial institutes is a must in order to expand EE lending market throughout.

Recommendation 22 *In the light of the establishment of General Directorate of Energy Efficiency and the proposal to create the new Energy Efficiency Centre, strategic positioning and clear responsibilities must be assigned. It is recommended that the recently created DGEE and the project to create the EE Centre, the DGEE should take the role of policy maker while EE Centre should take the responsibility of implementing agency. Also, is highly recommended that capacity building in both organizations is extremely vital.*

As policy maker, DGEE would set the direction and overall target for EE improvement in industry sector. If the Energy Conservation Fund is set, DGEE would play a role of fund manager who allocate appropriate budget for implementation. Then, DGEE would evaluate all implementation results and review the target year by year. EE Centre, as the implementing agency, would follow DGEE's instruction and carry out projects as such. EE Centre, then, needs to report to DGEE in an annual basis, at least. With the task assigned, it is recommended that the new EE Centre should be established in such a way that it has great management flexibility. In another word, it should be a private or semi-private agency.

However, the Centre should still be audited and accountable for their work to ensure efficiency and transparency.

Training or coaching program will enhance the work of the two important agencies. Study visit or participating in international conferences is also helpful to learn about what other countries are doing and successful criteria in both policy making and implementation.

5. POLICY MEASURES – ELECTRICITY SECTOR

5.1. Critique

The electricity sector in Peru has experienced improvements in the past 15 years. In 2008, electricity accounted for 18.1% of the total final energy consumption. Access to electricity has increased from 45% in 1990 to 80% in 2009 and with a goal to reach 85% by 2012. In 2008, the total installed electricity capacity in Peru is 7158 MW. Installed capacity was almost equally divided between hydropower, with 45%, and thermal power (e.g. natural gas, diesel, coal and bagasse) with 55%.

The main power transmission grid in Peru is known as the National Interconnected Electrical System (SEIN). Additionally, Peru has a small power transmission grid: the Isolated Systems (Sistemas Aislados or SA). In 2007, 98% of the total electricity generated in the economy was delivered through the SEIN; the remaining 2% was delivered through SA.

The Electricity Concessions Law, which allows for the privatisation of the electricity sector with regard to power generation, transmission, and distribution, was established in late 1992 to help promote competition and efficiency within the sector. The law of 1992 was modified by Law No. 26876 in 1997, which promotes competition in the electricity sector by prohibiting the control of more than 15% of electricity generation, transmission, or distribution by any one firm.

In July 2006, the government has expanded the rules established in the Electricity Concessions Law to enable the introduction of bidding and incentives for the optimal supply of electrical energy; the establishment of a spot market; the modification of functions held by the Comité de Operación Económica del Sistema (COES) with the purpose of forming an independent operator for the electricity system; and an adjustment of the legal framework corresponding to the formation of transmission prices. The privatisation policy set by the government has encouraged involvement by many private companies in the generation, transmission as well as the distribution business. The Energy and Mining Investment Supervisory Body (OSINERGMIN - Organismo Supervisor de Inversión en Energía y Minería) has the responsibility to oversee the price regulation and supervision of the overall technical and legal aspects of Peru electricity supply industry. In this regard, both OSINERGIM and COES have specific works, which trough them it could be possible to identify the energy savings potential in the sector.

As part of Efficient Energy Use Referential Plan 2009-2018, MINEM has identified potential sectoral electrical energy demand reduction. In addition to that other stakeholders within the electricity supply industry can also play their roles. The distribution companies can consider offering energy efficiency (EE)

awareness program to their customers. Rebates and incentives can be offered to customers implementing EE projects and utilising efficient equipment. It is understood that the business model of these companies is to sell as much power as they can hence they might be reluctant to offer such EE program. OSINERGMIN can assist in providing a regulatory framework often called 'decoupling' in which the revenue generated is not directly tied to how much power is produced (e.g. in California). Alternatively a separate fund can be created to support relevant EE initiatives.

The PREE team acknowledges that significant effort has been made to improve and reduce the electrical transmission and distribution losses. The team was informed that within ten years, the T&D losses has been improved from 22% to 12% with an average of 8% for distribution and 4% for transmission. Based on experience in other economies, there is still opportunity to reduce this further. Similarly the generation companies can also consider embarking on various efforts to ensure that their plant can operate in optimal efficiency. Network and plant efficiency improvement not only contribute towards overall energy efficiency improvement but also on operational efficiency and enhanced asset utilisation.

MINEM has put in place plan to expand Peru Renewable Energy Resources (Solar, Wind and Micro-Hydroelectric). Proper mapping of these resources should be done not only to identify a sustainable RE resources availability but also at the same time a strategic placement to ensure proper interconnection in meeting load requirements and minimising network losses.

5.2. Recommendations

Recommendation 23 *It is recommended that further effort is made to reduce the T&D losses and at the same time improve the thermal power plant efficiency. Audit and assessment can be conducted to identify the existing power plant efficiency and areas for improvement.*

Recommendation 24 *It is recommended that the Peruvian Government to institutionalise the legal framework within the electricity market and delivery sector. Amongst others:*

- *Regulators/OSINERGMIN together with COES to be given more power to specify and enforce EE related laws and regulation*
- *Energy projects should embed EE related requirements and specifications (as part of National Policy)*

Recommendation 25 *There is opportunity to translate the proposed demand reduction to real action plan with active involvement from OSINERGMIN/COES/transmission-distribution operator/customers through the following:*

- *Utility should also play their roles to promote and encourage Energy Efficiency*
- *Rebates and incentives to customers implementing EE projects and utilising efficient equipment*
- *Establish funding mechanism for to support EE programs and initiatives*

Recommendation 26 *Proper planning is recommended for DG and RE interconnection together with rural electrification projects to ensure optimises asset utilisation, network expansion and reinforcement thus minimising network losses. This can also be linked to other initiatives towards achieving supply and load controllability, energy efficiency and Smart Grid.*

Recommendation 27 *It is recommended that the regulator enforces the requirement to have EE managers for certain type and size of electricity consumers. Thus, it is necessary to have in place a national program to develop the required competent people in EE.*

6. POLICY MEASURES – COMMERCIAL AND RESIDENTIAL SECTOR

6.1. Critique

Based from the National Energy Balance data 2008, residential, commercial and public sectors, are the thirds largest energy consuming sectors in Peru, accounting for 28.6% of the economy's total energy demand.

For residential and commercial, the annual growth rate decreased by 0.26 % during 1985 – 2008 period. The consumption structure is dominated by firewood for cooking. Electricity and LPG demands have increased by 25% and 16% respectively, while kerosene consumption has decreased drastically during the period 2004-2008 due to an increase of the Excise Tax – Impuesto Selectivo al Consumo (ISC) which was added in 2007. This tax has changed the use of kerosene in stoves to LPG which is much more efficient (from 10% to 60%).

In the public sector, the energy consumption decreased by 0.6% per annum during 1985 – 2008 periods, a lower demand of turbo was recorded in this sector. Additionally, it is important to point out that diesel consumption has decreased during this period.

The three sectors together have the an important energy efficiency potential considering to that economic growth in Peru will increase the prosperity, having as result in increased consumption of energy, especially electricity for appliances. The Government of Peru (trough DGEE) has recognised this and has determined that restraining the growth of consumption in these sectors highest priority as stated in the Law for the Efficient Use of Energy, continued with regulation related to labelling and standard and energy saving measure for the public sector.

From 1985-2008, Peru's energy consumption increased at annual growth rate by 1.24% and during the year 2008, the production of electrical energy was increased 9.9% to the previous year, at the same time the electricity's final consumption had an increase of 10.4%.

In 2008 the sectors with greater participation in consumption of electricity are residential, commercial and public sectors (43%), the industrial sectors (29%) and the metal metallurgical sector (26%). The

residential and commercial sector consumes 23.7% and public sector 1.6%[12]. The demand of electricity in residential and commercial sector increase by 11.8% in 2008 and public sector 8.62%, respectively.

The increase in residential, commercial and public electricity demand, is evidence of the increasing electricity use because of increasing GNP, with an increase per year of around 6 % from 2002 – 2008[13] and also population (in 1993-2008 increase 1.6%), hence, the energy consumption per population tends to increase year by year.

Use of household appliances such as air conditioning, televisions, and refrigerators will increase with increasing population and prosperity. This is decided by the Peruvian government to create a Master Plan on Energy Efficiency

Residential sector

In the Referential Plan mentioned priority programs that have a major impact on energy savings are modernization of lighting, improved energy consumption habits of people, replacement of electric water heaters with solar water heater systems and replacement of traditional stoves with improved stoves. To support the use of household appliances has made efficiency labels as shown in Figure 25.

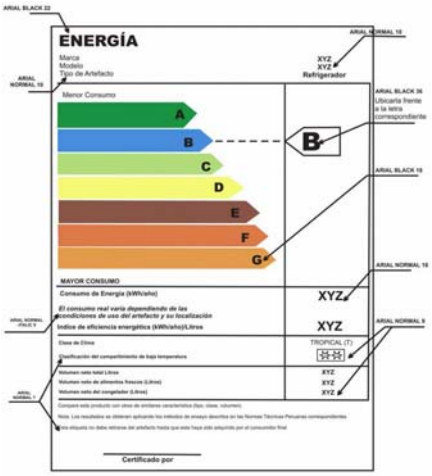


Figure 26. Energy Efficiency Label in Peru

Public and Commercial Sectors

The government realizes that in future the competition will be very strict and therefore the program in this sector are directed how to optimize energy usage. In this sector, program on modernization of lighting, improved efficiency of motors, boilers and the use of co-generation technology is prioritized.

[12] National Energy Balance of Peru 2008
[13] Peru economic indicator (APERC)

To support the implementation of the program, the government will implement the funding mechanisms and incentives.

Based on the Referential Plan, savings target is around 15%, for there are some things that need to be added in the master plan, which are:

a. Planning action plan / program in more detail

1. Current status of energy efficiency, this activity is part of the energy efficiency roadmap to determine the current position that will be used to create strategies and programs to reach 15% savings. One result of the activities is to find potential energy savings of each sector. It should be specified indicators are required in each sector (intensity indicator) as kWh/m^2 year, kWh / bed occupancy rate, so the savings will be seen in the reduction of the intensity indicator.

2. Other programs that need to be specified are part of a strategy of capacity building, i.e. training, education and campaigns. Activities capacity made per segment and for the commercial segment is not only trained in technical issues but also the financial or economic problems, so that energy efficiency is expected to be accepted in the market.

3. Monitoring and evaluation activities need to be specified by making the phases of time and accomplishments to get a new base and create a new target (if needed) in each phase. The first phase is the basis for the second phase as well for the next phase.

b. Organizations related to energy efficiency should be established

1. Further improvement in the coordination and centralization is needed by an agency in charge of operational activities of the national energy efficiency, while regulatory activity retained by GDEE

2. While waiting for an agency that specialized in energy efficiency, it needs a nationally coordinated energy efficiency activities by ministries (multi sectors coordination). Energy efficiency activities are the task of the authorities in their respective ministries while GDEE will coordinate and other necessary activities related to the resource.

c. Additional policies are needed

1. Policies relating to the legal framework and mandatory standards, to ensure the implementation of policies or standards, the mandatory method should be developed.

2. Protection policies for low-income communities. Low-income segments of society require subsidies for energy utilization as for lighting equipment, subsidies for buying of energy saving lamps will greatly assist them in accessing energy.

6.2. Recommendations

Recommendation 28 *It is recommended to conduct detailed studies on energy efficiency status in order to obtain indicators of the efficient use of energy of each economy's sector.*

To know the energy efficiency's state-of-the-art in Peru it is required a review of the status of energy efficiency in more detail. The reviews should be in each sector, include efficiency indicators in each sector and sub sector. For the commercial sector, status can be accessed from hotels, hospitals, apartment, department stores and government buildings as well as domestic buildings. The core of the study is to obtain indicators of the efficiency of energy utilization as kWh/m^2 year, kWh / bed occupancy ratio, kWh / households etc. By knowing the position of this energy efficiency, calculations of potential energy savings can be performed and at the same time make targeted savings that might be achieved.

Recommendation 29 *It is highly recommended to improve the energy efficiency campaign programs, incorporate energy efficiency subjects in education materials and provide effective training related to technical, financial and economic fields.*

To improve the awareness campaign should be sustained per segment of society. To achieve the level of bottom-of-the-line absorption of energy efficiency in society is necessary to study the effectiveness of delivering the most appropriate campaign (Campaign master plan). In terms of education, syllabus needs to be reviewed to incorporate the material efficiency in the existing curriculum, such as incorporating elements of efficiency in the subjects of physics or chemistry. In terms of training, strategies need to be made towards the interest, desire and action. Therefore, training is not only on technical issues but also related to financial and economic problems that often become obstacles in the implementation of energy efficiency in the field.

Recommendation 30 *The Peruvian government should implement monitoring and evaluation of policies in order to establish the steps towards the next stage as well as to provide an indicator of the efficiency benchmarking.*

The master plan needs to be made on short term, medium term and long term. Each stage should indicate monitoring and evaluation of policies that have been done, so that the evaluation results can be used to establish step towards the next stage. Monitoring method can be done as a regional survey or with the energy mandatory reports for large energy users. Results of monitoring and evaluation can be made as an indicator of the efficiency benchmarking.

Recommendation 31 *It is recommended to delegating tasks and authority of the ministries concerned.*

While waiting for the establishment of an implementing agency, it can be delegated authority to the ministries related program. Each ministry has task and authority to perform activities ranging from planning, organizational formation, implementation and evaluation and also to provide their own funding. The position of GDEE is more on coordination and initialization programs such as training and technical consulting activities.

The follow-up of energy efficiency delegation is multi-sector partnership program, the involvement of stakeholders such as consultants, academia, financial institution and NGOs are necessary that would make energy efficiency received by the market.

Recommendation 32 *It is necessary to develop and implement mandatory energy efficiency standards and seek for its international harmonization.*

Mandatory standard is needed for commercial buildings such as for air conditioning, lighting and building envelope and energy auditing method. There is also a need to make building code for building energy for both new and existing buildings. In addition it is necessary to develop a mandatory energy management standard which could be harmonized with the ISO 50001 which plan to be published in 2011.

Recommendation 33 *Competence development of energy managers and energy auditors.*

To support the mandatory standard is required competency standards of competencies for energy managers and energy auditors. Implementation of competency standards and certification bodies need to be an independent institution so that they can be trusted by the market.

Recommendation 34 *It is highly recommended to develop minimum energy performance standards as a priority action in the commercial and residential sector.*

Performance standards are needed to determine the performance of energy utilization equipment as Minimum Energy Performance Standard (MEPS). The follow-up activity is to make labeling. Based on experiences in several economies standards could be evaluated every 2 years for setting a higher standard of performance. Equipment that can be standardized among other household appliances such as refrigerators, lights, TV, Air conditioning, LPG and kerosene stoves.

Recommendation 35 *Create efficiency program for low-income communities.*

Low-income communities have a shortage in the initial financing for the purchase of energy efficient equipment which is relatively more expensive. For that, we need a mechanism for government subsidies. For example the marketing of energy saving lamps (CFLs) can be conducted simultaneously with demand side management programs of electric utilities with gradual payment method combined with the monthly electricity payment. CFL prices can be depressed price because of reduced distribution costs, based on experience in distribution costs to reach 30-50% of the price of the lamp.

7. POLICY MEASURES – TRANSPORT SECTOR

7.1. Critique

The transport sector has been the largest energy consuming sector in Peru. At the end of 2008, Peru had a total energy consumption in transport sector of 210,093 TJ, with a share of 37.3% of total economy's energy. Among the fuels consumed, diesel is the largest with a 62.7% share or 131,708 TJ of energy

consumed as shown in Figure 27. The second largest is motor gasoline, with a total consumption of 37,633 TJ (or a 17.9% share) at the end of the same year.

From 1985 to 2008, diesel consumption has shown a robust increase due to high commercialization and imports of diesel vehicles. However, this tendency could change because of the use of natural gas in the sector as projected for the long-term. Natural gas consumption in transport sector started in 2005 and it has shown an aggressive increase, reaching 5,448 TJ in 2008 and showing an annual growth rate of 283.9% between 2007 and 2008. This increase has been possible due to high natural gas resources from Camisea field and the conversion of vehicles from motor gasoline to natural gas as well as due to the strategy policy to use clean fuels in transport. Also, the use of natural gas for public transportation is one of the most important initiatives that the Peruvian government, specifically the government of Lima City (Municipalidad de Lima), has implemented. The construction of their new bus line known as "Metropolitano" under the Bus Rapid Transit (BRT) scheme started operations in mid 2010.

The government of Peru well understands that transport sector has a high energy efficiency improvement potential by the use of clean fuels and the construction of rapid transit system. However, high dependency on petroleum products is still a challenge. Among these challenges is the continuing use of road freight transport, the equipment of which is more than 30 years old; Peru has an old trucks` fleet for freight transportation and this gives another opportunity to improve energy efficiency in the sector. Because the use of more efficient fuels such as natural gas (because of its high abundance in the economy) has been focused on as the best alternative, the use of other alternatives such as electric train mass transport system has not been considered as an aggressive plan. In Lima City, a metropolitan electric train corridor known as Tren Eléctrico (Electric Train) is currently being built by Lima municipality, however this project requires more financing for its expansion. For this purpose, in June 2009 the Ministry of Transport and Communications (MTC) announced a bidding for the expansion of the Tren Eléctrico with a plan to finalize the first phase of construction in June 2011.[14] Next phase will comprise the expansion through San Juan de Lurigancho district which is the most populated in Lima.

[14] Discussion with Mr. Andrés Italo and Ms. Ursula Fernández of the MTC, 09-11-10

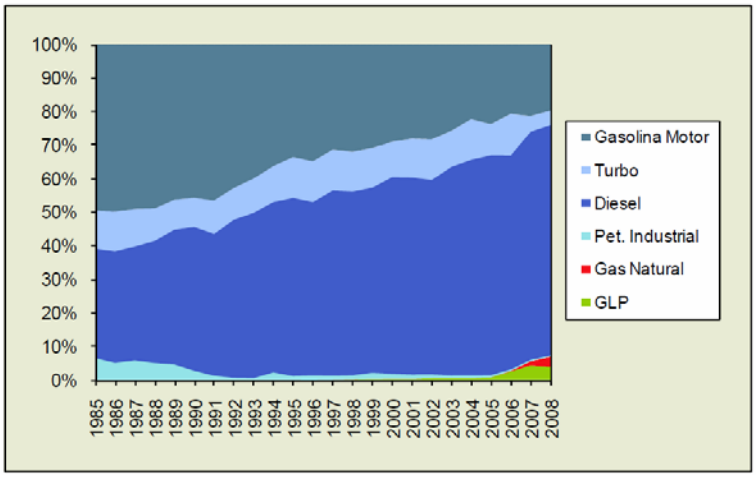


Figure 27. Share of Energy Fuels in Transport Sector 1985 - 2008

Under the Peruvian energy policy to improve energy efficiency in the transport sector, through the publication of the Referential Plan for the Efficient Use of Energy 2009-2018, several actions are in force to achieve energy efficiency goals during the period. The referential plan has quantified two important projects, among which are the “Efficient Driver Project” and the “One Day without a Car Project”, that together aim to reduce energy demand of the transport sector by 80.95 TJ from 2009 to 2018. However, future actions also include the following: learning from best practices and capacitating programs for energy efficiency for vehicles; promoting training and updating in driving, engines and fuel use of taxi, public transport and truck drivers; implementing the standards and labelling for vehicles; and improving traffic management.

Finally, the Review Team found that the participation of the Ministry of Energy and Mines (MINEM) and the Ministry of Transports and Communications (MTC) should work together in order to strengthen the energy efficiency plans in transport sector; for MTC energy efficiency projects are not a goal, but it is a result of MINEM. Activities of MTC are not well connected to transport energy efficiency issues and those should be coordinated under working-groups together with MINEM and other ministries and organizations.

7.2. Recommendations

Recommendation 36 *It is recommended that Ministry of Energy and Mines through DGEE and the Ministry of Transport and Communications should work together to develop medium and long-term planning programs.*

It is necessary to ensure that both ministries follow-up the plans and programs that cover all modes of transport for passengers and freight. For example, encouraging the standards and labelling of vehicles.

Recommendation 37 *The Government of Peru should develop a roadmap for the introduction of new transport technologies such as HYBRID cars as one of the alternatives to reduce the future high dependency of natural gas in the sector.*

By taking into account the international experience from developed economies regarding the introduction of HYBRID vehicles and the increasing production of them, a new long-term vision to change by the use of natural gas in this high intensity energy demand sector could be determined.

Recommendation 38 *The MINEM, MET, MTC and MINAM should develop and implement programmes with National and International Banks in order to promote the financing of new vehicles (for mass transportation such as taxis and freights) at local and regional level for lower income drivers.*

It is necessary to replacement old vehicles for transportation of passengers and freight which currently are both highly inefficient and polluting. This will help reduce the high demand for petroleum products (gasoline and diesel) that currently is estimated at least 70% of total, as well as reduce the CO_2 emissions.

Recommendation 39 *Government should regulate the transport (taxis and freight drivers) in order to achieve best energy efficiency practices and incentives for car drivers.*

More regulation provides better behaviour in energy use and establishes the rules to final users.

Recommendation 40 *To follow up on the construction of public transport such as "Metropolitano" under the Bus Rapid Transit (BRT) scheme, the electric transport of the Electric Train Lima (Metro) and others and provide more information to final users about their benefits and advantages.*

Better information and education campaigns for final users are some of the best ways to promote of the use of public transport. Also, planning for construction of new lines could be supported by international experience in order to identify possible bottle-necks for financing and construction for medium and-long term.

8. APPLIANCES AND EQUIPMENT

8.1. Critique

Peru has been implementing several government actions aimed to promot energy efficiency equipment and appliances, as standardization programs, efficient equipment replacement programs, diffusion programs and labelling programs.

Since 1996, Peru has developed 42 standards, 29 of them related to energy efficiency as well as related to specified labelling requirements, however only 6 (related to lighting and household appliances) defined energy efficiency test methods and minimum energy performance standards (MEPS). As a result, Peru has not developed mandatory standards.

After an international comparative analysis, MEPS were proposed in Peru, rather than the development of energy consumption testing on equipment currently sold in Peru, because there are not certified energy efficiency testing laboratories. However there is an established infrastructure of laboratories with different purposes other than energy efficiency.

Peru has rules and legal framework that in some cases have similar energy efficiency goals and objectives (standards and guides) and duplicate efforts instead to join them. The government of Peru, through the, Ministry of Energy and Mines (MINEM), has energy efficiency goals defined in the Energy Efficiency Use Referential Plan 2009 – 2018, however action plans addressed to appliances and equipments are limited. According with the information from EE Referential Plan, replacement of motors and lighthing are considered, however there is no specific action to implement MEPS. In this regard, the Review Team identified that Peruvian government should focus on energy efficiency in appliances and equipments with major assistance from international and national cooperation.

Peru has developed studies to determine the highest consumption end-use in order to set its energy savings goals; however such consumption is not tested. It is important that efforts focus on high consumption equipment studies and testing to anticipate increase consumption trends.

Peru has designed and implemented campaigns aimed towards the rational use of end-use equipment mainly in residential and education sector.

8.2. Recommendations

Recommendation 41 *MEPS should be based on energy performance of shipped products in the Peruvian domestic stock (international references shall be established on a particular energy performance that is not native to Peru). We strongly recommend that Universities or Research Institutes support to establish technical level of MEPS, these levels should consensus with all stakeholders.*

Recommendation 42 *The government of Peru should seek legal mechanisms necessary to ensure that, at the same time to comply with its constitution, to establish mandatory energy efficiency standards basing on the environmental benefits involved in their implementation.*

Recommendation 43 *Peru should be supported by universities or laboratories to perform studies with measurements, surveys and statistical data to determine, where efforts should be concentrated; it is required to achieve the goals set. Efforts in Peru should be centralized, it is necessary that all efforts and past experiences to focus on the newly established office to have a starting point and the new goals.*

Recommendation 44 *The international experience indicate that mandatory standardization programmes encourages market transformation, for example, the impact of mandatory standards programme on the Mexican electricity system has been significant; in terms of capacity, it has reduced the need for total generating capacity of 3440 MW, or 6.4% of capacity installed by 2005.*

Recommendation 45 *Peru could determine the mechanisms for standard monitoring compliance and therefore should implement an infrastructure (laboratories network) for compliance verification and monitoring and surveillance to verify compliance with the standards.*

Recommendation 46 *The energy saving campaigns should be addressed to recommend better energy-use habits for major energy-consuming equipment as was done in 1995. These campaigns should be permanent to encourage a savings culture, despite people tend to forget that these campaigns have become habits and habits form a culture.*

9. ENERGY EFFICIENCY RELATED RESEARCH AND DEVELOPMENT

9.1. Critique

The research and development technology (R&DT) and innovation issues in Peru have been of low importance in the public policies. In Peru, science, technology and innovation issues are not part of the long-term national agenda. Despite the political discourse about improving competitiveness and joining the knowledge society, the government has made limited efforts to promote the generation, diffusion and adoption of knowledge at a pervasive level in the economy. The declaration of policy statements has led to the promulgation of new laws on science, technology and innovation and on competitiveness, as well as the adoption of the concept of innovation systems as a policy instrument. However, the implementation of such laws has been poor.[15]

Secondly, research in these issues has also been inhibited because of the lack of available data. Although science and technology indicators are being collected regularly, most of them refer to public institutions and are obtained through public sector sources.

Despite these two factors, Peru has with important institutions such as the Science, Technology and Innovation National Council (CONCYTEC), established in 1968 and supported by the Law of Science and Technology No. 28303 and the Supreme Decree No. 082-2005-PCM, referred to the adscription of the Ministry of Education and the Law of CONCYTEC No. 28613. Furthermore, CONCYTEC is the leading institution of the National System of Science and Technology and Technology Innovation (SNACYT).

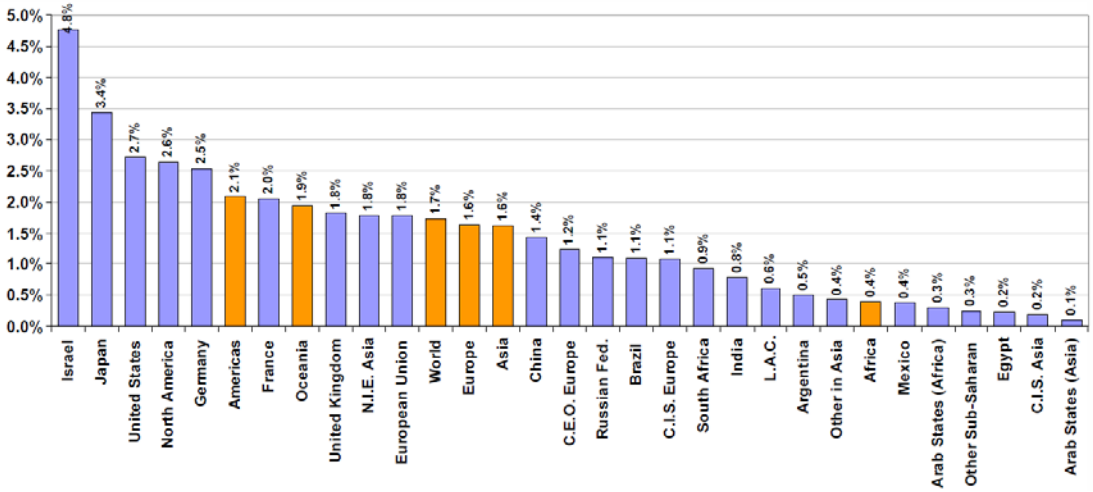
In Peru, a major change on innovation and technology policy took place in 2007. After 5 years of preparations, the Peruvian Government agreed with the Inter-American Development Bank (IADB) to sign up for a loan of US$ 25 million to support innovation activities in Peruvian firms. The loan is funding the Science, Technology and Innovation Fund (FINCYT) and is the first major policy instrument to support the private sector innovation. It is encouraging projects of basic, applied and pre-competitive research in firms and institutions; technological missions; the design of courses on innovation management; the procuring of scientific equipment and the funding of scientific and technological events, among others.

The economic support for science, research and development through loans funding and national budget is very low (around 0.15% of gross domestic expenditure)[16] in comparison with other economies of the Latin American region like Argentina (with 0.5%) and Brazil (with 1.4% of the gross domestic

[15] Juan José Díaz and Juana Kuramoto, GRADE, October 2008.

[16] Discussion with Dr. Augusto Mellado, President of CONCYTEC, 10-11-10

expenditure) as shown in Figure 28. CONCYTEC receives only US$ 4 million from gross domestic expenditure for science and technology purposes. New proposal to create a Ministry of Science and Technology has been discussed in Peru, however no more positive results have been achieved.



Source: UNESCO Institute for Statistics, 2010.

Figure 28. Gross domestic expenditure on R&D as a % of GDP (main regions)

The Peruvian government has established, through CONCYTEC, a specific program on “Clean Technologies”, which focusses on research and development of alternative technologies to improve the reduction of emissions, achieving social security on local and regional level. Three specific projects have been established: 1. Special Project of Clean Technologies; 2. Regional Desk-Technological Transfer Network; and 3. Horizontal Cooperation Program on Clean Technologies and Renewable Energy.

The Review Team believes that Peru should make a greater effort to support science, research and technology development in areas where it is the economy’s strategy to improve the use of natural-energy resources such as hydrocarbons, renewable energy sources and electricity. Also, the economy should aim to create more economic incentives for professionals with higher education level in order to give them more development opportunities within the economy, as well as to create an energy-research culture among the universities at graduate and post-graduate levels.

9.2. Recommendations

Recommendation 47 *It is highly recommended that CONCYTEC should be an independent organisation, separate from the Ministry of Education, in order to have better management autonomy and provide institutional strengths.*

It is necessary that research and development of an economy should be supported by several organizations and ministers in order to be involved in the national policy strategy. CONCYTEC as an independent organization can strengthen its institutional position by the support of an internal council

(from public and private sectors) as well as to achieve autonomous management and receive more economic benefits from national budget.

Recommendation 48 *The International Cooperation Programmes should be strengthened in order to achieve more financing and investment for R&D programmes with high priority in Universities and Research Centres.*

This strategy is pointed out in order to attract more investments (as a joint-venture mechanism) in innovation projects focused on energy efficiency. Also, such programs should be supported by the national/international - public/private experiences (know-how).

Recommendation 49 *The Peruvian Government should increase its gross domestic expenditure in Science Research and Technology Development.*

The international experience shows that Science, Research & Development is a key to economic growth. The Government could profit from this opportunity in order to create incentives in research programs addressed to energy savings or energy efficiency (for example: programs on natural gas, renewable energy, electricity and environment issues).

Recommendation 50 *It is highly recommended to establish National Institutes in areas such as Hydrocarbons (e.g. Petroleum and Natural Gas) and Electricity/Renewable Energy in order to strengthen research and development in specific areas with the formation of Postgraduate professionals with Master and Ph.D. degrees.*

The establishment of National Research and Development Institutes provides more detailed achievements related to the efficient use of natural resources. These institutes are the executive framework of Ministry of Energy with a target to provide detailed forecast analysis of energy sector.

Recommendation 51 *It is recommended to establish a National Researchers System (Sistema Nacional de Investigadores) to be dependent from CONCYTEC in order to incentivize high quality professionals and reduce the "brain-drain" from Peru.*

It is of upmost importance to provide economic incentives to national researchers and promote the study of Master and Ph.D. degrees (Post-Graduate students) at national level with the support from Universities and Institutes.

APPENDIX A: PEER REVIEW TEAM MEMBERS

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5. Prasert SINSUKPRASERT, Director of Planning Division, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand.
6. Brian T. CASTELLI, Executive Vice-President, Programs and Development. Alliance to Save Energy (ASE), Washington. D.C., United States.
7. Joel HERNANDEZ – SANTOYO, Researcher, Asia Pacific Energy Research Centre (APERC).
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APPENDIX B: ORGANISATIONS AND OFFICIALS CONSULTED

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Mr. Luis A. Gonzáles Talledo, Director General of Hydrocarbons

Mr. Luis A. Haro Zavaleta, Director General of Energy Efficiency

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Mr. Luis Saldarriaga Colona, Sub-director of Mining Promotion

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Mr. Víctor Vargas, General Directorate of Mining

Mr. Guillermo A. Tardillo, General Directorate of Energy Efficiency

Mrs. Cristina Condezo Alarcón, General Directorate of Energy Efficiency

Ministry of Transport and Communications

Ms. Ursula Natty Quintana Castellanos, Director General, General Directorate of Social-Environment Affairs

Mr. Ítalo A. Díaz, Director, General Directorate of Environmental Management

Ministry of Environment

Mr. Rafael R. Millán García, General Directorate of Climate Change, Diversification and Water Resources

Mr. Montalvo Figueroa, General Directorate of Environmental Quality

Mr. Pedro Sánchez Cortez, Expert

Ministry of Housing, Construction and Sanitation

Mr. Roberto Prieto, General Directorate of Construction

Supervising Organization of Energy and Mines Investment (Osinergmin)

Mr. Daniel A. Hokama Kuwae, Specialist, Natural Gas Division

Development Financing Corporation (COFIDE)

Mr. Juan Carlos More Cárdenas, Business Department

Science, Technology and Innovation Technology National Council (CONCYTEG)

Dr. Augusto Mellado Méndez, President, CONCYTEG

Private Investment Promotion Agency (ProInversion)

Mr. Luis Ortigas Cúneo, Chef of Electric and Hydrocarbon Projects

Mr. Mario Tejeda Chauca, Technical Advisor, Direction of Technical Affairs

National Institute of Competitiveness Rights and Intellectual Property Protection (INDECOPI)

Ms. Soraya Lastra

Peruvian Construction Chamber (CAPECO)

Mr. Yamada, Specialist

Electric Distribution Company of North Lima (EDELNOR)

Mr. David Osco, Sub Directorate of Engineering and Building Planning, Technical Planning, EDELNOR

Mr. Oscar Peña, Luz del Sur, Specialist

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Mr. Raúl Del Rosario, Coordinator of Electricity Department, Chef of the Electricity Laboratory

Ecoeficiency and Social Responsibility Center (CER) – Grupo GEA

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Mr. Miguel Huaroto, Consultor

MEN Ingenieros S.A.C.

Dr. Johnny Nahui Ortíz, General Manager

APPENDIX C: REFERENCES

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