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**Joint ICTP-IAEA Workshop on Sustainable Energy Development: Pathways and Strategies after Rio+20**

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# Sustainable Energy Development in Peruvian Rural Areas

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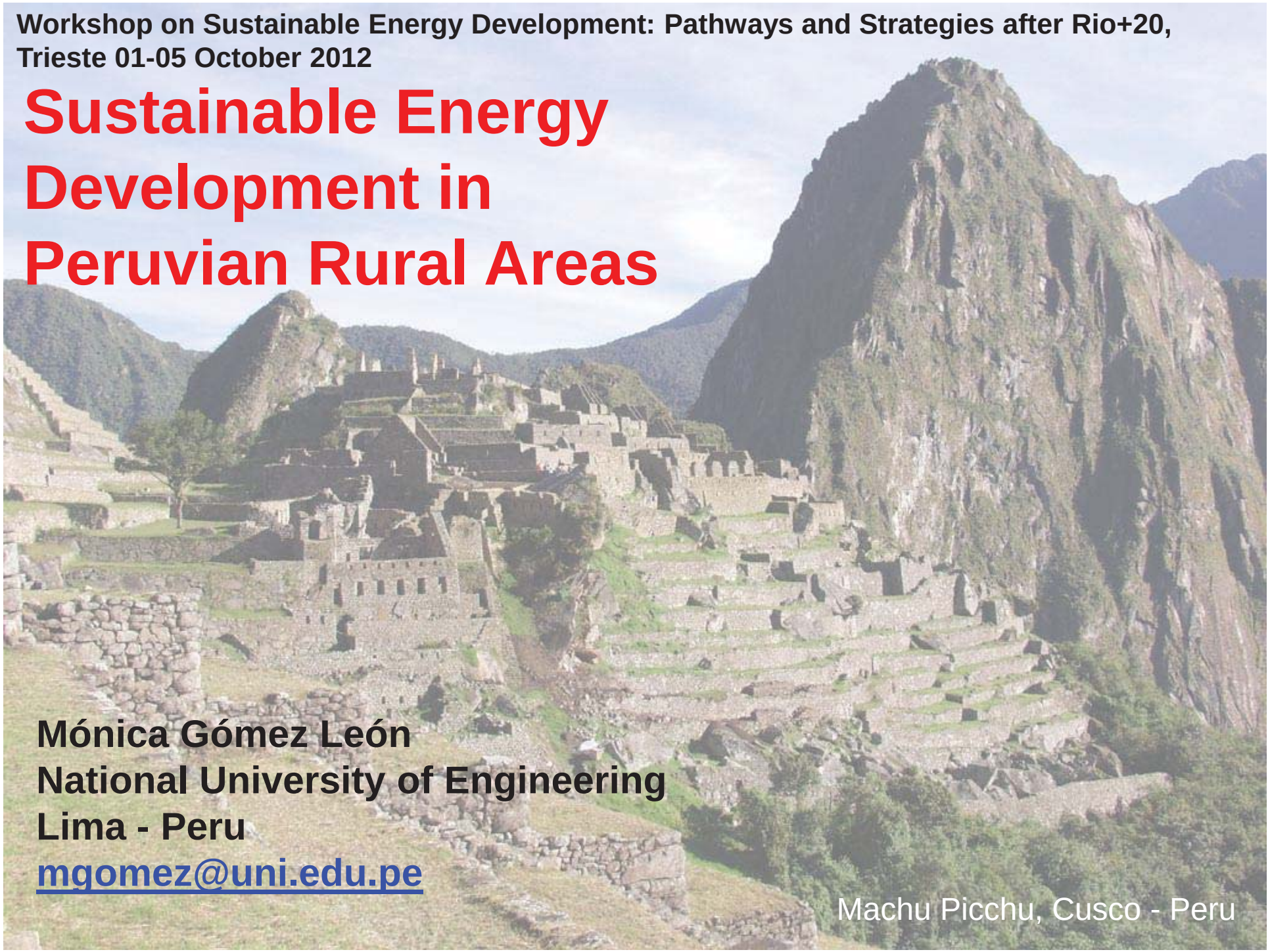
Workshop on Sustainable Energy Development: Pathways and Strategies after Rio+20, Trieste 01-05 October 2012

# Sustainable Energy Development in Peruvian Rural Areas



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Machu Picchu, Cusco - Peru

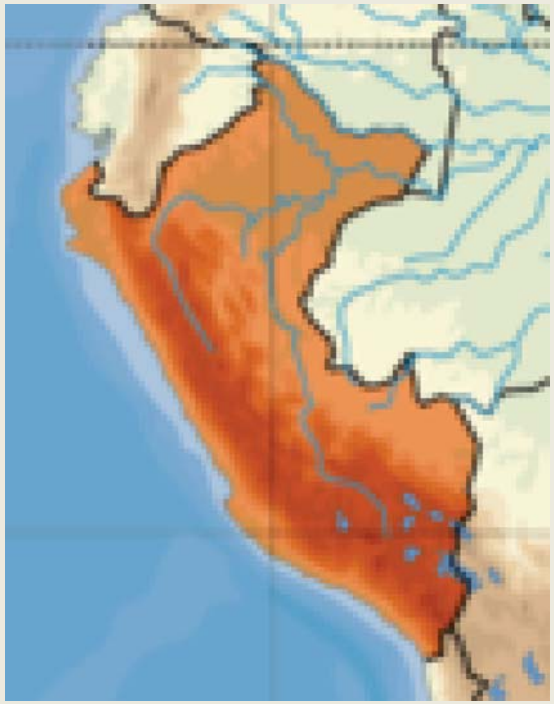
# Outline:

- Energy needs in Peru
- Rural energy situation in Peru

# Energy needs in Peru

The access of energy is the only way to obtained development and democracy.

The most expensive energy is the absent one: For each no generated 1MWh/year Peru losses 4 000 USD of the GDP.



# PERÚ

**Geographical Area: 1 285 216 Km²**

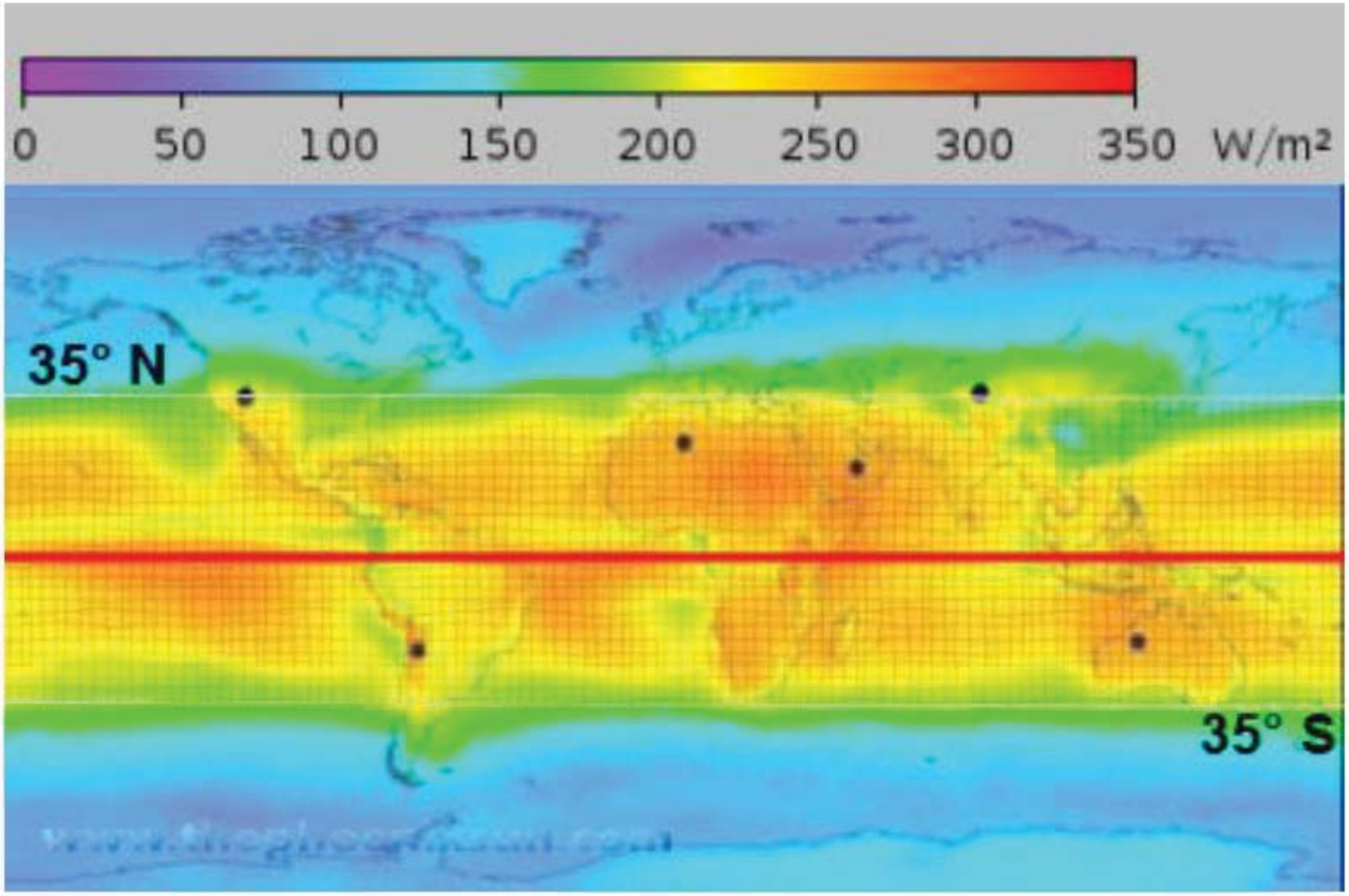
**Population: 29 399 817**

- **30% concentrated in Lima**
- **24% living in rural areas**
- **82 % access to electricity**

**GDP per capita: 4 700 USD**

# The solar resource

Latin American countries belong to the “sun belt” ( 35°N - 35 °S) with high solar radiation, all year long (> 5 kWh/m$^2$ day)



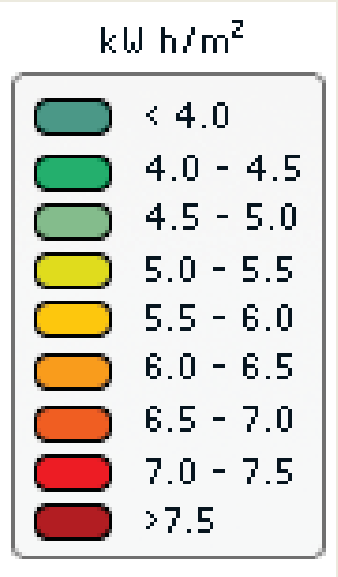
## Solar irradiance

**Perú is a privilege country:**

**Most of the territory, particularly in Andean Villages, there is a high solar radiation during whole year**

**Monthly average:**

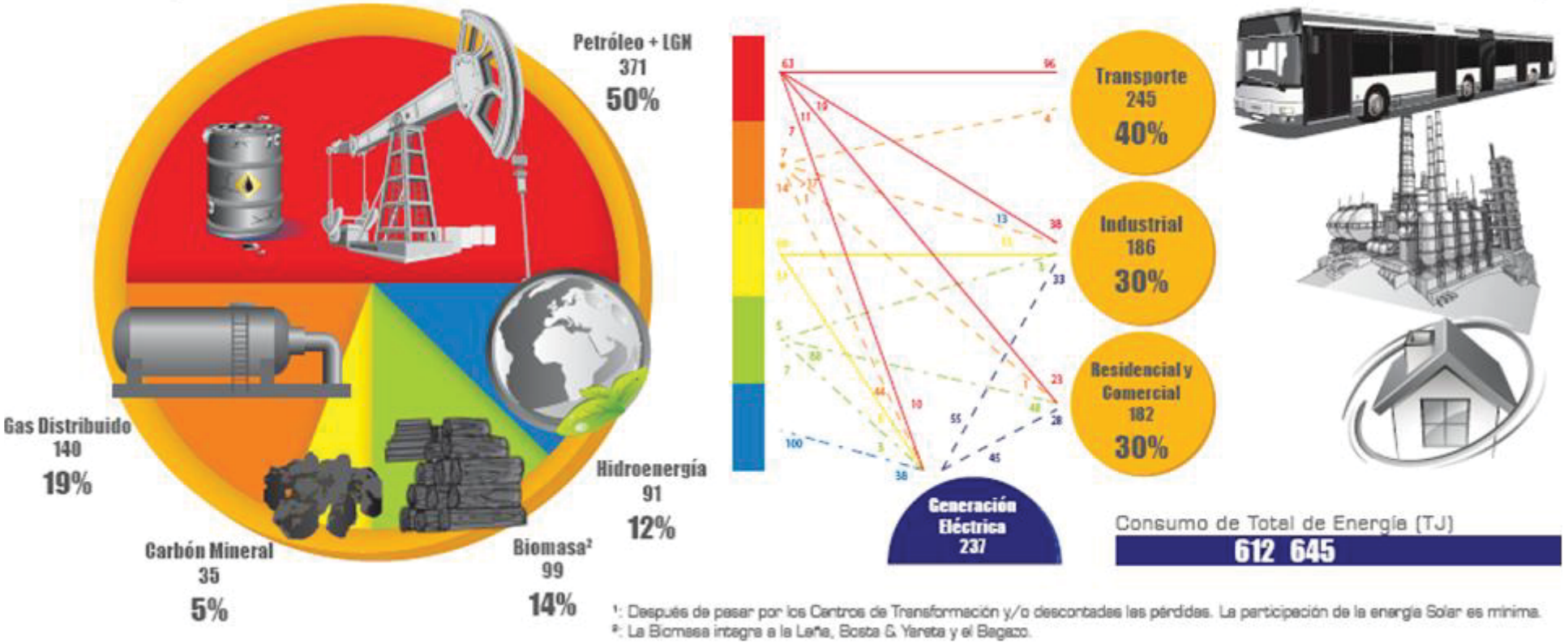
**5 ± 1 kWh /m² day**



# Energy Matrix of Peru: 2010

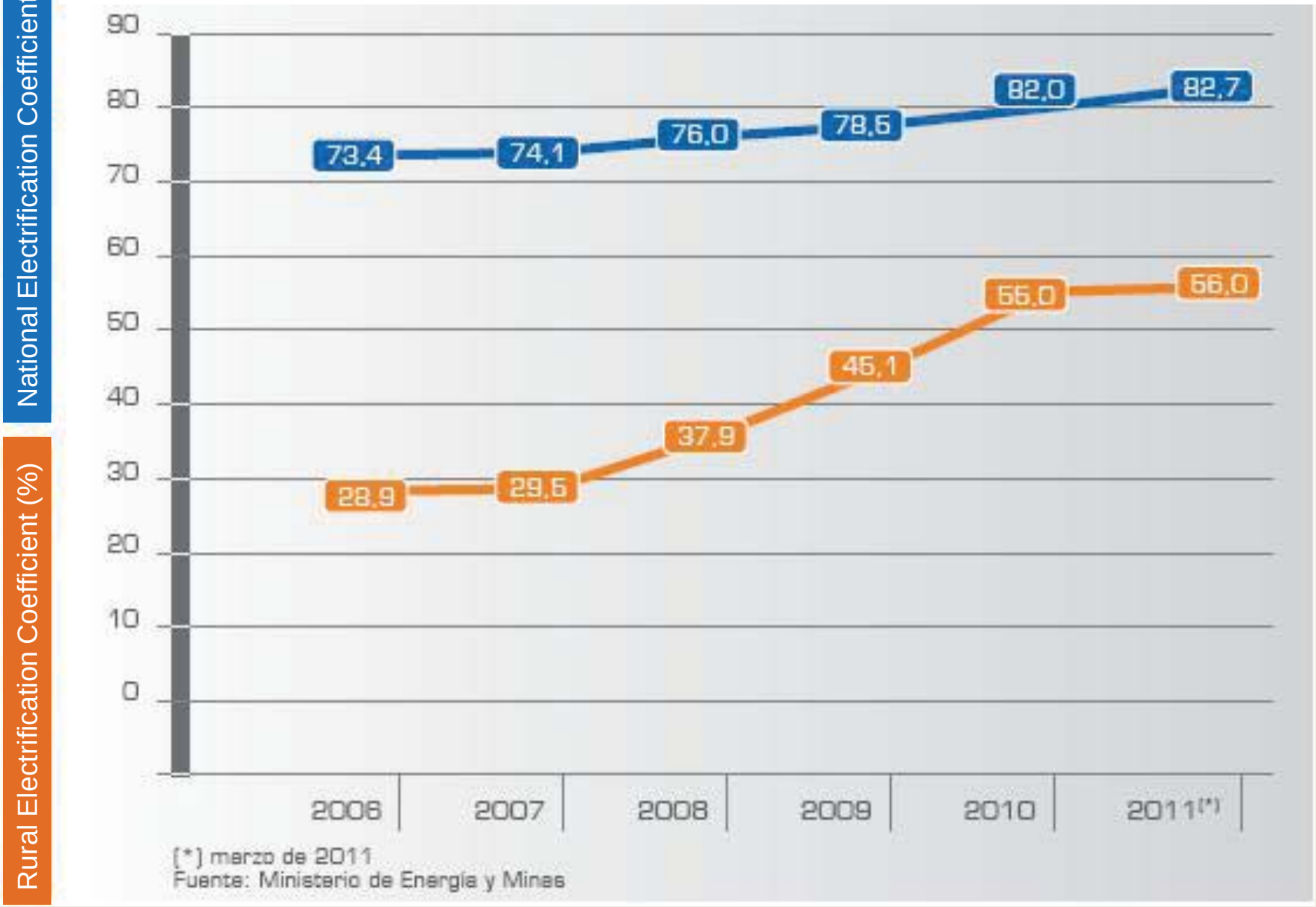
Source participation

Sector participation




¹: Después de pasar por los Centros de Transformación y/o descontadas las pérdidas. La participación de la energía Solar es mínima.
²: La Biomasa integra a la Leña, Bosta & Yareta y el Bagazo.

# Evolution of the Electrification Coefficient (%)



# Peru - PV market overview(*)

2010

- Off Grid ~ 3 MW (*), including ~ 12 000 SHS half by government projects
- Grid Connected ~ 30 kW (in Lima: private initiatives)

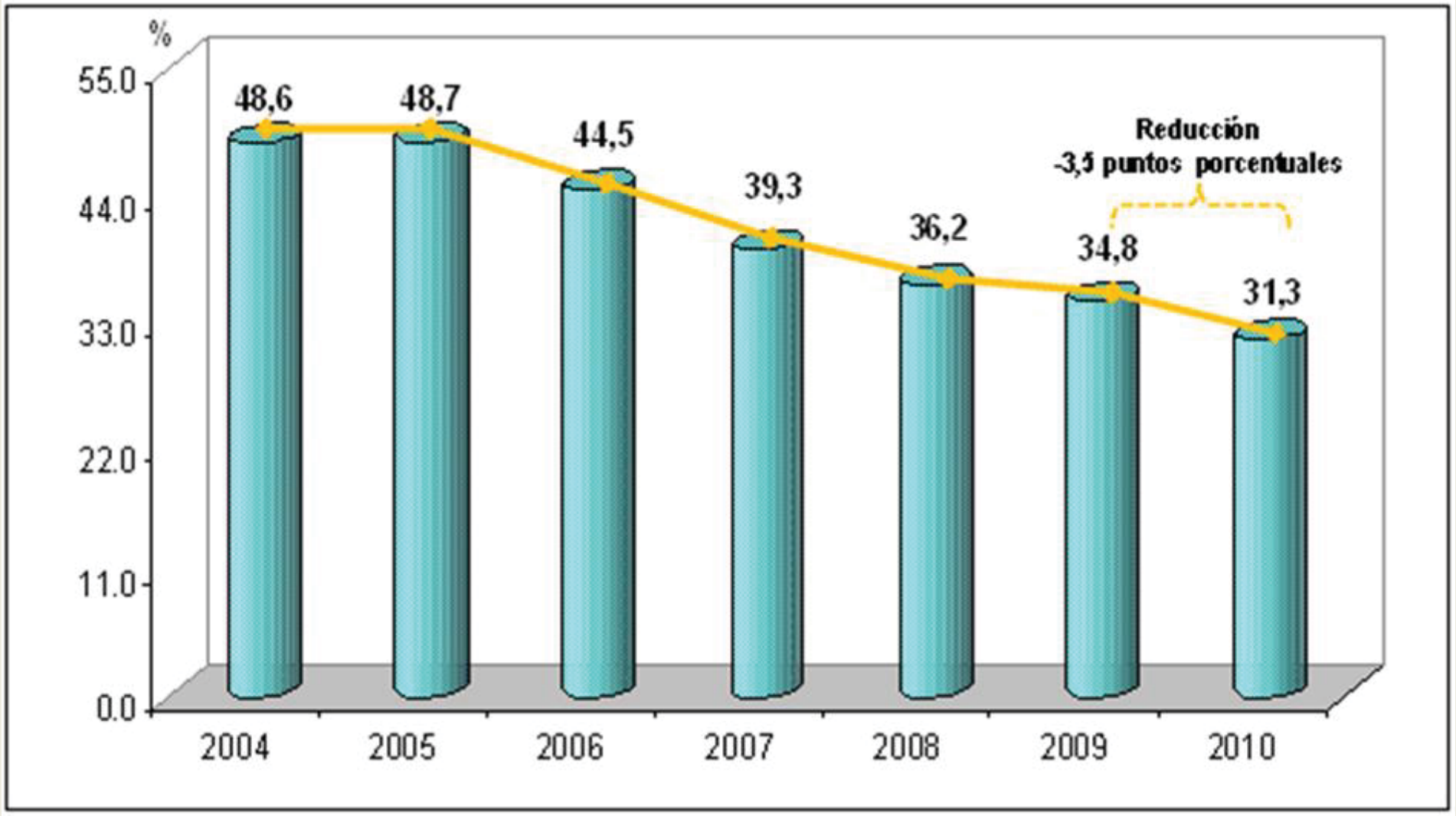
- 1 200 000 homes still without electricity
- 280 00 households are planned for RE
- 50 000 Pico FV project (2010 – 2011)

- Grid connected centralized 4 x 20 MW:
  (in Arequipa, Moquegua and Tacna), contracted with Solarpack Corp. Tecnológica SL & T-Solar S.A. , both from Spain,
  to enter in operation in 2012;

(*) Manfred Horn, Inter Solar North America, San Francisco, July 12-14, 2011.

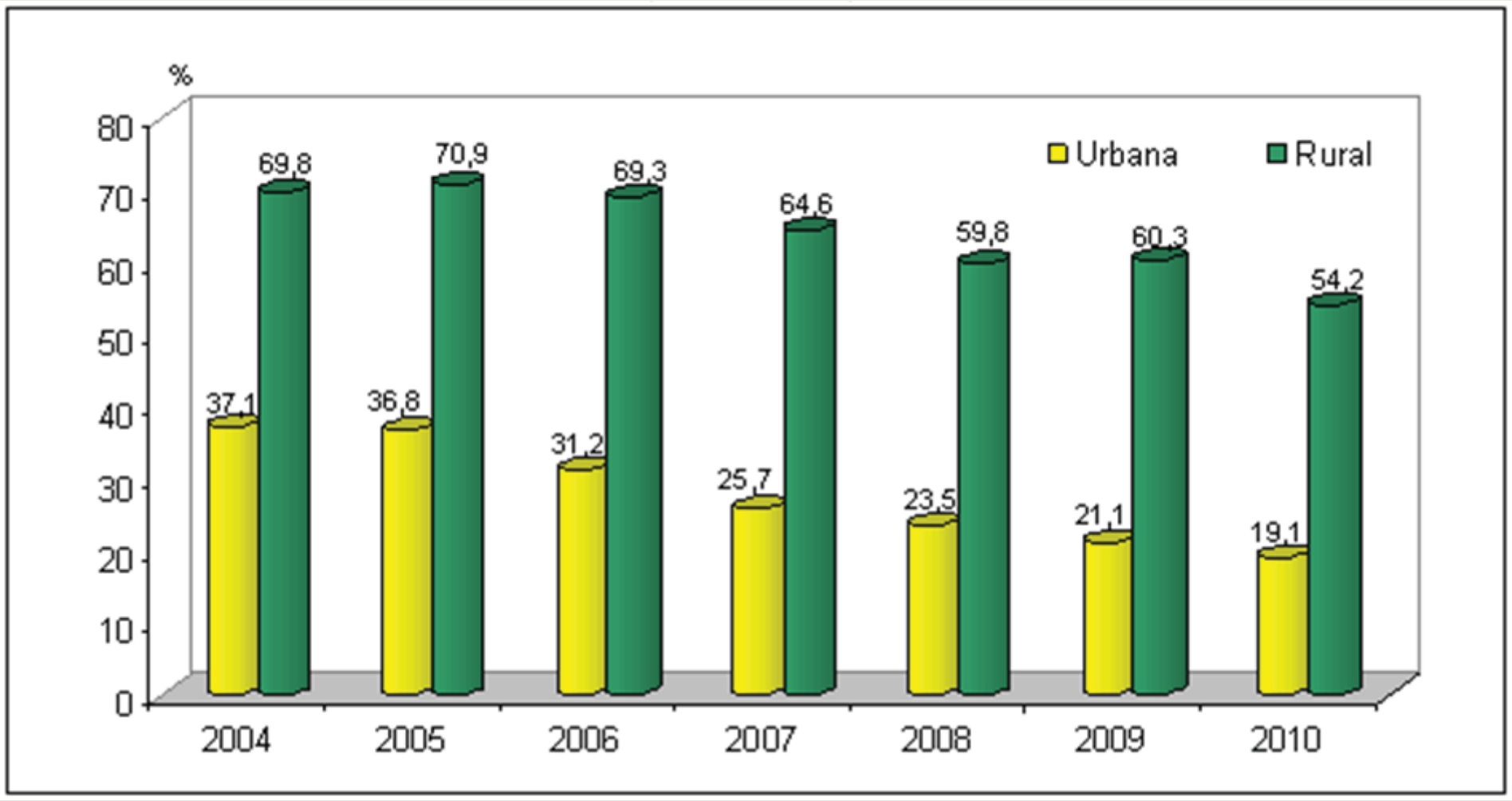
# Rural energy situation in Peru

# Peru: Total poverty, 2004-2010
(percentage)



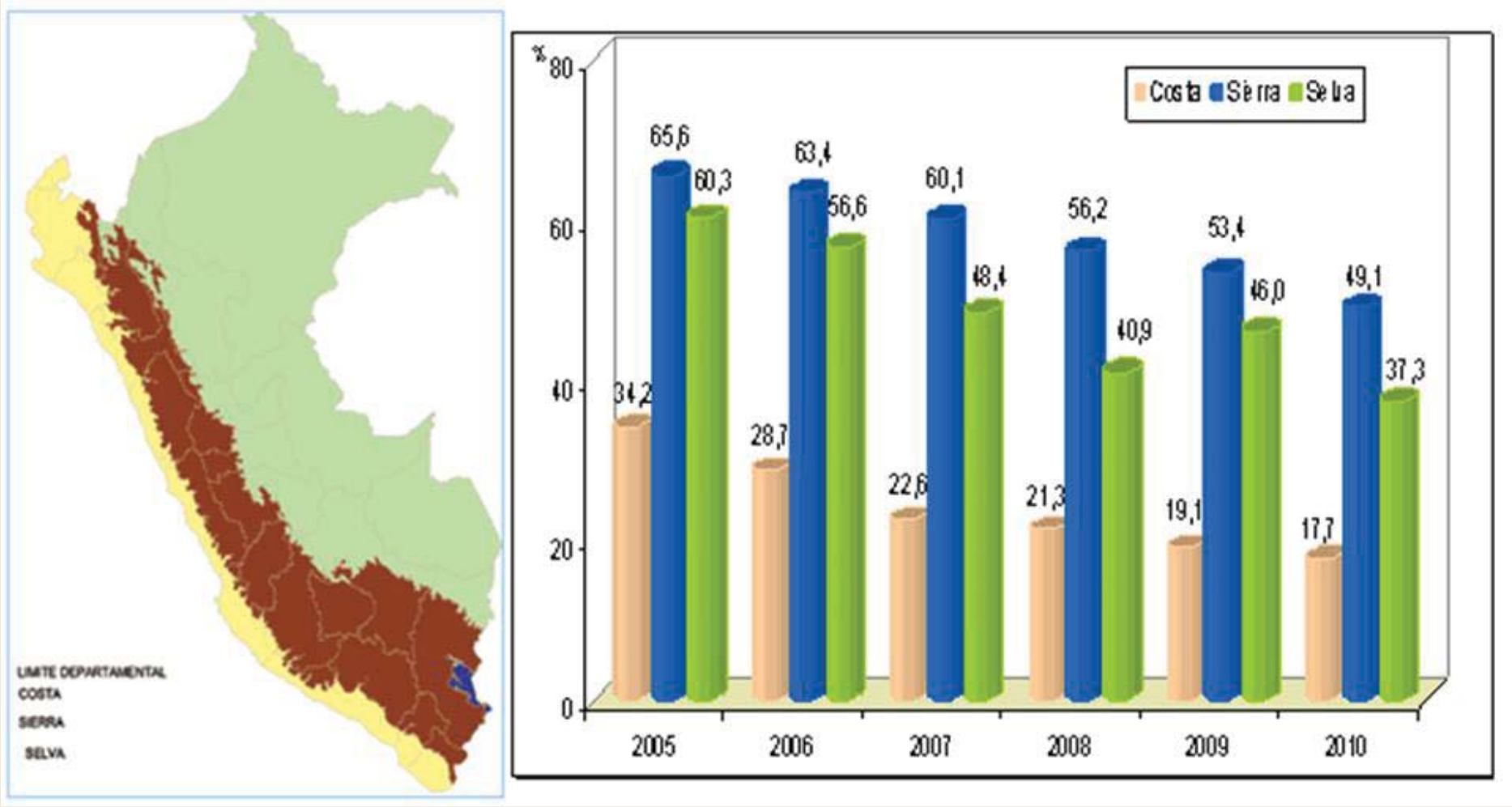

Source INEI: National Survey of Households, 2004-2010

# Total poverty: Area of Residence, 2004-2010 (percentage)




Source INEI: National Survey of Households, 2004-2010

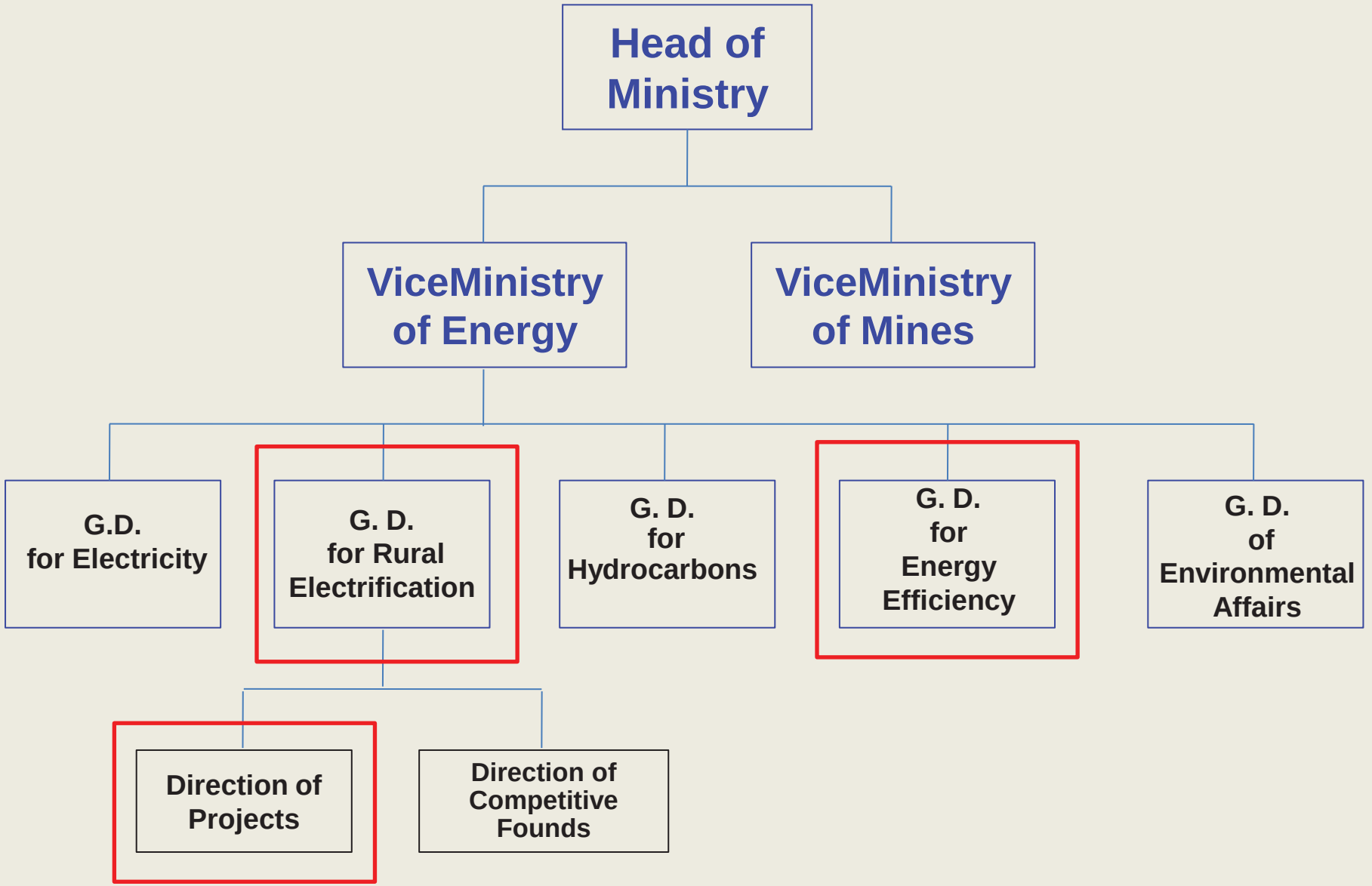
# Total poverty: Natural Regions, 2004-2010 (percentage)




Source INEI: National Survey of Households, 2004-2010

# ¿What is the position of the Peruvian Government for the rural energy situation?

# General Direction for Rural Electrification
# Ministry of Energy and Mines

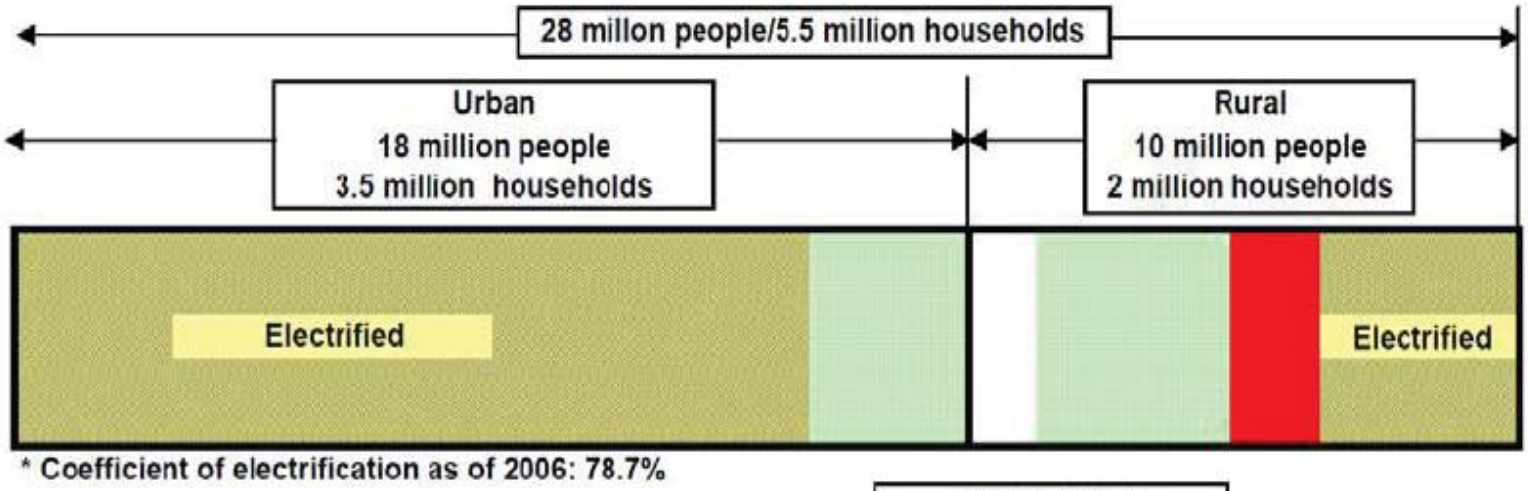


**Peruvian Government has done, through the Ministry of Energy and Mines, important actions to incorporate Renewable Energy in the National Energy Matrix:**

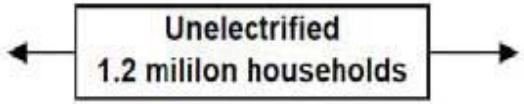
- **Elaboration of Solar and Wind Maps**

  **http://dger.minem.gob.pe/atlassolar**

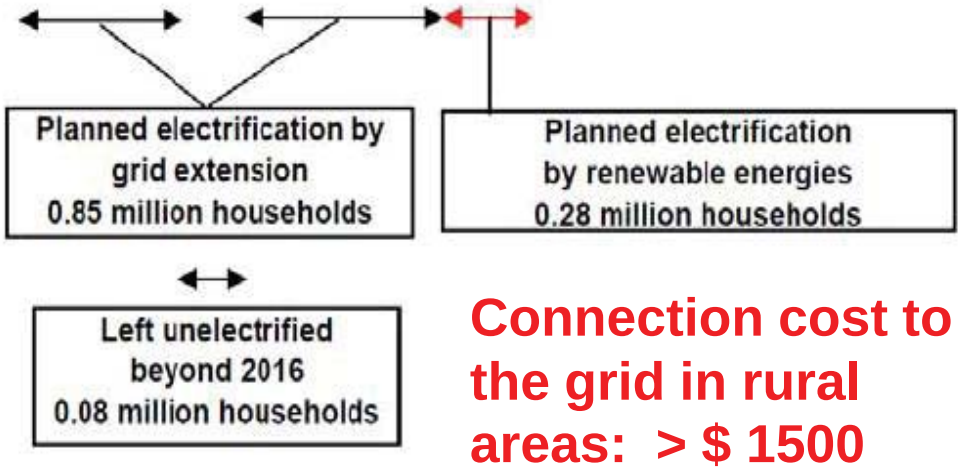
- **GVEP(Global Village Energy Partnership International) participation to promote energy in rural areas (2008).**
- **General Law for Rural Electrification (2006) and its regulation (2007).**
- **Legislative decree for electric generation using Renewable Energy (2008).**
- **Elaboration of the Strategic Plan for Sustainable Energy and Bioenergy in Peru (2012).**




* Coefficient of electrification as of 2006: 78.7%




**280000 households are planned to have electricity with RE by 2020.**




**Connection cost to the grid in rural areas: > $ 1500**

**Master Plan Study for Rural Electrification with Renewable Energy in the Republic of Peru**
**Japan International Cooperation Agency**
**Ministry of Energy and Mines, 2008**

The study of this Master Plan has identified the following as main issues on rural electrification by renewable energies

i) Inadequate knowledge of electrification of rural inhabitants
ii) Inadequate capability of local governments
iii) Gap between central and local levels on information and decision-making
iv) Absence of sustainable management organization of electrification system
v) Absence of supply chain for operation and maintenance
vi) Regional disparity due to uneven distribution of financial resources

Master Plan Study for Rural Electrification with Renewable Energy in the Republic of Peru
Japan International Cooperation Agency
Ministry of Energy and Mines, 2008

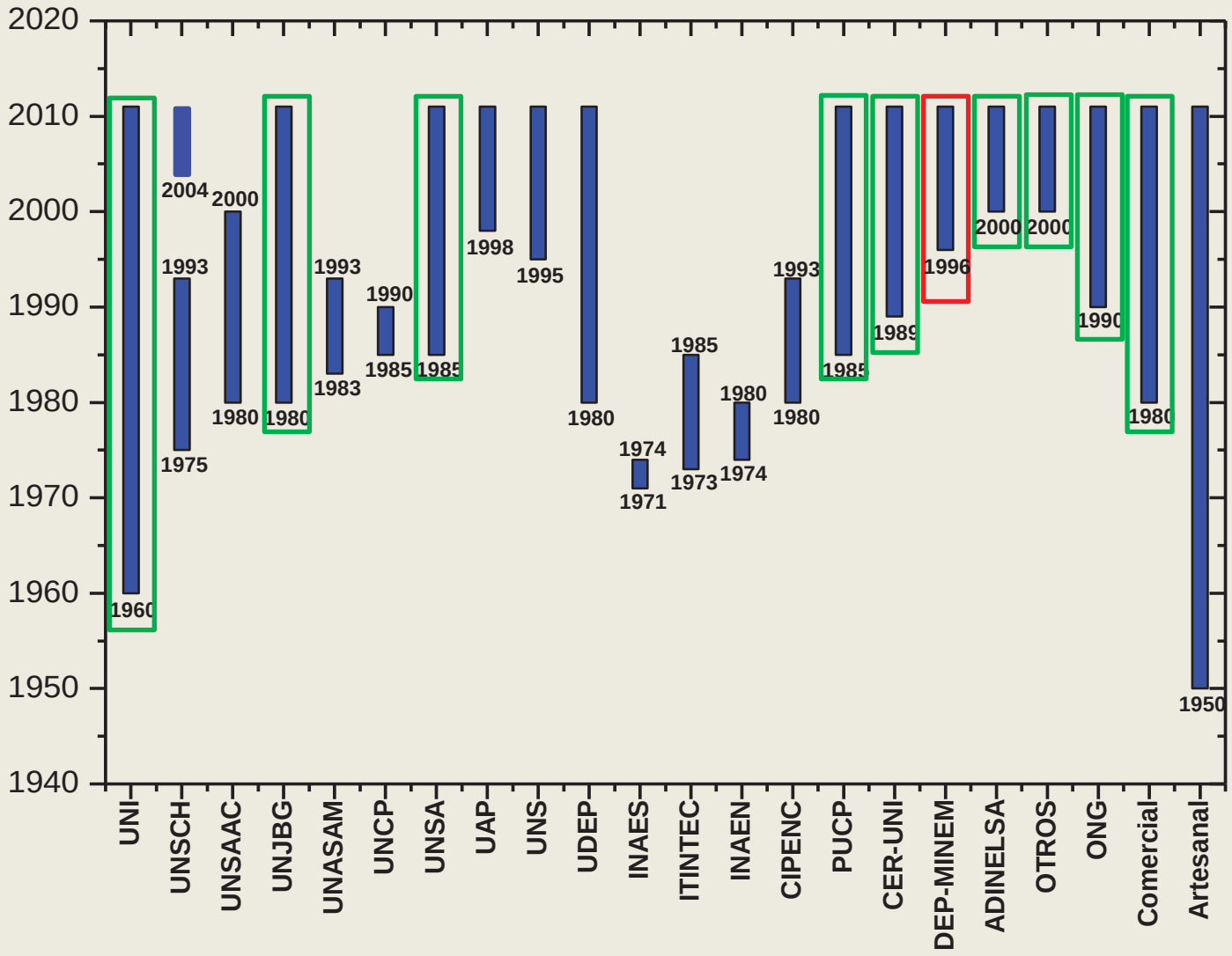
| | | Phase I (Period for infrastructure) | | | Phase II (Period for initial electrification) | | Phase III (Period for development of electrification) | | | | | | Phase IV (Period for completion of electrification) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | |
| No. of households to be electrified | Solar | | | | 10000 | 20000 | 30000 | 30000 | 30000 | 30000 | 30000 | 30000 | 30000 | 21520 | Total 261520 |
| | Hydro | | | | | | 1930 | 2006 | 1840 | 1085 | 3551 | 8086 | | | 18498 |
| | Total | | | | 10000 | 20000 | 31930 | 32006 | 31840 | 31085 | 33551 | 38086 | 30000 | 21520 | 280018 |

*Fgures shown in each year are the number of households which have been electrified in the respective years

**Meanwhile…**

**…there are many organizations and institutions contributing with RE development in rural areas.**

# Institutions and Organizations involve in Development of Renewable Energy in Peru



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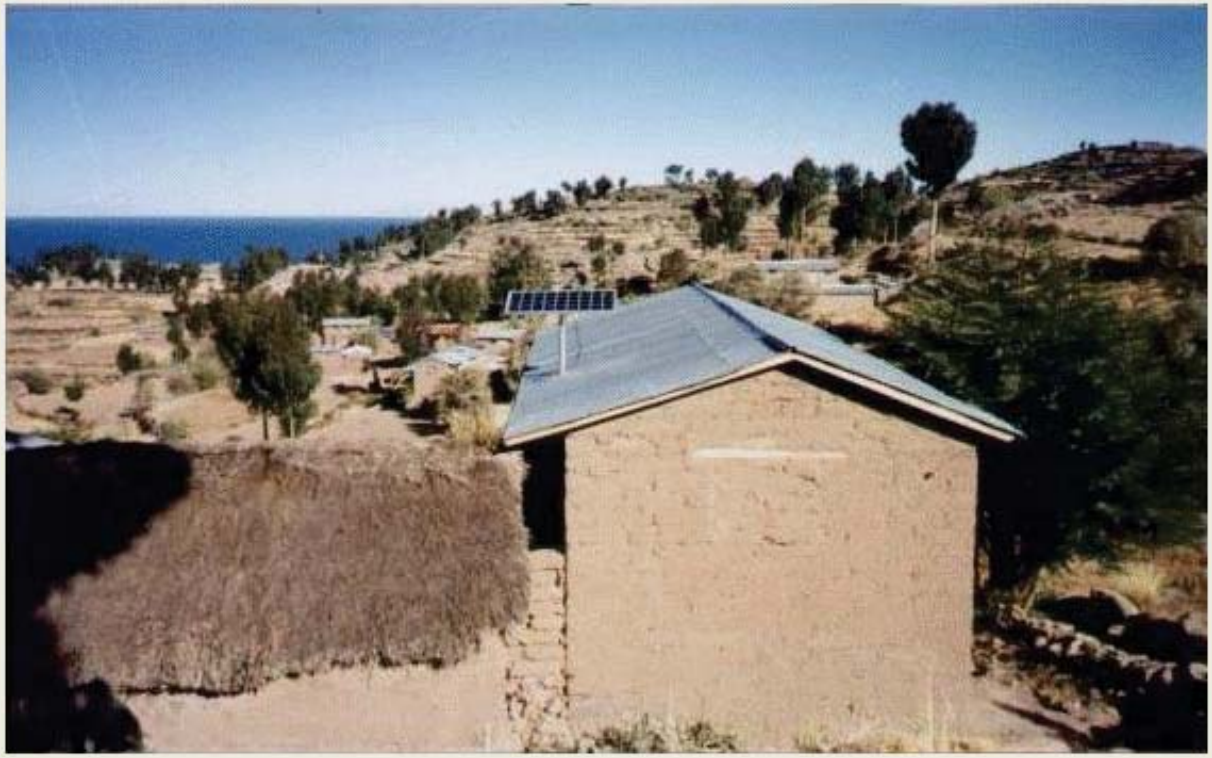
During 1980 led an important national project in Solar Dryer Systems.



**Led rural electrification during 1996 working in Taquile (147 SHS).**

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# Design, Construction and Evaluation of Confortable Rural House

San Francisco de Raymina Comunity, Huambalpa, Vilcashuaman, Ayacucho.

Vilcallamas Arriba Comunity, Pisacoma, Chucuito, Puno.

National University of Engineering

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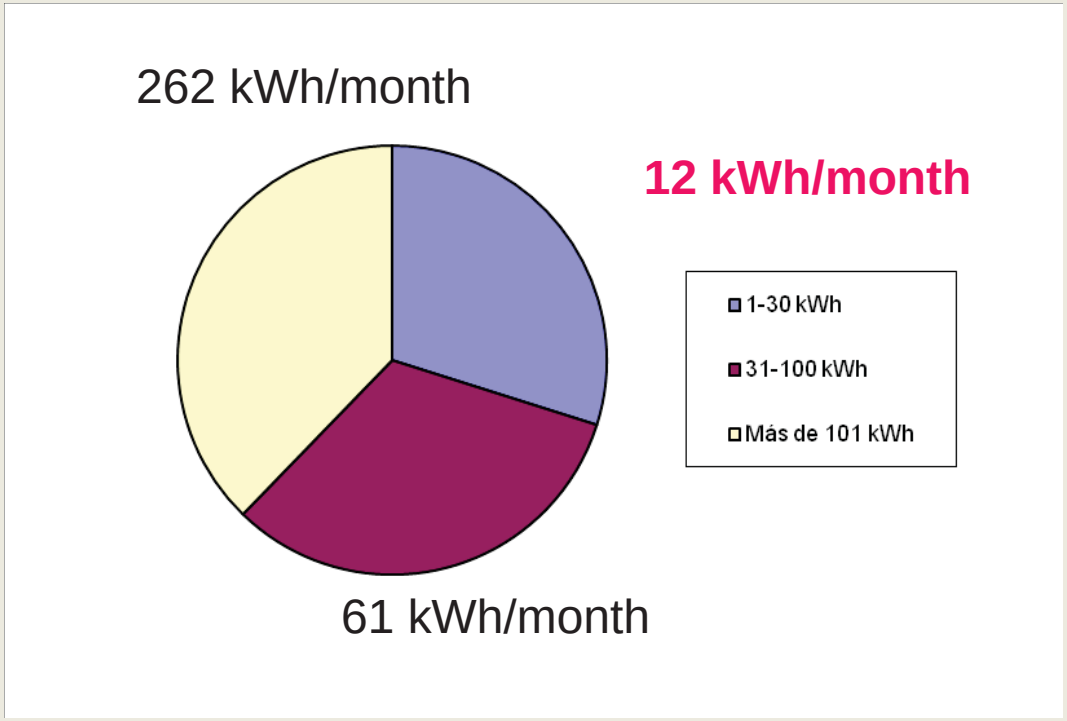
# Theoretical and Experimental Evaluation of Houses

Original House

New House

## Castrovirreyna, Huancavelica

# Average Consumption of the Grid Connected Households (kWh/month)




One third of households connected to grid consume only:

12 kWh/month

These households are mainly located in rural areas where they use electricity just for illumination.

Source: Anuario OSINERGMIN 2008

# Light for the poorest, with Pico PV System (*)

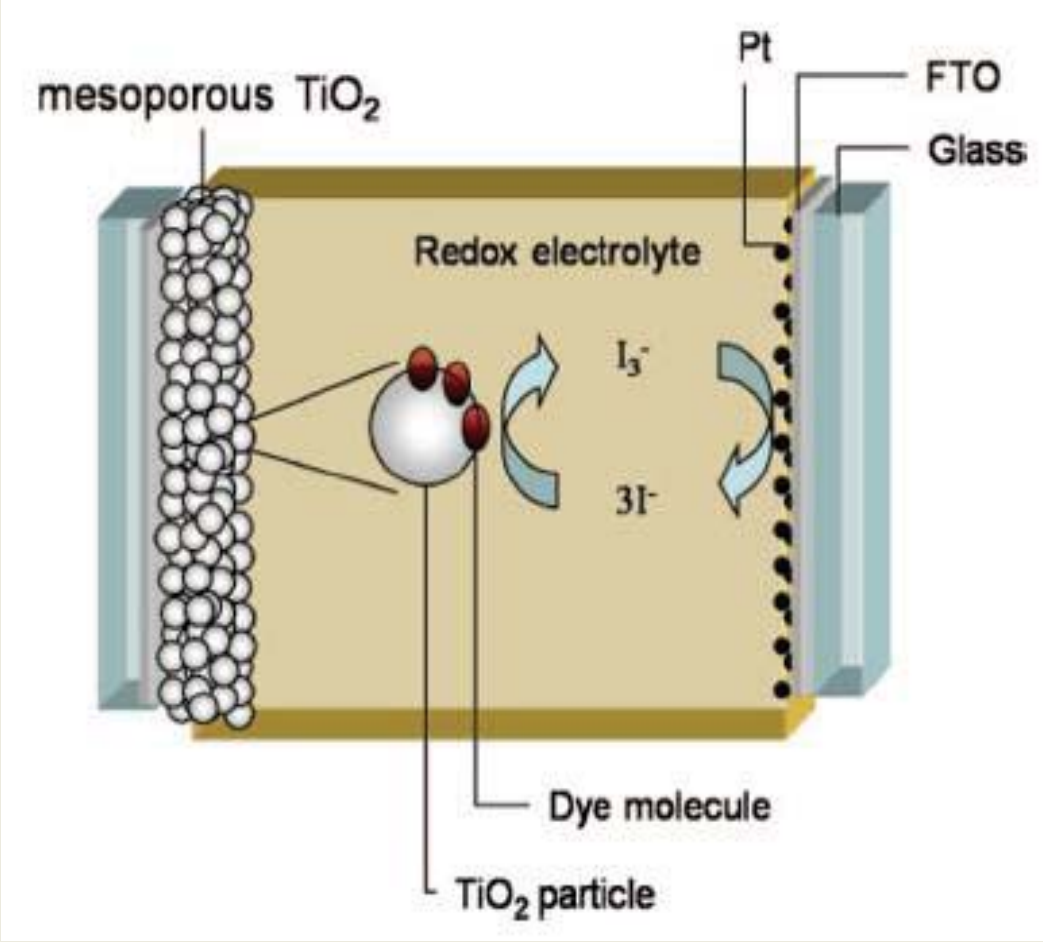
Rural grid connected households consume in Peru, on the average, 12 kWh/month, mainly for lighting, using incandescent light bulbs. The same luminous energy can be obtained with a modern Pico PV system (2 W LEDs, 5 Wp PV)

Based on this argument, and in order to replace kerosene lamps (kerosene is forbidden in Peru, because it is used for cocaine production) the Peruvian Government started in 2010 a pilot project with the goal to install 50 000 Pico PV systems. As the first step , and with the support of GIZ, 11 different LED lamps were tested in the laboratory.

As a next step, a field test with 100 – 200 families will be made using the lamps with the best laboratory results, before, finally, implementing the main project.

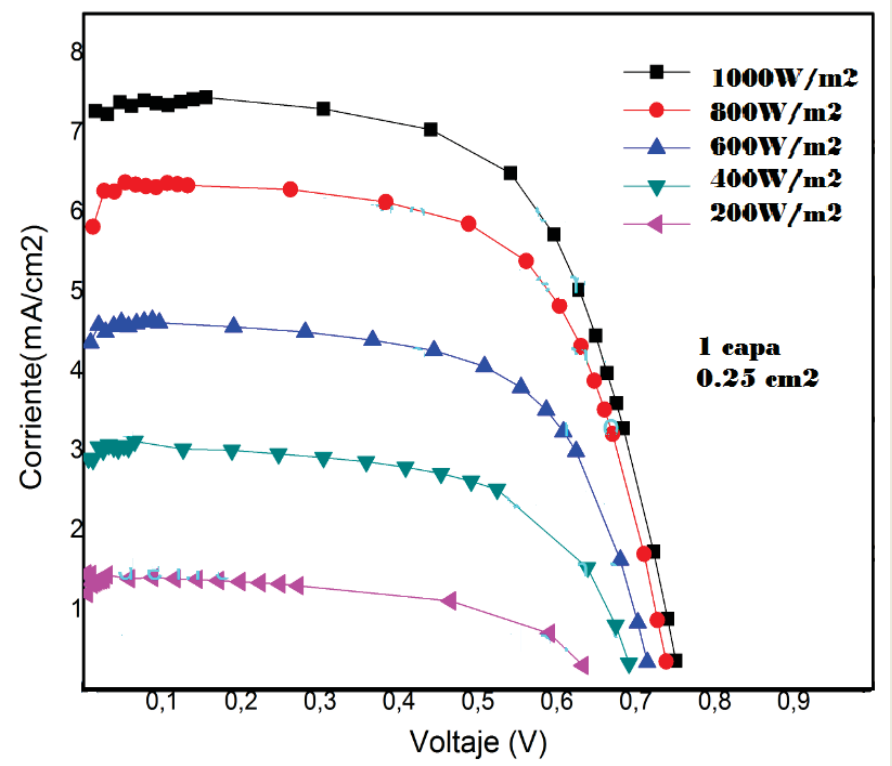
(*) Manfred Horn, Inter Solar North America, San Francisco, July 12-14, 2011.

# Dye-sensitized Solar Cell




A. Hagfeldt *et al.*, Chem. Rev. 2010, 110, 6595–6663

# Dye-sensitized Solar Cell

# CECADE

## Centro de Capacitación para el Desarrollo

http://cuscosolar.org/

# CECADE

## Centro de Capacitación para el Desarrollo

http://cuscosolar.org/

Location: Yauli – Espinar (Cuzco) 3915 masl

Solar heaters

# Solares cookers

http://www.taller-inti.org/

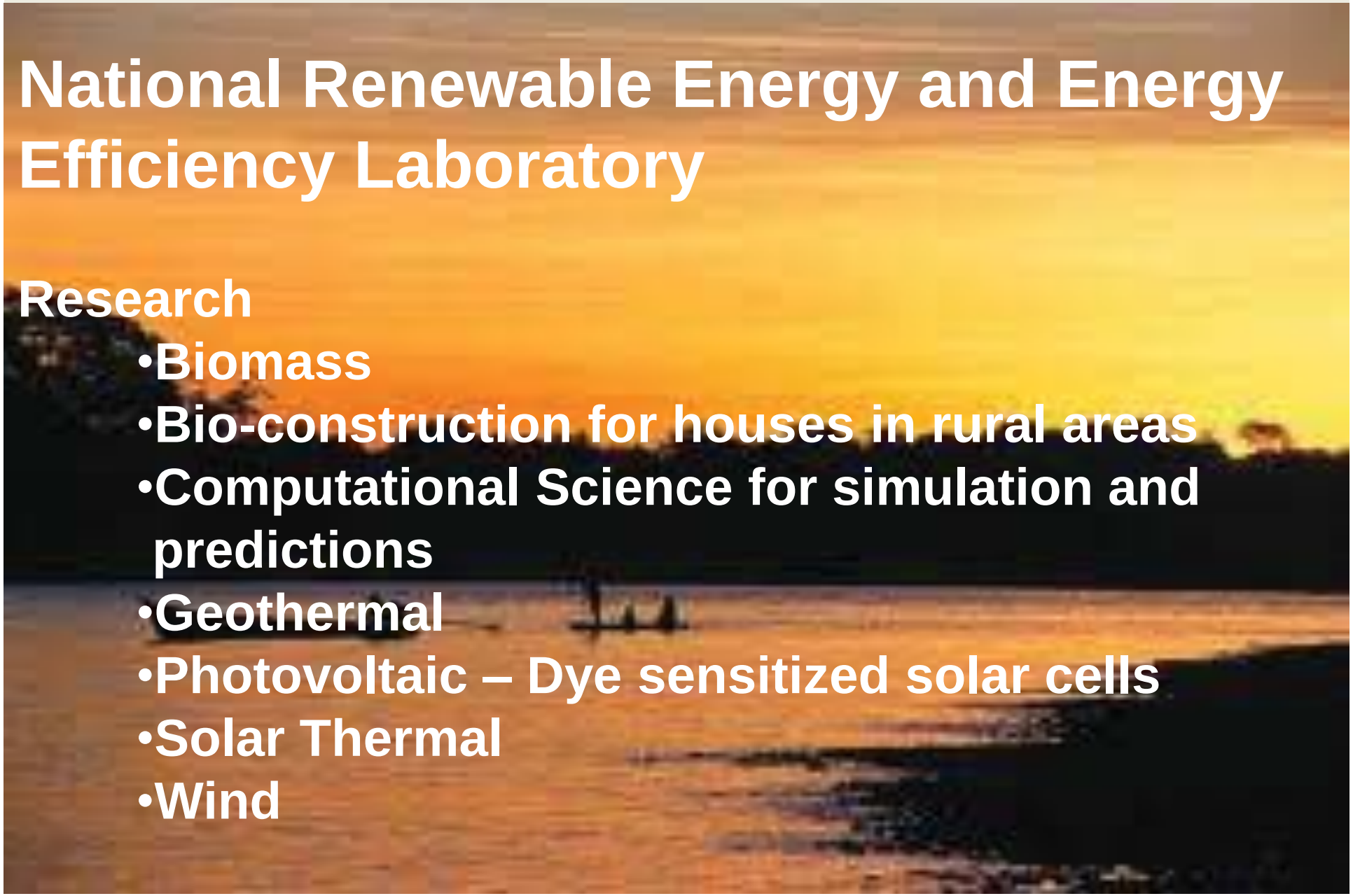
## Solar Home Systems

http://www.taller-inti.org/film/film1/film1.htm

# Conclusions

- There is a significant Sustainable Energy Development in rural areas in Peru, but still their demands are not satisfied.
- The government is facilitating public and private sectors investment in Renewable Energy Technologies.
- It is needed much more national R&D.

A dream….



# National Renewable Energy and Energy Efficiency Laboratory

**Research**

- **Biomass**
- **Bio-construction for houses in rural areas**
- **Computational Science for simulation and predictions**
- **Geothermal**
- **Photovoltaic – Dye sensitized solar cells**
- **Solar Thermal**
- **Wind**

# Thank you for your atten


## ...see you in

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