

INTEGRACIÓN Y SEGURIDAD ELÉCTRICA EN AMÉRICA LATINA

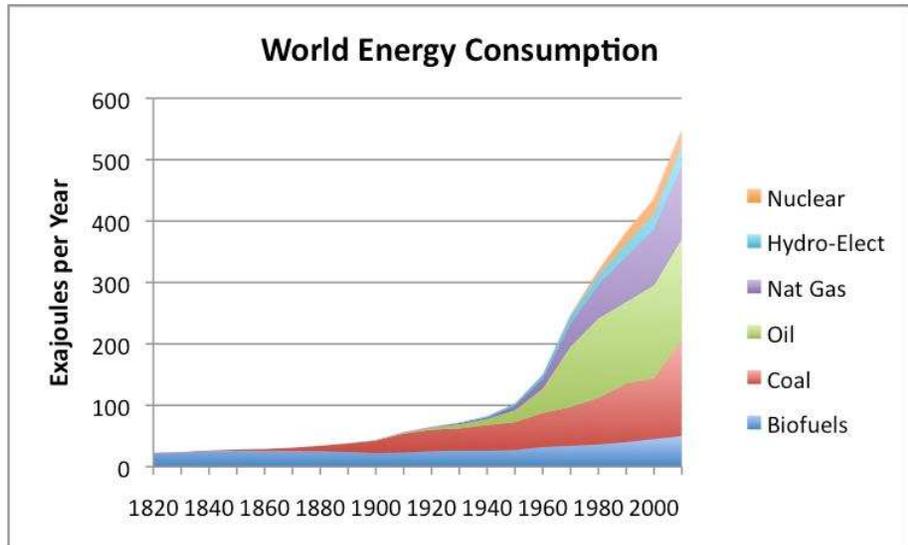
Integración de los Mercados Eléctricos en Europa y América Latina: desafíos y avances
Ricardo Raineri Bernain

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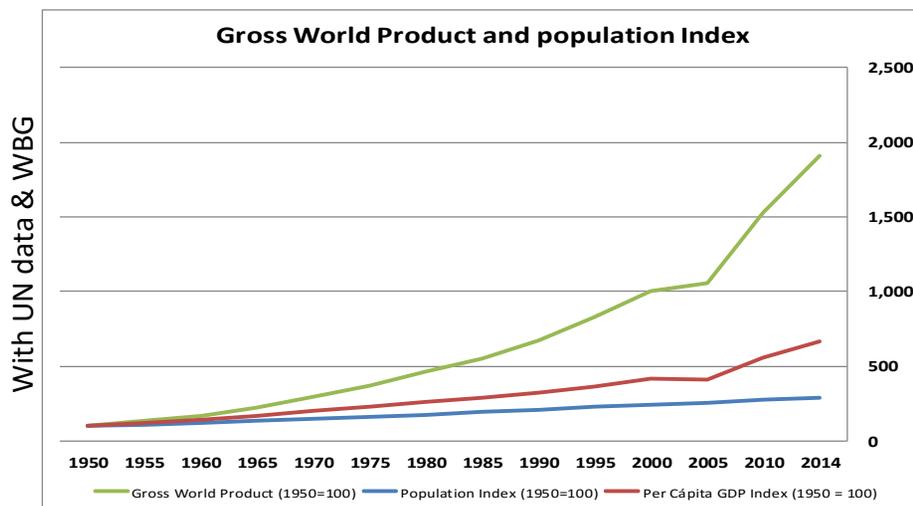
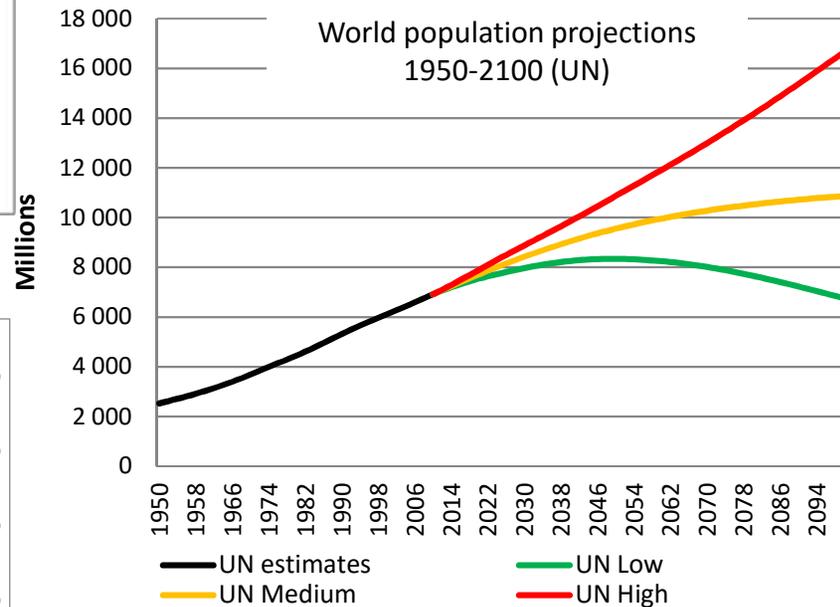


Primary Energy

- Since the industrial revolution until today energy consumption has multiplied by more than 20 times. Today 87% of primary energy we consume comes from fossil fuels.



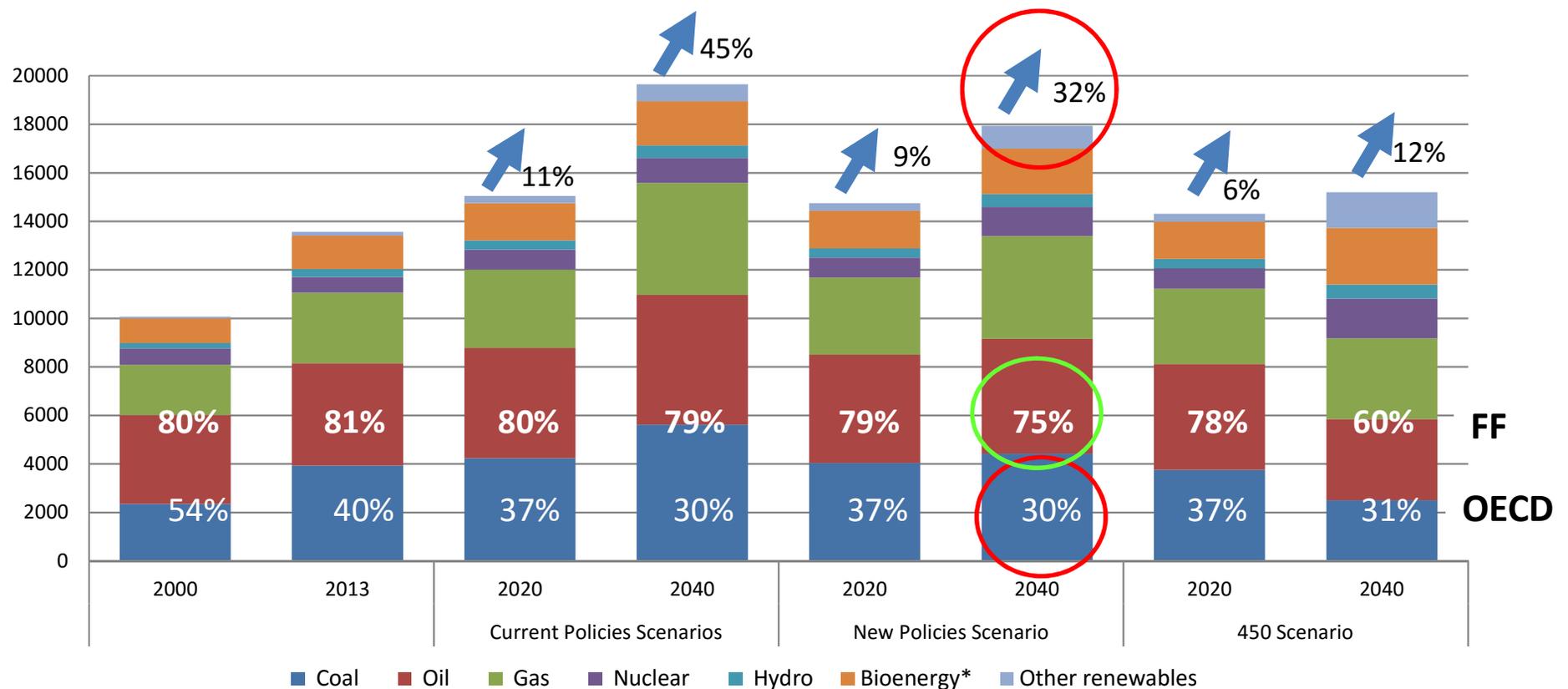
Source: Based on Vaclav Smil estimates from *Energy Transitions: History, Requirements and Prospects* together with BP Statistical Data for 1965 and subsequent. On www.ourfinitemworld.com



Energy Demand

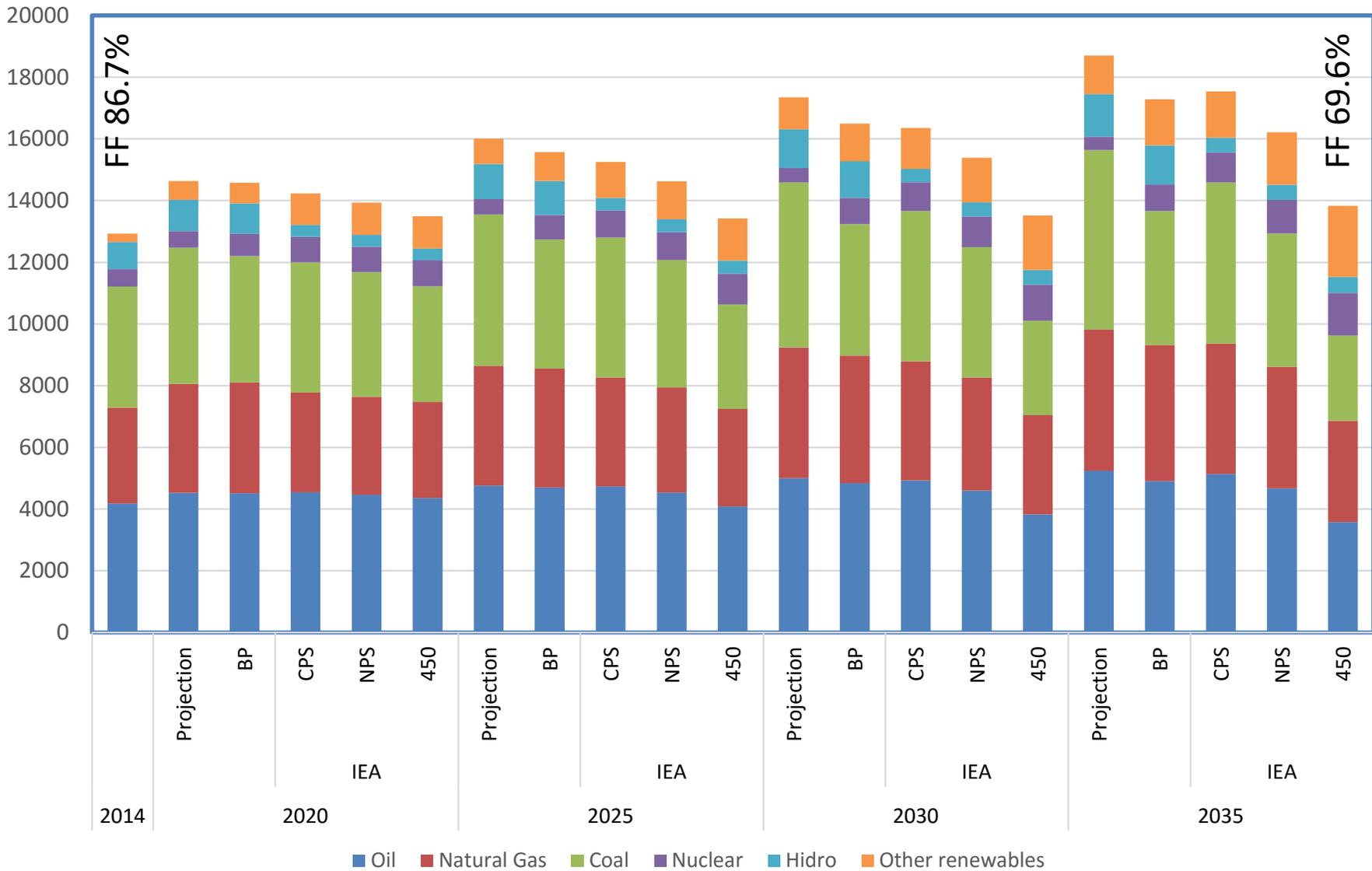
- According to IEA world energy demand is expected to growth from 13,559 Mtoe in 2013 to 17,934 Mtoe in 2040 in its New Policies Scenario , what represents a 32% increase in energy consumption, where fossil fuels participation in primary energy demand are expected to decrease from 81% in 2013 to 75% in 2040.

World primary energy demand by fuel and scenario, and FF share
Mtoe, Data source WEO 2015



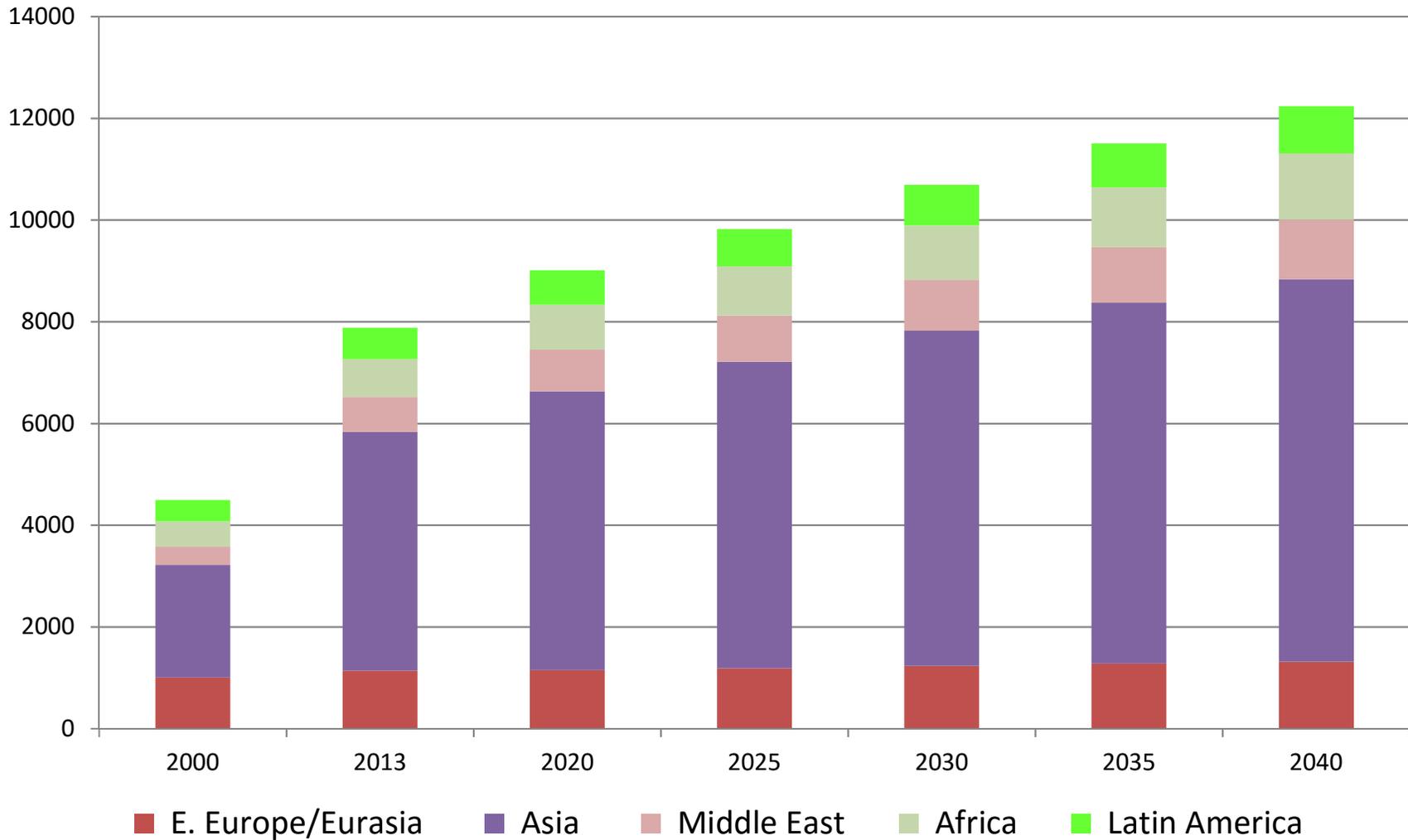
World Primary Energy Demand by Fuel and Scenario

Primary Energy Demand Projections BAU, BP, EIA



Energy Demand Developing World

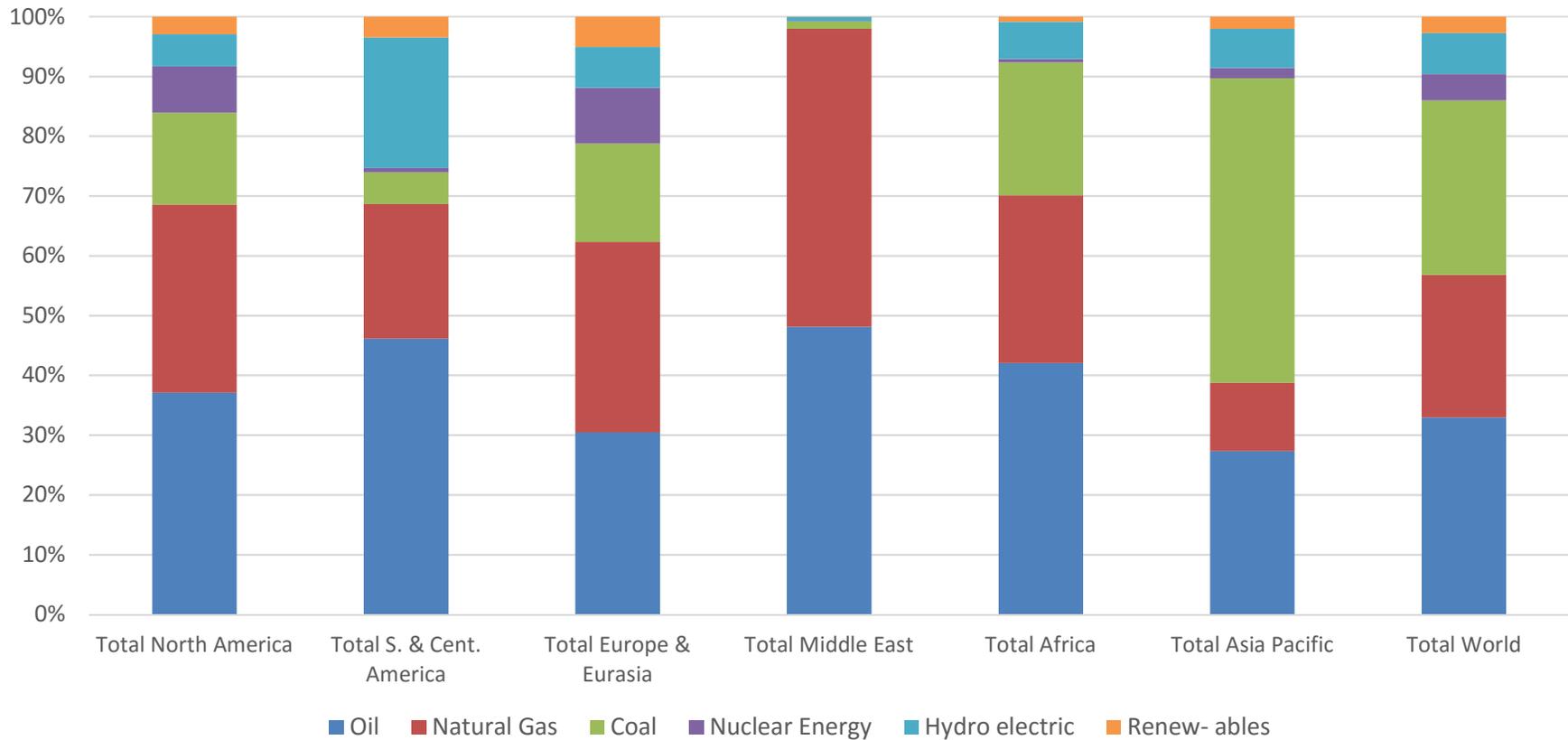
Developing World primary energy demand in the New Policies Scenario (Mtoe)



Regional Energy Mix

- LAC share of renewable energies in the primary energy mix was 21.2% in 2015 v / s 9.6% world average
- LAC proportion of renewable energy generation is 55% (49% large hydro) v / s 11% world average

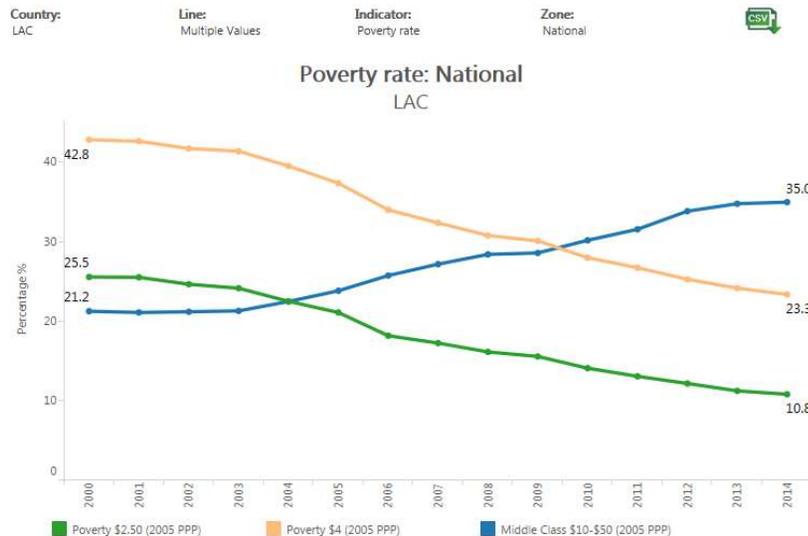
Primary Energy Consumption by Fuel, 2015 BP



Population and the Economy

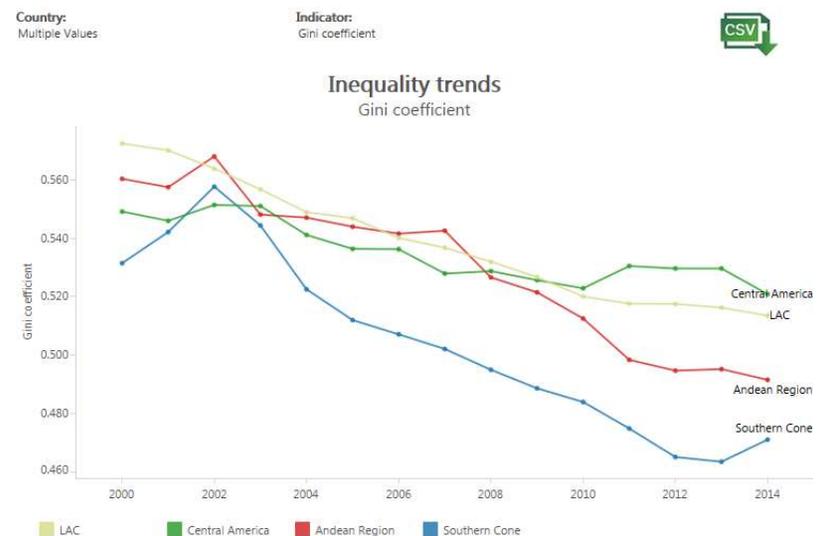
- **Reduction in poverty levels globally:** Across the planet, the number of people living in extreme poverty has dropped by more than half since 1990, when 1,908 million people lived on under \$1.25 a day, or 43,1% of world population, compared to 836 million in 2015, or 11,4% of global population, according to the UN.
- **1.1 billion people – almost the population of India – don't have access to electricity.**
- **LAC 623 million, 100 million more expected in 2030, but still more than 22 million (3.5%) without access to electricity and 80 million (13%) without access to modern cooking facilities.**

A huge appetite for energy: we are more and the modern economy is addicted to energy.



Source: LAC Equity Lab tabulations of SEDLAC (CEDLAS and the World Bank).

Note: Since the numbers presented here are based on SEDLAC, a regional data harmonization effort that increases cross-country comparability, they may differ from official statistics reported by governments and national statistical offices. In cases where data are unavailable for a given country in a given year, values have been interpolated using WDI data to calculate regional measures. The number of poor is based on total population from WDI. The LAC aggregate is based on 17 countries in the region for which microdata are available at national level. Urban and rural poverty rates are not available for the LAC aggregate or subregions. Updated April 2016

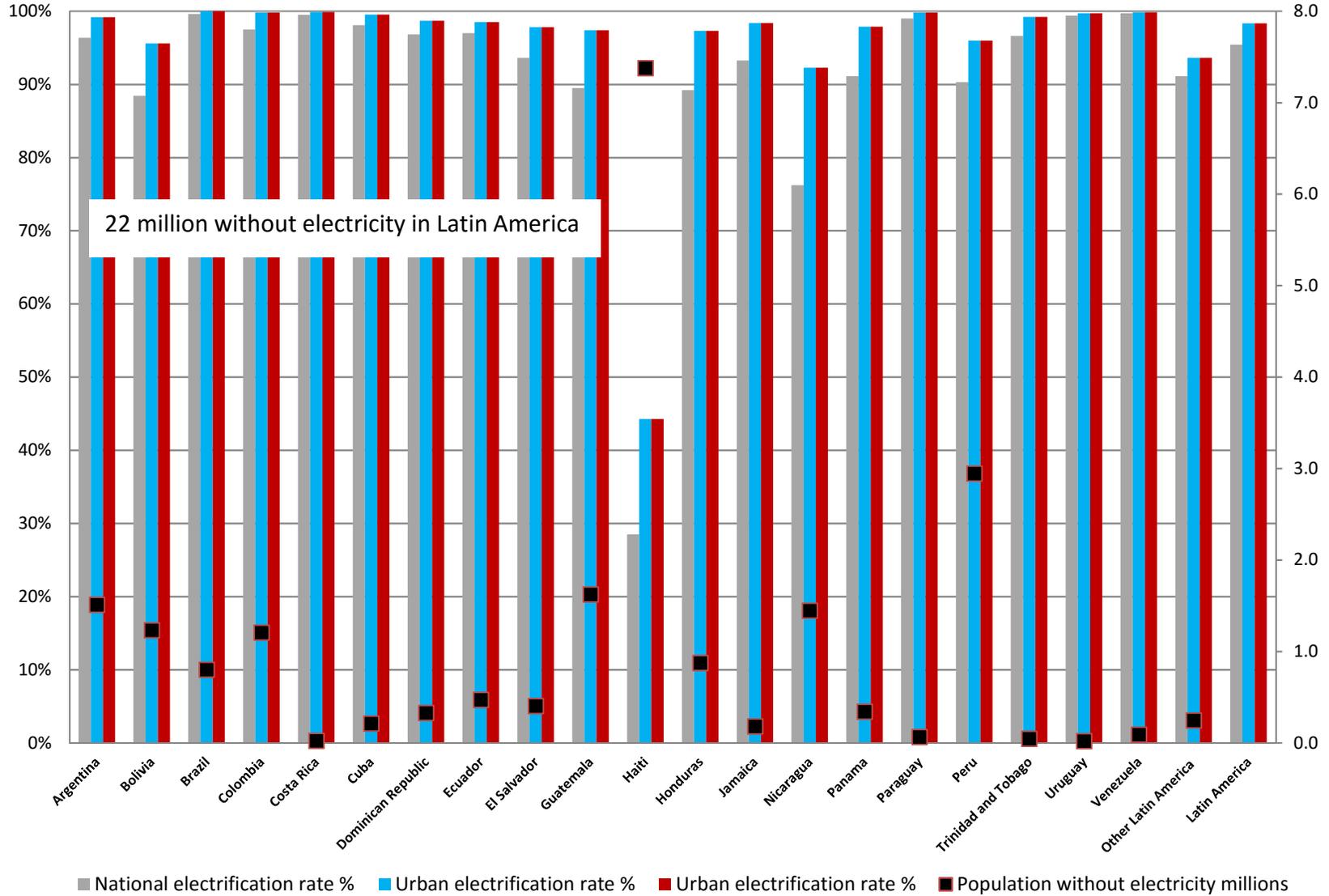


Source: LAC Equity Lab tabulations of SEDLAC (CEDLAS and the World Bank) and World Development Indicators (WDI).

Note: Since the numbers presented here are based on SEDLAC, a regional data harmonization effort that increases cross-country comparability, they may differ from official statistics reported by governments and national statistical offices. The LAC aggregate is based on 17 countries in the region for which microdata are available; they do not include Haiti. In cases where data are unavailable for a given country in a given year, values have been interpolated using WDI data to calculate regional measures. Updated April 2016

Energy Demand LAC

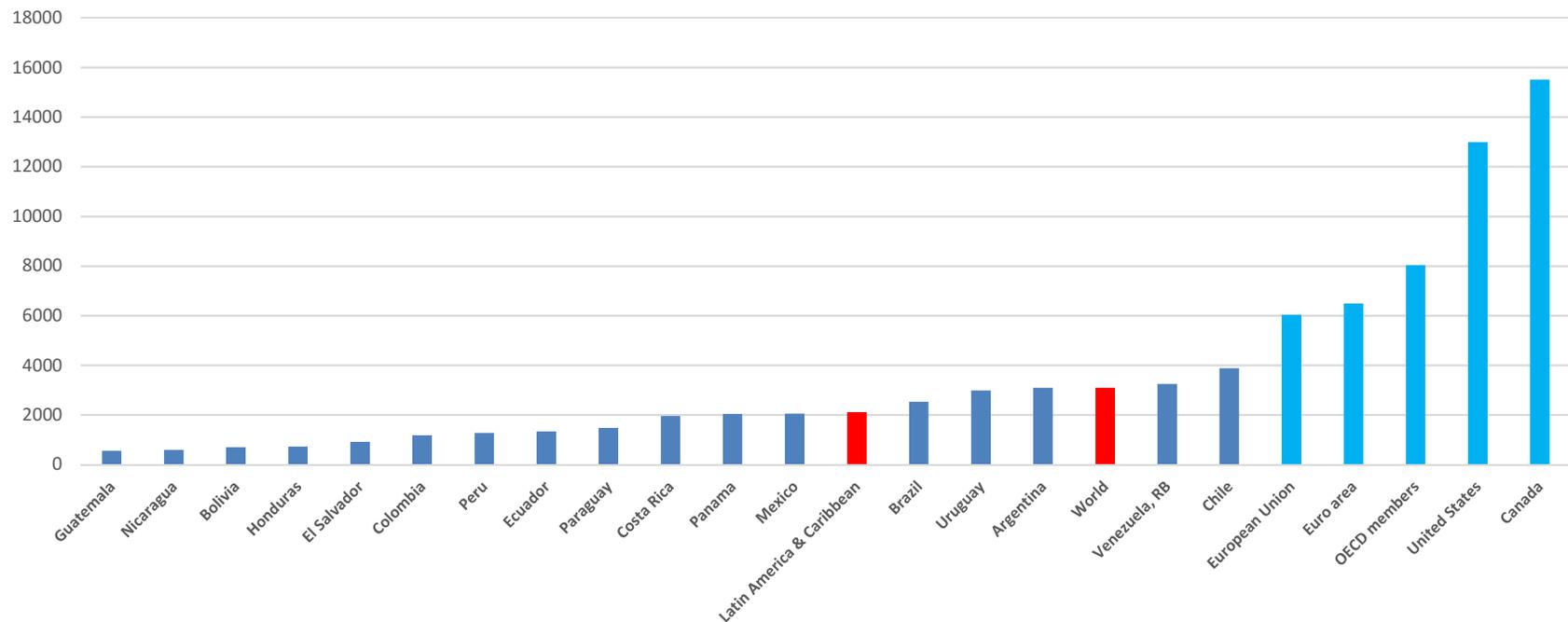
Electricity access in Latin America - 2013



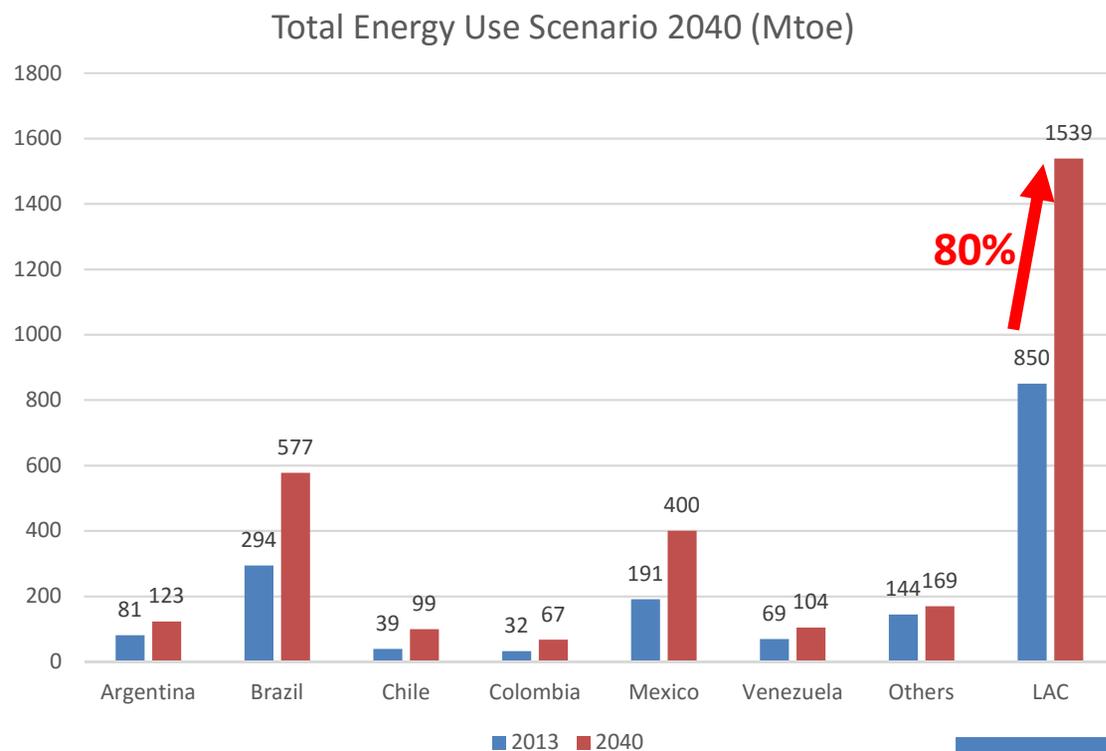
Energy Demand LAC

- Regional levels of per capita electricity consumption average **1/3 of the European Union, ¼ of OECD members, and less than 1/6 of the one in the US**. Thus, while the region keeps improving the standard of living of its population, the number of people living in poverty decreases, and the population that is incorporated to the middle class increases, and the regions increases the size of its economy and productive activities, we will expect that energy demand will increase further.

Electric power consumption 2013 (kWh per capita, source WBG)



Primary Energy Demand LAC



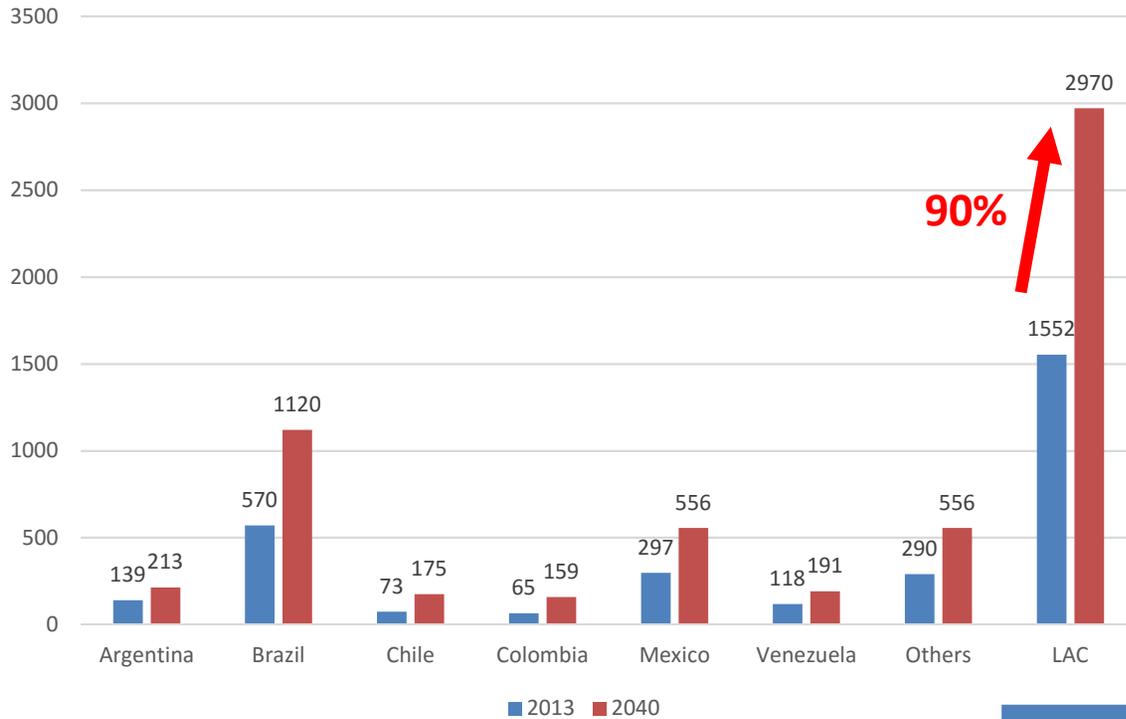
LAC primary energy consumption represents only 6.7% of world energy consumption, and it has grown more than 100% in the last 25 years, or at an annual rate of 2.9%.

Total Energy Use Scenario 2040 (Mtoe)				
	2013	2040	Growth	CAGR
Argentina	81	123	51.9%	1.56%
Brazil	294	577	96.3%	2.53%
Chile	39	99	153.8%	3.51%
Colombia	32	67	109.4%	2.77%
Mexico	191	400	109.4%	2.78%
Venezuela	69	104	50.7%	1.53%
Others	144	169	17.4%	0.59%
LAC	850	1539	81.1%	2.22%

Source: Lights On? Energy Needs in Latin America and the Caribbean to 2040. Lenin H. Balza, Ramón Espinasa, Tomas Serebrisky. IDB 2014.

Electricity Demand LAC

Electricity Needs Through 2040 (TWh)



Electricity Needs Through 2040 (TWh)				
	2013	2040	Growth	CAGR
Argentina	139	213	53.2%	1.59%
Brazil	570	1120	96.5%	2.53%
Chile	73	175	139.7%	3.29%
Colombia	65	159	144.6%	3.37%
Mexico	297	556	87.2%	2.35%
Venezuela	118	191	61.9%	1.80%
Others	290	556	91.7%	2.44%
LAC	1552	2970	91.4%	2.43%

Source: Lights On? Energy Needs in Latin America and the Caribbean to 2040. Lenin H. Balza, Ramón Espinasa, Tomas Serebrisky. IDB 2014.

LAC Resources: Fossil Fuels

LAC has 22% of the world's proven oil reserves, 4% of natural gas and coal 1.7%

OIL PR Total LAC as % World	21.95%
Venezuela	19,62%
Brazil	0,79%
Mexico	0,62%
Ecuador	0,49%
Argentina	0,14%
Colombia	0,14%
Otros LAC	0,14%

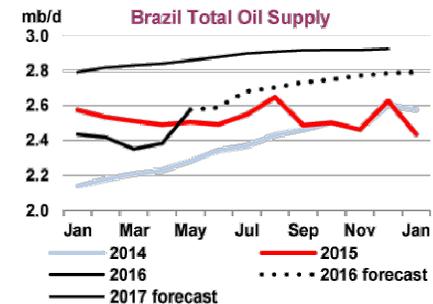
Source: BP 2016

EIA estimates that LAC has **18% of technically recoverable Shale Oil**, where 7% is in Argentina, 4% within Colombia and Venezuela in the Maracaibo basin, and 3% in Mexico

Pre Salt Brazil: there are **an estimated 13.3 billion barrels** of commercially recoverable reserves from announced projects in offshore Brazil

Natural Gas PR as % World PR	4.3%
Venezuela	3.0%
Mexico	0.2%
Brazil	0.2%
Trinidad and Tobago	0.2%
Peru	0.2%
Argentina	0.2%
Other LAC	0.3%

Source: BP 2016



Shale gas:

EIA 22% in LAC, Argentina 9%, Mexico 6% and Brazil 3%

LAC Resources: Renewables

IADB, Rethinking our Energy Future



- LAC has developed **1/3 of regional hydropower potential (320 GW)**
- Great potential for wind, geothermal, solar and other renewables
- Brazil is the second largest producer of ethanol and biodiesel

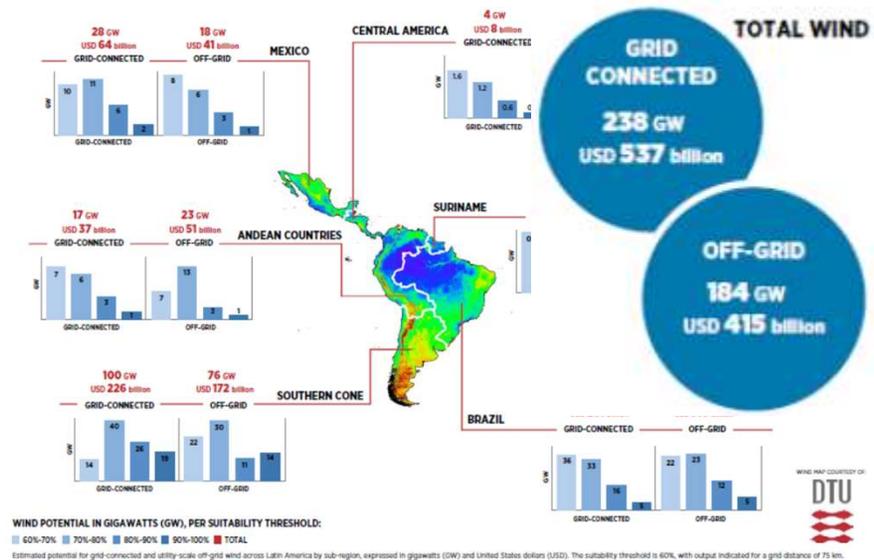


Figure 4: Wind energy - Grid-connected and utility-scale off-grid technical potential estimates for Latin America by region, expressed in GW and USD. The suitability threshold is 60% and the output is indicated for a grid distance of 75 km.

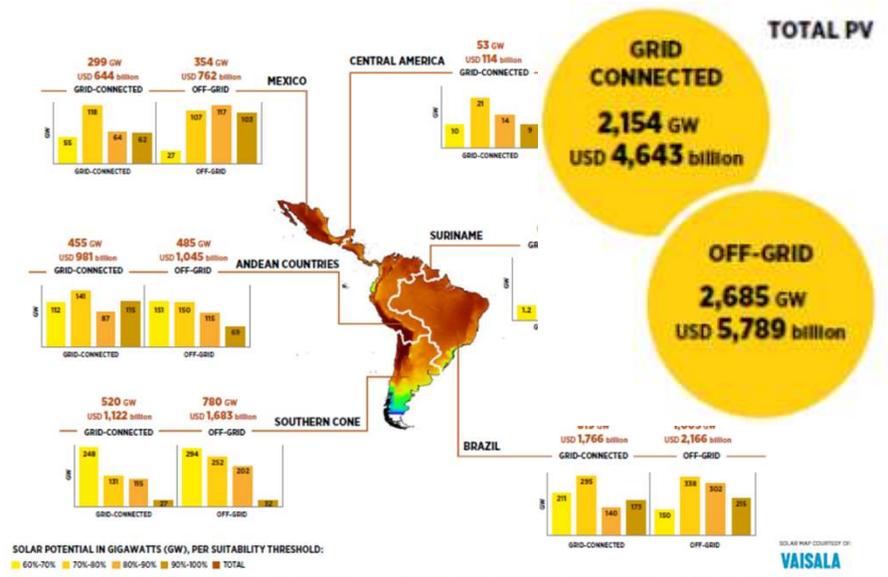


Figure 5: Solar PV - Grid-connected and utility-scale off-grid technical potential estimates for Latin America by region, expressed in GW and USD. The suitability threshold is 60% and the output is indicated for a grid distance of 75 km.

SA major power generation and electrical interconnections 2014

Ref.	Country	Name	River	Inst. Cap.	Comment
A	Br -Py	Itaipú	Paraná	14.000 MW	In operation
B	Ar -Uy	Salto Grande	Uruguay	1.890 MW	In operation
C	Ar -Py	Yacyretá	Paraná	3.200 MW	In operation
D	Ar -Br	Garabí	Uruguay	1.500 MW	In Study
E	Ar -Py	Corpus	Paraná	3.400 MW	In Study

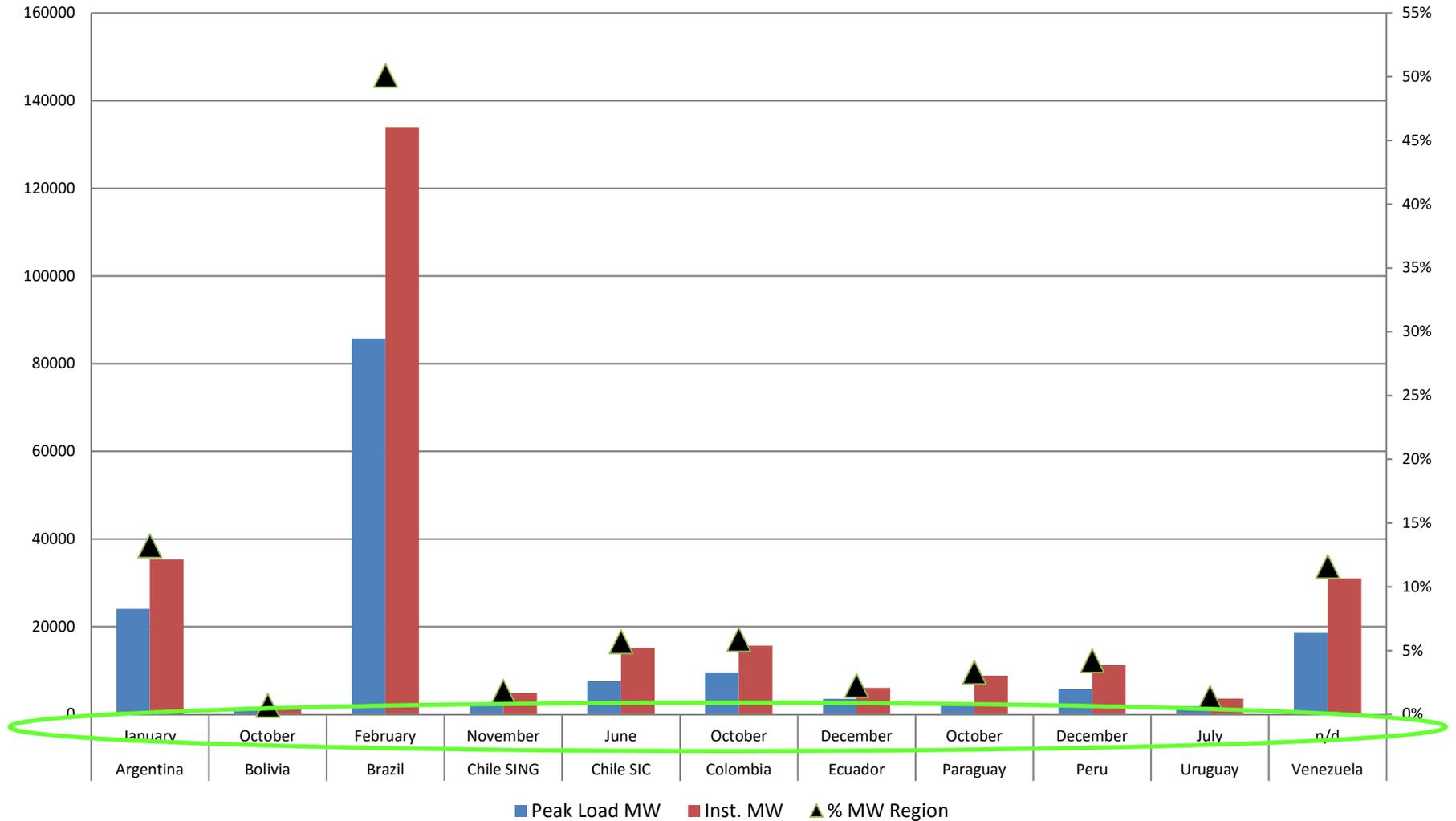
Ref.	Country	Name	River	Inst. Cap.	Comment
F	Pe	Inambari	Inambari	2.300 MW	In Study
G	Bo	Cachuela Esperanza	Madeira	800 MW	In Study



South America Power Sector

South America: Peak Load, Inst. Cap. and % Regional Inst. Cap. 2014

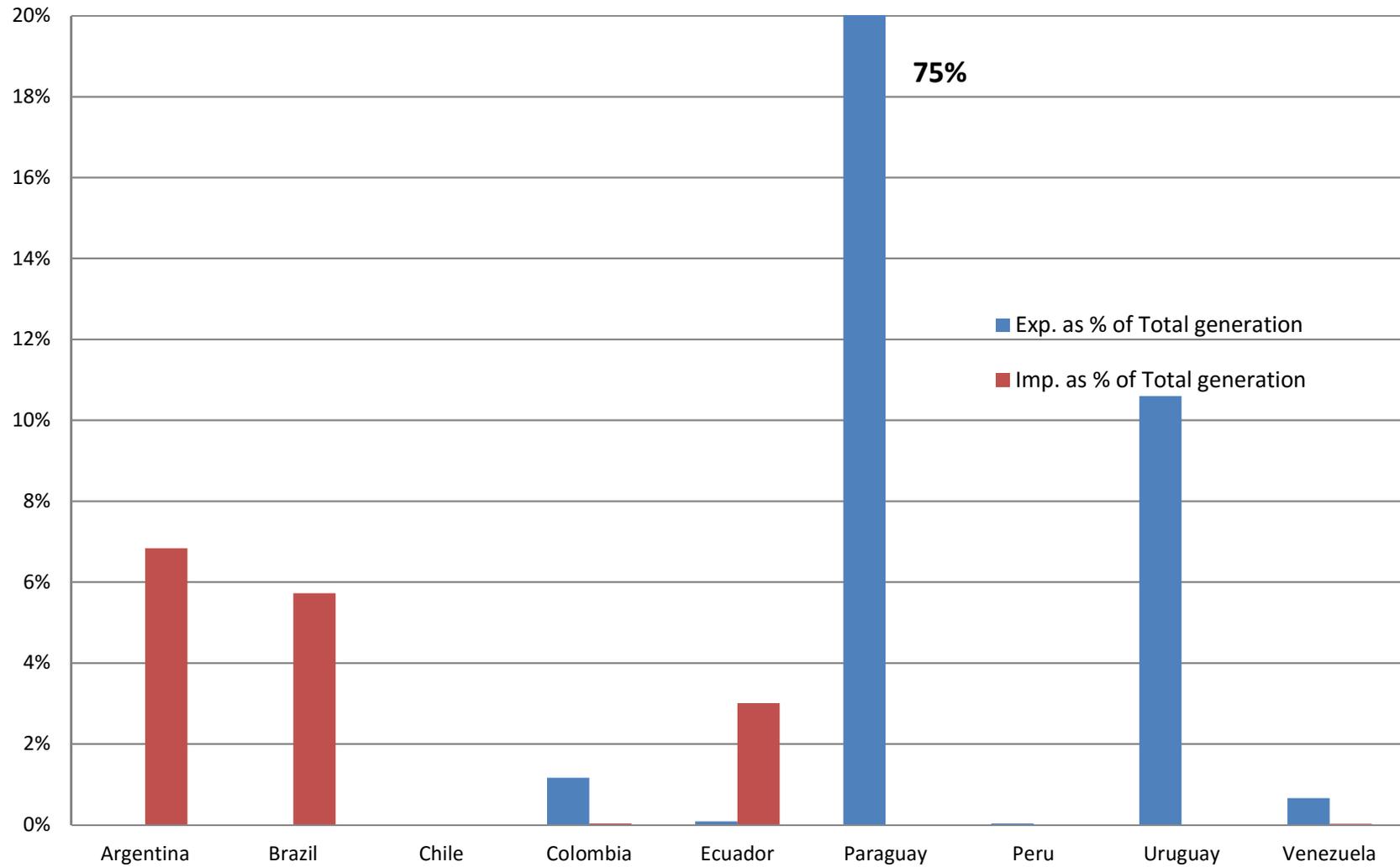
MW. Source: CIER y MinEnergia



South America Power Exchanges

Energy exchange as% of local generation, 2014

(Source: Cier 2015)



South America Power Exchanges

Regional Power Exchanges GWh 2012									
	Argentina	Brazil	Colombia	Ecuador	Paraguay	Peru	Uruguay	Venezuela	Total Imp.
Argentina		79			7.646		194		7.919
Brazil					40.016			705	40.721
Colombia				7					7
Ecuador			236			2			238
Paraguay				5					5
Peru	279	463							742
Uruguay			478						478
Venezuela									
Total Exp.	279	542	714	17	47.662	2	194	705	50.110
	Total GWh generation South America								1.083.766
	Power Exchange as % of Total generation								4,6%

Regional Power Exchange GWh 2014										
	Argentina	Brazil	Chile	Colombia	Ecuador	Paraguay	Peru	Uruguay	Venezuela	Total Imp.
Argentina		3	4			8,461		1,267		9,735
Brazil	1					32,939			839	33,779
Colombia					20					20
Ecuador				718			13			731
Venezuela				28						28
Total Exp.	1	3	4	746	20	41,400	13	1,267	839	44,293
	Total GWh generation South America								1,141,144	
	Power Exchange as % of Total generation								3.9%	

Main Gas Pipelines, South America 2014

Gas Trade in 2015 (billion cubic meters)				
World Gas CONSUMPTION	3468.6			
LNG	9.8%			
PIPE	20.3%			
Total gas trade LNG and Pipe	30.1%			
LAC Gas CONSUMPTION	258.0			
	Pipeline	LNG	Pipeline	LNG
	imports	imports	exports	exports
Mexico	29.9	7.1	0.0	0.0
Trinidad and Tobago	0.0	0.0	0.0	17.0
Other S. & Cent. America	18.5	20.0	18.5	5.0
LAC Total trade	48.3	27.1	18.5	22.0
LAC LNG imports/LAC Gas Consumption				10.5%
LAC PIPE imports/LAC Gas Consumption				18.7%
LAC LNG and PIPE imports/LAC Gas Consumption				29.2%

Source: Own calculations with BP data.



Oil trade in 2015 (Thousand barrels daily)				
	Crude	Product	Crude	Product
	Imports	Imports	Exports	Exports
Total World	39707	21516	39707	21516
Mexico	±	774	1201	171
S. & Cent. America	404	1908	3462	605
LAC	396.2	2647.0	4,655.2	740.5
Oil Production LAC				10,299.7
Oil Production WORLD				91,670.3
Crude Exports LAC/Oil Production LAC				45.2%

Source: Own calculations with BP data.

Siepac



Central American Interconnections

Ref.	Region/ countries	Location	Voltage kV	Cap. MW	Comment
1	Siepac	Sistema de Transmisión Regional (1.800 kms): <ul style="list-style-type: none"> • 283km en Guatemala; • 286 km en El Salvador; • 275 km en Honduras; • 307 km en Nicaragua; • 499 km en Costa Rica; • 150 km en Panamá 	230	300	In operation
2	Gt - Mx	S.E. Brillantes (Gt) – S.E. Tapachula (Mx) (101 kms): <ul style="list-style-type: none"> • 71 km en Guatemala • 30 km en México 	400 / 230	200	In operation
3	Co - Pa	Cerromatoso (Co) – Panamá (Pa)	-	300	Under study

North Arch



Gas pipeline Mexico Guatemala

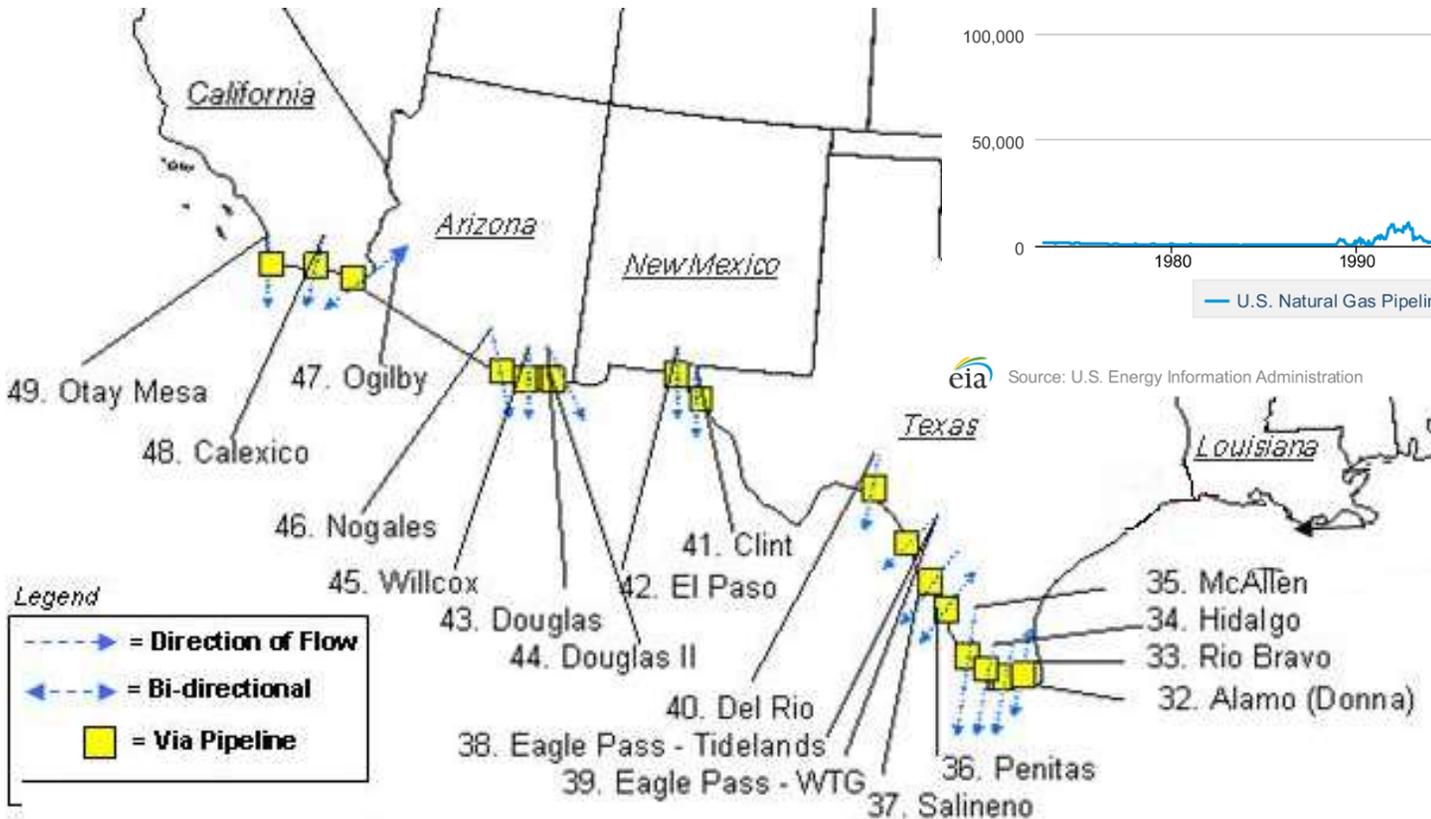
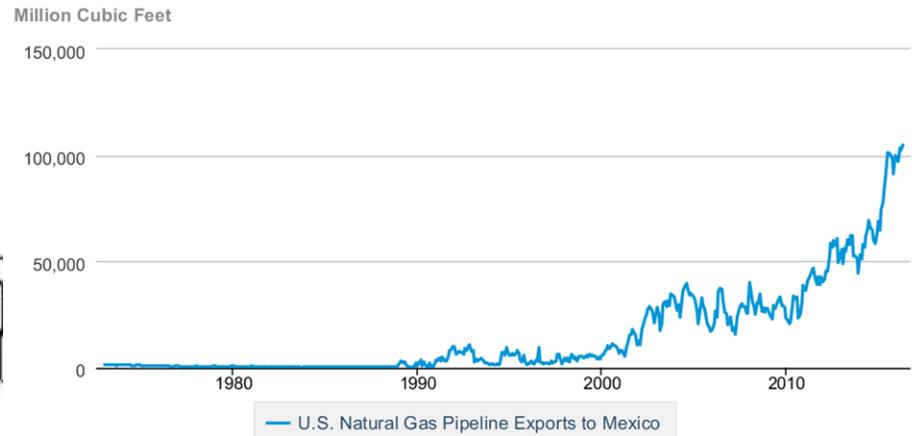
- In 2014 Mexico and Guatemala signed the Memorandum of Understanding for the construction of 600 kms pipeline linking Salinas Cruz in Mexico to Escuintla in Guatemala.
- In April 2015 the Economic Complementation Agreement on Trade and Transport of Natural Gas from Mexico, Guatemala and El Salvador signed. Honduras has applied for joining the project. The start of construction is scheduled for 2016 and completion for 2019.



Mexico - U.S. Natural Gas Pipelines

Currently there are 18 pipelines where NG is exported from the US to Mexico

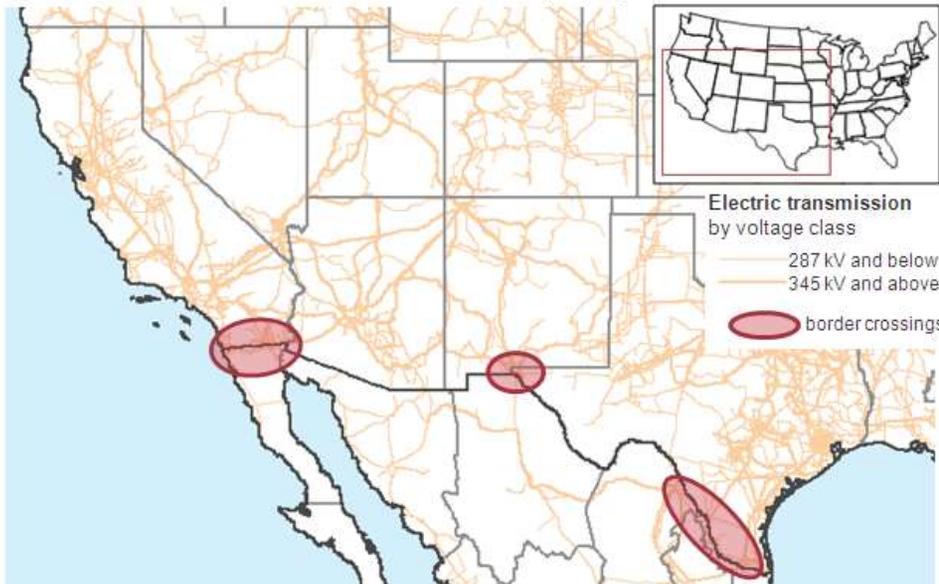
U.S. Natural Gas Pipeline Exports to Mexico



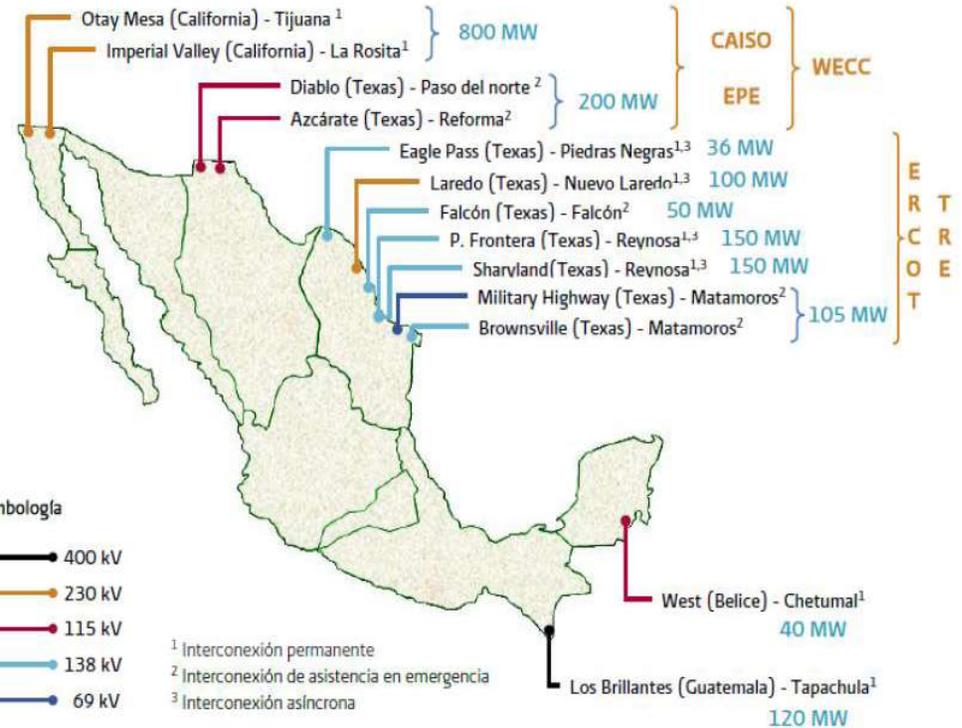
Source: U.S. Energy Information Administration

Mexico - U.S. Electricity Interconnections

Electric transmission crosses U.S.-Mexico border in only a few places



U.S. electricity trade with Mexico represents a small fraction—less than a hundredth of a percent—of total U.S. electricity use. A small amount of electricity trade with Mexico exists in California, New Mexico, and Texas.



Electricity interconnections 2011

Source: eia & Hugo Ventura, CEPAL

Main Advantages

- LAC has abundant renewable resources and FF, unevenly distributed, but with great complementarities
- LAC has sufficient resources for its energy needs and to contribute to the energy needs of other regions

Expected advantages:

- Integration of the countries and with the rest of the continent
- Generates wealth for countries and monetize energy resources
- Increase system reliability
- Optimizes the use of natural resources
- Cleans the electricity mix and improves environmental sustainability
- Uses the complementarities of the basins and reduce system energy costs
- Reduces the cost of buying oil for power generation

Potential Benefits In Sub Zones

- Central America
 - **Economies of scale**
 - Enable more efficient energy infrastructure
 - Reduce energy costs and dependency on oil for power generation
- Andean community
 - Energy exchanges
 - Optimization of an integrated power system
 - **Complementarities on power generation for peak demand**
 - **Complementarities on rain seasons with Niño and Niña**
- South cone + Brazil
 - Chance to optimize the use of energy resources
 - **Binational hydro projects**
 - **Electricity and natural gas swaps**
 - **Energy Wheeling**
 - Synergies between natural gas, hydro, wind, solar and biomass.
 - **Energy infrastructure for export**

Challenges

Challenges for energy integration

- **Exists a crisis of multilateralism in the region**, which is not indifferent to the results of regional integration.
- **There are different views on energy development, organization, roles of the market and the state**, etc.
- Need for **well crafted agreements between States**
- What is allowed, at what price, and the need to have an appropriate mechanism for dispute resolution
- Pre-established **transit policies, pricing and development** of transport systems
- **Role of international organizations and multilateral development banks**
- Avoid the public goods problem
- Ensure energy security and proper level of investments, system sufficiency. Escape underinvestment problem in a world of global corporations.
- **Confidence that energy will not be used as an arm of geopolitical power**

Challenges

- Overcome mistrust, without compromising energy security
- There is fear and resistance to the "**loss of sovereignty**" (Argentinean Gas crisis).
- The need to **manage the integration issue with a multidimensional perspective that gather the different interests of political, business, social groups, media etc.**
- The models and regulatory practices in the region are diverse
- Exist regulatory loopholes in the sector at national and regional level
- Absence of integrated planning for the expansion of systems and transparent mechanisms that allow us to generate preventive actions
- **Energy integration should protect national interest**
- **Game changers and the irruption of NC renewables**

LAC Vision of the Energy Sector to 2025

- Close the gaps on universal access to energy services.
- Unlock the great potential of energy resources to create wealth, promote economic and social development in a sustainable manner, contributing to fiscal balance, to meet regional energy needs and also to meet the energy needs of other regions

Huge financial needs in the region for electric sector, renewables, oil and gas in Pre-salt, Mexico, Argentina, and others

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A different story: Chilean Experience on energy integration

- The 1990`s and the need to diversify the energy matrix: the attempt on Argentinean natural gas (multiple pipelines)
 - Household consumption
 - Power generation and cross border power generation
 - Industrial purposes, and Methanex in Magallanes
- Argentinean economic crisis and shutdown of NG exports to Chile
 - Increasing since 2004
 - US\$ 140 oil price
 - Severe dry season which magnifies the problem

Actions

- Important of well functioning energy markets, with clear signals for proper energy investments
- LNG, two terminals
 - Quintero
 - Mejillones
- NG power plants converted to use oil
- Increase awareness on EE and prices that reflect the scarcity of the resources

- But, we have been left with a system that operates out of a long run efficient condition.

- Increasing citizens concerns with the environmental impacts of FF/coal power plants and large hydropower plants

2010 Forward

- Interconnect the two largest power systems, SIC and SING
- Close the remaining gaps on national energy security
- Diversification of the energy mix (20% renewables by 2025, net billing)

- Open the dialogue with Argentina, Bolivia and Peru on energy collaboration and integration
- Advance with the Pacific Alliance and the Andean Community on a common energy integration agenda

- All these beyond an 8.8 earthquake

Where we are today

- SIC – SING interconnection expected for 2017 or 2018
- New reality on oil and NG prices
 - Concerns of 2000`s decade on the lack of energy disappear, besides the large increase in energy consumption in the developing world over the last two decades
 - How to create wealth from natural resources
- Huge disruption of renewables, solar, wind as their efficiency increases and prices collapse
- Chile is exporting NG and electricity to Argentina

What this new energy environment means for LAC energy integration

- Concerns on national energy security are diminished
- Huge opportunities to create wealth and to take advantage of the energy resources and complementarities of the region on NG, oil, hydro and renewables
- Trust and a key role for multilateral institutions

Chile



Chile electricity auctions

- Low GDP growth and energy demand
- Lower prices of renewables, wind and PV
- Low oil price
- SIC-SING interconnection as an enabler of renewable investments
- New electricity transmission Law, 100% paid by consumers
- Reduced guarantees and risk rating for the companies that present bids in the auction
- Environmental licenses with expiration date since 2010
- Price indexation favor renewables against NG projects

Chile electricity auctions

- Exists concerns regarding the capacity of the projects to access to finance
 - The country might be left with Discos contracts with low energy prices in a system with high marginal costs,
 - And without the needed efficient capacity for power generation
- Risk do not disappear in the system, they might be transferred between the players