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Renewable Energy
Global and Brazilian Trends

pwc

Contents

Energy Sector Overview

1

World Energy Sector Overview

- Majority of power generation in the world comes from Fossil Fuels:
  - Coal makes up more than 40% of generation with United States and China as main players;
  - Gas has more than 20% of generation;
  - Oil mainly used for transportation.

- Renewables are mainly used for electricity generation with transportation increasing in use.

- Few countries rely in renewables as a primary source of energy (ex. Brazil).

Renewable energy generation should triple by 2035 from 2010.

3x

Source: IEA World Energy Outlook 2012

World Energy Sector Generation Overview

Electricity generation by source (TWh)

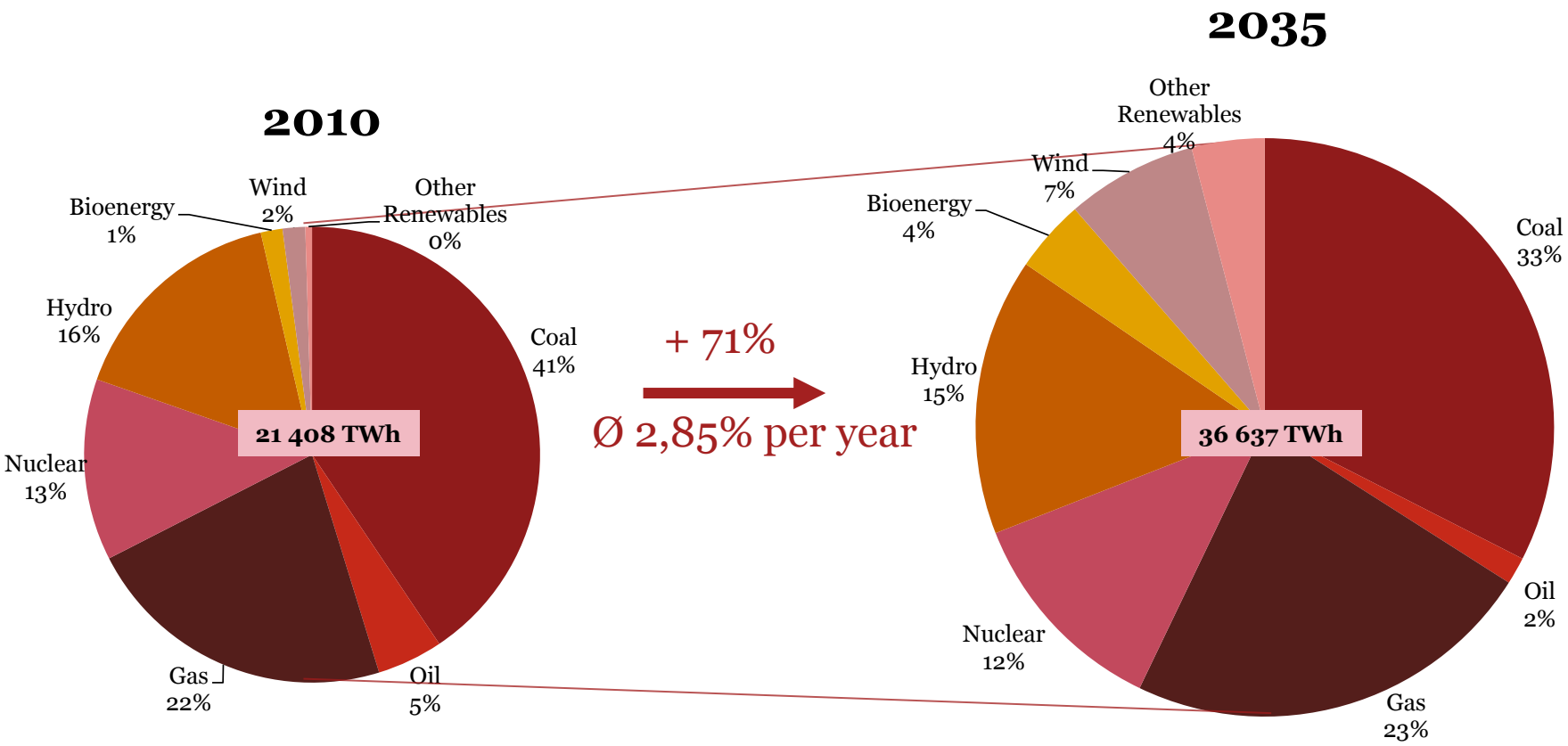
	1990	2010	2020	2035
OECD	**7 629**	**10 848**	**12 153**	**14 110**
Fossil fuels*	4 561	6 600	6 981	7 948
Nuclear	1 729	2 288	2 299	2 240
Hydro	1 182	1 351	1 474	1 578
Other renewables	157	609	1 400	2 343
Non-OECD	**4 190**	**10 560**	**17 040**	**26 255**
Fossil fuels*	2 929	7 847	12 167	18 882
Nuclear	283	468	1 099	1 668
Hydro	962	2 079	2 916	3 771
Other renewables	15	166	858	1 934
World	**11 819**	**21 408**	**29 194**	**40 364**
Fossil fuels*	7 490	14 446	19 148	26 829
Nuclear	2 013	2 756	3 397	3 908
Hydro	2 144	3 431	4 390	5 350
Other renewables	173	775	2 259	4 277

* Includes coal-, gas- and oil-fired generation.

Source: IEA World Energy Outlook 2012

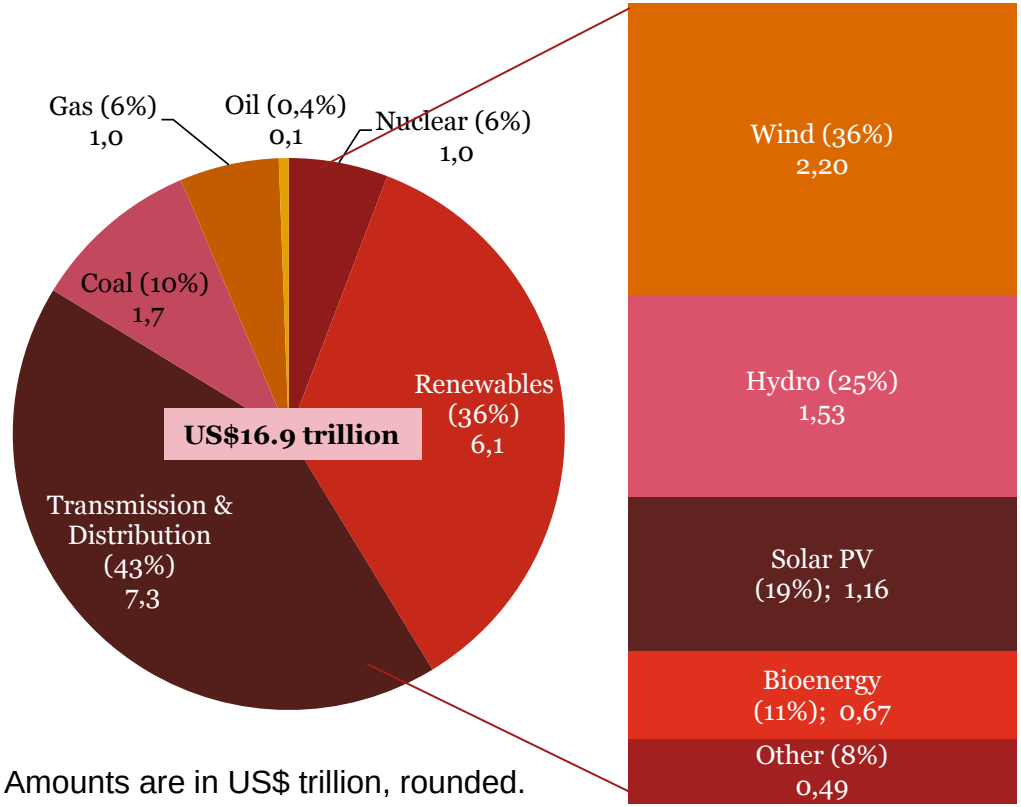
Global Power Generation Fuel Mix and Future Trend

Profound changes in global fuel mix by 2035 due to substantial drop of fossil fuels (mainly coal by -8%) and growth of renewables (+11%).



Source: IEA World Energy Outlook 2012

Power Sector Cumulative Investment Needs: US$16.9 trillion investment by 2035



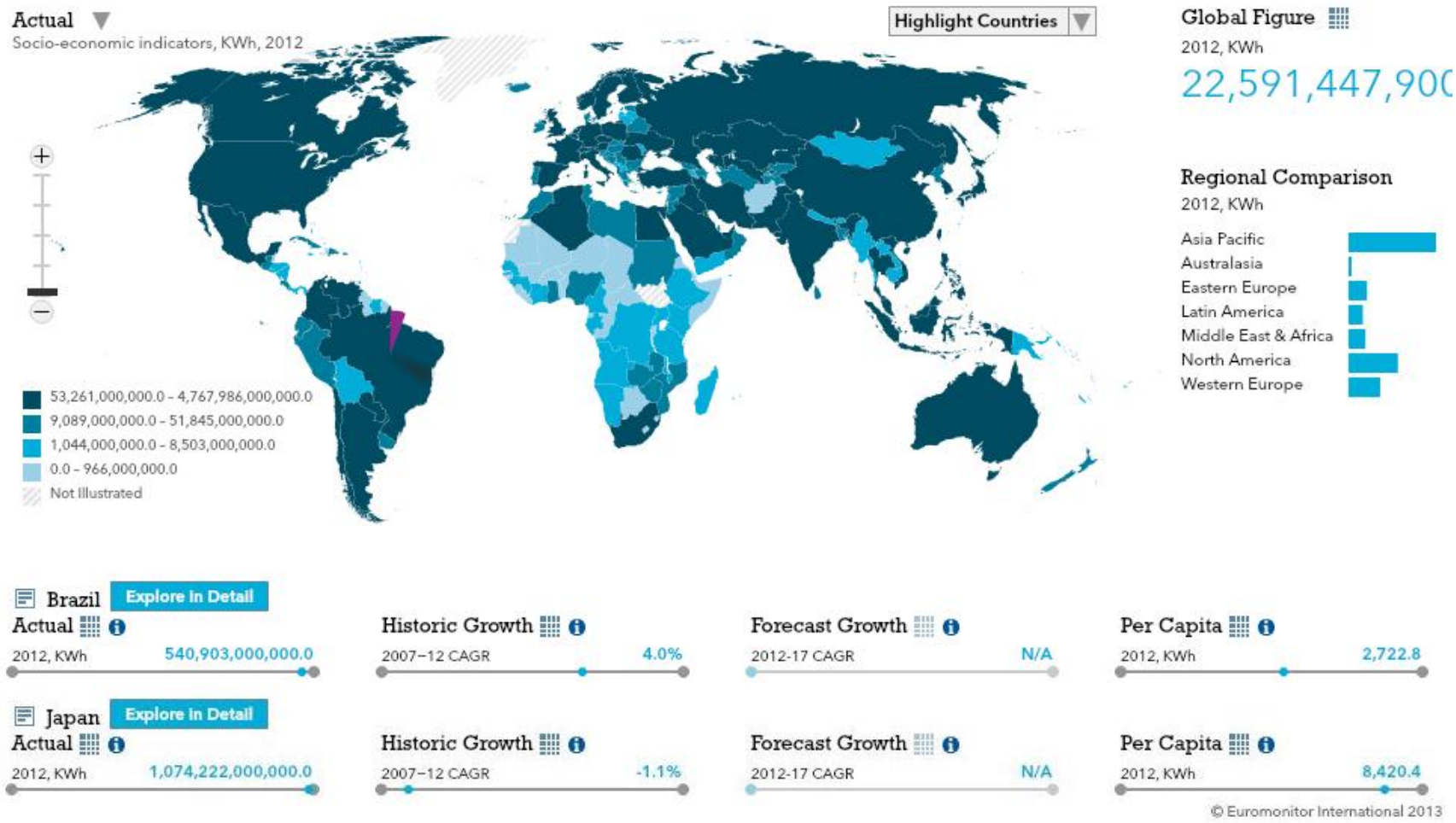
Amounts are in US$ trillion, rounded.

Other includes geothermal, concentrating solar power and marine.

- Cumulative investment needed by 2035 is roughly equivalent to the GDP of the entire European Union in 2011.
- Investment in power plants accounts for 57% of the power sector total, over 60% of it for renewables.

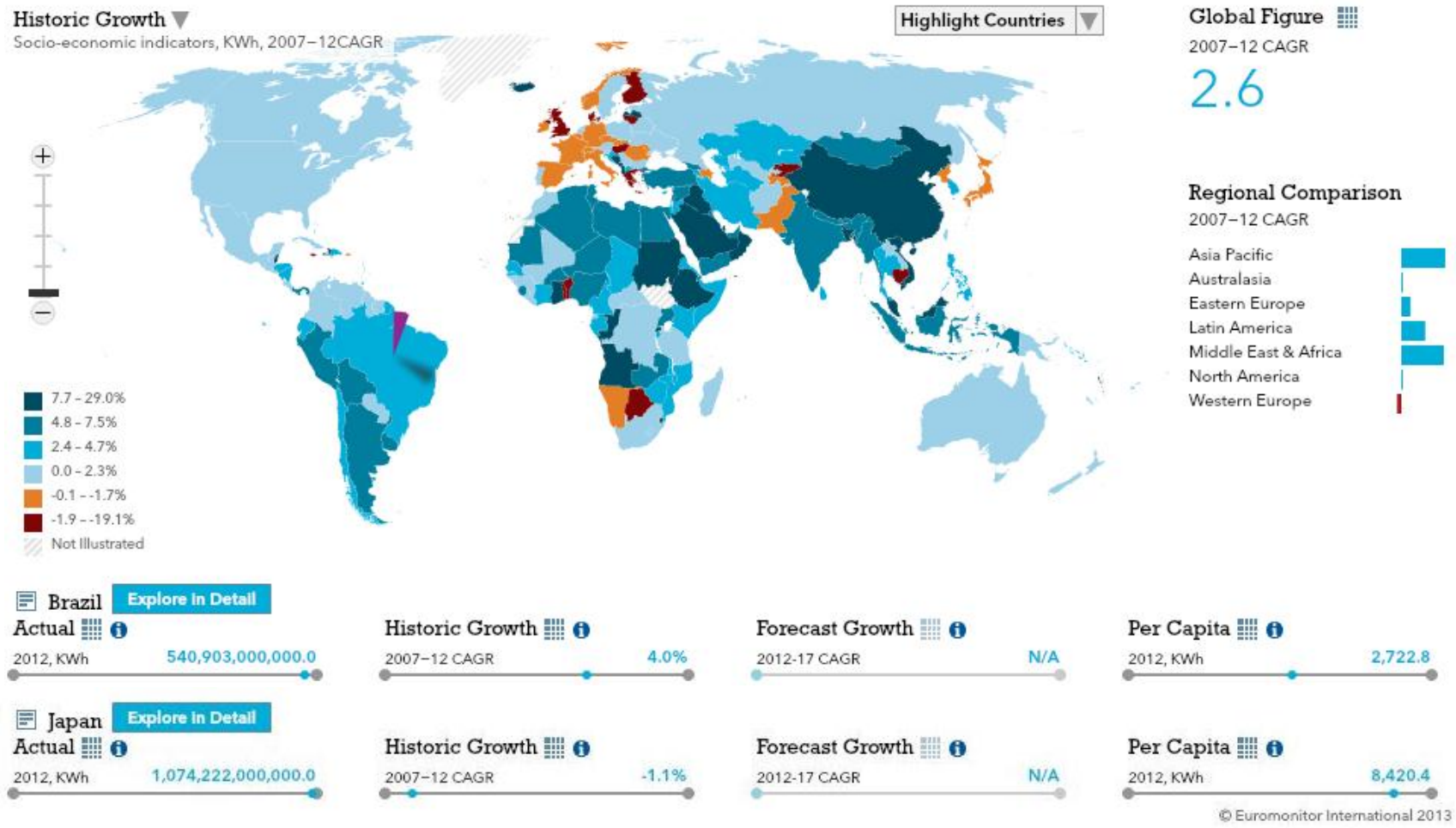
Source: IEA World Energy Outlook 2012

World Electricity Production



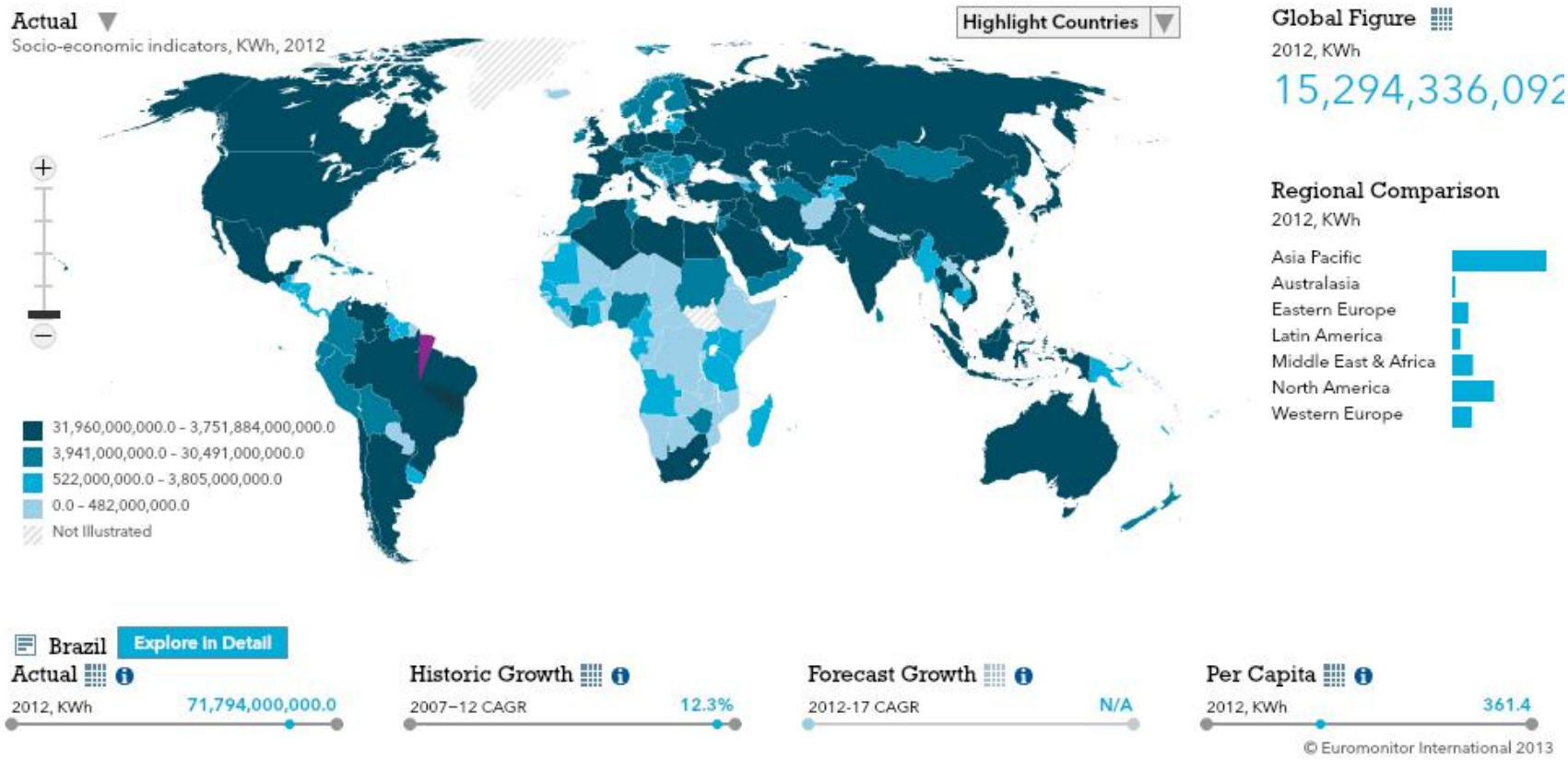
Source: Euromonitor International 2013

World Electricity Production Historic Growth 2007-2012



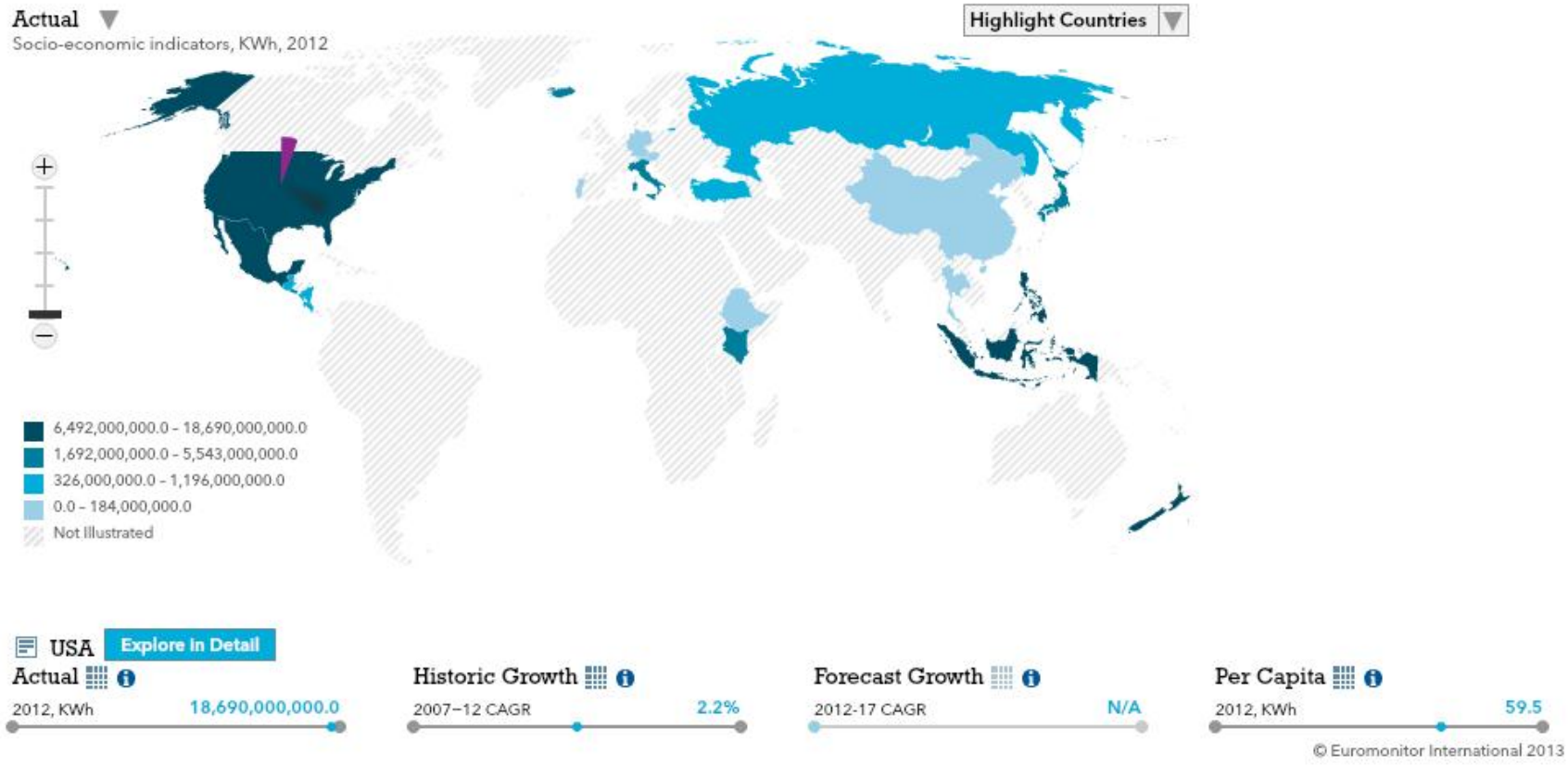
Source: Euromonitor International 2013

Electricity Produced by Fossil Fuels



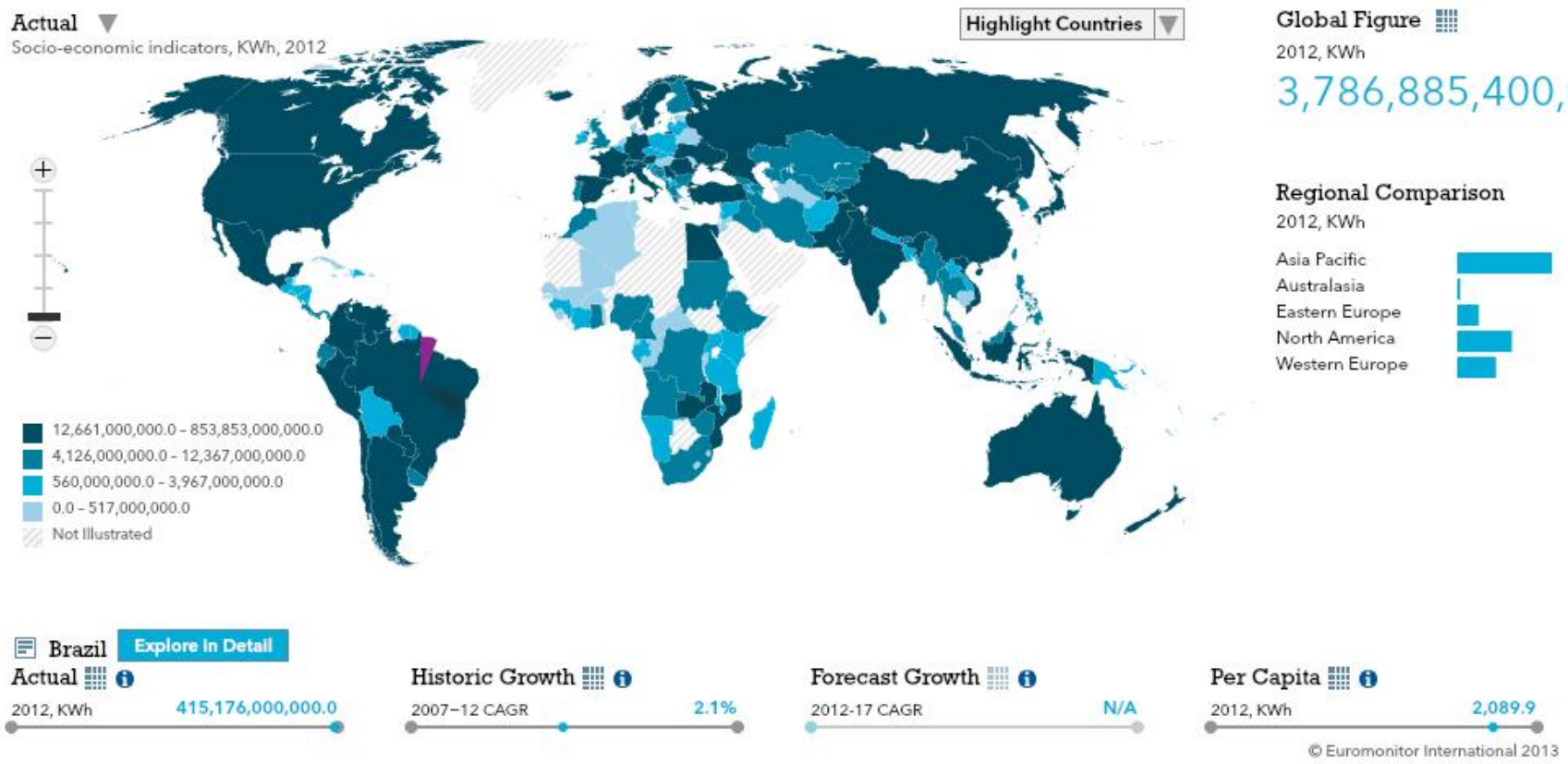
Source: Euromonitor International 2013

Electricity Produced by Geothermal Generation



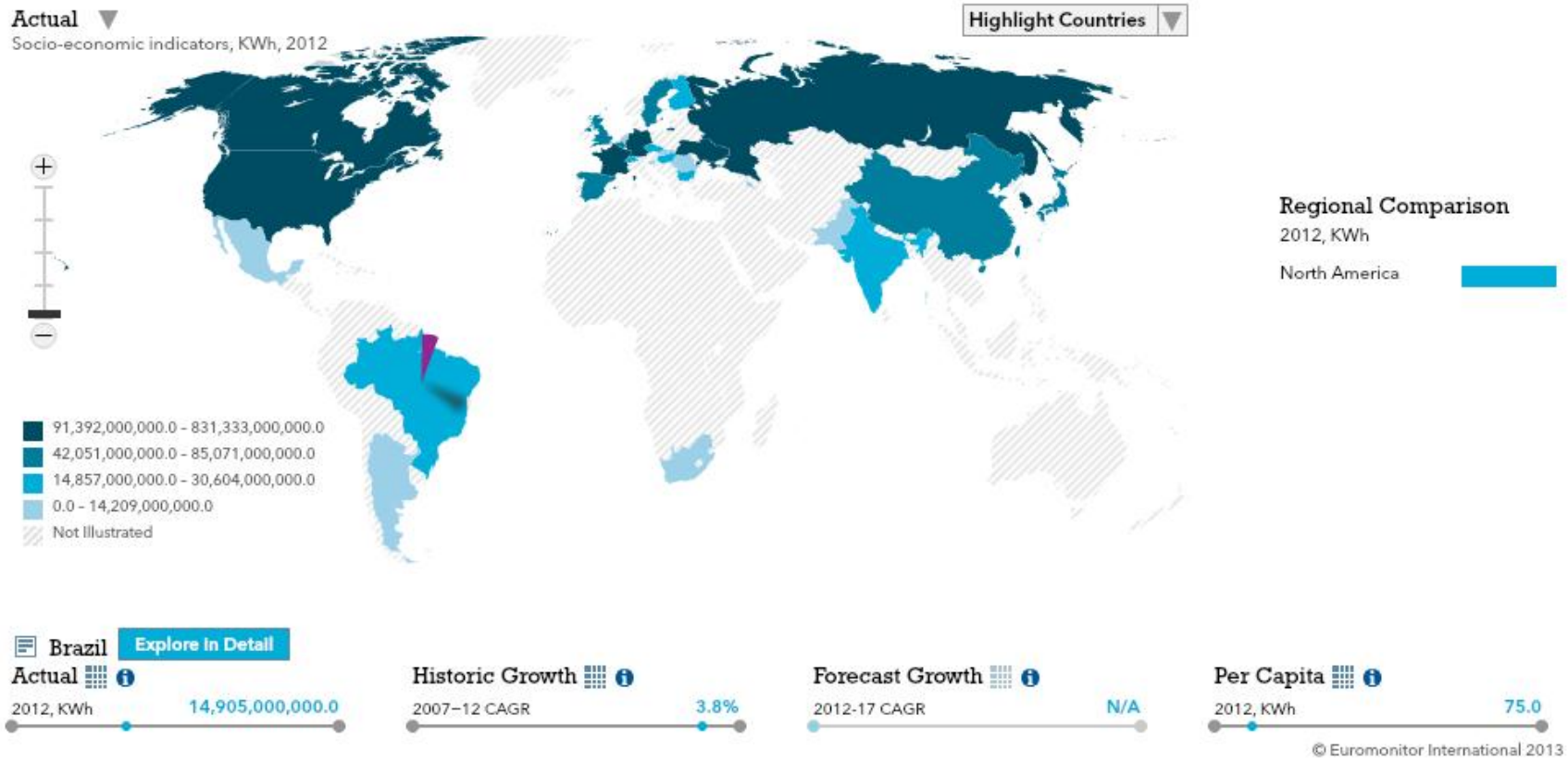
Source: Euromonitor International 2013

Electricity Produced by Hydroelectric Generation



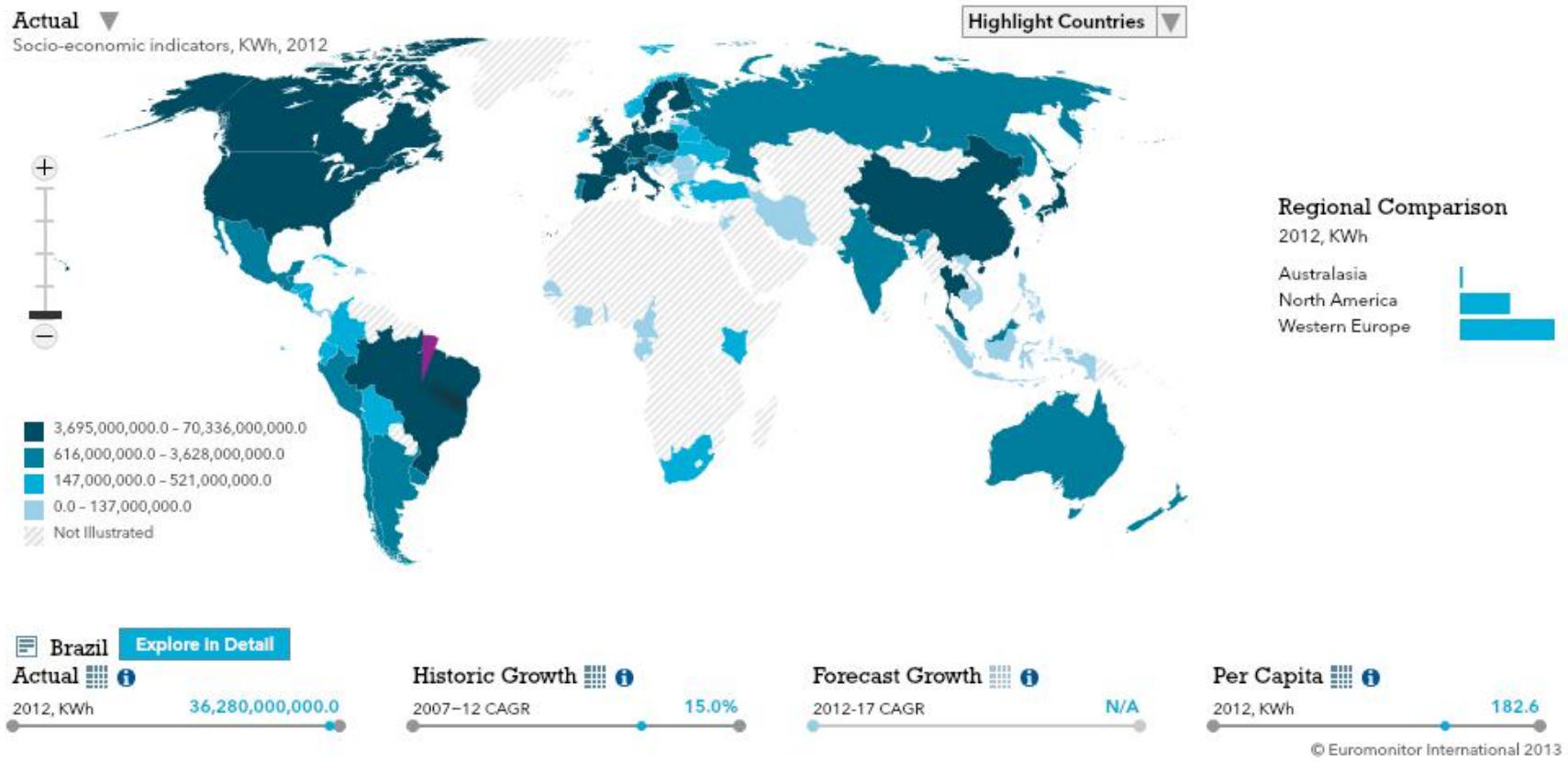
Source: Euromonitor International 2013

Electricity Produced by Nuclear Generation



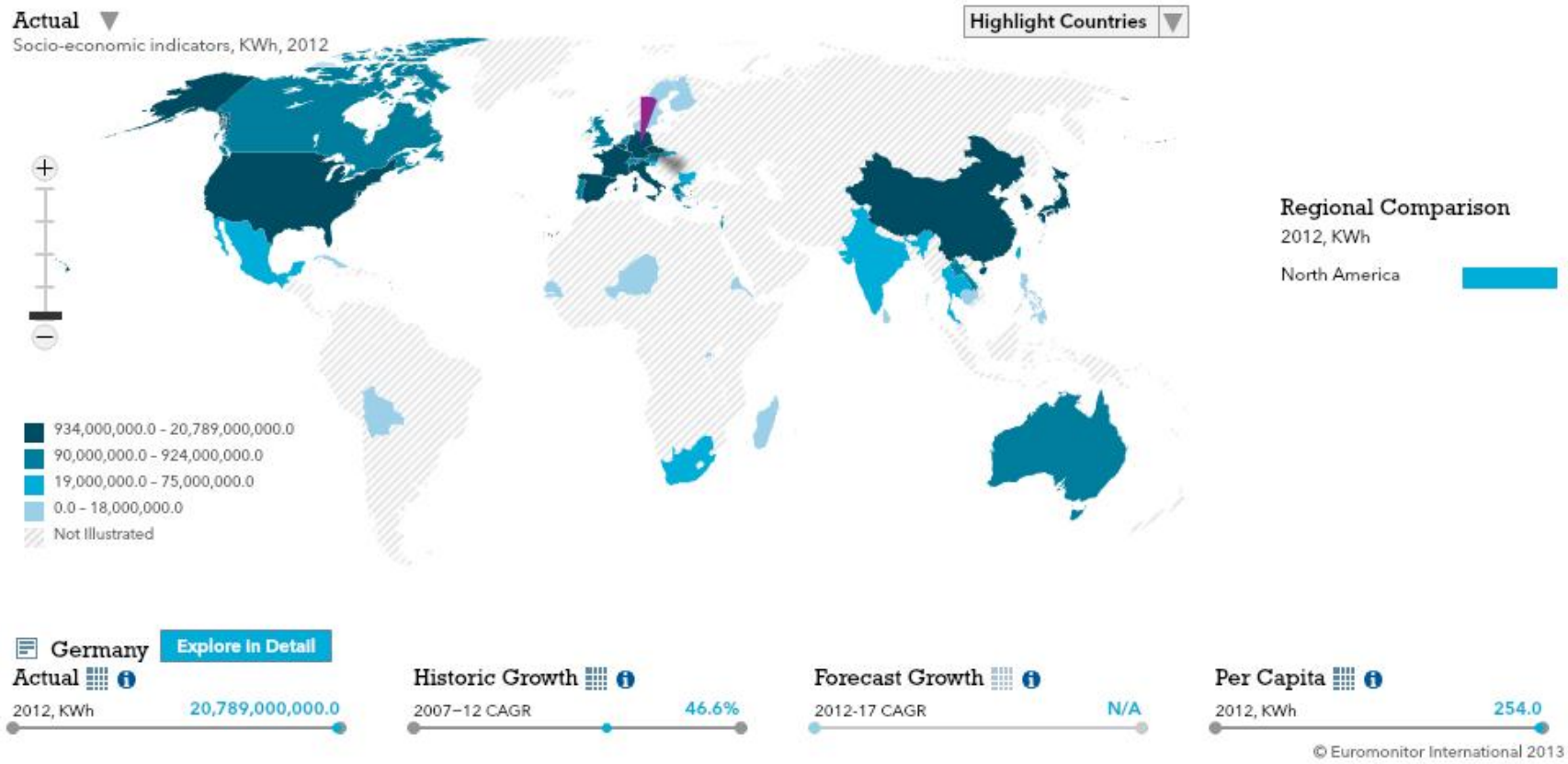
Source: Euromonitor International 2013

Electricity Produced by Combustible Renewables and Waste Generation



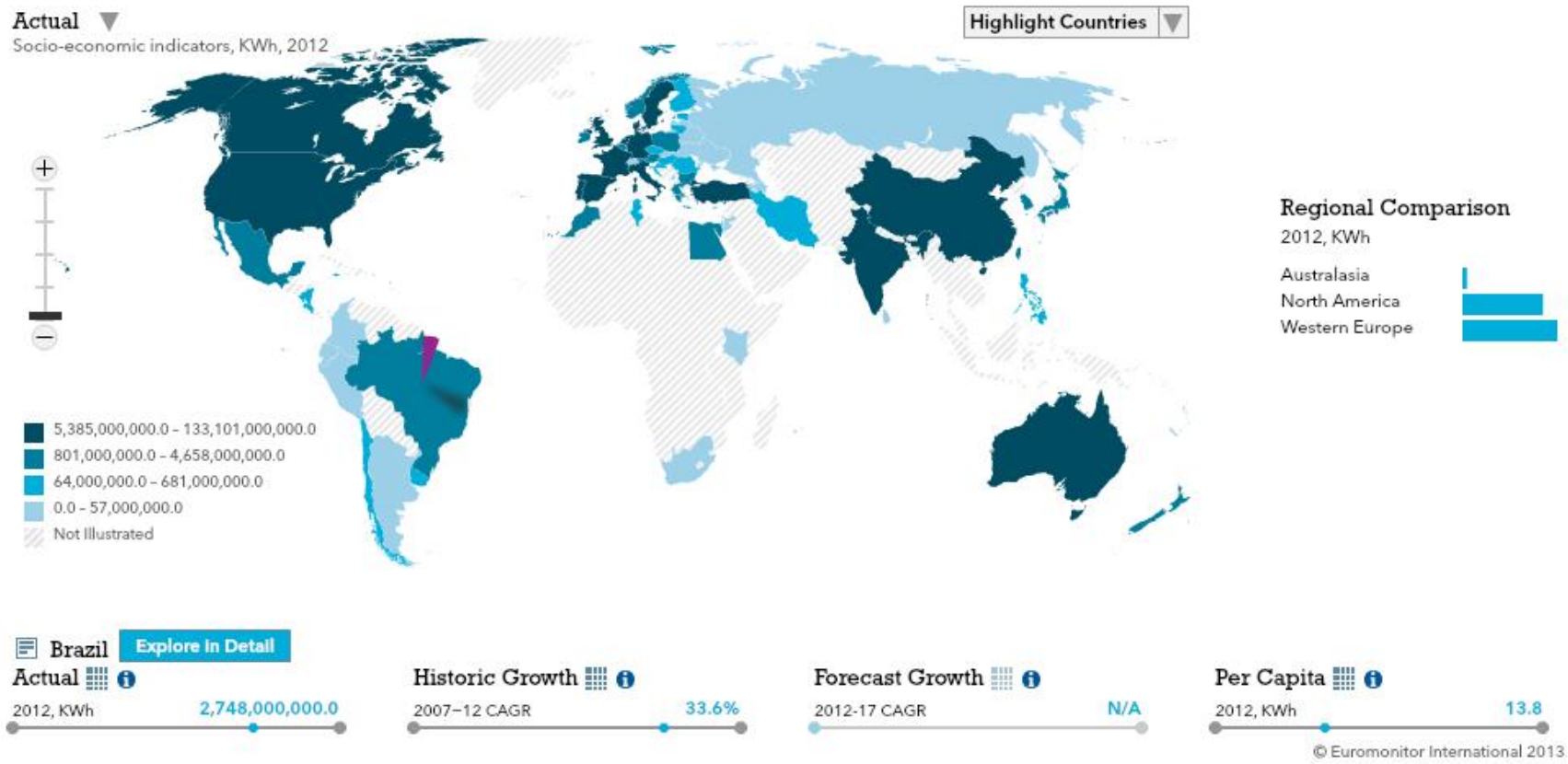
Source: Euromonitor International 2013

Electricity Produced by Solar Generation



Source: Euromonitor International 2013

Electricity Produced by Wind-Powered Generation



Source: Euromonitor International 2013

What the future holds for the Energy Sector?

Global energy demand will be about 30% higher in 2040 compared to 2010. By 2040, electricity generation will account for more than 40% of global energy consumption.

From 522 to 705 Quadrillion Btus.

Oil, gas and coal continue to be the most widely used fuels, making up about 80% of total energy consumption in 2040.

Energy demand growth will slow as economies mature, efficiency accelerates and population growth moderates.

Demand for coal will peak and begin a gradual decline, in part because of policies to curb emissions.

Gains in efficiency through energy-saving and technology will temper demand growth and curb emissions.

Natural gas will grow fast enough to overtake coal for the number two position behind oil. Demand for natural gas will rise by more than 60% by 2040.

From 330 to 540 billions of cubic feet per day.

Global energy-related CO_2 emissions are at a record high, while the renewables industry is under strain.

Sources: ExxonMobil's 2040 and IEA 2012 vision

Brazilian Energy Sector Overview

- Brazil has the largest economy in South America = largest consumer of energy in the region.
- One of the cleanest energy grid in the world with 70 percent of the power generation from hydroelectric power plants.
- Over 115,000 MW of installed capacity with a demand of around 479,000 GWh.
- Brazil's transmission system has roughly 100,000 kilometers of lines and spans about the same length as the entire European transmission system

Installed capacity for electricity generation in Brazil by type of plant (MW)

	2007	2008	2009	2010	2011	Δ% (2011/10)	Part. % (2011)
Total	**100,352**	**102,949**	**106,569**	**113,327**	**117,135**	**3.4**	**100.0**
Hydro Power Plants	74,937	74,901	75,484	77,090	78,371	1.7	66.9
Thermoelectric Plants	21,229	22,999	25,350	29,689	31,244	5.2	26.7
SHP	1,820	2,490	2,953	3,428	3,870	12.9	3.3
HP	112	154	173	185	216	17.0	0.2
Nuclear Plants	2,007	2,007	2,007	2,007	2,007	0.0	1.7
Wind Power Plants	247	398	602	927	1,425	53.7	1.2
Solar	-	-	-	1	1	8.7	0.0

Source: IBGE, EPE, National Agency of Electricity (ANEEL), ABRACEEL

Note: SHP=Small HydroElectric Plant; HP= HydroElectric Plant

Overview of Brazilian Energy Sector

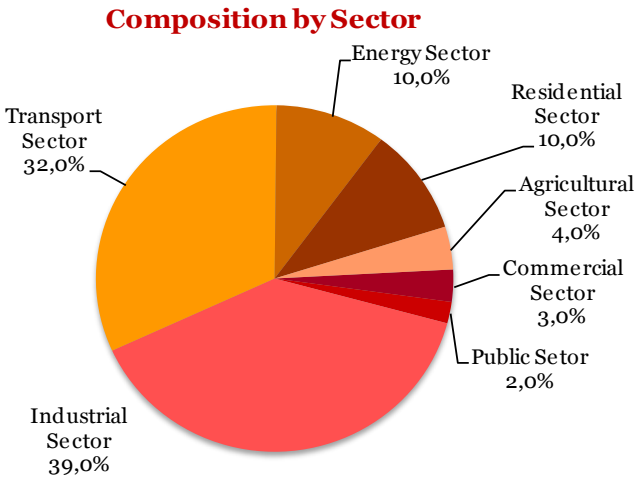
Generation – Transmission – Distribution

- Power Generation (mainly state owned companies)
- Power Transmission (> 230 kv) (mainly state owned companies)
- Power Distribution and Subtransmission (< 230 kv) (mainly private companies)

Free and Captive client

- **Captive Consumer < 3MW (Household, Commercial and Small Industries)**
  Distributor supplier is compulsory, with regulated tariff, isonomic to the same class (A1, A2, A3 and A4). The price is the result of a mix of long-term contracts, with hiring up to 103% load and risks transfer to price differences between submarkets, the additional thermal generation when we checked in and the currency fluctuations effect.

- **Free Consumer > 3MW (Large Commercial and Industrial)**
  Energy is freely traded. The consumer has the obligation to prove 100% of hire, after measuring the amount consumed. The value of your energy is a result of their individual option to purchase, which may include contracts of different maturities and more or less exposure to short-term price.



Source: Plano Decenal de Expansão (2012)

Brazilian Energy Sector Structure

CNPE – National Energy Policy Council

CBEE – Brazilian Retailer of Emergency Energy

MME – Ministry of Mines and Energy

CMSE – Monitoring Committee of the Electricity Sector

EPE – Energy Research Company

ANEEL – National Agency of Electrical Energy

Government Entities

Class Associations

Private Entities or Mixed

Eletrobras

Generation

ONS – National System Operator

Company Commercialization Sale, Purchase and Transfer

Transmission

CCEE – Electric Power Trade Board

Distribution

Class Associations

Electricity Commercialization

Overview of Government Incentives in the Energy Sector

2

Overview of Government Incentives for Renewable Energy in the World

Driven by policies, more than 70 countries are expected to deploy renewable energy technologies in the power sector by 2017

Renewables have also been supported to stimulate economies, enhance energy security and diversify energy supply.

Government policies have been and continues to be essential to growth in renewable energy

Environmental concerns have been a key policy driver, targeting emissions reductions of carbon dioxide and local pollutants

Overview of Government Incentives for Renewable Energy in the World - Japan

2009

Renewable energy policy revised and extended through legislation in 2009

2010

Basic Energy Plan revised

2012

July 2012, new feed-in tariff system for wind and solar power and other renewables, creating incentives which are among the most generous in the world.

Following Fukushima Daiichi, released the Innovation Strategy for Energy and the Environment in September 2012

- Goal of reducing the role of nuclear power.
- Compensated by increasing the deployment of renewable energy.
- Calls for power generation from renewables to triple by 2030 compared to 2010 (about 30% of total generation)

Overview of Government Incentives for Renewable Energy in the World - European Union

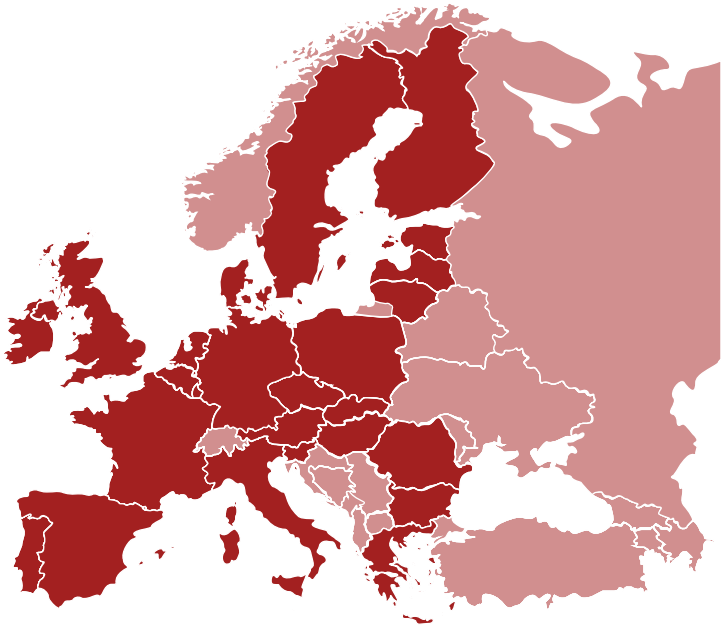
2009

Renewable Energy Directive

- Legally binding targets for the share of renewable energy (covering electricity, heat and biofuels) in gross final energy consumption by 2020, equating to 20% in total

2011

European Commission report indicated that renewable energy could meet 55-75% of final energy consumption by 2050, compared with less than 10% in 2010 (EC, 2011; EU, 2011)



Overview of Government Incentives for Renewable Energy in the World - United States

2011

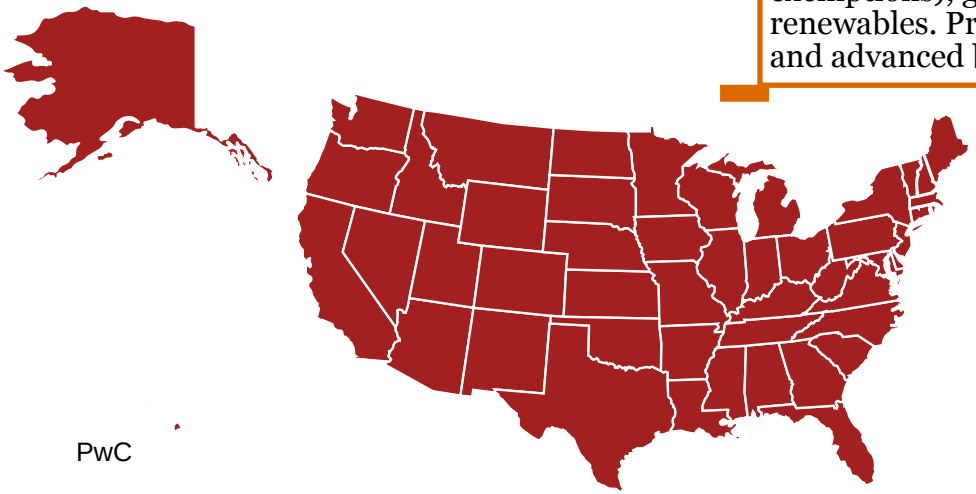
Renewable Energy surpassed Nuclear for the first time

1978-2012

Renewable portfolio standards

- Regulations requiring a specified share of electricity sales from renewables or a minimum amount of renewables capacity – now exist in 29 states.

USA also provides tax incentives (credits, rebates, and exemptions), grants and loans to support the growth of renewables. Production tax credits for wind power, biodiesel, and advanced biofuels.



Overview of Government Incentives for Renewable Energy in Brazil

- Relies on capacity tenders to increase renewable-based electricity generation.
- In 2004, the Brazilian federal government launched the Incentive Program for Alternative Sources of Energy (Proinfa) to diversify the national energy matrix
- 2020 Plan - renewables to account almost 80% of total installed capacity in by 2020. Expected to be met mainly by hydropower, but with increase in wind and biomass.

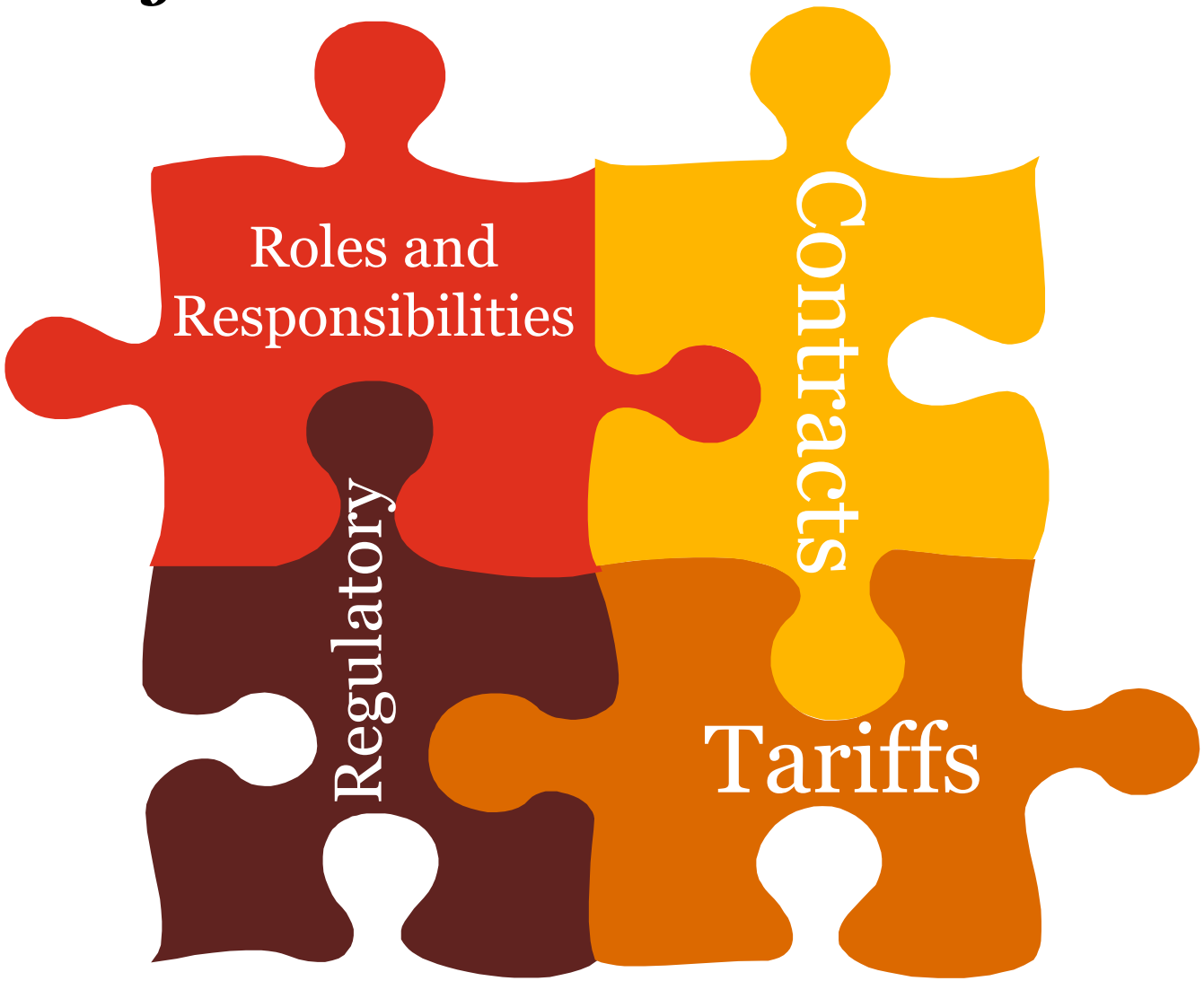
- Biofuels – a major focus of Brazilian renewable energy policy. Mandatory minimum blending levels for ethanol in gasoline were revised down in 2011, from 25% to 20%, because of a reduced sugarcane harvest and record sugar prices in the year. Brazil has had a 5% biodiesel blending mandate since 2010. Policy is driving increase in ethanol production, thus opening possibilities for co-generation.

Source: IEA World Energy Outlook 2012

Energy Sector Challenges for the Brazilian Market

3

Regulatory


Roles and Responsibilities
Contracts
Regulatory
Tariffs

Key Factors Against Renewable Energy in Brazil

- Brazil has a history of regulatory issues that continue to present difficulties for companies in the sector.
- High tariffs including large amount of taxes and energy charges (pass-through) are common in the country.
- Need for subsidies because of the high costs of Renewables in comparison to fossil fuels.
- Environmental legislation and the difficulties for environmental licenses:
  - It could be easier to get an environmental license for thermal plants than hydro power plants.
  - Environmental Costs are evaluated in 15% of the overall cost of hydro power plants. Main reasons:
    - Poor quality of environmental studies;
    - Environmental movements (resettlement);
    - Lack of information that are submitted to the Environmental agency;
    - Long periods to obtain environmental license from Environmental agency;
    - Others.

Renewable Energy

4

Overview of Renewable Energy in the World

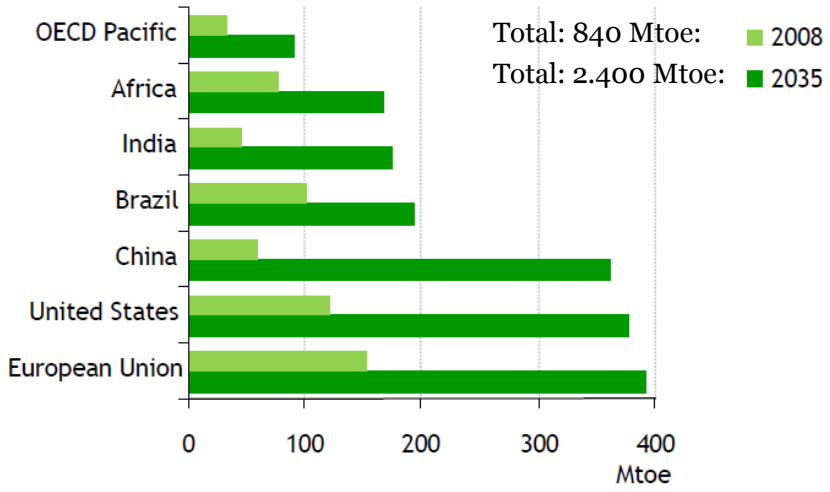
Renewables-based electricity generation by region (TWh)

	Renewable electricity generation							Share of total generation	
	1990	2010	2015	2020	2025	2030	2035	2010	2035
OECD	**1 339**	**1 960**	**2 493**	**2 963**	**3 444**	**3 936**	**4 436**	**18%**	**33%**
Americas	718	896	1 105	1 297	1 504	1 724	1 953	17%	29%
United States	379	454	600	750	909	1 074	1 238	10%	23%
Europe	472	887	1 138	1 351	1 545	1 734	1 937	24%	44%
Asia Oceania	149	177	250	315	396	477	546	9%	24%
Japan	102	116	161	199	247	292	325	10%	27%
Non-OECD	**977**	**2 245**	**3 038**	**4 037**	**4 904**	**5 851**	**6 906**	**21%**	**30%**
E. Europe/Eurasia	266	309	315	347	391	446	516	18%	22%
Russia	166	170	176	195	224	260	305	16%	21%
Asia	281	1 090	1 688	2 445	3 039	3 663	4 320	17%	27%
China	127	779	1 223	1 789	2 112	2 400	2 689	18%	27%
India	72	136	213	318	466	644	826	14%	25%
Middle East	12	18	28	46	72	119	208	2%	12%
Africa	57	110	141	198	275	374	495	17%	36%
Latin America	361	718	866	1 000	1 127	1 248	1 367	67%	73%
Brazil	211	437	514	585	646	701	754	85%	79%
World	**2 316**	**4 206**	**5 531**	**6 999**	**8 348**	**9 786**	**11 342**	**20%**	**31%**
European Union	310	687	922	1 113	1 285	1 450	1 626	21%	43%

Source: IEA World Energy Outlook 2012

Renewables Enter the Mainstream

Renewable primary energy demand

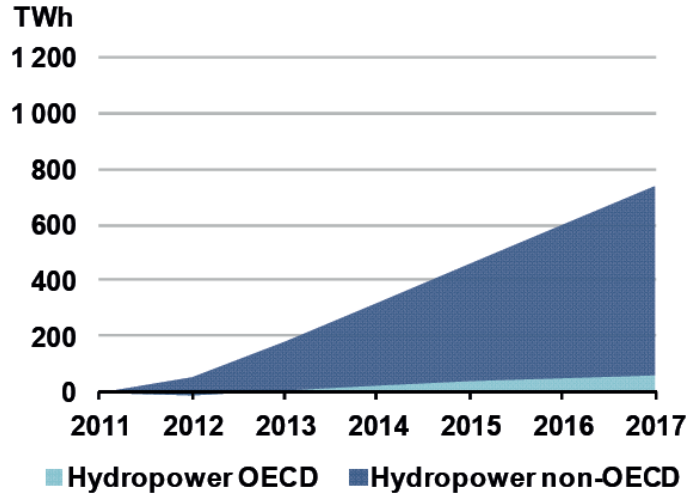


The use of renewables triples by 2035, driven by the power sector: share in electricity mix rises to 32% in 2035.

- Renewable energy is growing at double-digit rates but still only comprises about 16% of global energy production.
- The main challenge with renewable energy is producing it at a cost that is comparable to other energy sources.
- Economies of scale have yet to be achieved, but with the global investment in renewables, continued progress is expected.
- By 2030, it is expected that 20-30% of the global energy supply will come from renewables.

Renewables: Hydro Remains the Main Source

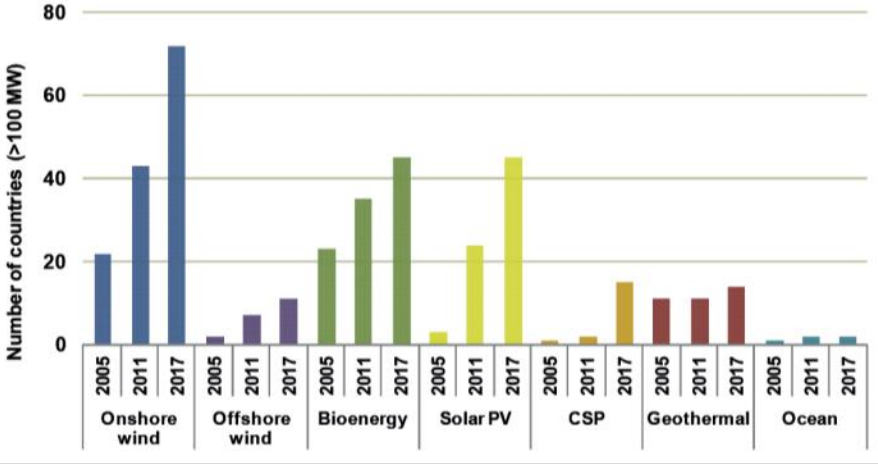
Global hydropower forecast cumulative additions (2011-2017)



Hydropower production in 2011 accounted for 80% of total renewable generation.

Source: IEA Medium-Term Renewable Energy Market Report 2012

Number of countries with non-hydro renewable capacity above 100 MW

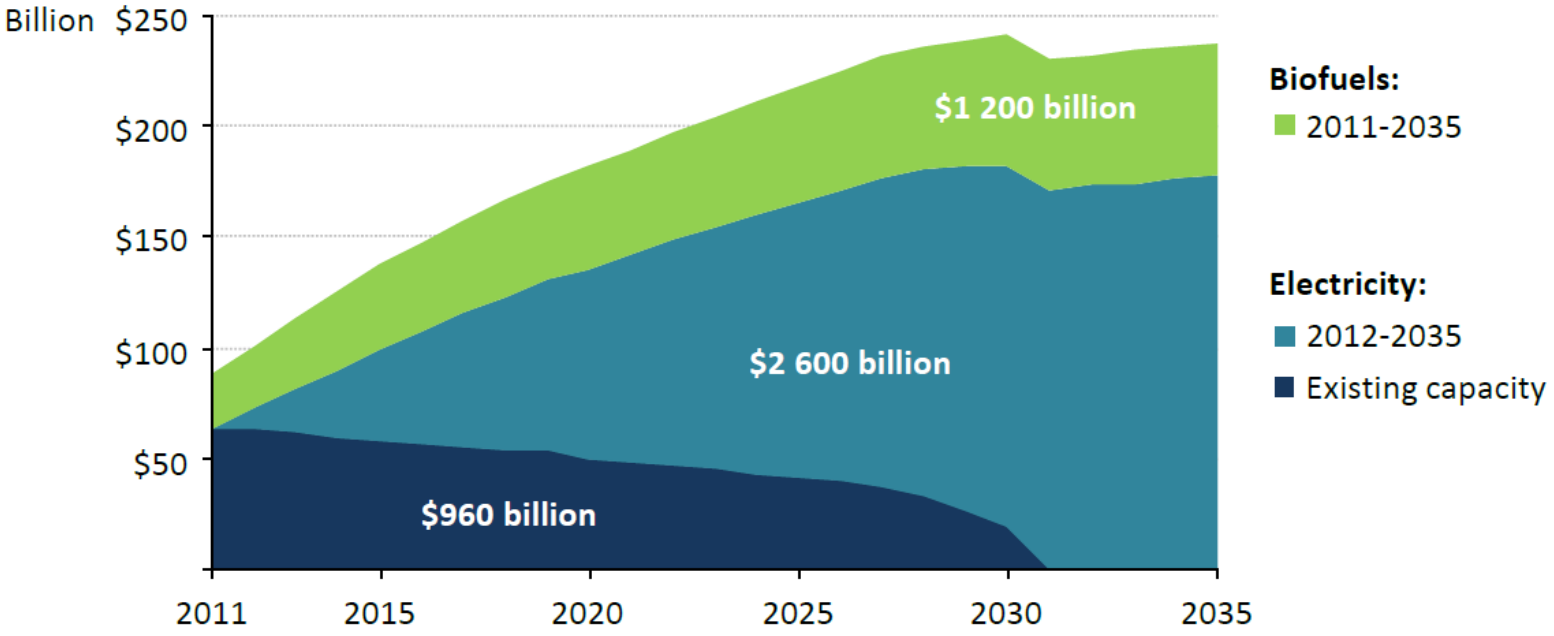


- In 2017, the number of countries with cumulative renewable electricity capacities above 100 MW increases significantly for most non-hydro technologies.
- China accounts for almost 40%, or 270 GW of the global renewables market, followed by the United States, India, Germany and Brazil.

Renewables' Global Subsidies: The Multiple Benefits Come at a Cost

Over the period to 2035 need to amount to $4.8 trillion.

Over half of this has already been committed to existing projects or is needed to meet 2020 targets.

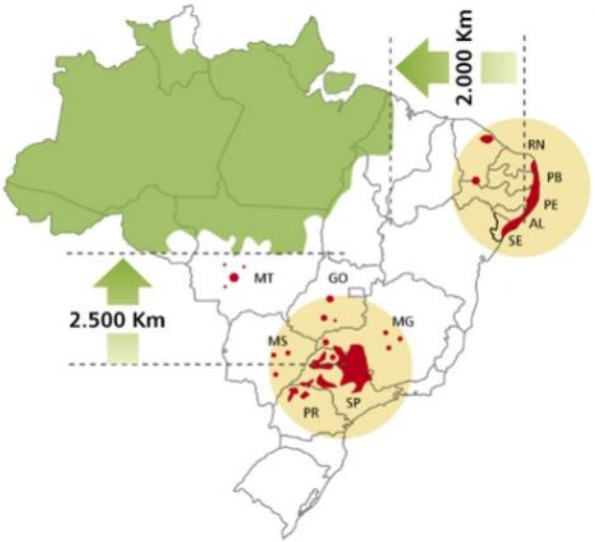


Source: IEA World Energy Outlook 2012, New Policies Scenario

Biomass Energy in Brazil

Bioelectricity: Sugarcane Biomass (clean and renewable)

- Sugarcane production concentrates in Center-South and Northeast regions of Brazil. Planted areas and sugarcane processing mills are represented by the red areas in the map aside. Also, the map shows the distance to the Amazon Rainforest;
- Ethanol from sugarcane is the only commercially produced non-cellulosic biofuel in the world that is designated as advanced by the U.S. Renewable Fuel Standard (RFS2);
- U.S. Environmental Protection Agency (EPA) classified Brazilian sugarcane ethanol as capable of reducing greenhouse gas (GHG) emissions by at least 50% compared to gasoline;



- Residues from sugarcane processing (bagasse and straw) are alternatives for generating electricity. The amount of bioelectricity of the available biomass is estimated as equivalent to more than three hydro plants the size of Belo Monte;
- In 2011, a Brazilian mill was the world´s first to obtain the seal from Bonsucro Certification, accepted by the European Union to fulfill its legislation on renewable energy. By April 2012, 14 mills had already earned this certification in Brazil.

Source: Campinas State University (NIPE-UNICAMP), Brazilian Institute of Geography and Statistics (IBGE), Sugarcane Technological Center (CTC), Sugarcane Industry Union (UNICA).

Biomass Energy in Brazil

Opportunity

• If its full potential is realized, bioelectricity supplied to the national grid could represent up to 18% of the Brazilian energy grid by 2021, increasing the annual reduction in emissions generated by the use of ethanol and bioelectricity in Brazil from 46 million tons of CO2 equivalent (Mt.CO2eq) reached in 2011, up to 112 Mt CO2eq by 2020.

• Biomass and combined cycle thermoelectric generation are complementary to hydro power and small hydro plants, and so, essentially important and strategic to the operational reliability of the Brazilian National Interconnected Power System.

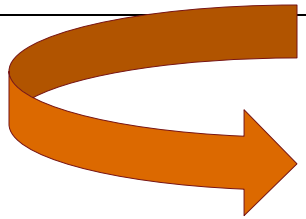
Financing

• BNDES – 60% national production and national technology restriction

• International Banks - IDB, WB

• Private Investment Funds

• Self-Financed

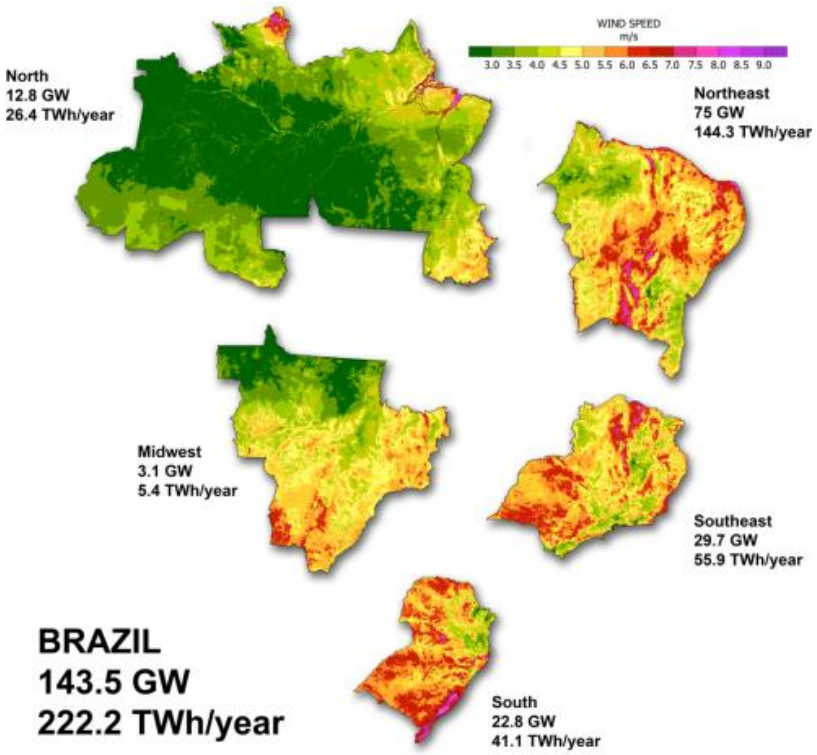


Potential market for Co-Generation technology and investment

Wind Energy in Brazil

Great Potential to be Explored

Brazilian Wind Map



- 143.5 GW Brazilian Wind Potential.
- July 2013, Brazilian installed capacity of wind power generation reached the 2.8 GW mark with 119 wind power plants.
- Evolution of installed capacity and the growth forecast due to the signings already made at auctions and open market indicates 8.7 GW of wind power in operation in the Brazilian energy matrix till 2017.

National Wind Power Atlas- Amarante et al., Ministry of Mines & Energy (MME)/ Eletrobrás/ CEPEL / Cresesb,2001

Source: Abeeólica

Wind Energy in Brazil

- Estimates by ANEEL are that in 2020 the installed wind capacity in Brazil should be on order of 10,000 MW representing about 6.7% of the energy, compared to the current 1%. Other countries in Europe uses around 10% for comparison.

- BNDES (National Development Bank of Brazil), has signed or are in the process of signing around 51 contracts of direct and indirect funding, totaling R$ 4.1 billion for the deployment of 1,369 MW. Another 44 operations are in analysis, with applications for funding of around R$ 3.3 billion.

Source: Moody's, National Agency of Electricity (ANEEL), Globo Natureza, GWEC.

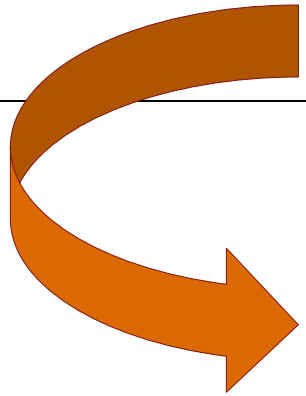
Wind Energy in Brazil

Opportunity

- State environmental secretaries are working to expedite environmental licensing – only need installation license
- Different states have exemption of ICMS as incentive for installation of wind parks
- Wind energy technology firms growth in the region

Financing

- BNDES – 60% national production and national technology restriction
- International Banks - IDB, WB
- Private Investment Funds
- Self-Financed
- Tax incentives



Potential market for wind energy equipment manufacturers and introduction of imported technology

Solar Energy in Brazil

- Solar renewable energy is incipient in Brazil.
- Northeastern Region in Brazil has solar radiation levels comparable to the best regions in the world – Dangola city in Sudan desert and Dagget region in Mojave Desert, California
- August 2011 – First Brazilian commercial solar plant with 1.0 MW capacity, located at Ceará State. This first solar plant had financial support from the Inter-American Development Bank (BID). The amount of energy can attend locally 1.5 thousand families. This solar plant is intended to expand, and result in more than three times potential increase;
- 2012 Largest Brazilian solar plant began operations. The 1,1 MW capacity plant is situated in state of São Paulo State. This solar plant was funded from Research and Development Program approved by ANEEL in December 2011;
- Different energy sector players are already developing new projects with a range of capacity from 1,0 to 3,0 MW, most of them with the benefits of Research and Development Program encouraged by government and ANEEL;

Source: Época Magazine, Globo G1 News Portal.

Solar Energy in Brazil

Opportunity

•ANEEL recently approved new regulations for small-scale generation by individuals (microgeneration) .

• Individuals will be able to install generation units up to 1 MW and receive "credits" for the exceeding energy.

•Same regulation established a 80% discount on transmission charges for solar power plants up to 30 MW that will start operations until 2017.

Financing

• BNDES – 60% national production and national technology restriction

• International Banks - IDB, WB

• Private Investment Funds

• Self-Financed

• R&D Program – only applicable for Generation, Transmission, Distribution companies

Potential market for solar panels and introduction of imported technology

Waste to Energy in Brazil

Major News from Waste-to-Energy Sector

- Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of creating energy in the form of electricity or heat from the incineration of waste. WtE is a form of energy recovery where electricity is directly produced through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels;
- There are new and emerging technologies WtE other than incineration;
    - New technologies produce energy from waste and other fuels without direct combustion, and are more efficient. Some incipient applications in Brazil consider thermal technologies (gasification and pyrolysis), and non-thermal technologies (anaerobic digestion, fermentation production and mechanical biological treatment);
- Nowadays there are 22 projects that consider WtE based on solid residues, and only two of them "export" their surplus energy. Both in São Paulo State.

Source: Public Clean-up and Special Residues Brazilian Companies Association (ABRELPE), Sector Energy News.

Waste to Energy in Brazil

Opportunity

• The WtE perspectives in Brazil show a 282 MW potential to be developed and installed by 2039, but the viability of these projects depends on government policies to become competitive versus other renewable energies, and solid residues destination policy;

• In 2010 the National Policy of Solid Residues was enacted and predicted to take effect on August 2014. It has the potential to increase the 282 MW estimate to 500 MW by 2039;

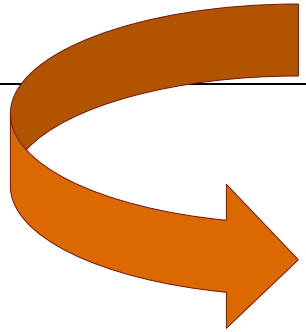
Financing

• BNDES – 60% national production and national technology restriction

• International Banks - IDB, WB

• Private Investment Funds

• Self-Financed



Potential market for imported technology

Investment in the Energy Sector

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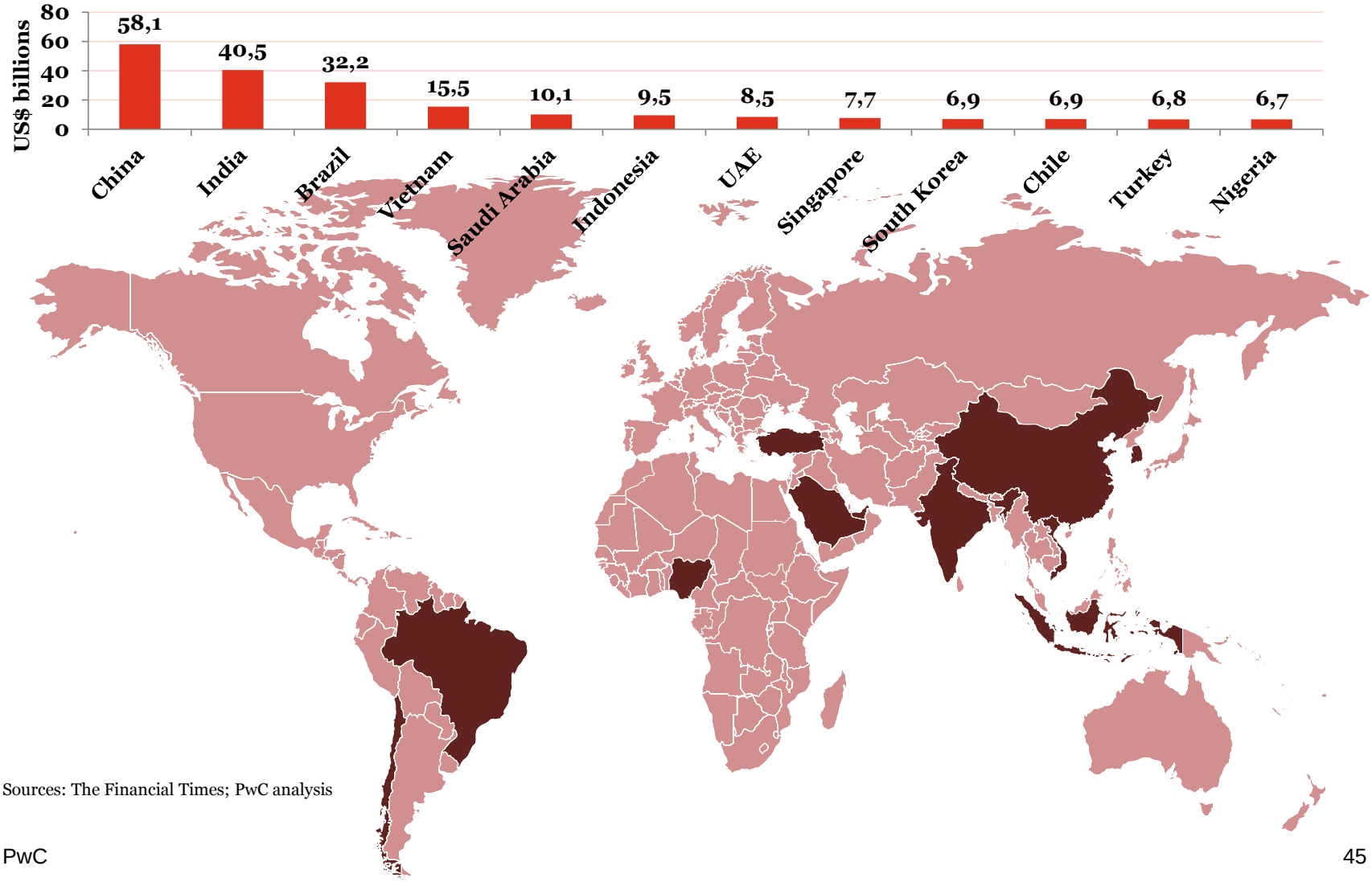
Emerging markets are attracting significant investment from the West

Largest 12 destination countries for Foreign Direct Investments to emerging markets, US$ billions, 2010



Sources: The Financial Times; PwC analysis

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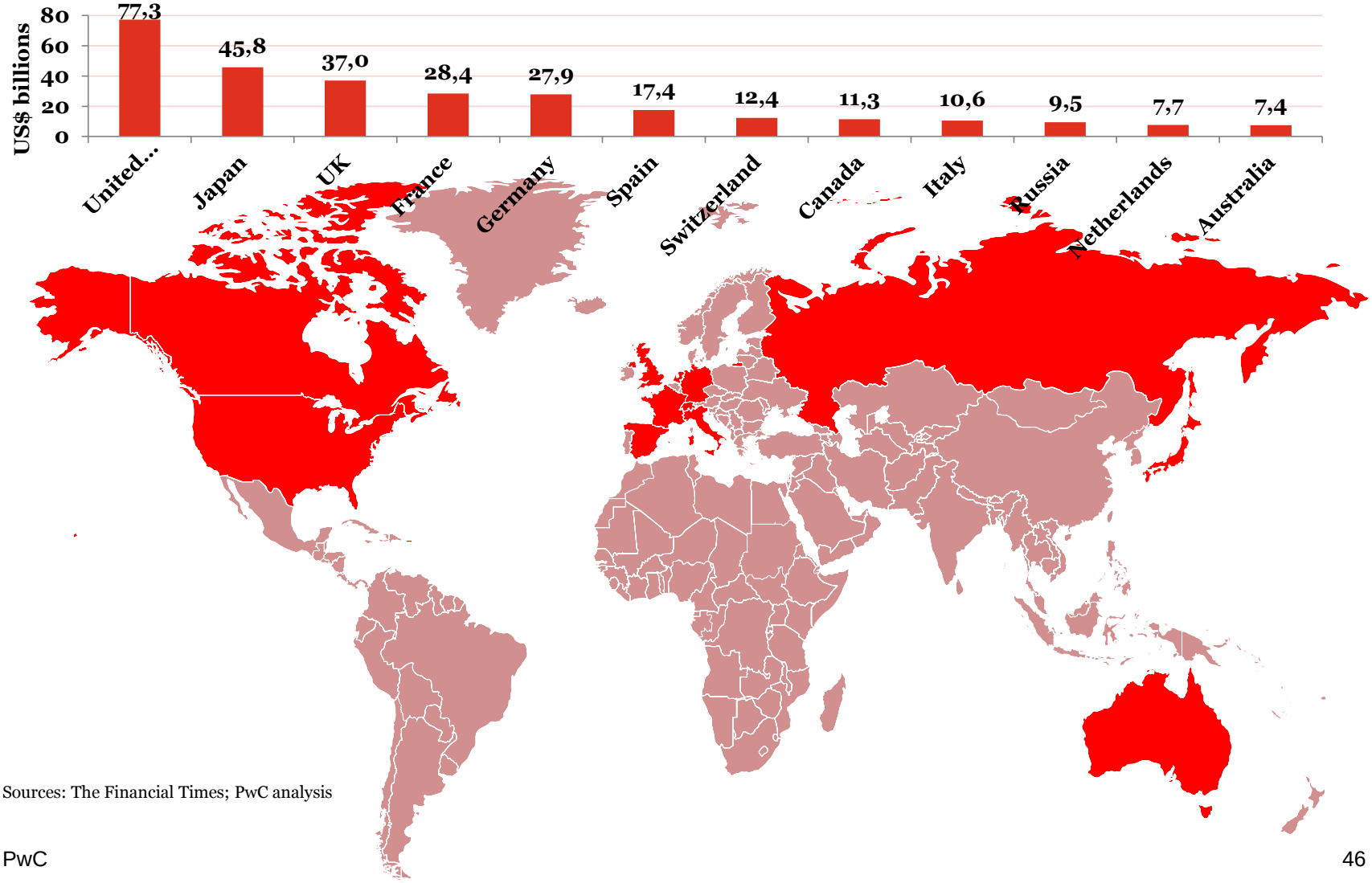


Sources: The Financial Times; PwC analysis

Investments in Power & Utilities infrastructure

Expected investment in the energy sector in Brazil through 2014

$250B

Source: Bank of America Merrill Lynch

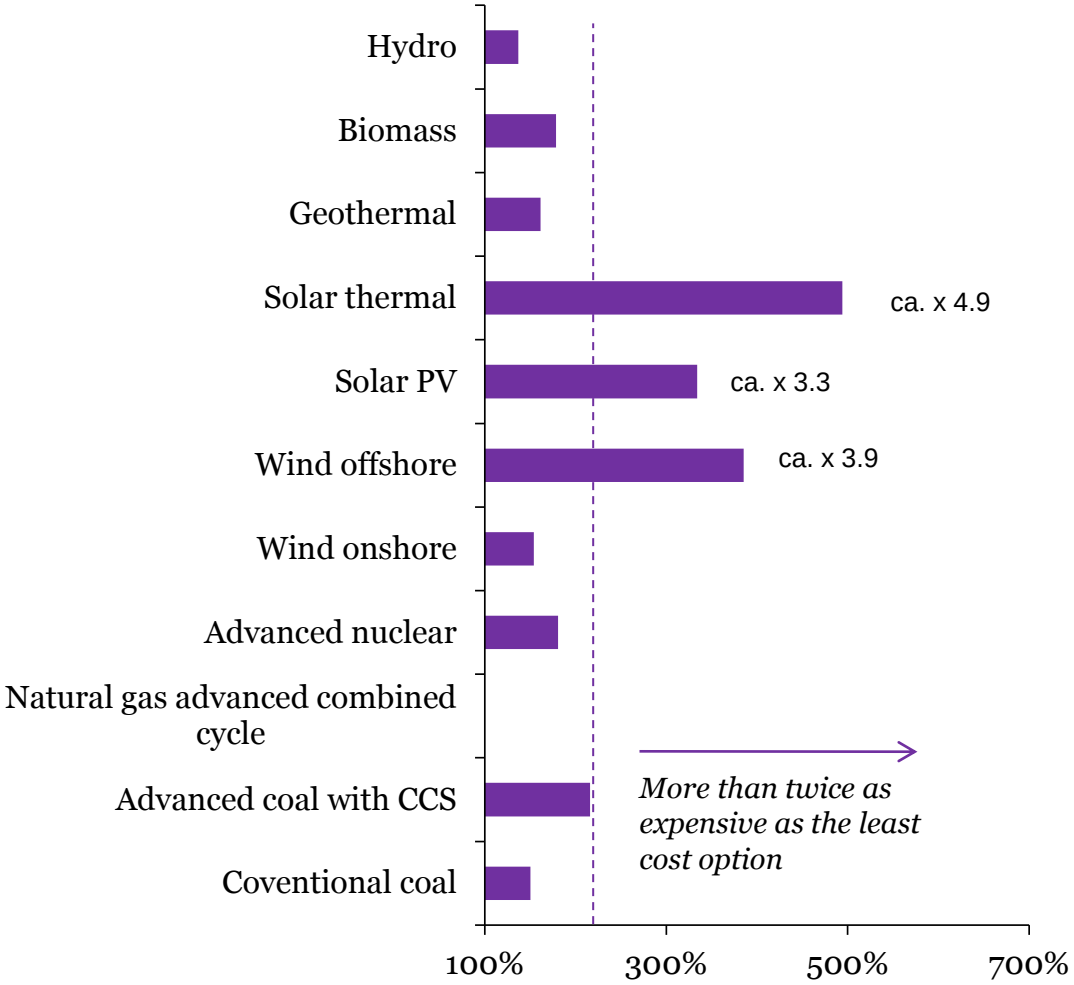
How much investment is required?

- In March 2010 the Brazilian government announced plans to spend more than $500 billion on infrastructure over the next four years, with half of it expected to be spent in the energy sector.
- $ 250 billion:
  - 71% Oil and Gas
  - 18% Generation
  - 4% Transmission
  - 7% Biofuels

Renewables and the Costs

6

Commercial Maturity of Renewables



- Nearly all renewable technologies are more expensive than gas combined cycle turbine.
- Electricity costs from offshore wind, solar (thermal & PV) are up to almost five times more expensive than current electricity costs from fossil fuels.
- Geothermal and hydro have low scalability due to location restrictions.
- Wind onshore is almost at par with conventional coal.

Source: PwC analysis

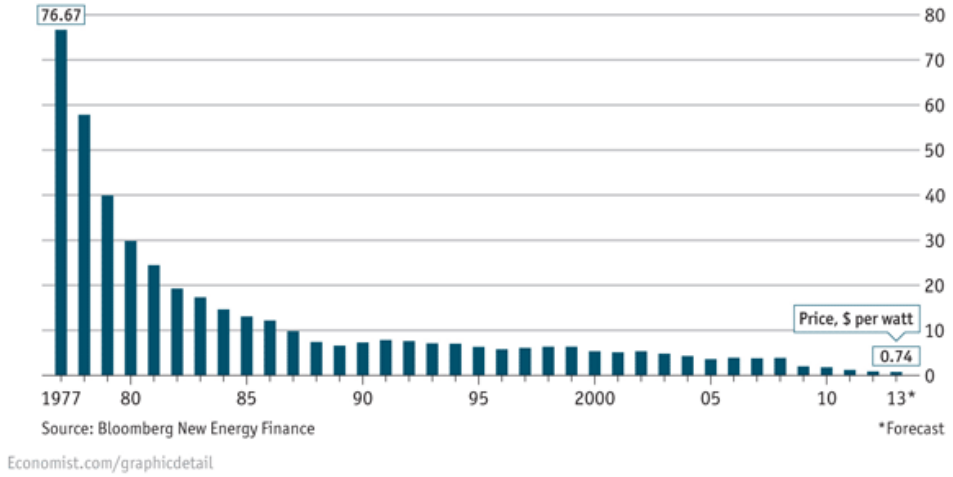
Would Swanson's law drive Solar PV sector in the future?

Swanson's Law is an observation that the price of solar PV cells tends to drop 20% for every doubling of industry capacity:

- The Law is named after Richard Swanson, the founder of SunPower Corporation a solar panel manufacturer.
- Swanson's Law has been compared to Moore's Law.
- Crystalline silicon photovoltaic cell prices have fallen from $76.67/watt in 1997 to a forecast $0.74/watt for 2013, lending support to the law.
- Since the cost of PV solar modules is the largest part of PV electricity production cost, it is not surprising that since 2008 PV electricity production prices were dropping down by 50%.

The Swanson effect

Price of crystalline silicon photovoltaic cells, USD$0.74 per watt



Source: Bloomberg New Energy Finance

Thank you

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