Meeting tomorrow's energy challenges

How technology will define our energy future

Francesco Starace
Chief Executive Officer and
General Manager, Enel SpA

Harvard University, December 3, 2014

Agenda

- Enel today
- Technology Evolution in Energy
- Renewable Energy
- Smart Grid
- Smart Customer

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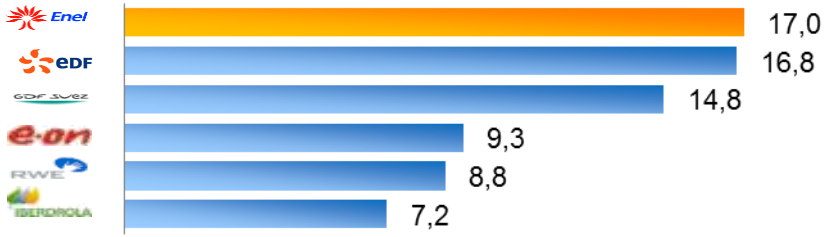
Enel today
Key figures[1]

Key indicators

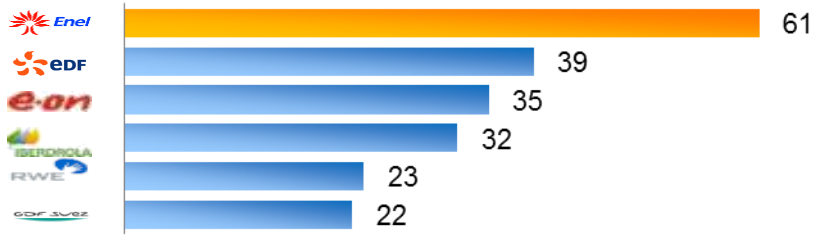
Net installed capacity [GW]	99
Electricity production [TWh]	286
Customers [num]	61 mln
Distribution networks [km]	1,9 mln
Employees [num]	70,3
Revenues [Bln€]	80,5
EBITDA [Bln€]	17
Capex Plan [Bln€][3]	26

Enel and European competitors

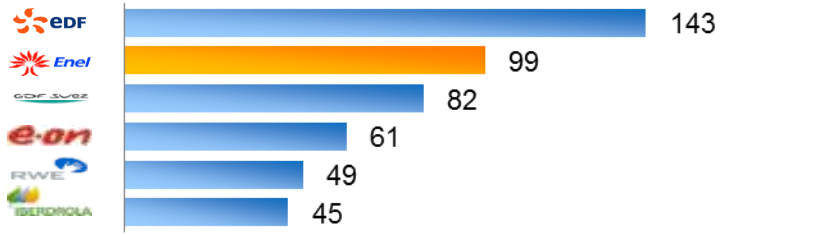
EBITDA [Bln€]



Customers [mln]



Net installed capacity [GW]



1.Data as of December 31st 2013
2.Restated according to IFRS 11
3.Enel Investment Plan 2014-2018 (march 2014). Value not including connection fees

Enel today
Global presence

USA &
1,7 GW **Canada**

Central America[2]
0,8 GW

Colombia
1° in generation[3] (20%)
1° in distribution[3] (24%)
2,9 GW
2,8 M customers

Brazil
Presence in generation and distribution
1,2 GW (0,2 GW)
6,3 M customers

Chile
1° in generation (31%)
1° in distribution (40%)
6,2 GW (0,3 GW)
1,7 M customers

Spain & Portugal
1° in generation (27%)
1° in distribution (43%)
24 GW (1,9 GW)
13 M customers

Peru
1° in generation (21%)
2° in distribution (30%)
1,8 GW
1,3 M customers

Argentina
1° in generation[3] (12%)
2° in distribution (20%)
4,4 GW
2,4 M customers

Italy
1° in generation (27%)
1° in distribution (85%)
40 GW (3 GW)
31 M customers

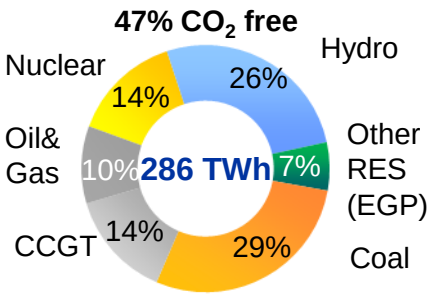
Russia
9,1 GW
0,1 M customers (incl. Russian Railways)

Slovakia
1° in generation (78%)
5,4 GW

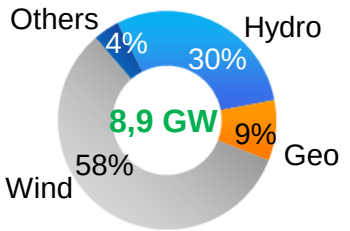
Romania
2° in distribution (33%)
0,5 GW
2,7 M customers

Rest of Europe[4]
0,5 GW

Enel generation mix



EGP capacity



Under construction[5]: 1,8 GW

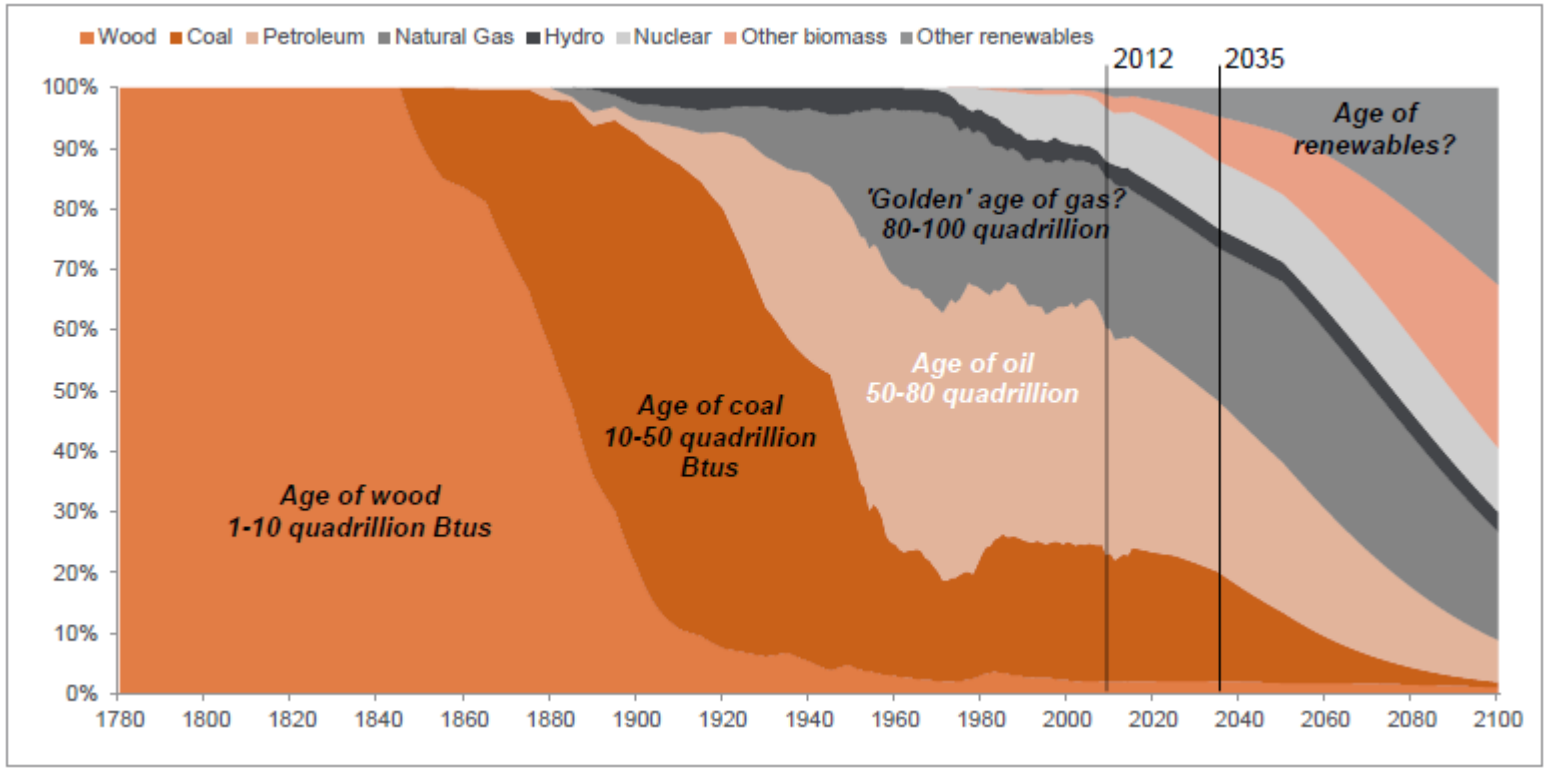
Pipeline[6]: 20,5 GW

Enel presence
Enel Green Power presence
 # Market position
% Market share
 # GW Enel Green Power capacity

1.Data as of 31/12/2013
2.Mexico, Panama, Guatemala, Costa Rica, El Salvador
3.Among private operators
4. France, Greece, Bulgaria
5. Includes projects of the Portuguese JV ENEOP
6. Includes New Countries

Technology evolution in energy
History of fuel substitution in the US

Evolution of the U.S. primary energy mix (1780-2012) and projection to 2035-2100



Technology has always driven the energy sector's **transition** to **tackle the key issues** of the day, but it has also **set the stage for future challenges and opportunities**

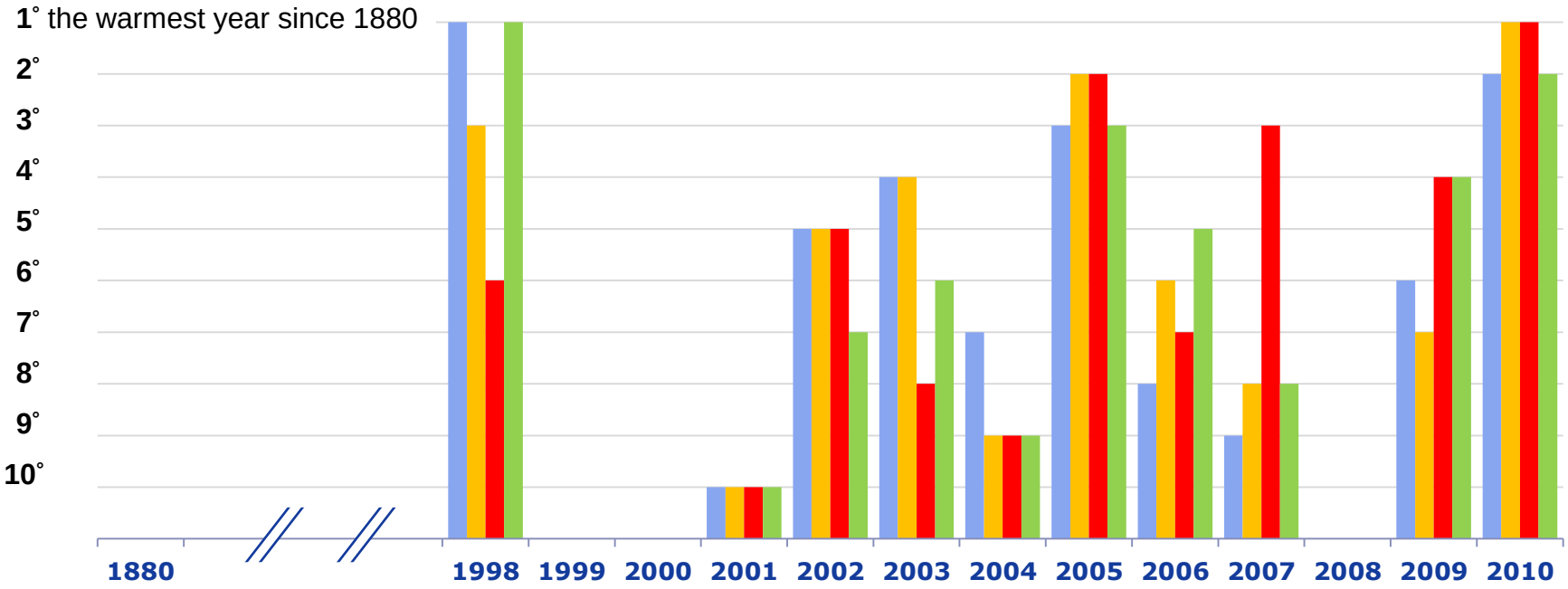
Source: IEA, EIA, Citi Research

Technology evolution in energy

Impacts of fossil fuel use: climate change

Hadley Centre UK Meteorological Office
NOAA National Climatic Data Center
NASA Goddard Institute for Space Studies
Japanese Meteorological Agency

The highest position = the warmest year since the beginning of observations in 1880

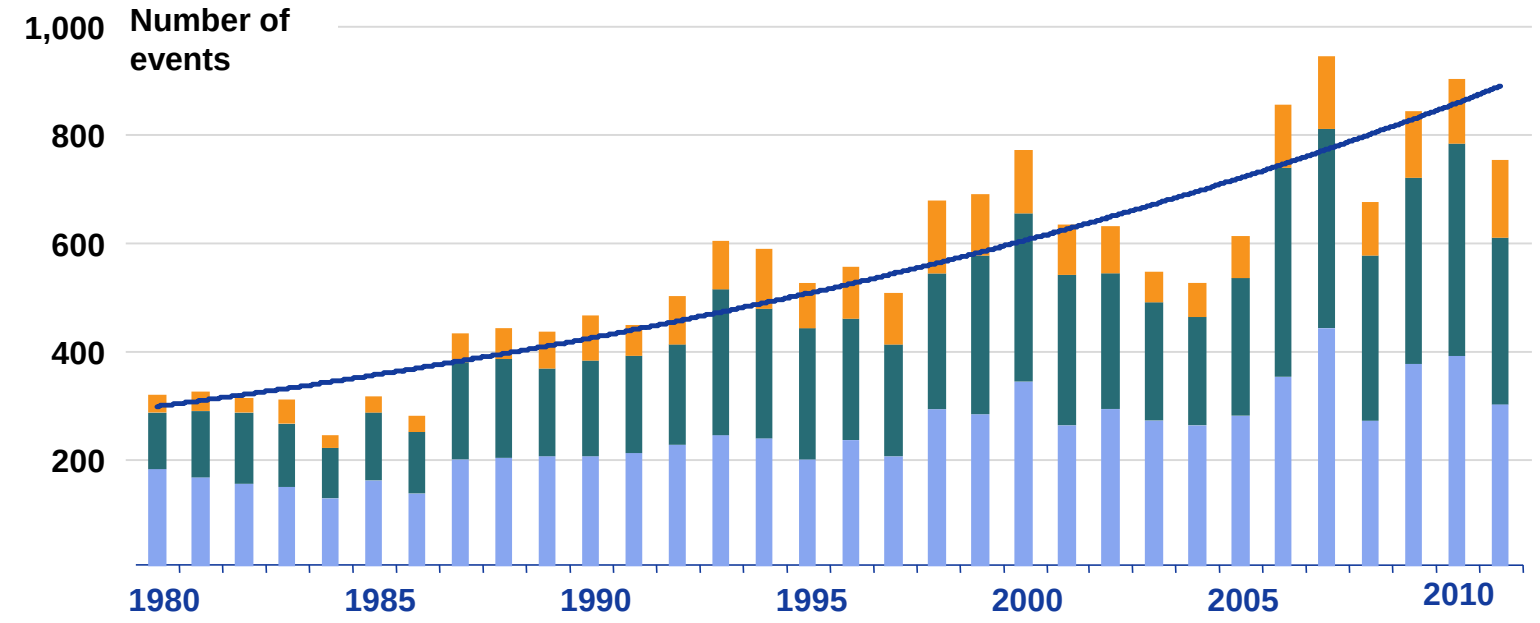


Fossil fuels ushered the era of energy abundance but accelarated **climate change –** one of the key challenges of our time

Source: 2011 United Nations Environment Program, Keeping Track of Our Changing Environment, June 2012

Technology evolution in energy

Impacts of fossil fuels: climate change



Metereologic events
(Storms)

Hydrological events
(Floods)

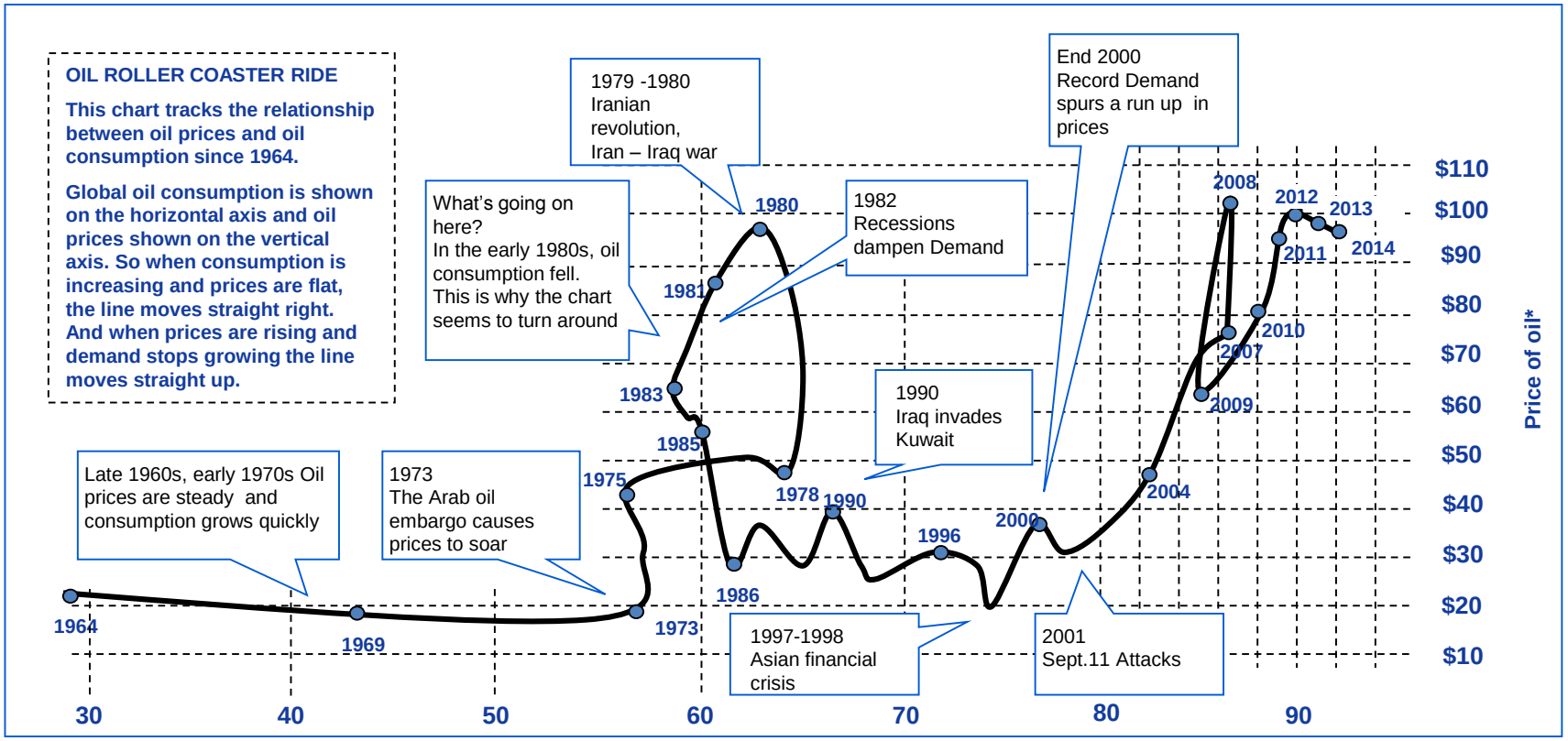
Climate events
(Extreme temperatures, draught, forest fires)

Number of metereologic catastrophes increased exponentially in the last years

Source: Munich RE, Geo Risks Research, NatCatSERVICE , January 2012

Technology evolution in energy

Impacts of fossil fuel use: oil price volatility



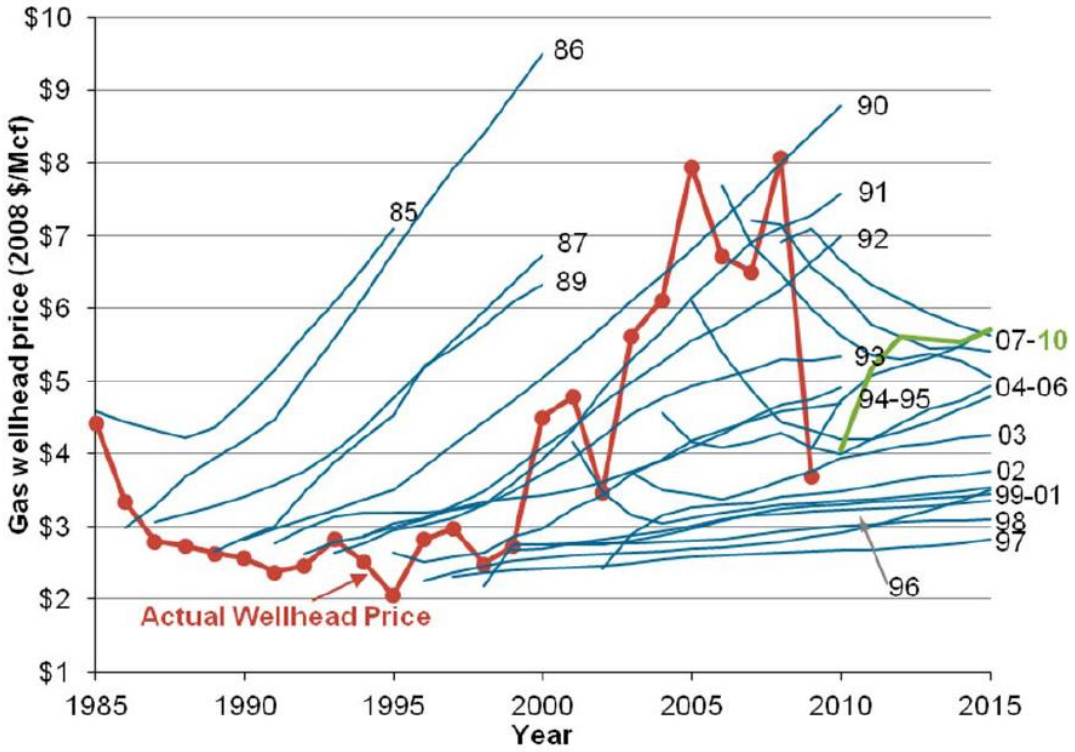
World oil consumption
Million barrels a day

**Average annual price of West Texas Intermediate crude oil, adjusted for inflation using the Consumer Price Index. Posted prices (not spot prices) are shown before 1983.*
Source: Energy Information Administration, Federal Reserve, Bureau of Labor Statistics, Rocky Mountain Institute

Gas and oil domination in the fuel mix predetermined **price volatility** as another challenge

Technology evolution in energy

Impacts of fossil fuel use: gas price volatility



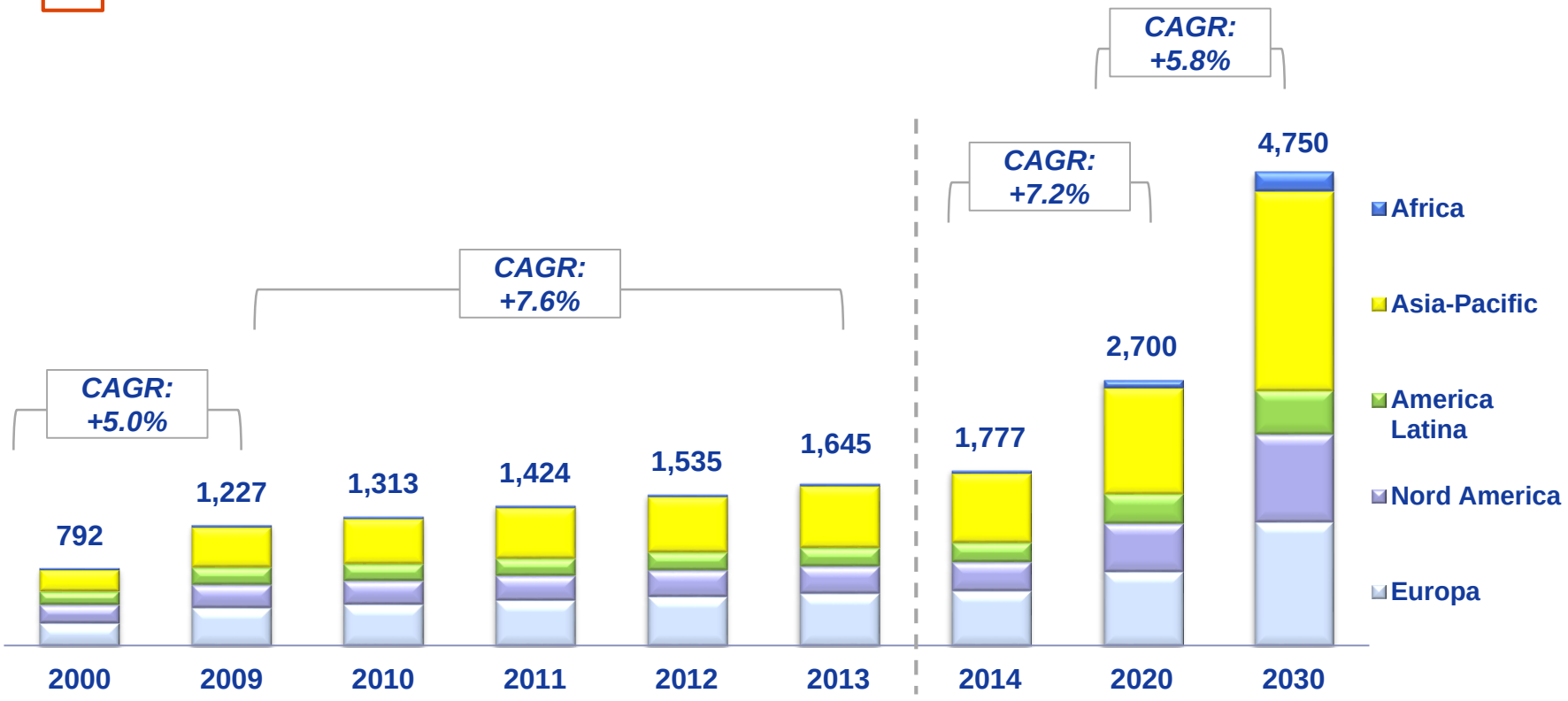
Note: Each blue line represents forecasted wellhead natural gas prices from the AEO of the corresponding labeled year (1985–2010). The bold red line shows actual historical wellhead prices

- Projected low **natural gas prices are driven by a number of factors**, including growth in unconventional gas supplies and demand for natural gas both within the electricity sector and by other end-use sectors
- **Gas prices may react to difficult-to-predict changes** in underlying market drivers, leading to **substantial historical price volatility**

Due to their dependence on **main market drivers** gas prices show a **high volatility** that does **not allow any very reliable forecast**

AEO: Annual Energy Outlook, published by EIA (Energy Information Administration)
Source: NREL, Renewable Electricity Futures Study, 2012

Renewable energy
Installed capacity growth by region

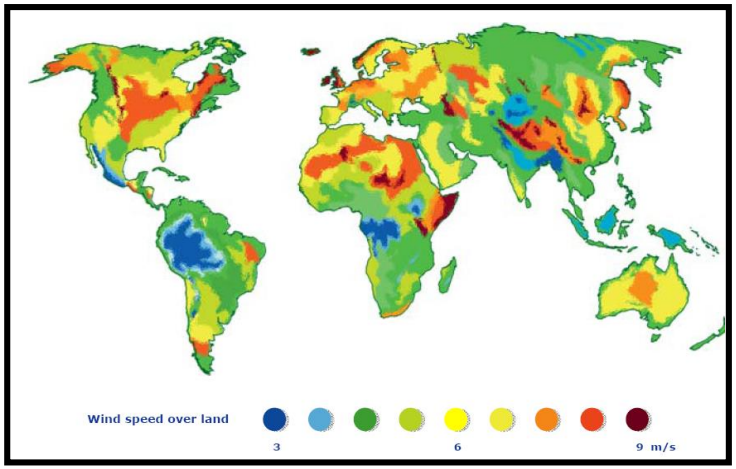


Technology allowed **renewable sources** to become part of the answer to address climate change and price volatility

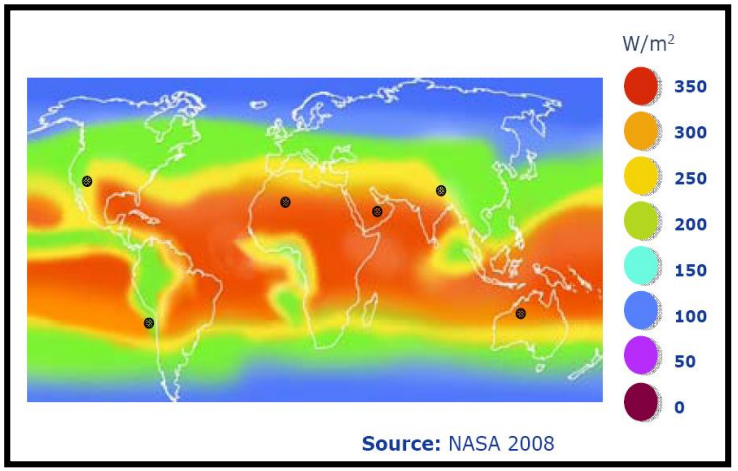
Sources: national TSOs, Enerdata, EER, GWEC, EWEA, EPIA, IEA (dati 2000-2013). Stime EGP su BNEF "4Q2014 Market Outlook for Wind, PV, CSP" e WEO 2014 report; internal estimates based on national plans, governments targets, WEO, IEA "Medium Term renewable energy report", GWEC, EWEA, EPIA, BNEF (2020-2030).

Renewable energy
Resource availability by technology

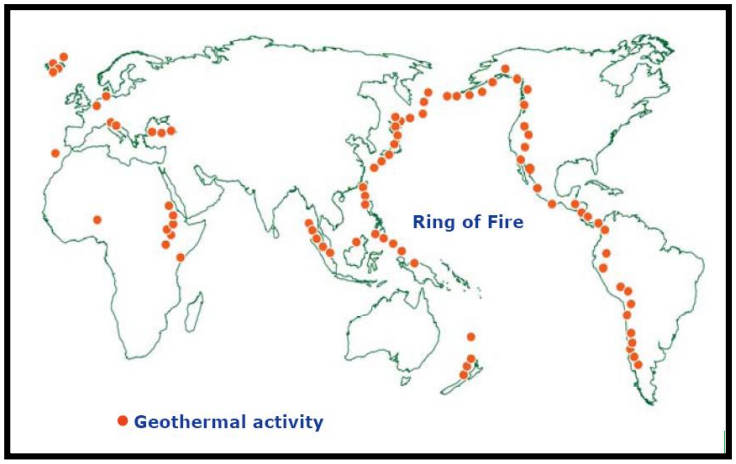
Wind



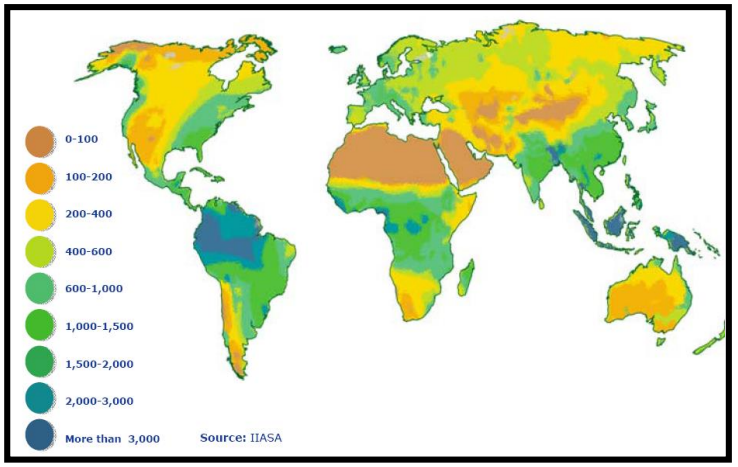
Solar



Geothermal



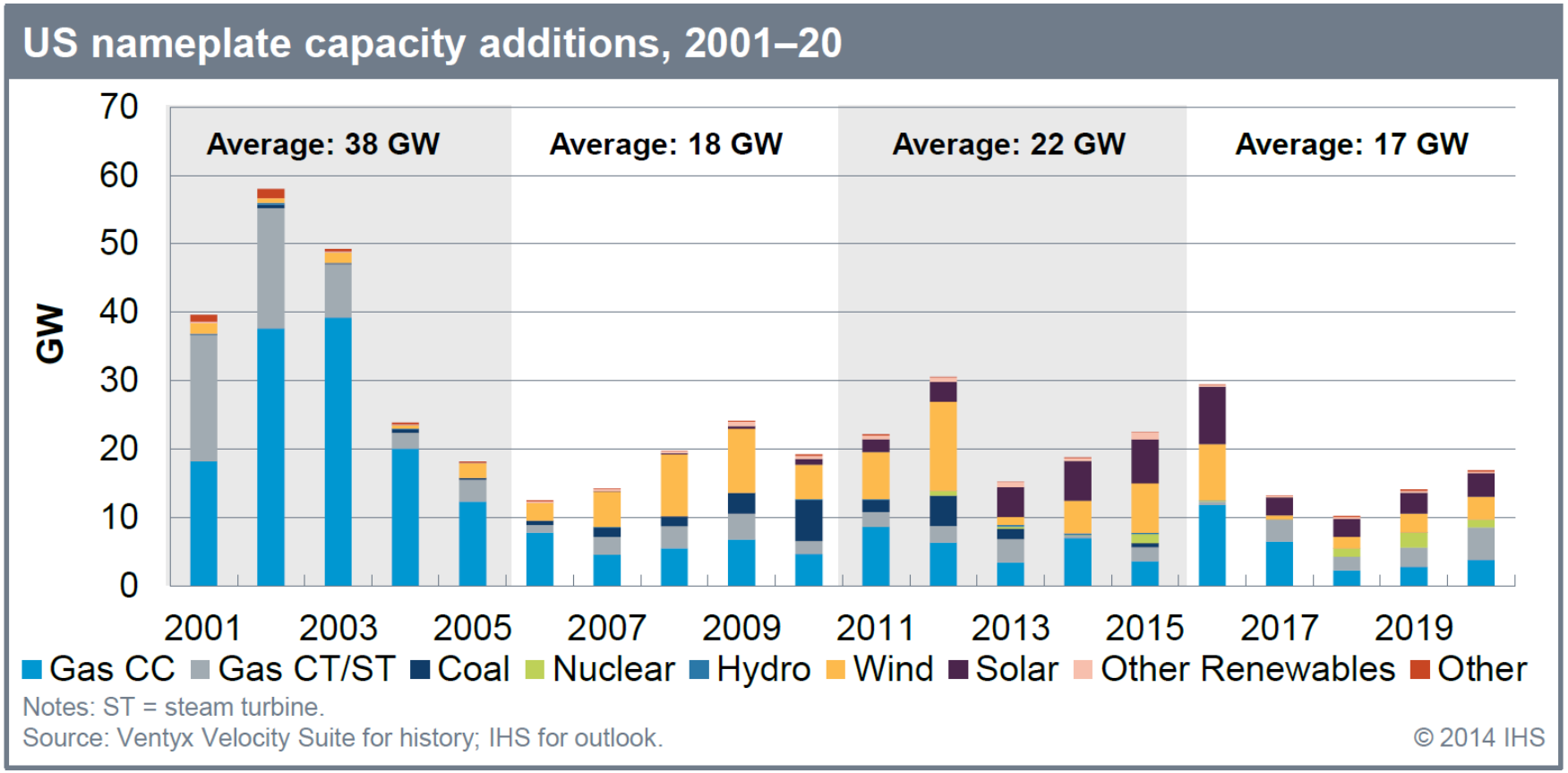
Hydro



Renewable resource **available worldwide**

Renewable energy

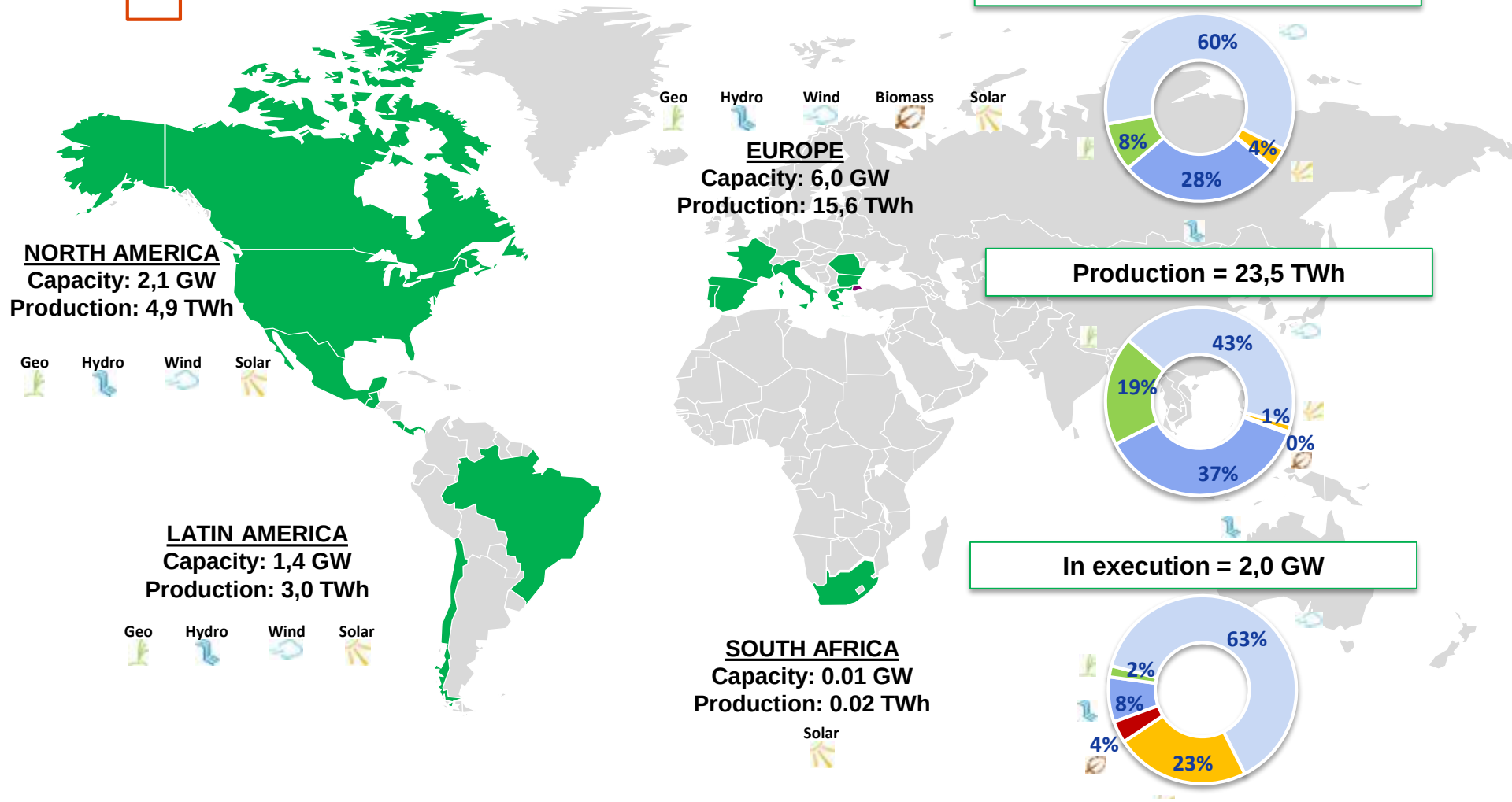
Capacity additions in the US



Robust renewables growth since 2006

Renewable energy

Enel Green Power global presence

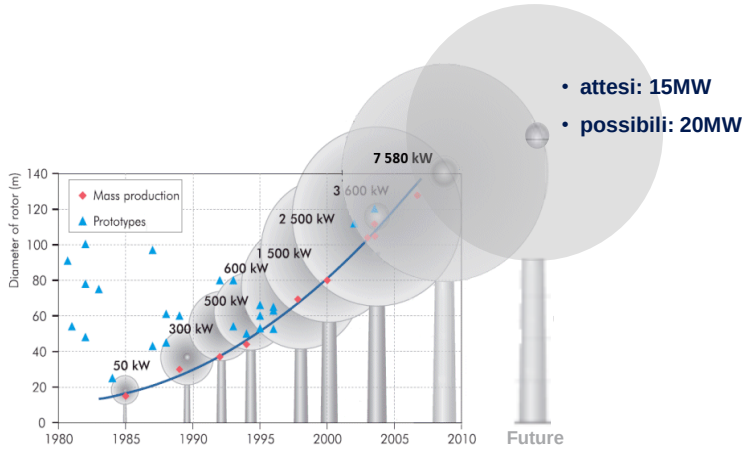


Industry leader with a unique geographic and technological mix

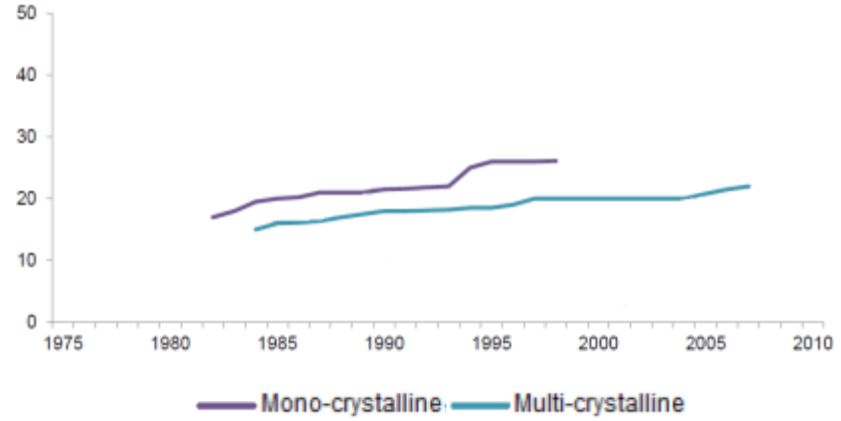
Renewable energy

Rising competitiveness of renewables

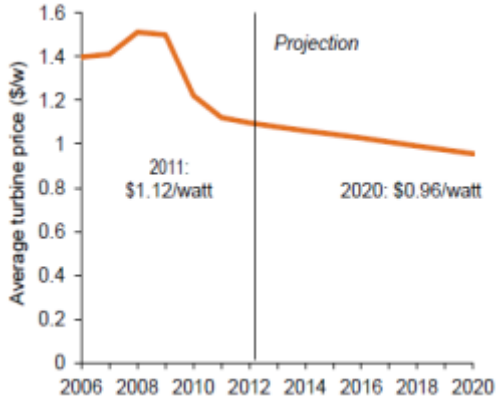
Wind turbines dimensions (1980-2010)



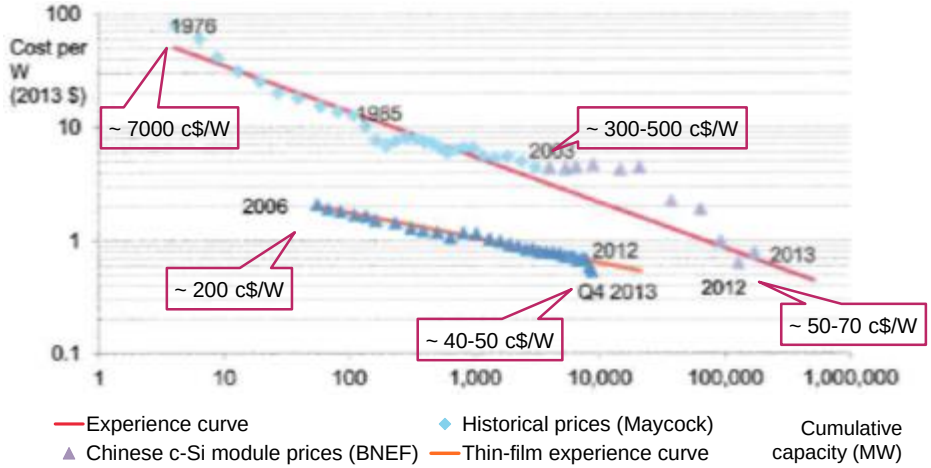
Cells efficiency for PV technolgies (%)



Wind turbines costs evolution ($/W)



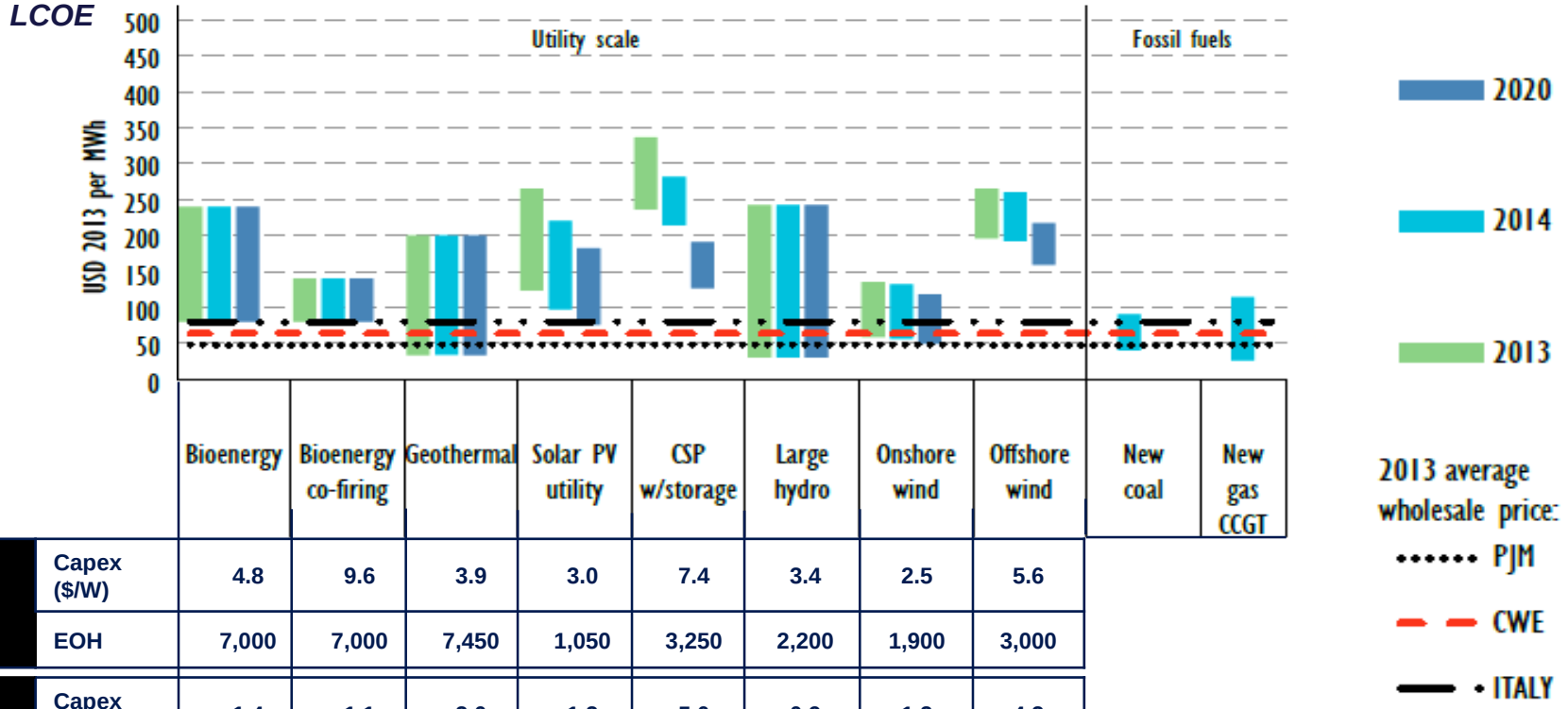
PV panels cost evolution ($/W)



Technology and scale driving **costs down** and improving **efficiency**

Renewable energy

LCOE comparison



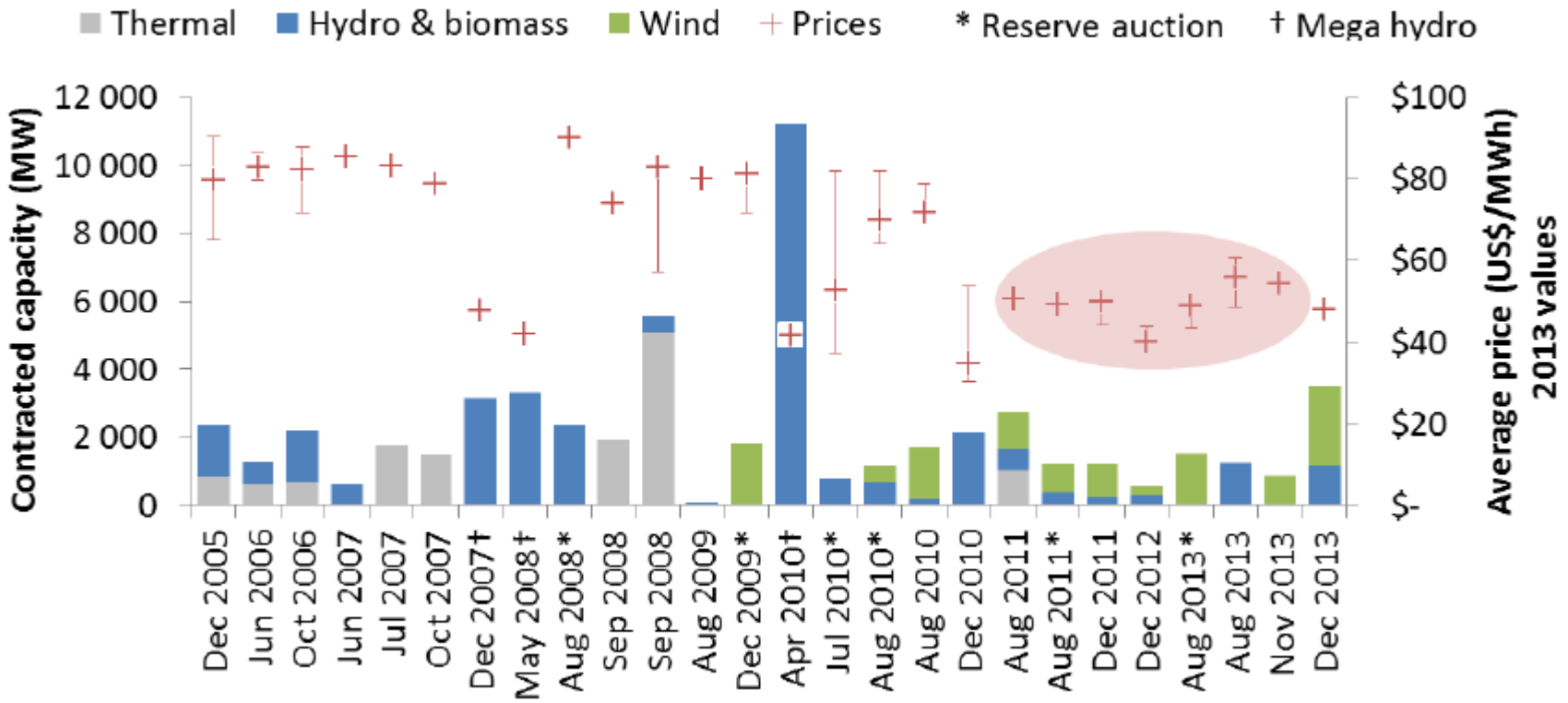
		Bioenergy	Bioenergy co-firing	Geothermal	Solar PV utility	CSP w/storage	Large hydro	Onshore wind	Offshore wind	New coal	New gas CCGT
LCOE max	Capex ($/W)	4.8	9.6	3.9	3.0	7.4	3.4	2.5	5.6		
	EOH	7,000	7,000	7,450	1,050	3,250	2,200	1,900	3,000		
LCOE min	Capex ($/W)	1.4	1.1	2.0	1.2	5.0	0.9	1.2	4.2		
	EOH	7,000	7,000	7,450	1,500	3,370	6,600	2,800	3,900		

Renewable energy approaching **competitiveness at wholesale level**

Source: IEA “Renewable Energy Medium-Term Market Report 2014” July 2014

Renewable energy

Auctions for long-term contracts in Brazil



In the past years, **wind** in Brazil became **fully competitive** in auctions for new generation long-term contracts, resulting in **converging prices for all technologies and lower costs for consumers**

Source: WorldBank

Renewable energy

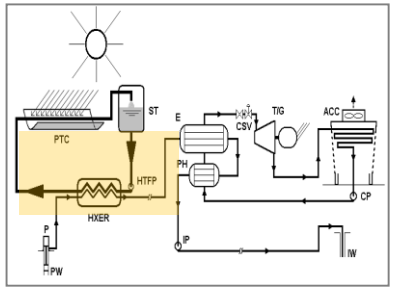
Technology innovation in Enel Green Power

Performance improvement	Renewables integration in urban environment	New renewable resources
Improve availability, mitigate intermittency, integrate different technologies	Machines with reduced dimensions and visibility	Exploitation of new renewable resources

Success stories

Geothermal-solar hybrid

Operating geothermal plant integrated 26 MW PV in 2012. Currently integrating 2 MW Concentrated Solar Power (CSP).



Storage Project

Compensating load forecast error, participation in ancillary services market and maximization of effective capacity.

Storage for wind parks

Technological Partner: TOSHIBA, SAMSUNG

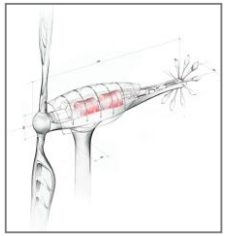
Storage for PV parks

Technological Partner: GE

Micro-wind

2-turbine wind generator with nominal capacity of 55 kW

Prototype undergoing tests

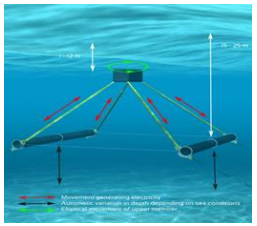


Marine Energy Project

Test installation of a 150 kW generator underwater and utilizing wave kinetic energy

Partnerships with maritime industry:

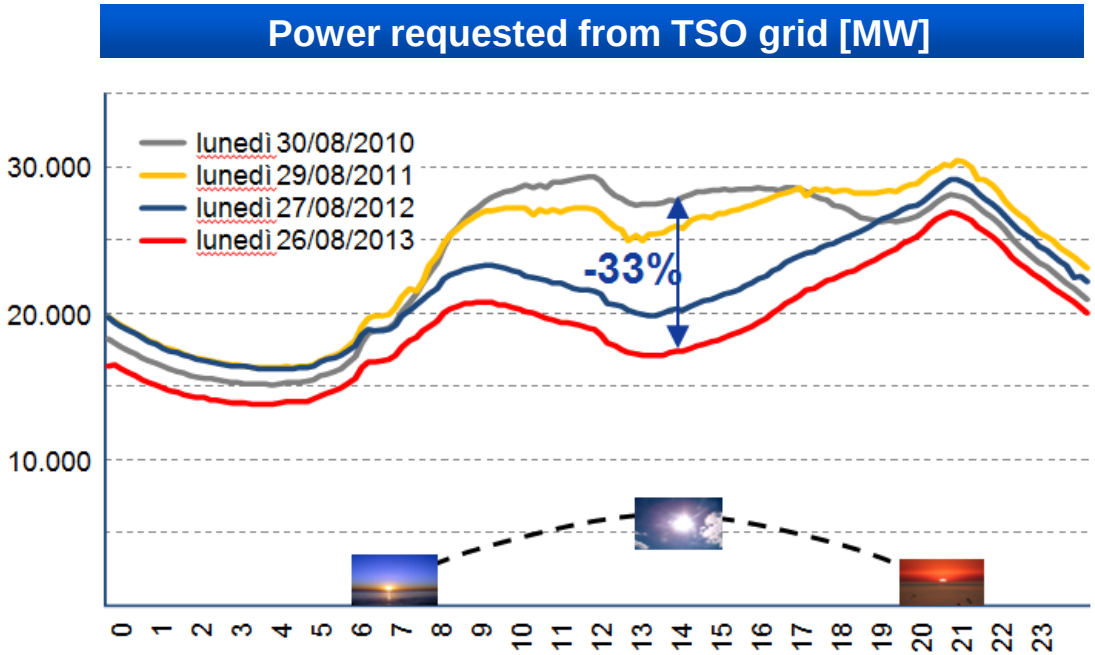
- **DCNS**, France, leader in defense navy;
- **Asmar**, Chile, leader in shipbuilding



Commitment in **research and development** to improve performance, expand areas of use, and exploit new sources

Smart grid

Impact of distributed renewable generation



In Italy **electricity flow is no more unidirectional,** from big power plan to final clients: always more often **inverted flows** from distribution grid toward transmission grid (number of transformer HV/MV with inverted flow of energy between 2010 and 2013[1] **+229%**)

Digitization and automation of the grid allows the penetration of renewable energy without endangering grid stability**.**

1. In a year Inverted flow of electricity happens for more then 5% of the time

Smart grid
New opportunities

Key challenges

- Integration of distributed generation from intermittent **renewables**
- Active participation of **customers**
- Promotion of electricity for new uses (e.g. **electric mobility**)
- New **solutions and services** for the energy market
- **Environmental impact** reduction
- **Quality service** improvement

Steps towards smart grid		Enel's experience
Smart meter		Full-scale smart meter deployment in Italy and Spain (38.8 mn meters installed in total)
Digitalization of electric grid		Project in Puglia region (Italy): 102 smart primary substations and 4000 smart secondary substations
Electric mobility Integration		2.400 recharging poles installed in Europe
Storage		5 storage facilities (up to 2 MVA/MWh each) to be put in operation by the end of 2014

Grid modernization creates **a virtuous cycle of new improvements and market opportunities**

Smart grid
Smart City vision

Smart meters
- Electricity
- Gas
- Water
- Heat

Cloud Computing

E-mobility
- Vehicle-to-Grid
- Fast-Charge
- Load Shaping
- Distributed storage

Wide band/ Ultra-wide band

Big Data

Secondary substation as Data Hub
- Sensors network
- Big Data
- Data on urban area, environment, energy

Smartphone Wearable devices

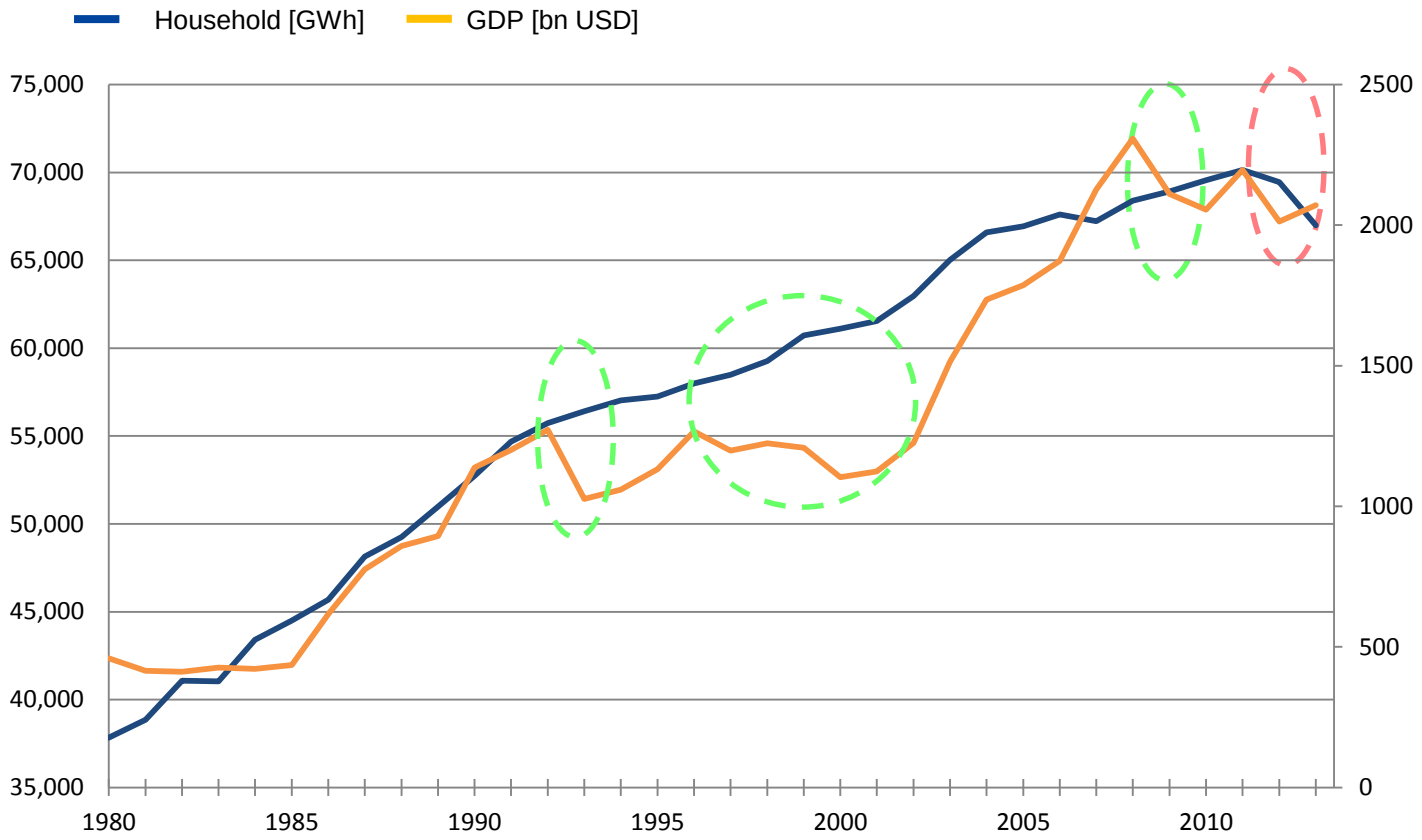
Active demand
- Servizi al Mercato
- Smart-Info
- Energy-Box
- Bilanciamento dei carichi

Renewables integration
- Dispatchment
- Network automation
- Forecast
- Storage

Smart Grids are **catalysts of Smart Cities**

Smart customer

Household consumption in Italy

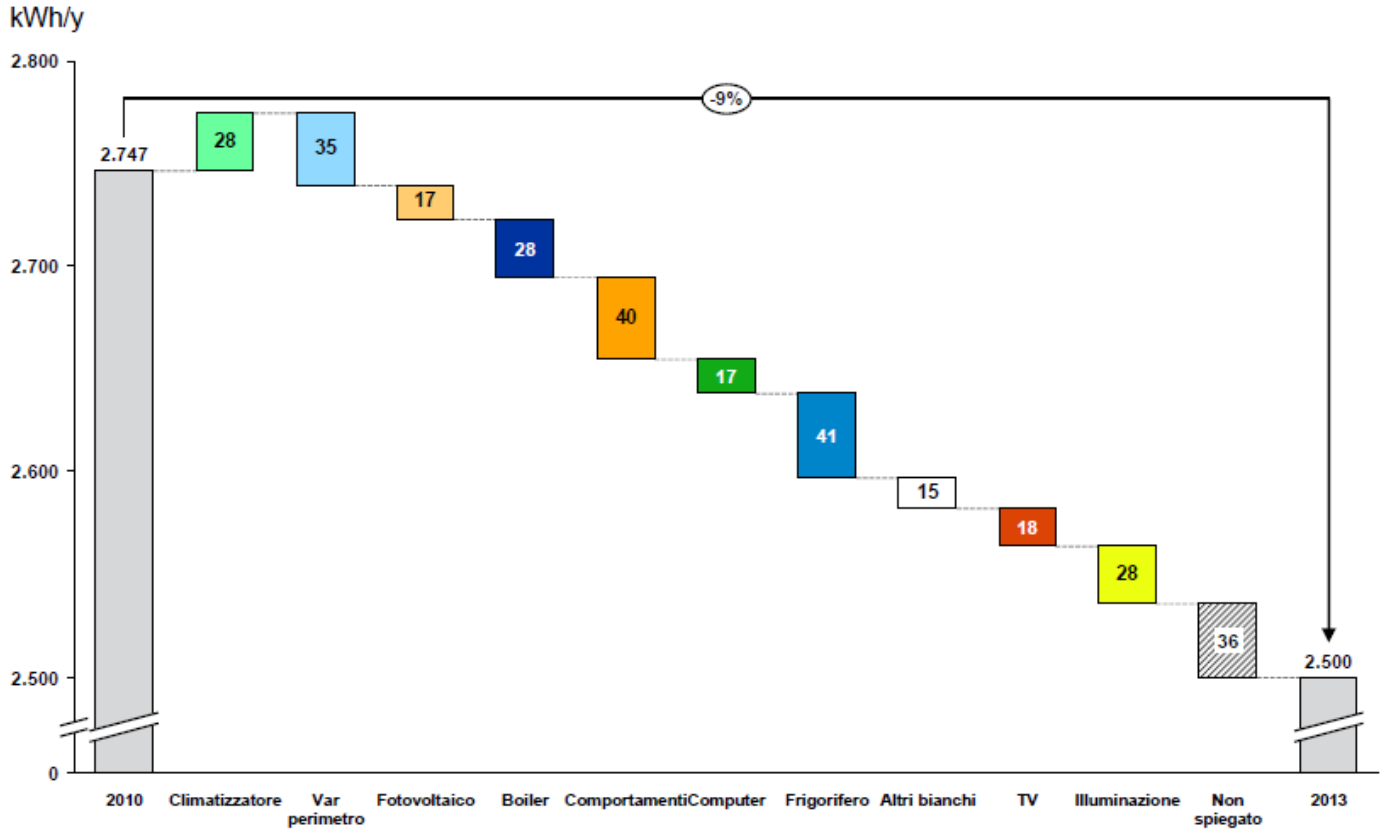


Historically **household consumption** continued to rise throughout the economic cycle. Beginning 2012, it recorded an **unprecedented downturn**.

Source: Terna, WorldBank

Smart customer

Technology driving energy efficiency



- Climate systems
- Perimeter variation
- PV roof-top
- Boiler
- Behaviors
- Computer
- Refridgerator
- Other appliances
- TV
- Lighting
- Not explained

Customers becoming **“smarter” on their energy use**

Source: internal survey

Smart customer

Information technology accelerating change

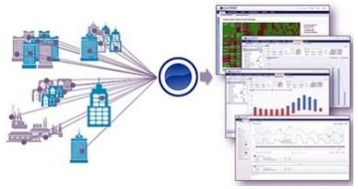
Increasing complexity

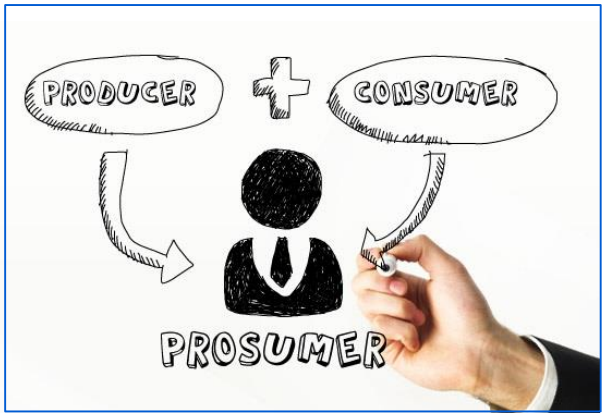
Smart Monitoring

Data Analytics

Energy management

Demand Aggregation





Customers are increasingly sophisticated, informed, thanks to the web and new technologies, aware of their energy consumption and able to produce by their own energy

Challenge and opportunity for utility business model

Concluding Thoughts

- Technology as constant driver of change
- Inertia inherent in the infrastructure, but not any more (fragmentation of industry, entry of information technology, demand-side changes)
- We need to resist the temptation to keep the status quo (opposition to emergence of gas generation in the 80s & 90s, to renewables today)
- Market design and regulation need to adapt to the new evolving reality