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# Technology innovation in the energy sector and RES potential in the mitigation of Climate Change

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DIPARTIMENTO DI INGEGNERIA INDUSTRIALE





# The talk in brief

1. There are economic reasons that are changing the technology paradigm in the energy sector
2. The business models have changed forever
3. The choice of Renewable Energy Sources (RES) follows an economic rationale, even in high demand growth countries
4. The climate constraints are stimulating a positive innovation, valuable in economic terms





# Two constraints for sustainability

1. Distribution of energy resources
2. Climate

Dealing with these aspects is crucial for the present generation





# Sustainability and technology growth

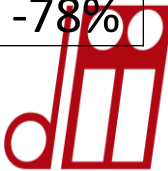
- R&D and new energy technologies have to give proper answers to 2 main challenges:
  - Environment protection
  - Resources distribution
- Short term solutions are not good in the long term. We need to find the sustainable solutions to the energy supply challenge. The energy giants have very short time horizons due to stock performances
- A regulated approach to energy investments is needed





# EU Roadmap 2050: CO<sub>2</sub> emission reduction

GHG reductions compared to 1990	2005	2030	2050
Total	-7%	-40 to -44%	<b>-79 to -82%</b>
Sectors			
Power (CO <sub>2</sub> )	-7%	-54 to -68%	-93 to -99%
Industry (CO <sub>2</sub> )	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO <sub>2</sub> aviation, excl. maritime)	30%	+20 to -9%	-54 to -67%
Residential and services (CO <sub>2</sub> )	-12%	-37 to -53%	-88 to -91%
Agriculture (Non-CO <sub>2</sub> )	-20%	-36 to -37%	-42 to -49%
Other Non-CO <sub>2</sub> emissions	-30%	-72 to -73%	-70 to -78%





# Roadmap 2050: power sector

- The power sector has the biggest potential for cutting emissions. It can almost totally eliminate CO2 emissions by 2050. Electricity could partially replace fossil fuels in transport and heating.
- Electricity will come from renewable sources like wind, solar, water and biomass or other sources that are low in carbon emissions like nuclear power plants or fossil fuel power stations equipped with carbon capture and storage technology.
- The share of these clean technologies in power generation could increase rapidly, from 45% today, to around 60% in 2020 and almost 100% in 2050. For this to happen the cap on emissions from the power sector under the EU Emission Trading System will need to be strengthened and considerable investment put into smart grids.





# Roadmap 2050: buildings

- Emissions from houses and office buildings can be almost completely cut, by around 90% in 2050.
- The energy performance of buildings will be improved drastically; 'passive' housing technology will become mainstream for new buildings and old buildings will be retrofitted. Heating, cooling and cooking will be largely powered by electricity and renewable energy, instead of fossil fuels.
- Investments can be recovered over time through reduced energy bills.





# Roadmap 2050: Industry

- Energy intensive industries will also make a large contribution by cutting emissions by more than 80% by 2050. Technologies used will get cleaner and more energy-efficient.
- In addition, a large-scale introduction of carbon capture and storage technologies, which allow CO<sub>2</sub> to be stored underground instead of pumped into the atmosphere, would be needed. This would require big investments of €10 billion annually by 2040-2050.







# Roadmap 2050: agriculture

- As global food demand grows, the share of agriculture in the EU's total amount of emissions will raise to about a third by 2050. But reductions are possible and it is vital to achieve these emission cuts in the agricultural sector as well; otherwise other sectors will need to make a bigger reduction effort.
- Agriculture will need to cut emissions from fertiliser, manure and livestock and can contribute to the storage of CO<sub>2</sub> in soils and forests. But also changes towards a more healthy diet with more vegetables and less meat can reduce emissions.





# Energy policy targets

- Energy policy has 3 main targets, with changing priority:
  - Environment,
  - Security of Supply,
  - Efficiency.
- RES perform well on the first and second. The third target depends on the time scale. Keeping a short lead time does not help to achieve the maximum social welfare.
- The rationale to give priority to RES are becoming economic, more than environmental.





# The energy world has changed

- The basics of the energy economics have changed in the last decade:
  - Scale economies: ?
  - Role of utilities
  - Market contendibility
  - Demand reduction in EU
  - Digital load control and demand response
- We will never go back to the energy sector of 10 years ago, for demand profiles and business models of the utilities





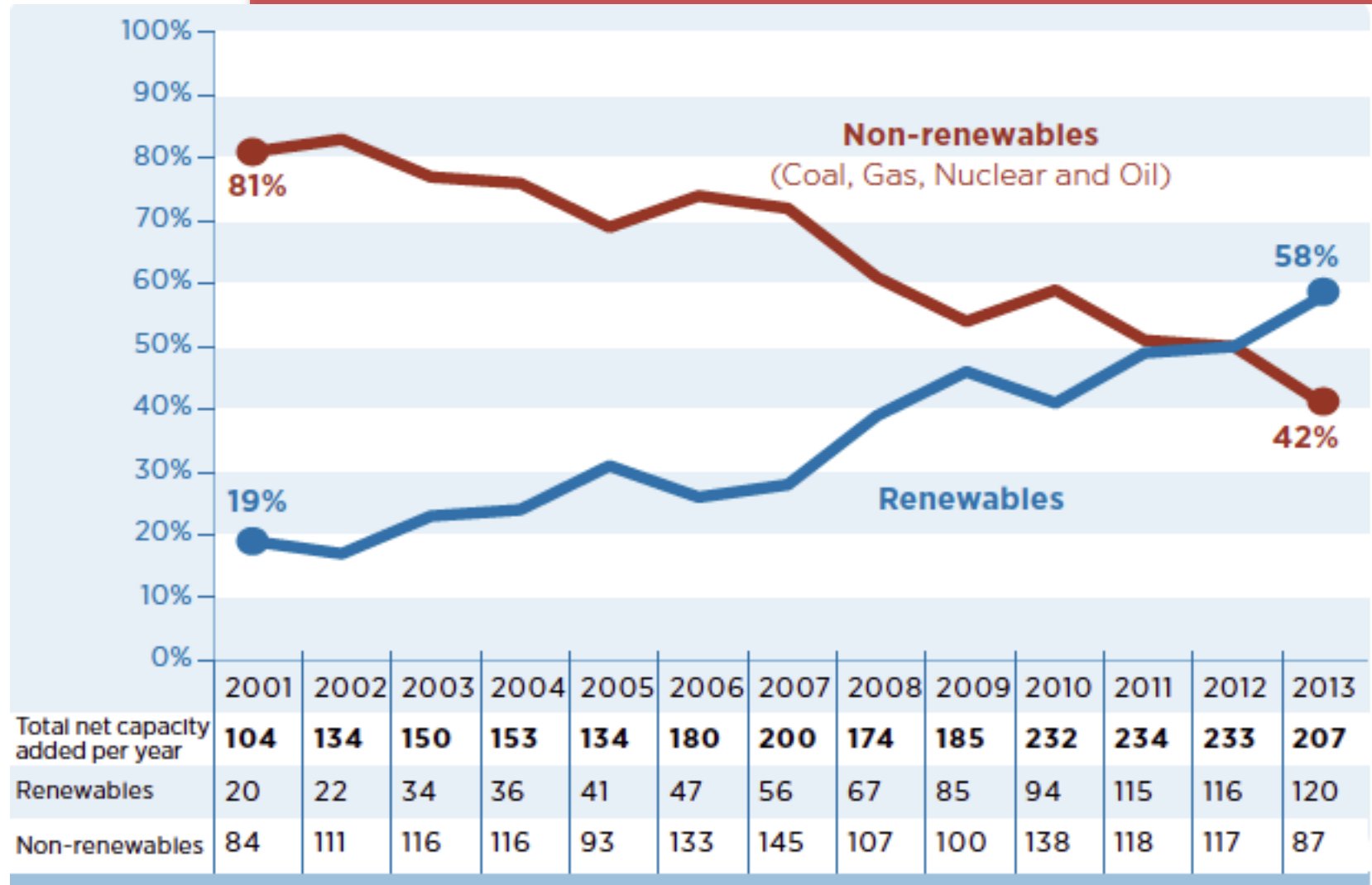
# New sources, new technologies

- The affirmation of new renewable energy sources comes from the new technical constraints:
  - Fading scale economies
  - Choice of the competitive model
  - Tensions on the international fuel markets
  - Hard access to the financing large projects
  - Need to improve local conditions in terms of labour, quality of life, business opportunity





# Has ALREADY changed!

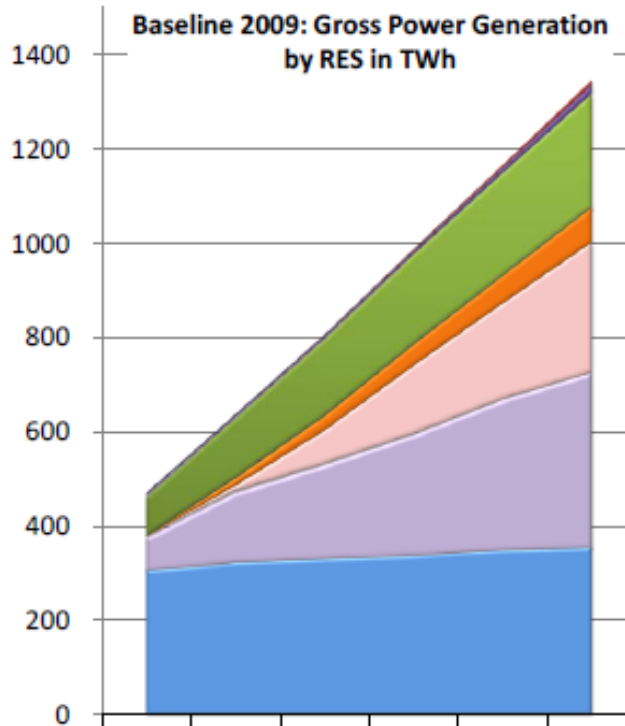


Source: IRENA database

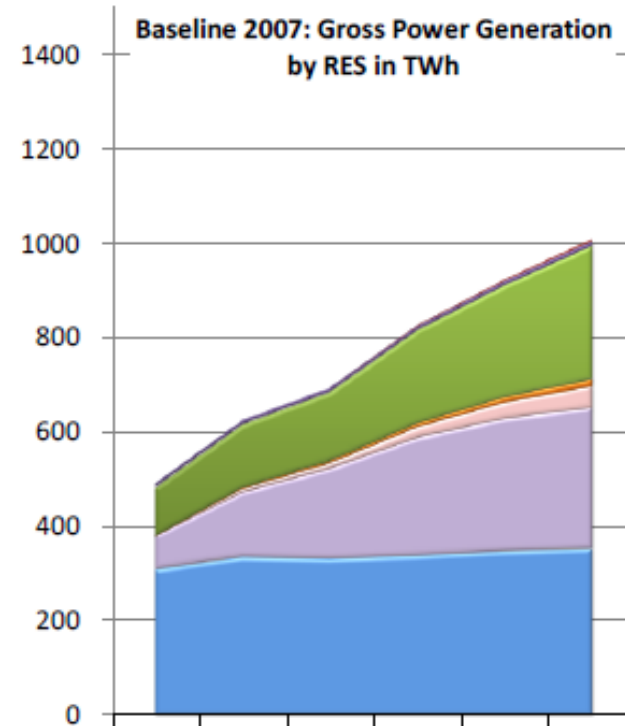




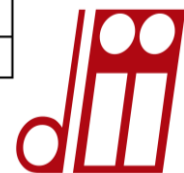
# New scenario for 2030 in EU: what a change!



	2005	2010	2015	2020	2025	2030
Tidal, etc.	0	0	1	3	6	9
Geothermal	5	6	6	7	11	19
Biomass/waste	84	127	164	191	218	241
Solar	1	17	32	46	60	75
Wind offshore	2	14	72	146	204	276
Wind onshore	68	147	197	253	316	368
Hydro	307	323	332	339	349	355

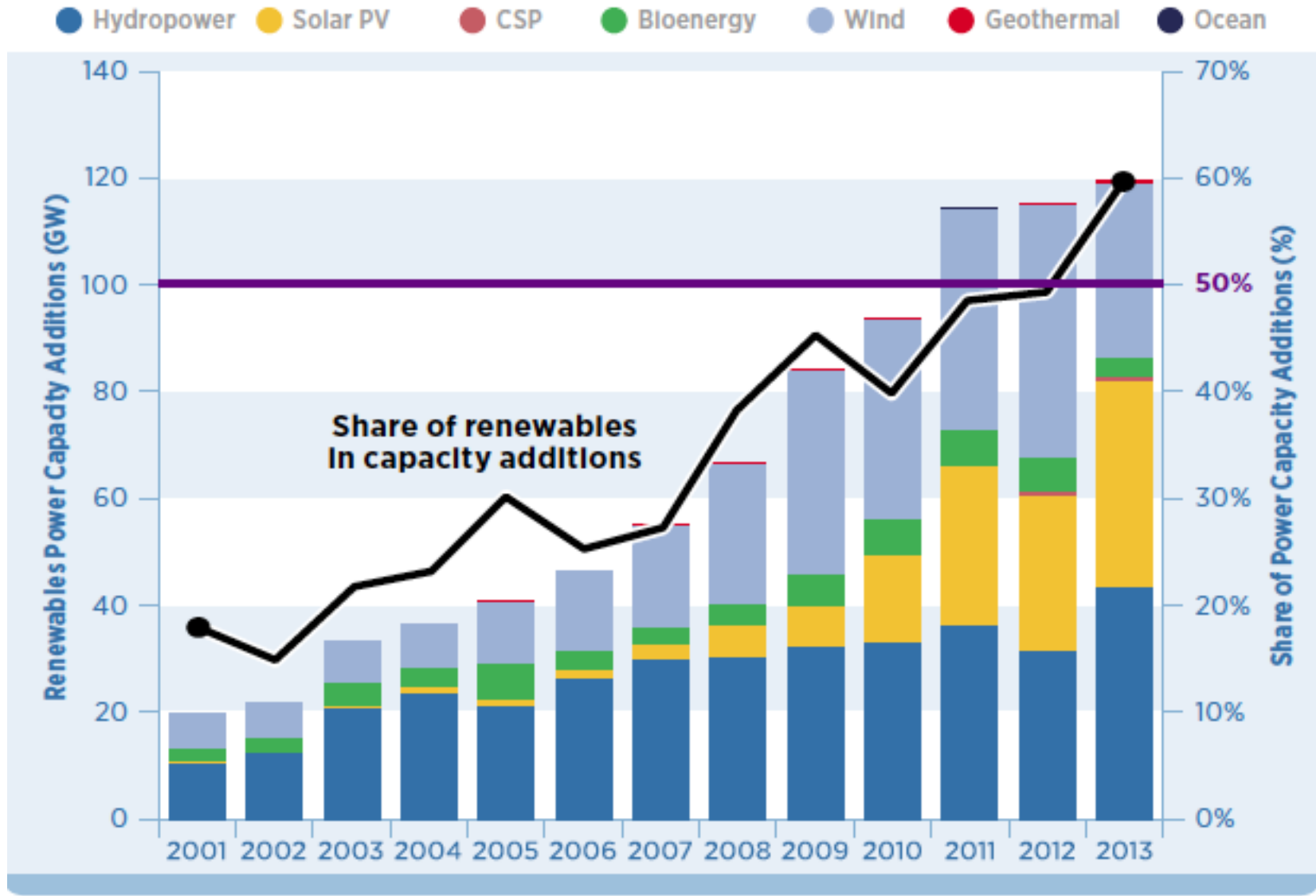


	2005	2010	2015	2020	2025	2030
Tidal, etc.	0	0	0	2	3	5
Geothermal	8	8	8	8	9	9
Biomass/waste	102	133	145	196	235	282
Solar	1	4	6	9	13	17
Wind offshore	0	9	13	24	36	46
Wind onshore	70	136	189	247	279	296
Hydro	307	333	329	336	345	351





# “New” sources are the prevalent area of investments



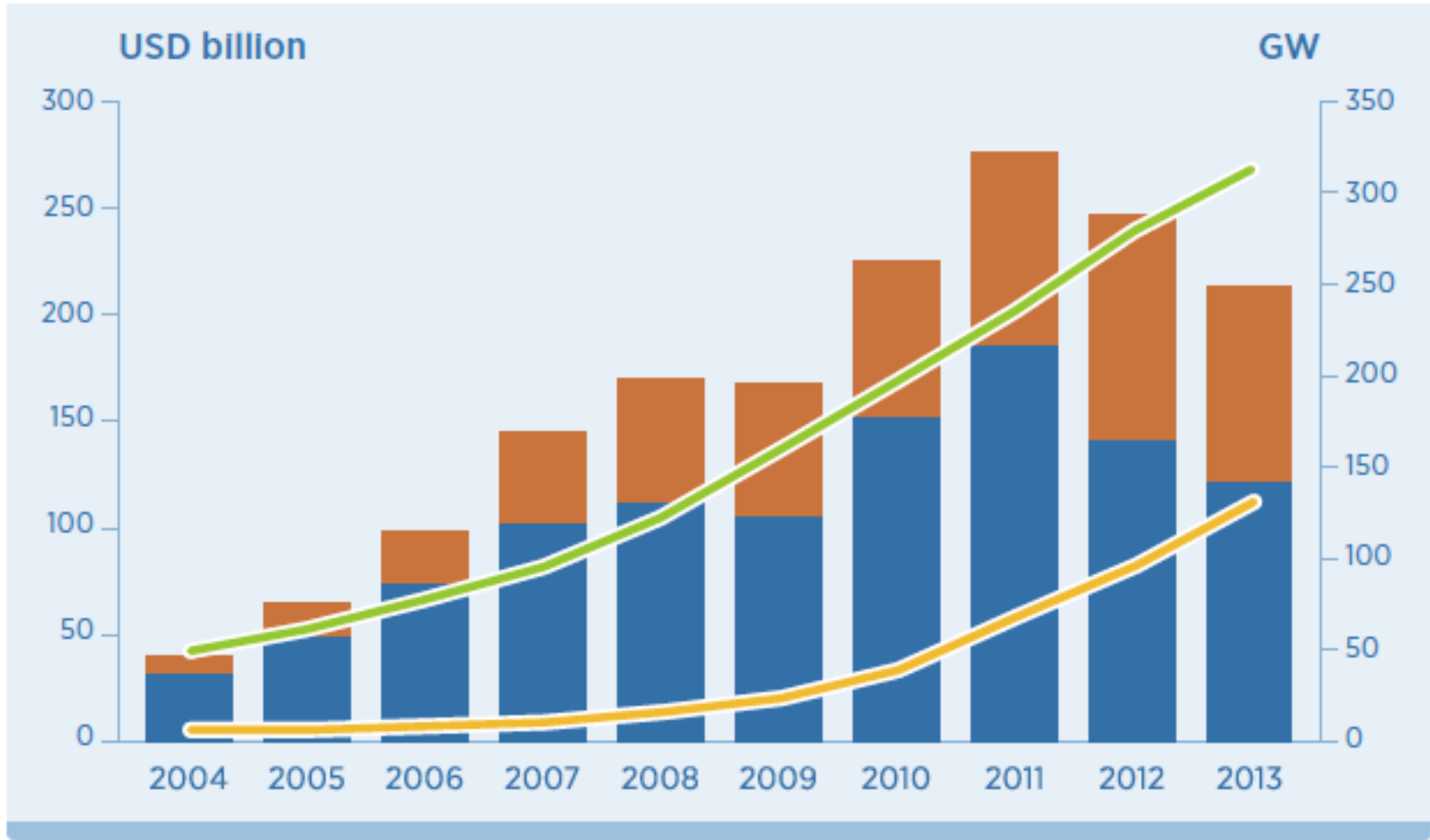
Source: IRENA database





# And the investments are moving towards developing countries

Developed countries (USD billion)    Developing countries (USD billion)    Solar (GW)    Wind (GW)

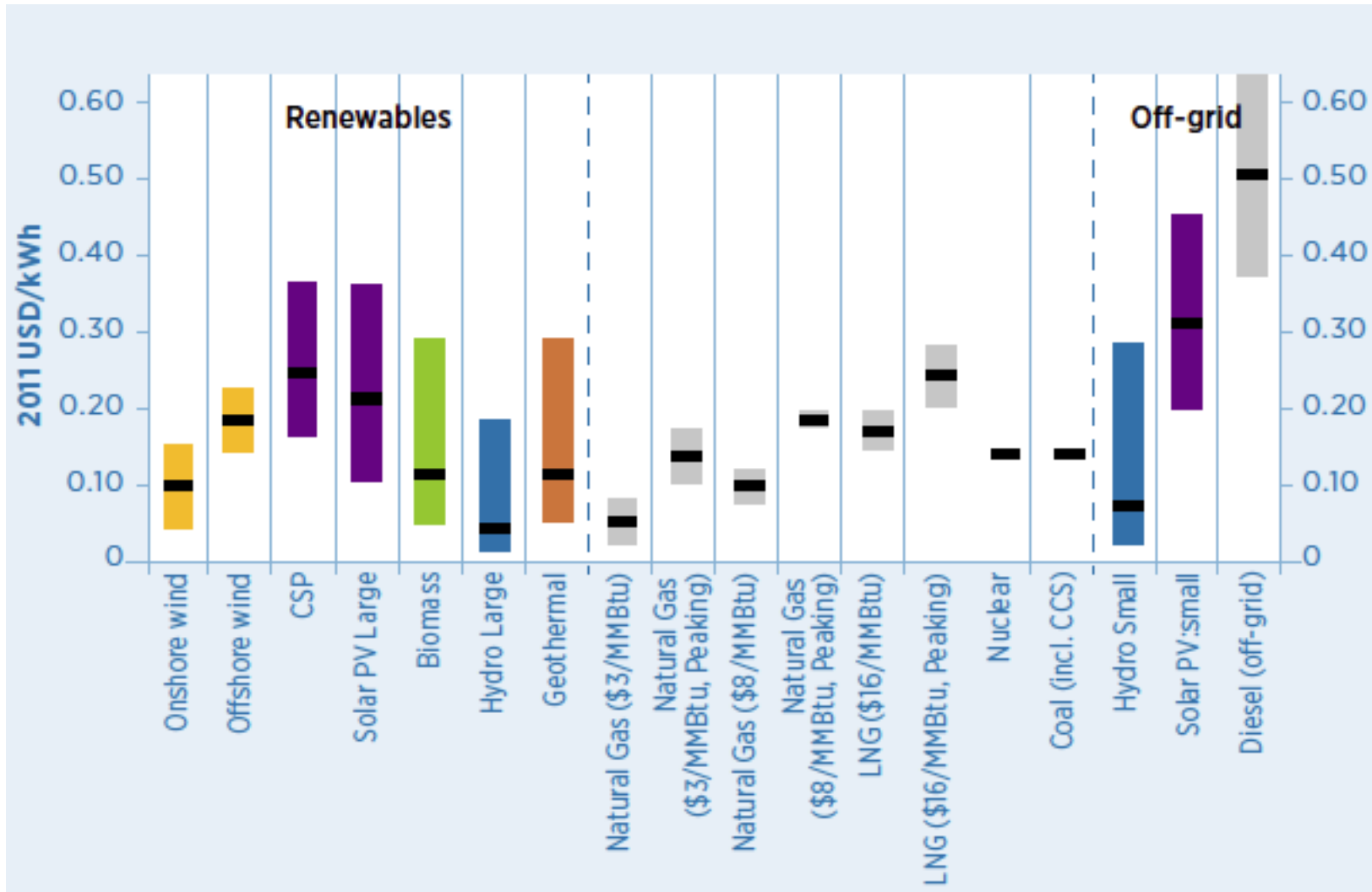


Source: IRENA based on (UNEP, BNEF and FS, 2014) and (REN21, 2014)





# Electricity cost (LCOE)



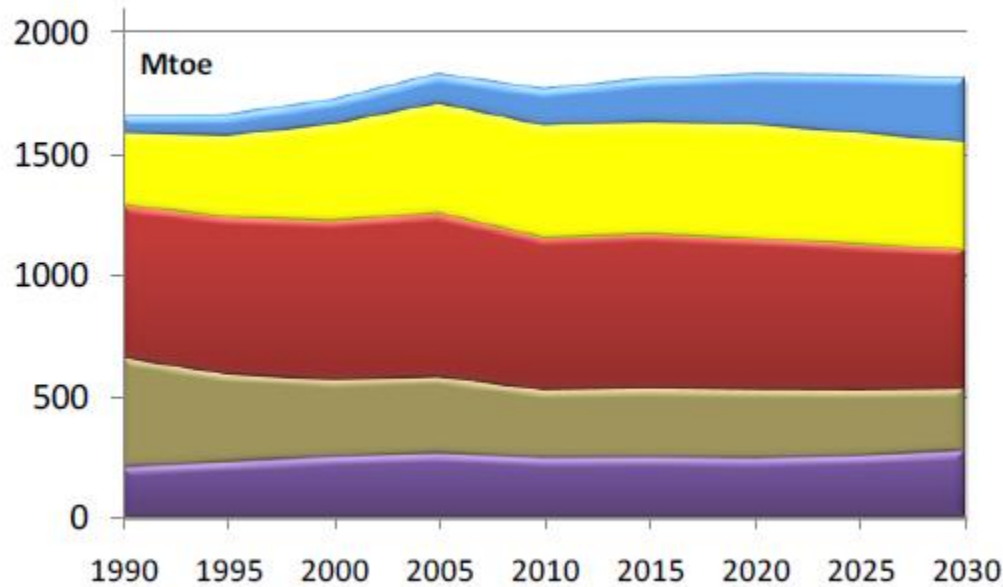
Source: IRENA Costing Alliance (n.d.) for renewable energy technologies and PwC database for non-renewable energy technologies.



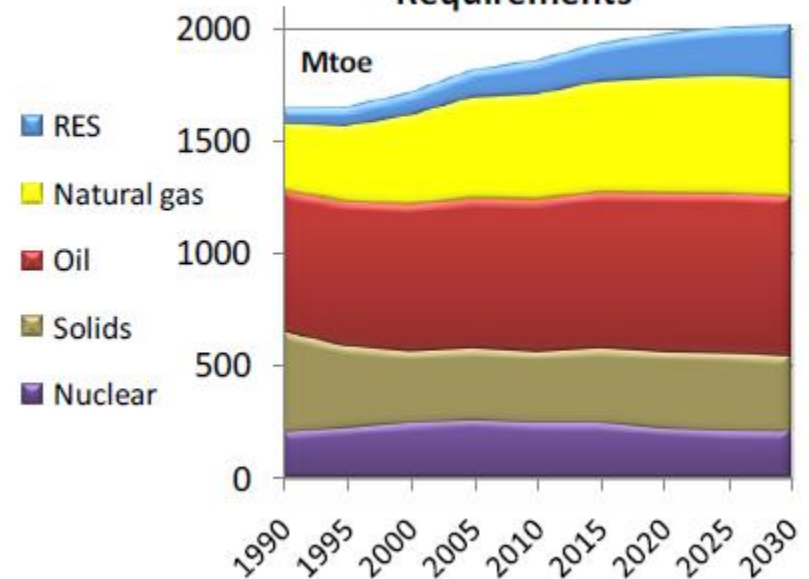


# New scenarios for energy demand in EU

Baseline 2009: Primary Energy Requirements



Baseline 2007: Primary Energy Requirements



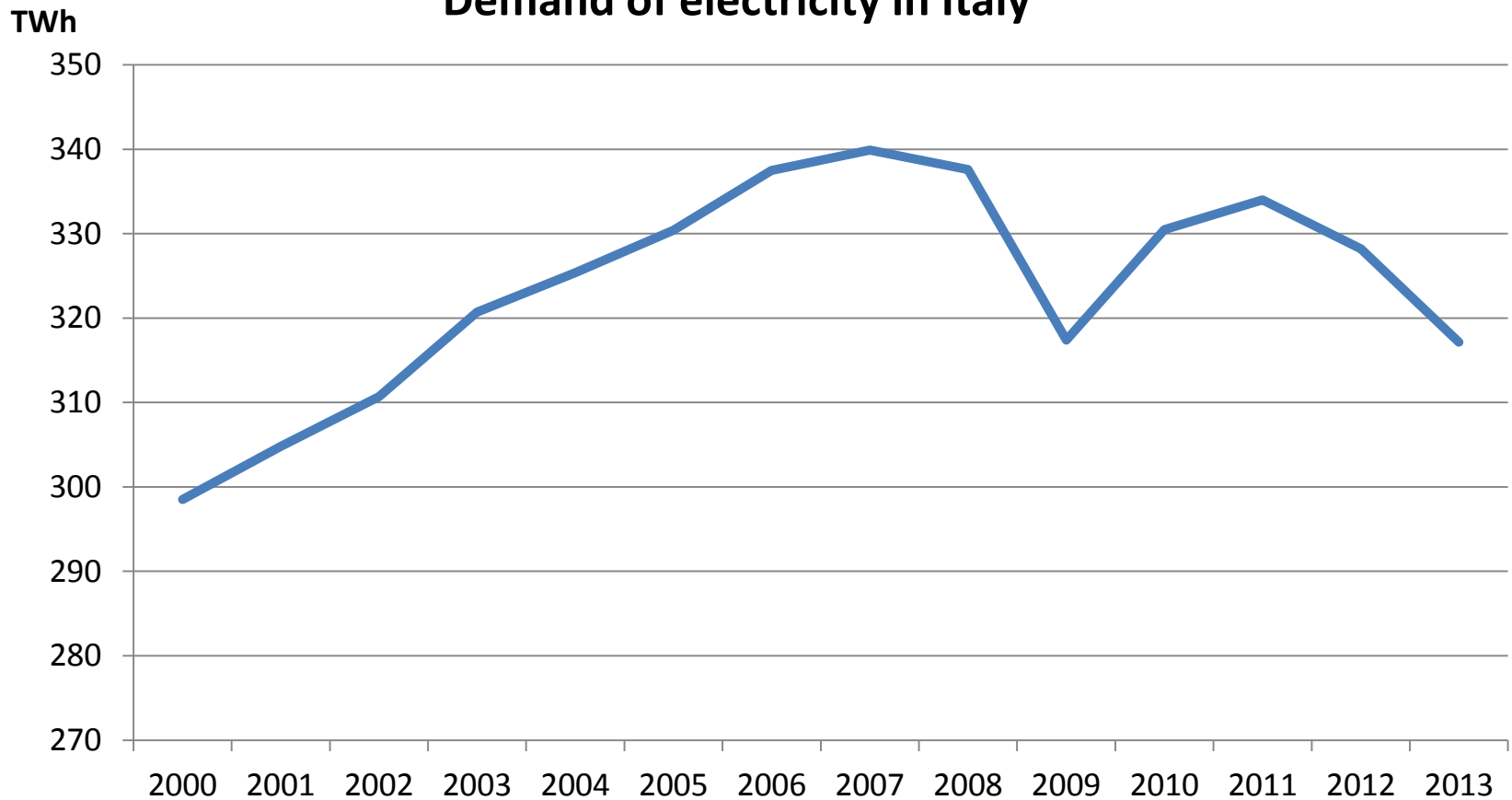
Source: EU Energy trends 2030





# Electricity demand collapses

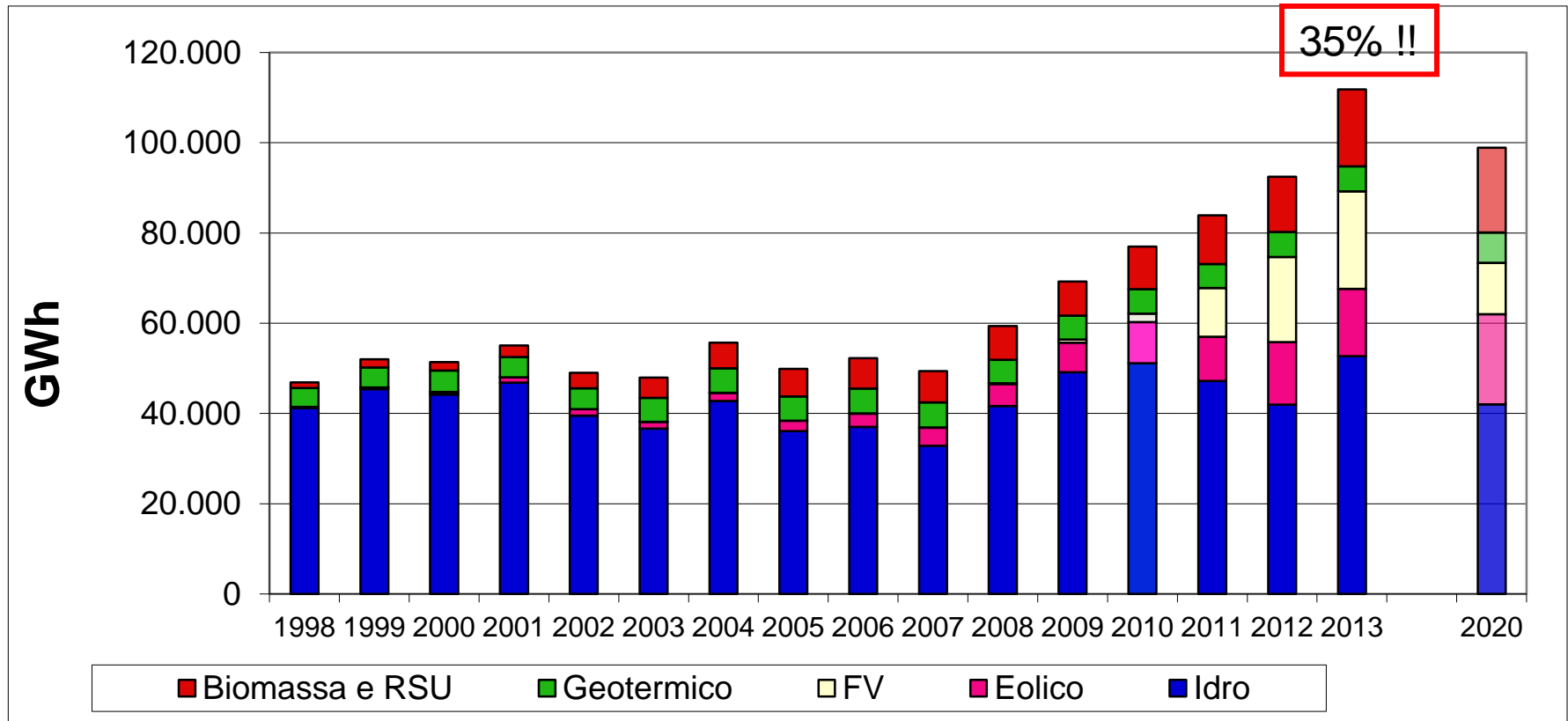
## Demand of electricity in Italy



2014 (Jan.- Aug.): -3,3% !



# RES-e production in Italy

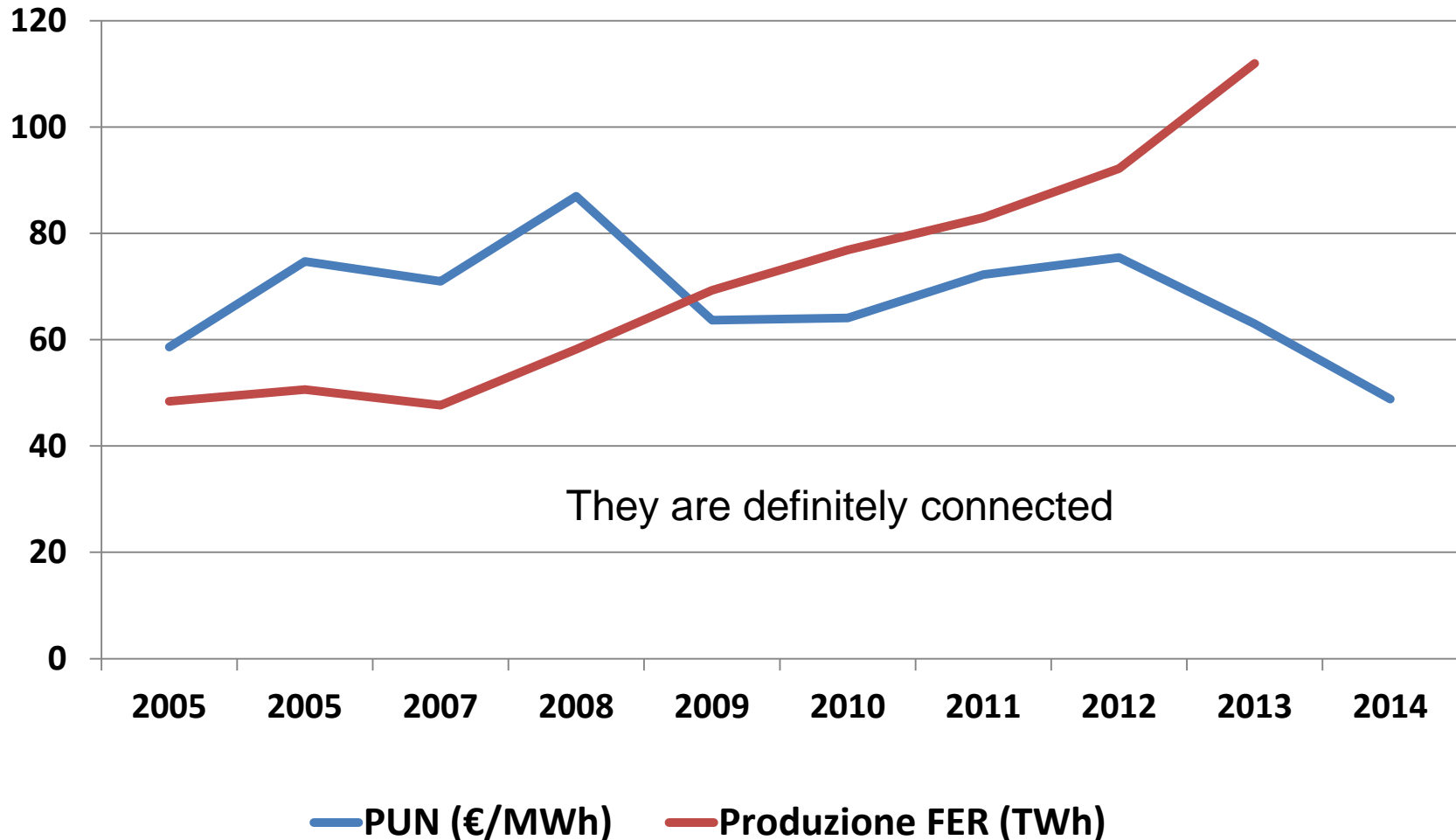


Due to the economic situation, the transition towards a new energy system is accelerated respect to expectations



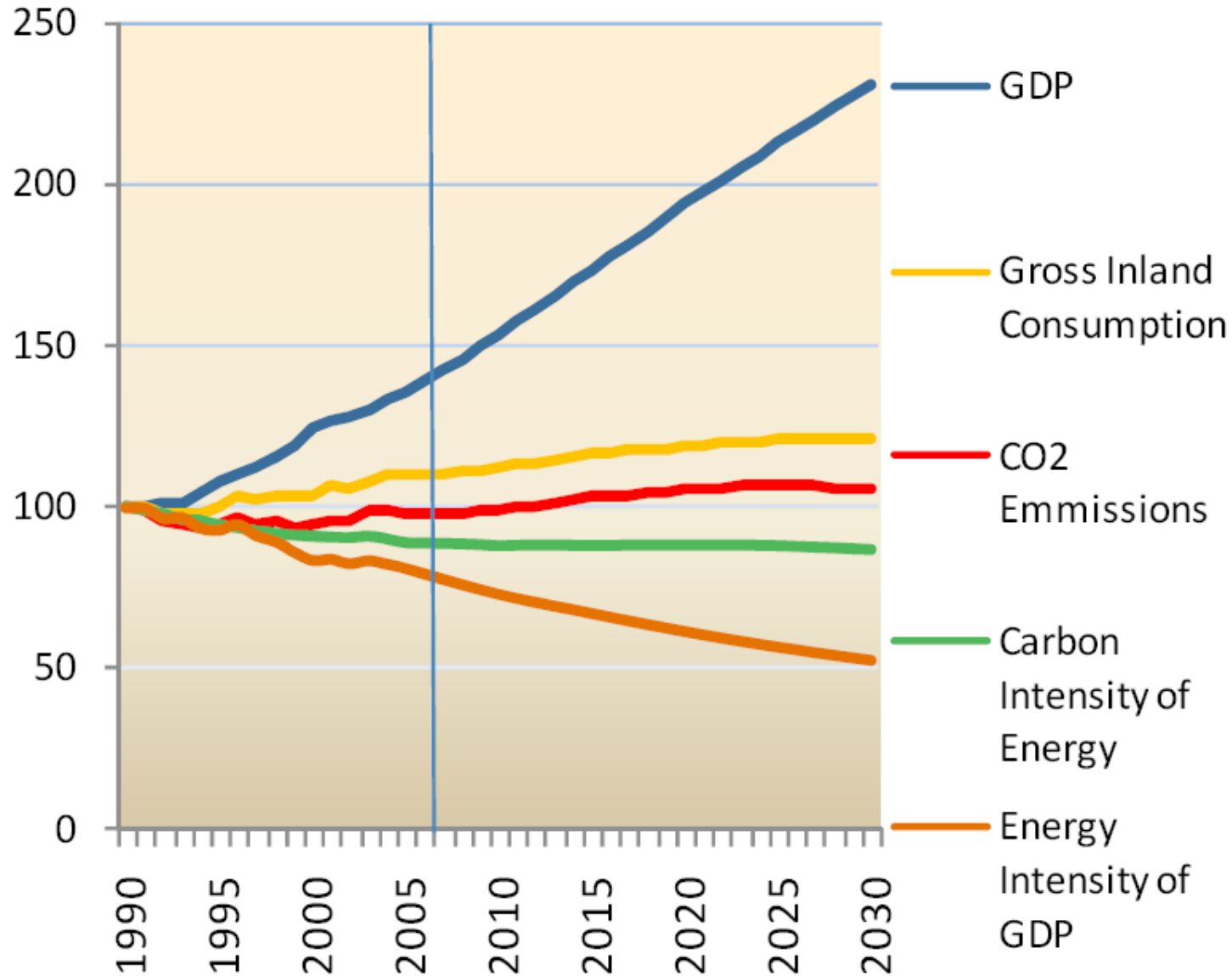


# Electricity price and RES production



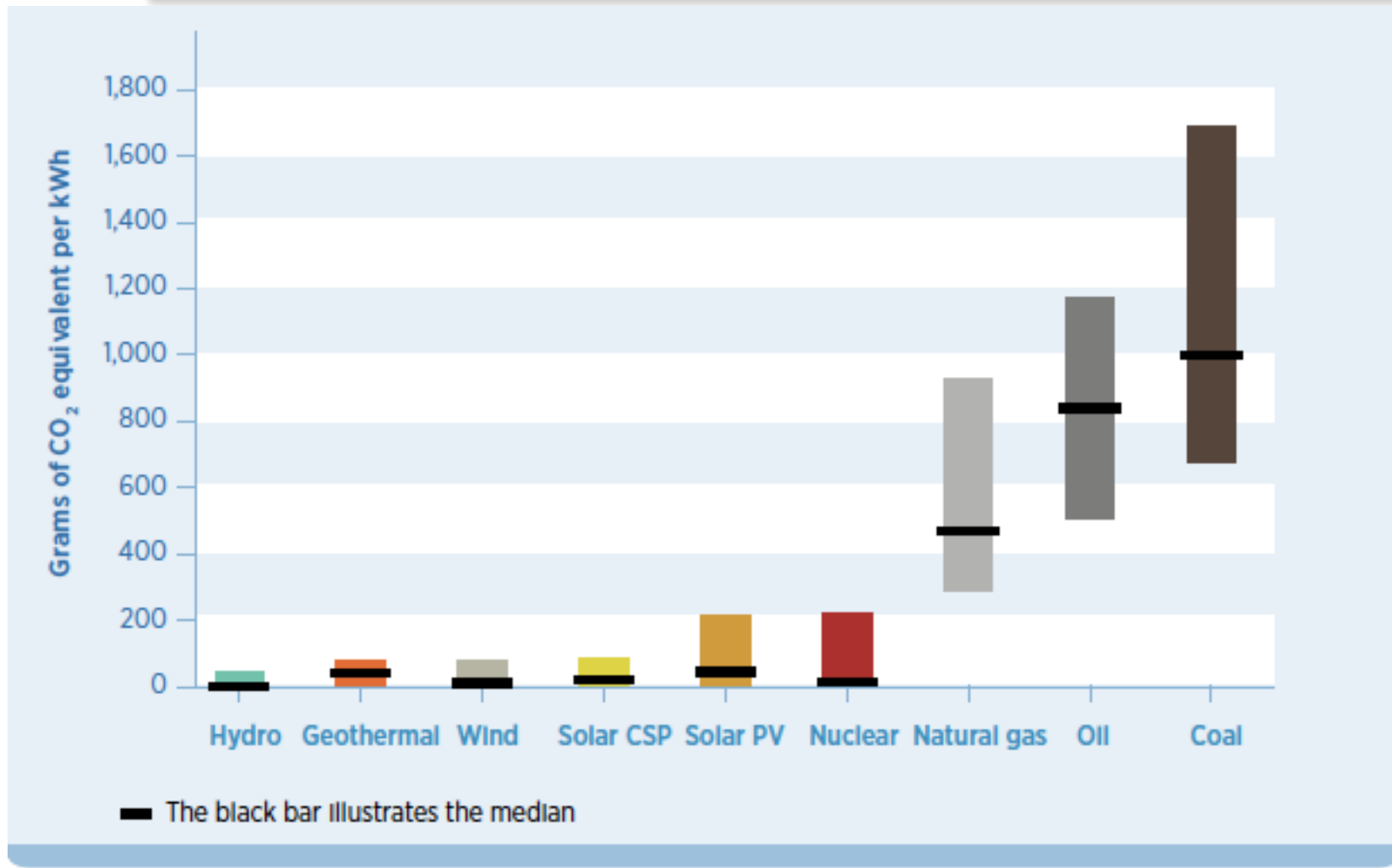


# The challenge: decoupling growth and emissions





# GhG emissions in the life cycle



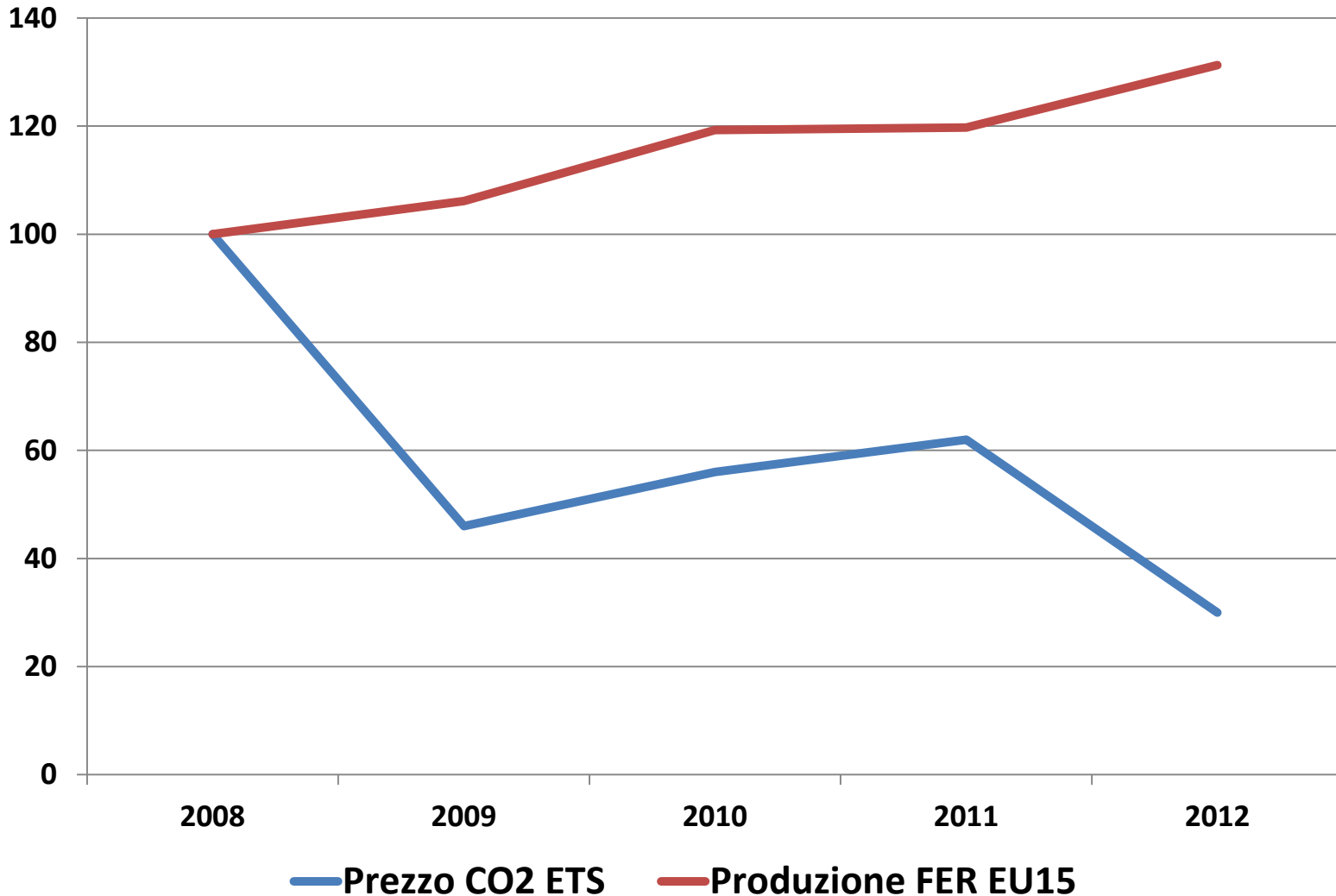
Source: IPCC (2011)

\* Estimates of total life-cycle greenhouse gas emissions do not account for contributions from either land use change or heat production (in cases of cogeneration).



# CO<sub>2</sub> price and RES growth in EU

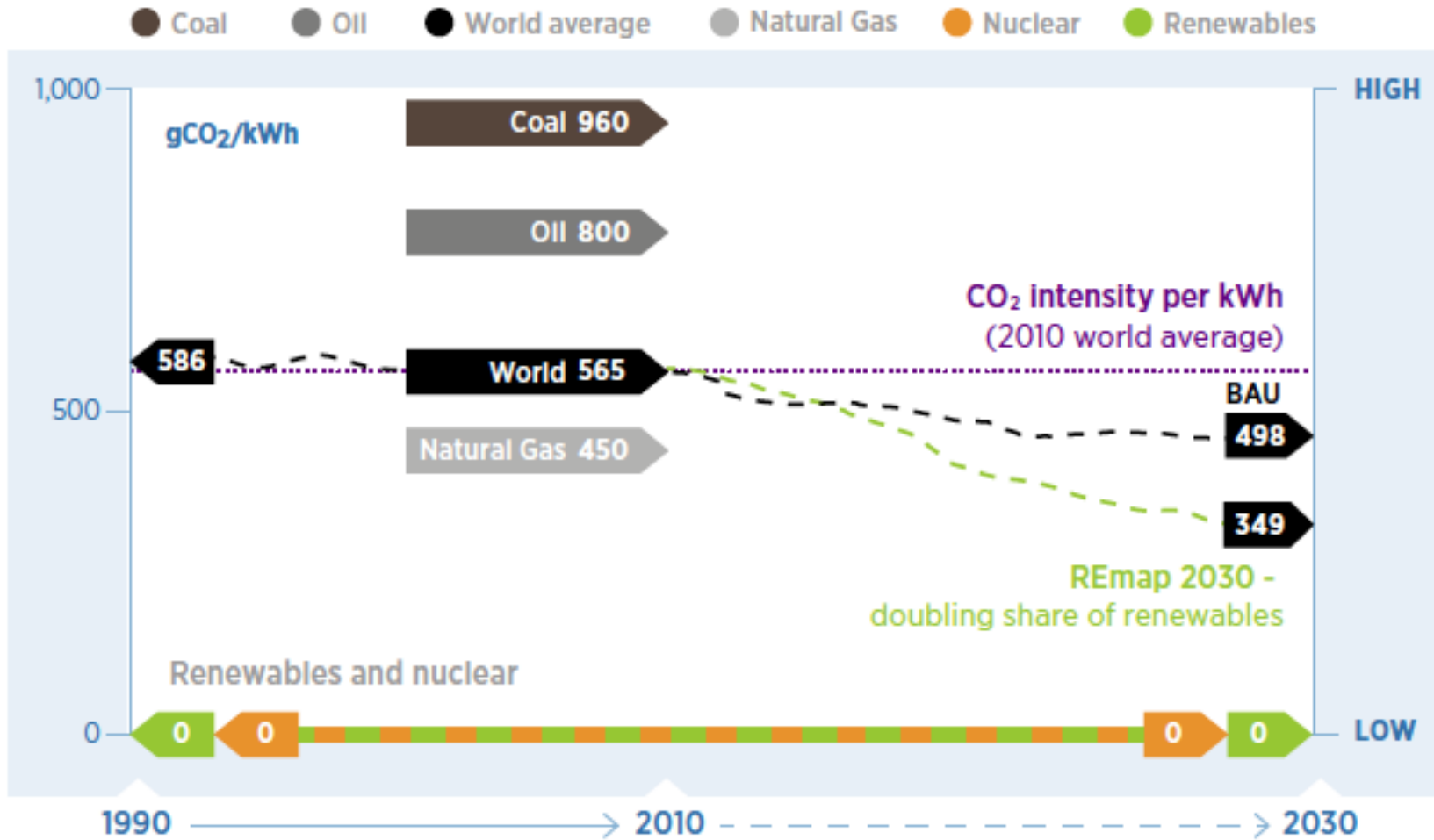
Index, 2008 = 100







# RES contribution to GhG emission reduction



Source: IEA (2010) and IRENA (2014a)



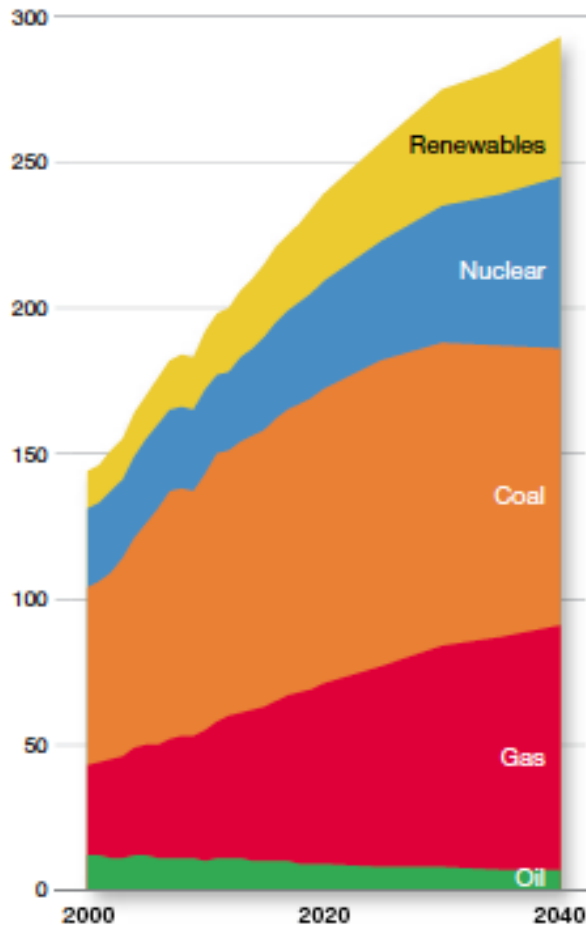


# Someone is still skeptic ...

## Exxon Energy Outlook 2040

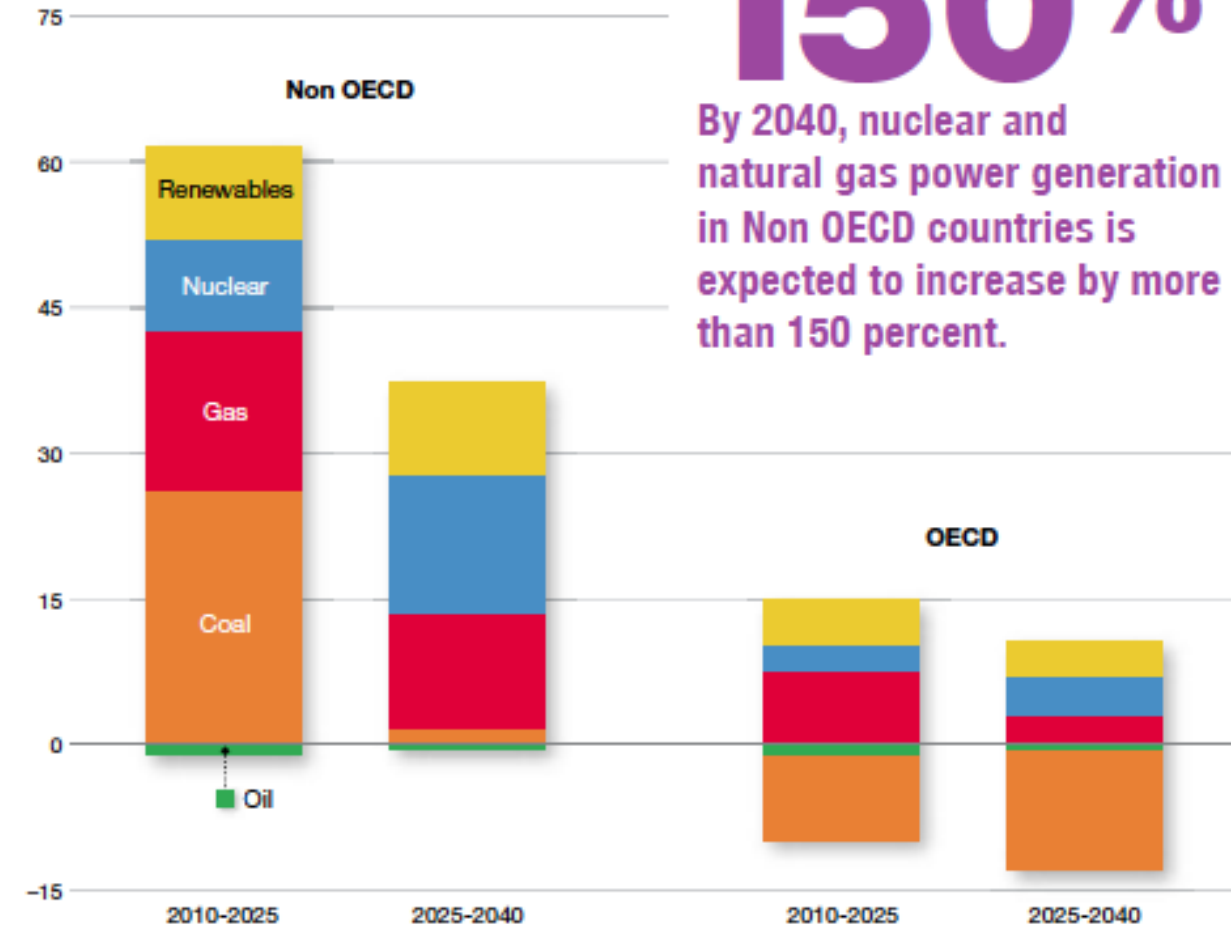
### Fuel into electricity generation

Quadrillion BTUs



### Growth in fuels for electricity generation

Quadrillion BTUs



# 150%

By 2040, nuclear and natural gas power generation in Non OECD countries is expected to increase by more than 150 percent.



# New perspectives

- The environmental constraints have changed the energy sector forever
- The technical innovations are now giving fruits, with new perspectives also in the new markets
- The EU electricity markets are changing and new rules are being written
- The economics of the new system seem to be much better than expected





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