Example of the French electricity mix

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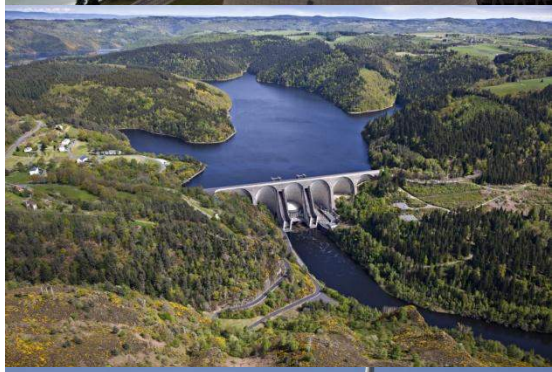

The French electricity mix

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- ❑ System characteristics
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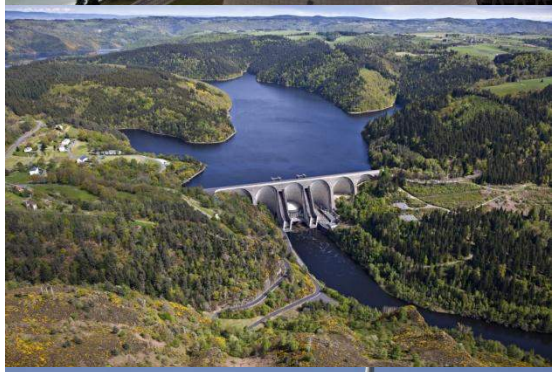
- ❑ Challenges for tomorrow

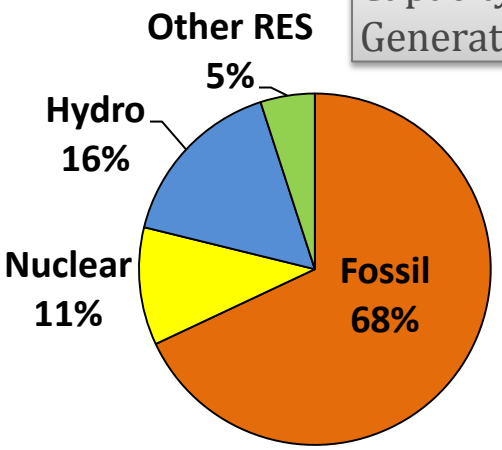


A WORLD ELECTRICITY GENERATION MIX STILL DOMINATED BY FOSSIL FUELS

Nowadays 2/3 of worldwide electricity is generated from thermal sources

World Generation 2012

Capacity: 5 680 GW
Generation: 22 720 TWh



32% low carbon

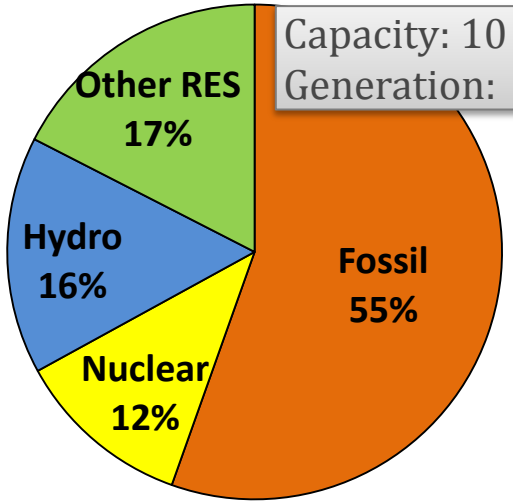
Coal ≥ 800 gCO2/kWh

Gas ≈ 400 gCO2/kWh

Source: IEA WEO 2014

World Generation 2040
"New Policies Scenario"

Capacity: 10 720 GW
Generation: 40 100 TWh



45% low carbon

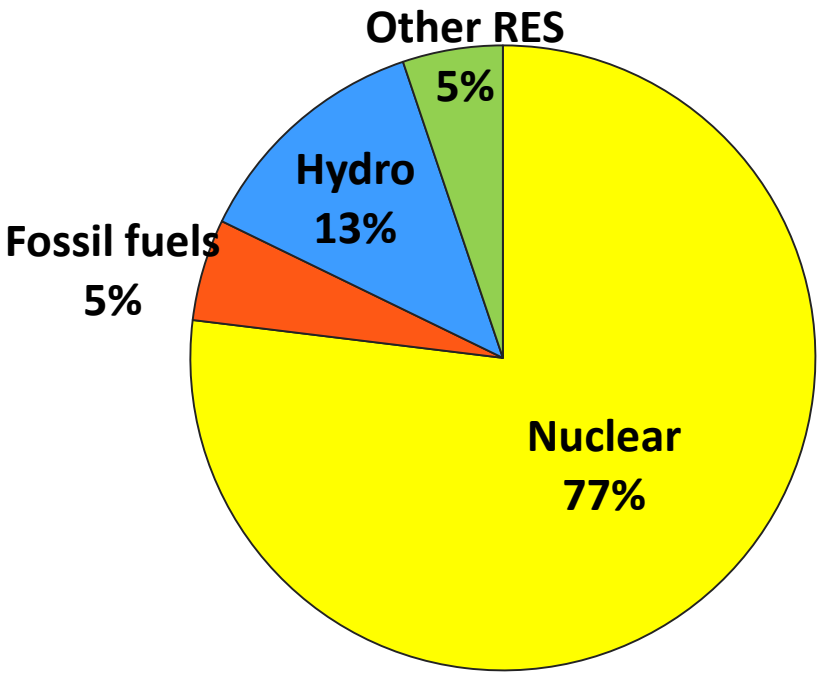
Europe has a more balanced mix between Coal, Gas, Nuclear and RES (about 1/4 of electricity generation each)

BY COMPARISON, FRENCH ELECTRICITY MIX IS 95% LOW CARBON

French electricity mix end 2014 (GW)

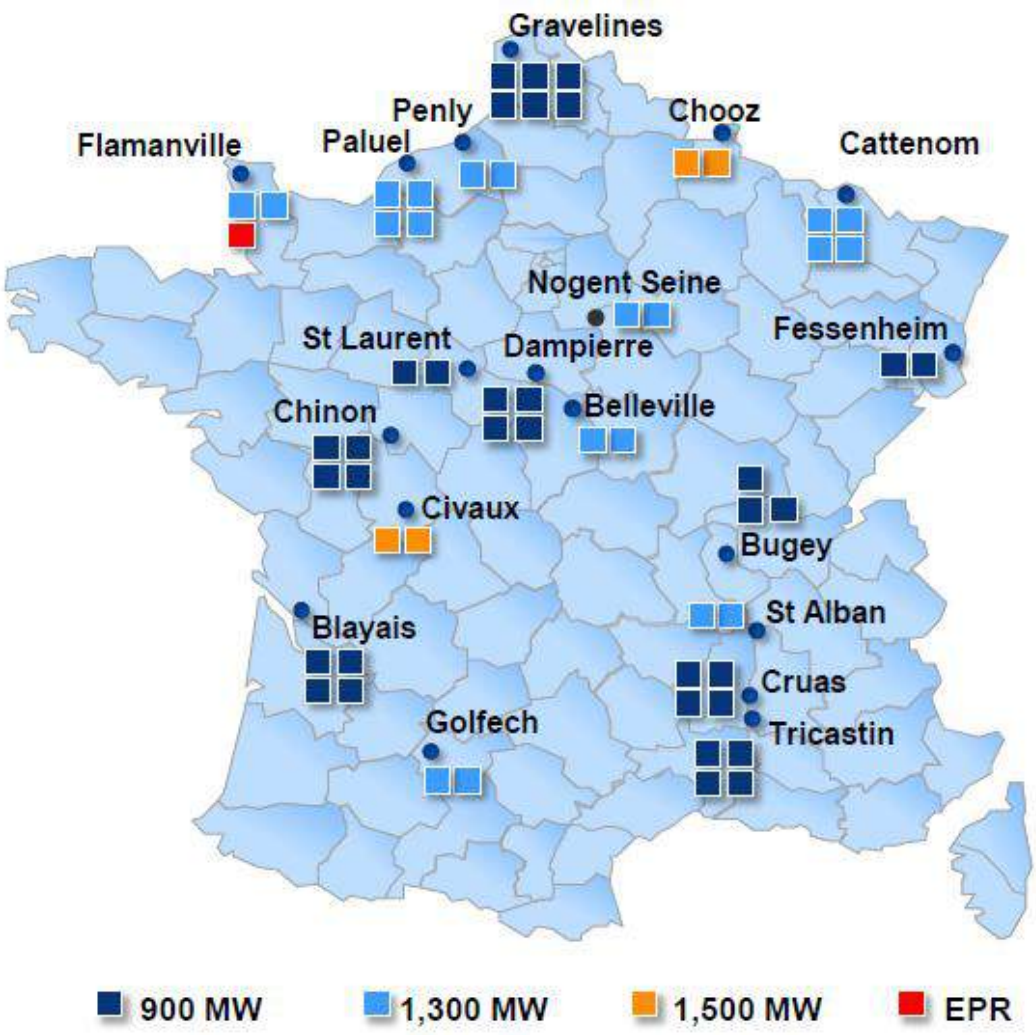
Nuclear	63,1
Hydro	25,4
Other RES	16
Fossil	24,4
Total	128,9

French electricity generation in 2014 (TWh)



Source: RTE - Electricity report for 2014

EDF PWR NUCLEAR FLEET IN FRANCE



EDF is the first nuclear operator in the world

- **58 reactors** across 19 sites
- COD between 1977 and 1996
- Average age : 29 years
- **63,1 GW** capacity
- **416 TWh** generated in 2014

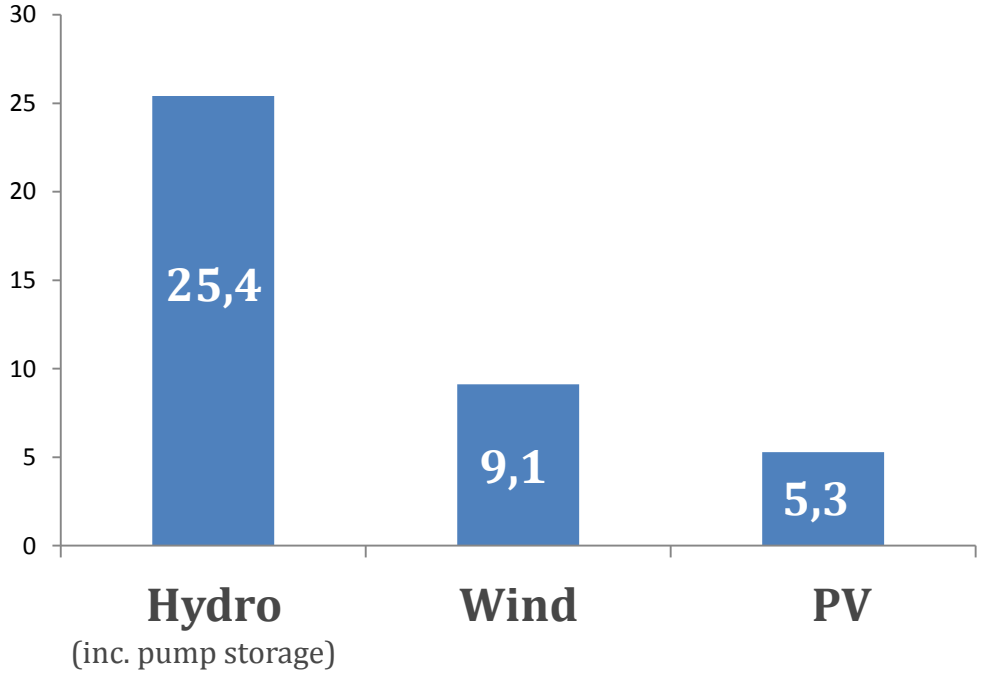
- **1 EPR under construction** at Flamanville

RENEWABLES FLEET IN FRANCE

In 2014: more than 40 GW & 90 TWh

19,5% of power consumption

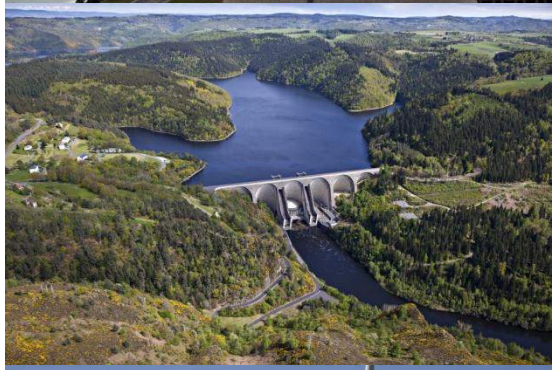
Renewables fleet in France end 2014 (GW)



Source: RTE - Electricity report for 2014

The French electricity mix provides major benefits

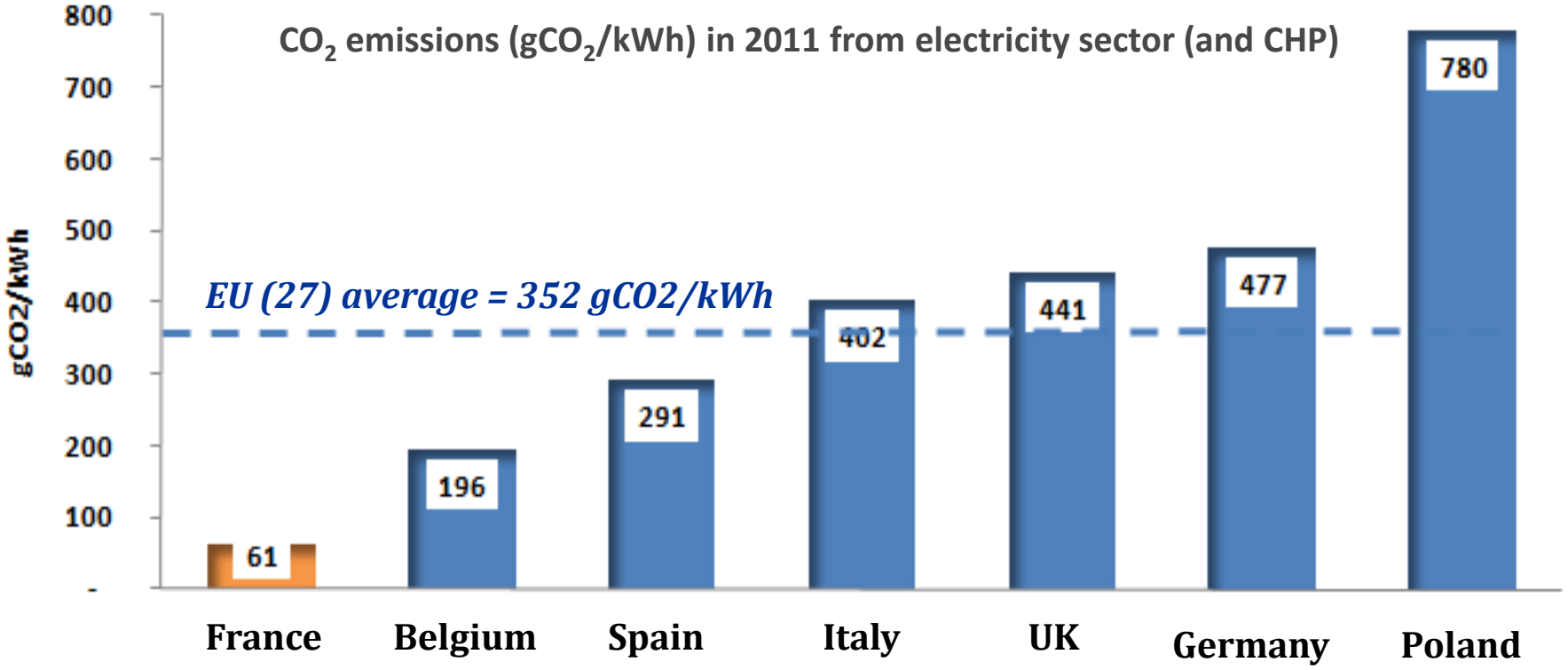
- Low carbon electricity generation
- Affordable electricity
- Security of supply, supporting the trade balance
- A large number of jobs in high performing industries



GENERATION MIX AND CO2 EMISSIONS (1)

CO2/kWh much lower in France than European average

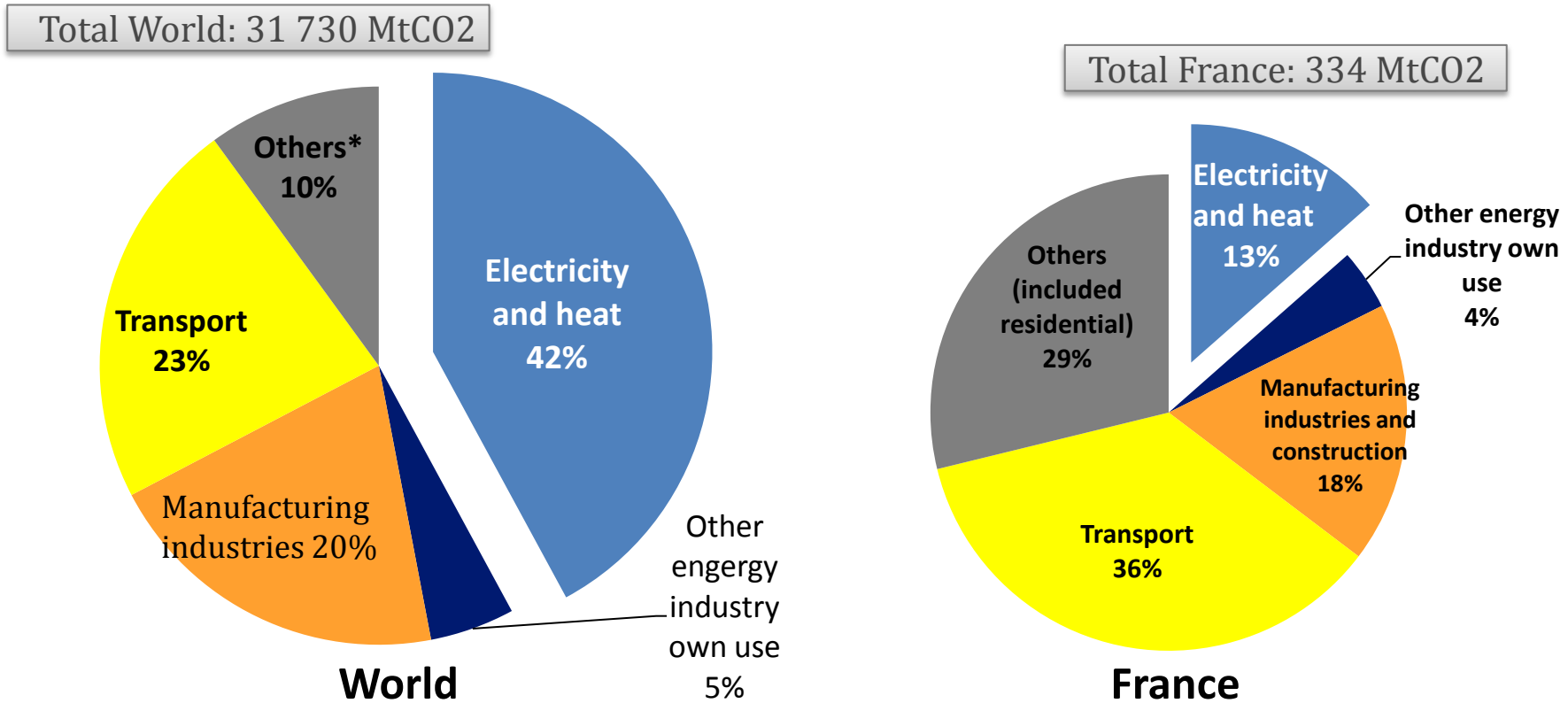
- French electric system CO2 emissions = 19 Mt in 2014 (continental France)
- CO2 factor of EDF mix = 17 gCO2/kWh in 2014 (metropolitan France + part of overseas systems)



Source : AIE Edition 2013 , CO2 Emissions from fuel combustion

GENERATION MIX AND CO2 EMISSIONS (2)

CO2 emissions by sector in 2012



40% of the CO2 world's emissions come from electricity and heat production.

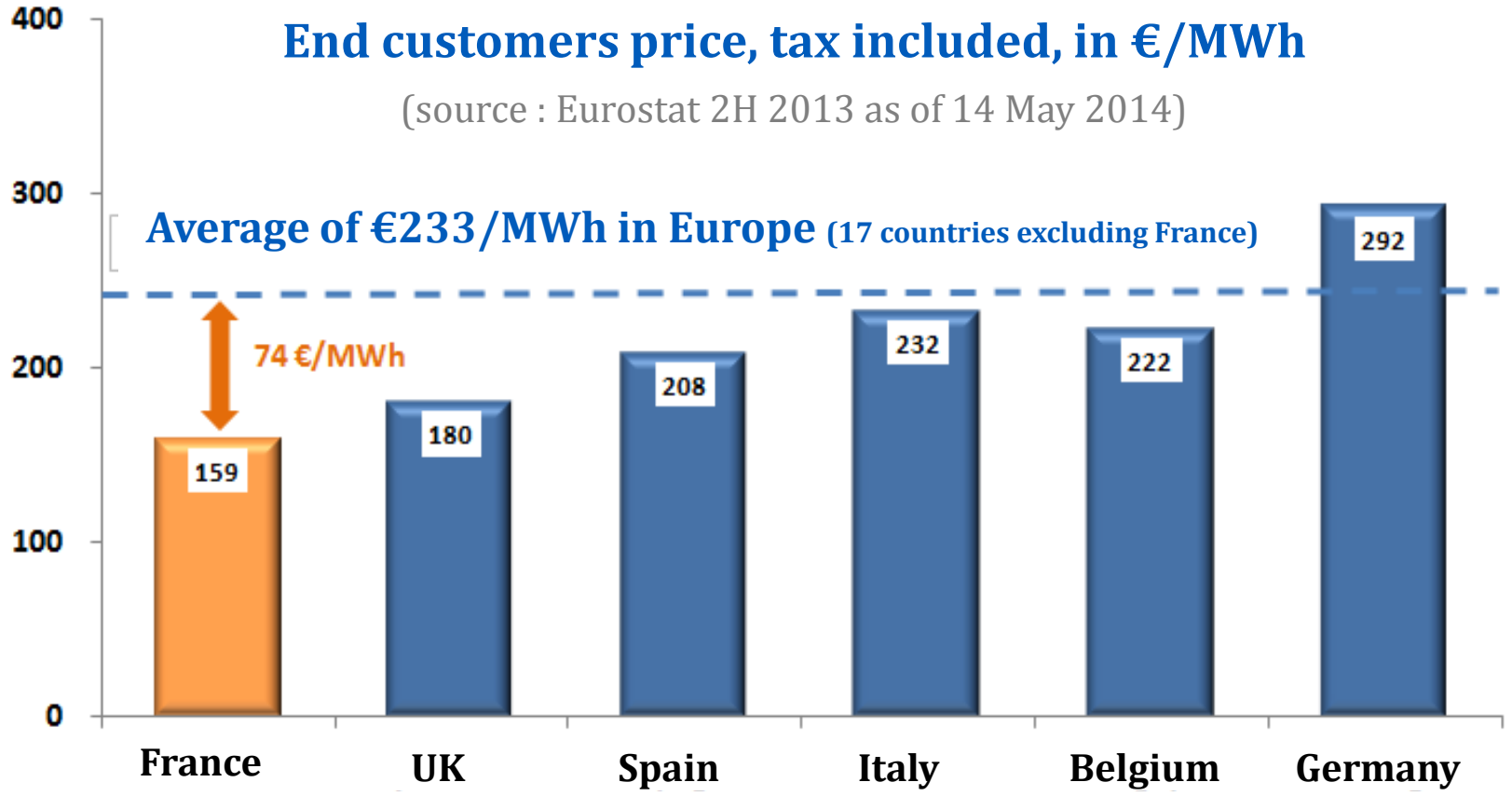
Low carbon electricity is a solution to decrease CO2 emissions at national level.

* Others include commercial/public services, agriculture/forestry, fishing, energy industries

Source: CO2 Emission from Fuel Combustion Highlights, IEA 2014

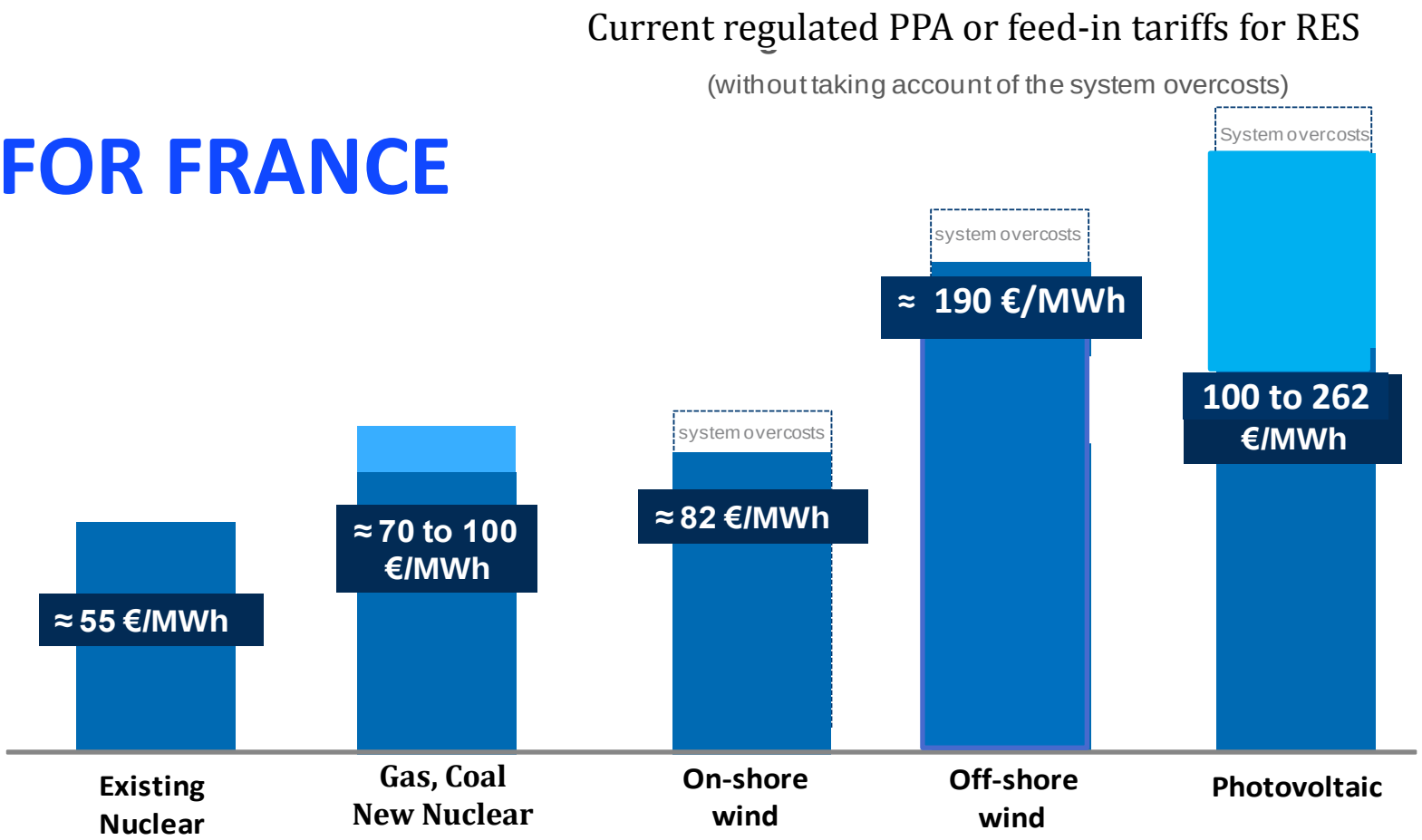
FRENCH CONSUMERS PAY THEIR ELECTRICITY CHEAPER THAN OTHER EUROPEANS

An electricity 30% cheaper than the EU average for residential customers



AN AFFORDABILITY POSSIBLE THANKS TO COMPETITIVE GENERATION MEANS

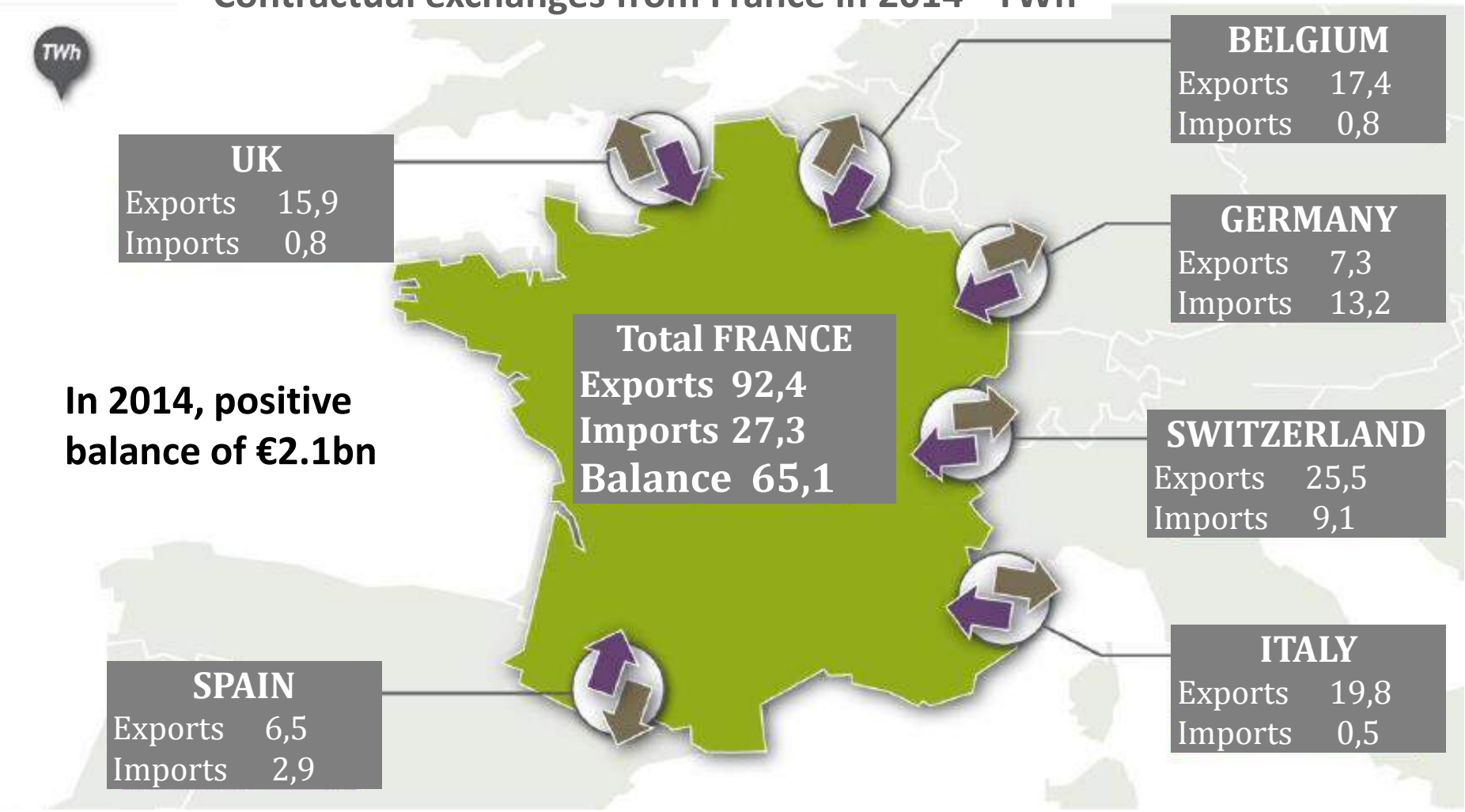
FOR FRANCE



Source: EDF, 2015 based on CRE and Cour des Comptes information

A MIX PROVIDING ENERGY INDEPENDENCE

Contractual exchanges from France in 2014 - TWh



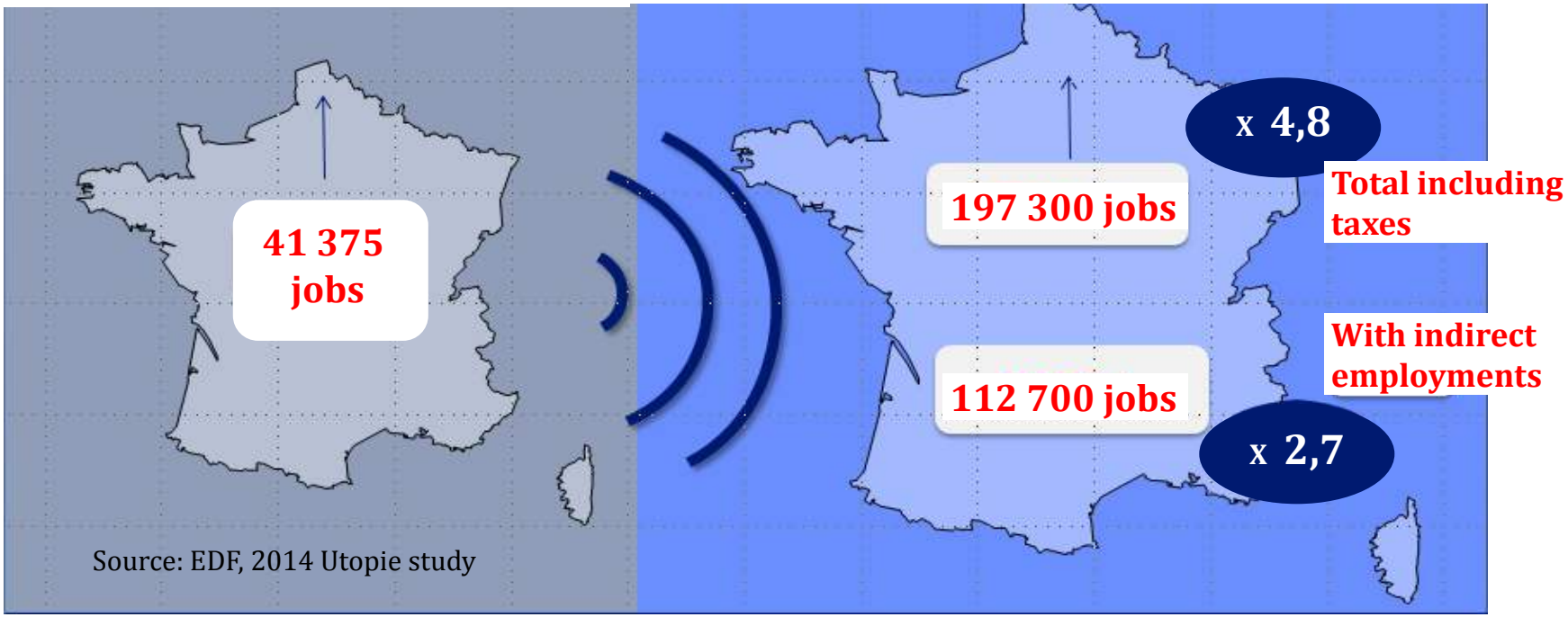
In 2014, positive balance of €2.1bn

Source: RTE - Electricity report for 2014

A MIX CONTRIBUTING TO EMPLOYMENT

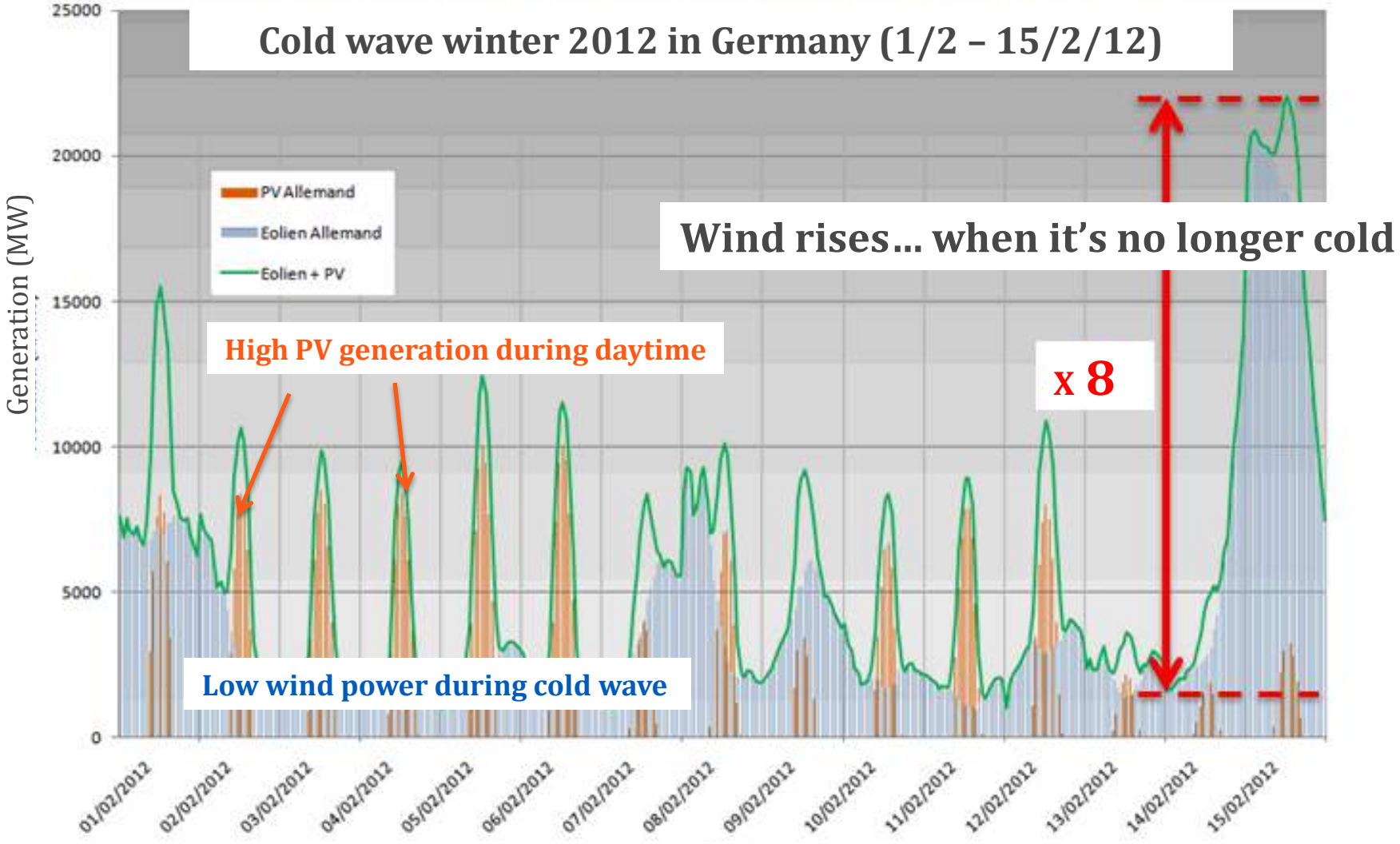
EDF generation mix in continental France

Direct employments **Total employments**



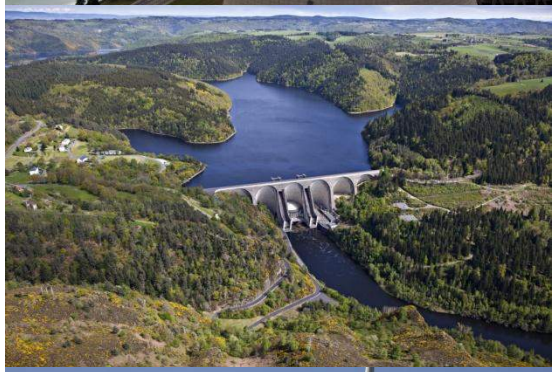
French nuclear industry is the third French industrial sector (220 000 jobs)

DISPATCHABLE MEANS NECESSARY TO FACE PV AND WIND POWER INTERMITTENCY



Challenges for tomorrow

- Industrial challenges
- Market design and regulation
- Future electricity needs



THE INDUSTRIAL CHALLENGE OF "GRAND CARENAGE" PROGRAMME

- **EDF faces an important programme of investments until 2025 in order to renovate and increase even more the safety of its reactors** :
  - Replacement of several main components (steam generators, transformers, alternators...)
  - Significant safety modifications, taking into account lessons learned from Fukushima accident
- **An amount of about** $_{2013}$**€55bn investments until 2025**
- **This programme will be progressively engaged,** in coherence with the strategic plan the new French law about energy transition will require from EDF and the Energy Multiannual Programme

THE INDUSTRIAL CHALLENGE OF NUCLEAR NEW BUILD

- **EDF is constructing an EPR at Flamanville**
- **This EPR is a first of a kind for France :**
  - in a context where no new reactor has been built for years
  - with a safety step (GEN3)
- **Lessons learned will be driven from this development**
- **Work in progress on basic design optimisation by EDF and AREVA**

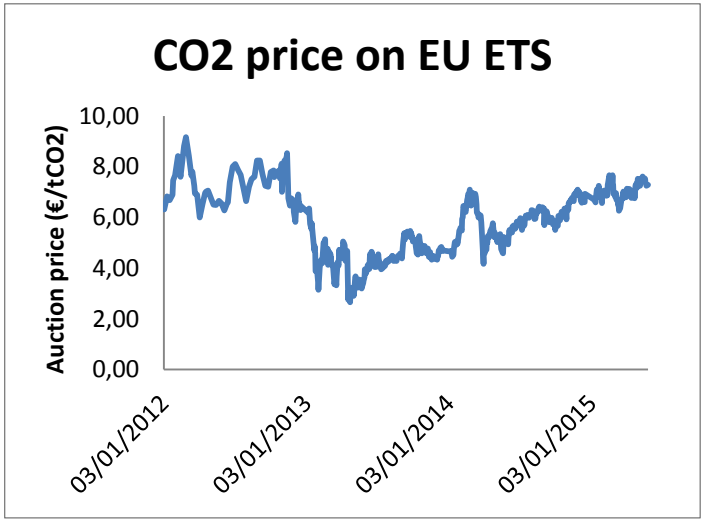
MARKET DESIGN AND REGULATION ISSUES

In a context where :

- RES development is regulated "outside the market" (via feed-in tariffs, calls for tenders)
- Retail prices are rising … while wholesale prices have much fallen

Need for adaptations :

- **CO2 price regulation** : visibility on a more representative CO2 price
- **Capacity mechanisms** : a capacity obligation in 2017 in France
- **Sustainable regulation for renewables and others**

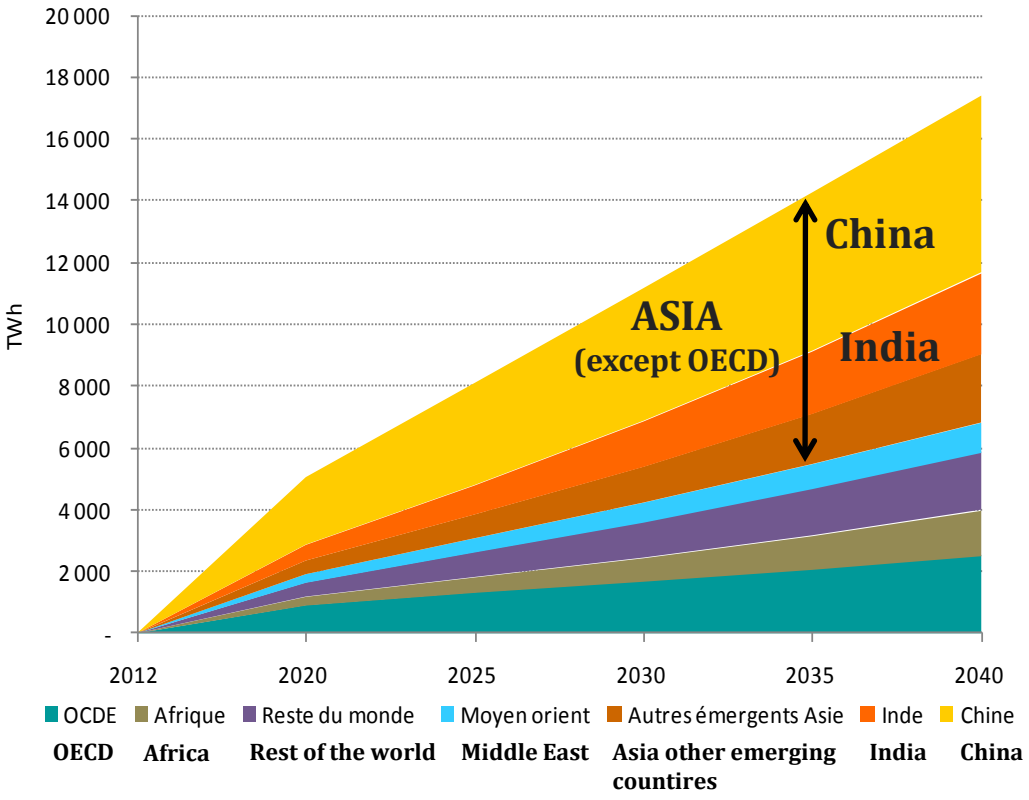


Source: EEX (05 2015)

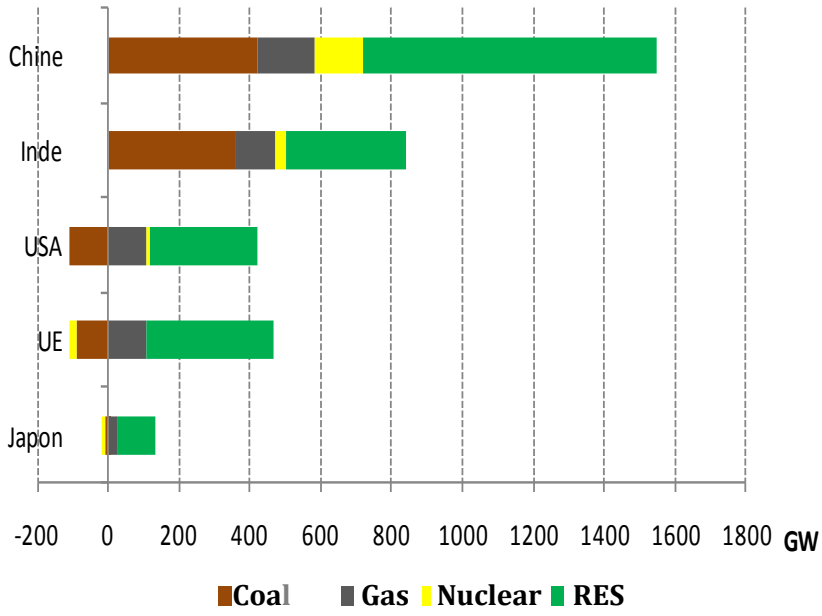
FUTURE WORLDWIDE POWER NEEDS WILL REQUIRE LOW CARBON AND COMPETITIVE GENERATION

A possible increase of power needs around +80% in 2040

Increase of electricity generation (TWh) 2012-2040



Evolution of generation fleets (GW) between 2012 and 2040



Source: IEA WEO 2014

Conclusion

No doubt nuclear will find its place:

As a sustainable, secure and affordable energy,

As a good solution to secure an electricity mix together with the development of RES

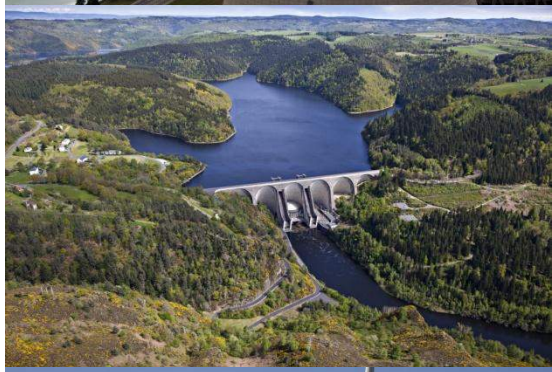
In France:

Nuclear will stay the basis of the generation mix

Nuclear and RES are complementary

In the World:

Nuclear is part of the solutions to decrease CO2 emissions from electricity



Thank you for your attention