

Nuclear Energy Outlook Impacted in Europe by Distorted Electricity Market Prices

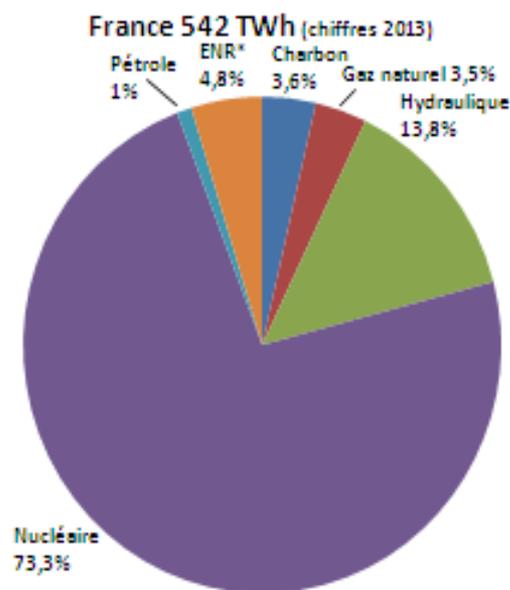
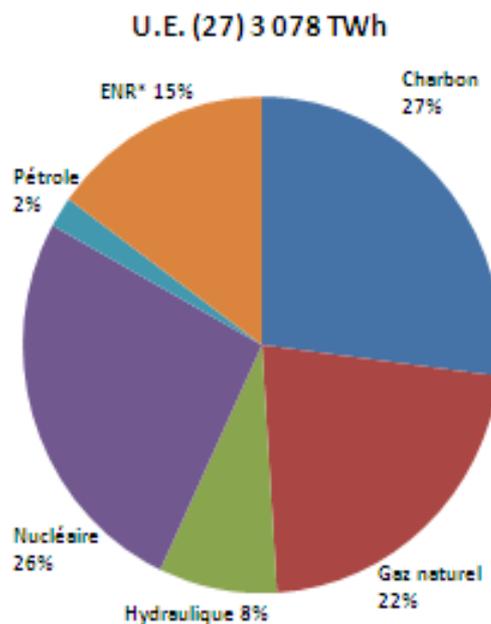
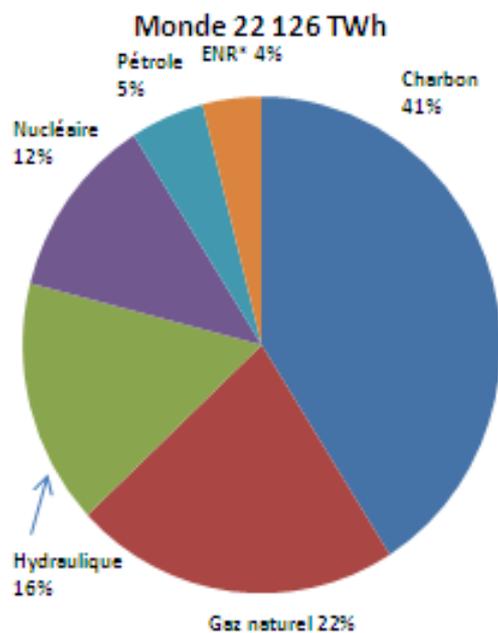
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ASCPE / FORATOM

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In Europe, Nuclear Investments are penalised by Distorted Electricity Market Prices

- **Because of its negative effects, the scheme for aiding renewable energies presently in force in Europe is likely to penalise investments in nuclear energy. The F.I.T. system (feed-in tariffs) is a costly mechanism and a source of perverse effects as a switching of the merit order curve on the spot electricity market (with sometimes negative prices).**
- **Restoring an equity and “equal opportunity” for nuclear energy in Europe needs to implement a “Contract for Differences” scheme for nuclear energy, like the model now gaining favour in the U.K.**
- **Either the market is left on its own to send the signals to all investors (including renewables), or a minimum of regulation is introduced in order to limit the costly surges of under and over capacity. But in the latter case it is necessary to treat all the energy sources in an equal way and guarantee the nuclear industry that it will also recover its fixed costs over the long term.**



Structure de la production d'électricité

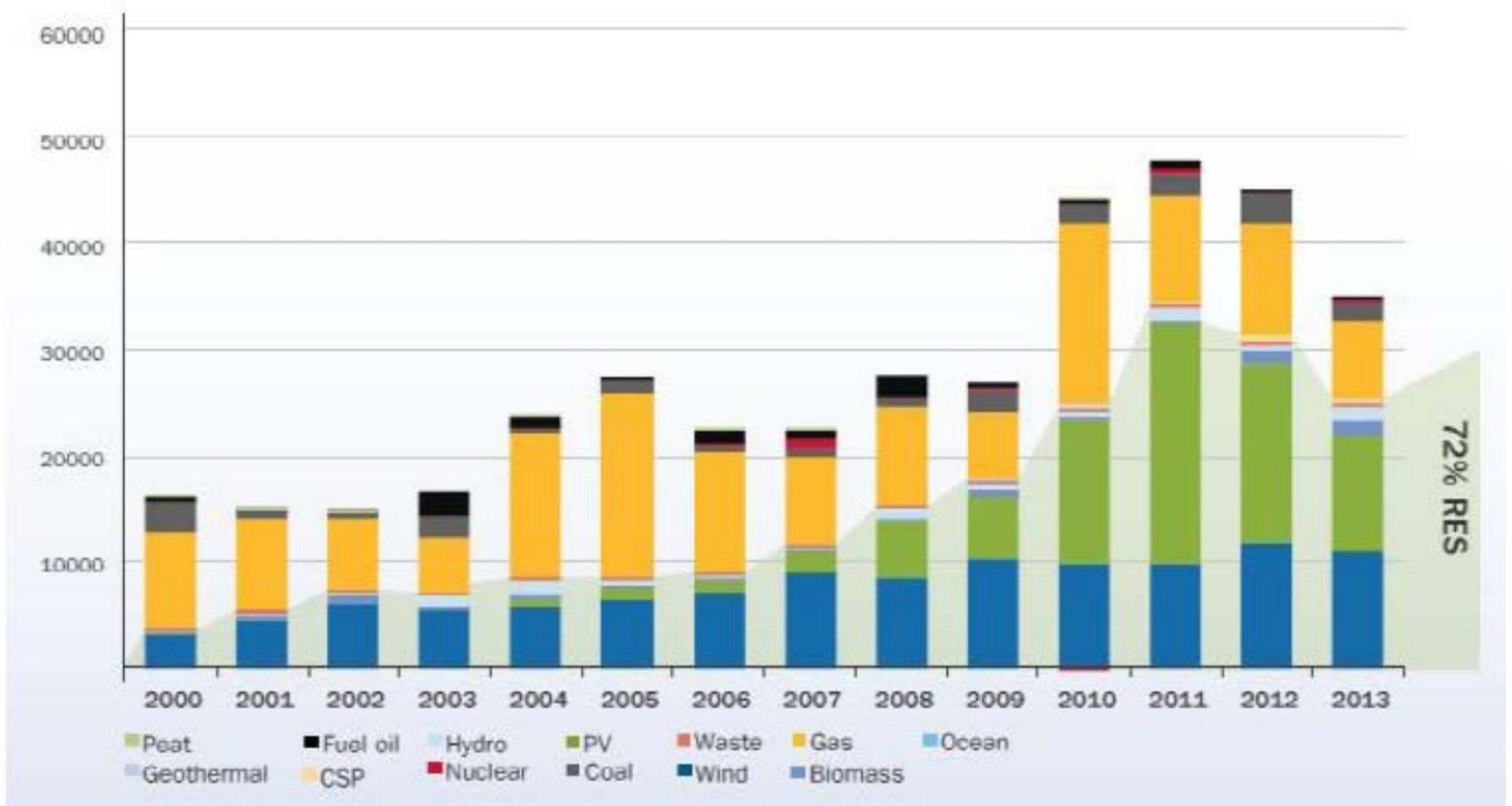
Chiffres 2012, sauf 2013 pour la France. Source : données AIE.

*Les ENR comprennent l'éolien, le solaire, la biomasse, hors hydraulique.

I PERVERSE EFFECTS DUE TO RENEWABLES

- **The nuclear revival is now a reality throughout the world, except in the United States, where the low price of shale gas penalises investments in all the alternative solutions (coal-fired plants, nuclear, etc.) and in Europe, where the dysfunction observed on the wholesale electricity markets penalises investors by the absence of financial aid.**
- **Outside of Europe and North America, nuclear energy benefits from regulated sales prices or financial support which ensure its long-term profitability. This is notably the case in Asia, and especially in China. In Europe, renewable energy profits from regulated prices but this is not the case for nuclear energy.**

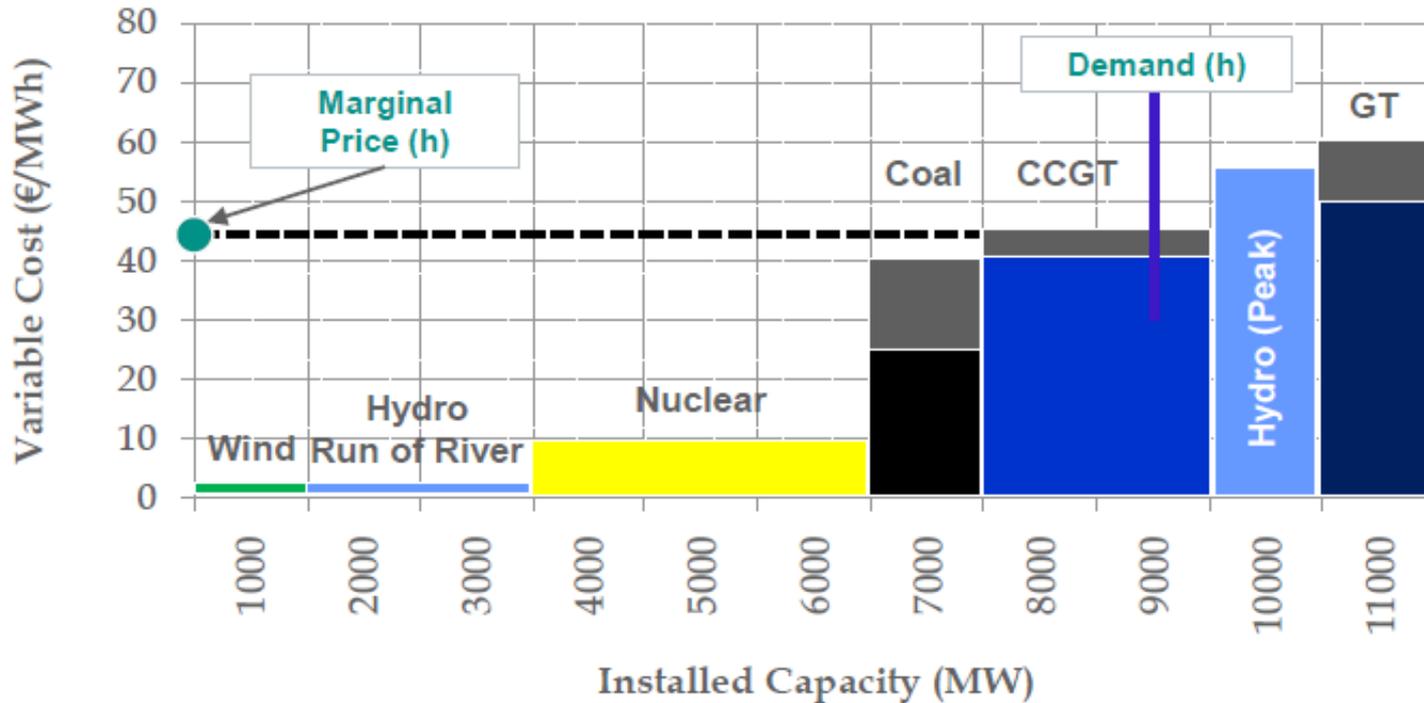
Installed Electricity Capacity per Year (wind in blue; P.V. in green; gas in yellow)



Source: EWEA (2014), p.7

Market Electricity Pricing on the Spot

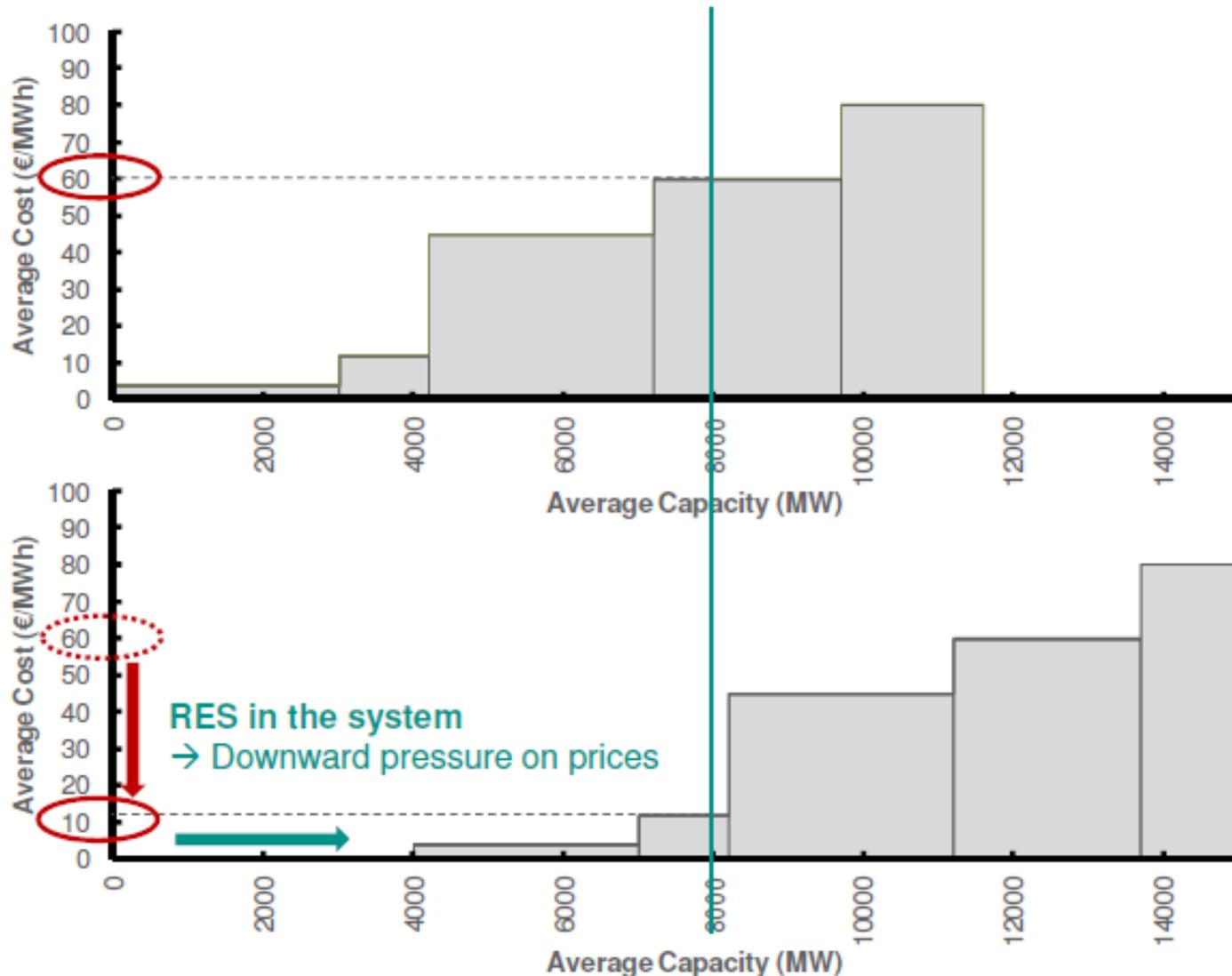
- The electricity price is always based on the marginal cost when electricity demand changes (merit order logic)
- With such a pricing system, fixed costs are recovered during peak periods when, for instance, nuclear kWh is sold on the base of the marginal cost of a thermal kWh



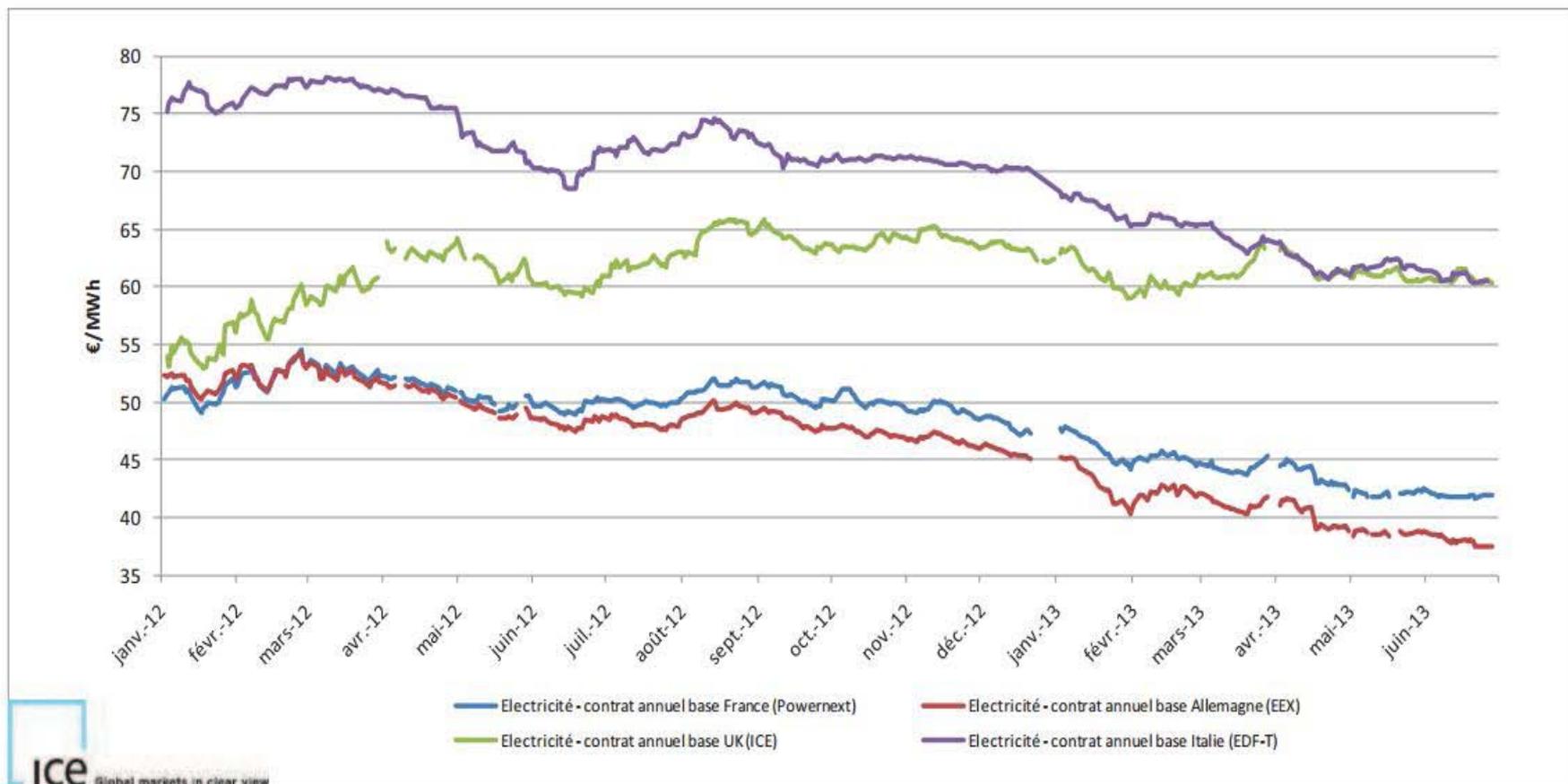
Source : CEEME, GDF Suez

« Switching » caused by renewables: translation of the « merit order » curve

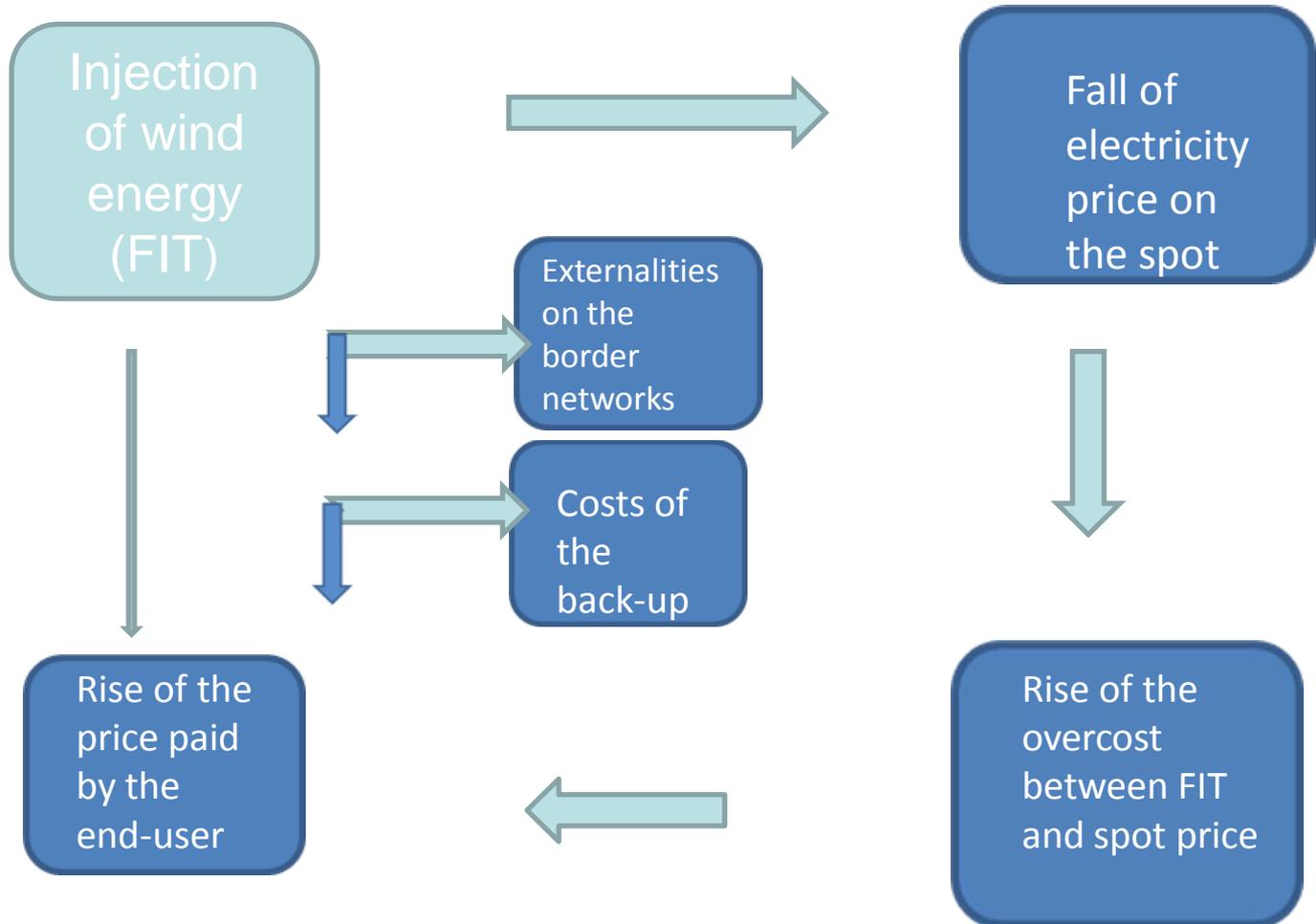
(see Hansen and Percebois 2010)



Electricity spot market in Germany, France, Italy and UK (red: Germany; blue: France; green: UK; black: Italy)



Perverse effects of FIT system (source J Percebois CREDEN)



CONCLUSION 1

The FIT scheme had the merit of encouraging a rapid take-off of wind and solar photovoltaic production;

But this scheme turns out to be quite expensive for consumers and has given rise to undesirable effects on the spot market (negative prices). The renewable electricity producers are not at all responsive to the spot-market price for electricity because they are completely remunerated off-market. We have observed the same perverse effects as those observed with the “Common Agricultural Policy” (PAC)

A FIP (feed-in premium) system is probably a better system: the benefit of this system lies in the fact that producers are completely integrated into the spot electricity market and obtain an adder intended to cover additional costs (subsidy/MW installed)

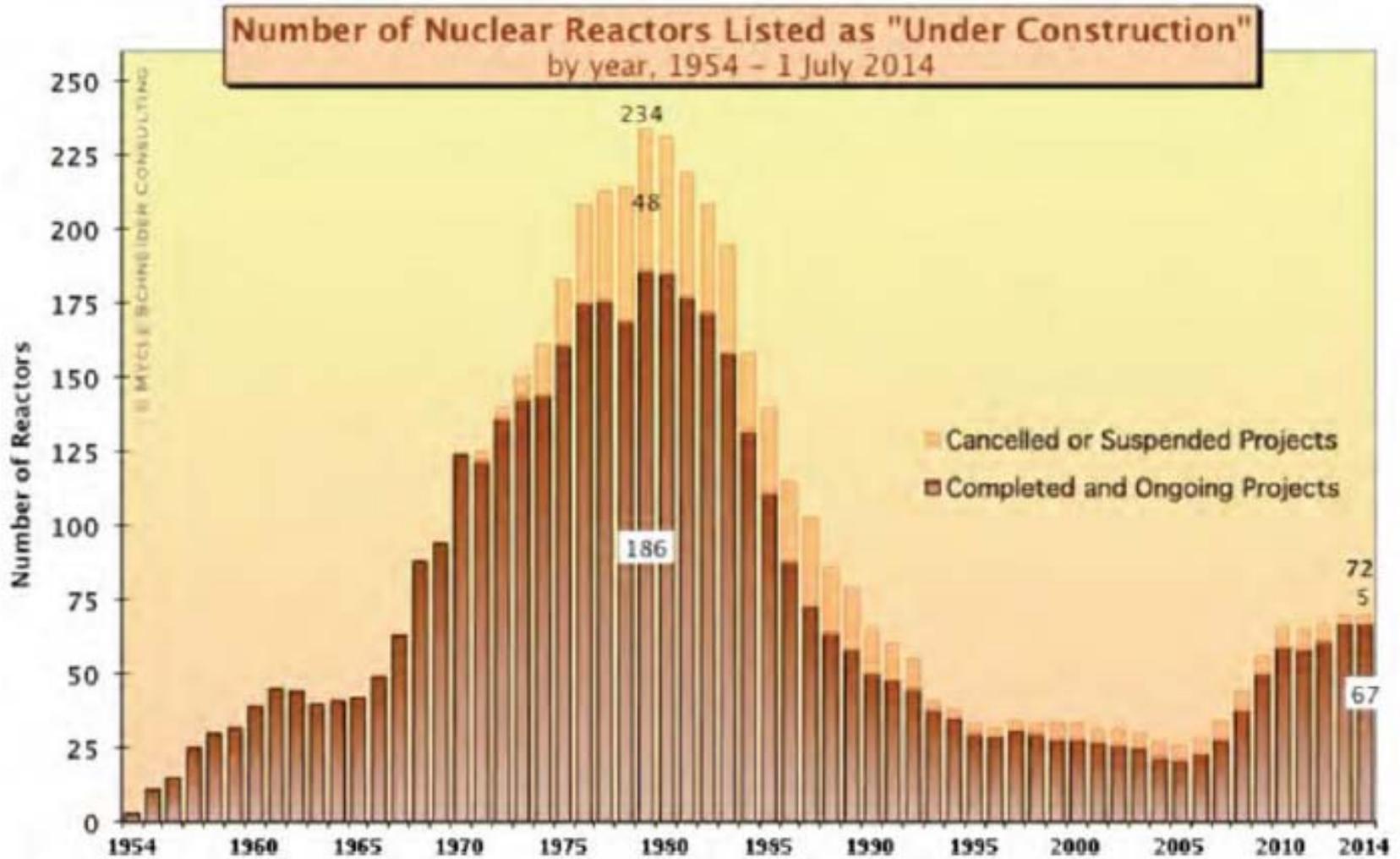
II Nuclear Energy: a cost-effective and carbon-free Energy

- **The perspectives of Nuclear Energy are promising in the World (today and tomorrow with Generation IV)**
- **Reducing the part of Nuclear Energy (French Law) is not justified from an economic point of view (phase-out means economic value destroyed)**
- **The Nuclear Power is an Asset for the European Industry**
- **Low prices for oil and coal, in a context where the cost of CO₂ is very low, are an obstacle for Nuclear Energy take-off...**

II.1.Nuclear Energy Perspectives in the World

- At the beginning of 2015, there were 437 nuclear reactors in operation worldwide, for an installed capacity of about 392 GWe (IEA). Amongst the 31 host countries identified, there were 100 reactors in the United States, 58 in France and 33 in Russia. **Within the European Union, there were 131 reactors installed (in 14 of the 28 Member countries), with a total capacity of 122 GWe. Half of the nuclear energy produced in the EU comes from France.**
- 4 new nuclear reactors are currently under construction in the EU: 1 EPR in Finland, 1 EPR in France and 2 VVER-400 (Russian technology) in Slovakia. Worldwide, 72 reactors, with a capacity of about 75 GWe, are under construction, including 29 in China and 10 in Russia. Many reactors have been ordered or programmed (179 according to the International Atomic Energy Agency, including 60 in China, 31 in Russia and 18 in India), and this is true for countries with significant hydrocarbon resources like Saudi Arabia and the United Arab Emirates.

Number of Nuclear Reactors built on 1954-2014 Period



Source: The world nuclear industry status report 2014, Mycle Schneider

Nuclear Reactors under Construction in the World

source World Nuclear-industry Status Report 2013

1979	1985	1990	1995	2000	2005	2013
186	110	49	27	26	25	72 dont 28 en Chine 9 en Russie 7 en Inde 5 en Corée 3 au USA 1 en France 1 en Finlande Et projets arrêtés (2 EPR au RU)

Costs of Electricity Generation (in euros)

For Renewables: FIT

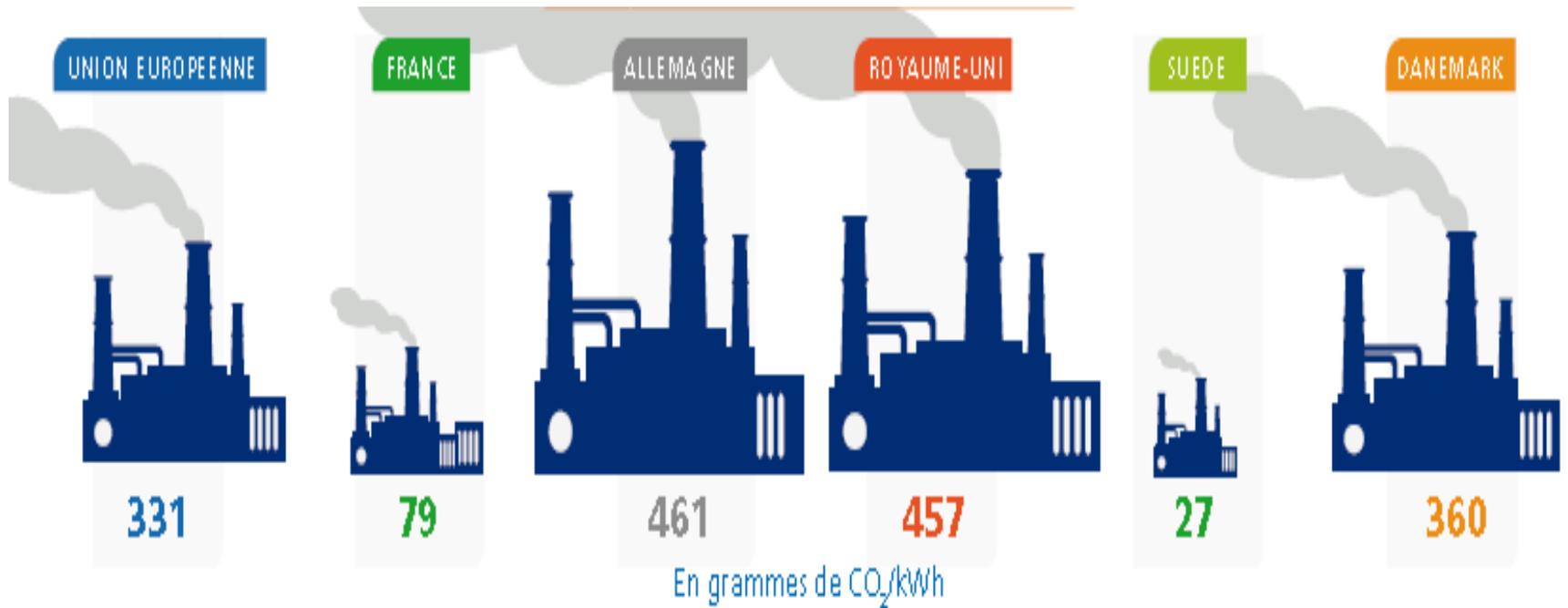
source Rapport de la Cour des Comptes July 2013 and June 2014

NUCLEAR (Generation II)	49,5 but 59,8 in 2014
GAS (GCC)	70
COAL	65
SOLAR (PV)	114-547
SOLAR (THERMO)	94-194
WIND OFF-SHORE	87-116
WIND ON-SHORE	62-102
METHANISATION	61-241
BIOMASS	56-223
GEOHERMAL POWER STATION	50-127
HYDRO	43-188
NUCLEAR (Generation III , EPR)	70-90

Various costs of nuclear MWh

Approaches	Euros/MWh
Cost of new nuclear (Generation 3, EPR) (estimate)	75 -90 –(100?)
Current Economic Cost (with extension of life expectancy investments) (Generation 2, PWR)	54 to 65 (Cour des Comptes)
Current Economic Cost (without extension of life expectancy investments) (Generation 2, PWR)	49.5 to 59.8 (Cour des Comptes)
ARENH (cost for the incumbent EDF taking into account amortized capital and extension of life expectancy investments) (Generation 2, PWR)	39 – 42 (Champsaur)

CO2 Emissions due the Electricity Generation in 2010 (source IEA)



II.2. An Industrial Vision for Nuclear Energy is required

- **1. Priority is Safety (Independent Safety Authority)**
- **2. Necessity to Develop an Long Term Industrial Vision for Nuclear Activities in Europe (Partnership with China or Russia?)**
- **3. A good Scientific Framework for Developing Nuclear Research in Europe (R and D)**

But it is not easy to intensify the European nuclear cooperation in a context where each European country wishes to implement its own energy policy.

The French Nuclear Industry

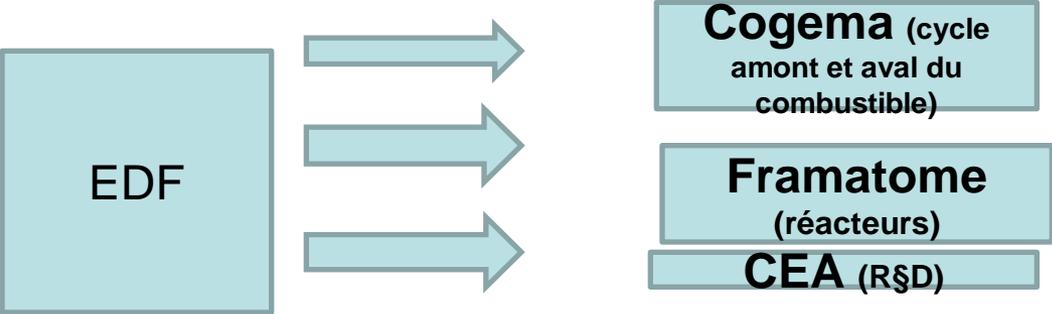
Macroeconomic Figures	%
GDP	2%
Turnover	46 billion euros (5,6 for exports)
Employment	410 000
among	120 000
Direct jobs	23 000
upstream	27 000
reactors	47 000
operating	23 000
downstream	
Indirects jobs	290 000

Role of the French Nuclear Industry in the World

Type of Activity	% of France
Uranium	17% (World Production of Uranium)
Enrichment	22% (World Enrichment) (concurrence britannique et russe)
Fuel Cycle	35% (World Production)
Reactors	6% (World Building of Reactors)(très forte concurrence, de Rosatom en particulier; nécessité de trouver de nouveaux marchés; c'est le point faible; bonnes perspectives de coopération avec la Chine?)
Operating	EDF 1 ^{er} Operator in the World(possède 20% de la puissance mondiale et participe à l'exploitation de 18 réacteurs à l'étranger)

The French Nuclear Industry (in the past and today)

HIER



AUJOURD'HUI



Implementing a Contract For Differences System as in U.K.: the best solution for a nuclear take-off in Europe?

- **It must be indicated at the outset that England's nuclear power stations (the two EPR reactors programmed at the Hinkley Point C site) will not benefit from a subsidised feed-in tariff but from a system close to the CfD (Contract for Differences).**
- **Once the EPRs come into operation, if the market price for electricity is lower than what is considered to be the project's break-even point (the reference price, which is a kind of virtual guarantee price), the consortium will receive a top-up payment corresponding to the difference between this virtual guarantee price and the market price for a period of 35 years.**
- **Conversely, if electricity prices soar and the project payback is greater than the price guaranteeing a given break-even point, the consortium will have to share the profits, this time for a period of 60 years: 70% for the consortium and 30% for UK authorities beyond a break-even point of 11.4%; 40% for the consortium and 60% for UK authorities beyond a break-even point of 13.5%. The reversibility of this agreement is essential. The income supplement will only be granted ex post and in function of a theoretical break-even point for the capital invested. It may be that the future winner will be the UK rather than the consortium.**

CONCLUSION 2

The functioning of today's spot electricity market does not send the right signals to investors, not only because it is a short-term market but also because that functioning is distorted by the presence of electricity at a regulated price set off market. Moreover negative externalities (as CO2 emissions) are not taken into account...

There are two possible solutions to this problem: either the market is left on its own to send the signals to all investors (including those in renewable energies), which is likely to give rise to large fluctuations in investment cycles related to the sharp volatility of the spot prices, or a minimum of regulation is introduced in order to limit the costly surges of under- and over-capacity.

But in the latter case, it is necessary to treat all the energy sources in an equal way and guarantee the nuclear industry that it will also recover its fixed costs over the long term. In essence, that means that there is a need for an energy policy with a long-term vision of electricity supply and demand, taking into account an industrial vision of nuclear industry, but this does not exclude the fact that the market can also send signals to correct the planner's inevitable errors.