Electricity Generation and Renewables under Carbon Mitigation Policies

Nadia Maïzi, Edi Assoumou

Centre for Applied Mathematics
Mines ParisTech

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EU main goal for climate protection

☞ **A firm independent commitment to achieve at least a 20% reduction of GHG emissions by 2020 compared to 1990**

"the European Council is confident that a substantive development of energy efficiency and renewable energies will . . . reduce GHG emissions":

- **stress the need to increase energy efficiency** in the EU so as to achieve the objective of saving 20% of the EU's energy consumption compared to projections for 2020
- **put a binding target** of a 20% share of renewable energies in overall EU energy consumption by 2020

Presidency Conclusions of the Brussels European Council (8/9 March 2007)

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The “triple 20” targets

By 2020

- a 20% reduction of CO_2 emissions level
- a 20% share of renewable energies
- 20% gain in energy efficiency

This study explores the complex links between the three targets through the assessment of different mitigation policies

1. using **long term planning** exercices (MARKAL-Times)
2. delivering insights on **future mix** and **technologies**
3. and focusing on **electricity generation** and its interaction with **renewable ressources**

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Defining scenarios: modelling assumptions

1. The constraints

By 2020

- a 20% reduction of CO_2 emissions level
- 20% gain in energy efficiency

☞ Consequences on renewable energies

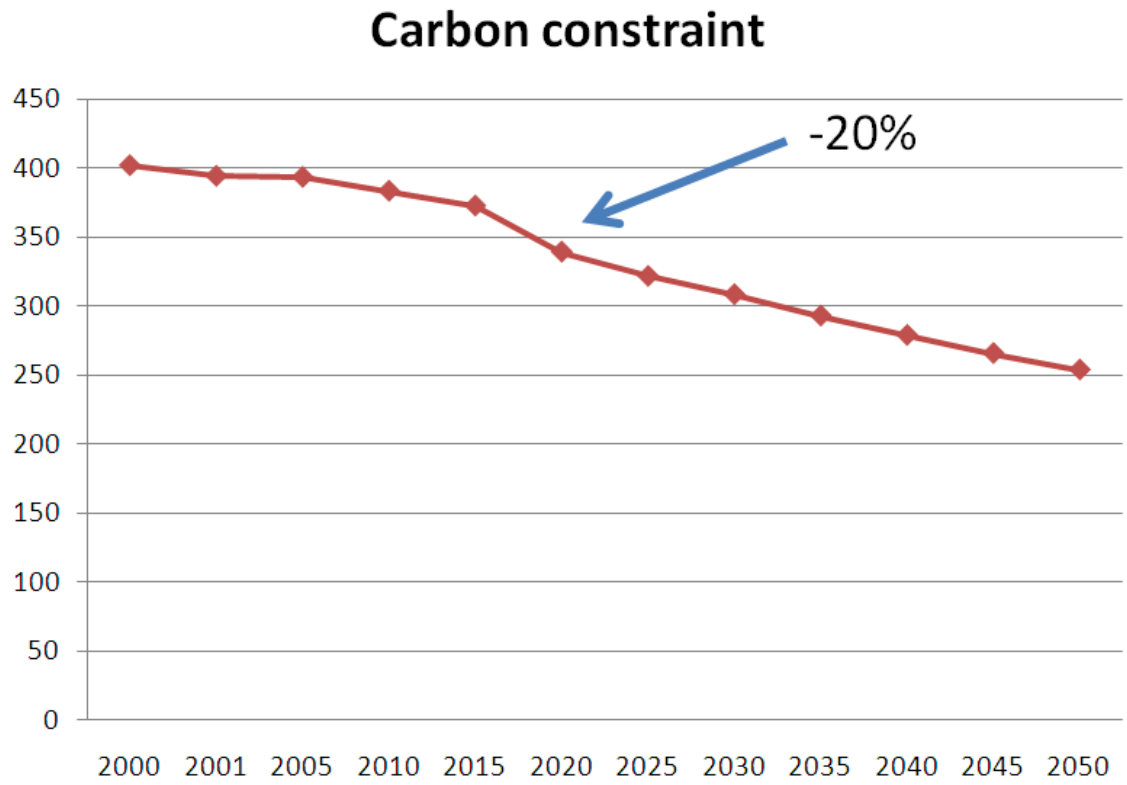
2. An exogeneous demand : low carbon society
3. Macro economical hypotheses : prices, rate

Low-carbon society modelling assumptions: 5 scenarios

Scenarios identified	Efficiency target by 2020	CCS available	Common assumptions
F2	**no**	**no**	**Carbon cap** profile 20 to 50 %
20CP	cut **Primary** by 20%	**no**	**DSM** Voluntary action
20CPSEQ	cut **Primary** by 20%	**yes**	
20CF	cut **Final** by 20%	**no**	**Nuclear** unlimited to 65GW
20CFSEQ	cut **Final** by 20%	**yes**	**Insulation** up to 75% potential

Constraint on CO_2 emission levels

Reduction by 20 % by 2020 compared to 1990 level with a profile reaching a reduction by 50% in 2050



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Energy Efficiency as a quantitative target

Defined as saving of Energy Consumption

Primary Energy Consumption

refers to the direct use at the source, or supply to users without transformation, of crude energy, that is, energy that has not been subjected to any conversion or transformation process.

Final Energy Consumption

the amount of energy delivered to the final consumer's door for all energy.

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EE target as

1. **20% saving on primary consumption**
2. **20% saving on final consumption**

compared to projections for 2020

ref N. Maïzi, E. Assoumou, V. Mazauric "Energy efficiency and the "triple 20" european policy: lessons drawn from the french case", IAEE Conference, Istanbul, July 2008.

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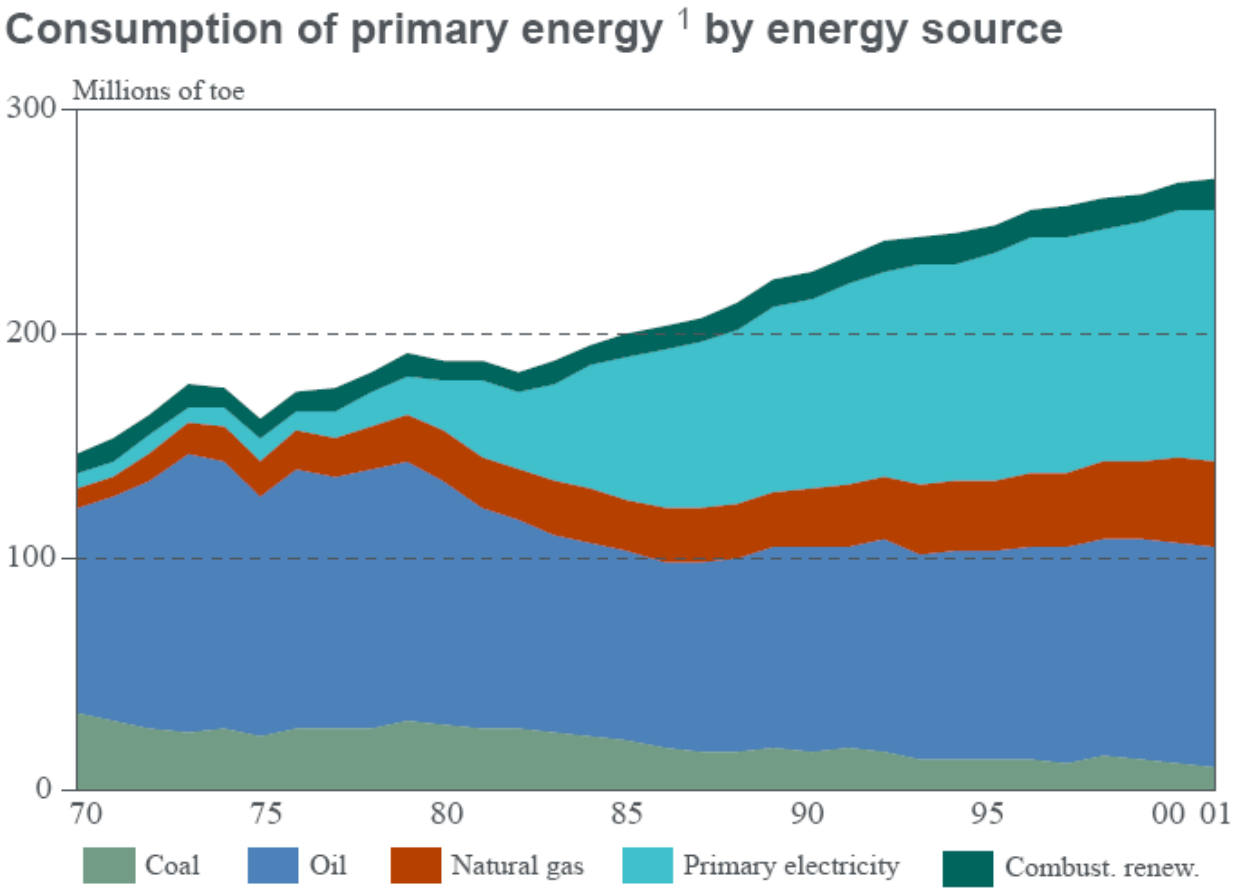
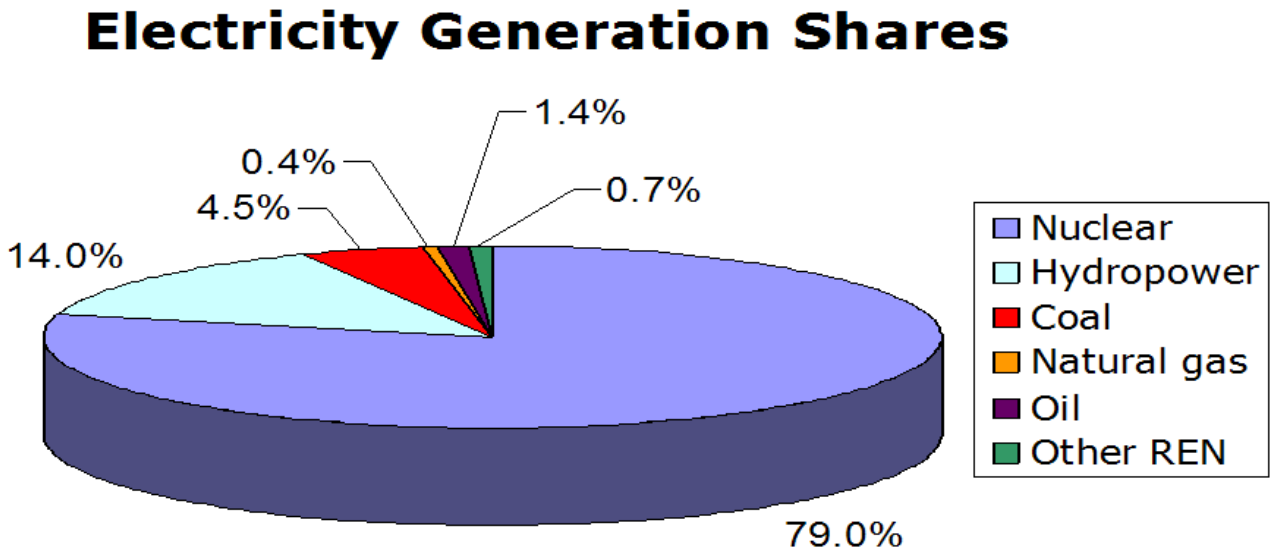
The specifities of France

☞ **French electricity production is dominated by nuclear power (79%)** : *significant weight of primary electricity supply*



1: Corrected for climate.

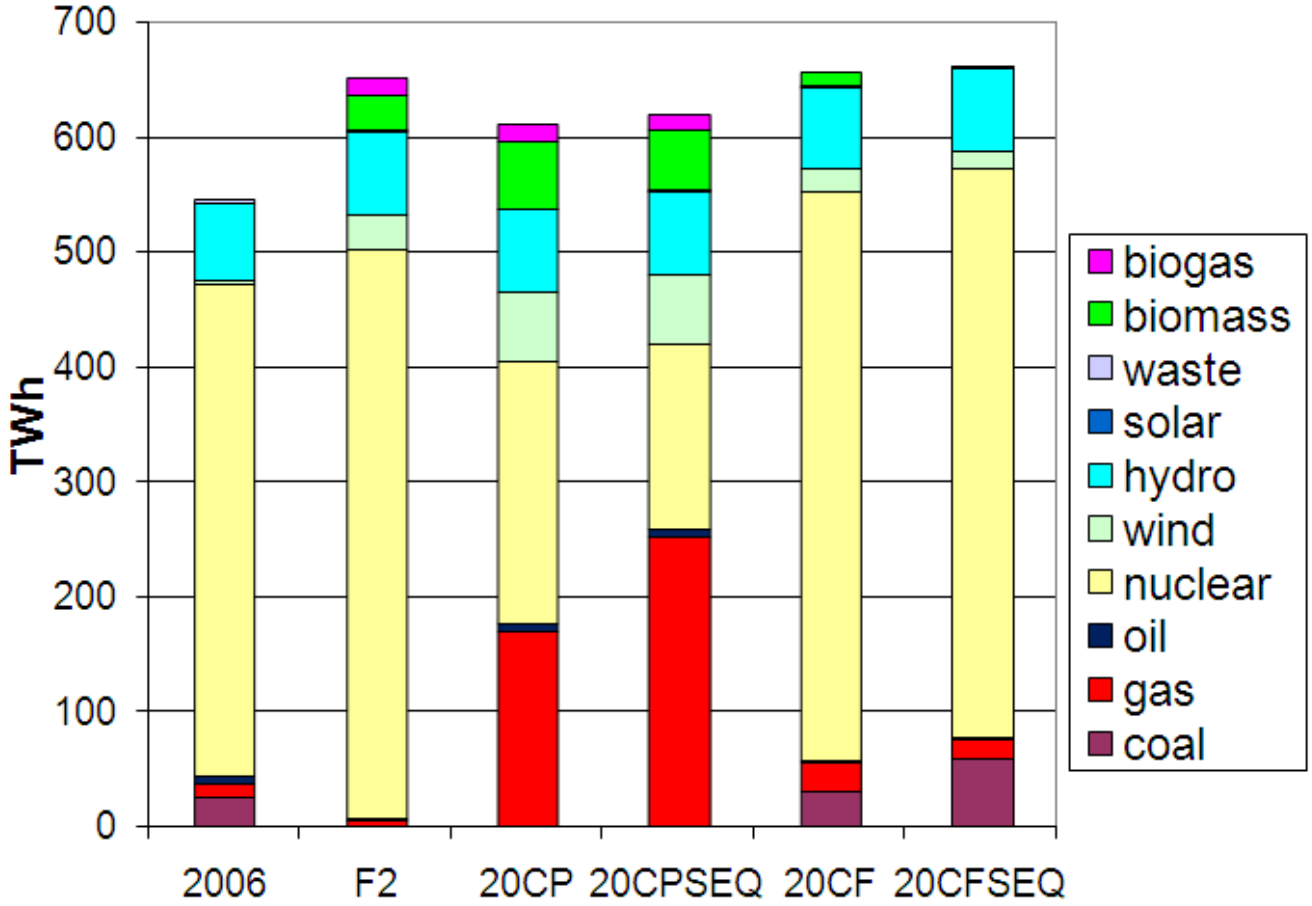
Overview of French electricity generation sector



$\sim$ 500 TWh : A global production dominated by nuclear power (79%)

25 to 30 TWh : A classical thermal production (relying on fossil plants) (less than 6%)

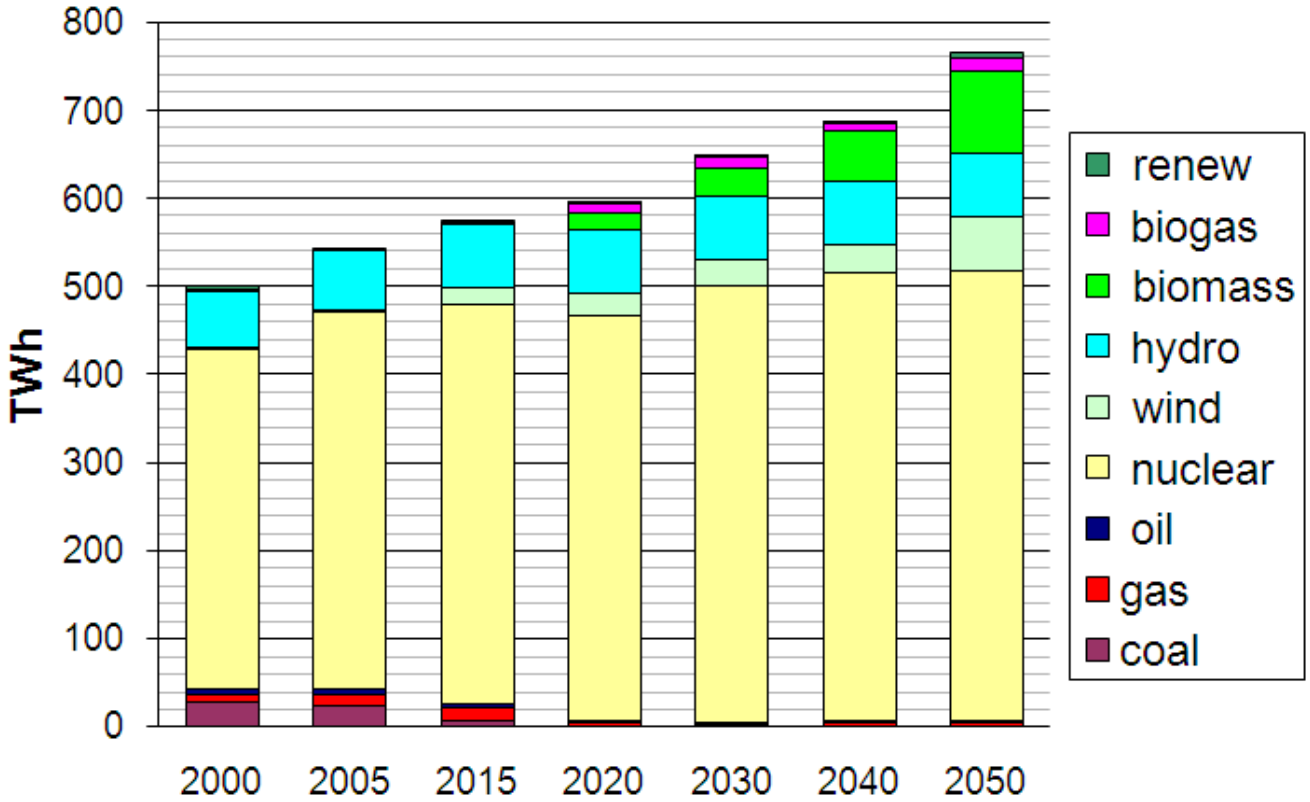
Electricity generation mix in 2030: all scenarios



☞ Contrasted figures (mix and volumes): need of further investigations.

2030 production levels : F2 = 650 TWh, 20CP = 610 TWh, 20CF = 654 TWh

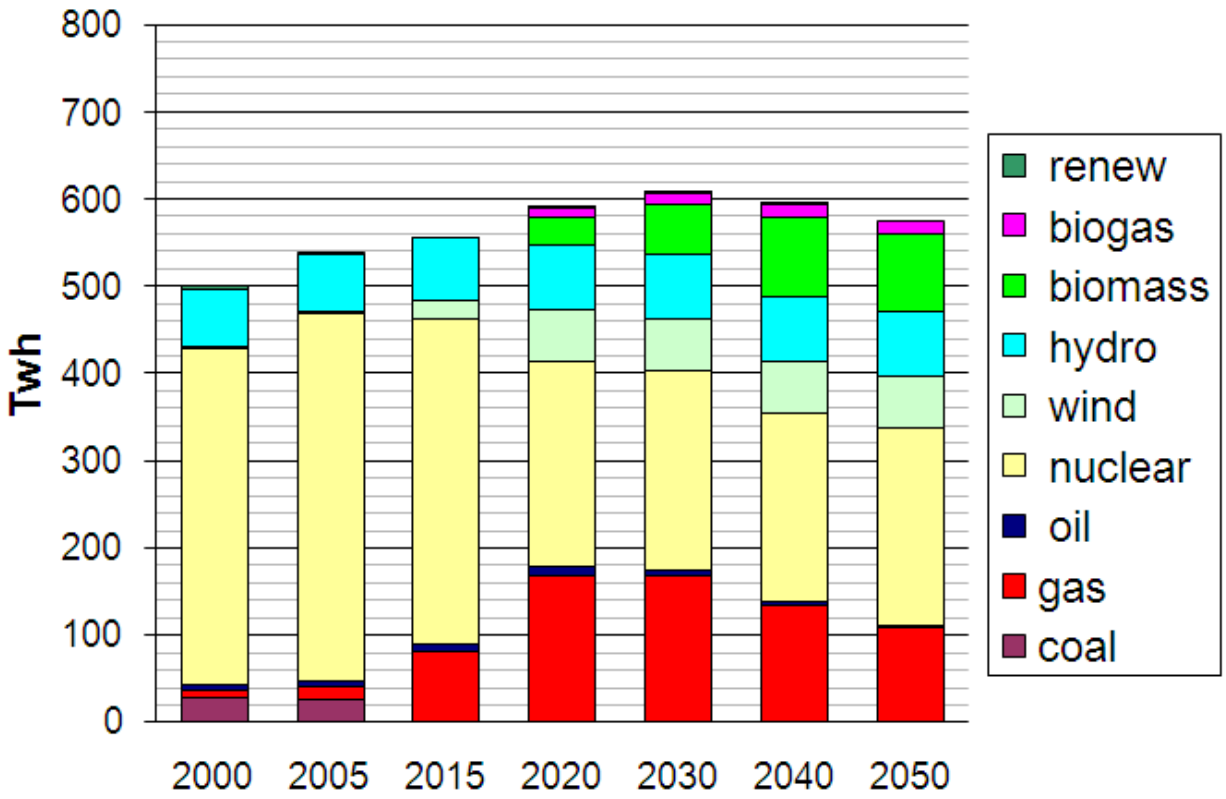
Electricity generation mix: scenario F2



☞ Nuclear power remains dominant:

For an only low carbon objective: cost-competitive and carbon-free generation technology; renewable increase are fostered.

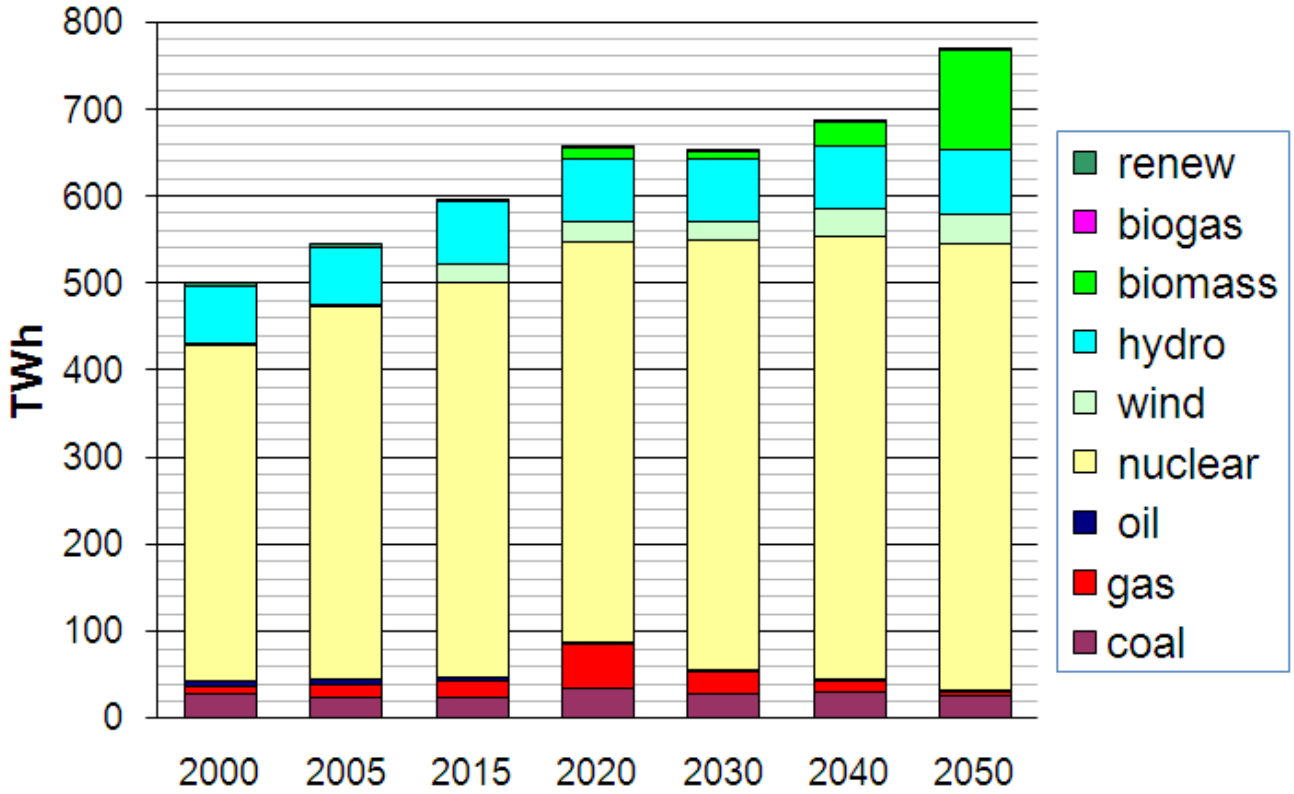
Electricity generation mix: scenario 20CP



☞ A sharp decrease of nuclear:

Low efficiency of Carnot cycle combined with a (Low carbon objective + energy consumption reduction policy) favour fechnologies with high primary efficiency : Gas fired CC (60 % efficiency), hydro, wind, biomasse.

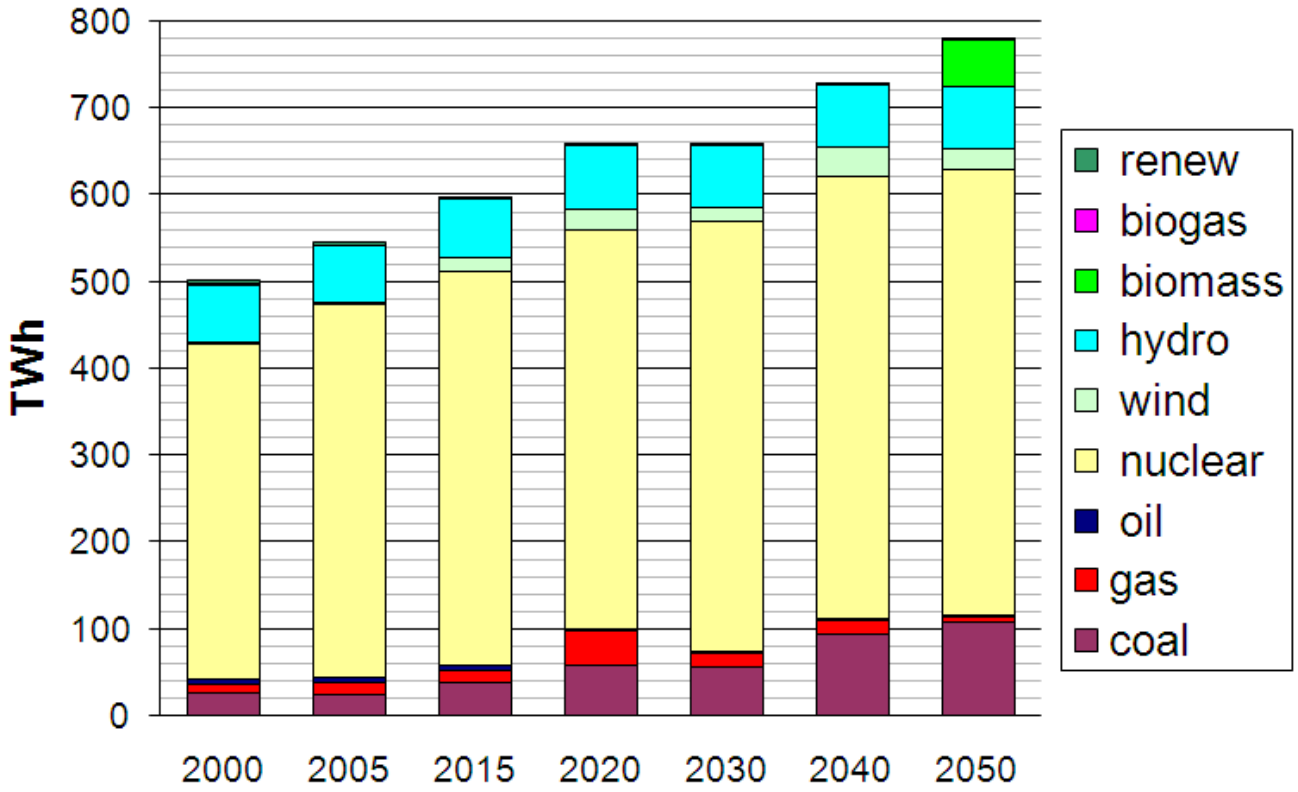
Electricity generation mix: scenario 20CF



☞ Electricity generation increases:

Electrical appliances are fostered because of their high end use efficiency; but contribution of renewable is lowered (low carbon objective is easiest to achieve even with gas and oil fired plants).

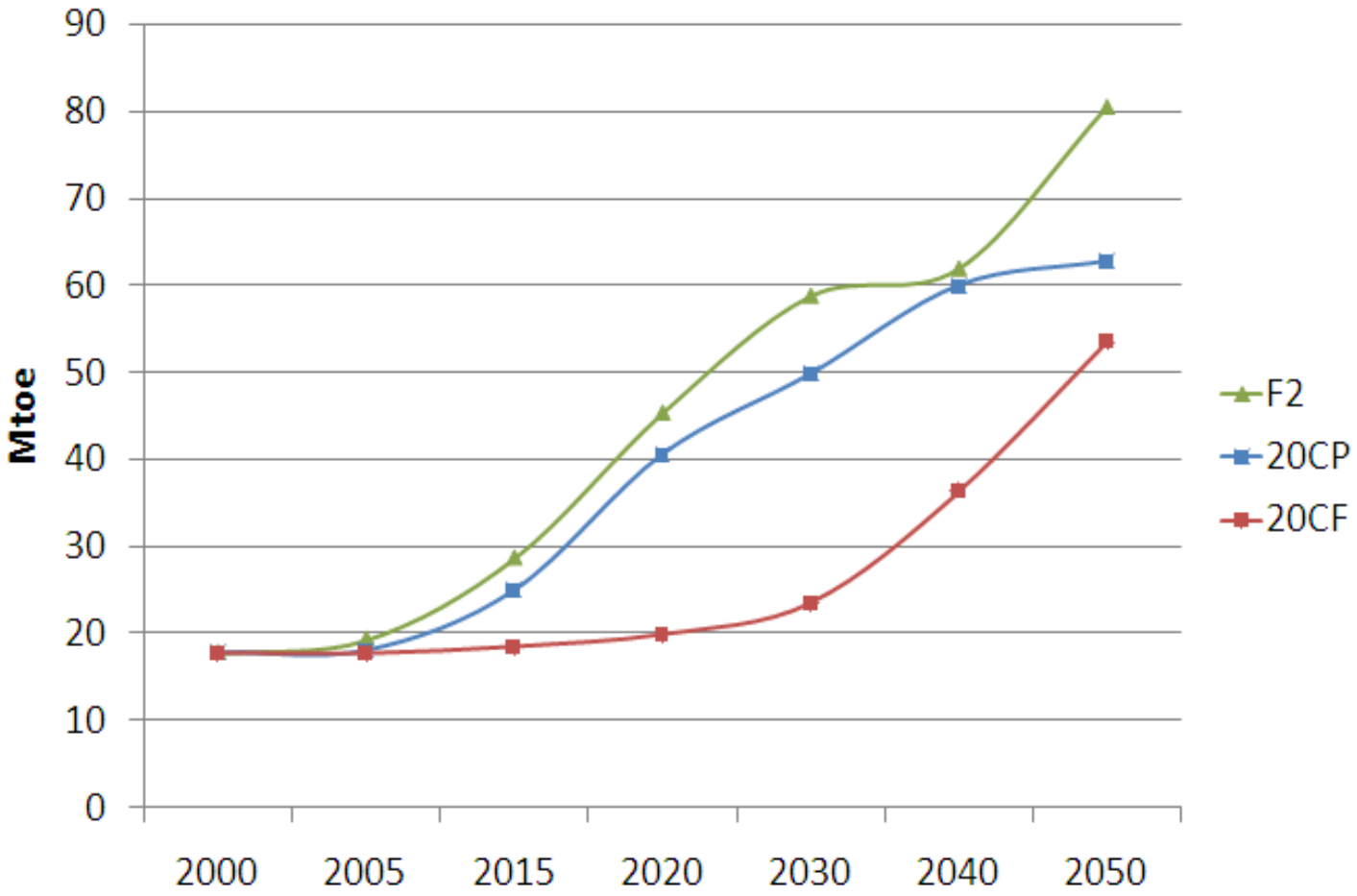
Electricity generation mix: scenario 20CFSEQ



☞ CCS pushes towards more fossil energy and less renewables:

CCS availability allow for more oil and gas in the trade-off between cost and efficiency.

Primary use of renewables for all scenarios



☞ Relatively smooth evolution still hiding a wide range of behavior and a great disparity between renewable sources and use.

Electricity generation and renewables in France

1. Solid biomass
   - Today 9 Mtoe are converted in energy mainly for space heating 8.3 Mtoe
   - Biomass potential today could be more than tripled: agricultural land, third forest in Europe.
2. Geothermal : Heat pumps and electricity
3. Biofuels and electricity

Ref N. Maïzi, E. Assoumou “Electricity Generation and Renewables under Carbon Mitigation Policies”, Conference IEEE Energy 2030, Nov 2008, Atlanta.

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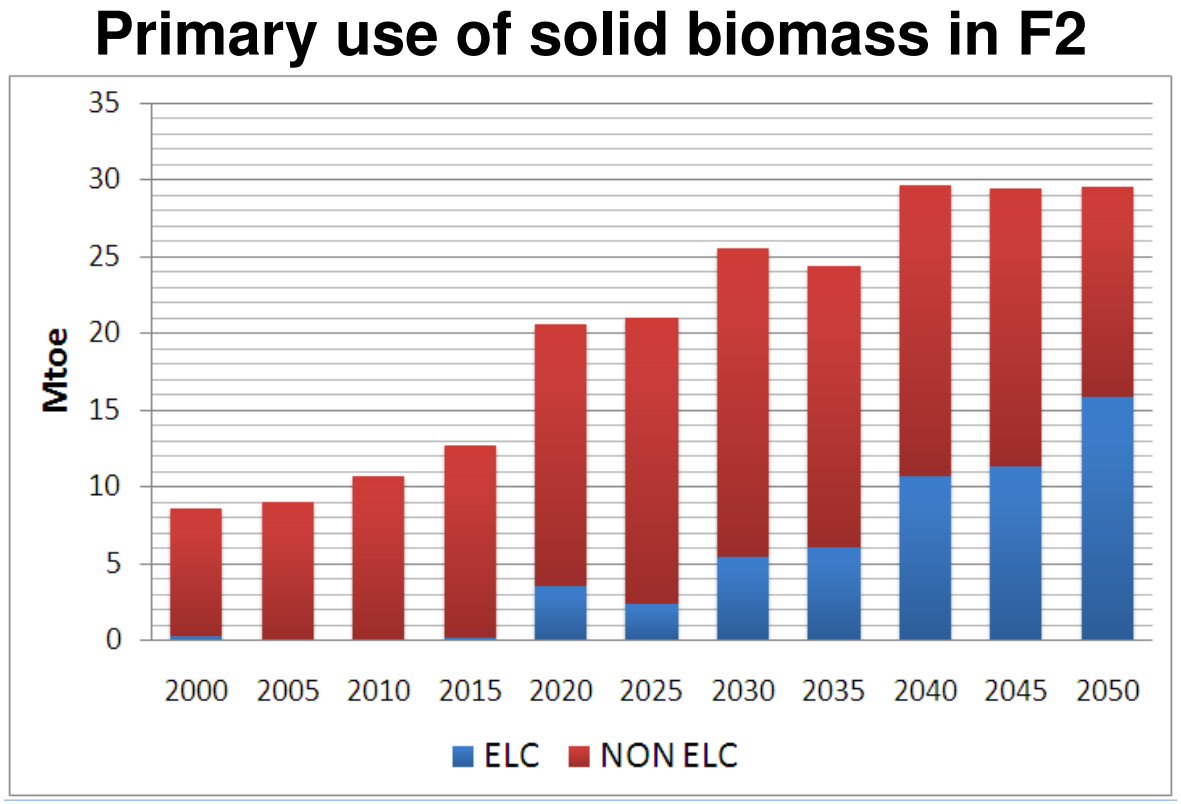
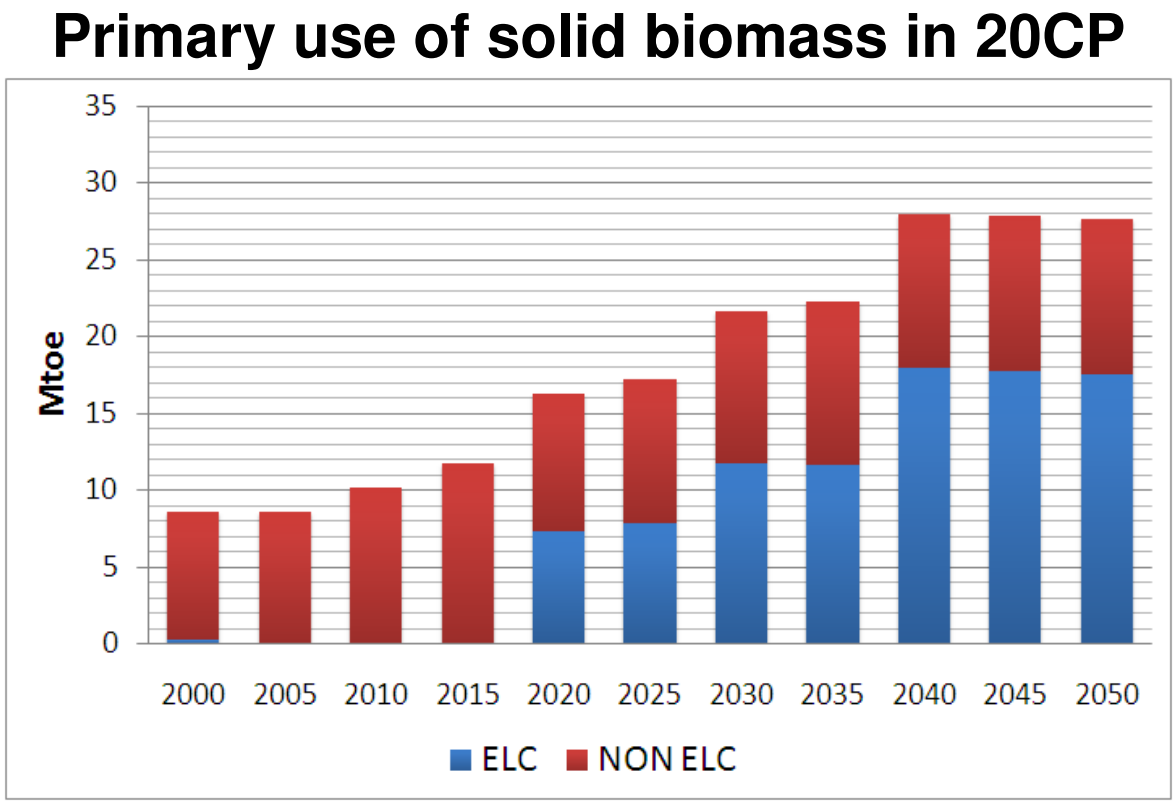
Solid biomass in scenario F2



☞ Use of biomass shift from end-use heating purposes to the electricity supply sector:

Increase in the electricity supply sector: from 3.5 to 15.8 Mtoe amplified in scenario 20CP.

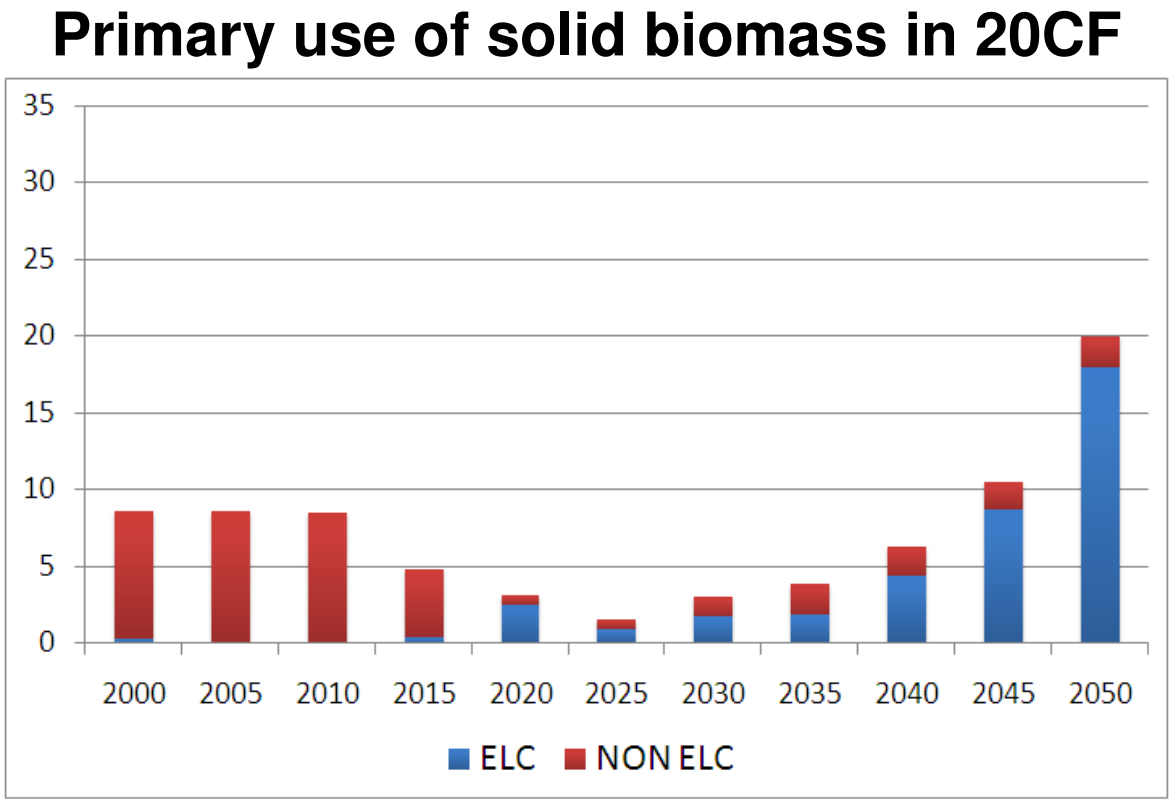
Solid biomass in scenario 20CP



☞ Sharp rise in electricity production :

The need for CO_2-free electricity production favours modern CHP (combined heat and power plants) and IGCC (integrated gaseification combined cycle plants) with high primary efficiency (80 and 50 % resp.)

Solid biomass in scenario 20CF



☞ A sharp decrease in biomasse use:

For heating purposes, higher end-use efficiency (condensed gas boilers, electricity appliances) are needed to achieve final consumption reduction target; by 2050 biomass is again increasingly needed for CO_2-free electricity

Results on the assessed scenarios

The triple 20 EU targets have risen different questions for France:

EE target as a constraint on primary energy consumption reduction 20CP

penalizes O-CO_2 emission technologies (the current mix) through a massive shift from nuclear energy to gas and biomass

EE target as a constraint on final energy consumption reduction 20CF

penalizes renewables as energy sources for it favours high efficiency electrical appliances : heat use shift from solid biomass to condensed gas boilers

Focusing on electricity and renewables

☞ Long term planning exercises have highlighted several complex dependencies that must be taken into account in the design of relevant mitigation policies:

Complex and various interactions between electricity and renewables:

- electricity as a quasi exclusive way of valorisation: wind, hydro;
- electricity use in competition with renewable use : heat use / biomass;
- electricity as an exogeneous input to exploit renewable sources: heat pump, biofuels.

Equal quantities of energy from different sources

yield different levels of useful services depending on the transformation of end-use technologies used

Burden sharing 3x20 among EU countries

☞ *Lack of consistency of three concurrent quantitative targets in order to respond to climate change :*

- mitigation of GHG emission
- energy consumption savings
- spread of renewable energies

An efficient design of climate policies should

- take into account national circumstances i.e. existing portfolios
- reflect energy flow exchanges and substitutions
- be focused on a clear and unique goal.

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