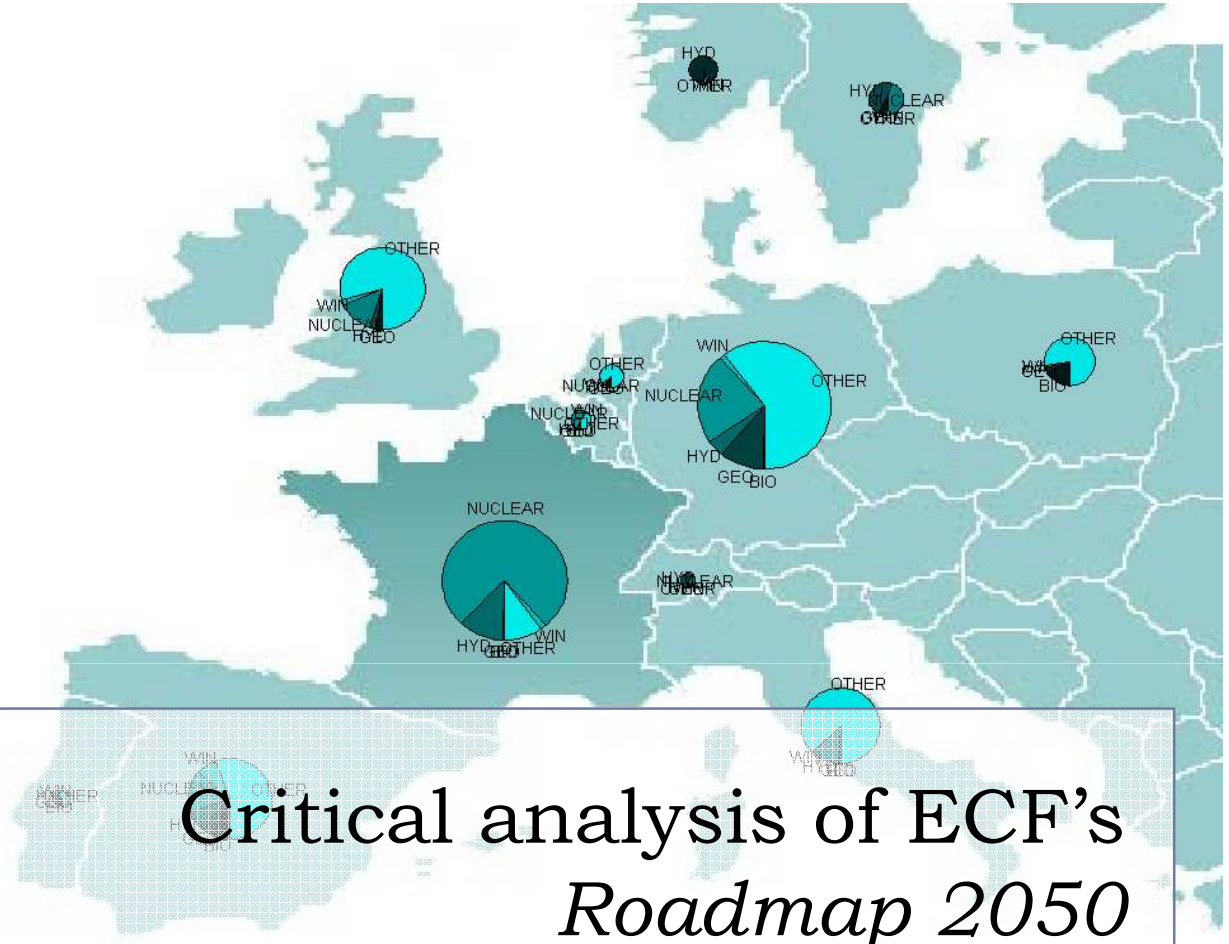


Critical analysis of ECF's *Roadmap 2050*

Journée de la Chaire, 11 octobre 2011

Chaire ParisTech Modélisation prospective au service du développement durable

MINES ParisTech

By : Adrien Atayi

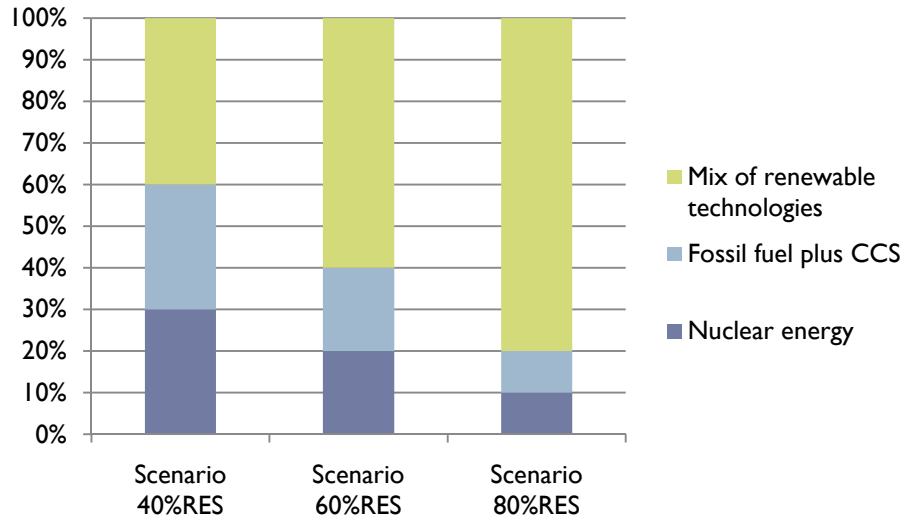
Tutors: Nadia Maïzi and Sandrine Selosse

Outline of the presentation

- Context et objectives
  - ECF's Roadmap 2050
  - MARKAL/TIMES
- *Roadmap 2050*'s assumptions
- Analysis of scenarios
  - Impacts of 80% mitigation in Europe
  - Impacts of 95% mitigation in the European electric sector
  - Our 40%RES scenario
- Conclusions

Context and objectives

- Europe's objective is to mitigate its GHG emissions by at least 80% in 2050 compared to 1990 levels.
- ECF's *Roadmap 2050* report details 3 different "plausible" pathways (focus on power generation sector)



Roadmap 2050's scenarios

- Electricity production is assumed to mitigate its emissions by at least 95%.

Context and objectives

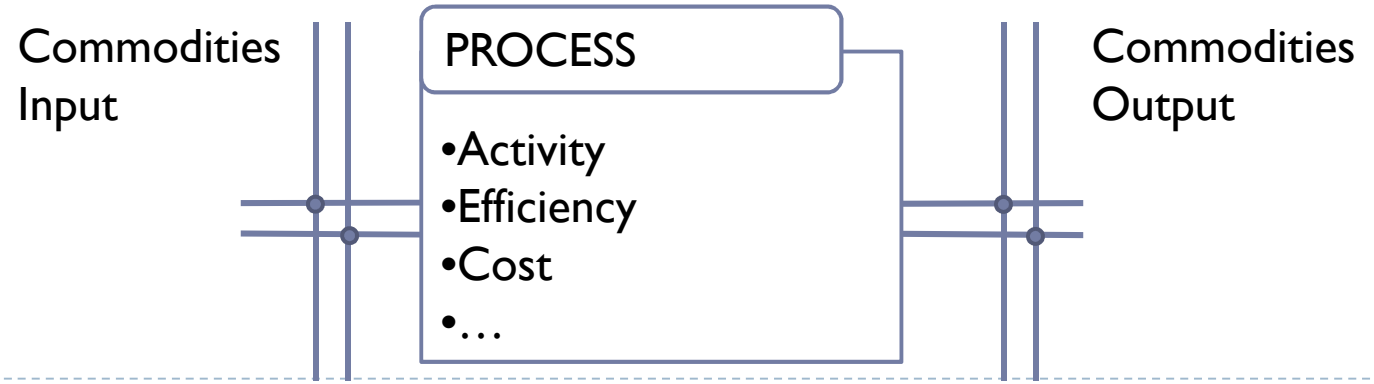
- What would be a cost-effective way to mitigate Europe's emissions? What could be the regional implications of ECF's scenarios?

- This study is based on optimization models
  - Bottom up, driven by demand
  - Confront and complete ECF's "Back-casting" and our optimization methods

Context and objectives

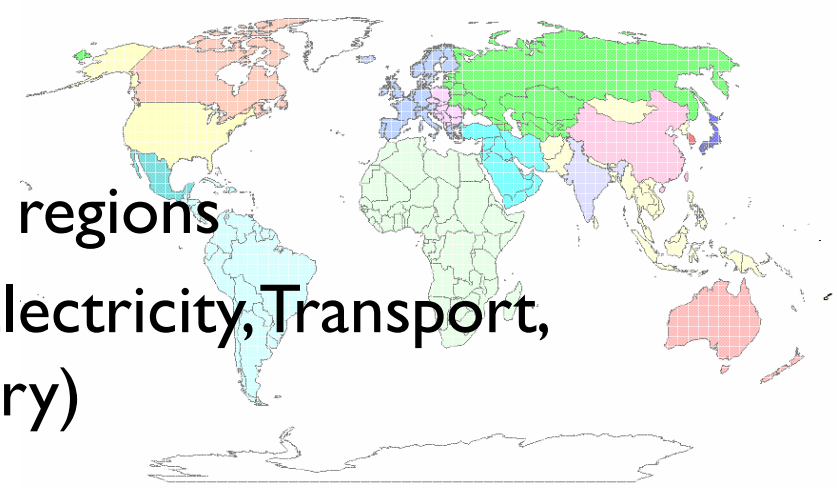
MARKAL/TIMES

- Bottom-up model
- Demand driven
- Model logic:
  - Objective function: total levelized cost of the energy system
  - Constraints: Demand, User constraints (Renewable…)



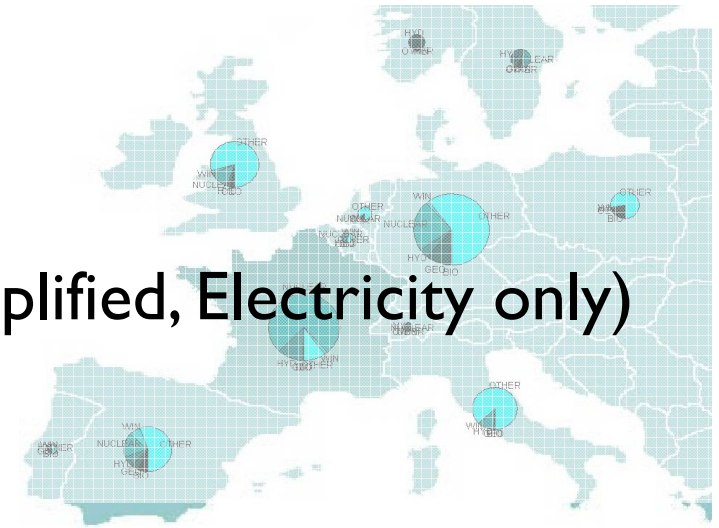
Context and objectives

TIAM-FR



- World integrated model in 15 regions
- Different sectors of activity (Electricity, Transport, Residential, Agriculture, Industry)

Europe



- Europe in 30 regions
- Different sectors of activity (simplified, Electricity only)

Outline of the presentation

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Roadmap 2050's assumptions

- Many companies have been involved:

McKinsey&Company
- Overall content analysis, project management, data collection
- Reach out to industries, workshop facilitation

KEMA
- Grid design and investments, production capacity and costs associated with providing a plausible, secure electricity system for each of the pathways

Imperial College London
- In-depth modeling of system balancing requirements, reliability optimisation of transmission and back-up investment

OXFORD ECONOMICS
- Provide analysis of macro-economic impacts of decarbonization scenarios

European Climate Foundation

Roadmap 2050's assumptions

Main conclusions

- This report pins down all the key issues: from grid modeling to load curve and RES potentials

- The starting assumption has not been discussed : 95% mitigation in European power generation
- The grid modeling methodology is mysterious
- Lots of inconsistencies in the assumptions
- Some assumptions are too "optimistic" (CCS, load factors…)

Outline of the presentation

- Context et objectives
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- Impacts of 80% mitigation in Europe

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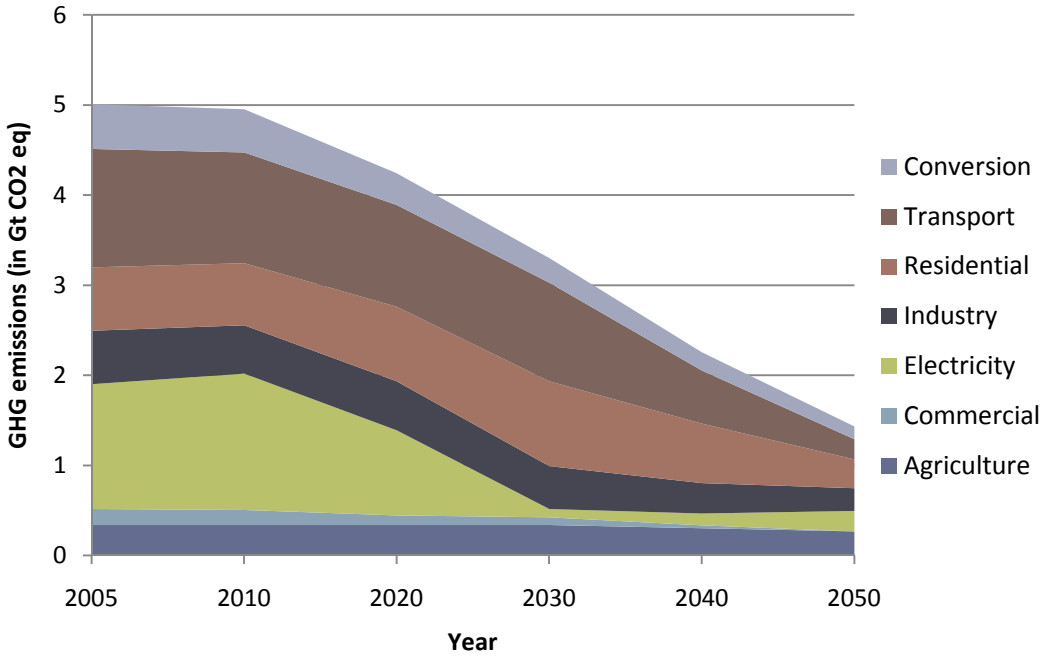
Impacts of 80% mitigation in Europe

Overall impacts through optimization



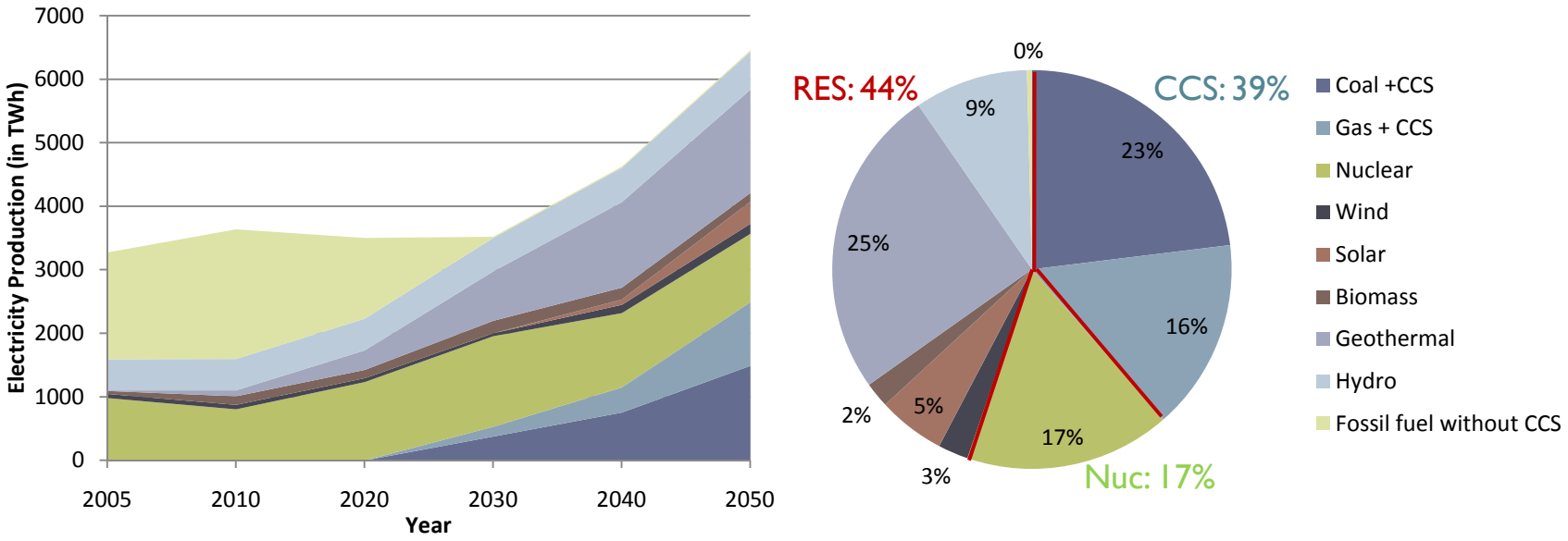
Sectorial GHG emissions evolution in Europe

Most impacted sectors:

- electricity (-85% between 1990 and 2050)
- transport (-83% between 2005 and 2050)

Impacts of 80% mitigation in Europe

Impacts on power generation



European power technology pathway (left) and mix in 2050 (right)

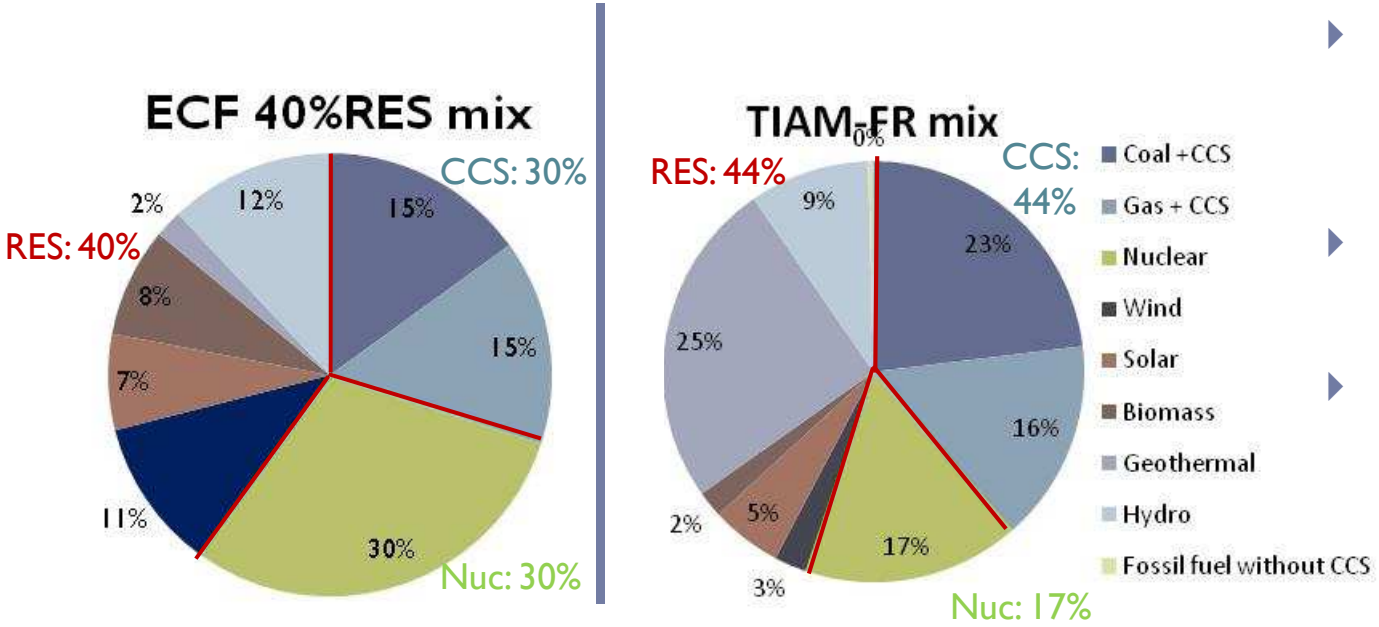
Impacts of 80% mitigation in Europe

Comparison with ECF's *Roadmap 2050*

- The electric system is the key to achieve the 80% mitigation in Europe (sector emissions and fuel-shift)
- The 95% mitigation assumption on power generation seems plausible but a bit too aggressive (role of biofuels)
- The closest scenario to an optimized one in *Roadmap 2050* is the 40%RES scenario

Impacts of 80% mitigation in Europe

Comparison with ECF's *Roadmap 2050*



European electric mix in 2050

- About the same share of RES but RES used are different
- Less nuclear in TIAM-FR
- Different fossil techs used in TIAM-FR (NGCC + oxyfueling pulverized coal cofiring + CCS)

Outline of the presentation

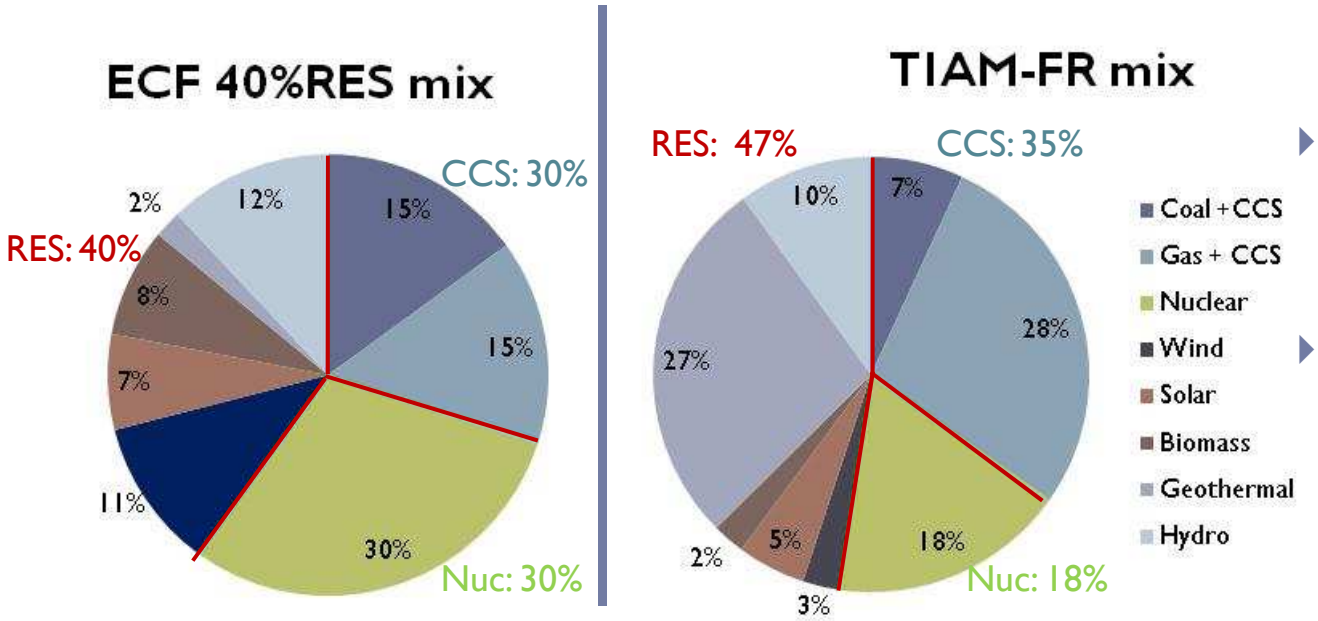
- Context et objectives
- *Roadmap 2050*'s assumptions
- Impacts of 80% mitigation in Europe

- Impacts of 95% mitigation in the electric sector

- Our 40%RES scenario
- Conclusions

95% mitigation in the electric sector

Comparison with ECF's *Roadmap 2050*



- About the same share of RES but RES used are different
- A lot more of Gas + CCS!

European electric mix in 2050 in the 40%RES scenario and obtained with TIAM-FR

Outline of the presentation

- Context et objectives
- *Roadmap 2050*'s assumptions
- Impacts of 80% mitigation in Europe
- Impacts of 95% mitigation in the electric sector

- Our 40%RES scenario

- Conclusions

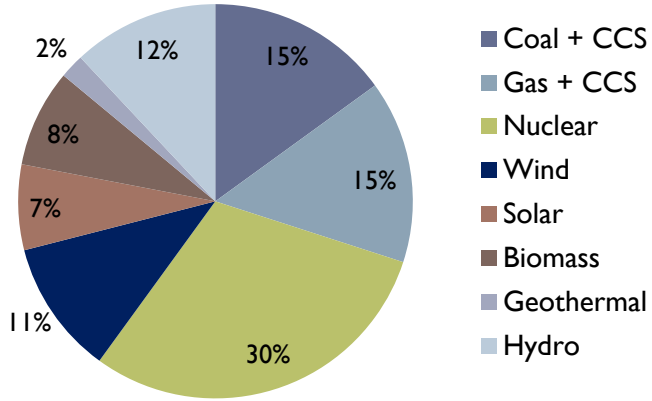
Our 40%RES scenario

Objectives

- Determine the regional implications of this scenario

Assumptions:

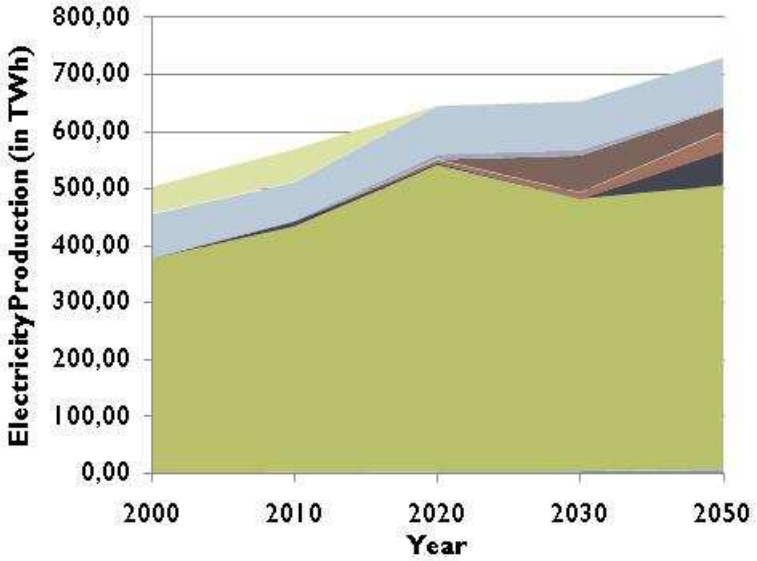
- 80% mitigation in GHG emissions in 2050 (ref 1990)
- No interconnection capacity reinforcement

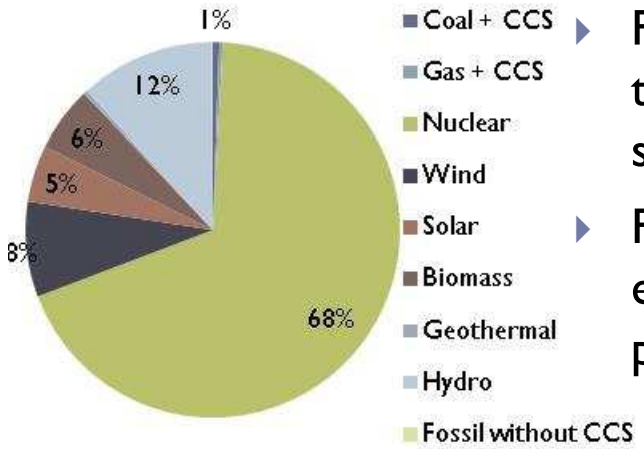


European electric mix in 2050

Our 40%RES scenario

Impacts on France's power generation



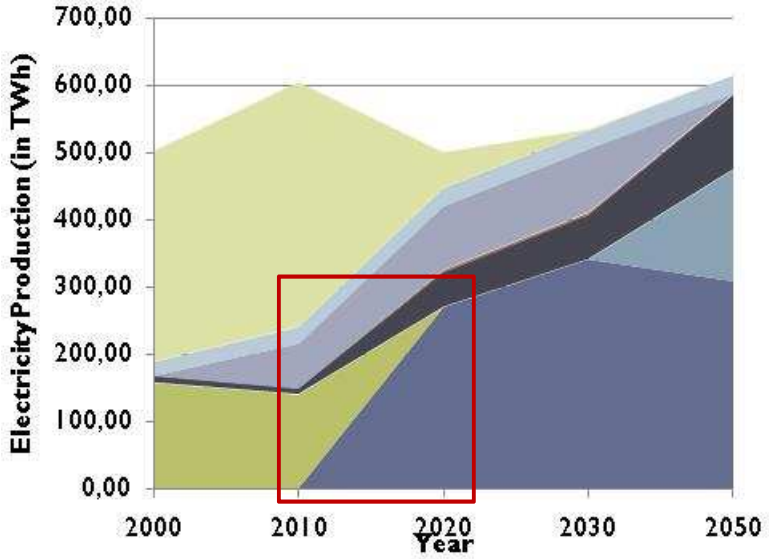


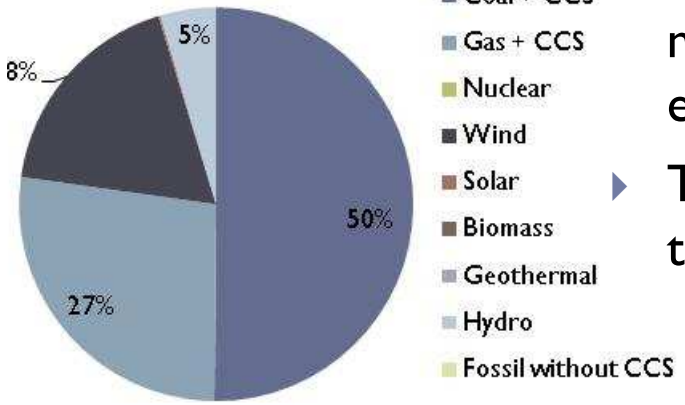
- Fuel-shift from nuclear to biomass, wind and solar
- From 2020 onwards, existing nuclear power plants are not replaced

Power technology pathway (left) and mix in 2050 (right)

Our 40%RES scenario

Impacts on Germany's power generation



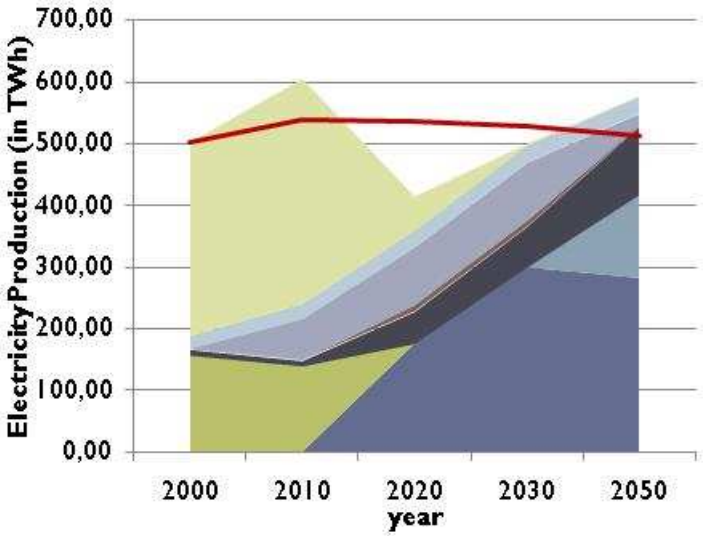


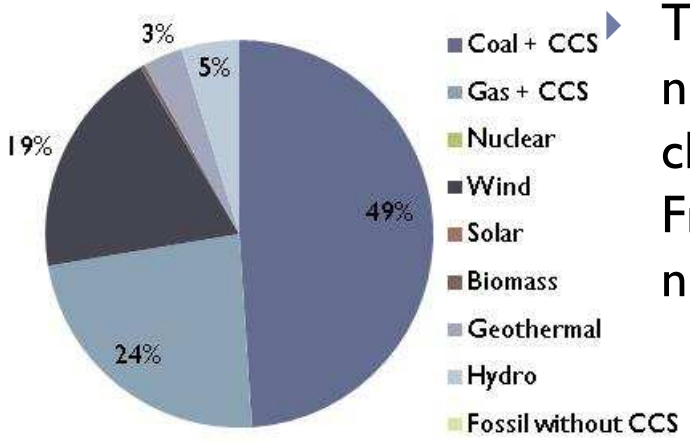
Power technology pathway (left) and mix in 2050 (right)

- 77% of electricity made with CCS-equipped plants
- The question of this tech potential raises
- To cope with the constraints, need of 37GW of CCS equipped plants in 10 years!

Our 40%RES scenario

Effects of interconnections reinforcement on Germany





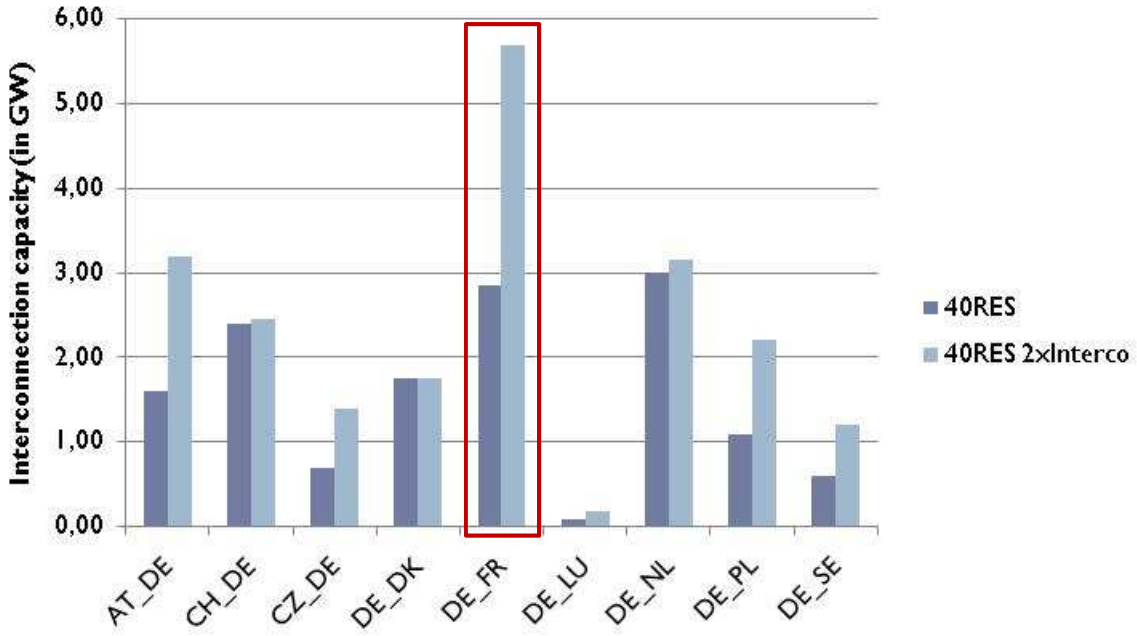
- The power balance is negative due to cheaper electricity in France (high rate of nuclear)

Power technology pathway (left) and mix in 2050 (right)

- The red line on this chart represents Germany's electricity consumption

Our 40%RES scenario

Effects of interconnections reinforcement on Germany



Increase of Germany's interconnexions capacity

- Reinforcement of DE-FR interconnection

Outline of the presentation

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Conclusions

- Power generation is a key sector to achieve 80% GHG emissions mitigation, but 95% mitigation in this sector seems too high.
- A cost-optimization approach shows that ECF's 40%RES scenario is the most effective.
- The regional impacts are really sensitive to grid reinforcement and the more the interconnections grow, the more the system's cost reduces.

- A better representation of CCS potential is necessary to improve the results.


2050 EUROPEAN ENERGY GRID
DECARBONIZED GRID POWER DISTRIBUTION
SOLAR POWER
WATER POWER PLANTS
BIOMASS PLANTS
WIND POWER
GEOTHERMAL
COAL-OIL-GAS
NUCLEAR POWER PLANTS
Thank you!
Any Questions?
274 ROADMAP 2050: A PRACTICAL GUIDE TO A PROSPEROUS, LOW-CARBON EUROPE

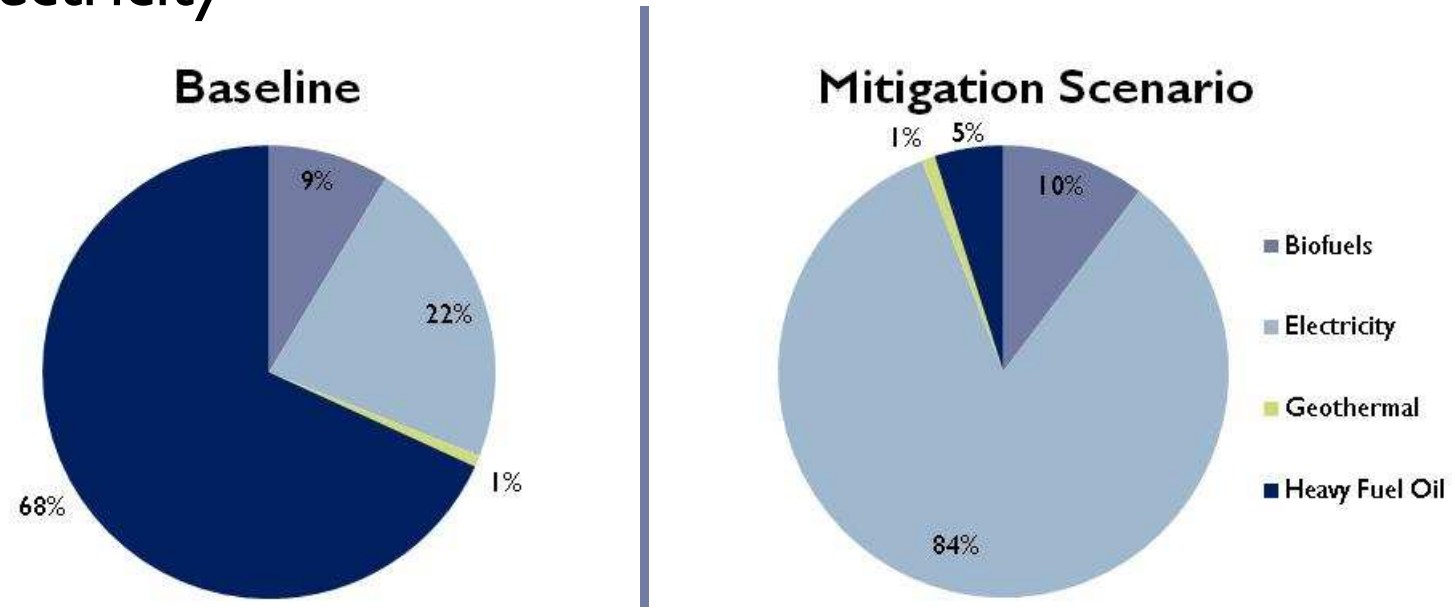
Annexes

- 80% mitigation, impact on other sectors
  - Residential
  - Transport
- 40%RES:
  - Europe's elecric pathway
  - Electricity production by country
- Economic comparison
  - Total cost
  - CO2 cost
  - Electricity cost

Impacts of 80% mitigation in Europe

Impacts on other sectors

- In Residential sector, fuel-shift from heavy fuel oil to electricity

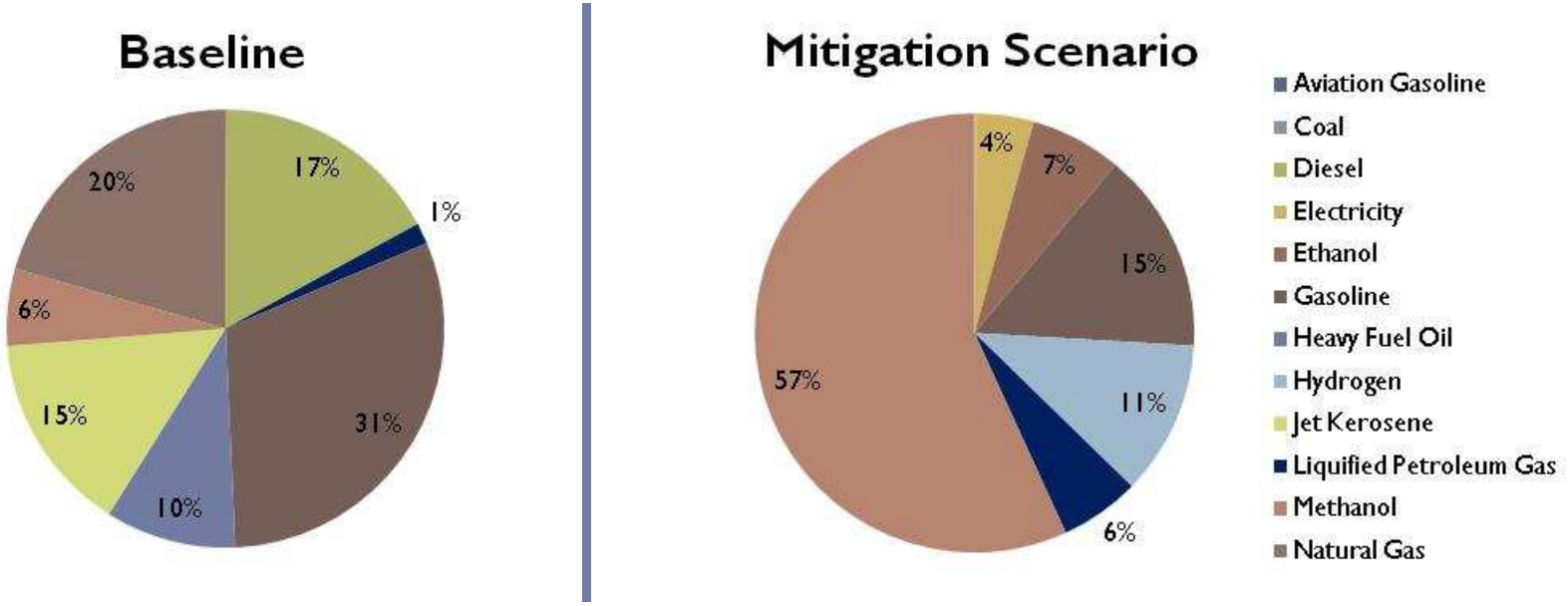


Fuels used in RESIDENTIAL sector in 2050

Impacts of 80% mitigation in Europe

Impacts on other sectors

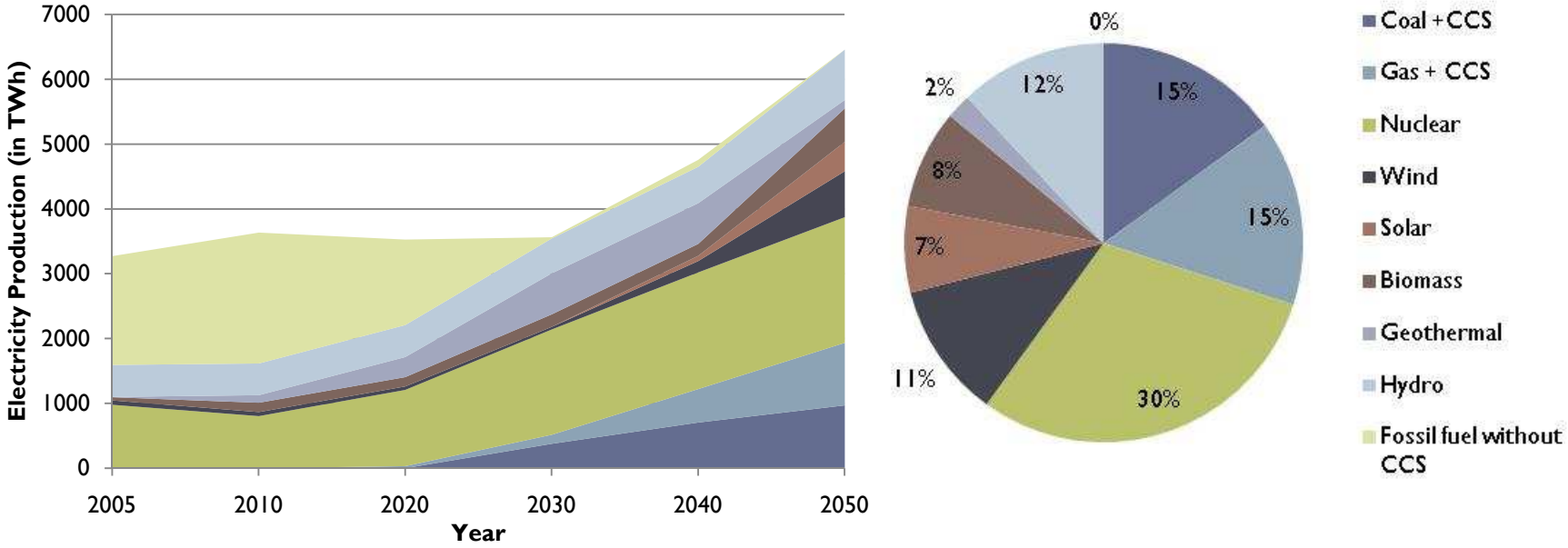
- In Transports, fuel-shift from diesel to methanol



Fuels used in TRANSPORT in 2050

40%RES scenario

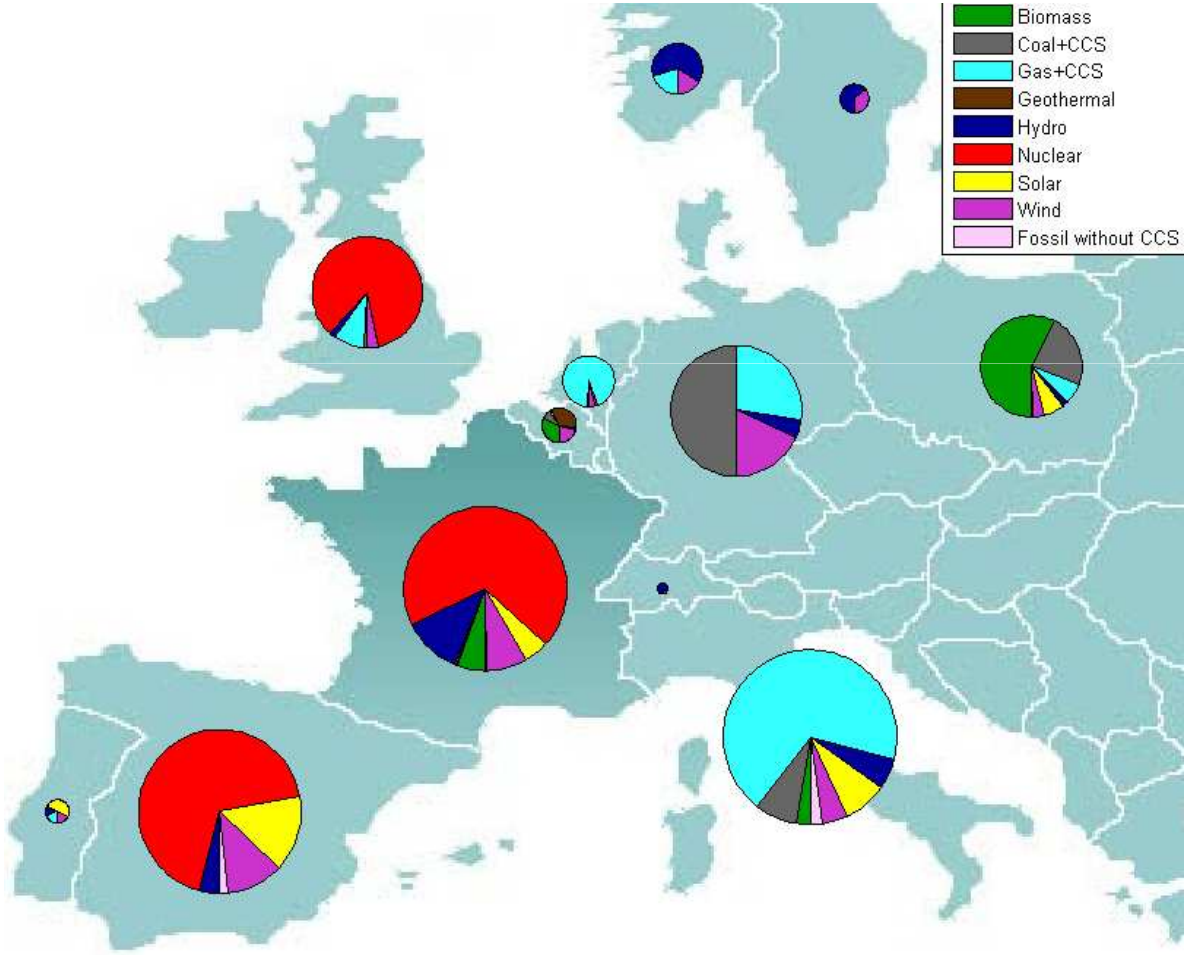
Impacts on Europe's power generation



Power technology pathway (left) and mix in 2050 (right)

Our 40%RES scenario

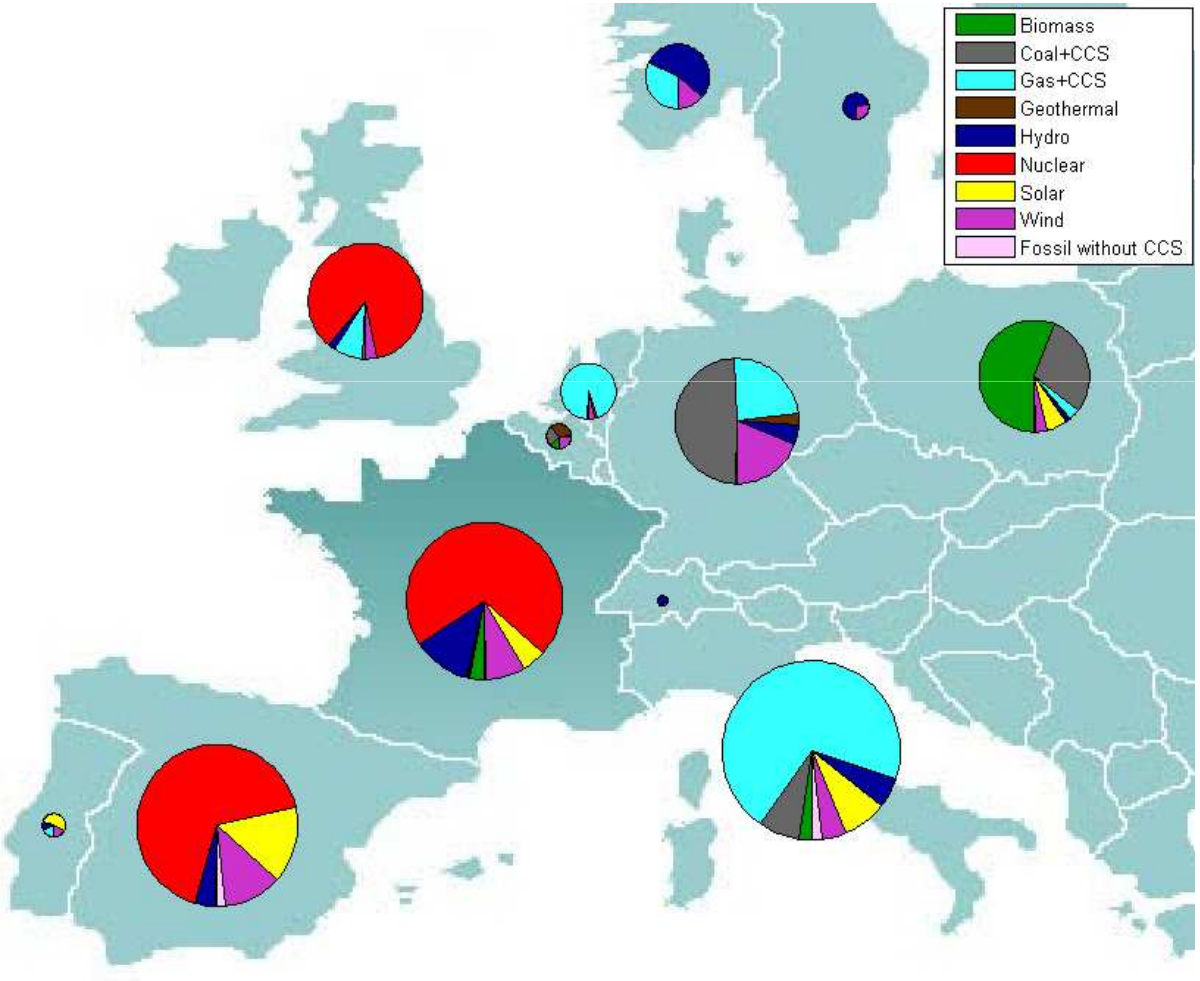
Electricity prodution by country in 2050



- Main Solar energy producers:
  - Spain, Italy
- Main Wind energy producers:
  - Spain, Germany, France

Our 40%RES scenario

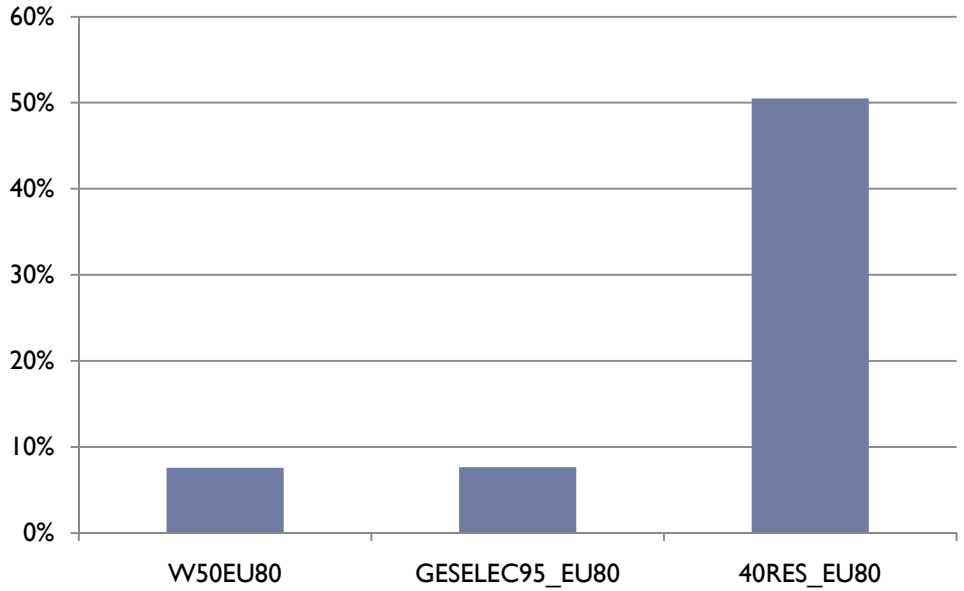
Effects of interconnections reinforcement on Europe



- Drop of electricity production in Germany
- Increase of the share of RES in Spain and Portugal

Costs comparison

Cost of Europe's energy system

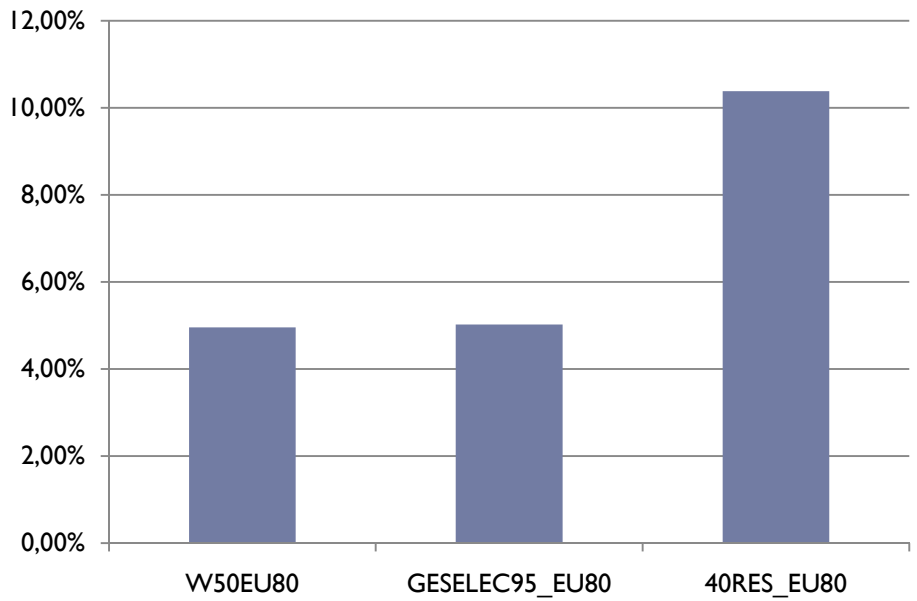


Total energy system cost in the scenarios VS baseline

- W50_EU80 and GESELEC95 are 10% more expensive than the baseline
- 40RES is 50% more expensive
- In *Roadmap 2050* this cost decreases
  - Different fossil fuel prices

Costs comparison

Total cost of the energy system



Total energy system cost in the scenarios VS baseline

- W50_EU80 and GESELEC95 are 5% more expensive than the baseline
- 40RES is 10% more expensive