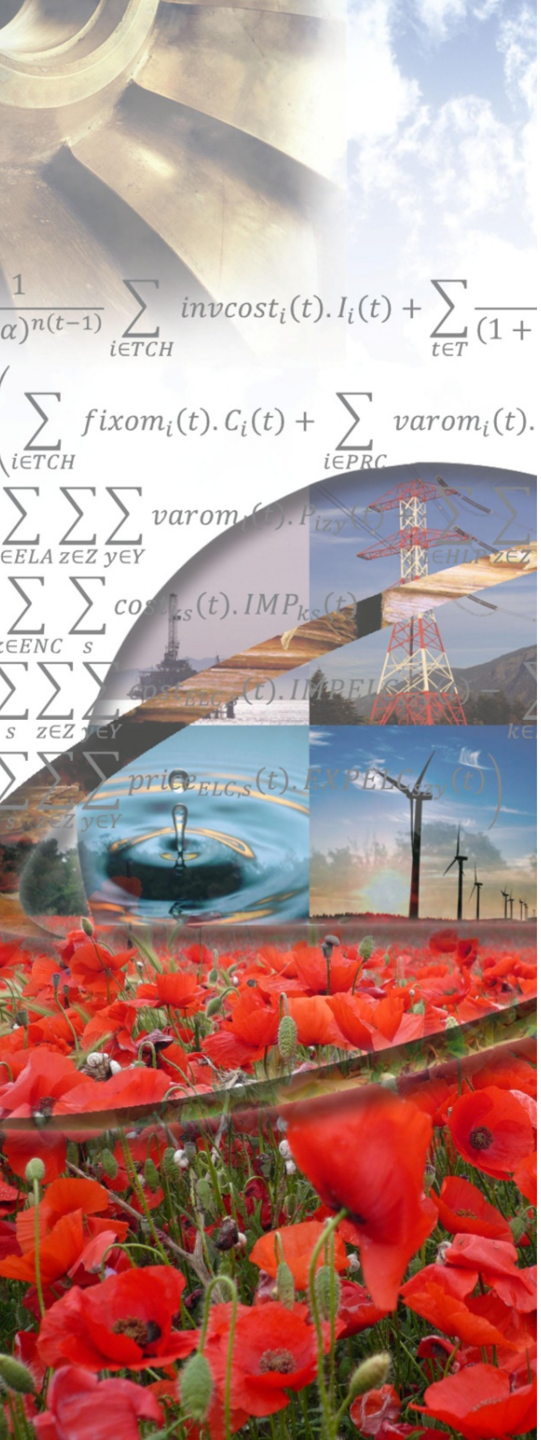

Centre for Applied Mathematics

Sustainable and greener: challenges in (re)thinking the French energy system by 2030 and 2050

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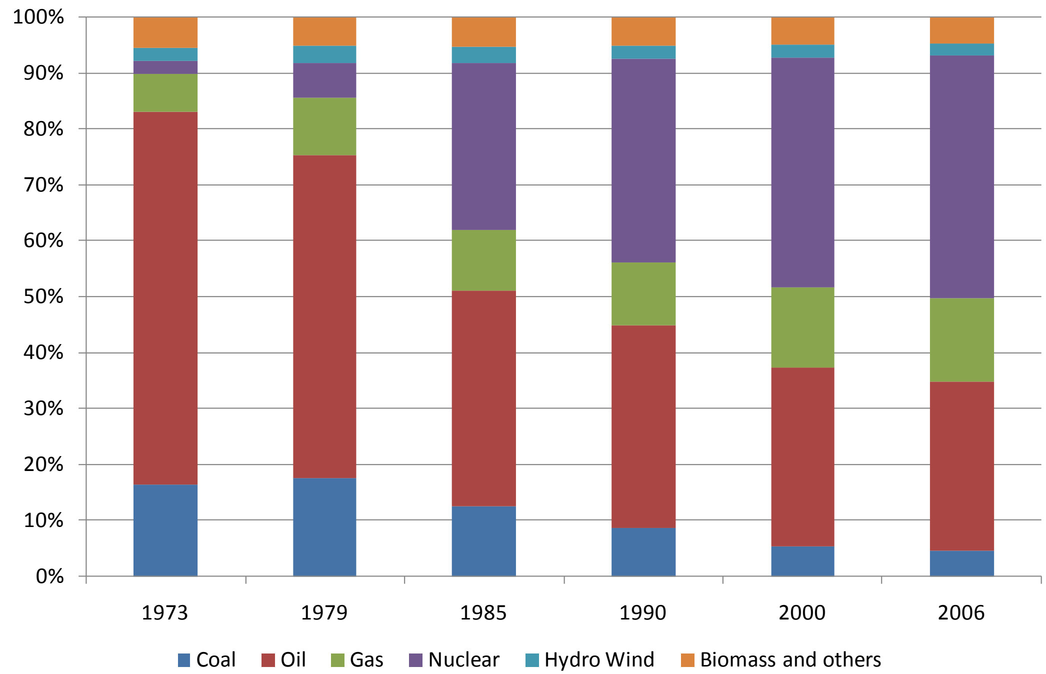
ParisTech Chair Modeling for Sustainable Development

Novembre, 12, 2013

COP 19 – Warsaw – European pavilion

Energy context and method

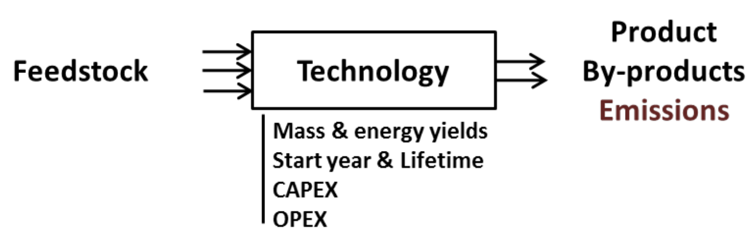
- French energy mix



- little fossil resources, large renewable potential

Energy context and method

- Ambitious policy objectives
  - EU climate package and NREAP
  - Factor4 (75% GHG mitigation) in 2050
  - Sector specific policies: nuclear, biofuels …
- Analysis methodology
  - Optimisation model based
  - Completed by insights from litterature



Investigated issues

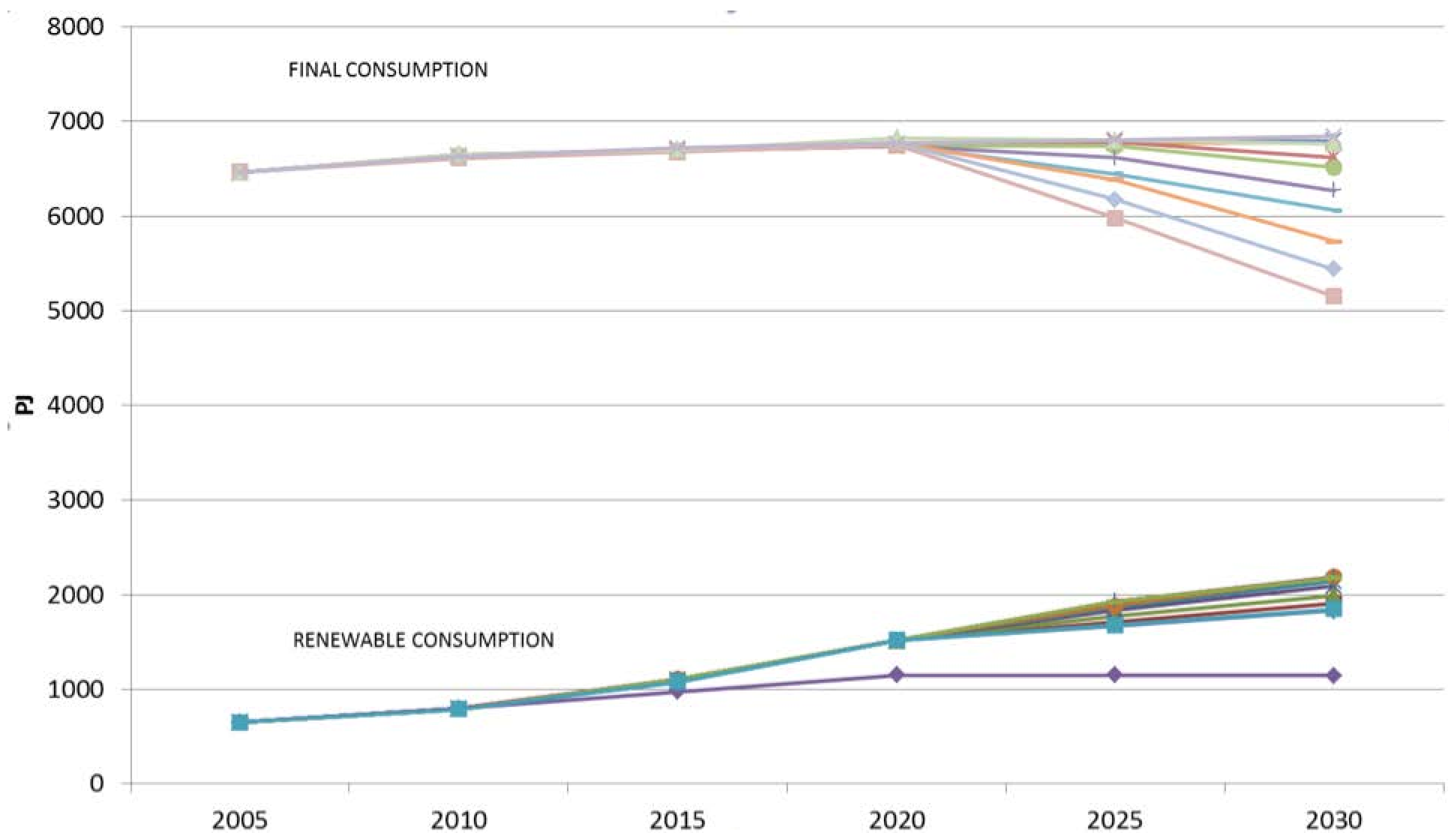
- Rethinking the system to include more renewables in final consumption
- Rethinking the future of the natural gas industry
- Rethinking the future of the bioenergy sector

More renewables in total final energy consumption

- Development beyond current REN targets
  - EU's climate package, French NREAP
  - IRENA REMAP 2030 complementary country analysis discussions
  - REN: 23% in 2020, 27% to up to 42% in 2030
- What systemic interactions?
  - Potentials/technologies/energy service demands
  - What types of renewables sectors/sources?
  - Cost insights

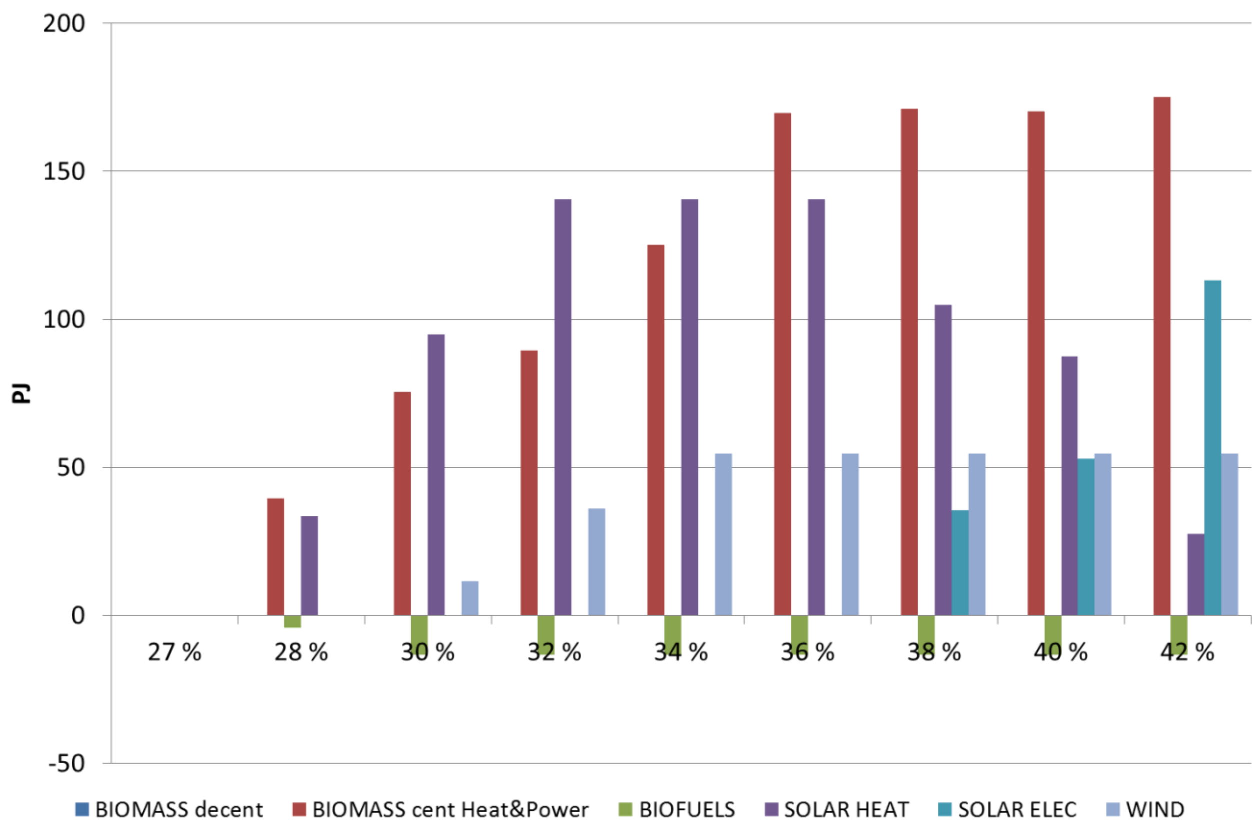
More renewables in total final energy consumption

- The global picture



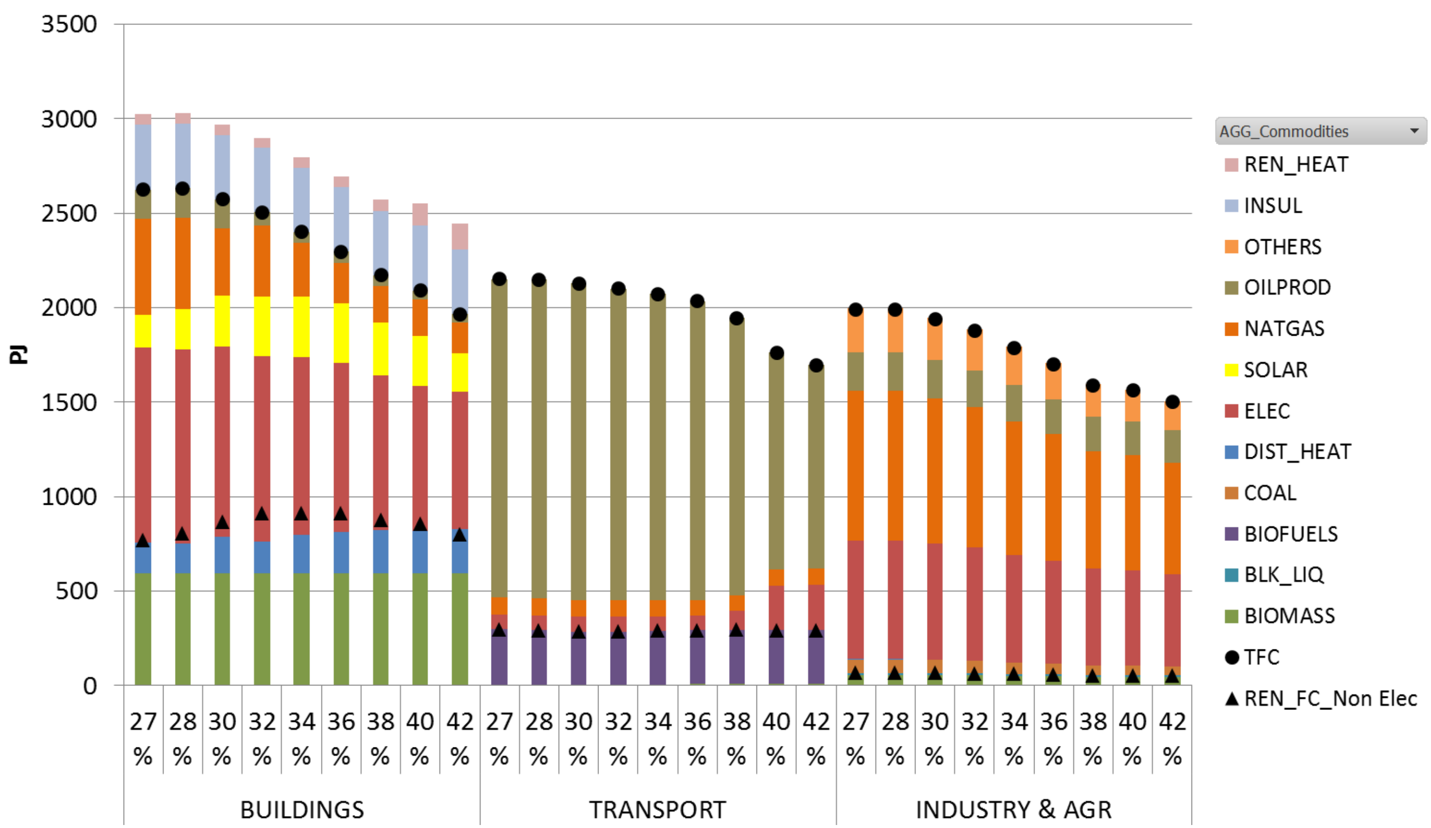
More renewables in total final energy consumption

- Additional renewables sources



More renewables in total final energy consumption

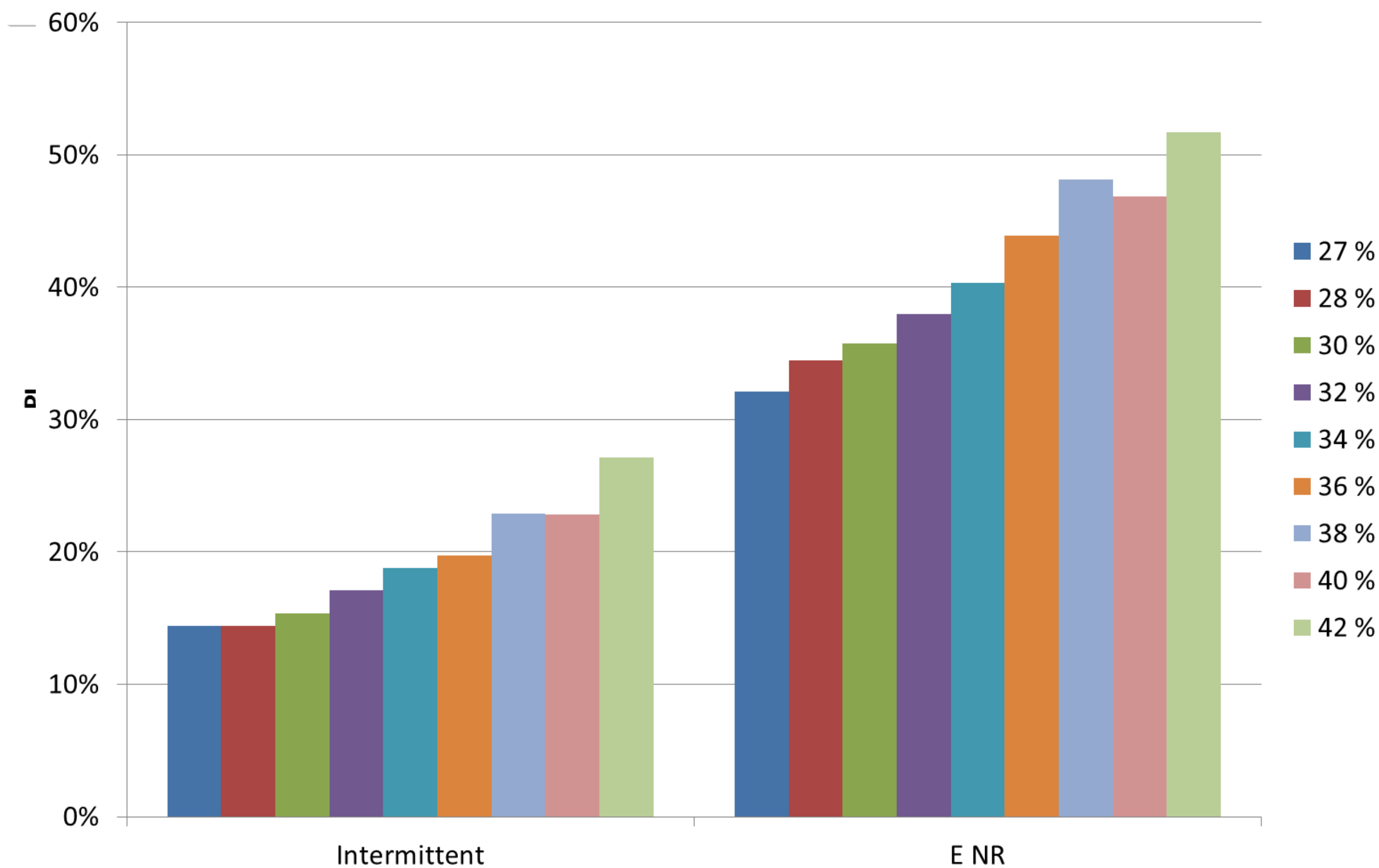
- TFEC changes in end-use sectors



Limits for renewables in industry: batch process, labor and logistic

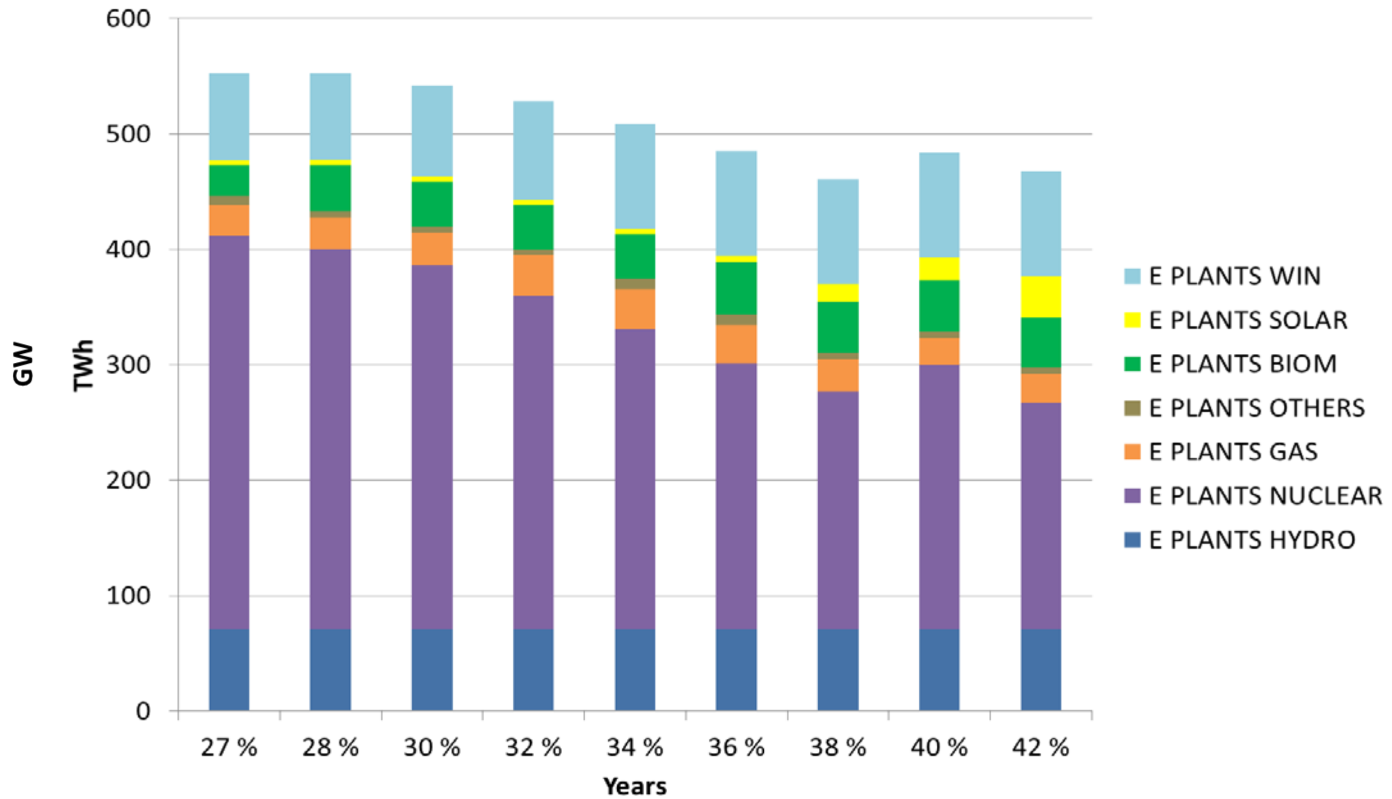
More renewables in total final energy consumption

- Electricity sector changes: intermittence



More renewables in total final energy consumption

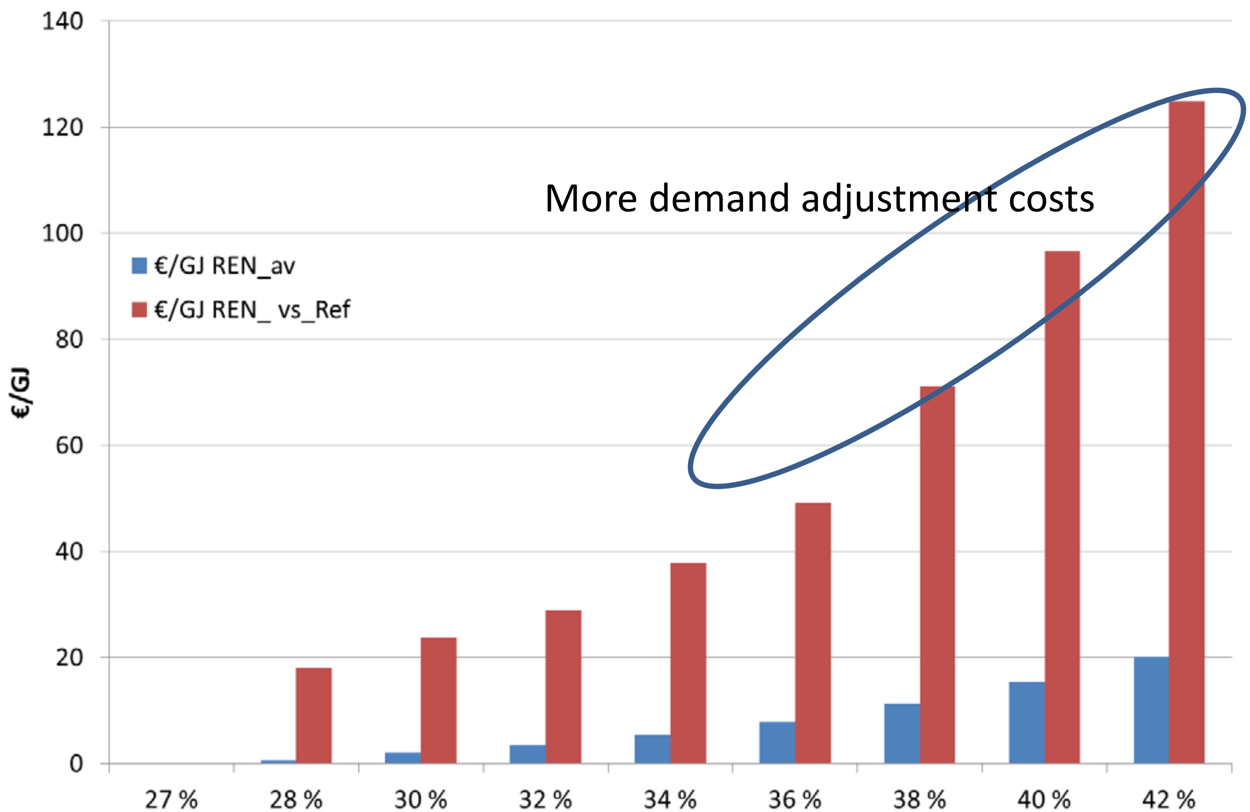
- Electricity sector changes: more GW



But average capacity utilization dropping from 4000h to 3000h per year

More renewables in total final energy consumption

- Costs issues

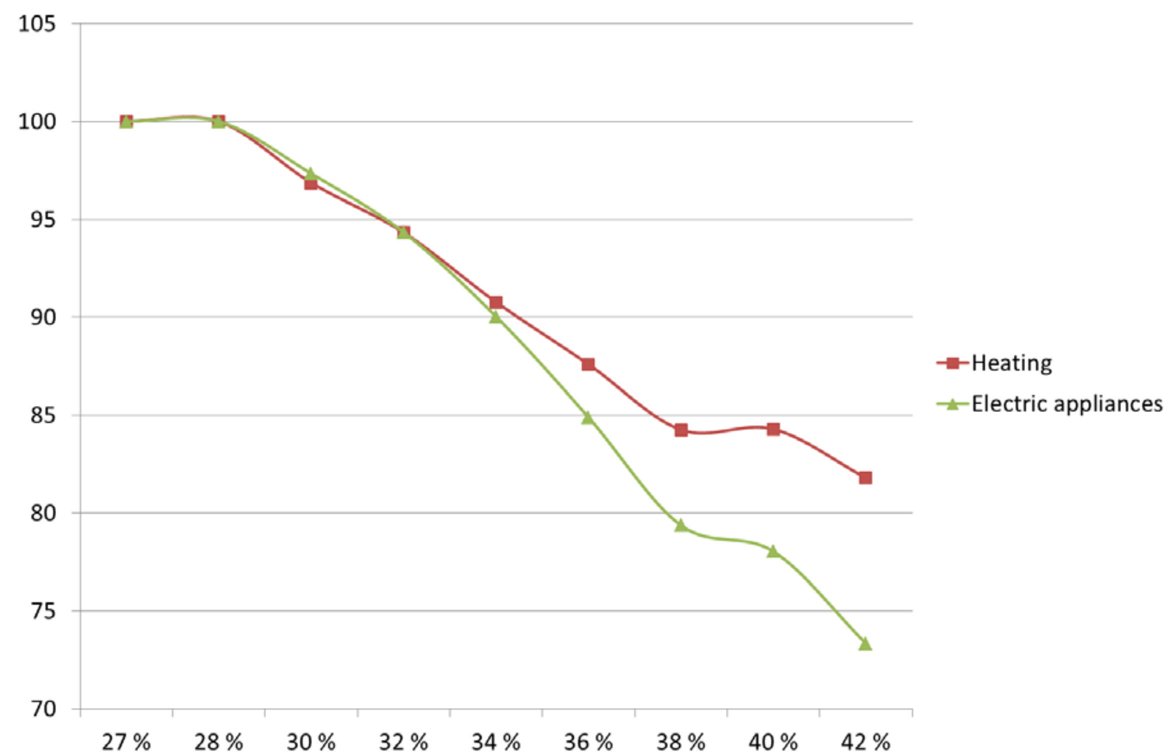


Blue curve : Increase in total cost vs 27% case/total renewable

Red curve: Increase in cost vs 27% case/ increase in renewables vs 27% case

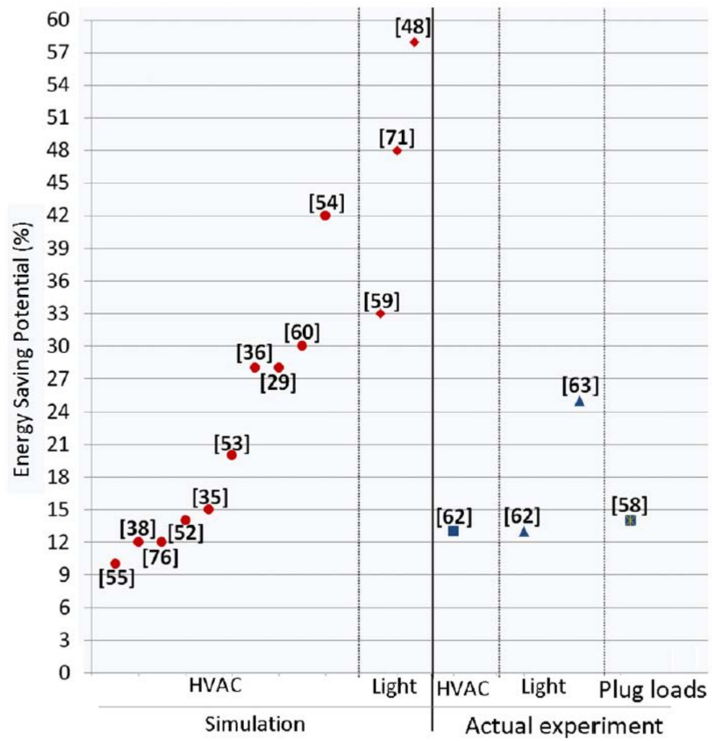
More renewables in total final energy consumption

- Demands adjustment and their link to ICT applications: building sector
  - decreasing specific electric uses



More renewables in total final energy consumption

- Demands adjustment and smart buildings litterature

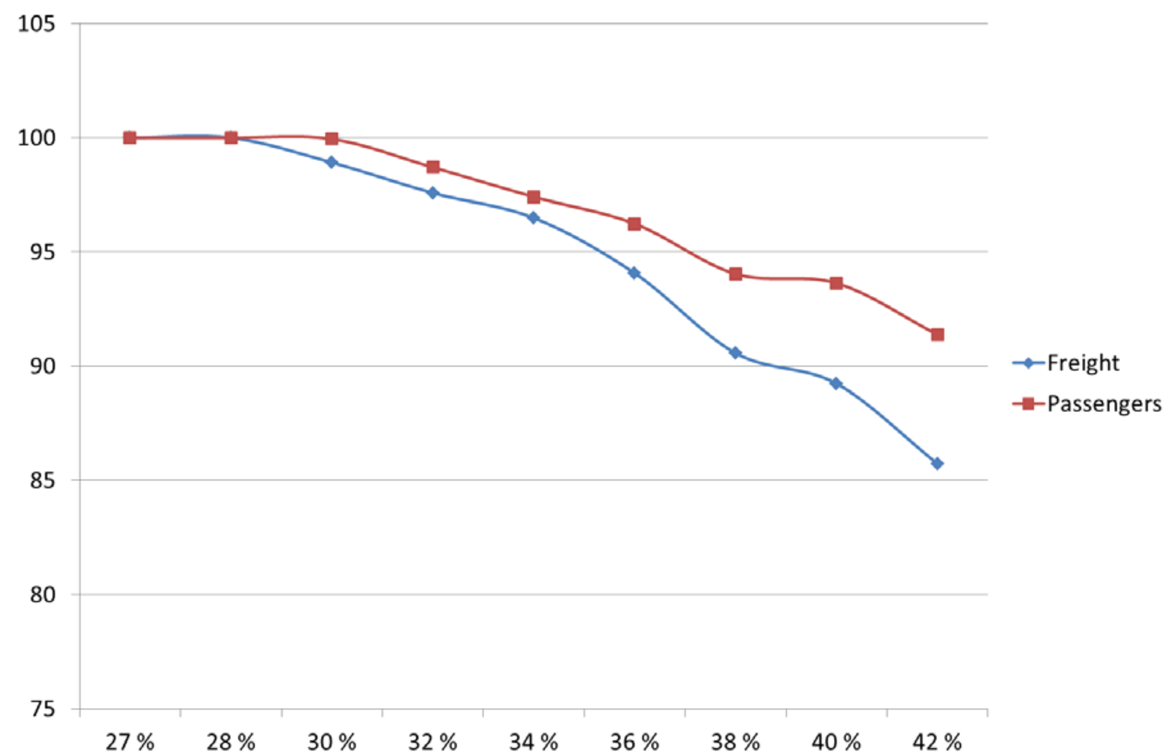


Source: Energy intelligent buildings based on user activity: A survey, Tuan Anh Nguyen, Marco Aiello, 2013

Actual savings are significantly less than potential

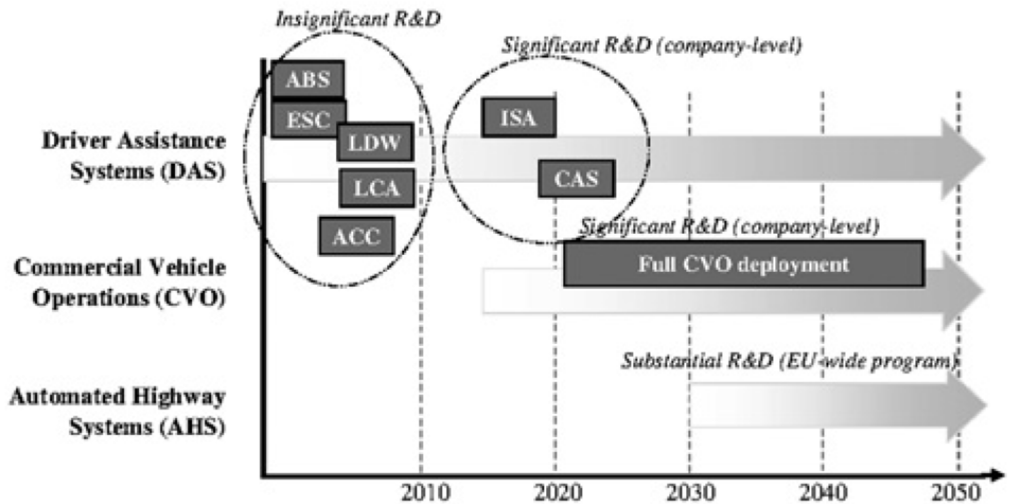
More renewables in total final energy consumption

- Demands adjustment and their link to ICT applications: transport sector
  - decreasing the mobility demand



More renewables in total final energy consumption

- Demands adjustment and ITS
  - Limited quantitative evaluation



Source: Techno-economic assessment of the potential of intelligent transport systems to reduce CO2 emissions, Psaraki et al 2012

AHS potential: 30% to 70% mileage reduction potential, 930 to 1000€/tCO_2

CVO potential: 15% mileage reduction, 25 to 29€/tCO_2

Necessary to overcome acceptability issues and risks of rebound effects

Investigated issues

- Rethinking the system to include more renewables in final consumption
- Rethinking the future of the natural gas industry
- Rethinking the future of the bioenergy sector

Rethinking the future of natural gas in France

- Issues of the natural gas industry
  - Low carbon fossil fuels and more evenly distributed resources
  - LNG and market coupling opportunities
  - High import dependency
  - Several CCG plants in recent years
  - But … still carbonated
  - What future uses?

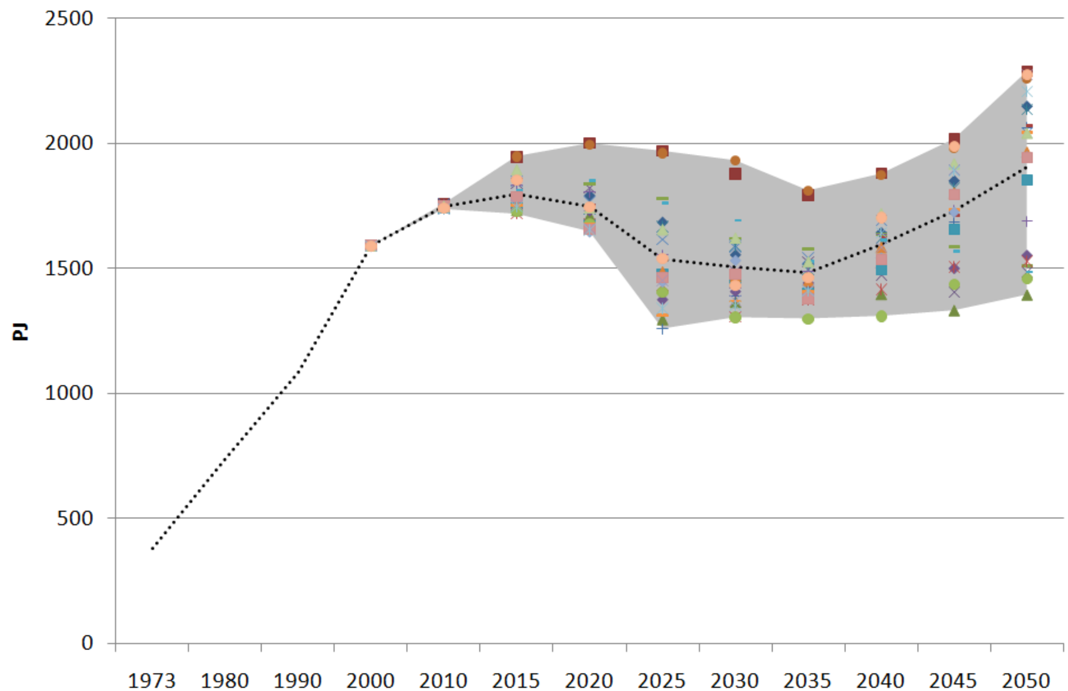
Rethinking the future of natural gas in France

- Issues of the natural gas industry
  - Future uses: insights from WEO review

		Natural gas supply 2030		Average growth rate	
		Mtoe	Share of TPES	Gas	All
Reference scenarios					
WEO 2005	(2003-2030)	3942	24.2%	2.1%	1.6%
WEO 2006	(2004-2030)	3869	22.6%	2.0%	1.6%
WEO 2007	(2005-2030)	3948	22.3%	2.1%	1.8%
WEO 2008	(2006-2030)	3670	21.6%	1.8%	1.6%
WEO 2009	(2007-2030)	3561	21.5%	1.5%	1.5%
WEO 2010	(2008-2030*)	3724	22.0%	1.7%	1.5%
WEO 2011	(2009-2030*)	3858	22.5%	2.0%	1.7%
Alternative scenarios					
WEO 2008	(550 ppm)	3383	21.8%	1.4%	1.2%
	(450 ppm)	2950	20.5%	0.9%	0.8%
WEO 2009	(450 ppm)	2941	20.4%	0.7%	0.8%
WEO 2010	(450 ppm)	3106	21.3%	0.8%	0.8%
WEO 2011	(450 ppm)	3147	21.5%	1.0%	0.9%

Rethinking the future of natural gas in France

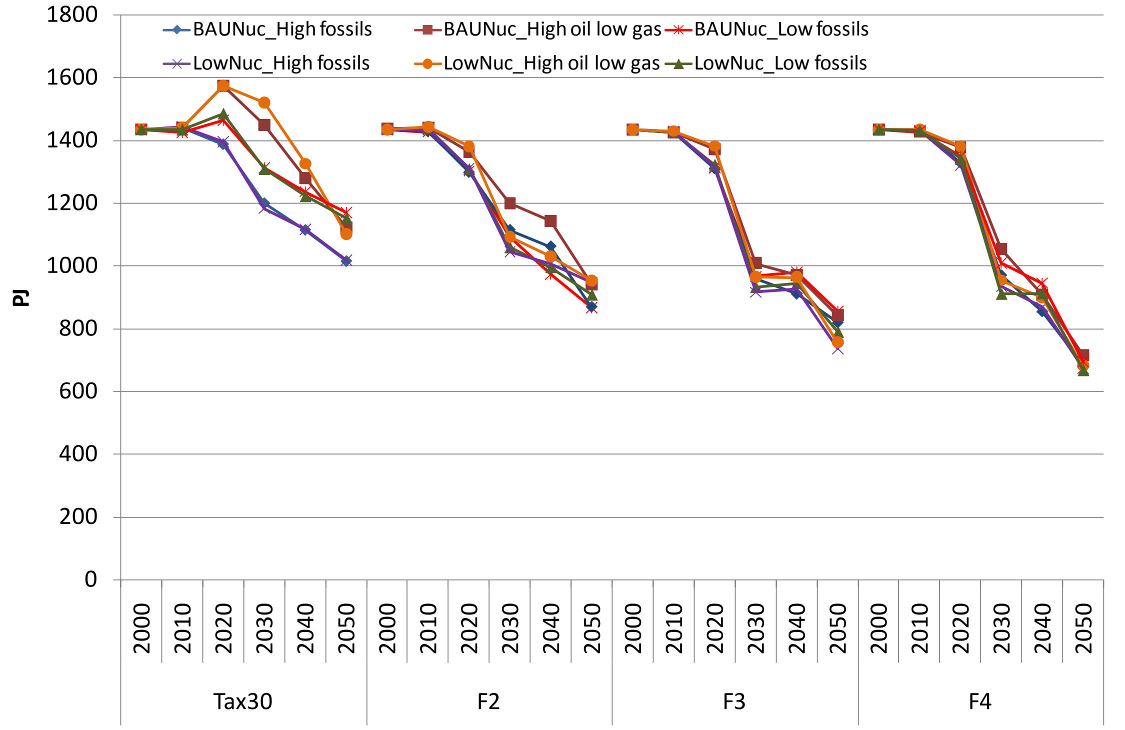
- Range of prospects for France



Approach: several scenarios crossing fuel prices, nuclear policy, environmental policy intensity, technology availability

Rethinking the future of natural gas in France

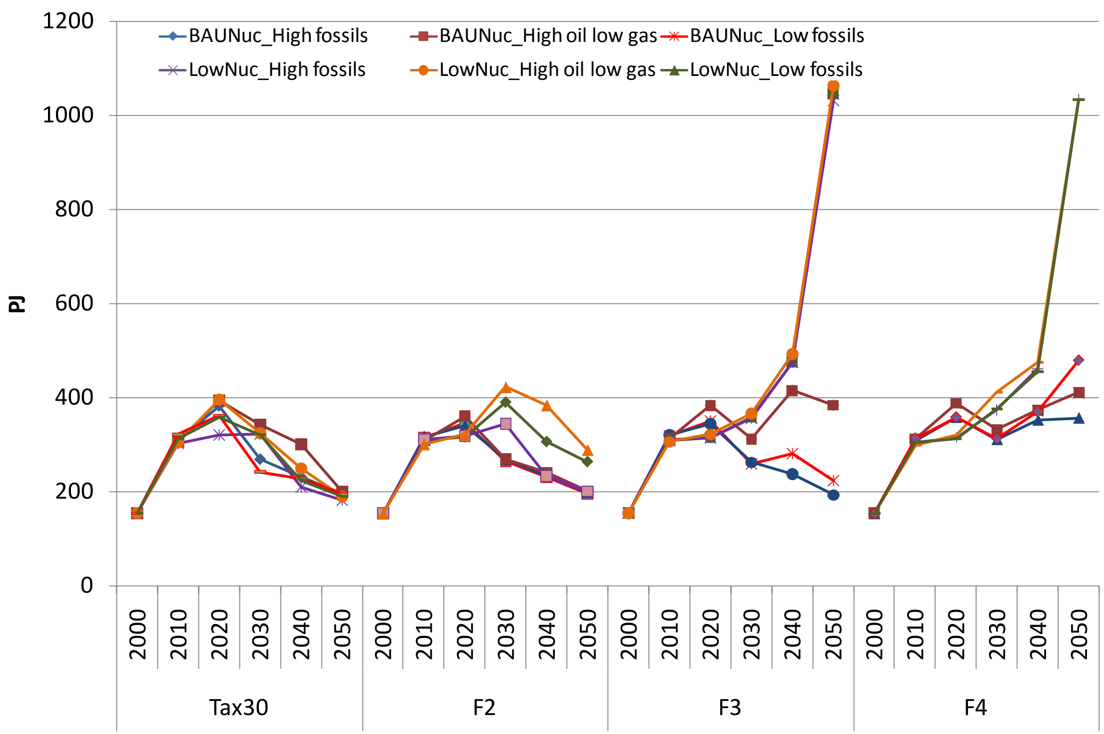
- Developments in traditional markets



24% to 52% decrease vs 2010

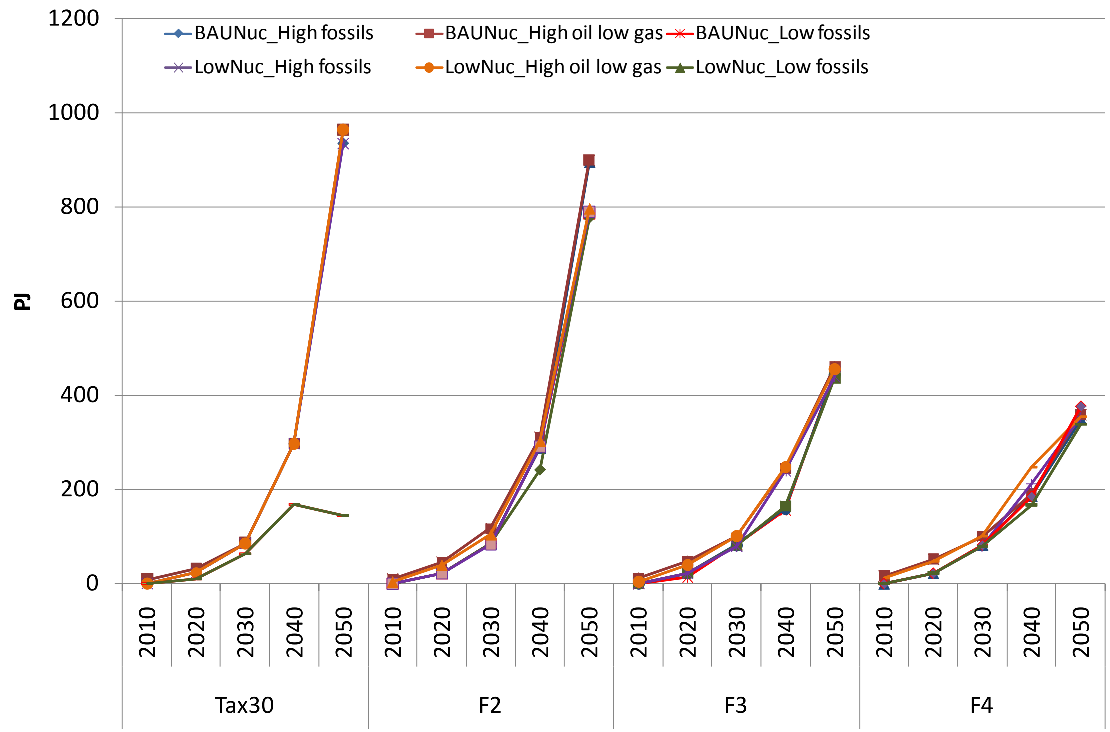
Rethinking the future of natural gas in France

- Opportunities in the electricity sector



Rethinking the future of natural gas in France

- Opportunities in the transport sector



Investigated issues

- Rethinking the system to include more renewables in final consumption
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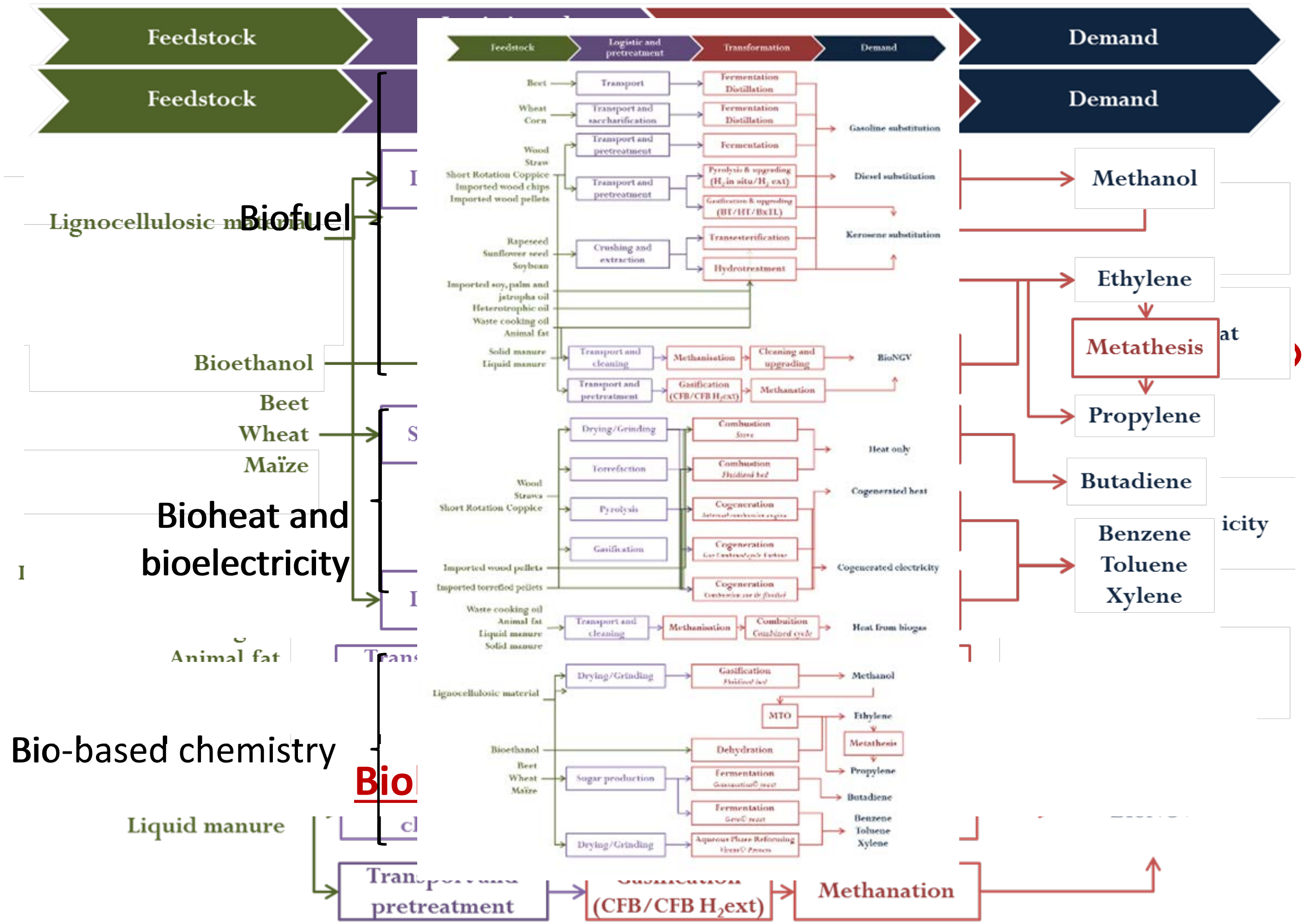
Rethinking the future of bioenergy sector in France

- Bioenergy sector's development
  - High expected contribution to sustainable energy systems
  - Competing usages
    - Energy: Heat, electricity, fuel
    - Chemistry: feedstock
  - Competing processes
    - Chemical vs thermochemical conversion

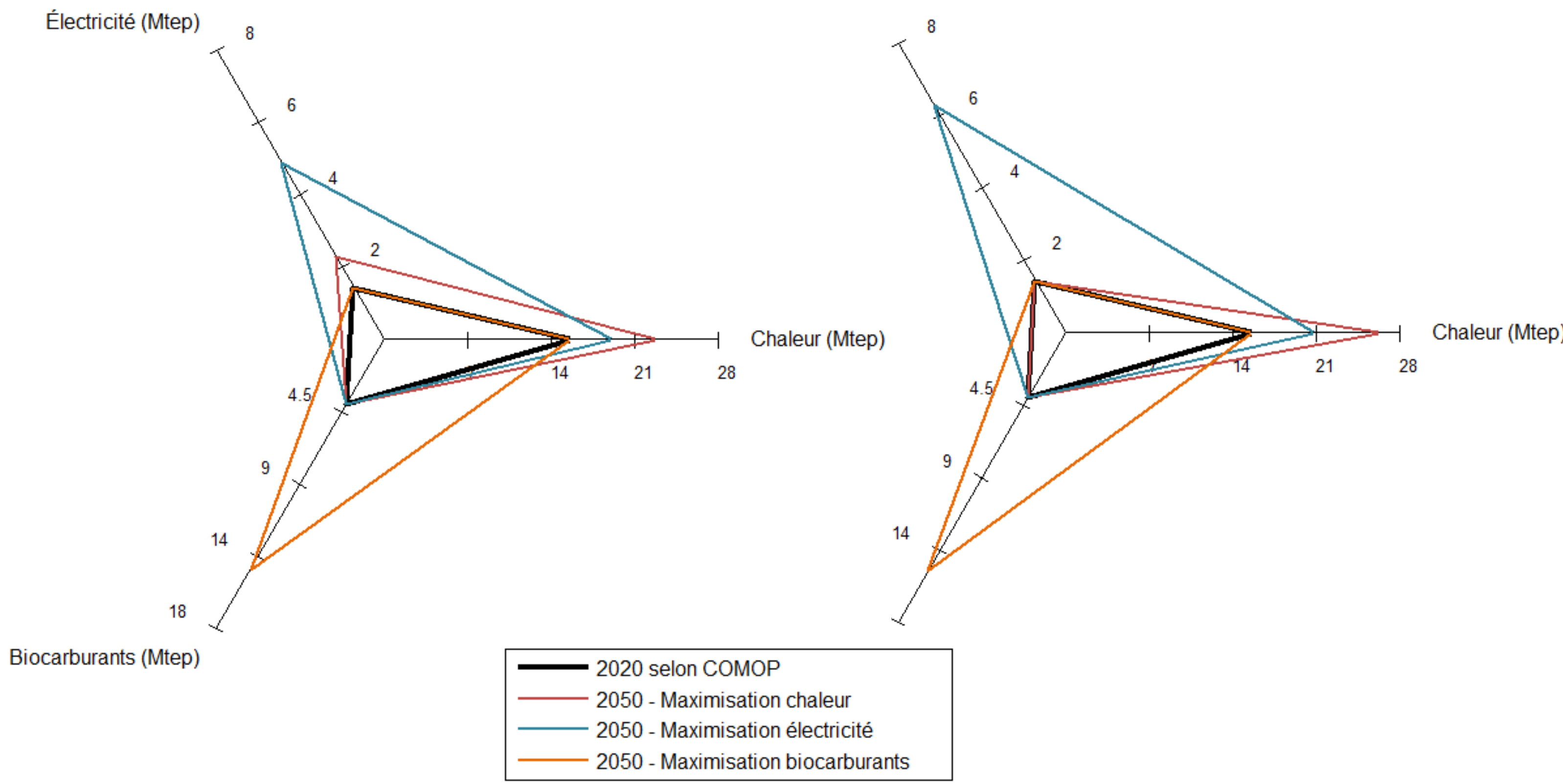
Dedicated technical pathways model



Biofuel sector

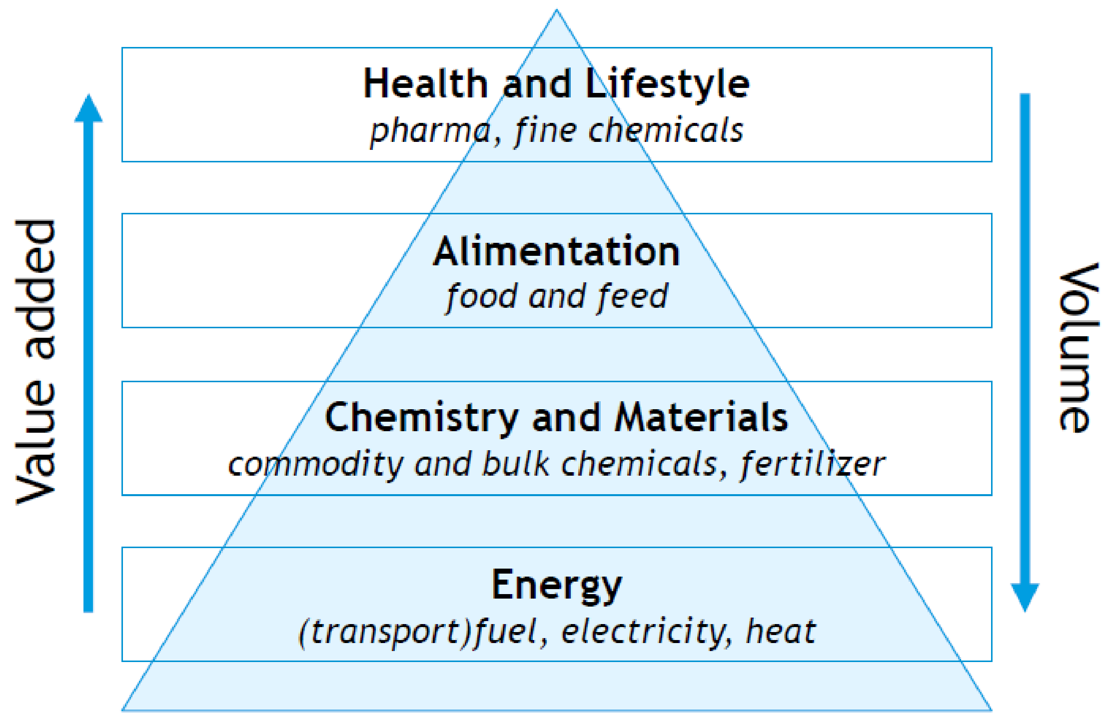
Bio - heat, electricity or fuel?

- Aggregated view of max. final bioenergy



Impact of bio-based chemistry

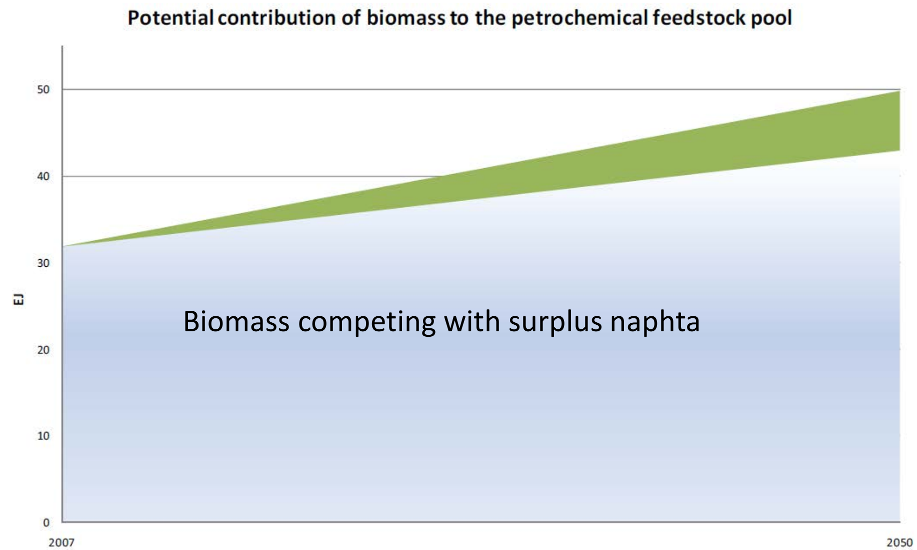
- Biomass value pyramid



Source: Odegard et al 2012, 13 Solutions for a Sustainable Bio-based Economy: Making Better Choices for Use of Biomass Residues, By-products and Wastes

Impact of bio-based chemistry

- UNIDO 2010, Renewable Energy in Industrial Applications

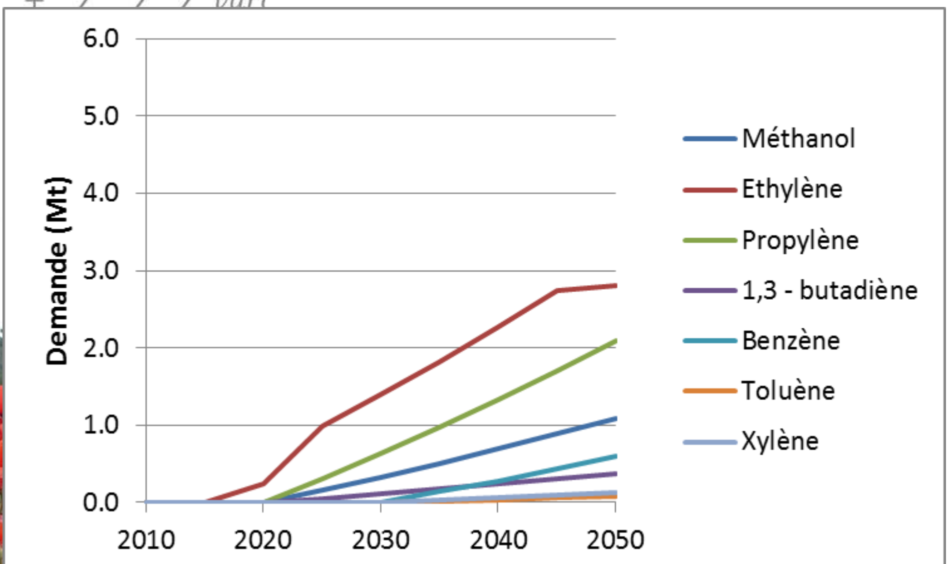


- JRC 2013, Nita et al, Bio-economy and sustainability: a potential contribution to the Bio-economy

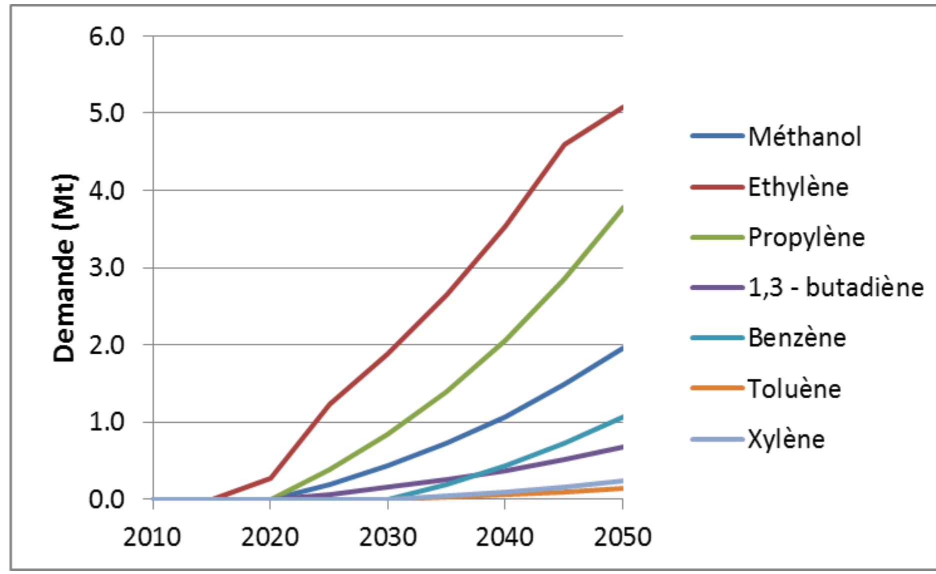
- France: French Chemical Industry Association set a 15 % incorporation target of renewable feedstock by 2017

Bio-based chemistry scenarios

- 2050 scenarios for 7 key products

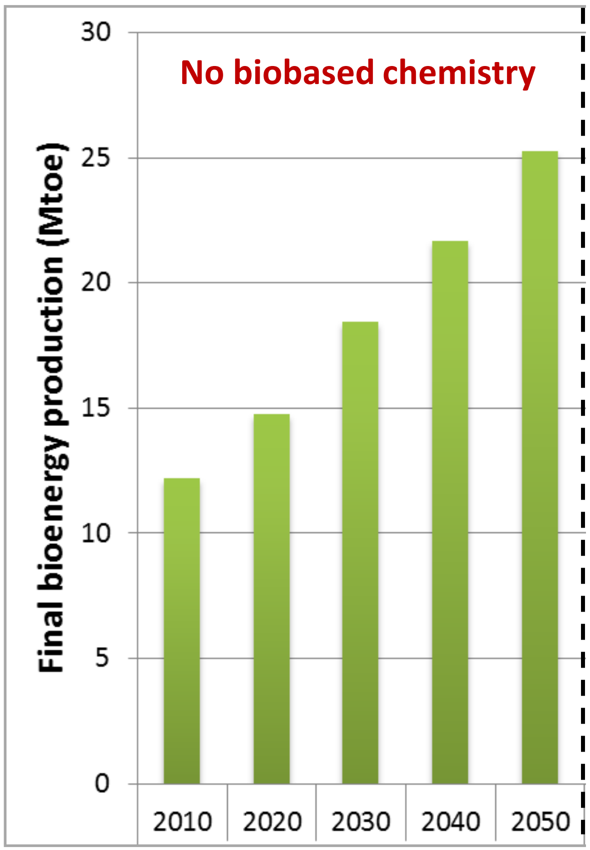


Low bio-based scenario (CAGR = 0.5 %)



High bio-based scenario (CAGR = 2 %)

Bio-based chemistry impact on bioenergy sector



10% to 20% decrease

Conclusion

- Thinking beyond conventional development paths is necessary to move towards a greener and more sustainable energy system
  - Increasing the share of renewable to 42% in TFEC by 2030 requires strong energy savings, subsidies, and up to 50% renewables share in the power sector
  - To meet France’s ambitious 2050 climate targets the natural gas industry have to anticipate a reorientation from traditional to new markets
  - An adapted bioenergy strategy should consider the potential impact of biomass as feedstock for bio-based chemistry

Conclusion

- Intelligent transition encompasses both balancing and planning challenges
  - Synchronicity is challenging to capture simultaneity from yearly multi energy balances to instantaneous equilibrium.
  - Strategic transition is crucial to accompany shifts that need a long term anticipation
- A systemic approach is needed as a support to capture the interaction of multiple competing or cooperating options