An economic assessment of decarbonization pathways for Central-Western Europe

Pierre-Laurent Lucille, Chief Economist, ENGIE

8th European Energy Forum

11-12 June 2019

ENGIE

Full decarbonization of Central-Western Europe energy systems

An economic assessment of transition pathways

Geographical scope of the study

- Objective of the study: an ***economic assessment*** quantifying the impacts of decarbonization objectives focused on energy-related CO_2 emissions : heating, power, transport sectors.

- Methodology:
  - — An integrated model optimizing investments and dispatch to meet energy demand
  - — An increasing European CO_2 tax applied to all energies and sectors leading gradually to a full decarbonization in 2050
  - — A focus on the comparison of two different decarbonization pathways to a Business-As-Usual one

Massive electrification : strong constraints on biomass resources require higher electrification

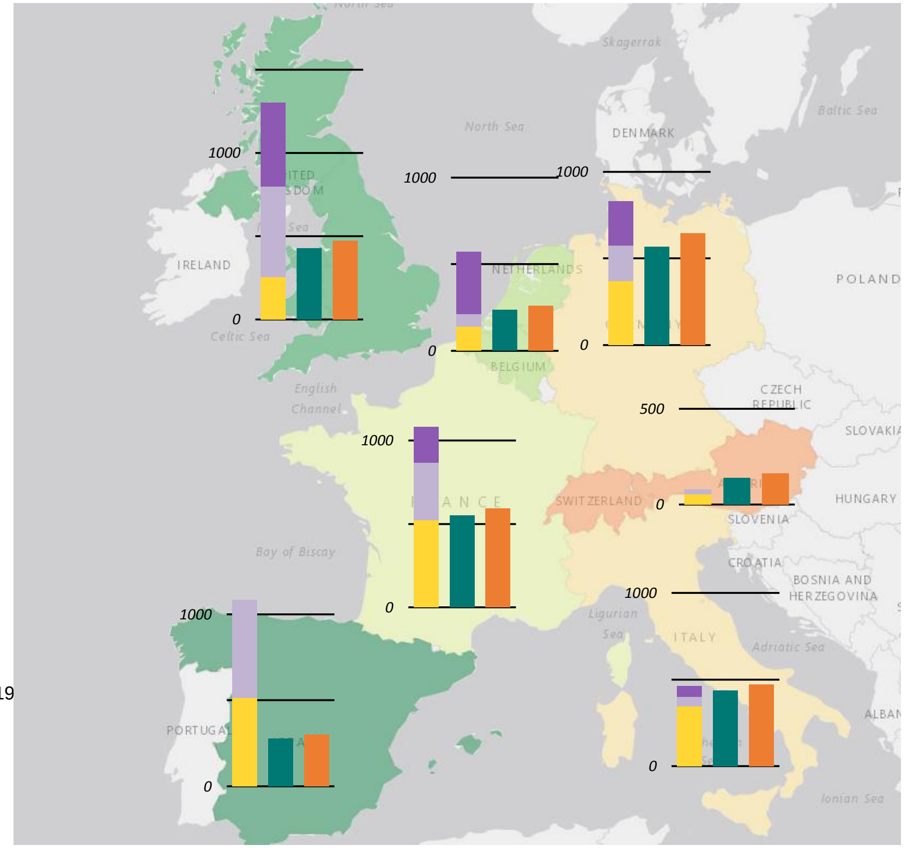
Multi Energy Carriers : biomass constraints mitigated by green gas imports

BAU

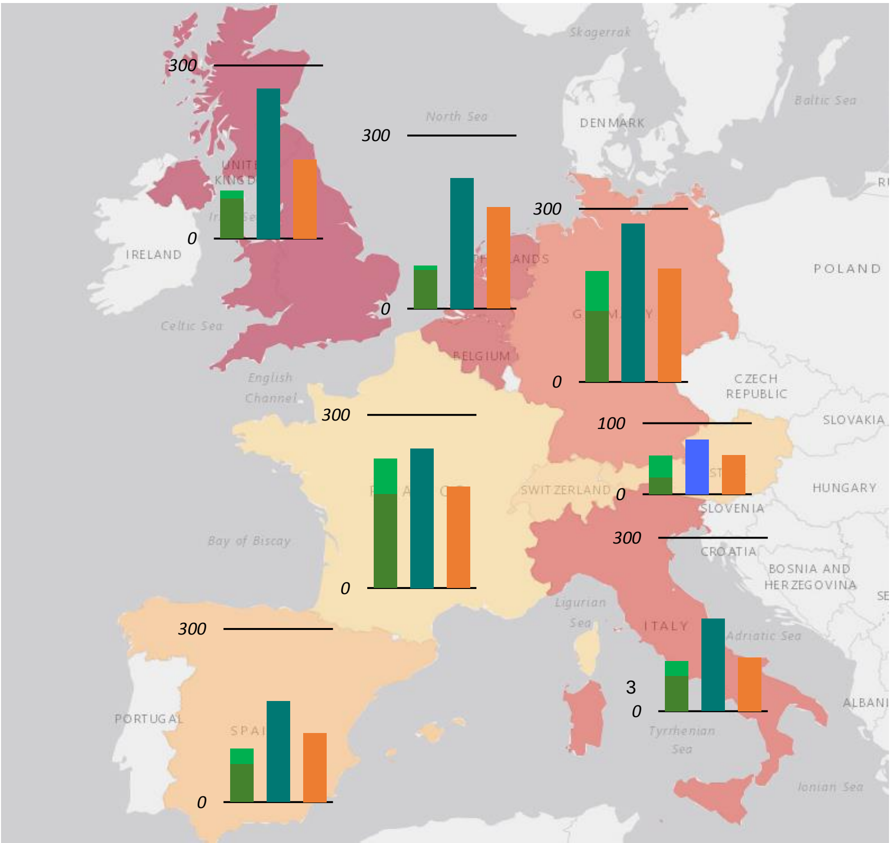
Business As Usual : scenario accounting for current climate policy up to 2030 and leading to -30% decarbonization

Renewable/Biomass potential: Sufficient resources to support further electrification but limited resources for biomethane*, leading to a need for alternatives.

VRES potential vs. 2050 final electricity demand** [TWh]



Biomethane potential vs 2050 final gas demand [TWh]



RES sources
- PV
- Wind Onshore
- Wind Offshore

Biogas sources
- Digestion
- Gasification

Decarbonization scenarios
- Multi Energy Carrier
- Massive Electrification

April 2019

* Based on JRC-EU study, assuming medium availabilities of ressources and 1/3 of 2G potential used for gasification (total= 820 TWh). With high availabilities of ressources, potential = 1400 TWh.
** Final demand, i.e. not accounting for hydrogen or synthetic methane production

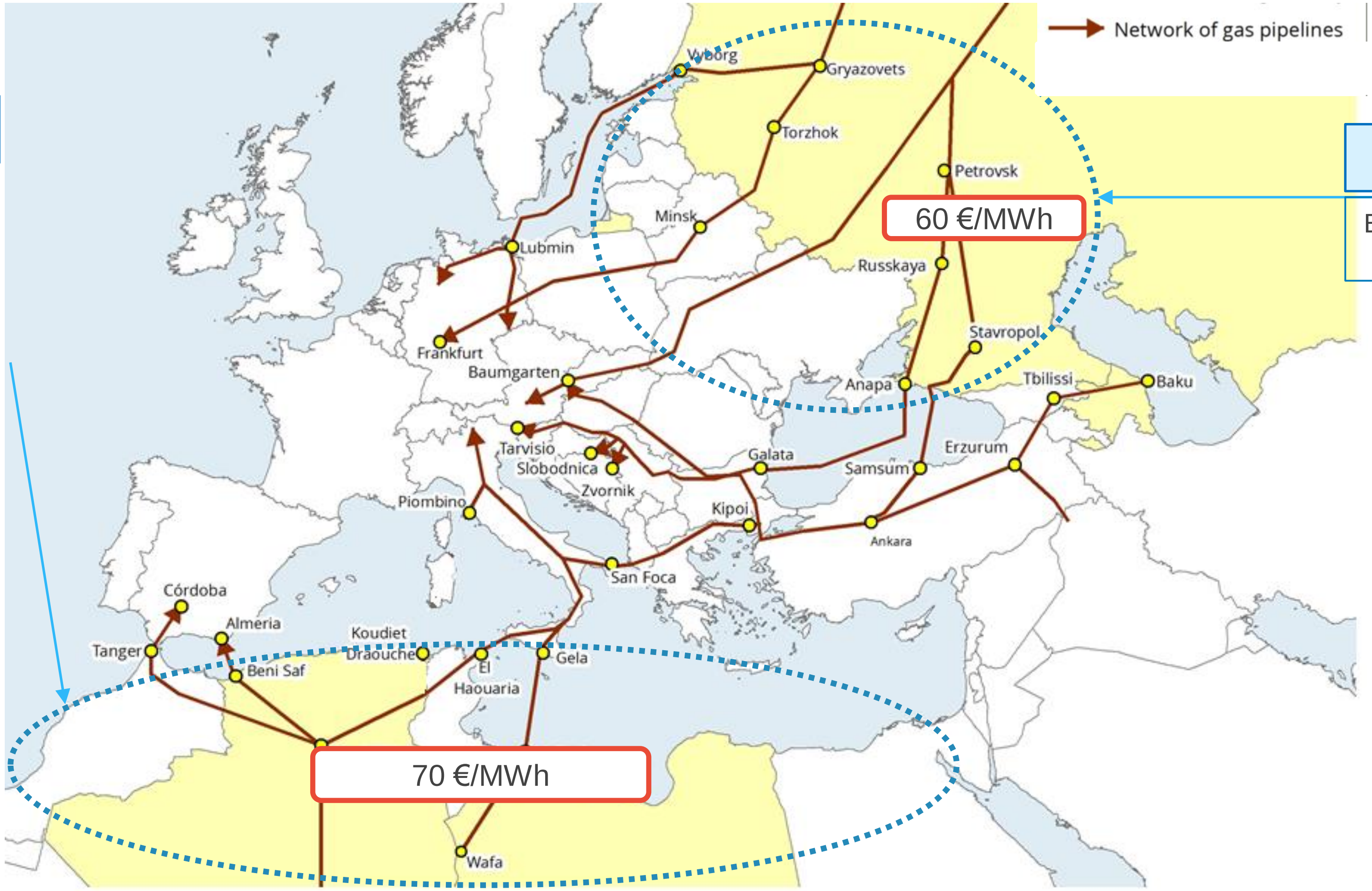
EU importing Green Gas: Different sourcing available leading to an import price around 75 €/MWh in 2050.

Northern Africa

Renewable synthetic methane (Power-to-Gas)

- Assets: PV and Wind Onshore, electrolyser, hydrogen storage, CO_2 direct air capture technology and methanation plant
- Average production cost around 70 €/MWh, leading to an import price of 75€/MWh for EU).

Capacity of existing import infrastructures :
- Pipelines : **708 TWh/year**
- liquefaction plants : **520 TWh/year**



Ukraine & Russia

Biomethane potential of ~ **180 TWh**

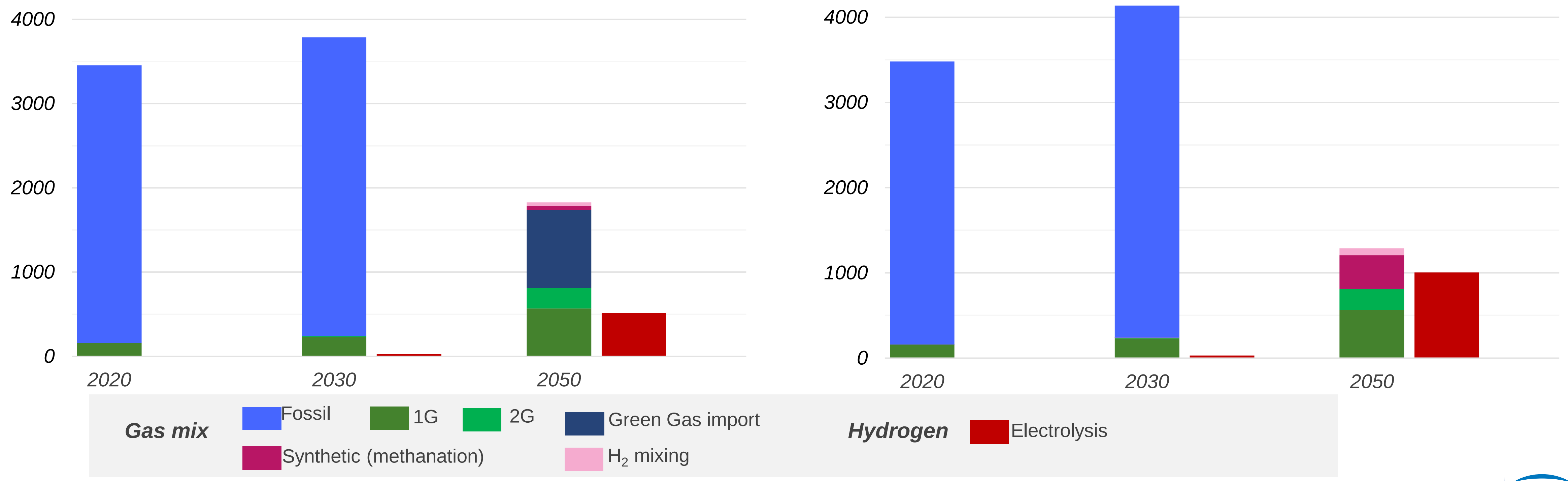
Biomethane ressources (1G+2G) are fully exploited in both scenarios. In 2050 synthetic gas is also needed. Natural gas is essential during the transition period.

By 2050 : 500 TWh of Hydrogen and 90 TWh of domestic Synthetic Gas

By 2050 : 1000 TWh of hydrogen and 480 TWh of domestic Synthetic Gas

C-WE Gas supply in “Multi Energy Carriers” [TWh/yr]

C-WE Gas supply in “Massive Electrification” [TWh/yr]



Need for a major shift in development pace for renewables

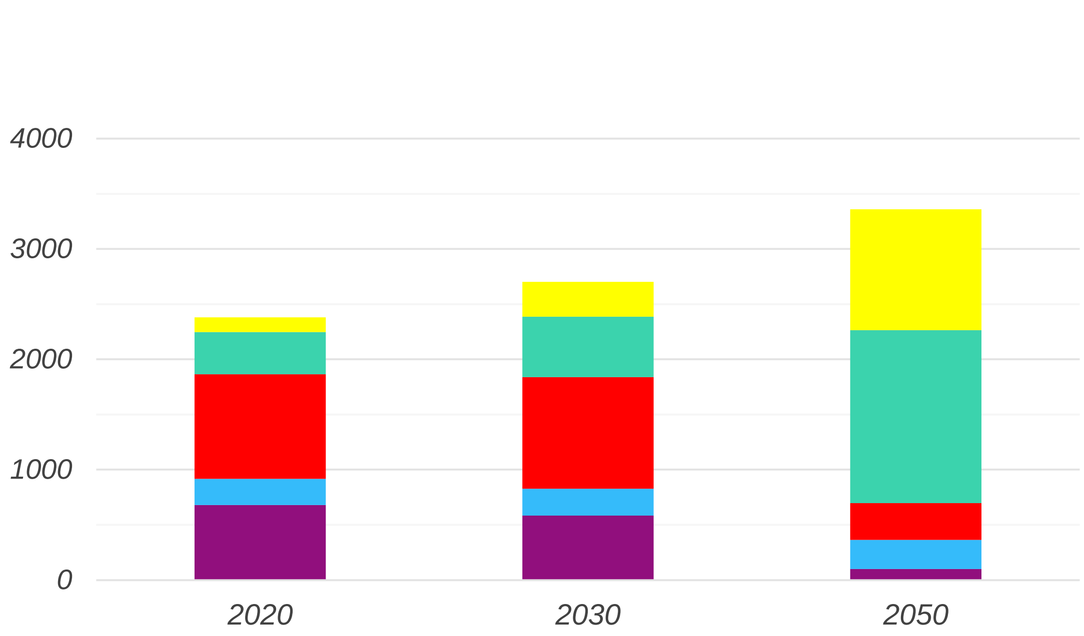
Nuclear | Hydro | Thermal | Wind | PV

Investment of 27 GW/yr in PV and 17 GW/yr in wind capacities to reach renewable production of 2660 TWh in 2050*

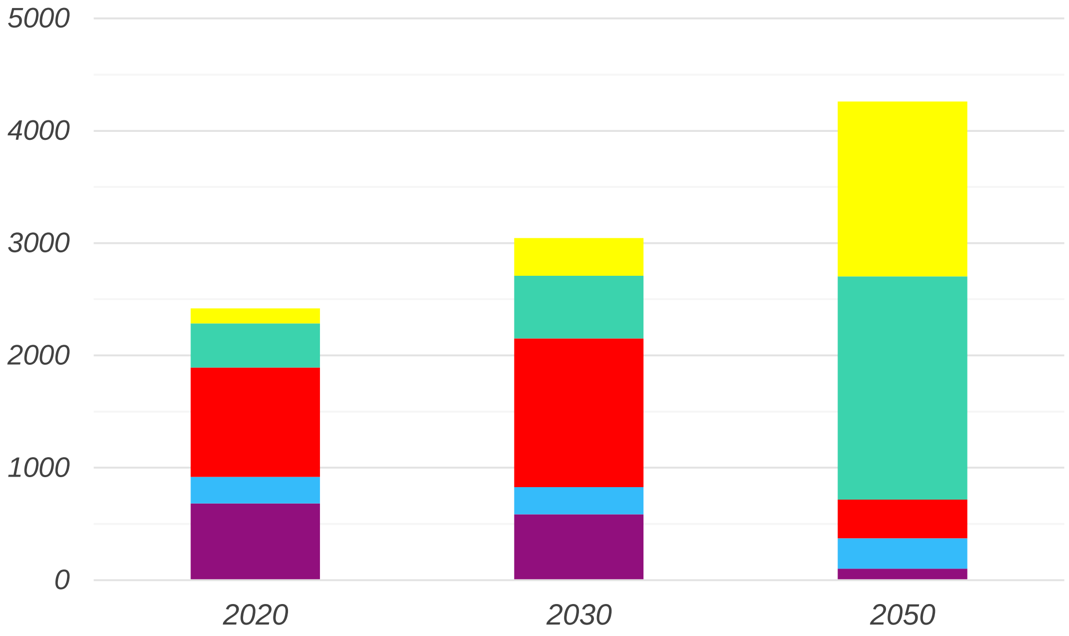
Investment of 41 GW/yr in PV and 22 GW/yr in wind capacities to reach renewable production of 3540 TWh in 2050*

*New EPR not competitive neither in UK nor in FR**.*

C-WE Electricity production by fuels in “Multi Energy Carriers” [TWh/yr]



C-WE Electricity production by fuels in “Massive Electrification” [TWh/yr]

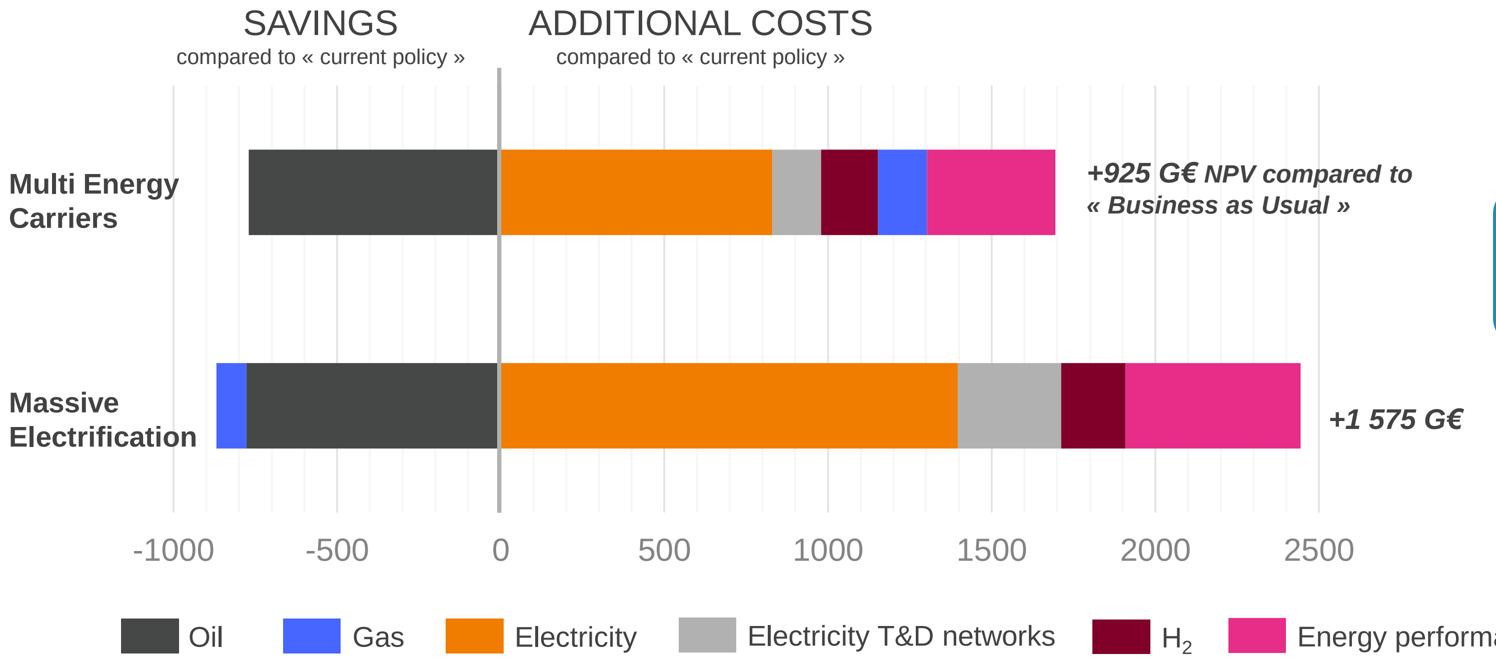


** Max. installation rate historically observed in CW-E : 21GW/yr for PV, 10GW/yr for wind.*

*** New EPR only considered as an investment option in FR and UK. New nuclear would be competitive at ~4800€/kW (6350€/kW assumed in this study)*

Decarbonization leads to a major shift of oil expenditures towards electricity and hydrogen.

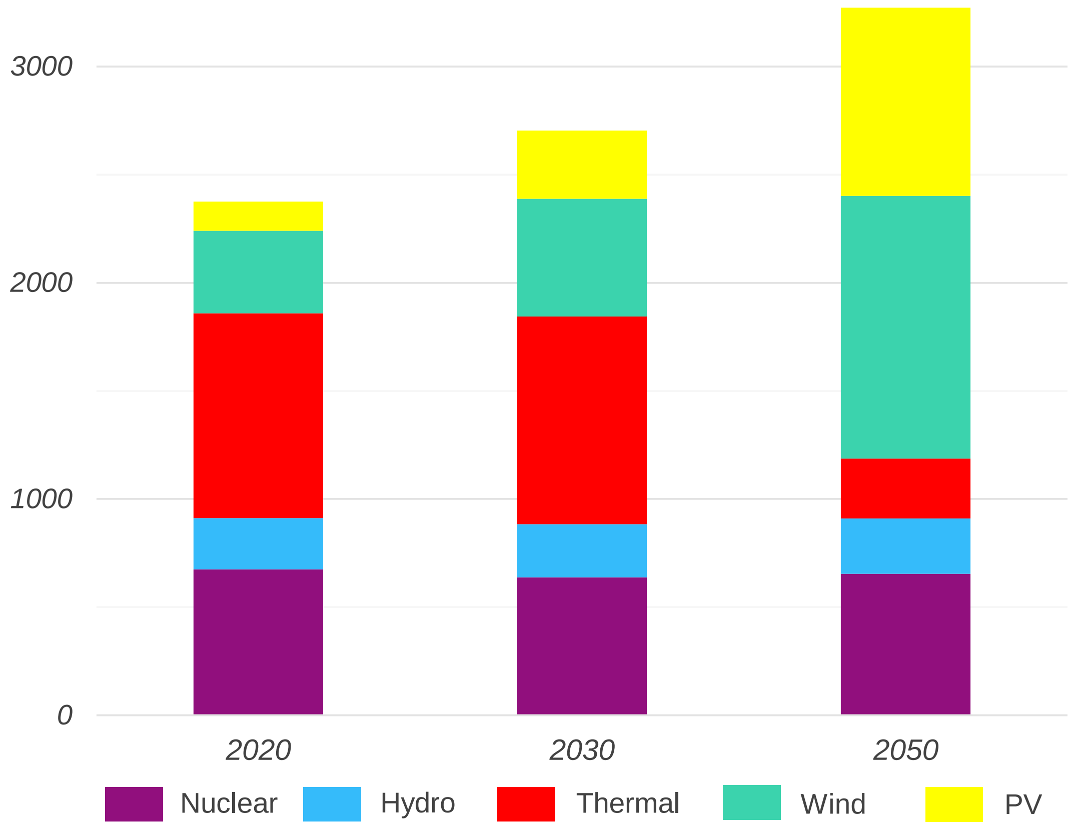
Energy system costs compared to "Current policy"
[ΔG€ in net present value]



Total cost difference of 650 G€

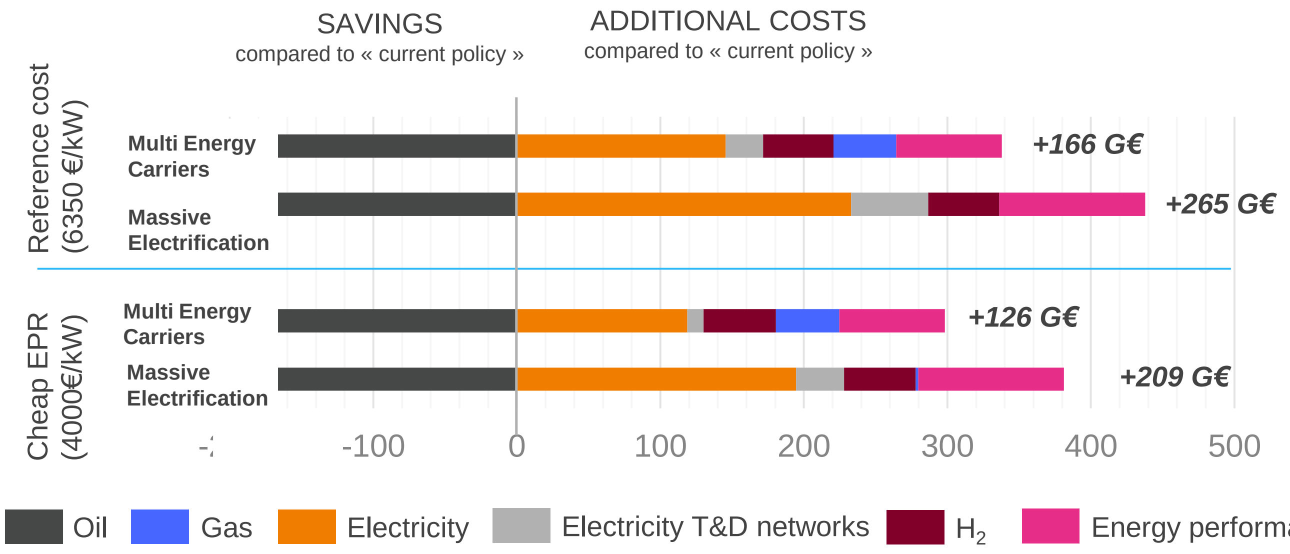
Assuming a cost of 4000€/kW, the EPR technology becomes competitive but impact on scenarios comparison is minor.

C-WE Electricity production by fuels in "Multi Energy Carriers" assuming cheaper EPR capex, and allowing development in FR and UK [TWh/yr]



- ❑ In 2050, 57 GW of nuclear in France and 27 GW in the United Kingdom.
- ❑ Additional nuclear production of ~600TWh, mainly replaces RES production (wind onshore and PV).

French energy system costs compared to "Current policy" [ΔG€ in NPV]



KEY TAKE-AWAYS

THREE ESSENTIAL PILARS FOR DECARBONIZATION

- **Energy efficiency:** final energy demand decreases by 42% compared to current demand
- **Significant use of green gases:** European biomethane resources are fully used in all decarbonation scenarios
- **Partial electrification:** electricity develops in all scenarios considered

MULTI ENERGY CARRIERS LIMIT COSTS AND OPTIMIZE INVESTMENTS

- **Global costs:** 650 G€ lower amount compared to a Massive Electrification
- **Fewer investments:** existing gas infrastructures do not need to be replaced by new power infrastructures
- **Less volatility in power prices:** a steadily increasing price duration curve gives a better price signal for investments

MULTI ENERGY CARRIERS LIMIT RISKS

- **Security of Supply:** in the transition phase natural gas is essential to ensure it
- **Biomethane, a no-regret option:** even if expected cost reductions are not achieved
- **Less risk of failure of the energy transition:** in the Massive Electrification scenario, the PV and wind installation rates must be multiplied by 2 during 30 years compared to the highest level observed