Sector coupling for the decarbonation of the energy system and grid stability

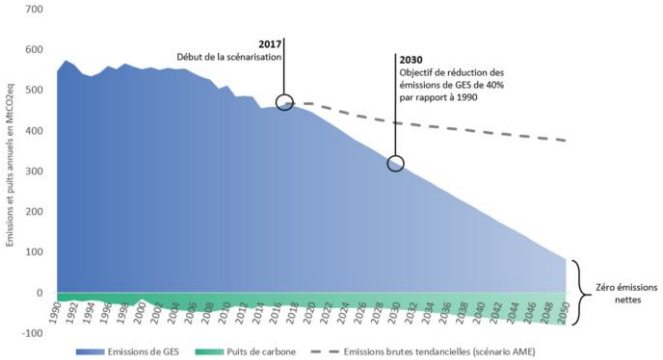
OFATE/DFBEW conference, 9th june 2020

Particular attention is paid to the problem of coupling between electricity and other energy carriers

In 2019, RTE has launched analyses on the interfaces between electricity and other energy carriers in order to answer various questions:

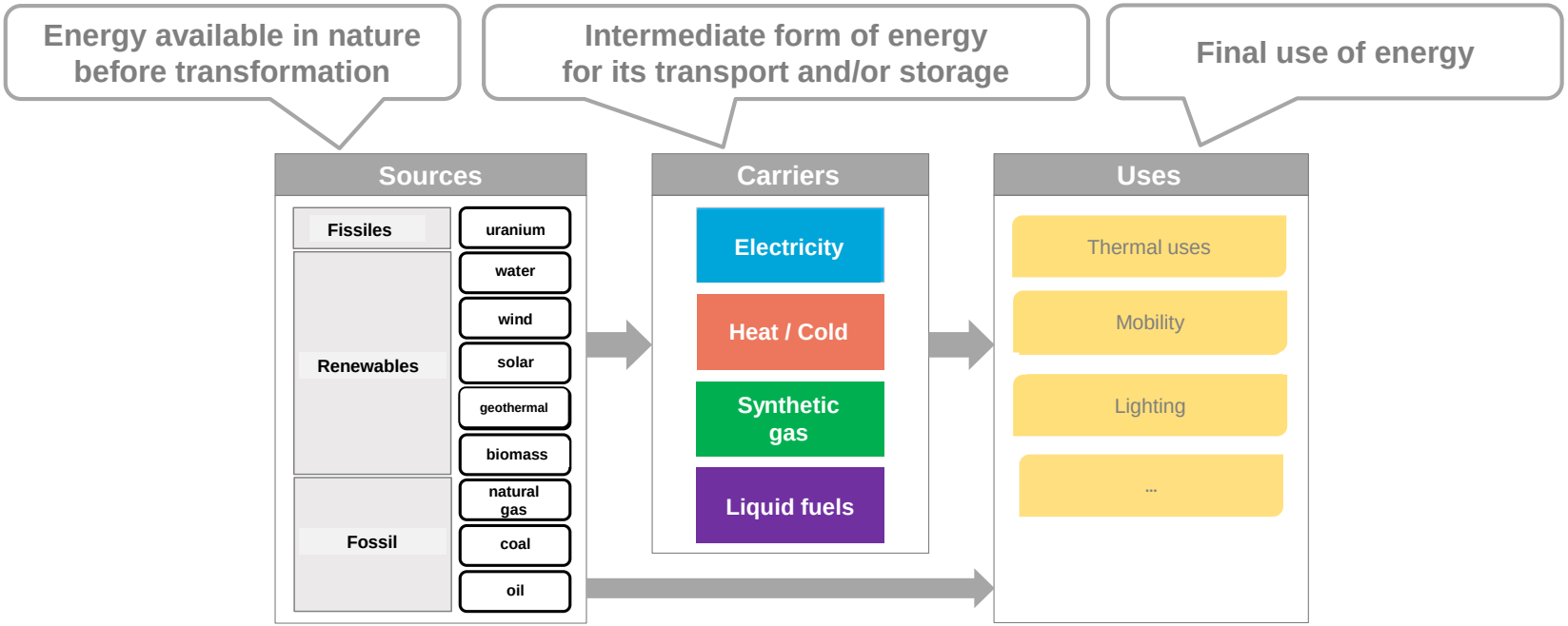
1. Analyses aimed at fuelling the public debate and the **construction of the next long-term scenarios of the Adequacy Forecast**
   - They fulfil one of RTE's legal missions: to ensure the security of France's electricity supply
   - They are part of the framework defined by the public authorities: achieving carbon neutrality by 2050 according to the trajectory defined by the French NECP

2. **As part of the national hydrogen plan,** a request from the Minister to study the services that electrolysers can provide to the electrical system.



RTE report available here:
https://www.rte-france.com/sites/default/files/rapport_hydrogene_vf_2.pdf

Energy carriers interacting with electricity



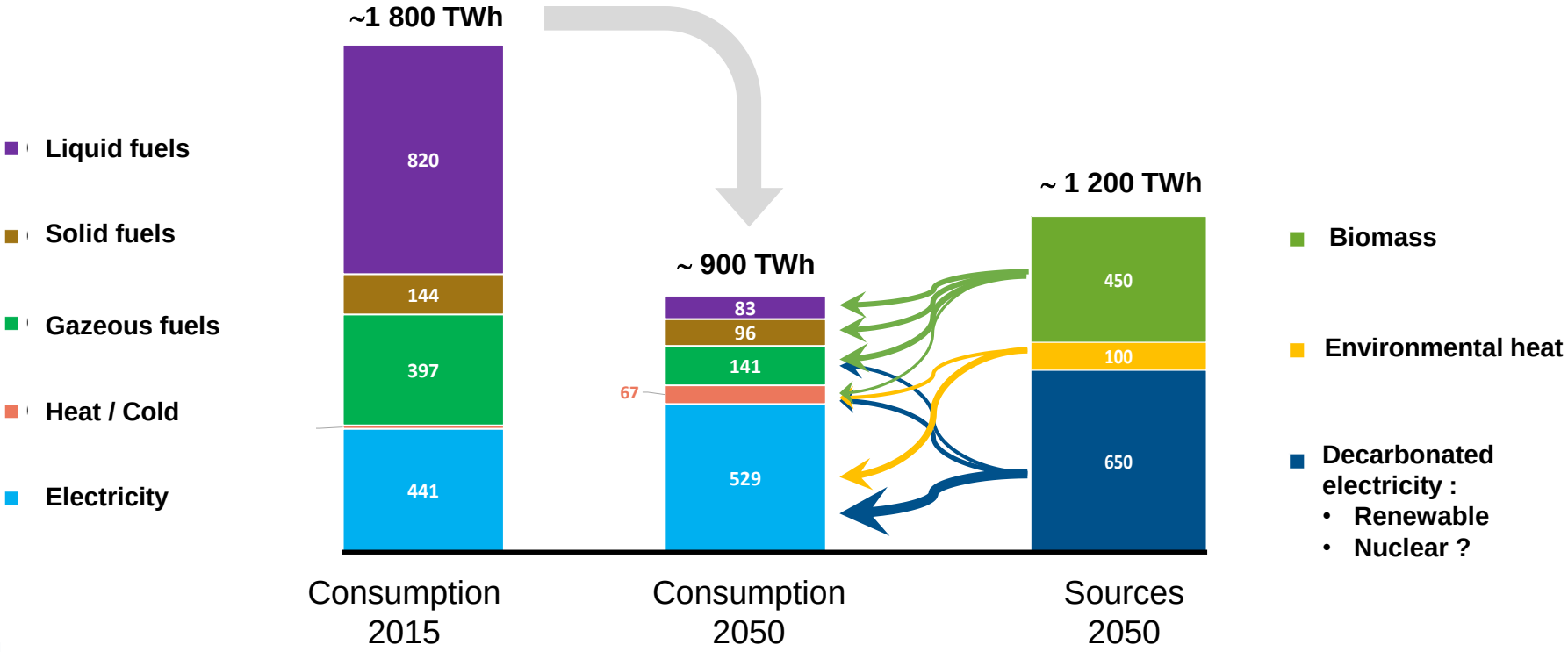
3 categories of carriers interacting with **electricity**

- **Heat or cold**, associated with a network or a storage facility
- **Gaseous fuels**: hydrogen, biogas, synthetic methane, ammonia, ...
- **Liquid fuels**: petrol, diesel, methanol, ...

The French national strategy is based on 2 main axes

The reduction of energy consumption (approximately a division by 2 compared to 2015)

Conversion of domestic energy production to decarbonated sources



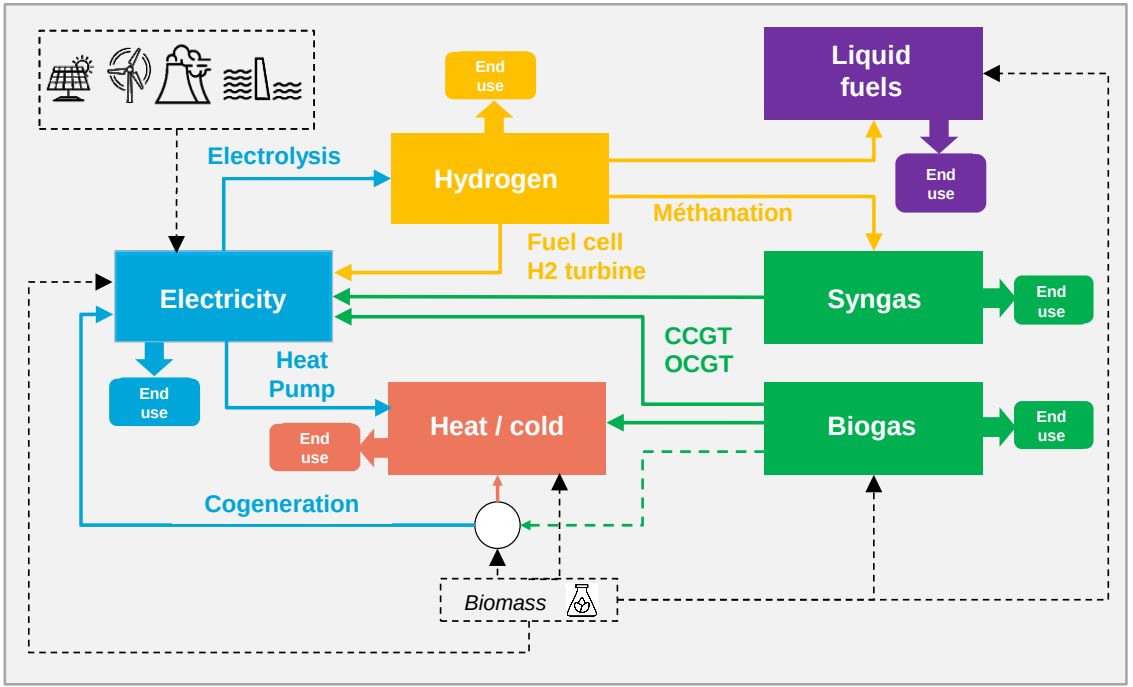
Power-to-X and X-to-Power : the five considered interactions

Power-to-X

1. **Electrolysis** for the production of hydrogen
2. **Heat pumps** for the production of heating or cooling networks

X-to-Power

3. Generation from **biogas or synthetic methane**
4. Generation from **hydrogen**
5. Electricity from **cogeneration**



Other interactions are possible, but are not considered for reasons of low efficiency or constrained capacities in relation to needs (e.g. producing electricity with synthetic fuels).

There are two reasons for the interaction between electricity and other energy carriers, not to be confused

1

Decarbonize the other energy carriers (hydrogen, heat, ...)

To meet national and international decarbonation targets

Power-to-X

≠

2

Contributing to the balance of the power system by generating or even storing electricity

Generation from non carbonated fuels and flexibility of loads

X-to-Power
&
Flexible loads

Power-to-X: an interest from the decade 2020-2030 to decarbonize the other energy carriers and uses

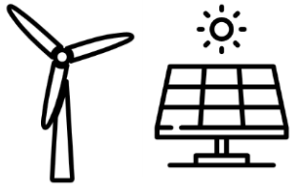
- The climate emergency makes it necessary to find solutions that are effective in reducing greenhouse gas emissions **from the decade 2020-2030**
- Technologies are mature enough to **replace the use of fossil fuels with carbon-free electricity**:
  - **Heat pumps** for thermal uses in buildings
  - **Battery electric vehicles** for light mobility
- Technologies for the **production of hydrogen by electrolysis** are expected to rapidly reach the industrial stage sufficient to
  - **Decarbonizing industrial uses of hydrogen,** replacing natural gas steam reforming
  - **Consider hydrogen fuel for heavy mobility** as a substitute for oil, and as an alternative to direct electricity.

Two necessary conditions for Power-to-X: the development of decarbonated production and the legibility of the CO2 value

- The interest of Power-to-X in the fight against global warming is based on the **development of carbon-free power generation in Europe**
  - It is a **no-regrets option**, whatever the scenario and whatever the vector that the decarbonated electricity production will feed (electricity, heat, hydrogen (and then possibly methane or methanol)): the uses associated with the different vectors will develop in line with their technical and economic maturity and questions of acceptability.
  - On the other hand, the development of electricity uses that are not accompanied by new carbon-free production could prove counterproductive, by making greater use of existing fossil fuels.

- The economic trade-off of these solutions requires a **shared, single, stable and long-term CO2 abatement value**
  - **A single European guardian value for CO2** would be necessary in order to avoid distorting decisions in Europe and to make it possible to compare the expected benefits of the different carriers

X-to-Power for electrical system flexibility: an extra brick in a complex assembly



An increasing need for flexibility

Historical leverages disapearing

New leverages searching for their place

Leverages interacting with other energy carriers

Changing needs for power system flexibility

- There is not ONE but **MANY needs for flexibility** of the electrical system, according to the different horizons: seasonal, weekly, daily, ... They can be qualified in power and energy
- Increasing share of non-controllable **renewable production** in the production mix increases the need for flexibility on all horizons, but in variable proportions depending on the respective rates of wind and photovoltaic energy

	Horizon					
	annual		weekly		daily	
	energy	power	energy	power	energy	power
Wind	↘	↗	↑	↑	→	↗
Photovoltaïc	↑	↑	↗	↗	↑	↑

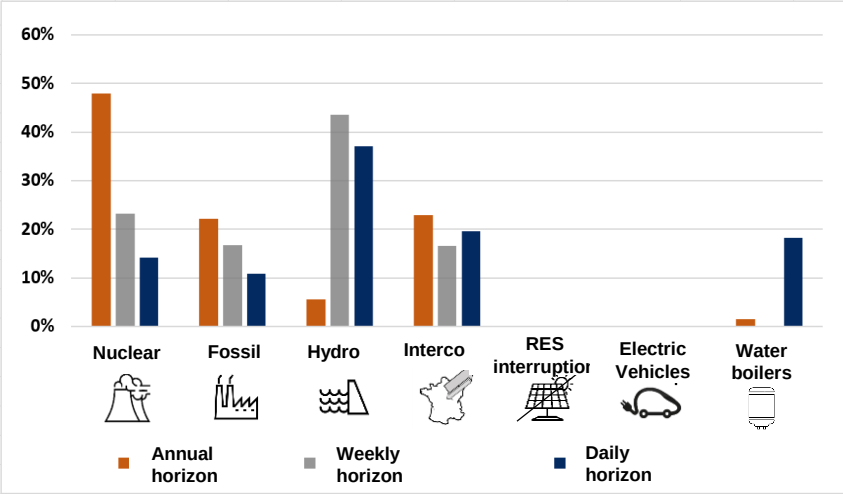
Qualitative effect of wind and photovoltaic production on the need for flexibility

- The need for flexibility will also change as **electricity consumption evolves**, depending on the thermal sensitivity of uses, changes in temperature (the climate is changing) ... and new uses of electricity including Power-to-X

More on flexibility needs in: *Multi-temporal assessment of power system flexibility requirement, Thomas Heggarty et al., Applied Energy 238 (2019) 1327–1336*

X-to-Power for power system flexibility needs: a potential later interest (2040-2050)

- RTE's analyses show that, based on European NECPs, the available flexibility levers including electric vehicles mean that X-to-Power is not necessary to 2035.
- **The potential interest of X-to-Power will come later (2040-2050)**, when the European electricity system will no longer have controllable fossil fuel (gas, coal) units, depending on the system's flexibility needs and the presence or absence of other levers (nuclear, CCS, batteries, etc.)



Current use of flexibility levers in France

Taking into account the interaction between electricity and other energy vectors is a key factor in analyses with a view to achieving carbon neutrality

The role of these interactions will depend on many parameters that need to be scenarized

- **National choices** within the interconnected European system (nuclear? CCS?)
- **The fixed costs** of certain technologies under development (fuel cells, hydrogen turbines)
- **The variable costs of electricity production**: what are the costs of green gas produced in Europe? or imported?
- **The available potentials for decarbonated energies produced in Europe**, for both electricity and gas, **regarding the total demand of energy in Europe**

→ **These elements will be integrated into RTE's work to draw up the next long-term electricity adequacy forecast**

Thank you for your attention !