Prospective analysis of supply systems for french gas/electricity final demand

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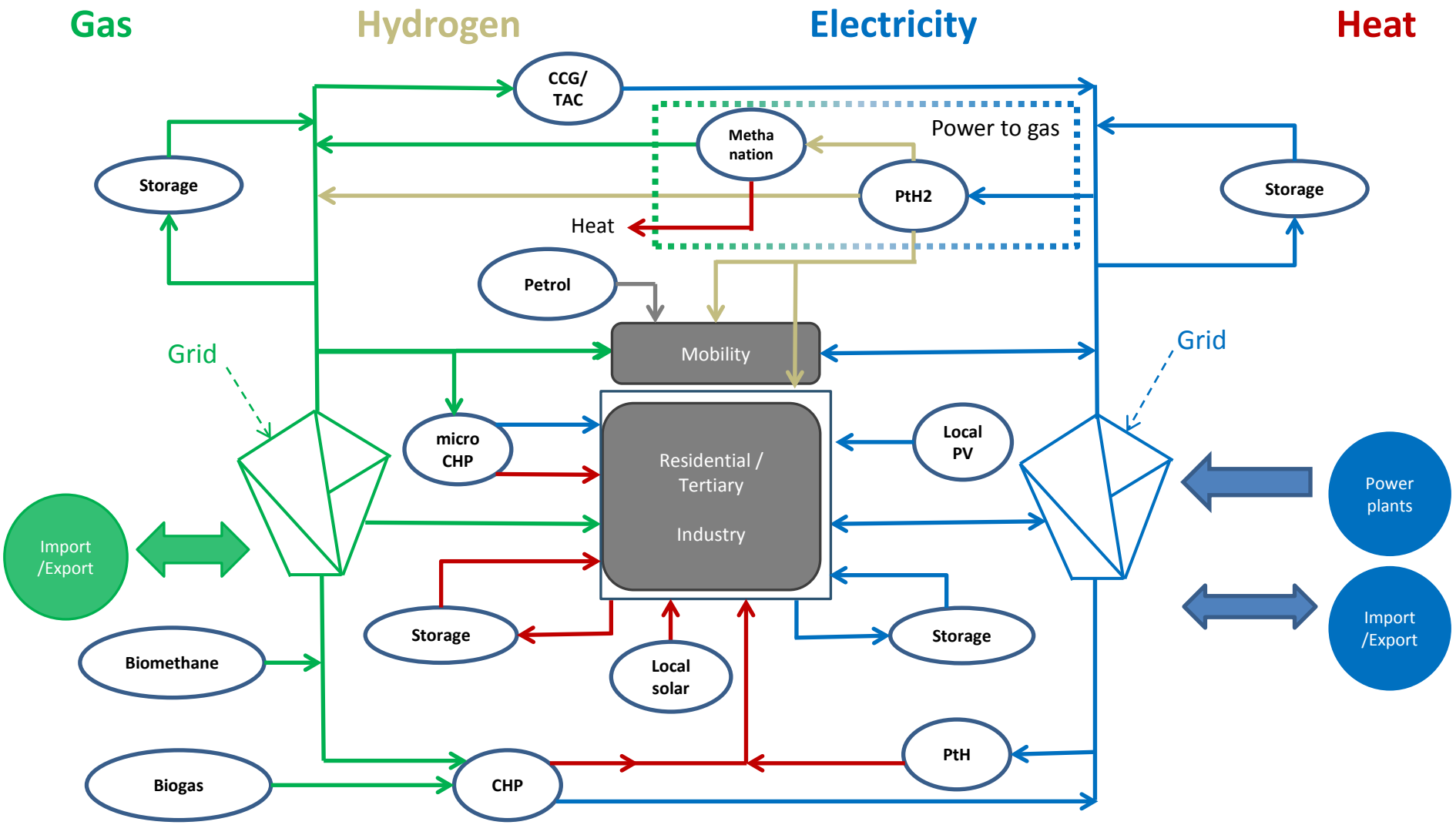
RÉMY DOUDARD

Contents

- I – Introduction
- II – Methodology & scenarios/assumptions
- III – Focus on annual gas/electricity mix
- IV – Conclusions

I - Introduction

I – New pathways for end-uses



I – New pathways for end-uses

- **Long term : Which role for energy vectors/technologies ?**
- **For which end-uses ?**

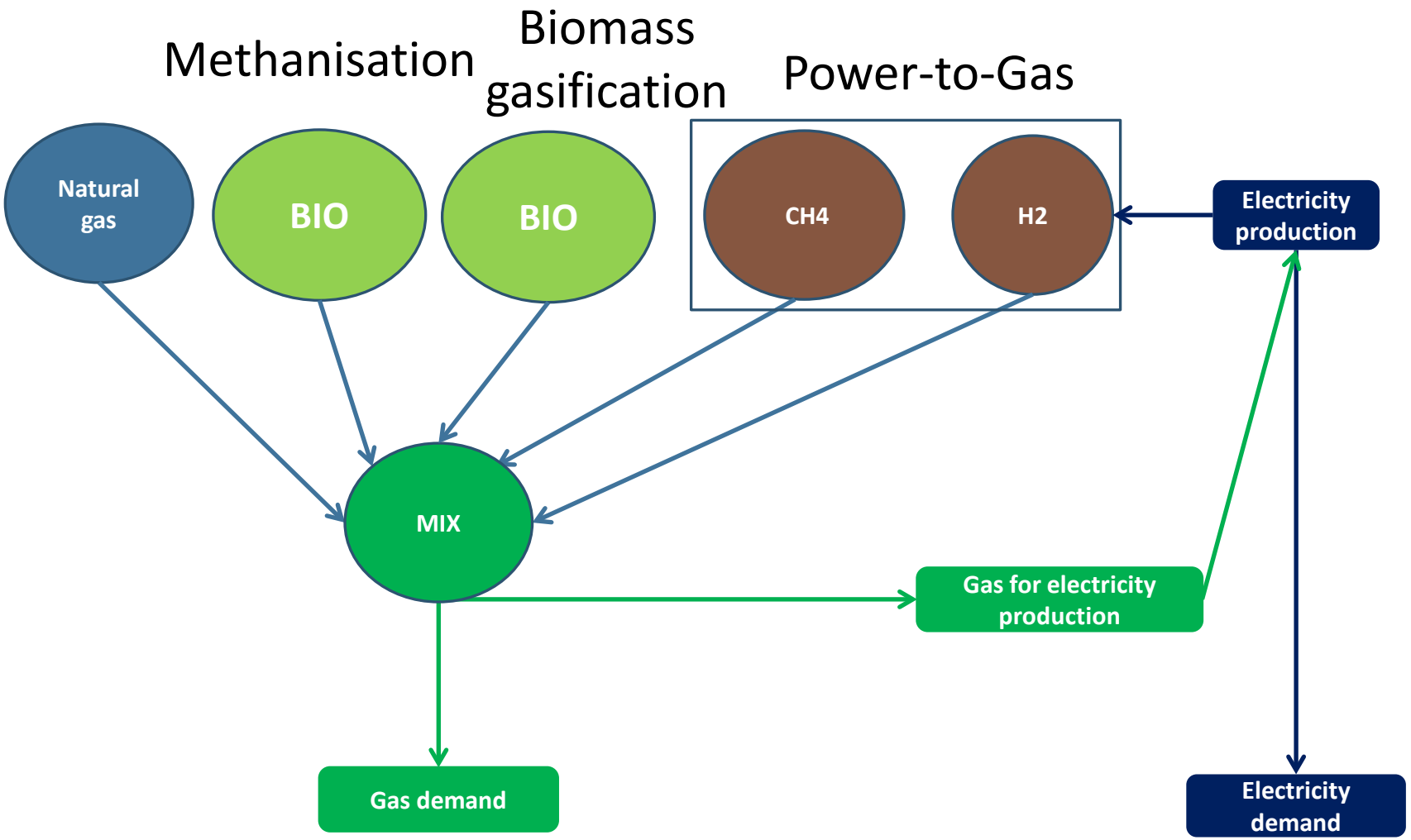
Technologies availability

Demand scenario

Decarbonization pathway

In this presentation: focus on gas/electricity systems

I- New sources for gas mix within electricity/gas systems



I – Biomethane from methanisation: what prospects for CO2 (by-product) ?

Methanisation in digester

Input

- Agricultural waste
- Industrial effluents
- Purification plant sludge
- Organic waste

Biogas

- 60% CH4
- 30% CO2
- 10% other

Purification

Biomethane

- 100% CH4

CO2 (by-product)

Methanation ?
Underground storage ?

Combined heat & power

I – Biomethane from gasification: what prospects for CO2 (excess) ?

Gasification

Methanation

Input

- Lignocellulosic biomass
- Solid Recovered Fuel (SRF)

Syngas

- 30%-45% H2
- 15%-25% CO2
- 20%-30% CO
- 8%-12% CH4
- 3%-5% N2

Biomethane

- 100% CH4

CO2 (excess)

Methanation ?
Underground storage ?

Combined heat & power

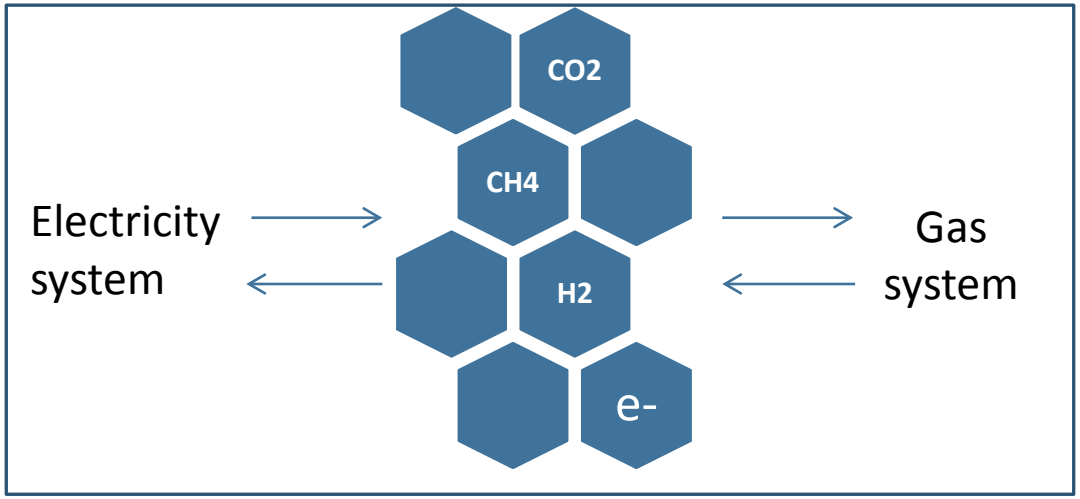
I - Composition, operation and interactions of electricity/gas systems could be changed

Biomethane (methanisation)

Power-to-gas

Gas to Power

Biomethane (gasification)

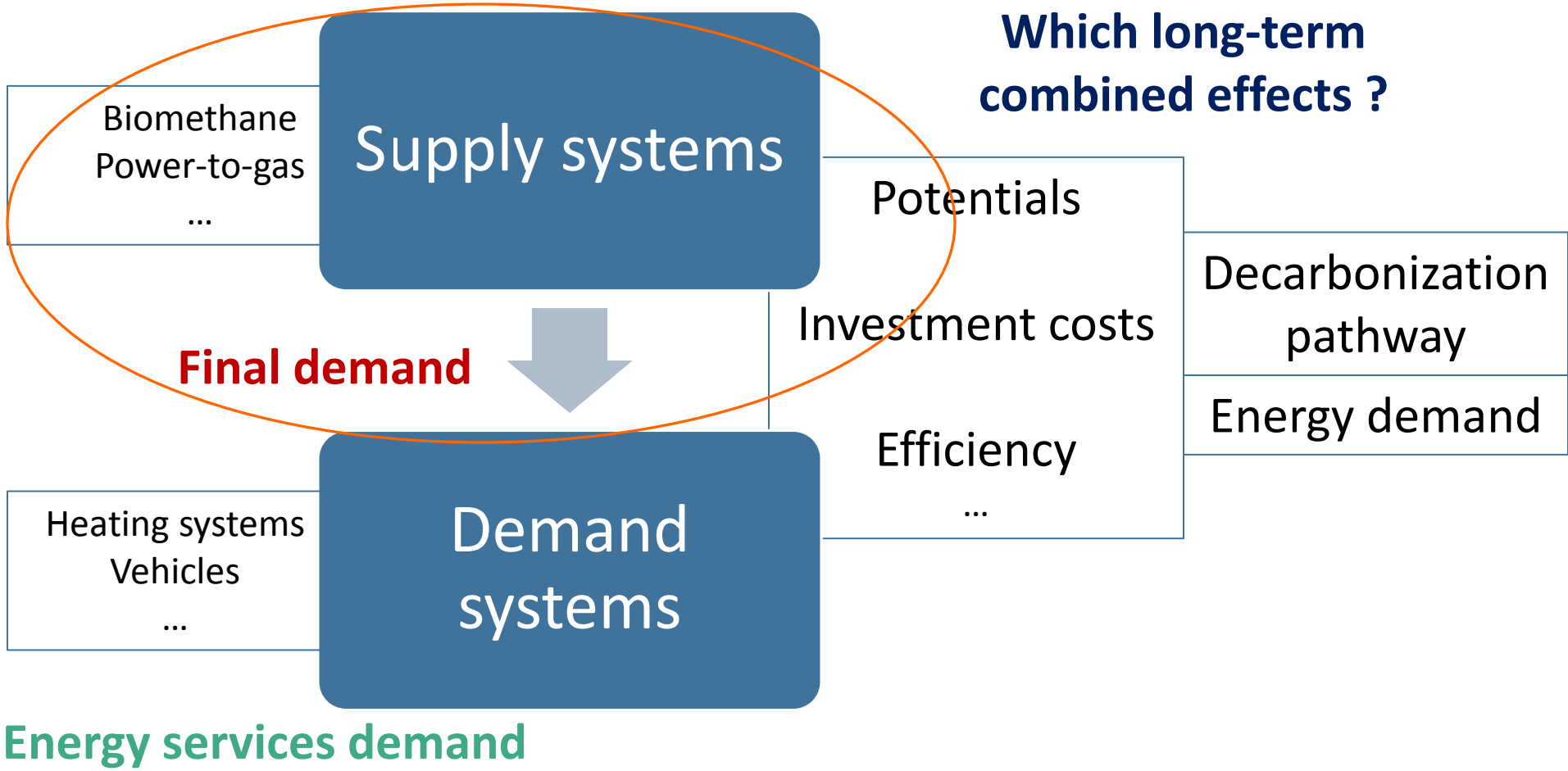


Which modifications ?

When could they occur ?

In which context ?

I – Thesis overview



In this presentation:
Focus on supply systems for gas/electricity final demand

II – Methodology & scenarios/assumptions

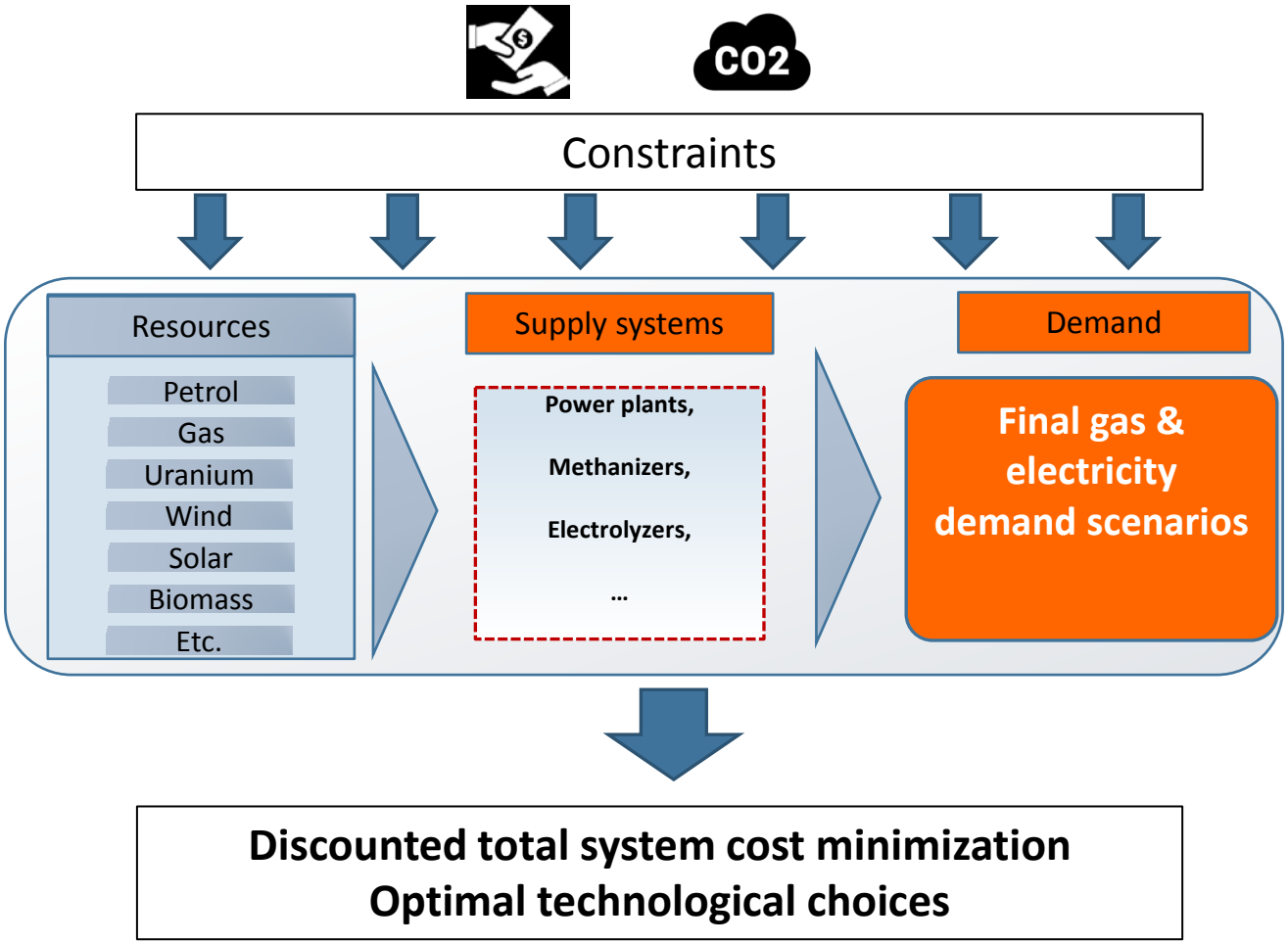
II – Modelling choices for prospective analysis

- Identify the best configuration regarding demand scenarios, technologies availability…
  - **Optimal paradigm**

- Embed complexity of systems with various energy pathways and technological options
  - **« Bottom-up » modelling approach**

- Embed two different time-scales: energy system long term evolution (2050 horizon) and operational time-scale (supply/demand balance)
  - **Gas and electricity demand hourly time-step in order to embed flexibility constraints**

II – Joint hourly gas/electricity system optimization with TIMES_FR_GAZEL model



12 months

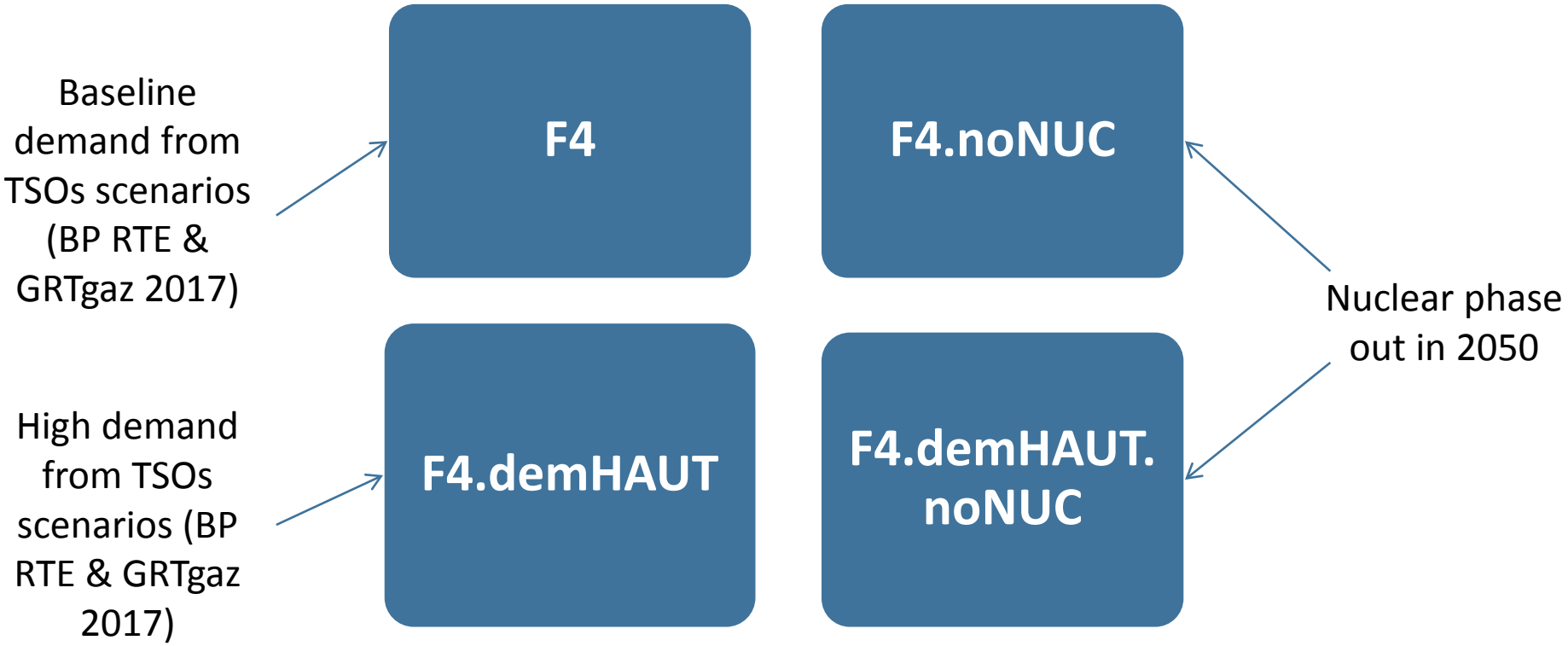
2 representative days (Week/WE)

24 hours/day

(576 timeslices)

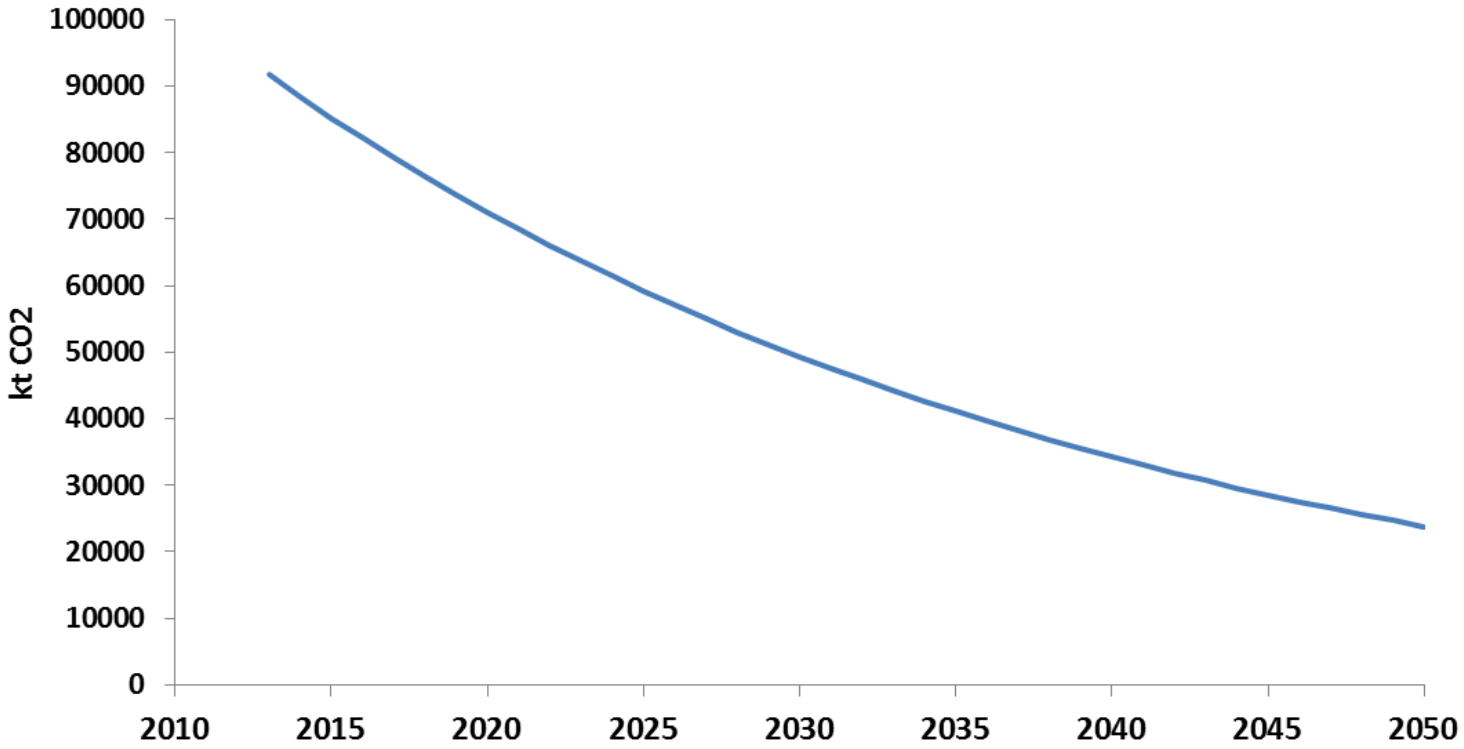
II – Scenarios « factor 4 »

4 scenarios « factor 4 » are presented (no demand elasticity) :

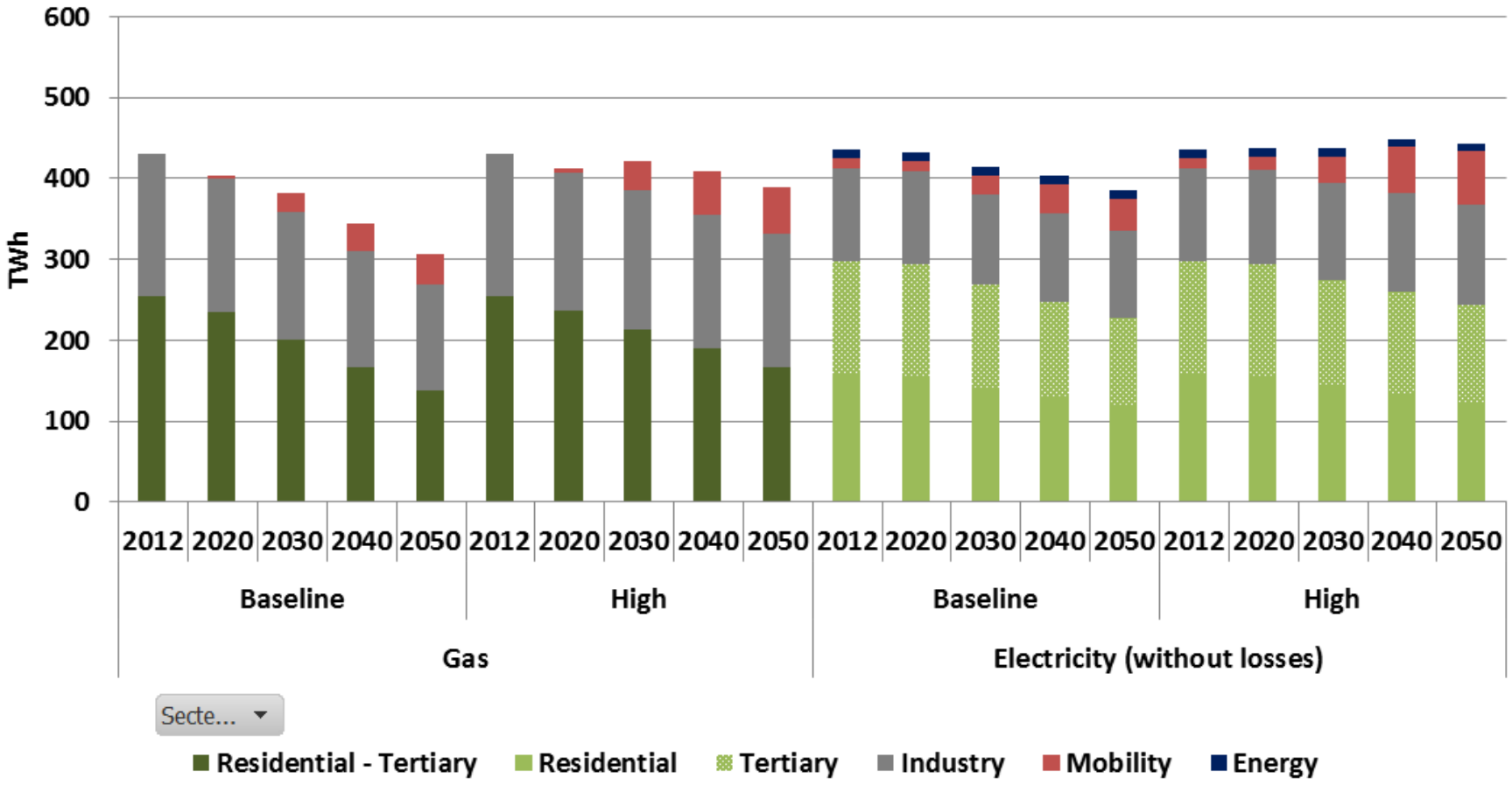


F4 until 2050 on both electricity & gas systems

II – Decarbonization constraint

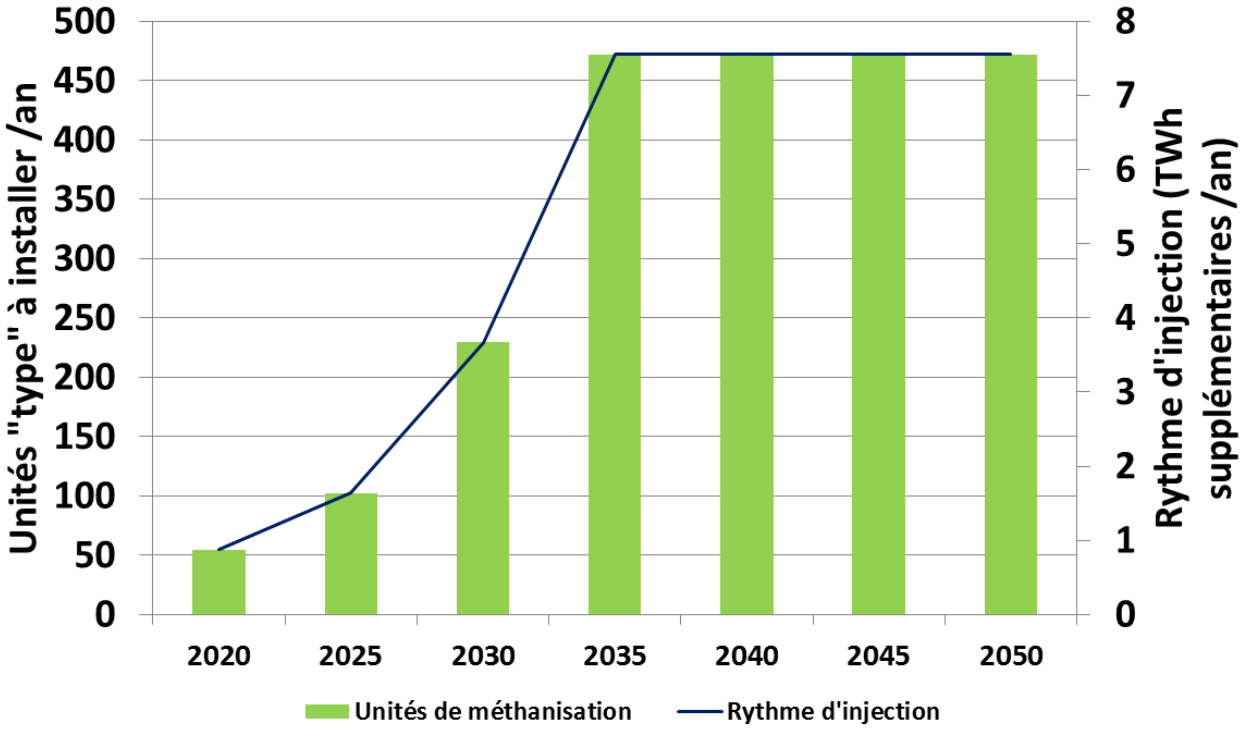


II – Demand scenarios cross analysis



II - Focus on renewable gas assumptions

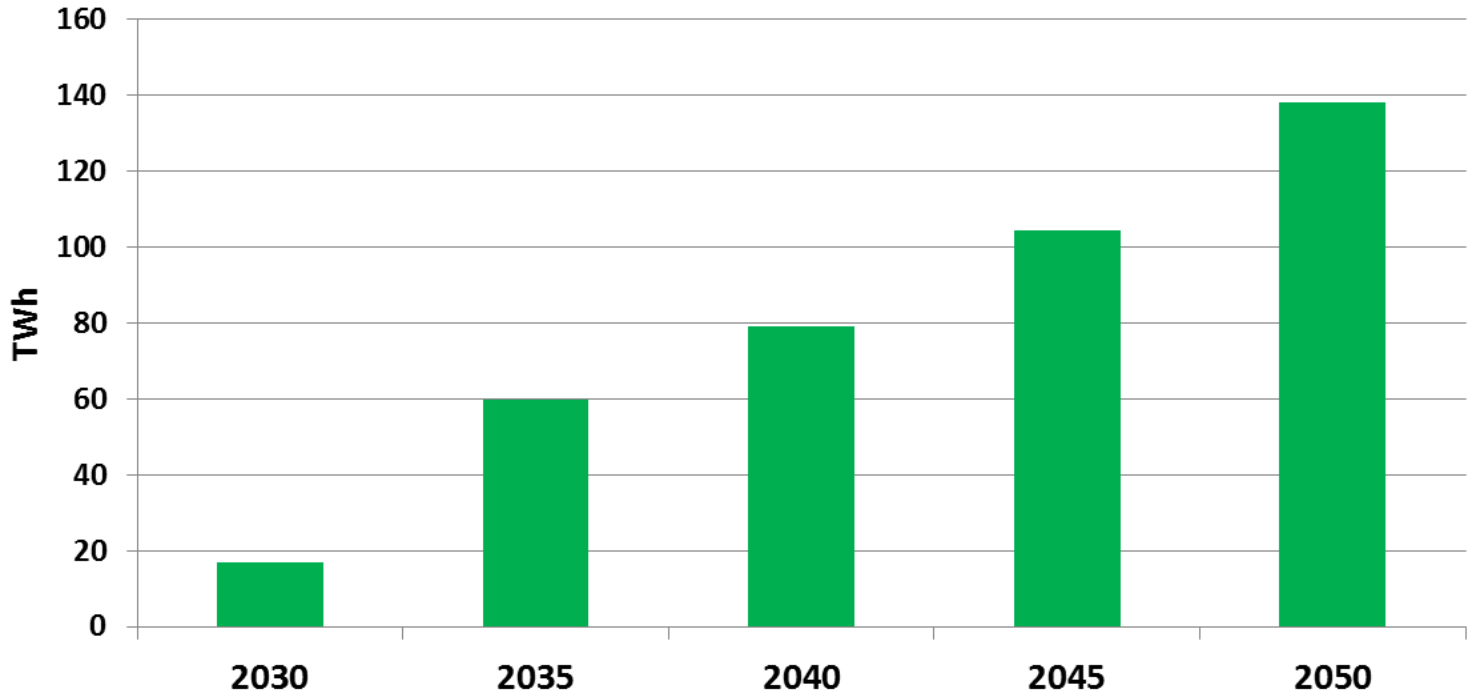
- ADEME 100% renewable **biomethane from methanisation** scenario **(2050 limit : 128 TWh)**
  - **Methanizer mean capacity : 16 GWh / year**
  - **Speed of deployment : GRT gaz scenario A**



II - Focus on renewable gas assumptions

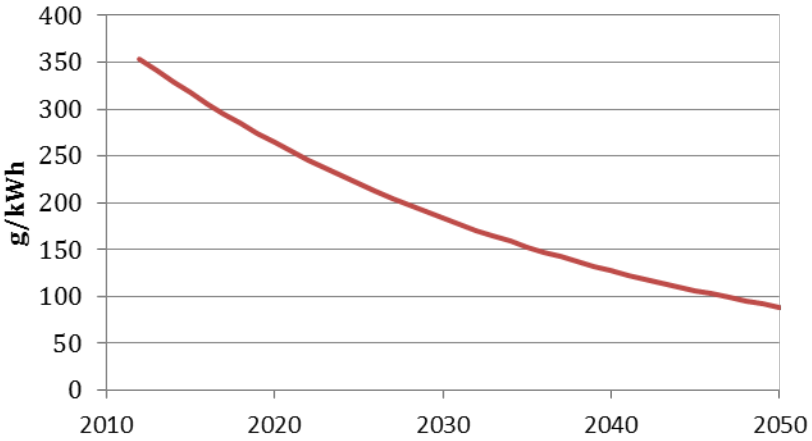
- ADEME 100% renewable **biomethane from gasification** scenarios **(2050 limit : 138 TWh)**

  - **Speed of deployment : GRT gaz scenario B (until 2035)**
  - **2050 limit : 138 TWh (ADEME scenarios)**



II – Assumptions on imports

- Electricity : CO2 content progressive degrowth

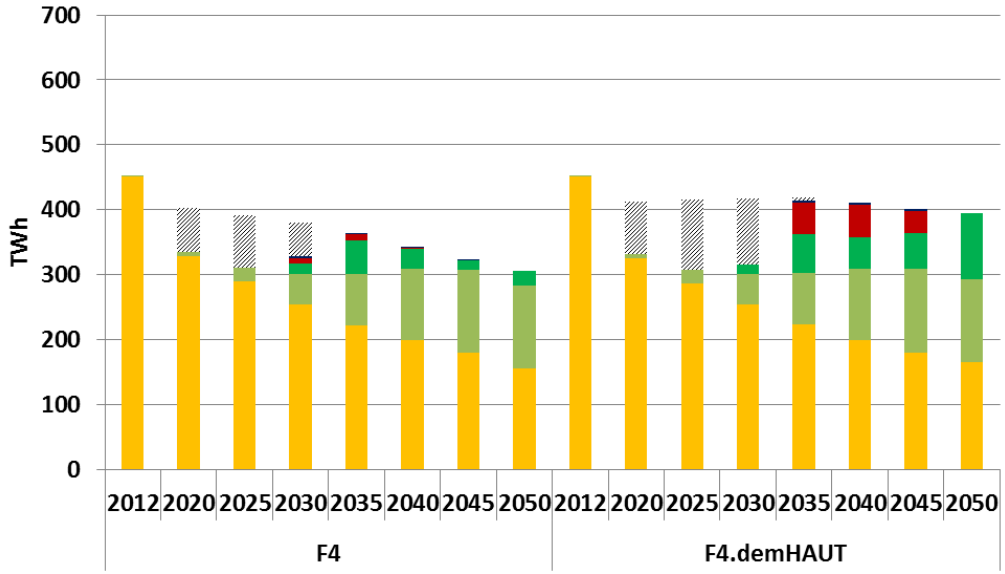


- Gas : natural gas import only

III : Focus on gas/electricity mix

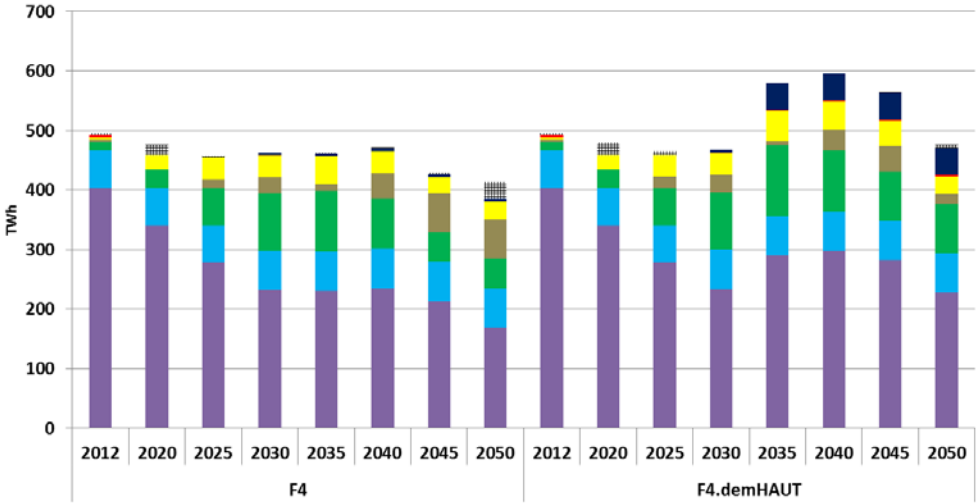
III – Gas/electricity mix cross analysis

Influence of biomethane speed of deployment on gas mix



Gas mix

- Virtual import
- Hydrogen
- Methanation
- Biomethane (gasification)
- Biomethane (methanisation)
- Natural gas

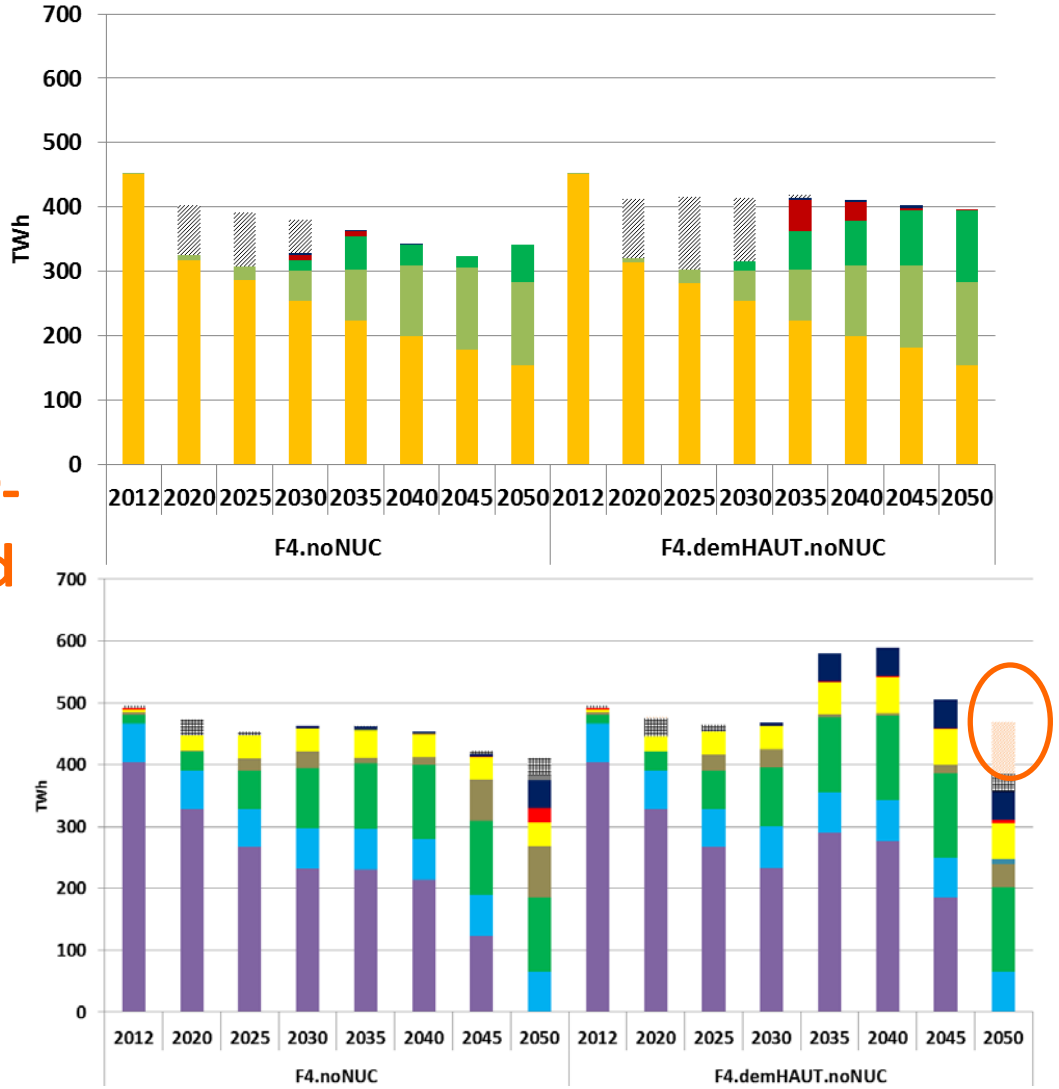


Electricity mix

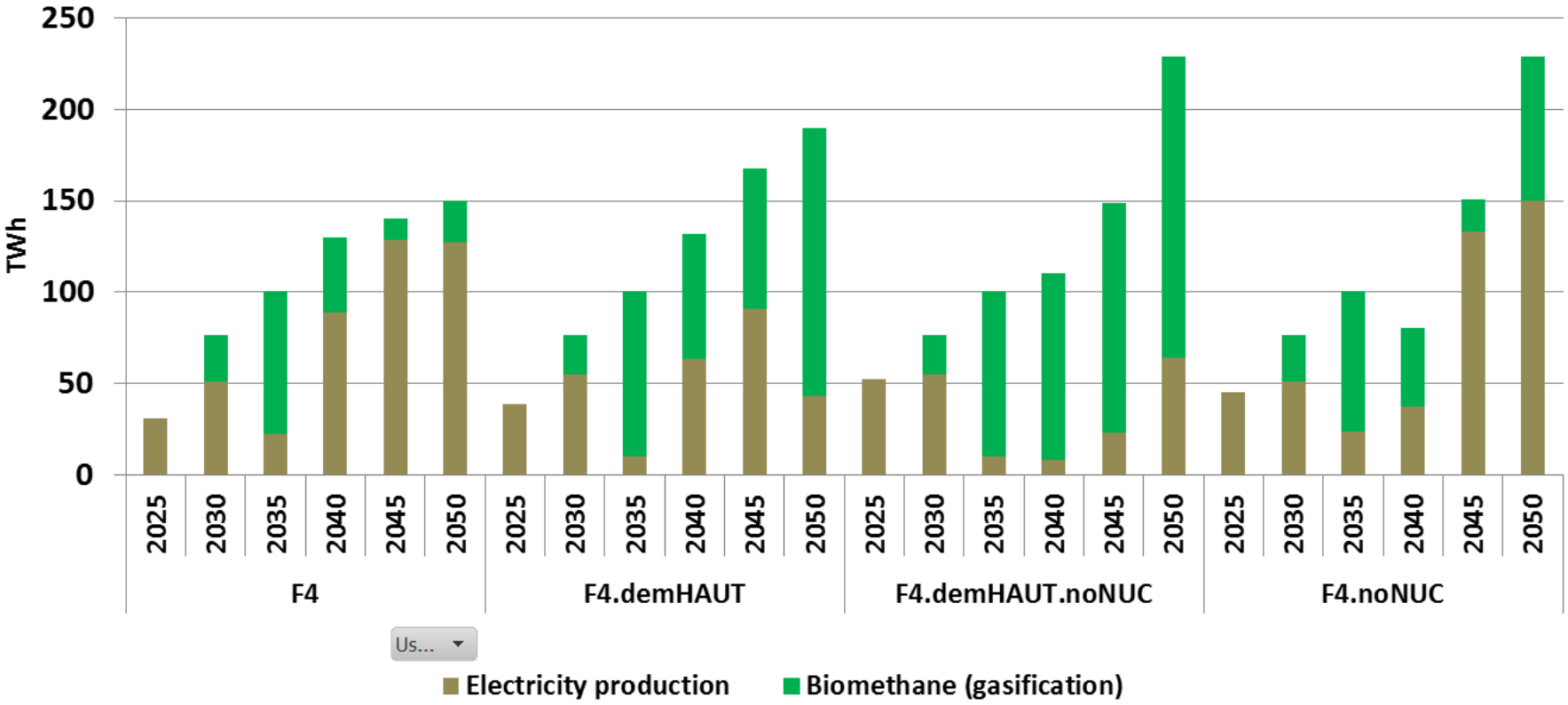
- Solar
- Biomass
- Wind
- Hydropower
- Nuclear
- Importations
- Marine
- Gas

III – Gas/electricity mix cross analysis with nuclear phase-out in 2050

2050 : model over-constrained with high demand

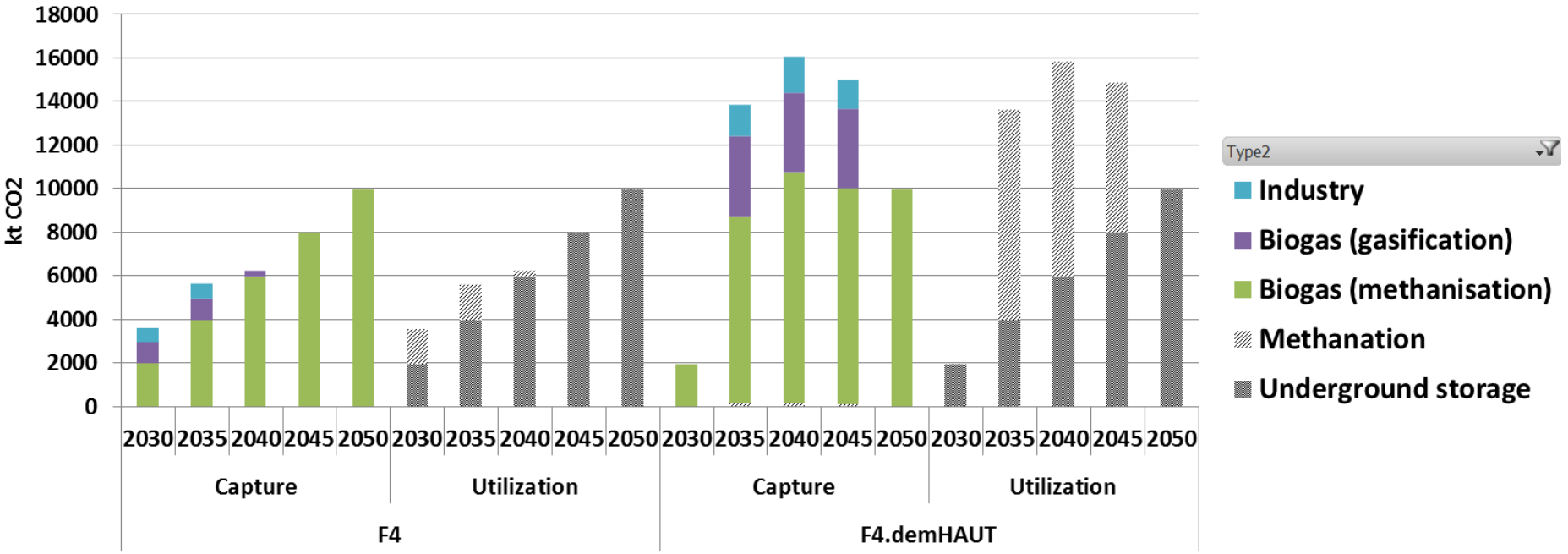


III – Use of wood



III – CO2 capture & utilization sources (methanation/underground storage)

- **Biogas & Syngas** are the main **CO2 capture sources**
- **CCS** is used at **maximum potential** because of **negative emissions**



IV – Conclusions

IV - Conclusions

- Influence of **biomethane speed of deployment** on **gas/electricity mix**
  - In this model, power-to-gas used only if biomethane potential is saturated
  - Satisfying both electricity & gas demand and producing gas from methanation at the same time requires to highly increase installed capacities

- **CO2 from biomethane** play a key role in order to **decarbonize the system**
  - Influence of assumptions on CO2 underground storage capacity

- Influence of **demand scenarios** on **gas/electricity mix**
  - Shows the interest of gas/electricity demand joint hypothesis

What impact if we consider energy vectors substitutions for end-uses ? (ongoing work)

Thank you !