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Etienne de Chambost, G. Boissonnet, Louis Merceron. From biofuels to e-fuels: a review and techno-economic assessment. 6th Research and Development 20 (RD20) for Clean Energy Technologies, Dec 2024, New delhi, India. cea-04874204

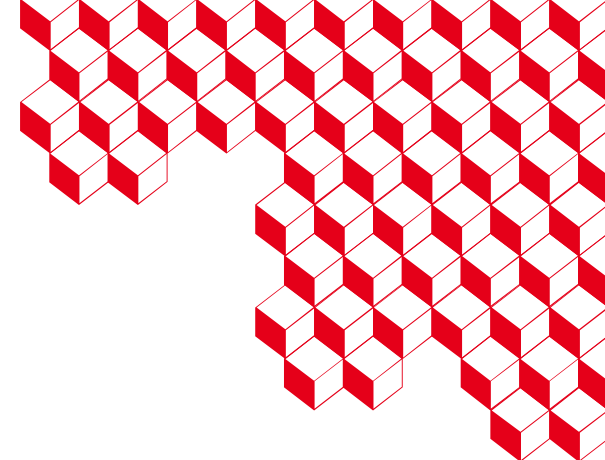
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From biofuels to e-fuels: a review and techno-economic assessment

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- B. Methodology : what to measure ? How ?**
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A ■ Sustainable fuels,

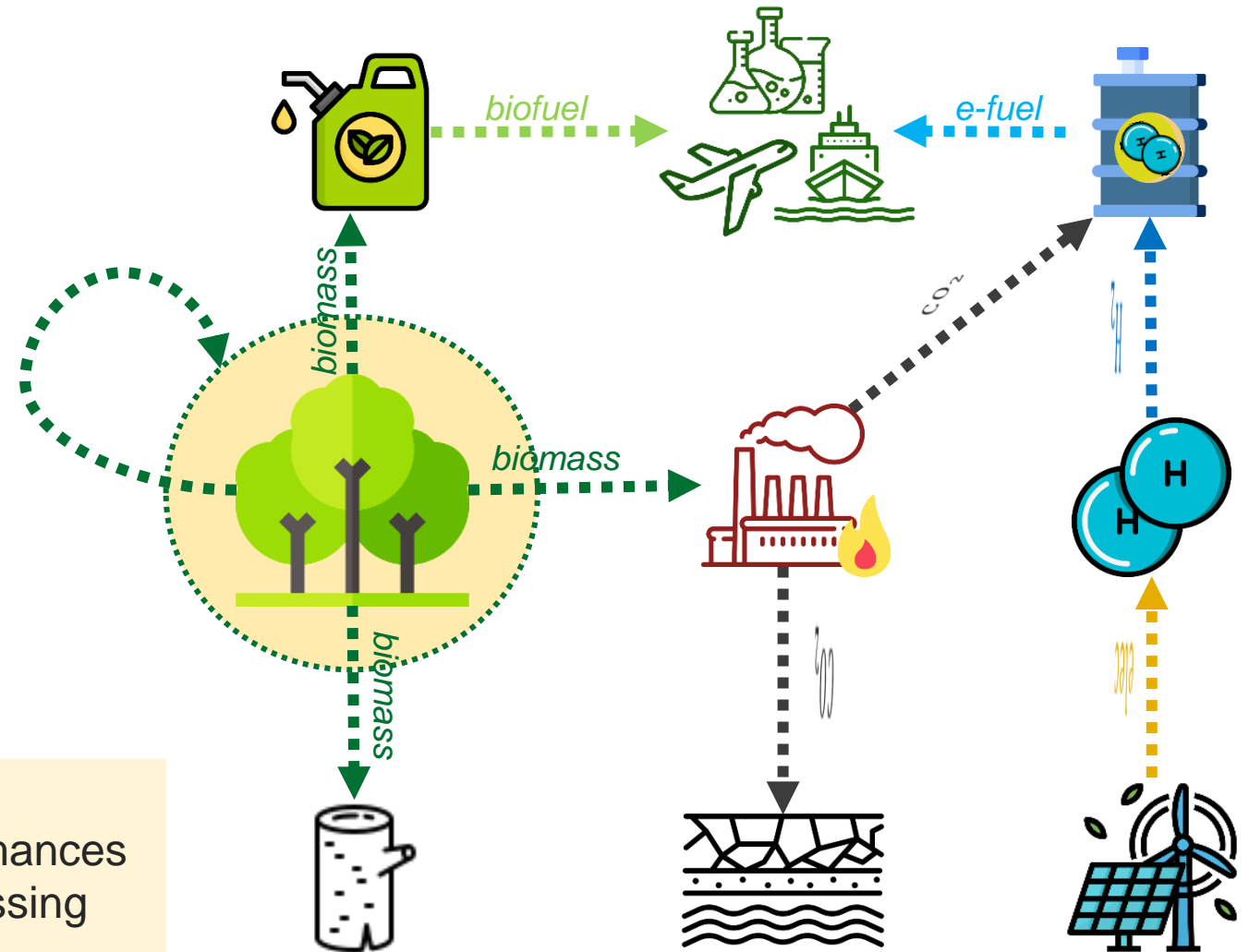
what is at stake ?

Context

- Achieving carbon neutrality by 2050
- Substituting fossil fuels
- Integrating 70 % of SAF in 2050

- Resource availability
- GHG emissions reduction
- Economic performance

What are the **technical and economic** performances of **biofuel**, **e-fuel**, and **e-biofuel** main processing routes?

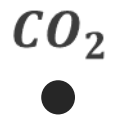
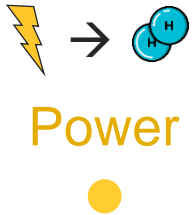
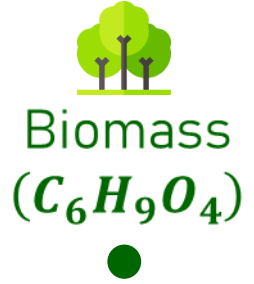




B ■ Methodology

What to measure ? How ?

Scope

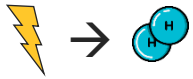
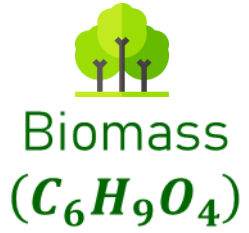


●
B = biofuel

● ●
PB = e-biofuel

● ●
P = e-fuel

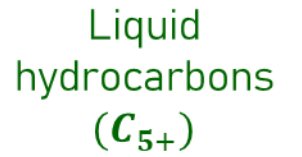
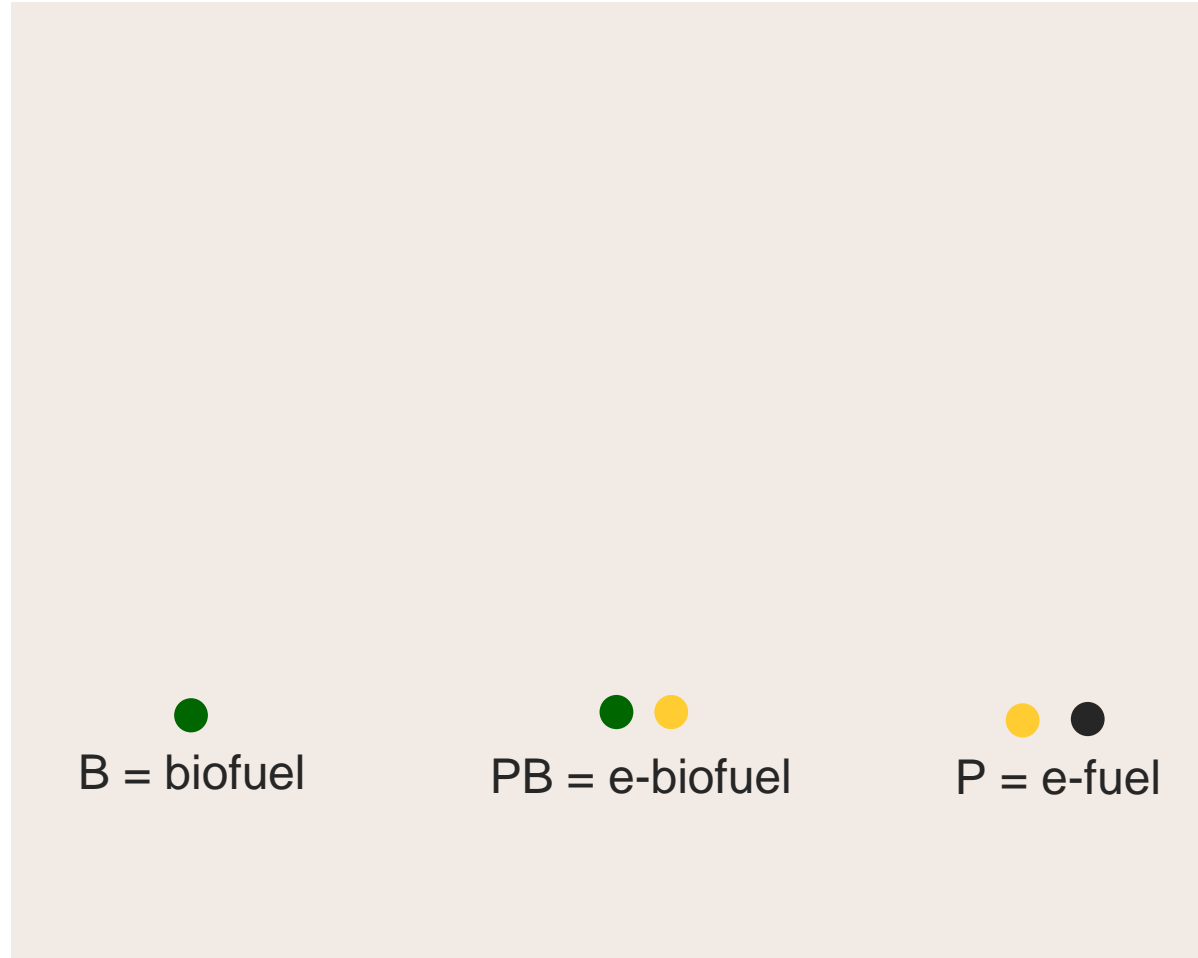
Scope



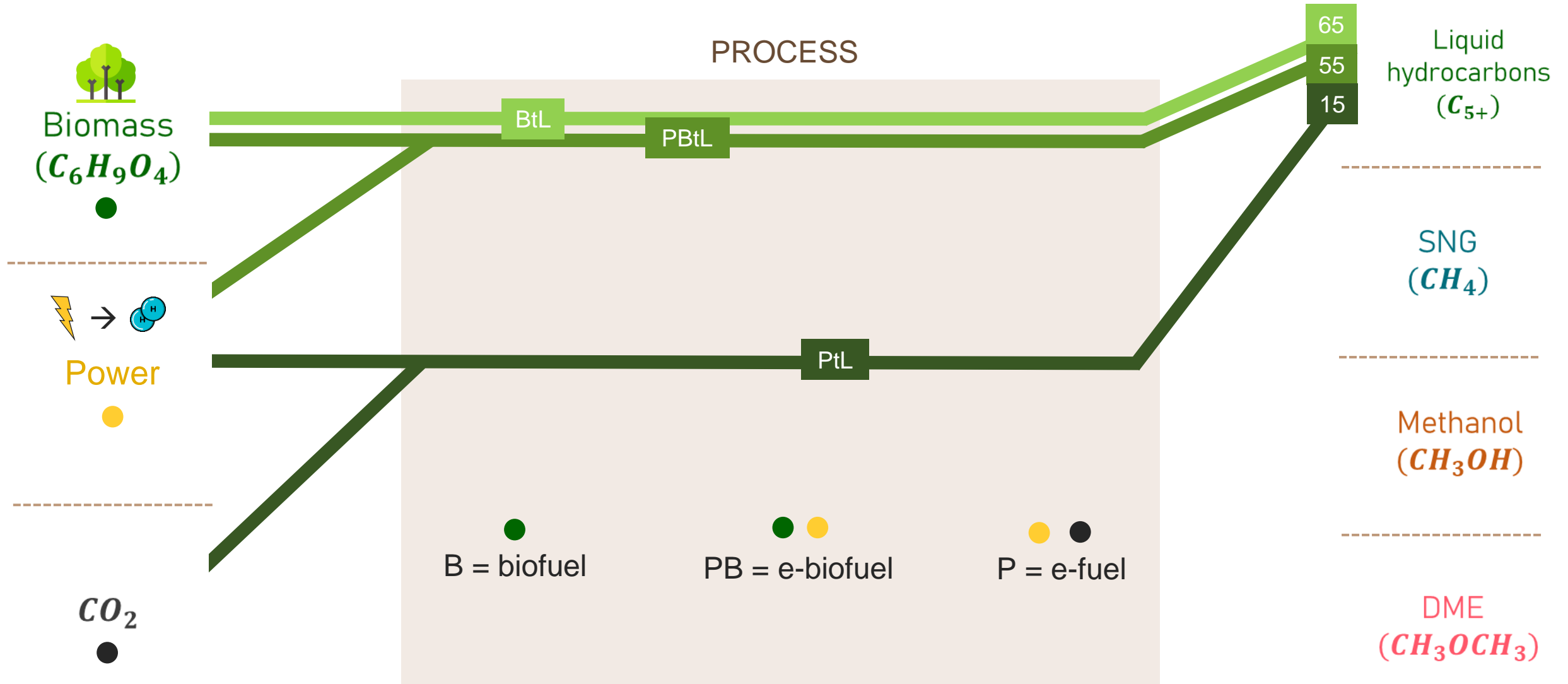
Power



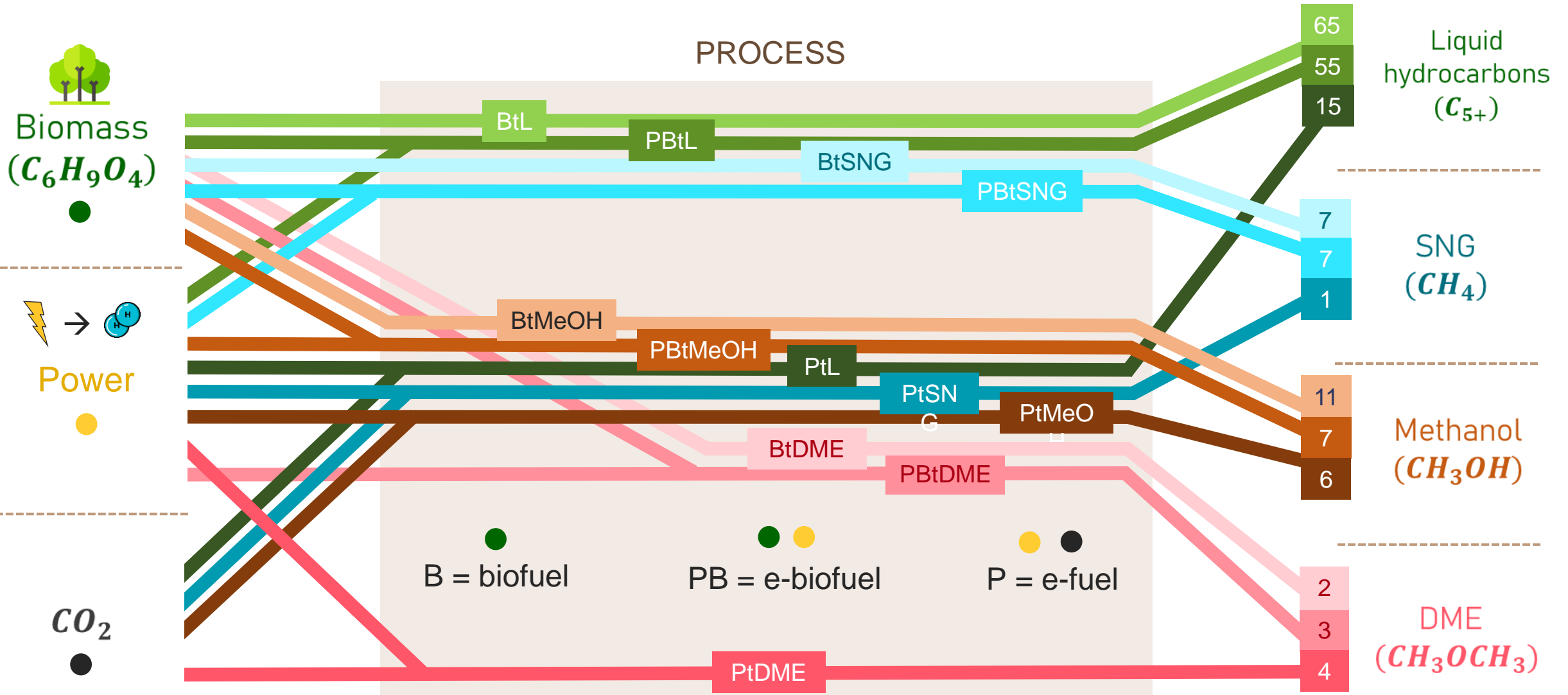
PROCESS



Scope



Scope



Key performance indicators



Carbon conversion

$$\frac{C^{\text{out}}}{C^{\text{in}} + C^{\text{in}}_{\text{CO}_2}}$$

How to minimize carbon losses?

Key performance indicators



Carbon conversion

Energy efficiency

$$\frac{C^{\text{out}}}{C^{\text{in}} + C^{\text{in}}_{\text{CO}_2}}$$

How to minimize carbon losses?

What combination of energy sources is the most efficient?

$$\frac{P^{\text{out}}}{P^{\text{in}} + P^{\text{in}} + P^{\text{net}}}$$

Key performance indicators



Carbon conversion

$$\frac{C^{\text{out}}}{C^{\text{in}} + C^{\text{in}}_{\text{CO}_2}}$$

Energy efficiency

How to minimize carbon losses?

What combination of energy sources is the most efficient?

$$\frac{P^{\text{out}}}{P^{\text{in}} + P^{\text{in}} + P^{\text{net}}}$$

Investments

$$\frac{\text{€} \cdot f_{TIC} + \text{€}}{P^{\text{out}}}$$

What is industrial-scale capital intensity?

Key performance indicators

Carbon conversion

$$\frac{C^{\text{out}}}{C^{\text{in}} + C^{\text{in}}}$$

Energy efficiency

How to minimize carbon losses?

Investments

$$\frac{\text{€} \cdot f_{TIC} + \text{€}}{P^{\text{out}}}$$

Production costs

What is industrial-scale capital intensity?

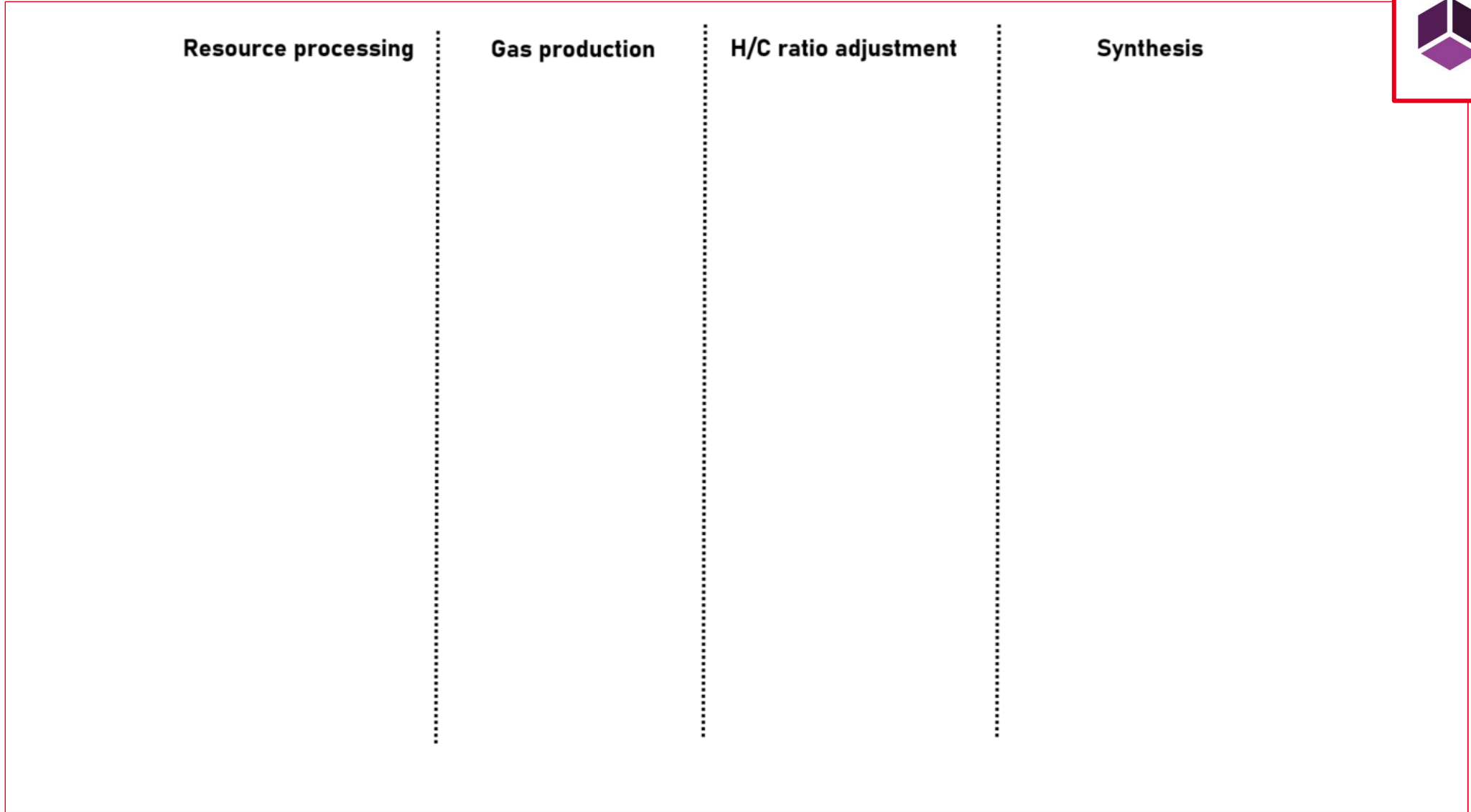
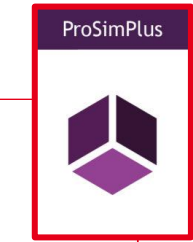
What combination of energy sources is the most efficient?

$$\frac{P^{\text{out}}}{P^{\text{in}} + P^{\text{in}} + P^{\text{net}}}$$

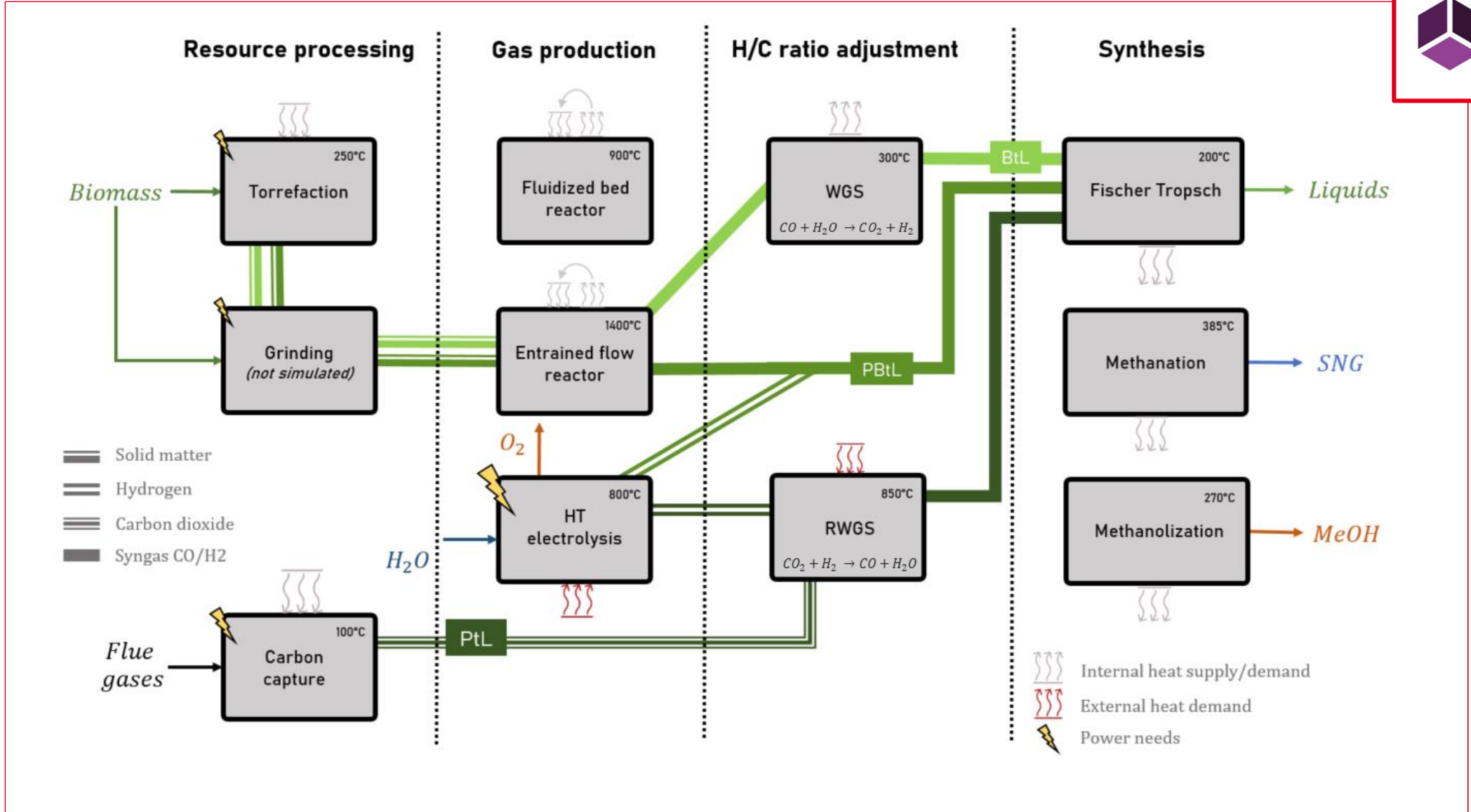
What main drivers of production cost sensitivity?

$$\frac{\text{€} + \text{€} + \text{€} + \text{€} + \text{€}}{V^{\text{out}}}$$

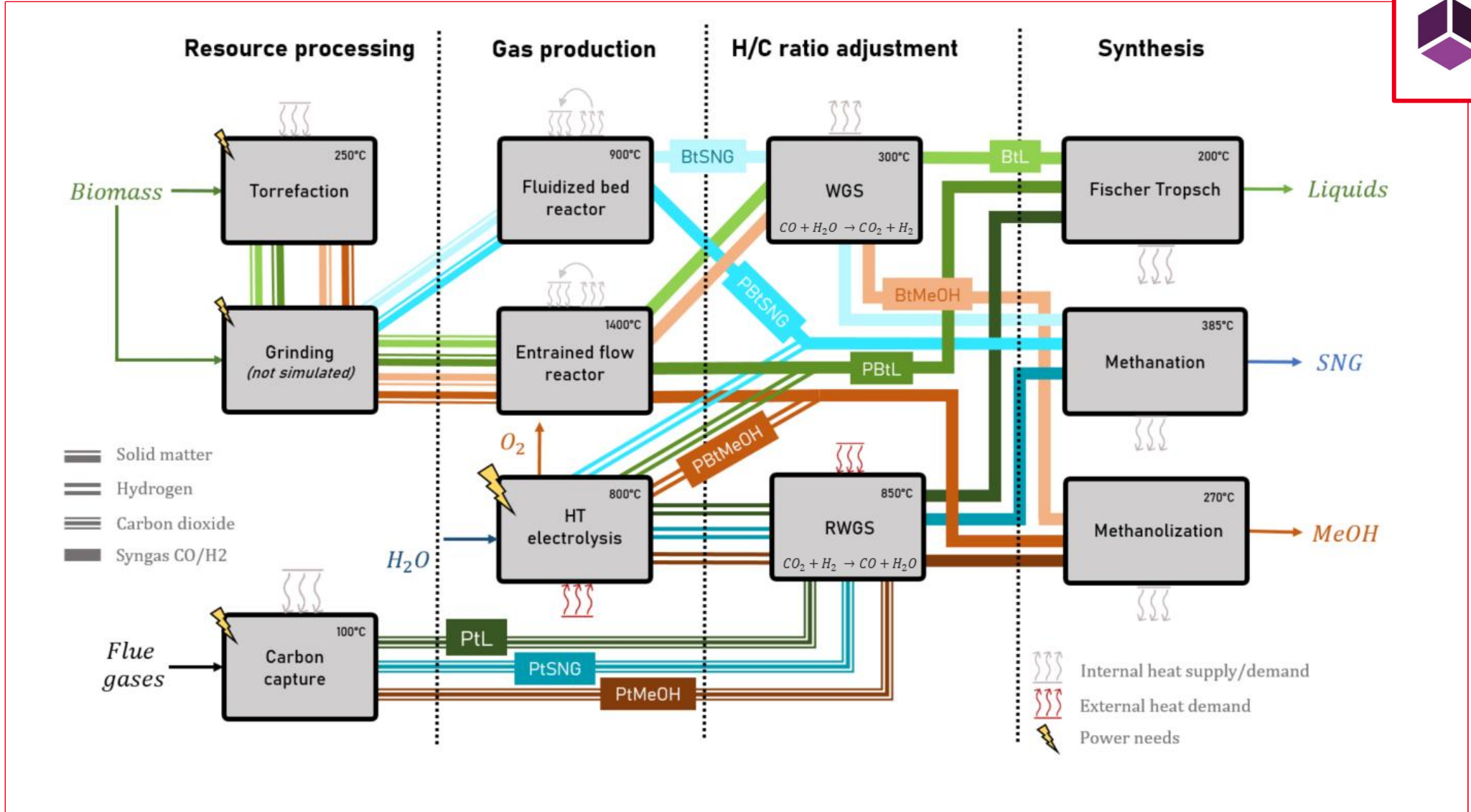
Modeling



Modeling



Modeling

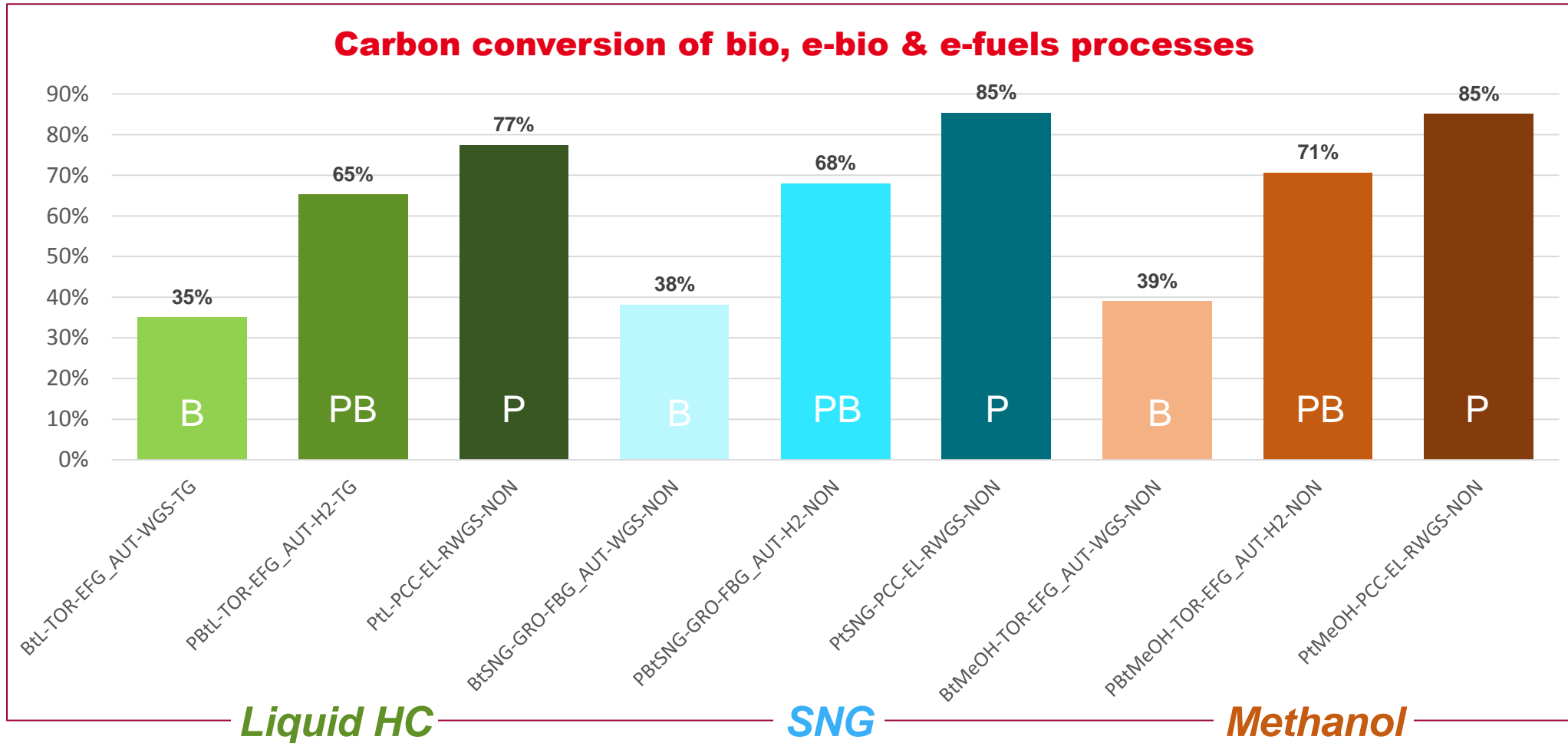




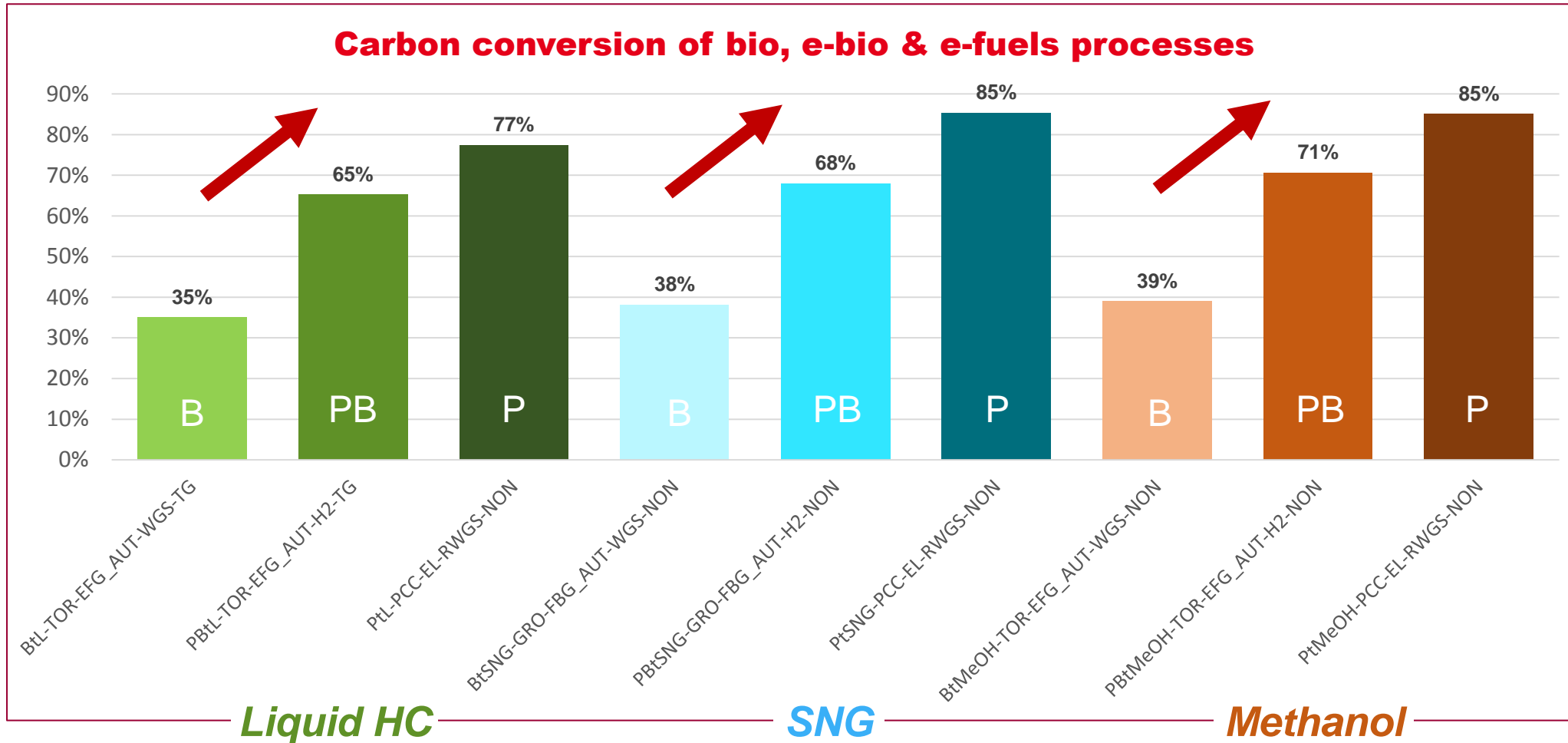
C ■ Results

Technical and economic performances

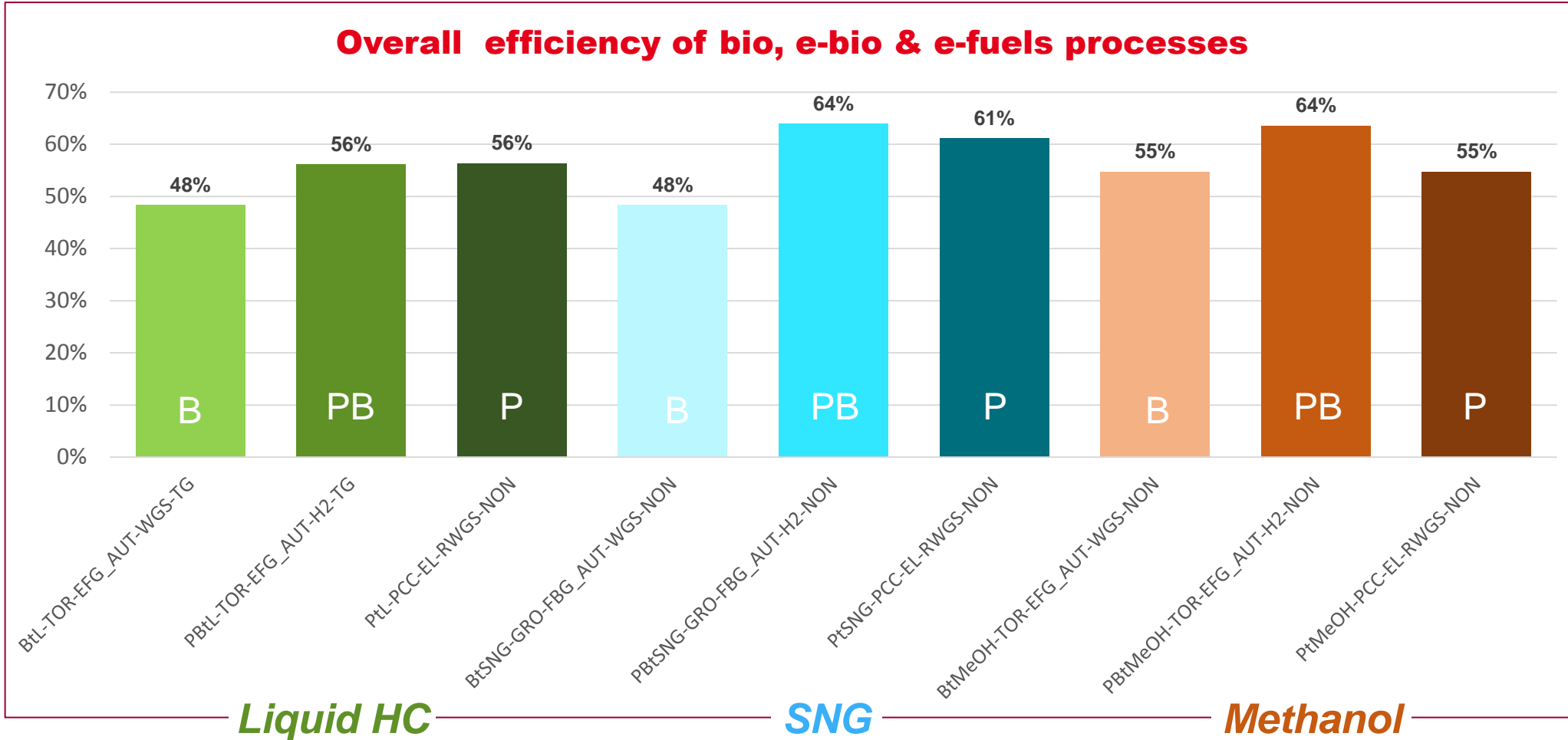
Carbon conversion



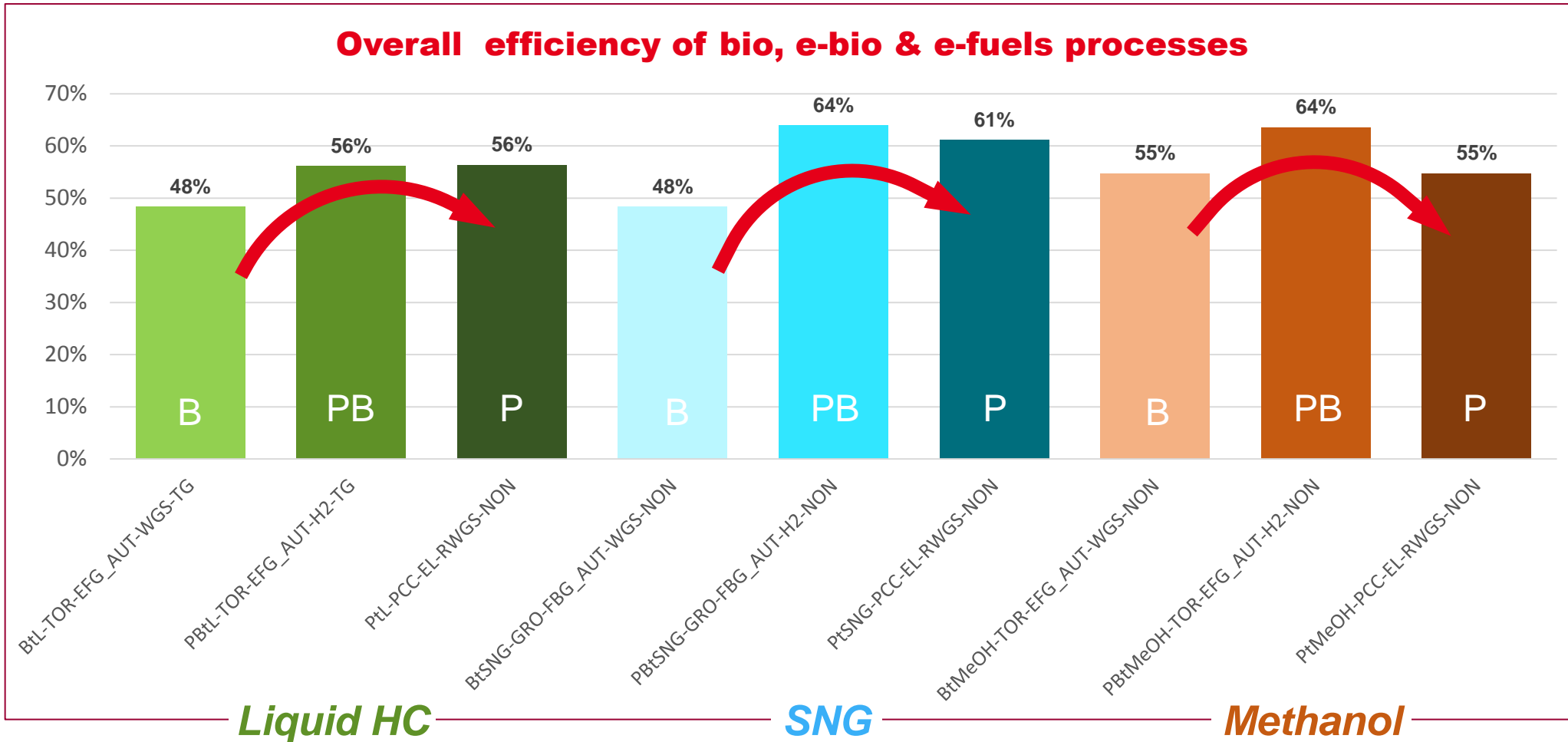
Carbon conversion



Energy efficiencies

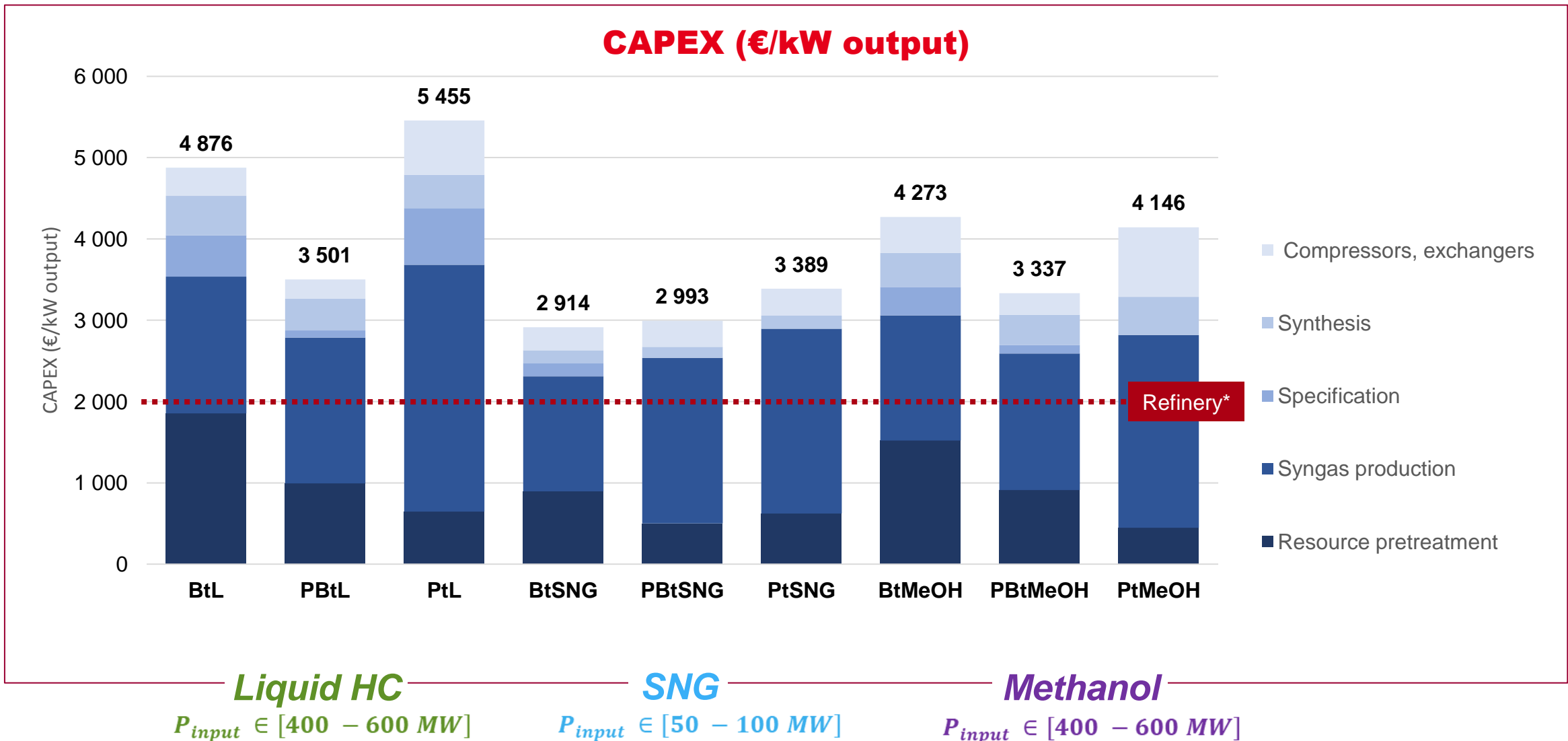


Energy efficiencies



CAPEX

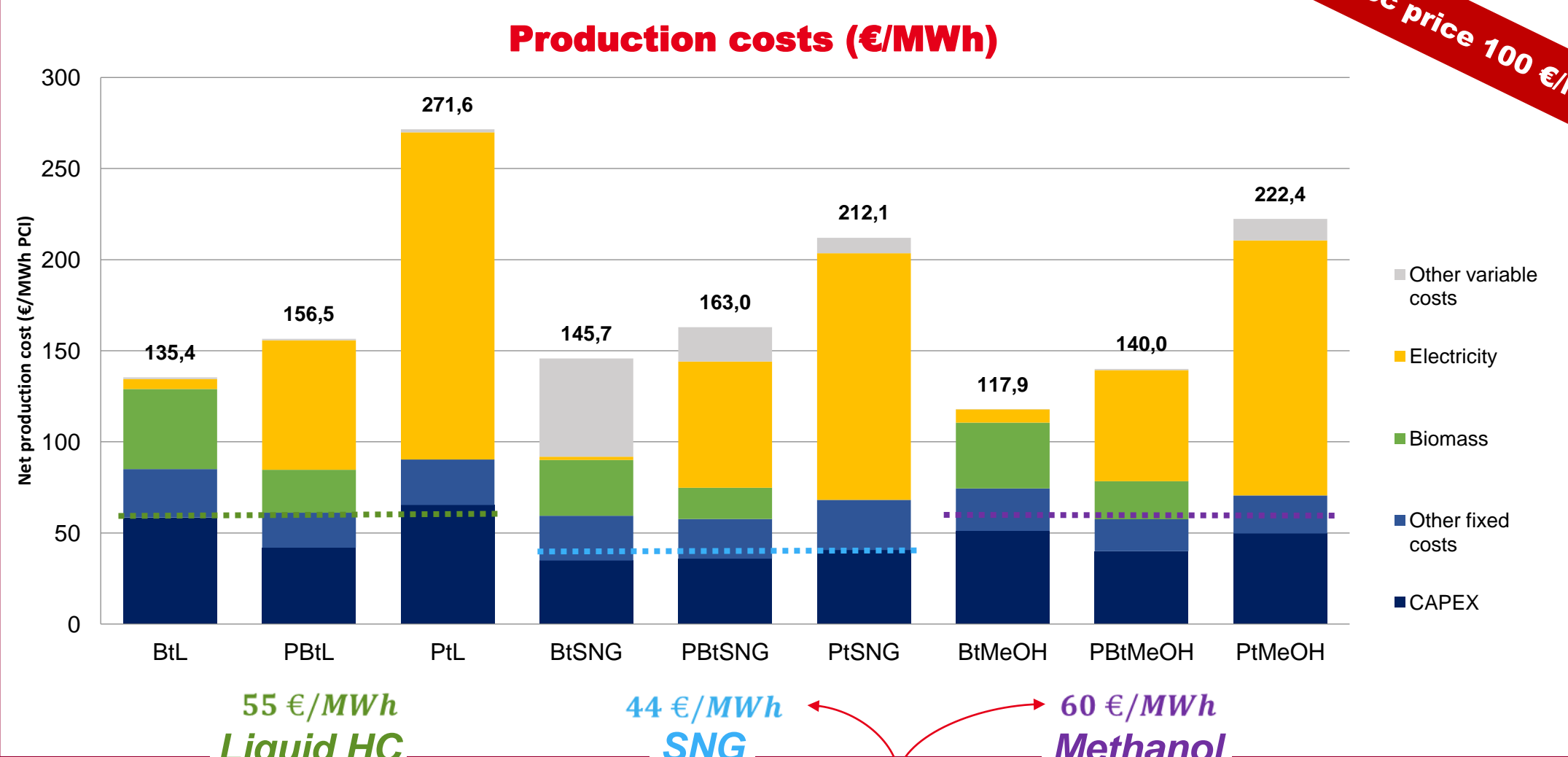
*Source : The Palgrave handbook of International Energy Economics



Production costs



Elec price 100 €/MWh



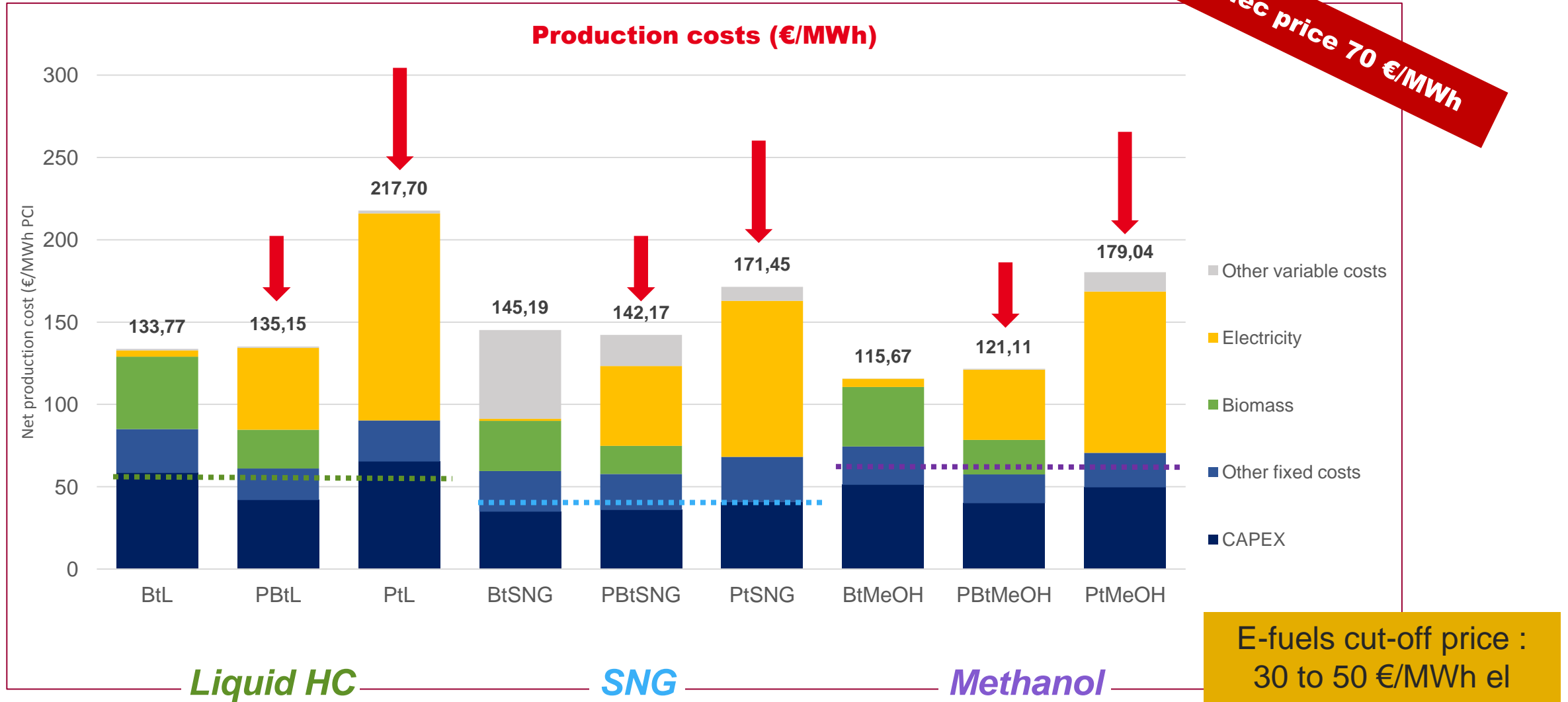
55 €/MWh
Liquid HC

44 €/MWh
SNG

60 €/MWh
Methanol

Market price

Production costs





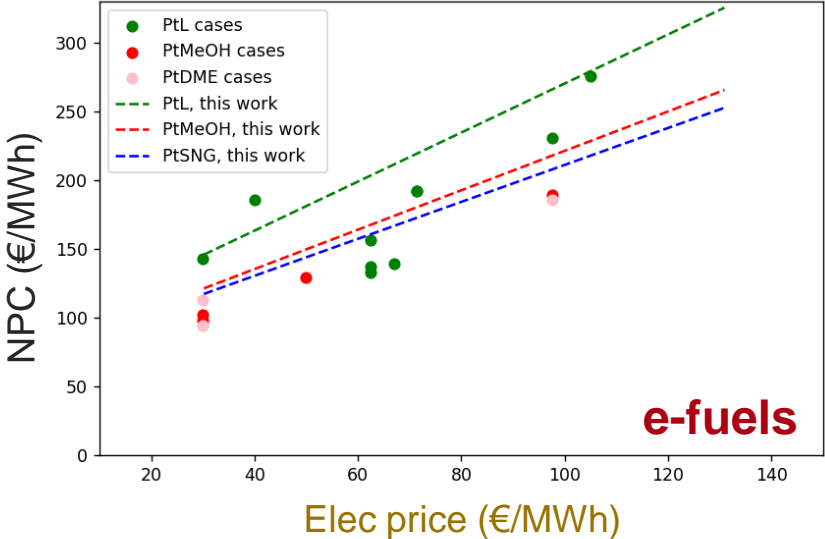
D ■ Stepping back

To analyze global trends

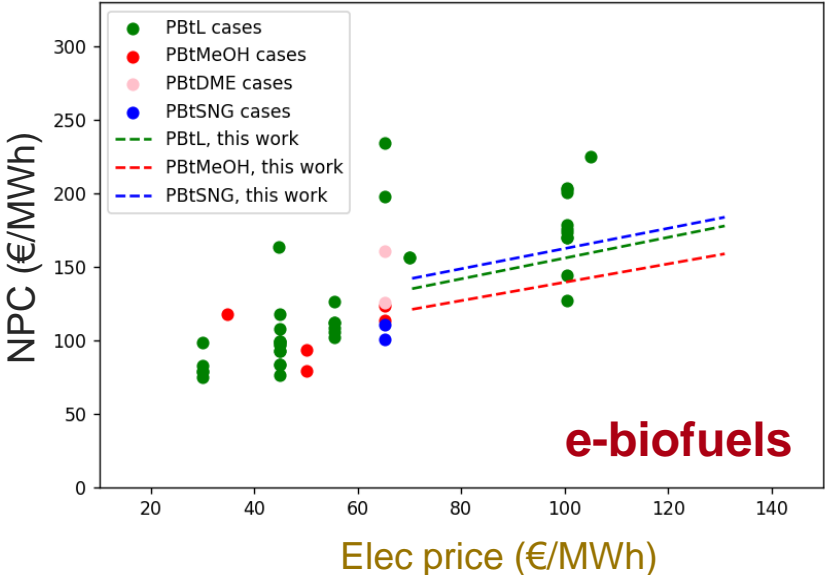
Positioning within the literature



1



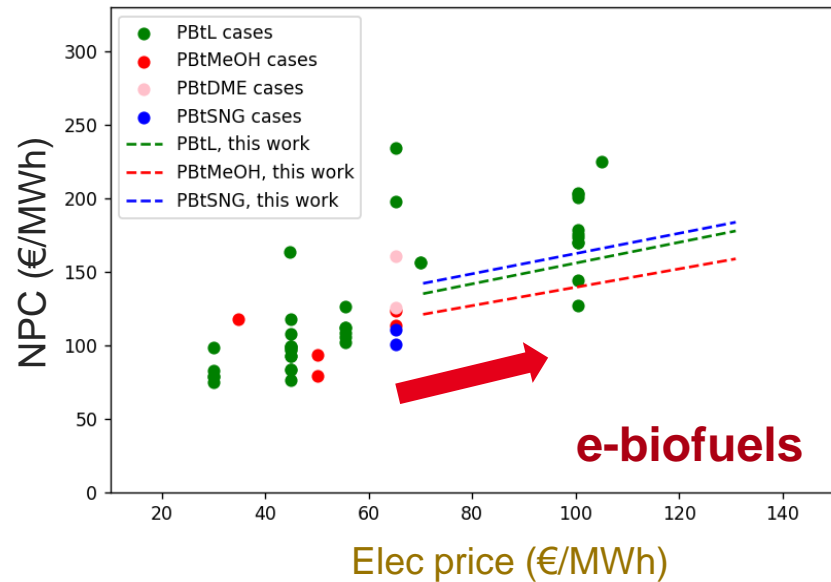
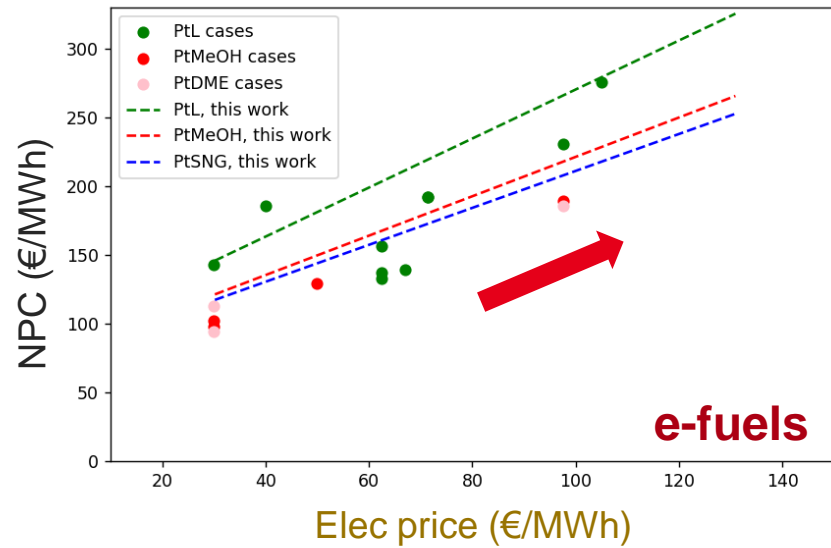
❖ Net production cost € [50 → 250 €/MWh]



Positioning within the literature

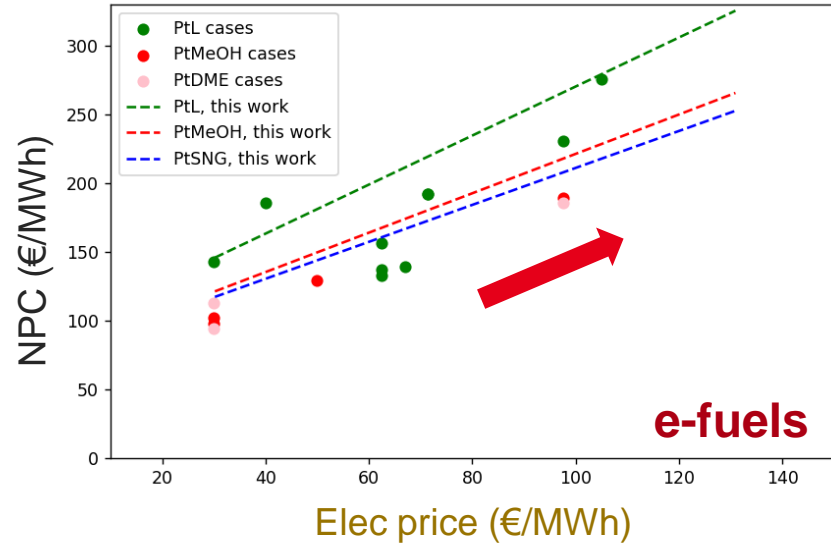


1

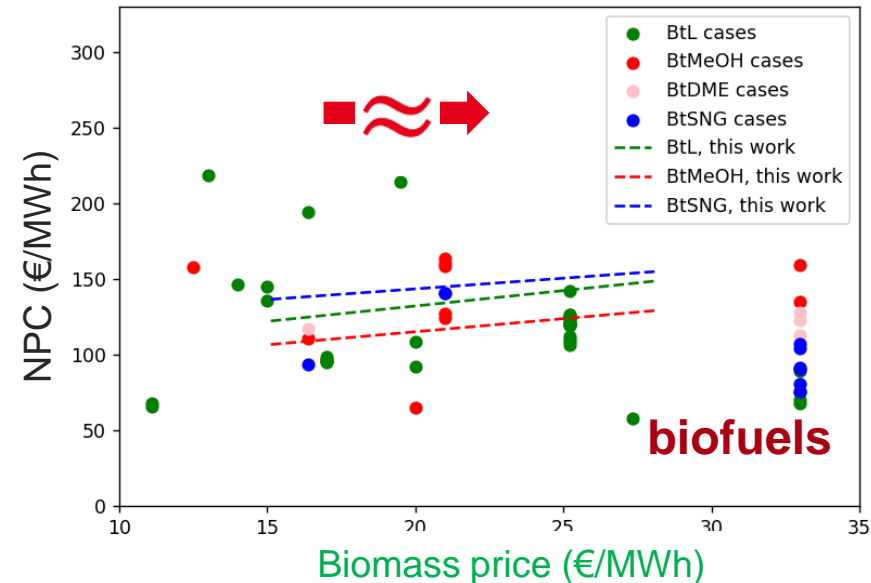
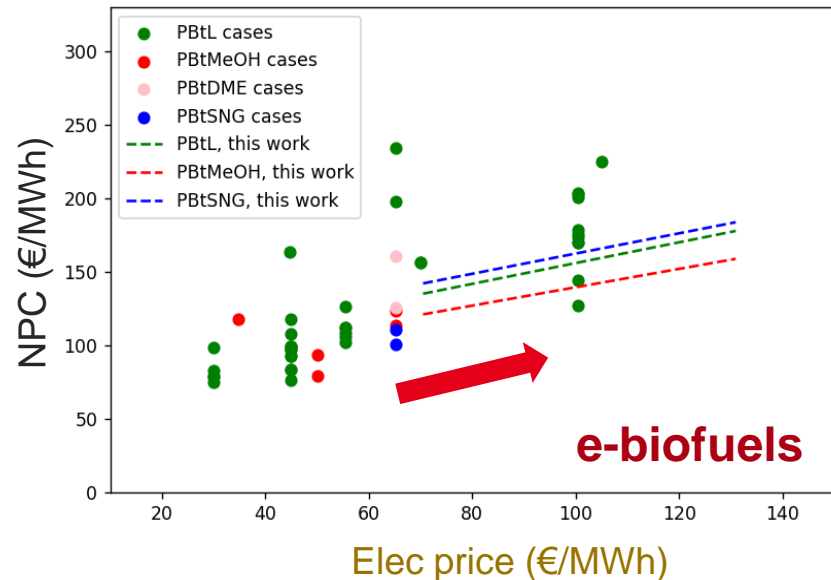


- ❖ Net production cost € [50 → 250 €/MWh]
- ❖ A strong influence of **electricity** input price on NPC for **e-fuels** and **e-biofuels**

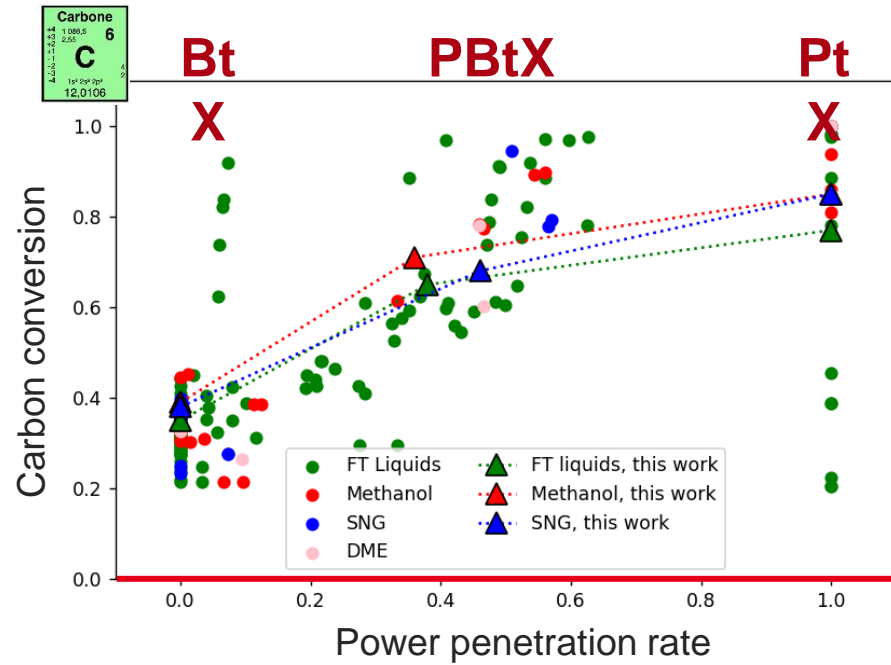
Positioning within the literature



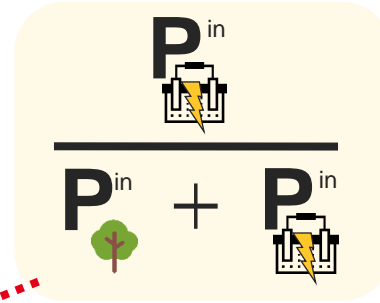
- ❖ Net production cost € [50 → 250 €/MWh]
- ❖ A strong influence of **electricity** input price on NPC for **e-fuels** and **e-biofuels**
- ❖ No visible correlation between **biomass** input price and **biofuel** NPC



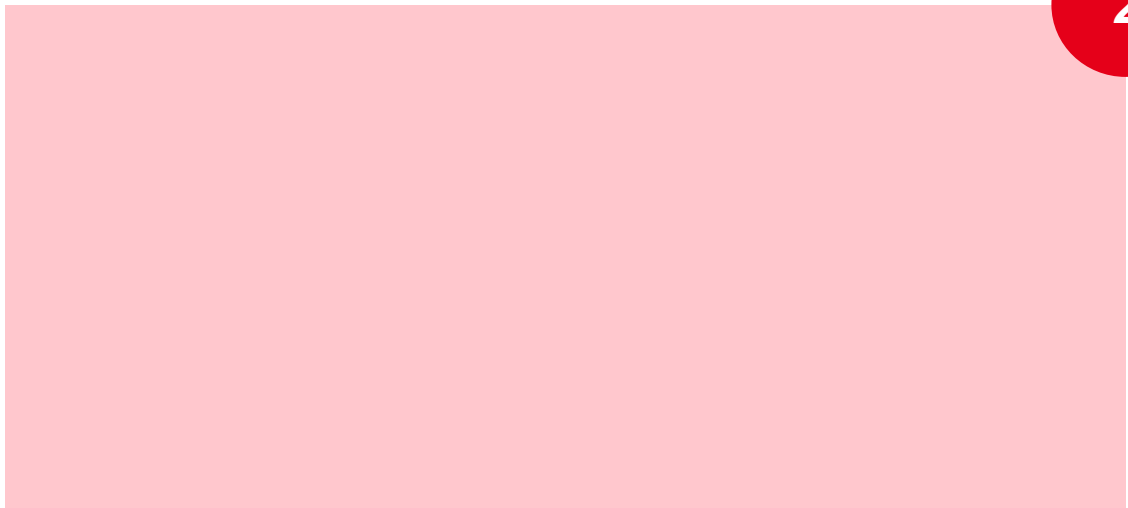
Influence of energy sources on efficiency



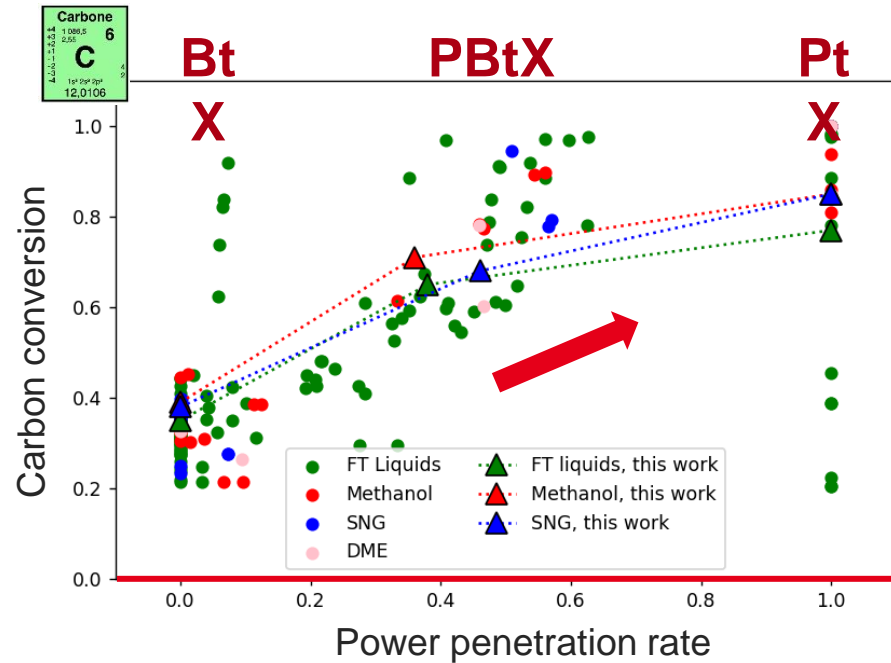
Definition of power penetration rate :



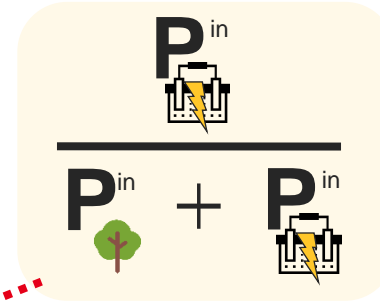
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Influence of energy sources on efficiency



Definition of power penetration rate :



Biofuels (BtX) $\rightarrow 0$

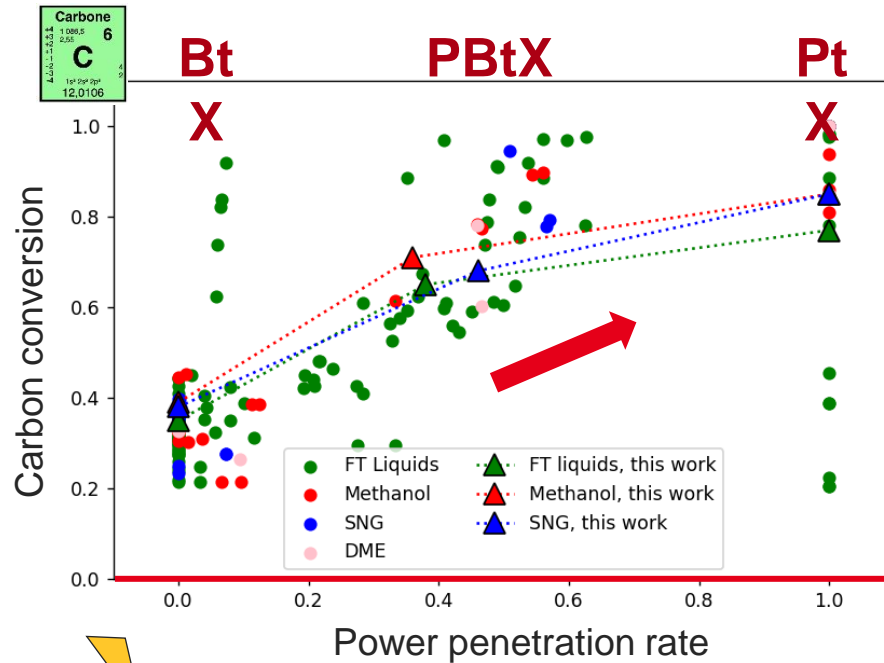
E-biofuels (PBtX) $\rightarrow [0.36 - 0.46]$

E-fuels (PtX) $\rightarrow 1$

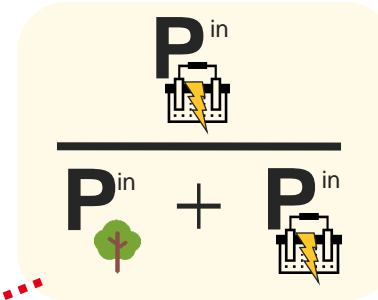
2

❖ From biofuels to e-fuels: increase of **carbon conversion**

Influence of energy sources on efficiency



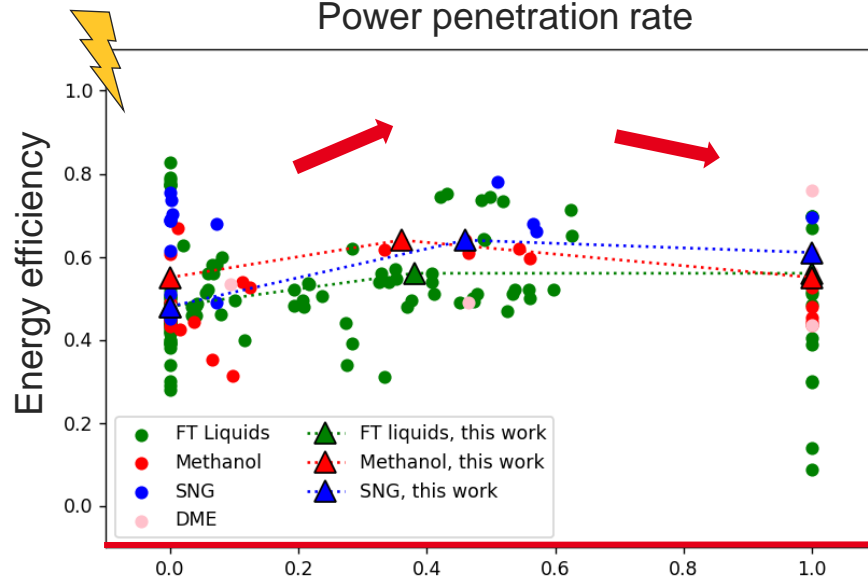
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Biofuels (BtX) $\rightarrow 0$

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2

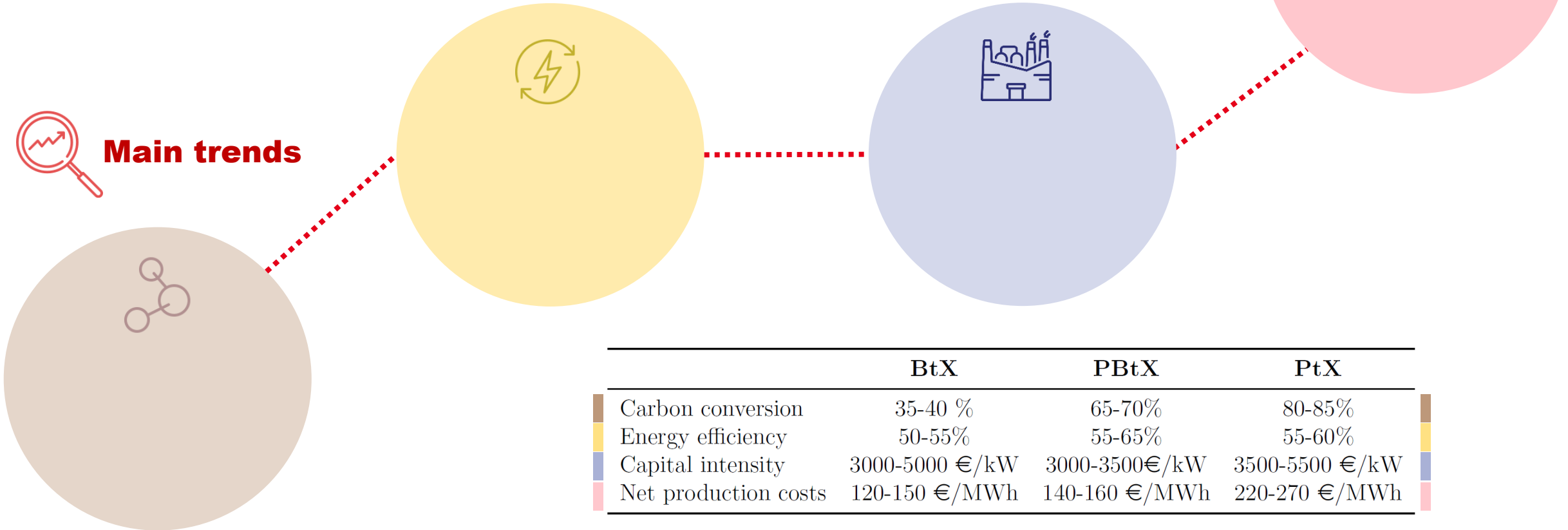
❖ From biofuels to e-fuels: increase of **carbon conversion**

❖ From biofuels to e-fuels: maximum **overall energy efficiency** for hybrid **e-biofuel** processes

Conclusions

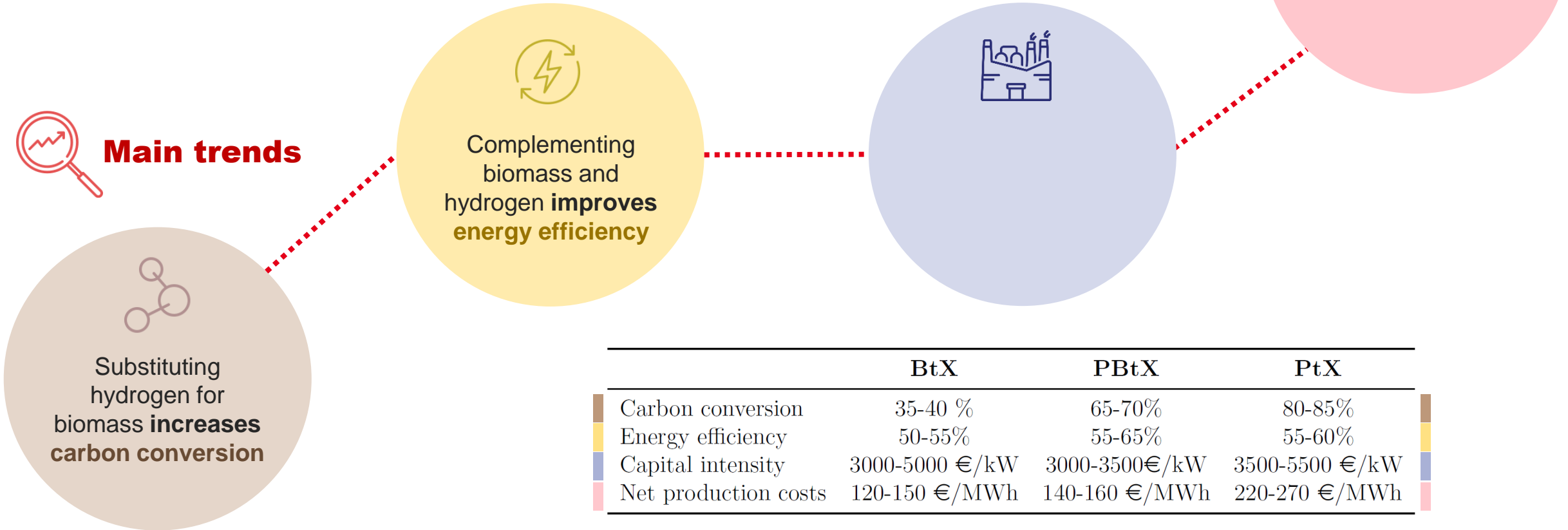


Conclusions



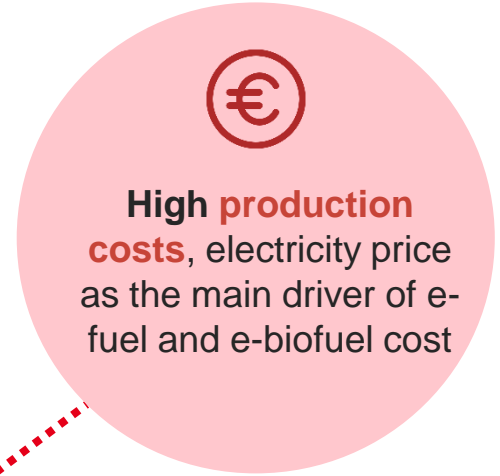
	BtX	PBtX	PtX
Carbon conversion	35-40 %	65-70%	80-85%
Energy efficiency	50-55%	55-65%	55-60%
Capital intensity	3000-5000 €/kW	3000-3500€/kW	3500-5500 €/kW
Net production costs	120-150 €/MWh	140-160 €/MWh	220-270 €/MWh

Conclusions

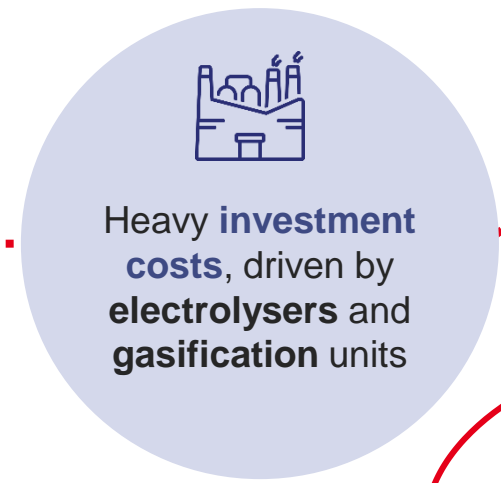
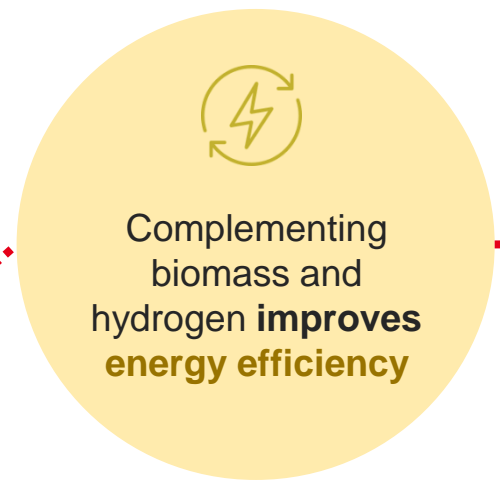
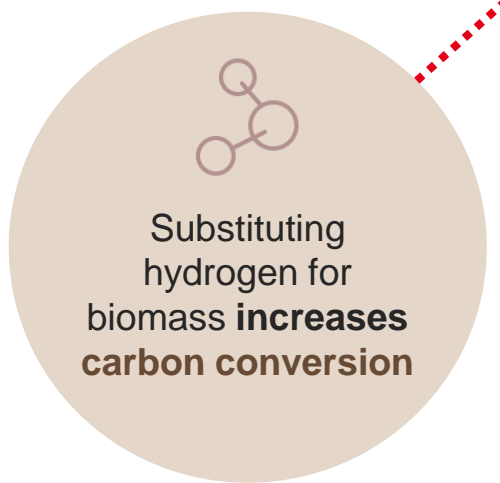


	BtX	PBtX	PtX
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Conclusions



Main trends



Interesting trade-off!

	BtX	PBtX	PtX
Carbon conversion	35-40 %	65-70%	80-85%
Energy efficiency	50-55%	55-65%	55-60%
Capital intensity	3000-5000 €/kW	3000-3500€/kW	3500-5500 €/kW
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“ Thank you for your attention !