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Cost reduction analysis for sustainable ethylene production technologies

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Content of the presentation

- Background
- Research goals
- Methodology
- Results
- Questions

Where do we use ethylene?

Diapers

Bottles

Trash bags

Sealants

Paint

Clothes

Footwear

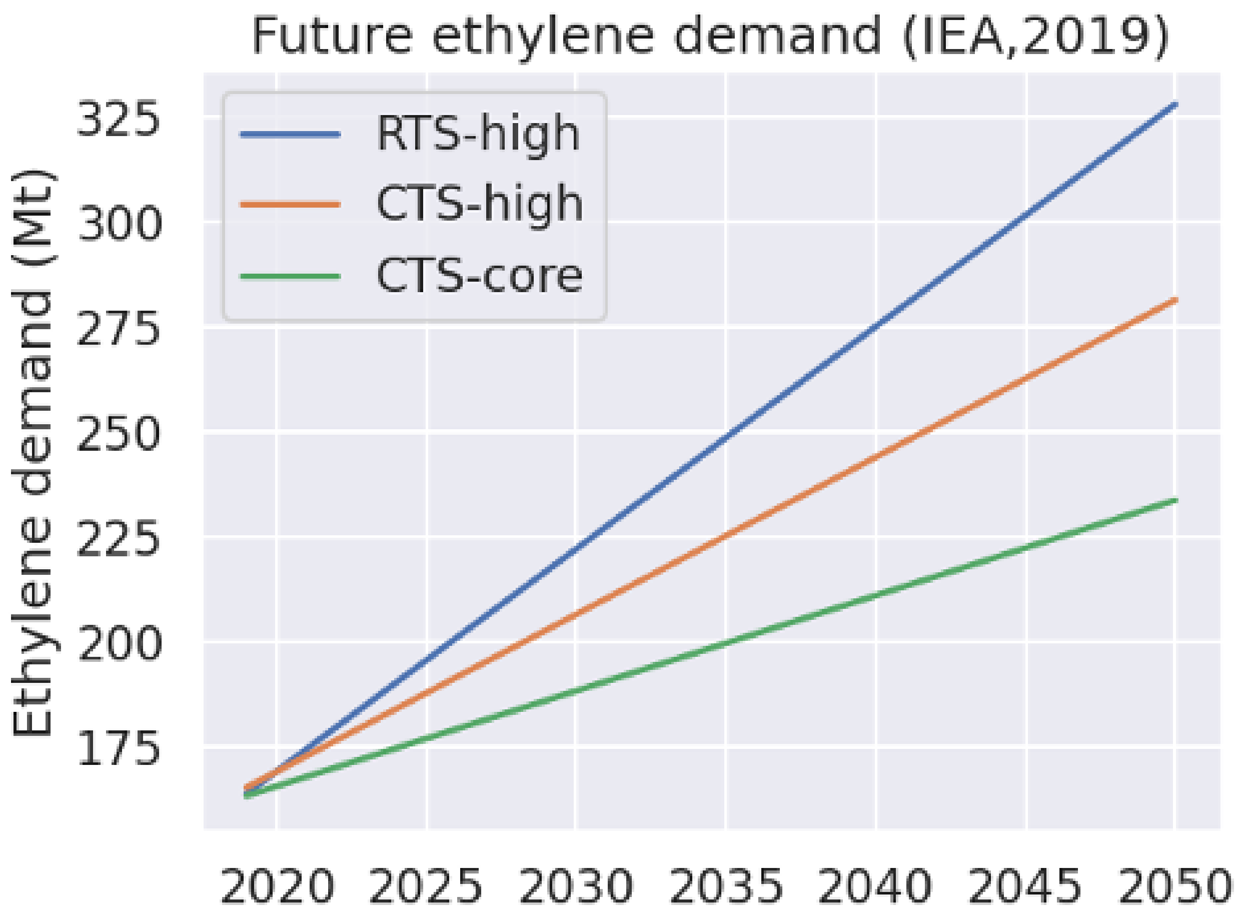
Tires

Food packaging

Detergent

Regional markets

Expected ethylene demand up to 2050



- ***Demand in 2019:*** 164 million metric ton.
- ***Expected growing demand*** due to growing global economy, and rising population (IEA,2019).
- ***Heavy dependency on fossil fuels***: both as energy source and as feedstock.

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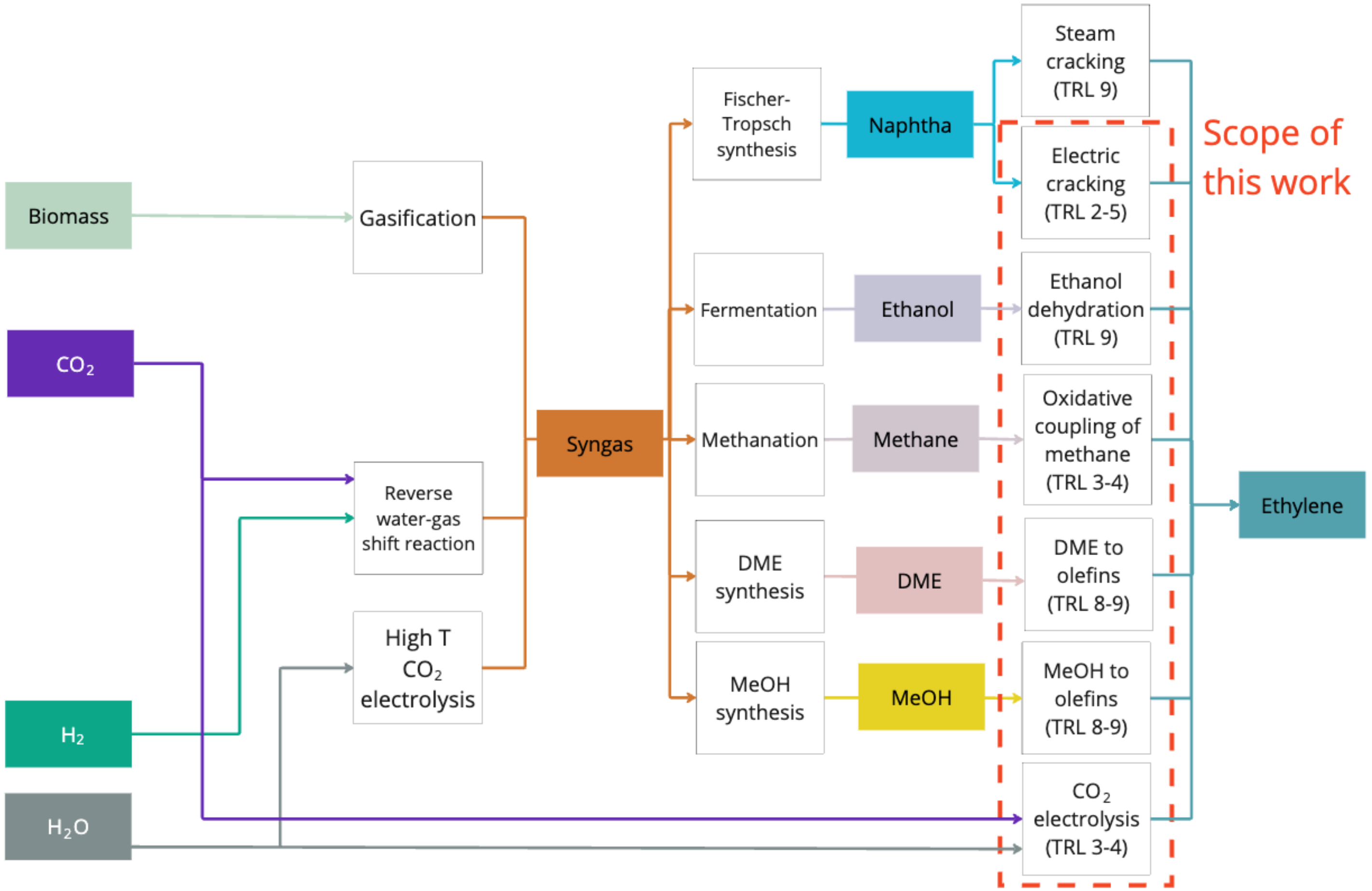
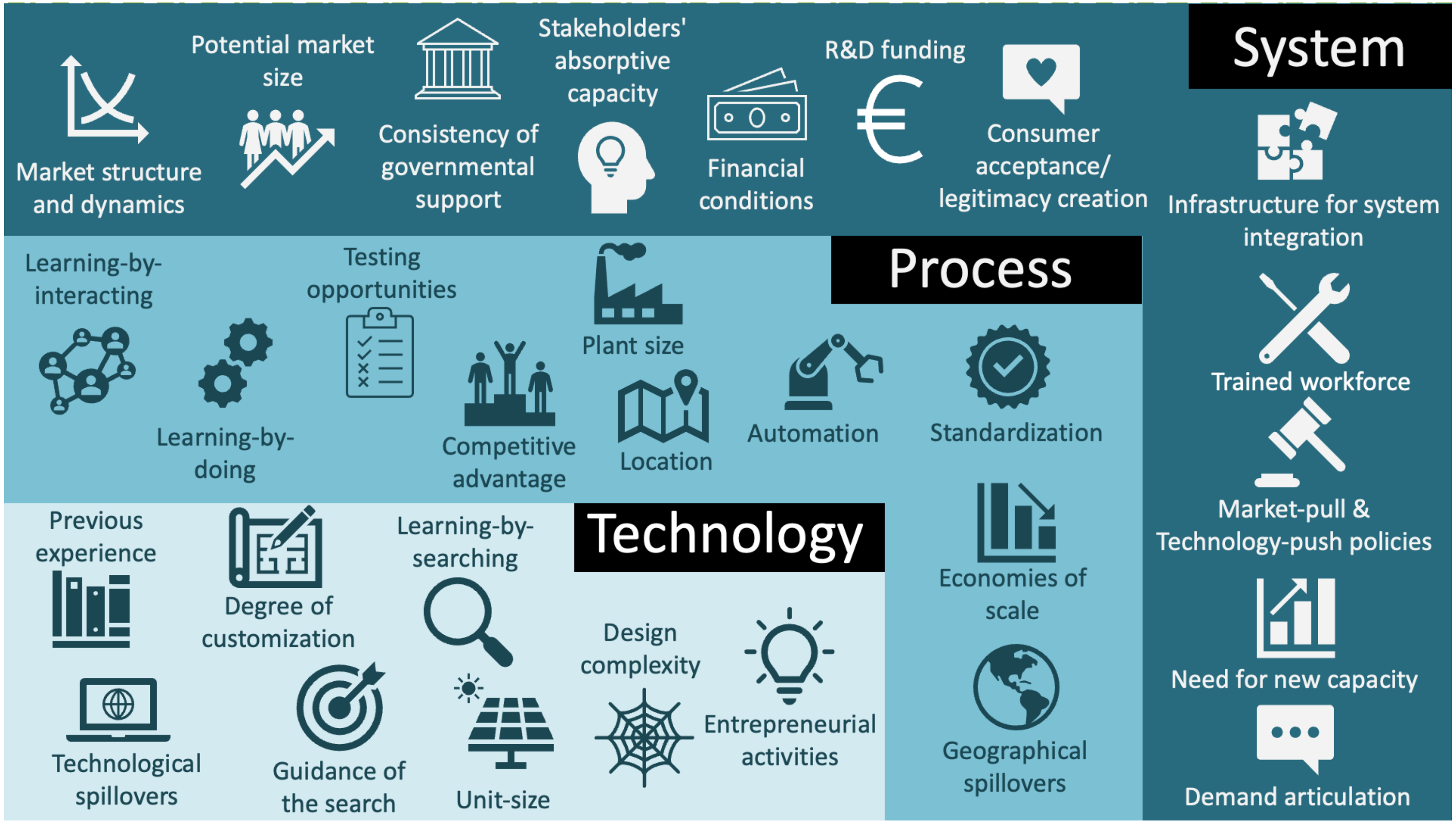
Sustainable pathways for ethylene production



Research goal

To determine under which technological learning and market deployment conditions renewable ethylene production technologies can become cost competitive by 2050.

Methodology



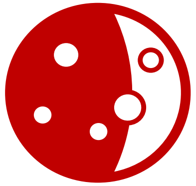
Future ethylene supply scenarios

One takes all

In 2050, one single new technology supplies **100% of ethylene demand**.

Existing **MTO and ethanol dehydration** plants are decommissioned based on a **20-year lifetime**

Steam cracking plants are phased out as the new technology is adopted.



Phase out

Fossil-based ethylene (from naphtha and ethane) is **reduced by 1% annually** starting 2024.

Ethylene production from fossil sources falls to **163 Mt by 2030** and **133 Mt by 2050**.

A **single new technology** meets new demand, but **additional measures** (e.g., demand reduction or another technology) may be needed.

Joint supply

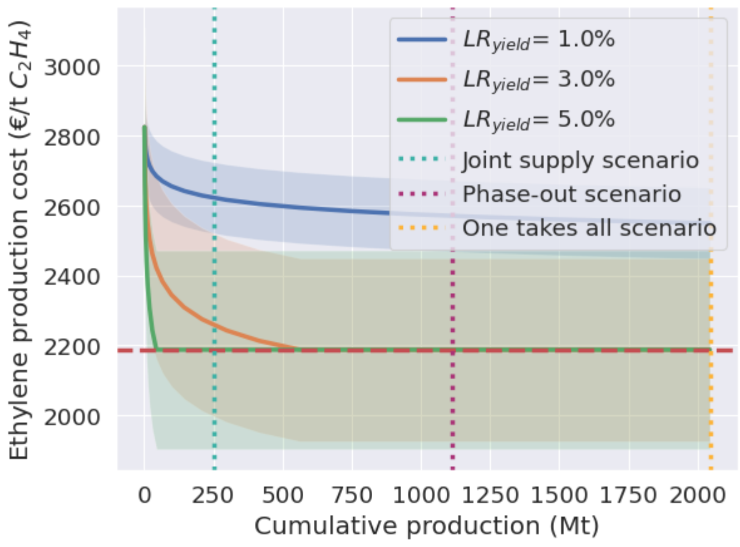
In 2050, **41% of ethylene** still comes from **steam cracking**, while **59% is supplied by six new technologies**.

OCM, DMETO, and MTO each contribute **11%**, ethanol dehydration **7%**, and the rest is **equally split** between **CO_2 electrolysis** and **electric cracking**.

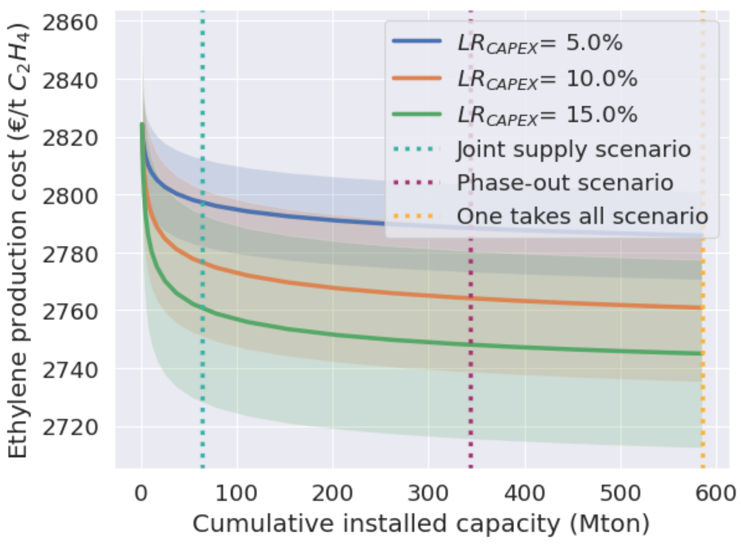
Emphasizes a **diversified approach** to renewable ethylene production.

Our three-level approach enables cost reduction analysis at the technology, process, or system level.

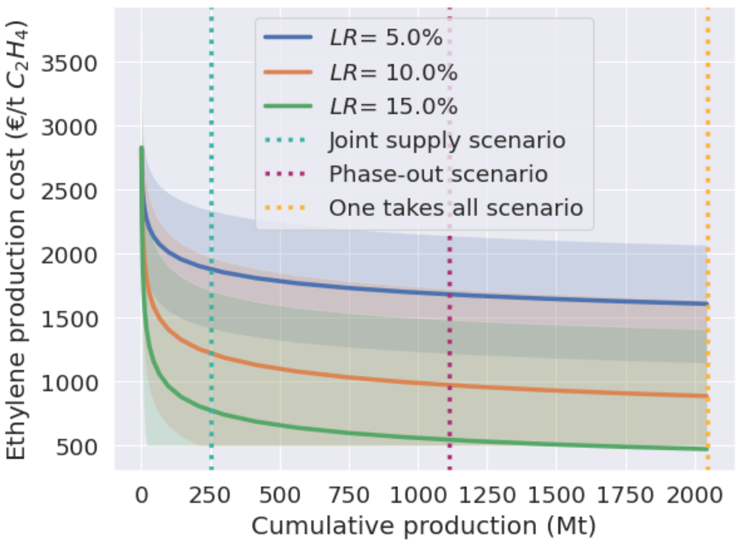
Technology
Improvements in performance



Process
Reductions in capital investment cost



System
Reductions in feedstock cost



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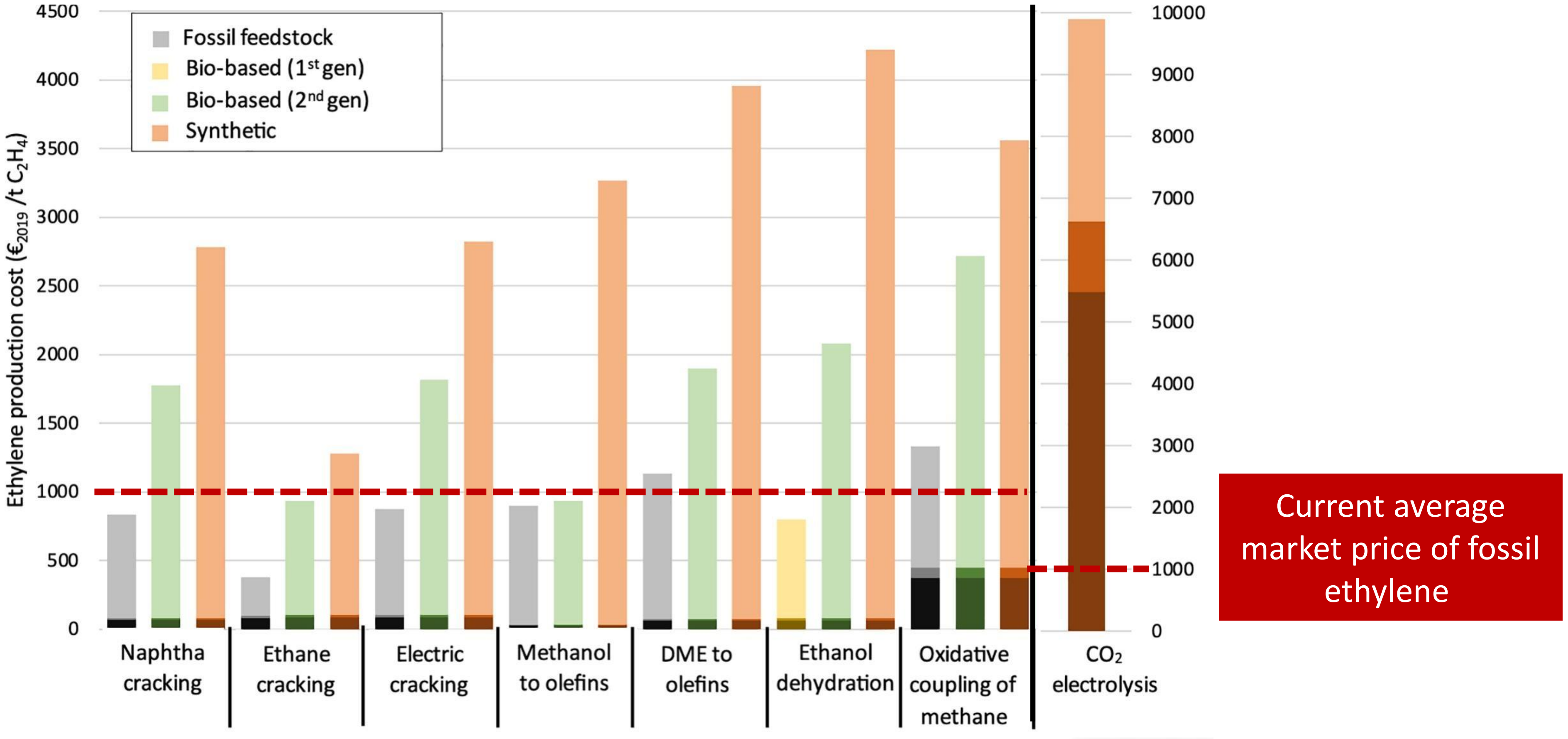
Renewable ethylene costs 3–9 times more than the current average market price.



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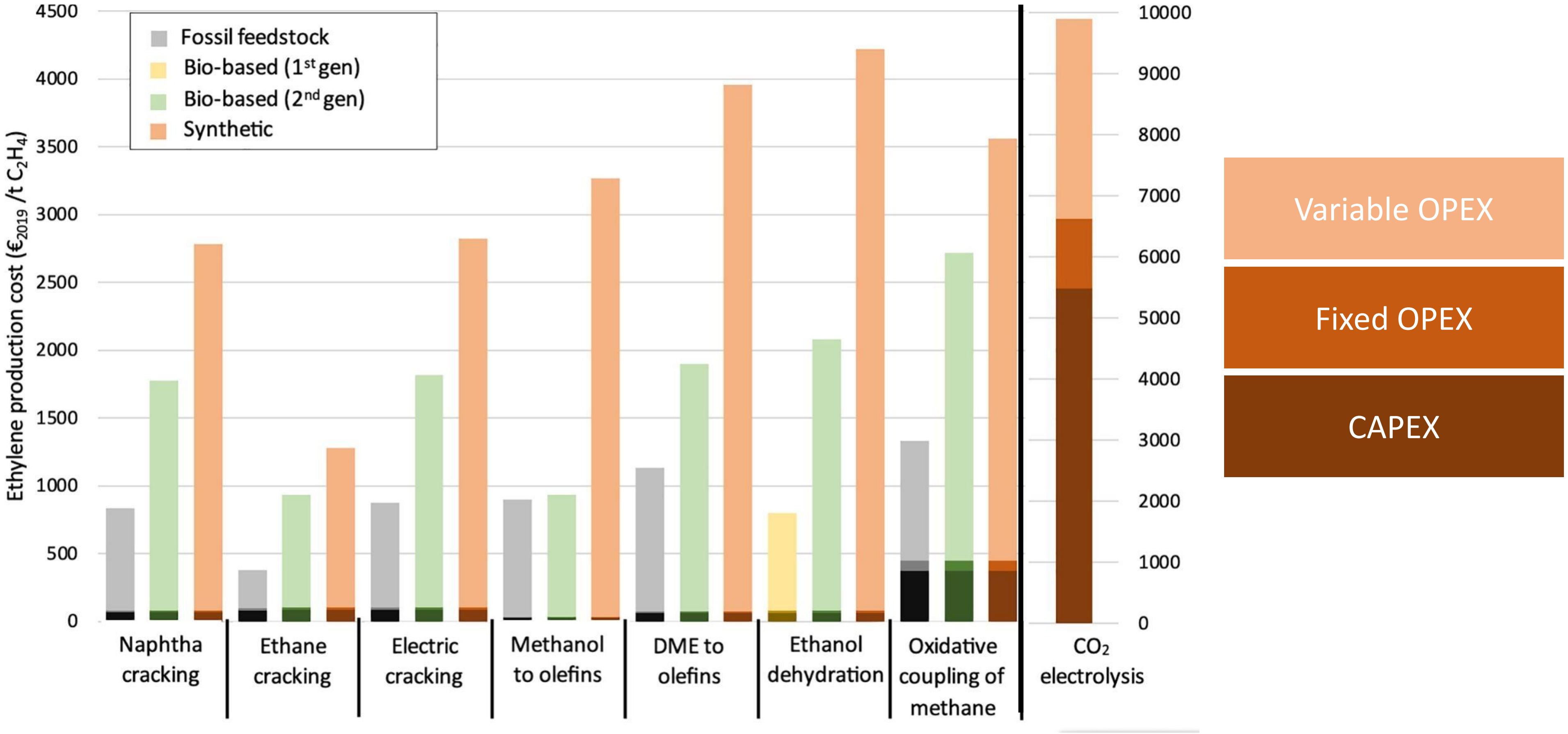
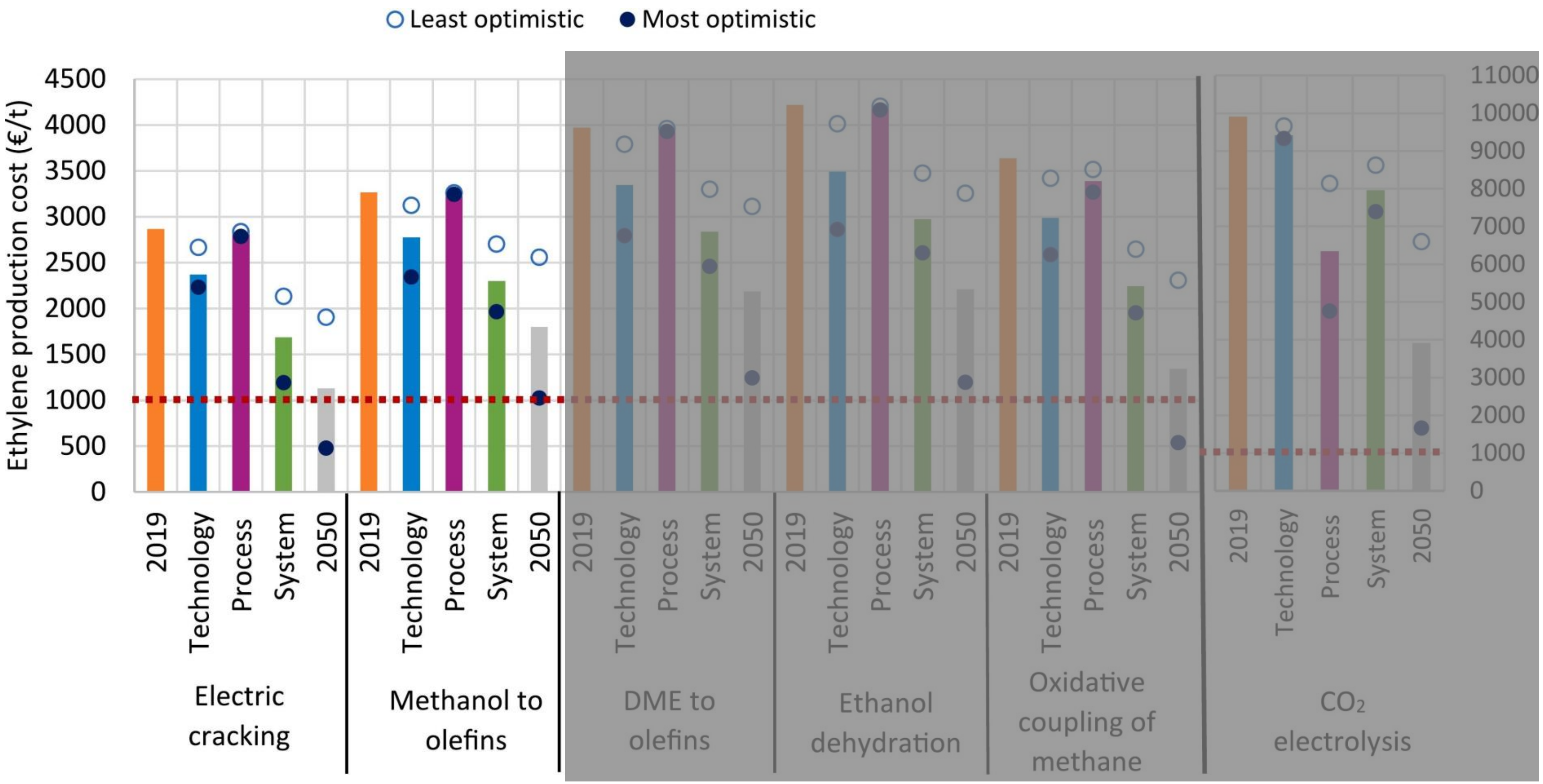
Feedstock price has the greatest impact on costs, followed by performance and CAPEX.



Electric cracking and MTO may become cost-competitive by 2050 with lower feedstock prices.



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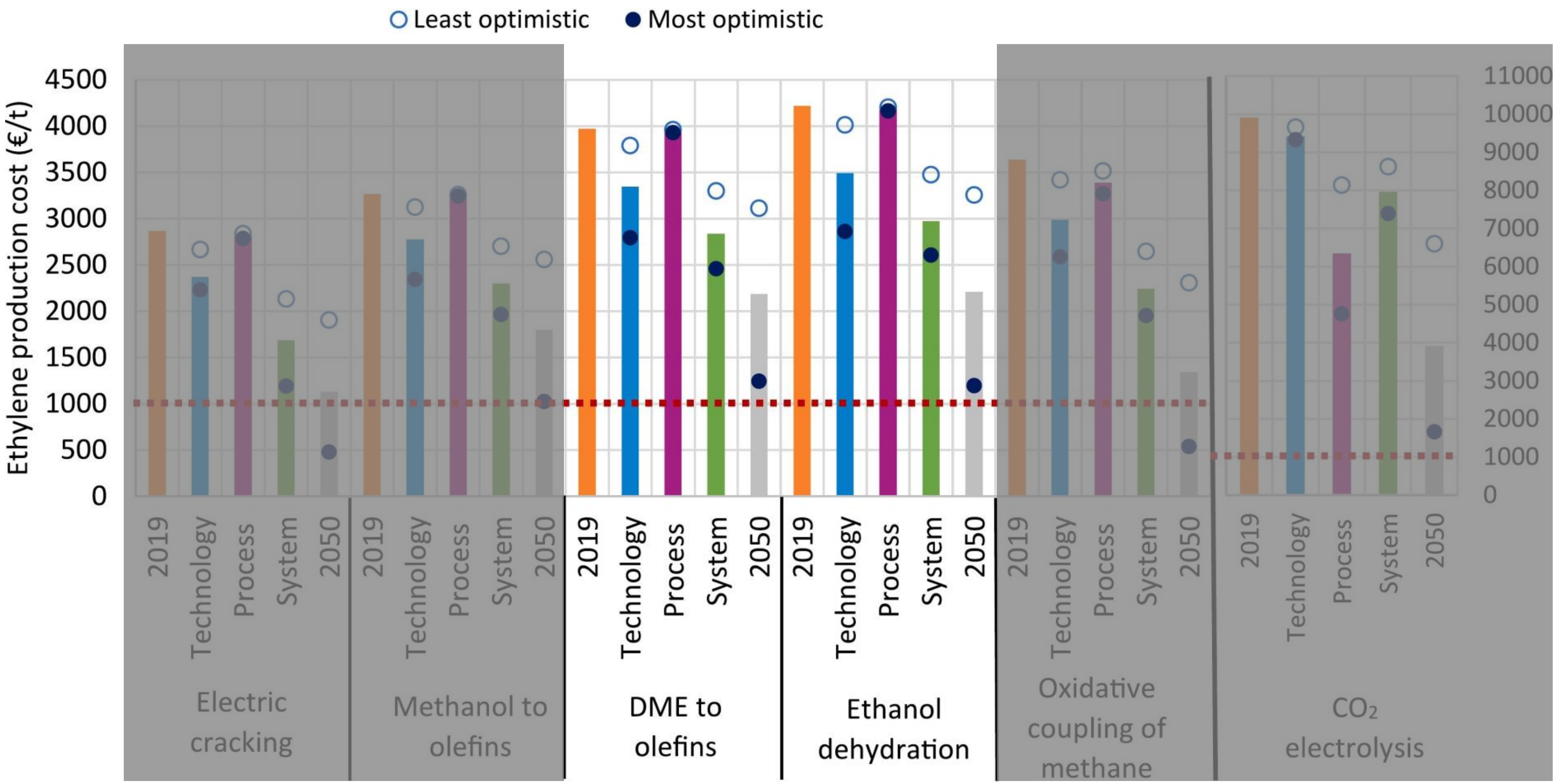
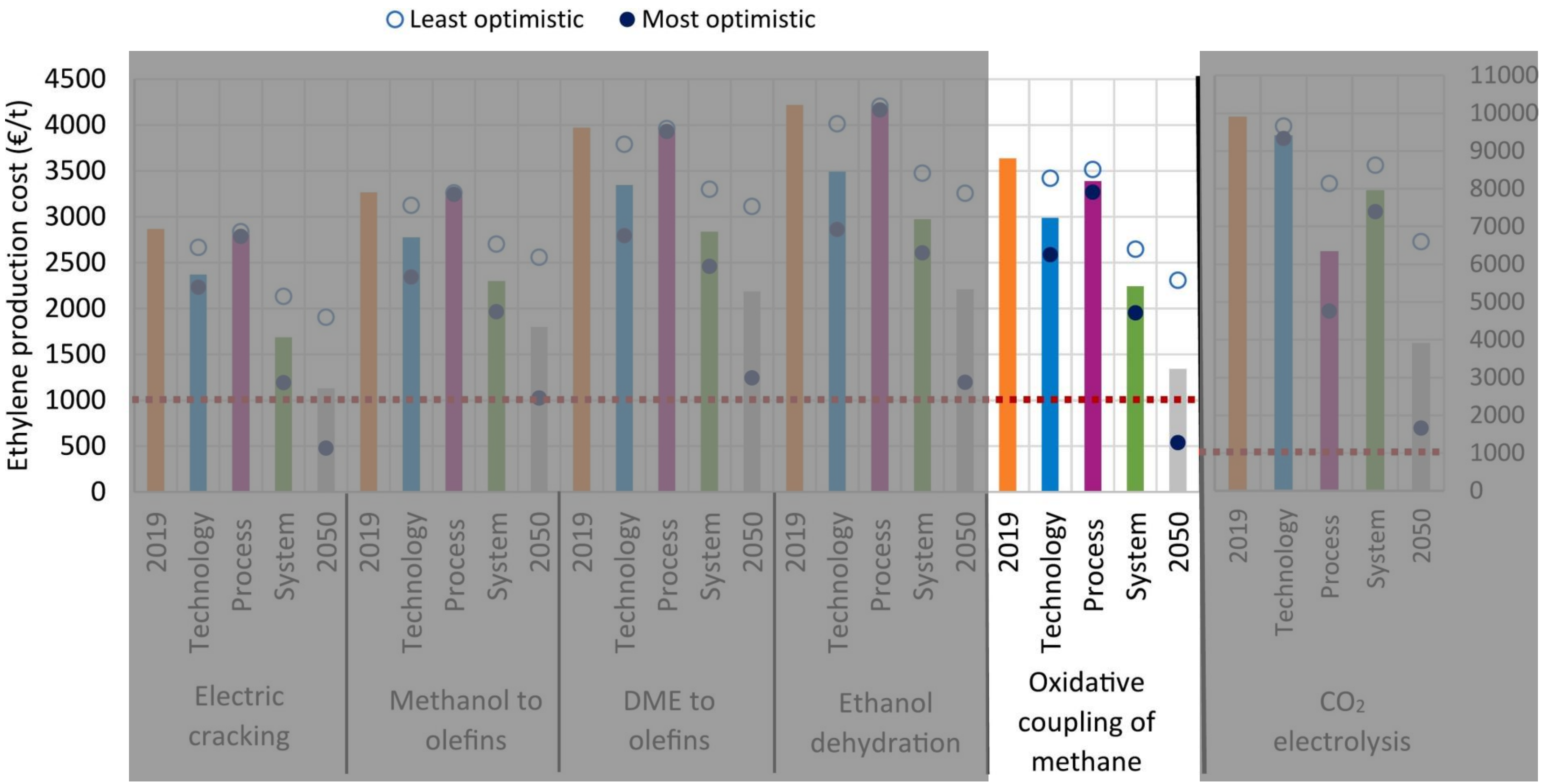
DMETO and synthetic ethanol dehydration need market-pull policies to be competitive.



Yields over 63% are required for OCM to reach cost competitiveness by 2050



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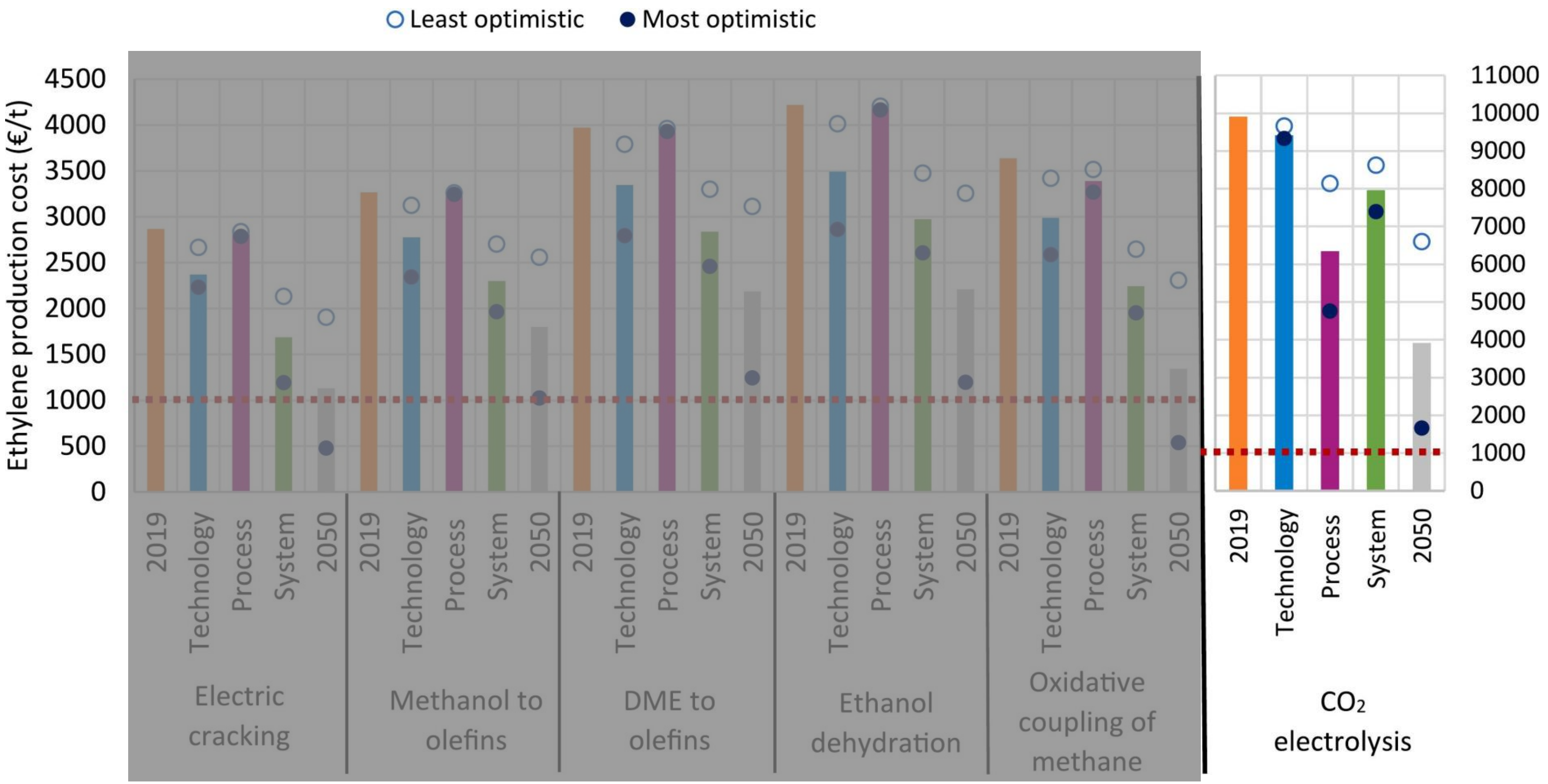
Ethylene from CO_2 electrolysis may cost 1660€/t in 2050 (under optimistic assumptions).



Recommendations

Collaboration and Data Validation

To **validate** modelling **results**, reduce cost uncertainties, and improve data transparency

Focused research priorities

Address data gaps in process design and techno-economic analysis, especially for electric cracking, CO_2 electrolysis, and OCM.

Testing and validation at lab or pilot scale.

Tailored policy support

R&D funding for CO_2 electrolysis and OCM,

Market-pull policies for ethanol dehydration and DME-to-olefins,

Reduce feedstock prices for MTO and electric cracking.

Methodological enhancements

Broaden analysis to include upstream processes and emerging low-TRL technologies (e.g., plasma catalysis, bio-catalysis).

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Summary

1

Ethylene production remains heavily reliant on fossil fuels, and while several emerging technologies could decarbonize the process, they are not yet cost competitive with conventional methods.

2

This study aimed to identify the conditions under which renewable ethylene technologies could become cost competitive by 2050, using a five-step methodology and analysing six promising technologies

3

Three future supply scenarios were modelled, applying a three-level framework (technology, process, system) to assess cost reduction potential, revealing key influences like ethylene yield, CAPEX, and feedstock price uncertainty.

4

Achieving cost-competitive, renewable ethylene requires coordinated action among researchers, industry, and policymakers, focusing on performance improvements, pilot testing, data sharing, and supportive market and policy environments.