From Ambition to Action

Making Circular Value Chains Competitive

Business game @ Transition to Circularity

MNEXT/Avans University, TNO Vector, GCNE



Rudi Hafkamp, Willem van Liemt, Nicole van Klaveren, Willem Manders

Goal of todays game

Why → Create insight in competitiveness of green *value chains*

What → For the future packaging market (bulk olefins)

How → Interactive game with a full value chain model

If you feel the urge for detail: Ask us!

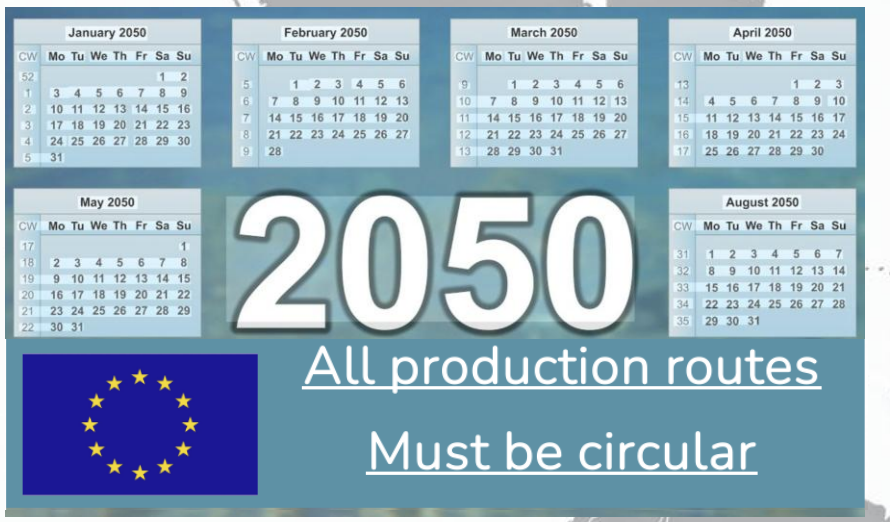
The Scene

Plastic recycling

Bio-feeds

CO_2 – capture

Packaging plastics



Value Chain Capture Project

Model

Game

European Union (EU)

China

Middle East (selected countries)

The Game

Three teams – each a production route/chain

Short explanation about the model

1. Plenary round and demo
2. Technical round
3. Global strategy round

Discussion and reflection

Prize ceremony

CO_2 – capture

Bio-feeds

Plastic recycling

Set Up

Single transparent Excel Tool

Sources
CO_2
Electricity
H_2
Biofeed
Plastic waste

Production routes
Pyrolysis
Gasification
Torrefaction
Methanol to Olefin
Cracking

Value Chain
Result step 1→ step 2 → step 3

Comparative cost to produce Ethylene/ Propylene

Round 1

Variables I
Energy prices
Feedstock prices
Efficiency processes

Variables II
Total capital investment
Cost of capital
Operational & Fixed cost

Round 1

Variables III
Scale + continuous/batch
Subsidies
Outsourcing (other regions)

Set Up

Single transparent Excel Tool

Sources
CO_2
Electricity
H_2
Biofeed
Plastic waste

Production routes
Pyrolysis
Gasification
Torrefaction
Methanol to Olefin
Cracking

Value Chain
Result step 1→ step 2 → step 3

Comparative cost to produce Ethylene/ Propylene

Variables I
Energy prices
Feedstock prices
Efficiency processes

Variables II
Total capital investment
Cost of capital
Operational & Fixed cost

Variables III
Scale + continuous/batch
Subsidies
Outsourcing (other regions)

Round 2

The Starting Teams

Three teams representing value chains, blue, green and orange:

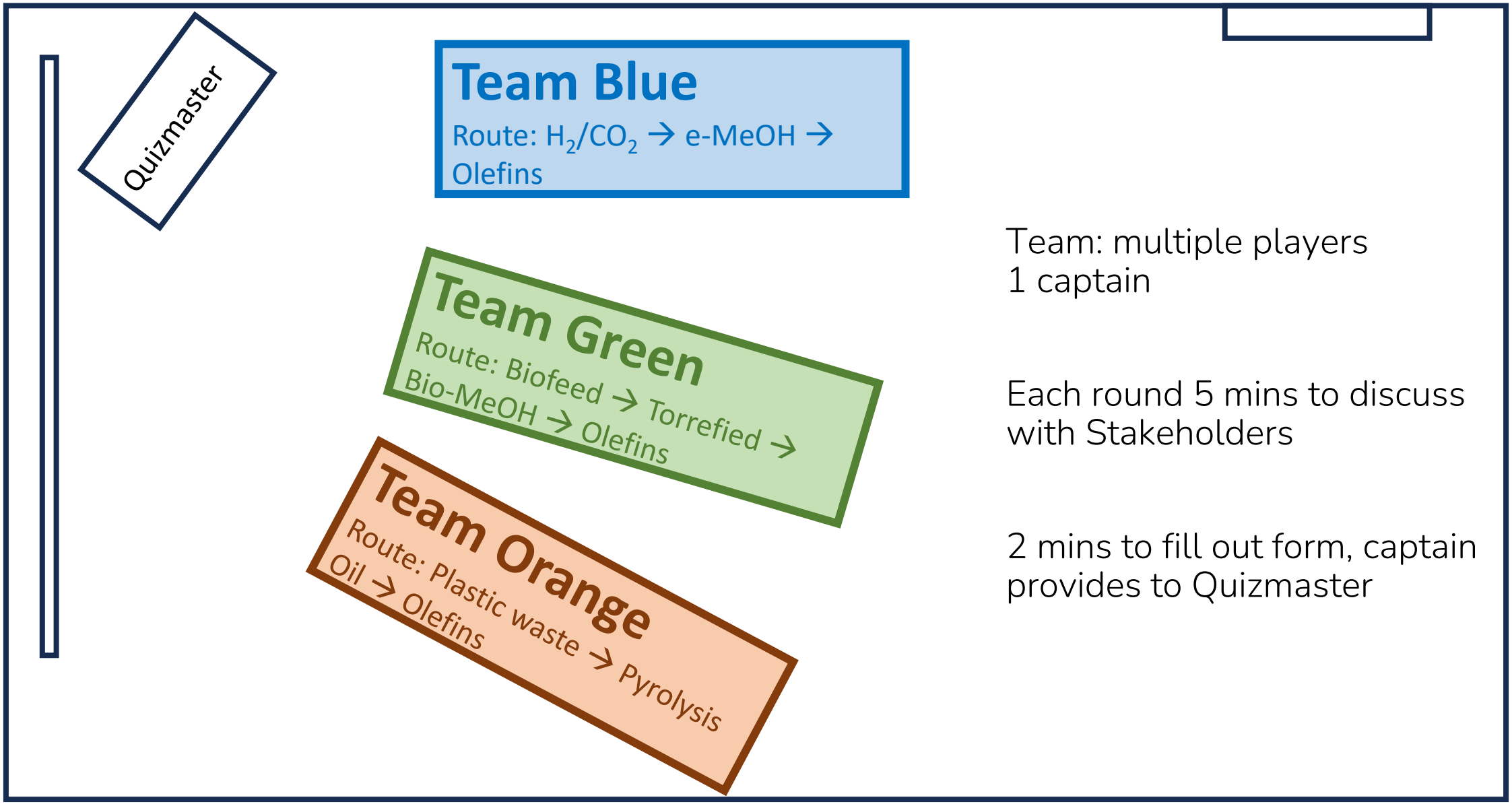
Team Blue: H_2 → + CO_2 → e-MeOH → Olefins*

Team Green: Biofeed → Torrefied → bio-MeOH → Olefins*

Team Orange: Plastic waste → Pyrolysis Oil → Olefins*

***Ethylene/Propylene**

Organisation of the Game

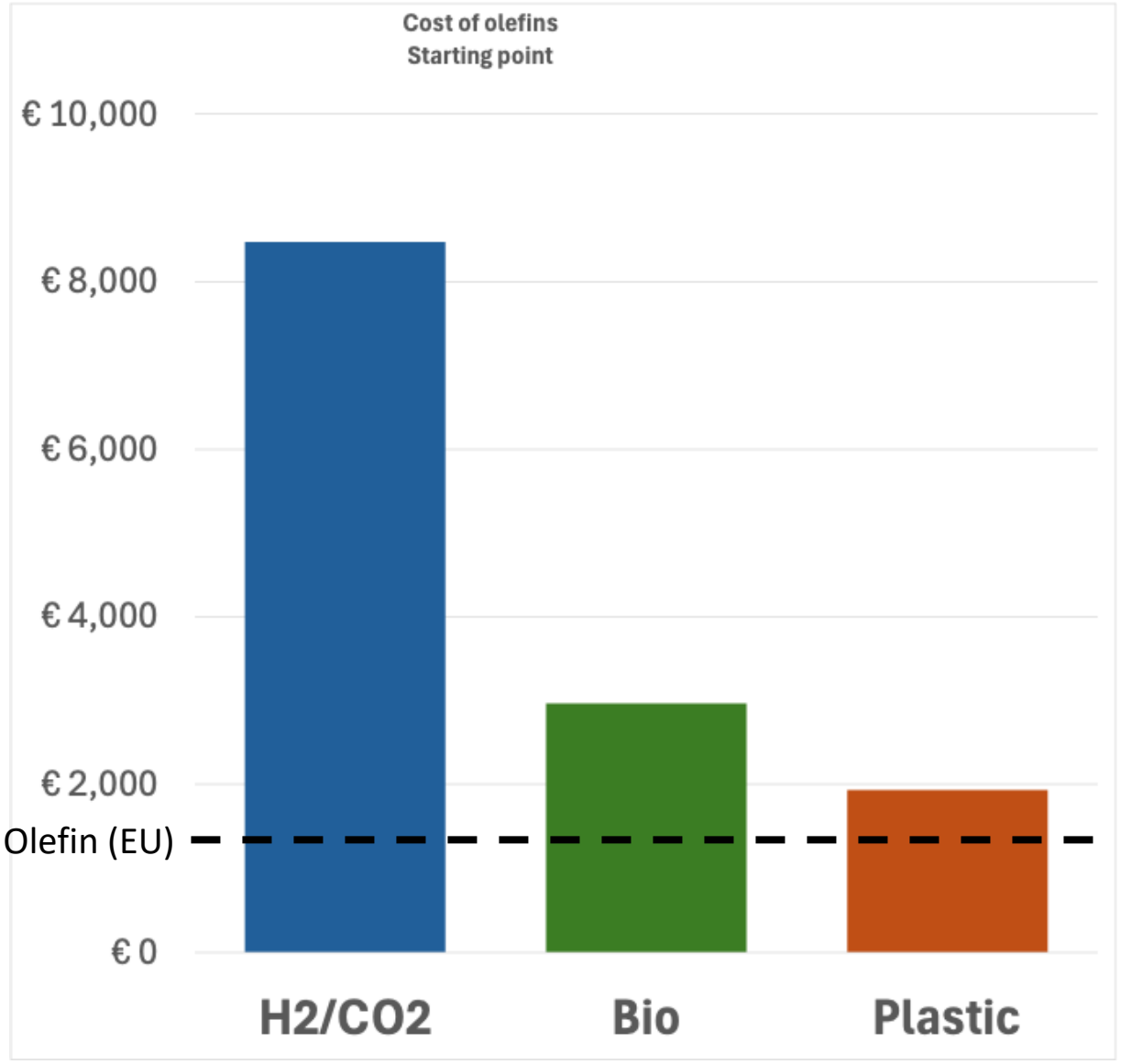


Team: multiple players
1 captain

Each round 5 mins to discuss with Stakeholders

2 mins to fill out form, captain provides to Quizmaster

The Starting Point 2025 …. Big Differences



Source of H_2: Grid (NL)

Medium Scale

Batch Pyrolysis

Life is all about making choices

Plenary Round:

Get a feeling for your value chain

Teams: vote by raising hands

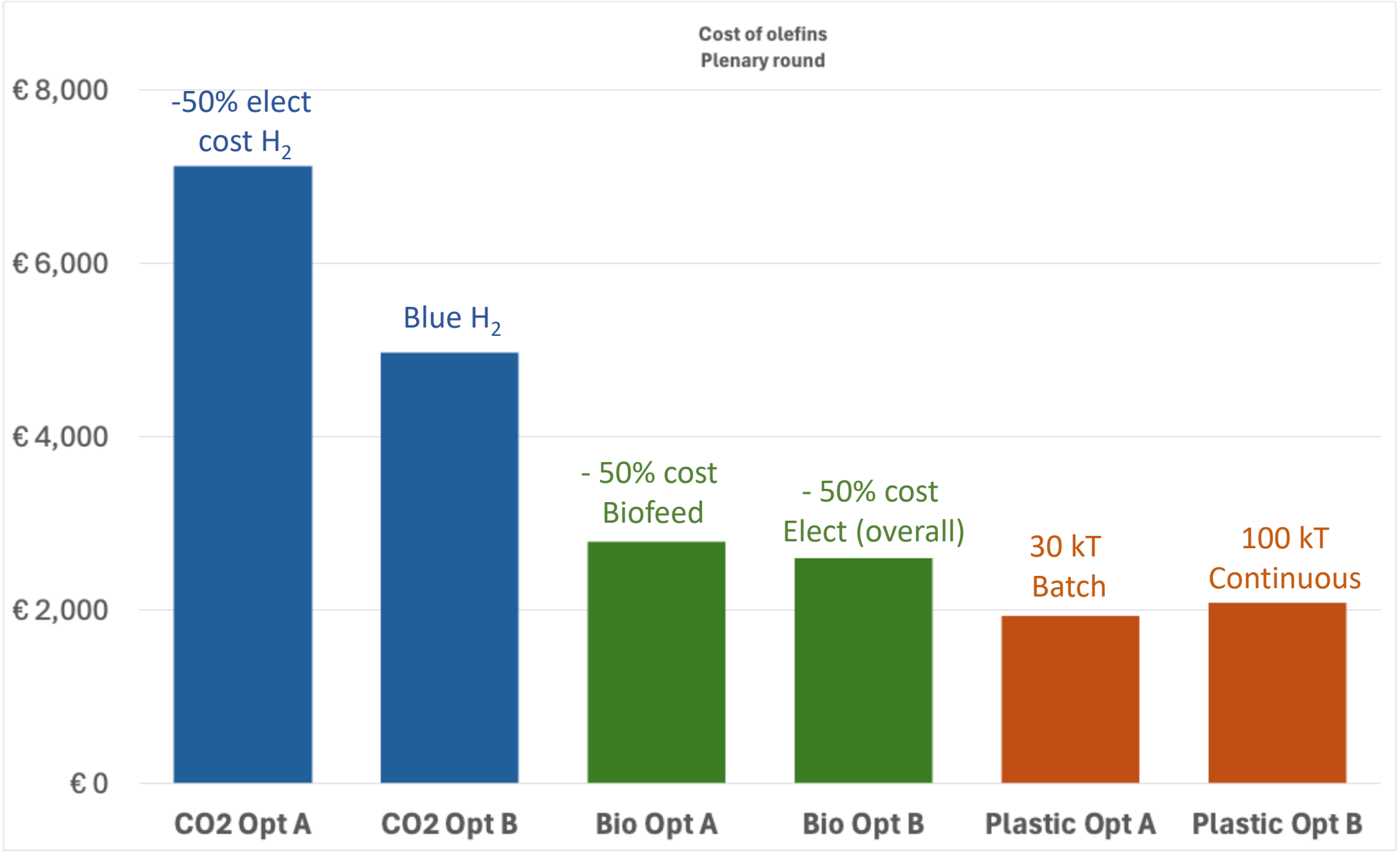
Source of H_2:
Option A : Blue H_2
Option B: Electricity cost -50%

Reduction feed cost:
Option A: -50% Bio-feed cost
Option B: - 50% Electricity cost

Process type (pyrolysis):
Option A: 30 kT batch
Option B: 100 kT continuous

*After this round, for next round values will go back to default values

Life is all about making choices



Round 1 – Technical



Each team to decide on steps to improve economics

Team Green:

Option A: Allow decentral torrefaction (~20% lower bio feed cost)

Option B: Scale up MeOH & olefin production to 1000 kT

Team Blue:

Option A: H_2 from 2050 mix (PV /Wind offshore)

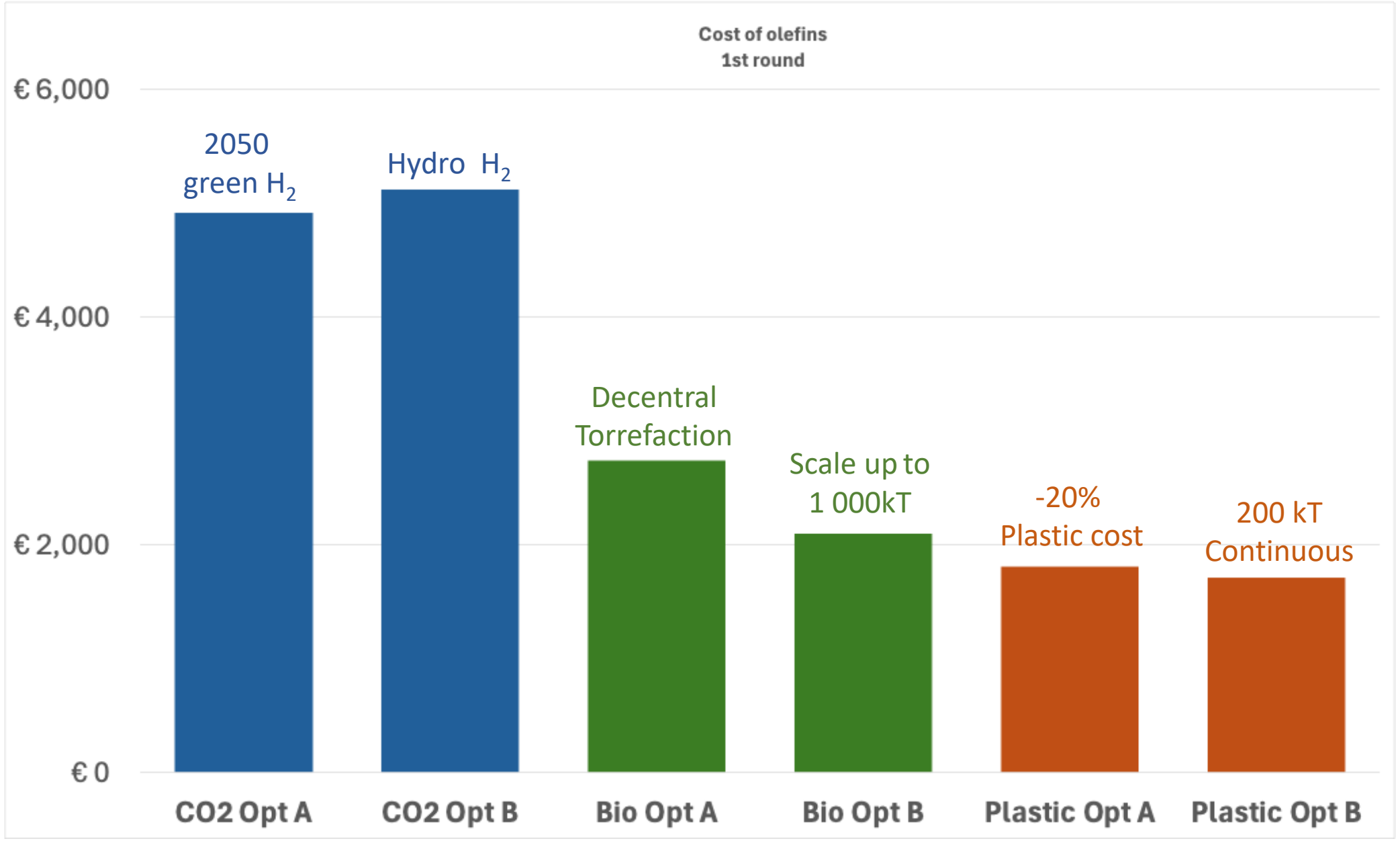
Option B: H_2 pipeline from Nordic (source hydro power)

Team Orange:

Option A: Lower cost of plastic waste by 20%

Option B: Scale py-oil production to 200 kT continuous

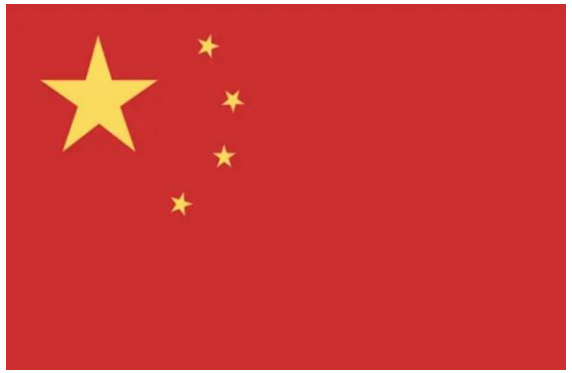
Round 1 – Technical



Round 2 – Strategy: EU Subsidies vs Outsourcing

Each team to decide on outsourcing production to Middle East or China, or stay in EU and receive subsidy







All steps of chain in EU

- EU Subsidy options 25% of total capital

Some or all steps outside EU

* Or visa versa, only for plastic team

Round 2 please select your option

Energy → H_2

CO_2 + H_2 → e-MeOH

e-MeOH → Olefins

- ☐ All steps EU (Blue H_2 + 25% subsidy on all technologies)
- ☐ All steps in ME (olefins shipped to EU)
- ☐ All steps in China (olefins shipped to EU)
- ☐ H_2 and MeOH created in ME (MeOH shipped to EU) - olefins created in EU (25% subsidy on last step)
- ☐ H_2 and MeOH created in China (MeOH shipped to EU) - olefins created in EU (25% subsidy on last step)

Round 2 please select your option

Biofeed Torrefaction

Torrefied feed → Bio-MeOH

bio-MeOH → Olefins

- [ ] All steps in EU (25% subsidy on all technologies)
- [ ] MeOH in ME (Torrefied Bio imported), olefins made in ME and shipped to EU
- [ ] MeOH in ME (Torrefied Bio imported) (MeOH shipped to EU) - Olefin made in EU (25% subsidy on last step)
- [ ] All steps in China, olefins shipped to EU
- [ ] MeOH created in China (and shipped to EU) - olefins made in EU (25% subsidy on last step)

Round 2 please select your option

Plastic waste → Pyrolysis Oil

Pyrolysis Oil → Olefins

- ☐ All steps EU (25% subsidy on all technologies)
- ☐ All steps in ME (olefins shipped to EU)
- ☐ All steps in China (olefins shipped to EU)
- ☐ Pyrolysis in ME (Pyoil shipped to EU), olefins made in EU (25% subsidy on last step)
- ☐ Pyrolysis in China (Pyoil shipped to EU), olefins made in EU (25% subsidy on last step)

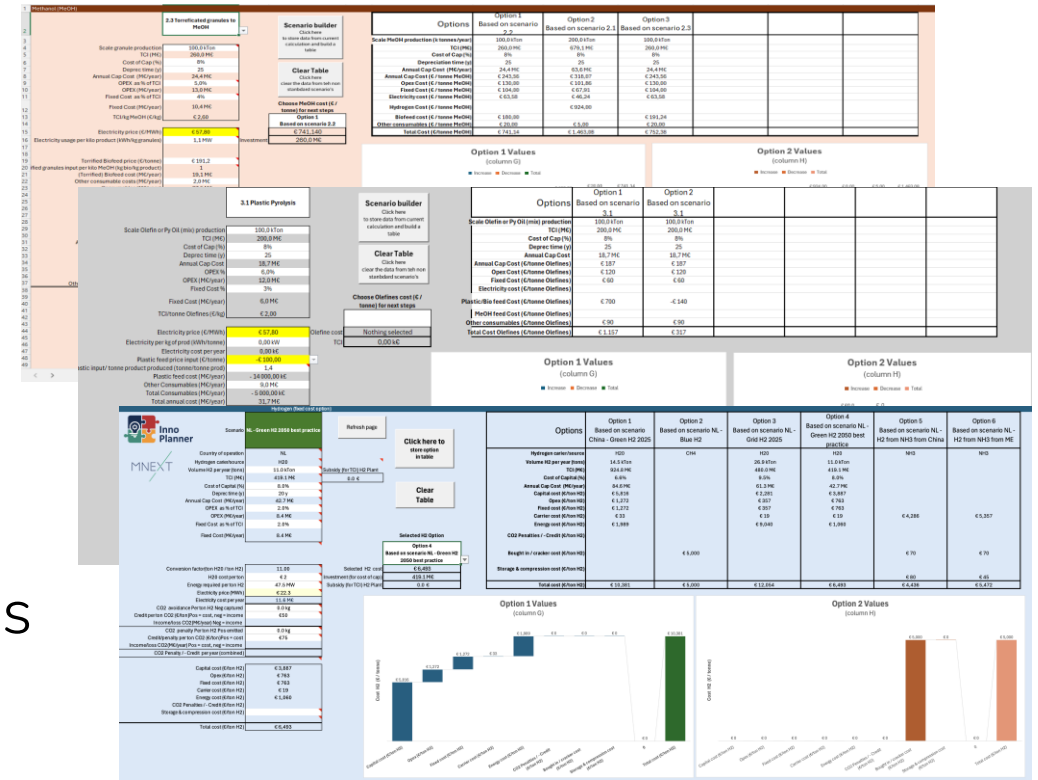
Intermezzo - why develop the model?

- Competitiveness unclarity is a barrier
- Comparability
- Transparent assumptions
- Future flexibility
- Educate

Intermezzo – about the model

- 42 academic TEA sources
- Commercial partner input
- Transparent & accessible (Excel based)
- VERY flexible: 41 scenarios, 200+ variables
- High-level comparison of value chains
- Individual process economics

- Not at process flow level
- Does not take into account “FOAK” conditions
- No commercial margins between individual steps



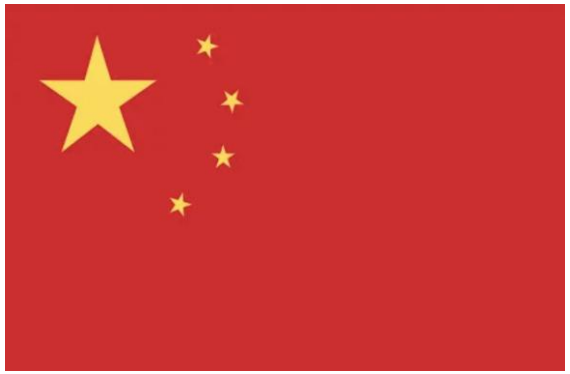
- Results round 2

Results round 2



All steps of chain in EU

- EU Subsidy options 25% of total capital





Some or all steps outside EU

Discussion with Teams

triggering challenges to the teams

Blue Team

"CO_2/H_2 is intrinsically uncompetitive"

Green Team

"not competitive without global biofeed commoditisation"

Orange team

"can plastic recycling be competitive without fossil (cofeed)?"



After continued incidents in the South Chinese Sea threatening the sovereignty of Taiwan, the European Union have decided to increase tariffs on Chinese manufactured goods by 25%



EU decided to increase tariffs on ME manufactured goods by 25% in order to finance the continued safety of supply routes in the region



After shutdown of nearly all AI agents following global incidents, electricity prices in Europe dropped to zero, leading to a surplus of EU generated hydrogen trading at 0,50 EU/kg

Observations from the model (and the game)

Regional competitiveness scenarios can be calculated

European routes more competitive when needing less “additional” energy

CO_2 – H_2 route not competitive energetically and economically – H_2 cost is the dominant driver

Biofeed route has significant energy and feedstock need, scaling helps

Plastic recycling route lowest on cost, mass balancing with fossile a watchout

For Pyrolysis and Bio route, EU can be competitive at subsidy levels close to the “capital investment gap” with China

Thank you – please give us your feedback

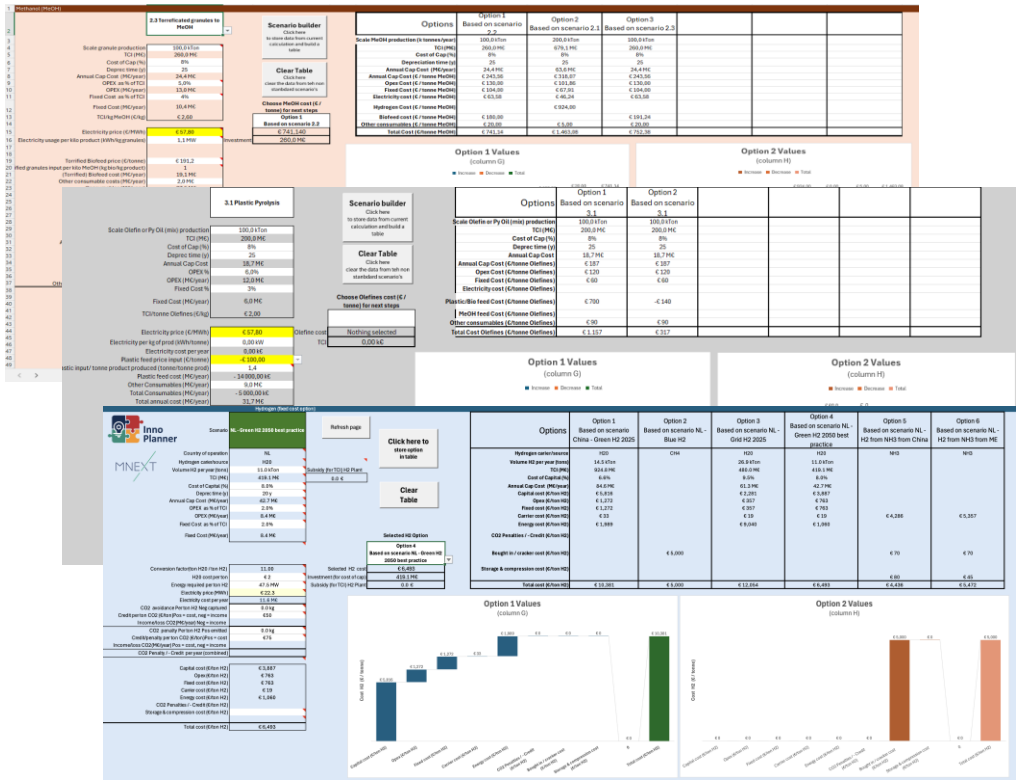
- Your view on regional competitiveness
- Your view on barriers to grow regionally

- Happy to organize deeper dive with model

InnoPlanner

Accelerating Innovation & Scenario Planning

Innoplanner2025@gmail.com
+31646800867



Supporting printouts