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Transforming industry

Climate neutral Chemistry inspired by Chemelot

Arnold Stokking

Managing Director Brightsite

Proud partners

Sitech Services

TNO

Maastricht University

Brightlands Chemelot campus

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Arnold Stokking

Business Law, Radboud University
Business Administration, Rotterdam School of Management

Passion for technology-driven innovation
Innovation and alliance manager
Ecosystems including Public-Private-Partnerships

Managing Director **BRIGHTSITE** Geleen

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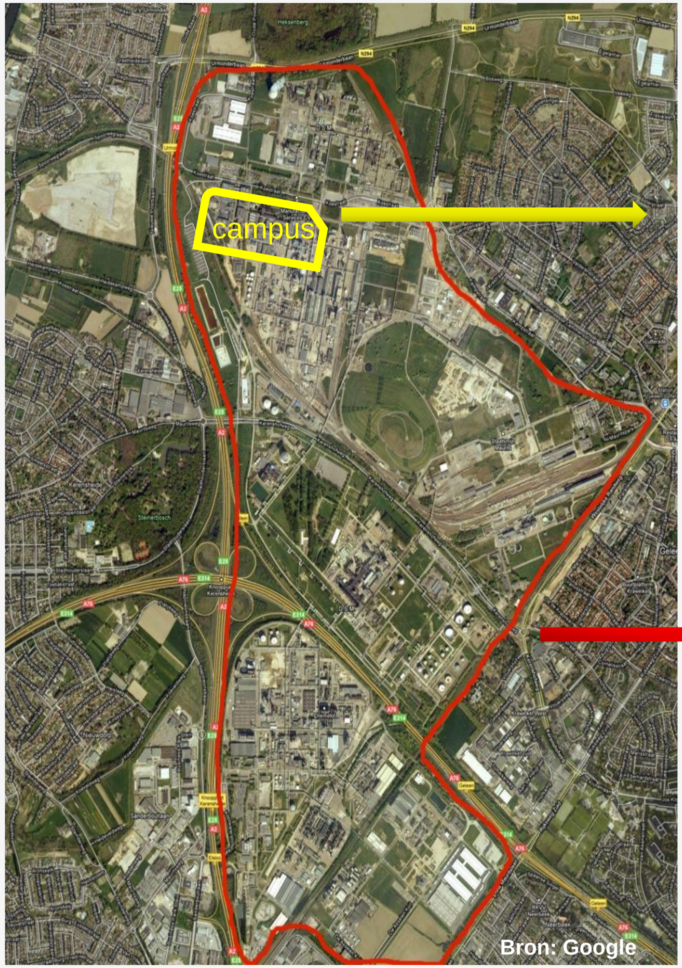
Integrated chemical site

well positioned for the transition

chemelot

for today's future



8 June 2022

Why?

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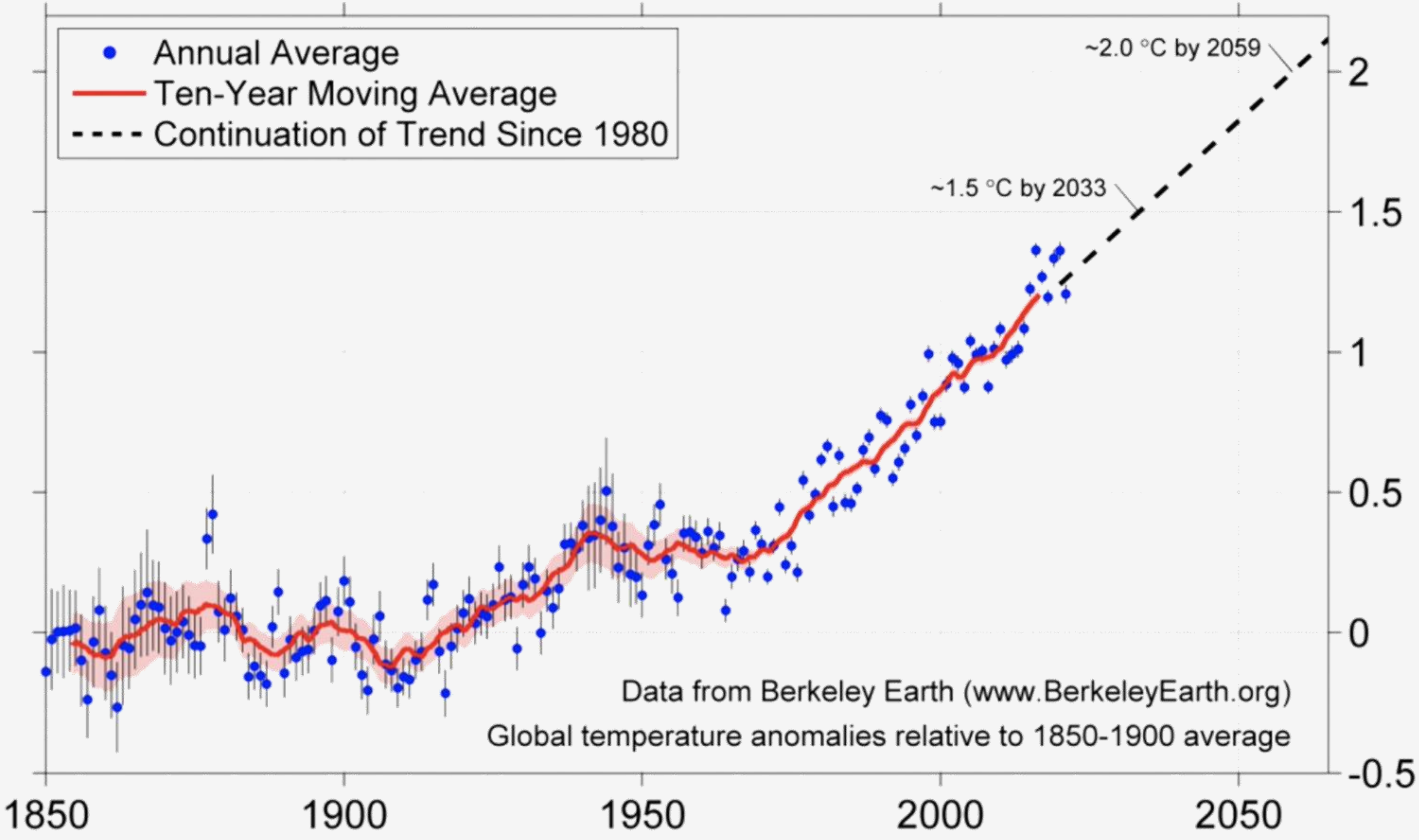

Chemical industry impact on emissions
example Chemelot Scope 1, 2 en 3 (2019)

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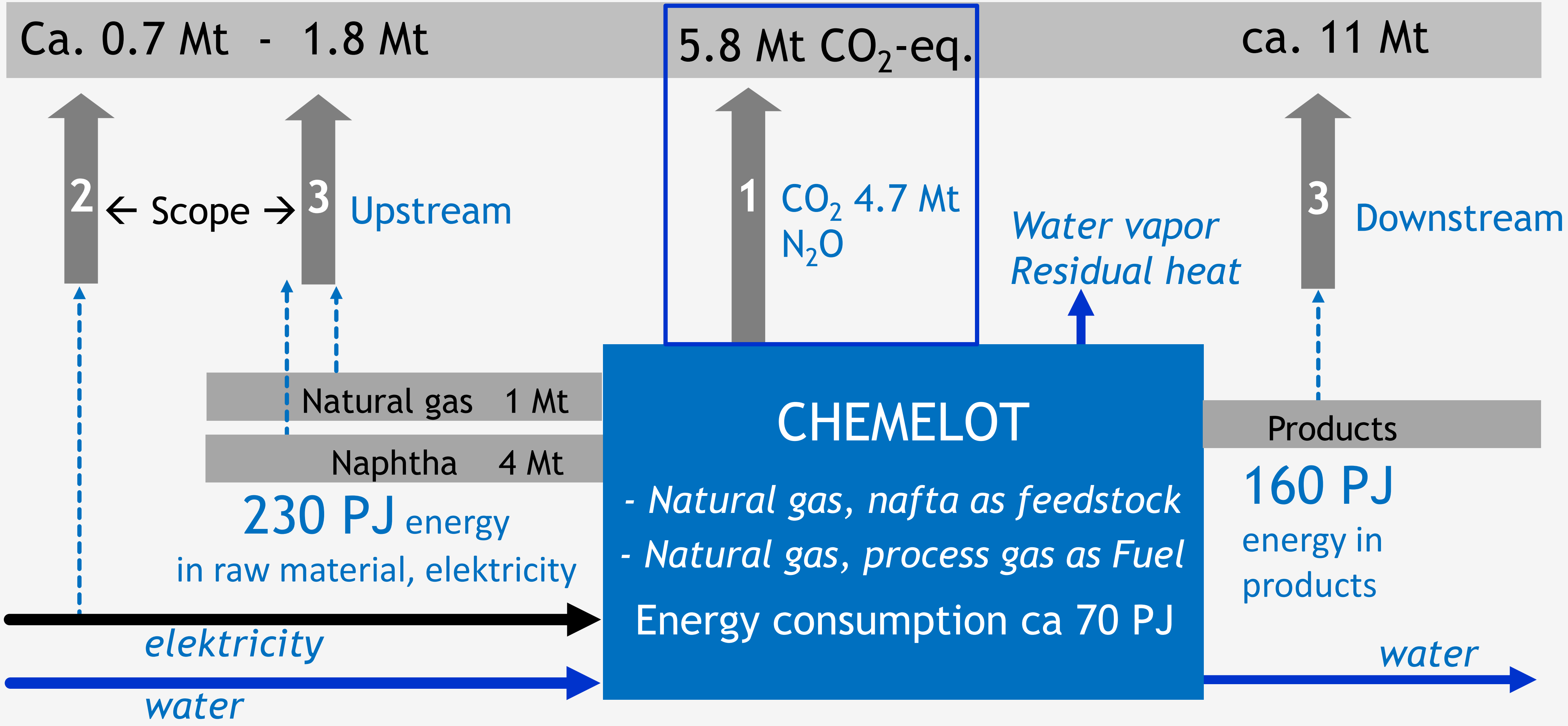

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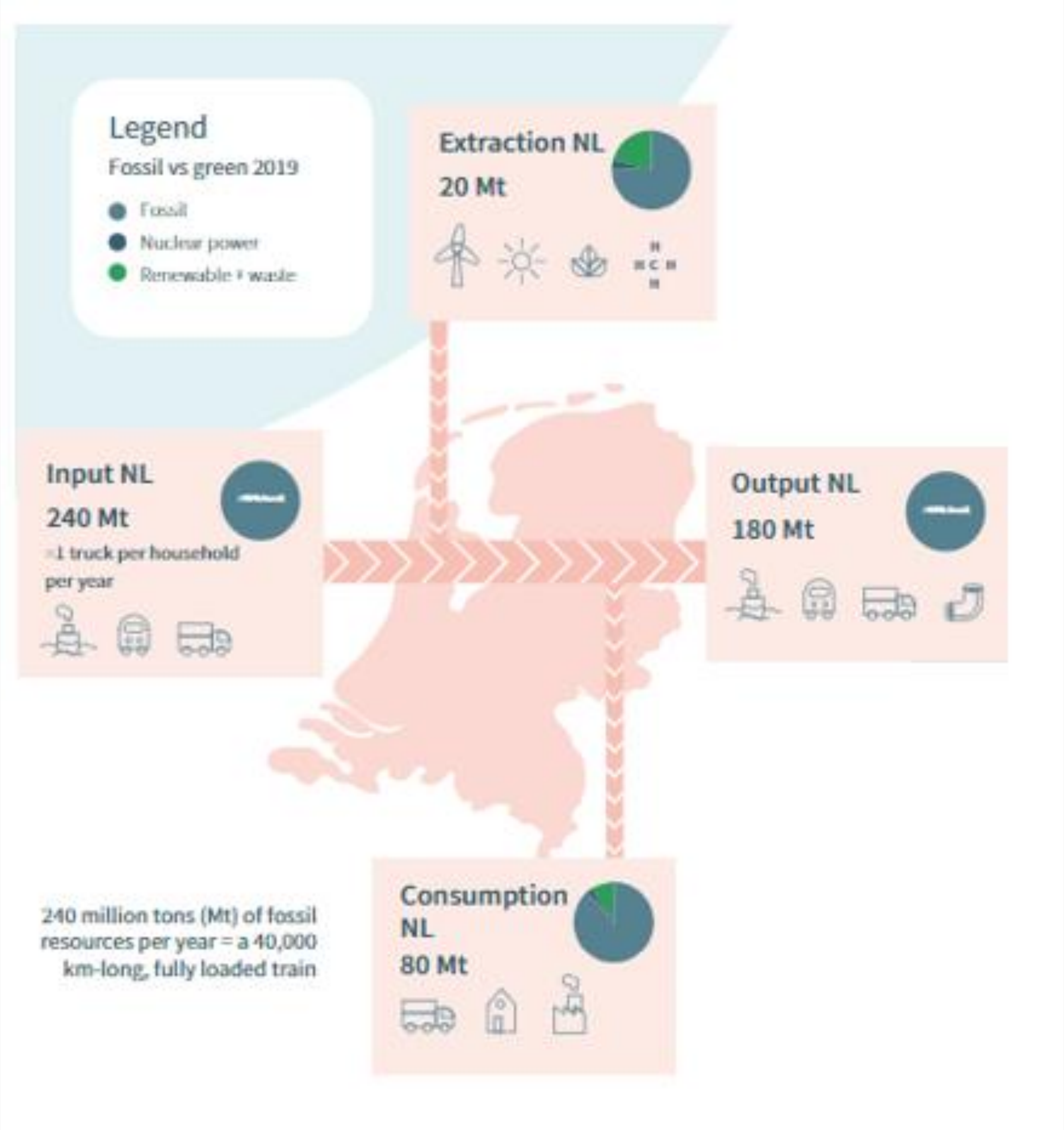
The Transition Challenge:

Fossil resources consumption Netherlands for fuels and feedstock

Netherlands: 80 Million ton
90% energy / 10% feedstock

Chemelot: 5 Million ton (~6%/NL)
25% energy / 75% feedstock



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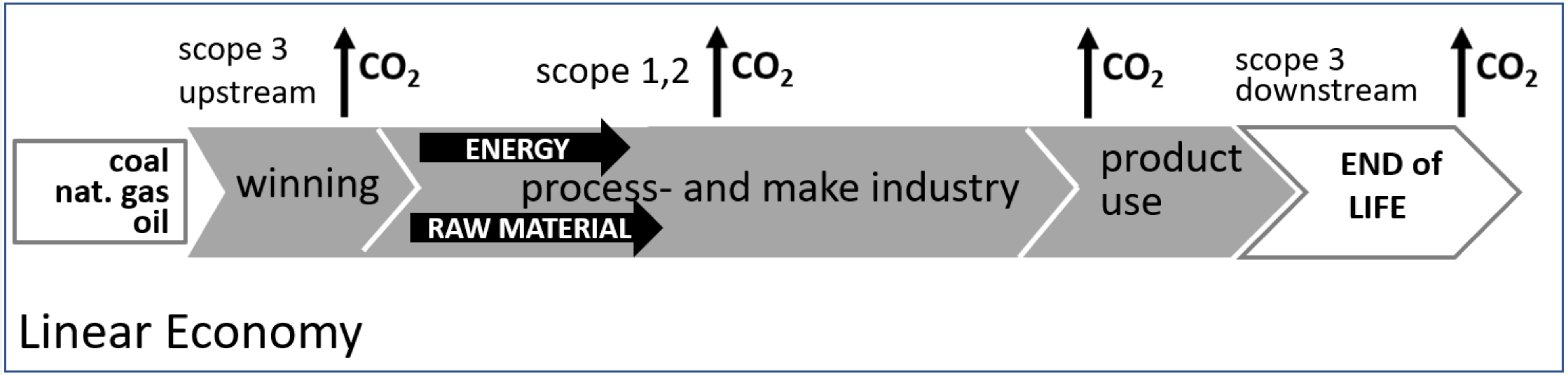
Current linear value chain



The transition is in it's very early stage

We need time…!

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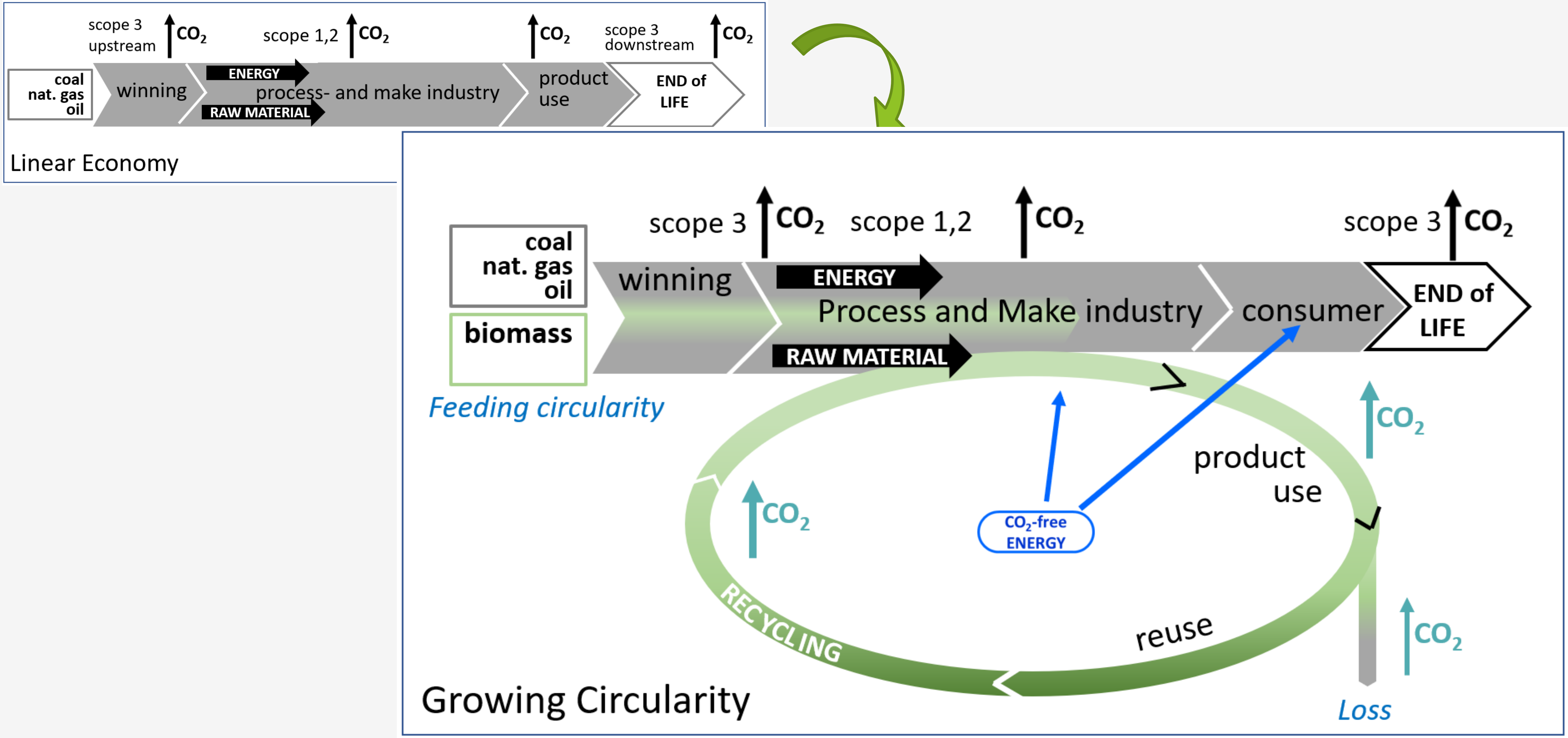

The future will be circular and green

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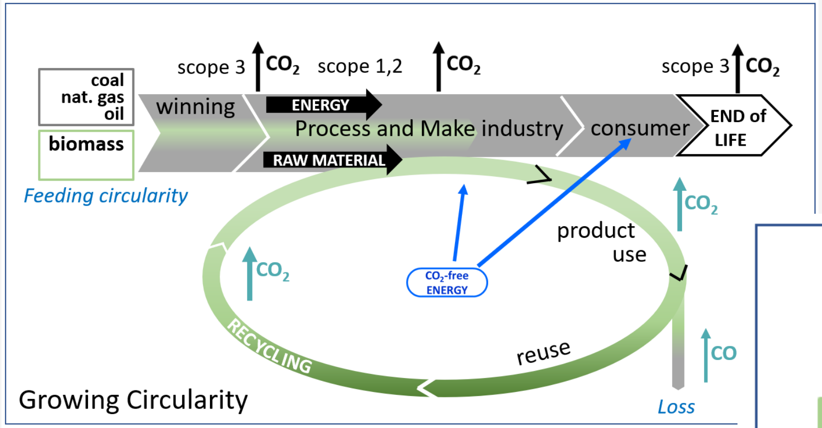

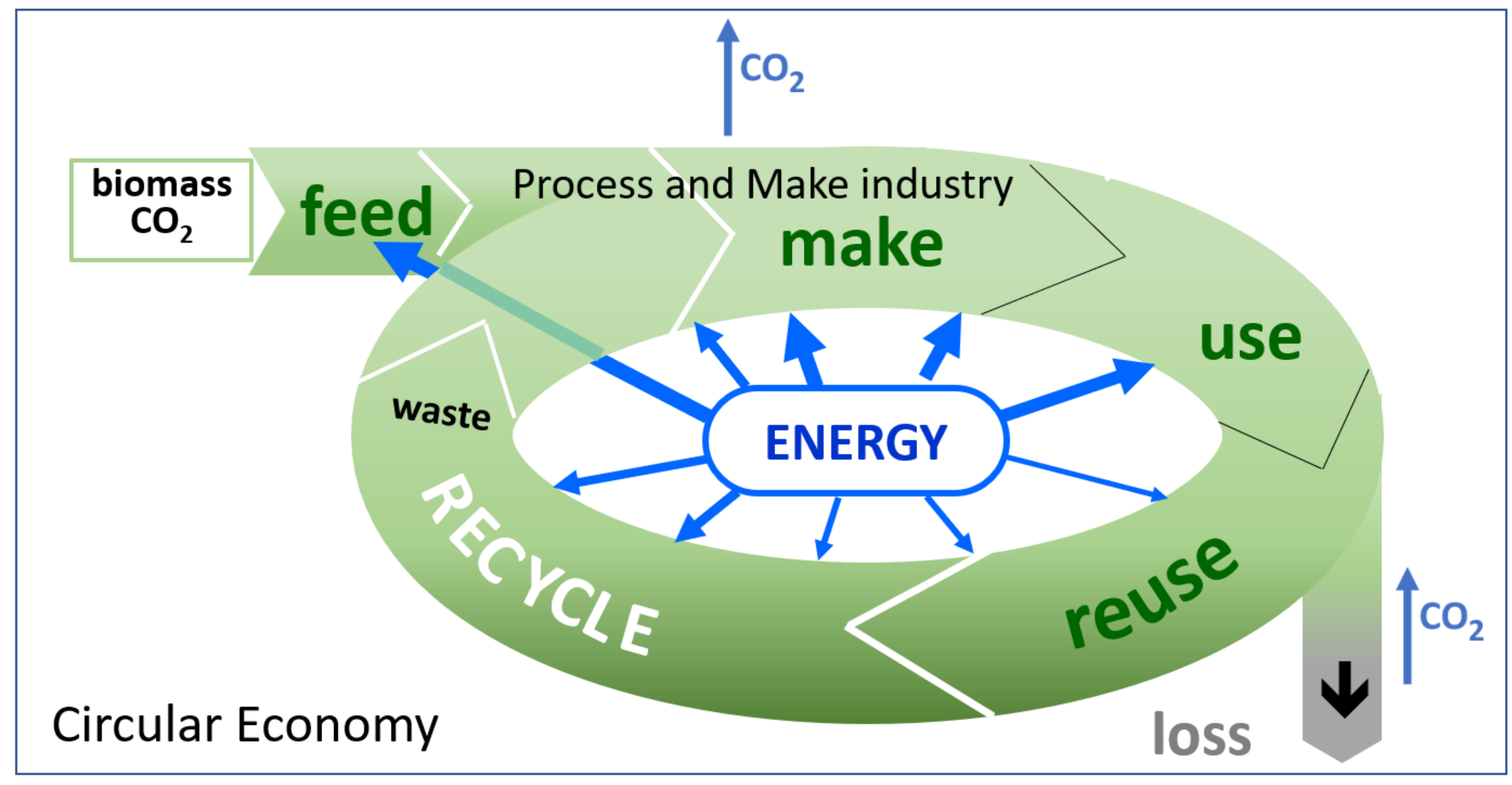

Electrification reduces GHG emissions significantly

Chemelot (Cluster Energy Strategy 2021)

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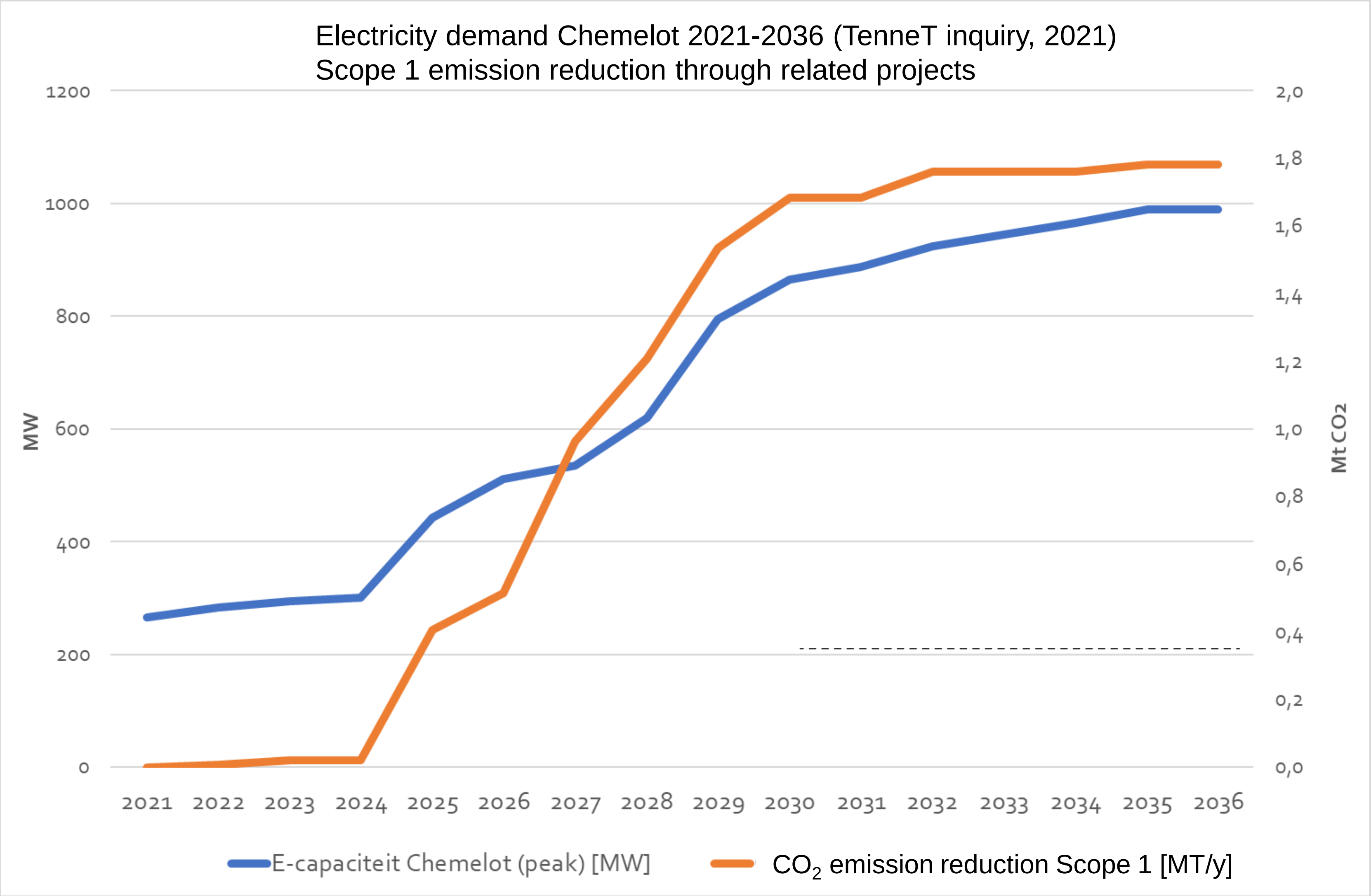
750 MW extra required until 2030 only
1.8 Mton CO_2 reduction Scope 1

Distribution of 43 projects:

20% existing factories
30% electric cracking
25% new factories
15% new factories scope 3
10% new factories for H_2



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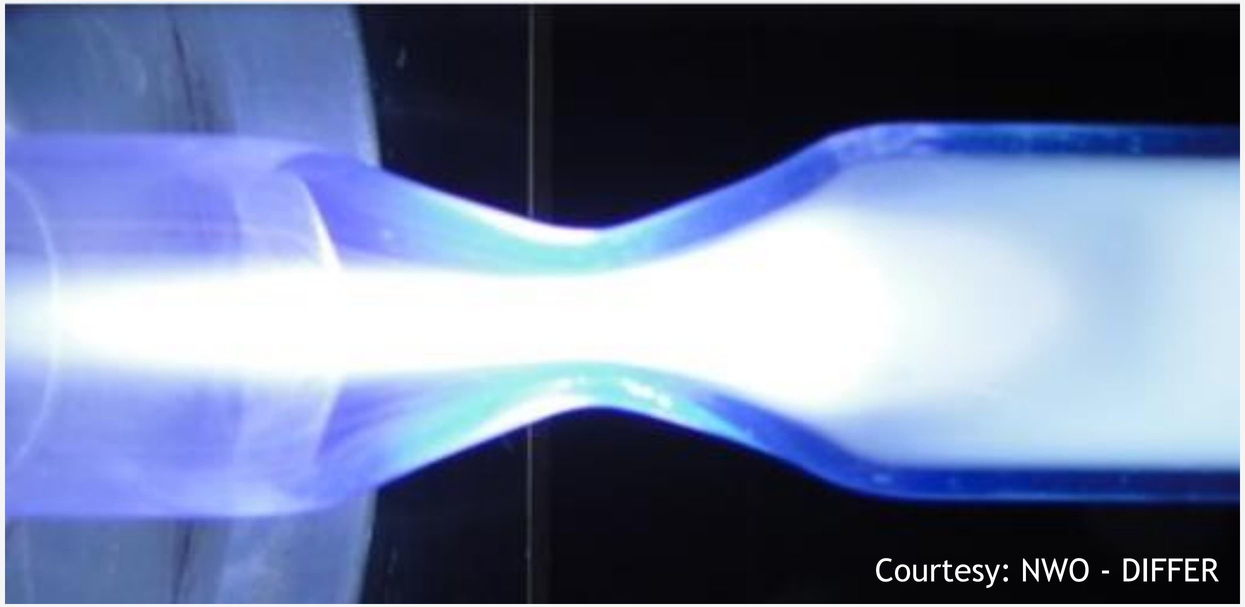
Further energy need beyond 2030

electrification: “plasma chemistry” +1 GW 2040?

Typical high temperature processes: > 900 ºC

The flame that doesn’t burn



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2 energy intensive routes for circular feedstock

- Synthetic molecules, e.g. H_2 and CO from H_2O and CO_2

- Renewable carbon: CO_2, biomass and waste

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Steam: currently the energy carrier at Chemelot

Future need for extra baseload heat supply?

Electrification of high temperature demand has significant impact on both steam production and steam demand

The Steam system at Chemelot delivers

55 PJ

per annum

Steam demand development due to new planned processes is still uncertain.

On purpose steam production will reduce but remains necessary. Uncertain whether sufficient base load heat will be available from residual process heat only. Demand for flexible heat emerging (E-boilers)

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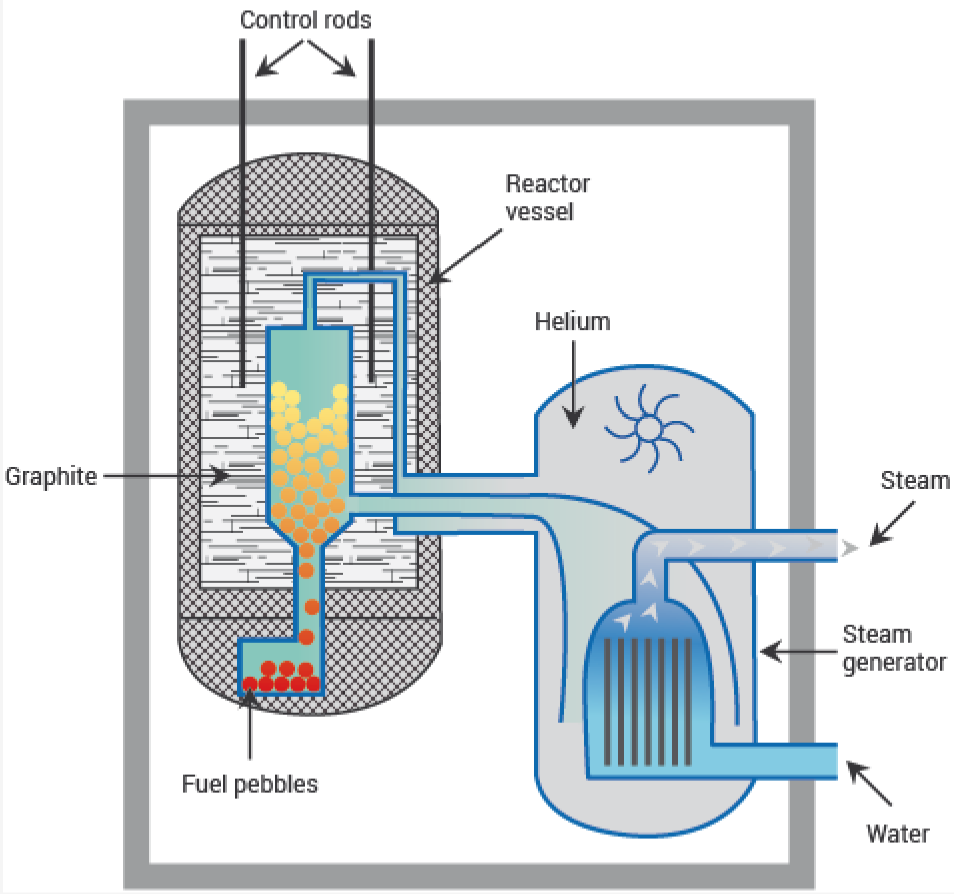
A typical Advanced Small Modular Reactor can combine heat and electricity supply

Typical capacity: **300 MW thermal:** Heat 500 – 700 ^{0}C or
**130 MW electrical + ** Heat ~ 100 ^{0}C

Optimal efficient approach:
- Heat efficiency first
- Electric heating at high temperatures only

Challenges:
- Direct use of heat requires integration with process plants.
- Typical process temperatures are 900 ^{0}C and beyond
  Preheating combined with electrical high temperature heating?
- 24/7 4–6 years continuous operations required
- Societal acceptance (dense populated areas)
- Nuclear waste
- Business case

A High-Temperature Reactor (HTR)



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On our way to climate neutral chemistry
huge additional demand for 24/7 CO_2 free energy

1. Energy: Electrification of High Temperature processes
   - Chemelot is planning 750 MW extra until 2030.

2. Energy: Electrification of new processes such as Plasma Technology
   - Potential demand of 1 GW beyond 2040?

3. Circular Feedstock: Creation of new synthetic building blocks such as H2 and CO:
   Hydrogen: (H_2O > H_2 and O_2) current use Chemelot is 200 kton / annum
   Carbon Monoxide: (CO_2 > CO) potential feedstock for Chemelot

4. Circular / renewable Feedstock: biobased and waste recycling, drying and processing
   Chemelot current use is 4000 kton / annum fossil cracker feed (naphta).

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