

Gas industry challenges – using current infrastructure for new opportunities in the energy transition

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CONTENT

- **Gas as an element in the energy transition**
- **Gas-CCS for industries: turning gas into hydrogen**
- **Heating the built environment: hybrid electrification**
- **Synergies with existing gas infrastructure**



Bert den Ouden

- 1982-87 CE Delft consultancy: energy conservation & renewables
- 1987-96 Dutch Ministry of Economic Affairs: energy conservation, market liberalization
- 1997-99 Energie Nederland Association, preparing & founding energy exchange APX
- 1999-2013 CEO of APX → APX-ENDEX:
 - Gas & Electricity exchange in Netherlands, Belgium, Great Britain
 - Architect of European Market Coupling (power markets)
 - Launch of gas markets on TTF and Zeebrugge
- 2013: Berenschot consultancy: group leader on energy markets / energy transition

Current gas infrastructure

Upstream

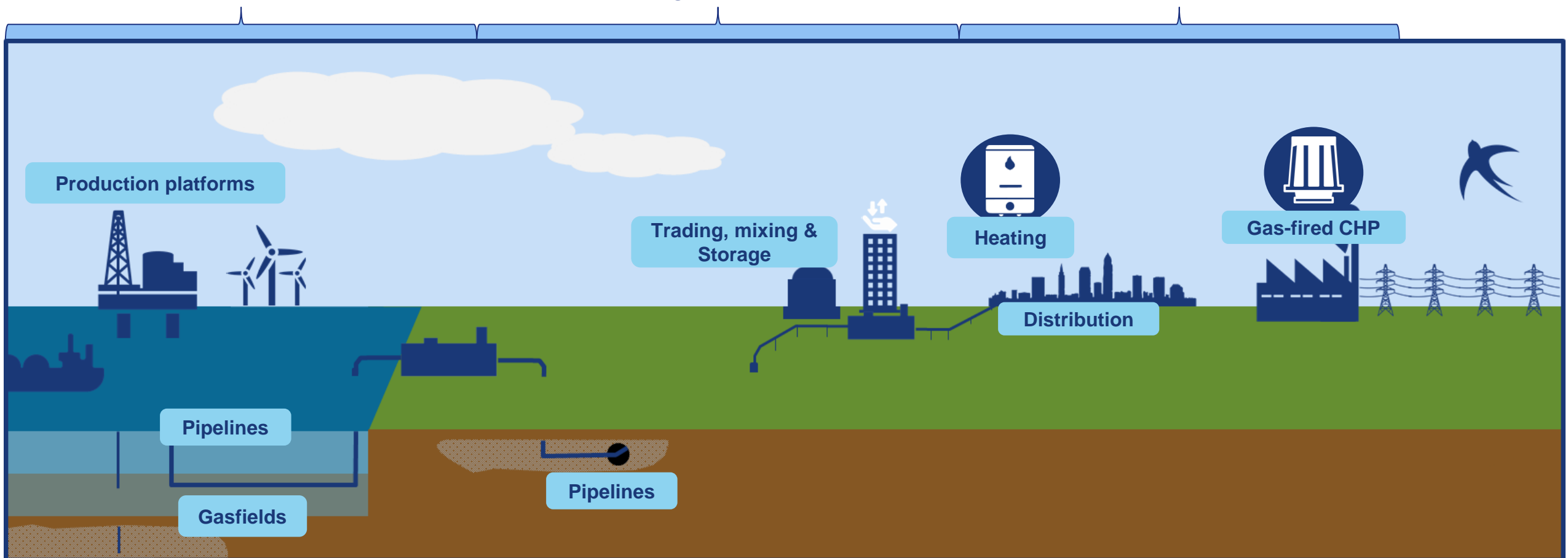
- Gas fields
- Production platforms
- Upstream pipelines

Midstream

- Midstream pipelines
- Mixing facilities
- Gas Storage
- Trading facilities

Downstream

- Distribution grids
- Heating boilers at consumers
- Gas-fired CHP



Dutch Energy Report: The problem is CO2

Ambition 2050: safe, reliable, affordable energy.

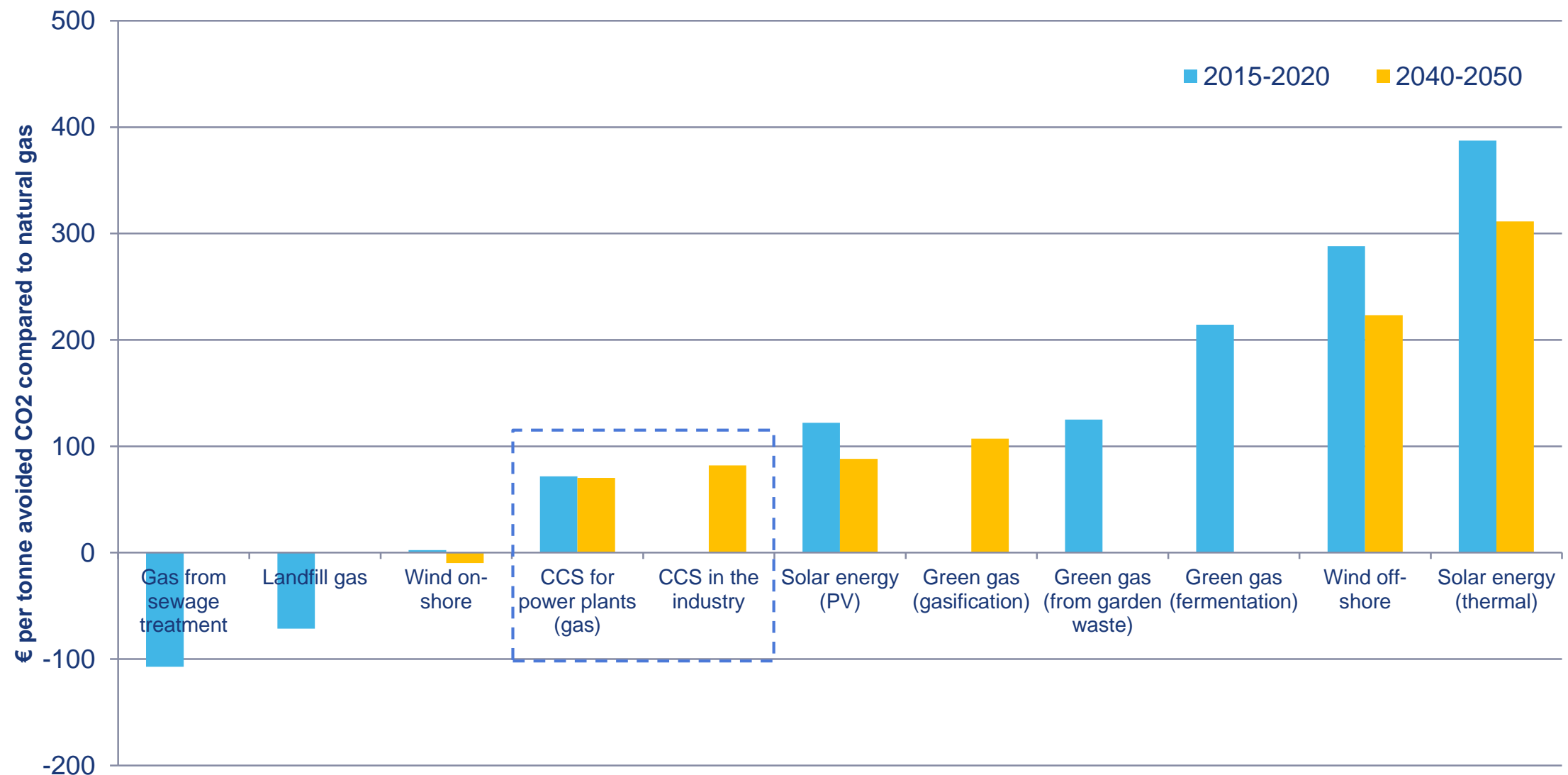
With 80-95% reduction of greenhouse gasses vs 1990

- Solar & Wind alone: unlikely to fulfill full ambition
 - Cost of carbon free pure all-electric solution will be very high
 - Nobody has been really calculating this, yet
- Next to sound electrification, we need carbon-free gas:
 - Storage, Back-up
 - Bridging the windless winter periods “dunkelflaute”

In this presentation, we'll explore carbon-free gas solutions and their value in the energy transition
And see if this will utilize current gas infrastructure

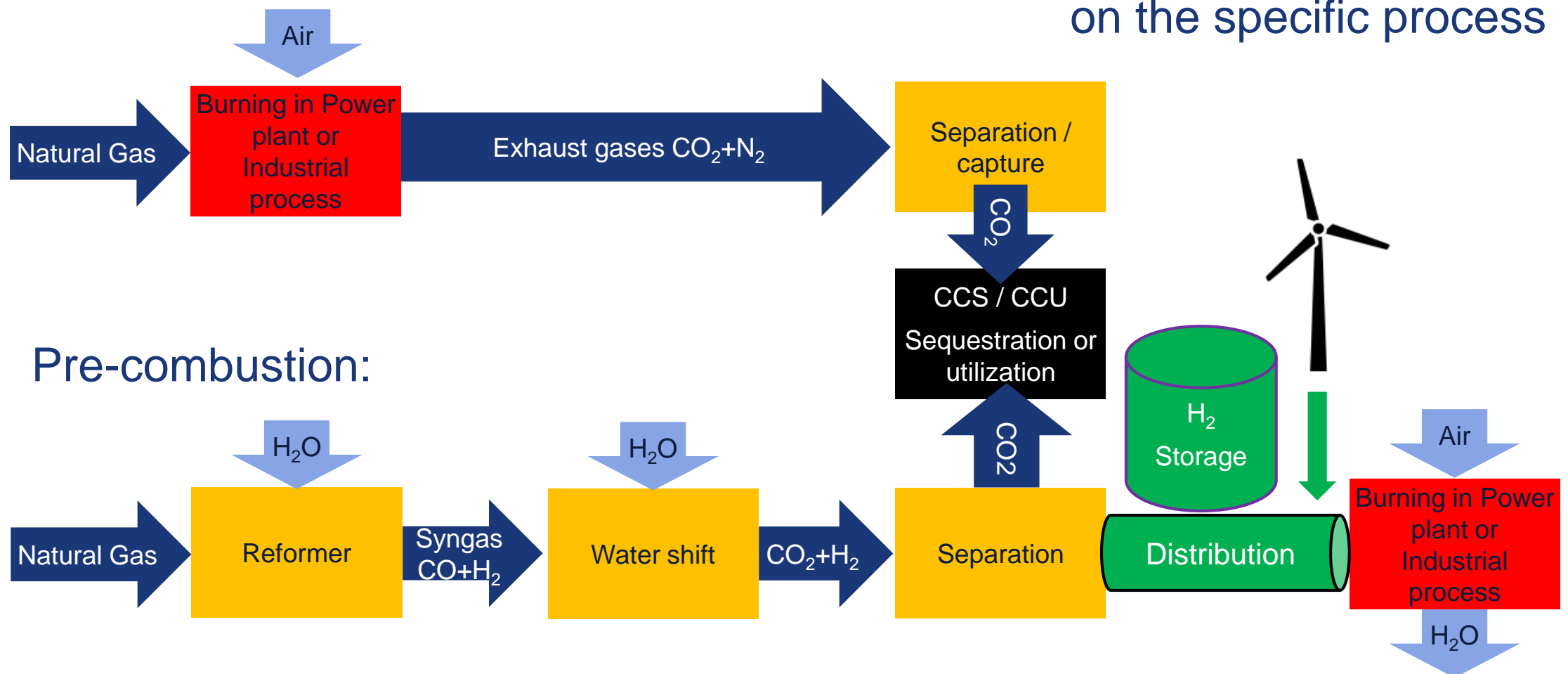
1. Gas Carbon Capture

Gas Carbon, Capture, Utilitization and Storage (Gas-CCUS) seems cost-competitive with other sustainable solutions



Post-combustion / pre-combustion CO₂ capture

Post-combustion: decentralized at each power plant / industry, depending on the specific process



Pre-combustion capture converts natural gas into hydrogen. This can be done centrally, independent from the end process. The H₂ to be stored and distributed in the gas grid, for carbon-free decentralized application.

Pre-combustion CCUS advantages

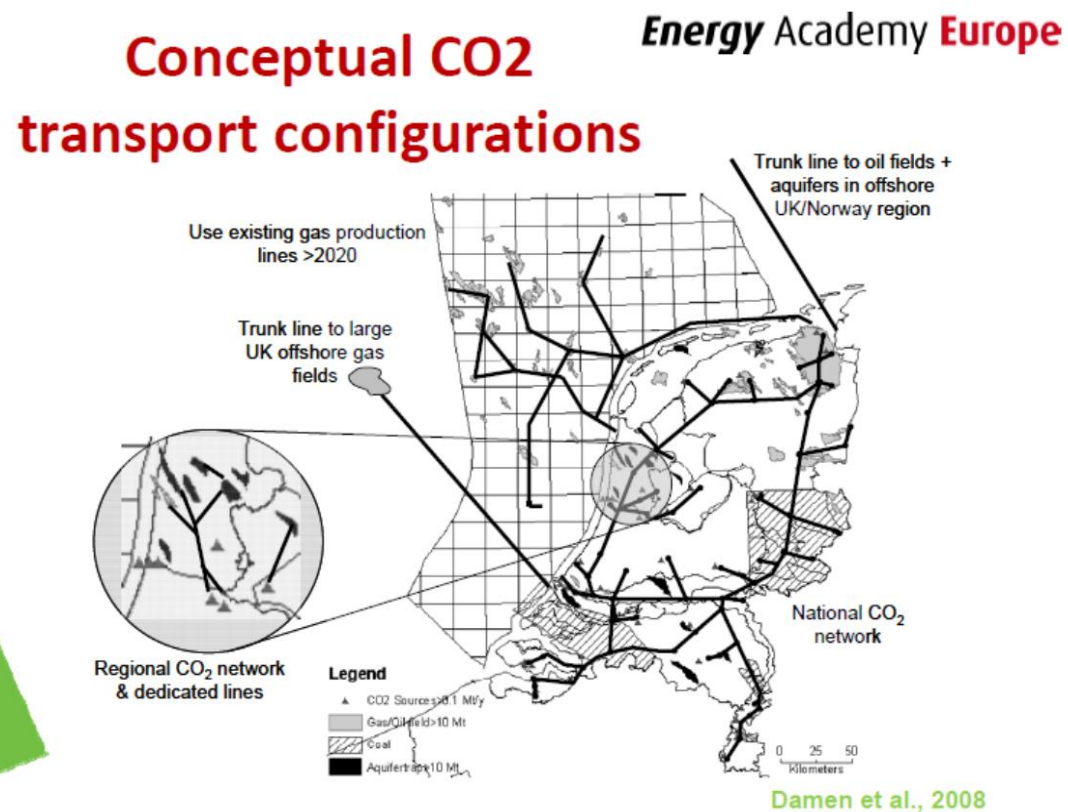
- Pre-combustion CCUS is a decoupling between process and capture
- Pre-combustion CCUS plus H₂ storage works for intermittent processes:
 - All industries
 - Flexible gas power plants

Post-combustion CCS doesn't do that or is much more expensive

- Can be applied and CO₂ stored directly at the source (Noordzee)
- A hydrogen infrastructure can be created fast, in synergy with renewables
 - Can be done now with current technologies
 - P2G from wind offshore excess: later on, plug into same infrastructure
- Hydrogen is a green storable backup for (intermittent) sustainable electricity

Pre-combustion gas-CCUS is fundamental step toward sustainability

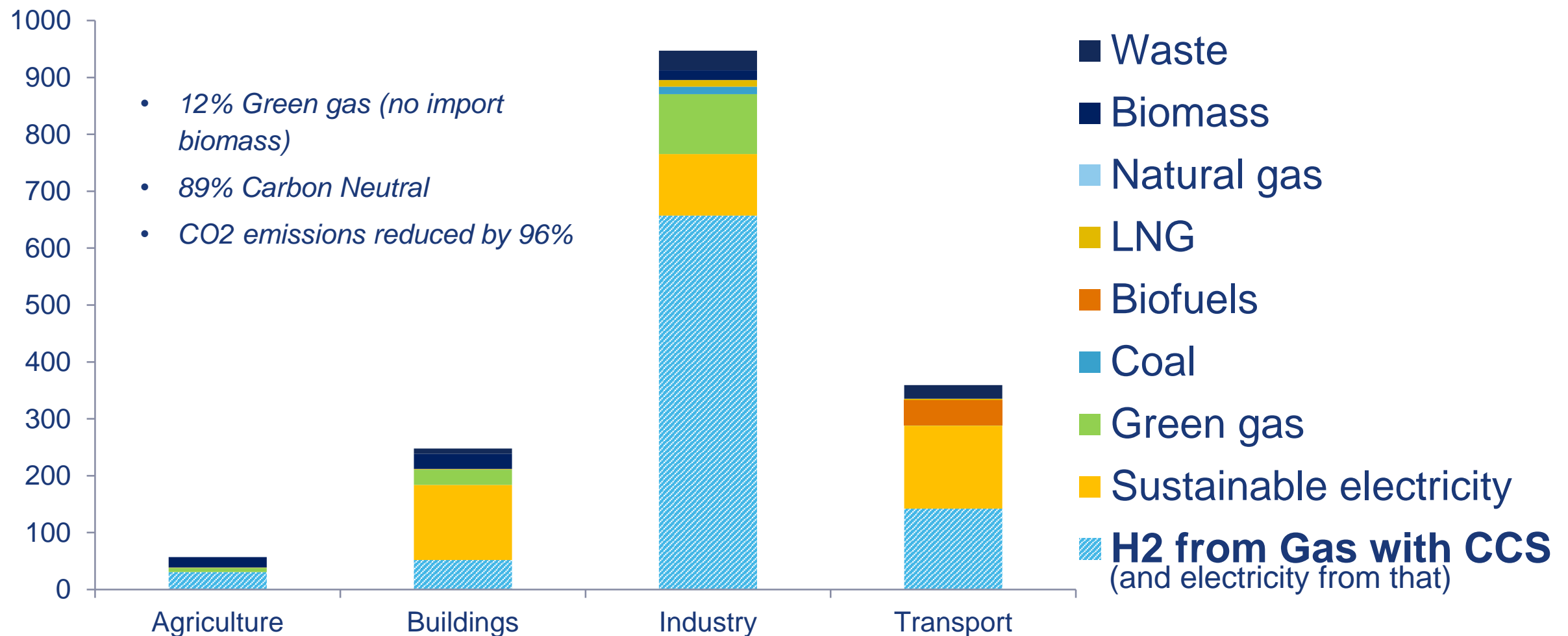
Netherlands has competitive edge



- Re-use existing infrastructure
- (partially) empty fields are available
- Transportation of CO₂ or hydrogen: gas pipelines (re-)utilized
- Storage of hydrogen: part of available caverns

A carbon-free solution: Hydrogen from gas + CCUS

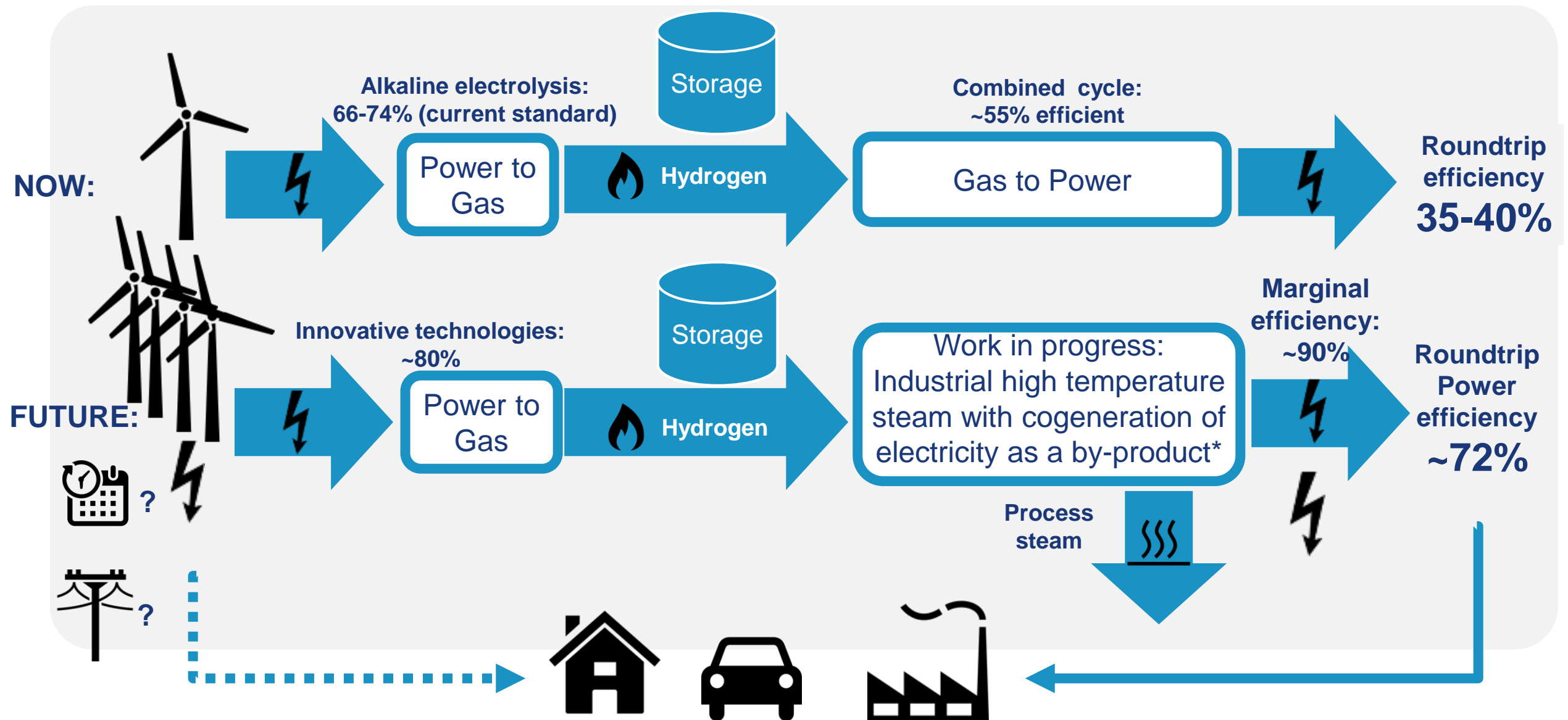
Scenario for a CO₂-neutral energy supply per sector (in PJ/yr)



This one the few realistic scenarios (especially in the large industry) without large-scale import of biomass

Hydrogen from gas-CCS paving the way for power-to-gas infrastructure

E.g. future efficient P2G upstream combined with cogeneration downstream



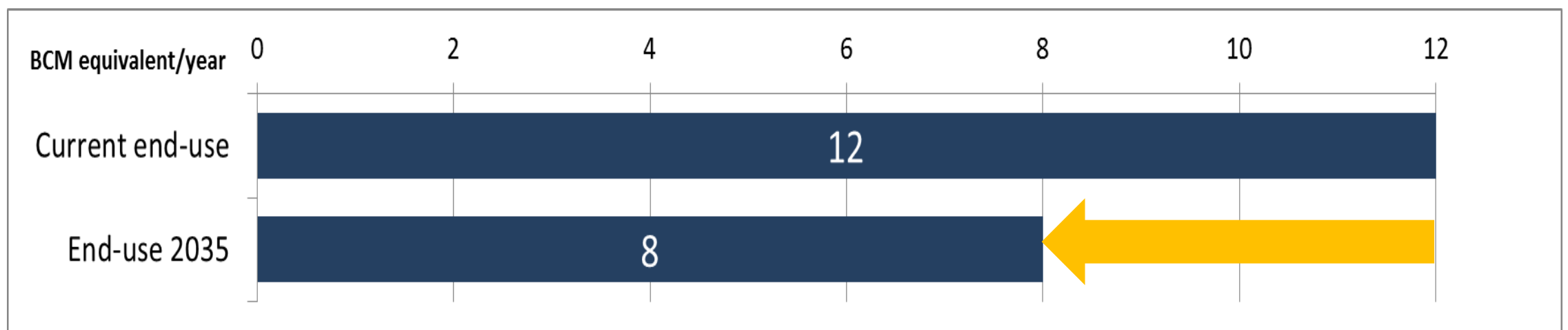
High marginal electrical efficiencies can be obtained in the industry with cogeneration: producing process steam (~90%) with electrical power as a by-product (~10%). Berenschot and Innecs are conducting research on the potential contribution of this opportunity to the energy system in the future. Some of the first tentative insights are shown above.

INNECS
innovative energy conversion systems

2. Heating the built environment

Heating for Houses and Buildings

- Current energy demand: ~ 12 Billion m³ (BCM), mostly natural gas
- Can be reduced to 8 BCM by conventional measures (insulation)

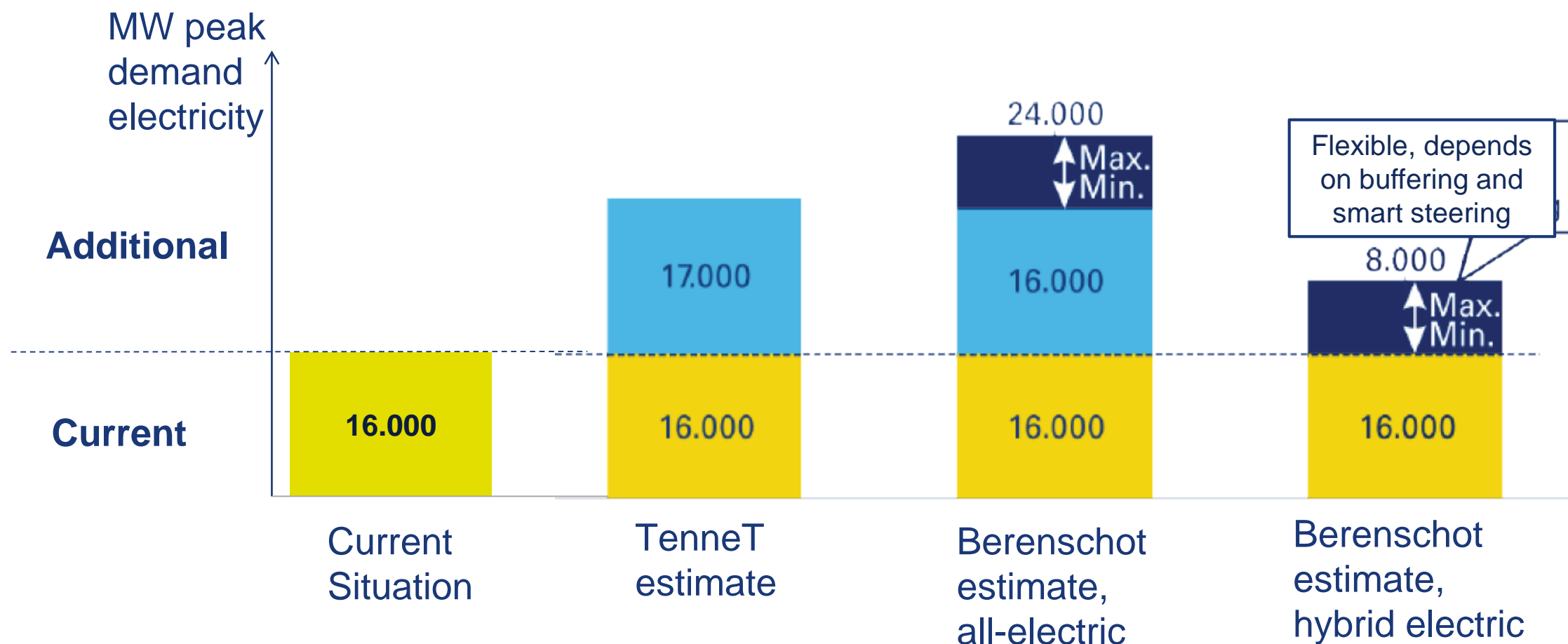


How to reduce further? Challenges:

- Extreme insulation: OK for new houses – less so for existing ones.
- By far the largest challenge is in the 6 million existing houses:
 - District heating? Only in concentrated areas with nearby heat sources
 - Green gas? Only a few BCM available, normally

Additional peak demand electricity in the Netherlands: DOUBLING

If all-electric heating 75% of houses and buildings

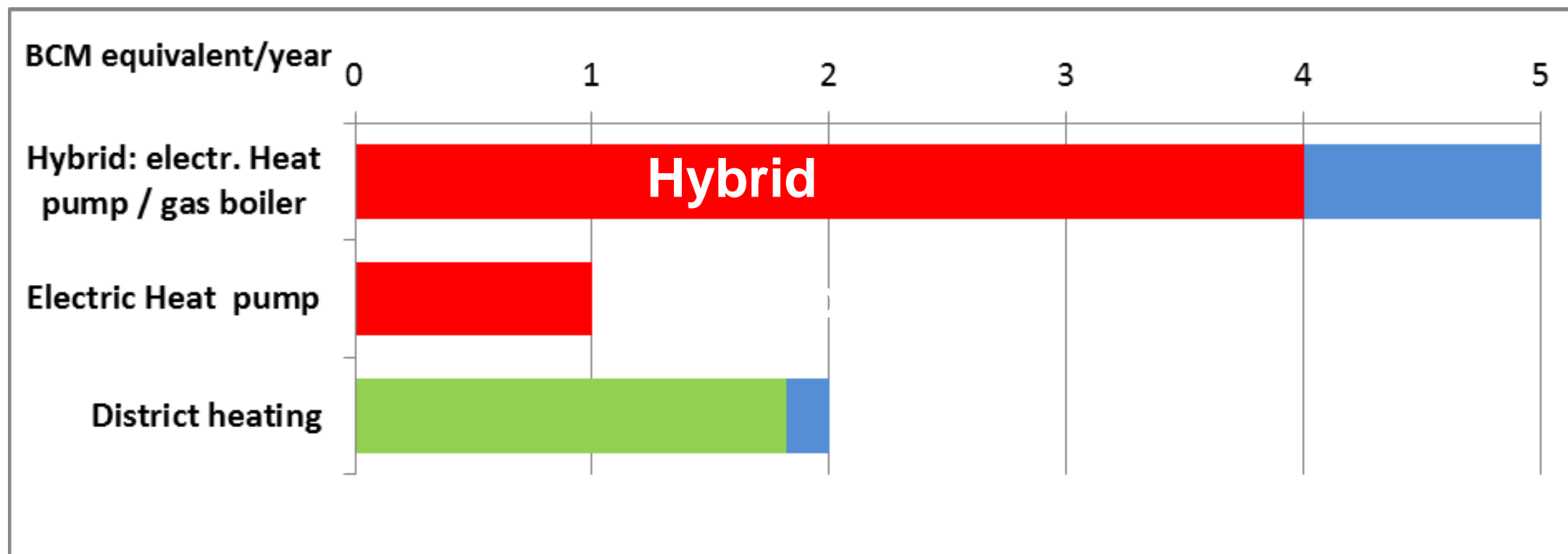


Electrification of heating 75% of houses

All-electric or Almost-electric?

Decrease the gas volume real and fast

Heating by a mix of electrical heat pump (80% volume) and gas (20%)



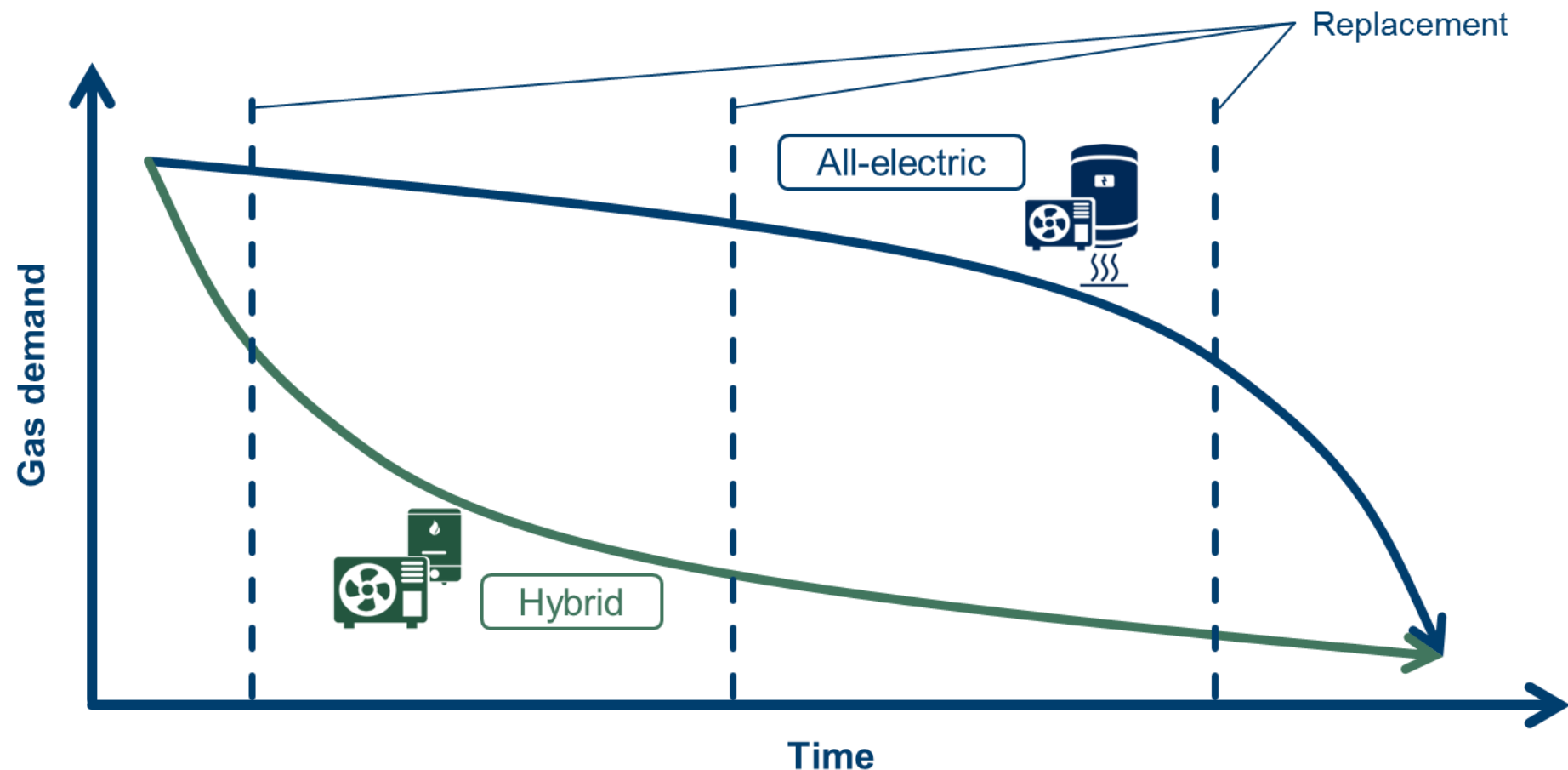
Advantages:

- Lower cost: smaller heat pump, less adaptation of heating system
- Peak demand grows moderately; steerable
- Fast implementation: in replacement cycle central heating ~ 10 years

Hybrid gives a faster energy transition

Faster reduction of CO2 emissions

- Decrease the gas demand faster → solution for the Groningen field problem
- Rapid electrification - even faster than with all-electric!

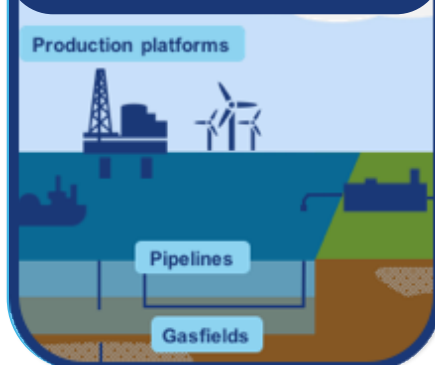


Consequences for infrastructure:

- Less need for large investments in electricity infrastructure
- Maintain the gas distribution infrastructure on the mid-term

Summary : smart transition and current gas assets

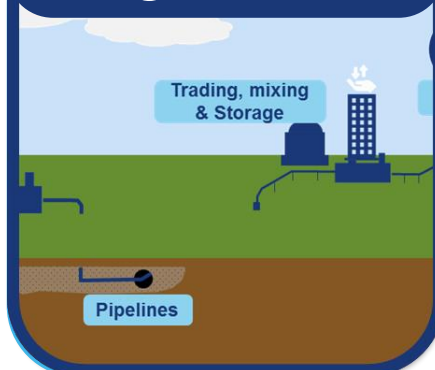
UPSTREAM



- Gas fields
- Production platforms
- Upstream pipelines

- CO2 storage
- CO2 storage + conversion?
- CO2 and/or H2 transportation (from gas-CCS or P2G)

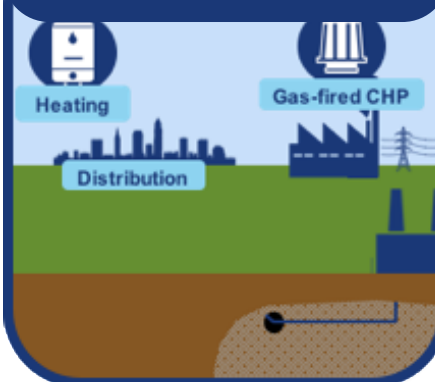
MIDSTREAM



- Midstream pipelines
- Mixing facilities
- Gas Storage

- H2 to industries / power plants (from gas-CCS or P2G)
- Mixing facilities
- H2 Storage

DOWNSTREAM



- Distribution grids
- Heating boilers at consumers
- Gas-fired CHP

- Green gas distribution
- Hybrid heating: electrical WP for base, green gas boiler for peaks
- Cogeneration fed by P2G

Ongoing project initiatives

H2 from gas with pre-combustion carbon capture

- Project in preparation
- Spin-offs to future projects

Multi-client Scenario project

- How to show the benefits of gas-facilitated transition
- Participation invited

Smart & hybrid gas appliances solutions

- Hybrid heat pumps
- Flexible electrification and cogeneration

Conclusions:

- Gas is a partner in the energy transition
- Pre-combustion gas CCS provides a much-needed transition solution, helping renewables as well
- Gas infrastructure and smart gas applications can boost the electrification and reduction of gas volume
- By doing the above, we may utilize much of the current gas infrastructure in a cost-efficient way
- We need a strong vision and innovative projects to grab the opportunities. Join the effort!

