Effect of H_2 on chemical industry applications – a first screening

Dr. Alexander Kronimus, HIPS-NET-workshop, June 26 2014, Brussels

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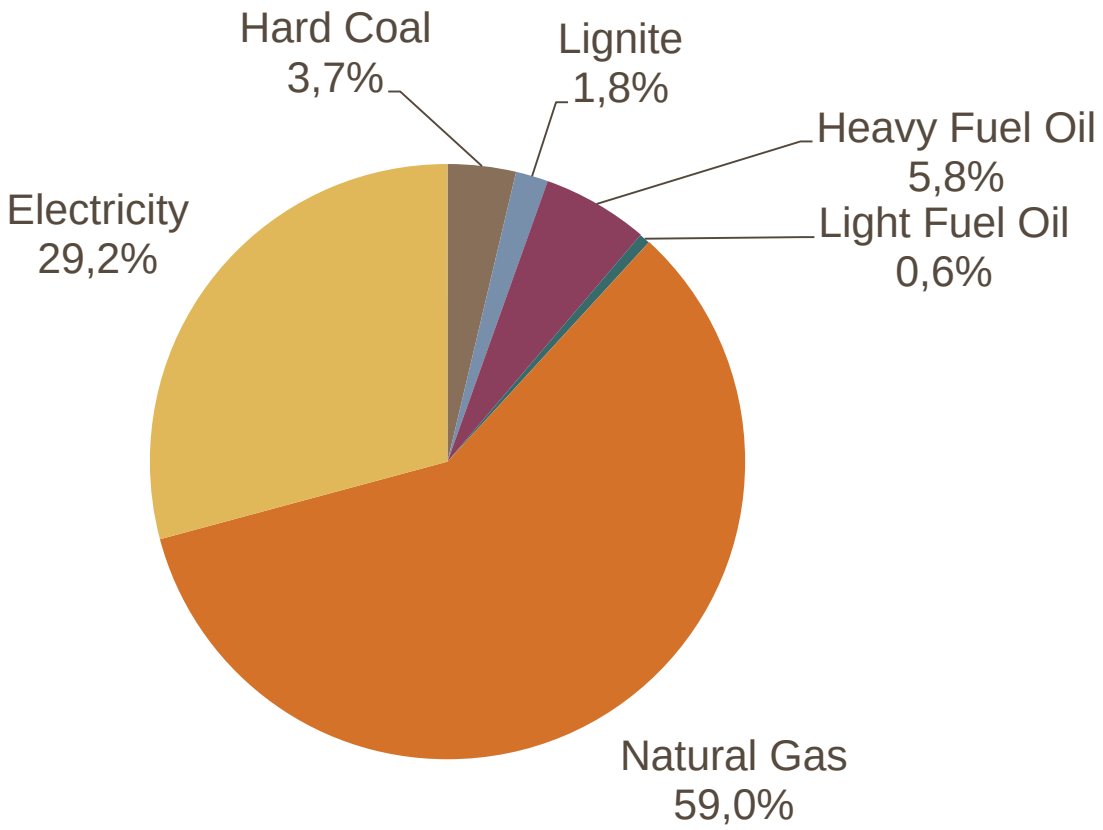
Natural gas is most important energy carrier for the chemical Industry

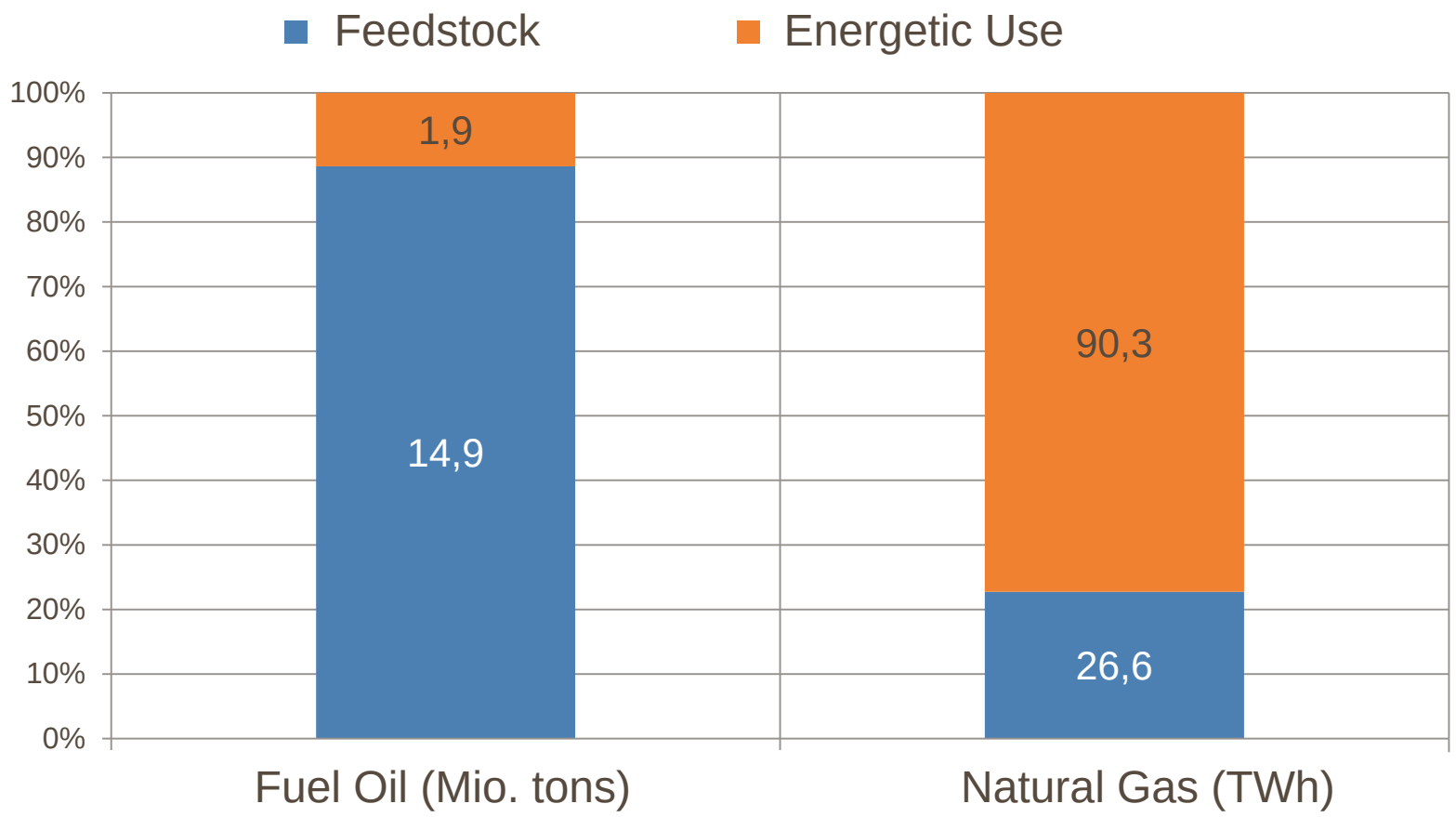
Final energy consumption by selected energy carriers, 2012



Source: Destatis, VCI

Chemical industry utilises hydrocarbon fuels for feedstock

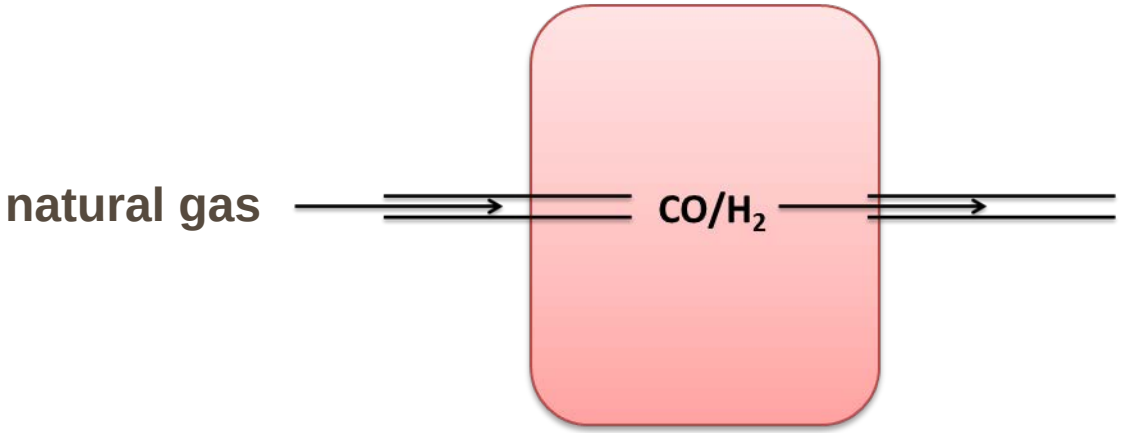
Utilisation of fuel oil and natural gas in the chemical industry, 2012



Source: FEK, VCI, Destatis

Natural Gas Reforming

- Potential problems due to hydrogen contents of natural gas:
  - e.g. gas infrastructure, gas turbines, storages
  - **and utilisation as feedstock**



- Two major procedures
  - SMR: $CH_4 + \mathbf{H_2O} \rightarrow CO + 3\,H_2$
  - POX: $2\,CH_4 + \mathbf{O_2} \rightarrow 2\,CO + 4\,H_2$

Impacts of hydrogen on gas reforming

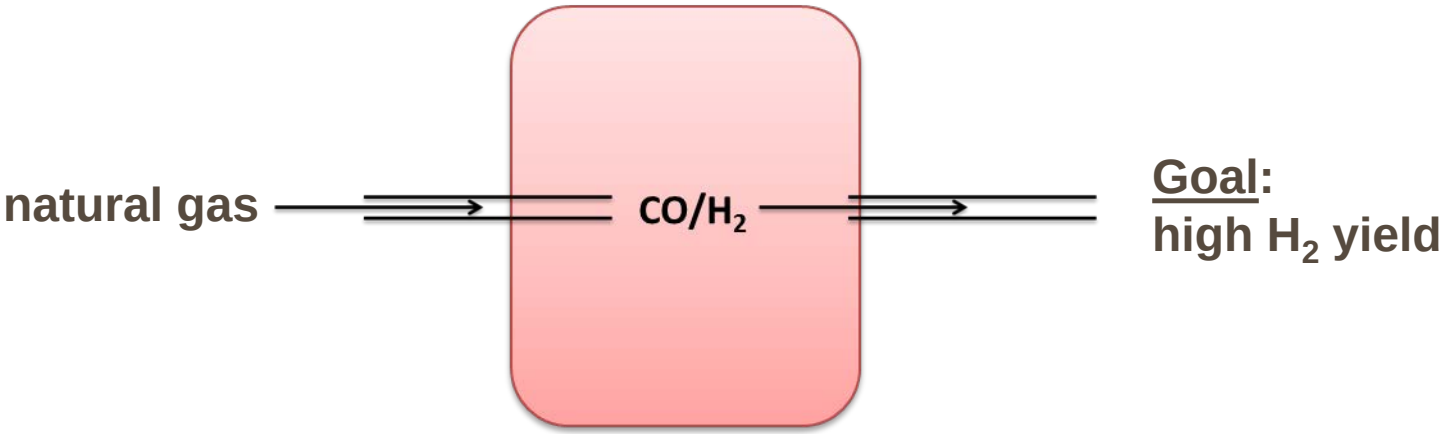
- Impacts of hydrogen on gas reforming:

  3 cases

  1. No significant impact
  2. Economic impacts, i.e. loss of productivity
  3. Technical impacts

Impacts of hydrogen on gas reforming processes
No significant impact (case 1)

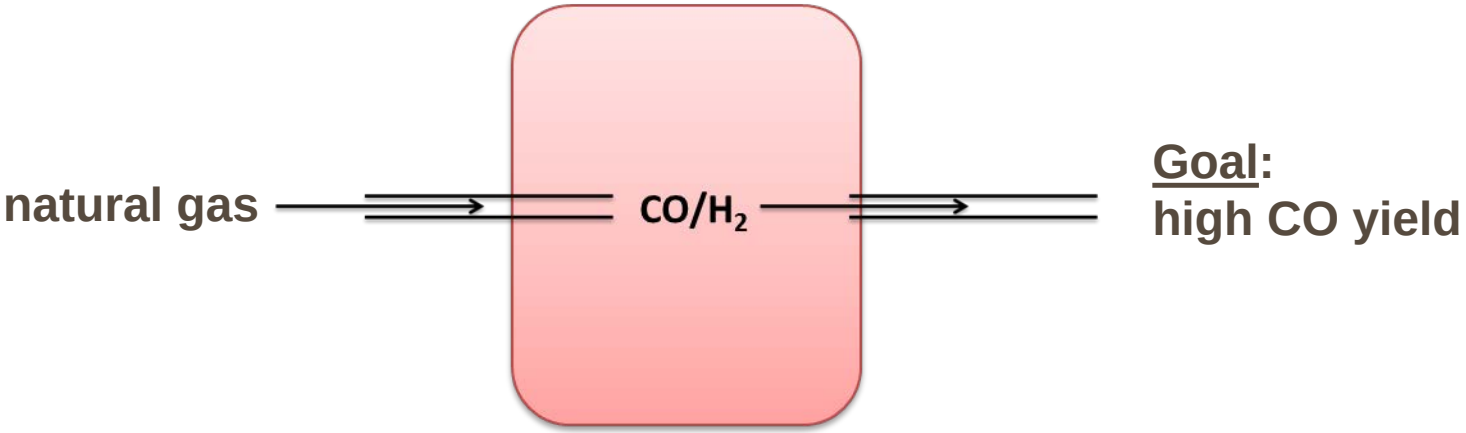
- Example: Hydrogen production
- SMR: $CH_4 + H_2O \rightarrow CO + 3\,H_2$
- $CH_4 : H_2 \triangleq 1 : 3$



- Hydrogen contents may even enhance hydrogen output

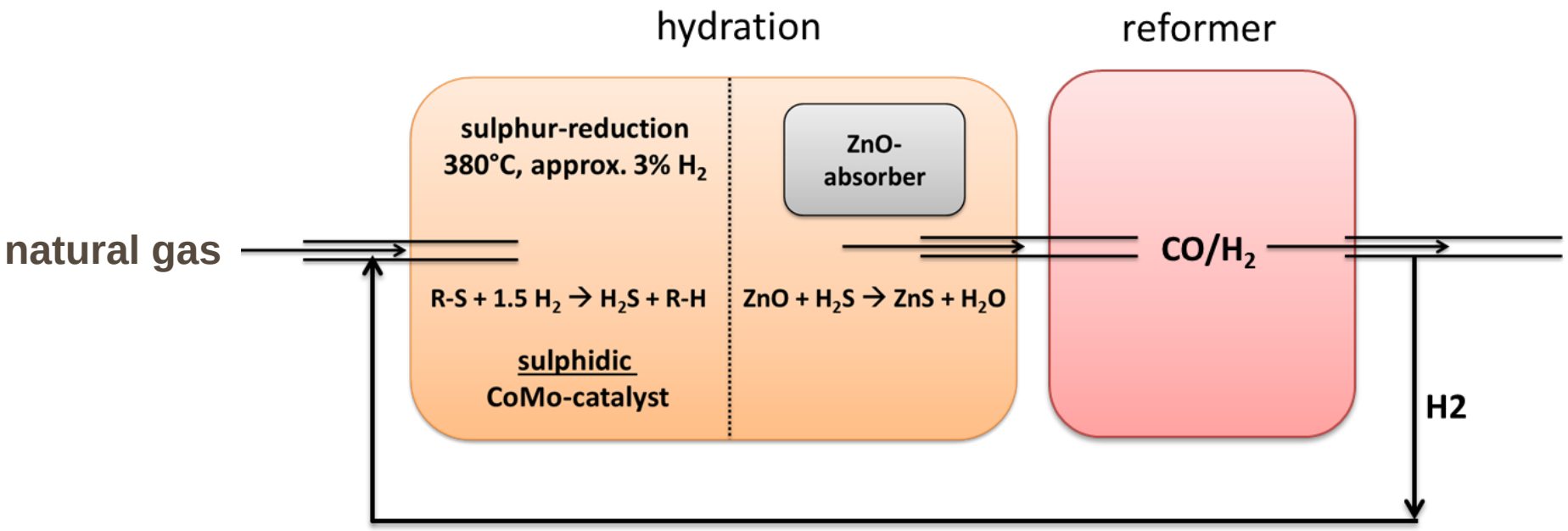
Impacts of hydrogen on gas reforming processes
Loss in productivity (case 2)

- Example: CO-Produktion
- POX: $2\ CH_4 + O_2 \rightarrow 2\ CO + 4\ H_2$
- $CH_4 : H_2 \triangleq 1 : 2$
- Target component CO



- Hydrogen in input stream dilutes target component (CO)
- Hydrogen requires procedural capacity

Impacts of hydrogen on desulphurisation
Technical impacts (case 3)



- Two conceivable problems:
  - Hydrogen content in input stream exceeds operational concentration
  - Variations too high/quick to adapt procedure
- Possible consequences: deactivation of catalysts, interruptions, damage of facilities

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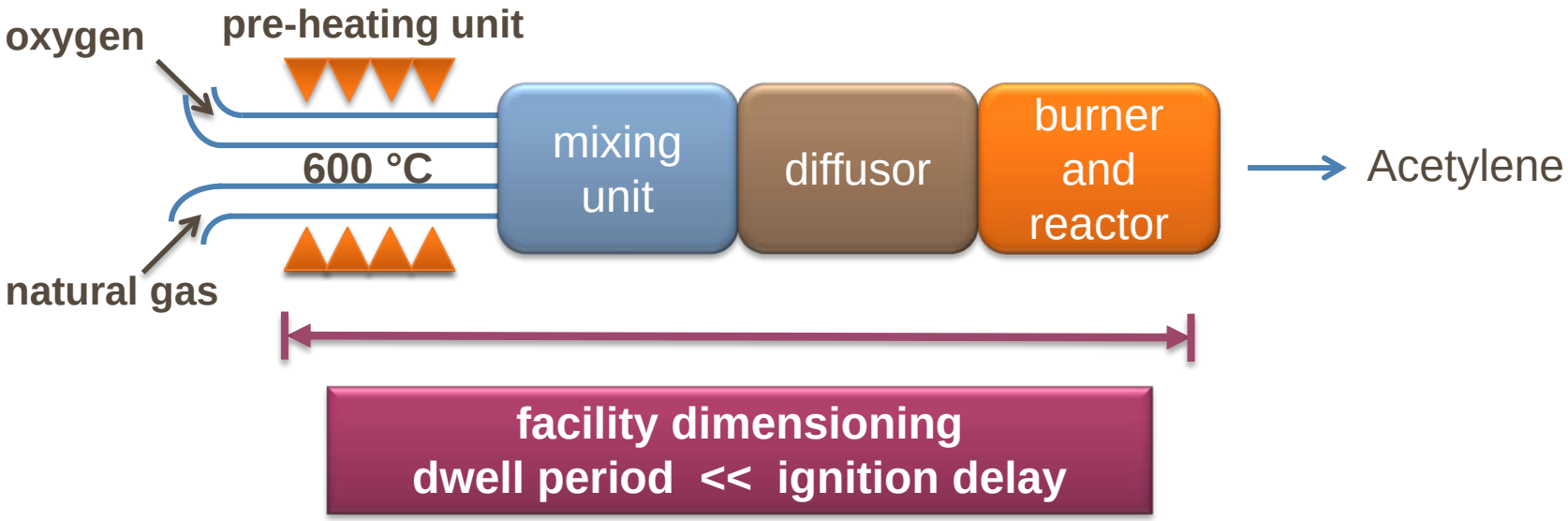
Impacts of hydrogen on acetylene production
Technical impacts (case 3)

$$2\ CH_4 \xrightarrow{1500\ °C} C_2H_2 + 3\ H_2$$



- Hydrogen supports pre-ignition
- Consequences: security shut-down or even damage
- Deterioration of materials
- **Hydrogen content <1 vol.-%:** Probability of pre-ignition not enhanced

VCI-position

- Before the evaluation of impacts of hydrogen is finalised
  - from a technical point of view
  - and from an economical point of view
  - ➔ VCI requests to limit the hydrogen concentration of 1 vol.-%
- Second step: Consultation of an economically optimised limitation
- Protection of sensitive applications by specific actions in grid operations – if possible

Chemical industry as part of the solution

- Chemical industry can be part of the solution
- Power-to-Gas: Consider use of RES generated hydrogen as feedstock
- Chemical industry can absorb excess energy in products
- Besides water electrolysis, chemical industry operates additional processes for use of electricity as feedstock
  - Chlorine-alkaline electrolysis
  - Electric arc synthesis

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Outlook

- Drafting a research proposal
- Procedural
  - Process simulations
  - Impact on desulphurisation catalysts
- Material science
  - Decarbonisation of steel under p/T-conditions typical for reforming
- Theoretical/experimental investigations

Thank you very much for your attention!