# Fuel Specification for fuel cells

EU workshop on Regulations, codes and standards for $H_2$/FC technologies

February 25, 2005

Paul van den Oosterkamp

Frank de Bruijn

ECN-Fuel Cell Technology

# Outline

- Fuel Cell Applications and Fuels
- Fuel diversity and Fuel Cells
- Production of Fuels for Fuel Cells
    - Centralised
    - Decentralised
- Impurities for PEMFC
- Impurities in Fuel Processing
- Conclusions

# Fuel Cell Applications and Fuels

Hydrogen
Methanol

Portable Power (1-200 W)

Natural Gas
Propane

Micro CHP
(1-5 kW)

Natural Gas

Stationary Power (< 250 kW)

Marine oil

Ships APU and propulsion
(10-10000 kW)

Hydrogen
Gasoline

Transport (50-200 kW)

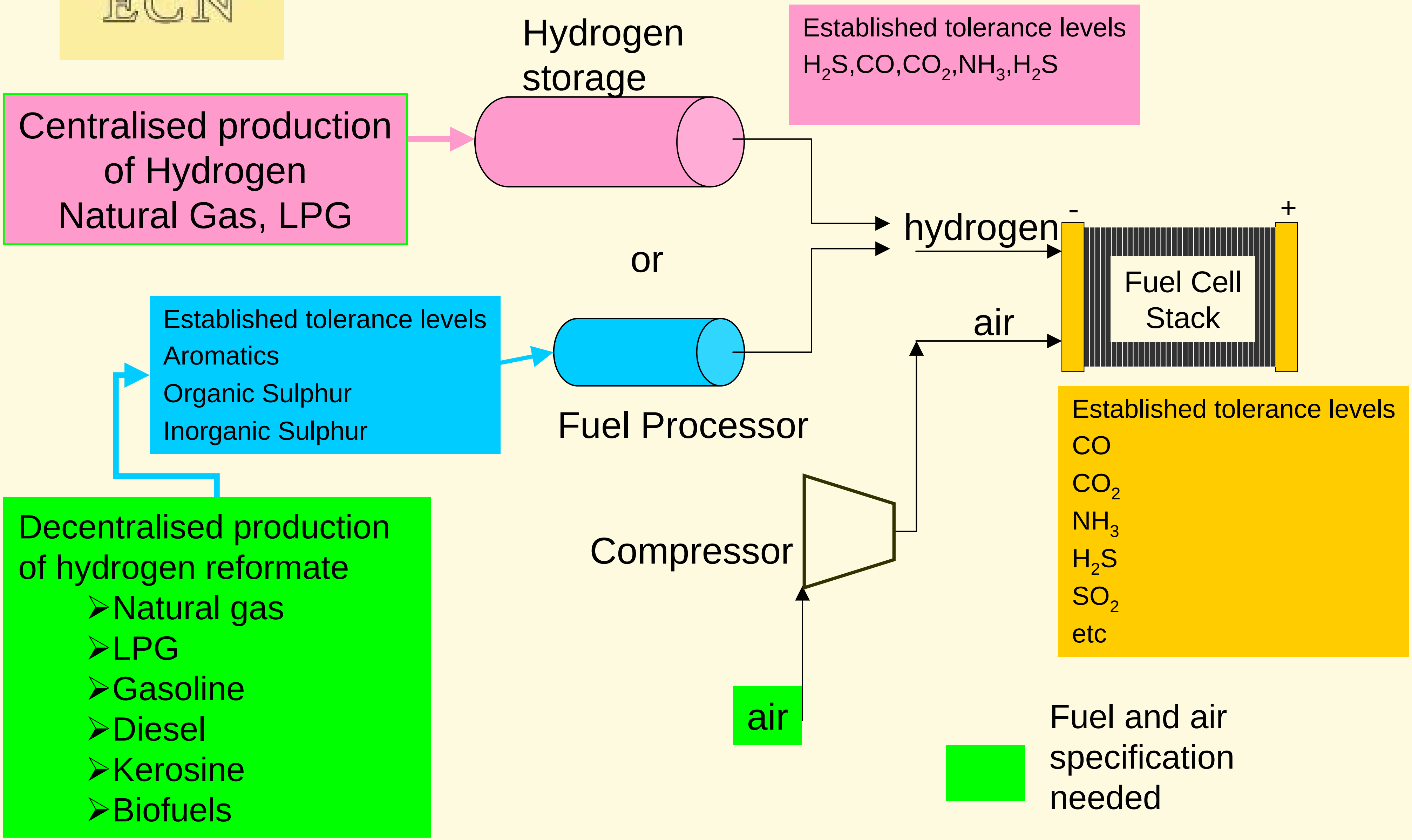
Hydrogen
Gasoline

City Transport (2-5 kW)

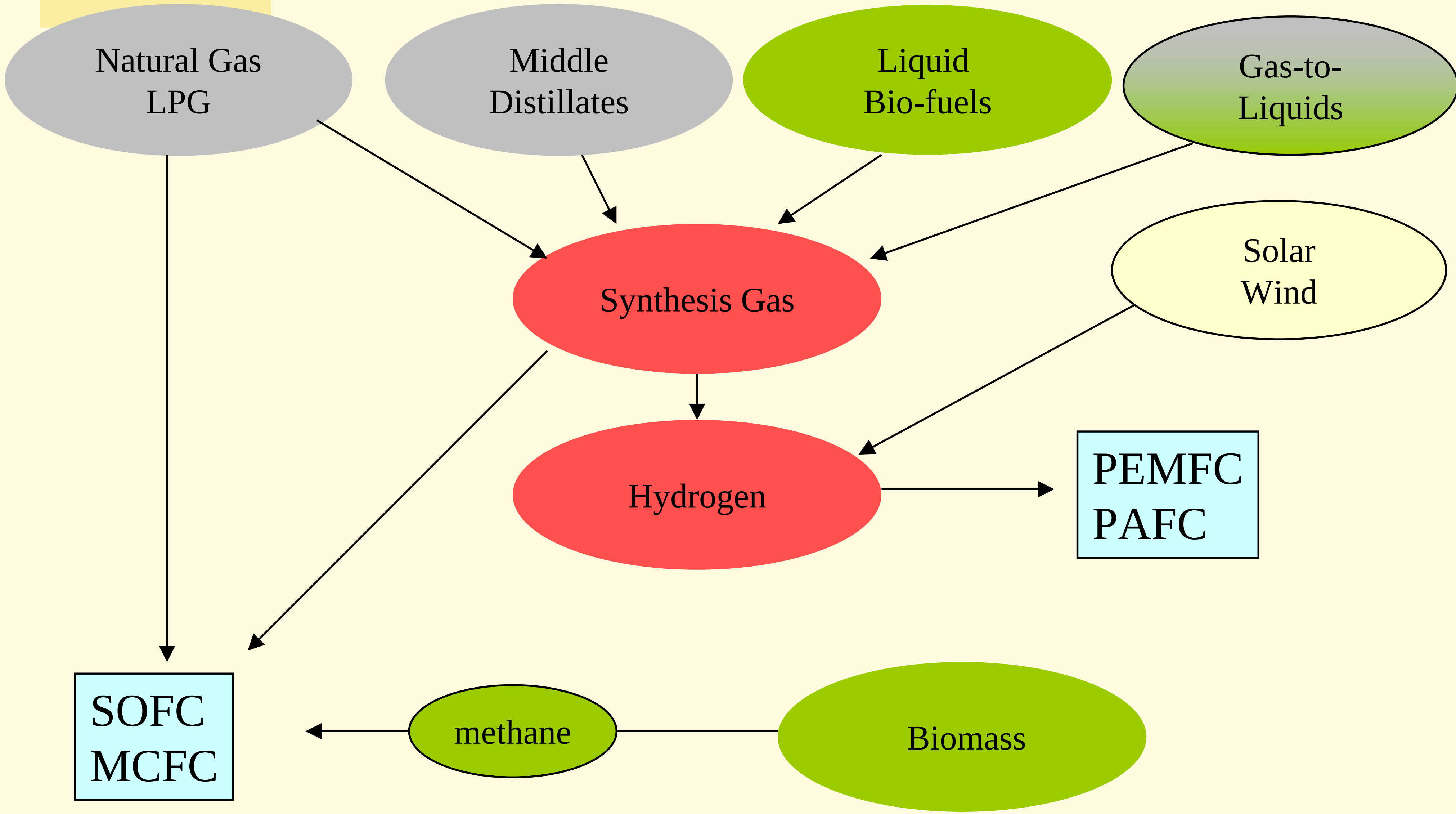
Kerosine

Airplane APU (100-500 kW)

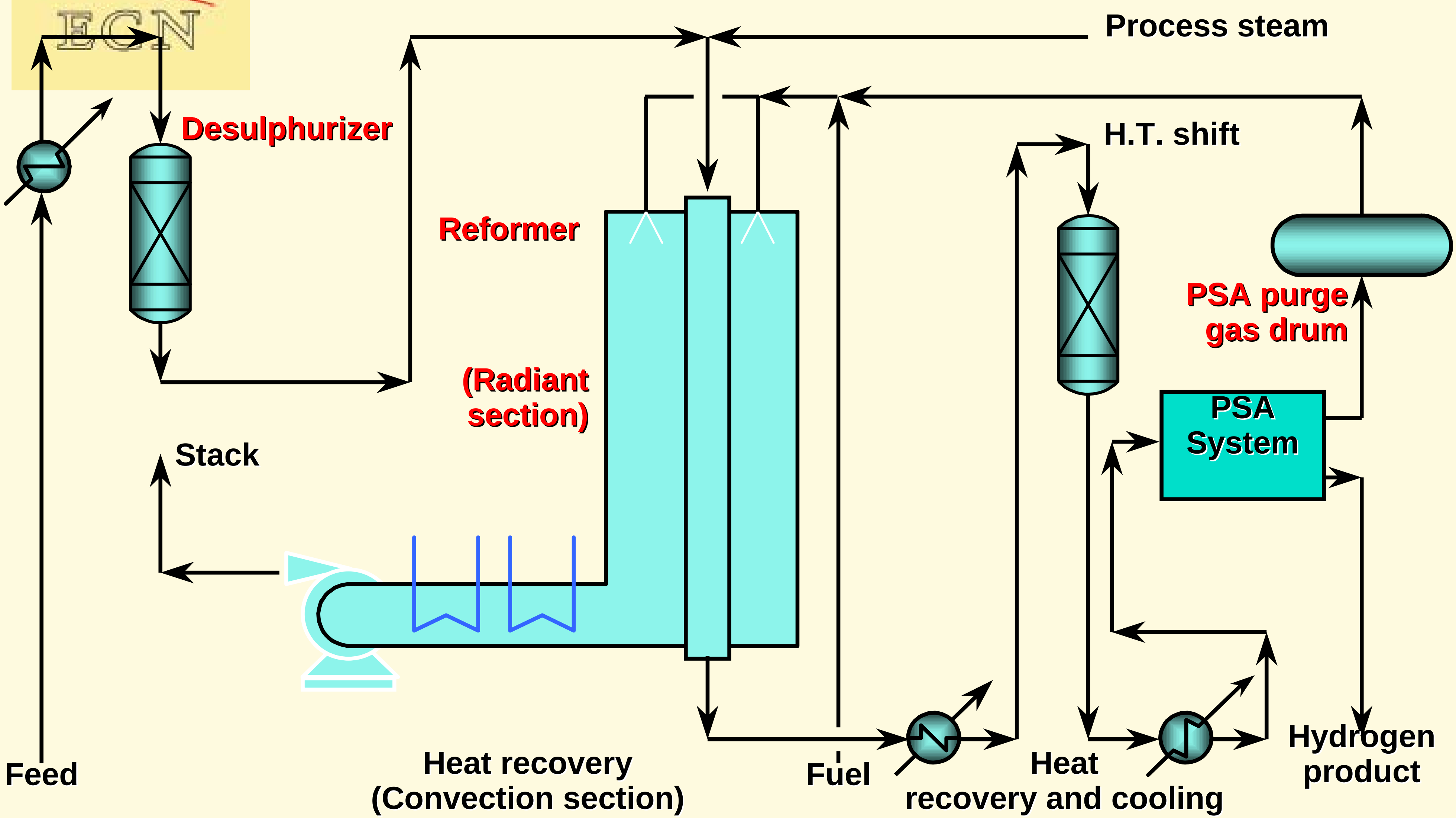
# Fuel specifications and reformate/hydrogen production



# Fuel diversity and fuel cells

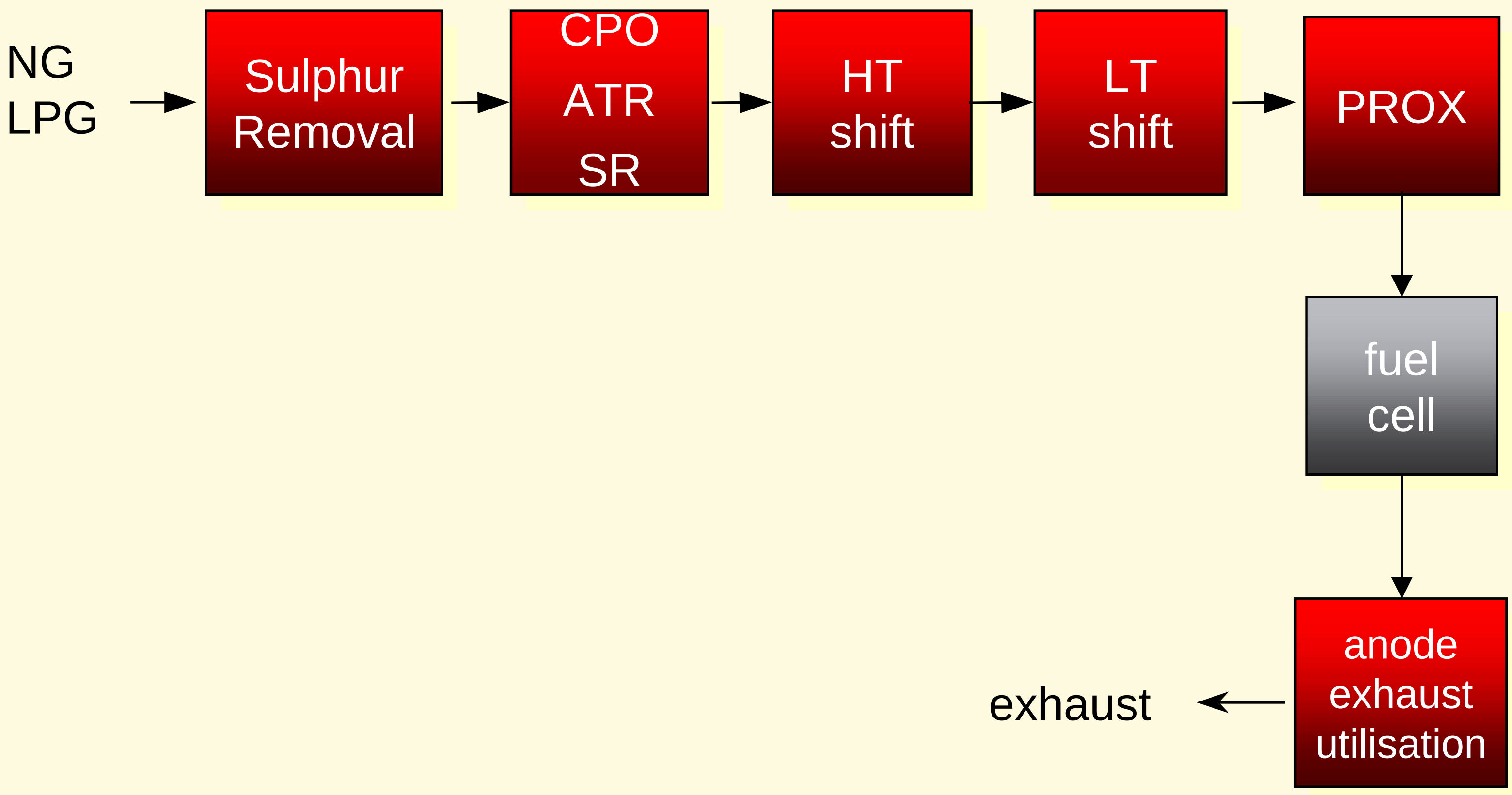


# Centralised Hydrogen production




99,999 % $H_2$

# Decentralised Hydrogen production

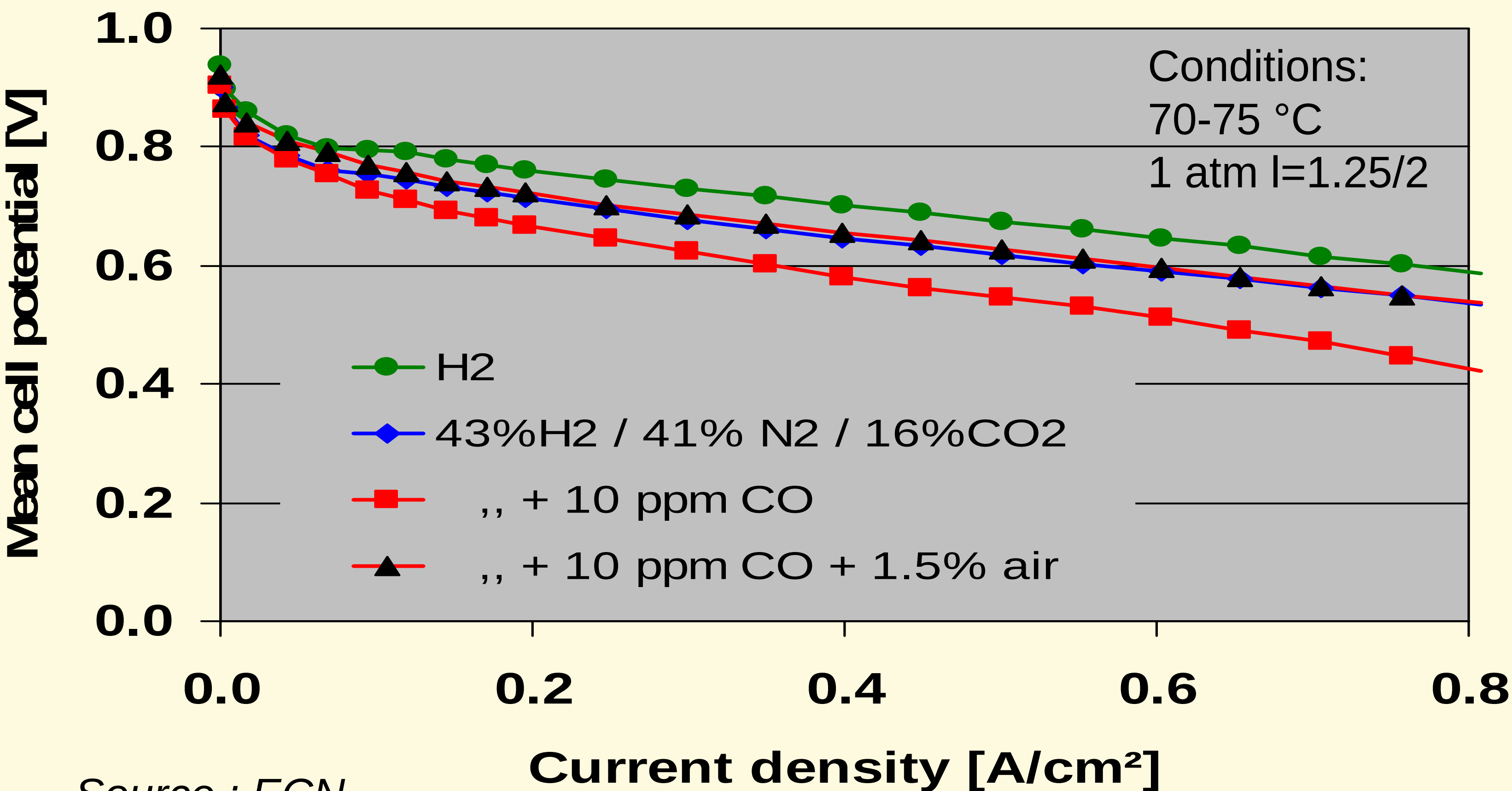



Combined Heat & Power (1-5 kW)

# Influence of impurities

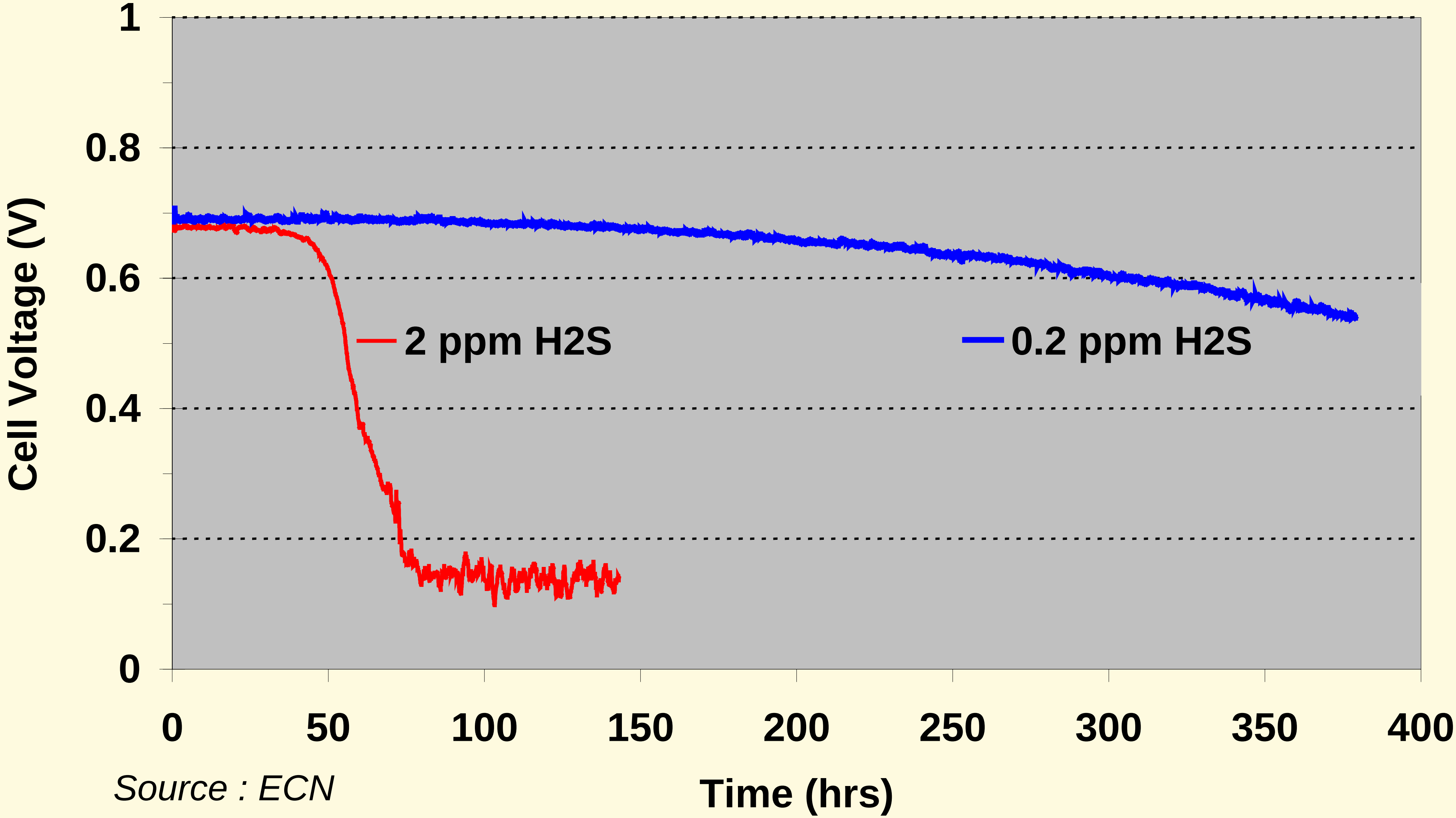
- PEMFC
- Reformer
  - Primary reformer (SR/ATR/CPO)
  - Shift (HT & LT)
  - Pref.Oxidation (Prox)

# Influence of CO in reformate PEMFC




*Source : ECN*

# Influence of $H_2S$ in hydrogen for PEMFC

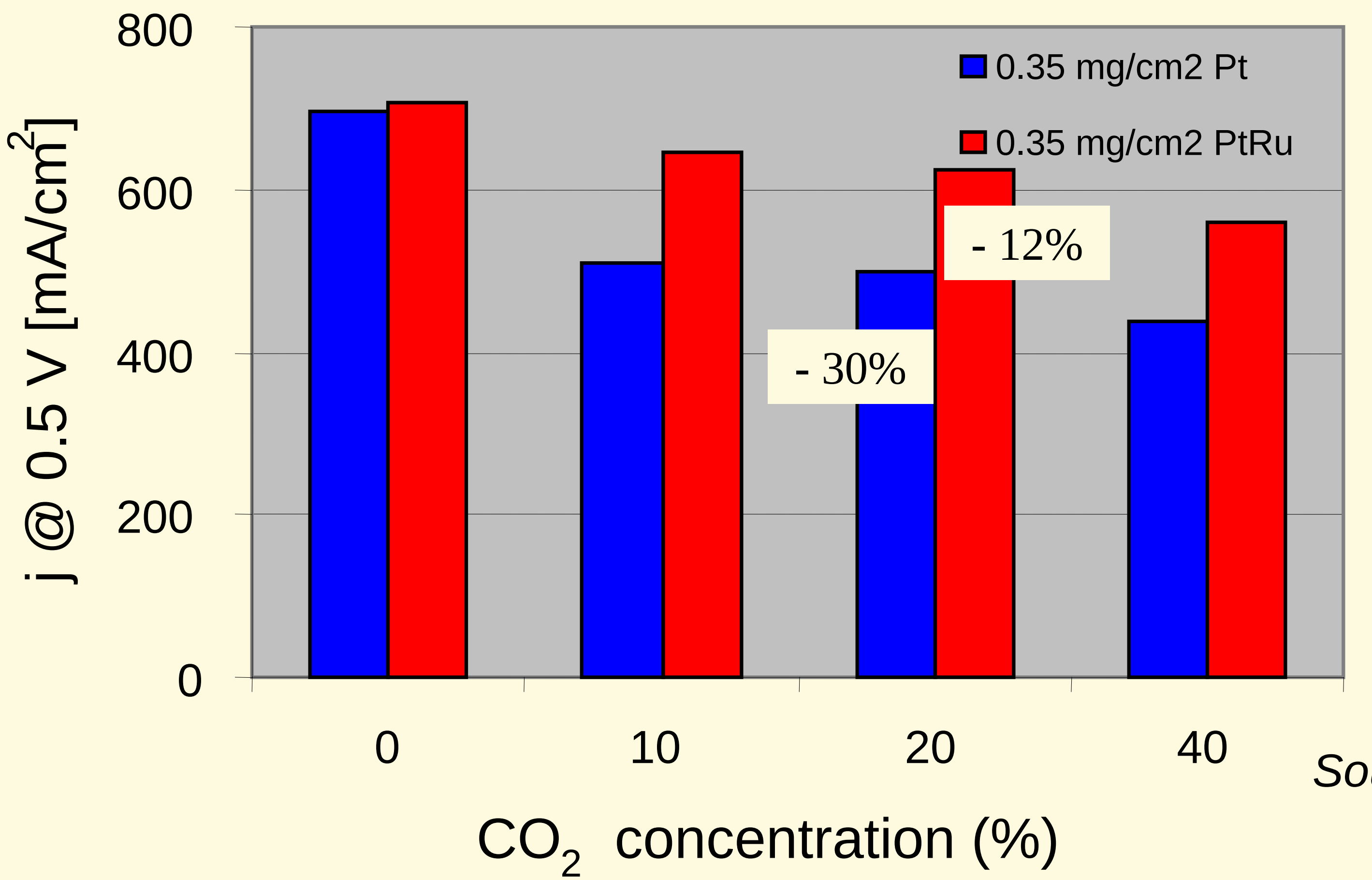



*Source : ECN*

# Influence of $CO_2$ in reformate PEMFC

Reverse watergas shift

$$CO_2 + H_2 \leftrightarrow CO_{g,ads} + H_2O$$

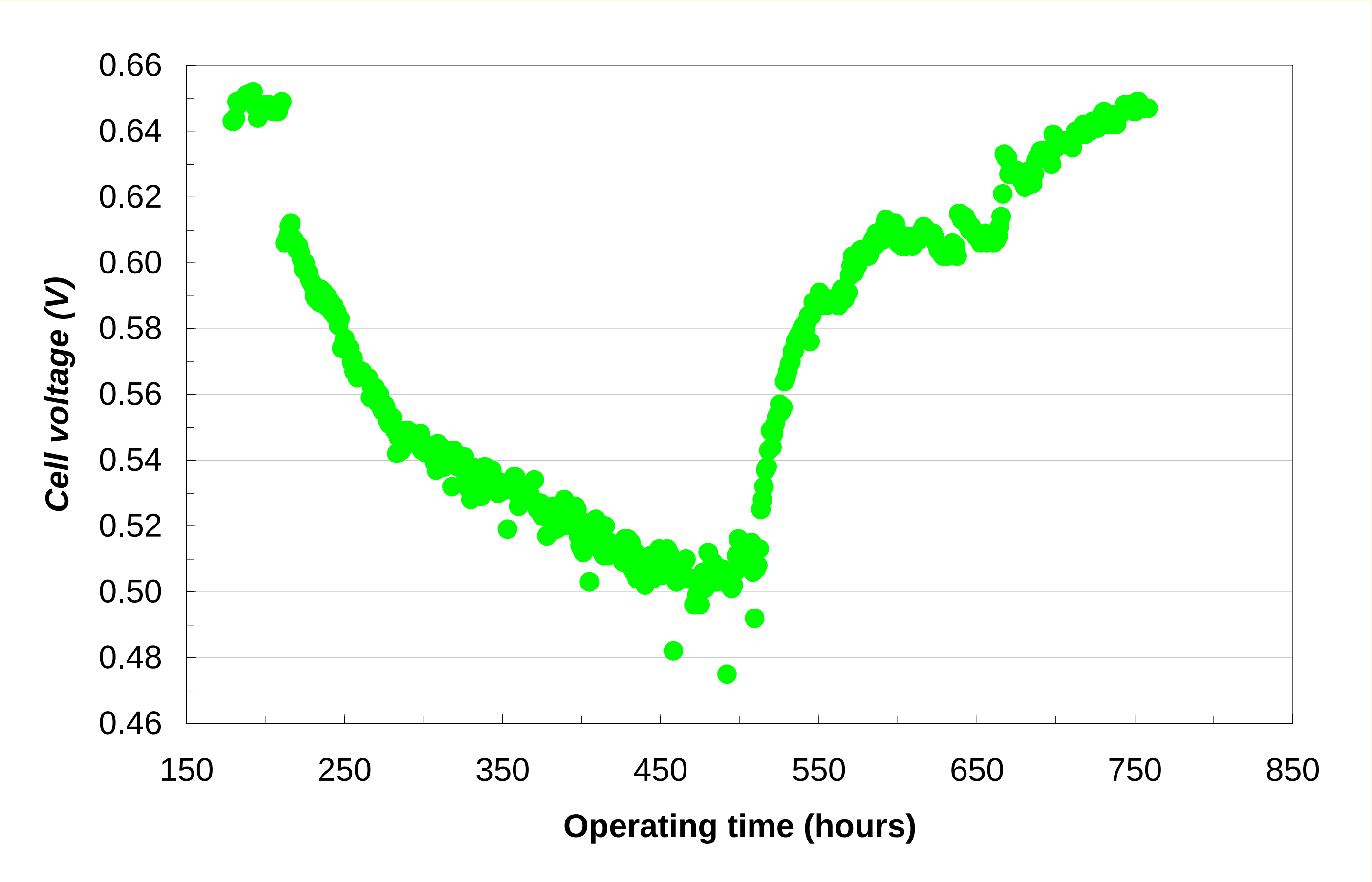



20% $CO_2$ is equivalent to 10 ppm CO

Reverse WGS is hindered on PtRu

*Source : ECN*

# Influence of $NH_3$ concentration in reformate PEMFC

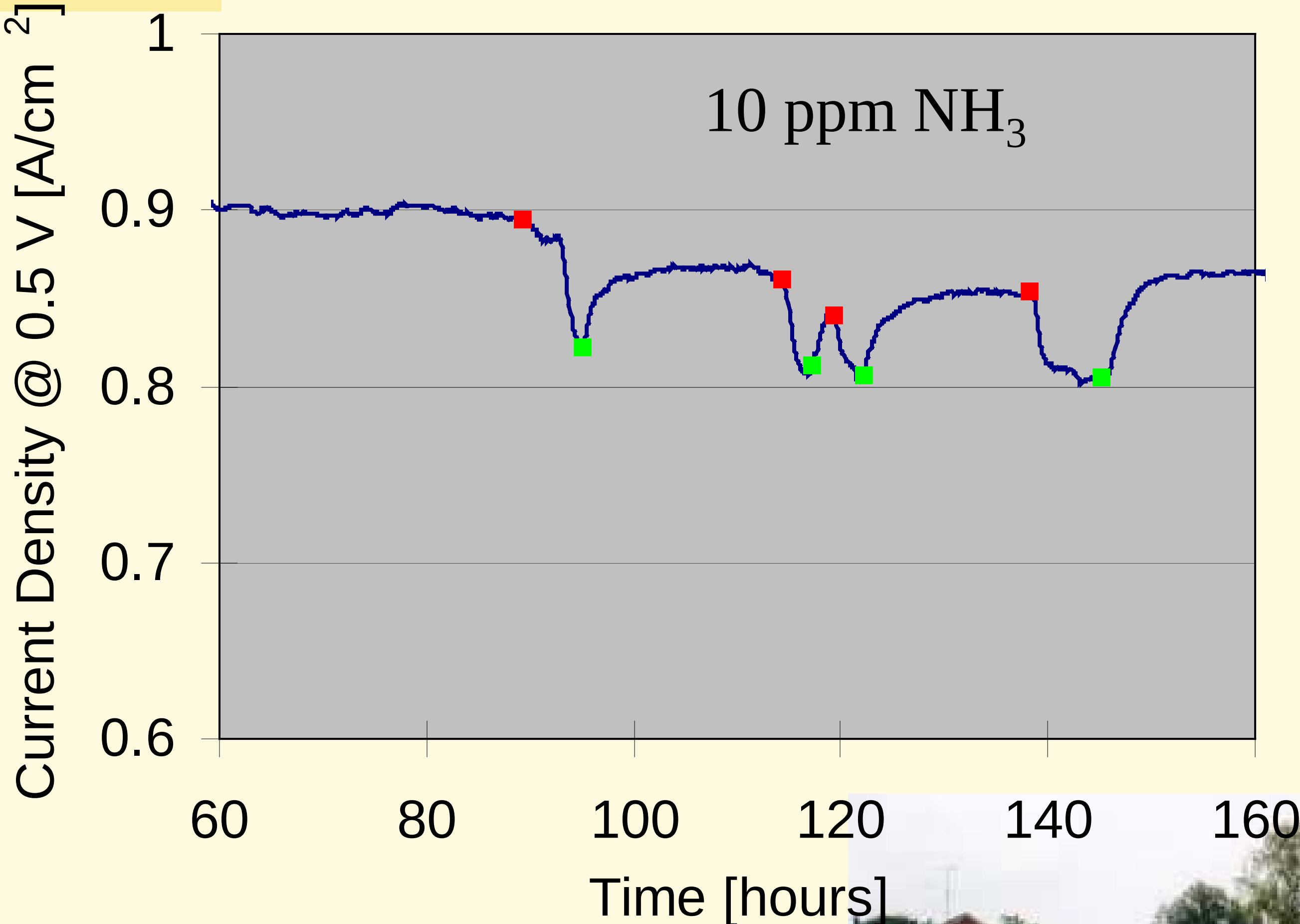



Reversible degradation

*Stationary performance of a cell fed with a mixture of 75% $H_2$ / 25% $N_2$ and 5 ppm $NH_3$ in the interval from 210 hours to 475 hours. Current density is 500 mA/cm$^2$.*

*Source : ECN*

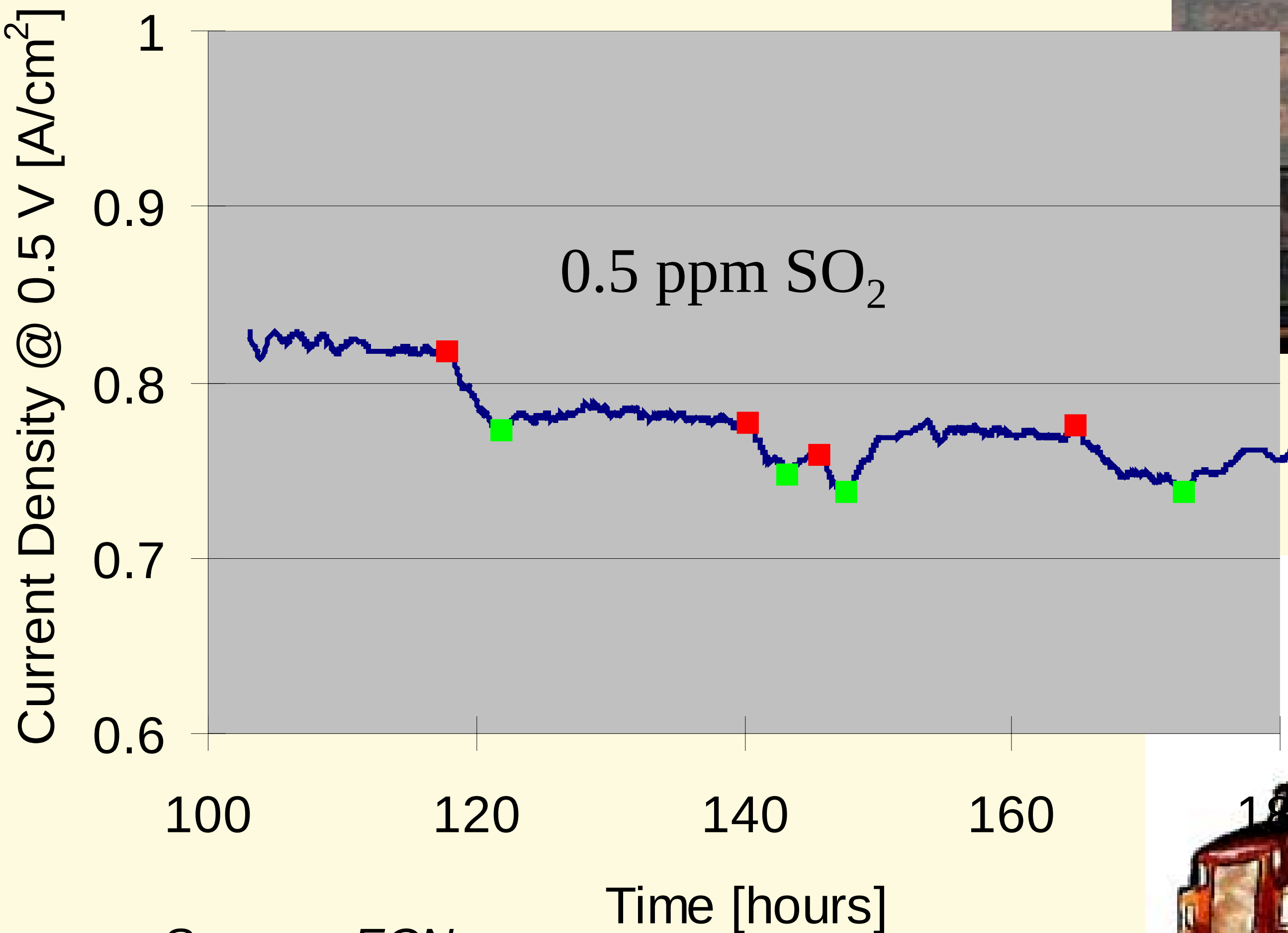
# Influence of $NH_3$ in cathode air PEMFC




Anode = cathode = 0.4 mg.cm$^{-2}$ Pt

*Source : ECN*

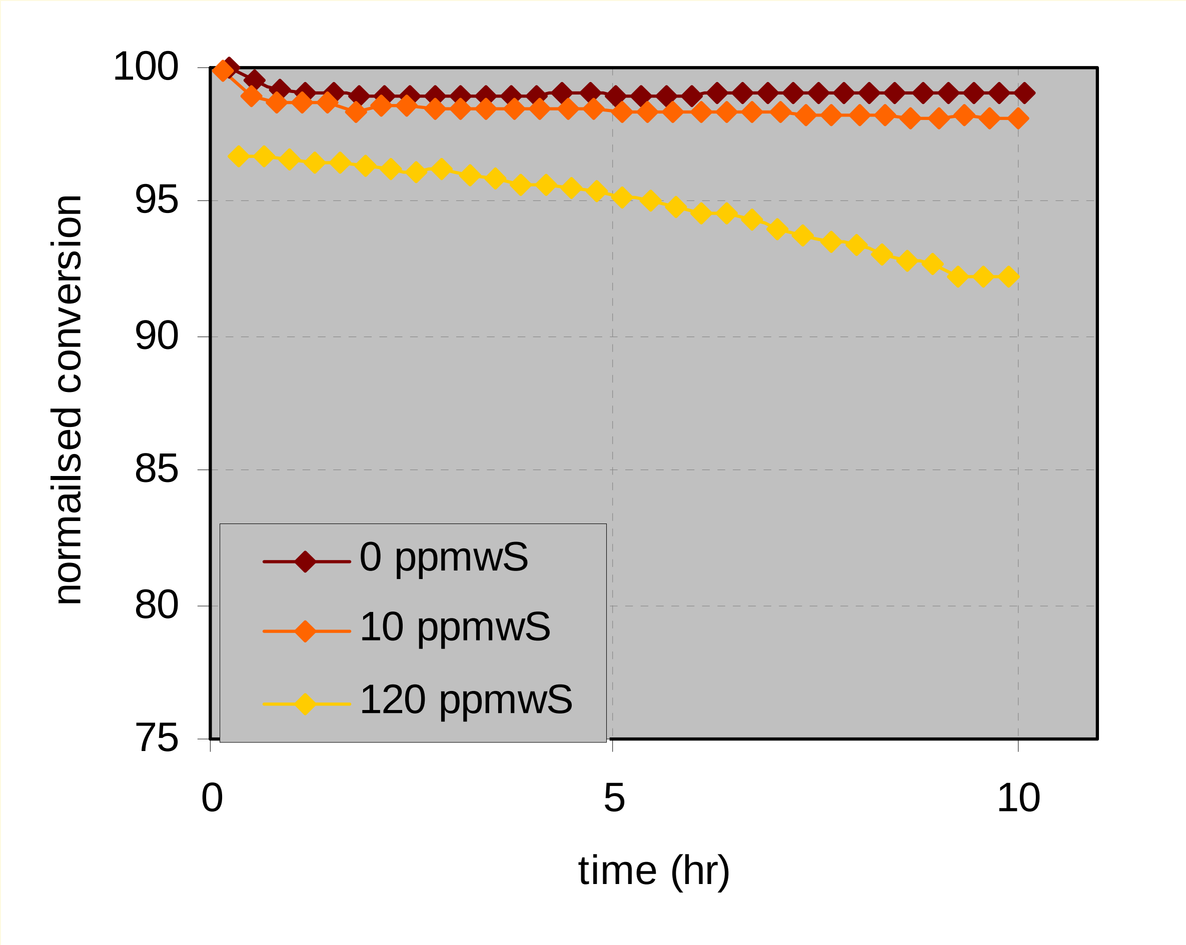
# Influence of $SO_2$ in cathode air PEMFC





*Source : ECN*

# Example Sulphur influence on CPO reforming (typical conditions)




Same trend is visible for Shift

*Source : ECN*

# Impact on lack of fuel specifications for fuel cells ; example : Sulphur

- DESIRE (WEU project).

  Initial fuel specification: NATO-F76 (0.2 wt.% S)

  R&D spent on sulphur removal: app. 200 kEuro

  By lack of succes in S removal from F-76, City diesel (10 ppm S) is now used.

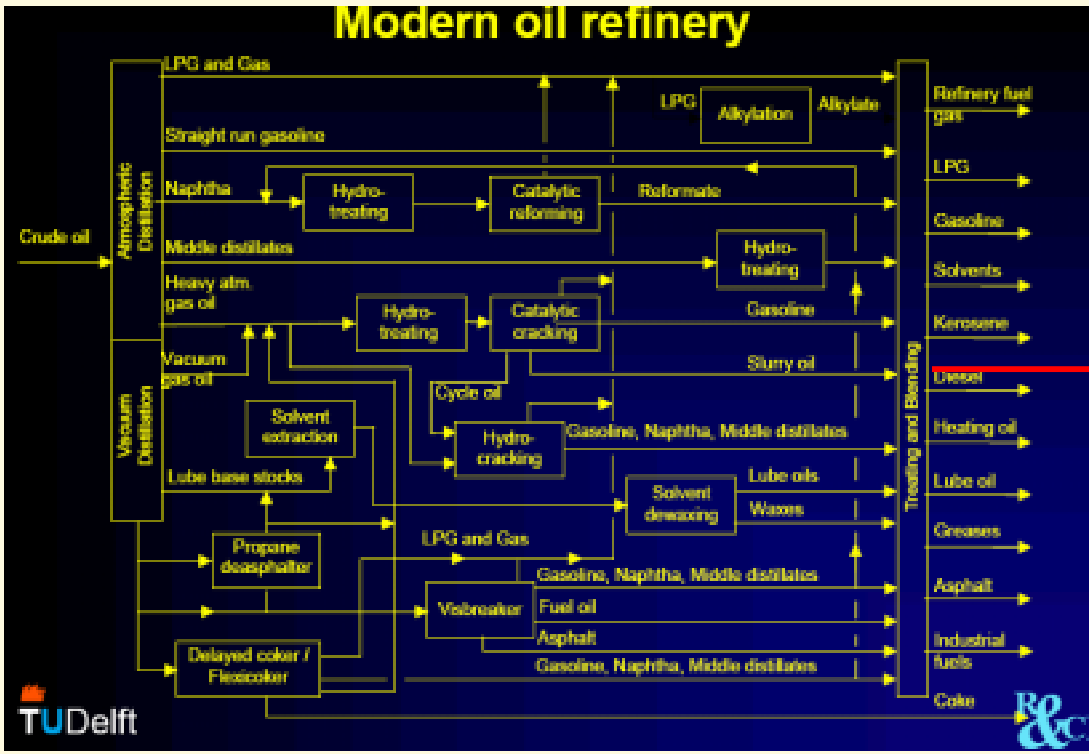
- Celina (EU project)

  Fuel specification:3000 ppm (kerosene)

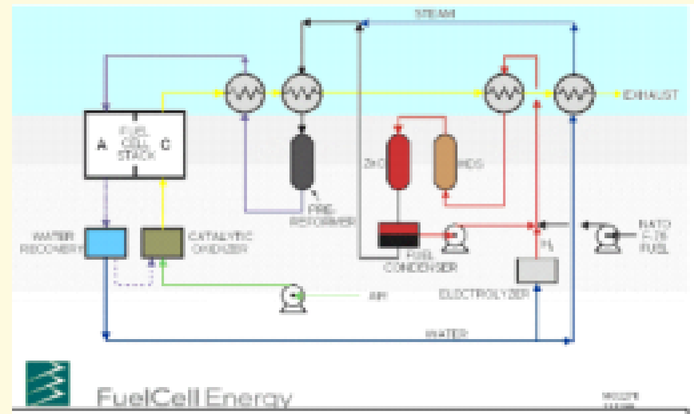
  R&D to be spent on fuel characterisation and sulphur removal: app. 250 kEuro.

# Impact on lack of fuel specifications for fuel cells (2) : example : Sulphur

Optimisation of centralised production of low sulphur fuels in refinery vs.decentralised S-removal (which needs a lot of R&D)




Fuels for fuel cell systems




Source : Fuel Cell Energy

Source : TU-Delft

# Fuel specifications/conclusions

• Should **not** only focus on hydrogen

• Should **not** only focus on fuel cell, also on reformer components

• Quick decisions on future fuel specifications can save a lot of R&D efforts and money. Especially for liquid fuels with S presence.

• Specifications need to be a compromise between impact on cost for fuel cell,costs for hydrogen production and costs for infrastructure.

• It makes no sense to have a fuel quality for the fuel cell which is much higher than the air quality.