

The PCM and Düsol projects

GTT-Technologies contributions to the
„Energiewende“

GTT Users' Meeting, TPH Herzogenrath, 30. June 2017

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Evaluation of low melting salt systems for use as Phase Change Materials:
thermodynamic modelling and experimental methods

PCM-Screening

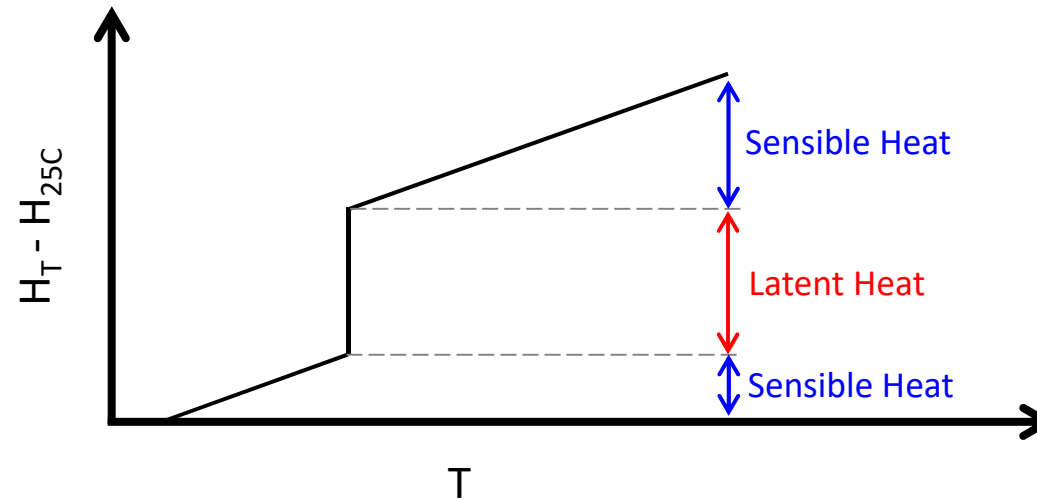


Thermal Energy Storage

Demand, supply, efficiency...



Heat Storage Media



- **Sensible Heat**
 - High heat capacity
 - High ΔT
- **Latent Heat**
 - High enthalpy increment
 - Low ΔT
 - Phase transition



Latent Heat Storage (PCM)

- Application specific



Low temperature range

- Air conditioning and cooling (4-25°C)
- Low temp. heat pumps (30-50°C)
- Small cogeneration units (70-90°C)



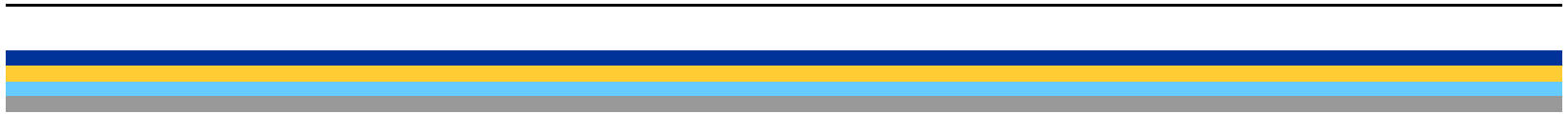
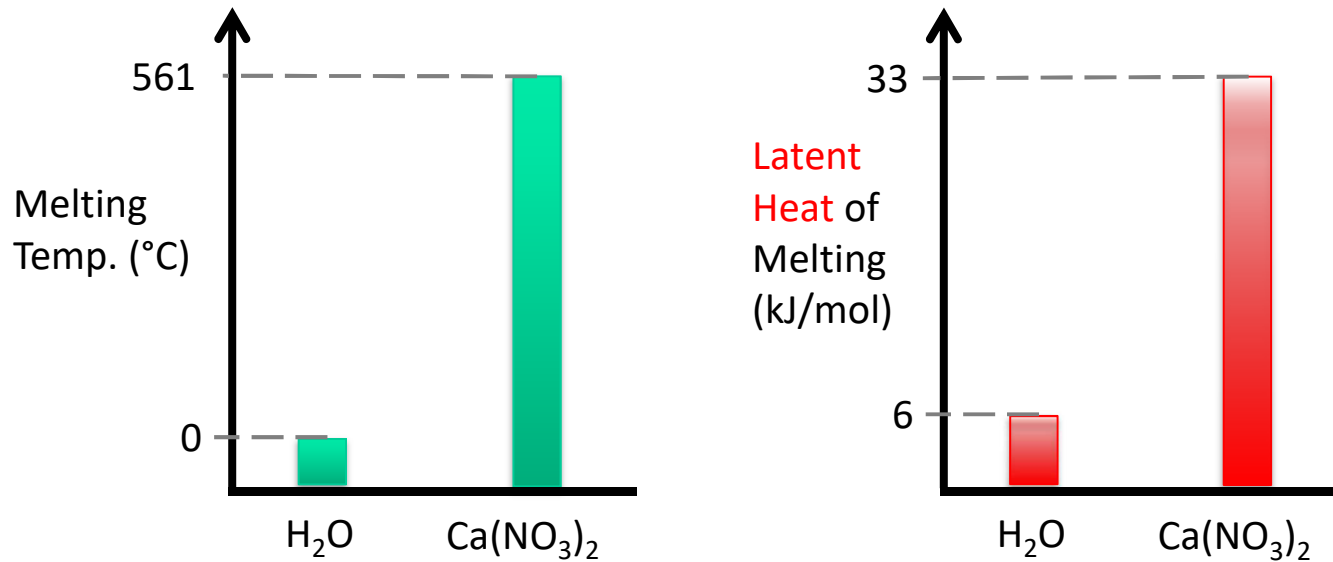
High temperature range (100-500°C)

- Industrial heat recovery
- Conventional power plants
- Solar power plants



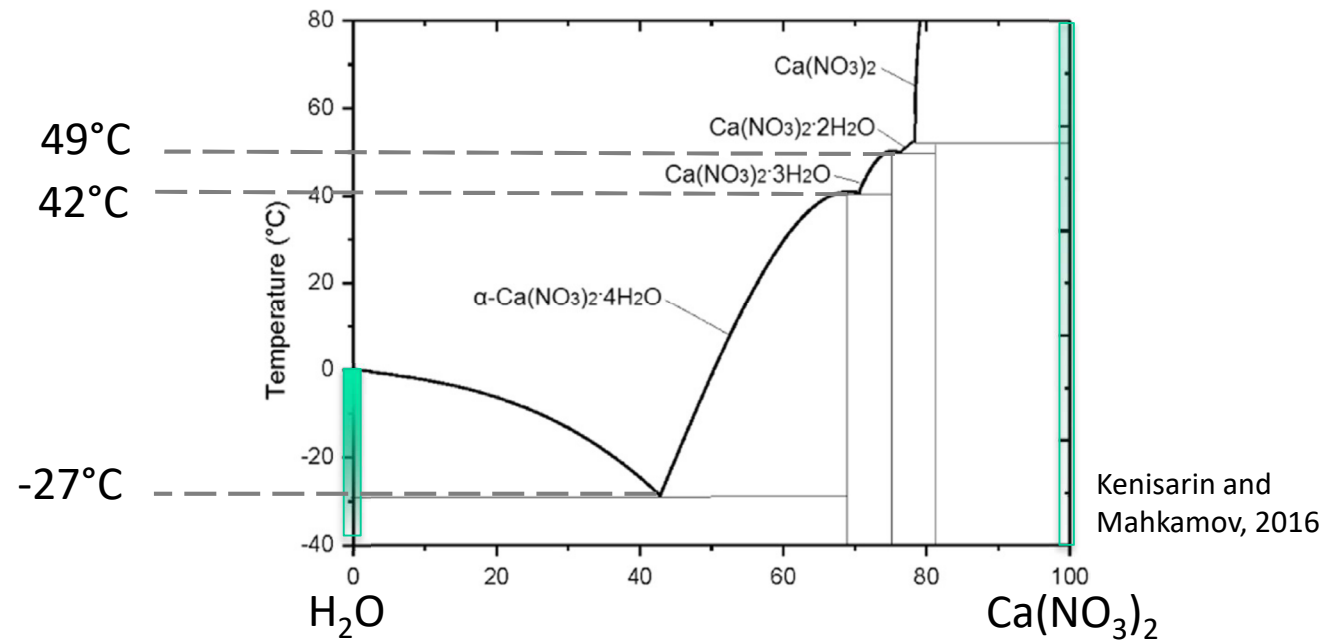
Latent Heat Storage (PCM)

- Pure Substances
 - Limited availability

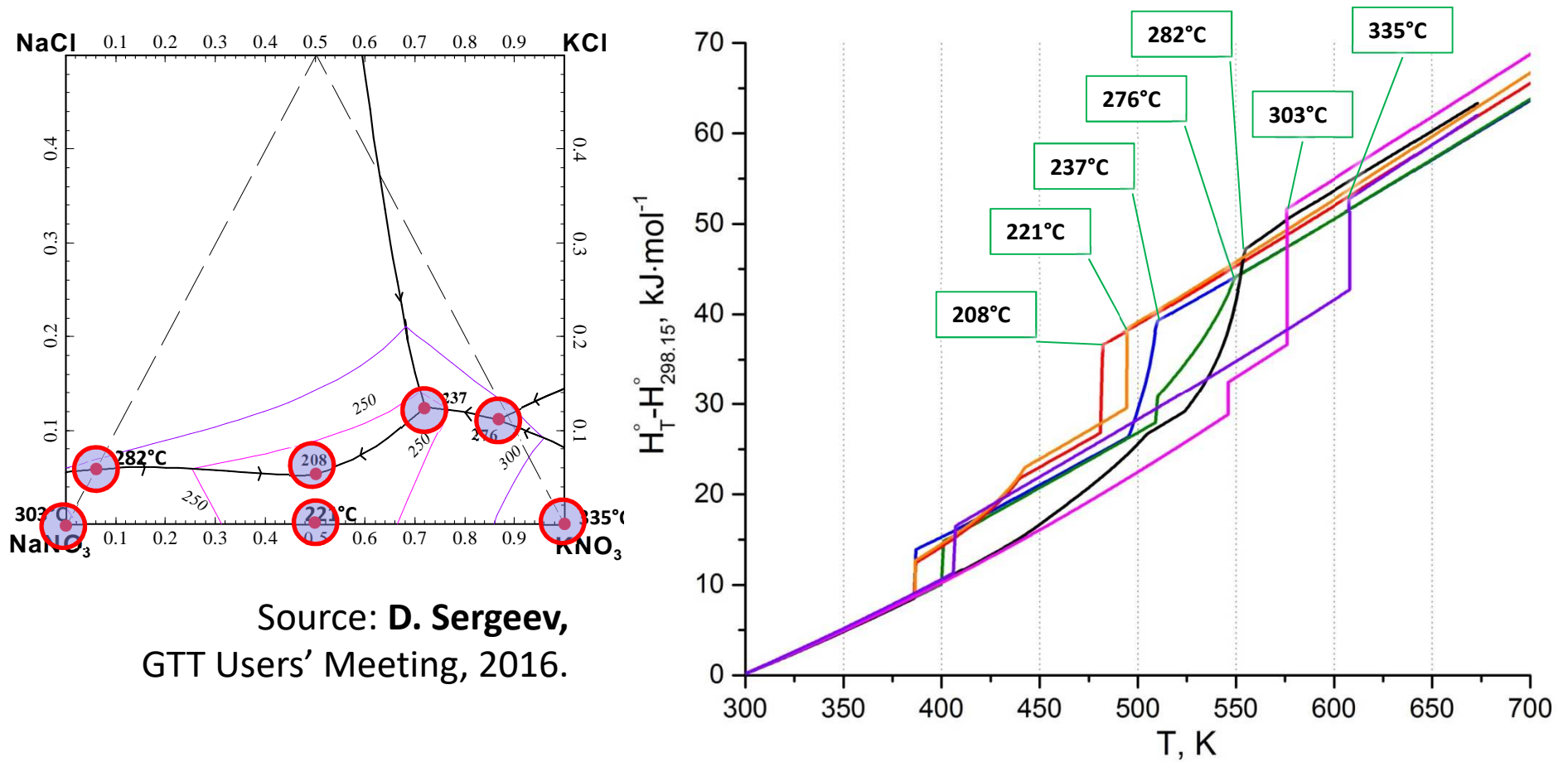


Latent Heat Storage (PCM)

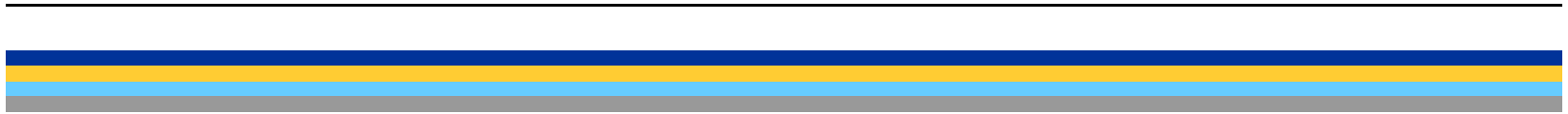
- Eutectic Mixtures
 - Similar behaviour to Pure Substances



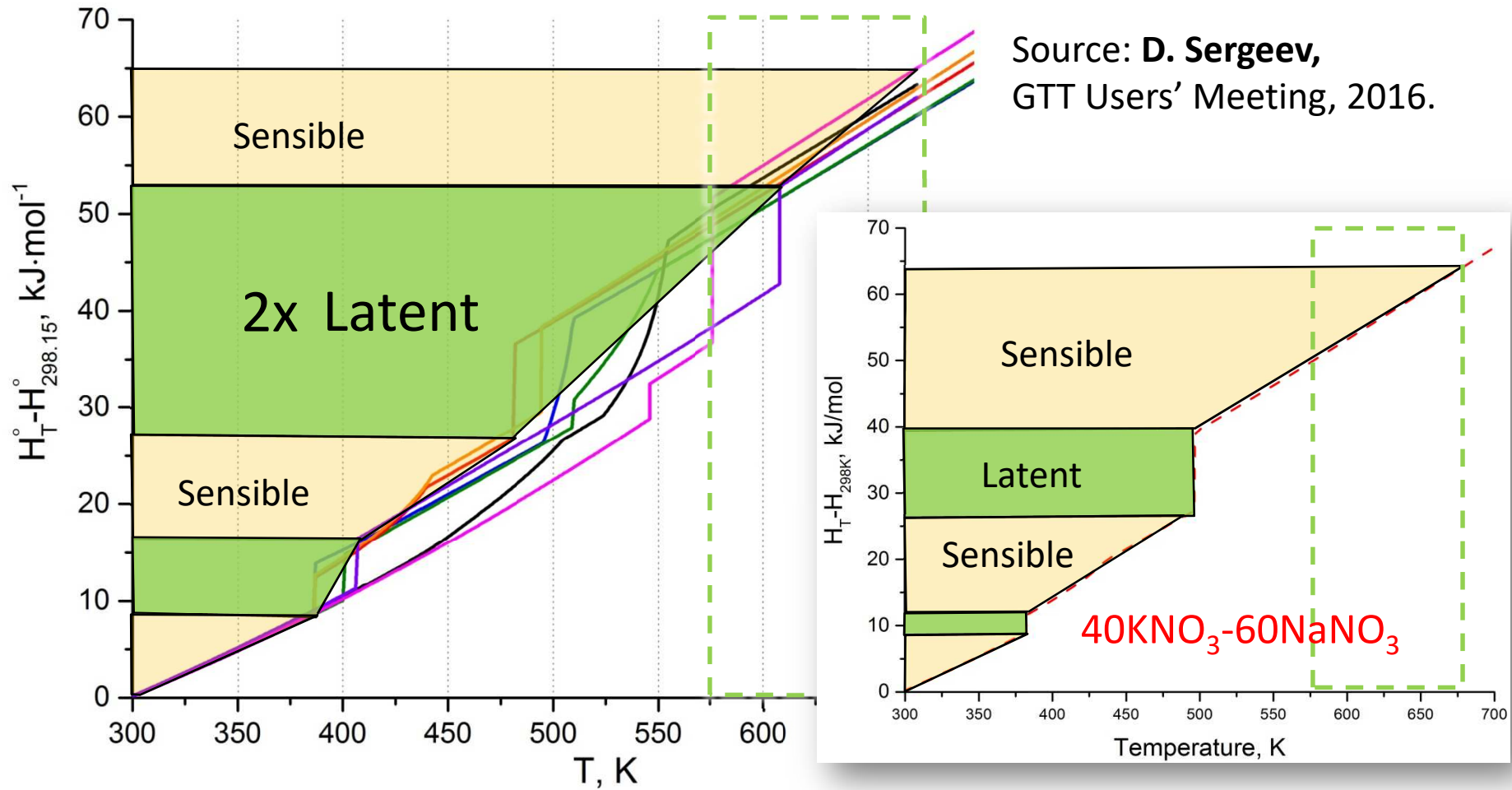
Cascaded Latent Heat Storage



Source: D. Sergeev,
GTT Users' Meeting, 2016.



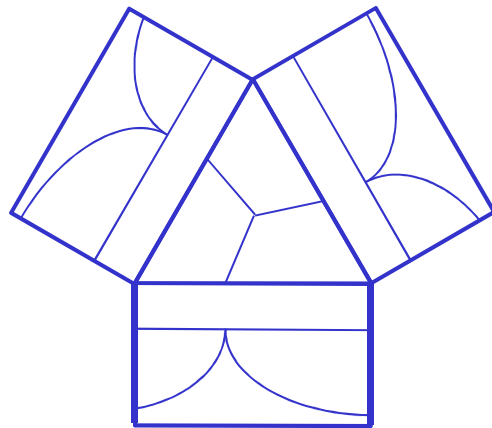
Cascaded Latent Heat Storage



PCM-Screening

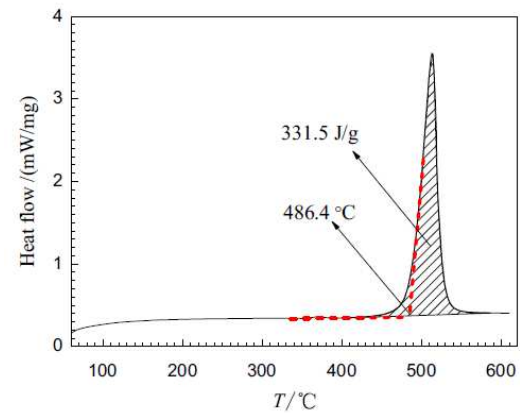
- Thermodynamic modelling

- Binary
- Ternary
- Multicomponent



- Experimental methods

- DSC
- Drop Calorimeter
- Mass Spectrometry
- Transient Methods





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Sustainable fertilizer production from sun, air and water

DÜSOL



Food Production



Synthetic fertilizers

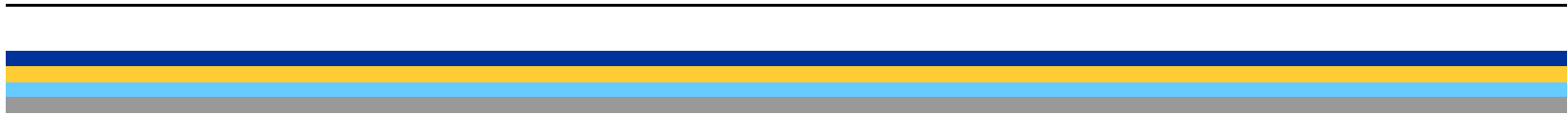
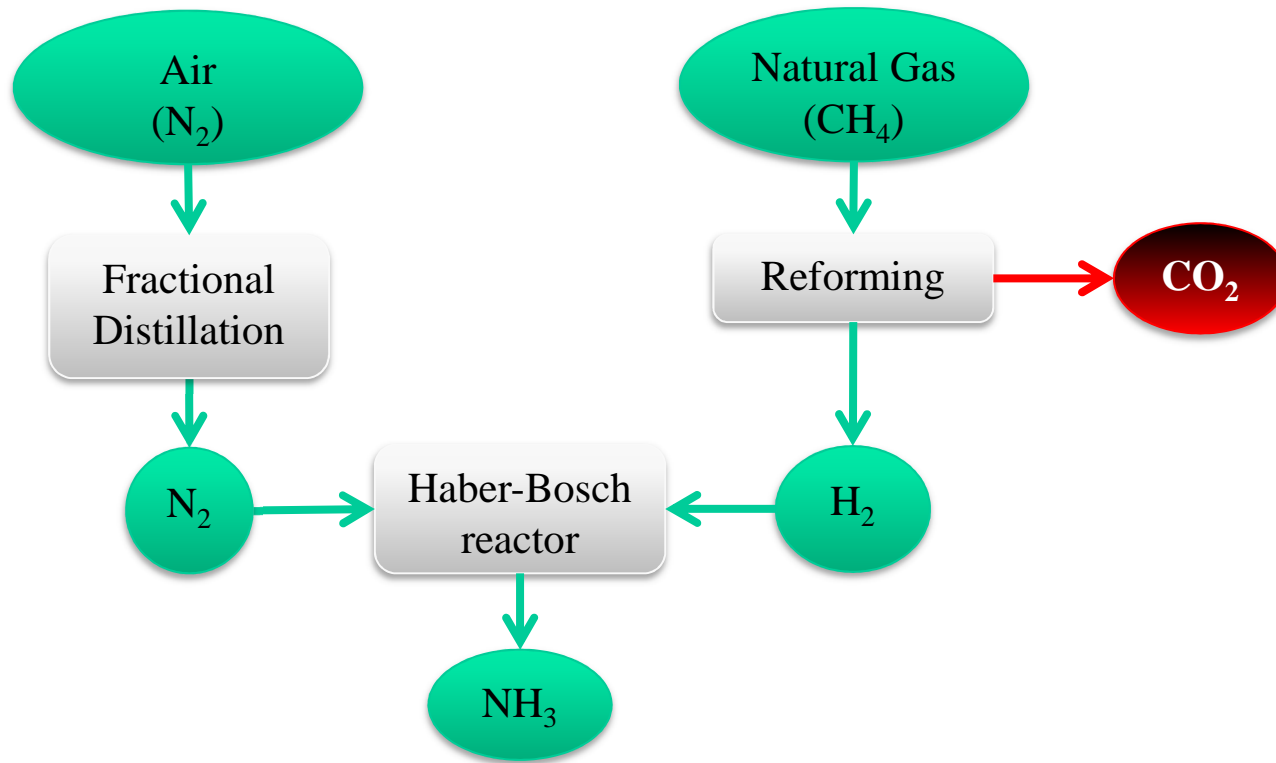
- Urea (≈ 184 million tons, 2012)
- Natural Gas (≈ 20 trillion kWh)
- 2.3 tons CO_2 / ton NH_3
- CO_2 (≈ 500 million tons per year)

Growing demand

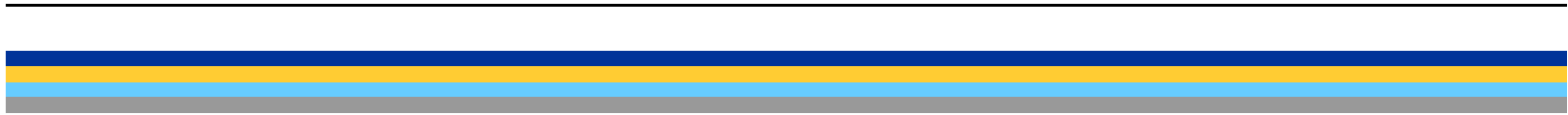
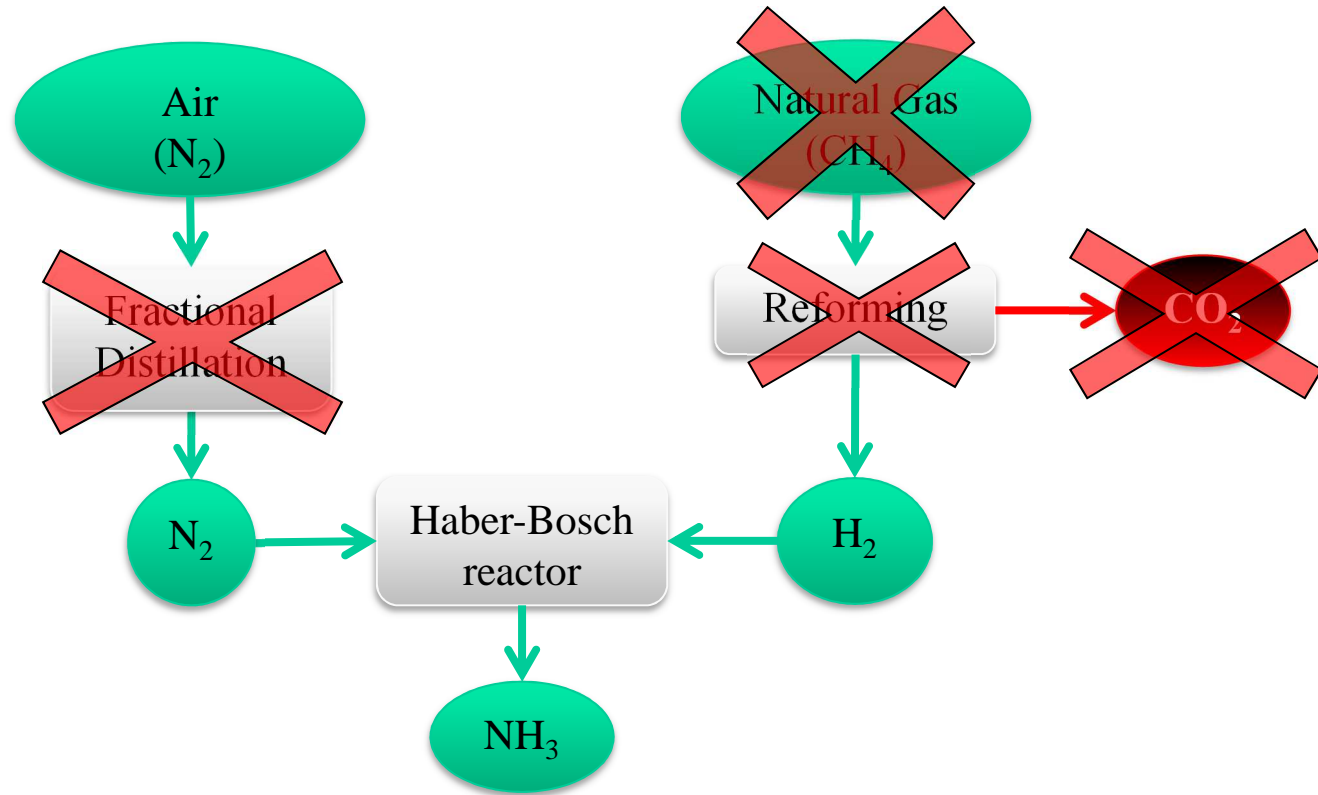
- Population
 - 7.5 billion today
 - ≈ 8 billion, 2030
 - ≈ 9 billion, 2050



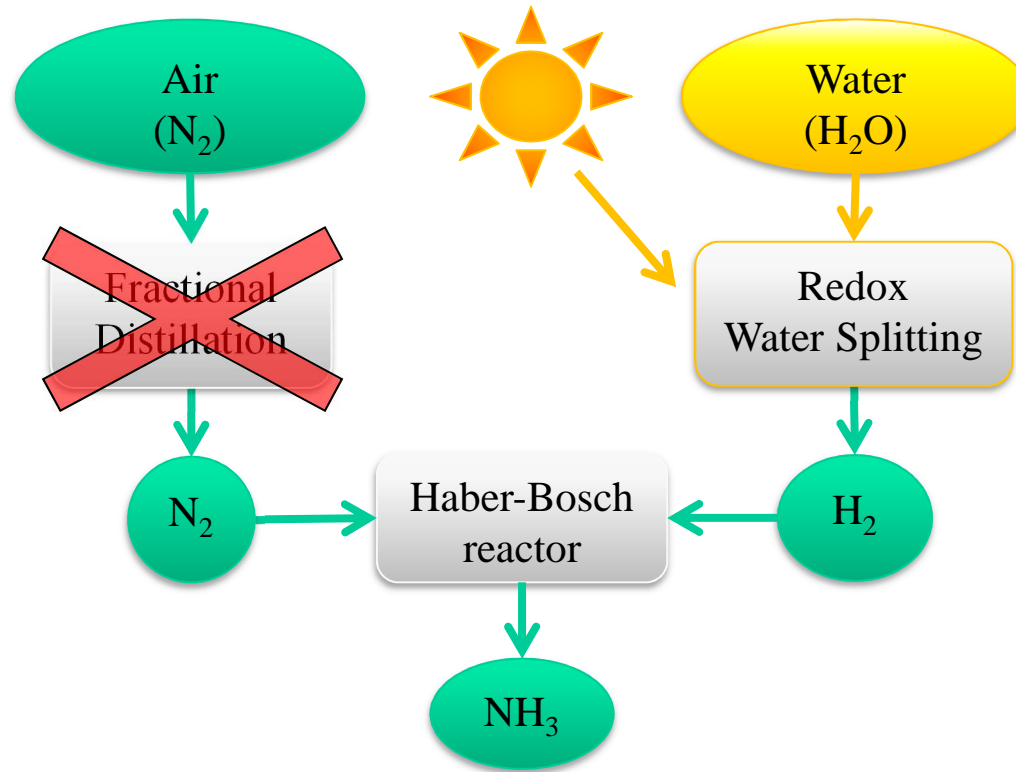
Ammonia Production



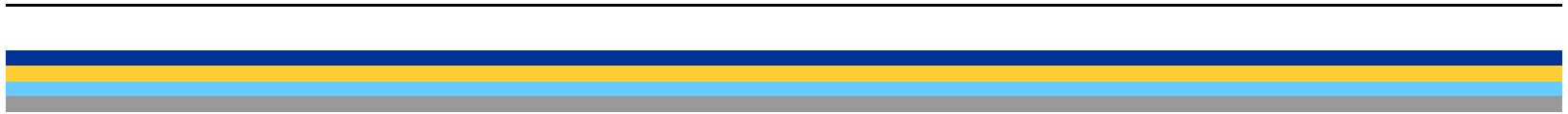
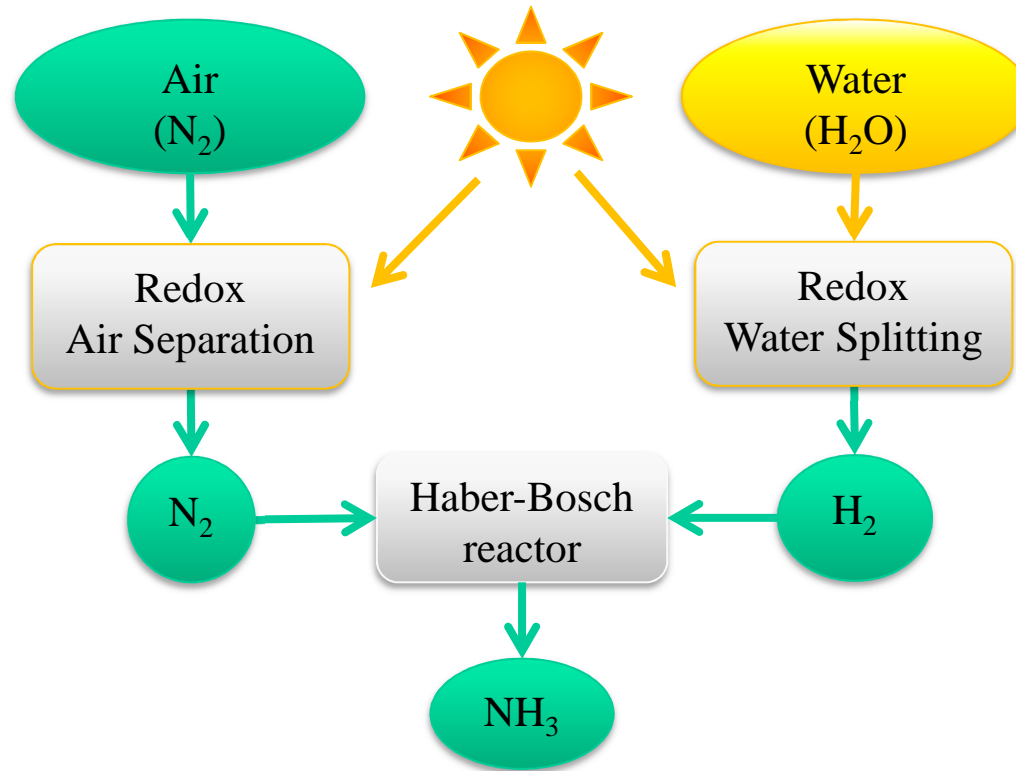
Düsol Concept



Düsol Concept

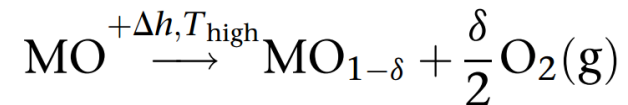


Düsol Concept

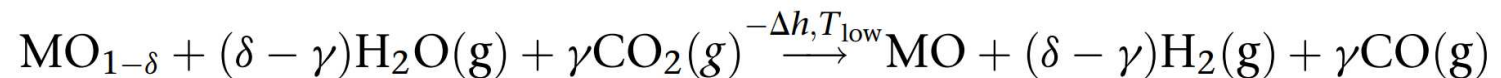


Redox Cycle

- Reduction at T_{high} :

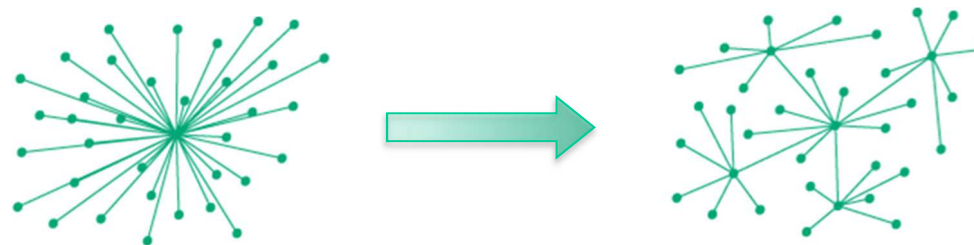


- Oxidation at T_{low} :



Düsol

- Solar powered redox chemistry
 - Sustainable, CO₂-free processes
 - Urea-based fertilizers
 - New regions
 - Decentralised productions
 - Small plants
 - Reducing transport costs
 - Affordable to smallholder farmers



Thank You

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