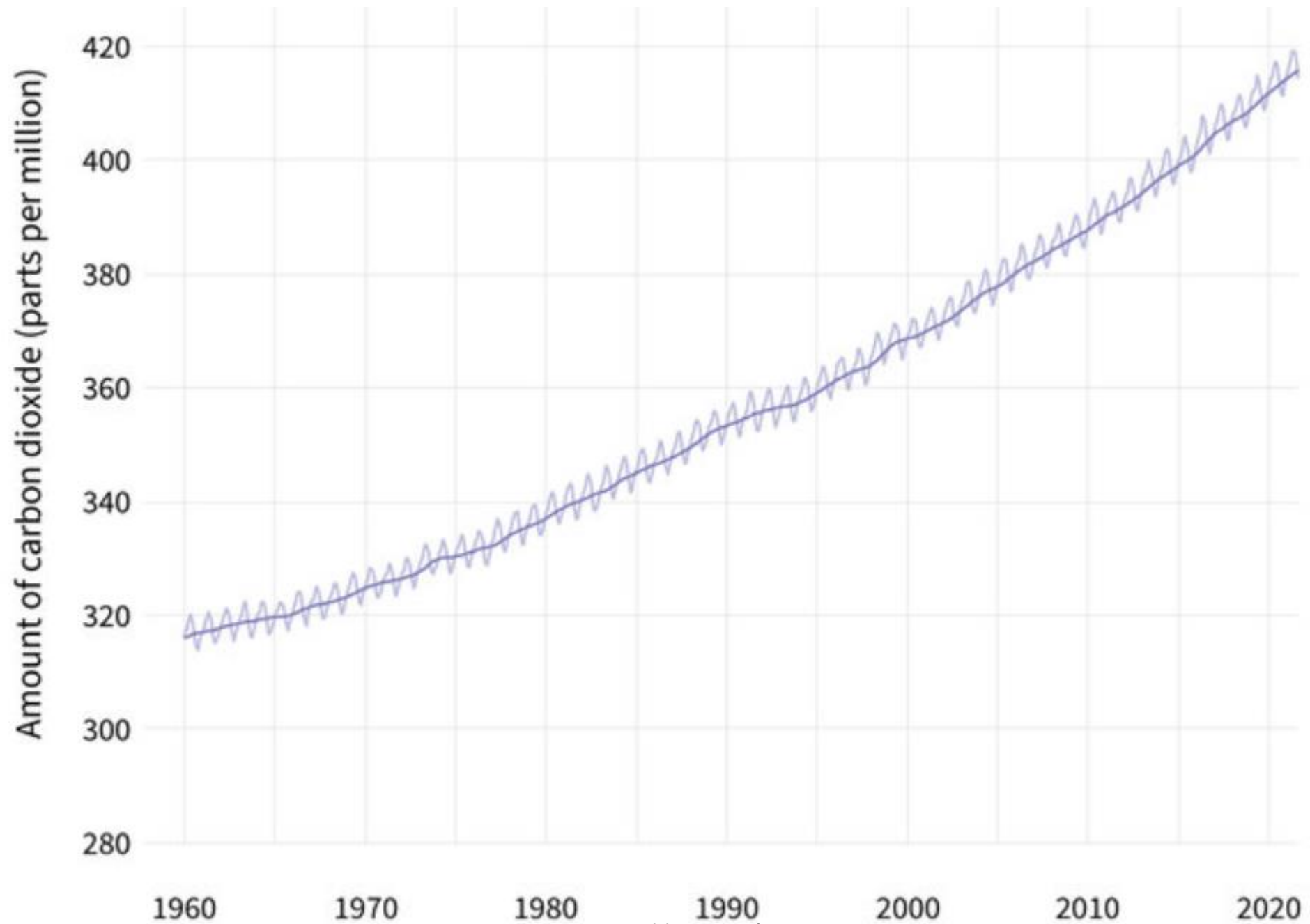


Nieuwe gevaren van de Energie Transitie

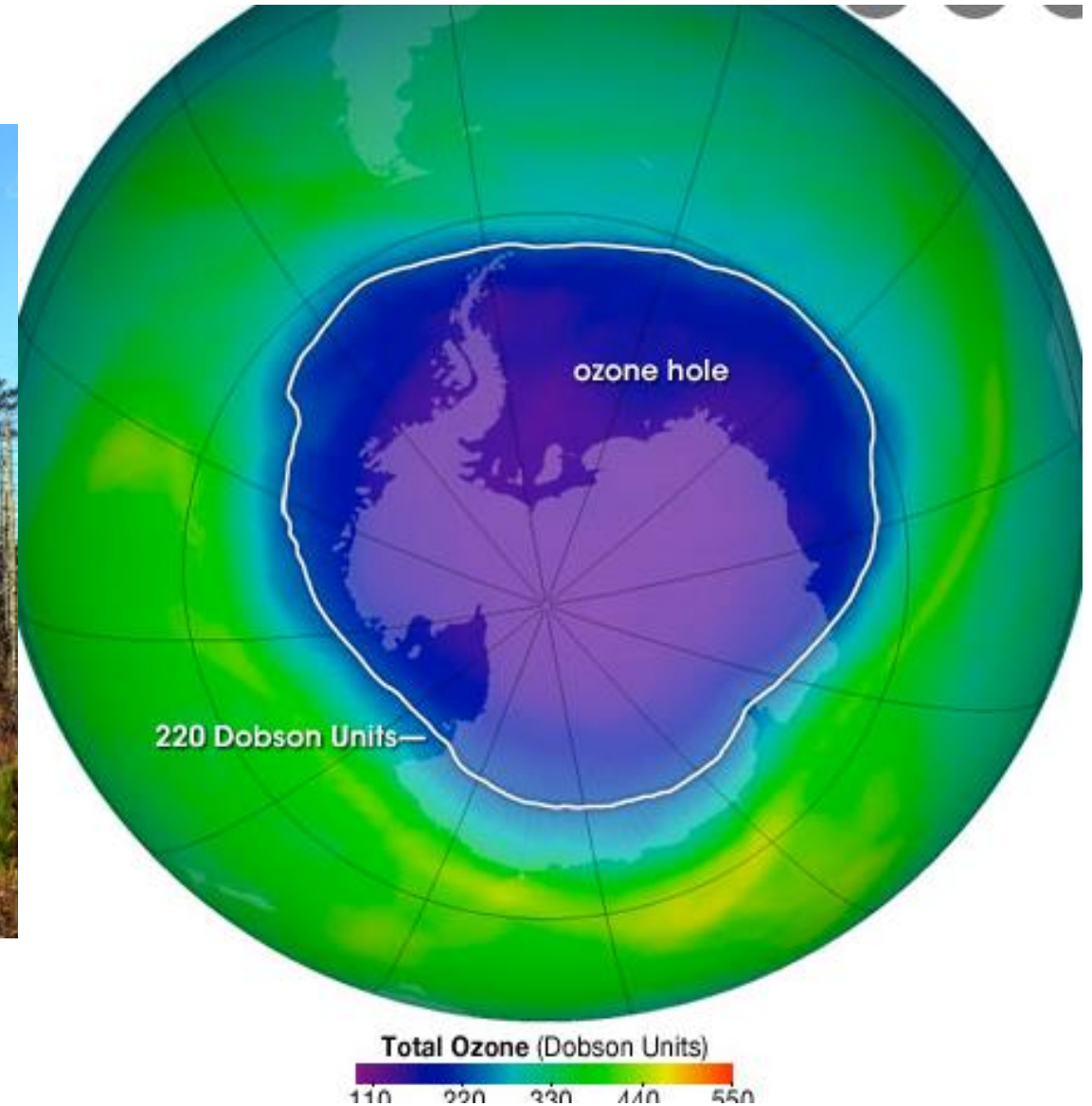
NAP bijeenkomst Houten

Voor NAP SIG Process Safety, Tijs Koerts





Technology will solve things....



Paris

1.5 degree ; 2.0 degree

How much more CO₂ can we emit and by when is that expected?

Paris

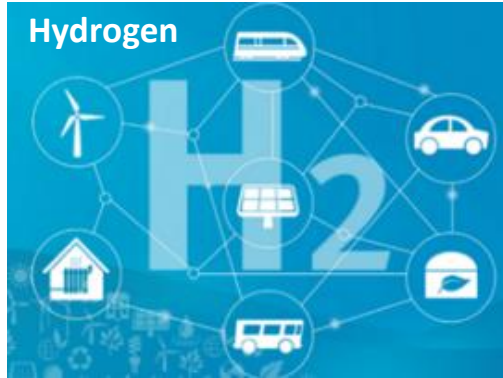
1.5 degree ; 2.0 degree

How much more CO₂ can we emit and by when is that expected?

How many earth consume the Dutch?



EPSC WG Focus topics



Transport with
new fuels on
chemical sites



Decarbonization



Hydrogen

Produced from CH_4 and H_2O using water gas shift (eventually with CCS), CH_4 pyrolysis or electrolysis from green electricity.

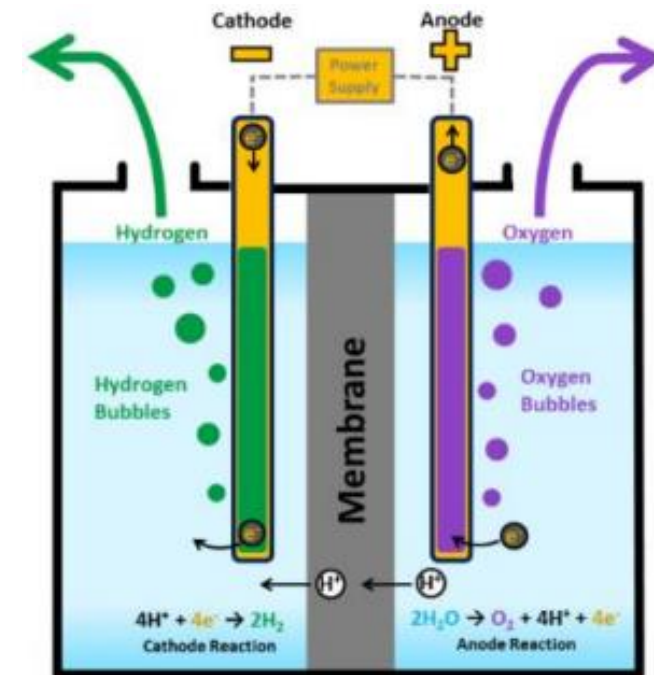
H_2 is weight effective energy carrier, easy to produce electricity. Flammable and hard to liquify. Transport in pipelines or e.g. as NH_3 (l) in vessels

Electrolyser parks to be developed, constructed and operated

➤ New Hazards : hydrogen is flammable, easy ignitable. Membrane permeation

➤ Reference: [Presentation](#) RHDHV

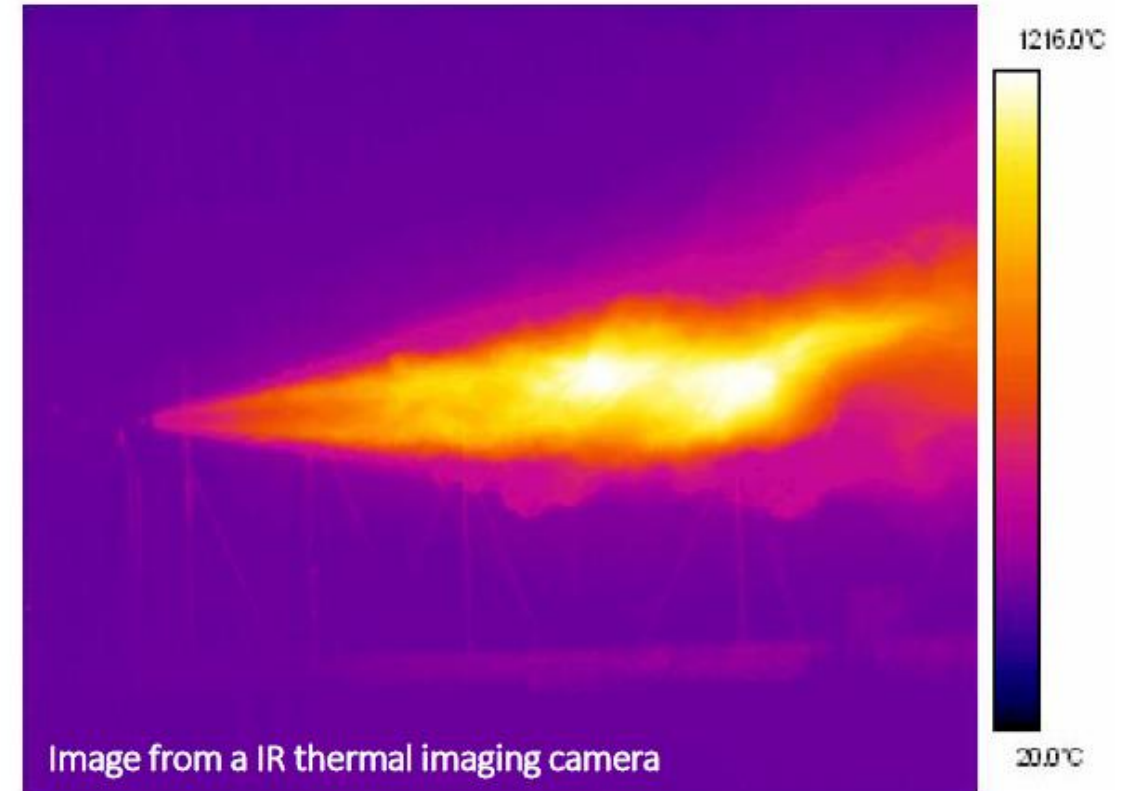
Color	GREY HYDROGEN	BLUE HYDROGEN	TURQUOISE HYDROGEN*	GREEN HYDROGEN
Process	SMR or gasification	SMR or gasification with carbon capture (85-95%)	Pyrolysis	Electrolysis



Hydrogen Hazards



Hydrogen Hazards



Explosion behavior of Hydrogen vs Natural Gas



Estimate overall energy efficiency



Using Solar Energy from Egypt, to drive a car in Europe:

Photons \rightarrow Electricity \rightarrow H_2 \rightarrow $\text{NH}_3(\text{l})$ \rightarrow Transport by boat \rightarrow NH_3 storage
 \rightarrow H_2 \rightarrow pipeline \rightarrow Load to Car \rightarrow electricity (fuel cell) \rightarrow speed (car)



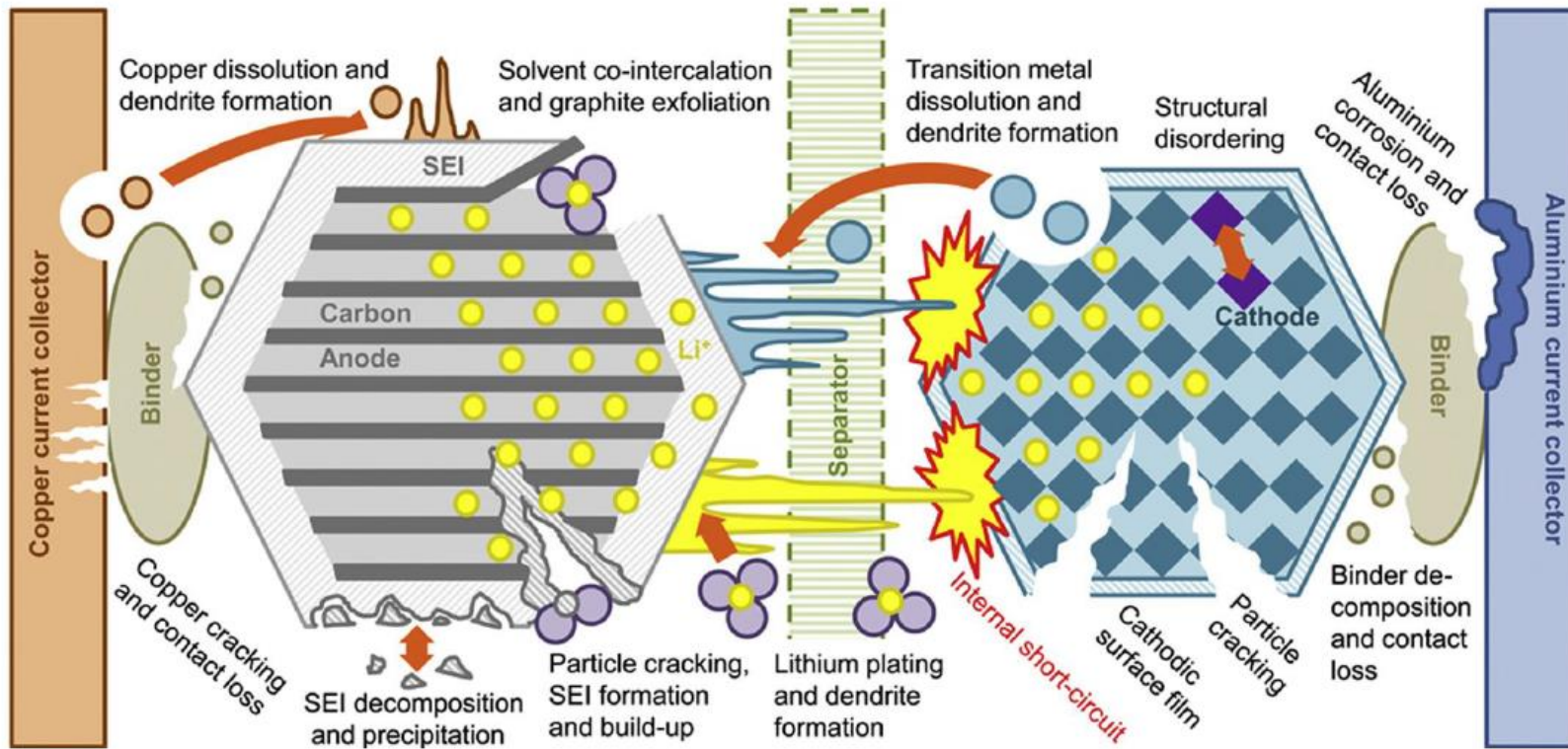
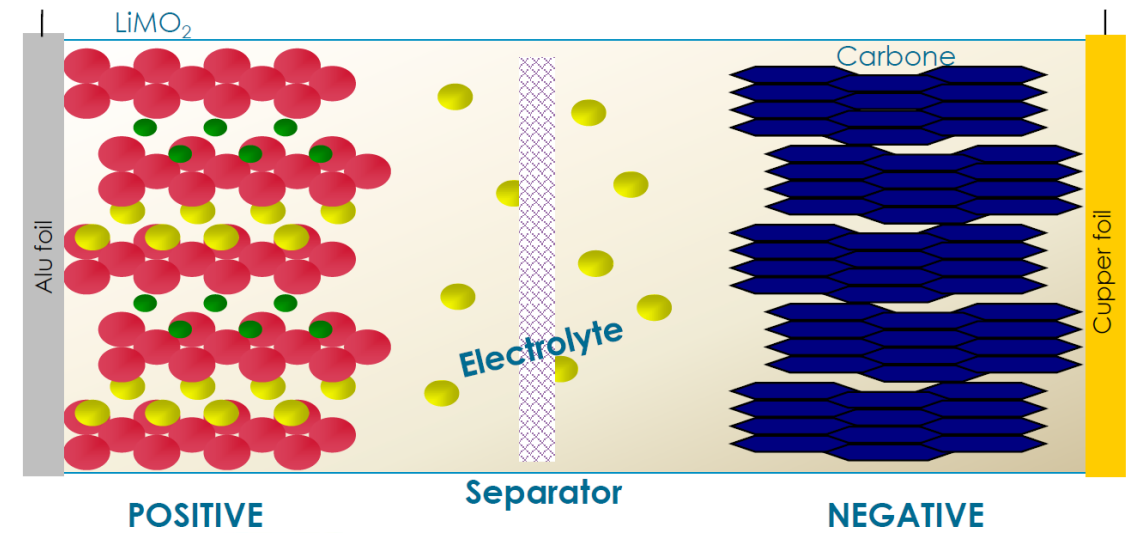
Blue ammonia shipped from Saudi Arabia to Japan



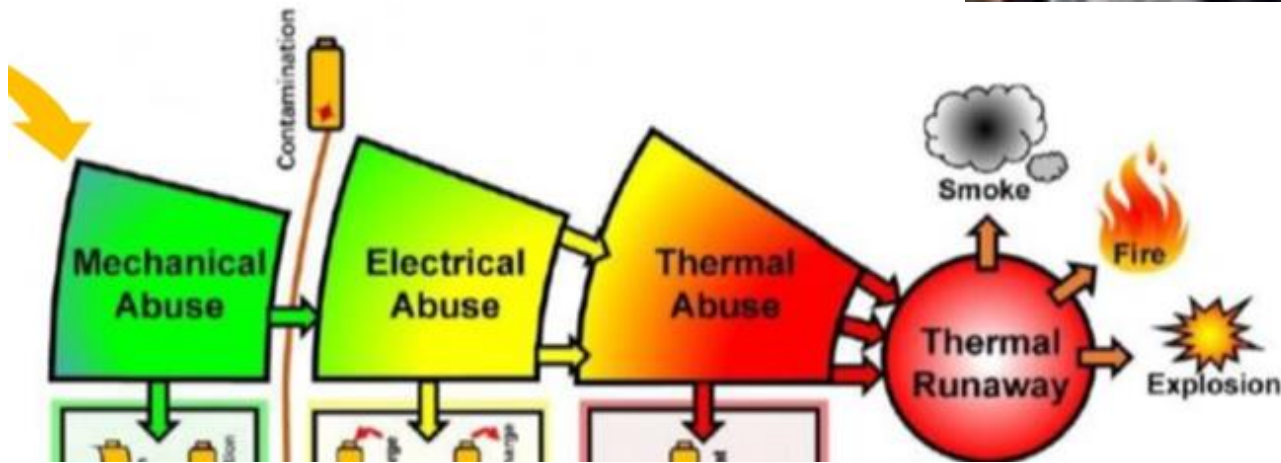
LH2 from Australia to Japan

Electricity storage

Li Battery



Thermal runaway



Li batteries runaway

1 Electrical

- Overcharge
- Cell external short circuit, sparks
- BMS failure
- Electrical abuse
- High voltage/current
- Permanent energy

2 Thermal

- Cell over-temperature
- Internal heat production and dissipation
- Insulation failure
- Condensation/Corrosion
- Thermal regulation failure
- Harsh climatic conditions

3 Electrochemistry

- Cell casing rupture
- Electrolyte spillage
- Volatile organic solvents spillage
- Internal cell short-circuit

4 Thermal runaway

- Parts ejection
- Internal fire ignition & propagation
- Gas & toxic fumes emissions
- Explosive atmosphere

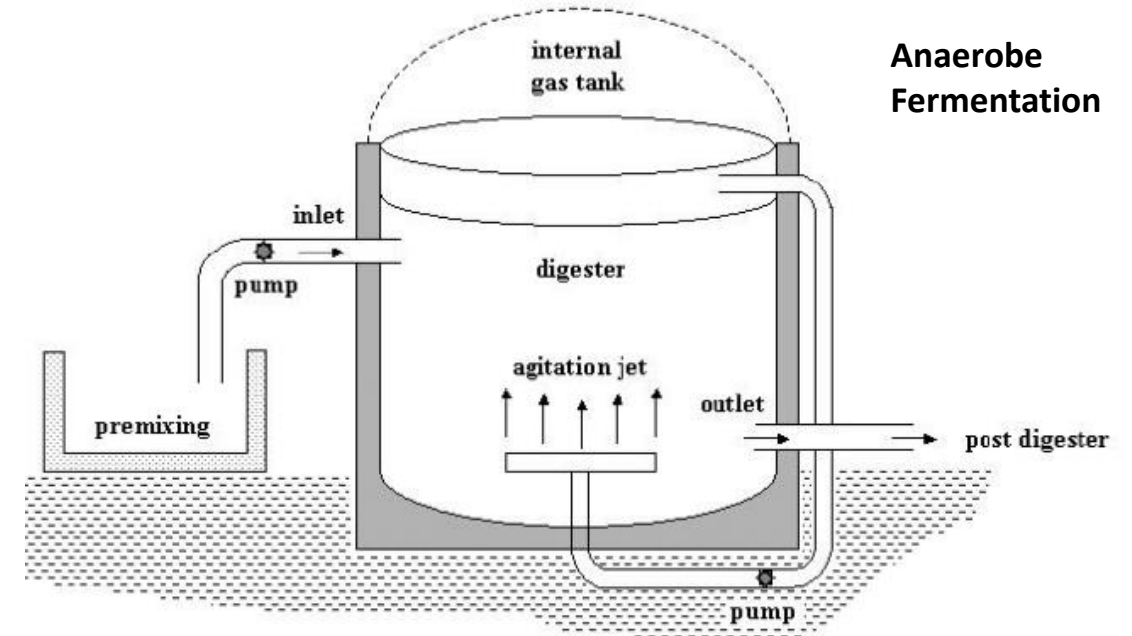
Bio Gas



Sources: Crop residues, Municipal solid waste, Wastewater, Woody, Animal manure

Process: Anaerobe Fermentation of organics.

- New Hazards : hazardous chemicals (H_2S , CO , CH_4 , CO_2 , solvents). Chemical processes in less industrialized environment. Inert atmosphere. Few bar over pressure.



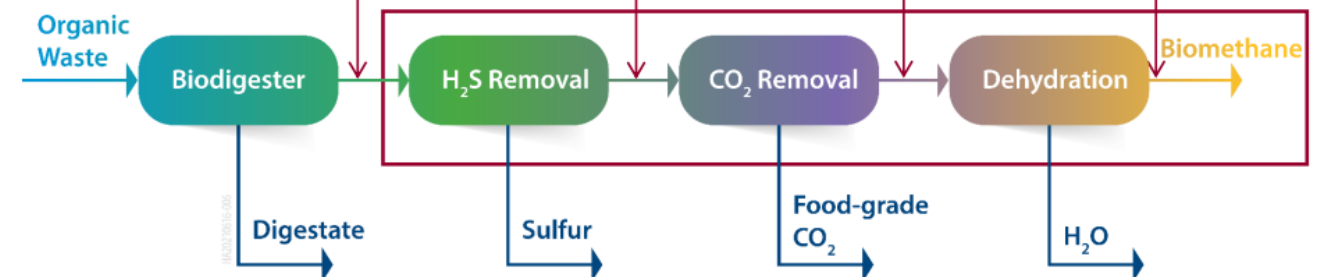
Biogas cleaning

Flow	1500Nm ³ /h
Temp.	35°C
Pressure	3.0bar
CH ₄	60mol %
CO ₂	39.8mol %
H ₂ S	0.2mol %
H ₂ O	Sat.

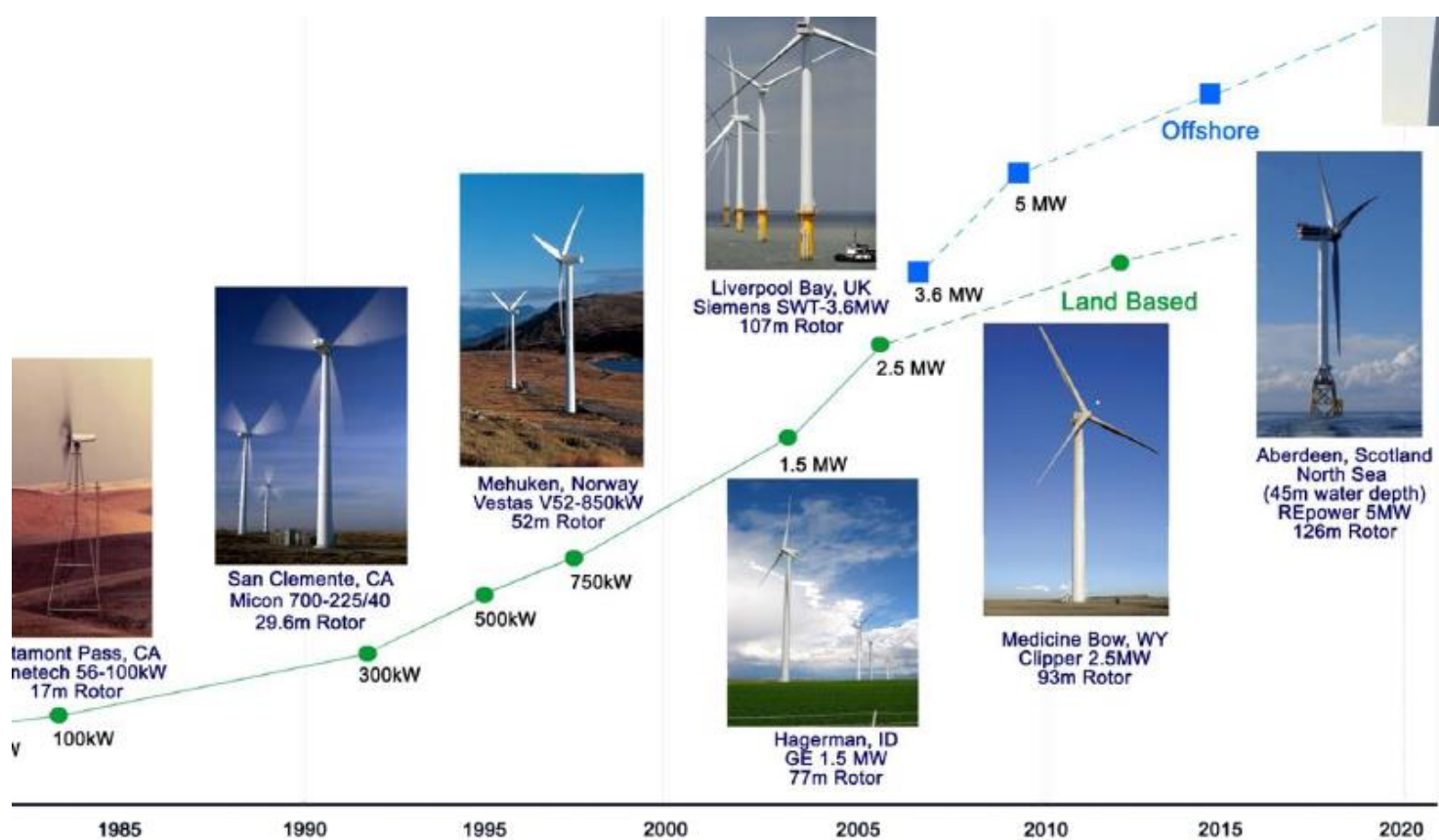
Flow	1500Nm ³ /h
Temp.	35°C
Pressure	2.9bar
CH ₄	60mol %
CO ₂	39.8mol %
H ₂ S	4ppm
H ₂ O	Sat.

Flow	1500Nm ³ /h
Temp.	35°C
Pressure	2.8bar
CH ₄	96.5mol %
CO ₂	2.3mol %
H ₂ S	4ppm
H ₂ O	Sat.

Flow	1500Nm ³ /h
Temp.	35°C
Pressure	2.7bar
CH ₄	97.6mol %
CO ₂	2.4mol %
H ₂ S	4ppm
H ₂ O	23mg/Nm ³



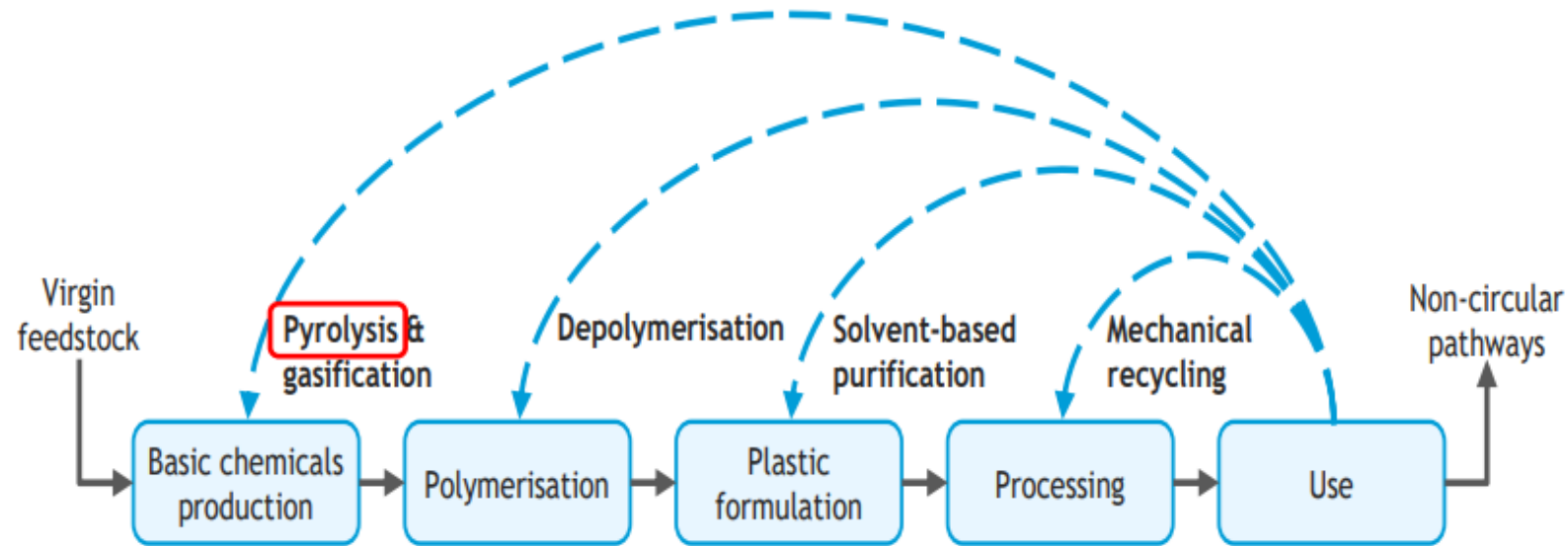
Wind



Plastics Pyrolysis

For plastics like PP, PE, PS

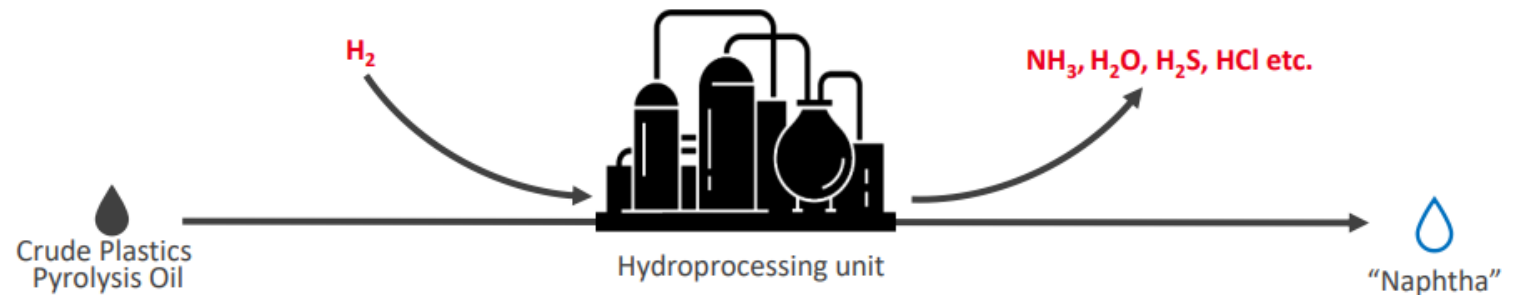
Energy intensive



Plastics decomposition in inert atmosphere e.g. 410 °C & 8 Barg to become a feedstock (pyrolysis oil)

Product quality related to contaminants like: N, O, S, Cl, metals, double bonds,

Hydro treatment (hydrogenation) required to



➤ Problems : Gum formation, fouling, corrosion, catalyst poisoning

➤ Hazards : high pressure hydrogen, plugged equipment, corrosion leakages, O_2 injection

Thank you for your attention

