

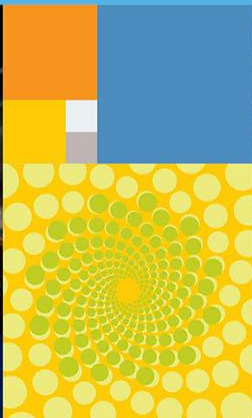


Knowledge grows

Hydrogen i industri skala

Bernhard Stormyr

Direktør for bærekraft og samfunnsansvar



1905

The power of one idea: extract nitrogen from the air

Our remarkable founders asked brave questions and took bold action to solve a human challenge.

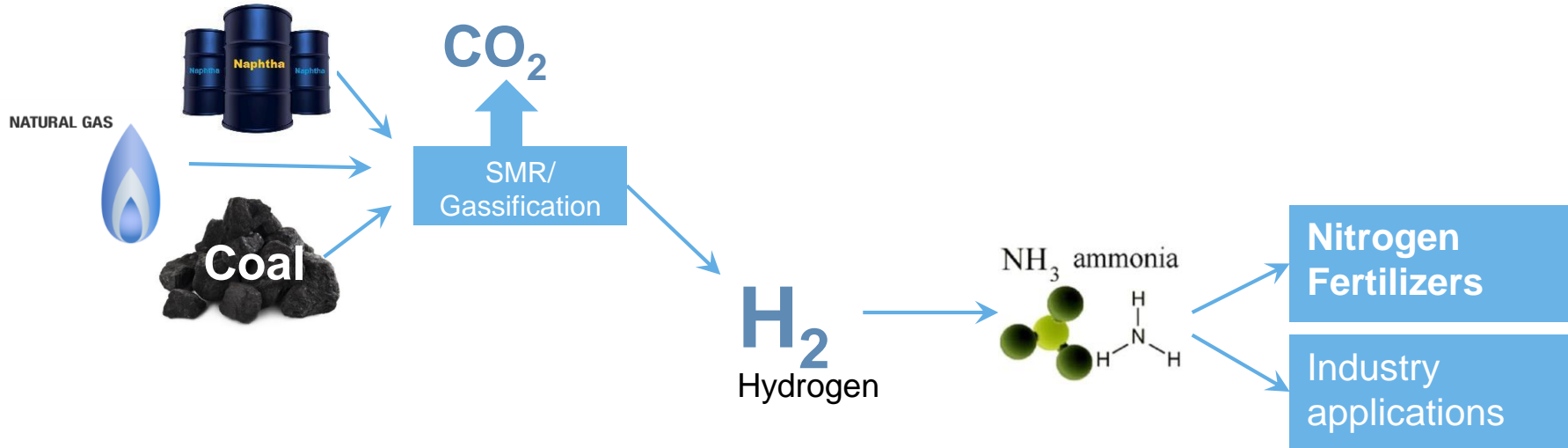
Their collaboration saved lives, fed millions and helped farmers create profitable businesses.



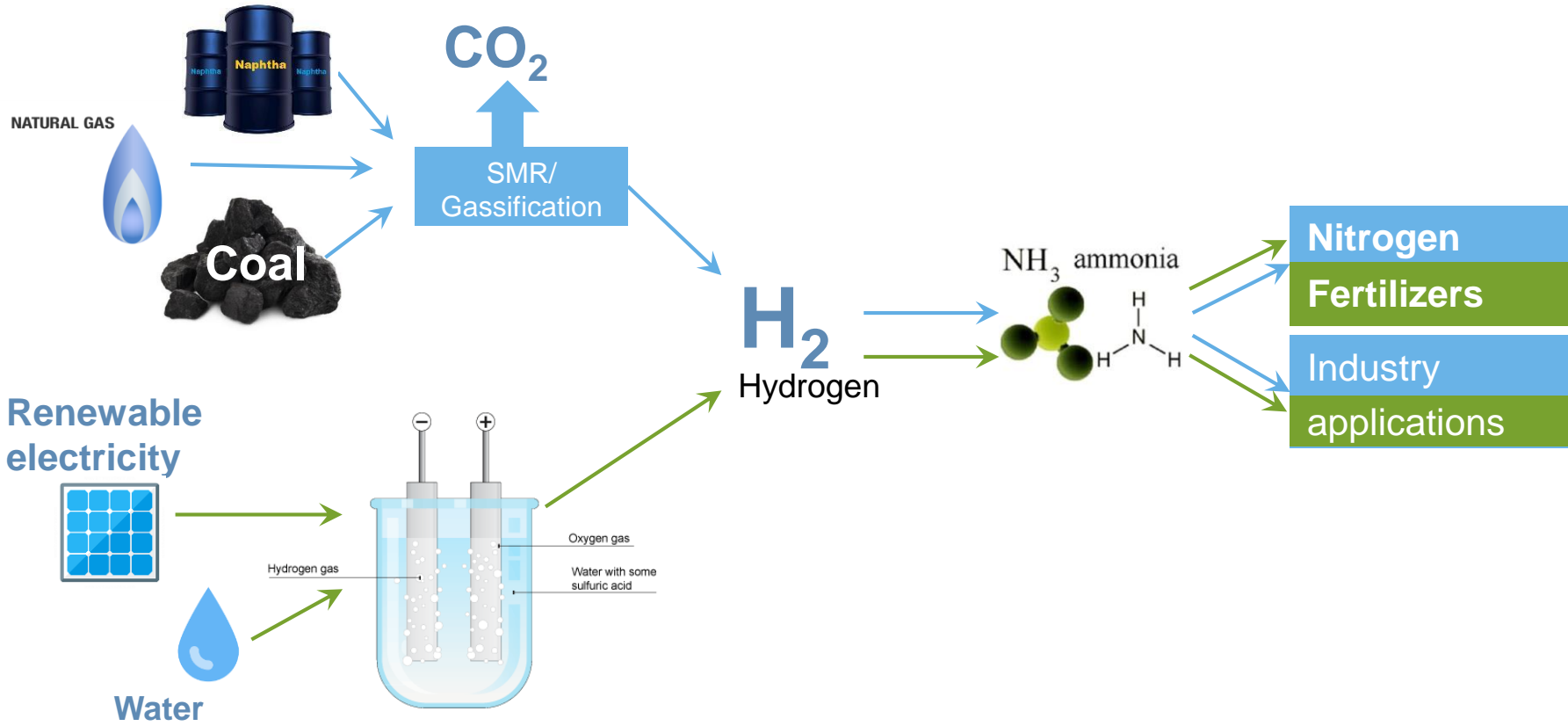
Picture: courtesy of Nel Hydrogen ASA

Notodden: 1927 – 1968; Rjukan: 1929 – 1971; Glomfjord: 1953 - 1991

Going from fossil fuel to renewable based production

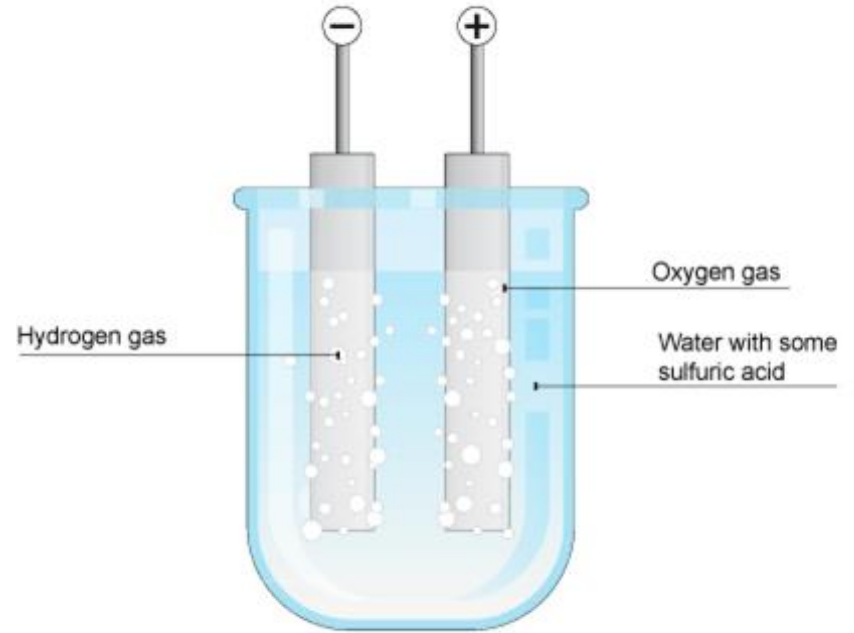


Going from fossil fuel to renewable based production

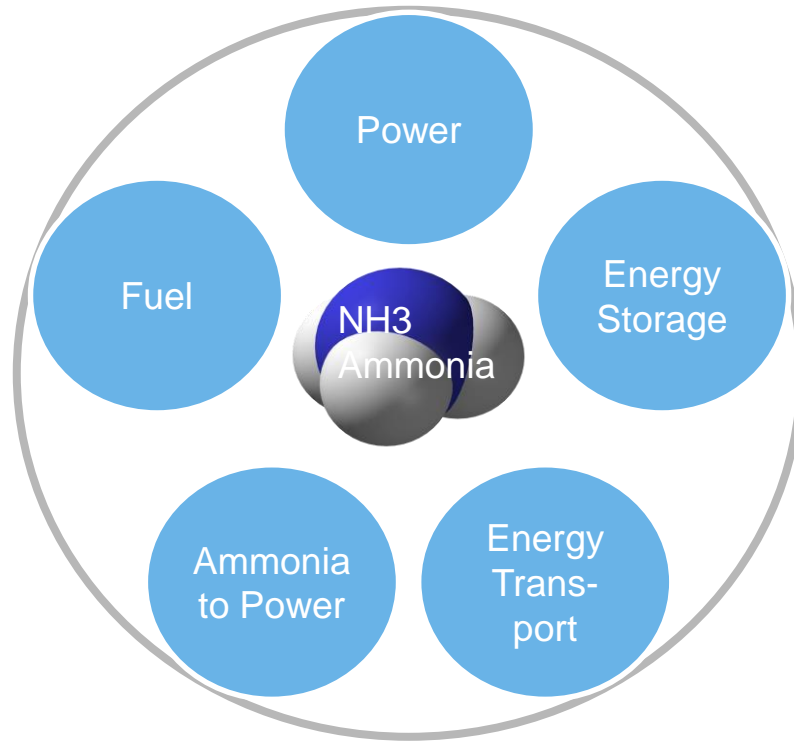


Electrolysis of water is a proven technology

Renewable power cost & stability are our only barriers to a cleaner future



Green ammonia creates a world of new possibilities in renewable energy



Green ammonia as energy carrier could be used in several ways



Ammonia applications	How it works and other options	Total market size if replaced by ammonia
<p>Fuel for transportation – deep sea shipping most relevant</p>	<ul style="list-style-type: none"> • Method: Internal combustion, fuel cells • Alternatives are biofuels, hydrogen and batteries, but these solutions have challenges 	<ul style="list-style-type: none"> • +500 million tpa (if replacement of all conventional marine fuel, =3x the global NH3 prod.) • Would replace ~6% of world's oil consumption
<p>Transport of renewable energy</p>	<ul style="list-style-type: none"> • Could use established infrastructure • Sea transport could be fueled by own load • Ammonia is likely low cost compared to H2, as high pressure / ultra low temperature required 	
<p>Dispatchable power / Storage of renewable energy</p>	<ul style="list-style-type: none"> • Large scale grid supply/demand balance • Smart grids, improved cable connectivity, pumped hydro and hydrogen salt caverns, batteries etc • Ammonia may be among lowest cost option for large scale/periodic reserve 	<ul style="list-style-type: none"> • Difficult to quantify but could be significant
<p>Feedstock for heat and power prod</p>	<ul style="list-style-type: none"> • Cracking to H₂ + fuel cell, direct in turbine or fuel cell 	

Walking the talk: setting up the world's first certified fossil free food chain



- Electrolysis based on renewable electricity replacing fossil natural gas.
- Availability of low cost electricity
- Continued technical development to reduce production cost
- Target to start production by 2022

Collaboration for
sustainable
farming



From field to fork

- Lantmännen are vertically integrated From field to fork.
- Enables engagement towards B2C and B2B customers.
- To succeed the value of going fossil free must be distributed in the value chain.



Knowledge grows

