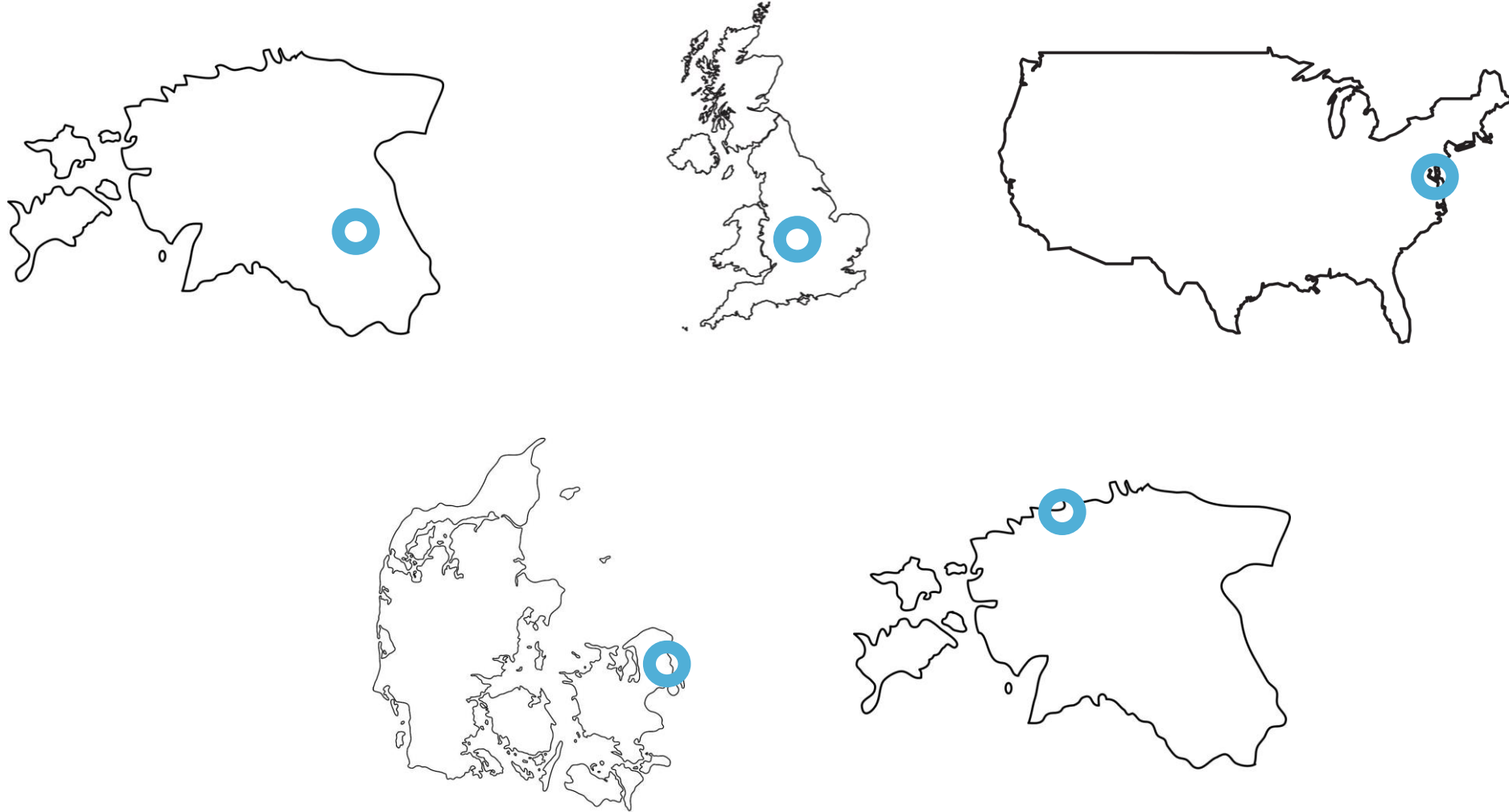
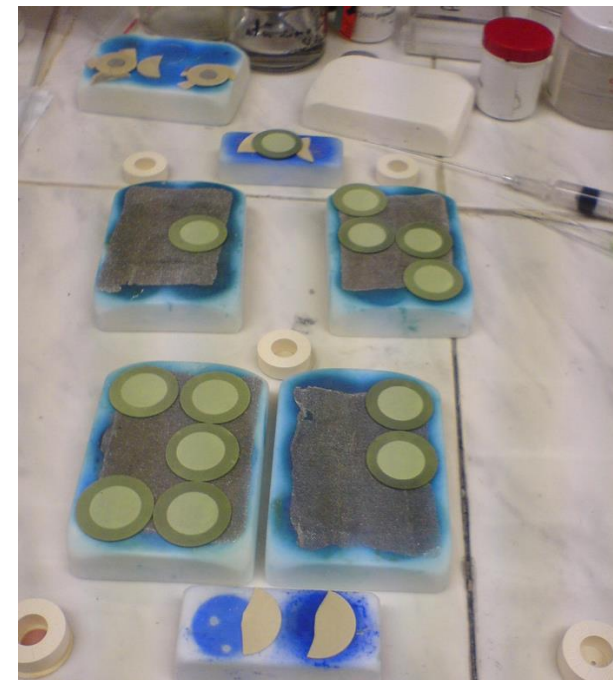
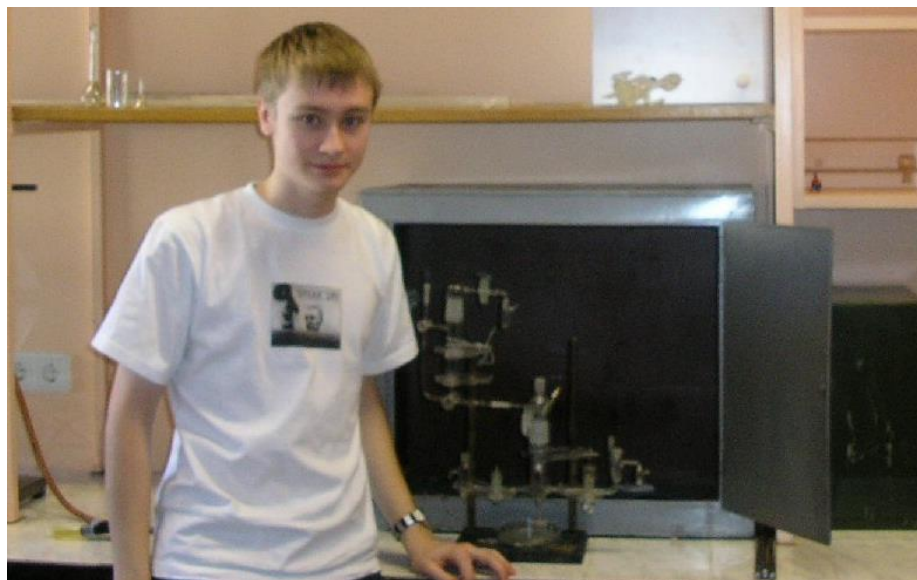
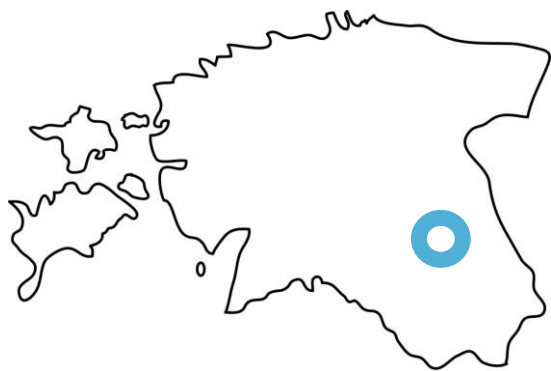


Keemia ja materjaliteaduse roll rohepöörde läbiviimisel

Kes ma olen? Kust ma tulen?



2003-2008 Tartu Ülikoolis



Dr. Gunnar Nurk



Prof. Enn Lust



2007 Rolls-Royce Fuel Cell Systems, UK

25/11/2023



Solid Oxide Fuel Cells

Reliable Energy local to where it is needed



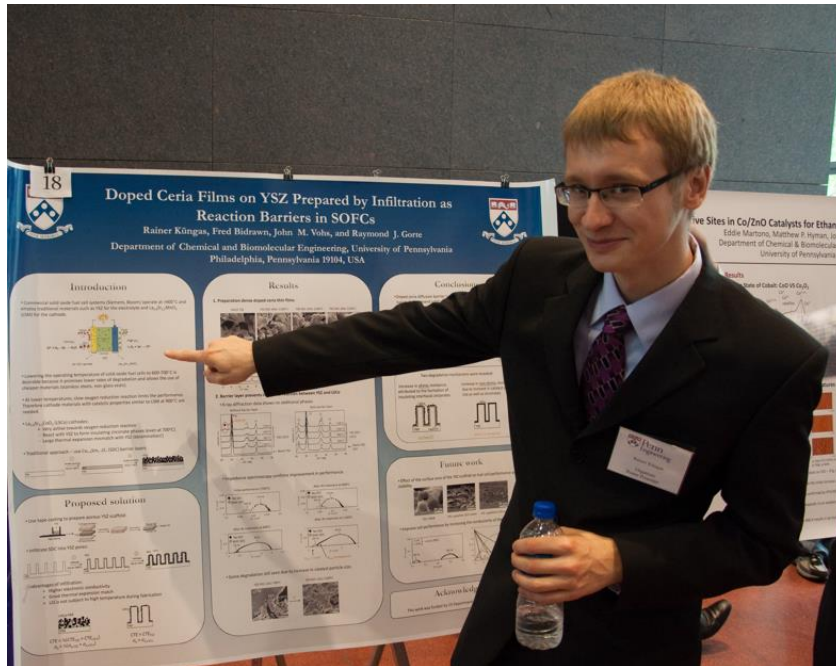
- Potential fuel-efficiency in the 60-70% range
- Multi-fuel (natural gas, liquid and biofuels)
- Negligible air emissions, low-carbon
- Distributed generation minimises transmission losses and reduces infrastructure costs



Loughborough, UK



2008-2012 Pennsylvania Ülikoolis



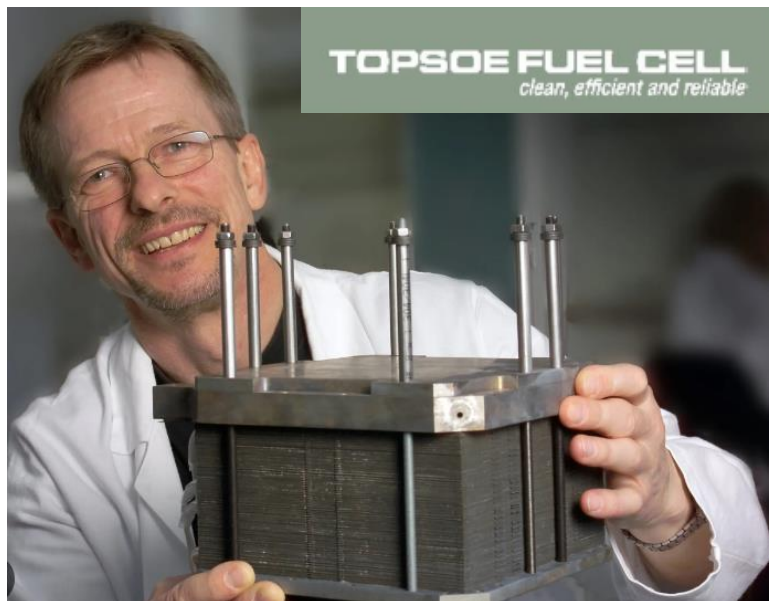
Prof. Ray Gorte



Prof. John M. Vohs



2012-2021 Haldor Topsoe, Taani



HALDOR TOPSOE 



Internal fuel manifold
External air manifold
Cell group voltage probing



Compact and robust casing



eCOs plant, Columbus, Ohio, USA

REVIEW

ELECTROCHEMISTRY

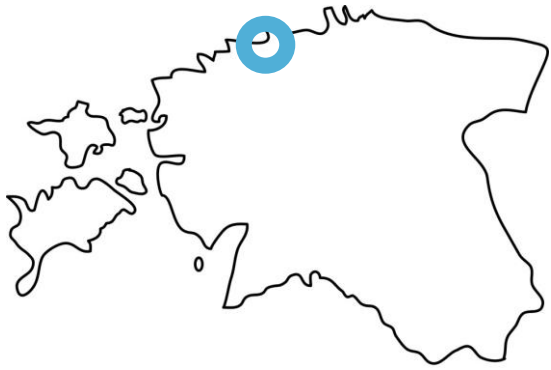
Recent advances in solid oxide cell technology for electrolysis

A. Hauch^{1*†}, R. Küngas^{2†}, P. Blennow^{2†}, A. B. Hansen^{3†}, J. B. Hansen^{2†},
B. V. Mathiesen^{4†}, M. B. Mogensen^{1†}

Hauch *et al.*, *Science* **370**, eaba6118 (2020) 9 October 2020

Science

2021-... Stargate Hydrogen



Stargate Hydrogen



Töötajaid: 40



Mehi-naisi: 50-50%

Eri rahvusi: 10



Doktorikraadiga: 8

Magistrikraadiga: 20



Patenditaotlusi: 5

Professional experience from:

HEXIS

TOPSOE

skeleton+



Enapter

veriff

STARSHIP

Autoliv

HOB

FILTER
ENERGY WATER SOLUTIONS

MITSUBISHI
HEAVY INDUSTRIES, LTD.

Bolt

ETS NORD



TAL
TECH



HARJU ELEKTER

Electrifying Tomorrow

ESTANC

Eesti
Energia



Teadus-arenduskoostöö



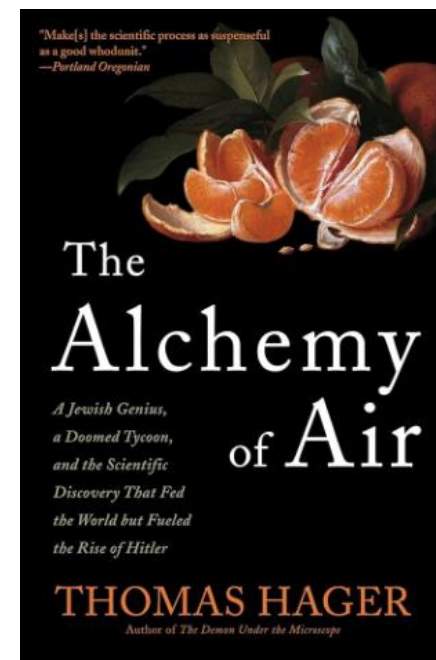
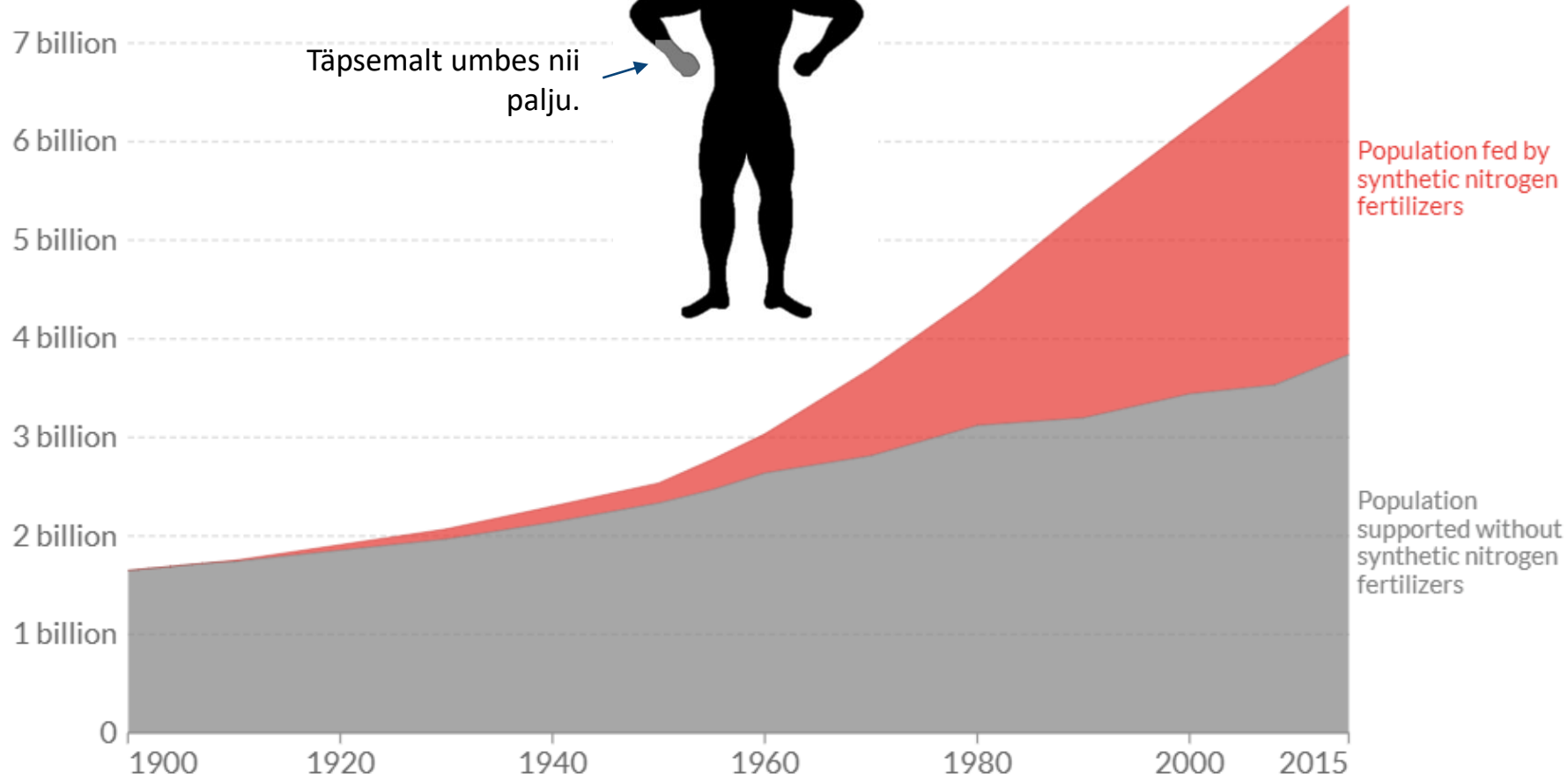
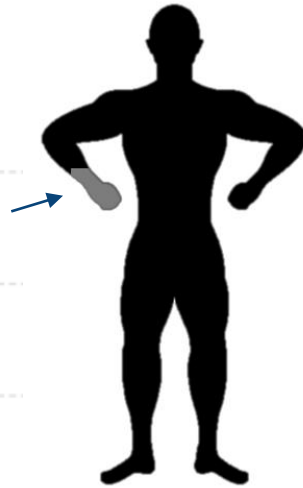
Keemia ja materjaliteaduse roll rohepöörde läbiviimisel



Keemikute roll inimkonna toidulaua katmises

Ka Sinu kehas on lämmastikku, mis on kunagi olnud väetis.

Täpsemalt umbes nii palju.

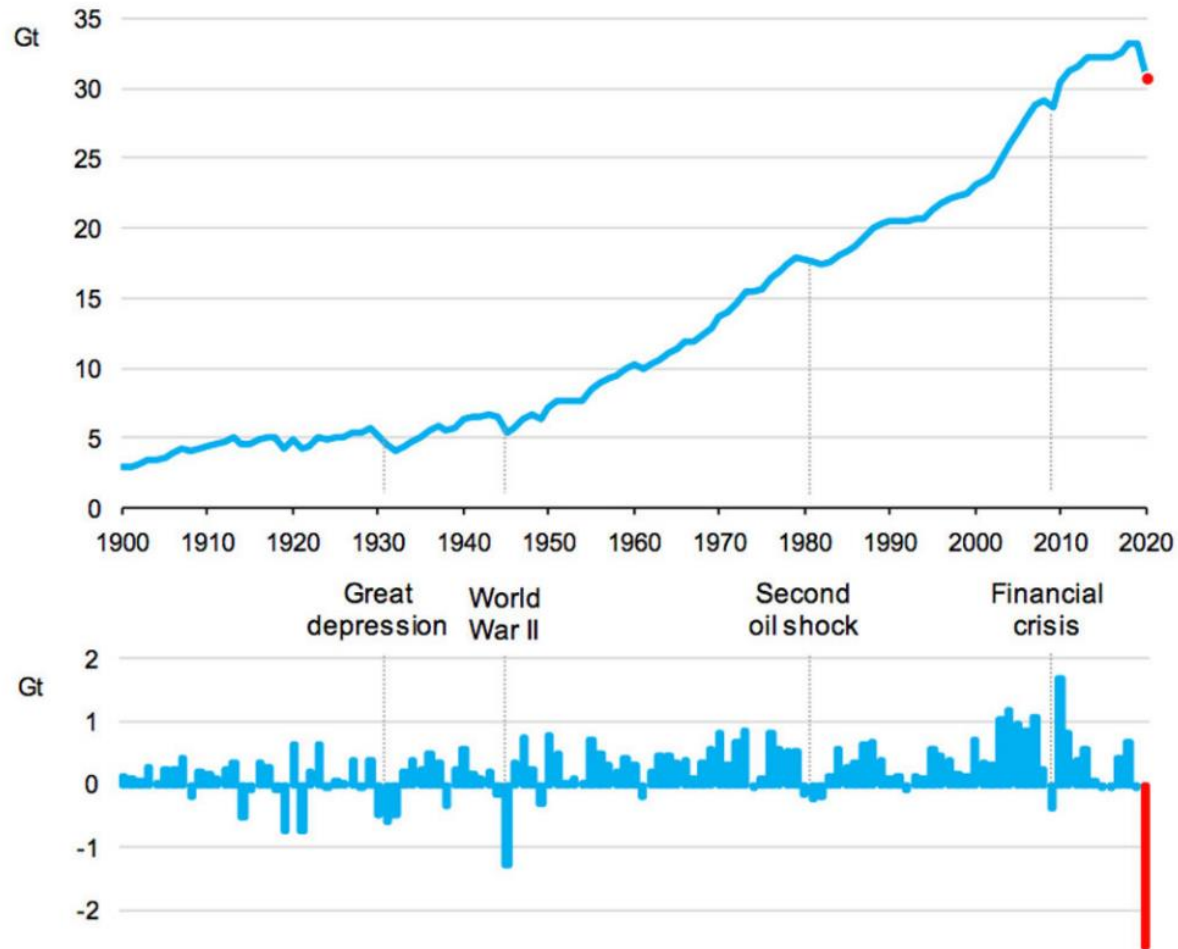


Source: Erismann et al. (2008); Smil (2002); Stewart (2005)

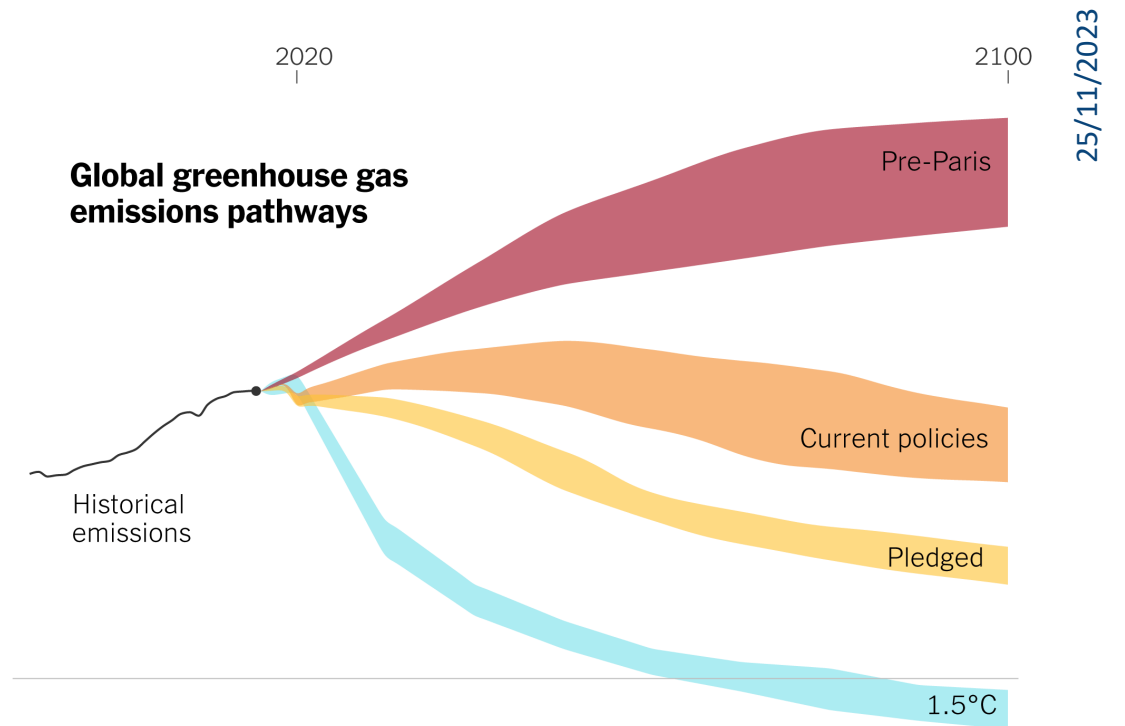
[OurWorldInData.org/how-many-people-does-synthetic-fertilizer-feed/](https://www.ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed/) • CC BY



CO₂ heitmed



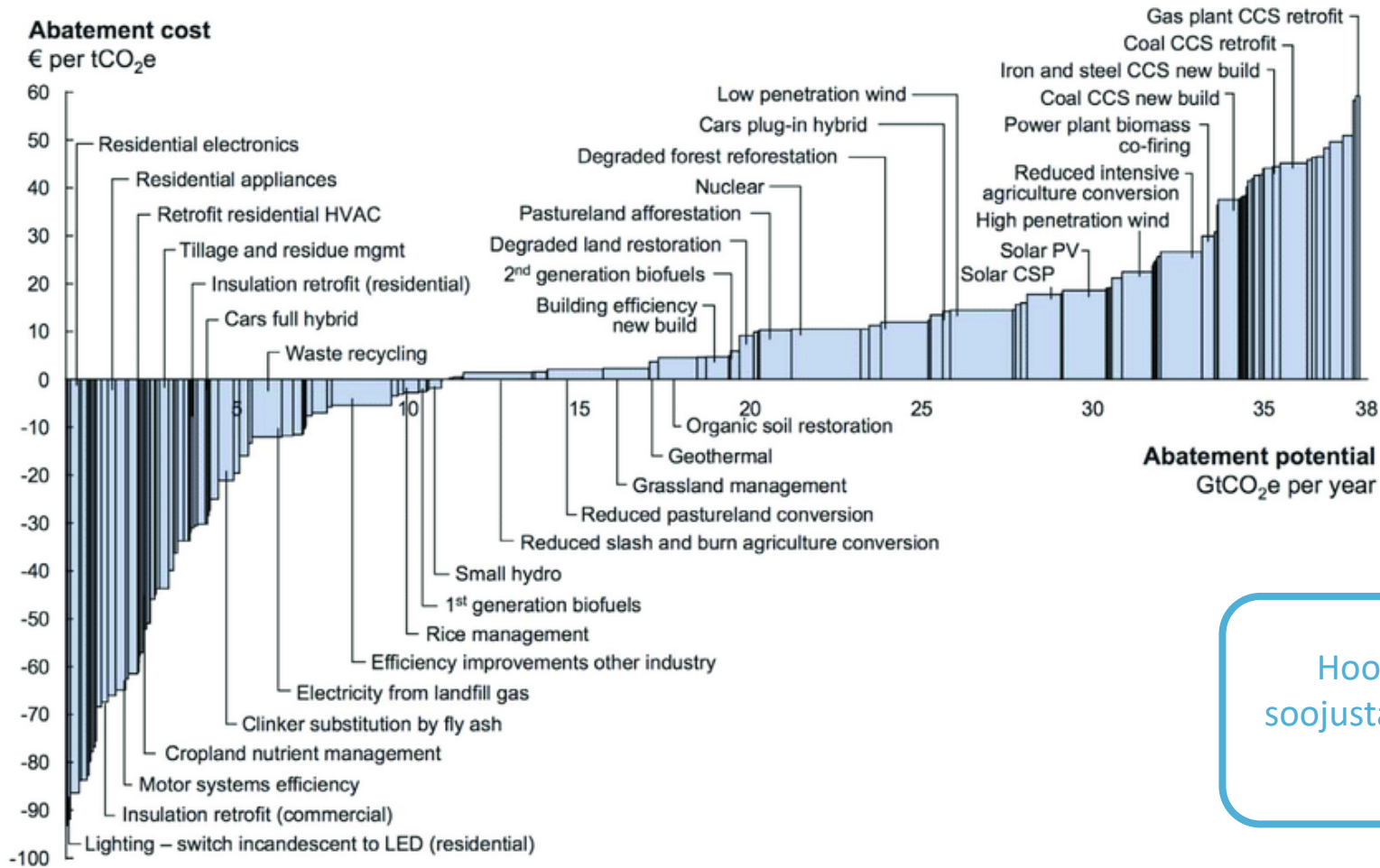
Globaalsed energeetika-valdkonna CO₂ emissioonid (üleval) ja nende iga-aastane muutus (all) gigatonnides. 2020. aasta andmete hinnang on näidatud punasega. Allikas: IEA.



Selleks, et jääda 1,5-kraadise soojenemise piiresse, on vaja jätkata CO₂ heite vähenemisega 2020. aasta tempos järgmised 10+ aastat!



Kust alustada?



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: McKinsey

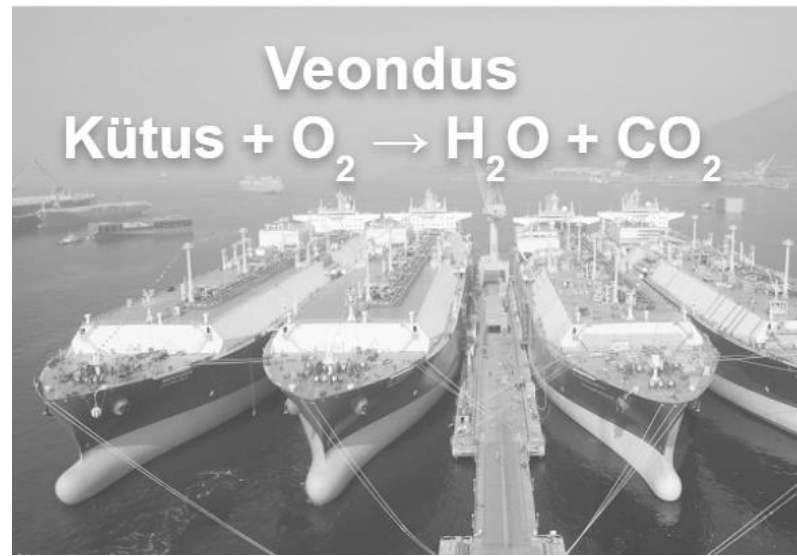
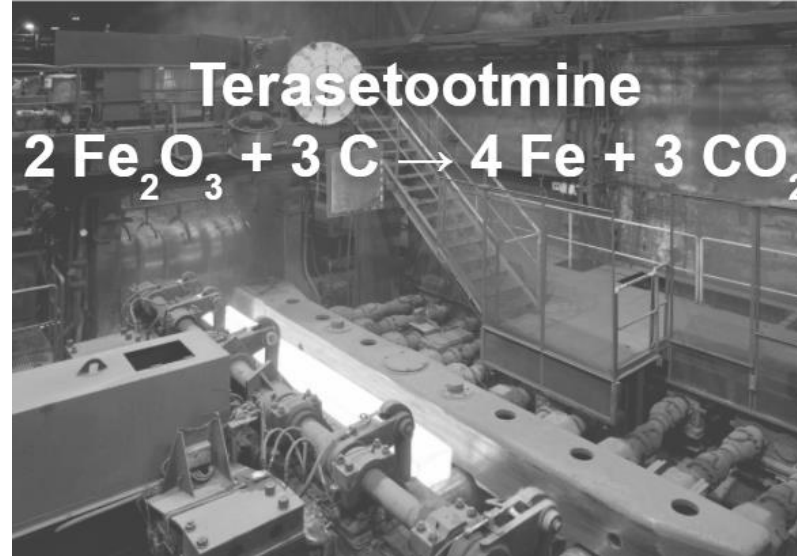
Hoonele, mis ei ole korralikult soojustatud, ei ole mõtet paigaldada päikesepaneele.



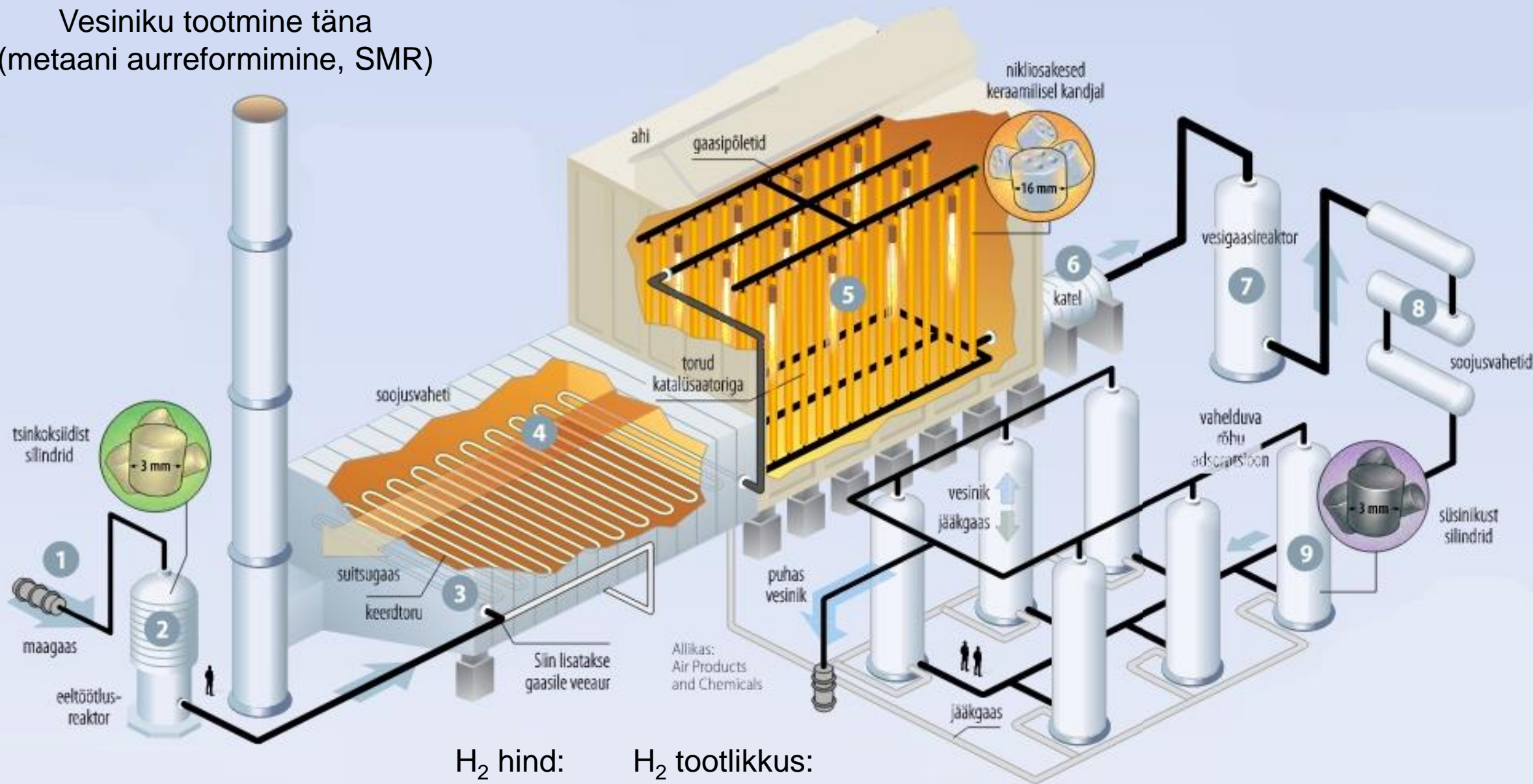
Raskesti dekarboniseeritavad sektorid



Raskesti dekarboniseeritavad sektorid



Vesiniku tootmine täna (metaani aurreformimine, SMR)

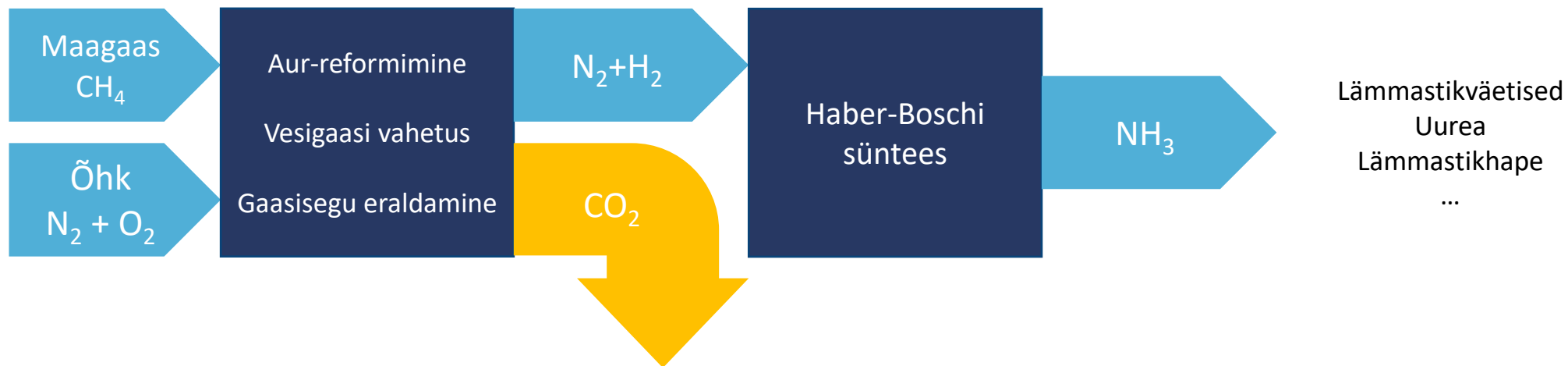


H₂ hind:
1-2 EUR/kg

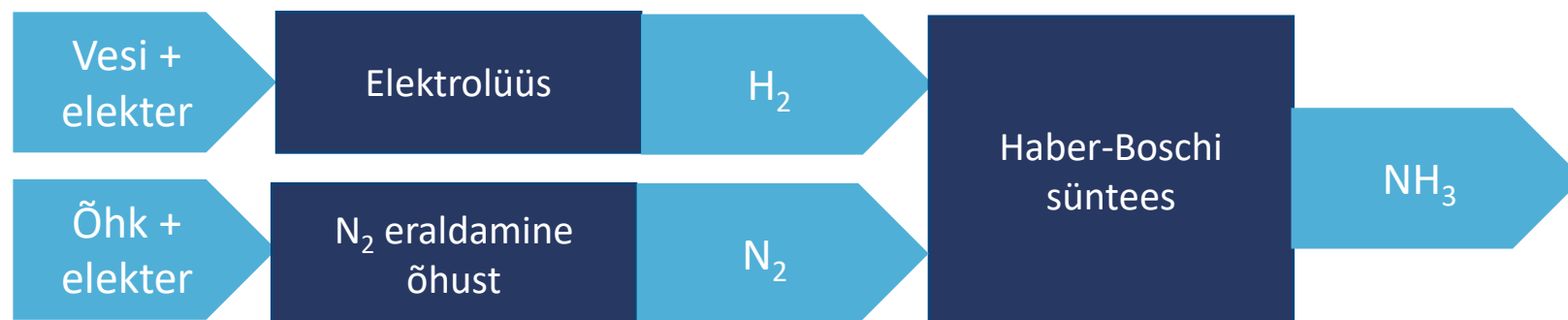
H₂ tootlikkus:
15 t H₂/h

Ammoniaagi tootmine täna ja tulevikus

Hall ammoniaak



Rohe-ammoniaak

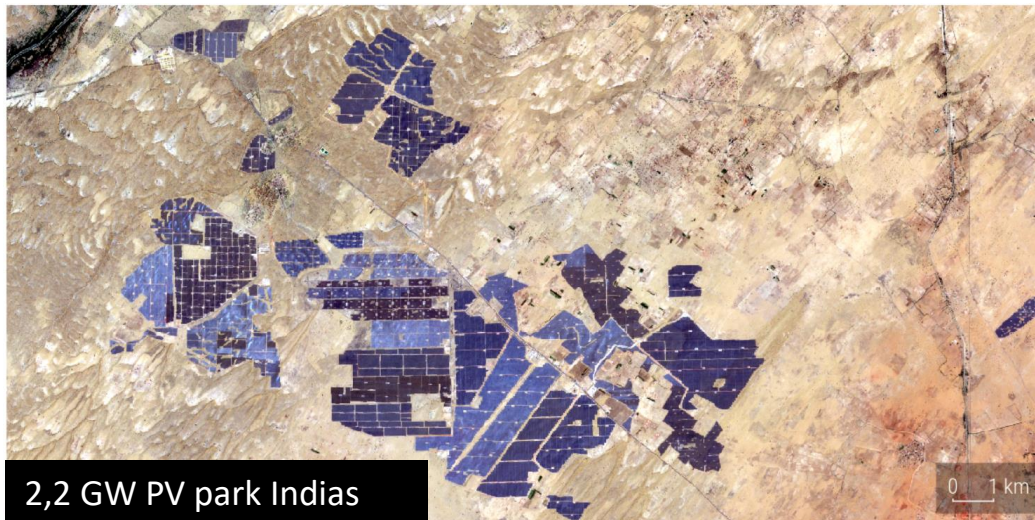
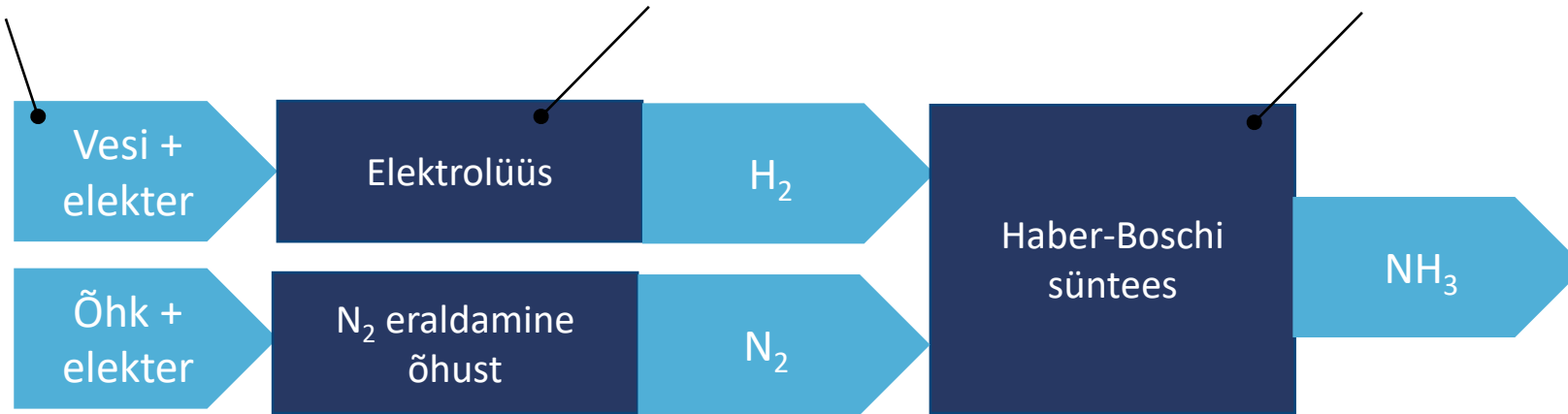


NEOM: rohe-ammoniaagi mega-projekt Saudi Araabias

4 GW päikesepaneelide park
(täna suurim: 2,2 GW park Indias)

2,2 GW elektrolüüsereid
(täna suurim: 0,2 GW park Hiinas)

„Tavalise suurusega“ ammoniaagitehas
(3300 t NH₃/päev)



2,2 GW PV park Indias

- Jaama eeldatav maksumus: 8 miljardit USD
- Planeeritav tootmise algus: 2026



NEOM ja meie tuleviku ammoniaagivajadus

NEOM
(1,2 milj t NH₃/a)



Väetise
tootmine
(200 milj t NH₃/a)

Mere-
transport
(200 milj t NH₃/a)





- Elektrolüüs on juba täna laialdaselt levinud:
 - Alumiiniumi tootmiseks elektrolüüsi teel kulub 4% maailma elektritoodangust (870 TWh)
 - Kloori tootmiseks elektrolüüsi teel kulub 0,8% maailma elektritoodangust (215 TWh)
- Laiatarbe-kemikaalide tootmine elektrolüüsi abil on võimalik ja seda tehakse igapäevaselt.



21. sajandi keemiatööstus on
elektrokeemiatööstus.

Uus tööstus vajab hädasti keemikuid
ja materjaliteadlasi.

Meid ees ootavate väljakutsete
mastaap ei ole enneolematu, aga
me ei ole varem pidanud tegutsema
nii kiiresti.

