BUSINESS FINLAND

VTT

Introduction of Finland's Hydrogen Road Map and EU's hydrogen policy

Juhani Laurikko
Principal Scientist, VTT

ISY Syysseminaari 19.11.2020

INTRODUCTION

- Business Finland contracted VTT to prepare a National Hydrogen Roadmap for Finland in June
- Time horizon for the framework was set to 2030
- The main context was defined to view Finland as a member state in the European Union
- Work was mainly based on information from public sources
- The work encompassed also interviews with relevant industry representatives
- Only public information and results of team VTT's own judgements are presented

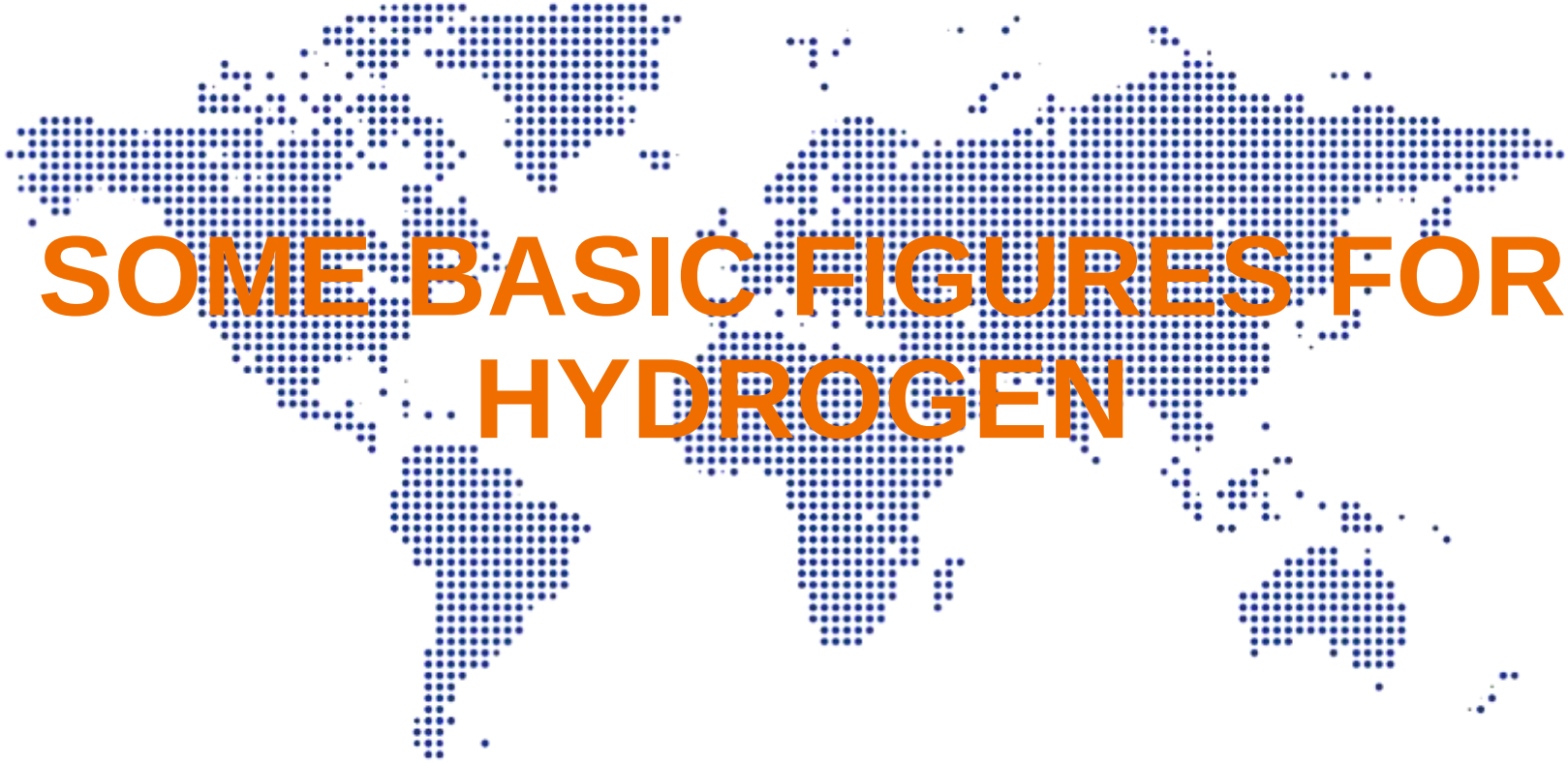
PRESENTATION OF THE CORE TEAM

- **JUHANI LAURIKKO, DTech, Principal Scientist & Project Leader**
- **JARI IHONEN, DTech, Principal Scientist**
- **JARI KIVIAHO, PhD, Senior Principal Scientist**
- **OLLI HIMANEN, DTech, Team Leader**
- **VILLE SAARINEN, DTech, Research Scientist**

- **Additional assistance from: Janne Kärki, Markus Hurskainen and Robert Weiss**

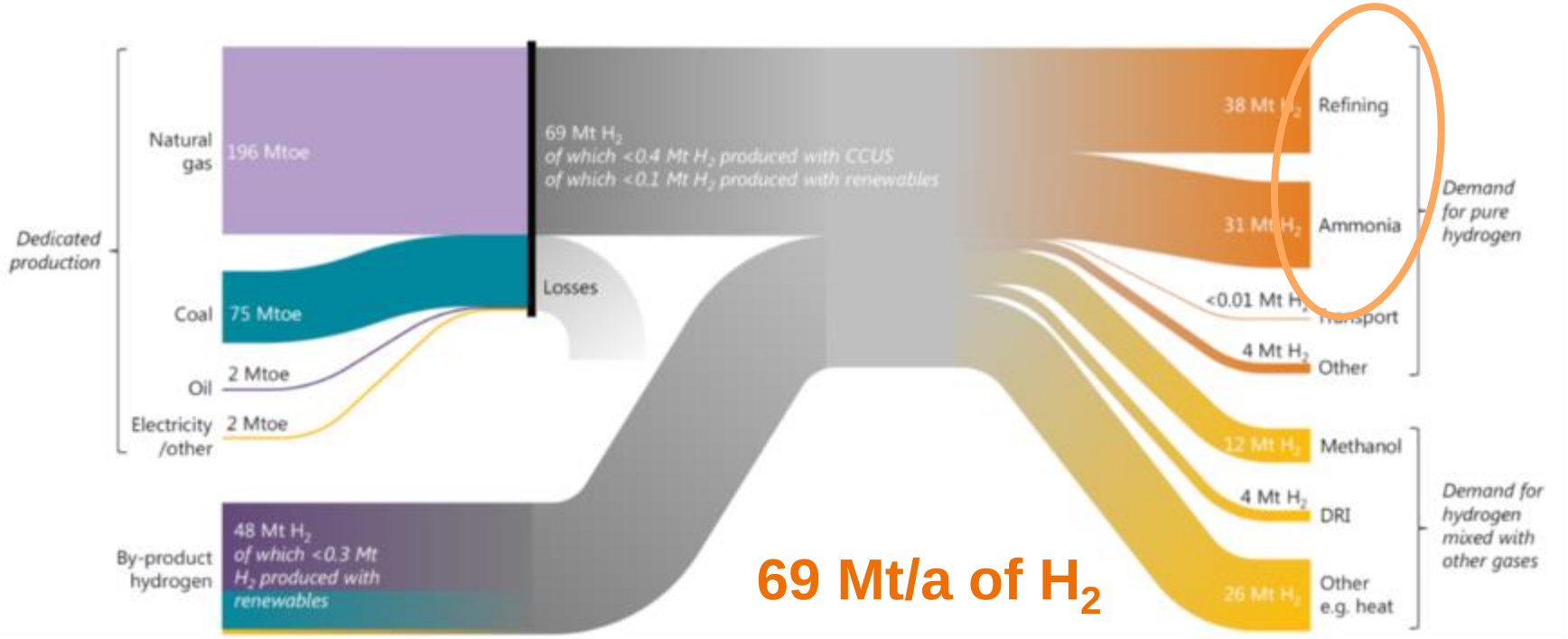
ROADMAP VS. STRATEGY

- In this context, we have characterised that a Roadmap is a description of the operating environment, including rules & regulations, necessary, available (and missing) assets, geography etc., all related to production and use of “good” hydrogen made in a sustainable way
- It serves as a basis for setting a vision and a strategy, and assist in navigating thru the landscape to reach that vision



SOME BASIC FIGURES FOR HYDROGEN

SOME BASIC FIGURES FOR HYDROGEN - GLOBAL



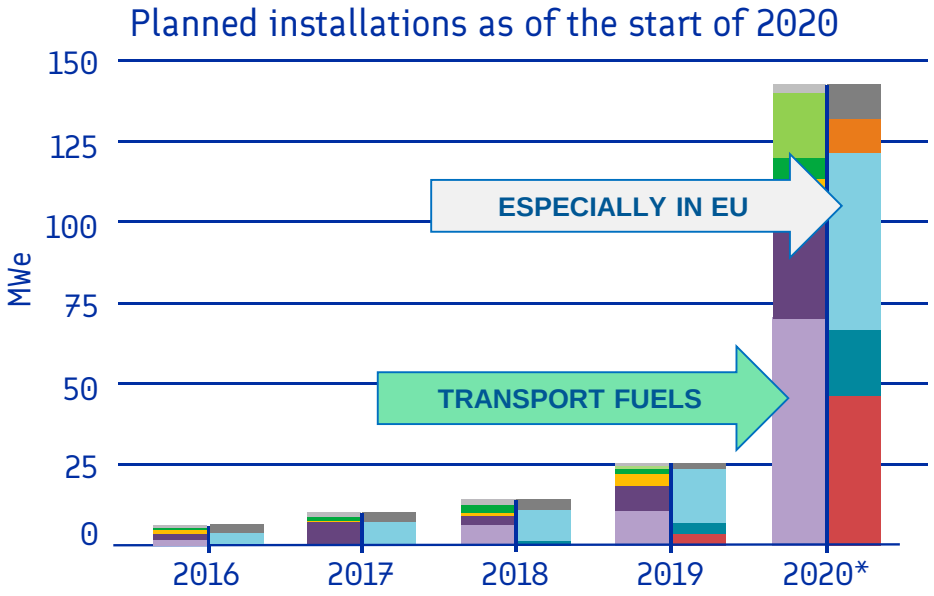
SOURCE: IEA 2019

SOME BASIC FIGURES FOR HYDROGEN - GLOBAL

- **According to IEA, global hydrogen market size is:**
- **69 mt/a of H_2 = 2300 TWh (LVH)**
- **To replace that with renewables, needs about 4000 TWh of new clean electricity generation, which is**
- **More than today's total electricity generation in EU!**

If implemented, equals capturing of about 800 Mt of CO_2 and corresponds to nearly 2% of global emissions

IEA PREDICTS A STEEP GROWTH



By intended use of hydrogen (left) and by geography (right)

By geography (right-side bars)

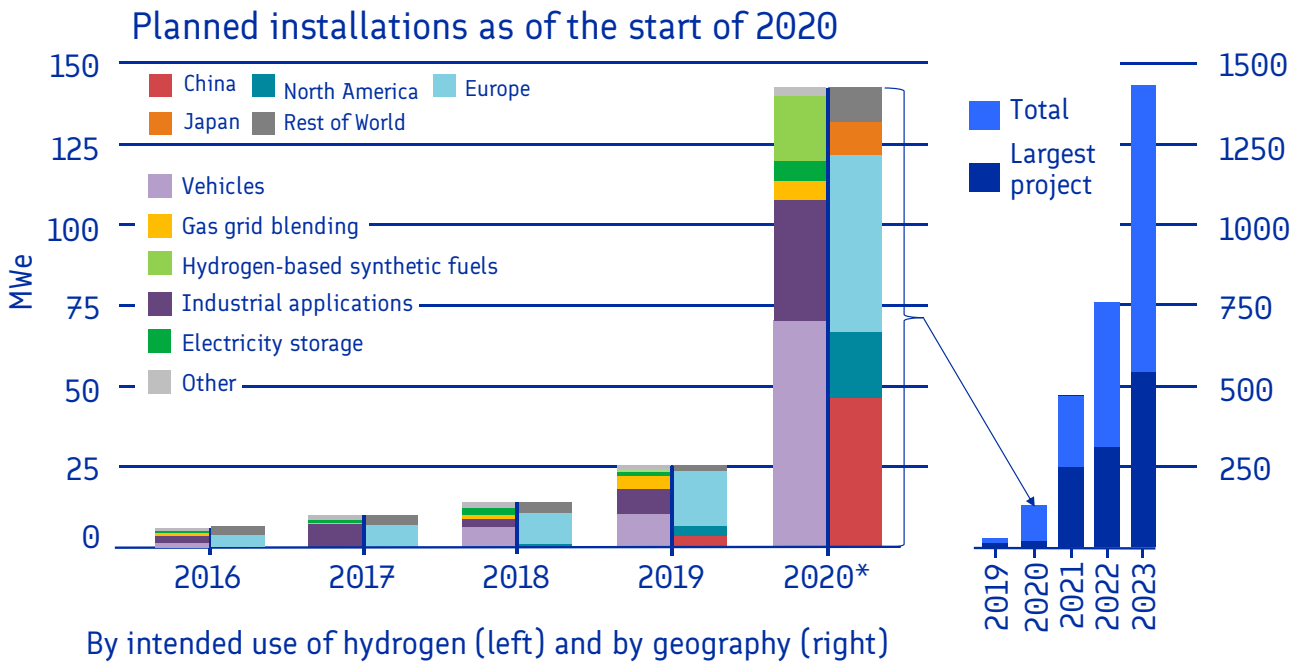
- China
- North America
- Europe
- Japan
- Rest of World

By intended use (left-side bars)

- Vehicles
- Gas grid blending
- Hydrogen-based synthetic fuels
- Industrial applications
- Electricity storage
- Other

Data Source: IEA World Energy Investment (2020)

IEA PREDICTS A STEEP GROWTH



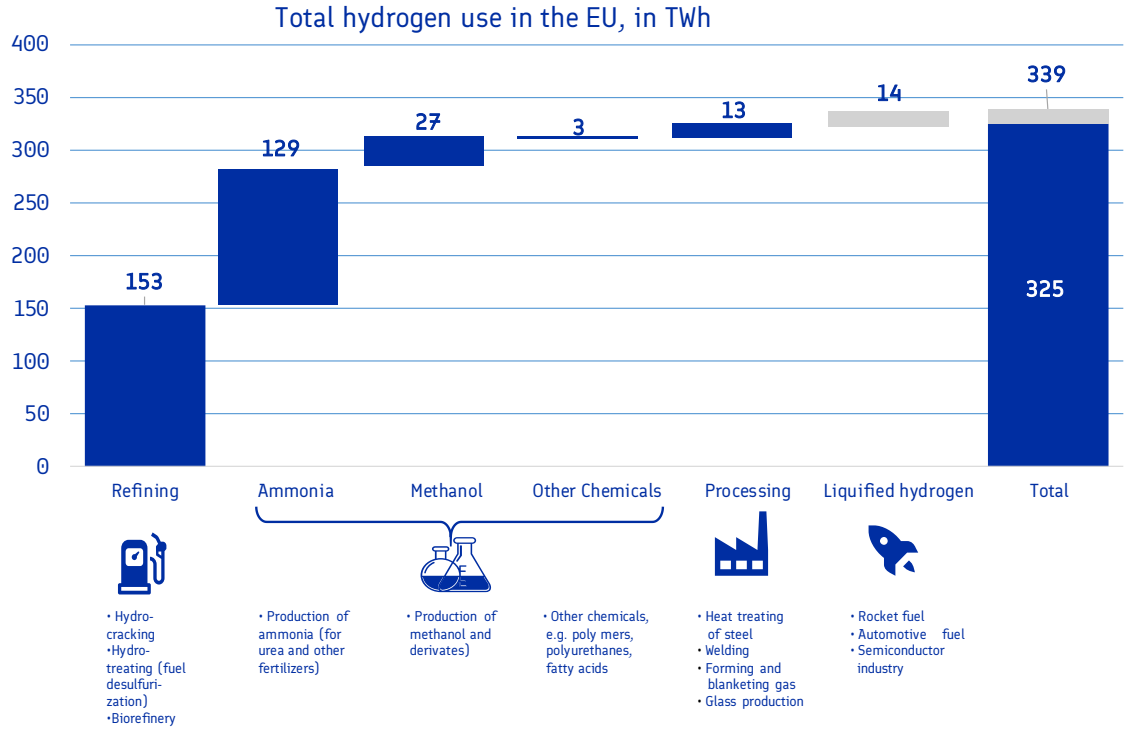
THIS CALLS FOR ADDITIONS IN INSTALLED ELECTROLYSER CAPACITY, BY

SEVERAL GW's ANNUALLY

CAN THE PRODUCTION KEEP UP WITH THIS PACE?

Source: IEA World Energy Investment (2020)

SOME BASIC FIGURES FOR HYDROGEN - EU



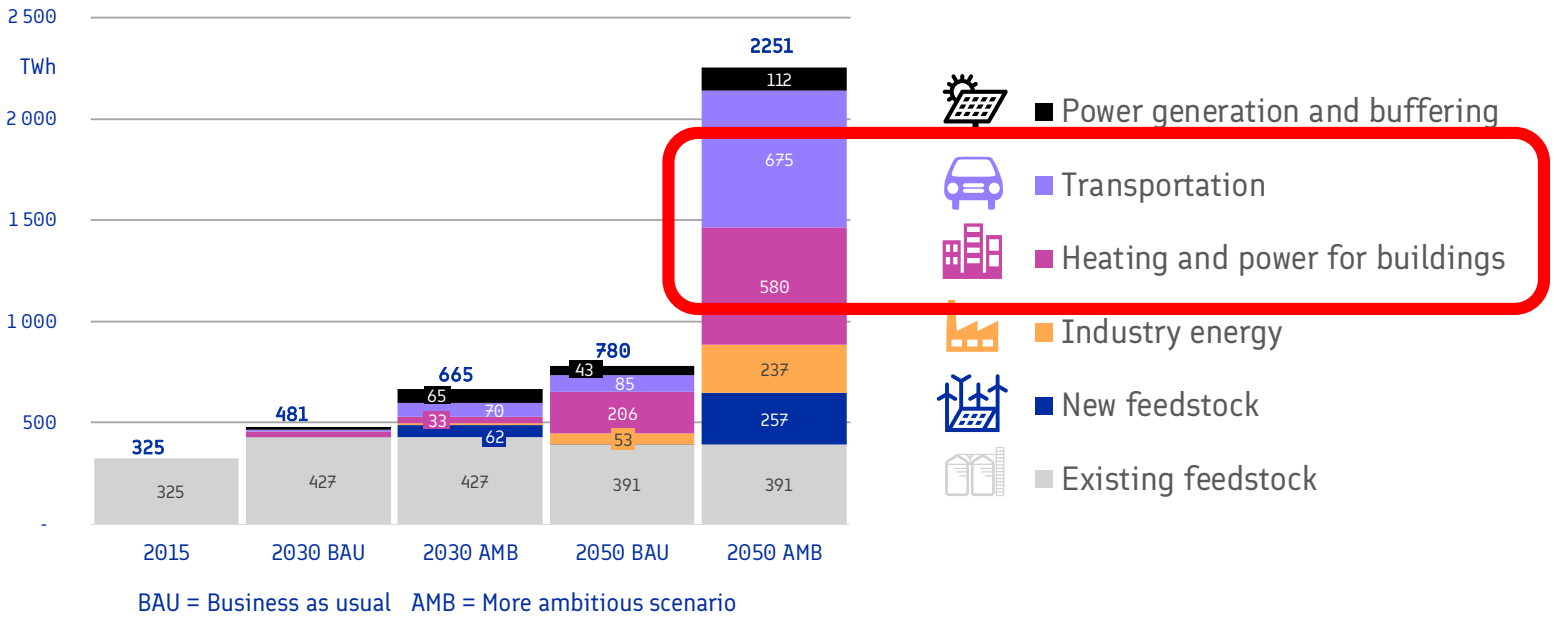
PRESENT USE OF HYDROGEN IN EU IS 339 TWh

- **200 TWh is dedicated, pure H_2 production**
- **Equals 300-350 TWh of new, clean electricity generation**
- **10% of total present electricity use in EU**

Adapted from: FCH JU (2019) Hydrogen Roadmap Europe

EU ALSO ECHOES THE GROWTH

Projected hydrogen demand in EU for 2030 and 2050



BAU = Business as usual AMB = More ambitious scenario

Adapted from: FCH JU (2019) Hydrogen Roadmap Europe

WHY HYDROGEN IS IMPORTANT JUST NOW

WHY HYDROGEN IS IMPORTANT NOW?

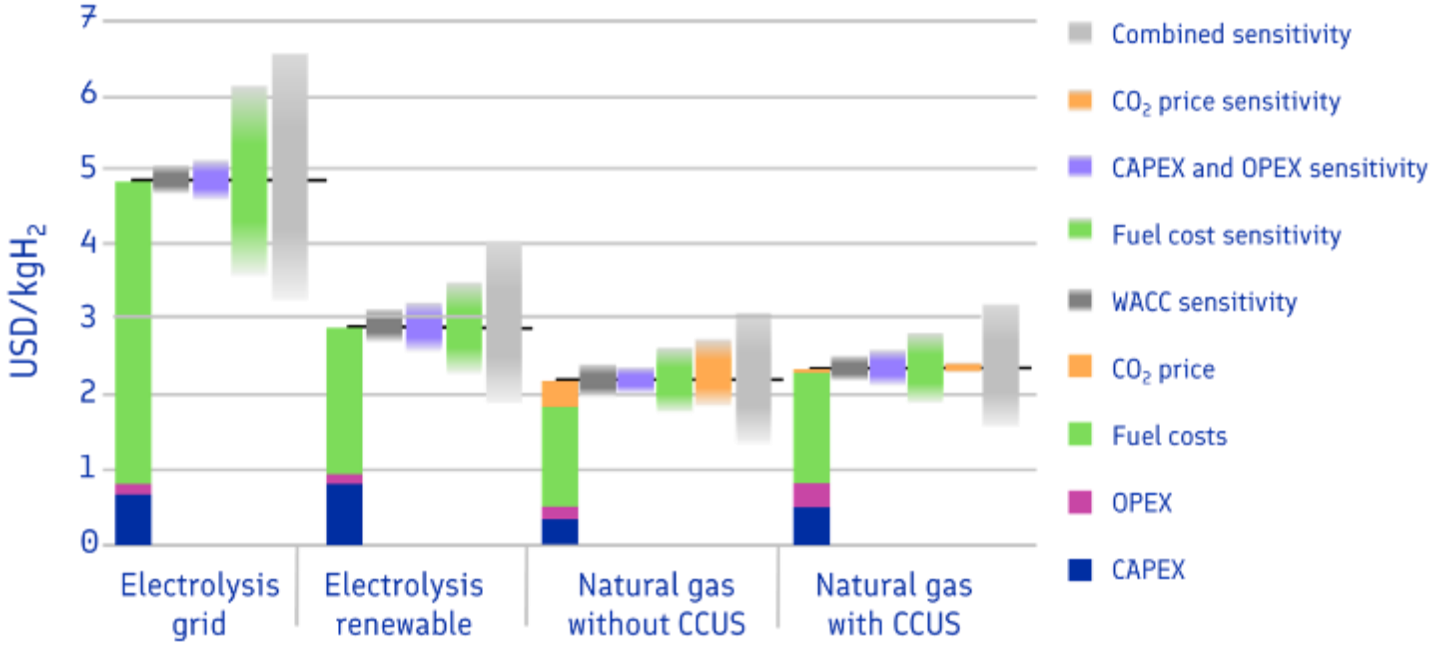
- **In RED II, renewable hydrogen is accepted, both**
  - **as transportation fuel and**
  - **as intermediate product for replacing fossil hydrogen in conventional transport fuels**

- **Other (global) target programmes for GHG reductions**

- **Reduction of the cost of ”good” hydrogen, due to**
  - **Progress in the technology of electrolysers**
  - **Increasing production of low-cost renewable electricity**

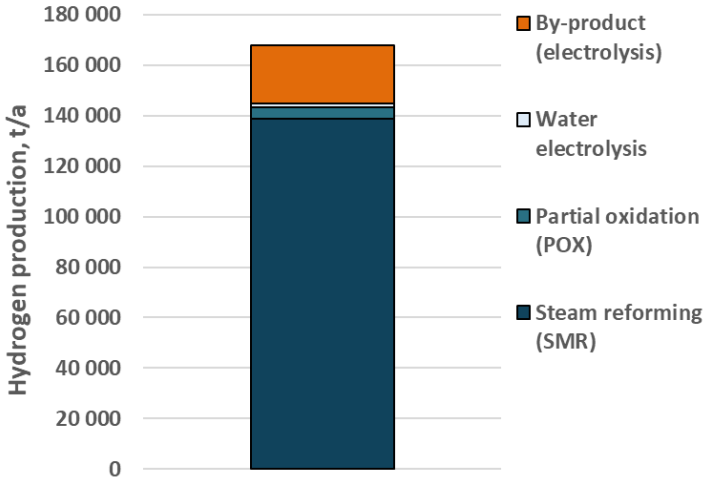
COST OF “GOOD” HYDROGEN IS A HIGHLY ELUSIVE FIGURE

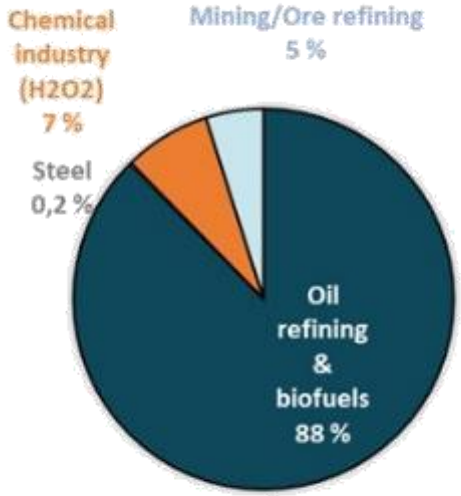
PRODUCT COST IS DEPENDENT ON A MULTITUDE OF DIFFERENT FACTORS



HYDROGEN IN FINLAND

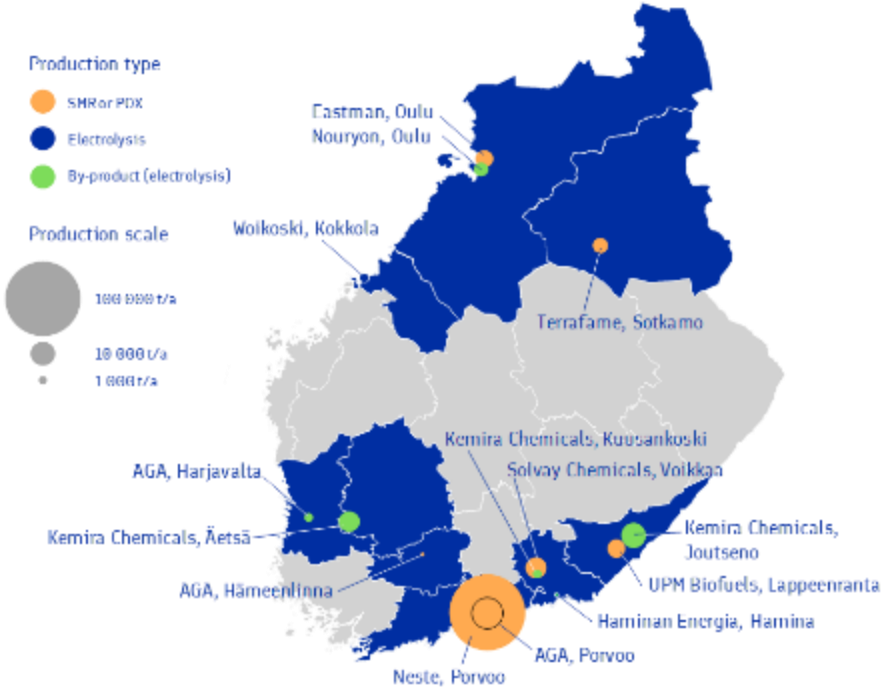
HYDROGEN FINLAND – CURRENT PRODUCTION AND USE





CURRENT PRODUCTION AND USE CA. 150 000 t/a

HYDROGEN FINLAND – CURRENT PRODUCTION AND USE

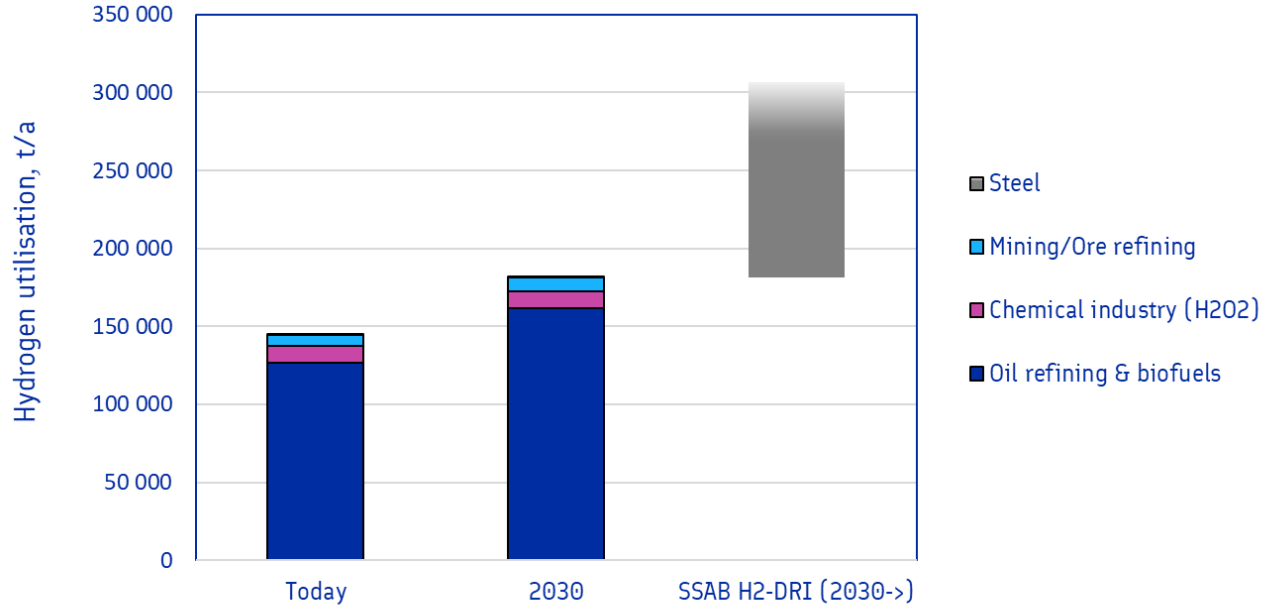


CURRENT PRODUCTION AND USE CA. 150 000 t/a

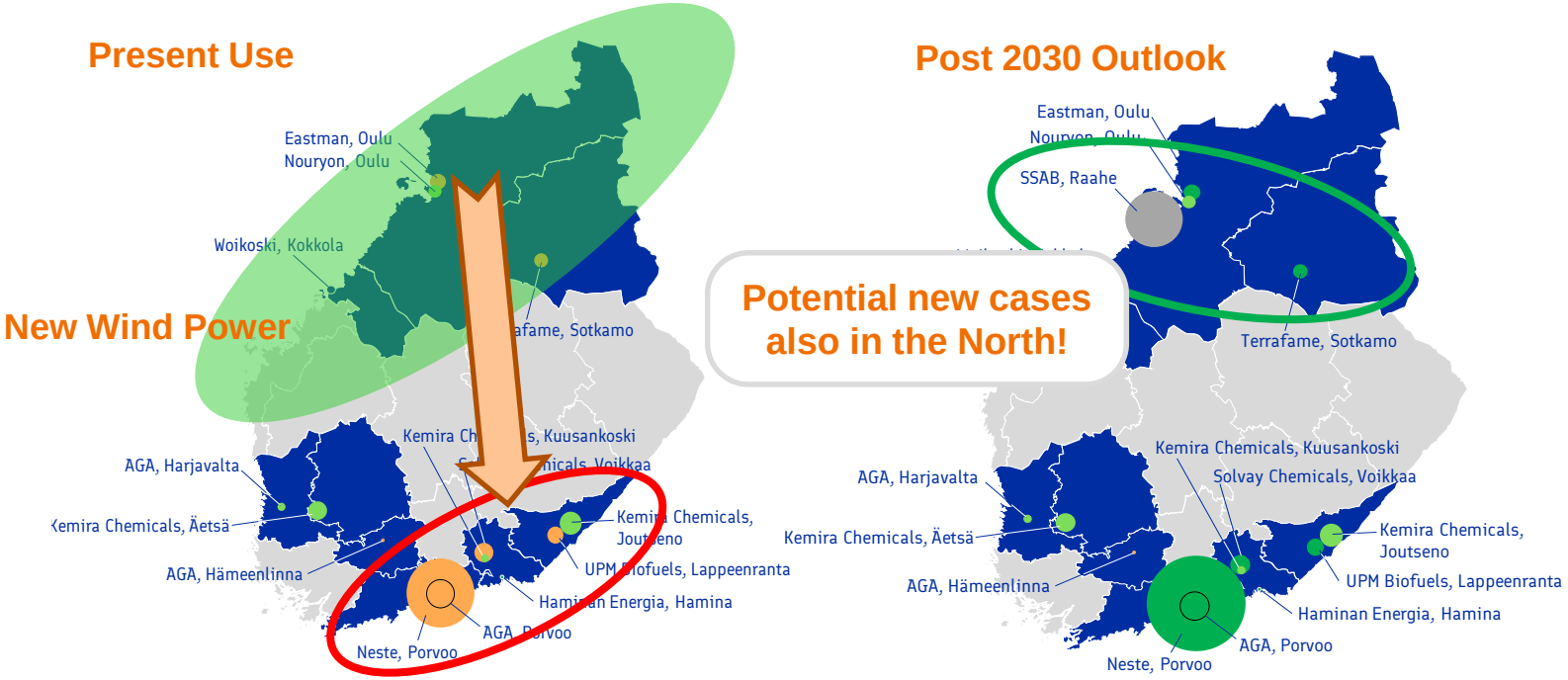
POTENTIAL NEW USE OF HYDROGEN IN FINLAND

- **Existing/enlarging production of renewable transport fuels**
  - **Neste/Porvoo: HVO/NEXBTL***
  - **UPM Kymmene/Lappeenranta: HVO/BioVerno***
- **Terrafame mine, Sotkamo**
  - **production of H_2S for the ore refining process***
- **SSAB steel plant, Raahe**
  - **production of CO_2-free steel (Hybrit process)**
- **Direct use in heavy transport vehicles**
  - **Use of hydrogen fuel cells to lower transport costs in selected point-to-point logistic cases**

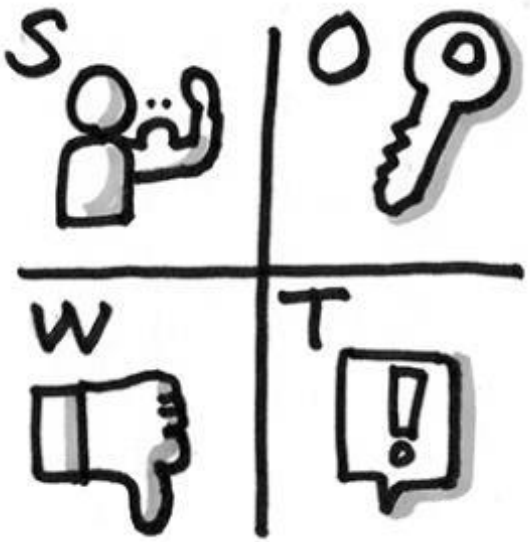
POTENTIAL NEW USE OF HYDROGEN IN FINLAND



NEW WIND POWER GENERATION IN FINLAND



SWOT FOR FINLAND



SWOT FOR FINLAND – STRENGHTS & ASSETS

- **Good wind resources – both onshore & offshore**
- **Strong electricity transmission grid**
- **Stable, predictable regulation framework**
- **Strong experience in industrial hydrogen use**
- **Repurposing of the present natural gas pipeline (?)**

SWOT FOR FINLAND – WEAKNESSES

- Higher electricity market price vs. Sweden & Norway
- Less hydrogen experience outside of industry
- No hydrogen use in traffic & transportation
- No formations like salt caverns (for storage)

SWOT FOR FINLAND – THREATS

- **Changes and/or interpretations of RED II Directive that could prove to be unfavourable for Finland**
- **Price of technology remains high***
- **Low prices for fossil fuels and CO_2 allowances***
- **Delayed scale-up of electrolyser manufacturing capacity***

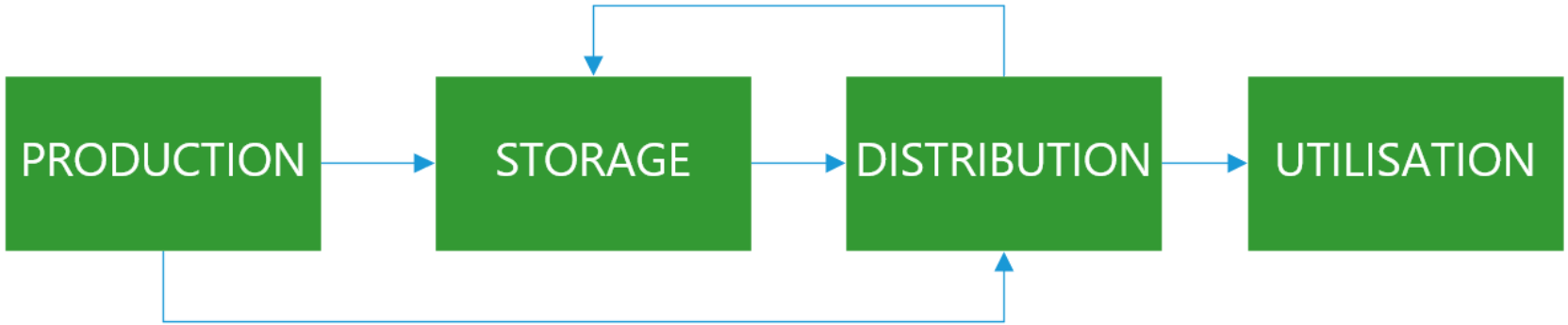
*not unique to Finland, but global

SWOT FOR FINLAND – OPPORTUNITIES

- **Existing production of renewable transportation fuels**
- **Cost-efficient decarbonisation of existing hydrogen use**
- **Enabler for CO_2-free steel production**
- **Offers lowering the cost of logistics for industry**
- **Use of waste heat for district heating purposes**

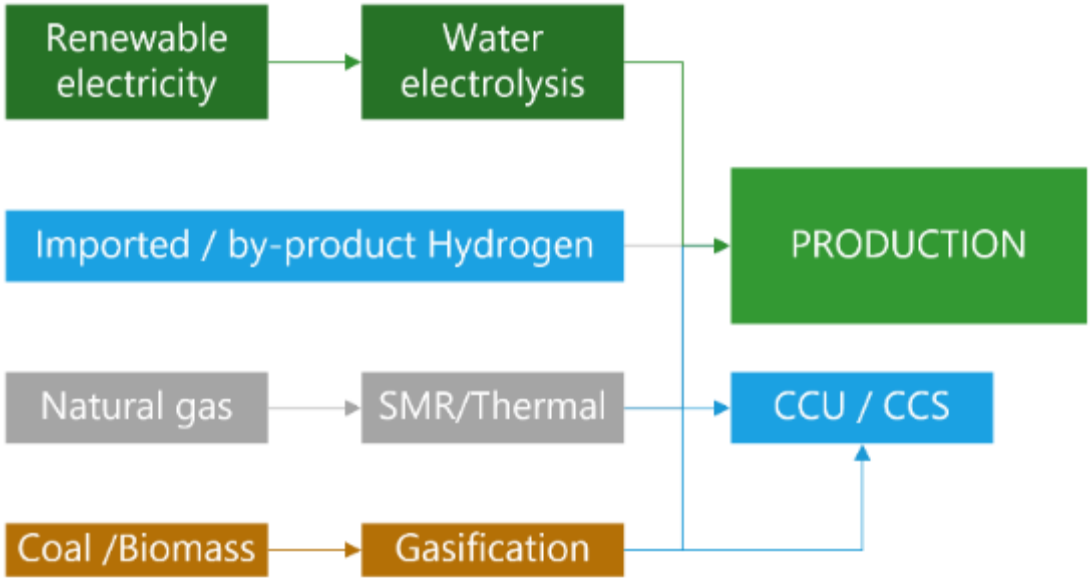
HYDROGEN VALUE CHAIN ANALYSIS FOR FINLAND

SIMPLE VALUE CHAIN FOR HYDROGEN



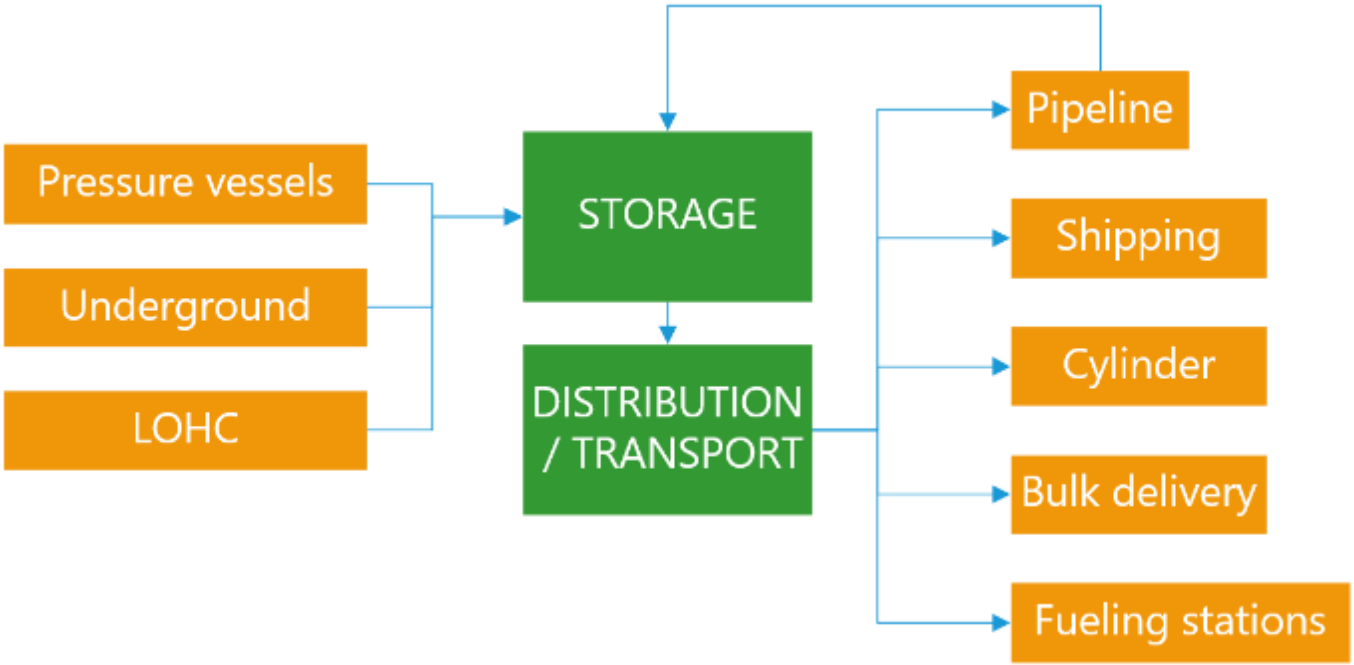
Graph: Ville Saarinen, VTT

VALUE CHAIN FOR HYDROGEN PRODCUTION



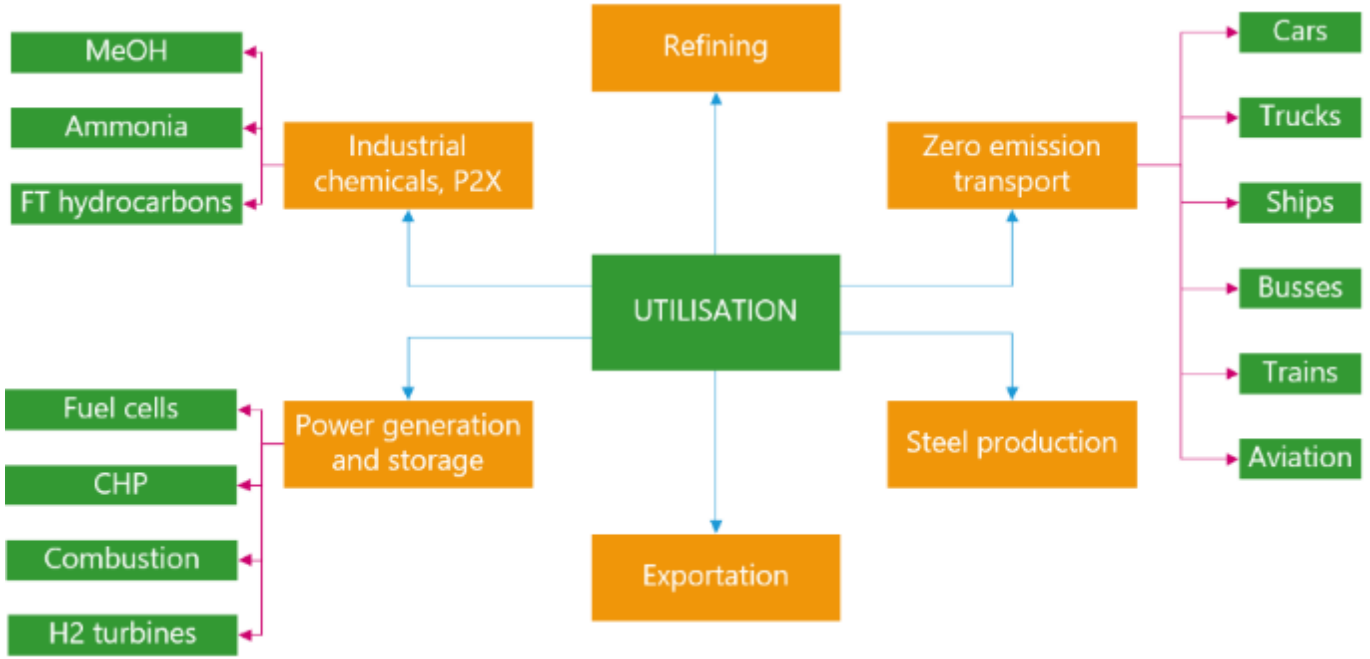
Graph: Ville Saarinen, VTT

VALUE CHAIN FOR HYDROGEN STORGAGE & DISTRIBUTION



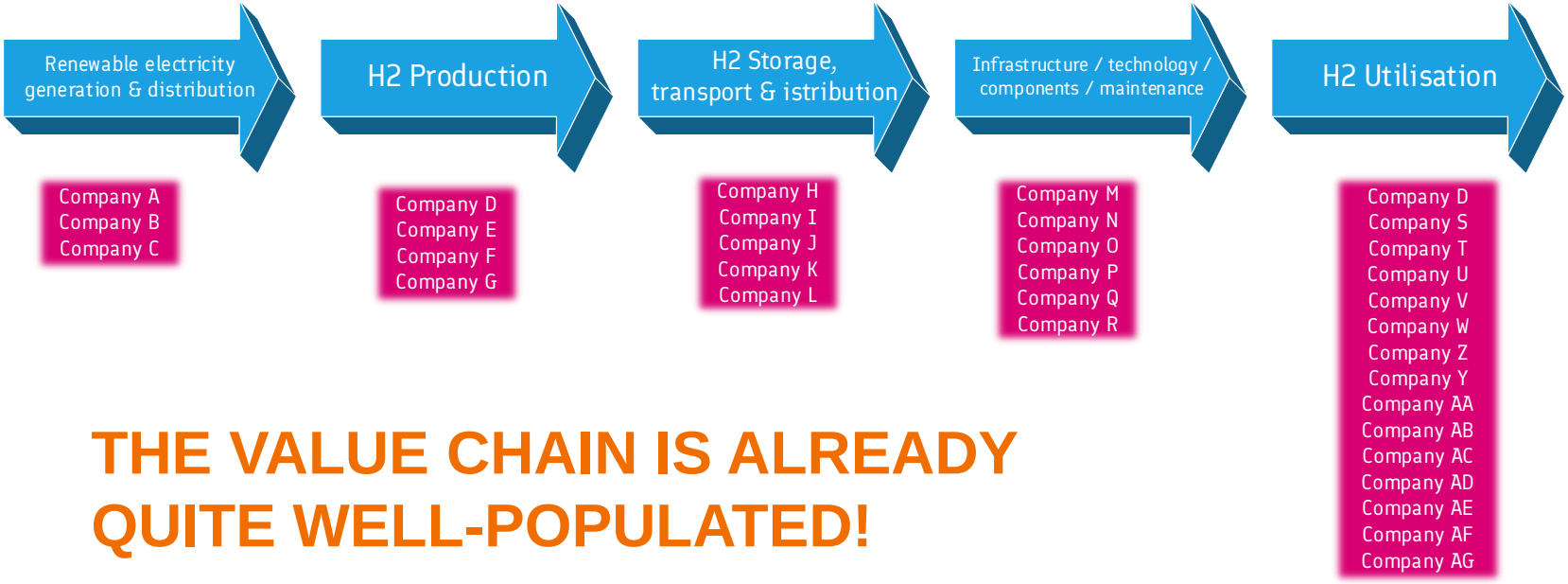
Graph: Ville Saarinen, VTT

VALUE CHAIN FOR HYDROGEN UTILISATION



Graph: Ville Saarinen, VTT

VALUE CHAIN FOR HYDROGEN IN FINLAND



THE VALUE CHAIN IS ALREADY QUITE WELL-POPULATED!

Graph: Ville Saarinen, VTT

KEY FINDINGS AND RECOMMENDATIONS

PRODUCTION

- We need additional low carbon electricity and strengthening of grid
- In Finland, use of by-product heat from electrolysis is an opportunity, and should be studied more
- Fossil hydrogen can be gradually replaced by hybridising the existing system with electrolysers and short-term local hydrogen storage
- Potential for green hydrogen is between 100 kt and 150 kt by 2030 mostly in same location as now
- In some new locations large-scale hydrogen use can start, if the financials are good enough, e.g. carbon-free steel

STORAGE & TRANSPORATION

- **Use of clean hydrogen in large industrial facilities favours hydrogen supply chain solutions, centralised electrolyser units and transport of hydrogen to smaller consumers**

- **First transport is by tube trailers, but pipelines can be built later**
- **Pipelines enable larger hydrogen storage facilities and improve security of supply**

ENERGY CONVERSION AND STORAGE

- Use of hydrogen as energy buffer needs large-scale storages
- Cost of storage is also a key parameter for end-user price
- Value of hydrogen as energy storage comes from electrolysers reacting fast, and production can be quickly shut down in a shortage of power

- R and D of most feasible storage options should be initiated, leading to
- Demonstration of first industrial-scale storage, and later to
- Build-up of the first large-scale storage

INDUSTRIAL USE

- **Clean hydrogen can replace fossil-based hydrogen in all industrial use when cost-competitive**
- **There is direct positive net effects as carbon emission reductions, but also indirect for national economy, when imported energy, mainly natural gas, is replaced by indigenous renewable electricity.**
- **Support use of hydrogen in P2X and other new applications, and**
- **Study the impact of replacing imported chemicals like ammonia and methanol with equivalents made with renewable electricity**

MOBILITY AND FUEL CELLS

- Follow the widening offering of hydrogen-fuelled heavy transport vehicles
- Study the potentials of hydrogen use in selected candidate cases, and ensure that effects of climate are studied
- Develop step-by-step scenarios in connection with international developments in HRS and filling stations
- Follow progress in marine applications, as Ahvenanmaa archipelago could become an excellent test area

OVERARCHING ISSUES

- Follow development and revisions of RED II directive, as changes may have substantial consequences
- Ensure that all national rules for safety do not hinder enlargement of use of “good hydrogen”
- Communicate effectively and widespread that all safety aspects of hydrogen use are well catered
- Consider need of raising the status of hydrogen in all public education
- Continue inventory of industries that can use hydrogen in future
- Support the integration of hydrogen into national energy, industrial and transport policies

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

- **Finland has already a fairly well-populated value chain for hydrogen production and use**
- **Strong grid and potential for new renewable electricity generation**
- **Strong high-tech industry in hydrogen technology**
- **Identified, potential large-scale targets for new hydrogen use**
- **Good potential to accelerate RD&D efforts, but also some other cases suitable for public support**
- **Safety and security issues must be communicated effectively**
- **Enlarging hydrogen-related domestic market is necessary**

https://www.businessfinland.fi/4abb35/globalassets/finnish-customers/02-build-your-network/bioeconomy--cleantech/alykas-energia/bf_national_hydrogen_roadmap_2020.pdf

VTT

beyond
the obvious

Juhani Laurikko
juhani.laurikko@vtt.fi
+358 20 722 5463

@VTTFinland

www.vtt.fi