

# FLYWHEEL FOR INNOVATION

NL-IL Mini-Symposium on Green Hydrogen Production

Date: 29 April 2021 11:00-13:00 IL time / 10:00-12:00 NL time

**TNO** innovation  
for life

## Green Hydrogen

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TNO.NL

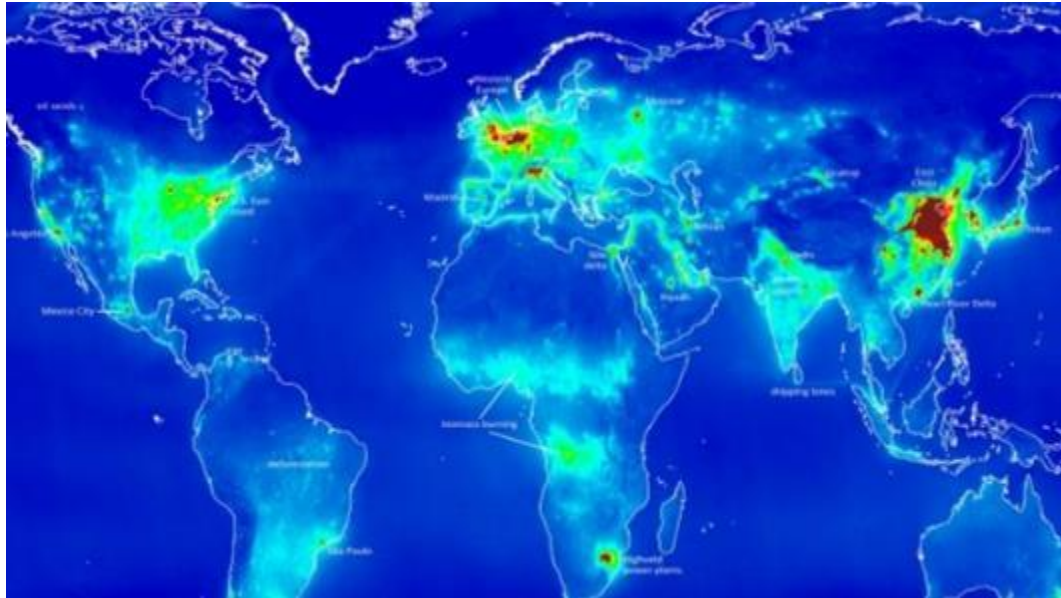
intermediair  
FAVORIEETE  
WERKGEVER  
AWARDS

18

# Research along the entire hydrogen supply chain

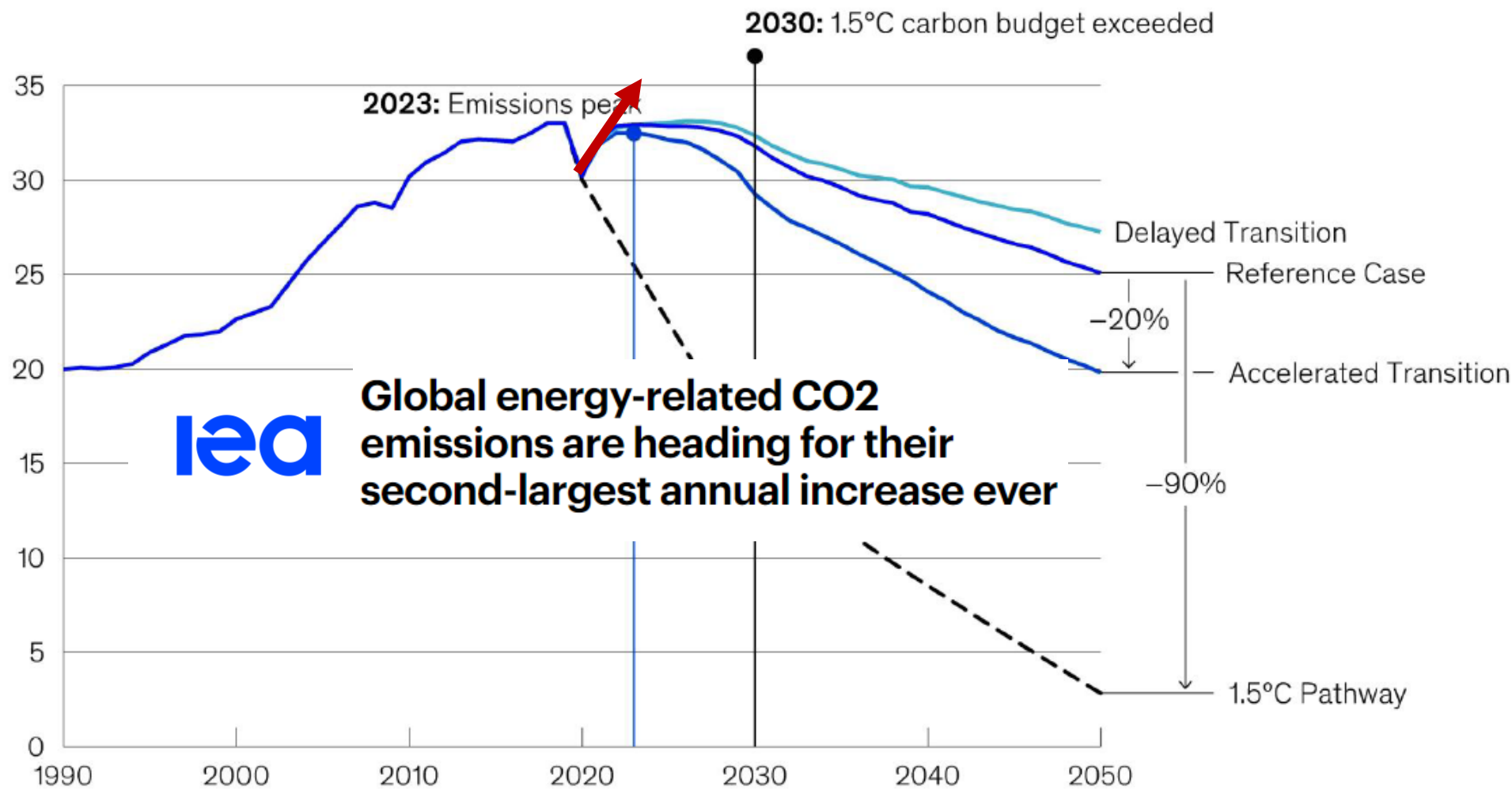


# WHY THE NETHERLANDS SHOULD LEAD THE TRANSITION TOWARDS A SUSTAINABLE ENERGY SYSTEM



# ACCELERATION IS NEEDED TO STAY UNDER THE 1,5°C GLOBAL WARMING.

## GLOBAL ENERGY RELATED CO2 EMISSIONS, GTCO2 PER YEAR



Source: McKinsey Global energy perspectives 2021 ([link](#))

# INTERNATIONAL COOPERATION OF LEADING INSTITUTES

POSITION PAPER

## HySpeedInnovation

A JOINT ACTION PLAN  
FOR INNOVATION AND UPSCALING  
IN THE FIELD OF WATER  
ELECTROLYSIS TECHNOLOGY

**cea**

**Fraunhofer IFAM**

**Fraunhofer ISE**

**Hydrogen Europe Research**

**JÜLICH**  
Forschungszentrum

**SINTEF**

**TNO** innovation for life

**MIT** MITREAN INSTITUTE OF TECHNOLOGY

**INSTITUTE IDEA**

**DLR**

**Institute for Sustainable Process Technology**

**FONDAZIONE BRUNO KESSLER**

**IREC<sup>R</sup>**  
Sharing Energy for a Sustainable Future

**eifer**  
European Institute for Energy Research

**LNEG**

**Empa**  
Materials Science and Technology

**tecnalia** Inspiring Business

**Fraunhofer IPT**

**VTT**

**H<sub>2</sub>** HYDROGEN FOR A SUSTAINABLE FUTURE

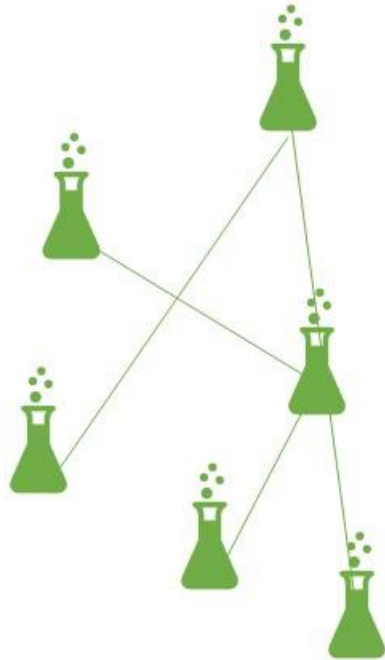
**ZSW**

**HyCentA**  
HYDROGEN CENTER OSTRAVA

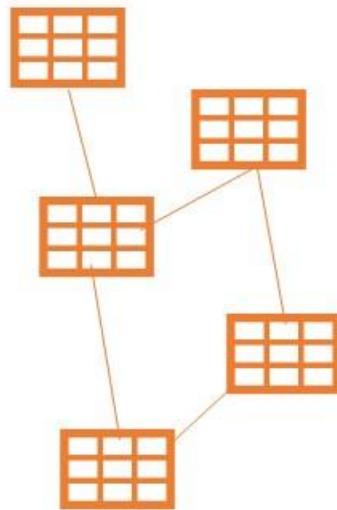
Source: TNO (2020) European RTOs: accelerating development of electrolysis ([link](#))

# HOW CAN WE ACCELERATE?

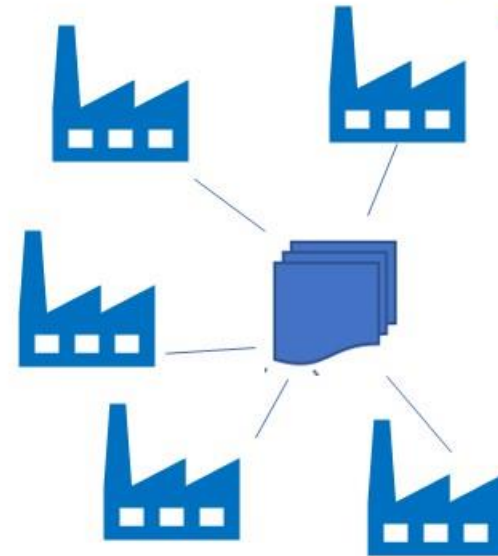
HySpeedInnovation how the research institutes accelerate green hydrogen → GW green hydrogen



(1) Connecting hydrogen labs



(2) Set clear quality standards



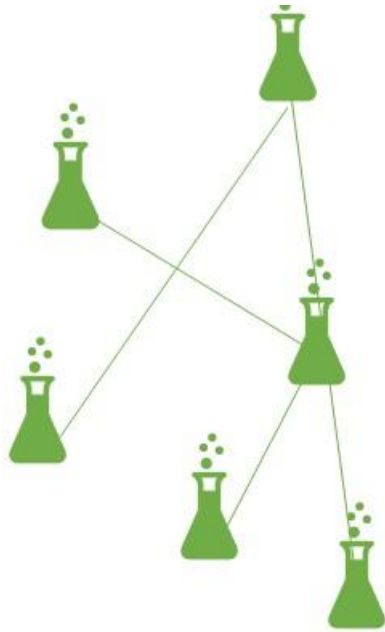
(3) Monitoring performance of subsidized pilots



Results: Faster learning curves

# › INNOVATION IS ESSENTIAL FOR COST REDUCTION

**HySpeedInnovation** how the research institutes accelerate green hydrogen → GW green hydrogen



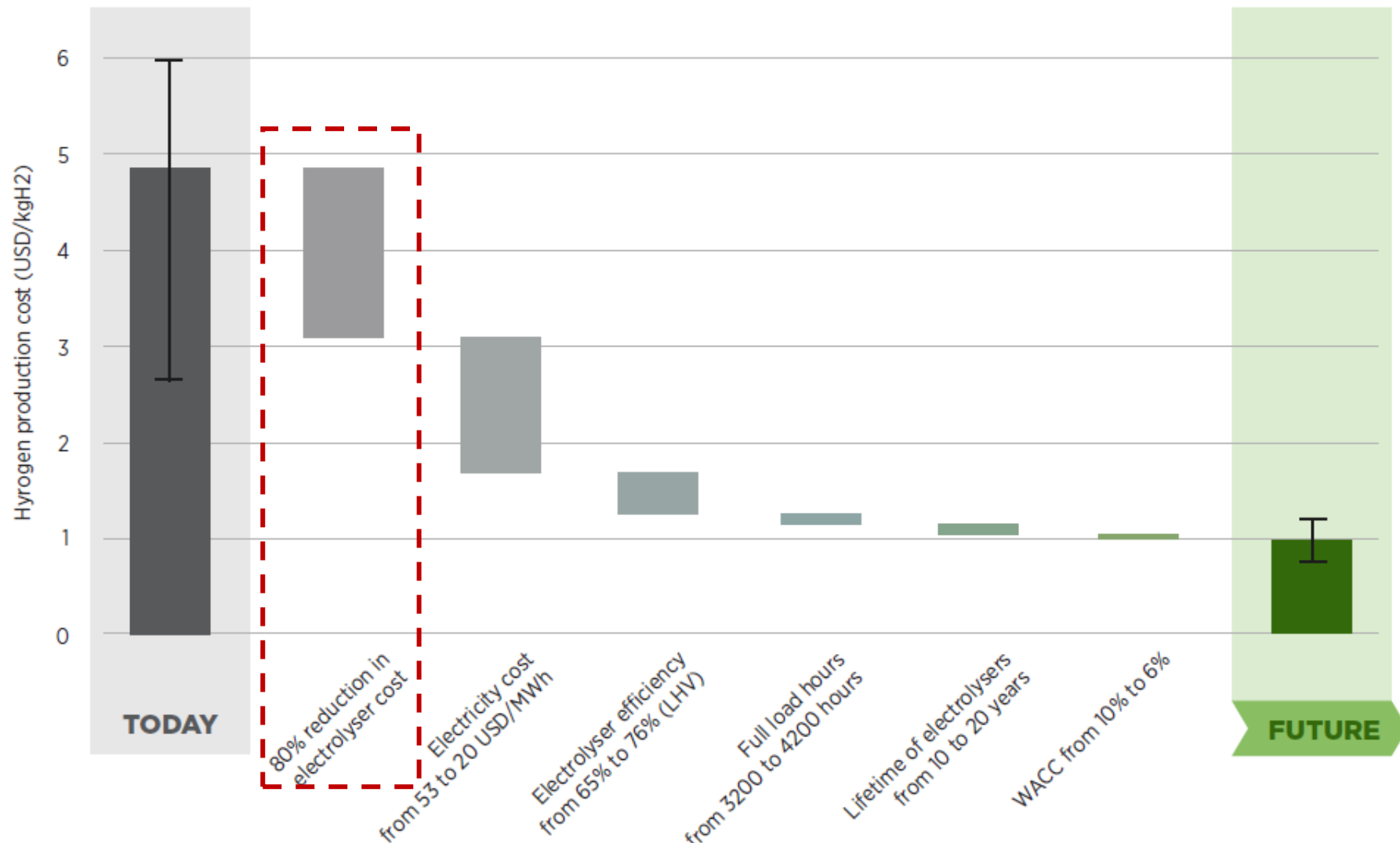
- › To reach the needed electrolyser cost reduction novel materials, and components are required
- › A complete new supply chain is needed to meet the future demand. Support innovative newcomers
- › Work on the 2<sup>nd</sup> generation electrolyser systems is crucial

(1) Connecting hydrogen labs

Create a strong European R&D infrastructure

# COST REDUCTION POTENTIAL GREEN HYDROGEN

## -85% IS EXPECTED

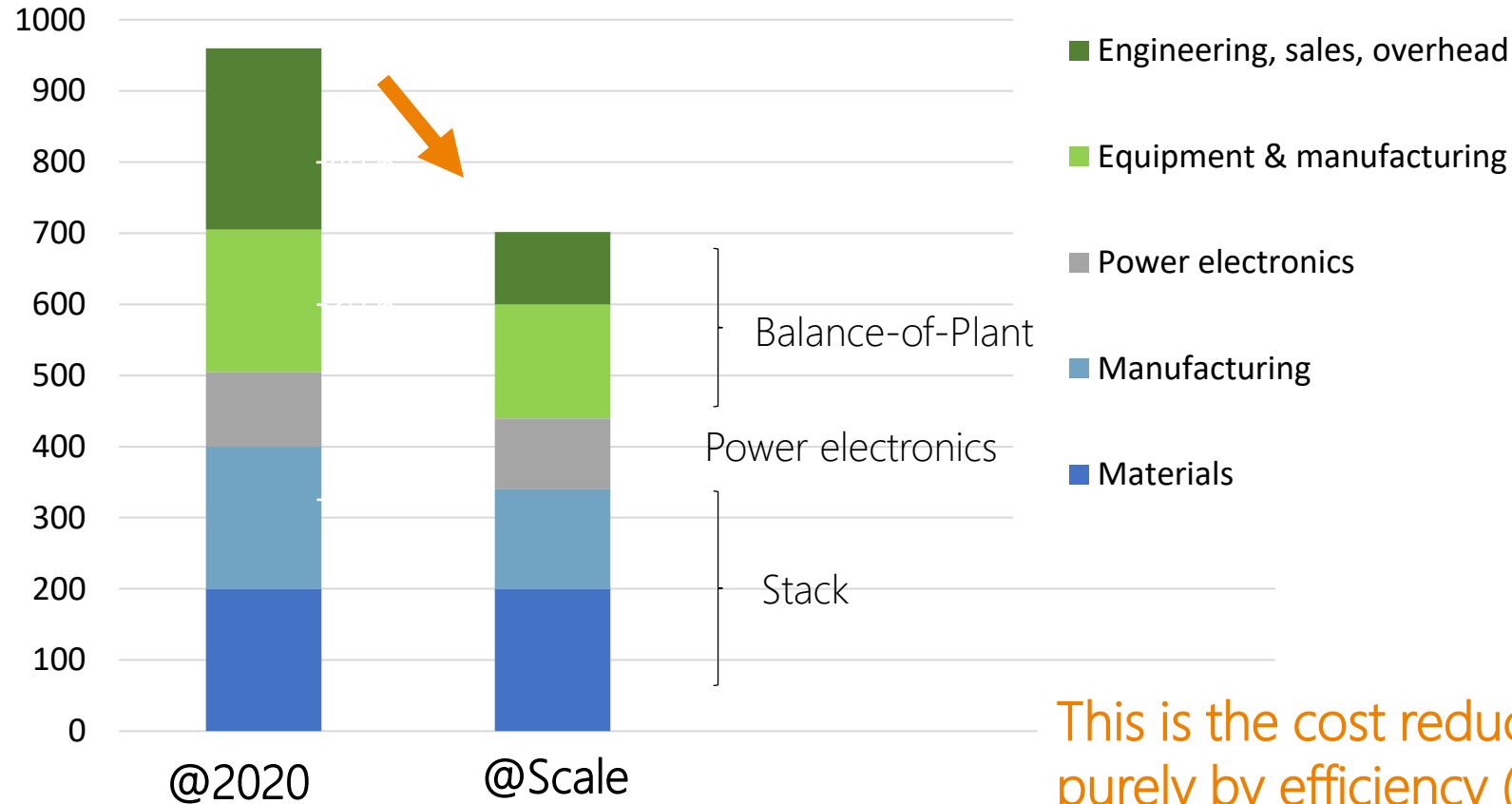


Increase **value** of green hydrogen!



# ELECTROLYSER SYSTEM COST ESTIMATE

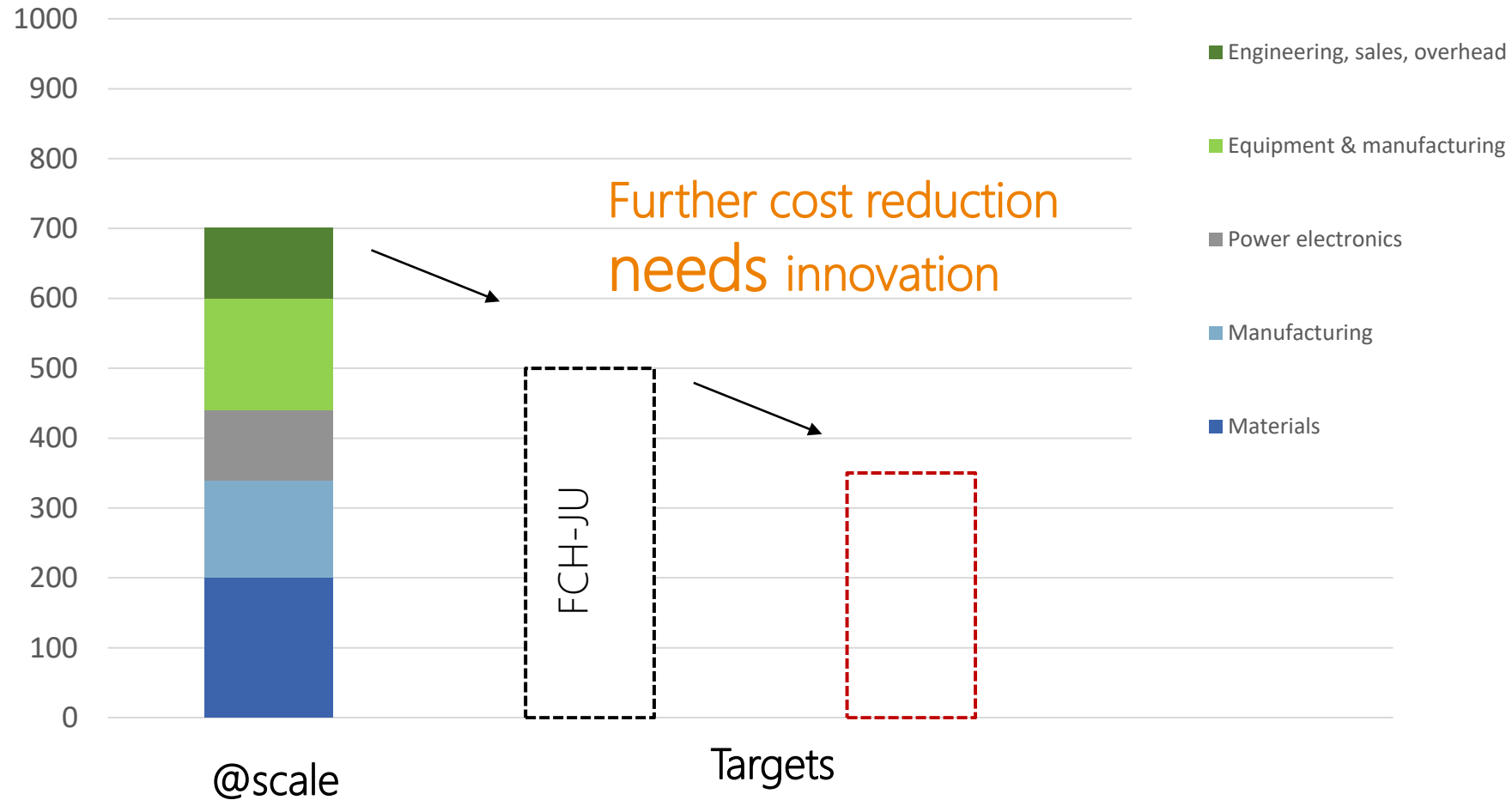
COST REDUCTION BY STANDARDISATION AND REMOVING INEFFICIENCIES



This is the cost reduction achieved purely by efficiency (no innovation)

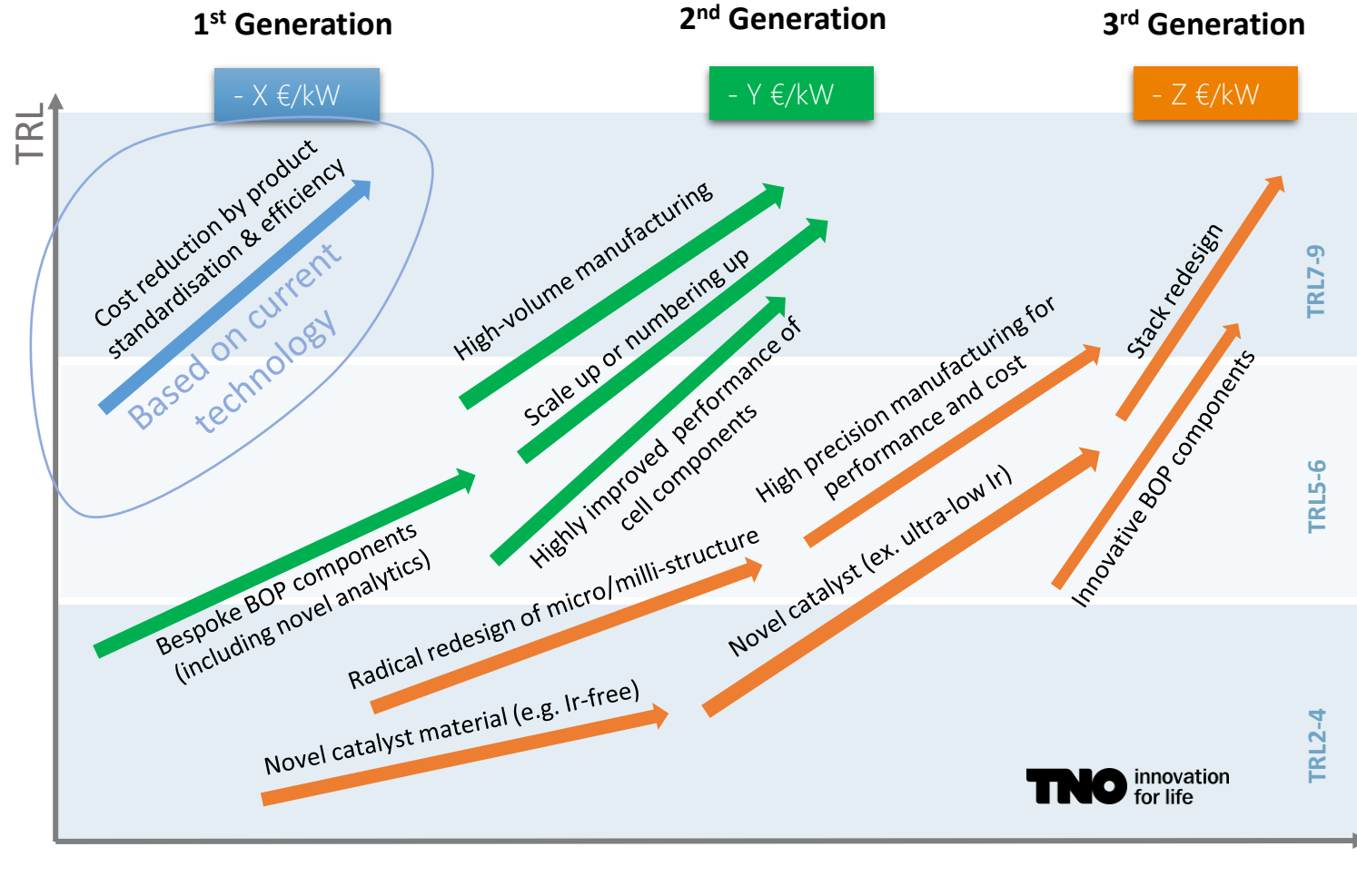
# ELECTROLYSER SYSTEM COST ESTIMATE

## COST REDUCTION BY (TECHNICAL) INNOVATION



# COST REDUCTION ELECTROLYSER SYSTEMS

## WHAT DRIVES COST REDUCTION



Cost reduction is achieved by:

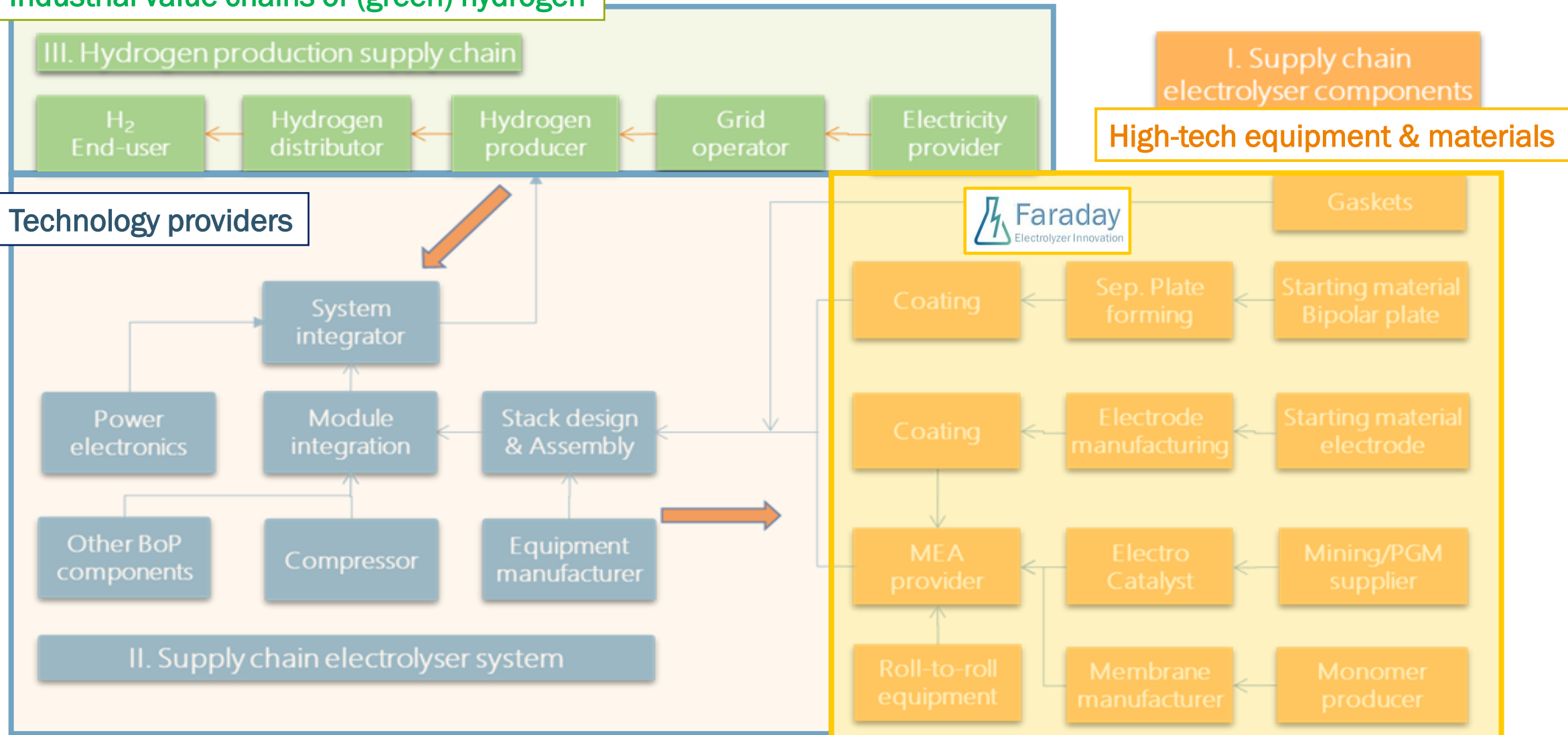
- Market volume
- Improved components
- Break through technology

R&D impact & focus

Time

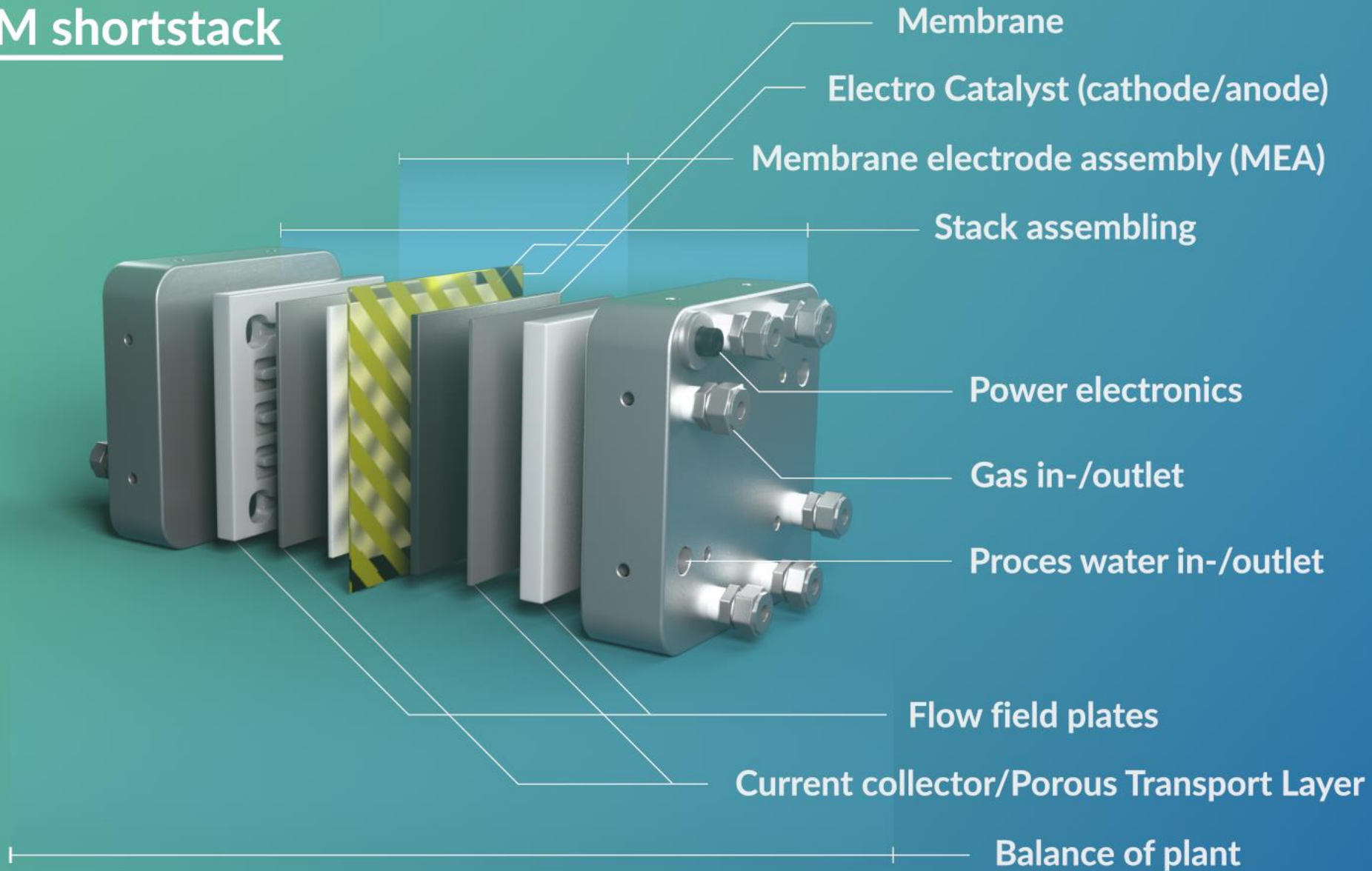
# DEVELOPING THE HYDROGEN SUPPLY CHAIN

## Industrial value chains of (green) hydrogen

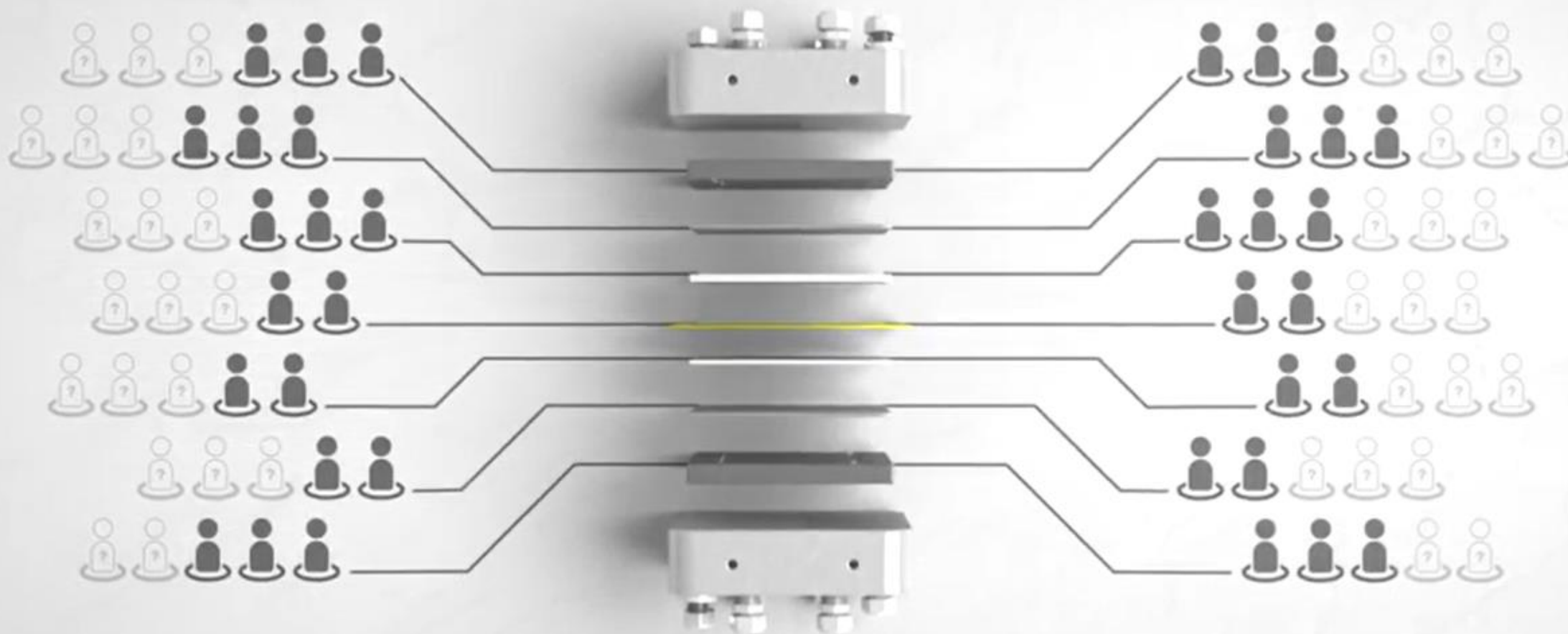


# DEVELOPING THE HYDROGEN SUPPLY CHAIN

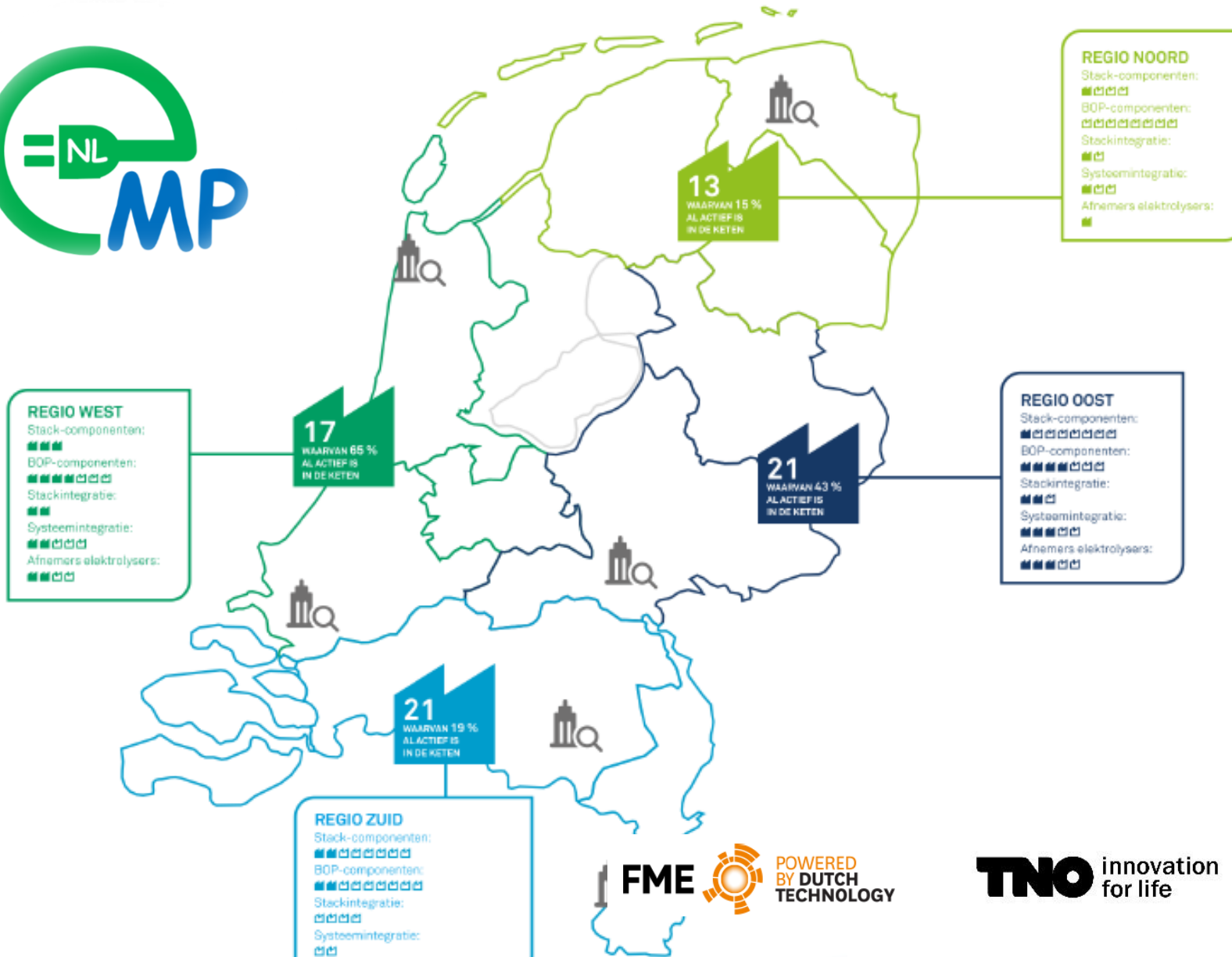
## PEM shortstack



# DEVELOPING THE HYDROGEN SUPPLY CHAIN



# ELECTROLYZER MAKERS PLATFORM NL



provinsje fryslân  
provincie fryslân

Provincie Noord-Brabant

provincie Drenthe

Provincie Noord-Holland

provincie groningen

provincie Overijssel

provincie HOLLAND ZUID

PROVINCIE UTRECHT

provincie Gelderland

Provincie Zeeland

provincie limburg

ABB

BOSCH  
Technologie voor het Leven

COORSTEK

DEMCON

douna  
MACHINERY

elestor

EMMEI GREEN

FINN

FRAMES

+GF+

hydronenergy

HYGEAR  
THE SPECIALIZED HYDROGEN SOURCE

Institute for Sustainable Process Technology

ionbond

Magneto  
Special Anodes

MAN Energy Solutions

INTSA  
TECHNOPOWER

New Energy Coalition

TECHNOLOGY added

TKI NIEUW GAS  
Topicator Energy

TU/e  
EIRES

VDL  
VDL Energy Systems

vecor

vonk

vsparticle

wateralliance

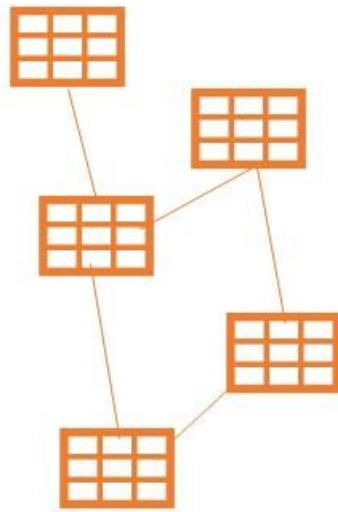
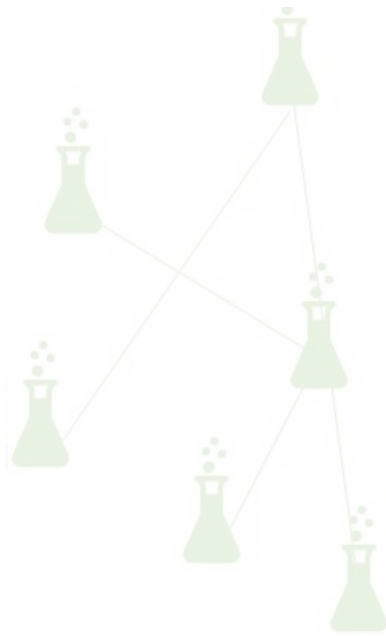
Z E F

FME  
POWERED BY DUTCH TECHNOLOGY

TNO innovation for life

# › REQUEST FOR STRONG KPI'S

**HySpeedInnovation** how the research institutes accelerate green hydrogen → GW green hydrogen



(2) Set clear quality standards



Maintain technology leadership

- › Set high technology performance standards in European and National hydrogen tender specifications
- › Safety, performance and environmental footprint should be important parameters
- › Stimulate the harmonization of technology standards, test protocols and benchmarks



# CURRENT ELECTROLYSERS ARE USING SCARCE MATERIALS STRATEGIES FOR CIRCULARITY NEEDED

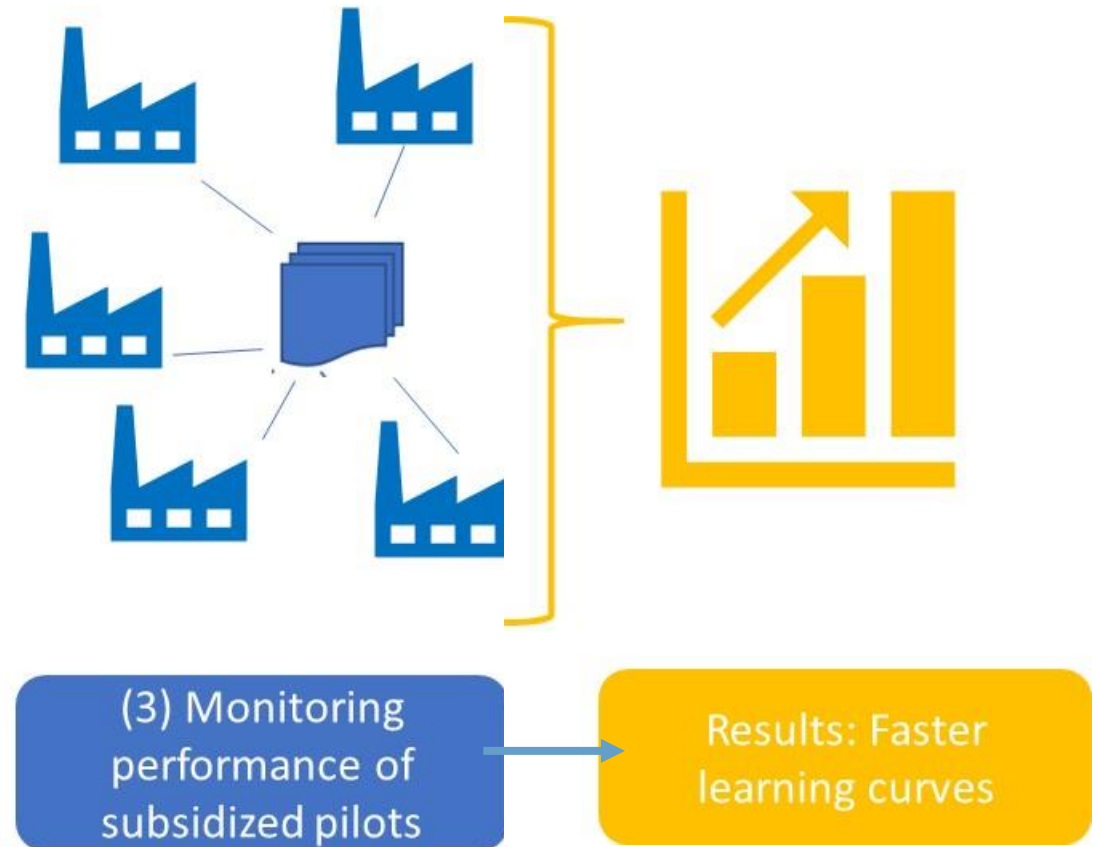
## % of CRM global annual supply used as a result of each strategy

CRM	Scenario 4 base case	+ S1: reduction	+ S2: substitution	+ S4: higher productivity	+ S5: extended lifetime	+ S6-9: recycling	
PEM	Iridium	106%	5%	106%	71%	80%	106%
	Tantalum	33%	2%	33%	22%	25%	33%
	Platinum	24%	0.1%	1%	1%	20%	23%
AEL	Raney-Ni	0.4%	0%	1%	0.1%	0.3%	0%
	Nickel (class 1)	3%	3%	3%	1%	2%	3%
	Cobalt	0.1%	0.1%	0%	0%	0%	0.1%

# › THE FIRST DEMO PROJECTS SHOULD ACT AS A CATALYST

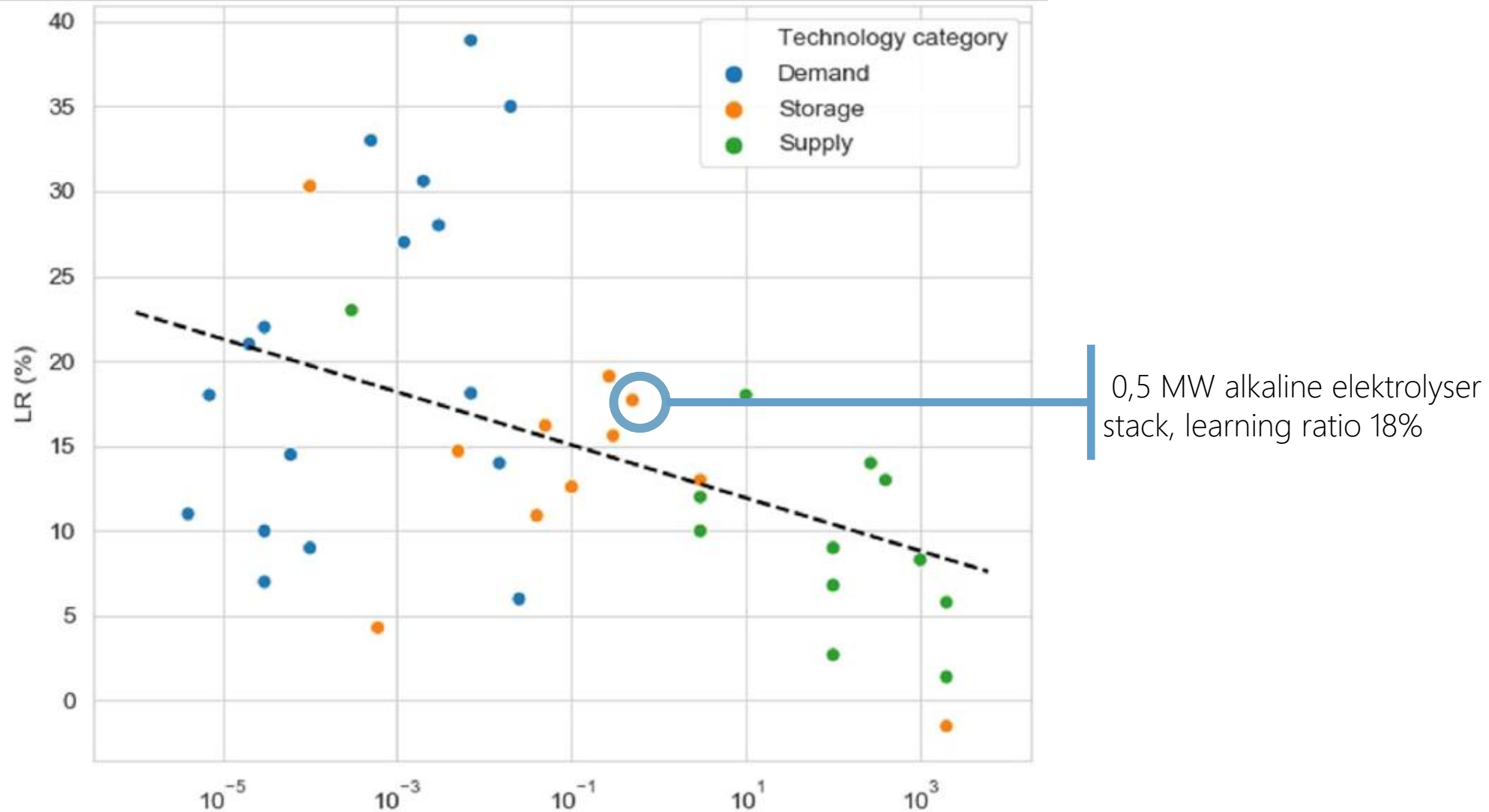
**HySpeedInnovation** how the research institutes accelerate green hydrogen → GW green hydrogen

- › Implement an Open Access policy for aggregated data sharing and learnings.
- › Make this mandatory for all subsidized projects
- › Develop a shared direction and common frame of reference for technology development



# › CAN WE LEARN FASTER?

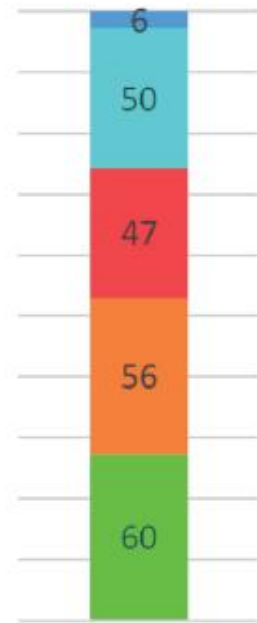
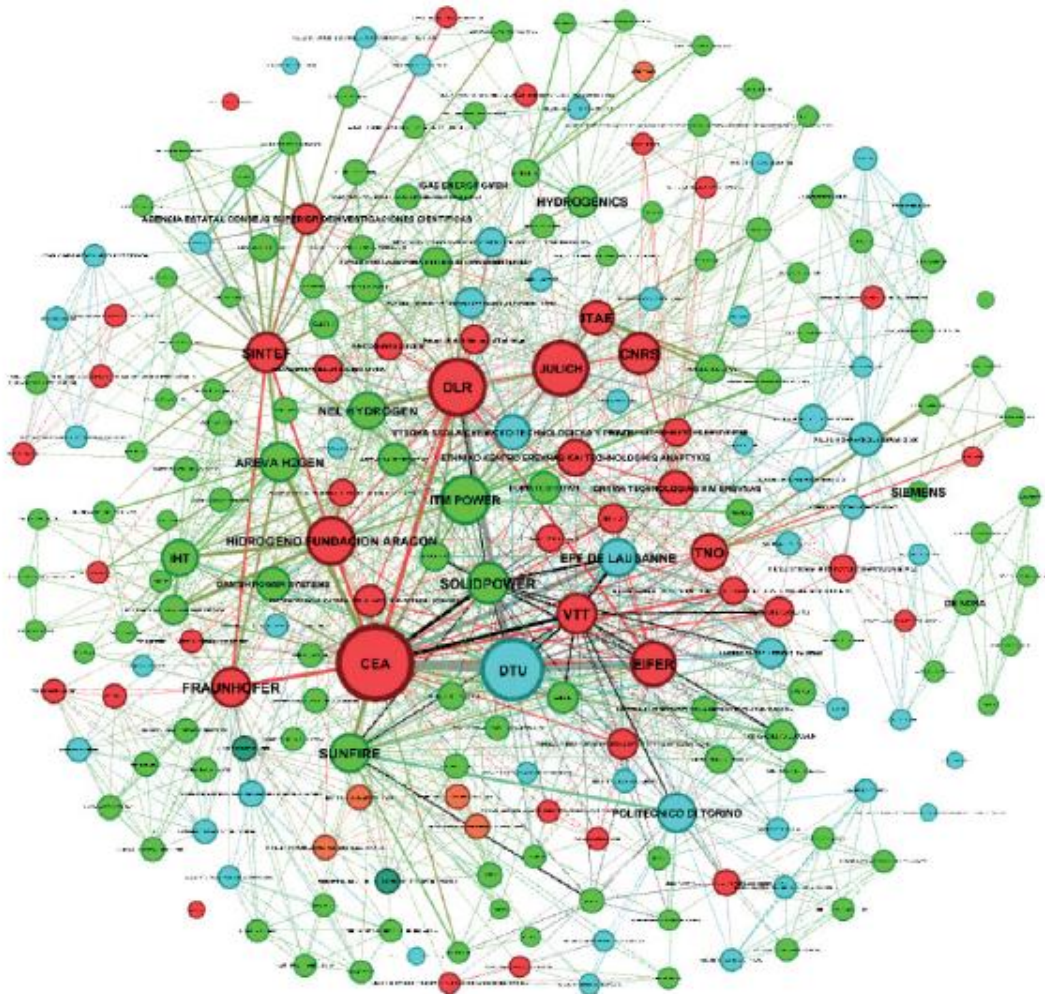
## SMALLER UNIT SIZE = HIGHER LEARNING RATE



Source: TNO (2020) Evaluating the Role of Unit Size in Learning-by-Doing of Energy Technologies ([link](#))

# STRONG EUROPEAN INNOVATION ECOSYSTEM

## RESEARCH ORGANISATIONS PLAY A KEY ROLE



Category 1  
 ■ SMEs ■ PCs  
 ■ RTOs ■ EIS

- › 70 green Hydrogen projects
- › 2003-2019
- › Public co-funded (FP6, FP7, H2020)
- › Nodes (circles) represent organisations and the size number of partnerships
- › Lines show partnership between projects

# 2 GW ELECTROLYSER CONVERSION PARK ROTTERDAM (NL) FIRST GREENDEAL PROJECT 200 MW ELECTROLYSER



Thank you for your attention!  
Do a virtual tour in our new lab here >> [\(link\)](#)  
Contact: Lennart.vanderburg@TNO.nl

