



# Herøya opening

April 20, 2022



# Positioning Nel for the industry take-off



ANDERS SØRENG  
CHIEF TECHNOLOGY OFFICER

Hydrogen will play an important role in the world's transition to green energy solutions



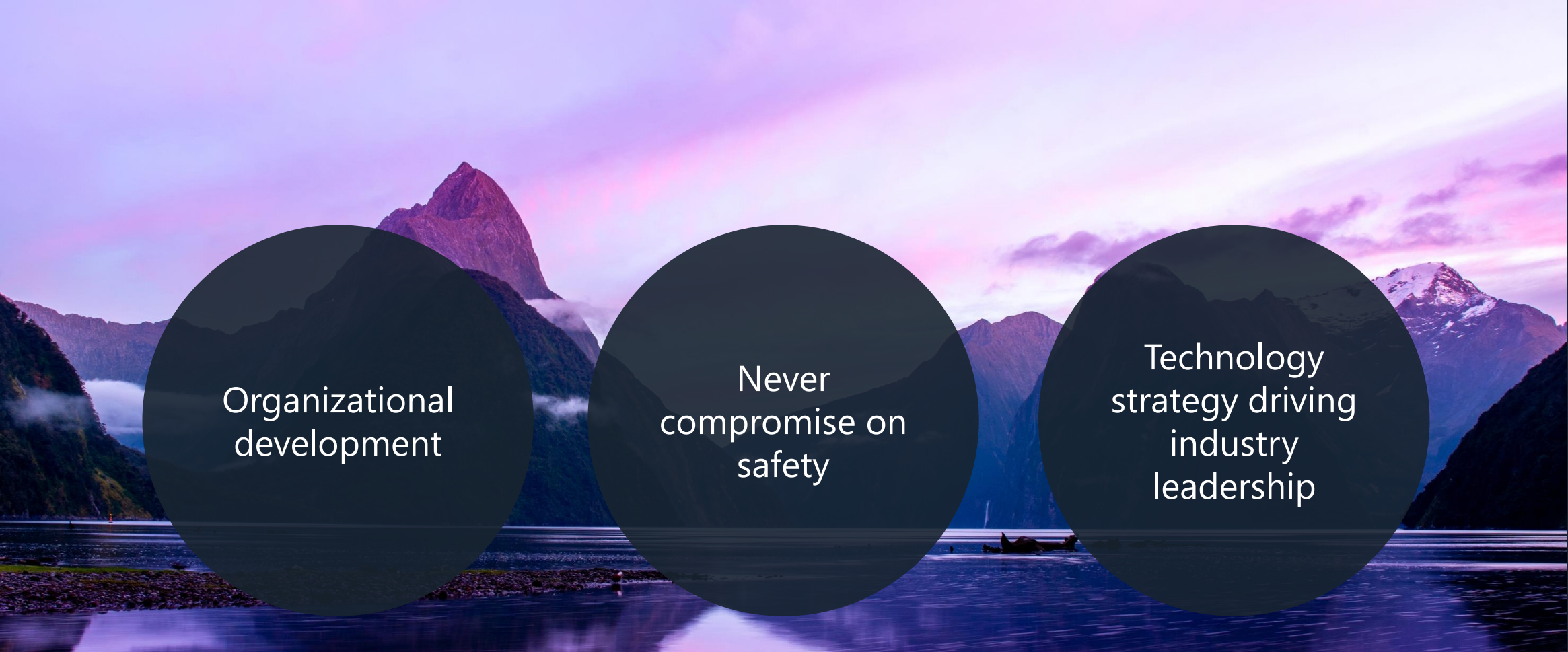
# \$1.5/kg

## Nel green hydrogen cost target by 2025

Assumptions: Nel analysis based on electricity of \$20/MWh, >8% cost of capital, cost of land, civil works, installation, commissioning, building water etc., lifetime 20 years incl. O&M cost, at 30 bar



# Enablers for success



Organizational  
development

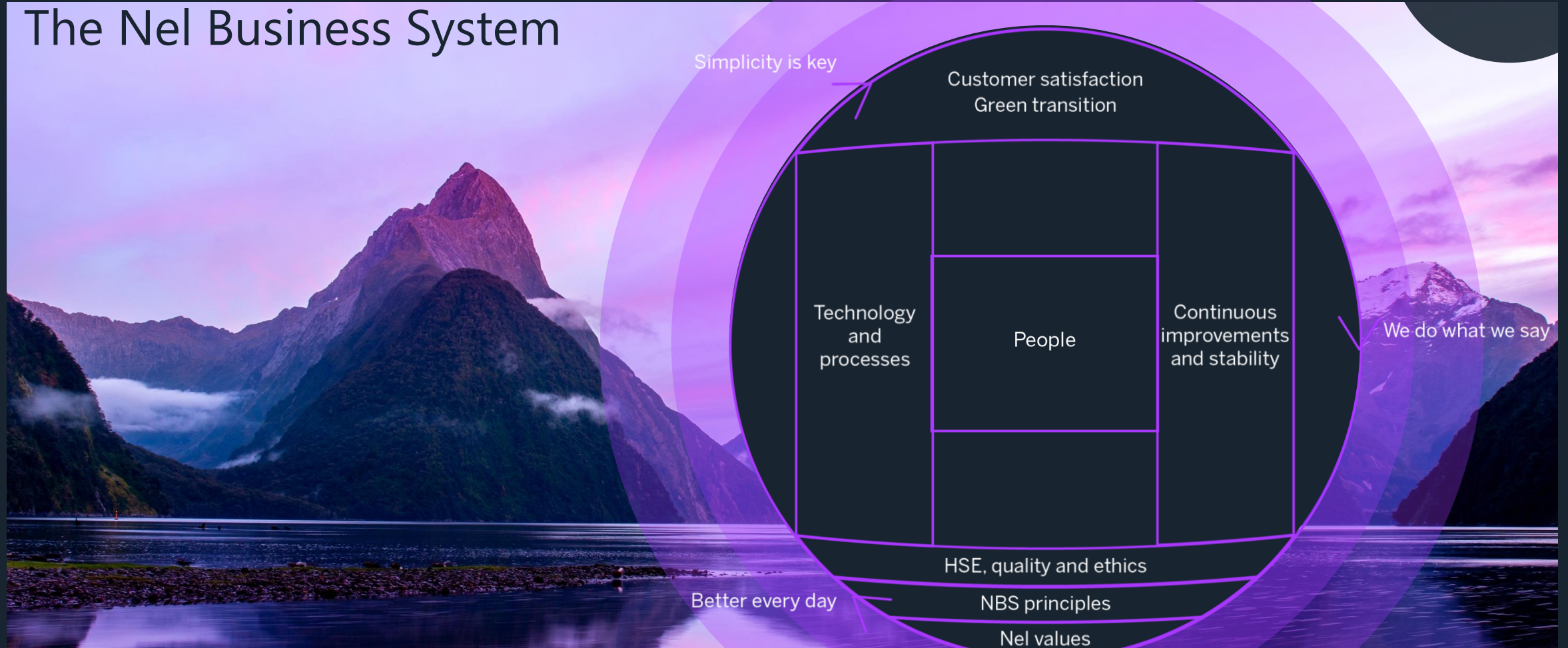
Never  
compromise on  
safety

Technology  
strategy driving  
industry  
leadership

# Enablers for success

Organizational  
development

## The Nel Business System

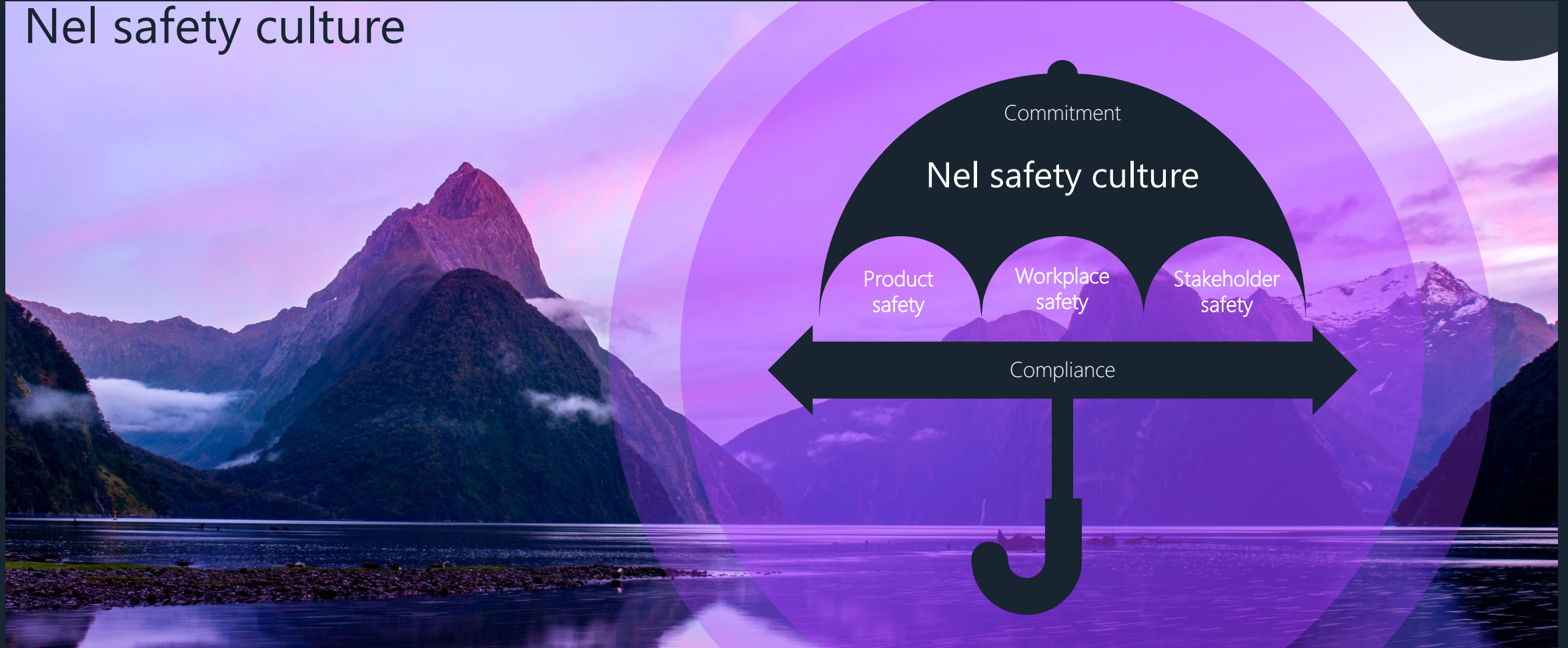




# Enablers for success

Never  
compromise on  
safety

## Nel safety culture



# Enablers for success

Technology  
strategy driving  
industry  
leadership

## Nel technology strategy

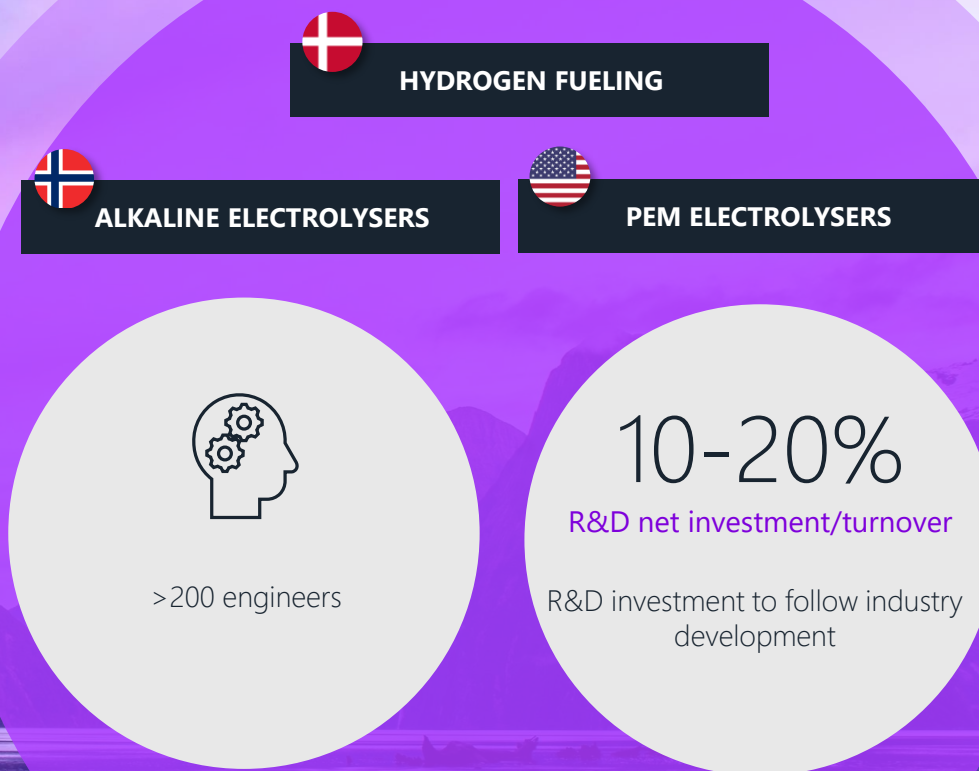
- Ensure world-class organization and facilities
- Develop modular designs for large-scale deployment
- Further enhance bankability
- Further reduce product TCO
- Timely introduce technologies with predictable performance and lifetimes



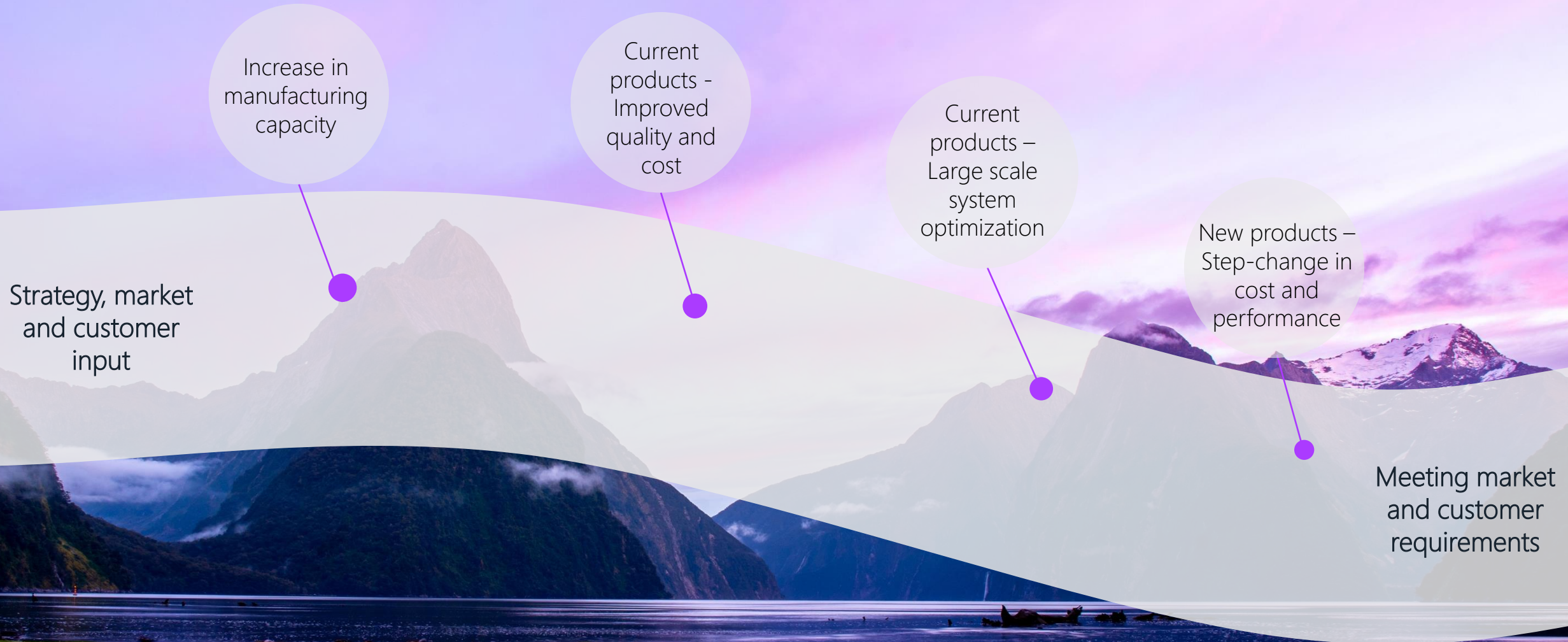
# Enablers for success

People  
Activities  
Infrastructure

## Investing in technology



# Aligning with industry and customer expectations





...unmatched!

1930-1990's

2022

2022 →

H2 gas

Equipment

- Further development of Nel's workhorse
- Among industry lowest TCO
- Based on past and present knowledge and capabilities

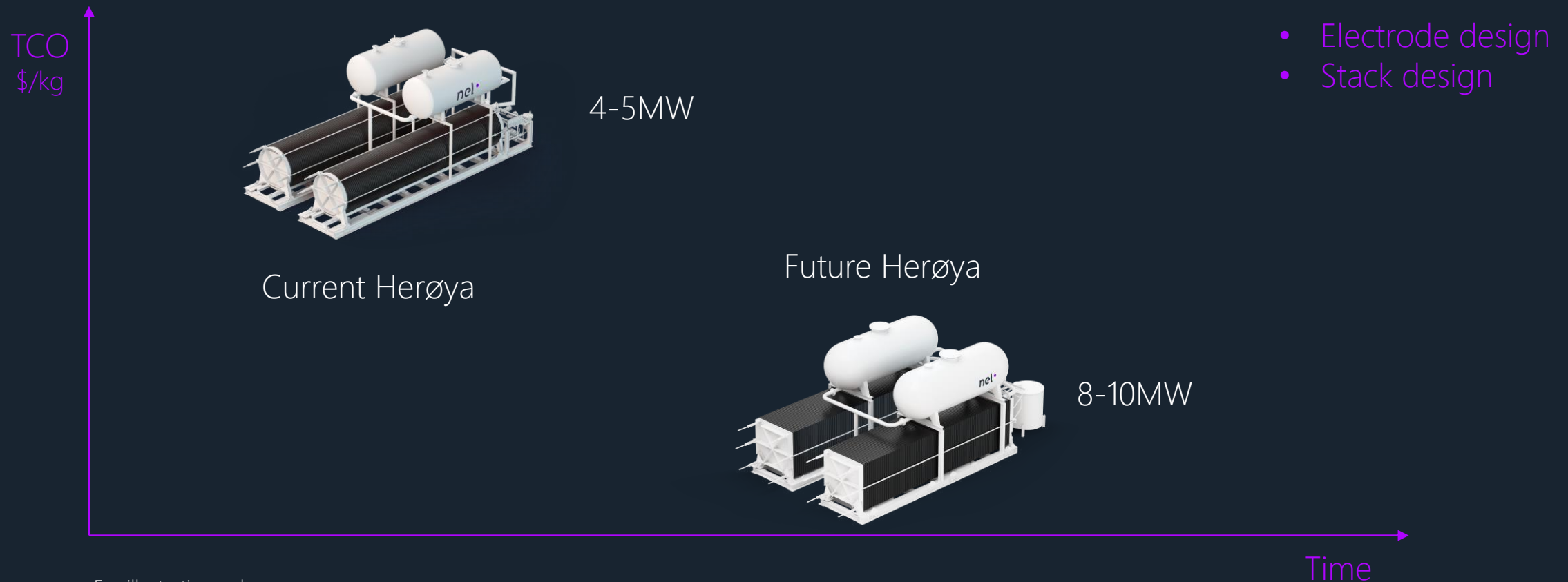
World's two largest  
hydrogen production  
plants

World's largest electrolyser  
equipment production  
plant



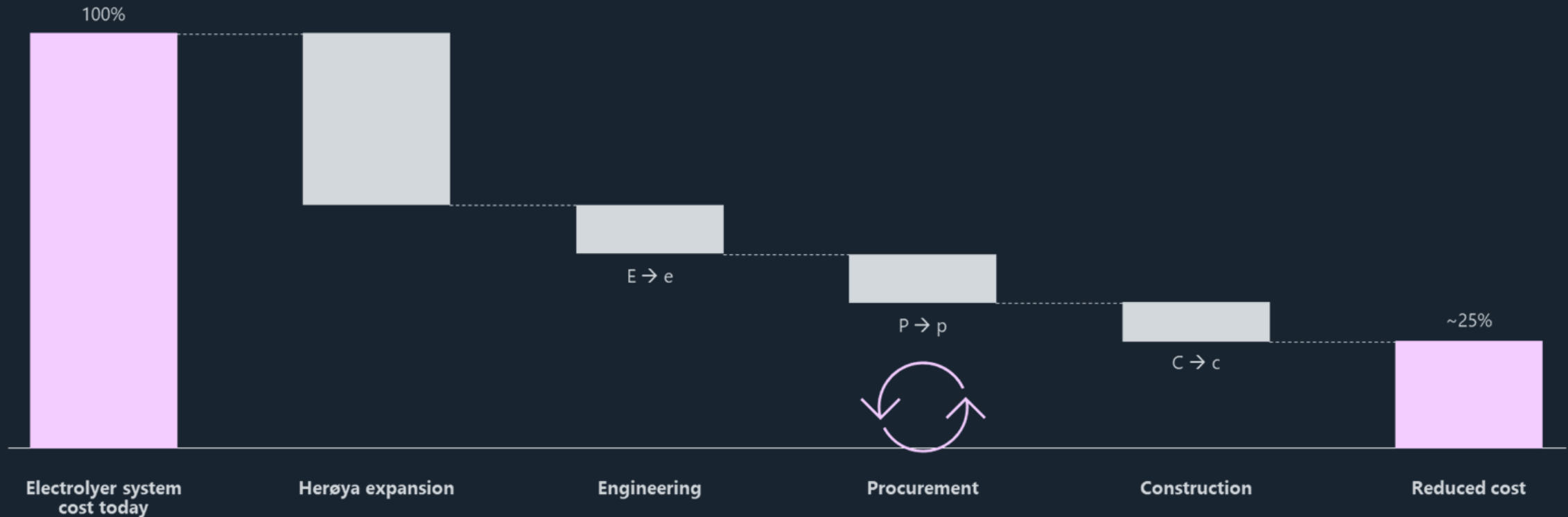
# Further product development – improving efficiency and capacity of cell stack

Targeting CAPEX and OPEX reductions beyond original roadmap in current manufacturing line

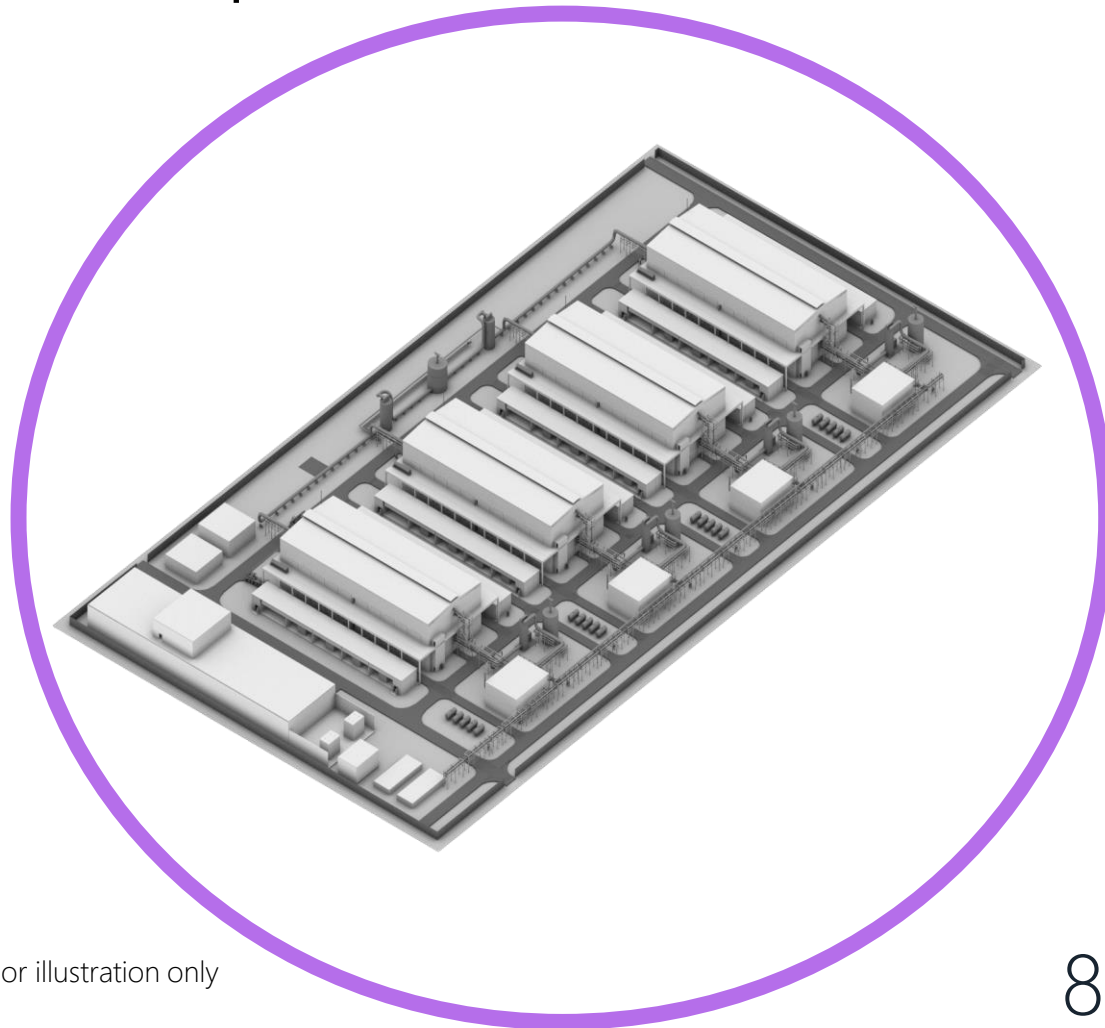


For illustration only

High volume production and product standardization  
reducing **system** cost to enable \$1.5/kg



**Building blocks** that enable scalable solutions to meet customers' need for larger hydrogen production plants



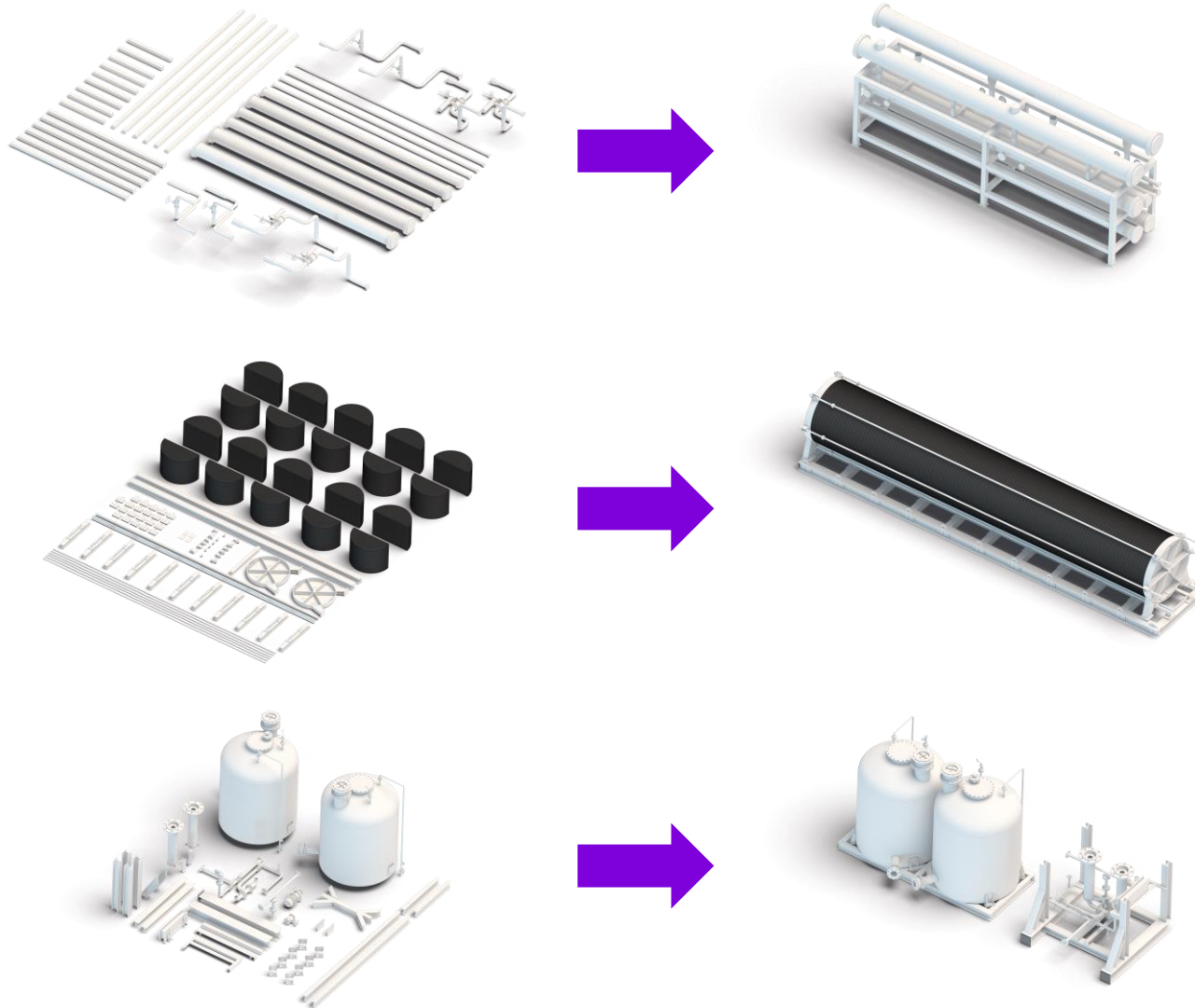
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800 MW

- Completed design for 800 MW green hydrogen plant
  - 200 MW building blocks
  - Safety in design
- Consolidated balance of plant elements to optimize CAPEX
- Realizing synergies to reduce cost
- Nel is the only company with a large-scale track record
  - Bankable, proven technology with performance guarantees

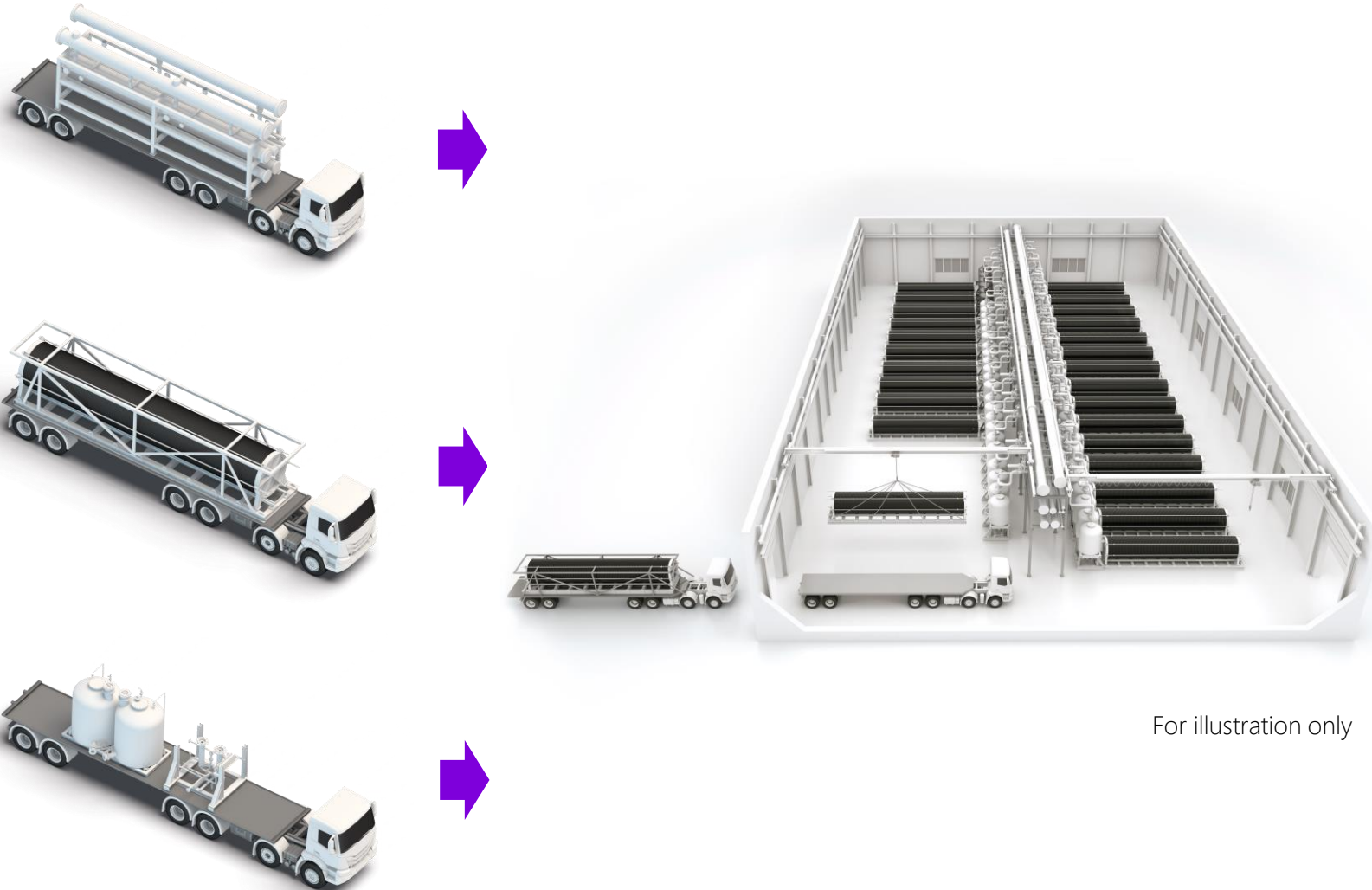


# Safe, cost-efficient and hassle-free installation



- Pre-assembled pipes, stacks and separators - ensures hassle-free installation in a safer and more efficient way
- Reduces time and cost for customers
- Produced by pre-qualified contract manufacturing partners

# Safe, cost-efficient and hassle-free installation



For illustration only

- Develop skids for easy transportation
- Easy to unload
- Easy to assemble
- Fully automated stack assembly at Herøya from 2023
- Ensures scalability from 20 to 800 MW plants and beyond

High-volume production

Low-cost solution

Safe product design

Our  
products

nel•

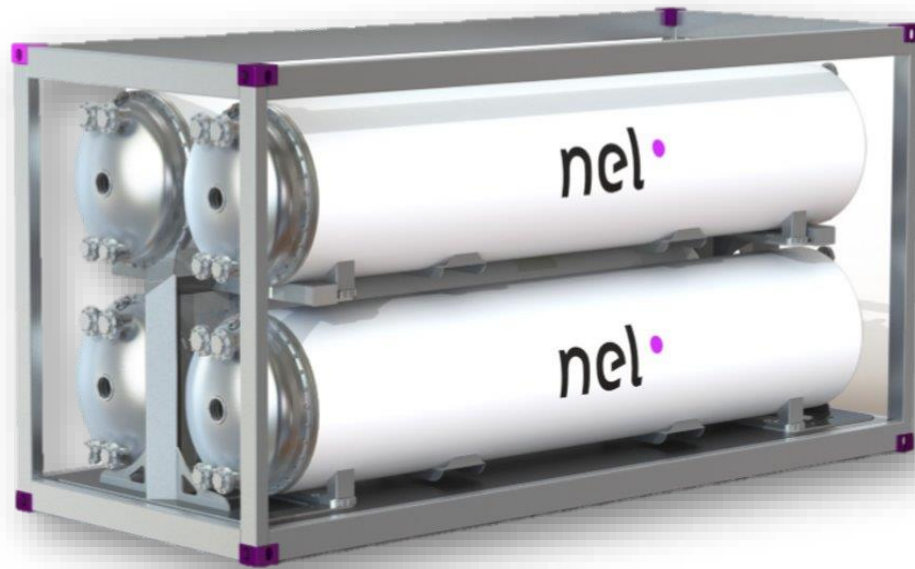


...and now some new stuff

....unique pressurized alkaline electrolyser technology

....targeting market optimization with both atmospheric and pressurized alkaline technologies

# Unique electrolyser design optimised for safe operations, energy efficiency and cost



For illustration only

Unique design targeting the lowest TCO

- Developed for off-grid connection to renewables
- 10-15 bar system output pressure
- Min. 5 MW optimized skid solution fits inside 20 ft. open frame
- Skid-based design for flexibility - scope of supply and plant scalability
- World-class efficiency performance
- Designed for automated manufacturing and low-cost supply chain
- Outdoor classification, no building required
- Thermally insulated to minimise heat loss
- Bankable

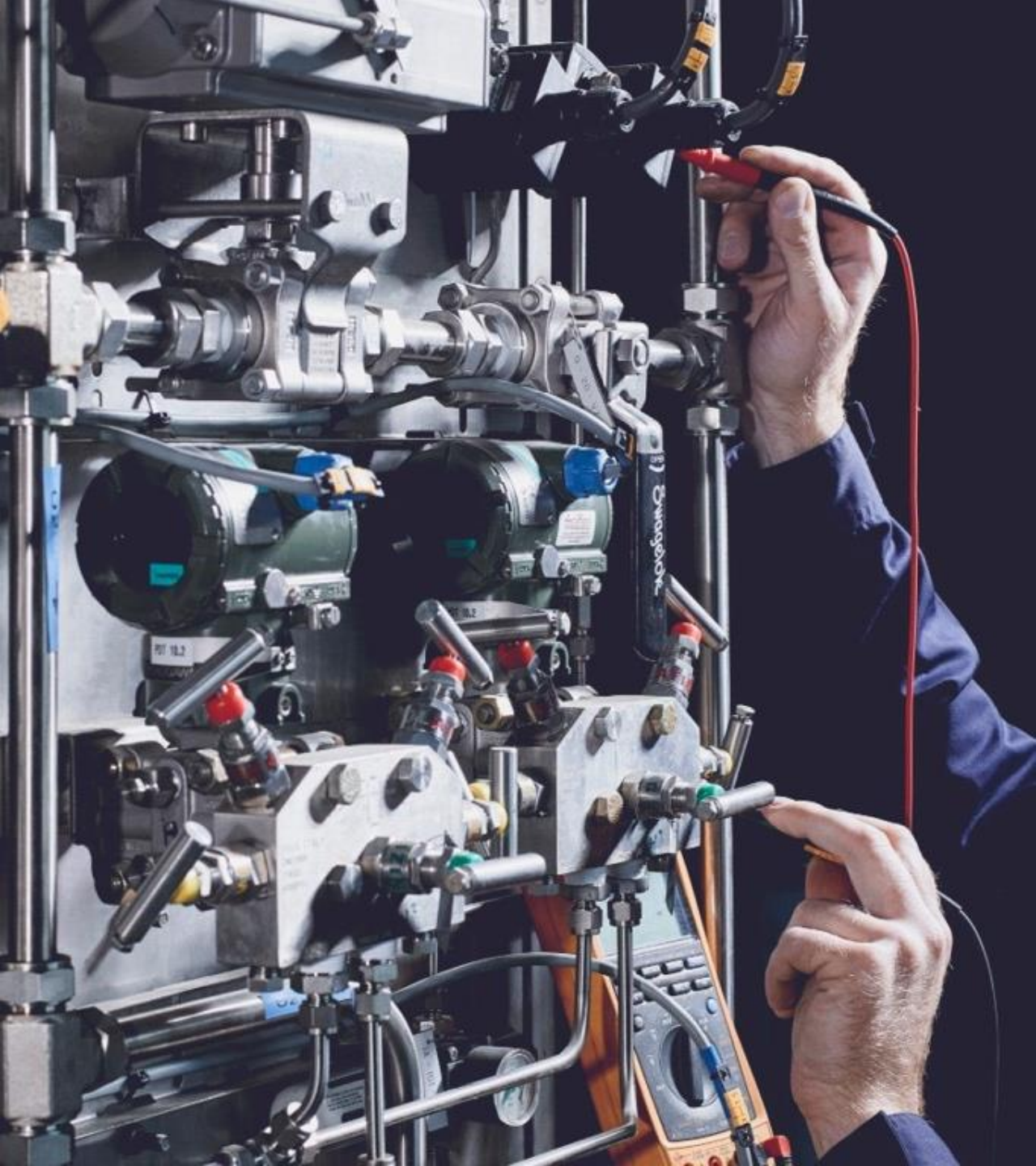
“We unlock the potential of renewables and enable global decarbonization”

Nel is on its way  
to pursue  
\$1.5/kg target in  
2025

Nel is positioned  
to deliver among  
lowest cost  
products today

More fun to  
come!





HERØYA OPENING

# Factory tour

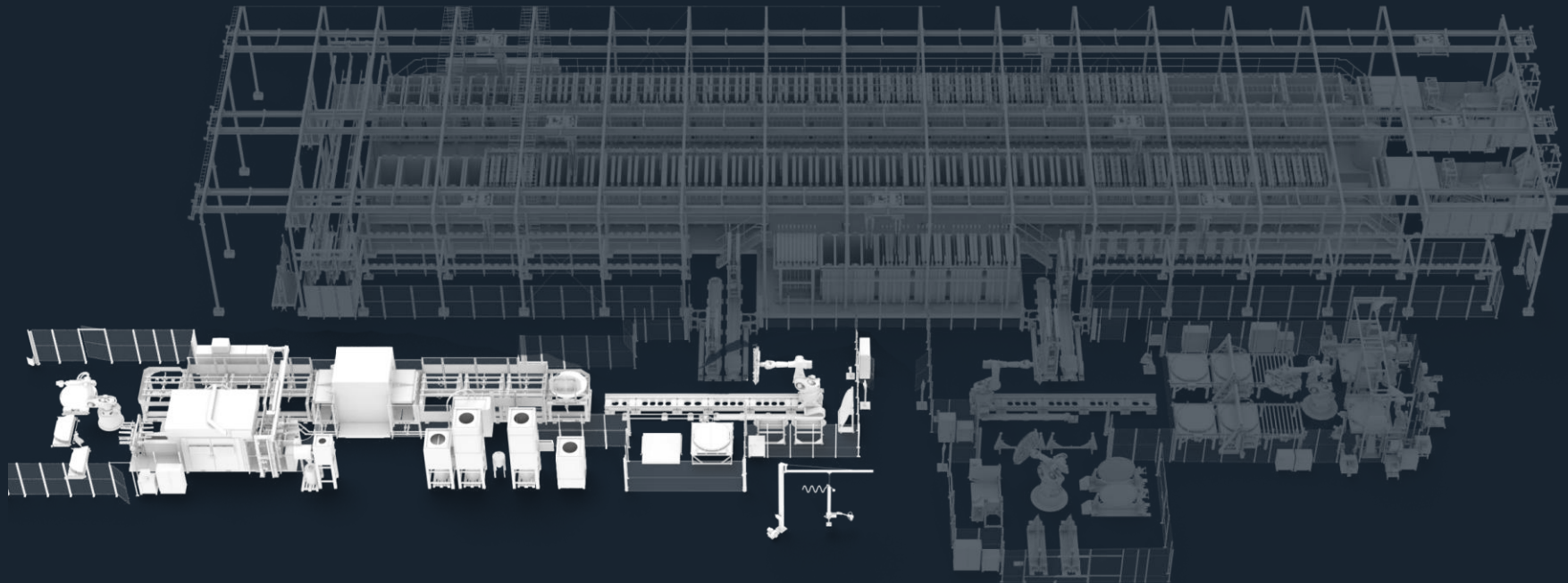
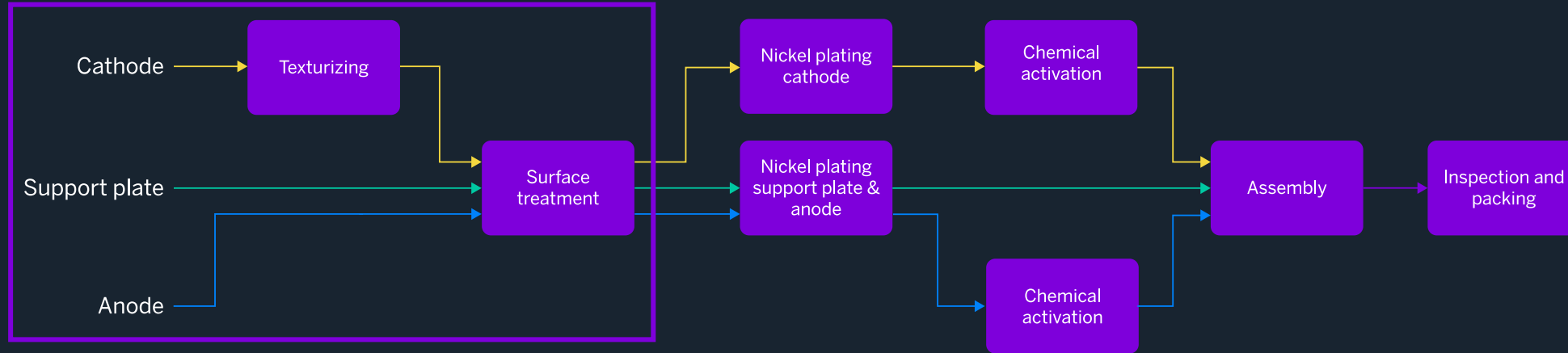


# Pre-Treatment

Gamechanger event



# Pre-Treatment

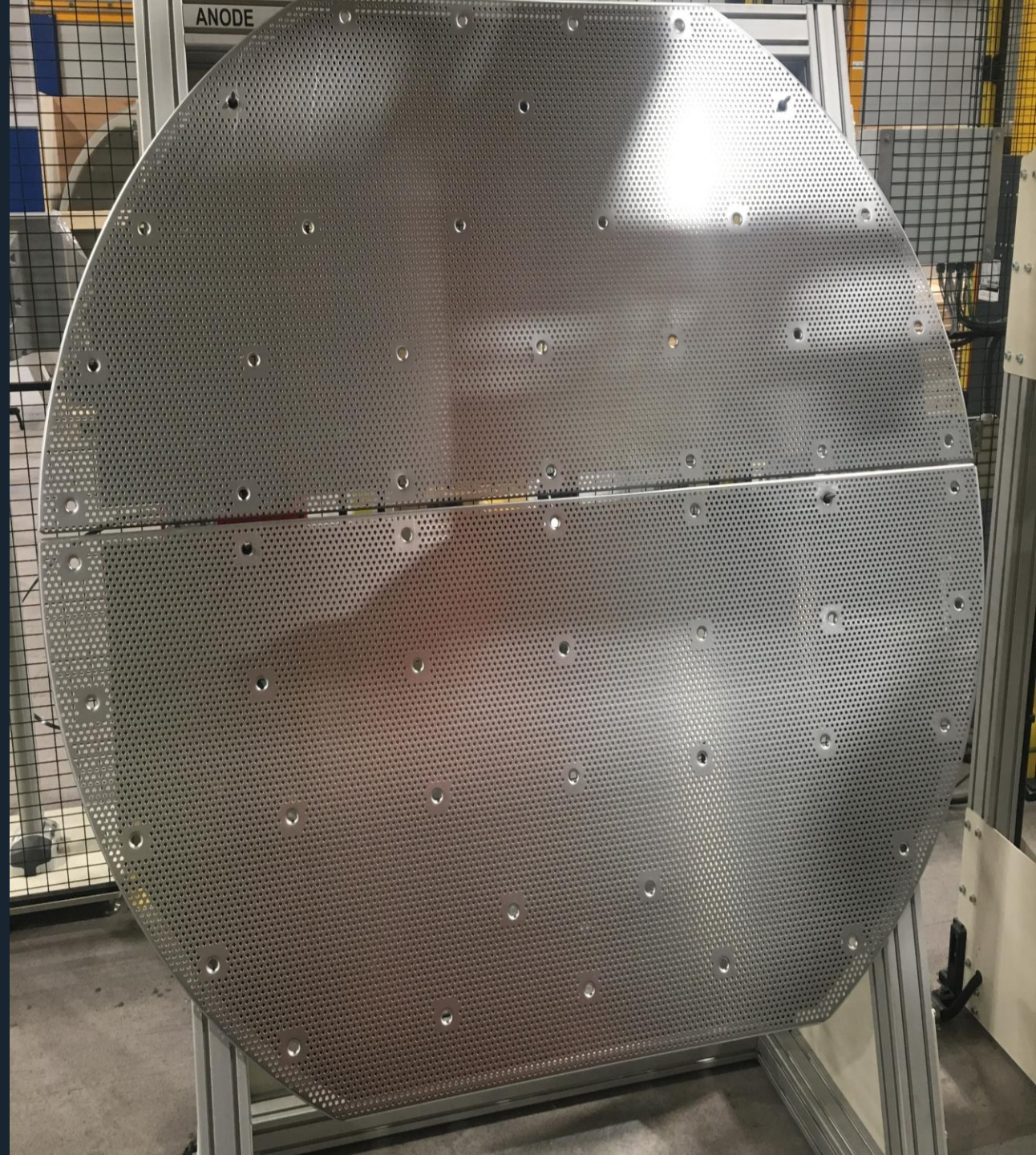




## Pre-Treatment

Treatment of 3 parts before chemical line:

- 1) Separation/carrying plate
- 2) Two x electrode plates for anode
- 3) Two x electrode plates for cathode





# Fully automated line

- High volume
- High repeatability & quality
- Low overall cost including manpower
- Low maintenance
- Simple and green process method

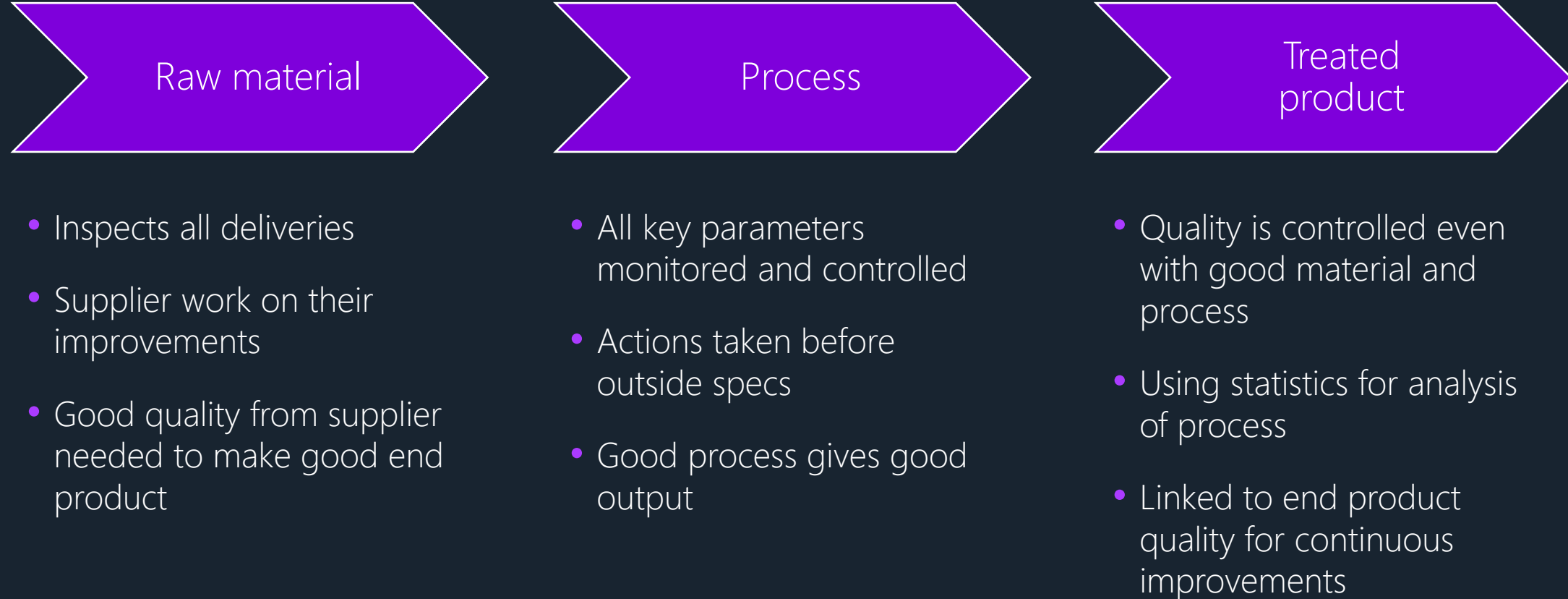


# Nel Business System





# Quality control



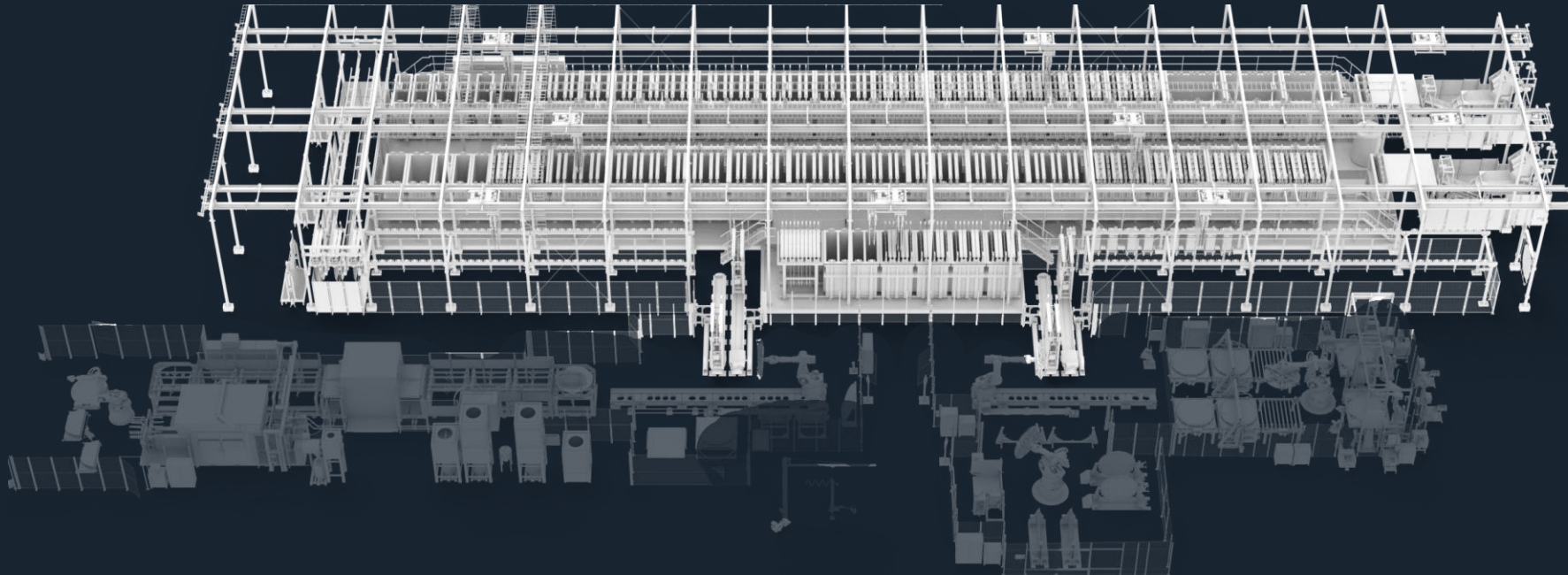
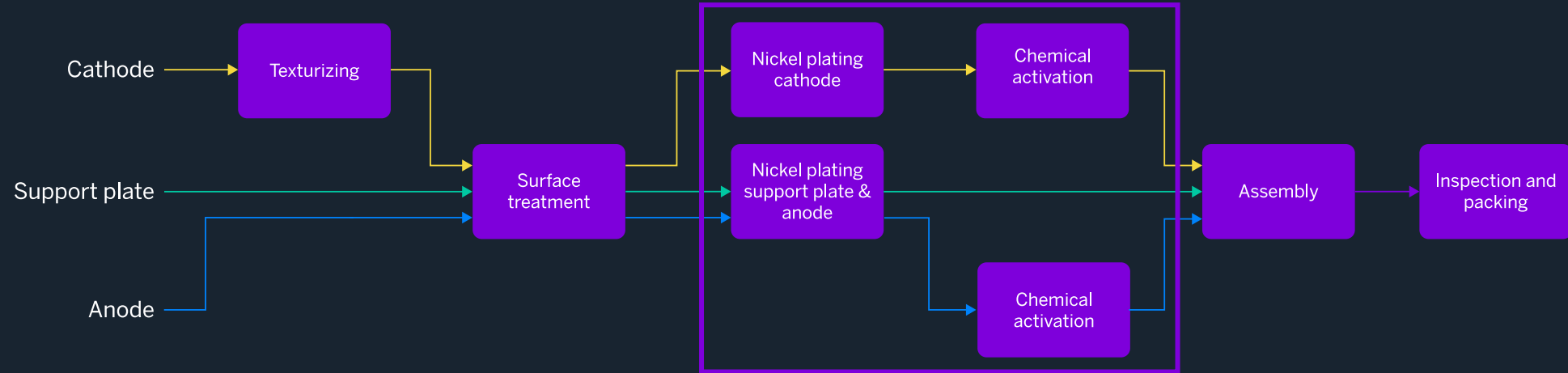


# Chemical line

Gamechanger event



# Chemical line





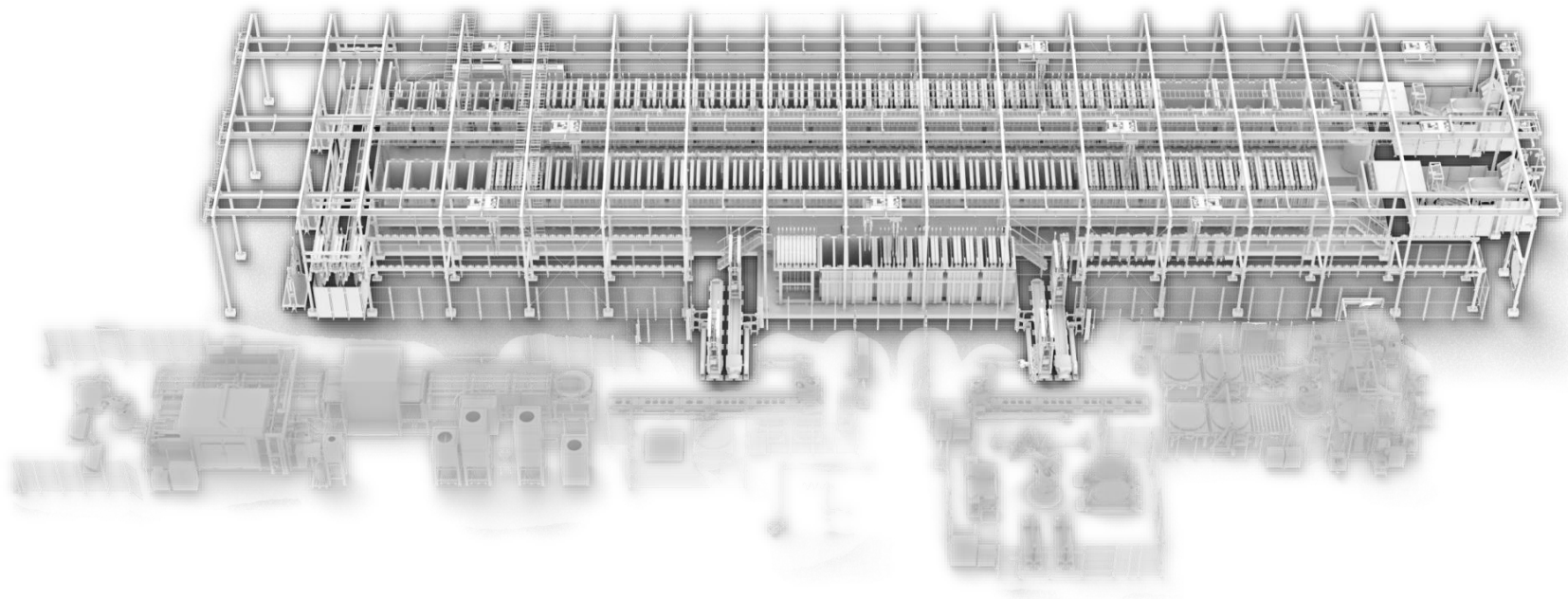
# Chemical line functions



The two main functions of the chemical line:

- Nickel plating for corrosion resistance
- Catalytic loading for cell energy efficiency

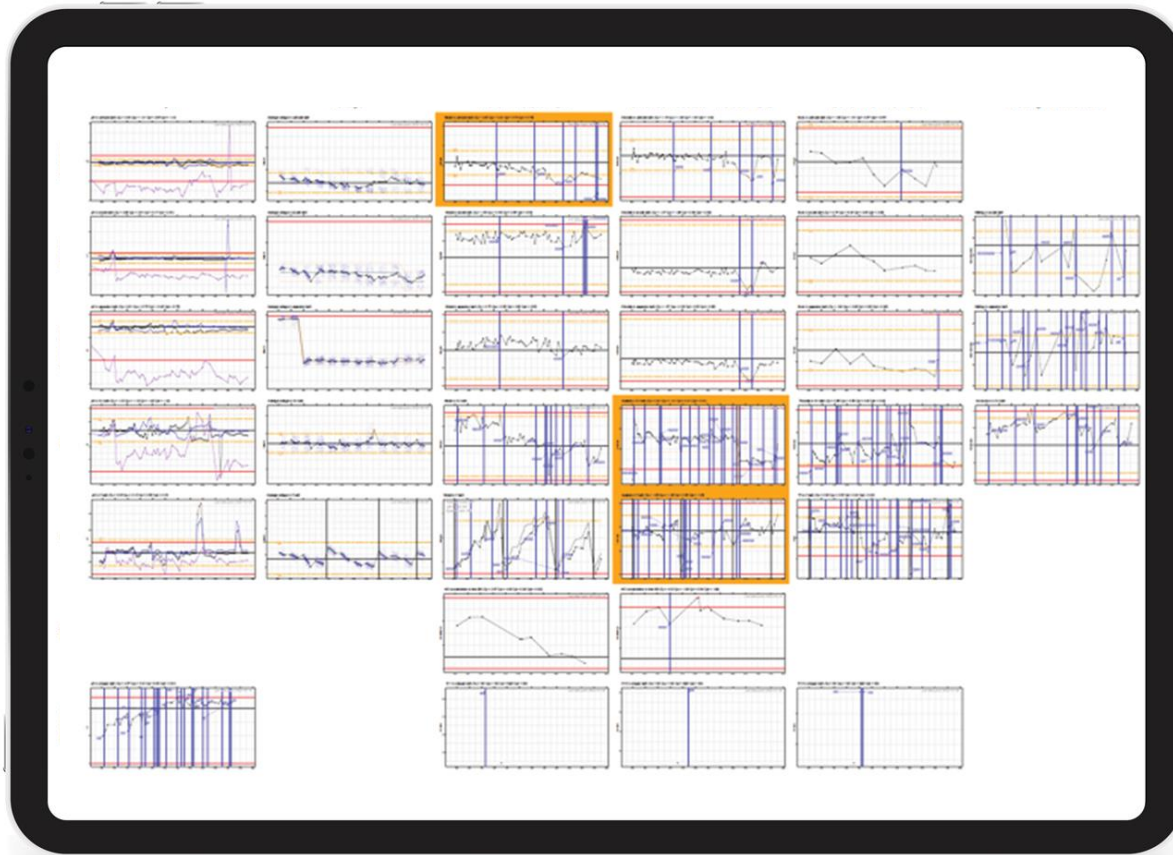
# Chemical line operation



Operation of the chemical line:

- Fully automatic process control
- All process steps can be optimized individually
- Fully automatic care of jigs/racks
- Daily cross-functional monitoring meetings

# In Control, Capable and Maintained methodology (ICCM)



## Methodology:

- Process understanding
- Process viewpoint – Focus on leading indicators
- Statistical Process Control (SPC)

## Outgoing Quality Control:

- Mechanical properties
- Electro-chemical properties
- Layer composition



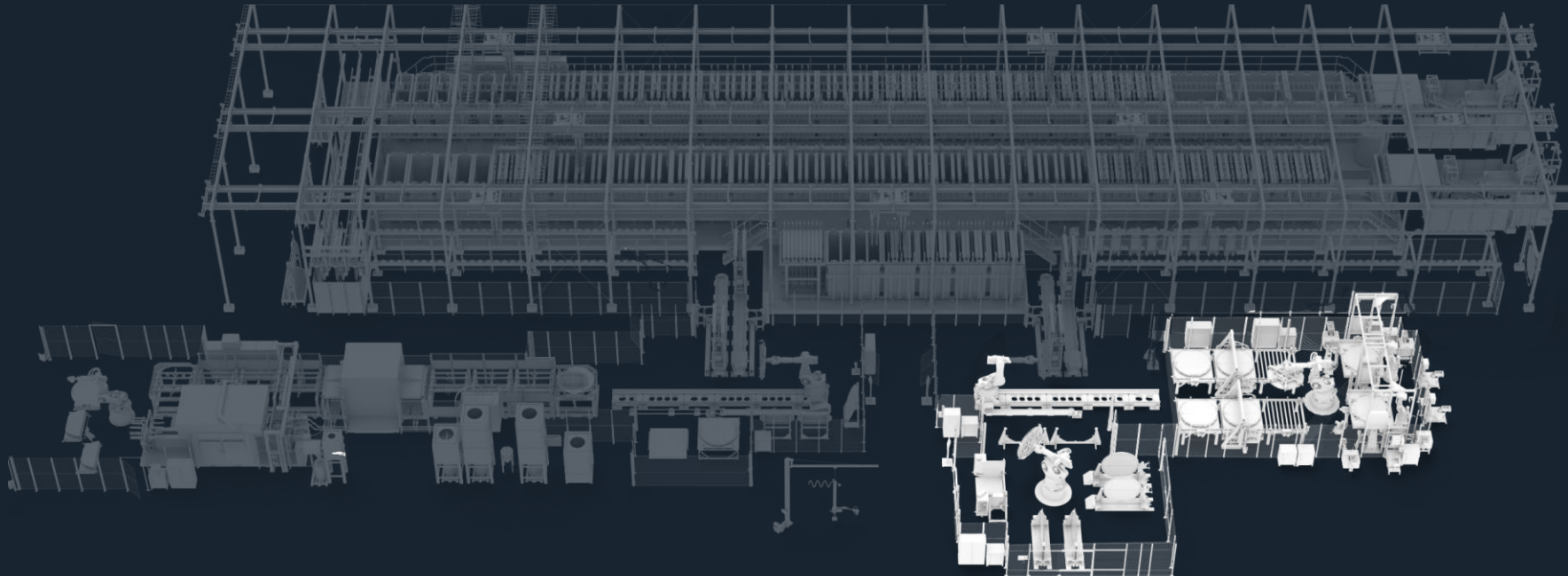
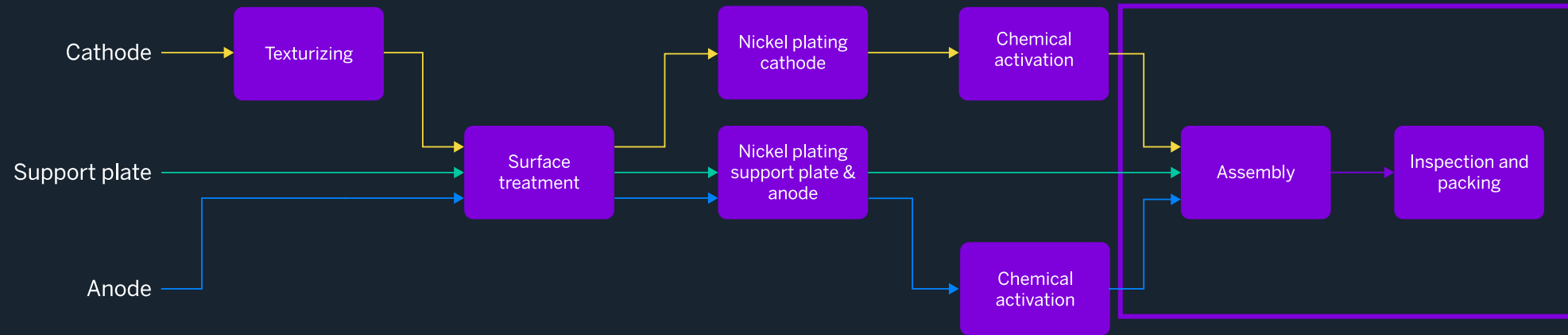


# Assembly and inspection

Gamechanger event

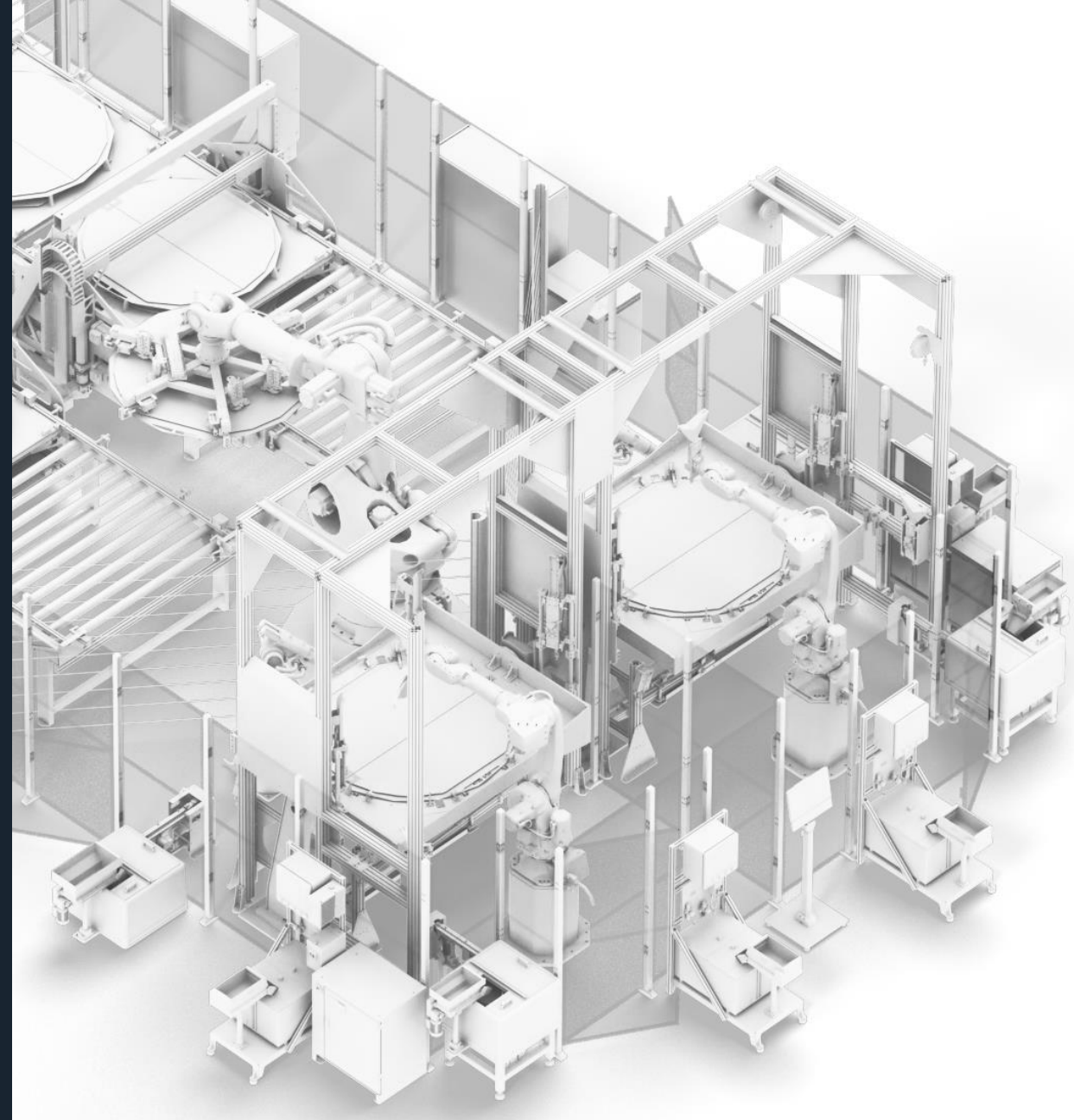


# Assembly and inspection packing station



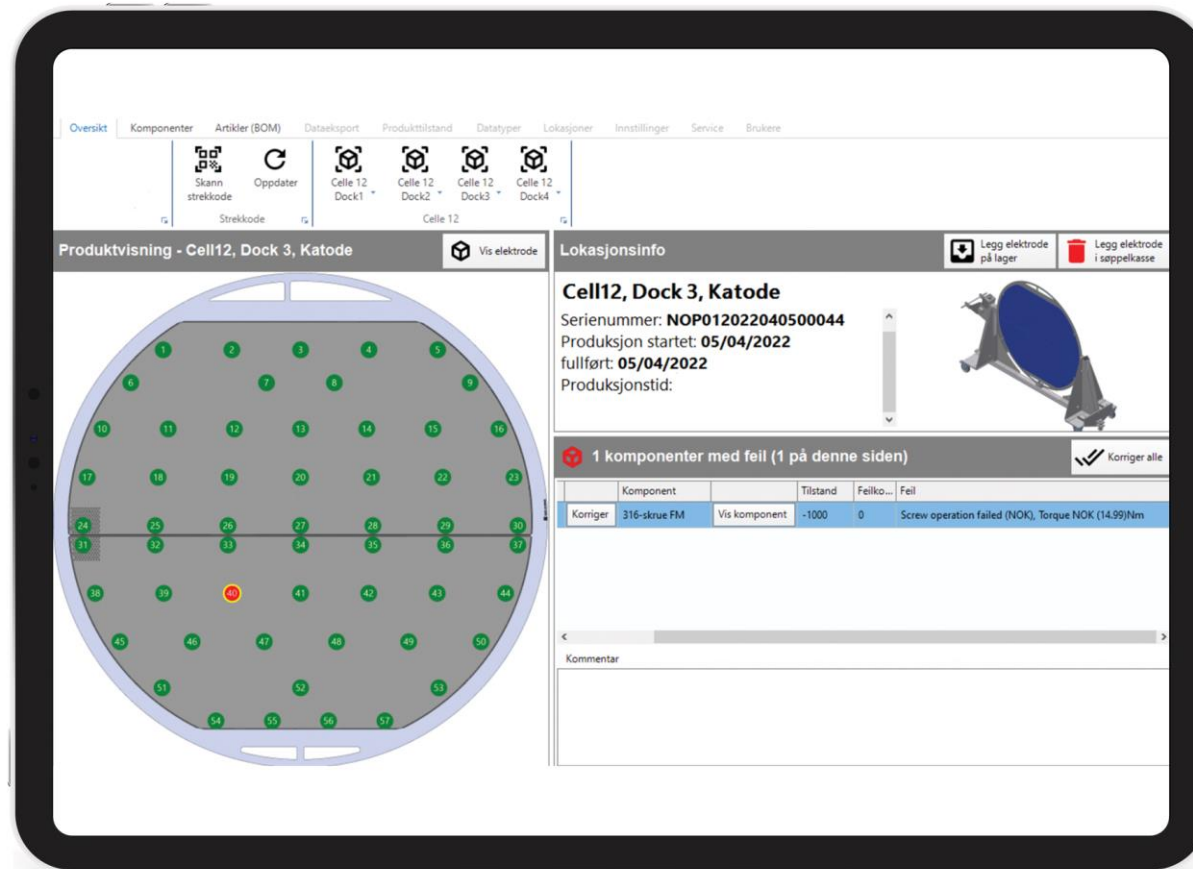
# Assembly station

- Significantly improving the HSE for the operator
- High repeatability and quality
- Process control includes torque, rotation and time
- Each electrode has a unique serial number
- Full traceability of all material used and all process parameters





# Final Inspection Station



- 4 Inspection stations for manual inspection
- Data from assembly station shown visually
- Final visual inspection of surfaces
- >95% of electrodes approved in final inspection
- Nel Business System utilisation



# Unlocking the potential of renewables with Nel's PEM technology

Filip Smeets  
SVP Electrolyser





# Manufacturing facility in Wallingford

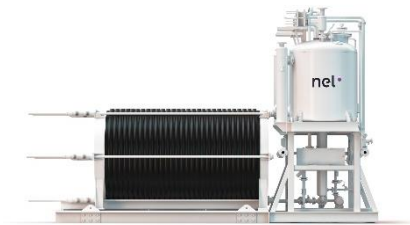


- Nel has the longest track record in PEM electrolysis with **over 25 years of experience**
- Originally the PEM units were developed for **respiratory oxygen in submarines**. Hence our focus on reliability
- Nel PEM skill center is based in the US with an **R&D and manufacturing facility in Wallingford, CT.**



# Unique qualities

## ALKALINE ELECTROLYSERS



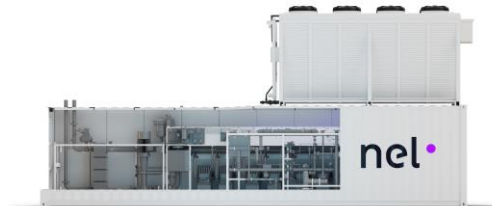
### **Atmospheric alkaline**

Low cost  
High efficiency  
Large scale

### **Advanced alkaline**

Dynamic response  
Intermittent operation

## PEM ELECTROLYSERS



### **PEM**

Dynamic response  
Intermittent operation

### **Advanced PEM**

Lower cost  
High efficiency  
Larger scale

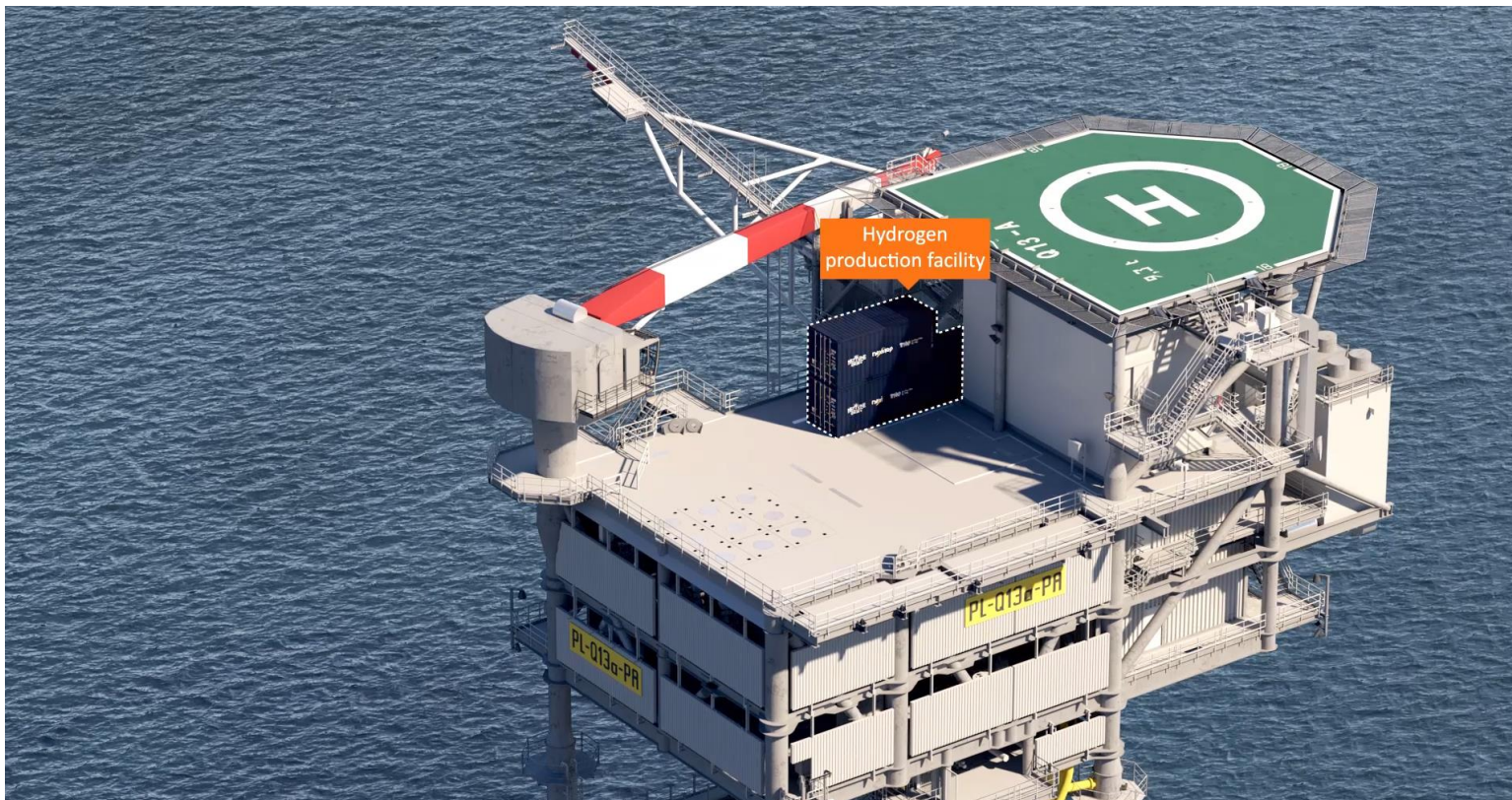
- Both Alkaline and PEM have unique features, some of the most important strengths of the PEM-technology are:
  - **Fast response time**
  - **Operating flexibility**  
ideal for pairing up with intermittent renewable power sources
  - **Very small footprint (size)**

# Green hydrogen from intermittent power sources



- The PEM platform is perfect for production of **green hydrogen** from intermittent power sources such as wind and solar
- Ideal for sites where you have **little space**, such as existing industrial estates, hydrogen refueling stations or for off-shore hydrogen production

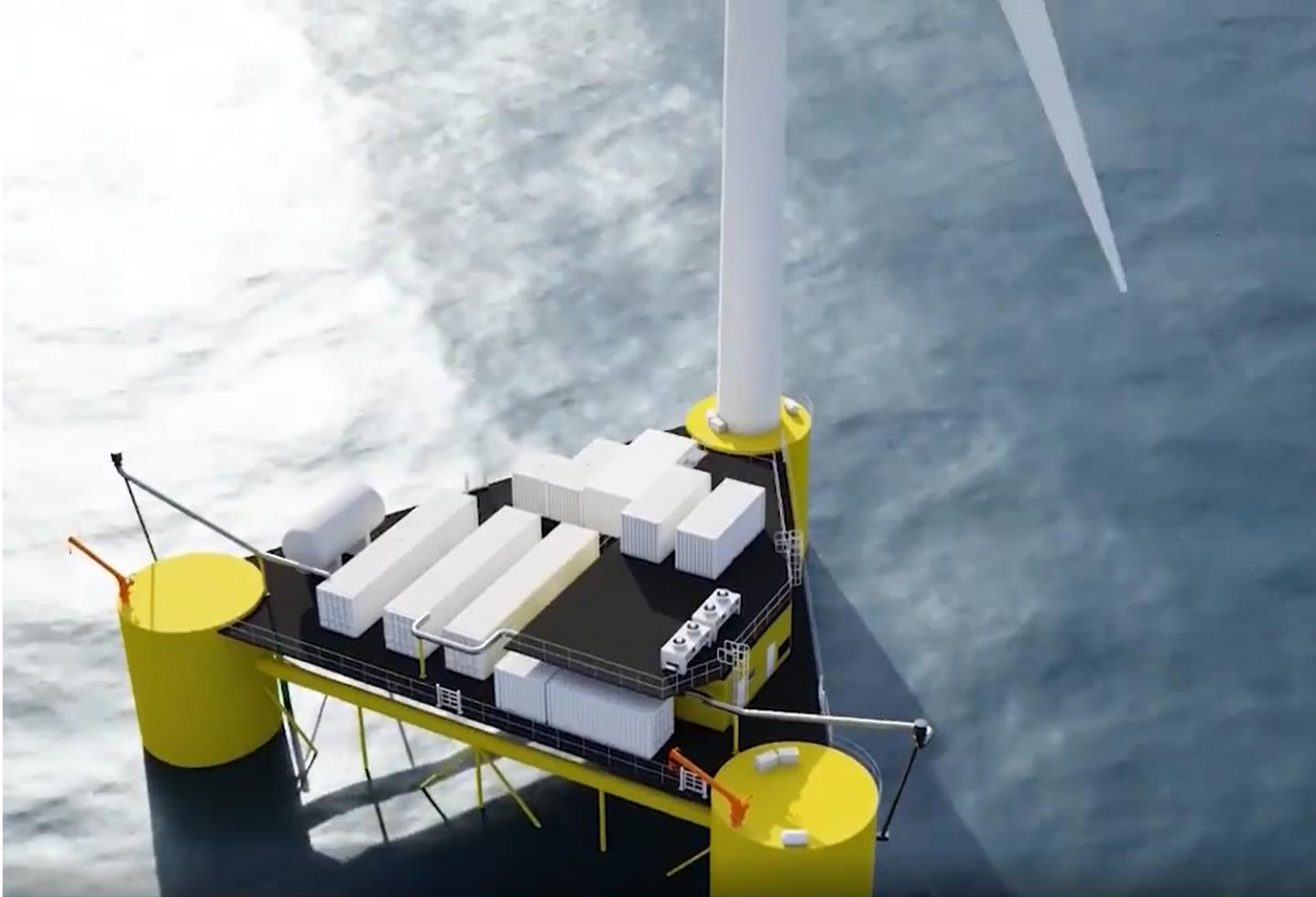
# PosHYdon – Green Hydrogen on offshore installation



- Innovative pilot project 13 kilometer off the coast of Scheveningen, NL
- Green hydrogen to be produced offshore on operational platform
- Investigating the practical aspects of energy systems at sea and producing hydrogen in an offshore environment



# Large scale green hydrogen production from offshore floating wind



- To produce large-scale 'green' hydrogen from offshore floating wind
- To integrate electrolysis and wind turbine on moored floating sub-structure
- Around 80 % of the world's offshore wind resource potential is in waters deeper than 60 meters
- Concept developed by ERM

# Industrializing our PEM platform

- Scaling up and automation will drive down cost
- Reducing overall material usage
- Reducing dependence on exotic materials such as iridium and platinum







nel

# Fueling the green transition

Robert Borin  
SVP Nel Fueling





## OUR AMBITION – FOSSIL PARITY

Make it **as easy** and **to the same price**, to fill up a fuel cell electric vehicle compared to vehicles running on petrol or diesel – and, provide comparable driving range

# The advantages of hydrogen



## No emissions

An obvious prerequisite for all modern vehicles, making all fossil fueled vehicles obsolete



## Long driving range

A well-functioning truck must be able to drive 1500 km on one tank.



## Fueling time

Where the battery electric vehicle can not compete with a traditional fossil fueled vehicle on charging time, the fuel cell electric vehicle can.



X 15

## Land requirements

Charging of battery electric vehicles require 15 times\* more land area than fueling hydrogen vehicles

# The green transition is a reality



Rapidly  
growing  
network



Transport  
for  
London



Heavy  
Duty



# So, what does it take?

- User convenience
- Fast fueling
  - HD – less than 12 minutes
  - LD – less than 3 minutes
- Higher volumes
  - HD – more than 80 kg
  - LD – 5 to 10 kg
- Competitive Total Cost of Ownership (LCoH)
- Fossil parity uptime and reliability



# This is only the beginning!



number one by nature