

Strategies for Improving Efficiency and Sustainability in Chlor Alkali Plants

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thyssenkrupp
nucera

Agenda

State-of-the-Art Chlor-Alkali Electrolysis Technology

Optimal Design of Process Units

Innovative Operational Strategies

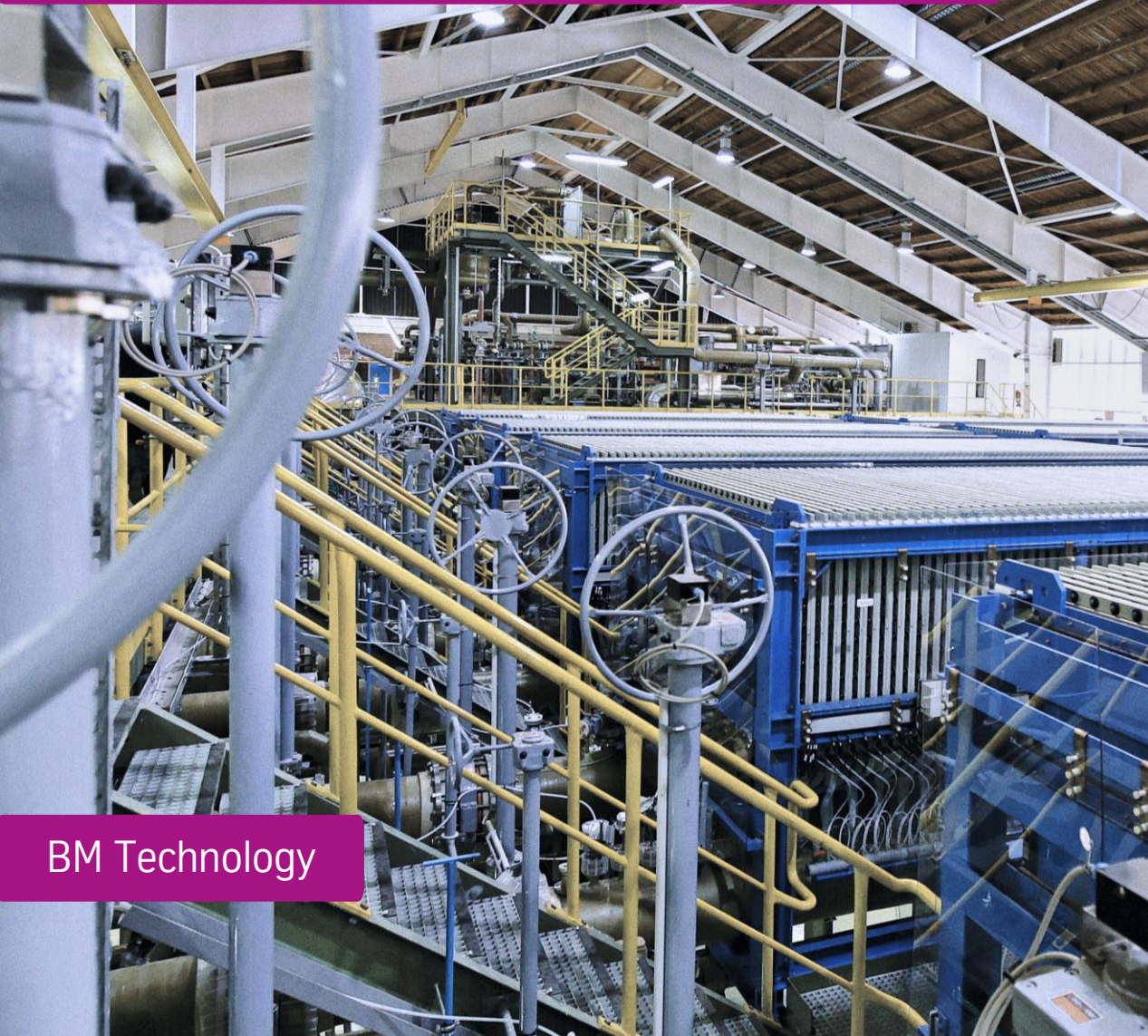
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Chlor-Alkali Technology



BM Technology



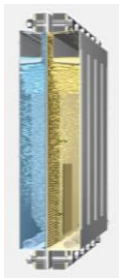
BiTAC Technology

Technology improvements based on a strong heritage leads to cutting-edge products

BM2.7v3



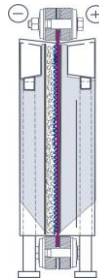
BM2.7v4



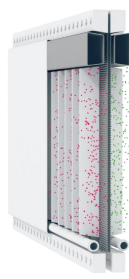
BM2.7v5



BM2.7v6



BM2.7v6plus



BiTAC



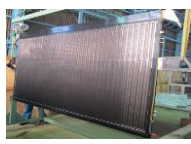
n-BiTAC



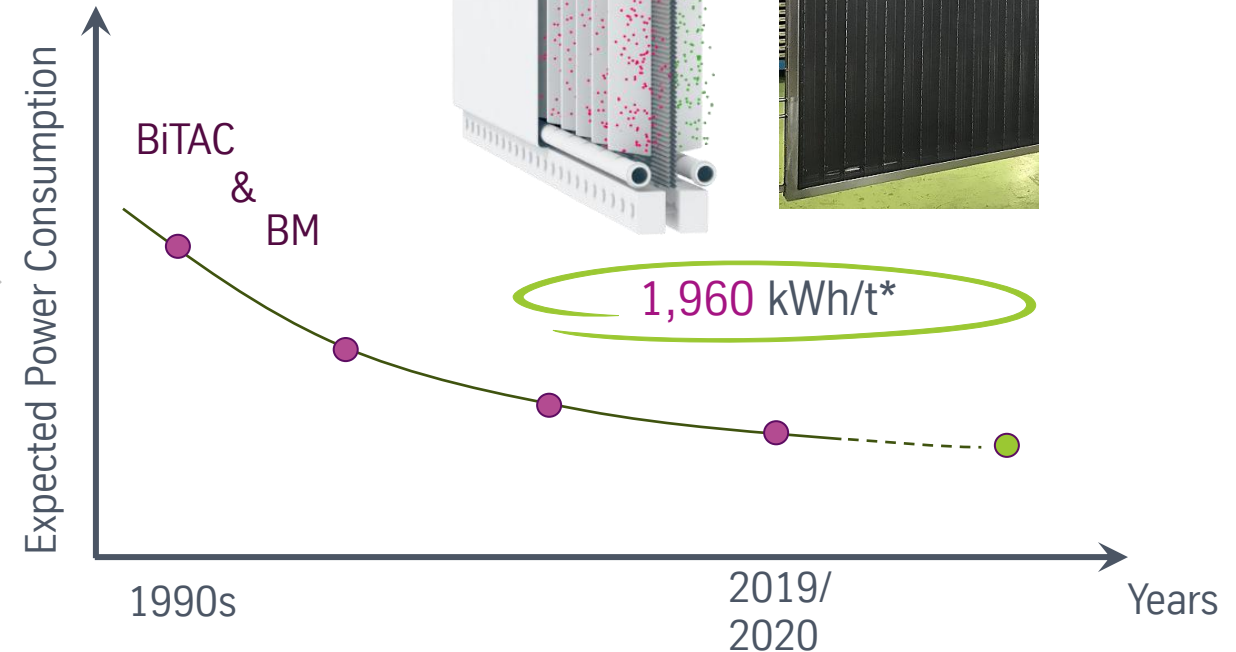
nx-BiTAC



nx-BiTAC plus



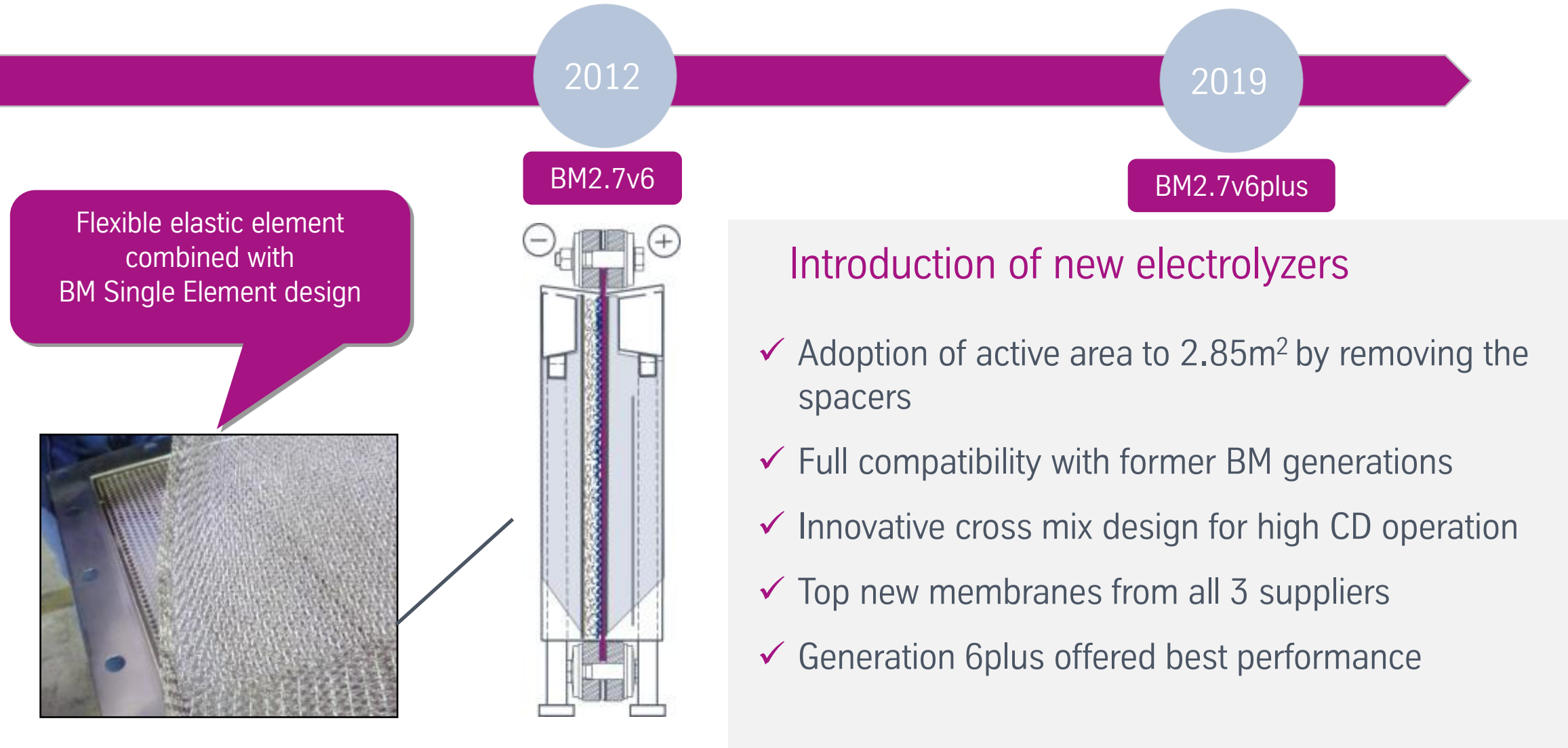
e-BiTAC v7



Power consumption for **BM2.7 Generation 6plus** and **e-BiTAC v7** reaches less than **1960 kWh / mt NaOH**

¹⁾ per t of NaOH 100%, at 6 kA/m², 90°C, 32 % NaOH product

Generation 6 & 6plus are first full zero gap cells in history of BM



The Single element Generation 6plus key features

Hydraulic design

- Optimized downcomer design improves **hydraulic and fluid dynamics**
- Anodic **concentration gradients** are mitigated
- Deep acidification & high CD operation ensured

Mechanical design

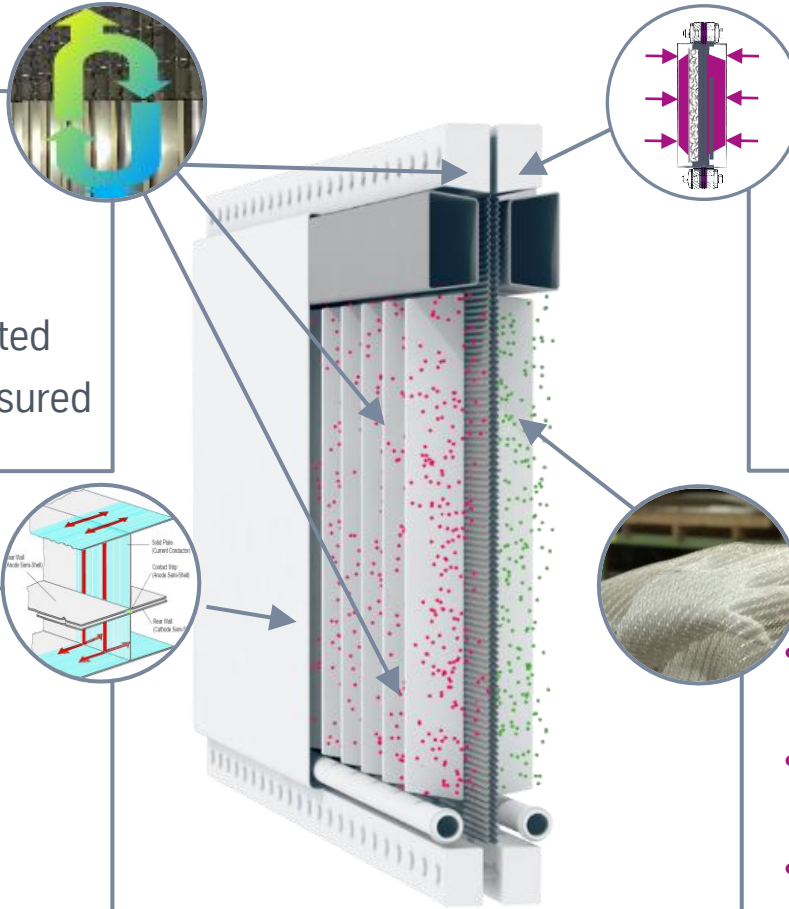
- Bolting system forces compressing the gasket system for superior sealing
- **100% leak proof cell** throughout service life due to durable sealing system

Electrical design

- Electrical current **evenly distributed** to the electrodes
- **Uniform distribution** by continuous laser welding
- Design **minimizes ohmic losses**

Zero gap

- Combination of elastic element with flexible woven mesh cathode enables **“zero gap”**
- **Elastic element compression independent** from element sealing forces
- Zero gap improves **Membrane lifetime & performance**



Know-how and experience needed for a cell effectively performing at high current density with high efficiency

Generation e-BiTAC v7 combining BiTAC and BM features



Introduction of new electrolyzers



Expected power consumption of 1960 kWh/t NaOH at 6 kA/m²



Compatibility with existing BiTAC generations



Operability up to highest current densities (8 kA/m²)



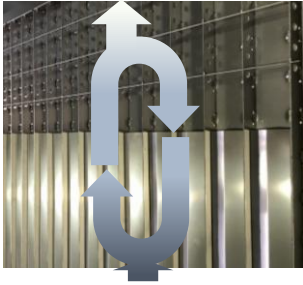
High efficiency and good product quality



Key features - e-BiTAC v7

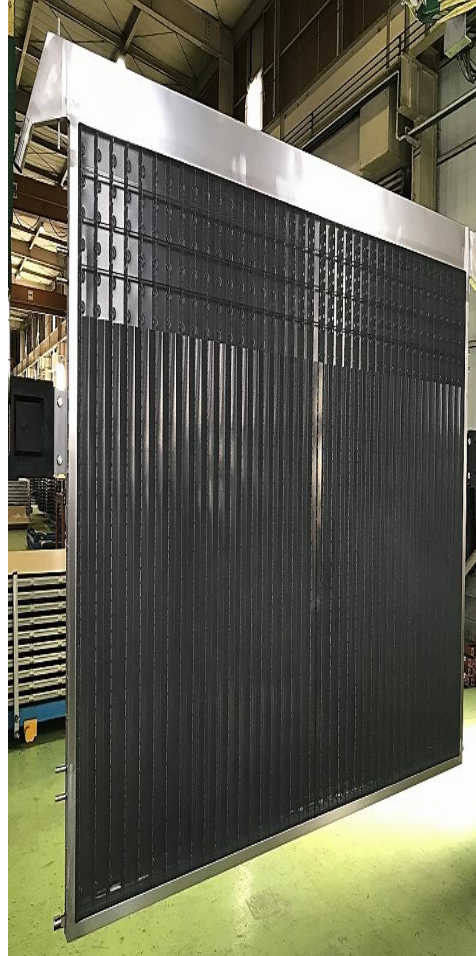
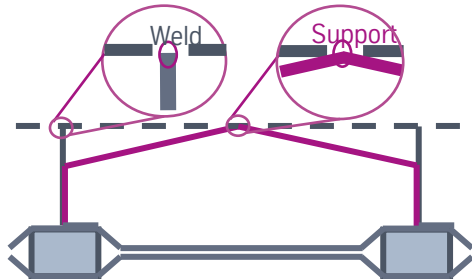
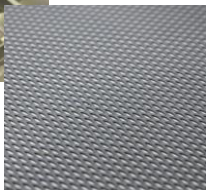
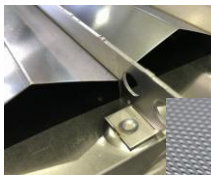
Uniform Brine concentration

V shape downcomer design improves in Anode side improve mixing and uniform Anolyte concentration



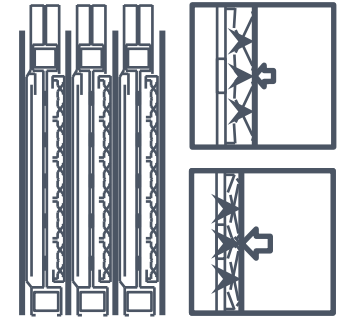
Simple Welding Structure

New structure can reduce the risk of down comer damage during anode re-meshing



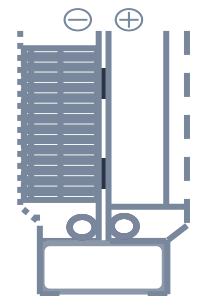
Stable surface pressure

MWX: A highly conductive and elastic spring system on the Cathode side



Easy maintenance

Simple PTFE distribution tube is easy for on site maintenance / reduce down time



e-BiTAC v7 is the first child born in thyssenkrupp nucera group

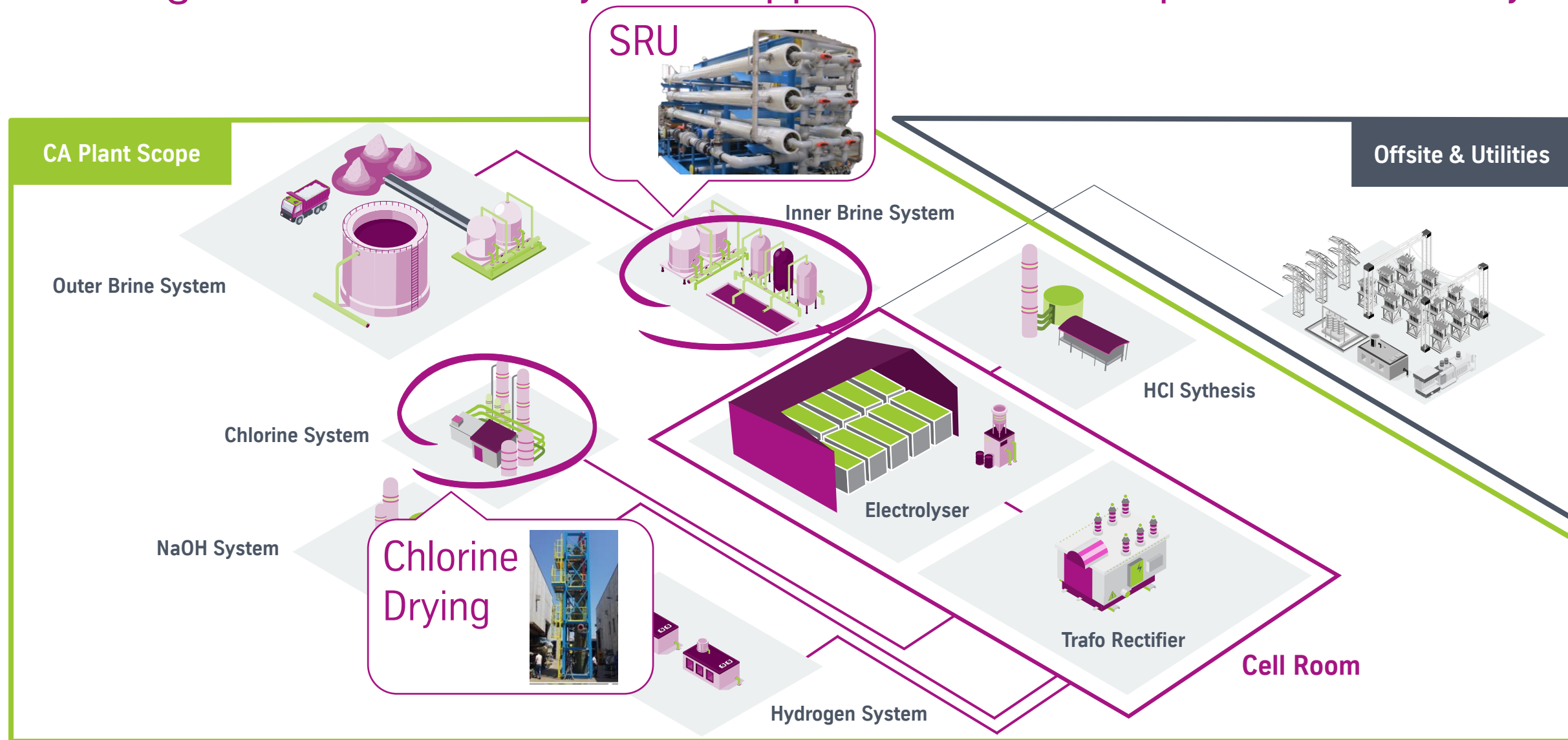
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State-of-the-Art Chlor-Alkali Electrolysis Technology

Optimal Design of Process Units

Innovative Operational Strategies

Covering the Core – How thyssenkrupp nucera delivers process efficiency

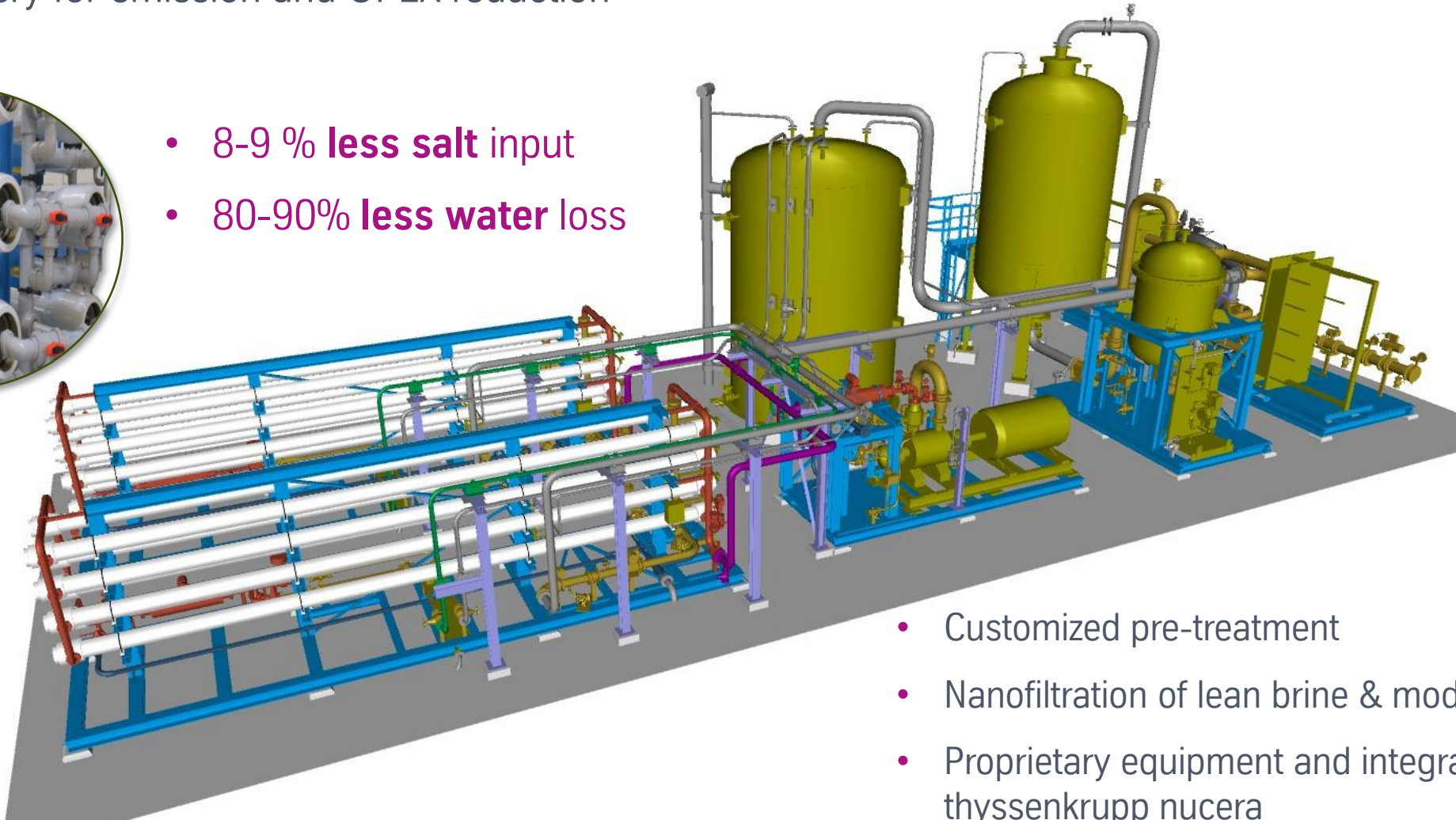


nucera SRU - Developments/Improvements in Brine System

Purge recovery for emission and OPEX reduction



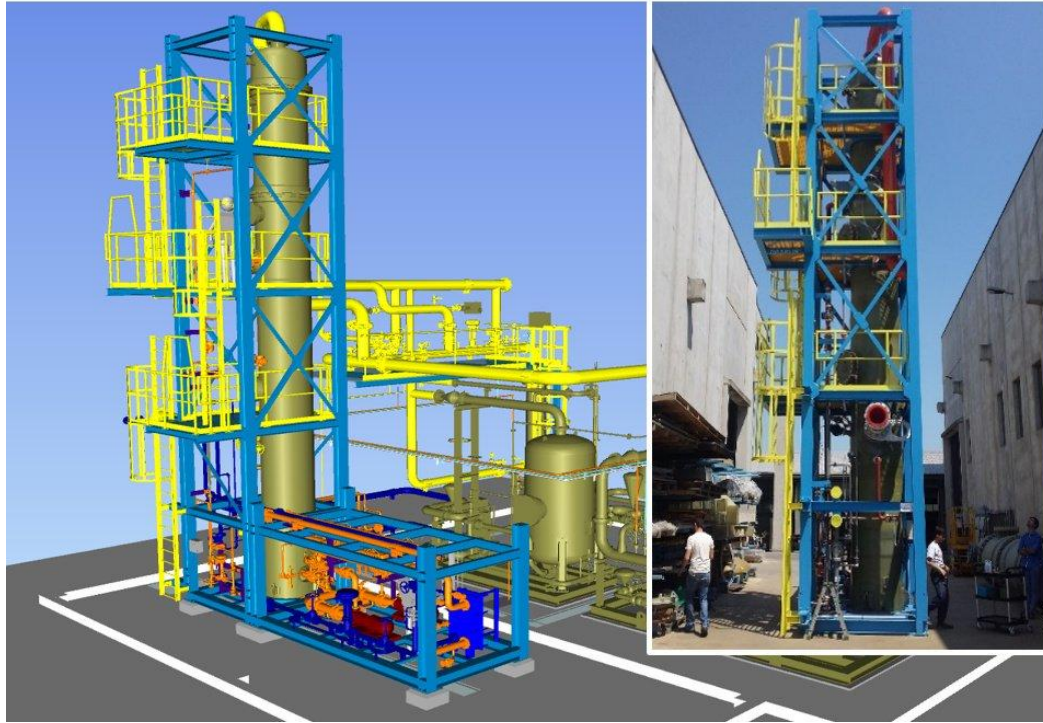
- 8-9 % **less salt** input
- 80-90% **less water** loss



- Customized pre-treatment
- Nanofiltration of lean brine & modular scale up
- Proprietary equipment and integrated services by thyssenkrupp nucera

A step toward more environmentally friendly production

nucera Drying Tower - Improvement of product quality



Proposed Solution

- Single Drying Tower System for new plants and to replace old inefficient drying system

Results/Advantages

- Low moisture content of 5 – 10ppm w/w basis
- Less space requirement compared to multi-tower systems
- Low OPEX (power, utilities and maintenance)
- Proven technology
- Skid unit that is easily integrated into existing plants (optional)
- Short erection time at site

Reducing moisture in chlorine gas with lowest footprint and minimized OPEX

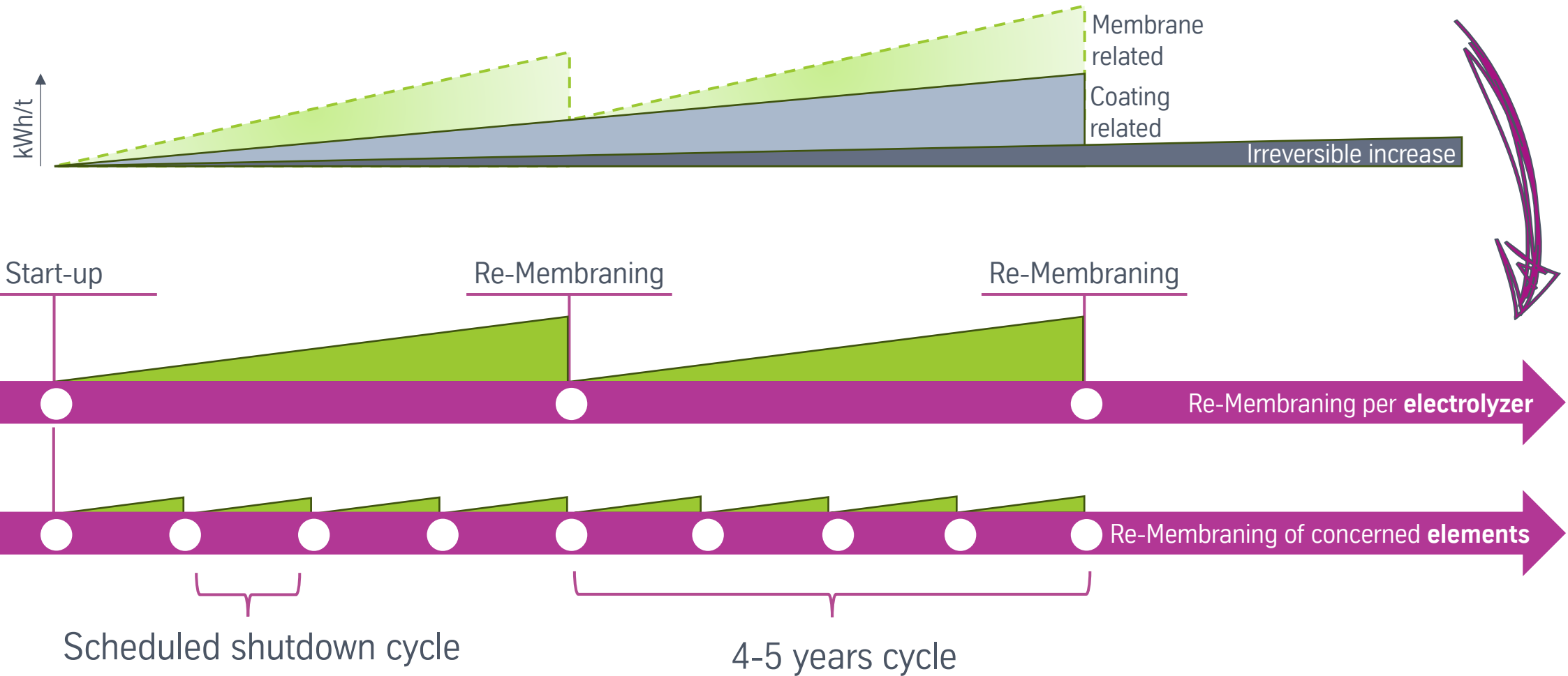
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State-of-the-Art Chlor-Alkali Electrolysis Technology

Optimization of Process Plant Designs / Optimal Design of Process Units

Innovative Operational Strategies

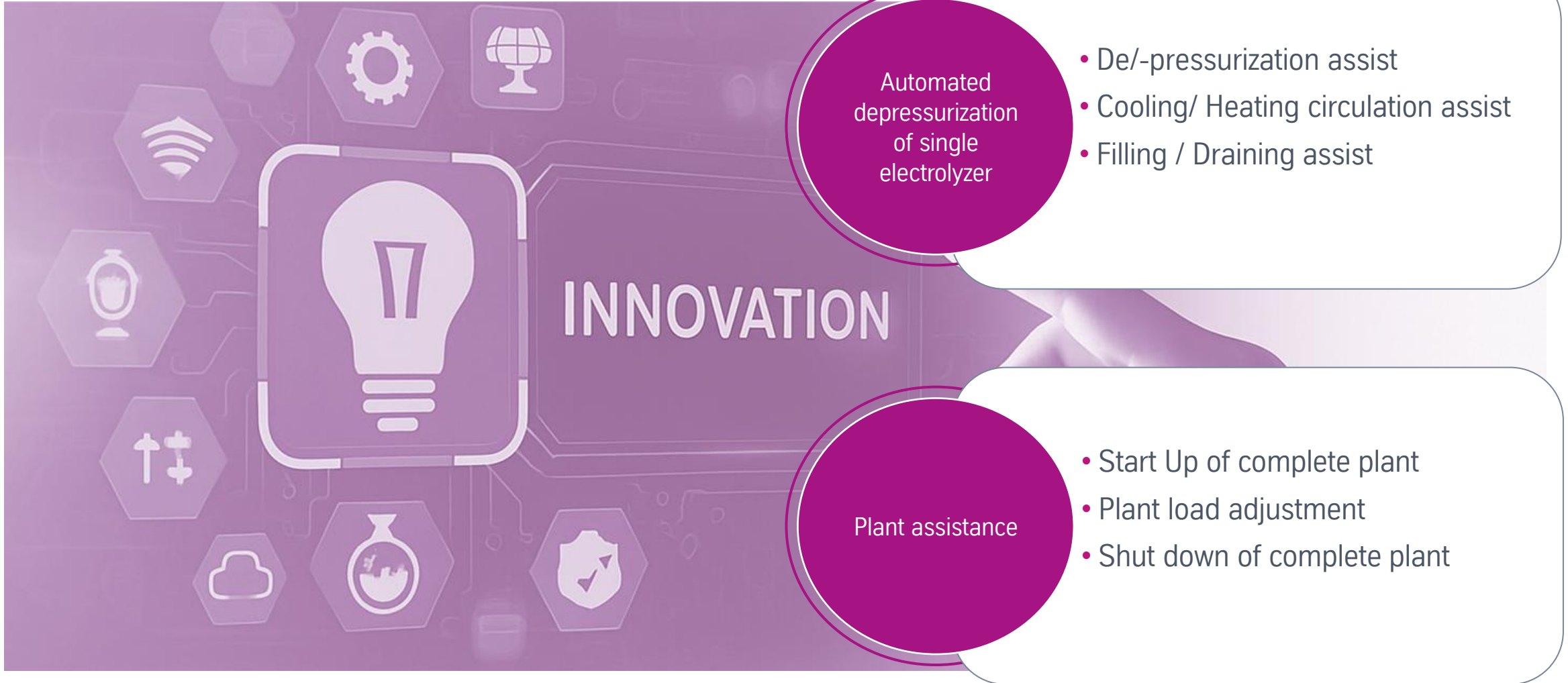
Membrane related increase of power consumption can be managed in different ways



Lower power consumption over time | Continuous OPEX for new membranes | Downtime driven by scheduled shutdowns

Advanced Automation operator support through DCS

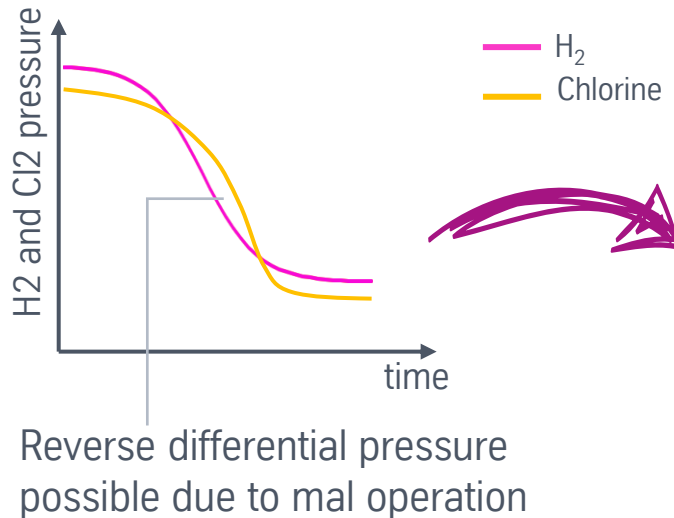
Several assistance Sequences and Programs to support the cell operation



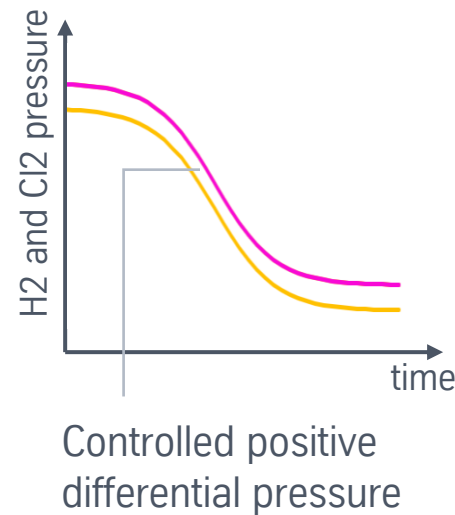
Depressurization Assist with support through DCS

Automation of operator activities during separation of single electrolyzer

Manual Depressurization



Automated Depressurization



Automated
depressurization
of single
electrolyzer

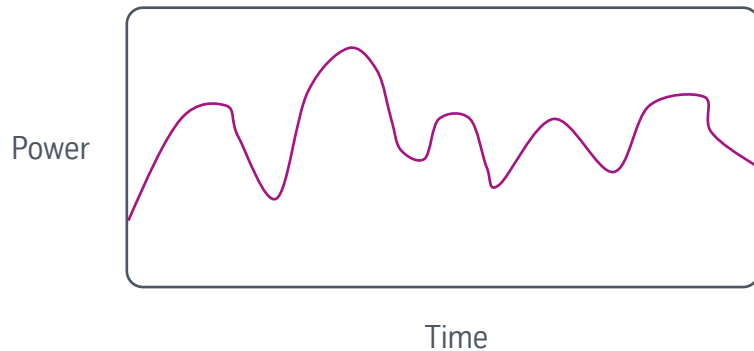
- DCS programmed working steps according to operating manual
- Positive differential pressure maintained
- Minimal operator involvement

Controlled positive differential pressure enabled through DCS!

Flexible Operation of C/A Plants

State of the Art in C/A Plants

- Primary and secondary power control for grid stabilization
- Control of plant load directly and automated
- Load shedding on daily basis
- Plant automation



Challenges and opportunities in C/A Plants

- Higher flexibility given for fluctuating renewable energy input
- Low-load operation must consider product quality and efficiency
- Optimized ramp strategies based on cell and plant design
- Support from thyssenkrupp nucera via debottlenecking and automation

Summary



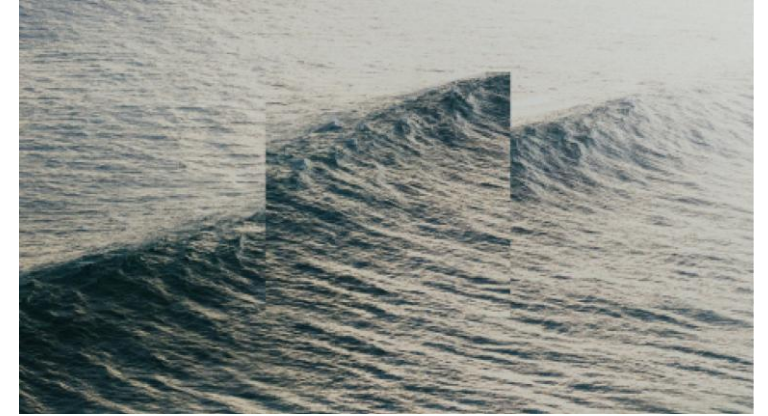
Electrolysis Technology

Energy consumption below
1960 kWh/t NaOH for
BM and BiTAC



Process Unit Design

Improved sustainability
through smart and integrated
engineering solutions



Operational Strategies

Efficient plant operation ensures
reliable and **safe** production



thyssenkrupp
nucera

An aerial photograph of a powerful waterfall. The water is a deep turquoise color, and the base of the falls is covered in thick, white foam. The surrounding landscape is dark and rugged.

We shape
the new era.