

Setting new standards for plant operations

C/A electrolyzers revamp and after sales support:
an overview of thyssenkrupp nucera's strategies

ChloroSur 2022 – Sauípe, Bahia BRAZIL
22 November 2022 | Matteo Gamondo
thyssenkrupp nucera Italy srl



thyssenkrupp
nucera

AGENDA



Technology upgrade

- Metal and precious metal market
- Benefit of early change from SE Gen. V3, V4 to V6
- Cell room revamping



Uhde® E-SWAT

- Introduction to Uhde® E-SWAT
- Web-Based Uhde® Evaluator
- Installed base



Remote & Field Services

- Comparison of plant performances
- RCM – Remote Conditions Monitoring
- Field Service Package

Technology upgrade



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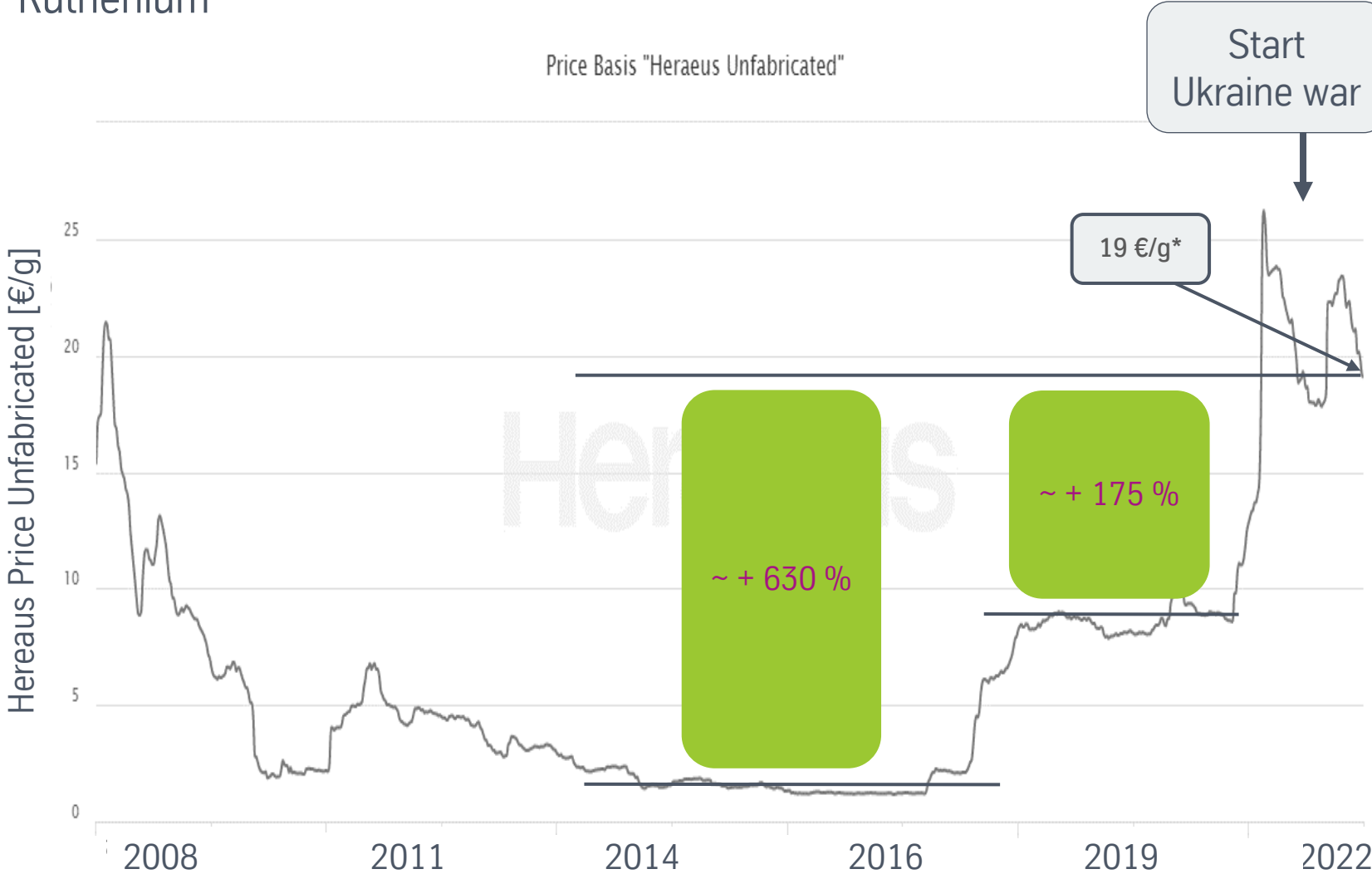
Remote & Field Services

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Precious metal market

Ruthenium

Price Basis "Heraeus Unfabricated"

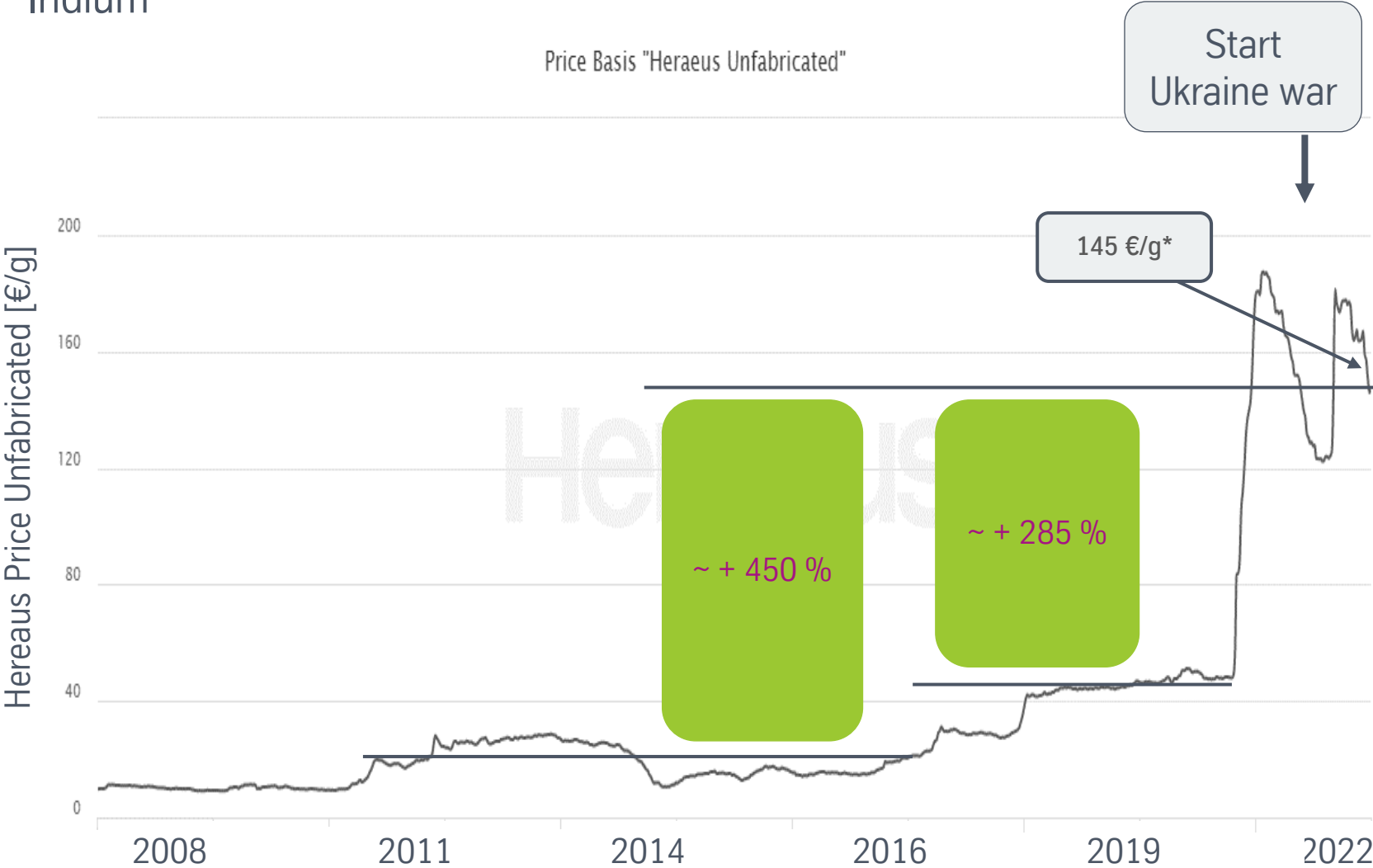


Ruthenium increased by 630 % in last 6 years.

Source: heraeus.com
*October 2022

Precious metal market

Iridium

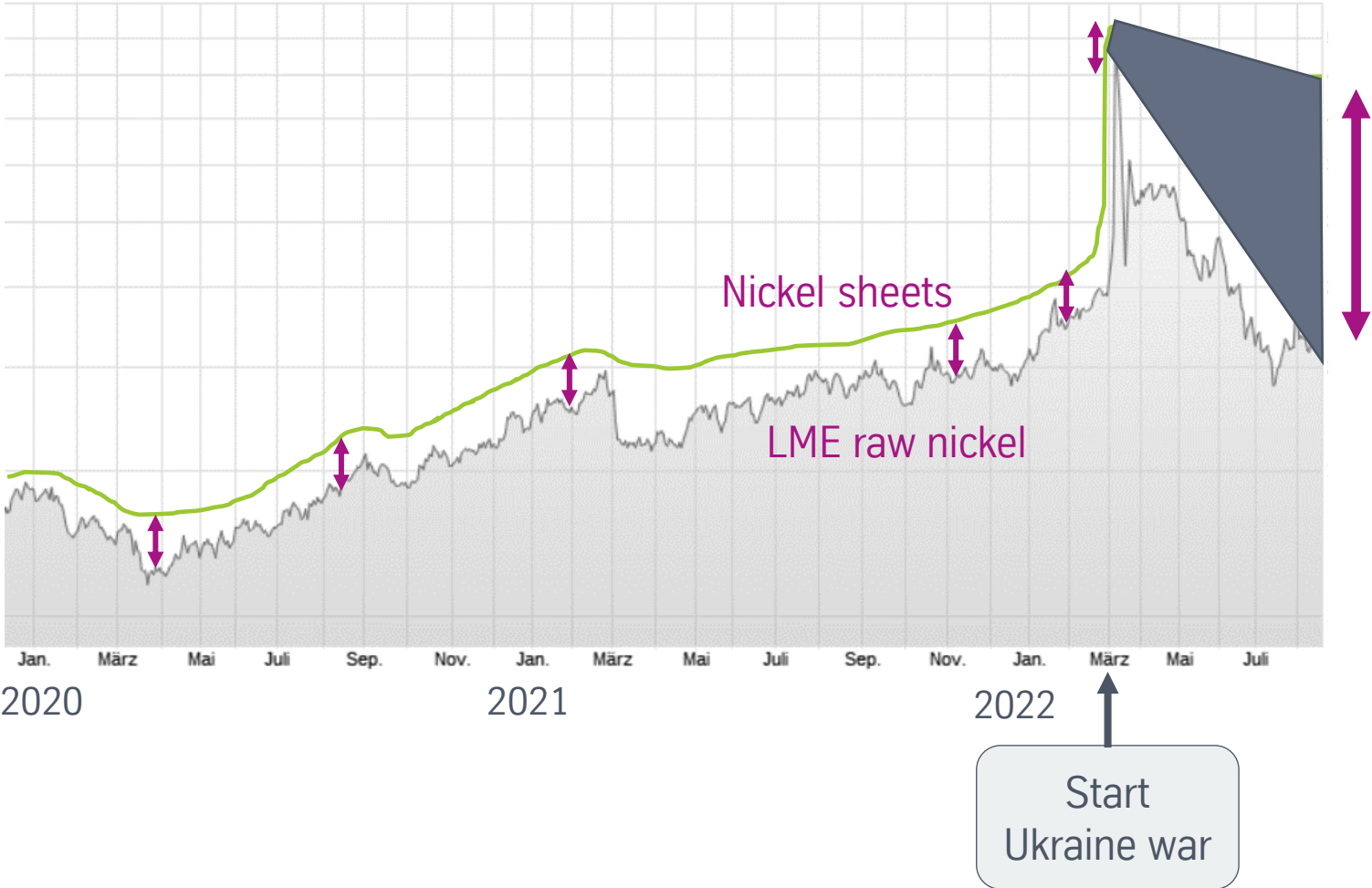


Iridium increased by 450 % in last 6 years.

Source: heraeus.com
*October 2022

Precious metal market

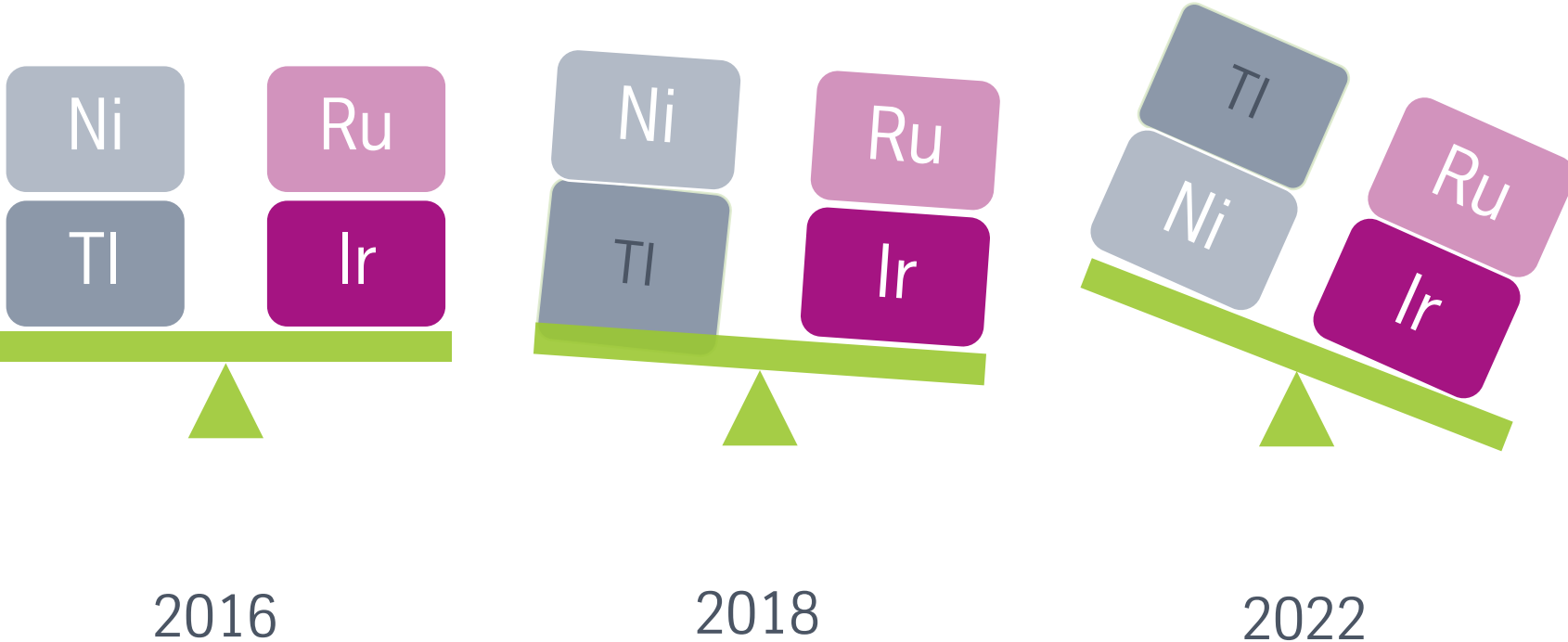
LME Nickel price trend 01/2020 – 08/2022



Significant increase of processing costs for nickel sheets since 03/2022.

Metal and precious metal market

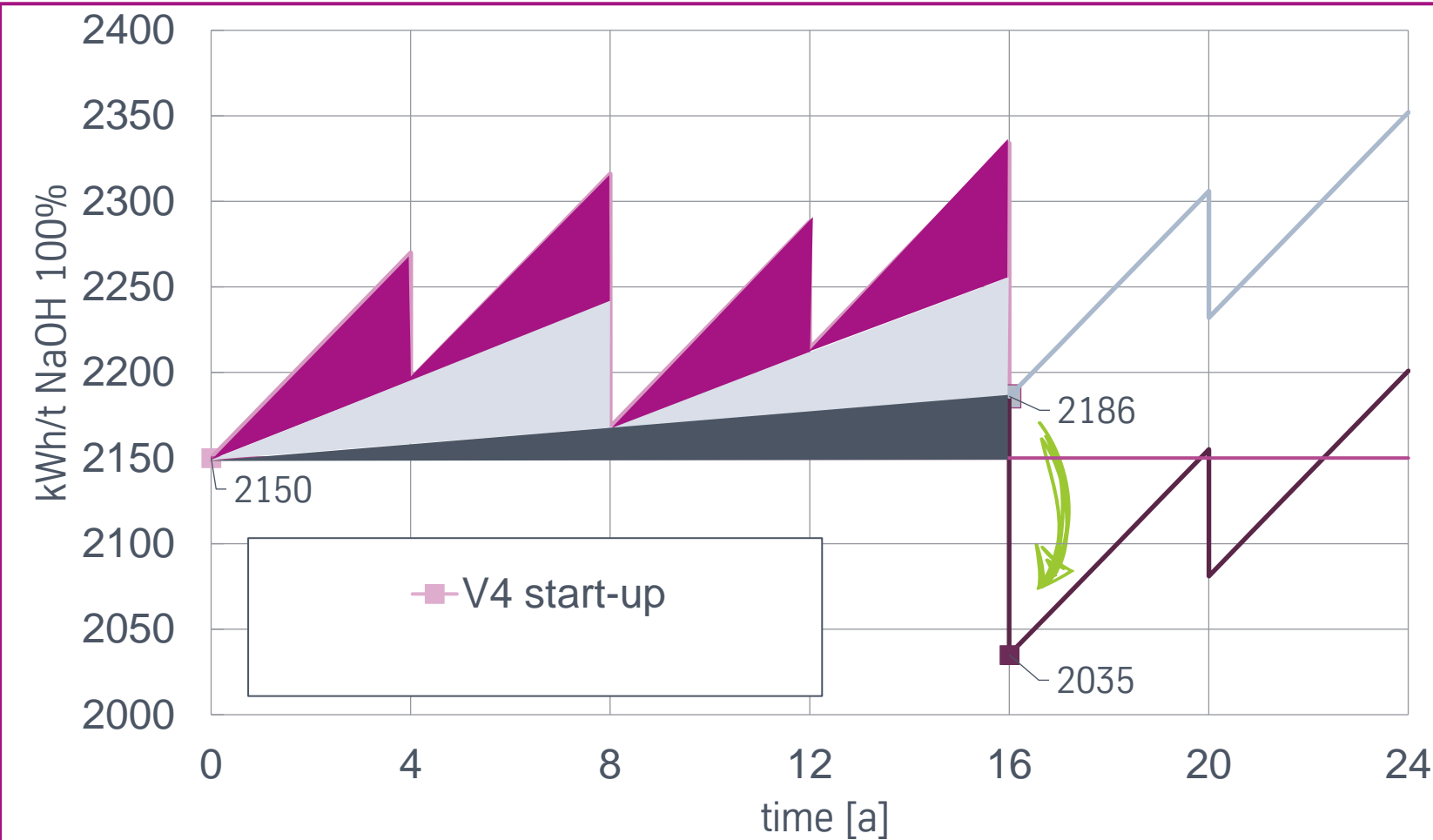
Relative influence on costs for v6b40 elements



Coating accounts for >> 50 % of the element cost in 2022.

Benefit of earlier change SE Gen. V3-4 to V6

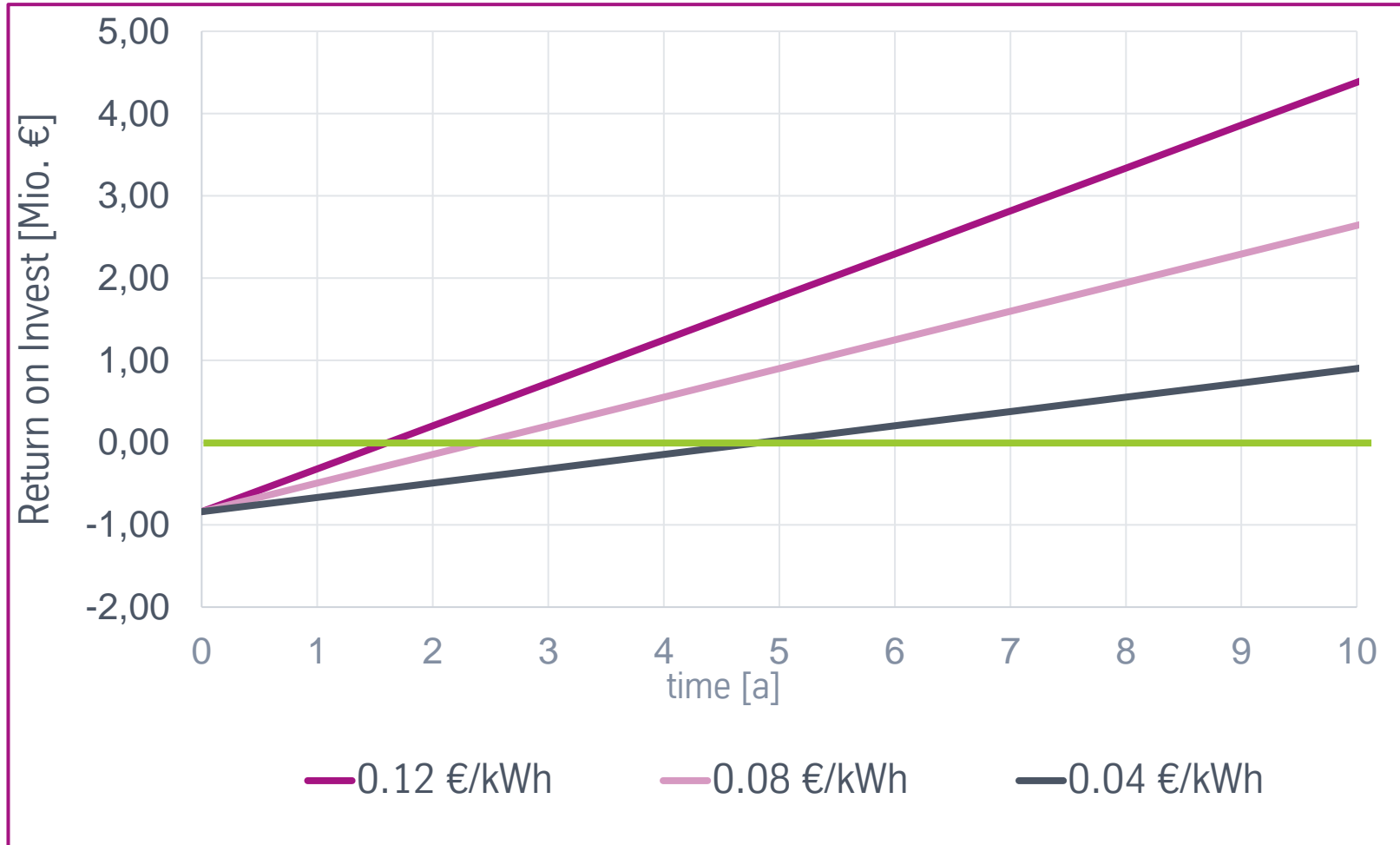
Comparison between recoating and element exchange



Go to V6 after second cycle and
save more than
 $150 \text{ kWh/t}_{\text{NaOH}}$.

Benefit of early change from v4 to v6

Return on Invest (ROI) for different power prices



Example: 1 Electrolyzer, 150 elements; Element price: 16,000 €, Recoating price: 10,400 €; Operating hours: 8300 h/a; CE 95%; CD 6 kA/m²,

ROI for additional cost for v6 compared to recoating costs between 1.5 to 4.5 years + Availability.



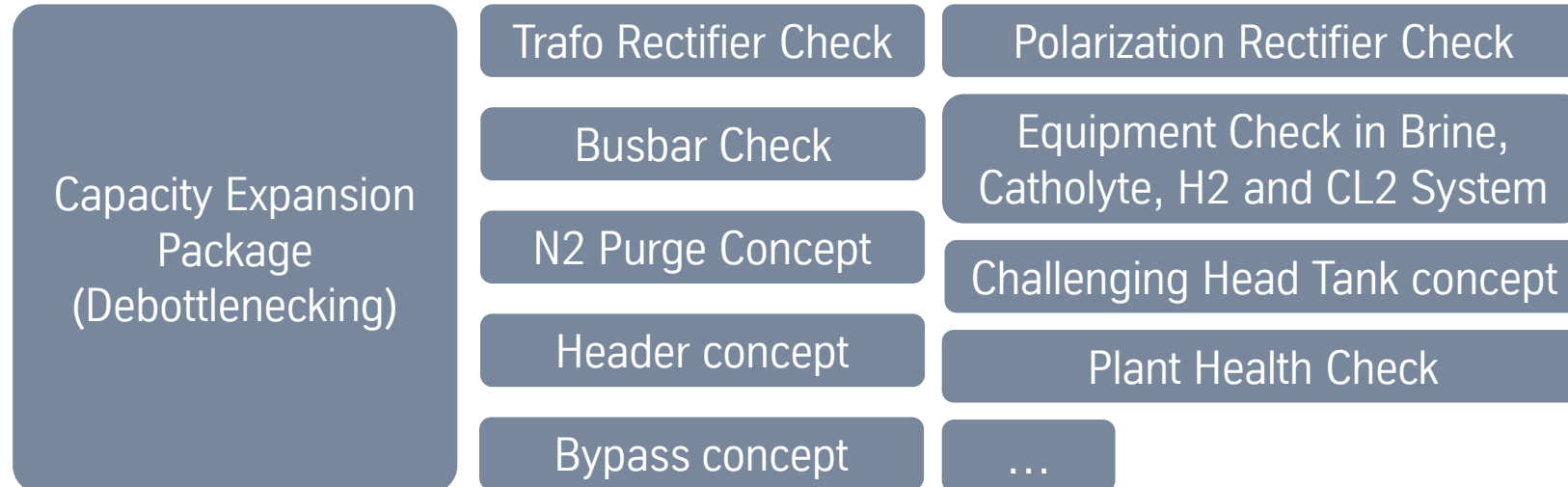
Cellroom revamping from SE Gen. V3-V4 to V6

Revamp strategies beyond element exchange

Mandatory revamps

- Rack modification: Exchange upper beam for elements on rolls
- Crosscheck heating system and implementation additional feed line depending on execution concept
- Replace rack pressing system

Optional modular revamps



Supported by **thyssenkrupp**
nucera revamp experts.

Uhde® E-SWAT



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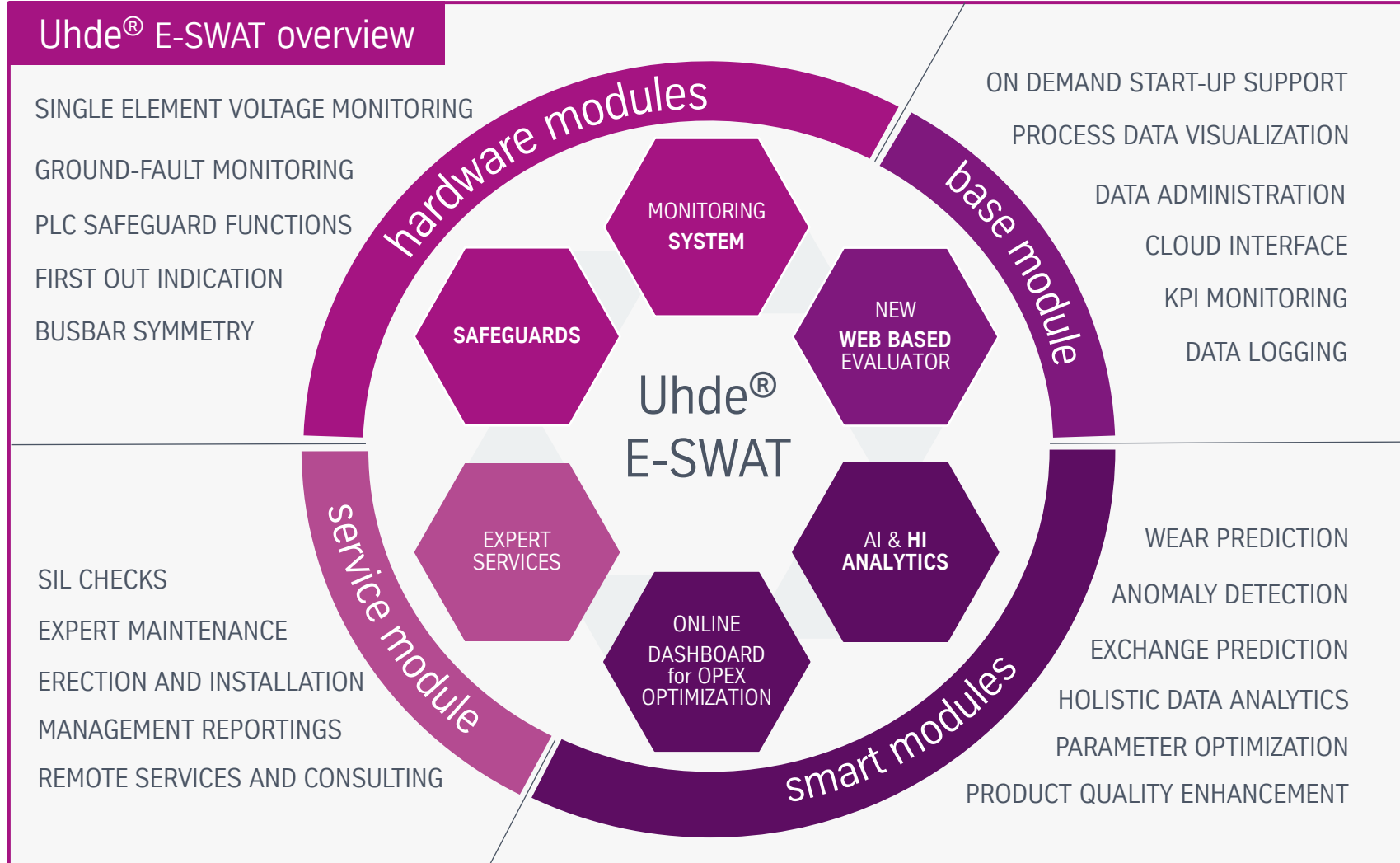


Remote & Field Services

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Uhde® E-SWAT at a glance

Protection of the customers' assets

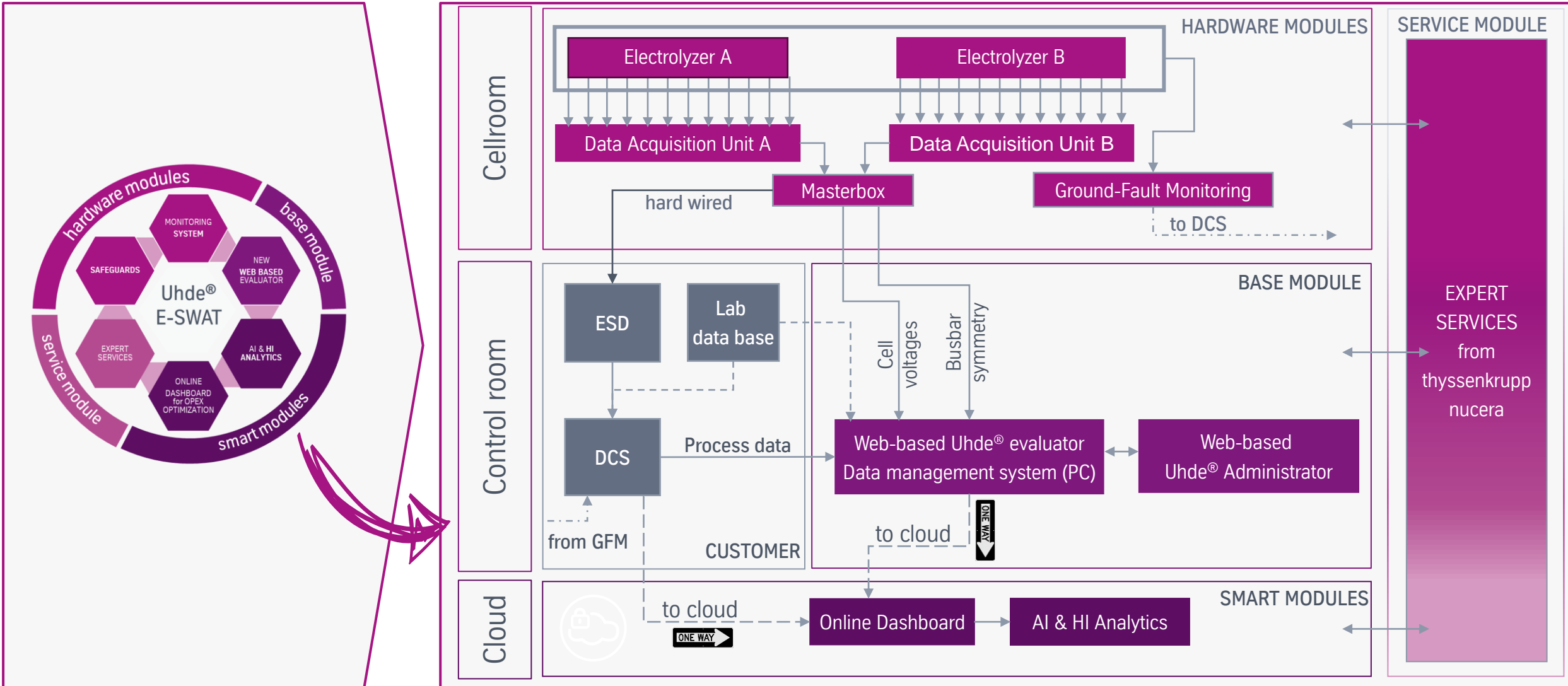


Uhde® E-SWAT key facts

- Modular product
- Available up to SIL 2 or ex-zone if requested
- Web-Based Uhde® Evaluator heart of Uhde® E-SWAT
- Harmonized with customers IT infrastructure
- Easy integration
- Reliable to protect you assets

Uhde® E-SWAT – Easy to integrate

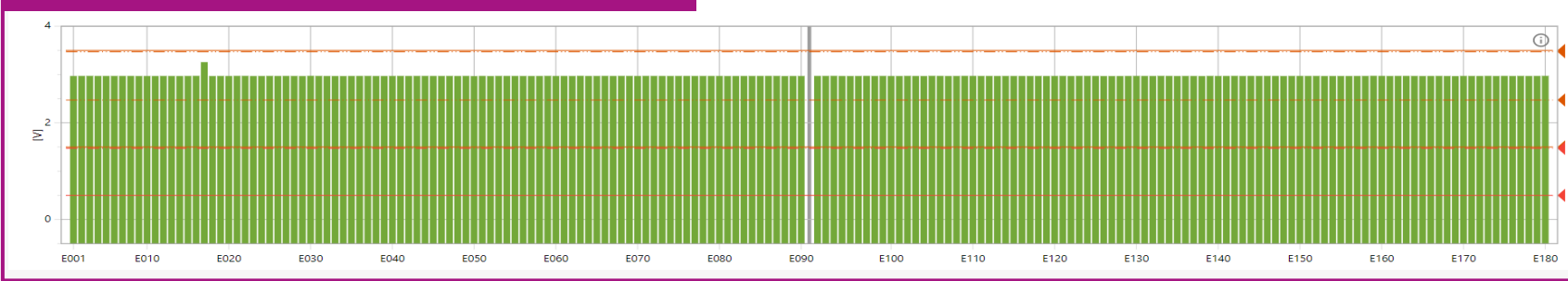
Process landscape to protect your assets



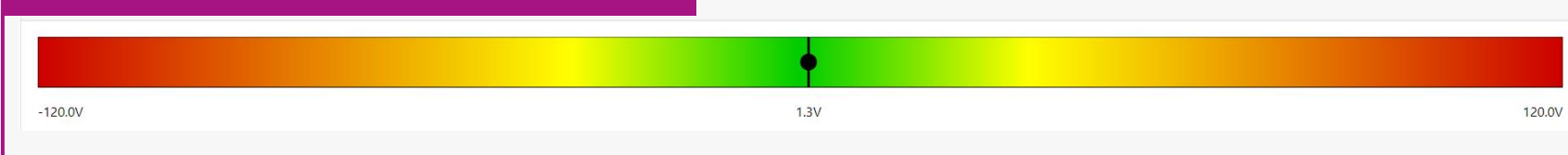
Uhde[®] E-SWAT - Web-Based Uhde[®] Evaluator at a glance

Details & characteristic

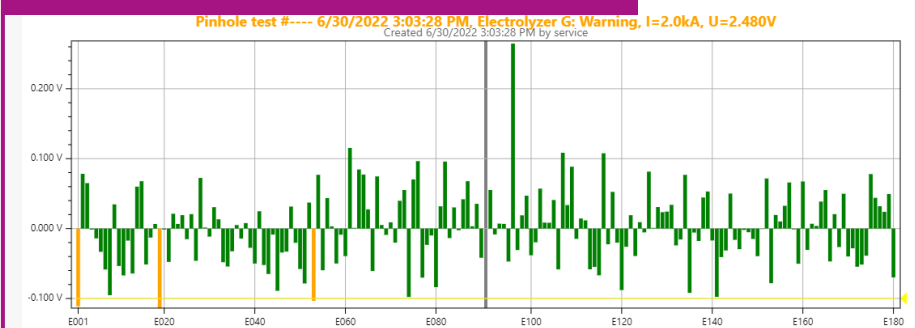
BAR CHART SINGLE ELEMENT VOLTAGE



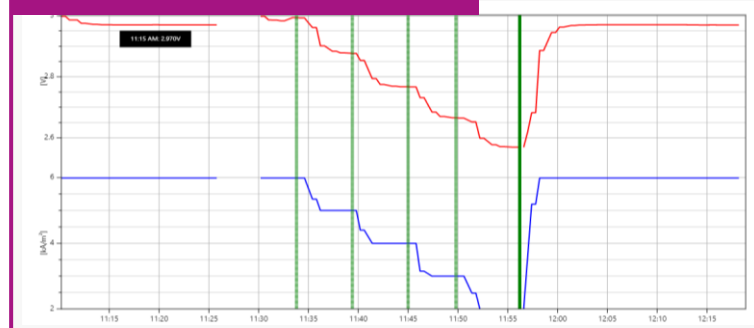
BUSBAR UNSYMMETRY MEASUREMENT



ONLOAD PINHOLE DETECTION



U-I-CURVE EVALUATION



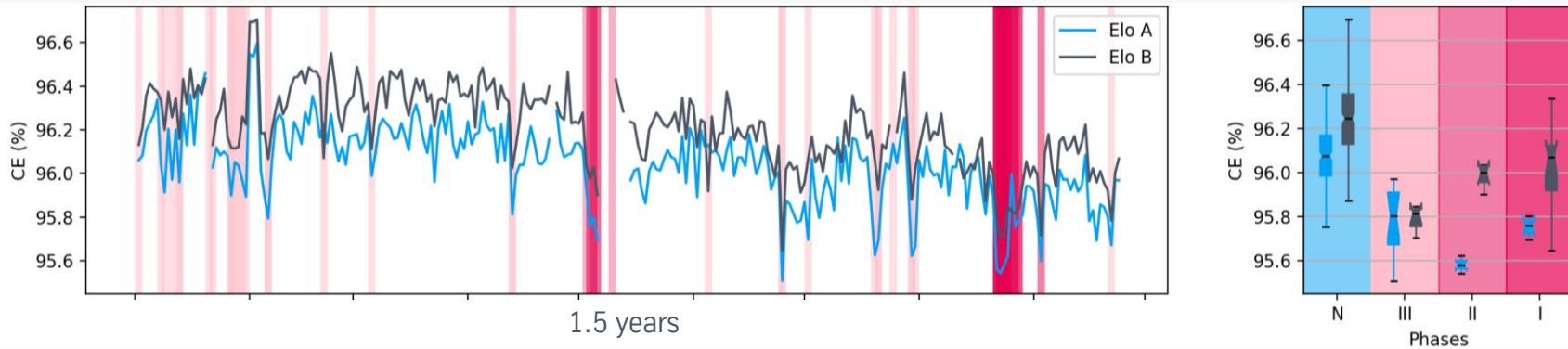
Offline Web-browser application

- Multiple operating systems
- Fast and simple
- Flexible
- Easy accessible
- Remote office solutions
- Blazing fast historic data access

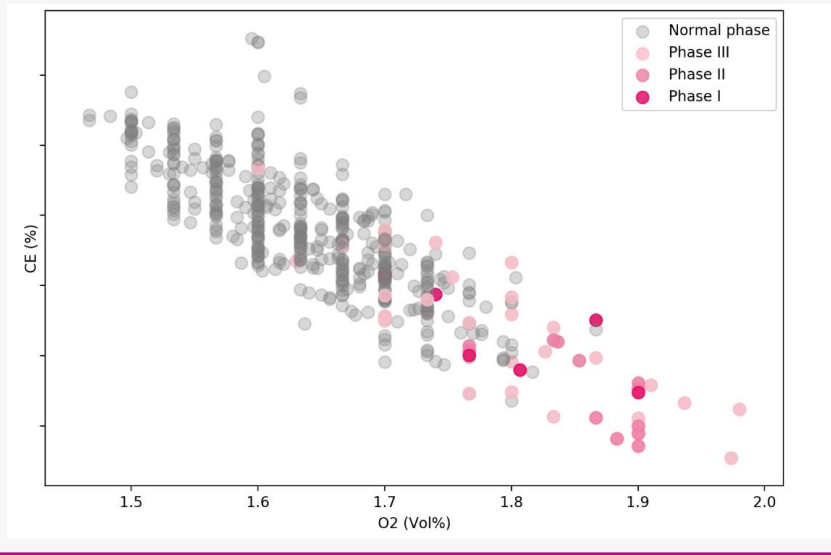
Uhde[®] E-SWAT - Smart Modules

Case Study: Frequent Current Efficiency drops

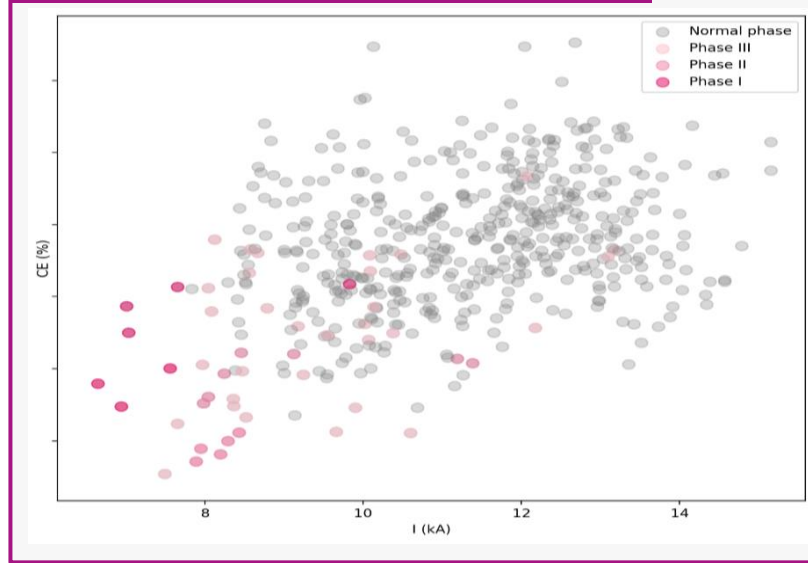
CURRENT EFFICIENCY [%] TREND FOR 1.5 YEARS



CE AS FUNCTION OF O₂ IN Cl₂ [Vol.%]



CE AS FUNCTION OF LOAD I [kA]



Evaluation

- 22 GB raw data tags
- data scientists found correlation by using PCA method
- thyssenkrupp nucera expert validated PCA and confirmed correlation

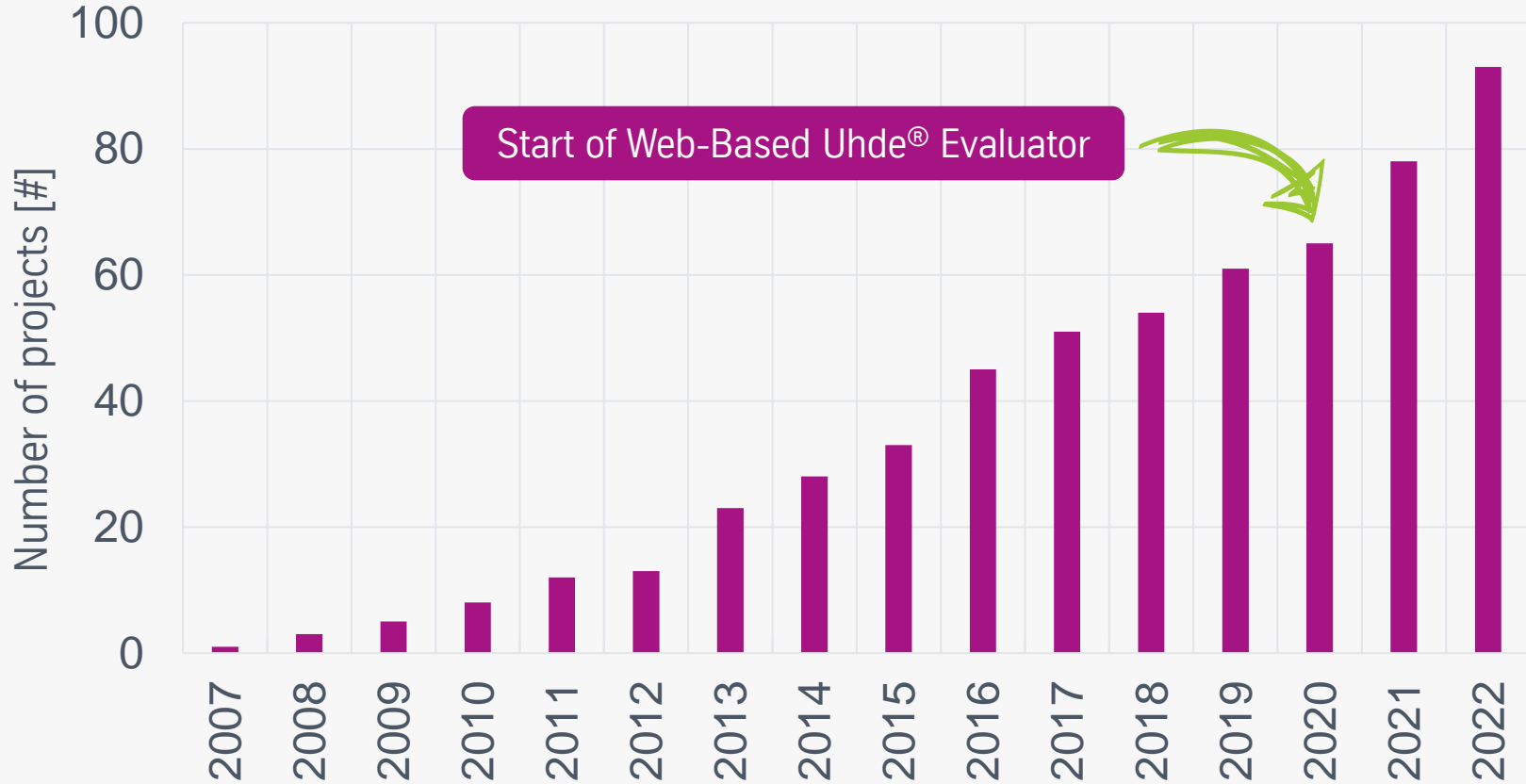
Result

- Dependency of CE on current I
- Optimize load distribution
- Increased efficiency
- Reduced OpEx

Uhde® E-SWAT - Web-Based Uhde® Evaluator

Project overview

CUMULATIVE EVALUATOR PROJECTS



Web-Based Uhde® Evaluator projects for

- New-built
- Revamp project
- Stand-alone projects

Language packs

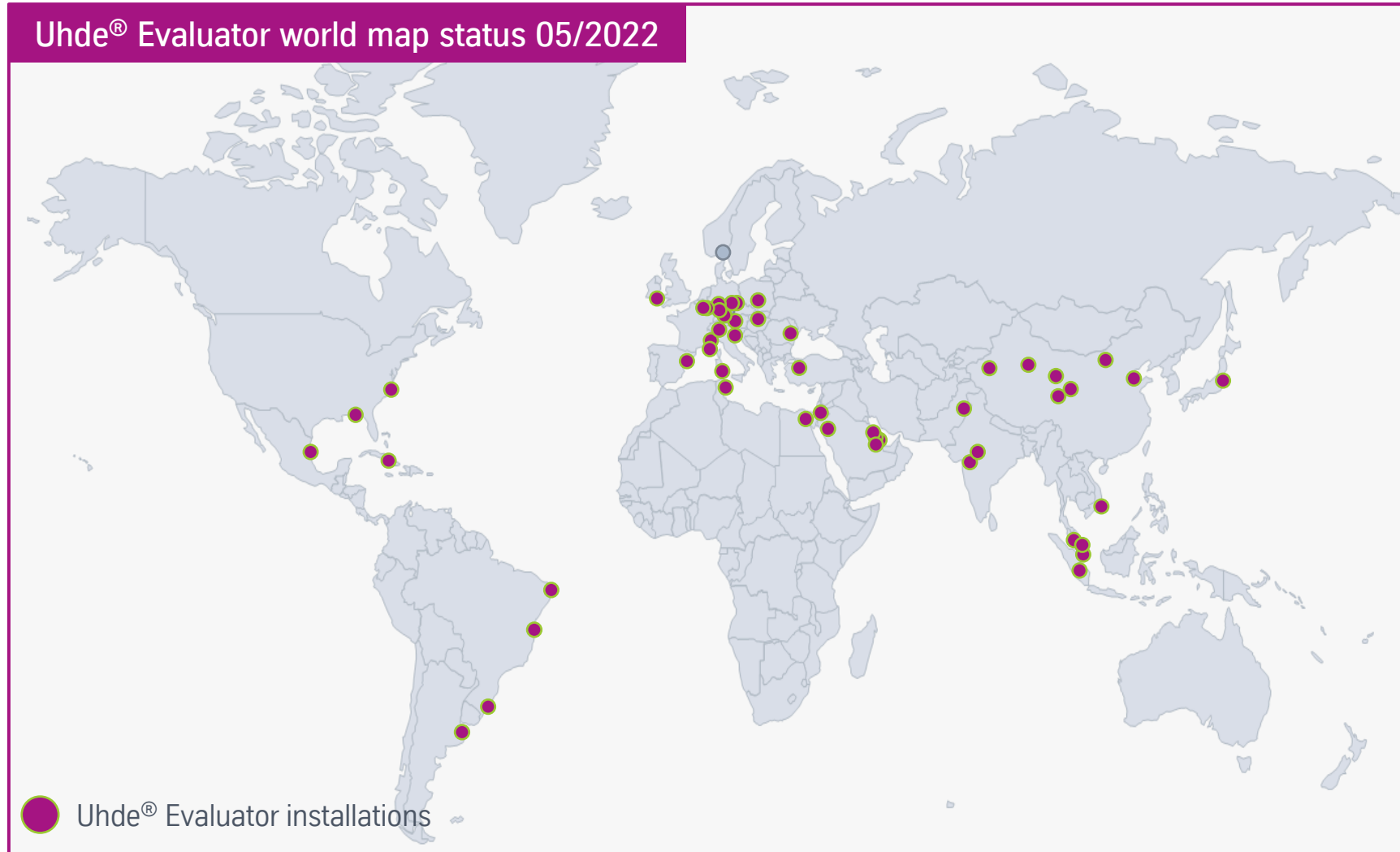
- +10 and on demand

Technology platforms

- For BM, BiTAC, HCI-ODC, AWE

Uhde® E-SWAT - Web-Based Uhde® Evaluator

World map



- Present in **26 countries** on 4 continents
- **Best in class** for protecting our BM, BiTAC, HCI-ODC and AWE technology platforms
- As technology provider **best technology expert**

Remote & Field Services



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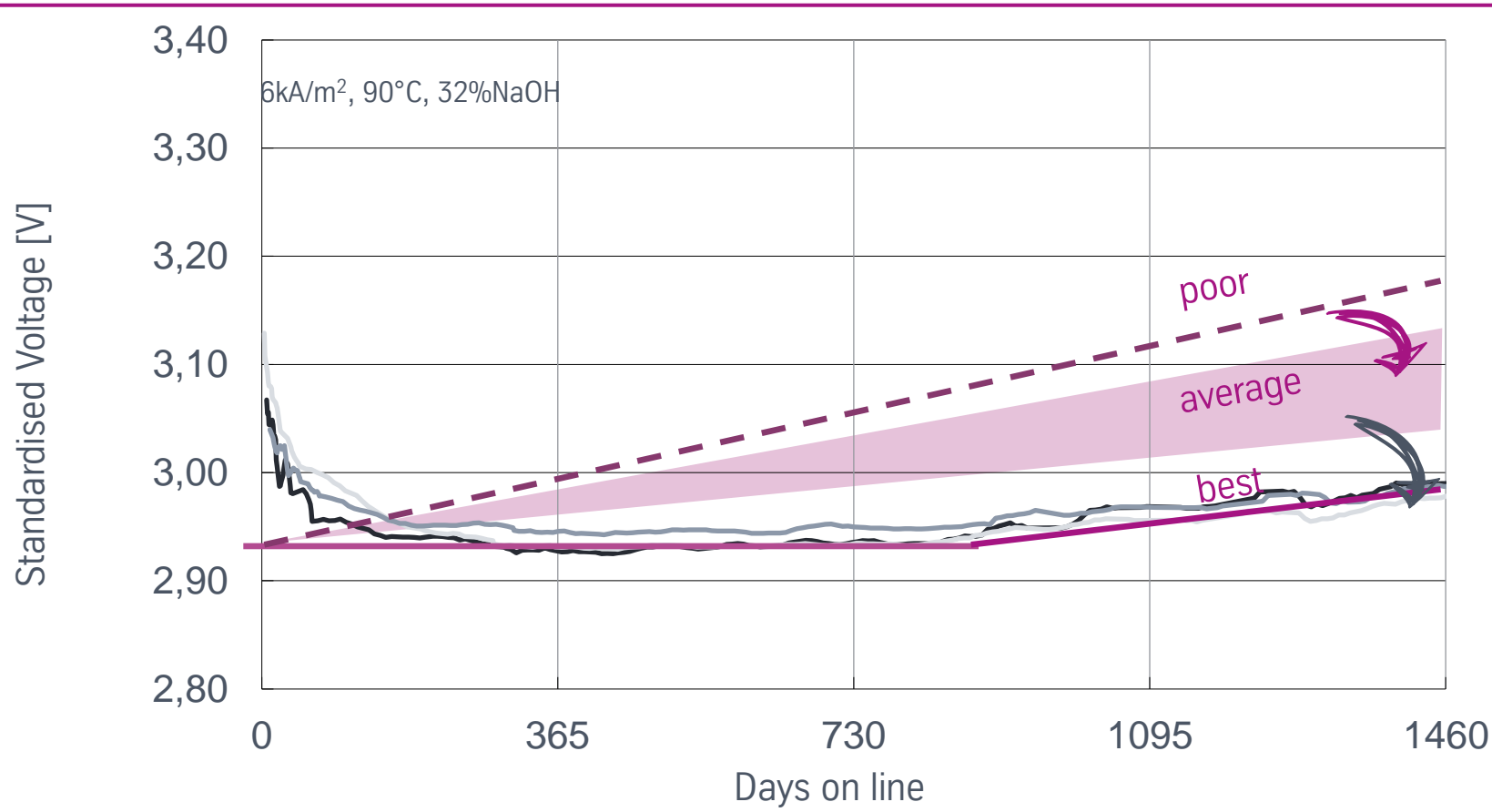


Remote & Field Services

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Remote Services – Performances

Comparison of plant performances – Standardized Voltage



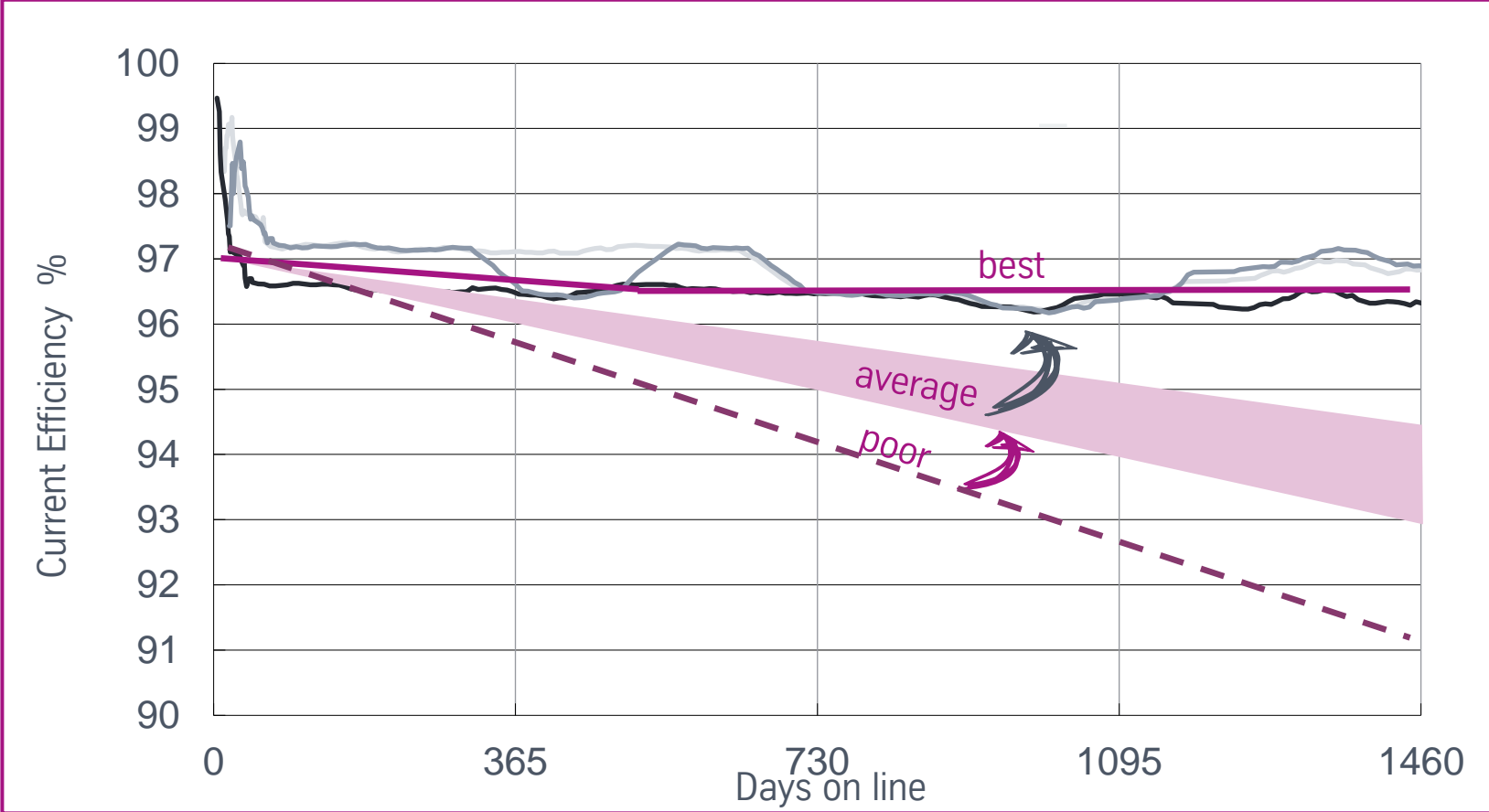
*680 t/day NaOH 100% production capacity

Saving potential

- Poor to average: 1.6 MW*
- Average to best: 1.8 MW*

Remote Services - Performances

Comparison of plant performances – Current Efficiency



Power consumption



Membrane lifetime

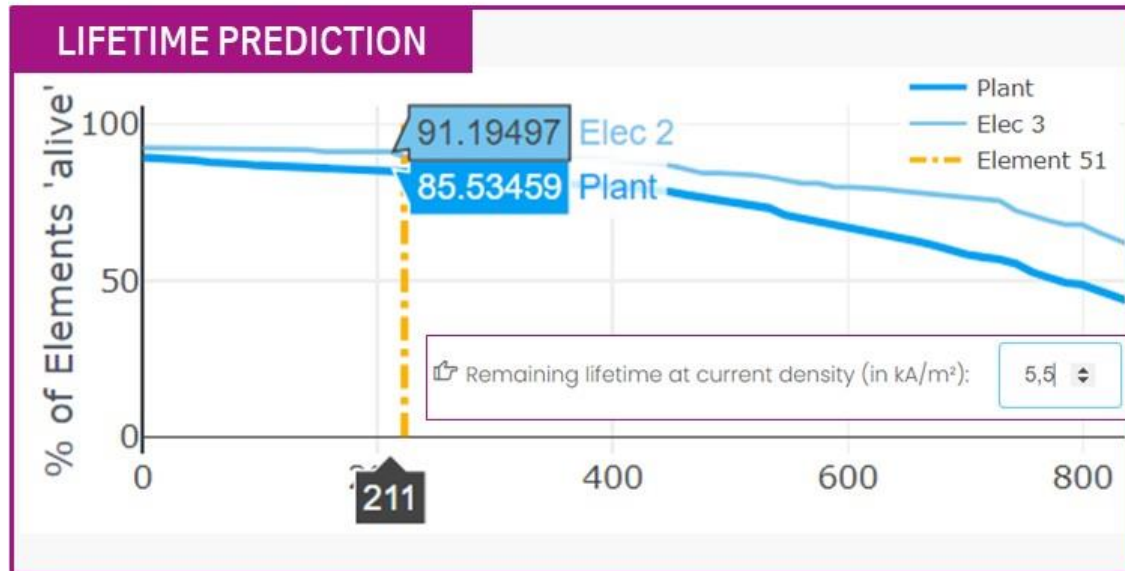
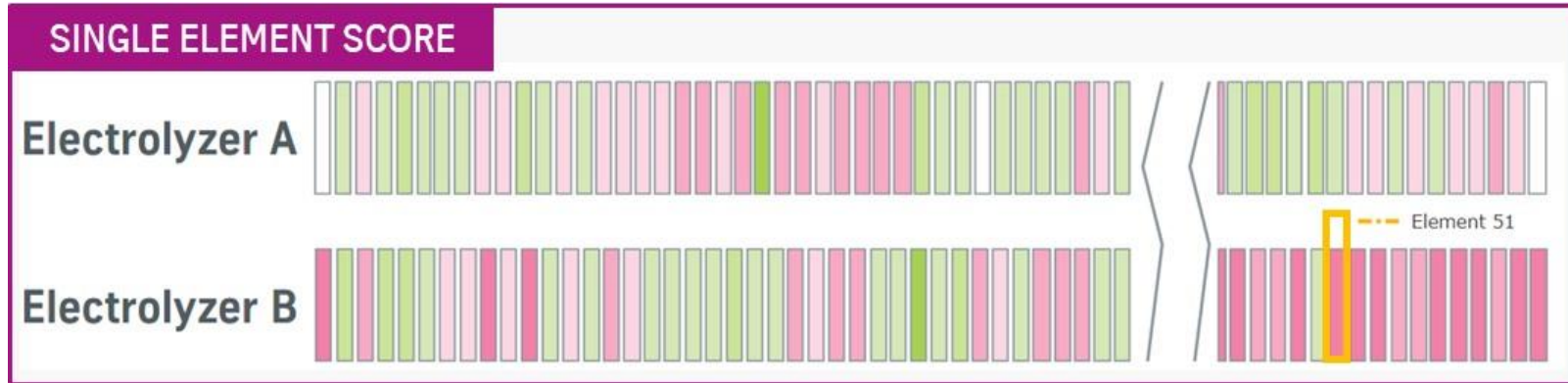


Product quality



Remote Conditions Monitoring

RCM – Smart Module ONLINE DASHBOARD



Predictive Maintenance with economic evaluation:

- Plan your maintenance activities properly
- Decision guidance to exchange bad performing element or wait until next opportunity
- Money saving

Field Service Package Reporting

USER/OWNER
Britec S.p.A.
JOB NAME

JOB NO. : TE02161
DOC NO. : N7-AR0062
ISSUED for : Report

TOTAL SHEET 27 (incl. cover)

INDEX

- Plant Overview
- Cell Room Overview
- Standardization formula
- EL data elaboration
- Lab analysis
- Cell component status
- Summary
- Next - Actions proposed

ELS | Cell voltage

Union Chlorine_UAE / EL
STD avg. voltage trend
Membrane type: AGC F80

| FI 2022/08 | BITAC - Union Chlorine_UAE (Status as of 2022 Sep)

DISTRIBUTION

Customer	T	PE
CHINA	CB	TS
	CA	RV
	ED	PCB
TOKYO		

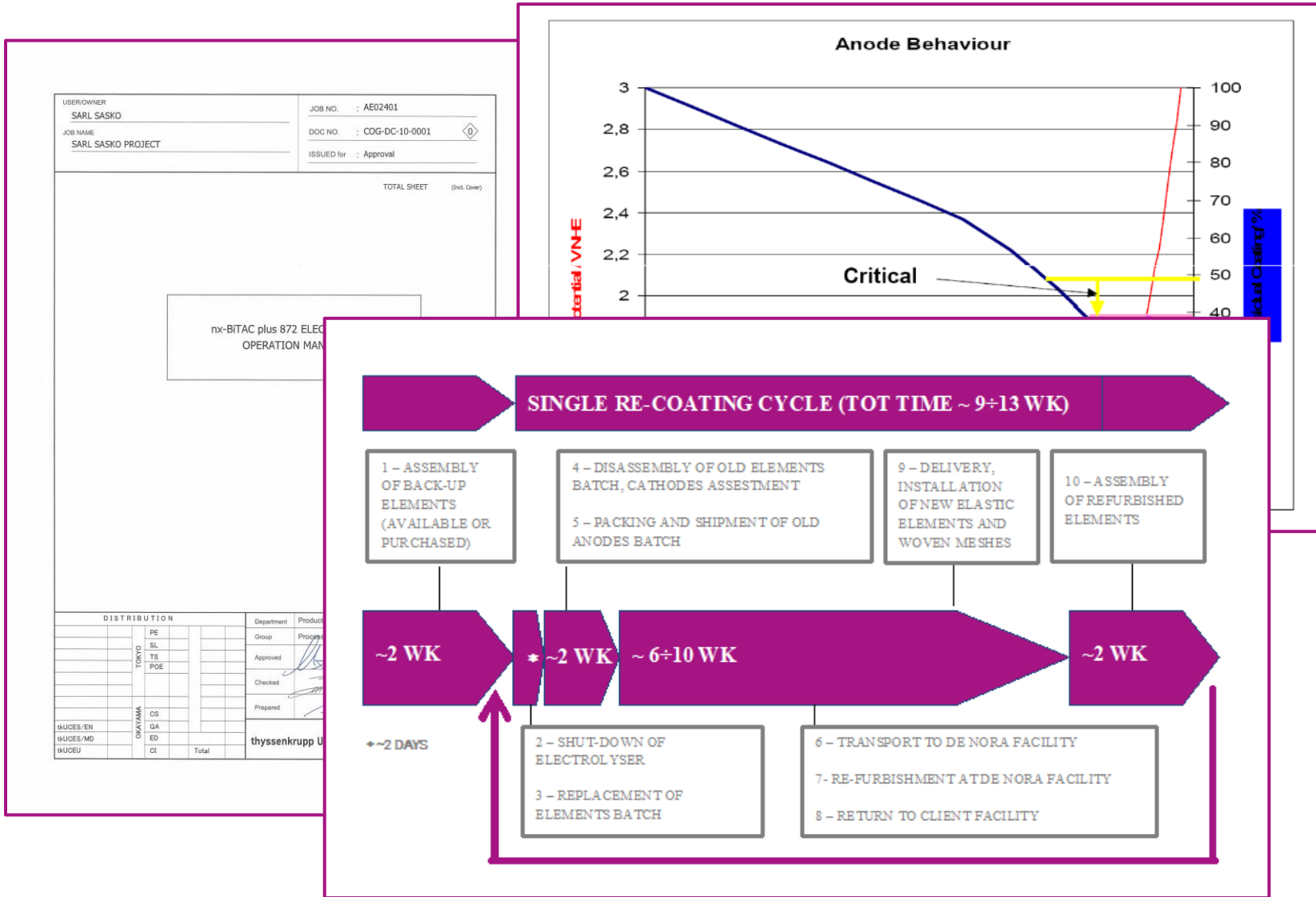
thyssenkrupp

Key points covered in the periodical reports:

- Plant operating data elaboration and analysis
- Plant monitoring and lab analysis data assessment
- Interaction and coordination of key partners: membrane manufacturers, cell suppliers and coating manufacturers, ...
- Joint planning of electrolyzers re-membrating and re-coating activities

Field Service Package

On-site surveys



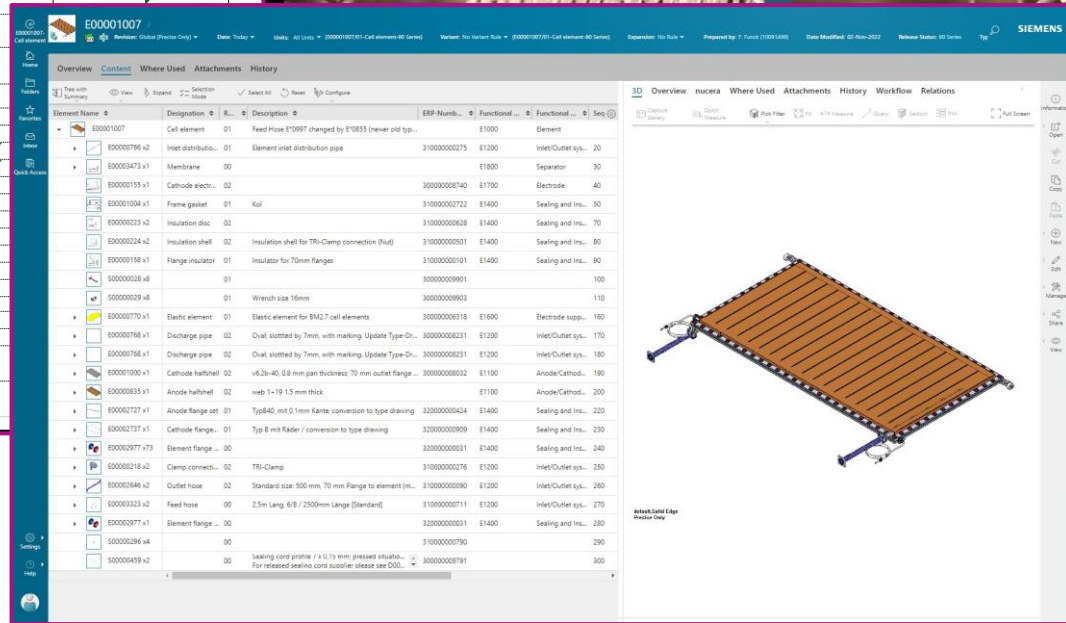
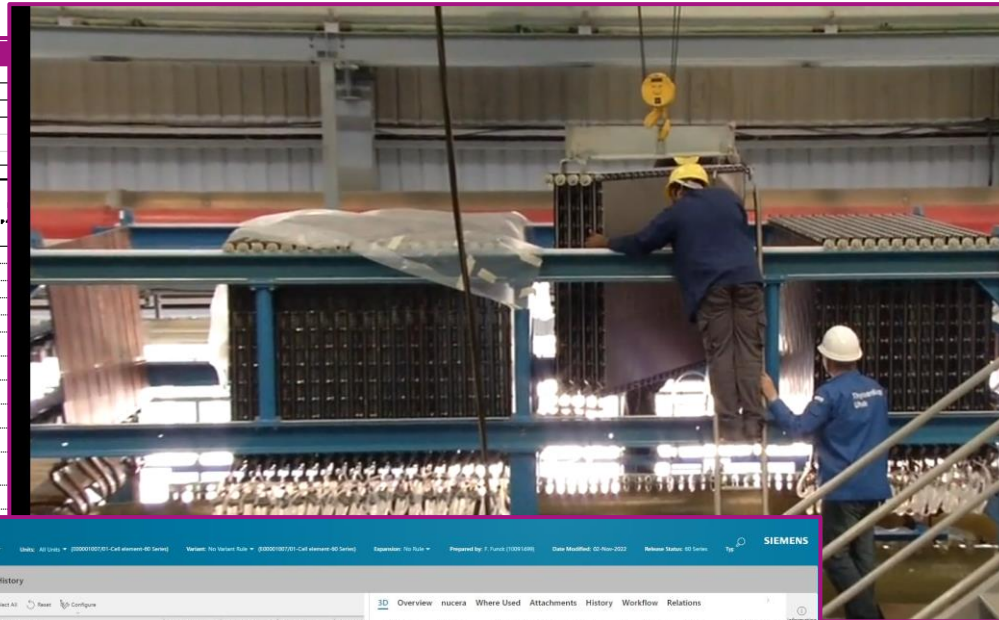
Key points covered during plant surveys:

- Joint review of Electrolysers status and Balance of Plant
- Routine questions (cellroom, balance of plant, ...)
- Plant monitoring and lab analysis, units troubleshooting
- Training of new operators
- Technology review and update on existing issues / undergoing projects

Field Service Package

Spare parts and optional services

Recommended items for re-assembly activities after 8 yrs operations							
Name of Client :		Cifel Singapore					
NCA-IT project-no:		117CPS & 125CPS					
No. 1	Electrolyser - Gen. 6a with no.	70	elements	=	No. 70	total elements	
PDS.	Description	Material	NCA part-no.	Quantity fitted per element	Total quantity installed in plant	NCA recommended percentage for re-membraneing	NCA recommended quantity for re-membraneing
1	Inlet distribution pipe	PTFE	0196.1	2	140 pr.	100%	140 pr.
2	Discharge Pipe Anode (Round Type)	PTFE	123	1	70 pr.	100%	70 pr.
3	Discharge Pipe Cathode (Oval Type)	PTFE	124	1	70 pr.	100%	70 pr.
4	Anode Flange set	RS177-2	0141	1	70 pr.	100%	70 pr.
5	Cathode Flange set	RS177-2	0142	1	70 pr.	100%	70 pr.
6	Welding AS 4011-24.5mm	Permedlar	0142.5	2	140 pr.	5%	7 pr.
7	Shoulder screw ISO T378-M12x30	12-8ECE	0142.6	2	140 pr.	5%	7 pr.
8	Washer ISO T378-M12	AL512H	0142.7	2	140 pr.	5%	7 pr.
9	Flange bushings	IGLIDUR	0142.8	4	280 pr.	5%	14 pr.
10	Frame Gasket	TFH1600	0146	1	70 pr.	100%	70 pr.
11	Gen. Sealing Cord (see call. 45 m length)	Special	0147	15 mtr.	1,050 mtr.	100%	1,050 mtr.
12	Hex. Nut M10	10-8ECE	0149	74	5,180 pr.	50%	2,590 pr.
13	Hex. Nut M10	10-8ECE	0149	74			
14	Conical discharge Ø40x10.5x3.7	50Cr14	0150	140			
15	Insulating Washer Ø42x10.5x2	H0W272.Tar	Permedlar TF680	0151	140		
16	Insulating shell 12.510.5x35	PTFEIC-N	0152	74			
17	Membrane	Special	0170	1			
18	Flange Insulator	PC	0199	1			
19	Elastic element	NS	0191	1			
20	Wrench mark (cathode electrode)	16 covered	0192	1			
21	Feed Hose	PTFE1457H	0201	2			
22	Clamp Connection	1.4029	0202	2			
23	Outlet hose	PTFE1457H	0203	2			
24	Cable Fixing Strip	PA6.6	0205	6			
25	Hex. Screw M10 x 40 mm	A2-70	0206	8			
26	Hex. Screw M10 x 50 mm	A2-70	0207	8			
27	Hex. Nut M10	A4-70	0208	16			
28	Inlet pipe	PTFE	0219	1			
29	Insulating disc	PE	0252	2			
30	Insulating hose	PTFE	0253	2			
31	Case of grease Molybden BR2 (One can 1kg)						
32	Case of Fluorinated oil for maintenance* Feklin VHS-zetol (see call. 1kg)						
33	Standard cathode electrode (No. 1)						



Main features:

- Fast identification of parts.
- Pre-developed guidelines for preventive and emergency maintenances
- Tailor made spare parts list with supply directly at site at pre-defined terms
- Plant operators and shift managers training
- Analysis of salt, filtered brine, ultra-pure brine
- Uhde® Evaluator SW and HW maintenance
- Specific on-site interventions for trouble-shooting, supervision

Field Service Package

Summary of the main features

1	RCM - Remote Condition Monitoring	<ul style="list-style-type: none">Data transfer of main electrolyzer / plant operating parameters via mail / electronic files): periodical reporting according to NCA standard format, frequency to be agreed.	<ul style="list-style-type: none">Typically twice per year
2	On-site surveys & Assessments	<ul style="list-style-type: none">2-3 days on-site per year in a period of mutual convenience to be mutually agreed.	<ul style="list-style-type: none">Typically once / twice per year
3	On-site training	<ul style="list-style-type: none">1-2 days on-site per year (focus: Electrolyser operating procedures) in a period of convenience to be mutually agreed.	<ul style="list-style-type: none">Typically once per year
4	Spare parts service	<ul style="list-style-type: none">Storage of proprietary equipment accessories, excluding: bipolar/end-terminals, membranes and consumables for scheduled / unscheduled maintenance and delivered at site according to pre-agreed terms.	<ul style="list-style-type: none">Details for relevant supply terms (typically by dedicated P.O.) TBD
5	Optional services	<ul style="list-style-type: none">To be evaluated case by case according to the effective needs and specific situation.	<ul style="list-style-type: none">Pre-defined optionsTailor-made options
	FIELD SERVICE PACKAGE	<ul style="list-style-type: none">Price and other commercial aspects to be detailed in a dedicated contract.Minimum duration is one year, with automatic renewal every year up to a maximum of four years.Possibility to evaluate specific needs on request.	

CONCLUSIONS



Technology upgrade

1. Possibility to enhance plant operations by means of dedicated projects involving thyssenkrupp nucera specialists.



Uhde® E-SWAT

2. New functionalities are available to support plant trouble-shooting and optimization of operating parameters both by plant technicians and in cooperation with thyssenkrupp nucera specialists.



Remote & Field Services

3. Extended cooperation multi-years agreements can be implemented with thyssenkrupp nucera having customized features and tailor-made services based on the effective needs of each plant.



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nucera

An aerial photograph of ocean waves crashing, showing white foam and deep blue water. A magenta rectangular overlay is positioned in the lower right quadrant of the image, containing the text 'Thank you for your attention' in white. The text is arranged in two lines: 'Thank you for' on the top line and 'your attention' on the bottom line.

Thank you for
your attention