
CHLOR-ALKALI TECHNOLOGY



A Partnership for Life

INEOS Technologies

Philip See (Business Development Manager)

- **Chartered Mechanical Engineer**
- **26 Years in Chlor-Alkali with ICI/INEOS**
- **Engineering Manager for**
 - 40 kte KOH Plant (ICI FM21 membrane electrolyzers)
 - 600 kte Chlorine Plant (ICI amalgam electrolyzers)
- **Plant Design and Commissioning**
 - 430 kte Chlorine Plant (BICHLOR™ Electrolyzers)
 - Technology benchmarking and operability studies



INEOS Overview

TURNOVER

**\$47
BILLION**

EMPLOYEES

15,000



PRODUCTION

**60
MILLION
TONNES**



HERITAGE

AMOCO, BASF, BAYER,
BOREALIS, BP, DEGUSSA,
DOW, ENICHEM,
ERDOLCHEMIE, HOECHST,
ICI, INNOVENE, LANXESS,
MONSANTO, NORSK
HYDRO, SOLVAY

SITES

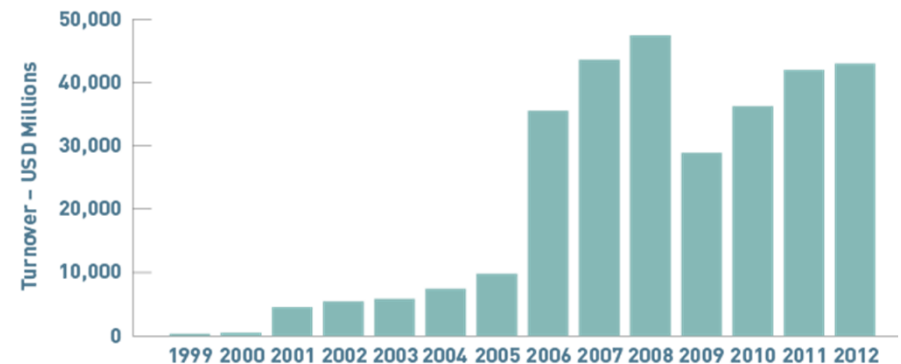


51 MANUFACTURING
PLANTS IN 11 COUNTRIES

HISTORY

- 15 Petrochemical/Chemical Businesses
- Growth by acquisition since 1998
- World's 4th largest independent chemical company

GROWTH



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INEOS Technologies Portfolio and Heritage



- Polypropylene
- Maleic Anhydride



- Chlorine
- EDC
- VCM
- PVC



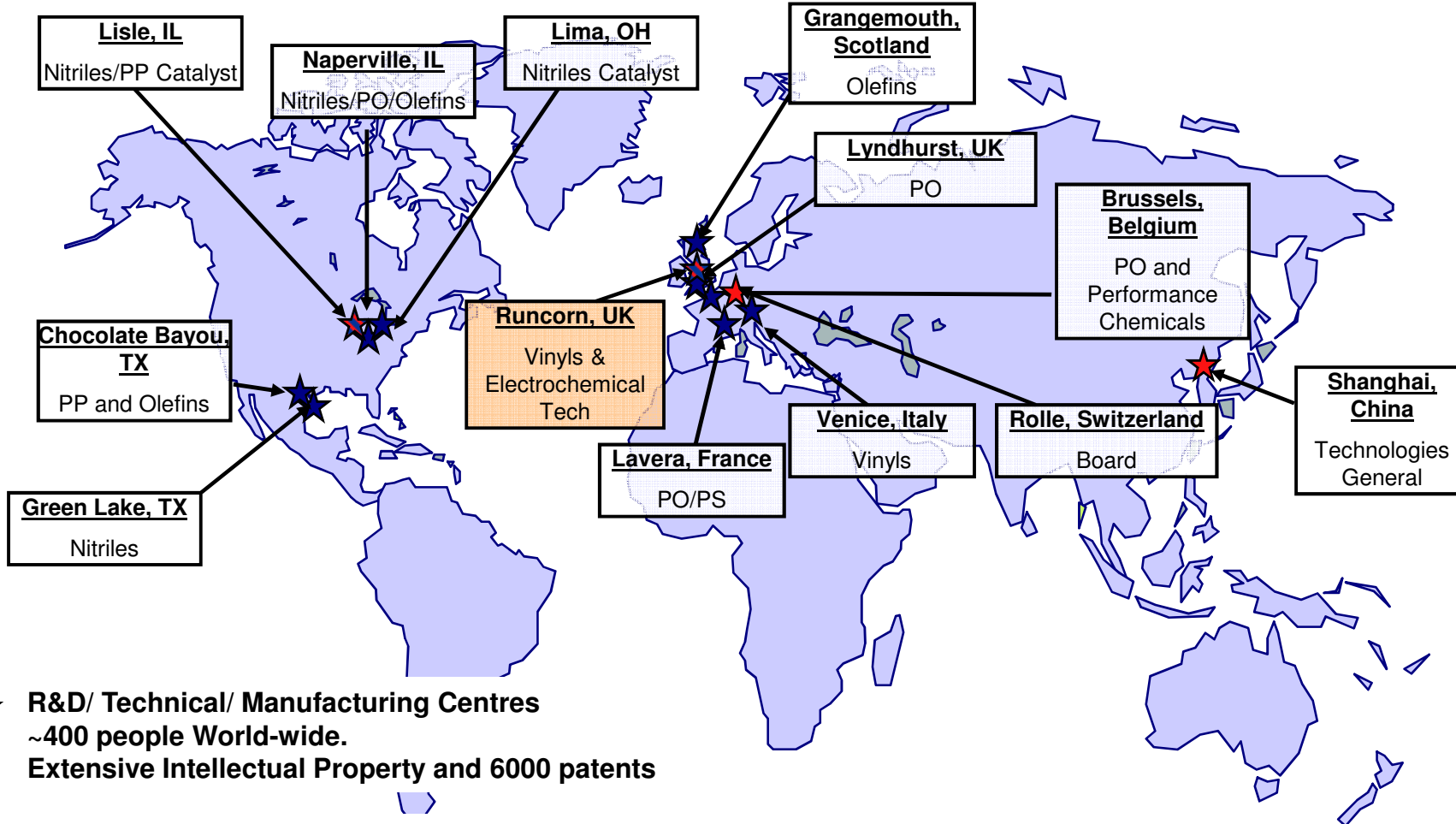
- LL/HD swing Polyethylene
- Acrylonitrile
- Maleic Anhydride
- Expanded Polystyrene



- HD bi-modal slurry Polyethylene



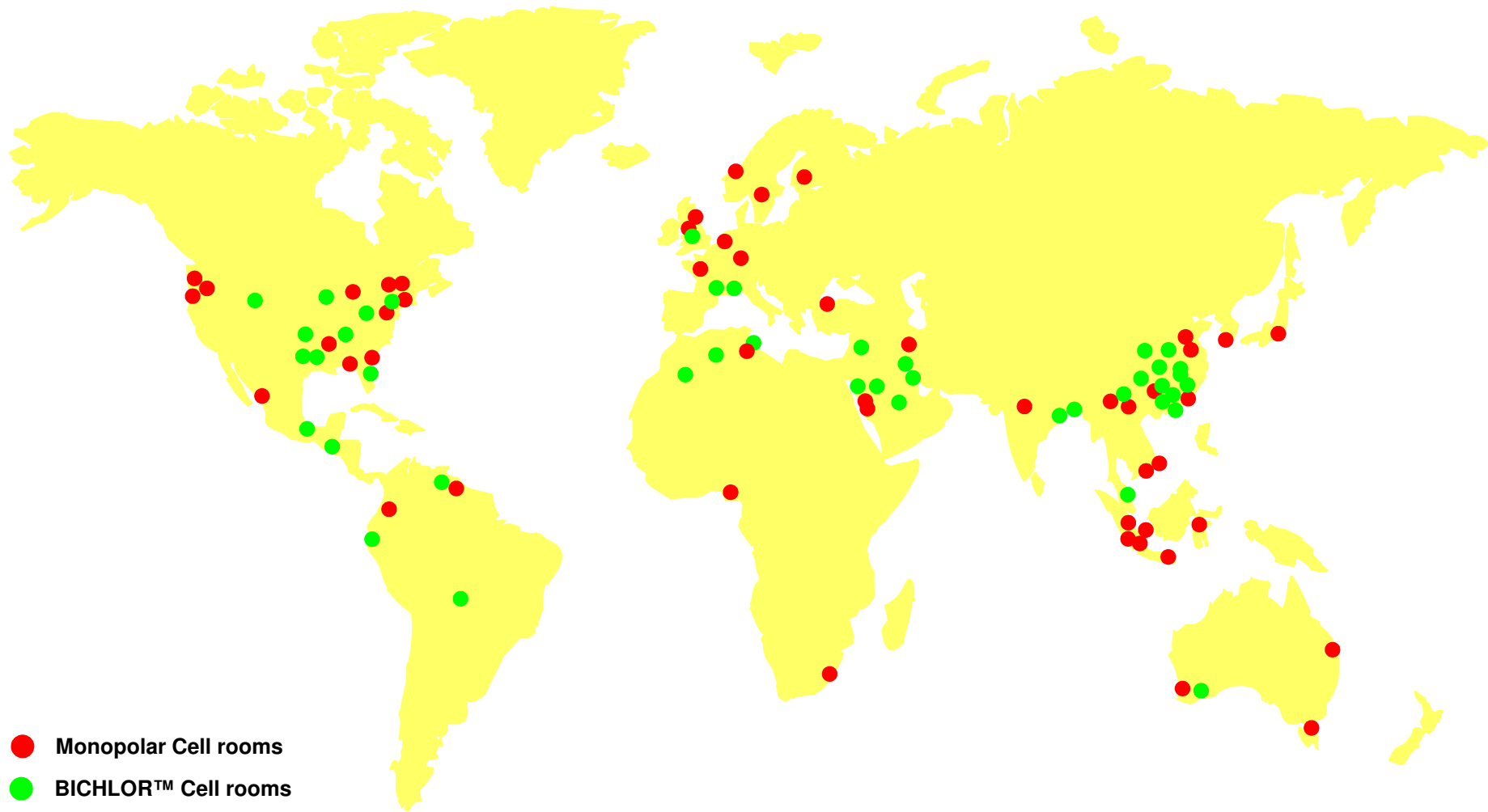
INEOS Technologies – Locations



★ R&D/ Technical/ Manufacturing Centres
 ~400 people World-wide.
 Extensive Intellectual Property and 6000 patents

★ Commercial Centres - Rolle (Switzerland), Lyndhurst and Runcorn (UK), Lisle (USA), and Shanghai (China)

117 chlor-alkali projects over 30 years

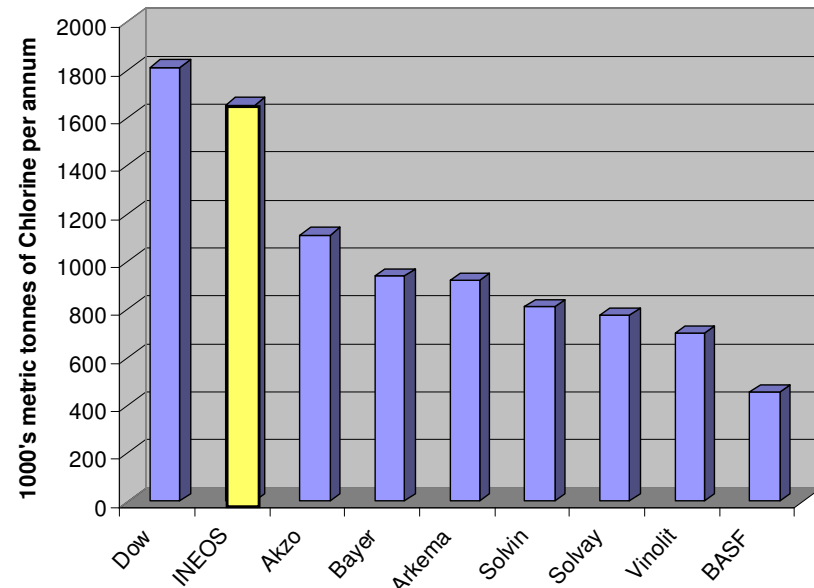


Americas – Strong and Growing Presence

Company	Location	Year
HF Chlor-Alkali	USA	2014
Skymine	USA	2013
Fluoders	Paraguay	2013
Kuehne	USA	2001 / 2011
Olin	USA	2011 / 2014
FSTI/CSP	USA	2008
Allied	USA	2009
Lapsolite	Mexico	2006
Proquimsa	Ecuador	2005 / 2009
Proctor + Gamble	Guatemala	2003 / 2006

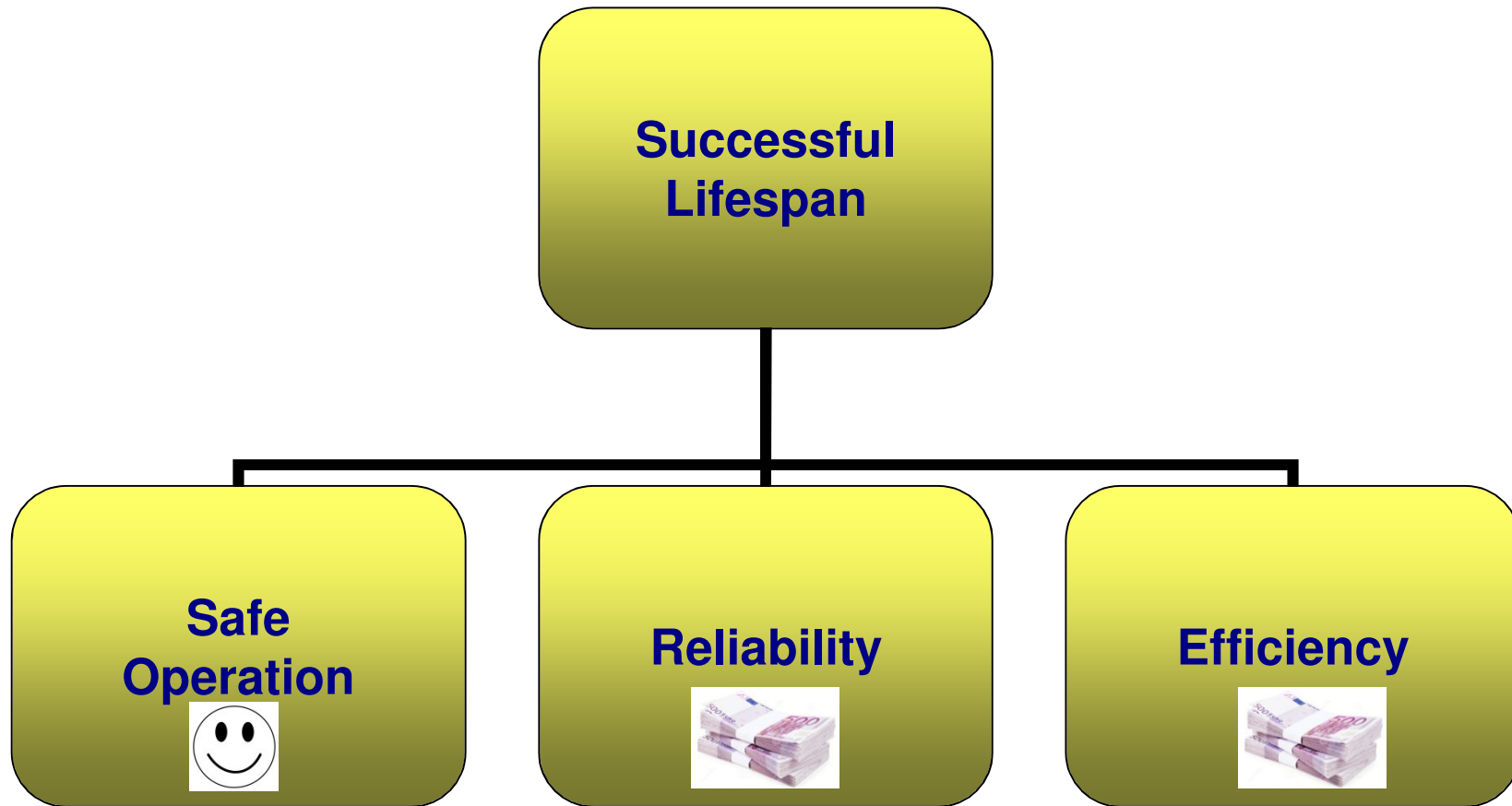
Successful Plant Lifespan – Vital to INEOS ChlorVinyls

- A designer and operator of chlorine plants for over 110 years
- 7 cell-rooms across Europe, total capacity 1,600,000 MTPA Cl₂
- A major European Chlor-Vinyls Manufacturer



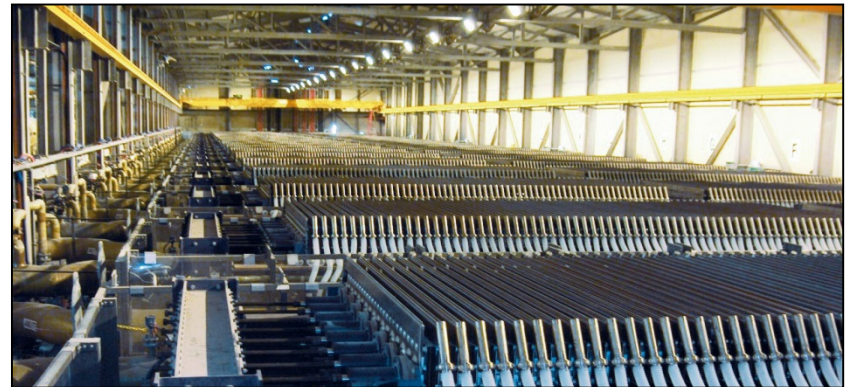
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Successful Plant Lifespan – Key Factors



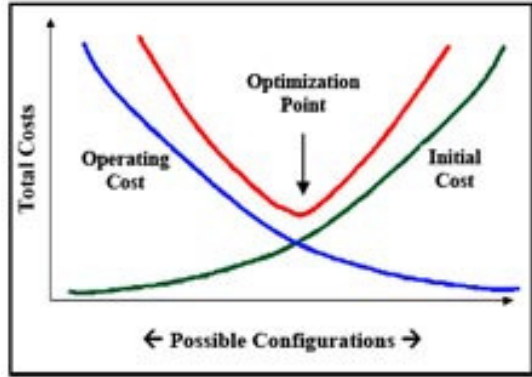
INEOS Runcorn – Driving Continuous Improvement

- 430kte/yr chlorine
- 20 BiChlor electrolyzers
- Designed to Lifecycle Principles
- **INEOS Know-How applied**
- **World Class Performance**



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Techniques – A Structured Way of Working

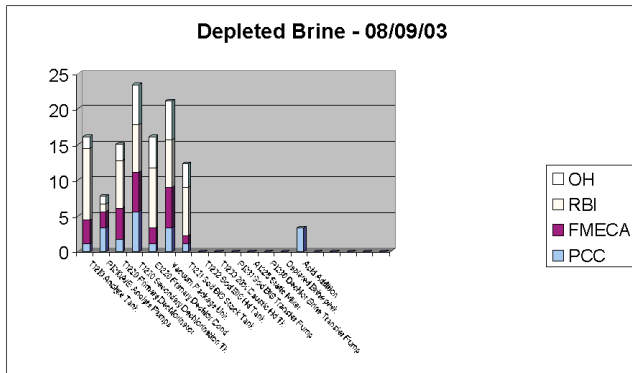


Lifecycle Value Analysis



1. Process Description/Purpose	2. Potential Failure Mode	3. Potential effect of failure	4. Sev	5. Potential cause of failure	6. Occ	7. Current Controls	8. Det	9. RPN	10. Recommended actions	11. Responsibility/ start date	12. Action Results
Performance of O Ring carriers	Wrong material used in manufacture	Stiffness	10	Supplier changes RM without informing RCL	2	None	10	200			
	Disinfect/Wear away Chemical Degrades	Supplier changes RM	10	Supplier changes RM without informing RCL	1	Change of BOM Process - Agree BOM integrating into ERP systems	3	30			
	Thermal Expansion effect on seal	Change of supplier	10	Change of supplier	2	Specification - QA systems & registration	3	60	Generate approved supplier list		
	Process	Raw materials to supplier changes without their knowledge	10	Raw materials to supplier changes without their knowledge	45	Specification - maybe not detailed enough QA systems & registration	9	450	Review specification & produce audit trail & review Specifications agreed with supplier.		
	Sticks to top tube	9									
	Cause reaction with other materials/products	10									
	Lack of detailed agreed specification	10									
	Operator inspection & operational experience	10									
	Shelf Life: -Components	1									
	None - shelf life not known - no stock rotation	10									
Establish if there is Shelf life Develop Stock rotation process	10										
Performance of O Ring carriers	Dimensional by strong	Too Narrow - Can't Assemble	2	Supplier delivers outside of spec	8	Drawings Operate	3	48	Develop robust spec Carry out QC Check on subassembly		
	Too Wide - Leaks in service	10	Supplier delivers outside of spec	8	Drawings Operate Cell room measurements	9	720	Sample test			

Loss Elimination - FMECA

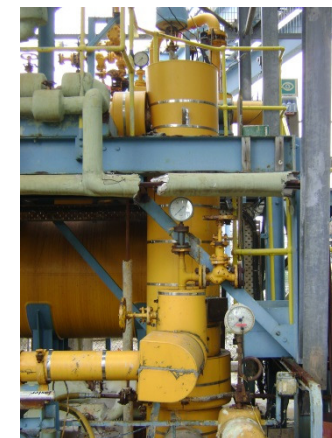
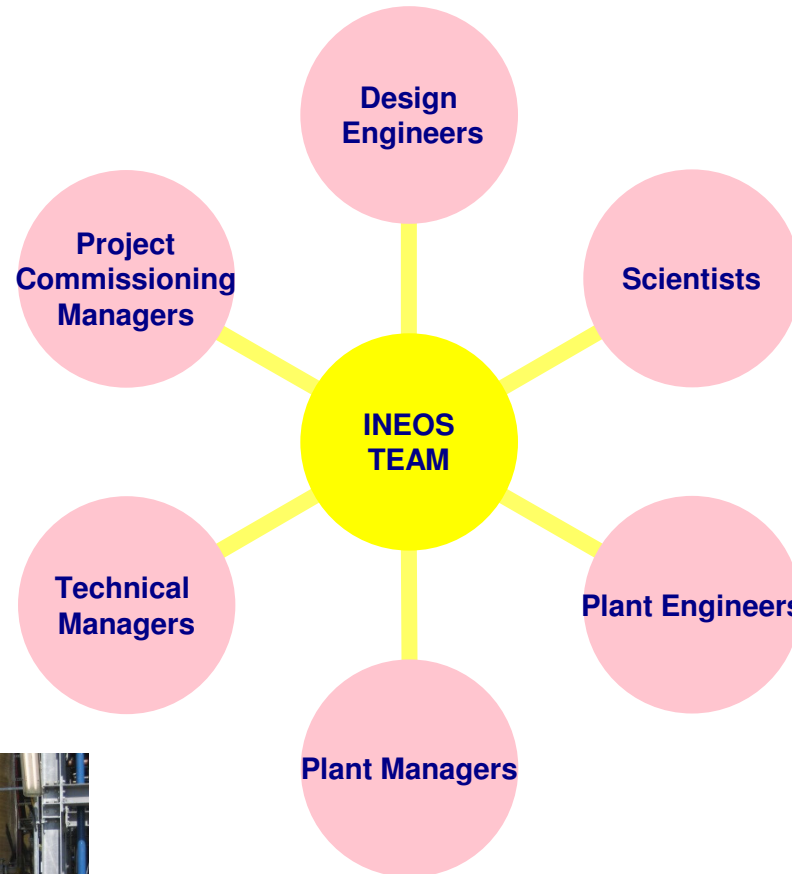
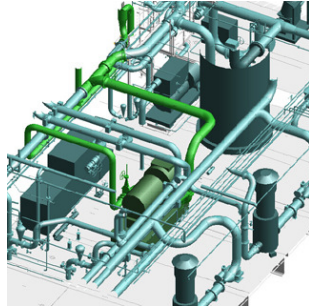


Critical Items Analysis

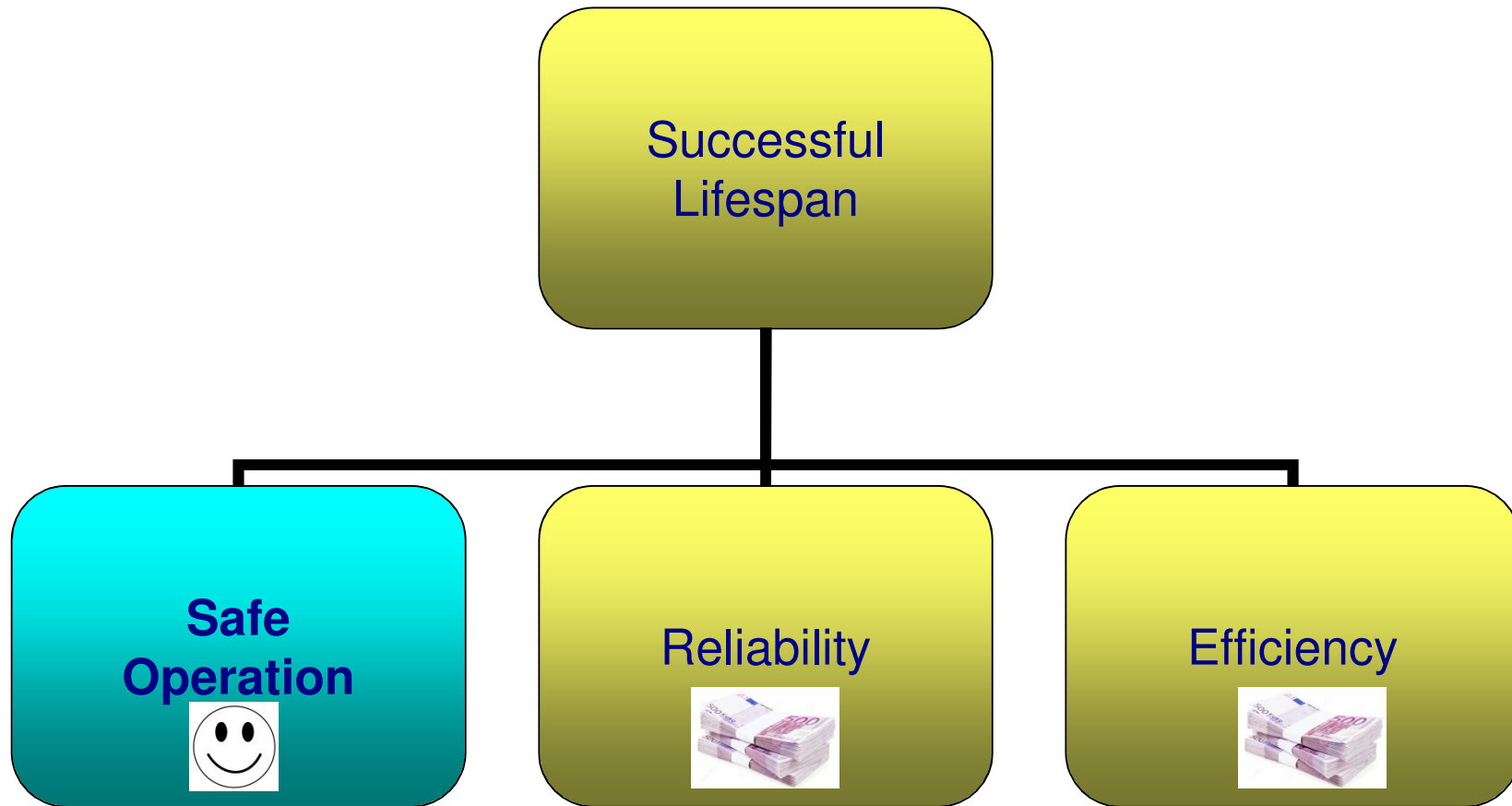


Risk Based Inspection

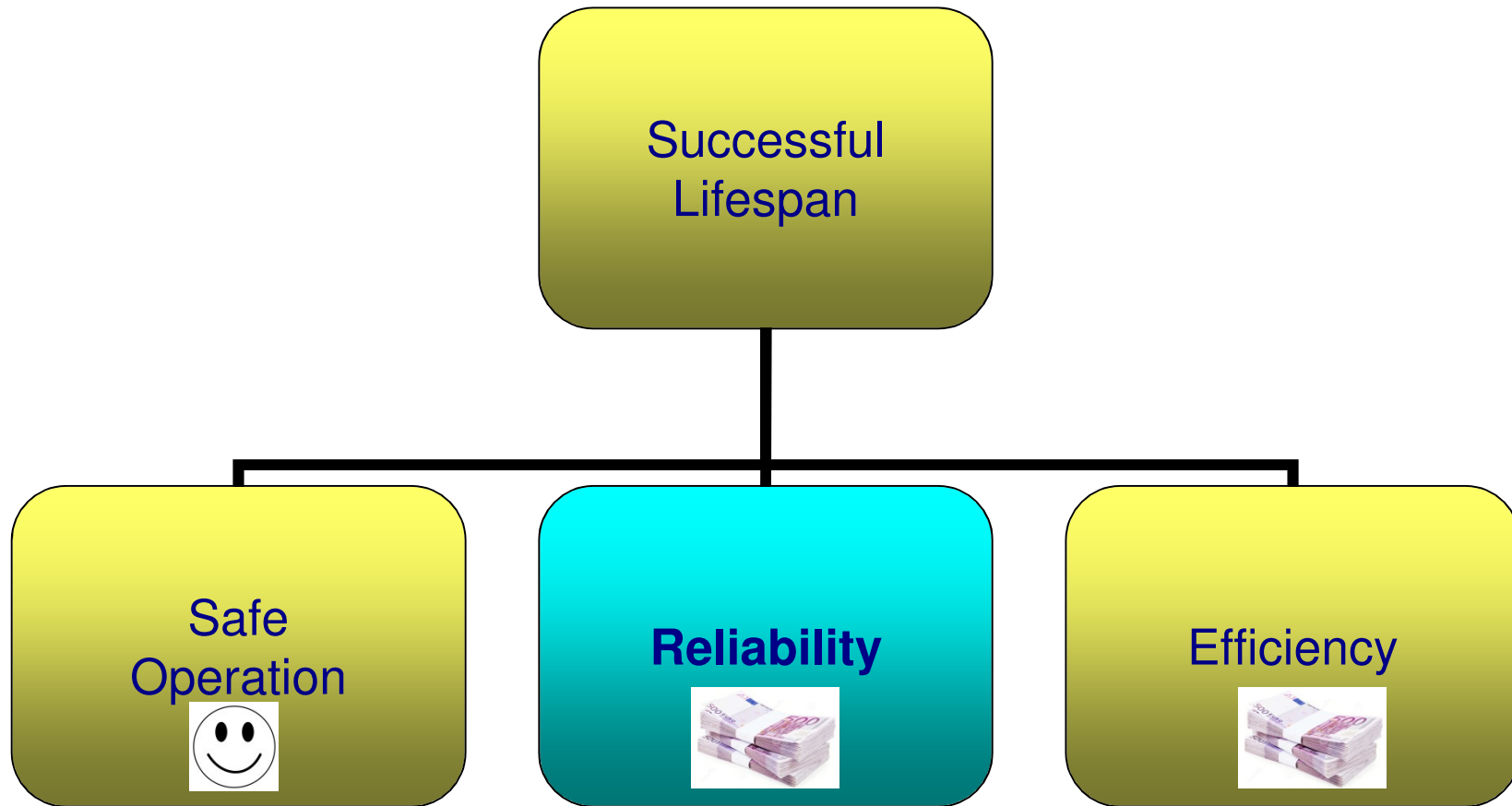
INEOS Technologies Team – Chlorine Experienced



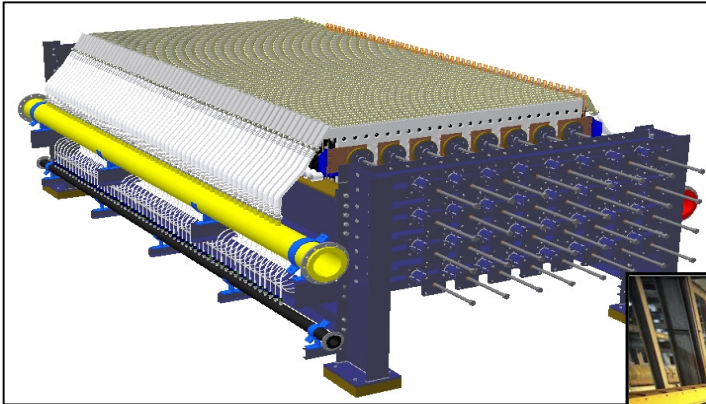
Safe Operation



Reliability



Reliability – INEOS has the Knowledge



Accessible Headers

High Integrity Design

Stray Currents

Optioneering

Rapid Module Change



Dynamic Modelling

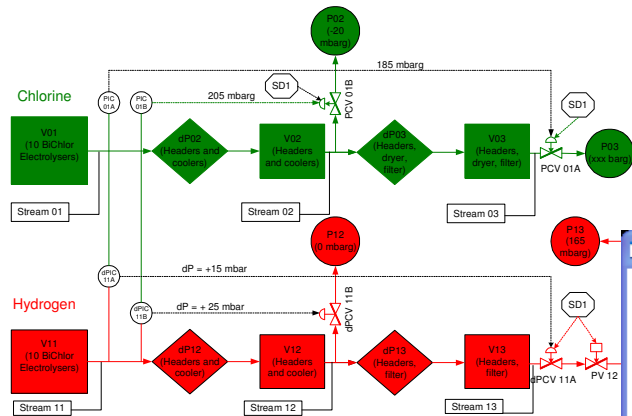
Materials of Construction

Robust electrode coatings

Layout analysis

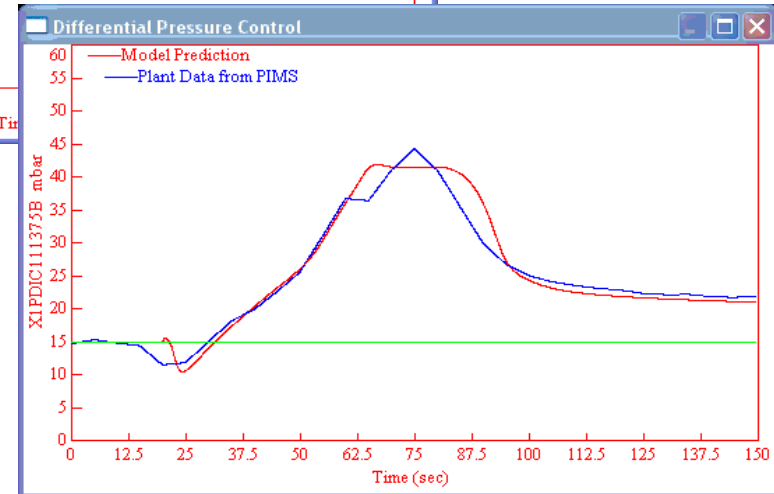
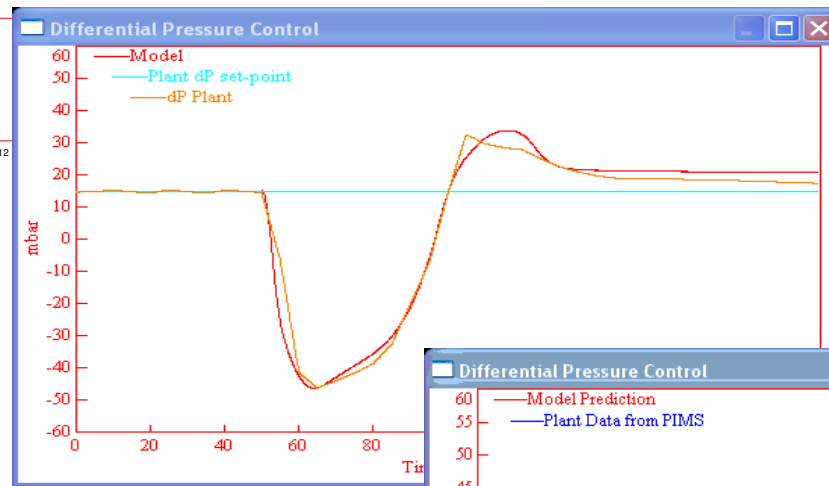


Reliability – Avoiding Damaging Pressure Excursions



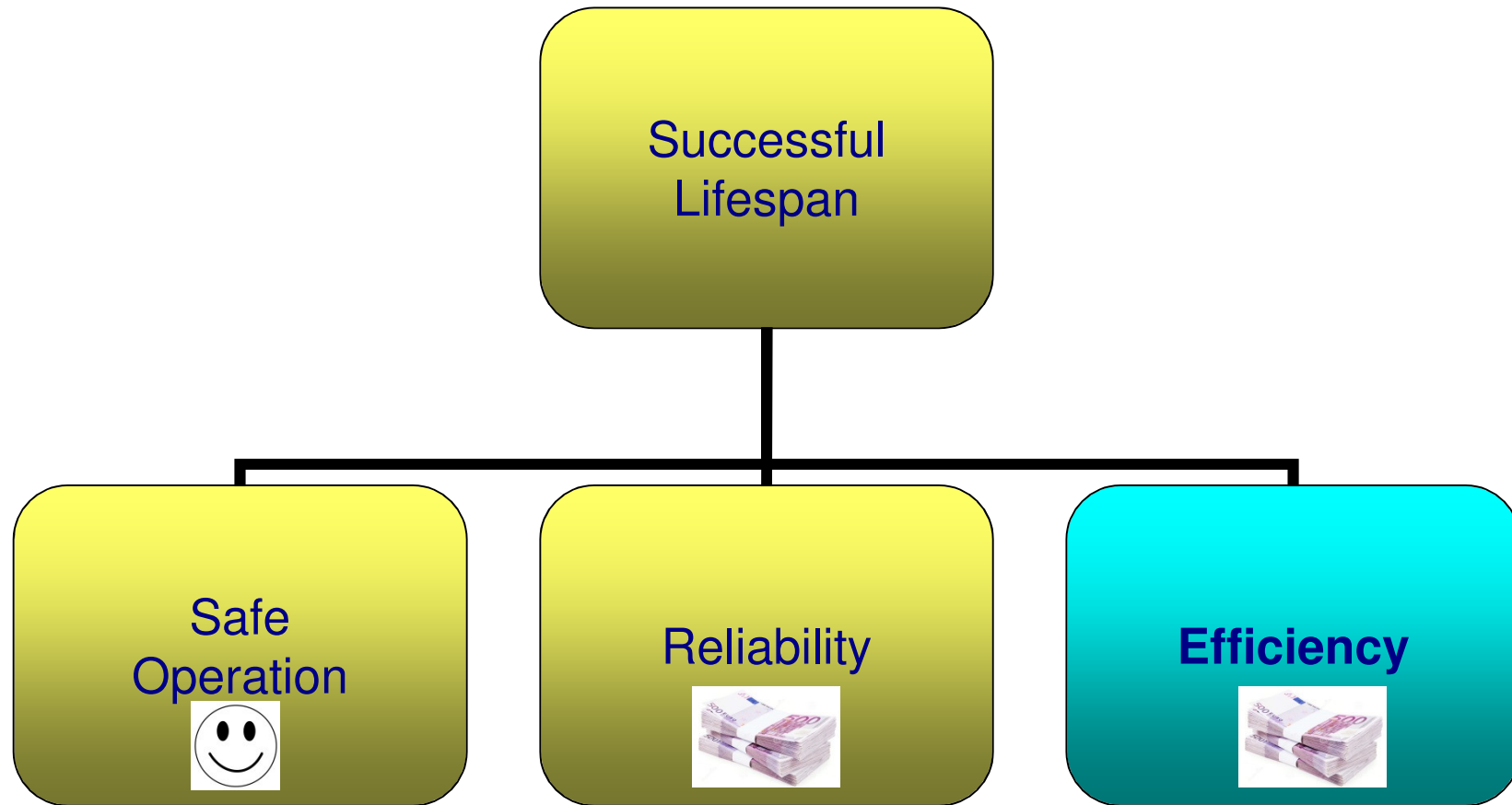
- Dynamic model of the gas section downstream of electrolyser
- Simulate transient events – cellroom trip, electrolyser trip, load changes

- Model validated by comparing DP predicted by model with plant data
- Large negative DP excursion – improvement required



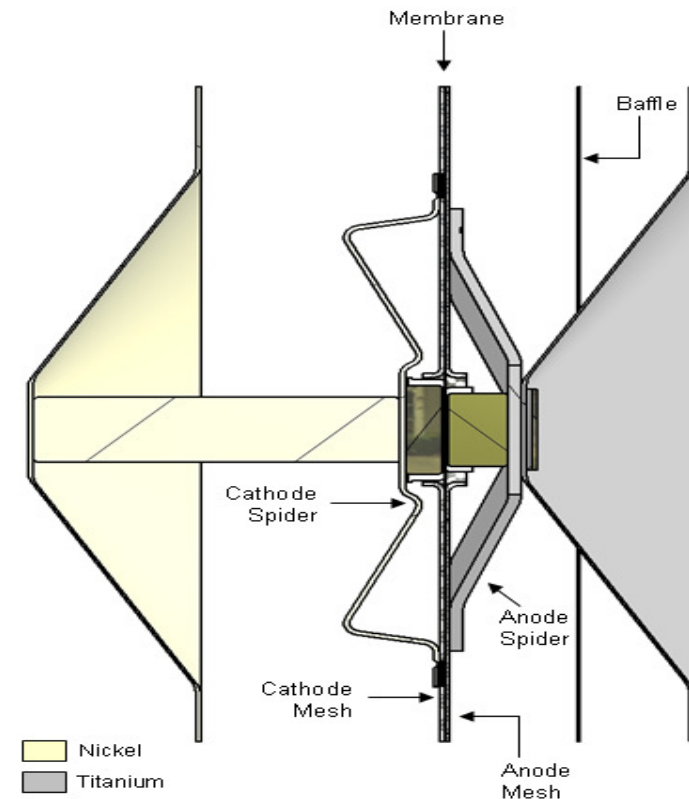
- Model used to develop control scheme to avoid reverse DP
- Excellent system response

Efficiency



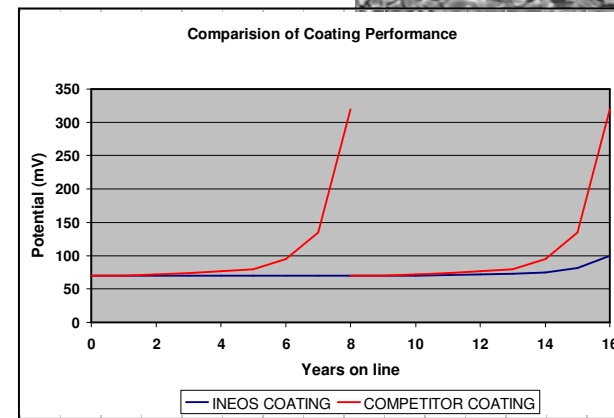
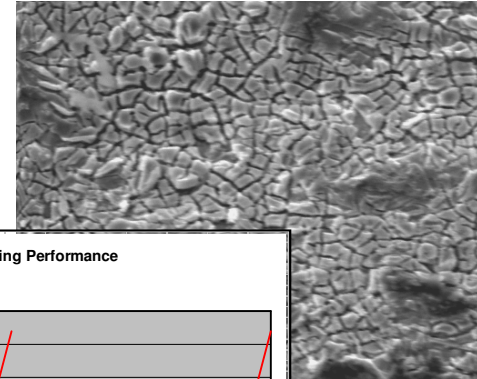
Power Efficiency – At the Heart of BiChlor

- **Module low voltage dimple design**
 - Max use of nickel post in cathode pan
 - Min use of titanium post in anode pan
- **Explosion bonded Ti/Ni discs for excellent inter-module connection**
- **Zero gap electrodes**
- **Self aligning modules**



Efficiency – 30 Years of Coatings Development

- Anode Coating
 - Lower power consumption
 - Greater resistance to Alkaline wear
- Cathode Coating
 - Highly resistant to upset conditions
 - 16 year warranty
- Modern coating plant and extensive refurbishment centre



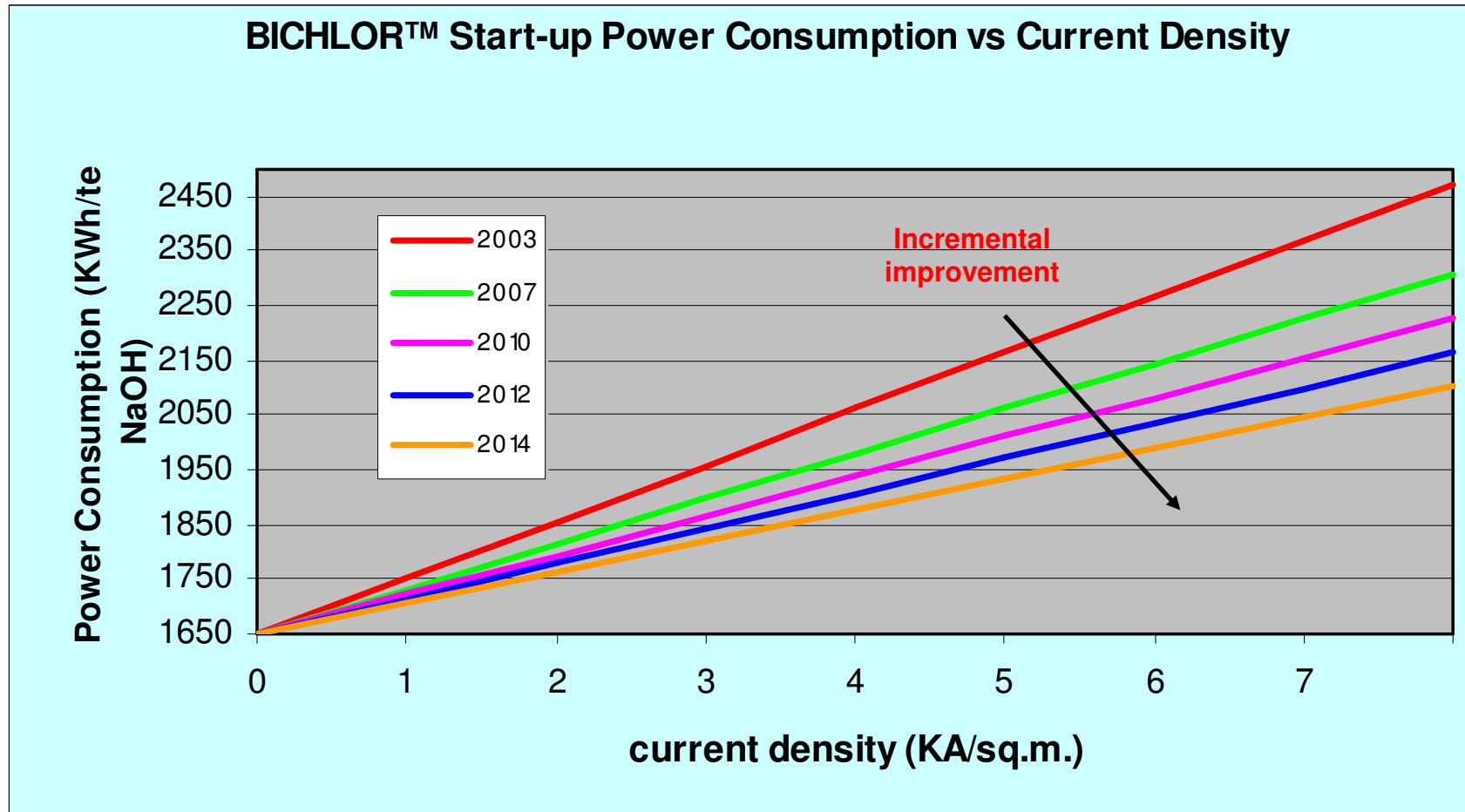
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Efficiency – Accessing our Operations Expertise

- **Designated Technical Service Manager**
 - Experienced chlor-alkali specialist
 - Usually member of original commissioning team
 - Regular visits and contact
- **Getting the most from your plant**
 - Performance evaluation
 - Operating and Technical support
 - Electrolyser maintenance planning
- **Customer forum every 2 years**
 - Technical and Social content
 - Highly valued by clients



Efficiency – Evolution not Revolution



INEOS – A Partnership for Life

- **Unrivalled knowledge of chlor-alkali technology and operations**
- **Technology built to perform over the long term**
- **A partnership for the long-term**



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