INEOS
Electrochemical Solutions

Technology Sustainability in Chlor-Alkali

ASPIRE IDEEKSHA Workshop

February 2024

Introduction

Rob Craig

- Technology Manager for INEOS Electrochemical Solutions
- Leads the businesses electrolyser development activities
- Graduated with a Master's degree in Chemical Engineering from Newcastle University
- Over 15 years' experience in operations, plant design, project delivery and technology development across the chlor-alkali and petrochemical industries

INEOS

$68 bn Sales

25,000 Employees

182 Manufacturing Sites Globally

Ranked 4th - Global Chemical Companies 2020

Europe's No 1 Vinyl's Producer











Who we are

A major global supplier of industrial electrochemical technologies

INEOS | Electrochemical Solutions

We Research & Develop World Class Electrochemical Products

- FM & BICHLOR™ electrolysers
- CHLORCOAT™ coatings

We Sell Electrolysers, Associated Parts & Technical Services

- 4 generations of electrolyser technology, installed globally

We Refurbish & Re-coat Electrolyser Structures

- IES Technology (Aftersales)
- Third party technologies

www.ineos.com/electrochemical

Over 40 years of innovation

- We operate our own electrolyser plants, so we understand chlor-alkali
- Proud history of serving the industry
  - Four generations of electrolysers
  - Numerous technology patents
  - Global Sales & Technical Service team
- Research & Technology team dedicated to chlor-alkali process improvement

We’re operators designing for operators – and we support our customers for life

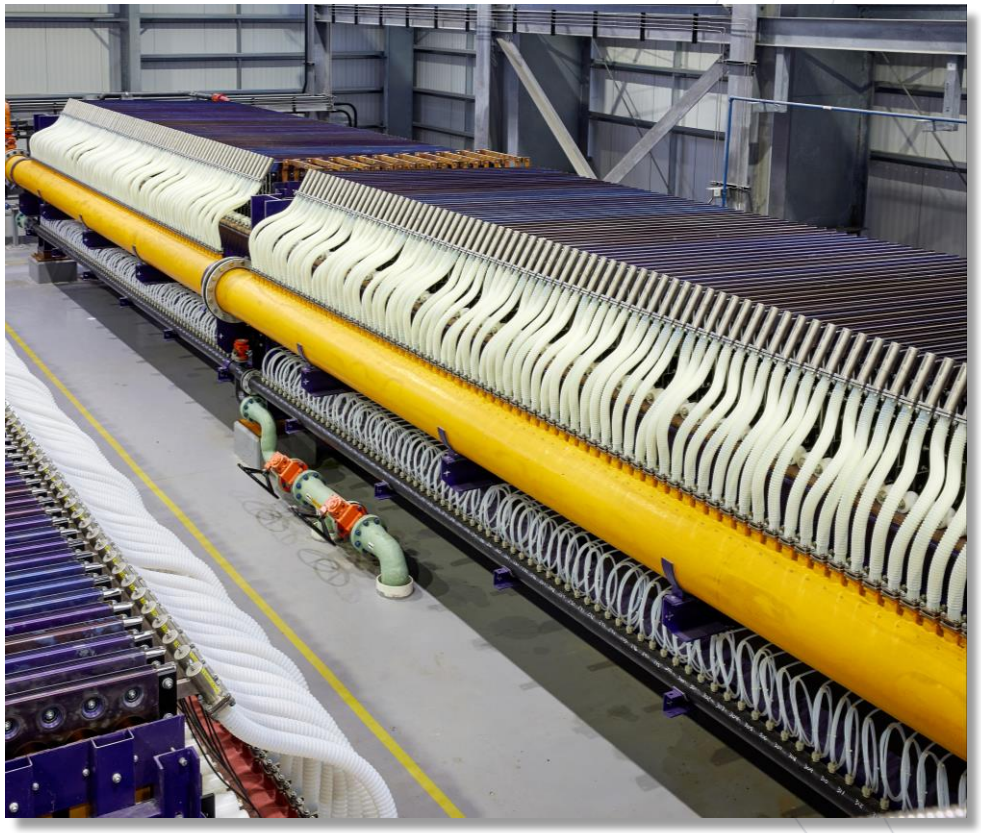
Global cellroom installations

- Over 4m tonnes of installed capacity

BICHLOR Electrolyser

Significant energy savings and long-lasting performance over a lifetime of chlor-alkali production

- Less than **1962* kWh/te NaOH** @ 6kA/m^2 power consumption
- Class leading output of **54,000 MTPA NaOH** per electrolyser**
- Largest effective working area of **3.4m^2** per module means fewer modules are required per tonne of NaOH
- **Widest operational pressure range**, (atmospheric to 400mbarg) - all operator requirements can be met
- Zero gap, “modular” bipolar design delivers full use of the membrane area and extends the membrane’s life
- Robust, safe construction with superior strength and resistance to damage and distortion

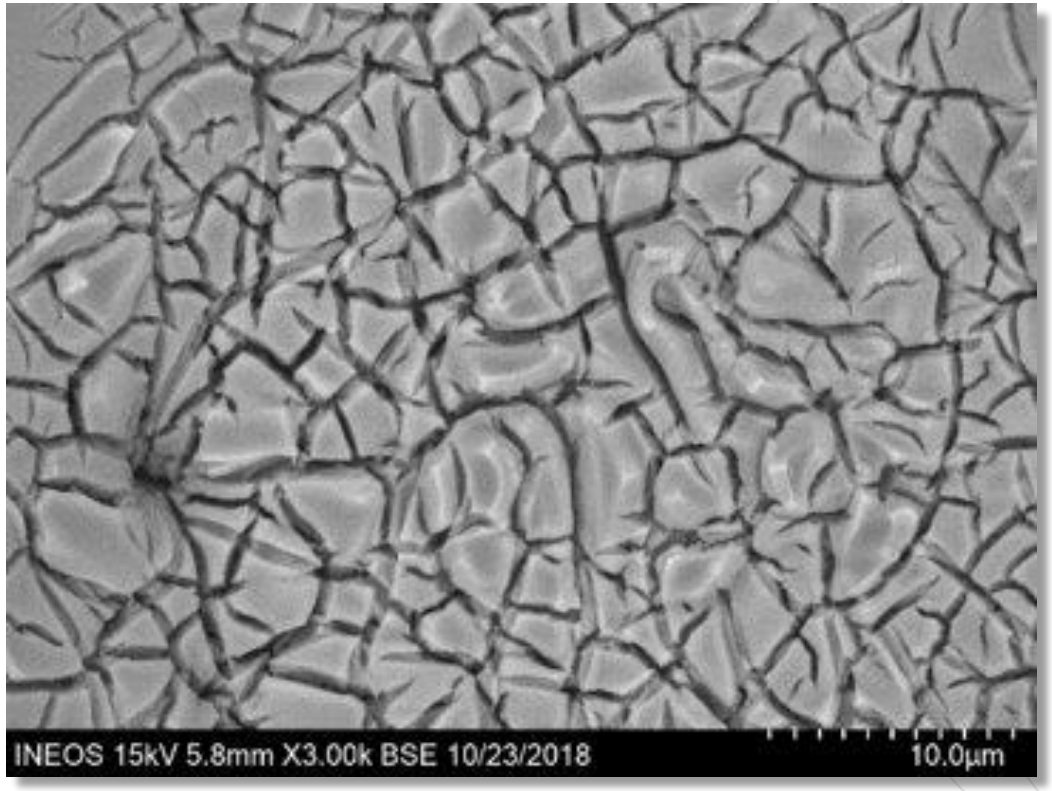


* Expected value @ 385mbarg Cl_2, 90°C and 32wt% NaOH **Based on 350 days operation and 7kA/m^2

CHLORCOAT Coatings

Our advanced electrode coatings underpin our technology performance

- Promote Cl_2 or H_2 evolution at low voltage
- Contain precious metals for resistance to key life-limiting processes
- High resistance to alkali wear, reverse currents and impurities
- Extensively used and proven in both our own technology and 3rd party technologies
- Latest AC03 cathode coating offers class leading overpotential
- Electrode coatings are a core capability within the business and a focus that differentiates our offering



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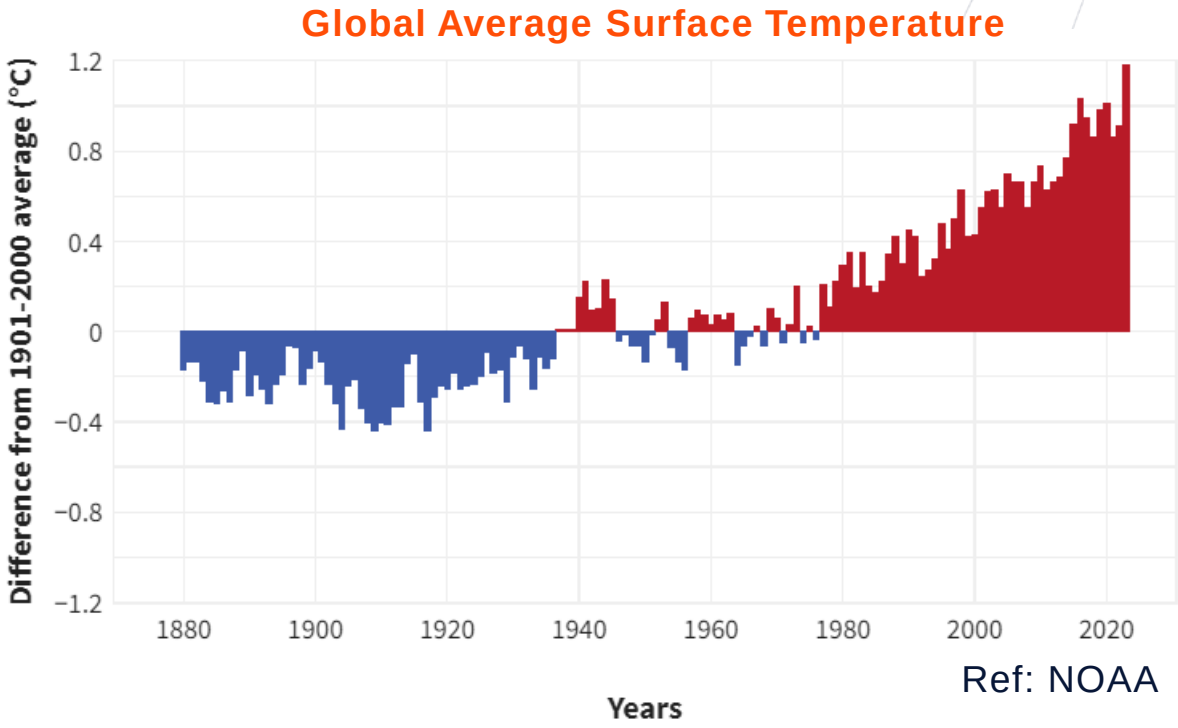
Sustainable Industry

Why discuss sustainability?

- Global temperature increase must be limited to 1.5°C above pre-industrial levels to avert the worst effects of climate change; **avg. 1.52°C Feb-23 to Jan-24**
- 45% emissions reduction needed by 2030 and net zero by 2050; **Paris agreement**
- Chemical industry has a **major** part to play in achieving this



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Where can chlor-alkali help?

11 Sustainable Cities & Communities

- PU foam insulation
- PVC windows
- H_2 fuel for transport
- Smart tech for city transport

3 Good Health & Wellbeing

- Medicines, packaging & medical equipment
- Tropical disease protection e.g. mosquito sprays / nets
- Disinfectants

7 Affordable & Clean Energy

- Solar panels (Si purification)
- Wind turbines (Cl based epoxy resins)
- KOH for nickel metal hydride batteries

6 Clean Water & Sanitation

- Drinking water disinfectants
- PVC pipes

A sustainable chlor-alkali industry

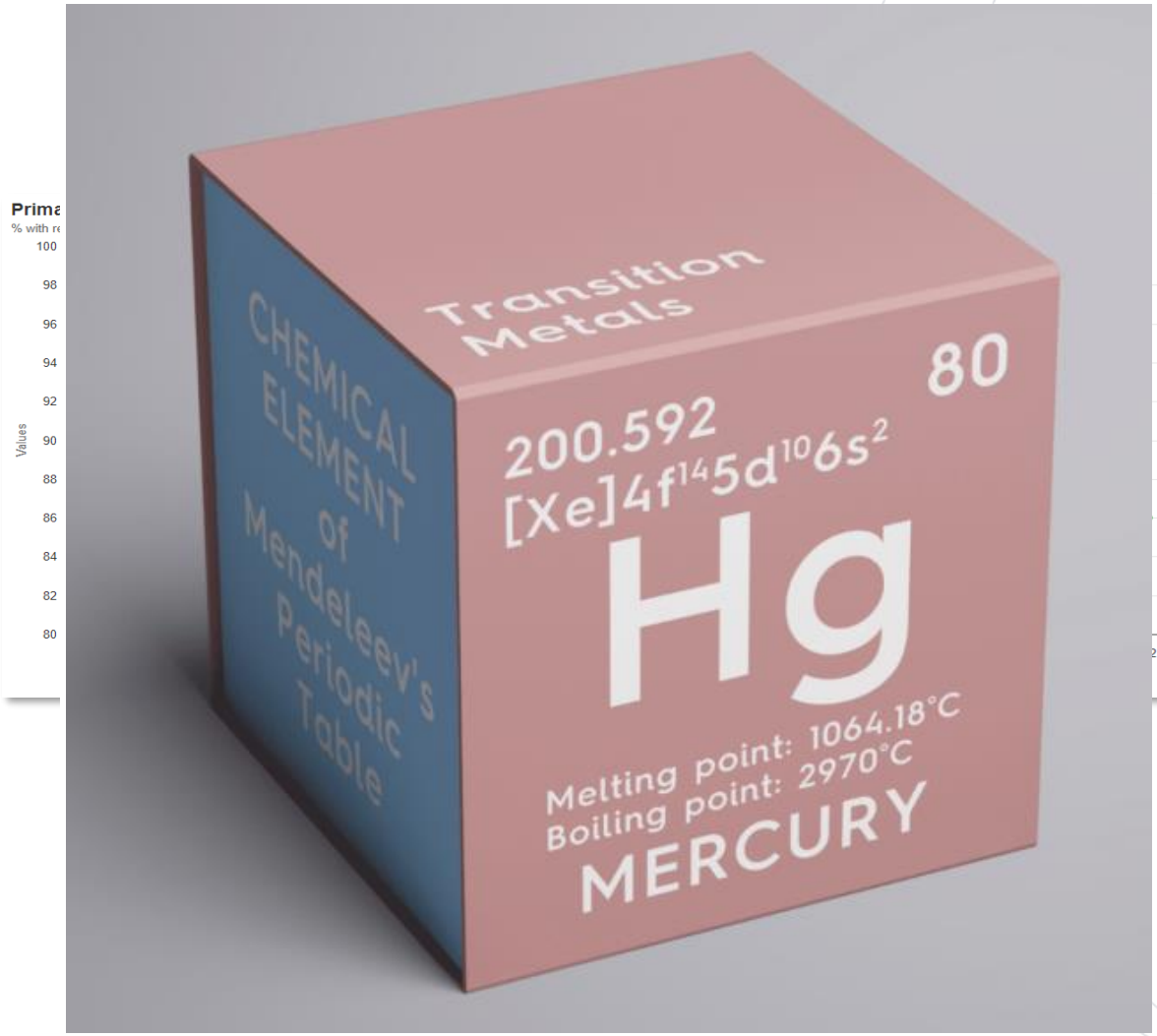
Energy Consumption
- Improvement
- Renewable sources

Hydrogen Utilisation
- Beneficial use
- Process capability

Grid Balancing
- Capacity available
- Flexibility / capability

Circularity
- Membrane recycling
- Waste reduction

Mercury Treatment
- Conversion to stable compounds



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Sustainable Technology

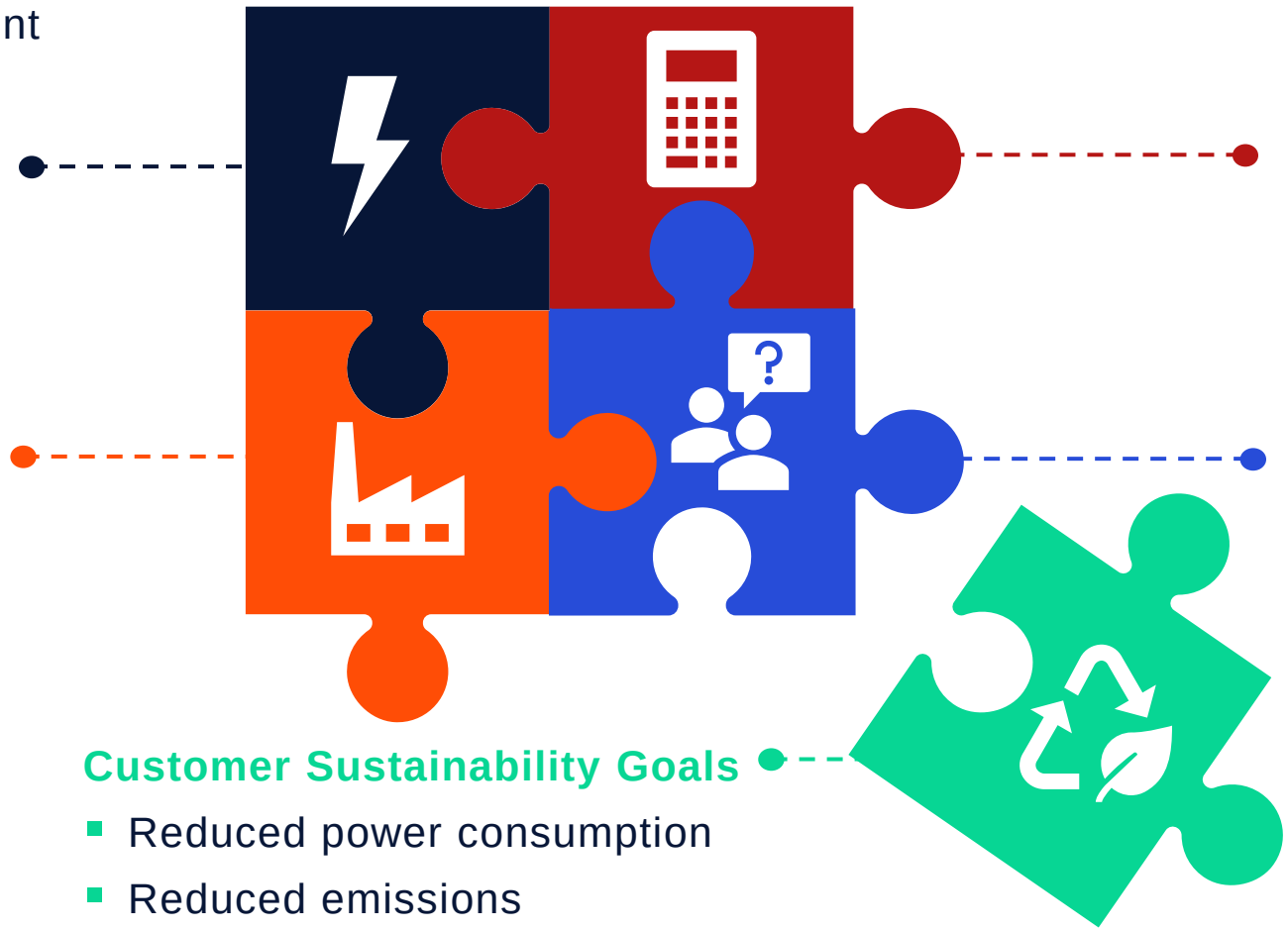
A sustainable offering from IES

Electrolyser Product

- Performance improvement
- Product development
- Recyclability
- Packaging
- Low carbon applications
- Material sourcing

Manufacturing / Refurb

- Optimisation
- Energy consumption auditing and reduction
- Waste reduction
- Management of waste streams



Customer Sustainability Goals

- Reduced power consumption
- Reduced emissions

Engineering Solutions

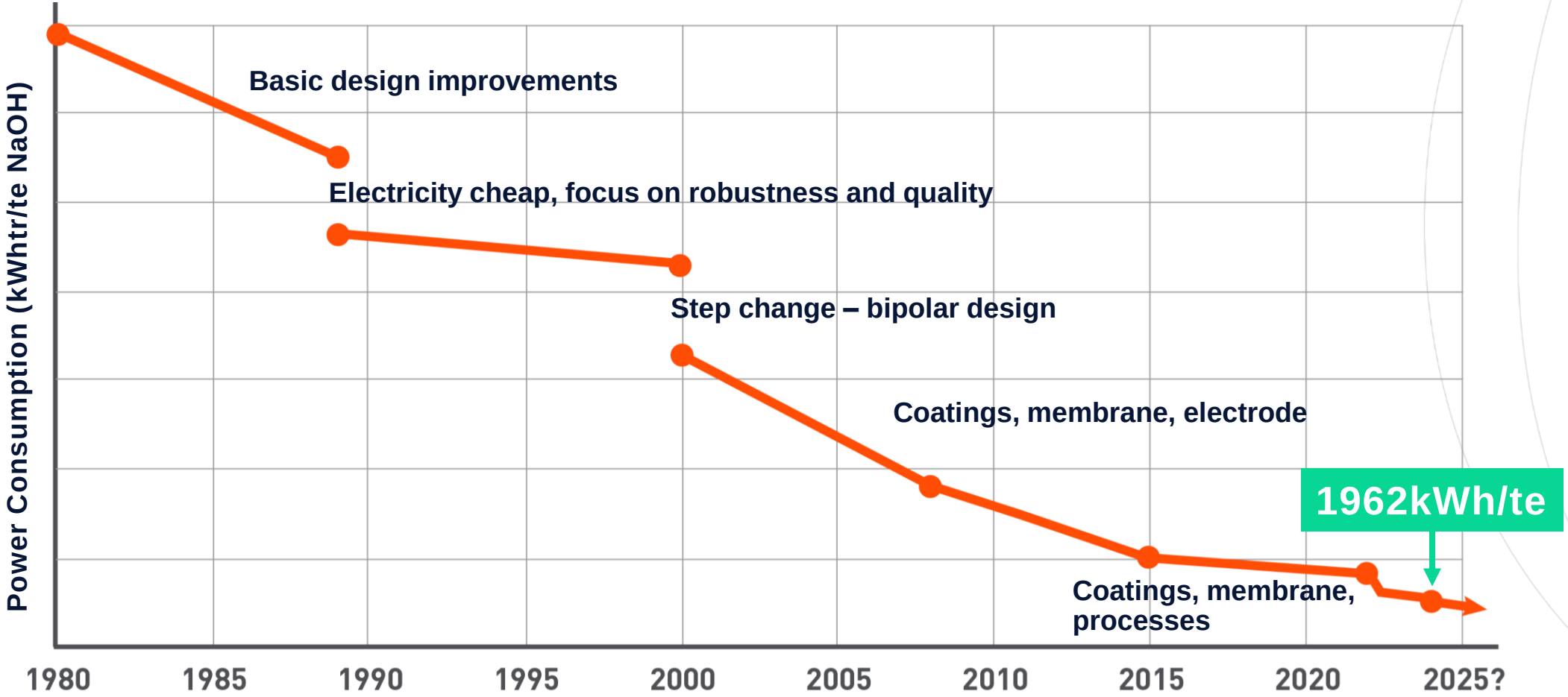
- Optioneering
- Optimised design
- Heat integration
- Value engineering
- Effluent minimisation

Tech & Ops Support

- Maximising performance
- Optimising component lifetime
- Refurbishment support

What we've done

Evolution of excellence



What we're doing

Overcoming the overpotential

Measured voltage	=	Reversible potential	+	Over-potential	+	Ohmic Resistance
~2.9V	=	~2.25V	+	~0.65V		

A function of current density

Coating innovations

- Potentially 20-30kWh/te available
- 30kWh/te is **~0.6Mte/yr CO_2** worldwide
- Robustness / life

Membrane improvements

- Integrating latest membrane supplier developments
- Evaluating lifetime durability
- Ready to support recycling concepts

9,921,052	Tree seedlings grown for 10yrs
133,518	Cars driven for 1 yr
75,620	Homes powered for 1 yr
1.5	NG fired power plants for 1 yr

What operators can do

Reduce power consumption and hence CO_2 emissions

- Operate within the design envelope
  - Good control of brine quality and pressure control
- Upgrade technology
  - Latest technology has a lower power consumption
  - New generation membranes with lower resistance
- Reduce current density
  - More modules needed – higher capital cost, cellroom footprint
- Increase operating pressure:
  - Reduced gas system size & cooling / drying requirements
  - Effect on equipment pressure rating, safety case, pressure control system

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Key Takeaways

Key Takeaways

- Urgent action needed to address climate change; chemical industry plays a key role
- Chlor-alkali provides critical products to achieve sustainable development goals, but must do this sustainably
- Reducing energy consumption and transitioning to green energy are major challenges
- We recognise our responsibility as a major chlor-alkali operator and technology supplier to lead the transition to net zero
- IES committed to ensure our products and solutions meet the demands of a sustainable chlor-alkali industry
- **IES can help you achieve your sustainability goals**


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Thank You
Designed for life.
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UCI
WORLD
TEAM
PINARELLO