

Integrity Engineering for a Sustainable Future

Mitigating Environmental and Sustainability Impacts of Cathodic Protection in Seawater

Sustainability

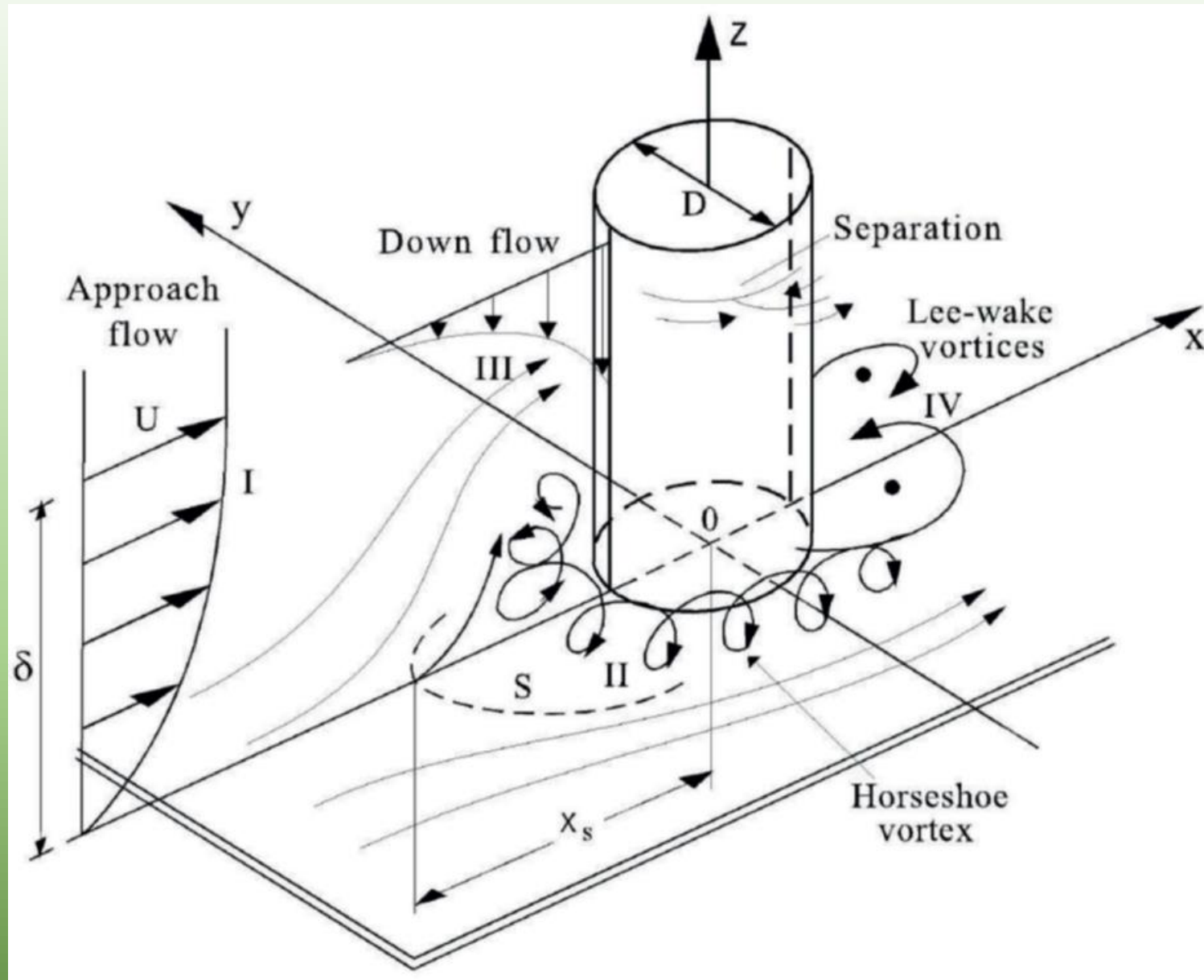
- Described by the UN as a generic concept allowing us to
- “meet the needs of the present without compromising the ability of future generations to meet their own needs.”
- Environmental Product Declaration (EPD)
- Life Cycle Assessment (LCA)

Environmental Product Declaration

- An EPD is a report communicating what a product is made from and how it impacts the environment across its entire life cycle.
- CP systems and anodes are only part of a larger and more complex asset e.g OWT (Foundation structure)
- Life cycle impact dependant on other factors not in the control of the supplier

Life Cycle Assessment (LCA)

- A compilation and evaluation of the environmental and sustainability impacts of a product throughout its life cycle (ISO 14040)
- LCA includes...
- Life cycle inventory analysis (LCI)
- Life cycle impact assessment (LCIA)

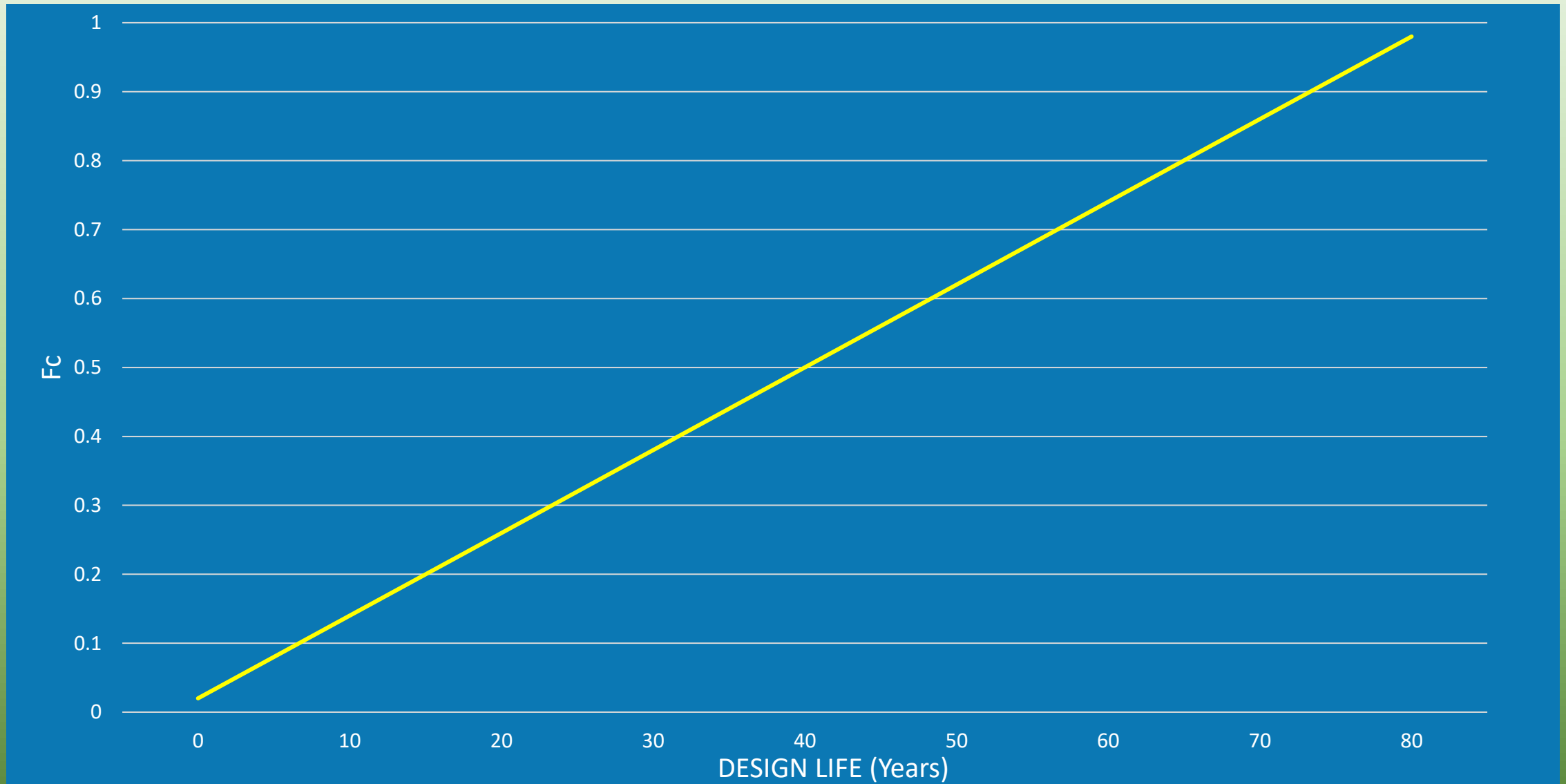


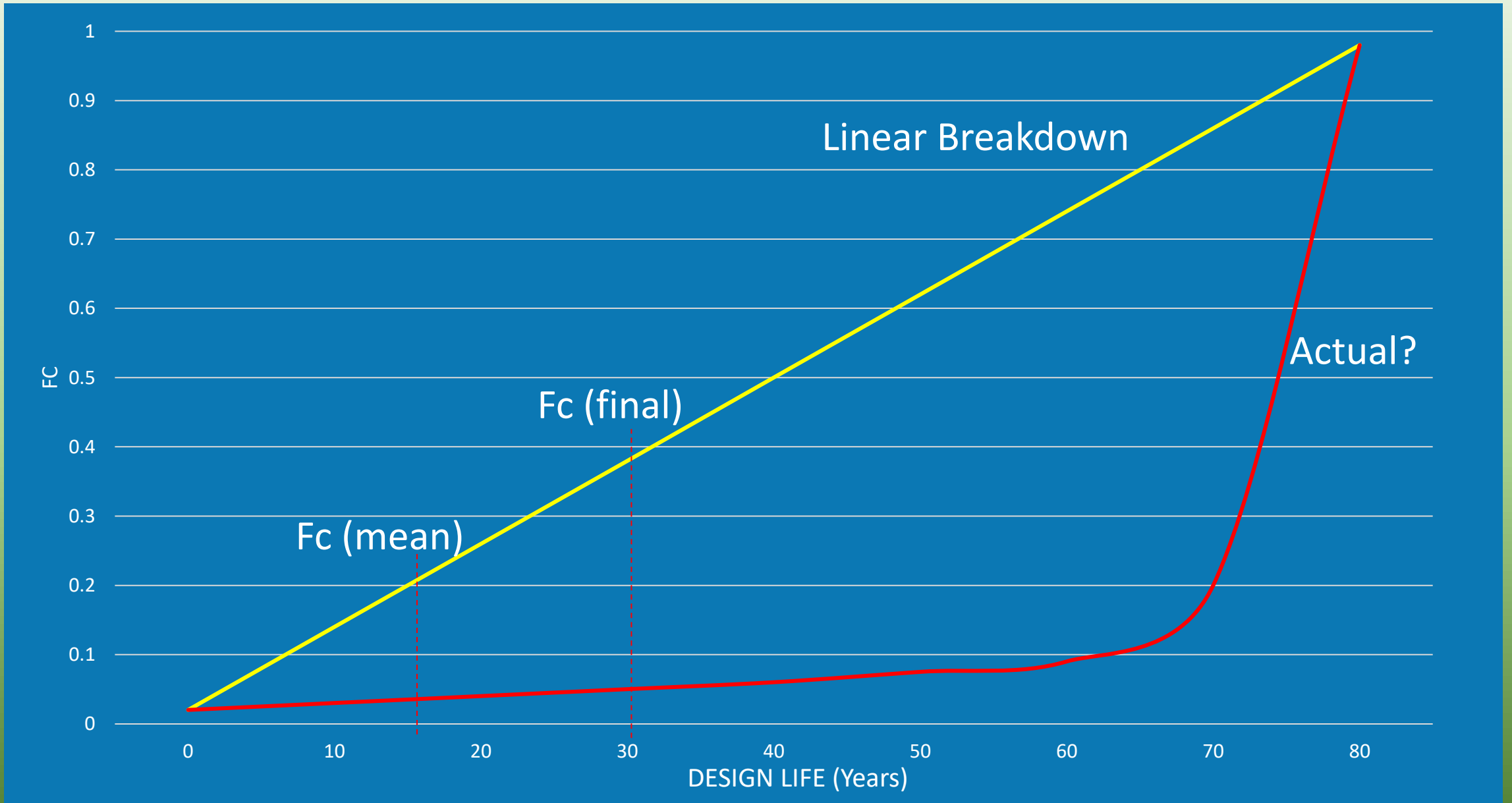
Flow Pattern around an OWT Monopile

Coating Breakdown

Cat III – ISO12944-9 Im4

Linear model DNV RPB401 & others





Sustainability & Environmental Impact of Galvanic Anodes

DOWNSTREAM - Impacts due to metal emissions into the sea

Metal distribution:

- Studied by NRA (EA) on estuaries/marinas on S & E UK coasts
- Studied in previous project – EFFORTS
- New studies in ANEMOI Project (also paint flake destination)
- Constituents (of galvanic anodes) are “ **largely within the known variability for the North Sea**”
- “**No direct effects on the marine environment can currently be recognised.**”



Build-up of Al(OH)₂ on Anode Surface

Sustainability & Environmental Impact of Galvanic Anodes

DOWNSTREAM - Impacts due to metal emissions into the sea

Toxicity to marine species:

- Some laboratory studies carried out - but not comprehensive
- **“Currently there is no clear evidence of negative impact of corrosion protection systems on the marine environment.”**
- **“A direct environmental threat by the use of galvanic anodes for cathodic protection of wind turbine support structures in the marine environment was not indicated.”**

Sustainability & Environmental Impact of Galvanic Anodes

UPSTREAM - Climate change impacts due to energy use

Primary metals:

- Ore mining, transport and refining (global activities)
- Transport of primary metal (international warehousing)

Anode manufacture:

- Transport of primary metal (Warehouse to foundry)
- Melting and casting operations
- Transport to customer (often international)

Energy Source	Impact CO2 Emissions g/kWh (1)	Fuel Mix % UK Average (1)	UK Supplier Fuel Mix %	
			EDF	SSE
Coal	1002	3.8	1.6	0
Natural Gas	372	38.5	15.1	70.1
Nuclear	0	16.1	63.1	0
Renewables	0	38.7	19	29.9
Other	795	2.9	1.2	0
Overall av CO2 (g/kWh)		198	82	261

(1) UK Gov. Dept for Energy Security and Net Zero 2021 - 2022

	Total Energy Used Mwh	Tonnes CO2 released from energy use per tonne finished product
2010	12,250	1.15
2011	11,418	1.05
2012	9,827	1.05
2013	14,634	1.06
2014	9,496	0.88
2015	7,284	0.61
2016	7,547	0.54
2017	6,979	0.37
2018	6,628	0.43
2019	4,694	0.58
2020	4,662	0.6
2021	3,608	0.74
2022	3,359	0.61

- 2014 Introduction of new 6t batch furnaces.
- 2015 New energy efficient compressor installed
- 2016 – 2018 recognises the impact of reduced energy output due to large zinc contracts.
- 2019 – Relocation to a new manufacturing site with improved efficiencies.
- 2021 – Alternative shift / manufacturing pattern introduced

2023 going forwards...

- Alternate methods of melting.
- Increased furnace efficiency through increased insulation and burner control.



De-commissioned Platform
with recyclable anodes



Stand-off Anode



Saddle Anode

	Stand-off Anode Trapezoidal Section 2400 x 245 x 250	Saddle Anode 3m dia x 200 lg 60 thk 50 thk		Saddle Anode 6m dia x 200 lg 60 thk 50 thk	
Initial Net wt kg	330	205	169	199	163
Current Output A at End of Life	3	3	3	3	3
Alloy Weight Saving		38%	49%	40%	50%

Prioritisation of sustainability

CHALLENGES FOR DESIGN

CP SYSTEM SELECTION

MATERIALS SELECTION

INSTALLATION & OPERATION

RECYCLING

AWARENESS & COST RECOGNITION

