Project Britannia   Technical Basis & Derivation Notes

Date: 2026 | **Companion to:** *Project Britannia: National Strategic Blueprint (Teesside & Humber)* |
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Purpose

This document explains where the key sizing numbers and system conclusions in the Britannia white paper come from: power-to-hydrogen conversion, water and brine flows, compression loads, and the "circularity" logic. It is concept-level and intended to be updated with FEED-grade data, site-specific pipelines, and regulator feedback.

1. Source inputs used

- **Uploaded proposal text:** *UK_Offshore_Nuclear_Hydrogen_Government_Proposal.txt* (contains the high-level concept framing and decommissioning liability figures). The accessible excerpt references UKCS decommissioning cost range 244 282bn and taxpayer exposure 224bn+.
- **Uploaded brine notes:** *brine use.txt* (brine re-use categories; "Britannia Advantage" argument; mineral recovery positioning; strong recommendation to position lithium as a "circular economy dividend" rather than a primary revenue line).
- **Engineering assumptions:** standard industry order-of-magnitude figures for PEM specific consumption, SWRO energy intensity, and compression energy. These should be replaced with vendor quotes during Pre-FEED/FEED.

2. Core assumptions (explicit)

Parameter	Base value	Notes
Electrolyzer technology	PEM	Chosen for fast control, compactness, and offshore modularity (site-specific selection may include alkaline where appropriate).
Net power to PEM (case)	300 MW (base)	Also an upside sensitivity at 350 MW net to PEM if available.
PEM specific electricity consumption (system-level)	55 kWh/kg H 8	Conservative concept-level number for continuous operation; FEED should use vendor performance guarantees at operating pressure and temperature.
Water intensity for electrolysis make-up	12 15 kg water/ kg H 8	Includes losses, purge, and quality management. Stoichiometric is 9 kg/ kg.
SWRO specific energy	3 15.5 kWh/m 3	Site dependent: salinity, temperature, intake/outfall design, fouling control.

Parameter	Base value	Notes
Compression energy to export pressure	2 14 kWh/kg H 8	Depends on inlet pressure, export pressure, train configuration, intercooling, and flowrate.

3. Hydrogen production calculation

Daily electrical energy supplied to PEM is:

```
E_day (kWh/day) = P_net (kW)  4 24
```

Daily hydrogen mass is:

```
m_H2 (kg/day) = E_day / SEC
```

3.1 Base case: 300 MW net to PEM

- **P_net** = 300 MW = 300,000 kW
- **E_day** = 300 4 24 = 7,200 MWh/day = 7,200,000 kWh/day
- **SEC** = 55 kWh/kg
- **m_H2** 6 7,200,000 / 55 6 **130,900 kg/day** 6 **131 t/day**

3.2 Upside: 350 MW net to PEM

- **E_day** = 350 4 24 = 8,400 MWh/day = 8,400,000 kWh/day
- **m_H2** 6 8,400,000 / 55 6 **152,700 kg/day** 6 **153 t/day**

4. Water requirement derivation

Electrolysis consumes water; additional water is used for system management. Concept-level range:

```
m_water (kg/day) = m_H2  4 (12 to 15)
```

4.1 300 MW case

- Water 6 130,900 4 12 6 1,571,000 kg/day 6 **1,571 m 3/day**
- Water 6 130,900 4 15 6 1,964,000 kg/day 6 **1,964 m 3/day**

5. Brine volumes and the "zero-to-minimum waste" strategy

Reverse osmosis desalination produces a brine stream whose flow depends on recovery ratio. Conceptually:

- If recovery is 50%, then **brine 4 permeate**.
- If recovery is 40%, then **brine 1.5 4 permeate**.

For a permeate need of ~1,600 2,000 m 3/day, brine will typically be **~1,600 3,000 m 3/day** for the cluster, depending on design choices.

5.1 What the brine strategy changes

Historically, desalination brine is discharged to sea; Britannia proposes to treat brine as a saleable co-product:

- **Step A (optional):** mineral recovery (e.g., lithium) where pilots prove performance and economics.
- **Step B:** export remaining brine to shore for de-icing / chemical feedstock uses.
- **Environmental outcome:** reduced routine brine discharge and improved marine acceptability.

Per *brine use.txt*, the recommended policy positioning is to treat lithium as a "circular economy dividend" rather than a primary project revenue line, to avoid overpromising given seawater dilution and capture uncertainty.

6. Compression/export power (why gross SMR may need to exceed net-to-PEM)

Hydrogen export via pipeline will typically require drying, metering, and compression. A concept-level estimate uses specific energy:

```
P_comp (MW)  6 (m_H2 (kg/day)  4 kWh/kg) / 24,000
```

Example: if 131,000 kg/day at 2.5 kWh/kg, then energy/day is ~327,500 kWh/day and average power is ~13.6 MW.

Implication: if the SMR is rated 300 MWe gross but the requirement is 300 MW net to PEM, then the gross plant rating must cover:

- Compression and export systems (order-of-10s of MW at this scale)
- Platform utilities (HVAC, safety, control systems)
- Electrical distribution losses (distance dependent)

7. Oxygen byproduct and options

Stoichiometry gives ~8 kg O 8 per kg H 8 produced. For ~131 t/day hydrogen, oxygen is on the order of **~1,050 t/day**. Options:

- Vent safely (simple, but must be justified and hazard-managed).
- Partial utilisation offshore/onshore (industrial use), which can improve project economics but adds equipment.

8. Safety case logic (summary of the reasoning)

The white paper s safety strategy is based on first principles used in both nuclear and offshore industries:

- **Hazard separation:** nuclear island separated from hydrogen processing platforms; power transferred electrically.
- **Defense in depth:** multiple layers of prevention/mitigation for leaks, fires, loss of cooling, collisions, and extreme weather.
- **ALARP demonstration:** risks reduced as low as reasonably practicable through design, operations, and emergency planning.

9. Why Teesside and Humber were added as landing points

- They are major industrial demand centers with strong policy focus on hydrogen hubs and decarbonisation.
- They provide immediate, high-value offtake: chemicals (Teesside/Wilton) and large-scale industry (Humber).
- Direct pipeline delivery minimises logistics emissions and cost compared with transported hydrogen.

10. Items to be replaced with FEED-grade data (data requests)

- Vendor-secured PEM performance and degradation curves at operating pressure and temperature.
- Site-specific seawater temperature/salinity/fouling profiles for SWRO design.
- Export pipeline specifics: metallurgy, weld records, inspection history, pressure cycling history.
- Compression train selection and export pressure targets.
- Brine commodity pathway: volume, concentration specification, onshore customers, and brine export pipeline feasibility/cost.
- Regulatory pathway definition for offshore SMR siting and licensing.

11. Short statement on uncertainty and integrity of claims

This concept is intentionally framed to be robust under scrutiny:

- Hydrogen output figures are derived directly from net electrical input and conservative PEM energy intensity.
- Water and brine figures are presented as ranges based on standard desalination recovery assumptions.
- Mineral recovery (e.g., lithium) is positioned as optional upside, not the primary economic driver.

End of technical basis notes.