ON-SITE HYDROGEN GENERATION FOR SWANSEA BAY

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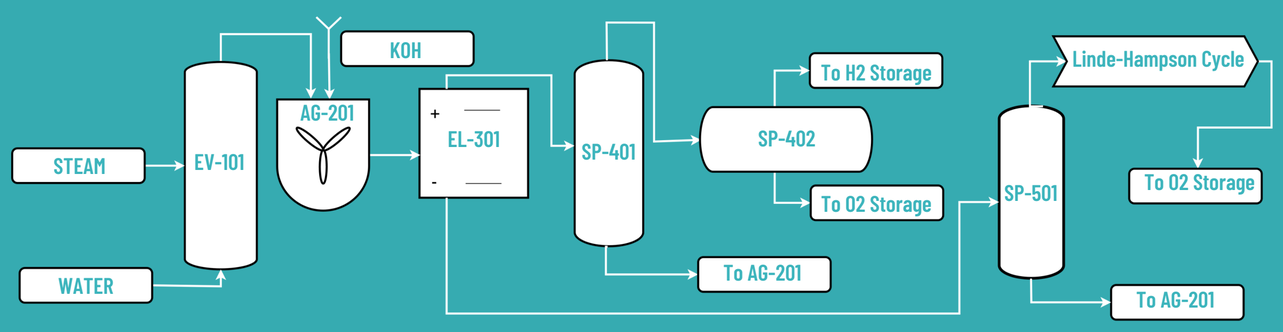
PLANT PROPOSAL

Design Objective: Hydrogen is at the forefront of transforming the current global economic landscape into a more renewable and sustainable environment for future generations. On a global scale, legislations are being implemented to rely on hydrogen as an alternative energy fuel source. Our mission is to supply 1879 ton/year of hydrogen to Swansea University to convert to electricity. The current energy demand according to HESA is 70,000 MW per/year. The following information models our proposal for an Alkaline Water Electrolysis process plant.

- Major Units of Operation: Evaporator, Agitator, Electrolyser, Oxygen Refrigeration, Hydrogen Purification
- Method of Production: Alkaline Water Electrolysis
- H2 production: 1879 tonnes/year
- O2 production: 5760 tonnes/year
- Operational hours: 7200 hours
- Energy demand: ~1000TW/ year



Unit	Evaporator (EV-101)	Agitator (AG-201)	Electrolyser (EZ-301)	H2 Separation (GS-401)	O2 Separation (GS-501)
Flow IN (kg/hr)	**4937**	**9995**	**13553**	**5855**	**9956**
Flow OUT (kg/hr)	**4581**	**9995**	**11230**	**5855**	**9695**
Temperature range (°C)	**52-107**	**87**	**80**	**200**	**20**
Pressure (bar)	**0.15 - 1**	**1**	**16**	**3**	**16**

PROCESS DESCRIPTION

SUSTAINABILITY

According to the IChemE metrics, the project is carbon neutral and there is no environmental burden on both atmospheric and aquatic life.

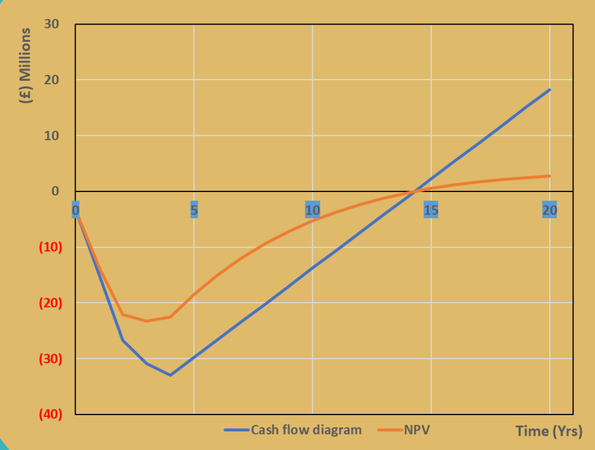
Energy for everyday operations is based off the accumulation of renewable energy sources, such as the solar farm on Baglan bay and wind turbine farm not far off Swansea Bay.

The procurement of materials e.g., construction of individual large units and transportation of said materials to site, along with construction of plant , is estimated to be 1 year. This should create a negative carbon footprint overall when accounting for lifespan of plant - 20 years.

All affect to enviroment according to IChemE standards are calculated to be negligible.

- Atmospheric acidification
- Global warming
- Human Health burden
- Ozone depletion
- Photochemical ozone
- Aquatic Acidification
- Aquatic Oxygen Demand
- Ecotoxicity to Aquatic Life
- Eutrophication

FEASIBILITY AND PROJECT APPRAISAL



At first glance the project seems an unwise decision. However, this is because the cost estimation was over approximated.

Transportation of goods were considered which are normally payable by buyers.

Even with extra energy equipment added, as well as cost for fixtures and backup equipment expenditure, to assure operating conditions and no pinch analysis conducted. The project breaks even at 14 years.

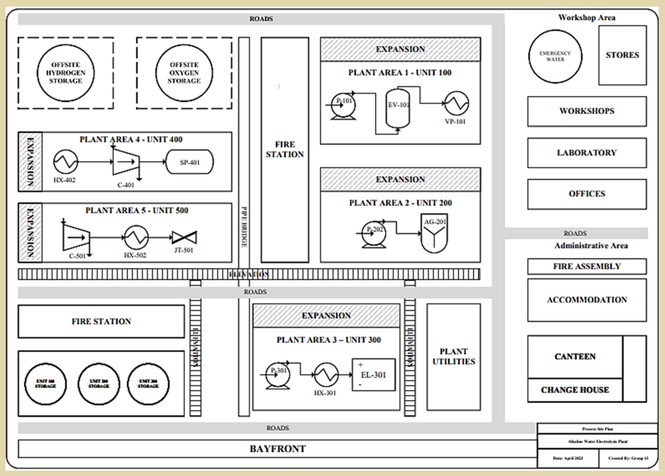
Considering the future trends, and capital + operating expenditure, the project has relatively high feasibility.

Rate of Return: 3.24%

Fixed Capital Investment: £11 Million

Project Lifetime: 20+ years

PLANT LAYOUT & SAFETY



The plant layout consists of plant utilities, an administrative area and a workshop area and Personal protective equipment, (PPE) is mandatory across all plant areas.

In accordance with the principles provided by the Health and Safety Executive UK, the plant has two designated fire response stations and an allocated water supply.

Plant area 4 and plant area 5 are at the top left as they are the most hazardous plant areas, Considering the westerly winds, and stop spread towards high traffic areas.

Safety consideration analysis was performed across the plant to evaluate the major hazards and risks. A HAZOP and HAZID study outlined all relative risks and provided associated actions. To account for the substances involved in the plant, a COSHH assessment was conducted to highlight the potentially harmful components.

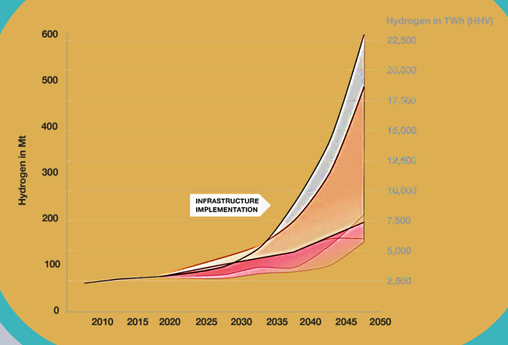
PLANT LOCATION

As requested in the brief, it is necessary that the plant can accommodate for on-site hydrogen production for Swansea Bay.

Location: Baglan Bay
Area: 180-acre plot
Key features

- Bayfront Access
- Previous industrial site
- Westerly orientated winds
- Solar farm

FUTURE TRENDS



The government target for the UK is to reach Net Zero emission by 2050. In September 2022, 40 countries had hydrogen strategies in place, detailing the planned investment in production and propositions for hydrogen use.

Goldman Sachs one of the leading accounting companies estimated in 2022 that low-carbon hydrogen would have a global market share of at least €10 trillion in 2050 (House of Commons, 2022).

The graph on the left taken from PWC another leading accounting company shown the projection for hydrogen growth.

RECOMMENDATIONS

Certain aspects of plant can be tweaked making the plant a lot more economically viable and profitable. E.g.,

- Mineral waste stream can be recycled back to water treatment facilities.
- With larger capital expenditure, sea water can be used instead of tap, making it more independent.
- Electrolyser can be changed for Fuel cell, the whole process can be reversible, for electric supply.
- Pinch analysis over plant.
- Use ceramic technology.

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