Hydrogen-Based Energy Autarky Smart Cities

Startup Project Proposal
Business Plan

"A New Hydrogen Energy Storage System"

For
Australian National Government Budget Review
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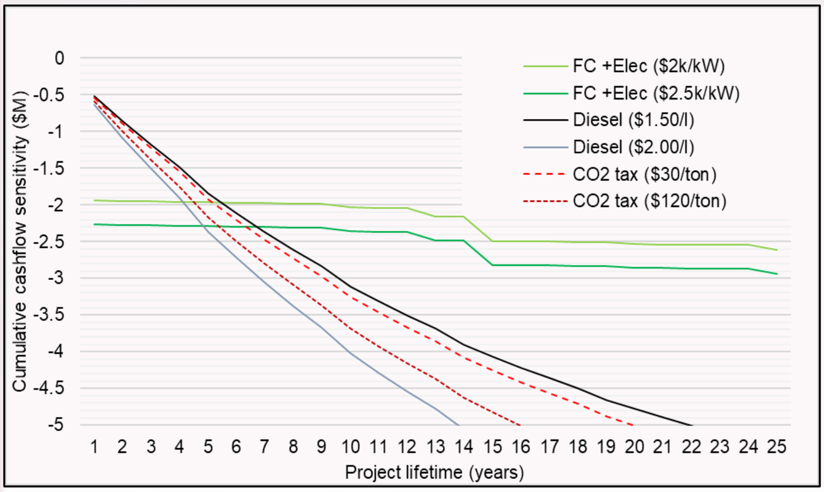
Executive Summary

An innovative Renewable Hydrogen system has been developed to solve today's main challenge in developing residential or industrial stand-alone settlements in remote areas. Clean energy of zero life cycle emissions is urgently needed to keep the global warming under control. An Energy-Water-Waste nexus approach with smart stand-alone microgrid is techno-economically viable solution to reduce cost of energy and eliminate emissions.
H2E Group designed and evaluated a 100% renewable energy integrated model for a stand-alone hybrid microgrid where Hydrogen is the backbone for energy storage and distribution. A module of a hybrid PV-Battery-Hydrogen system to serve one hundred dwelling (400-500 dwellers) with 2 MWh of average daily energy demand has been modelled and simulated in comparison with conventional use of Diesel fueled energy generation. Water is generated by solar desalination and condensation from the humid atmospheric air. A bio-waste and waste-water recycling plant is an essential additive to reduce the environmental impact and save water as well as to generate power and gas. The energy model techno-economic simulation shows a considerable reduction in the cost of energy by up to 53% and eliminate 1.6-ton CO_2 per capita per year Carbon emissions (total of 643 tons of CO_2/year). The project can achieve a payback in 5.45 years depending on Diesel costs and an effective Carbon Tax. The proposed project is a holistic solution for the trilemma of emissions, pollution and sustainability challenges. The Modular design can be replicated.
This project can create energy-water autarky smart cities in the isolated or remote areas that generate electricity, gas and water supply from 100% renewable resources. This will make Australia a Global Hydrogen Energy Hub as well as overcoming the national policy barriers and change the decision makers perception for a 100% renewable energy.

Highlights

- A 100% Renewable energy and a stand-alone hybrid microgrid.
- (Power to Hydrogen - Li-Ion Battery) Hybrid energy storage and Hydrogen direct fuel.
- Water supplied by solar water desalination and humid atmospheric air condensation.
- Modular design which can be replicated.

Financial Overview



Diesel Price ($/L)	Carbon Tax ($/Ton)	Discounted Payback Period (Yrs.)
1.5	0	**5.45**
	30	**5.14**
	120	**4.5**

Net Present Costs	
Capital	$1.93M
Operating	$101,801
Replacement	$513,458
Salvage	-$74,124
Fuel	$0.00
Total	$2.47M

Objectives

The aim of this project is to Design, integrate and implement a 100% renewable energy innovative zero-emissions autarkic stand-alone smart cities via energy-water-waste nexus approach with the following goals: -

- Diminish the cost of energy and water.
- Green mobility.
- Eliminate pollution.

Mission Statement

H2E Group is addressing the pollution and sustainability challenges via an innovative nexus way of thinking by integrating existing technologies in a modular hybrid system. The diversity of scientific backgrounds and experience of the H2E Group ensures the integration and interoperability of the proposed system. Our modular type of approach optimizes capital investments and reduce the risk of failure. The implementation of our Hydrogen-based pilot project is a real opportunity to fill the remote desert darkness with green, self-sufficient and sustainable shining stars.

Keys to Success

- Green policy and awareness.
- Internalize the externalities.
- Community engagement and social perception.

H2E Group / Entity

The Hydrogen Energy Group (H2E) is formed by PhD students, alumnus from Murdoch University and Hydrogen energy experts in Perth, Western Australia.

https://h2e.com.au

Delegates

1. Furat A. Dawood; PhD candidate in Power to Gas - Murdoch University, Perth WA Australia.
2. Neil Salam; Professional renewable energy and chemical engineer. Master of Renewable and Sustainable Energy – Murdoch University.
3. Raoul Abrutat; Professional renewable energy engineer, Fremantle Wind Farm Cooperative Ltd, Perth WA Australia.
4. Bruno Benaise; Managing Director H2DO and ex-Vice President Customer Program Management APAC – Technicolor, Perth WA Australia.

Engineering and Consultancy Services

The diverse experience of our engineers, economists and business managers enables our company to integrate many existing technologies to function as a holistic integrated system. We use the vertical, horizontal and star methods of integration to achieve efficiency and sustainability which individual sub-systems cannot achieve.

Project Location

This project to be implemented at the remote and inhabitable areas of Australia for residential or industrial purposes as well as farming villages or indigenous communities.

1. The Green Hydrogen Innovative Project

An innovative renewable hydrogen system has been developed and its applicability evaluated to suit the Smart Hydrogen Stars project. The developed integrated system is illustrated in Fig 1, which encompasses the following sub-systems and components: -

1. Renewable energy generator with a total capacity of 800 kW_p Solar PV;
   - 250 kW_p solar PV farm connected to the microgrid AC bus.
   - 650 kW_p solar PV farm connected to the microgrid DC bus.
2. Power to Gas to Power (P2G2P) system;
   - 500 kW PEM electrolyser on the microgrid DC bus.
   - 400 kg hydrogen storage tank (compressed gas 350 bar).
   - 150 kW PEM Fuel Cell
   - 240 kW AC/DC converter connected between the microgrid AC and DC buses.
3. 200 kWh Li-Ion Battery bank connected to the microgrid DC bus.
4. Smart Energy management system.
5. Water system (condensation and solar desalination plant plus a rainwater tanks).
6. Recycling system (Waste to Power and Gas).
7. 5 kg per day Hydrogen load for household demand and fuel cell vehicles.
8. Hydrogen refueling station.
9. EV charging station
10. An emergency backup generator

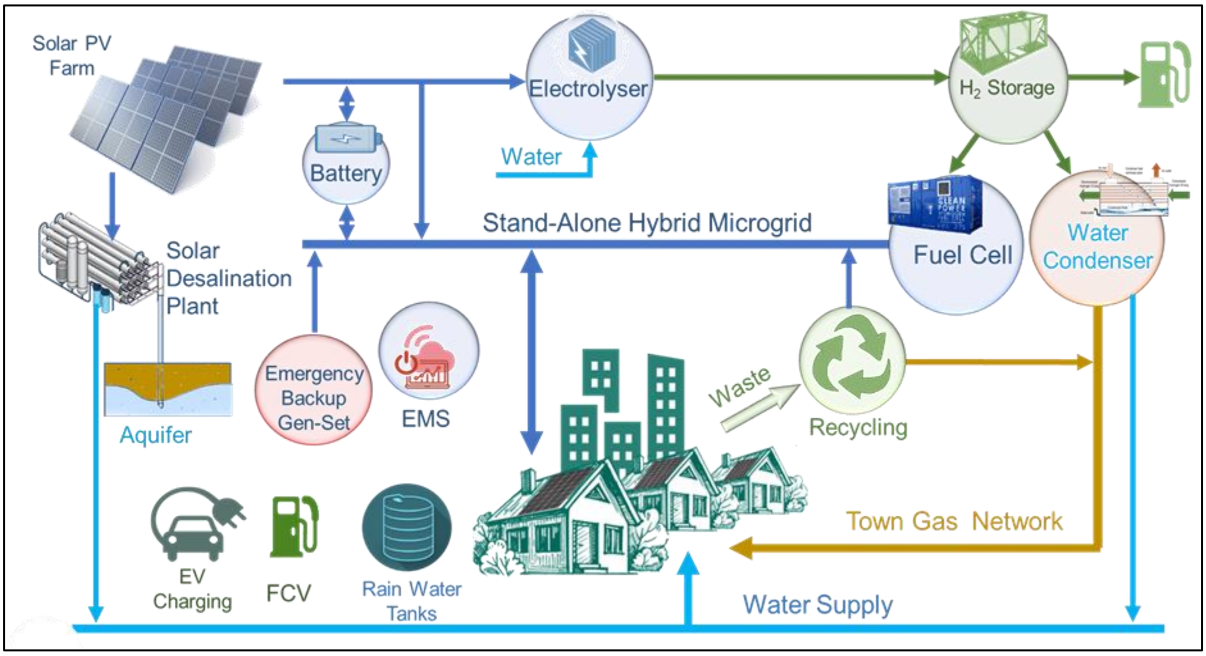


Fig. 1: The Smart Hydrogen Stars proposed system diagram

What's in it for Australia?

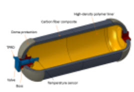
- Investing in our project makes Australia a Global Hydrogen Hub.
- Achieving climate change agreements.
- Aligned with 'patient capital' goals like diversification of the Australian economy.
- Local renewable power and gas supply based on Green Hydrogen.
- Transition to 100% renewable energy.
- Reduce the cost of energy and ensure the security of supply.
- Flexibility in utilising Hydrogen, e.g. Direct fuel, power and waste treatment.

Energy System Model and Simulation

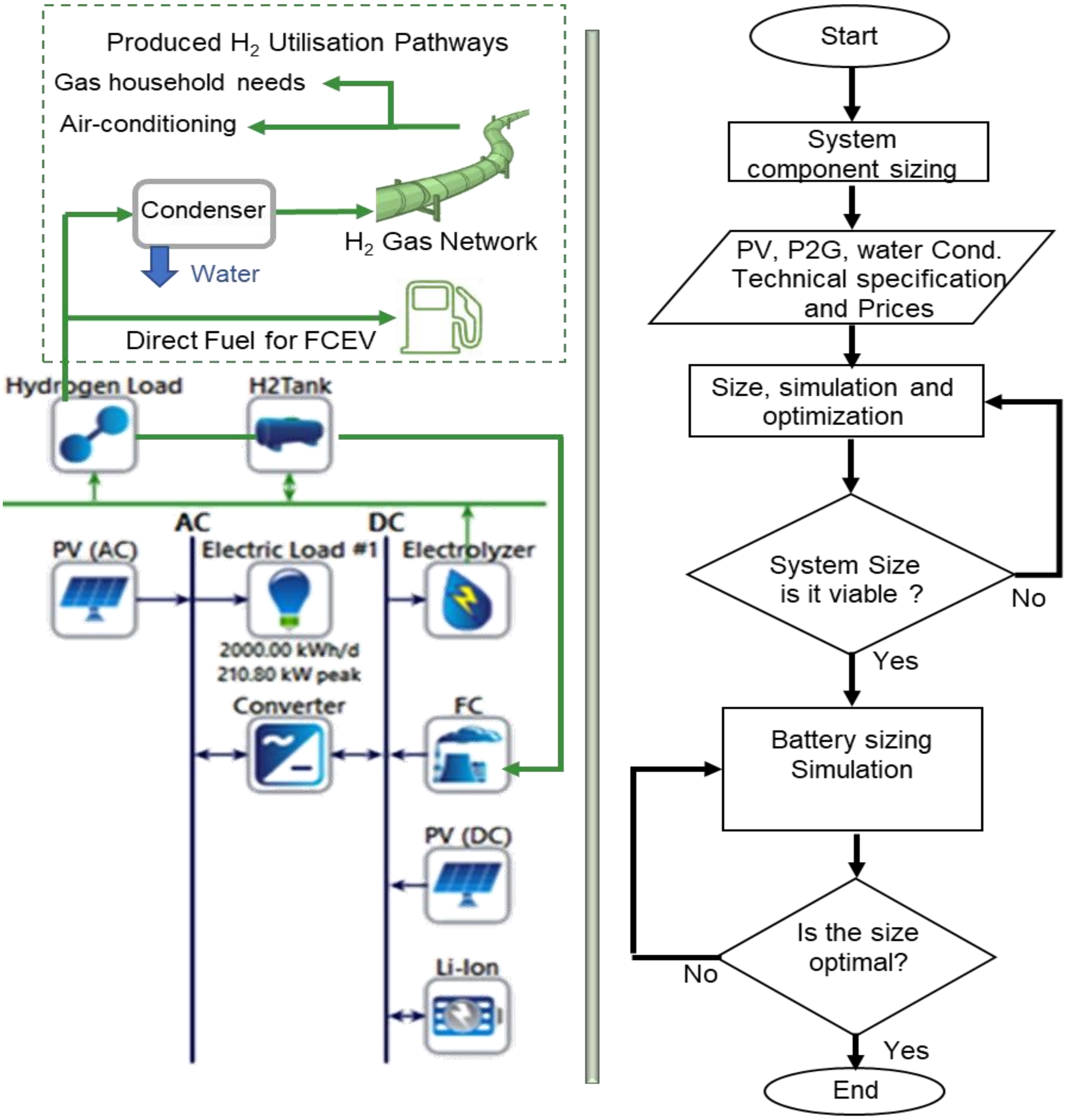
Our modular project entails utilisation Hydrogen as a system backbone to deliver the electricity, gas and water needs from a 100% renewable (solar) resources. The Hydrogen will be used as an energy carrier, storage medium, direct fuel and water generator by condensation utilising the (Hydrogen and Oxygen) decompression-cooling energy (see Fig 1). The required energy for our system is generated by a large-scale solar PV plant (other renewable resources can be added like Wind energy, Wave, Geothermal, etc.). Hydrogen will be generated by water electrolysis via a large-scale PEM electrolyser. Hydrogen is stored and utilised in the following pathways: -

1. Generate electricity via a Fuel Cell (FC) in combination with suitable medium scale Li-Ion battery (Hybrid) for its merit of quick response to stabilize the stand-alone microgrid.
2. Hydrogen direct fuel for the gas needs (hydrogen gas network) of the households in the Smart Desert Star Settlements. The distributed Hydrogen gas via the pipe network will be used for fuel cell vehicles, cooking and hot water which will reduce the electrical load. Hence, results in smaller battery-FC capacity required.
3. The Hydrogen gas in the distribution network will be supplied in a low-pressure form, i.e. 8-10 bar. Whilst, the Hydrogen generated by typical Polymer Electrolyte Membrane (PEM) electrolysers will be at around 30 bar. The Hydrogen and Oxygen decompression will be used to generate cooling to condensate water from humid ambient air which will deliver the electrolyser water needs (0.9-1 L/Nm^3 H_2), results in self-sufficient water electrolysis. Moreover, an extra hydrogen storage capacity will exist by considering the hydrogen gas network pipes as storage capacity. Australian case specific Preliminary calculations are attached in appendix CC.
4. The HOMER Pro software has been used for this model. The simulation assumptions are tabulated in Table 1, and the system model and the optimization method are illustrated in Fig 2.

Table 1: The simulator inputs

Stand-Alone Microgrid Base Case Diesel Generator	Generator cap (kW):	250	Lifetime (hrs):		40000
	Fuel Consumption (l/kW):	0.337	Capital cost ($):		100000
	Fuel Diesel cost ($/l):	1.5	CO2 (kg/l):		2.4-2.8
Electric Daily Load Profile	Load Type:	AC	**Electrolyser**	Type:	Proton Exchange Membrane (PEM) Electrolyser
	Peak Month:	July		Lifetime (hrs):	15,000
	Time step size (min.):	60		Capacity (kW):	500
	Average (kWh/d):	2000		Efficiency:	75
	Peak (kW):	210		Water Consumption (L/kg H2)	11
				Capital cost ($/kW)	2000
SOLAR PV	Panel Type:	Flat Plate PV	**Fuel Cell**	Type:	Proton Exchange Membrane Fuel Cell (PEMFC)
	Peak Month:	January		Lifetime (hrs):	40,000
	Aggregated Capacity (kW):	900		Capacity (kW):	500
	Efficiency (%):	18		Efficiency (%):	75
	Temp. Coefficient:	-0.47		Capital cost ($/kW)	2000
	Operating Temp.(Deg. C):	45			
	Lifetime (years):	25			
	Capital cost ($/kW):	300			
Battery Bank	Type:	Lithium-Ion	**H2 Storage Tank**	Lifetime (years):	15
	Nominal Capacity (kWh):	200		Capacity (kg H2):	400
	Nominal Voltage (Volts/string):	250		Capital cost ($/kW)	500
	Roundtrip Efficiency (%):	90			
	Capital cost ($):	60000			
	Lifetime (years):	10			

Note; In the scope of this startup project, the energy model (electric and hydrogen production) has been simulated and evaluated for the purpose of techno-economic feasibility. The differentiation components as oppose to the conventional Diesel gen-set system are only evaluated.



(a) Model diagram (b) Simulation and Optimization

Fig. 2: The proposed system diagram and methodology

Model Evaluation

The proposed model is simulated using HOMER Pro Energy software for the electric side and Hydrogen production to supply the daily load and the energy autonomy at the storage tanks (350 bar H_2 gas). The model evaluation optimized the system component sizes and capacities for the minimum cost of energy in comparison to the same energy load supplied by a conventional Diesel generator. The Hydrogen load of the hot water, fuel cell vehicles and the household gas demand are supplied by 5kg of H_2 per day. The renewable energy system is optimized to enable the electrolyser to produce enough hydrogen during the sunshine hours. A Simulation for the project lifetime of 25 years has been derived based on an hourly system functioning. A 24 hours system's component functioning cycle (daily demand/supply profile) to demonstrate the system integrity is plotted in Fig 3 below.

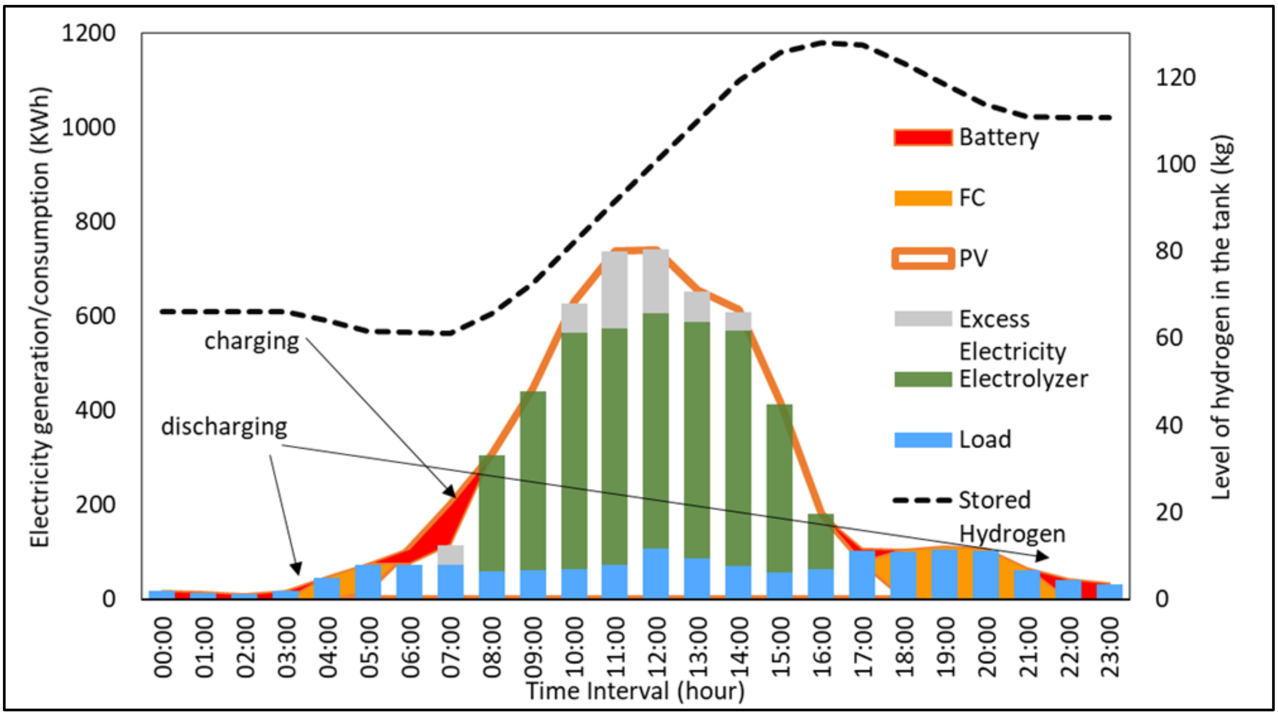


Fig 3: Daily Power and Hydrogen demand/supply

The graph in Fig 3, reveals that the electrical demand is supplied by the battery from 22:00 – 4:00 am and then the FC provides the required electricity for the consumers between 4:00 – 6:00 and 6:00 – 22:00 and between that the PV panels can produce a sufficient amount of electricity to supply the load and charge the battery, then supply the electrolyser. It should be noted that a part of solar energy is excess energy (~18.9%) during the day due to lack of load. The system operator can bring a lot of benefit to the system by incentivizing the consumers to consume more energy during the day by demand response (DR) schemes. Given the energy state of the battery and the excess production of PVs, the system is able to meet a high level of uncertainty in generation/consumption of even failure of some components. Moreover, the amount of hydrogen stored in the tank is depicted in Fig 3, which is enough to fulfill the gas demand of the system. The hydrogen autonomy in the tank secures 2 days of energy supply. Battery switches only once a day which enhances its lifetime.

The Hydrogen load operates at 8-10 bar in the distribution network (cost of pipelines considered as a prerequisite for any modern city development). Hence, the decompression of the hydrogen from the electrolyser output at 30 bars to 10 bar as well as the Oxygen are put through a large-scale condenser shown in Fig 4 below to produce atmospheric water; more detail attached in Appendix CC. The excess renewable energy will be used to drive a controlled volume of air to keep the condenser temperature at the dew point below the ambient temperature where the water vapor condensates.

Water System Evaluation

The preliminary calculations reveal that in a volume of 100 m^3 of air at 40^{o}C and 80% relative humidity there are 2.5 litres of water moisture. The condensate water will be used for the electrolysis. Referring to the model simulation results, the condensation system shown in Fig 4, designed to deliver 440 litres of water per day to feed the electrolyser to produce 39.57 kg H_2 per day for a water efficiency of 1 litre of water per Nm^3 H_2.

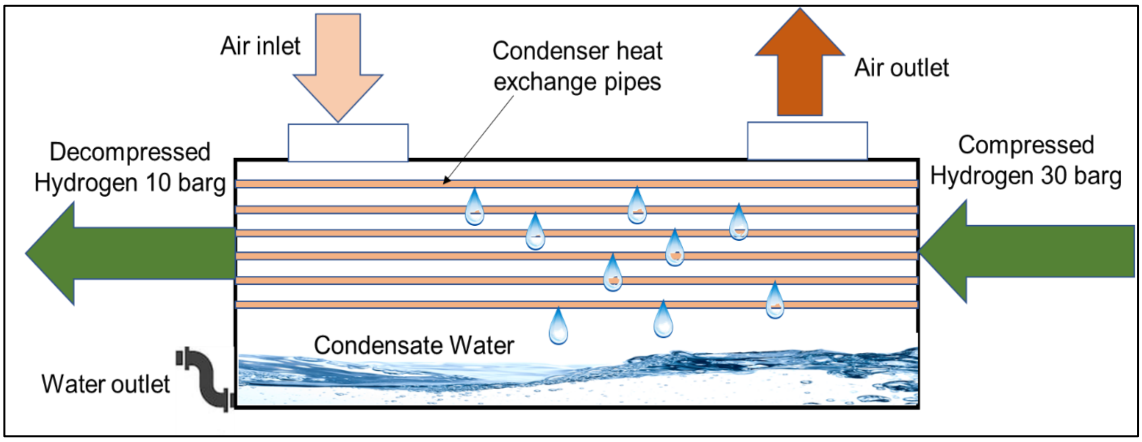


Fig 4: Large-scale condensation system diagram

Considering the volume of condensed water (refer to Appendix CC, Fig CC1), we propose to run the water condensation system during the time slots, where excess energy is available (18.9% of the total PV generation) to fulfill the water demand of electrolyser. For instance, water can be obtained by utilizing the excess electricity during six hours between 9:00 to 15:00 in a typical day in July (see Fig 3). The excess water excluding the electrolyser water demand will be stored to be used later; more details are attached in Appendix CC. According to Fig CC1, the water condensation potential in July till September is relatively low, thus the water demand can be met by using the stored water. Furthermore, the cooling energy is achieved by decompression and recompression of H_2 from 30 Bar to 10 Bar and O_2 from 30 Bar to 1 Bar. The excess renewable energy can drive the air fans of the condenser as well as the Hydrogen gas compressors.

A solar-powered desalination plant can deliver water supplies from the aquifer or the sea water which stored and treated for drinking and other household needs. However, the PV-desalination plant requires expansion in the system solar PV capacity. The engineering design of this system is at the next step of this proposal.

The rainwater tanks store the harvested rain water to reduce the water desalinated from the aquifer.

Suppliers

Reliable manufacturers will be used to supply the system components. The H2E Group engineers will ensure the system integrity and interoperability between the different standards and manufacturers. A list of the prospect manufacturers is in Appendix DD.

Service

H2E Group provides engineering and consultancy services before, during and after the project execution and commissioning as well as designing the required Energy Management System (EMS) with an essential dashboard for monitoring and control.

Manufacturing

Some of the system components and the connections between the sub-systems can be manufactured locally to ensure capacity building and after sale services.

Energy System Risk Assessment

The utilisation of mature and proven technologies and equipment reduces the risk of system failure. A list of sub-systems from around the world is attached in Appendix EE. The emergency backup system assumed to exist in all systems (not included in the comparison) is always essential to secure the power supply. The risk of dealing with Hydrogen is indifferent compared to the natural gas systems if implemented in accordance with international standards. Therefore, strict compliance with safety regulation, best practice and material specifications as well as following defined procedures shall control the risk exposure.

The other Strength, Weakness, Opportunities and Threat (SWOT) related to our innovative startup project are summarized in Table 2 below.

Table 2: The SWOT Analysis

Strengths	**Weaknesses**
- 100% renewable energy.	- Higher initial CAPEX
- Climate change mitigation.	- Market costing for hydrogen Production.
- Self-reliant towns, save diesel costs.	- No pilot of such an integrated system exist.
Opportunities	**Threats**
- Jobs and manufacturing.	- Regulatory and policy barriers.
- Self-sufficient Smart Cities.	- Society perception of hydrogen.
- Wastewater/ biogas opportunities.	- Lack of standards for distributed Hydrogen.

2. Economic Evaluation

Table 3, shows a 25-year project lifetime comparison between the conventional Diesel generators and our P2G2P system which, illustrate the benefit of reducing the cost of energy by more than 50% over the long-term with zero Carbon emissions.

Table 3: Cost of Energy per kWh comparison for Australia (Pilbara)

Diesel System	Diesel Cost ($/L)		Electrolyser cost ($/kW)		P2G2P System
Carbon TAX ($/ton CO2)	1.5	2	2000	2500	FC capital cost ($/kW)
0	0.562	0.731	0.283	0.310	2500
30	0.589	0.757	0.275	0.302	2000
120	0.836	0.844			
CO2 Emissions = 643 ton/yr			Zero Emissions		

The capital investment of 1.93 million US Dollars with zero fuel cost and emissions shown in Table 4, results in a high return on investment (lower Net Present Cost) and shorter payback period in comparison to the Diesel System. The annualized costs and the cashflow in comparison of both systems are attached in Appendix AA, Table AA1 and Fig AA1 subsequently.

Table 4: Net Present Costs Comparison

System	Capital	Operating	Replacement	Salvage	Fuel	Total
Proposed Green Hydrogen	$1.93M	$101,801	$513,458	-$74,124	$0.00	$2.47M
Diesel Gen Set	$160,000	$142,849	$247,782	-$12,577	$4.77M	$5.31M

Capital investment breakdown of both systems components is tabulated in Table 5, which demonstrate the initial cost of the Proposed hydrogen system dependency on the cost of the P2G2P components. Subsequently, the payback period is highly depending on the cost of the components as well as the cost of the Diesel fuel. In the central scenario, we assumed that $2000 per kW capacity for both the electrolyser/fuel cell is a rational price. The Diesel fuel cost $1.5 per litre is used in our economic evaluation. Moreover, the classic trends are showing that the Hydrogen system's components prices are decreasing while, the Diesel cost is increasing.

Table 5: Capital investment of the comparative components (P2G2P vs Diesel); Ref Table 1

System Component	Nominal Capacity	Unit Capital cost	Capital/Component
Solar PV Farms	900 kW	$300/kW	$270,000
Battery Bank	200kWh	$300/kW	$100,000
Electrolyser	500kW	$2000/kW	$480,000
PEM Fuel Cell	150kW	$2000/kW	$300,000
H2 Tank	400kg	$500/kg	$200,000
System Converter	240kW	$208.33/kW	$50,000
System Controller	Load following	$10000 / unit	$10,000
System Peripherals			$5,000
Integrated System total capital investment =			$1,415,000
Diesel Gen Set	250 kW	$100000/unit	$150,000
System Controller	Load Following	$10,000 / unit	$10,000
Diesel System total capital investment =			$160,000

Payback Period

The financial sensitivity analysis reveals that the payback period is inversely proportional to the Diesel fuel cost and the Carbon emissions penalties i.e. Carbon tax scheme. A comprehensive sensitivity analysis is attached in Appendix BB. However, following the assumed rational prices in central scenarios shows that our green Hydrogen project can payback the capital investment in 5.45 years as plotted in Fig 5 below. Moreover, adding an assumed rational Carbon penalty of 30 USD per ton can reduce the period by approx. four months as illustrated in Fig 5. Hence, the capital investment can be recovered during the lifetime of all the system components. Such a payback period is a promising value for the implementation of our innovative green Hydrogen project. The Payback period sensitivity analysis related to the cost of the Diesel fuel and the P2G2P components (electrolyser and FC) is shown in Appendix BB, Fig BB1. The effect of the Carbon tax is demonstrated in Fig BB2, which reveals that internalizing the externalities like emission penalties, health and environmental impacts benefits our proposed project.

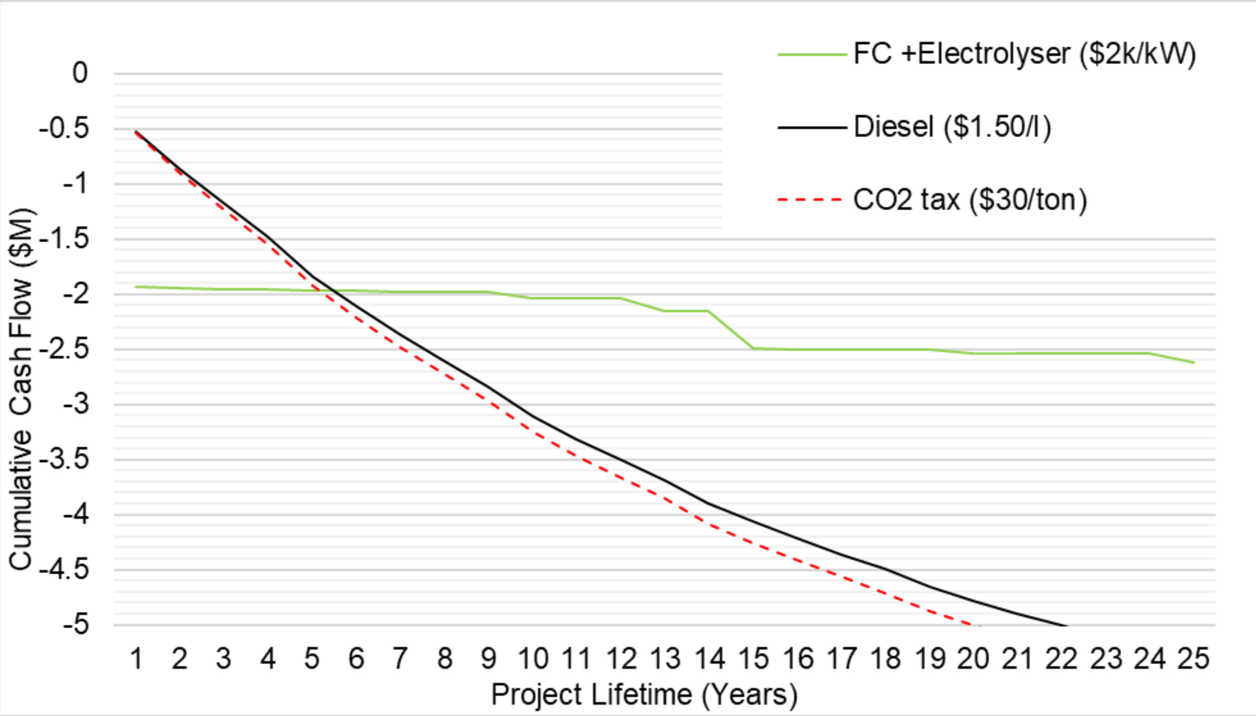


Fig 5: Cumulative cash flow showing the payback period using the central scenarios

Cash Flow

The chart in Fig 6, shows the cost of the Diesel fueled system in comparison to the proposed green Hydrogen system over a lifetime of 25 years. This proves that the reduction of the cost of energy utilising the hydrogen system is due to the high cumulative cost of the Diesel fuel of $1.50 per litre. The cost of the Diesel in the central scenario (i.e. $1.50/L) is more than double the initial cost of the proposed green system in the long run i.e. 25 years lifetime. The simulation of both systems reveals that the annual cost is $247.00 per person per year (400 dwellers) compared to $531.00 per person per year for the conventional Diesel system. The annualized Net Present Cost detail is attached in Appendix AA, Table AA1.

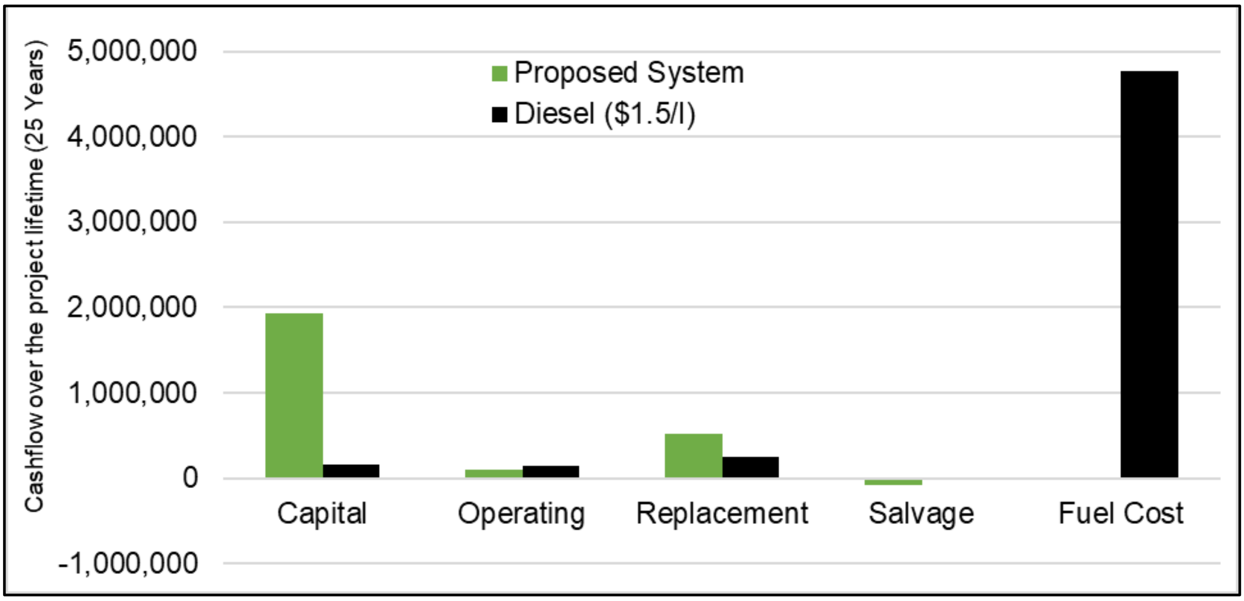


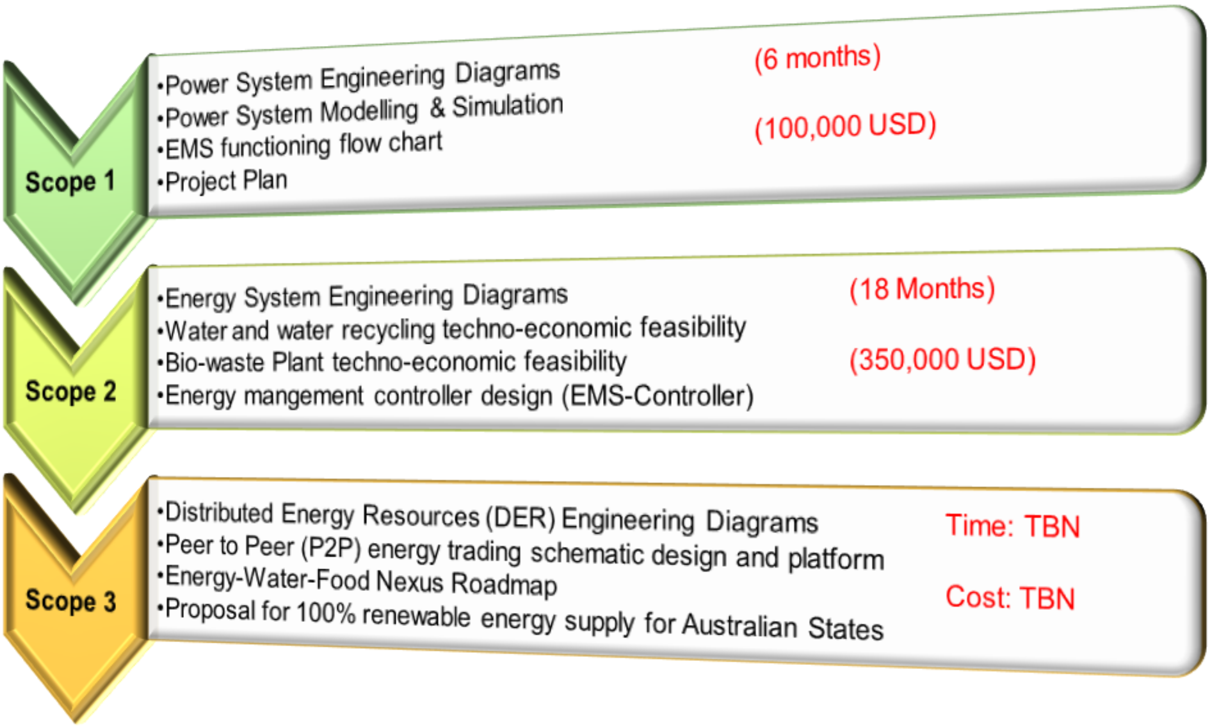
Fig 6: Net present costs (cashflow) by category comparison

Market Segments

The main market segments we will consider are residential areas, mining towns and farming communities. These were determined to be areas with large potential around the world as well as good areas to implement various stages of our project. Further details on the scale and components of these systems will be context dependent.

Strategy, Investment and Implementation

H2E Group is seeking a new venture capital to be invested in our Smart Hydrogen startup project. The summary below depicts the scenarios and corresponding cost and time.



Appendixes

Appendix AA. Annualized Analysis

Table AA1, shows the annualized costs of the green hydrogen system in comparison to the conventional Diesel system. This table reveals that the annualized cash flow total of $191,153 per year (400 people) for the green Hydrogen project lifetime of 25 years. Also, it shows that the total annualized cost of the Diesel system is 215% more than the green Hydrogen system in the long run of the project lifetime. Hence, the annual cost for a total of 400 dwellers is $247.00 per person per year compared to $531.00 per person per year for the conventional Diesel system.

Table AA1: Annualised Costs comparison

Name	Capital	Operating	Replacement	Salvage	Fuel	Total
Li-Ion Battery	$7,735	$2,000	$5,467	-$741.23	$0.00	$14,461
Load Following System Controller	$773.54	$100.00	$262.56	$0.00	$0.00	$1,136
Hydrogen Tank	$15,471	$2,000	$0.00	$0.00	$0.00	$17,471
PEM Electrolyser	$77,354	$1,000	$24,615	-$4,633	$0.00	$98,336
PEM Fuel Cell	$23,206	$2,350	$8,390	-$174.60	$0.00	$33,771
Solar PV	$20,886	$225	$0	$0	$0	$21,111
System Converter	$3,868	$200.00	$984.58	-$185.31	$0.00	$4,867
Integrated System	$149,294	$7,875	$39,718	-$5,734	$0.00	$191,153
Diesel Gen set System	$12,377	$11,050	$19,167	-$972.87	$369,019	$410,640

The annualized cash flow chart in Fig AA1, demonstrate the higher cash flow of the Green Hydrogen system in the first year compared to very low cash flow for the Diesel system. Whilst, the Diesel system incurs a continuous amount of cash flow due to the Diesel fuel cost compared to zero fuel cost for the renewable energy resources system.

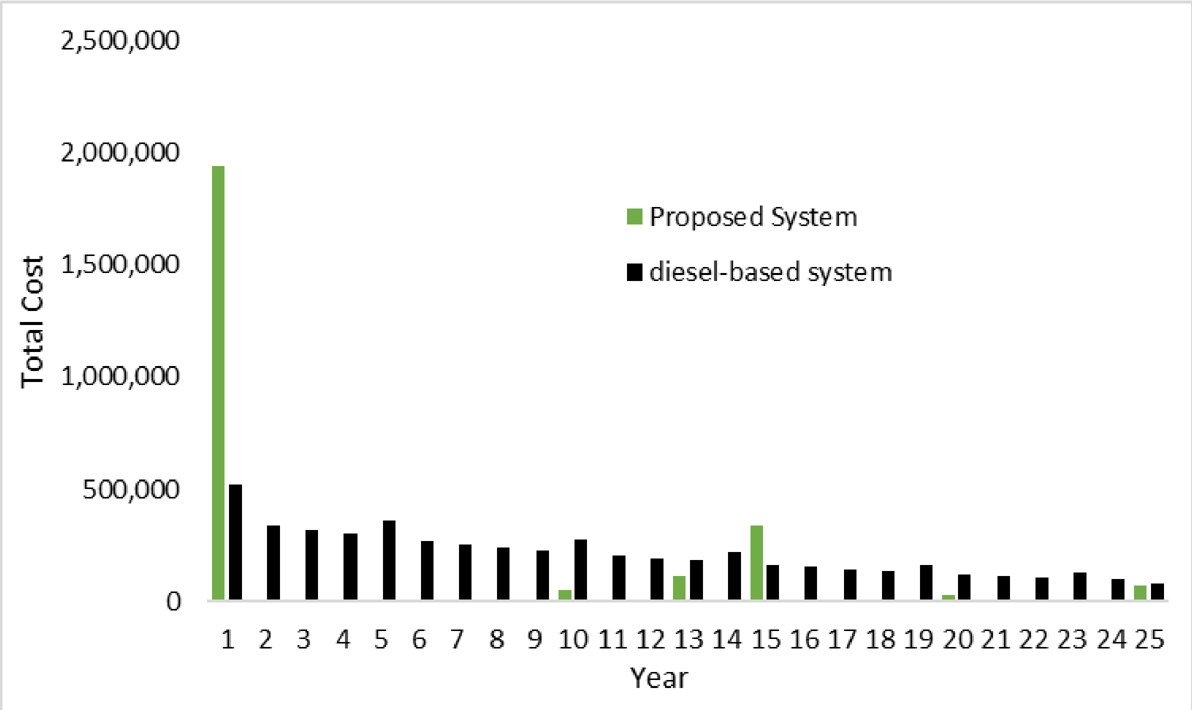


Fig AA1: Annual cash flow comparison

Appendix BB. Payback Sensitivity Analysis

The payback period and the return on capital investment of our project is very sensitive to many interconnected and interdependent factors which must be considered. The financial evaluation of our green Hydrogen system does not just depend on the system components capital costs but, the trend of the fossil fuel prices and subsidies as well as the regulatory and energy policy. The payback period sensitivity of our project on the Hydrogen system components capital costs and the Diesel fuel prices are plotted in Fig BB1.

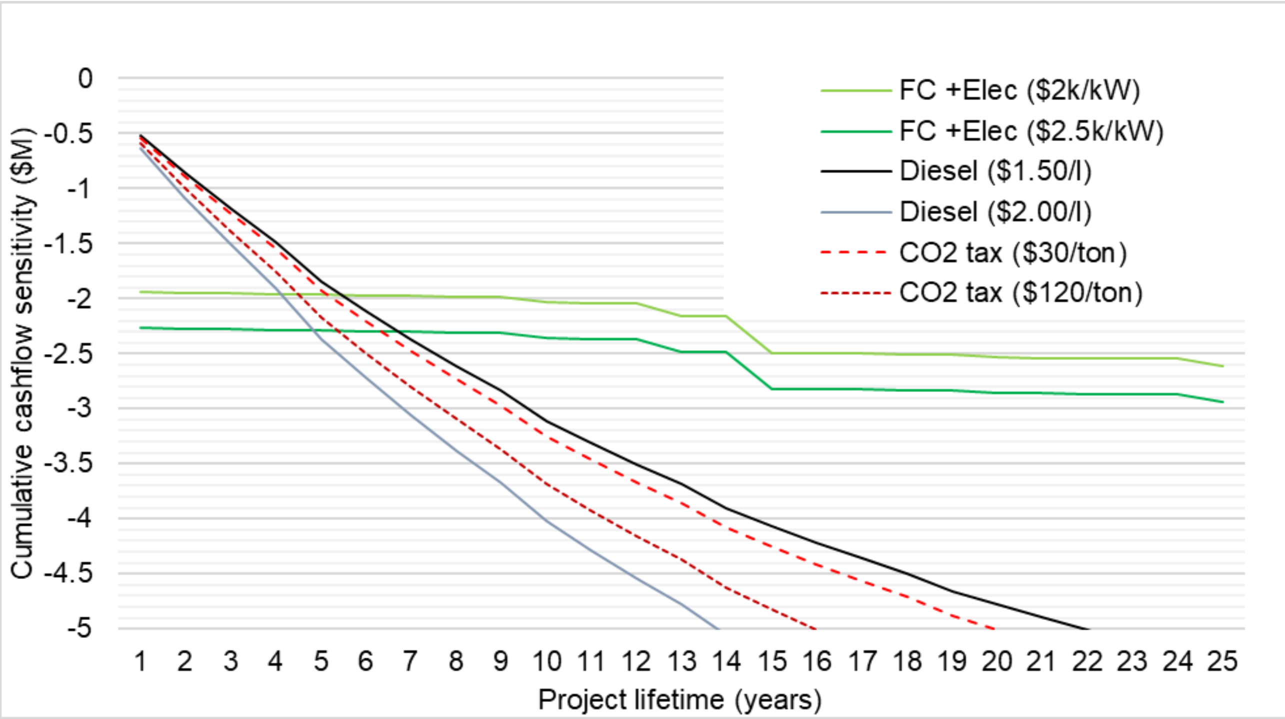


Fig BB1: Payback Sensitivity Analysis Graph

Moreover, the payback of the capital investment in our project affected by the Carbon emission penalties i.e. Carbon tax scheme. The more Penalties for polluting the less time required for investing in our project to payback.

Appendix CC. Water System Evaluation

The condensation system (ref to Fig 4), preliminary calculations revealed that at 20ºC temperature difference; a 100 m^3 of air at 40ºC and 27% relative humidity contain 2.5 litre of water. Australia's climate is characterized by having the highest temperature (average 42.2°C) and the highest absolute air humidity (6 g/kg) in December/January. We assumed an efficiency of the condenser of 80% shown as "Water condensate L/h" blue line in Fig CC1 below.

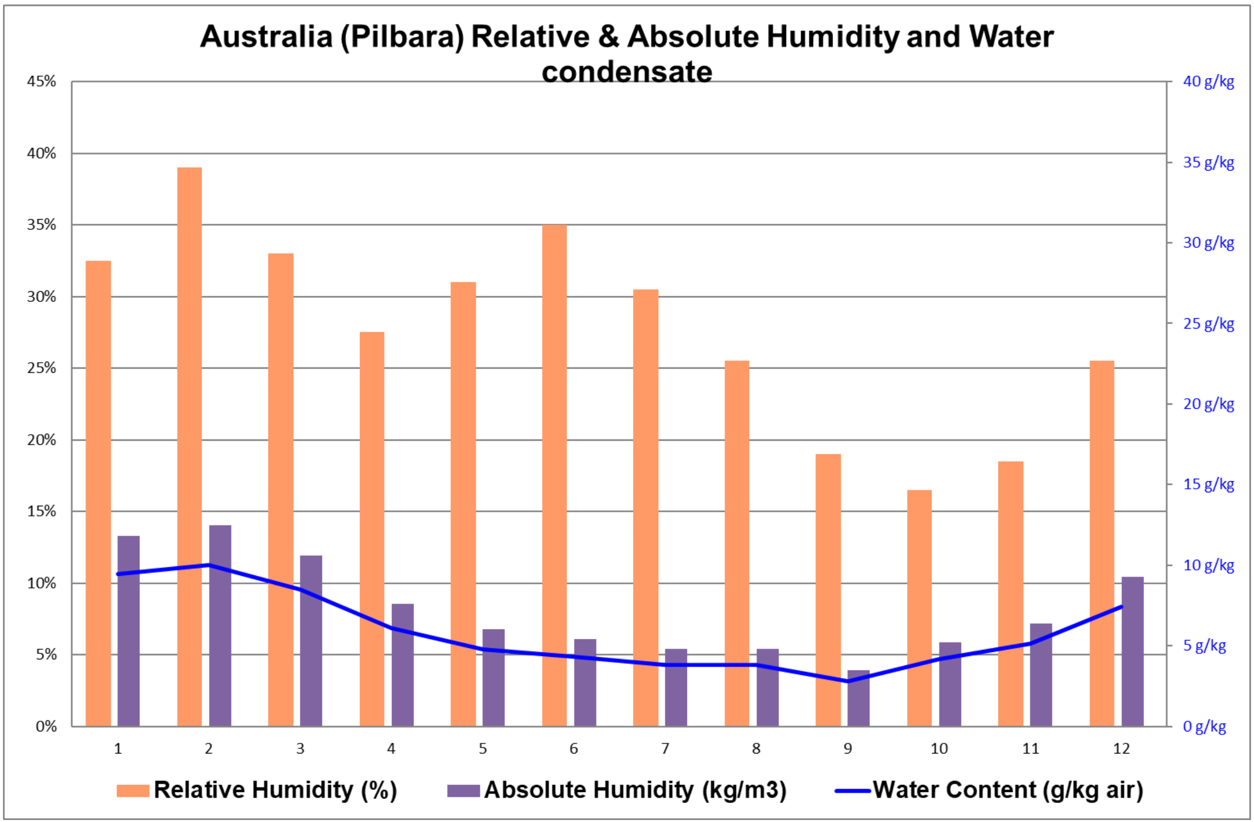


Fig CC1: Australian (Dampier) Relative & Absolute Humidity and water content

We have assessed the concept of humid air condensing for water reclamation form within our electrolyser system using the cooling capacity from expanding the Hydrogen and Oxygen gases produced to feed the condenser, using energy that otherwise would be lost.

While this process is inherently inefficient, i.e. more energy intensive than seawater desalination with Reverse Osmosis, it contributes to precious water capture on a local level and improves the electrolysis water efficiency of the entire project when water is unavailable in the isolated or remote area.

Adding a Reverse Osmosis plant to the Project will require an increase in installed capacity of the dedicated PV system (solar reverse osmosis desalination). The engineering design of this system is in the next scope of this proposal. The rainwater tanks can reduce the water desalinated from the aquifer.

Appendix DD. Suppliers and Sub-Systems Review

Supplier List

Table DD1: List of major Power to Gas to Power component manufacturers

Components	Suppliers
Solar PV	REC, SunPower, LG Solar etc.
Fuel Cells	HyTech, Siemens, Nel Hydrogen, Hydrogenics, McPhy
Electrolysers	Nel Hydrogen, McPhy, ITM
Solar powered desalination technology	Water Source, Hitachi, OsmoSun
Battery	Samsung, Tesla, LG Chem
Hydrogen Storage	BOC (Linde Group), Air Liquide
Condensation technology	EnExio

*All Suppliers are subject to further analysis and are context dependent. The list is given as an example.

Sub-Systems Review

Table DD2: Examples of similar systems around the world

Similar systems (Mature technology)	Details
Engie/Schneider (Singapore)	Semakau Island - Off the coast of Singapore, an island is becoming a full-scale laboratory for the deployment of an autonomous energy network, a multi-energy microgrid – and hydrogen is a key element.
CNX Construction (Thailand)	Thailand-based development company CNX Construction is set to debut the world's first 24-hour, solar-powered hydrogen storage multi-house complex.
HDF Energy (French Guiana)	The CEOG scheme consists of a 55MW solar park and 140MWh storage station based on hydrogen which, according to the project developer, enables the storage of large amounts of energy for long periods.
Nilsson Energy AB/AT Solar (Sweden)	RE 8760 is to show how the storage of renewable energies can make them usable all year round. The generated solar power is stored and converted into hydrogen. It can also be conserved over long periods and used to recharge fuel cell vehicles during the dark winter months.
ARENA/South Australian Government (Australia)	Neoen Australia Hydrogen Super hub – Crystal Brook energy park Neoen Australia's 50 megawatts (MW) Hydrogen Superhub planned at Crystal Brook is envisioned to be the world's largest co-located wind, solar, battery and hydrogen facility.

Appendix EE.

The Big Vision

A vision of shining green hydrogen stars for future prosperity and a better lifestyle for the world. The concept is world changing in that it can contribute to the world by putting energy and water needs in the control of the country, create wealth, contribute to achieving SDG and COP 21 goals. The idea can be adapted to many types of settlements creating opportunity and creating a cleaner, pollution free world. It can be applied in many types of settlement and has wide-ranging positive benefits for society, the environment and business.

Milestones