SOLAR HYDROGEN TURBINE ELECTRICITY

Submission

Introduction

The reactive effect of climate change questions the efficiencies to produce clean renewable energy from **wind, solar** & **hydro** installations.

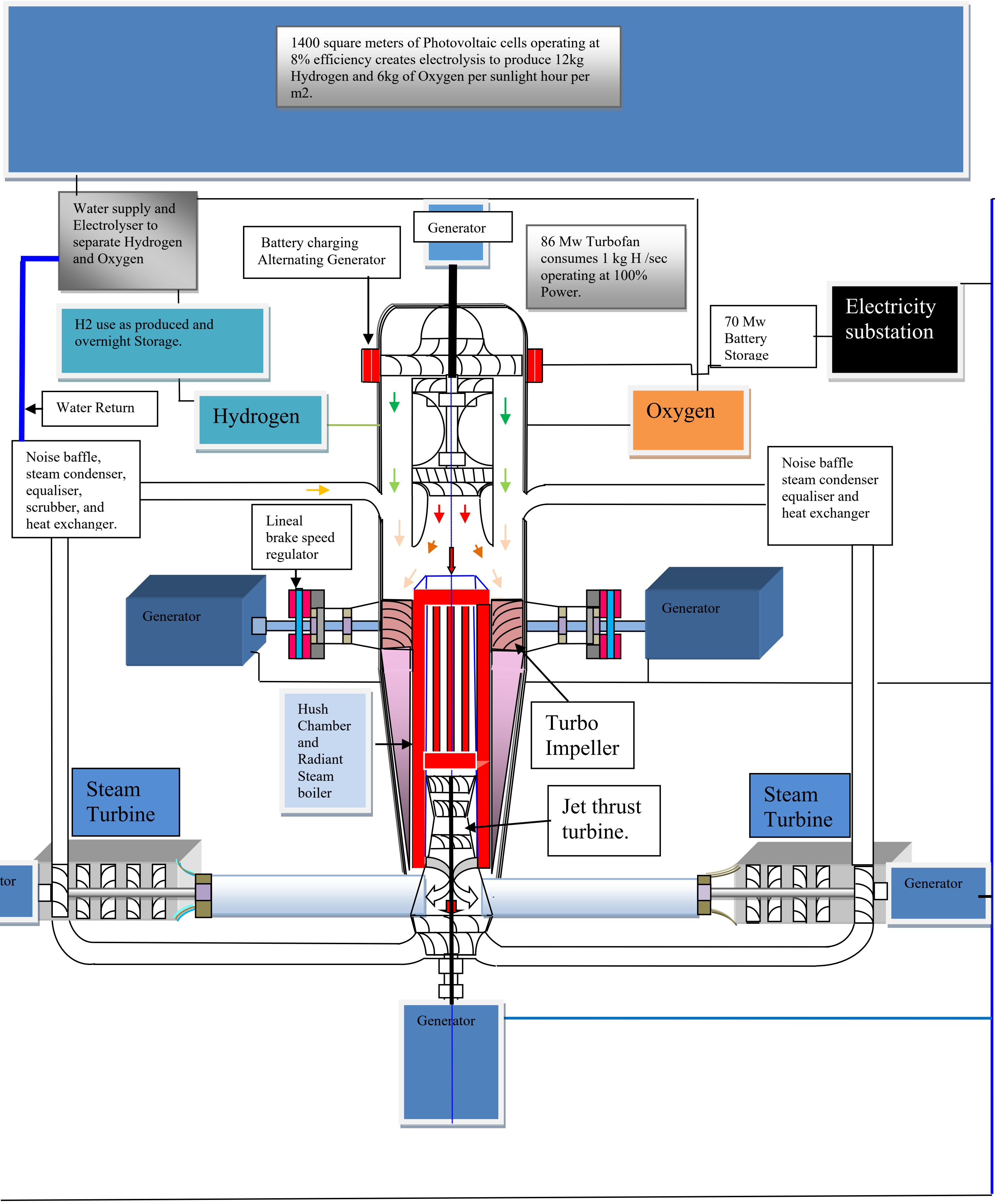
The present system has revealed systematic failures resulting in cost over runs, inability to meet targets, energy rationing, over-development, visual pollution, loss of amenity and congestion caused by curtailment requiring *Renewable Energy Zones* to link renewables which allows energy markets to demand inflated green energy prices creating inflation and cost of living pressures resulting in a short-term gain for a long-term legacy.

These failures have triggered a change in thinking, a Paradigm shift to evaluate the advantages of a **Solar Hydrogen Energy Recovery Gas Turbine** and reset how electricity and underground delivery can be provided more effectively as compared to the supply methods and industrial problems that plague Gas, Gas Fracking, Hydro, Grid Feed Solar farms, and Wind Turbines. These inefficiencies and mounting resistance are now calling for the construction of **Nuclear Reactors**.

Reportedly in 2019 the cost for a 440Mw Nuclear plant was Au $2.5 Billion requiring a 40 Hectare footprint. Maintenance for Nuclear safety is costed at $200 million for each 100Mw generating one gigawatt. A 2Mw land-based wind turbine cost $4 million. Maintenance $48,000 pa requires a 17-Hectare footprint with a noise level of 105dbl at 50m. A one Mw Solar Farm and services reportedly requires approximately 5 Hectares costed at $1,36 million and $15,000 per Mw for maintenance.

In comparison, an 86-330Mw Solar Hydrogen plant is costed at $36.5 million, maintenance $0.2 million pa and operates at 60dbl at 60m from an area the size of a football field.
Green Hydrogen produced from 1,400 square metres of electrolysing solar panels and *Variable Frequency Generators* produces sufficient fuel and overnight storage to power the turbine for a 24-hour/365-day period while direct grid feed from the same solar panel area can only generate during sunlight periods a maximum of 301 Kw/Hr at 40% efficiency.
The package plant as shown in the following diagram uses off the shelve technology to harvest the suns nuclear fusion to produce Hydrogen and Oxygen to fuel the most efficient and reliable energy generator the Hydrogen Gas Turbine.

Solar Hydrogen Electricity Generation (nts)



Advantages

1. No operational Carbon footprint.
2. Eliminates the need for gas fracking.
3. Not operationally dependant on consumable natural resources.
4. Uses existing shovel ready off the shelf technology.
5. Can be refurbished and fully recyclable.
6. Produces genuine and constant renewable energy.
7. Addresses fuel storage for renewables non-generation periods.
8. Variable Frequency Generators under turbine operation, manufactures "*use as produced*" hydrogen.
9. Exceeds Solar, Wind, Coal, Gas and Nuclear capabilities for less cost and greater efficiency.
10. Hydrogen fuel produced from renewables to power gas turbine electricity generation is a bankable product.
11. The EROI (*Energy Return on Investment*) part is satisfied.
12. Package convenience to strategically place at pole and wire grid conversion points.
13. Meets Distribution Standard for design and construction of Kiosk electrical substation and switching station.
14. Balances output to avoid intermittent energy interruption with remote aircraft reliability when grid supply cannot service energy demands.
15. Strategically locatable as a package plant where base loads occur.
16. Avoids the need for "*Renewable Energy Zones*" currently requiring a reported 28,000 km of environmentally damaging, visually polluting and amenity destroying poles and wire.
17. Reignites the feasibility of replacing poles and wires with underground transmission to avoid intensifying lighting strikes and storm damage caused from climate change.
18. Manages congestion caused by curtailment affecting 80% of the National Energy Market.
19. Variable Frequency Generators also function as *Synchronous Condensers* to maintain grid stability congestion by supplying reactive power on demand.
20. Addresses energy security risks.
21. Addresses existing generators in congested areas from becoming financially unviable because of differential pricing.
22. Balances loads to allow for a congested relief market caused by curtailing to trade with unaffected generators.
23. Safeguards against the grid becoming a strategic target in the advent of Australia becoming involved in a military conflict.

24. Reduces the vulnerability of the Energy Grid becoming a target for criminal or rogue state hackers.
25. Safe Nuclear Fusion can produce Hydrogen for an estimated five billion years.
26. Mining of known Uranium reserves is estimated to have an eighty-year reserve.
27. Exceeds the Australia Federal Governments clean energy and renewable projects 2050 net Zero commitment.
28. Solar Hydrogen qualifies for Carbon Credits.
29. Modern construction methods for Gas Turbine installations reduce operational noise to 60dBL at 60m.
30. Comparably, sixty-seven Installations developed on forty hectares of land will exceed the electricity output of China's Three Gorges Hydroelectric scheme.
31. Futuristic concepts such as Plasma Harnessing, Electric Plasma Jet Engines, Super Collider technology and Nuclear Diamond batteries remain uncertain as to cost, development sustainability, or reliability.
32. The Snowy Hydro Scheme provides the perfect platform to install 18 **Solar Hydrogen Energy Recovery Gas Turbines** covering 9 Hectares by retrofitting existing Hydro plants to produce 6000Mw using the existing transmission lines and infrastructure.
33. Prevents Australia from becoming a dumping ground for foreign polluting countries industries to obtain carbon offsets from wind and solar farms.

Precis

The feasibility of a **Solar Hydrogen Energy Recovery Gas Turbine** package plant without going into the explicit technicalities of a purpose design can be demonstrated by a simple hybrid example, being an extract from the working design which uses off the shelf technology to generate genuine renewable green energy using an infinite fuel source, hydrogen, that is produced from the sun's Solar Fusion.
According to the CSIRO Australia's usable sunlight irradiance has the highest solar coverage of any continent.
Solar coverage is measured by Global Horizontal Radiator and Direct Solar Irradiance measurements.

The hybrid example comprises commercially available Solar Photovoltaic Cells, Hydrogen Gas and steam turbines, industrial turbochargers, Industrial Electrolyser, and electrical generators.

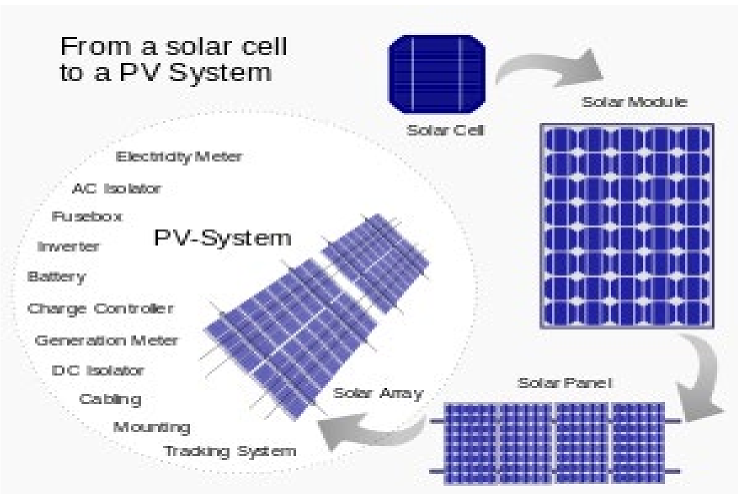
The world's total power generating capacity in 2018 was according to the IEA estimated at 22,315TWh and estimated to increase by 3.8% PA.

The largest electrical power generating plant is reportedly the Japanese Kashiwazaki-Kariwa Nuclear Power Station having an electrical output 0f 8,212 Mw generated from five 1,100Mw and 2 1,3,56,Mw electrical generators

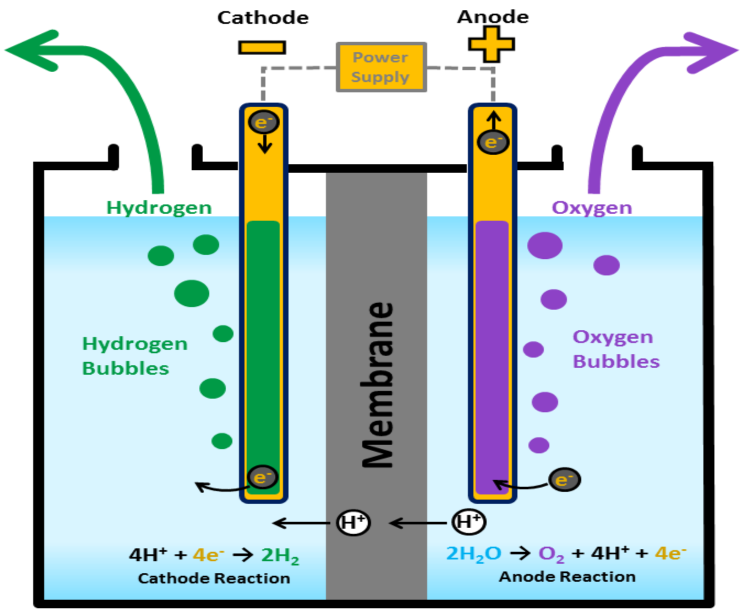
A Solar Gas turbine is best suited to service the current and increasing needs as the turbine's resultant energy is not only proportionally operated to meet its energy demands but more importantly its fuel is carbon free and renewable, equipment can be refurbished, readily maintained by stage isolation without decommissioning and has an end-of-life recycle plan.

The concept has a significant advantage over conventional electrical generating Natural Gas turbines in that the operational thrust and unwanted heat generated from the peak power band, instead of being vented as waste is harnessed in a closed loop recovery design to recover waste and amplify energy from 86Mw up to 330 Mw. A package plant can be operated on a parcel of land as small as a football field with noise level as low as 60dBL at 60m.
The design is compact, draws on proven historical technology that is enhanced with Artificial Intelligence to deliver a fully recyclable platform with a genuine sustainable outcome for the natural and built environment.

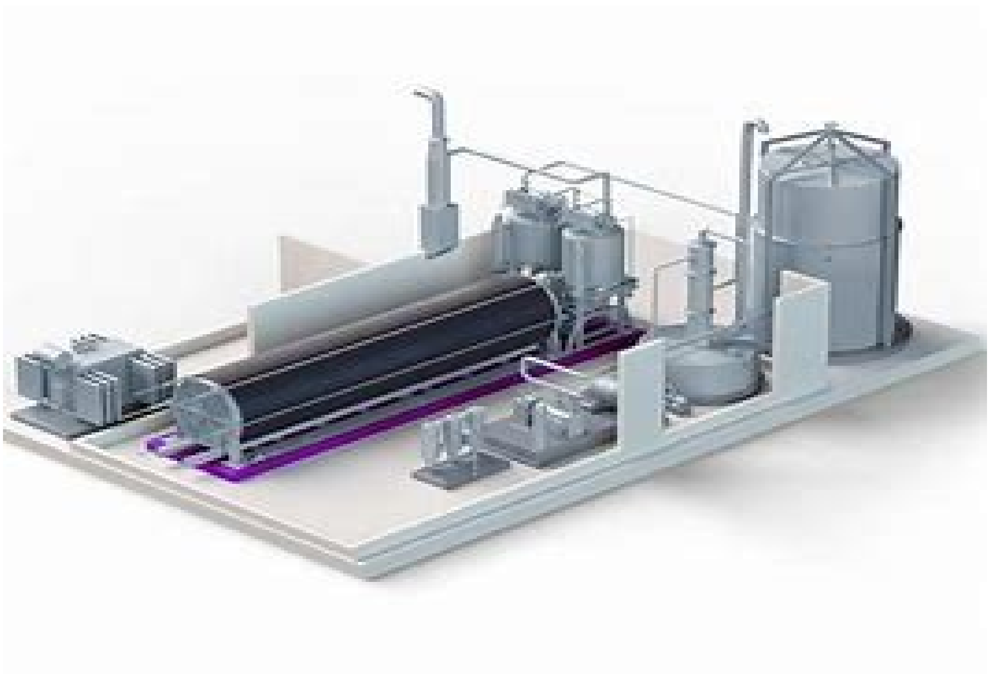
The technology for Gas turbine electricity generating developments and Solar Hydrogen farms already exists. They have been individually constructed in isolation but never combined. The present operational designs for gas turbines leave significant room for improvement.



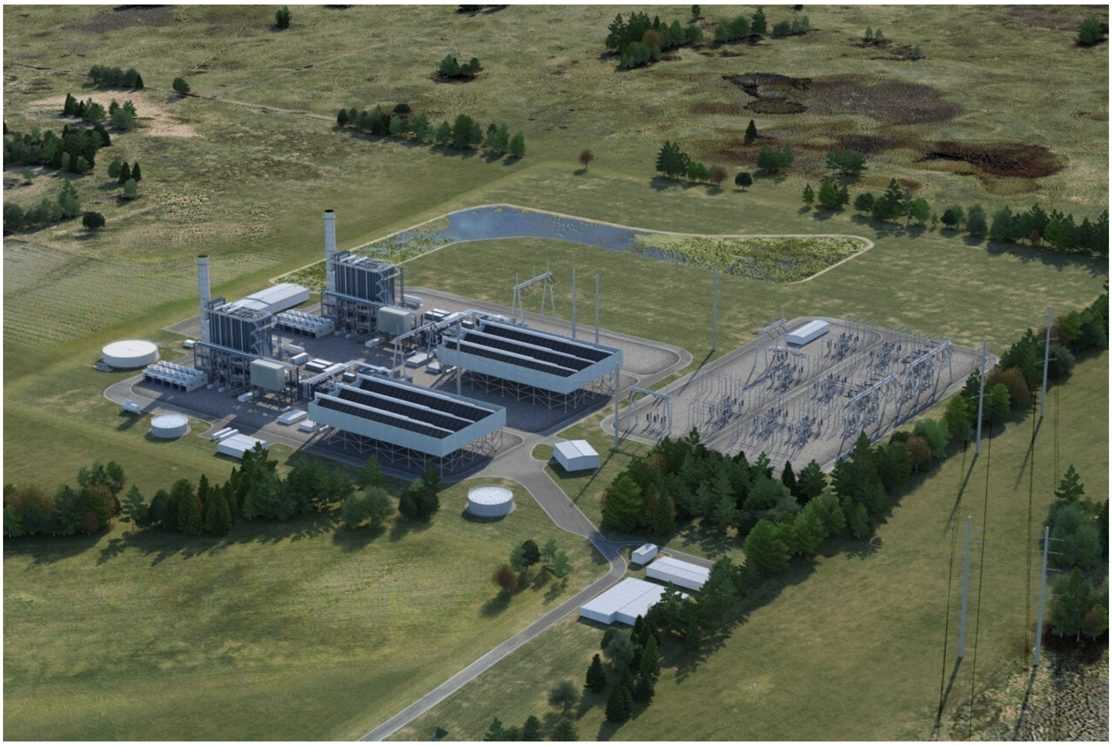
SOLAR CELL



ELECTROLYSIS



INDUSTRIAL ELECTROLISER



Gas Turbine Plant

Solar Hydrogen Plant

Process

Gas Turbines are the forerunners to turbofans which are synonymous with modern aircraft propulsion.

Land based Gas Turbines are currently used to generate electricity from greenhouse producing natural and fracked gas supplies.
Expended but recoverable exhaust thrust and heat from the present-day technology is traditionally by-passed and vented as environmental impacted waste which creates noise and amongst other, releases NOx and Carbon Dioxide. Certain types of Gas turbine incorporate heat recovery steam generators but are only capable of operating between 25 and 35% efficiency due to the BTU.

The Hydrogen Turbofan concept has a significant design advantage over conventional gas turbines as the waste stream is not only harnessed and controlled as recovered energy but more effectively it can be used with controlling variable vanes in a closed loop process to control heat and thrust with calculated efficiency. Turbofans are fuel efficient and quieter because they produce significantly less exhaust noise with greater exhaust thrust.

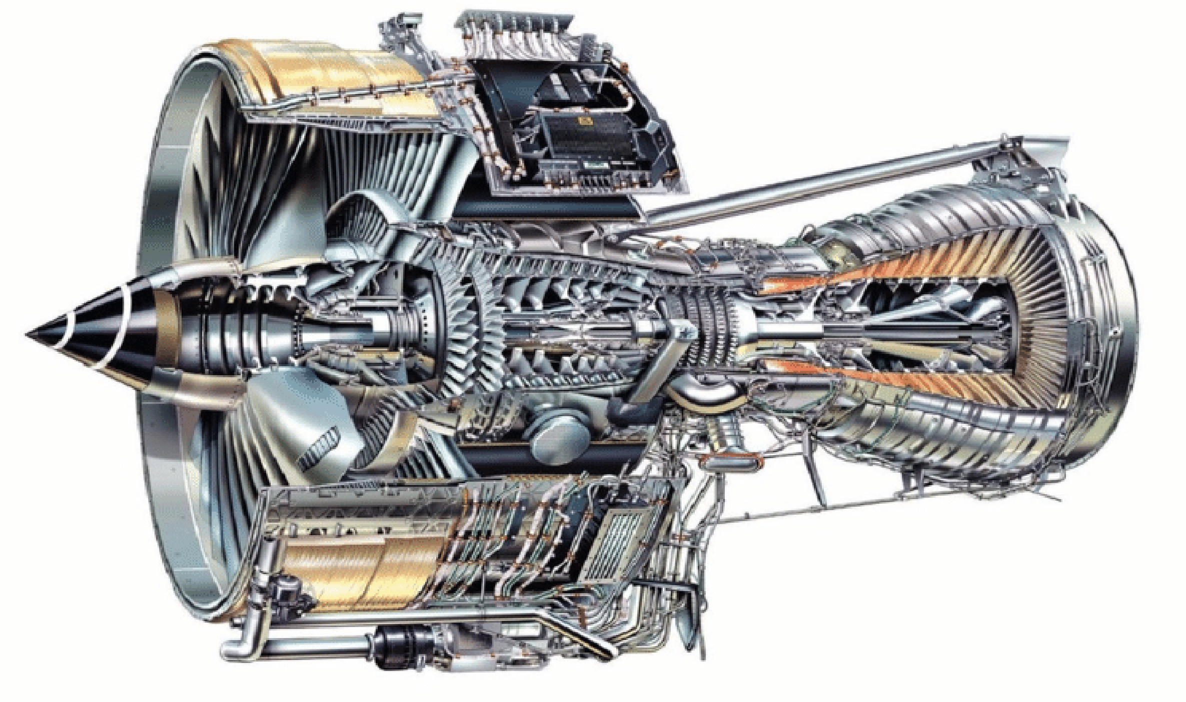
Comparably, operational procedures that aircraft technicians deal with daily are essential for safe reliable air travel. The development of modern aerospace Hydrogen fuelled Gas Turbines have gone through significant developmental stages to overcome technological developments that are problematic for aircraft, However, when used for land- based operations to generate electricity rather than propel aircraft the air-based problems become land-based energy solutions.

Energy produced from sunlight and in turn Hydrolysis to produce Hydrogen has progressed from roman times to amongst other researchers, Albert Einstein being awarded the noble peace prize in 1921 for explaining the *photoelectric effect* being a forerunner to modern solar panels.
Presently, Photovoltaic solar cells are being underutilized and affected by congestion. The industry is now asking for subsidy and contributing to the over-development of operational land when they can be used more efficiently in minimal concentrations to create electrolysis for hydrogen production rather than direct grid energy feed.

Modern turbine engines are the most efficient and reliable power plants used today. When used with magnetic bearing technology and Oxygen by-pass injection, service intervals can exceed 80,000 hours.
The cost of certified aircraft turbine engines is high. However, these costs are significantly reduced when airworthy certification is not required.

The Gas Turbine selected to demonstrate the feasibility is the Rolls Royce "*Trent*" Turbofan 900 that powers the A380 Airbus.

The Trent's success as is other turbines measured by its developmental successes.
The "Trent" Turbofan because of its rigorous experimental and testing is today a modern marvel of science, technology and engineering that unassumingly serves its assignments with remarkable efficiency and reliability.



TRENT 900

The "Trent" 900 aviation certified engine reportedly costs Au $25 Million, (uncertified $8.2 million) weighs 6.5 tonne, measures 5.4 m long and 3.0 m in diameter. The Turbine is rated at 86 Mw at an operating efficiency of 51% and consumes aviation fuel at 1 Kg /sec at 100% operation. Maximum thrust range is 374Kn exhaust temperature can reach 1700 C with exhaust speed exceeding 2000Kph.

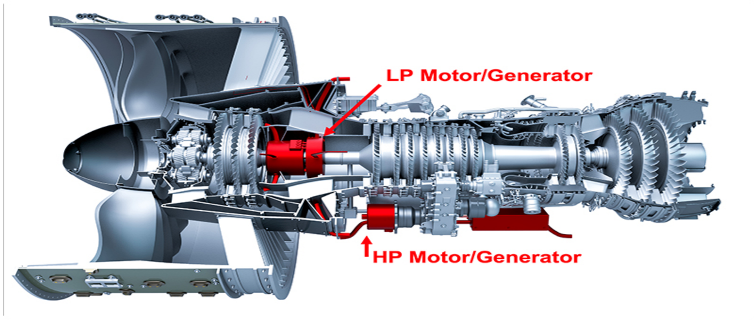
(Theoretically, Thermoelectric energy harvesting is possible by generating voltage from temperature gradient above 1700 C.)

(The GE 9X Turbofan is rated at 112 Mw has a thrust capacity of 490 Kn, air certified list price is $41.4 million.).

The turbine has a reported service life of 37,000 cycles equivalent to 14 years of continuous operation. The turbines service life for aircraft includes factors for multiple bird strikes and fan containment. Complete air certified refurbishment is reportedly US $7 million.

The noise level for the Planetary gearbox design is so whisper quite that the manufacturer has demonstrated a mobile phone conversation taking place next to a fully operational test engine at full power. This design will power the next generation aircraft.

An added advantage is that Turbines for reliable aviation purposes are equipped with *Variable Frequency Generators* up to 1400Kva amps as shown in the following diagram.
The generators are equipped with powerful efficient compact high frequency switching solid state circuitry that generates DC power for whichever frequency is optimal for the application and allows the required power to be generated more effectively.
In effect an operational Turbine produces its own renewable energy.
These generators can be used to serve a dual role. Firstly, as *Synchronous Condensers* to maintain grid stability and manage congestion by supplying reactive power on demand.
Secondly, their production of voltage during turbine operation is used in multiple series to generate *use as produced* hydrogen based on the equation that electrolysis requires a minimum of 1.229 volts to create 285 watts/hr. Electrolysing between 39 to 50 watts/hr is sufficient to create one litre of Hydrogen and 0.5 litres of Oxygen.
(The Faraday constant of electrons is 1 amp flow for 1 second to create 1 *coulomb (F=Le)* establishes the quantity of electricity.)



VARIABLE FREQUENCY GENERATORS

In the example selected, non-operational components for essential air travel can be excised from the redesign. This combined with a geared Turbofan planetary gearbox allows fuel consumption and noise to be significantly reduced as the calculations are based on the variation of an aircraft mass exceeding six hundred tonnes being accelerated through the atmosphere. Without an equation that can calculate mass and velocity together the capability of the engine for sole electricity power generation is significantly optimised.

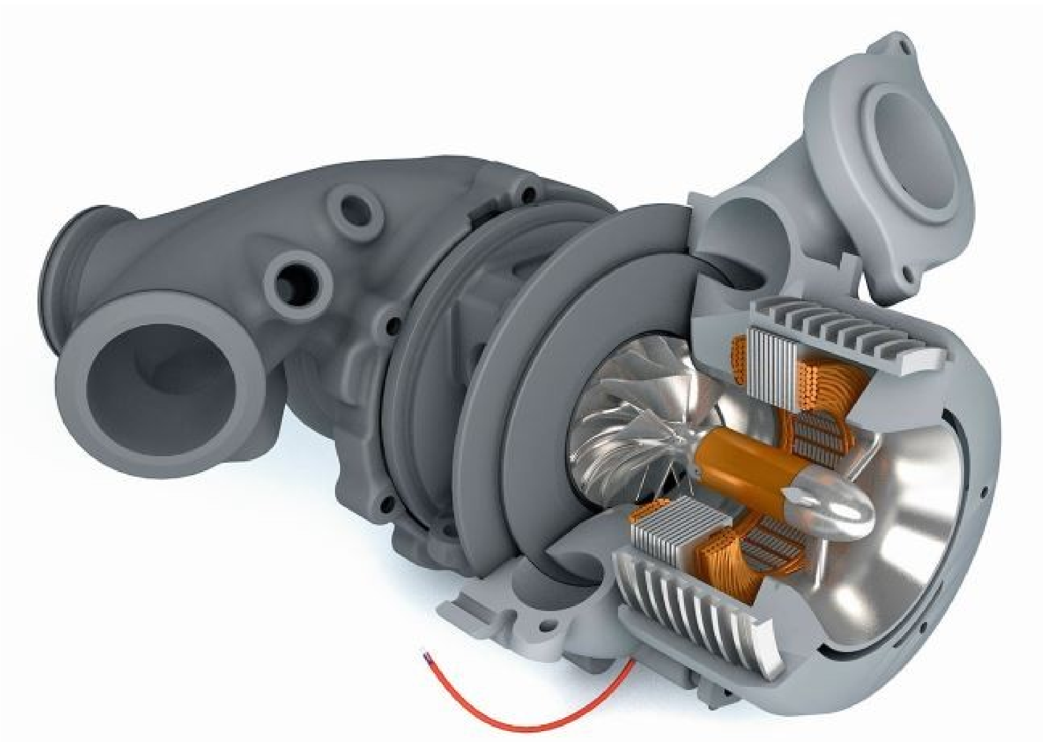
In addition, Hydrogen fuel is rated at twice the BTU of aviation fuel and approaches 90% efficiency to convert thermal and thrust power to electricity.

In comparison the equation used to convert coal fired thermal power to electricity is calculated at 33% based on the following formula.

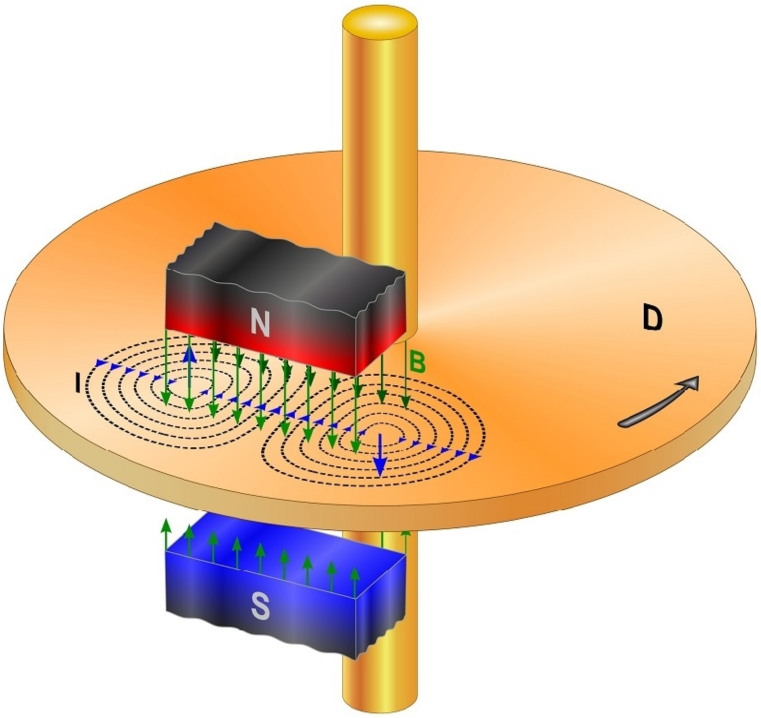
3 MT produces 1 MWe with heat and thrust being vented as waste.
A more exact Calculation can be gauged by $W = \Delta K + \Delta U + \Delta E_{th}$
where W can change Δ=a systems potential energy (*K*=Potential energy) (*U*=Thermal energy) (*Eth* = any combination of the three) or W=Fad (W=Work) (F=Force measured in Newtons) (d=displacement)

The following images gives a perspective of the auxiliary operational equipment to meet the concepts objectives.

INDUSTRIAL TURBOCHARGER

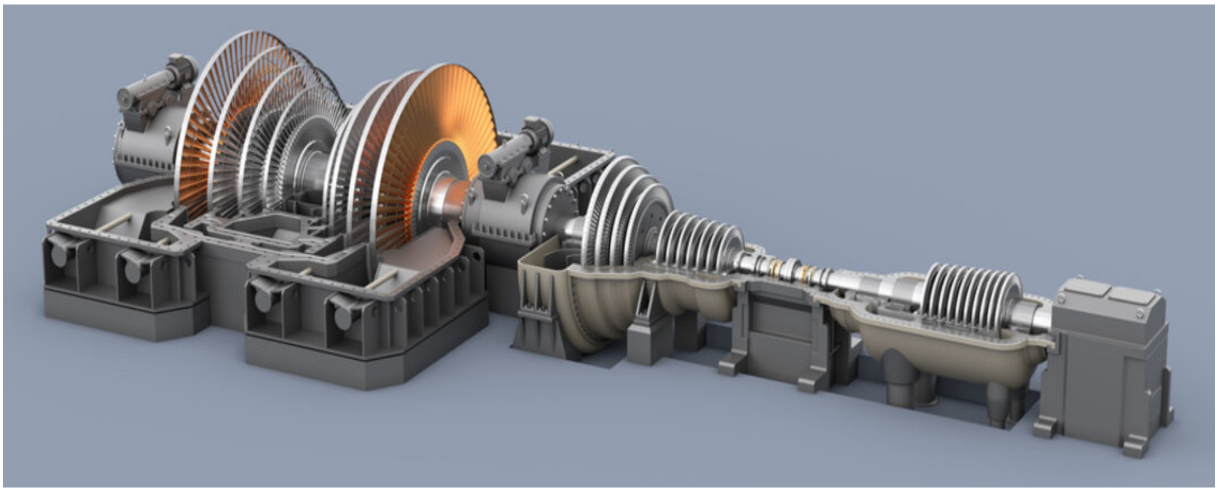


CUT AWAY TURBO CHARGER SHOWING ELECTRICAL GENERATOR

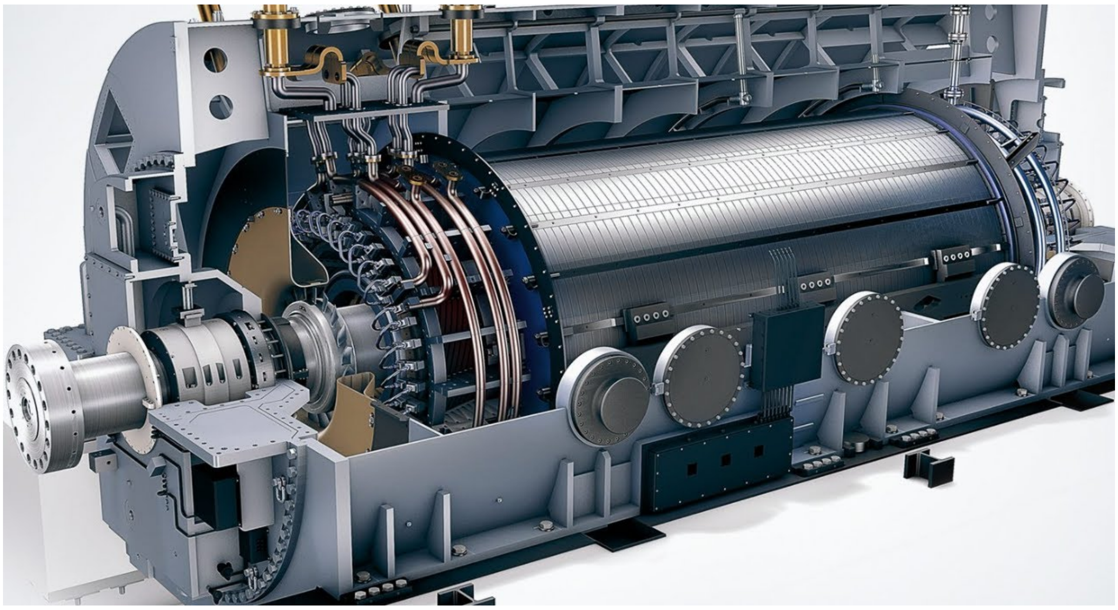


FRICTIONLESS LINEAR EDDY ELETROMAGNETIC BRAKING

RAIDIENT TUBE STEAM BOILER



STEAM TURBINE



ELECTRICAL GENERATOR

Feasibility

To assist the reader, this discussion paper refers to the following published documents in support of the concept's feasibility.

1. The Australian Government COAG Energy Council published a report paper on a National Hydrogen Strategy addressing Hydrogen support for electricity systems which coincides with this discussion papers proposal.
   The concept addresses the lack of an explicit market mechanism in the National Electricity market to value storage.

2. The US *Department of Fossil Energy and Carbon Management* turbine program has identified that using Hydrogen with gas turbine will increase the overall energy cycle efficiency approaching 80%.
   The US Government recognises the importance of Green Hydrogen produced from solar electrolysis and in 2023 announced a tax credit of $3.00 per kilogram plus investors can claim up to 30% investment tax. Other countries have similar schemes.

3 According to a research paper produced by GE dated February 2019 an equivalent stand-alone Gas Turbine the 6F-03 being operated without Turbo fan and without energy recovery was capable of 87Mw.
   The peer reviewed report substantiated Hydrogen calculations for the 6F-03 turbine that reportedly place the heat output at 857GJ/Hr, Hydrogen (H2) flow rate 78,000M3/Hr requiring water at 68M3/hr and requiring Electrolysis power of 3,600 GWh to supply 100% H2 flow for 8,000hrs.
   The published report concluded that hydrogen fuel produced from renewables to power gas turbines and generate electricity was a bankable product.

The similarities of the 6F-03 turbine varies significantly from the "*Trent*" concept in that it makes no provision for recovered water through the closed loop recycle condenser nor does it consider energy recovery from the Variable Frequency Generator, resultant heat to produce steam nor utilisation of the resultant thrust energy from the turbofan to amplify the power output.

To remove any doubt that the 330 Mw concept is feasible from the "Trent 900" example, consideration only needs to be given to the availability of the GE SDF -D250 Steam turbine that has a 100-300Mw Non reheat capability up to 140 bar/565 C including the STF D650 200-700Mw with reheat up to 190 bar 585 C. Cost range in 2023 for a turn key generator package is reported between US $670 to $1,149 per base Kw but proportionally reduces as Kw increase, The life span exceeds 50 years. Both steam turbines are operational within the Gas Turbines Maximum heat range of 1,700 degrees Celsius.

The problems that have held back Solar hydrogen Turbine development is that gas turbines are traditionally noisy and historically, hydrogen fuel is volatile, not suitable for long term storage and can affect metal parts that are incompatible for the purpose.
Modern Turbofan construction with its unique “Boomerang” shaped blades and planetary gearbox have not only overcome the noise problem but also the development of materials such as third generation single crystal material and thermal barrier coatings such as *Ceramic Matrix Composites* has overcome metal and heat incompatibility which address Hydrogens unique molecular properties.

The modelling includes bypass storage for converting the gas to liquid for short term storage including battery and in operation storage for electrolysing to compensate for periods when sunlight is not available.
As a back-up, sustained energy is also available when the individual turbines are not in use as energy stored in optional batteries and the solar cells photovoltaic process can still feed into the grid for isolated linked electrolysis purposes to allow loadings to be balanced from strategic conversion points.

(Emerging technology such as Titania Ceramic photoelectrodes and shadow photovoltaic developments are poised to significantly increase the efficiency of solar panels. Current day solar cells have a 40% efficiency but only 8% has been adopted for this modelling.)

(Earlier research going back decades established that Hydrogen can also be produced in vast quantities at room temperature without energy input, using any source of water mixed with a catalyst comprising three parts of gallium to one part aluminium [3:1 composite.] The gallium removes the aluminium oxide coating to produce aluminium nanoparticles that strips the oxygen from water to leave Hydrogen.
Aluminium waste is easily sourced; Gallium is more expensive and less abundant but can be recovered and reused without losing effectiveness.)

(A more recent development is using catalytic electrodes and perovskite solar cells fused together in a single unit. Immersed in water under sunlight creates hydrogen.)

The advantage of selecting a modern Hydrogen Turbofan as compared to an industrial gas turbine for use in a closed loop operation is that operational noise is significantly reduced, the turbofan provides

additional by-pass thrust and governs temperature control, aviation fuel can be replaced with hydrogen fuel which was the originating fuel used in the development of the Gas Turbine and Oxygen produced from the electrolysis process can be used as a combustion catalyst to increase the engines efficiency.
In addition, a Hydrogen Gas turbine package plant is a natural selection to avoid the "*Renewable Energy Zones*" required delivery systems that include Synchronous Condensers, Compensators and Power Flow Controllers including the newer technology relating to Grid Forming Convertors.
A particularly important oversight is that any *Renewable Energy Zone* by its very expansion will become a strategic target in the advent of Australia becoming involved in a military conflict.
There is also the increasing risk of the Energy Grid becoming a target for criminal or rogue state hackers. This cybersecurity threat is heightened because *Renewable Energy Zones* can only be operated with above ground vulnerable compensated delivery systems. The more Complicated the system the more vulnerable it becomes.
If climate change is to be taken seriously than underground transmission becomes the responsible option to address the long-term problems.

Another safeguard for continuous operation is a turbofans ability to continue to operate even when subjected to adverse environmental conditions such as blizzards and freezing temperature, earthquakes, hurricanes, hail, dust, bushfire and water inundation. Turbines will also continue to operate even when inundated with Volcanic Ash providing the turbine's operating temperature is maintained below 1100 C to prevent silica fusing onto the turbine blades and nozzle guide vanes.

Stages.

1. **Stage 1**. Rated under Standard Test Conditions (STC) and based on an irradiance of solar fusion at 1000w/h per square meter, a solar array of photovoltaic solar cells measuring 1,400 square metres (37.5 x 37.5m=823 solar panels using direct current 12 volt (generates 24-48 volts) off the shelf electrolysing technology produces during average daylight a target range of 12kg of Hydrogen and 6kgs of oxygen per square metre/hour. Electrolysing at just 8% efficiency using natural water without a catalyst is sufficient to produce enough Hydrogen including overnight storage to power an 86 Mw gas turbine for a 24-hour 365-day period.

During turbine operation the *Variable Frequency Generators* generate *use as produced* Hydrogen to supplement the solar panels electrolysis.
Overnight storage is achieved with by-pass Hydrogen Fuel during irradiance periods.
(Comparison-823 electrolysed solar panels used at 8% efficiency produces sufficient fuel to generate 330Mw. Direct grid feed from solar panels is only 301Kw at 40% efficiency.)
(Solar Panel size 1400/ 1.7x1.0=823 panels 823/18= 45x6.6=301 kw)

2. **Stage Two**. Hydrogen derived from the electrolysing process powers the turbine and direct axial connection generates 86 Mw at 51% of the engine's efficiency.

   (Being a three staged system, the proposal can work as a standalone turbine operation or converted to an energy recovery operation utilising thrust and steam energy.)

3. **Stage Three**. The resultant thrust from the turbine's combustion process and turbofan bypass air spins another two turbines using the same principals as a combustion engine turbocharger. This process can produce up to 86 Mw of power as the resultant thrust is at the peak of the engines power band to drive the front mounted axial connected generator and because there is no mechanical connection all thrust is converted to electrical generating torque. The gas turbines optimal rate of spin is between 2500-4500 with an exhaust speed approaching 2000Kph. The resultant jet thrust is controlled by "*Frictionless Linear Eddy*" electromagnetic braking technology to govern rotation speed of the Turbo chargers without the need for a variable regulating gearbox.

4. **Stage Four**. Radiant heat from the jet stream produces steam as the turbine exhaust approaches 1700 degrees Celsius. This operating temperature when calculated using the "Rankine cycle," water can be heated to the required constant 275C at 50 bar, and with bypass turbine thrust assistance is sufficient to produce enough energy to work two 55 MW steam turbines between 47% and 60% efficiency. (The same technology used in coal fired and nuclear power stations.) The steam flash area contained within the Radiant Tube steam boiler is not only used to generate steam to drive the steam turbines but also acts as the primary "Hush Chamber" to quieten the jet stream.

   The advantage of using Turbofans for steam generation is that the thermodynamic efficiency increases as the average temperature of the cycle can be kept in a constant isentropic state governed by the amount of fuel used. This process becomes more efficient when using the by-pass thrust from the turbofan to control the thermodynamic efficiency via regulating variable vanes to control temperature and capture bypass thrust as recovered energy.

5. **Stage five**. Turbofan bypass air not only regulates the temperature for steam flash but also merges with the remaining jet exhaust thrust as recovered energy to drive a final rear mounted 48 Mw radiant heat turbine. (There is also capacity to incorporate an additional rear mounted *free turbine power shaft* to drive an additional 20Mw generator) This uses the same principals as the steam turbine the only difference is that steam is replaced with jet exhaust. This has a two-fold purpose. The radiant heat turbine not only slows the direct air velocity from the jet stream but also acts as a secondary dampener by harnessing the turbines noise and converting the noise to harnessed energy to further quieten the jet thrust. The remaining bypass thrust is fed via turbine impellers to assist bypass steam and aids in the depletion of turbine thrust. Operational pressure is equalised and regulated by fail-safe industry pressure relief systems.
   (The final drive can be set up in series to run multiple thrust generators based on the same design principals used in Hydro, Coal, and nuclear installations)

6. **Stage six**. By using the "*Pre Cooled Jet Engine*" principal the dissipating radiant heat and steam travels through heat exchangers to condense and distil water vapour not only for reuse but also to pre cool and further quieten the exhaust air before equalising air pressure is redirected back to the engine intake where oxygen obtained as a by product from the electrolysis process is injected into the fuel stream to increase the engines efficiency and significantly extend the engines service life beyond the 80,000 hr service interval.

Costing

For comparison, a new "*Trent*" 86Mw air worthy certified Turbofan including air worthy operational control equipment costs up to US 25 million dollars. (adopted for the purpose of costing)
(With the same reliability but without airworthy certification the turbine cost is revised to 8.2 million.)
Auxiliary equipment is costed at $7.8 million. Facility and infrastructure at $3.7 million. ($7.6 for retrofitted Hydro platform)
Total 36.5
For a pilot installation, 20% or 7.3 million is added as a contingency and 5.7 million for research and development. Total 49.5 million.

(Equivalent to the cost of thirteen 2 Mw Wind turbines or 0.13% of a 12 Mw Offshore Wind turbine)

In consideration of the Federal Governments extraordinary funding for renewable energy without a guarantee of meeting the Zero Emission target or claimed energy supply, continuity or end of operational life decommissioning, Solar hydrogen turbine electricity has the attributes to deliver a continual guaranteed supply at a sustainable cost that is well below the current ideology investment for solar, wind and hydro.

There are 5 Major Companies that build Turbo Fan Turbine Engines. They include *GE Aerospace, General Electric*. *Rolls Royce*, *Pratt and Whitney*, and *Safran*.

There are two major companies that build Gas Turbines specifically for electricity generation and include *Siemens Energy* and *GE Gas Power.*

Ten Major companies build Steam turbines for electricity generation. They include *Dongfeng Electric corporation Limited*, *Harbin Electric Company Limited, GE Power, Toshiba Energy Systems and Solution Corp, Shanghai Electric Group Co Ltd, Doosan Enerbility Co Ltd, Siemans AG* and *Mitsubishi Hitachi Power Systems Ltd.*

Companies that build Industrial Hydrogen Electrolysers include *Linde Plc, Air Liquide International, Messer Group, Air Products and Chemicals, Reliance Industries Ltd, Cummins Incorporated, Parker Hanifin and Hydrogenics.*

As previously mentioned, to gauge the concepts feasibility, the world's largest Hydro Electric dam, China's Three Gorges Hydro scheme is compared.
The Hydro Scheme cost US 26 billion dollars to construct in 2012. Its thirty-two turbines have a reported generating capacity of 700 Mw each for a combined 22,400Mw. The turbines cost US 50 million dollars each. The water storage area to generate the energy is approximately 1036 square kilometres. The wall is 181 metres high and spans 2.3km.

On present day costings a Solar Hydrogen Energy Recovery Gas Turbine equal to China's Three Georges Dam would require sixty-seven installations including 307x307 (94,300) square metres of solar panels operating at 8% efficiency taking up a combined land area

less than 40 hectares to produce the same energy for under US $2.5 billion.

The decommissioned Liddell Coal Power Station in NSW generated 2000Mw. The land area occupied is in Square Kilometres.
6 Solar Turbines with 100x100 square metres of solar panels occupying 3 Hectare would produce the equivalent output.

The Snowy mountains Hydro Electric Scheme constructed prior to present day technology is reported to have a generating capacity of 3800Mw. It has an operational area of 5,124 square kilometres, includes sixteen dams, 8 km of aqueducts, 145 km of tunnels and 1600 Km of roads and railway tracks. Its transmission capacity is 4100 Mw.
Comparably 12 Solar Turbines with one hectare of solar panels covering a 6 Hectare footprint would produce the equivalent output.

In September 2023, the Federal Government using the CSIRO Gen Cost modelling claimed that it would cost 387 billion dollars to construct seventy-one small Nuclear Modular Reactors generating 300 Mw each to service Australia needs.
The per capita cost is quoted at $18,167 while Large Scale Solar is quoted at 1,058 per Kw and onshore wind turbine at 1,989Kw.
The required land footprint for Nuclear is 2,840 hectares.

In comparison an 86- 330Mw Hydrogen Gas Turbine installation is costed at $36.5 million with a guaranteed 5-billion-year supply of Nuclear Fusion.
The 330 Mw solar turbine equivalent for Nuclear is sixty-five installations for $2.4 billion but only requires an operational footprint of thirty-three hectares.

Based on the projected cost of solar hydrogen to energy proof Australian without gas or coal dependency it is very important to note that the Federal government's decision to cap Gas and Coal in December 2022 is currently costing the Australian Taxpayer between $1.5 to two billion annually to subsidise carbon emissions being the very source that is claimed to be driving climate change and natural weather disasters.
$1.5 billion would fund 62% of the required Solar Turbines to service Australia's energy needs.

If the cap is kept the compensation will increase but if lifted the consumer price for energy will inevitably increase as will inflation by 0.5%.
This is a perfect lose-lose scenario for the environment and taxpayer but a perfect win-win double for the governments consultancy advisors who provided the decision-making feedback to the Federal Government from market providers on behalf of multi nationals.

According to the Gen Cost report just one 300Mw Nuclear plant is costed at 5.4 billion, construction time 12 years but there is only 80 years supply of known minable Uranium reserves.
Two cost prohibitive and unproven projections predict extraction of Uranium from sea water to supplement minable reserves and *Fuel Recycling Fast Breeder Reactors* which theoretically will generate more fuel than is consumed is possible in theory but must be relegated to future advances.
At present Uranium, just like oil, has a finite supply and if history repeats itself without achieving the theoretical projections, then Uranium depletion with certainty will lead to global conflict as supplies are used up and demand increases.
In 2021 the reported cost to maintain a nuclear reactor is $200 Million per year based on each 100-megawatt output producing one gigawatt per annum.

The examples of green energy under development strongly shows a vast cost disparity with little to no certainty of costings or guaranteed continuity of *Firming* for power output.

Systemic blow out costs for green projects such as *Snowy 2.0.* was proposed at $2 Billion to produce an added 2000Mw when construction commenced in 2019.
Snowy 2.0 is using Carbon Offsets based on Snowy Hydro confirming that its renewable energy procurement program contracted 888Mw of wind and solar facilities in 2019.
The offset does not appear to include the upstream construction carbon footprint of a 2 Mw Wind Turbine installation quoted at 1,688 tonne.
The projects operational land disturbance footprint is quoted at 620 hectares, requires two Double Circuit 330Kva overhead transmission lines cutting 10 Km through the Kosciuszko National Park, requiring a 120-metre-wide easement. The project is predicted to generate an estimated 50 million tonnes of CO_2 during construction.
The environmental impact includes the production of 14 million cubic metres of excavated material with an unacceptable proposal to dispose of

7 million cubic meters of contaminated tailings including asbestos into either Talbingo or Tantangera Reservoirs.
The projected cost has now exceeded $12 billion for a projected seven-year build and latest estimates is expected to exceed twenty-nine billion over 10 years which will make the project cost prohibitive.
Despite claimed technological advances for Snowy 2.0 being a closed system relying on cheaper green energy to pump water uphill to a reservoir battery then releasing the water to drive the water turbines when peak energy is required will still result in inefficient use of pumping energy as it takes more energy to pump water uphill than it can generate for flow downhill.
There is still no certainty that wind or solar panel generating capacity will be available when required and based on past natural disasters there is no guarantee to future proof Hydro against climate change including the 11year sun cycle which ends in drought and bushfire and commences with flood.
History has shown that Hydro dams are a prime military target.
The expenditure and environmental impact compared to an equivalent Solar Hydrogen package of six installations without the need to acquire carbon offsets and covering an operational land footprint of 3 Hectares using existing transmission lines with natural disaster protection for a cost of $219 million dollars raises fundamental questions.

According to the 2020 *Levelized Cost of Energy* estimates per MWh the following costs were quoted.

- Solar $35 to $110.
- Wind $40 to $60
- Geothermal $50 to $80
- Nuclear $55 to $164
- Natural Gas $59 to $100
- Coal $60 to $112
- Natural Gas Peak $175
- Storage $132 to $189

Solar Hydrogen has a target production cost of $2 kg which places fuel costs (excluding oxygen for "*Pre-Cooled Jet Engine*") operating at 100% and 51% efficiency for the purpose of the exercise at $12,960 hr to produce 330 Mw ($39 per Mwh).

Carbon Market

Carbon Offset was designed to help consumers counteract the impact of expected or future emissions by investing in projects that counteracts the carbon burden by funnelling proceeds into renewable energy sources such as Wind Solar and Hydro. Carbon Credits in 2023 are trading between $40 to $80 per metric tonne. Carbon offsets are trading at around $ 3 to $5 per metric Tonne.

Solar Hydrogen qualifies for genuine Carbon Credits and Carbon Offset income with a net zero operational carbon footprint which is an added safeguard against Australia becoming a dumping ground for wind and solar farms including Hydroelectric projects to enable polluting industries to "*Greenwash"* their activity by securing Carbon Offsets to increase their pollution levels.
A good example is a foreign owned coal producer investing in Australian renewables such as wind and solar farms including Hydro to offset its extraction intensification and increase its carbon footprint.
This is relevant to a term known as *Stranded Assets* and covers a failure for carbon markets to adjust investment in line with the emissions target required to limit global warming.
There is a growing concern that points to systemic failures of the voluntary market as the carbon market is being flooded with millions of tonnes of poor-quality credits where polluting companies can set an *ambition* and because this is not binding to reduce carbon emissions, they are in fact being used to increase their emissions with the aid of offsets which is responsible for accelerating global climate change.
The sole purpose for Carbon Credits was to make it more expensive for regulated industries to pay for the carbon units they emit and disincentivise future emissions.

Estimates by BP put electricity generating costs per Kwh installed at Au700 for gas /coal fired plants and $4,700 for wind generated electricity.

To show the income cost variation including pointing out the current overuse and underutilisation of Solar Panels the following cost comparison used in this paper can be interpolated based on 1m2 of solar panels and electricity consumer cost of $0.30Kw/h.

Source	Expenditure	Return
Solar panel	1.0m2 X 0.35w/hr x 30cents Kw/h	= $ 0.105c hr
Hydrogen	1.0m2 X 12kg/hr X $2.00 Kw/h	= $ 24.00 hr
Turbine	1.0m2 X 86Mw/hr X 30cents Kw/h	=$ 172.00hr
Turbine /Steam	1.0m2 x 330Mw/hr X$0.30cents	=$ 660.00hr

As of July 2021, there were 4,800 Wind turbines in Australia producing 9,690 Mw. Excluding environmentally damaging installation and unsealed service roads generating dust levels, each installation with bushfire clearance protection and extensive chemical use to control vegetation regrowth requires 17Ha per installation.
Each Turbine/Generator reportedly costs Au $4 Million dollars and with regular maintenance costing an average of $48,000 pa has a life span of 120,000 hrs or 13.6 years.

Studies undertaken into the US West Texan windfarms using satellite data between 2003 and 2011 investigated the impacts of wind farms on land surface temperature.
These studies concluded that wind farms are adversely affecting climate change and causing atmospheric temperature to rise as wind turbines convert kinetic energy into electricity.
In doing so the rotating turbine blades being higher than the surrounding natural features draws the warmer ground surface into a cooler atmosphere and because of heat convection the process is not reversed by drawing cooler air to the ground which causes warming of the atmosphere.
The compounding problem is related to the geographic locations for wind farms requiring the turbines to be placed in special patterns to suit the geography so that the turbine blades can collect distributed wind energy more effectively.
According to the studies the uplift caused by the rotating turbine blades is causing atmospheric warming which is the very conundrum the wind turbines credentials are trying to prevent.
An observation as to how the height of wind turbines above the natural features affect the isotropic proficiency of natural temperature variations between ground and atmosphere can be observed in the tree lines that are naturally cropped.

The proposed offshore wind farm projects will allow wind turbines with capacity ranging from 12 to 18 Mw with projected operational and installation costs approaching $400 million each. The offshore projects are costed at $3,720 per installed Kw. The power factor is represented by the following formula P=0.5pv3. (*Power being equal to ½ the air density X wind velocity cubed and the radius squared*.)
The size of the largest wind turbine the H260 18Mw turbine has been compared to the size of an A380 Airbus however, an overlooked factor is that the A380's four engines produce 344Mw, has an operational life of 14 years a new plane costs $446 million and weighs 600 tonne

Another comparison is the proposed Illawarra offshore Wind farm that is projected to cost $10 billion to produce 2,000Mw.
The propensity for offshore turbines to also increase air temperature is connected to the extended height of the offshore turbines and global warming of sea water temperature.

The largest Gas Turbine is reportedly the 500,000 bhp *GE Harriet* that can run a 600Mw steam power plant. Its maximum noise level is 92.5 dB at the inlet plenum. Its fuel capacity caters for 681,000 litres of liquefied natural gas. Development cost was estimated by GE at one billion dollars. Its Maximum power output can cause severe grid instability.

An 86-330Mw Solar Hydrogen gas turbine installation is costed at Au $36.5 million dollars requires 0.50 ha of land and the turbine has a minimum maintenance free period of 80,000 hours and 14-year continuous life cycle operating at 51% efficiency. Unlike the GE Harriet the 86-330Mw turbofan design with aircraft efficiency effectively balances energy loads and protects against grid instability.

Comparably, just 86Mw of wind turbines requires forty-three installations costing $172 Million, a land area of 731 hectares without a guarantee of a constant wind supply with an efficiency rating quoted between 20 to 40%.
The offshore 12 Mw equivalent is twenty-eight installations costing $11.2 billion which is more expensive than Nuclear.
The carbon manufacture and commissioning comparison weight for a 2 Mw land based Wind Turbine installation is quoted at 1,688 Tonne. The *Trent* 900 86 Mw turbine is 6.5 Tonne.

In addition, wind turbines and solar farms require *Renewable Energy Zones* comprising a reported 28,000 Km of overhead poles and wires costed at $10 billion to prevent congested areas from becoming financially unviable because of differential pricing including the balancing of loads to allow for a congested relief market caused by curtailing to trade with unaffected generators. This aspect and decommissioning have not been factored into the total operational costs for Wind and solar.
(Allowing for a hypothetical error factor of 400% and excluding energy recovery capability would still make the Solar Hydrogen package a more viable and economic proposition to wind turbines.)

Environmentally wind turbine fiberglass blades are toxic, cannot be recycled, can only be disposed to land fill, visually polluting, amenity destroying, subjects prime Agricultural land to resumption. high mortality for birdlife, governed by wind conditions and prone to damage from cyclonic conditions, land footprint and isolated dependant, bushfire prone requiring clearing and highly dependent on chemical use to control regrowth, A major bushfire fault requires turbines to be placed on top of escarpments which is the Achilles heel for bushfire attack. Turbines can also present a hazard to aerial bushfire fighting aircraft due to bushfire smoke reducing visibility to the turbine structures. Requires all weather dust producing unsealed service access roads and have a noise level approaching 105db A.

Solar panels have the potential to be recycled as the panels are reportedly 75% Glass 10% Polymer, 8% aluminium 5% silicon and 1% copper. There is also 1% of heavy metals such as Lead and tin which prevents the panels from landfill disposal.

It is planned in 2022 to install another 21,845 wind turbines. This coupled with the increasing uptake of agricultural land for solar panels and the controversial proposal for ocean-based wind turbines has collectively made Solar and Wind renewable farms environmentally damaging and unsustainable.
There is also an emerging question concerning a reported Deed Rate Return agreement with Multi Nationals that allows an undisclosed financial benefit paid by the taxpayer even if power is not generated from the installed wind turbines.

Reportedly the Australia Federal Government has committed $25 Billion Dollars for clean energy and renewable projects for 2022-2023 to meet the 2050 net Zero commitment requiring a reported additional 28,000km of visually polluting and environmentally destroying power lines. The unilateral takeover of targeted land needed for the installation is meeting increased resistance.
In 2023 The Institute for Public Affairs released a study report entitled ANALYSIS OF LAND USE BY VARIABLE RENEWABLE ENERGY PRODUCTION BY 2050. The study examined four possible scenarios and quoted sixty-eight million hectares, equivalent to 9% or the size of ten Tasmania's would be required to transition to renewables.

Australia's electricity generating capacity in 2021 was estimated at 188.6 Terawatt hours. One Terawatt hr can reportedly fully service 70,000 households for a year.

According to Siemens Energy in Dec 2023 the demand for renewable energy sources for grid stabilisation technology will require an investment of at least US $21.4 trillion by 2050 to support a **Global** net zero trajectory.

In November 2021, the Australian Government released a joint media report claiming three million homes have Solar Panels that provide 7% of Australia's total energy needs. As of December 2022, there are reportedly 3.36 million PV installations in Australia generating 29.7 Gigawatts.

Solar panels are available in 12-, 24- and 48-volt configurations.
In operation a 400-Watt solar panel has a voltage range of 44 to 48 volts for a 12 Volt panel, 88 to 96 volts for a 24-volt panel and 176 to 192 volts for a 48-volt panel.

Ohms law formula V=IR where V is the voltage, I is the Current and R is the Resistance.

Excluding commercial installations, the 2016 Census estimated there are 8.3 million dwellings in Australia with an average of 100,000 constructed per year.

Using daily average energy consumption for dwellings at 18 Kw/hr, just one 86Mw turbine plant utilising energy recovery can power 18,000 households.

(It is acknowledged that the costings are subject to change based on emerging technology, inflation, and currency rates. The following simplistic equation does not take into consideration that hydrogen has twice the BTU of standard fuel nor has there been a saving factor included for the added *Pre-Cooled Jet Engine* **efficiency principal, increasing solar efficiency from 8% to the present-day efficiency exceeding 40% or carbon credit and offset eligibility)**

COSTINGS ESTIMATE 330 Mw plant.

Facilities and infrastructure (one off) (9-year life span with optional 5-year contingency Av 4.05 million per year)	**Au $36.5 million**
Hydrogen production per annum	$**4.73 million**
Overheads and operating costs per annum	$**1.7 million**
Preventative Maintenance	**$0.2 Million**
Running costs per annum	$**2.1 million.**

Expenditure total 45.23 million

9-year Annualised Total 12.78 million PA

Income (18,844 homes averaging $1,212 per quarter) **$91.35 million PA.**

Based on these figures and excluding Carbon Credits the EROI (*Energy Return on Investment*) component is Satisfied.

(Note: *Variable Frequency Generators* operating DC current can also be used to charge Optional Battery storage. This is costed at $0.8 Million per Mw. Construction costs break-even excluding battery storage is based on a 7-month return. 70 Mw battery storage is 3 years.)

OVERVIEW

Environmental Issues.

Noise.

Modern aircraft turbine noise at take-off and full power approaches 140dba at 50m. Jet exhaust noise is caused by the violent turbulent mixing of the exhaust gasses, influenced by the shearing action caused by the relevant speeds between the exhaust gas and atmosphere. Shock waves will occur unless governed to prevent the exhaust velocity from exceeding the speed of sound.

Advanced technologies are shovel ready to control noise. For example, the same technology that makes the inside of an aircraft cabin silent to its passengers such as the A380 Airbus, four Trent 900 turbofans at take-off power is measured at a maximum of 69.5 decibel. The same technology is to quieten the turbines operation to the environment is simply reverse engineered. In addition, the high quality of balancing rotational forces, land based "*hush channel*" with damping and added energy recovery, noise cancelling equipment and vibration suppressant mountings like that used in jet engine testing facilities can also reduce operational noise levels to a modern factory environment equivalent to sixty decibels at sixty metres. Additional noise reduction measures include turbofan with planetary gearbox and changing the pattern of the exhaust jet to include diffusing outlets surrounding the main jet stream without efficiency loss. The achievable turbine noise reduction level is significantly less than a modern coal fired electricity generating plant, or nuclear reactor workplace level of 85-90 dB or a 2Kw wind turbine which generates an operational noise level of 105dB at 50m.

Water.

There is no operational water pollution caused by either hydrogen combustion, steam generation or the electrolysis process. The benefit of recovering water vapour for recycling from the hydrogen combustion process and steam condensing system treats water to a pure condition by distillation for reuse.

Air.

Because hydrogen and oxygen are the primary source of fuel there is no carbon production as hydrogen reverts to water after combustion and sustains a zero-carbon footprint. However, Hydrogen combustion will create NOx.

NOx also occurs naturally during lighting events and during extreme bushfire events due to the extreme heating and cooling process.

In copious quantities NOx is dangerous to the environment including human health which is attributed to lung damage, breathing and respiratory problems. NOx is formed by endothermic reaction such as hydrogen being burnt at a gradient temperature of 1,350 degrees Celsius. Above this temperature gradient, NOx disassociates into its atomic state. The primary source of NOx caused by combustion comes from the ambient air itself as Nitrogen and Oxygen react together under elevated temperature.

To eliminate NOx formation from hydrogen fuel, research has determined it's as simple as slowing down the rate at which the fuel and air mixes. This is a design known as lean burn technology which is incorporated into modern Turbofan gas turbines.

Diffusion flame will also avoid the formation of NOx.

In the advent that NOx is formed to a natural detection level accepted as 25 PPM it would be either neutralized by the operational exhaust heat above 1,350 degrees Celsius and arrested in the closed loop scrubber process. Other available control methods include selective catalytic reduction, lean NOx traps and exhaust gas double burn recirculation.

Safety

Hydrogen fuel just like any other fuel is by its nature explosive. Current technology has addressed storage problems and developed storage

methods that enable it to be stored and contained in the same manner as fuel is stored for automotive use which makes it no more dangerous than standard fuels.
An added safety supply and associated storage hurdle is to use the fuel at the point of production to enable a use and replenish operation to compensate for periods when electrolysis is less effective.
Theoretical pressure explosions from sources such as hydrogen leakage, sabotage, natural disaster, military threats including internal and external environment sources such as fire, gas and rotational failures have been considered.
In the unlikely but possible advent that fundamental Construction shielding, automated fire suppression and industry pressure fail safe shut down relief mechanisms were to fail causing an explosion then the insulating encasement of the turbine, steam generating facilities and gas storage becomes the last line of defence which incorporate a construction design to allow any explosion to vertically vent to prevent horizontal pressure damage.

Benefits

Gas Turbines were invented in the 1930's and originally designed to run on Hydrogen Gas. Hydrogen is still the most efficient fuel for gas turbines and are simpler to build and operate than conventional aviation fuelled jet engines.

A significant advantage of hydrogen turbine use is its package convenience that allows the units to be constructed using today's technology. There is also the minimisation of complexity associated with distributed energy resources connected to the Grid such as the small-scale generators.
In addition, it addresses the Architecture and stability for distributed energy resources including the *Global Power System Transformation Consortiums* primary interest, being for the rapid decarbonisation of the power sectors. Unlike Hydro, Nuclear, Grid feed Solar farms or Wind turbines a package plant can be strategically located where base loads occur such as existing pole and wire grid conversion points to balance demand when grid supply cannot service energy demands.

One of the biggest benefits of using minimal concentrations of solar panels in geographically linked series throughout the Australian mainland for hydrogen production instead of direct grid feed is to take advantage of Australia's usable sunlight irradiance which has the highest solar coverage of any continent. This concept is intended to manage irradiance periods to prevent demand exceeding supply and avoid blackouts or energy rationing.

One of the contested problems with renewables is that they are ineffective when the wind doesn't blow, and sun doesn't shine.
According to some energy experts this is incorrect and would be overcome by linking geographically isolated wind and solar to the grid but that can only be done by constructing *Renewable Energy Zones.*
According to the AEMO there will in addition to renewables be a large demand on storage such as batteries, Hydroelectric and gas fired plants.
There is also a claim that renewables for the whole of Australia will come with a $121 billion cost to decarbonise the electricity system.
According to the Grattan institute that is an economic activity cost made up of jobs and materials however, that claim is questioned on the basis that the expenditure would be better spent on other more economic and productive energy projects.

According to the Australian Energy regulator approximately 8% of retail electricity is transmission and 35% related to distribution expenses.
The CSIRO Gen Cost report claimed that the integration of renewables will provide the cheapest form of energy based on $94 to $134 per MW /hr in 2023.
Coal was assessed at $110 to $217 per Mw/hr.
According to the NSW Agricultural Minister of the Minn's Government stated that renewables would only take up approximately 55.000 hectares.

Solar Hydrogen has not been made available for consideration in the CSIRO Gen Cost report but is costed at $39Mw/hr using existing transmission corridors and retrofitting the remaining 24 coal fired and 120 Hydroelectric platforms with sixty five Solar Hydrogen plants to service Australia's energy needs with zero carbon emissions from an operating footprint of 33 hectares and a 2023 costing of 2.4 billion.

Overhead Transmission

The modernisation of any poles and wires to service renewables should be underground not only to protect supply systems from intensifying storm events caused by climate change raising sea temperatures but also to prompt a rethink on the distribution of energy supply as should the methods that govern the consumer price paid at the meter.

The proposal to spend over ten billion dollars to unilaterally link isolated "*Renewable Energy Zones*" will reportedly require 28,000 km of

environmentally damaging lines and wire which not only socially impacts on land ownership and farmland resumed for the purpose but also destroys the amenity of the community.
The savings made by Solar Hydrogen would make it more cost effective for underground transmission which has not been a serious consideration in the costings prepared by consultants on behalf of overseas investors as the cheaper poles and wires is intended to give the investors a greater return at the cost of Australia's environmental destruction.

Overhead high voltage power lines increase the induction risk of fatally electrifying metal structures such as farm fences and metal sheds and other steel structures as these structures are predominately classified as exempt development under planning legislation and are not effectively regulated against construction under power lines with the same safeguards afforded by the planning assessment process.
There is also the health risk of increasing electromagnetic radiation from overhead poles and wires compared to underground.
Experts from the International Agency for research on Cancer (IARC) working group classified ELF-EMFs from overhead high voltage power lines as "possibly Carcinogenic to humans." by constructing an additional 28,000km that risk increases as does the risk to electricity disruption caused from solar storms such as the *1859 Carrington Event* which if occurred to the modern overhead electricity grid would be catastrophic and one of the primary reasons why power grid failures are termed as S*ignificant Risk Events.*
There is also the consideration of the increasing risk for a hostile military electromagnetic pulse which can be significantly reduced by a *Faraday Cage* protected underground transmission system.
The Solar Hydrogen proposal questions if the expenditure and environmentally damaging development of renewables is sustainable given the intensifying pushback that the high impact pole and wires, intensive solar farms and wind turbines including Snowy 2,0 are having on the natural and built environment.

Reportedly, overhead power transmission lasts for up to 70 years and underground 35 years. Cost for overhead is ten times less than underground but have a substantially higher maintenance cost. Overhead power lines use the surrounding air for insulation while underground requires thickened insulation. Overhead lines are prone to lighting strikes, mechanical impacts, falling trees, wind damage and causing bushfires. Maintenance includes extensive chemical use including the use of organophosphates and continual vegetation clearing. Power lines as do wind turbines and solar farms require environmentally destroying bush

fire buffer zones while underground is protected. Power outage for underground is halved but more difficult to repair. Low voltage is suitable for underground and above ground is suitable for both low and high voltage.
According to *Ausgrid* in 2023 it will cost consumers between $1,200 to $2,200 for 40 years to place transmission underground and cost consumers approximately sixty billion for renewables. Inevitably these costs will be passed on to the consumer,
The asset value for the electricity network in 2023 is quoted at just over $100 billion dollars. There is no available figure for overhead poles and wire maintenance which would considerably offset the cost of underground transmission.

According to the *World Economic Forum,* Climate Change attributed costs caused from extreme weather events between 2000-2019 at $16 million per hour. If Climate Change is to be taken seriously then it is economically feasible to locate all power transmission underground to future proof energy delivery against Climate change.
The latest state of the art research involves high power gas insulated underground transmission that involves very high-power capability, low capacitance, lower resistance losses, negligible magnetic fields, no aging phenomenon of the insulating system and maintenance free design which is already under development by the IEEE SA Standards Association.

The Clean Energy Council reported in 2018 there were 120 Hydro Electrical Generation stations providing 33% of Australia's Clean energy Generation. A hydro station is a perfect operating platform to construct solar hydrogen installations.

As previously mentioned, the 2023 CSIRO Gen Cost report calculated a total of seventy one 300Mw Nuclear plants would service Australia's energy needs for an estimated cost of $387 billion. Snowy 2.0 has now exceeded $12 billion for 2,000Mw.
The Nuclear equivalent of Sixty-Five 86-330 Mw Solar Hydrogen installations for a cost of $2.4 billion (even allowing for each installation to be costed as a pilot plant for $49.5 million per platform would place the total cost at $3.25 billion.)
By strategically placing linked Solar Turbine plants throughout the mainland on existing energy grid lines conversion points there is a reduced need for poles and wires. Unlike that experienced by wind turbines the units can be linked in series to sustain constant electrolysing production from existing grids because a gas turbine is capable of instantaneously bridging sudden frequency drops and operated from a

central control point by remote control with aircraft efficiency anywhere within the linked series.

Hydrogen Gas existing as a natural reserve is small because of its tendency to weakly bond with other natural elements. Being the most abundant of elements Hydrogen can be produced on an environmentally responsible commercial scale to separate it from other bonded elements.

The use of solar cells to create electrolysis from sunlight is self-perpetuating. Solar panels capture protons from the suns nuclear fusion known as proton-to-proton chain reaction which creates enormous amounts of energy as the Sun's Hydrogen is fused into Helium to create sunlight. Solar panels capture protons from the suns fusion process and creates electricity for electrolysis and releases hydrogen from its bonded elements.
This process is a far superior preference over present technologies that are reliant on the suns resultant energy to create wind and direct energy feed from solar constants that become unreliable energy sources due to intermittent disruption as the technologies without battery storage causes energy curtailment, because the energy supply cannot store its energy, nor be used outside their resultant natural energy sources which is the sole contributor to energy congestion and firming.

Using Solar Panels to feed electricity directly into the grid instead of producing electrolysis is not only self-defeating but also counterproductive as substantially more expatiating energy can be extracted from less solar panels by the electrolysing process.

Another significant benefit is battery storage viability generated from both the turbines *Variable Frequency Generators* combined with solar panels which can use bypass electrical energy available to charge batteries constantly and continually for direct electrolysing or grid feed purposes.

The closest comparison to a solar hydrogen turbine is a Nuclear Reactor. However, Uranium comes with historical problems as it requires mining of a limited resource and a purification process which produces a long lasting and dangerous by product.
While Nuclear Fission from Uranium splits atoms to create energy, Solar Hydrogen is produced from Nuclear Fusion that creates sunlight.

Sunlight fusion unlike Uranium is a purer and safer form that is available and essential for life. Natural sunlight created by the sun's Solar Fusion

produces a constant 1kw of energy per square metre with an estimated 5-billion-year supply.
Uranium supplies based on current extraction rates but excluding reserves for new online reactors are reportedly estimated to have an eighty-year reserve but carries with it, thousands of years of unsafe legacy.
According to the OECD and IAEA excluding all other uses of uranium the worlds known minable Uranium supplies is quoted at 8.74 million Tonnes. The world's total operational nuclear reactors in 2023 require 67,500 tonnes per year.

Environmental impacts from Ground fracking have also been considered as Solar Hydrogen gas produced from solar panel electrolysis will negate the need to continue extraction of Natural Gas to fire planned Natural Gas power stations or hydrogen production.
According to IRENA approximately 47% of global hydrogen production comes from natural gas and 76% of hydrogen comes from steam methane reforming of Natural gas. The Federal Government has committed $53 million in 2023 to fund gas fracking projects which is a high emitter of methane and Carbon dioxide that is predicted to raise Australia Greenhouse gas emissions between 7 and 22%.
This figure does not take into consideration the dangerous fugitive gas escapes that include *Benzene, Toluene, ethylbenzene xylene. hydrogen sulphide* and *nitrogen oxides* including *volatile organic compounds,* Fine particulate matter, and silica dust. Ground fracking has a disastrous historical environmental record because of its significant impact on water contamination, heavy chemical use to control vegetation, waste disposal and impacted land use including an inability to remediate because of the operational depth varying from 1,600 to 3,000m.
The land area and number of wells currently used for gas fracking in Australia is undisclosed but as an indicator Australia's largest gas producer Australia Pacific LNG is currently seeking approval in 2023 to frack an additional one thousand wells in Queensland.
The required operational land varies from 1 to 2 hectares but does not include additional land for infrastructure such as pipelines, unsealed access roads and storage tanks. The industry is ventured by overseas conglomerates that are driven by the largest return for the least cost which makes the Australian environment again the end loser and that will not only impact on Australia's future generations but contribute to the very greenhouse emissions that are causing climate change.

With the increasing scientific predictions of escalating climate change and global warming causing sea temperatures to rise with resulting severe storm events and perpetuated by massive land clearing and land forming for power line construction and greenhouse gas production to address the growing human population it makes no logical sense to deny the benefits of technology that exists today to sustainably produce clean economical and continual renewable energy until more proven efficient outcomes can be developed.

The reader can be left with no doubt that the technology and intellectual ability to construct the projects to achieve 100% of the renewable electricity target is achievable with solar hydrogen. It will not only future proof Australia's electricity supply but also be carbon free.
Based on the CSIRO's Gen Cost report identifying seventy-one mainlands Nuclear installations generating 300 Mw each would service Australia needs. That can be done with solar hydrogen without reliance on Nuclear, Hydro, Wind or Solar farms for less than 10% of the 2023 projected final cost for Snowy 2.0 and with its modular turn-key construction platform the projects can be done in half the time.

History has never been kind to mankind's ideological developments that produce short term gain for long-term legacies.
Unsustainable renewables resulting in environmental destruction and loss of amenity without achieving targeted outcomes or contingency for end-of-life plan falls into this category and the primary reason as to why there urgently needs to be a rethink on more efficient use of existing and proven technology.

This discussion proposal demonstrates a practical alternative solution to an economic and social world problem because the present solutions currently being employed to meet unachievable targets are based on the same ideas that created the problems.

In conclusion, the reader will readily understand the identified benefits and for the others, with the greatest respect for their reasoning, it is simply not their time.

END

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