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Process Technology for insitu Generation of Green Energy & Potable Water Without Emission of Green House Gases by Utilisation of Sunlight, Natural Water and Nano Particles (as Photocatalysts)

Tryambak De
Student, 2st Year, Dept. of Mechanical Engineering, Indian Institute of Engineering Science and Technology, Shibpur, Howrah, West Bengal, India

Abstract: *Energy, fertiliser, bio-fuels and potable water are vital input for social and economic development of a nation. As a result of the generalization of agricultural, industrial and domestic activities, the demand for energy, fertilisers, fuels,& potable water have increased remarkably, especially in emergent countries like India. These have meant rapid growth in the level of greenhouse gas emissions in the existing process of energy generation, fertiliser/fuel production , the increase in fuel & fertiliser prices, crisis of potable/drinking waters specially in coastal/desert area and requirement of organic waste management which are the main driving forces behind efforts to utilize this renewable energy/fertiliser/fuel sources more effectively, i.e. energy/fuel/fertiliser /potable water which come from natural resources and are also naturally replenished. Despite the obvious advantages of renewable energy, it presents important drawbacks, such as the discontinuity of generation, as most renewable energy resources depend on the climate, which is why their use requires complex integrated process technology design, planning and control optimization. This paper presents the current state of the art in the process technology applied for renewable and sustainable energy/fuels/potable water generation by utilising available natural resources, with a clear vision for advancement in this field.*

I. Background Information

Today's dominant technologies that harness solar energy are photovoltaic and solar thermal technologies that suffer from some serious drawbacks in storage, maintenance, space requirements, etc which calls for a better and newer approach to harness this abundant source of renewable energy, i.e, sunlight.

1 Primary disadvantages of solar thermal and photovoltaic technologies

a For storage of thermal energy in solar thermal technology uses molten salts which are corrosive and inefficient .The most successful solar thermal technology plant, as of 2010, the Andasol station in Spain , gains only an extra 6 hours of generation from the process.

b Large arrays of mirrors are required , which calls for land acquisition

c Also due to the corrosive nature of the molten salts used , the maintenance costs are also substantially increases.

d Photovoltaic technology makes use of solar panels but the installation cost is high, power generation per unit area is low, requirements of large tracts of land, high maintenance cost, ineffective storage of energy using lead acid accumulators which has the following drawbacks

1. Requires regular replacement increasing the maintenance cost .

2. Causes pollution due to improper disposal.

3. Manufacturing of solar panels and lead acid accumulators produces greater amounts of carbon dioxide as these processes are power intensive.

4. Power stored in the batteries cannot be used to provide round the clock power supply.

5. The innovative process technology that we have developed harnesses sunlight , water and catalysts to photolysis water to produce hydrogen and oxygen which can be readily stored and used for power generation round the clock thereby removing the primary disadvantages of the available solar technologies and also has some added advantages.

1 Zero emission of Green House Gases as it is based upon solar energy thereby leading to reduced Green House Effect and moreover it conserves non-renewable resources like coal, petroleum and natural gas, prevents acid rain as it does not produce SO_x, NO_x, etc and helps combat global warming and saves our mother earth.

2 Produces desalinated water which can be used for domestic purposes. This is particularly useful in states and countries which are close to sea and face severe potable water crisis.

3 Provide employment opportunities to a large number of people through the development of this self sustaining plant as it leads to the development of manufacturing sector in India there by raising per capita income.
4 This plant effectively solves the problem faced by the production of electricity only by photo voltaic technology as it can produce electricity during day & night.
5 This combines both photovoltaic and the photochemical technology. During the day the solar panels installed across the plant generate electricity while the photolysis unit stores the solar energy by converting it into the chemical energy in the form of H_2& O_2 which are stored and combusted at night to generate electricity in the absence of sunlight. Thus providing a steady supply of electricity 24 X 7.
6 The continuous supply of electricity will also promote the development of various industries and effectively manage the power crisis in India.
7 The plant also earns a lot of carbon credits as it produces minimal carbon dioxide which can be sold off to other industries.
8 The various modules have been developed for specific utility taking care of the variegated requirements of the society and industry as well as availability of space even in the densely populated areas .
9 It promotes localised power generation concept which will take care of the issues of power loss in transmission and power theft which is one of the major challenges of the power sector particularly in India.
10 Maintenance cost is low
11 Installation cost is low to moderate depending on the type of module being used.

Objective

The objective of this invention is to generate cheap electricity, fuel, potable water by harnessing sunlight (a renewable source of energy) through the process of photolysis using suitable catalysts through state of the art in the process technology with a clear vision for advancement in this field.

II. Summary

- Zero emission of Green House Gases as it is based upon solar energy thereby leading to reduced Green House Effect and moreover it conserves non-renewable resources like coal, petroleum and natural gas, prevents acid rain as it does not produce SO_x, NO_x, etc and helps combat global warming and saves our mother earth.
- Produces desalinated water which can be used for domestic purposes. This is particularly useful in states and countries which are close to sea and face severe potable water crisis.
- Provide employment opportunities to a large number of people through the development of this self sustaining plant as it leads to the development of manufacturing sector in India there by raising per capita income.
- This plant effectively solves the problem faced by the production of electricity only by photo voltaic technology as it can produce electricity during day & night.
- This combines both photovoltaic and the photochemical technology. During the day the solar panels installed across the plant generate electricity while the photolysis unit stores the solar energy by converting it into the chemical energy in the form of H_2& O_2 which are stored and combusted at night to generate electricity in the absence of sunlight. Thus providing a steady supply of electricity 24 X 7.
- The continuous supply of electricity will also promote the development of various industries and effectively manage the power crisis in India.
- The plant also earns a lot of carbon credits as it produces minimal carbon dioxide which can be sold off to other industries.

III. Detailed Description of the Process

1. Water storage unit:

Input: Water is taken from the sea or river or surface water sources

Process: i) The majority of water is pumped from sources or directed into pipes or holding tanks

ii)Screening: In this process large debris as sticks, leaves, rubbish and other large particles which may interfere in subsequent steps are removed.

iii) Coagulation & Flocculation:

In this process the suspended impurities are settled down by addition of suitable coagulating agents (e.g. alum)

iv)Sedimentation: After coagulation & flocculation process, the water is allowed to stand in large sedimentation tanks where the suspended particles are settled down and thus removed from water

2. Water Photolysis Unit:

Input: a) Catalyst (In Ga P and suitable Co-catalyst) in the form of nano particles b) Water from the storage tank

Process: i) The clean water from the storage tank is mixed with the catalyst in the mixing tank. This mixing tank is fitted with an agitator which is mixing catalyst with water to form a colloidal suspension.
ii) This colloidal suspension is then fed into the photolysis unit along with a steady supply of N_2 which acts as an inert medium for avoiding formation of explosive mixture of produced H_2& O_2 from water in this unit.
iii) In the photolysis unit water decomposed into H_2& O_2 in the presence of sunlight & catalyst
iv) In the H_2 storage tank H_2 is stored and in O_2 storage tank O_2 is stored.
v) Separation of H_2 & O_2 takes place due to the presence of two diff. semi permeable membranes. The semi permeable membrane in H_2 storage unit allows the H_2 to pass through but not O_2
Similarly, the membrane in O_2 storage tank allows the O_2 to pass through but not H_2

3. H_2& O_2 Storage Unit:
Input: H_2& O_2 from the photolysis unit
Process: H_2& O_2 from the storage tanks in the photolysis unit are stored in auxiliary H_2& O_2 storage unit

4. Power Generation Unit:
Input: H_2 and O_2 from auxiliary storage unit
Process: The H_2& O_2 from storage unit is mixed in 2:1 ratio and fed into a combustion unit where it is fully combusted to produce high pressure steam to run turbine for generation of electricity.
The steam from turbine is used to heat up another unit containing water, this again produces high pressure steam and used to run an auxiliary turbine.
The steam from this auxiliary turbine is fed back into the heating mechanism along with steam from primary turbine.
In this way we get distilled water as well as electricity.

5. Catalyst separation & Salt production Unit:
The concentrated water from the water photolysis unit is fed in this unit where catalysts are separated and recycled. Further evaporation of residual water takes place for production of salts which is sold to the market for house hold use or for industrial purposes.

6. Water Processing Unit:
Input: Distilled water (H_2O)
Process & Output: The pure water is processed as follows-
i) Packaged and sold for industrial purpose
ii) Minerals are added and packaged to produce packaged drinking water
iii) Minerals are added and supplied to the municipal water supply system

Following are the different type module designed for specific utility
A: SHIP MODULE (Attachment type)
This attachment consist of :
a) Water photolysis unit – which produces H_2& O_2. Produced H_2& O_2 are stored in storage tank in the ship and are utilised as
- Fuel for cooking in the kitchen of the ship
- For heating purpose
- For production of electricity by using fuel cell (H_2-O_2 type) which is used for ship operation
- For production of drinking water

B: Housing Complex Module
This consists of dome or pillar shaped structures(depending on the availability of space) made of transparent material which allows the sunlight to pass through. The photolysis takes place in this unit and H_2& O_2 get separated through membrane separators. These are then stored in the underground storage tanks .

Utilisation:
- Generation & steady supply of electricity through H_2-O_2 fuel cell
- Water produced as by product are used for drinking purposes after suitable treatment
- Excess electricity is supplied to Grid

C: Village Unit Module
This consists of dome or pillar shaped structures (depending on the availability of space) made of transparent material which allows the sunlight to pass through and hence allows photolysis to take place.

This is of 2 types:

- **Specific type** which is exclusively used for generation of electricity only.
- **Comprehensive type** which meets the various requirements of the villages besides generating electricity.

Utilisation:

- The H_2& O_2 produced is fed into H_2-O_2 fuel cells which produce electricity and supplied locally for various utilisation in villages.
- Water produced as by product are used for drinking purposes after suitable treatment
- Excess electricity is supplied to Grid
- Excess H_2 is supplied to the village homes through pipelines as domestic fuel for cooking(no smoke fuel)
- Excess H_2 is supplied to the village small scale industries through pipelines
- Excess O_2 is filled in Oxygen cylinders for satisfying village healthcare requirement even in remote places at a very low cost
- Further it minimises the transmission loss of electricity and also prevents theft of electricity as electricity is generated locally in the villages thereby making villages self sufficient in electricity and provides for 24X7 electricity supply even in the remote villages.

D: Hydel Power Generation Unit Module

The distilled water from the condensation unit is stored in a storage tank and made fall through a gradient to generate hydel power. This can be easily achieved as the steam condensation and auxiliary unit can be placed at higher gradient/height. Thus distilled water stored into a tank at a particular height has stored potential energy which is used to generate a steady supply of electricity.

E: Floating Type Unit Module

This water photolysis and separator unit is made in the form of a floating device.

This device can be floated in the sea or river continually producing H_2& O_2 during daytime which are transported through pipelines and stored in the storage units on shore and thus, the area of land requirement for this plant is minimised.

Utilisation

- Can be easily setup in densely populated coastal areas where both electricity and drinking water are in high demand
- India having a long coast line is advantageous from this view point and large amount of H_2& O_2 can be produced
- This will help in fighting the drinking water scarcity in coastal area
- Moreover, the huge amount of H_2& O_2 can be used as fuels in other industries thereby reducing non-renewable fuel requirement and help in the growth of industries in costal area
- Provide livelihood to the people living in this area of coastal belt and particularly helpful for Islands.
- This type of unit for generation of electricity minimises transmission loss, transportation cost as well as distribution cost.
- Excess O_2 is filled in Oxygen cylinders for satisfying village healthcare requirement even in remote places at a very low cost

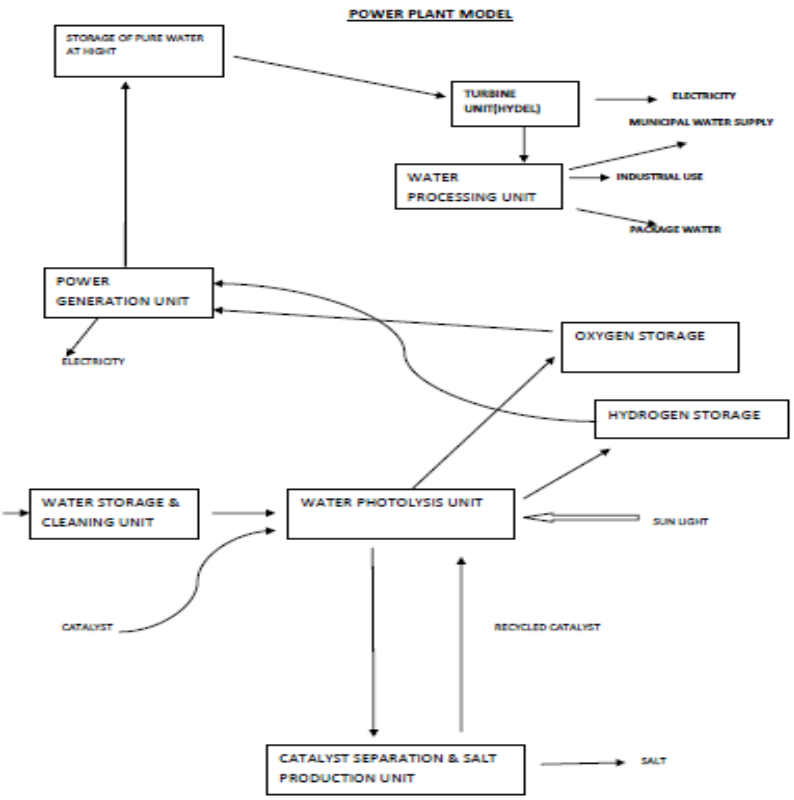
Abbreviations

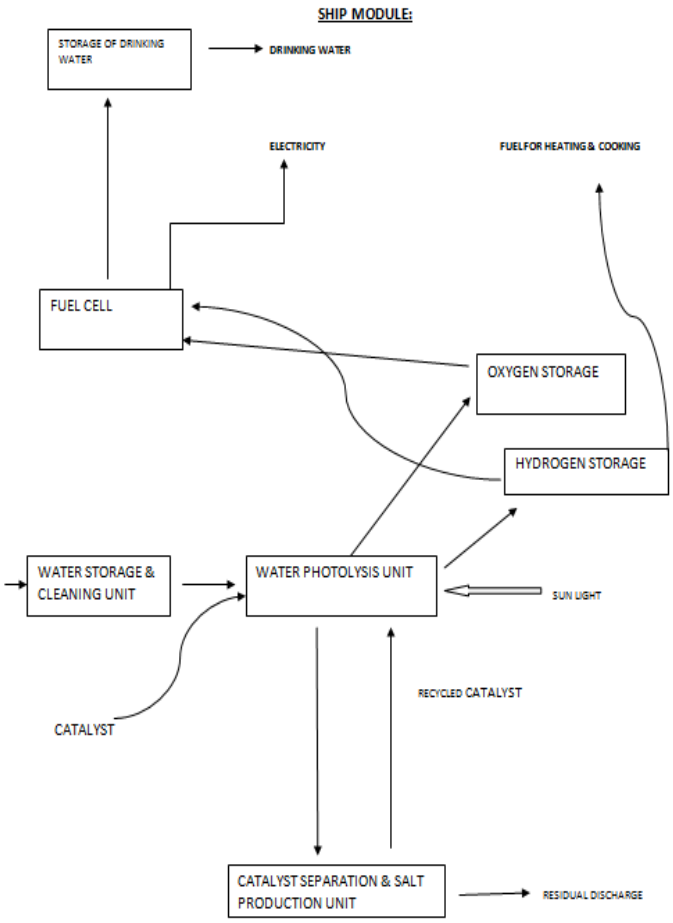
H_2 - Hydrogen
N_2 - Nitrogen
H_2O - Water
SO_x – Sulphur compounds
NO_x - Nitrogen compounds
In Ga P – Indium Gallium Phosphite

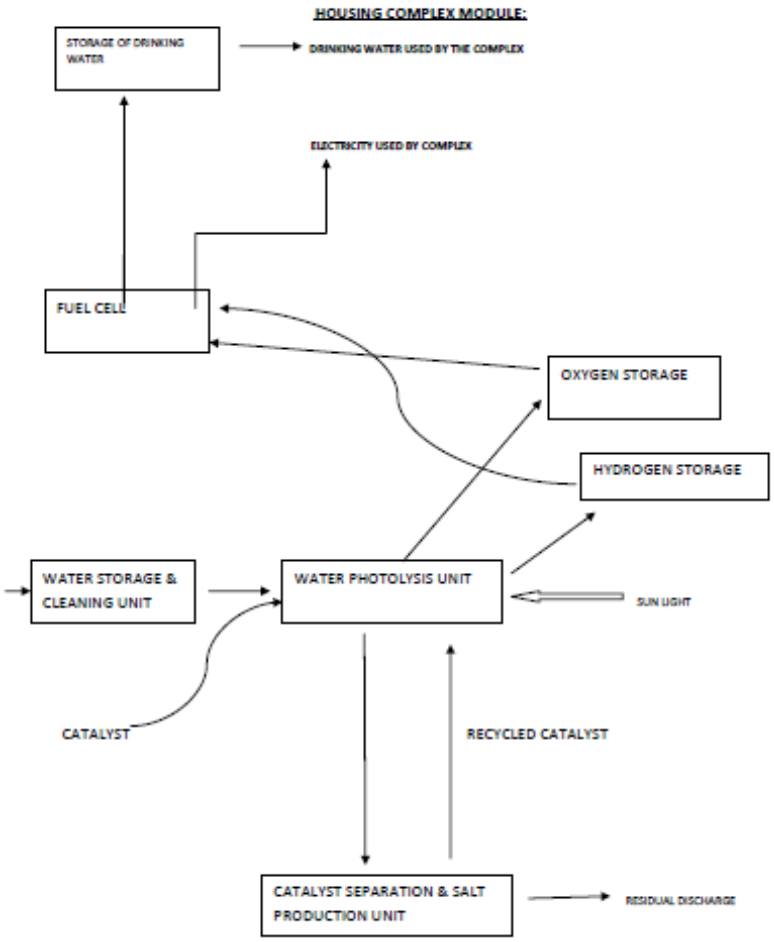
IV. Conclusion

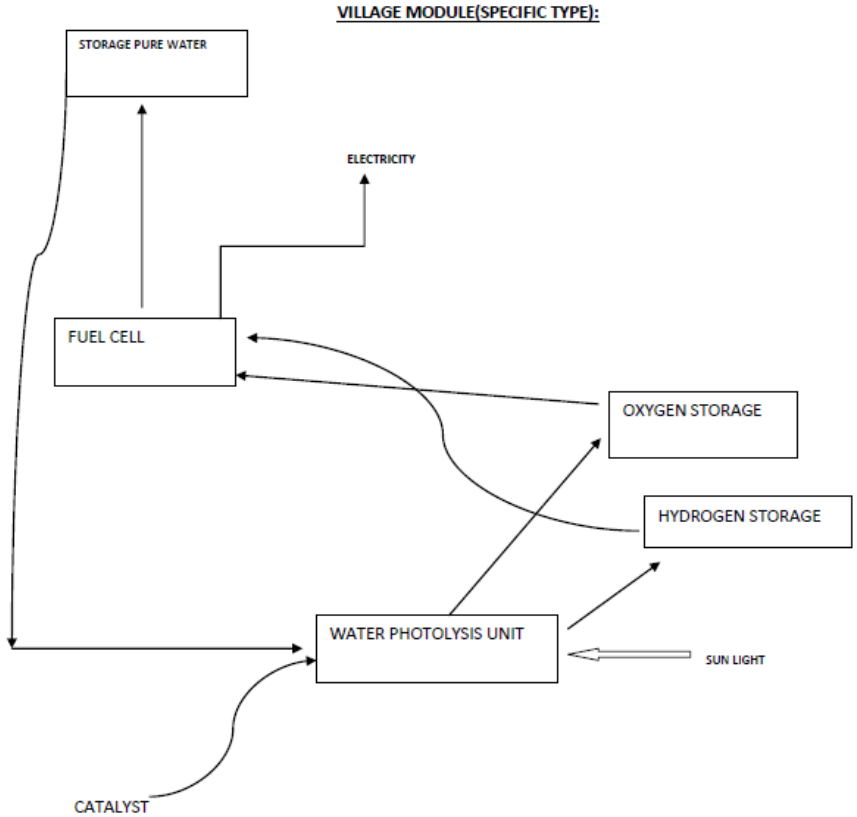
This process technology uniquely takes care of the present day necessities of electricity, potable water, fuel using the renewable resources like sunlight and water both of which are available in abundance. It solves the problem of global warming as there are no emissions of green house gases and provides for a sustainable economic growth of the nation generating employment opportunities as well. Thus it can be concluded that the development of this single plant can solve a large number of problems faced by India and World at present, though it will require moderate initial cost of investment but the operational cost is very low for production of low cost electricity and the payback period is also short(2 to 3 years)

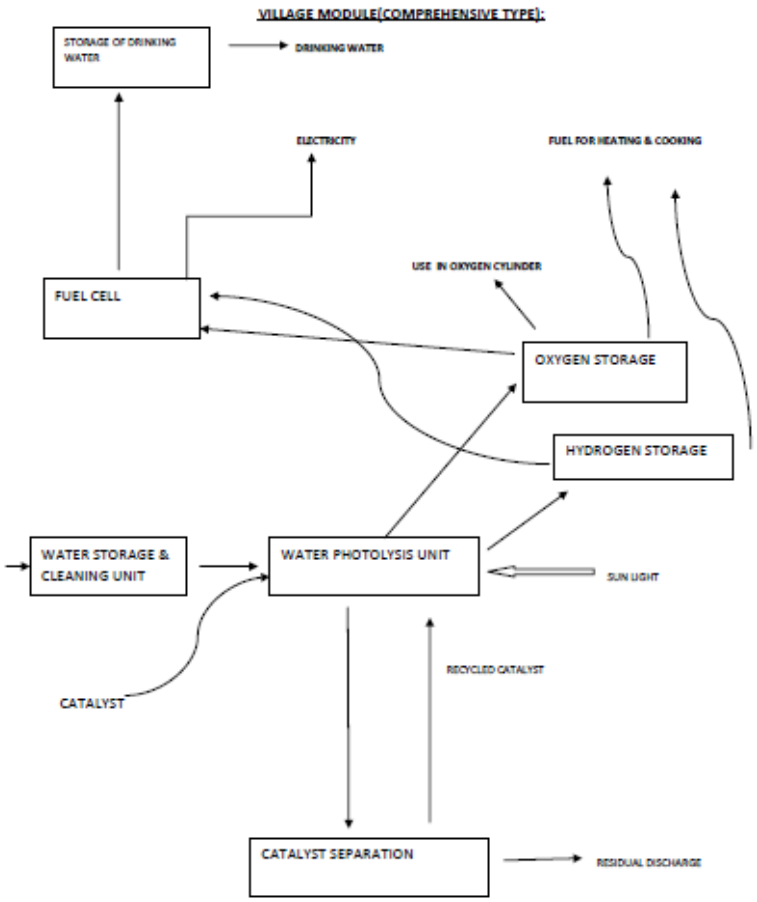
FLOW CHARTS:


POWER PLANT MODEL
STORAGE OF PURE WATER AT HIGHT
TURBINE UNIT(HYDEL)
ELECTRICITY
MUNICIPAL WATER SUPPLY
WATER PROCESSING UNIT
INDUSTRIAL USE
PACKAGE WATER
POWER GENERATION UNIT
ELECTRICITY
OXYGEN STORAGE
HYDROGEN STORAGE
WATER STORAGE & CLEANING UNIT
WATER PHOTOLYSIS UNIT
SUN LIGHT
CATALYST
RECYCLED CATALYST
CATALYST SEPARATION & SALT PRODUCTION UNIT
SALT


SHIP MODULE:
STORAGE OF DRINKING WATER
DRINKING WATER
ELECTRICITY
FUELFOR HEATING & COOKING
FUEL CELL
OXYGEN STORAGE
HYDROGEN STORAGE
WATER STORAGE & CLEANING UNIT
WATER PHOTOLYSIS UNIT
SUN LIGHT
RECYCLED CATALYST
CATALYST
CATALYST SEPARATION & SALT PRODUCTION UNIT
RESIDUAL DISCHARGE


HOUSING COMPLEX MODULE:
STORAGE OF DRINKING WATER
DRINKING WATER USED BY THE COMPLEX
ELECTRICITY USED BY COMPLEX
FUEL CELL
OXYGEN STORAGE
HYDROGEN STORAGE
WATER STORAGE & CLEANING UNIT
WATER PHOTOLYSIS UNIT
SUN LIGHT
CATALYST
RECYCLED CATALYST
CATALYST SEPARATION & SALT PRODUCTION UNIT
RESIDUAL DISCHARGE


VILLAGE MODULE(SPECIFIC TYPE):
STORAGE PURE WATER
ELECTRICITY
FUEL CELL
OXYGEN STORAGE
HYDROGEN STORAGE
WATER PHOTOLYSIS UNIT
SUN LIGHT
CATALYST



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