CARBON NEGATIVE GREEN HYDROGEN TURBINE COMBINED CYCLE TRI-GENERATION PLANT

FOR

HIGH RISE BUILDING

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<u>CARBON NEGATIVE HYDROGNE TURBINE TRI-GENERATION PLANT FOR HIGH</u> <u>RISE BUILDINGS IN HONG KONG</u>

<u>1.1 Background</u> 1.1.1 The urgent need to reduce carbon intensity in high rise building

Current Local Energy Mix consists of little renewable energy but there is potential to sharply increase that by generating hydrogen from renewable source or even import from across border and other countries.

- CLP Electricity PV Panel, Coal, Nuclear, Landfill gas, Fossil Gas & oil.
- HKE Electricity PV Panel, Wind Turbine, Coal, Fossil Gas & oil.
- Towngas Landfill gas, Fossil with mix of natural gas and naphtha 50% grey hydrogen content.

Possible zero carbon hydrogen production including:

- Using large scale PV and wind power to generate hydrogen using water and electrolyze as planned in many overseas countries.
- Using existing nuclear power stations to generate hydrogen during off-peak periods e.g. night time so that nuclear power will be fully utilized.
- To generate hydrogen using advance process from landfill gas, sewage gas and natural gas; Since the embed carbon in landfill and sewage come from atmosphere, any solid carbon sequestration will become a carbon negative process.

High power consumption in high rise building, efficiency increase helps but cannot achieve net zero carbon.

- Air-conditioning need
- Computing power and lighting
- Lift, escalator and water pumps
- Hot water, steam

<u>1.1.2 Why Green/Blue hydrogen could sharply reduce our carbon intensity</u></u>

Advantage of Hydrogen as Green Energy Storage

- High energy density
- High energy storage capacity
- Hydrogen could be generated from water using renewable electricity and
- Using patent process from biogas & natural gas that also produce solid carbon for easy carbon sequestration.

Easy to reuse to generate electricity, heat and propulsion power.

- Hydrogen fuel cell to power light and heavy vehicles.
- Lower cost Hydrogen turbine for power, heat and aviation.

Approach zero emission

• Generate water vapour

Hong Kong has unique experience of operation with a gas network that already consists of up to 50% of hydrogen by volume. It could be used to transport green/blue H2 effectively.

- 50% of hydrogen already being transport via Gas network today.
- Could increase green hydrogen and renewable content in town gas network.
- Negative Carbon is technically possible if the source is from biogas and generate solid carbon (biochar/graphene) for easy carbon sequestration and utilization.

Local power companies also operate power stations with hydrogen cool high voltage generators.

2.0 Concept of Hydrogen Tri-generation Plant

Our system will recover hydrogen onsite using a proprietary hydrogen recover system that consists of special membrane and pressure swing adsorption system. The hydrogen gas recovered will be pressurize to 8 barg for the operation of the hydrogen micro turbine.

Special feature of the hydrogen turbine including dual stage radial turbines, magnetic floating bearings, special heat recuperator and special hydrogen burner developed in Germany. Different from major power generation system, the advantage of distributed power system is that all the waste heat generated will be recovered to power two systems namely Organic Rankine Cycle ORC to generate extra electricity and hot water to power the waste heat adsorption chiller to generate renewable/free chilled water for the central air-conditioning system throughout the year. Should there be any slip CO2 in flue gas it could be used to feed small green house on roof top. This way, thermal efficiency over 85% (41% higher than local fossil power plants) is possible. We also anticipate close to 96% of hydrogen utilization rate.

A 1200kWe system consists of 3 module of Micro turbines will reduce 5248 ton of CO2 emission per year provided that:

- 8000 hours of annual operation
- Hydrogen in gas network is Green/Blue or
- Gas with renewable certification
- Waste heat is recovered and utilized

2.1 How Green/Blue Hydrogen could be generate off-site :

Green hydrogen is usually generate by renewable electricity using Photovoltaic solar panels, or wind turbines, power then fed to electrolyser which separate the hydrogen and oxygen in water. Whereas blue hydrogen usually generates by Advance High temperature process using

natural gas, sewage gas and landfill gas to split carbon and hydrogen in methane. The best process could even generate solid carbon (biochar) that is the easiest for carbon sequestration.

For our local operation, it would be easiest to inject pure hydrogen into our existing town gas network to transport Green/Blue Hydrogen. When the amount of hydrogen reach a certain level, it would be wise to increase hydrogen content in gas network step by step.

On the other hand, since there is already a certain level of renewable gas generated from landfill gas already present in the town gas network, by issue Green certificate for some user. Building could declare certain amount of green energy even today.

Hence, the best system is to increase the hydrogen content on site so that only water vapour is emit in that building, in case of any slip of carbon dioxide, the flue gas could feed into small green house on roof top so that any CO2 detected will be absorb by the plants growing in the green house.

3.0 How to accommodate the system in a high rise building :

The space require for the followings system are as follows:

One Micro Turbine module (Indoor or Outdoor) Length: 6500mm Width: 2500mm Height: 2900mm Turbine generator would weight 7,300kg without any fluid inside. Power electronic for Micro Turbine module (Indoor) Length: 6000mm Width: 600mm Height: 2300mm Dimension of one Gas compressor and HRS serve one : Length: 3200mm Width: 2500mm Height: 1900mm Dimension of one waste heat adsorption chiller that serve one : Length: 4900mm Width: 2100mm Height: 2400mm

Optional ORC unit. Dimension of one water cool ORC unit serve one : Length: 2600mm Width: 1600mm Height: 2600mm

3.1 Site Preparation

For the case of One Taikoo Place, the Hydrogen Turbine Tri-Generation Plant could utilize the space currently use for the solar PV panels at MRF and raise the PV panels to above the tri-gen plant room or as a new building, using the similar space for the 100% biodiesel CCHP plant.