Storage of Green Power As H_2. 5kW Power-to-Gas Demo Project

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Abstract:

The goal of the I-GIT Power-to-Gas (P2G) project is to demonstrate how current state of the art techniques in: hydrogen production, storage, and fuel cell based electrical power generation can be combined, in order to make instantaneously generated renewable energy available beyond the moment it was generated. In demonstrating this capability we hope to build confidence in the applicability of P2G systems in providing conditionless, carbonless, renewable energy. In this poster we present an overview of the key components of the I-GIT P2G demonstration project and our plans for investigating each of these components in order to quantify their performance and prove their applicability towards meeting the goal of around the clock zero-carbon renewable energy.

Primary Renewable Generation:

Renewable energy generation is an important and highly researched field. Solar and Wind power have dominated the renewable energy market. These energy sectors have grown markedly and the LCOE scores of each have decreased drastically due to fundamental research into improving efficiency and reducing costs. However one major drawback to these technologies is that their output is highly dependent on the environment, which creates issues with grid stability.

A similar growth trajectory is predicted for renewable fuel based energy generation such as renewable natural gas and H_2. Fuel-based energy production is not dependent on the environment. It follows that coupling a fuel-based energy generation technique with dependent renewables could alleviate grid stability issues.

Solar Energy:
- Only produce during daylight hours
- LCOE 27c/kWh
- 23% of US production

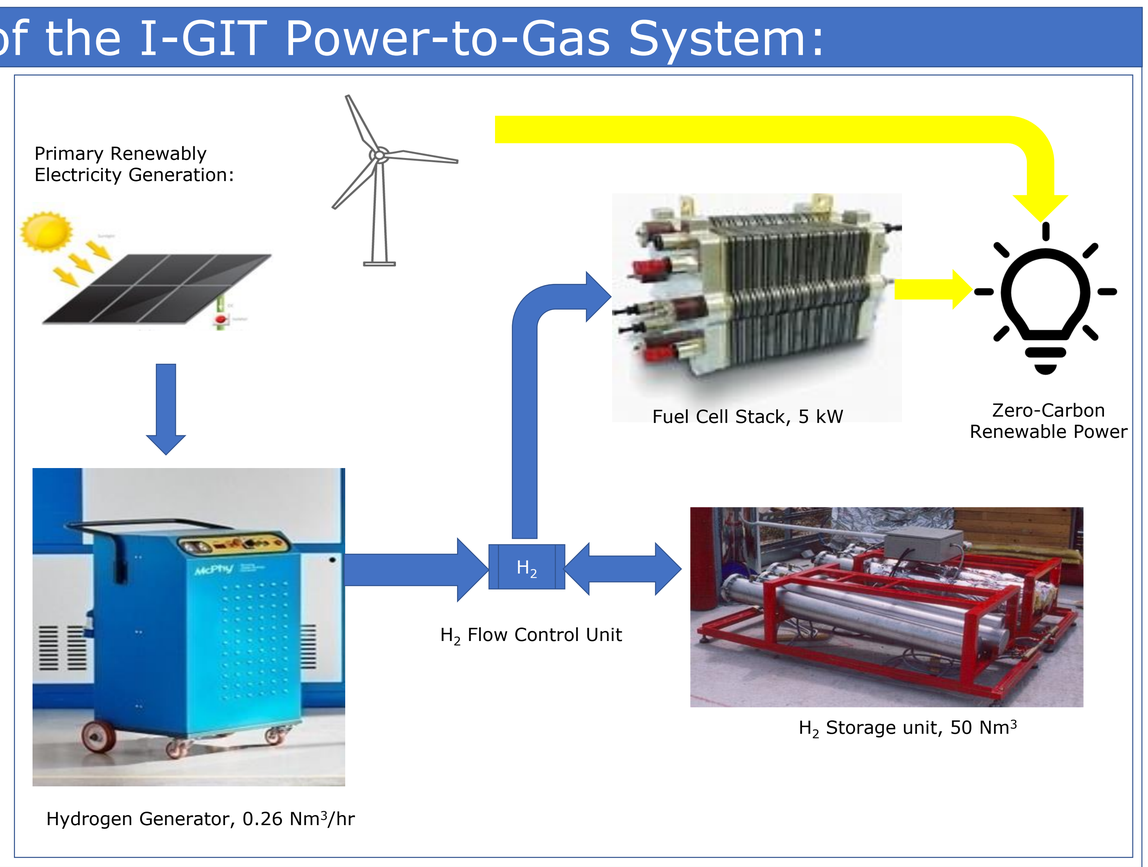
Wind Energy:
- Output proportional to wind speed
- LCOE 27c/kWh
- 15% of US production

Fuel-Based Energy:
- Output independent of environment
- 50% of US production
- Energy produced with fossil fuels

Overview of the I-GIT Power-to-Gas System:

The I-GIT P2G system includes five core subsystems.

1. Is a source of time-dependent renewable energy, such as solar panels or wind turbines.
2. Is a hydrogen generation unit, in this case a PEM electrolyzer.
3. Is a hydrogen gas control system which measures gas output and directs hydrogen to either the fuel cell or a hydrogen storage system.
4. Is a hydrogen storage unit, in this case tubes filled with an adsorbent metal hydride material.
5. Is a Fuel Cell Stack, in this case a PEM system, for producing electricity from generated or stored hydrogen



Hydrogen Generation & Purification

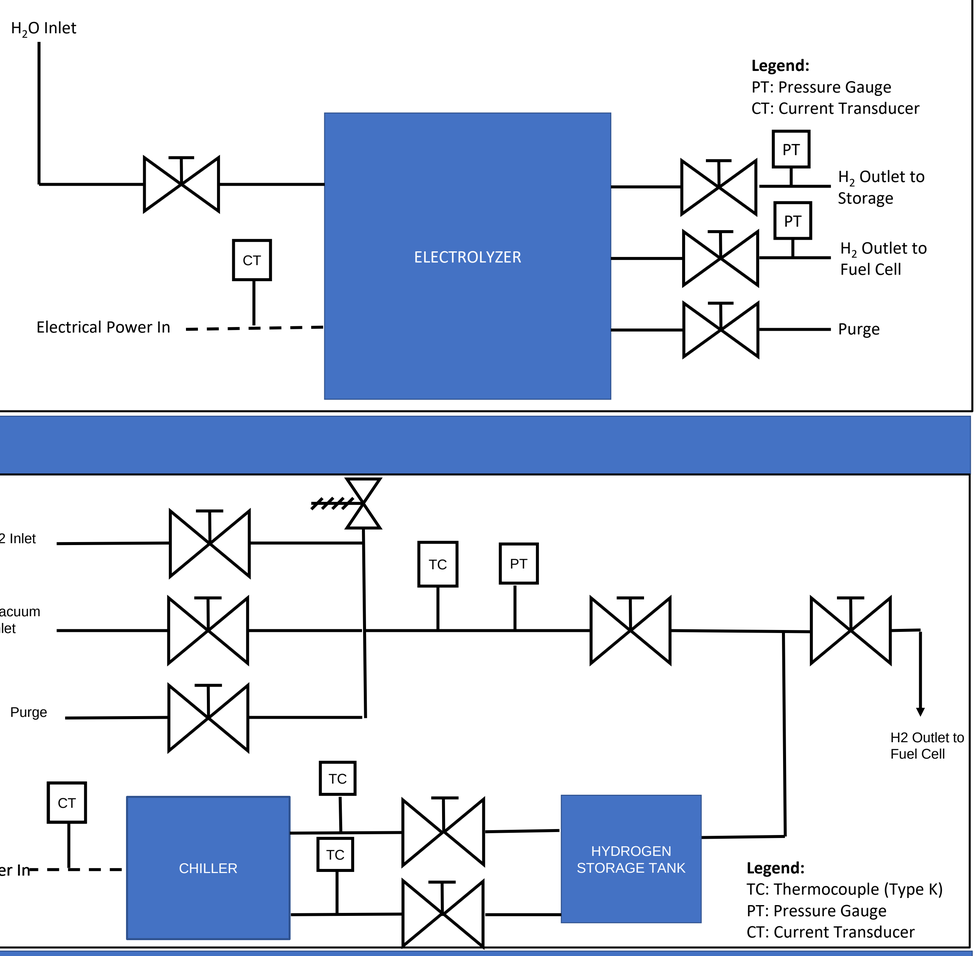
The heart of the power-to-gas project is a PEM electrolyzer. The specific unit we are using is a $Hogen^{®}$ Model S10. The unit itself will be plumbed with a 2.4 MΩ DI H_2O inlet, dual hydrogen outlets (both to storage and to the fuel cell), and a purge line to be used for maintenance procedures.

Planned Work:

Testing of the electrolyzer system will include: verification of the published H_2 production rate, as well as measurements of H_2O and power consumption rates.

(Electrolyzer)

$Hogen^{®}$ hydrogen generator



H_2 Storage Unit

The hydrogen storage system used in the power-to-gas project is a custom-built apparatus consisting of 14 canisters containing Hy-Stor 208, a mischmetal-nickel-aluminum alloy powder. The purpose of this material is to facilitate room temperature adsorption and desorption of hydrogen, which will allow the canisters to serve as a hydrogen storage system.

Planned Work:

Testing of the hydrogen storage unit will include: verification of the hydrogen adsorption isotherms at room temperature and verify the integrity by testing for leaks.

Hydrogen storage system

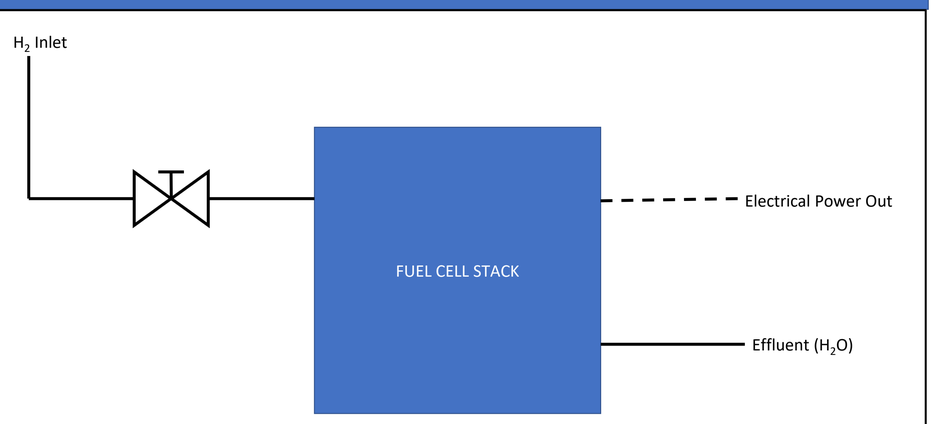
Fuel Cell Stack

The fuel cell stack for this demo includes two Independence 1000 units made by Avista Labs. These fuel cells together should produce 5 kW of power at 48 volts.

Planned Work:

Testing of the fuel cell stack unit will include: verification of the hydrogen consumption (supposedly 15 $\frac{L}{min}$) and power production of each unit.

Fuel Cell Stack



Summary

- Test the $Hogen^{®}$ hydrogen generator H_2 production rate.
- Measure the amount of H_2O and power consumed by the $Hogen^{®}$ hydrogen generator during use.
- Conduct leak tests on the hydrogen storage units.
- Verify hydrogen adsorption isotherms of the hydrogen storage units, utilizing a Sieverts apparatus.
- Confirm the hydrogen consumption rate of the Independence 1000 PEM fuel cell listed by the manufacturer.
- Measure the power production of the two PEM fuel cells.
- Demonstrate how these components can be utilized around the clock zero-carbon renewable energy.

References

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