



# **HYDROGENICS**

SHIFT POWER | ENERGIZE YOUR WORLD

## **THE ENERGY SHIFT IS UNDERWAY**

**SUSTAINABLE ENERGY ECONOMY WORKSHOP**

**Ryan Sookhoo**  
**[rsookhoo@hydrogenics.com](mailto:rsookhoo@hydrogenics.com)**

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# HYDROGENICS

SHIFT POWER | ENERGIZE YOUR WORLD

**70+ years** of experience in delivering top-tier hydrogen solutions

Leading **PEM stack** and system technology, including unmatched **power density** in a single stack (3MW)

Only global company with leading technology in both **electrolyzers** and **fuel cells**

**Zero-emission** technology



## Ownership

A Cummins Company



Cummins ~80%



**Air Liquide**

Air Liquide ~20%

Serving customers in **100+ countries** around the world

Over **145 patents**



# Hydrogenics designs and builds Fuel Cell Power Modules and Electrolyser systems

## Fuel Cells



Fuel Cell Bus Integrators, China



Alstom Coradia iLint, Germany



UPS Delivery Van, US

## Electrolysers



Uniper 2MW P2G, Germany

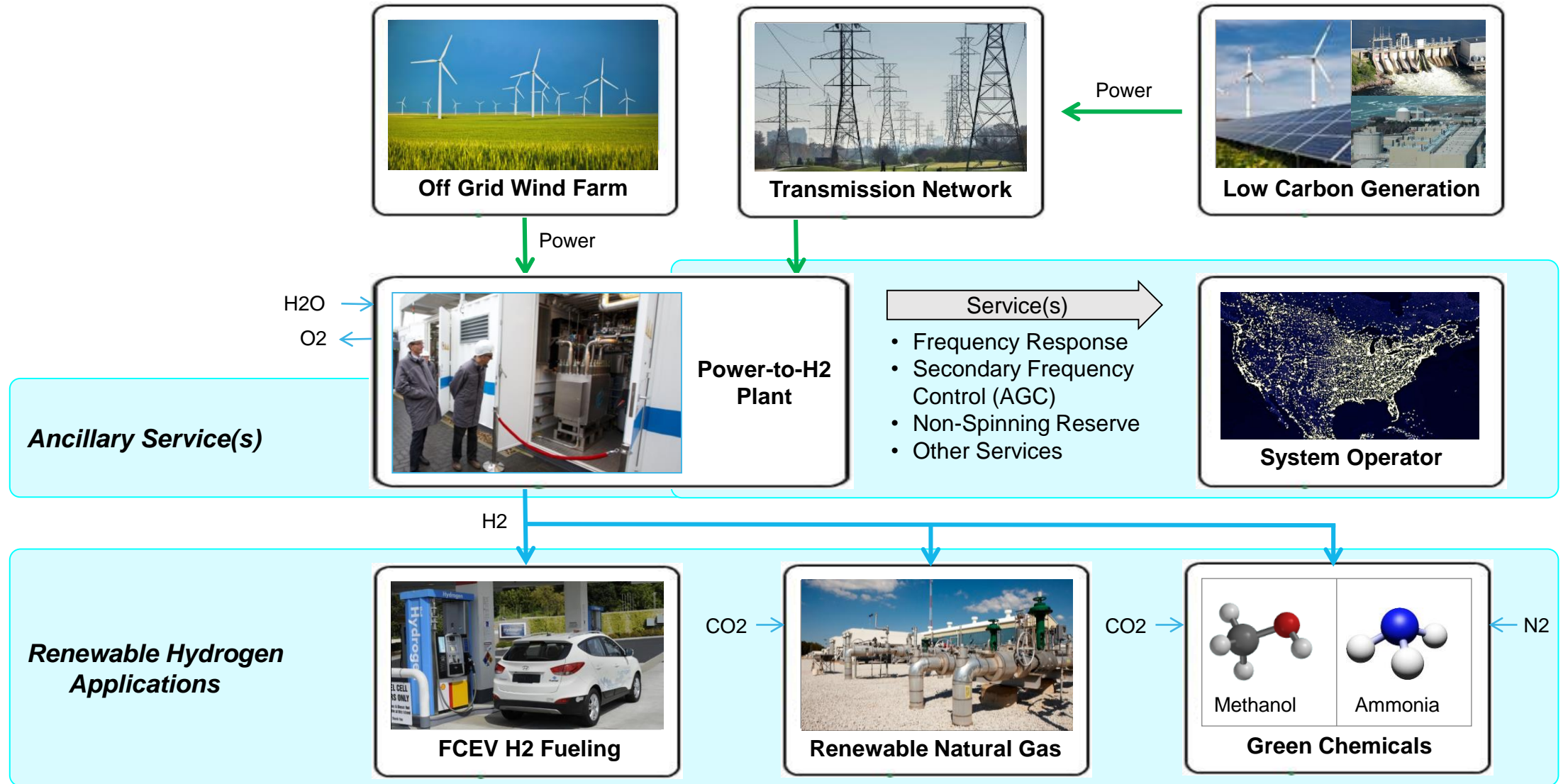


P2G H<sub>2</sub> Fueling, California



2.5MW Power-to-Gas, Ontario

# Power-to-Hydrogen





# Hydrogenics' PEM Electrolyser Product Development



Test Large Stack



Field Test 1.5 MW Electrolyser



Indoor Architecture



2.5MW Stack



1999

2003

2012

2014

2015

2017

2018

2020



Small Scale PEM Electrolyser



1.5 MW Cell Stack



Dual Cell Stack Design

HyLYZER®-1000

5MW Product Platform

# Falkenhagen P2G Plant, Germany

## Hydrogen Blending and Direct Injection to NG Grid

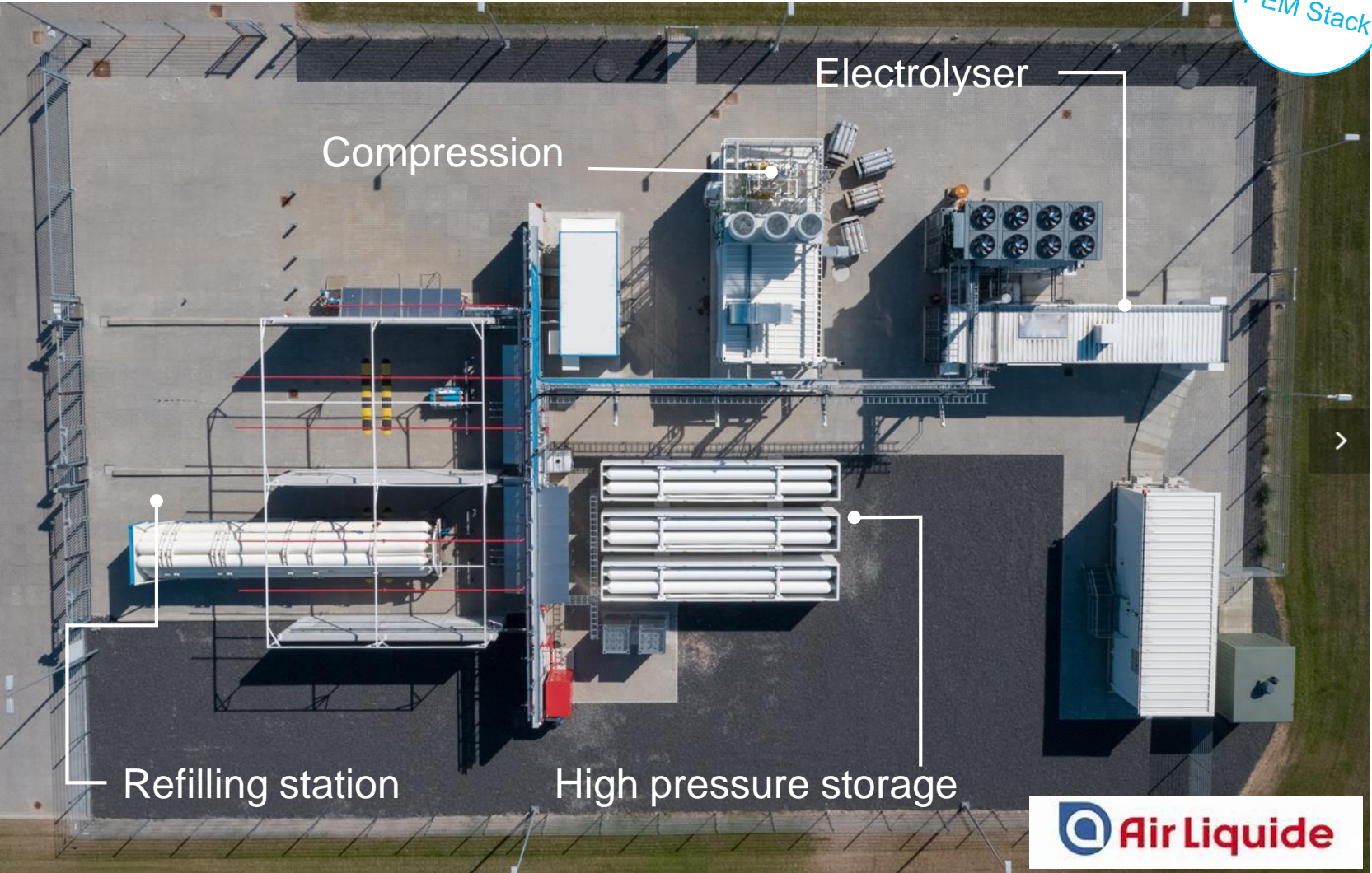
World's First  
Direct  
Injection





# HyBalance Facility, Denmark

## Hydrogen for refueling stations and industrial customers



Dual  
PEM Stack



# Markham Energy Storage Facility, Ontario

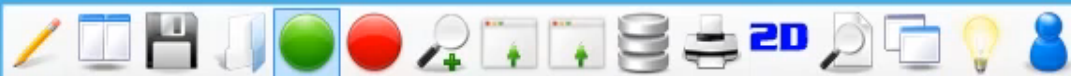
## Regulation Services for IESO

Indoor  
Architecture



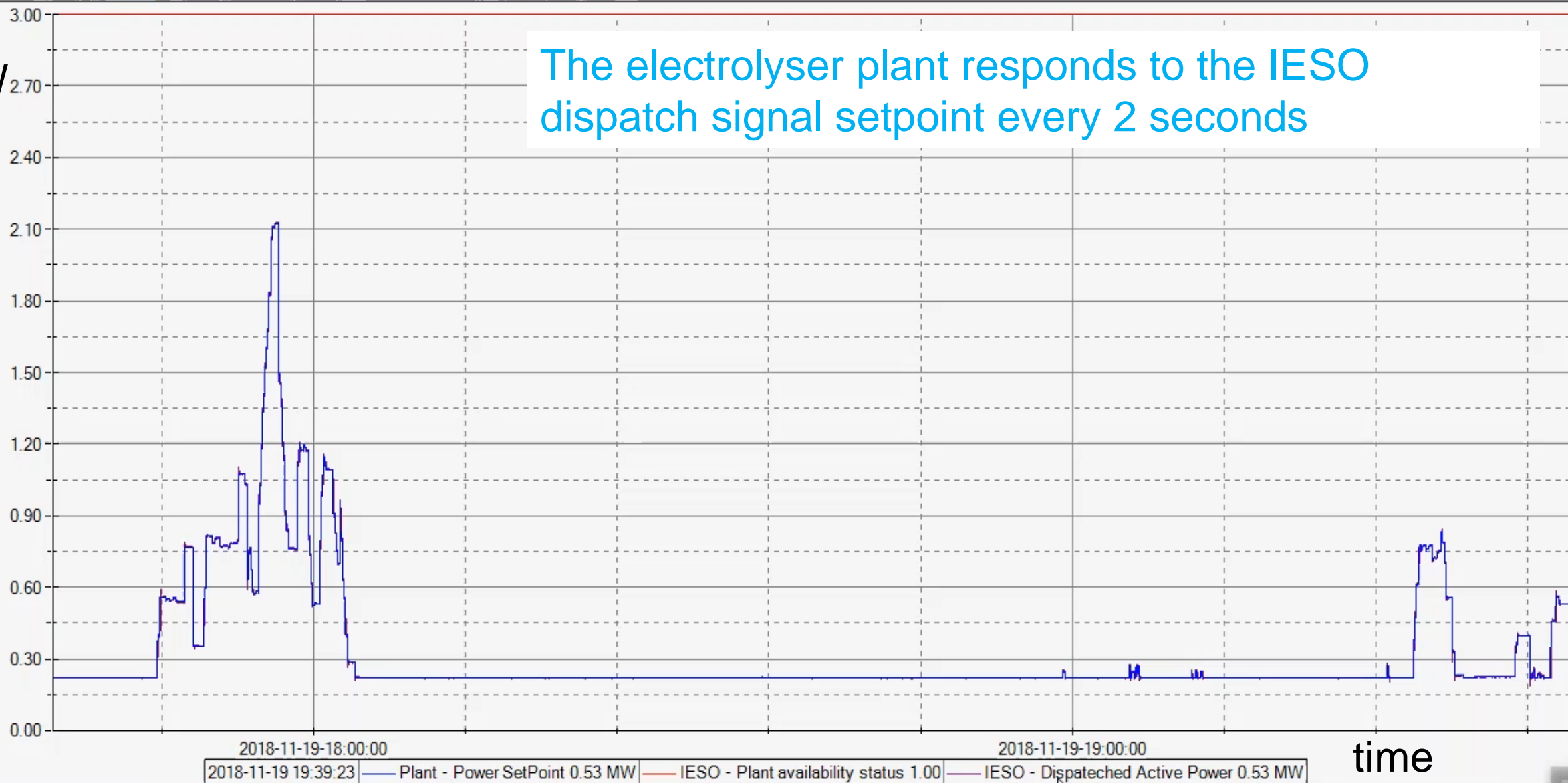
 **ENBRIDGE**





kW

The electrolyser plant responds to the IESO dispatch signal setpoint every 2 seconds

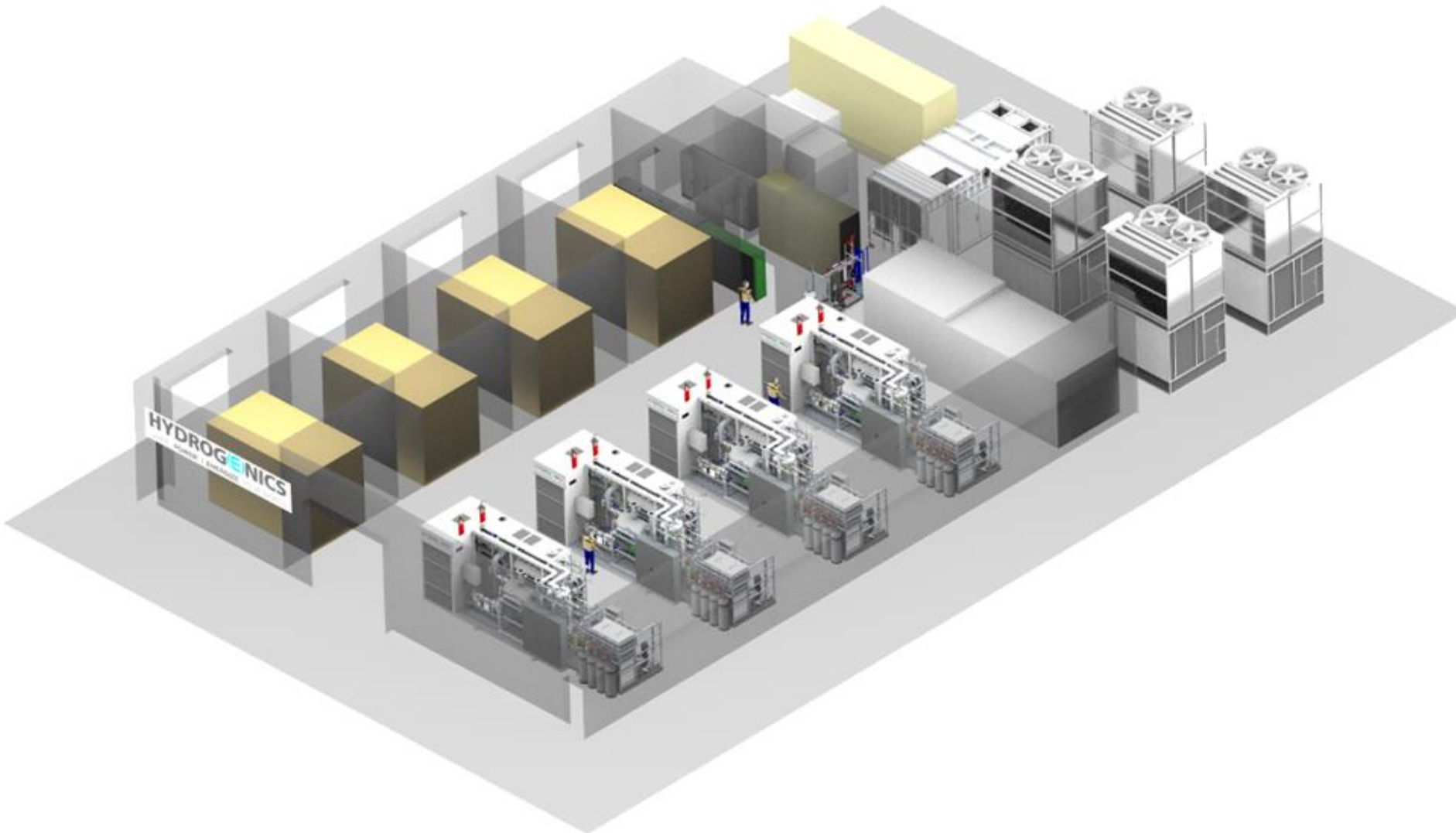


# Markham Energy Storage Facility Highlights

- Plant has been designed for 5MW or 1,000 Nm<sup>3</sup>/hr or 2,160 kg/day capacity
  - Currently installed 2.5MW or 500 Nm<sup>3</sup>/hr or 1,080 kg/day capacity
- High purity H<sub>2</sub> is produced by the PEMWE stacks at 30 bar<sub>g</sub>
- Plant provides +/- 1.05 MW of regulation service for the IESO
  - 2 second response time, 2 MW/sec ramp rate
- No operating restrictions—can provide full range of regulation capacity 24/7 (no state of charge limitations as with Battery Energy Storage Systems)
- Highest power density electrolyser stack in the world
- Meets the highest standards of safety and quality
  - Installed on Enbridge property, residential neighbourhood across the street
- Fully approved for operation by multiple certification bodies having jurisdiction:
  - IESO, Technical Standards and Safety Authority (TSSA) Fuels, TSSA Boiler and Pressure Vessels (BPV), Electrical Safety Authority (ESA), Canadian Standards Association (CSA), City of Markham, Ministry of Environment and Climate Change (MOECC)



# 20MW, 8000kg/day Power-to-Hydrogen Plant



## Air Liquide Plant

- New plant at Air Liquide's Quebec Facility
- 4 HyLYZER-1000s
- Capacity 8000 kg/d of hydrogen a day
- Annual GHG abatement of 27,000 tonnes
- Commercial operation in 2020