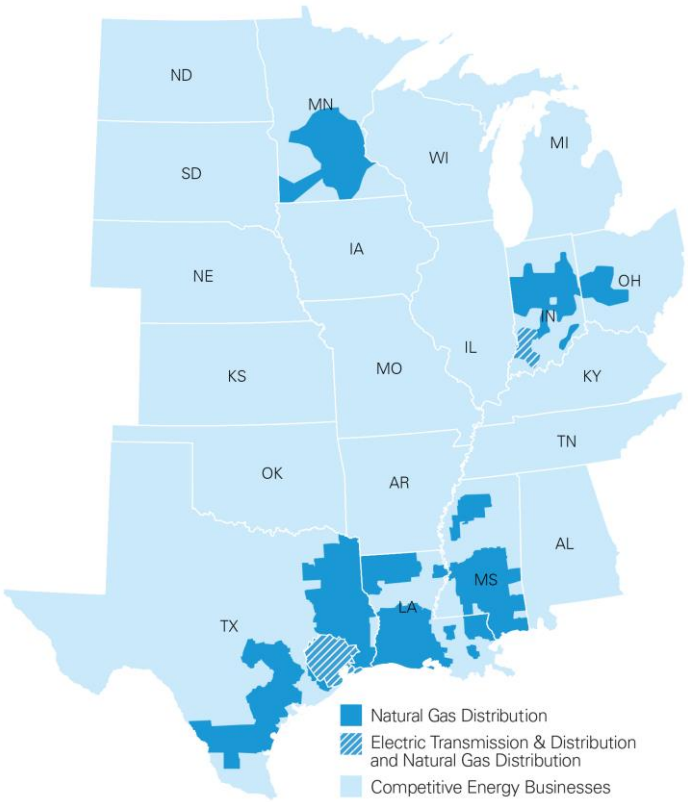
Clean Energy and Innovation

February 15, 2022
Amber Lee

CenterPoint Energy

CenterPoint Energy at a Glance



Gas Utility Services

Regulated gas distribution jurisdictions in 6 states with

- ~ 4 million customers, second largest in the U.S.
- ~ 102,000 miles of pipe, largest in the U.S.

Electric Utility Services

- Electric transmission and distribution operations with ~2.4 million metered customers across ~5,000 sq. miles in and around Houston, Texas
- Electric generation, transmission, and distribution to ~145,000 metered customers in southwestern Indiana

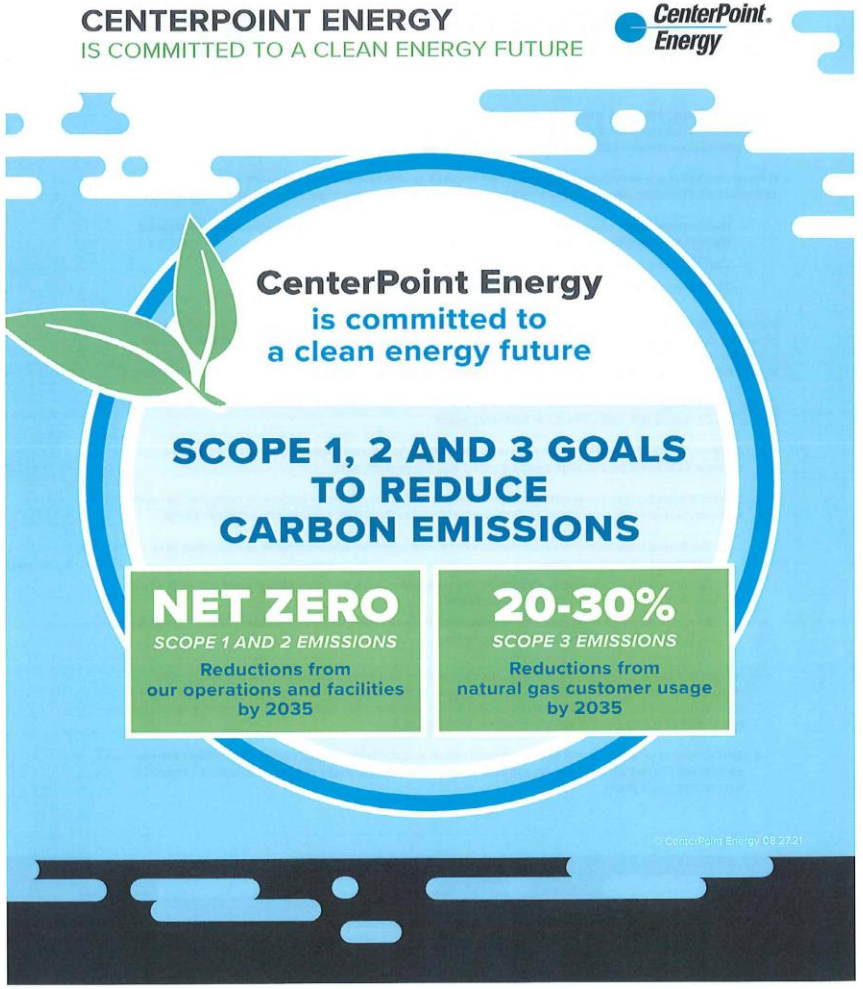
CenterPoint Energy Minnesota Gas

Largest natural gas distribution business in Minnesota:

- Serving
  - 900,000+ customers
  - 260+ communities
- Employing
  - 1,200 employees

CenterPoint Energy Inc.: Corporate Carbon Policy

- **Already Underway:**
  - Reducing methane leakage on our system
  - Promoting energy efficiency
- **Next Steps:**
  - Ramp up energy efficiency (EE) and new EE technologies
  - Incorporate lower carbon fuels onto our system
    - Renewable natural gas (“RNG”)
    - Renewable hydrogen
    - Others
  - Reduce carbon emissions from customer end use.

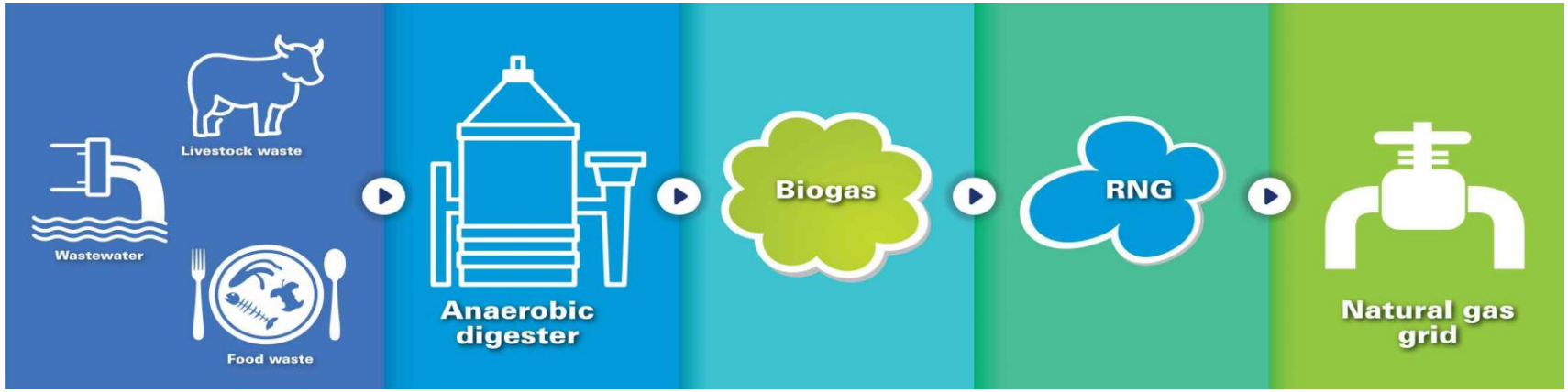


What is Renewable Natural Gas (RNG)?

- **AGA: “Pipeline compatible gaseous fuel derived from biogenic or other renewable sources that has lower lifecycle CO2e emissions than geological natural gas.”**

Examples include pipeline compatible gas derived from:

- Wastewater treatment plants
- Landfill gas
- Anaerobic digestion gas
- Power to gas from renewable electricity
- “Syngas”



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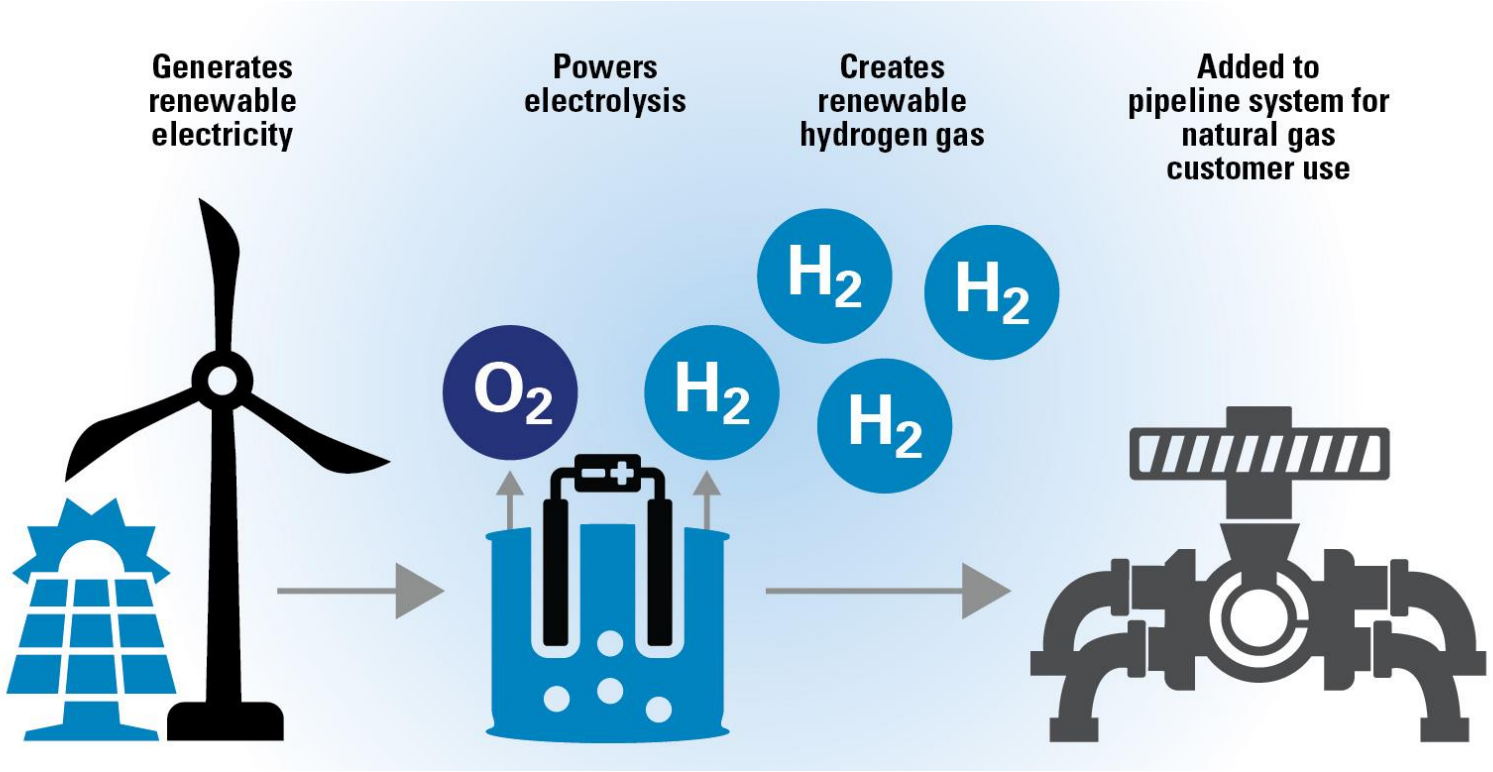
What is Hydrogen?



Natural Gas Innovation Act

- Included in 2021 Special Session Omnibus Energy Bill H.F. 6, which has become law
- Creates a PUC process for utility programs for utility investment in innovative resources
- Innovative resources are biogas, carbon capture, district energy, energy efficiency, power-to-ammonia, power-to-hydrogen, RNG, and strategic electrification
- Cost cap starts at 1.75% of utility revenue and may increase up to 4% by 2033 if certain cost effectiveness thresholds are met

Stakeholder Engagement

auri
Agricultural Utilization Research Institute

Laborers' International Union of North America
LiUNA!
Feel the Power

Hispanics In Energy
BIOMASS COAL GAS HYDRO OIL NUCLEAR PETROLEUM SOLAR WIND

MMCA Minnesota Mechanical Contractors Association

Fresh Energy

THE COALITION FOR RENEWABLE NATURAL GAS

mui
MINNESOTA UTILITY INVESTORS

MWMO
Protect it. Pass it on.

ampAMERICAS

MINNESOTA PIPE TRADES

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

M-RETS
Renewable Thermal

CONSERVATION MINNESOTA

Xcel Energy
RESPONSIBLE BY NATURE

mn COMMERCE DEPARTMENT

cee
Center for Energy and Environment

DEM-CON COMPANIES

we
PARTNERSHIP ON WASTE AND ENERGY
HENNEPIN | RAMSEY | WASHINGTON

AMERICAN BIOGAS COUNCIL

ROESLEIN
ALTERNATIVE ENERGY, LLC

BIOECONOMY
COALITION OF MINNESOTA

Pilots to Be Included in First Innovation Plan

Thermal Energy Leadership Challenge

- Pilot thermal energy leadership challenge for small- and medium-sized businesses.
- Audits to identify steps businesses can take to reduce or avoid GHG emissions from natural gas usage, and incentives to take those steps.

High-Heat Industrial Processes

- Pilot to provide innovative resources for hard-to-electrify industrial processes.
- Dedicated hydrogen system?

District Energy

- Pilot largely undefined; can include research and development

Electric Air-Source Heat Pumps

- Pilot to facilitate deep energy retrofits and installation of cold climate electric air-source heat pumps with natural gas backups
- “Deep energy retrofit” means the residence operates at 10 BTU/hour/square feet or less

PUC Frameworks – June 1, 2022
Docket No. 21-566

(1) Life Cycle Assessments

- a general framework for the comparison of power-to-hydrogen, strategic electrification, renewable natural gas, district energy, energy efficiency, biogas, carbon capture, and power-ammonia according to their lifecycle greenhouse gas intensities; and

(2) Cost-Benefit Framework

- a cost-benefit analytic framework to be applied to innovative resources the commission will use to compare the cost-effectiveness of those resources and innovation plans.

Interconnection Basics

Access

- Process for producers seeking interconnection
- Quality standards for injection

Transport

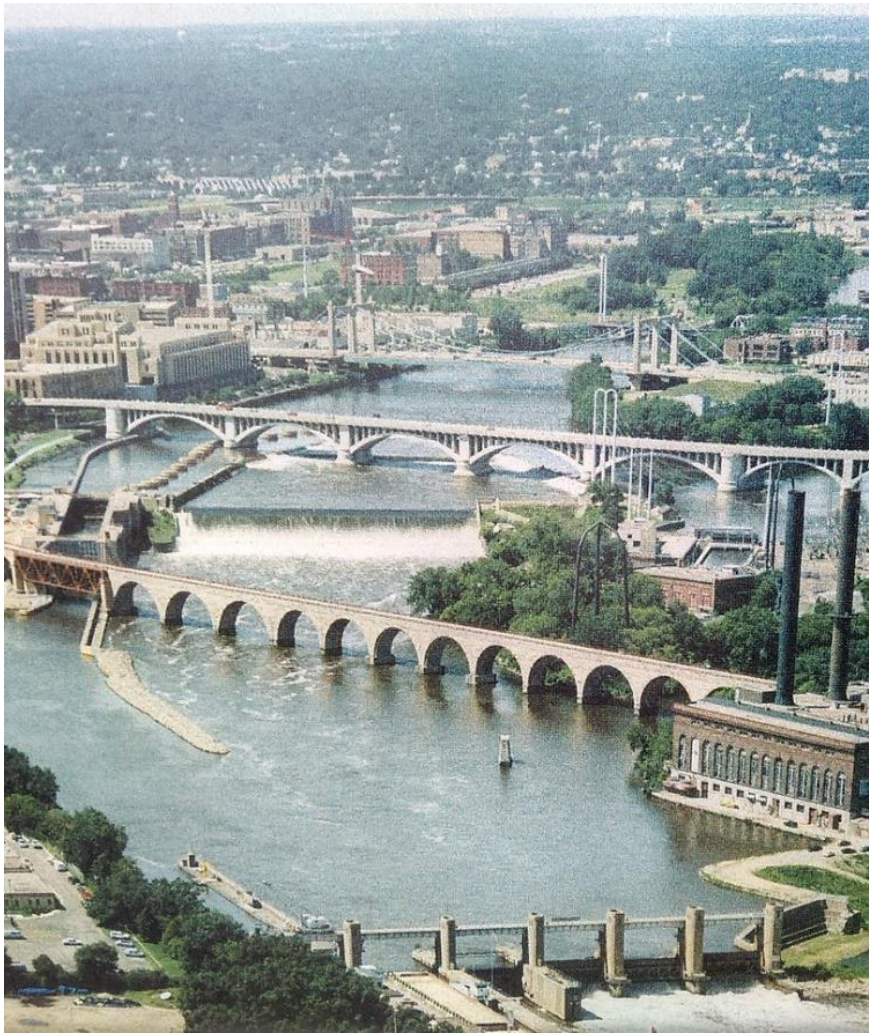
- CenterPoint Energy will not (necessarily) buy the RNG – will transport to interstate system for producer
- Will charge similar to existing transport tariff – a monthly basic charge, a volumetric “receipt” charge
- CenterPoint Energy will earn a return on investments to serve RNG developers similar to return for transport customers
  - Reduces the need for upfront payment by developer

Interconnection Approved Tariff

- PUC approved RNG Interconnection Tariff November 2020
- Declined to endorse quality standards, left that to CenterPoint
- Next Steps Specified
  - Develop a carbon accounting framework for interconnecting producers
  - Consider different pricing system for large producers

Hydrogen Pilot underway in Minneapolis

- 1 MW or renewable electrical power driving electrolyzer producing 7,500 SCFH of hydrogen
- Operated and maintained by CenterPoint peak shaving staff
- Located at an existing CenterPoint facility in downtown Minneapolis
- Will blend into CenterPoint's general gas supply
- Planned in-service date Q1 2022



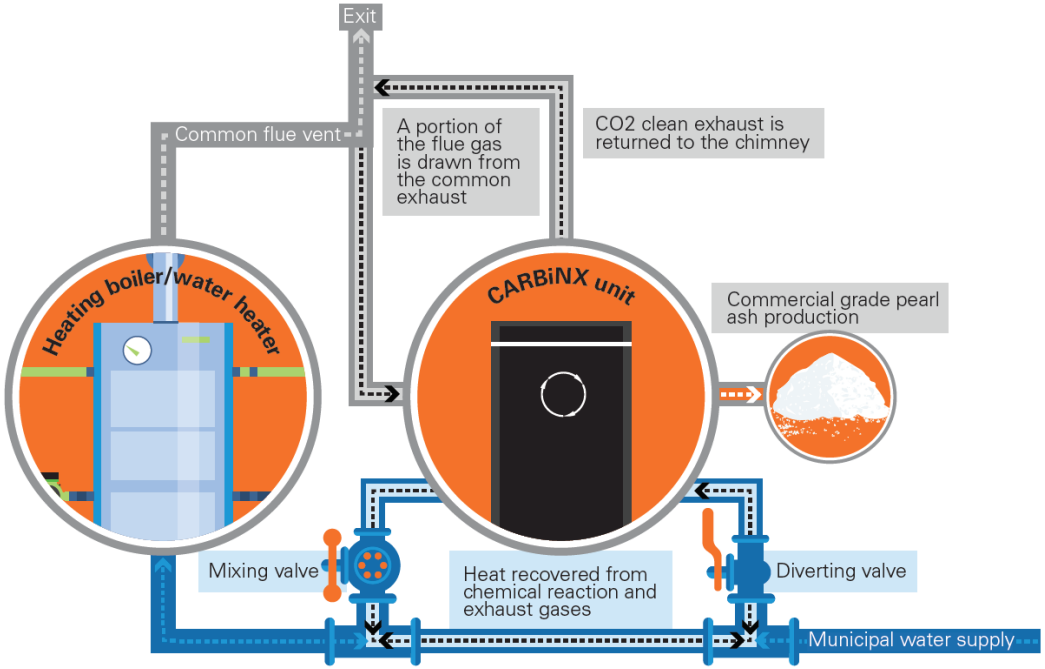
What is Carbon Capture and Recycling?

- **Carbon Capture Technology either:**
  - Prevents the CO_2 from entering the atmosphere from combustion
  - Removes CO_2 from the atmosphere
- **Traditional Carbon Capture and Storage**
  - Capture up to 90 percent of CO_2 emissions from fossil fuel combustion
  - Store compressed CO_2 underground in appropriate geological formations
- **Advanced Technologies**: Remove CO_2 directly from the atmosphere.
- **Minnesota Geology Prevents Local Storage**
- **Carbon Capture and Recycling**
  - Capture technologies enable the separation of a portion of CO_2 from fossil fuels during either pre- or post-combustion.
  - The captured CO_2 can then be used to manufacture fuels, building materials and more.

Carbon Capture & Heat Recovery – CleanO2 Technology

- **Canadian Company**
- **First decentralized commercial carbon capture device**
  - Boilers or hot water tanks
  - Hotels, malls, schools, hospitals, fitness centers, etc

- **Benefits to Customers**
  - Reduces up to 20% of CO2 emissions
  - Saves up to 20% in energy costs
  - Pearl ash profit sharing



Clean O2's CARBiNX™ technology

Sustainable Circular System

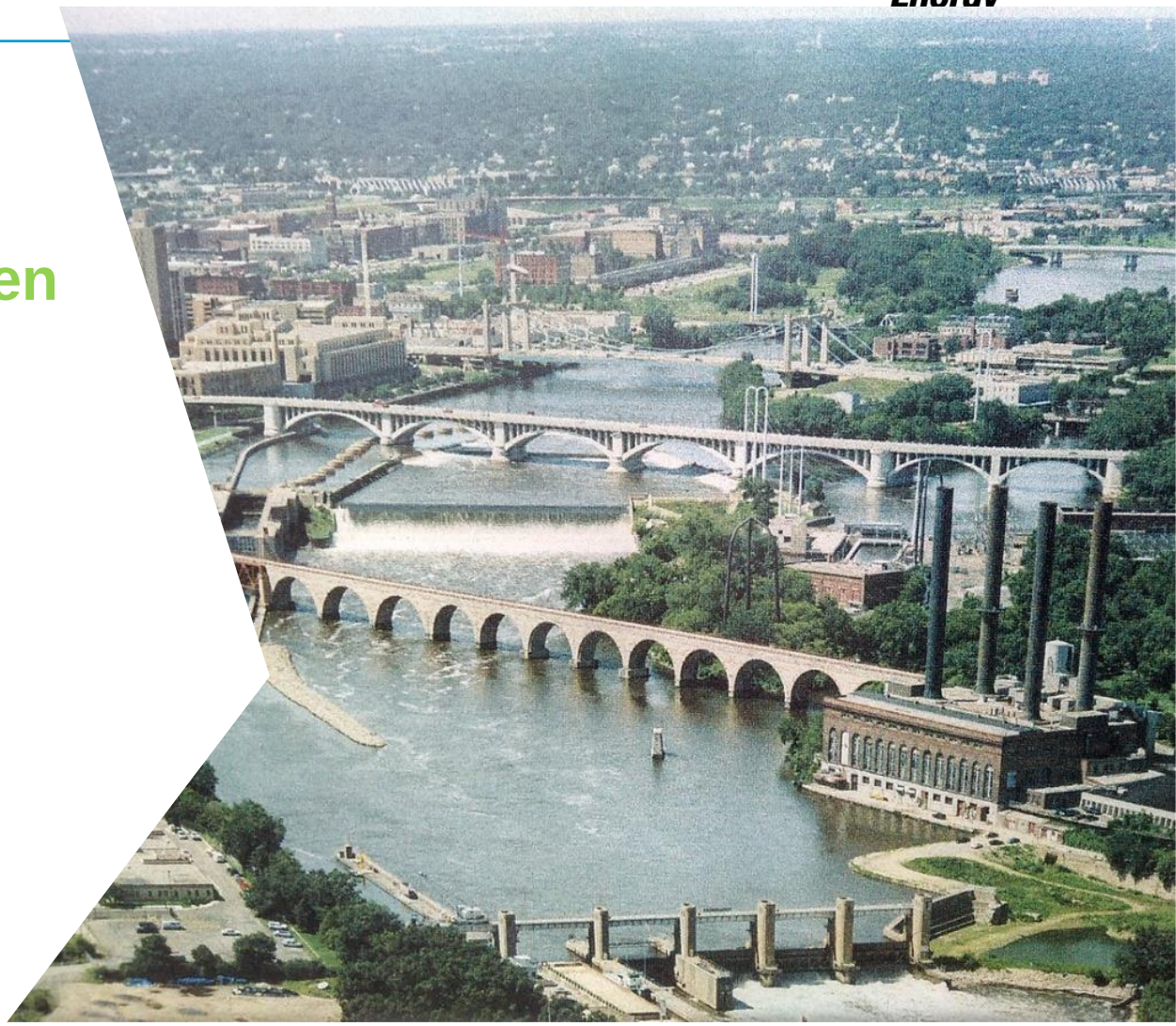
CenterPoint Energy Pilot Project (2021/2022)

- **Objectives**:
  - Measurement and verification
  - Facilitate adding the technology to or energy efficiency programs (or an innovation plan)
- **Benefits to customers:**
  - No cost equipment and installation
  - No risk participation
  - Can choose to keep the equipment post-pilot
- **Next Steps:**
  - Obtain permit for the first unit from the Department of Labor and Industry
  - Installations in 2022
  - Data collection in 2022

CleanO2 carbon capture technology

Questions & Answers

Minnesota Hydrogen Project

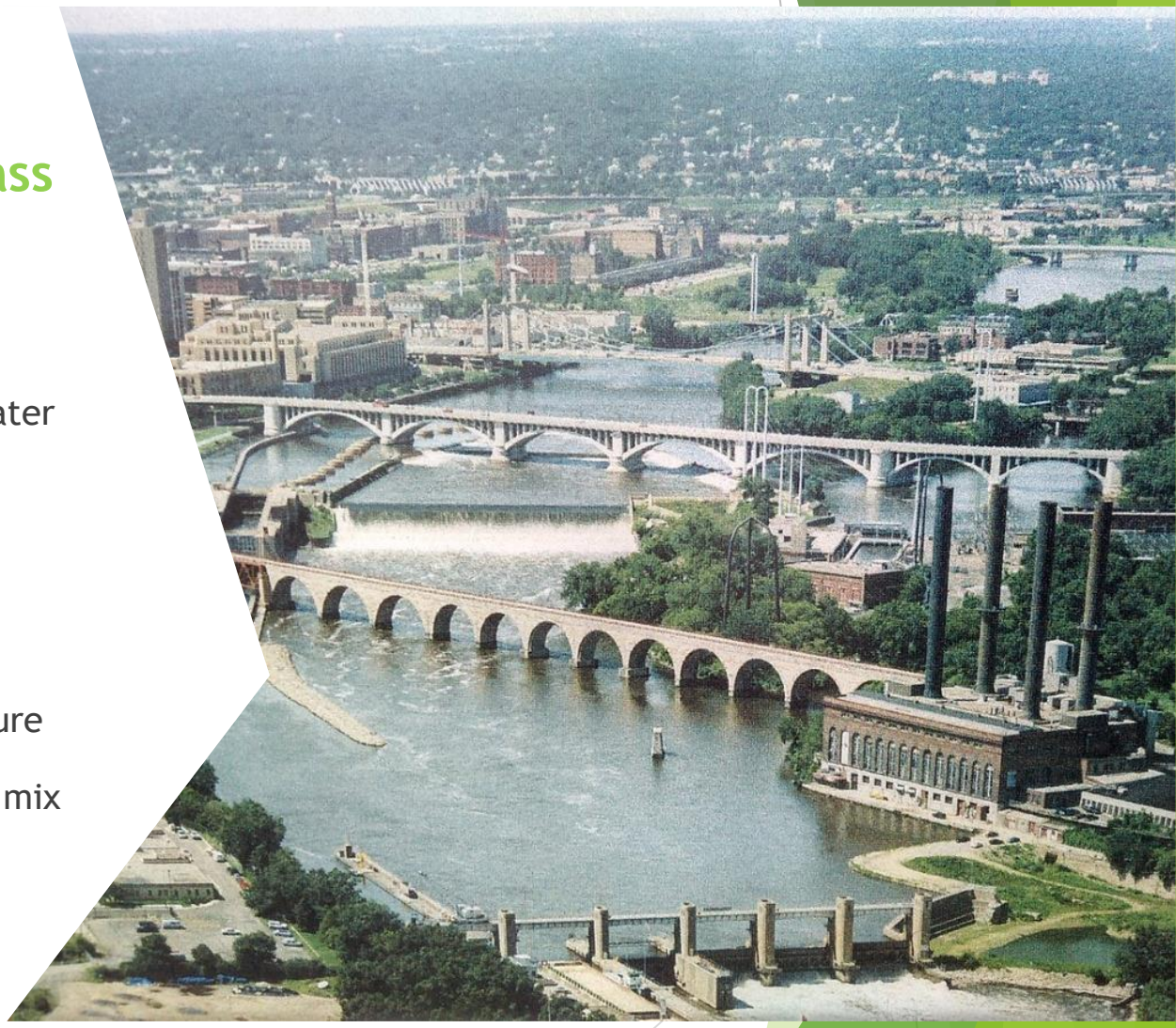


John Heer, P.E.
Director, Storage and Supply Planning

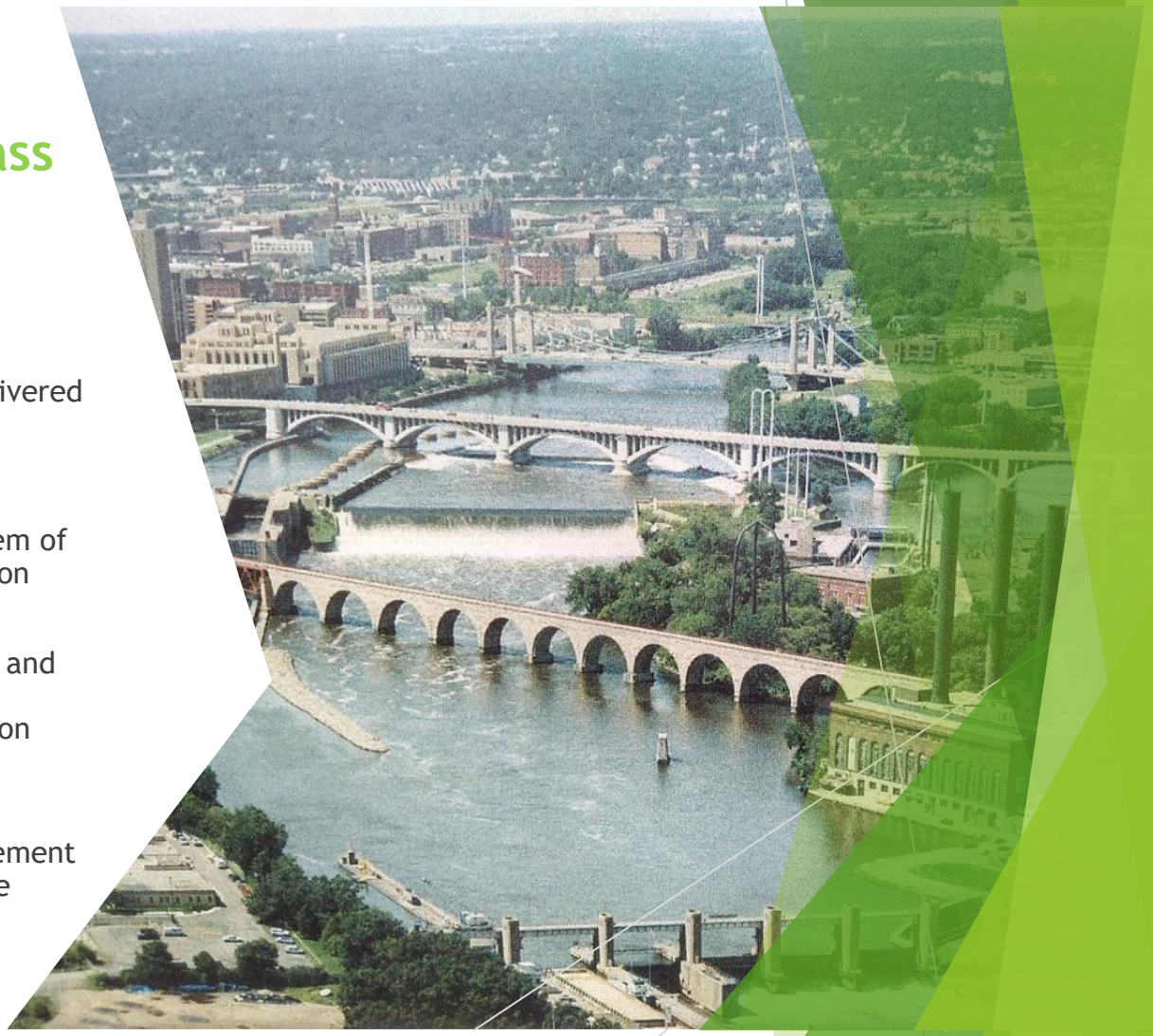
CenterPoint Energy Hydrogen Megawatt Class Hydrogen Pilot Plant

Scope of Project

- Hydrogen to be produced by water electrolysis
- Renewable electricity used for powering the Electrolyzer
- Hydrogen mixed into low pressure natural gas distribution system controllable at low percentage mix



CenterPoint Energy Hydrogen Megawatt Class Hydrogen Plant

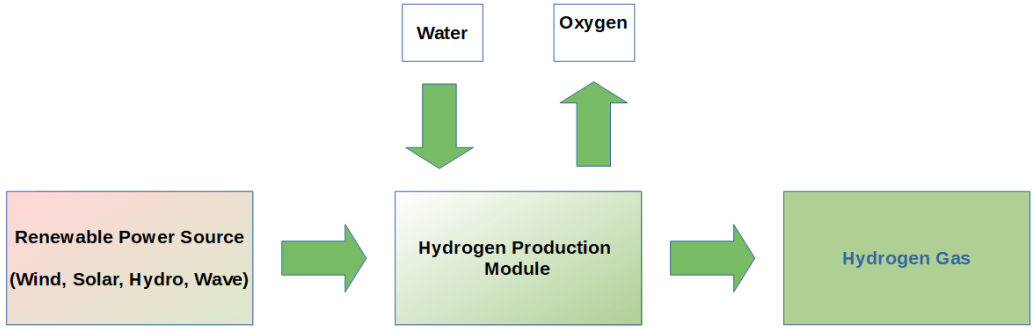


Goals of Project

- Reduce the carbon content of our delivered energy
- Learn from direct experience
- Study effects on the distribution system of various low levels of hydrogen injection
- Educate stakeholders about hydrogen and potential scaling of hydrogen as supplemental gas in the gas distribution system
- Educate our employees, create excitement and demonstrate CNP as an innovative company.

The Hydrogen Production Concept

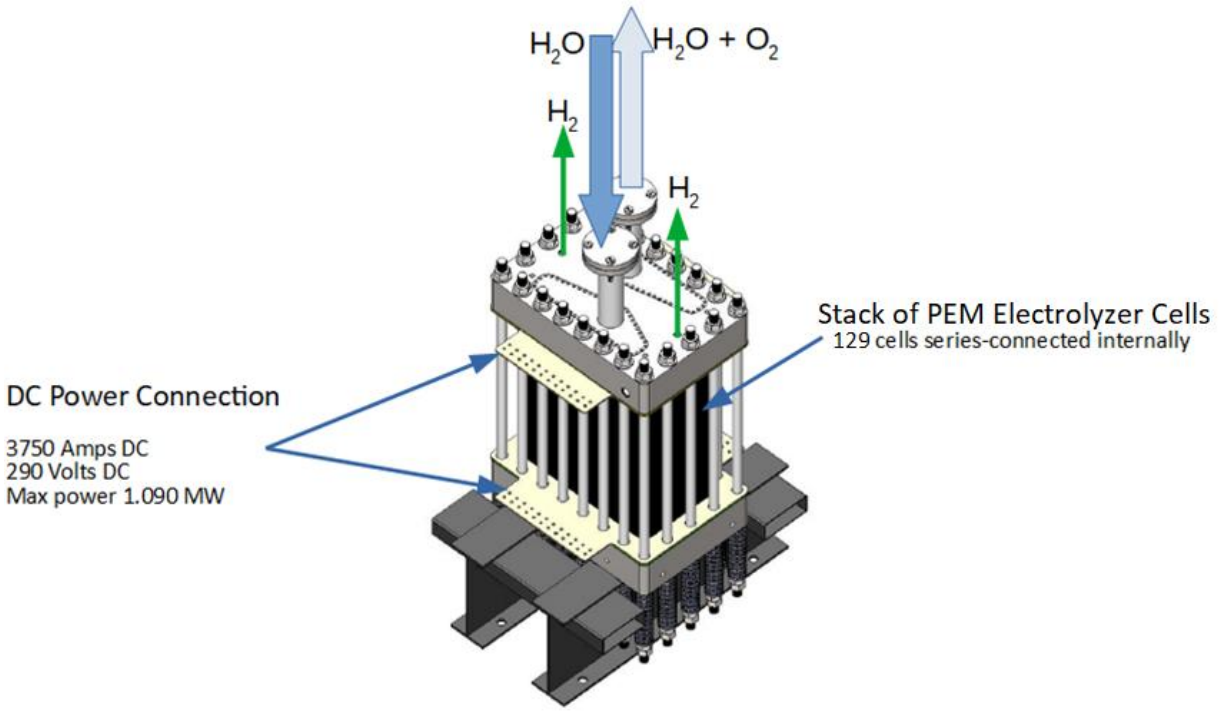
- **Zero-carbon energy conversion process**: from the renewable source to the hydrogen injected into the distribution system
- Water used as feedstock to produce hydrogen with renewable energy
- Showcase:
  - Decarbonization technologies
  - Demonstrating the production and use of next generation gaseous fuels



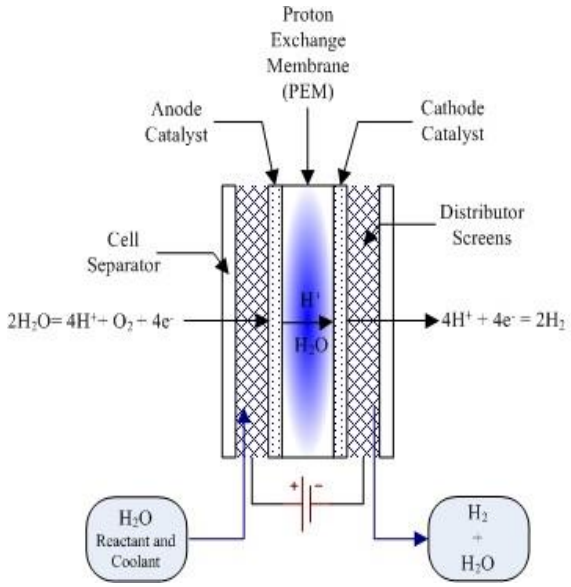
Hydrogen Production Package

- Up to 1 Megawatt of renewable electrical power to drive production of up to 2.5 Dth/Hr of hydrogen (18KG/Hr)
- Water usage: 2 gpm
- Turn down 10:1, allowing the injection percentage control
- PEM electrolyzer design with extremely rapid control response
- USA supplied electrolyzer with system design and packaging by a Minnesota company

Electrolyser Stack



Technical Principle of the PEM-Based Water Electrolyser



PEM Cell Reactions

$H_2O \rightarrow 2H^+ + 2e^- + \frac{1}{2}O_2$ Anode half-cell reaction

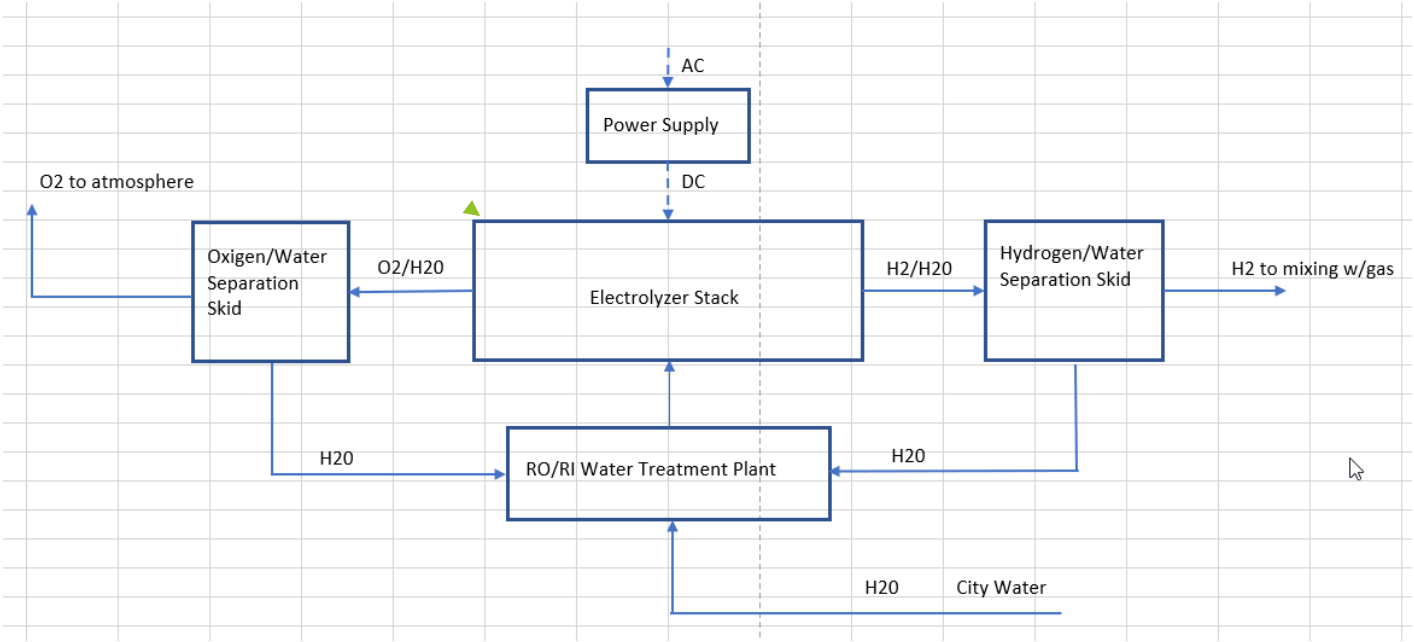
$2H^+ + 2e^- \rightarrow H_2$ Cathode half-cell reaction

$H_2O + 2e^- \rightarrow H_2 + \frac{1}{2}O_2$ Overall reaction

Water permeation through PEM

$\sim 3H_2O/H+$

Hydrogen Production by Electrolysis from Clean Water



Hydrogen Production by Electrolysis

GENERAL CONCEPT

- Hydrogen production by electrolysis. Installation centered around Electrolyzer stack (proton-exchange membrane electrolyzer).
- 18 kg/h (7,590 scfh) max H2 production at water consumption of 2 gpm and 1MW electric consumption. 200 gpm water circulates to cool down the stack.
- H2 produced from stack at 580 psig and 50 deg F dew point and then passes though additional drying.
- 142 kg/h of O2 at 30 psig will be vented to atmosphere.
- Power supply – direct current; 1MW water cooled IGBT rectifier provides a current 0 to 3750A, voltage range 0 to 290 VDC; 3ph 480V at 60 Hz as a supply.

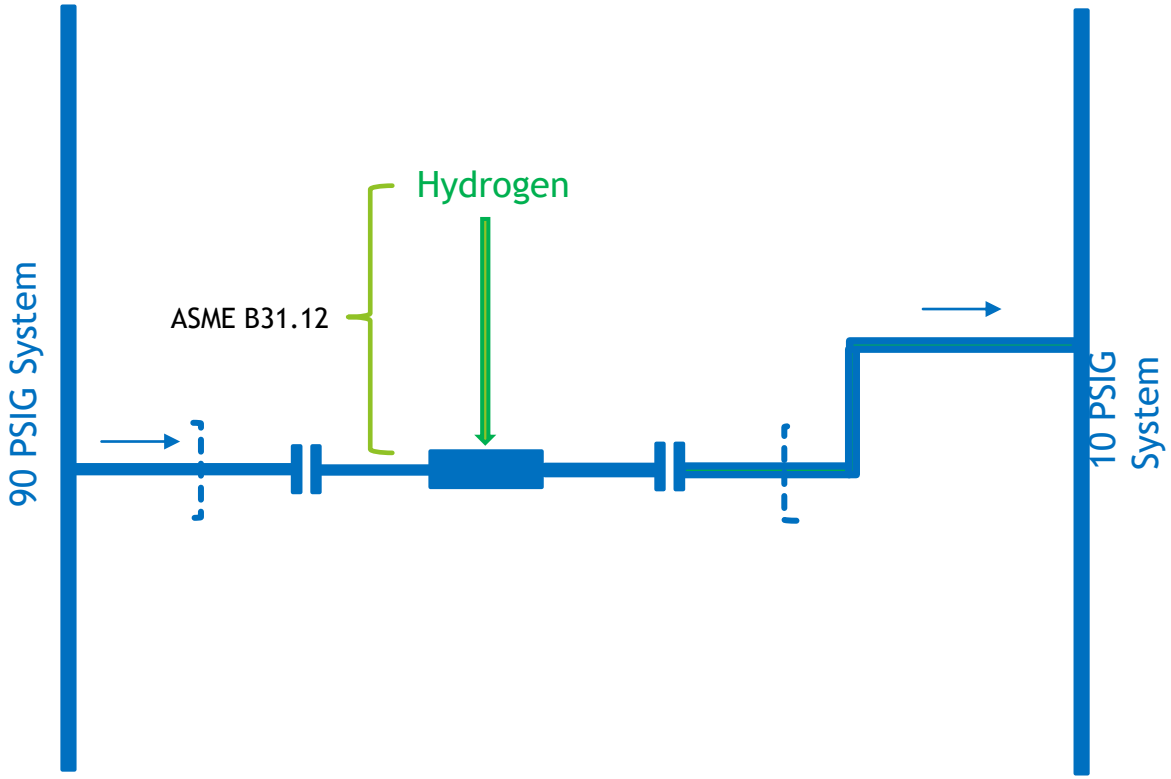
Supporting Equipment: Hydrogen Handling

- **Hydrogen is produced at a pressure of up to 600 psig**
- **Output**: 99.97% hydrogen content.

Distribution System Injection

- **Mixed into 10 psig distribution system.**
- **Injected at a large 90 psig to10 psig district regulator station**
- **Will be mixed up to 5% H2 by volume with starting levels at 1% to 2%**
- **Natural gas in Minnesota already contains up to 0.25% H2 from pipeline supply**

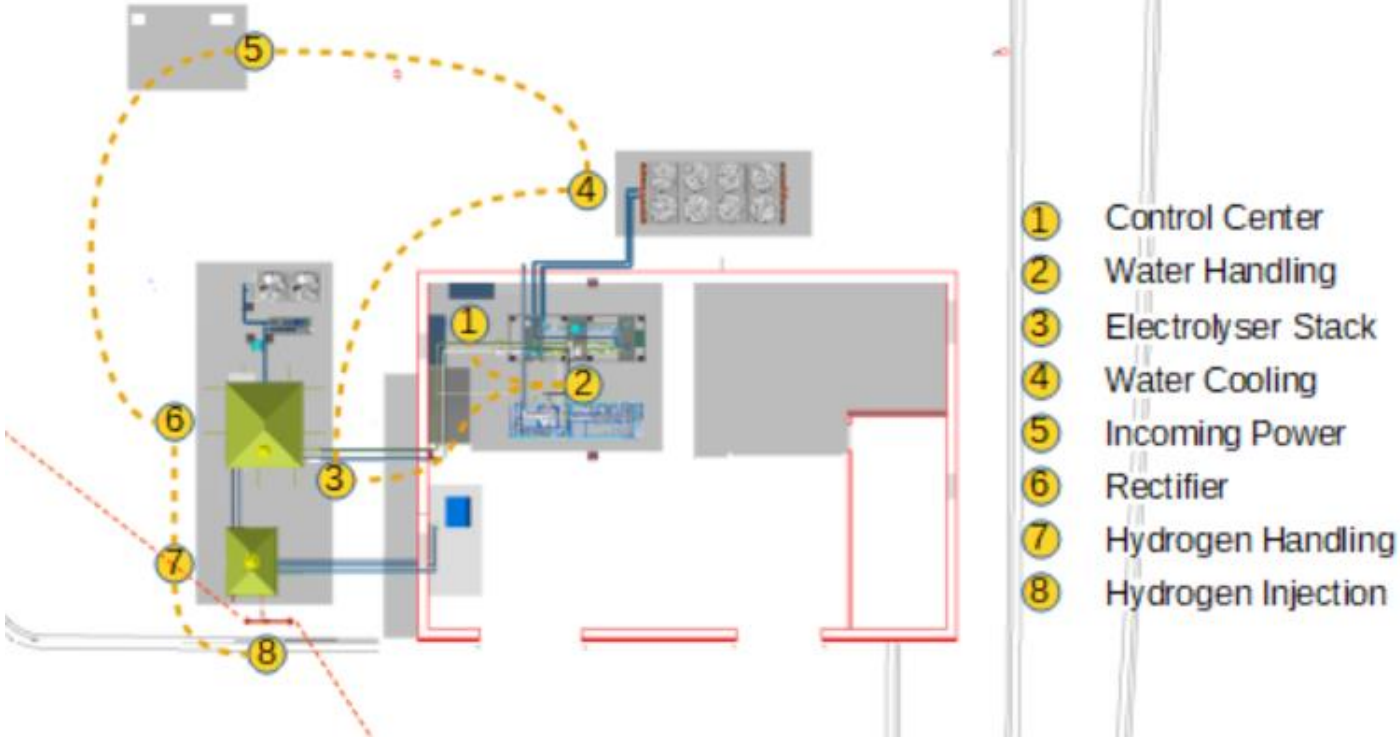
Injection Design



Some Safety Considerations

- Rigorous PHA conducted and reviewed by CenterPoint Energy and its system design engineering company personnel
- No hydrogen storage in the system design.
- CenterPoint Energy's Minnesota natural gas distribution system has had low levels of hydrogen in its supply for many years at levels of about ¼%. (from North Dakota gas supply)
- Hydrogen injected into a low pressure, low stress, 10 psig distribution system.
- CenterPoint Energy's has decades of experience with supplemental gas interchangeability limits and customer impacts.
- Pilot will provide opportunities for additional research.

Hydrogen Pilot Plant Layout



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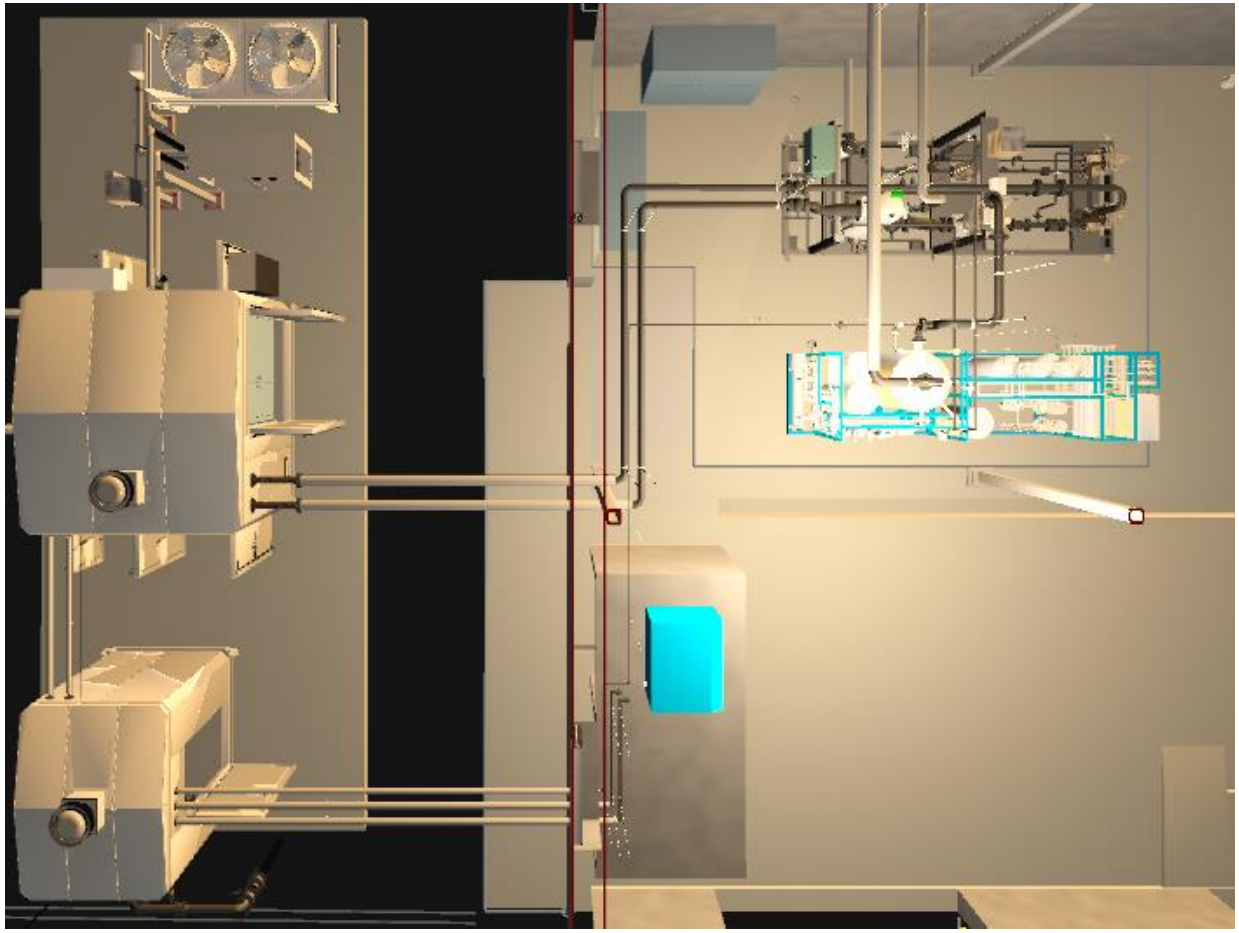
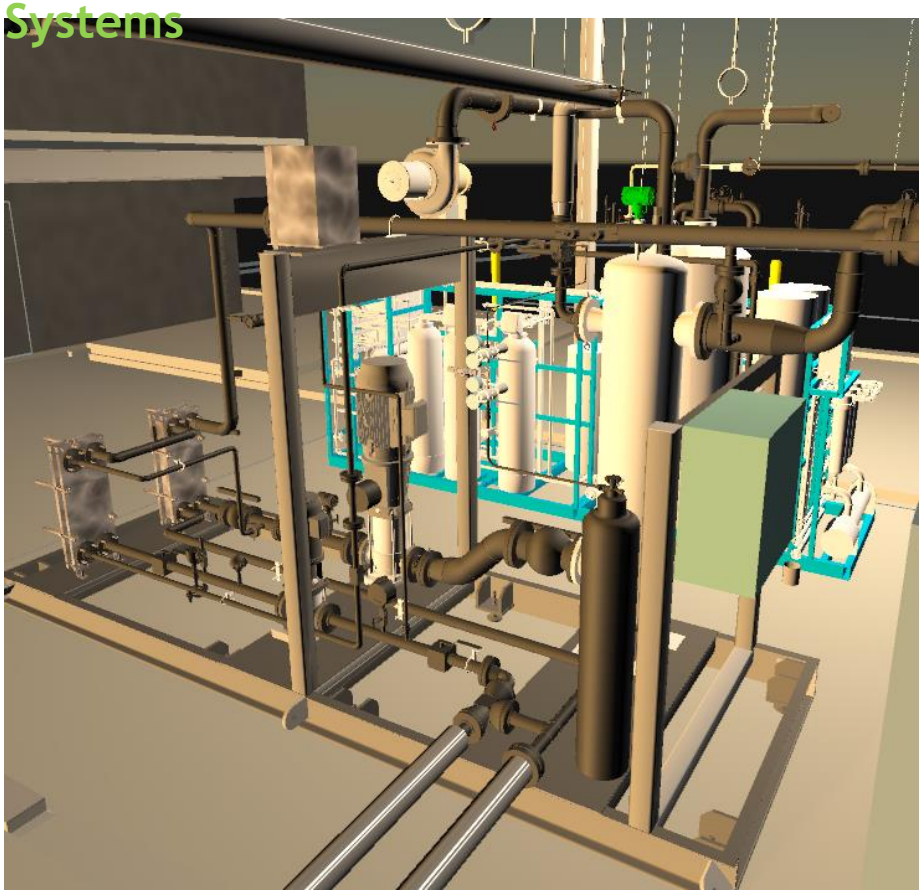


Hydrogen Pilot Plant Layout:

- Consists of a single electrolyser stack / power supply unit. Design allows for expanded capacity with multiple stacks.

Hydrogen Production

Hydrogen Production Support Systems



Water Treatment

Oxygen Separation

Cooling Systems

Why Pilot a Hydrogen Program at CenterPoint Energy?

- Nuclear Power and Solar Power both began circa 1954
  - Nuclear power cost has skyrocketed
  - Solar power cost has dropped so far it is now one of the most competitive sources of electricity

"Of the many reasons for this, one is the benefit brought by extended small-scale experimentation. Energy technologies cannot be magicked into being fully formed, …..; they need an adolescence."

The Economist, 9 January 2021