WEC Energy Group

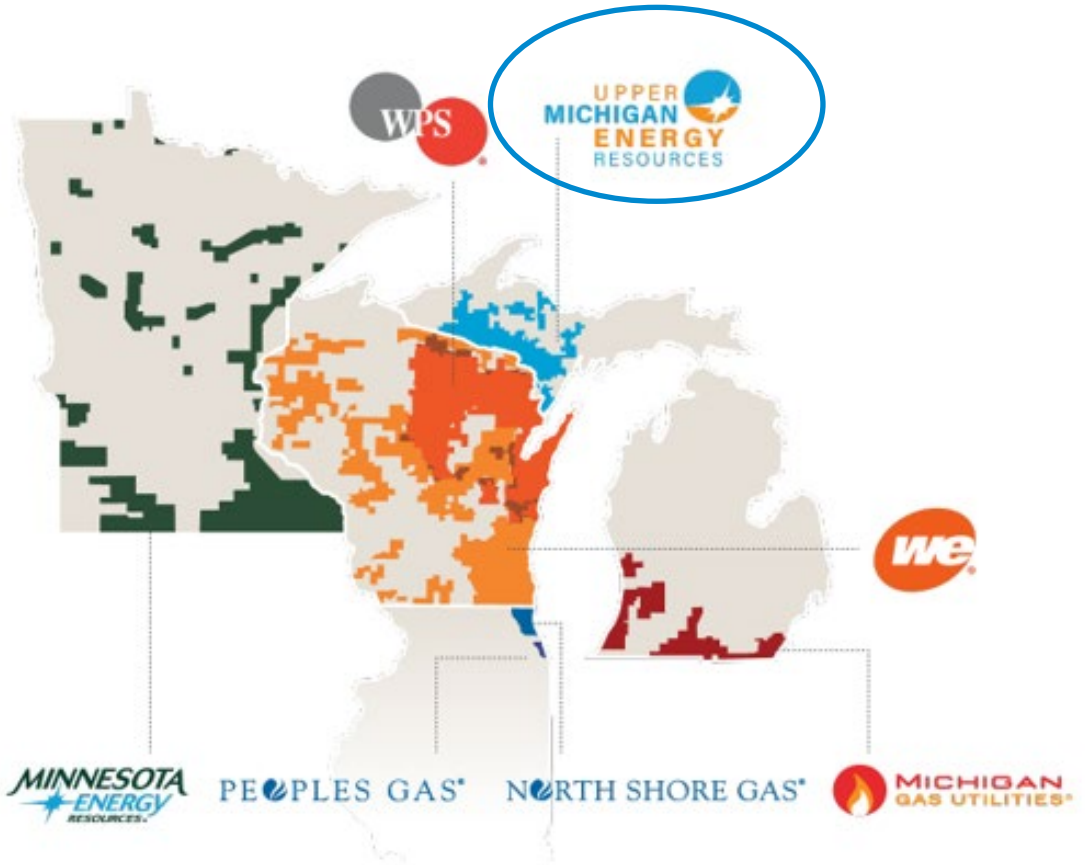
Use of Hydrogen-Natural Gas In Electricity Production:

A case study in the UP of Michigan

WEC Energy Group

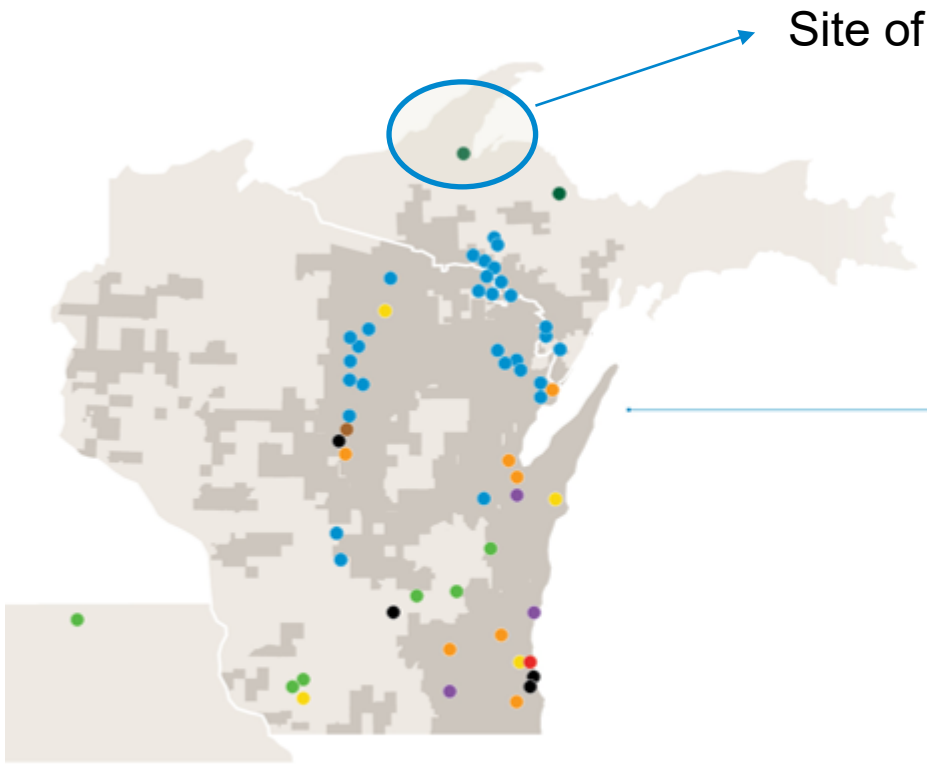
The Premier Energy Company in America's Heartland

- **$28.0** billion market cap*
- **4.6** million retail customers
- **60%** ownership of American Transmission Company
- **$41.9** billion of assets



* As of Feb. 28, 2023

Power Generation: Utility (WPS, WE, UMERC)



- Biomass (fluidized bed boiler): **1**
- Coal: **4**
- Combustion turbine: **7**
- Combined cycle: **3**
- Gas-driven steam turbine: **1**
- Hydroelectric: **30**
- Reciprocating internal combustion engine: **2**
- Wind: **6**
- Solar: **4***

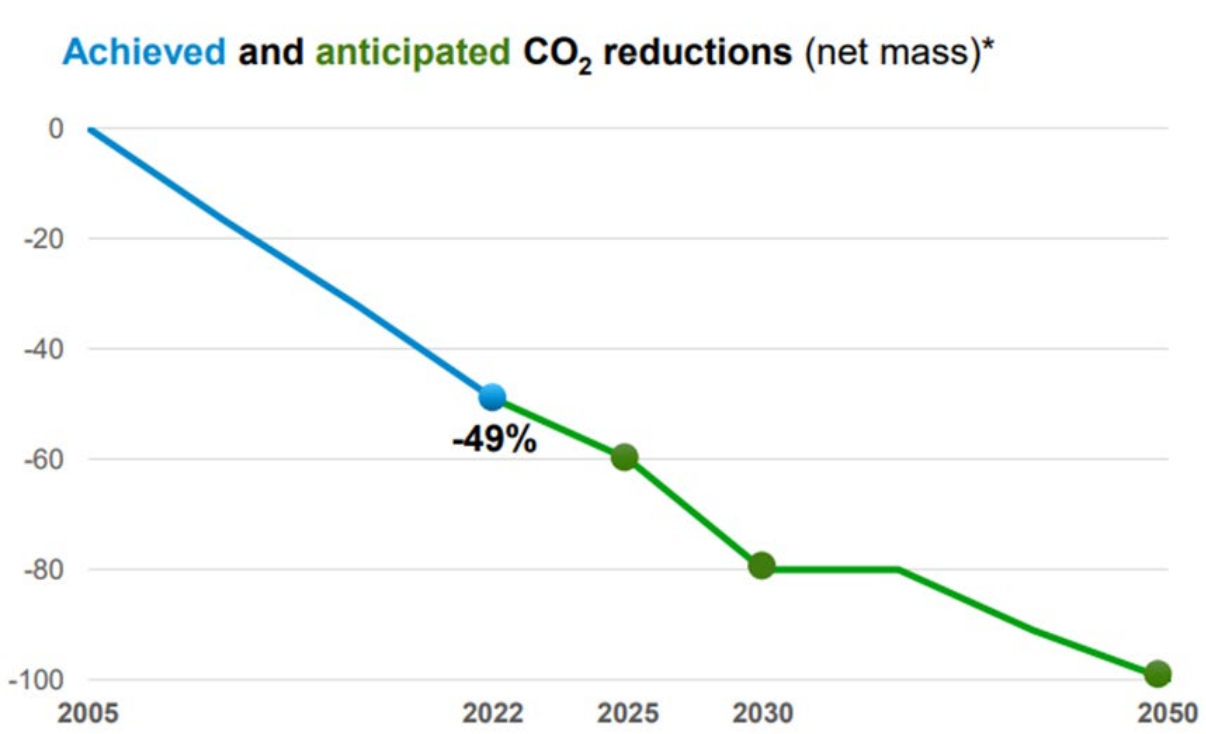
As of March 2023

WEC Strategy

- Meet investor and customer expectations relative to “ESG” with a plan for “*ESG*”
  - Global understanding of “ESG”
    - Environment, Social, and Governance
  - WEC strategy “ESG”
    - Efficiency, Sustainability, and Growth
      - Environmental Goals
      - Generation reshaping
      - Investments in clean energy and reliability projects
      - Must support “ARC” = Affordable, Reliable, and Clean energy

WEC Strategy: Environmental Goal

Carbon Reduction Goals – Electric Generation



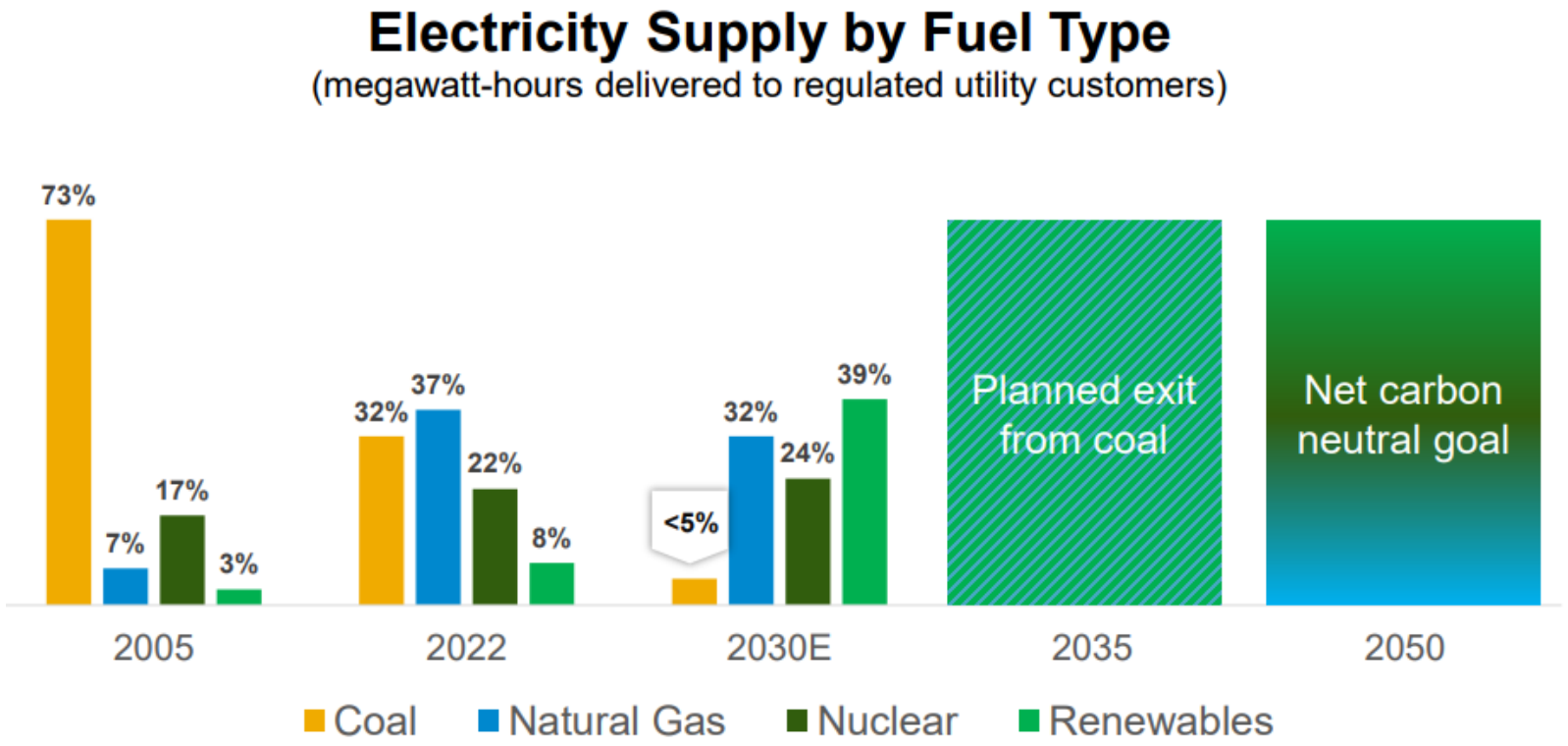
Reduction goals:

60%
below 2005 levels by the end of 2025

80%
below 2005 levels by the end of 2030

Net carbon neutral
by 2050

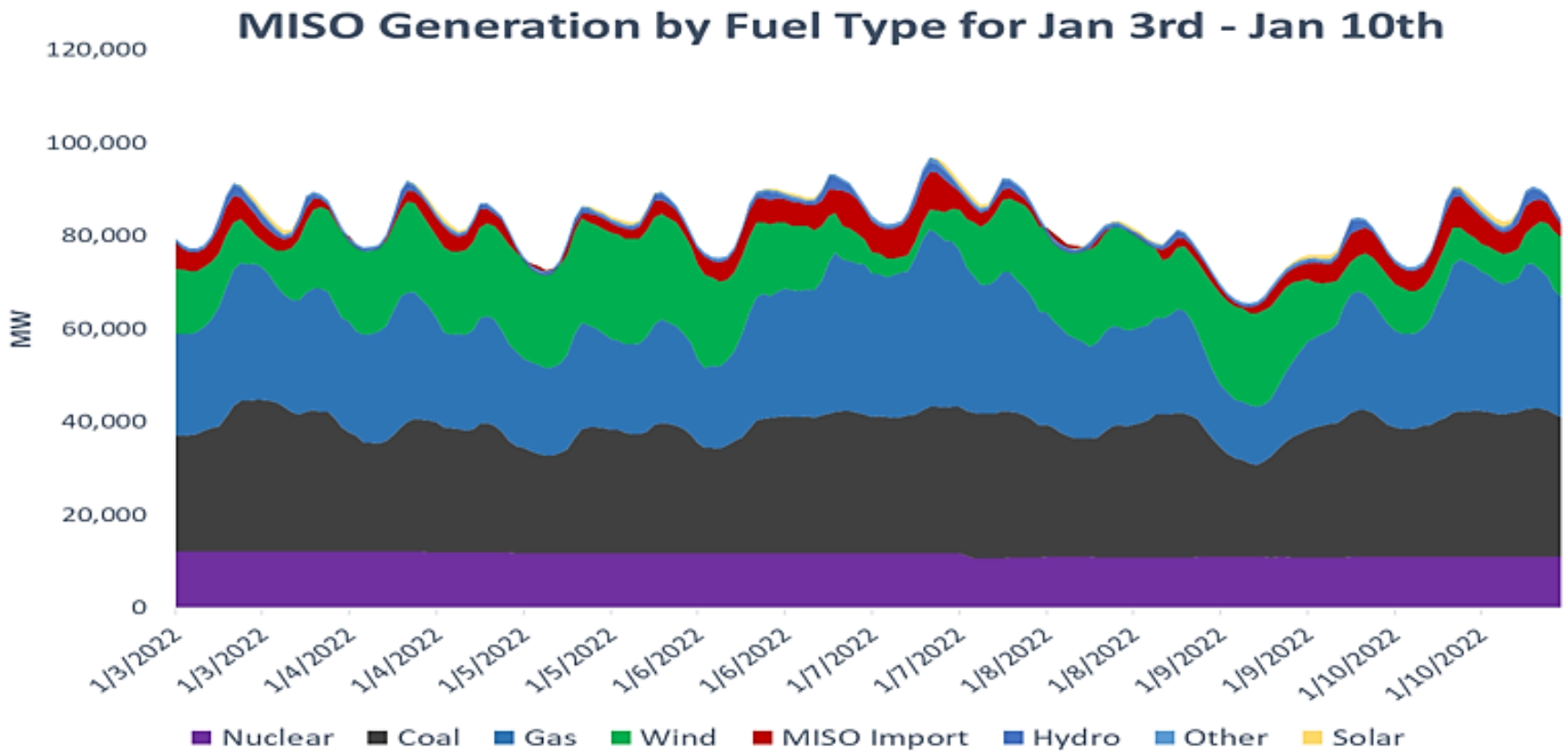
Shifting energy mix lowers CO2; but what about reliability?

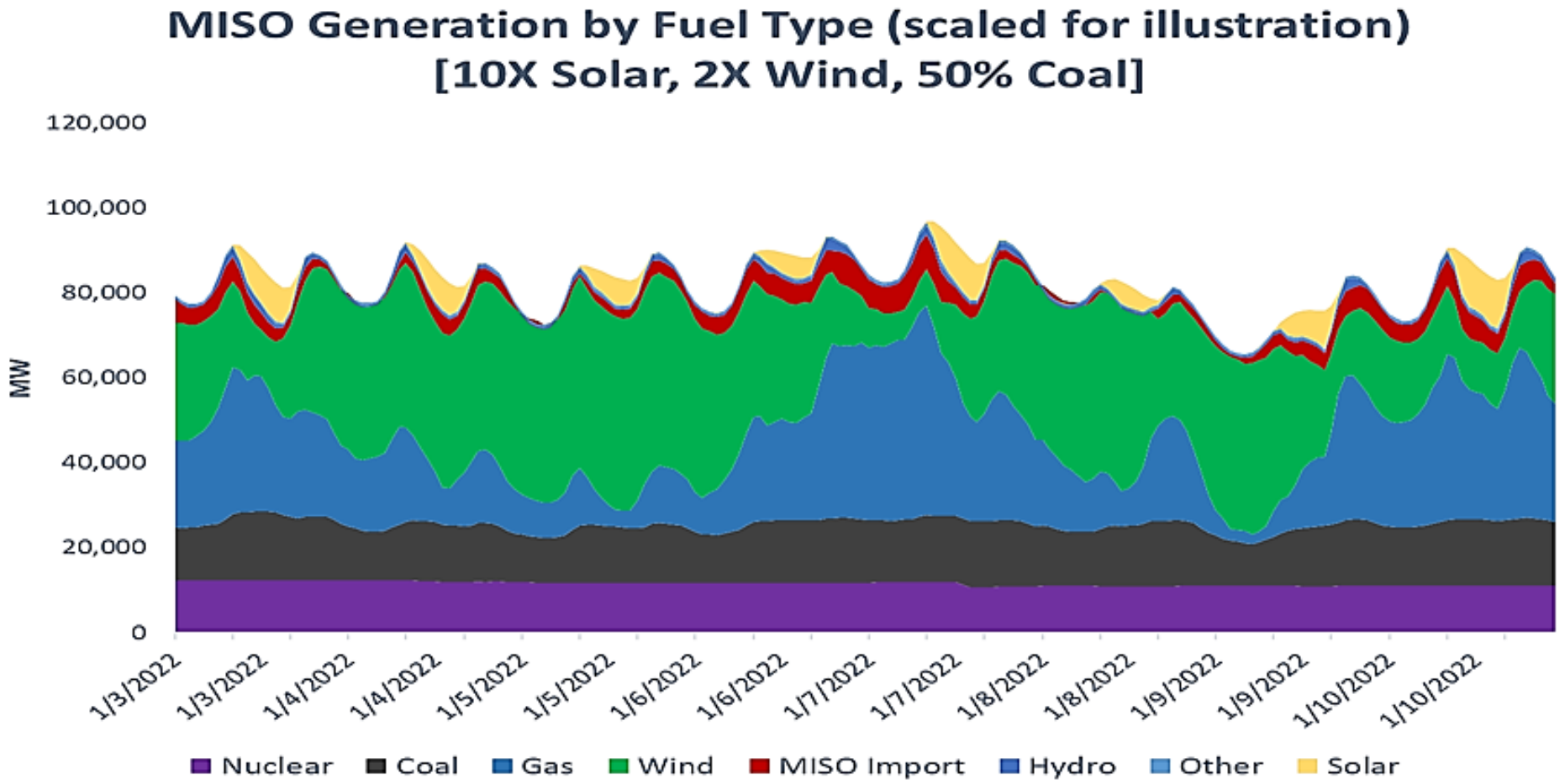


Our natural gas fired generation is the key to enabling renewable generation investment and CO2 reductions while maintaining grid reliability.

Grid operation…. supply must equal demand at all times

- The mission for our natural gas fleet is to enable the success of our renewable energy investments by maintaining reliability
  - Natural gas generation reliability and dispatch flexibility
  - Coal plant fuel flexibility (natural gas co-firing)





Natural gas assets provide the reliability bridge, but what about net zero CO2?

- Ensure those generating assets are fuel flexible with hydrogen!
  - Meeting the on-demand needs of the grid
  - Not contributing CO2

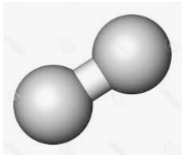
Reciprocating Internal Combustion Engines

Perfect fit for the grid of the future

- High dispatch flexibility
  - Fast start
  - Good on automatic generation control (AGC)
  - Inherent reliability via multiple smaller units
- Efficient
  - Heat rate better than simple cycle combustion turbine
  - A little worse than a combined cycle (about equal to duct firing)
  - Maintains efficiency at part load
- Lean O&M
  - Low fixed costs
  - Remote operation
  - Consumables and parts closely matched to operating hours
- Fuel flexible (natural gas and hydrogen)

Fuel attribute comparison

Hydrogen (H_2)



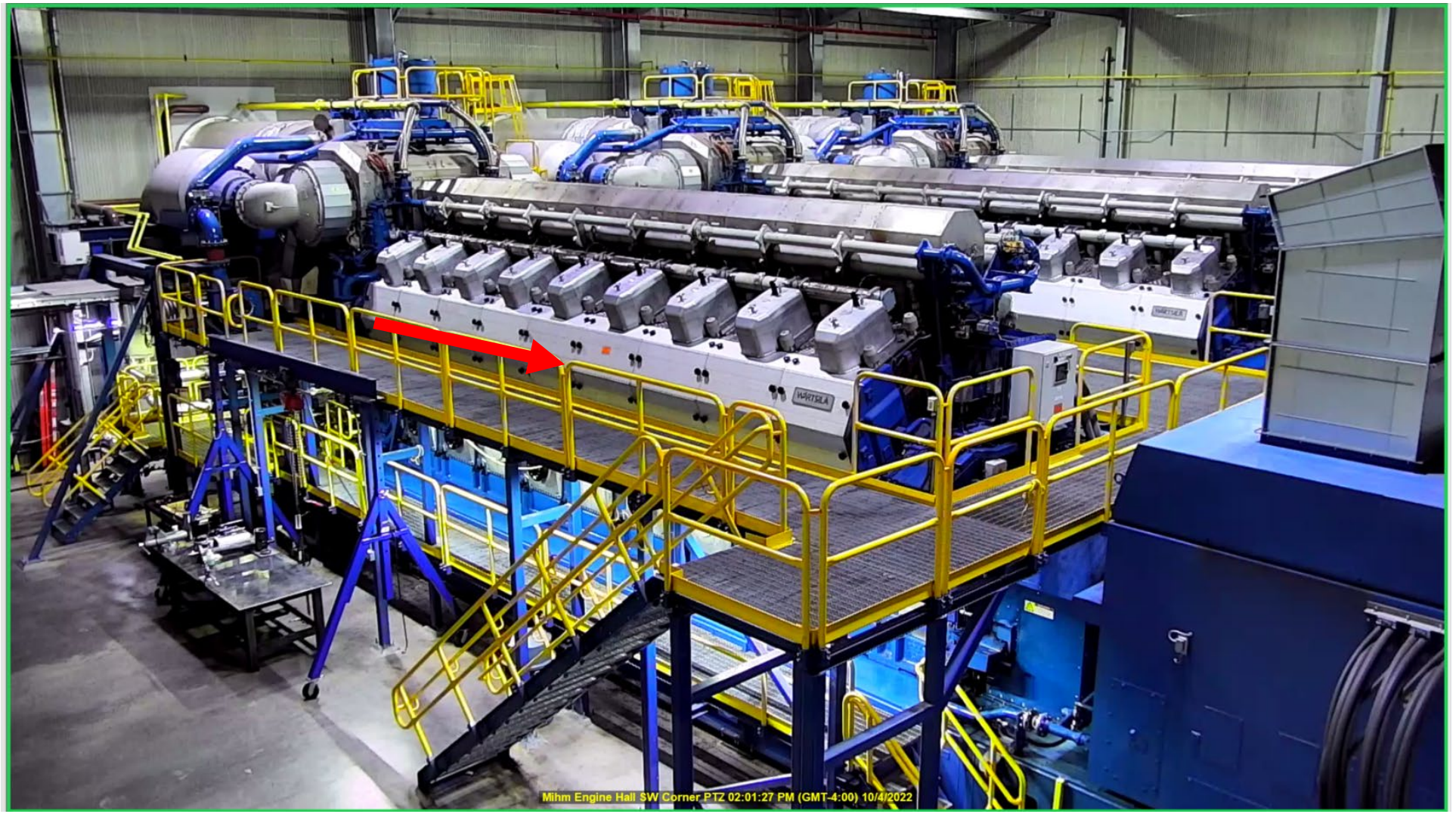
Natural gas (methane – CH_4)

	Hydrogen	Natural Gas	Notes
Symbol	H_2	CH_4	Hydrogen has no carbon
Mass (g/mole)	2	16	Hydrogen is smaller/lighter
Flammability limits	4% to 70%	7% to 20%	Higher % easier combustion
Flame speed	250	35	Faster speed has control challenges
Heating value (btu/ft^3 LHV)	266	881	Hydrogen volume needs 3 to 1 to replace natural gas
Primary emissions	H_20	CO_2	Hydrogen main output water
Other emissions	NO_X	NO_X	Expect higher NO_X with hydrogen

Purpose of the pilot

- Begin the process to determine potential for grid-scale RICE units to run on hydrogen
  - Start with a blend of 25% hydrogen and 75% natural gas by volume
  - Determine safety and process methods
  - Measure engine performance
    - Output
    - Efficiency
    - Emissions

Mihm Plant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Hydrogen storage

Emission controls and monitoring

Results

- ✓ Safety protocols followed
- ✓ Equipment handled hydrogen without leaks
- ✓ Engine controls adapted to hydrogen blends ranging from 10% to 25% by volume
- ✓ Engine efficiency was maintained throughout test
- ✓ NO_X increased off engine as expected
- ✓ Emissions controls equipment removed added NO_X
- ✓ CO_2 emissions decreased with increasing hydrogen blend as expected

The Team

- WEC Energy Group
- Electric Power Research Institute (EPRI)
- Wartsila
- Burns and McDonnell
- Certarus

Q&A