Demonstration of electrolyzer operation at a nuclear plant to allow for dynamic participation in an organized electricity market and in-house hydrogen supply

2019 Fuel Cell Seminar
H2@Scale Meeting, November 5, 2019

Exelon

$21B

Being invested in utilities through 2021

$52M

In 2017, Exelon gave approx. $52 million to charitable and community causes

#1

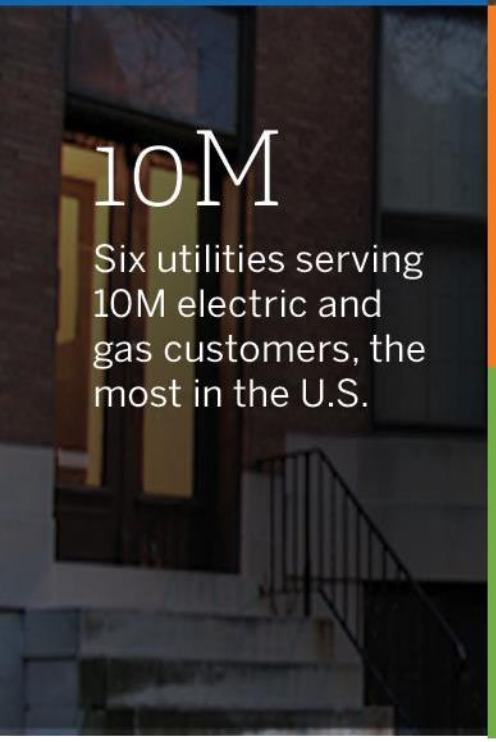
zero-carbon energy provider in America

210 TWh

Customer load served

35,200

Megawatts of total power generation capacity



10M

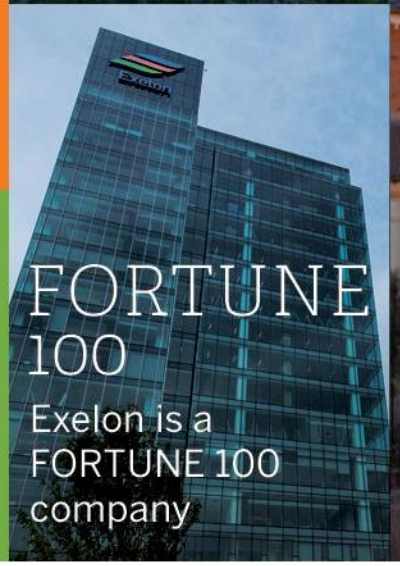
Six utilities serving 10M electric and gas customers, the most in the U.S.

34,600

employees

$33.5B

Operating revenue in 2017

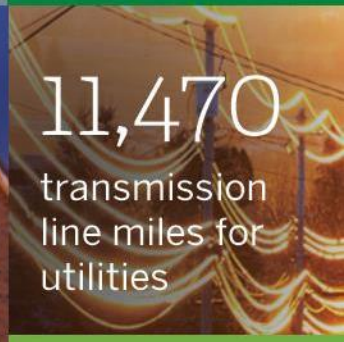


FORTUNE 100

Exelon is a FORTUNE 100 company

2M (Approx.)

Exelon's Constellation business serves residential, public sector and business customers



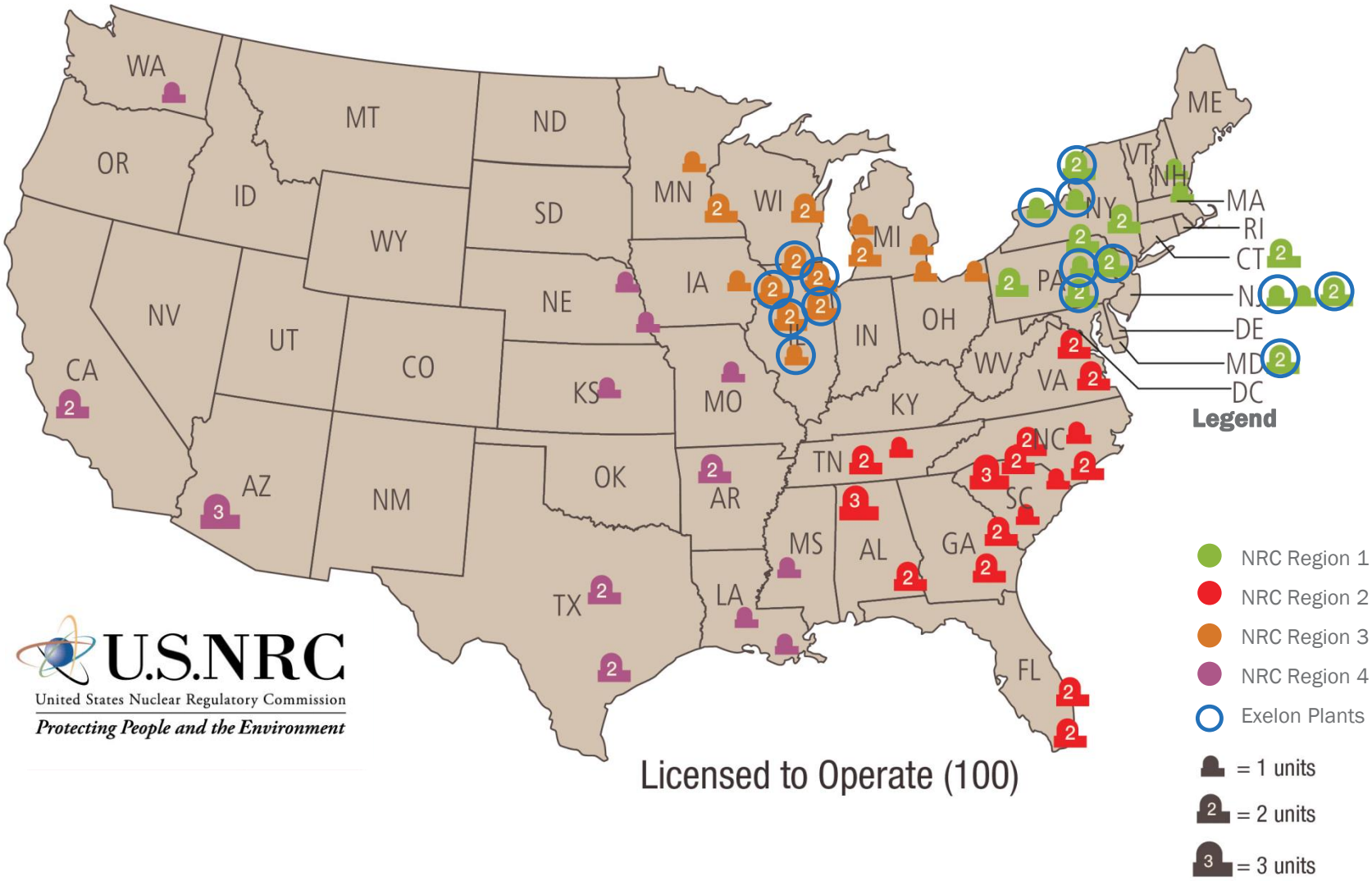
11,470

transmission line miles for utilities

9.5M

Smart meters installed

Exelon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VT
NH
MA
RI
CT
NJ
DE
MD
DC
Legend
NRC Region 1
NRC Region 2
NRC Region 3
NRC Region 4
Exelon Plants
= 1 units
= 2 units
= 3 units
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment
Licensed to Operate (100)

Natural gas prices (which fuels marginal generators in many regions) have dropped by more than 50%

Load growth is down due to both the economy and increased energy efficiency programs

Renewables penetration has suppressed wholesale energy prices in some regions

Across the U.S. nuclear fleet, operating costs have increased (albeit with reductions in recent years)

Exelon

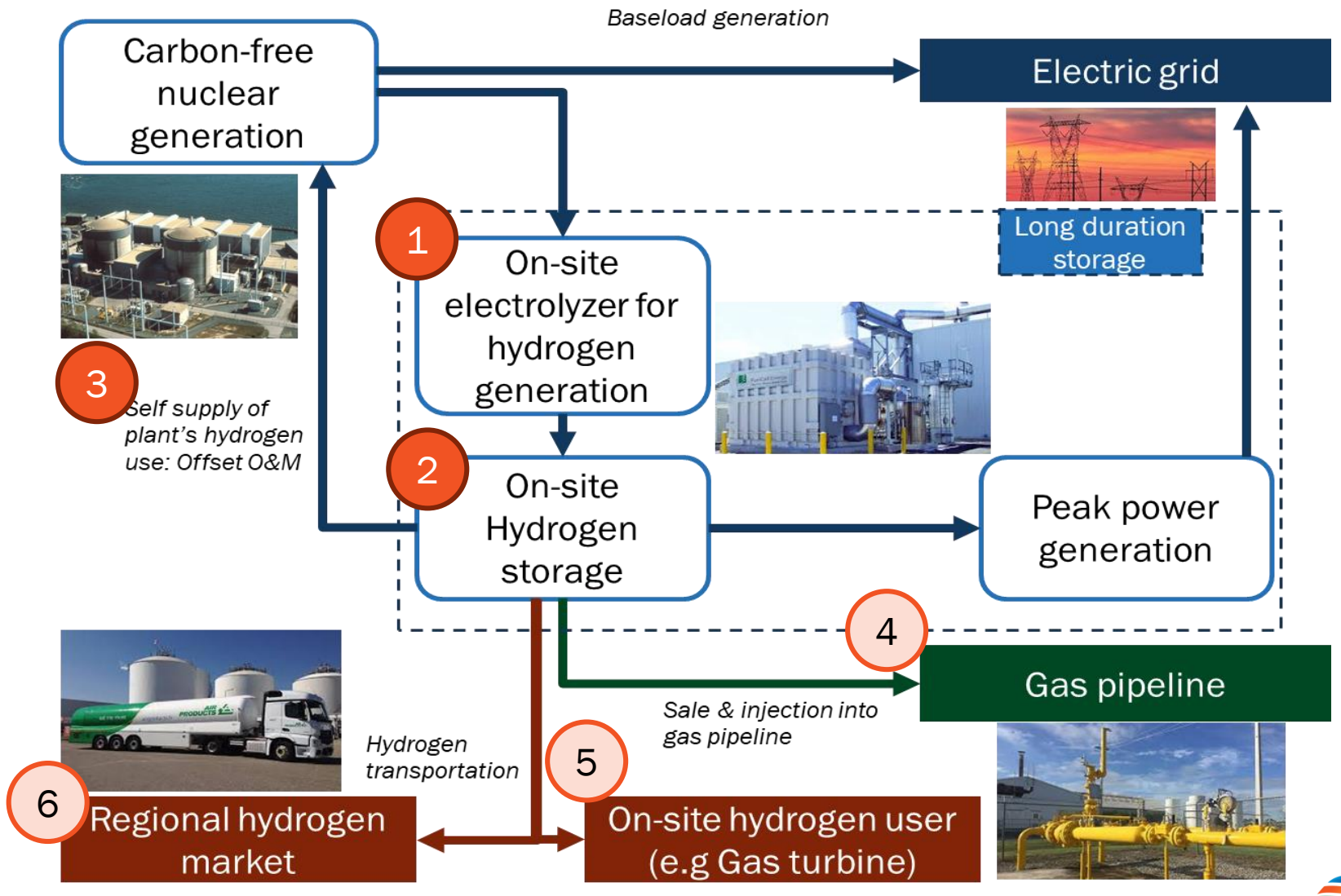
Between 2013 and 2014, **four nuclear plants that generated more electricity than all solar electricity produced in the U.S.** in 2014 were prematurely closed. Their closure resulted in the **carbon dioxide equivalent of adding three million new cars on the road**.

If all at-risk reactors close, the US will **lose the power equivalent of five times all solar power generated** in 2015, and emissions will rise, adding the carbon dioxide-equivalent of **13 million new cars on the road**.

Nuclear plants generally employ **400 – 700 workers each**, at salaries that are more than **30% higher than typical wages** in their areas.

*EnvironmentalProgress.org

Exelon


Baseload generation
Carbon-free nuclear generation
Electric grid
Long duration storage
1
On-site electrolyzer for hydrogen generation
3
Self supply of plant's hydrogen use: Offset O&M
2
On-site Hydrogen storage
Peak power generation
4
Gas pipeline
Sale & injection into gas pipeline
Hydrogen transportation
5
6
Regional hydrogen market
On-site hydrogen user (e.g Gas turbine)

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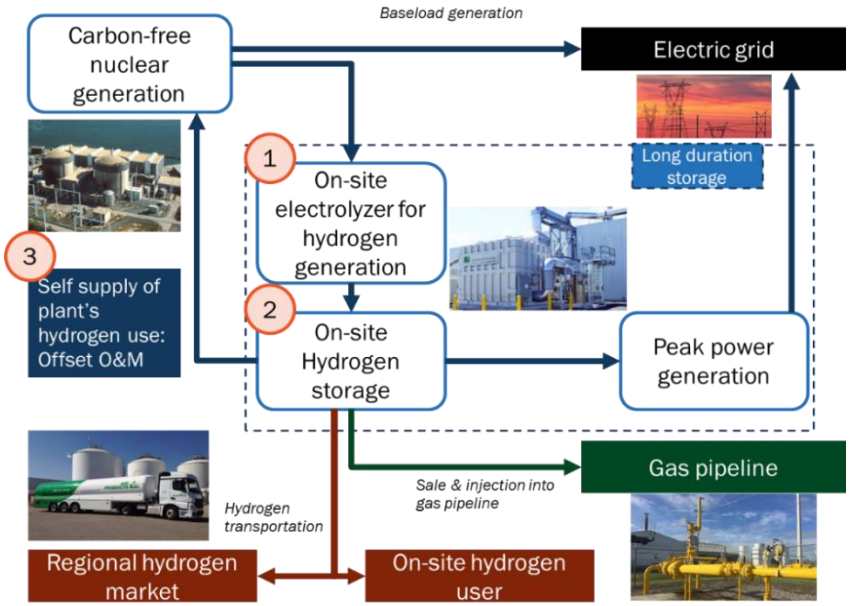
2022-1648

Ugi Otgonbaatar, Lara Pierpoint/ Exelon

Technology Summary

Exelon is partnering with Nel Hydrogen and multiple national laboratories to demonstrate an integrated hydrogen production, storage and utilization facility at an Exelon nuclear plant site. Exelon will install a Proton Exchange Membrane (PEM) electrolyzer and an associated hydrogen storage system, supporting infrastructure, and a control system to enable dynamic operation of the electrolyzer. One project goal includes economic supply of carbon-free hydrogen for internal nuclear site use. In addition, Exelon will work with the labs to simulate and demonstrate dynamic control of the electrolyzer, paving the way for participation of hybrid power/hydrogen systems in organized power markets.



Key Personnel

Dr. Ugi Otgonbaatar,Dr. Lara Pierpoint (Exelon), Stephen Szymanski (Nel Hydrogen U.S.), Dr. Richard Boardman (INL), Mark Ruth (NREL),Dr. Amgad Elgowainy (ANL)

Program Summary

Period of performance:
36 months

Federal funds:	$3,619,061
Cost-share:	$3,619,061
Total budget:	$7,238,122

	Key Milestones & Deliverables
Year 1	• Site selection, 30% engineering design • Simulation using prototype electrolyzer
Year 2	• 100% engineering design, decision to install • Complete manufacture, test of electrolyzer.
Year 3	• Start of steady state operation of electrolyzer • Simulation of scale-up electrolyzer operation • Demonstration of dynamic operation on site

Technology Impact

Scaleup of hydrogen production in the U.S. power sector faces regulatory, market, and cost barriers. This project represents a FOAK installation of a dynamically operable hydrogen production facility at a nuclear plant to enable nuclear units to be dispatchable.

The mechanism for hydrogen-based energy storage systems to improve nuclear plant participation in organized power markets is not established, and this project will serve as a first step in demonstrating the feasibility.

Clean H_2 production enabling dispatchable, carbon-free power

U.S. DEPARTMENT OF ENERGY