2020 DOE Hydrogen and Fuel Cells Program Review Presentation

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

P.I. Uuganbayar Otgonbaatar, Ph.D.

Exelon Corporation

Project ID

TA028

6/16/2020

Overview of project scope

Timeline and budget

- Conditional award: 10/01/2019
- Removal of condition: 04/01/2020
- Project End Date: 04/01/2023
- Total Project Budget: $7.2MM
  - Industry cost share $3.6MM
  - Total Federal Share: $3.6MM

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)

Questions, challenges

- **Site Selection**
  - What are the criteria for site selection?
- **Regulatory**
  - What are the relevant regulations that affect nuclear H2 production?
- **Market-related**
  - What is the effective electricity price that the electrolyzer pays?

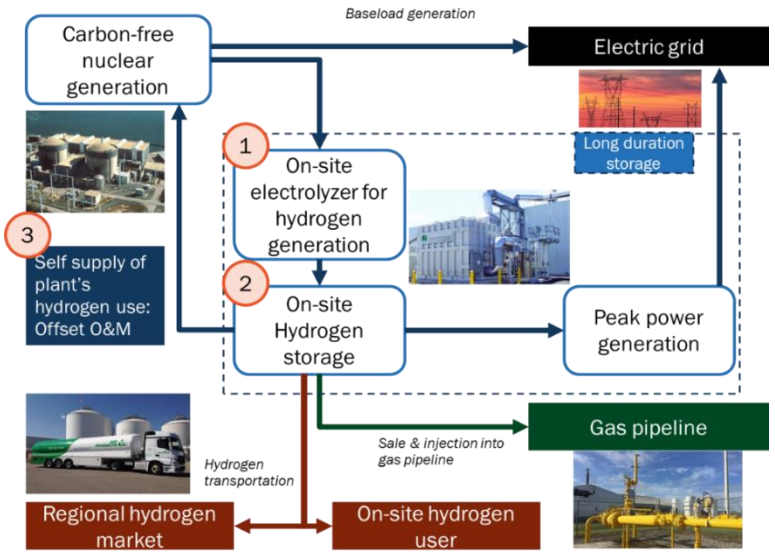
Partners

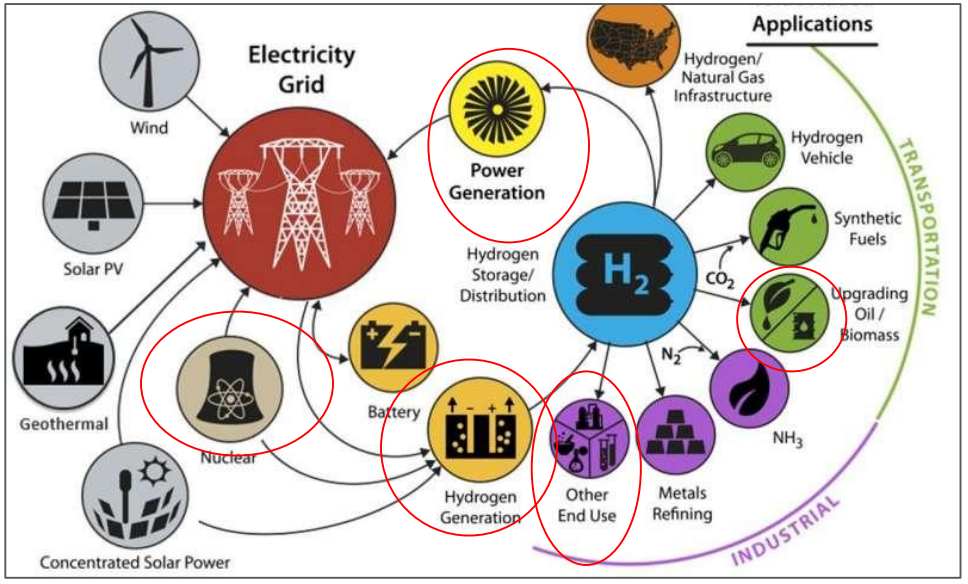
- **Exelon Corporation**
- **Nel Hydrogen**
- **Idaho National Laboratory**
- **National Renewable Energy Laboratory**
- **Argonne National Laboratory**

Relevance: The project demonstrates nuclear hydrogen pathway described in H2@scale vision

Technical Objectives

- Install a 1MW PEM electrolyzer and supporting infrastructure at an Exelon nuclear power plant
- Provide economic supply of in-house hydrogen consumption at the plant
- Simulate a scale-up operation of a larger electrolyzer participation in power markets





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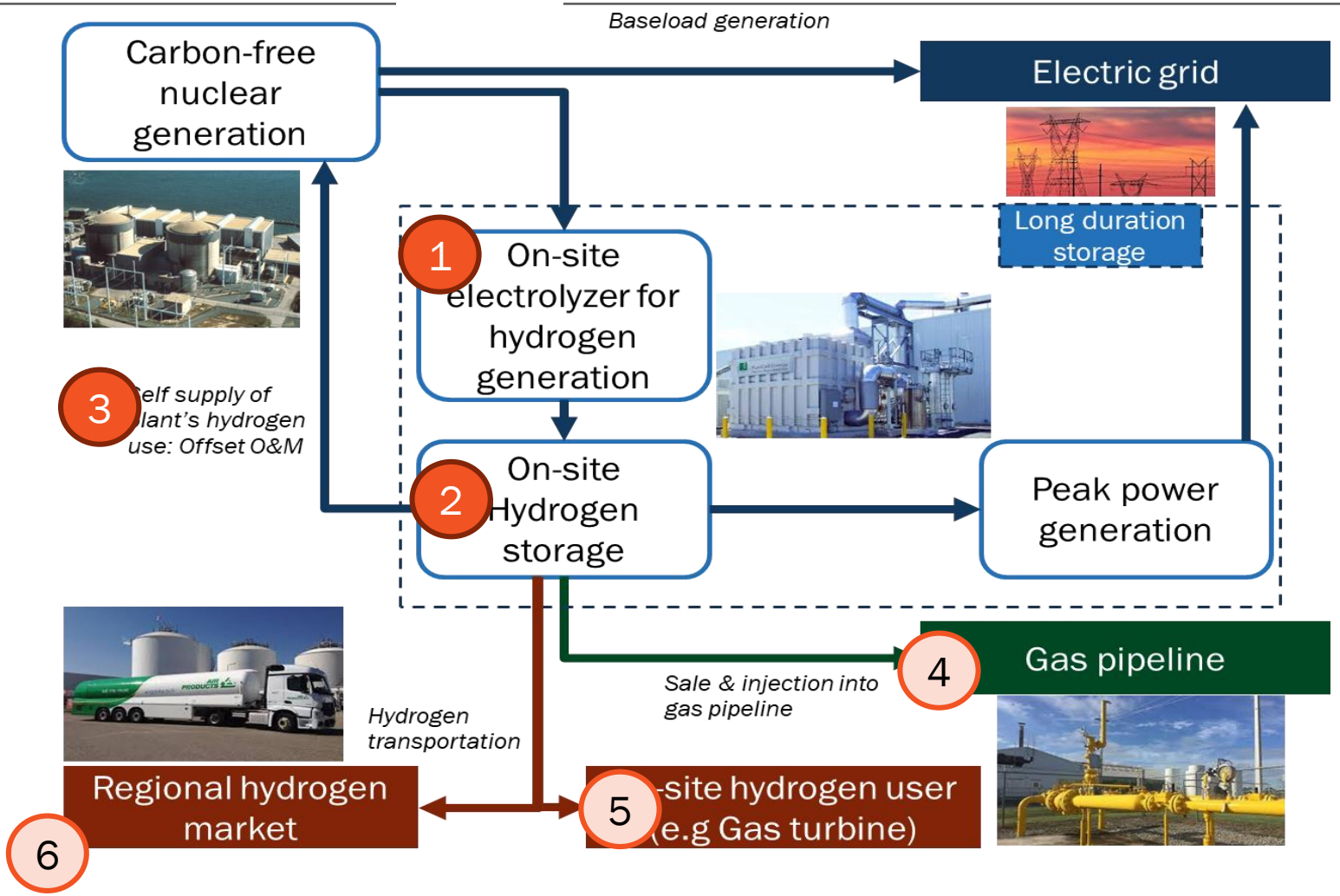
Approach: Exelon is exploring hydrogen production as a way to enhance the value of nuclear power plants



The project will demonstrate pathways 1-3. In budget period 1, the team will complete 30% design and demonstrate dynamic operation

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Tasks and Milestones

Task #	Task	Description	Verification	Month from start
1.0	Successful selection of an optimal site.	Exelon selects a site based on technical and economic factors	Site selection is announced to project partners	1
2.0-A	30% conceptual engineering design complete	30% design engineering is completed with input from Nel	30% Engineering report is completed	11
4.0	Demonstrate dynamic operation of a ~1 MW electrolyzer	Perform factory acceptance testing and demonstrate dynamic operation of a ~1 MW electrolyzer. These tests include (1) operating the system at steady state for 24 hours with observation of minimal degradation (<0.1%); (2) from steady operation at 100% power, suddenly cut power to 0% and then restore power and hydrogen production to 100% within 30 minutes; and (3) verifying that the power cycling did not cause greater than 0.1% efficiency degradation.		11
4.0	Simulation model of electrolyzer operation	Verified by inspecting the results of a simulation model of the local electrical grid including interactions between the grid and the nuclear station and a 1 MW PEM system. .		9
5.0	Identification of optimal sites for scale-up.	Verified by a technical report comparing candidate sites and down selecting the optimal location for future scaleup.		11

Completed

In progress

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Accomplishments to date: Site selection matrix is completed to identify top 4 choices

H_2 Production Pilot Site Selection Matrix				Site#1			Site#2			Site#3			Site#4		
Overall Score						326.9			332.7			234.2			253.5
Criterion	Description	Must vs Want	Weight	Must Req Met	Score	Subtotal	Must Req Met	Score	Subtotal	Must Req Met	Score	Subtotal	Must Req Met	Score	Subtotal
V	Electrical	Must Have	7	Yes		60.8	Yes		68.5	Yes		60.9	Yes		45.7
V01	House Load Margin		5		10	50		10	50		9	45		10	50
V02	Availability of Spare MV Switchgear	Y	10	Y	7	70	Y	10	100	Y	10	100	Y	4	40
V03	Spare Switchgear Proximity to PEM-ES		3		10	30		8.2	24.6		1.8	5.4		0	0
V04	Short Circuit Rating		7		10	70		10	70		10	70		10	70
V05	House Load Tariff		1		5.9	5.9		10	10		5.9	5.9		9.8	9.8
C	Constructability	Must Have	10	Yes		58.4	Yes		69.8	Yes		39.9	Yes		39.2
C01	Concrete Slab Space	Y	10	Y	5	50	Y	7	70	Y	8	80	Y	5	50
C02	Tie In to Plant H2 Location		1		8	8		5	5		10	10		8	8
C03	Siting Constructability		4		7	28		7	28		4	16		5	20
C04	Trenching / Penetrations		4		6	24		4	16		2	8		3	12
C05	Routing of MV Power		2		10	20		8.2	16.4		1.8	3.6		0	0
C06	Routing of Potable Water		5		8	40		6	30		2	10		3	15
C07	Routing of Drains		2		8	16		8	16		2	4		4	8
C08	Security Hardware		2		6	12		10	20		2	4		6	12
C09	Mod for H2 Storage Type		8		3	24		8	64		2	16		3	24
W	Water Management		7			56.0			53.7			15.6			25.7
W01	Overall Convenience of Quality Supply		3		8	24		7	21		2	6		2	6
W02	Preferred Water Source		5		8	40		8	40		2	10		4	20
W03	Testability of Water Source		1		8	8		8	8		4	4		7	7
H	Hydrogen Use	Must Have	10	Yes		83.4	Yes		77.9	Yes		79.0	Yes		83.2
H01	Site H2 Use < Expected H2 Production		3		10	30		10	30		10	30		8	24
H02	Site H2 Cost ($)		8		5.2	41.6		10	80		4.9	39.2		5.5	44
H03	PEM-ES Operating (% Time)		4		9.2	36.8		3.7	14.8		7.1	28.4		10	40
H04	H2 Value to the site	Y	10	Y	10	100	Y	7	70	Y	10	100	Y	10	100
R	Regulatory Issues		5			41.3			41.3			31.3			41.3
R01	Distance to Safety-Related Structures		1		10	10		10	10		10	10		10	10
R02	Distance to Security		1		8	8		10	10		10	10		10	10
R03	Emergency Plan Impact		1		10	10		10	10		10	10		10	10
R04	Environmental Impact		4		7	28		7	28		3	12		7	28
R05	Government Stakeholder		1		10	10		8	8		8	8		8	8
F	Human Factors		3			27.0			21.5			7.5			18.5
F01	Operational / Chemistry Convenience		3		8	24		7	21		1	3		5	15
F02	Supply Convenience		1		10	10		2	2		10	10		2	2
F03	Security Monitoring Convenience		2		10	20		10	20		1	2		10	20

Exelon completed a comprehensive site selection process

Responses to Previous Year Reviewers' Comments

This project was not reviewed last year

Collaboration and coordination

Partner	Role
Exelon	Lead applicant responsible for overall project, design, installation and operation of the 1MW electrolyzer. Licensing, regulatory market deliverables.
Nel	Vendor supplier for 1MW PEM electrolyzer unit. Providing support for prototype electrolyzer testing
INL	Development of front end controller, dynamic operation of prototype electolyzer
NREL	Development of front end controller, dynamic operation of prototype electolyzer
ANL	Analysis for scaled-up hydrogen production, hydrogen market analysis

Proposed Future work

1. DOE reporting
   a) AMR presentation submitted
   b) Hydrogen safety plan (hydrogen safety plan exists for Exelon): Due 6/20/2020-
   c) Progress report (SF-425 and technical progress): Due 7/30/2020
2. Exelon internal
   a) Communicate with the co-owners of the selected site about the project before releasing for public disclosure
   b) New PM is appointed (stationed at the selected site). PM transition
   c) Assemble team members at the selected site, begin 30% design process
3. Nel-Exelon
   a) Complete sub-contract

4. Exelon/Nel/National labs
   a) Sign 4 way NDA between Exelon/Nel/INL/NREL
   b) Potential change of prototype electrolyzer testing location
   c) NREL to look for prior hydrogen safety plans

5. External events/communication
   a) EPRI NPC, DOE GAIN workshop, EEI workshop, ANS meeting, IAEA workshop

Summary

1. Project is successfully launched
   - Exelon team successfully finished the award negotiation with DOE and officially started the Budget Period 1 activities on 4/1/2020.
2. Team coordination setup
   a) Exelon assembled a multidisciplinary team for the project including expertise from centralized engineering design organization, licensing, environmental, supply/procurement, legal, policy and others.
   b) The Exelon team has established a weekly meeting cadence. Internal accounting procedures are setup to track project spending.
   c) Exelon established a biweekly progress update call with Nel/INL/NREL/ANL
   d) Nel is in constant communication with Exelon to finalize sub-contract
3. Technical achievements
   a) Exelon has narrowed down the site selection to 4 top choices and very close to finalizing the decision
   b) Top site is identified and pending authorization for communication
   c) Exelon completed a robust economic analysis for hydrogen generation to off-set site hydrogen use
4. External events/communication
   a) Exelon made presentations about the project at EPRI NPC, DOE GAIN workshop, EEI workshop, ANS meeting, IAEA workshops

Acknowledgments

- Financial support from DOE EERE Fuel Cell Technology Office under award # **DE-EE0008849**

- DOE program manager: Michael Hahn

- Exelon team

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