

Hydrogen Education for a Decarbonized Economy

(H₂EDGE)

(DE-EE0009253)

Project ID: SCS028

DOE Hydrogen Program
2021 AMR Review & PE Meeting

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Electric Power Research Institute (EPRI)
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“This presentation does not contain any proprietary, confidential, or otherwise restricted information.”

Project Goal

- Enhance workforce readiness through training and education (T&E) for the emerging hydrogen industry with the Hydrogen Education for a Decarbonized Global Economy (*H₂EDGE*) initiative by focusing on the four pillars of production, delivery, storage use of hydrogen in a safe manner.
- Develop T&E materials and deliver professional training courses and university curriculum content.



Project Overview

Timeline & Budget

- **Project Start Date: 1/1/21**
- **Project End Date: 12/31/24**
- **Percent Complete: 2%**

- **Total Project Budget: \$2.65M**
- **Total Recipient Share: \$0.65M**
- **Total Federal Share: \$2.0M**
- **Total Funds Spent: \$13,611**

Barriers & Targets

- **Barrier: Increasing workforce for the emerging hydrogen economy**
- **Target: Establish workforce development infrastructure that is responsive to meeting the anticipated hydrogen industry development**

Partners

- **Gas Technology Institute**
- **Oregon State University**
- **Purdue University**
- **University Delaware**
- **Embedded Assessments**
- **Industry Partners**

Relevance



The emerging hydrogen industry needs a workforce to provide all aspects of H₂ -- production, delivery, storage use of hydrogen in a safe manner. As such, the EPRI project team has been organized to develop & deliver training materials at the academic and professional training levels. This initiative is dedicated to creating a new workforce from the academic level as well transforming and developing the existing industry workforce to satisfy the emerging hydrogen economy needs via *H₂EDGE* .

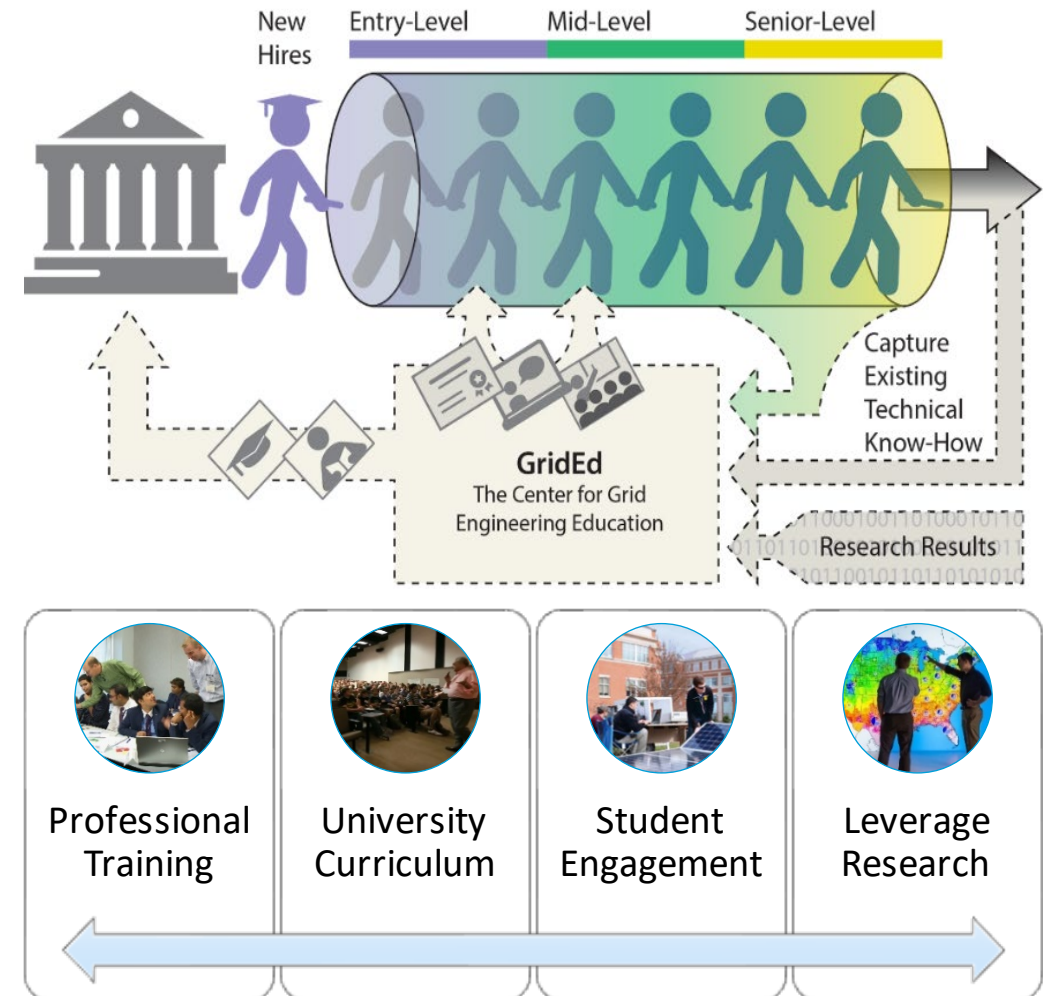
H₂EDGE Goal: ***Sustain adequate workforce development*** to meet the need of the fuel cell industry. For example, as of December 2018, global shipments for fuel cell power for transportation and stationary applications had an average annual growth rate of 40% from 2015 through 2018

https://www.hydrogen.energy.gov/pdfs/review19/plenary_overview_satyapal_2019.pdf

H₂EDGE Goal: ***Build a sustainable infrastructure*** for developing a workforce for the emerging hydrogen economy. One study (American Solar Energy Society (ASES) and Management Information Services Inc. (MISI), 2019) forecasts up to million jobs by 2030 with successful hydrogen technology advancements

GridEd's H_2 EDGE Initiative for the Hydrogen Economy

Train and educate an energy industry workforce for the emerging hydrogen resource as a part of the decarbonized global economy.



EPRI | U™ Infrastructure for Training Records and PDHs

Acronyms: GridEd – The Center for Grid Engineering Education, a workforce development infrastructure; EPRI|U – EPRI University

H₂EDGE Team

Approach



EPRI

- Tom Reddoch
- Brittany Westlake
- Annette Rohr
- Joseph Stekli
- Erin Jones
- Amy Feser

Professional Support Organizations

- Kristine Wiley – GTI
- Ted Barnes – GTI
- Matt Champagne – Embedded Assessments

Partner Universities

- Nick AuYeung – Oregon State University
- Timothee Pourpoint – Purdue University
- Ajay Prasad – University of Delaware

Cost Share to support effort

Low Carbon Resource Initiative (LCRI)

Cost Share to support effort

Industry Advisory Board

17 Organizations Letters of Support

H₂EDGE – Three Key Activities

Approach

Core Elements

- Technical Resource Advisory Committee
- Profession Training Development & Delivery
- Regional Training Hubs
- Workshops, Seminars, Conference Engagements
- EPRI University (EPRI|U)

Industry Professionals

- Credentials & Certifications
- Professional Training Courses and Workshops
 - *Production*
 - *Delivery*
 - *Storage*
 - *Use*
 - *Safety*

University Curriculum/Students

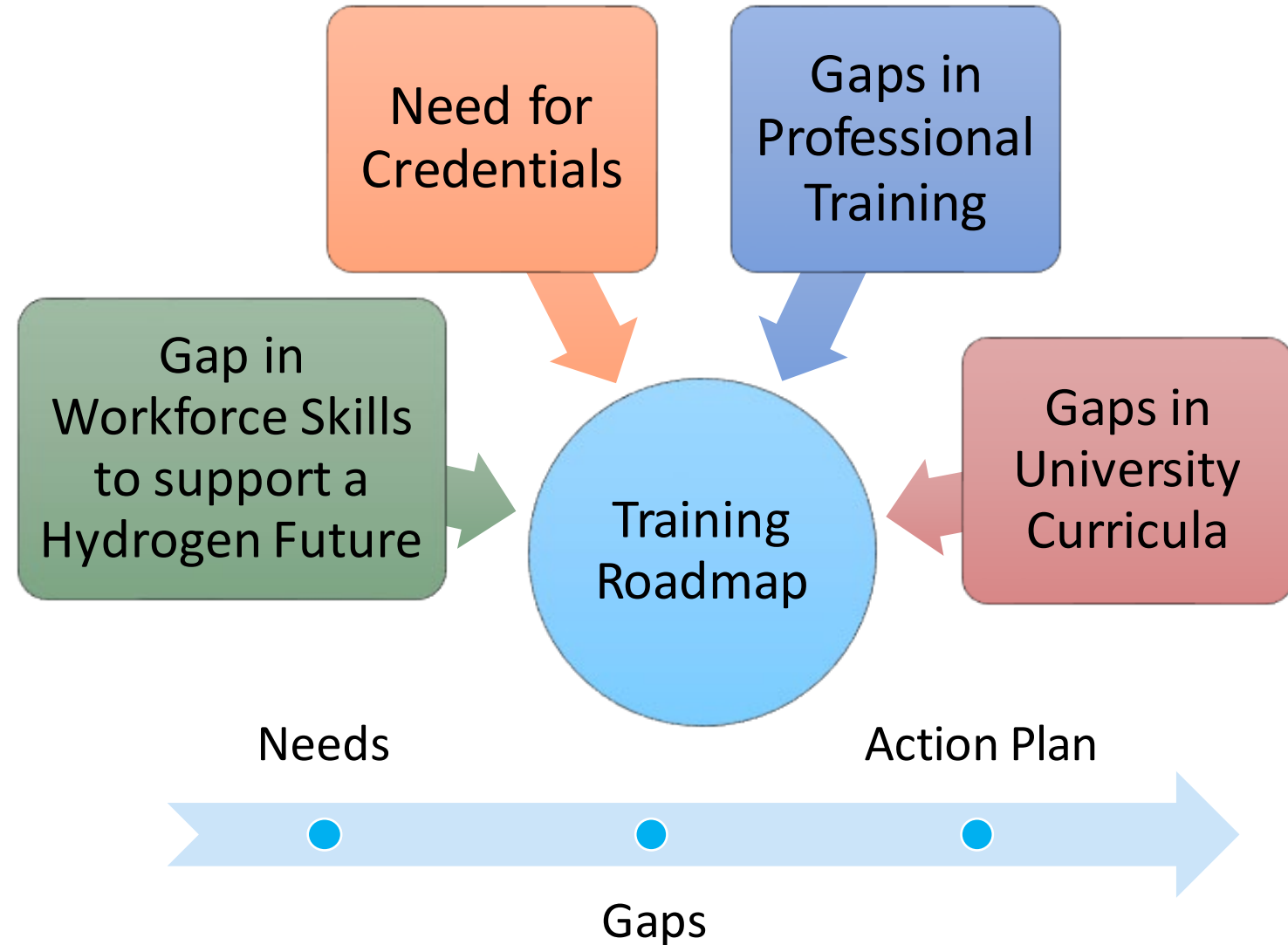
- New and Revised University Courses
- Co-developed Course - Introduction to Hydrogen Technology and its Applications
- Undergraduate Design Projects
- Course Repository
- Laboratory Experiments

H₂EDGE Training and Education Roadmap

Approach

What is it?

- Project action plan for training & education curriculum based on gaps assessments

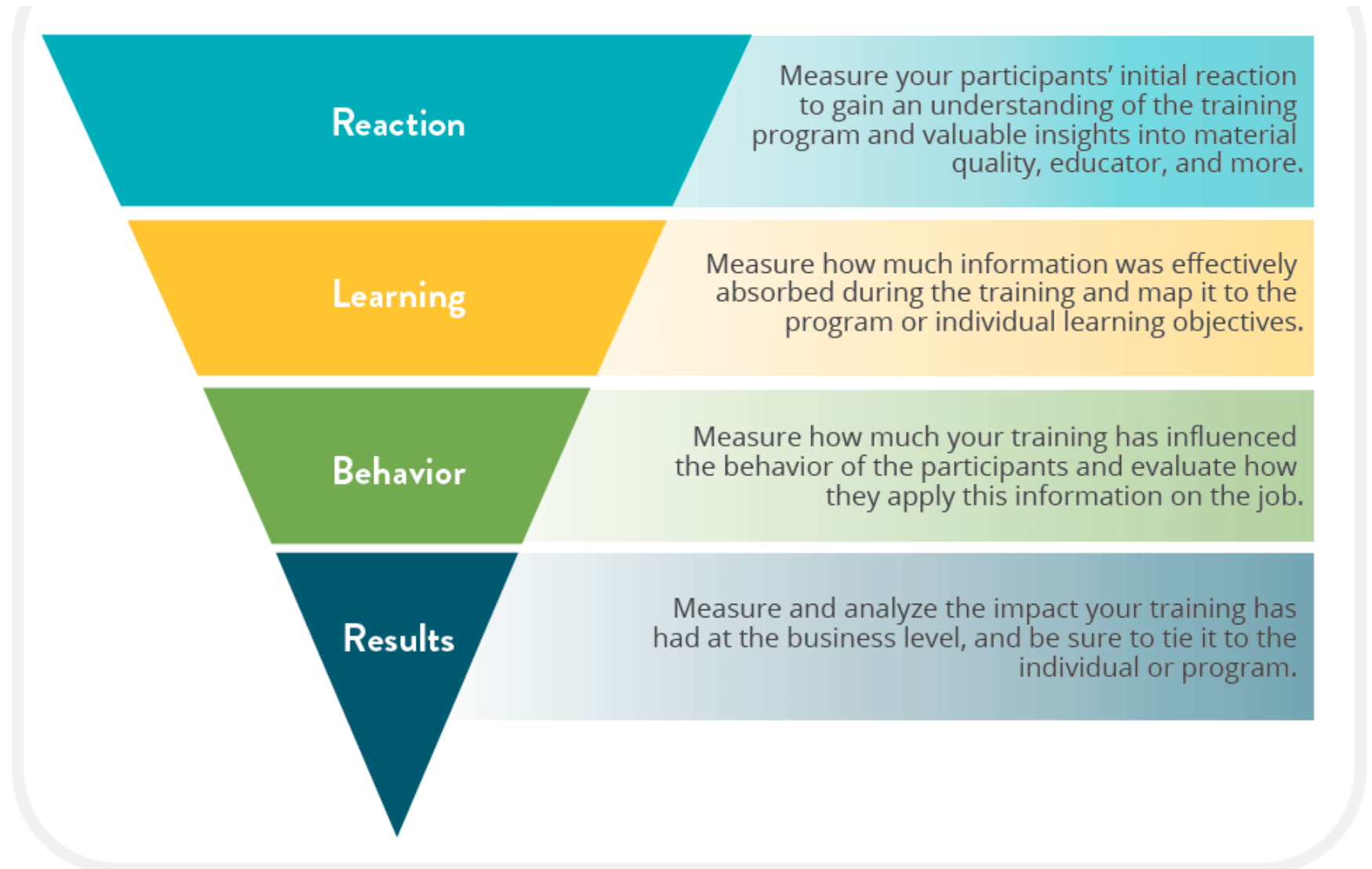


Embedded Assessments

Approach



Solid Foundation for Evaluation



1.0 Management, Evaluation, & Sustainability

- 1.1 Project Management, Coordination & Reporting
- 1.2 Evaluation Plan & Metrics Collection
- 1.3 Sustainability & Expansion Plan

2.0 Utility Advisory Committee & Gaps

- 2.1 Technical & HR Advisory Boards
- 2.2 Job Qualifications & Certifications
- 2.3 Gaps and Training Roadmap

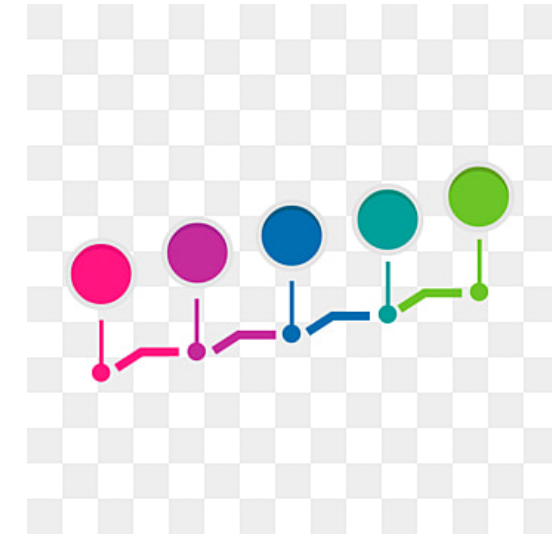
3.0 Professional Training Program

- 3.1 Training and Education Plan
- 3.2 Develop Short Course Materials
- 3.3 Deliver Short Courses
- 3.4 E-Learning (CBT's and Videos)
- 3.5 Establish Repository of Materials

4.0 University & Student Engagement

- 4.1 Gap in H₂ Engineering & Science Education
- 4.2 New & Revised University Materials
- 4.3 Co-Developed Hydrogen Course
- 4.4 Deliver New & Revised Curriculum
- 4.5 Tech Transfer & Training Programs
- 4.6 Student Sponsorship Programs

Project Task Structure



5.0 Communication and Outreach

- 5.1 Website & Communications
- 5.2 Regional Hubs & Workshops
- 5.3 Workshops & Attend Conferences

Accomplishments and Progress of the project

The following four items are the first milestones for the project

- **Kick-off meeting with DOE on February 25**
- **Statements of work (SOWs) are in development with prime subcontractors: 1) Gas Technology Institute, 2) Embedded Assessments, 3) Oregon State University, 4) Purdue University, and 5) University of Delaware**
- **Preliminary Website for *H₂EDGE* is operational**
- **Discussions initiated with candidate industry advisory group participants**



Collaboration & Coordination

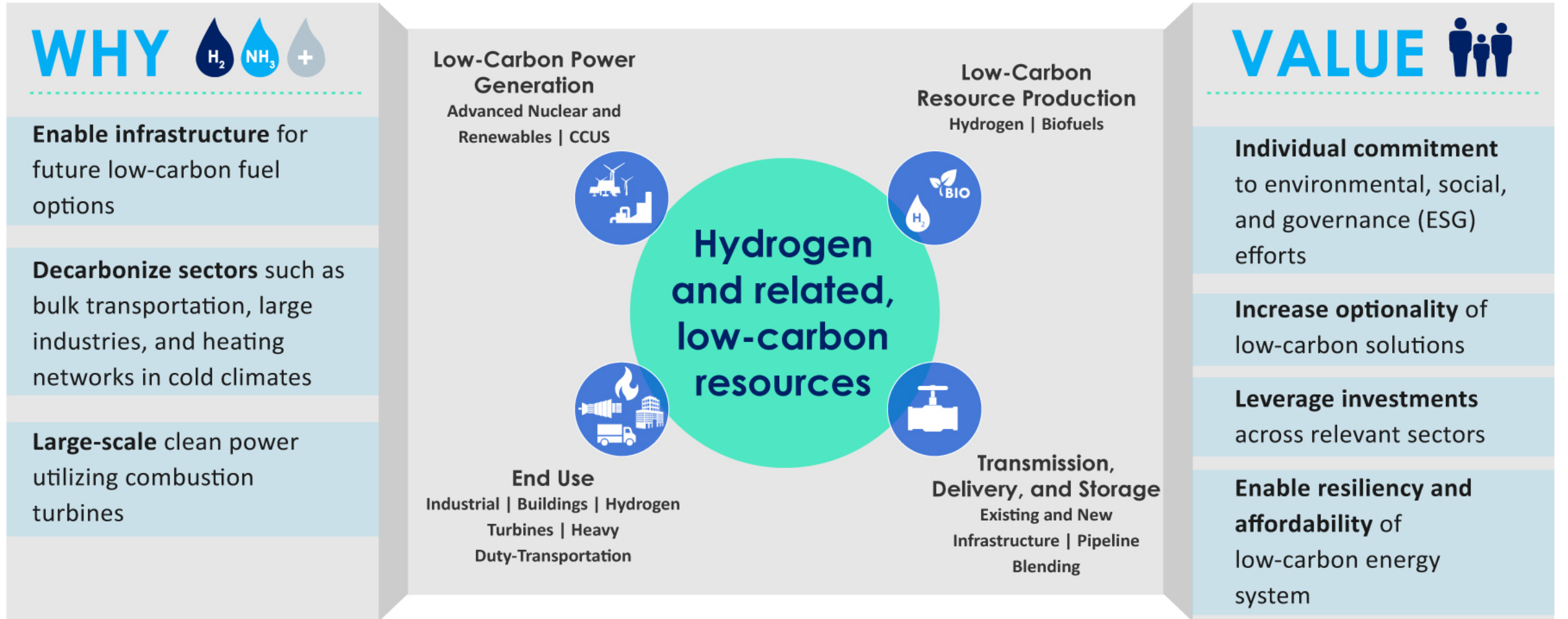
Safety Underpins *H₂EDGE*

- Safety and environmental impacts are embedded throughout the effort
- Training in protective and mitigative measures – and existing and future codes, standards, and regulations – is critical across production, delivery/storage, and end use
- Examples:
 - *Production*: Ignition risk and chemical exposures related to electrolysis
 - *Delivery/Storage*: Use of pressure vessels, need for suitable methods for wide area leak detection
 - *End Use*: Vehicle fueling station safety, consumer communication and education



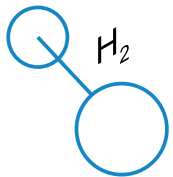
- EPRI is now a CHS member
 - Monthly membership meetings
 - Work group on Introducing H₂ into the Natural Gas Infrastructure
 - Sub-work group on Detection
- Hydrogen Safety Credential program
- Knowledge transfer opportunities

The **Low-Carbon Resources Initiative** (LCRI) is a five-year, focused R&D commitment to develop the pathways to advance low-carbon technologies for large-scale deployment. This initiative is jointly led by EPRI and GTI. The goal of the initiative is to enable a risk-informed understanding of options and technologies enabling significant economy-wide decarbonization through global partnerships and demonstrations, applied engineering developments, and technology acceleration of the most promising options.



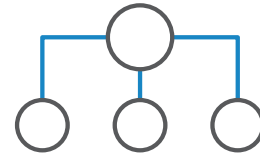
GTI's Hydrogen Technology Center (HTC)

The HTC offers integrated hydrogen testing and demonstration facilities across the entire value chain—from production, to storage, delivery, and use.



Low-carbon Production

- Compact Hydrogen Generator
 - Biomass gasification
- Hydrogen power generation



Compatibility with Natural Gas Delivery Infrastructure

- Material impacts of blending
 - Operational impacts
- Blending technology and standards



Use in Industry and Buildings

- End-use equipment testing
- Codes and standards



Use in Transportation

- California Fuel Cell Partnership
 - Fueling station technology
 - RNG-to-hydrogen fueling
 - H2@Scale

Education Programs @GTI

Training the next generation workforce

- Over 40 courses offered annually
- Over 70,000 industry professionals trained
- Open enrollment and onsite courses around the globe with students representing 20+ countries

Topic areas:

- Gas Distribution and Transmission
- Gas utilization and Marketing
- LNG
- E&P
- Workforce Development

Delivery options:

- Classroom courses or open enrollment
- Onsite for energy industry customers
- Online and self-guided programs



Natural Gas Field Skills Training Program

77 instructor-led courses now available for the classroom or online



Virtual Reality (VR) Training

University Hydrogen Programs

- **Developing hydrogen curriculum at each Partner University**
- **Conducting a gaps assessment on hydrogen training needs**
- **Creating an undergraduate course on the fundamentals of Hydrogen Science & Engineering**
- **Expanding to a national university network via “Affiliate” universities**
- **Introducing hydrogen to students as a future energy solution**



Next Steps as Future Work

- **Complete contracts and agreements with key partners and advisors**
- **Develop a basic course titled “Introduction to the Basics of Hydrogen” – Living in a “Green Technology World.” It will be a four-hour course in both a live and virtual format.**
- **Initiate the Gaps Knowledge and Training Assessment Reports for both university curriculum and professional training**
- **Expand the website**

Any proposed future work is subject to change based on funding levels.

Summary of Status

- **The Project is at origination**
- **A kick-off meeting for the project was held February 25, 2021 with DOE**
- **The *H₂EDGE* initiative is in the beginning stage getting contracts in place with our key partners**
- **Selection of industry advisory partners is underway**
- **Met with the University of Tennessee/Oak Ridge Institute to discuss potential collaboration opportunities on March 23, 2021.**
- **Quarterly review meeting is scheduled for May 27, 2021**



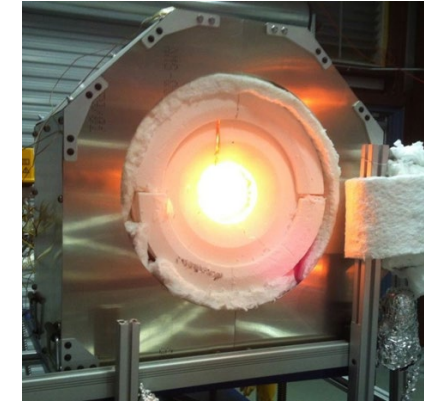
Technical Backup & Additional Information

Project Schedule for Early Tasks, Subtasks, & Milestones for BP1

Task Number	Task or Subtask (if applicable) Title	Milestone Type (Milestone or Go/No Go Decision Point)	Milestone Number* (Go/No Go Decision Point Number)	Milestone Description (Go/No Go Decision Criteria)	Milestone Verification Process (What, How, Who, Where)	Anticipated Date (Months from Start of the Project)	Anticipated Quarter (Quarters from Start of the Project)
Task	Budget Period One (Q1-Q6)						
1.1	Subcontracts	Milestone	1.1	Sign contracts with Subrecipients except universities	Signed agreements	3	1
2.1	Advisors	Milestone	2.1	Establish Advisory Participants	At least three (3) letters of Commitment	4	2
1.2	Evaluation Plan	Milestone	1.2	Complete & Test Evaluation Plan	Gather result from survey course participants to determine effectiveness	6	2
5.1	Website	Milestone	5.1	Add hydrogen training to the GridEd website	Updated website	6	2
1.1	Annual Merit Review	Milestone	1.1a	Attend Annual Merit Review Meetings	Conduct project review	7	3
2.1	HSP Advisor	Milestone	2.1a	Select HSP as an Advisor	Appoint an advisor from HSP	7	3
3.2	Develop short courses	Milestone	3.2	Begin development of short courses	Initiate course development	7	3
1.1	Subcontracts	Milestone	1.01	Sign contracts with all Subrecipients	Signed agreements	9	3
2.2	Training Gaps	Milestone	2.2	Conduct a knowledge and training gaps assessments	Completed Gaps Assessment Report	9	3

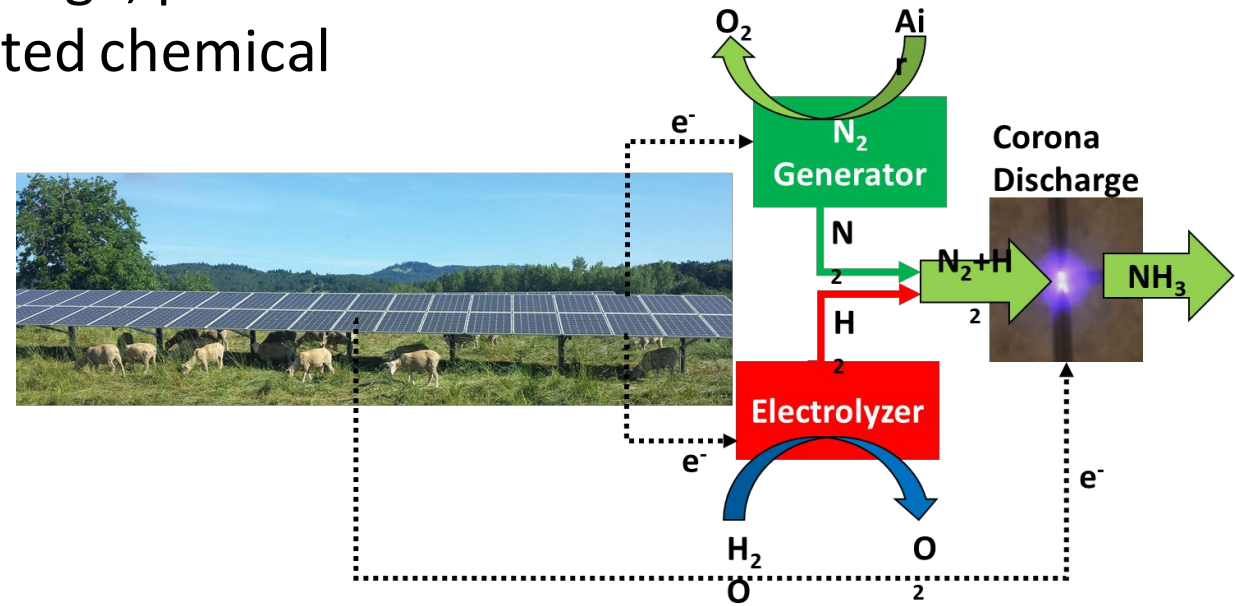
Nick AuYeung, Assistant Professor, Oregon State University

- B.S. (UConn): Chemical Engineering
- Ph.D. (OSU): Thermochemical Water Splitting
- Postdoc (UF): Solar Thermochemical Fuels
- DOE projects from ARPA-E, EERE, SETO
- Other interests include thermal energy storage, plasma chemistry, water purification, and distributed chemical production.



Solar Thermochemical H₂

- Strong connections to:
 - Solar
 - Ocean
 - Nuclear
 - Electrolysis
 - Additive manufacturing.



Agrivoltaic-driven plasma synthesis of ammonia

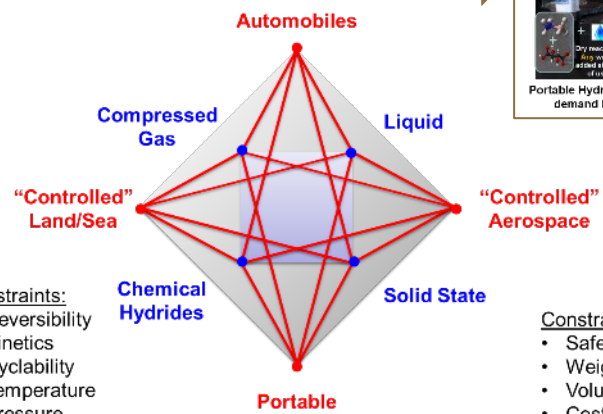
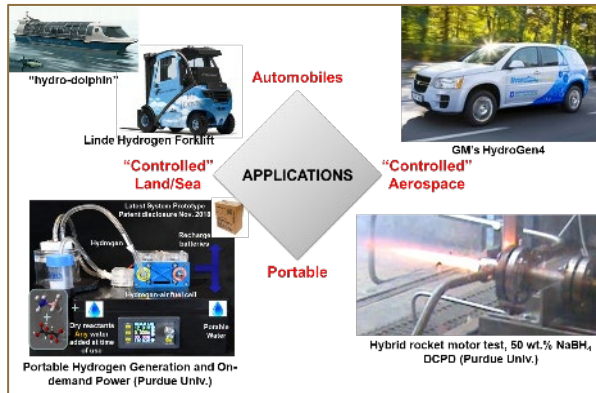
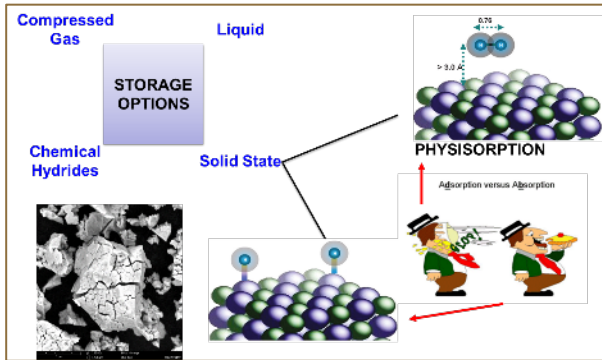
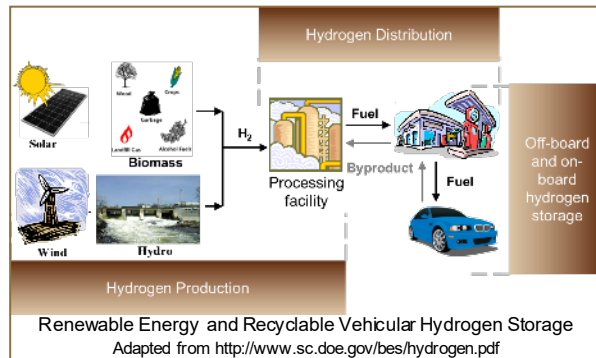


Proposed Classes @ Purdue University

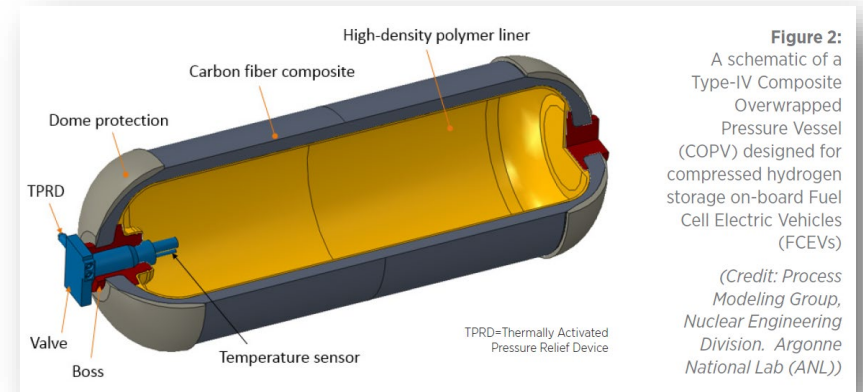


Hydrogen Storage: Status, Perspectives, and Industrial Applications

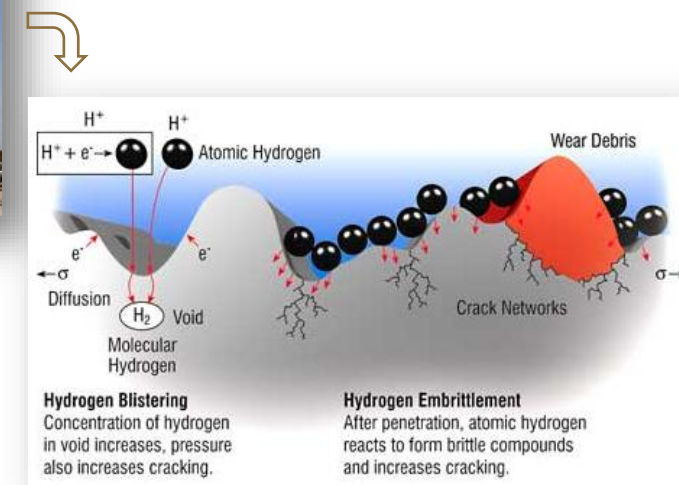
Timothee Pourpoint



Pressure Vessels and Hydrogen Embrittlement



<https://www.energy.gov/sites/prod/files/2017/03/f34/fcto-h2-storage-fact-sheet.pdf>



For details, please contact: Dr. Pourpoint, (timothee@purdue.edu)



Ajay K. Prasad
Engineering Alumni Distinguished Professor and Chair
Department of Mechanical Engineering
University of Delaware

Bio-sketch

- Have conducted research and training in fuel cells since 2004
- Founded the Center for Fuel Cell Research in 2009 and served as its Director till 2017
- Founded the UD Fuel Cell Bus Program in 2005 and served as its Director to date
- Secured over \$12M in funding from FTA, DOE, DE state, and industry
- Published over 80 journal papers on fuel cells, hydrogen generation, hydrogen storage, electrochemical compression of hydrogen, and lithium-ion batteries
- Published five patents in the area of fuel cells and started one company (www.soninjector.com)
- Trained over 40 UG, MS and PhD students, and post-docs in fuel cells and the hydrogen infrastructure
- Created “Intro to Fuel Cells” in 2004 and taught it continuously to UG and grad students
- Developed and taught the short course “Fuel Cell Basics and Applications” to hundreds of industry participants

