

Sustainability Criteria for Hydrogen Deployments

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WBS 8.6.2.1
May 7, 2024

DOE Hydrogen Program
2024 Annual Merit Review and Peer Evaluation Meeting

Project ID: SA188

Project Goal: Provide guidance on improving existing methods to quantify and characterize sustainability benefits of hydrogen projects

“Vision” *Create a framework with which to characterize quantifiable sustainability metrics for hydrogen supply chain projects*

What

- Identify existing sustainability metrics such as GHG emissions and air quality standards by EPA, sustainable development goals by the UN, and life cycle assessments
- Assess gaps in existing sustainability metrics as applicable to hydrogen supply chain projects
- Propose guidance to improve existing sustainability metrics

How

- Review existing literature on hydrogen or energy supply chain infrastructure
- Identify expert practitioners with experience in developing and monitoring sustainability ratings to seek guidance and input on improving sustainability metrics
- Conduct case studies on hydrogen projects in collaboration with experts

Why

- Hydrogen infrastructure development is growing. Aside from GHG emissions standards, there are few mature frameworks for quantifying and rating sustainability of such projects
- Providing a framework for rating the sustainability of a hydrogen infrastructure project can guide investment decisions and ensure projects provide a net benefit to all stakeholders

Overview

Timeline and Budget

- Project Start Date: September 1, 2022
- FY23 DOE Funding (if applicable): \$200,000
- FY24 Planned DOE Funding (if applicable): \$200,000
- Total DOE Funds Received to Date**: \$400,000
 - ** Since the project started

Barriers and Targets

1. Identify gaps in literature and existing sustainability rating systems that are applicable to hydrogen projects
2. Address these gaps by improving existing frameworks with quantifiable sustainability metrics
3. Apply this framework to at least two international case studies to assess the appropriateness and impact of such sustainability metrics.

Partners

- Mark Chung, PI NREL
- Mission Innovation via Department of State
- HFTO, DOE
- BRE Group, HDR Inc., Institute for Sustainable Infrastructure

Potential Impact

Driving Factor

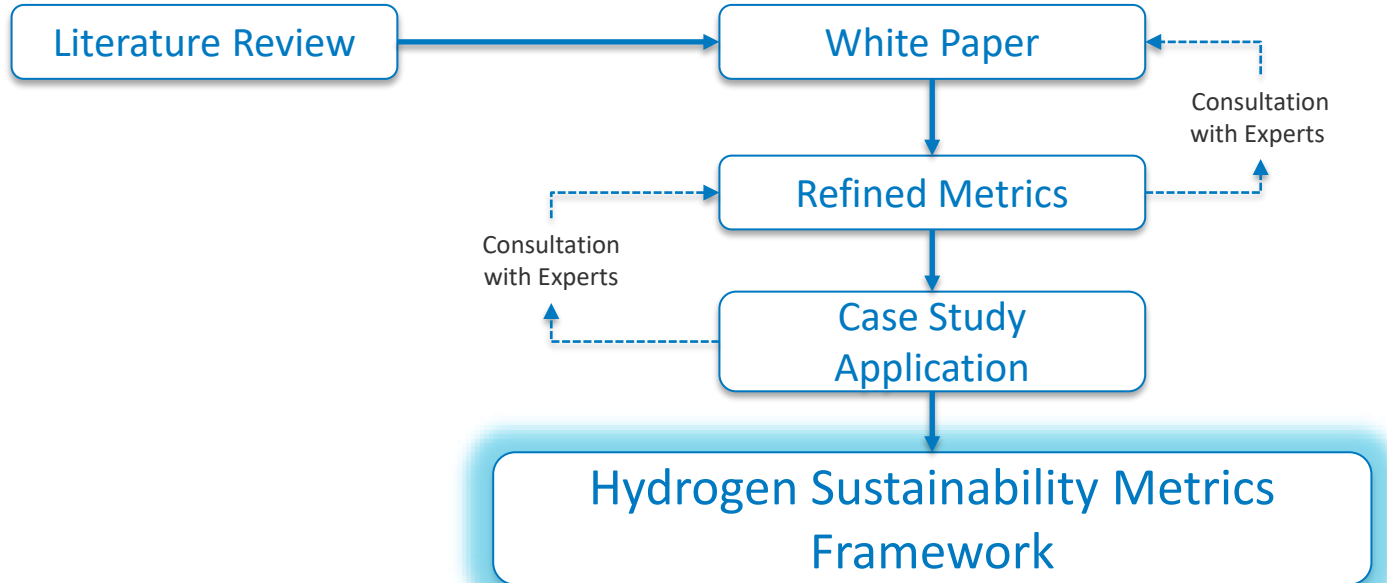
The Inflation Reduction Act and Bipartisan Infrastructure Law are unleashing billions of federal dollars into clean hydrogen technologies over the next decade, resulting in significant growth across the supply chain (production, transmission, storage, end use). Evaluating sustainability of hydrogen will be necessary to accommodate this growth.

The Impact

Improving the framework for assessing sustainability of hydrogen projects is not only needed to measure sustainability of a project, but also to better inform future investments in the hydrogen supply chain. This project will not only refine the standard economic and environmental metrics of hydrogen sustainability but will also include a social metric assessment to provide a holistic approach to sustainability.

Approach

To ensure a comprehensive framework with quantitative metrics is developed, independent research will be supplemented with feedback from industry experts with experience across consulting, creating, and measuring of metrics in the sustainability field.



UN Definition of “Sustainability”

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

*UN Definition of Sustainability**

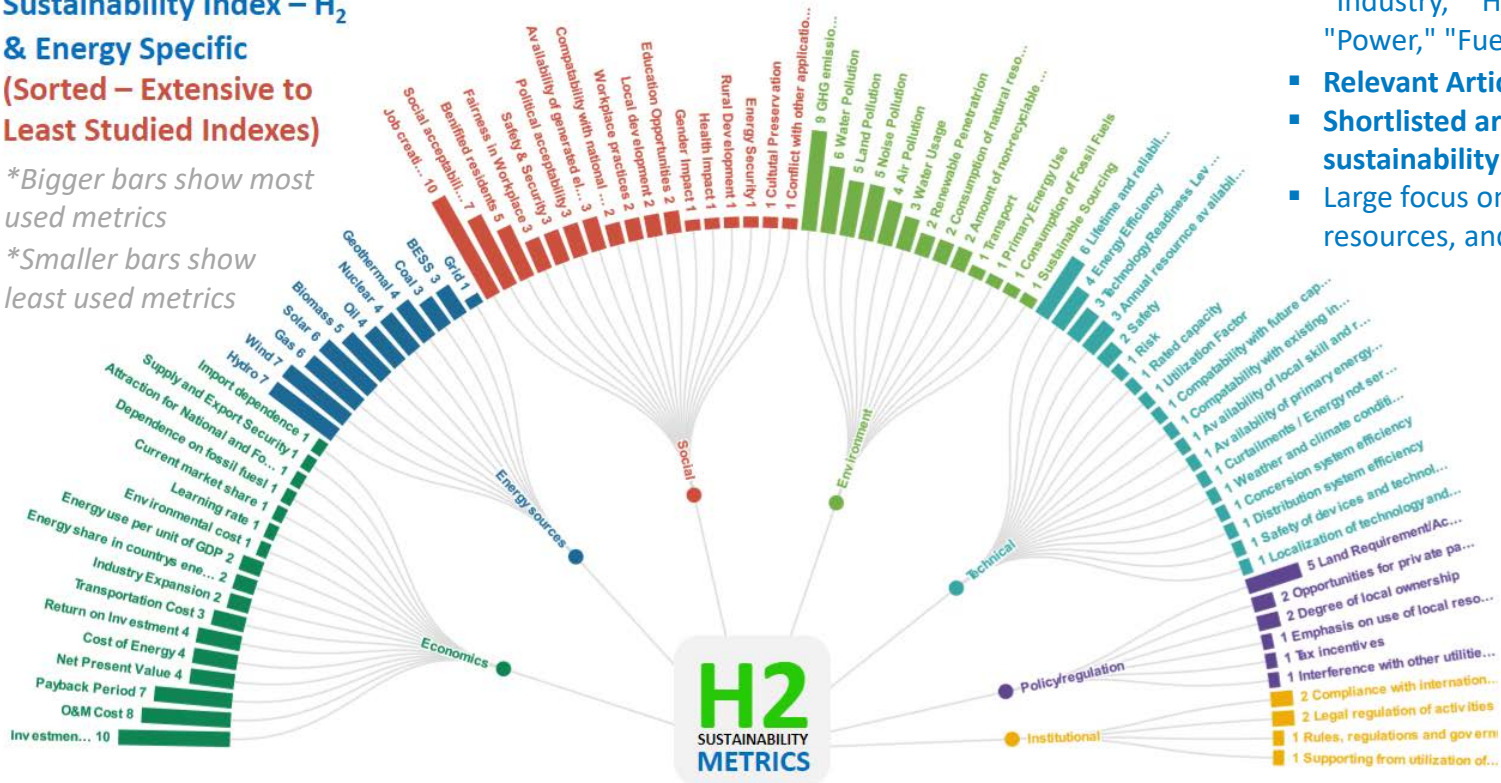
Accomplishments and Progress (1/9):

Literature review on hydrogen sustainability metrics

Available Literature On Sustainability Index – H₂ & Energy Specific (Sorted – Extensive to Least Studied Indexes)

*Bigger bars show most used metrics

*Smaller bars show least used metrics



- Key words used: "Industry," "Hydrogen," "Energy," "Power," "Fuel," and "Gas."
- Relevant Articles Found: 59
- Shortlisted articles relevant to sustainability : 26
- Large focus on economics, energy resources, and environment



Accomplishments and Progress (2/9):

Selected three expert stakeholders to provide guidance and expertise



Description

Provider of construction research and consulting services.

Year founded

1921

Framework developed

BREEAM Infrastructure
(formerly CEEQUAL)



Primary industry

Consulting Services

Focus area

Environmental Sustainability

Keywords

- Advisory services
- Sustainable infrastructure
- Construction consulting
- Training courses
- Innovative research

Sample Energy Sustainability Case Studies*

- Frodsham Wind Farm
- High community engagement
 - Efficient resource use and management



Provider of engineering, architecture, consulting and other related services.

1917

Utilizes industry frameworks, standards, and best practices
Consulting Services

Multidisciplinary Consulting

- Healthcare industry
- Corporate engineering
- Architecture design
- Technology market

West Riverside Energy Center

- Cleaner, more efficient facility
- Improved air quality and reliable power



Provider of education, training, and third-party verification services.

2010

Envision Sustainable Infrastructure Framework



501(c)3 Education and Research Nonprofit Organization
Sustainable Infrastructure

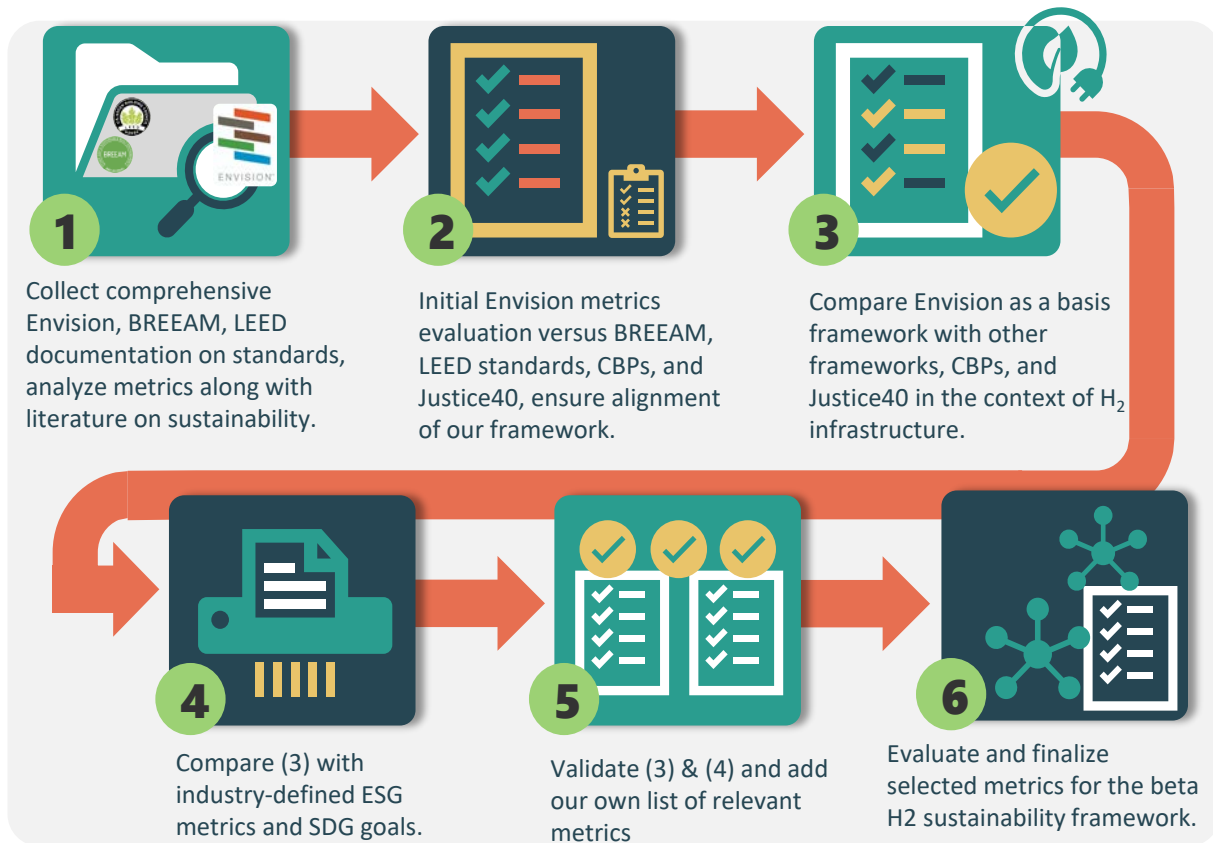
- Infrastructure (Transportation, energy, water etc.)

Bear Creek Solar Project - Alliant Energy

- Sustainable communities
- Minimized construction impacts

Accomplishments and Progress (3/9):

Sustainability framework process



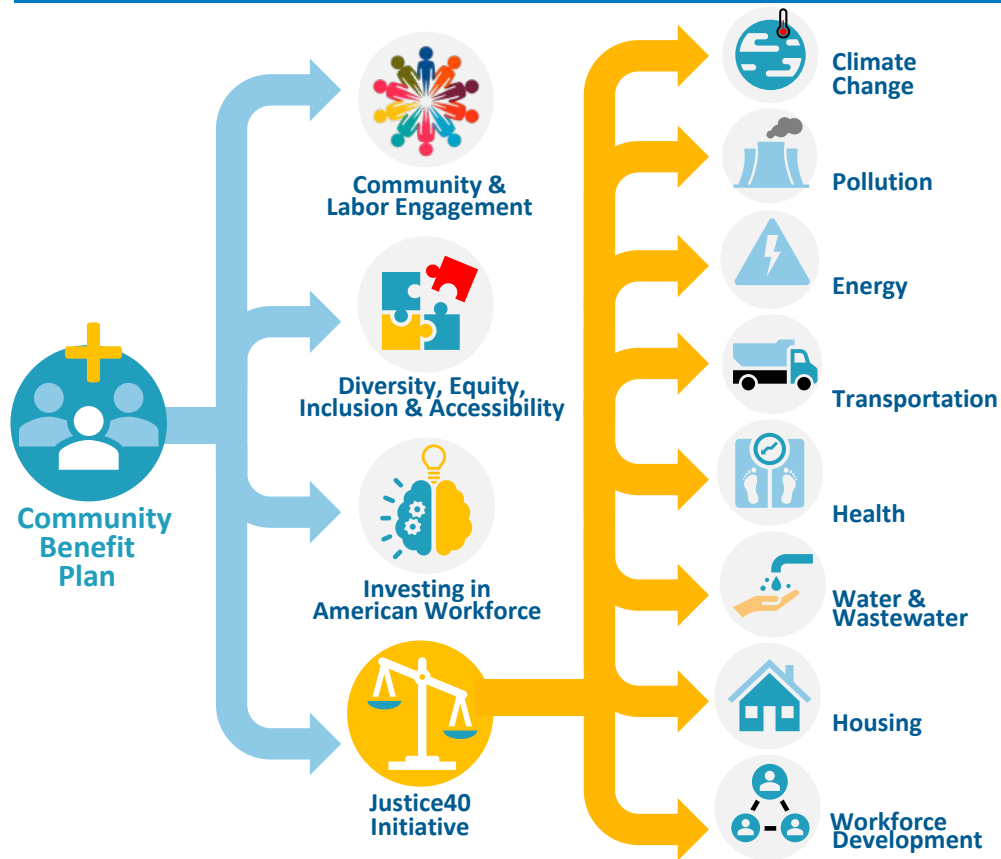
Accomplishments and Progress (4/9):

Learnings from literature provide useful insights

- Very few studies are focused on sustainability of hydrogen projects (~ 5)
- These studies proposed frameworks that were:
 - Limited in metrics that provide a holistic review of sustainability. Technical, economic, and environmental metrics were well covered.
 - Comprised of subjective weighting of sustainability metrics determined by an individual.
 - Highlighting the need for equitable weighting that considers all stakeholders perspectives
 - Comprehensive in supply chain evaluation considering metrics spanning from production to consumption.
 - Inclusive of a range of receptors over a range of time horizons (e.g. various points of view and/or stakeholders over short- and long-term horizons).
 - Inclusive of comparative metrics to other technology types (e.g. PV-powered electrolysis vs. gas reforming or PV-battery hybrid system).

Accomplishments and Progress (5/9):

Lessons from CBPs and Justice40



Key sustainability takeaways include:

- Taking a holistic approach is key, recognizing the interconnectedness of social, economic, and environmental factors.
- Measurable goals ensure accountability, allowing for clear tracking of progress and levels of achievement over time.
- Transparency and stakeholder engagement foster trust and ensure that assessment processes are inclusive.
- Tailoring solutions to specific project and community contexts enhances effectiveness and relevance, promoting sustainable outcomes that benefit both people and the planet.

Accomplishments and Progress (6/9):

ESG vs. Sustainability

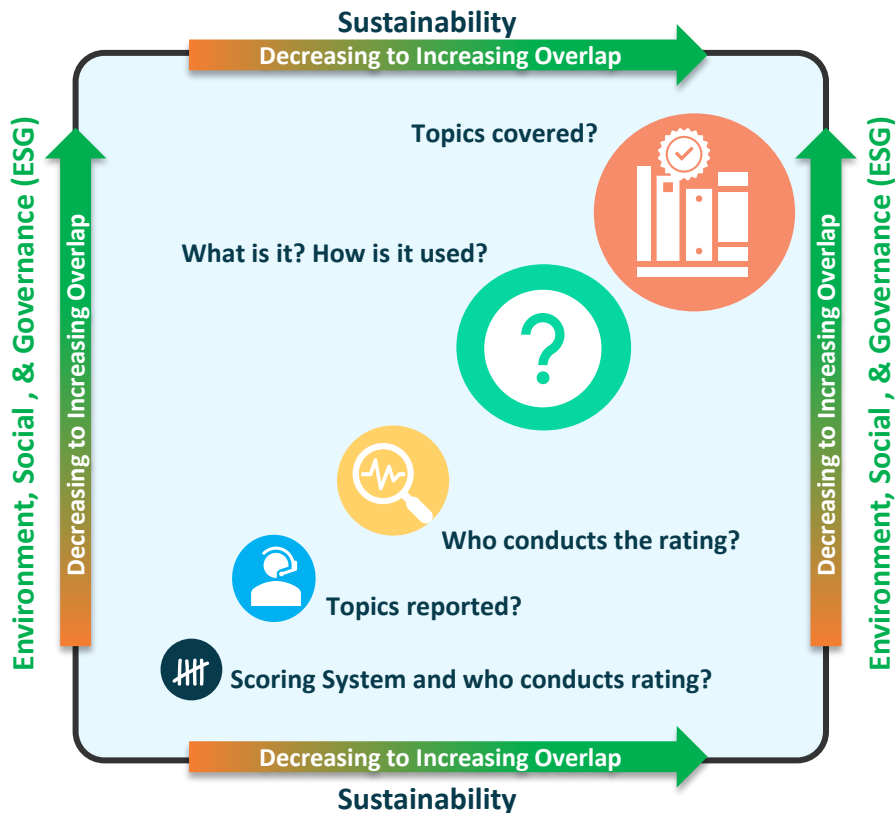
ESG overlaps with sustainability to a degree but diverge significantly when it comes to reporting.

<u>Aspect</u>	<u>ESG</u>	<u>Sustainability</u>
Focus Organizations	GRI, SASB	BREEAM Infrastructure, ISI Envision
Topics Covered?	Emissions, air quality, water management, biodiversity impacts, security, human rights and rights of indigenous people, community relations, healthy and safety, and business ethics.	Management, communities and stakeholders, health and wellbeing, energy, resources, resilience, land use and ecology, landscape and environment, pollution, transport, and information.
What is it and how is it used?	Detailed standards (i.e. metrics) used by companies to assess sustainability-related risks or provide transparency on how an <u>organization</u> contributes or aims to contribute to sustainable development.	Frameworks with detailed metrics for companies to use to assess and score sustainable performance and resiliency of <u>infrastructure projects</u> .
Scoring System?	None. Metrics defined to <u>enable disclosure</u> .	Clearly defined metrics with <u>scoring system</u> to achieve a minimum level of performance and higher levels of achievement.
Topics Reported?	Reporting responsibility lies with reporting entity, but <u>subject to materiality</u> as determined by that entity. No defined minimum level of achievement.	Metrics evaluated to tally up the score must be <u>documented</u> . <u>Minimum levels of achievement</u> are defined and required for any reported metric.
Who conducts the rating?	Third-parties using <u>black box approach</u>	Self assessment or third-party verification <u>utilizing framework scorecard</u>

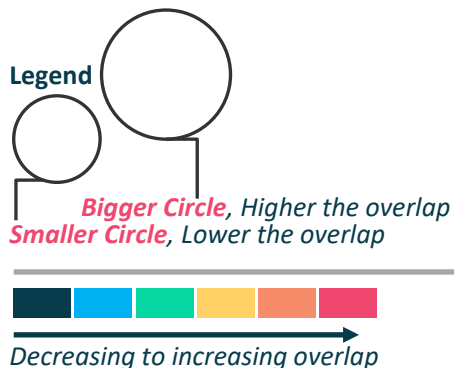
Increasing to decreasing Overlap

Accomplishments and Progress (7/9):

ESG vs. Sustainability

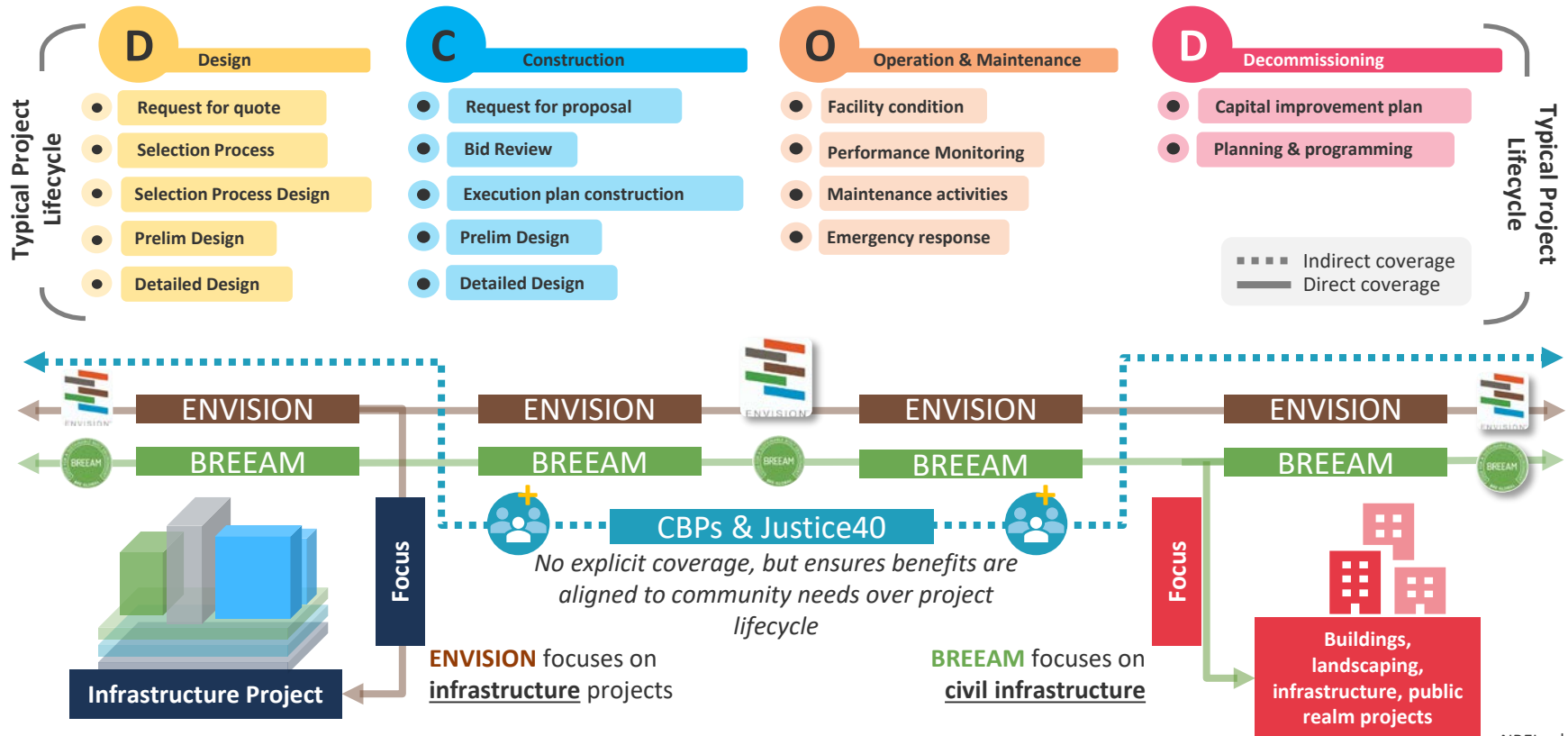


“ESG overlaps with sustainability to a degree but diverge significantly when it comes to reporting.”



Accomplishments and Progress (8/9):

Sustainability frameworks application over project lifecycle



Accomplishments and Progress (9/9):

Proposed hydrogen metrics

Problem	Category	Proposed Criteria	Proposed Requirement Overview (Preliminary)
Public Education	Education	Community education	Efforts been made to reach out to community groups and local stakeholders to educate the fundamentals of hydrogen. Higher levels of achievement for depth and breadth of audience reach.
		First responder training	Educational sessions held or material distributed to first responders. Regularly occurring sessions to keep training up-to-date.
		Public acceptance and willingness to pay	As part of community education, obtaining some acceptable percentage of public acceptance for the project. Consider marginal willingness to pay as a metric.
Leakage of hydrogen	Environment	Monitoring for hydrogen leaks	If regulations are lacking, follow suggested criteria by trusted third party. Higher levels of achievement obtained through detailed logs of events and assessment of root causes of leaks, component failure or other and used to inform and conduct quantitative risk assessment.
Reliability of hydrogen components	Resilience	Reliability of hydrogen components	Reliability of hydrogen components sufficiently tested to minimize component failure and downtime to ensure robustness of hydrogen facility.
Supply chain risk	Materials	Materials and component procurement risk	Identify what components and minerals are sourced from abroad and pose risk of procurement (e.g. excessive cost or problems sourcing). Higher levels of achievement obtained by decreasing reliance on such materials or countries of component origin.

Not an exhaustive list. Additional metrics under development and will be covered in forthcoming publication.

Response to Previous Year Reviewers' Comments

- This project was not previously reviewed

Collaboration and Coordination

- Key Project Partnerships include:
 - Collaboration with expert stakeholders that include: BRE Group, HDR Inc., Institute for Sustainable Infrastructure
 - Collaboration with other sustainability experts at NREL
 - Feedback from HFTO on proposed hydrogen criteria
 - Feedback from industry on proposed hydrogen criteria

Remaining Challenges and Barriers

- Case study identification may present challenges as there may be a lack of sufficient data to apply hydrogen sustainability metrics
- Social impacts may be difficult to capture in metrics either due to lack of data or ability to measure

Proposed Future Work

- **FY24 Proposed Work:**

- Finalize metrics to be used in the proposed sustainability framework
- Collaborate with experts on applying these metrics to one or more international case studies. These case studies will assess viability of proposed metrics.
- Publish a journal article on the proposed metrics and applicability in the case studies assessed

Summary

- NREL is contributing to the field of hydrogen sustainability metrics in collaboration with Mission Innovation, Department of State, Department of Energy, and numerous sustainability experts.
- Identifying and quantifying gaps in sustainability metrics is essential to support Department of Energy funding for hydrogen supply chain projects and will help guide private investment towards highly impactful and sustainable projects.
- Economic and environmental metrics are commonly found in literature, but more research is warranted to refine existing metrics and identify additional metrics beyond economic and environmental dimensions that drive impactful, sustainable investment decisions.

Thank You

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NREL/PR-5400-89543

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08G028308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Hydrogen and Fuel Cell Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.



Technical Backup and Additional Information

Technology Transfer Activities

- There is no known patent, licensing, or potential licensing information associated with this project.