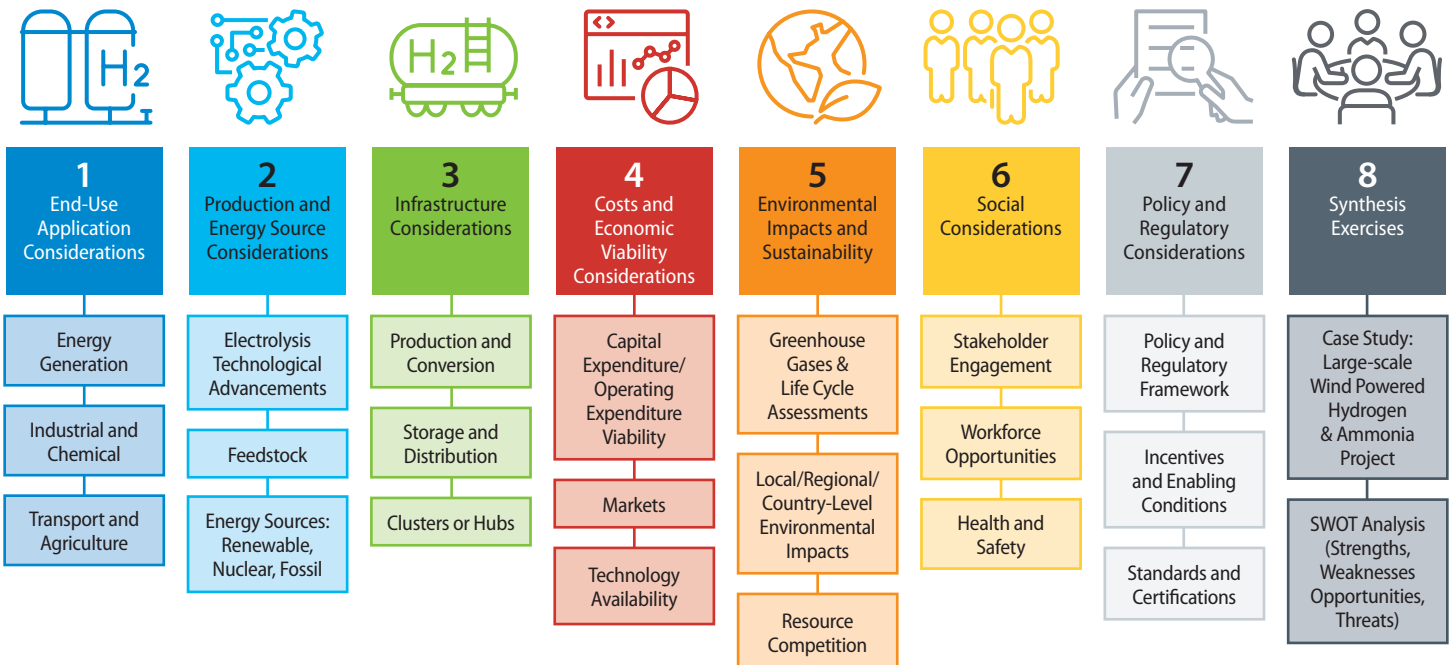




Photo by Werner Slocum, NREL 17648

Guiding Sustainable Hydrogen Integration: A Capacity Building Approach

The **Hydrogen Considerations Tree** is designed to empower institutions to explore and consider the costs, benefits, and tradeoffs of hydrogen and its derivatives (e.g. e-fuels and green ammonia) and inform hydrogen strategy, policy, and investment decisions within unique contexts around the world. Key topics are organized into a “Considerations Tree,” enabling stakeholders to explore technical, regulatory, economic, environmental, social, and other analysis questions systematically and holistically. The Hydrogen Considerations Tree was funded by the U.S. Agency for International Development (USAID) through the USAID-NREL Partnership. Visit the USAID-NREL Partnership website to learn more: www.nrel.gov/usaid-partnership.



Hydrogen Considerations Tree Structure



Module	Theme	Questions Addressed
Module 1: End-Use Application Considerations	Different uses of hydrogen and its derivatives, including key decision-drivers for the selection of hydrogen end uses.	<ul style="list-style-type: none"> • What are the niche applications for hydrogen and its derivatives that can compete with near-term market alternatives, such as electrification? • Why is proximity and access to end users a critical consideration for developing economically viable hydrogen projects?
Module 2: Production and Energy Source Considerations	Hydrogen production pathways, including quantitative metrics.	<ul style="list-style-type: none"> • How flexible is hydrogen as an energy carrier, and what factors influence its life cycle carbon or greenhouse gas emissions? • What is the significance of the availability, reliability, and sustainability of energy sources for the viability of hydrogen projects?
Module 3: Infrastructure Considerations	Required infrastructure for hydrogen delivery and the associated cost implications in the context of specific business cases.	<ul style="list-style-type: none"> • What are the critical considerations for developing infrastructure (storage, transport, distribution, and delivery) for hydrogen projects? • How can centralized hubs optimize and minimize infrastructure requirements for hydrogen storage and transport?
Module 4: Cost and Economic Viability Considerations	Holistic costs and economic considerations associated with hydrogen projects.	<ul style="list-style-type: none"> • When evaluating the viability of a project, how important is the identification of specific end-use applications, offtakers, and their respective willingness to pay? • What factors increase the cost of storage and transportation of hydrogen and its derivatives compared with other energy carriers, and how can these costs be minimized during the project design phase?
Module 5: Environmental Impacts and Sustainability Considerations	Environmental implications of hydrogen deployment, including water, land use, and carbon emissions across the life cycle of the projects.	<ul style="list-style-type: none"> • What are the potential environmental benefits and/or impacts of hydrogen, and how do they vary with energy source, end-use application, geography, and available alternatives? • How can the significant impacts of hydrogen projects on land and water resources be reduced and managed?
Module 6: Social Considerations	Social dimensions of hydrogen projects, considering land use and access, community engagement, social justice, water usage, human health and safety, and more.	<ul style="list-style-type: none"> • Why is early-stage community engagement and planning critical for hydrogen projects, and how can it mitigate potential social barriers, issues, and health and safety risks? • What lessons can be learned from other sectors to ensure the just and equitable deployment of hydrogen projects, with a focus on gender equity and supporting underserved communities?
Module 7: Policy and Regulatory Considerations	Required policy and regulatory frameworks for the deployment of hydrogen technologies, including the role of stakeholders, incentives, safety, certification schemes, and standards.	<ul style="list-style-type: none"> • Why are global certification schemes a priority for the development of an international hydrogen market? • What types of policies and regulations are needed across sectors and phases of hydrogen production, distribution, and delivery?
Module 8: Synthesis Exercises	Actively engage participants in the decision-making process and understand the potential benefits, challenges, and trade-offs associated with hydrogen technologies and projects.	<ul style="list-style-type: none"> • What are the strengths, weaknesses, opportunities, and threats of an example case study from different stakeholder perspectives? • What is the relative importance of production, energy sources, end uses, infrastructure, cost viability, environmental, social, and regulatory considerations when making decisions on project development?

 Explore the full Hydrogen Considerations Tree: www.nrel.gov/docs/fy24osti/87797.pdf

 Learn how to work with NREL to apply these materials by contacting our team at USAID.NREL@nrel.gov.