WYOMING ENERGY AUTHORITY

Cheyenne LEADS
The Cheyenne-Laramie County Corporation for Economic Development

ROADMAP TO BUILD A HYDROGEN ECONOMY

2022 - 2026

Wyoming's Hydrogen Roadmap provides a course of action with specific roles and responsibilities for various stakeholders over the next five years, from 2022-2026. This roadmap leverages the combined strengths of these stakeholders to deliver on our shared vision while simultaneously addressing the challenges that must be overcome.

VISON

Wyoming is the Energy State with an all-of-the-above net-zero energy strategy and leads the region in the low-carbon hydrogen economy.

WYOMING'S HYDROGEN ROADMAP: STRATEGIC PRIORITIES

1. Develop resources, utilizing all feedstock options, for a robust, decarbonized production ecosystem.

2. Invest in the development of core and adjacent infrastructure including transportation, storage, and carbon management.

3. Identify and develop end use options and evolving markets both within and outside of Wyoming.

4. Develop supportive policy and regulatory framework for the advancement of hydrogen as an energy source.

5. Develop workforce and community infrastructure.

The roadmap is a multi-dimensional strategy which leverages the opportunities and addresses the challenges as Wyoming plays a major role in for the domestic and global low-carbon hydrogen economy.

WYOMING'S OPPORTUNITY IN THE HYDROGEN ECONOMY

WYOMING WILL BUILD ON ITS INHERENT STRENGTHS AS THE ENERGY STATE BY HARNESSING THE FOLLOWING OPPORTUNITIES:

1. Create legislative support for hydrogen, through education and the provision of impartial and credible advice.
2. Leverage private partners across all phases of the hydrogen value chain.
3. Be the home to international leaders in the energy industry who are prepared to aggressively scale clean energy, with billions in investments already underway and a vision for infrastructure and energy production hub projects.
4. Commit to innovation and opportunities for commercialization of technology by supporting pilot projects in collaboration with the private sector.
5. Leverage centers of learning and research in the state and region to educate our workforce, address our limitations, create capacity and maximize our opportunities. This includes the University of Wyoming School of Energy Resources, community colleges, our partnerships with the Idaho National Laboratory and the Wyoming Next Frontier Energy Action Team
6. Unlock stranded renewable resources using hydrogen to provide an alternative transmission medium. Provide an added-value opportunity for renewable electricity.
7. Utilize Wyoming's carbon management infrastructure and expertise together with the existing production and transportation industry to develop a sustainable pathway for the state's hydrocarbon resources.
8. Preserve and enhance the state's extensive intra- and inter-state transmission systems involving rail, interstate highways, existing pipeline infrastructure to connect Wyoming with neighboring states and extended markets.
9. Preserve and enhance the experienced and future energy workforce by committing to training.
10. Growing markets within and beyond the state boundaries.
11. Demonstrate ongoing commitment by the State of Wyoming leadership to pursue an all-of-the-above net-zero carbon economy with continued investment of resources and authority in the state's agencies and instrumentalities.

ACKNOWLEDGING THE MAJOR CHALLENGES

Our vision will require the State of Wyoming to overcome the following challenges:

1. An evolving regulatory environment. There is a need for clear, consistent and supportive policies and regulations at both the state and federal levels.

2. Insufficient infrastructure to meet hydrogen production growth projections.

3. Lagging investment in storage and transportation infrastructure.

4. The impact of permitting, finance, technology development, and demand pull on ROI.

5. Supply chain constraints for hydrogen production, technology components, maintenance, and more.

6. The critical role that water plays in all hydrogen production methods.

COLLABORATING TO DRIVE THE ROADMAP: NEXT FRONTIER ENERGY ACTION TEAM

The Next Frontier Energy Action Team is a group of global and national companies with operations spanning the net zero energy value chain working with other stakeholder groups supporting the Wyoming Energy Authority's all-of-the-above net-zero strategic initiatives. The objective of the Team is to support a comprehensive approach to enable adoption of policies, regulations, financial investment and research that advance net-zero energy production, efficient and safe storage and transportation, and market demand.

The Action Team will:

1. Be a single clear voice for the next frontier of the energy industry.

2. Actively engage representatives from industry to partner with government, academic led R&D, and economic development to accelerate low-carbon energy deployment via supportive policies and investments.

3. Provide a forum for identifying the most pressing barriers, opportunities and impactful tactics to advance net zero energy strategies.

4. Prioritize and advance recommendations to policy makers at the state and federal levels regarding actions needed to advance net zero energy deployment and transport across state-lines to growing markets.

5. Develop strategies to attract investment in infrastructure and decrease time to market while reducing the investment risks and operational cost.

6. Identify gaps in the supply chain and opportunities for new business development in Wyoming's evolving new energy economy.

7. Identify opportunities for project-oriented collaboration to realize synergies and add value.

8. Proactively support deployment of the Wyoming Energy Authority's Hydrogen Economy Roadmap and other strategic planning activities.

ACTION STEPS FOR HYDROGEN INFRASTRUCTURE, SUPPLY, MARKETS, & DELIVERY

1. DEVELOP RESOURCES, UTILIZING ALL FEEDSTOCK OPTIONS, FOR A ROBUST DECARBONIZED PRODUCTION ECOSYSTEM

2. INVEST IN THE DEVELOPMENT OF CORE AND ADJACENT INFRASTRUCTURE INCLUDING TRANSPORTATION, STORAGE, AND CARBON MANAGEMENT.

3. IDENTIFY AND DEVELOP END USE OPTIONS AND EVOLVING MARKETS BOTH WITHIN AND OUTSIDE OF WYOMING.

4. DEVELOP SUPPORTIVE POLICY AND REGULATORY FRAMEWORK FOR THE ADVANCEMENT OF HYDROGEN AS AN ENERGY SOURCE.

5. DEVELOP WORKFORCE AND COMMUNITY INFRASTRUCTURE.

STAKEHOLDERS

Wyoming Energy Authority	**Private Sector**	**UW School of Energy**	**Government (State & Local)**	**Economic Development Agencies (WBC & Regional EDOs)**	**Resource & Enabling Organizations**

1. DEVELOP RESOURCES, UTILIZING ALL FEEDSTOCK OPTIONS, FOR A ROBUST DECARBONIZED PRODUCTION ECOSYSTEM

Wyoming Energy Authority	Private Sector	UW School of Energy	Government (State & Local)	Economic Development Agencies (WBC & Regional EDOs)	Resource & Enabling Organizations
1. Actively support and invest in the deployment of hydrogen production technologies and infrastructure. 2. Invest in pilot projects with the greatest potential to advance commercial and technical readiness levels, and achieve scale. 3. Guide focus of state funded R&D, with initial emphasis on leveraging Wyoming's key advantages i.e., abundant natural resources and addressing Wyoming's critical needs (i.e., water use and storage). 4 Continue efforts to support production of low-carbon hydrogen from fossil fuels. 5. Represent the State of Wyoming to federal agencies such as DOE and the National Laboratories regarding technology deployment, infrastructure development, and economic transformation. 6. Pursue and develop an integrated energy economy in WY leveraging the inter-connected prospects of CCUS, Hydrogen, Advanced Reactors, REE and the potential for synergies and value-add opportunities.	1. Diversify business portfolios, invest in hydrogen and other ventures across an integrated all-of-the-above net zero energy economy. 2. Deploy carbon management technology and infrastructure at scale. 3. Develop new hydrogen products and applications. 4. Pursue joint ventures to realize synergies and add value. 5. Identify gaps in the supply chain and work with economic development agencies to actively fill the gaps. 6. Integrate funding opportunities such as 45Q and 45W tax credits, and state Low Carbon Fuel Standard initiatives, to improve economic performance. 7. Continue to build out zero-emissions electricity generation capacity, including wind, solar, geothermal and nuclear. 8. Explore alternative water sources for hydrogen production.	1. Work with the private sector to utilize Wyoming's existing resources and transform them into potential feedstock for clean hydrogen including coal, natural gas, wind, solar and uranium. 2. Undertake R&D that addresses critical barriers and supports those emerging technologies that are most commercially ready for all forms of clean hydrogen including low-cost coal via gasification, natural gas resources via methane reforming, high-capacity wind energy via electrolysis, potential for solar, nuclear, and more. 3. Undertake research on water usage and availability; and use of produced water as a feedstock for hydrogen production while conserving freshwater resources in Wyoming; expand research on water treatment for energy feedstock. 4. Support and partner with Wyoming Energy Authority, national laboratories, academic institutions, and industry for projects in the pilot project phase. 5. Develop and support CCUS technology and capacity.	1. Develop policies and incentives that stimulate deployment, remove barriers, and facilitate development of a hydrogen industry. 2. Continue to invest in relevant agencies and instrumentalities, R&D, pilots and demonstrations to facilitate development of a hydrogen industry.	1. Identify and recognize hydrogen as a key component of Wyoming's energy industry sector in economic development strategies. 2. Update strategic plans to include opportunities for hydrogen-based initiatives, including recruitment of businesses in all areas including fossil fuels with carbon capture, wind, solar and nuclear, as well as other sources of feedstock and supply chain. 3. Be an active partner with the private sector to advocate for and to drive approval of large incentives, or other policy needs supporting project development. 4. Support companies diversifying portfolios and investing in hydrogen and low carbon ventures. 5. Support and partner with Wyoming Energy Authority, other agencies, and private parties for pilot and demonstration projects. 6. Develop new economic development tools such as "Energy Development Zones" and "Energy Parks."	1. Western Green Hydrogen Initiative

2. INVEST IN THE DEVELOPMENT OF CORE & ADJACENT INFRASTRUCTURE INCLUDING TRANSPORTATION, STORAGE, & CARBON MANAGEMENT

Wyoming Energy Authority	Private Sector	UW School of Energy	Government (State & Local)	Economic Development Agencies (WBC & Regional EDOs)	Resource & Enabling Organizations
1. Guide focus of state activities, with emphasis on issues such storage, distribution, fueling and backup power systems. 2. Take the lead, working with the private sector, to attract investment in infrastructure. 3. Continue efforts to support carbon management.	1. Invest in hydrogen production, storage, and distribution systems. 2. Invest in adjacent infrastructure areas such as carbon sequestration hubs and advanced net-zero manufacturing. 3. Develop safe and large hydrogen storage capacity. 4. Work with pipeline companies, and other providers of transportation services (i.e., rail), to determine the most cost-effective forms of transportation to markets within and external to Wyoming.	1. Undertake research on infrastructure including transportation, storage, and carbon management. 2. Work with industry to identify and investigate emerging issues such as short-term and seasonal storage for hydrogen produced from renewables and other sources.	1. Leverage Federal and private sector investments for pipeline infrastructure; particularly on state lands. 2. Facilitate development of hydrogen fueling infrastructure. 3. Collaborate with neighboring states in order to build region-scale infrastructure. 4. Develop strategies for transport corridors, production and fueling hubs, etc. on interstates and highways (I80 and I25). 5. Leverage existing rights-of-way for low impact CO2 and hydrogen transport infrastructure. 6. Facilitate pipeline easements and other local approvals for local distribution systems. 7. Create incentives and policies supporting production, transportation and storage of hydrogen and hydrogen derivatives to lower cost and risk, and to accelerate market launch 8. Leverage existing Wyoming expertise, infrastructure and policy to establish hydrogen storage capacity in the state.	1. Seek out industry partnerships and joint ventures to create a “business case” for investment in Wyoming’s Hydrogen Economy. 2. Work with industry to develop strategies to attract investment, decrease time to market, and reduce risks and operational cost burden of investing at the front end of the market. 3. Offer incentives for expansion of existing businesses and new business development. 4. Facilitate pipeline easements and other local approvals.	1. Wyoming Pipeline Corridor Initiative 2. Carbon Utilization Research Council 3. Western Tribal Nations Natural Gas Initiative

3. IDENTIFY AND DEVELOP END USE OPTIONS AND EVOLVING MARKETS BOTH WITHIN AND OUTSIDE OF WYOMING

Wyoming Energy Authority	Private Sector	UW School of Energy	Government (State & Local)	Economic Development Agencies (WBC & Regional EDOs)	Resource & Enabling Organizations
1. Facilitate and support the Next Frontier Energy Action Team. 2. Support industry initiatives to identify, capture, and grow markets. 3. Work with govt and economic development agencies to advance hydrogen use case awareness and gain market recognition. 4. Facilitate public-private partnerships and govt-to-govt relationships, including Tribal Nations, to complete the value chain and allow Wyoming hydrogen access to markets. 5. Develop inter-agency relationships in likely demand centers to preserve, develop and expand market access. 6. Pursue and develop an integrated energy economy in WY in order to expand local demand and add-value to WY hydrogen production.	1. Identify and pursue leading markets for hydrogen end-use opportunities (i.e., power generation, energy storage, domestic and global markets, transportation, and feedstock for industrial processes). 2. Participate in education and outreach to advance awareness to the public, elected officials and economic development agencies.	1. Undertake research to identify emerging markets ranging from power generation to energy storage to transport, industrial energy, building heat and power, industry feedstock and more. 2. Work with industry and UW faculty to enable research on future technologies such as hydrogen-powered devices. 3. Work with industry and government to investigate and accelerate installation of a future state-wide production, storage, distribution and refueling infrastructure.	1. Proactively support the private sector to attract new market opportunities to Wyoming. 2. Demonstrate commitment to hydrogen as a component of Wyoming's energy strategy such as increasing all methods of production, setting targets to decrease carbon emissions, and creating public awareness. 3. Include hydrogen-based options in government procurement and support development of a hydrogen fueling infrastructure, for example for vehicle fleets or government buildings.	1. Invest in economic development projects that stimulate markets. 2. Be a partner in advancing awareness to elected officials, community leaders, and the public. 3. Be a partner in a market deployment strategy, including branding and messaging for business and talent recruitment. 4. Support industry in matching large-scale hydrogen production with local and regional baseload demand.	1. Western Inter-State Hydrogen Hub 2. R.A.N.G.E. 3. WBC

4. DEVELOP SUPPORTIVE POLICY AND REGULATORY FRAMEWORK FOR THE ADVANCEMENT OF HYDROGEN AS AN ENERGY SOURCE

Wyoming Energy Authority	Private Sector	UW School of Energy	Government (State & Local)	Economic Development Agencies (WBC & Regional EDOs)	Resource & Enabling Organizations
1. Work with various stakeholders to increase public awareness and acceptance of hydrogen, i.e., increased information and education of all levels of elected officials and the public. 2. Represent the State of Wyoming to federal agencies involved in policies and regulatory oversight related to hydrogen. 3. Be a clearinghouse for information on proposed federal legislation, policies and regulations, and funding opportunities. 4. Serve as the designated representative of the State of Wyoming to regional and multi-state coalitions. 5. Work with state legislators to develop pro-active policy that benefits all aspects of a hydrogen industry in WY.	1. Identify and prioritize recommendations to policy makers at the state and federal levels regarding specific actions needed to advance hydrogen deployment in the State of Wyoming and transportation across state-lines to growing markets.	1. Conduct regulation and policy analyses geared toward optimizing hydrogen transportation networks in Wyoming and to Wyoming energy customers elsewhere. 2. Work with the private sector and state agencies to identify and develop regulatory responses to issues such as retrofitting existing facilities, safety and other issues related to production, storage, and carbon management. 3. Identify gaps for establishment of a regulatory framework for hydrogen storage and help to facilitate the necessary change.	1. Identify and recognize hydrogen as a key component of Wyoming's energy industry sector in economic development strategies. 2. Review existing codes, safety regulations and standards to confirm they account for and are compatible, with hydrogen i.e., pipeline integrity, operation safety standards, grid stability, fuel specifications, etc. 3. Make Wyoming "hydrogen energy ready" by supporting the development of state-wide policies and scope of regulatory requirements for businesses to guide and facilitate hydrogen projects and encourage investments, i.e., codes and standards, permitting requirements, regulations for safe and secure storage, transportation; as well as financial incentives. 4. Prepare the state's regulatory agencies to be knowledgeable and engaged for the efficient and safe development of production, storage and transportation. 5. Represent the State of Wyoming to federal agencies involved in policies and regulatory oversight related to hydrogen. 6. Develop regulatory framework, in partnership with stakeholders, that emphasizes safety across all aspects of the hydrogen value chain.	1. Work with the private sector to attract select market users for new business development such as fuel cell manufacturers. 2. advocate for incentives and supportive legislation.	1. Great Plains Institute 2. Clean Hydrogen Future Coalition 3. Labor Unions 4. Carbon Utilization Research Council 5. Clean Air Task Force 6. Western Green Hydrogen Coalition 6. DEQ, WOGCC

5. DEVELOP WORKFORCE AND COMMUNITY INFRASTRUCTURE

Wyoming Energy Authority	Private Sector	UW School of Energy	Government (State & Local)	Economic Development Agencies (WBC & Regional EDOs)	Resource & Enabling Organizations
1. Provide relevant data and resources in support of public education at the state and local level.	1. Identify talent and skills; and participate in defining education and training needs. 2. Participate in talent attraction efforts. 3. Leverage programs such as the Wyoming Innovation Partnership; Training, Internship and Apprenticeship Program; and industry partnerships.	1. Lead capacity building efforts, where deemed necessary, to develop academic programs to train Wyoming's next generation of hydrogen workforce.	1. Invest in the education of Wyoming's future energy workforce with a focus on K-12 and college-level education. Consider models adopted in other states/ countries. 2. Utilize resources such curriculum developed by other countries, US DOE's materials to integrate the subject of hydrogen into the K-12 curriculum and curriculum for teacher learning; and govt. grants. 3. Invest in the training and re-training of Wyoming's workforce for the hydrogen economy's needs.	1. Be a partner in talent attraction initiatives. 2. Work with local communities to development appropriate community infrastructure.	1. Wyoming Community Colleges; engage with the School of Energy resources and Industry to develop technical programming for training a hydrogen workforce. 2. Labor unions 3. Wy. Dept. of Workforce Services