State Strategies to Develop and Support the Emerging Clean Hydrogen Workforce

A Clean Hydrogen State Working Group Tool

NASEO
National Association of State Energy Officials

Breakthrough Energy

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Introduction

As the U.S. clean hydrogen economy continues to grow, State and Territory Energy Offices will be well positioned to support the emerging clean hydrogen workforce and help their communities maximize the anticipated job opportunities and economic development benefits. By incorporating workforce considerations into state clean hydrogen roadmapping activities, policy and program planning discussions, and community engagement efforts, State Energy Offices can help identify workforce needs, build partnerships, and improve job quality and access in the expanding clean hydrogen sector.

The U.S. Department of Energy (DOE) Pathways to Commercial Liftoff: Clean Hydrogen report notes that the growth of the hydrogen economy could produce approximately 100,000 net new direct and indirect jobs by 2030 (or about 450,000 cumulative job-years through 2030).[1] These "net new" jobs would support the development of new clean hydrogen projects and infrastructure, including direct engineering and construction jobs and indirect manufacturing and supply chain jobs. The analysis also estimates that the hydrogen economy could create an additional 120,000 direct and indirect jobs by 2030 to support ongoing operation and maintenance of hydrogen plants and infrastructure.[2] An analysis by Rhodium Group provides project-level job potential estimates based on a sample hydrogen facility.[3] For an electrolytic hydrogen facility, a 100 MW plant could produce 330 average annual jobs during the 2-year construction period and 45 average annual jobs related to ongoing operations and maintenance. For a sample carbon capture retrofit of a fossil fuel hydrogen plant (capturing 500 kilotons of CO_2 per year), the analysis estimates 550 average annual jobs during the 4-year construction period and 80 ongoing jobs.

In addition to the quantity of new jobs expected, recent federal investments also prioritize workforce development and the creation of good quality jobs[i] in the clean hydrogen industry. The Regional Clean Hydrogen Hub opportunity in the Infrastructure Investment and Jobs Act (IIJA) requires a detailed Community Benefits Plan outlining existing and planned engagement with workforce stakeholders and efforts to create good quality jobs and build a diverse and skilled workforce.[4] Additionally, clean hydrogen projects must meet prevailing wage and apprenticeship requirements to receive the highest tax credits available through the Inflation Reduction Act (IRA).[5]

i The U.S. Department of Energy defines a "good job" as a "job with (1) fair, transparent, and equitable pay that exceeds the local average wage for an industry, while delivering; (2) basic benefits (e.g., paid leave, health insurance, retirement/savings plan); (3) providing workers with an environment in which to have a collective voice; and (4) helps the employee develop the skills and experiences necessary to advance along a career path. In addition, good jobs provide (5) predictable scheduling, and a safe, healthy, and accessible workplace devoid of hostility and harassment. With good jobs, (6) employees are properly classified with the limited use of independent contractors and temporary workers. Workers have a (7) statutorily protected right to a free and fair choice to join a union under the National Labor Relations Act (NLRA). Good jobs are provided by management's rigorous knowledge of these rights and other employment rights that protect against harassment, discrimination, and retaliation and their active attempt to avoid any violations of the NLRA and other labor and employment laws; such as worker intimidation or harassment, or unwarranted delay in negotiations or grievance resolution."

The anticipated growth of the clean hydrogen industry in the United States provides states with an opportunity to bring good-paying jobs and economic development benefits to their communities, while reducing emissions in hard-to-abate sectors. The expansion of the clean hydrogen economy can also help states support a just transition by offering meaningful career pathways to workers in industries currently tied to fossil fuel production, transport, and use. Clean hydrogen jobs require many of the same skills needed for jobs in the fossil fuel and industrial sectors. According to an analysis by the Energy Futures Initiative, "roughly 45 percent of the workforce in industries that are most at-risk during the clean energy transition are well suited for jobs in clean hydrogen."[6] Clean hydrogen projects can also help support local economies traditionally reliant on tax revenues and other economic development benefits tied to fossil fuels. For example, in Utah, the Intermountain Power Agency (IPA) is converting a coal-fired power plant into a hydrogen and natural gas-powered plant, the Intermountain Power Project Renewed. Instead of leaving the county after the coal plant closure, IPA is intentionally using existing infrastructure for the hydrogen project to keep investments in the local economy and create new jobs for the community.[7]

Whether supporting workers transitioning from other sectors or training new workers, states will play an important role in preparing the emerging clean hydrogen workforce and will likely need to adapt existing training programs or develop new programs to meet industry needs and expand access for populations historically underrepresented in the energy industry. While many of the skills and education required for clean hydrogen jobs overlap with other industries, the growing clean hydrogen industry will require a large pool of workers with diverse skillsets across the value chain. A report by Cavendish Energy LLC lists over forty potential job titles, average salaries, and anticipated training and education requirements for jobs in the hydrogen and fuel cell industries, including pipeline construction workers, fueling station managers, power system engineers and technicians, electricians, and plant operations managers.[8] (See Table 1 on the following pages for the full list of emerging occupations identified by Cavendish Energy LLC).

Table 1. Compiled list of job titles, salaries, and educational requirements for emerging occupations in the hydrogen and fuel cell industries.[9]

Occupational title	Average salary (2016$)	Minimum educational requirements
Director of hydrogen energy development	$138,000	Bachelor's (Business)
Hydrogen fueling station manager	$56,300	Bachelor's (CE)
Hydrogen/fuel cell R&D director	$129,000	Doctoral
Hydrogen fuel cell system technician	$39,500	HSD/GED/OJT/TS/apprenticeship
Junior hydrogen energy technician	$23,400	HSD/GED/OJT/TS/apprenticeship
Fuel cell engineering intern	$6,800	HSD/GED/OJT/apprenticeship
Fuel cell manufacturing technician	$45,650	Associate's
Fuel cell fabrication and testing technician	$45,800	Associate's
Hydrogen power plant installation, operations, engineering, and management	$69,700	Bachelor's (EE, ME, CE)
Hydrogen energy systems designer	$47,900	Apprenticeship/TS
Fuel cell plant manager	$90,500	Bachelor's (EE, ME)
Hydrogen energy system operations engineer	$68,100	HSD/GED
Hydrogen fueling station designer & project engineer	$74,200	Bachelor's (Engineer)
Hydrogen fuel transporter – trucker	$36,950	OJT
Hydrogen fueling station operator	$29,700	OJT
Hydrogen fuels policy analyst & business sales	$56,200	Bachelor's (Business)
Hydrogen systems program manager	$73,220	Bachelor's (Engineer)
Emissions accounting & reporting consultant	$64,200	Bachelor's (various)
Fuel cell quality control manager	$74,600	Master's (Science/Engineering)
Hydrogen pipeline construction worker	$46,300	HSD/GED/OJT/TS/apprenticeship
Fuel cell designer	$78,200	Master's (Science)
Hydrogen energy engineer	$72,300	Bachelor's (Engineer)
Fuel cell power systems engineer	$76,400	Master's (EE)
Fuel cell fabrication technician	$23,150	HSD/GED/OJT/TS/apprenticeship
Hydrogen systems & retrofit designer	$90,600	Bachelor's
Fuel cell retrofit installer	$41,600	HSD/GED/OJT/TS apprenticeship
Fuel cell retrofit manufacturer plant labor	$36,500	HSD/GED
Hydrogen vehicle electrician	$44,800	HSD/GED/OJT/TS apprenticeship
Fuel cell vehicle development engineer	$69,800	Bachelor's (Engineer)
Hydrogen systems safety investigator – cause analyst	$88,350	Bachelor's (various)
Hydrogen lab technician	$40,600	Associate's
Hydrogen energy system installer helper	$23,200	HSD/GED
Hazardous materials management specialist	$55,300	Bachelor's (Science)

Occupational title	Average salary (2016$)	Minimum educational requirements
Hydrogen energy system installer	$31,500	HSD/GED/OJT/TS apprenticeship
Fuel cell power systems operator and instructor	$50,900	HSD/GED/OJT/TS apprenticeship
Fuel cell backup power system technician	$40,200	HSD/GED/OJT/TS apprenticeship
Senior automotive fuel cell power electronics engineer	$69,700	Bachelor's (EE)
Emissions reduction credit portfolio manager	$47,400	Bachelor's (Business)
Emissions reduction project developer specialist	$63,450	Bachelor's (various)
Emissions reduction project manager	$78,600	Bachelor's (various)
Hydrogen systems sales consultant	$53,800	Bachelor's (Business)
Hydrogen plant operations manager	$95,200	Bachelor's (EE, ME)

To take advantage of the job opportunities and economic development benefits expected to accompany the growth of the clean hydrogen economy, states will need to incorporate workforce development considerations into their policies, planning, and programs and build in key protections and worker supports to ensure the jobs are good quality[10] and inclusive of groups historically underrepresented in the energy sector. The State Strategies to Develop and Support the Emerging Clean Hydrogen Workforce tool aims to help State Energy Offices better understand and respond to workforce challenges in the growing clean hydrogen sector and offers examples of key actions state leaders can take, including: 1) assessing the current and future hydrogen workforce, 2) fostering workforce development partnerships, and 3) ensuring job quality and equitable access to career pathways. Recognizing that the clean hydrogen industry is nascent, it draws on workforce and economic development approaches from other energy technologies and industries to highlight potential strategies for states interested in expanding their hydrogen economy.

Source: Adobe Stock/wladimir1804

1. Assessing the current and future hydrogen workforce

Prior to planning and implementing workforce development efforts, it may be helpful for states to conduct a workforce needs assessment, either focused on clean hydrogen jobs or jobs in the overall energy industry and related sectors. Several states have developed or supported the development of energy workforce assessments. For example, the Pennsylvania Department of Environmental Protection's Energy Programs Office (the State Energy Office) published a series of energy workforce assessments, including a Clean Energy Gap Analysis.[11] The analysis used data from the United States Energy Employment Report (USEER),[12] as well as prior state-level reports and a survey of employers to identify key hiring and retention barriers, training and education gaps, and job quality metrics among several high-growth clean energy sectors in Pennsylvania.

Given that the clean hydrogen industry is still new in many states, assessments of the current clean hydrogen workforce and future job potential may be challenging. In particular, the data needed to conduct assessments and identify gaps is lacking. The types of jobs in the clean hydrogen industry (and the hydrogen industry overall) vary and do not fall under a unique industry category within the North American Industry Classification System (NAICS), which the Bureau of Labor Statistics uses to report job totals, wage data, and other industry-specific trends. For example, some clean hydrogen jobs may fall under the Industrial Gas Manufacturing NAICS code category, while others may be categorized under Other Electric Power Generation or Fuel Dealers.[13] Additionally, while the USEER does track hydrogen and fuel cell vehicle jobs (which grew 25% from 2021 to 2022), it does not report on other jobs within the hydrogen industry (i.e., jobs related to production, distribution, or other end use applications). The USEER also relies on relatively small sample sizes for state and local data, which may prevent in-depth analysis at the state level. Without comprehensive data collection and straightforward reporting on clean hydrogen jobs at the federal level, states may need to utilize more time-intensive methods, such as employer surveys, to track clean hydrogen employment in their state.

Despite the lack of clean hydrogen jobs data, several states are incorporating job estimates and forecasts into their clean hydrogen planning and roadmap efforts. For example, the Colorado Energy Office's Roadmap on Opportunities for Low-Carbon Hydrogen in Colorado analyzed the job opportunities in the hydrogen sector through 2050, across different scenarios and sub-sectors.[14] The Renewable Hydrogen in Iowa study published by the Iowa Economic Development Authority (State Energy Office) also includes an assessment of economic development and job impacts of the clean hydrogen industry. Acknowledging the limited availability of clean hydrogen job data, the study provides a range of job projections based on the Fuel Cell and Hydrogen Energy Association (FCHEA) national job estimates, European job estimates, NREL demand data, Midwest regional job forecasts, and job growth across other renewable industries in Iowa.[15]

Even without conducting a formal workforce assessment, states can identify questions to inform hydrogen workforce policies and programs and work with employers, academia, and labor partners to help answer those questions and plan next steps. For example, Connecticut's Hydrogen Task Force included the following research questions as part of the Policy and Workforce Development Working Group's charter:[16]

- What is the potential for job creation associated with hydrogen development in the state?
- What skillsets will be required to support a clean hydrogen ecosystem in Connecticut and what are the current gaps in capability?
- What strategies and best practices are likely to address capability gaps through equitable workforce transition planning in Connecticut?
- How can energy and environmental justice concerns be incorporated into best practices for hydrogen policy and workforce development strategies?

States can also refer to resources, such as the DOE Hydrogen and Fuel Cells Career Map, as a starting point to better understand the types of jobs and associated skillsets needed in the industry. The DOE map allows users to explore job profiles and career pathways, from entry level to advanced, for a variety of positions across three segments of the industry (Research and Development, Engineering, and Manufacturing; Operations and Management; and Communication, Training, and Outreach).[17] A non-profit focused on the net-zero transition in Canada also developed a resource that may be helpful to states in assessing the clean hydrogen workforce. The Hydrogen Workforce Assessment Tool provides detailed descriptions of key occupations across the industry supply chain, including general qualifications, requirements specific to the hydrogen industry, typical activities and tasks, and talent opportunities and risks for each occupation.[18] Figure 1 below shows an example of one of the "core occupations" described in the tool.

Figure 1. Example of a Core Occupation in the PEM Electrolysis Production Sector[19]

Core Occupation	Typical Qualifications (min)	Key Activities	Unique Requirements for Hydrogen	Potential Talent Risk/Opportunity
ENGINEERS				
Automation & controls specialist	*Multiple pathways to this career:* • Bachelor's Degree: Automation, Instrumentation & Controls or Electrical Engineering • Certificate of Qualification in Instrument technician • Technology Diploma: Instrumentation or Automation Engineering	• Support automation and controls functions including supervisory control and data acquisition (SCADA), programmable logic controller (PLC), remote terminal unit (RTU), distributed control system (DCS), human-machine interfaces (HMI), communications hardware, protocol and programming languages and related technologies. • Configure systems, troubleshooting and support equipment related to process control including leak detection technology	• Hydrogen properties, behaviour and potential hazards created • Safety when working with or around hydrogen • Knowledge of automated process systems and controls systems associated with electrolyzers	Skills/knowledge and industry transferability opportunity with other industrial process manufacturing including oil & gas, chemicals, petrochemicals, pulp & paper. • Natural gas processing closest match • Relevant codes and standards • Automated process systems and controls systems
Chemical/Process engineer	Bachelor's Degree: Chemical or Process Engineering or Electrochemistry	• Ensure safe, reliable and efficient operation of the process equipment by applying knowledge of thermodynamics, electrochemistry, fluid mechanics, and materials science • Troubleshoot production and process issues • Oversee plant modifications and upgrades to processes and related equipment ensure comply with regulatory standards • Participate in Root Cause and Failure Analysis	• Hydrogen properties, behaviour and potential hazards created • Safety when working with or around hydrogen • Understanding of electrochemical reactions, processes and hydrogen production using PEM electrolyzers	Experienced talent pool relatively small Expanded use of electrochemical technology for clean energy is likely to drive increased demand

2. Fostering workforce development partnerships

After compiling information about the current hydrogen workforce and anticipated job demand, states can help form partnerships to develop plans and support the implementation of new and expanded workforce development programs. Given their role convening stakeholders and coordinating among diverse partners, State Energy Offices, in particular, can help lead planning activities to identify priorities and goals, outline clear roles and responsibilities, and ensure ongoing collaboration. These planning efforts can improve coordination among stakeholders and inform decisions made by employers, investors, workforce agencies, labor unions, and other partners. Clean hydrogen workforce plans could be included in broader state energy workforce planning efforts or incorporated into clean hydrogen roadmaps (See NASEO guide on Developing Clean Hydrogen State Roadmaps). For example, the Wyoming Hydrogen Roadmap includes a number of goals and recommendations related to workforce development. The fifth action step, "Develop Workforce and Community Infrastructure," assigns roles and responsibilities to key stakeholder groups, including the Wyoming Energy Authority (which serves as the State Energy Office), the University of Wyoming School of Energy Resources, private sector partners, community colleges, labor unions, and economic development agencies (Figure 2).[20]

Figure 2. Wyoming Hydrogen Roadmap

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

Building and maintaining partnerships will also be critical in the implementation of workforce development activities to prepare an adequate pipeline of qualified workers and ensure there are inclusive pathways to good quality jobs after workers complete their training. At this stage, most states do not have dedicated clean hydrogen training programs – and may not need them – given the overlap in skills required for related occupations. However, existing workforce development networks and programs will need to be updated and expanded to meet the hydrogen industry's evolving needs while providing career growth opportunities for workers and trainees. State Energy Offices can help address these needs by bringing together education and training partners, clean hydrogen employers, and other state agencies to determine skills and certifications required, update curricula, and identify career pathways and recruitment strategies.

To ensure collaboration among stakeholders is successful and sustainable in the long term, states may want to formalize partnerships through a Memorandum of Understanding (MOU), board leadership, a shared staff position, or an inter-agency working group.

For example, the Colorado Energy Office hired a dedicated staff person to serve as a liaison on clean energy workforce issues.[21] In Washington, state legislation (SB 5910) directed the Department of Commerce (which houses the State Energy Office) to include key workforce and training partners, such as labor organizations and community and technical colleges, as part of the public-private partnership entity created to apply for the Regional Clean Hydrogen Hub opportunity.[22] This requirement led to the inclusion of a diverse group of stakeholders as part of the Pacific Northwest Hydrogen Hub's board, which brought workforce and labor voices to the table early on and provided an opportunity for meaningful engagement and leadership.[23]

The following sections provide additional details and examples of the types of partnerships State Energy Offices can pursue when developing and implementing clean hydrogen workforce plans. The list of potential partners is not exhaustive, and some partners may be more, or less, relevant, depending on each state's clean hydrogen and workforce priorities.

Building regional partnerships

Given that clean hydrogen infrastructure and transportation networks will likely cross state boundaries, partnering with neighboring states on workforce assessments and planning efforts will be critical. States can reference resources like DOE's H2 Matchmaker[24] and the Great Plains Institute's Atlas of Carbon and Hydrogen Hubs[25] to identify opportunities for regional partnerships. Many states have already formed collaborative groups to coordinate regional hydrogen activities and support economic development and workforce goals. For example, the Western Green Hydrogen Initiative (WGHI) was created to develop a regional strategy to promote the growth of clean hydrogen infrastructure in the Western region. The state-led collaborative includes industry partners, non-profits, and representatives from eleven states in the Western U.S., as well as Florida, Louisiana, Ohio, and two Canadian provinces.[26] Among other objectives, the WGHI aims to "identify education and workforce opportunities that support the transition to a local and resilient green hydrogen energy system."[27]

States can also leverage regional partnerships established to pursue the DOE Regional Clean Hydrogen Hub funding opportunity when planning workforce development efforts. All concept papers and applications for the hub funding required a Community Benefits Plan, which describes how the hub would "1. Support meaningful community and labor engagement; 2. Invest in America's workforce; 3. Advance diversity, equity, inclusion, and accessibility; and 4. Contribute to the Justice40 Initiative."[28] Regional and state-level workforce development efforts and plans will likely factor into each of these elements. As one example, the Western Inter-State Hydrogen Hub (WISHH) outlined in the coalition's concept paper how the WISHH will work with each state involved "to engage local businesses, particularly small and minority-owned businesses" and will partner with unions, non-union workforces, universities, community colleges, apprenticeship organizations, local residents, EEEJ communities, and tribes on workforce and economic development to ensure the continuance and growth of economically viable jobs."[29] While not all applicant groups were selected to move forward with their proposed hydrogen hub, the partnerships formed among workforce stakeholders across neighboring states and geographies are valuable and can help lay the foundation for the growth of regional hydrogen economies nationwide.

Coordinating across state and local government

State Energy Offices can also engage other agencies within their state to coordinate education and training efforts, combine resources, and take advantage of existing programs and networks. This could include state departments of education, state workforce agencies, local workforce development boards, state departments of corrections, state departments of transportation, and economic development organizations. State workforce agencies, in particular, can serve a pivotal role by providing information about current workforce programs, highlighting gaps, sharing best practices, and encouraging jobseekers to pursue pathways to good quality careers in the sector.[30] At the local level, workforce development boards can form sector-specific partnerships to support in-demand occupations, connect clean hydrogen employers with relevant training providers, and leverage Workforce Innovation and Opportunity Act (WIOA) funds.[31]

Economic development organizations also play a critical role in workforce development planning. By attracting investments and working with the private sector, these organizations can encourage clean hydrogen employers to create and retain good quality jobs in the state, which helps ensure that training programs lead to meaningful career opportunities for participants. In New York, the state's economic development agency, Empire State Development (ESD) has partnered closely with the State Energy Office, the New York State Energy Research and Development Authority (NYSERDA), to bring clean energy jobs and investments to the state. For example, ESD recently awarded up to $45 million in performance-based Green Excelsior Jobs Tax Credits to Plug Power to incentivize the creation and retention of jobs at the company's new fuel cell manufacturing facility.[32] Additionally, although not specific to hydrogen, the Wyoming Energy Authority established the Wyoming Energy Regional Economic Coordination Office to promote greater collaboration among industry and government partners, develop roadmaps for new energy technologies, conduct county-by-county assessments, and create plans for a just and equitable energy transition.[33]

Working with industry partners

States will need to engage with companies across the clean hydrogen value chain to help ensure the industry's workforce and training needs are met and maximize job benefits for communities. State Energy Offices can help connect clean hydrogen employers with training and education partners to identify in-demand occupations and skills, inform curricula and training program development, and align recruitment strategies. Given the higher tax credits available for clean hydrogen projects that meet the prevailing wage and apprenticeship requirements outlined in the IRA, employers will have additional incentive to offer apprenticeship programs or partner with local apprenticeship program providers, which states can help facilitate. Finally, states can work with employers to encourage more inclusive hiring and recruitment practices and improve job quality (See more detail on page 16 in the section on Ensuring job quality and equitable access to career pathways).

Engaging with organized labor

Labor unions and training institutions can serve an important role in coordinating workforce planning and deployment across states and regions. Especially in infrastructure projects demanding a large upfront investment of workers, states may benefit from tapping into labor forces that are already trained in the building and construction trades, and ready to be deployed to demolish, construct, and install projects. Offshore wind developer Orsted cited such reasons in partnership with North America's Building Trades Unions (NABTU): steady access to a pool of skilled labor; compliance with safety and quality standards; and on-time project completion.[34]

Trade unions relevant to hydrogen production, use, and transport (such as electricians, plumbers and pipefitters, ironworkers, sheet metal workers, and boilermakers), also offer paid on-the-job training opportunities through registered apprenticeship programs. For example, the Building Trades' affiliated unions and partner contractors have trained 75,000 new registered apprentices on average each year since 2017.[35] The registered apprenticeship programs offer on-the-job training and classroom education at no cost at over 1,600 Joint Labor-Management Training Centers across the U.S.[36] Throughout the training programs, which typically last three to five years, registered apprentices receive full-time pay with benefits, and are then placed as journey workers in the Trade after successful completion of the program.

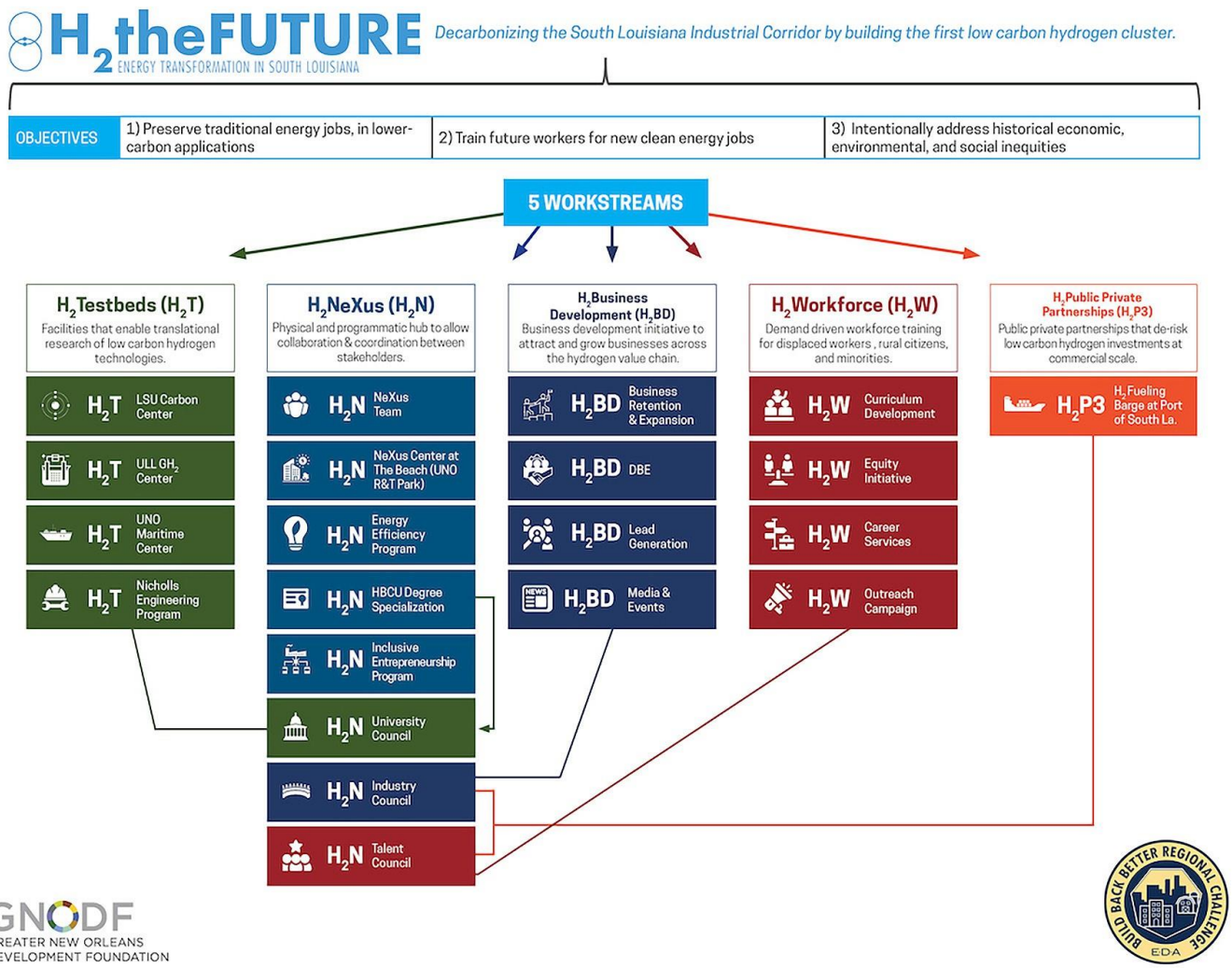
Given labor unions' training capacity and ability to respond to industry needs, State Energy Offices and their partners may benefit from including labor leaders on boards, planning teams, and advisory committees to help inform and respond to workforce considerations related to clean hydrogen deployment. For example, the Connecticut Clean Hydrogen Task Force included leadership from the Connecticut AFL-CIO as part of the Policy and Workforce Development Working Group.[37] The Pacific Northwest Hydrogen Hub board also includes several labor leaders, such as the President of the Washington State Labor Council AFL-CIO and the President of a local United Steelworkers union.[38]

Coordinating with educational institutions

Colleges and universities, including community and technical colleges and minority-serving institutions, will also be essential partners in preparing the next generation of clean hydrogen workers, as well as upskilling workers with experience in related fields. Many State Energy Offices already collaborate with institutions of higher education – whether through workforce development programs,[39] innovation hubs,[40] or strategic public-private networks[41]—and could leverage existing relationships and infrastructure to coordinate support for the growing clean hydrogen workforce. For example, the California Energy Commission (the State Energy Office) released the IDEAL ZEV Workforce Pilot[42] solicitation in 2022 with funding and support from the California Air Resource Board (CARB). California State University, Los Angeles was awarded grant funding to develop classroom curricula, hands-on hydrogen fueling station training, and establish an internship program that prepares students for hydrogen career pathways that lead to good quality jobs in the industry and within their communities.[43]

While the University of Delaware has launched a Center for Clean Hydrogen,[44] and the University of Houston offers a micro-credentialing program through their Hydrogen Economy Program,[45] most colleges and universities do not have dedicated clean hydrogen programs. However, states could help connect clean hydrogen employers with relevant college and university departments (such as chemical and electrical engineering) to integrate new curricula into existing programs and share information with students through school career centers and events. In Louisiana, the state's community and technical college system is leading a demand-driven workforce training program designed to expand access for displaced workers, residents of rural areas, minorities, and formerly incarcerated individuals through "curricula development, equity initiatives, career services, and awareness campaigns across the eight community and technical colleges in South Louisiana."[46] The effort is part of a broader initiative, H_2theFuture, which aims to reduce emissions across the Southern Louisiana Industrial Corridor through five key strategies, including workforce development, business development, and public-private partnerships (See Figure 3 below for a schematic of the initiative's planned workstreams).

Figure 3. H_2theFuture strategy workstreams.[47]



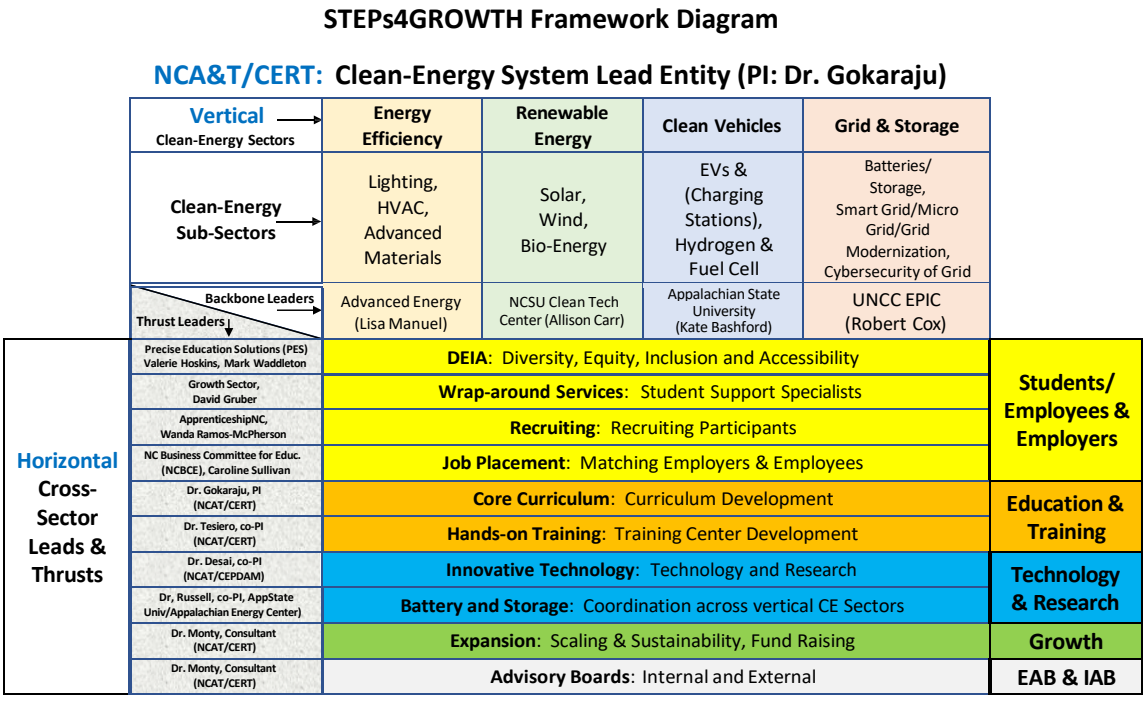
Source: Adobe Stock/style-photography

Given the growth of new technologies and processes in the clean hydrogen space, educational institutions can also play an important role in supporting research, development, and demonstration (RD&D) activities. By utilizing state and federal RD&D support and working with the national laboratories and the private sector, colleges and universities can help students access new hydrogen technologies, gain exposure to career opportunities, and receive hands-on training and education. For example, the Virginia Tech Corporate Research Center is collaborating with public and private stakeholders to build a green hydrogen demonstration lab in the Hampton Roads region using GO Virginia grant funding and additional matching funds. The demonstration center will provide education and training programs to connect local residents with career opportunities in the region's emerging clean hydrogen industry and offer programs to educate and build support among community members. Faculty members from the Virginia Tech College of Engineering will help develop curriculum and design a "Hydrogen Academy framework."[48] DOE's Hydrogen Fuel Cell Technologies Office also recently funded five clean hydrogen technology projects at three minority-serving institutions, including the University of California Riverside, California State University Los Angeles, and the University of Texas at El Paso.[49]

While not specific to clean hydrogen, the North Carolina Department of Environmental Quality (State Energy Office) has helped build robust partnerships among clean energy employers, community colleges and universities (including minority-serving institutions), labor unions, community-based organizations, and other state agencies. These partnerships were critical to the launch of the nation's first statewide clean energy pre-apprenticeship program.[50] The network of partners and success of the pilot program laid the groundwork for a comprehensive workforce development model led by North Carolina Agricultural and Technical State University (NC A&T), which recently received a $23 million grant through the Economic Development Association's Good Jobs Challenge and could serve as an example for other states and additional clean energy sectors.[51]

NC A&T's STEPs4GROWTH model provides a comprehensive framework to coordinate clean energy workforce development efforts across the state, with an initial focus on four key sub-sectors in four regions of the state. The plan designates a partnership team led by one or two "backbone" organizations for each sub-sector vertical (efficiency, renewable energy, clean vehicles, and grid and storage) as well as cross-sector teams with representatives from each vertical. The cross-sector teams will help prepare participants for jobs in each of the four clean energy sub-sectors through nine projects and initiatives, including wrap-around services, job placement, curriculum development, fundraising, and diversity, equity, inclusion, and accessibility (see Figure 4 below).

Figure 4. STEPs4GROWTH Clean Energy Sectoral Partnership Framework[ii]



ii The Framework of sectoral strategy partnership in STEPS4GROWTH is co-designed by Dr. Greg Monty and Dr. Balu Gokaraju at North Carolina A&T State University. The Framework's implementation is funded by the sponsoring agency, United States Department of Commerce (USDOC), Economic Development Administration (EDA)-Good Jobs Challenge; Awarded to North Carolina A&T State University for the project STEPS4GROWTH. Weblink: https://www.eda.gov/news/press-release/2022/08/03/us-department-commerce-invests-237-million-develop-clean-energy.

3. Ensuring job quality and equitable access to career pathways

In addition to facilitating partnerships, State Energy Offices could provide direct support or funding to help create or expand workforce development programs and promote broader access to training opportunities in the clean hydrogen sector. Several State Energy Offices have already developed or supported the development of workforce training programs in other emerging energy industries. For example, the Maryland Energy Administration's Offshore Wind Workforce Training Program provides grant funding to training centers that prepare workers for jobs in the offshore wind industry. The grants can be used for capital expenditures and operating expenses, but training must be provided at no cost to participants, and evaluation criteria include project job potential and plans to "engage members of historically marginalized groups for job opportunities."[52]

To help remove barriers to accessing and completing training programs, particularly for participants from underserved communities, State Energy Offices can work with workforce agencies and training partners to provide financial support for wraparound services, such as childcare, transportation, job readiness materials, and hardship assistance. For example, the Maine Governor's Energy Office awarded $2.5 million in grants to nine clean energy workforce initiatives, including a flexible offshore wind training program and on-the-job weatherization training program that cover equipment and transportation costs and other barriers to training access and participation.[53] States can also work with unions, training partners, and other worker-serving organizations to help fund pre-apprenticeship programs, which are designed to help jobseekers prepare for and succeed in registered apprenticeship programs. Often, pre-apprenticeship programs can help expand access to good-paying jobs and apprenticeships for underrepresented groups, such as women, people of color, and underserved communities. For example, the Building Pathways Inc. pre-apprenticeship program has helped increase the number of female apprentices in Massachusetts by 200%.[54]

While training and education programs are critical to supporting a diverse and well-qualified clean hydrogen workforce, prioritizing job quality can help attract and retain employees while ensuring project success. While definitions of job quality may vary based on the type of job or location, the Department of Labor's Good Jobs Initiative outlines eight principles that may be used as a model, including: recruitment and hiring; empowerment and representation; job security and working conditions; organizational culture; pay and benefits; diversity, equity, inclusion, and accessibility; and skills and career advancement.[55]

States can promote good quality jobs in the sector through a number of ways, such as encouraging job quality through an incentive-based approach or integrating job quality provisions into procurement processes by requiring or preferencing contractors that meet certain criteria. For example, Washington State's Clean Energy Transformation Act utilizes an incentive-based approach by offering state tax credits for projects that meet job quality metrics, such as paying prevailing wages or negotiating a community workforce agreement.[56] This approach has also been used in bills directly addressing hydrogen production, including HB 1988 (laws of 2022), which provides parallel tax incentives tied to the attainment of certain labor standards for activities like production of green electrolytic or renewable hydrogen.[57] In Connecticut, the procurement process for offshore wind requires bidders to pay workers the prevailing wage and "engage in a good faith negotiation of a project labor agreement."[58] In one local example, Seattle's regional transit agency requires contractors to complete training to prevent worksite bullying and harassment.[59]

Conclusion

The expected growth of the clean hydrogen industry in the United States and recent federal policies and investments provide a significant opportunity for states to decarbonize hard-to-abate sectors, while supporting a just transition and creating good-paying jobs. State Energy Offices can play a pivotal role in preparing the emerging clean hydrogen workforce by assessing current and future job demand and training needs; facilitating partnerships among employers, workforce agencies, educational institutions, and other partners; and investing in programs and processes that expand access to clean hydrogen careers for historically underserved groups. By incorporating workforce development considerations into their clean hydrogen policies and planning efforts, State Energy Offices can maximize the job benefits of the clean hydrogen transition, while advancing state climate and economic development goals.

Source: Adobe Stock/Grispb

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