

OHIH Quarterly Report

December 2020

Integrated Value Chains for H₂ Supply and Demand | Technology to Market Platforms

A vision originated in the Okanagan Valley, British Columbia



About OHIH

The Okanagan Hydrogen Innovation Hub (OHIH) is a North American cohort of indigenous, industry, university and local government leaders whose aim is to develop a hydrogen based clean tech incubator through a regional R&D and commercialization network that features project-based value stacks. The K'U'L H2Go Technology Platform (KHTP) is the flagship demonstration project and the University of British Columbia Okanagan (UBCO) is the lead academic partner. The KHTP will include a digital twin based on the system configuration that functions as the first node in a digital supercluster. This regional supercluster will form the foundation of a future Canadian H2 Exchange that integrates into a North American H2 Bloc designed to compete in the global hydrogen economy.

OHIH will promote the adoption of hydrogen energy and associated technologies with an emphasis on production, storage, transport, injection into municipal gas networks, and end-use in various sectors (notably, heating and transportation). Data analysis (real-time and simulations, collection and synthesis) and digital twinning across the network will be leveraged in unique ways to understand the network, support decisions, and ensure efficiency. This will be ensured by employing digitally networked hydrogen infrastructure that collects data from, and shares associated analytic results real-time between, partners and their guests to help assess and refine potential projects. Using the internet of things and cloud computing, the OHIH H2 Data Platform will provide intelligence for hydrogen production, storage, transport, and consumption across Canada, commencing in the Okanagan Valley, British Columbia. This digital platform will integrate with hydrogen producers, storage technologies, blending facilities, and end-users to enable a near-simultaneous Canadian hydrogen sector growth to commercial readiness levels (CRL2) and self-sustaining competitiveness.

As an industry-led group composed of various stakeholders, OHIH will play a leading role in the design, investment, and development of innovative hydrogen projects, starting in BC and moving east into Canada and south into US markets. The KHTP is scheduled for a 1Q2021 Phase 1 demonstration in Penticton, BC. This initial phase will pair HTEC's PowerCube, a storage and rapid fueling device, with Hydra Energy's hydrogen injection kit for heavy duty vehicles. This demonstration is funded through the BC Fast Pilot fund and fully contracted with NRC-IRAP and Innovate BC. The demonstration will be followed by the 2H2021 deployment across the Westhills fleet of heavy-duty vehicles and will function as a pilot project for the City of Penticton. Phase 2 will offer an expanded platform that will include a refueling station as well as onsite production from BayoTech, which connects to an ATCO hydrogen microgrid for storage and distribution. This expanded H2 production platform will serve as the physical system for the digital twin built using SEED Energy's Odyssey techno-economic software and will function as the first node in a regional digital supercluster.

OHIH's project design sequence begins with the end-user to determine the proper platform sizing for supply and demand. Utilities and municipalities will be more willing to produce renewable hydrogen during a period of low electricity demand if they know there is an immediate end-user willing to purchase the hydrogen, and the requisite storage and transportation providers to facilitate the exchange. The network will connect utilities, transportation hubs (freight, rail, vehicle refueling), stationary end-users, storage infrastructure, and blue-to-green hydrogen production assets. Digital twins employing smart technology, data fusion, and big data analytics will help grow the market by virtual demonstrations of how technology innovations can synergize across the full spectrum of hydrogen sector stakeholders associated with this Canadian community of practise. Moreover, through this digital supercluster development, OHIH will synergize hydrogen energy exchanges, foster end-use improvements, and reduce redundancies or inefficiencies in the network, greatly improving Canadian competitiveness and expediting improved technology transfer into best practices.

About this report

OHIH presents this document as its first quarterly report and will provide updates as the hydrogen economy develops and advances toward mainstream investment. Hydrogen is poised to become a first option energy carrier and preferred transportation fuel as governments and industry stakeholders rapidly deploy technologies and infrastructure around the world. However, a major issue with implementation to date has been finding demand, in the form of end-users, to purchase and use both produced hydrogen and readily available hydrogen technology. Accordingly, the OHIH launch strategy is based on a distributed generation model and behind the meter matrix of commercially available technologies that can make an immediate impact in current energy infrastructure.

Acting as a clean-tech incubator, OHIH hopes to achieve its goals by simultaneously creating both supply and demand for hydrogen through the activation and acceleration of various niche technologies and resources provided by our partners. This report presents the overall objectives of the OHIH and offers a detailed list of potential projects within the Okanagan/Thompson region that may serve to increase hydrogen production, distribution and use in North America. Our Valley has the potential to act as one of the first hydrogen technology platforms in Canada. Through these projects, the OHIH hopes to learn how to create and market a multi-jurisdictional network integrating producers, consumers, exporters and transmission assets across a broad region that includes North American and global markets.

Acknowledgements

OHIH would like to thank the following organizations who have generously contributed their time, knowledge and perspectives through their participation in extended OHIH consultations and pre-planning meetings:

- Penticton Indian Band
- K'uL Management Group
- City of Penticton
- University of British Columbia Okanagan
- Hydra Energy
- Hydrogen Technology & Energy Corporation (HTEC)
- BayoTech
- ATCO
- H2M
- Wildstone Construction Group
- SEED ENERGY Odyssey Software
- Cariboo Central Railway Contractors Ltd
- Cariboo Low Carbon Fuels
- FortisBC
- BC Hydro
- Canadian Hydrogen and Fuel Cell Association (CHFCA)
- H2GO Canada
- Natural Resources Canada
- International Inter-Tribal Trade and Investment Organization (IITIO)
- Nation First Investment Group
- ReGen Global
- RedwoodAdaptive
- US Department of Energy H2@Scale
- National Renewable Energy Lab Hydrogen & Fuel Cells
- Sandia National Laboratories Hydrogen and Fuel Cells
- Iron Horse Industrial Park
- Oklahoma Department of Commerce
- Oklahoma Manufacturing Alliance

Introduction

The Okanagan Valley, located in the Southern Interior of British Columbia, Canada can be established as a vibrant, locally supported hydrogen hub at the forefront of the developing hydrogen economy in Canada. This opportunity will be fortified by this diverse coalition of public and private partners that believe working together will promote sustainable prosperity, effective climate solutions and broad societal benefits. This report presents a vision for the role that hydrogen could play in the Okanagan Valley and spreading throughout British Columbia, Alberta and Saskatchewan. These partners are varied, but each offers their own benefits and specializations to the projects that OHIH hopes to see developed in the coming years. OHIH will feature various components of the H₂ value chain that include supply, demand and end-use designed to quickly and dramatically reduce energy costs and carbon emissions.



UBC Okanagan's Commitment to a Sustainable Hydrogen Economy

UBC Okanagan will act as the lead HQP training and research partner in OHIH testbed projects. Hydrogen-related university research can be applied to real world infrastructure developed by OHIH and its participating members. For example, UBC Okanagan will use \$500,000 invested by FortisBC to study how the utility can further reduce emissions from its natural gas supply by delivering hydrogen through its extensive distribution network. Fortis needs to know how to blend hydrogen safely and reliably with natural gas within its existing system, and to understand the potential effects hydrogen may have on the current natural gas system. As stated by Rehan Sadiq, the Executive Associate Dean at UBCO's School of Engineering, "the School of Engineering and FortisBC have forged a strong research partnership to uncover smart energy and clean technology solutions for British Columbia. We have the unique position of fostering leadership in sustainability through our actions as a university and of enabling technological innovation through research collaborations like this one." UBCO will also participate in projects by gathering data and analyzing system performance of the various potential projects. Moreover, this OHIH partnership will promote educational and training opportunities in hydrogen and its application to the built environment.

As the lead academic partner in OHIH, UBC Okanagan brings a major source of innovative hydrogen practices stemming from the multiple green-focussed research labs throughout its campus. Sustainability is deeply embedded across UBC thanks to the dedication and commitment of the faculty, staff, and students. Both on and off campus, UBC promotes sustainability focussed research, education and industry practices. Dr Gordon Lovegrove, an Associate Civil Engineering Professor in UBCO's School of Engineering is at the forefront of this team. His research team's work on Hydrail (Hydrogen fuel-cell / battery hybrid rail power) has demonstrated hydrogen as Canada's transportation fuel of the future. Moreover, his empirical research results have concluded that hydrail will be the most economic, practical and sustainable gateway technology used to convert all 25,000 North American regional passenger and freight rail locomotives from diesel-electric to zero-emission hydrogen-electric systems.

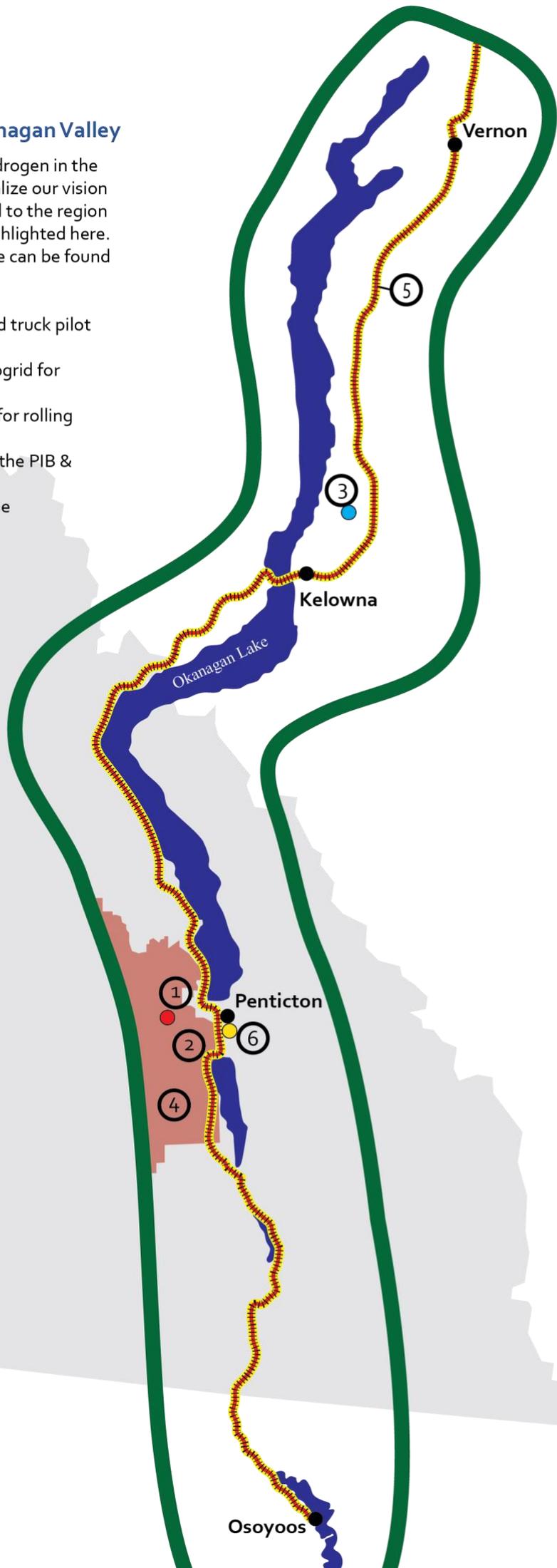
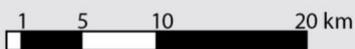
K'uL H2Go will continue its support for Hydrail through the Canadian Urban Transit Research & Innovation Consortium (CUTRIC) and the various R&D programs for the US freight Class 1 system in a large transportation sector that moves a significant amount of freight throughout the country. K'uL and ReGen Global work with the Iron Horse Industrial Park to offer Foreign-Trade Zone benefits such as incentivized manufacturing and access to an onsite rail spur which could prove to be a critical location for Hydrail in a North American H2 Bloc.

Hydrogen potential in the Okanagan Valley

This map explores the potential for hydrogen in the Okanagan. Projects that could help realize our vision are displayed here. OHIH partners local to the region as well as points of interest are also highlighted here. Detailed explanation of each point here can be found on the following pages.

1. Westhills Aggregate hydrogen-hybrid truck pilot demonstration
2. Skaha Hills hydrogen powered microgrid for home heating & power
3. Hydrogen retrofit package research for rolling stock application
4. Renewable hydrogen production by the PIB & K'uL Management Group
5. Hydrogen powered passenger rail line
6. City of Penticton demonstration

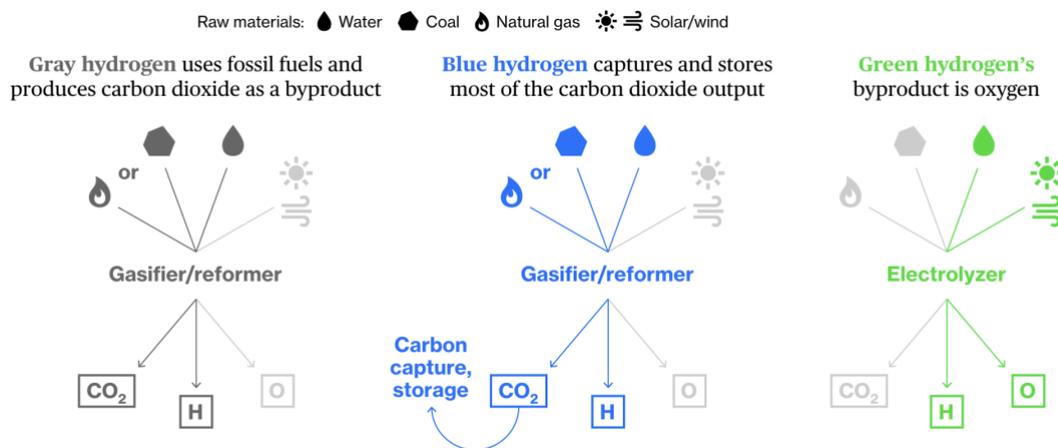
-  PIB Reservation no. 1
-  Proposed OVER PR line
-  UBC Okanagan Campus
-  Penticton Indian Band
-  K'uL Management Group



Why Hydrogen?

Hydrogen, as the most abundant element in the universe, could be a critical enabler in meeting many climate change targets that have been in place since the Kyoto Protocol of 1992. Hydrogen has more recently been recognized as a strong candidate to address greenhouse gas emissions reduction targets across multiple sectors including transport, industry, energy, and heating. This is due to the fact that when hydrogen is converted to usable energy - by ignition or chemical conversion - only water and heat are emitted. Apart from burning cleanly and being the most abundant element in the universe, hydrogen provides three significant benefits that make it a strong candidate for widespread use. First, hydrogen is an extremely dense energy carrier. The energy density of hydrogen is nearly three times that of diesel or gasoline, roughly double that of LNG, propane, or methane, and over four times as dense as coal. This means that on a weight basis, hydrogen can store significantly more energy than other commonly used energy sources today. Second, hydrogen offers significant long term storage advantages such as summertime renewable hydrogen (RH₂) stored for wintertime demand. Third, it can be produced in many different ways with numerous methods being researched and developed with regularity. Production methods are categorised in the following three ways:

The Gray - Blue - Green Transition and the 2030 Horizon



Source: Bloomberg, Hydrogen is a Trillion Dollar Bet on the Future, Fickling, December 2, 2020

The H₂ vector presents a transformational market making opportunity as OHIH plans and executes a regenerative economic development strategy by maximizing the combined technical, financial, infrastructure and energy resource assets of the hydrocarbons and renewables sectors. Regeneration requires that we adopt a biomimetic approach to new growth that considers the full environmental impact of clean tech technologies which includes extractive profiles and waste streams of all future economic planning and development that considers both climate and non-climate variables in a net environmental impact assessment (NEIA).

We're clearly facing runaway climate change that accelerates with each new season and supercharged natural disaster, but the required response must include the collective wisdom and market intelligence of all industry leaders across the energy and power sectors. The increasing momentum across Canada and the US to develop a decarbonization strategy that provides a transitional pathway for the natural gas sector coupled with renewables is perfectly timed for this inaugural year of the hydrogen decade.

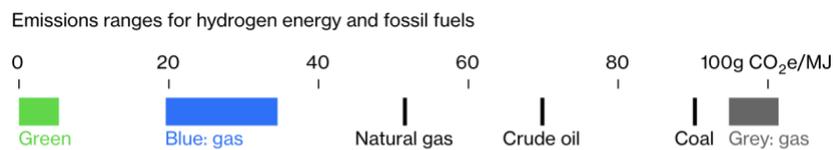
Accordingly, this paper advocates for the production and end use of hydrogen along a spectrum that leverages existing infrastructure and investment in ways that create immediate cost and emissions reductions. For example, the pairing of a BayoTech onsite production system with the Hydra Hydrogen Injection System (HIS) creates fuel savings of over 35% and emissions reductions of over 40%. Based on a Scripps 12/01/2020 reading from the Mauna Loa Observatory of 413.73 ppm of CO₂, the BayoTech Hydra configuration projects to 248.23 ppm, or 31.77 below the 280 ppm level of the Holocene Period. Further, OHIH is firmly committed to a future transition to an RH₂ economy as the levelized cost of hydrogen (LCOH) continues its rapid decline and will always consider RH₂ as the first option where the technical resource potential and existing infrastructure provide for electrolyzed hydrogen at a competitive price:



Source: International Energy Agency

OHIH and its partners believe that a rapid and widespread shift to a hydrogen economy will help meet emission reduction targets and slow climate change. Unfortunately, many hurdles must be overcome before hydrogen's full potential can be realised. Primarily, demand for hydrogen must be increased; without it, production will not happen. Second, investments must be made in new supply infrastructure; this can only be achieved through combined efforts by private and public entities. By increasing both the demand and supply of hydrogen, our overdependence on medium and long chain hydrocarbons can be mitigated and the carbon intensity of the global energy system can be dramatically reduced.

To achieve Canada's 2050 net zero target, the development of a Canadian hydrogen economy will play a vital role. By investing in hydrogen technologies and infrastructure, Canadian organizations can capitalise on best practices overseas and throughout North America while becoming global leaders in an innovative hydrogen economy.



Sources: Pembina Institute; Australian National Greenhouse Accounts
 Note: Hydrogen with as little as 36.4 grams CO₂e/MJ is counted as "grey hydrogen," but most emits considerably more.

The OHIH emissions strategy begins with an immediate reduction in long lived atmospheric carbon dioxide (CO₂) and the GHG warming potential of methane (CH₄). The execution of this approach requires the full participation of the hydrocarbons and renewables sectors which is increasingly likely due to policy support and mounting pressures for expanded investment portfolios in the new energy economy.

Building A Canadian H₂ Exchange

OHIH plans to develop the Okanagan Valley, specifically the Penticton region, as the first of many planned hydrogen technology platforms in Canada and the US. Commencing with the Westhills Aggregates pilot demonstration, OHIH plans to implement SEED Energy's ODYSSEY, a techno-economic analysis software for complex energy systems. This software, which has been developed specifically for energy systems built for hydrogen, creates a digital twin of the physical system by modeling each of its components, the interactions with energy networks and the system operating rules (energy management strategy). This digital twin can then be used in dynamic simulations allowing for cross-sectional and longitudinal system observations, making it possible to accurately estimate short and long-term operating impacts such as investment levels, operation, maintenance and replacement of components. On the other side, the digital twin simulations allows the OHIH to precisely quantify services provided by the system (supply of electricity, heat, hydrogen, gas, etc.), related revenues, and environmental / societal impacts. The profitability and environmental performance of the various projects can then be assessed and used to refine future project design, delivery and distribution business models, including for example such indicators as net present value, payback time, rate of return, and avoided CO₂ emissions. OHIH plans to first implement this ODYSSEY software at the Westhills Aggregates pilot demonstration, as part of its roll-out to various hydrogen projects in the region. OHIH will learn from how these

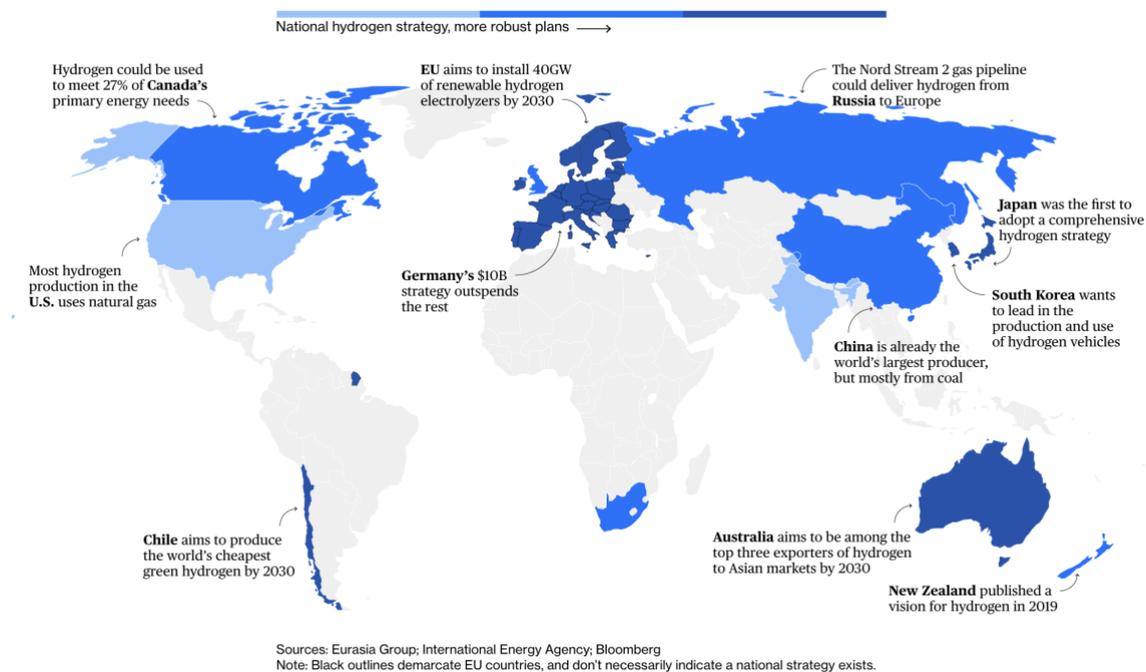
projects operate alongside each other and the benefits each project brings, including the various component performances as well as the system in aggregate. This initial demonstration and regional roll-out will benefit all OHIH partners, via the resulting outputs and lessons learned. OHIH envisions a future in which all hydrogen projects and technology innovations are digitally linked in an intelligent, cohesive manner that provides a tremendous benefit to all participating partners and society as a whole.

Alberta and Saskatchewan are also developing their hydrogen plan very quickly with plans to scale it rapidly. If hydrogen production demand cannot be met locally within British Columbia, Alberta will likely be able to supply hydrogen throughout BC. OHIH believes that a partnership between BC and Albertan organizations could help tremendously to achieve the goals of OHIH; especially when considering microgrids for heating and powering homes which may be situated near pipelines capable of supplying energy directly for use.

A North American H2 Bloc as a Global Competitive Advantage

Canada is the largest energy trading partner with the US based on the combined value of energy exports and imports. Although the value of bilateral energy trade with Canada has varied over the last decade, the overall energy trade balance has changed relatively little, with US energy imports from Canada consistently exceeding US energy exports to Canada by a large margin. The hydrogen decade offers a critical opportunity to expand this relationship into new technologies and high growth markets. Canadian companies that target US markets are well positioned to supply US demand for fuel cell powered buses, trains and heavy-duty vehicles, material handling equipment, back-up & stationary power, hydrogen production, distribution and storage.

Canadian technologies play a significant role in renewable energy systems across the world, integrating with wind and solar technologies to balance electrical loads. The policy support and early investments made in Canadian hydrogen technology and education combined with an expansive US R&D portfolio with increased funding totals for international applicants has created an important foundational platform that positions North America as a critical H2 bloc. The Canadian hydrogen and fuel cell sector can expand its global leadership in pioneering new technologies and industry expertise through scale in US markets.



On the US side, the Fuel Cell and Hydrogen Energy Association (FCHEA) is based in Washington D.C. and represents the leading companies and organizations that are advancing innovative, clean, safe, and reliable technologies. FCHEA drives support and provides a consistent industry voice to regulators and policymakers. Their efforts promote the environmental and economic benefits of fuel cell and hydrogen technologies. The US Department of Energy (DOE) has recently released its DOE Hydrogen Program Plan that updates a previous version which built upon preceding strategic and planning documents including the DOE Hydrogen Posture

Plan and the National Hydrogen Energy Roadmap. Based on extensive stakeholder input and progress over the last two decades, the Plan serves as a guiding summary of focus areas and the path forward across all relevant DOE offices. In addition to this overarching DOE-wide plan, each office within DOE has its own detailed technical plans and strategies relevant to their mission areas.

The Hydrogen Program Plan features a focus on applied research, development, and innovation to advance hydrogen and fuel cells for transportation and diverse applications enabling energy security, resiliency, and a strong domestic economy in emerging technologies. 2019 funding awards from various sources included \$53M distributed among 36 university and corporate awardees. The awards include research into novel hydrogen carrier development; hydrogen effects in materials for fueling infrastructure; advanced water splitting materials research; affordable biological hydrogen production for biomass resources; co-production of H₂ and value-add byproducts; reversible fuel cell development and validation; and integrated production, storage and fueling systems.

In a truly game-changing development in the grand disruption to the global energy system, Shell and Rice University in Houston have launched the Carbon Hub, a major research initiative to create a zero-emissions future in which oil and natural gas provide both clean energy and advanced materials that help house, move, clothe and feed people. Inaugurated by Shell with a \$10 million commitment, the Carbon Hub will partner with companies to fundamentally change how the world uses hydrocarbons. Instead of burning them as fuel and releasing carbon dioxide, hydrocarbons will be split to make clean-burning hydrogen fuel and solid carbon materials that can be used to make buildings, cars, clothing and more. This initiative clearly illuminates hydrogen's abundant potential as a multi-modal, multi-purpose energy vector that can achieve widespread integration as an advanced energy input across the full spectrum of economic development and activity.

Oklahoma has emerged as a very strong contender for a US H₂ Exchange based in Tulsa that together with the Canadian H₂ Exchange creates an early stage North American H₂ Bloc. The city was once a major world oil capital and retains much of the market intelligence, critical manufacturing, infrastructure and investment that required for scaling hydrogen markets. In an enthusiastic step forward into the new energy economy, Tulsa recently finished second to Austin in its bid for a Tesla factory. The Tulsa Innovation Labs funded by the Kaiser Foundation offers tech clusters and cross industry enablers in energy tech, drones and analytics which are core requirements of our H₂ technology platforms.

Canada is home to a significant concentration of global hydrogen and fuel cell companies including all elements within the supply chain that offer tremendous investment opportunities in the US. There are a growing number of US Canada partnerships such as the \$290 million acquisition by Cummins of Hydrogenics that will rapidly expand a North American H₂ Bloc across all relevant sectors. OHIH's second quarterly report in March 2021 will explore these new collaborative innovations and investments and provide updates on all OHIH projects.

OHIH Project Pipeline 2030

① Westhills Aggregate Heavy Truck H₂ Pilot (K'uL H₂Go)

Location: Westhills Aggregates, Penticton, BC

Participating Members: ReGen Global, HTEC, Westhills Aggregates, Hydra Energy, ATCO, K'uL Group, FortisBC, BayoTech, Wildstone Construction

Fields: Production, Storage, Transfer and Industry

Date: Early 2020's

HTEC will demonstrate the use of their High-Volume Hydrogen Transfer System (HV-HTS) in combination with their PowerCube modular hydrogen distribution system as a hydrogen distribution/delivery and hydrogen fueling solution for heavy-duty applications to the K'uL Management Group at the Westhills Aggregates Facility in Penticton, BC. This will be performed in combination with Hydra Energy's Hydrogen Injection System (HIS) retrofit kit for conventional HD diesel engines on a truck similar to that used within Westhills Aggregates operations. The intention is to further deploy the solution to the entire fleet, and then to market and distribute other similar organizations with a focus on indigenous heavy equipment operators (mining, aggregate, trucking and long-haul freight companies). ATCO will participate in the project's development through the inclusion of their hydrogen microgrid which can use off-peak hydroelectricity from FortisBC to produce RH₂. This will be

the first customer-facing demonstration of this equipment which creates both supply and demand for hydrogen in the Okanagan. Through this successful demonstration, existing fleets of diesel-powered heavy-duty trucks in the Okanagan will be fitted with the hydrogen-hybrid kits and realize an immediate saving of 30% in diesel costs and a proven emission reductions of over 40%; powered, in part, by completely renewable, locally produced hydrogen.

With the Westhills Aggregate pilot demonstration acting as a showcase of the current state of various hydrogen technologies, the project will also serve as the first and primary node in the network of digitally twinned systems that OHIH hopes to create. By implementing SEED ENERGY ODYSSEY software to create a digital twin of the Westhills demonstration - and any further implementation of the technology showcased there. This digital twin can then be used in dynamic simulations allowing to observing complex system operations over several years. This data can then be used to accurately estimate expenses, O&M requirements, system service potentials, revenues, and environmental impacts. OHIH expects that by gathering this data and developing a digital twin of the various systems in the network, feasibility studies can be done quickly and key indicators for decision makers such as net present value, payback time, rate of return, and avoided CO₂ emissions can be determined instantly.

② Hydrogen Microgrid for Skaha Hills ReGen Village (K'uL H2Go)

Location: Skaha Hills Real Estate Development, Penticton, BC

Participating Members: ReGen Global, ATCO, FortisBC, PIB, K'uL Group, UBC, H2M, BayoTech, Wildstone

Fields: Production, Storage, Transfer, Transport, Power and Heating

Date: Early 2020's

Through the development of a sequenced microgrid system within the ReGen Village of Skaha Hills, homes will be powered by renewables during the summer months and stored hydrogen during the winter months. During the summer, on-site renewables and off-peak hydroelectricity will be used to heat and power homes while simultaneously producing renewable hydrogen which is stored for later use. During the winter months, this hydrogen can then be used in conjunction with fuel-cells to produce heat and energy; surplus hydrogen can be used by the community for transportation or sold for use in industry. ReGen Village will be a prototype village demonstrating new technologies and smarter ways to build communities. The concept will be shared with the world and expanded to the Penticton Indian Band (PIB) when feasible. Hydrogen in Motion (H2M) can showcase their new and innovative solid state hydrogen storage nanomaterial; decreasing space requirements and improving safety when compared to conventional hydrogen storage used today. The K'uL Group hopes to use this project as a testbed for future applications for remote indigenous communities throughout North America with the preliminary project planning estimated to provide power and heat to 200 family homes.

③ Rolling Stock Retrofit

Location: UBC Okanagan Campus, Kelowna, BC

Participating Members: UBC Okanagan, H2M

Fields: Storage and Transport

Date: Mid 2020's

A research team at the UBC campus is currently developing a retrofit kit to change existing diesel-powered locomotives to hydrogen-battery hybrids powered by fuel cells. The design concept of the kit is such that diesel and diesel-electric locomotives in use today can be easily and inexpensively converted to a fuel cell battery hybrid zero-emission vehicle (ZEV); eliminating the need to replace an entire vehicle by reusing many of the existing components from these diesel locomotives. By retrofitting to hydrogen powered locomotion, emissions can be completely eliminated at use at less than 20% of the cost to purchase new. A scale Hydrail 1 prototype has been built, and work on a full-scale locomotive hydrail retrofit is underway. This hydrail retrofit kit is a low-cost, practical gateway technology to convert all 25,000 existing North American regional passenger and freight rail locomotives to ZEV, thus helping to address our climate change challenges.

④ Renewable Hydrogen for all of BC

Location: Interior BC

Participating Members: K'uL Group, ReGen Global, PIB, FortisBC, ATCO, BayoTech, HTEC, Wildstone

Fields: Production, Storage, Transfer, Power and Heating

Date: 2020's

Through the development of local hydrogen production facilities by the K'uL Management Group (its entity K'uL H2Go) in partnership with OHIH, the K'uL Group hopes to increase renewable hydrogen production and distribute it through the existing natural gas line. Adding hydrogen could make the gas system more efficient and further reduce greenhouse gas emissions. Initial projects are most likely to occur on the low pressure parts of the Fortis BC grid, while Fortis implements regulation and policy on their high pressure grid to further support hydrogen blending. On September 5th 2019, then current Chief Chad Eneas of the Penticton Indian Band and Jonathan Baynes, CEO, K'uL Group, met with President and CEO of FortisBC, Roger Dall'Antonia and a number of his staff. High level discussions and commitments to explore the adoption of RH₂ and distribute this through the existing gas line were had. FortisBC and other pipeline developers across Canada have often been met with suspicion. K'uL H2Go is positioned to help address historical injustices in this space and help companies transition to a clean energy ecosystem, improve their relationship with First Nations and add value to existing projects on First Nation territories. We are confident that with the right partners and the cultural and political strength of the Penticton Indian Band and Okanagan Nation we can have a significant impact on energy production and distribution for generations to come.

⑤ OVER PR

Location: Okanagan Valley, BC

Participating Members: UBC Okanagan, K'uL Group

Fields: Transport

Date: Late 2020's Early 2030's

The Okanagan Valley Electric Regional Passenger Rail (OVER PR) has been designed as a passenger tram/train rail line connecting small and rural communities along Hwy 97 between the US border and Kamloops. Dr Lovegrove's researchers, in partnership with the K'uL Group, used Province of BC Business Case template, demonstrated up to a 20-to-1 benefit/cost ratio for the OVER PR, due primarily to tourism demand for safer, greener, more equitable transport choices. This tram/train hydrail line would use self-powered ZEV passenger coaches on imbedded rails along/beside the highway to connect communities throughout the Okanagan. Tram/trains using this same technology (Alstom iLint Coradia) have been running in Germany since 2018. UBC Okanagan continues to participate in the research and development of the hydrogen economy and hopes to make hydrogen powered rail accessible to all residents and visitors of the Okanagan.

⑥ City of Penticton Demonstration

Location: Penticton, BC

Participating Members: City of Penticton, K'uL Group, ReGen Global, FortisBC, ATCO, BayoTech, HTEC, Wildstone

Fields: Production, Storage, Transfer, Power and Heating, Transportation

Date: 2020's

The City of Penticton has considered converting over 2MW of existing diesel-powered generators into cleaner, hydrogen powered generators. Furthermore, the city has also expressed interest in converting part of their existing fleet of vehicles to hydrogen-powered or hydrogen-supplemented vehicles. Such a change will dramatically reduce the city's emissions. Hydrogen can be locally supplied by the K'uL H2Go, who are planning to have a hydrogen production site available for their use.

The Value of Partnerships

OHIH firmly believes that by working together, much more can be achieved. For this reason, the following pages have been dedicated to some of our current partners:

Penticton Indian Band

The original people of the Okanagan are known as the Syilx speaking people – the “Okanagans” and according to their history they have been here since the beginning of people on this land. The Okanagans (Syilx) people occupied an area which extended over approximately 69,000 square kilometres, stretching from the area of Mica Creek, just north of modern-day Revelstoke, BC and east to Kootenay Lake. The southern boundary extended to the vicinity of Wilbur, Washington and the western border extended into the Nicola Valley. The Penticton Indian Band is involved in project and business development throughout the Okanagan: pib.ca

K’uL Management Group

The K’uL Group leads and manages the business interests of the Penticton Indian Band. K’uL Group is governed by its own independent board of seasoned business professionals and the shares are wholly owned by the Penticton Indian Band. K’uL Group began exploring the emerging global hydrogen economy in the autumn of 2018 as a point of entry into the renewable hydrogen and power to gas sectors by forming K’uL H2Go as its project entity for advancing its participation in the hydrogen economy. Its first project is the implementation of the hydrogen-hybrid kits to the Westhills Aggregate fleet of heavy duty vehicle and equipment. K’uL H2Go has developed a strong working relationship with ReGen Global as its key partner providing critical subject matter expertise: kulgroup.ca

City of Penticton

The City of Penticton is actively taking steps to reduce energy consumption and greenhouse gas emissions to ensure our community will continue to be a healthy place for us – and future generations. As a corporation, the city has been carbon-neutral since 2016. This will continue to be an ongoing priority as hydrogen technology is included in the cities plans: Penticton.ca

University of British Columbia Okanagan

UBC’s Okanagan campus aspires to build and demonstrate a sustainable campus that reflects a balance in its environmental, economic, and socially responsible values across campus operations, teaching, learning, and research. The UBC Vision is all about inspiring people, ideas and actions for a better world. UBC pursues excellence in research, learning and engagement to foster global citizenship and advance a sustainable and just society across British Columbia, Canada and the world: ok.ubc.ca

Hydra Energy

Hydra energy is accelerating the shift to clean combustion in transportation through their work converting existing diesel fleets to cleaner, hydrogen-hybrid options. Hydra leverages their unique expertise and business model with its partnerships to provide “Hydrogen as a Service”. Hydrogen fuel helps fleets run smarter, reduce fuel spend, and cut emissions – all while incurring no additional costs to fleet operators through their unique zero-cost start-up fee: hydraenergy.com

Hydrogen Technology & Energy Corporation (HTEC)

HTEC is unlocking the potential of hydrogen to reduce climate change and air pollution. The company designs, builds and operates hydrogen fuel supply solutions to support the deployment of hydrogen fuel cell electric vehicles. Partnering with government, industrial gas companies, key equipment suppliers, automotive companies, and energy companies, HTEC is delivering safe, reliable, convenient, sustainable, and low-cost hydrogen to customers and consumers, how, when and where they need it. HTEC: Fueling the Drive to Hydrogen: htec.ca

BayoTech

BayoTech is an energy solutions company committed to addressing the need for a consistent, cost-effective supply of hydrogen. They offer modular, scalable, and rapidly deployable hydrogen production systems through sales, rentals, leases, and gas-as-a-service to customers worldwide. Headquartered and produced in New Mexico, USA, BayoTech’s on-site hydrogen generators are more efficient than legacy steam methane reformers, leading to lower carbon emissions and low-cost hydrogen. BayoTech also offers the option to add biogas to the SMR to create green hydrogen with a CCS option that creates a carbon negative project - something that can’t be achieved with electrolysis. If animal waste biomethane is used, the hydrogen generated would be carbon negative without CCS: bayotech.us

ATCO

ATCO serves more than two million customers around the world with innovative and sustainable solutions in the sectors that are fundamental to global growth and prosperity. ATCO provides integrated solutions in: Structures & Logistics; Energy Infrastructure (including electricity and natural gas); Ports and Transportation Logistics; and Commercial Real Estate. From efficient and reliable energy for homes and businesses to affordable buildings for living, working and learning, ATCO builds communities and energizes industries like no other company in the world. ATCO is solving customer challenges in a way that balances responsible development with environmental stewardship and is proud to have innovative partnerships with Indigenous communities: atco.com

ATCO Hydrogen is committed to advancing energy solutions for customers that will further lower emissions and reduce costs. With the support of the Australian Renewable Energy Agency, ATCO is investing \$3.3 million in a leading research and development facility at its Jandakot Operations Centre, called the Clean Energy Innovation Hub - a testing bed for hybrid energy solutions that integrates natural gas, solar PV, battery storage and hydrogen production. In a first of its kind project for Alberta, ATCO will blend hydrogen into a subsection of its Fort Saskatchewan natural gas distribution system at a concentration of five per cent by volume: atcohydrogen.com

H2M

H2M's team of highly dedicated expert specialists have collaborated on the design and development of their patented hydrogen storage technology. They are continuously committed to advancing their solutions for solving complex technology challenges and helping the world realize hydrogen as the future of clean energy. From drawing board to complex research and planning for scaleup strategies, they're working together to develop and deliver a clean energy future: hydrogeninmotion.com

Wildstone Construction Group

Wildstone is an organization built on diversity among their people and projects and they embrace a shared culture for providing a higher level of service and a better building experience. Their core values guide their decisions, actions and best practices which makes them ideal partners for OHIH. Wildstone is a medium sized general contractor with over 150 employees across Western and Northern Canada. They offer self-perform services in civil, concrete, foundations, structural and mechanical construction: wildstone.com

SEED ENERGY Odyssey Software

SEED-Energy supports its customers in their skills development on innovative, smarter, multi-energy and multi-technology energy systems, with the aim of promoting the integration of new and renewable energies. SEED-Energy develops and markets the software ODYSSEY, a tool for investment decision making in energy systems, and offers the use of this tool for feasibility studies: seed-energy.fr

Cariboo Central Railway Contractors Ltd

Cariboo is involved in the development of railroad projects focussed on all aspects of the rail industry including construction and maintenance projects, consulting, and all rail-related equipment and track materials. Cariboo believes that Hydrail presents a cost-effective, zero-emission, mass transit opportunity for the Okanagan Valley. Its advocates promote the new advances in the technology as a much more affordable option compared to an electrified system: cariboorail.com

Cariboo Low Carbon Fuels

Cariboo Low Carbon Fuel Ltd. plans to build, own and operate an integrated low carbon fuel complex that includes a natural gas to liquids facility and a hydrogen production facility in the Thompson-Nicola Regional District of British Columbia's interior region and a similar facility in Belle Plaine/Regina region in the province of Saskatchewan. Blue hydrogen will enable green hydrogen for fuel cell electric vehicles, stationary fuel cell power development and clean hydrogen as renewable natural gas for injection into the provincial natural gas transmission system: cariboolcf.com

FortisBC

FortisBC is an electricity and natural gas distribution utility in the Canadian province of British Columbia, a subsidiary of Newfoundland-based Fortis Inc., Canada's largest private utility company. They understand the importance of a lower-carbon future for their customers throughout BC and are committed to leading the way. To do this successfully, they will balance financial, environmental and social factors. Their focus on sustainability is about prioritizing the health and well-being of their customers, communities, the environment and their employees - today, and into the future: [fortisbc.com](https://www.fortisbc.com)

BC Hydro

BC Hydro is a Crown corporation, owned by the government and people of British Columbia. It's their job to safely provide customers with reliable, affordable and clean electricity throughout the province. BC Hydro has become a leading sustainable energy company by producing and delivering electricity in environmentally and socially responsible ways. From environmental impact analyses to new initiatives to help reduce carbon emissions, they're committed to ushering in a clean energy future: [bchydro.com](https://www.bchydro.com)

Canadian Hydrogen and Fuel Cell Association (CHFCA)

The Canadian Hydrogen and Fuel Cell Association (CHFCA) is a collaborative effort of industry, academia, government agencies, financial organizations and other stakeholders focused on advancing the use of advanced hydrogen and fuel cell technologies and products to help tackle our world's most critical energy challenges. With a 40-year legacy of industry expertise, they are considered global leaders in hydrogen and fuel cells as a result of their pioneering technologies and a strong history of partnerships between industry, academia, governments and other international professional associations that are working to advance hydrogen and fuel cell technologies: [chfca.ca](https://www.chfca.ca)

H2GO Canada

H2GO Canada believes that a hydrogen strategy for Canada can be developed according to a set of principles, such that it capitalizes on existing advantages and opportunities by focussing on the development of markets to accelerate scale-up, helping mobilize Canada's resources for export, delivering clean air benefits to the public, and prioritizing a net gain in employment: [h2gocanada.com](https://www.h2gocanada.com)

Natural Resources Canada

There is increasing interest in the use of hydrogen and fuel cells to decarbonize energy use across economies around the world. With 185 countries including Canada being signatories to the Paris Agreement, there is now a global focus on reducing greenhouse gas (GHG) emissions, while working to achieve clean growth and long-term economic benefits. Hydrogen and fuel cells can reduce the environmental impact of economy-wide energy use, while supporting job creation and economic prosperity using innovative, clean technologies: [nrcan.gc.ca](https://www.nrcan.gc.ca)

International Inter-Tribal Trade and Investment Organization (IITIO)

Based in Ottawa, the International Inter-Tribal Trade and Investment Organization has a vision for indigenous trade relationships where there exists a global flow and exchange of Indigenous goods, services and investments. Their mission is to support and enhance the implementation of this vision by developing, over time, the tools, mechanisms and analysis necessary to assist in the global flow and exchange of Indigenous goods, services and investments: [IITIO.org](https://www.iitio.org)

Nation First Investment Group

Nation First is a trusted platform for building bridges of success between indigenous individuals, nations and investors. They help indigenous nations and individual landowners explore and develop opportunities for sustainable wealth and economic development, through partnership with investors that have shared values. Currently, Nation First is developing programs in the areas of: health and wellness, clean energy, infrastructure, cultural tourism, and leveraging existing assets: [nationfirst.ca](https://www.nationfirst.ca)

ReGen Global

ReGen creates new market opportunities in the global hydrogen economy through regenerative growth initiatives designed for decadal impacts. Their approach relies on project-based value stacks for H₂ production

to end user platforms that feature digital twins as the first nodes in a Canada US regional supercluster. ReGen provides collaborative project design, delivery & distribution services that leverage the work done by the K'uL Group of British Columbia and connects a North American innovation ecosystem that includes industry leaders, universities, governments, national labs, and indigenous collaborative partners and investors: regenglobal.us

RedwoodAdaptive

RedwoodAdaptive (RA) is an energy and environmental consultancy that specializes in networked innovation in the new energy economy that creates an innovative impetus in complex collaborative partnerships and adaptive capacity acquisition in individuals and organizations. RA's work with ReGen Global features niche activation and acceleration through advanced analytics and anticipatory planning for hydrogen technology to market initiatives that feature ecosystem and market interface and integration throughout a regional digital supercluster built on distributed technology and end user platforms: redwoodadaptive.com

US Department of Energy Hydrogen Program

H2@Scale is a U.S. Department of Energy (DOE) initiative that brings together stakeholders to advance affordable hydrogen production, transport, storage, and utilization to increase revenue opportunities in multiple energy sectors. It is a framework in which national laboratories and industry can work together through government co-funded projects to accelerate the early-stage research, development and demonstration of applicable hydrogen technologies: hydrogenenergy.gov

National Renewable Energy Lab (NREL) Hydrogen & Fuel Cells

Researchers in the Hydrogen & Fuel Cells Lab at NREL's Energy Systems Integration Facility (ESIF) work on hydrogen and fuel cell R&D that focuses on developing, integrating, and demonstrating hydrogen production delivery, storage and fuel cell technologies for transportation, stationary, and portable applications. Projects range from fundamental research to overcome technical barriers, manufacturing process improvement to enable high-volume fuel cell production, systems analysis to identify the most promising commercialization pathways and market transformation to support early market deployments. NREL and Natural Resources Canada have developed an alternative vehicle locator tool that can be used for collocating new hydrogen infrastructure in North America: nrelhydrogen.gov

Sandia National Laboratories Hydrogen and Fuel Cells

The Sandia National Lab contributes to the science of advanced hydrogen and fuel cell technologies by providing a deep, quantitative understanding and scientific basis for materials interaction with hydrogen and safety. Sandia researches and develops methods to discover materials for hydrogen production, storage and use, evaluating their properties and performance. Sandia also provides the technical basis for assessing the safety of hydrogen fuel cell systems and infrastructure and accumulates knowledge used to inform relevant codes and standards. Sandia recently received an Excellence in Technology Transfer Award due to the success of licensing high-efficiency hydrogen generation technology to BayoTech, OHIH's preferred supplier of onsite hydrogen production: sandiahydrogen.gov

Iron Horse Industrial Park

Iron Horse is a 400-acre expandable industrial park located on Native American Trust Land in the center of the U.S. Iron Horse also holds a Foreign Trade Zone designation and is served by a Class I railroad (Union Pacific). It is also located within 10 miles of Interstate 40 and 2 ½ miles west of U.S. Hwy 177. The park is owned by the Citizen Potawatomi Nation, a federally recognized Native American government. The Citizen Potawatomi Nation is targeting industries in the oil & gas, environmental sustainability, automotive, and aerospace sectors. While there are several available sites of varying sizes within the Park, a trans-load facility and warehousing area are also being built: ironhorsecpn.com

Oklahoma Department of Commerce

The department of commerce focuses on bringing employment, investment, and economic prosperity to the state of Oklahoma. Through dynamic partnerships and innovative collaborations with companies, universities, not-for-profit organizations, and government leaders, they're building a business environment that supports growth and shared community prosperity. Centrally located in Oklahoma in North America, location and

transportation infrastructure provide access to receive and deliver goods around the world with pro-business incentives for startups and global businesses looking to establish access to the US market: okcommerce.gov

Oklahoma Manufacturing Alliance

Since 1992, the Oklahoma Manufacturing Alliance (OMA) has been dedicated and committed to serving the state’s most important industries and growing Oklahoma’s economic base while improving the lives of its citizens. Oklahoma is a recognized resource for building sustainable, innovative manufacturing that positions manufacturers to achieve their full potential by delivering comprehensive, proven solutions. OMA is passionate about manufacturing and is committed to exceeding their clients’ expectations by leveraging collective genius through collaboration and teamwork that brings vision, innovation and technological advances to create broadly beneficial results: okalliance.com

Appendix

ReGen Global developed OHIH as a model for the first of many hydrogen innovation hubs that can be deployed in communities and regions around the world. The ReGen K’uL Westhills H2 Technology Platform is designed for replication, adaptation and scale for a race to market strategy:

