

# CHARGE

## The Consortium for Hydrogen and Renewably Generated E-Fuels

**Making Washington State a Global Hub for  
Commercializing Alternative Fuels**



## **The Goal**

Leverage Northwest assets to develop a public-private partnership for hydrogen and electro-fuels (E-Fuels) commercialization

## **The Driver**

Deep expertise in technology for carbon-neutral hydrogen and E-fuels production, but investments are needed to advance to pilot-scale

## **The Ask**

We are seeking partners in this effort to engage in planning and ultimately investments to match state and federal funding opportunities



# Problem: Electrification can't do it all

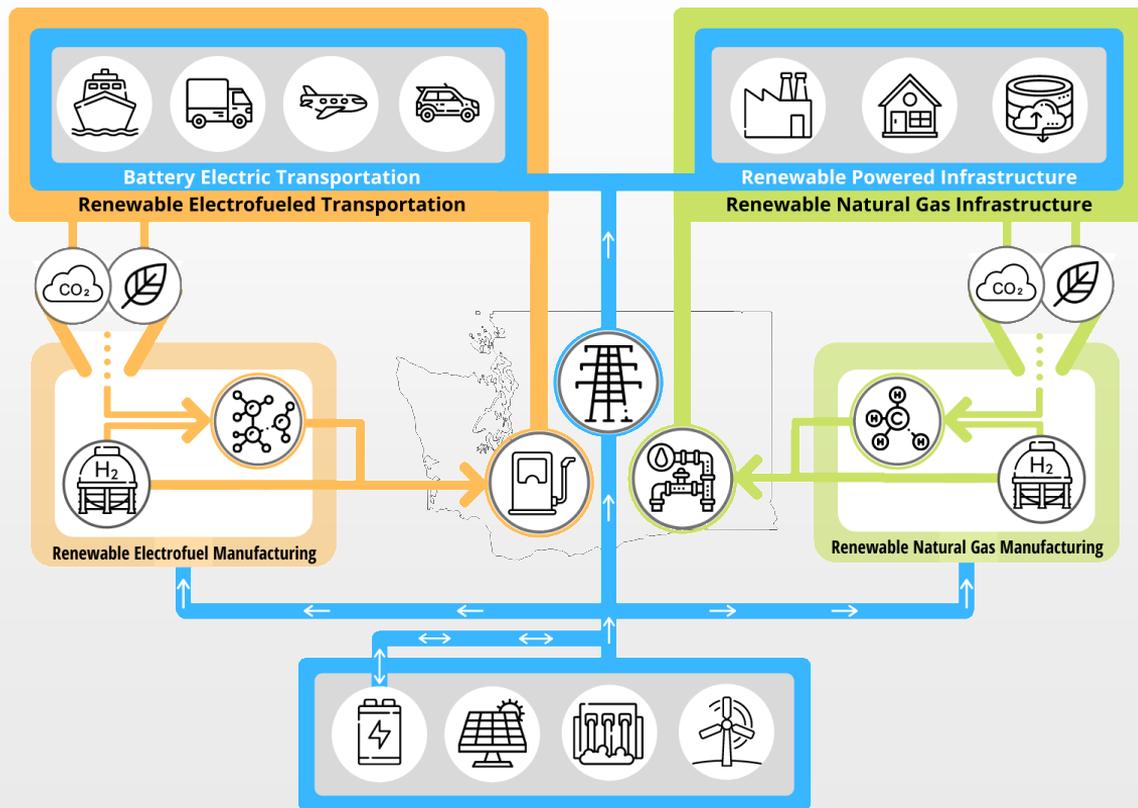
- There is a need for fuels derived from renewable energy to support GHG reduction in high power demand applications.
- Washington State transportation OEMs and the tech companies are building assets that will be in place for decades but need to be decarbonized
- Washington State utilities produce low carbon electricity at some of the lowest costs on the planet





# Technical Solution: Leverage clean electricity to yield fuels that can power these sectors

- Carbon must remain in a closed loop system where it is recycled
- Hydrogen is produced from renewable electricity
  - Used to directly power sectors which can't be easily electrified
  - OR hydrogen is a feedstock for e-fuel manufacturing
- E-fuels are produced from recycled carbon and renewable hydrogen with renewable electricity





# Organizational Solution: Leverage regional expertise and local / global partners to fund pilot projects

- Fundamental science is largely in place
  - Future R&D should be directed towards lowering cost and ensuring supply chain resilience through earth abundant material choices
- Pilot projects are necessary to prove scalability and technoeconomic feasibility and identify areas for improvement
  - Requires engagement throughout the value chain: Utilities, System Integrators, Process Engineering, Site logistics, OEM Customer
- Anticipated funding opportunities will award grants to comprehensive organized teams who have initiated planning and have matching funds



Successful Pilot Projects



External or Internal Funding Opportunities



Proposal Concepts with Consortium Matching



CHARGE: Utilities, Transportation, System Integrators, Researchers



# Traction: In addition to regional renewable energy infrastructure WSU has multiple relevant centers of excellence

- JCDREAM – Joint Center for Deployment and Research of Earth Abundant Materials
- ESIC – Energy Systems Innovation Center
- HYPER – HYdrogen Properties for Energy Research
- ASCENT – Aviation Sustainability Center



- NARA – Northwest Advanced Renewables Alliance
  - Leverage network and learning from NARA program – now concluded





# Joint Center for the Deployment and Research in Earth Abundant Materials (JCDREAM)



**Ensure new energy and transportation technologies are aligned with sustainable earth abundant material supply chains**

- Connect WA State researchers, industry, and government around critical material challenges
  - Website is a focal point with: monthly blog, equipment availability, JCDREAM virtual symposium
- Promote, facilitate, and fund research in earth abundant material alternatives to critical materials
  - Two rounds of capital investment - \$2M each
  - Four rounds of seed grants - 30+ grants / ~\$25k each
- Conduct educational outreach to students, educators, the general public, policy makers, legislators, and industry decision makers
  - Launched Materials Washington an education and workforce development consortium program committed to publishing curriculum



# Energy Systems Innovation Center (ESIC)



- Leading center of excellence in power engineering education, outreach and research
- Utilities-funded membership programs for supporting research and education: ~ 50 years old
- Well-funded by DOE, NSF and power industry
- Annual research expenditures at ~ \$4M
- Scaling renewables requires new paradigms for design and operation of electric power grid
- E-fuels can serve to move energy back and forth between power grid and e-fuel networks to manage the intermittency of renewables
- E-fuel loads on the grid require pilot studies



# Hydrogen Properties for Energy Research (HYPER)

## Cool. Fuel.

- The *only* cryogenic hydrogen laboratory in US academia.
- Developed current NIST property models for hydrogen fuel.
- Founding member (only academic) of Center for Hydrogen Safety.
- World's first 3D printed LH2 tank. World's first cryogenic origami fuel bladder. World's first liquid hydrogen UAV built by students. World's first commercial scale hydrogen liquefier built by students.



Although >90% of small merchant hydrogen is distributed as cryogenic liquid, the efficiency of liquefiers remains <40%. This is could be the biggest opportunity for near-term disruption in clean energy.





# Sustainable Aviation Fuels



- Focus for more than 10-years on difficult to decarbonize transportation sectors like aviation with stakeholder integration across the sector including producers, airports, OEMs, and airlines



- Leverages combined expertise of WSU and PNNL researchers



- Cluster of expertise in biomass processing and catalyst development with focal areas in electrocatalysis and C1 chemistry



# Catalysis Capabilities at WSU Chemical Engineering

- ~ 10 faculty with critical capabilities in synthesis, advanced characterization, and theoretic calculations to address the atom and energy efficiency with mitigated environmental impact for a broad thermochemical and electrochemical conversions.
- \$19.6M support for the past 5 years from both government and private sectors (NSF, DOE, USDA, ONR, JCATI, FAA, JCDREAM, ADM, Nissan, Boeing, GTI, RAPID, Ascend Performing etc).
- >200 high impact publications for the past 5 years in *Science*, *Nature Catalysis*, *Nature Communications*, *JACS*, *Angewandte Chemie*, *ACS Catalysis*, etc.





# PNNL Alignment with CHARGE

- PNNL will play an active leadership role through existing WSU-PNNL strategic relationship
- PNNL will commit resources to support: Technology, Pilots, Expertise, Strategy, Partnerships, DOE interface
- PNNL and WSU have shared history in addressing CO<sub>2</sub> emissions
  - Bioproducts Institute
  - Advanced Grid Institute – closely aligned with ESIC
  - CHARGE will build on these interactions to leverage existing partnerships
- PNNL research focus is already aligned with CHARGE
  - Electro-catalysis
  - Hydrogen Fuel Cells PEM/SOFC
  - Cryogenic hydrogen handling
  - E-fuels / biofuels



**Pacific Northwest**  
NATIONAL LABORATORY



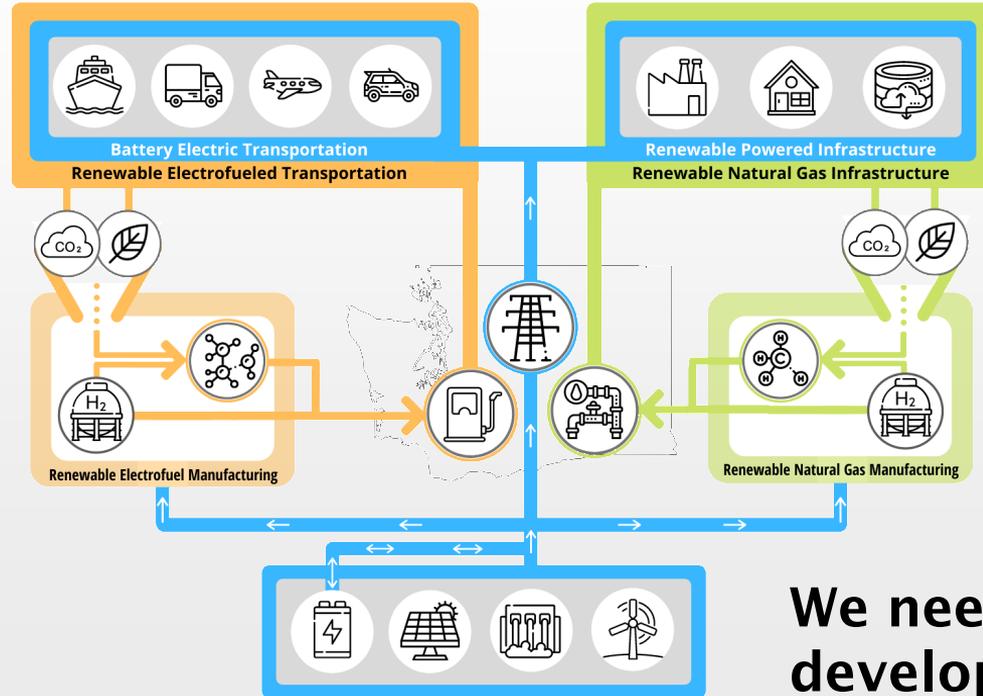
# Approach to Consortium Intellectual Property

- This is a complex and multifaceted project and will require creative approaches to Intellectual property (IP) management.
- Ultimately, the goal is deployment and this needs to remain the focus in IP management practice.
- WSU and partners in this effort will need to commit to an IP sharing model that enables deployment while maintaining necessary risk management structures for participants.

**A key part of this planning effort will be to develop and refine such a model.**



We have all the assets in place to develop this system



We need your help to develop the necessary resourcing



# Join The Partnership

1. We want your thoughts and your time
  - Form teams and project plans that will result in winning proposals
  - Industry, researchers, government agencies, and startups are welcome
2. We will help match your funds to win proposals
  - Leverage funds from WSU and member capital
  - Designate available assets to support projects
  - Launch event will help to organize partnerships



# Contact



**JCDREAM**

JOINT CENTER FOR DEPLOYMENT & RESEARCH IN  
EARTH ABUNDANT MATERIALS

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