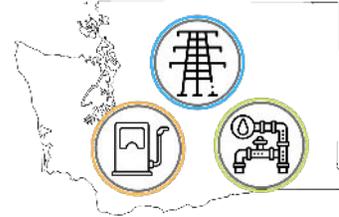


# The Joint Center for Deployment and Research in Earth Abundant Materials A Washington State Organization with a Holistic Focus on Sustainability

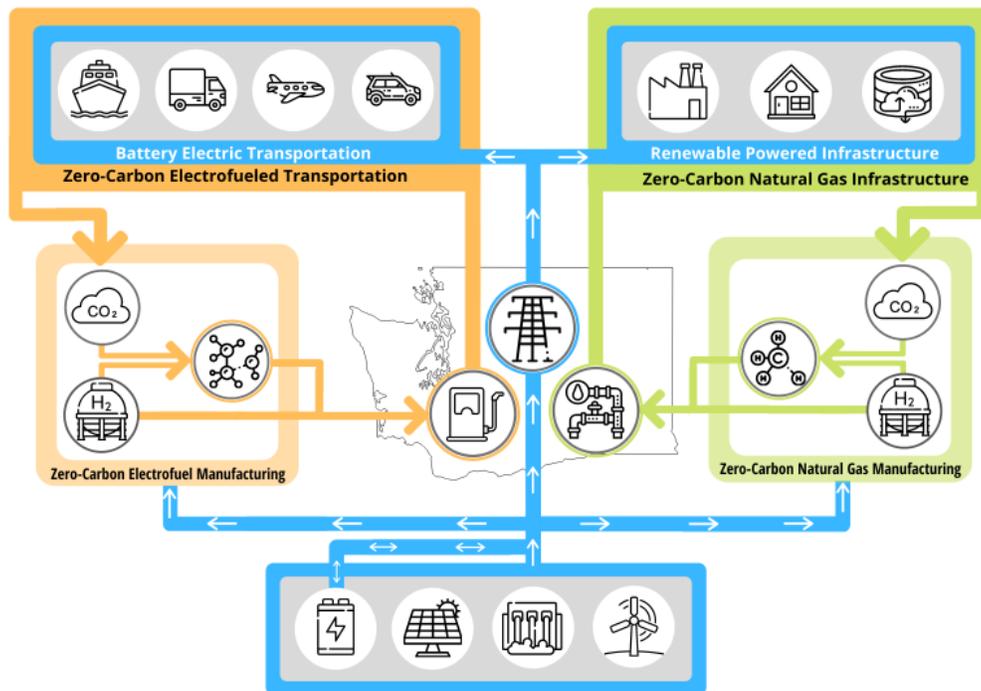
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**The Challenge:** From transportation to energy infrastructure to cloud computing, our global economy relies heavily on carbon-emitting fossil fuels and critical materials. These critical materials are imported from only a few places, are rare within the earth's crust or mined using practices that harm humans and the environment. Our unsustainable use of conflict minerals and rare earth elements stifles growth in new industries and supports human rights-violating regimes.

This is a problem for all industries, but it is particularly troublesome for the emerging clean energy sector. As in most of the world, Washington State's economy is powered by three sources of energy: electricity, liquid fuels for transportation, and gas fuels for heat and power. We need to decarbonize these energy sources with technology and supply chains built on recycling and earth abundant materials.



**The Solution:** In the proposed future ecosystem illustrated below, **electricity**, **liquid fuel**, and **gas fuel** all still play a part, but CO<sub>2</sub> is recycled. Abundant renewable electricity is the foundation, and it feeds the power grid where electricity can also be stored in batteries or other energy storage systems to supply power when renewables are unavailable. Zero-carbon electricity can power transportation, buildings, agriculture, and industry as shown by the **blue** lines.



However, certain parts of our transportation network (e.g. aviation or long-haul trucks) depend on **liquid fuels**, and existing natural **gas fuel** infrastructure provides seasonal stability and backup power. Instead of abandoning these parts of our economy, they can be decarbonized by recycling CO<sub>2</sub> from transportation and industry for use as a chemical feedstock in electro-fuel plants shown in **orange** and **green** boxes. Here CO<sub>2</sub> is combined with clean hydrogen to produce zero-carbon electro-fuels which function just like jet fuel, diesel, or natural gas in existing infrastructure. With heavy investment in renewables, high value zero-carbon electro-fuels may even be exported.

**We Start in Washington State:** Washington State is the ideal place to launch the pilot programs that will propel us into this new economy. The state's energy grid is powered by clean, abundant, and low-cost electricity from hydro-electric and renewable sources with very little reliance on fossil fuels. Our early building-level efficiency gains and electric vehicle adoption have put Washington further along the path than most other states.

We are uniquely positioned to lead the clean energy economy and the industries that surround it. Our local aerospace, truck, and ship manufacturers are all ideal partners for pilot programs in the development of new electro-fuels and further electrification of transportation. As the cloud computing capital of the world, local tech companies will ensure that the burgeoning data economy is built on clean energy and earth abundant supply chains. Washington State utilities are progressive innovators that are already active in this space. Between local ports and e-commerce, our state is poised to decarbonize global shipping and logistics operations. Our research institutions are second to none in their ability to deliver innovative earth abundant solutions, and the entrepreneurial spirit of local investors and startups is vibrant and ready to bring these new technologies to manufacturing scale.

**Our Immediate Focus:** The priorities as we move forward include:

- **Increasing reliability of renewable generation** with short- and medium-term storage solutions so that we can eliminate the remaining fossil fuels on our power grid.
- **Reducing the cost of e-fuel** technology to add seasonal stability to renewables with existing infrastructure e.g. clean hydrogen and zero-carbon methane in current natural gas pipelines.
- **Scaling electro-fuel technology** by combining recycled CO<sub>2</sub> with hydrogen (from splitting water with clean electricity) to power the parts of our society that are not easily run on batteries including:
  - Aviation fuel where medium and long-haul flights are very unlikely to be battery powered;
  - Diesel fuel substitutes for trucking when long-haul truck routes make EV solutions impractical;
  - Fuel for ships such as liquid hydrogen, liquid natural gas, or hydrocarbon electro-fuels.
- **Growing renewable generation capacity** to power electro-fuel-based transportation and non-electric sectors and enable Washington to become an exporter of zero-carbon electro-fuels.
- **Developing earth abundant technology** to ensure sustainable supply chains for all of the above.

**JCDREAM:** The Joint Center for Deployment and Research in Earth Abundant Materials (JCDREAM), formed in 2015, addresses these challenges by supporting Washington State industry through our world-class research institutions. Through public private partnerships, we work to propel Washington to a position of global leadership in clean energy built on sustainable material supply chains. JCDREAM provides a framework to stimulate innovation in earth-abundant materials and recycling of critical materials at the nexus of clean energy and transportation. We fund and promote new research on earth abundant energy materials while ensuring that academic progress is well aligned with commercial interests. We promote STEM and education in materials science so that the next generation of workers is ready to build a new economy around truly sustainable solutions.

**Join the Partnership:** JCDREAM has already made substantial progress and we want you involved. We are making connections in the transportation, energy, and technology sectors. Industry, researchers, government agencies, and educators are welcome. By building and aligning partnerships, we aim to leverage JCDREAM funds, grow our scope and help bridge the gaps in energy storage and electro-fuels.

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