



www.colorado-hydrogen.org

Monthly Meeting
18 June 2024

Agenda

- New CHN membership categories
- Launching a Colorado “Clean Energy Hub”
- Student hydrogen RC car racing in Colorado
 - Racing sponsorship

Thank You Emerson!

- Hydrogen Summit, June 13th in Boulder
 - Will Toor, Ex. Dir. Colo. Energy Office
 - Colorado PUC
 - NREL
 - RMI
 - CHN and more
- Three hours of presentations and panels
- Networking Social
 - Avanti restaurant, Boulder



Brad Healey
Director,
North America



Breanna Real
Product Mgmt.
Specialist

Fuel Station Grant - Denver Public Meeting

- June 5th at CSU Spur Campus National Western Center
- Overview of the project
- Attending:
 - NREL, Nikola, Drive Clean Colorado RTD, Xcel, DoE, City of Denver Saoradh Enterprise Partners Rising Creek Transport
- Vehicles on display
 - Nikola Class-8, operating in Colorado
 - Thanks to Roy Hensler, Rising Creek Transport
 - Mirai owned by Brendan Doner
 - Licensed and fueled in Colorado



Colorado Hydrogen Network Membership

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Background

- CHN has operated 4 ½ years with a shoestring budget
 - Expenses are small (website, Zoom, some marketing material)
 - Labor is all volunteer
- Only a handful of paying members supports the organization
 - We'd like to get more stakeholders invested in CHN
 - High dues have been an issue (starting at \$1K)
- CHN membership has included CCIA membership
 - CHN is an Initiative of CCIA
 - Dues follow CCIA's membership rates.

The Solution

- Add new low-cost dues
 - \$50 for individuals
 - \$200 for start-up companies (for first 2 years)
 - These dues are voluntary and tax deductible
- Everyone will continue to be welcome to participate and engage with CHN at no charge
- Benefits of donating
 - Help to support and grow CHN
 - Get more invested and engaged in CHN
 - Enable CHN to (someday) have paid positions
 - Allows CHN to sponsor events
 - Your name and logo on a CHN members page on the website.

New CHN Memberships



	Individual	Start-up (2 years)	1-20 Employees	21-50 Employees	51-150 Employees	151+ Employees
Annual Dues	\$50	\$200	\$1,000	\$2,500	\$5,000	\$10,000
Tax Deductible Donation	✓	✓				
CCIA Membership included			✓	✓	✓	✓

*Tax deductible donations
can also now be accepted*

More info at coloradocleantech.com



Call to Action

- We'll send an e-mail soon inviting stakeholders to join or donate
 - The “Join” page is: www.colorado-hydrogen.org/join
- In future years membership renewals will be sent every June
- Tax-deductible donations can also now be made.

Website “Join” Page



Join

Membership in the Colorado Hydrogen Network has been provided as a joint membership in both CHN and our parent organization, the Colorado Cleantech Industries Association (CCIA). CCIA's dues are tailored for established companies, but CHN stakeholders include many individuals and start-up companies, many of whom would like to have a stake in supporting CHN.

So new in 2024, we're adding CHN-only dues so that individuals and start-up companies can help support the organization. These dues are voluntary and tax deductible. The rate for start-up companies is limited to the first 2 years of membership. The complete set of annual dues is shown in the table.

	Individual	Start-up (2 years)	1-20 Employees	21-50 Employees	51-150 Employees	151+ Employees
Annual Dues	\$50	\$200	\$1,000	\$2,500	\$5,000	\$10,000
Tax Deductible Donation	✓	✓				
CCIA Membership included			✓	✓	✓	✓

Why Join?

CHN is a non-profit organization devoted to advocating for hydrogen infrastructure and educating, so everyone is welcome to participate in the organization whether they pay dues or not. But here are the benefits of donating:

- Help to support and grow CHN
- Allows CHN to sponsor events
- To be invested and engaged in CHN
- Enable CHN to eventually have paid staff
- Your name and logo on the CHN members page on the website

Join



Questions & Discussion

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Colorado Clean Energy Hub

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The Problem

- It's difficult for Clean Energy stakeholders to enter the market because there is no market
- A Market consists of multiple:
 - Sources
 - Users
 - Infrastructure
- And these sources, users and infrastructure have to be deployed:
 - At the same time
 - Same scale
 - *And at a price competitive with petroleum*

***Leadership, a Plan and Cooperation is Needed
To Break This Stalemate***



The Solution

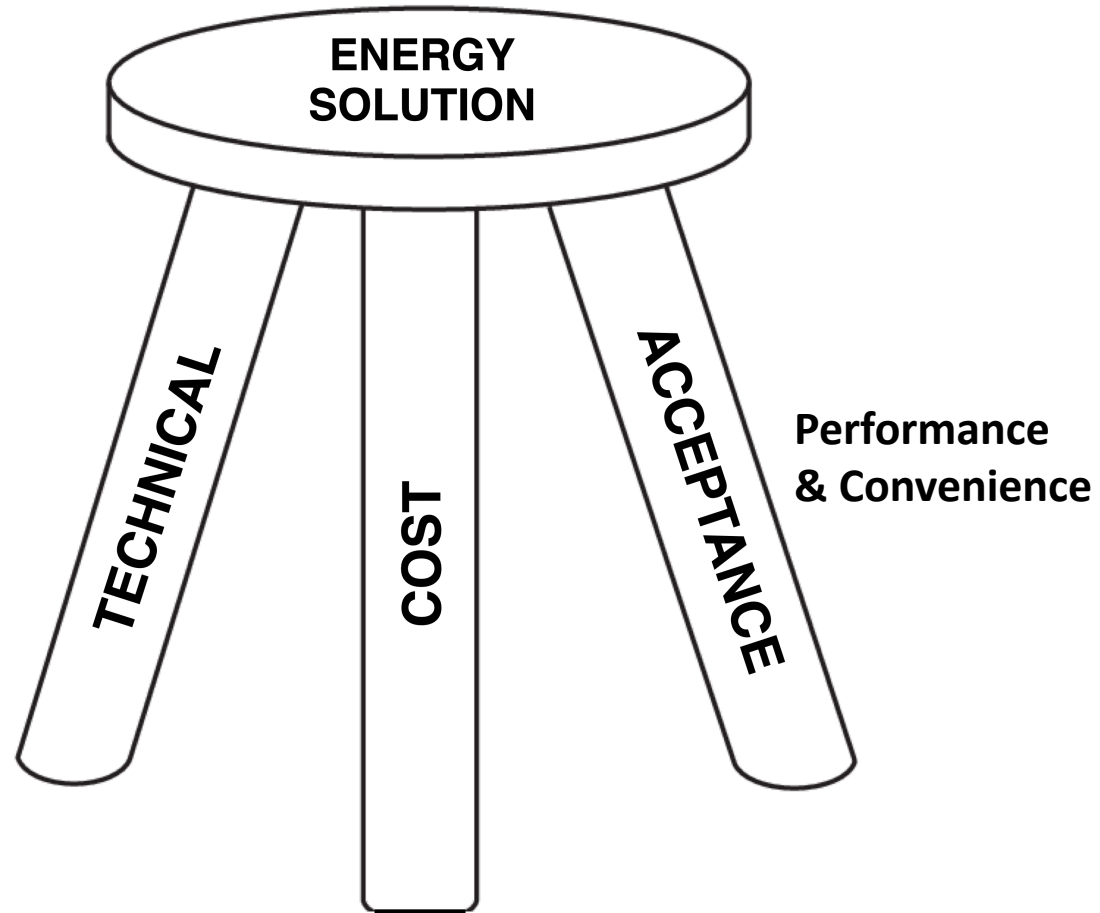
Help start the market by sponsoring a *Clean Energy Hub* to:

- Create a plan for a Colorado Clean Energy Market
 - Supply, transport, dispense, users, infrastructure, funding
 - Solve the “what” (system design) and the “how” (cooperation, timing, funding)
 - To focus efforts & guide decisions
- Enlist a Consortium of stakeholder participants
 - To help mold the plan
 - To be participants in this market-ecosystem
 - A way for stakeholders to cooperate and collaborate
 - Issue RFP’s
- Seek funding sources and grants and other support.

Clean Energy Consortium

- Suppliers
 - Natural hydrogen wells
 - GU Hydrogen (Generated Underground from petroleum reservoirs)
 - Energy conversion
 - Electrolysis, ammonia, biofuel
 - Tanks (NH₃, biofuel, GH₂, LH₂)
 - Pipeline
- Infrastructure
 - Vehicles – MD/HD
 - Turbines & ICE engines (H₂ to electricity)
 - Transport – Trucks & pipelines
- Users
 - Fleets – transit and MD/HD vehicles
 - Industry – Steel, glass, cement
 - Utilities – Turbines burning hydrogen
 - Oil developers – Stationary power generators
- Funding
 - Tax incentives
 - Investors
 - Colorado State (“Enterprises”)
 - Vehicle and infrastructure funding.

To Create a Plan Which Form of Energy Is Right for Each Use?



**Energy Solutions Must Meet
Three Criteria**

Performance
& Convenience

Clean Energy Source Summary

Source	Renewable	Zero GHG	GHG Neutral	GHG Negative
Wind	✓	✓		
Solar	✓	✓		
Geothermal	✓	✓		
Hydroelectric	✓	✓		
Hydrogen wells	✓	✓		
Generated Underground (GU) Hydrogen		✓		✓
Biomass or algae to biofuel	✓		✓	✓
Biomass or algae to hydrogen	✓	✓	✓	✓
Nuclear		✓		

Energy Definitions

- “Clean” Energy does not increase atmospheric GHG
 - Zero GHG (Greenhouse Gas)
 - No emissions
 - GHG neutral
 - Use may emit GHG
 - Production absorbs an amount equal to emission
 - GHG negative
 - If the use of a fuel emits GHG
 - Production of that fuel removes more GHG from the atmosphere than emitted
- Renewable energy
 - Source is replenished by natural processes
 - Is not depleted

*All Renewable Energy is Clean
Not all Clean Energy is renewable*

“Clean” and “Renewable” are Separate Characteristics

What About “Green” Energy?

Color is a shorthand to allow us to specify two parameters with one label (color)

- Whether the source of energy *emitted CO₂* or not
- Whether the source of energy was *renewable* or not

- Natural hydrogen wells (see: nh2e.com)
- Wind, Solar, Geothermal, Hydroelectric electricity and hydrogen generated from them
- Hydrogen and biofuel from biomass with 100% carbon capture and sequestration

		Emits CO ₂	
		No	Yes
Source	Renewable	Green	Tan
	Non-Renewable (fossil & nuclear)	Blue	Gray

Hydrogen and biofuel from biomass with less than 100% Carbon Capture (Tan Proposed).

Energy from fossil fuels with less than 100% Carbon Capture

- Electricity and hydrogen from fossil fuels with 100% carbon capture
- Generated Underground (GU) Hydrogen from petroleum wells with carbon left in the ground (<https://protonh2.com>)
- Electricity and hydrogen generated using nuclear power

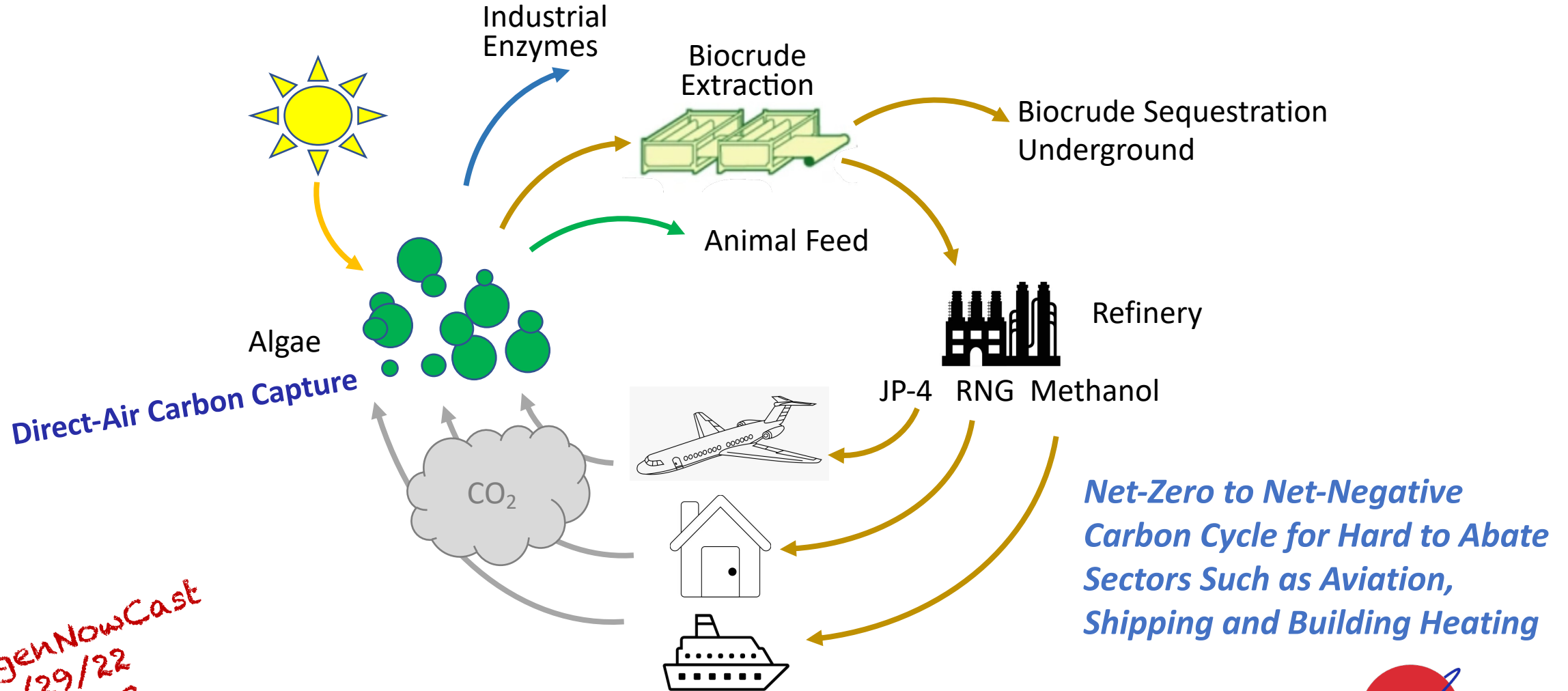
Only Four Colors Are Needed to Describe Any Energy
A Carbon Intensity (CI) Score is Needed for More Details

Energy Forms for Each Sector

Sector	Electricity	Hydrogen	Biofuel	Key Discriminator
Electric Grid	✓			
Transportation	✓	✓		Performance & Convenience
Industrial Heat		✓	✓	Technical & Cost
Aviation		✓ (Short range)	✓ (Long range)	Technical
Building Heat	✓ (New construction)		✓ (Existing)	Cost
Maritime			✓	Technical

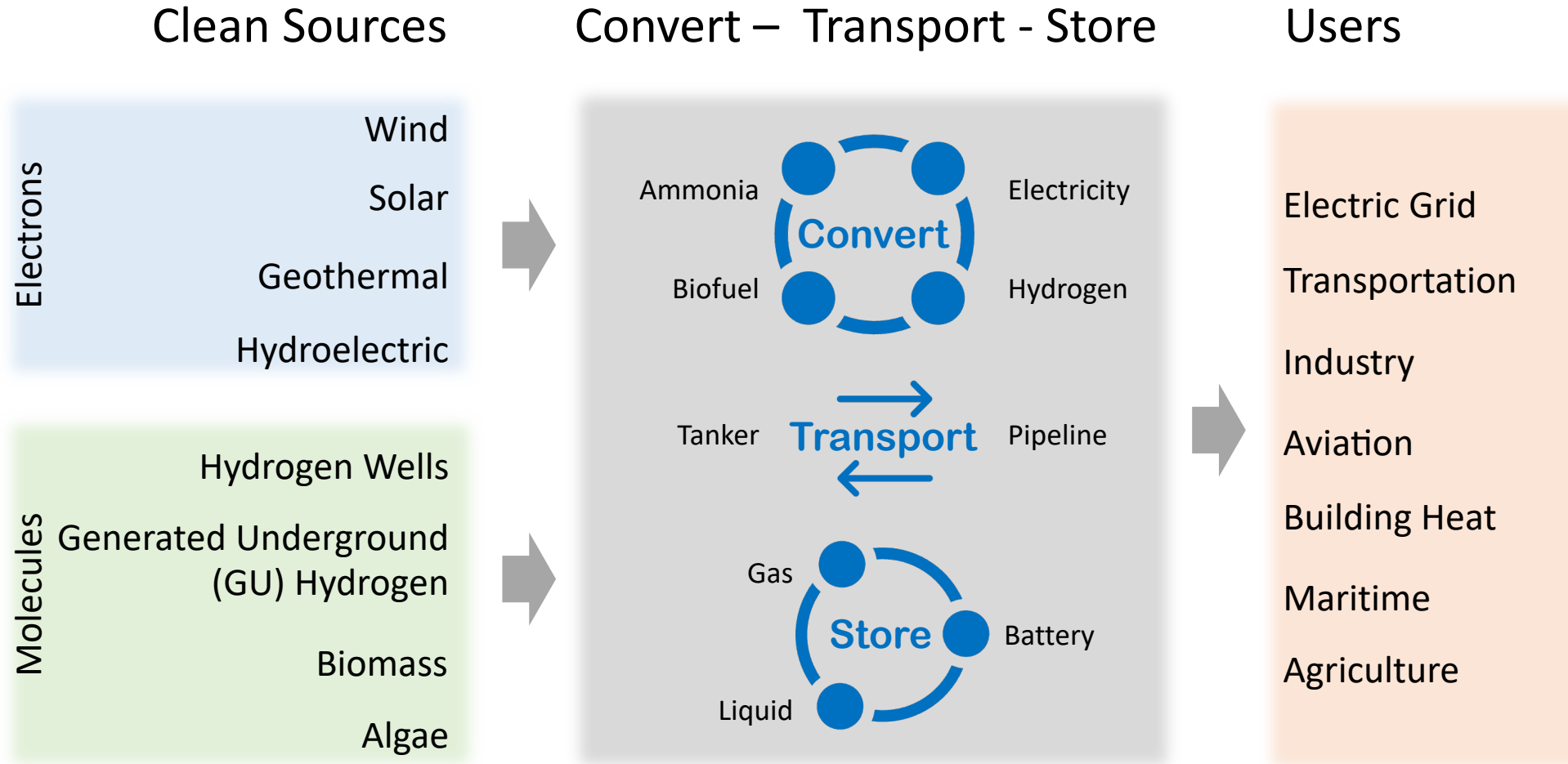
See: Tech Brief - Which Energy Form to Use

Biofuel Example - Algae

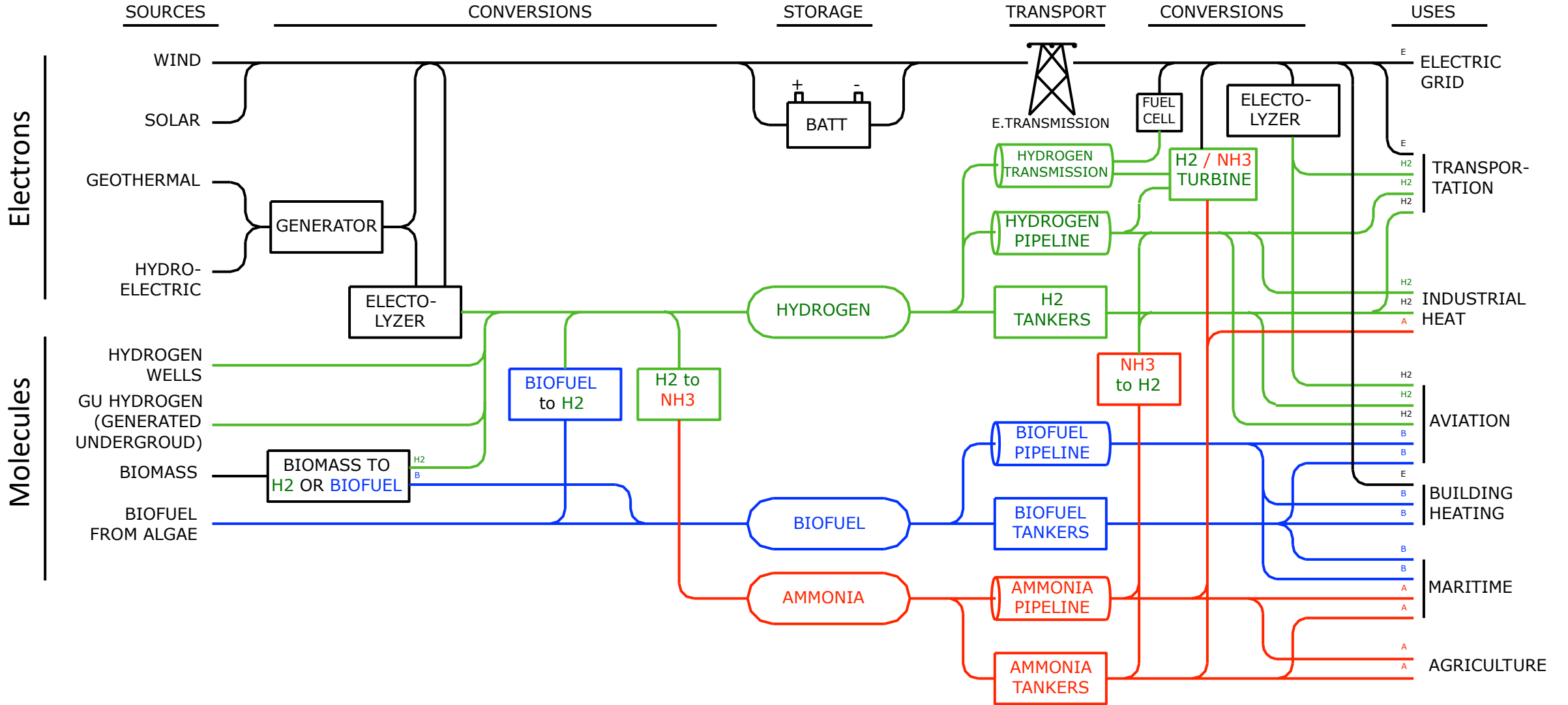


HydrogenNowCast
4/29/22
2/10/23

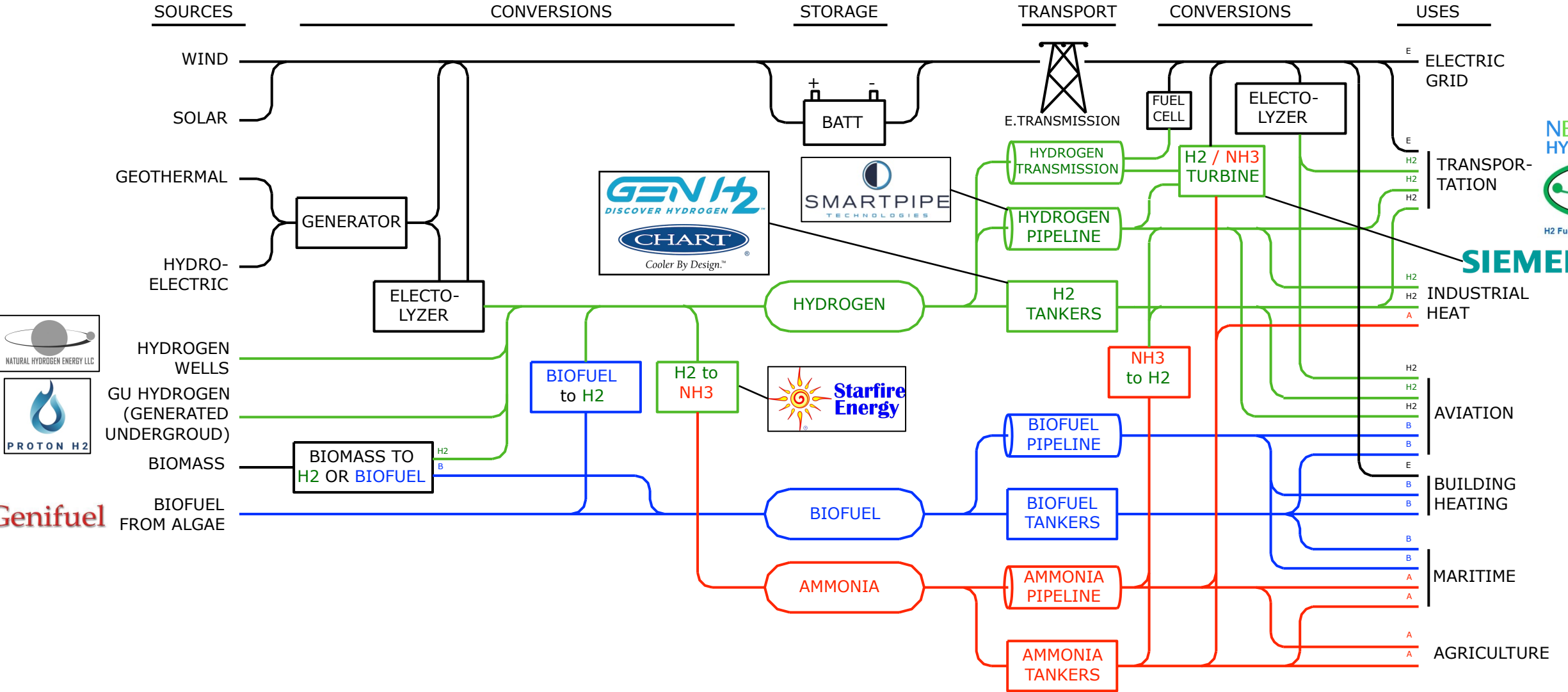
Complete Clean Energy Market-Ecosystem



Clean Energy Market-Ecosystem



Clean Energy Market-Ecosystem Some Stakeholders



Implementation

- Enlist Consortium members
- Develop an agreed-to Market-Ecosystem (diagram)
- Identify and deploy Ecosystem paths:
 - Of interest to participating stakeholders
 - Deploy the dependent elements together
 - Some elements of the market-ecosystem may not be deployed in Colorado
 - Algae for example.

Questions & Discussion

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Highschool Hydrogen RC Car Racing and STEM Curriculum

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High School Hydrogen RC Car Racing

- The H2GP Foundation and CHN have teamed up to sponsor high school hydrogen RC car racing in Colorado
- Horizon Educational was founded in 2003 to bring miniature fuel cells to schools and students
 - Hardware kits & curriculum
- In 2015, Horizon launched the *H2 Grand Prix* series of races
 - Greater engagement of students through competition
 - Students learn to design, test and redesign
 - Races are international
 - 2,500+ teams, 20,000+ students, 20+ countries
- In 2023 Horizon launched the non-profit H2GP Foundation
 - To promote and sponsor the H2 Grand Prix races
 - Donations are tax deductible



www.H2GP.org



H2 Grand Prix Pro Racing

- H2 Grand Prix PRO is a STEM-based educational program for high school students where they design, construct and race hydrogen-powered RC cars
- Working in teams, students design, engineer, and construct a 1:10 scale fuel cell-powered RC car
- Students work collaboratively to bring their car from the design stages through prototyping and manufacture, working with chemistry, physics, engineering, and mathematics along the way
- A variety of experiments and teaching materials turn understanding into hands-on learning
- The program culminates in a series of regional 4-hour endurance races, where students put their engineering skills to the test and compete against other teams.

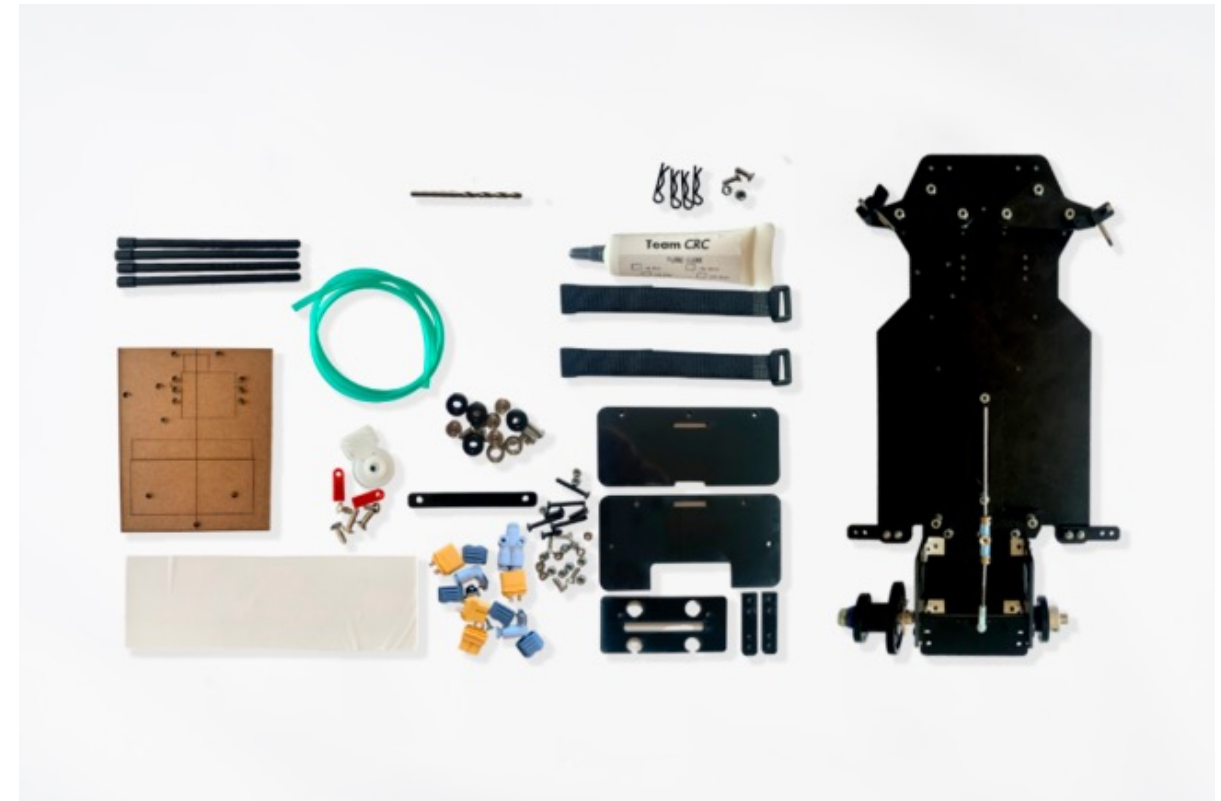
Year 1 H2 Grand Prix PRO Starter Package

- Includes everything needed to race from day-one
- Introduces teams to the basics of fuel cells and allows them to learn to drive the car
- All the components needed for creating a functioning FCEV racing car are included
 - RC Car Kit with fuel cell and electric motor
 - RC controller
 - Desktop electrolyzer to refill the metal hydride cartridges
 - Using distilled water and electricity
 - 14 HYDROSTICK cartridges
 - Rather than compressing hydrogen gas, the safe, and reliable HYDROSTICK binds hydrogen with a metal alloy to form a solid metal hydride



Year 2+ H2 Grand Prix PRO Advanced Package

- Developed for teams who want a greater degree of freedom to build winning car
- The RC car chassis and components have been selected to meet the quality and performance requirements of top hydrogen endurance racers
- Accessories are available to enhance the performance of the car
- All the components of the starter kit
 - RC Car Kit with fuel cell and electric motor
 - RC controller
 - Desktop electrolyzer to refill the metal hydride cartridges
 - Using distilled water and electricity
 - 14 HYDROSTICK cartridges
 - Rather than compressing hydrogen gas, the safe, and reliable HYDROSTICK binds hydrogen with a metal alloy to form a solid metal hydride



Help Us Contact Schools and Sponsors

- Identify Schools
 - Recommend teachers or principals that we can contact (provide e-mail)
 - If you have a school in mind, but don't have a PoC, let us know anyway
- Identify sponsors (tax deductible)
 - Individual and corporate sponsors
 - Sponsor a team – \$6K (1 car, 5 students)
 - Need \$11K to acquire track & carpet (one time expense)
 - Sponsors will receive promotional recognition

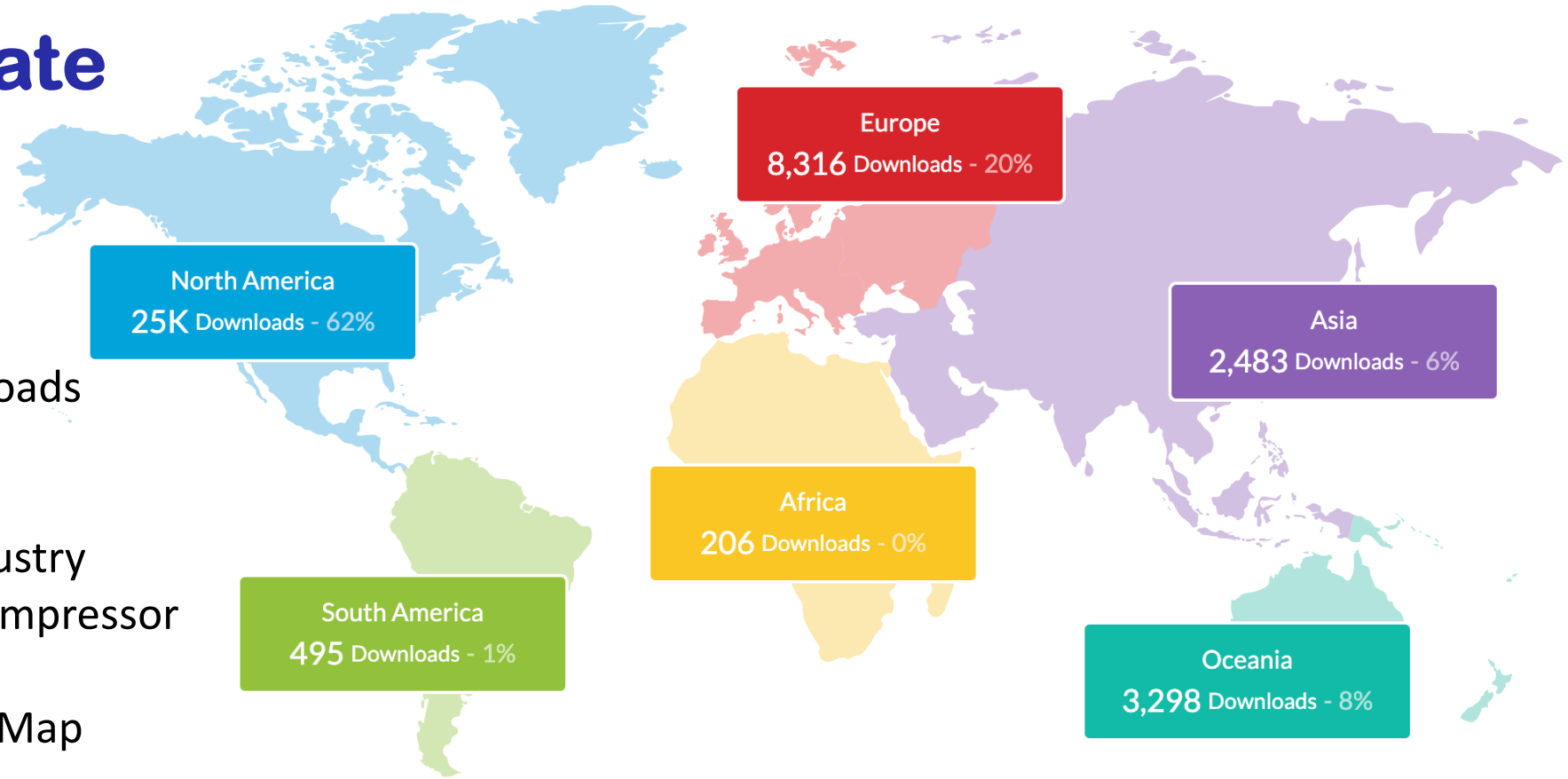
Please contact brian.debruine@gmail.com with Points of Contact



Podcast Update

The *HydrogenNowCast*

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 - Path to Zero-Carbon Industry
 - HyET electrochemical compressor
 - Geological Hydrogen
 - Saoradh Hydrogen Data Map



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