

Regular Meeting 18 February 2020

Agenda

- Business Meeting
 - Comments on nominating officers, signing up members and elections for Advisory Board members (Brian)
- Activity Report
 - DoE FOA Grant
 - CHN plan to submit (Brian)
 - Contacts
 - FCHEA posted notice of CHN formation (Brian)
 - Key California H2 & Fuel Cell group offer of support for CHN (Energy Independence Now) (Brian)
 - City of Boulder H2 fueling & FC Bus (Brian)
 - Colo Energy Office plans for H2 Roadmap (Frans)
 - New Energy Coalition (Frans)
 - Others? (Frans)
- Actions
 - Feb 6 meeting Action Items (Frans)
 - Roadmap topics, actions and dates (Frans)

Officers, Board and Membership

- Call for nomination and self-nomination for Officers is active
 - E-mail Feb 14
 - Director of Operations, Director of Strategy and Partnerships, Communications Director
 - Of special concern is Communications Director – please nominate if you know someone
- Membership sign-up page is active on the website
- Nominations and election of board members will occur once membership reaches critical mass
- Planning a letter to CCIA members offering CHN membership
 - Requesting formal response to initiate CHN membership

Activity – DoE FOA Grant (2197)

- CHN considering submitting a Concept Paper
 - For hydrogen fueling station(s) in Denver and/or Fort Collins
 - Electrolysis based, 350 Bar initially with planned growth to 700 Bar
 - Creating a non-profit (501(c)(3)) co-operative with the following possible members:
 - Users (car owners or lease-holders)
 - Truck and/or bus operators
 - Car dealers
 - Automakers
 - Oil companies
 - Electrolyzer supplier & general contractor
 - CSU
- Colo Div. of Oil & Public Safety (OPS)
 - CDOT not ready to proceed with Glenwood-DEN-Ft. Collins route
 - OPS changed approach to single fuel station for RFTA bus at Glenwood Springs
 - House hearing of HB20-1192 moved to Feb 20, Thursday morning (upon adjournment) Rm 107

Activity – Contact – FCHEA

Fuel Cell and Hydrogen Energy Association (fchea.org)

- National organization, in Wash DC, to promote hydrogen & fuel cells
- Contact with
 - Jennifer Gangi – Director Of Communication (acquaintance of Brian’s)
 - Morry Markowitz – President (thank you to Frank Novachek, Xcel)
- FCHEA posted a press release announcing CHN formation
 - Weekly member newsletter, Feb 7

“In December 2019, the Colorado Hydrogen Network (CHN) was founded as a non-profit, membership-based business league to promote the use of hydrogen across the state of Colorado. CHN, sponsored by the Colorado Cleantech Industries Association, a Colorado-based clean technology association, highlights the economic and environmental benefits of hydrogen and fuel cell technology.”

Activity – Contact – Energy Independence Now (einow.org)

EIN in California

- Dedicated to advancing fuel cell electric vehicles (FCEVs) and renewable hydrogen infrastructure for transportation
- Developed the initial framework for California’s “Hydrogen Highway.”
- Created the initial models and maps of the hydrogen fueling infrastructure
- Co-authored bill for first standard for renewable hydrogen
- Successfully promoted inclusion of renewable hydrogen mandate
- Contacted by Brian Goldstein, Executive Director (thanks to Gordon Dash)
 - Brian is CU Graduate and former Colorado resident
 - He personally wants to help Colorado deploy FCEV
 - Also sees that it helps California by deploying FCEV’s in other western states
 - Has invited CHN representatives to visit California to convey lessons-learned
 - Targeting June-July for Frans, Brian & Mahesh to visit
 - Offering the use of an FCEV to drive between Los Angeles and Sacramento

Activity – Contact – City of Boulder Fuel Cell Buses

- Contacted Alison Burchell with the City Council (thank you Ski Milburn)
- Boulder is interested in fuel cell buses
- Provided information about hydrogen fueling and buses
 - City council to review on Feb 20
- Also offered to submit a DoE grant application
 - Not enough time
- Brian will stay in contact and continue to work

Colo Energy Office plans for H2 Roadmap

- Meeting with Zach Owens on Wednesday February 19
- Input to Hydrogen Roadmap report to be outsourced by the Colorado Energy Office.
- Assume similarity to the Renewable Natural Gas Market Study (June 2019)
 - GHG goals Colorado
 - GHG emissions in Colorado all segments
 - Value proposition hydrogen in all segments
 - Technology status of hydrogen supply and consumption equipment
 - Capital and operational cost today and projected
 - Incentives (Federal and State) assessment and recommendations
 - Timing of hydrogen implementation per segment
 - Capital requirements for next 10 years

Colorado Energy and GHG emissions 2016

Figure 2. Colorado Energy Consumption by Sector, MMBTU's and percent total, 2016¹³

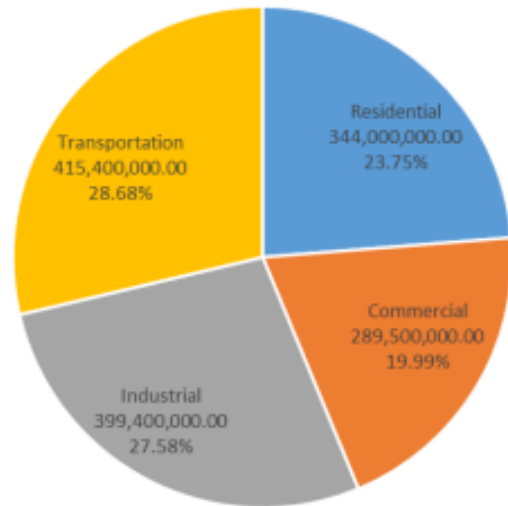
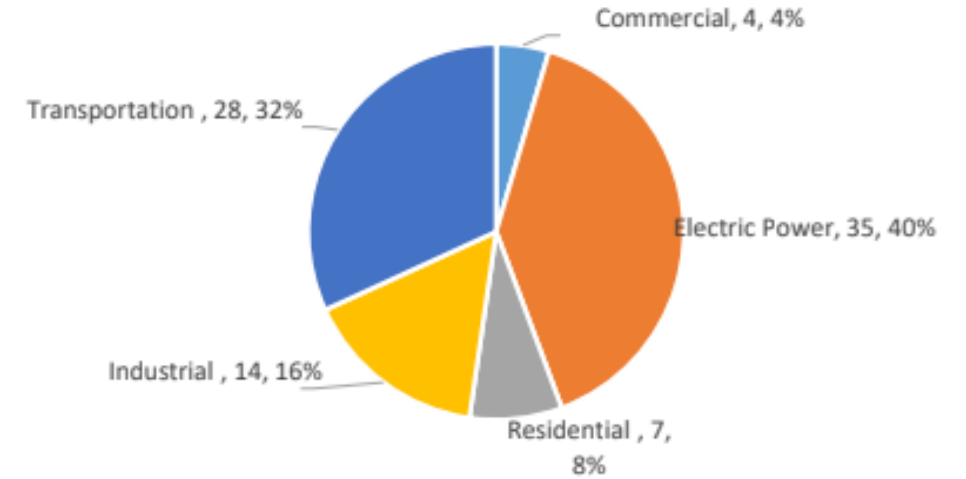


Figure 3. Colorado Emissions by Sector, MMT CO₂e and percent total, 2016¹⁵



Colorado Transportation annual fuel use

- \$6 Billion Fuel spend
- 2.5 Billion DGE's
 - 76% Gasoline
 - 23% Diesel
 - <1% other

TABLE 5. ESTIMATED TRANSPORTATION FUEL CONSUMPTION, 2016¹⁷

(Based on US EIA)

| Fuel | 2016 MMTBUs | Diesel Gallon Equivalents (DGEs) ¹⁸ | Percent consumption |
|--|--------------------|--|---------------------|
| Distillate fuel oil (diesel) | 81,000,000 | 589,601,182.11 | 22.96% |
| Electricity ¹⁹ | 249,625 | 1,817,028.63 | 0.07% |
| Motor gasoline | 270,600,000 | 1,969,704,689.88 | 76.72% |
| Conventional natural gas ²⁰ | 470,798 | 3,426,951.33 | 0.13% |
| Propane | 400,000 | 2,911,610.78 | 0.11% |
| TOTALS | 352,720,423 | 2,567,461,462.72 | 100.00% |

Diesel fuel and motor gasoline clearly dominate highway fuel consumption in Colorado, accounting for over 99% of on-road fuels consumed.

COLORADO ENERGY CONSUMPTION COSTS

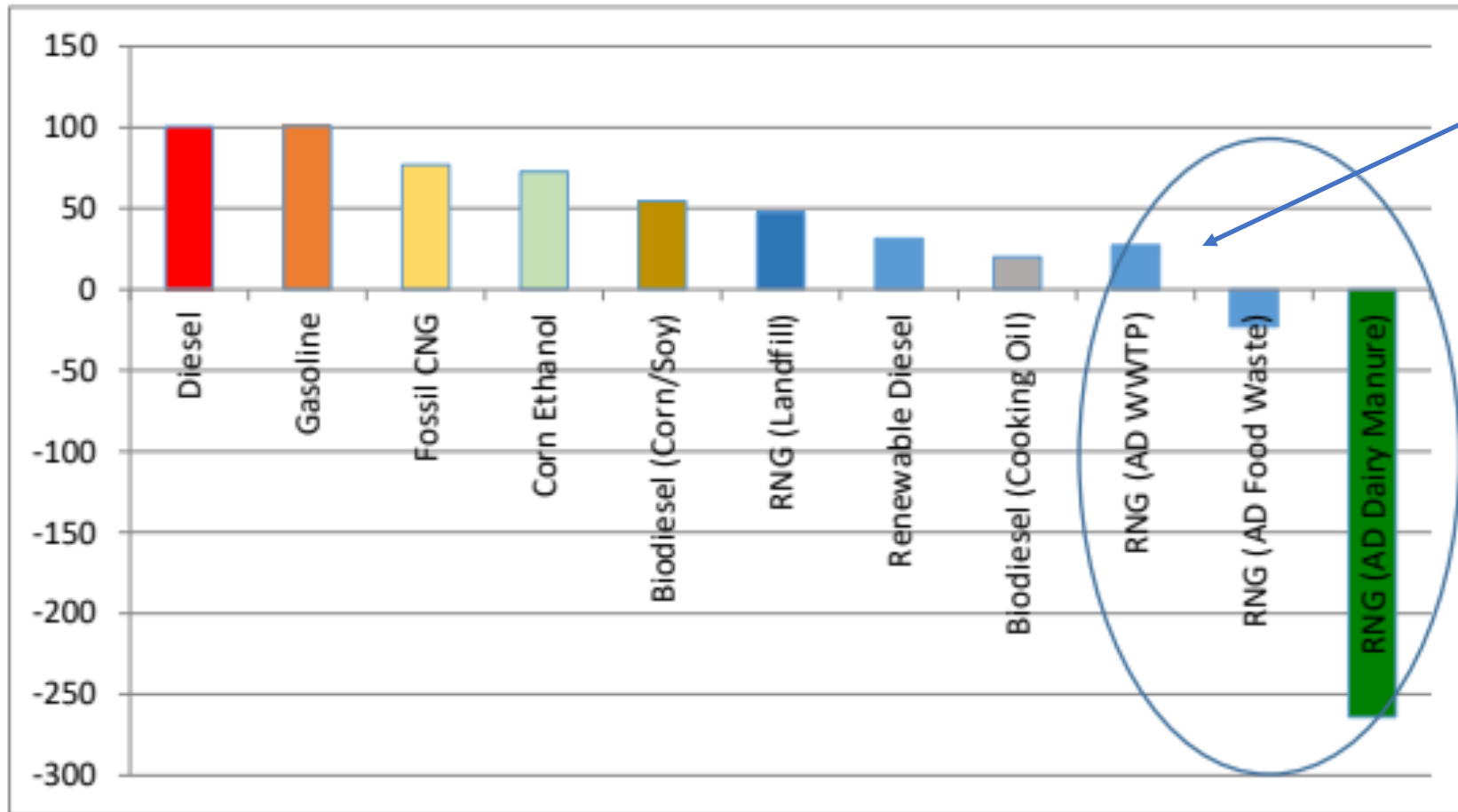
In 2016, highway fuel consumers in Colorado spent over \$6 billion dollars.

TABLE 6. ESTIMATED TRANSPORTATION FUEL COSTS (RETAIL), 2016²¹

| Fuel | 2016 Average \$/MMBTU | 2016 MMTBUs | Total |
|--|-----------------------|-----------------------|------------------------|
| Distillate fuel oil (diesel) | \$16.12 | 81,000,000.00 | \$1,305,720,000 |
| Electricity ²² | \$28.63 | 249,625.21 | \$7,174,228 |
| Motor gasoline | \$17.37 | 270,600,000.00 | \$4,701,800,000 |
| Conventional natural gas ²³ | \$9.21 | 470,798.00 | \$4,336,049 |
| Propane | \$12.40 | 400,000.00 | \$4,960,000 |
| TOTALS | N/A | 352,720,423.21 | \$6,023,990,278 |

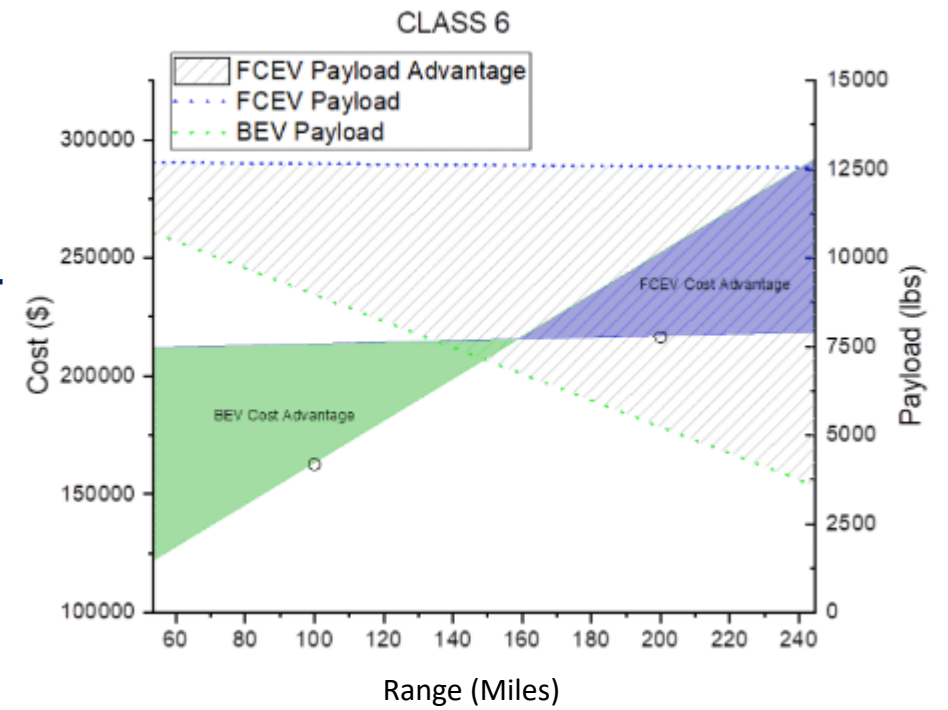
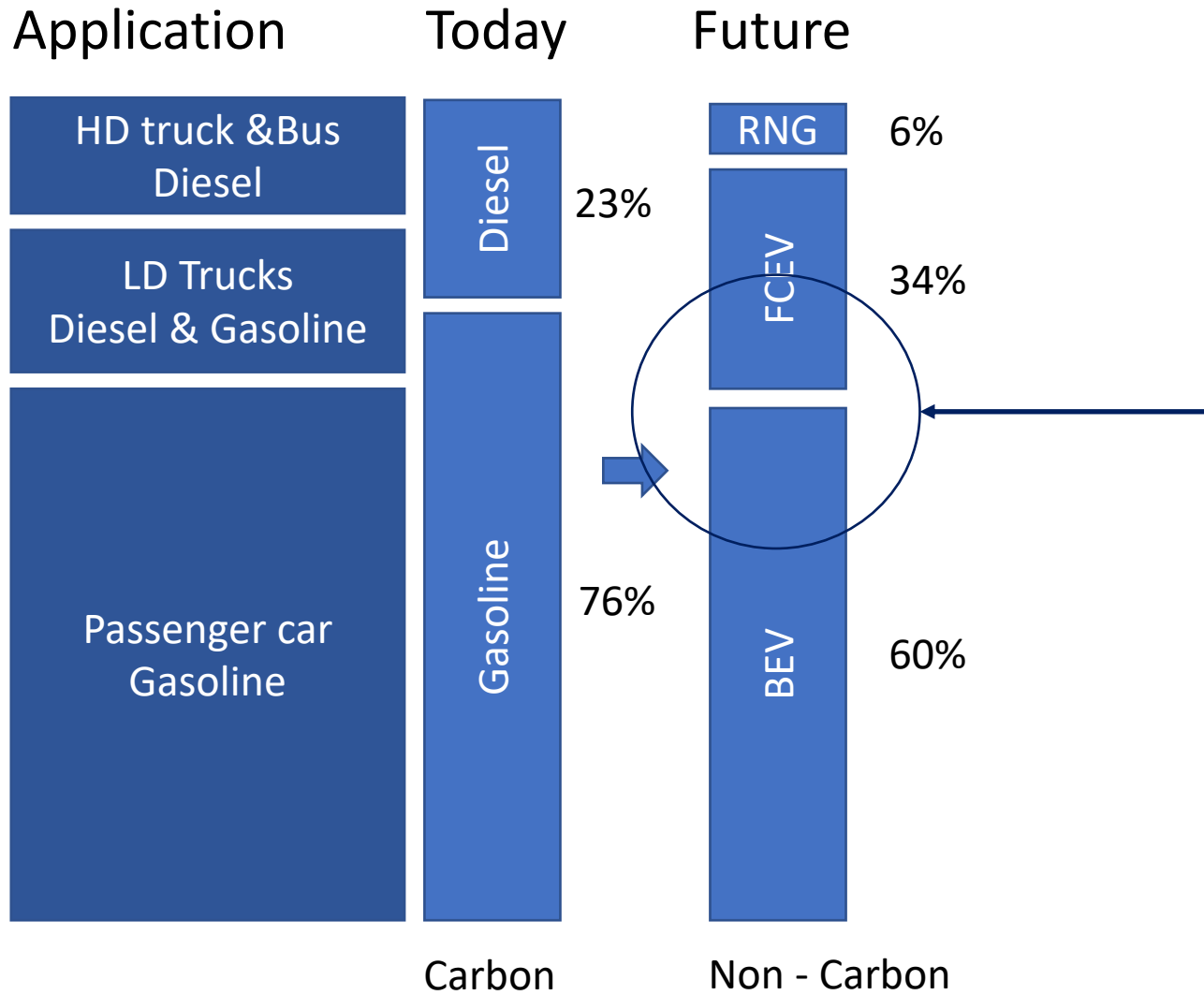
Transportation fuels GHG impact (28%)

FIGURE 1: Lifecycle Carbon Intensity (g CO₂e/MJ); Petroleum & Alternative Fuels



(Source: CARB 2017, 2019²)

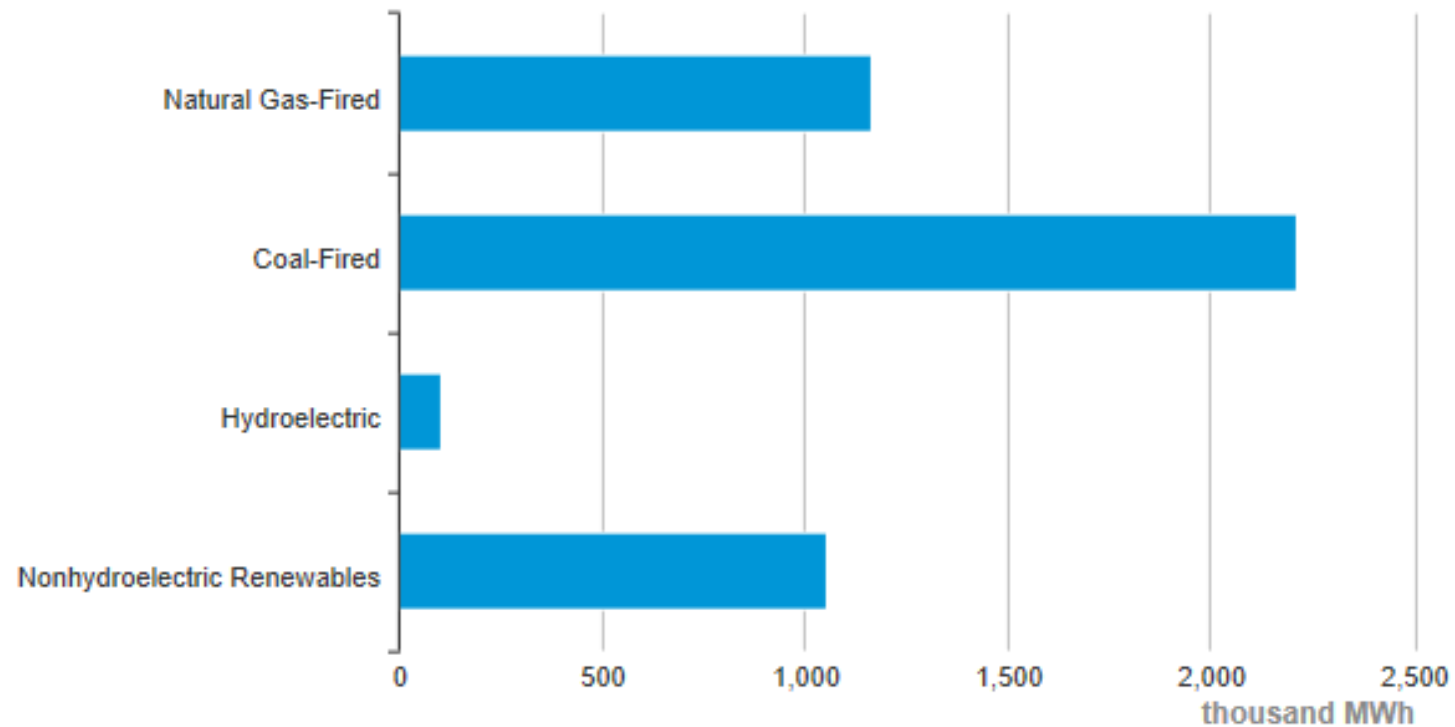
Colorado Transportation fuel transformation



Hydrogen > \$2 Billion potential

Colorado Electric Power GHG impact (36%)

Colorado Net Electricity Generation by Source, Oct. 2019 [↓ DOWNLOAD](#)



Source: Energy Information Administration, Electric Power Monthly

New Energy Coalition

- Interview conducted with Jan Jaap Aue, Professor at The University of Groningen, Netherlands and CEO of Etrance
- Jan Jaap has been a key initiator in the past 10 years of driving hydrogen initiatives in the North of the Netherlands.
 - 8 years ago he started a 'volunteer organization' to promote hydrogen
 - New Energy Coalition - Today 40 FTE payroll organization, \$35M project budget
 - Interview topics:
 - Asked to tell their story
 - Lessons learned
 - What worked/didn't work
 - Potential collaboration with CHN
 - Follow on interview to be scheduled.
- Formalize question list and conduct similar interviews with other consortia
 - Had an informal discussion with Ken Dragoon from HEA (North West states)

Feb 6 meeting Action Items

- Review action tracker spreadsheet.

Proposed topics

- Hydrogen distribution (start)
 - 350 versus 700 bar
 - SMR versus hydrolysis
 - Cost of transportation
 - Well to wheel cost and carbon
 - Where are the first strategic locations
 - Business model including incentives
 - How do we fund this
- Hydrogen users
 - State government
 - City government
 - Major progressive distribution chains (Amazon, Brewers, UPS etc).
 - Vehicle availability
 - Business model including Incentives or lack there-of
 - Outreach

Proposed topics

- Supply chain
 - Most promising future technologies
 - State of the art technology and pricing
 - Capital and operational cost expectations/projections
 - Centralized versus decentralized
 - Lessons learned from other regions
 - How to start with hydrogen supply in Colorado
- Industrial and Utility Use
 - Who are heavy users of NG that are early adapters of non carbon energy
 - Outreach to key players
 - Hydrogen as long-term energy storage
 - How much curtailed wind are we expecting
 - Lessons learned from other regions – applicability in Colorado

Roadmap topics, actions and dates

- Amazon warehouse hydrogen extension to delivery vans
- Small to mid size hydrolysis plant
- Truck size extender fuel cell demonstrator (University)
- Small scale demonstrator H₂/Ammonia/H₂ (NREL, CSM, HyET, Starfire) 10kg hydrogen
- Next scale system 100kg compressor HyET with ?
- Ammonia combustion demonstrator
- Other