Midwestern Hydrogen Partnership Request for Input

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1 What is needed to move the hydrogen economy forward?

1. Production using carbon-free sources
2. Storage and transport of hydrogen at scale
3. Safety in use technologies
4. Monopoly regulation versus deregulation

1.1 Production using carbon-free sources

Presumably a hydrogen economy is being considered as a way to eliminate carbon-based energy at least in the US. A realistic estimate of how a hydrogen economy can be effected given current energy needs would be helpful. US energy use in 2019 was approximately 100 quadrillion BTUs (about 3.4E06 MWe continuous.)[1] All electrical production by nuclear power in the US was about 809,000 MWe-hr (about 92.3 MWe continuous) in 2019.[2] The total energy production from wind in the US in 2019 was approximately 300,000,000,000 kWh (about 34 MWe continuous.)[3] Consider Table 1 that

Table 1: Increases in production units needed to meet US energy needs assuming production per unit numbers remain as in 2019.

Type	Existing (number of units)	Required
Nuclear	96	3,483
Wind	58,000	5,666,027

summarizes the scale required by two examples of carbon-free energy sources that could be used

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[1]From https://www.eia.gov/energyexplained/us-energy-facts/. Accessed 28 January, 2021.

[2]From https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx. Accessed 28 January, 2021.

[3]From https://www.eia.gov/energyexplained/wind/electricity-generation-from-wind.php. Accessed 28 January, 2021.

to produce hydrogen to replace US energy use ignoring hydrogen production energy inefficiencies for production and pressurized storage. It appears a big challenge will be the ability to supply the energy we need to produce hydrogen using carbon-free methods. An advantage of producing hydrogen is that it is a carbon-free energy storage technology that has substantial environmental benefits compared to battery and pumped hydro.

1.2 Storage and transport of hydrogen at scale

Storage infrastructure for scale use of hydrogen has not been widely implemented and details of the technologies for use storage, distributed storage, and bulk storage has not been worked out. Think of vehicle "gas tanks," retail "gas stations," and "oil tank farms" as examples of these technologies.

Transport and distribution technologies of produced hydrogen at scale needs to be worked out. If "everything" runs on hydrogen, there will need to be a transportation and distribution network developed for hydrogen similar to the way the electrical grid works now. It is not clear that, for example, natural gas lines, oil pipelines, and their concomitant metering, instrumentation, piping, pump stations, and maintenance such as corrosion control and inspection methods will be adequate for hydrogen.

1.3 Safety in use technologies

Hydrogen is explosive at the LEL and fire control is difficult in enclosed spaces.[4] Storage in automobiles in garages is safe as long as no leaks are in the "gas tank." However, leakage from an automobile into a house or house garage may result in an explosion capable of destroying the structure. Similar circumstances could be imagined in several settings. However volatile fuel such as gasoline and natural gas have been successfully managed in the same settings so it seems the challenge will be to develop standards that would produce similar levels of safety for hydrogen.

1.4 Monopoly regulation versus deregulation

It seems transition to hydrogen would not necessarily take place in the absence of a pressing need which is not currently present. Investors would need to reassured of return on investment which can be easily realized in monopoly markets. Therefore, it would seem that a monopoly market would need to be advanced, similar to the way wind and solar are being promoted in monopoly markets currently. Clearly such monopolies require government intervention because citizens are paying for the technology development and lose access to alternate sources that would compete at lower cost points. Therefore the correct political environment must be in place to create the necessary market conditions. Such monopolistic settings are being used to advance solar and wind energy sources. It seems reasonable that similar markets could be developed for hydrogen. Because pipelines and other transportation methods would generally cross state lines, the Interstate Commerce Commission would be involved with regulating the commerce.[5]

[4] See for example, `https://www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2014/May-June-2014/Features/All-Things-Hydrogen` Accessed 228 January, 2021.

[5] See for example, `https://www.icc.illinois.gov/home/illinois-gas-pipeline-safety-program`, `https://www.icc.illinois.gov/home/illinois-gas-pipeline-safety-program`, , and `https://www.ferc.gov/sites/default/files/2020-06/ica.pdf`. Websites accessed 28 January, 2021.

2 What should be the main focus and priorities for the Partnership?

1. Scaling
2. Political influence
3. Technology development
   (a) Hydrogen storage
   (b) Hydrogen separation (electrolysis)
   (c) Energy for production

2.1 Scaling

How will the technology be scaled up? Because the amount of hydrogen production, transport, and distribution is so large, the technology will be difficult to scale up in one step. The progress for scale up should be developed in a measured way so that at each stage, the feasibility of the approach can be evaluated and risks (investment and technology) going forward can be more easily understood.

2.2 Political influence

Political influence will be required to be able to move forward with technology development and deployment. Influence is required on regulations, grants and other seed money, site permits, emergency plans, and so forth will be needed at local and state levels, and ultimately at the federal level. An effective lobbying team will be required for this. Strategy development, communication plans, and return on influence (where to best exert influence) to realize results will be required.

2.3 Technology development

As described above, much of the technology needed to move to a full hydrogen economy needs to be developed. Hydrogen is commonly used in industrial applications which gives a "head start" but the diversity of applications especially non-commercial use in automobile and truck transportation needs to be considered. Technology development will be required. The level of confidence in the technology will translate to risk perception by the public and the regulators who serve the public. The risk understanding and the technology engineering go hand-in-hand. Proper risk communication to the public and regulators will be essential.

3 What groups and/or individuals need to be involved in this partnership?

1. Lobbyists
2. Regulators
3. Engineers

4. Academia
5. Risk analysts

4 Based on your experience with the November 12th workshop, what did you like/dislike and what would you like to see more of in future meetings?

We believe the workshop was a good start. There might need to be a series of workshops that are developed to solve problems individually followed by workshops at intervals that maintain the communication and coordination among the individual problem-solving efforts.