Value of Transitioning to Renewable Hydrogen (H2) Now

Climate Emergency

Safe, fully contained Green Hydrogen Electric Storage (H2 production, storage and electric output) is available now as a turnkey single point solution.

No pipelines, no natural gas, no emissions other than water.

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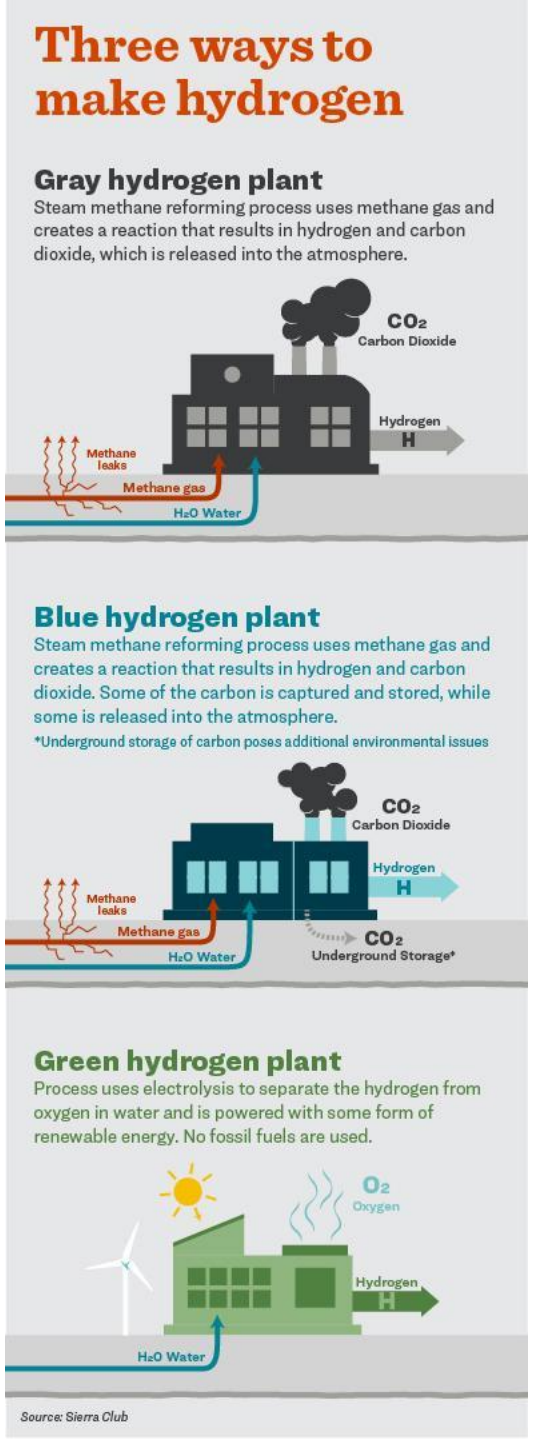
Hydrogen – Is there a Clean Hydrogen Available?

- **Yes.** Green hydrogen is available as a single point solution where the hydrogen is produced using water as the feed stock and the energy to enable the electrolysis is provided from renewable sources such as solar, wind or geothermal. There are other approaches than electrolysis such as **P**hoto**E**lectro**C**hemical, but these approaches are in their early stages of development purporting to be available in the next several years.

- All hydrogen made using natural gas as the feed stock is inherently dirty (this includes grey, blue or even some other new variants defined using natural gas as the feedstock).

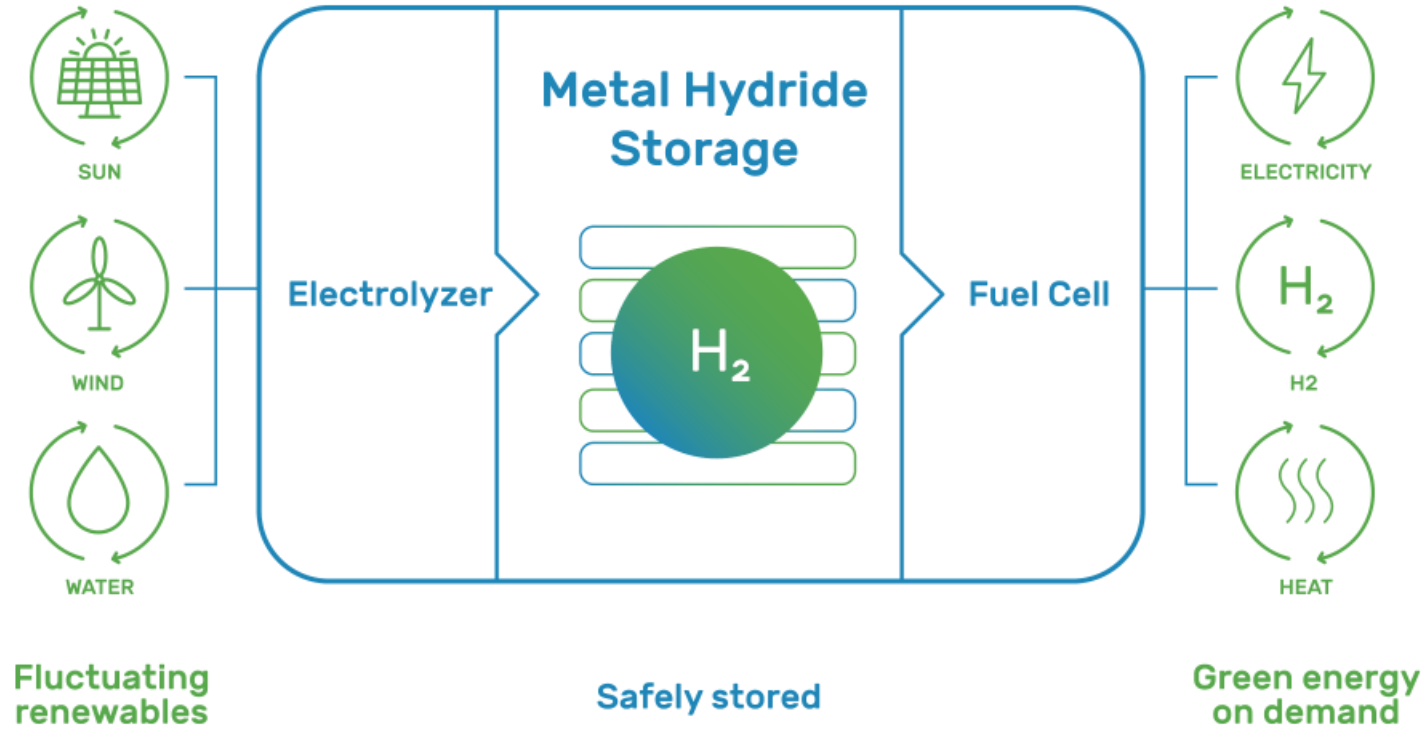
- Hydrogen produced using other fossil fuels are also considered ‘dirty’.

- There are many people touting micro nuclear hydrogen generation, but considering there is already an issue with disposing the spent nuclear fuel rods other than burying the rods encased in cement within water pools at the facility. It isn’t a mater of if, but when spent nuclear fuel rods contaminate the nearby environment.



What is a Green Hydrogen Single Point Storage Solution?

- It is where the hydrogen is produced and stored and converted to electricity at a **single location** with minimum special pipe interconnections between the three phases. A fully contained single system.
- Where **water and renewable electricity are the only inputs** and **water and electricity are the only outputs**.
- Where the resource water is available throughout the US and New Jersey.
- Where hydrogen is an abundantly available resource stored in a tank either using low pressure hydrogen or metal hydrides that are recyclable.
- **Where there are no other input or output emissions.**



Types of Hydrogen Storage Used in Single Point Solution

- Low pressure Hydrogen storage (less than 100 psi), which can store up to 72 kilowatt hours of electricity.
- Metal hydride hydrogen storage requires no pressure has storage options from 165 to 8,600 kilowatt hours.

Low Pressure Hydrogen Storage – Elektrik Green Hydrogen

Hydrogen: A Cleaner Option for Residential & Commercial Energy Storage

1. **Solar panels** – capture sunlight and output DC
2. **Inverter** – converts DC to AC and provides disconnect
3. **H2 energy storage system** – uses electrolysis to convert solar energy to green hydrogen
4. **Meter** – measures solar generation and energy consumption
5. **Electric panel** – input and output 240V AC
6. **Hydrogen storage tank** – stores solar energy to provide power for days to weeks
7. **Energy management** – mobile app to monitor usage and identify maintenance needs
8. **Fuel/recharging station** – option to power up hydrogen or electric vehicles

Hydrogen Energy Storage System

Fuel cell – converts energy stored in hydrogen back into electricity

Dryer – ensures fuel cell operates at maximum efficiently

Electrolyzer – uses solar energy to split water into hydrogen and oxygen

Water purifier – treats tap water to be used in H2O extraction process

www.elektrikgreen.com

Metal Hydride Storage - GKN Hydrogen

165 to 480 kilowatt hours

1,000 to 2,000 kilowatt hours

8,600 kilowatt hours

Why is Green Hydrogen Single Point Storage Solution Critical to New Jersey Grid?

- Fossil fuel energy power plant sources can be replaced with renewables ***only if*** it is directly coupled with utility controlled distributed renewable electric storage.
- The difference between fossil fuel generation versus renewables is that fossil fuel electric generation is ‘always on’, constant combustion that creates the ‘constant’ energy supply.
- Green Hydrogen Electric Storage (GHES) provides a fast tracked solution that directly reduces greenhouse gas emissions **and also** creating a viable business growth for NJ Public Utilities to expand their services into Grid-Edge Services controlling the Clean Hydrogen Electric Storage.
- GHES enables NJ Public Utilities to directly offset peak demand and reduce grid load and reduces the costs of transmission supplier electricity during peak times.
- GHES increases grid power resilience and can mitigate power outages at the transformer level.
- GHES provides immediate value stated above, but more critically, enables NJ Public Utilities to strategically deploy grid upgrades including Smart Load Transformers (DOE refers to these as Solid State Transformers) as the distributed GHES is built out.
- GHES is renewable with recyclable components.

What are the costs for a Green Hydrogen Single Point Solution?

- $70,000 to $150,000 depending on size, type and installation method
- Very similar to cost of solar back in 2010 (15 kilowatt solar array was approximately $90,000, which now can be purchased for less than $32,000). Each panel has tripled in power while half the price.
- By enabling early adopters now through subsidies and Public Utility investment into distributed public electric storage at the residential and business endpoints, this will drive the costs of these solutions down by at least 50% in ten years.
- In DOE Solid State Roadmap, it calls for distributed electric storage in each Public Utility's distribution grid as we shift away from fossil fuels, but that requires the utility owning substantial space to deploy the massive amounts of distributed electric storage necessary. This proposal addresses that issue.

Why not consider Lithium Batteries for distributed storage?

- Not considered a clean renewable method of electric storage.
- Requires aggressive mining expansion for rare earth around the world.
- Not abundant source, difficult recyclability and spent lithium batteries are considered hazardous to the environment and humans.
  https://pubs.rsc.org/en/content/articlehtml/2021/ee/d1ee00691f
- Toxic fluoride gas emissions from lithium-ion battery fires
  https://www.nature.com/articles/s41598-017-09784-z/
- Charge integrity is subject to weather fluctuations and deteriorates quickly over time (loses its charge and ability to be recharged).
- Lithium has its role in the electric infrastructure, but it can't be the main method of distributed electric storage due to its limitations and inability to hold a sustain constant charge over time.

What are the Policy Proposals for NJBPU?

- Enable / authorize NJ Public Utilities to extend services to Grid-Edge components at homes and business that are willing to allow the installation. Policies to consider
  - State Subsidy and Public Utility investment to cover the costs of installation and ongoing maintenance of system in exchange for rent free public utility electric storage for all locations where income is less than $200,000.
  - Require early adopters to agree to higher storage amounts (higher is better for NJ Public Utilities) such as the 2 megawatt hour Hydrogen Electric Storage solutions. With just five 2 Megawatt hour installations for one residential section off of one transformer will enable that entire neighborhood to be resilient even when the power goes out.
  - Attempt to pair as many as possible hydrogen electric storage installations with solar tracking dual axis solar arrays that have least impact on environment and 1.8 times the solar generation of fixed solar arrays.
  - Target low income residents with smaller hydrogen electric storage options.
  - Explicit NJ policy that bans natural gas hydrogen generation in New Jersey.
- By enabling early adopters now through subsidies and Public Utility investment will drive the costs of these solutions down by at least 50% in ten years, directly decrease methane and VOC emissions and substantially improves resilience and load management of NJ Utility grids.

Why do Environmental Organizations Label All Hydrogen as Dirty?

- Environmental Organizations **focus only on hydrogen produced using natural gas as the feed stock**.
- Use the Reference that 95% of all hydrogen produced today in the US is from fossil fuels. This is true **since fossil fuel powered hydrogen production has been in place within the industry infrastructure for many decades**. Only recently has green hydrogen production started to be built around the world.
- Environmental organizations are very much against the development of hydrogen hubs and transmission pipelines and the proposals of mixing hydrogen into natural gas pipelines or reusing natural gas pipelines for dedicated hydrogen transmission. These are valid points.
  - Hydrogen hubs are needed, but need to be built for local city (densely populated) areas using renewable electric generation and Green Hydrogen Electric Storage; and
  - Current pipelines are not suited for Hydrogen transmission and hydrogen transmission through pipelines over long distances requires more energy than to just produce hydrogen locally. Until utilizes a method similar to what https://plasmakinetics.com/ has targeted to be available in 2024.
- I have spoken with environmental groups (Empower, Sierra Club, Food and Water Watch and others) and none of them believe that a green hydrogen single point solution is even possible. One person admitted that they just want to have a clear consistent message against hydrogen so that natural gas fed hydrogen is not further developed.

Recent Environmental Publications Defining Hydrogen as Dirty

https://www.sierraclub.org/sierra/2023-3-fall/feature/how-clean-is-green-hydrogen

Green Hydrogen is a Pipe Dream

Green hydrogen is another technology being pitched by GDCs as an excuse to continue to build new infrastructure. It is (excuse the pun) a pipe dream.

The November 15, 2021 report of London Economics International, commissioned and accepted by the BPU, said this: "Green hydrogen is also at a much earlier stage of development than RNG. It still faces several obstacles to deployment, most notably, cost. Per unit of energy, hydrogen supply costs are 1.5 to 5 times those of natural gas. Moreover, the economics of electrolysis – the method of producing hydrogen that can be powered by renewable resources – has yet to be tested at a large scale." [17]

There are multiple reasons for these increased costs. Transporting hydrogen is expensive due to its low energy density, which means that large amounts of space are required to hold a relatively modest amount of hydrogen energy. To have hydrogen replace the energy supply of fossil gas in the global economy would require building 3 to 4 times more storage and pipeline infrastructure. Hydrogen also causes metal embrittlement, increasing prevention and replacement costs.[18] Safely transporting, storing, and handling hydrogen can add significant costs. It only costs a few dollars per kilogram to produce hydrogen from fossil gas. Yet the average retail price of hydrogen at fueling stations in California is about $16.50 per kilogram—the equivalent of about $6.40 per gallon of gasoline. Precautions against leaks are also necessary at each stage of handling hydrogen. Containing hydrogen is more challenging than containing other gasses because hydrogen is the smallest and lightest molecule in the universe.[19]

Hydrogen, green or otherwise, cannot totally replace methane for running gas appliances. Burning hydrogen, which also produces high levels of NOx, would require total replacement of the appliances and the supporting gas network. At best green hydrogen could "decarbonize" a small percent of the methane in today's gas network. But this would quickly become a dead end and is not a path to any future decarbonization or transition to true renewable energy.

How Clean Is "Clean Hydrogen"?

Black and brown communities are asked to bear the risks of the new energy economy. As usual.

Submitted to NJBPU by Empower which is a coalition of 35 organizations within NJ.
https://publicaccess.bpu.state.nj.us/DocumentHandler.ashx?document_id=1313327

Why is Hydrogen using Natural Gas as the feed stock so dirty?

- **All hydrogen made using natural gas as the feed stock is inherently dirty** (this includes grey, blue or even some other new variants defined using natural gas as the feedstock).
    - The natural gas supply chain emits hundreds of tons of methane and tens of tons of VOCs at every facility from Well Heads to Processing Plants (that separate the natural gas from the shale slurry), to transmission pipelines (with facilities approximately every 50 miles to move the natural gas along the transmission pipeline), to the end point hydrogen production facility (Steam Methane Reforming Process).
    - The End Point Hydrogen Production (Steam Methane Reforming) Facility using natural gas as the feedstock emits tons of VOC and methane that is not depicted in the diagrams for several reasons:
        - **Natural Gas valves leak** (fugitive emission) since it is under extreme pressure (includes both VOC & Methane emissions);
        - **Natural gas facilities venting** (fugitive emission) natural gas when natural gas flow is obstructed in the pipes and valves (which is very common and why all facilities report to FERC that they will emit at least 100 tons of methane and 400 pounds of VOCs every year from venting alone); and
        - The **natural gas burners** (combustion) used for heating the steam in the Steam Methane Reforming process. The Steam Methane Reforming production facility may also use **natural gas-fired turbines** (another form of combustion) for moving the natural gas and also for compressing and pumping the carbon dioxide into the ground which also emits methane and VOCs in the tons per year.
    - The notion of different colors as to whether or not the carbon dioxide is pumped into the ground to supposedly recapture the carbon emissions is another aspect where we have no idea of the environmental impact of that carbon dioxide in the ground, nor the risks when a carbon dioxide pipe bursts and causes a substantial kill zone radius.

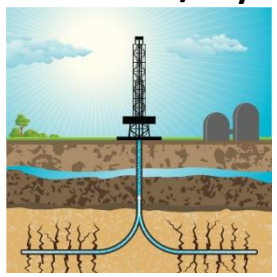
Natural Gas Supply Chain

Natural Gas is Not Clean

High Pressure Fracturing Injection

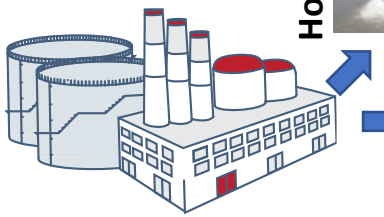
MM Gals/day

Shale Carbon Sink regions



Wellheads

Pulverizing & chemically altering naturally occurring shale **carbon sink, extracting shale slurry.**



PROCESSING PLANT

Separating natural gas from sludge & pumping sludge into holding pools or sprayed on dirt roads in PA.

Holding Pools

Constant expansion of transmission pipelines under FERC from competing companies, increasing pipelines, capacity & impact.

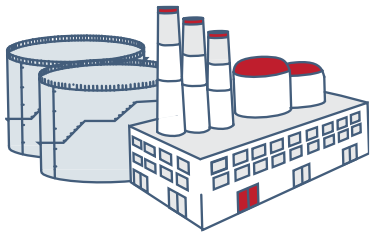
Transmission Pipelines

Transmission of natural gas through **thousands of miles of pipeline with compressor stations approx. every 50 miles** to move gas along pipeline. Across all the competing companies, there are more than 1.5 million miles of natural gas transmission pipelines in the United States.

Every compressor station is a major source of methane & air pollutant emissions.

Distribution

To homes & businesses



Power Plants

Industrial

Export

LIQUEFIED NATURAL GAS SHIPPING

'Blue' H2

Blue Hydrogen - Steam Methane Reforming

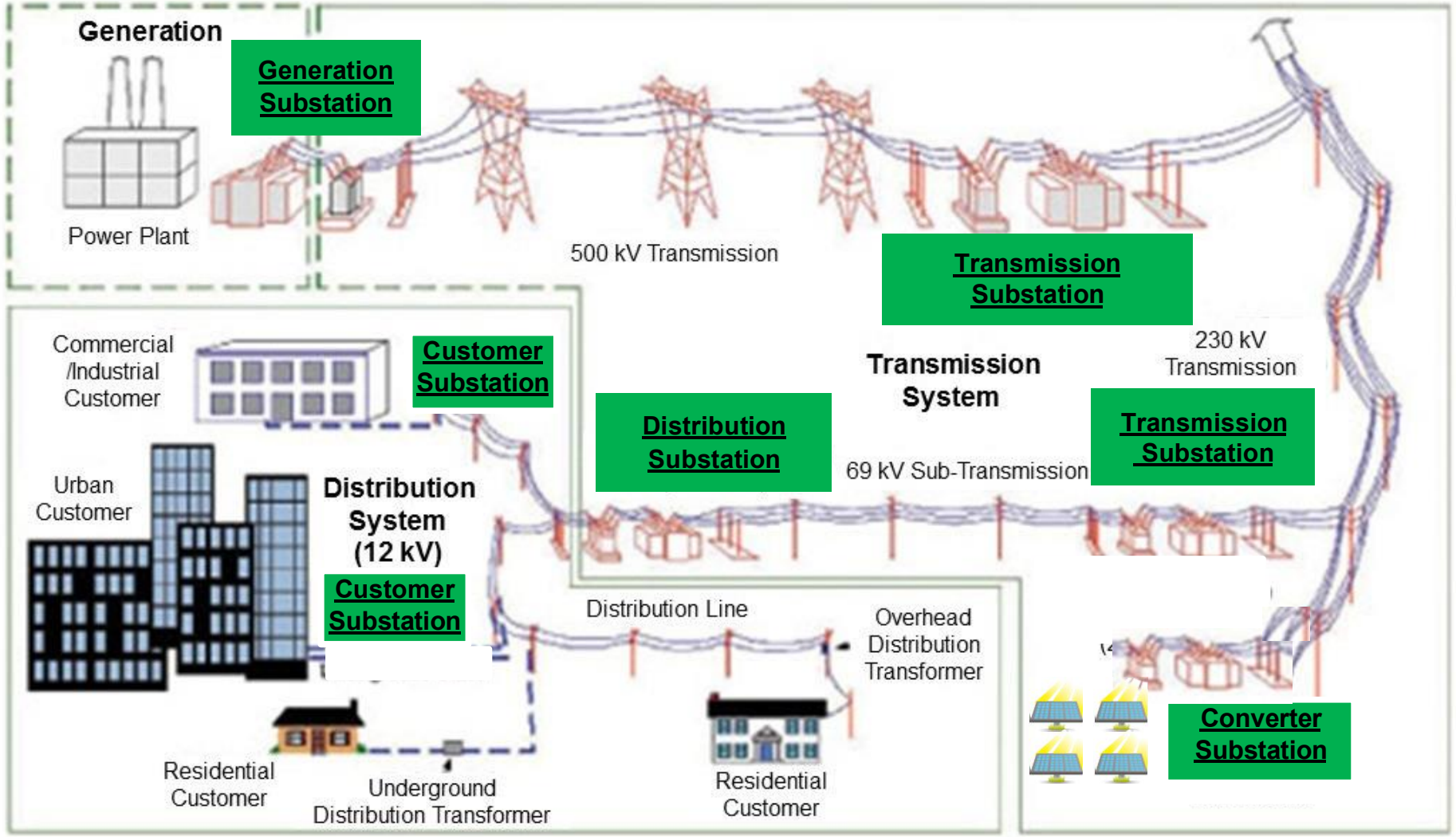
Inputs	Outputs
• 2.2 tons Methane From Natural gas • 4.9 tons of water • 5.7 MWh heat	• 1.1 ton Hydrogen • 6 tons Carbon Dioxide (CO_2)

In 2018 alone, the Marcellus shale region contaminated & injected 10 billion gallons of water, produced 20 trillion cubic feet natural gas - *that is 270,270 empire state buildings worth of shale removed in 1 year.*

The Natural gas companies in the Supply Chain have many loopholes that enable them to conceal methane and toxic emissions

- The EPA and NJDEP currently only require estimate emissions updates once a year.
- **The greater than 2,000 pound VOCs blowdown Loophole** where the VOC emissions don't have to be included in the annual estimate emissions and all other emissions including methane are not recorded at all. For all blowdowns and venting below 2,000 pounds of VOCs, no recording of the emission is required by NJDEP nor the EPA.
- All facilities that are electric do not have to provide annual estimate emissions updates to NJDEP or EPA despite all facilities emit at least 100 tons of methane each and every year.

Typical Grid Structure Connecting Power to Customers



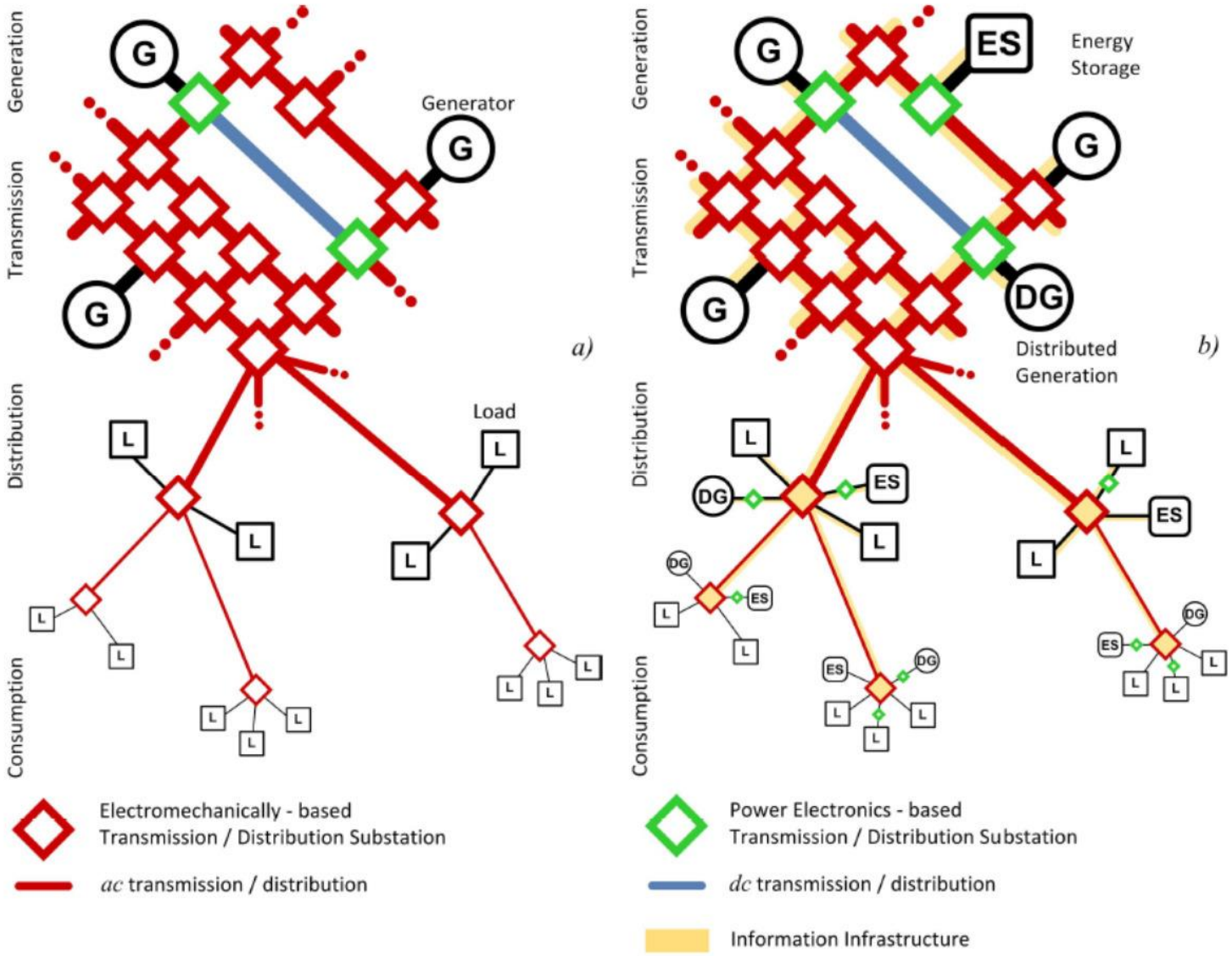
Traditional Fossil Fuel Grid Structure of massive generator plants pushing power across interstate transmission lines to Utility Substations where the power is distributed out to customer and business electric sectors.

No transmission company wants to encourage renewable supply at the local transformer section, but that's what occurred at the dawn of home solar installations.

We need to take this to the next level where homes and businesses can be power suppliers, power storage and power consumption (load).

DOE Solid State Power View – Add more Energy Storage

https://www.energy.gov/oe/articles/solid-state-power-substation-technology-roadmap



DOE is adding middle tier prior to distribution out to homes and businesses.

Where

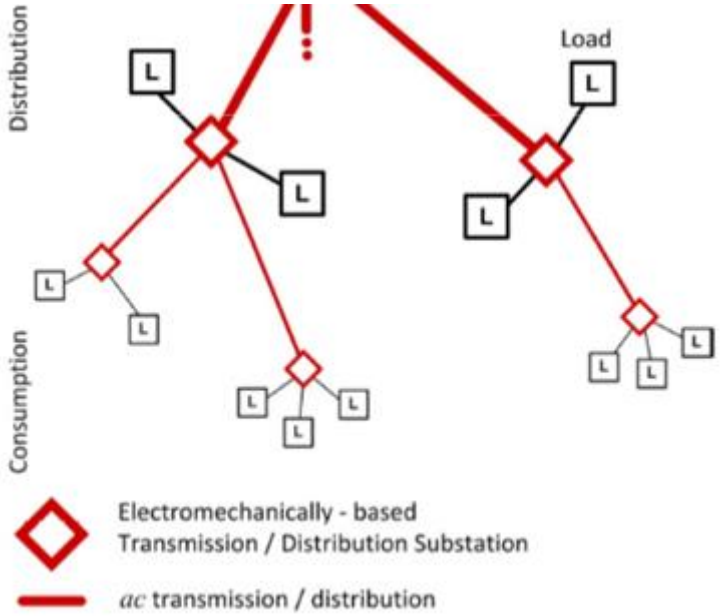
- G = Generation
- DG = Distributed Generation
- L = Load from customer home or business.
- ES = Energy Storage

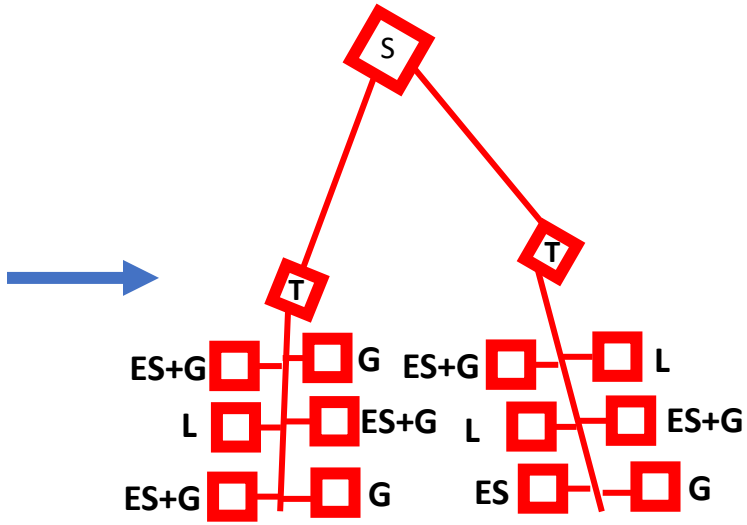
My proposal for NJBPU is to enable NJ Public Utilities to be able to control Energy Storage at the home and or business depicted as L in this diagram.

Proposed Electric Grid with Grid-Edge storage

- The tendency is to start from the large renewable installations such as windpower, but without the storage deployed within the grid, that energy is neither controlled or stored to provide a consistent constant energy within the grid.
- This proposal is to build out the storage at the homes where it the H2 electric storage is controlled by the Public Utility so that it can be utilized to take in extra capacity during times of high generation and distribute power during times of peak load. Effectively reducing the overall load demand from the Substations to Transformers.
- Since it is managed and controlled from the Public Utility the energy supplied from storage is the public utility selling the electricity back to the residents.

Target 30% homes and businesses conversion by 2030.





Where:

S = Substation

T = Transformer

ES = H2 Energy Storage

L = Load

G = Renewable Generation Supplier

Structure of the Traditional Utility

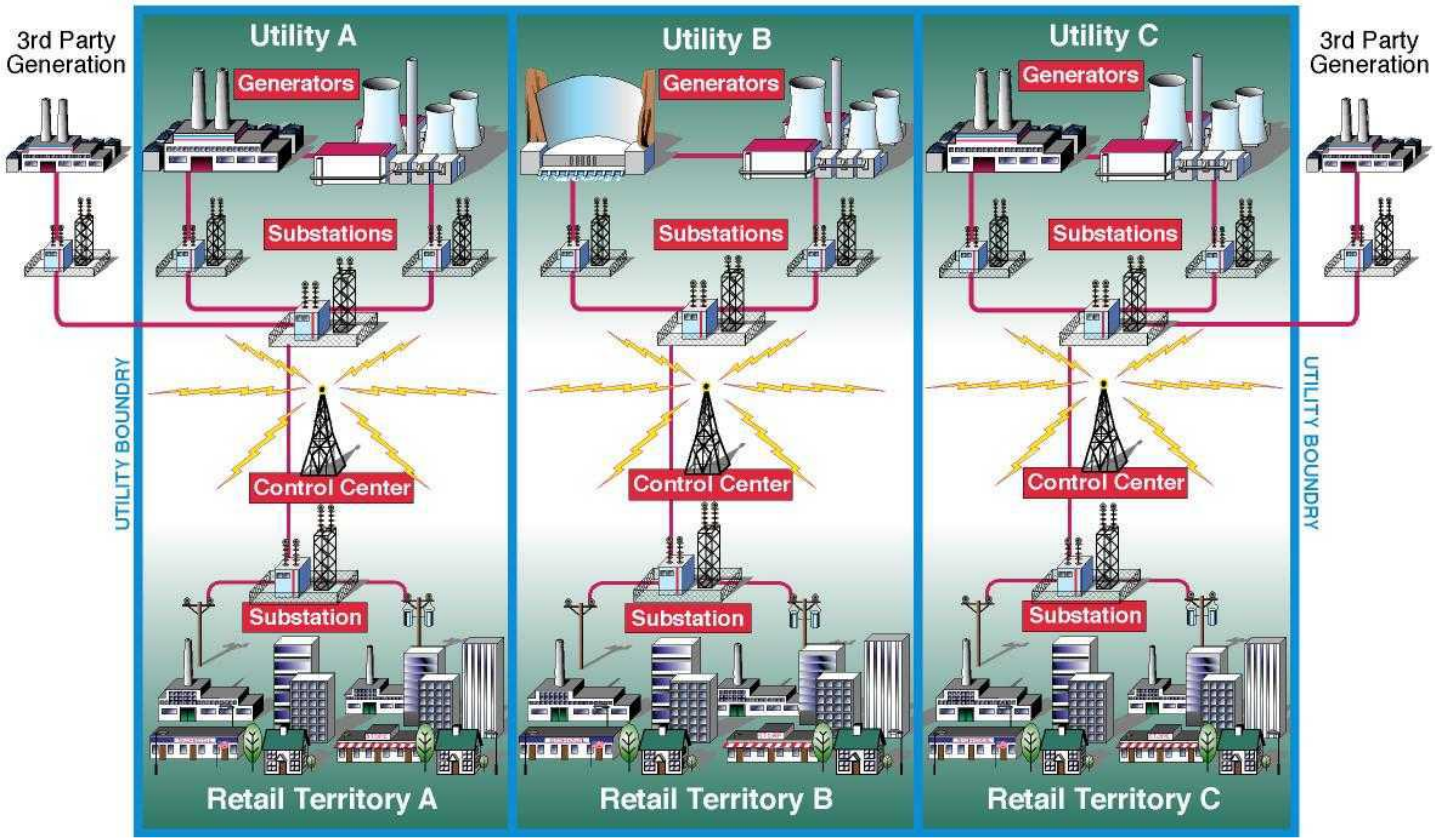
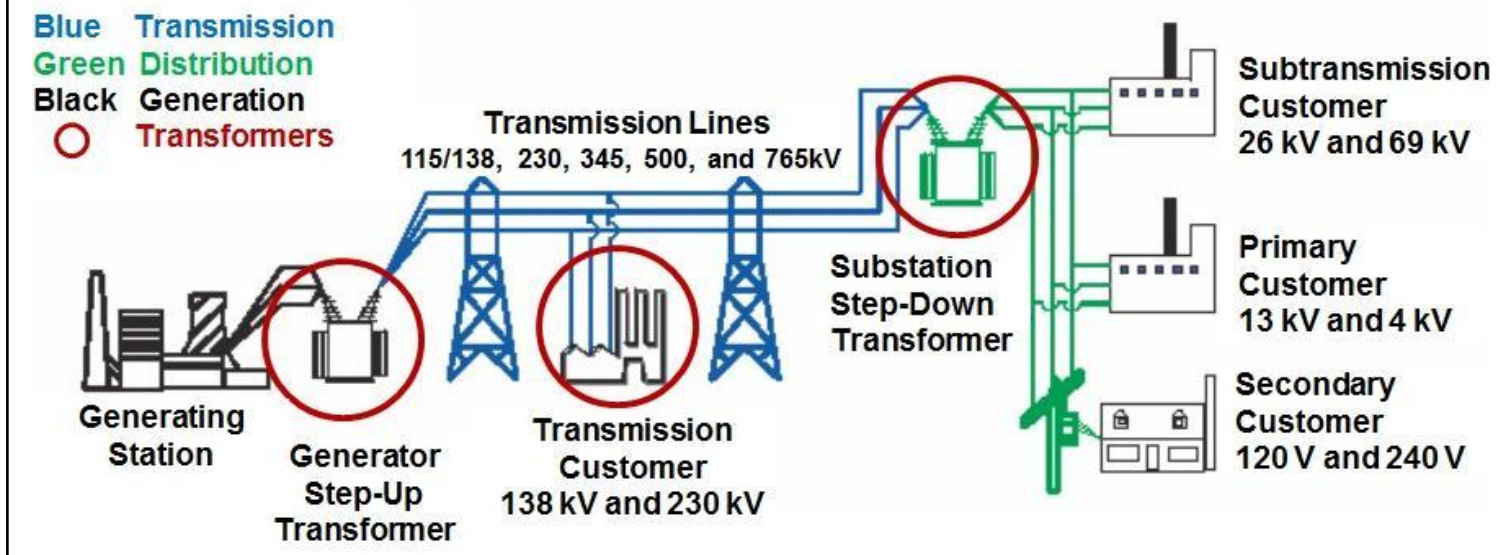


Figure 1. Electric Power Grid Representation



Source: DOE, 2006; see Footnote 14. Modified based on industry review.