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Description:	Pete Budden, Hydrogen Advocate, Climate and Clean Energy Program Natural Resources Defense Council pbudden@nrdc.org
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CALIFORNIA ENERGY COMMISSION: HYDROGEN

Pete Budden, Hydrogen Advocate, Climate and Clean Energy Program

Natural Resources Defense Council

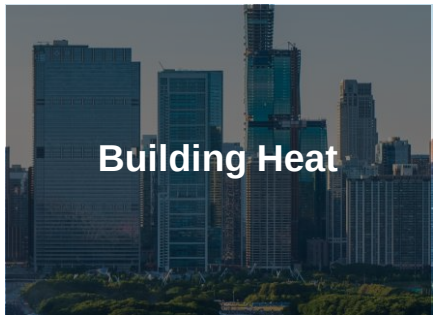
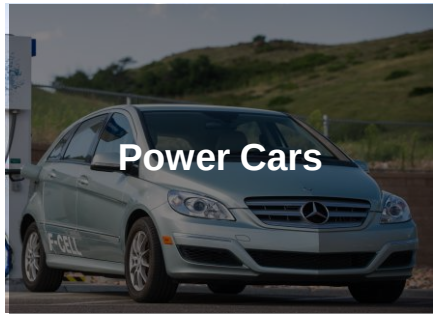
pbudden@nrdc.org

Outline

1. Hydrogen applications
2. Electrolytic production and the necessary guardrails
3. Examples from other states

HYDROGEN APPLICATIONS

Hydrogen can technically fuel nearly everything fossil fuels can

Gas	 Building Heat	 Electricity Generation	 Iron & Steel	 High Temperature Industrial Heat
Oil	 Power Cars	 Power Trucks	 Maritime Shipping	 Aviation

But just because you CAN doesn't mean you SHOULD
Electrification is more cost effective where possible

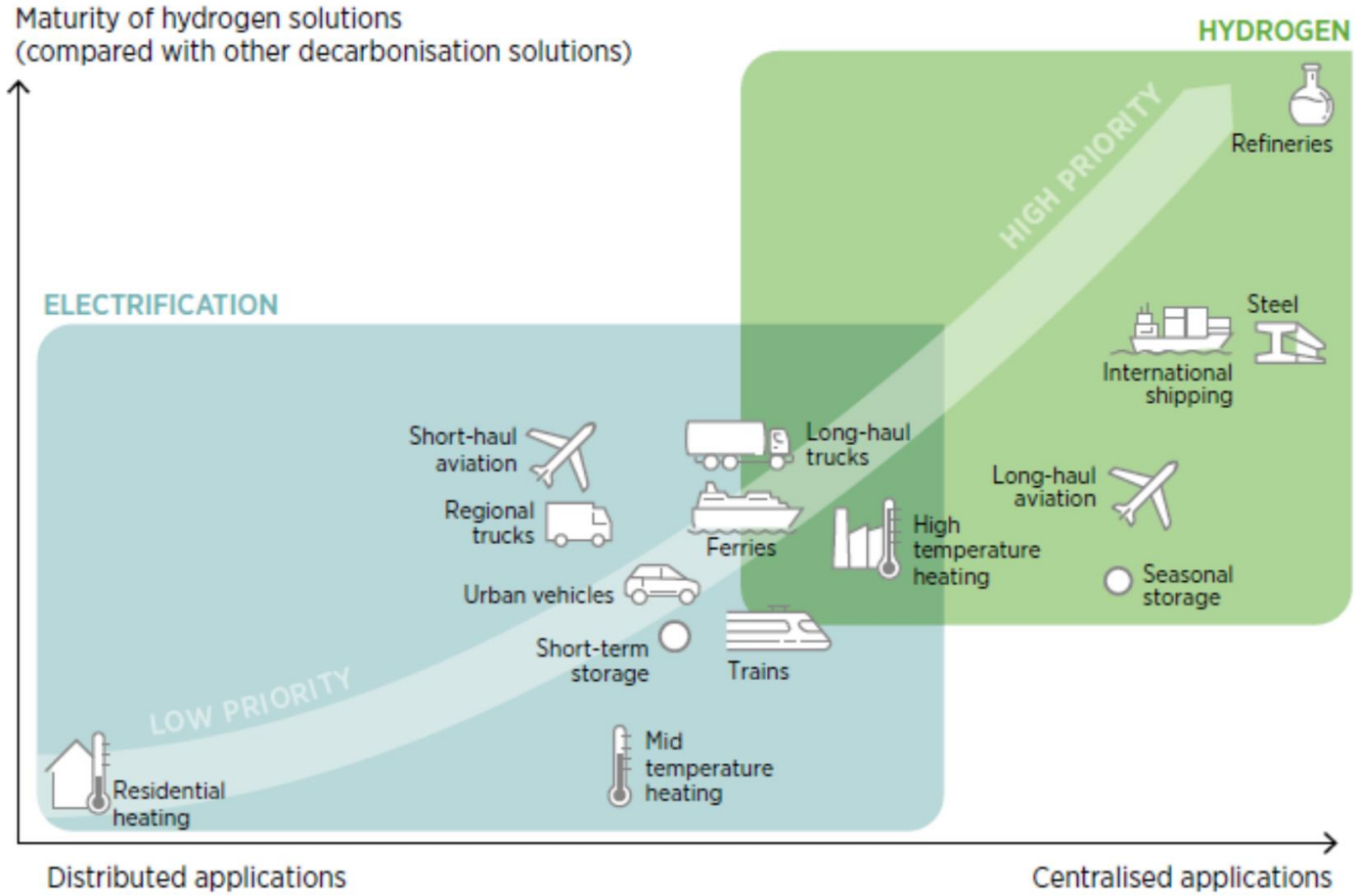
Hydrogen may stall climate progress and increase costs for Americans if it's not strategically deployed.

Green hydrogen takes over five times more energy to produce heat compared to electrification

Number of wind turbines needed to cover heating demand in the UK where one symbol = 1,500 turbines

Source: Energy Monitor analysis of Committee on Climate Change and Renewable UK figures. This is illustrative for the UK assuming all gas used for heating is substituted with green hydrogen or using heat pumps. In reality not only wind power would be used to provide the electricity.

There's strong consensus around “good” and “bad” hydrogen uses.



Source: International Renewable Energy Agency

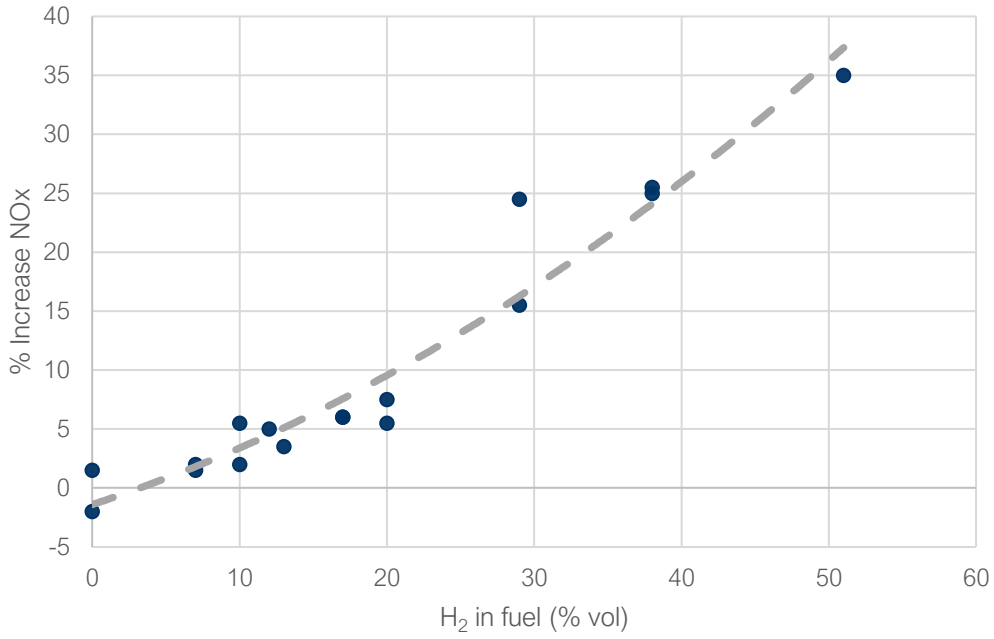
Opportunities in California

- Replacing existing gray hydrogen use, for example as a chemical feedstock for fertilizer
- Long-distance shipping and aviation
  - Must ensure hydrogen does not derail or delay electrification of port operations and port decarbonization goals
- High-temperature heat for industry
  - Electrification can tackle almost all low and medium temp applications, with promising potential to also tackle high temp
- Potentially, a subset of long-distance heavy-duty trucks – but BEVs rapidly improving in this area
- Long duration energy storage – could provide dispatchable power, must address NOx

Combustion of hydrogen produces NO_x

- NO_x is a harmful air pollutant, causes smog.
- Replacing gas plants with hydrogen cannot proceed unless NO_x levels are proved to be mitigated.
- More research is needed to understand potential and costs of reducing NO_x by:
  - Controlling combustion conditions
  - Aftertreatment of flue gas

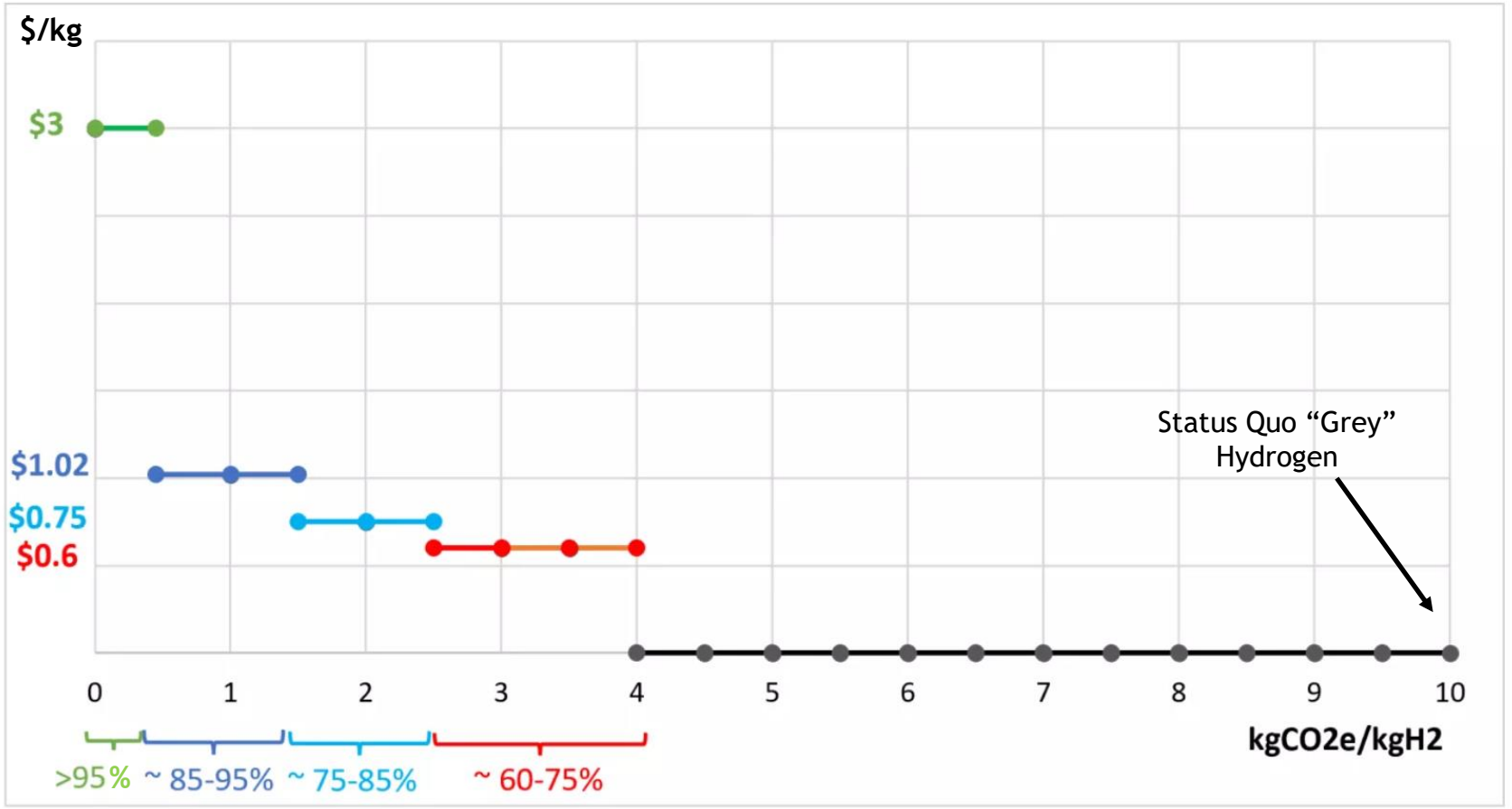
NOx emissions increase with hydrogen blends[1]



GE extrapolates that gas turbine NOx emissions could potentially double if operating at or near 100% hydrogen.

HYDROGEN PRODUCTION

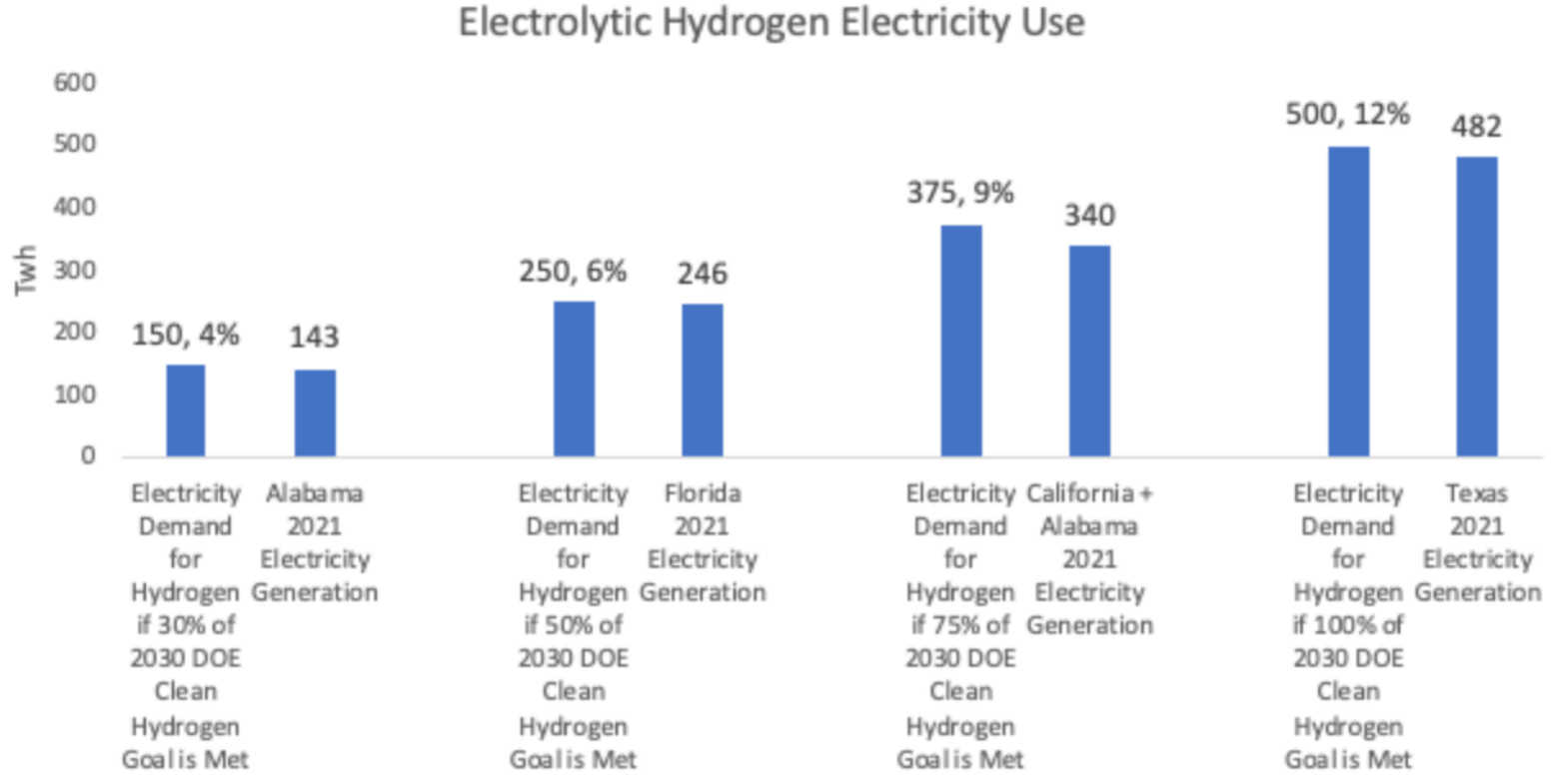
45V Production Tax Credit



Production tax credit in $ per kilogram of hydrogen produced ($/kg) relative to the carbon intensity of the produced hydrogen in kilograms of carbon dioxide equivalent per kilogram of hydrogen (kgCO2e/kgH2).

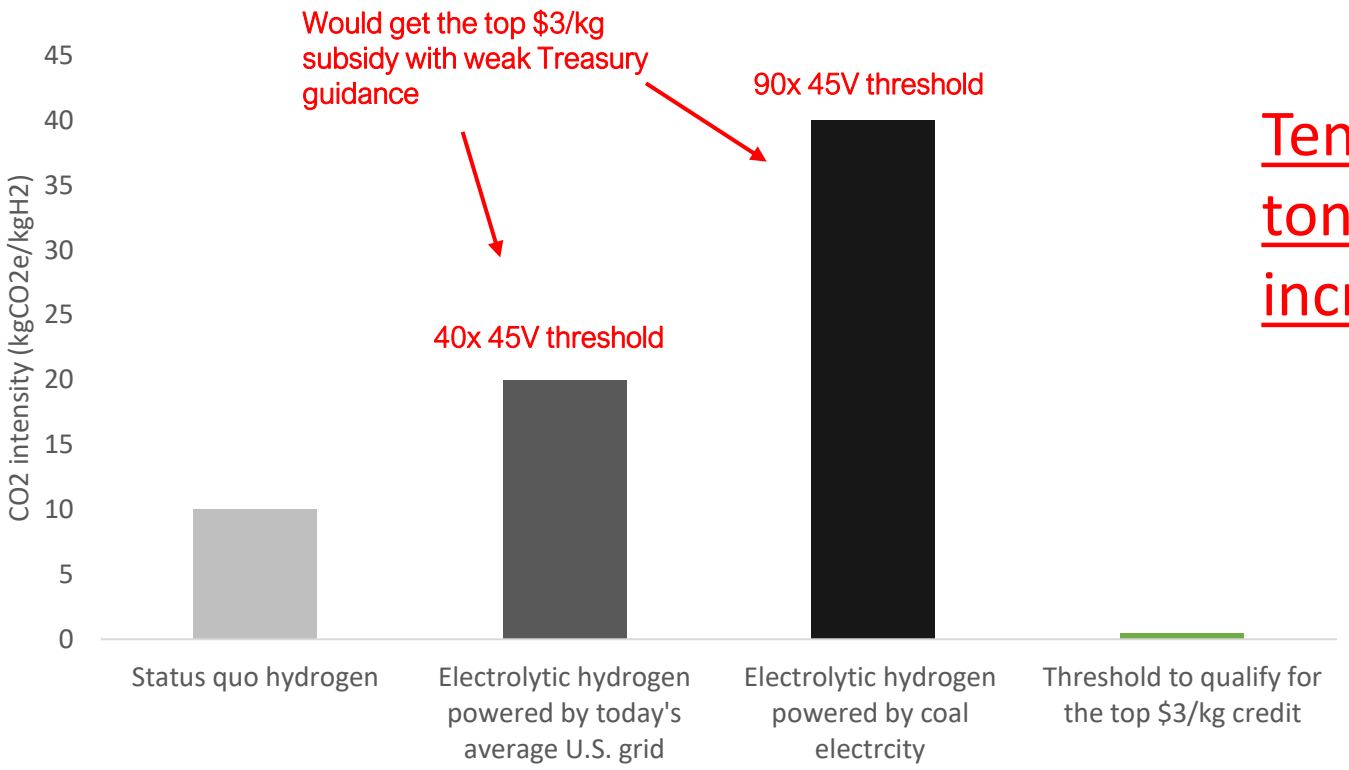
Electrolytic Hydrogen Production

- Electrolysis can split water into hydrogen and oxygen
- Splitting water means breaking chemical bonds - very energy-intensive
- Achieving DOE 2030 hydrogen goal of 10MMT would require adding the equivalent energy demand of Texas.



High risk of 45V *increasing* emissions if Treasury guidelines are weak

- Even small shares of fossil-fueled electricity powering electrolysis would result in significant emissions



Tens to hundreds of millions of tons of potential emissions increases in this decade.

Three pillars are needed to avoid these emissions

- Energy intensity and size of 45V credit (amounting to $60/MWh) mean that need to make sure that the electricity powering electrolysis is squeaky clean
- The three pillars are the only system of safeguards that can ensure squeaky clean power

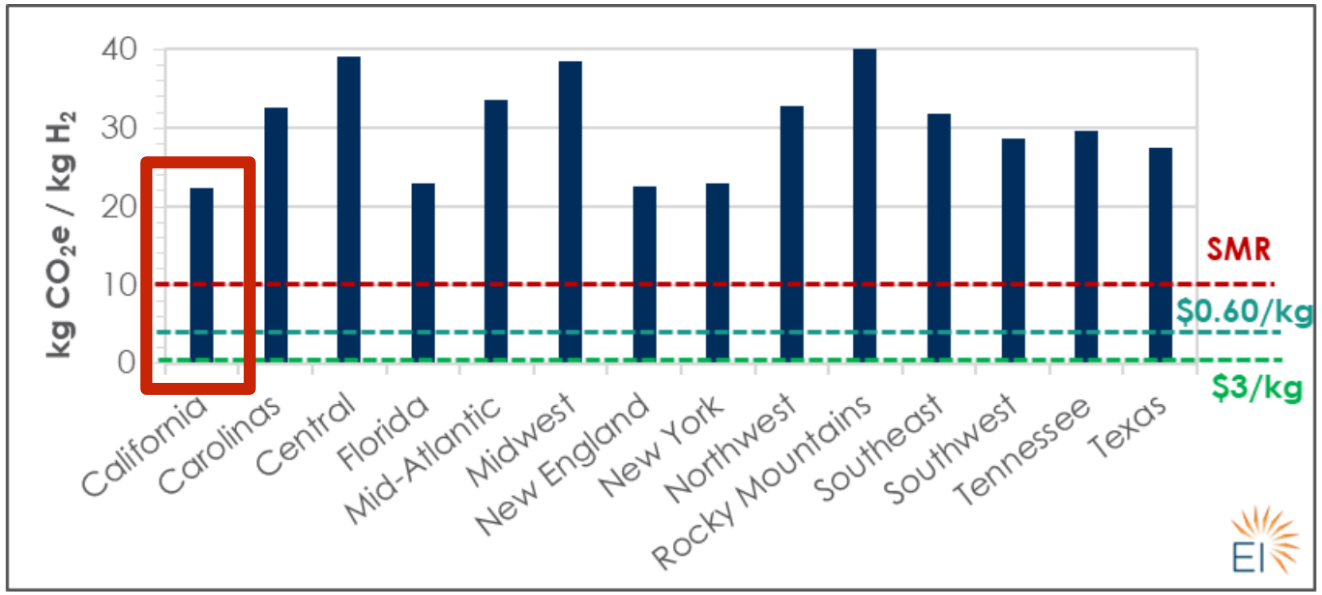
Three Pillars: 1. New clean supply

- New clean supply (aka, additionality): a hydrogen project must be powered by a clean energy project not currently on the grid
- Weak alternative: hydrogen projects can locate on the grid, add significant demand without adding new clean supply to meet that demand
- **Straightforward implementation**:

Multiple options, including (*not limited to*):

- A hydrogen developer enters into a power purchase agreement with one or more new clean energy projects (e.g., new wind and/or solar project)
- A hydrogen project purchases credits from a clean energy project built within 36 months of hydrogen project (EU approach)

Figure 6. Electrolysis emissions impact of forgoing additionality

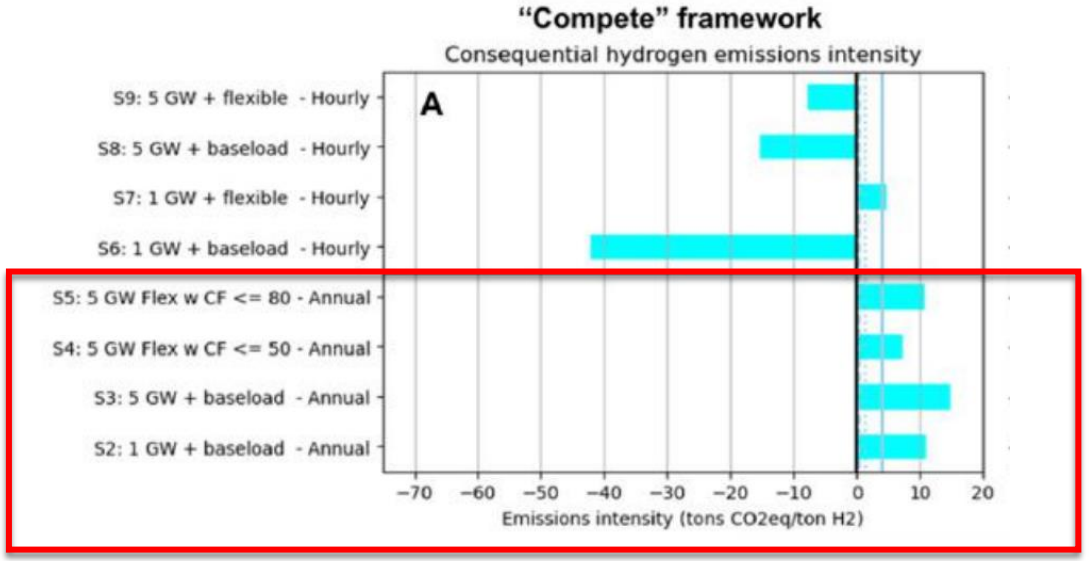


Three Pillars: 2. Hourly matching

- Hourly matching: a hydrogen project can only operate ***during the same hours*** where the procured new clean energy project operates
- Weak alternative: Annual matching, a hydrogen's project's *annual* operations must match a clean energy projects *annual* generation, on a volumetric basis

→ will spur increased fossil fuel generation

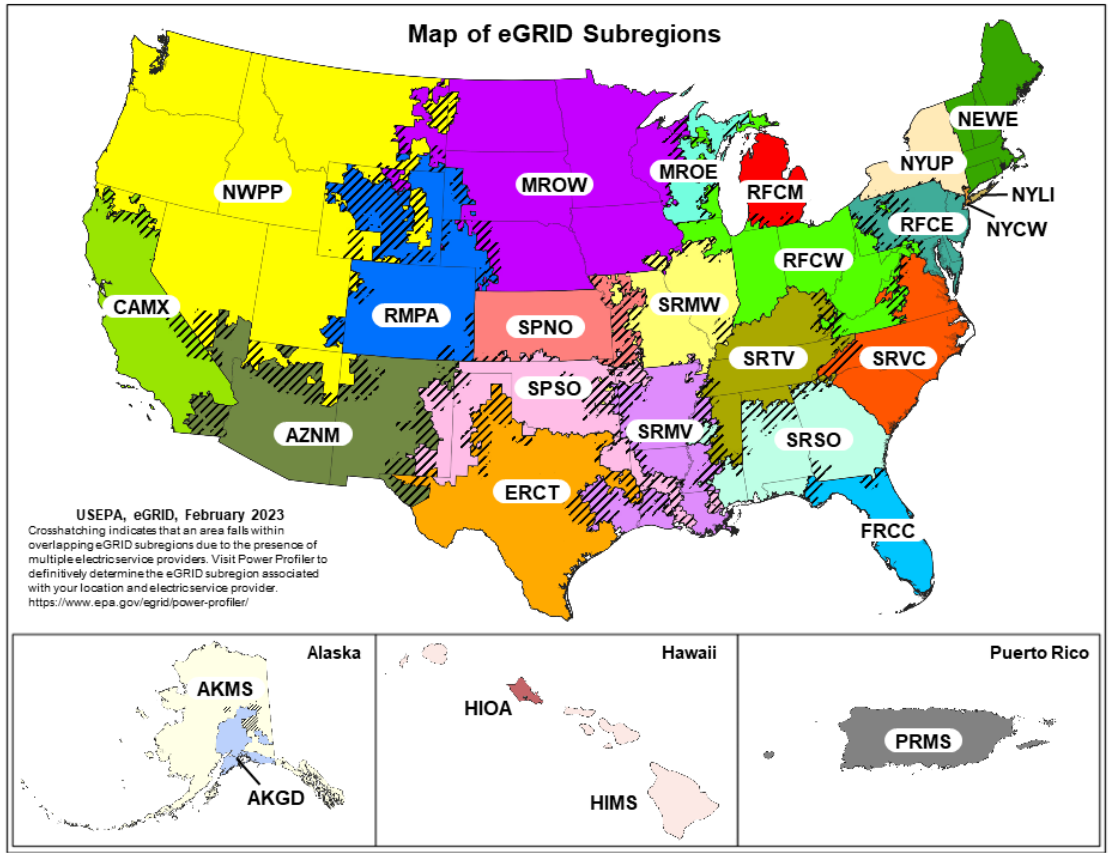
- **Straightforward implementation:**
  - A hydrogen producer demonstrates that its hourly operations match the hourly operations of a new clean energy project (either via books and records, or via credits)



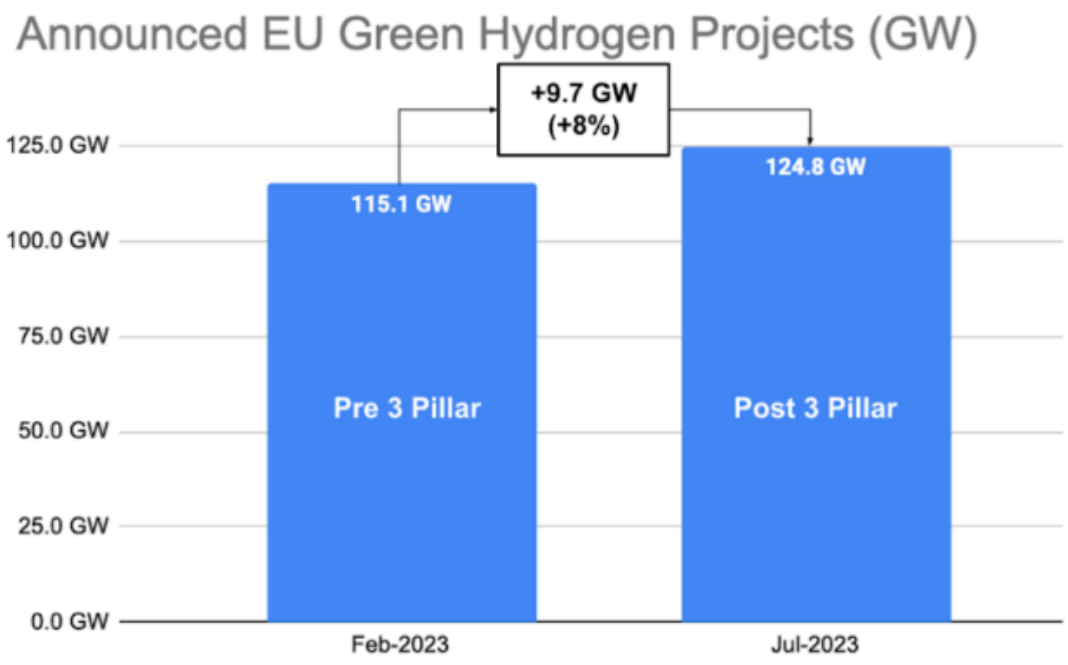
MIT Energy Initiative

Three Pillars: 3. Deliverability

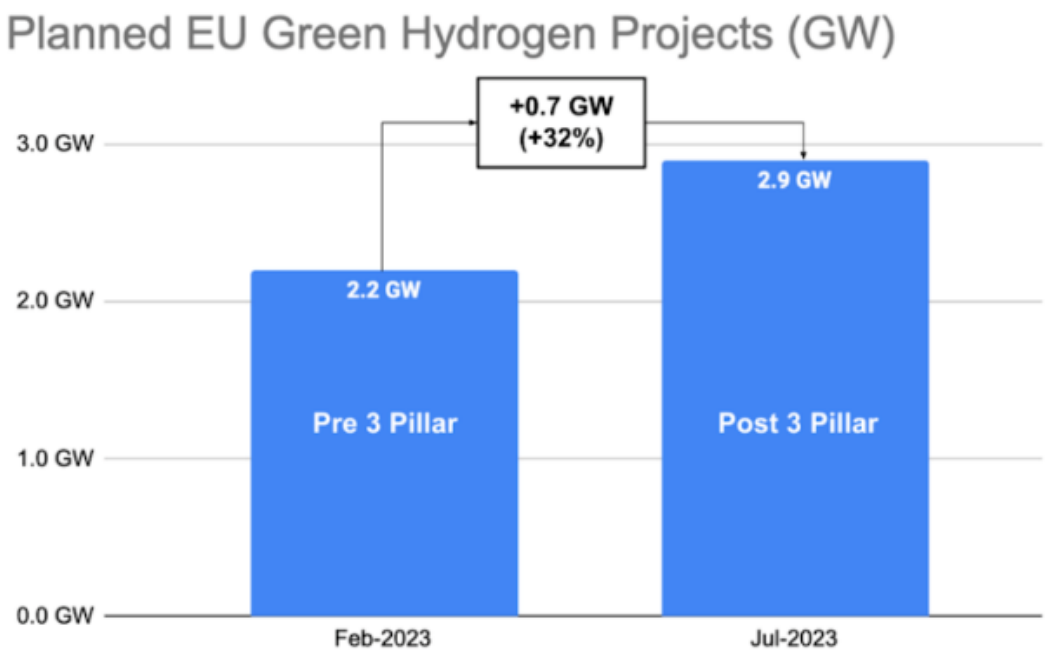
- Deliverability: the new clean energy project(s) must be physically deliverable to the location where the hydrogen project is located
- Weak alternative: no geographic/spatial requirements
- **Straightforward implementation:**
  - A hydrogen project and clean energy project must be located within specific boundaries (e.g., eGRID subregions)



Three Pillars will support robust industry growth



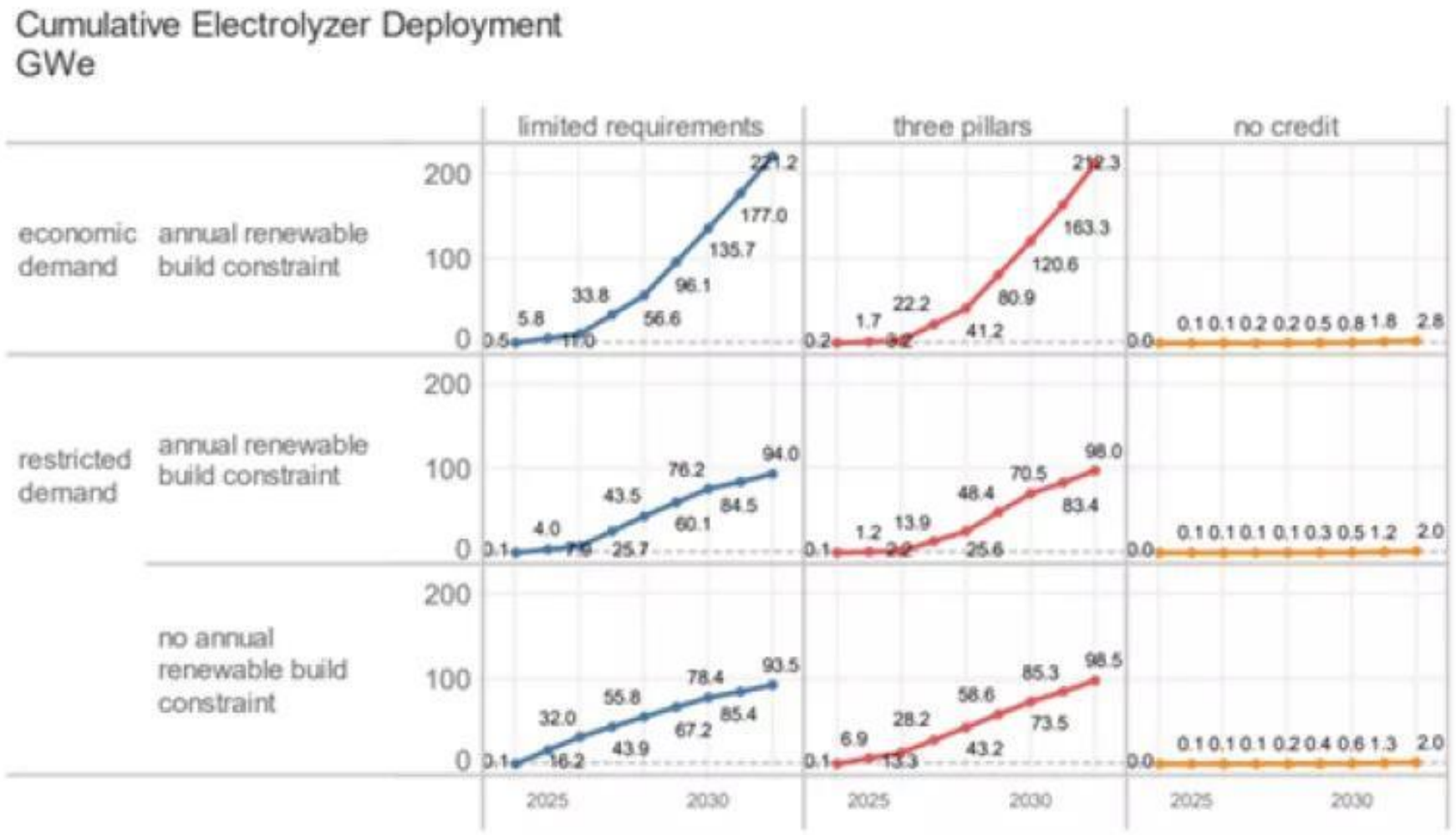
Source : GlobalData



Source : GlobalData

Growth in the European Union's green hydrogen project pipeline after the announcement of rules based on the Three Pillars in February 2023.

Three pillars support ample deployment to enable cost reductions



Lax rules have negative consequences beyond emissions

- We cannot afford another crypto - uncontrolled additions of inflexible loads to the grid will jeopardize state emissions goals. The costs of this will be socialized to all power consumers and the climate. In New York, crypto-mining has pushed up annual electric bills by about $165 million for small businesses and $79 million for individuals (Berkeley Haas).
- Consumer power costs will increase - 5 GW of electrolyzers without three pillars will mean 8% increase in wholesale power prices in southern CA, 10% in CO/WY (Princeton).
- Dirty hydrogen will undermine industry credibility and amplify public opposition to a necessary climate tool.
- Three pillars = flexible operation which require modern, likely US-built PEM electrolyzers.
  - Alternative is inflexible alkaline electrolyzers, made in China.

California must join others in ensuring climate- and community-aligned hydrogen development

- CO have passed their own incentives for hydrogen use:
  - Aligned with 3 pillars by 2028 at the latest
  - Only high-value end uses (no cars or buildings)
  - Cumulative impacts studies to protect communities
- IL has passed an end-use tax credit limited to hard-to-electrify uses
- PA have a bill introduced to limit end uses and implement 3 pillars.

THANK YOU!

QUESTIONS?

Pete Budden, Hydrogen Advocate, NRDC

Contact: pbudden@nrdc.org