Overview of Recent Hydrogen Policy Developments

Emily Beagle, PhD
UT Hydrogen Day
5 October 2023
Recent years have seen significant international momentum to develop the hydrogen economy.
The bipartisan *Infrastructure Investment and Jobs Act* (*IIJA or BIL*) delivers tens of billions of dollars for climate and energy.
The Bipartisan Infrastructure Law includes $9.5 billion for hydrogen programs.
BIL hydrogen programs target early stage R&D through large-scale demonstration and hydrogen hubs

- Regional Clean Hydrogen Hubs ($8 billion)
- Clean Hydrogen Electrolysis ($1 billion)
- Manufacturing and Recycling RD&D ($0.5 billion)
Regional Clean Hydrogen Hubs program ($8 billion) is currently in application phase and has specific requirements.
Regional Clean Hydrogen Hubs program ($8 billion) is currently in application phase and has specific requirements.

**Production**
- At least one from...
  - Renewable energy
  - Nuclear energy
  - Fossil fuels

**End Use**
- At least one in...
  - Residential and commercial heating
  - Electric power generation
  - Transportation
  - Industrial sector
Regional Clean Hydrogen Hubs program ($8 billion) is currently in application phase and has specific requirements.

**Production**
- At least one from...
  - Renewable energy
  - Nuclear energy
  - Fossil fuels

**End Use**
- At least one in...
  - Residential and commercial heating
  - Electric power generation
  - Transportation
  - Industrial sector

**Geography**
- Each in different regions of the US
- At least two in...
  - Natural gas producing regions
Map of publicly known US hydrogen hub proposal locations

Concept papers submitted: November 2022

Initial proposals submitted: April 7, 2023

Project selection status: ongoing - expected announcements Fall 2023

Emily Beagle, PhD
Hydrogen Day at UT
5 October 2023

Map by: Resources for the Future
Texas is aiming to be a central location for regional clean hydrogen hub projects.
The BIL also mandated establishment of a clean hydrogen production standard (CHPS) in the US.

Well-to-gate system boundary for emissions considered in finalized CHPS guidance.

Finalized guidance:

\(<4 \text{ kg CO}_2e/\text{kg H}_2\) lifecycle emissions

Guidance document available [here](#).
The *Inflation Reduction Act* also included provisions for clean hydrogen

- Signed into law: August 2022
- Passed strictly on party lines (51-50 Senate; 220-207-4 House)
- Three main sections (not just a climate/energy bill)
  - 1) Climate and Energy
  - 2) Healthcare
  - 3) Tax Code Changes
The *IRA* strategically targets all sectors of the economy to reduce emissions

- Agriculture conservation investments
- National Forest fuel and restoration projects
- Energy efficient commercial building deduction
- Energy efficient home credit
- Electrification appliance credits
- CCUS 45Q Credit
- Clean hydrogen PTC
- Clean energy manufacturing investment credit
- Incentives for bio and alternative fuels
- Sustainable aviation fuel credit
- Clean vehicle credit
- Clean electricity production tax credit
- Clean electricity investment tax credit
- Transmission line grants

**US GHG emissions by Economic Sector - 2020**

- Agriculture: 11%
- Commercial & Residential: 13%
- Industry: 24%
- Electric Power: 25%
- Transportation: 27%

And many more…!
The new Clean Hydrogen Production Tax Credit in the *Inflation Reduction Act* could make clean hydrogen production competitive.

![Graph showing the relationship between credit amount and lifecycle emissions for clean hydrogen production. The graph indicates that as the credit amount increases, the lifecycle emissions decrease.](image-url)

- **Credit Amount ($/kg H2)**: 0, 0.75, 1.5, 2.25, 3
- **Lifecycle Emissions (kg CO2/kg H2)**: 0, 1, 2, 3, 4

*Includes full tax credit bonuses*
The new Clean Hydrogen Production Tax Credit in the *Inflation Reduction Act* could make clean hydrogen production competitive.

- **Credit Amount ($/kg H₂)**
  - 0
  - 0.75
  - 1.5
  - 2.25
  - 3

- **Lifecycle Emissions (kg CO₂/kg H₂)**
  - 0
  - 1
  - 2
  - 3
  - 4

- **Emissions of 2.5 - 4 kg CO₂/kg H₂ → $0.60/kg**

*Includes full tax credit bonuses*
The new Clean Hydrogen Production Tax Credit in the *Inflation Reduction Act* could make clean hydrogen production competitive.

<table>
<thead>
<tr>
<th>Credit Amount ($/kg H₂)</th>
<th>Lifecycle Emissions (kg CO₂/kg H₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.25</td>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>0.75</td>
<td>3</td>
</tr>
</tbody>
</table>

- Emissions of 1.5 - 2.5 kg CO₂/kg H₂ → $0.75/kg
- Emissions of 2.5 - 4 kg CO₂/kg H₂ → $0.60/kg

*Includes full tax credit bonuses*
The new Clean Hydrogen Production Tax Credit in the *Inflation Reduction Act* could make clean hydrogen production competitive.
The new Clean Hydrogen Production Tax Credit in the *Inflation Reduction Act* could make clean hydrogen production competitive.

![Diagram showing credit amounts and lifecycle emissions](image)

- **Lowest emission production (<0.45 kg CO₂/kg H₂) eligible for $3/kg H₂**
- Emissions of 0.45 - 1.5 kg CO₂/kg H₂ → $1/kg
- Emissions of 1.5 - 2.5 kg CO₂/kg H₂ → $0.75/kg
- Emissions of 2.5 - 4 kg CO₂/kg H₂ → $0.60/kg

*Includes full tax credit bonuses*
Carbon intensity of hydrogen production varies significantly even across similar pathways.

- **Coal Gasification**
- **SMR**
- **SMR + CCS**
- **Pyrolysis**
- **Electrolysis**
- **Biomass**

### Lifecycle Carbon Emissions (kg CO2/kg H2)

- **25**
- **20**
- **15**
- **10**
- **5**
- **0**
- **-5**
- **-10**
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.

Emissions of electricity vary electrolytic hydrogen intensity.
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.
Carbon intensity of hydrogen production varies significantly even across similar pathways.

The same production pathway can have very different carbon intensity…

…carbon intensity defines greenhouse gas and climate impacts and credit eligibility.
Carbon intensity of hydrogen production varies significantly even across similar pathways.

NOTE: SMR + CCS is also eligible to take 45Q - Carbon Dioxide Storage Credit.
Tax credit values are significant compared to current cost of clean hydrogen production

<table>
<thead>
<tr>
<th>Life Cycle Emissions (kg CO$_2$/kg H$_2$)</th>
<th>PTC Value ($/kg H$_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 - 2.5</td>
<td>$0.60</td>
</tr>
<tr>
<td>2.5 - 1.5</td>
<td>$0.75</td>
</tr>
<tr>
<td>0.45 - 1.0</td>
<td>$1.00</td>
</tr>
<tr>
<td>&lt; 0.45</td>
<td>$3.00</td>
</tr>
</tbody>
</table>

- $0.60
- $3.00
Specific guidance documents with the details of clean hydrogen tax credit requirements expected soon

• IRS expecting to release final guidance for the Clean Hydrogen Production Tax Credit from IRA in the next several months

• Remaining questions on details of implementation:
  – How will grid connected electrolyzers ‘count’ renewable energy?
  – How will the implemented standards compare to other international guidance?
  – How will renewable natural gas as a feedstock be counted?
  – And others
Two meaningful bills related to hydrogen were passed in the recent Texas legislative session

**HB2847**
- Provides the *Texas Railroad Commission* regulatory jurisdiction over hydrogen pipelines and underground storage facilities
- Establishes the Texas Hydrogen Policy Council, which will study the development of the hydrogen industry in Texas and make recommendations regarding oversight and regulations

**HB4885**
- Creates the Texas Hydrogen Infrastructure, Vehicle, and Equipment Grant Program administered by the *Texas Commission on Environmental Quality*
- Up to $8 million a year in grants for heavy duty trucks powered by hydrogen and their supporting fueling infrastructure
Grid-connected electrolyzer projects complicate the requirements of renewable hydrogen.

Electrolysis

Electrolyzer with dedicated renewables

H₂
Grid-connected electrolyzer projects complicate the requirements of renewable hydrogen

**Technical Challenge**
- impact of variable electricity input on electrolyzer performance and longevity

**Economic Challenge**
- low capacity factor and utilization yields high cost hydrogen
Grid-connected electrolyzer projects complicate the requirements of renewable hydrogen.

**Technical Challenge**
- impact of variable electricity input on electrolyzer performance and longevity

**Economic Challenge**
- low capacity factor and utilization yields high cost hydrogen

Electrolyzer with dedicated renewables

Grid Connected Electrolyzer
Grid-connected electrolyzer projects complicate the requirements of renewable hydrogen

**Technical Challenge**
- impact of variable electricity input on electrolyzer performance and longevity

**Economic Challenge**
- low capacity factor and utilization yields high cost hydrogen

---

**Technical Opportunities**
- Power balancing and long duration energy storage for the grid

**Economic Benefits**
- High utilization yields lower cost hydrogen

**Challenge:** How do we show that the produced hydrogen is low-carbon?
The EU’s framework for grid connected electrolyzers sets important standards for renewable electricity inputs.

Additionality

Renewable generation added to system that would not have been built if not for the hydrogen project.
The EU’s framework for grid connected electrolyzers sets important standards for renewable electricity inputs

Additionality

Renewable generation added to system that would not have been built if not for the hydrogen project

Temporal Matching

Electricity taken from the grid for hydrogen production must match time of renewable generation
The EU’s framework for grid connected electrolyzers sets important standards for renewable electricity inputs.

**Additionality**

Renewable generation added to system that would not have been built if not for the hydrogen project.

**Temporal Matching**

Electricity taken from the grid for hydrogen production must match time of renewable generation.

**Geographic Matching**

Renewable electricity installations must be in the same region as the hydrogen production.
Fossil fuel generation pathways have options for tax credit selection

**45Q Carbon Capture Tax Credit**
- awarded per ton of CO₂ captured

**45V Clean Hydrogen PTC**
- awarded per ton of clean hydrogen produced
- varies based on carbon intensity

**No Double Dipping** → facilities must choose which of the two tax credits to take

**Tradeoffs for project economics**
- More costly higher carbon capture rate equipment *might* push facility into higher tier of 45V credit
- Lower cost equipment might unlock enough of 45Q to make competitive
Policies should also ensure that novel hydrogen production technologies are not excluded

• Geologic hydrogen
• Methane pyrolysis
• And others

How do we ensure that new, and perhaps better, hydrogen pathways aren’t excluded from existing policies and standards?
Clean hydrogen project announcements are accelerating globally

By 2030, current proposed hydrogen projects would mean:

- **27 Mt** hydrogen production based on **electrolysis and low emission electricity**
- **10 Mt** hydrogen production based on **fossil fuels with carbon capture and storage**

Global hydrogen demand in 2022 was 95 Mt, of that 0.67 Mt (0.7%) was low-emission hydrogen.
Emily Beagle

Research Associate

e.beagle@utexas.edu
www.webberenergygroup.com