U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

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Carbon Conversion R&D Program

Updates on Infrastructure Bill Impacts and International Collaborations

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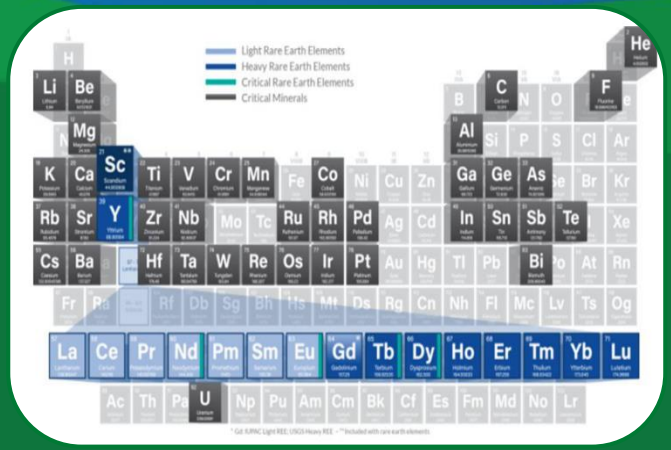


Carbon Dioxide Removal

Removal of atmospheric CO_2 and durable store

Carbon Conversion/Utilization

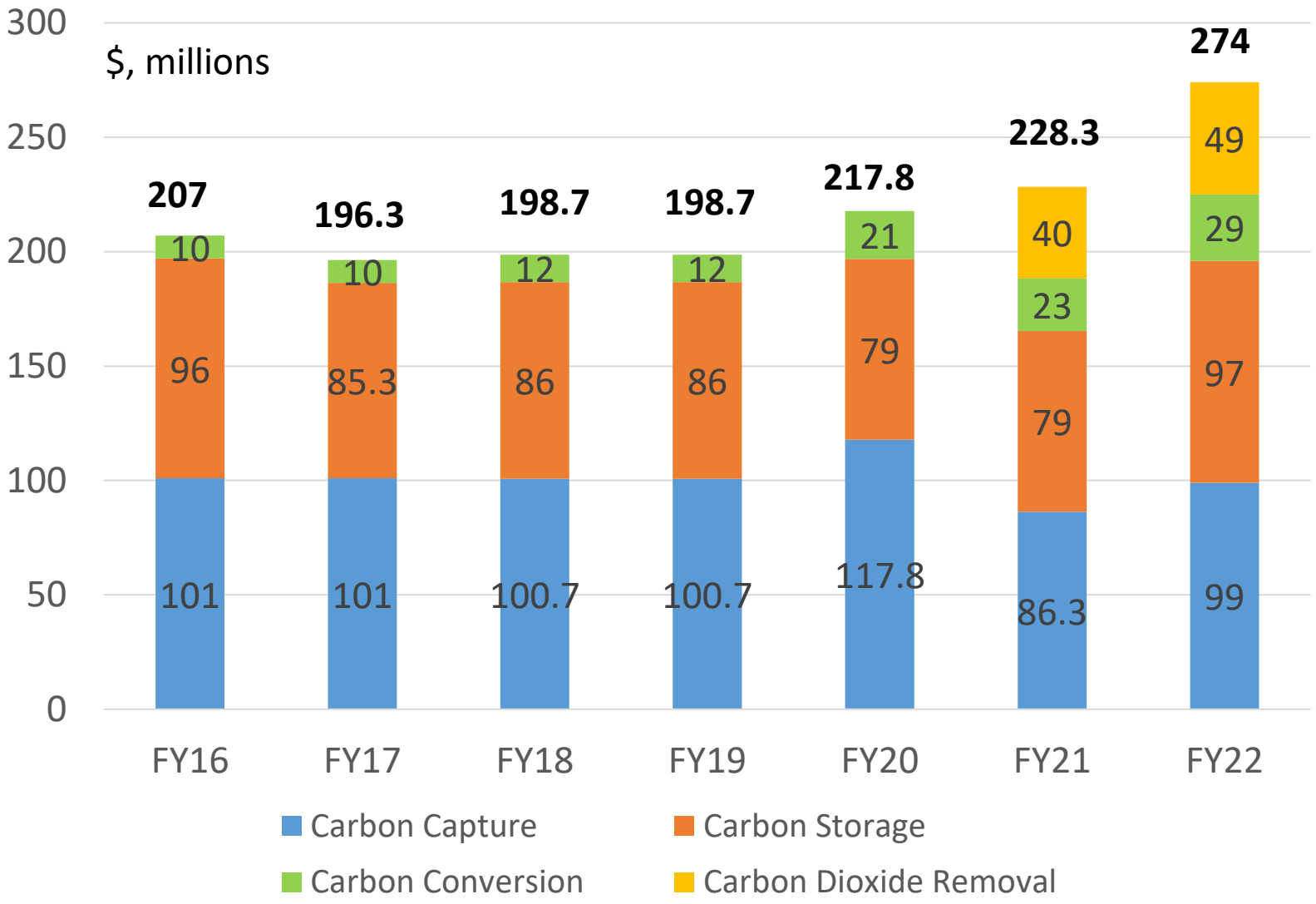
Conversion of CO_2 to value-added products

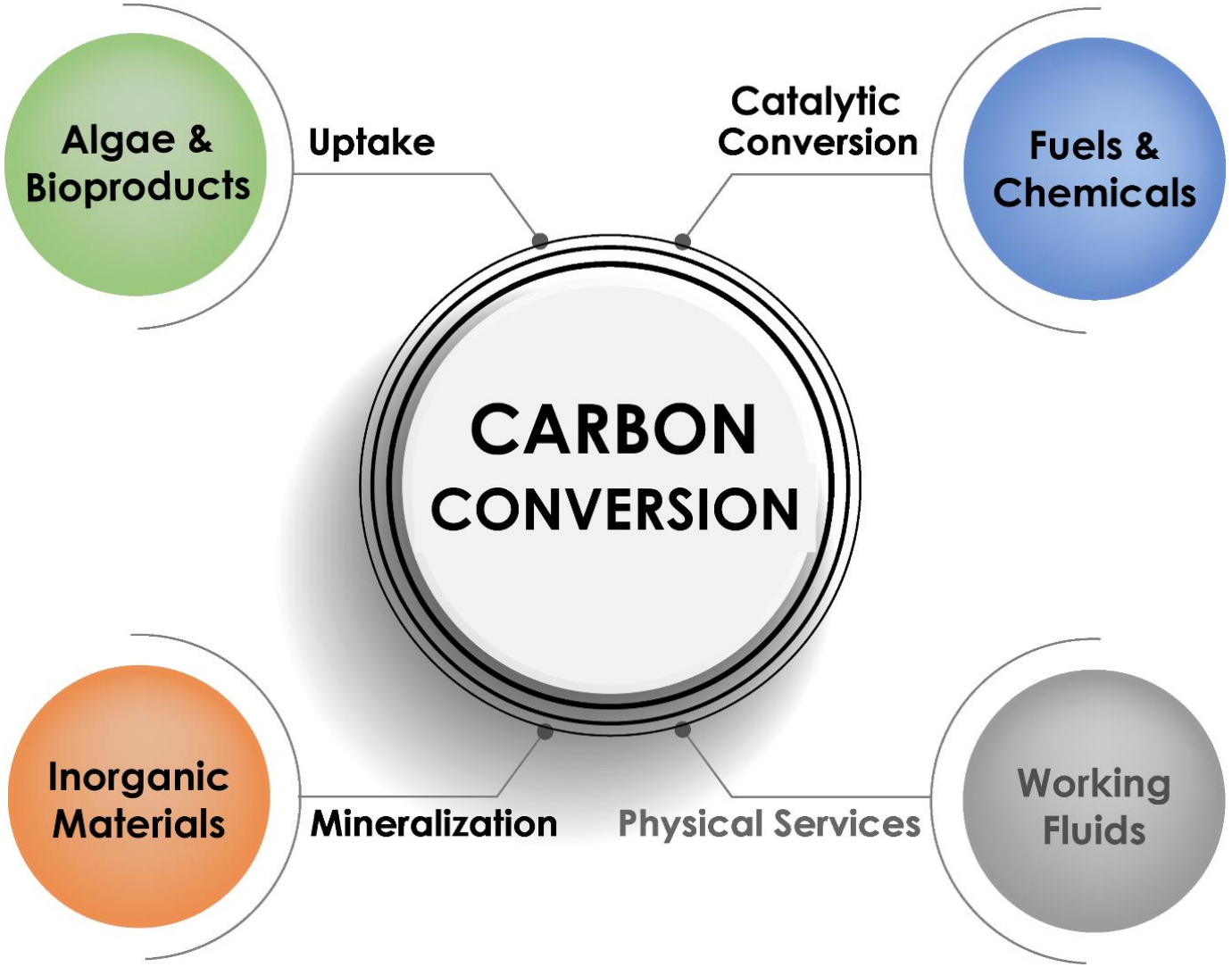
Carbon Storage

Safe, cost- effective, and permanent geologic storage of CO_2

Carbon Capture

Capturing CO_2 from new and existing industrial and power plants





Focus of other programs

IRA Impacts - https://bipartisanpolicy.org/blog/inflation-reduction-act-summary-energy-climate-provisions

- Extends the deadline for construction to January 1, 2033 and increases the credit amount.
  - From $50 to $85 per ton for CCUS for industrial facilities and power plants for saline geologic formations.
  - **From $35 to $60 per ton for utilization** of captured CO2 and its precursor carbon monoxide to produce low and zero-carbon fuels, chemicals, building materials and other products, or for enhanced oil recovery (EOR).
  - From $50 to $180 per ton for DAC stored in saline geologic formations and **from $35 to $130 per ton for utilization or EOR.**
- Decrease minimum plant size threshold:
  - From 100,000 to 1,000 tons per year for DAC.
  - From 500,000 to 18,750 metric tons per taxable year for Electric Generating Facility paired with design capacity requirement below.
  - **From 25,000 to 12,500 metric tons per taxable year for any other facility.**
- Design Capacity Requirement: Point-source carbon capture projects on electric generating units will be required to design capture equipment to capture at least 75% of unit (not facility) CO2 production, subject to a review if facility emissions increase in future years.
- Direct Pay Compromise: Projects will receive direct pay for the first 5 years after the carbon capture equipment is placed in service (no direct pay option for the final 7 years of the credit). Nonprofit organizations and co-ops can receive direct pay for all 12 years of the credit.

SEC. 40302 of IIJA or BIL

Directs the Secretary to establish a program for **eligible entities …**to submit ….an application…. An eligible entity shall use a grant received to **procure and use commercial or industrial products** that

(i) use or are derived from *anthropogenic carbon oxides*; and

(ii) demonstrate significant net reductions in *lifecycle greenhouse gas emissions compared to incumbent technologies, processes, and products.*

https://uscode.house.gov/view.xhtml?hl=false&edition=prelim&req=granuleid%3AUSC-prelim-title42-section16298a&f=treesort&num=0

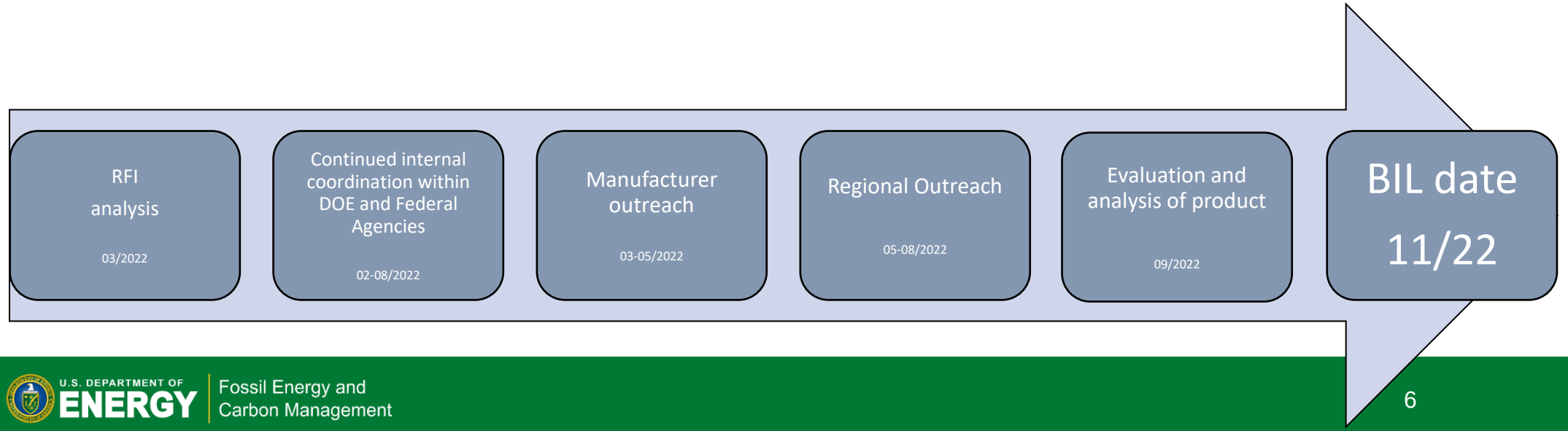
Appropriations and Timeline

PP 988 of BIL

(d) AUTHORIZATION OF APPROPRIATIONS.-

- $41,000,000 for fiscal year 2022;
- $65,250,000 for fiscal year 2023;
- $66,562,500 for fiscal year 2024;
- $67,940,625 for fiscal year 2025; and
- $69,387,656 for fiscal year 2026.

Funding totals ~$310MM over five years are given to the PROGRAM



Critical Points

- DOE total funding for *demonstration* Procurement Grant program is flexible
- Procurements grants will go to eligible entities
  - State government
  - Local government
  - Public utilities
- Net reduction in life cycle GHG emissions

DOE/NETL CO2U LCA Guidance Toolkit

- CO2 utilization LCA guidance and tool package for Carbon Utilization Program primary research projects
- LCA guidance, open source LCA software (openLCA), NETL data, and results reporting tools
- An openLCA database has been populated with data and an example to help conduct LCA within the openLCA software
- An Excel tool has been created to take openLCA results and translate them into stacked bar charts for results communication

Toolkit available at netl.doe.gov/LCA/CO2U

Preliminary LCA Process for Procurement Grant Program

Product manufacturer completes LCA for eligible product(s) in accordance with guidelines and submits for review

DOE reviews manufacturer LCA:

- Conformance with guidelines
- Minimum of 10% improvement over business-as-usual

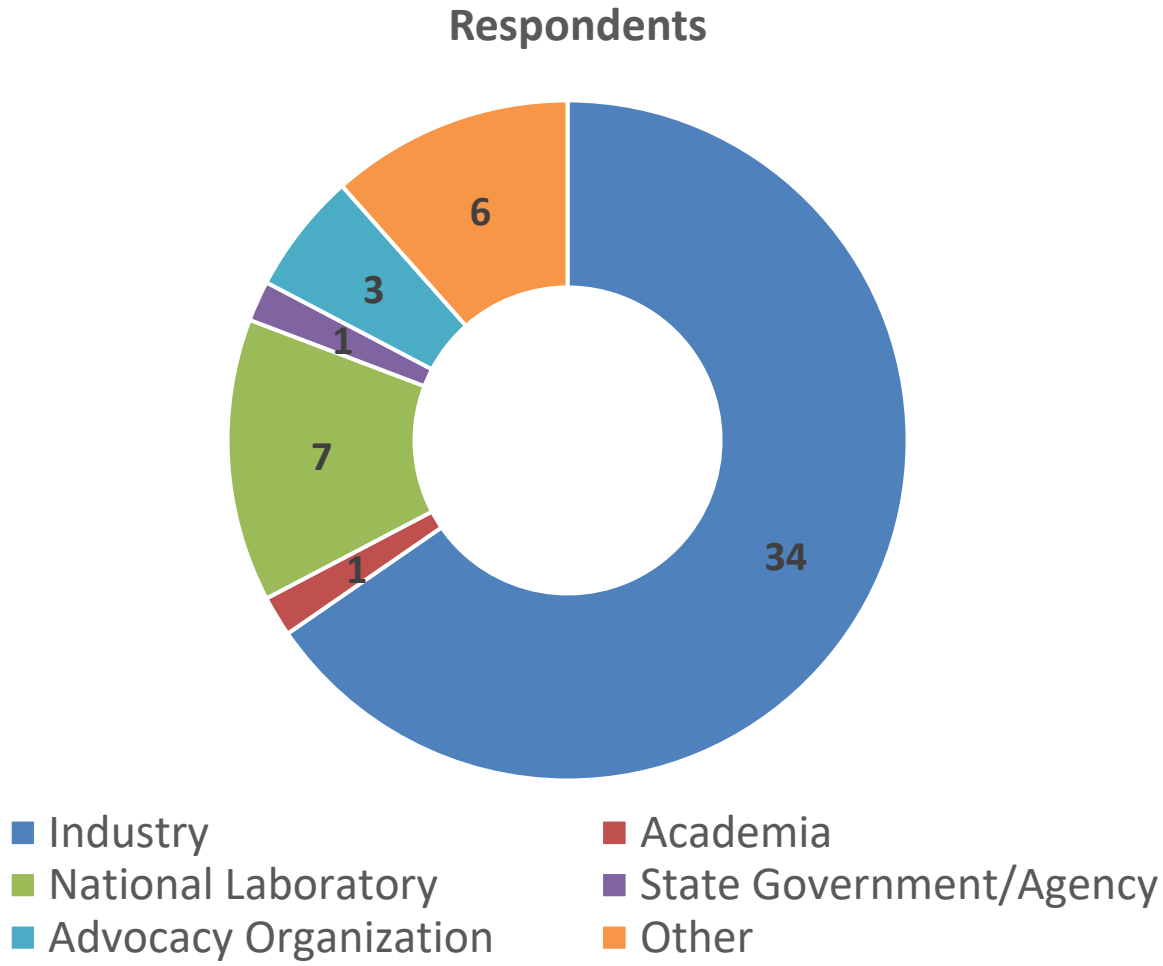
Once approved, manufacturer and product are added to an approved list of vendors

Eligible entities engage approved suppliers and establish a purchase agreement

RFI Technical Area #6 - Deployment and Demonstration Opportunities for Carbon Reduction and Removal Technologies

Response overview (52 total respondents)

- **Industry (34)**
- **Academia (1)**
- **National Laboratory (7)**
- **State Government/Agency (1)**
- **Advocacy Organization (3)**
- **Other (6)**
  - **Includes non-profits, consultant, foundation, initiative, institutes**



RFI Technical Area #6 Overall Summary

Funding, business models, and market considerations

- The current market offers a non-attractive business case due to high-cost premiums compared to fossil-derived materials.
- Several respondents expressed uncertainty on if or when 45Q applied to CO_2 conversion and this results in investment hesitation. Updated 45Q credit and/or other funding and incentives must be implemented to promote and, in some cases, sustain the commercialization of CO_2 conversion technologies/products.

Engagement and Existing Government Procurement Mechanisms

- Respondents most often specified that DOE should engage stakeholders at the state level, but responses varied from the Federal level all the way down to customers. The most common response is to engage commercially motivated stakeholders (i.e., industries) as well as government groups and agencies at all levels.

Product Codes, Standards and Certifications

- There is no current standard practice to measure, quantify, or report the carbon footprint of a product or technology. There is no verification that a product utilizes CO_2. There is no sufficiently detailed, standard method to perform life-cycle-analysis for CO_2 conversion.
- These issues must be remedied in order to allow for technology/product developers to obtain/qualify for some “low-carbon” certification (and possible subsequent incentive) and to encourage consumers to purchase such certified products. This will promote commercialization.

Technology

- Responses covered a wide variety of CO_2 conversion products and pathways.
- The discussed CO_2 utilization technologies spanned a range of maturity levels, but most technologies are at a lower TRL.
- Respondents commonly expressed the need for both standards and certifications as well as funding, incentives, and policy to support scale-up and commercialization efforts.
- The respondents claimed that CO_2 conversion would reduce CO_2 emissions. Details were scant for the market scale/emissions reduction potential of individual technologies and products, but several reports were cited that indicated that the CO_2 conversion market would see expansive growth and use up to several gigatons of CO_2 per year.
- Major commercialization is expected to commence in the early to mid 2030’s.
- Economic support to Underserved Communities, due to CO_2 conversion commercialization, would be provided due to the creation of new jobs ranging from construction, to product manufacture, to product value chains.

Additional References

- https://usea.org/event/virtual-carbon-management-applicant-education-workshop
- LCA Toolkit available at netl.doe.gov/LCA/CO2U

International Collaboration

- USDOE first joined ACT partners in ACT 2
- In ACT 3, USDOE supported more than 5 multilateral project through national lab network
  - Conversion program supports NEXTCCS, CoCaCo2la, ACTION

ACT 4 is currently open

http://www.act-ccs.eu/calls Due 9/12

Bilateral Efforts

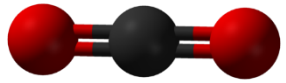
India- Department of Science and technology

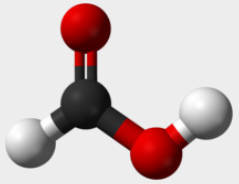
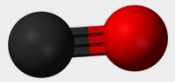
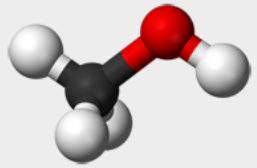
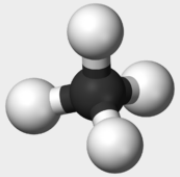
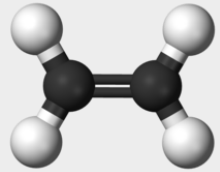
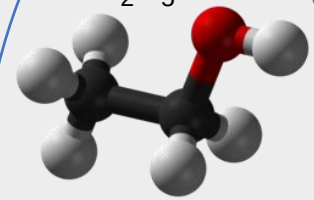
Japan- National institute of Advanced Industrial Science and Technology

Canada – National Resources Canada

CO_2: A Potential Reactant to Platform Chemicals

Carbon Dioxide
CO_2



Electrons Required:	+2e⁻	+2e⁻	+6e⁻	+8e⁻	+12e⁻	+12e⁻
Products	**Formic Acid** $HCOOH$ 	**Carbon Monoxide** CO 	**Methanol** CH_3OH 	**Methane** CH_4 	**Ethylene** C_2H_4 	**Ethanol** C_2H_5OH 
Current Industrial Production Methods	Methyl Formate Hydrolysis $CH_3OH + CO \rightarrow HCOOCH_3$ $HCOOCH_3 + H_2O \rightarrow HCOOH + CH_3OH$	Coal Gasification $C + H_2O \rightarrow CO + H_2$ Steam Reforming $CH_4 + H_2O \rightarrow CO + 3H_2$	Syngas Conversion $CO + 2H_2 \rightarrow CH_3OH$	Major Component of Natural Gas	Steam Cracking $C_2H_6 \rightarrow C_2H_4 +$ other cracking products	Ethylene Hydration $C_2H_4 + H_2O \rightarrow C_2H_5OH$ Fermentation $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ (using yeasts)

https://netl.doe.gov/coal/carbon-utilization

Questions?

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