



U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

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Carbon Utilization R&D Program

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Division for Carbon Dioxide Removal and Conversion



Legend:

- Light Rare Earth Elements
- Heavy Rare Earth Elements
- Critical Rare Earth Elements
- Critical Minerals

H	He																	He					
Li	Be																	B	C	N	O	F	Ne
Mg																	Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn							
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr							
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu									





Carbon Dioxide Removal

Removal of atmospheric CO₂ and durable store



Carbon Utilization

Conversion of CO₂ to value-added products



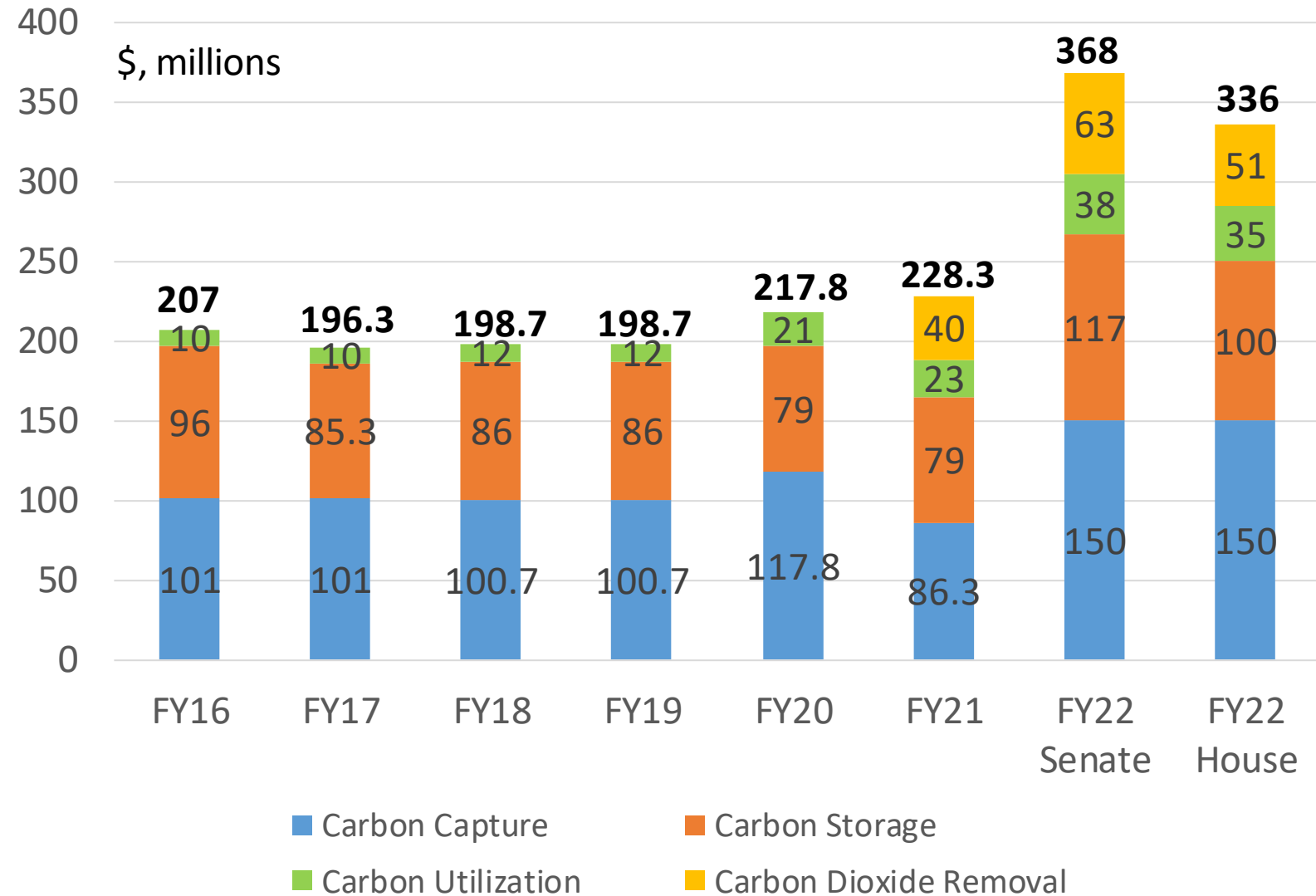
Carbon Storage

Safe, cost-effective, and permanent geologic storage of CO₂



Carbon Capture

Capturing CO₂ from new and existing industrial and power plants



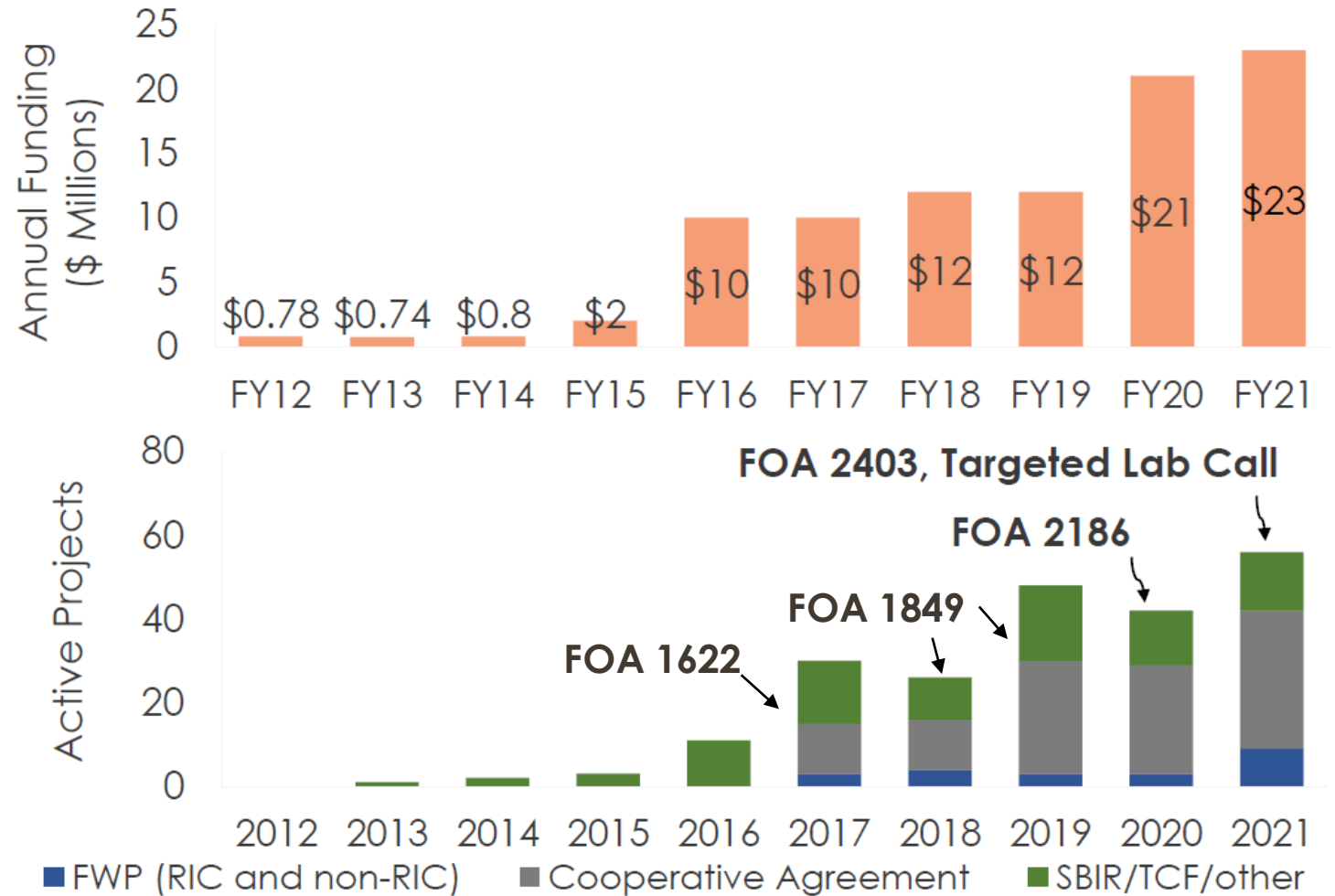
PROGRAM HIGHLIGHTS

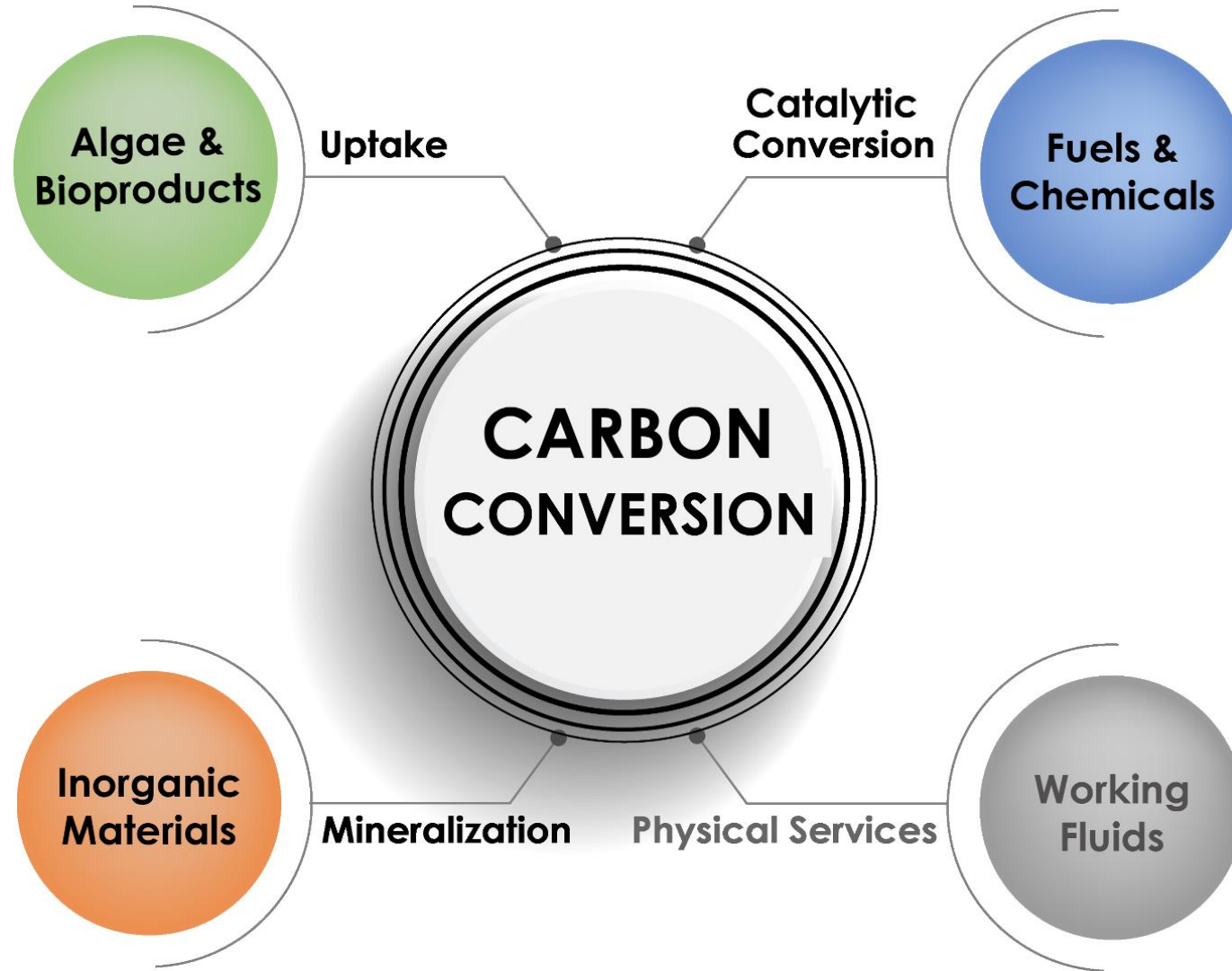
70+ ACTIVE RESEARCH PROJECTS WITH OVER 30 DIFFERENT PARTNERS

LIFE CYCLE ANALYSIS & TECHNO-ECONOMIC ANALYSIS TOOLS

TECHNOLOGY TESTING FACILITIES

KNOWLEDGE SHARING AND COLLABORATION

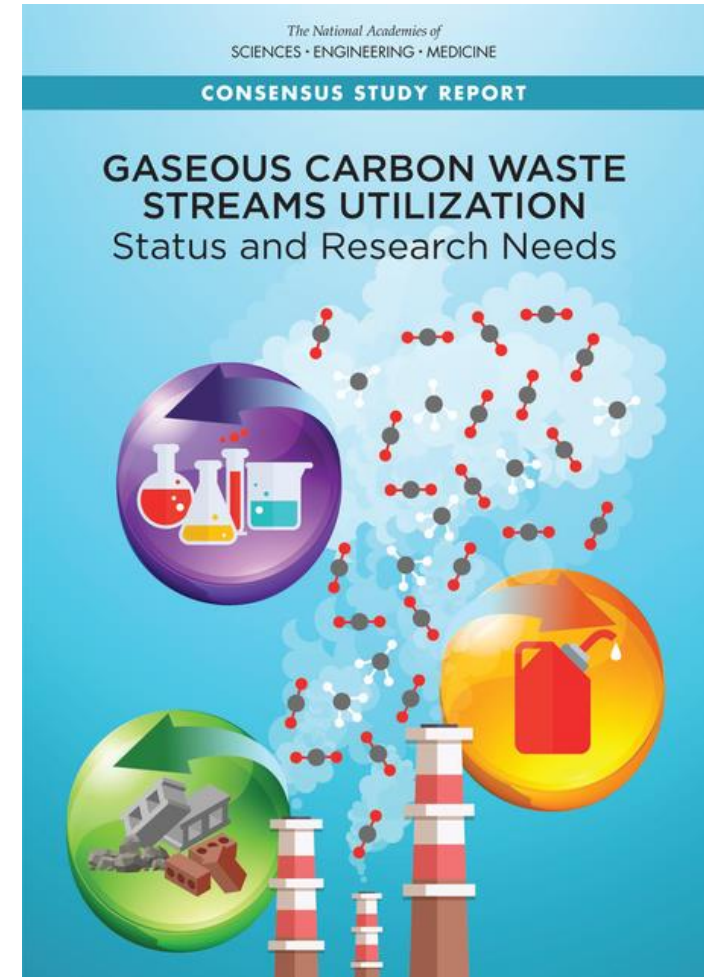




Focus of other programs

Gaseous Carbon Waste Streams Utilization: Status and Research Needs

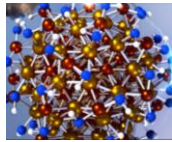
- Characterization of Carbon Resources
- Research Agenda and Challenges
- Technical review of Conversion Pathways
- Enabling technologies
- Life cycle assessment
- Market and Commercialization Opportunities



<https://www.nap.edu/catalog/25232/gaseous-carbon-waste-streams-utilization-status-and-research-needs>

Carbon Utilization Challenges

Catalytic Conversion Challenges



Catalyst
Durability
and Stability

High
Energy
Reactants

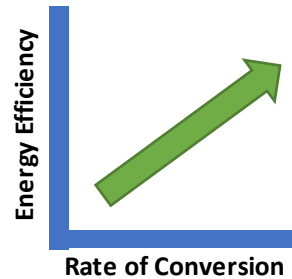
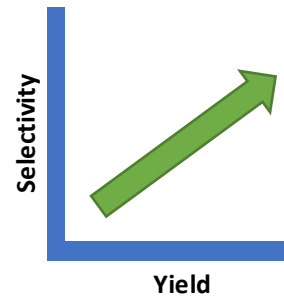


Limited C₂+ products

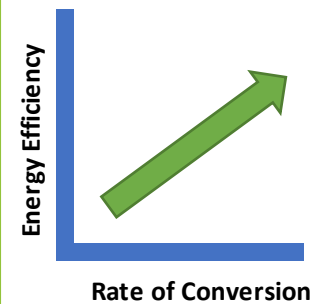
CO_{2(g)}
(-394 kJ/mole)
Gibbs Free Energy

Reliable, inexpensive
carbon free energy

Electrochemical & Photochemical Challenges



Mineral Carbonation

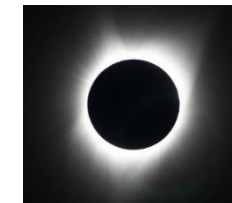


Availability of
Alkaline Industrial
Wastes

Biological Capture & Conversion



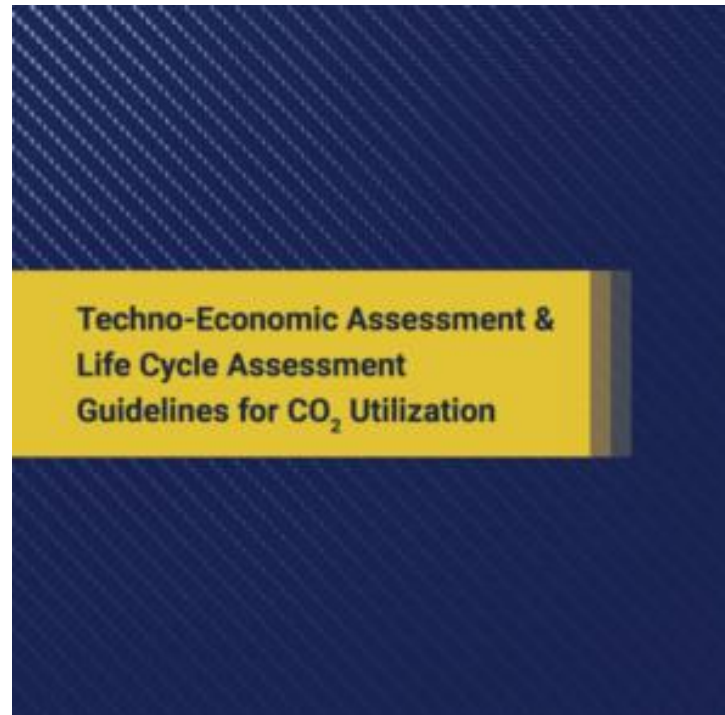
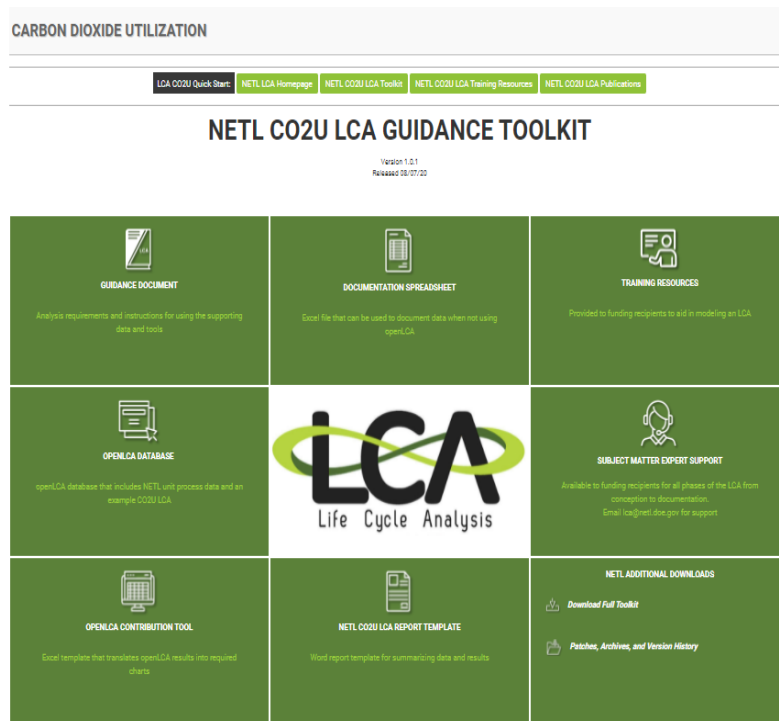
Efficient land use
Algae processing



Efficient capture of total
radiation

Evaluation of technologies

Tools we have now



What we need:

- Benchmarking
- Reporting
- Testing Facilities
- Systems-level understanding of risks & benefits
- Knowledge sharing across disciplines

Reactive Capture and Conversion (RCC)

Newer area of focus within the program where CO₂ becomes incorporated into the final product and is neither regenerated, transported for further use, nor stored as pure CO₂. Selected five new national lab projects to:

- (1) address the mismatch in existing rates
- (2) develop approaches that are robust under intermittent operation;
- (3) identify locations with availability of CO₂, access to inexpensive, renewable electricity, and proximity to product markets.

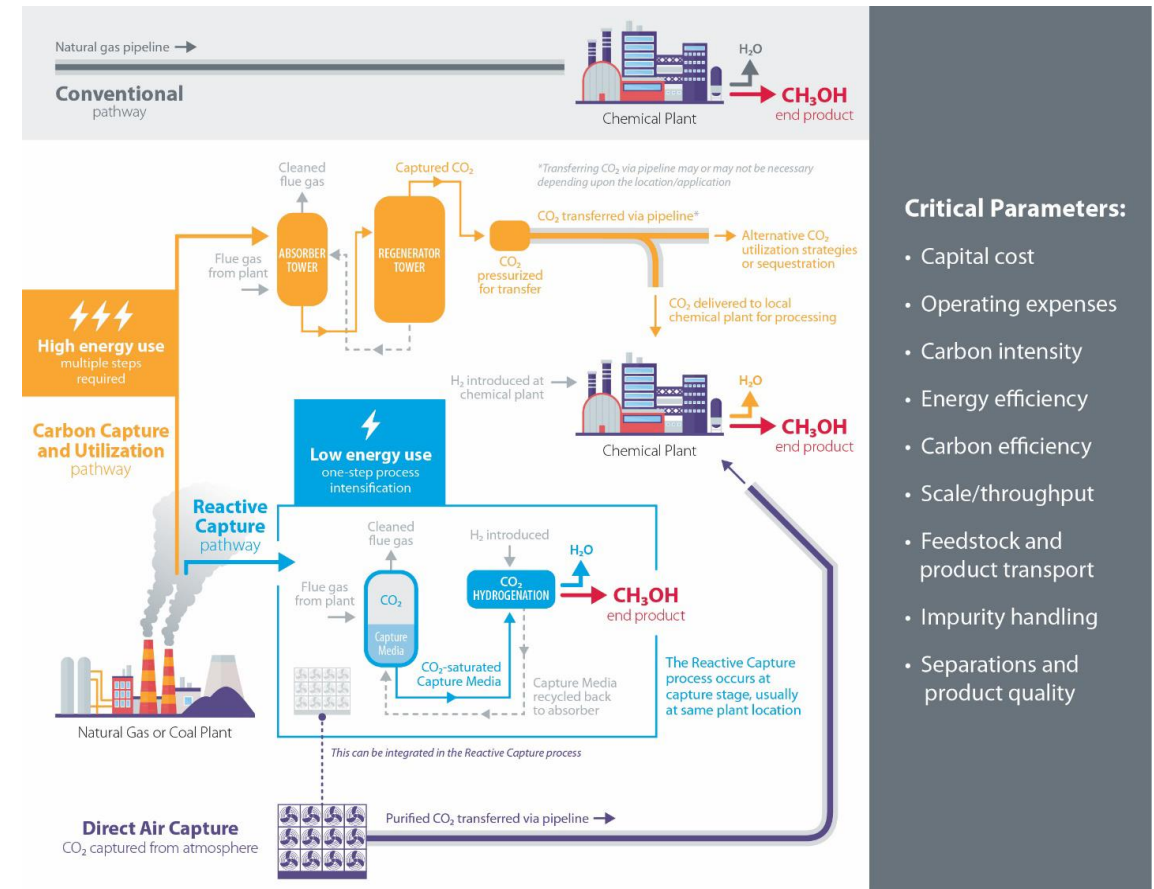
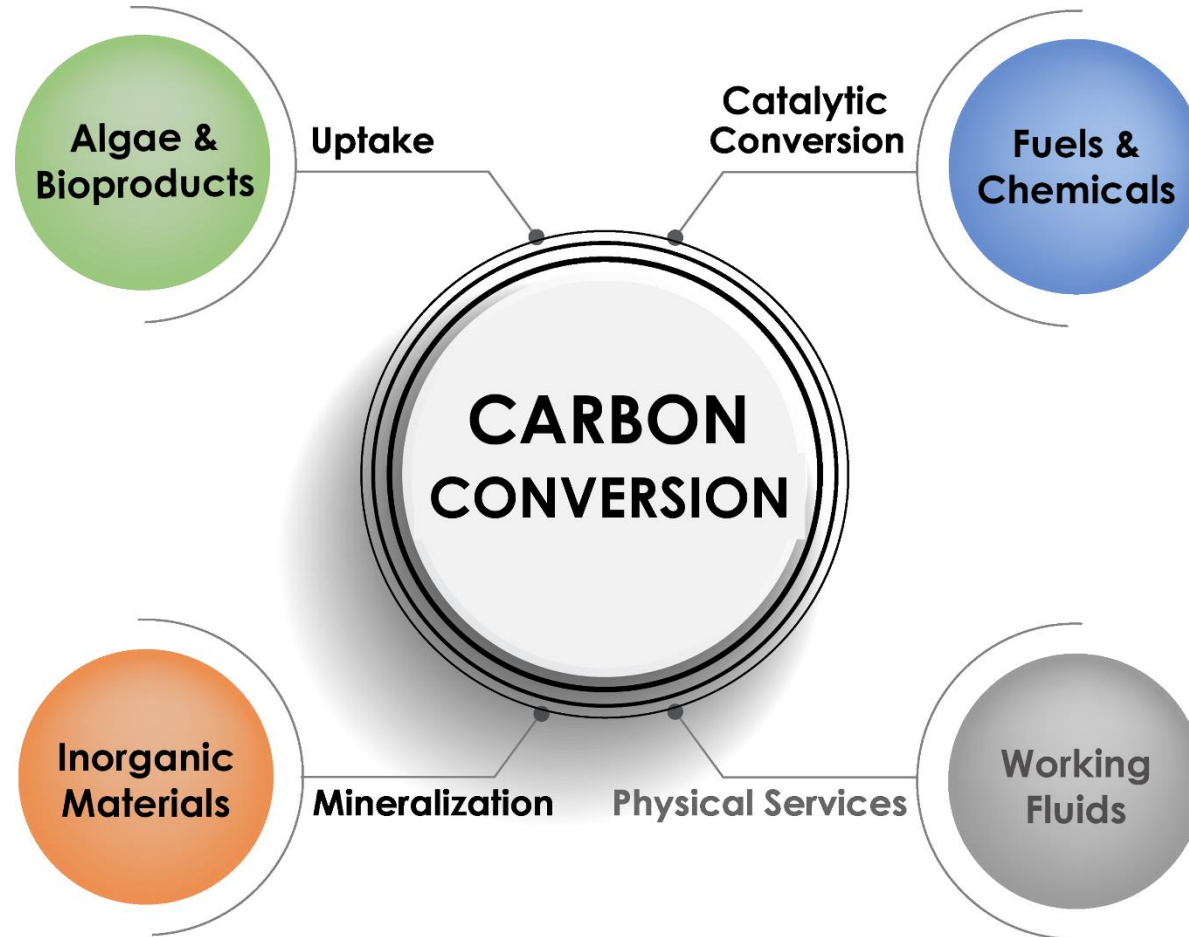


Figure 2 from Summary Report of the Reactive CO₂ Capture: Process Integration for the New Carbon Economy Workshop, February 18–19, 2020

Carbon Utilization Program Structure



Focus of other programs

Challenges

- Scale & Rate of CO₂ emissions relative to of CO₂ conversion
- Determining economic viability and environmental impact requires significant resources -> very place-based
 - Technical viability is relatively easy to qualify
- Sweet spot of low carbon & low-cost energy like electricity, CO₂ sources, markets, and transportation between it all



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

Questions?

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