Rhodium Group

The Economic Benefits of Direct Air Capture Hubs

South Texas DAC Hub and Project Cypress

Energy & Climate

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Analysis overview and objectives

The Economic Benefits of Direct Air Capture Hubs

Direct air capture (DAC) is an important carbon dioxide removal technology that can help the US achieve deep decarbonization. The Infrastructure and Investment Jobs Act (IIJA) provided the Department of Energy (DOE) with funding for a range of DAC research and development efforts, including the Regional Direct Air Capture Hubs program, with a total of $3.5 billion for four commercial-scale DAC hubs. These hubs will provide significant experience in deploying DAC at scale, accelerating the commercialization of DAC technologies.

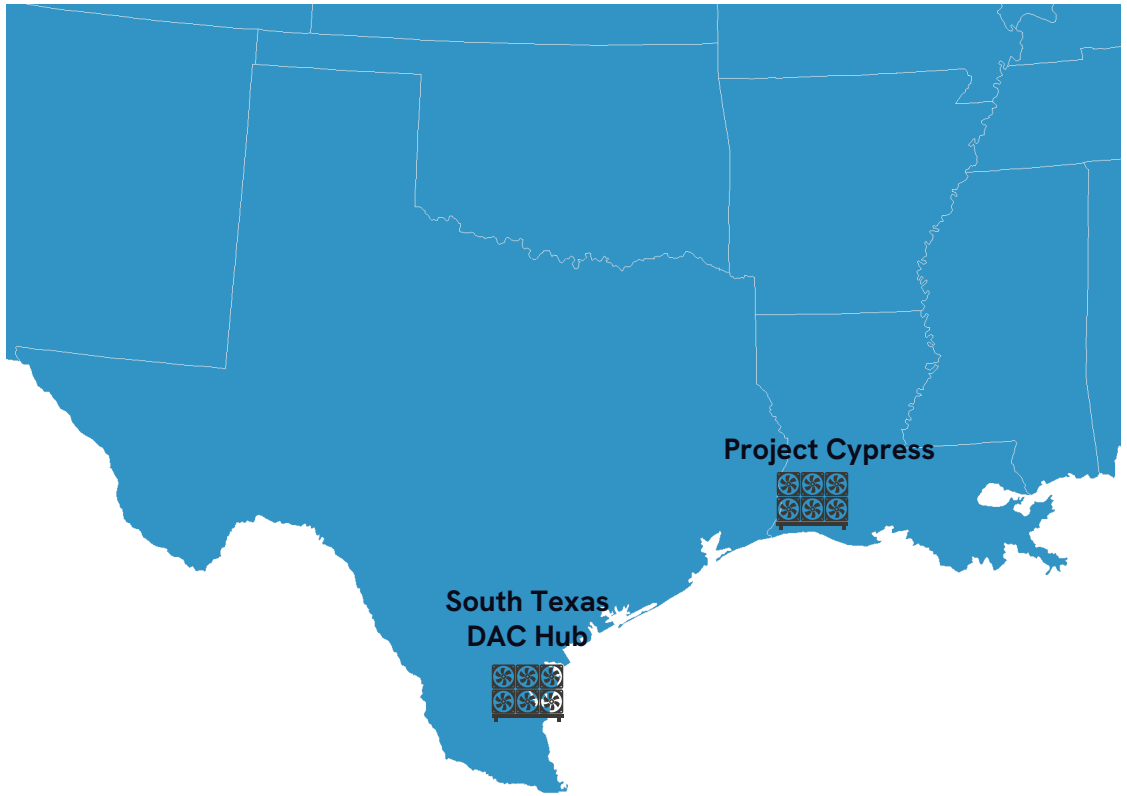
The Great Plains Institute (GPI) commissioned Rhodium Group to conduct an independent analysis exploring the economic benefits associated with the announced DAC hub projects.

Rhodium Group has identified state-level opportunities for DAC deployment to help meet US decarbonization goals. We've also released an occupational analysis characterizing the workforce required to build commercial-scale DAC facilities. Combined with this new analysis of the economic benefits of DAC hubs, this stream of research aims to identify the geographic and topical areas in which workforce preparation is needed to allow DAC to continue to scale.

Analysis overview

- The IIJA will ultimately support four DAC hub projects. At the time of this analysis, the DOE has announced two projects: the South Texas DAC Hub in Texas and Project Cypress in Louisiana (see map).
- This analysis estimates the direct economic benefits, including private sector investment and employment opportunities associated with constructing and operating these DAC hubs.
- Reported employment numbers represent in-state jobs directly related to the construction, engineering, materials, equipment, and labor to build and operate the hubs.
- The range of job estimates reflect Rhodium's range of cost and performance estimates for DAC plants, CO_2 injection and storage, and energy inputs for each hub.

Announced DAC Hub Locations



Source: Rhodium Group.

Methodology and assumptions

Cost research

Rhodium Group conducted a review of public and private industry cost estimates, expert interviews, and the academic literature to develop estimates of capital costs and ongoing operations and maintenance costs for DAC facilities as well as for CO_2 storage in onshore saline storage reservoirs.

Employment analysis

We use the economic model IMPLAN's state-level tools (2022 date year) to translate costs into an employment analysis. For the on-site solar jobs analysis at the South Texas DAC Hub, we use the National Renewable Energy Laboratory's Jobs and Economic Development Impact (JEDI) model. This analysis does not include jobs associated with any CO_2 transport infrastructure from the capture site to the injection well.

Outputs

Jobs associated investment and installation are the average annual jobs over a 5-year construction period. Ongoing operation jobs represent the on-site and off-site jobs associated with operating and powering the DAC hub each year. Employment estimates do not include upstream supply chain jobs or induced jobs. Employment per industrial output is assumed to stay constant over time.

South Texas DAC Hub

Key information about the South Texas DAC Hub

Kleberg County, Texas

Plant Attributes

- The plant is expected to have 1 million metric tons (MMt) of annual CO_2 capture capacity.
- This plant will use Carbon Engineering's liquid solvent DAC technology.
- This hub will include on-site CO_2 injection and storage and on-site solar power.

Industry Stakeholders

- Owner: 1PointFive (Occidental subsidiary)
- DAC Technology Provider: Carbon Engineering (Oxy Low Carbon Ventures/Occidental subsidiary)
- Expected EPC contractor: The Worley Group

Investment

- Rhodium estimates a total investment of $1.3 to $2 billion will be required to support building this DAC plant.
- As part of this investment, the federal government has committed approximately $600 million in funding to this project under the Infrastructure Investment, and Jobs Act (IIJA).

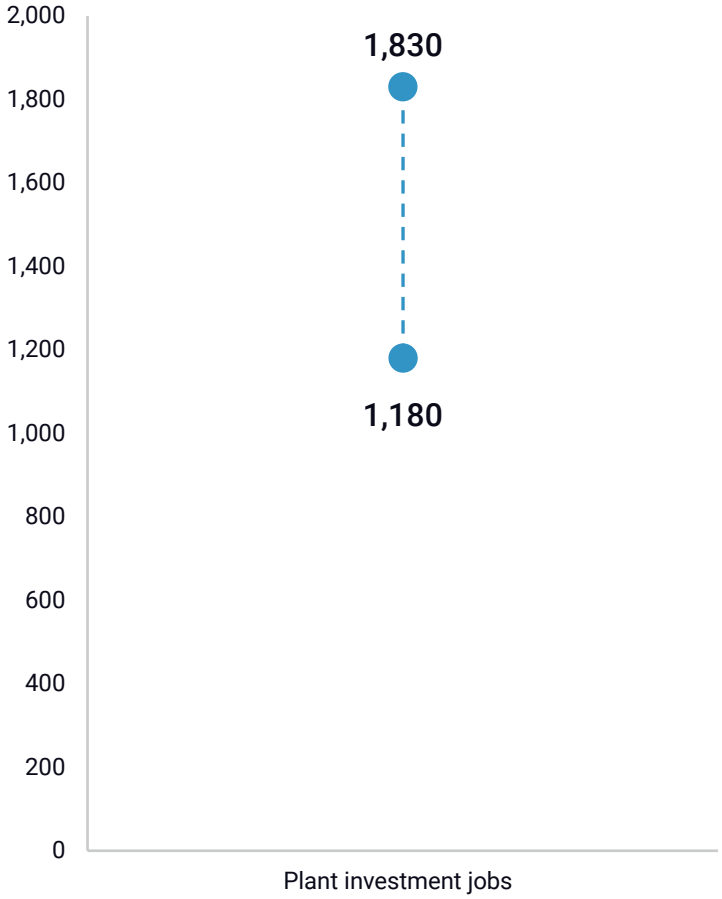
Construction and installation

Numbers reflect a plant with 1MMt of annual capture capacity

- Jobs associated with constructing and installing the South Texas DAC hub total 1,180 to 1,830 annual average jobs over the construction period.
- This includes 110 to 140 average annual jobs associated with on-site solar installation.
- In addition, this hub will have on-site CO_2 injection and storage. 10 to 15 average annual jobs are associated with establishing these wells.

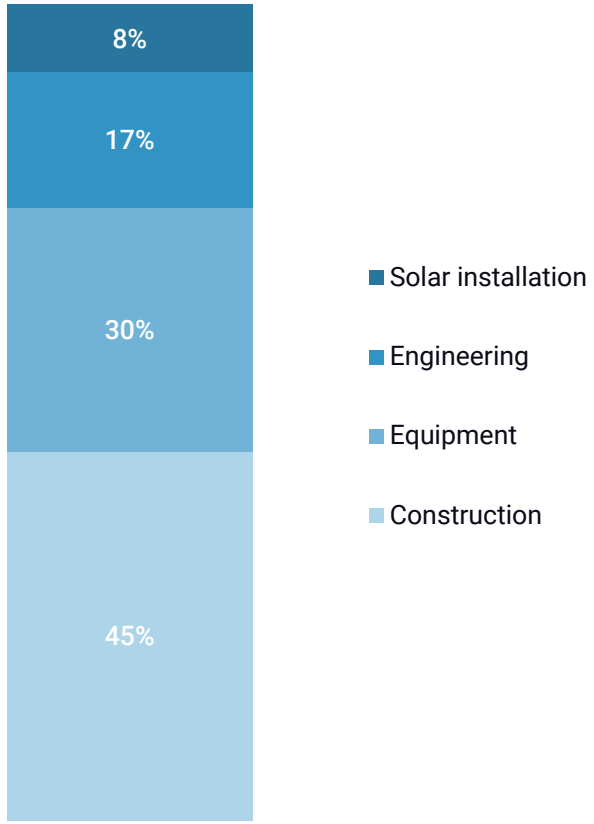
Plant Investment Jobs

Average annual jobs over 5-year construction period



Breakdown of Plant Investment Jobs

Percentage of jobs by industry



Source: Rhodium Group analysis, Keith et al. 2018, National Academies of Sciences, Engineering, and Medicine, Department of Energy, NREL.
Notes: Values reflect a range of cost and performance estimates for a liquid solvent DAC plant, CO_2 injection and storage, and energy inputs. Plant investment, solar installation, and CO_2 storage investment jobs are annualized over an assumed 5-year construction period.

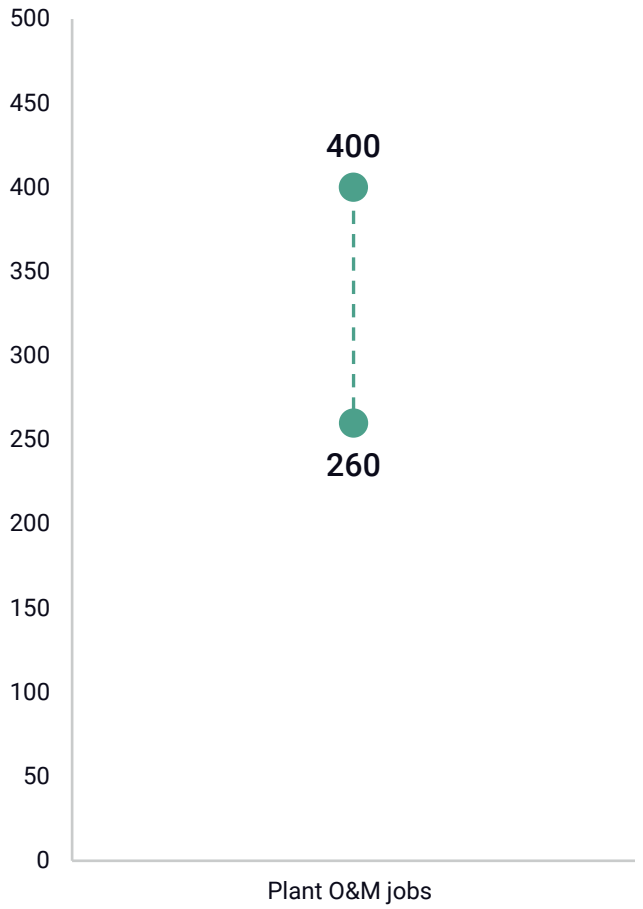
Operations and maintenance (O&M)

Numbers reflect a plant with 1MMt of annual capture capacity

- Annual jobs to operate the hub total 260 to 400 ongoing jobs.
- Additionally, 6 to 9 ongoing jobs are associated with the 1MMt of annual CO_2 storage.

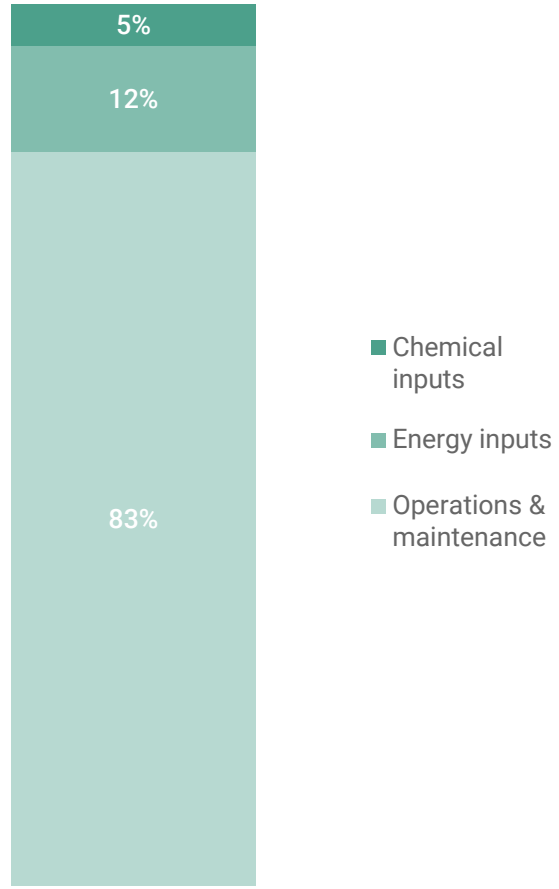
Ongoing O&M Jobs

Average annual jobs over the lifetime of the plant



Breakdown of O&M Jobs

Percentage of ongoing jobs by industry



Source: Rhodium Group analysis, Keith et al. 2018., NASEM, Department of Energy, NREL.
Notes: Values reflect a range of liquid solvent DAC plant cost and performance estimates. We expect DAC plants to be operational for 20-30 years. Ongoing CO_2 injection and storage jobs are associated with just the 1MMt from the DAC facility; however, project leads have indicated they are open to storing CO_2 from other projects in the area. Project assumes an injection depth of 10,000 feet.

Project Cypress DAC Hub

Key information about Project Cypress

Calcasieu Parish, Louisiana

Plant Attributes

- The plant is expected to have 1 million metric tons (MMt) of annual CO_2 capture capacity.
- This plant will use a combination of DAC methods, both Climeworks' solid sorbent technology and Heirloom's mineralization technology.

Industry Stakeholders

- Owner: Batelle
- DAC Technology Providers: Climeworks Corporation and Heirloom Carbon Technologies
- Expected CO_2 Offtaker: Gulf Coast Sequestration

Investment

- Rhodium estimates a total investment of $1.0 to $1.7 billion will be required to support building this DAC plant.
- As part of this investment, the federal government has committed approximately $600 million in funding to this project under the Infrastructure Investment, and Jobs Act (IIJA).

Note: An expected EPC contractor has not been announced for this project.

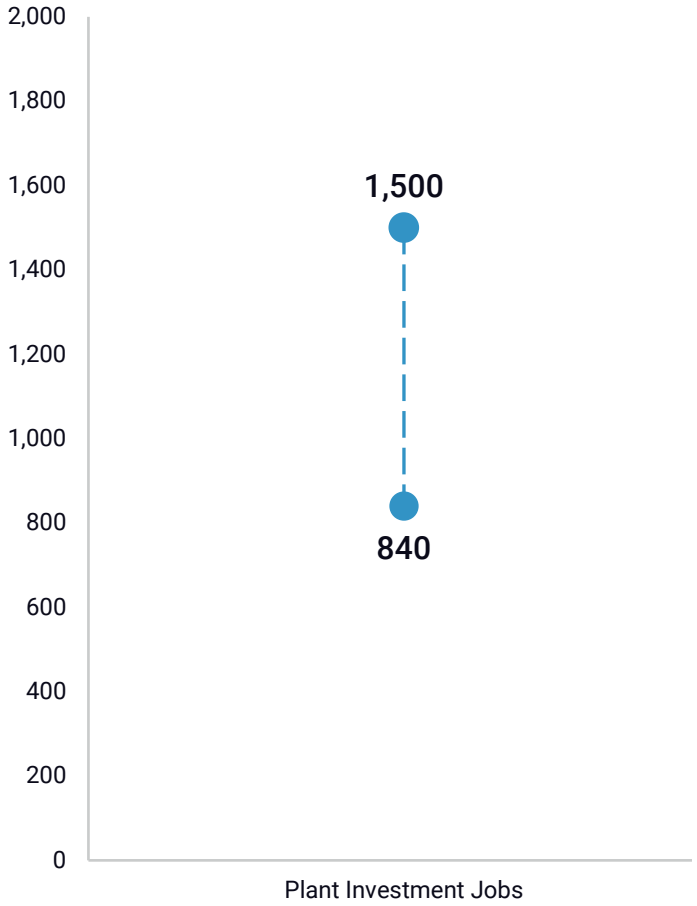
Construction and installation

Numbers reflect a plant with 1MMt of annual capture capacity

- Jobs associated with building and constructing the Project Cypress hub total 840 to 1,500 annual average jobs over the construction period.
- In addition, this hub will include CO_2 injection and storage. 10 to 15 average annual jobs are associated with establishing these wells.

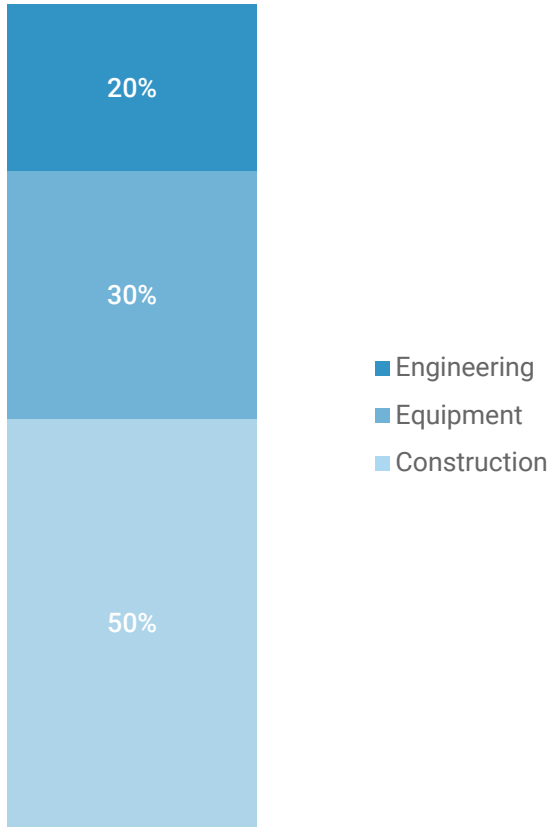
Plant Investment Jobs

Average annual jobs over 5-year construction period



Breakdown of Plant Investment Jobs

Percentage of jobs by industry



Source: Rhodium Group analysis, NASEM, Heirloom, Department of Energy.
Notes: Values reflect a range of solid sorbent and mineralization DAC plant cost and performance estimates. We assume an even split between the two DAC technologies. Jobs associated with capital investments, solar installation, and injection and storage investment are the average annual jobs over a 5-year construction period.

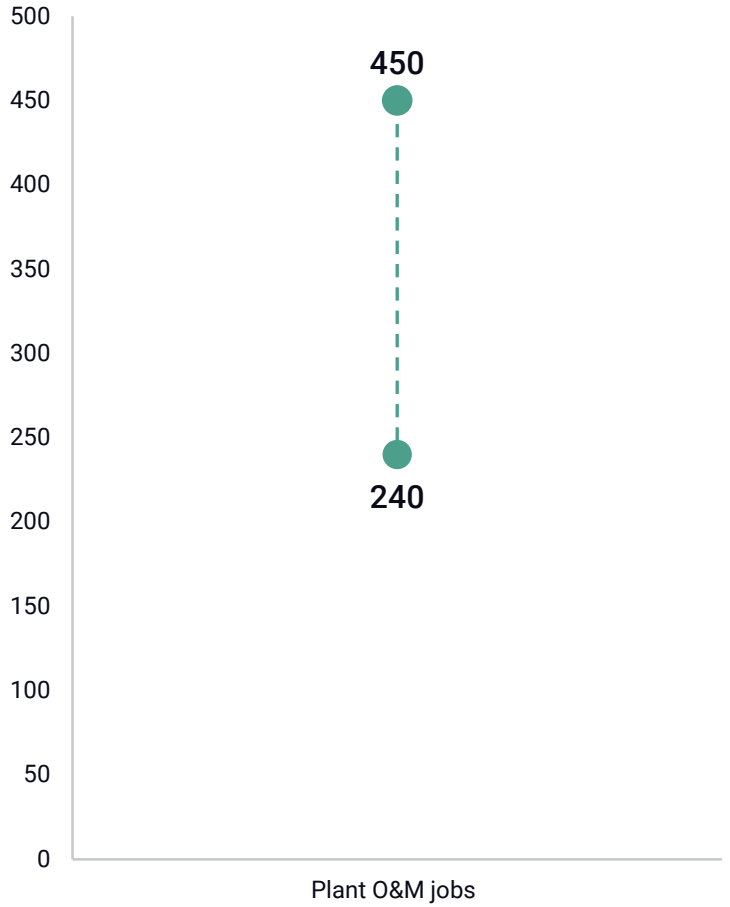
Operations and maintenance (O&M)

Numbers reflect a plant with 1MMt of annual capture capacity

- Annual jobs to operate the hub total 240 to 450 ongoing jobs.
- Additionally, 8 to 10 ongoing jobs are associated with the 1MMt of annual CO_2 storage.

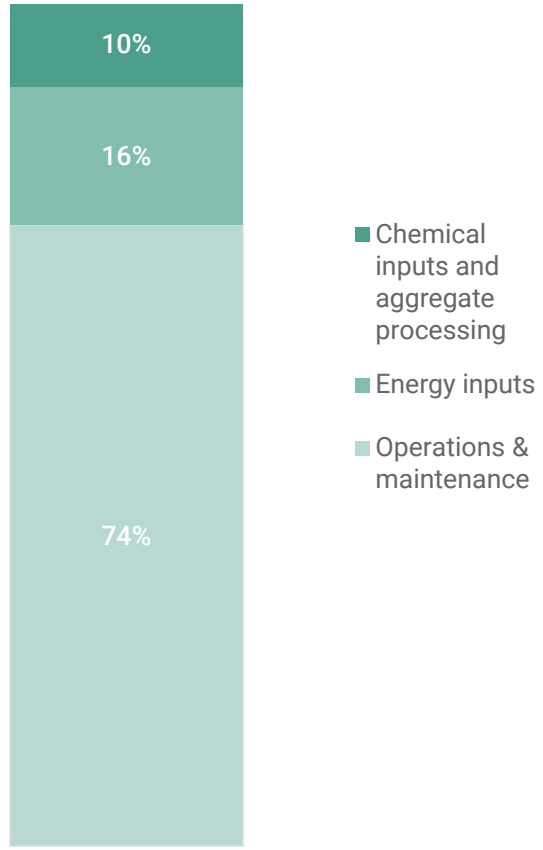
Ongoing O&M Jobs

Average annual jobs over the lifetime of the plant



Breakdown of O&M Jobs

Percentage of ongoing jobs by industry



Source: Rhodium Group analysis, NASEM, Heirloom, Department of Energy.
Notes: Values reflect a range of solid sorbent and mineralization DAC plant cost and performance estimates. We assume an even split between the two DAC technologies. We expect DAC plants to be operational for 20-30 years. Ongoing CO_2 injection and storage jobs are associated with just the 1MMt from the DAC facility. Project assumes an injection depth of 8,200 feet.

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