



# *CO<sub>2</sub> Pipeline Infrastructure – Overview and Pipeline Network Modeling*

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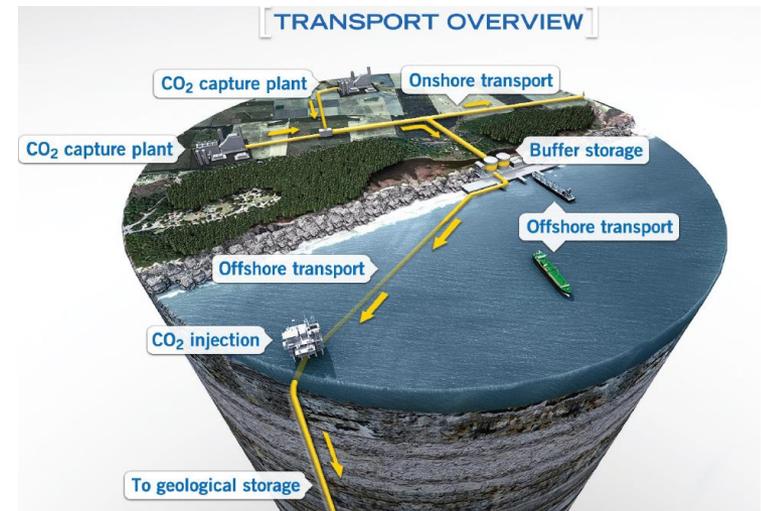
# How is CO<sub>2</sub> Transported?

**Safely and reliably transporting carbon dioxide (CO<sub>2</sub>) from where it is captured to a storage site is an important stage in the carbon capture and storage (CCS) process.**

**Pipelines** are – and are likely to continue to be – the most common method of transporting the very large quantities of CO<sub>2</sub> involved in CCS.

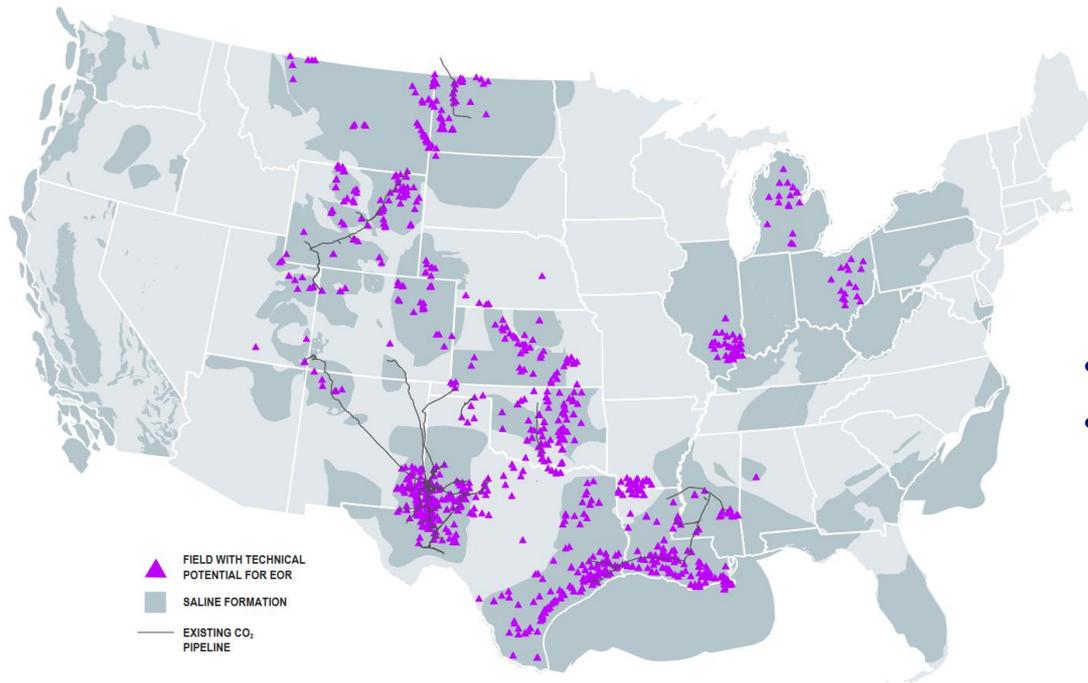
**Ship transportation** can be an alternative option for many regions of the world. Shipment of CO<sub>2</sub> already takes place on a small scale in Europe and Asia.

**Transport of CO<sub>2</sub> by truck and rail** is possible for small quantities. Trucks are used at some project sites, moving the CO<sub>2</sub> from where it is captured to a nearby storage location.



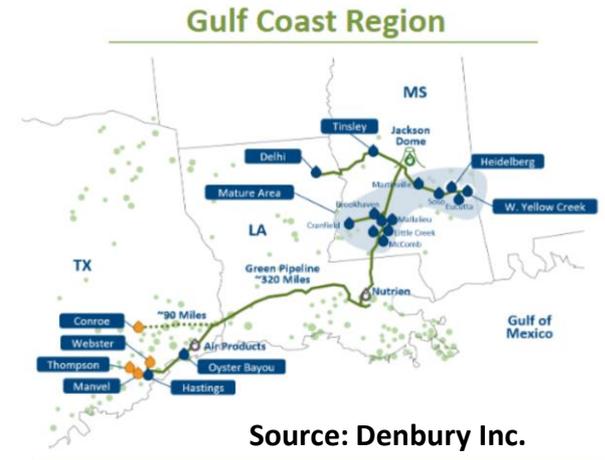
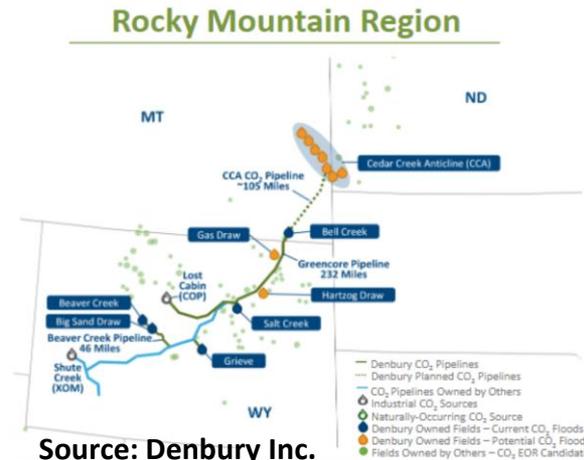
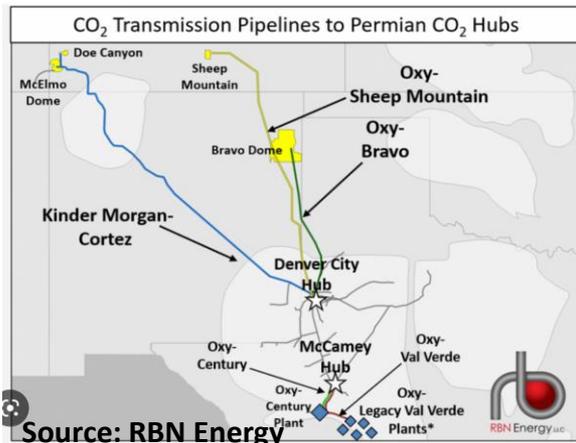
Source: Global CCS Institute

# Existing CO<sub>2</sub> Pipelines in the U.S.



- Approximately 5,000 miles
- Primarily linking natural CO<sub>2</sub> sources to aging oil fields for EOR

Figure authored by GPI based on data from ARI and NATCARB.



# How many miles of new pipeline will need to be built to achieve net-zero emissions by 2050?

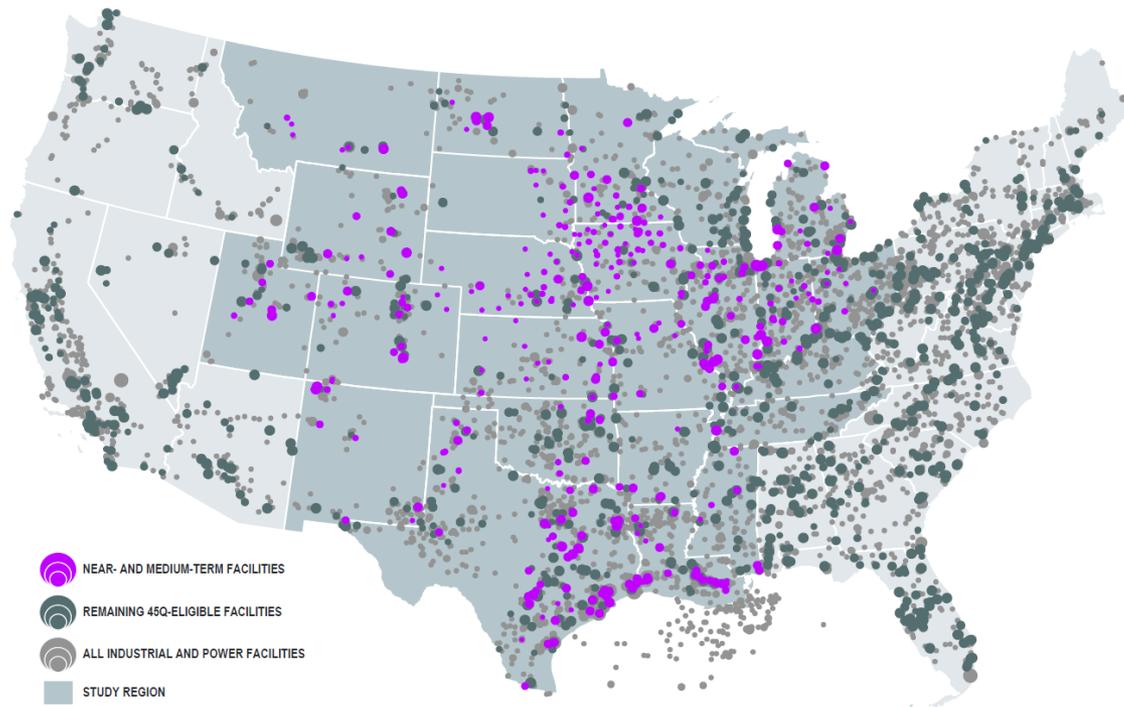
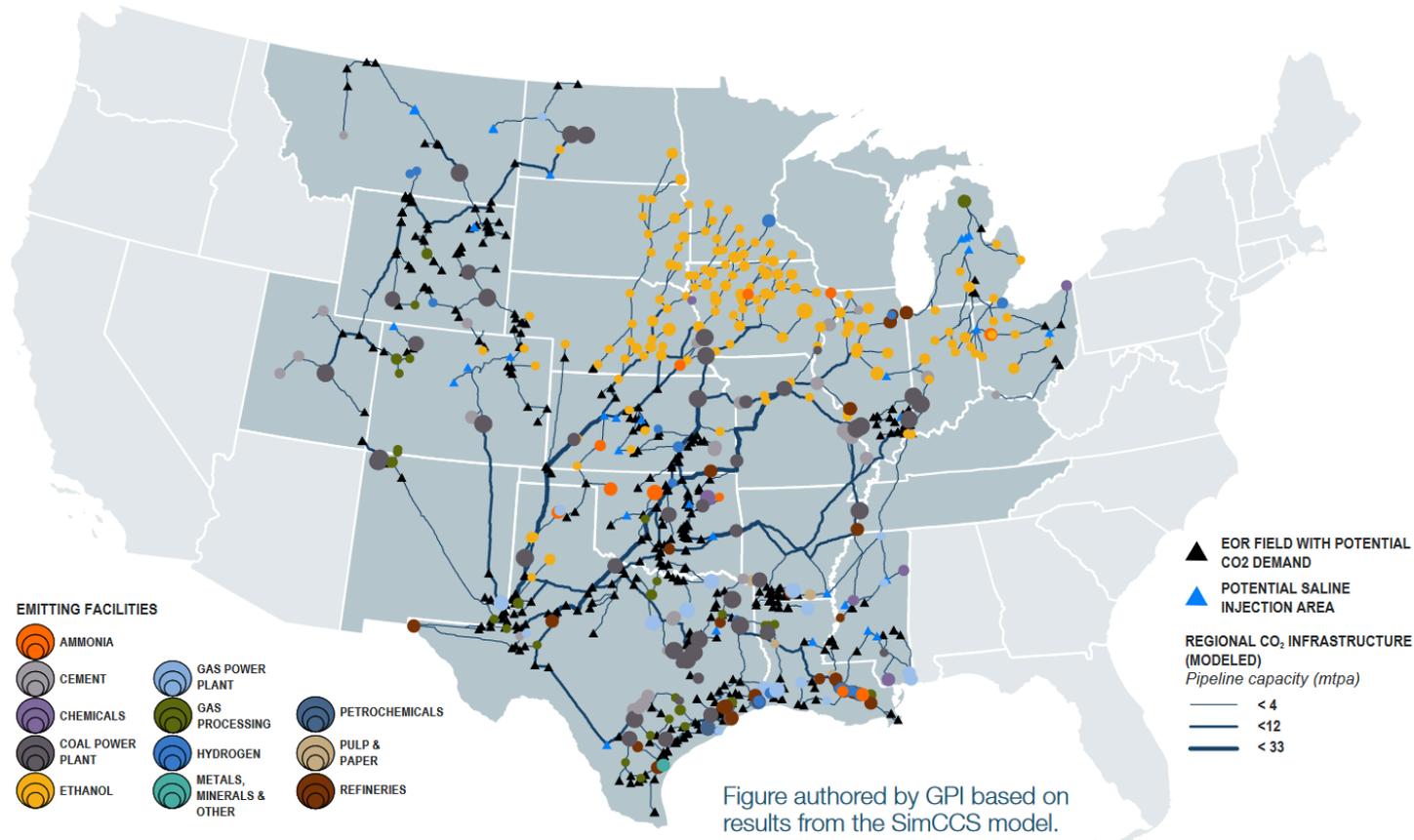


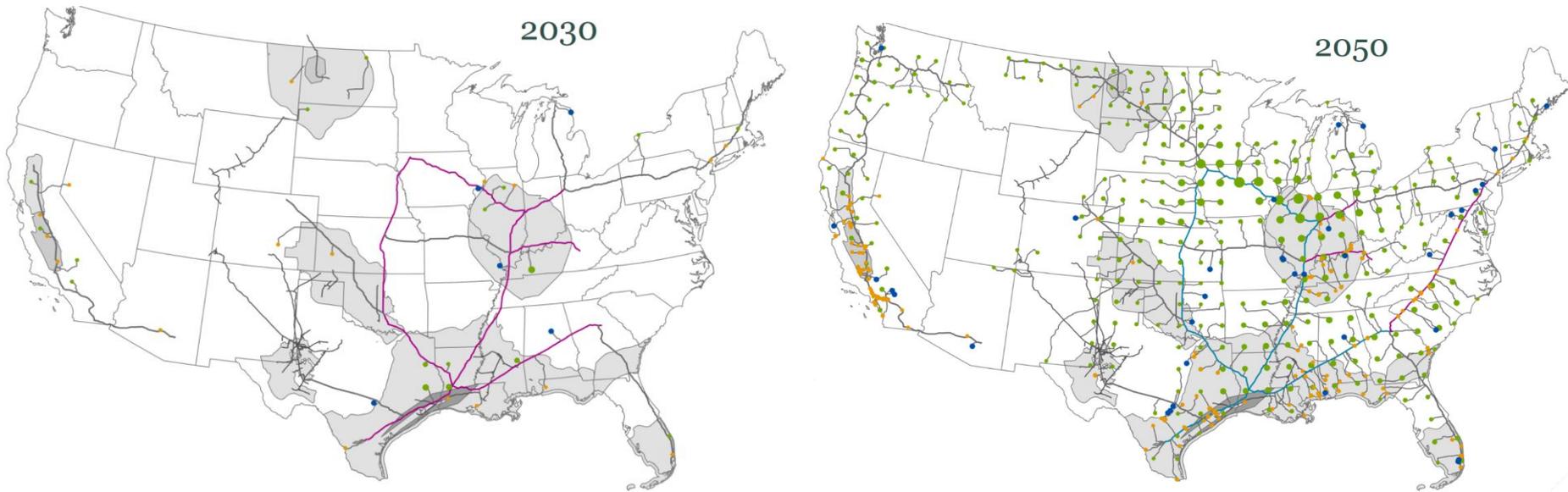
Figure authored by GPI based on data from EPA FLIGHT 2018.

# Transport Infrastructure for Carbon Capture and Storage – Abramson et al., GPI, 2020



- 669 million metric tons/year
- 29,922 miles pipelines in total

# Net-Zero America: Potential Pathways, Infrastructure, and Impacts - Larson et al., 2021



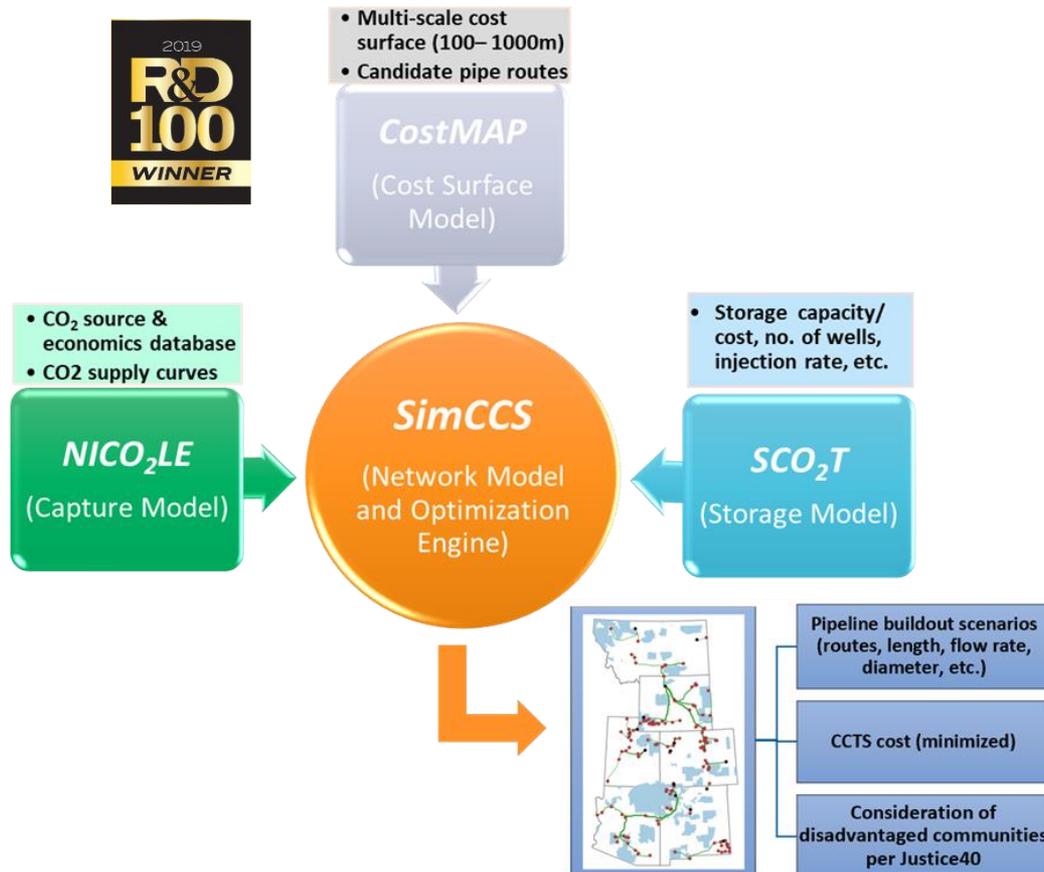
- 65 million tCO<sub>2</sub>/year – 11,806 miles pipelines in total

- 929 million tCO<sub>2</sub>/year – 65,865 miles pipelines in total
  - 13,049 miles trunk lines; 52,816 miles spur lines

# National Scale CCS Pipeline Network Modeling by LANL

- **Objective:** Use *SimCCS* platform to understand potential national scale CCS infrastructure deployment scenarios
- In coordination with DOE-FECM
- In collaboration with OnLocation Inc.

# Technology Background



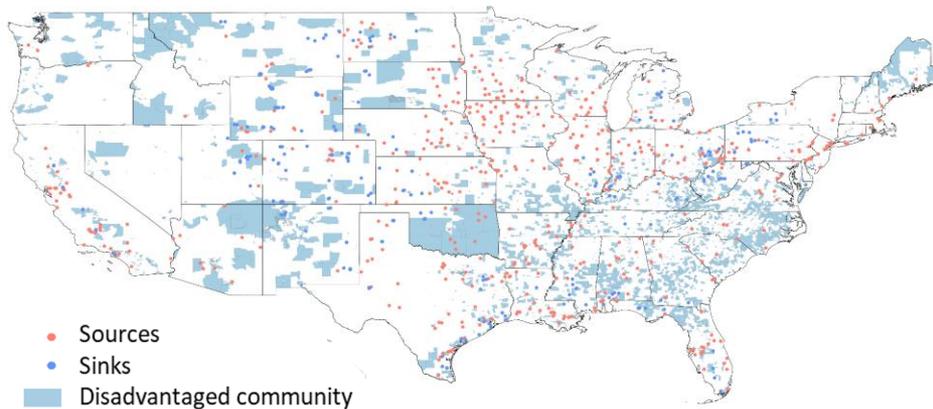
- **NICO<sub>2</sub>LE**
  - Understand commercial-scale capture opportunities.
  - Geodatabase: Source locations, CO<sub>2</sub> streams, & capture costs.
- **SCO<sub>2</sub>T**
  - Rapidly calculate realistic injection & storage & costs.
- **CostMAP**
  - Identify likely corridors by integration of topography, population density, landownership, etc.
  - Develop candidate pipeline routes for *SimCCS* optimization engine.

# SimCCS<sup>3.0</sup>

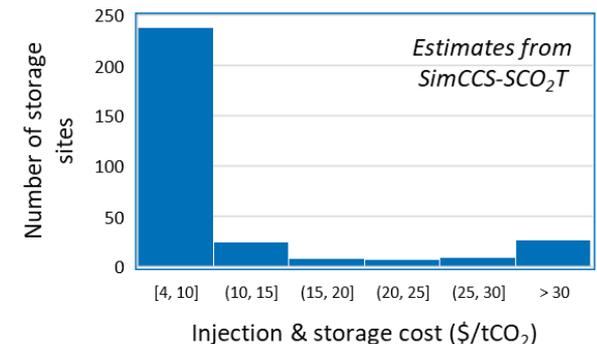
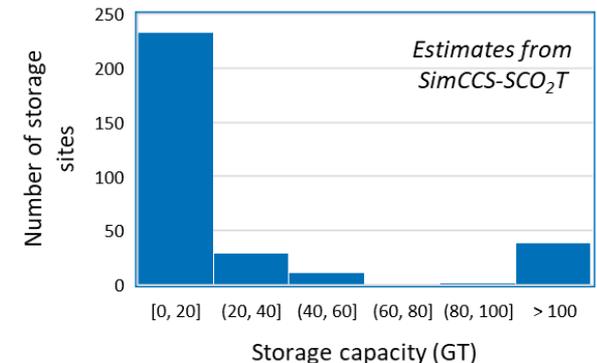
- Address emerging CCUS infrastructure deployment challenges
  - National-scale, regional-scale deployment
  - Phased deployment
  - Account for disadvantaged communities per Justice40 initiative
  - Account for environmentally sensitive areas
  - Dynamic nature of future CO<sub>2</sub> capture (decommissioning of sources, new sources, variable capture amounts)
  - Potential utilization of existing CO<sub>2</sub> pipelines

# Scenario: Climate Goals

- Net Zero GHG emissions by 2050 via the use of economy-wide Cap-and-Trade constraint
- Zero carbon power sector by 2035, includes abatement by use of Direct Air Capture offsets.



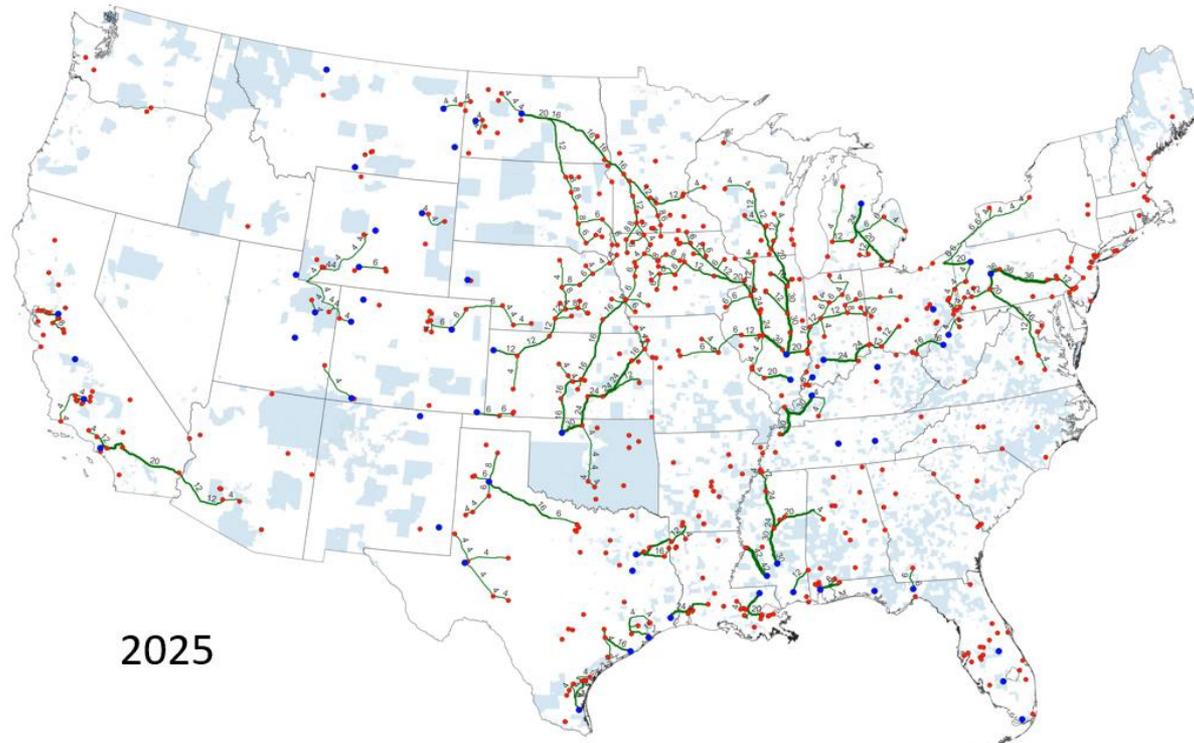
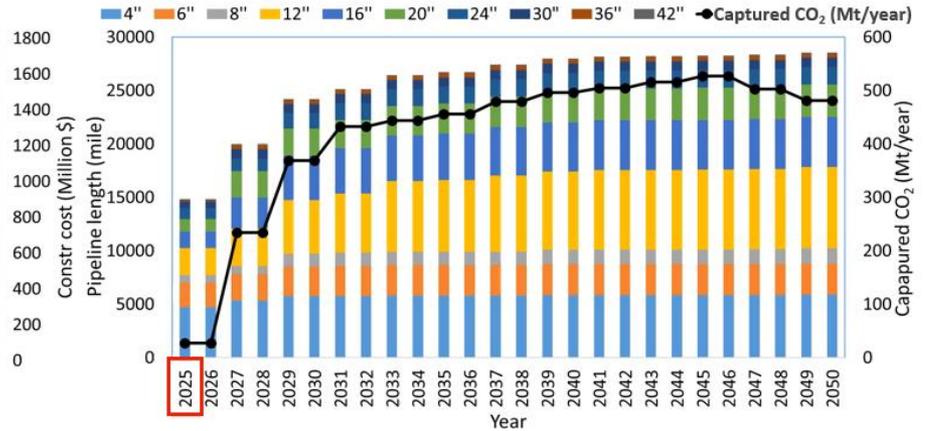
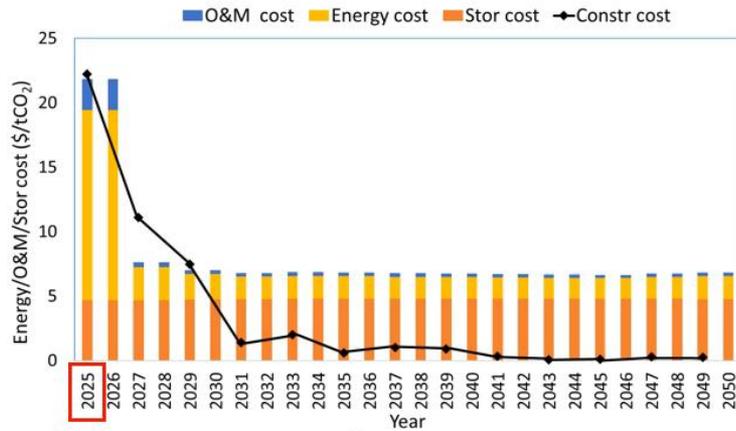
- 671 regional point sources by OnLocation (FECM/NEMS)
- Yearly captured CO<sub>2</sub> amounts vary over a 26-year period (up to 2050)
- 314 geologic sinks – saline formations only (NATCARB)



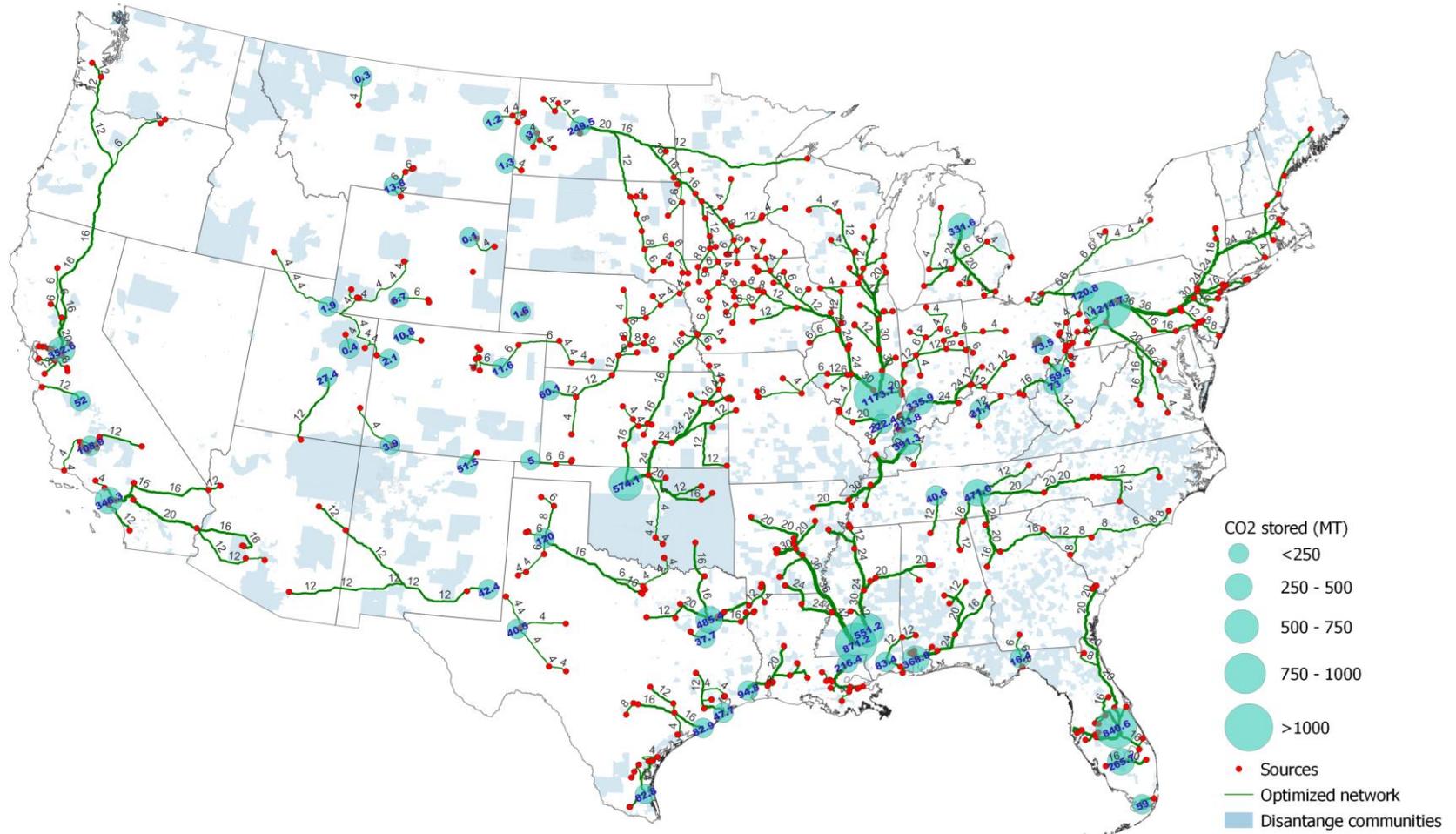
# Case studies

- Case 1: Pipelines do not cross DCs (Disadvantaged Communities)
- Case 2: Pipeline can cross DCs
- Case 3: Pipeline do not cross DCs and existing CO<sub>2</sub> pipelines are utilized where possible

# Case 1: Pipelines do not cross disadvantaged communities

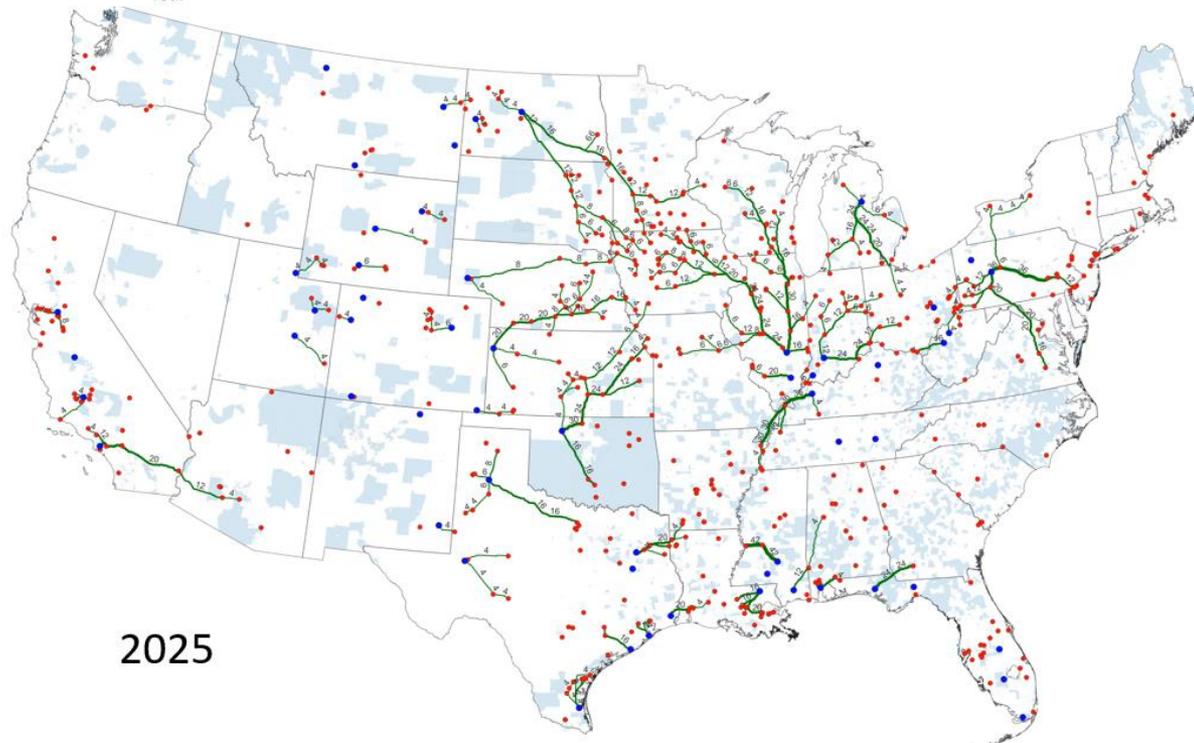
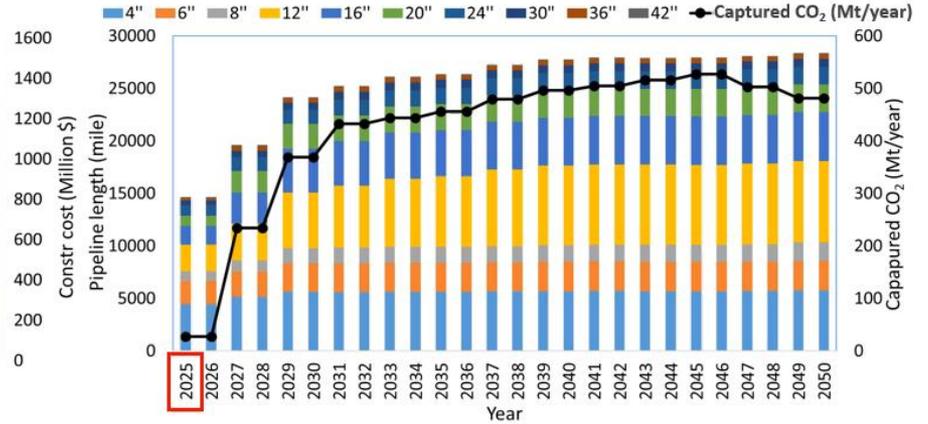
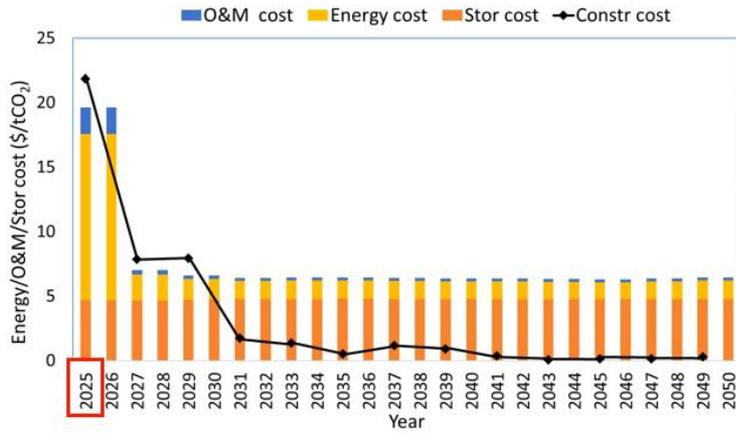


# Case 1: Pipelines do not cross disadvantaged communities

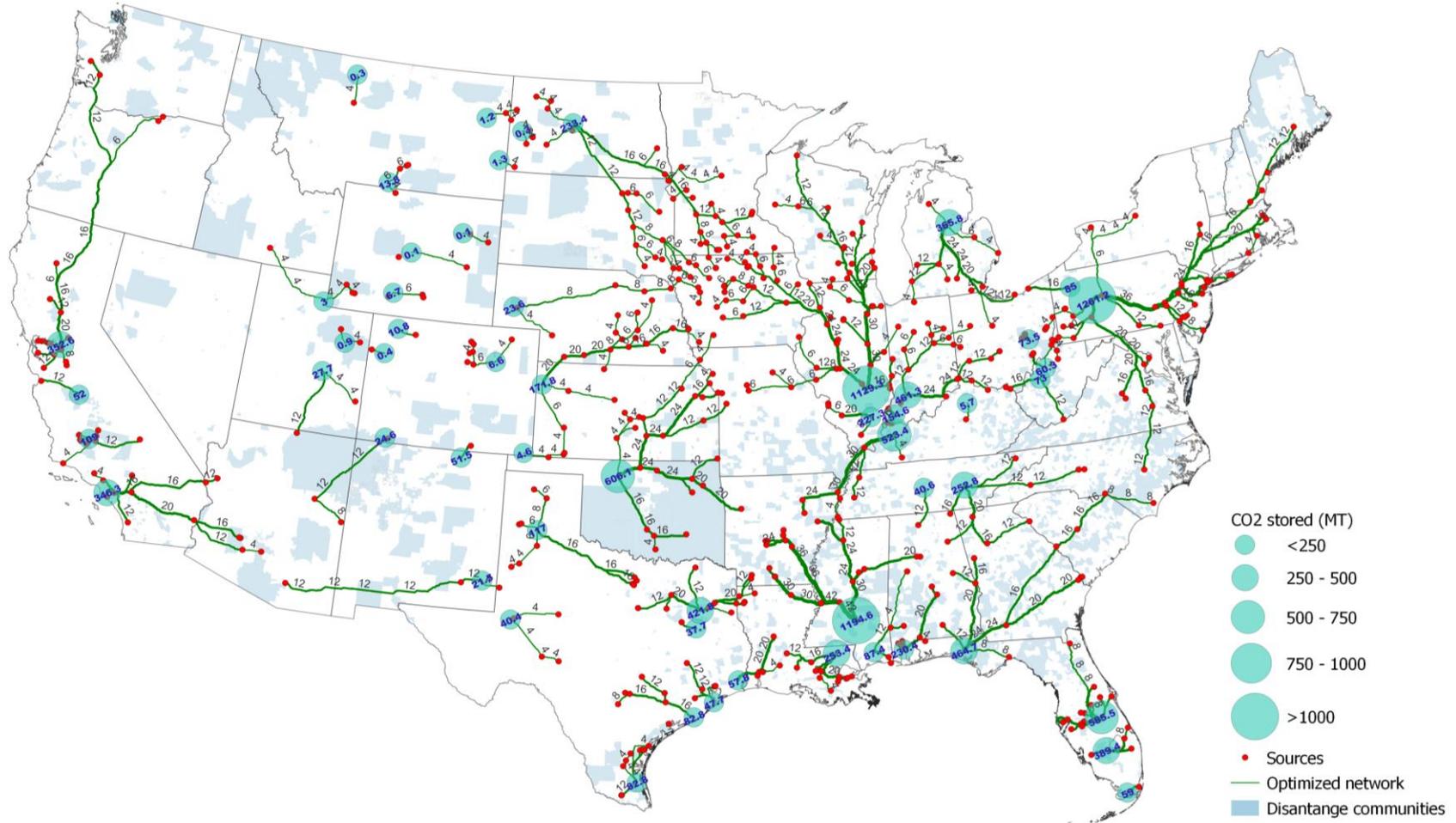


- Total pipeline length: 28,547 miles
  - By 2035: 26,704 miles (93.5%)

# Case 2: Pipelines can cross disadvantaged communities

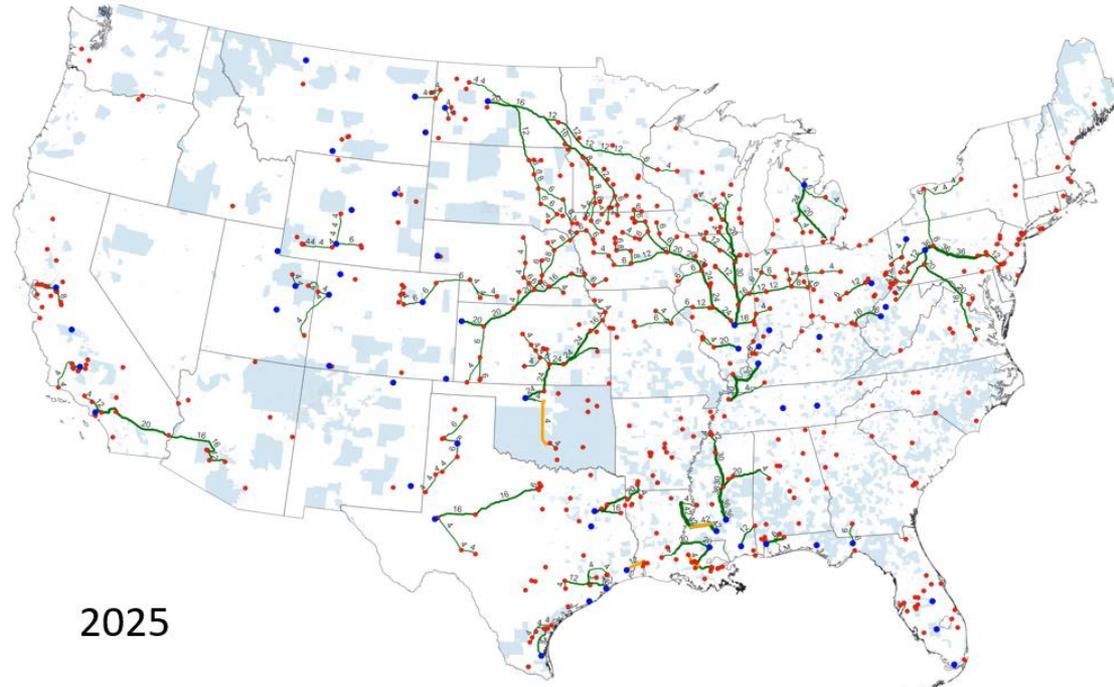
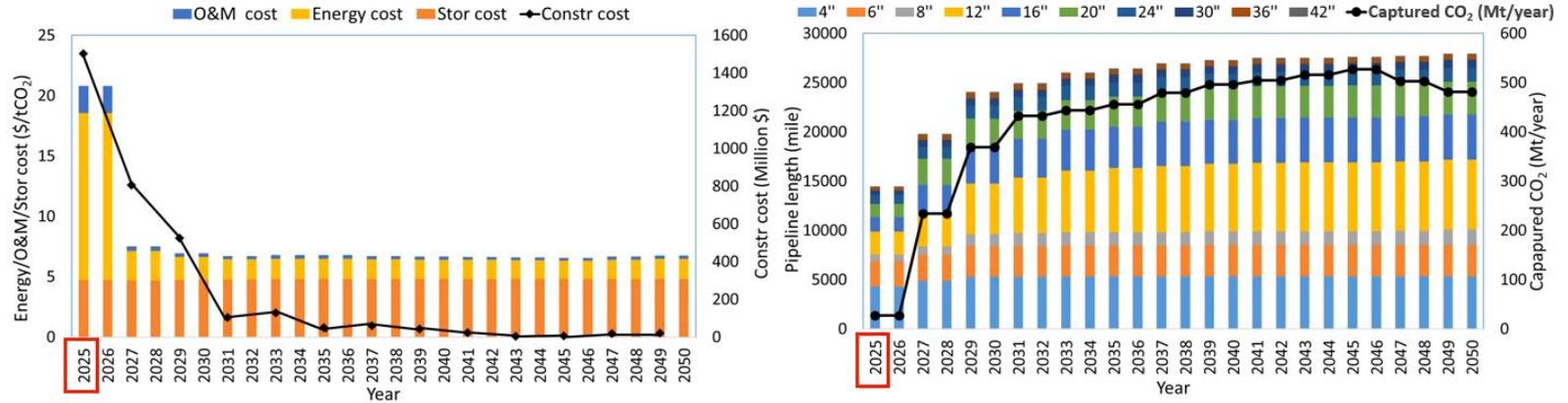


# Case 2: Pipelines can cross disadvantaged communities



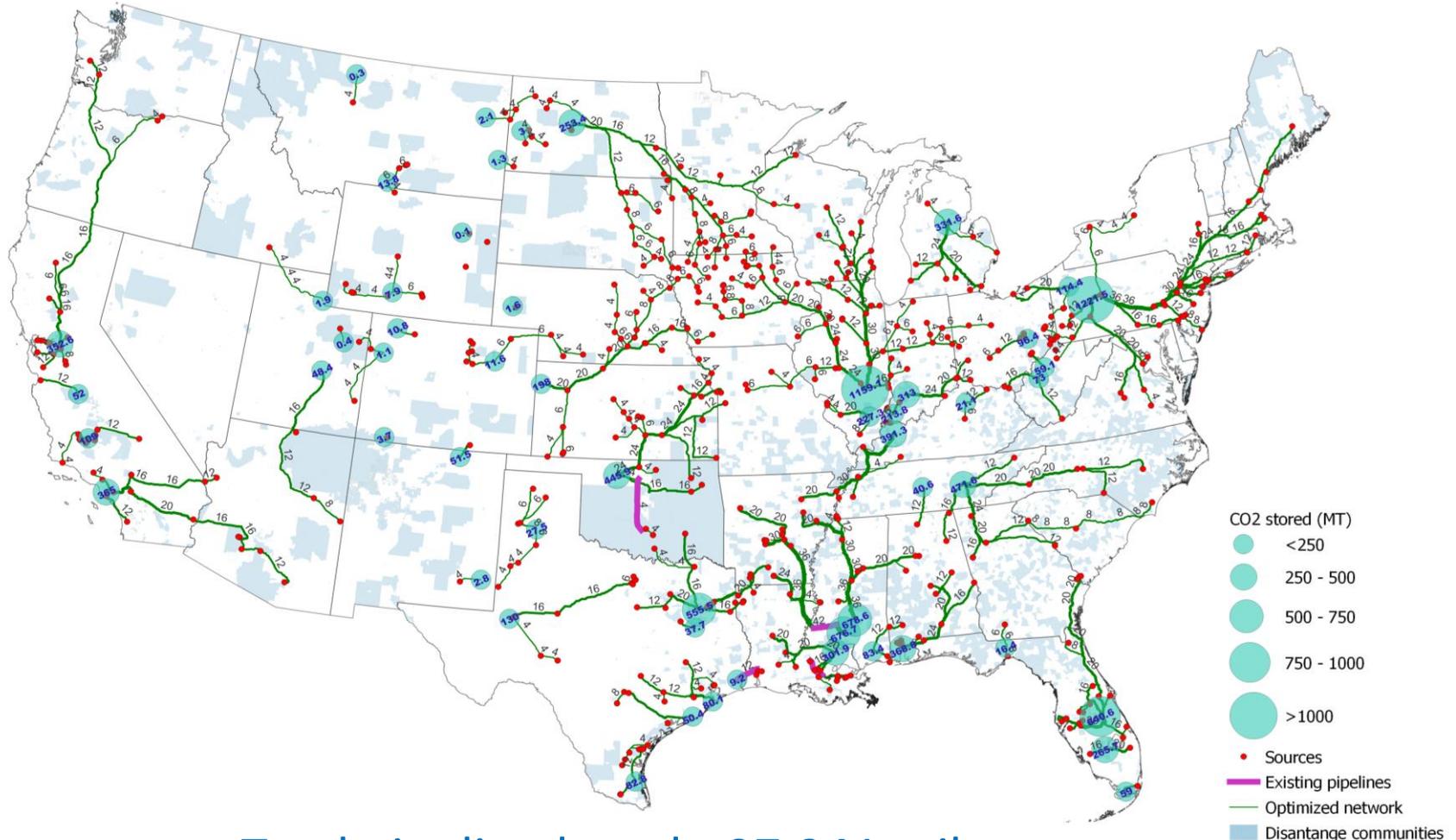
- Total pipeline length: 28,354 miles
  - ~193 miles shorter compared to Case 1
  - By 2035: 26,359 miles (93%)

# Case 3: Pipelines do not cross disadvantaged communities and existing CO<sub>2</sub> pipelines are utilized



2025

# Case 3: Pipelines do not cross disadvantaged communities and existing CO<sub>2</sub> pipelines are utilized



- Total pipeline length: 27,941 miles
  - By 2035: 26,431 miles (94.6%)
  - ~271 miles of existing CO<sub>2</sub> pipelines are utilized

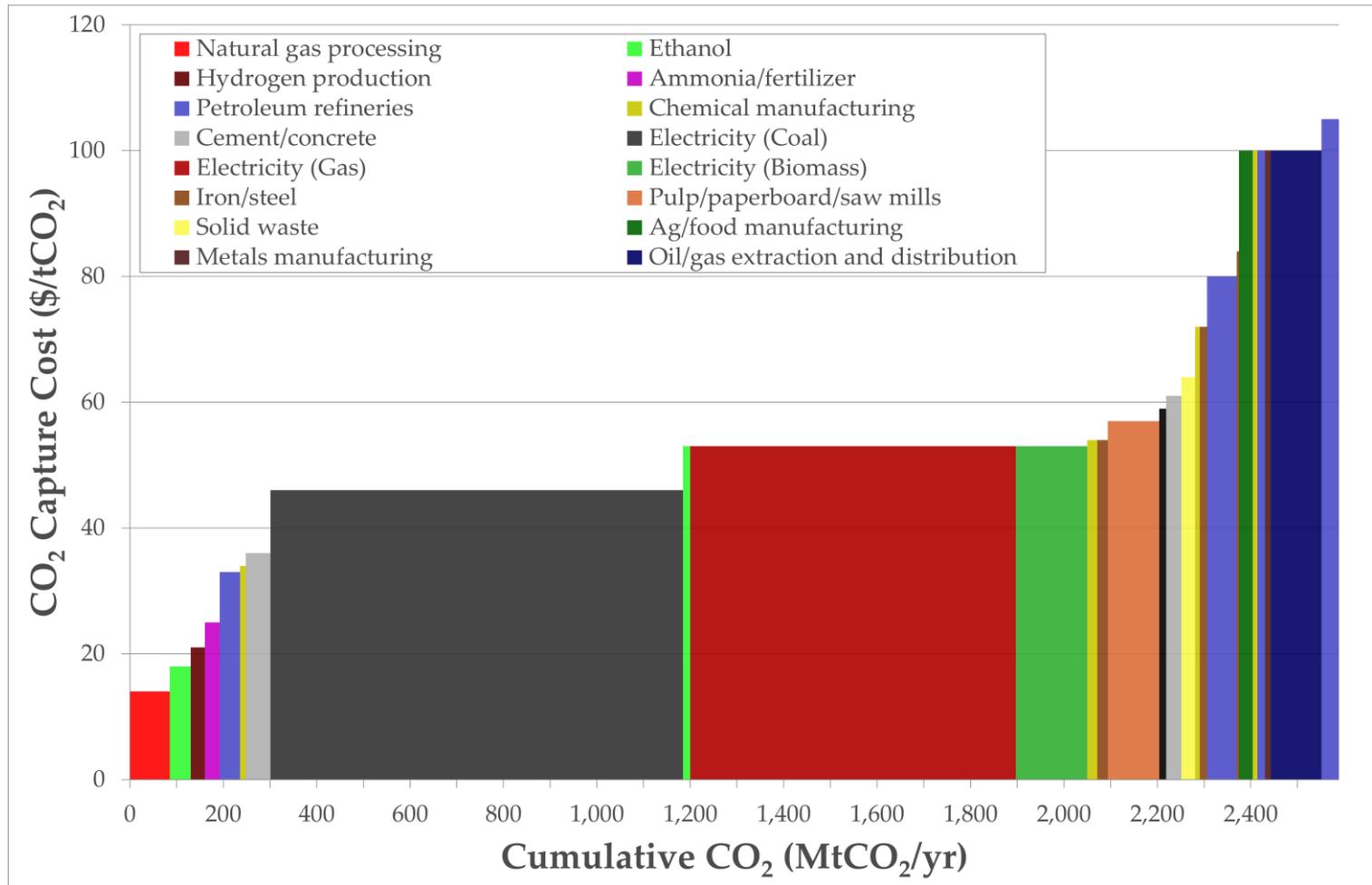
# Observations

- Deployment of large-scale CCS will require large-scale regional infrastructure:
  - Capture CO<sub>2</sub> from multiple sources and transport it to multiple sinks
- ~28,000 miles of new pipelines will need to be constructed to capture and store the emissions from the point sources (as identified in OnLocation scenario).
  - ~93% - 95% of new pipelines will have to be constructed by 2035 to meet the goal of zero carbon power sector (91.4% emissions are from power sector)
  - ~271 miles of existing CO<sub>2</sub> pipelines can be potentially utilized
  - The eastern, mid-western, western regions of US will need to have higher number of trunk lines to facilitate transport of captured CO<sub>2</sub>

Thank you!  
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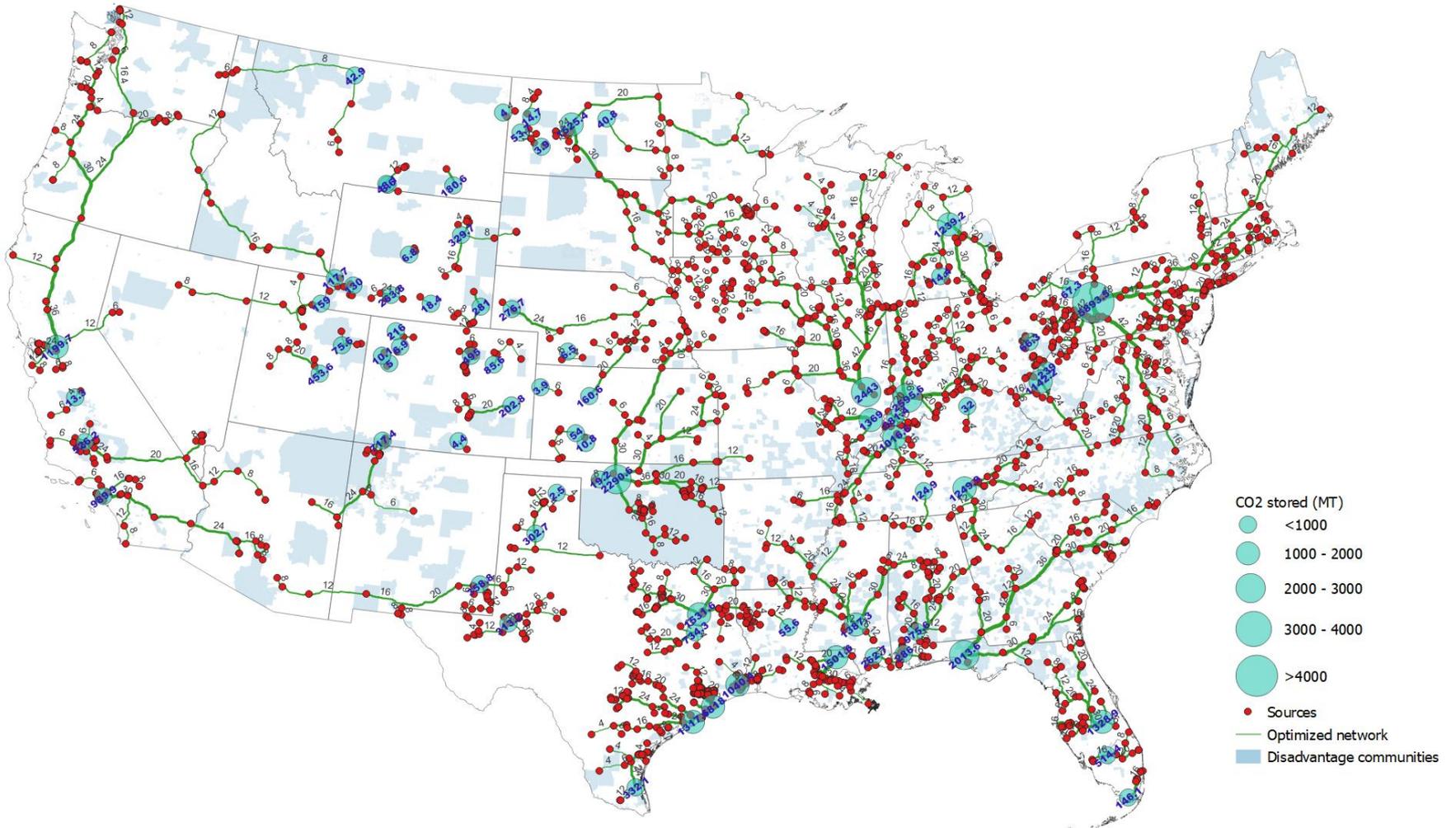
Capture all 45Q eligible point  
CO<sub>2</sub> sources?

# CO<sub>2</sub> supply curve – based on point source characteristics

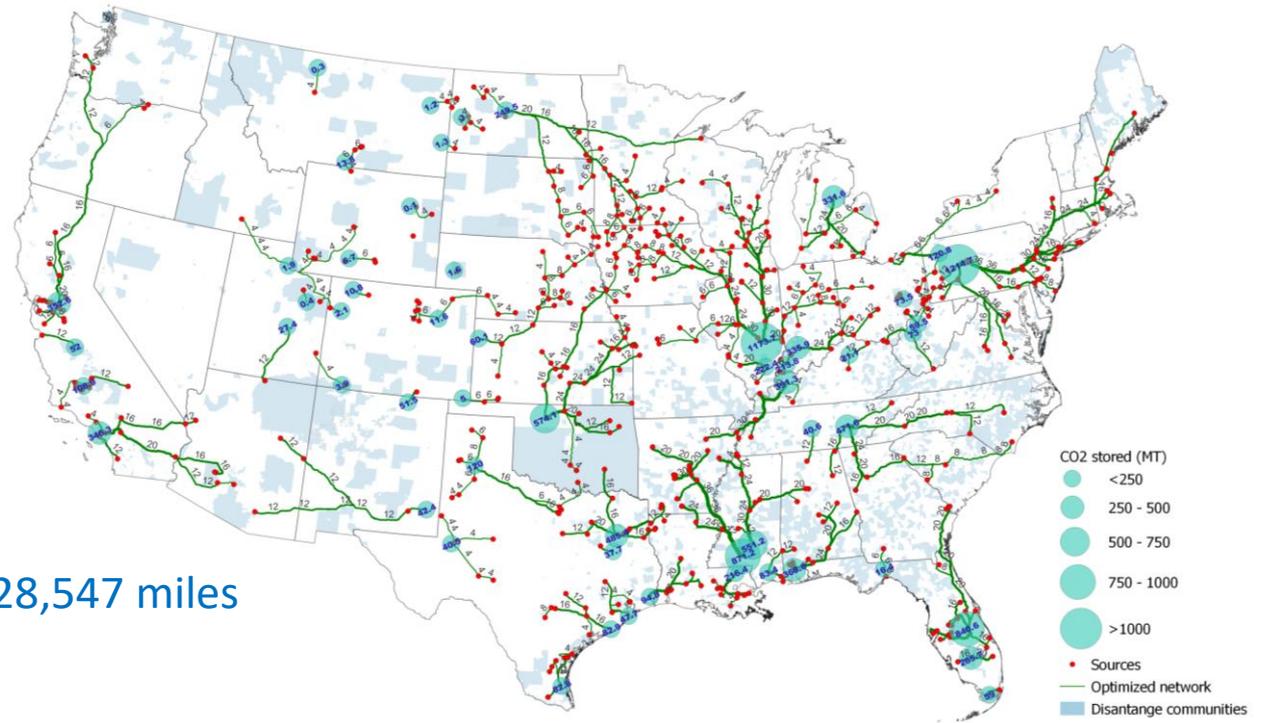


- Data source: EPA GHGRP & eGRID (2021)
- 2,087 CO<sub>2</sub> point sources - 2.27 Gtons/year
- Bipartisan Budget Act of 2018

# Pipeline network

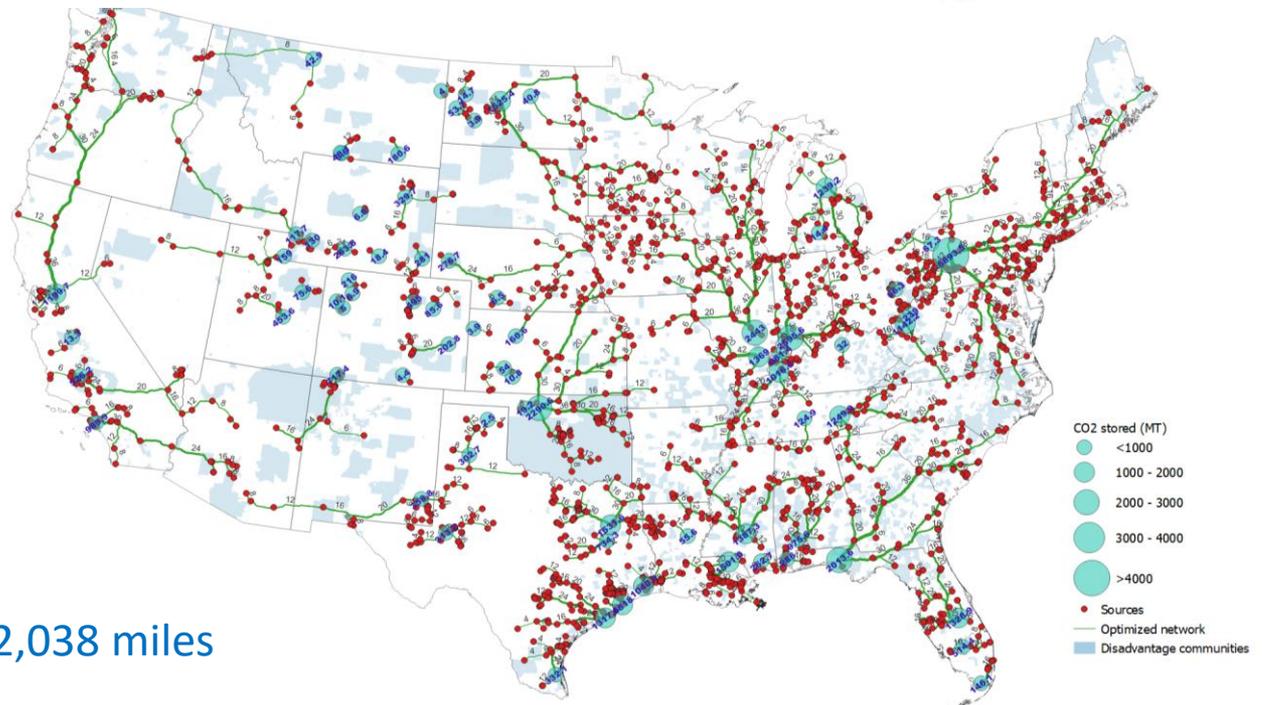


- Total pipeline length: 42,038 miles



## Case 1

- Total pipeline length: 28,547 miles



## All 45Q eligible

- Total pipeline length: 42,038 miles