Overview of Shale Development in Ohio Since 2011

2022 Ohio NARO Convention

September 17, 2022

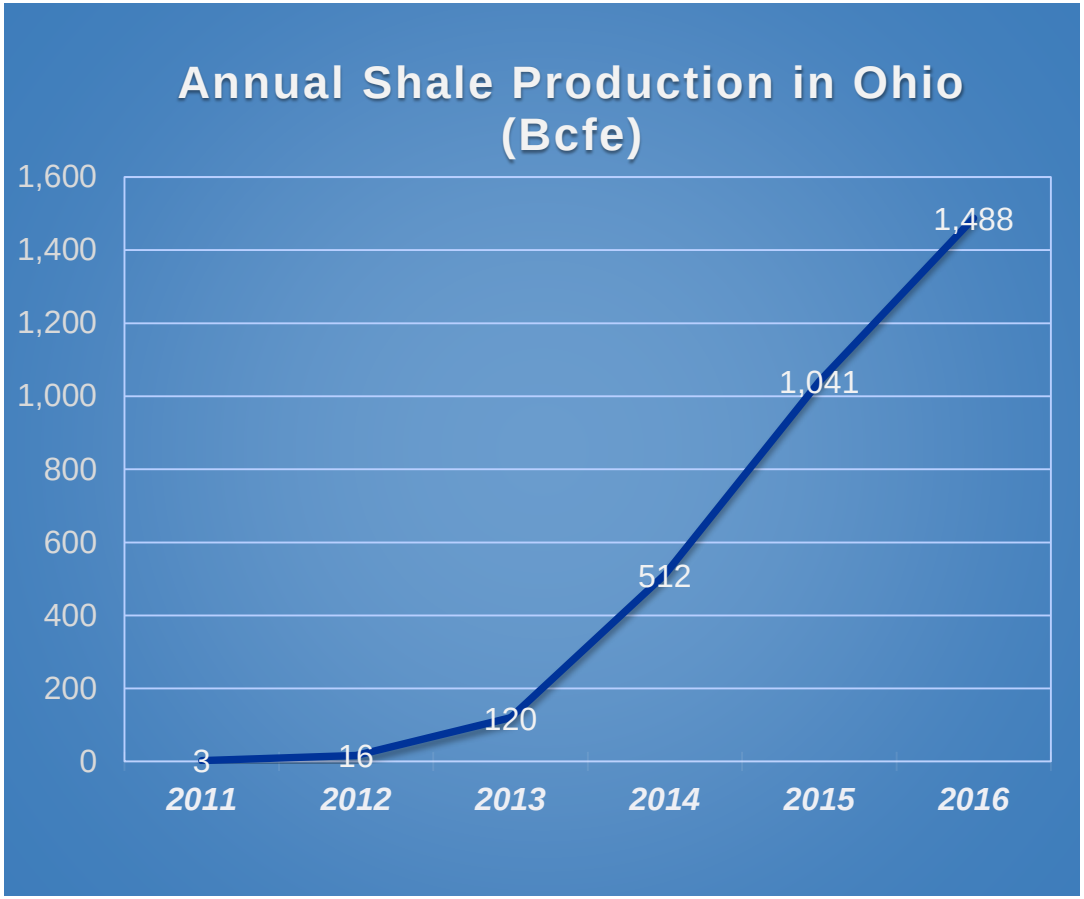
Energy Policy Center at Cleveland State University

Andrew Thomas (Director)

- Research Areas
  - ✓ Hydrocarbon development
  - ✓ Hydrogen economy
  - ✓ Electricity markets & regulation
  - ✓ Microgrids & energy storage
  - ✓ Sustainable transportation
  - ✓ District energy systems

- Clients & Grants
  - ✓ JobsOhio
  - ✓ Cuyahoga County
  - ✓ Stark Area Regional Transit Authority
  - ✓ Federal Transit Administration
  - ✓ U.S. Department of Energy

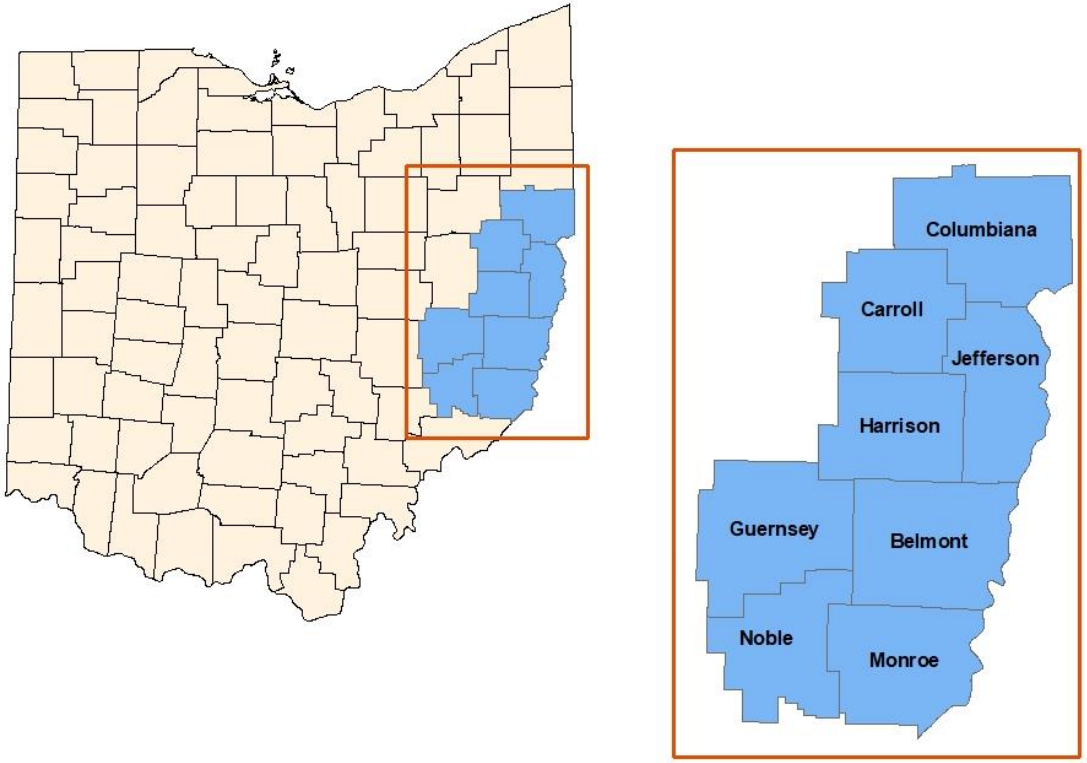
Motivation for Shale Dashboard



By 2016:

- 2,000 shale wells drilled
- Annual production of 1.5 Bcfe
- No systematic review of investment

Oil & Gas Segments, Geography, and Data Sources



Data Sources: ODNR | PUCO | Ohio EPA | Annual Financial Reports (10-K) | Company Interviews | County Engineer's Office | Investor Presentations | Ohio Oil & Gas Association | Interstate Natural Gas Association of America | EIA

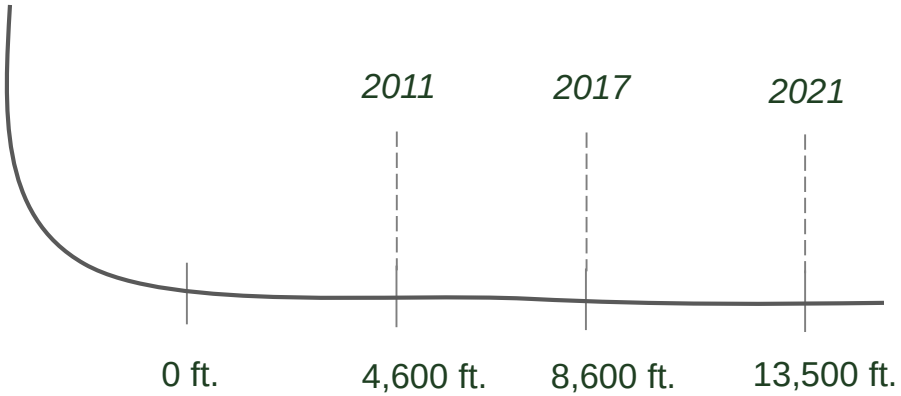
Upstream Investment

Investment Categories:

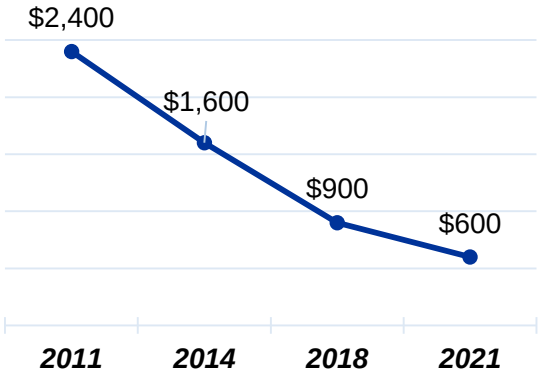
- Drilling
- Lease operating expenses
- Royalties
- Roads
- Lease renewals & new leases

Assumptions need regular updating:

Avg. Lateral Length in Ohio



Drilling Costs per Foot in Utica

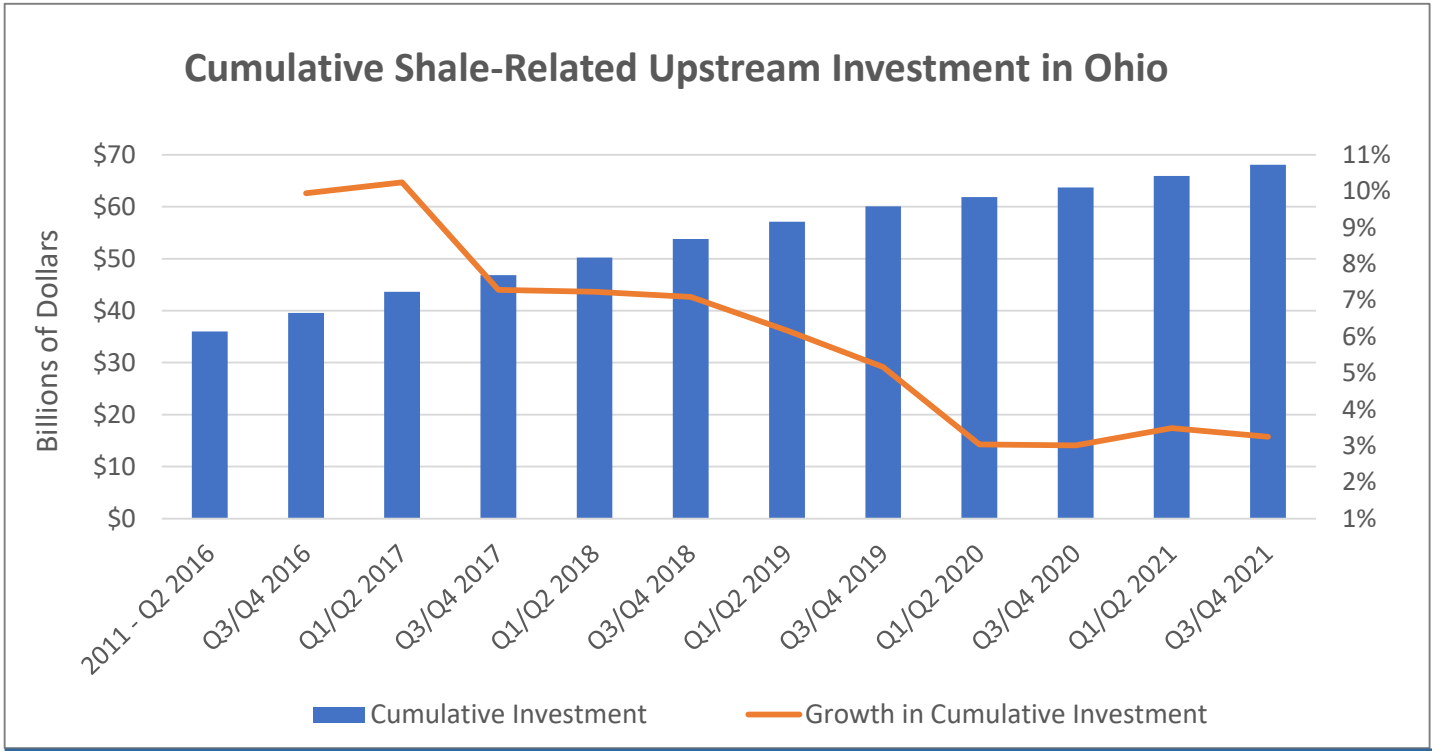


Upstream Investment

Other important upstream assumptions:

- Lease bonuses of $5000/acre
  - May be too high
  - Little publicly available data
  - Recent leases for public entities
    - Muskingum Watershed Conservancy District (2022)
    - Belmont County Commissioners (late 2019)
- Royalties rates of 20% of gross production
  - Same issues as for lease bonuses
  - MWCD and Belmont County Commissioners
    - 20% royalty
  - Varies by location
- Residue gas royalties based on NGI Appalachia Regional Avg. daily price.
- Oil and NGL royalties based on Ergon's Marcellus/Utica prices for light crude.
  - NGLs sells for ~30% of price for Marcellus-Utica light crude.

Estimated Upstream Investment



Investment	Cumulative Amount Since 2011 ($Billions)
New and Renewable Lease Bonuses	$25.7
Drilling	$29.1
Roads	$1.1
Lease Operating Expenses	$2.5
Royalties	$9.8
Total	**$68.1**

Midstream Investment

Interstate pipelines:

- Rover ($3.1 billion in OH alone)
- Nexus ($1.8 billion in OH alone)

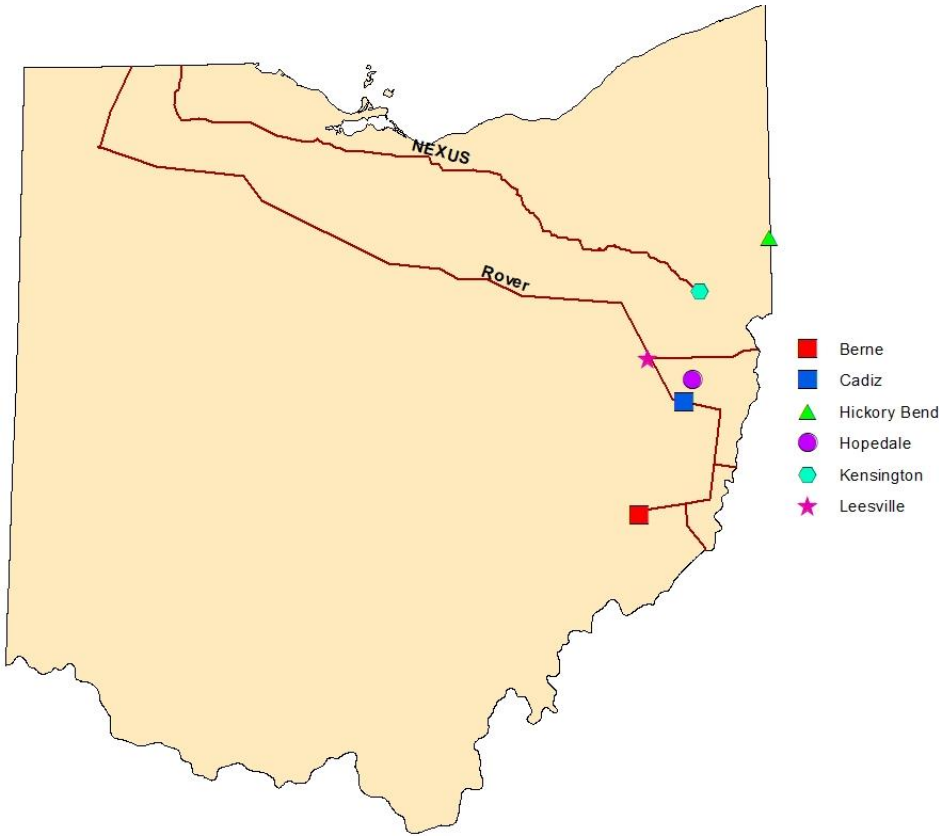
Processing and Fractionation for NGLs:

- Cryogenic processing ~3 billion cu. ft./per day capacity
- Fractionation ~600 bbl/day capacity
- $3 billion invested through mid-2021

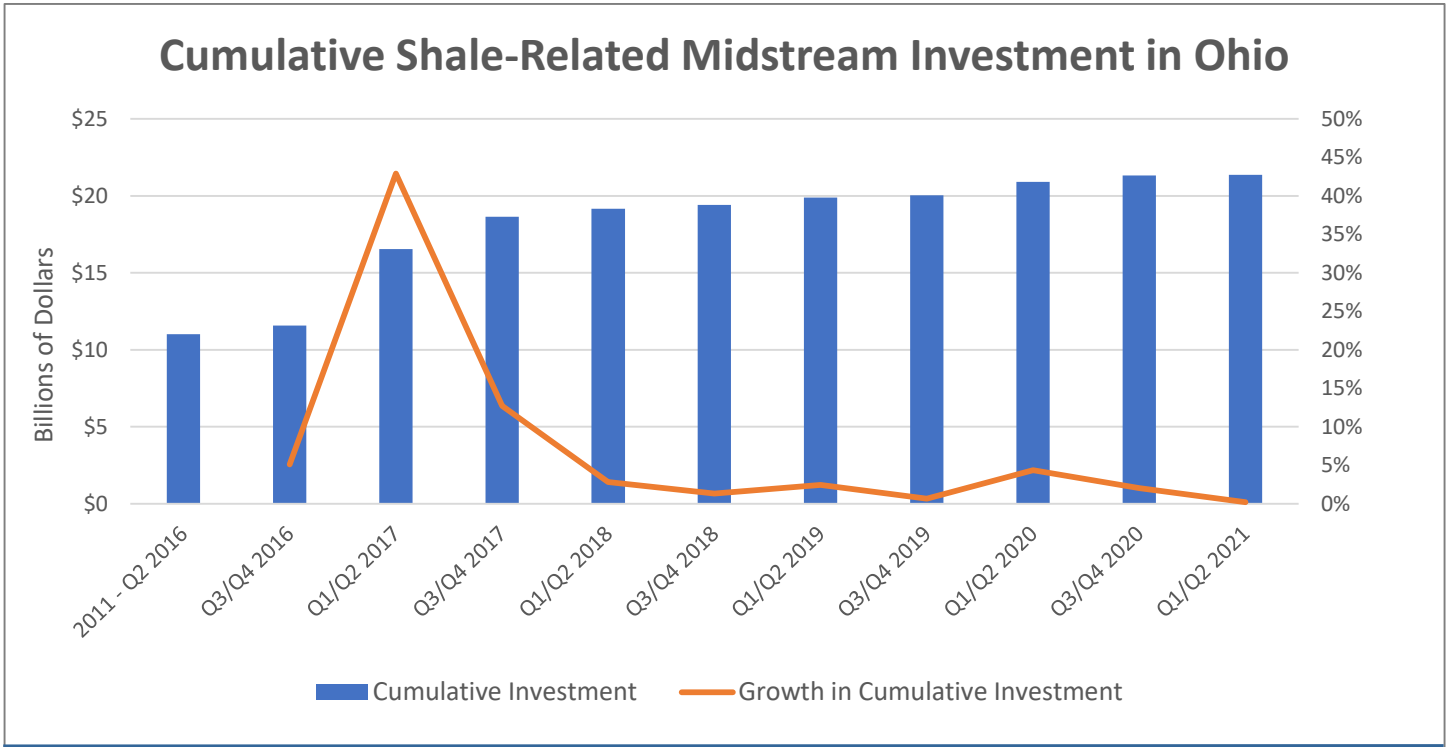
Gathering System Buildout:

- ~1,300 miles of gathering pipeline
- >600,000 hp of compression

Sample of Midstream Projects



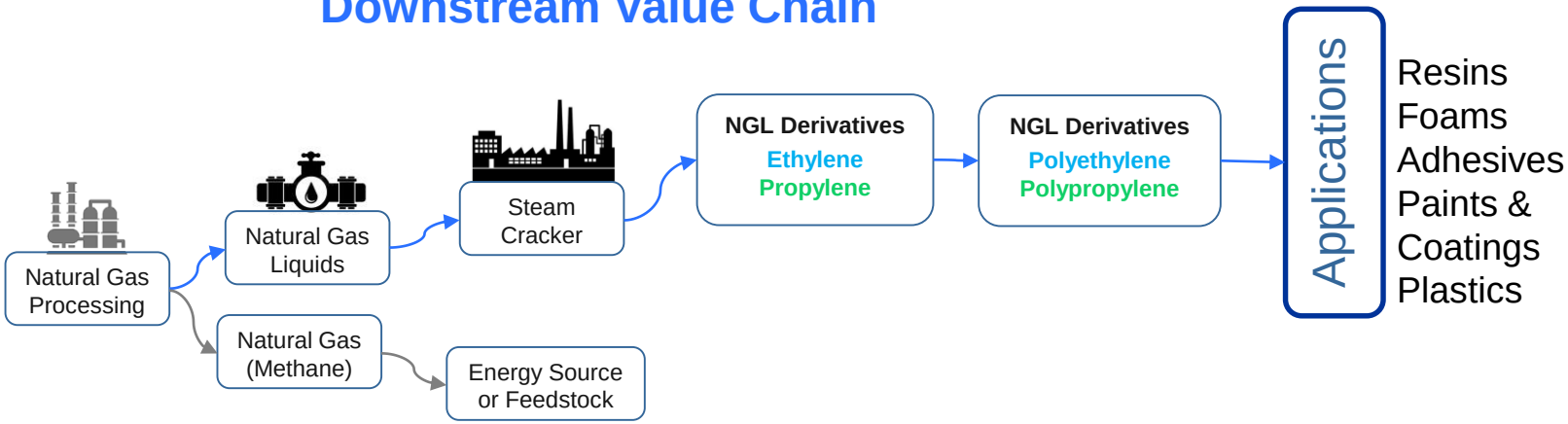
Estimated Midstream Investment



Investment	Cumulative Amount Since 2011 ($Billions)
Midstream Gathering	$7.7
Processing Plants	$1.3
Fractionation Plants	$1.7
NGL Storage & Rail Loading Terminals	$0.4
Transmission Pipelines	$10.3
Total	**$21.4**

Downstream Investment

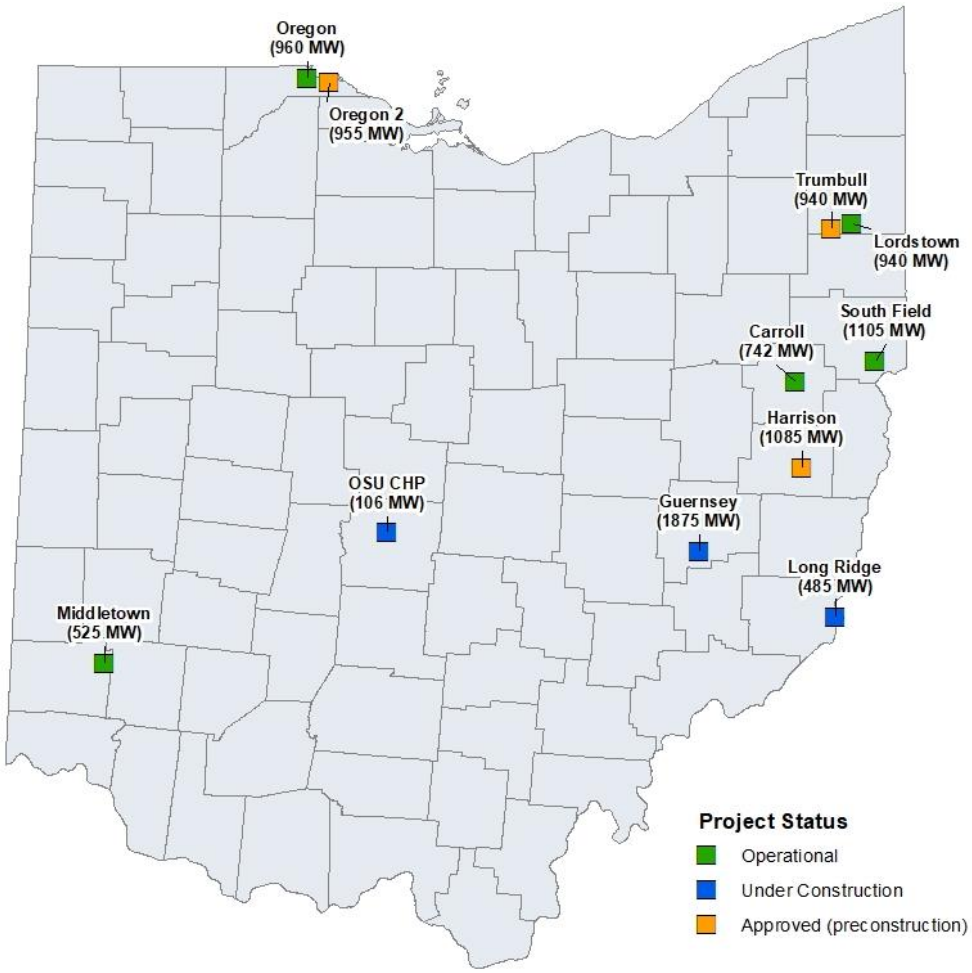
Downstream Value Chain



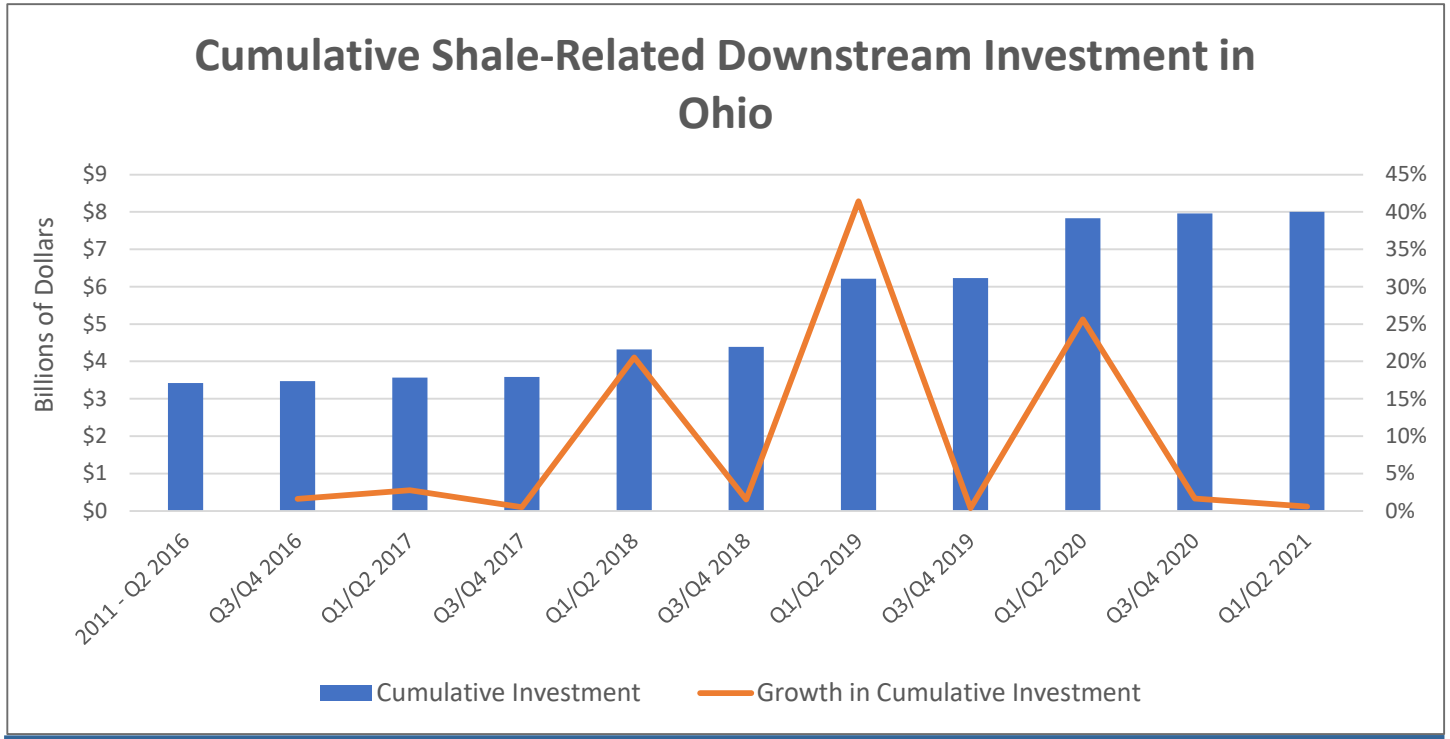
- Natural gas power plants
- Refineries
- Natural gas refueling stations (CNG)
- Ammonia plants
- Methanol plants

Natural Gas Power Generation Since Start of Shale Development

- Natural gas provides 44% of Ohio's net electricity generation (largest share by energy source).
- 4.3 GW became operational in 2017 and 2018.
- Additional 2.5 GW under construction.



Estimated Downstream Investment



Investment	Cumulative Amount Since 2011 ($Billions)
Petrochemical Plants and Refineries	$0.6
Other Industrial Plants (Ammonia, Steel)	$0.8
Natural Gas Refueling Stations	$0.1
Natural Gas Power Plants	$6.4
Combined Heat and Power (CHP) Plants	$0.1
Total	**$8.0**

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