An Appalachian Petrochemical Renaissance

--Within Reach

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Summary

Opportunity

- Ethane and other NGLs
  - Underutilized co-products of the Appalachian shale gas industry
  - Ethane is a principal petrochemical feedstock for a diversity of products
  - Opportunity to drive an Appalachian petrochemical industry renaissance
- Revitalized Appalachian petrochemical industry could support
  - Five world-scale petrochemical crackers
  - A regional pipeline and storage network (the “hub”)
  - Downstream manufacturing facilities

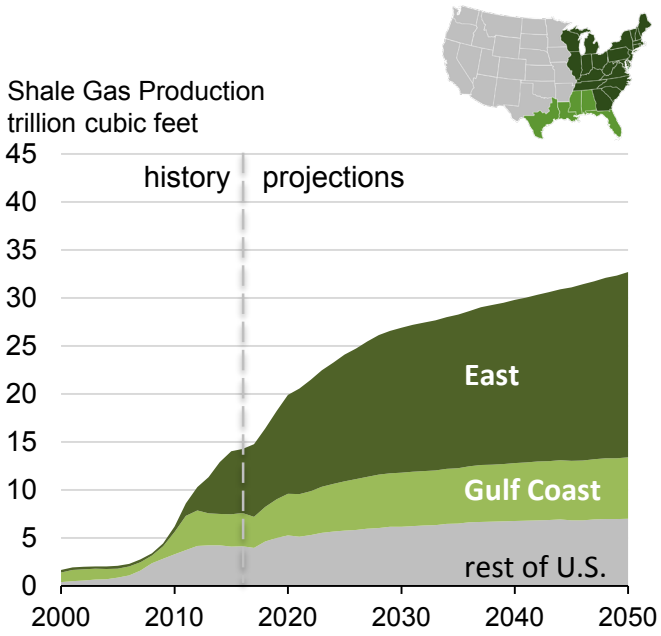
Economic Benefits

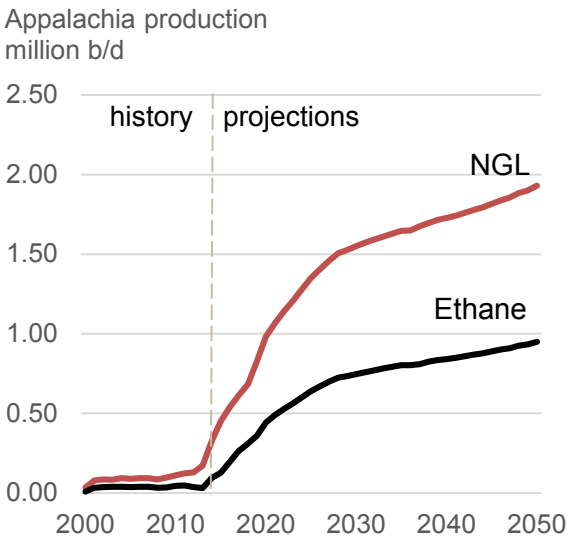
- 100,000 permanent jobs
- $6B annual payroll
- $30B+ private capital investment
- $28B annual revenue
- $3B annual tax revenue

Energy and Manufacturing Security Benefits

- Geographically diversifies U.S. petrochemical manufacturing base
- Creates expanded shale gas production opportunities
- Creates a lower cost, regional supply point for NGL derivatives

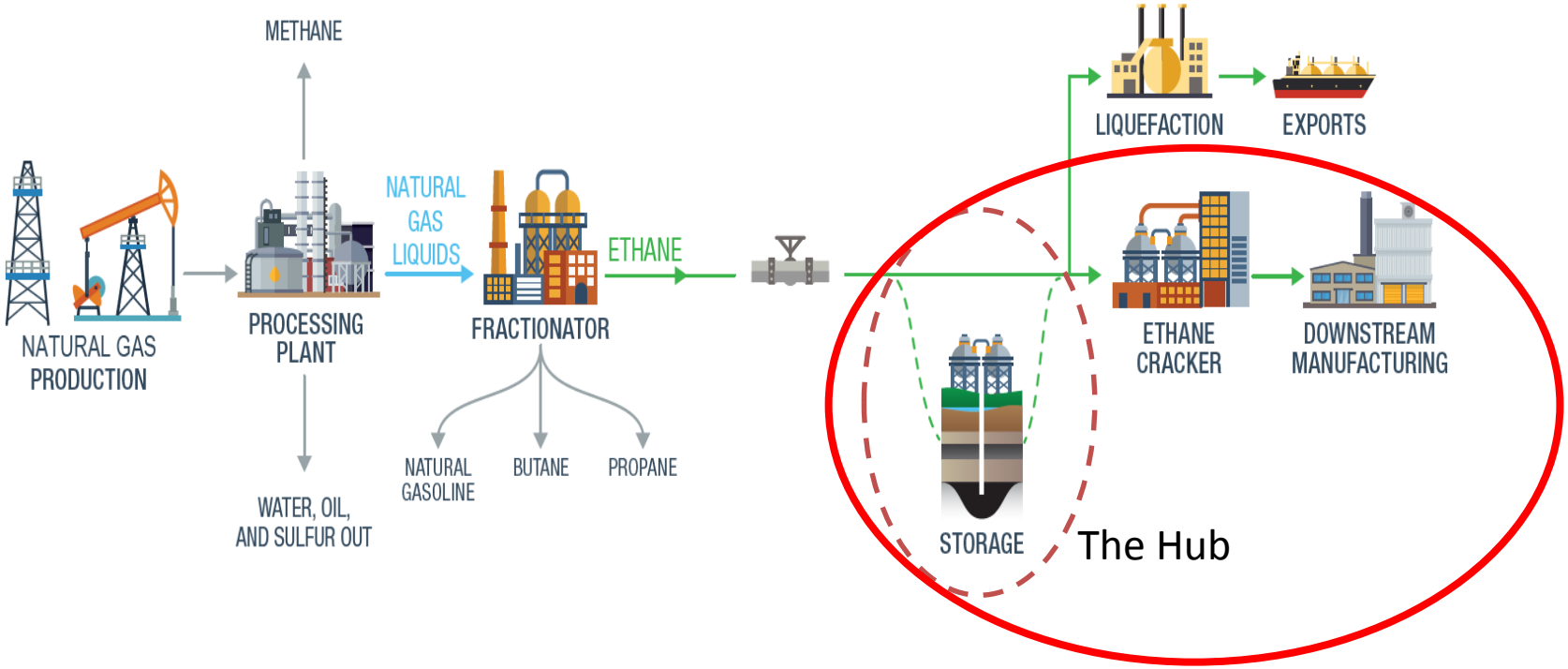
Natural Resource Base





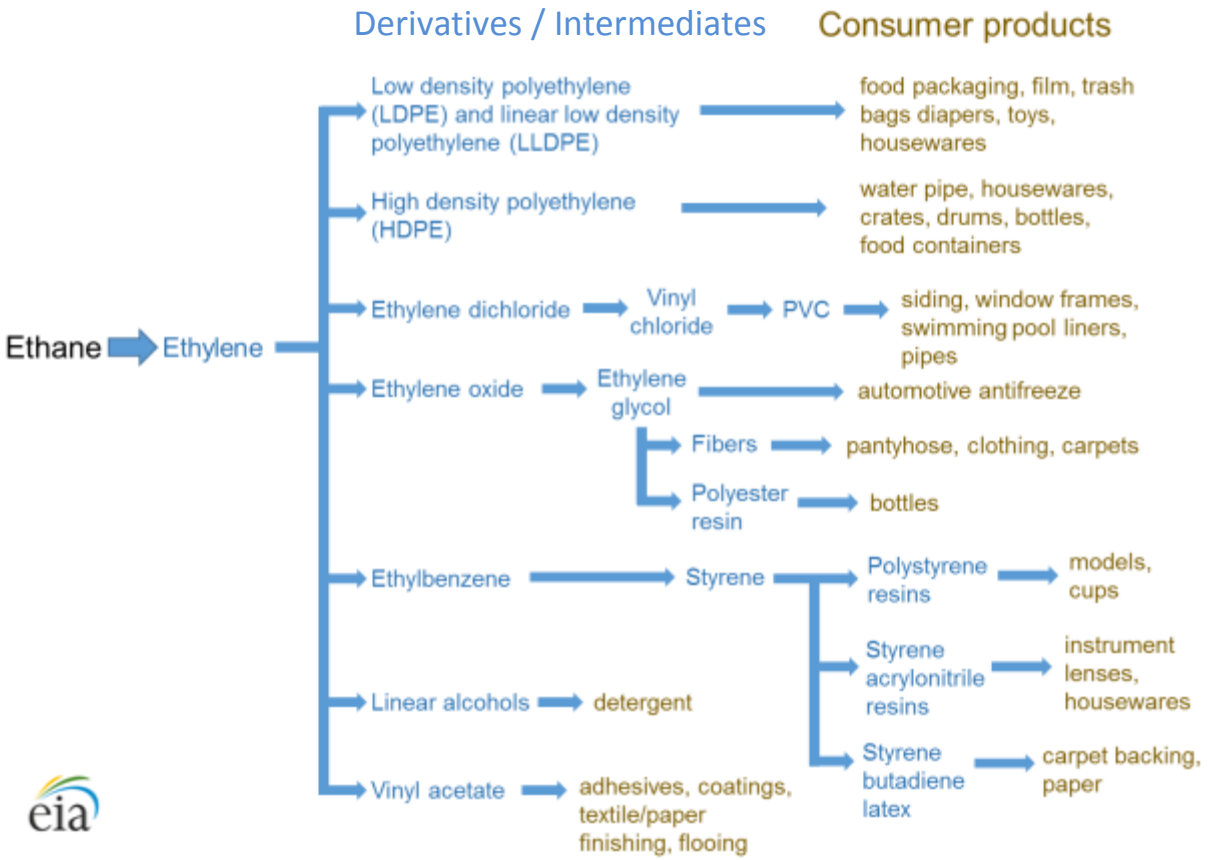
- **Appalachian shale gas is the principal driver for growth in U.S. natural gas production**
- **Co-produced natural gas liquids (NGLs), including ethane, propane, butane, and pentanes+ are projected to grow to 1.9 million bbls/day by 2050**
- **Appalachian ethane production is projected to be 640,000 bbls/day by 2025 and 950,000 bbls/day by 2050**
- **A world-scale ethane cracker processes ~90,000 bbls/day**

Ethane Supply Chain



The Petrochemical Industry

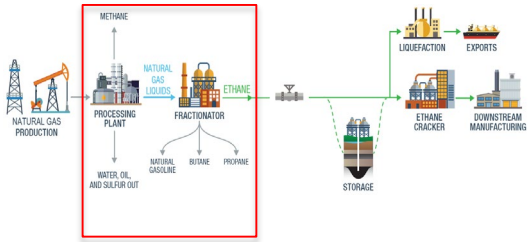
Products Derived from Ethane

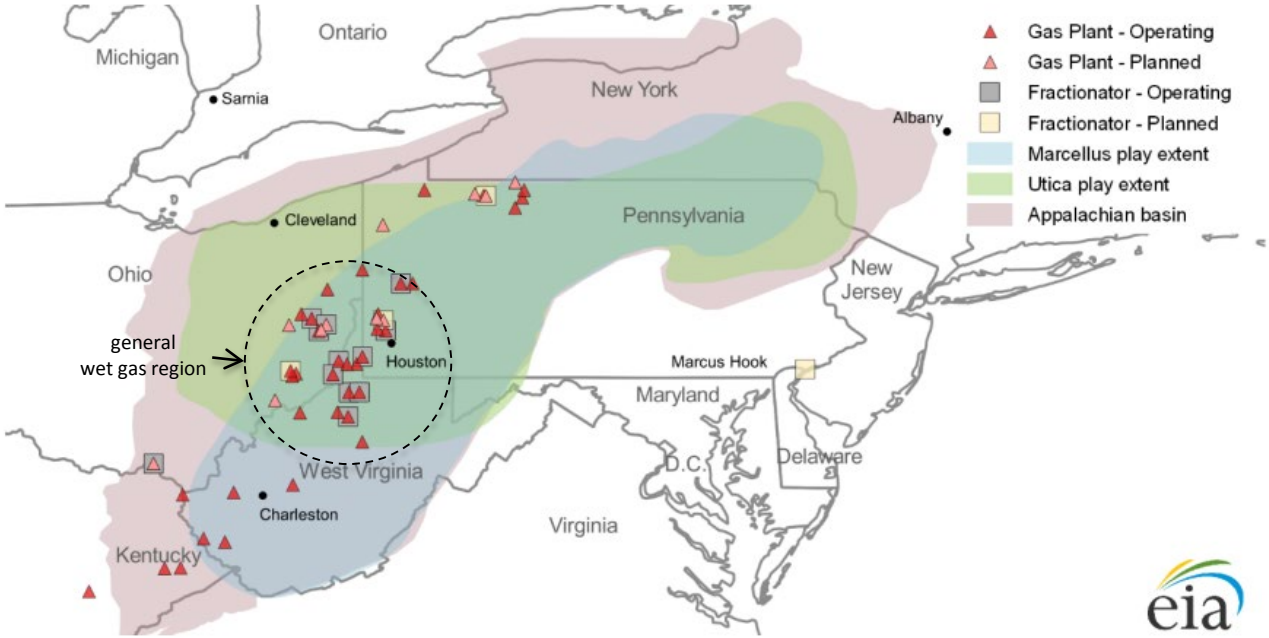


Appalachian NGL Production Infrastructure

Appalachian NGLs predominately produced in Ohio River Valley

- **NGL condensate separated in the vicinity of production**
- **NGL Condensate fractionated at larger, centralized facilities**



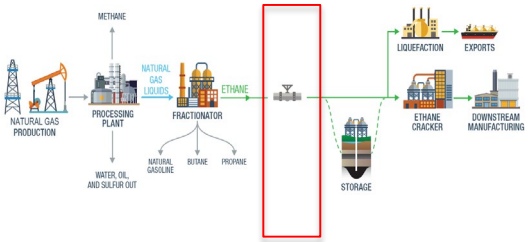


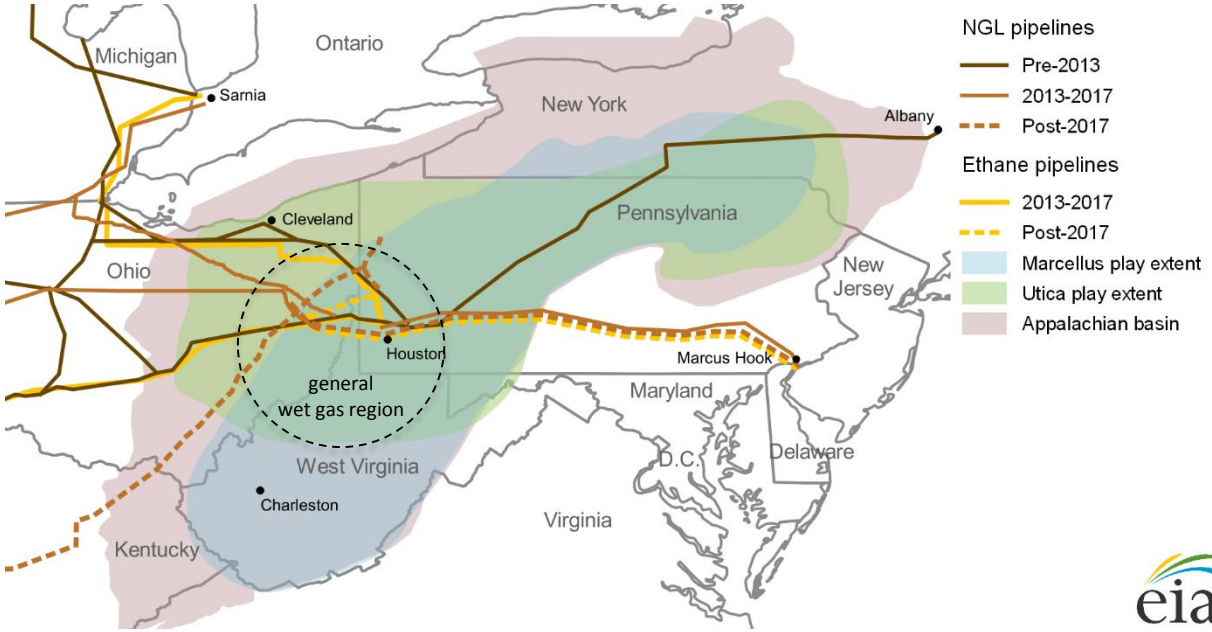
Appalachian NGL Pipeline Infrastructure

Appalachian Ethane is predominantly

- **Transported via pipeline to the Gulf Coast for processing**
- **Exported**
- **Rejected**
- **Avoided by producers**

Value of processing ethane in-region currently lost





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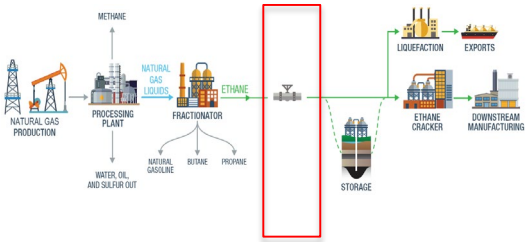
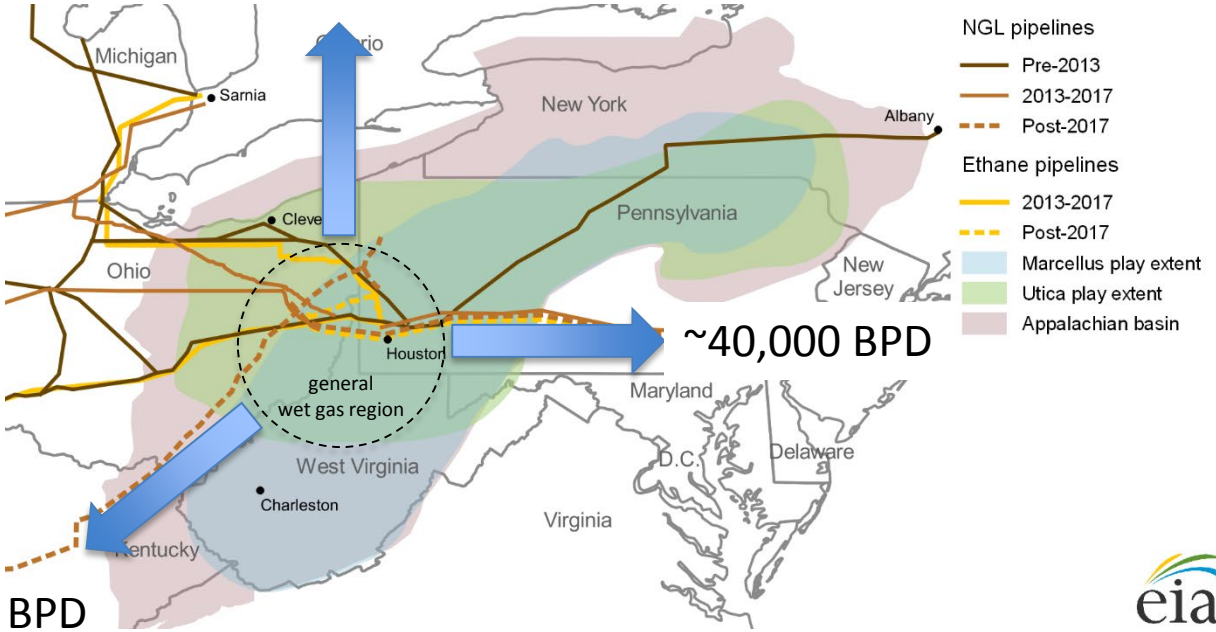


Value of processing ethane in-region currently lost

~70,000 BPD

Total Production
~260,000 BPD



~40,000 BPD

~150,000 BPD

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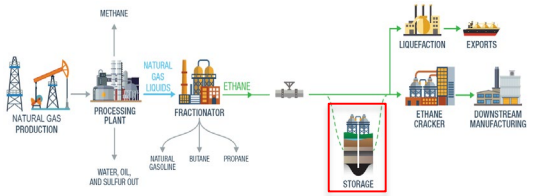
Storage Infrastructure (the "Hub")

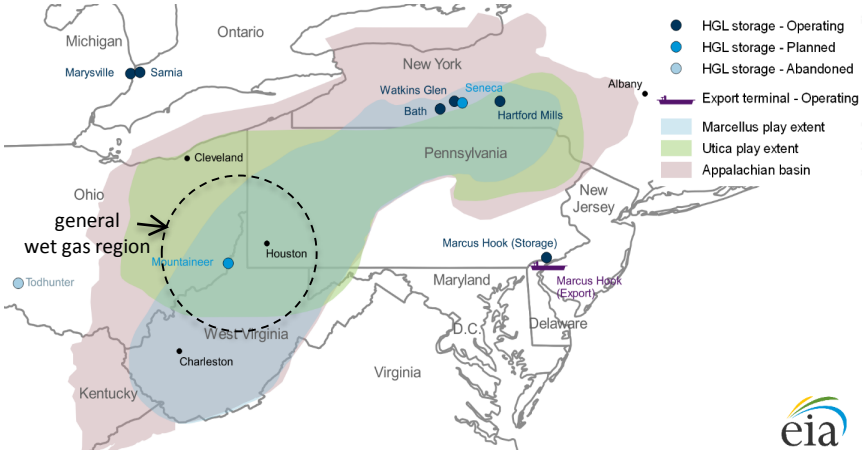
Storage is essential in a mature industry to managing

- **Seasonal supply variability**
- **Processing facility outages**
- **Holding for transport or export**



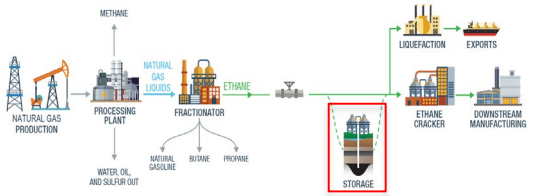
Large-scale storage does not exist in the wet gas subregion of Appalachia where crackers are likely to be sited

Smaller-scale above ground storage exists principally to support fractionators



Storage Infrastructure

Storage economics favor underground storage when large quantities require storage



Candidate geology is in the wet gas region

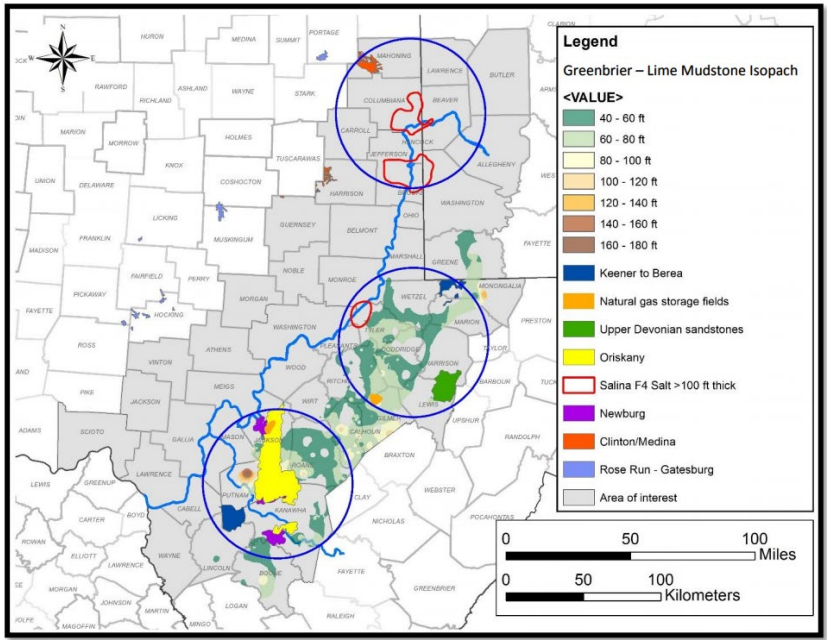
- Saline caverns
- Hardrock caverns

Underground storage is capital intensive

Firm storage contracts with one or more crackers, fractionators, or producers are the most likely mechanism for storage projects to become investable by the private sector

Multiple project developers actively seeking such contracts

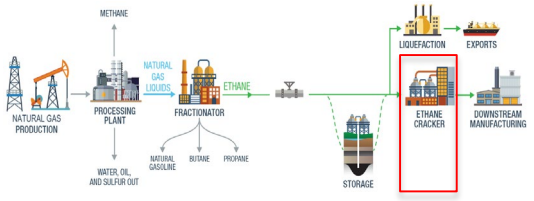
- Likely to be modular growth in capacity over time



Appalachian Cracker Infrastructure

No world-scale cracking facilities

- One small-sized ethane cracker in Calvert City, KY



Two major active projects

- Under Construction
  - Shell Chemicals Appalachia, LLC
  - $6B+ ethane cracker with polyethylene production lines
  - Two dedicated ethane pipelines to fractionators
  - First 6000 person construction workforce onsite
  - 500 permanent plant operators
- Pending Final Investment Decision (FID)
  - PTT Global Chemicals/Daelim Chemicals
  - $10B ethane cracker with derivatives production
  - Permitted
  - Pipeline infrastructure and some storage
  - 6000 person construction workforce
  - 600 permanent plant operators

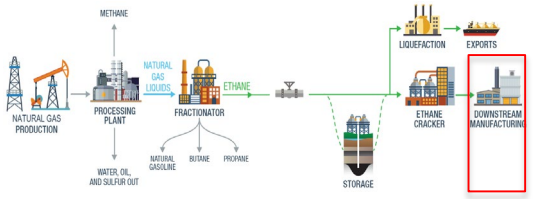
Early-Market Entrants

- Validate private sector investment interest
- Illuminate requirements and challenges of attracting additional private sector investment

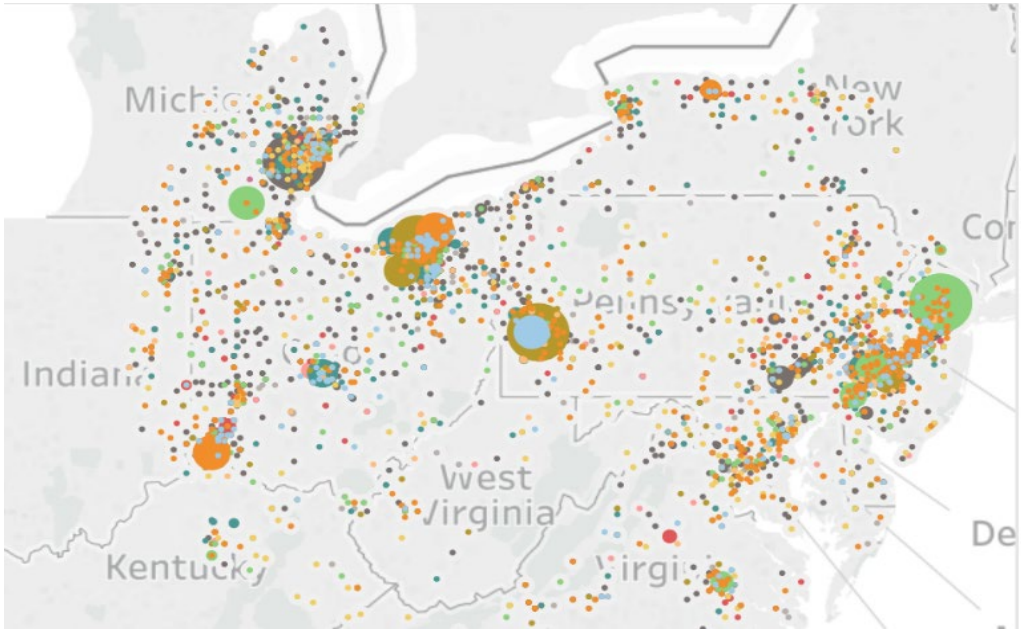
Downstream Manufacturing

Downstream manufacturing within 300 miles of Pittsburgh

- $300 billion revenue
- 900,000 workers
- 7500 businesses

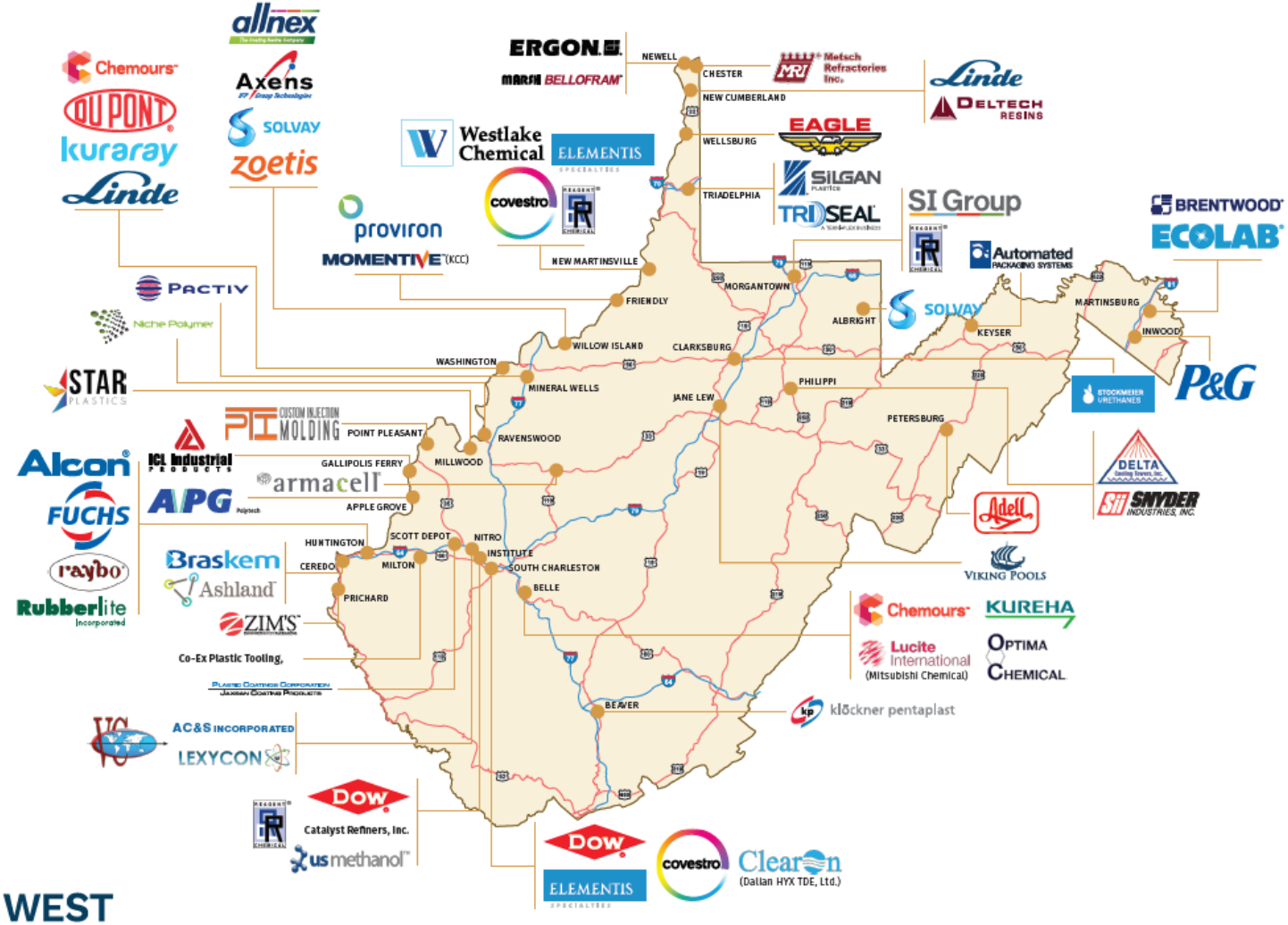


Feedstocks for manufacturing (originating from ethane) are Currently trucked/railed from the Gulf Coast



- Adhesive Manufacturing
- Chemical Product Manufacturing
- Laminated Plastic Manufacturing
- Organic Chemical Manufacturing
- Paint Manufacturing
- Petrochemical Manufacturing
- Plastic & Resin Manufacturing
- Plastic Bottle Manufacturing
- Plastic Film, Sheet & Bag Manufacturing
- Plastic Pipe & Parts Manufacturing
- Plastic Products Miscellaneous Manufacturing
- Rubber Product Manufacturing
- Synthetic Fiber Manufacturing

WV Manufacturing



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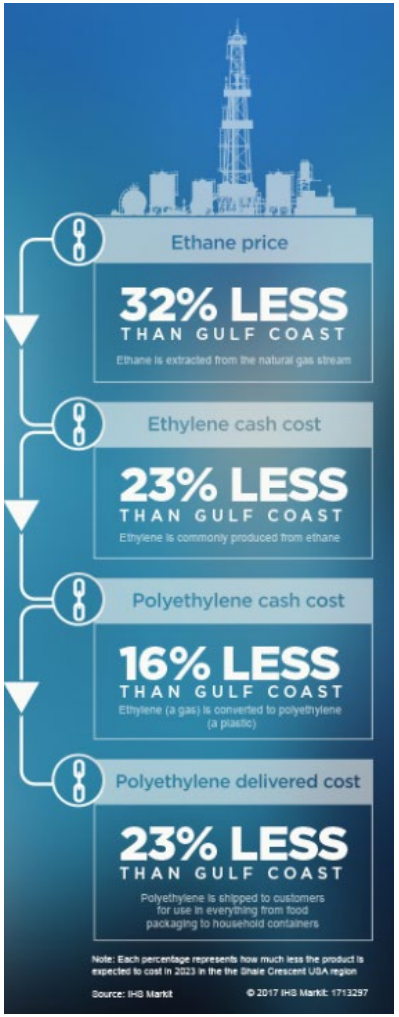
Expanded Private Investment

Industrial investor requirements and the Appalachian business environment

- Equitable return on their capital investment
  - Appalachian plant economics are favorable relative to a Gulf Coast benchmark plant providing certain project risks can be mitigated
- Reliable supply of affordable petrochemical feedstocks
  - Appalachian ethane supplies are abundant.
  - The current lack of large-scale storage is viewed as a significant issue
- Skilled workforce for construction and operation
  - Skilled and productive regional workforce
  - A substantial build-out will draw from national labor pool
- Buildable sites
  - Appalachian topography, acreage, and existing brownfield sites pose substantial, although not insurmountable, challenges
  - Water and low-cost natural gas for fuel are net positives in Appalachia
- Supporting public infrastructure
  - Roads, rail, river, communications, and local community infrastructure often, although not exclusively, a challenge
- Manageable regulatory requirements
  - Projects are largely State-regulated and manageable; although different than traditional petrochemical investment locations
- Local support
  - Highly favorable



Path Forward: Federal Role

Spur an Appalachian petrochemicals industry renaissance:

- Enhances U.S. energy and manufacturing security
- Creates substantial economic benefit

Coordinate federal economic development efforts, across agencies and with stakeholders, to catalyze private sector investment

- Communicate the market opportunity and its benefits
- Invest in supporting public infrastructure
  - Bridges, roads and heavy haul infrastructure
  - Rail infrastructure
  - River-based infrastructure
  - Utility infrastructure
  - Communication infrastructure
- Support workforce development
  - Trade unions
  - Vocational schools
  - Colleges and universities
- Enhance the investment environment
  - Pro-growth tax and regulatory policies
  - Build-ready sites, including redeveloped brownfields
  - Loan guarantees