Ethanol and Pennsylvania: A Logistics Overview

September 5, 2007
CrossOver 2007
Penn State Center for Supply Chain Research
Ethanol and Pennsylvania: A Logistics Overview

Kusumal Ruamsook, CSCR
Chris Liller, MBA student
Susan Purdum, CSCR
Evelyn Thomchick, SC&IS Department
Impact of Ethanol (E10) on Pennsylvania’s Infrastructure

• Project objectives:
  – Understand supply chain implications of ethanol blended gasoline
  – Identify supply chain issues pertaining to PA state-wide E10 adoption
  – Recommend areas of further research
Project Methodology

- Extensive Literature Review
  - Public sector information
  - Trade journals
- Interviews with various stakeholders or subject matter experts
  - College of Agriculture
  - PennDOT’s Transportation Planning Research
  - PennDOT’s Rail, Ports, and Waterways contact
  - BNSF and Norfolk Southern perspectives
  - Smeal’s SC&IS faculty
Project Outline

- Ethanol drivers and overview of federal and state gasoline programs and requirements
- Current supply and demand of fuel ethanol
- Ethanol supply chain
  - Ethanol sources for PA consumption
  - Transportation mode and infrastructure evaluation
- Summary of issues
- Recommendations for further research
Pennsylvania Ethanol Policy

- Philadelphia area
  - RFG area
  - Using E10 following 2006 MTBE switch

- Pittsburgh area
  - Boutique RVP requirements
  - RFG used to meet requirements

- PennSecurity Fuels Initiative
  - Proposed by Governor Rendell
  - If passed, would require E10 state-wide
Project Outline

- Ethanol drivers and overview of federal and state gasoline programs and requirements
- Current supply and demand of fuel ethanol
- Ethanol supply chain
  - Ethanol sources for PA consumption
  - Transportation mode and infrastructure evaluation
- Summary of issues
- Recommendations for further research
Update all structuring slides to reflect “Ethanol supply chain” bullet changes.

Ethanol Plant Locations

- Proposed plants in PA not shown

Biorefineries in Production (115)

Biorefineries under Construction (79)

Source: Renewable Fuels Association 4.3.07
Typical Ethanol Supply Chain

1. Corn fields
2. Bulk truck transport preprocessed corn grains
3. Bio-refinery to produce ethanol
4. Ethanol shipped in tank cars*
5. Ethanol unloaded from tank cars to tank trucks at rail terminals *
6. Ethanol shipped in tank trucks to distribution terminals *
7. Ethanol unloaded from tank trucks for storage separately from gasoline
8. Ethanol blended with gasoline (arrived via pipelines) while loading to tank trucks
9. Last leg of transportation via tank trucks to retail gas stations.
10. Ethanol blended gasoline unloaded for underground storage at gas stations and made available for consumptions

Areas of significant impacts:
*Increased Inbound Complexity due to Ethanol

* Alternative modes used in some instances: pipeline, barge, etc.
Map of PA Railroads and Proposed Plants
Project Outline

- Ethanol drivers and overview of federal and state gasoline programs and requirements
- Current supply and demand of fuel ethanol
- Ethanol supply chain
  - Ethanol sources for PA consumption
  - Transportation mode and infrastructure evaluation
- Summary of issues
- Recommendations for further research
## Ethanol Transportation: Types of Vessels

<table>
<thead>
<tr>
<th>Mode</th>
<th>Size</th>
<th>Availability (New)</th>
<th>Efficiency (1T eth / 1g of fuel)</th>
</tr>
</thead>
</table>
| Rail Car | 30,000 gal.        | • Backlog into 2009  
• 2007: 18,500 new deliveries projected                                              | 386 mi                           |
| Barge    | 1,176,000 gal.  
Approx 39 rail cars | 2 year backlog                                                                   | 522 mi                           |
| Truck    | 8,000 gal.  
Approx 3.75 trailers to unload 1 rail car                                          | 59 mi                            |
| Pipeline | n/a                | None  
• Kinder Morgan investigating  
• 15 MMGY given as feasibility threshold                                               | n/a                              |
Logistics Cost and Management Impacts

Ethanol Supplier → Terminal Owner → Retail Station

Transportation Carriers
Logistics Cost and Management Impacts

- Own tank cars
  - Tank cars (new): $100,000 / car
  - Maintenance and management of tank cars
- Lease tank cars
  - Leasing fees
- Feedstock supply management
- Outbound byproduct logistics (DDGs)
- Transportation management (in-house or outsource)
Logistics Cost and Management Impacts

One-time set-up/conversion costs

- Storage tanks (new) $450,000 for 25,000-barrel tank, taking 14 to 24 months to build
- Storage tanks (converted) Approx. 20% of cost of a new tank, taking 60 to 90 days with all the required permits in place
- Unloading equipment and piping $20,000
- Blending equipment $300,000 to $400,000 for 2 blending units
- Own rail spur track
  - Rail spur track $75 to $95 / foot
  - Unloading equipment & piping $15,000 (Continue next)
**On-going costs and management**

- Ethanol supply management
  - Due diligence of (ethanol) supply market
  - Sourcing strategies (contract and spot purchases, contract terms and management)
  - Additional suppliers to manage
- Storage and delivery optimization (utilization of dedicated tanks, pipes, and truck loading equipment)
- Transportation management (additional modes and carriers to manage)
- Inventory management
  - Additional SKUs to manage
  - Additional safety stock requirements (higher transportation variability by rail vs. pipeline, and higher risks of damage with more transfer points)
Logistics Cost and Management Impacts

**One-time set-up/conversion costs**
- Water removal and cleaning
  - Water Removal $400 / station
  - Tank Cleaning $800 / station
  - “Water Bottoms” Removal $400 / station
- Administrative and Labeling $150 / station
- Pump and dispenser replacement Not available
- 10 micron “water sorb” filter Not available

**On-going costs**
- Ongoing testing for water incursion Not available
Logistics Cost and Management Impacts

**Ethanol Supplier**

**Terminal Owner**

**Retail Station**

**Transportation Carriers**

**Rail carriers**
- Mainline track: $200 to $300 / foot
- Car turnover management and optimization

**Truck carriers**
- Tank truck fleet (dedicated)
- Tank truck and equipment cleaning of prior content (mixed uses)

**Transloaders**
- Transload terminal and equipment investment
- Efficient rail-truck transload management
- Investment in dedicated pipelines from transloader to storage terminals
Project Outline

- Ethanol drivers and overview of federal and state gasoline programs and requirements
- Current supply and demand of fuel ethanol
- Ethanol supply chain
  - Ethanol sources for PA consumption
  - Transportation mode and infrastructure evaluation
- Summary of issues
- Recommendations for further research
Summary of Issues

• Ethanol supply management
  – Ethanol supply capacity not a concern in the near future with Midwest producers as primary sources of supply
  – Local management of ethanol supply needs to be considered
  – Will require due diligence of ethanol supply market

• Long-haul transportation issues
  – Rail as primary long-haul transportation mode to PA
  – Incremental traffic from ethanol not a concern
  – Overall rail service and capacity could be a concern.
  – Ethanol rail terminals service continuing to develop along the eastern seaboard (NS and CSX)
Summary of Issues

- Distribution and storage terminals
  - Inbound
    - Direct access to rail is limited
      - Direct rail to storage terminals is most efficient when available
      - Pipelines, trucks can also be used for terminal delivery
      - “Hub” terminals can reduce infrastructure investment
    - Inventory management is more complex with ethanol
  - Outbound
    - Storage and distribution requirements need to be considered
    - Blending stations can be a potential bottleneck
Summary of Issues

• Proposed PA ethanol production
  – Concerns
    • Economic viability
    • Insufficient local feedstock
  – Benefits
    • Service to local market
    • Local use of byproduct (DDGs)

• Future cellulosic ethanol production
  – More local feedstock available
  – Significant logistics challenges
Areas for Further Study

- Case studies of distribution/storage terminals in states with widespread ethanol use
- Identification and investigation of supply chain best practices in similar industries
- Supply chain optimization study
  - GIS modeling of key stakeholder locations, routing alternatives and capacity
  - Supply chain network design and optimization from selected sources of ethanol to market destinations
Areas for Further Study

• Participation of Penn State or Pennsylvania Transportation Institute (PTI) in PA’s new inter-agency ethanol committee
• Evaluate areas for state investment (e.g. infrastructure, production, etc.)
• Assess potential impact of cellulosic ethanol production in Pennsylvania
Questions?