An Intermodal Network Model of Coal Distribution in the U.S.

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Presentation Overview

- Integrated Freight Network Model
- Application of model for coal shipments
- Coal shipments at the national level
- Coal and the Ohio River Basin

How does the movement of coal to, from or within the Ohio River basin fit into the larger national picture of coal production and consumption?
Integrated Freight Network Model

- Incorporates three modes of travel
  - Roadways
  - Railways
  - Waterways
- Intermodal Points
  - Ports
  - Intermodal facilities
  - Rail switchyards
- Network attributes (impedances) enable model to optimize routing for shippers across all three modes
What is not yet included?

- Capacity constraints on corridors and nodes
- Speed
- Travel time
- Weight or cargo restrictions
- Characteristics of haul
  - Railcar/barge/truck types
  - Unit train? Backhaul possibilities?
Shipping Rates

• A number of possibilities to estimate or model shipping rates for different modes
• Order of magnitude used to supply generic rate information
  • Barge = 1 x distance
  • Rail = 3 x distance
  • Truck = 6 x distance
• “Fee” for switching mode or rail carrier
Modeling freight data: Coal

- Energy Information Administration (www.eia.gov)
  - Publishes annual data on movement of energy sources domestically in the US (coal, petroleum, natural gas)
- For coal, data includes
  - Origin (mine)
  - Destination (power plant)
  - Mode (rail, water, road, conveyor)
  - Volume
- Network models optimal routing of coal from origin (generalized to county centroids) to destination (power plants), as described by the EIA data
- Coal volumes aggregated along network segments for analysis
- Modeled routes 87% accurate, when compared to EIA data
Coal, statistically

- In 2010, 1.1 billion tons of coal were produced in the U.S.
- 88,000 employees, 1,300 coal mines, 24 states
- Total value of coal production at $45 billion
- 90% of coal produced in the US is consumed domestically (electricity, industry), 10% exported
- 10 million tons of coal also imported (about 1% of total US consumption)
- Coal is the leading fuel source for generation of electricity in the US, accounting for about 40% of total grid
Coal production in the US, 2010
Coal consumption in the US, 2010

Volume of coal consumed (millions of tons)
- < .5
- .5 - 1
- 1 - 3
- 3 - 6
- 6 - 10
- 10+
Energy consumption by fuel type, all sectors
Forecasted fuel consumption for electricity

Source: Adam Sieminski 2013; www.eia.gov
Coal exports

- Coal exports have declined since their peak in 2012. Still account for appx. 100 million tons annually.
- Decline results from decreased demand from Europe and Canada and increased supply from Asia (Australia, Indonesia, others)

Source: www.eia.gov
Coal modeled across all modes
Coal transportation: Waterways

• Coal is 2\textsuperscript{nd} leading ton-mile commodity (just behind petroleum) for the barge industry

• In 2009, coal accounted for 24\% (volume) of all commodities shipped on the inland waterways

• Of domestic coal shipments, 11\% were at least partly on inland waterways

• Share of coal shipments is larger when including imports and exports
Modeled coal movements on waterways
Coal transportation: Railways

• For the rail industry, coal is the single largest ton-mile commodity
  • 43% of total rail tonnage
  • 25% of gross revenue
• In 2010, 771 million tons of coal, or 74% of total production, went by rail for at least part of its route
• Primary mode of transport for coal out of the Powder River Basin of Wyoming
Modeled coal movements on railways
Coal transportation: Roadways

- In 2010, 197 million tons of coal, or 19% of total production, went at least a part of its shipment route by truck. Of this,
  - 107 million tons solely by truck
  - 89 million tons only part of way by truck
- Mostly shorter distance hauls
- More common east of the Mississippi R.
Modeled coal movements on roadways

Volume of coal (thousands of tons)
- <10
- 10 - 100
- 100 - 500
- 500 - 1000
- 1000+
Modal comparison for hauling coal

Modeled coal movements from the Powder River Basin in 2010

462 million tons produced
Modeled coal movements from the Central Appalachian Basin in 2010

156 million tons produced
Modeled coal movements to Texas and Illinois

- Powder River Basin
- 58 million tons consumed
- 91 million tons consumed
Modeled coal exports (millions of tons)

- Mobile: 9.7
- New Orleans: 9.4
- Norfolk: 32.0
- Baltimore: 13.9
Coal in Ohio River Basin

Coal production around the Ohio River in 2010

- Illinois Basin: 102 million tons
- Northern Appalachian Basin: 133 million tons
- Central Appalachian Basin: 156 million tons
Coal consumption around the Ohio River
Coal consumption around the Ohio River

116 million tons of coal received at power plants along the Ohio River in 2010
State origins of coal that ships on the Ohio River (millions of tons)
State destinations of coal that ships on the Ohio River (millions of tons)
Full intermodal routes of coal that ships on the Ohio River
State origins of coal that ships on the lower Mississippi River (millions of tons)

 Origins of coal that shipped on the lower Mississippi River in millions of tons

- WY: 8.6
- CO: .6
- UT: .1
- IL: 3.4
- IN: .6
- KY: 2.9
- WV: 6.2
- PA: .4

WY: Wyoming
CO: Colorado
UT: Utah
IL: Illinois
IN: Indiana
KY: Kentucky
WV: West Virginia
PA: Pennsylvania
State origins of coal that ships on the lower Mississippi River (millions of tons)

Destinations of coal that shipped on the lower Mississippi River in millions of tons:
- LA: 6.3
- TN: 2.5
- MS: 0.8
- AL: 0.9
- FL: 8.7

Exports through New Orleans: 3.5
Full intermodal routes of coal that ships on the lower Mississippi River
Potential Future directions

• Modeling coal data across multiple years to identify spatial and modal trends
  • Identify potential pinch points or bottlenecks in the network
• Expansion of model to include other energy-related transportation movements
  • Coal, petroleum, natural gas
  • Capacity considerations
• Diversion studies
  • What happens if a segment of the network is closed
• Incorporation of more robust shipping rate data
  • Modeling and estimation of all types of commodities across the three modes