Ideas for the New
NEMS Liquid Fuel Market
Model

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Liquid Fuel Markets

- Key outputs are prices and margins, which are highly volatile
  - Recent crude-price moves
  - Shifts in crude slates have radically changed unit economics
  - This is a well-connected world market that is less dominated by the US than in the past
- Mandates mess up the economics
- Refining is likely to be a declining business with significant investments in response to market shifts and regulations

First Problem

- Decide what is knowable and what is not
- Are the models unsatisfactory or is the world uncooperative?
- Need to balance can do and timidity with realism

Knowability

"There are no facts about the future." Are there facts about the past?

- Data history
- Backcasting
  - Look a EIA forecasting successes and failures
  - Look at the successes and failures of others
- Ask if after-the-fact explanations could have been made before the fact (Black Swan)

Current Problems and Concerns with the Refinery Model

- Too large
- Lacks transparency
- Too resource intensive
- Outdated modeling software
- Boundaries between it and other forecasting systems probably in the wrong places
- Quality of the forecasts?

Model Foci

- Industry—understand the future state of the industry, especially in a low/no-growth future.
- Energy markets—forecast prices and quantities of petroleum-based fuels in the US.
- Energy policy/regulations—estimate the impacts of proposed policies and regulations on energy markets, including new sources of liquid fuels.
- Environmental policies and other non-energy policies—estimate the impacts of these policies on energy markets.

Model Boundaries

Where are the interactions?
- Demand elasticities low
- Little oil consumed in other energy sectors
- US refinery output mix is heavily dependent on the mix of product imports
- Price differentials for crude quality dependent on world supply slate and demands outside the US as well as in the US

LFMM outputs will depend more on the rest of the world than other US energy sectors.

Hypothesis: LFMM need run only once per NEMS solution year

Modeling Choices

- Model consequences or decisions?
- LP's model decisions
  - Are good for representing operating decisions where there is certainty in the environment
  - Capture the economics of decisions
  - Duals provide prices
  - Aggregation doesn't distort results too much
- Econometric models model consequences
  - Extract the most information from data
  - Smooth heterogeneity and not an LP bang-bang
  - By modeling consequences the complexity of decisions do not have to be captured

Representations to Decide

- US refinery operations
- US capacity expansion and retirements
- International operations
- International capacity expansion and retirements
- Crude supply
- Liquid fuel demand in the US and rest of world
- New technologies

Real question: what is the tail and what is the dog?

US Refinery Operations

- Use a linear programming model of refineries
  - Pros
    - It's what refiners do, so this is a simulation of what is actually done.
    - New technologies can be implemented directly and the behavior of the technologies can be observed.
    - Duals make good prices, except when regulations mess up the prices, as with biofuels.
    - Econometric modeling cannot handle biofuels or other regulatory changes.
    - Nonlinear models better fit some operating units. However, that adds too much complexity.
  - Cons
    - It is too easy to make the model too large.
    - May get too much bang-bang in the solution from small cost changes, leading to administrative bounds or excessive growth in size.
    - Too easy to pretty up the results

US Capacity Expansion and retirements

- Capacity expansion should be modeled econometrically.
  - LP is a computational tool but not the decision maker in corporate planning.
  - Different companies have different forecasts, resulting in a distribution of decisions, not all-or-nothing outcomes. An estimated model captures the effect of the distribution of outcomes, unlike capacity activities in an LP.
  - Even though units such as heavy crude units are discrete lumps of capacity when added, at the scale of EIA's forecasts that is not a big deal and half a unit is effectively an expected value.
  - Capacity additions would be smooth and respond appropriately to crude price differentials.
  - Capacities are only indirectly linked to demands because of product imports. So, the data series used should include net demands on US refineries, but mainly focus on spreads.

International Operations

- Pros for expanding the domestic linear program
  - The interactions with the world are greater than the interactions with other parts of NEMS.
  - Easy to do.
  - International refiners run LP's.
  - For the major international refining regions there probably is sufficient data.
  - More stable, but evolving, world product mix.
- Cons
  - If the regional models are too small, then the imports could be subject to wide swings.
  - If the models are too large, then LFMM becomes too unwieldy.
- Pros for estimated import equations
  - The model stays small.
  - No specific policies need to be represented. So, modeling the decisions is less important.
- Cons
  - Can complicate solving domestic LP.
  - The data may not support estimating what is happening in the BRIC nations
  - Policies in other countries that affect the US are not captured in the data.

International capacity expansion and retirements

- Keep this very simple but do sensitivities to be sure that this part of the model does not drive the rest of the LP solution.

- Try not letting the capacities be determined as part of the international operations submodel because that might give too much flexibility to add capacity internationally and dump product in the US.

Crude Supply

- Look at the data on crude qualities coming from different petroleum provinces, both in the US and around the world.

- Don't use a slate in fixed proportions. All crudes are not equal in constructing a supply curve and world spare capacity is most likely in heavier crude.

Petroleum Product Demand

- Current US models seem to be working well

- Address E-85 in hybrids

- Do more to capture international demand trends and what product gets sent to the US.

New Technologies and Regulations

- Subsidies and taxes can be combined, as they represent adjustments to the cost coefficients on the activities.

- Mandates can distort prices.

- Technology representation in the main is no different from other process technologies.

- Carbon taxes are just markups. Low within-year demand elasticities means LFMM carbon can just be added to the rest of NEMS.

Other

- A more resource-constrained world with energy just another commodity
- Exchange rates are an important driver in energy costs and are now very unstable

Operational Issues

- Before fixing on a detailed implementation, an operations workflow diagram should be written of the current system.
- A new workflow diagram should be done for any new design.
- Move to a more modern modeling language
- Don't forget transparency
- For the long run spend more time on non-energy policy impacts on energy
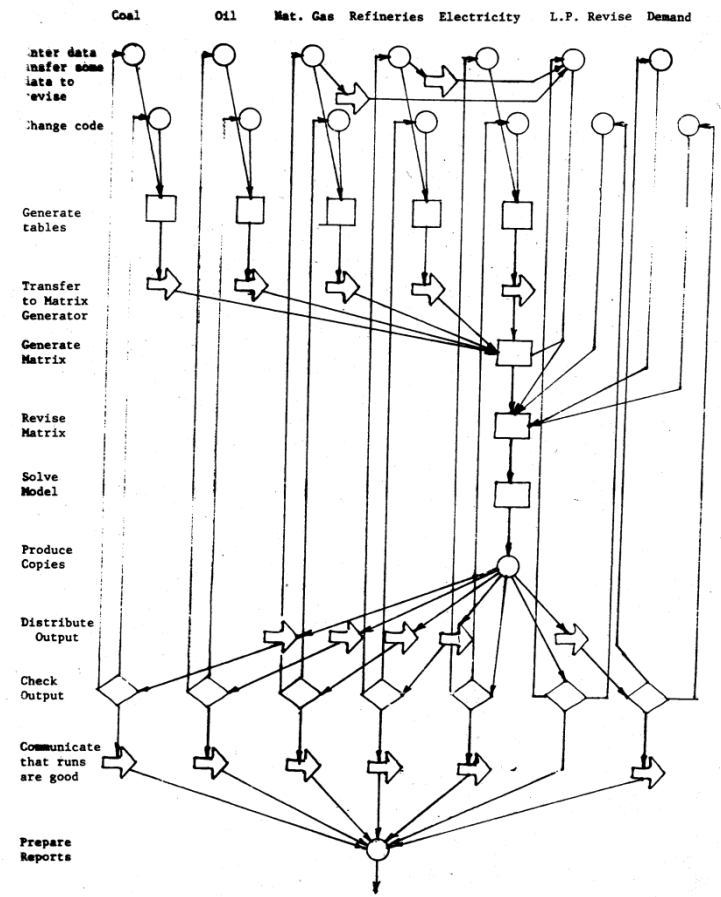
PIES Workflow

Figure 5   Workflow Diagram for PIES

Steps to Take

- Backcast the current model to know what works and doesn't work.
- Search the literature for what others have done.
- Know industry best practices.
- Decide what can be known.
- See what data is available.
- Work in a test platform that allows rapid experimenting, e.g. Excel, GAMS, or MPL.
- Determine what the drivers of the solution are and work hardest there.
- Don't pretty the solutions to the prototypes.