

Reassessing the Outlook of US Oil Dependence Using Oil Security Metrics Model (OSMM)



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**2014 U.S. DOE Hydrogen Program and
Vehicle Technologies Program Annual
Merit Review and Peer Evaluation
Meeting**

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Project ID: van010

OVERVIEW

Timeline

- Project start date: Oct. 2005
- Project end date: Continuing

Barriers/Targets*

- Supports program portfolio management by quantifying the value of reducing future U.S. petroleum consumption and improving substitutes (p. 3.0-2).
- Measures and explains past economic costs of oil dependence to enhance public understanding of the importance of reduced petroleum dependence (p. 1.0-5)

**from 2011-2015 VTP MYPP*

Budget (DOE share)

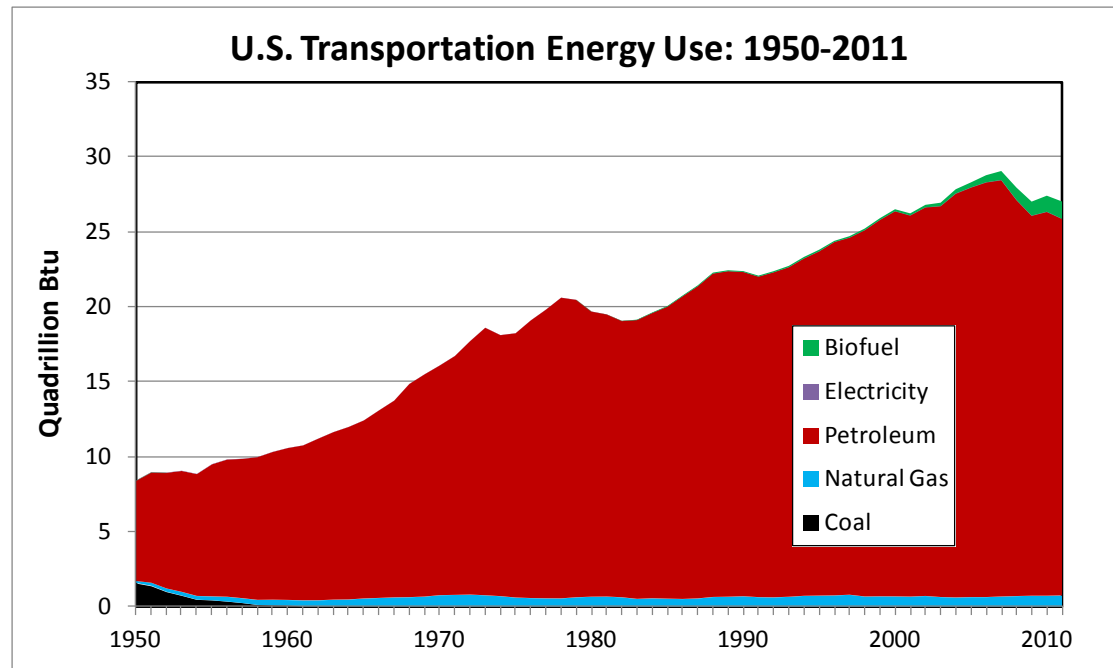
- FY13 funding: \$100k
- FY14 funding : \$100k

Partners

- University of Tennessee
- Argonne National Laboratory
- Project Lead: ORNL

Relevance: The OSMM estimates the cost of U.S. oil dependence and the direct economic value of reducing it.

- Enhancing US energy security is a primary objective of the DOE.
- The transportation sector's oil dependence is probably the greatest threat to US energy security.
- The OSMM project tracks and explains oil dependence costs and measures the energy security benefits of vehicle technologies and alternative fuels in an uncertain future.



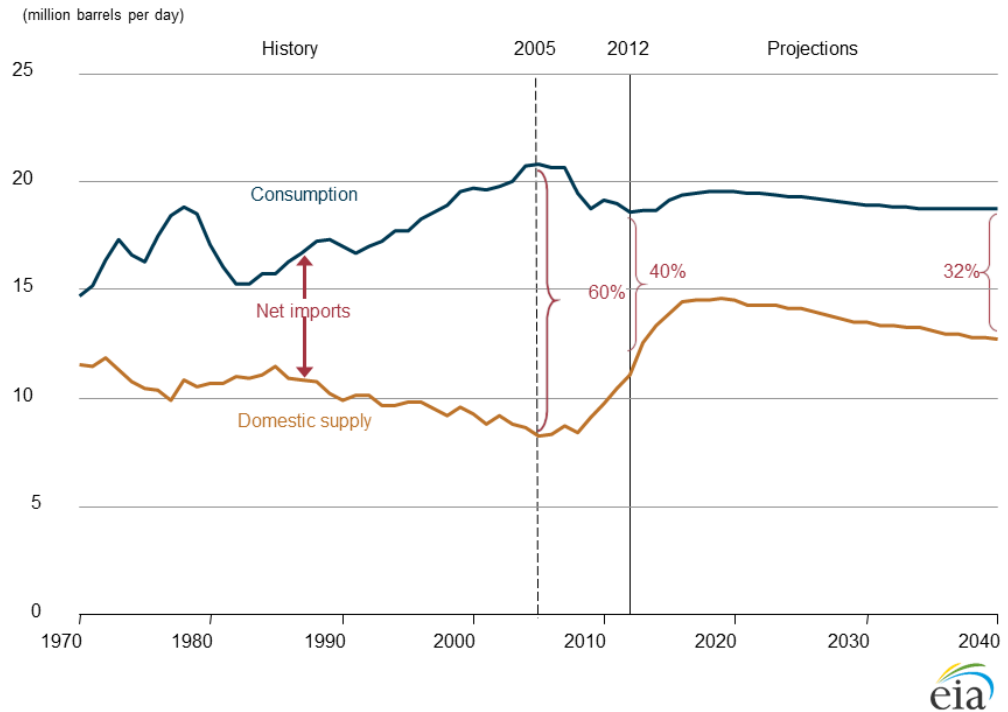
Source: EIA

Objective: Reassess the outlook for US oil dependence given resurgent US oil supply and new world oil market dynamics

Market Dynamics:

- Increased domestic oil production and no growth in demand have reduced US oil import dependence from 60% in 2005 to 40% in 2012.
- Oil prices are at historic highs and projected to go higher in the future.
- Recent estimates indicate that the price responsiveness of oil demand and supply are decreasing.
- OPEC's market share is likely to remain at 40-45% for the next 30 years.

Figure 12. U.S. petroleum and other liquid fuels supply, 1970-2040



OSMM is substantially improved to reflect new understanding of the oil market.

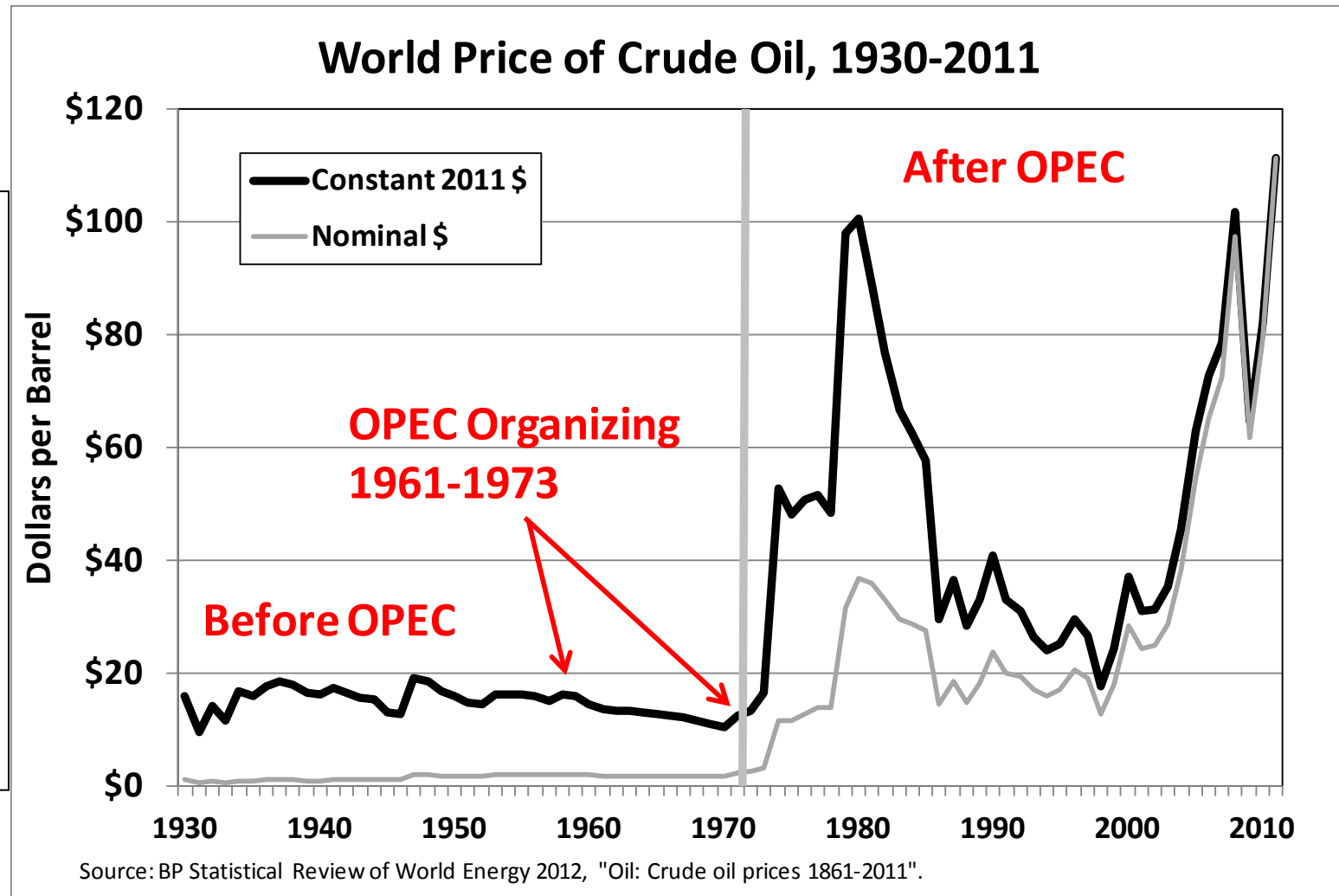
FY14 Milestone, Tasks and Status

FY14 AOP Milestone	Due Date	Sub-task	Status as of 04/15/2014 (% completed)
Model Update	03/31/ 2014	Calibrate to AEO 2013	100%
Model Improvement	06/30/ 2014	Review recent literature on oil market and adjust price elasticities and competitive oil prices in OSMM accordingly	90%
		Enhance oil supply shock simulation algorithm	90%
Analysis	06/30/ 2014	Preliminary results on US oil dependence cost estimation	90%
Reporting	09/30/ 2014	Submit a paper for peer-review publication	0%

Approach: The OSMM recognizes the influence of the partial monopoly of oil-producing states on the world oil market.

“The real problem we face over oil dates from after 1970: a strong but clumsy monopoly of mostly Middle Eastern exporters operating as OPEC.” Prof. M. Adelman, MIT, 2004.

[Algeria](#)
[Angola](#)
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[Kuwait](#)
[Libya](#)
[Nigeria](#)
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[Saudi Arabia](#)
[UAE](#)
[Venezuela](#)



Approach: The OSMM is built upon the oil market module that simulates the evolution of world oil market

INPUTS:

- AEO projections of Oil demand, supply and prices
- Price elasticity
- Changes in oil consumption due to DOE VT progress

MODEL:

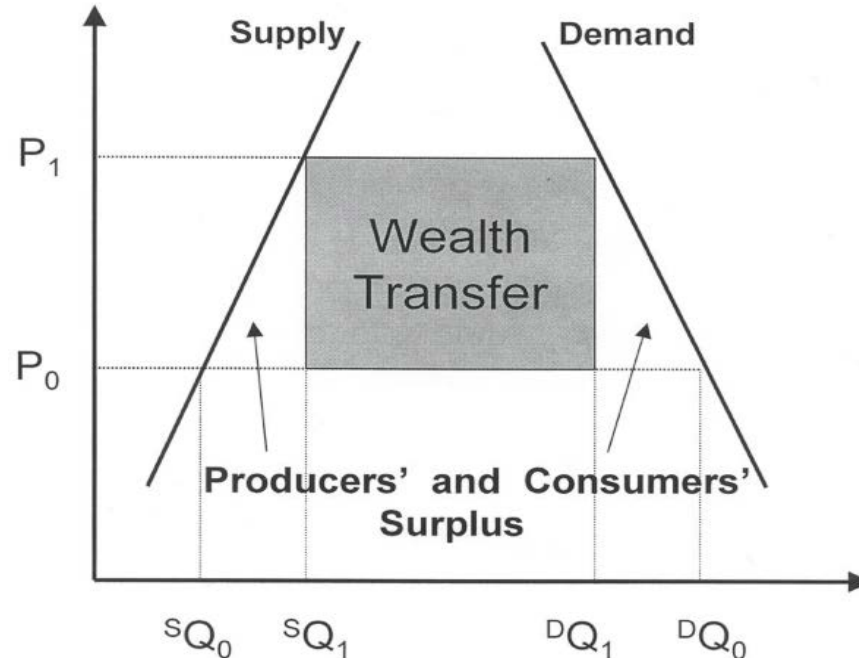
- Linear supply and demand equations
- Simulate oil supply shocks
- Uncertainty analysis using @risk software

OUTPUTS:

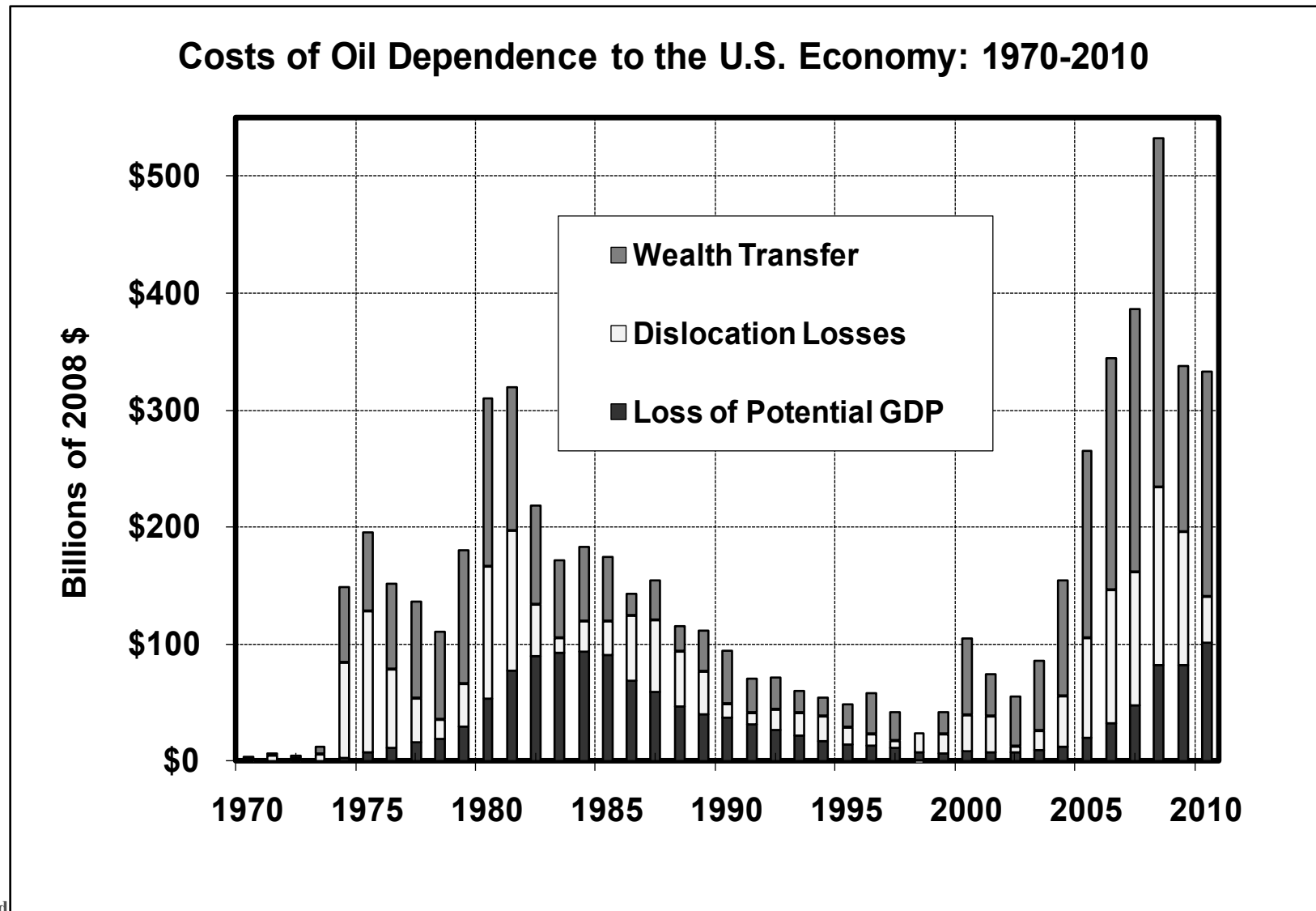
- U.S. oil dependence cost
- Oil security net benefits of DOE R&D programs and other policies

Approach: The OSMM measures 3 losses to the U.S. economy in comparison to a competitive market.

1. **Loss of potential GDP** = producers' & consumers' surplus losses in oil markets (dynamic).
2. **Dislocation losses** of GDP due to oil price shocks.
3. **Transfer of wealth** due to monopoly pricing and price shocks (requires counterfactual competitive price).



Technical Accomplishments : Oil dependence cost the US about \$500 billion in 2008 and about \$3 trillion from 2005 to 2010.

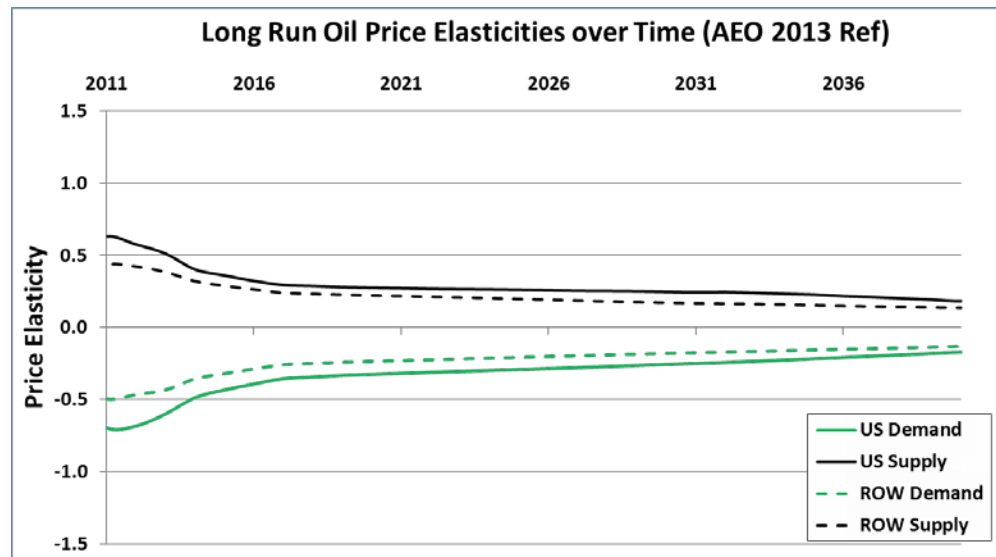


Technical Accomplishments - Model Improvement

Model improvement considers the new dynamics of oil market: reduced price responsiveness of oil supply and demand.

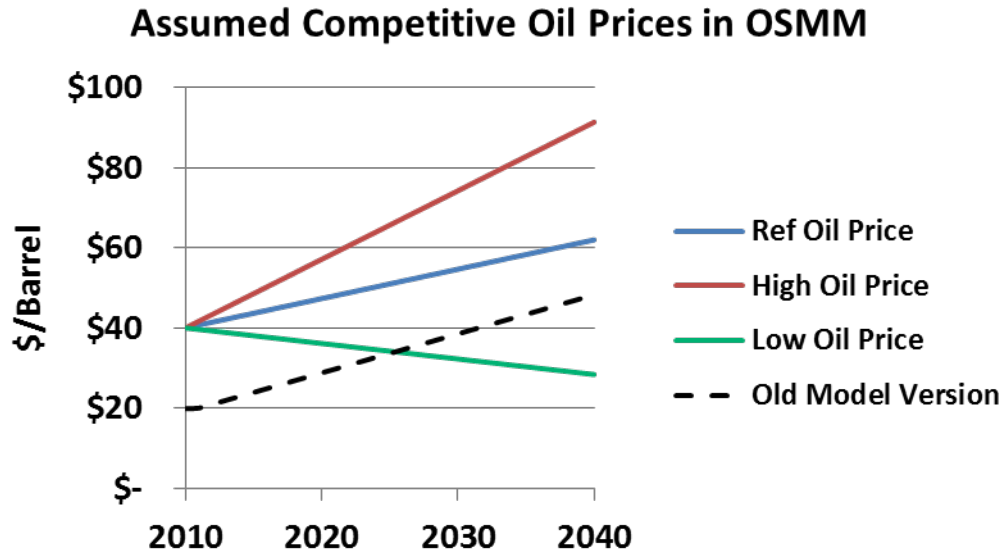
- Peaking of conventional oil implies it is more difficult and more costly to find and produce oil outside of OPEC.
- Environmental concerns and regulations will make the increase of supply more slow and costly.
- Demand has become concentrated in less price sensitive sectors (i.e., transportation).
- Demand has shifted towards less price sensitive economies (i.e., non-OECD countries).

Long run price elasticities are revised to be consistent with recent literature estimates (Dagay and Gately,2010; Baumeister and Peersman,2013)



References: J.M. Dargay and D. Gately, 2010, *Energy Policy*, v. 38, pp. 6261-6277; C. Baumeister and G. Peersman, 2013, *J. Applied Econometrics*, v. 28, pp. 1087-1109.

Competitive oil prices are updated to reflect recent assessment of oil supply cost and future paths are tied with AEO cases



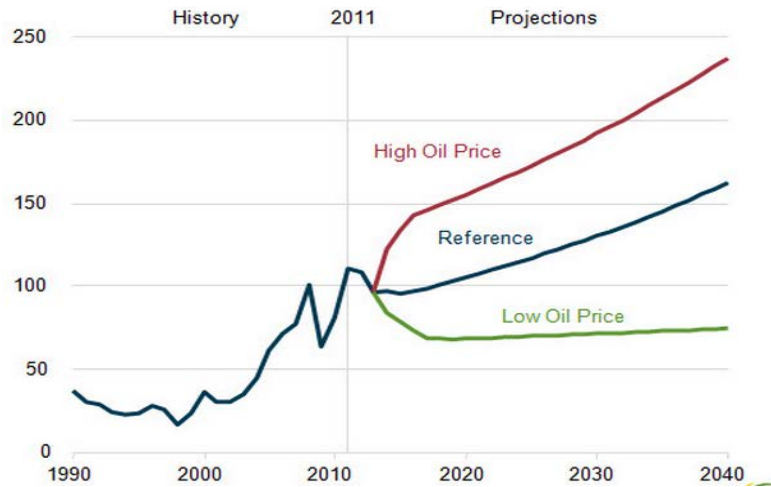
References:

- IEA, World Energy Outlook, 2013
- Aguilera et al., 2009, The Energy Journal, Vol. 30, No.1

An improvement to supply shock simulator is under way by allowing for post-shock recovery period, i.e., OPEC increases supply and retakes market share.

Technical Accomplishments: US Oil Dependence Cost (without OPEC supply shocks)

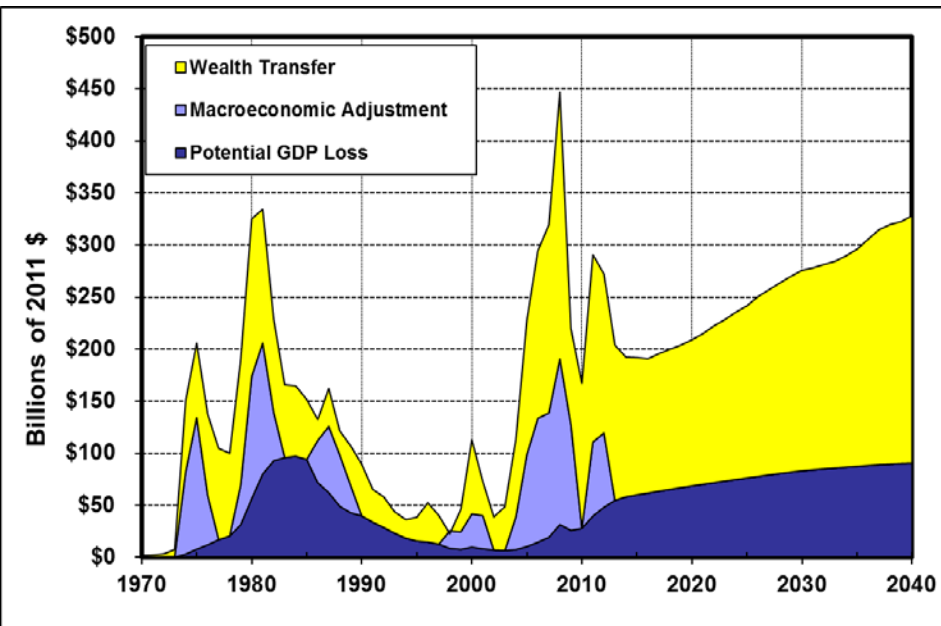
Oil Price Projection in AEO 2013



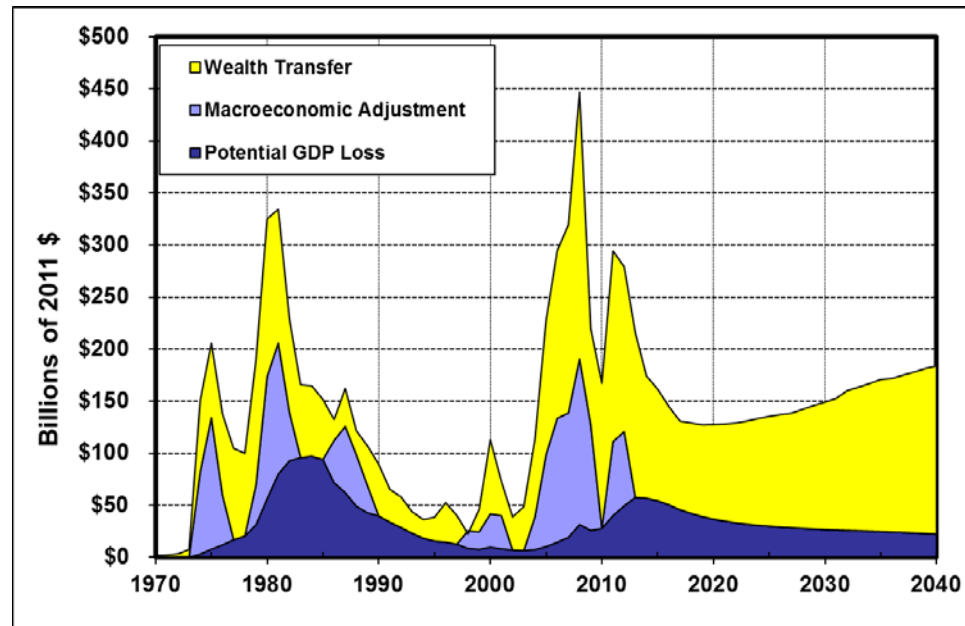
Comparing cost estimates using AEO reference case and low oil price case:

- Total cost in AEO low oil price case is in the range of \$120 Billion to \$180 Billion vs. \$200 Billion to \$330 Billion in AEO reference case.

OSMM Cost Estimate with AEO Reference Case



OSMM Cost Estimate with AEO Low Oil Price Case



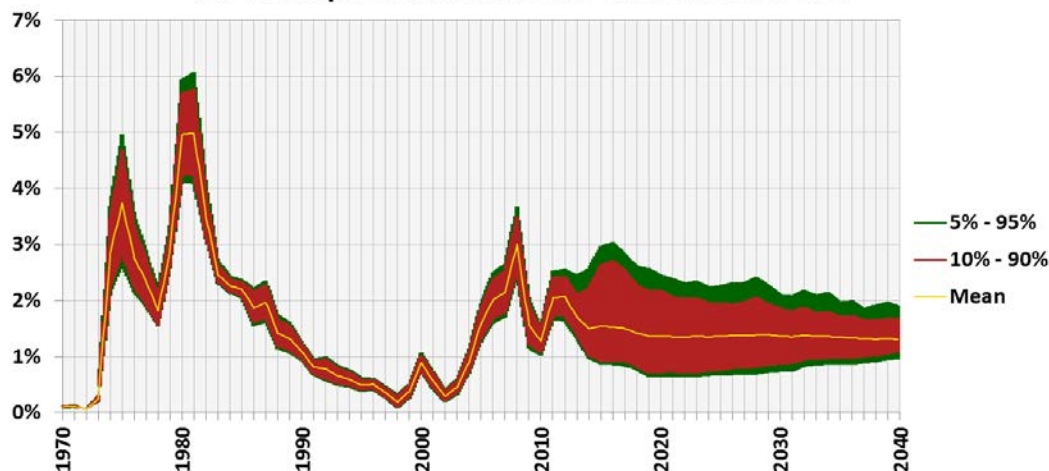
Technical Accomplishments

Preliminary Assessment of the outlook of US Oil Dependence using Monte Carlo simulation: U.S. is doing better in terms of oil dependence cost relative to GDP, but the absolute costs are still high.

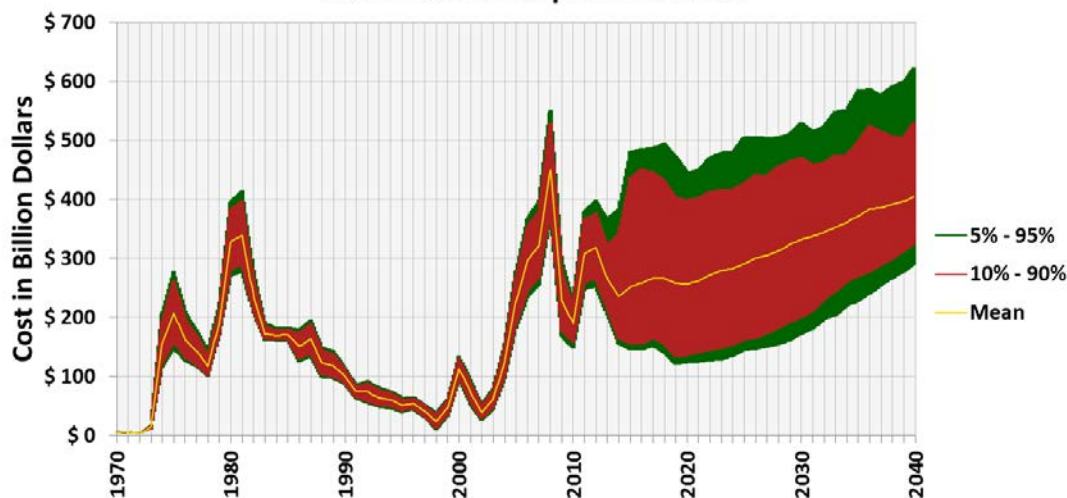
1000 Iterations:

- Prob. Distribution of Model Parameters (e.g. price sensitivities)
- OPEC supply Shock Simulator
- Random selection of alternative AEO scenarios

US Oil Dependence Cost As a Percent of US GDP



US Annual Oil Dependence Cost



COLLABORATION AND COORDINATION

Paul Leiby (ORNL) and many others have contributed to the development of the Oil Security Metrics Model. 2013-14 collaborations are the following:

- David Greene, University of Tennessee, model development and policy analysis**
- Janet Hopson, University of Tennessee, update of the model and data**
- Tom Stephens, Argonne National Laboratory, analyzing the impact of VTO program on oil security**

PROPOSED FUTURE WORK

- **Remainder of FY2014**

- Finalize model revision of price elasticity and competitive oil price
- Finish improving OPEC supply shock simulator
- Complete assessment of the outlook for U.S. oil independence
- Make the model more user friendly and available to other researchers

- **FY2015**

- Continue model update and enhancement
- Assess the impacts of VTO technology penetration scenarios
- Publish analysis of the outlook for US oil dependence and potential impacts of transition to electric and fuel cell vehicles.

Summary

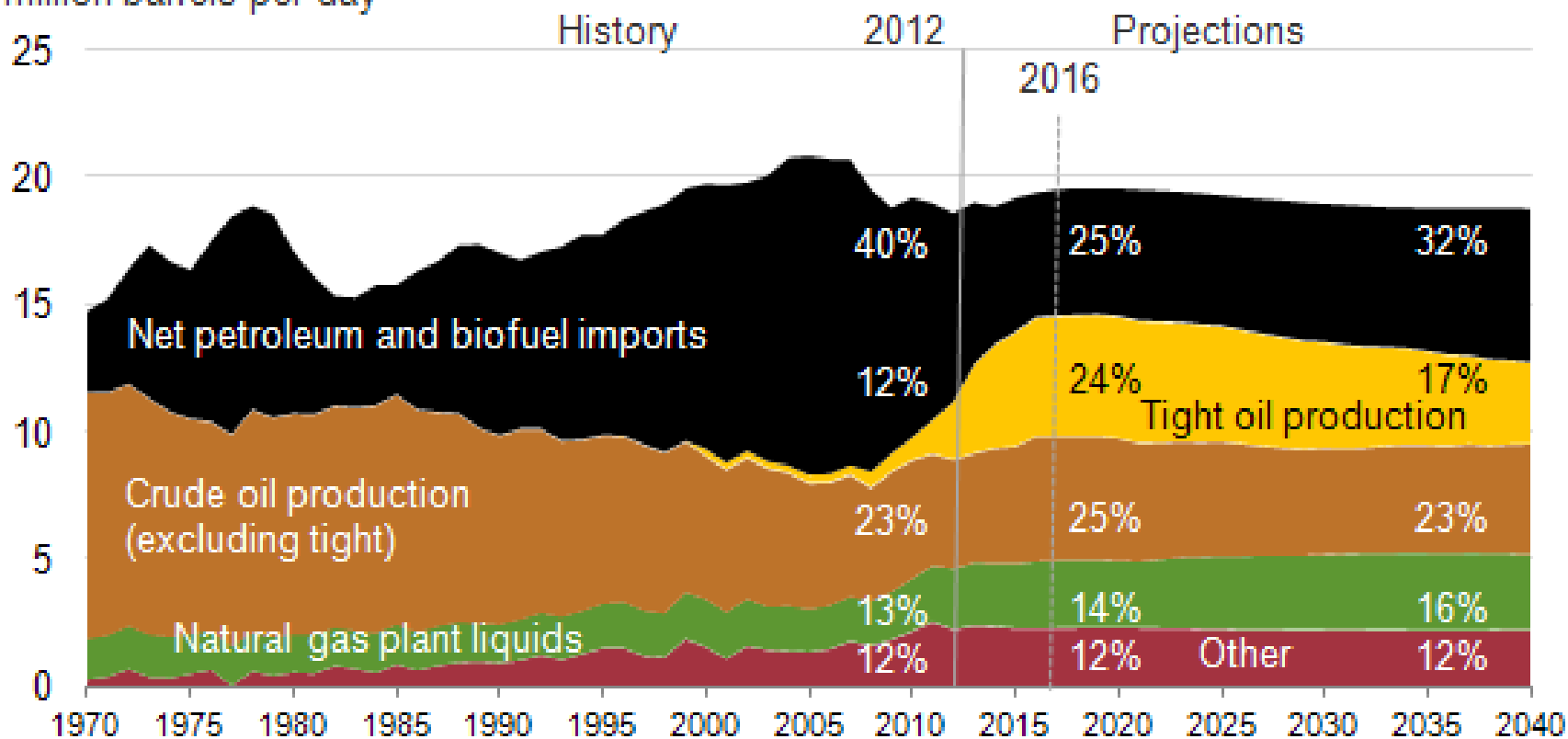
- **Relevance:** The OSMM project tracks and explains oil dependence costs and measures the energy security benefits of vehicle technologies and alternative fuels.
- **Objective in FY14:** Reassess the outlook of US oil dependence given resurgent US oil supply and new world oil market dynamics
- **Technical Accomplishments in FY 14:**
 - Calibration to AEO 2013
 - Price elasticities revision
 - competitive oil prices update
 - Oil price shock simulator improvement
 - Estimate US oil dependence cost
- Preliminary assessment of the outlook of US oil dependence suggests
 - US oil dependence situation is improving under current policies.
 - But absolute values of dependence cost are still likely to be high, on the order of several hundred billion dollars per year.
- **Future work** will estimate the benefits of advanced vehicle technologies and transitions to alternative fuels.

Thank you!

Technical Back-Up Slides

Increased domestic production of non-conventional oil.

U.S. liquid fuels supply
million barrels per day



Source: AEO2014 Early Release