Summary of the Economic Impacts of Implementing "Recommendations to the Nation on Reducing U.S. Oil Dependence"

A study commissioned by

ENERGY SECURITY LEADERSHIP COUNCIL

Securing America's Future Energy

Introduction

The Interindustry Forecasting Project at the University of Maryland (Inforum) and Keybridge Research LLC are pleased to release the following study that measures the long-term economic effects of policies designed to reduce the oil dependence of the U.S. economy. This study was commissioned by the Energy Security Leadership Council (ESLC), a project of Securing America's Future Energy (SAFE), and reflects the policy proposals detailed in the ESLC's *Recommendations to the Nation on Reducing U.S. Oil Dependence*, published in December 2006. The policies are designed to achieve three basic goals: reduced petroleum demand in the transportation sector through more aggressive vehicle fuel economy standards, expanded supply of renewable alternative fuels, and enhanced domestic production of petroleum in conjunction with stricter environmental protections.

The University of Maryland/Keybridge Research modeling team collectively has many decades of experience building and performing simulation studies with large-scale econometric models and conducting public policy research on energy and macroeconomic issues. This study relies upon comprehensive simulation analysis employing the highly respected Inforum LIFT model, an inter-industry macroeconometric model of the U.S. economy. The point of departure for the study was to develop a baseline scenario over the period 2007 to 2030 that was generally consistent with the forecast contained in the U.S. Department of Energy's *Annual Energy Outlook 2006* (AEO 2006). A second scenario for the same period was then developed incorporating the fuel conservation, alternative fuel production, and domestic oil and natural gas supply assumptions of the ESLC proposals. This second scenario also required estimates to be made for the cost of policy compliance, the pace of technological innovation in energy use, the cost of alternative fuel production, and for other key inputs as well. The estimates were drawn from, or corroborated by, well respected sources such as reports by the Energy Information Agency and the National Academy of Sciences. The two scenarios were then compared to quantify the changes in energy and oil intensity, oil imports, production, employment, and income that result from the ESLC policy package.

The study finds that, with the ESLC policy package, the U.S. economy will experience a number of beneficial impacts between now and 2030. With reduced oil dependence, household incomes and American employment will be higher and the U.S. trade deficit will be smaller. And even after paying for subsidies and other measures to implement these policies, the U.S. government is expected to come out ahead in net terms, because economic activity and income levels will be higher. Probably the single most important conclusion of the study is that by substantially reducing America's oil dependence, the economy will be much better prepared to withstand a future oil shock such as those that hit the U.S. economy and contributed to recessions in 1973-74, 1980-81, and 1991. That is, the ESLC energy package can be thought of as a self-financing insurance policy that will make the economy more robust in good times and more resilient in the face of potential energy shocks.

Jeffrey F. Werling, Ph.D.
Executive Director
Inforum, Department of Economics
University of Maryland
College Park, MD

Robert F. Wescott, Ph.D.
President
Keybridge Research LLC
Washington, DC
Former Chief Economist at the U.S. President's Council of Economic Advisors

Reducing U.S. Oil Dependence

The Energy Security Leadership Council (ESLC), a project of Securing America's Future Energy (SAFE), was founded to bring together business executives and retired military leaders in an effort to reduce oil dependence. In December 2006, the ESLC unveiled its *Recommendations to the Nation on Reducing U.S. Oil Dependence*. Broadly speaking, the ESLC program targets three main policy areas: reducing petroleum demand in the transportation sector, expanding the supply of renewable alternative fuels, and enhancing domestic petroleum production in conjunction with stricter environmental protections.

INCREASES IN TRANSPORTATION EFFICIENCY

Each day Americans consume more than eight million barrels of oil to fuel the 220 million light-duty vehicles that provide the extraordinary mobility so central to our way of life. For several decades, the majority of these vehicles have been subject to government-mandated Corporate Average Fuel Economy (CAFE) standards enacted in 1975 in the aftermath of the 1973–1974 Arab oil embargo. CAFE was instrumental in helping Americans steadily raise fuel economy performance through 1985, but its requirements have remained essentially unaltered for twenty years even as technological advances have made improvements increasingly possible.

In the view of the ESLC, reformed and strengthened CAFE standards—combined with appropriate government incentives and strict adherence to technology neutrality—are the critical components of any comprehensive plan to reduce U.S. oil dependence. The ESLC is also convinced that these efficiency standards should be extended to cover medium and heavy trucks.

TRANSPORTATION EFFICIENCY POLICY ELEMENTS	PROJECTED OIL SAVINGS BY 2030, COMPARED TO AEO 2006
1. Significantly reform and strengthen fuel efficiency standards for *passenger cars and light-duty trucks* by mandating 4% annual increases in mpg performance. Allow "off-ramps" to relax the mandate in years when 4% increases are not cost-effective, technically infeasible, or unsafe. Employ manufacturing and consumer incentives.	4.3 MBD*
2. Set and then annually strengthen fuel efficiency standards for *medium-duty vehicles* employing Federal subsidies as suitable.	0.2 MBD
3. Set and then annually strengthen fuel efficiency standards for *heavy-duty vehicles* employing Federal subsidies as suitable.	0.9 MBD
4. Require the Federal Aviation Administration (FAA) to improve air traffic routing to increase safety and decrease fuel consumption.	0.4 MBD
Total Primary Demand Savings	**5.8 MBD**
Total Realized Primary Demand Savings (See Footnote 1)	**4.8 MBD**

*MBD=Millions of Barrels Per Day

ENHANCED PRODUCTION OF ALTERNATIVE FUELS

Diversifying our transportation fuel supply must be a key part of any comprehensive effort to improve U.S. energy security. Without an expanded supply of alternatives, conventional petroleum will continue to power nearly all of our motor transport. Such reliance on a single non-substitutable input creates profound economic dangers.

Corn-based ethanol is by far the most successful domestic alternative transportation fuel. Production in the U.S. rose from 1.4 billion gallons a year in 1995 to about 4 billion in 2005, equivalent in terms of energy content to approximately 2% of our gasoline demand. At a maximum, corn-based ethanol may be able to displace 10% of our gasoline use before corn demand outstrips supply, but newer feedstock technologies have the potential to loosen this constraint.

ALTERNATIVE SUPPLY ENHANCEMENT POLICY ELEMENTS	PROJECTED OIL SAVINGS BY 2030, COMPARED TO AEO 2006
1. Expand production of ethanol for motor fuels	0.7 MBD
2. Grow the biodiesel market	0.2 MBD
Total Projected Increase in Alternative Fuels	**0.9 MBD**

EXPANDED DOMESTIC PETROLEUM SUPPLY

The U.S. plays a critical role in global petroleum production. Currently the third largest oil producer in the world after Saudi Arabia and Russia, America has produced more total oil than any other nation. Nevertheless, the U.S. is the world's largest consumer by far, accounting for 25% of the world's daily oil consumption while providing only around 10% of supply.

Much of America's untapped resources are legally off limits to production. These production "moratoria" are often justified on environmental grounds, even though the oil production industry has amassed an excellent environmental record. From 1985 to 2001, U.S. offshore operators produced 7 billion barrels of oil with a spill rate of only .001%. More recently, 3,050 of the Gulf's 4,000 platforms and 22,000 miles of Gulf pipelines were in the direct path of either Hurricane Katrina or Hurricane Rita. Despite the destruction of 115 platforms, damage to 52 other platforms and 535 pipeline segments, and the near total shut-down of the Gulf's offshore oil and gas production, there were no major oil spills attributed to either storm.

The ESLC believes it is sensible to increase access to exploration and production on the Outer Continental Shelf (OCS) as long as government and the oil and gas industry are willing to reasonably strengthen the legal and financial penalties that can be imposed in the event of any damage to the environment.

EXPANDED SUPPLY POLICY ELEMENTS	PROJECTED OIL PRODUCTION BY 2030, COMPARED TO AEO 2006
1. Expanded crude oil supply, Outer Continental Shelf (OCS)	1.3 MBD
2. Expanded OCS natural gas, displacement of oil use	0.2 MBD
3. Enhanced oil recovery (EOR)	1.0 MBD
Total Projected Increase in Domestic Supply	**2.5 MBD**

The Economic Impacts of the ESLC Recommendations

In order to quantify the economic security benefits of the *Recommendations*, the ESLC worked with economists at the Interindustry Forecasting Project at the University of Maryland (Inforum) and Keybridge Research LLC. The research team employed LIFT, an extremely detailed general equilibrium simulation model that captures the effects of purchases and sales among nearly 100 industry groups. LIFT is especially suitable for a study of this kind, because it models the interaction between detailed industry flows in the economy, such as energy use, with macroeconomic aggregates, such as GDP, consumption, employment and the trade balance. (Appendix A contains a summary of findings. Appendix B offers a general overview of the LIFT model.)

The LIFT model was used to compare an economic projection subject to the ESLC policies over the 2007–2030 period to a baseline projection calibrated to be generally consistent with the expectations of the U.S. Department of Energy's *Annual Energy Outlook 2006* (AEO 2006). The simulation results clearly demonstrate that the ESLC policies will generate substantial economic benefits.

Direct economic benefits that will flow from implementation of the ESLC policies include higher energy productivity, reduced petroleum imports, and slightly lower global oil prices. These changes will translate into additional macroeconomic benefits that include higher real income and employment, a lower current account deficit, and a reduced federal government deficit. Last but not least, the ESLC program will buffer the economy against oil price shocks: that is, as the ESLC measures reduce the petroleum dependence of the economy, any given sudden spike in global oil prices will be less harmful to the economy than would have been the case without the policies.

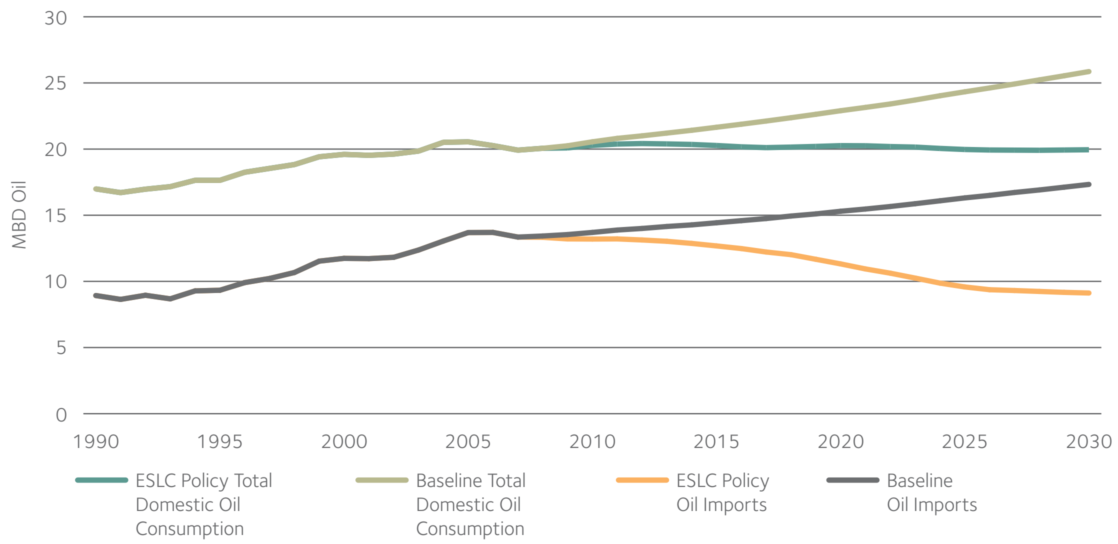
If policy implementation begins after 2007, benefits will be delayed in time, but they will be similar in magnitude and direction.

DIRECT ECONOMIC EFFECTS

Under the ESLC package, the U.S. economy becomes significantly less oil intensive. By 2030 oil demand of the U.S. economy is 5.9 MBD less than in the baseline scenario: instead of consuming 25.9 MBD as in the base case, demand would be 20.0 MBD, a reduction of 22.8 percent. Efficiency measures such as reformed and strengthened CAFE standards generate 4.8 MBD of the 5.9 MBD conserved.[1] Another 0.9 MBD of savings results from substitutions made possible by the expanded availability of ethanol and biodiesel fuels. Finally, under the ESLC plan, an additional 0.94 trillion cubic feet (TCF) of natural gas is extracted from the OCS, and this gas replaces 0.2 MBD of oil demand in 2030.

1 The ESLC program forecasts 5.8 MBD in savings from vehicle efficiency standards. In keeping with the realism of the LIFT approach, the model registers these savings at an economy-wide net of only 4.8 MBD. The lower result comes through two dynamic effects captured by the LIFT model. First, higher real GDP and income levels mean that the consumption of energy and oil will be higher, all other things being equal. Also, the substantial production of ethanol and biodiesel will require more energy consumption by the agricultural and chemical sectors than under the baseline scenario.

ESLC POLICY IMPACTS ON OIL CONSUMPTION AND IMPORTS



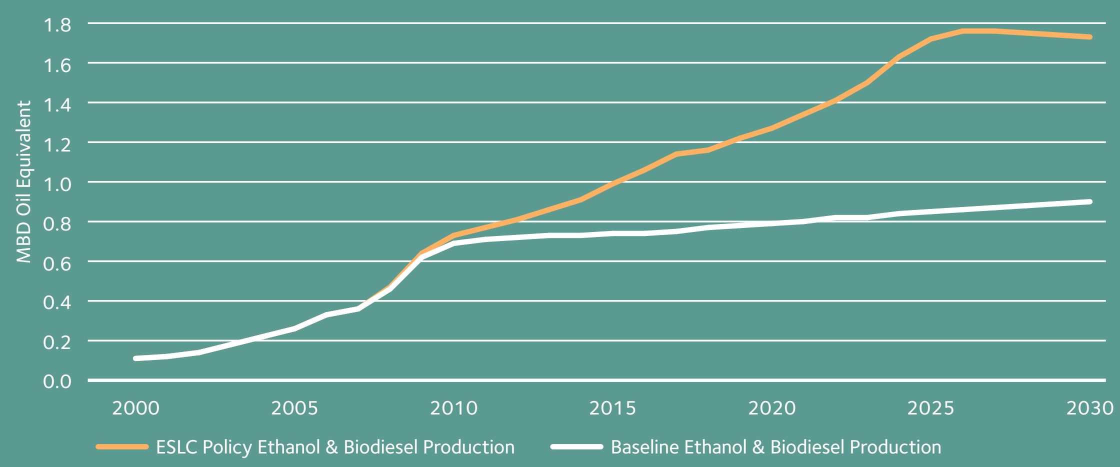
Complying with vehicle efficiency standards will generate non-trivial incremental vehicle production costs as auto and truck manufacturers are compelled to incorporate advanced motors or engines, lightweight materials, superior electronics, and other new technologies that can help achieve higher fuel economy.

To ensure realistic findings, the LIFT model was calibrated to include significant vehicle cost increases. For the simulation, the increases for the period through 2020 were guided by information contained in *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*, a study published by the National Academy of Sciences (NAS) in 2002. The NAS study excluded the potential for achieving fuel economy gains through vehicle weight reductions, and it also failed to consider diesel engines and hybrids as substantial near-term technology options for the U.S market. Arguably, these decisions resulted in the overestimating of the cost of increasing fuel economy. For the period from 2020 to 2030, the LIFT simulation added additional dollars (10% of average vehicle cost) to "pay" for fuel economy gains not foreseen by the NAS study. The possibility of a technology breakthrough that could dramatically reduce the price/fuel economy ratio was not entertained in the simulation.

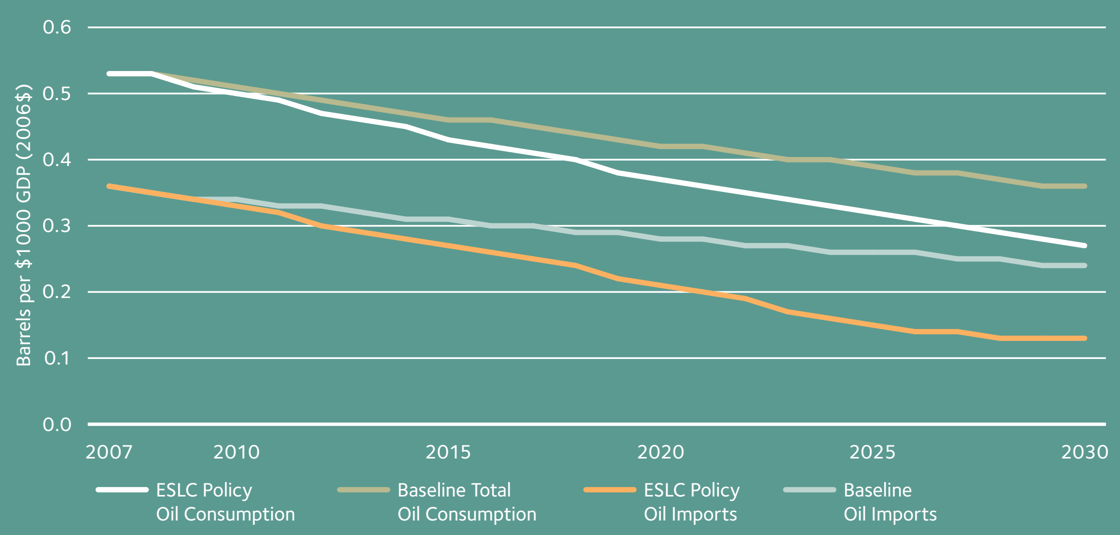
In sum, these input cost requirements increase domestic motor vehicle production costs relative to the baseline by about 1.0 percent in 2010, increasing to 9.3 percent by 2020, and reaching 16.9 percent in 2030. These production cost increases result in an escalation in motor vehicle retail prices by 0.5 percent in 2010, to 5.7 percent in 2020, and to 10.6 percent by 2030. From the consumer perspective, these incremental costs are expected to be at least partially offset by tax credits available for the purchase of vehicles that achieve higher fuel economy.

The ESLC program increases the supply of alternative fuels above the level already envisioned by AEO 2006 for 2030 by 0.9 MBD of crude oil equivalent (0.7 for ethanol, and 0.2 for biodiesel). If corn alone were relied upon to produce this ethanol, a restructuring of agricultural production would likely be necessary. However, emerging technologies make it probable that ethanol will be produced from alternate feedstocks such as switchgrass.

ESLC POLICY IMPACTS ON ETHANOL AND BIODIESEL PRODUCTION



U.S. OIL INTENSITY



In cumulative terms over the 2007 to 2030 period, the ESLC policy package saves 22 billion barrels of crude oil through conservation and the use of alternative fuels. This figure is approximately three times the 7.4 billion barrels of crude oil consumed by the United States in 2006.

Under the ESLC program, increased access to the OCS and support for accelerated development of enhanced oil recovery (EOR) techniques combine to boost domestic crude oil production substantially over the projection horizon. Improvement in domestic oil production supply reaches 2.3 MBD by 2030. Over the 2007 to 2030 forecast horizon, the cumulative augmentation to domestic crude oil supply is 10.2 billion barrels—well over current annual consumption of 7.4 billion barrels.

In terms of oil intensity, or the amount of oil consumed to generate a unit of GDP, the ESLC policy package accelerates the rate of intensity reduction to achieve a figure of 0.27 barrels per $1,000 of GDP in 2006 dollars by 2030—24.5 percent less than the baseline figure of 0.36 barrels. Reduced oil intensity acts as insurance that can mitigate the effects of sudden oil price shocks or sustained high oil prices. As a result of the halving of oil intensity since the mid-1970s, the high energy prices experienced in the summer of 2006 represented a smaller relative cost to the economy. To the extent that Americans can continue to lower our nation's oil intensity, we will increase our energy security still further.

Compared to the baseline case, ESLC supply enhancements and conservation measures combine to reduce imports of crude oil by 8.2 MBD by 2030, a 47.3 percent decrease. Cumulatively over the 24 year period, the U.S. imports 32.2 billion fewer barrels of foreign oil. By way of context, remaining proved reserves for Prudhoe Bay in Alaska are currently estimated at 4.3 billion barrels. The corresponding figure for the entire United States is less than 30 billion barrels.

The AEO 2006 reference case projects a world production capacity of about 123 MBD and a nominal world oil price of $107 per barrel in 2030. The combination of transportation demand reductions and enhancements to supply due to ESLC policies results in a 8.2 MBD reduction in U.S. crude oil imports. This is roughly equivalent to an increase in supply of 8.2 MBD for the rest of the world market, or almost 6.7 percent of the total. The lower U.S. demand on the global oil supply should lead to modestly lower world oil prices throughout the projection horizon. The model predicts that a 6.7 percent reduction of the U.S. claim on non-U.S. production by 2030 will lower the world price of oil to $95 per barrel, or about 11.5 percent. The implied elasticity of price with respect to supply is 1.7 (11.5%/6.7%), which represents a conservative assumption compared to the elasticity figures implied by AEO 2006.[2] The price changes in the simulation appear gradually and linearly over the forecast horizon.

Compared to the baseline case, the reduction of import volume and lower world oil prices reduce the cost of oil imports by $278 billion in 2030. Over the 2007 to 2030 period, the nation's economy avoids the expenditure of $2.5 trillion for imported crude oil. These savings can be spent on other imports, or they can stay at home—to be spent on domestic output or invested in domestic productive capital.

2 The 2006 AEO presents alternative scenarios for world oil prices based on varying assumptions concerning global supply. The "low price case" assumes that supply is 15 percent higher than in the reference case, resulting in a 40% lower world oil price. The AEO "high price case" posits that global supply is 15 percent lower than in the reference case, with the oil price about 70 percent higher. These scenarios imply that DOE's assumed elasticity of price with respect to changes in supply is between 2.7 (40%/15%) and 4.7 (70%/15%).

INDIRECT MACROECONOMIC EFFECTS

The reduction of oil consumption is even more remarkable when one considers that enhanced energy efficiency also provides a significant boost to real income. By using less energy, productive processes in general—and transportation in particular—become more competitive. In addition, more domestic income stays in the country. As a result, the level of GDP is increased by 0.2 percent by 2030, and the level of real personal disposable income is enhanced by 0.8 percent, both compared to the baseline.

Under the ESLC program, the typical U.S. household in 2030 enjoys $1,103 (2006 dollars) more real income. Cumulatively over the 2007 to 2030 period, households should experience an increase of almost $1.7 trillion (2006 dollars) in aggregate income—money that could be spent on goods and services or saved for a more comfortable retirement.

The rise in real disposable income is multi-causal and dynamic. First, productive processes, especially those involving transportation, become more competitive relative to the global marketplace. In essence, lower energy costs enhance exports and lower imports, thereby allowing U.S.-based industry and employment to grow faster. Second, Americans transfer less money abroad to petroleum exporters. The lowering of the "OPEC tax" comes about through both a lower volume of petroleum imports and lower global petroleum prices. As a result, more income stays at home to be consumed on domestically made items or saved and invested in U.S. production resources. Finally, higher energy productivity and lower income transfers abroad help stimulate greater capital investment and labor participation within the U.S. economy. The availability of greater capital and labor resources means that the economy can reach a higher level of overall production without generating inflationary pressures.

Under the ESLC program, the typical U.S. household in 2030 will spend $732 (2006 dollars) less on energy for transportation. The combination of higher real income and less spending on energy provides the average household with $1,835 (2006 dollars) more real *discretionary* purchasing power. The 24-year cumulative enhancement in this "non-energy purchasing power" is nearly $2.9 trillion.

Because of the higher levels of income and GDP that result from the energy policy package, the U.S. federal budget deficit would improve by a cumulative (2007 to 2030) $578 billion when compared against the baseline case. Estimating the policy package's cumulative nominal cost to the U.S. Treasury at $180 billion, this yields a benefit-to-cost ratio for the U.S. government fiscal balance of over three. That is, in federal budget terms, the energy policy package would pay for itself three times over during the course of the next 24 years.

The more energy efficient economy enjoys a higher level of GDP and lower energy prices, which translate into an increase in overall jobs of 1.2 million, or 0.7 percent, by 2030. Among the employment effects expected for 2030, the model projects 139,000 more manufacturing jobs, 91,000 more jobs in professional services, and 199,000 more jobs in travel and tourism.

SUPPLY SHOCK INSURANCE

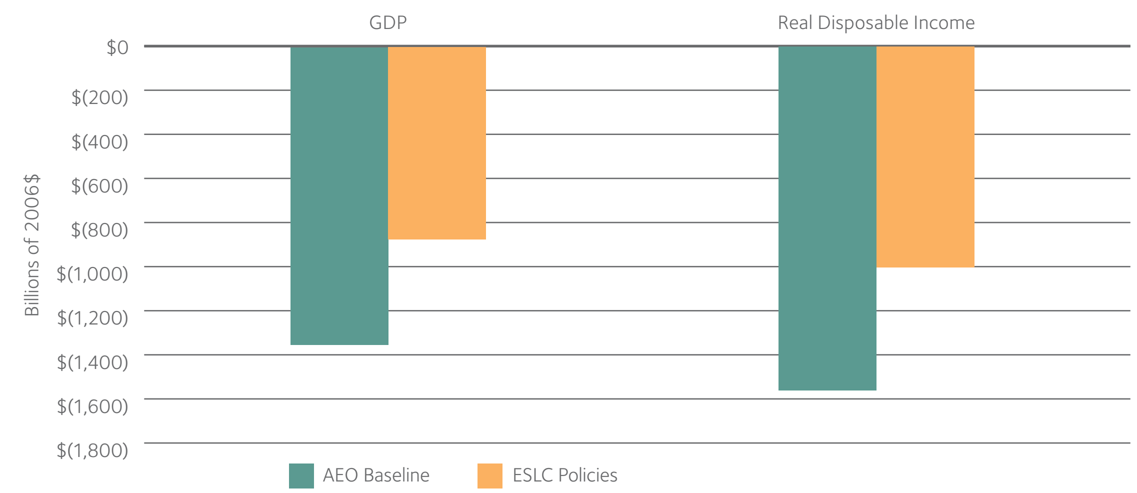
Perhaps the most important impact of the ESLC energy program is that it reduces America's vulnerability to petroleum supply and price shocks.

Oil supply shocks can be triggered by many different causes, ranging from natural disasters to terrorist assaults to politically influenced supply cutoffs. Sudden and unexpected by definition, such shocks can wreak havoc by generating massive macroeconomic adjustment costs, with output and labor usage declining until prices, wages, and interest rates belatedly adjust to the shortage of a key economic input.

Based on recent history, current tensions, and predicted trends, future shocks are highly probable. Even minor shocks act as a headwind on economic growth. A particularly severe shock might trigger a serious economic crisis. Lower dependence on oil could mean the difference between an economic slowdown and a full-blown recessionary contraction.

LIFT experiments were conducted in which the price of oil was doubled in 2026, with the price still 66 percent higher in 2027 and 25 percent higher from 2028 through 2030. Such a shock would harm the economy regardless of the energy policies in place, but the ESLC policy measures reduce the damage to income and employment by 30 to 40 percent.

CUMULATIVE IMPACTS OF 2026-2030 SUPPLY SHOCK



Under the AEO 2006 baseline scenario, the simulated price shock produces a loss of 1.8 percent of GDP in the first year and 2.4 percent in the second year. Under ESLC policies, the same percentage price shock results in a GDP loss of only 1.2 percent in the first year and 1.5 percent in the second year. Under existing policy, the oil shock produces a real disposable income loss of almost $600 billion (2006 dollars) by 2027. The maximum 2027 income loss under the ESLC policies is just $366 billion, only 63 percent of the damage without the policy changes. Under the baseline policies, a doubling of oil prices results in the loss of more than 4 million jobs by the second year of the shock, while the loss under ESLC policies is 2.5 million jobs.

The cumulative shock-induced negative impact on GDP over the period 2026-2030 is estimated at $1,348 billion under the AEO baseline but only $871 billion in the ESLC case (all in 2006 dollars). The cumulative negative impact on real disposable income over the same period is estimated at $1,559 billion in the AEO baseline and $1,002 billion in the ESLC case (again in 2006 dollars).

Appendix A

SUMMARY OF FINDINGS

- The U.S. economy becomes significantly less oil intensive under the ESLC package. By 2030, the oil demand of the U.S. economy is 5.9 million barrels per day (MBD) less than in the baseline, a reduction of 22.8 percent.

- The nation conserves 4.8 MBD of the 5.9 MBD through efficiency measures such as redesigned and stricter corporate average fuel economy (CAFE) standards. Another 0.9 MBD of the savings are the result of substitution measures that displace oil through greater production of ethanol and biodiesel fuels. Finally, an additional 0.94 TCF of natural gas extracted from the Outer Continental Shelf (OCS) replaces 0.2 MBD of oil demand in 2030.

- In cumulative terms over the 2007 to 2030 period, the ESLC policy package reduces consumption by 22 billion barrels of crude oil equivalent through conservation and the use of alternative fuels. This aggregate figure is about three times the 7.4 billion barrels of crude oil consumed by the United States in 2006.

- In terms of oil intensity, or the amount of oil consumed to generate a unit of GDP, the ESLC policy package will accelerate the rate of reduction to achieve a figure of 0.27 barrels per $1,000 of GDP in 2006 dollars by 2030, 24.5 percent less than the baseline figure of 0.36 barrels. The oil intensity of the U.S. economy in 2006 was 0.56 barrels per $1,000 of GDP.

- Increased access to the OCS for purposes of oil and natural gas production and support for enhanced oil recovery (EOR) techniques boost domestic crude oil production substantially over the projection horizon compared to the AEO baseline. The annual incremental improvement in domestic oil production supply reaches 2.3 MBD by 2030. Over the 2007 to 2030 forecast horizon, the cumulative augmentation to domestic crude oil supply by EOR and OCS is 10.2 billion barrels—almost 38% over current annual consumption of 7.4 billion barrels.

- Compared to the baseline case, the supply enhancements and conservation measures combine to reduce imports of crude oil by 8.2 MBD by 2030, a 47.3 percent decrease. Cumulatively over the 24-year period under consideration, the U.S. would import 32.2 billion fewer barrels of foreign oil. This figure compares to estimated remaining proved reserves of 4.3 billion barrels for Prudhoe Bay in Alaska and less than 30 billion barrels for the entire United States.

- Reduced U.S. demand on the global oil supply should lead to modestly lower world oil prices throughout the projection horizon. The baseline case assumes a nominal price of oil of $107 by 2030. This study estimates that the price of oil would be $95 per barrel, or about 13 percent lower, with the ESLC policy package.

- The reduction of import volume and lower world oil prices mean that, by 2030, oil imports will be lower by $278 billion per year. Over the 2007 to 2030 period, the nation's economy will avoid the expenditure of $2.5 trillion for imported crude oil. These savings can be spent on other imports, or they can stay at home—to be spent on domestic output or invested in domestic productive capital.

- This study estimates that, through 2030, the policy package will improve the U.S. current account deficit by about $175 billion dollars, or about 0.4 percent of GDP. (This figure indicates that approximately $103 billion of the savings from avoided oil imports will be spent on the import of other good and services.)

- Enhanced energy efficiency also provides a significant boost to real income. By using less energy, productive processes in general—and transportation in particular—become more competitive. Moreover, more domestic income stays in the country. Therefore, U.S. real GDP and U.S. real income are higher. The GDP is increased by 0.2 percent by 2030 and the level of real personal disposable income is enhanced by 0.8 percent.

- With the ESLC policy package, the typical U.S. household in 2030 should receive $1,103 (2006 dollars) more income than it would in the reference case. Cumulatively during the 2007 to 2030 period, households would experience an increase in income of almost $1.7 trillion (2006 dollars)—money that could be spent on goods and services or saved for a more comfortable retirement.

- By 2030, the typical U.S. household would be spending fewer dollars directly on energy for transportation. The combination of higher income and less spending on energy means that the average household would be able to enjoy about $1,835 (2006 dollars) in incremental discretionary purchasing power. That is, they will have $1,835 more income to use for savings or for the purchase of consumer goods and services other than energy. The 24-year cumulative enhancement in this "non-energy purchasing power" is nearly $2.9 trillion.

- This study assumes that the cost of domestic motor vehicle manufacturing relative to the baseline increases steadily, adding an incremental 1.0 percent in 2010, an incremental 9.3 percent by 2020, and an incremental 16.9 percent in 2030. These cost increases are the result of the incorporation by auto and truck manufacturers of more expensive motors/engines, lightweight materials, advanced electronics, and other new technologies that help achieve higher fuel efficiency/fuel economy. This altered production pattern will cause other industries to see greater demand for their products.

- The adoption of the ESLC policy package can significantly reduce the economy's vulnerability to an oil supply shock. Experiments were conducted in which the price of oil was doubled in 2026, with the price still 66 percent higher in 2027 and 25 percent higher from 2028 through 2030. Such a shock would harm the economy regardless of the energy policies in place, but the ESLC policy measures reduce the damage to income and employment by 30 to 40 percent.

- Assuming the AEO baseline as a point of departure, the price shock produces a real disposable income loss of almost $600 billion (2006 dollars) by 2027. The maximum income loss under the ESLC policies by 2027 is only $366 billion, only 63 percent of the damage without lower oil dependence. Under the baseline, a doubling of oil prices results in the loss of more than 4 million jobs by the second year of the shock, while the loss under ESLC policies is 2.5 million jobs.

- The cumulative shock-induced negative impact on GDP over the period 2026-2030 is estimated at $1,348 billion under the AEO baseline but only $871 billion in the ESLC case (all in 2006 dollars). The cumulative negative impact on real disposable income over the same period is estimated at $1,559 billion in the AEO baseline and $1,002 billion in the ESLC case (again in 2006 dollars).

Appendix B

THE LIFT MODEL OF THE U.S. ECONOMY

Inforum's flagship model, LIFT (Long-term Interindustry Forecasting Tool), is a 97-sector general equilibrium representation of the U.S. economy. It is unique among large-scale models of the U.S. economy. Combining an interindustry (input-output) formulation with extensive use of regression analysis, it employs a "bottom-up" approach to macroeconomic modeling. For example, aggregate investment, total exports, and employment are not determined directly, but are computed by the sum of their parts: investment by industry, exports by commodity, and employment by industry. Indeed, LIFT contains full demand and supply accounting for 97 productive sectors. (See below for LIFT sector titles.)

The demand/production block of LIFT uses econometric equations to predict the behavior of real final demand (consumption, investment, imports, exports, government) at a detailed level. Then, the detailed predictions for demand are used in an input-output production identity to generate gross output (total revenue adjusted for inflation). LIFT's approach to projecting industry prices is similar. Behavioral equations estimate each value-added component (e.g., compensation, profits, interest, rent, indirect taxes) for each industry. Value added per unit of output is then combined with the prices of intermediate goods and services with the input-output price identity to form industry prices. Prices by industry are also dependent on measures of slack in each industry, and, in some cases, international prices. Thus, income and prices are directly related and are consistent. In turn, relative price terms and income flows are included as independent variables in the regression equations for final demand, creating a simultaneity between final demand and value-added.

This bottom-up technique possesses several desirable properties for analyzing the economy. First, the model works like the actual economy, building the macroeconomic totals from details of industry activity, rather than distributing predetermined macroeconomic quantities among industries. Second, the model describes how changes in one industry, such as increasing productivity or changing international trade patterns, affect related sectors and the aggregate quantities. Third, parameters in the behavioral equations differ among products, reflecting differences in consumer preferences, price elasticities in foreign trade, and industrial structure. Fourth, the detailed level of disaggregation permits the modeling of prices by industry, allowing one to explore the causes and effects of relative price changes.

Despite its industry basis, LIFT is a full macroeconomic model, with more than 800 macroeconomic variables determined consistently with the underlying industry detail. This macroeconomic "superstructure" contains key functions for household savings behavior, interest rates, exchange rates, unemployment, taxes, government spending, and current account balances. Like in an aggregate macroeconomic model, this structure insures that LIFT exhibits "Keynesian" demand driven behavior over the short-run, but neoclassical growth characteristics over the longer term. For example, while monetary and fiscal policies and changes in exchange rates can affect the level of output in the short-to-intermediate term, in the long term, supply forces—available labor, capital and technology—will determine the level of output.

Another important feature of the LIFT model is the importance given to the dynamic determination of endogenous variables. For example, investment depends on a distributed lag in the output growth of investing industries and imports and exports depend on a distributed lag of foreign price changes. Therefore, LIFT model solutions are not static, but are fully capable of projecting a time path for the endogenous quantities.

Finally, the LIFT model is linked to other, similar models with the Inforum Bilateral Trade Model (BTM). Countries included in this system include the U.S., Japan, China, South Korea and the major European economies. Through this system, sectoral exports and imports of the U.S. economy respond to industry-level demand and price variables projected by models of U.S. trading partners. In summary, the LIFT model is particularly suited for examining and assessing the macroeconomic and industry impacts of the changing composition of consumption, production, foreign trade, and employment as the economy grows through time.

LIFT's data foundations are drawn from a number of sources. A summary of the most important sources follows:

U.S. Bureau of Economic Analysis (BEA)
Input-output tables
National Income and Product Accounts (NIPA)
Industry output and value added
International trade deflators

U.S. Bureau of the Census
Population
International trade
Recent industrial and service sector activity

U.S. Bureau of Labor Statistics
Employment (aggregate and industrial)
Consumer and producer prices

U.S. Federal Reserve Board
Interest rates
Exchange rates
Industrial production
Money supply and credit

The current LIFT model is the fourth discrete version of a modeling framework that has been in continuing existence since 1967. Since its inception, LIFT has continued to develop and change. The structure and properties of the model have been modified with the experience of working with clients with partners in other countries. A detailed description of the LIFT model can be found at: http://www.inforum.umd.edu/WorkPaper/INFORUM/wp01002.pdf

Table A-1

PRODUCING SECTORS OF THE LIFT MODEL OF THE U.S. ECONOMY

Agriculture, forestry, & fish
1 Agriculture, forestry, & fish

Mining
2 Metal mining
3 Coal mining
4 Natural gas extraction
5 Crude petroleum
6 Non-metallic mining

Construction
7 New construction
8 M & R construction

Non-Durables
9 Meat products
10 Dairy products
11 Canned & frozen foods
12 Bakery & grain mill product
13 Alcoholic beverages
14 Other food products
15 Tobacco products
16 Textiles and knitting
17 Apparel
18 Paper
19 Printing & publishing
20 Agric fertilizers & chemicals
21 Plastics & synthetics
22 Drugs
23 Other chemicals
24 Petroleum refining
25 Fuel oil
26 Rubber products
27 Plastic products
28 Shoes & leather

Durable Material & Products
29 Lumber
30 Furniture
31 Stone, clay & glass
32 Primary ferrous metals
33 Primary nonferrous metals
34 Metal products

Non-Electrical Machinery
35 Engines and turbines
36 Agr., constr., min & oil equip
37 Metalworking machinery
38 Special industry machinery
39 General & misc. industrial
40 Computers
41 Office equipment
42 Service industry machinery

Electrical Machinery
43 Elect. industry equipment
44 Household appliances
45 Elect. lighting & wiring eq
46 TV's, VCR's, radios
47 Communication equipment
48 Electronic components

Transportation Equipment
49 Motor vehicles
50 Motor vehicle parts
51 Aerospace
52 Ships & boats
53 Other transportation equip

Instruments & Miscellaneous Manufacturing
54 Search & navigation equip
55 Medical instr & supplies
56 Opthalmic goods
57 Other instruments
58 Miscellaneous manufacturing

Transportation
59 Railroads
60 Truck, highway pass transit
61 Water transport
62 Air transport
63 Pipeline
64 Transportation services

Utilities
65 Communications services
66 Electric utilities
67 Gas utilities
68 Water and sanitary services

Trade
69 Wholesale trade
70 Retail trade
71 Restaurants and bars

Finance & Real Estate
72 Finance & insurance
73 Real estate and royalties
74 Owner-occupied housing

Services
75 Hotels
76 Personal & repair services
77 Professional services
78 Computer & data processing
79 Advertising
80 Other business services
81 Automobile services
82 Movies & amusements
83 Private hospitals
84 Physicians
85 Other medical serv & dentists
86 Nursing homes
87 Education, social serv, NPO

Miscellaneous
88 Government enterprises
89 Non-competitive imports
90 Miscellaneous tiny flows
91 Scrap & used goods
92 Rest of the world industry
93 Government industry
94 Domestic servants
95 Inforum statistic discrepancy
96 NIPA statistical discrepancy
97 Chain weighting residual

Securing America's Future Energy
1747 Pennsylvania Avenue, NW
Suite 200 Washington, DC 20006
Tel: 202-461-2360
Fax: 202-318-8934
SecureEnergy.org

The Energy Security Leadership Counceil is a project of Securing America's Future Energy

This report has been printed with soy-based inks.

Design by Matthew Schwartz Design Studio