The Inforum LIFT Model
U.S. Energy and Economic Outlook

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Overview

- The Inforum *LIFT* Model
- Treatment of energy flows and emissions in *LIFT*.
- Calibrating to AEO
- Model extensions
- U.S. Energy and Macroeconomic Outlook
- Modeling of energy and environmental regulation

LIFT: An Interindustry Macro (IM) Model

- Input-Output (IO) relationships form the core of *LIFT*, both for output and price calculations.
- Of the 90 industries in *LIFT*, 7 are primary or final energy products:
  - 3. Coal mining
  - 4. Natural gas extraction
  - 5. Crude petroleum extraction
  - 24. Petroleum refining
  - 25. Fuel oil
  - 66. Electric power
  - 67. Natural gas
- The *LIFT* IO table shows flows of these energy products to all other industries and to final demand.

Energy Flows in *LIFT*

- The flows of energy product sales to all markets are calculated in the IO framework.
- Sales of coal to other industries and to final users, is shown on the next slide.
- The largest consumers are Electric utilities (70%), Ferrous metals, Paper and Other chemicals.
- Final demands for coal are relatively small.

U.S. Coal Market Outlook

Units: Millions of 2005$

	2010	2020	2030	2035
3 Coal mining	2410	4254	4318	4326
18 Paper	295	342	389	394
21 Plastics & synthetics	51	80	115	123
23 Other chemicals	216	274	340	316
31 Stone, clay, glass	336	499	581	586
32 Primary ferrous metals	1201	972	932	810
66 Electric utilities	18962	26457	29623	30893
Total Intermediate	**24129**	**33666**	**37187**	**38394**
40 Fuel oil & coal	43	39	42	40
SUM: Personal Consumption	43	39	42	40
Inventory Change	-20	-469	-726	-931
Exports	4776	6133	7875	8923
Imports	-670	-1517	-2582	-3562
Output	**28550**	**38157**	**42115**	**43192**

Source: Inforum LIFT AEO 2010 Baseline

Energy Use by Consumers

- Consumer demand is the largest component of final demand, and includes both residential energy and transportation functions.
- Energy categories in personal consumption in *LIFT* include:
  - 37. Electricity
  - 38. Natural gas
  - 40. Fuel oil and coal
  - 65. Gasoline and oil
- Personal consumption for 92 categories (including the above) is solved jointly in *LIFT*.

Imports and Exports

- Imports and exports are tracked in *LIFT* for 90 commodities.
- Relative prices are significant both for imports and exports.
- The U.S. *LIFT* model is linked via trade flows to Inforum models of other countries (China, Japan, Germany, etc.)

Calibration to the *AEO*

- Although Inforum produces a baseline *LIFT* forecast to 2035, for this exercise we controlled *LIFT* to agree with the AEO for the following macroeconomic variables:
  - Real components of GDP.
  - Population, labor force and productivity growth.
  - Nominal GDP and inflation.
  - Energy prices and interest rates.
- Inforum also calibrates *LIFT* to agree with the AEO forecasts of residential, commercial, industrial and transportation energy demand, by type of energy (coal, natural gas, petroleum refining, electricity).

Energy Consumption by Sector and Source

- Each major sector of the AEO is related to aggregates of variables in *LIFT*.
  - Residential – Personal consumption of energy for household operation: natural gas, electricity, fuel oil and coal
  - Commercial – Intermediate energy use in the commercial industries plus government energy use.
  - Industrial – Intermediate energy use in the industrial sectors.
  - Transportation – Intermediate energy use in the transportation industries plus personal consumption transportation energy use (gasoline and oil).
  - Electric power – Fossil fuels consumption by electric utilities.

- Ratios are used to relate *LIFT* constant price flows to quantity units (Btus, tons of carbon). With the model forecast calibrated to AEO, most of these ratios are quite stable.

U.S. Outlook for Energy Consumption

Energy Consumption by Major Sector and Source
(Quadrillion Btus)

	2008	2020	2035	Growth Rate 2008 to 2035
Residential	21.54	22.06	24.36	0.5
Electricity	4.71	5.04	5.88	0.8
Natural gas	5.01	4.81	4.96	0.0
Commercial	18.58	20.90	24.36	1.0
Electricity	4.61	5.37	6.57	1.3
Natural gas	3.21	3.43	3.79	0.6
Industrial	32.07	32.89	33.82	0.2
Electricity	3.35	3.51	3.50	0.2
Natural gas	6.84	7.23	6.91	0.0
Petroleum derived	8.99	9.01	8.70	-0.1
Transportation	27.90	29.19	32.69	0.6
Motor gasoline	16.76	16.77	16.47	-0.1
Jet fuel	3.15	3.48	3.79	0.7
Distillate	6.09	6.72	8.38	1.2
Total	**100.09**	**105.04**	**115.23**	**0.5**

Source: Inforum LIFT AEO 2010 Baseline

Projections of U.S. Carbon Emissions

- Carbon emissions depend mostly on use of fossil fuels and can be related to consumption of coal, petroleum products, natural gas, and process emissions.
- The next slide shows the carbon emissions projection in the *LIFT* AEO 2010 scenario.
- The biggest components are Transportation and Electric Utilities. Coal for electricity accounted for 1/3 of all carbon emissions in the U.S. in 2008. Transportation accounted for another 1/3 (mostly refined petroleum).
- Technologies to reduce carbon emissions reduce the carbon coefficient for specific use or change the fuel mix toward lower carbon content.

U.S. CO_2 Emissions Outlook

Carbon Dioxide Emissions by Sector and Source
(Million Metric Tons)

Sector and Source	2008	2035	Growth Rate 2008 to 2035
Residential	346	324	-0.2
Commercial	218	245	0.4
Industrial	966	1,002	0.1
Transportation	1,925	2,115	0.3
Electric Power			
Petroleum	40	38	-0.2
Natural Gas	362	404	0.4
Coal	1,946	2,180	0.4
Other	12	12	0.0
Total electric power	2,359	2,634	0.4
Total Economy	5,814	6,321	0.3
Carbon Dioxide Emissions (tons per person)	19.0	16.2	-0.6

Source: Inforum LIFT AEO 2010 Baseline

The Electric Power Sector

- Burning of fossil fuels by the electric utility sector accounts for over 1/3 of total carbon emissions.
- Disaggregation of the electric utility sector is necessary for understanding the effects of a changing mix of generation types (wind, solar, nuclear, coal, gas), as well as understanding the potential of carbon capture and sequestration (CCS) for reducing carbon emissions.
- The Electric Power IO column in *LIFT* is split into 8 sub-columns of electricity generation: (Coal, Gas, Petroleum, Nuclear, Hydro, Solar, Wind, Geothermal and Other)

U.S. Electric Power Outlook

Units: Billions of Kwh

	2008	2020	2035	Growth Rate 2008 to 2035
Coal	1,981	2,034	2,231	0.4
Natural gas	801	661	934	0.6
Petroleum	42	42	44	0.1
Nuclear	806	883	898	0.4
Renewables	339	631	688	2.6
Hydro	245	297	299	0.7
Wind	52	196	215	5.2
Solar	1	2	3	5.0
Geothermal & other	41	135	171	5.3
Total	**3,969**	**4,250**	**4,794**	**0.7**

Source: Inforum LIFT AEO 2010 Baseline

LIFT Macroeconomics

- *LIFT* builds up both the product side and income side of GDP from the industry detail.
- Total employment, wages and hours worked are also modeled at the industry level.
- *LIFT* maintains a full accounting of the federal and state & local governments. All sectoral balances (business, consumer, government, foreign) are consistent.
- Foreign trade is modeled in conjunction with Inforum international models, and an integrative model called the *Bilateral Trade Model* (BTM).

U.S. Macro Outlook Summary

	2008	2020	2035	Growth Rate 2008 to 2035
Billions of 2005$				
Gross Domestic Product	13,312	17,666	25,178	2.36
Consumption	9,291	12,103	17,874	2.42
Investment	1,964	3,007	5,090	3.53
Government	2,518	2,695	3,099	0.77
Exports	1,629	3,223	6,883	5.34
Imports	2,124	3,159	6,655	4.23
Price Indexes = 1.0 in 2005				
GDP Price	1.08	1.32	1.83	1.94
Consumer Price	1.09	1.40	1.92	2.09
3-month Treasury	1.37	3.14	3.02	2.95
Population	305.4	342.6	390.8	0.91
Labor Force (millions)	154.3	166.8	182.9	0.63
Employment	146.7	157.9	173.8	0.63
Unemployment Rate	5.59	5.79	5.70	
Private Sector Labor Productivity	33.53	42.36	56.69	1.95

Source: Inforum LIFT AEO 2010 Baseline

Using *LIFT* for Policy Analysis

- Department of Commerce, *An Analysis of the Economic Impacts of the 2007 Energy Independence and Security Act*, September, 2008.
- Business Roundtable, *Balancing Act: Climate Change, Energy Security and the U.S. Economy,* June, 2009.
- Electrification Coalition, *Economic Impact of the Electrification Roadmap*, April 2010.
- Department of Energy, *Using the Inforum LIFT and Mudan Models to Investigate the Impacts of Cap and Trade Legislation on International Leakages*, August 2010.
- Energy Modeling Forum 25, *Energy Demand Analytics Using Coupled Technological and Economic Models*, December 2010, with the Mitre Corporation.

Electrification Roadmap (ER)

Main Policy Components:

- Incentives for accelerated production and purchase of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs).
- Incentives for accelerated domestic production of batteries for EVs and PHEVs.
- Enhancing the nation's electrical system through tax credits for electric utility information technology upgrades to achieve a smart grid.
- Incentives for accelerated deployment of the charging infrastructure necessary for electric vehicles.
- Incentives for improving efficiency, both with regard to liquid fuels and electricity, for light duty vehicles (LDVs).

ER Impact: Transportation Fuels/Electricity

Motor Fuel and PHEV Electricity Consumption

	Base Case		EC/SAFE Policy Scenario	
	Motor Fuel Consumption (bil gal)	PHEV Electricity Consumption (bil Kwh)	Motor Fuel Consumption (bil gal)	PHEV Electricity Consumption (bil Kwh)
2010	133.8	0.0	133.8	0.0
2015	129.2	0.3	117.8	3.9
2020	123.9	0.7	100.6	25.0
2025	123.9	1.4	82.2	102.5
2030	125.8	2.3	63.6	222.1

ER Impact: Oil Imports

Oil Imports, MBD

	Base	SAFE	Difference
2015	12.5	11.7	-0.9
2020	12.4	11.0	-1.5
2025	11.8	9.5	-2.2
2030	12.1	8.9	-3.2

Total BBL of Oil Reduction 2010-2030 **11,908 Million BBL**

Policy package and simulation results are described at:
http://www.electrificationcoalition.org/media/EC_ImpactReport.pdf

Inforum LIFT: U.S. Outlook

Thank You!

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