Explorations with the LIEF 2002 Model

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ABSTRACT

The Long Term Industrial Energy Forecasting (LIEF) model, developed by Argonne National Laboratory in 1993, is designed for convenient study of future industrial energy consumption, taking into account the sectoral composition of industry, energy prices, rates of technology diffusion, capital recovery factors and the effects of policy initiatives. LIEF is an econometric-engineering framework, based on industrial energy-use and price data from 1958 to 1985. A 2002 update by Gale Boyd, which we use in this analysis, has revised some of the model parameters to reflect data from the 1990s. This updated model has not yet been in wide use, so our LIEF analysis is in the nature of exploratory work to test the behavior of the model under different assumptions.

This paper makes use of the 2002 version of the LIEF Model to develop industrial electricity scenarios out to 2020 for the Southwest United States. A base case and four efficiency scenarios for electricity consumption were constructed for six states – Arizona, Colorado, New Mexico, Nevada, Utah, and Wyoming – by changing the penetration rate (to reflect the spread of new technologies), the capital recovery factor (to represent incentives for investment) and the electricity prices (to reflect a carbon tax). We find that there is significant potential for energy savings by 2020.

The three policy levers in LIEF – the technology penetration rate, the capital recovery factor (CRF) and electricity prices – were used to develop electricity projections for each state based on certain policy assumptions.

The LIEF 2002 Model

The Long Term Industrial Energy Forecasting (LIEF) model is a spreadsheet model designed for convenient study of future industrial energy consumption, taking into account the sectoral composition of industry, energy prices, rates of technology diffusion, capital recovery factors and policy initiatives.

The model is based upon conservation supply curves (CSCs) constructed from industrial data from 1958-85. The CSC is an analytical tool that captures both the engineering and the economic perspectives on energy conservation. The curves show the energy conservation potential as a function of marginal cost of conserved energy, where the marginal cost of conserved energy is equal to the price of energy. It can be thought of as the marginal cost required to save an additional unit of energy, given an existing level of energy savings. The curve is upward sloping because increasing energy efficiency comes at a higher marginal cost.

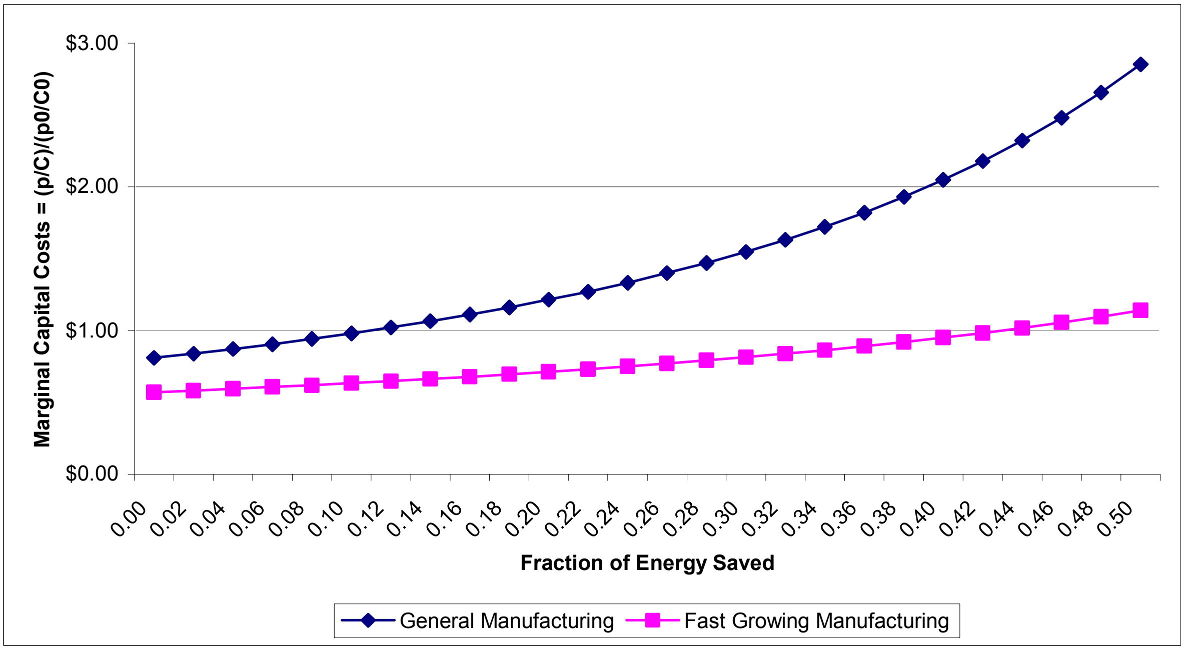
The equation for the maximum energy savings in each time period relative to the model base year (reflected by the CSC curves) is:

$$\text{Maximum Energy Savings}^1 = M = 1 - \left(\frac{\frac{p_0}{C_0}}{\frac{p}{C}} \right)^{(A)} * (1 - G_0), \text{ where:}$$

- p_0 = Price for each fuel (electricity or fossil) in the base year.
- p = Price of each fuel in the given year.
- C_0 = Capital recovery factor (CRF) for the base year.
- C = Capital recovery factor for the given year.
- A describes the magnitude of response to changes in price levels specific to each industry, and has been econometrically determined.
- G_0 is the intensity gap, or the base year fraction by which ideal energy intensity is less than actual intensity. G_0 can be thought of as the energy savings that would be economically viable in the base year, but have not been realized. If price and CRF in the given year equal the base year values, then M = G_0. A larger G_0 implies a greater potential for energy savings.

Examples of CSCs for the Fast Growing and General Manufacturing Sectors in Arizona are shown in Figure 1. The steeper curve for the General Manufacturing sector shows that greater capital outlays are required to achieve equivalent energy savings in this sub-sector as compared to Fast-Growing Manufacturing.

Figure 1. CSC Curves for the Fast-Growing and General Manufacturing Sectors



[1] This equation ignores the autonomous time trend component of LIEF.

While this approach is less detailed than a technology-specific bottom-up approach, it provides convenient and reasonably accurate estimates of industrial electricity savings potential on an aggregate basis. In addition it does not require the detailed disaggregated end-use energy data needed for a bottom-up analysis. While such data may be available on a national basis, it is generally not as readily available at a state or regional level.

A 2002 update to the LIEF model by Gale Boyd has revised some of the model parameters to incorporate industrial energy use data from the 1990s. The current analysis uses this updated version of the model.

Key features of the updated LIEF Model are:

1. Data for the manufacturing sectors in LIEF (12 of the 17 LIEF sectors) has been updated to 1998.
2. The same parameters as before are used to determine what the value of *Gap0* would have to be in 1990 to be consistent with the observed energy intensities in 1998. 1990 remains the base year for the model and it goes out to 2030.
3. The autonomous trend parameters for changes in electricity intensities have been adjusted to reflect energy trends in the eighties and nineties. These changes result from structural changes, new technologies or environmental controls in industrial sectors, rather than changes in costs of fuels.
4. The benchmark *Gap0* parameters have been updated. The new estimates are called *Gap1990*. Many of the new estimates are similar to the old ones but there are some substantial changes (electricity in fast-growing manufacturing, electricity in petroleum refining and fossil fuels in glass.) The *Gap0* parameter reflects the difference between the actual energy intensity of the sector and the idealized energy intensity. A larger *Gap0* implies a greater potential for energy savings.
5. *Gap1998* parameters are also computed as a check. They decline to reflect falling energy prices in the 1990-1998 period. We have used these 1998 estimates in our analysis.
6. The Organic Chemicals and Inorganic Chemicals sectors have been combined into one sector called Organics and Inorganics.

Please refer to Appendix 1 for a tabular comparison between the old and new LIEF parameters.

Input Data Required for the New LIEF Model

The inputs and drivers of the model remain similar to the ones used in the old LIEF model. They are:

1. The sector output (measured in 10^9 \$) for each of the 17 sectors.
2. Assumed production growth rates (% per year) for each sector for the period of analysis.
3. Energy prices for electricity and fossil fuels (in \$/btu) for the period of analysis.
4. The assumed yearly penetration rate (PEN), which is a measure of the rate at which firms purchase energy-using capital and adopt conservation projects.

5. The assumed annual capital recovery factor (CRF), based on an implicit discount factor, which is generally higher than the cost of money in order to account for non-monetized externalities such as costs of safety improvements and administration.
6. LIEF sector fuel shares (electricity and fossil fuels) and base year sectoral energy demand (electricity and fossil) in Quads (10^{12} btu)
7. Energy recycling rate (R).
8. Any assumptions about autonomous trends (e.g. autonomous improvements in energy efficiency, fuel switching etc.)

LIEF provides *Gap0* (the gap between actual and idealized energy intensity, roughly the intercept of the conservation supply curve), *Ae*, *Af* (elasticities with respect to fuel prices for the sector, roughly the slope of the CSC), *Be* and *Bf*, (autonomous time trend parameters).

Application of LIEF 2002

The LIEF model was used to construct a Base case and three Policy Scenarios for industrial electricity demand in six states in the Southwest – Arizona, Colorado, New Mexico, Nevada, Utah and Wyoming. The basic inputs into the model were the base year output (Value of Shipments in this instance) for 15 of the 17 LIEF sectors (General manufacturing, Fast-growing manufacturing, Pulp and Paper, Organic and Inorganic Chemicals, Petroleum Refining, Glass, Cement, Stone and Clay, Iron and Steel, Primary Aluminum, Nonferrous Metals, Agriculture, Mining, Oil and Gas, Construction)[2], the base year electricity demand for each of the sectors and the growth rate of output over the horizon of the model (1998-2020)[3]. The model then calculated electricity consumption for each state by sector for the model horizon. The basic methodology behind these calculations is that electricity consumption will grow as output grows, tempered by internal modeling parameters that change electricity intensity for each sector over time. These parameters are the *Gap0* (the gap between actual and ideal energy intensity in the sector in the base year), *Ae* (shape of the conservation supply curve) and *Be* (autonomous time trend).

In this current work, we have chosen to model only electricity and not fossil energy demand so as to keep the analysis simple and clear. The LIEF model does allow for such modeling and includes the possibility of incorporating fuel-switching over time. The use of these features would require significant additional input data and introduce significant additional complexes to the analysis.

The three policy levers in LIEF– the technology penetration rate, the capital recovery factor (CRF) and electricity prices – were used to develop electricity projections for each state. For the base case, the CRF was assumed to be 33% and the penetration rate was 3.27% per year, based on the literature and to reproduce the overall regional projections of *Annual Energy Outlook* (EIA 2001). For the four energy efficiency policy cases, the following parameter values were used:

1. The CRF was reduced to 16.5%
2. The penetration rate was increased to 6.48%.

[2] We did not have data for the Feedstocks and Uranium industries for the states in this analysis.
[3] The growth rate in output was determined using economic projections from Economy.Com.

3. The CRF was reduced to 16.5% and simultaneously the penetration rate was increased to 6.48%.
4. A carbon tax causes electricity prices to rise by 20% by 2020[4].

The LIEF results we will describe embody the following assumptions:

1. The autonomous trend towards increased electrification over time has been removed for all sectors for projections into the future. This implies that there is no further increase in electrification due to electricity-intensive technological changes.
2. There is no fuel switching over time. LIEF allows for the modeling of the electricity and fossil fuel sectors separately. To do so, one must turn off the fuel switching option. This can be done by setting the fuel share factor to zero in the global parameters worksheet. Alternatively, one can set up a price trajectory that ensures that the ratio of fossil to electricity prices remains the same for the period of analysis. Thus, there would be no opportunities for cost savings through fuel switching and it would end up being zero.
3. The base case electricity prices are set constant and equal to the 1999 price from the 1999 State Energy Price Report. For policies 1, 2 and 3, these prices were also kept constant. Only for policy 4 do we vary prices, introducing a 20% increase by 2020. The base prices for the six states were:

Table 1. State Electricity Prices

State	Electricity Price in 1999 cents/KWh
Arizona	5.04
Colorado	4.38
Nevada	4.77
New Mexico	4.25
Utah	3.36
Wyoming	3.34

4. The CRF in the base case of LIEF were smoothed out to a constant 33% over the entire time horizon (1998-2020). For the policy 1 and 4, this constant 33% was maintained. For policies 1 and 3, it was reduced to 16.5%.
5. The penetration rate was kept at 3.27% for policies 1 and 4 and increased to 6.48% for policies 2 and 3.
6. All policy case parameters are implemented in the model starting in the year 2003.
7. The LIEF base case growth rate for the southwest states (taken together) was calibrated by a factor of 0.73 to match the growth rate from AEO/NEMS 2002 for the NEMS Mountain region[5]. This factor was then applied to the growth rate for each individual state. The results of the policy scenarios were calibrated so as to maintain the absolute difference between base and policy case growth rates that emerged from the LIEF model itself.

[4] This would correspond to a tax of approximately $75/ton carbon, or $20/ton of carbon dioxide.
[5] The Mountain region includes AZ, CO, NV, NM, UT, WY, ID and MO.

Results of the LIEF Analysis

The results of our analysis using the LIEF model are outlined below:

Table 2. Total Industrial Electricity Demand in 2020 (Trillion Btu)

	Calibrated LIEF Base Scenario	Calibrated LIEF Policy 1	Calibrated LIEF Policy 2	Calibrated LIEF Policy 3	Calibrated LIEF Policy 4
Arizona	66	60	63	51	65
Colorado	65	59	62	52	63
New Mexico	25	22	24	19	24
Nevada	37	33	35	28	36
Utah	55	50	51	43	54
Wyoming	37	33	35	28	36
Southwest Total	285	258	270	220	279

These results translate into the following percentage electricity savings by 2020:

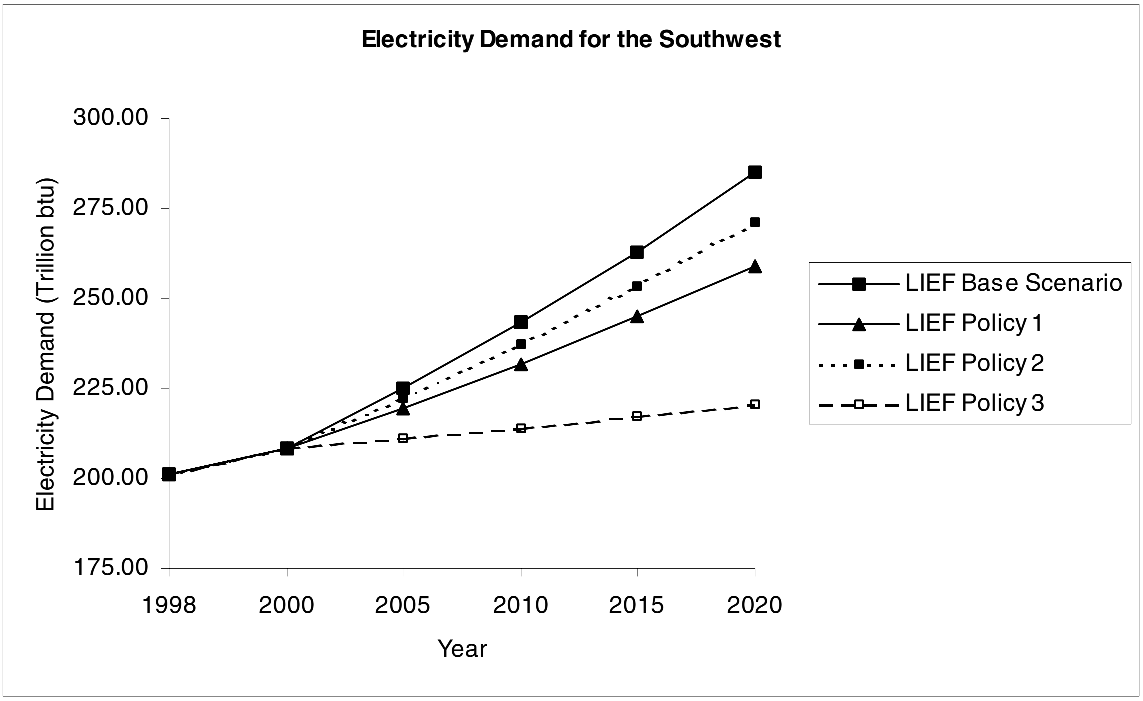
Table 3. Industrial Electricity Demand in 2020: Percentage Savings of Policy v. Base Case

	Policy 1 v. Base Case	Policy 2 v. Base Case	Policy 3 v. Base Case	Policy 4 v. Base Case
Arizona	-9.7%	-5.4%	-23.6%	-2.4%
Colorado	-6.5%	-2.6%	-18.7%	-0.1%
New Mexico	-10.9%	-5.1%	-25.6%	-2.8%
Nevada	-10.1%	-4.9%	-23.9%	0.0%
Utah	-8.1	-5.7%	-20.8%	0.0%
Wyoming	-11.1%	-5.5%	-26.4%	-2.8%
Southwest Total	-9.0%	-4.7%	-22.5%	-1.2%

Our results show that halving the capital recovery factor (Policy 1) is almost twice as effective in reducing electricity consumption that doubling the penetration rate (Policy 2). Not surprisingly, a combination of the two policies (Policy 3) results in an even higher electricity saving. In fact, we find that the policies reinforce each other in a manner that makes their combined effect greater than the sum of their individual effects. Finally, Policy 4 is shown to be not very effective in this context. The primary reason for this is that we set up the model to allow for price-based energy efficiency improvements but not fuel-switching. As a result, the rise in electricity prices could not result in fuel switching which would have increased the impact. Further research that uses fuel switching would be required to fully evaluate this policy.

The graph that follows presents the results for electricity savings in the base case and all three policy cases.

Figure 2. Electricity Demand for the Southwest



The overall electricity demand results are worth breaking down to examine sector specific impacts of the various policies. We present and discuss these results for Policy 1 and then follow with the results from Policies 2 and 3.

Table 4. Sectoral Distribution of Electricity Savings for Policy 1

Industry	Base Case Electricity Use in 2020 (Trillion Btu)	Policy 1 Energy Use in 2020 (Trillion Btu)	Savings Potential by 2020
General Manufacturing	50.1	44.1	11.8%
Fast-growing Manufacturing	12.9	11	14.5%
Pulp and Paper	10.1	9.5	5.7%
Organics and Inorganics	22.2	20.9	5.8%
Petroleum Refining	12.5	12.0	3.9%
Glass	0.9	0.8	5.8%
Cement	15.9	15.9	0.1%
Stone and Clay	5.7	5.7	0.1%
Iron and Steel	1.1	1.0	6.9%
Primary Aluminum	5.3	5.3	0.1%
Non ferrous	16.0	15.2	5.0%
Agriculture	14.5	12.8	12.0%
Mining	84.8	74.6	11.9%
Oil and Gas	24.4	21.5	12.0%
Construction	8.5	7.5	12.0%

Discussion of Results

From the above table, we can see that certain industries – General manufacturing, Fast-growing manufacturing, Agriculture, Mining, Oil and Gas and Construction have the biggest percentage savings from this policy. In the particular example of these southwest states, consumption of electricity in General Manufacturing and Mining is very large in absolute terms as well, so that the savings in absolute Btu are also the largest in these sectors. Other sectors, such as Cement, Stone and Clay and Primary Aluminum, show negligible electricity savings.

These results are very much dependent on the modeling parameters embedded in LIEF. An examination of these parameters lends insight into how the model responds to policy changes. Some sectors in LIEF (Cement, Stone and Clay, Primary Aluminum) have zero or negative *Gap0s* and therefore show no efficiency gains over the 20-year horizon of our analysis. As described before, a low *Gap0* implies that the industry is at or near its ideal energy intensity, thus there is a lower (or non-existent) potential for energy savings. These parameter values reflect the lack of changes in electricity intensity in these sectors during the 1990s, which saw limited investment in these industries in new facilities. The potential introduction of new technologies (CEF 2002) into these industries could create efficiency opportunities not reflected in these values.

Also, the *Gap0s* are the same for Agriculture, Mining, Oil & Gas and Construction (0.2 in all cases), hence the similar percentage savings for those sectors. However, it is important to note that due to lack of good data on energy use and trends, it was not possible to recalibrate the *Gap0s* for these sectors in the 2002 version of the LIEF Model.

The CRF is used to characterize a number of policies that are reflected in a change in the implicit discount rate observed in industry. The base case CRF of 33% reflects both the actual cost of money for the company and other factors that enter into the industrial decision maker calculus in evaluating a project. Among these other factors are the perceived risk of the project, competition for capital and staff resources, the presence of non-energy benefits from the project, and whether the project offers some strategic benefit. The policies that can be modeled by varying the CRF and/or the penetration rate include:

- Various incentives including grants, tax credits or subsidized interest rates that reduce the costs of implementing projects,
- Educational programs that reduce the transaction cost and risk of implementing new technologies,
- Government networking programs that increase communication within an industry, establishing greater connectiveness that has been demonstrated to facilitate deployment of new technologies, and
- Technical assistance programs that can reduce actual project cost and reduce perceived risks of the project.

It is important to note that a possible limitation with doing a sub-national analysis is that the region/state might differ from the nation in energy intensity. The *Gap0s* in the LIEF model have been calculated based on national averages of actual vs. ideal energy intensities. This gap could arise because of industry-specific factors that are similar throughout the country. But it could also be a result of region/state-specific factors, in which case the national-level *Gap0s* would no longer be applicable. These differences could result in regional variations in the mix of facilities within the sectors or from regional-specific differences in industrial facilities in the region compared to national average[6]. We have stuck to the national-level numbers here.

For the purposes of illustration, we also present the sectoral breakdown of electricity savings for policies 2 and 3. We see that a similar distribution of electricity savings across sectors occurs as that explained previously.

Table 5. Sectoral Distribution of Electricity Savings for Policy 2

Industry	Base Case Electricity Use in 2020 (Trillion Btu)	Policy 2 Energy Use in 2020 (Trillion Btu)	Savings Potential by 2020
General Manufacturing	50.1	48.7	2.8%
Fast-growing Manufacturing	12.9	11.2	13.1%
Pulp and Paper	10.1	9.7	3.6%
Organics and Inorganics	22.2	21.2	4.4%
Petroleum Refining	12.5	10.9	12.3%
Glass	0.9	0.8	5.6%
Cement	15.9	15.9	0.03%
Stone and Clay	5.7	5.7	0.03%
Iron and Steel	1.1	1.0	5.3%
Primary Aluminum	5.3	5.3	0.04%
Non ferrous	16.0	14.3	10.5%
Agriculture	14.5	13.8	5.3%
Mining	84.8	80.3	5.3%
Oil and Gas	24.4	23.1	5.3%
Construction	8.5	8.0	5.3%

Table 6. Sectoral Distribution of Electricity Savings for Policy 3

Industry	Base Case Electricity Use in 2020 (Trillion Btu)	Policy 3 Energy Use in 2020 (Trillion Btu)	Savings Potential by 2020
General Manufacturing	50.1	37.6	25.0%
Fast-growing Manufacturing	12.9	7.7	40.2%
Pulp and Paper	10.1	8.7	14.2%
Organics and Inorganics	22.2	18.8	15.2%
Petroleum Refining	12.5	10.0	19.6%
Glass	0.9	0.7	16.5%
Cement	15.9	5.7	0.2%
Stone and Clay	5.7	5.7	0.2%
Iron and Steel	1.1	0.9	18.2%
Primary Aluminum	5.3	5.3	0.2%
Non ferrous	16.0	12.8	19.8%
Agriculture	14.5	10.5	27.8%
Mining	84.8	61.3	27.8%
Oil and Gas	24.4	17.7	27.8%
Construction	8.5	6.1	27.8%

[6] For example, in the food industry wastewater treatment accounts for a significant share of the energy use but depending upon the region may be performed by the facility or by the municipal utility.

The LIEF model also makes it possible to evaluate the investment costs associated with the electricity savings realized under each policy regime. The following table summarizes the investment costs of the policies under consideration.

Table 7. Investment Expenditures on Electricity Savings

	Base Case	Policy 1	Policy 2	Policy 3
	46	149	61	216
Arizona	36	113	46	163
Colorado	14	47	18	67
New Mexico	25	80	31	113
Nevada	22	66	31	101
Utah	19	61	23	87
Wyoming	161	516	209	747

A benefit-cost ratio can be computed by comparing the dollar value of energy savings to the investment costs required to achieve these savings by 2020. Examining the benefit-cost ratio for each of the policies, we find that they vary considerably. Policy 1 has a benefit-cost ratio of 0.7, Policy 2 has one of 2.8 and Policy 3 has one of 1.02.

Future Research

While significant advances have been made in characterization and modeling of energy use in the industrial sector, important issues remain that need to be addressed:

- Currently, the LIEF model is based on past industrial energy use, with no attempt made to incorporate future technology advances into the model parameters. Analyses of emerging industrial technologies, such as Martin et al. (2000) and Interlaboratory Working Group (2000), indicate that significant advances are likely on the near-term horizon. The LIEF model would benefit from the exploration of means of incorporating technology innovation into the calculation of model's parameters.
- Similarly, as has been noted, regional variations in energy use trend would warrant further investigation. While every attempt has been made in the characterization and modeling of state industrial energy use to incorporate state-specific factors, national data has been used to assess energy intensity trends and develop the LIEF model's parameters. This simplifying assumption has not been tested. A study of the regional variation in energy use would validate this assumption, or lead to the development of regional weighting factors or perhaps even regional parameter sets.
- To date most of the state-level industrial analysis has focus on electricity because of the availability of state-level industrial electricity data and the focus by most state programs on electricity resulting from the presence of electric system benefit funds. Extension to non-electric industrial energy use poses a number of challenges. Most significant is the lack of data availability upon which to base the analysis. Reporting of non-electric energy is much more limited than is electricity use data. Complicating this situation is the reality that many industrial facilities can switch fuels based on price and market availability. In addition, there appears to be more regional variation in fuel selection than we see in electricity. Finally, the use of fuels tends to be more

site-specific than does electricity, so understanding how savings potential can be realized is more complex.

- Another important issue for future exploration will be the interaction between electric and non-electric energy use. As mention above, switching among non-electric fuels by industry is well documented. A trend has also been noted toward electrification that was captured in the original version of the LIEF model. The analysis leading to the revision of the LIEF model noted that this trend appears to have diminished, as we have turned off this autonomous trend variable. Some other analysts have questioned this assumption in view of market pressure including environmental permitting and insurance requirements for boilers leading to a continued shift of loads to electric power. This trend warrants further exploration.
- Another potential market change that would affect these interactions would be expanded use of combined heat and power (CHP). CHP allows electricity to be competitively produced on-site using fuel, displacing grid-purchased electricity. In addition, the availability of relatively low-cost steam encourages a shift of electric loads to thermally driven systems. This issue was noted in the documentation of the original LIEF model, but current industrial sector modeling has yet to address this issue. Recent advances in the understanding of CHP system can form a foundation that can be built on to more robustly model these issues.

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Appendix 1: Comparison Between Old and New LIEF Parameters

Table A-1. Old LIEF Parameters

Sector	Name	Gap0e	Gap0f	Ae	Af	Be	Bf
1	Gen Manufacturing	0.3	0.2	0.60	0.40	-0.021	0.0025
2	Fast-growing Manufacturing	0.3	0.2	1.00	0.60	0.000	0.0040
3	Pulp and Paper	0.15	0.15	0.25	0.20	-0.011	0.0050
4	Inorganics	0.15	0.15	0.25	0.22	-0.018	0.0060
5	Organics	0.15	0.15	0.25	0.20	-0.018	0.0060
6	Petroleum Refining	0.15	0.15	0.25	0.20	-0.018	0.0060
7	Glass	0.10	0.10	0.25	0.25	-0.018	0.0060
8	Cement	0.20	0.20	0.20	0.20	-0.019	0.0020
9	Stone and Clay	0.20	0.20	0.20	0.20	-0.016	0.0040
10	Iron and Steel	0.10	0.10	0.30	0.20	-0.020	0.0060
11	Primary Aluminum	0.05	0.10	0.10	0.20	0.001	0.0050
12	Nonferrous	0.15	0.15	0.25	0.20	-0.018	0.0060
13	Agriculture	0.20	0.20	0.60	0.50	-0.007	0.0070
14	Mining	0.20	0.20	0.60	0.50	-0.018	0.0040
15	Oil and Gas	0.20	0.20	0.60	0.50	-0.018	0.0040
16	Construction	0.20	0.20	0.60	0.50	-0.018	0.0040
17	Feedstocks	0.00	0.00	0.00	0.00	0.000	0.0000
18	Uranium	0.00	0.00	0.00	0.00	0.000	0.0000

Table A-2. New LIEF Parameters (Based on Gap1998 Estimates)

Sector	Name	Gap0e	Gap0f	Ae	Af	Be	Bf
1	General Manufacturing	0.110	0.050	0.55	0.19	0.000	0.004
2	Fast-growing Manufacturing	0.430	-0.090	1.00	0.80	0.000	0.007
3	Pulp and Paper	0.140	0.120	0.24	0.36	0.000	0.000
4	Organics & Inorganics	0.170	0.180	0.25	0.22	0.000	0.006
5	Petroleum Refining	0.410	0.070	0.20	0.10	0.000	0.006
6	Glass	0.210	0.750	0.26	0.25	0.000	0.012
7	Cement	-0.040	0.160	0.20	0.19	0.000	0.003
8	Stone and Clay	0.000	-0.030	0.20	0.20	0.000	0.007
9	Iron and Steel	0.200	0.030	0.31	0.10	0.000	0.005
10	Primary Aluminum	-0.020	0.060	0.08	0.20	0.000	0.000
11	Nonferrous	0.36	-0.030	0.25	0.20	0.000	0.006
12	Agriculture	0.200	0.200	0.60	0.50	0.000	0.007
13	Mining	0.200	0.200	0.60	0.50	0.000	0.004
14	Oil and Gas	0.200	0.200	0.60	0.50	0.000	0.004
15	Construction	0.200	0.200	0.60	0.50	0.000	0.004
16	Feedstocks	0.000	0.000	0.00	0.00	0.000	0.000
17	Uranium	0.000	0.000	0.00	0.00	0.000	0.000

Note: In the above tables 'e' denotes Electricity and 'f' denotes Fossil fuels.