W&J Energy Index

U.S. Energy Overview and Index Technical Notes

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Table of Contents

1. A Brief History of Energy Independence in the U.S. 3
   1.1. Brief Overview of Current U.S. Primary Energy Use 4

2. Overview of the W&J Energy Index 4

3. Base W&J Energy Index (Index 1): 5
   3.1. Weights: 6
   3.2. Description of Primary Energy Sources for the U.S.: 7
   3.3. Projections of Future Primary Energy Use in the U.S. 14
   3.4. Trends in Energy Intensity 16

4. W&J Energy Index – Inclusion of Exports (Index 2): 17

5. W&J Energy Index – Inclusion of Import Diversity Measure (Index 3): 18

6. W&J Energy Index – Inclusion of IDM and Political Stability (Index 4): 20

7. W&J Base Energy Index Calculated for U.S. Census Regions 21
   7.1. Regional Weights 21
   7.2. Calculating Imports 22

References 24

Appendix 27
   Appendix A: Weights 28
   Appendix B: X^1_{jt} 29
   Appendix C: X^2_{jt} 30
   Appendix D: Comparison of Indexes 1 and 2 31
   Appendix E: IDM_{jt}, IDM^{pol}_{jt}, *and* IDM^{opec}_{jt} 32
   Appendix F: Comparison of Indexes 1, 2, 3, and 4 33
   Appendix G: MSN codes in SEDS and, $consumption_{j.k.t}$ *, and* $production_{j,k,t}$ *Calculations for Regions* 34
   Appendix H1: Weights – Census Region 1: Northeast 36
   Appendix H2: Weights – Census Region 2: Midwest 37
   Appendix H3: Weights – Census Region 3: South 38
   Appendix H4: Weights – Census Region 4: West 39
   Appendix I1: $X^1_{j,k,t}$ *– Census Region 1: Northeast* 40
   Appendix I2: $X^1_{j,k,t}$ *– Census Region 2: Midwest* 41
   Appendix I3: $X^1_{j,k,t}$ *– Census Region 3: South* 42
   Appendix I4: $X^1_{j,k,t}$ *– Census Region 4: West* 43
   Appendix J: $I^1_{j,k,t}$ *– By Census Region* 44

1. A Brief History of Energy Independence in the U.S.

The idea of energy independence, or more specifically oil independence, has been prevalent in the United States since the 1973 oil embargo enacted by Arab states in response to U.S. support of Israel during the Yom Kippur War.[1] The oil embargo led to increased gasoline prices and shortages at many stations, and ultimately to increased total spending on foreign oil due to increased oil prices. Politically the embargo resulted in the involvement of then President Richard Nixon and the federal government in the oil market, including the enactment of controls on the allocation of oil within the country. "Project Independence" was introduced in 1973 with the goal of ending reliance on foreign energy sources by 1980, mainly through technological advancement. After the embargo was lifted focus on energy independence in the US was reduced although President Gerald Ford did continue many of the previous policies and kept the deadline for energy independence at 1980. The Energy Policy and Conservation Act of 1975 authorized creation of a strategic oil reserve, increased fuel economy standards for automobiles, allowed the federal government to mandate more electricity generation from coal rather than oil and gas, and created state energy conservation programs. However, the bill did not end oil price controls.

President Jimmy Carter continued the goal of energy independence by attempting to reduce oil imports substantially by 1985, principally through energy conservation. The first major energy package passed under President Carter included tax incentives for production of gasohol, tax credits for renewable energy, a gas guzzler tax, and tougher restrictions on the use of oil and gas to produce electricity. An oil worker strike in Iran and the resulting shortage of oil and gasoline in parts of the U.S. led to the second energy package of President Carter's term. The package included a windfall profits tax on oil companies and increased tax credits for renewable energy and synthetic fuels. The Synthetic Fuels Corporation was created by a later act of Congress to encourage large-scale production of synthetic fuels although it did not accomplish its goals and was eventually terminated.

President Ronald Reagan represented a stark change to previous energy policy. Within ten days of becoming president he ended the price controls on oil and gas and made clear his preference for reliance on market forces, partly with the intent to encourage increased domestic production. President Reagan also reversed many of the energy policies and priorities of the previous three presidents. The Iran-Iraq War of the late 1970s reduced worldwide exports from the Persian Gulf substantially and led to a large increase in world oil prices. During this time U.S. imports of oil decreased substantially until the mid 1980s, when imports began to rise again. This decline in imports was likely due to multiple factors, including increased production from Alaska and reduced demand due to high prices. World oil prices remained relatively low from the mid 1980s until the early 2000s with no major interruption in world supply.

Recent presidents, including George W. Bush and Barack Obama, have also focused on energy independence in response to world events and increases in oil prices. The Energy Independence and Security Act of 2007 includes three major provisions. The bill increases the corporate average fuel economy target to 35 miles per gallon by 2020[2], it increases renewable fuel standards with

[1] For a perspective on the issue from this time period see Wilson (1973).

[2] More recently the Obama administration has agreed with most major automobile manufacturers to set a target of 54.5 miles per gallon by model year 2025. See http://www.whitehouse.gov/blog/2011/07/29/president-obama-announces-new-fuel-economy-standards.

specific targets for cellulosic ethanol and biofuels, and it mandates energy efficiency standards to light bulbs and appliances. Provisions that were not included in the bill were a renewable energy portfolio standard (although 24 states do have binding renewable portfolio standards in place as of 2009) and the repeal of corporate oil and gas subsidies.[3] This bill represents the most recent piece of major energy legislation (U.S. Senate Committee on Energy & Natural Resources).[4]

1.1. Brief Overview of Current U.S. Primary Energy Use

In 2009, oil accounted for just over 37% of primary energy usage in the U.S. making it the largest energy source. Natural gas accounted for 25%, coal 21%, nuclear 9%, and renewables (hydroelectric, solar, wind, geothermal, and biomass) accounted for 8%. Oil is used primarily in the transportation sector, with 72% of all oil going to transportation in 2009. Likewise transportation is almost completely dependent on oil with 94% of energy in the sector coming from oil. Natural gas use is more evenly distributed among sectors of the economy, with 32% going to the industrial sector, 35% going to the residential and commercial sectors, and 30% going to electricity generation in 2009. Coal is used primarily in electricity generation, with 93% of coal going to that use in 2009. The remaining seven percent was used in the industrial sector. Nuclear energy is used exclusively to produce electricity. The majority of renewable energy, 53%, goes to producing electricity with 12% used in the transportation sector, 26% in industrial, and nine percent in residential and commercial for 2009 (U.S. EIA 2011g). A historical perspective on the primary energy mix in the U.S. can be seen in Table 1 below.

2. Overview of the W&J Energy Index

The purpose of the W&J Energy Index is to measure the share of total primary energy consumption that is produced domestically. This is both a simple and complex issue. We will begin by creating a simple and straightforward index that will quantify "energy independence" in the United States over time. Considerable effort was given to keep the methodology and analysis accessible to a general audience. The issues related to energy consumption and its side effects are numerous. Our focus is purposefully narrow in dealing with the aspects of energy consumption and the sources of primary energy in the U.S., although related issues are discussed to some extent. As additional relevant issues are incorporated (political stability and production concentration) the index will be modified. These modifications primarily deal with oil consumption, as this is the major imported energy source in the U.S. Even with the changes being made to the index, simplicity is still a focus and goal.

An additional objective when creating the indexes was to use free and readily available data that has been consistently reported over time. The hope is that this index will be easily updated as new statistics become available without having to modify previously reported index values because of a change in the available statistics. In addition, we try to not use preliminary statistics in creating the index because of the high probability of these statistics being changed when they become finalized in later reports. Although this will increase the lag in the index, it seems the better option as

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[3] For more information on state renewable portfolio standards see http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm. U.S. DOE Energy Efficiency and Renewable Energy.

[4] A more recent piece of legislation that did not pass is the 2009 American Clean Energy and Security Act. http://energy.senate.gov/public/index.cfm/american-clean-energy-leadership-act-of-2009.

opposed to having to modify already published values.[5] The majority of the statistics at the national level are from the 2011 Annual Energy Review published by the U.S. Energy Information Administration (will be referred to as AER and EIA respectively).

One of the central difficulties in dealing with and talking about "energy independence" is the variety of definitions of independence. Loungani (2009) gives an insightful comparison and critique of three recent books on the subject and Darmstadter (2006) provides an overview of relevant issues[6]. Greene and Leiby (2006) and Greene (2010) point out that some authors view energy independence as having no imports, generally no oil imports, or using no oil whatsoever. They agree that under this definition energy independence, and more specifically oil independence, is almost certainly unattainable. They argue that a more appropriate definition of energy independence is a situation where the costs of dependence are low enough to have no impact on federal government policies under any possible future oil market situation.[7] In other words, this is a situation where the economic costs of being dependent on oil imports are negligible due to their size relative to total economic production accounting for oil market uncertainty. However, they and Sovacool (2007) note that this would likely require a substantial change in current economic and energy policies that affect both supply and demand in the oil market.[8]

Finally, the issue of "energy independence" could also be applied to the regional level. While an intra-country analysis will restrict some aspects of any energy index it can prove useful to compare the production versus the consumption within different regions when trying to understand the national energy mix. This should be particularly true for the U.S. where resources are relatively abundant and the regional mix of primary energy availability and usage differs notably. The most significant limitation is an inability to identify specific import sources (from another state, region, or country) for a state or region due to data limitations. However, the base index will allow for examination and comparison of the production and consumption of the primary energy sources for U.S. regions and give some insight into "energy independence" at these disaggregated geographic levels. Further explanation of the regional analysis is below.

3. Base W&J Energy Index (Index 1):

$$I_t^1 = \left(\sum_j w_{jt} \cdot X_{jt}^1 \right) \cdot 100 \qquad (1)$$

$$X_{jt}^1 = \frac{C_{jt} - I_{jt}}{C_{jt}} \qquad (2)$$

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[5] For example, EIA recently reduced the estimate of unproved technically recoverable natural gas reserves in the US from 827 trillion cubic feet to 482 trillion cubic feet. Annual Energy Review 2012 Early Release Overview, http://www.eia.gov/forecasts/aeo/er/.

[6] Two of the books that illustrate the divergence of views on the subject are *A Declaration of Energy Independence by* Jay Hakes and *Gusher of Lies: The Dangerous Delusions of 'Energy Independence'* by Robert Bryce. Both were published in 2008.

[7] Greene (2010) specifically notes that this would be achieved if the costs of dependence were less than 1 percent of GDP with a probability of 95 percent.

[8] For an in-depth analysis of possible energy policy options refer to *Toward an New National Energy Policy: Assessing the Options*, published by Resources for the Future and National Energy Policy Institute in 2010. http://www.energypolicyoptions.org/

Equation 1 shows the calculation for the base W&J Energy Index. The index has two main components, the weight (w_{jt}) associated with primary energy source j and the share of consumption coming from domestically produced sources (X^1_{jt}) of primary energy source j. C_{jt} is the total amount of primary energy source j that is consumed within the United States in year t. I_{jt} is the imports of source j into the United States in year t. $C_{jt} - I_{jt}$ gives the consumption of j that is from domestic production. The value of X^1_{jt} can range from 0 to 1. In year t, if the supply of energy source j is from sources completely within the United States then the value of X^1_{jt} will equal 1. Conversely, if the supply of energy source j comes entirely from imports, then the value of X^1_{jt} will equal 0. An increase in X^1_{jt} represents an increase in the share of supply of j coming from domestic sources.

3.1. Weights:

w_{jt} is the weight of energy source j in the index based on the share of total primary energy consumption in the United States in year t coming from primary energy source j. The U.S. EIA lists the sources of primary energy consumption for the United States as fossil fuels, renewable energy, and nuclear power.[9] Fossil fuels include coal, natural gas, and petroleum. Renewable energy sources are hydroelectric power, geothermal, solar/PV, wind, and biomass. The statistics used to calculate the weights come from Tables 1.3 and 10.1 in AER[10]. The statistics are given in British thermal units (Btu). The advantage of calculating the weights and import statistics separately, as is being done in this index, is that the units used in the weights and in X^1_{jt} can differ. The overall consumption statistics when being compared between the different sources are commonly given in Btu so that direct comparisons can be made. Whereas import and export statistics are given in the unit commonly associated with that source, such as short tons for coal and barrels for petroleum. Statistics on primary energy consumption by source are currently available from 1949 to 2009. Table 1 gives a sample of the percent associated with each primary energy source. The actual value assigned to w_{jt} ranges from 0 to 1 as opposed to using the percent value and can be found in appendix A.

Table 1: Primary Energy Consumption by Source

	Percent of total Consumption								
Year	Coal	Natural Gas	Petroleum	Hydro	Geothermal	Solar/PV	Wind	Biomass	Nuclear Power
1950	35.68	17.25	38.47	4.09	0.00	0.00	0.00	4.51	0.00
1960	21.82	27.48	44.19	3.57	0.00	0.00	0.00	2.93	0.01
1970	18.07	32.10	43.48	3.88	0.01	0.00	0.00	2.11	0.35

[9] Coal coke net imports and electricity net imports are included in the totals given in table 1.3 AER. We have not included these values in our weights. The values are extremely small.

[10] The source for the statistics used to calculate the weights are tables 1.3 and 10.1. In table 1.3 hydroelectric, geothermal, solar, and wind are given in a combined measure referred to as noncombustible. Table 10.1 in AER gives the breakdown of noncombustible sources. See http://www.eia.gov/totalenergy/data/annual/.

1980	19.77	25.93	43.83	3.72	0.07	0.00	0.00	3.17	3.51
1990	22.70	23.21	39.72	3.61	0.20	0.07	0.03	3.24	7.23
2000	22.89	24.15	38.79	2.85	0.17	0.07	0.06	3.05	7.97
2009	20.86	24.73	37.51	2.83	0.21	0.10	0.76	4.13	8.85

3.2. Description of Primary Energy Sources for the U.S.:

Table 2: Select Values of X^1_{jt}

Year	Coal	Natural Gas	Petroleum	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel Ethanol	Biodiesel	Nuclear Power
1950	0.999	1.000	0.868	1.000	0.000	1.000	1.000	1.000	0.000	0.000	0.000
1960	0.999	0.987	0.815	1.000	0.000	1.000	1.000	1.000	0.000	0.000	1.000
1970	0.9999	0.961	0.767	1.000	1.000	1.000	1.000	1.000	0.000	0.000	1.000
1980	0.998	0.950	0.595	1.000	1.000	1.000	1.000	1.000	0.000	0.000	1.000
1990	0.997	0.920	0.528	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000
2000	0.988	0.838	0.418	1.000	1.000	1.000	1.000	0.999	0.997	0.000	1.000
2009	0.977	0.836	0.378	1.000	1.000	1.000	1.000	0.990	0.982	0.755	1.000

Coal:

As shown in Table 1, coal has been an important contributor to energy supply throughout the time period being studied. The U.S. has vast coal reserves (estimates indicate there is enough to last approximately 200 years at current consumption levels, EIA 2012) and coal is the largest domestic energy source. The top producing states are Wyoming (with nearly 41% of U.S. production), West Virginia, Kentucky, Pennsylvania, and Montana. The electric power sector is the primary consumer of coal in the U.S. Since 1977, the electric power sector accounts for over 75% of total coal consumption. In 2009, 93.6% of coal was consumed by the electric power sector (AER Table 7.3, 2011). The U.S. has imported a limited amount of coal while exporting around 8% of our domestic production on average. From 1949 to 2009, annual net exports (exports – imports) have always been positive. Table 2 reports the calculated values of X^1_{jt} for each primary energy source for select years. All values for X^1_{jt} are shown in appendix B. From 1949 to 2009, the value of X^1_{jt} for coal ranges from 0.967 to 0.9999, which shows that almost all of our consumption is supplied by domestic sources. In 2009, the United States consumed 997.5 million short tons, imported 22.6 million short tons, and exported 59.1 million short tons of coal (AER Table 7.1, 2011). From 2000 to 2009 the primary country that the United States imported coal from was Colombia. In 2009, 17.8 of the 22.6 million short tons of coal imported into the United States originated from Colombia (AER Table 7.4, 2011). The majority of United States coal exports in 2009 were sent to Europe (50.9%), Canada (17.9%), and Brazil (12.5%) (AER Table 7.5, 2011). Coal consumption and trade statistics are given in short tons and are from AER table 7.1.[11]

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[11] For overview, data, analysis, and projections for coal see http://www.eia.gov/coal/.

Natural Gas:

In 2009, natural gas supplied almost 25% of total primary energy used in the United States. From 1949 to 1957, U.S. net exports of natural gas were positive. After this time though, net exports have been consistently negative, which can be seen in Figure 1. Table 2 shows that the value of X^1_{jt} has also been decreasing for natural gas, although there has been some increase in the value in 2008 and 2009. The values of X^1_{jt} range from 0.801 to 1[12]. At the beginning of the time period, our entire supply of natural gas came from domestic sources, shown by X^1_{jt} being equal to 1. The percent of natural gas consumption coming from domestic sources fell to its lowest value of 80.1% in 2007 but has been increasing since to nearly 84% in 2009. The major reason for this increase in domestic production is the ability to access unconventional shale plays.[13] The biggest domestic producers in 2009 were Texas (31% of production), Federal Offshore in the Gulf of Mexico (11%), Wyoming (11%), Oklahoma (8%), and Louisiana (7%). While imports have declined, a majority of natural gas imports come from Canada. In 2009, 87.2% of all natural gas imports into the United States came from Canada. At the same time most exports of natural gas are destined for Canada and Mexico. Mexico received 31.6% of U.S. natural gas exports, whereas Canada received 65.3%. These trade relationships show that the primary transportation method for natural gas across borders is by pipeline. Almost 88% of natural gas imports into the U.S. in 2009 via pipeline with a much smaller portion entering as liquefied natural gas (US EIA 2011c).

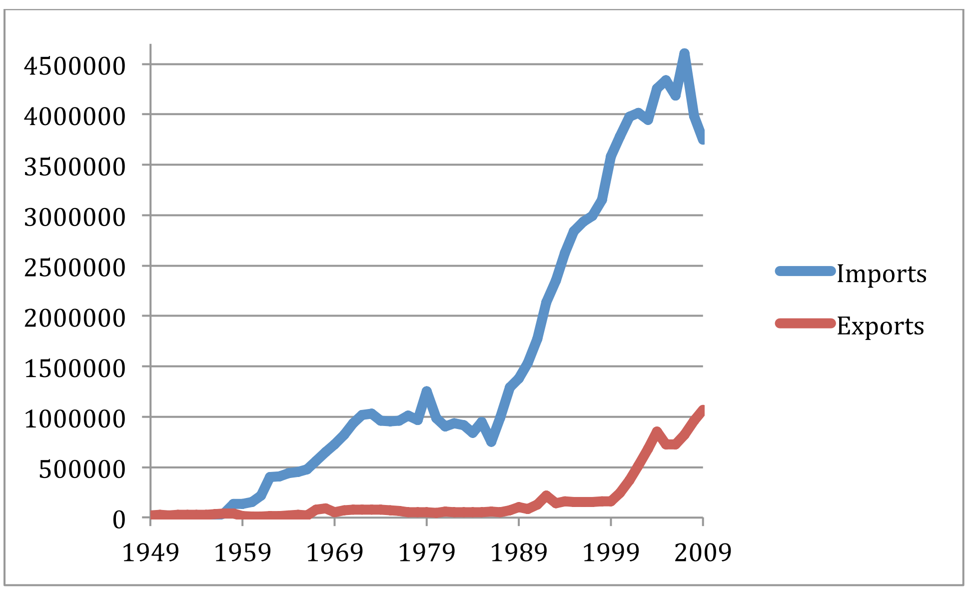

Figure 1: Natural Gas Imports and Exports 1949 – 2009, million cubic feet
Source: US EIA

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12 "Supplemental gaseous fuels are included in the calculations for X^1_{jt} but not when calculating the weights (AER, 2011).

13 For overview, data, analysis, projections, and more information on shale gas plays see http://www.eia.gov/naturalgas/. Gabriel (2010) provides insight on natural gas expectations.

Petroleum:

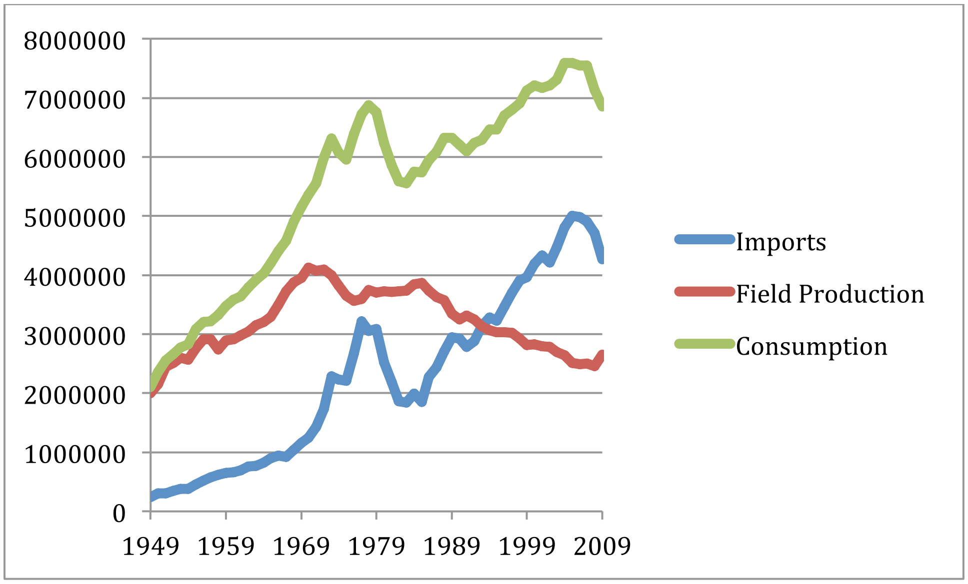

Figure 2: Petroleum Consumption, Imports, and Field Production 1949 - 2009, thousand barrels
Source: US EIA

When talking about "energy independence" the focus is almost always on oil dependence since this is the major energy source that the U.S. imports from abroad. This can be seen in Tables 1 and 2. As mentioned above, supplies of coal and natural gas are abundant domestically. Additionally, the transportation sector is almost completely dependent on oil and has very limited ability to substitute for other fuels at this time. Increased dependence on imported oil can be broadly explained by reduced domestic oil production, which peaked in the early 1970s, and increased demand for oil in the U.S. and worldwide, as shown in Figure 2. This situation is not unique to the U.S. as many other developed nations are in similar situations of imported large shares of their consumed oil. Typically economists would argue that reliance on a worldwide commodity market is not a bad thing. However, it is possible that the oil market does not function properly due to the market power possessed by Organization of Petroleum Exporting Countries (OPEC), concentrated supply in the Persian Gulf, and the widespread control of oil reserves by state-owned entities. These issues will be considered in the modified indexes below. OPEC accounts for approximately 75% of proven conventional oil reserves worldwide and around 40% of current world oil production.[14] The geographic concentration is a bit less pronounced, however approximately 66% of proven conventional reserves are located in the Persian Gulf region and the region accounts for 31% of current world production (Sovacool 2007). Nine of the ten largest oil companies in the world are state owned and these nine account for 79% of proven oil reserves (Greene 2010). Because nationalized companies may pursue other motives that do not lead them to respond to market conditions the market may not always function as expected.[15] This also makes it clear that the

[14] For more information on OPEC see http://www.opec.org/opec_web/en/.
[15] A recent example would be threats by Iran to reduce their production and exportation of oil or to interrupt passage through the Straight of Hormuz. For more information on possible consequences and reactions to these issues see http://www.reuters.com/article/2012/02/25/us-usa-economy-geithner-idUSTRE81N12120120225.

popular notion that large, privately owned oil and gas companies have undue influence on oil markets and prices is simply not true.

In response to the decrease in domestic production and the increase in domestic consumption, the U.S. has been importing a growing quantity of petroleum. However, U.S. dependence on imported oil has decreased in recent years. From 1949 to 2009 the value of X^1_{jt} for petroleum ranges from 0.339 to 0.888. Figure 3 shows the values of X^1_{jt} during the time period being studied and reflects the relationships shown in Figure 2. Imported oil accounted for 60.3% of U.S. oil consumption in 2005 and that number was down to 49.3% in 2010. This is partially explained by reduced consumption resulting from the economic recession, efficiency improvements, and economic growth patterns less reliant on manufacturing. Other factors are the increasing use of biofuels and increased oil production in the U.S. Of this imported oil, 41.6% is imported from OPEC countries with the remaining 58.4% coming from non-OPEC countries. This shows a substantial shift in imports compared with the late 1970s when approximately 70% of imports came from OPEC countries. The five biggest importers of oil to the U.S. are Canada (25%), Saudi Arabia (12%), Nigeria (11%), Venezuela (10%), and Mexico (9%).[16] In 2009, the U.S. received petroleum from approximately 90 different countries (US EIA 2011e). The historical import trend was increasing reliance on oil imports until the late 1970s, then a reduction of imports from 1979 to 1985, then a substantial increase in reliance on imports until 2005, and finally the falling dependence of the last several years.

Although the U.S. is the world's largest consumer of oil, accounting for 22 percent of worldwide consumption, it is also the third largest producer of oil and exports approximately 2 million barrels per day (generally refined oil products). Related to this, the U.S. share of world consumption has decreased steadily over the last several decades. Developing nations, China in particular, have driven the increase in demand outside of the U.S. This trend is expected to continue. A 2005 article from Resources for the Future notes that there are 780 cars per 1,000 people in the U.S. while in China the ratio is 8 cars per 1,000 people (Parry and Anderson 2005). Economic growth and increased demand for oil and primary energy in developing nations is very likely to put upward pressure on energy prices in the future.[17] Figure 4 below shows the changing share of total petroleum consumption for the U.S. and China since 1980 and Figure 5 shows the same measure for total primary energy consumption.

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[16] The Canadian oil sands have become an increasingly important part of the oil future. For more information on this source see http://www.eia.gov/countries/country-data.cfm?fips=CA and Reynolds (2005).

[17] For overview, data, analysis, and projections for petroleum see http://www.eia.gov/petroleum/. In addition, Duetch (2010), Duetch et al (2006), and Leiby (2007) provide in-depth analysis of oil dependence.

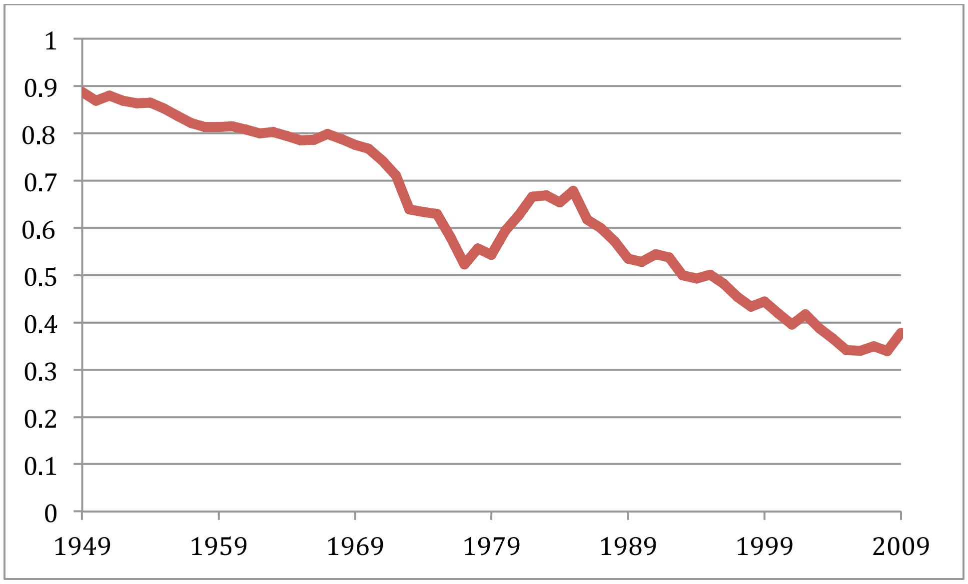

Figure 3: Petroleum Consumption from Domestic Production Sources
Source: US EIA

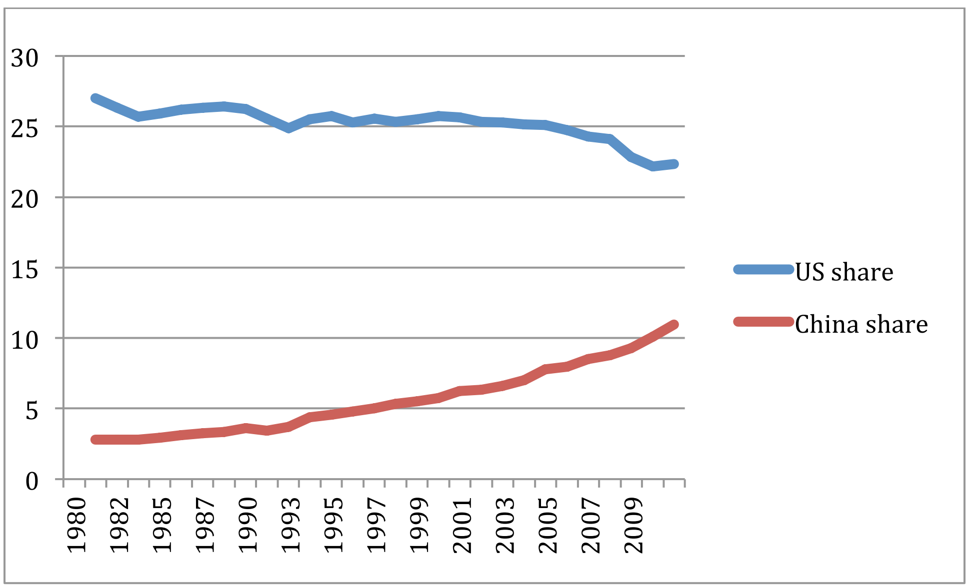

Figure 4: Percentage of Total World Petroleum Consumption
Source: US EIA

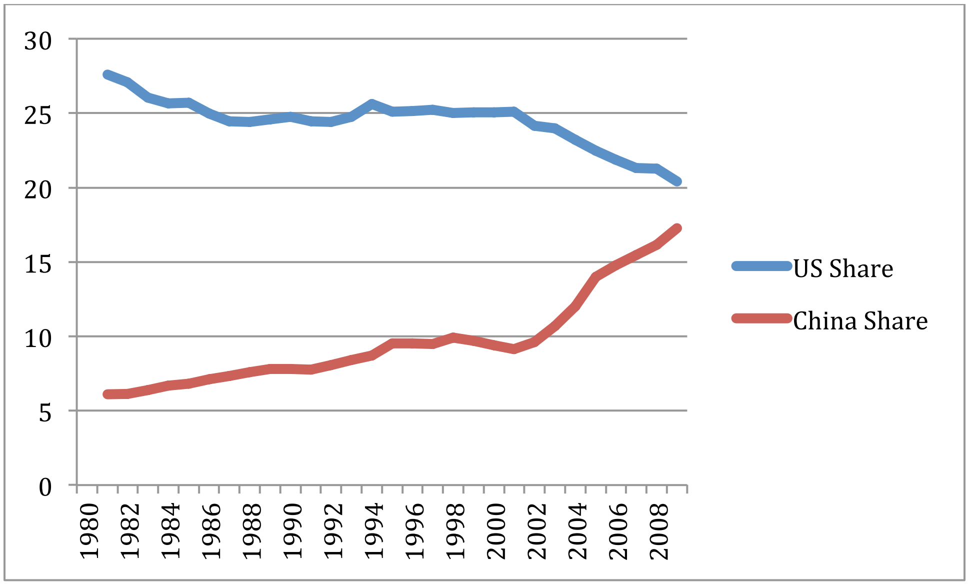

Figure 5: Percentage of Total World Primary Energy Consumption
Source: US EIA

Renewable Energy Sources:

In 2010, hydroelectric power generation accounted for 6 percent of total electricity generation, the largest share of any renewable energy source. The vast majority of hydroelectric power is generated in the western U.S. with Washington, California, and Oregon being the largest sources of this renewable energy. Wind energy generated 2 percent of total electricity in 2010 and has grown noticeably since 2000 when capacity was 6 billion kilowatt hours to a current capacity of 95 billion kilowatt hours. This is the largest total wind energy capacity in the world. In 2010, 36 states generated wind power with the top producers being Texas, Iowa, California, Minnesota, and Washington. Biomass is another important source of energy and produced 4 percent of total energy in the U.S. in 2010. Biomass consists of organic material from plants and animals. For production of energy the most common sources are wood, crops, alcohol fuels (primarily ethanol and biodiesel), and landfill gas. Of these wood and biofuels contribute the most to energy production. Geothermal energy production uses heat from the earth in the form of steam or water to generate energy. The heat can be used directly or it can be used to generate electricity. In 2009, 15 billion kilowatt hours of electricity were produced from geothermal energy, which accounted for 0.4 percent of total electricity generation. The largest producers were California (35 geothermal plants) and Nevada (18 geothermal plants). Hawaii, Idaho, and Utah had one plant each. These are concentrated in the West due to proximity of tectonic plate boundaries, which generally produce the greatest amount of geothermal energy. Solar power can be generated directly through photovoltaics or indirectly by focusing the solar energy on a fluid. California contains the largest solar thermal plants in the world (US EIA 2011f). Overall, solar energy is still a small part of the current U.S. energy mix but the potential for growth could be substantial.[18]

[18] For overview, data, analysis, and projections for renewables and alternative fuels see http://www.eia.gov/renewable/ and Fischer and Preonas (2010).

The supplies of hydroelectric power, geothermal, solar/PV and wind are produced completely domestically. As a result, the value of X^1_{jt} is 1 for all years being studied. The same is true for biomass until 1993 when we began importing small amounts of ethanol. Biomass includes wood and wood waste, municipal solid waste, landfill gas, biogas, ethanol and biodiesel (AER 2011). The biomass consumption statistics are split into wood, waste, and biofuels. With the exception of biofuels, all that is consumed is produced domestically in this category. From 1949 to 1980 the statistics only include the consumption of wood and waste. From 1981 to 2000 the statistics also include ethanol consumption. From 2001 on, biodiesel consumption is included[19]. In appendix B, biomass is split between wood and waste, fuel ethanol and biomass. From 1981 to 2009 X^1_{jt} for fuel ethanol ranges from 0.867 and 1 and from 2001 to 2009 X^1_{jt} for biodiesel ranges from 0.002 to 0.904.

Nuclear:

Nuclear power is an important source of electricity in the U.S. accounting for around 20% of electricity generated in the electric power sector annually. It accounts for just over 8% of all energy consumed in the U.S. This power comes from 65 nuclear power plants that hold 104 total reactors. The U.S. has the largest nuclear capacity in the world but several other nations are more reliant on nuclear power as a sizable portion of their energy mix, most notably France, Japan, and Germany. In the U.S., no new reactors have been ordered since 1978 and the last to come online was in 1996. Because of this the share of nuclear generated electricity has been relatively constant over the past 20 years at around 20 percent although capacity may increase due to improved efficiency. The five states with the largest nuclear capacity are Illinois, Pennsylvania, South Carolina, New York, and Texas and the majority of nuclear capacity is located in the eastern U.S.

Uranium is the primary fuel for nuclear fission and the vast majority of uranium in the U.S. is imported currently. In 2009, 88.7% of the uranium loaded into U.S. commercial nuclear reactors was purchased from non-domestic sources. The largest share of imports, 41%, came from Kazakhstan, Uzbekistan, and Russia. A sizeable portion was also imported from Australia and Canada (US EIA 2011d).[20]

To calculate X^1_{jt} for uranium is not straightforward due to the limited amount of historical statistics reported on uranium consumption and purchases. Beginning in 1994, statistics are available on both the total uranium loaded into U.S. commercial nuclear power reactors and the portion of that value that is from domestic and foreign sources. While these statistics could be used to calculate X^1_{jt} nuclear power output is treated as a primary energy source in the calculations in keeping with EIA methods and definitions. In addition, unrefined uranium is relatively abundant and represents a very small portion of operating costs. The major cost in nuclear power production is the construction of

[19] Biofuel statistics used to calculate the weights include fuel ethanol less denaturant and biodiesel consumption plus losses and co-products. When calculating X^1_{jt} denaturant is included in consumption calculation because import statistics include denaturant. Losses and co-products are not added in when calculating X^1_{jt}.

[20] For overview, data, analysis, and projections for nuclear power and uranium see http://www.eia.gov/nuclear/.

appropriate facilities. This means that X_{jt}^{1} will have a value of 1 for all years of the study. The value of the base index is reported in appendix D.

Table 3: Source and Unit of Measurement of Statistics Used to Calculate X_{jt}

	Unit of Measurement	**Source of Statistics for X_{jt}**
Coal	Short Tons	AER, 2011 - Table 7.1
Natural Gas	Cubic Feet	AER, 2011 - Table 6.1
Petroleum	Barrels	AER, 2011 - Table 5.1b
Hydroelectric Power	Billion Btu	AER, 2011 - Table 10.1
Geothermal	Billion Btu	AER, 2011 - Table 10.1
Solar/PV	Billion Btu	AER, 2011 - Table 10.1
Wind	Billion Btu	AER, 2011 - Table 10.1
Wood and Waste	Billion Btu	AER, 2011 - Table 10.1
Fuel Ethanol	Thousand Barrels	AER, 2011 - Table 10.3
Biodiesel	Thousand Barrels	AER, 2011 - Table 10.4
Nuclear	Billion Btu	AER, 2011 – Table 1.3

3.3. Projections of Future Primary Energy Use in the U.S.

The EIA Annual Energy Outlook 2011 provides projections of future energy trends in the U.S. One of the major trends predicted is reduced total energy imports due to increasing use of biofuels, increasing domestic production of natural gas from shale, stricter fuel mileage standards for automobiles, and consumer response to higher energy prices. The projections call for a reduction in the net import share of total energy consumption to 17 percent in 2035 from 24 percent in 2009. This is due in large part to the expected reduction in oil imports from 51 percent of oil consumption in 2009 to 42 percent of consumption in 2035. Two important reasons for this are the increase in shale gas production and increasing use of renewable energies, particularly wind and biomass. From 2000 to 2006 shale gas production grew at an average rate of 17 percent. The average annual increase in production from 2006 to 2010 increased to 48 percent. As of 2009 shale gas accounted for 16 percent of all natural gas production, however this share is expected to increase to 47 percent of all natural gas by 2035. This increased production is expected to moderate natural gas prices over the time period. This is also expected to increase the use of natural gas in electricity production (from 23 percent in 2009 to 25 percent in 2035), although coal will still account for the largest share of electricity production at 43 percent in 2035. The portion of electricity generated by renewable sources is projected to increase from 11 percent in 2009 to 14 percent in 2035. Finally, carbon dioxide emissions are expected to grow slowly in the coming decades at an average annual rate of approximately 0.6 percent. At this rate carbon emissions would return to 2005 levels by 2027.[21] Carbon dioxide emissions have decreased in recent years, mainly due to the economic downturn. The slower growth in emissions will come mostly from increased use of natural gas and renewables and from improved efficiency (AEO 2011).

[21] For more information on energy, emissions, and climate change see Bang (2010), Dincer (1999), Gordon (2009), Huntington and Brown (2004), and Turton and Barreto (2006).

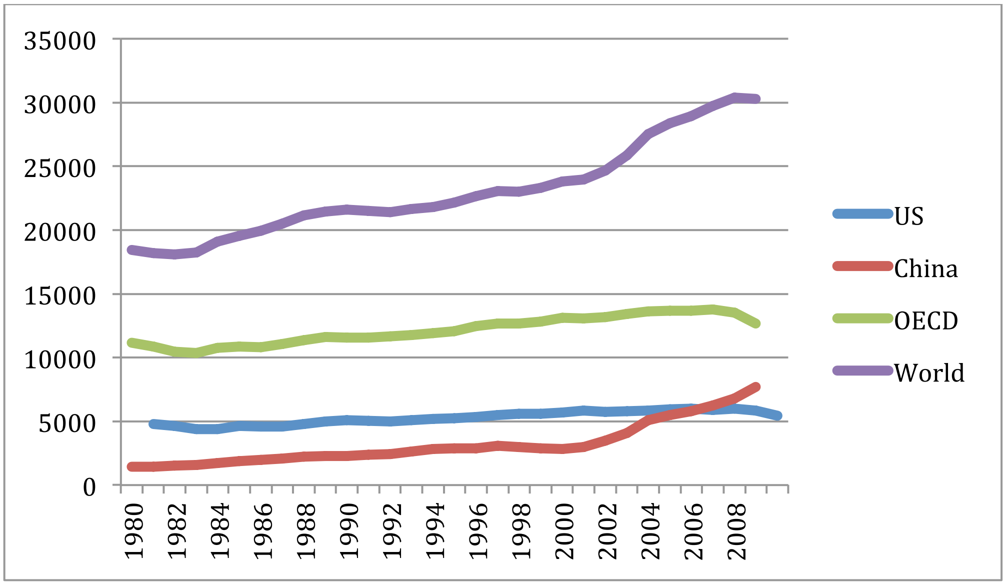

Figure 6: Total CO_2 Emissions from Energy (million metric tons)
Source: US EIA

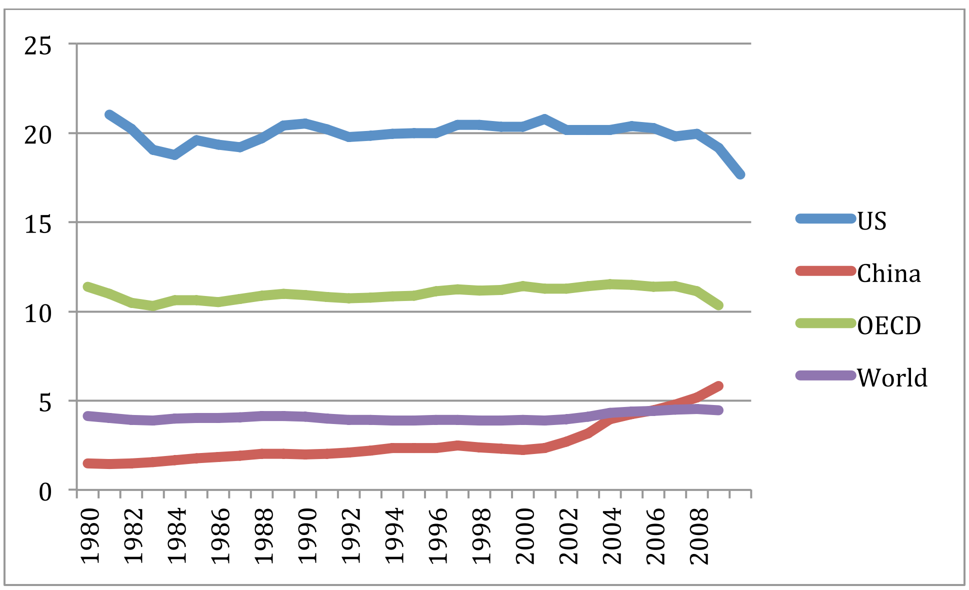

Figure 7: CO_2 Emissions from Energy Per Capita (metric tons per person)
Source: US EIA

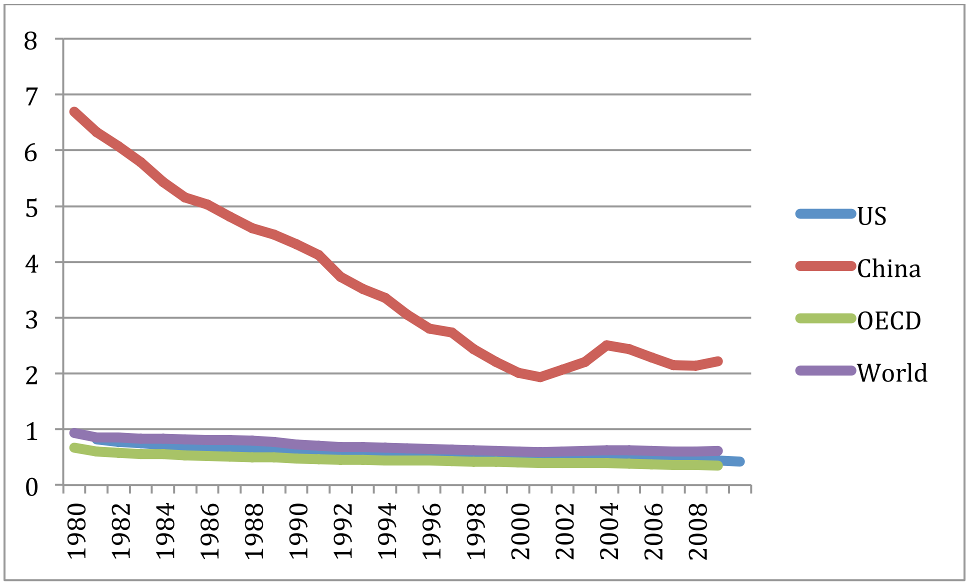

Figure 8: Carbon Intensity (metric tons of CO2 per thousand 2005$)
Source: US EIA

3.4. Trends in Energy Intensity

When looking at energy consumption it is useful to look at energy consumption per capita, to account for the size a nation, and also energy consumption per dollar of Gross Domestic Product (GDP), to account for the size of a nation's economy relative to energy use. In 2006 the U.S. used 334.6 million Btus per capita. The world average for 2006 was 72.4 million Btus per capita. Germany's per capita use was 177.5, the United Kingdom was 161.7 and China was 56.2. The highest per capita use in the U.S. occurred in 1978 and 1979 when use was at 359 million Btus per person. The most recent data for 2009 showed that per capita used has dropped to 308. In addition, EIA projections show an continued decline in consumption per capita to 293 million Btus per person in 2035. Examining energy consumption per dollar of GDP, often referred to as energy intensity, gives a different perspective about energy use in the U.S. For 2006 energy consumption per real dollar of GDP was 8,841 Btus in the U.S., 6,428 in Germany, 5,233 in the United Kingdom, and 13,780 in China. The world average was 8,874. The U.S. has seen a large decline in this measure since 1970 when energy consumption was at 15,890 Btus per real dollar of GDP. The latest data for 2009 shows a more than 50% reduction since 1970 to 7,280. The reduction can be attributed to increased conservation, improved efficiency, and structural changes in the U.S. economy as services have become an increasing large part of the economy and manufacturing has declined. EIA projects energy intensity to drop an average of 1.9 percent a year from 2009 to 2035 (AEO 2011).

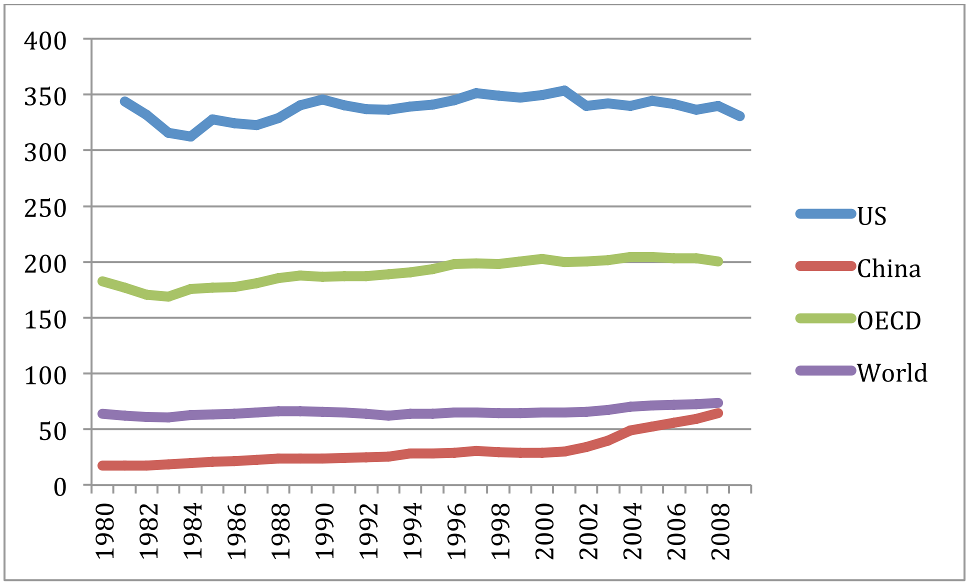

Figure 9: Total Primary Energy Consumption Per Capita (million Btu per person)
Source: US EIA

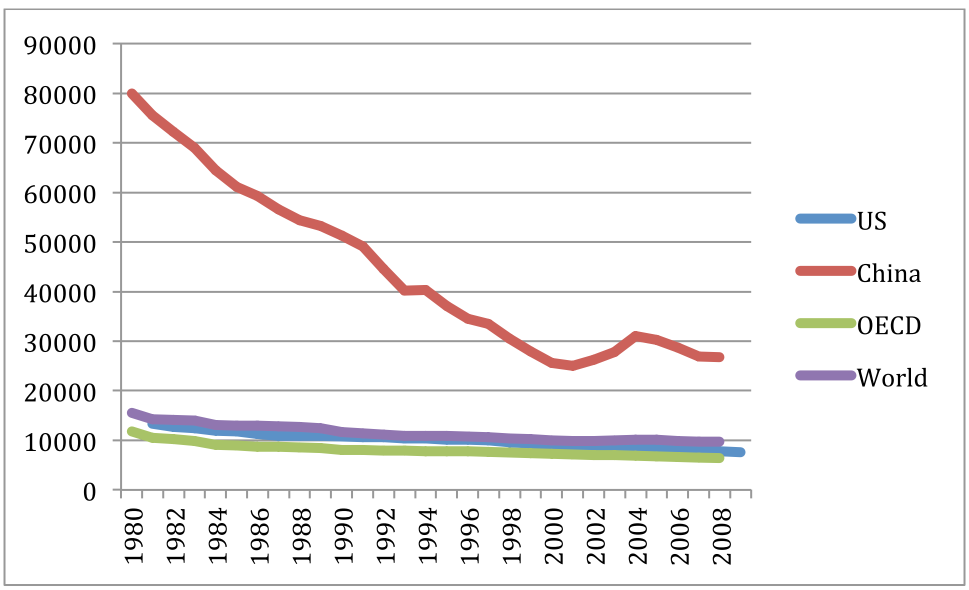

Figure 10: Energy Intensity – Total Primary Energy Consumption per Dollar of GDP (Btu per 2005$), Source: US EIA

4. W&J Energy Index – Inclusion of Exports (Index 2):

It is common that the Unites States both imports and exports energy sources. This is true for all of the fossil fuels. For instance, in 2009 4,267 million barrels of petroleum were imported while 739 million barrels of petroleum were exported. The first modification made to the base index is to include exports in the index. This is done by changing the calculation of X_{jt}.

$$X^2_{jt} = \frac{C_{jt} - I_{jt} + E_{jt}}{C_{jt}} \quad (3)$$

Equation 5 shows that now exports are added in while imports are subtracted out of consumption of primary energy source j, as before. If there were additional supplies of energy source j needed in the domestic economy, the thought is that these exports could be re-routed to domestic uses. This is the only modification made in the calculation of Index 2. In some instances the value of X^2_{jt} could be greater than 1. An example of this is coal. For every year being studied the calculated value for X^2_{jt} is greater than 1. We have set the maximum value for X^2_{jt} at 1. This modification is based on the assumption that there is not inter-fuel substitution, which is reasonable if looking at the annual numbers as a short run perspective. For instance, coal could not be used outside of the electricity market in the U.S., for something like transportation (petroleum) or heating large numbers of homes (natural gas), without a very large time and resource commitment. A comparison of the calculated values for X^1_{jt} and X^2_{jt} for select years are given in Table 4 for coal, natural gas, petroleum, fuel ethanol, and biodiesel. X^2_{jt} is larger for all fuels except for fuel ethanol showing that the U.S. does not export fuel ethanol. The addition of exports in this index increases the independence for the major energy sources and shows that domestic supplies of coal and natural gas are substantial. The independence of petroleum is increased noticeably (as mentioned above the U.S. is the world's third largest producer), however it is clear that consumption would still be highly dependent on imports as X^2_{jt} is still less than 0.5 in 2009. The values for X^2_{jt} are reported in appendix C and the values for index 2 can be found in appendix D.

Table 4: Select Values of X^1_{jt} and X^2_{jt}

Year	Coal X^1_{jt}	Coal X^2_{jt}	Natural Gas X^1_{jt}	Natural Gas X^2_{jt}	Petroleum X^1_{jt}	Petroleum X^2_{jt}	Fuel Ethanol X^1_{jt}	Fuel Ethanol X^2_{jt}	Biodiesel X^1_{jt}	Biodiesel X^2_{jt}
1950	0.999	1.00	1.000	1.000	0.868	0.916	0.000	0.000	0.000	0.000
1960	0.999	1.00	0.987	0.988	0.815	0.835	0.000	0.000	0.000	0.000
1970	0.9999	1.00	0.961	0.964	0.767	0.785	0.000	0.000	0.000	0.000
1980	0.998	1.00	0.950	0.953	0.595	0.627	0.000	0.000	0.000	0.000
1990	0.997	1.00	0.920	0.925	0.528	0.578	1.000	1.000	0.000	0.000
2000	0.988	1.00	0.838	0.848	0.418	0.471	0.997	0.997	0.000	0.000
2009	0.977	1.00	0.836	0.883	0.378	0.486	0.982	0.982	0.755	1.000

5. W&J Energy Index – Inclusion of Import Diversity Measure (Index 3):

When energy independence or security is discussed it is important to consider US petroleum import partners. This index is modified to include a concentration index for import partners. Index 3 builds on Index 2 with the additional consideration of the diversity of import sources. The thinking with this index is that an increased diversification of import partners will lead to an improvement of energy security and should lead to a generally more efficient oil market. A common measure used to calculate concentration in an industry is the Herfindahl-Hirschmann index (HHI). An advantage of HHI is that it takes into account not only the number of firms but also the market share of these firms. A modified HHI will be used in this study to look at the concentration of countries in the U.S. import of petroleum and natural gas. With the growth of nationalized companies in this industry, it has become more appropriate to think at the country level as opposed to the firm level in these industries. Cohen et al. (2011) create a country specific diversification index (CDI) to look at the changes in diversification and these ties to energy security over time for the OECD countries.[22] Following this, the measure used here is specific to U.S. imports and is known at the import diversity measures (IDM). The IDM calculation is shown in equation 4.

$$IDM_{jt} = \sum_i \left(\frac{NPI_{ijt}}{C_{jt}} \right)^2 \cdot 100 \qquad (4)$$

C_{jt} is the total consumption of the fuel (either petroleum or natural gas) for the U.S. and the calculation for NPI_{ijt}, which is the net positive imports from country i to the U.S., is shown in equation 5.

$$NPI_{ijt} = \max\left(0, I_{ijt} - E_{ijt}\right) \qquad (5)$$

If the imports from country i to the U.S. exceed the exports from the U.S. to country i then NPI_{ijt} will equal the value of this difference. If instead, the U.S. is exporting more to country i then is being imported from that country then net imports will be negative and the value of NPI_{ijt} will be 0. The IDM is incorporated into the index by modifying X_{jt} for petroleum and natural gas. For all other primary energy sources it will be the same calculation used in equation 3, which is the design used to account for exports in Index 2. The modification made to X_{jt} for petroleum and natural gas is shown in equation 6.[23]

$$X_{jt} = \left(\frac{C_{jt} - I_{jt} + E_{jt}}{C_{jt}} \right) \cdot \left(1 - \frac{IDM_{jt}}{100} \right) \qquad (6)$$

An increase in IDM would indicate a decrease in the diversification of import partners signifying a decrease in energy security. When a country has only one import partner, and is therefore completely reliant on this one partner, the value of IDM would equal 100 whereas if the country does not import any of the primary energy source j in year t then the value would be 0. The possible values of IDM range from 0 to 100 (Cohen et al., 2011). An increase in the value of X_{jt} is seen as a decrease in the dependence of consumption from foreign sources. To have both measures moving in the same direction and to keep the index bounded by 0 and 100 the IDM is modified in the way shown in equation 6. While this is a more complicated index measure and interpretation is less straightforward than the first two indexes, the benefit is that it incorporates an important consideration for energy security.

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[22] See also Loschel et al (2010) for indicators of energy security.

[23] The same could have been used for coal and uranium but was not done. We import very small portions of our coal used in domestic consumption so this calculation was not thought to be needed. We do import much of our uranium and this calculation would be appropriate but due to limited data availability at this time uranium could not be included in this way.

Additionally this index is calculated in two separate ways. The base way treats each country separately. The index is also calculated to treat the OPEC member countries as a single entity given that they make production decisions as a group.

6. W&J Energy Index – Inclusion of IDM and Political Stability (Index 4):

There are concerns associated with not only how much but who we import from due to risks associated with certain countries. As mentioned above, nationalized oil companies are a very large part of the world oil market and this could increase the possibility of supply disruptions in the market. Related to this, social and political uncertainty within an oil exporting country could impact production and supply to the world market and to the U.S. For instance, the U.S. almost certainly prefers to import primary energy sources from Canada, a neighboring country with a stable political environment, versus a country with social and political tensions. This is particularly true given the current importance of petroleum to the domestic economy. This is incorporated into Index 4 by using a modification from Cohen et al. (2011) shown in equation 7.

$$IDM_{jt}^{POL} = \sum_{i} \left(\frac{NPI_{ijt}}{C_{jt}} \right)^2 \cdot POL_{it} \cdot 100 \qquad (7)$$

POL_{it} is a measure of political risk of country of the country. Cohen et al. (2011) use the International Country Risk Guide (ICRG) risk rating as their measure of political risk. This study uses the World Bank World Governance Indicators as opposed to ICRG due to the measure being publicly available and widely utilized in research. Specifically, the political stability measure is used which "measures the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism."[24] The percentile rank of each import partner is used to provide a measure of relative political stability.

$$POL_{it} = \frac{100 - RANK_{it}}{100} \qquad (8)$$

where $RANK_{it}$ is percentile rank for country i. The POL_{it} is modified so that countries with stable political environments and higher percentile ranks will have low scores while a low percentile rank would lead to a relatively high score. That allows the current measure to be consistent with the setup of the previous indexes. A high POL_{it} score lead to a higher IDM score and ultimately to reduced energy security for the U.S. as measured by the index. The values for IDM_{jt} and IDM_{jt}^{POL} for both natural gas and petroleum and IDM_{jt}^{OPEC} for petroleum are reported in appendix E. A comparison of all calculated indexes from 1993 to 2009 is shown in appendix F.

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[24] The World Bank World Governance Indicators Political Stability measure uses information from eight sources, one of which is the International Country Risk Guide. A full description is available here: http://info.worldbank.org/governance/wgi/index.asp.

7. W&J Base Energy Index Calculated for U.S. Census Regions

The issue of "energy independence" could also be applied to regional and even state level. It is interesting to compare the production versus the consumption within a region in the United States. The base index (index 1) is calculated for the four U.S. Census regions by aggregating state level statistics. Since the value given for a state as an import only refers to the amount of the commodity coming from a source outside the U.S., there was no import statistics given that were able to be used at the state and regional level. The term import at the regional level now refers to anything entering from another region or country. As a result, the import value has to be calculated. All statistics used to calculate the regional indexes are from the State Energy Data System (SEDS) created by the Energy Information Administration. Statistics are available from 1960 to 2009.

7.1. Regional Weights

In the same manner as the national index, $w_{j,k,t}$ is the weight of energy source j in the index based on the share of total primary energy consumption in the region[25] k in year t coming from primary energy source j. The SEDS dataset measure of total energy consumption includes coal, natural gas, petroleum, nuclear electric power, renewable energy, net interstate flow of electricity[26], and net electricity imports. When calculating $w_{j,k,t}$ the net interstate flow of electricity is excluded at the regional level because the assumption is that the interstate flow is all contained within the region. Electricity net imports are also excluded at the regional level as was done at the national level. See appendix G for a description of the codes used in SEDS and the calculations used to solve for $w_{j,k,t}$. Table 5 reports each of the primary energy sources' percent of total consumption in the region. There is variation in the consumption patterns between regions. For example, the West has a higher percent of consumption relying on renewables than other regions and nuclear is more prominent in the Northeast. The calculated weights for all regions from 1960 to 2009 are in appendix H.

Table 5: Percent of Total Consumption, 2009

Region	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geo	Solar	Wind	Wood Waste	Fuel Ethanol
Northeast	11.99	26.15	39.43	15.07	2.90	0.03	0.06	0.27	2.90	1.20
Midwest	33.08	21.83	31.45	8.90	0.60	0.09	0.02	1.10	1.91	1.01
South	20.91	24.43	39.69	9.15	1.28	0.05	0.10	0.58	2.91	0.89
West	12.98	28.80	40.16	3.95	8.96	0.85	0.25	1.14	1.97	0.93

[25] Census Regions: Region 1: Northeast – Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Region 2: Midwest – Indiana, Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; Region 3: South – Alabama, Arkansas, Delaware, D.C., Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; Region 4: West – Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming

[26] If the reported value of net interstate flow of electricity/losses is positive then the state has imported more electricity than exported from state and if negative then the state is a net exporter.

7.2. Calculating Imports

At the national level, the term import refers to a primary energy source entering the United States from another country. At the regional level, the term import will now refer to the primary energy source entering the region from another country and from another region within the United States. Since statistics are not reported in this fashion, the inflow from another region must be calculated.

$$z_{j,k,t} = consumption_{j.k.t} - production_{j,k,t} \qquad (9)$$

$z_{j,k,t}$ is the difference between consumption and production of primary energy source j in region k in year t. If $z_{j,k,t} \geq 0$, then $imports_{j,k,t} = z_{j,k,t}$ and $exports_{j,k,t} = 0$. When consumption exceeds production then the additional amount of the primary energy source being consumed must be imported from outside the region. If instead $z_{j,k,t} \leq 0$, then $exports_{j,k,t} = z_{j,k,t}$ and $imports_{j,k,t} = 0$, meaning that production exceeded consumption and the region was able to send the excess elsewhere. At the regional level, the production and consumption values are the summation of all states within the region. All production and consumption values are given in Btus.

When making the above comparison between consumption and production there were a few modifications that had to be made to the published statistics. Natural gas production includes natural gas plant liquids, which are not included in natural gas consumption. Instead, natural gas plant liquids are included within the consumption of petroleum products. Natural gas plant liquids are included as a portion of two different categories of petroleum consumption including liquefied petroleum gas and pentanes plus. Pentanes plus is not given as a separate category instead, it is listed in the broader category of other petroleum products so cannot be added to the natural gas consumption. The category of liquefied petroleum gases is added to natural gas consumption. This may overstate the consumption of natural gas because liquefied refinery gases are also included in liquefied petroleum gases. Natural gas consumption may be understated because we are not able to include pentane plus[27].

Petroleum production is not available at the state level. Only crude oil production is available at the state level. As a result, petroleum production is assumed to be crude oil production. Consumption statistics are available for both petroleum products and crude oil but the consumption of petroleum products is used. The consumption of crude oil is referring to the use of the oil in the industrial sector in crude oil processing. When the SEDS dataset is comparing total production and consumption, crude oil is used as the measure of production and petroleum products are used as the measure of consumption. We do the same. Since we adjusted natural gas consumption to include liquefied petroleum gas we will exclude those from petroleum consumption. In addition, fuel ethanol consumption is subtracted from petroleum consumption.

Fuel ethanol production at the state level is limited. To calculate the production of fuel ethanol renewable energy production other than fuel ethanol is subtracted from total renewable energy production. At this time, biodiesel production and consumption statistics are not available at the state level. The values for $X^1_{j,k,t}$ for each region in 2009 are reported in table 6. There is a

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[27] Email communication with Yvonne Taylor, SEDS Data Expert (1/4/12) and Energy Information Administration, State Energy Data System, http://www.eia.gov/state/seds

significant variation between regions. All regions, except for the Midwest, are producing close to the amount that they are consuming in terms of coal. Natural gas production equals or exceeds consumption in the South and the West, whereas consumption is significantly larger than production in the Northeast and Midwest. Petroleum production relative to consumption is also higher in the South and the West. The Midwest is a fuel ethanol exporter. The values for $X^1_{j,k,t}$ for each region from 1960 to 2009 are reported in appendix I. Appendix J reports the base index values for each region.

Table 6: Values of $X^1_{j,k,t}$ for Regions, 2009

Region	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geo	Solar	Wind	Wood Waste	Fuel Ethanol
Northeast	0.904	0.092	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.044
Midwest	0.359	0.140	0.128	1.000	1.000	1.000	1.000	1.000	1.000	1.000
South	0.921	1.000	0.482	1.000	1.000	1.000	1.000	1.000	1.000	0.207
West	1.000	1.000	0.530	1.000	1.000	1.000	1.000	1.000	1.000	0.273

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Appendix

Appendix A: Weights

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol	Biodiesel
1949	0.375	0.161	0.372	0.0000	0.045	0.0000	0.0000	0.0000	0.048	0.0000	0.0000
1950	0.357	0.172	0.385	0.0000	0.041	0.0000	0.0000	0.0000	0.045	0.0000	0.0000
1951	0.339	0.191	0.390	0.0000	0.038	0.0000	0.0000	0.0000	0.041	0.0000	0.0000
1952	0.308	0.205	0.407	0.0000	0.040	0.0000	0.0000	0.0000	0.040	0.0000	0.0000
1953	0.302	0.210	0.413	0.0000	0.038	0.0000	0.0000	0.0000	0.038	0.0000	0.0000
1954	0.265	0.227	0.432	0.0000	0.037	0.0000	0.0000	0.0000	0.038	0.0000	0.0000
1955	0.278	0.224	0.429	0.0000	0.034	0.0000	0.0000	0.0000	0.035	0.0000	0.0000
1956	0.272	0.230	0.430	0.0000	0.034	0.0000	0.0000	0.0000	0.034	0.0000	0.0000
1957	0.259	0.244	0.429	0.0000	0.036	0.0000	0.0000	0.0000	0.032	0.0000	0.0000
1958	0.229	0.256	0.445	0.0000	0.038	0.0000	0.0000	0.0000	0.032	0.0000	0.0000
1959	0.219	0.270	0.445	0.0001	0.036	0.0000	0.0000	0.0000	0.031	0.0000	0.0000
1960	0.218	0.275	0.442	0.0001	0.036	0.0000	0.0000	0.0000	0.029	0.0000	0.0000
1961	0.210	0.283	0.442	0.0004	0.036	0.0000	0.0000	0.0000	0.028	0.0000	0.0000
1962	0.207	0.287	0.440	0.0006	0.038	0.0000	0.0000	0.0000	0.027	0.0000	0.0000
1963	0.210	0.290	0.437	0.0008	0.036	0.0000	0.0000	0.0000	0.027	0.0000	0.0000
1964	0.212	0.295	0.430	0.0008	0.036	0.0000	0.0000	0.0000	0.026	0.0000	0.0000
1965	0.214	0.292	0.430	0.0008	0.038	0.0000	0.0000	0.0000	0.025	0.0000	0.0000
1966	0.213	0.298	0.428	0.0011	0.036	0.0000	0.0000	0.0000	0.024	0.0000	0.0000
1967	0.202	0.305	0.429	0.0015	0.040	0.0001	0.0000	0.0000	0.023	0.0000	0.0000
1968	0.197	0.308	0.432	0.0023	0.038	0.0001	0.0000	0.0000	0.023	0.0000	0.0000
1969	0.189	0.315	0.432	0.0023	0.040	0.0001	0.0000	0.0000	0.022	0.0000	0.0000
1970	0.181	0.321	0.435	0.0035	0.039	0.0001	0.0000	0.0000	0.021	0.0000	0.0000
1971	0.167	0.324	0.441	0.0060	0.041	0.0001	0.0000	0.0000	0.021	0.0000	0.0000
1972	0.166	0.312	0.453	0.0080	0.039	0.0002	0.0000	0.0000	0.021	0.0000	0.0000
1973	0.171	0.298	0.461	0.0120	0.038	0.0003	0.0000	0.0000	0.020	0.0000	0.0000
1974	0.171	0.294	0.453	0.0172	0.043	0.0003	0.0000	0.0000	0.021	0.0000	0.0000
1975	0.176	0.277	0.455	0.0264	0.044	0.0005	0.0000	0.0000	0.021	0.0000	0.0000
1976	0.179	0.268	0.463	0.0278	0.039	0.0005	0.0000	0.0000	0.023	0.0000	0.0000
1977	0.179	0.256	0.477	0.0347	0.030	0.0005	0.0000	0.0000	0.024	0.0000	0.0000
1978	0.173	0.251	0.476	0.0379	0.037	0.0004	0.0000	0.0000	0.026	0.0000	0.0000
1979	0.186	0.256	0.460	0.0344	0.036	0.0005	0.0000	0.0000	0.027	0.0000	0.0000
1980	0.198	0.259	0.438	0.0351	0.037	0.0007	0.0000	0.0000	0.032	0.0000	0.0000
1981	0.209	0.260	0.420	0.0396	0.036	0.0008	0.0000	0.0000	0.034	0.0002	0.0000
1982	0.210	0.251	0.414	0.0429	0.045	0.0007	0.0000	0.0000	0.036	0.0005	0.0000
1983	0.218	0.236	0.412	0.0440	0.048	0.0009	0.0000	0.0000	0.039	0.0009	0.0000
1984	0.223	0.240	0.406	0.0464	0.044	0.0011	0.0000	0.0000	0.038	0.0010	0.0000
1985	0.229	0.232	0.405	0.0534	0.039	0.0013	0.0000	0.0000	0.038	0.0012	0.0000
1986	0.226	0.217	0.421	0.0572	0.040	0.0014	0.0000	0.0000	0.037	0.0014	0.0000
1987	0.228	0.224	0.417	0.0603	0.033	0.0014	0.0000	0.0000	0.035	0.0016	0.0000
1988	0.228	0.223	0.415	0.0677	0.028	0.0013	0.0000	0.0000	0.035	0.0015	0.0000
1989	0.225	0.231	0.404	0.0661	0.033	0.0019	0.0006	0.0003	0.036	0.0015	0.0000
1990	0.227	0.232	0.397	0.0723	0.036	0.0020	0.0007	0.0003	0.031	0.0013	0.0000
1991	0.225	0.237	0.389	0.0761	0.036	0.0021	0.0007	0.0004	0.031	0.0015	0.0000
1992	0.223	0.242	0.391	0.0756	0.031	0.0021	0.0007	0.0003	0.033	0.0017	0.0000
1993	0.227	0.243	0.387	0.0734	0.033	0.0021	0.0008	0.0004	0.031	0.0019	0.0000
1994	0.224	0.244	0.389	0.0753	0.030	0.0020	0.0008	0.0004	0.032	0.0021	0.0000
1995	0.221	0.250	0.379	0.0779	0.035	0.0017	0.0008	0.0004	0.032	0.0022	0.0000
1996	0.224	0.246	0.380	0.0755	0.038	0.0017	0.0007	0.0004	0.032	0.0015	0.0000
1997	0.227	0.246	0.383	0.0699	0.039	0.0018	0.0007	0.0004	0.031	0.0019	0.0000
1998	0.228	0.241	0.388	0.0745	0.035	0.0018	0.0007	0.0003	0.029	0.0021	0.0000
1999	0.224	0.237	0.392	0.0789	0.034	0.0018	0.0007	0.0005	0.029	0.0022	0.0000
2000	0.229	0.242	0.388	0.0797	0.029	0.0017	0.0007	0.0006	0.028	0.0024	0.0000
2001	0.228	0.237	0.398	0.0836	0.023	0.0017	0.0007	0.0007	0.025	0.0026	0.0000
2002	0.225	0.241	0.392	0.0835	0.028	0.0018	0.0006	0.0011	0.025	0.0031	0.0000
2003	0.228	0.233	0.396	0.0813	0.029	0.0018	0.0006	0.0012	0.025	0.0041	0.0000
2004	0.225	0.229	0.403	0.0822	0.027	0.0018	0.0006	0.0014	0.025	0.0050	0.0000
2005	0.228	0.225	0.403	0.0815	0.027	0.0018	0.0006	0.0018	0.025	0.0056	0.0001
2006	0.226	0.223	0.402	0.0826	0.029	0.0018	0.0007	0.0027	0.025	0.0074	0.0003
2007	0.225	0.234	0.393	0.0835	0.024	0.0018	0.0007	0.0034	0.025	0.0093	0.0005
2008	0.226	0.240	0.376	0.0850	0.025	0.0019	0.0009	0.0055	0.025	0.0134	0.0004
2009	0.209	0.247	0.375	0.0885	0.028	0.0021	0.0010	0.0076	0.025	0.0162	0.0004

Appendix B: X_{jt}^{1}

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol	Biodiesel
1949	0.999	1.000	0.888	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1950	0.999	1.000	0.868	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1951	0.999	1.000	0.880	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1952	0.999	0.999	0.869	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1953	0.999	0.999	0.864	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1954	0.999	0.999	0.864	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1955	0.999	0.999	0.852	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1956	0.999	0.999	0.836	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1957	0.999	0.996	0.821	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1958	0.999	0.987	0.814	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1959	0.999	0.988	0.813	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1960	0.999	0.987	0.815	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1961	1.000	0.982	0.808	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1962	0.999	0.970	0.800	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1963	0.999	0.971	0.802	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1964	0.999	0.970	0.795	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1965	1.000	0.970	0.786	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1966	1.000	0.971	0.787	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1967	1.000	0.968	0.798	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1968	1.000	0.965	0.788	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1969	1.000	0.964	0.776	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1970	1.000	0.961	0.767	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1971	1.000	0.957	0.742	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1972	1.000	0.954	0.710	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1973	1.000	0.953	0.639	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1974	0.996	0.955	0.633	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1975	0.998	0.951	0.629	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1976	0.998	0.952	0.581	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1977	0.997	0.948	0.522	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1978	0.995	0.951	0.556	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1979	0.997	0.938	0.543	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1980	0.998	0.950	0.595	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1981	0.999	0.953	0.627	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1982	0.999	0.948	0.666	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1983	0.998	0.945	0.668	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1984	0.998	0.953	0.654	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1985	0.998	0.945	0.678	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1986	0.997	0.954	0.618	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1987	0.998	0.942	0.599	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1988	0.998	0.928	0.572	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1989	0.997	0.928	0.535	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1990	0.997	0.920	0.528	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1991	0.996	0.909	0.544	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1992	0.996	0.894	0.537	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1993	0.991	0.887	0.500	1.000	1.000	1.000	1.000	1.000	1.000	0.991	0.000
1994	0.991	0.877	0.492	1.000	1.000	1.000	1.000	1.000	1.000	0.991	0.000
1995	0.990	0.872	0.502	1.000	1.000	1.000	1.000	1.000	1.000	0.988	0.000
1996	0.992	0.870	0.482	1.000	1.000	1.000	1.000	1.000	1.000	0.987	0.000
1997	0.993	0.868	0.454	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
1998	0.992	0.858	0.434	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.000
1999	0.991	0.840	0.444	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
2000	0.988	0.838	0.418	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
2001	0.981	0.821	0.396	1.000	1.000	1.000	1.000	1.000	1.000	0.992	0.679
2002	0.984	0.825	0.417	1.000	1.000	1.000	1.000	1.000	1.000	0.994	0.504
2003	0.977	0.823	0.388	1.000	1.000	1.000	1.000	1.000	1.000	0.996	0.708
2004	0.975	0.810	0.366	1.000	1.000	1.000	1.000	1.000	1.000	0.958	0.848
2005	0.973	0.803	0.341	1.000	1.000	1.000	1.000	1.000	1.000	0.967	0.904
2006	0.967	0.807	0.340	1.000	1.000	1.000	1.000	1.000	1.000	0.867	0.828
2007	0.968	0.801	0.350	1.000	1.000	1.000	1.000	1.000	1.000	0.936	0.608
2008	0.969	0.829	0.339	1.000	1.000	1.000	1.000	1.000	1.000	0.945	0.002
2009	0.977	0.836	0.378	1.000	1.000	1.000	1.000	1.000	1.000	0.982	0.755

Appendix C: X^2_{jt}

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol	Biodiesel
1949	1.000	1.000	0.945	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1950	1.000	1.000	0.916	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1951	1.000	1.000	0.940	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1952	1.000	1.000	0.928	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1953	1.000	1.000	0.917	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1954	1.000	1.000	0.910	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1955	1.000	1.000	0.896	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1956	1.000	1.000	0.885	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1957	1.000	1.000	0.886	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1958	1.000	0.991	0.844	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1959	1.000	0.990	0.835	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1960	1.000	0.988	0.835	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1961	1.000	0.983	0.825	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1962	1.000	0.971	0.816	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1963	1.000	0.972	0.822	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1964	1.000	0.971	0.813	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1965	1.000	0.972	0.802	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1966	1.000	0.972	0.803	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1967	1.000	0.972	0.822	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1968	1.000	0.970	0.805	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1969	1.000	0.966	0.793	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1970	1.000	0.964	0.785	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1971	1.000	0.961	0.757	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1972	1.000	0.957	0.724	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1973	1.000	0.957	0.652	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1974	1.000	0.958	0.646	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1975	1.000	0.955	0.642	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1976	1.000	0.955	0.594	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1977	1.000	0.951	0.535	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1978	1.000	0.953	0.575	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1979	1.000	0.941	0.569	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1980	1.000	0.953	0.627	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
1981	1.000	0.956	0.664	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1982	1.000	0.951	0.719	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1983	1.000	0.949	0.717	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1984	1.000	0.956	0.700	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1985	1.000	0.948	0.727	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1986	1.000	0.958	0.666	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1987	1.000	0.945	0.645	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1988	1.000	0.932	0.619	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1989	1.000	0.933	0.584	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1990	1.000	0.925	0.578	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1991	1.000	0.916	0.604	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1992	1.000	0.905	0.593	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1993	1.000	0.894	0.558	1.000	1.000	1.000	1.000	1.000	1.000	0.991	0.000
1994	1.000	0.884	0.545	1.000	1.000	1.000	1.000	1.000	1.000	0.991	0.000
1995	1.000	0.879	0.555	1.000	1.000	1.000	1.000	1.000	1.000	0.988	0.000
1996	1.000	0.877	0.536	1.000	1.000	1.000	1.000	1.000	1.000	0.987	0.000
1997	1.000	0.875	0.508	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
1998	1.000	0.865	0.484	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.000
1999	1.000	0.847	0.492	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
2000	1.000	0.848	0.471	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.000
2001	1.000	0.838	0.445	1.000	1.000	1.000	1.000	1.000	1.000	0.992	0.840
2002	1.000	0.848	0.466	1.000	1.000	1.000	1.000	1.000	1.000	0.994	0.649
2003	1.000	0.853	0.439	1.000	1.000	1.000	1.000	1.000	1.000	0.996	1.000
2004	1.000	0.848	0.417	1.000	1.000	1.000	1.000	1.000	1.000	0.958	1.000
2005	1.000	0.836	0.397	1.000	1.000	1.000	1.000	1.000	1.000	0.967	1.000
2006	1.000	0.840	0.403	1.000	1.000	1.000	1.000	1.000	1.000	0.867	0.961
2007	1.000	0.836	0.419	1.000	1.000	1.000	1.000	1.000	1.000	0.936	1.000
2008	1.000	0.870	0.432	1.000	1.000	1.000	1.000	1.000	1.000	0.945	1.000
2009	1.000	0.883	0.486	1.000	1.000	1.000	1.000	1.000	1.000	0.982	1.000

Appendix D: Comparison of Indexes 1 and 2

Year	I_t^1	I_t^2
1949	95.81	97.95
1950	94.91	96.75
1951	95.28	97.65
1952	94.63	97.09
1953	94.34	96.56
1954	94.10	96.12
1955	93.62	95.53
1956	92.92	95.07
1957	92.22	95.10
1958	91.35	92.81
1959	91.35	92.40
1960	91.44	92.40
1961	91.00	91.81
1962	90.31	91.07
1963	90.51	91.40
1964	90.28	91.12
1965	89.90	90.66
1966	90.01	90.77
1967	90.34	91.54
1968	89.75	90.66
1969	89.19	89.98
1970	88.64	89.51
1971	87.23	88.00
1972	85.43	86.16
1973	81.95	82.68
1974	81.98	82.75
1975	81.73	82.45
1976	79.27	79.99
1977	75.85	76.60
1978	77.56	78.63
1979	77.35	78.65
1980	80.92	82.42
1981	83.07	84.74
1982	84.83	87.13
1983	84.99	87.11
1984	84.80	86.77
1985	85.60	87.75
1986	82.85	85.03
1987	81.97	84.00
1988	80.59	82.69
1989	79.47	81.67
1990	79.33	81.51
1991	80.00	82.57
1992	79.23	81.76
1993	77.72	80.33
1994	77.03	79.49
1995	77.69	80.11
1996	76.95	79.33
1997	75.70	78.10
1998	74.43	76.73
1999	74.20	76.46
2000	73.26	75.82
2001	71.32	74.11
2002	72.57	75.42
2003	71.08	74.35
2004	69.53	73.00
2005	68.35	71.97
2006	68.33	72.38
2007	68.99	73.29
2008	70.23	75.43
2009	72.09	77.78

Appendix E: IDM_{jt}, IDM_{jt}^{pol}, and IDM_{jt}^{opec}

Year	Natural Gas IDM_{jt}	Natural Gas IDM_{jt}^{pol}	Petroleum IDM_{jt}	Petroleum IDM_{jt}^{opec}	Petroleum IDM_{jt}^{pol}
1993	1.144		2.233	6.834	
1994	1.400		2.216	6.539	
1995	1.577		2.367	6.570	
1996	1.569	0.196	2.569	6.743	1.564
1997	1.564	0.260	2.809	7.114	1.674
1998	1.834	0.380	2.755	7.766	1.611
1999	2.209	0.368	2.450	7.407	1.401
2000	2.216	0.278	2.743	8.083	1.438
2001	2.569	0.329	2.992	9.123	1.652
2002	2.447	0.320	2.797	6.897	1.410
2003	2.050	0.282	3.123	8.176	1.641
2004	2.104	0.502	3.144	9.088	1.970
2005	2.349	0.635	3.108	8.749	1.896
2006	2.281	0.368	3.226	8.816	1.827
2007	2.085	0.352	3.152	10.453	1.753
2008	1.710	0.302	3.185	10.833	1.711
2009	1.283	0.166	2.812	8.033	1.286

Appendix F: Comparison of Indexes 1, 2, 3, and 4

Year	I_t^1	I_t^2	I_t^3	$I_t^{3,OPEC}$	I_t^4
1993	77.72	80.33	79.60	78.61	
1994	77.03	79.49	78.72	77.80	
1995	77.69	80.11	79.27	78.38	
1996	76.95	79.33	78.47	77.62	78.97
1997	75.70	78.10	77.22	76.38	77.72
1998	74.43	76.73	75.83	74.89	76.35
1999	74.20	76.46	75.54	74.59	76.12
2000	73.26	75.82	74.87	73.89	75.50
2001	71.32	74.11	73.07	71.98	73.75
2002	72.57	75.42	74.40	73.66	75.09
2003	71.08	74.35	73.39	72.51	74.00
2004	69.53	73.00	72.06	71.06	72.57
2005	68.35	71.97	71.03	70.13	71.55
2006	68.33	72.38	71.42	70.52	72.01
2007	68.99	73.29	72.36	71.16	72.93
2008	70.23	75.43	74.56	73.32	75.09
2009	72.09	77.78	76.99	76.04	77.51

Appendix G: MSN codes in SEDS and w_{jt}, $consumption_{j.k.t}$, and $production_{j,k,t}$ Calculations for Regions

MSN Code[28]	Description
CLPRB	Coal production, billion Btu
CLTCB	Consumption of coal, billion Btu
EMTCB	Fuel ethanol consumption, excluding denaturant, billion Btu
GETCB	Geothermal energy consumption, billion Btu
HYTCB	Hydroelectricity consumption, billion Btu
LGTCB	LPG Consumption, billion Btu
NGMPB	Natural gas marketed production, billion Btu
NNTCB	Natural gas consumption, excluding supplemental gaseous fuels, billion Btu
NUETB	Nuclear electricity production, billion Btu
PAPRB	Crude oil production, including lease condensate, billion Btu
PATCB	Petroleum products consumption, billion Btu
REPRB	Renewable energy production, billion Btu
ROPRB	Renewable energy production, not including fuel ethanol, billion Btu
SOTCB	Photovoltaic and solar thermal consumption, billion Btu
WWTCB	Wood and waste consumption, billion Btu
WYTCB	Wind energy consumption, billion Btu

Descriptions:

Calculated Variables	Description
$TECB_{k,t}$	Calculated total energy consumption for state k in period t
$w_{j,k,t}$	Equals the weight of energy source j in the index based on the share of total primary energy consumption in the region k in year t coming from primary energy source j, value ranges from 0 to 1
$consumption_{j.k.t}$	Equals the consumption of energy source j in the region k in year t coming from primary energy source j, given in billion Btu
$production_{j,k,t}$	Equals the production of energy source j in the region k in year t coming from primary energy source j, given in billion Btu

Calculations[29]:

$$TECB_{k,t} = CLTCB_{k,t} + PATCB_{k,t} + NNTCB_{k,t} + NUETB_{k,t} + HYTCB_{k,t} + WWTCB_{k,t} + GETCB_{k,t} + SOTCB_{k,t} + WYTCB_{k,t}$$

	$j = coal$	$j = natural\ gas$	$j = petroleum$
$w_{j,k,t}$	$CLTCB_{k,t} / TECB_{k,t}$	$NNTCB_{k,t} / TECB_{k,t}$	$(PATCB_{k,t} - EMTCB_{k,t}) / TECB_{k,t}$
$consumption_{j.k.t}$	$CLTCB_{k,t}$	$NNTCB_{k,t} + LGTCB_{k,t}$	$PATCB_{k,t} - EMTCB_{k,t} - LGTCB_{k,t}$
$production_{j,k,t}$	$CLPRB_{k,t}$	$NGMPB_{k,t}$	$PAPRB_{k,t}$

[28] Energy Information Administration, State Energy Data System, http://www.eia.gov/state/seds

[29] Assume that each variable is the sum of the values of all states in region k

	$j = nuclear$	$j = hydro$	$j = geo$	$j = solar$
$w_{j,k,t}$	$NUETB_{k,t} / TECB_{k,t}$	$HYTCB_{k,t} / TECB_{k,t}$	$GETCB_{k,t} / TECB_{k,t}$	$SOTCB_{k,t} / TECB_{k,t}$
$consumption_{j.k.t}$	$NUETB_{k,t}$	$HYTCB_{k,t}$	$GETCB_{k,t}$	$SOTCB_{k,t}$
$production_{j,k,t}$	$NUETB_{k,t}$	$HYTCB_{k,t}$	$GETCB_{k,t}$	$SOTCB_{k,t}$

	$j = wind$	$j = wood\,waste$	$j = fuel\,ethanol$
$w_{j,k,t}$	$WYTCB_{k,t} / TECB_{k,t}$	$WWTCB_{k,t} / TECB_{k,t}$	$EMTCB_{k,t} / TECB_{k,t}$
$consumption_{j.k.t}$	$WYTCB_{k,t}$	$WWTCB_{k,t}$	$EMTCB_{k,t}$
$production_{j,k,t}$	$WYTCB_{k,t}$	$WWTCB_{k,t}$	$REPRB_{k,t} - ROPRB_{k,t}$

Appendix H1: Weights – Census Region 1: Northeast

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.273	0.128	0.553	0.0003	0.023	0.0000	0.0000	0.0000	0.024	0.0000
1961	0.257	0.131	0.560	0.0014	0.027	0.0000	0.0000	0.0000	0.023	0.0000
1962	0.251	0.135	0.561	0.0012	0.029	0.0000	0.0000	0.0000	0.023	0.0000
1963	0.252	0.141	0.555	0.0021	0.026	0.0000	0.0000	0.0000	0.023	0.0000
1964	0.269	0.141	0.542	0.0017	0.024	0.0000	0.0000	0.0000	0.022	0.0000
1965	0.265	0.141	0.548	0.0021	0.023	0.0000	0.0000	0.0000	0.021	0.0000
1966	0.251	0.149	0.552	0.0023	0.025	0.0000	0.0000	0.0000	0.021	0.0000
1967	0.234	0.145	0.572	0.0034	0.026	0.0000	0.0000	0.0000	0.020	0.0000
1968	0.222	0.149	0.577	0.0051	0.026	0.0000	0.0000	0.0000	0.021	0.0000
1969	0.199	0.157	0.591	0.0056	0.027	0.0000	0.0000	0.0000	0.021	0.0000
1970	0.187	0.156	0.602	0.0106	0.025	0.0000	0.0000	0.0000	0.020	0.0000
1971	0.165	0.160	0.614	0.0161	0.024	0.0000	0.0000	0.0000	0.020	0.0000
1972	0.151	0.156	0.631	0.0160	0.026	0.0000	0.0000	0.0000	0.019	0.0000
1973	0.160	0.147	0.626	0.0197	0.027	0.0000	0.0000	0.0000	0.019	0.0000
1974	0.164	0.144	0.611	0.0309	0.028	0.0000	0.0000	0.0000	0.021	0.0000
1975	0.164	0.139	0.601	0.0453	0.029	0.0000	0.0000	0.0000	0.022	0.0000
1976	0.157	0.141	0.601	0.0495	0.028	0.0000	0.0000	0.0000	0.023	0.0000
1977	0.149	0.131	0.614	0.0563	0.025	0.0000	0.0000	0.0000	0.025	0.0000
1978	0.144	0.130	0.609	0.0646	0.024	0.0000	0.0000	0.0000	0.028	0.0000
1979	0.165	0.147	0.572	0.0584	0.026	0.0000	0.0000	0.0000	0.032	0.0000
1980	0.164	0.171	0.543	0.0528	0.026	0.0000	0.0000	0.0000	0.044	0.0000
1981	0.159	0.184	0.518	0.0627	0.028	0.0000	0.0000	0.0000	0.049	0.0000
1982	0.153	0.187	0.515	0.0678	0.029	0.0000	0.0000	0.0000	0.047	0.0000
1983	0.161	0.186	0.504	0.0610	0.031	0.0000	0.0000	0.0000	0.057	0.0000
1984	0.167	0.189	0.502	0.0651	0.029	0.0000	0.0000	0.0000	0.047	0.0000
1985	0.165	0.179	0.496	0.0839	0.029	0.0000	0.0000	0.0000	0.048	0.0000
1986	0.147	0.166	0.524	0.0911	0.031	0.0000	0.0000	0.0000	0.040	0.0000
1987	0.153	0.178	0.515	0.0903	0.028	0.0000	0.0000	0.0000	0.036	0.0000
1988	0.158	0.174	0.512	0.0960	0.023	0.0000	0.0000	0.0000	0.037	0.0000
1989	0.160	0.185	0.499	0.0937	0.026	0.0000	0.0001	0.0000	0.037	0.0000
1990	0.160	0.188	0.474	0.1149	0.032	0.0000	0.0001	0.0000	0.031	0.0000
1991	0.158	0.199	0.462	0.1170	0.030	0.0000	0.0001	0.0000	0.034	0.0000
1992	0.157	0.224	0.441	0.1129	0.029	0.0000	0.0001	0.0000	0.036	0.0000
1993	0.154	0.222	0.436	0.1215	0.030	0.0000	0.0001	0.0000	0.037	0.0001
1994	0.147	0.234	0.431	0.1222	0.029	0.0000	0.0001	0.0000	0.037	0.0002
1995	0.151	0.253	0.418	0.1121	0.026	0.0001	0.0001	0.0000	0.039	0.0007
1996	0.154	0.245	0.419	0.1097	0.031	0.0001	0.0002	0.0000	0.040	0.0005
1997	0.158	0.252	0.422	0.0954	0.030	0.0001	0.0002	0.0000	0.041	0.0006
1998	0.151	0.240	0.434	0.1069	0.029	0.0001	0.0002	0.0000	0.039	0.0003
1999	0.141	0.243	0.428	0.1234	0.025	0.0001	0.0002	0.0000	0.039	0.0002
2000	0.150	0.231	0.433	0.1218	0.025	0.0001	0.0002	0.0000	0.040	0.0002
2001	0.144	0.229	0.440	0.1331	0.022	0.0001	0.0002	0.0000	0.031	0.0002
2002	0.146	0.239	0.426	0.1343	0.024	0.0001	0.0002	0.0001	0.029	0.0001
2003	0.144	0.230	0.441	0.1311	0.025	0.0001	0.0002	0.0001	0.028	0.0003
2004	0.142	0.224	0.447	0.1302	0.024	0.0001	0.0002	0.0003	0.029	0.0032
2005	0.143	0.221	0.448	0.1320	0.025	0.0002	0.0003	0.0003	0.028	0.0024
2006	0.149	0.224	0.423	0.1400	0.028	0.0002	0.0003	0.0007	0.028	0.0065
2007	0.145	0.242	0.414	0.1381	0.024	0.0002	0.0004	0.0010	0.028	0.0080
2008	0.139	0.246	0.403	0.1419	0.027	0.0002	0.0005	0.0015	0.031	0.0095
2009	0.120	0.262	0.394	0.1507	0.029	0.0003	0.0006	0.0027	0.029	0.0120

Appendix H2: Weights – Census Region 2: Midwest

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.335	0.240	0.398	0.0002	0.008	0.0000	0.0000	0.0000	0.018	0.0000
1961	0.323	0.255	0.395	0.0005	0.008	0.0000	0.0000	0.0000	0.018	0.0000
1962	0.321	0.262	0.390	0.0010	0.008	0.0000	0.0000	0.0000	0.017	0.0000
1963	0.321	0.263	0.390	0.0009	0.008	0.0000	0.0000	0.0000	0.017	0.0000
1964	0.320	0.274	0.381	0.0011	0.008	0.0000	0.0000	0.0000	0.016	0.0000
1965	0.320	0.279	0.376	0.0010	0.010	0.0000	0.0000	0.0000	0.015	0.0000
1966	0.322	0.286	0.367	0.0013	0.009	0.0000	0.0000	0.0000	0.015	0.0000
1967	0.308	0.298	0.368	0.0010	0.010	0.0000	0.0000	0.0000	0.014	0.0000
1968	0.302	0.298	0.375	0.0009	0.010	0.0000	0.0000	0.0000	0.014	0.0000
1969	0.298	0.309	0.368	0.0007	0.011	0.0000	0.0000	0.0000	0.013	0.0000
1970	0.287	0.318	0.370	0.0018	0.010	0.0000	0.0000	0.0000	0.013	0.0000
1971	0.271	0.326	0.374	0.0055	0.011	0.0000	0.0000	0.0000	0.013	0.0000
1972	0.271	0.313	0.382	0.0119	0.010	0.0000	0.0000	0.0000	0.013	0.0000
1973	0.271	0.302	0.388	0.0175	0.008	0.0000	0.0000	0.0000	0.013	0.0000
1974	0.268	0.306	0.383	0.0210	0.009	0.0000	0.0000	0.0000	0.013	0.0000
1975	0.276	0.285	0.384	0.0319	0.010	0.0000	0.0000	0.0000	0.013	0.0000
1976	0.276	0.273	0.393	0.0348	0.008	0.0000	0.0000	0.0000	0.015	0.0000
1977	0.283	0.253	0.404	0.0372	0.007	0.0000	0.0000	0.0000	0.016	0.0000
1978	0.272	0.253	0.406	0.0414	0.009	0.0000	0.0000	0.0000	0.019	0.0000
1979	0.285	0.261	0.385	0.0401	0.008	0.0000	0.0000	0.0000	0.020	0.0000
1980	0.302	0.257	0.360	0.0400	0.008	0.0000	0.0000	0.0000	0.032	0.0000
1981	0.316	0.254	0.342	0.0450	0.008	0.0000	0.0000	0.0000	0.035	0.0002
1982	0.310	0.254	0.343	0.0463	0.010	0.0000	0.0000	0.0000	0.036	0.0006
1983	0.323	0.237	0.342	0.0467	0.010	0.0000	0.0000	0.0000	0.040	0.0012
1984	0.329	0.241	0.335	0.0464	0.009	0.0000	0.0000	0.0000	0.038	0.0013
1985	0.329	0.232	0.335	0.0530	0.010	0.0000	0.0000	0.0000	0.039	0.0015
1986	0.330	0.219	0.345	0.0571	0.010	0.0000	0.0000	0.0000	0.037	0.0018
1987	0.330	0.212	0.347	0.0640	0.008	0.0000	0.0000	0.0000	0.037	0.0020
1988	0.323	0.223	0.333	0.0743	0.007	0.0000	0.0000	0.0000	0.037	0.0019
1989	0.322	0.227	0.330	0.0819	0.007	0.0001	0.0001	0.0000	0.030	0.0022
1990	0.331	0.226	0.330	0.0800	0.008	0.0001	0.0001	0.0000	0.024	0.0020
1991	0.327	0.234	0.321	0.0843	0.007	0.0001	0.0001	0.0000	0.024	0.0024
1992	0.317	0.238	0.329	0.0811	0.008	0.0001	0.0001	0.0000	0.024	0.0028
1993	0.318	0.241	0.328	0.0828	0.007	0.0001	0.0001	0.0000	0.020	0.0032
1994	0.322	0.240	0.331	0.0738	0.008	0.0002	0.0001	0.0000	0.021	0.0037
1995	0.318	0.243	0.324	0.0828	0.009	0.0002	0.0001	0.0000	0.021	0.0034
1996	0.320	0.244	0.326	0.0750	0.010	0.0002	0.0001	0.0000	0.023	0.0021
1997	0.329	0.240	0.335	0.0623	0.010	0.0002	0.0001	0.0000	0.021	0.0030
1998	0.341	0.221	0.342	0.0644	0.008	0.0002	0.0001	0.0001	0.020	0.0034
1999	0.326	0.220	0.346	0.0760	0.009	0.0002	0.0001	0.0004	0.020	0.0037
2000	0.334	0.224	0.331	0.0801	0.007	0.0002	0.0001	0.0005	0.019	0.0042
2001	0.338	0.214	0.333	0.0860	0.006	0.0003	0.0001	0.0007	0.018	0.0044
2002	0.333	0.223	0.330	0.0855	0.007	0.0003	0.0001	0.0010	0.016	0.0050
2003	0.339	0.218	0.330	0.0829	0.006	0.0004	0.0001	0.0011	0.017	0.0056
2004	0.338	0.209	0.337	0.0864	0.006	0.0004	0.0001	0.0012	0.017	0.0054
2005	0.340	0.210	0.334	0.0842	0.005	0.0004	0.0001	0.0018	0.019	0.0055
2006	0.343	0.200	0.336	0.0891	0.005	0.0005	0.0001	0.0028	0.017	0.0057
2007	0.338	0.211	0.328	0.0895	0.005	0.0006	0.0001	0.0034	0.018	0.0069
2008	0.340	0.219	0.313	0.0886	0.005	0.0007	0.0001	0.0065	0.018	0.0092
2009	0.331	0.218	0.314	0.0890	0.006	0.0009	0.0002	0.0110	0.019	0.0101

Appendix H3: Weights – Census Region 3: South

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.163	0.383	0.389	0.0000	0.025	0.0000	0.0000	0.0000	0.040	0.0000
1961	0.163	0.386	0.388	0.0000	0.025	0.0000	0.0000	0.0000	0.038	0.0000
1962	0.162	0.386	0.392	0.0000	0.024	0.0000	0.0000	0.0000	0.036	0.0000
1963	0.170	0.386	0.391	0.0000	0.019	0.0000	0.0000	0.0000	0.035	0.0000
1964	0.168	0.385	0.391	0.0000	0.023	0.0000	0.0000	0.0000	0.033	0.0000
1965	0.175	0.379	0.394	0.0000	0.021	0.0000	0.0000	0.0000	0.032	0.0000
1966	0.178	0.380	0.392	0.0000	0.018	0.0000	0.0000	0.0000	0.031	0.0000
1967	0.173	0.392	0.385	0.0000	0.021	0.0000	0.0000	0.0000	0.029	0.0000
1968	0.175	0.393	0.386	0.0000	0.018	0.0000	0.0000	0.0000	0.029	0.0000
1969	0.167	0.399	0.389	0.0000	0.017	0.0000	0.0000	0.0000	0.027	0.0000
1970	0.159	0.405	0.395	0.0000	0.016	0.0000	0.0000	0.0000	0.026	0.0000
1971	0.149	0.405	0.402	0.0010	0.018	0.0000	0.0000	0.0000	0.025	0.0000
1972	0.150	0.385	0.419	0.0022	0.018	0.0000	0.0000	0.0000	0.025	0.0000
1973	0.154	0.369	0.426	0.0069	0.021	0.0000	0.0000	0.0000	0.024	0.0000
1974	0.152	0.363	0.428	0.0126	0.020	0.0000	0.0000	0.0000	0.024	0.0000
1975	0.156	0.340	0.436	0.0219	0.022	0.0000	0.0000	0.0000	0.025	0.0000
1976	0.162	0.330	0.445	0.0214	0.016	0.0000	0.0000	0.0000	0.026	0.0000
1977	0.155	0.319	0.453	0.0316	0.015	0.0000	0.0000	0.0000	0.026	0.0000
1978	0.153	0.316	0.454	0.0356	0.014	0.0000	0.0000	0.0000	0.028	0.0000
1979	0.166	0.305	0.452	0.0301	0.018	0.0000	0.0000	0.0000	0.028	0.0000
1980	0.185	0.305	0.433	0.0356	0.014	0.0000	0.0000	0.0000	0.028	0.0000
1981	0.200	0.302	0.419	0.0399	0.009	0.0000	0.0000	0.0000	0.029	0.0000
1982	0.205	0.284	0.415	0.0455	0.016	0.0000	0.0000	0.0000	0.034	0.0001
1983	0.218	0.265	0.414	0.0506	0.017	0.0000	0.0000	0.0000	0.033	0.0003
1984	0.222	0.271	0.402	0.0521	0.016	0.0000	0.0000	0.0000	0.035	0.0004
1985	0.238	0.256	0.403	0.0541	0.013	0.0000	0.0000	0.0000	0.036	0.0006
1986	0.238	0.247	0.414	0.0524	0.010	0.0000	0.0000	0.0000	0.037	0.0007
1987	0.237	0.250	0.409	0.0562	0.013	0.0000	0.0000	0.0000	0.034	0.0008
1988	0.236	0.248	0.412	0.0621	0.008	0.0000	0.0000	0.0000	0.034	0.0006
1989	0.230	0.254	0.398	0.0606	0.016	0.0001	0.0008	0.0000	0.040	0.0005
1990	0.230	0.255	0.396	0.0656	0.016	0.0001	0.0008	0.0000	0.036	0.0004
1991	0.228	0.252	0.394	0.0727	0.015	0.0001	0.0009	0.0000	0.036	0.0004
1992	0.227	0.249	0.398	0.0722	0.015	0.0001	0.0009	0.0000	0.038	0.0004
1993	0.236	0.250	0.395	0.0655	0.014	0.0001	0.0009	0.0000	0.038	0.0002
1994	0.227	0.247	0.397	0.0746	0.015	0.0001	0.0009	0.0000	0.039	0.0003
1995	0.227	0.256	0.384	0.0795	0.013	0.0001	0.0009	0.0000	0.039	0.0002
1996	0.231	0.252	0.386	0.0785	0.014	0.0001	0.0009	0.0000	0.038	0.0002
1997	0.232	0.250	0.390	0.0781	0.013	0.0001	0.0008	0.0000	0.036	0.0003
1998	0.229	0.245	0.395	0.0834	0.013	0.0001	0.0008	0.0000	0.034	0.0003
1999	0.232	0.239	0.403	0.0826	0.009	0.0001	0.0008	0.0001	0.034	0.0003
2000	0.234	0.245	0.397	0.0818	0.008	0.0001	0.0008	0.0001	0.032	0.0003
2001	0.232	0.234	0.412	0.0843	0.009	0.0001	0.0008	0.0003	0.028	0.0004
2002	0.228	0.243	0.405	0.0831	0.010	0.0002	0.0007	0.0006	0.030	0.0006
2003	0.232	0.231	0.410	0.0812	0.014	0.0002	0.0007	0.0007	0.030	0.0007
2004	0.226	0.225	0.420	0.0835	0.012	0.0002	0.0007	0.0009	0.031	0.0007
2005	0.232	0.220	0.421	0.0819	0.011	0.0003	0.0007	0.0012	0.031	0.0012
2006	0.231	0.219	0.423	0.0820	0.008	0.0003	0.0007	0.0020	0.031	0.0026
2007	0.232	0.228	0.412	0.0831	0.007	0.0003	0.0008	0.0025	0.031	0.0035
2008	0.234	0.234	0.395	0.0859	0.008	0.0004	0.0009	0.0045	0.030	0.0069
2009	0.209	0.244	0.397	0.0915	0.013	0.0005	0.0010	0.0058	0.029	0.0089

Appendix H4: Weights – Census Region 4: West

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.039	0.311	0.486	0.0000	0.129	0.0001	0.0000	0.0000	0.035	0.0000
1961	0.042	0.321	0.482	0.0000	0.123	0.0001	0.0000	0.0000	0.033	0.0000
1962	0.037	0.327	0.471	0.0000	0.133	0.0001	0.0000	0.0000	0.032	0.0000
1963	0.039	0.331	0.463	0.0003	0.134	0.0002	0.0000	0.0000	0.032	0.0000
1964	0.041	0.342	0.455	0.0005	0.130	0.0003	0.0000	0.0000	0.032	0.0000
1965	0.044	0.331	0.449	0.0004	0.145	0.0002	0.0000	0.0000	0.030	0.0000
1966	0.042	0.339	0.451	0.0015	0.137	0.0002	0.0000	0.0000	0.029	0.0000
1967	0.040	0.336	0.444	0.0031	0.149	0.0003	0.0000	0.0000	0.028	0.0000
1968	0.039	0.338	0.450	0.0059	0.140	0.0004	0.0000	0.0000	0.027	0.0000
1969	0.038	0.332	0.440	0.0062	0.157	0.0006	0.0000	0.0000	0.026	0.0000
1970	0.044	0.336	0.434	0.0056	0.155	0.0005	0.0000	0.0000	0.026	0.0000
1971	0.044	0.330	0.438	0.0056	0.157	0.0005	0.0000	0.0000	0.025	0.0000
1972	0.050	0.328	0.442	0.0054	0.148	0.0012	0.0000	0.0000	0.025	0.0000
1973	0.060	0.304	0.468	0.0061	0.136	0.0016	0.0000	0.0000	0.024	0.0000
1974	0.065	0.281	0.454	0.0068	0.166	0.0021	0.0000	0.0000	0.024	0.0000
1975	0.073	0.273	0.460	0.0083	0.160	0.0027	0.0000	0.0000	0.024	0.0000
1976	0.083	0.259	0.470	0.0079	0.151	0.0029	0.0000	0.0000	0.026	0.0000
1977	0.098	0.246	0.505	0.0156	0.104	0.0028	0.0000	0.0000	0.028	0.0000
1978	0.089	0.222	0.501	0.0112	0.145	0.0023	0.0000	0.0000	0.029	0.0000
1979	0.101	0.240	0.486	0.0131	0.128	0.0028	0.0000	0.0000	0.029	0.0000
1980	0.107	0.239	0.469	0.0103	0.144	0.0038	0.0000	0.0000	0.027	0.0000
1981	0.124	0.239	0.446	0.0101	0.145	0.0044	0.0000	0.0000	0.031	0.0001
1982	0.128	0.234	0.422	0.0106	0.171	0.0038	0.0000	0.0000	0.030	0.0003
1983	0.121	0.215	0.428	0.0111	0.186	0.0048	0.0000	0.0000	0.034	0.0004
1984	0.128	0.217	0.430	0.0186	0.166	0.0057	0.0000	0.0000	0.035	0.0003
1985	0.135	0.227	0.427	0.0268	0.143	0.0069	0.0000	0.0000	0.035	0.0003
1986	0.127	0.194	0.444	0.0389	0.155	0.0076	0.0000	0.0000	0.034	0.0002
1987	0.137	0.224	0.441	0.0387	0.118	0.0077	0.0000	0.0000	0.033	0.0003
1988	0.146	0.215	0.445	0.0468	0.106	0.0070	0.0000	0.0000	0.034	0.0005
1989	0.143	0.228	0.432	0.0350	0.114	0.0099	0.0016	0.0014	0.034	0.0005
1990	0.144	0.230	0.421	0.0427	0.119	0.0102	0.0017	0.0018	0.029	0.0005
1991	0.144	0.244	0.406	0.0407	0.121	0.0107	0.0019	0.0019	0.028	0.0006
1992	0.153	0.250	0.412	0.0461	0.095	0.0107	0.0019	0.0018	0.029	0.0006
1993	0.151	0.250	0.405	0.0394	0.113	0.0110	0.0019	0.0019	0.027	0.0010
1994	0.155	0.257	0.412	0.0404	0.094	0.0101	0.0020	0.0021	0.026	0.0009
1995	0.139	0.244	0.409	0.0402	0.128	0.0086	0.0019	0.0019	0.025	0.0012
1996	0.136	0.240	0.406	0.0416	0.139	0.0089	0.0019	0.0019	0.024	0.0011
1997	0.138	0.248	0.396	0.0397	0.141	0.0090	0.0019	0.0018	0.023	0.0011
1998	0.144	0.263	0.395	0.0421	0.121	0.0088	0.0018	0.0016	0.021	0.0012
1999	0.140	0.255	0.402	0.0400	0.128	0.0088	0.0017	0.0019	0.021	0.0011
2000	0.146	0.260	0.409	0.0422	0.107	0.0083	0.0016	0.0021	0.022	0.0012
2001	0.147	0.282	0.417	0.0409	0.079	0.0084	0.0017	0.0023	0.021	0.0014
2002	0.140	0.263	0.420	0.0430	0.099	0.0087	0.0016	0.0029	0.020	0.0016
2003	0.144	0.261	0.419	0.0411	0.096	0.0086	0.0016	0.0032	0.020	0.0039
2004	0.144	0.271	0.419	0.0377	0.091	0.0085	0.0015	0.0038	0.020	0.0048
2005	0.143	0.263	0.423	0.0389	0.092	0.0083	0.0015	0.0041	0.020	0.0063
2006	0.130	0.262	0.425	0.0356	0.105	0.0081	0.0016	0.0054	0.020	0.0063
2007	0.132	0.275	0.424	0.0384	0.088	0.0080	0.0018	0.0070	0.019	0.0070
2008	0.135	0.285	0.406	0.0391	0.088	0.0082	0.0022	0.0096	0.019	0.0085
2009	0.130	0.288	0.402	0.0395	0.090	0.0085	0.0025	0.0114	0.020	0.0093

Appendix I1: $X^1_{j,k,t}$ – Census Region 1: Northeast

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.816	0.095	0.009	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1961	0.812	0.082	0.008	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1962	0.820	0.068	0.007	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1963	0.871	0.065	0.007	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1964	0.826	0.055	0.007	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1965	0.809	0.054	0.006	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1966	0.813	0.053	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1967	0.825	0.053	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1968	0.801	0.049	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1969	0.893	0.041	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1970	0.935	0.038	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1971	0.956	0.036	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1972	1.000	0.036	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1973	0.922	0.040	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1974	0.986	0.045	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1975	1.000	0.051	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1976	1.000	0.050	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1977	1.000	0.055	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1978	1.000	0.061	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1979	1.000	0.056	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1980	1.000	0.051	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1981	1.000	0.061	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1982	1.000	0.062	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1983	0.975	0.064	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1984	0.989	0.083	0.005	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1985	0.920	0.084	0.006	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1986	1.000	0.092	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1987	0.930	0.083	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1988	0.884	0.083	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1989	0.854	0.085	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1990	0.874	0.082	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1991	0.831	0.068	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1992	0.861	0.054	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1993	0.751	0.052	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1994	0.805	0.045	0.003	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1995	0.777	0.038	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1996	0.824	0.045	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1997	0.894	0.028	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1998	1.000	0.045	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1999	1.000	0.056	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2000	0.902	0.051	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2001	0.961	0.051	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2002	0.849	0.058	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2003	0.778	0.060	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2004	0.776	0.075	0.002	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2005	0.771	0.069	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2006	0.761	0.074	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.000
2007	0.751	0.069	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.005
2008	0.818	0.072	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.091
2009	0.904	0.092	0.004	1.000	1.000	1.000	1.000	1.000	1.000	0.044

Appendix I2: $X^{1}_{j,k,t}$ – Census Region 2: Midwest

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.519	0.236	0.312	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1961	0.523	0.229	0.319	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1962	0.534	0.228	0.313	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1963	0.548	0.233	0.293	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1964	0.548	0.226	0.287	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1965	0.550	0.216	0.264	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1966	0.564	0.213	0.247	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1967	0.606	0.203	0.231	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1968	0.585	0.188	0.208	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1969	0.593	0.179	0.187	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1970	0.641	0.175	0.169	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1971	0.621	0.169	0.153	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1972	0.639	0.170	0.135	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1973	0.563	0.172	0.119	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1974	0.552	0.175	0.119	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1975	0.560	0.185	0.122	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1976	0.546	0.185	0.121	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1977	0.530	0.195	0.120	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1978	0.485	0.209	0.115	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1979	0.525	0.193	0.128	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1980	0.535	0.208	0.157	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1981	0.491	0.202	0.183	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1982	0.565	0.170	0.204	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1983	0.526	0.187	0.212	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1984	0.574	0.195	0.211	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1985	0.538	0.209	0.209	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1986	0.551	0.205	0.183	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1987	0.528	0.212	0.162	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1988	0.495	0.209	0.151	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1989	0.503	0.210	0.141	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1990	0.511	0.212	0.139	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1991	0.481	0.222	0.140	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1992	0.499	0.220	0.129	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1993	0.403	0.217	0.115	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1994	0.443	0.224	0.106	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1995	0.386	0.217	0.101	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1996	0.383	0.204	0.097	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	0.379	0.216	0.096	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1998	0.367	0.219	0.086	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1999	0.349	0.197	0.072	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2000	0.297	0.188	0.079	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.334	0.189	0.077	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2002	0.318	0.174	0.077	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003	0.310	0.160	0.074	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2004	0.309	0.165	0.072	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2005	0.308	0.157	0.074	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2006	0.312	0.170	0.080	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2007	0.307	0.157	0.085	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2008	0.321	0.135	0.107	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2009	0.359	0.140	0.128	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix I3: $X^1_{j,k,t}$ – Census Region 3: South

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1961	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1962	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1963	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1964	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1965	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1966	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1967	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1968	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1969	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1970	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1971	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1972	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1973	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1974	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1975	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1976	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1977	1.000	1.000	0.917	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1978	1.000	1.000	0.842	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1979	1.000	1.000	0.783	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1980	1.000	1.000	0.806	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1981	1.000	1.000	0.827	1.000	1.000	1.000	1.000	1.000	1.000	0.058
1982	1.000	1.000	0.871	1.000	1.000	1.000	1.000	1.000	1.000	0.210
1983	1.000	1.000	0.863	1.000	1.000	1.000	1.000	1.000	1.000	0.496
1984	1.000	1.000	0.879	1.000	1.000	1.000	1.000	1.000	1.000	0.464
1985	1.000	1.000	0.868	1.000	1.000	1.000	1.000	1.000	1.000	0.341
1986	1.000	1.000	0.797	1.000	1.000	1.000	1.000	1.000	1.000	0.298
1987	1.000	1.000	0.732	1.000	1.000	1.000	1.000	1.000	1.000	0.285
1988	1.000	1.000	0.660	1.000	1.000	1.000	1.000	1.000	1.000	0.332
1989	1.000	1.000	0.620	1.000	1.000	1.000	1.000	1.000	1.000	0.397
1990	1.000	1.000	0.602	1.000	1.000	1.000	1.000	1.000	1.000	0.445
1991	1.000	1.000	0.622	1.000	1.000	1.000	1.000	1.000	1.000	0.540
1992	1.000	1.000	0.587	1.000	1.000	1.000	1.000	1.000	1.000	0.428
1993	1.000	1.000	0.553	1.000	1.000	1.000	1.000	1.000	1.000	0.698
1994	1.000	1.000	0.527	1.000	1.000	1.000	1.000	1.000	1.000	0.563
1995	1.000	1.000	0.526	1.000	1.000	1.000	1.000	1.000	1.000	0.612
1996	1.000	1.000	0.515	1.000	1.000	1.000	1.000	1.000	1.000	0.268
1997	1.000	1.000	0.517	1.000	1.000	1.000	1.000	1.000	1.000	0.410
1998	1.000	1.000	0.499	1.000	1.000	1.000	1.000	1.000	1.000	0.386
1999	1.000	1.000	0.480	1.000	1.000	1.000	1.000	1.000	1.000	0.423
2000	0.969	1.000	0.475	1.000	1.000	1.000	1.000	1.000	1.000	0.456
2001	1.000	1.000	0.467	1.000	1.000	1.000	1.000	1.000	1.000	0.415
2002	0.945	1.000	0.460	1.000	1.000	1.000	1.000	1.000	1.000	0.366
2003	0.885	1.000	0.448	1.000	1.000	1.000	1.000	1.000	1.000	0.367
2004	0.910	1.000	0.405	1.000	1.000	1.000	1.000	1.000	1.000	0.430
2005	0.913	1.000	0.376	1.000	1.000	1.000	1.000	1.000	1.000	0.249
2006	0.906	1.000	0.377	1.000	1.000	1.000	1.000	1.000	1.000	0.119
2007	0.861	1.000	0.382	1.000	1.000	1.000	1.000	1.000	1.000	0.095
2008	0.887	1.000	0.394	1.000	1.000	1.000	1.000	1.000	1.000	0.164
2009	0.921	1.000	0.482	1.000	1.000	1.000	1.000	1.000	1.000	0.207

Appendix I4: $X^{1}_{j,k,t}$ **– Census Region 4: West**

Year	Coal	Natural Gas	Petroleum	Nuclear	Hydro	Geothermal	Solar/ PV	Wind	Wood/ Waste	Fuel ethanol
1960	0.939	0.852	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1961	0.896	0.813	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1962	0.900	0.783	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1963	0.951	0.785	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1964	0.964	0.758	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1965	0.939	0.785	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1966	0.919	0.767	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1967	0.947	0.746	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1968	0.943	0.735	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1969	1.000	0.719	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1970	1.000	0.705	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1971	1.000	0.700	0.923	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1972	1.000	0.656	0.846	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1973	1.000	0.677	0.768	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1974	1.000	0.710	0.788	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1975	1.000	0.707	0.762	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1976	1.000	0.746	0.702	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1977	1.000	0.762	0.753	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1978	1.000	0.805	0.965	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1979	1.000	0.733	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1980	1.000	0.797	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000
1981	1.000	0.837	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.232
1982	1.000	0.832	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.283
1983	1.000	0.863	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.474
1984	1.000	0.890	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.667
1985	1.000	0.835	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1986	1.000	0.867	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1987	1.000	0.816	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1988	1.000	0.831	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.690
1989	1.000	0.805	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.592
1990	1.000	0.863	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.498
1991	1.000	0.869	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.482
1992	1.000	0.935	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.409
1993	1.000	0.935	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.262
1994	1.000	0.983	0.985	1.000	1.000	1.000	1.000	1.000	1.000	0.331
1995	1.000	1.000	0.951	1.000	1.000	1.000	1.000	1.000	1.000	0.218
1996	1.000	1.000	0.887	1.000	1.000	1.000	1.000	1.000	1.000	0.099
1997	1.000	1.000	0.860	1.000	1.000	1.000	1.000	1.000	1.000	0.164
1998	1.000	0.974	0.793	1.000	1.000	1.000	1.000	1.000	1.000	0.164
1999	1.000	1.000	0.701	1.000	1.000	1.000	1.000	1.000	1.000	0.162
2000	1.000	1.000	0.662	1.000	1.000	1.000	1.000	1.000	1.000	0.169
2001	1.000	1.000	0.646	1.000	1.000	1.000	1.000	1.000	1.000	0.155
2002	1.000	1.000	0.638	1.000	1.000	1.000	1.000	1.000	1.000	0.176
2003	1.000	1.000	0.625	1.000	1.000	1.000	1.000	1.000	1.000	0.084
2004	1.000	1.000	0.588	1.000	1.000	1.000	1.000	1.000	1.000	0.053
2005	1.000	1.000	0.560	1.000	1.000	1.000	1.000	1.000	1.000	0.053
2006	1.000	1.000	0.515	1.000	1.000	1.000	1.000	1.000	1.000	0.159
2007	1.000	1.000	0.501	1.000	1.000	1.000	1.000	1.000	1.000	0.270
2008	1.000	1.000	0.524	1.000	1.000	1.000	1.000	1.000	1.000	0.357
2009	1.000	1.000	0.530	1.000	1.000	1.000	1.000	1.000	1.000	0.273

Appendix J: $I^{1}_{j,k,t}$ – By Census Region

Year	Northeast	Midwest	South	West
1960	28.65	38.17	100.00	95.16
1961	27.60	37.99	100.00	93.56
1962	27.21	37.97	100.00	92.54
1963	28.38	37.70	100.00	92.68
1964	28.12	37.15	100.00	91.58
1965	27.21	36.10	100.00	92.62
1966	26.29	35.83	100.00	91.77
1967	25.34	35.73	100.00	91.25
1968	24.00	33.55	100.00	90.81
1969	23.96	32.56	100.00	90.68
1970	23.84	32.71	100.00	90.08
1971	22.63	30.95	100.00	86.72
1972	22.05	31.22	100.00	81.90
1973	22.19	28.94	100.00	79.32
1974	25.08	29.02	100.00	82.20
1975	26.86	30.92	100.00	81.06
1976	26.63	30.64	100.00	79.42
1977	26.41	30.76	96.25	81.68
1978	27.06	30.05	92.85	93.89
1979	29.08	31.79	90.18	93.59
1980	29.68	35.18	91.62	95.16
1981	31.16	35.69	92.74	96.10
1982	31.17	38.13	94.65	96.05
1983	32.04	38.49	94.32	97.05
1984	32.53	40.17	95.13	97.59
1985	33.02	39.90	94.64	96.26
1986	32.69	39.58	91.53	97.42
1987	31.32	38.70	88.98	95.87
1988	31.20	37.72	85.97	96.35
1989	31.00	37.68	84.83	95.54
1990	33.45	37.62	84.23	96.83
1991	32.70	37.24	85.06	96.77
1992	32.66	36.91	83.53	98.34
1993	31.62	33.20	82.34	98.31
1994	31.81	33.83	81.19	98.91
1995	30.58	32.42	81.78	97.90
1996	32.00	31.36	81.28	95.33
1997	31.55	30.54	81.15	94.37
1998	33.78	29.88	80.19	91.06
1999	34.31	29.02	79.05	87.89
2000	33.40	27.89	78.37	86.09
2001	33.74	29.45	78.02	85.15
2002	32.70	28.42	76.86	84.68
2003	31.20	27.71	74.65	83.92
2004	31.13	27.96	72.90	82.28
2005	31.26	27.82	71.62	80.81
2006	32.89	28.84	71.23	78.85
2007	31.84	28.75	70.94	78.33
2008	33.65	30.04	72.78	80.15
2009	34.70	32.58	77.01	80.45