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Energy Consumption in the U.S. Food System

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CORNHUSKER ECONOMICS

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Market Report	Yr Ago	4 Wks Ago	10/26/12
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight	$121.79	$123.00	$127.12
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	155.74	162.70	162.62
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	145.00	144.46	148.63
Choice Boxed Beef, 600-750 lb. Carcass	186.97	191.77	198.49
Western Corn Belt Base Hog Price Carcass, Negotiated	86.21	74.54	80.39
Pork Carcass Cutout, 185 lb. Carcass, 51-52% Lean	*	79.41	86.46
Slaughter Lambs, Ch. & Pr., Heavy, Wooled, South Dakota, Direct	168.50	85.75	98.50
National Carcass Lamb Cutout, FOB	405.73	311.15	300.33
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	6.43	8.44	8.35
Corn, No. 2, Yellow Nebraska City, bu.	6.43	7.44	7.38
Soybeans, No. 1, Yellow Nebraska City, bu.	11.88	15.61	15.36
Grain Sorghum, No. 2, Yellow Dorchester, cwt.	10.98	12.61	12.46
Oats, No. 2, Heavy Minneapolis, MN , bu.	3.52	3.85	4.04
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton	190.00	237.50	237.50
Alfalfa, Large Rounds, Good Platte Valley, ton	132.50	212.50	215.00
Grass Hay, Large Rounds, Good Nebraska, ton	92.50	185.00	190.00
Dried Distillers Grains, 10% Moisture, Nebraska Average	222.50	276.50	275.00
Wet Distillers Grains, 65-70% Moisture, Nebraska Average	74.50	110.13	102.50

***No Market**

In 2011, the U.S. consumed 97 quadrillion Btus[1] of energy. This amounted to 41 percent of energy consumed by countries belonging to the Organization of Economic Co-operation and Development (OECD), and 18 percent of energy consumed worldwide that year. Fossil fuels accounted for 82 percent of U.S. energy consumption, with petroleum accounting for 36 percent, natural gas for 26 percent and coal for 20 percent. Renewable energy and nuclear power accounted for nine percent each. Of a total U.S. supply of 108 quadrillion Btus, 26 percent was imported and most of it (85 percent) was crude oil. The shares of energy consumption by end-user sectors were 31 percent for the industrial sector,[2] 28 percent for the transportation sector,[3] 22 percent for the residential sector,[4] and 19 percent for the commercial sector.[5]

The question of how much of U.S. energy consumption goes to the U.S. food system has prompted research, predominately from non-economists, since the Organization of Petroleum Exporting Countries (OPEC) oil embargo in 1973. To my knowledge, the first attempt to address the question is by Hirst,[6] and the most recent by Canning, et al.[7] In between, eight studies[8] have made similar attempts using different

[1] A Btu, short for British Thermal Unit is the amount of heat energy required to raise the temperature of one pound of liquid water by 1^0 F, measured at its greatest density (approximately 39^0 F).
[2] Production and processing of all goods including food.
[3] All vehicles for personal or freight transportation.
[4] All private residences including dormitories.
[5] Retail stores, offices, restaurants, schools and other workplaces.
[6] Hirst, E. 1974. "Food Energy Related Requirements." *Science* 184:134-138.
[7] Canning, P., A. Charles, S. Huang, K R. Plenske and A. Waters. March 2010. *Energy Use in the U.S. Food System*. USDA, ERS, Economic Research Report 94.
[8] Steinhart J. and C. Steinhart. 1974. "Energy Use in the U.S. Food System." *Science* 184-307-316; Hendrickson, J. Undated. *Energy Use in the U.S. Food System: A Summary of Existing Research and Analysis*, Center for Integrated Agricultural Systems, University of Wisconsin-Madison; Heller, G. H. and G. A. Keolelan. *Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System*. Center for Sustainable Systems, University of Michigan, Report No. CSS00-04.

methods and breakdowns of the various stages of production in the U.S. food system.

On the last page of this article you will find a table in which I compiled the diverse research findings, along with energy-related data from the Energy Information Administration (http://www.eia.gov), and food-related data from the United States Department of Agriculture http://162.79.16.125/default.htm). Column-wise are the years covered by the studies. Row-wise are energy use in the entire U.S. economy, energy use in the U.S. food system, the share of the food system in total energy use, the respective energy shares at each stage of the system (on-farm, processing, packaging, transportation, commercial food services, and at-home), the food supply in energy units, fossil energy used per unit of food energy supplied, oil imports in energy units, and oil imports per unit of food energy supplied. All energy units are in Btus.

To expend less energy reading the table, let's focus on the shaded columns. They give the average for the years covered in each decade. The last column gives the average growth rate between decades. So in the 1950s, for example, the U.S. economy consumed 37 quadrillion Btus, of which 5.03 quadrillion was used by the U.S. food system, or 13 percent of the total. When broken down by stages, on-farm energy use as a proportion of energy use in the food system ranked highest (26 percent), followed by at-home energy use (19 percent), processing (17 percent), commercial food services (14 percent), transportation (14 percent), and packaging (11 percent). During the same decade, the U.S. food supply in Btus was 0.733 quadrillion. This means that during the 1950s it took on average seven units of energy to produce one unit of food. As energy independence and climate change continue to receive national attention, it is helpful to compare U.S. food supply with oil imports. Looking at the 1950s again, oil imports averaged about 2.72 quadrillion Btus. This amounted to an average of 0.57 units of oil imports per unit of food supplied in the U.S. The rest of the decades can be read in a similar manner.

The key takeaways from the table are as follows:

- While energy use grew in the entire U.S. economy and the U.S. food system, the latter grew faster (34 percent) than the former (28 percent), over the time period studied.[9] The share of the U.S. food system in total energy use hovered between 13 and 15 percent, with an average share of 14 percent and an average growth rate of five percent between decades.

- At-home energy consumption holds the largest share of total energy use in the U.S. food system, averaging about 25 percent. Farming and processing used the same amount of energy (20 percent each), followed by commercial food services (19 percent), packaging (9 percent), and transportation (10 percent). However, while energy used on-farm, in packaging, and in transportation registered negative average growth rates (-13, -6 and -22 percent, respectively), energy used in processing, commercial food services, and at-home food services registered positive average growth rates (7, 20, and 11 percent, respectively).

- The average growth rate of the U.S. food supply in energy units was 23 percent, significantly below the 34 percent average growth rate in energy use in farming, processing, packaging, transporting, commercializing, and at-home food services.

- On average, it took nine units of energy to produce one energy unit of food.

- The ratio of oil-imports to food supply averaged one, meaning that each energy unit of the U.S. food supply has pretty much soaked up each unit of imported energy. Since 1975, the ratio has been consistently above one.

The breakdown of energy use by stage of production is revealing in many respects. While it takes on average 20 percent of total energy use for on-farm food production, it takes 55 percent to get the food to consumers and 25 percent for at-home food services. The share of energy use on-farm stands at odds with the notion that farming is the major user of energy in the U.S. food system. Furthermore, growth in on-farm energy use registered the largest decline (-13 percent), second to transportation (-23 percent). The highest average growth rates occurred in commercial food services and at-home food services.

While future energy trends are not available for each stage in the U.S. food system, they are available for the food manufacturing sector. Energy consumption in this sector has been projected to increase by 19 percent from 1997 to 2020.[10] Reasons cited are increasing demand for energy-intensive foods, such as fresh processed foods, ready-to-eat foods, and fruits and vegetables; such foods require more energy to avoid spoilage during the journey from farm to fork.

The five priority actions spelled out in a recent report prepared for The United Nations, *Sustainable Energy for All Initiative*[11] by Accenture, are solid examples of strategies that private businesses can adopt to become more energy-efficient. These actions are:

- "Create closed-loop systems that reuse waste streams as production inputs;

[9] Since data for overall U.S. energy consumption is available for every year since 1950, the actual average growth rate of average energy consumption per decade is 21.11 percent. Since no similar data are available for the energy use in the U.S. food supply chain, the average growth rate reported here must be interpreted with caution.

[10] U.S. Environmental Protection Agency. *Energy Trends in Selected Manufacturing Sectors: Opportunities and Challenges for Environmentally Preferable Energy Outcomes*. Final Report, March 2007.

[11] *Sustainable Energy for All: Opportunities for the Food and Agricultural Industry*. Prepared by Accenture for the United Nations Global Compact. October 2012.

- Increase the energy efficiency of growing food crops;
- Increase the energy efficiency of production, packaging, and transportation processes;
- Increase the use of renewable energy to meet operational energy needs;
- Use waste streams to provide access to energy in areas where access is limited."

Note that the focus of the five priority actions is mainly on food production, manufacturing, and distribution, which consume 75 percent of the energy used in the food system. This does not address the at-home segment, which accounts for the remaining 25 percent. I conjecture that the focus of private strategies, public research, and public policies on enhancing energy efficiency in the U.S. is disproportionately weighted toward the 75 percent segment. Of note is the prevalence in Europe and Japan, relative to the U.S., of research initiatives on sustainable households and sustainable consumption. The former focuses on improving energy efficiency by households, and the latter on altering consumption habits of households to lessen their energy load.

Not surprisingly, U.S. public research efforts in the energy area are in sync with the five private business strategies listed above. However, the extent to which the strategies are implemented hinges to a great degree on both their technical (engineering) and economic feasibility. The latter, in particular, is influenced in large part by the incentive structures created by public policies and regulations, some of which affect energy use in the U.S. food system directly (e.g., emissions standards), and some of which affect energy use indirectly (e.g., competition policy).

In short, economics - in collaboration with the physical and engineering sciences - has an important role to play in researching energy use in the U.S. food system.

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(TABLE ON NEXT PAGE)

	Energy cosumption in the US food system and energy use in the entire US economy																				
	1950	**1954**	**1958**	**1950s**	**1960**	**1963**	**1964**	**1968**	**1960s**	**1970**	**1975**	**1978**	**1979**	**1970s**	**1997**	**1999**	**1990s**	**2002**	**2007**	**2000s**	**Average**	**Average growth rate**
Energy use in the whole US economy (Btus)	3.46E+16	3.66E+16	4.16E+16	3.76E+16	4.51E+16	4.96E+16	5.18E+16	6.24E+16	5.22E+16	6.78E+16	7.19E+16	7.99E+16	8.08E+16	7.51E+16	9.45E+16	9.49E+16	9.47E+16	9.76E+16	1.01E+17	9.94E+16	7.18E+16	28%
Energy use in the US food system (Btus)	4.72E+15	4.97E+15	5.40E+15	5.03E+15	5.72E+15	8.19E+15	6.71E+15	8.02E+15	7.16E+15	8.62E+15	1.12E+16	1.32E+16	1.37E+16	1.17E+16	1.15E+16	1.02E+16	1.09E+16	1.41E+16	1.59E+16	1.50E+16	9.95E+15	34%
Share of the food system in total energy	14%	14%	13%	13%	13%	17%	13%	13%	14%	13%	16%	17%	17%	15%	12%	11%	11%	14%	15.70%	15%	14%	5%
Energy use by stage of production:																						
On-farm	25%	26%	26%	26%	26%	18%	26%	25%	24%	24%	13%	18%	18%	18%	14%	22%	18%	14%	NA	14%	20%	-13%
Processing	17%	17%	16%	17%	16%	36%	15%	15%	20%	14%	31%	29%	29%	26%	16%	17%	16%	19%	NA	19%	20%	7%
Packaging	12%	10%	10%	11%	10%	*	9%	9%	10%	10%	**	**	**	10%	6%	7%	7%	6%	NA	6%	9%	-6%
Transportation	14%	13%	13%	14%	14%	*	14%	15%	14%	15%	11%	10%	11%	12%	4%	14%	9%	4%	NA	4%	10%	-23%
Commercial***	14%	14%	14%	14%	14%	16%	14%	13%	14%	14%	18%	17%	17%	16%	31%	10%	21%	28%	NA	28%	19%	20%
At-home	18%	19%	20%	19%	20%	30%	22%	23%	24%	24%	27%	26%	26%	26%	29%	32%	31%	28%	NA	28%	25%	11%
US food supply in energy units (Btus)	7.06E+14	7.32E+14	7.60E+14	7.33E+14	8.11E+14	8.50E+14	8.62E+14	9.30E+14	8.63E+14	9.50E+14	9.70E+14	1.03E+15	1.04E+15	9.99E+14	1.40E+15	1.E+15	1.43E+15	1.62E+15	1.70E+15	2.E+15	1.14E+15	23%
Fossil energy used per unit of food energy	7	7	7	7	7	10	8	9	9	9	12	13	13	11.65	8	7	8	9	9	9	9	11%
Oil imports in energy units (Btus)	1.91E+15	2.35E+15	3.88E+15	2.72E+15	4.19E+15	5.09E+15	5.45E+15	6.91E+15	5.41E+15	8.34E+15	1.40E+16	1.91E+16	1.95E+16	1.52E+16	2.52E+16	2.73E+16	2.62E+16	2.94E+16	3.47E+16	3.E+16	2.E+16	94%
Oil imports per unit of food energy produced	0.41	0.47	0.72	0.53	0.73	0.62	0.81	0.86	0.76	0.97	1.25	1.45	1.42	1.27	2.19	2.67	2.43	2.08	2.18	2.13	1	47%

* Packaging and transporation are aggregated with processing.

** Packaging is aggregated with processing.

***Commerical inclues wholesale/retail trade and away from home food services.

NA = Not available

Source: Compiled by the author from the cited works.