Energy Input Labeling Standards

2008 v1.0

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1. Introduction

This document provides uniform standards for labeling energy inputs in producing goods and services as well as guidelines how to implement energy input labeling.

1.1 Scope of Standards

These standards concern calculating and reporting energy utilized by a firm to produce a good or service.

Most firms do not produce goods or services from scratch. Nearly always, raw materials, parts, or the services of other firms are utilized. Therefore, ***total energy*** utilized includes energy inputs by both a producer and as well as upstream energy inputs (parts, raw materials, subcontractors).

Unfortunately, calculating information about externally-produced goods or services is often impractical. Therefore this document chiefly describes ***added energy inputs*** rather than total energy inputs, or in other words, "energy added" input labeling. ***Energy added*** provides an incomplete picture of energy inputs, for the energy used by other firms is neither considered nor reported. Despite its limited reach, ***energy added labeling*** is worthwhile since it is quite achievable for most products and provides valuable information for consumers.

If a firm actually creates a product or service from scratch, or if all upstream suppliers utilize energy input labeling, then total energy can be reported. Nevertheless, the focus of these standards shall be on energy added.

1.2 Energy Contained By A Product Is Not Considered

Energy inputted into a product does not refer to how much energy a product contains. Fuels presumably contain much more energy than was utilized to obtain the fuel. For example, coal contains more energy than it used to mine and process it. Likewise, considerable energy might have been utilized to produce an iron casting, but the final casting contains relatively little available energy. Rather, energy inputted merely refers to the energy utilized to make that product regardless of how much energy it actually contains. In physical terms, energy is not conserved within the production process.

1.3 Definition of Energy

Energy referred to in this document means usable energy, in particular the Gibbs Free Energy if no other type is specified. Gibbs Free Energy is a measure of available energy widely used in chemistry and it is convertable into other measures of energy.

1.4 Units of Energy

In these Standards, energy will be expressed in Joules. When expressing individual inputs in the calculation process, it is reasonable to express energy in its measured or reported units, such as kilowatt-hours for electric energy inputs. For example, most electrical energy usage is reported in terms of kilowatt-hours. In many plants, nearly all of the equipment is some form of electric-powered machinery. In an ideal world, these other units should then be converted into Joules.

However, traditions within a particular field or market might encourage energy labeling to be expressed in other units. In addition, competitive reasons may encourage use of one unit of energy over another. Expressing energy inputs in terms of kilowatt-hours may make production seem much more energy-efficient than expressing the same amount of energy in Joules. Energy inputs may be stated in units widely used in the product's industry or by consumers. This is acceptable within these standards, but in any event, the units used should be stated in energy labeling.

1.5 Sources of Energy

Ideally, the sources of energy should be included as well. If electric power is procured from the local utility, all that is necessary to specify is "electricity." However, if the raw source is actually known, such photovoltaic cells mounted on the producer's plant, then the raw source should be included.

The percentage from each source should be specified as well as is known. Sources should be listed in order from largest source to smallest source. However, where all of the energy is from one source, it is not necessary to specify 100%, as that could be viewed as a guarantee.

1.6 Sample Energy Input Label

Samples of energy added input labeling are as follows:

Energy Added Inputs:
1.5 kilowatt-hours
80% from electricity
20% from human labor

Energy Added Inputs:
6.5 kilowatt-hours
95% from electricity (solar)
5% from human labor

Energy Added Inputs:
0.12 kilowatt-hours
60% from electricity
25% from natural gas
15% from human labor

2. Approaches

There are two approaches that can be taken to calculate how much energy has been inputted into a unit of good or service—direct and indirect.

2.1 Direct Approach

The ***direct approach*** itemizes all of the directly identifiable energy inputs. For example, if a machine is operated for 15 minutes to produce a product, then the energy used to run that machine for that amount of time would be the energy input. If that machine operates at 40 kilowatts, then the energy input for that product would be 10 kilowatt-hours. This is calculated in the following manner: 10 kilowatt hours = 40 kilowatts x 0.25 hours.

2.2 Indirect Approach

The ***indirect approach*** considers the entire energy used by an enterprise and divides that energy by the quantity of products produced to determine the energy input. For example, if a factory uses 10,000 kilowatt-hours in a month and produces 500 units of product in that month, then the energy input for that product would be 20 kilowatt-hours. This is calculated as: 20 kilowatt-hours = 10,000 kilowatt hours / 500 units of product.

3. Methods to Calculate Energy Inputs

In accordance with the above approaches, several methods will be presented. These Standards will focus on direct methods, although indirect methods will be also be discussed.

3.1 Individual Product Method (Method I)

The *Individual Product Method* (Method I) concerns the direct energy inputs involved in the individual production of a single product, for instance if a carpenter builds a single wooden birdhouse.

For Method I, all significant direct inputs should be identified for production of the product or unit of service. Identifiable, significant indirect inputs (HVAC, etc.) should also be identified and divided per unit of production. Here, significant inputs are defined as those contributing more than the uncertainty of the largest input.

3.2 Batch Production Method (Method II)

The *Batch Production Method* (Method II) concerns the energy inputs involved when batches of products are simultaneously produced, for instance when a baker produces an entire batch of cookies. Both direct and indirect inputs can be considered.

For Method II, all significant direct inputs should be identified for production of a batch (or run) of products or delivery of a batch of services. Indirect inputs (HVAC, etc.) should also be identified and divided per unit of production per unit of time. Here, significant inputs are defined as those contributing more than the uncertainty of the largest input.

3. Multi-Product Method (Method III)

The *Multi-Product Method* (Method III) is similar to Method II, but allocates inputs among several different product lines, such as when a bakery produces bread, cookies and muffins. Both direct and indirect inputs can be considered.

For Method III, all significant direct inputs should be identified for production of a batch (or run) of products or delivery of a batch of services. However, energy inputs that cannot be allocated to a single batch or product line are allocated using a reasonable basis. Indirect inputs (HVAC, etc.) should also be identified and divided per unit of production per unit of time. Here, significant inputs are defined as those contributing more than the uncertainty of the largest input.

4. Input Categories

There are several major energy input categories. Not every method or product will use all categories, yet most inputs will fall into these categories:

- Human labor
- Equipment time
- Fuel
- HVAC
- Upstream Inputs

The following discusses how to include each category. Deviations from these Standards constitute exceptions. Exceptions must be expressly noted and justified when compiling energy input calculations.

Human labor represents time spent by people on production. A chef scrambling a bowl of eggs or a machinist monitoring an automated milling machine are examples of *direct human labor inputs*. An accountant tracking revenues or a janitor mopping a factory floor are *indirect human labor inputs*, unless specific instances of their time can be tracked to specific units of product. The typical energy input per worker is 100 W. For one hour of labor, this input would be 360 kJ (=100 J/s x 3600 s/hr) unless a legitimate exception exists. Lumberjacks using manual equipment and requiring a 6000 Calorie diet per day would be a legitimate exception.

Energy inputted by labor is a special case. The human body consumes about 100 Watts per hour. However, the energy expended by society to maintain a human is much higher than 100 W per hour. This could be handled in either of two ways. The first way is to simply assign a value based on actual energy consumption by a human body, such as 100 W per hour for each worker involved in production. A second way would be to divide the entire national energy consumption by the national amount of hours worked, and to calculate an hourly expenditure figure. These standards utilize the first way in order to reduce uncertainty. If the second way is utilized, this should be noted on the labeling.

Equipment typically consumes energy when it is used to produce goods and services. Regardless of the efficiency of the equipment, it consumes energy. Most equipment (unless fabricated in-house) contains an energy rating. Equipment might not always operate at that rating. It is possible to use measuring devices to measure actual current and (if the voltage is known) therefore power. If no better information is known, use the rating on the equipment. For example, if the equipment current is rated at 10 A (10 amps) and the voltage at 120 V (120 volts), then power = 5 A x 120 V = 600 W. If operated continuously, equipment would use (600 W x 1 hour = 600 J/s x 3600 s/hr = 2,160 kJ) per hour.

Fuel is used to operate machinery and to heat and process parts and materials. Natural gas is used for heaters and ovens, and occasionally to power mechanical equipment. Heating oil is used for many of the same purposes as natural gas. Gasoline is used primarily to power electrical generators or engines.

Where a firm uses fuels to generate electricity, the energy value of the fuel should be used (this can be easily approximately calculated from a standard table of Gibbs Free Energy of the fuel less that of the waste products, or of 50% water and 50% CO_2 if the waste products are not known). However, the energy cost to create the generators need not be reported unless the firm built the generator.

Where solar or wind energy are used by a firm to generate electricity, the value of the electric energy should be considered plus the energy cost of maintaining solar cells or turbines.

Heating, Ventilation, Air Conditioning and Cooling (HVAC) is an important input for some products manufactured in buildings. Generally, HVAC is not applied to single units of production. It is usually an indirect input.

Upstream inputs represent energy inputted to produce raw materials, parts and other supplies procured to produce the good or services being reported. Upstream inputs can be utilized if known, but should be included under total energy inputs rather than added energy inputs and labeled separately.

5. Competition and Expectations

Energy input labeling can improve product demand where consumers are energy conscious. Consumers may even pay a premium for energy input labeled products.

It is understandable that a producer would wish to take steps to avoid negative impacts upon their competitive position due to energy input labeling. For example, a firm that produces most of its own product content would report a higher added energy inputs than a competitor who procures most content externally, possibly leading to a competitive disadvantage. To help remedy this situation, a labeler may list the percentage of materials produced internally, but the basis must be stated (by cost, weight or total estimated energy inputs).

Firms that produce their own energy (such as through biomass or solar power) could use the phrase "__% of energy is 'home-grown' or a similar phrase. Firms that generate their own electricity from procured fuels could indicate that.

Expectations

At present, there is no certification for energy labeling. Adherence to these standards will be on a voluntary basis. In lieu of participating in a certification program, energy input labelers (labelers) are urged to conform to the following expectations.

1. Labelers will follow the Energy Input Labeling (EIL) Standards as closely as is practical.
2. Labelers will take measurements as carefully as is practical and in good faith.
3. Labelers will account for all known energy added inputs.
4. Labelers will provide honest, truthful estimates and calculations of energy inputs.
5. Labelers will update their labels in a timely fashion to reflect changes in energy inputs.

Appendices

Appendix A—Definitions

batch production method concerns the energy inputs involved when batches of products are simultaneously produced.

direct approach itemizes all of the directly identifiable energy inputs.

direct human labor inputs are specific instances of energy inputs due to human labor that can be tracked to specific units of product.

energy added input labeling is reporting energy inputted by the producer but does not include upstream inputs.

energy added inputs are energy inputs added to a product by a particular producer but not by upstream producers. *Energy added inputs* include electrical power, gas or other energy used to power production machinery such as lathes, ovens and printing presses. It can also include the calories burned by the bodies of humans during production labor. Included are air conditioning, ventilation and lighting energy if such can be measured and allocated to units of product.

I*ndirect approach* considers the entire energy used by an enterprise and divides that energy by the quantity of products produced to determine the energy input.

indirect human labor inputs are inputs of energy due to human labor that cannot be tracked to specific units of product.

individual product method concerns the direct energy inputs involved in the individual production of a single product.

multi-product batch production method is similar to the batch production method, but allocates inputs among several different product lines.

plant method concerns all of the energy utilized by a plant for a single product line, and allocates it on a per product unit basis.

t*otal energy* utilized includes energy inputs by both a producer and as well as upstream energy inputs.

total energy inputs include both energy added inputs and upstream energy inputs.

upstream energy inputs are energy inputs used to produce raw materials, parts and services procured by a producer that lead to the production of a good or service.

Appendix B—Abbreviations and Units

These Standards utilize the SI standard, but other units are mentioned.

Units:

A	Amp, a unit of current
BTU	British Thermal Unit, a traditional unit of energy, frequently used to characterize fuels and appliances
cal	calorie, a traditional unit of energy
Cal	Calorie, a unit that concerns the energy content of food, but equals 1000 calories
J	Joule, the standard unit of energy
s	second
V	Volt, unit of voltage
W	Watt, a unit of power

Multipliers:

k	kilo	= 1,000
M	Mega	= 1,000,000

E.g 1 kW = kiloWatt = 1000 Watts = 1000 W

E.g. 1 MJ = 1,000,000 J = 1,000,000 Joules

Appendix C—Useful Formulas and Conversions

Energy and Energy Usage: (they are the same for purposes of these standards)

Energy = Energy Usage = Power x Time

E.g. Joules = Watt x seconds

E.g. 1 kiloWatt hour = 1000 Watts x 1 hours

E.g. 1 kW hr = 1000 W x 3600 s = 3,600,000 W s = 3.6 MW s

E.g. 3.6 MJ = 3.6 MW s = 1 kW hr

Note: food Calories are different than standard calories:

1 standard calorie = 4.186 Joule

1 food Calorie = 1000 calories = 4186 Joules

Power:

Power = Energy/Time

E.g. Watts = Joules/second

E.g. For a typical human body,

2000 food calories/day = 2,000,000 calories/day

2,000,000 calories/day = 8,372,000 Joules/day

8,372,000 Joules/day x 1 day/86,400 seconds/day

= 96.90 Joules/second

96.90 Joules/second = 100 Watts

Electric Power = Current x Voltage

E.g. For electric power, 1 Volt x 1 Amp = 1 Watt

Appendix D—Examples [See spreadsheets]

These examples use some of the templates to illustrate added energy inputs for actual commercial products

1—Booklet

A booklet is sold in bookstores. It is printed one at a time on a high quality laser printer, then assembled and bound by hand.

Energy usage for the equipment was determined by multiplying maximum current (read from the equipment labels) by the wall voltage (120 V) by the amount of time used.

2—Computer database consulting service

Customized databases are developed and delivered to customers via electronic file. There is no physical product in this example. 40 hours per week of service is delivered to clients and 2 hours of overhead time for billing and paperwork is incurred. A laptop is utilized during service hours. Both a laptop and a laser printer are utilized during overhead hours.

Energy usage involved during the 2 hours of indirect, overhead time must be allocated to the 40 hours of service. In this way, the energy cost for each hour of service is more accurately reported.

3—Baked goods

Example 3 concerns a bakery that produces four types of products: bread, rolls, cookies and muffins. The major source of energy used is electricity used to power four electric ovens. The bakery is continuously staffed with one person during regular business hours (an 8 hour day, but in this case, 7 days per week). During one week, 100 loaves of bread are produced, etc. Information for HVAC energy usage was unavailable.

Appendix E—Templates [See spreadsheets]

There is one template for each of the four calculation methods. Each template is created in a spreadsheet program. Some templates can use additional worksheets for sub-calculations and notes.

1— *Individual Product Method (Method I)*

The *Individual Product Method* template is the simplest. All the producer needs to do is list and sum the direct energy inputs for a particular unit of product. Energy due to both human labor and equipment is included.

2— *Batch Production Method (Method II)*

The *Batch Production Method* template concerns allocating a lump sum of energy usage to a quantity of substantially identical units of production. If indirect inputs can be allocated to the batch, they should be included. Likewise it is possible to group multiple, similar batches together into a larger batch if this enables indirect energy usage to be allocated.

3— *Multi-Product Method (Method III)*

The *Multi-Product Method* template is more complicated than the other templates. Several product lines are considered. Energy inputs need to be allocated to particular product lines. Such allocations need to be made carefully and in good faith, because estimates and judgment calls will be required in the absence of actual allocation data.

This method makes it possible to more easily consider resources that may be dedicated to more than one product line. For example, a freezer might be used to simultaneously store ingredients used for multiple product lines. Likewise, staff might be simultaneously involved in the processing of several different product lines where automated equipment is used or where other simultaneous operations occur.

Energy Input Template — Individual Product (Method I)

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Product:

Energy Added:

Direct:	Amount (kW hrs)
Equipment energy usage: (in kW hrs)	0.00
Human energy: (0.1 kW/hr/person)	0.00
Direct Fuel Used: (converted to kW hrs)	0.00
Total Direct	0.00
Total Energy Added Per Unit of Product	0.00

Notes

Sub-Calculations

Equipment energy usage calculation

Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
Machine #1		120		0		#VALUE!
Machine #2		120		0		#VALUE!
Total						#VALUE!

Human energy calculation
(Using rate at which typical person burns kilocalories)

	x		=	
Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
				0

Notes

Energy Input Template—Batches (Method II)

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Product:

Energy Added:

Direct:	Amount (kW hrs)	
Equipment energy usage: (in kW hrs)	0.00	
Human energy: (0.1 kW/hr/person)	0.00	
Direct Fuel Used: (converted to kW hrs)	0.00	
Total Direct		0.00
Indirect:		
Equipment energy usage: (in kW hrs)	0.00	
Human energy: (0.1 kW/hr/person)	0.00	
Direct Fuel Used: (converted to kW hrs)	0.00	
Subtotal of Indirect	0.00	
Quuantity of production	0.00	
		#DIV/0!
Total Energy Added Per Unit of Product		#DIV/0!

Notes

Sub-Calculations

Equipment energy usage calculation

	Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
Machine #1	0		120		0		0.00
Machine #2	0		120		0		0.00
Total							0.00

Human energy calculation

(Using rate at which typical person burns kilocalories)

Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
0.1		0		0

Energy Input Template—Multiple Products (Method III)

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Company:

Products

Product A:
Product B:
Product C:
Product D:

		Allocations:				Energy Per Product:			
Energy Added:	Total	Product A	Product B	Product C	Product D	Product A (kW hrs)	Product B (kW hrs)	Product C (kW hrs)	Product D (kW hrs)
Direct:	Amount (kW hrs)								
Equipment energy usage: (in kW hrs)	0.00	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00
Human energy: (0.1 kW/hr/person)	0.00	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00
Direct Fuel Used: (converted to kW hrs)	0.00	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00
Total Direct	0.00					0.00	0.00	0.00	0.00
Indirect:									
HVAC, Lighting	0.00	0.00%	0.00%	0.00%	0.00%	0	0	0	0
Other Indirect	0.00	0.00%	0.00%	0.00%	0.00%	0	0	0	0
Total Indirect	0.00					0	0	0	0
Total Energy Added	0.00					0.00	0.00	0.00	0.00
Quantity of Product Produced						0	0	0	0
Energy Per Unit:						#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Sub-Calculations

Equipment energy usage calculation

Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
Machine #1		120				0.00
Machine #2		120				0.00
Total						0.00

Human energy calculation
(Using rate at which typical person burns kilocalories)

Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
0.1		0		0

Notes

Energy Input Template—Single Unit of Product Revised August 27, 2007

Product: Booklet

Energy Added:

Direct:	Amount (kW hrs)
Equipment energy usage: (in kW hrs)	0.12
Human energy: (0.1 kW/hr/person)	0.03
Direct Fuel Used: (converted to kW hrs)	
Total Direct	0.15
Total Energy Added Per Unit of Product	0.15

Notes

A 50 page, plastic covered, comb-bound booklet supplied for retail sale by bookstores. Copies are individually laser-printed, then assembled, punched and bound using human-powered equipment.

Sub-Calculations

Equipment energy usage calculation

	Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
CPU and Monitor (iMac)	6.75		120		0.15		0.12
LaserWriter 12/640 PS	5.5		120		0.15		0.10
Total							0.22

Human energy calculation

(Using rate at which typical person burns kilocalories)

Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
0.1		0.25		0.025

Further Notes

Overhead energy usage such as fuel to keep work premises warm in not known.

Energy Input Template—Batches (Method II) Revised August 27, 2007

Product: Database Design Service

Energy Added:

	Amount (kW hrs)	Amount (kW hrs)
Direct:		
Equipment energy usage: (in kW hrs)	0.46	
Human energy: (0.1 kW/hr/person)	0.10	
Direct Fuel Used: (converted to kW hrs)	0.00	
Total Direct		0.56
Indirect:		
Equipment energy usage: (in kW hrs)	2.24	
Human energy: (0.1 kW/hr/person)	0.20	
Direct Fuel Used: (converted to kW hrs)	0.00	
Subtotal of Indirect	2.44	
Quuantity of production (hours)	40.00	
		0.06097
Total Energy Added Per Unit of Product		0.62

Notes

Assume 40 hours of production per week.
Overhead time comprises bookkeeping and invoicing, performed once per week.
Overhead time required 2.00 hours weekly.

Sub-Calculations

Direct Equipment energy usage calculation

	Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
Laptop computer	18.75		24.5		1		0.4594
Total							0.4594

Direct Human energy calculation
(Using rate at which typical person burns kilocalories)

Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
0.1		1		0.1

Indirect Equipment energy usage calculation

	Current Rating (Amps)	x	Voltage (Volts)	x	Time/Product (hours)	=	Energy Used (kW hrs)
Laptop computer	18.75		24.5		2		0.9188
Laserprinter	5.5		120		2		1.3200
Total							2.2388

Human energy calculation
(Using rate at which typical person burns kilocalories)

Burn Rate (kW)	x	Time/Product (hours)	=	Energy Used (kW hrs)
0.1		2		0.2

Energy Input Template—Multiple Products

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Company: Bakery

Products

Product A: Bread
Product B: Rolls
Product C:Cookies
Product D: Muffins

		Allocations:				Energy Per Product:			
Energy Added: (Per Day)	Total	Product A	Product B	Product C	Product D	Product A (kW hrs)	Product B (kW hrs)	Product C (kW hrs)	Product D (kW hrs)
Direct:	Amount (kW hrs)								
Equipment energy usage: (in kW hrs)	10.32	25.00%	13.00%	9.00%	53.00%	2.58	1.34	0.93	5.47
Human energy: (0.1 kW/hr/person)	5.60	25.00%	25.00%	25.00%	25.00%	1.40	1.40	1.40	1.40
Direct Fuel Used: (converted to kW hrs)	0.00	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00
Total Direct	15.92					3.98	2.74	2.33	6.87
Indirect:									
HVAC, Lighting	0.00	0.00%	0.00%	0.00%	0.00%	0	0	0	0
Other Indirect	0.00	0.00%	0.00%	0.00%	0.00%	0	0	0	0
Total Indirect	0.00					0	0	0	0
Total Energy Added	15.92					3.98	2.74	2.33	6.87
Quantity of Product Produced						100	100	48	60
Energy Per Unit:						0.04	0.03	0.05	0.11

Sub-Calculations

Equipment energy usage calculation

Current Rating (Amps)	x	Voltage (Volts)	x	Time (hours)	=	Energy Used (kW hrs)
Machine #1: Electric 4 ovens						
60		120		1.433		10.32
Machine #2						
						0.00
Total						10.32

Human energy calculation

(Using rate at which typical person burns kilocalories)

People Hours (7 x 8)	x	Burn Rate (kW)	=	Energy Used (kW hrs)
56		0.1		5.6