A PROCESS-BASED TAXONOMY FOR ENERGY-MANAGEMENT PLANNING

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It is being recognized that energy use and consumption depend as much on processes and activities as on building and space characteristics. This is especially true of the industrial and commercial sectors. However, current data bases on energy use are not "process-based", making it difficult to analyze process-related energy uses.

The paper proposes a process-based taxonomy as an alternative.

As an initial step, a commercial or industrial facility is viewed as a place where products or services are created. Products/services require activities to create them.

The paper divides the range of possible activities needed to create products, or to supply services, into ten standard categories. Each category represents a class of activities/processes which can be carried out in a given commercial/industrial space.

The uses of any commercial or industrial space can therefore be completely described using these categories, and energy use can be totalled along activity or process categories for a commercial or industrial subsector.

The use of this taxonomy in a series of test commercial and industrial sties is illustrated in the paper. It is suggested that the taxonomy (1) narrows the variances in energy-use intensities that are typical in other energy-use taxonomies; (2) focuses attention on the technologies of energy use; (3) allows clearer analysis of the interactions between process and non-process energy uses.

BACKGROUND

It has been recognized that energy use and consumption depend as much on processes and activities as on building and space characteristics.

In the residential sector, processes are almost synonymous with building or space-defined end-uses. The process of heating residential spaces, for example, involves the same parameters as the end-use labelled HVAC (Heating, Ventilation and Air Conditioning). The end-use labelled Residential Lighting is virtually equivalent to actual processes for lighting interior residential spaces. Because of this synonymity, many energy analysts literally cannot "see" the distinction between end-uses and energy-using processes, and find it difficult to handle the complexities of energy-use analysis in non-residential sectors.

In the commercial sector, the end-use/process equation begins to get fuzzy. The same end-use can be satisfied by many different kinds of processes. For example, the HVAC end-use could be accomplished by several different processes, each depending on such factors as type of commercial space use, building vintage, occupancy patterns and building characteristics.[1] This is not an isolated example. The range of commercial-sector activities and building sizes means that many different processes

[1] *In a recent study of Seattle area commercial sector HVAC systems, there were TEN possible DIFFERENT HVAC categories. Each category stood for a different pattern of HVAC energy use by Kwh/hour and by load shape. Even this could have been an oversimplification.*

can be included under every single end-use. There are also processes occurring within commercial establishments that are not covered under a current end-use category. Plug loads for computers and office equipment are a typical example. Estimating commercial energy use by end-use or building characteristics therefore becomes an increasingly imprecise art, with problematic consequences for energy management programs and policies.

The problem is especially acute in the industrial sector, where there are many different kinds of processes that use energy. Some of these processes can be tied down to broadly defined end-uses, such as Industrial Lighting. Others can be isolated and used as the basis for a specific energy-management thrust; Industrial Motor Replacement programs would be an example. This leaves a substantial amount of energy use in the industrial sector outside these two strategic classifications, with no well-defined methods for identifying and estimating it.[2]

The exigencies of energy management planning for the industrial sector have brought into existence a considerable body of literature on industrial processes. This can be roughly grouped into three types.

1. *Specific-Process Studies:* Assessments have been made of specific industrial processes or "electro-technologies", such as commercial refrigeration or industrial motors. The degree to which these processes or technologies are amenable to energy-management strategies has been exhaustively researched. Demand-side strategies and programs have been developed to deal with these specific items.

2. *Non-Process Energy Use Assessments:* The argument has been made that much of the process-based energy use in industry involves gas or oil. Electrical energy used outside manufacturing and industrial processes (for example, HVAC, lighting and office support costs) has therefore been separately identified, classified, and treated similarly to commercial end-uses for which data and analysis methods are available.

3. *SIC/Key-Process Cross-Referential Databases:* Database systems using broad cross-references between selected key processes and industrial SIC categories are being developed for use in demand-side planning. These systems match specific electro-technologies under key processes to industrial sub-sectors where these processes are used. The matrices provide planners with overview energy-management strategies.

All these are promising developments, and suggest that research is finally focussing on the need for information in industrial energy-management planning. Most of the systems developed so far, however, are in their preliminary stages of development. At present, they are best seen as planning tools rather than analytical models. As they are applied, they will undoubtedly create the need for further information about industrial energy management. But they do not deal directly with how a process-based industrial energy-use database should be most effectively compiled and organized.

In fact, there are very few industrial data bases on energy use that are fully process-based. The difficulties are two-fold. The more obvious one is that it is extremely difficult to collect or verify detailed industrial energy-use data. The less obvious problem is that there is no process-based classification system for gathering and storing industrial-sector energy use information, even if the data were available. This means that analyzing process-related energy consumption with any kind of accuracy or detail is a thankless task at present, and fraught with pitfalls and perils.

A process-based taxonomy could be useful to the commercial sector as well, especially in characterizing energy uses that an end-use-based approach finds difficult to handle. Even the residential sector could, in the long run, benefit from a process-based approach as long-run changes in residential patterns focus attention on the essential "processes" that

[2] *An approach which holds some promise is that of constructing "end-use/process" matrices. This would mean taking broad end uses such as Lighting, Process Heat, Motors, etc. and distributing them over industrial process categories; for example, Process Heat could be distributed over Extraction (metals), Finishing (ceramics), etc. Of course this begs the questions. Some process taxonomy is needed to try this methodology.*

constitute the dynamics of residential activity.[3] It is important to keep this in mind, if only in the background. The use of a special taxonomy for a single energy-use sector may be dictated by expediency. Logic might require us to extend the approach to other energy-use sectors as well.[4]

This paper proposes a process-based taxonomy as an alternative framework for gathering, storing and accessing energy-use data. The initial emphasis is on the industrial sector, but the method is kept sufficiently general to allow it to be extended to the commercial and residential sectors. As an initial step, a commercial or industrial facility is viewed as a place where products or services are created. Products/services require activities to create them, and these activities are the basis on which the taxonomy is developed.

PRELIMINARY DEFINITIONS

To begin the exercise of developing a process-based taxonomy for energy management purposes, we need to go back to the basics and define what it is we are talking about. Accordingly, the following definitions are offered.

A *process* is defined as a series of actions with an *intended* result, or outcome.

An industrial process is defined as a process intended to make commodities for sale or use in the marketplace. By contrast, commercial processes are defined as those which intend to provide services, and residential processes as those aimed at supplying amenities.[5]

A *product* is the *measurable output* of a process. For industrial processes, products can be specified in terms of the commodity units intended to be produced. For services and amenities, the quantification issue is more difficult.[6] The usual econometric procedure is to adopt a proxy measure for service/ amenity levels.

In mathematical terms, a product Y of an industrial process P can be described as Y = P (X1, X2,...,Xn) where X1, X2 etc are inputs into the industrial process.

Energy is defined as an input into industrial or commercial processes. That is, there is some relationship between output Y and energy input Xe, which is specified by the form of the function P.[7]

In a typical process, there can be a final product Y as well as intermediate products Y1, Y2, etc. The relationship between intermediate and final products, which can be visualized using process flowcharts, is Y1 -> Y2 -> Y3.. -> ->Y. Each intermediate product is produced by a sub-process P1, P2, P3 etc., in the total process, and becomes an input to the next sub-process leading to the final product Y.[8]

The complete equation for representing a major industrial process with a final product Y and three intermediate products Y1, Y2 and Y3 would therefore be the nested equation Y = P1 (X1,...Xn, P2 (X1,..,Xn, P3(X1,..,Xn,Y3))); and the process of nesting can continue as long as there are intermediate products to be counted in the industrial process.

[3] *For example, the activities of preparing and storing food, in-home recreation, indoor climate control, etc. may need to be emphasized if we are to track residential energy use through shifting living patterns into 2000 A.D.*

[4] *The argument from logic is that if process-based measures of energy efficiency and effectiveness are used for the industrial sector, optimizing the use of energy across ALL sectors would require similar parameters for non-industrial sectors as well.*

[5] *This description does NOT match standard descriptor classifications. The same commercial SIC site could house commercial, industrial and residential processes. One manufacturer (as defined by Seattle City Light ID codes) could be packaging a product (e.g. a computer) and a service (e.g. a warranty) in the same unit of "manufacturing" activity. On the other hand, the same industrial process, e.g. transportation, could cover several sites with their own SIC designations. Re-classification by process, in other words, cuts across other categories.*

[6] *The quantification issue is a conceptual one as well. For example, why should food-processing be an industrial process, while restaurant cooking, which also involves making and selling food, be considered a commercial one? The reason is that the unit of account for restaurants is the meal, which is a service, while in the food-processing industry it is the can or package, which is a commodity.*

[7] *Typically, the demand for energy, Xe, which is actually a vector comprising different forms and units of energy, is treated as a "derived demand" based on the production of commodities, goods and services. However, there are difficulties with this approach.*

[8] *In practice, the relationship is not always sequential, but this is a useful simplification.*

The Cobb-Douglas Production Function is a good example of an industrial process formula. It possesses the form $Y = K1 * X1^{a1} * X2^{a2} * X3^{a3} * ... * Xn^{an}$ where the set of exponents $a1 + a2 + ... + an = 1$. The "first nesting" with one intermediate product Y1 would therefore be $Y = K1 * X1^{a1} * X2^{a2} * X3^{a3} * ... * Xn^{an} * Y1$; the second nesting with two intermediate products Y1 and Y2 is $Y = K2 * X1^{a1} * X2^{a2} * X3^{a3} * ... * Xn^{an} * X1^{a'1} * X2^{a'2} * X3^{a'3} * ... * Xn^{a'n} * Y2$; and so on. Note that each successive nesting preserves the form of the Cobb-Douglas Function. The difference is only that the exponents for each input X1 are $a1 + a'1 + a''1 +$ etc, or the sum of the exponents for input X1 for ALL of the sub-processes producing intermediate products. The totalled exponents can be used as soon as they are normalized to allow for economies-of-scale effects. This form would be preserved even when the intermediate products are not in strict linear sequence, i.e. are dispersed over a process flowchart.

If electrical energy is being used in an industrial process, the term for the electrical energy input Xe is simply $Xe^{(ae + a'e + a''e ...)}$, where ae, a'e, are the energy-use exponents for sub-processes P1, P2 etc. Here is the analytical reason why a process-based technology is useful for the analysis of energy use in industry. If overall use of electrical energy in an industrial facility can be separately estimated (e.g. through industrial billings), technical and empirical data collected for industrial energy use by sub-process could define econometric functions for energy use in that facility. This is a great improvement over the use of projections or simulation-model outputs, since it provides explanatory parameters which can be "tweaked" to determine the underlying structures of energy use. This makes energy-use forecasting more interesting for the economist, and demand-side management more focussed for the industrial conservation planner.

The issue then becomes, what are the different kinds of sub-processes involved in industrial activity.

As stated earlier, there are no readily available taxonomies which describe all industrial activity. The usual approach is to divide industries into three types---process-based, metals and fabrication-based--and deal with electro-technologies that apply to each sub-category. Although this is useful for development of electro-technologies, it does not provide sufficiently generalizable information for economic analysis or planning.

The procedure adopted at Seattle City Light was to select twelve *TYPES* of sub-processes, each of which was assigned a two-digit code, from 01 to 12. They are described in the following section.

DIRECT PROCESS STEPS

The first seven process steps, or sub-processes, are those that directly alter the characteristics of the product. The intermediate products look, feel and behave differently as they pass through direct process steps.

For each of the direct process steps, a Process Equation has been suggested to indicate an analytical framework within which data gathered for the process can be stored and analyzed (see Table 1). The equations are presented only in generic form. They ought to serve as guidelines for the kinds of data that need to be gathered if the process is to be fully documented within the industrial sector.

INDIRECT PROCESS STEPS

The next five process steps are those that deal only indirectly with the product. They do not deal with the product itself, but its context; i.e. its location, storage, and the environment in which the product is made and maintained. These indirect steps can be coded, labelled and defined in the same ways as direct ones. The indirect process steps, or sub-processes, shown in Table 2.

APPLYING THE TAXONOMY

The taxonomy described in the previous section was developed by Seattle City Light for assembling and organizing data for an Industrial Sector Energy Management Plan. The idea for such a Plan grew out of Seattle City Light's experience with industrial conservation, which can be summarized as follows.

Table 1. Direct Process Steps

CODE	LABEL	DEFINITION	EXAMPLE	PROCESS EQUATION
01	SEPARATE	Extract/Remove product from associated materials	Removing metal ore from rock (slurry processes)	Y1 - (Z1 +..+Zn) = > Y2, where Z1,..,Zn are materials associated with Y1 in "unprocessed" form
02	REFINE	Reduce Residual Impurities from partially processed product	Membrane or electrolytic separation; dielectric processes	Y1 - r => Y2, where r = residue, typically a vector r = (r1, r2, ...,rn) where r1, r2, etc. are identified residue elements
03	PRODUCE	Complete Processing of product to all Content requirements	Producing raw wheat flour from silo-stored grains	Generalized sub-process function, which is Y1 = P1 (X1,..., Xn, Y2)*
04	SHAPE	Apply Form/Structure to Processed product	Waterject cutting; making castings or shapes from injection moulds	Y1 (c1, c2,.., cn) = >Y2 (c'1, c'2,..,c'n) where c1,..,cn and c'1,..,c'n are characteristic sets for distinguishing unshaped from shaped/formed product
05	FINISH	Apply External characteristics to product	Applying primer and paint to fabricated metal (cars, airplanes)	Y2 (c'1, c'2,..,c'n) =>Y1 (f1, f2,..,fn) where c'1,..,c'n and f1,..,fn are characteristic sets for distinguishing shaped from finished product
06	ASSEMBLE	Assemble shaped and finished products	Putting together automobiles, radios, TVs, etc. from components	A (Y1.1, Y1.2, Y1.3,..,Y1.n) => Y2, where A stands for an assembly function and Y1.1, Y1.2, etc. are finished components fo final product Y2
07	PACKAGE	Design external containment(s) from product	Designing safe packages for electronic devices for crosstown or interstate delivery	Y1 + [e1, e2,..,en] = Y2 (e'1,..,e'n), where e1,..,en are external elements of packaging and e'1,..,e'2 are product characteristics added to Y1 through packaging, to yield Y2**

* All processes that carry label prefixes 01, 02 and 03 can be calculated with generic sub-processes, e.g. Cobb-Douglas functions. Energy input into these processes is of the form Xe^a(01.1)+..+a(01.n)+a(02.1)+..+a(02.n)+a(03.1)+..+a(03.n), i.e. the extended Cobb-Douglas form where X1,..Xn are primary inputs into the production process and the exponents are numbered for all pre-production and production process.

** The TOTAL attribute vector c1,..cn,c'1,..,c'n,f1,..fn, can map products through process types 04 and 05. Energy use rates can be expressed per degrees of vector shift per unit product. OR as per changes in value per vector element. A methodology like conjoint analysis can then COMPARE vector shifts and scalar element changes.

An end-use taxonomy for the industrial sector had been attempted by Seattle City Light. In essence, the approach consisted of taking the eight major subsectors in Seattle City Light's industrial sector, constructing an end-use matrix for each subsector, and estimating the cell-by-cell values, i.e. for annual KwH consumption by end-use per subsector. This type of data is needed for the Industrial Sector Energy Management Plan, which calls for Seattle City Light to develop programs in Industrial energy management in 1991 and beyond.

The idea of a comprehensive Industrial Sector plan is a new one for Seattle City Light. Up to the present time, industrial-sector projects at Seattle City Light have been limited to a measure-by-measure energy savings program for industrial customers with financial assistance provided via the Bonneville Power Administration (BPA).

Following the matrices developed in 1988, efforts were made in 1989 to obtain data on the industrial sector in Seattle City Light's service area. Industrial subsectors were identified by SIC code, major customers in each subsector were picked out from billing records, and a telephone survey was conducted to find out how electric energy was being used by industry in the Seattle area. The results of this initial survey are presented in Table 3.

It was quickly discovered that although the customers who were being surveyed represented 70% of all industrial use of electricity in the area, their diversity even within the same subsector was so great that very few generalizations could be made about energy use and savings potential from their responses.

Table 2. Indirect Process Steps

CODE	LABEL	DEFINITION	EQUATION TYPE*
08	MOVE	Change physical location of product (e.g. transport raw materials, intermediate and final products within, into and out of facility	Delta transport function, with distance, weight and portability characteristics as independent variables
09	SUPPORT	Maintain EXTERNAL conditions for processing of product (e.g. temperature controls, space, lighting, etc.)	Standard cost function with support activities covered under fixed and semi-variable costs
10	CONTROL	Maintain information flow/control for process(es), direct and indirect, in producing product	Stochastic information equations in simplified form, with feedback/stabilizer loops
11	STORE	Store product at different stages of processing, from initial input/raw material stage, through to intermediate and final products	Inventory models with stock/flow variables, intermediate and final product storage characteristics storage characteristics
12	MAINTAIN	Maintain INTERNAL conditions for processing of product (e.g. process quality controls, equipment repair, etc.)	System/feedback models with stochastic and threshold-value variables, system stability conditions and capacity constraints

* Process equations of the types used for steps 01 through 07 are not useful for the "indirect" steps 08 through 12, because changes in the actual characteristics of a unit of product are not involved. Instead, these steps can be represented by standard econometric equations for each of these "indirect" activities, and energy use can be estimated using joint demand functions.

Table 3. 1986 SCL Industrial Energy Use in Annual Average Megawatts (Mw)

			Direct Processes (By Equipment Type) 01 to 07						Indirect Processes 08 to 12			
SIC CODE	Load Forecast Industrial Group	1986 Load (Annual MwH)	Air Comp	VFD Apps	Other Motor	Furnace Oven	Refrig-eration	Welding	Lights	HVAC/ Other	TOTAL	Subsector Load as % of Total
20	Food	150,217	1	2	5.8	0	5.6	0	2.1	0.7	17.2	11.3%
32	Stone, Clay, Glass	279,257	2.5	0.8	11.3	16	0	0	1.4	0	32	21.0%
33	Primary Metals	273,261	0.6	0.8	7.3	21.6	0	0	0.9	0	31.2	20.4%
372	Aerospace	400,486	3.5	0.3	14.2	1.5	1.2	0	14.2	5.4	40.3	26.4%
373	Shipbuilding	32,319	0.7	0	1.4	0	0	0.8	0.1	0.7	3.7	2.4%
	Other* (All other SCL Industrial Group)	247,060	1.3	0.3	3.5	7.5	8.5	1.6	4.3	1.3	28.3	18.5% 100.0%
	TOTALS	1,382,600	9.60	4.20	43.50	46.60	15.30	2.40	23.00	8.10	152.70	
	End Use Loads as % of Sector Total		6.3%	2.8%	28.5%	30.5%	10.0%	1.6%	15.1%	5.3%		

* Based on 1987 Load data.

The taxonomy proposed in this paper was an outgrowth of this experience, and reflects its purpose as well as the need it addresses.

As it happens, Seattle City Light initiated a research program in 1988, called the Industrial Retrofit Demonstration Project for measuring energy savings from retrofitted industrial measures. Initial data gathered from the Industrial Retrofit projects could be used to test the new taxonomy.

Once the logic and the backup formulas for the proposed new industrial taxonomy had been constructed, a standard form for collating field data was developed. The form can be used for analysis of individual industrial customers based on data already available in Industrial Research Project or Customer Assistance Files. It can also be used for unstructured field interviews, or for systematically documenting walk-throughs in industrial plants. The use of the form as an operational tool is being examined by the Industrial Customer Services Division at Seattle City Light.

For test purposes, the forms were completed using descriptive data from the industrial research projects. As can be seen from the form, each firm is documented separately, with its own name and under its SIC Code identifier. The data reflect the form's intended use as part of a first-stage, field-level audit to describe the processes actually being used in an industrial firm.

A second-stage audit, probably as part of a routine customer service contact, could then obtain more specific data on those identified processes which are *EITHER* generic and substantial users of electrical energy for the industrial sector as a whole, *OR* which account for the bulk of electrical energy use in the subsector that the firm represents. The second-stage audit would gather information on the kinds of initial and intermediate products used in the selected processes, energy use per unit of product, and on costs of energy for applying the particular process.

A third-stage audit could be conducted of major energy-consuming processes. This would require labelling all sub-processes, identifying and quantifying the detailed process equations, and deriving econometric relationships between process energy use and supply/demand parameters. Although the third-stage audit is likely to be more analysis than data collection, it has to wait until sufficient second-stage data has been gathered.

The initial case studies using the taxonomy, which were intended as proxies for first-stage audits, are presented in the attached Appendix.

RESULTS

When reviewed in the context of (unpublished) proprietary and detailed energy-use information obtained by Seattle City Light as part of its research effort, these case studies confirm that industrial activities can indeed be grouped under the 12-item taxonomy presented in this paper. Here are further findings:

1. Most energy-using activities in the industrial firms in the case studies were found to be possible to label and classify. There are a few *unknowns*, indicating areas where activities were known to be taking place, but where information clearly could not be obtained via preliminary audit. Since the field data had been gathered before the taxonomy had been developed, the finding is that a process-based taxonomy can actually draw the field-level auditor out into defining *WHAT* he needs to know; starting from the process categories listed in the taxonomy, a field-level auditor can look for energy uses that meet the classifications, and thus arrive at a more complete picture of energy use in an industrial establishment.
2. The columns headed by process labels for the surveyed firms show similarities between their listed sub-processes, even though the industries are very different from each other. This was confirmed by an in-depth review of known energy-use facts regarding the case study processes and firms. The process classification, therefore, seems to work in identifying broadly similar kinds of energy use, although levels of actual energy usage can still vary considerably.[9]
3. While similar sub-processes can be found in the case study firms, the sets of sub-processes making up the"process profiles" of the case study firms are very different. No two firms have exactly the same process profile. In this connection, this turned out to be a decided "bonus". It was clear to the persons doing the review that even preliminary (descriptive) audits can sufficiently

[9] *However, the variations are far less than by end-use or SIC code. Informal estimates are that ranges of variability can be reduced 50% or even 100% using a process based approach.*

identify differences between firms to allow a "cluster analysis" approach for purposes of market segmentation and analysis. Since other forms of market segmentation (such as SIC codes) have proved to be so unhelpful in the industrial sector for making energy-use generalizations, the possibility of clustering around industrial processes would be a marketing breakthrough.

In summary: the taxonomy showed promise as a field-audit tool and a data-organizing instrument. It seems that any commercial or industrial space can have its energy usage completely described using these categories.

It also appears energy use can be totalled along activity or process lines, with fewer variability problems than researchers encounter when using commercial or industrial subsectors. The point is at present an intuitive one, but reflects the underlying characteristics of the data as noted from visual inspection. If confirmed by more case studies, this could add a whole new dimension to energy planning, possibly turning it into a stochastic rather than an allocative exercise.[10]

CONCLUSIONS

A question often asked in energy management circles is whether an industrial taxonomy is really necessary. After all, each industry (and, possibly, each firm within an industry) has ways of using energy that can be considered unique, or idiosyncratic. Could industrial conservation programs not be executed on a case-by-case, subsector-by-subsector basis? Could not the common denominator simply be "negawatts"? In attempting to develop an industrial energy-use taxonomy, could we be succumbing to the sin of over-specification?

10 *The term "allocative" covers approaches which can be solved by some programming methodology such as Simplex or convex programming. "Stochastic" methods would be those which took process time-dependencies into consideration and worked their interactions into estimating their "allocable" optima. The difference between "allocative" and "stochastic" methods becomes especially important when looking at process and non-process uses of energy in the same model, because time-dependent differences are likely to be substantial and highly interactive.*

The answer depends, at least in part, on whether one believes there is any need to look at energy management in terms other than programmatic expediency. Any attempt to design long-range plans in energy management, especially for the industrial sector, will necessarily require a process-based taxonomy. This is because all the categories dear to the hearts of the short-range energy planner or forecaster--characterizable square feet, end-use measures, end-use characteristics--change and even dissolve over time. Space use changes, new technologies replace current ones, buildings alter their characteristics. Only a "process"-based approach which accommodates technology and "context" (i.e. space, location) shifts within a flexible definition can track energy-use changes to some degree over time.

The proposed taxonomy is intended as a start towards creating the kind of database that will be needed in the 1990s for energy management planning. It is designed for purely descriptive uses in the industrial sector at first. But, as the process equations offered along with the taxonomy are meant to suggest, there are open-ended possibilities for in-depth analysis as more and better data are collected. The way also remains open for extending the taxonomy to the commercial sector. The details of such an extension will be covered in another paper.

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Stuart Schnell edited the manuscript, developed its presentation format and supporting materials and exercised control over the final product.

Needless to say, none of the above persons are responsible for any errors or omissions in this paper.

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APPENDIX

INDUSTRIAL ENERGY-USE ANALYSIS FORM

DIRECT:							INDIRECT:				
SEPARATE 01	REFINE 02	PRODUCE 03	SHAPE 04	FINISH 05	ASSEMBLE 06	PACKAGE 07	MOVE 08	SUPPORT 09	CONTROL 10	STORE 11	MAINTAIN 12
	BRASS FOUNDRY:										
N/A	N/A	0301 Metal Melting (Resistance) 0302 Metal Melting (Induction)	0401 Casting (Motors) 0402 Shakeout (Motors) 0403 Tamper (motors)	0501 Grinding (motors) 0502 Sawing (Motors)	N/A	N/A	UNKNOWN	0901 Lights 0902 HVAC	N/A	UNKNOWN	UNKNOWN
	BAKERY:										
N/A	N/A	0301 Mixing (Motors) 0302	N/A	N/A	N/A	0701 Air Cmpressrs 0702 Conveyors	UNKNOWN	0901 Lights 0902 HVAC	1001 PC-Proc.cntrl	UNKNOWN	UNKNOWN
	HEAT TREATERS:										
		0305 Furnaces (Resistance) 0306 Fans (motors) 0307 Induction Coil					0801 Cranes (Motors)	0901 Lights 0902 HVAC	1001 PC		
	BOTTLING:										
		0301 Mix (Motors) 0302 Mix-Chill (Refrig)				0701 Bottling (Motors) 0702 Conveyors	0801 Conveyors (Motors)	0901 Lights 0902 HVAC	1001 PCs	1101 W'Hs Lights 1102 W'Hs HVAC	
	SHIPYARD:										
			0401 Plasma Torches 0402 Welders 0403 Regular Torches	0501 Grinders (Motors) 0502 SprayPntrs (AirComp) 0503 PaintBooth Ventlln. (Fans)	0601 Welders 0602 Pwrtls (AirComp) 0603 Powrdock Lifts (Motors)		0801 Cranes (Motors)	0901 Off.Lights 0902 Off.HVAC 0903 Ship power 0904 Yard Lights			