Industrial Energy Use Benchmarking

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ABSTRACT

Corporate energy efficiency improvement offers significant potential to reduce greenhouse gas emissions. However, only by understanding current performance can a company hope to improve performance consistently into the future. Benchmarking enables organizations to measure their performance and compare with others, offering a tool to support continuous efficiency improvement. This paper addresses existing benchmarking efforts in the industrial sector and the value the benchmarking concept may provide for energy efficiency improvement, and associated greenhouse gas emissions reductions, in energy intensive industries. Industrial benchmarking activities, in the private sector or as part of voluntary government programs, are discussed.

Introduction

The goal of this paper is to explore the application of the benchmarking concept to voluntary agreements between government and private industry, with a particular focus on energy intensive, or "heavy" industry. The industrial sector consumes roughly one third of the energy produced in the United States. Carbon emissions from the industrial sector are a function of primarily two characteristics: activity level and activity carbon intensity. In turn, carbon intensity is driven by energy intensity of each process and the fuel and conversion efficiency of the energy source. Thus, reducing energy intensity, the energy required to produce a unit of product, is an important means reduce human impact on the climate.

To achieve emissions reductions without resorting to strict regulatory regimes, a number of national governments have set up voluntary agreements with companies in their industrial sectors. In general, these voluntary programs have sought to achieve the goal of reduced emissions through improving information available to participating firms and improving the incentives structure for environmentally preferable actions. Benchmarking represents one way to increase the level of information available to industrial firms and is used to varying extents in existing voluntary agreements. The potential to be gained from the use of benchmarking as an explicit component of voluntary agreements is a key issue area discussed in this paper.

Essentials of Benchmarking

Benchmarking is the process of identifying and understanding differences in performance between similar processes or organizations (APQC). The long-term success of any organization requires adaptation to a shifting competitive environment. This necessarily involves management of different aspects of firm performance. Access to appropriate information about these different aspects eases decision-making and transforms guesses into

management decisions. Performance measures important to any firm involve standard financial statement figures such as revenues, costs and profit, but may include less obvious variable or aspect of performance.

Basic Types of Benchmarks

Three distinct varieties of benchmarking are common: internal tracking of performance over time; comparison of similar processes within a plant or company; and industry-wide comparisons. Each offers positives and negatives, but in general the information and consequent value of benchmarking increases with each increase in scope. Benchmarking variables of organizational performance against other similar organizations provides additional data and a broader context of operational styles. These advantages can lead to increased potential to identify best practices.

Defining Metrics and Scope

Meaningful benchmarking involves comparison of several groups using a specific common metric. Energy efficiency represents an often ignored metric that has substantial impact on corporate financial performance especially in heavy manufacturing (including such energy intensive industries as chemical, pulp and paper, iron and steel, glass and aluminum manufacturing). In addition to direct measurement of energy and process efficiency benchmarks, comparison of management attitudes and practices regarding energy issues is an important metric. The first step in developing a benchmark is to identify the process, or product, or practice to be compared. There is a trade-off that has to be made between completeness and accuracy: the more business processes that are brought into the benchmark the more likely that there will be differences among benchmarked systems.

Information Collection and Verification

Once a metric has been specified, data must be gathered on the processes in question and verified in some fashion to ensure reliability and comparability of processes and measured data. While data collection should be a straightforward result of metric development and firm measurement activities, verification is a slightly more complex concern. Additional layers of verification beyond self-verification may be desirable. When used as a component in a voluntary agreement, verification by the government or a third party is appropriate to provide impartial, independent assurance of corporate progress.

Benefits of Benchmarking to Voluntary Programs From a Governmental Perspective

From a governmental perspective, benchmarking offers a variety of benefits for the development of voluntary programs. These benefits can be categorized into two general areas. First, benchmarking could serve as a driver for improved efficiency and lower emissions of greenhouse gases from benchmarked processes and industries. Rapid acceptance of this approach in the marketplace is possible because business practices are already commonly benchmarked and because industry's own information would serve as the basis of the resulting system. Rapid acceptance could lead to significant results: as is often

noted, you cannot manage what is not measured. While measurement will not automatically lead to better management, the availability of information will no longer be a potential hurdle to effective action. Also, clear indications of performance relative to competitors could be adopted as performance criteria or goals within industrial firms. In addition, management practices benchmarked help focus senior management attention on valuable opportunities to improve product and efficiency. Finally, because benchmarking revolves around relative performance, it offers great potential as a tool for continuous improvement. In effect, once set in motion, the process would not necessarily reach a natural sunset point as would an absolute intensity target.

The second benefit is improved emissions data. Benchmarking could conceivably deliver more reliable data on emissions performance and potential for improvement than currently exists. Depending on the type of benchmarking performed and the degree of detail required, data on energy intensity and best practices could be used effectively in industry and national inventories and projections and form the basis for a record of emissions and reductions over time.

Reliable data is important to assess progress towards national carbon emissions targets that countries adopt under the Kyoto Protocol, and is critical to assure the integrity of a potential carbon trading programs. In the U.S., credit for early action to reduce greenhouse gases (GHG) emissions has been proposed. The information provided to support credits would need to meet some stringent quality criteria. The quality of data needs for early credit was examined in a 1998 study by the U.S. General Accounting Office (GAO). The GAO reviewed the Voluntary Reporting Program (VRP) which provides organizations with a means of voluntarily submitting information about their efforts to reduce greenhouse gases to the U.S. Department of Energy's Energy Information Agency. The program allows companies to report whatever they please, an no standard quality assurance/quality control steps are required. The GAO found that many of the claims submitted to the VRP would be ineligible for credit depending on the restrictive nature of the crediting mechanism. Information required for benchmarking is more rigorous than the VRP accepted data. Therefore reports of company progress using carefully chosen benchmarks could dramatically increase reliability and usefulness of publicly available information regarding corporate emissions and reductions.

Companies may be interested in participating in an voluntary agreement with benchmarking for a couple of reasons. First, useful information about their energy use as well as their competitors would be generated. This is especially important for sectors where benchmarking does not currently occur. Second, and perhaps the largest draw, is the having reliable data useful to applying for early credits or establishing a baseline under any future trading program. Credits generated, either early or beyond program requirements, would have monetary value in a trading program.

Potential from Benchmarking

While there are many benefits to benchmarking, inclusion in a program should only occur if real energy savings will result. If this outcome is possible, then questions of benchmarking system structure and budget can be considered. Activities currently being undertaken by the industry are examined below. Voluntary programs with a benchmarking component are also studied to gain further insight.

Industry Activity

Benchmarking of energy is currently being done in a variety of forms and by various entities. These include manufacturing companies, equipment manufacturers and client service companies specializing in conducting benchmarking studies. As energy can account for a significant amount of total costs, energy use is often a component of benchmarking programs in energy intensive industries. For example, energy costs account for an estimated 20% of iron and steel manufacturing costs, up to 30% for some products in the chemical sector and 30–40% for cement manufacturing.

Some companies, usually large ones, have dedicated energy management teams which not only collect information but also benchmark as a means to improve efficiency. For example, DuPont's Corporate Energy Leadership Team (CELT) collects and publishes energy metrics, conducts internal and external benchmarking assessments and, identifies and leverages energy "best practices" (Stewart 1998). From 1991 through 1996, DuPont's global energy intensity has decreased by more than 10%, saving more than $100 million per year (Stewart 1998). This activity is helping DuPont achieve several corporate goals for the 1990-2000 period: reducing energy intensity by 15% and reducing GHG emissions by 40%. Some other manufacturing companies which publicly acknowledge that they benchmark energy use include the following: Royal Dutch Shell, BASF, Dow and Chevron. Many of these companies also have corporate commitments to reduce GHG emissions; Shell, for example, has committed to reducing its 1990 GHG emissions by 10% in 2002. Other companies benchmark energy use or intensity internally, however the extent of this is unknown to us.

Equipment manufacturers also collect information about energy use by their products. This information is used as a means to promote the product as well as to provide real world data on product performance for their own use. For example, OxyTech, a chlorine cell manufacturer, provides customers with information about the efficiency of their processes relative to maximum potential. This underscores that benchmarked energy information is viewed as a valuable tool, hence possible selling point, to their customers. Customers can incorporate it into their purchasing decision.

In addition to internal benchmarking activity, there some industry-wide benchmarking studies. These studies are performed by private companies which recruit companies to participate. So far, we have identified only three US sectors which have or will have benchmarked energy performance data for multiple years: chemicals, refining and pulp and paper. Benchmarking may be especially important in these industries because of their maturity, low margins and high energy costs. Even within these sectors, benchmarking only occurs for certain sub-sectors/product lines. Some examples of sub-sectors benchmarked in the chemical sector are ethylene and chlorine. Fittingly, these are among the most energy-intensive processes in the sector.

These benchmarking efforts have several key features which affect their suitability for government purposes. To maintain the confidentiality of client participants, the results of these studies are not available to the public. Hence, it is difficult to determine the extent of resulting energy savings. The relationship between provider and client is very important to the success of the studies. Clients work closely with benchmarking providers to develop standard metrics and questionnaires used with all participants. The benchmarking companies also perform quality checks on the data. Because of the amount of interaction and the

confidentiality of process, the results have credibility with the industry and are a cited in discussions of energy intensity. The quality of data from these studies recommend them as possible mechanisms to determine GHG emissions and reductions, however the study methodology makes this problematic.

Even where benchmarking studies of industry-wide energy use exist, those with an exclusive focus on energy are rare. Usually the studies are driven by interest in the profitability of a process, of which energy cost is a component. Nevertheless, energy savings may also be a secondary effect of other benchmarking mechanisms. For example, productivity benchmarking can result in energy savings. Using "Six Sigma," an internal statistical benchmarking method, Dow Chemical aims to increase capacity by 3% to 5% per year. In doing so, it expects to achieve a 2% annual improvement in energy efficiency (Wood 1997). Similarly, in the early 1990's, Chevron Chairman Derr sought to create a company where "best practice sharing, reporting units working together and cross-function teamwork are the norm." In 1992, Chevron began to track implementation of process improvements and performance metrics systematically, while building a company-wide summary of best practices. Furthermore, Chevron established an energy efficiency team to identify best practices and assist in internal implementation. By the end of its first year, the team generated $150 million in savings; by 1997 they had saved a total of $648 million (O'Dell et al. 1998). Thus, while energy specific benchmarking may not be common across the industrial sector, other forms of benchmarking which are more common offer potential avenues to introduce the subject.

These examples show that benchmarking practices currently used in some companies can increase energy use performance. It follows that benchmarking can assist climate protection through accelerating corporate investment in activities and processes which ultimately reduce GHG emissions. While benchmarking provides an additional source of feedback on performance, information alone appears insufficient to ensure improvement: lack of management attention is a common problem. DuPont provides an example where energy benchmarking resulted in savings because of management attention facilitated by a corporate goal of Energy Excellence.

Having a corporate system to manage energy in place reminds executives to focus on this important contributor to productivity. A successful energy management system encourages review of energy use information at the highest corporate levels. Consistent review at upper levels of management not only ensures that energy efficiency improvement is not a one-time event following a site energy audit, but also creates an environment where longer term efficiency projects can be proposed and approved. For example, BP Chemicals improved the energy management information system at their Hull, UK manufacturing complex, reducing energy consumption by 8% and saving $3.5 million a year (Energy World 1997). Hence benchmarking corporate systems to manage energy is another means of increasing energy efficiency.

Current Voluntary Agreements with Benchmarking

There are two ways voluntary agreements currently use benchmarking. One way is to provide benchmarking information as a service to its participants, in which case companies are not required to implement any specific activities. These are considered to be informational programs The other is to base compliance with the voluntary agreement on

benchmarking results. One of these two approaches appears in each of the programs we have reviewed, a sample which includes the following national programs:

- Benchmarking Energy Efficiency Covenants, Netherlands
- Canadian Industry Program for Energy Conservation (CIPEC), Canada
- Energy Efficiency Best Practice Program (EEBPP), Australia
- Energy Efficiency Best Practice Programme (EEBPP), United Kingdom
- Industry's Network for Energy Conservation (IEEN), Norway.

Except for that of the Netherlands, all these programs use benchmarking as a component within a larger program targeted at reducing energy use in a sector. With this approach, the purpose of benchmarking is to raise company-level awareness of energy use in hopes of creating incentives for action. Other components of the programs include disseminating technical information through case studies or training modules.

Often, program results are used to support other voluntary programs related to GHG emissions reduction goals. Information developed under the Australian EEBPP can be used by firms that later enter into a Greenhouse Gas Agreement. Similarly, CIPEC's mission is to reduce industrial energy intensity not only to enhance economic performance, but to also meet Canada's carbon dioxide stabilization objectives (CIPEC 1998).

Many of the informational programs are based on the UK EEBPP and have started within the last year. If results from the UK EEBPP are any indication, it is expected that definite savings will result from the programs. UK EEBPP is expected to save almost 2.7 million tonnes C from the industrial sector by 2000 (Collingwood et al. 1998). Based on an evaluation of the program, estimated savings between 1989 and 1998 were approximately 133 TBtu's, of which 28 MBtu from chemicals, 13 MBtu from food and drinks, and 3 TBtu from glass sector (Collingwood et al. 1998). Savings have also been achieved in a cost-effective manner: for every dollar spent, UK EEBPP claims that five are saved in the larger economy. Without considering downstream savings, carbon emissions reductions cost approximately $30–50 per tonne, much cheaper than some initial estimates (Mallaburn et al. 1998).

One reason why programs can result in savings is because they have been selective in the sectors selected for benchmarking. For the informational programs, the choice depends on the availability of information, corporate requests and the relative complexity of the products or processes used in the sector. For instance, Canada decided to undertake benchmarking at the request of firms reporting emissions into the Climate Change Voluntary Challenge and Registry (Munroe 1999). They also began with the pulp and paper industry because the association already collects the necessary information for benchmarking.

Recognizing that benchmarking energy use is not enough, the UK EEBPP also provide participants with an Energy Management Matrix. The matrix enables participants to evaluate their management performance in six key areas: motivation, management organization, information systems, marketing and investment. The matrix recognizes five levels of achievement for each issue area.

The Netherlands uses benchmarking as a tool to achieve its 8% Kyoto emissions reduction target. The Netherlands Benchmarking Covenants are expected to reduce emissions by 1 to 3 million tonnes C in 2012, relative to 1990 levels (NOVEM 1998). This is equivalent to 10 – 20% of their Kyoto target. Participants in the covenant are associations

and or individual companies in the chemical, refining, iron and non-ferrous metals, paper and electricity production sectors. These sectors account for more than 80% of energy consumption by Dutch heavy industry and power generation (NOVEM 1998a).

Not only are the signatory sectors energy intensive, they also have a large potential to reduce energy use. Savings are expected, because these industries are not at "the top of international standards." This criteria is defined as performance where the energy intensity of each plant is either (1) in the best 10% of plants operating worldwide (excluding Dutch facilities), or (2) comparable to the average of the best region in the world. Choice of option (1) or (2) is up to the company. If no fully-developed benchmarking system is available, company performance will be assessed on the basis of a best practice approach (NOVEM 1998b). A preliminary assessment performed in 1998 determined that, as yet, none of the sectors have met the standard (Phylipsen et al. 1998).

Characteristics of Benchmarking Programs

The type of voluntary agreement and how benchmarking is used depends on a number of factors such as, degrees of effectiveness, cost to the government and characteristics of participating sectors. There are a number of similarities among the informational benchmarking programs. These are listed below and in Table 1. Since the Netherlands is not considered to be an informational program, it is not included in Table 1 (ETSU 1999; Finden; Michel 1999; Munroe 1999; NOVEM 1998a).

- Associations are active in benchmarking effort by collecting and analyzing information;
- Sectors which are benchmarked are ones which have generic processes or are benchmarked on a sub-sector level;
- Government funds the benchmarking activities;
- Benchmarking is a component of a voluntary program which is aimed at increasing energy efficiency; and
- Voluntary energy efficiency program complements voluntary climate change programs and policies.

Table 1. Description of Informational Benchmarking Programs

Program and Responsible Agency	Benchmarking Activity	Industrial Sectors, as of March 1999	Other Program Activities
Australia , EEBPP Ministry for Industry, Science and Resources, Energy Division	Government funds sector studies and associations perform benchmarking study	Baking, dairy, coal mining	Sector studies, good practice guides and case studies, education and training, marketing and promotion Complements Greenhouse Challenge
Canada, CIPEC Natural Resources Canada, Office of Energy Efficiency	Government reimburses sector associations who collect information and perform benchmarking study	Dairy, pulp and paper, cement (in discussion with mining to benchmark ventilation)	Voluntary sector task forces determine potential for energy efficiency improvements and report and track progress Complements Climate

			Change Voluntary Challenge and Registry
Norway, IIEN Ministry of Petroleum and Energy through the Institute for Energy Technology	Information about company energy use and production data is a requirement for membership, used to develop benchmarks.	Pulp and paper – paper and cellulose production, dairy – drinking milk, slaughterhouse and meat processing, aluminum production, baking, others	Targeted at small and medium enterprises, energy management and analysis, sector and technology studies, demonstration projects
UK, EEBPP Department of Environment, Transport and the Regions, Energy Technology Support Unit (ETSU)	Government work with associations to develop questionnaire, but government performs benchmarking	Brick and pottery, glass, pharmaceutical, iron foundry, closed die forging, plastics (injection moulding of thermoplastics, extrusion blow moulding), others	Energy consumption guides, good practice guides, new practice case studies, energy management matrix, collaborative R&D Complements Making a Corporate Commitment Campaign, Industry Consultations

The contribution of associations is an important aspect of voluntary agreements with benchmarking. Associations offer a number of benefits. For example, Australia has associations as the signing partners to enhance their buy-in and ownership of the program (MISR, 1998). This helps to ensure that associations will be active in working with their member companies. In the letter to the Australian EEBPP, associations indicate the expected level of industry involvement by noting the number of firms which will be participating. This confirms the associations' intention to encourage participation (MISR 1998).

In the case of Canada's program, the program builds off of existing relationships with associations which have been formed through CIPEC. CIPEC has about 20 voluntary sector task forces which establish sector-specific energy efficiency targets and action plans. Another reason the Canadian program works through associations instead of individual companies is because they can leverage information currently being collected by the Canadian pulp and paper association. Why reinvent the wheel when the needed information already exists. Some associations in the U.S. currently collect information from their members. It may be possible to use that as a vehicle as part of benchmarking in the U.S.

Working with the associations can also relieve concern about confidential business information (CBI). Company's are afraid that CBI may not be secure by giving it to the government and that the information may be used against them somehow. So if information was not directly given to the government, company's may be more willing to participate in surveys.

Access to technical expertise is another reason why it is important to work through the associations. Association's can provide guidance on what the key processes are to benchmark and what the right information to collect is. This is especially true for industries with multiple and complex processes. As an example of the cooperative participation, the UK Association of the British Pharmaceutical Industry and some industry representatives assisted ETSU to develop the information survey for the Pharmaceutical Industry Energy Consumption Guide (ETSU 1993).

To also encourage participation the in the program, funding for the benchmarking activity is paid for by the government. For example, Australia pays for a staff liaison in the industry association, sector studies about energy use in the industry and all other costs associated with implementation of the overall program (Michel 1999). The other programs may not be as generous, but the bulk of the costs are borne by the program. While the associations are very active in the development of the benchmarking study, they do not have unlimited authority. The Canadian associations will only be reimbursed for their studies as long as the studies meet guidelines set by the government.

The voluntary agreement in the Netherlands differs in a couple of respects from the informational programs. While the covenants are voluntary, they are legally binding documents. Hence, benchmarking is required because it is used to determine whether the participant is meeting its obligations. Because of these two differences, the characteristics and issues of the program are very different than the ones above. They are:

- Associations are signatories to agreement, but individual companies also need to sign if they want to participate;
- Multiple government agencies are signatories to the agreement;
- Energy intensive sector involvement; and
- Benchmarking is paid for by the company with some assistance from Government.

Once again, the associations are the direct participants of the agreement, not individual companies. Companies take part via a Participation Statement (NOVEM 1998b). As party to the Covenant, the government is obligated to not impose any additional specific measures aimed at energy conservation or reduction of CO_2 emissions on companies taking part. Some example activities are: no specific national energy tax; no additional compulsory energy efficiency or CO_2 target; and no additional CO_2 or energy requirements. Due to the cross-sector impact of the commitment, more than one government agency is part of the Covenant. They include: Minister of Economic Affairs, Ministry of Housing, Physical Planning and the Environment and the Inter-provincial Consultative Forum.

Companies themselves are responsible for determining the "top of international standards" by working with consultants to undertake the study. The Netherlands Agency for Energy and the Environment (NOVEM 1998b) will act as an independent authority verifying various stages of the benchmarking process. It will verify the instructions to the consultants and the final report (NOVEM 1998a). The government will fund the costs with administering the Covenant. The companies will bear the cost of their participation in the benchmarking studies and of developing new benchmarking systems (NOVEM 1998b).

This type of covenant is expected to be an effective means of achieving emissions reductions and minimizing costs. However, it may only be successful if there is a large incentive for companies to participate and if the government has the authority to provide those incentives. So this type of agreement may not be appropriate for all countries.

A potential problem with basing the Covenant on benchmarking is that participation of facilities in other parts of the world needs to be secured in order to meet covenant requirements. For certain sectors, it is anticipated that benchmarking will not be a problem because the information currently exists or that certain sectors/companies already collect the necessary information for a benchmarking study. A set of two pilot projects, in

polypropylene and ammonia manufacture, will assess the difficulty in obtaining representative global participation.

The Netherlands Covenant approach will have several positive externalities. First, it will increase the level of industrial benchmarking. A sample of sufficient size will require more firms to benchmark than there are currently. Second, the Dutch system may well require more detailed information than is gathered under current benchmarking approaches. Third, since many of the participants are multinational companies, foreign spill-over effects due to internal benchmarking and information transfer may be high.

Conclusion

It appears that indeed benchmarking could be a means of achieving and accelerating energy efficiency gains. From examples of companies which have benchmarked and government programs which use benchmarking, significant savings in energy and GHG emissions are found. In addition to those benefits, benchmarking also serves plant level performance information needs. Benchmarking could also provide reliable data which is important for early credit and benefits all parties involved. Thus, benchmarking can benefit both industry and government.

If benchmarking is to be included in a voluntary agreement program, it should be targeted to practical sectors since not all sectors can be easily benchmarked. Benchmarking can be time consuming and incur costs. Current voluntary agreements with benchmarking work directly with industry associations, rather than individual companies. The benefits of this include: coordinating with one entity instead of trying to recruit multiple companies, access to technical expertise and overcoming concern of releasing CBI to the government. Finally, benchmarking should not just be limited to energy use benchmarking, but also include management priorities and practices.

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