Execution Experience with the Dutch Energy Efficiency Benchmarking Covenant between the Government and the Chemical Industry

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ABSTRACT

In July 1999 the Dutch government and various Dutch industry associations including the chemical industry association (VNCI) concluded an agreement (The Energy Efficiency Benchmarking Covenant). Under the terms of the agreement, the members of the association with high-energy consumption sites agreed to voluntarily benchmark the energy efficiency of their processes against the best similar processes on a global basis. Those sites with collective process results not within 10% of the best agreed to submit and implement improvement plans to reach the top 10% level by the year 2012. Phillip Townsend Associates (Townsend), as an independent third party, was retained by a number of Dutch companies to conduct these benchmarking studies.

This paper describes the approach laid out in the covenant, the methodologies Townsend developed to carry out the tasks and the experiences that arose in the initial execution of the program. The lessons learned and considerations for implementation of similar types of programs elsewhere are discussed.

Introduction

Following the Kyoto climate conference at the end of 1997, The Netherlands and the European Economic Union (EEU) decided to proactively pursue programs for reduction of carbon dioxide and other greenhouse gases[1]. Improving energy efficiency has a direct effect on reducing emissions. However, the Dutch government did not want to impose heavy restrictive measures as a method of improving energy efficiency because such measures might cause industry to relocate elsewhere. As an alternative, the concept of a cooperative covenant was developed in which companies would agree to evaluate themselves against their best global competitors and to work toward energy efficiency improvements that would lead to environmental and economic gains.

This covenant was developed cooperatively between the national government, the provincial governments, and the Confederation of Netherlands Industry and Employers VNO-NCW. VNO-NCW represents six major industry associations - chemicals (VNCI), iron and steel (NIJSI), non-ferrous industry (NFI), petroleum (VNPI), paper and cardboard (VNP), and electrical utilities (SEP)[2].

In return for companies entering into the covenant, the government agreed not to impose any national energy taxes and not to introduce any new efficiency or CO_2 targets or CO_2 ceilings. Companies would not be asked to target some theoretical objective, but only

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[1] Benchmarking Commission. October, 2000. Going for the Top – energy efficiency benchmarking covenant. The Hague, The Netherlands.

[2] Benchmarking Committee. July 6, 1999. Energy Efficiency Benchmarking Covenant.

rather to come close to what their best international competitors were already doing. About two thirds of the energy intensive sites were expected to sign the covenant though no firm numbers were available at the time of this publication.

Covenant Guidelines

The covenant lays out the guidelines for how the program is to be carried out. The key elements of the covenant are:

Participants

Production sites must consume 0.5 Peta Joules or more of energy per year to participate. Sites may contain two or more process plants that individually do not meet the 0.5 PJ test, but in total do.

Term

The covenant runs for a period of 12 years (until 2012). Companies are supposed to benchmark themselves in the first year and every four years thereafter. 2004 will be the first evaluation of the progress to see how much improvement companies have made toward implementing improvements.

Oversight

A benchmarking committee made up of representatives of the Ministers of Economic Affairs (EZ), the Inter-Provincial Consultative Forum (IPO) and the participating sector organizations (VNCI, etc.) conducts supervision of the process and reports to the government ministers. The Energy Benchmarking Verification Bureau (VBE) was set up as an independent bureau affiliated with the government to monitor the process. Their role is to insure the integrity of the process, interpret the covenant guidelines, advise participating companies and qualify the improvement plans submitted. They qualify independent benchmarking firms and assure the rigor of the benchmarking efforts. They also assure the confidentiality of the data created in the process by committing not to distribute any of the underlying details to other government departments or organizations.

Process

The process defined in the covenant is as follows.

Select method. One of three benchmarking approaches is to be used depending on the situation in that industry.

If there is an existing benchmarking program for that industry, the participants are obligated to use it if possible.

If no such program exists or can be initiated in the time allowed, then a "Best Practice" evaluation is to be conducted. This means the most energy efficient plant in the

world for that process should be identified and its energy efficiency determined for comparison with the Dutch site.

If the manufacturing process is determined to be unique such that no equivalent process can be found for comparison, the site is supposed to retain a third party firm to conduct an efficiency audit. This audit is supposed to measure that process's current efficiency against what it potentially could be if it were run in the most energy efficient way. Very few processes were anticipated to fall into this third category.

Who to benchmark. Companies must retain an independent third party to conduct the benchmarking effort for them. The VBE must approve the qualifications of the third parties. If there are two or more companies in The Netherlands in that industry, they must agree on the same consultant. Different companies with the same process can not hire different consultants that might come up with different calculations of the best international standard.

Third parties have to meet a number of qualification criteria for approval. Briefly, they have to demonstrate: 1) a competence in the process being evaluated, 2) an ability to conduct international benchmarking studies, 3) independence, integrity and a willingness to work with the Dutch authorities in explaining the approaches used and the results obtained.

How to benchmark. A nine-step process is to be followed for either a benchmarking program or a Best Practice analysis.

First, document the Dutch site's process and energy consumption for that process. Energy values at the plant for steam and power usage were collected in or converted to giga joules.

Second, identify any nonstandard conditions (correction factors) that would apply either to the Dutch site or to the sites to be benchmarked so that all sites are on a comparable basis. The covenant allows for eleven possible correction factors that might apply.

1. Scope – normalize for configuration differences (e.g., utility island)
2. Composition/Quality/Conditions of raw materials (e.g., monomer purification)
3. Intermediate product generation
4. Product qualities (e.g., grade slate products with different energy intensities)
5. Storage - raw materials (e.g., tank farm storage versus pipeline receipt)
6. Terms of delivery (e.g., raw material requiring pressurization to use)
7. Climactic conditions – extreme temperatures requiring extra energy to operate.
8. Environmental measures taken – extra equipment for local standards.
9. Capacity utilization – an adjustment for energy use at below capacity conditions.
10. Scale effects
11. Cogeneration – plants using cogen sources can claim an efficiency benefit.

No adjustment is allowed for different technology versions used to produce the same product.

Third, evaluate the correction factor requests for reasonableness and compliance with guidelines. Submit them to the VBE for approval.

Fourth, apply the allowed correction factors to the rest of the plants in the benchmarking data set or to the Best Practice plants.

Fifth, convert site energy values to primary energy equivalent values. Since the objective is to reduce carbon dioxide and other greenhouse gases, the Covenant calls for site

energy consumption values (e.g., giga joules of steam) to be converted to the fossil fuel equivalent (primary) energy values used to create the steam and power. The standard conversion efficiencies that were to be used are significantly different (0.9 for steam and 0.4 for power).

Table 1. Primary Energy Conversion

Electricity	1 GJ Site	2.5 GJ Primary
Steam	1 GJ Site	1.1 GJ Primary

Sixth, normalize all values to a units-of-production basis. Total giga joules were divided by metric tons of output of the plant to obtain a giga-joules-per-ton value.

Seventh, calculate the international standard for comparison. Where a benchmarking process is used, the covenant allows for two methods (Decile or Regional) of calculating the international standard and allows the Dutch participants to select the most favorable (the higher) approach.

Decile Method – in this approach the non-Dutch plants in the benchmarking group are ranked from low to high based on their primary energy value. The international standard is the plant value at the tenth percentile in a list (the decile plant).

Regional Method – In this method the plants are grouped into geographic regions approximately equivalent to the output of the plants in The Netherlands. The energy value of the regions is calculated as the simple average of the primary energy values of the plants in the region. The regions are ranked low to high and the international standard is the value of the lowest region.

Where a Best Practice approach is used instead of benchmarking results, the Covenant states that the international standard shall be equal to a value 10% above that of the best international plant.

Eighth, compare the Dutch plant results with the international standard and compute a gap (positive or negative). If, for example, the international standard for a given chemical was calculated to be 1.0 GJ/Tonne, and the Dutch plant value was 1.4 GJ/Tonne, then a positive gap of 0.4 GJ/T was determined. This gap value was multiplied by the plant's output tonnage to get a total peta joule gap for that plant. This means that plant needs to improve by that gap amount.

Ninth, prepare a report documenting the methodology used and the findings from the investigation and analysis. Meet with the client company and the VBE to explain the analysis and answer any questions. All reports were to be submitted by late 2000 so that covenant participants would have time to compute their site-wide primary energy values, and if necessary, develop an improvement plan. Site-wide values mean the net effect of all of the individual plant gaps (positive and negative) on the site.

Report Usage

Upon receipt of the reports for each of the plants on their site, companies must conduct a site-wide accounting. They must calculate the net effect of the gaps of all of their processes, positive and negative, to determine whether the site total is positive or negative and therefore needs to submit an improvement plan or not. If the site result is negative, a plan with a list of projects and the expected effect was to be submitted. This plan is supposed to

contain one or more projects that in total will bring the site up to the international standard by 2012. If the net site result is positive, no action is required, even on individual processes that may have a negative rating.

The 2012 target of this plan is supposed to take into effect the expected improvement in the industry by 2012. This industry improvement forecast may be based on some known changes expected to occur, such as the agreed upon phase out of mercury cell equipment in the chloralkali industry by 2008-9. In the absence of any such insight, companies are to assume a 0.8% per year rate of improvement in the international standard for each process.

These improvement plans were to be submitted to the VBE by January 6, 2001. The VBE was to review and approve these plans. Due to the complexities of initiating this benchmarking process, delays have occurred and some extensions have been granted by the VBE where companies are making good faith efforts to comply.

Execution Experience

For both the benchmarking programs and the Best Practice investigations, the assessment process developed and used by Townsend was as follows:

Documentation

Meet with site representatives to document major process steps, non-standard characteristics (correction factors), energy consumption of steam, power and fossil fuel by major process step and the degree of use of cogeneration. This typically went smoothly. A description of the process and a calculation of its energy consumption were written up and returned to the producer for confirmation and approval.

Approval

Townsend evaluated proposed process adjustments (correction factors) whose role as an independent third party required a balanced assessment of these requests. Factors were considered for compliance with the covenant guidelines. The effect of each was quantified. The correction factors and justification were presented to the VBE for approval. The companies also had discussions with the VBE to justify their case for the proposed adjustments. The final agreement between the VBE and the company became the guideline used for the rest of the analysis.

Correction Factors Use

For processes where Townsend had an existing benchmarking program in place, the approved correction factors were quantified and applied to all of the participating companies in the benchmarking database. In some cases this was a direct one-for-one credit based on energy usage, while in others models had to be developed to allocate the credit. For example, in polypropylene there is an energy intensity range across the product grade slate that has a relationship to the melt flow index (MFI). This is a standard industry test that measures the rate of flow of the material at a fixed temperature and pressure using an industry standard piece of test equipment. The lower the index rating, the slower the flow and the more energy

required to produce the product. A mathematical model was developed to quantify this effect for each producer's grade slate. In cases where a site in the benchmarking program had not provided a particular data item needed to calculate a credit, the average credit calculated for the rest of the group was applied to this site.

Globalize Data Set

For each existing benchmarking program, a decision was made between the Dutch company or companies, the VBE and Townsend about whether it would be possible to include the rest of the plants in the world that were not currently in the benchmark. In these cases it was necessary to determine whether a definitive list of all plants could be assembled and whether there was enough profile information about these plants to allow an accurate estimate of their energy usage. Regression models were developed based on the energy use and on different known characteristics of the plants in the benchmarking programs. Then the R^2 values indicating the degree of predictiveness were evaluated to decide whether the relationships were meaningful.

In some cases these approaches were predictive and were used to estimate the energy of the plants not in the program allowing a global ranking of plants. In other cases good predictive models could not be developed and plants not in the benchmarking database were not used. The VBE's interest in these cases was to be comfortable that the predictive models were reliable and that the subset of companies in the benchmark data set were representative of the larger global set. Once the approach to be used was determined and agreed upon by the company and the VBE, the process proceeded as described previously to identify the primary energy levels of the decile and regional methods.

Best Practice Evaluations

Identifying the best global plant and determining its energy consumption rate.

Investigation - Townsend identified the companies and plants producing the product. The key technology licensors of this process were identified and contacted to request energy data and other summary process information of the most current versions of the technology. This particular task was not successful in all cases. Some processes are old and have stagnant markets such that there are no active licensing organizations, while other leading technologies are not licensed for competitive reasons. And some licensors were not cooperative in providing this type of information. Public literature on new plant openings, upgrades and other information related to these processes was reviewed. Also, relevant patent filings were studied to understand the latest developments and to see which producers were leaders in developing and advancing the technology of the process.

Best Plant – From the investigations described in above, it was possible to determine the top few plants for each process. Typically they were the largest and newest plants with the latest technology. These were contacted to obtain summary energy consumption information. To facilitate this request we asked the client company to offer to exchange some summary energy information with the best plant. Sometimes the client plant did not want to exchange information so the best plant had no incentive to provide information. In other cases, even with the offer of an information exchange, the best plant declined to participate.

Where best plant data was received, their primary energy use value was calculated, converted to the international standard value and compared with the Dutch plant(s).

Hypothetical Best Plant – Where it was not possible to obtain actual best plant information, we created a hypothetical best plant with a calculated energy consumption value. This was based on all the information gathered to date from the client process and their industry insights, any knowledge available about the process used in the best plant and on the most advanced licensor and patent data available. These calculations were always reviewed with the client for accuracy and for consistency with the client site configuration.

Cogeneration Adjustments

Cogeneration is a more efficient user of primary energy (fossil fuels) per GJ of energy output than independent generation approaches (stand-alone boilers, etc.). The parties to the Covenant agreed that plants (Dutch and/or best global ones) using cogeneration sources should get a credit. To meet this objective, some Dutch companies hired a third party consultant for cogen investigations. The process developed was that when Townsend and other consultants working on benchmarking or best practice evaluations determined a set of plants as the best or near the best, they were submitted to this third party firm for investigation.

Near best plants were investigated because if they used cogen and the best plant did not, the near best plant could actually have the lower primary energy value. The cogen consultant was supposed to find out if the plant(s) used cogen, their mix of power and steam, what percent of their energy use came from cogen sources and what the efficiency of the cogen unit was. From this they were to calculate an overall efficiency credit value for that site. At this time, this company has had mixed success in obtaining this cogen information both on use of cogen and on efficiency of that cogen.

Report Creation

When all calculations were complete, a report was prepared and submitted to the client company. When they approved the approach and findings, they authorized the report be sent to the VBE. The client had the responsibility to submit their individual results to the VBE. The report was written with an executive summary that was suitable for submittal to the local authorities that have an implementation oversight role for the improvement plans.

VBE Review

In each case, after the VBE finished their review of the report, a meeting was required in which they audited the detailed data and calculations and assured themselves that everything was reasonable and correct. Their main concerns had to do with whether the process was inclusive such that the companies studied really were the best, and that analysis approach made sense and was consistent with the covenant guidelines.

Data Security/Confidentiality

A key role that Townsend defined for itself with the Dutch companies and with the VBE was one of data confidentiality. Townsend met this role by providing no individual company data to the VBE and by keeping all company data anonymous (no name or location) during audit reviews and discussions. There are also two built in factors that assure the privacy of the actual data in the process. The first is that all data is presented and analyzed in its primary (fossil fuel equivalent) form (after conversion by the 0.4 and 0.9 efficiency factors). So if the mix of power and steam for a given company is not known (is never shown or discussed), there is no way to work backward from the primary value to the net actual values. And of course all of these net values were adjusted from the gross values by one or more correction factor amounts. The second factor is that all of these values are normalized to a per ton amount.

Program Learnings

As with any new program, there were many things that were not clearly foreseen and had to be worked out during the process. Some of these were as follows.

Schedule

Companies did not get organized internally and make a commitment to proceed in time meet the timelines in the covenant. Overall the target completion dates slid for many companies by about three to six months from the original plan.

VBE Expectations

Auditors initially had some misconceptions about the role of the consultants. For example, they requested the consultants to:

- audit (certify) the correctness of the client's data
- provide detailed flow charts of the client's process
- provide detail process flow charts of the best plant
- provide detailed lists of all global plants for a process with owner, location, age, capacity, licensor technology in use, etc.

These requests were not possible to fill with any reasonable amount of effort.

Cogeneration Effects

The methods of handling the effects of cogen were not defined in the beginning. Many meetings and a lot of time were required of all parties including third parties to identify the issues and reach workable solutions. Some things not worked out ahead of time included how the credit would be calculated, how the benefit would be allocated and whether the benefit should be allocated among the processes at the time of the process benchmarking or as a site value at the time of final accounting of the site's performance.

Cogeneration Data Acquisition

Another issue turned out to be how the data would be obtained. Even now, as these approaches are being carried out, there are still issues to be resolved. The cogen consulting firm has not been uniformly successful in obtaining cogen results from best plants. It has not been determined what should be done if data can be obtained for some plants but not others? To ignore these non-reporting sites will result in an incorrect result. If data can't be obtained from all benchmarked sites, the credit will either have to be dropped or an alternative plan developed such as the application of some type of average credit.

Correction Factors

Methods of applying the correction factors in consistent ways required generalized approaches to be defined and worked out with the VBE. For example, how should a stand-alone process be compared to a site with two vertically integrated processes that save energy consumption. The industry standard in chloralkali is to evaporate the caustic (one of the output products) to a 50% concentration level for transportation and commercial use. If a second downstream process on-site does not need its caustic concentrated to a 50% level, there is an energy savings. However, initially this site has been required to receive a debit to artificially raise its energy use to that of the industry standard for comparison sake. Discussions are ongoing with the VBE to reach a fair result for this company such as some type of offsetting site credit.

Regional versus Decile Benchmarking Methods

The assumption by the covenant that the decile and regional methods of calculating a best international standard in a benchmarked process will result in relatively close values does not always work in practice. If the numbers of participants in the global benchmark is not large enough, then the best region that can be assembled may not be as comparable as expected with the decile value in an overall list of all participants.

Another requirement of the regional benchmarking calculation method is that the regions created have a total output approximately equal to that of the plants in The Netherlands. That proved to be difficult to do and ended up being given limited consideration in the creation of regional groupings.

Best Plant Information

Assumptions about the willingness of best plants to provide energy data or even cogen data were optimistic. This has not been a productive endeavor. Better approaches are needed here. Some of the issues are uncertainty about the security of the data (by the consultant and/or the Dutch government), lack of incentive to confirm their suspected competitive advantage and the level of effort required of the best plant to provide the needed data (the cogen questionnaire is 3 pages).

Post Report Changes

In a few cases, after all the agreements with the companies and the VBE were complete, and the analysis and report completed, one or the other of these two parties would want to revise the approach. A client determines that there were more correction factors applicable for that process at his site. Or the VBE is not satisfied with results. Aside from budget considerations, this is an example of the kind of thing that has contributed to the difficulty of achieving the original schedule of January 2001. However it is very typical of what should be expected of a complicated process the first time through.

Conclusions

My conclusion is that overall the process has worked very well for implementing a program of this magnitude in a relatively short time period. There were many details to be worked out for which the methods were not defined in the covenant. The government and company representatives seem to work together cooperatively to resolve issues in reasonable ways.

I think the program will be effective in the long term because it is designed to recognize efforts companies may already have in place that are world class in energy efficiency. The approach of setting goals that are near the current world best and with a continued improvement requirement is one that is challenging, but that can be met with existing technology and practices. And, it has the benefit to the companies of giving them flexibility in their approach as well as relief from specific taxes and penalties.

The next things to watch for will be how companies respond to their own deficiencies and how performance changes (both international standards and Dutch industry) in the next benchmarking cycle in four years.