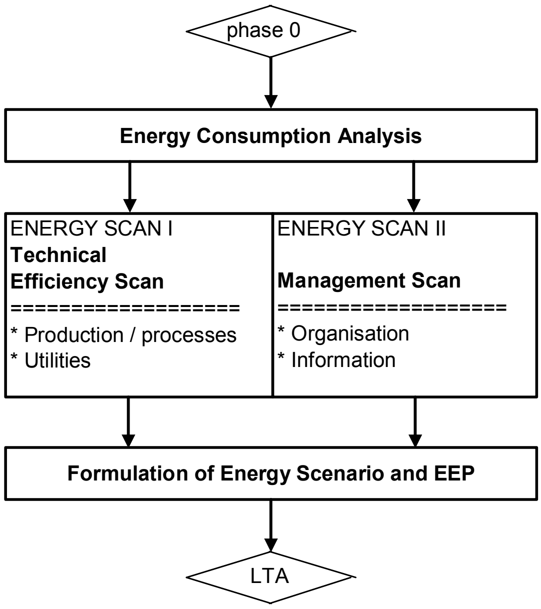
Manual for Energy Potential Scan in Turkey
(draft version May 2008)



<u>Executive Summary</u>:

The Energy Potential Scan that SenterNovem further developed within the framework of Long Term Agreements (LTAs) is an ideal participatory instrument for analysing the existing energy situation of a company and at the same time generating options for energy-efficiency improvement. This manual has been further developed in the framework of the Dutch-Turkish government-to-government project “Promotion of energy-efficiency by Voluntary Agreements in Turkish Industry” in co-operation with the Turkish Ministry of Energy and Natural Resources.

The most important advantage of EPS is that it generates options for energy-efficiency projects and measures including energy management that originate from a wide range of employees within the company itself. This guarantees a high level of involvement, motivation and acceptance towards implementation of improvement steps.
Furthermore EPS is a well proven, flexible and cost-effective tool for defining a company’s LTA plan on energy-saving options as well as improving its energy management system. EPS will almost automatically lead to the formulation of an Energy-Efficiency Programme that can also be used for negotiating LTA targets or for participating cost-effectively in other approaches like CO_2 emission trading systems.

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Contents:

1. Introduction

The Energy Potential Scan (EPS) methodology offers an effective tool for analysing the energy consumption of a company as well as options for energy-efficiency improvement. Also it will map areas in which the energy management of a company can be improved

This manual provides guidelines and recommendations on how to implement the participatory approach of EPS. It highlights crucial preconditions and related consequences for a company related to the successful implementation of EPS.

This manual has been developed in the framework the Dutch-Turkish government-to-government project "Promotion of energy-efficiency by Voluntary Agreements in Turkish Industry" in co-operation with the Turkish Ministry of Energy and Natural Resources.

In this manual answers will be given to questions like:
- How to get commitment for EPS?
- How to form an Energy Action Team (EAT)?
- How to organise and execute the EPS methodology?
- What are the overall deliverables of EPS?

The outcome of the EPS will be the formulation of a company's Energy-Efficiency Programme. This will include drafting a first version of its Energy-Efficiency Plan and taking the first steps towards implementation of an improved energy management system.

Execution of EPS methodology requires full commitment from general management of involved company. A precondition for or obtaining this commitment is that the management team must have proper information and insight into all advantages and disadvantages of EPS and the follow-up steps like implementing energy management and other energy-efficiency improvement actions.

Support and active participation are important prerequisites for successfully implementing the EPS method and the generated energy improvement projects and measures. For effectiveness reasons, personnel members of a company form an Energy Action Team. This team compiles a schedule of the EPS activities and performs the analysis and scan steps itself with assistance and facilitation from an external advisor or consultant.
Also this team ensures that know-how and expertise available within the company are optimally utilized.

The most important advantage of EPS is that it generates options for energy-efficiency projects and measures including energy management that originate from a wide range of employees within the company itself. This guarantees a high level of involvement, motivation and acceptance towards implementation of improvement steps.

In the Netherlands EPS has proven to be a flexible and cost-effective tool for defining a company's LTA plan on energy-saving options as well as improving its energy management

system. EPS will almost automatically lead to the formulation of an Energy-Efficiency Programme (EEP) that needs to be sanctioned and endorsed by the company's management team. This EEP can subsequently be used for negotiating LTA targets or for participating cost-effectively in other approaches like CO_2 emission trading systems.
The approach described in this manual relates to industrial plants with energy costs exceeding a million euro per annum. For less energy-intensive or less complex plants a simpler form of the EPS needs to be used

2. Participatory method of approach for getting motivation and commitment for actions

The participatory method of EPS has many advantages compared to expert type of studies. These advantages are described in section 2.1. The method of approach adopted for the EPS is directly linked from a formula on effectiveness taken from management science. This will be explained and illustrated in section 2.2. For EPS there is also a need for facilitation by external advisors or consultants. Their role is described in section 2.3.

2.1 Reasons for participatory approach

The main reasons for application of the participatory EPS methodology instead of expert type of consultancy approaches are listed below:

- Emotions of employees can be more easily addressed and streamlined and as a consequence less resistance and more relaxation towards implementation of improvement steps will be realised.
- There is far better access to reliable and high-grade information about opportunities and problems within a company.
- Active involvement of company's staff creates more motivation to solve own problems.
- Existing knowledge can be utilised for evaluation of fit for purpose of chosen solutions within own situation.
- Involvement by exchanging information with colleagues creates awareness of new (second order) problems and a positive attitude towards solutions that were not considered to be desirable or realistic on beforehand.
- Involvement creates more self-assurance of employees and develops enterprising competences of managers on all levels.

- Broad participation leads to better decision-making and performance of all departments within company.

- Last, but not least the participatory approach experienced by EPS leads to better overall performance of the company not only in the field of energy-efficiency and other environmental issues, but also in the field of internal and external communication, innovation management and sustainable economic development.

In conclusion, the participatory approach guarantees that the personnel will consider the generated energy-efficiency improvement actions realistic and feasible. This means that the actions will have high level of support from inside the company. This characteristic of the EPS method clearly distinguishes it from other expert type of analysis methods carried out by consultants. Although the output of these other methods seem to be rather similar – a list of actions – there is often far less support for the actions derived from expert studies compared to EPS.

2.2 Effectiveness of Energy Potential Scan

For cost-effective implementation of LTAs between government and industrial sectors there is a high need for good and reliable EPS data on energy consumption as well as ambitious and at the same time realistic options to improve energy-efficiency. These options can be split up in three categories:

a. good housekeeping measures;
b. energy saving projects;
c. strategic and replacement investments.

For LTA facilitation and management reasons it is crucial to have clear and transparent indications of feasible energy savings as percentage of total energy consumption. This type of EPS information will be required prior to the actual signing of LTA for each company or industrial sector that intends to negotiate with government on targets. By having insight in these partly confidential data it will be possible to conclude cost-effective LTAs with both ambitious and realistic targets going far beyond the autonomous trend of energy-efficiency improvement.

The method of approach adopted for the EPS is directly linked to the following formula taken from management science:

$$\text{Effectiveness (E)} = \text{Quality (Q)} * \text{Acceptance (A)}.$$

In other words the **Effectiveness** of the solution to a problem depends on the **Quality** and the **Acceptance** of that solution.

The purpose of the EPS methodology is to find **solutions** for reducing energy consumption in a plant. An important aspect is that the EPS should result in energy-saving options that are considered to be *realistic* and *feasible* by the employees of the plant. The main outcome of the EPS is the identification of projects and measures that will be adopted and implemented in short-, medium- and long-term.

For searching and obtaining solutions of good/high **quality** it is necessary that:

- expert company staff is involved that is familiar with all aspects of the plant configuration and the production processes;
- external facilitators, advisors or consultants (SenterNovem, Bulgarian EPS consultants, etc.) provide tools that have been developed especially for EPS;
- experienced or trained external facilitators, advisors or consultants support the implementation of the EPS by company staff.

For creating optimum **acceptance** of the energy-saving options it is necessary that:

- full commitment is obtained at (general) management level;
- EPS is carried out under the responsibility of the general or plant operation manager;
- employees of various departments of the plant will perform the study in co-operation with the external facilitators, advisors or consultants.

These EPS prescriptions for good quality and optimum acceptance imply the following implementation steps:

1. The management team approves EPS implementation and selects the expert staff from various relevant departments that will carry out the study. The name of this team is: Energy Action Team (EAT).
2. The Energy Action Team will implement the EPS.
3. The EPS tools will enable the EAT to perform the study systematically and efficiently.
4. The external advisors, facilitators or consultants that facilitate the EPS implementation are experts in the field of energy and other environmental engineering as well as energy and environmental management. Furthermore they need to be thoroughly prepared for this supportive EPS task.
5. On the basis of the EPS results, the EAT draws up a provisional Energy-Efficiency Programme (EEP).
6. The management team sanctions and endorses the final EEP.

These steps will be elaborated in chapters 3, 4, 5 and 6.

In conclusion, the participatory EPS leads to and results in a high degree of involvement within the plant and a better chance of energy-saving ideas actually being implemented This is favored by three important intrinsic EPS aspects:

- existing expertise from all levels within the company are mobilised and utilised; energy-saving ideas that already exist within the plant are automatically introduced and combined in this way;
- EPS encourages employees to become even more aware of energy consumption as well as feasible options how to minimise energy consumption;
- the ideas that emerge from the EPS approach will be more readily accepted.

2.3 Facilitation by external advisors or consultants

For a structured and efficient EPS process, the EAT may call upon the services and technical and organising advice of the following types of consultancy:

- management consultancy;
- production-engineering consultancy;
- utilities-engineering consultancy.

The various types of support and advice from external facilitators are related to the following two main tasks:

1. the facilitators provide the EAT with required and/or requested (technical) background information and they provide service and advice with respect to the training and implementation of EPS methods and tools;
2. occasionally they draw attention to missing energy-saving options and give advice on possible improvement steps with respect to energy management.

However, the EPS organisation is the main task and responsibility of the chairman of the EAT. He is in control of the planning and required EPS budget. He manages that all necessary EPS activities can be performed within budget and that the involved colleagues within the company will be invited and informed in time and will provide required input for EPS. The activities of the EPS proceed in line with agreed EPS time table. The EAT will adapt this planning according to their specific needs also related to the complexity of the plant configuration. The experience of the external EPS consultants will enable that friction losses will be minimised within the EAT and that the EPS planning will be fit for purpose to achieve 80% of required results with only 20 % of efforts. Also the external advisors or consultants can ask the "stupid" questions that nobody dares to ask within the company. This task should not be underestimated, as it has been often proven that the answers to these questions are rather crucial for exploring new ideas to improve energy-efficiency.

In conclusion, the external EPS advisors or consultant have to be skilled at even a higher level than an expert consultants, as they need both the technical and organisational expertise as well as the skills to hide these skills. They have to facilitate the EPS process in such a way that most of the existing and hidden energy saving options are generated by a wide range of employees and summarised by the EAT.

3. Preparation phase 0 for Energy Potential Scan

The preparation phase has two important objectives:

1. Informing the management team on EPS and LTA in such a way that all members are convinced of the importance of LTA and LTA related tools like EPS and the implementation of energy management.
2. Ensuring that the management team commits itself to the proposed EPS approach and allocates sufficient funds and qualified personnel to it. If this will not be achieved, the

EPS execution will fail and there will be hardly any commitment for implementing energy saving projects and measures or energy management.

Therefore at least several weeks prior to the actual execution of the EPS a meeting needs to be organised with representatives of management team for getting their commitment for proposed LTA activities. This crucial EPS preparation step is described in section 3.1. The outcome of this meeting will be that the management team allocates qualified employees to the EAT. The right people should be involved in the EPS and especially in the EAT. For example departmental or production heads that bear responsibility for energy consumption, should be included in EAT. The requirements and tasks for this EAT are elaborated in section 3.2.

3.1 Informative meeting for getting management commitment

A crucial step for starting up the EPS process in a company is the organisation of an informative meeting with representatives of the management team. A discussion of less than 15 minutes with the general manager could already be very effective, as long as he fully understands the main characteristics of EPS and accepts that EPS needs sufficient attention from the other members of his management team.

In a meeting of about one to two hours the advantages and disadvantages of EPS will be discussed with members of management team including consequences for funds and personnel. In the Netherlands the overall EPS information was presented in a general way by one or two representatives from SenterNovem assisted by the envisaged Dutch EPS consultant(s). This proved to be very effective, as all issues dealing with EPS process and contents can be addressed in a proper way. In most cases this informative meeting led to convincing the management team of the importance of EPS.

A contributing factor proved to be the perceived need for signing LTAs with ambitious targets. The management team is normally quite concerned about the ratio between costs and benefits of implementing energy saving options. Presented experience from previous EPS studies made them feel much more comfortable, as this information demonstrated that the annual benefits each year following the EPS far outweigh the EPS costs in year 1. Also the benefits for the environment limiting the amount of global warming contribute to the willingness of companies to manage energy consumption and energy costs. Execution of EPS and further LTA implementation convert that willingness of companies in their energy saving actions.

Also the Dutch EPS studies indicated that about half of the identified options for energy saving was related to human behaviour. Even after realisation of a significant reduction in energy consumption, continual attention must be devoted to this behaviour or else the savings will disappear over time. If energy management would have been implemented in time, the energy savings would have been maintained and the overall energy-efficiency would have been improved by new savings. This type of information is very useful for knowledge dissemination for considering EPS execution and subsequent LTA implementation or participation in other approaches like CO_2 emission trading systems.

In conclusion, execution of EPS can only be carried out effectively after informing and convincing company's management team of the importance of EPS and other LTA tools like energy management. Their commitment is needed for the formation of the EAT.

3.2 Formation of Energy Action Team

During EPS implementation the EAT has the following tasks:
- planning and organisation;
- implementation;
- presentation and reporting of the results.

External advisors, facilitators or consultants will support the members of E&EAT in these tasks.

3.2.1 Planning and organisation

The EAT is responsible for ensuring that the EPS activities can be carried out efficiently and thoroughly as well as for monitoring and supervising the EPS progress.
The EAT draws up the planning for EPS implementation, arranges appointments with staff outside the EAT to be partially involved in EPS, makes reservations for meeting rooms and budgets for sufficient time of involved staff.
The EAT organises the meetings at which the provisional EPS results are discussed and takes care of communicating and reporting these results within the company.

3.2.2 Implementation

The EAT is responsible for the following research activities:
- collecting the energy consumption data of production processes, buildings and utilities;
- generating and quantifying energy-saving options;
- ranking these options on the basis of technical and economic criteria;
- developing a (provisional) energy-saving scenario and a (provisional) EEP.

The members of the EAT are responsible for collecting the energy and environmental data. In some cases they will themselves make the data available by measurement, (gu)es(s)timation or calculation, in other cases they will act as intermediaries for other groups within the plant that provide the required EPS data.
The EAT evaluates the quality of the collected EPS data and interprets it in a systematical way. Using their knowledge of the plant and the production processes, the EAT members are in a good position to come up with points for further improvement.

3.2.3 Presentation and reporting

The EAT records its findings in a report and presents the overall EPS results and the provisional EEP to the plant management team.

After EPS completion and EEP endorsement by management, the EAT might continue its activities by preparing and implementing the energy-saving projects in consecutive LTA period.

3.2.4 Composition of EAT

The composition of the EAT depends to a large extent on the type and scale of the company. For an energy-intensive plant in which industrial products are manufactured, the following guidelines may apply:

- Departments that have or may have a major effect on (future) energy consumption have to be represented: Production, Mechanical Engineering, Process&Product Development, Marketing&Sales and Plant Engineering.
- For the sake of team effectiveness, the number of EAT members should be limited to 4 or 5. Off course more employees can be consulted occasionally regarding detailed issues because of their specific knowledge and contribution.
- In general, most energy consumption takes place in production. Preferably a production executive is chosen to be chairman of the E&EAT.
- The function of secretary of the EAT may be accomplished by, for example, the energy and/or environmental coordinator.

For a structured and efficient EPS process, the EAT may call upon the services and technical and organising advice of external advisors or consultants (see section 2.3).

3.2.5 Chairman of EAT

The EPS organisation is the main task and responsibility of the chairman of the EAT. He is in control of the planning and required EPS budget that mainly consists of hours of involved employees. He creates such conditions that all necessary EPS activities can be performed within budget. Also he takes care of inviting and informing other colleagues within the company in time for providing required input for EPS.

4. Execution phase 1 for Energy Consumption Analysis

The Energy Action Team (EAT) performs the EPS as a short-term project, under the responsibility of management. Depending on the size of the company, this team consists of 3 to 8 personnel members. It is crucial that management is represented and that departmental heads participate in the team. Further the team has to reflect the operational situation and all departments responsible for a significant share of energy consumption have to be represented.

For compiling energy-efficiency improvement options, the EPS method prescribes a number of structured steps. The EAT will start with the Energy Consumption Analysis (ECA).
This analysis maps the existing energy consumption of the various parts of the operations and/or organisation. During this first phase of EPS the analysis will also take inventory of relevant process streams like industrial gases, steam and water. This is done based on purchasing data, measurements and estimations. These data can be represented in a format that is predefined or in a format that is common and well known to stakeholders in Bulgaria. The collected energy and corresponding process data are divided into two main groups by the EAT:

- the production process;
- the utilities (compressed air systems, power equipment, boilers etc.)

The ECA result is a list of the applied energy types, the energy flows and the major energy consumers.

4.1 Timetable for Energy Consumption Analysis

On the first day of the Energy Consumption Analysis a kick-off meeting will be held, attended by the members of the Energy Action Team and the consultants. At this meeting there will be a focus on three main issues:
- exchanging information (1/2 day);
- establishing the structure of the ECA data required (1/4 day);
- drawing up the detailed timetable for the ECA (1/4 day).

4.1.1 Information exchange

The consultants provide the Energy Action Team with information about EPS methods in general and the ECA in particular. The ECA serves as the guideline for this part of the meeting. The Energy Action Team provides the consultants with general information of the company. This will enable them to get familiarised with the local situation: the organisation, the premises, the production processes and the utility installations.
For a smooth start it is important that during the kick-off meeting some general plant data are available by way of introduction. This means that these data must be collected on beforehand. The type of information to be made available is summarised in figure 1.

Figure 1 Information required for Energy Consumption Analysis

Organisation:
1. Current tasks (type and size of the production package)
2. Organisation chart of the plant, including names of the departmental managers
3. Total number of employees
4. Intensity of plant usage (operational times, shifts)

Production:
1. List of production processes (including date of construction and modifications)
2. Available process flow diagrams
3. Possibly known major consumers of energy, industrial gases, steam and water

Premises:
1. Plan of the plant, including list of accommodation
2. List of surface area of the accommodation in m^2
3. Age of the accommodation (including major modifications)

Utilities:
1. Types and amounts of energy purchased
2. Types and amounts of internally generated industrial gases, steam and water

4.1.2 Structure of ECA data

The Energy Action Team and the consultants decide which data relating to energy consumption will be collected during the ECA. They classify production processes and utilities data in line with perceived needs for additional information on missing energy and process data. This will determine the structure according to which these ECA data will be collected.

4.1.3 Detailed timetable

At the end of the kick-off meeting the Energy Action Team will draw up a detailed timetable for the activities to be performed during the ECA. This timetable shows:

- which type of data will be collected;
- how and when these data will be classified;
- who will collect and process these data.

The actual lead time of 1-3 weeks will be determined by the Energy Action Team and is related to:

- the size and complexity of the plant;
- the availability of data relating to energy consumption.

In appendix 1 an indicative overall timetable is shown for the Energy Consumption Analysis phase of the Energy Potential Scan.

4.2. Guidelines and recommendations for Energy Consumption Analysis

Usually several relevant process and/or energy consumption data are not accurate. If so, the Energy Action Team will have to make reliable estimates of the energy consumption and corresponding process data of specific units of the plant. Especially for production processes with high energy-saving potential, these guesstimations need to be made available in consultation with staff from the production departments concerned.

In some cases it might be necessary to carry out some specific measurements on very relevant missing ECA data. If it proves to be impossible to perform these measurements within the ECA time frame, it is recommended to set up a dedicated follow-up project to improve the quality of the ECA data afterwards.

In many cases it will be necessary to contact and involve colleagues that are not members of the EAT for collecting specific process and energy consumption data. The (chairman of the) Energy Action Team needs to inform these employees in time on wishes and needs for missing ECA data that are expected to be provided by them in a structured way.

In most cases the implementation of the ECA does not take up the same amount of time from all members of the Energy Action Team. The plant engineer in particular (or the head of the energy department) and an employee from Production Department will spend most time on collecting and classifying ECA data.

Computer programmes are available for processing and presenting the collected ECA data. It is recommended that the involved EPS consultants (equipped with portable PC) will provide assistance with the processing and presenting of ECA data in a structured and transparent way.

At the end of ECA all collected data need to be summarised in a ECA report that highlights the main energy consumers, types of energy consumed and large energy flows that account for at least 80% of total energy consumption.

5. Execution phase 2 for Technical Efficiency and Management Scans

The next step of the EPS is studying a number of energy consuming processes in more detail. The EAT will performed two types of scans:
- Technical Efficiency Scan;
- Management Scan.

The technical efficiency scan will be elaborated in section 5.1 and the management scan in section 5.2.

5.1 Technical Efficiency Scan

On the first day of the second part of the EPS a second kick-off meeting is held to be attended by the members of the EAT and the involved consultants. In this meeting of about half a day, three topics will be discussed:
- information on EPS scanning methods;
- selection of the plant installations to be examined
- detailed timetable for the Scans and the Energy Efficiency Programme

5.1.1 Information of EPS scanning

At the second kick-off meeting the consultants explain the purpose and methodology of both types of scans as well as the Energy Efficiency Programme. They provide detailed information and guidelines on the application of the scanning tools and the reporting requirements.

5.1.2 Selection of process installations

In this part of the kick-off meeting the results of the ECA will be discussed. The EAT and the consultants will have to reach a joint decision about which production processes should be considered for the Efficiency Scans. The following criteria are taken into account in this selection process:
- process facilities with relatively high energy consumption;
- process facilities with (expected) sufficient potential for energy saving.

5.1.3 Detailed timetable for the Scans and the Energy Efficiency Programme

During the first week of the second phase of EPS an inventory needs to be made of the energy-efficiency improvement options. In the second week an energy-saving scenario will be formulated and in the second or third week a provisional version of the Energy Improvement Programme will be drawn up. At the end of the second or third week the Energy Action Team prepares the presentation for the plant management team.

In appendix 1 an indicative overall timetable is shown for the scanning and reporting activities during the second phase of EPS. The EAT will determine how many weeks will be used for the execution of all activities for EPS phase 2. This planning depends primarily on the complexity of the plant and on the number of production processes or installations that needs to be scanned.

5.1.4 Guidelines and recommendations for Technical Efficiency Scan

Very often experienced staff from the plant that are not members of the EAT, need to be involved during the execution of the Technical Efficiency Scan. They must be informed in time about their specific EPS tasks and expected timing for their participation in the EPS scanning process. These invited employees will normally be colleagues that have specific knowledge of and experience with production processes and utility installations.

The timetable should include a short daily meeting to discuss progress. During this discussion the entire EAT, if possible together with the consultants, can pinpoint interactions between different process and utility areas of scanning. It will provide exchange of information and facilitate internal coordination of partly conflicting scanning activities. There will always be some overlap in terms of scanning results between production processes and utilities. Discussion will solve emerging bottlenecks that might have been caused by imperfect selection and demarcation of processes and utilities.

The report drawn up by the Energy Action Team at the end of the EPS has the status of an internal and confidential document. Only aggregated and/or non-confidential data can be published after approval of management team. The implementation of the second part of the EPS requires a high level of commitment from all members of the Energy Action Team. It will also require ad hoc involvement of experienced staff to be invited by the EAT.

The main steps of technical efficiency scans are:

- systematic brainstorming of reduction options according to procedure and/or questions of Efficiency Scan Handbook (see appendix 2);
- reporting of generated ideas without discussion;
- evaluation and ranking of options from longlist towards shortlist;
- quantification of energy saving of all individual options from shortlist;
- rough evaluation of technical and economic feasibility of all individual options from shortlist.

In appendix 2 more detailed guidelines are presented on how the scanning is performed on the basis of the Process-Input-Output (PIO) model and how the intermediate and final results will be reported.

5.2 Management Scan

By means of the Management Scan the quality of energy management within the company will be investigated. The Management Scan assesses to what extent energy management improvements are desirable and/or necessary.

This Management Scan is performed for following two reasons:

- to ensure that sufficient attention is and will be paid to the efficient use of energy;
- to ensure implementation of the proposed Energy-Efficiency Programme.

The Management Scan focuses on two areas, i.e. energy monitoring and organisation of energy management. These areas are crucial with respect to (successful) management of energy consumption.

5.2.1 Energy Monitoring

Energy Monitoring means and involves the systematic collection of **energy data** (also combining them with relevant **production data**) and the processing thereof into relevant information for management and users. An adequate energy information supply system is an important aspect for ensuring structural attention for the energy-efficiency improvement within a company.

5.2.2 Organisation of Energy Management

This organisation entails the allocation of duties and responsibilities that are necessary in order to control the company's energy consumption. This part of the Management Scan also includes a check on the presence of a consultative structure on energy related issues. This will make clear which types of internal communication procedures and agreements exist with respect to the management of energy consumption. This scan addresses questions like who will receive which type of information and what will be done with this information.

5.2.3 Two phases of Management Scan

The Management Scan is performed in two phases:

1. The “Energy Monitoring” component is largely elaborated during the Energy Consumption Analysis.
2. The “organisation of Energy Management” takes place during the performance of the Technical Efficiency Scan.

5.2.4 Guidelines and recommendations for Management Scan

The interviews that take place as part of the study into the quality of energy management should preferably be held on a single day. The interviews are arranged with at least the heads of departments that are important in terms of energy consumption and with the plant engineer. The interviews are conducted by a member of the Energy Action Team assisted by the management consultant.

The results of the management scan are included in the report that will be discussed during the evaluation session. All relevant comments from management team will be incorporated in the final EPS report.

In appendix 3 some guidelines are presented on how the management scan can be performed on the basis of specific organisational questions and how the intermediate and final results will be reported.

5.3 Advantages of and reasons for Energy Management

SenterNovem has experienced that implementation of various energy-efficiency measures and projects by means of Long Term Agreements can lead to a substantial reduction in energy consumption for a company. However in the period after implementation of good housekeeping measures and energy-saving projects, energy consumption might rapidly increase again.

The main reason for such a steep decline in the achieved savings is the absence of an adequate system of Energy Management. Plant management and end-users within a company can be actively involved in an Energy Management system via:

- the provision of information;
- procedures and responsibilities;
- medium- to long-term planning.

Energy Management means structural attention for energy with the objective of continually reducing energy consumption and maintaining the achieved improvements. It ensures that a company continually passes through the cycle of making policy, planning actions, implementing actions and checking results. Based on these checks new policy will be made and the cycle will continue with new actions and checks. This cycle makes continual improvement possible as reflected in Deming's Circle with Plan, Do, Check and Act.

The main advantages of this structural Energy Management approach are:

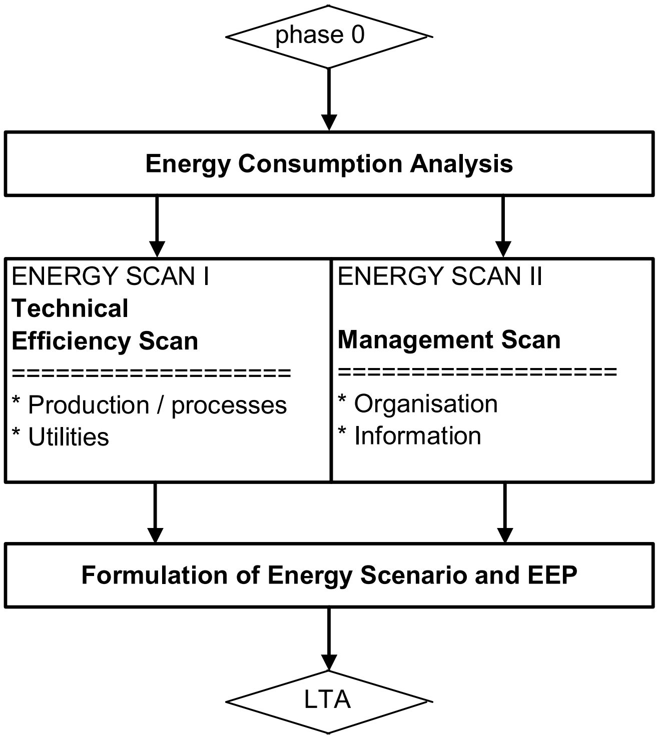
- significant discrepancies in energy consumption for each process installation can be anticipated at an early stage;
- the individual and overall effects of energy-efficiency improvement programmes can be more closely monitored;
- this monitoring of individual projects is beneficial for the successful implementation of energy-efficiency improvement measures;
- the positive effects of energy-efficiency improvement programmes can be maintained.
- an increase in energy-saving awareness that will produce more ideas for energy-savings and lead to a positive change in behaviour.

6. Execution phase 3 for Formulation of Energy-Efficiency Programme

The Energy Potential Scan will be concluded by formulating the company's Energy-Efficiency Plan. In this final EPS phase the overall results of the scans from phase 2 will be transformed into a long-term Energy Scenario and a short- and medium-term Energy-Efficiency Programme. The provisional Energy-Efficiency Programme will contain this Energy Scenario as well as the detailed plan for the following year and a plan of action for implementing measures, projects and higher level of energy management for the coming five years. After discussion with the management team this provisional programme will be further developed and refined in line with their comments. Subsequently the approved Energy-Efficiency Programme can be used for negotiating LTA targets and for formulation of the Energy-Efficiency Plan after signing this LTA covenant with Bulgarian government.

Figure 2 shows schematically the consecutive EPS steps of phase 1 (ECA), phase 2 (Scans) and phase 3 (Formulation of EEP). As illustrated in this figure 2, preparation phase 0 for getting commitment for EPS precedes the execution of this participatory tool. The EPS will be followed by the signing of a LTA covenant with government if both sides can agree upon both realistic and ambitious targets for energy-efficiency improvement and mutually acceptable conditions for LTA implementation.

Figure 2 Schematical representation of Energy Potential Scan phases 1, 2 and 3



6.1 Formulation of Energy Scenario

In phase 3 the overall results of the scans from phase 2 will be transformed into a long-term Energy Scenario that will describe company's long-term strategic aspirations in combination with the expected autonomous product and market developments. By definition, this type of strategic information can only be formulated in terms of a scenario or a set of sub-scenarios, as future developments can not be predicted with a high degree of certainty. On the other hand this Energy Scenario will facilitate the decision making process to determine which types of short- and medium-term energy-efficiency improvement projects are no-regret with respect to long-term strategic considerations. The Energy Scenario is the company's policy instrument that is primarily of importance for long-term planning and strategic investment decisions. It has a scouting and investigative character addressing expected future developments and trends. It is not directly linked to current operation and therefore does not need to have a detailed structure. It is meant to provide plant management with a helicopter view on energy-related strategic issues with a horizon of 5-10 years.

6.2 Formulation of provisional Energy-Efficiency Programme

The provisional Energy-Efficiency Programme will contain this Energy Scenario as well as the detailed plan for the following year and a plan of action for implementing measures, projects and higher level of energy management for the coming five years. This medium-term plan of action will be drawn up and evaluated in line with the considerations and perspectives of the Energy Scenario. The feasibility of all energy-efficiency measures and projects as described in the provisional EEP will have to be examined in much greater detail than the long-term strategic and/or replacement investments, as most of these short- and medium-term options will be implemented the coming years.

6.2.1 Procedure for Formulation of provisional Energy-Efficiency Programme

The following four steps can be distinguished in the development of the provisional Energy-Efficiency Programme:

1. Generation of energy-efficiency improvement options;
2. Clustering and quantifying these options;
3. Classification of these clustered and quantified options;
4. Planning these classified options over time.

The energy-efficiency improvement options emerge from the execution of the Technical Efficiency Scan and Management Scan, as all generated ideas and concrete options have been reported on summary lists during the scans. In step 1 a wide variety of options is split up and/or combined in a logical and structured way.

In step 2 the Energy Action Team and EPS consultants will cluster options that are directly linked to one other. Subsequently each clustered option will be quantified in terms of energy-saving (GJ/a) and total net cost saving (€/a) as well as required investment costs (€).
Step 2 is concluded by calculation of the pay-back time of the options by means of the formula:

$$\text{Pay-back time (years)} = \frac{\text{Investment (€)}}{\text{Annual savings (€/a)}}$$

In EPS follow-up studies more sophisticated decision-making methods can be used like the methods of internal rate of return or net present value, but these more advanced methods are not needed during the execution of EPS.

In step 3 the options will be classified based on differences with respect to profitability and the degree of confidence related to the estimated technological feasibility.

An example of this classification with fictive numbers is shown below in figure 3.

Figure 3 Classified inventory of measures and projects via Energy Potential Scan

% of Energy Saving	Level 1 PBT of 0-1 year	Level 2 PBT of 1-5 years	Level 3 PBT >> 5 years	Total
Category A Technologically proven in this industrial sector	4	2	3	9
Category B Technologically proven in other industrial sectors	3	2	1	6
Category C R&D pilot option still to be demonstrated	2	5	7	14
Total	9	9	11	29

The confidence category can also be split up differently like:

- A : technology available, feasibility certain (>75%);
- B : technology available, feasibility uncertain (25-75%);
- C : technology not yet available, feasibility very uncertain (<25%).

The profitability may vary largely between sectors and different ranges of pay-back times can be used depending on specific Bulgarian needs. Typical EU ranges would be:

- 1 : pay-back time between 0 and 2 years;
- 2 : pay-back time between 3 and 5 years;
- 3 : pay-back time greater than 5 years.

The profitability should also take into account the life expectancy of the process and utility installations, i.e. the length of the energy-saving effect. It would be of very limited use to invest in projects with a pay-back time quite similar to the remaining period of operation. On the other hand it is very important to include strategic energy-efficiency improvement projects with relatively long pay-back times in the provisional EEP. The future might change faster than anticipated due to possible changes in governmental policy and/or technological breakthroughs.

In step 4 the classified options will be planned over time taking into account the considerations and perspectives of the Energy Scenario. Several basic assumptions to be adapted to Bulgarian context can be used for this planning step like:

- do not include options with a pay-back time over 7 years;
- include options with pay-back time shorter than 3 years in 5-year plan;

- start in year 1 with basic options like implementation of higher level of energy management and all good housekeeping measures from category A1;
- options C1 will be feasible after 2 years (as a result of EPS follow-up studies);
- etc.

The required investment pattern over time can also be indicated in a figure and will also affect the planning of options in the provisional Energy-Efficiency Programme. It should be realised that pay-back times could also be shortened to some extent by (future) financial LTA incentives that might be provided by Turkish government.

6.3 Formulation of approved Energy-Efficiency Programme

The Energy Action Team will present the provisional Energy-Efficiency Programme to the management team. This presentation will be followed by an open discussion with the management team on the various options that need to be double-checked, verified with respect to underlying assumptions, modified due to new insights arising from the discussion and/or eliminated as a result of reasons (partly) unknown to Energy Action Team. After this meeting the provisional programme will be further developed and refined in line with the general and specific comments of the management team.

Subsequently the modified and updated Energy-Efficiency Programme has to be approved and endorsed by the general plant manager. The formulation of this approved EEP is the last activity of the Energy Action Team within the framework of the EPS execution.

If the company intends to proceed with the LTA process it is advised that the Energy Action Team will continue its energy-efficiency improvement activities shifting its focus from company's policy making towards implementation of energy-saving measures and projects.

7. Conclusions

The main advantages of the participatory EPS approach are:

- Existing expertise from all levels within the company are mobilised and utilised; energy-saving ideas that already exist within the plant are automatically introduced and combined in this way.

- EPS encourages employees to become even more aware of energy consumption as well as the options how to minimise energy consumption.

- The ideas that emerge from the EPS approach will be more readily accepted.

The overall result will be that there is a high degree of involvement within the plant and a better chance of energy-saving ideas and increased level of energy management actually being implemented. The outputs of EPS can be used as valuable input for LTA negotiations.

It is desirable that also category C3 options will be included in energy-efficiency plans as future perspectives might change faster than anticipated due to possible changes in governmental policies or a change in the technological situation, e.g. by the emerging of breakthrough technologies.

Appendix 1 Indicative overall timetable for the Energy Potential Scan

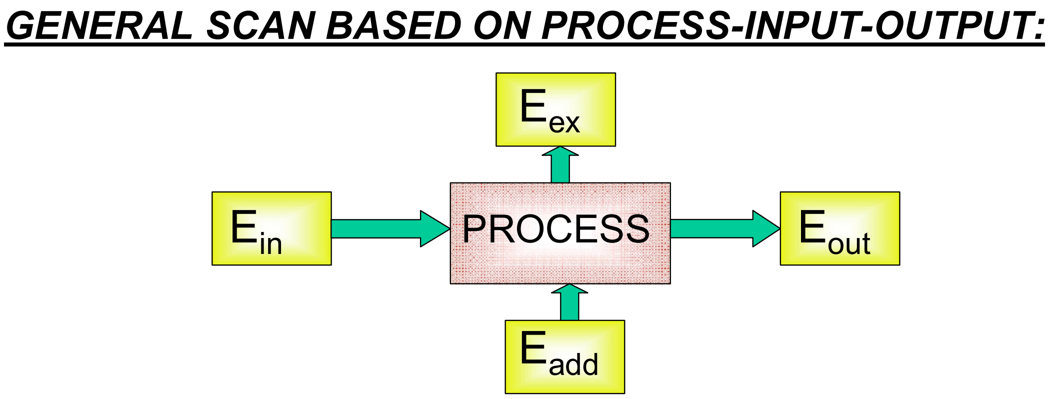
OVERALL EPS TIME TABLE:

		Week 1	Week 2	Week 3	Week 4	
Introduction	**x**					
Training		**x**		**x**		
Analysis (ECA)		**xxxx**	**xxxxx**			
Scans (E&MS)				**xxxx**	**xxxx**	
Programme (EEP)					**x**	
Presentation						**x**

- First part of EPS: Energy Consumption Analysis
- Second part of EPS: Efficiency and Management Scans

Appendix 2 Guidelines for technical efficiency scans

All technical scans are more or less based on the Process-Input-Output (PIO) model as shown below.



E_{in} : Energy Content of incoming mass flow (products, gases, water, etc.)
E_{out}: Energy Content of outgoing mass flow (products, gases, water, etc.)
E_{add}: Energy added to process (gas, electricity, EC of added gases or water)
E_{ex} : Energy extracted from process (waste heat, used gases, losses)

In most cases saving energy means reducing E_{add} (and E_{ex} as well)

Often the added energy is ultimately converted into heat and extracted by means of hot products or insulation losses.

The efficiency ε of the process is used to compare actual energy consumption with ideal situation.
This efficiency is calculated as the ratio between the (theoretical) minimum amount of energy required for a process (E_{net}) and the actual amount of energy added ($E_{in} + E_{add}$).

If there is no specific scan for a production process, the General Scan based on the PIO-model can be used. In this scan the general approach to the energy analysis of a process is described.

Process Input-Output (PIO) model

The process or machine to be investigated is regarded as a closed system. In the PIO-diagram four incoming and outgoing energy flows are distinguished.

For stationary process conditions the following formula applies:

$$Ein + Eadd = Eout + Eex$$

In most cases saving energy means reducing Eadd and sometimes Eex as well.

On the basis of this diagram all aspects of a process can be systematically examined with respect to energy-efficiency improvement possibilities. The scan covers four different phases:
A. Process;
B. Input energy (Ein + Eadd);
C. Output energy (Eout + Eex);
D. Alternative processes.

A. Process

The energy consumption of a production process is determined by the process and by the product (materials, dimensions). In this scan we will cover only the process.
Conversions of energy flows take place within the process (e.g. electricity into heat or motion). The components used for this are referred to in this scan as energy converters. Examples of these are: burners, electric motors, heating elements, pumps).
In the majority of cases all the added energy is ultimately converted into heat and in this way extracted via (for example) hot products, heated extract air or as insulation losses.

The efficiency ε of the process is used to compare actual consumption with the ideal situation.
The efficiency ε is calculated as the ratio between the (theoretical) minimum amount of energy required to implement a process (Enet) and the actual amount of energy added (Ein + Eadd):

$$\varepsilon = \frac{Enet}{Ein + Eadd}$$

Aspects that can affect energy-efficiency are divided into three categories:
- intrinsic engineering measures;
- constructional and control engineering measures that reduce the energy consumption of each product;
- the quality of the internal energy converters.

A process like the one described here is often further subdivided into various sub-processes. Off course the diagnosis may if necessary be refined by also performing the analysis on these sub-processes.

B. Input energy (Ein + Eadd)

Energy is added to the process in a variety of ways.
This is done via the incoming mass flow (for example a hot product on a hot product carrier), by the energy added to the process (gas, electricity) and by the industrial gases and water supplied to the process.
The total energy consumption is determined by multiplying power by time. By comparing the production flow and the energy consumption over time it is possible to detect energy-efficiency improvement possibilities.

Significant differences might occur between the energy consumption and the production flow. This can lead to the following type of observations:

- Process was started up too early;
- Energy consumption increases more than linearly with production;
- Production flow is zero, energy consumption is unchanged (during lunch break!);
- Zero load consumption looks rather high.

C. Output energy (Eout + Eex)

The energy content of the products, gases, industrial gases and water, etc., that leave the process and the insulation losses via the encasing can usually be regarded as losses. In principle the idea is to aim for a minimum energy content of these extract substances, i.e. Eout=0 and Eex=0.
If it is not possible to reduce the output energy any further, then options should be considered to use this output energy somewhere else in the process (or in a different process).

D. Alternative processes

Phases A, B and C are directly linked to the current process. Besides an analysis of the current process conditions it is however also possible to investigate whether the energy-efficiency can be improved by using new equipment or best practice process technologies.

During the scanning process of all four phases the following considerations should be taken into account in order to improve energy-efficiency without affecting the process or products in a negative way:

- The consequences of projects and measures should not jeopardise the product quality;
- The decreased or increased load of production equipment should not lead to increased wear, undesirable heating or cooling, additional maintenance or repair and/or other operational nuisance;
- The projects and measures should have no negative interactions with other functions of the production equipment, for example a gas flow that appears to be too high but which is used not only for protection but also for cooling;
- Also no negative interactions should be created with functions outside the scanned production process like the following fictive examples:

- reduction in the heat supplied to location A in the production line results in additional heat having to be provided to location B;
- improvement to furnace insulation means that the production hall has to have additional heating;
- increase or reduction of compressed air consumption results in less energy-efficient options for the compressed air supply infrastructure.

Scanning questions on process issues:

1. What are the specified requirements for the scanned process and have these requirements been optimised with respect to energy-efficiency?

   - On which considerations are the process specifications and the production instructions based?
   - Are the requirements optimal with regard to energy consumption?

   Examples:
   • improve maximum temperature and temperature gradients for heat treatment;
   • determine optimal nitrogen consumption for inert conditions;
   • more accurate stamping can eliminate the need for additional finishing.

2. Can the process efficiency be improved?

   - How the energy consumption per product can be limited by process engineering, control engineering or constructional modifications?
   - How critical process parameters are measured and how control is carried out on the basis of which type of measurements or results (process control)?
   - How often sensors are checked and/or calibrated? Do standards exist for this type of issues? Are these standards accepted by Operational Department?
   - How can the production capacity be increased or how can the utilisation rate be improved?
   - How the available (waste) energy and industrial gases and water can be used more efficiently?
   - How will it be possible to control the process on the basis of production load?
   - How can rejects and off-spec products be reduced? (Reducing rejects = saving energy!)

   Examples:
   • introduce on/off cycle with optimal energy-efficiency improvement;
   • better to operate less installations continuously than more installations on partial load;
   • index system rather than continuous slip-action drive;
   • lighter moulds in a furnace require less warming up energy;
   • more compact moulds provide greater loading density;

• wider moulds allow for higher capacity or utilisation rate;
• better positioning of the flame towards product flow improves the heat transfer;
• shorter processing time, faster product throughput speed

3. Are the converters as efficient as possible?
   - How the efficiency of the converter can be increased by maintenance, overhaul or replacement?
   - Is the converter ideal for the current operation and if not, how can it be optimised?
   - Do clear maintenance instructions exist (who, what, when)?
   - Is the consumption of the converters regularly checked so as to monitor their quality?

   Examples:
   • turnover due to wear;
   • fit new, more efficient motor or drive;
   • replace old fan by new speed regulated fan;
   • local vacuum production using compressed air has very low efficiency (ca. 1 %);
   • prevention or reduction of fouling;
   • compare the consumption of a number of identical machines or processes.

<u>Scanning questions on "input energy Ein + Eadd"</u>

4. Do the input conditions of products, industrial gases and water, etc. match the process requirements?

   - Do the process settings match the process specifications?
   - Are there any measurement devices (temperature, gas flow, power)?
   - If not, how is the correct setting determined?
   - Do the process settings, the product specifications (dimensions, temperature, etc.) and/or the quality (pressure, dew point, etc.) of the industrial gases and water vary over time?
   - How energy can be saved by linking this process to a previous process?

   Examples:
   • pressure variations in the compressed air network;
   • purity of compressed air (oil concentration, dew-point).

5. Can the added energy be reduced by optimising heatflow, mass flow or chemical reaction conditions?

   - Is the consumption of energy and industrial gases and water checked and evaluated regularly?
   - Optimum process conditions for minimising the added energy?

Examples:
• optimum inlet temperature of the products and industrial gases and water;
• replace compressed air by blower air;
• use nitrogen rather than gas mixture;
• reduce compressed air pressure.

6. Does the comparison of the energy consumption and the consumption of industrial gases and water with the production flow give rise to unexpected observations over time?

  - Is the process started up efficiently?
  - Does the energy consumption increase more or less than proportionally to an increase in product flow?
  - Is the process switched off promptly when production is stopped (during breaks, weekends, etc.)?
  - Is zero load consumption minimal?

Scanning questions on "output energy Eout + Eex"

7. Can the amount of output energy be reduced by decreasing heat flow, mass flow or chemical reaction conditions?

  - Are there any leaks?
  - Optimal process conditions for minimising the output energy?

Examples:
• improve insulation;
• fit radiation screens;
• a compressed air leak with a diameter of 1 mm costs some € 500 a year.

8. How energy consumption can be reduced by combining or integrating various process stages or processes?

  - How the number of process stages can be reduced?
  - How the heating and cooling stages of a product can be linked?

Examples:
• send air to be heated first towards products to be cooled;
• improve the stamping process so as to eliminate the need for finishing;
• lead back warm conveyor belts.

9. How can the extracted energy be recovered?

- How to utilise output energy?
- How to convert output energy leading to better options for energy-efficiency improvement?

Examples:
• use residual heat of cooling air to heat space;
• heat recuperator;
• afterburning of extracted hydrocarbons;
• heat pump;
• preheat burner air by passing the air through the furnace.

10. Are the utility extraction facilities as efficient as possible?

- Are the utility extraction facilities (exhaustion, ventilation) ideally dimensioned for the current process?
- Are these facilities regulated (preferably automatically) according to production flow?

Examples:
• local versus central extraction (source extraction fan avoids effect on production-room)

<u>Scanning questions on alternative processes</u>

11. Can energy consumption be reduced by the use of other (best practice) equipment, processes or structural measures involving additional process equipment?

- What are alternative options?
- How 80% of best practice can be achieved with 20% of investments?

Examples:
• replace equipment by new, modern (energy-efficient) equipment;
• replace thermosetting adhesive by UV adhesive or snap fit connection;
• replace gas flame by high frequency heating;
• continuous flow process instead of batch process.

12. Which type of energy saving measures have been taken in previous years past and which ideas have not been researched any further or implemented?

- What are experienced or expected side-effects?
- What happened with previously generated ideas?

Examples:

- idea box
- filing and reconsidering of ideas in current context

Appendix 3 Guidelines for Management Scan

The development of energy-efficiency can be monitored in various ways, depending on the complexity of the organisation and the scale of energy consumption.

level 1	Energy consumption is monitored by hand by the accounting department.
level 2	Energy consumption is monitored and analysed with the aid of a spreadsheet by an employee from staff department.
level 3	The central energy coordinator processes energy data with the aid of an energy monitoring system.
level 4	For each production unit there is one person from operational department responsible for energy management. The data are collected and processed automatically.

There are various software packages available for the collection, processing, analysis and presentation of energy data. The EPS consultant will draw the company's attention to the existence of these packages and, if desired, relevant suppliers will be contacted for the provision of further information on these packages.