

Project: CARE+ (Grant Agreement IEE/07/827/SI2.499212 D7286)

Issue: Deliverable D9, part of WP 5

Date: 27 November 2009

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What Is CARE+ About?

Energy efficiency fuels SME' s good business performance

The international chemical industry has for many years recognised that responsible stewardship of the environment is part of its overall operating duties. Cefic, the European Chemical Industry Council, has been a leading party in the industry's efforts through the Responsible Care Initiative. The CARE+ project is a complementary initiative to focus on the efficient use of energy in the vast number of small and medium sized chemical companies across Europe.

CARE+ aims to

- Develop, test and offer an energy efficiency scheme for SMEs in the European chemical industry;
- Disseminate information about energy efficient technologies and energy management systems to SMEs (e.g. best practices);
- Through training and auditing demonstrate to SMEs energy efficiency reserves and cost-effectiveness of improved practices and technologies;
- Develop special investment schemes to facilitate implementation of identified energy efficiency measures in SMEs;
- Improve the sector's energy efficiency performance.

High energy prices and fierce global competition have stimulated energy efficiency in the chemical industry because energy constitutes an important part of the chemical industry's cost structure. Nevertheless, a potential for energy efficiency improvements remains, especially in SMEs, where energy consumption is not always seen as a major cost factor nor identified as a priority. Thus this project is designed to bridge the gap between the potential and the current practice.

CARE+ is funded and supported by the European Commission under the framework of "Intelligent Energy Europe".

This Energy Efficiency Self Audit Guide, together with the accompanying Energy Efficiency Best Practices are an essential part of CARE+, as they are the main support tools for SMEs to help improving their energy performance.

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Save energy, increase your profit

Are you a small or medium sized enterprise producing chemicals? Then you are probably interested in how to

- Be competitive
- Improve your profit

This Energy Efficiency Self Audit Guide and the accompanying Best Practices help you to achieve this by improving the energy efficiency of your installations and reducing your energy bill.

For the chemical industry in general, including for SMEs, managing energy use and energy costs is essential for long term competitiveness, Responsible Care and sustainable operation. In addition, energy efficiency reduces the carbon footprint of the chemical products, avoiding CO₂ emissions. Regulation makes CO₂ increasingly a cost factor and being CO₂ efficient can be a strong selling point and marketing tool.

Energy efficiency also makes perfect business sense. It reduces the need for energy, improving the company's bottom line results and thus, net profits.

Typically, chemical SMEs have energy costs that can be as much as 25% of their total production costs. With a strategic focus on energy efficiency, you can reduce these energy costs by as much as 10% to 20%. For example, in a chemical company with an annual sales volume of say €25 million, an energy bill of €4 million, and a net profit of €2 million, a 10% reduction in energy costs will improve the bottom line results and the return on sales by 20%.

Figure 1. Bottom line improvement with energy efficiency

		Your starting point	Improvement with a 10% energy saving	Business impact
Annual Sales	€mln	25	25	
Energy Costs	€mln	4	3.6	10% lower
Gross Profit	€mln	5.2	5.6	8% higher
Net Profit	€mln	2	2.4	20% higher
Profit Margin	%	8.0	9.6	20% higher

Managing your energy use and energy costs can create substantial economic benefits. Therefore, you should not treat energy costs simply as fixed overhead but as a manageable cost factor. You can do something about your energy consumption and the Energy Efficiency Guidance Material from CARE+ will support you in achieving this goal.

An energy efficiency audit is a simple way to check your energy consumption and this Self Audit Guide explains you how to do it.

Why use this Energy Efficiency Self Audit Guide?

To identify energy saving opportunities in your business it is indispensable to conduct an energy audit. An energy audit quantifies trends of current energy use and equivalent greenhouse gas emissions and related costs, and results in recommendations for energy efficiency improvements. The scope of an energy audit can vary a lot and can include an entire building or plant, or focus on energy use associated with a specific process.

This Energy Efficiency Self Audit Guide (SAG) provides small and medium sized companies in the European chemical industry with a tool to check your energy management performance and energy consumption and helps to determine saving opportunities. It is a simple step-by-step approach and provides basic data collection sheets and check lists to gather and analyse the necessary information to do an energy audit. It also includes a scheme for evaluating improvement options from a financial perspective and helps you to draw the necessary conclusions for implementing energy saving measures.

The work undertaken during an audit should include the following four steps and should of course end with implementation measures:



Any energy audit should result in an evaluation of your company's energy efficiency performance and if necessary, recommendations for energy efficiency measures. An energy efficiency action plan should be proposed to and agreed by the management for implementation. Don't let your report get dusty in the cupboard but agree with your management on an action plan for implementation!

This guide will lead you step-by-step through these audit activities. It provides the basic information

collection sheets and check lists. You will find examples on how to use these templates. If you already have an energy information system established, you can also use existing data sheets.

The Self Audit Guide is best used in combination with the Energy Efficiency Best Practices, as there you can look up information about major areas for energy savings. The so called Best Practices give detailed description of what is "best in class", improvement options how to get there and technical and financial evaluations. This will help you specifically in the analysis phase. Nevertheless, this Self Audit Guide can also be used as a stand alone tool.

The Self Audit Excel Sheets, which are referred to throughout the document, provide you with the template for both the qualitative and quantitative data gathering for your energy audit. They can also be downloaded as a spreadsheet from www.cefic.org/careplus. The sheets also have the advantage that they are interlinked and will help you with the calculations and analysis, providing useful ratios and graphs. Feel free to use different templates and sheets when these are readily available within your company.

The four steps of an energy efficiency self audit

1. Audit preparation



Working through this Self Audit Guide is already the first preparatory step of your audit, as it indicates to you exactly which steps you need to take. The guide is mainly meant to serve companies which have not yet a large experience with energy audits, but can also help companies which are more advanced in their energy management. The guide provides you with a basic set of documents, which can be used as such or adapted according to your needs.

1.1. Agreement of management on audit scope and objectives

The preparation phase should be used to determine the scope and the objectives of your audit.

First thing is to do a rough calculation on how much your energy costs account for in your total cost, as this allows you to establish the importance of energy efficiency for your business. **STEP 1** of the Excel sheets helps you with this calculation.

< 5%	It is always worth to increase energy efficiency, but there might be other activities with a higher impact on your competitiveness.
> 5% and <15%	Check your business for energy savings, you can have an impact.
> 15%	If you did not yet work on energy efficiency, it is high time to get started and focus on this important competitiveness and cost factor.

Next, you should already identify major energy consuming application, as they will be a primary focus of your energy audit. Going through this Guide gives you an overview of what kind of information will be needed and gives you an overview of the effort that will be required. You should match the required effort

with your available resources. If you want to go beyond the activities and level of details which are indicated in this guide, do not hesitate to take the necessary steps, this Guide is meant to be a flexible tool.

Once you have determined the scope and objectives you need to involve your management and get the agreement to do the energy efficiency audit. It is important to have the management support for your energy efficiency activities and possible implementation measures.

1.2. Planning: what needs to be done, when and by whom

When you have the go ahead from the management, the energy audit needs to be organised. It is necessary to get a first overview on what information is readily available in order to evaluate the time and manpower that is needed to complete the audit.

STEP 2 of the Excel sheets provides assistance on gathering general overview information on the target installation of your energy audit, focusing on space and capacity data, principal products, state of repair and age of the production equipment on site and the energy transformation equipment.

Then you need to plan your activities, what needs to be done when and determine who is responsible for which step.

2. Information gathering



The information that you need for your audit can be organised in two groups, qualitative information for the broader picture and quantitative information. This information will be the basis for the next step of analysing your performance and improvement potential.

The qualitative information focuses on what are your organisational settings and business approach to energy efficiency and also covers technical information on your installation and processes (STEP 3, 4 and 5 of the Excel sheets).

The quantitative information refers to data on energy, production and finances to evaluate your current performance and possible energy saving measures from a quantitative perspective. You should also gather overall business data of your company. (STEP 6 - 11 of the Excel sheets).

2.1. Qualitative Information

The qualitative analysis will help you to assess the organisational settings to implement energy efficiency improvements, for example which management measures are in place and how your installation is run. This also covers current technological applications in your different processes.

2.1.1. Energy Walk Round

An Energy Walk Round is a must to prepare and do an energy audit. It gives you a good overview on the energy status of the operations of your plant. The checklist in the Excel sheet STEP 3 will help you in examining energy items on your walk round. It mainly focuses on good housekeeping measures, but should only be considered to be an indicative list. Do not hesitate to add items specifically for your company or processes, according to your energy efficiency target or your action plan.

TIP: Conducting regular walk rounds to monitor the daily operations and energy use can identify interesting opportunities for energy savings and will help to sustain what has been achieved.

Below you find an example from STEP 3.

Figure 2. Example STEP 3: The Energy Walk Round

Energy Walk Round		
Date of Walk Round	Reviewed (Yes/No)	Remarks(or not applicable)
18/11/2009		
Item		
Steam system		
When were boilers and boiler house equipment last serviced and when is the next service being scheduled?	Yes	Last Serviced 02/2009, Next Service 02/2010
Are boilers operating at the correct steam pressure?	Yes	Boilers are regularly checked
Is the combustion control system working with the correct air/fuel ratio?	Yes	Boilers are regularly checked
Is the boiler blow down set at the correct ratio?	Yes	Yes this is fine
Is the deaerator working at the correct pressure?	Yes	Yes this is fine
Are steam traps being inspected and tested regularly?	No	No systematic regime
Check for steam leakages in the system	Yes	Some minor leaks in factory area
Is the steam pipework well insulated and is the insulation in a good state of repair?	Yes	Lagging is poor in quite a few places
Are heat exchanger surfaces regularly checked for scaling & fouling?	Yes	No systematic regime

2.1.2. Approach and organisational setting for energy efficiency

In order to evaluate your company’s current approach to energy efficiency it is necessary to assess your organisational strengths and weaknesses across the main areas of energy management. A good energy management system indicates a continuous approach to evaluate your energy performance and identify improvement potentials and it is also the basis for long term energy efficiency and sustainable cost savings. Your company will be evaluated on the following areas (STEP 4 in the Excel sheets):

- Commitment & Energy policy
- Clear roles & Responsibilities
- Targets & Projects
- Continuous energy performance monitoring
- Awareness & Training
- Communication

More information on energy management can be found in **Best Practice 1**.

2.1.3. Major energy consuming installation

Although a good energy management system is crucial to formalize and work constantly on energy efficiency, an energy audit also needs to look at your major energy consuming installations. This includes the energy conversion equipment, such as boilers, CHP, compressed air plant, but also your energy consuming equipment, for example motors and drives and last but not least the production processes that are part of your installation.

Excel sheet **STEP 5** on energy transformation and major production processes aims at collecting the relevant qualitative information on these items, including for example age and state of installations, capacity and use pattern. Especially if an external auditor is doing your site audit or supporting you with your auditing activities, this is the basic information that you need to provide. Below you find an example sheet which collects data on the steam and hot water boilers.

Figure 3. Example STEP 5: Energy transformation and major production processes

Energy Conversion Equipment			
Steam Boilers and Combined Heat and Power			
Number of Heat Only Boilers	2	Boiler 1	Boiler 2
You have room for up to 4 boilers. Enter the number in the box above. If you do not have a CHP plant leave that column blank.			
Age of CHP/Boiler		30	30
Steam Capacity of CHP/Boiler	Tonnes/h	18	12
Maximum Pressure	Bar (abs)	10	10
Maximum Temperature	°C	250	250
Fuel Type	Gas/Coal/ Fuel oil	Gas	Gas
Economiser	Yes/No	Yes	Yes
Air Pre-heater	Yes/No	No	No
Operational hours per year		4800	4800
Last Service	Date	févr-09	févr-09
DE-AERATOR			
Temperature	°C	100	100
Remarks and Observations		Boilers are getting very old and need replacing soon	

2.2. Quantitative Information

With the basic qualitative data gathered and recorded you are ready to approach the more detailed quantitative data. It might well be that the Energy Walk Round has shown you where to take a closer look. You need to gather the basic quantitative information in order to be able to analyse your performance and detect and evaluate financial feasibility of improvement options.

Please keep in mind that the data you are collecting here are for internal use only and are meant to support your energy efficiency analysis. You can consider the financial information as confidential and do not need to share it with anybody outside your company.

Start with general data concerning your site: its turnover, financial performance and total energy cost and consumption. Then you should go into more detail, looking at the different energy carriers, doing a breakdown by production process or application. If you do not have the data readily available, you need as a minimum to collect data for the last three years on an annual basis. It is however better to have data at the monthly level and for some analysis you might even need daily data.

Collect the data by using the data sheets provided as excel files.

STEP 6 Site Energy Usage

STEP 7 Site Production And Financial Data

STEP 8 Energy Transformation Data

STEP 9 Production Line Data

STEP 10 Process Energy Consuming Devices

STEP 11 Buildings Energy Use

Do not forget that the CARE+ Excel Sheets provide you with a good start for checking energy data availability and energy performance and they represent the minimum level of information to successfully realise an energy audit. Moreover they have the advantage of being interlinked and therefore automatically doing the calculations for the analysis. These are exemplary data collection sheets, please do not hesitate to adapt them to your needs or use templates that are available within your company. However be aware that the automatic calculations and graphs are only working when you use the proposed sheets.

More information on how to collect data can be found in [Best Practices 2](#) and [3](#) which deal with measuring and analysing your energy consumption and bills and how to set up an energy information system.

Figure 4. Example STEP 7: Site production and financial data

Monthly Financial Data								
	Total Production	Energy Costs	Total Production Costs	Sales Revenues	Gross Profit	Return on Sales	Energy Cost / Total Costs	Energy Costs / Tonne of Production
	Tonnes	€	1000 €	1000 €	1000 €	%	%	€
January	27.000	€ 236.912	€ 1.160	€ 1.000	-€ 160	-16,0%	20,4%	€ 8,77
February	28.000	€ 237.224	€ 1.130	€ 1.750	€ 620	35,4%	21,0%	€ 8,47
March	28.000	€ 236.424	€ 1.140	€ 1.500	€ 360	24,0%	20,7%	€ 8,44
April	28.000	€ 248.102	€ 1.190	€ 1.500	€ 310	20,7%	20,8%	€ 8,86
May	27.000	€ 247.900	€ 1.090	€ 1.000	-€ 90	-9,0%	22,7%	€ 9,18
June	25.000	€ 225.071	€ 1.000	€ 1.000	€ -	0,0%	22,5%	€ 9,00
July	12.000	€ 128.255	€ 750	€ 900	€ 150	16,7%	17,1%	€ 10,69
August	20.000	€ 196.546	€ 1.000	€ 1.500	€ 500	33,3%	19,7%	€ 9,83
September	25.000	€ 222.016	€ 1.100	€ 2.000	€ 900	45,0%	20,2%	€ 8,88
October	26.000	€ 222.576	€ 1.050	€ 1.500	€ 450	30,0%	21,2%	€ 8,56
November	27.000	€ 232.736	€ 1.150	€ 1.000	-€ 150	-15,0%	20,2%	€ 8,62
December	20.000	€ 194.645	€ 900	€ 750	-€ 150	-20,0%	21,6%	€ 9,73
Total	293	€ 2.628.407	€ 12.660	€ 15.400	€ 2.740	17,8%	20,8%	€ 8,97

3. Analysis and evaluation



With the qualitative and quantitative information gathered you should now be able to do a first analysis of your energy performance and improvement potential. This includes two main steps: first an analysis to determine different improvement options and the respective implementation cost and second a financial comparison of the cost impact and return on investment of the different energy efficiency improvement possibilities.

3.1. Determining energy efficiency improvement options

Go back to the information that you have collected, qualitative and quantitative. This is the input to establish the current performance of your plant, production installations and single applications, such as a boiler or motor, from a technical perspective, but also quantitative perspective.

The analysis of your data from the energy audit will give you a good understanding of where energy is used on your site and how much. **STEP 12** of the Excel sheets gives you a summary of all the data collected so far and calculates for example total cost of the different energy carriers and useful ratios to measure your performance. The figure below looks for example specifically at energy consuming technology equipment.

Figure 5. Example STEP 12 Energy using technology

Energy Consumption Data					
Energy Consuming Technology					
Total Production	Delivered Energy Consumption	Consumption		Energy Costs	
	MWh	MWh	% of Total	€	% of Total
Steam CHP and Boilers	104.676,12	104.676,12	91,13%	€ 2.365.083	91,54%
Hot Water CHP and Boilers	241,48	241,48	0,21%	€ 5.456	0,21%
Air Compressors	290,63	645,83	0,56%	€ 13.829	0,54%
Motors and Drives	1.636,13	3635,83	3,17%	€ 77.852	3,01%
Refrigeration	573,70	1274,89	1,11%	€ 27.299	1,06%
Heating Ventilation and Air Conditioning	836,55	1859,00	1,62%	€ 39.806	1,54%
Other Thermal Equipment	0,00	0,00	0,00%	€ -	0,00%
Lighting	151,41	336,46	0,29%	€ 7.204	0,28%
Other Electrical Equipment	990,00	2200,00	1,92%	€ 47.108	1,82%
Total	109.396,00	114.869,61	100,00%	€ 2.583.637	100,00%

When the numeric information is combined with the results of the Energy Walk Round you can start to identify areas where energy savings can be made. For example, you can look at energy consumption per unit of production and the monthly performance over a year. Are there any outstanding figures, and if yes, what are the underlying reasons for these? You should focus your attention in the audit analysis on the most energy intensive production processes or major energy consumers.

The accompanying Best Practices of this Energy Efficiency Handbook look at the typical areas of improvement potential, such as boilers, motors and drivers and the energy management programme. The Best Practices describe what is best in class for different applications and indicate no-cost (good house keeping measures), low cost and other options to improve your energy efficiency.

Typical things that you should analyse and which are covered in the Excel sheets are:

- determining energy consumption and cost and comparing with total cost
- evaluating impact of energy cost on profitability
- investigating consumption of all types of energy, for the total site, by production operation or by application (eg heating and cooling) and relating energy consumption to output
- reviewing energy management strategies, including monitoring systems and evaluation process.

STEP 13 gives you a framework to collect the strengths and weaknesses of your installation in the main areas of energy consumption, the organisational settings, the site, specific production lines and the energy transformation processes. An example can be found below.

Figure 6. Example STEP 13: Energy analysis

Energy Transformation Processes	
Strengths	Good maintainance
Weaknesses	Old Boilers
Suggestions For Improvement	Replace the two steam boilers

Take a look at the **Best Practice Cases** for comparing your business performance with state of the art installations. In addition, the CARE+ website provides a list of links to additional information.

When you have collected this information you are ready to go as a next step into more detail and determine specific energy efficiency options.

3.2. Financial evaluation

With the performance and technical evaluation, draw up a list of energy saving projects and their respective energy savings, cost savings and investment cost. Most of the Best Practices end with a list of possible measures to give you some ideas. For each identified measure that needs expenditure you should prepare a business case as indicated in the **STEP 14** of the Excel tables.

Do not forget all the good housekeeping measures that typically can be found in most installations and have already a significant cost saving potential when implemented at no cost at all. For measures that require no expenditure, such as switching of a pump when it is not in use, you should draw up an action list for immediate implementation.

TIP: Do not forget to check the possibility for financial assistance, eg government subsidies or special loans, as this might change your cost and pay back period.

The types of initiatives that could come out from the analysis include:

- Changes to operational procedures
- Review of maintenance as it affects efficient use of energy
- Modification or replacement of existing equipment
- Further in-depth studies of potential to reduce energy use of particular processes
- A commitment to ongoing training and information dissemination to increase awareness among staff

Last but not least you should rank the different options, for example by their pay back time, as energy savings really pay off. But you might also establish different priorities, for example if you have a legal obligation to replace certain light bulbs or reach a certain greenhouse gas efficiency. **STEP 14** helps you to summarize your results.

TIP: If it costs you a lot of time to gather the relevant data, the first recommendation out of this audit is to set up a simple continuous energy data reporting scheme. As a minimum, you should be able to make a monthly energy balance of the energy use on your site and a monthly reporting of your energy purchasing costs.

The top prioritised measures should then be used for the list of recommendations for implementation, as you can find it in the Excel sheet **STEP 15** and in the figure below.

Figure 7. Example STEP 15 Recommendations for implementation

Number	Measure	Energy Savings (MWh)	CO ₂ Savings (Tonnes)	Energy Cost Savings (€)	Other Cost Savings (€)	Investment Cost (€)	Payback Period (years)	Impact of Measure on energy Costs (%)	Impact of Measure on Gross Margin (%)
	Totals	8,819.38	1,777.83	€ 199,518	€ 5,000	€ 35,550	0.53	7.59%	7.46%
SAG 1	Light sensors in Storage area	10.00	6.27	€ 476		€ 550	1.16	0.02%	0.02%
SAG 2	Meters on Steam Production	2,590.99	521.05	€ 58,542	€ 5,000	€ 20,000	0.31	2.23%	2.32%
SAG 3	Improved maintenance of steam traps	5,181.99	1,042.10	€ 117,083		€ -	0.00	4.45%	4.27%
SAG 4	Upgrade insulation on steam pipes	1,036.40	208.42	€ 23,417		€ 15,000	0.64	0.89%	0.85%

This results in a concise list of recommended energy saving activities! You have almost finished your energy audit, there is only one small step missing after all the work that you have done.

4. Reporting



The last step of the audit is to prepare a report of the audit results which lists the recommended energy saving measures and describes the energy audit procedure.

Below you find a list of key elements of an audit report and where you can find the respective information in the Excel tables.

Figure 8. Key elements of an energy audit report

Item of the audit report	Where to find the information in the Excel sheets
Executive summary with recommendations in a priority order, and estimates of their implementation costs and pay back periods	Excel sheet STEP 15
Relevant plant and process data	Excel sheet STEP 2
Equipment data with measurements or estimates of the energy consumption for individual plant items	Excel sheet STEP 9
Actual energy consumption records	Excel sheet STEP 6
Energy use analysis in graphical form	Excel sheet STEP 12
Details of energy efficiency improvements	Excel sheet STEP 15
Comparison of actual consumption with analysis of estimated results from recommended actions	Excel sheet STEP 15
Recommendations to include energy management strategies such as monitoring systems and review process	Excel sheet STEP 15

An example of the content for an energy audit report is given below.

Content of an Energy Audit Report

EXECUTIVE SUMMARY

1. INTRODUCTION
 2. GENERAL PRESENTATION OF SITE
 - 2.1 Presentation of the Company
 - 2.2 Production data
 - 2.3 Main financial indicators
 - 2.4 Purchased energy data
 - 2.5 Energy management system estimation
 - 2.6 Energy information system estimation
 3. ENERGY CONSUMPTION ANALYSIS
 - 3.1 Energy audit overview
 - 3.2 Steam and hot water production data
 - 3.3 Compressed air production data
 - 3.4 Annual energy accounting
 - 3.5 Monthly energy accounting
 - 3.6 Average energy loads
 - 3.7 Breakdown of energy usage by main processes
 - 3.8 Annual energy efficiency
 - 3.9 Estimation of implemented energy saving measures
 4. FINDINGS AND CONCLUSIONS
 5. ENERGY SAVING OPPORTUNITIES AND ACTION LIST
- ANNEXES (Procedures, checklists, business cases)

Congratulations, you have completed your Energy Efficiency Self Audit. This is an important step to save energy and increase your profit, but only if you start implementing your recommendations.

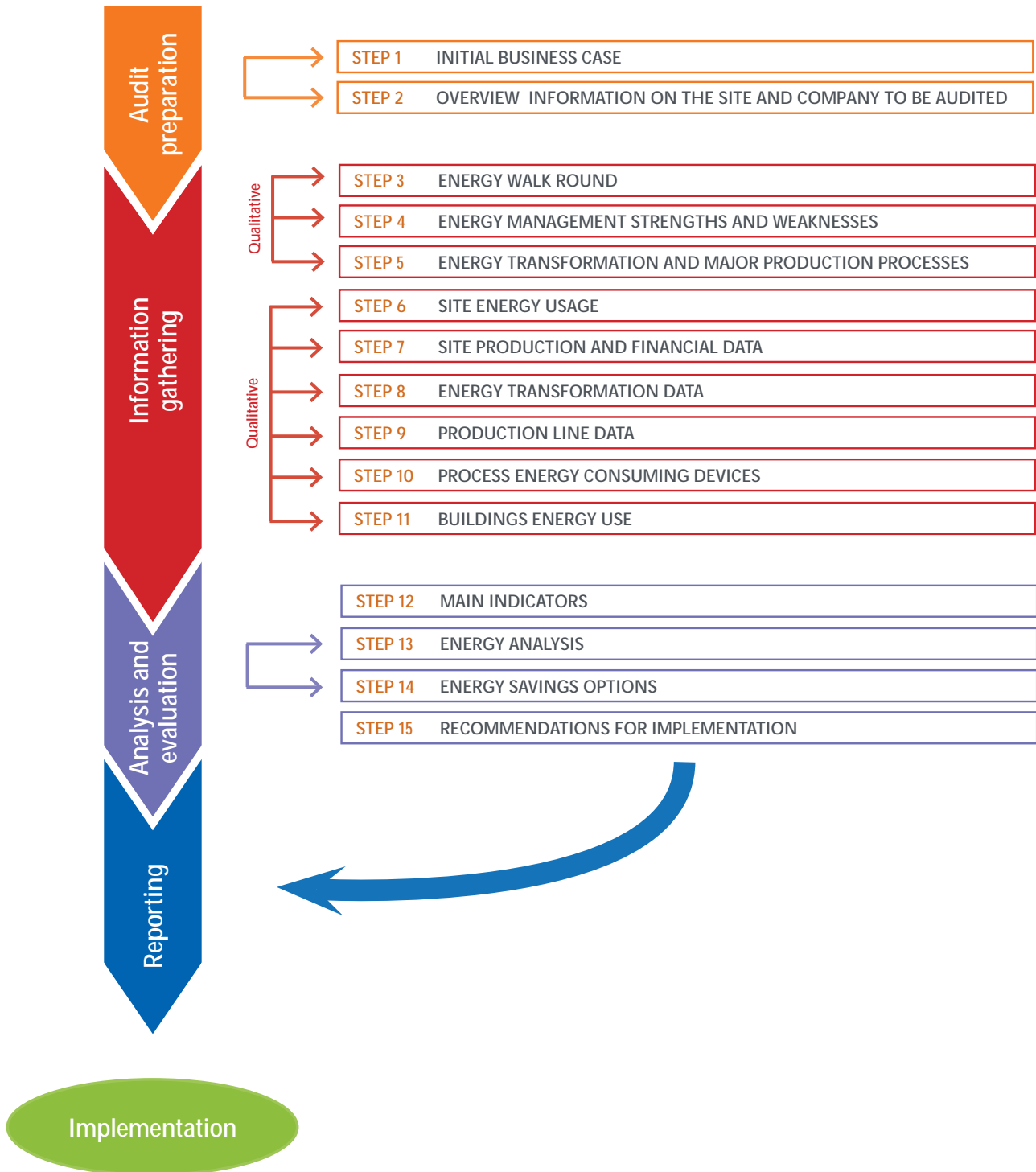
Implementation



To make an energy audit worthwhile, the recommendations from the audit report need to be incorporated into an action plan which needs to be approved by the responsible management.

Now implementation can start. The next energy audit will then already show you your achievements!

Explanatory scheme for the Self Audit Guide and the Excel Tables





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