



**RESOURCE AND ENERGY EFFICIENT MANUFACTURING**

# **BEST PRACTICES BOOK**

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For further information visit our website [www.reemain.eu](http://www.reemain.eu)



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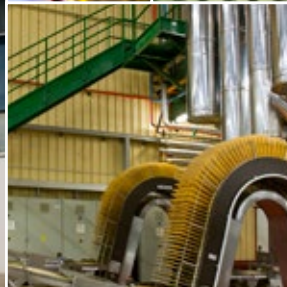


## BEST PRACTICES BOOK

# TABLE OF CONTENTS

<b>INTRODUCTION</b>	<b>5</b>
<b>METHODOLOGY</b>	<b>7</b>
<b>BEST PRACTICES</b>	
Best practices on Design	<b>8</b>
Best practices on Operation & Maintenance	<b>18</b>
Best practices on Exploitation & Dissemination	<b>22</b>
<b>USING RESOURCES TWICE OVER TO SAVE MONEY</b>	
Interview to Anibal Reñones Dominguez	<b>30</b>







# INTRODUCTION

The REEMAIN project has provided us with the opportunity to expand our knowledge and experience in the Resource and Energy Efficient Manufacturing world. During the demonstration actions at the factories, our team has experimented energy and materials saving technologies and process and, of course, tested their effectiveness. Similarly, this has been a valuable opportunity to test our modelling approach.

As our project comes to an end, we have produced this Best Practices Book as a way of sharing our experience with other professionals in the material and energy efficiency manufacturing domain. The Best Practices featured are based on our experience while searching and testing efficiency measures in our three demo factories: GULLON (Biscuit), BOSSA (Textile) and SCM (Iron & Steel).

These 18 Best Practices are a summary of the key findings and recommendations we make to the overall community involved in this kind of projects (designers, research institutions, factory owners, workers, contractors, public bodies, investors, etc.), to help you find your way around if you decided to get involved in an efficiency improvement within a factory. The table on the following page shows the relevance of these Best Practices to each type of stakeholder.

It is our hope that this book will reach the right scientific, professional and business communities in order to share the REEMAIN project experience and encourage others to capitalise on it. Let this be one further step towards the “Material and energy efficiency manufacturing” challenge.





# BEST PRACTICES AND RELEVANCE TO STAKEHOLDERS

	Designers 	Research institutions 	Factory owners 	Workers 	Contractors 	Public Bodies 	Investors 
<b>Best practices on Design</b>							
1 Conceive the factory "as a whole" beyond its own boundaries.	•	•	•		•		•
2 Better planning of efficiency measures through integrated simulation	•	•	•		•		
3 Factories: be prepared to cooperate with research organizations	•	•	•	•	•	•	•
4 Aggregating systems are the key!	•	•	•	•	•		
5 Define a monitoring strategy before installing efficiency measures.	•	•	•		•		
6 Carefully choose your Key Performance Indicators	•	•	•	•			•
7 Identify elements of major interest and focus on them	•	•		•			
8 Tech roadmap on design and integration of RES, storage and waste heat recovery solutions for efficient manufacturing.	•	•	•			•	
9 Life Cycle Thinking for factories.	•	•	•	•	•	•	
<b>Best practices on Operation &amp; Maintenance</b>							
10 Sense of belonging is the way to maintenance and operation	•		•	•	•		
11 Get users on board	•	•	•	•	•		•
12 Great potential lies in production strategies	•	•	•	•			
13 Provide clearly defined access to gathered data and information	•	•		•			
14 Analyse your data and maintain your monitoring system		•	•	•	•		
<b>Best practices on Exploitation &amp; Dissemination</b>							
15 Integrate energy efficiency in your services portfolio	•	•			•		•
16 Find catchy ways for involving users		•	•	•	•	•	•
17 Integrating standardization into R&D projects	•	•	•	•		•	
18 Manufacturing Reference Scenario (MRS) benchmark methodology		•	•		•		•

# METHODOLOGY

The REEMAIN Best Practice Book summarises the key findings from our experience of over four years working on the project.

It is also the opportunity for our team to turn these lessons into recommendations for the community of stakeholders that the project has been targeting: designers, research institutions, factory owners, workers, contractors, public bodies, investors, etc.

At the core of our experience lie the activities undertaken at the REEMAIN demo sites: GULLON (Biscuit sector), BOSSA (Textile sector) and SCM (Foundry sector).

The Best Practices, conceived using the experience and inputs from these three test cases, are not limited to the reference factories, but they have been designed with a view to be relevant in a wide range of applications and industries. Indeed, the Best Practices Book is not thought to refer to a specific set of users, but it targets to help the design of efficiency measures without boundaries on the applicability field.

By working on-site and implementing the solutions developed by the project, the REEMAIN team had the opportunity to validate its methodology and measures in a real environment and, where necessary, to undertake corrective actions.

The Best Practices featured in this publication have been developed and drafted by the REEMAIN team. They fall into three main thematic areas: Best Practices on Design, Best Practices on Operation and Maintenance and Best Practices on Exploitation.

The backbone of each Best Practice is a combination of descriptive content, recommendations and assessment.

**Summary and REEMAIN practical experience** - The description of each Best Practice is itself a recommendation. The “REEMAIN practical experience” paragraph is deliberately anchored to the experience at the demo-site during this implementation phase and – basically – indicates why a specific Best Practice is particularly relevant for our project.

**Recommendations** - These are a key feature of this booklet and their message is twofold. They indicate the category of stakeholders they are addressed to, as these may vary with each Best Practice. Moreover, they provide a few practical guidelines (as well as things to avoid) based on our experience. The style of these recommendations is straightforward to ensure the key messages come across clearly. Readers interested in obtaining more in-depth information may retrieve additional material from the project website ([www.reemain.eu](http://www.reemain.eu)).

**Replicability** - Since the deployment and replication of the REEMAIN methodology is one of our objectives, each Best Practice contains an overall replicability score, drawing on an assessment exercise by the project partners and measuring how each Best Practices is applicable to other cases. Partners providing their input were asked to qualitatively assess how replicable a specific Best Practice is, by using a 5 points scale (being 1 less replicable than 5).

**Impact Rating** - A similar qualitative approach has been followed for the Impact Rating score. Five Indicators were preliminarily identified (energy consumption, environmental impact, planning expenditures, performance impact and economic and administrative impact). For each of them, partners specified how high their impact on the factory performance is expected to be. In this instance, a 5 points scale has been used as well (having 1 a lower impact than 5).



**BEST PRACTICES ON  
DESIGN**



# CONCEIVE THE FACTORY “AS A WHOLE” BEYOND ITS OWN BOUNDARIES

There is a lack of knowledge and integration between factories building shell, technical building services (TBS) and manufacturing production systems. So, from the design stage of an efficiency measure, a factory needs to be conceived as a whole, and the design process should take into account all systems and surroundings (interactions and requirements). In the analysis stage of an efficiency measure a common methodology uses, e.g., the waste heat in the same machinery (or near) whose generate that “resource”.

## STAKEHOLDERS



Designers



Research institutions



Factory owners



Contractors



Investors

## REEMAIN PRACTICAL EXPERIENCE

Considering the relations among different production processes, a lot of opportunities for energy saving and for coupling manufacturing production system waste heat with its building related TBS can be found. In our foundry case study, we found an interlinking between waste heat from the furnace exhaust to external end users, e.g. SMEs (external use of internal resource). In the biscuit factory, cool outside air was used for generating cold water (internal use of external resource). In the textile factory, a huge amount of steam was saved recovering waste energy from heat treatment baths (internal use of internal resource).

## ✓ OUR ADVICE

- Start with an exhaustive evaluation including all factors influencing energy consumption, process production and the cost of all used resources.
- Be flexible to adapt the factory to energy saving needs.
- Centralize design information about capacities of different manufacturing means (size of machinery, nominal consumption, location).

## ⚠ CAUTION

- Be prepared to factories' departments resistance to design efficiency measures that connects various workshops with different energy meters.

## IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## BETTER PLANNING OF EFFICIENCY MEASURES THROUGH INTEGRATED SIMULATION

In the design stage, technical building systems and production facilities are often planned only using static calculations (e.g. based on nominal thermal/production loads). Simulation helps to include dynamic influences (like seasonal effects) and to analyze how the planned factory will behave in the future. Integrating the simulation of material and energy flows, further allows to investigate the existing interrelations. Simulation is extremely valuable for sizing the efficiency solutions.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Contractors

### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN we developed tools for the integrated simulation of technical building systems and production. They help in the energetic assessment of the project's starting state and in the evaluation of the efficiency measures. Their application proved very valuable in planning new production and efficiency strategies. In the process of implementation of efficiency measures is important to have tools to analyse in advance the impact of energetic solutions planned to be installed.

### ✓ OUR ADVICE

- Simulate what was planned before making decisions.
- Investigate energy and material flows alongside each other.

### ⚠ CAUTION

- Decide on the scope of the simulation models before commencing the simulation study.
- Precision of simulations is strictly related to level of detail of factory production profiles.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## FACTORIES: BE PREPARED TO COOPERATE WITH RESEARCH ORGANIZATIONS

Implementation of, for example, energy efficiency measures is not always easy in factories and the expected results are only possible if there is a real commitment from them. As factories do not always have the time or required technical staff in house required for this, they should look into collaborations with research organizations or other experts in the field. Such cooperation should help them define the technical aspects which guarantee project innovation and find the expected results.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Workers



Contractors



Public Bodies



Investors

### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN we see quite clearly how important this kind of collaboration was. Production and consumption data from factories are limited and often confidential, limiting the possibilities for information exchange and improvement. Because of this, joining forces with the research organizations is a key factor in order to define the technical improvements and its assessment both before and after measures are installed.

### ✓ OUR ADVICE

- Provide as many specific and detailed data as possible. Being generic won't help reaching the efficiency goals.

### ⚠ CAUTION

- If you are thinking about a very innovative project don't assume you can do it all by yourself. You may need help, at least on certain aspects.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## AGGREGATING SYSTEMS IS THE KEY!

Use a common energy system for a whole factory, rather than isolated systems. This approach can be applied to hot, cold and compressed air generation systems, usually found in any factory (especially in factories built by successive extensions). Design/create internal energy rings from which individual factory processes can extract the energy/service they need (heat, cool, compressed air, etc.). This simplifies a lot the integration and use of renewables or heat recovery systems.

### STAKEHOLDERS



### REEMAIN PRACTICAL EXPERIENCE

In the REEMAIN biscuit factory, we unified separated energy generation systems (with medium or low load) into a system that coordinates and centralizes the hot water production. Boilers were connected to a common manifold to distribute the produced hot water to the already existing specific manifolds. This way, the system can work with part of previous generation systems, but with boilers working at full load, i.e., where boilers have higher efficiency.

### ✓ OUR ADVICE

- Look for renewable energy and/or waste heat sources across the “project” boundaries too.
- Don’t look at every process as a single unit but try to centralize energy systems to boost up efficiency.

### ⚠ CAUTION

- There is no “best” energy efficiency measure. Systems must be robust and easy to control but flexible enough to adapt to external conditions/processes.
- The advantages of complex solutions should be treated with caution.

### IMPACT RATING





## DEFINE A MONITORING STRATEGY BEFORE INSTALLING EFFICIENCY MEASURES

Data acquisition on different levels requires an efficient planning and decision process for the integration of sensors and communication technology. Here, planning and preparation should be considered as time consuming and extensive processes. After this, the monitoring system concept is defined, developing energy, material, and information flows (typically before the installation of the Efficiency Measure). Finally, specific sensors are chosen, taking into account the resulting accuracy for chosen indicators. Historical data could also be used.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Contractors

### REEMAIN PRACTICAL EXPERIENCE

It is fundamental to define a method to monitor a factory efficiency measure from the very beginning to ensure that the process doesn't go off track at any point. An interdisciplinary team should define such a method and goals. In REEMAIN, we:

1. Defined useful and interesting KPIs (provided by the factory experts)
2. Defined the monitoring concept (energy, material, and information flows)
3. Defined monitoring hardware, checking accuracy for chosen indicators
4. Analyzed existing systems data or historical data to finalize the new design

### ✓ OUR ADVICE

- Fully understand the main operational targets of the factory.
- Follow the commissioning process during every stage.
- If you don't intend to spend money in a full monitoring system, at least leave your system ready for the implementation of new solutions in the future.
- You can use temporary metering without needing to stop lines for installation.

### ⚠ CAUTION

- Make sure that all your sensors are completely insulated, well calibrated and installed in order to ensure correct measures.
- The fact that any sensor has been "working" for years does not guarantee its measure is 100% reliable.
- Keep in mind that target oriented acquisition of data also requires the necessary infrastructure, access points as well as storage capacity.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## CAREFULLY CHOOSE YOUR KEY PERFORMANCE INDICATORS

Defining the right KPIs is the basis for good performances. Key performance indicators are one of the most important aspects to define in the preliminary phase of the project, during the design phase, and are necessary to objectively assess the quality of a new measure. Monitoring is also essential during the maintenance phase. A good monitoring plan guarantees a reliable evaluation of the indicators which feed into the monitoring system.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Workers



Investors

### REEMAIN PRACTICAL EXPERIENCE

In the three factories of REEMAIN was devoted huge time in KPIs analysis. In general terms, we can say that “local KPIs strategy” allow good inefficiencies detection. However, sensors cost and working-hours to data analysis are their weakness. “Global KPIs strategy” doesn’t require an extensive, complex and expensive monitoring system. However, information they provide is limited. The two contributions must be balanced to ensure information and cost efficiency.

### ✓ OUR ADVICE

- Share the specifications among all the stakeholders involved.
- Capitalise on the information from the previous phases.
- Simplify to make evaluation easier.
- Choose sensor accuracy based on final accuracy desired for KPIs.

### ⚠ CAUTION

- Avoid just copying the KPIs from another factory.
- Avoid using a complex set of KPIs.
- Avoid developing at the last moment.
- Monitors points necessary for the calculation of the chosen KPIs.
- Check sensors installation conditions.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## IDENTIFY ELEMENTS OF MAJOR INTEREST AND FOCUS ON THEM

In preparation of planning and application of different methodologies and simulations to factories, main system parts should be separated from sections with less influence. The execution of methodologies becomes more efficient when systems' elements and connections are reduced to an efficient optimum. These are not just a collection of existing information (rarely centralized in an only person or department) but rather a complete remaking of knowledge scattered over several departments within the factories, such as: Planning, Provisioning, Quality, etc.

### STAKEHOLDERS



Designers

Research  
institutions

Workers

### REEMAIN PRACTICAL EXPERIENCE

REEMAIN provides different guidelines and concepts to analyse/design energy and resource-efficient factories. The analysis is more time-consuming as the complexity of the system increases. In REEMAIN, the analysis of production processes and machineries (its retrofit or replacement) led to two interest groups:

1. Intensive energy/resource systems, technically and economically expensive but with a high impact on energy/resources consumption.
2. Marginal energy/resources systems, easy in technical and economic terms but with a low impact on energy/resources consumption.

### ✓ OUR ADVICE

- Start with a prior analysis (e.g. Pareto) to identify main consuming system elements and estimate their impact on targeted results. Especially in case of time critical tasks results may be accessible quickly and efficiently.
- Required information will be gathered from multiple departments like maintenance, production planning, purchases, etc.

### ⚠ CAUTION

- The reduction in complexity and the avoidance of excessive levels of detail should not lead to superficial analysis.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## TECH ROADMAP ON DESIGN AND INTEGRATION OF RES, STORAGE AND WASTE HEAT RECOVERY SOLUTIONS FOR EFFICIENT MANUFACTURING

There is often a lack of knowledge which technologies are market ready or near-to-market like innovative renewable energy sources (RES), storage and waste heat recovery technologies for efficient manufacturing in a factory environment to reduce and improve the overall conventional energy demand of production processes.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Public Bodies

### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN, a set of different energetic solutions (RES, storage and waste heat recovery) mainly related to the three industry sectors (textile, biscuit and iron casting) were investigated, ranked and described in detail including SWOT analysis. In total, 32 different technologies are described and ranked in this unique technology roadmap for each defined generation cluster (cold, electricity, heat, poly-generation and storage). Based on results, there are highly interesting technologies for manufacturing processes depending on different applications.

### ✓ OUR ADVICE

- Investigate innovative technologies to be used in the factory environment to reduce and/or improve the overall energy consumption of production processes or factory buildings.
- Be flexible to adapt the factory to energy saving needs as well as RES, storage and waste heat recovery technologies.

### ⚠ CAUTION

- It has to be noted that road mapping is a living process as new technologies and application areas are continuously in development.
- It has been evident that the technologies scouted and assessed within are at different TRLs (Technology Readiness Level) and typically along development lines of increasing efficiency and lowering costs.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact



## LIFE CYCLE THINKING FOR FACTORIES

Life Cycle Assessment considers the whole life cycle of a specific product, even after the product goes out of the factory (final disposal, recycling, etc.). For the companies, it is interesting to elaborate this kind of assessment because it allows to obtain information about the process both inside and outside the factory. The company has the opportunity to improve the environmental profile of the product in the use, maintenance and end of its life.

### STAKEHOLDERS



Designers

Research  
institutionsFactory  
owners

Workers



Contractors

Public  
Bodies

### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN, we determined where the main environmental impacts were in our 3 different industry sectors. Results showed us that, considering the materials, transportation and manufacturing processes in the biscuit, textile and foundry sectors: the raw materials stage is the most impacting in Biscuit factory, the manufacturing process represents the higher contribution in Textile factory and the energy consumption is the most impacting stage in the foundry.

### ✓ OUR ADVICE

- *Environmental assessment following a normalized approach (ISO 14040) will provide you relevant information about your impacts.*

### ⚠ CAUTION

- *Be careful when communicating environmental results only considering some stages of the Life Cycle.*
- *Remember that impacts of different stages can provide different results depending on the indicator selected, so be careful in the way you communicate your results and with absolute asseverations.*

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact



# BEST PRACTICES ON MAINTENANCE & OPERATION

## SENSE OF BELONGING IS THE WAY TO MAINTENANCE AND OPERATION

Central to optimal operation and maintenance is a continuous commissioning plan based on several pillars: a commissioning team with clear roles and accountability, training of operators, monitoring, fault management (detection, diagnosis, remediation) and contingency plans. All these elements should work cohesively in order to establish efficient measures in a seamless way. Hence, a good coordination of the commissioning plan is required.

### STAKEHOLDERS



Designers



Factory  
owners



Workers



Contractors

### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN we have verified the importance of involving from the very beginning all departments of the factory that directly or indirectly will be “affected” with the implementation of the efficiency measure (mainly production and maintenance departments). Measures’ effect on factory maintenance, additional efforts and final benefits must be agreed with people in charge of maintenance and production, usually focused on achieve their own deadlines and cost targets.

### ✓ OUR ADVICE

- Develop the right KPI and identify the team to ensure sound operation.
- Pay special attention to fault management.
- Verify and prioritise on a regular basis.

### ⚠ CAUTION

- Don’t assume that the measure performance is right.
- Don’t wait for failures before reacting.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## GET USERS ON BOARD

Users need to understand and really appreciate the advantages of energy saving so that they use the efficiency measures in the right way. They must consider energy saving as a priority and personal challenge to engage with. For this purpose, a central role is played by the communication of solutions and results. Simple scoreboards with KPI-benchmark values and daily energy saving tips applied to commonly used spaces are a simple and effective way to engage them and obtain their commitment.

### STAKEHOLDERS



Designers



Research institutions



Factory owners



Workers



Contractors



Investors

### ✓ OUR ADVICE

- Promote the opportunities for energy savings as a personal green contribution.
- Encourage users through incentives and training to save energy.

### ⚠ CAUTION

- Don't overstate technology. Design "easy to use" energy saving systems. They have to be handy for the everyday use.

### REEMAIN PRACTICAL EXPERIENCE

User engagement with a simulation platform is a big consideration when designing a software. The simulation tool developed in REEMAIN help to guide the users through the process. The web based aspect of the tool also allows users to visually interpret the performance of a particular measure once it is up and running. The tools developed within an efficiency project should always be user-friendly and supported by training/support sections, for seamless integration.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact



## GREAT POTENTIAL LIES IN PRODUCTION STRATEGIES

Much of a factory's energy demand and wastes are directly linked to the production processes. To cope with the integration of renewable energy sources, locally and in the grid, production strategies play a major role. Influencing production schedules, shift times and the general production processes allows for increasing energy efficiency and reacting to volatility caused by renewable energy sources.

### STAKEHOLDERS



Designers

Research  
institutionsFactory  
owners

Workers

### ✓ OUR ADVICE

- Consider which production processes have major effect on the overall consumption.
- Search for ways to control and analyse the production in an energy-sensitive way.

### ⚠ CAUTION

- Don't forget about the workers. They have to accept new production strategies.

### REEMAIN PRACTICAL EXPERIENCE

New energy-sensitive production strategies were developed in the E<sup>3</sup>-Research Factory (Energy- and resource- Efficient production, Emission-neutral factory and Ergonomics in human-centered production) to improve the overall performance using renewable energy sources. Significant savings could be projected using simulation, which allows the correlation of several parts of the production within a global view of the processes and allowing for a holistic planning of the strategies.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## PROVIDE CLEARLY DEFINED ACCESS TO GATHERED DATA AND INFORMATION

In the factories, with the target to collect, analyse and process data in different cases at several points in time a clear documentation of the storage structure and data transmission is necessary. This allows for a clear identification of the path followed by data, with no ambiguity about the origin of information and a subsequent improvement in data analysis efficiency from both the results and working time points of view.

### STAKEHOLDERS



Designers



Research  
institutions



Workers

### REEMAIN PRACTICAL EXPERIENCE

In many cases the existence of distinct relevant data is known but there is no clarity about the referring sources. This leads to much more expenditure for gathering and proofing the correctness of data. The time spent in these actions can be limited using a reference document gathering all the important information about the data transmission along the whole energy/material/production improvement process in factories.

### ✓ OUR ADVICE

- Elaborate a clear document (handbook, presentation) with structured guidelines and descriptions for the extraction of the required information sources.

### ⚠ CAUTION

- The person in charge of the necessary document should also take care of future updates so that they are instantly integrated and accessible for participants.

### IMPACT RATING



Energy consumption



Environmental impact



Planning expenditures



Performance impact



Economic/admin. impact

## ANALYSE YOUR DATA AND MAINTAIN YOUR MONITORING SYSTEM

It is important to check the monitoring system considering mounting issues and problems related to harsh operating conditions, which can affect the measures. Sensor offsets must be identified and corrected using operational data. The health of the monitoring system needs to be assessed periodically, with a case-dependent frequency which should be higher for sensors in harsh environments. It is crucial to periodically analyse the chosen indicators. This often leads to the identification of operational improvements for the Efficiency Measure.

### STAKEHOLDERS



### REEMAIN PRACTICAL EXPERIENCE

Monitoring data were checked with high frequency (e.g., daily/weekly) during the first month after the installation of an Efficiency Measure. Periodic checking with reduced frequency (e.g. monthly) was then carried out during the next months for about 1 year. This allowed to readily substitute broken/unreliable sensors. Comparison with nominal performances was carried out in order to have a constant evaluation of working efficiency.

### ✓ OUR ADVICE

- Start with a prior analysis (e.g. Pareto) to identify main consuming system elements and estimate their impact on targeted results. Especially in case of time critical tasks results may be accessible quickly and efficiently.
- Required information will be gathered from multiple departments like maintenance, production planning, purchases, etc.

### ⚠ CAUTION

- The reduction in complexity and the avoidance of excessive levels of detail should not lead to superficial analysis.

### IMPACT RATING

★☆☆☆☆  
Energy consumption

★☆☆☆☆  
Environmental impact

★★★★☆  
Planning expenditures

★★★★☆  
Performance impact

★★★★☆  
Economic/admin. impact



**BEST PRACTICES ON  
EXPLOITATION & DISSEMINATION**



## INTEGRATE ENERGY EFFICIENCY IN YOUR SERVICES PORTFOLIO

In general, it is very hard to convince a new customer to start a technology adoption project based on an EU-Funded result, if this customer has just been approached. Conversely, when a customer has already a relation in place (i.e. when the initial confidence has already been gained), he will be much keener to consider an efficiency measure implementation within its factory, especially if given the possibility to benchmark with a case history which he can identify with.

### STAKEHOLDERS



### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN, we realised that additional users (i.e. other foundries, food factories, etc.) tended to be cold and diffident if approached with the proposition “do you want us to improve your energy and resources efficiency?”. On the other hand, when proposing the REEMAIN technologies to contacts already in place, where technology consulting was already being deployed, users tended to consider the efficiency measures more seriously, as an interesting add-on to other services/investments.

### ✓ OUR ADVICE

- Train “energy efficiency ambassadors” within your company/institute, capable of matching companies needs with the developed technologies
- Be ready to customize your solution, the new services/products should be adapted to different facilities and fields.

### ⚠ CAUTION

- Energetic optimization issues are generally underrated, so the offering and results should be sufficiently attractive and innovative.

### IMPACT RATING

★★★★☆  
Energy consumption

★★★★☆  
Environmental impact

★★★★☆  
Planning expenditures

★★★★☆  
Performance impact

★★★★★  
Economic/admin. impact

# FIND CATCHY WAYS FOR INVOLVING USERS

A seminar on energy efficiency topic could be organised and, along with the project partners, appealing speakers for a particular region/territory could also be invited. Attendees will be informed on the project results, opportunities and experiences. Any type of exploitation event helps getting closer to new possible “customers”. Demonstration sets, publications, fair booths can also be helpful to show the results obtained, involve new users and underline the importance of energetic optimization.

## STAKEHOLDERS



## REEMAIN PRACTICAL EXPERIENCE

In REEMAIN, we realised that, when organising events/seminars, energy efficiency is not a very sexy argument. However, it represents a crucial point for a high number of industries. Hence, it is fundamental to get the audience’s attention, possibly highlighting the match of energy efficiency with the “buzzwords” that for sure raise the listeners’ attention (i.e. “industry 4.0” as of 2017).

## ✓ OUR ADVICE

- Adopt a clever communication strategy, where recipients are attracted by the link with up-to date general issues
- Always highlight quantifiable benefits from technologies adoption (i.e. “an average foundry will obtain XX annual savings”)

## ⚠ CAUTION

- Present benefits in a solid, scientifically sound manner, in order to avoid losing credibility.

## IMPACT RATING

★★★★☆  
Energy consumption

★★★★☆  
Environmental impact

★★★★☆  
Planning expenditures

★★★★☆  
Performance impact

★★★★★  
Economic/admin. impact

## INTEGRATING STANDARDIZATION INTO R&D PROJECTS

Standardization is a strong tool for the dissemination and for the knowledge transfer of the project outcomes, Particularly REEMAIN's ones. Furthermore, is a key tool for the introduction of these outcomes into the market, getting confidence to users, granting compatibility and interoperability with what already exists and providing a faster and easier way for the market introduction of new technologies.

### STAKEHOLDERS



### REEMAIN PRACTICAL EXPERIENCE

Standardization in REEMAIN project has had two main benefits. First, getting standard references, which have helped partners in their researches, e.g., defining of KPIs through ISO 22400, exploring the capabilities of the PLC communication to prototype the monitoring power consumption and data transmission through EN 14908-3, etc. Second, dissemination of the REEMAIN Methodology for Resource and Energy Efficiency Manufacturing through the standardization system opening, spreading the knowledge outside the project.

### ✓ OUR ADVICE

- Consider the implementation of standardization activities at early proposal stages. Try to engage a national standardization body in the R&D projects if standardization activities are included in the project.
- Find, analyse and use the existing standards or draft standard which could help the project researches saving time and efforts since there is work already done.
- Identify the output target to be standardized from the very beginning of the project, this will lead to a more successful standardization.

### ⚠ CAUTION

- Inform about the foreseen standardization activities to all the identified related technical bodies of the standardization system.

### IMPACT RATING

★☆☆☆☆  
Energy consumption

★☆☆☆☆  
Environmental impact

★★★★☆  
Planning expenditures

★★★★★  
Performance impact

★★★★☆  
Economic/admin. impact

## MANUFACTURING REFERENCE SCENARIO (MRS) BENCHMARK METHODOLOGY

In order to be able to compare different factories in their individual industry sector, it is necessary to deploy a benchmarking strategy (Company factor) whose include internal company parameters (e.g. KPIs), as well as Carbon dioxide emissions concentrated on the energy source (to take into account environmental effects).

### STAKEHOLDERS



### REEMAIN PRACTICAL EXPERIENCE

In REEMAIN we developed a benchmarking strategy to compare different companies in their specific sector. The methodology for the calculation of the MRS-score was done based on the individual subgroups Renewability, Company and Environmental Effects. In order to quantify the potentials of using renewable energy sources a statistical investigation (Renewability) with a holistic approach has been undertaken. The MRS investigation results interesting potentials on certain locations for using RES systems in Europe and comparisons regarding energy consumptions of different companies (especially in the automotive sector).

### ✓ OUR ADVICE

- In the benchmark strategy, internal company data (energy consumptions, production, etc.) and external (weather data, energy prices), are required
- If a statement regarding environmental effects is desired the distribution of the energy source should be available

### ⚠ CAUTION

- Take the significance of the scores into account.
- Due to the fact that it is a statistical approach, modifications/ changes in the data selection are influencing the results.

### IMPACT RATING

★★★★★  
Energy consumption

★★★★★  
Environmental impact

★★★★★  
Planning expenditures

★★★★★  
Performance impact

★★★★★  
Economic/admin. impact







# USING RESOURCES TWICE OVER TO SAVE MONEY

*“Directly integrating a small to medium amount of green electricity into a factory is quite simple. In some countries however, the legal framework needs to be changed if the manufacturing sector is to adopt renewables more widely”, says Spanish analyst Anibal Reñones Dominguez*

Over the last four years, three factories in Spain, Italy and Turkey have been testing novel solutions to show how it is possible to cut energy bills and use fewer resources while maintaining productivity. Performed in the food, foundry and textile industries, the experiments are now set to be upscaled in the same fields.

Anibal Reñones Dominguez, deputy head of the Systems





Division at the Cartif Technology Centre, and coordinator of the European project REEMAIN explains how these results were possible by recovering the lost energy, optimising production and integrating renewables.

***How do you appreciate the overall outcome of the project (1 October 2013 - 30 September 2017), now that the tests are over?***

It was a good opportunity to interact with the factories and inform them about the experiments and the energy efficiency outcomes. Usually factories outsource energy saving measures. Under REEMAIN, we engaged with factory managers from the outset and involved them in the selection and design process: they were shown the different technologies and range of energy efficiency solutions; they could make their own decisions according to the technologies' return on investment and level of innovation. I would like to emphasize that this is a demonstration project. When it ends, we will provide an unbiased evaluation and will recommend in full honesty the best technology for each factory.

***What kinds of energy saving technologies have been tested in each industry?***

We did several demonstrations in each industry. We suggested cookies producer Gullon use the outside cold air to produce cold water in a sustainable and efficient way. Therefore, the factory could obtain its own cold water for different stages of the production process, such as cooling the biscuits after removal from the baking ovens or providing air conditioning for the rooms where the chocolate or creams are applied. This would save electricity and be an environmental friendly solution.

The biscuit factory is located in the Northern Spain, where the temperatures are low enough during the cold seasons. Biscuits are food products which need to be kept dry and at cooler temperatures. Factories usually prefer a simpler, although less sustainable, electricity-based cooling water system instead of a more complex system capable of drawing on outside renewable resources.

Another example is the recovery of the wasted heat from the baking oven chimneys. This can be used to preheat the ovens instead of using natural gas.

At textile factory Bossa, in Turkey, we tested the impact of using organic raw materials such as cotton and indigo dye in the manufacturing processes. We also tried to make the residual waters from the industrial process more ecological.

The textile industry requires a lot of water, especially for dyeing the denim fabrics. To neutralise the waste water before releasing it into the nature, the factory's workers used to add sulfuric acid. We suggested carbonic acid instead, which is more ecological. It avoids the formation of salts in the treated water, which is what happens when using sulphuric acid. The factory now plans to capture CO<sub>2</sub> from the boilers and use it to treat water.

The foundry is a typical example of where a lot of energy is used for melting iron. The exhaust fumes from this process are very hot (400-600 degrees Celsius) and the industry must cool them down before they are released into the atmosphere. We suggested SCM Group Spa – Fonderie use this heat to produce thermal water. In possibly a couple of years, this thermal water could go onto heating the local district or the factory's own purposes.

***Which technology was the most “challenging” and posed the most difficulties during the tests?***

The heat recovery from the cupola furnace of the foundry in Italy was a great challenge for us. The high variations in temperature and the exhaust fumes put a lot of pressure on the heat exchanger, which has to recover as much heat as possible. Current foundries need to release energy to cool down the furnaces' exhaust fumes. Once the exchanger technology is ready, it will have a huge impact on foundries' energy bills. It will be used to generate hot water directly from the exhaust fumes and it is expected to capture more than 50% of the wasted energy.





*“Our suggestion to managers is to treat the design stage of an efficiency measure looking at the factory as a whole, taking into account all systems and surroundings, interactions and requirements”*

Renewables also represent a challenge, albeit a more general one. Technically, it is quite straightforward to directly integrate a small to medium amount of green electricity into a factory. However, in some countries such as Spain, the legal framework needs to be changed if the manufacturing sector is to adopt renewables more widely. Due to high costs and legal uncertainties, we are not able to integrate renewables as much as we would like.

***The project’s team have also developed a “Decision support tool” which helps managers to better analyse the alternatives and to enhance efficiency. Could you tell us how this tool works and what kind of information it gives to managers?***

This is a software tool which can model the interdependencies between buildings, surroundings and the manufacturing production system (energy and material flows). It is applicable to any kind of factory and uses data about the factory’s equipment, energy used, enveloping materials of the walls and the factory’s production background. Once this data has been entered, the software analyses the factory’s working profile and provides managers with preliminary advice as to where they may save energy and resources.

Different solutions of various sizes, such as applying a solar roof, can be simulated. The tool can make long-term calculations to see how much energy is generated in this case. Users can also combine virtual solutions and accurately estimate return on investment.

***Can the solutions tested within this project be used by other sectors?***

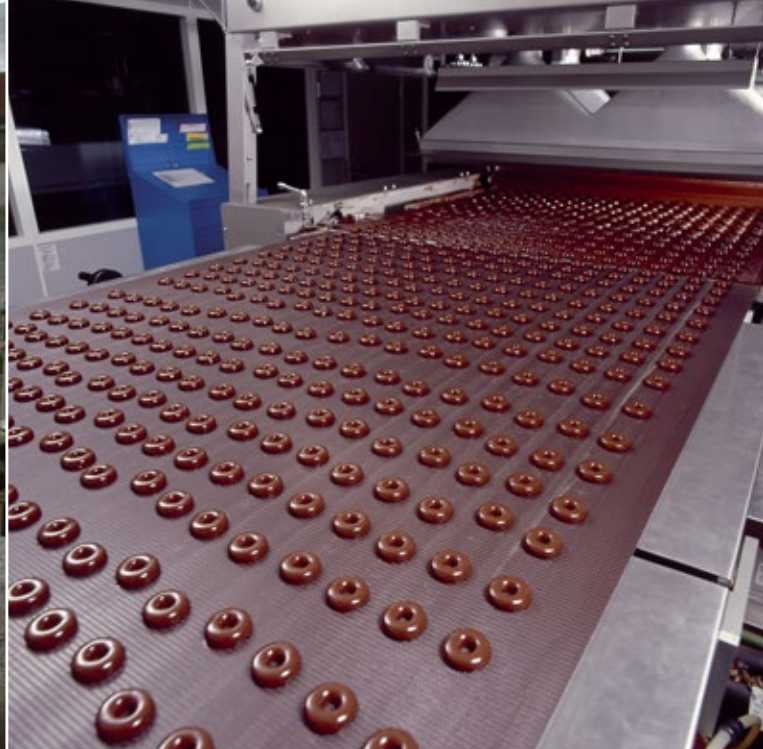
Sure, a cooling solution based on renewable energy could be applied across many food sectors, where cooling systems are needed in the processing chain. Also, the technology we tested for heat recovery can save a lot of energy in industry. We are drafting a plan to replicate the REEMAIN project’s demonstrations and are calculating their impact in other more or less similar sectors.

***What suggestions would you make to managers for them to successfully compete in an increasingly tough market while remaining environmentally friendly?***

We would suggest they read our best practice book, as it gathers interesting practical examples we experimented during the project. It shows managers where and how they could save energy, and how to improve production.

By examining different situations and points of view, managers are more able to notice issues or inefficiencies in their own businesses. Factory building shells, technical building services and manufacturing systems are not properly integrated with one another and knowledge does not flow enough. Therefore, the design stage of an efficiency measure must look at the factory as a whole, taking into account all systems and surroundings, interactions and requirements. Surprisingly, the installation of energy efficiency measures has revealed many small inefficiencies and mismatches in the existing measurement and control systems. The fact that one system provides the required services (e.g. hot water) does not necessarily mean that it is performing in the most efficient way.







[www.reemain.eu](http://www.reemain.eu)