AmI-MoSES Demonstrators

AmI-MoSES Project

Ambient-Intelligent Interactive Monitoring System for Energy Use Optimisation in Manufacturing SMEs

FP7-ICT-224250

Public Project Report

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Executive Summary

Demonstrations of functionalities of the developed ICT system for Energy Efficiency Optimisation in three business cases of system users are described here. The system prototype was developed in the project AmI-MoSES – Ambient-Intelligent Interactive Monitoring System for Energy use Optimisation in Manufacturing SMEs. The project aim was to develop an intelligent monitoring system to observe energy consumption in manufacturing SMEs and to combine this information with process and ambient related measurement data for the purpose of creating a knowledge-based support for optimisation of energy efficiency.

The deliverable presents applications of the full prototype of the AmI-MoSES platform in real industrial environment in three end-user partner companies from the project consortium. Description includes, for each business case, short presentation of the company and its objectives followed by the demonstrated system functionalities, step by step illustrated by corresponding screenshots of the GUIs for each functionality. Future plans regarding the application and exploitation of the system are also presented for each of the companies.

Table of Contents

Abbreviations

a.m.	afore mentioned
AmI	Ambient Intelligence
AMS	Automated Manufacturing Systems
API	Application Programming Interface
BC	Business Case
CBR	Case Based Reasoning
CS	Core Services
DoW	Description of Work
e.g.	exempli gratia = for example
EC	European Commission
ECD	Energy Consumption Data
EE	Extended Enterprise
EJB	Enterprise Java Bean
EP	Early Prototype
etc.	et cetera
EUP	Energy Use Parameters
FP	Full Prototype
GUI	Graphical User Interface
HW	Hardware
i.e.	id est = that is to say
ICT	Information and Communication Technology
IT	Information Technology
KM	Knowledge Management
MS	Manufacturing Systems
MSI	Management of Social Interactions
PUDF	Plan for Using and Disseminating Foreground
R&D	Research and Development
RTD	Research and Technological Development
S&T	Scientific and Technological
SME	Small and Medium Sized Enterprise
SOA	Service Oriented Architecture
SW	Software
UDDI	Universal Description, Discovery and Integration
w.r.t.	with respect to
WP	Workpackage

1 Introduction

This document describes demonstrations of the developed ICT system in the three business cases of the project AmI-MoSES – Ambient-Intelligent Interactive Monitoring System for Energy use Optimisation in Manufacturing SMEs. The project aim was to develop an intelligent monitoring system to observe energy consumption in manufacturing SMEs and to combine this information with process and ambient related measurement data for the purpose of creating a knowledge-based support for optimisation of energy efficiency. The deliverable presents applications of the full prototype of the AmI-MoSES platform in real industrial environment in three end-user partner companies from the project consortium. System functionalities are demonstrated in the three business cases and benefits are verified at the end-users' sites.

Full Prototype of the AmI-MoSES system – Platform and belonging Energy Efficiency Services – is described in detail in the previous project deliverables also publicly accessible, D7.9 AmI-MoSES Full Prototype and D5.4 Assessment of the Full Prototype and the Methodology.

The targeted readers of this document are the members of the User Interest Groups, and other industrial companies which plan introduction of the Energy Efficiency optimisation measures and supporting systems.

This document consists of:

- Chapter 1 Introduction – describes the purposes of this document, the position of this document with respect to the project, and provides a brief overview of the contents of the document.
- Chapter 2 Description of Business Cases including demonstrated functionalities
- Chapter 3 Conclusions

2 Description of Business Cases

2.1 Business Case MBAS

2.1.1 Description of the Company

Mb Air Systems limited, was born following the management buyout of the business and assets of Motherwell Bridge Air Systems Limited, which was originally established in 1973, from the Motherwell Bridge Group in December 2002. Its operations, with over 37 years of expertise and service to a wide range of clients, specialises in the fields of compressed air, material handling (industrial lifting), power tools, pneumatics and product finishing systems.

MBAS internationally provides a wide range of products and services, such as:

- Air Compressors
- Compressed Air Treatment: Air Dryers, Filters
- Filter Receiver
- Maintenance Solutions
- Winches & Hoists
- Product Finishing
- Pneumatics
- Power Tools, Motors & Starters

MBAS is centred on providing complex engineering services to industry, mainly dealing with air compressor solutions, but also supplies capital equipment taking advantage of its international network of suppliers, being ISO9001 certified for these subjects.

2.1.2 MBAS Business Objectives in AmI-MoSES

2.1.2.1 Background

One of the businesses of MBAS is analysing, designing, and commissioning of compressed air system solutions to industries. MBAS normally gathers client's requirements for compressed air systems. Based on the results analysis, MBAS provides system solutions. On acceptance of the suggested solution (containing the system design and cost/benefit analysis), MBAS installs and commissions the systems. Service contracts – as the main outcome of these activities – represent one of MBAS's main sources of revenue.

Compressed air is a very versatile utility and almost all industrial businesses use it to power equipment such as hand-tools, valve actuators, pistons and machinery. Over 10% of electricity supplied to a typical industry is used to compress air. Energy cost is the by far highest cost, and accounts for approximately 75% of the total cost of a compressed air system over 10 year life cycle (see Figure 1).

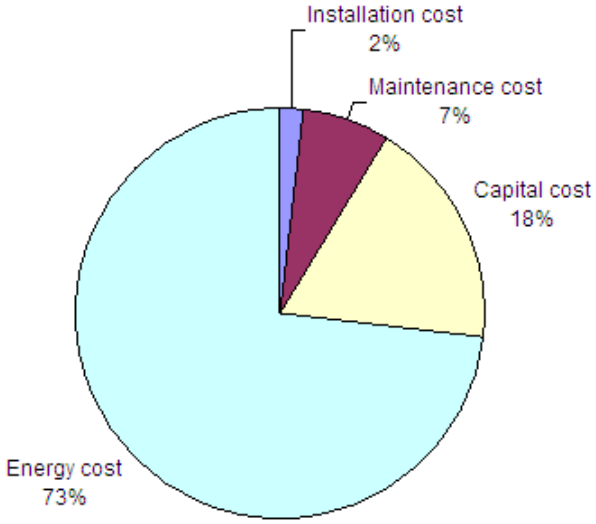


Figure 1: Compressor costs over a 10-year life

Despite the high cost of production, many systems waste up to 30% of the compressed air through leaks, poor maintenance, and poor control.

Current energy audit services provided by MBAS are more static and normally take place at the start of the project / new system installation. Additional audits are performed due to changes to the clients' requirements.

In order to increase our current share of the market, there is a need for provision of a more comprehensive energy saving services. This would be in a form of more dynamic monitoring of the energy consumption of compressed air systems. This would involve identifying additional parameters, which would affect the energy efficiency of the monitored systems. Application of the AmI-MoSES platform would contribute to getting a more detailed view upon energy efficiency by taking into account those identified additional parameters.

2.1.2.2 Objectives

Business objectives:

- Reduction of energy waste for compressed air system
- Reduce time necessary to provide appropriate knowledge on customer site.
- Utilising AmI-MoSES added value proposition to help us with our customer retention strategy and market share growth strategies. Help us promote a unique advantage to our clients.

Technical objectives:

- Knowledge-based approach for solutions / service,
- Notify / warn client on unusual energy usage,
- Provision of diagnostic system to improve energy efficiency, and
- Provision of energy use monitoring over internet (remote access to the energy use).

2.1.3 Demonstrated Functionalities

2.1.3.1 Scenario

MBAS used one of the complete compressed air systems commissioned at one client site. This is a typical complete compressed air system, which MBAS commissions and provides maintenance solutions for to a large number of clients. In general, most of industries make use of compressed air systems in one form or another.

Figure 2 shows a schematic of the compressed air system at the client's site.

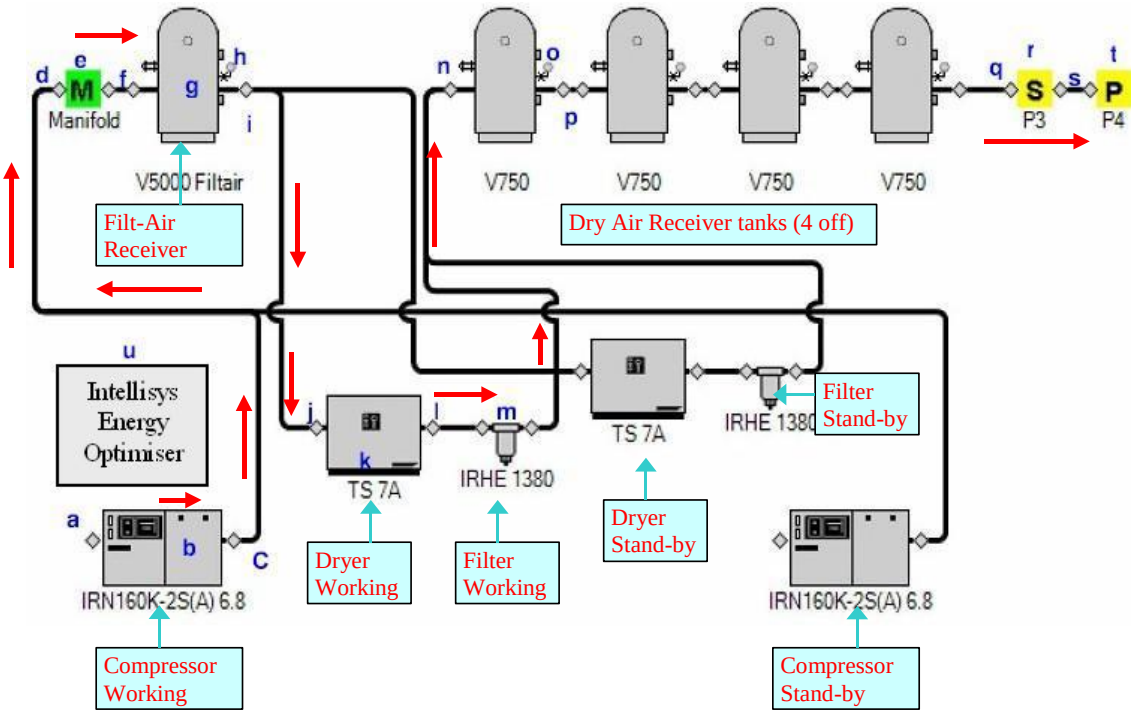


Figure 2: Compressed Air System

The platform set-up steps taken for the scenario:

- Access AmI-MoSES platform using log-in screen
- Initial set-up of the Platform; configuration of measurement system, including definition of measurement devices for environment (compressor housing) and process ambient (in-put / output air temperature and pressure).
- Connecting sensors with the platform via data collector
- Setting up the Knowledge base by adding products data
- Context definition by incorporating product types and use conditions
- Defining EUP and associated ranges for different contexts
- Arrangement of alarms conditions and their notification modes.

2.1.3.2 Demonstrated AmI-MoSES platform usage

Using the steps described previously the set-up procedure was demonstrated. This enabled the whole system to make use of the Energy Efficiency services.

The demonstrated services (for collaborative problem solving) are:

- Unusual pressure drop across Pressure vessel warning – where the AmI-MoSES system identifies that EUP values are outside the predefined range.
- The problem / alarm was defined and detailed with all the appropriate links to the process and persons to be notified and take actions across the full network chain.

Some examples of screen shots steps, in defining problems (pressure drop across FiltAir receiver), right through notifying the appropriate persons, are shown in figures 4 to 10.

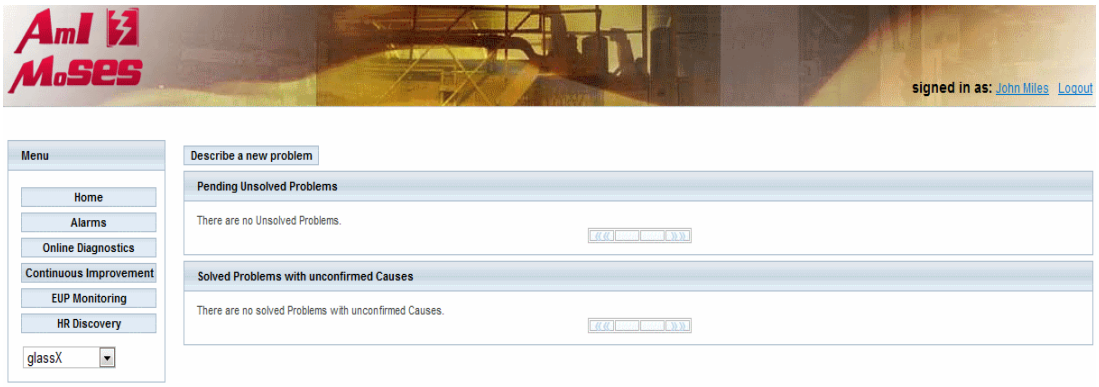


Figure 3: Commence problem solving

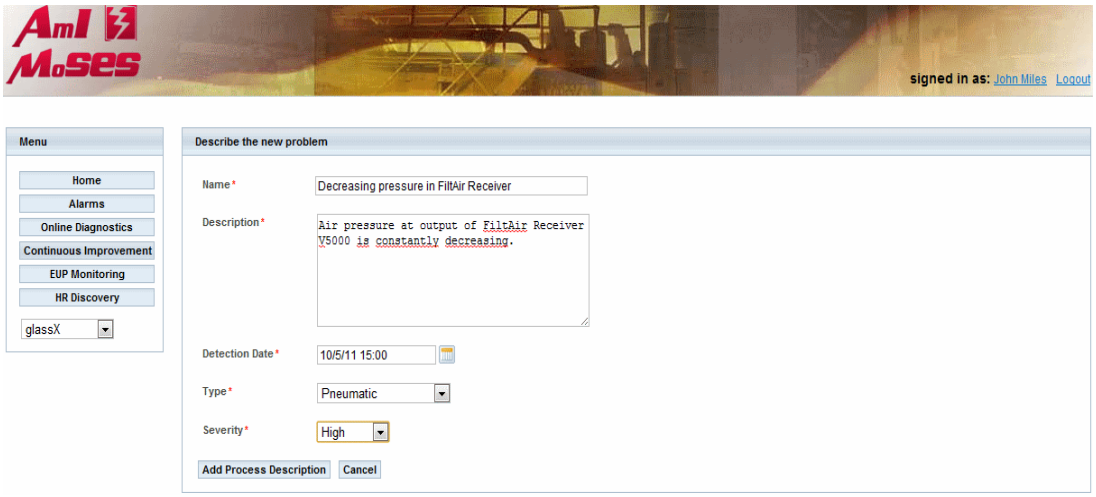


Figure 4: Define the Problem / Alarm

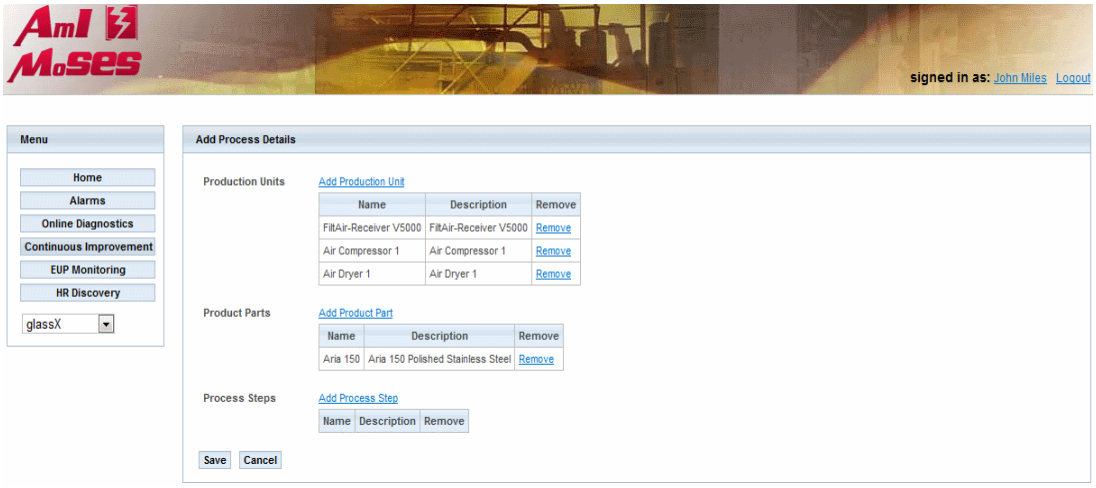


Figure 5: Define the Process chain

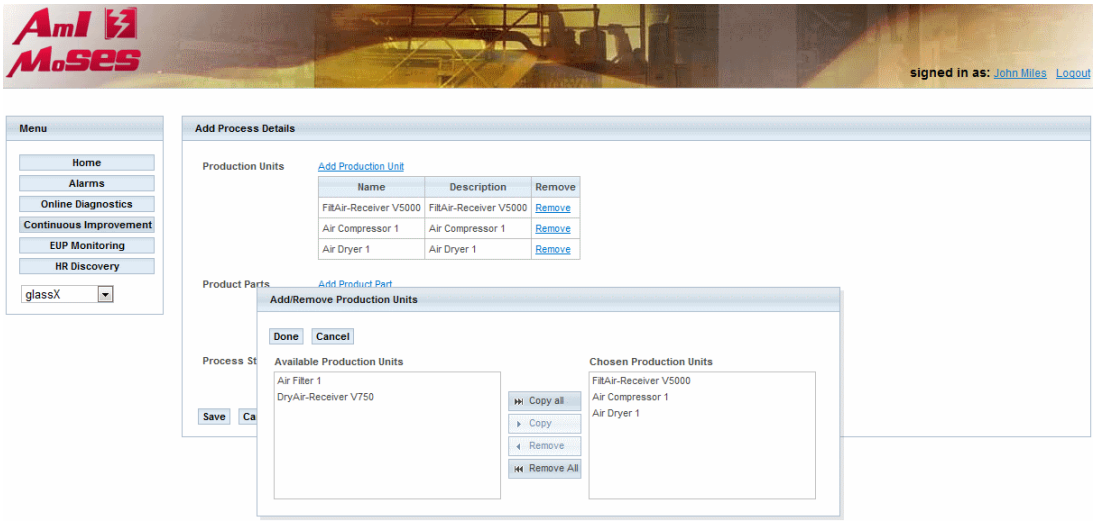


Figure 6: Define process – select process components

Figure 7: New Problem added to the system (defined)

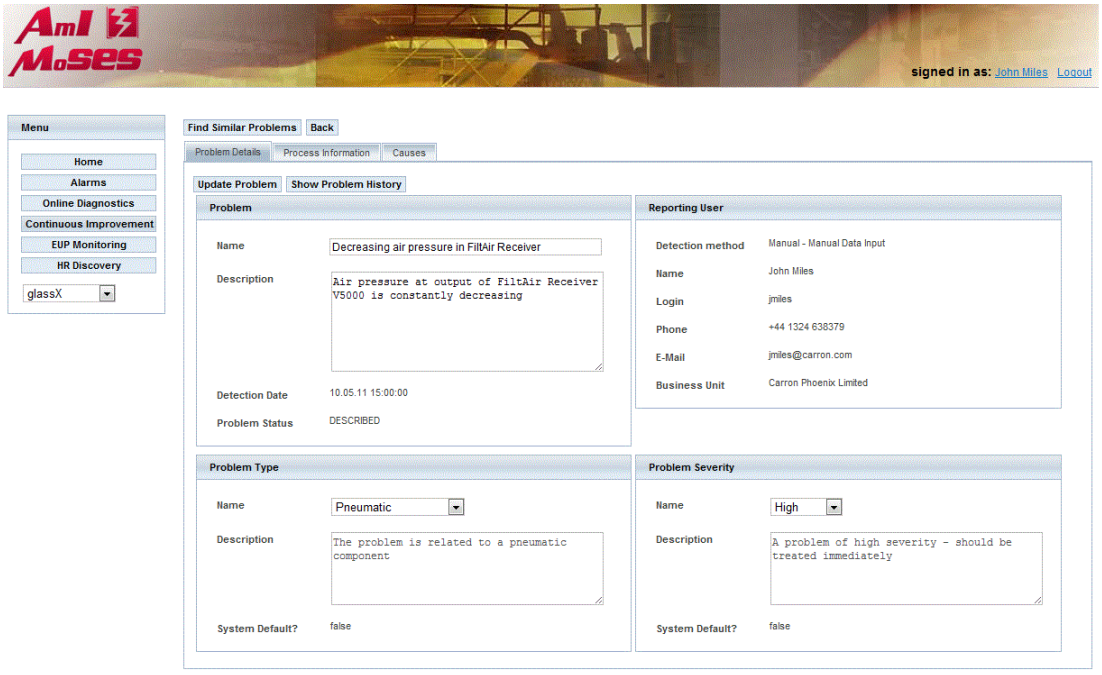


Figure 8: Basic Information about the New Problem

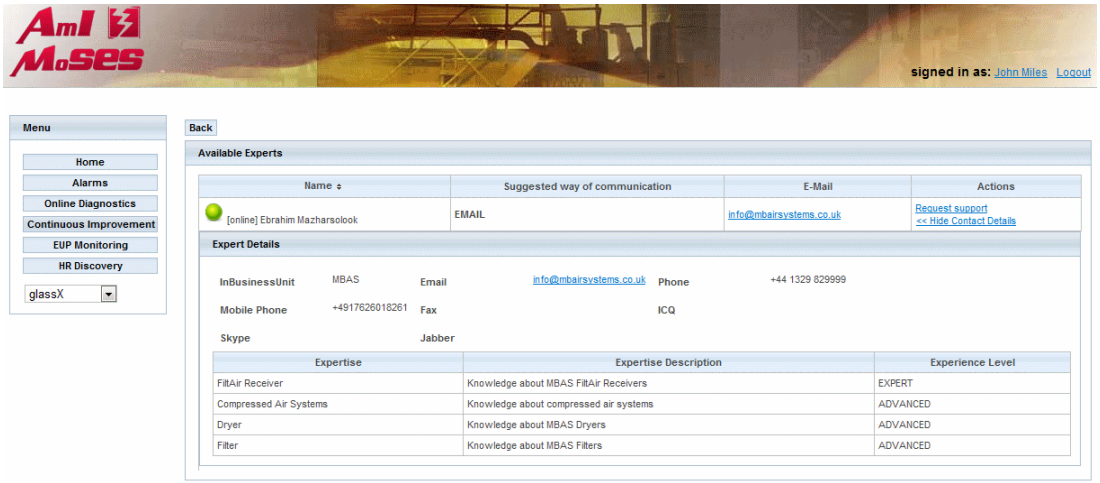


Figure 9: Expert search results – contact expert

2.1.4 Future Applications

In order to increase the awareness of benefits of the AmI-MoSES, there is a need for longer use of the system. This will result in creation of a more comprehensive knowledge and more visible benefits.

The pilot system will then be extended to some of existing valued clients. By successful additional pilots, the company intends to add the AmI-MoSES platform as standard to packaged compressed air systems. In parallel, MBAS will start negotiation / discussion with Ingersoll-Rand for possibility / fusibility of the AmI-MoSES platform as add on to their major products.

2.2 Business Case RIFOX

2.2.1 Description of the Company

The company RIFOX-Hans Richter GmbH Spezialarmaturen, was founded in 1949 and has ever since been solely engaged in the production and development of high quality steam traps for heat and energy economy, as well as fine dryers and filters for steam, gas and compressed air in the pressure range of PN 6 up to PN 320 and temperatures from minus 195° up to plus 550°C. The task of steam traps and dryers is basically to discharge condensate of steam or compressed air/gas and to prevent the loss of steam and compressed air during the process. RIFOX manufactures a wide range of standard products within the four most applicable steam trap systems which solve all operational problems that might arise.

Although RIFOX steam traps operate over decades without operational disturbance, they may cause considerable energy waste if not functioning properly. Therefore it is very important, when selecting steam traps, to consider the purchasing price but also the "operating price". The "operating price", in addition to the purchasing price, involves exploitation costs in terms of e.g. energy loss, cost of maintenance (frequent dismantling of traps, spare parts and storage costs, etc.). Considering the "operating price" RIFOX has no competitor worldwide.

2.2.2 RIFOX Business Objectives in AmI-MoSES

2.2.2.1 Background

As described above steam traps have the task to discharge the resulting liquids and/or condensate from compressed air, gas and steam systems and to prevent the outflow of the gaseous medium, which (outflow) can cause high energy losses. The control process is fully automatic i.e. closing

a valve without external control. The float controlled condensate traps operate completely mechanically by the condensate level dictated float movement.

For efficient energy use in the plants where steam traps are installed it is of high importance to properly select and deploy them. Problems may appear already during installation phase if steam traps are not appropriately selected, and also during exploitation phase when it must be assured that the traps are properly operating.

It appears that steam trap failures can be detected in advance from the structure-born sound which is assessed during regular maintenance activities or upon request when energy loss on a pipeline is detected. Targeting an advanced energy management in the customers' (steam trap users) plants, RIFOX business case was focused on early faults detection based on additional monitoring of the structure-born sound.

2.2.2.2 Objectives

Business objectives:

- Assure avoidance of energy waste at customers' sites, where RIFOX's steam traps are used, offered as services for customer.

Technical objectives:

- Create knowledge base for helping to identify steam trap deterioration process that would lead to operational disturbance and subsequent energy waste in end-user systems
- Establish knowledge-based approach for solutions/service innovation, by optimized knowledge search needed for services both for customers and for internal use
- Provide warnings and diagnostics on energy use problems in plants where steam traps are used

2.2.3 Demonstrated Functionalities

2.2.3.1 Scenario

In order to investigate application of the AmI-MoSES platform to assure avoidance of energy waste at customers' sites, the AmI-MoSES platform is applied within a test bench, equipped with steam generator, necessary armatures and control and measuring instruments (see Figure 10) as a simulation environment of real industrial application by customers.

The scenario for demonstration comprised:

- AmI-MoSES platform user log-in
- Platform setup comprising measurement system configuration including definition of measurement instruments for both environment ambient (shop floor conditions) and process ambient (medium temperature and pressure) as well as additional measurements of structure-born sound frequency, which enable more detailed energy efficiency monitoring
- Connection of the sensor systems with AmI-MoSES system using data collector
- Knowledge base setup by inserting product data and simulated process data
- Context definition which includes product types and product usage conditions
- EUP and corresponding ranges definition for different contexts
- Configuration of alarm conditions and alarm notification modes.

Figure 10: RIFOX test bench installation

2.2.3.2 Demonstrated AmI-MoSES platform usage

Based on the scenario the whole procedure described above was demonstrated in order to prepare the system for enabling usage of the Energy Efficiency services.

The demonstrated services are:

- Condition-based Energy Consumption Warning – where the AmI-MoSES system identifies EUP values overriding the predefined range(s).
- Installation and Ramp-up support – helping customers to assure that the steam traps are properly selected and installed.

Since the Installation and Ramp-up Support service has already been described in section 2.1.3 for MBAS business case it won't be repeated here and the following screenshots illustrate the scenario for the Condition-based Energy Consumption Warning service.

As a first step the user has to log in to the AmI-MoSES platform with his username and password (see Figure 11), which – upon success – will lead the user to the AmI-MoSES platform's home page (see Figure 12).

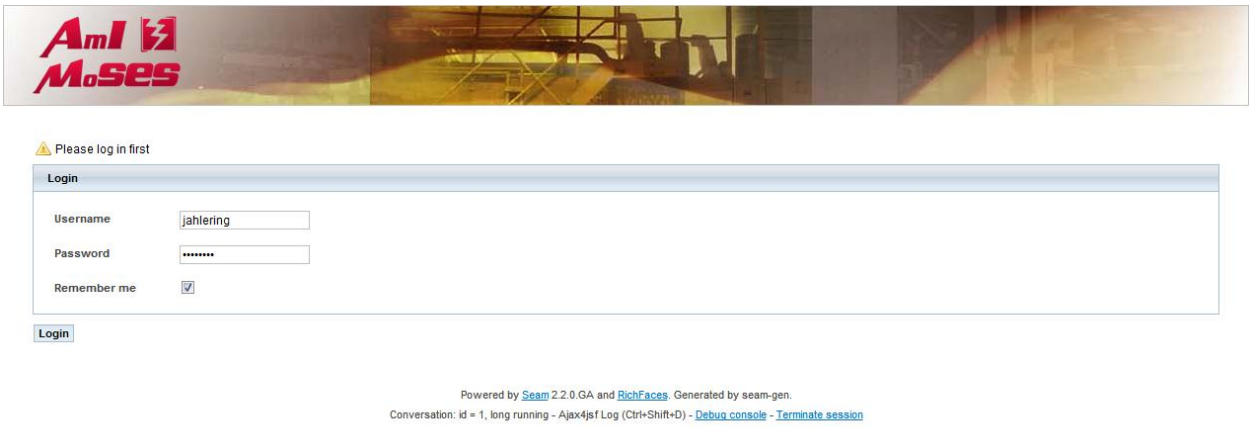


Figure 11: AmI-MoSES platform login

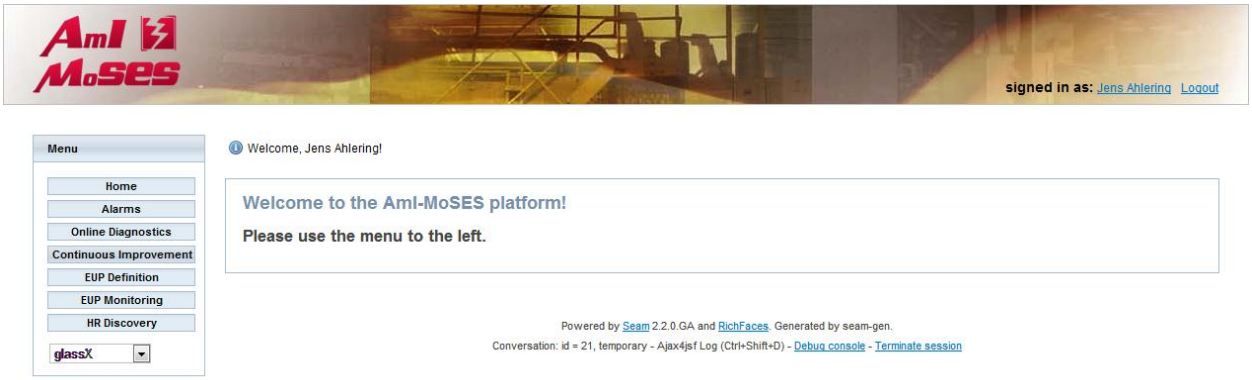


Figure 12: AmI-MoSES platform home page

Setup of measuring devices, EUPs, targeting models is done in the EUP Definition module, which can be reached by clicking the "EUP Definition" menu entry in the AmI-MoSES platform's main menu on the left. Figure 13 below shows the "Edit Measuring Device" screen where external measuring devices can be registered in the AmI-MoSES platform. This is needed for the AmI-MoSES platform to be able to identify incoming measured data and relate it to the corresponding ECD/AmI parameters and product and process information.

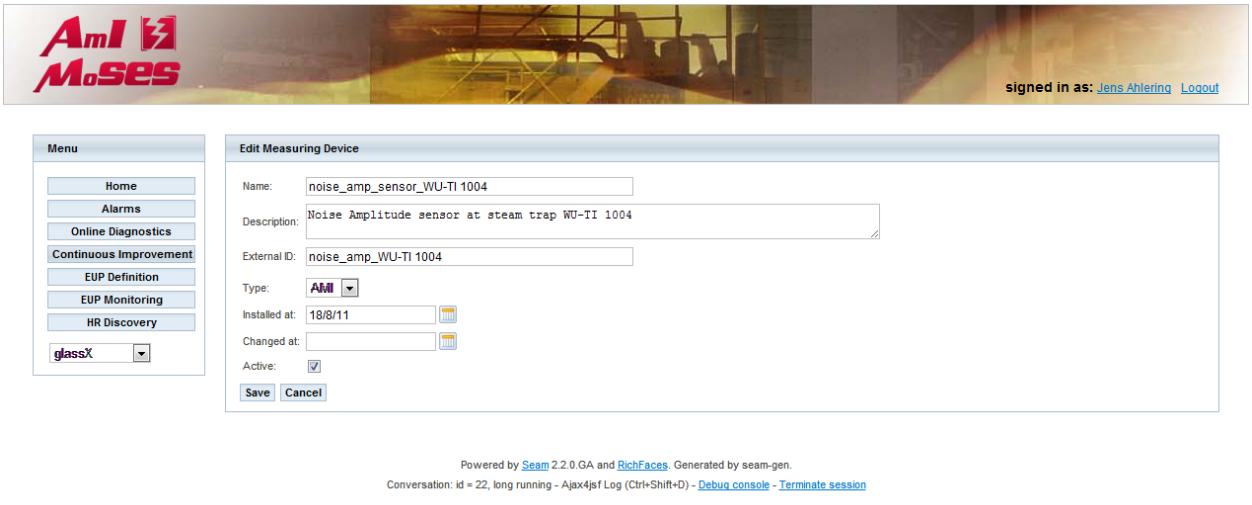


Figure 13: Define new measuring device for structure-born sound measurement

Based on the registered measuring devices corresponding ECD and AmI parameters can be defined (see Figure 14 and Figure 15).

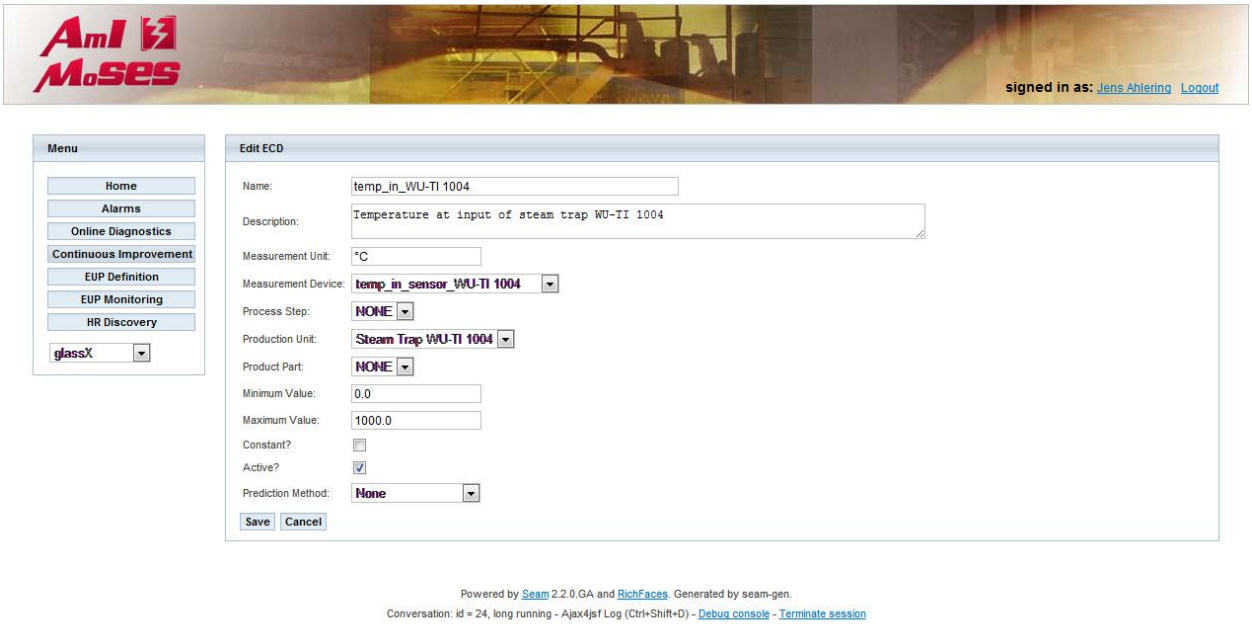


Figure 14: Define new environment ambient parameter

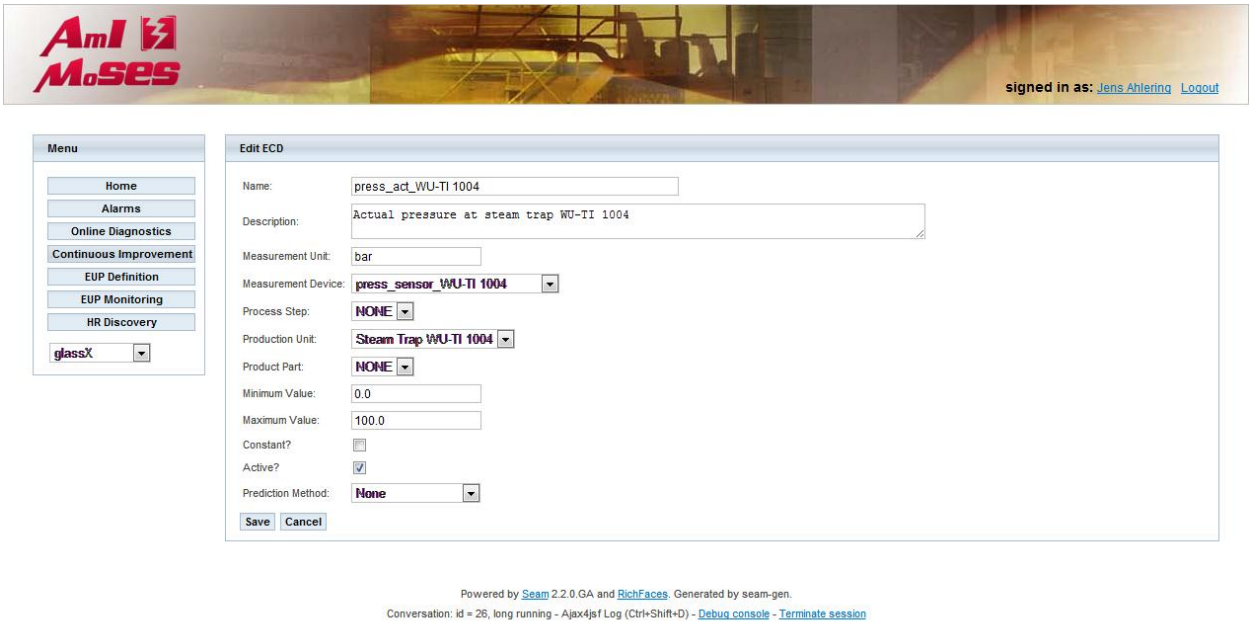


Figure 15: Define new process ambient parameter

The defined ECD and AmI Parameters can be combined into more complex EUPs by selecting two parameters (ECD, AmI or EUP or any combination of those) and combining them via a mathematical operation. Based on this, arbitrarily complex EUPs may be defined (see Figure 16).

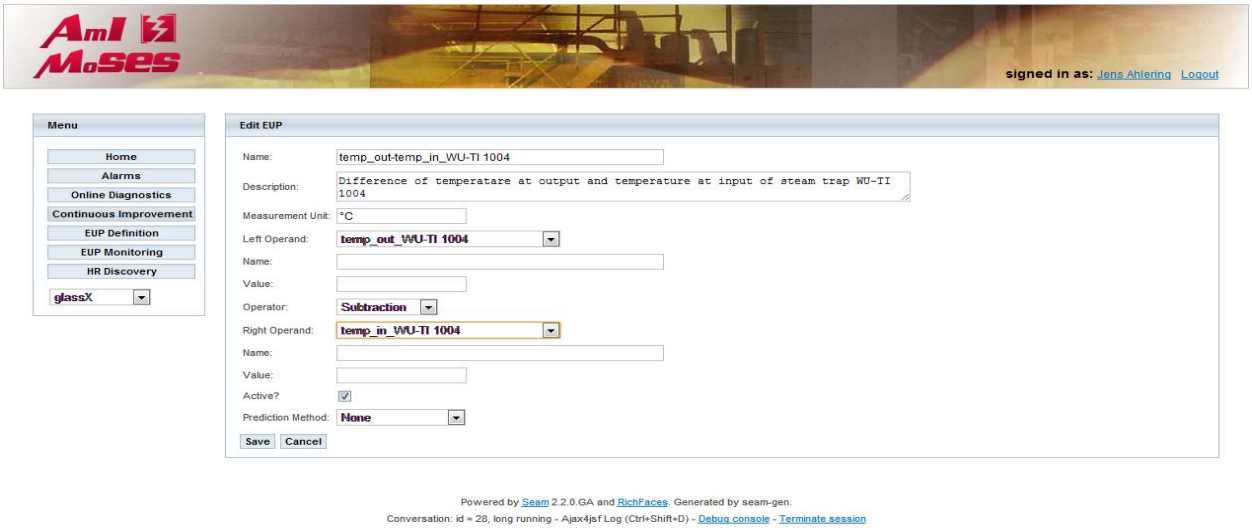


Figure 16: Define new EUP

To define the allowed values for an EUP in a certain context, i.e. those values that represent acceptable energy use in said context, the AmI-MoSES platform allows the definition of so-called target models within the "EUP Definition" module. In such a target model the user can select any number of parameters and add them to either the "Target" or the "Context" list. The first list defines the actual parameters that are monitored whereas the second list defines the context in which the parameters of the first list should be evaluated. For each entry of each of the two lists the user can define lower and upper thresholds for the chosen parameter thus defining the allowed range of values for that parameter (see Figure 17). The AmI-MoSES platform will continuously monitor the parameters defined in the targeting models and should the parameter values leave the range of allowed values under a given context, the AmI-MoSES platform will register the incident as an energy related problem.

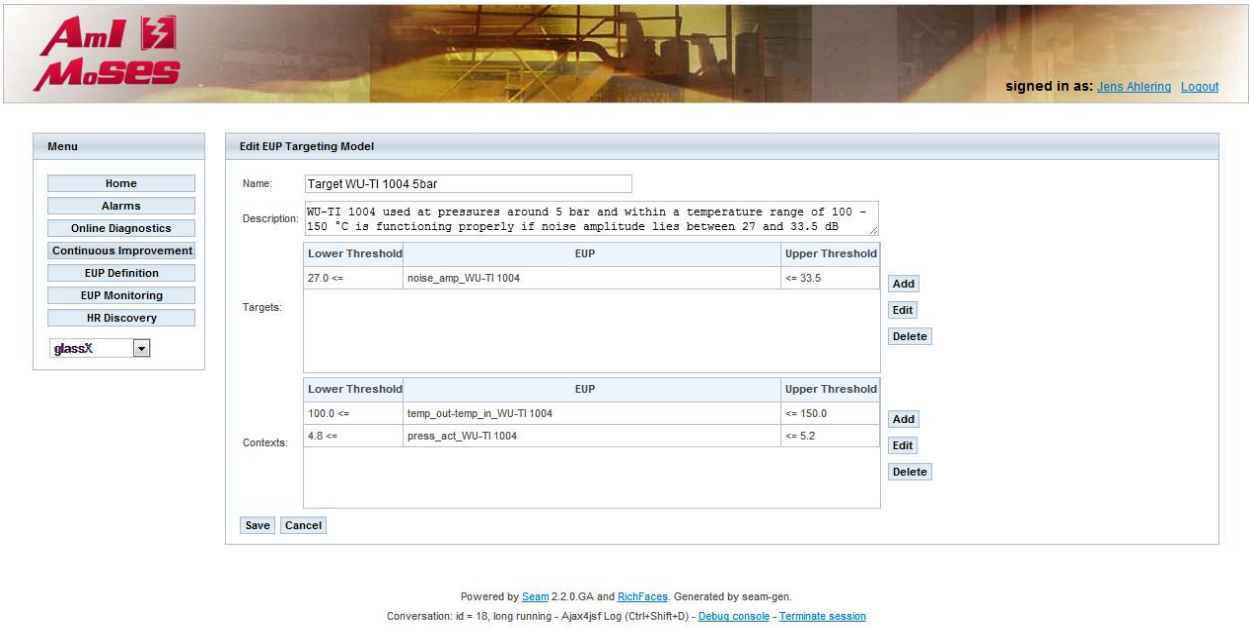


Figure 17: Define new target model

For users to be notified about the occurrence of energy-related problems the user can define so-called alarms to be notified (see Figure 18). Within these alarm definitions the user can set:

- for which target model the alarm is defined
- which users to notify if the alarm is triggered – including the way of notification.

  - E-Mail
  - SMS
  - Through a pop-up window in the platform
- what may have been the cause for the parameter values to exceed the set value range and the alarm to be triggered – if this is known
- a graphical representation of the process where the problem occurred

Once an energy related problem has been detected the relevant users will be notified by the AmI-MoSES platform, e.g. by a notification email such as the one displayed in Figure 19.

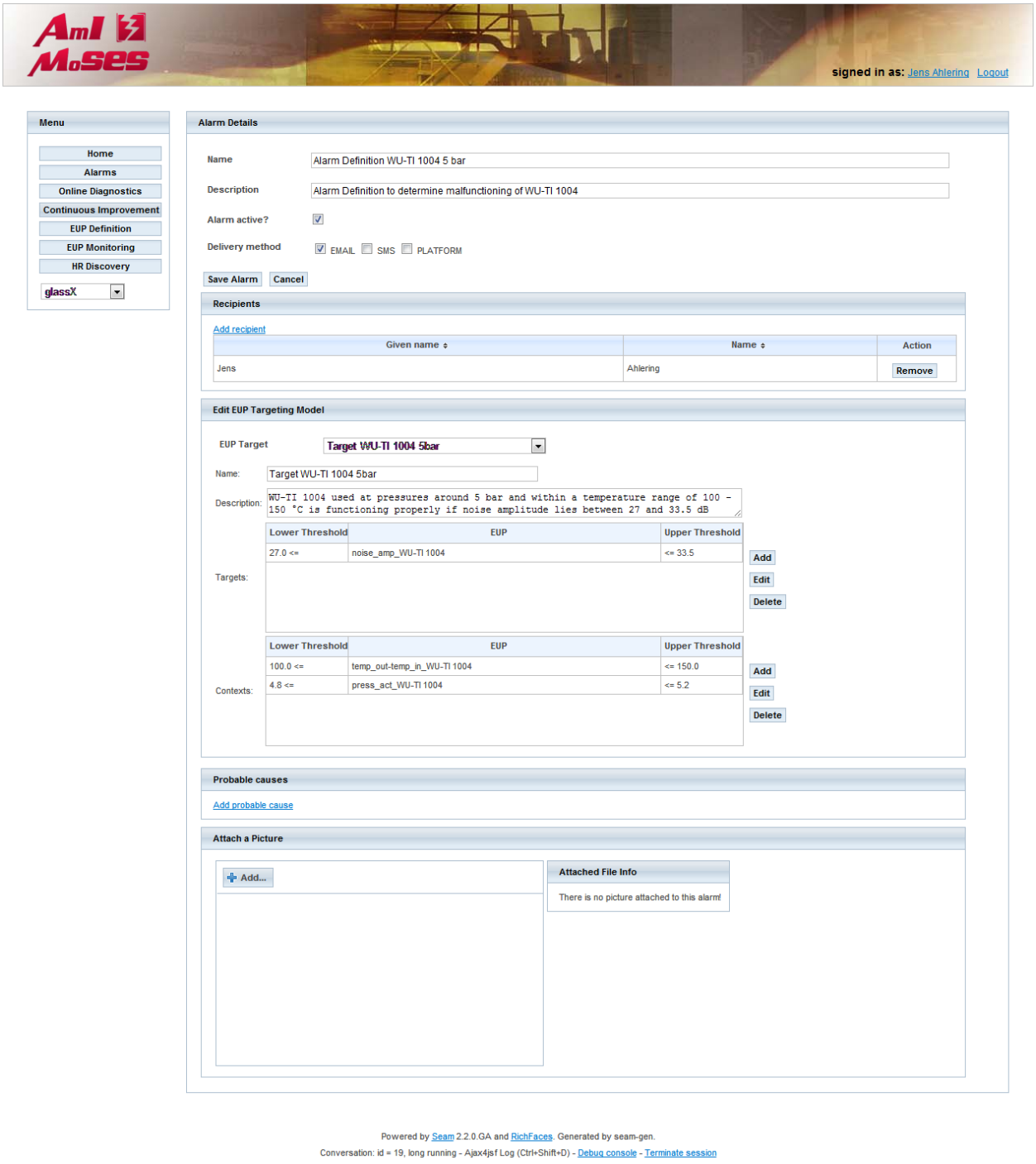


Figure 18: Define new alarm definition including notification settings

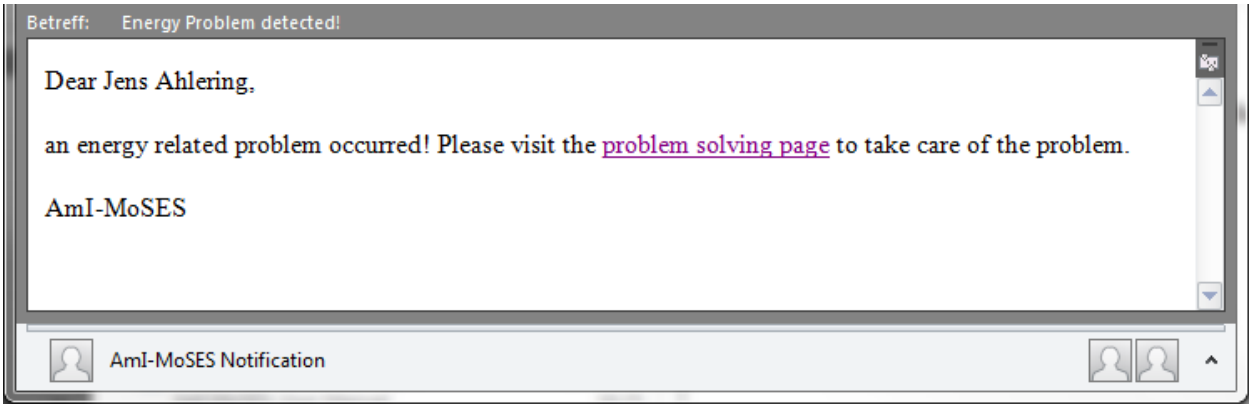


Figure 19: Alarm notification email

Following the link in the notification email in Figure 19, the user is led to the list of unconfirmed alarm instances (see Figure 20), i.e. those energy-related problems that have been detected but which have not yet been taken care of by anyone.

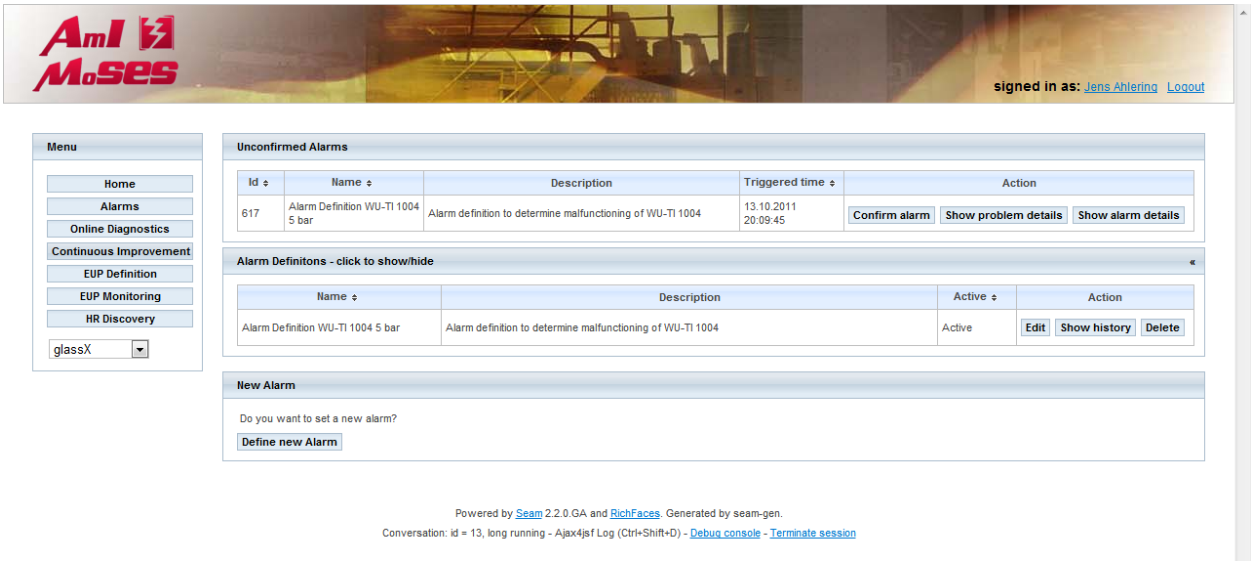


Figure 20: Alarm instance for detected problem

The user can confirm the alarm by clicking the “Confirm alarm” button next to the alarm instance entry, thus effectively taking responsibility for taking care of the energy-related problem. Doing so presents the user with two options (see Figure 21):

- just confirm the alarm and deal with the problem later
- confirm the alarm and start solving the problem right away

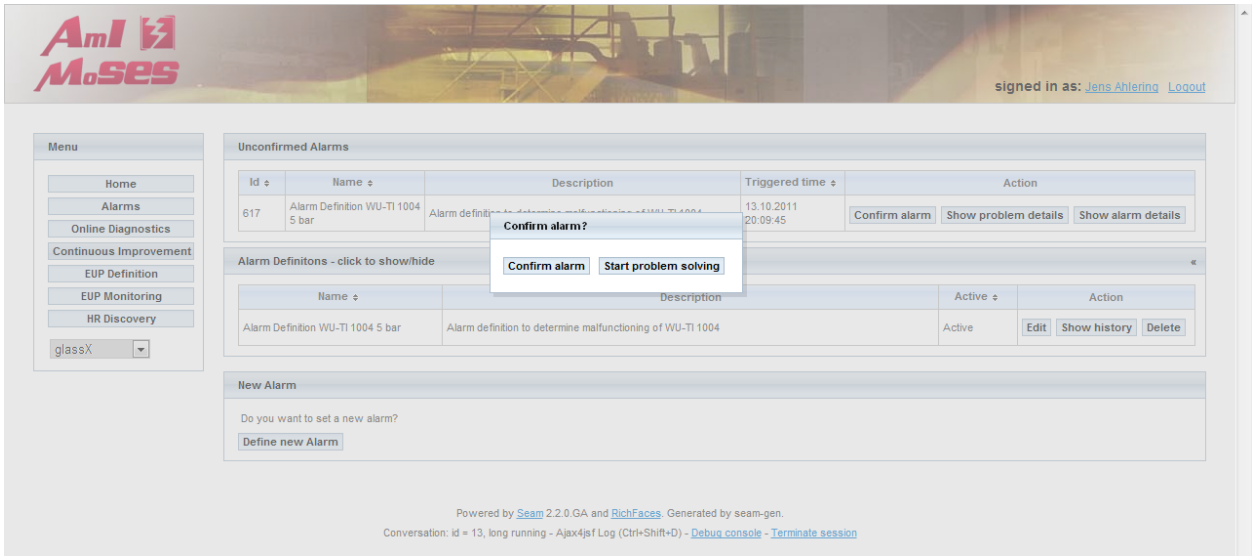


Figure 21: Alarm confirmation pop-up

The latter option brings up the "Online Diagnostics" module where the problem information corresponding to the confirmed alarm is already displayed. Particularly, since the alarm definition already included a probable cause for the problem occurrence information about that cause and the actions expected to solve the problem are directly presented to the user (see Figure 22). Starting from here the user can directly accept the pre-defined probable cause or follow the usual problem solving process making use of AmI-MoSES' problem solving capabilities (see the descriptions in sections 2.1 and 2.3).

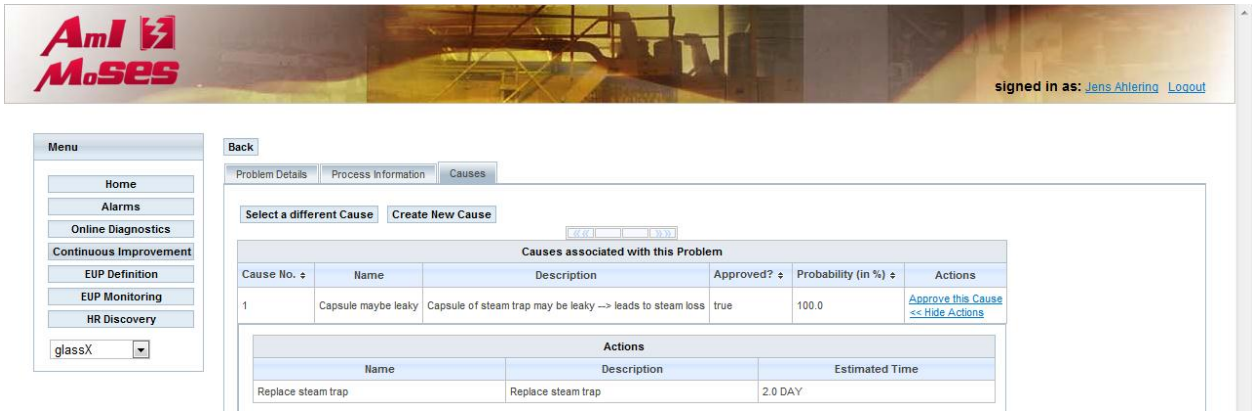


Figure 22: Problem with pre-defined probable cause and actions from alarm definition

2.2.4 Future Applications

Company RIFOX plans future applications or further developments through the refinement of the existing functionalities, and enriching of the data base with further data sets for different products-steam traps in order to make the application of the system comprehensive and general. Further extensions of the system are considered through adaptations to the conditions of other companies belonging to the international Virgo Group, to which RIFOX belongs, as well.

One of the directions of the AmI-MoSES system future development is also development of a portable device which would be used as a stand-alone device or in internet connection with a central system to facilitate diagnosing of problems at customers worldwide. Such a device would be a significant support to RIFOX maintenance staff working at customers' sites.

2.3 Business Case VICINAY

2.3.1 Description of the Company

VICINAY CADENAS, S.A. is a family owned enterprise with a long history of producing mooring chains and mooring accessories (forgings) in two manufacturing locations in Biscay, Northern Spain. Mooring chains are produced in Bilbao facility (main production facility), which will be moved soon to the near town of Sestao. VICINAY has world-wide presence with offices in the USA, UK, Norway and Singapore and manufacturing facilities in Brazil and China.

VICINAY's product portfolio contains products and services, such as:

- Offshore Mooring chains customised for any client requirement ranging from 60 mm. to 210 mm. of diameter
- Mooring accessories, such as mooring shackles, plates and connectors made from forged and/or rolled material
- Engineering services such as offshore assistance, chain loading and unloading assistance, fatigue testing, mooring design support, etc.
- Customer support
- R&D activities aimed to improving business processes developed with the collaboration of universities and RTDs

2.3.2 VICINAY Business Objectives in AmI-MoSES

2.3.2.1 Background

VICINAY has a set of commitments regarding Sustainable Development as declared in their Environmental Policy. The core business of VICINAY, of interest for AmI-MoSES project, is the manufacturing of offshore mooring chains (Ø60-210mm) and their subsequent heat treatment (DQT). These are the most critical processes from the energy efficiency point of view, because of the huge amount of energy they require. We envisage AmI-MoSES Energy Efficiency services helping us to dramatically increase energy saving. .

2.3.2.2 Objectives

Business objectives:

- Increase energy efficiency within chain production process
- Reduce energy costs of the plant
- Fulfil the commitments to become an environmental friendly enterprise
    - Eco-labelling certification (Green Label).
    - Improving the image as seen by clients and suppliers
- Online energy consumption control to improve business processes

Technical objectives:

- Set-up of a middleware in order to capture Energy Consumption Data (ECD), process-related parameters and AmI parameters and to send them to AmI-MoSES CR
- Usage of information from the existing AmI devices and addition of the necessary new ones to capture relevant parameters from the production plant
- Identify and create EUPs (from AmI, process parameters and ECD) in order to monitor and analyse energy consumption and establish knowledge base for helping to identify energy use problems in the production process and enable problems diagnostics
- Remote connection to AmI-MoSES platform

2.3.3 Demonstrated Functionalities

2.3.3.1 Scenarios

Heat treatment

AmI-MoSES platform will also be applied within the process of the heat treatment of the manufactured chain. This operation, together with the flash butt welding, is one of the key critical points in chain manufacturing. It is a triple heat operation in sequence carried out in a Double Quenching and Tempering (DQT) furnace that assures that every link gives a metallurgical response that falls within very tight margins.

a) System observed: DQT Furnace

b) Source of energy observed: Natural gas

c) Current process-related and AmI measurements:

   i) 18 fixed point temperatures within the furnace used for control of the 3 burners' aperture

   ii) Velocity of the chain. It depends on the diameter of the link i.e. the greater the diameter, the slower the speed should be

   iii) Diameter of the link to allow the operator to adapt the chain transit and establish the chain speed. This is a manual gauge that feeds the operator selected value into the ABB graphic recorder of velocities.

d) Current ECD related measurements: Gas consumption in m^3.

e) Possible process and AmI data to add:

   i) Temperature of the furnace insulation layer (cladding) and furnace environment temperature to enrich the process context

   ii) Detector of the on-off status of the furnace in order to measure the number of stop-start cycles.

f) Metering devices: Three gas counters and 18 thermocouples, 6 for each burner.

g) Logging systems:

   i) ABB SM2000 video graphic recorder for logging the velocity and diameter of the chain.

   ii) ABB SM1000 video graphic recorder for logging the temperatures.

   iii) ABB SM2000 video graphic recorder for logging gas consumption.

h) Control device: Nematron PLC as a regulator of the furnace temperature.

i) Computed EUP:

   i) Energy per kilogram of manufactured chain, in context of the chain size (from QWELD database), of furnace surface (cladding surface) and environment temperature, chain speed and number of stop-start cycles.

The Heat Treatment installation comprises a closed water refrigeration circuit where a cooling tower, whose energy consumption has influence on the outside temperature, is used to cool down the hot water that comes from the DQT furnace. One of the main drawbacks of this system is the

water leaks observed, due to the high length of the circuit. Consequently, water has to be pumped in to maintain the water level.

2.3.3.2 Demonstrated AmI-MoSES platform usage

Based on the described scenarios, the AmI-MoSES platform was adjusted so as to enable its usage within VICINAY's premises. The next Energy Efficiency Services were configured:

- Service for Condition-based Warning, where AmI-MoSES platform monitors EUP value patterns. Once the pattern overrides a predefined (normal) threshold a warning and an associated energy efficiency problem is triggered and an alert is sent to the appropriate recipients (operators). If the cause of the problem is known, the alert will include a proposed solution. Otherwise, if the cause is not known, the Service for Online Diagnostics is activated and Vicinay users can start the diagnostics facility in order to solve the problem based on AmI-MoSES knowledge base.
- Service for Online Diagnostics of Energy Related problems, where the AmI-MoSES system provides the users with reasoning tools that allow inferring solutions from previously solved problems to problems with unknown causes. In this regard, the features of the particular problem to be solved are compared to the features of the whole bunch of solved problems stored in the knowledge base. Subsequently, most similar problems are retrieved (based on similarity calculation settings adjusted by knowledge experts) and the causes and solutions contained within these problems can be transferred to the problem to be solved.
- Service for Continuous Improvement, aimed at analysing the solutions of recurrent similar solved problems in order to discover suggestions for improvement of production units, processes and products. In the long term, the application of these suggestions is expected to reduce the number of such problem type occurrences.

Scenario steps:

Within the Service for Condition-based Warning, the end-user is able to monitor the predefined EUPs as presented in Figure 23.

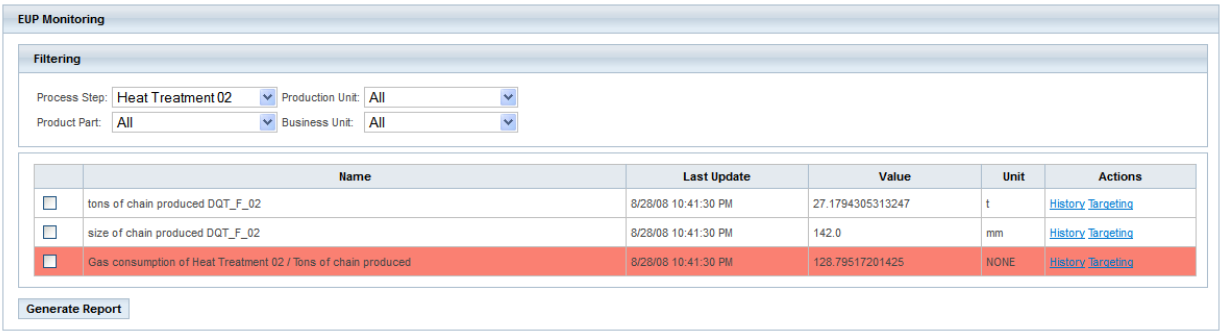


Figure 23: EUP monitoring service and overridden EUP

The EUP that appears in dark colour indicates that a threshold in the associated targeting model has been overridden. This event leads to the generation of a new notification alarm and registry, which represents a new energy efficiency related problem, in AmI-MoSES repository. For instance, the overridden EUP displayed in Figure 23 is related to the DQT furnace (scenario 2) and implies that the Energy per kilogram of manufactured chain, in the context of the chain size, of furnace surface and environment temperature exceeded a normal range. The alarms generated by the EUP Monitoring service can be dealt with in the initial AmI-MoSES page, as seen in Figure 24.

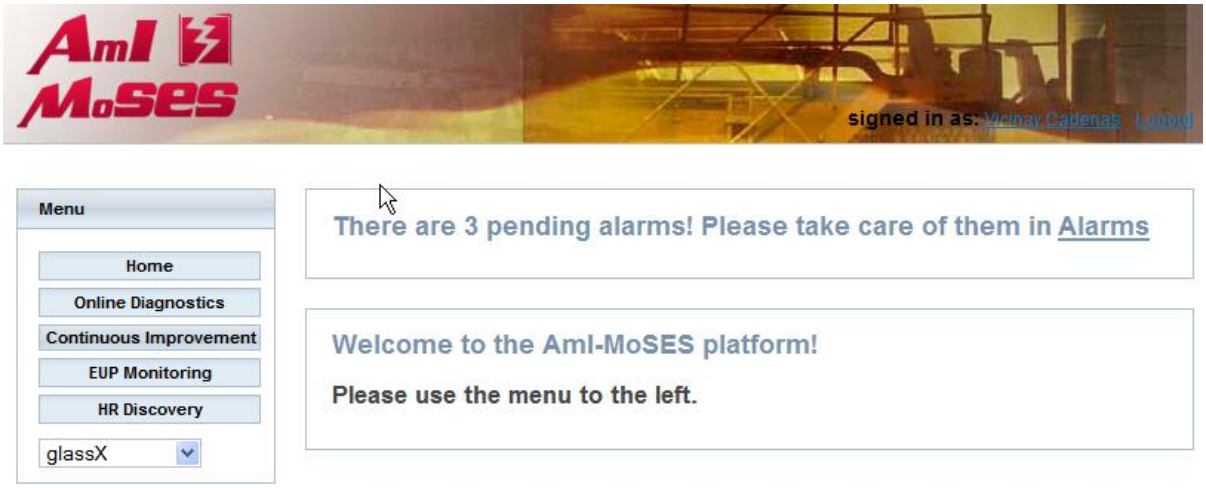


Figure 24: Alarms notification in AmI-MoSES platform

Clicking on the "Alarms" link, the list of alarms / problems that require human intervention is displayed (see Figure 25).

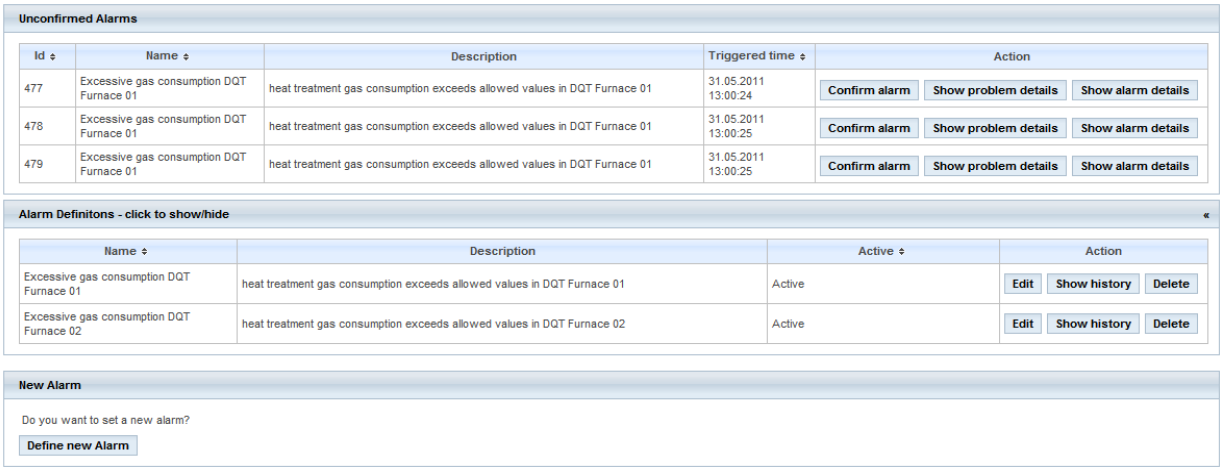


Figure 25: List of unsolved energy related problems

Clicking on the action related to alarm confirmation, and given that the problem has an unknown solution, the Service for Online Diagnostics is triggered (see Figure 26).

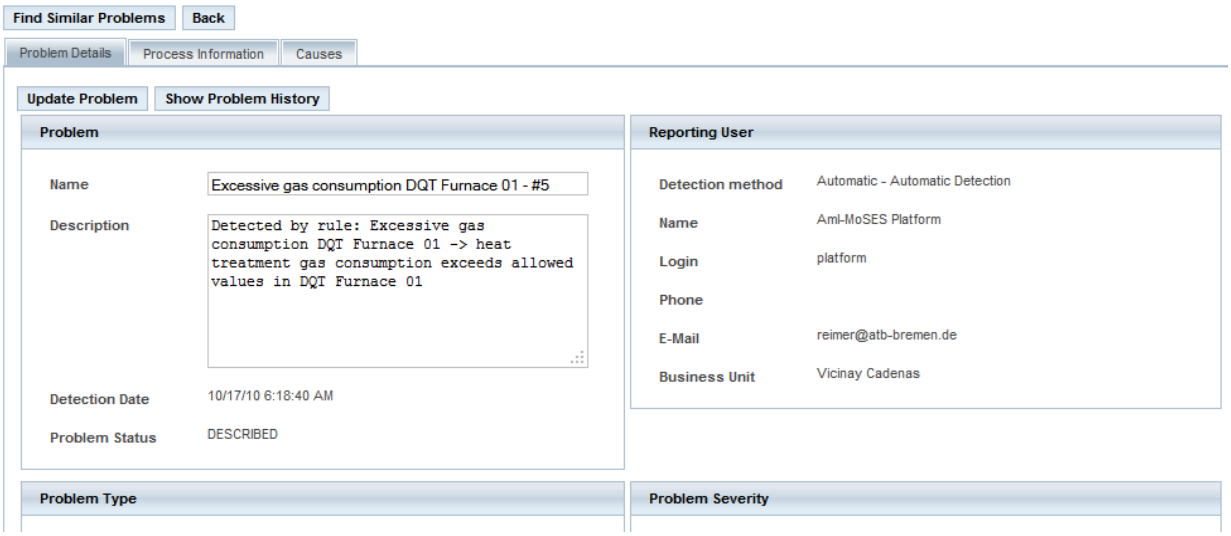


Figure 26: Problem diagnostics

Since the cause of the problem (and corrective actions) is unknown, as seen in Figure 26, the AmI-MoSES reasoning tool can be triggered via the "Find Similar Problems" button.

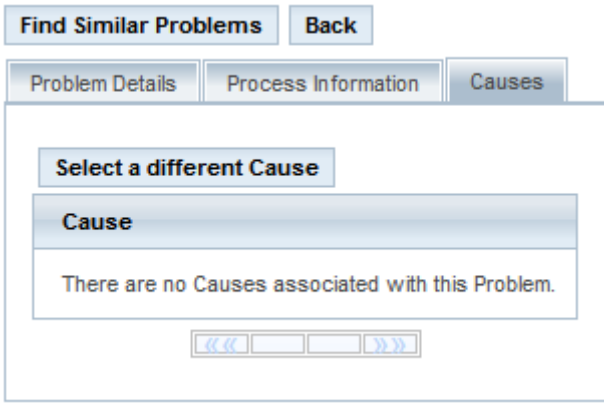


Figure 27: Problem causes and corrective actions

Figure 28 displays the settings for problem similarity calculation.

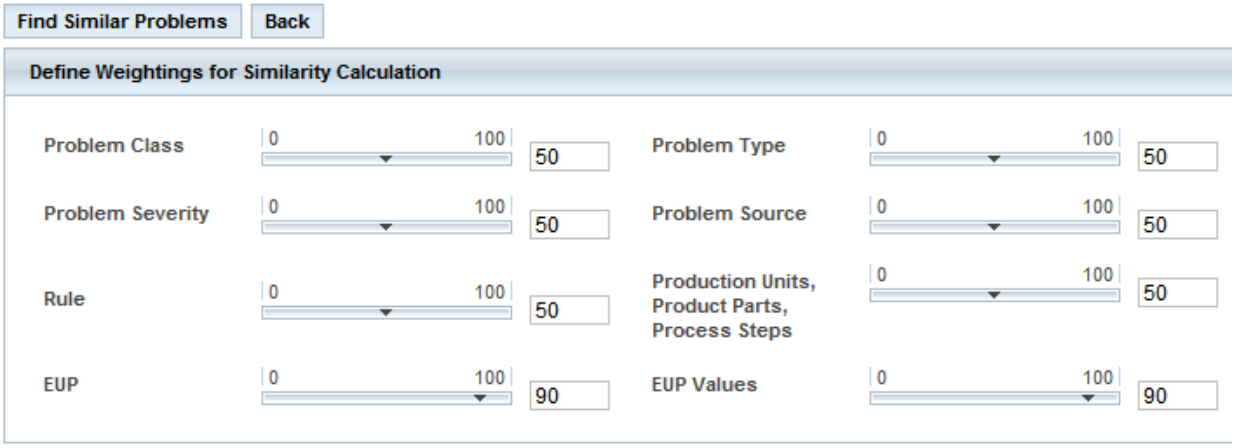
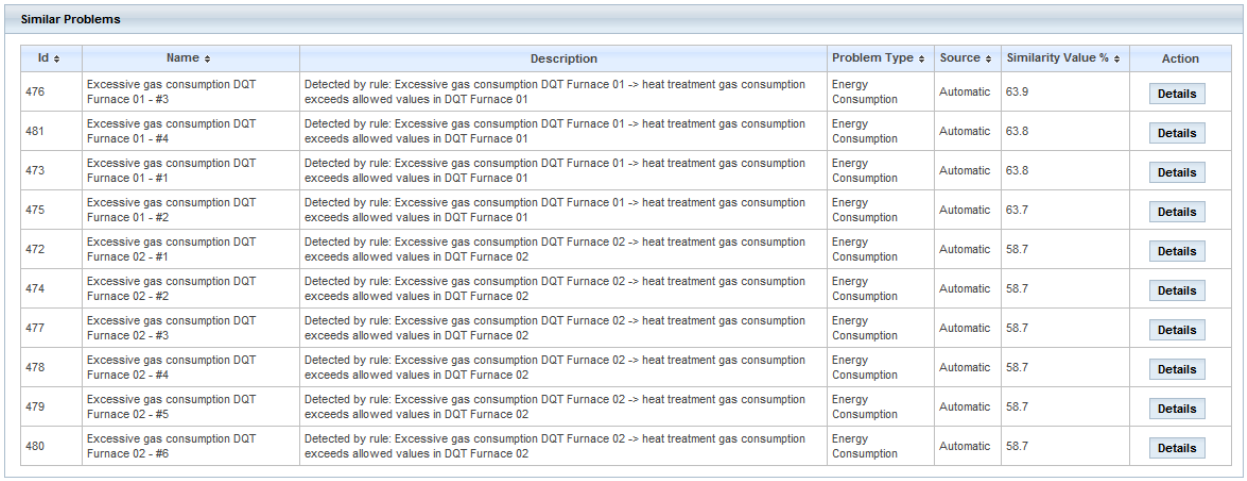


Figure 28: Problem similarity calculation settings (weight definitions)

A knowledge expert can adjust the retrieval of similar problems by means of defining the weighting of the problem features for similarity calculation. Clicking on the "Find Similar Problems" button, a list of most similar problems, along with the global similarity value, is presented to the user, as displayed in Figure 29.


Similar Problems

Id	Name	Description	Problem Type	Source	Similarity Value %	Action
476	Excessive gas consumption DQT Furnace 01 - #3	Detected by rule: Excessive gas consumption DQT Furnace 01 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 01	Energy Consumption	Automatic	63.9	Details
481	Excessive gas consumption DQT Furnace 01 - #4	Detected by rule: Excessive gas consumption DQT Furnace 01 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 01	Energy Consumption	Automatic	63.8	Details
473	Excessive gas consumption DQT Furnace 01 - #1	Detected by rule: Excessive gas consumption DQT Furnace 01 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 01	Energy Consumption	Automatic	63.8	Details
475	Excessive gas consumption DQT Furnace 01 - #2	Detected by rule: Excessive gas consumption DQT Furnace 01 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 01	Energy Consumption	Automatic	63.7	Details
472	Excessive gas consumption DQT Furnace 02 - #1	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details
474	Excessive gas consumption DQT Furnace 02 - #2	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details
477	Excessive gas consumption DQT Furnace 02 - #3	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details
478	Excessive gas consumption DQT Furnace 02 - #4	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details
479	Excessive gas consumption DQT Furnace 02 - #5	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details
480	Excessive gas consumption DQT Furnace 02 - #6	Detected by rule: Excessive gas consumption DQT Furnace 02 -> heat treatment gas consumption exceeds allowed values in DQT Furnace 02	Energy Consumption	Automatic	58.7	Details

Figure 29: List of solved problems similar to the unsolved problem

Clicking on the "Details" action of the most similar problem (the first row), the user is presented with a comparison of the two problems (see Figure 30).

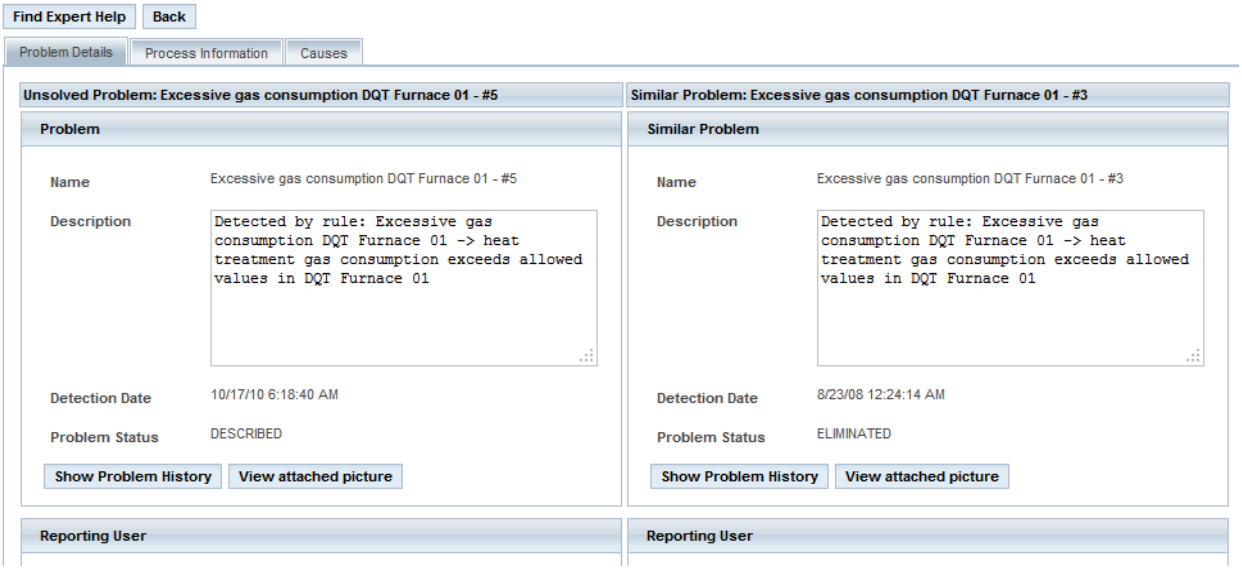


Figure 30: Comparison of problems (unsolved problem vs. the similar problem)

Hitting the "causes" tab, the end-user is able to consult the similar problem cause and corrective solution and, if appropriate, select this cause as the cause of the unsolved problem (see Figure 31).

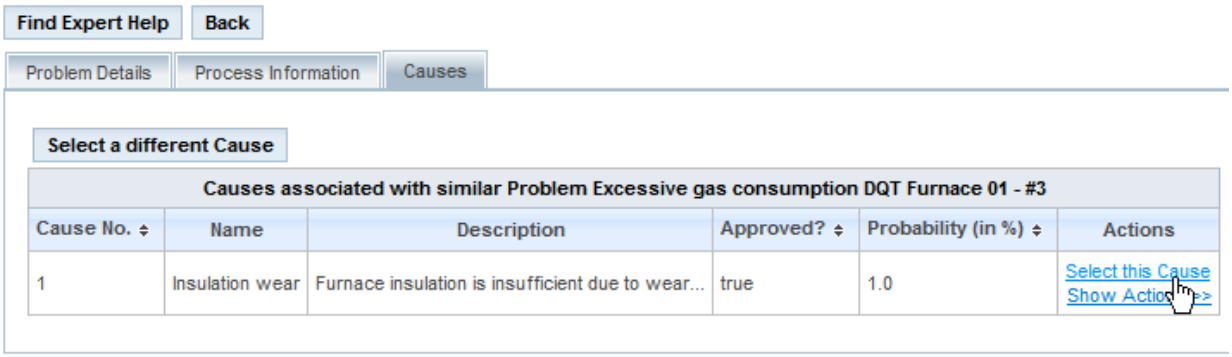


Figure 31: Selection (inference) of the cause of the similar problem as the cause of the unsolved problem

Alternatively, the end-user has the chance to select another cause from a list of generic causes or even ask available experts within the Extended Enterprise for help through the Management of Social Interaction facilities ("Find Expert Help" button). Once the cause and corrective action is defined, the problem is marked as solved and is stored in the AmI-MoSES repository for further reuse within the reasoning facility and further analysis within the Service for Continuous Improvement. In this regard, this service is capable of tracking the occurrences of problem types in order to detect if the number of a particular problem type is increasing. If this is the case, an alarm is triggered and the list of solved problem of a given type is presented to the user as seen in Figure 32, where a list of problems related to the DQT Furnace 2 in Heat Treatment 2 is presented.

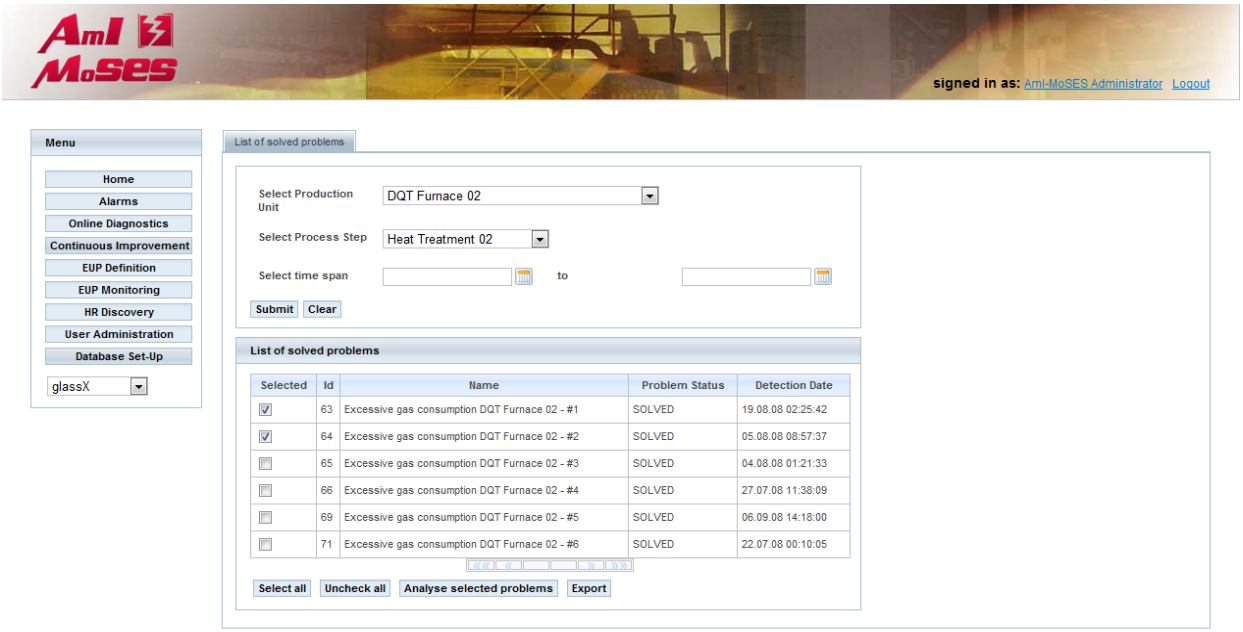


Figure 32: List of solved problems of a given type

The user can select some of those problems and press the 'Analyse selected problems' button (see Figure 33, where the problem analysis screen contains the list of selected problems).

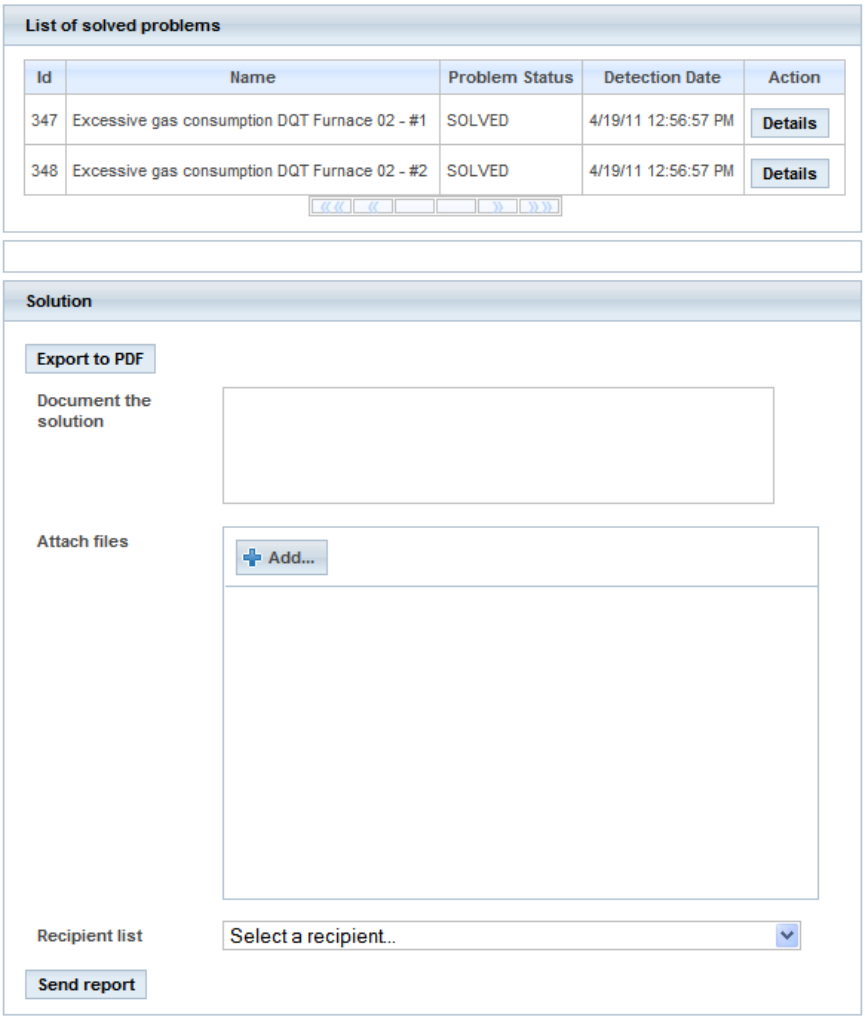


Figure 33: Problems analysis screen

The ‘Details’ button enables the analysis of a particular problem, as shown in Figure 34.

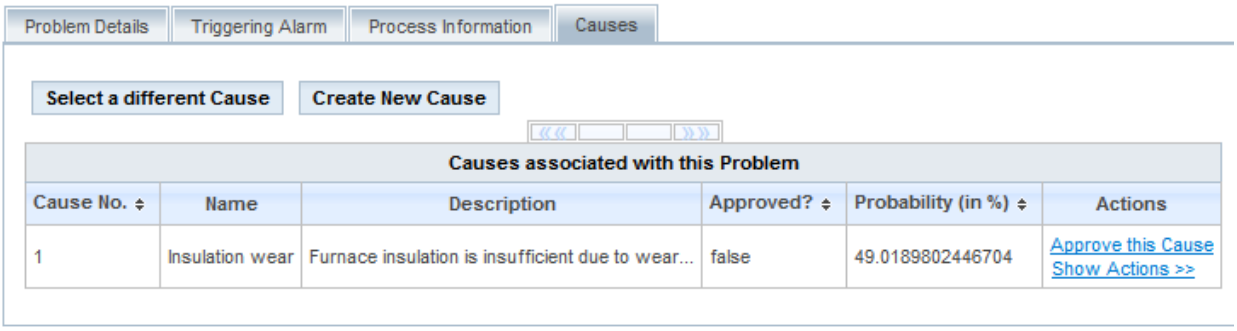


Figure 34: Solved problem details

In this particular case, the action performed for solving the problem of excessive gas consumption in DQT furnace number 2 was repairing the furnace insulation. The complete problem description of the selected problems, along with the involved production unit, process step, product part and action performed to solve the problems can be exported into a PDF report as seen on Figure 35, clicking on the ‘Export to PDF’ button in the Solution tab in Figure 33.

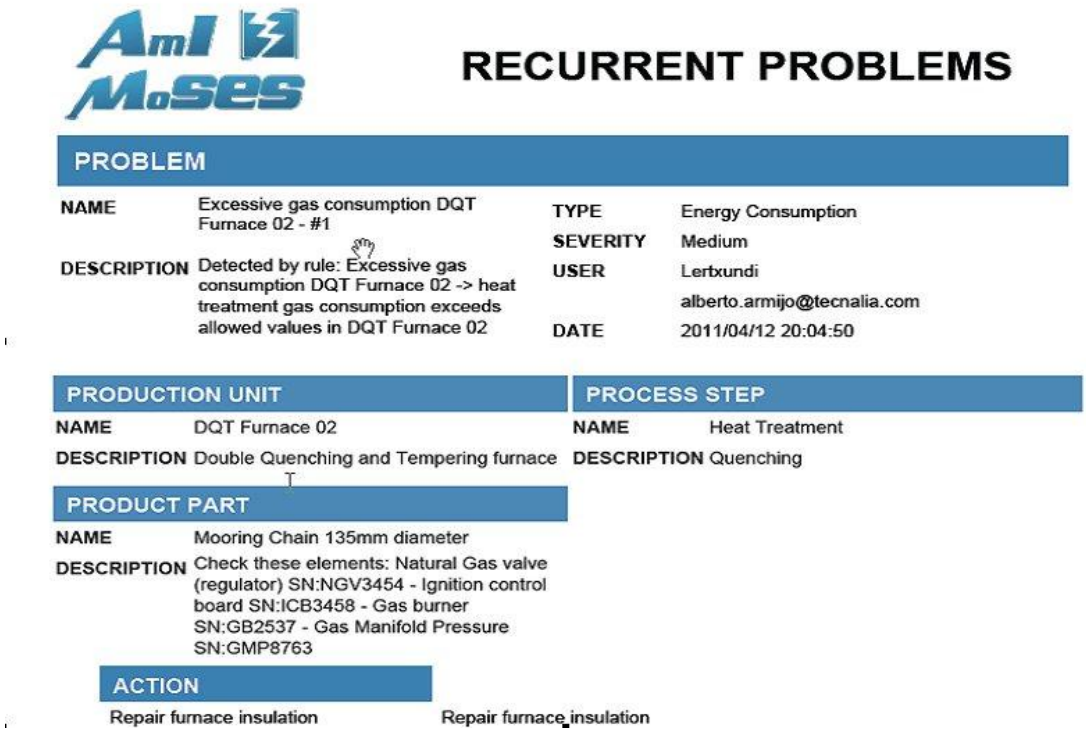


Figure 35: Recurrent problems description

After the analysis and study of the different solutions and the contextual information derived from the PDF report, the plant expert is capable to gather enough insight for the deduction of an innovative solution to solve the recurrent problem, as seen in Figure 36.

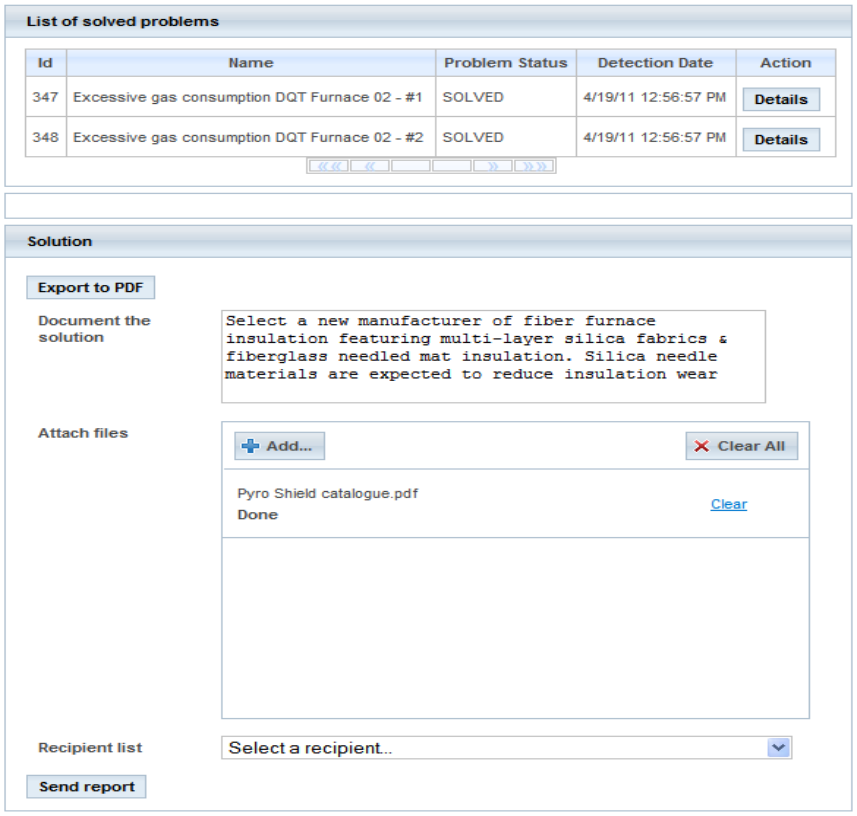


Figure 36: Description of the enhancement to avoid recurrent problem in the future

In this case, the plant expert proposes the selection of a new material for the insulation of the furnace, which may eventually reduce the gas consumption and the furnace downtime due to early insulation wear. The plant expert can also attach information to the innovative solution documentation process, for example, a catalogue of furnace insulation materials. To finish with the elaboration of the report, the plant expert selects the recipients who will get the suggestions report as feedback. These recipients, normally the design unit of the company, will carry on the required and affordable energy efficient actions aimed at reducing the number of future energy problems occurrence on a particular element of the manufacturing system

2.3.4 Future Applications

The AmI-MoSES platform will be the corner stone of Vicinay's energy-efficiency projects. In fact while the project has been underway the progress made has given rise to several internal sub-projects. These sub-projects deal with machine diagnostics in that they will help us to predict the "health" of our chain manufacturing equipment. The knowledge-based reasoning and diagnostic features of the AmI-MoSES platform will form an integral part of our new systems.

We are also in the process of building a new purpose built, state-of-the art factory some 15 kilometres from our current site. This move, expected to be completed within the next two years, allows us the perfect opportunity to design the new factory with the latest technology for chain-making equipment coupled with the latest technological advancements in production plant control.

Our commitment to energy efficiency can be seen through our membership and adherence to the United Nations Global Compact[1]. While we do not expect the AmI-MoSES platform to be used "as-is" it will serve as a point of reference in our endeavours to evolve our energy efficiency strategy to the maximum.

[1] http://www.unglobalcompact.org/participant/9962-Vicinay-Cadenas-S-A-

We envisage a time span of up to 6 months to achieve the correct optimum configuration of the platform for all common products and thus we fully expect to be, very soon, in a position to monitor energy efficiency. Equally importantly having these data on energy consumption allows us to effectively deduce when energy consumption affects positively or adversely in the quality of the final product; by identifying energy profiles and comparing them to the waste (scrap metal) we produce.

Obviously, in times of crisis, better energy efficiency translates into cash savings. So what we have undertaken as a moral obligation, energy saving for a better environment and social responsibility to our surroundings will benefit us directly in terms of the all-important return on investment.

To summarise our benefits and future applications are geared towards:

- Furthering our commitment to social responsibility
- Furthering our commitment to United Nations Global Compact
- Enlarging our portfolio of Environmental Product declarations[2]
- Reduced energy consumption
- Maximize efficient energy consumption
- Maximize return of investment

[2] http://www.environdec.com/en/EPD-Search/?query=vicinay

3 Conclusions

The demonstrators prepared within the AmI-MoSES project as showcases have justified the approach of bringing the live SW solutions to a wider end-users community as an optimal way of the project ideas and results dissemination. During the demonstration the functionalities which evolved from the initial specification in terms of the (on the testing based) characteristics refinement were successfully confirmed.

Based on the feedback from the consortium partners which participated in the demonstrators creation and from wider user community, it was concluded that the functionalities of the system, realised in the prototypes, are to a rather high extent answering the needs of that community and that these functionalities are even opening new possibilities with regards to energy efficiency optimisation in manufacturing industry.

It can be also concluded that such a decision-support system can be relatively easy adaptable to a number of other businesses. Due to the generic data model and ability to connect to various kinds of measurement systems as well as the ability to define Energy Use Parameters and decision support rules in a flexible way, the AmI-MoSES platform could be applicable in a variety of other business areas with relatively low efforts for customisation.