EMIS: Environmental Management Information System

An advanced Environmental Management System for industrial applications (EMAS, BS 7750, ISO 14001 compliant).

EMIS provides a complete, automatic, fully integrated, state-of-the-art ICT solution for environmental planning, compliance monitoring and impact assessment, emission control and emergency management for industrial enterprises. EMIS is built with a hierarchical structure, and can aggregate several enterprises in industrial parks or zones, or at a national or regional level for comparative analysis, ranking and benchmarking of environmental performance.
**EMIS: scope, functionality, implementation**

EMIS represents a new, innovative eConsulting solution that is effective and cost efficient through shared yet centralized tools, taking advantage of state of the art ICT hardware (high performance cluster computing) on a subscription basis without the need for investment, and fully supported scientific software solutions.

EMIS combines into one fully integrated distributed (web-based) information system for easy access to an unlimited number of local subscribers:

- **Administrative and techno-economic data bases** of one or more enterprises, emission sources, MSDS and hazardous substances data base, use and storage, waste streams, monitoring data analysis, embedded GIS for the industrial estates and surrounding environment and population, etc.

- **Real-time performance monitoring**, which uses model supported monitoring (now-casting) and reporting (continuous and for user defined periods up to multi-annual) and continuous regular forecasting (up to 120 hours) of all environmental impacts from normal operations (atmospheric and aquaticmarine releases, waste streams and hazardous waste, noise) with continuous and scheduled on-line compliance reporting, alerts and alarms based on monitoring networks, cascading advanced 3D dynamic simulation models and real-time expert systems technology.

- **Technological risk assessment and real-time emergency management** in the case of accidental release of hazardous materials, atmospheric or aquatic dispersion, oil spills, fires, BLEVE/explosion;

- **Scenario analysis, EIA**: planning level environmental impact assessment (for atmospheric, aquatic, soil and groundwater, coastal marine systems, noise, solid waste), population exposure, health impact analysis (workforce and surrounding environment/population);

- **Environmental management tools**: support for ISO 14001 EMS compliant pre-audit checklists and evaluation support, EMAS, BS 7550 and similar regulatory frameworks, using rule-based expert systems technology for easy-to-use environmental management plans;

- **Emission control optimization** tools for multi-criteria techno-economic optimization, energy efficiency and emission reductions of a wide range of pollutants including GHG and CO$_2$e.

**Operational real-time control:**

Real-time control functions (optional SCADA linkage) use an innovative rule-based forward chaining expert system that runs any number of scheduled and event driven tasks, maintains data integrity and quality and ensures up-to-date information by workflow control, error messages, alerts and alarms that can be issued by eMail, fax, or SMS to selected operators.
Implementation:
EMIS is implemented as a web-based, distributed client-server system, shared by any number of operators and institutions: a central EHS operator at the industrial enterprise, economic zone or estate level and any number of individual production plants, regulatory authority and optional public information system.

A central server or group of servers depending on size and components is connected to any number of external clients (simple, networked PCs and web browsers) and an optional monitoring network and RTUs (SCADA) through the Internet protocol TCP/IP. EMIS is implemented under Open Source Linux, which is open (no license costs for the operating system), safe for mission critical applications, and well scalable, supported by all major hardware vendors and the latest processor technology. This provides a cost efficient, easily scaleable and secure solution for an unlimited number of users sharing central hardware and services such as data base maintenance, backup, disaster recovery, regular updates, user support, online consultancy, and training.

Hierarchical structure:
EMIS covers an INDUSTRIAL ENTERPRISE as the primary administrative, logical unit which may consist of one or more locations, sites, or production units. Enterprises (and their constituent units) may again be aggregated into industrial zones or parks, or at national and regional geographical scale. These aggregates then contain any number of individual PLANTS or enterprises.

The system is designed both for the responsible HSE officer at any one of the hierarchical (physical or administrative) levels as well as his counterparts in any or all of the enterprises or plants within any of the aggregation levels. All data and information are maintained in a central - and thus always consistent - information system which is controlled by the HSE officer and his staff.

Access control:
Access to EMIS is controlled by user name and password with 128 bit encryption, and can also be based on IP address or domain of the client. Multi-level access rights can be assigned to individual users and groups. Each PLANT in the ESTATE has write access to its own plant specific data for regular updates, and can read (view) data from other plants for comparison and benchmarking if they are released for public access by the respective plants. Plants can use the shared analytical tools with their own data for planning tasks, scenario analysis and impact assessment including ISO 14000 pre-audit
environmental analysis. Selected components of the overall information can also be configured as a publicly accessible environmental information system.

Hierarchical structure

EMIS is designed for industrial zones as well as the component companies. There are three major target components:

- The entire industrial zone
- Major companies of environmental relevance
- Large number of smaller companies.

An important element in EMIS are the cumulative effects due to large numbers of individually relative small emitters that together may be responsible for major environmental impacts.

Ranking and benchmarking of these sources to facilitate optimal control and efficient environmental management are therefore major functions. Multi-criteria ranking and benchmarking will indicate the environmental performance and resource use efficiency of any plant within the industrial zone, using the entire set of all comparable plants as a reference.

At the plant level, EMIS is directly applicable to any company, industrial enterprise or production or storage unit that

- Uses substantial amounts of resources such as
  - Energy
  - Water
- Uses, stores, or produces hazardous substances in non-household quantities;
- Generates non-household waste, or any waste in large volumes, and in particular, any waste streams that contain hazardous substances;
- That are subject to any environmental or technological risk regulations.
Implementation examples

The EMIS pilot system is implemented as a real-time system with optional monitoring data compilation, analysis, and management. Parallel to the monitoring, several model are run automatically for regular forecasts and now-casts with data assimilation. The main menu offers a range of individual services, reports, and tools described below.

Real-time monitoring data

The data from any number of sensors can be compiled and analyzed by EMIS. Any violation or exceedance of substance specific standards are indicated by a color coded representation.

Each record leads to the time series of monitoring data compiled at that sensor location. User defined alert message or alarms (eMail, fax, SMS) can be defined for each of the sensors to alert an operator without delay especially in case of an emergency like an accidental release of a hazardous substance. For the analysis of the time series data, a range of statistical and display functions is available.

Where applicable, the monitoring data can be made available for the various simulation models automatically both in real-time and for scenario analysis.
**Industrial plants and enterprise data base**

EMIS has a hierarchical structure of two or more levels:

- The industrial estate or park, defined primarily geographically
- The individual enterprises and production plants within

Structurally, these objects are very similar, but many of the estate properties are aggregated from the component enterprises or plants.

Plants include again a number of objects such as:

- Containers and storage units
- Emission sources
- Waste streams
- Hazardous substances

which are all closely linked, e.g., a waste stream has one or more (hazardous) substances of concern that link to the MSDS data base.

An important function for the individual plant operator is the possibility to directly update his data, and to compare the environmental performance of his installation with ranking and benchmarking tools against all other installation as well as against international standards.

The real-time expert system continuously scans the system’s data bases for completeness, consistency and plausibility and reports any data quality problems detected.

**Containers and storage units** hold (hazardous) substances, raw material, intermediate or final products. They are potential sources of (accidental) release, and thus part of the technological risk assessment (Metodo Speditivo rapid screening-
level risk analysis model).

**Emission inventories**

Compile all atmospheric emissions (stack data, area and line sources) for a given area (spatial domain). These data are made available automatically to all air quality models, and the emission models that generate dynamic emission data in real time.

The emission inventories lead to the individual emission sources that can also be reached from the industrial plant, or the overall object data base of the EMIS.

**Hazardous substances data base and MSDS**

A basic component of any EMP includes the management of hazardous substances and waste. EMIS includes a data base of hazardous substances and MSDS with several hundred basic industrial chemical profiles (optional extensions include several thousand EPA registered substances).

The substance data follow either the EPA or EU MSDS structure; they include hazard classification, warning, handling, labelling and packaging instructions, transportation rules, first aid information, and the basic physical and chemical substance properties used by the simulation models and for risk and impact assessment.

EMIS includes a basic hazardous substances data base that combines the profiles of more than 700 chemicals from EU and US EPA sources. This includes basic identification and
classifications, risk and safety instructions, (R&S sentences), toxicological information, labelling etc. and is directly linked to the simulation models for the physico-chemical paremeters.

Environmental technologies
EMIS includes data bases of environmental technologies, including:

- Emission control technologies for atmospheric emissions;
- Waste treatment technologies linked to the RCRA (hazardous) waste-stream data base.

The technologies data include substance specific (removal) efficiencies and economic data (unit investment costs and operating costs) that can be used in optional multi-criteria optimization tools to design cost-efficient emission control and/or waste management systems that meet regulatory standards.

GIS: map catalog and composition
An embedded GIS provide tools for the composition, selection, and display of background maps and spatially distributed data (topical maps). They include any user defined combination of individual overlays of line features, polygons and raster background images such as satellite imagery and high-resolution aerial photography. The embedded GIS tools include interactive map import and export (ArcView/Info compatible shapefiles of *.e00 export files) map composition, but also the management of spatially distributed model results (rasters and matrices) and their numerical export.
GIS data are used as model inputs (e.g., digital terrain model, land use, bathymetry, surface characteristics, location of emission sources)
ISO 14001 and EIA

This component provides a range of scenarios for checklists based evaluation systems for both screening-level EIA for new plants or enterprises, individual emissions sources, changes in production technology or substances stored or used, waste streams etc. as well as ISO 14001 compliant pre-audit checklists for the evaluation. Monitoring, and adaptation of an EMS.

For the ISO 14001 and related evaluation schemes based checklists, a hierarchy of issues and steps in the valuation procedure is offered. This starts with five main levels:

- Environmental policy
- Planning and preparation
- Implementation and operations
- Monitoring, corrective actions
- Management review

Within each class of procedural steps, a summary evaluation uses a color coding to denote the current state of the EMS implementation or review process:

- Completed
- In progress
- Just started
- In preparation
- Not yet
- Not applicable

At the individual problem level a rule-based expert system is used to assist in the evaluation of the implementation procedure that can be summarized at the project level (both the entire industrial park as well as any one of the component plants or companies).
Evaluation of the implementation process or a screening level environmental impact assessment can be embedded in the real-time expert system to alert the operator whenever a time table defined is not being followed, or information used is out of date to facilitate a swift implementation procedure and reliable results with continuous background automatic quality control/quality assurance procedures based on artificial intelligence (AI) expert systems technology.

Industrial Production Processes and Waste Stream Data Base

Based on the US Resource Recovery and Conservations Act (RCRA) EMIS includes a data base of 154 industrial waste streams that are linked to the production processes of the individual plants, the hazardous chemicals data base (MSDS), and applicable waste treatment technologies.

The data include a (hyper)textual description of the waste stream and the originating industrial production process, the basic physical and chemical parameters, production process and main product, link to the plant, list of hazardous chemical in the waste stream, as well as the applicable waste treatment technologies. A link to scanned documents (PDF, Word or HTML format) provides additional background (e.g., regulatory or health related) information.

Simulation models
EMIS maintains a range of dynamic simulation models that can be used both for automatic, scheduled forecasting and now-casting runs (modelling cum monitoring, data assimilation) but also interactively for scenario analysis, planning, and environmental impact assessment.

**Air quality**

EMIS links to a basic version of the AirWare system and its functions. At the top layer, this includes a regional model to provide dynamic boundary conditions in real-time for all local models. The regional air quality modelling is driven by a 3D prognostic meteorological model (MM5) and the nested grid photochemical model CAMx producing regular 5 day forecasts that can be updated every six hours.

Within this framework local models for the individual sources and source groups of the industrial estate are operated automatically, on an hourly now-casting basis.

Specific interactive functions include scenario analysis and comparison, EIA for new or modified emissions, and support for the optimal location of monitoring stations.
Risk assessment

For accidental release of hazardous substances, atmospheric or aquatic dispersion, fire, BLEVE, or explosion, a range of technological risk assessment models is available. The main model is the rapid assessment tool Metodo Speditivo that provides a rapid screening level estimate of different danger zones around sources of risk (the container and storage units) depending on material characteristics, amounts, and meteorological conditions for some (dispersion) scenarios.

Other optional models can be used for the full range of possible accidents and their impacts, both for probabilistic risk assessment and for scenario analysis including 3D dynamic CFD code for heavy gas dispersion and near field high resolution modelling including explicit building obstacles.

Coastal water quality

For industrial parks in coastal locations including major harbours and related activities, coastal water quality for harbour basins and the costal waters is available, based on the ROMS/TOMS 3D dynamic flow and transport model system. With a very high vertical resolution in the dm range and corresponding computational time steps, the system can also handle double diffusive problems such as (warm) brine dispersion.
Emission control optimization

For any energy intensive industry, energy efficiency and thus emission control optimization in terms not only of standard air pollutants but also of CO2 and GHG is of increasing importance. EMIS offer an optional module for multi-criteria techno-economic emission control optimization, consisting of five major components:

GHG Emission inventory

**Basic emission inventory:** data base, multiple methods for emission estimation (IPCC guidelines, EMEP/CORINAIR guidebook and emission factors 2007, ISO 14064, WRI/WBCSD guidelines and tools, USEPA methods, DoE 1605(b), TANK fugitive emission modelling), analysis and reporting, user interface, web-based client server implementation for centralized administration with remote, distributed access. Includes simulation-based calibration (3D photochemical nested grid model (CAMx) with 3D prognostic meteorological pre-processor MM5) using bottom-up strategies for independent high precision estimates of GHG budgets. Optional integration with real-time site monitoring (direct emission monitoring or indirect through ambient air quality, stoichiometric ratios, and dispersion modelling as described above.

GHG Inventory Management Plan

**Automatic monitoring** of the emission inventory using a real-time expert system. Continuous analysis of data coverage, quality assurance testing: completeness, consistency, plausibility. Timed and event driven workflow management including automatic message/reminder and regular technical and administrative report generation.

Benchmarking

**Multi-criteria benchmarking** and comparative ranking: Extension of the basic GHG inventory analysis and reporting, requires data from comparable third party sources, installations, companies to visualize parameters and indicators in a global peer context (multi-criteria comparative ranking by basic parameters and user defined indicators), Top-10 analysis.

GHG Abatement Program

**Multi-criteria techno-economic optimization** of abatement strategies using arbitrary precision piecewise linear cost function of emission control technologies, comparison (CBA) with CO2 credits; includes a multi-media data base of abatement strategies and technologies and a discrete multi-criteria decision support tools (participatory group decision making).

Technical implementation:

The GHG emission inventory and support tools can be a fully integrated component of EMIS, or a separate, stand-alone solution, delivered as a customized software (turnkey installation with associated user training), including appropriate (multi processor quad- or
hex-core Xeon server under Open Source Ubuntu/Linux). The client is expected to provide a state-of-the-art (4Mb or better) symmetrical Internet connection for the server.

Remote support (Internet based) includes optional mirror installation for continuous process/transaction monitoring, backup, disaster recovery and on-line user support (eMail and web based with error report log and tracking facilities).

**Web-based, distributed solution**

The proposed GHG emission inventory software is implemented as a distributed (web based) client server system (unlimited number of users) with centralized industry standard data base (object-oriented PostgreSQL or ORACLE) remote secure access (domain restriction, IP filtering, 128 bit password encryption, VPN, multi-level user management and access privileges) from any PC with standard web browser. While the actual data holdings are centralized and non-redundant to guarantee consistency at all times, distributed user from individual installation can access the system to edit/update and analyze their respective data easily, on-line using any industry standard web browser on any PC with Internet access as the only client hardware and software required.

A distributed client-server solution combines the administrative advantages of a central data holdings and tools with the ease of remote access for distributed users at different installation in a large institution. A modular client-server system is open for continuing adaptation to changing requirements, easily scalable, and provides a cost-effective integration of central shared high-performance computing environment, the efficiency of central administration (from backup to upgrade management), with the distributed personal (PC) based access throughout an unlimited number of locations.
GHG Emission inventory

Basic emission inventory, consisting of
- Geo-referenced multi-media data base (industry standard RDBMS, using e.g., OO PostgreSQL or ORACLE data base engines);
- Multiple alternative (or parallel) methods for emission estimation
  - emission factors according to IPCC guidelines,
  - multi-tiered methodology including tier 3 specific methods according to EMEP/CORINAIR guidebook and emission factors 2007,
  - USEPA methods, DoE 1605, TANK fugitive emission modelling,
  - Statistical methods (non-parametric statistics and rule based estimation)
  - analysis and reporting,
  - user interface (graphical menu driven intuitive with expert system support and embedded help functions)
  - web-based client server implementation for centralized administration with remote, distributed access, detailed transaction logs.

Emission estimates can be combined with simulation-based calibration (3D photochemical nested grid model (CAMx) with 3D prognostic meteorological pre-processor MM5) using bottom-up strategies for high precision estimates. Optional integration with real-time site monitoring, plant level EIS.

Basic accounting and reporting principles are based on A Corporate Accounting and Reporting Standard, WRI/WBCSD, (Revised Edition 2005). Please note that there are currently NO sector specific tools or guidelines for the energy/gas sector available from WR or WBCSD. (www.ghgprotocol.org) even though the discussion on corporate GHG accounting is ongoing.

Basic estimation methodology:

Monitoring and direct measurement may involve continuous emission monitoring systems (CEMS) (emissions recorded over an extended and uninterrupted period), predictive emission monitoring (correlations developed between measured emission rates and process parameters) or source testing (e.g. stack sampling).

Mass balance involves the application
of the law of conservation of mass to a facility, process or piece of equipment. Emissions are determined from the difference in the input and output of a unit operation where the accumulation and depletion of a substance are included in the calculations.

**Emission factors** uses emission factors (EF) to estimate the rate at which a pollutant is released into the atmosphere (or captured) as a result of some process activity or unit throughput. The EFs used may be average or general EFs (simple activity based, tier 1; fuel and activity based, and 2), or technology-specific EFs. (complex models, tier three).

**Engineering estimates** may involve estimating emissions from engineering principles and judgement, using knowledge of the chemical and physical processes involved, the design features of the source, and an understanding of the applicable physical and chemical laws. In the proposed EIS, this is implemented as an backward chaining Expert System with first order production RULES.

**Statistical methods:** closely related are statistical methods that derive a first order estimate from the distribution of the respective variables within a set of comparable objects. This can be based on simple statistics (first moment of the distribution), an estimate like median for a user defined sub-class, or a fuzzy set methodology that uses classification with linguistic hedges (like large, average, small) and an appropriate corrections (e.g., plus/minus one standard deviation) from a base estimate.

**Multi-tiered assessment:**
The object oriented structure and implementation of the emission inventory software together with the multi-attribute classification of sources support a multi-tiered estimation process, following the logic and tier structure as described in the CORINAIR Guidebook (2007).

Every source class (defined by any one of its attributes selected for classification based on an underlying Hypercube (OLAP) data base architecture) and at the lowest level, each individual source, can have its individual emission factor(s), together with pollution abatement method, efficiency, and temporal availability of the abatement method;

**Tier 3:** the emission estimate can now also be made a function of any of the global variables available in the system (the date/time as used in the temporal emission patterns is one such example). This can include, as an example, temperature (for fugitive sources), but also the age of an installation, maintenance characteristics etc. and can be used as auxiliary data. These relationships are always expressed by a piecewise linear approximation.
**Tier 2:** the specific emission coefficient can be adjusted for local and specific individual coefficients by a rule based correction of the basic, default tier 1 estimates. Then apply correction factors (relative increases or decreases) from the basic tier 1 defaults (taken from the CORINAIR Guidebook emission factor tables), that are specified directly (based on field data, expert assessment, or rules); whenever no tier 3 data are available, tier 2 methodology will be tried; Tier 2 estimates can be derived and dynamically updated, *inter alia*, from the statistical analysis of directly determined emission factors for any classified grouping including attributes such as size or age of a source.

**Tier 1:** this provides a reliable and complete coverage for all cases where neither tier 3 nor tier 2 data are available.

**OOD: inheritance and overloading.** Thus, sources will always inherit the default values from their parent class, but can selectively overload these values depending on data availability. This flexibility supports incremental improvement of the data base with any updates during the continuing support, but most importantly guarantees a complete and consistent set of emission estimates at any point in time.

**Editing:** all editing tasks are supported by an on-line expert system that simplifies the dialog by offering defaults, symbolic classification, a range of editors, rule-based deduction for complex estimates, and immediate quality assurance as well as complete logs (time stamped and by user) of all interactive entries. Built-in context specific help pages as well as optional (eLearning) tutorials ensure easy and reliable use of the system.

**Reporting:** summary reports in terms of individual substances including CO2e can be generated interactively for any user defined geographical, functional, administrative and temporal framework. Automatic report with a user configured content and structure can be generated automatically at user defined intervals such as monthly, quarterly, annually. As soon as the necessary data are available over a sufficient period, this can also include the temporal reporting requirements of the Kyoto protocol (in compliance with the EU Council Decision 280/2004) Emission inventory summary page that can be adapted for installations and enterprises:
• provisional data on emissions of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxides (NOx) and volatile organic compounds for the twelve-month period preceding the previous year (i.e. year X-2), as well as final data for the year before that (year X-3);
• emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF6) in year X-2;
• greenhouse gas emissions resulting from land-use and forestry during year X-2;
• the accounting of emissions and removals from land-use and forestry for the years between 1990 and year X-2;
• information from national registries established pursuant to Directive 2003/87/EC;
• information on indicators used during year X-2.

Automatically generated reports can range from complete documents to very short status summaries distributed by eMail.

**Document management:** related to the emission inventory meta data and optional hypermedia description of emission sources, the emission inventory software includes an embedded document management system, where any source or class of sources can have technical or administrative documents (PDF, DOC, PS, HTML) attached. The documents are indexed by an open list of thesaurus keywords that can be flexibly extended by the user (see also Task 2).

**GHG Inventory Management Plan**

A GHG Inventory Management Plan for the continuous maintenance and updates of the inventory can be based on concepts of applied AI (artificial intelligence) implemented as real-time (time aware) rule based expert system. This can be run automatically, on a scheduled (e.g., every night) or event-based (new data have been entered) basis, or any combination of triggers. Tasks include:

• monitoring data content (completeness, consistency, plausibility)
• performing statistical analysis and quality monitoring tasks
• managing the work flow (automatic reminders by eMail or fax)
• performing automatic quality assurance tasks, issuing alerts where necessary
• issues regular status reports (web based, by eMail).

Any maintenance plan, strategy, SOP, can be encoded as a set of checklists and associated (timed or event driven) production RULES for automatic supervision, quality control, and workflow management. RULES include absolute and relative (elapsed) time and timers that can be set for task monitoring. The automated management plan coordinates the contributions (data compilation and updates) across different locations, installations, business groups and processes including:

• Power and utilities supply
• Operations and production (on- and of-shore, QG1-4, Refineries, terminals)
• Administration, office complexes
• Transportation and distribution system
• Employee travel, other energy use.
For each task or data component, responsibilities (institutional and/or personal) can be defined, checked regularly against the management plan, and any discrepancy reported, generating reminders for open tasks.

Please note that some of the update tasks can be achieved efficiently by coupling the GHG emission inventory management system to plant level Environmental Monitoring and Management Information Systems (e.g., ISO 1400, EMAS compliant) that compile would continuously compile substance specific mass budget and emission information as GHG inventory inputs.

**Benchmarking**

Extension of the basic GHG inventory analysis and reporting, requires data from comparable third party (regional or global) sources such as national GHG statistics, Kyoto protocol reports, installations, companies to visualize parameters and indicators in a global peer context (multi-criteria comparative ranking by basic parameters and user defined indicators).

Data sets for comparison can be geographically or topically referenced and selected. One or more parameter can be ranked and compared at a time.

User defined indicators can be constructed interactively as the basis for a multi-criteria ranking that can be customized for specific questions that do not have directly corresponding data sets. Examples are efficiencies or any normalized parameter.

Basic statistical analysis of the individual parameters for the multi-criteria ranking provides additional benchmarking information and explanatory (co-incidence of correlation) information.

Another important part of the benchmarking data holding is the compilation of a specific corporate environmental management knowledge base, including technology and knowledge transfer and management, best practice, BAT and BATNEEC solutions.
GHG Abatement Program

Multi-criteria optimization considers simultaneously:

- Environmental impacts
- Emission and risk management
- Economic criteria (investment, operations)
- Corporate image

Rational decision support for cost-efficient abatement: these tools support multi-criteria optimization of abatement strategies using piecewise linear cost function of emission control technologies for individual substances or CO2e (CO2 equivalents) from an emission control technology data base, comparison (CBA) with CO2 credits; includes a multi-media data base of abatement strategies and technologies and a discrete multi-criteria decision support tools (participatory group decision making).

The multi-criteria optimisation generates a large set of alternative strategies using a method of adaptive heuristics and genetic algorithms. These results are automatically partitioned into feasible solutions (that meet all used defined a priori constraints or requirements for the individual criteria and objectives) and infeasible values that can be discarded (still being used for sensitivity analysis and machine learning).

Given a (user defined) set of criteria (primary preference structure) the set of feasible solutions can be partitioned in

- pareto optimal solutions
- dominated solution

The display of solutions (ranked by individual criteria or as a scattergram of any combination of criteria, users can now

- select and de-select criteria
- set secondary constraints
- define a reference point to express specific policy objectives and targets.

The software then computes the best (efficient) solution according to the user preferences.
Business model:

EMIS is designed as SaaS (Software as a Service) or application service that is provided as an (optionally) outsourced solution to a large number of parallel and in fact cooperating users on a subscription basis. The service (cloud computing, utilizing shared HPCC, high performance cluster computing technology) can be based on any combination of local or remote information resources or servers and data bases with the associated systems maintenance and user support including technical (application level) consultancy.

For any individual subscriber that eliminates the need for major up-front investment, any major hardware or technical infrastructure and maintenance costs. The possibility to share development, implementation and operations costs (including high-performance cluster computing hardware and monitoring sensor) provides for very cost efficient and flexible solutions.

Costs would include: One-time setup fee (includes data compilation)
   Monthly subscription, annual or quarterly basis

In parallel to the provision of the system, its operation, and remote support, extended application support and system related consultancy as traditional and eConsulting services are available.

Please note that the system can also be licensed for local operation (directly at the industrial park or with a local ASP, and remote Internet based support by ESS), and delivered as a turn-key solution including the necessary server and optional monitoring and sensor hardware including local UHF/GPRS telemetry.