Intelligent Energy Management Systems to manage the New Energy Mix

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0. Introduction

Within the energy market we see new potentials in the Renewables and a changing business in the fossil power generation. Focus might vary within a certain region but main trends are obvious: Fossil fuels are gradually replaced by renewable energy in energy production. An enhanced efficiency will save money and smarter systems need to be used to manage the different, decentralized production units from a central view point. These systems need to ensure that the grid remains stable, generation plants work more efficient and environmental requirements are met.

Figure 1: A new challenge: manage the New Energy Mix

Customer needs are focused on reliable energy provision, flexibility to either produce or use energy from the grid, get energy at any point where it is needed, (e.g. eCar), get online information for cheap

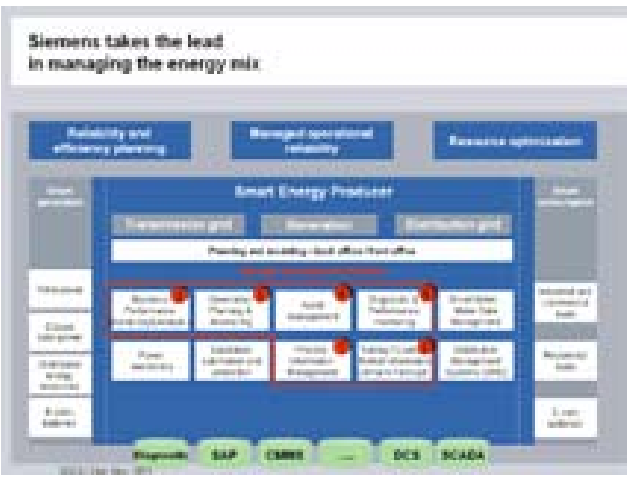


Figure 2: various IT-Systems need to be linked to enable the management of the New Energy Mix

tariffs and the actual information of their consumption / costs. All necessary data to manage these production units and customer needs are available in different systems. However, Generation companies usually don't have immediate access to consistent, processed and up to date information for data generated from production and maintenance, procurement, and logistics. This also applies to production costs directly from running production. Beside that, they should be ready to handle the challenges of online forecasts regarding availability and market trend.

1. System Components to manage the New Energy Mix

There is a general decision necessary upfront, whether or not data should be available centrally or decentralist. We believe that there are some good arguments for a centralized approach. All important information is available, role-based, and adequate prepared, directly at any work place with an intelligent Energy Management System for operation, controls and fleet management. Traders, performance analysts, plant, and maintenance managers etc.. all get information enabling faster decision making and reactions to the challenges of the new energy mix.

As an example for such systems, the Siemens Energy Management Suite (SPPA-EMS) supports users by providing the actual status on plant or fleet level, combining information from real-time DCS and SAP. It enables the customer to be prepared for increased renewable production and smart grids. Their main components are described below.

1. 1. Process Information Management – the basis

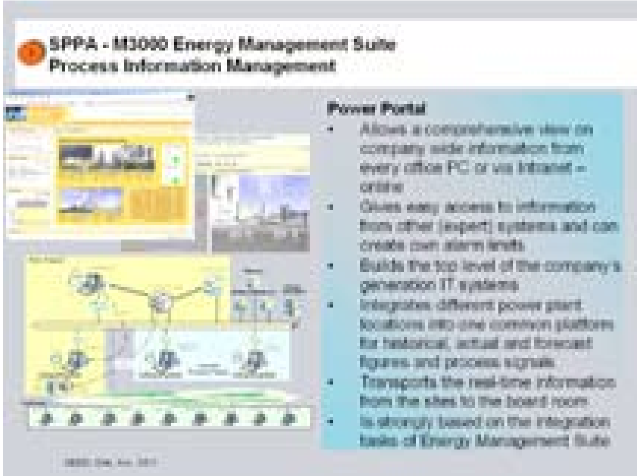
A Process Information Management System collects process data from a wide variety of systems, irrespective of their location without influencing the local DCS system. It then condenses and saves them uniformly in a real-time database, and processes the data to produce derived information, e.g. on efficiency and generation costs. The information is available via web on every office PC for further analysis. A rich set of interfaces enable an easy integration of various assets. A strong compression algorithm will reduce the amount of needed storage within a certain time frame (e.g. 10 years) and allows data storage and availability from thousands of assets. Time resolution is very granular and allows analyzing of "sequence of events" etc. Roll back enables to check process situations from any time into the past.

On the one hand, the data can be displayed as required at any workstation, e.g. in the form of plant displays, trends, bars or tables. On the other hand, technical reports can be generated, (automatically or at the push of a button), in a pre-formatted standard report and can be distributed to the right recipients. The design and data compilation are preconfigured and calculation rules are defined for reporting.

Figure 3: Typical Architecture of a Process Information Management system inside a portal for all office PC's with a powerful process historian and rich amount of interfaces

1. 2. Generation Planning and Monitoring

A Generation Planning and Monitoring System is the core application for managing the energy mix. Based on an accurate prognosis



of the energy demand of the companies contracted users or the statistical behavior of "normal consumers". and the predicted amount of renewable energy fed to the corresponding grid area, the system determines the optimum load dispatch strategy considering the optimum cost situation, unit capaci-ties, fuel supply, efficiency curves, environmental or other constrains. The forecast of unit capabilities relies on the schedule of planned and forced non-availability events and the corresponding plant/unit model. The result of this Economic Dispatch is a generation schedule for the thermal, nuclear and hydro plants. Services like spinning reserve or district heating /cooling/ process steam can also be considered. Generation planning reacts immediately to changes or lack of energy and provides recommendations for the dispatcher every 1-2 minutes.

Generation monitoring allows fast reactions to problems identified on fleet level, energy losses within the renewables or a new balancing order from the grid operator, by providing the right fleet overview on a single or cumulative production level and by linking current production directly with Economic Dispatch. This integrated view, versus the classical "island calculation mode with manual interface", enables the company to manage the new energy mix efficiently. The dispatcher will use a set point management system to give direct commands to remote components or units using the remote distance protocol IEC 60870-5-104 or IEC 60870-5-101. This allows the utility to react fast and reliably on demand or produce changes by adding generation capacities to the grid or removing energy consumers from the grid. Fax, or any other ways to communicate generation schedule changes, are now obsolete. Proper information security will assure that communication via the Internet will have no influence on the controlling and business systems.

Flexibility and response to generation changes can be increased by using modern and up to date process optimization systems enabling, for example, faster ramp curves and decreased minimum generation capacity without exceeding the borders of the involved components. As distributed generation using photo voltaic, diesel engines or other generators will become more and more popular, those systems are a must to manage the heterogeneous energy mix of tomorrow.

Energy Market Liberalization will lead to an increased competition between the various generation companies by trading. If degree of automation will be similar within market players, the value chains and the knowledge about customers will compete. The more digital these processes are and the smarter these predictions on prices and demands are, the better the market position will be. This should work for small and also big companies.

1. 3. Business Performance Monitoring & Analytics

Iinformation covering the whole supply chain to the decision makers is a key for a flexible and agile utility near real time. Such an operational intelligence solution should provide comprehensive management dashboards enabling the user to easily identify changes and areas where they should focus first. Such a system focuses on asset performance and all related information, whereas business warehouses, or business intelligence solutions, are focused on commercial reports. It will also allow them to check for the root cause when details are needed. Information from various systems will be easily integrated by providing a set of standard connectors to the various ERP, CMMS, DCS and other technical or commercial systems without duplicating data. Reports are delivered promptly without manual work by the responsible person via portal and role based access. A set of standard screens and accepted Key Performance Indicators, (e.g. NERC and VGB), shall enable the user to perform an interna-benchmark. A typical update cycle should take 10 minutes.

A Power Portal was established within a project in the German energy fleet of EnBW which integrates more than 1100 data elements from various plants onto approx. 500 screens. This enables the users to get an accurate, timely and focused management dashboard and also indicates the areas of action in an easily identifiable way by integrating various sources from different plants into those views.

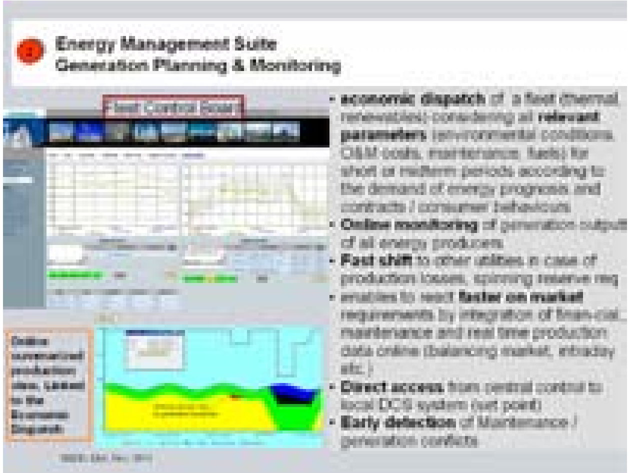


Figure 4: Generation Planning and Monitoring System enables the management of the New Energy Mix by integration demand and generation online and dispatching the needed resources.

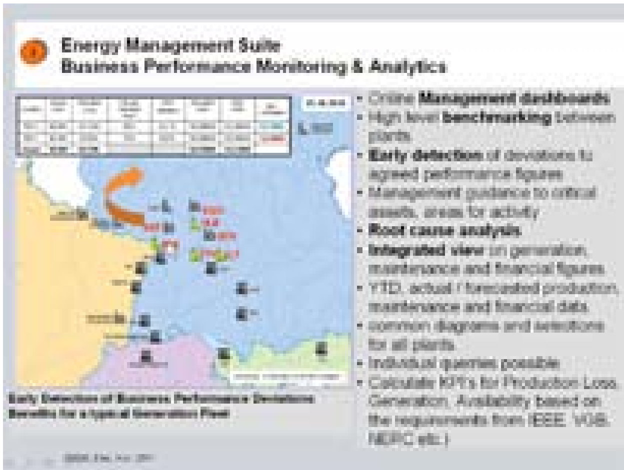


Figure 5: Operational Intelligence solution flexible to be integrated into the fleet, allowing management to see the areas for actions and root causes

1. 4. Asset Management

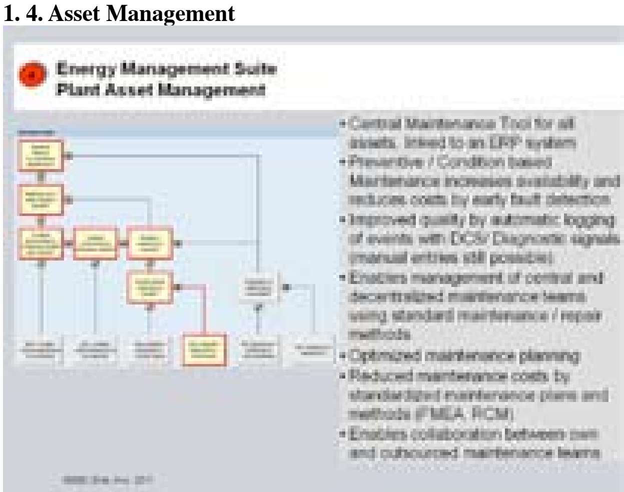


Figure 6: Asset Management Systems need to be ready for thousand of elements. Changes and optimization must become easy to handle across the supply chain components.

Asset Management systems provide specialized solutions for the technical work processes and tasks in the different generation/distribution areas. Planning, execution and documentation of corrective and preventive maintenance measures and spare parts management (including material requirements for work orders, purchasing of material and stock-keeping) are covered in most of the systems. Smooth interfacing with process control systems, (DCS), document management systems, (DMS), and commercial applications, (e.g. SAP ERP), can improve quality and process integration. An IT-System can help to reduce delays, (e.g. shift log execution), and also help the company to create knowledge assets due to the description of the problem and how it was fixed. Proper wording can help with reusing those assets and making them even more evolved by improving their content after the maintenance or repair work. This will lead to the determination and implementation of optimal maintenance strategies via definition of failure modes and the analyzing of fault consequences, (RCM & FMEA). A further extension of component usage can be completed by condition based maintenance. These tools can use some statistical or neural methods, in combination with some pattern recognition or rule engines, to identify as early as possible when maintenance work needs to be done. By using the same methods, such a tool can be used, with some component specific extensions, for all critical parts in the new energy world. Either a further consolidation will take place, or some inter-medium systems will be used to manage the heterogeneous systems from a central viewpoint.

With the knowledge of the maintenance needs of specific components, planning of outages can be improved and aligned with generation planning. Managing of thousands of assets can be done more efficiently with those systems (esp. when a new component has to be added and a best in class maintenance plan should be chosen from an existing one), including availability, time and cost constraints. Modern Engineering Tools will enable direct updates to the asset management repository in case a change is necessary. This will help Maintenance and Performance Engineers to see all components of the new energy mix in such a system and use the same up to date system base.

1. 5. Diagnostic and Performance Monitoring

Many types of diagnostic and performance systems are found due to the varying installation dates in power plants. These were bought become as best of breed over a longer period of time. Because they are not typically from a single vendor; these systems vary in form of user interface, functionality and operation system. Procurement of such systems was mostly driven by technicians. As a result of this, in most cases the user skills needed to be trained vary widely. Due to the retirement of these experts a knowledge and resource gap has appeared. This leads to a situation where a continuous monitoring for these expert systems is no longer guaranteed. The situation gets even worse if we consider that the new energy mix forces some additional stress on those components which have not been designed for a flexible energy generation. This in turn leads to additional tasks for their diagnostic systems and users.

This problem could be solved if we brought together the remaining experts within a “remote diagnostic center”. This means they will be brought together - either physically or virtually - within one room, using a portal where they have access to the most important information from the local plants. They will perform the diagnostic activities on an Early Warning System for the entire fleet, giving them a common user interface to the diagnostic and process signals from the different locations with different alarm levelos than in the DCS and workflow capabilities. Such a solution enables the company to increase the average availability of such thermal plants by 0.5-2 %.

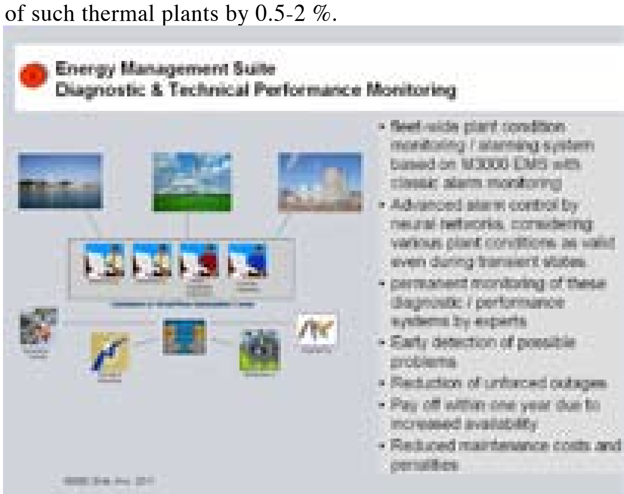


Figure 7: Remote Diagnostic Center helps companies assure proper controlling of important assets 7 days a week, 24 hours a day.

A Canadian utility project, Transalta, demonstrated that such a remote diagnostic center can provide the desired infrastructure for the integration of customer‘s core systems and all related diagnostic and monitoring services. It improves support for decision making for meeting the short and long term market needs.

This center now provides early detection of potential plant and unit issues for:

- reduced maintenance costs
- increased availability and efficiency
- economic and technical optimization of plant and fleet performance
- consistent management reporting

Monitoring of 11 units at 4 plants with a number of ca. 50K process signals is carried out within the centre. It is expected to recuperate the initial investment within two years, which is on track for payback within one year. Diagnostic engineers now spend more time on doing their job instead of traveling thousands of kilometers to the remote units.

2. System Architecture of an Energy Management Suite

The integration of different tools using various protocols and interfaces is key for central data storage and analysis for these process signals. Different Applications will still be needed to fulfill the requirements within the different process areas. Increased flexibility and cost pressure will lead to a consolidation of proprietary solutions by standard products. These standard products must cover the main process tasks and should be flexible for some customization. Therefore, a certain amount of dif-

Figure 8: Bigger solar power plants require mature DCS systems ready to manage complexity.

Figure 9: Smart Grids pilots can be seen across the world. Further standardization is necessary.

ferent applications will remain in an integrated utility. These should be linked to each other using web services to allow data exchange or new, integrated reports/dashboards. Development tools should enable programmers to connect these systems easily, focusing on business needs without wasting time on interface details. The SAP eSOA Suite with Netweaver tools such as composite environment have allowed e.g. Siemens to create such an energy management suite by integrating commercial data from a SAP system and DCS information within one screen and build business processes across both systems.

3. New Challenges will arise

Solar power is by far the earth's most available energy source, easily capable of providing many times the current total energy demand. The largest solar power plants, such as the 354 MW SEGS in the USA, have already been running commercially for over 20 years. Concentrating solar thermal plants, (CSP), normally focus the sun's energy for boiling water, which is then directed to a steam turbine to generate electricity through an attached generator.

Today's CSP are built in the range of 50 MW to 250 MW. Therefore, an established proven DCS systems from the generation industry is needed. Standard interface protocols are used to link the different plant areas. These plants will therefore still have few engineers to manage them so a common and scalable platform for engineering and control is a must.

The main goal for today's CSP is to lower the LCOE, (leverage cost of electricity), in order to outperform coal fire power plants. An established 4th generation DCS systems is not only capable of integrating control tasks for steam process and auxiliary system in the balance between plant and solar field. Process optimization and diagnostic can also support lowering operating and maintenance costs in order to decrease the LCOE.

This platform will be connected to an energy management system, enabling the central energy management center to view and control the generation and main components online from a central point. They will detect problems earlier and react faster to production changes, without influencing the service quality in the smart grid, by allocating the missing energy to others or delinking some energy consumers from the grid.

Feed in tariffs will attract new players in the generation area. These companies will use the generation assets to satisfy their shareholders and therefore will focus on their core business. This will enlarge the required service support. More and more small Generation companies will try to find a full service provider offering a remote service for their plants, fulfilling their basic needs for information and plant availability.

The need for Distributed Generation will increase. To compensate losses from Renew-ables either increased storage capacities or fast ramp up generation capacities are needed. There are various scenarios possible. Some might use some diesel engines to compensate losses from photovoltaic. Others might look like shown in figure 9 (left).

The number of distributed energy resources and the amount of decentralized energy will grow. These must be managed within an Energy Management Suite such as a virtual power plant. As well as this the suite needs to get information from thousands of households either producing or consuming energy, managing hundreds of thousands of data points. The demand and generation have to correlate. Decisions for additional generation or load shedding have to be made promptly and commands to the distributed energy producers or consumers have to be made. Batteries will help to manage this.

New concepts may even include thinking about some island modes for companies e.g. supermarkets or their fridges. As there is no standard yet available for most of the involved components, a lot of pilot projects have been started. A typical example of such a Smart Grid project capable to manage the new energy mix is shown in the picture below.

The pure amount of data might bring us to the conclusion that central systems might not be the right answer. Decisions should be made as early as possible. System should be scalable, supporting IPP's and big Generation companies in the new energy mix.

Thomas Duerr works more than 20 years with Siemens. Since the last 5 years he is responsible as a Senior Product Manager for the Siemens Energy Management Suite in Siemens Energy. He has designed the SOA architecture and the main Generation Management and Business Management Modules. He is the Partner Manager for SAP, ATOS and OSI Soft. As a technical sales he supports customers worldwide. He won major projects like Low Carbon London and Remote Diagnostic Center for Photovoltaic's.
He owns a university master degree of electrical engineering.