CO_2 monitoring in the context of an energy data system ATPEDS

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Abstract

Nearly ten years ago the process for the efforts of reducing the carbon dioxide (CO_2) amount in the air started. Finally a cap and trade system was installed, which obligates plants and factories, emitting CO_2, to use certificates corresponding to their emission rates. Therefore in 2003 Verbund Austrian Thermal Power ordered an energy data system, which had to handle all kinds of data around a power plant, especially the emissions and certificates. The system, based on Oracle's application server and data base, has been implemented by Simutech. It has to deal with different data sources and sinks. Special attention is paid to security and safety of measurement values, leading to strict rules for the access, change journaling and the value correctness. A formula module and different graphical, e.g. online displays support the evaluation of now more than five thousand parameters, among which the emission and certificate computation is one of the most important one.

1. Introduction

In 1997 politicians from around the world agreed in a compromise about the reduction of CO_2: the Kyoto protocol (European Commission 2005). According to this protocol CO_2 in Europe should be reduced by 8% until 2012.

In the years after 1997 discussions started, how this reduction could be reached. One of the samples then were the experiences with the "cap and trade"-model, which was introduced by the US-government in 1990 under president George Bush. At this time sulphur dioxide had been the target: and it led to a reduction of about 50% (US Congressional Budget Office 2001).

In 2002 the "Clear Skies" program in the USA extended the cap and trade method to other chemical parts in the air – except for CO_2 (Whitehouse 2002).

In those years in Europe most political parties voted against a scheme like "cap and trade", because this would be like the "letters of indulgence with hot air". But in December 2002 the governments of the European countries accepted the proposal of the European commission for an obligatory system of trading with CO_2 certificates.

1.1 Cap and trade

What does cap and trade mean?

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In a first run 5000 plants for energy, steel, chemical, paper production and some other areas where obliged to enter the system of trading with CO_2 certificates. At the beginning of a year each plant receives - based on a national allocation plan - an amount of certificates. This certificate is accompanied by a certain amount of CO_2, which may be emitted into the air.

If the company does not need all the certificates, it may sell the rest to the bidding highest. If the company does not succeed and needs more certificates than it received, it has three ways to deal with this situation:

- it must buy additional certificates or
- reduce the emission or
- receive a penalty of € 40,- (from 2008 on even € 100,-) per t CO_2

The official start of trading with certificates was in 2005 (BBC, Mulvey 2005).

Since this time different approaches have been tested and implemented to present, evaluate and model emission data, e.g. the German Emission Inventory (Schlenzig 2002), an information tool on emissions (Dürrenberger 2001), an Internet platform for corporate sustainable management (Schulz 2001).

2. The energy data system

In 2003 Verbund Austrian Thermal Power, the owner and operational management company of the thermal power plants in Austria, decided to introduce the energy data system ATPEDS (Simutech 2005). This system was then implemented by Simutech in tight cooperation with the experts from ATP within one year.

Therefore with the beginning of the “hot phase” of cap and deal it was already in the phase of full production.

Figure 1 Power Plant Voitsberg, Austria

2.1 Aims of ATPEDS

ATPEDS is designed for collecting, administrating, evaluating and presenting all kinds of data, which appear during the operation of thermal power plants.

- energy production and consumption (contracted, real amount),
- fuel and material management,
- environmental and chemical,
- proceeds and costs

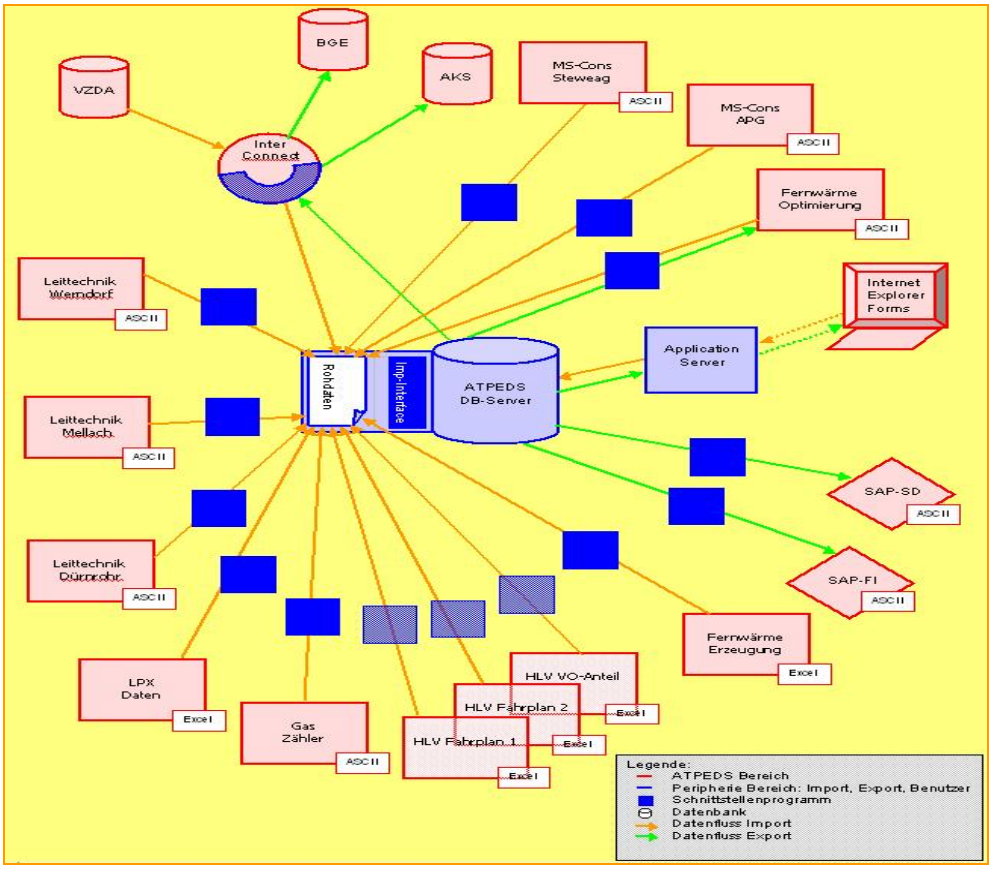


Figure 2 Overview of the data sources and sinks of the energy data system

Data is collected in time steps from some minutes to years. Data import uses different sources: controlling systems, counters, foreign data bases, e-mails, manual input. All values are stored in a data base.

Figure 2 shows data sources and sinks of ATPEDS.

2.2 Technical Details

ATPEDS is implemented as a typical three tier system:

- the relational data base (Oracle 10g; Oracle 2005)

- the middle ware: the application server (Oracle AS 10gR2; Oracle 2006)
- the client side: an Internet/Intranet browser

That means, that ATPEDS is fully Intranet-based; a client generally only needs a simple browser.

The system has been implemented using Oracle's developer suite; with Oracle Forms und Reports and some Java libraries for beans and servlets.

Seen from the IT specialist's view, these Oracle tools build up an application development system, which embeds menus, dialogues and database access (to the relational database) into an Intranet/Internet environment: an applet in the user's browser communicates with a servlet on the (middle-tier) server.

The main challenges have been

- the conception and implementation of an easy to use but comprehensive interface, for different kinds of users, like the coal operator, the accounting specialist, the plant administrator
- the integration of different kind of sources, like controlling systems, manual input, input of data coming from emails
- the creation of several different measured variables and formulas, describing the relation between the variables

At this time about 90 users work with the system. More than 5600 measured variables and 4000 formulas are implemented.

Figure 3 shows a typical value displaying mask with special signatures (green, grayed) for different kinds of value treatment steps and value sources. The values of all figures below are invisible or have been changed for security reasons.

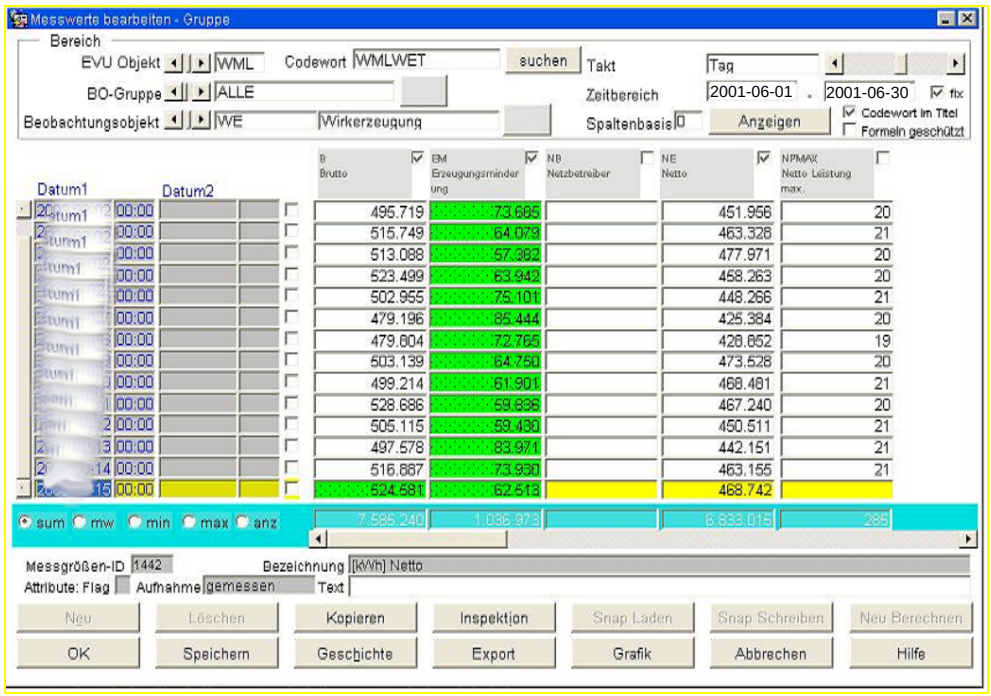


Figure 3 ATPEDS value displaying mask

2.3 Features and Functions

Let's point out some special features and functions of ATPEDS for getting a better overview.

2.3.1 Measured values and access

Measured variables are well-structured in a hierarchical system:

- power plant
- observed object
- measured type
- time dimension

Access is granted based on this system or by so-called list groups, which are freely definable sets of measured variables.

2.3.2 Security and safety

Data values of power plants are in any case highly sensitive. Therefore ATPEDS takes care of data security and safety. Users of ATPEDS belong to different user roles, which have well defined access rights to single measurement variables, reports and display masks.

Additionally each user is member of one of five access groups: administrator, working area administrator, operator, writer - may only insert values -, reader - only read access to values.

Each change of a measurement value is recorded; a list of such changes is displayed on demand, answering the questions who, when, what, why.

If values are proofed correct, they can be signed and are checked as unchangeable.

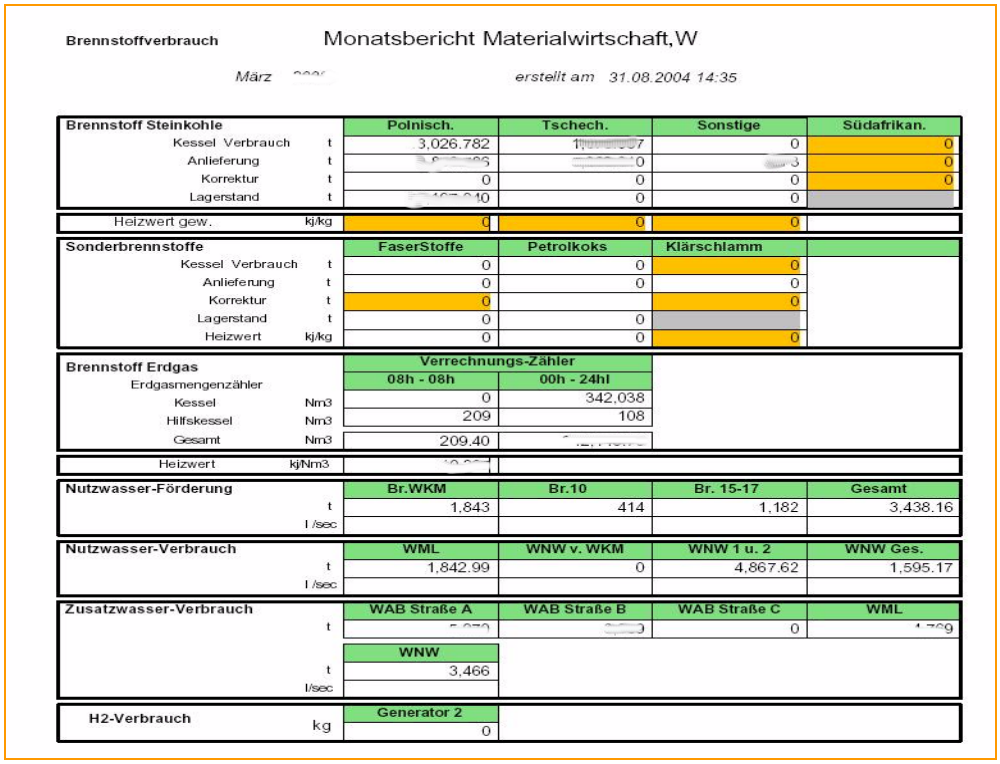
2.3.3 Formula Module

Using freely definable formulas and procedures new and changed values are automatically connected to new data series: algebraic computations as well as sums or stock values.

Users, which have the respective access rights, may create new formulas or change old ones. If one value changes or a new one is entered, dependent values will be created automatically. This is performed by using data base triggers.

Formulas are implemented as PL/SQL stored procedures or as Java stored procedures directly in the data base.

The formula module is the base and backbone for all computations around the CO_2 certificates computations.



Brennstoffverbrauch — Monatsbericht Materialwirtschaft,W

März [illegible] — erstellt am 31.08.2004 14:35

Brennstoff Steinkohle		Polnisch.	Tschech.	Sonstige	Südafrikan.
Kessel Verbrauch	t	3,026.782	1[illegible]7	0	0
Anlieferung	t	[illegible]	[illegible]0	[illegible]3	0
Korrektur	t	0	0	0	0
Lagerstand	t	[illegible]10	0	0	
Heizwert gew.	kj/kg	0	0	0	

Sonderbrennstoffe		FaserStoffe	Petrolkoks	Klärschlamm
Kessel Verbrauch	t	0	0	0
Anlieferung	t	0	0	0
Korrektur	t	0		0
Lagerstand	t	0	0	
Heizwert	kj/kg	0	0	0

Brennstoff Erdgas		Verrechnungs-Zähler	
Erdgasmengenzähler		08h - 08h	00h - 24hl
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Hilfskessel	Nm3	209	108
Gesamt	Nm3	209.40	[illegible]
Heizwert	kj/Nm3	[illegible]	

Nutzwasser-Förderung		Br.WKM	Br.10	Br. 15-17	Gesamt
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Nutzwasser-Verbrauch		WML	WNW v. WKM	WNW 1 u. 2	WNW Ges.
	t	1,842.99	0	4,867.62	1,595.17
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Zusatzwasser-Verbrauch		WAB Straße A	WAB Straße B	WAB Straße C	WML
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		WNW
	t	3,466
	l/sec	

H2-Verbrauch		Generator 2
	kg	0

Figure 4 Report for material in a power plant

2.3.4 Evaluation And Graphics

The evaluation of data contains statistics and data aggregation – paying special attention to the needs of the energy sector; additionally graphics, exports. Reports are produced using Oracle Reports (sample in Figure 4) and MS-Excel spread sheets.

A special viewer – implemented as a Java bean - allows for the user-defined displaying of any measured value in a graphic of two times two small views, e.g. for getting a fast overview of produced energy, contracted energy and produced emissions.

Figure 5 shows a typical layout scheme of a power plant. The values are updated every five minutes.

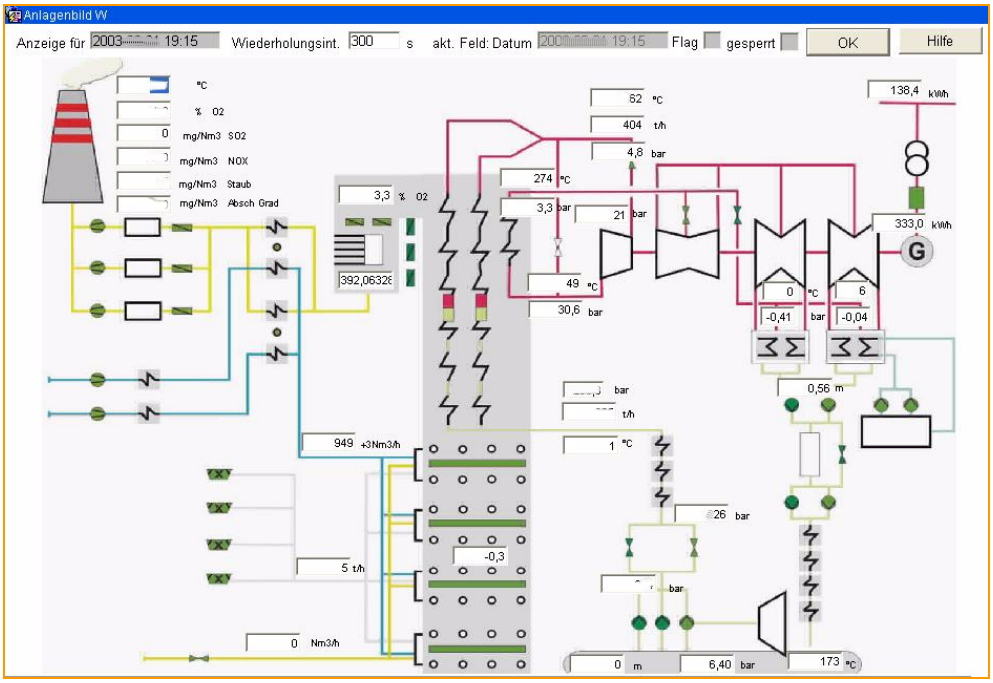

Figure 5 Layout scheme of a power plant with just-in-time values.

3. Computing CO_2 emissions

The computation of the CO_2 emissions is based on the amount of the consumed primary energy and different parameters of fuel, coal and gas. These parameters are first analyzed in laboratories of the plant owner and later on must be analyzed in certified laboratories.

The parameters of the plants' laboratories generally differ only very little from the parameters of the public, certified laboratories. Therefore the first ones can be used for the computations of the emission for getting the current emission and then the current amount of available certificates.

With a delay of three to four weeks the official data values arrive, which will then be used for the new and lasting computations.

The computation itself uses

- the cross caloric value
- the carbon content
- the oxidation factors

for finally getting the amount of emission.

Embedding the CO_2 monitoring system into a data information system has at least the following advantages against a "stand alone" solution:

- The data values need not be imported by hand, but are automatically transferred to the data base.
- The data values arriving in the system on different ways (see 2.1) are already verified by the responsible person within the power plant.

- You can get daily accurate evaluations, e.g. the number of CO_2 certificates in stock, for decisions on the use of the plant.

4. Conclusions

The reduction of CO_2 is not only an obligation for countries, but since the starting of emission trading "cap and trade" as well an important economical aspect for plant owners.

This importance comes clearer if one takes into account, that

- the penalty payments per ton CO_2 increase dramatically by 2008 and
- the prices for certificates are now (February 2006) as high as € 27,50 - and will increase continuously (costs of the Kyoto protocol: Viguier 2003)

These facts make it necessary to use state-of-the-art products, based on current techniques of informatics, for collecting all the relevant data values, aggregate and evaluate them.

Extendibility and distributibility are reached best by using data bases as backbone and web-based applications as front end.

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