

Energy on-line Management through Internet and a specialized Ontological Information System

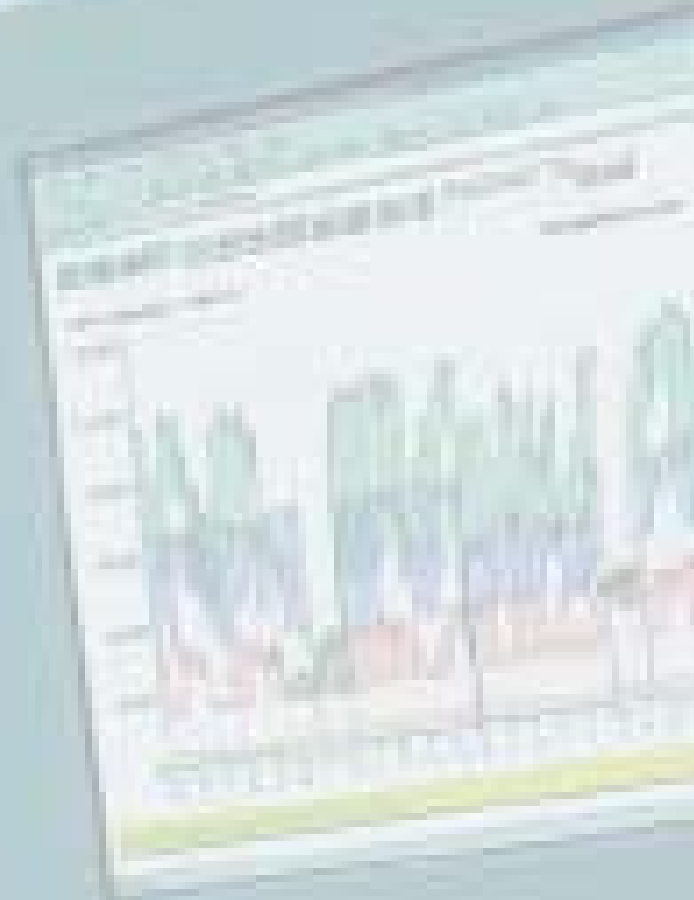
Web based Energy Management

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E.M.I.R. System

Energy Knowledge Management

- Ontology based data management
- AMR based on Wireless Networks and ADSL-based VPNs
- Integrated Knowledge Management
- Cross correlations & time-variant Energy Management
- Decision Support System and variable Pricing Methodology
- Energy Data warehouse for energy transactions
- Web based Energy Search Machine for dedicated Customer profiles
- On-line Energy Stock Market
- **Autonomous web-based broker for energy-based transactions**

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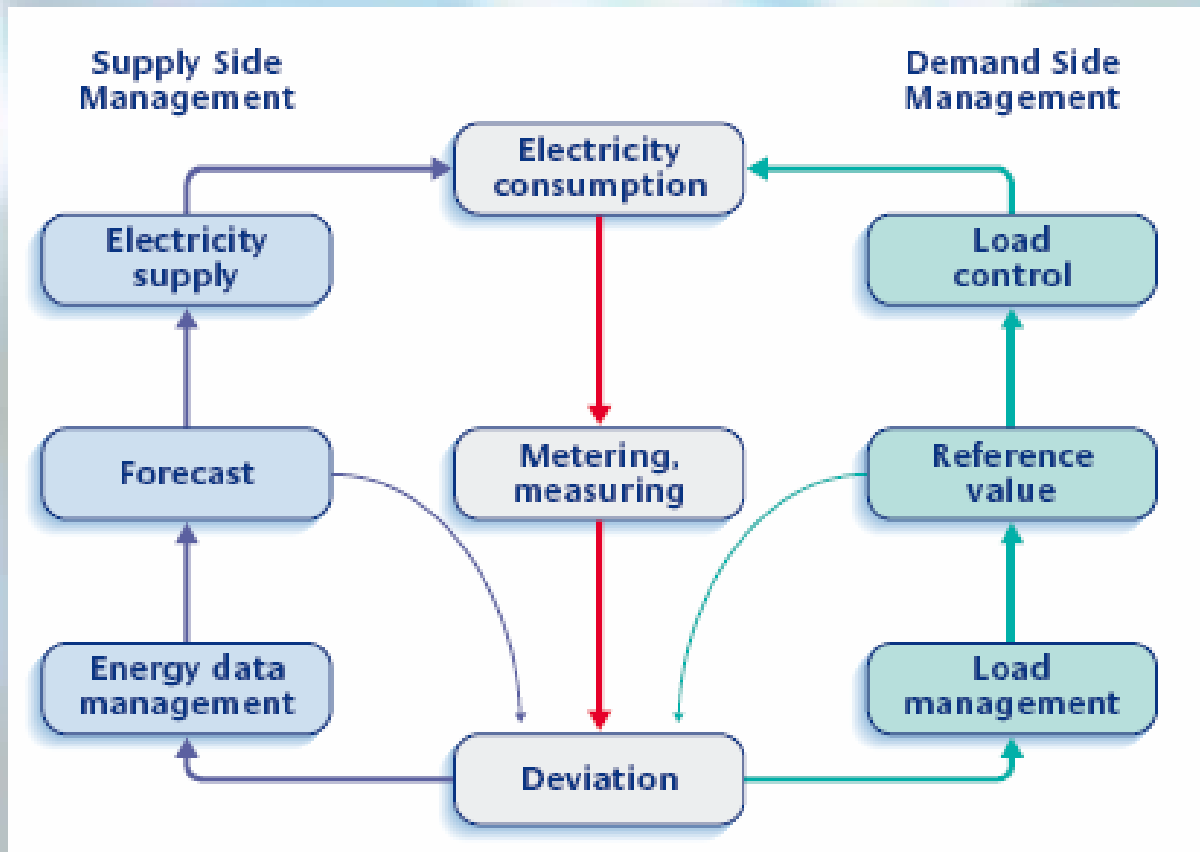
Bi-directional Energy Management

- Web-based System for **Energy Suppliers** to analyze and store energy information from various consumers
- Web based System for **Energy Consumers** to analyze their loads
- Bi-directional Energy Information System based on a simple Portal
- Bi-directional Energy Decision Support System
- Autonomous web-based Energy profiling of ad-hoc Customers
- System for on-line Peak Control during Summer days
- Control System of Energy Customers and variable Pricing

E.M.I.R. System

Bi-directional Energy Control

- Closed loop of Supplier vs Consumer



E.M.I.R. System

Basic Energy Modeling

- **Load Elasticity** Demand to be completely inelastic (i.e. independent of market clearing price)
- **Load Seasonality** Seasonality is a major driver for electricity demand observing seasonality over the daily, weekly, and yearly cycles
- **Load Mean reversion** Temporary spikes in electricity demand, often induced by extreme weather conditions. However, these spikes are not sustainable and demand reverts back to normal levels within a few days, hours
- **Stochastic growth** Growth in electricity demand is driven in part by trends in the overall economy.

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Basic Energy Equations

The typical load vector L_D , comprised of various daily load vectors μ_m can be described

$$L_D = \mu_m^L + \sum_{i=1}^j w_d^{Li} v_m^{Li}$$

where μ_m and v_m are deterministic parameters and w_d is a daily stochastic process.

A monthly [24x1] vector v_{Lm} is used to describe load behaviour, reducing the load equation to

$$L_D = \mu_m^L + w_d^L v_m^L$$

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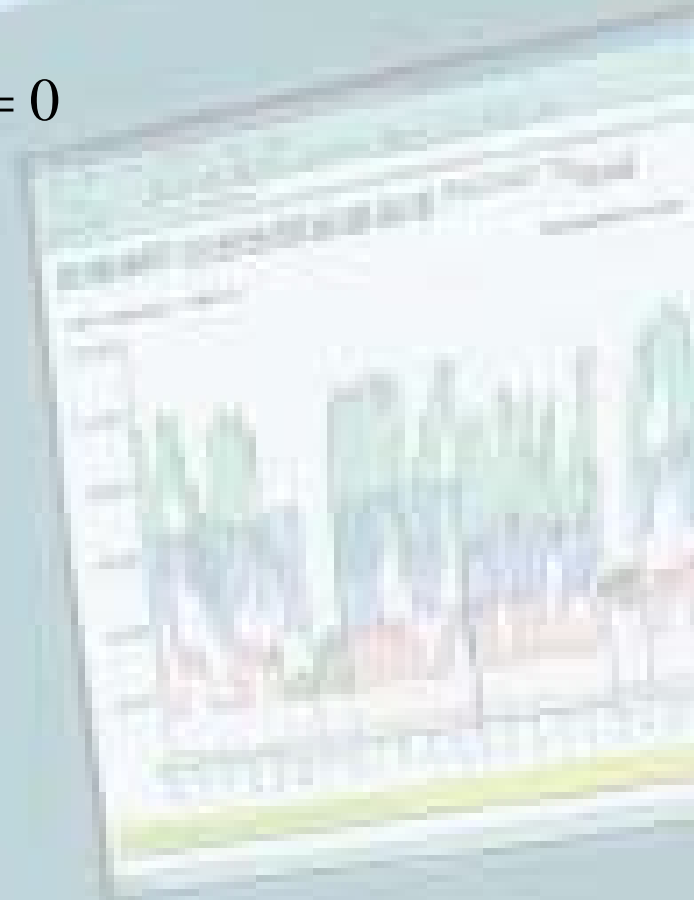
Energy Web-based Optimization

The basic Energy Objective function used (Energy Equilibrium Function)

$$\sum_{j=1}^n (Q_j - L_{\Delta} - L_E) * SMP + \sum_{i=1}^m (Q_i^a - L_i^a) * SMP = 0$$

$$\left[Q_i \propto \sum_{i=1}^k W_n^k \right] \propto e_r$$

Where Matrix **W** represents closed contracts between Suppliers and Consumers and **e** is a multidimensional stochastic vector



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Energy Customer Clustering

- Daily load curve indices has been proposed
- Coefficient $a = P_{min}/P_{max}$
- Fill-up coefficient $p = P_{av}/P_{max}$
- Modulation coefficient at peak hours $MC_{ph} = P_{av.,ph}/P_{av}$

P_{min} is the minimum power demand of the representative day,

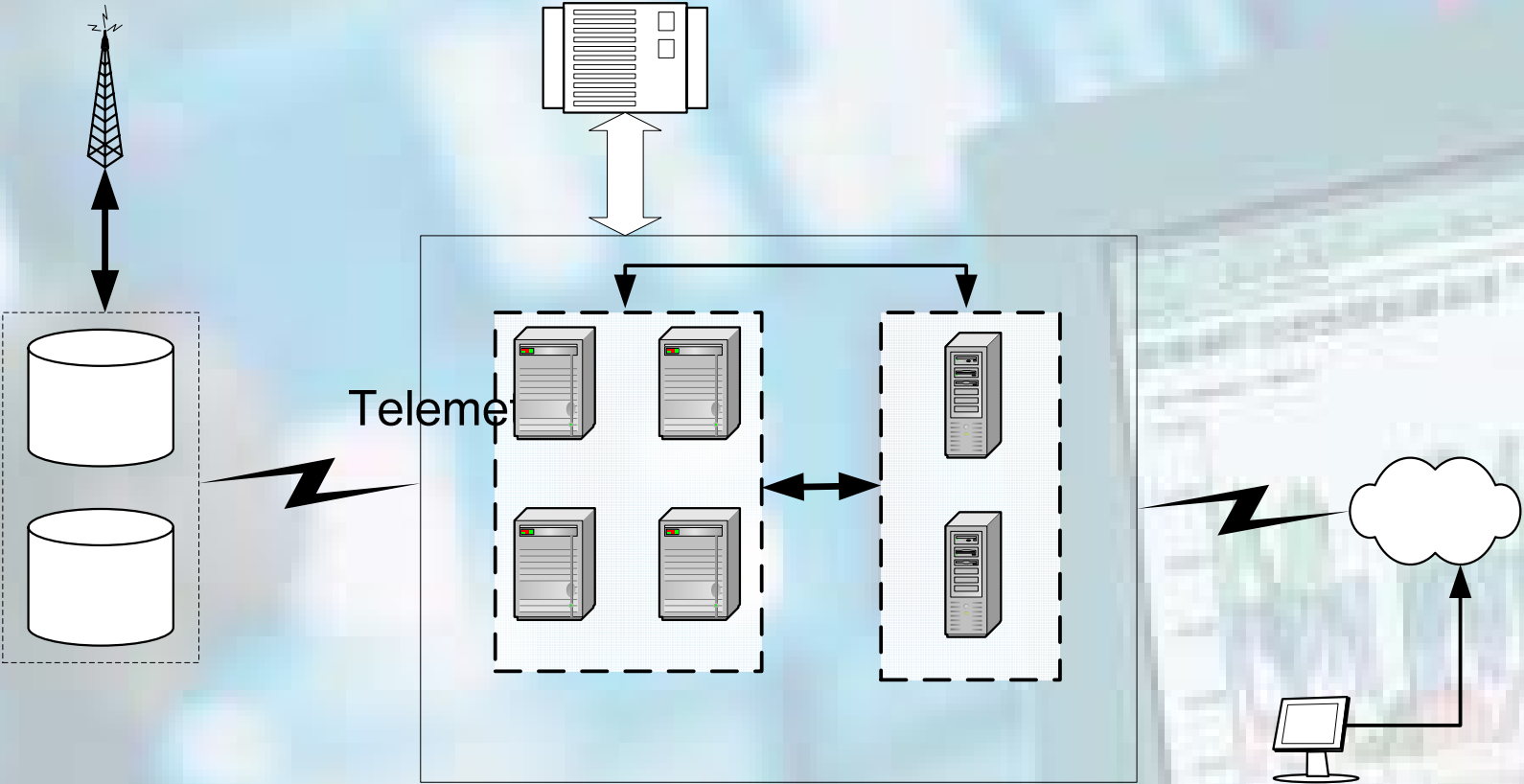
P_{max} is the maximum power demand,

P_{av} is the av. power demand, based on the ratio of the electricity consumption

P_{av.ph} is the average power demand during daily peak hours.

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Cluster Grid



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Address: <http://fermat.medialab.ntua.gr/emir/>

EMIR ROLAP Reporting - Microsoft Internet Explorer

DYNAMICALLY GENERATED REPORT by using on-line EMIR Decision Support Systems

Report Criterion : Reporting month of March - 2005

Report No : 2006_5_3_18_0_
Generated Date : 03-May-2006
Reporting Date : 4th of March
Reporting Month : March
Reporting Generated by : EMIR System (C)
Reporting Year : 2005
See report : [Click to see XML report](#)

Graphic Analysis

Total Daily Load

Total Daily load

The average Load over the day is : 6165.38 MWh and the STD : 895.481

1st Hour (MWh)	
Min	4630
Max	5830
Mean	5074.25

2nd Hour (MWh)	
Min	6321
Max	6927
Mean	6723.5

3rd Hour (MWh)	
Min	5913
Max	7544
Mean	6698.38

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EMIR ROLAP Reporting - Microsoft Internet Explorer

3D Cluster per month

Load (MWh)

Month Days

Hours per day

The above graph represent a 3D figure representation of the Load (MWh), the System Marginal Price (EMWh) and the days of the specific month.

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3D Load Cluster per month

The above graph represent a 3D figure representation of the Load (MWh), the System Marginal Price (€/MWh) and the days of the specific month.

2D Scatter by month

The above graph represent a K-means Clustering Scatter Diagram of the Load (MWh), the System Marginal Price (€/MWh). The algorithm has used 3 distinct clusters shown in Blue.

3D SMP Cluster per month

The above graph represent a 3D figure representation of the SMP (€/MWh), the System Marginal Price (€/MWh) and the days of the specific month.

Optimal Profit Scatter

The above graph represent a 2D representation of the Best Days and Hours where the profit margin is optimal ($SMP > \text{mean}(SMP)$ and $\text{Load} < \text{mean}(\text{Load})$).

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Conclusions

- Better on-line management of total energy usage
- Get details about the amount and timing of your energy use, so you can adjust accordingly and save money
- Advanced meter data can be stored and used to compare costs between competing utilities and to arrange for bulk-rate purchasing
- Identify and implement operational strategies to control load factor, peak load requirements and reduce energy waste
- Understand and improve consumption Clustering and Statistical patterns
- Measure and verify anticipated energy savings
- Secure a better variable **cross-correlated** pricing from the retail energy markets
- Highlight anomalies in electric consumption

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Conclusions

- Identify and assess on a real time basis the fiscal impact of the energy consumption
- Advanced notification via email of a higher peak demand being set
- Energy suppliers can acquire faster data enabling proactive energy management
They can immediately turn this data into valuable knowledge for them and their customers and offer improved services to their commercial and industrial clients
- Track in real time usage and load. Compare that to what has been scheduled and initiate any localized demand reduction during high market prices
- Manage peaks efficiently to avoid spot market energy purchases
- Reduce and limit the risk out of the energy business.
- Reduce the risks in a volatile energy market.

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