MARKET PLATFORM FOR REAL TIME EFFICIENCY OPTIMISATION IN ENERGY DISTRIBUTION

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ABSTRACT

*The objective of the EU-Commission for efficient use of energy concerning the growing dependence of the member states from external resources and primary energy carrier and the increasing decentralisation of the federal supply systems especially for electricity on the basis of rising amount of feed in by renewable or decentralized sources requires new concepts for coordination between supply and demand. This paper describes a concept for a market-oriented efficiency optimisation and service platform for electricity systems by using a consistent communication infrastructure to exchange necessary data, the project **I**ntegral **R**esource **O**ptimisation **N**etwork (IRON).*
The future needed, higher requirements for communication will be covered by the new infrastructure and the basis for utilisation of the unused, potential and virtual energy storages will be created. Without influencing the behaviour of the user directly and promoted by economic incentives, the energy consumption will be adapted to the existing resources of supply by using the available, virtual energy storages via a market platform. Occurring, expensive spikes of consumption can be reduced, and the partner of the IRON market concept can share the thereby resulting economisation of costs.
In this way the market platform leads to a more efficient use and contributes to reliability and stability of the electricity system.

Index Terms – Energy Systems, Automation, Load Management, Demand Side Management

I. INTRODUCTION

Communication between producers and consumers becomes more interesting as on the one hand the number of small, peripheral producers increase and on the other hand the end of capacity limit of conventional production facilities and of the transport and distribution power networks will be expected. Aim of the project IRON [1] ("Integral Resource Optimization Network") is to optimize the electricity supply systems by supporting an information exchange between the participants of the electricity supply system available.

II DEVELOPMENT OF BUSSINESSIDEAS

Based on the legal general conditions of the liberalized market in Austria [2] and regarding to the technical and organizational requirements of an electricity supply system a few market models were developed and checked for a perspective for an economic implementation.

Market model „Variable Price of Electricity"

Currently a customer for electricity in Austria pays on the one hand a fee for system utilisation prescribed by regulation authority and on the other hand a price for supplied electricity particularly agreed with a supplier. The electricity supplier, selected by the client, offers this price, commonly as a standard price, for a longer period. Anyway the price is independent of the moment of delivery for a short time. However the energy supplier pays a different price for his supply (or for a part of them) to his trader or at the spot market exchange for every hour, which depends on supply and demand on the market. Therefore energy is less expensive at times with fewer demands (at night and at weekend), more expensive at times with a higher demand (at midday and at evening). The basic idea of this model is to provide incentives to the customer to change his consumption behaviour by using the virtual storages by his units to reduce the consumption at times with high price and catch up on times with a low price.
A market platform will be provided to the customer by IRON, which helps to change the consumption behaviour through economic incentives. Corresponding to the IRON market concept, a variable electricity price is offered to the customer by the electricity supplier that incites to switch devices with storages, without affecting user requests or urgent operating conditions of the devices unallowable. This required characteristic is given by thermal uses predominantly. [3]
In the following the market model "Variable price of electricity" will be illustrated by an average consumption characteristic of a household. For all involved clients the current time dependent price of electricity is made available on the market platform. Now the customers are able to choose an individual price-level at which by exceeding the devices, released for operating with IRON market platform, will be switched automatically. Drops the price of electricity behind the chosen price level again, the devices will be switched again by the market platform. The energy, not purchased at a period of high prices, can be obtained at periods of lower price opportunely if it is necessary. The customer is able to parameterise the necessary conditions for controlling appropriate to his individual demand by the Internet. In this context the functional connection for an

average day load-profile of a customer is demonstrated in Figure 1. It is distinguishable that the energy demand is reduced while the energy price is higher as the switching threshold. If the price falls below the switching threshold the not supplied energy can be obtained as the required energy demand is covered.

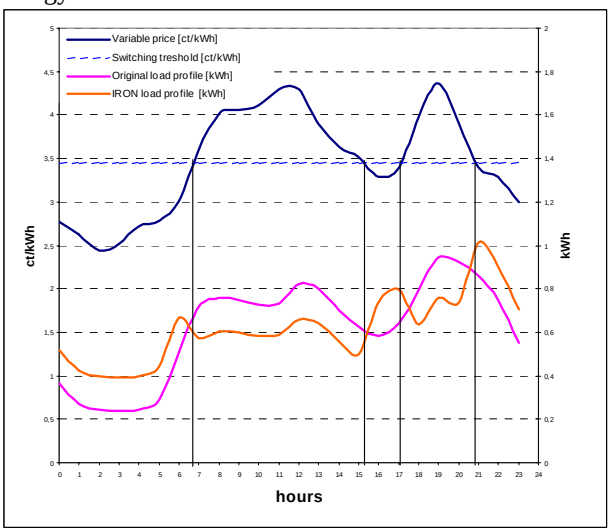

Figure 1: Energy demand modification on the example of a household (Annually energy demand 5000 kWh, load shifting potential 20%)

Market model Imbalance power (energy)

To obtain the operability in an electrical supply network system the balance between generation and consumption must be secured every time. Balance distortions cause immediately changes of the supply frequency that endangers the stable network operation.

To prevent inadmissible frequency deviations the observance of the rules prepared by UCTE [4] has been agreed by Transmission system operators (TSOs). According to these rules only slightly deviations of the supply frequency are acceptable. Therewith the operation of the electrical units of the customers can performed with no limitation in the agreed extent, currently the energy balance is performed by controlling of qualified power stations (river power plants, storage power plants). The provision of imbalance energy is classified into three categories depending on chronological adjusted kinds of application to meet different duties and requirements:

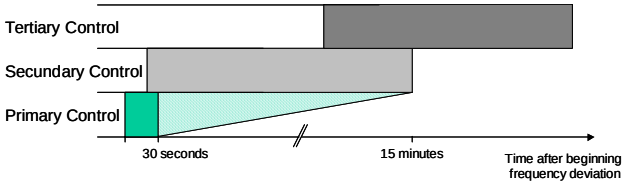

Figure 2: Imbalance energy chronological adjusted according to meet different duties and requirements

In the IRON market concept providing of switchable loads and as far available distributed switchable feed in electricity as well performs the implementation of the regulation requirements.

Corresponding to the UCTE rules primary control is activated by frequency deviation exclusively. If the frequency deviation exceeds ±20 mHz of the nominal value of 50Hz, the IRON market system must be able to operate according to the requirements (within 30 sec.), that means to connect or disconnect loads/suppliers to the supply network system.

The first condition to operate a device of the customer to perform primary control functions is to allocate the device to the IRON market system by the customer as switchable. For all switchable devices the IRON system has acknowledgement concerning the appliance operating condition to calculate whether the device can used for providing imbalance power (energy). On the basis of the received information the IRON market system has to calculate and to prescribe the expected operation to the participating devices in case of frequency deviations.

If in the Local IRON-Unit a frequency deviation in a range of 50Hz ± (20 – 180) mHz is detected, the appliance will be switched on or off corresponding to the precondition submitted by the Central IRON Unit. The amount of the provided primary control power will be measured and documented within the Central IRON Unit to fulfil agreements with TSO. The economic incentive for the customer for taking part in the IRON market is the payment of the provided imbalance power (energy).

Market model „Eco-energy (electricity)“

The possibility to purchase renewable electricity produced by an eco power station is given to a customer by the market rules.

The incentive to choose this model is on the one hand to purchase sustainable generated clean energy and on the other hand aimed to push the local energy supply. Currently an economic incentive over the prices of eco-energy isn't presentable, because the market price for energy is lower as the publicly sponsored price for clean energy generally. At this reason further economic analysis won't be performed for this model.

Market model „Transport costs optimisation“

The energy area of supply was separated of the network area by the deregulation of the electricity market ("Unbundling") in 19.2.1999 in Austria.

In the member states of the EU, and Austria too, an established regulator evaluates the price for system utilisation by a special developed procedure. This procedures is intended to prepare and to approve the costs of the separate network (voltage) levels as far as relevant. Then the network tariffs are calculated by relating the accepted costs to the amounts of energy and power transferred through the particular network levels. Therefore

this procedure results in transferring cost of higher to lower network (voltage) levels. The basis for the calculation of the network tariffs is formed by the transferred costs of the above and the costs of the respective network level. As rolling costs of the separate network levels by amounts (energy or power), an economic aspect can only be initialized by changing the costs of an individual network level or otherwise per a modification by the transported amounts.
To affect the tariffs in an individual network level by generation plants (eco-energy or conventional local power stations) is only possible as far as the generation plants takes on transport function of the network. This function can only be taken by the power stations when the transport function is durable secured. Whenever a sustainable release of the power lines is given by power stations, calculations have shown, that a local supply affects the cost basis of one or more network levels. Therefore the economic aspect acts reduced for the individual unit because the economy of the ascertainment of the network tariffs benefits all customers at a network level. A rearrangement of the situation requires an adjustment of the evaluation for the system utilisation price in direction to create tariff structures for small areas. But today no political majority is expected for such development.

III ANAYSIS OF BUSINESS IDEAS

Technical Feasibility

The provided IT- system is able to allocate the electric units depending on the one hand at their individual parameterisation by the customers and otherwise on the specific appearing requirements by the IRON market system.
To keep the operating potential active, the IRON market system is able to broadcast the required data like energy price, frequency deviation, measured values and operating condition between the Local and the Central IRON Unit.
Switching demands are executed for every device separately. Further details on the technical requirements for the IRON infrastructure have already been examined in [5] and [6].
The parameterisation of the devices by the customer is carried out at a homepage on the Internet and also special requirements of an appliance can be advertised and devices can be locked or allocated depending on demand. It isn't cost effective to built a new infrastructure for the IRON market system, therefore an utilisation of available systems will be aspired.
The handling of all activities in this context allows for example the IEM (Intelligent Energy Management) of LINZ STROM GmbH, realized over PLC (Power Line Communication).

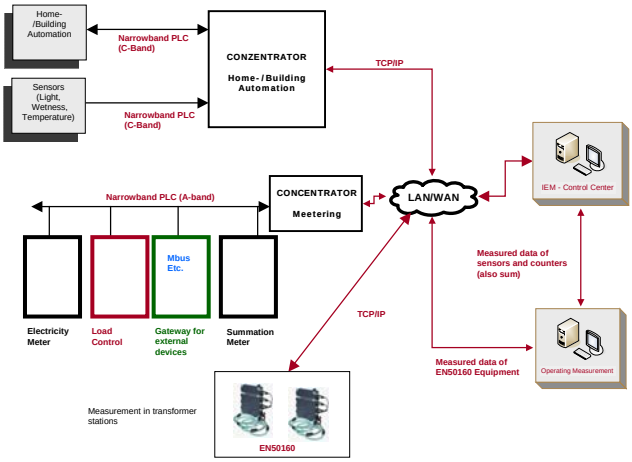

Figure 3: Infrastructure of the Intelligent Energy Management of LINZ STROM GmbH

Legal Feasibility

In Austria the effective legal position and effective market rules principally don't hamper an implementation of the IRON project. In the liberalized market in Austria it is common to rule rights and duties between market participants and customers by contracts.
The chosen IRON market model determines the extent of the individual contract. Basically no contractual problem is expected within IRON market models based on energy delivery to customers at measured load profiles. In the IRON Concept a supply of customers on the basis of standardized load profiles wouldn't be possible, so it is required to make necessary adjustments. It is eminently important to distinguish the economic incentive functions in the IRON contracts to assist the change the standard to the IRON contract.

Economic Assessment

For the market models „variable price of electricity" and „balancing power (energy)" can be shown that moderate economic incentives exists.
For our example in Figure 1 yearly savings of 5% - 6% according to the actual prices are possible. For customers with small consumption the economic incentive is low; quite contrary for a higher consumption an economic support for realisation of IRON market models subsists. The IRON market model for balancing energy (primary control) shows the best view for realisation because the request of the switching duration is relatively short (15 min) and therefore the degradation of service levels of the devices is slight. Important for realisation of the IRON market model is to take it into consideration during the actual establishment of the new market for primary control in Austria.
The extension of the market model for primary control to secondary or tertiary control is principally possible, but it is necessary to implement the request information from the TSO into the market system. Considering a convenient

conception of the communication system, the chronological standards should be soluble. A longer regulation period causes an unacceptable degradation of service levels. This should be avoided by optimising the switching periods of devices.
These positive views are not correct for the market models „Eco energy (electricity)“ and „Transport costs optimisation“, but the actual situation can change immediately on changing common conditions.

IV. BUSSINESS PROCEDURES

The business concept of an IRON market platform comprises the necessary main and detail procedures. On the basis of these procedures a business case calculation model was prepared and many business case calculations on different business concepts were carried out.

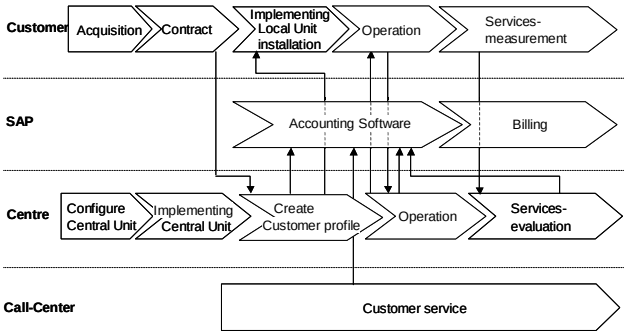

Figure 4: Overview IRON Procedures

The summary of the results of the business calculation is shown in section Economic Assessment and in section V Business Calculation.
In Figure 4 an overview of the main procedures is shown.

V. BUSINESS CALCULATION

As a result of the business calculation can be shown that for an economic realisation of the IRON model it is very important to develop and to use efficient IT- and communication infrastructure and to operate the business on efficient organisation.
It can be shown that a business on the basis of own infrastructure and organisation only for the IRON business model actual is not economic.
A positive result can be expected in the case of using existing structures or as add on for new systems of different commercial business.

VI. RESULTS

During IRON project different concepts for a market and service oriented platform for optimisation of electrical networks were developed. The necessary information will be distributed by using a real time communication infrastructure.
It can be shown that for few concepts actual economical incentives exists. For other business ideas no positive results can be expected currently but future changes of common conditions may change the situation.
Standards for the necessary IT- and communication infrastructure were developed and prototypes for Local and Central IRON Units were produced.
The technical and organisational requests for the economical roll out were developed. As a next step we will test our theoretical results during a pilot project phase.

VII. ACKNOWLEDGMENT

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