TECHNICAL REPORT

IEC TR 62195

First edition
2000-04

Power system control and associated communications –
Deregulated energy market communications

Conduite des systèmes de puissance et communications associées –
Communications dans un marché d'énergie déréglementé

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POWER SYSTEM CONTROL AND ASSOCIATED COMMUNICATIONS – DEREGULATED ENERGY MARKET COMMUNICATIONS

FOREWORD

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Technical reports do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful by the maintenance team.

IEC 62195, which is a technical report, has been prepared by technical committee 57: Power system control and associated communications

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/434/Q	57/457/RQ

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

This document which is purely informative is not to be regarded as an International Standard.

POWER SYSTEM CONTROL AND ASSOCIATED COMMUNICATIONS – DEREGULATED ENERGY MARKET COMMUNICATIONS

0 Scope

This technical report deals with electronic communication in deregulated markets.

0.1 Reference documents

IEC 61334 (all parts) *Distribution automation using distribution line carrier systems*

IEC 60870-6 (series) *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations*

1 Introduction

1.1 Task defined by TC 57

The task of the AHWG05 is to identify requirements and functional needs for communications in deregulated markets. In so doing, a clear distinction should be made between communications for control of energy systems and communications for the market. On the other hand, the interrelation and interworking between these separate fields have to be addressed.

The subject should include, but not be restricted to, the 'transport capacity market', the 'energy spotmarket', 'bilateral trades', 'accounting and billing' and general communication services such as electronic mail.

For the next TC 57 session (Lucerne) a report should be prepared including a proposal for a scope and a work programme.

In response to concerns on the objectives of this ad hoc group the following statement was also made:

The goal of the ad hoc working group is not (yet) to elaborate a standard, but to analyse whether and where a standard should be elaborated. It is not the intention of TC 57 to become involved in political issues nor to advise utilities how to organize the competition in the electricity market.'

1.2 Background

There had been some preliminary discussions on electricity trading within the UNIPEDE NORMICT group, particularly concerning trading across borders. This issue was subsequently raised at the TC 57 Plenary in Dresden in September 1996 where it was decided that, if there is need for standardization of communication protocols concerned with deregulated electricity markets, then this would fall within the scope of TC 57. A meeting was called at Dresden to discuss how to proceed and a possible scope. The response was greater than expected, but no conclusion was reached regarding scope. The Plenary then decided to create AHWG05 to study the matter.

AHWG05 has since studied existing and proposed solutions to deregulation in order to learn what the requirements should be. In this respect the initial approach has been 'bottom up'. In addition, the group has further refined its scope.

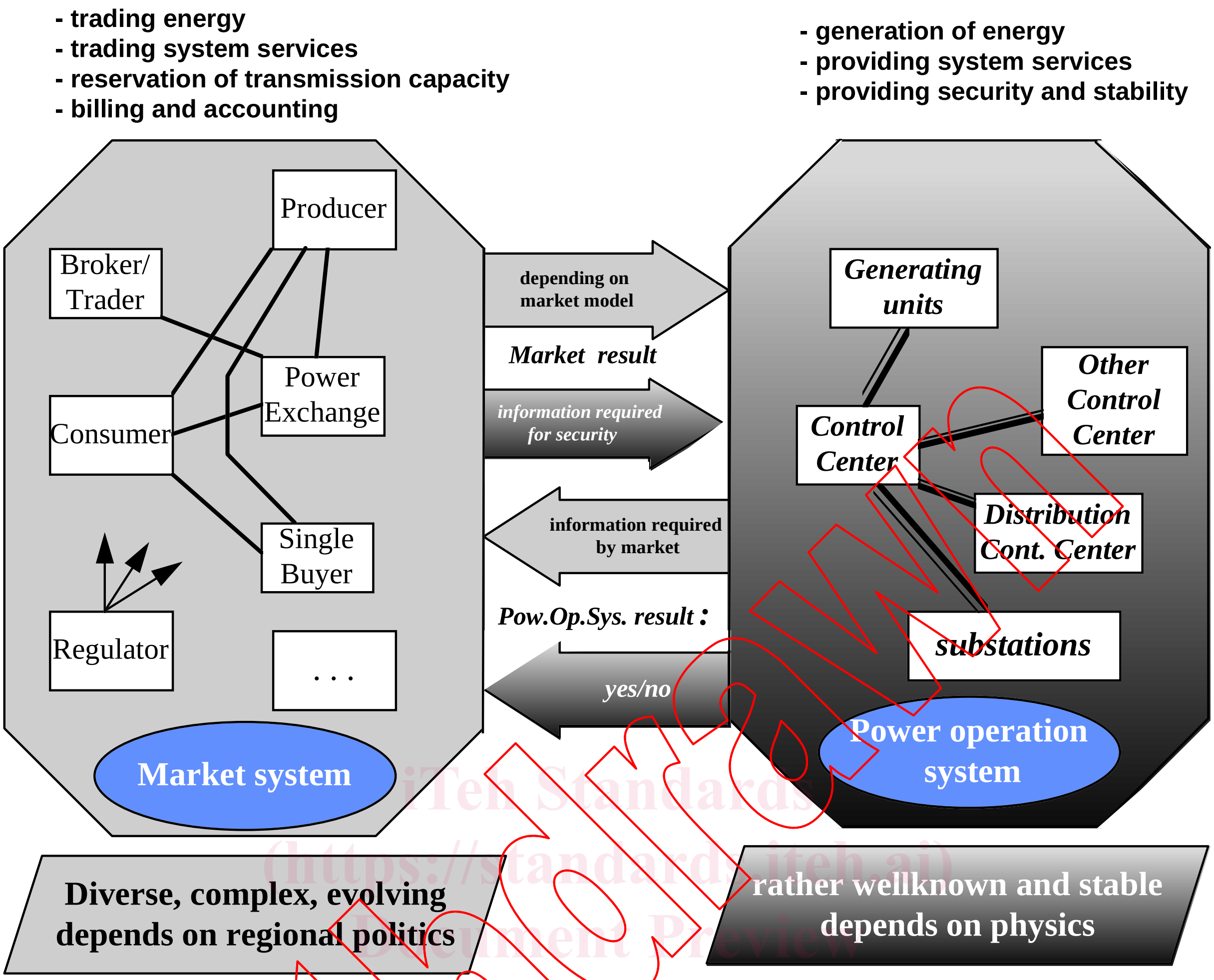

Figure 1 – Market system and power operation system

Firstly, a distinction has to be made between market and power operation communication systems. Figure 1 shows the main characteristics of these two worlds and their interfaces. Of course, the actors (boxes) and transactions (lines) have to be taken as an illustration and not as a reliable description of reality, that is far more complex.

The left-to-right arrows represent the information provided by the market to the power operation. One arrow (coloured in plain grey) is determined by regional organization (grid code, market organization, etc.). The other arrow (coloured in shaded grey) is the information the market has to provide to the ISO(Independent System Operators) in order to secure power system operation.

The right to left arrows represent the information provided to the market by power operation. The colouring code is similar to the above, but the first arrow provides data which depends on regional organization (metering, etc.) and the second that which is necessary for security.

An actual example of this model, representing the system in England and Wales, is given in annex D.

1.3 Quadrant diagram

The following diagram (figure 2) completes the former by a second classification: transactions and protocols. That leads to the structure with four quadrants:

Quadrant 1: Market information system (market applications and actors and transactions between them)

Quadrant 2: Available protocols for market transactions.

Quadrant 3: Technical information system (power system operation applications transactions)

Quadrant 4: Available protocols for technical transactions

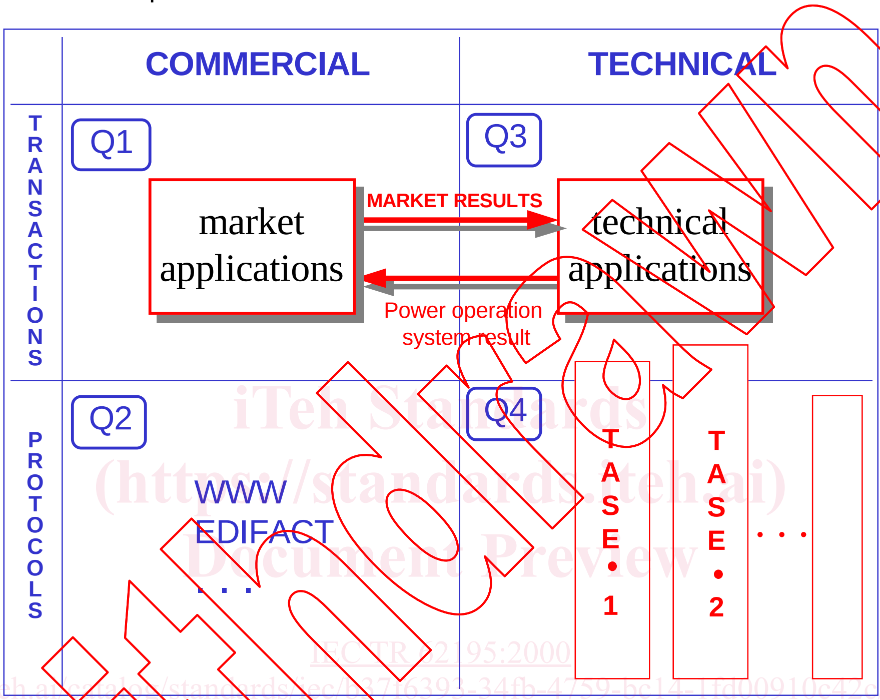

Figure 2 – Quadrant diagram

2 Transactions (quadrants 1and 3)

In deregulated energy markets, the notion of transaction model is important. This includes the actors, the transactions itself and the exchanged objects involved. With deregulation the transaction effort increases significantly in respect to integrated utilities because there are more interfaces between now independent functions and actors. It should be the aim of any standardization to decrease the transaction effort by use of advanced ICT (Information and Communication Technology). There are many examples of other markets that make extensive use of ICT. This report deals only with electronic communication interfaces. Standardization of these interfaces for more than one market would make these tools cheaper and new markets would benefit from the experiences of more advanced markets.

Transactions are basically split in this report into market transactions and technical (process) transactions. The process produces products as energy, transmission capacity with associated transmission schedule (firm or not firm) and interconnected system operation services (community services: generation and demand balance, transmission security, emergency preparedness, individual services: real power losses, energy imbalances, backup supply, load following) for the market. One-time integrated products of integrated utilities are now de-bundled into separate products and so billing and accounting becomes an issue from the reading of the meters, collection of accounting data, settlement of accounts to the bill. In some market models (UK) competition has been introduced into the supply and reading of meters.

Accounting becomes even more complicated because energy exchanges in deregulated markets become third party (customer) driven and may cross multiple control areas affording a whole chain of settlement of accounts (transactions are paid on the basis of contracts and differences between scheduled transactions and physical delivery).

Each market has its own regulatory framework to ensure non-discriminatory open access of end customers/load aggregators/generators/traders/etc., to the network to allow free trading of energy. The task of the process in full deregulated markets is limited to implementing the schedules decided by the market (generation and transmission) and to provide interconnected system operation services, and security and stability of system operation according to the laws of physics with paid and predefined quality of products.

In deregulated markets, many actors have two faces and therefore appear on the process side as well as on the market side. On the process side, the actors are concerned with the production process and on the market side with offering and trading of the products. Some of these products such as generation and demand balance, for example, cannot be traded and are mandatory for the functioning of the power system. On the other hand, 'end customers', i.e. those who finally consume the energy, only appear on the market side.

Because in full deregulated markets, the market decides who is contracted to deliver how much and to whom, and also the price, the 'interface between market and process' mainly deals with giving the market decision (trading of energy, capacity, optional services) to the process and getting the answer of the process if the market decision can be put into operation. The answer in most cases can be simply 'yes or no', but it can also be associated with additional information such as system constraints and curtailments. Then it becomes clear that many traditional transactions such as scheduling of energy generation (self-committed generators) and scheduling of energy transmission (third-party driven) move to the market side and control the process, whereas the process side implements it physically or makes it possible. Within the market process, it is not simply a question as to whether the supply can match the demand; there is the possibility of an iterative loop where demand is altered depending on the cost of supply.

The actors of full deregulated markets are Power Exchange (PX, bidding of generation and load), Traders/Brokers, System Operators Transport and System Operators Distribution, Independent System Operators (ISO) separated legally from Generation and Transport Providers, Security Co-ordinators (see USA), Transmission Providers ('wires'), Generation Providers, Distribution Providers ('wires'), Suppliers (purchasing and selling energy to distribution customers) and End Customers of both transport and distribution. The definition and naming of actors as well the interaction between them may be different in different markets and depends, besides logic, also on politics, history, regulation, experience and culture. To make it even more complicated, deregulated markets never are established overnight and develop in course of time by experience. So some markets have a history of 10 and more years of deregulation development.

One characteristic of these evolving market structures is the movement of responsibility for certain activities from the "technical" to the "commercial" domain (from quadrant 3 to quadrant 1), which makes any future model very sensitive to market factors. The boundary between quadrants 1 and 3 depends heavily on the market structure and requires specific consideration and more detail for standardization. Some markets (current state of OASIS/TIS in USA) implemented a simple customer interface ignoring the rules of physics (contract path) and are changing now to a more sophisticated mapping of the market to the process (parallel power flow analysis computed by power distribution factors applied to so called flowgates) to reconcile the market with the process.

It is also important to note the level of transactions is related only to the number of active traders and the frequency of trading. However, on the continental scale, the market transaction effort is greater in markets with high load, large population and industrial density and geographical size if these markets are based on multiple energy systems (control areas or zones with balancing generation and load) sometimes with a hierarchical control structure.

A first inventory of transactions and their implementation in observed or projected deregulated energy markets is given by annex A. The aim was to give a first comparison of different markets. Please note that this inventory is probably not comprehensive, and that names may have different meanings from one market to another (see definitions in annex B).

2.1 Market transactions (quadrant 1)

This subclause addresses transactions within the commercial market environment, instead of the technical and engineering environment covered by quadrant 3. Transactions in quadrant 1 are based on two broad classes of market structure models:

physical bilateral contract model, and

power exchange for spot energy and ancillary services.

Most markets mix both structures. The EU models TPA (Third Party Access) / NTPA (Negotiated Third Party Access) and Single Buyer both belong, in respect to the results, to the physical bilateral contract model, whereas the Electricity Pool of England and Wales in the UK is a Power Pool model with power exchange (load forecast instead of load bidding). The open access rules of FERC in the USA are like TPA. Besides this, pure financial markets for futures (price hedging) exist which are out of the scope of this report. The same is true for so called contracts of differences.

The following examples of market transactions, which may not be complete, are given from observed markets.

(1) Market transactions of Physical Bilateral contracts are:

Contracting generation and auxiliary services (deals on paper)

Transmission capacity market

- Offer of transmission capacity
- Reservation of transmission capacity
- Splitting and aggregation of transmission capacity
- Re-sale of transmission capacity
- Accounting and billing

(2) Market transactions of Power Exchange are:

Power Exchange (both energy and auxiliary services)

- Bidding of generation and demand
- Result of bidding
- Settlement of accounts
- Billing and accounting of traded energy services

or

Power Pool

- Bidding of generation and forecast of demand
- Result of bidding (price)
- Settlement of accounts
- Billing and accounting of traded energy

2.2 Technical transactions (quadrant 3)

Technical transactions are exchanged between 'technical actors' (i.e. control centres, generation units, substations, etc.) for power system real time operation. It is assumed that 'real time' represents 'what is concerned with power system on line operation'. That might include some provisional information (e.g. short term production schedules) and *a posterior* data (post mortem archives, realized load curve, historic protection relays operation, etc.).

As an example, the following technical transactions frequently happen in power system operation:

- status signals and events (switching device positions, transformer tap changer positions, protection relays events, alarms, etc.) transmitted from substations to control centres;
- measurements (voltage, active power and reactive power, current, primary reserve, etc.) and counter values transmitted from substations and generation units to control centres;
- inter control centre communication within a utility and between interconnection utilities (topology, measurements of tie lines, counter values, energy transmission schedules between control zones, operator messages);
- area or local switch commands (breakers, transformer tap changers, load shedding equipment, etc.) from control centres to substations;
- instructions (set point commands) from control centres to generation units;
- power generation schedules (P = f(t)) from control centres to generation units (this is not true for self-committed generators, see 2.3);
- unit commitment from control centres to generation units (this is not true for self-committed generators, see 2.3);
- exchange of information on transmission schedules between control centres;
- ...

Process information is also exchanged between the transport network and transport network customers (end customers, generators, distribution networks) for the security of power system operation. These transactions are part of the technical information system.

2.3 Interface between market and technical information system (quadrant 1/3)

In addition to what is used today power system operators in deregulated markets will need additional information to cope with bilateral trade and power exchanges in the TPA (open third party access to the network) environment. Note that the actors of the process have two faces and here only the interface between the market and technical information systems is described.

The observation of deregulated electricity markets shows some general trends:

a) By spot market or bilateral trade, the market gives to the process a first draft of schedules ('who produces, where, when, for whom, how much over time'), with or without reservation of transmission capacity. Examples are:

Energy transmission scheduling

- Request of transmission schedule
  - After reservation of transmission capacity
  - Without reservation of transmission capacity (all-in-one)
- Confirmation of transmission schedule
- Meter readings
- Settlement of accounts
- Billing and accounting

Generation schedules

- Aggregated schedules for system operator
- Meter readings
- Settlement of accounts
- Billing and accounting.
- ...

b) The final decision to implement the schedules is up to the system operators after transmission capacity and security analysis. In case of network constraints, counter purchasing of production and splitting of markets can be done either by the ISO, any other operational authority, or the market itself. As an example, this information could be:

- Simply ‘yes’ or ‘no’
- Notifications of constraints by the system operator, curtailments in case of disturbed operations
- Information on subsequent operational requirements that may have an effect on the market in terms of costs
- Actual operation costs
- ...

3 Available protocols

This clause covers 'available' protocols. In this context 'available' is taken to mean a protocol which is either already being used in support of deregulated energy market communications, or is suitably defined as a 'paper' specification, preferably as a published standard.

3.1 Protocols available for market transactions (quadrant 2)

3.1.1 EDIFACT

EDIFACT is a standard created by the UN for exchanging structured data. UN/EDIFACT is being recognized as the single international standard for EDI. In document SB3/13/INF, IEC Sector Board 3 endorses this and makes recommendations to formalize this.

In Scandinavia, EDIEL is now the standard for **E**lectronic **D**ata **I**nterchange for the **EL**ectricity Market trading. The aim was to reduce the use of fax and manual interfaces. EDIEL makes use of the existing EDIFACT standard, which is structured like a table of data elements. The first implementation used X.400 messaging over X.25 channels. It has also been implemented over ISDN and TCP/IP. EDIEL can easily adapt to the SMTP protocol and Internet instead of X.400 and X.25.

EDIEL is implemented over both public and private networks and links all market participants with non real-time communications associated with the market. It is used for transactions such as bidding, billing and exchange of production schedules (next day) but not for more immediate operations such as secondary regulation which is done by telephone. Information providers also have access for the provision of bulletin boards (Dow Jones, Reuters, etc.) of energy prices.

3.1.2 WWW

WWW is a world-wide used Internet technology with a great future including commercial applications. Security and performance are critical issues and should be taken into account. WWW is a client / server technology and uses HTML, FTP, JAVA applets and e-mail. For clients, cheap or free browsers can be used which run on every PC providing a graphical user interface. WWW has no standardized message formats for applications (to be individually standardized).