

Framework for energy market communications —

Part 102: Energy market model example

ICS 33.200

National foreword

This Published Document reproduces verbatim IEC/TR 62325-102:2005. This standard, as part of the IEC 62325 series of standards, supersedes PD IEC TR 62195:2002, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

Summary of pages

This document comprises a front cover, an inside front cover, the IEC/TR title page, page 2 to 38, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 8 April 2005

© BSI 8 April 2005

ISBN 0 580 45758 3

TECHNICAL REPORT

IEC TR 62325-102

First edition
2005-02

Framework for energy market communications – Part 102: Energy market model example



Reference number
IEC/TR 62325-102:2005(E)

CONTENTS

INTRODUCTION.....	4
1 Scope	5
2 Normative references	5
2.1 Generic Open-edl standards	5
2.2 Sectorial Open-edl standards	5
3 Terms, definitions and abbreviations	6
3.1 Terms and definitions	6
3.2 Abbreviations	6
4 Market guide	6
4.1 General.....	6
4.2 Trading.....	7
4.3 Supply.....	7
4.4 Customer management.....	7
4.5 Scheduling and balancing	8
4.6 Metering.....	10
4.7 Settlement of accounts and billing.....	10
5 UMM market model.....	10
5.1 Business modelling workflow	10
5.2 Business requirement workflow	23
5.3 Analysis workflow	29
5.4 Design workflow	35
Figure 1 – Value chains and services in the energy market.....	7
Figure 2 – Structure of the Business Operations Map (BOM)	17
Figure 3 – Business areas.....	19
Figure 4 – Process areas of system operation	19
Figure 5 – Process areas of services.....	19
Figure 6 – Process areas of trade	19
Figure 7 – Use case system operation.....	20
Figure 8 – Use cases service	22
Figure 9 – Activity diagram planning process of scheduling.....	22
Figure 10 – Overall conceptual market activity diagram	24
Figure 11 – Use case system operation.....	26
Figure 12 – Business collaboration planning (scheduling)	28
Figure 13 – Activity diagram of the planning process (scheduling).....	29
Figure 14 – Business transaction activity diagram planning phase 1.....	31
Figure 15 – Business transaction activity diagram planning phase 2.....	33
Figure 16 – Business transaction activity diagram planning phase 3.....	34
Figure 17 – Conceptual class diagram of the schedule messages	35
Figure 18 – Class diagram of the schedule document	36
Figure 19 – Sequence diagram of the planning (scheduling) business process	37
Figure 20 – Sequence diagram of change of supplier.....	38

Table 1 – Methodology and model artefacts.....	11
Table 2 – Business reference model.....	12
Table 3 – Business area generation	12
Table 4 – Business area trading	13
Table 5 – Business area supply.....	13
Table 6 – Business area system operation	14
Table 7 – Business area distribution.....	15
Table 8 – Business area energy services	15
Table 9 – Identification of the process area planning	16
Table 10 – Identification of the process area operation	16
Table 11 – Identification of business process scheduling	17
Table 12 – Identification of the business process choice of supplier	17
Table 13 – Business operations map.....	18
Table 14 – Methodology and model artefacts.....	23
Table 15 – Business process use case scheduling (intra area).....	25
Table 16 – Business collaboration planning (scheduling)	27
Table 17 – Business collaboration protocol table	27
Table 18 – Methodology and model artefacts.....	30
Table 19 – Business transaction scheduling phase 1	30
Table 20 – Business transaction property values	31
Table 21 – Business transaction transition table	31
Table 22 – Business transaction scheduling phase 2	32
Table 23 – Business transaction property values	32
Table 24 – Business transaction transition table	32
Table 25 – Business transaction scheduling phase 3	33
Table 26 – Business transaction property values	34
Table 27 – Business transaction transition table	34
Table 28 – Methodology and model artefacts.....	35

INTRODUCTION

The market model depends on the market rules of the country or region. An incomplete list may include the legal and regulatory framework, business rules, technical market rules (network access, balance management, schedule management, congestion management), identification schemas of market participants and e-business objects, metering code (service and access to metering values), grid code (operation), distribution code (operation), and load profiles (synthetic and analytical). The model has to comply with these rules and should include all market participants and transactions to allow seamless communication.

This part of IEC 62325 deals with the UMM (UN/CEFACT modelling methodology) modelling of the energy market and its result, the business and information model. The model has been derived but is not identical with those from some existing markets. It serves as an informative *example* for business processes and associated information. For the purpose of the IEC 62325 series, and for reasons of space, the model has been simplified and shortened and is by no means complete. Some descriptions and modelling parts are derived from existing technology independent market models as EDIEL (<http://www.ediel.org/>), ETSO (www.edi.etso-net.org/, see ETSO Scheduling System (ESS)), ERCOT (<http://www.ercot.com/>, see Market Guide), VDEW (<http://www.strom.de/>, see Choice of Supplier). An other approach would be to derive variations and extensions of an existing model from artefacts in a registry/repository and business library.

Where the UML business model workflow is almost completely described, the other workflows are complete only with focus on specific business processes within process areas such as the process planning of scheduling and to some extent the process change of supplier. For simplicity in the collaborations and transactions, only business failures are shown and technical failures and business signals (as acknowledgements on the messaging level) are omitted.

The message content is based on a energy market specific vocabulary which can be shared over messages, business areas and business domains. Note that with the planned market extension of the CIM (Common Information Model, IEC 61970-301) model of the power system, the vocabulary for system operators may be derived in future from the extended CIM acting as a knowledge based market information model. This will be treated in future parts of the IEC 62325 series.

FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 102: Energy market model example

1 Scope

This part of IEC 62325 defines a restricted (see introduction) *example* business model of the electricity market following the Open-edi reference model ISO/IEC 14662. Fundamental to the model is the division of the business transactions into the Business Operational View (BOV) and the Functional Service (FSV) with mapping of services between to ensure independence of the communication technology used.

Because energy markets vary, this model example is only informative. The main purpose of the model is to show how the modelling methodology can be applied to the energy market, and to serve as the base of technology-dependent configuration examples in other parts of the IEC 62325 series.

The model uses the UN/CEFACT modelling methodology UMM based on UML (Universal Modelling Language) for the Business Operational View, but other modeling methodologies may also be used. The modelling is done from the beginning for the whole market and its result is the “business process and information model” which can be taken as the input for the technology-dependent modelling in the design phase of systems and further for the Functional Service View. See IEC 62325-501 and future parts of the IEC 62325 series for this.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 Generic Open-edi standards

ISO/IEC 14662, *Information technology – Open-edi reference model*

UN/CEFACT *Modelling Methodology (UMM)*, NO90 R10 or higher

UN/CEFACT *Modelling Methodology Meta Model*, NO90 R10 or higher

NOTE Work is in progress at UN/CEFACT regarding the “content” of business information exchange for example as Core Components (UN/CEFACT - Core Components Technical Specification), Core Component Library (CCL, accessible through an registry/repository), Catalogue of Core Components (including industry groups), Common Business Processes, UMM Business Library, XML message design rules (UN/CEFACT – XML Naming and Design Rules (Draft 2004)).

The energy market specific vocabulary can be derived from Core Components or/and an energy market information model.

2.2 Sectorial Open-edi standards

Market modelling based on this implies to some extent sectorial standards. At the moment, no references are given.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

None.

3.2 Abbreviations

BIE	Business Information Entity
BOV	Business Operational View
CC	Core Component (based on BIE)
CIM	Common Information Model
DSO	Distribution System Operator
DUNS	Data Universal Numbering System (North America)
EAN	European Article Number (Europe)
EDI	Electronic Data Exchange
FOV	Functional Service View
ICT	Information and Communication Technology
ISO	Independent System Operator
IT	Information Technology
MIS	Market Identification Schema
UML	Unified Modelling Language
UMM	UN/CEFACT Modelling Methodology
SO	System Operator (Transmission, Distribution)
TSO	Transmission System Operator

4 Market guide

4.1 General

In the following, an informal and conceptual textual description of the electricity market called Market Guide is provided for basic understanding. The description is a not complete example. Real markets may differ. Note that different time intervals are used in energy markets for scheduling and metering.

Figure 1 shows a high-level presentation of the supply chain of energy with basically three main phases: in the *trading planning phase*, energy consumption is forecast and trading is planned. In the *trading operational phase*, energy is traded to meet the forecast, and respective generation resources are allocated. The implementation of the physical energy path from generation over the transmission and distribution network to consumption affords co-ordinated planning of balanced schedules in the *system operation planning phase* for generation, import/export and consumption. In the *system operation operational phase*, energy flows directly from the producer to the customer over the transmission and distribution network. System operation guarantees in this phase that generation meets consumption in real-time (balancing) and that the system is reliable. Many services are needed to support the core processes. In the *settlement phase*, for example, the settlement service provides the means to bill consumption and imbalances. Any imbalance of operation (difference between schedules and metered generation and consumption) is in the financial responsibility of the Balance-Responsible Parties (traders and others).

Additionally, supporting system operation services and energy services are necessary. Each business area has one or more market participants who initiate the business process and/or act as stakeholder responsible for the outcome of it. Exceptions to this are energy services, which may be outsourced and driven by various market participants following the value chain.

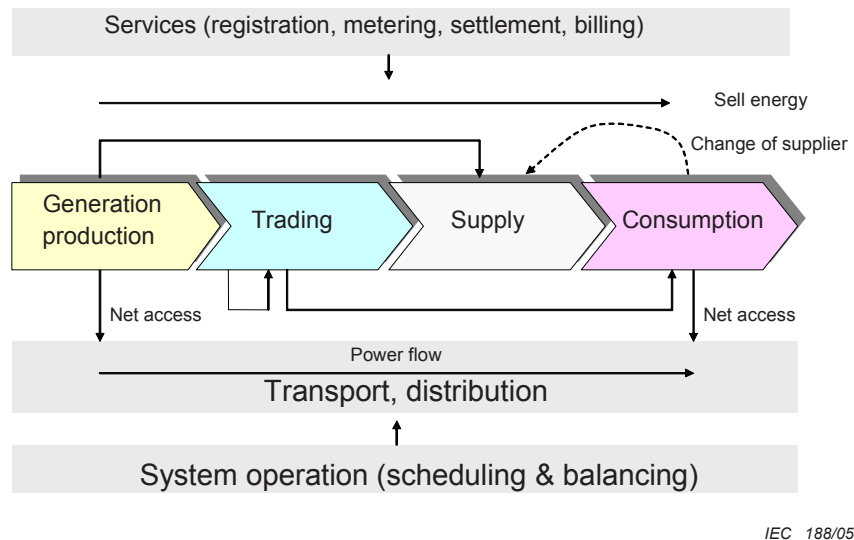


Figure 1 – Value chains and services in the energy market

4.2 Trading

There are two types of trading, bilateral contracts and trading on the spot market (power exchange). Bilateral trading may take place over an intermediate broker. Trading may also include seasonal products. Trading may afford a financial clearing of risks if one party is not able to fulfil the contract.

4.3 Supply

Suppliers represent competitive retailers that sell electricity directly to eligible customers who have the choice of supplier. Suppliers may be retail providers (without own distribution network) or distribution utilities in the role of suppliers. Suppliers will forecast their customer load and negotiate privately with traders to buy energy. Suppliers will communicate the resulting schedules to the transmission system operators (see 4.5).

With supply, many services are associated (see for example 4.6 and 4.7).

4.4 Customer management

The management of customers requires the business processes change of supplier, relocation of customer, metering and access to the metering values, change of meter, contract for new access to the network. Because some business processes are complicated, multi-party collaborations with shared market meta data, some markets have implemented a centralised clearing service for all these business processes within a region.

Suppliers interact with each other and the distribution service provider (providing network access) when they need to submit switching requests, where customers choose a new supplier. The switching requests are processed by working with metering service providers to obtain the initial and final meter reads, confirming switches with customers, and confirming the switch with the relevant suppliers once the switch is approved. Switch confirmations are also sent as notices to customers.

4.5 Scheduling and balancing

Scheduling and balancing of transmission system operators (TSO) follows two business processes: (1) planning of balanced scheduling, (2) operation. The first process involves the following three phases: schedule message validation, balance validation, and system validation.

The TSO is responsible for maintaining the real-time balance of consumption and generation and for the reliability of the electricity system within its region. The TSO relies on the availability of generation capacity to provide balancing energy to maintain the electric system within allowable reliability limits. The provision of capacity and energy are competitive services that will be provided in the market. Generation units that can be on standby and available to be called upon to provide energy or loads that are available to be interrupted to relieve the need for additional energy may provide these services. These services needed for generation or load resources to ensure reliability are called ancillary services. There are two types of ancillary services: (1) generation reserve available to be used if needed to provide balancing energy or loads available to be interrupted reducing the need for additional capacity and (2) balancing energy to ensure that supply and demand are in balance or loads interrupted to avoid the need for additional energy.

The TSO will continuously monitor the amounts of reserve capacity available across the system to insure against unforeseen events, ranging from differences between scheduled and actual demand to the sudden loss of a generating unit or transmission facility. If the analysis identifies a difference, the TSO will procure a replacement reserve to ensure sufficient capacity to deal with the projected capacity inadequacy or congestion.

As the TSO moves closer to the real-time interval in which the energy will actually be delivered, it will continuously get additional information that improves its ability to forecast system conditions. For instance, as the day-ahead energy schedules are finalised for a given 24-hour period, scheduling entities will submit resource plans for generators that indicate the amounts of:

- Capacity, which is generation capacity that will be readily available if needed, but is not actually delivered to the grid as energy.
- Energy, which is the energy that will be generated and sent to the grid to meet the generators' contracted amounts of load.

After evaluating the effect on the power grid of forecasted loads, schedules, transmission system conditions and resource plans, the TSO will determine how much additional capacity needs to be reserved to assure the TSO will have resources that can provide balancing energy in real-time to maintain reliability. The TSO will procure the needed capacity services to ensure that it is able to serve the scheduled loads as well as relieve loading on transmission lines that appear to be constrained upon a study of the submitted schedules. The TSO will procure balancing energy typically about 10 min before the time of actual power flow, by which time the right amount can be predicted very accurately using short-term forecasting tools.

Replacement reserve ancillary service providers will submit balancing energy bids when they submit their Replacement Reserve capacity bids. Their balancing energy bids will go in the balancing energy bid stacks for the hours for which they were awarded to provide Replacement Reserve capacity service. Ancillary service providers will not, however, bid the capacity that they have sold to the TSO into the market for other capacity services.

The TSO will select and deploy balancing energy in the amount necessary to keep the system in balance and minimise the net energy needed in real time from regulation service providers.

A key feature of the competitive retail electricity market is that it will be based on bilateral transactions between buyers and sellers of energy. Balance Responsible Parties (traders, producers and suppliers) are required to turn into the TSO balanced energy schedules of load and energy required to generate and serve the load. The balance schedules are a result of bilateral trade between load and resource entities. The TSO only operates the electricity market as far as the TSO is needed to mitigate the energy imbalances. This is unlike some other markets, where power generating companies sell electricity into a “pool” and load serving entities (trades, suppliers) purchase from the same “pool” in an exchange where the amount of demand and supply sets market prices for buyers and sellers.

Traders and supplier acting also in the role of traders buying energy and producers selling energy will communicate operational information such as their bilaterally arranged balanced schedules of loads and resources to the TSO through their scheduling entities. The TSO will ensure that the power network can accommodate the schedules that were generated by the bilateral market.

The TSO makes an assessment of the ancillary services needed to accommodate the bilateral schedules and the scheduling entities are asked to either provide their share of these services from their own resources or let the TSO purchase these services from the market on their behalf. Market participants may self-provide all or part of their share of ancillary services. The TSO is uniquely positioned to identify the ancillary services needed to resolve system conditions such as capacity inadequacy and congestion, to maintain reliability, as shown in the previous section.

The TSO, in addition to the activities described above, will help market participants plan and manage their competitive market operations effectively by giving them timely information like forecasts of weather, load, losses, and ancillary services requirements.

For every settlement interval, the TSO will accept balanced schedules from Balance Responsible Parties (traders, producers and suppliers) that identify the source and destination of contracted power flows, as well as their amount and timing. TSO will compare the sum of these schedules to its own load forecasts, to determine balancing energy and ancillary services requirements.

The TSO will work with traders and suppliers to procure ancillary services through a series of markets, which the TSO will operate, and will deploy them as needed to ensure system reliability. If the submitted schedules ultimately result in congestion of the transmission system and the TSO needs to re-dispatch system resources to resolve the congestion, market participants will pay for the re-dispatching or congestion costs.

In order to settle with the balance-responsible parties, the Imbalance Settlement Responsible party will aggregate load and resource data for every settlement interval. He will then calculate the load imbalance as the difference between scheduled and the aggregated load data, to issue the appropriate credits and/or debits to balance-responsible parties. The same comparison is made between aggregated energy supplied from the resources provided by the Balance-Responsible parties and the scheduled energy to allocate the appropriate debits and/or credits due to the resource imbalance.

The TSO will also work with distribution network providers to manage the transmission system. Distribution network providers are also responsible for load and resource meters installation as well as submitting meter data for all loads and resource meters that are not directly polled by the TSO.

The TSO which acts as an ISO (Independent System Operator) may have a central premise clearing system that will facilitate for example the customer switching process (choice of supplier) by transmitting switch requests and meter consumption data between suppliers and distribution network providers and keeping track of the association between premises and suppliers. In the case where there is no central clearing system, the customer switching process is decentralised between the suppliers and the Distribution Network Providers.

Producers are the only entities that can own generation or loads that can act as resources. They negotiate bilaterally in their role as traders with traders/power exchanges to sell their energy, and communicate the resulting schedules to the TSO.

Balance-responsible parties can also bid into the balancing energy market and other ancillary service markets from the resources in their portfolio. The TSO reimburses the balance-responsible parties at the market-clearing price if the TSO selects the bid.

4.6 Metering

Metering service provider or distribution network providers in the role of Metering Service Provider, provide meter reading and consumption information, in order to settle correctly the balancing energy and ancillary service markets. For example, consumption information for each supplier in the Balance-Responsible role will be needed to determine whether the actual load matches the schedules submitted. If it did not match, the difference will be settled at the balancing energy market-clearing price.

Most customer meters measure accumulated consumption between meter read-dates and are typically read once per month or year. An estimate of the energy consumption for each period (15 min for example) is needed to properly perform settlement. The estimation is done by standard load profiles that break down monthly consumption into the above mentioned periods for the different customer segments in the region. Some customers with load-profile meters can meter the consumed energy within periods.

Suppliers have authorised access to the meter readings for the purpose of forecast and billing. The optimisation of load schedules may afford the reading of load profile meters and the access to the meter readings each day.

4.7 Settlement of accounts and billing

The financial settlement for balancing energy and ancillary services that were used by the TSO will take place between traders and the TSO and is performed by the Settlement Responsible Party. Settlement of the balancing energy will be based on the load imbalance and resource imbalances from each Balance Responsible Party. The load imbalance is the difference between the scheduled load and actual load from each trader. Resource imbalance is the difference between the scheduled energy and actual energy for each trader. The actual load and energy amounts are derived from the load and resource meter readings. For example, if a trader's actual energy supplied from the resources it represents is insufficient to match the scheduled energy in the balanced schedule it provided to the TSO, that trader would be required to reimburse the TSO for the balancing energy the TSO procured, at the market clearing price or other price. On the other hand, if the TSO accepts a balancing energy bid from the ancillary services market, the TSO will pay for it as appropriate at the market-clearing price.

Suppliers bill their customers based on the metered consumption and tariffs. Transmission and distribution providers bill the producers and customers that have access to the network with a network usage fee.

5 UMM market model

NOTE The model uses the Unified Modelling Language (UML) notation.

5.1 Business modelling workflow

5.1.1 General

The purpose of business modelling according to UMM is:

- to understand the structure and dynamics of the business domain,

- to ensure that all users, standards developers and software providers have a common understanding of the business domain,
- to understand the daily business in the business domain independent of any technical solution,
- to create categories to help partition the business domain that enables an iteration plan to complete the model,
- to structure the model in the form of a Business Operations Map (BOM)
- to capture the justification for the project,
- to identify the stakeholders concerned with the modelled domain, some of whom will be independent of the processes within the domain.

Business areas can contain groups of process called process areas which in turn include individual business processes. Business processes identified in the business modelling workflow consist of business collaborations and transactions described in the requirement workflow and in more detail in the analysis workflow.

After this general structuring, UML use case diagrams are organised as groups within UML packages that use the names of business areas.

The main focus of business modelling workflow is on business domain, business area and business process areas understanding, not on processes, which are only identified.

Table 1 shows the workflow for methodology and model artefacts.

Table 1 – Methodology and model artefacts

Workflow	Methodology	Model artefacts (BOM with UML)
Business modelling	Domain analysis	Business area, process area (UML packages)
	Use case analysis	Use cases
	Process discovery	Identification of processes
	Activity modelling	Activity diagrams

5.1.2 Business process discovery and identification

For the high-level business domain, analysis worksheets are used.

5.1.2.1 Business reference model

Table 2 shows the worksheet business reference model for the business domain energy market. All worksheets, this and the following ones, are examples only.