Energy market trading systems in G6 countries

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Overview

Energy Market Overview

In the last three decades the energy market has run into big changes with reforms and laws aiming to unbundle and deregulate the market, in order to provide a better and cheaper service for the end user (see [1, 5, 6, 4] for some recent studies). There are several stages in order to have a smooth transition that, from a static monopoly market, can lead to a dynamic energy-exchange-based market in which more transparency appears through each stage, as described in [3]. In fact there are several differences between the bundled and the unbundled market, first of all the there is no more a big vertically integrated company that deals with all the energy process from production to end user distribution and billing; on the contrary there are several companies each dealing with specific part of the energy business. Moreover several energy-related-business companies are allowed to enter the market and thus resulting in the promotion of competition. For a more detailed description of the aspects involved by the reforms in energy sector we refer to [2].

One of the major issues with actual technologies is the inefficiency, and also economic disadvantage, in storing energy in considerable quantities. Though forecasting techniques have advanced in foreseeing energy requirements in different time-scales (e.g., season and weekday variations), energy companies anyway needs very fine grain mechanism to provide the exact quantity of energy required by the end-users. Therefore these two aspects imply that offer and demand of energy in the market must always be balanced between production and consumption bidders. Thus the mechanism developed and nowadays used in a mature energy market is composed by three types of exchange markets, based on time granularity:

- **Long term market**: producers and suppliers hedge their energy needs for the long term (e.g., buy or sell energy in long term future contracts). These contracts may be physical or purely financial. The time-frame granularity is the day.

- **A day-by-day market (known as day-ahead market)**: producers and suppliers adapt their consumption to operational needs (e.g., maintenance, shifts and predictable fluctuations of workload/consumption), by buying/selling energy on a day to day basis. This can be done in a spot market, through brokers or without middlemen with bilateral agreements. The market closes before the production and consumption takes place, usually 24 hours in advance. At that time, all buyers and sellers must
report to the grid operator the quantities they have bought or sold. The time-frame granularity is the hour.

• A real-time market: producers and suppliers trade energy to balance their real consumption, since estimations done days before might be incorrect or because of unexpected circumstances. If a transaction helps to balance the grid, the price of the energy can go even tenfold over the normal market price (balancing bonus), on the other hand if it brings more imbalance, a negative price can be applied and be very high (balancing fine). The time-frame granularity are the minutes.

In addition there is another market to trade ancillary services such as automatic generation control (AGC), real-time load balance, spinning reserve, and generating capacity required for grid congestion management. These services are especially needed in order to deal with unexpected and critical situations.

Technology Used in the Energy Market

The energy trading market nowadays is really similar to any other commodity market. In fact some energy transactions take place only at financial level on the future market in order to hedge energy price increase risk. So even form an Information Technology perspective the is not much difference compared to traditional stock exchange markets: all the trading mechanisms take place over the Internet in the telematic market. Often there are no specific request on the type of Internet connection the market participant need to have, otherwise in certain markets (i.e., UK) a special private connection service can be purchased. On the other hands there are constraints on the type of hardware (minimal system requirements), operating system and browser to be used for a supported configuration. As you see in the sections below every advanced market enable the trading through web-based applications accessible through web-browser-based technologies. Therefore all the typical aspects of security in a web environment are implemented such as authentication, confidentiality and data integrity.

One substantial difference compared to traditional stock markets lies in an aspects that do not deal with technological constraints: to enable the participation in the market for an energy operator legal and financial aspects are evaluated to provide participation in the market. Therefore there are not many operators trading on the market.

Aim of the Technical Report and Research Methodology

This report wants to describe the up-to-date mechanism used to trade energy in the market with particular attention to the Information Technology platforms used. The focus is limited to former G6 countries (i.e., United States of America, United Kingdom, Germany, France, Japan and Italy) as representing the most developed countries. The aim is to identify if the specific market supports an open interaction between participants providing solutions close to the Service Oriented Architecture (SOA) paradigm and the ease to interact with different markets with the same technological platform.

Since there is not relevant scientific literature, to the best of our knowledge, to extract these information from, the information is extracted from the
web sites and on-line documentation belonging to the market operator or the regulator authorities that manage the energy market for each specific country.

**Organization of the Report**

After this brief introduction the report proceeds analysing the characteristics of the energy trading market for each G6 country in a separate section. A general description about the operation of the market for each country is presented and a specific subsection is dedicated to the information system that supports the interaction between market participants. The reports concludes with a comparison that summarizes the main differences between the technological platforms used.

**Italy**

The Italian energy market manager is Gestore Mercati Energetici (GME) whose aim is that of “organizing and economically managing the Electricity Market, under principles of neutrality, transparency, objectivity and competition between producers, as well as of economically managing an adequate availability of reserve capacity.”

GME describes the market as: “The Electricity Market, commonly called Italian Power Exchange (IPEX), enables producers, consumers and wholesale customers to enter into hourly electricity purchase and sale contracts. Market participants connect to an electronic platform through the Internet and enter into on-line contracts under secure-access procedures based on digital certificates.”

In Italy the market can be divided as follow:

- the Spot Electricity Market is composed by:
  - Day-Ahead Market: in this market hourly block of energy are traded from the ninth day before to the day before the the physical exchange. This type of market is not a continuous market but an auction market: all bids are collected by GME and matched. The result are reported in order for the participants to take appropriate corrections in the Intra-Day Market. GME is central counterpart in the transactions.
  - Intra-Day Market: this market opens after the end of the Day-Ahead Market and closes on the same day of physical delivery. The participants are so able to adjust their bids based on the results of the matchings (or un-matchings) completed in the Day-Ahead Market. Also this market is an auction based market and not a continuous one. GME is central counterpart in the transactions.
  - Ancillary Services Market: this market enables the Italian grid operator to stock up the resources it needs for managing, operating, monitoring and controlling the power system. In this market the grid operator acts as counterpart in the transactions.
• Forward Electricity Market: in this market forward electricity contracts with delivery and withdrawal obligation are traded. GME is central counterpart in the transactions.

• Delivery of Electricity Derivatives: this section of the market is the place where physical delivery of financial contracts concluded on IDEX are executed. That is one of the counterparts of the forward contract has requested to exercise the option of physical delivery of the underlying electricity. GME in this case becomes the counterpart of the physical transaction of the delivered contracts.

As part of the organization and economic management of the Electricity Market, GME is also vested with the organization of trading venues for Green Certificates (giving evidence of electricity generation from renewables), of Energy Efficiency Certificates (the so-called “White Certificates”, giving evidence of the implementation of energy-saving policies) and of Emissions Allowances or Units.

Market access from Information System perspective
As stated in the GME’s document “Guidelines Facilitating Access to and Participation in GMEs Electricity Market” to submit an offer/bid into the Day-Ahead Market and Intra-Day Market markets, you may:

• complete the appropriate form (web form) that you may obtain from the Spot Electricity Market information system (“Invio offerte”-Offer/bid submission menu in the “Mercati”-Markets section); through the web form, you may submit offers/bids for single units, single markets and single sessions;

• submit (upload) an XML file, similar to the one contained in the document “XML Implementation Guide for Market Participants”, posted in the “GMEs Info/Library/Software” section of GME’s website. To submit offers/bids into the Ancillary Services Market (MSD), you may use only the second option, i.e. submit (upload) an XML file, similar to the one contained in the document “XML Implementation Guide for Market Participants”, posted in the “GMEs Info/Library/Software” section of GME’s website.

GME also provide a set of web services to submit bids on the market, the details about the web services provided are available through the GME’s website.

USA
The USA have different market operators for the several regions that compose the country as shown in Figure 1. In this report only two of them are analysed as representatives for the entire country.

3IDEX is the segment of the financial derivatives market of Borsa Italiana S.p.A. where financial electricity derivatives are traded.

5http://www.mercatoelettrico.org/en/GME/biblioteca/software.aspx
ISO New England

In New England the market Operator is ISO-New England. ISO New England is a regional transmission organization (RTO), serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. In addition to other responsibilities the main market-related aspect is: “Development, oversight and fair administration of New England’s wholesale electricity marketplace, through which bulk electric power has been bought, sold and traded since 1999.”


- The Day-Ahead Energy Market is a forward market in which hourly LMPs (Locational Marginal Pricing) at pre-determined locations are calculated for each hour of the next day based on supply offers, demand bids. These two types of proposal are bid on buying or selling certain physical quantity of energy at a certain location at a certain price. In addition there are other types of bids such as increment offers, decrement bids that are purely financial offers or request to buy energy (virtual, since there is no physical flow associated). Another type of interaction is the external transaction that enable the interaction on the market with companies belonging to the nearby regions. All traded quantities on this market may clear in partial MW quantities.

- The Real-Time Energy Market is a balancing market for energy in which the LMPs at pre-determined locations are calculated every five minutes based on the actual system operations security-constrained economic dispatch.

Additionally, in real-time on a five-minute basis, operating reserve requirements are met as part of the real-time dispatch process for which specific resources

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6 http://www.iso-ne.com/

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are designated as supplying operating reserve. Real-time reserve prices are calculated simultaneously with real-time LMPs.

Market access from Information System perspective

The interaction with the ISO-New England markets can be performed either interacting with a web site or creating files in an appropriate format that anyway need to be uploaded to ISO-New England’s servers.

- The web site gives the possibility to interact with forms and insert offerings, contracts and production assets in the system. The manuals that detail the web interface for the various activities are available on the web site\(^7\).

- Again using the web interface it is possible to upload (or download) the offerings and contracts in text based formats files:
  - CSV (Comma Separated Values)
  - XML (eXtensible Markup Language)

The details of the formats of the files together with a description of the various tags to be used is found on “ISO-New England Upload/Download File Formats” web site\(^8\).

- ISO-New England also provides some programming utilities and programming specifications to enable the automation of the upload and download process for CSV and XML files.

- The trading process can be achieved also using the web-based application eMkt. This application enables the interaction on the market by giving the user the possibility to fill in forms. It also allows the upload of bids for transactions using XML based files. eMkt guide is available in electronic format\(^9\) and also data formatting rules for use XML files\(^10\).

PJM

In the eastern part of the USA an important set of states is managed by the PJM Interconnection\(^11\) operator. As stated on PJM website: “PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. Acting as a neutral, independent party, PJM operates a competitive wholesale electricity market and manages the high-voltage electricity grid to ensure reliability”.

PJM Interconnection has the manages the operations of purchase, sell and delivery of wholesale electricity through the its energy market. In its role as

\(^7\) http://www.iso-ne.com/support/user_guides/index.html
\(^8\) http://www.iso-ne.com/support/tech/file_formats/up_dwn_frmts/index.html
\(^9\) http://www.iso-ne.com/support/user_guides/SBOs_Using_Emkt.pdf
\(^11\) http://www.pjm.com/
market operator, PJM balances the needs of suppliers, wholesale customers and other market participants and monitors market activities to ensure open, fair and equitable access. PJM’s energy market is similar to a stock exchange in which market participants establish a price for electricity by matching supply and demand.

PJM Interconnection manages different types of markets:

- **Real-Time Market** is a spot market in which current LMPs (Locational Marginal Pricing) are calculated at five-minute intervals based on actual grid operating conditions.

- **Day-Ahead Market** is a forward market in which hourly LMPs are calculated for the next operating day based on generation offers, demand bids and scheduled bilateral transactions.

- **Day-Ahead Scheduling Reserve Market** is a market-based mechanism to procure supplemental, 30-minute reserves on the PJM System. On a day-ahead basis, PJM operators need the ability to schedule sufficient generation so that unanticipated system conditions can be dealt with to preserve reliability during the actual operating day.

**Market access from Information System perspective**

PJM provides a set of software applications that enable the market participant not only to trade energy, but also to have updated real-time information, necessary to take the most appropriate business decisions. A web page\(^\text{12}\) is dedicated to the descriptions and information about the tools.

Basically for all the tools that PJM provides for managing the operations in the energy market three different alternatives of interaction are possible:

- **Web access through the web application**: this solution implies a direct interaction with a user that fills the appropriate fields in order to submit bids or monitor the market.

- **XML files**, edited in an appropriate format, can be uploaded and downloaded through the web application to avoid the manual filling of the fields.

- For almost every tool PJM has defined web-services to interact with. There are several documents (one for each tool) that explain the details of the XML syntactic format to use (XSD files) and the characteristics of the services available (WSDL files).

With the last solution PJM enables market participants to create an SOA interacting with its web services.

As differentiated in PJM eTools web site\(^\text{13}\) the tools available can be divided in two main categories:

- **eSuite**:

\[^{12}\text{http://www.pjm.com/markets-and-operations/etools.aspx}\]
\[^{13}\text{http://www.pjm.com/markets-and-operations/etools.aspx}\]
- OASIS: Open Access Same-Time Information System (OASIS) provides access to transmission services and transmission system information. No web service or automatic interaction available for this component, interaction is limited only through a web interface application.

- eData: eData enables all PJM stakeholders to view PJM operational and market data graphically. No web service or automatic interaction available for this component, interaction is limited only through web interface application, however data can be downloaded in XML format.

- eMTR: eMTR calculates a market participants actual interchange energy amounts to be used for real-time energy market settlements. Unattended interaction is possible using XML specific format documents (format is to use is available), DTD example files are also available. PJM also provide a java command line tool to proceed with a browserless file transfer.

- eMKT: eMKT allows PJM members to submit information and obtain data needed to conduct business in the Day-Ahead, Regulation and Synchronized Reserve markets. The web service interaction with this application together with data format and communication details are described in the document “PJM External Interface Specification Market Participant XML”.

- eFTR: eFTR (Financial Transmission Rights) is used by members and other transmission customers to manage their FTR portfolios. The web service interaction with this application together with data format and communication details are described in the document “eFTR External Interface Specification Guide”.

- Opportunity Cost Calculator: The eMKT Opportunity Cost Calculator calculates the maximum opportunity cost allowable if particular restrictions are applied to the generating facility (e.g., limits on emissions). No web service or automatic interaction available for this component, interaction is limited only through web interface application.

- EES: Enhanced Energy Scheduler (EES) facilitates the exchange of bulk power between PJM and other areas managed by other regional transmission organizations by enabling market participants to request, evaluate, track and confirm their external bilateral transactions. Upload and download procedures are done through XML files.

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14 [http://www.pjm.com/~media/etools/emtr/emtrspecs.ashx](http://www.pjm.com/~media/etools/emtr/emtrspecs.ashx)
with specific formats for upload file and download file. PJM provides a java command line tool to proceed with a browser-less file transfer (documentation and application are available to download).

- eRPM: The PJM eRPM system is an Internet-based application used by market participants to submit resource-specific sell offers or buy bids into Reliability Pricing Model (RPM) Auctions. Direct interaction through the web interface is available, upload and download XML samples are provided. The web service interaction with this application together with data format and communication details are available in the document “eRPM External Interface Specification Guide”

- eLRS: eLRS allows PJM members to administer the registration, notification, meter data and settlement process for demand side response resources in the PJM markets. Note that bids into the PJM wholesale market occurs directly in eMkt for energy and ancillary services and eRPM for capacity. The web service interaction with this application together with data format and communication details are available in the documents “eLRS Web Services Guide” and “LRS External WS Specifications” XSD schema and examples are also available.

- Additional applications not belonging to eSuite:
  - eDART: eDART (Dispatcher Applications and Reporting Tool) is used by transmission and generation owners to exchange operational and planning data with the PJM control center. Interaction is limited to the web application.
  - eDataFeed: eDataFeed is a PJM Web service that allows subscribers to select and stream PJM selected real-time Locational Marginal Price (LMP) data directly into their system. Data feed is accessible as a web service. In addition PJM provides a Java and .NET sample to download programs to ease the integration process for the market participants in their own systems.

20 http://www.pjm.com/markets-and-operations/etools/~/media/etools/ees/ees-xml-upload.ashx
– Load Response: Load Response was replaced with the new eLRS system. Load Response is in read only mode to allow members to review their prior demand side response information. This application is accessible through web services, the documentation together with an example of the client application are provided by PJM.

UK

The British system that govern the electrical energy trading is known as British Electricity Trading and Transmission Arrangements (BETTA). The working mechanism is displayed in Figure 2 which represents four specific working moments that are characterized by different possible interactions between market participants.

The information provided below are extracted from the National Grid web site.

Figure 2: British Electricity Trading and Transmission Arrangements market structure. Source: National Grid [http://www.nationalgrid.com/uk/]

Participation in the bilateral markets (i.e., the Forward/Futures contract market and the Short-term bilateral markets) and the Balancing Mechanism (i.e., offer/bid submission) is optional. Participation in Settlements is mandatory. In addition, certain categories of generator are required to provide Physical Notifications.

The Balancing and Settlement Code (BSC) provides the framework within which participants comply with the Balancing Mechanism and Settlement Process. The BSC is administered by a non-profit making entity called Elexon.[32]

A central moment is the Gate Closure which is the point in time when market participants notify the System Operator of their intended final physical position and is set at one hour ahead of real time. In addition no further contract notification can be made to the central settlement systems.

The market is divided in the following categories:

**Forwards and Futures Contract Market**

The bilateral contracts markets for firm delivery of electricity operate from a year or more ahead of real time (i.e., the actual point in time at which electricity is generated and consumed) typically up to 24 hours ahead of real time. The markets provide the opportunity for a seller (generator) and buyer (supplier) to enter into contracts to deliver/take delivery, on a specified date, of a given quantity of electricity at an agreed price.

The markets are optional with participants having complete freedom to agree contracts of any form. Formal disclosure of price is not required.

The Forwards and Futures Contract Market is intended to reflect electricity trading over extended periods and represents the majority of trading volumes. Although the market operates typically up to a year ahead of real time, trading is possible up to Gate Closure.

**Short-term Bilateral Markets (Power Exchanges)**

Power Exchanges operate over similar time-scales, as shown for forward and futures market, although trading tends to be concentrated in the last 24 hours before the Gate Closure.

The markets are in the form of screen-based exchanges where participants trade a series of standardized blocks of electricity (e.g. the delivery of xMWh over a specified period of the next day). Power Exchanges enable sellers (generators) and buyers (suppliers) to fine-tune their rolling half hour trade contract positions as their own demand and supply forecasts become more accurate as real time is approached. The markets are firm bilateral markets and participation is optional. One or more published reference prices are available to reflect trading in the Power Exchanges.

**Balancing Mechanism**

The Balancing Mechanism operates from Gate Closure through to real time and is managed by National Grid in its role as Great Britain System Operator (GBSO). It exists to ensure that supply and demand can be continuously matched or balanced in real time. The mechanism is operated with the System Operator acting as the sole counter party to all transactions.

Participation in the Balancing Mechanism, which is optional, involves submitting ‘offers’ (proposed trades to increase generation or decrease demand) and/or ‘bids’ (proposed trades to decrease generation or increase demand). The mechanism operates on a ‘pay as bid’ basis.

[32]www.elexon.co.uk
National Grid purchase offers, bids and other Balancing Services (e.g., ancillary services) to match supply and demand, resolve transmission constraints and thereby balance the system. As part of this process National Grid is also required to ensure that the system is run within operational standards and limits.

Generators and suppliers registered within the Balancing and Settlement Code are bound by the relevant requirements of the Grid Code which includes the arrangements for System Operator to accept Balancing Mechanism bids and offers, for calling off Balancing Services and for dealing with emergencies.

Market access from Information System perspective

UK market is managed by Elexon company that has been given the role by the UK government: “To procure, manage and operate the services and systems which enable the balancing and imbalance settlement of the wholesale electricity market and retail competition in electricity supply”.

From an information system perspective the way the participants are allowed to interact in the market with several agents that deal with different aspects of the transaction process. For the details and complete description of the agents we refer to the document: “Participant Communications Overview Guide”. A representation of the communication between parties, system operator and the agents available for market interaction is represented in Figure 3. The list of processes that involves the different agents are represented through flow diagrams in Elexon’s web pages.

The services provided by Elexon can be categorized by:

- Energy Contract Volume Aggregation Agent (ECVAA)
- Central Data Collection Agent (CDCA)
- Balancing Mechanism Reporting Agent (BMRA)
- Central Registration Agent (CRA)
- Settlement Administration Agent (SAA)
- Funds Administration Agent (FAA)
- Supplier Volume Allocation Agent (SVAA)

Figure 3: Agents available and interaction between participants in the BSC paradigm. Source: Elexon [http://www.elexon.co.uk/](http://www.elexon.co.uk/)

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34 [http://www.elexon.co.uk/documents/participating_in_the_market/entering_the_market_-_qualification_-_recommended/participant_communications_overview_guide_(pcog).pdf](http://www.elexon.co.uk/documents/participating_in_the_market/entering_the_market_-_qualification_-_recommended/participant_communications_overview_guide_(pcog).pdf)

35 [http://www.elexon.co.uk/bscrelateddocs/agentprocess/bscagentoverview/bpm_site/index_main.htm](http://www.elexon.co.uk/bscrelateddocs/agentprocess/bscagentoverview/bpm_site/index_main.htm)
• Low grade interfaces: these services are available through the public internet. In particular:
  
  – Low Grade BMRA Web (involved agents: BMRA), data is accessible through web site.
  
  – FTP Notification and reporting (involved agents: ECVAA/SAA/CRA/CDCA): the BSC Central Services FTP service allows submission of files containing BSC IDD (Interface Definition and Design) formatted data flows to Central Services. Files placed on this server are picked up and processed, and responses and reports are placed on the server for the participant to periodically poll for and collect.
  
  – ECVAA Web (involved agents: ECVAA): the ECVAA web service allows an alternative method for participants of the market to view their positions and notify to the ECVAA service in a more interactive way than the standard FTP notification method.

• High grade interfaces: The interfaces available using the High Grade service over the BSC Central Services private WAN are. In particular:
  
  – Tibco (involved agents: BMRA): this service uses industry standard Tibco data transmission software to stream a subscription customized feed of Balancing Mechanism data to the Participants site.
  
  – Enhanced High Grade BMRA Web (involved agents: BMRA): this service is similar to the Low Grade BMRA web service described above, but is enhanced for use with Tibco streamed BMRA data.
  
  – FTP Notification and Reporting (involved agents: ECVAA/SAA/CRA/CDCA) and ECVAA Web (involved agents: ECVAA) are the same as the ones offered by low grade service.

In addition there are some hardware and software requirements that must be satisfied, in particular XSec Encryption Software is required for communication with Central Services FTP server. It is possible to have an automatic interaction with the FTP server using a specific file format available in the document “Interface Definition and Design”. In the same documents the external interfaces the different services provide and the way it is possible to interact with, are described.

It is possible to use electronic file exchange or manual way. There are two classes of interfaces that are described:

• Funds Administration Agent for Trading and Transmission Arrangements Interface Definition and Design: this interface is used to provide the Funds Administration service, so every aspect dealing with fund management must be implemented according to the interfaces available. The interface description can be found in EPFAL Interface Definition and Design.
documents

- New Electricity Trading Arrangements (NETA) Programme Interface Definition and Design: services provided through NETA Programme deal with the operative part of the interaction in the market. The interface description can be found in NETA Programme Interface Definition and Design.

Germany

The German energy market is traded on the European Energy Exchange (EEX). This organization provides the trading market not only for electricity, but also for natural gas and emission trading certificates. EEX operates both Spot Markets for power, gas and emission rights as well as Derivatives Market on which futures and options on power, gas, emission rights and coal can be traded. As stated on EEX web site, “EEX is characterized by liquidity, transparency and fairness in pricing and this creates the confidence which the trading participants place in EEX. Safeguarding this is the central task of EEX and of its executive bodies”. EEX does not only provide market capabilities for Germany, but also for Switzerland, Austria and France through the European Power Exchange spot market (EPEX Spot) in which EEX is one of the main shareholders. The market follows general characteristics of other energy trading structures:

- Derivative market: this market is used to buy or sell options and forward contracts with a defined expiration date in the future.

- Spot market:
  - day-ahead market: day-ahead auction for hourly electricity contracts, this auction is held on a daily basis. In this auction hourly electricity contracts and block contracts for the respective next day can be traded at 12:00 am of every weekday, this is at the center of these markets. Contracts for Sunday and Monday are assigned in the auction on Friday. In the auction, bid functions both for every individual hour and block, bids comprising several contiguous hours, can be submitted.
  - intraday trading: this trading phase permits electricity trading “around the clock” until shortly before physical delivery. In fact it is possible to operate in this market till 75 minutes before the physical delivery of the electricity.

Bilateral trading: EEX platform gives the possibility of trading for the next day on a bilateral basis through the platform even after the central auction for the following day is over. This form of agreement takes place between the two parties directly exploiting EEX platform technology.

Market access from Information System perspective

EEX market uses software applications that are proprietary solution such as Xetra and Eurex platforms are the official trading instrument of the German stock exchange too (an introductory manual is available to download\[45\]). On the EEX web site the documentation about these products is restricted to members that are subscribed to data access and trading services.

Despite this lack of information Xetra and Eurex platforms provide a set of VALUES API (Virtual Access Link Using Exchange Services Application Programming Interface) to allow the communication with third party application. The use of this extension API allows participants to connect to any application they want and they are familiar with. With the interface, the exchange applications and the respective participant applications (e.g. order routing systems, position management and risk management tools) are decoupled from the functional and technical services and the network of Deutsche Borse. This separation into functional and technical components also means that Values API can be extended, at any time, without impairing efficiency for the users. These API are written in C programming language, and can be divided in two sub components:

- The VALUES API Call Interface is composed of connection and log-in functions. These technical components are called up by a user application in order to gain access to the exchange services.

- The VALUES API Application Requests provide the functional information needed by customers to gain access to the exchange services. They are used in connection with the access points of the call interface.

The Xetra APIs and development guide is available for download\[46\] and the Eurex APIs development guide too\[47\].

The other application that can be used on EEX is called ComTrader, despite the small amount of information available it is perceived the application has a web-based interface that together with fill-in direct interaction supports the import/export of files related to transactions (only some documents are available\[48\]). Both over-the-counter (OTC) and market based transactions can be exported to a comma separated values (CSV) format. For import functionalities the situation is different between OTC and normal transactions for which a CSV format can be used, while for block bids and hourly bids a copy-and-paste method from a spreadsheet application is advised.

\[45\]http://www.eex.com/en/document/4424/Einf%C3%BChrung%20B%C3%B6rsenhandel_Release_engl_01B.pdf
\[48\]http://www.epexspot.com/en/download-center/technical_documentation
Additionally EEX provides historical and end-of-day data about the commodities that are traded on the market. These data are available in different formats in order to ease the access by the end users:

- XML based files
- CSV based files
- XLS Xcel based files

All the specifications for the many different files representing the several commodities are available in the guides “Market Results Interface Specification”[49] and “Transparency Data Interface Specification”[50] All data in the different format described above are available through an ftp server[51] in addition the structure of the directories used to publish the data is given[52].

France

In France the market follows the same structure as the general model for the other developed countries. In particular the market can be divided in:

- Over-the-Counter market (OTC): most of the wholesale activity in the electricity market takes place over-the-counter, through direct transactions or through intermediaries (brokers and trading platforms). The total volume of OTC transactions is not public.

- Intermediated market, this market covers trading executed on organized markets and brokerage venues (intermediated OTC). This part of the market can be further divided into:
  - Spot products: these products include day-ahead contracts and continuous quotations.
  - Forward and Futures products: these products are used to negotiate long term purchase or sell of energy at a given point in time.

For both these types of products quotations take place in the EPEX spot market[53] the same market described above for German spot products.

In France there is a commission called Commission de Regulation de l’Energie (CRE) that must supervise the market in order to guarantee the smooth running of the electricity markets. So both the transactions that happen on the market as well as the bilateral ones can be monitored by this organization.

[51]ftp://infoproducts.eex.com
Market access from Information System perspective

The data that must be sent to CRE by companies involved in energy trading must follow a specific Excel based format, sample files are available.

As for the German market the technological platform used by French market is composed by proprietary solutions belonging to specific software of the trading sector. Specifically the two platforms are Global Vision and SAPRI platform. Global Vision is used to trade both on day-ahead market and real-time market; while SAPRI platform is accessible through a web browser-based application called Elweb and is used for day-ahead transactions only. For these platforms there is not much documentation publicly available on the network in order to have more details about data format used. The only documents available are the installation guides of the products, but neither the user manual nor the implementation guide are available. In addition no information about external interaction or extension is available.

Japan

In Japan the market has undergone reforms that brought the market to a condition close to the one in western countries. The market is regulated by Japan Electric Power Exchange (JEPX) and the entire operations are controlled by Electric Power System Council of Japan (ESCJ) to ensure fair and transparent operations of electric power transmission and distribution acting both as a rule-maker and as supervisor.

JEPX provides the following two types of market:

- **Spot Market**: this is the section of the market where the electricity to be delivered next day is traded. 48 products are traded every 30 minutes in 24 hours a day. The bidding is done by a single price auction system. Under the single price auction system, a bid is made for the combination of price and quantity of each product. A point of intersection where the buying and selling conditions comply with each other is sought, and the price and contract quantity are decided at this point.

- **Forward Market (Fixed-Form Products)**: this is the section of the market where the electricity to be delivered in a certain period of time is traded. It is possible to trade energy quantities for every hour of a day. This type of market has the characteristics of the typical intra-day market.

Market access from Information System perspective

The lack of documentation in English inhibits to have a complete comprehension of the software platform used. However in the market participant guide document (in Japanese) available on JEPX site it is stated that it is possible to connect to the trading market application using a web browser. It is also stated that there are API available to have a direct interaction between users' custom applications and the exchange system.

56 [url=https://dam.powernext.fr/](https://dam.powernext.fr/)
57 [http://www.jepx.org/English/index_e.html](http://www.jepx.org/English/index_e.html)
Discussion

All the markets analysed have an operational structure very similar to each other, providing the possibility to trade energy with different time granularity (e.g., from hours to minutes) and with different time horizon (e.g., from real-time markets to year away forward contracts); the differences are really very small.

The markets seem similar to other commodities and stock trading markets, the only difference is the constraints that characterize the energy market: always have a balance between offer and demand when the flow of energy is delivered. In order to keep the balance in the physical transactions the operators often have to recur to ancillary services for fast imbalance management.

More differences are present from an Information Technology infrastructure since every market has its own implementation and technological rules the participant has to follow to have a proper interaction in the market. The common aspect is the use of the Internet and the possibility to interact in the market with web-based applications. However for more complex and automatic interactions each market has its own implementation. There is not any standardization between different markets (even in geographically close markets such as France, Italy and Germany); so companies that want to participate in several markets at the same time must, in order to make the interaction more automatic than people filling web-based forms, develop their own set of specific applications to interface the specific reality of the specific market when available.

The main details of each specific market are summarized in a comparison chart in Table 1. The dimensions that are taken into account are:

- **Number of Entitled Participants**: the members that are legally entitled to operate in the market. This information can give a perception about the complexity and actual scalability requirements of the market.

- **Web Interface**: the presence between the mechanisms of interaction in the market of a web-based platform (i.e., a browser or a browser like application specifically developed) that can be used by the user to enter data about the quantities of energy that are bid.

- **Manual Files Upload/Download**: this features represents the ability of the web interface to upload/download files, in a specific-defined format, containing informations about bids. This procedure can speed-up the work of the market participants that can prepare those files in advance avoiding forms filling.

- **Web Service**: this feature refers to the possibility of interaction with the trading platform through interfaces based on web service technologies. These interfaces are provided by the market manager as another way of interaction in addition to the browser based interface.

- **SOA**: this feature is present only if the market enables a Service Oriented Architecture as a result of the provided interaction functionalities.

- **Proprietary/Open Solution**: this item refers to the type of platform required for trading, either it is a proprietary solution that does not enable much interaction or it is characterized by accessible open standards.
Additional Features: other interesting aspects specific for that market manager.

Table 1 provides an interesting insight on information systems used for energy trading in the different countries.

First of all the number of participants differs considerably: Japan has only 48 participants while in the USA PJM Interconnect alone has more than twelve times that number. Only for the German energy exchange the number of participants that are actually trading in the market (both for spot and derivative market) for the last year is given; while for other markets only the number of companies that have the right to trade is known. The information about the number of participants in the market gives also an idea about the complexity the information system has to manage. Moreover a limited number of participants allows the market operator to have more authority and more power in the technological choice for the platform to use, forcing the few participants to follow his rules.

The Web interface is the real constant between all the markets: every market enables the interaction through a Web browser or some sort of Web applications that are accessible through the Web browser (e.g., application downloaded and built at run time through java technology) through which the participant interact filling forms. In order to ease and speed-up the operations of the trader almost every market operator provides the upload functionalities to submit the bids, and download functionalities to retrieve the list of transactions cleared on the market. The type of these files is usually CSV or XML, that is also manageable easily by non-programmers with some kind of spreadsheet applications. In some cases, the market operator provides solutions (e.g., FTP server) or sample applications (that can be modified or integrated in market participant software suite) to automate even this upload/download interaction.

Market operators tend to provide solutions that are open to enable interaction with participant custom software. The main exception are the German and French markets that use propriety solutions. This is due to the influence the official trading platform of the German stock exchange (Xetra platform) has on those participants that are interested in the pure financial trading of energy commodities: they can use the platform and the knowledge they already own. The limited number of French market participants and the scarce number of contracts cleared on the market, compared to bilateral transactions, are a clear motivation not to require too much effort from the market operator to develop open solutions. However VALUES API can be used to create an extension to participant custom trading software to interact with a Xetra based platform.

The only two clear software solutions that are go towards the direction of a SOA system come from GME and PJM Interconnect. These two market operators provide extensive documentation about the interfaces that are exposed to participants through Web Service description Language (WSDL) and specifications about the XML conventions used, by providing Schemas in XML Schema Definition (XSD) files. The other markets do not have at the moment solution that follow this paradigm, but they try to provide external interaction through other mechanism that anyway miss the fundamental concepts of SOA and Web Services as well.
<table>
<thead>
<tr>
<th>Market Manager Name</th>
<th>Country</th>
<th># of Entitled Participants</th>
<th>Web Interface</th>
<th>Manual Files Upload/Download</th>
<th>Web Service</th>
<th>SOA Proprietary/Open</th>
<th>Solution</th>
<th>Additional Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>GME</td>
<td>Italy</td>
<td>190</td>
<td>✓</td>
<td>✓ XML format</td>
<td>✓</td>
<td>✓ Open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO New England</td>
<td>USA</td>
<td>422</td>
<td>✓</td>
<td>✓ CSV and XML format</td>
<td>X</td>
<td>X N/A</td>
<td></td>
<td>Possibility to use eMkt application</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Downloadable utilities for automatic upload/download</td>
</tr>
<tr>
<td>PJM Interconnection</td>
<td>USA</td>
<td>612</td>
<td>✓</td>
<td>✓ XML format</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Many software tools available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>One of the most advanced market operators</td>
</tr>
<tr>
<td>Elexon</td>
<td>UK</td>
<td>226</td>
<td>✓</td>
<td>✓ format according IDD rules</td>
<td>X</td>
<td>X Open</td>
<td></td>
<td>Low-end and high-end service available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Automatic file transfer through FTP protocol</td>
</tr>
<tr>
<td>European Energy Exchange</td>
<td>Germany</td>
<td>160 active members during last year</td>
<td>✓</td>
<td>✓ CSV format (for ComTrader platform)</td>
<td>X</td>
<td>X Proprietary Xetra based software</td>
<td></td>
<td>VALUES API are provided to interact with Xetra platform (APIs written in C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Fax based documents to submit offers is also available</td>
</tr>
<tr>
<td>European Power Exchange Spot</td>
<td>France</td>
<td>80</td>
<td>✓</td>
<td>N/A</td>
<td>X</td>
<td>X Proprietary software (SAPRI, Global Vision)</td>
<td></td>
<td>To submit data to CRE, specific Excel based format has to be used</td>
</tr>
<tr>
<td>Japan Power Exchange Spot</td>
<td>Japan</td>
<td>48</td>
<td>✓</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A Open as far as the small amount of information suggest</td>
<td></td>
<td>-Small amount of information in English</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-APIs for interaction with user custom application are available (no other information)</td>
</tr>
</tbody>
</table>

Table 1: G6 Information Systems Energy Markets Interaction Summary
Concluding Remarks

The main features of the current report want to describe the current operational mechanisms of the energy market of the most industrialized countries (former G6 countries) are presented in this report. We do not intend with this document to have a full and detailed description of each energy market also because the primary focus is on the information system perspective. In fact particular interest is devoted to the information systems and the technologies that are used to trade energy in the telematic market.

The key aspects show a fundamental homogeneity on the operational aspects of the market: the structure of the exchange is in practice common across the different markets. A common point form the technology perspective is the usage Internet based browser form filling for the basic interaction on the market. Much more heterogeneity arise in services that each market manager provides if a more automated interaction is required.

At the moment there is no standardization at the technological level, so companies that are present in more than one country have to develop specific software to provide an automated interaction with the market if necessary.

If the vision that is likely to establish in the following years is that of having much more small scale producers (e.g., micro-generation) across different countries that might interact with several market at the same time or companies that have big energy plants in certain countries and might sell energy in several other countries (e.g., the desertec project through which is envisioned that a big quantity of solar energy is produced in African deserts and exported to European markets) a standardization on the technology to access to the market is required. A natural way to address this issue is to enable an open common platform based on web services to realize a Service Oriented Architecture that only few markets enable today with their specific interfaces.

\footnote{http://www.desertec.org/}
References


