PERGAMON

International Journal of Project Management 20 (2002) 451–460

INTERNATIONAL JOURNAL OF PROJECT MANAGEMENT

www.elsevier.com/locate/ijproman

The OMEGA Project: Open Market Energy Generation Allocation in deregulated electricity markets

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Received 24 October 2000; received in revised form 7 February 2001; accepted 17 April 2001

Abstract

The OMEGA project is part of the 5th Framework Programme for R&D that the European Union has started in the year 2000. It is a highly complex and interdisciplinary project, with five countries and several companies involved. The project aims at developing a decision support system for electricity producers to support energy management and energy trading groups within these companies in the commercial activities on open and competitive electricity markets using an e-commerce framework. This paper presents the OMEGA project, describes the objectives pursued, evaluates the project workplan, shows the complex project management structure, highlights the management problems, and presents relevant conclusions.

Keywords: Project management; Electricity markets; E-commerce

1. Introduction

Since the European Commission presented its White Paper on the Internal Energy Market back in 1988, and especially since the introduction of its first proposal for a Directive on common rules for the internal market in 1992, a very lively debate has gone on at the European Union level as well as in the national capitals of the EU Member States regarding the liberalization of energy markets, and in particular of the electricity industry. Some Member States such as the United Kingdom had already set out on their own liberalization course during the 1980s in pursuing a general policy of liberalization and privatization of regulated industries (telecommunications, financial services, water supply) and of the energy market in particular (gas, electricity). However, it is reasonable to say that the debate at the European level was kicked off and subsequently kept going by the ideas put forward by the European Commission for the liberalization of electricity and natural gas markets which were worked out in the late 1980s and early 1990s. Although this European debate has not yet concluded, at the national level many policies for electricity competition and liberalization have been considered and discussed and in some cases are already being implemented by individual Member States, while at the European level the debate is continuing in full force.

The energy sector, not only in Europe but all over the Western world, faces a new business scenario due to the challenges arising from operating in a competitive market. This scenario introduces new business processes and also challenges the way traditional activities are performed.

E-commerce solutions have been proved very successful in activities such as retailing, air ticketing and hotel booking, entertainment, banking and finance. The number of such solutions has grown at a fast pace and it is forecasted to grow at even higher rates. However, e-commerce solutions oriented towards the improvement of the efficiency in many traditional industrial processes is not widespread. This is the case of the energy sector. Nevertheless, there are already in place some e-commerce solutions for energy spot bidding (e.g. Spain's Electricity Market, Amsterdam Power Exchange) but,

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0263-7863/02/$22.00
PII: S0263-7863(01)00038-2

although very successfully implemented, they provide only the mechanism for electronic bidding once the bidding strategy has been decided. Note that a bidding scheme in the electric sector implies generators freely offering prices for their energy generation. The energy offers are accepted in order of increasing price until the customer demand is met. The dispatched power units are paid the price of the most expensive offer, which corresponds to the so-called marginal or spot price.

The OMEGA project [1] aims to the development of concepts, models and tools for virtual marketplace and business communities. The result can be seen as a package tool for brokerage to enable new business models (i.e. open electricity markets) and new types of trades (e.g. electricity spot market). The innovative side of the OMEGA project resides in the use of e-commerce (by means of Web browsers, Active Server Pages, etc.) as the underlying technology providing a framework for a decision support system for the optimization of energy allocation using a stochastic approach. Such a solution is nowadays under development. Furthermore, there are very few operative e-commerce systems in the electric sector that integrate e-commerce with decision support capabilities.

2. Project objective

The main objective of the ongoing electricity market deregulation in Europe, and all over the world, is to decrease the cost of electricity, especially for industrial customers [2]. In such a context, all electric utilities must be able to generate energy at the minimum cost and must try to achieve the best value for their own production. Therefore, electric utilities have been or are being subjected to radical changes in their market and regulatory structure [3,4].

The goal of the OMEGA project is to contribute to the economic development of the European Union by ensuring its energy producing companies are exploiting the potential of electronic commerce.

The above goal is translated into the project objective that consists of developing a set of tools for supporting the energy management and energy trading groups within a generation company in the commercial activities of the different energy markets. The project's objective will be achieved by the operational goal that consists of developing, implementing and testing a decision support software to simulate and optimize trading oriented operations of a generation company operating in an open market via electronic commerce platforms. The software will address the generation allocation problem in an integrated manner and will be able to coordinate the decision problems with different time scales characterizing the open electricity market. Fig. 1 depicts the role of the OMEGA package in this context. The first interface layer is between the marketplace and the company managers through the e-commerce architecture. In this way, the managers are able to submit the bids and contracts selected by the OMEGA package. And the second interface layer is between the OMEGA package and the company managers, in order for them to get the right bids and contracts. In addition, the OMEGA package can access both the internal and market databases and the generating units (two-way connection) to help in the decision process.

3. Project workplan

The overall workplan consists of four main phases:

1. *Specification*. It consists of data collection for product validation, scenario generation, software definition, architecture design, model specification and electronic commerce protocol definition. This phase will be completed within the first 6 months of work.
2. *Prototyping*. Algorithm design and implementation of prototypes will be completed in month 12. The preliminary OMEGA modules will be evaluated on the data collected by the end-users; a prototype evaluation report will be delivered at month 17.
3. *Development*. The modules will be completed and integrated to form the final OMEGA package. The development will take into account the results of the intermediate validation performed in the previous phase. This phase is concluded at month 20.
4. *Assessment*. OMEGA assessment and evaluation on the data provided by the three end-users will be achieved at the end of the project (month 30).

The overall workplan is composed of 11 workpackages (WP), and within each WP there are several tasks to perform, as seen in Fig. 2.

WP1 and WP2: problem specifications, data collection and scenario generation. The end-user partners will be the major players.
WP3: the software design and requirements, the integrated architectural design, and the electronic commerce protocol definition of the OMEGA package will be established.
WP4: prototype algorithm design and software implementation.
WP5: algorithm design and software implementation for the modules 1: Medium-term Allocation of Bilateral Energy Sales Contracts, and 2: Water Future Expected Value Function Calculation.
WP6: algorithm design and software implementation for module 3: Weekly Energy Allocation.

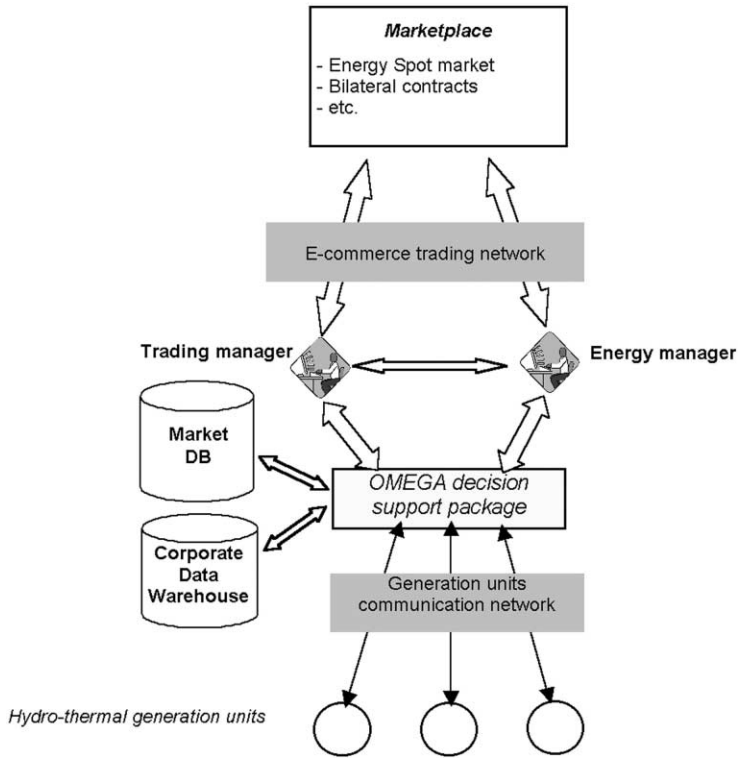

Fig. 1. Role of OMEGA package in a e-commerce competitive market.

WP7: algorithm design and software implementation for module 4: Energy Bidding under Uncertainty.
WP8: subsystems integration and interfacing designing and implementation, and product's release for final assessment and evaluation purposes.

The work in WP5, WP6 and WP7 will be carried out in parallel. The WP leaders and the project coordinator will be responsible for ensuring the appropriate coordination of the work.

WP9: system assessment and evaluation, which requires a heavy involvement of the end-users.
WP10: exploitation plan for results; it will involve all partners in three ways: internal exploitation by the end-users, dissemination of technical/scientific achievements by the academic partners, and commercial exploitation of the OMEGA package by the software vendor.
WP11: project organization and management, which is the main responsibility of the project leader.

At month 30 the final code will be released for exploitation purposes, and a final report will be produced to assess the gains from the project, specifically describing the major technical/scientific achievements and presenting the final exploitation plan and a business case.

4. Project management

Project management is considered of the utmost relevance for a challenging working environment such as the one presented. The two following subsections show its key elements. A specific project management work-package (WP11) is included for the implementation and execution of these management procedures.

4.1. General structure and core group

The project management is based on three main agents: the Project Manager (PM), duly supported by the Project Management Team (PMT), and the Project Steering Committee (PSC). Fig. 3 depicts the overall project management structure.

The *Project Steering Committee* (PSC) is the forum to control the project and decide upon top level strategic management matters. It is composed of one senior representative from each partner. The PMT members are also present. It meets twice a year, and at any other time at the suggestion of a partner or the PM. A chairman was appointed at the first meeting.

The *Project Manager* (PM) is the chief executive of the project and the chairman of the PMT. He reports to the PSC and is the official interface with the EU officers and the main responsible for all project matters and deliverables. He is in charge of all the management processes, adequately supported by the PMT. He takes care of the goals monitoring, the communication strategy, the coordination of activities and the resolution of conflicts. For this last point, he requires analysis and recommendations from the PMT before he and/or the PSC (the PM decides which forum to use) can reach a decision.

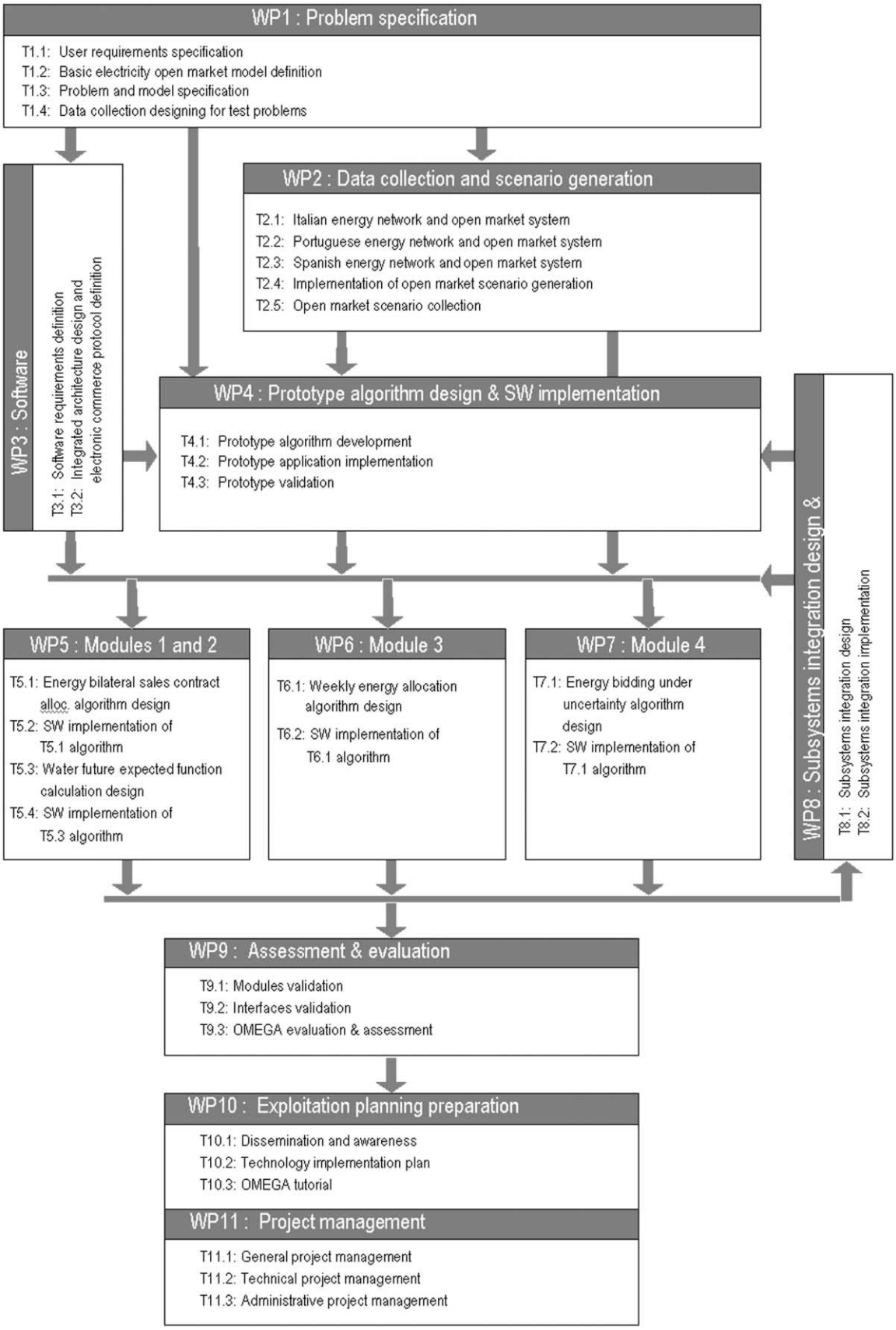

Fig. 2. Representation of the project's components.

The Project Management Team (PMT) assists the PM in his main decisions. Partners have agreed to institute it due to the project complexity. The Technical Liaison (TL) coordinates all technical activities. He acts as a liaison with the relevant WP leaders. Software quality is a main concern of the TL. For that purpose, he is assisted by the Software Quality Assistant (QA). The Administrative Liaison (AL), head of the administrative team, takes care of the administrative management of the project. The Administrative Team is composed of Administrative Officers appointed by the partners. Finally, the Exploitation Liaison (EL), leader of WP10, monitors the project development to guarantee that the exploitation objectives are achieved. He follows the Exploitation Team indications, which in turn is composed of representatives of the partners that veil for the fulfillment of their specific exploitation goals.

The Workpackage Leaders (WPLs) mission is the coordination, planning, monitoring, and reporting of their specific WP; they will act as a liaison with the Technical Liaison (TL). Whenever necessary the PM assisted by the TL and concerned WPLs may decide to settle adhoc operative structures (such as WP committees) for the efficient management of tasks.

4.2. Management instruments

Management reports are provided in a regular manner for monitoring and quality assurance purposes. The TL and PM use the WP individual reports as inputs for the project. Wherever adequate, reports include results obtained, compliance with the work programme and progress status of each task in terms of percentage of completion, estimated time to completion, person-months spent and person-months needed to complete the tasks. Detailed planning of the activities are prepared at the beginning of the work in a project launching document, detailing the tasks and the implication of the different partners. Project monitoring procedures are defined to early detect deviations from the initial planning, and guarantee progress towards the goals. At the PSC meetings and milestone reviews (months 6, 12, 17, 20, 24 and 30) the project progress and the outlook for exploitation of the results will be critically reviewed and compared to the initial planning and success criteria.

The communication strategy (CS) aims to give partners full information about the project status, the planning and all other important issues in order to maximise project transparency and increase co-operation synergies. All information (like minutes of meetings, visit reports, relevant publications, etc.) are communicated to the PM, who is responsible for channeling it to the other partners when appropriate. The use of e-mail, a data-base to easily obtain documents via FTP, and other electronic means are routinely used by the partners. The CS is reviewed at each PSC meeting.

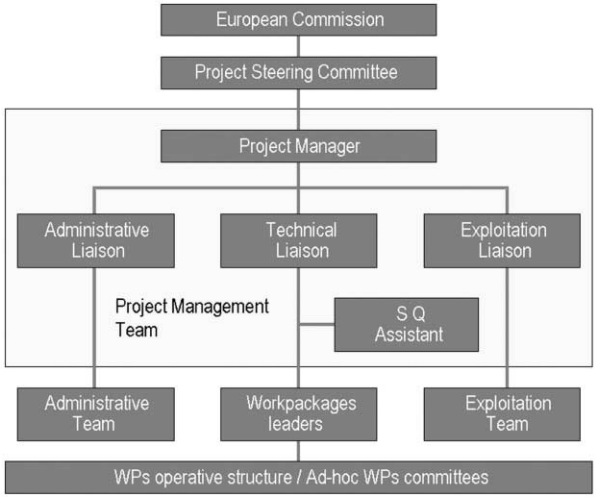

Fig. 3. OMEGA project management structure.

4.3. Management problems and experience

The development of the OMEGA project has been subject to several problems, mainly due to its multicultural context. Since the project is a consortium of industrial and academic partners, priorities are relatively different according to the members' background (Table 1). In connection to that, every partner almost always represents a different country and its view of the project is limited by the country's particular perspective. This means that there have been at least five different approaches to electricity market modelling.

The most difficult task in this project has been the harmonization of different requirements and objectives in search of a common modelling framework. Academic partners, more involved with research, need a significant time before industrial application of their research is possible. On the contrary, companies that will be future users of the project's software, are eager to use existing

Table 1
OMEGA project participants

Participant name	Participant short name	Country	Status[a]
IBERDROLA Ingeniería y Consultoría, S.A.	IBER	Spain	C
ENEL Produzione	ENEL	Italy	P
CESI	CESI	Italy	P
KW International Ltd.	KWI	UK	P
Norwegian University of Science and Technology	NTNU	Norway	P
REN-RED ELECTRICA NACIONAL, S.A.	REN	Portugal	P
SINTEF	SI	Norway	P
Universidad de Castilla-La Mancha	UCLM	Spain	P

[a] C, Co-ordinator; P, Principal Contractor.

Table 2
Project planning and time table

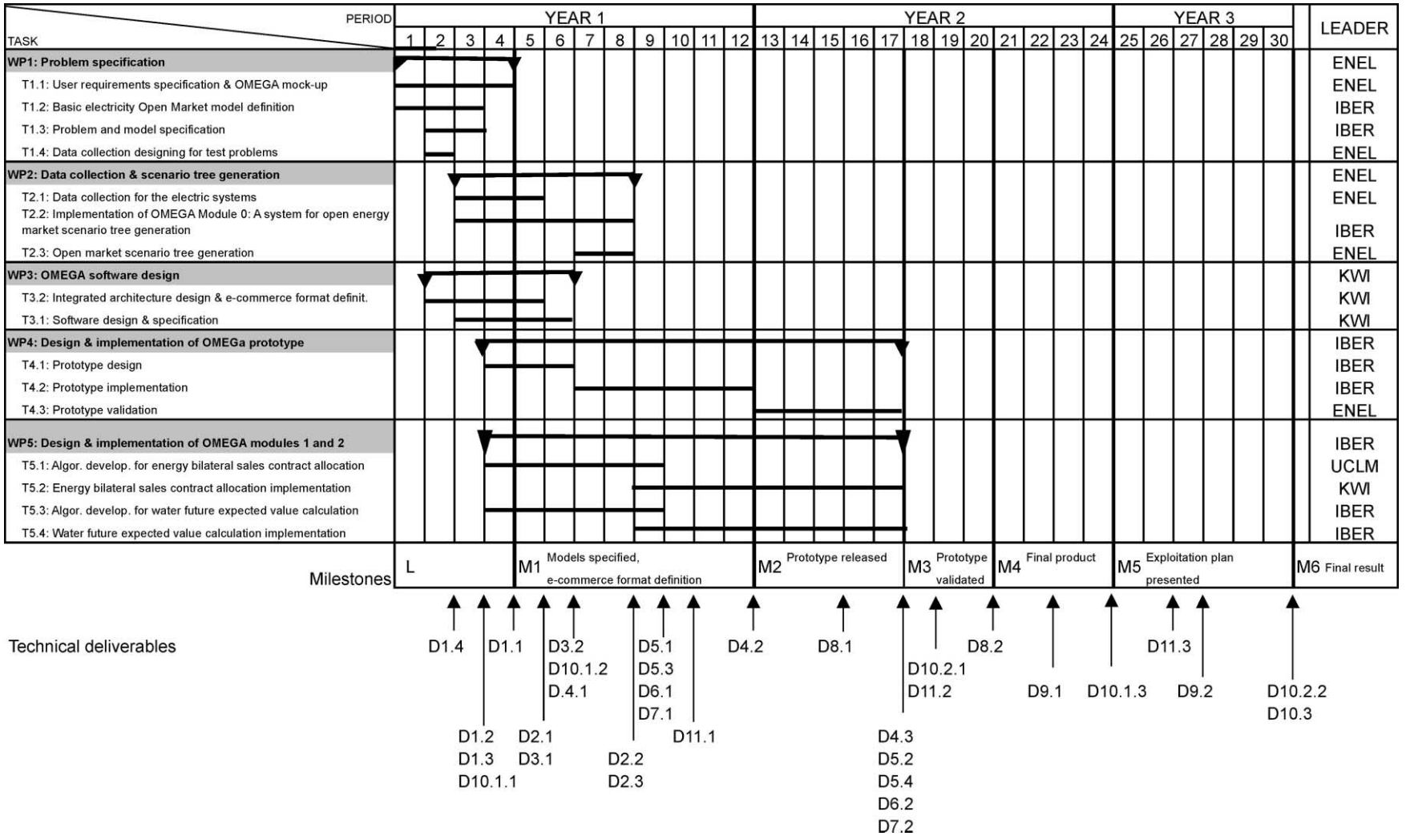

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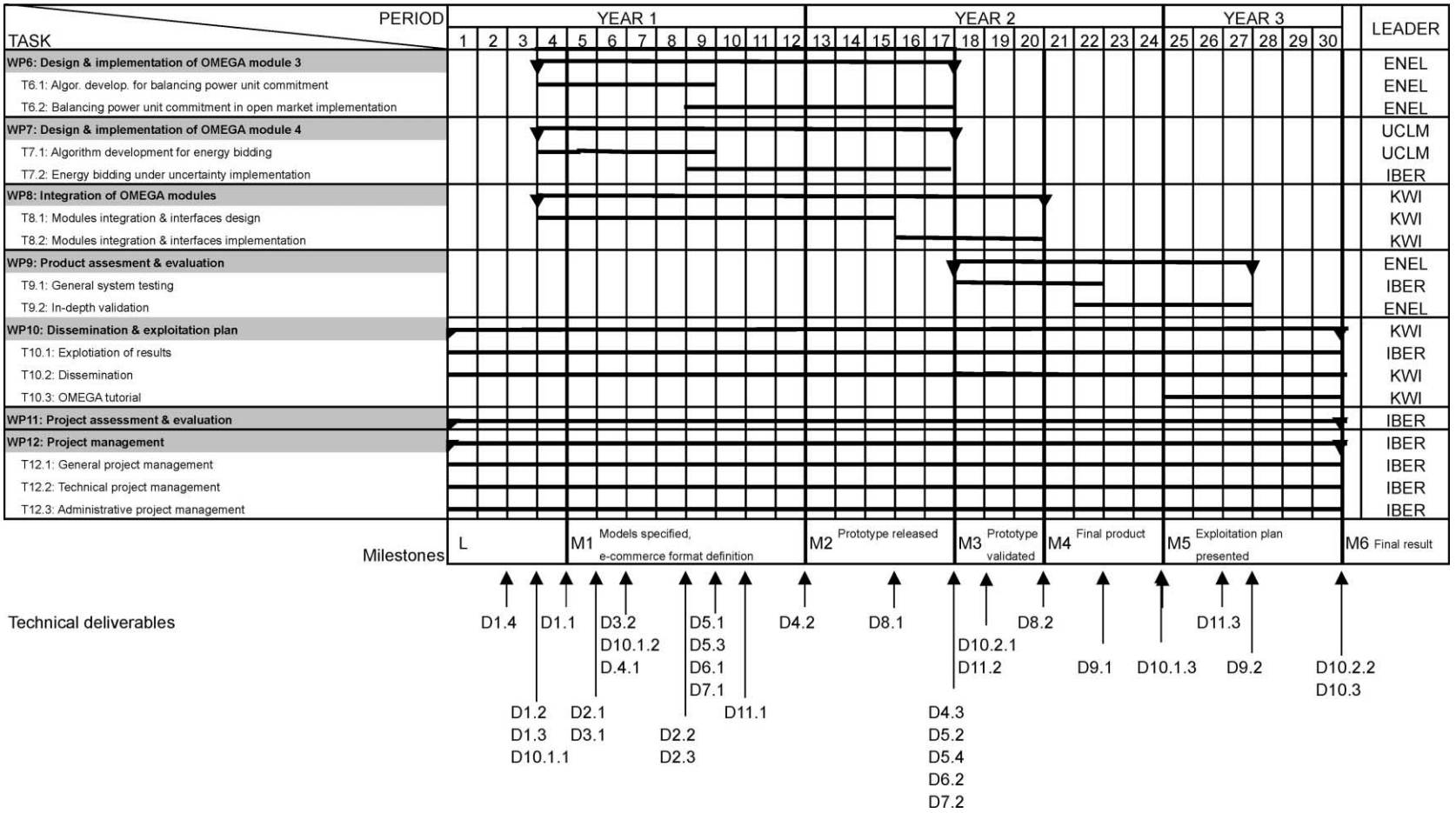
Table 2 (*continued*)



techniques to shorten the development time. Both academic and industrial approaches have been reconciled whenever possible.

What follows is a description of events that have been taking place from the beginning of the project.

The initial kick-off meeting took place on January 2000. At this meeting both the deliverable list and the Work Packages were introduced (see Tables 2 and 3 for the project planning timetable and the technical deliverables list, respectively). In this meeting, project costs were also presented, based on current manpower and hourly costs of every partner (see the cost breakdown structure in Table 4). The industrial partners got the lion's share, but they will also be the final users of the software. The proposal for estimated costs was approved without modification. Because the planning of the project was previously agreed upon by all partners, it was also approved. There was a clear distinction between tasks that should be performed by academic partners, industrial partners and software developers. Deadlines were clearly defined and all parties have been releasing their parts of the project with no relevant delays in later months.

Some disagreements between academic and industrial associates started when discussing the scope of WP2, the scenario tree generation, at a review meeting held in Porto, Portugal, in May 2000. Both IBER and NTNU are renowned experts in this field, although they have different approaches that produce similar results. During the meeting both parties supported their own standpoints and both approaches were incorporated. However, the lack of a common approach delayed and added extra complexity to the project. This issue is still under discussion.

Some additional disagreements were related to the use of different software packages by the parties involved. KWI was assigned the software development role in such a way that all the algorithms developed by the academic partners would be incorporated in a common platform. Since the academic institutions are the main developers of algorithmic prototypes, that need to be

Table 3
Technical deliverables list

Del. No.	Del. name	WP No.	Lead participant	Estimate person-months	Delivery (project month)
D1.4	Data collection design	1	ENEL	3.75	2
D1.2	Open market model specification	1	IBER	8.25	3
D1.3	Models description	1	IBER	5.50	3
D10.1.1	Project presentation	10	KWI	1.50	3
D1.1	User requirements specification and OMEGA mock-up	1	ENEL	20.90	4
D2.1	Test cases for the electric systems	2	ENEL	6.00	5
D3.1	Integrated architecture design and e-commerce format definition	3	KWI	19.00	5
D3.2	Software design and specification	3	KWI	16.50	6
D10.1.2	Dissemination and Use Plan	10	IBER	2.00	6
D4.1	Prototype design	4	IBER	18.50	6
D2.2	Technical report and SW implementation of OMEGA module 0: a system for open energy market scenario tree generation	2	IBER	8.75	8
D2.3	Scenario tree for the electric systems	2	ENEL	5.00	8
D5.1	Algorithm for OMEGA module 1: energy bilateral sales contract allocation	5	UCLM	16.00	9
D5.3	Algorithm for OMEGA module 2: water future expected value calcul.	5	IBER	7.00	9
D6.1	Algorithm for OMEGA module 3: balancing power unit commitment	6	ENEL	8.00	9
D7.1	Algorithm for OMEGA module 4: energy bidding under uncertainty	7	UCLM	16.50	9
D11.1	Project assessment and evaluation report A1	11	IBER	2.00	10
D4.2	Prototype implementation	4	IBER	20.50	12
D8.1	Modules integration and interfaces design	8	KWI	17.00	15
D4.3	Prototype testing	4	ENEL	12.00	17
D5.2	Subsystem code for OMEGA module 1: energy bilateral sales contract allocation	5	KWI	13.75	17
D5.4	Subsystem code for OMEGA module 2: water future expected value calcul.	5	IBER	9.00	17
D6.2	Subsystem code for OMEGA module 3: balancing power unit commitment	6	ENEL	19.00	17
D7.2	Subsystem code for OMEGA module 4: energy bidding under uncertainty	7	IBER	34.60	17
D10.2.1	Results from the OMEGA seminar	10	KWI	5.50	18
D11.2	Project assessment and evaluation report A2	11	IBER	2.00	18
D8.2	System code and user's manuals	8	KWI	21.00	20
D9.1	General system testing	9	IBER	17.20	22
D10.1.3	Dissemination and Use Plan updating	10	IBER	3.50	24
D11.3	Project assessment and evaluation report A3	11	IBER	1.00	26
D9.2	Product assessment and evaluation	9	ENEL	17.55	27
D10.2.2	Dissemination papers, webs, etc.	10	KWI	4.00	3–30
D10.3	OMEGA tutorial	10	KWI	7.50	30

tested on-site first (and later translated to other programming languages by the industrial partners), considerable delay has occurred to integrate all prototypes into the final product by KWI.

Another problem appeared months later, in November 2000, during a meeting with the European Union Project Managers in Brussels. The time scheduled to perform the EU review was adequate, but the project plan could not be fully explained to the EU officers. From the beginning, the number of questions and issues expressed by them delayed the presentation, making it impossible to carry out a complete review of the project. EU technical comments regarding the review meeting of November 2000 are quoted as follows [5]:

- The Consortium demonstrates adequate scientific expertise to arrive at successful results; however, the existing split in two camps endangers project progress and — ultimately — project success. This needs to be overcome.
- End user commitment is crucial as a prerequisite for the project to reach its objectives. So far, a strong level of activity can be seen.
- Experience from end users. Testing under different scenarios and market conditions should be the basis of the refinement of the software design. These plans should be documented in the related deliverable and prototype design.
- A detailed description of the intended market of the software is now of critical importance for the technical and future commercial results of the project.
- The models and tools for uncertainty handling and scenario development in the systems are critical and must be critically evaluated. The project should prove their successful application. The consortium must be aware that without a consensus on this subject the whole performance will be compromised.
- There remains a problem in the overall philosophy of the model, as the forecasted price in the e-market is used as an input in the optimization and production scheduling. If the producer using the system is large, as it seems to be assumed, then its market power will have an effect on the price, which on the other hand was taken to be predictable. The setting needs clarification.
- The web interface and integration into a front end to trading systems is a key element of the final development and must be diligently implemented, following the basic modular approach.

Some of the final recommendations expressed by the reviewers follow [5]:

- The consortium must make a joint effort to tighten up the development and to meet the project schedule; no further delays may occur. Tasks on data modelling and prototype design are crucial at the current stage. What is needed is a closer definition document, detailed design documents and a specification on how the prototype and scenarios will be implemented.
- End user involvement, to be documented, should be strong until the very end of the development, in order to assure the validity and usability of OMEGA. This concerns in particular system testing and in-depth validation. Prototype refinement, in line with end user requirements, should be intensively pursued. A cost-benefit analysis of results should also consider how this tool will contribute to the cost reduction for the consumers and how it will contribute to benefit the European industry.
- The results of ongoing tasks T8.1 and T8.2, dealing with integration of the modules and interface design, should be detailed and clearly assessed.
- In future reports it is important to make transparent and clear what the intended market is and the way this tool will be put in practice. It is important to clarify how this tool will be useful not only to centralized producers but also to players (and how).
- Dissemination and exploitation must be intensified and actions carried out. Contents and structure are to be improved. The coherence of Consortium partner activities should be emphasized. Results

Table 4
Cost breakdown schedule[a]

		Personnel	Equipment	Travel	Subcontracting	Overheads	Total
CO	IBER	464,608	0	26,291	6500	453,649	951,048
CR	ENEL and CESI	408,552	12,805	26,390	0	442,101	889,848
CR	KWI	292,873	16,938	26,848	0	300,105	636,764
CR	NTNU	89,417	0	20,423	0	17,897	127,737
CR	REN	118,494	0	16,890	0	91,222	226,606
CR	SI	134,612	0	24,442	0	149,373	308,427
CR	UCLM	102,026	33,200	9399	0	20,356	164,981
	TOTAL	1,610,582	62,943	150,683	6500	1,474,703	3,305,411

[a] Participant Role Codes: CO; coordinator; CR, Principal Contractor. All amounts are in E.

are to be presented. The Internet site must be populated with project information and made readily available to external users. A separate printed project brochure must be printed for wider dissemination through mail-shots or as hand-outs at dissemination events.

4.4. Management evaluation and conclusions

The EU's evaluation of the OMEGA project is described in the following [5]:

> Overall, project management needs to be tightened up. There has been an obvious communication problem among partners, as evidenced from the apparent essential, unresolved differences of opinion within the consortium on the modeling of the uncertainty and prediction of weather patterns, resulting in two separate parallel approaches currently being pursued. This is a major reason why the project is facing problems and delays. Another relevant reason is the different conception that the partners have of an electricity market. Partners' conceptions have to be unified. The project risks runing out of hand (with regards to time schedule, budget) and to be splitting into two separate developments without the possibility to bridge the gap, gravely endangering overall project success. A strong effort therefore must be made to overcome the separation and reach a consensus.

These views are fully supported by the authors, as previously explained in Section 4.3.

5. Conclusions

OMEGA will offer the power generating companies significant advantages towards an effective operation in the new electricity markets:

1. It allows the exploitation of the potential offered by an e-commerce network for electricity trading.
2. It supports new organizational schemes to enable energy producers, commercializers and energy users to establish new (electricity) supplier/consumer relationships. Note that the new open market tendency (already a reality in several countries, and just about to be in many others all over the world) consists of allowing suppliers and consumers to participate in the market by fixing their contractual terms (energy quantity and price, duration and interruption penalties, etc.).
3. It integrates multi-disciplinary technological approaches in a very innovative way, by using emerging technologies.
4. It anticipates market needs in decision support systems for the new energy open markets.

Overall, the expected economical impact of OMEGA on the European market is important, as it will support the trading operations in a competitive electricity market. This fact is expected to have a significant impact in terms of cost reduction for the consumers, with a positive implication on both the European industry and the citizens.

Although the software for development is targeting the electric sector, the methodology can also be used for developing an appropriate decision support system for the gas sector, where deregulation processes have just started, or are about to start in many countries. A gas market decision support tool, then, can use in a straightforward way the methodology to be developed in this project (except module 2, which applies only to energy systems with a hydro-generation component).

Large projects involving many countries are always problematic. Every country is tempted to see the world from its own point of view. The OMEGA project is a serious European attempt to make an impact on a market that is also targeted by US-based companies. European companies are still in time to develop the appropriate software and now, more than ever, the need for a common electricity market in Europe is imperative.

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