European Cooperation in the field of Scientific and Technical Research - COST -

Brussels, 21 November 2012

TD1207

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action TD1207: Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 186th meeting on 20 - 21 November 2012.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action TD1207
MATHEMATICAL OPTIMIZATION IN THE DECISION SUPPORT SYSTEMS FOR EFFICIENT AND ROBUST ENERGY NETWORKS

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to coordinate the ongoing efforts of experts of different fields, from academia and industry, in developing innovative tools for quantitative decision making, and applying them to the efficient and robust design and management of energy networks.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 64 million in 2012 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Energy Production and Distribution (EP&D) is among the biggest challenges of our time, since energy is a scarce resource whose efficient production and fair distribution is associated with many technical, economical, political and ethical issues like environmental protection and people health. EP&D networks have rapidly increased their size and complexity, e.g. with the introduction and interconnection of markets within the EU. Thus, there is an increasing need of systems supporting the operational, regulatory and design decisions through a highly inter-disciplinary approach, where experts of all the concerned fields contribute to the definition of appropriate mathematical models. This is particularly challenging because these models require the simultaneous use of many different mathematical optimization tools and the verification by experts of the underlying engineering and financial issues. The COST framework is instrumental for this Action to be able to coordinate the inter-disciplinary efforts of scientists and industrial players at the European level.

A.2 Keywords: Energy Networks Optimization and Safety, Infrastructure Optimization, Energy Saving, Mixed Integer Linear and Non-Linear Programming, Mathematical Modelling for Decision Support

B. BACKGROUND

B.1 General background

Energy management is of fundamental importance in Europe, and this will only increase in the future. Many European countries are reconsidering their energy infrastructure due to the continuous evolution of the involved political, economical, technological and ethical factors (e.g. the recent nuclear emergency in Japan). Energy management includes both Energy Production and Distribution (EP&D), which are tightly interconnected. Indeed, electricity cannot be effectively stored in large amounts, thus requiring to optimally coordinate production taking into account the many different energy sources, their characteristics and all technical, economical and regulatory factors. Furthermore, electricity can be generated with/substituted by other energy sources (gas, oil …) whose transport and use must therefore be coordinated. In other words, energy networks are already, and will be more and more, large-scale, valuable and interconnected systems requiring complex decision-making in all phases. Even minor improvements from design to operational management can have a substantial impact in many economical and ethical aspects of the society:

environmental protection, people health, responsible use of resources and fair energy distribution. Software tools based on mathematical optimization techniques have a long tradition in supporting planning and operational decisions in the energy sector; however, the current challenges call for a new generation of systems. This is due to the need of increasing both the scope and the granularity of the decisions, on the one side considering together what has traditionally viewed as independent (national electrical systems, electrical and hydrocarbon energy, …) and on the other hand including new factors like distributed generation by (many unpredictable) renewable sources and smart grids. This requires a highly inter-disciplinary approach where Application Domain (AD) experts of all the concerned fields and Decision-Support Systems (DSS) experts closely collaborate in the definition of mathematical models that on one hand accurately reflect the new reality of EP&D systems, but on the other hand are solvable within the time and resource constraints dictated by the operational requirements. This is extremely challenging because the models will necessarily be of huge size and simultaneously considering many different sources of complexity like discrete decisions (e.g. whenever parts of the system can either be functional or not), nonlinear processes (gas and power flows, fuel-to-produced-energy, water-to-produced-energy, …), uncertainty (energy demand, energy cost, availability of generating units, …), and interaction of different actors (producers, consumers, market operators, physical and social events, …).

B.2 Current state of knowledge

EP&D is and has been the subject of an enormous amount of research, with many international journals, scientific conferences, and entire research communities dedicated to the many different aspects of these problems. Energy issues are more or less directly at the core of a large number of European initiatives, even restricting to the most recent ones. Some of these are clearly and directly aimed at EP&D per se, like the whole of Euratom; these are mostly concerned with technological aspects of EP&D, which clearly are of paramount importance, although legal, regulatory and financial aspects are also considered. Yet, many other initiatives concern the energy aspects of all human activities at large. Even restricting to FP7 initiatives, the very recent FP7 calls alone contain over 20 energy-related calls, and many more previous initiatives are dedicated to energy issues (see Part E.3: Liaison and interaction with other research programmes).
This flourishing of energy-related initiatives on the one side clearly proves the crucial role that EP&D has in our society and the high stakes involved in future availability of affordable, clean and properly distributed energy. On the other hand, however, this multitude of different viewpoints and only partly related and communicating initiatives is a clear indication of the need of an overarching

coordination effort to support cooperation among the interested scientists and researchers and to avoid fragmentation and duplication of research. This is especially so since most of the research initiatives appear to concentrate more on quite specific issues, often technological ones, than on large-scale evaluation of all integrated aspects of EP&D; some of these issues are also hotly debated (e.g. impact of man activities on climate change, nuclear vs. renewables, hydrogen vs. hydrocarbons as energy vector, centralized decision and incentives vs. free market) and a significant amount of partisanship can be expected along the sidelines. Anyway, each of these research fields is vast, complex and possibly multi-faceted in itself, and having the different cultures and research communities to effectively communicate to each other to reach a global and unbiased view of all the relevant aspects of EP&D is absolutely nontrivial. To the best of our knowledge, such a coordination effort has not been tried yet. This is not particularly surprising, in that each research community involved in EP&D has its own views and objectives, sometimes contrasting with those of others, and even establishing a common reference system is nontrivial. This Action will help in this respect by tackling the problem from a different perspective: that of the Decision-Support Systems, based on mathematical models that are needed to rationally inform the many different decision levels in EP&D.

B.3 Reasons for the Action

The rationale behind this Action is to overcome the state of fragmentation and lack of communication between the different communities of experts interested to EP&D, comprising both AD experts (engineers, economists …) and DSS experts. Indeed, the latter are also traditionally subdivided into separate and often not enough communicating research communities devoted to the study of particular aspects of the solution of complex programs like discrete optimization, nonlinear programming, robust/stochastic optimization, multi-agent/multi-objective optimization and game theory, machine learning, and others. It is only recently that attempts of devising a unified methodological framework for those aspects flourished, as testified e.g. by the strong interest in Mixed-Integer NonLinear techniques from the academic community, commercial software developers and several large applicative projects (e.g. the “Open Grid Europe” project for gas transmission networks). This is due to the recognition that only properly considering all aspects one can model the wider range of complex structures required by the current industrial, technological and social needs, such as EP&D. While there is no lack of research in all the above aspects individually, both in terms of methodologies and of their application to EP&D, the sheer scale of

the problems and the number of different required approaches typically imply that each project focuses only on a small part of the issues, often inside a well-defined research community, such as experts in a particular methodology, experts in some particular energy issue, experts in the computer science and Information and Communication Technology (ICT) sides of the problems, experts of the financial side of the problems, and so on. This may result in duplicated efforts and lacks the critical mass to face the true challenges at the European scale. Hence, a coordination effort, which unifies these efforts in a wider framework, will entail substantial benefits both for EP&D and the study of DSS in general.

Indeed, the objective of the Action, which is to provide means for the different involved communities to collaborate and exchange research results, data and best practices will provide several benefits. From the EP&D viewpoint, close collaboration with top DSS experts will lead to more accurate models, which when validated and applied to the operating problems of the industrial partners will lead to cost/emission reductions, improvement of the efficiency and robustness of networks, and significant economic, political and regulatory impacts. From the DSS viewpoint, this will stimulate the development of innovative optimization methodologies, producing leading-edge scientific research, which, as usual in applied mathematics, will likely find use in other applied domains. As such, the Action will both advance science and technology in Europe and contribute to the satisfaction of pressing economic/societal needs.

EP&D is intrinsically interdisciplinary, comprising such diverse aspects as engineering and technological hurdles, economic considerations, political and regulatory issues, ethical decision-making, solution of mathematical problems and ICT aspects (e.g. data collection/management and computational solution of complex models). As such it involves different COST Domains, especially Earth System Science and Environmental Management (ESSEM) and of course ICT. More precisely, DSS based on mathematical optimization are part of the ICT Domain but they intrinsically need both iterative validation phases taking into account the diverse aspects outlined above and the positioning of those decisions within the framework of the Environmental Management. Such an interdisciplinary aspect of the Action makes it suitable for the COST framework and will be pursued so as to guarantee global benefits from design to management to operational handling of energy networks.

Coping with the highly inter-disciplinary nature of EP&D is nontrivial. The rationale of this Action lies in the fact that the development of mathematical models of reality is, and has always been, the “lingua franca” of science and technology. However, these models are only useful insomuch as they are algorithmically solvable; thus continuous interaction between DSS experts and AD experts is absolutely needed to avoid the risk of on the one side to optimally solving a model that does not

bear enough relation with reality to be actually useful to aid practical decisions, or, on the other hand, to define a very accurate model of reality that is not solvable efficiently enough to be useful. The Action will exploit and structure this necessary process to favour the timely and effective exchange of information between the many different involved research communities, in order to overcome the fact that the natural and unavoidable tendency to specialization often causes unnecessary, and actually harmful, fragmentation whereby the same concept is referred to differently among different communities, and the same techniques are developed several times over in different environments. This is true even among relatively narrow communities, such as the one concerned with mathematical optimization that is traditionally divided between Discrete Optimization and NonLinear Programming, despite the fact that both face the same basic set of underlying issues. Clearly, the tendency of re-developing from scratch ideas and tools already well-established in other disciplines is even stronger when facing intrinsically multi-faceted issues like EP&D, where communities with very different backgrounds and focuses need to effectively interact.

B.4 Complementarity with other research programmes

Several (funded) research projects, either academic or with the involvement of industry, are ongoing in many countries: Italy (Ministry of Research), Germany (energy company), Turkey (wind energy operator), Spain (energy company), Belgium (power/gas exchange), just to mention a few. In October 2012 a FP7-PEOPLE-2012-Initial Training Network on "Mixed Integer Non Linear Optimization" started its activity. All 14 groups of that network expressed their interest in participating in the activities of this COST Action and the synergies are certainly relevant. Connection with other FP7 ongoing projects of relevance will be created by sending invitation to workshops organized by the Action to potentially interested project partners. Projects with a potential linkage with COST activities are: FIT4GREEN (Energy aware ICT optimization policies) that takes into account networking aspects of energy saving policies, STORE (High temperature thermal energy Storage by Reversible thermochemical Reaction) that deals with unblocking the potential for energy storage infrastructure, PEGASE (Pan European grid advanced simulation and state estimation) that focuses on the most appropriate state estimation, optimization and time domain simulation frameworks, performance and dataflow requirements to achieve an integrated security analysis and control of the European Transmission Network, UMBRELLA (Toolbox for Common Forecasting, Risk assessment, and Operational Optimization in Grid Security Cooperation of Transmission System Operators, TSO) that aims to develop a toolbox to enable TSOs to ensure

secure grid operation also in future electricity networks with high penetration of intermittent renewables, and LIFESAVER (Context sensitive monitoring of energy consumption to support energy savings and emissions trading in industry) aiming at supporting manufacturing companies in optimizing the energy performance of their operations.
Moreover connection with other COST Actions will be established: Action IC0804 (Energy efficiency in large scale distributed systems) and TU1104 (Smart Energy Regions). COST Action IC804 will benefit from the result of this Action in the exchange of information and dissemination of innovative approaches, techniques and algorithms for saving energy, while COST Action TU1104 will take advantage of the information the present Action will provide on the technologies and processes available in order to create a low carbon built environment. Links with the COST Action MP1004 (Hybrid Energy Storage Devices and Systems for Mobile and Stationary Applications) will create an exchange of information on optimal use of scarce resources and storage availability and capacity. This Action will create connection with COST Action ES1002 (Weather Intelligence for Renewable Energies -WIRE) in particular with the activities related to new technologies dedicated to the management of power plants and electricity grids. Finally, synergies with the MARKet ALlocation (MARKAL) project will be established by exploiting the common focus on coordination and data analysis.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of the Action is to coordinate the ongoing efforts of experts of different fields, from academia and industry, in developing innovative tools for quantitative decision making, and applying them to the efficient and robust design and management of energy networks. The development of Decision Support Systems and their use in the energy production and distribution context aim at improving the economic, environmental and social impact of energy management in Europe.

C.2 Objectives

Multiple additional objectives, instrumental for the achievement of the main goal, will be attained by the Action. Namely,

- The applied context will contribute to push the simultaneous use of different methodologies, such as Discrete Optimization (DO) techniques and Non Linear Programming (NLP) algorithms, beyond their current limits, fostering methodological innovation in this emerging area of applied mathematics.
- PhD and Training schools, especially intended to involve early-stage researchers, will achieve the goal of training the next generation of scientists and practitioners to challenge the sidelines that --often surreptitiously-- divide different research communities, such as DO and NLP.
- The strong interdisciplinary nature of the topic will tighten the collaboration between Academia and Industry in an extremely strategic field.
- Researchers will be affected by the Action activities resulting in an impact on different scientific communities.
- Scientific articles will advance the academic knowledge.
- The need of practically solving industrial problems will require coordinated software development, which, in turn, implies establishing appropriate testing platforms and reference tools for analysis of the results, a long-standing and hardly obtained need.

C.3 How networking within the Action will yield the objectives?

Essentially, the main goal and all additional objectives listed in this section call for a coordination of efforts among different partners, namely, scientists in different (sometimes competing) communities, practitioners and industrial/political decision makers.
The first step of such coordination is the chance of working together, establishing a common language, understanding the real needs in the practical context, agreeing on unified platforms for validation, etc.
This is precisely the reason why intelligent networking within the COST Action will be instrumental to achieve the expected goals.

C.4 Potential impact of the Action

The leading idea of the Action is to overcome the state of fragmentation and lack of communication among the different communities of experts interested in EP&D, including both AD and DSS experts.

On the applied side, close collaboration with top DSS experts will lead to more accurate models, which when validated and applied to the operating problems of the industrial partners will reduce costs/emissions, will improve the efficiency and robustness of the networks, with an overall significant economic, political and regulatory impact.

On the scientific side, the interaction will foster methodological innovation especially in the emerging area of applied mathematics that simultaneously considers discrete decisions and nonlinear modelling. It will produce leading-edge scientific research, which, as usual in applied mathematics, will likely find use in other applied domains. As such, the Action will both advance science and technology in Europe and contribute to the satisfaction of pressing economic/societal needs.

C.5 Target groups/end users

The Action involves with the same role both scientists and application domain experts. On the scientific side, mathematical optimization plays a prominent role because the development of DSS is intended as an instrumental step for understanding the characteristics of the models in the Energy Production and Distribution area.
It is worth noting that the innovation and the key aspect of the Action is that the role of both scientists and application domain experts is totally equal: the end users will be the European citizens obtaining potential benefits from the interaction between those experts and their common discoveries. Because of what has been discussed above both scientists and application domain experts have been actively involved in the Action preparation.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The focus of the Action is on providing appropriate means to the different research communities interested in DSS and EP&D to effectively exchange results. This can be attained by taking a novel approach, that is, exploiting the often-overlooked fact that the construction of the mathematical models underlying a DSS entails the need to “distil” information about the actual application from the (often conflicting) view of the many different experts that study the different aspects of a complex problem. Thus, the construction of a DSS, other than a mean in itself, can also be a way for facilitating the dialogue and understanding between researchers and practitioners working (often, separately) on the different views of the same problem. The goal of DSS experts in this case is potentially different from that of all the AD experts of each individual aspect of the problem; the model has to be as much as possible an unbiased representation of reality if the results have to be acceptable for the actual decision process, and thus fairness is a fundamental prerequisite. A consequence of this state of affairs, that is not exploited often enough, is that mathematical models and the corresponding data are not only a technical mean to facilitate decisions but also a way to collect fair and unbiased representations of reality that help specialists focused on different aspects of the same problem to understand each other's views and thus reach a more global grasp of a large and complex problem such as EP&D.

It must be immediately admitted that, being the construction of these models in itself a rather complex activity (mainly due to the need of finding a workable compromise between the need of accurately representing the fragments of reality to be decided upon and that of algorithmically solving the model), the community working on DSS is certainly not immune from partisanship, and sidelines are indeed formed for relevant technical and cultural aspects like discrete optimization vs. nonlinear programming, constraint logic programming vs. mathematical programming, heuristic vs. exact approaches, and others. However, when applied to a vast and complex subject such as EP&D these differentiations have necessarily to be transcended in that the specific algorithmic technicalities are mostly a consequence of the particular application to be dealt with. That is, different algorithmic techniques are needed to tackle different problems, and with such a vast application portfolio as that required by the whole of EP&D basically all approaches are appropriate at some point or other in the decision chain. Furthermore, it is clear that these aspects are ancillary with respect to the need of efficiently providing effective decision support. Sticking to the DSS viewpoint can lead to an all-inclusive approach to EP&D that provides a convenient umbrella under which many current research initiatives and trends can be brought together to obtain the strong

synergies that are not possible in isolation. Furthermore, this Action is intended to provide a strong incentive and contribution to communication between the different communities interested in the various aspects of DSS systems, which in itself will improve scientific research and benefit numerous other applications other than EP&D.

D.2 Scientific work plan methods and means

The main challenge to this Action is to provide an environment for the exchange of research results that be on the one side rich and flexible enough to accommodate the diverse needs of the many and very different research communities involved, but, on the other hand, structured in such a way that each contribution can be placed in its appropriate context and easily retrieved by any interested party. To do that this Action introduces a matrix approach where the Action is organized into four Working Groups (WGs) providing a methodological subdivision of the activities and subjects together with three Transversal Topics (TTs), touching all WGs. Even this classification effort is nontrivial and possibly debatable, and there could have limitations and the existence of borderline topics that do not perfectly fit; however this is true for any such attempt.

D.2.1 Working Group 1: State of the Art

This WG will be participated by both DSS and AD experts in roughly the same proportion. The aim of the WG is to provide a comprehensive yet flexible and dynamic database of all applications of DSS to EP&D, with extensive cross-link. One nontrivial issue that will need to be faced is the fact that the same or closely related problems / methodologies are known with different names by different groups, and cross-references are not clearly established. As for the other WGs, other than by “traditional” means like conferences, researcher exchanges programs and summer schools (see Part E: Organisation), this WG will extensively enable web-based, dynamic and remote collaboration tools to produce a “dynamic memory” of the discussion that be immediately available to the other WGs, and later to all the interested researchers; “wiki” systems are likely one of the appropriate technological solutions. It is possible that subdivision of the WG into different sub-WGs will be appropriate, but the issue has to be properly discussed, as nontrivial cultural issues surely need to be sorted out. This whole process will be an interesting proof-of-concept that could subsequently be followed in other possible large and complex ADs such as transportation and healthcare.

D.2.2 Working Group 2: Methodology

This WG will mainly consist of DSS experts. The focus is to complement and contribute to the "wiki" of WG1 regarding the methodological advances that are relevant to make novel EP&D problems addressable. Due to the multi-scale and multi-featured nature of the problems, a relevant cultural issue will be to clarify the numerous existing links between the different approaches developed by different communities to face similar topics (e.g. search methods, global optimality checking, algorithmic techniques, exploitation of novel software and hardware architectures). This will provide an open forum for discussion and collaboration between experts of different approaches, which will surely end up providing cross-fertilizations and avoiding duplications.

D.2.3 Working Group 3: Validation

This WG will mainly consist of AD (EP&D) experts. The aim is on complementing and contributing to the "wiki" of WG1 on the subject of the technical validity of the mathematical models (and associated solutions) currently used in EP&D applications. In particular, the most relevant contribution of the AD experts will be the discussion of the limitations of the current models with reference to what would actually be needed in the application, and which improvements would result in the largest advances in term of effectiveness of the decision support. A fundamental focus for this WG is on data: collecting and/or developing detailed test cases for the various EP&D problems at stake, organizing them in appropriate hierarchies (possibly starting from the subdivision suggested by TT, but this can be subject to discussion), so that, for instance, multi-scale models can be built using data of smaller scale ones, and providing information about the best known decisions for each model, the efficiency of the corresponding solution approaches (in collaboration with WG2), and the issues encountered when these decisions have to be implemented in reality. A nontrivial technical issue to be faced is that on data formats, with the aim of establishing guidelines and possibly software components (in collaboration with WG4) that allow easy re-use and modification of the available data sets.

D.2.4 Working Group 4: Software

This WG will most likely consist of DSS experts, but several AD experts with an interest in algorithmic development and especially to software issues could provide a useful contribution. The main task of this WG will be to "substantiate" the methodological results of WG2 with actually usable software, ready to exploit data provided by WG3. An important focus will have to be onto the exploitation of structured modelling languages capable of providing a flexible, user-friendly yet mathematically sound representation of the many different models collected by WG1; this will be a

crucial step towards the stated goal of using mathematical models as a mean for enabling communication between different research communities, whereby models will have to be both easily understandable and verifiable by AD experts and immediately exploitable as input for appropriate solution approaches. Another significant focus of the WG will be on facilitating the exploitation of state-of-the-art methodologies of WG2 into as many applications as possible. This will probably dictate a substantial push towards these methodologies that can be effectively integrated into general-purpose solvers so that AD experts can use those solvers with little knowledge of the corresponding algorithmic issues and without extensive support from DSS experts.

As for the three transversal topics, our aim is to try to provide a fresh and comprehensive view of EP&D by describing each aspect not along the lines of one particular technology, system or approach, but rather according to the time-scale of the decisions that are involved. Thus, largely mirroring a classification that is well-known and used in many other contexts, this Action subdivides the discussion as follows.

D.2.5 Transversal Topic 1: Short-term (operational) EP&D

This concerns EP&D problems requiring decisions that affect a time span variable from the minutes to the days/weeks/few months range. These typically are scheduling and resource allocation problems involving

- production, such as Intraday Optimal Redispatch, Economic Dispatch, Unit Commitment and Market Positioning (Self-Scheduling and Optimal Bidding) in Electrical Power Production (EPP),
- distribution, such as AC/DC Load-Flow models in EPP and Optimal Gas Transmission and Procurement Policy in Natural Gas Distribution (NGD), and
- combined production/distribution such as the Optimal Transmission Switching in NGD and short-term Lot-Sizing and Transportation Scheduling in Oil Refinement and Distribution (ORD).

As usual these problems assume a very detailed knowledge of the system and the tasks to be performed, although uncertain elements can be present (e.g., energy demands or renewables energy production), and mostly focus on technical issues (e.g. production/distribution constraints, system stability) although financial aspects like pricing and bidding can also be included. This in turn calls

for very detailed mathematical models with both nonlinear and combinatorial aspects that need to be solved in very short time (seconds to minutes) and therefore a focus on the balance between the accuracy of the model and the responsiveness of the available algorithmic techniques.

D.2.6 Transversal Topic 2: Mid-term (tactical) EP&D

This concerns EP&D problems on time spans ranging from one week to one (or a few) year. Again these problems mostly concern the optimal use of the existing energy infrastructure and allocation of scarce resources such as water in hydroelectric systems, downtime in nuclear refuelling or network maintenance, and transmission/storage capacity or availability under existing contracts (considering such issues as capacity forwarding and take-or-pay) in hydrocarbon distribution. Due to the different time scale these problems are less concerned with a detailed representation of the technical constraints of the system. Instead, financial aspects and uncertainties regarding the future external and internal state of the system are considered in more detail. As such they typically still require nonlinear and/or combinatorial aspects, but also appropriate means for dealing with data uncertainty that make them considerably more challenging; furthermore, it is often the case that the system comprises different elements that are considered independent on the short term but that need to be tackled simultaneously in a broader perspective, giving rise to multi-source (EPP and NGD and ORD …) and/or multi-vector (pipelines and tankers …) setups. At this time scale one also starts to find multi-actor problems, usually related with the need of some central governing body of the energy system to ensure reliability and fairness in the face of contrasting needs from different actors, such as detection of possible treats to mid-term network stability or of anti-competitive behaviour or collusion. On the bright side, the longer time scale implies that the time constraints for the solution of these problems are less tight.

D.2.7 Transversal Topic 3: Long-term (strategic) EP&D

These problems concern the long-term evolution of EP&D over the course of several years due to the combined effect of several different factors. These can be incremental changes like expected variation in energy demand/availability/pricing or predictable technology improvements, whose economical, technical and regulatory aspects need be assessed beforehand to ensure stability, affordability and efficiency of the system; a well-known class of these problems concern long-term electrical network resilience against transmission and/or generation outages. However, disruptive events such as the introduction of entirely innovative energy models (the hydrogen scenario, smart grids, distributed generation) or substantial technological breakthroughs in crucial areas (shale gas extraction, energy storage by liquid supercapacitators, room-temperature superconducting) may also

need to be attentively studied, e.g., in order to evaluate the potential of each approach and inform political decision-making about research incentives. This kind of studies can (and should) use results from short- and mid-term problems, but typically call for somewhat different approaches such as scenario analysis and simulation, or at least an extra modelling layer such as game-theoretical or multi-agent approaches and multi-scale models. Furthermore, even with respect to mid-term models these problems are less of "repeatable" and more of a "one-of-a-kind" nature. This indeed is a strong element in favour of the need for a coordination effort, since, in want of a well-structured and available pool of knowledge (and software) for short- and mid-term problems, the long-term models are necessarily going to be implemented with very simple and crude approximations of the corresponding real technological issues. This has a potential substantial detrimental effect on the accuracy and relevance of the obtained results.

The above classification provides a handy guidance for researchers interested in different aspects of the problem. On the DSS side, many modelling and algorithmic techniques are more or less clearly fitted in one of the three TTs. Similarly, researchers in EP&D should find it easy to properly locate the TTs they are mostly interested in. Of course, for both the DSS expert side and the AD expert side there are several intersections between the TTs, as the same optimization technique can be used at several stages. However, this is true for basically all other possible (not extremely fine-grained) subdivisions, and this Action has the advantage of not following along the sidelines familiar to most researchers, be them DSS or AD ones. For instance, both nonlinear and combinatorial techniques are needed at all levels; similarly, a specific technological, financial or regulatory issue can have impacts on decisions at all timescales. This is consistent with the main aim of a COST Action, which is to gather a research community that is open and vibrant and thereby capable of seizing all the opportunities offered by a truly inter-disciplinary approach.

E. ORGANISATION

E.1 Coordination and organisation

The COST Action will be handled with an organized and effective structure. At a higher level, four Working Groups will work on State-of-the-Art, Methodology, Validation and Software. Transversally, all Working Groups will follow three planning and decision levels (Transversal Topics): Operational, Tactical and Strategic (see Part D: Scientific work plan - methods and means). These levels will identify the main research areas of the Working Groups.

The management and supervision of the Action will be operated by the Management Committee

(MC). During the first meeting, the MC members will nominate the MC Chair. The role of the MC Chair is to provide the reference point of the Action, to chair the MC meetings and to prepare all scientific reports such as the annual progress and the final report. The Management Committee will meet on a regularly basis every six months, mostly at some important milestones, where important reports are available, so as to perform a joint peer review and to quickly identify and resolve any issues that require attention by the MC. Milestones will include the Kick-off of the Action, setup of the COST Action website, MC and Work Group meetings, Training schools, Short Term Scientific Missions (STSMs) and publications. The MC will promote an active policy of short-term exchanges of young and senior scientists, with a priority for PhD and young postdoc students. The MC chair will arrange the assessment of the STSM and Training schools by evaluating how effectively they will contribute to the scientific aims of Action.

The Vice-Chair is nominated by the members of the MC. He/she will take care of practical issues and will represent the MC in the relations with the external world, thus allowing the Chair to concentrate on scientific and MC issues. The MC Vice-Chair will be responsible for reimbursement, preparing and sending financial and progress reports to the COST Office, will be responsible for fulfilment of web-based communication and project dissemination tasks, maintenance and logistics for all events and monitoring and evaluation of Action activities.

The Training, Dissemination and Liaison Manager (TDL) will support the MC Chair for the management and organization of the General and WG events. Finally, the TDL will be in charge of creating cooperation with other projects or industrial activities.

The Secretary will support the MC Chair and Vice-Chair in the preparation and running of the meetings by sending out the agenda and the appropriate reminders, by keeping updated the Key Performance Indicators for Action monitoring and evaluation of the activities and will manage the website through a content management system, so that the site can be kept constantly up-to-date.

The Steering Committee (SC) comprises the MC Chair, the MC Vice-Chair, the WG Coordinators, and the TDL. The SC will provide directions at strategic, tactical and operational levels. The SC will meet every six months (the meeting will be joined to the MC meeting and to the Action Conference), and should solve most of the issues by e-mail and/or phone/video conference.

The Action will achieve a significant networking effect among the 63 academic institutions and energy companies and industrial partners that already expressed their interest in participating. At the time of the proposal 16 different COST countries were involved. This networking effect will be achieved by:

- 1 coordinated series of seminars, organized at regular intervals from all partner institutions in turns and endowed with means for remote participation (web site with distribution of material and/or video recording);
- 1 Action Conference per year to discuss industrial experiences, methodological advances and software development (together with WG1 and WG2 meetings);
- 1 industry-driven workshop per year to validate the methodology in the applied context (together with the WG3 meeting);
- 1 workshop per year devoted to advances and coordination on software (together with the WG4 meeting);
- 4 PhD schools granting credits recognized by the academic institutions involved;
- 4 additional Training schools (one per year), targeting at a regular attendance of 100 PhD students/early-stage researchers.

Both academic and industrial researchers will be affected by these activities and the interdisciplinary nature of the topic will result in an impact on different scientific communities. Scientific articles will advance the academic knowledge. The need of practically solving industrial problems will require coordinated software development, which implies establishing appropriate testing platforms and reference tools for analysis of the results.
Specific monitoring tools for evaluation of the progress of the Action will be an online database of models developed, validated and contributed within the Action and a networking evaluation through a pictorial representation of a “collaboration (hyper)graph” in which nodes are the groups involved and an edge connecting two nodes represents an active and measurable collaboration.

E.2 Working Groups

The Working Groups will work by following the three Transversal Topics (decision levels), namely, Operational, Tactical and Strategic. The MC will elect coordinators for both WGs and TTs during the kick-off meeting. The WG coordinators are in charge of the technical and scientific coordination and they will support the MC Chair. The TT coordinators have the responsibility of coordinate the three decision levels within the different WGs. WG coordinators will carry out the following activities with reference to the WG they are in charge of:

- Coordinate the working group activities by organizing the research within the Action;

- State WGs progress by periodically compiling progress reports for the MC Chair;
- Plan the appropriate scientific meetings;
- Promote the writing of common publications;
- Promote the set-up of joint research (e.g., making use of STSMs).

WG scientific meetings will be organized once per year, when appropriate together with Action Conferences. Additional WG meetings will be organized when required within individual activities, for example in order to help participants to exchange information on current activities and to organize future activities. Most of the time will be dedicated to sessions during which research and development activities will be presented.
Each WG will propose Training Schools on specific research topics and will discuss them during the MC meeting. Each WG coordinator will collect and manage the applications for STSMs from students and researchers in the network and will present the candidatures to the MC for final decisions.

E.3 Liaison and interaction with other research programmes

This Action will cooperate with other existing European and international research programmes dealing with related topics. Energy issues are more or less directly at the core of a large number of European initiatives, even restricting to the most recent ones. Some of these are clearly and directly aimed at EP&D per se, like the whole of Euratom and the recent Energy Calls FP7-ENERGY-2013-1/2/IRP. These are mostly concerned with technological aspects of EP&D, which clearly are of paramount importance, although legal, regulatory and financial aspects are also considered. Yet, many other initiatives largely concern the energy aspects of all human activities. To mention but a few of them, the very recent FP7 calls for “Smart Cities and Communities” (FP7-SMARTCITIES-2013) contains several energy-related calls (FP7-ICT-2013.6.2/4, ENERGY.2013.7.1.1, ENERGY.2013.7.3.1/2, ENERGY.2013.8.8.1), the “Europeans Green Cars Initiative” (GC.SST.2013-1/7) and “ICT for Green Cars” (FP7-2013-ICT-GC) are largely energy-related and so is the “ICT for a Low Carbon Economy” (ICT-2013.6.5). Finally, energy concerns find their less central but still relevant role in many EU initiatives such as “ERA-NET Plus” (ENERGY.2013.10.1-1/3) and, of course, in environmental-related projects (e.g. ENV.2013.6.2-5 in call “Environment 2013”).
The cooperation will be established by personal contacts in the first instances. The members of the

Action that already are members of the other programmes will serve as the primary contact point for establishing the initial contacts. MC through relevant WGs will look at expanding contacts with other European and international research programmes by inviting scientists to participate in the Action conferences and focused workshops. Existing links to international experts in other continents will be maintained.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

Women and young researchers are highly represented as leaders and coordinators in the Action: women are nearly 40% of the unit leaders, and two thirds of the unit leaders are less than 45.

Training schools are especially intended to involve early-stage researchers at the deepest possible level. This is especially important because the interaction between Discrete Optimization and Non Linear Programming, two of the methodological topics involved, is a relatively new scientific field that needs to establish ways to train the next generation of scientists and practitioners.

F. TIMETABLE

Activity	Year 1	Year 2	Year 3	Year 4
Kick off	M1			
SC Meeting	M5 M11	M5 M11	M5 M11	M5 M11
MC Meeting	M5 M11	M5 M11	M5 M11	M5 M11
Mid term evaluation		M11-M12	M1	
Action Conferences	M11	M11	M11	M11
WG Meeting	To be decided			
Workshop	M5	M5	M5	M5
Industry driven workshop	M11	M11	M11	M11
Seminar	To be decided			
STSM	To be decided			
PhD school	M7	M7	M7	M7
Training school	M11	M11	M11	M11
Report	M11-M12	M11-M12	M11-M12	M11-M12

M=Month (i.e. M1 =Month 1)

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, DE, DK, EL, ES, FR, HU, IL, IT, NL, NO, PT, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 64 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

Both academic and industrial researchers will be affected by the Action. At a first level, dissemination will be achieved within the Action, because internal dissemination of the knowledge generated by each WG is essential for the proper integration of the work performed under the Action and will produce the synergies needed to tackle the complexity of topic. Three important aspects do guarantee this integration by dissemination. First, the participants have long-standing joint research tradition that will favour regular interaction. Second, the research topics are tightly connected and questions, results and achievements will move fast, fostered by the regular meetings. Third, the software that will be developed within the Action will be made available during the development phase, so as to allow multiple testing and a more robust software engineering design under the supervision of the industrial partners.

At a second level, dissemination will be achieved in the scientific community at large. Of course, the most important venue in this context is represented by publications in scientific journals and presentations at Action Conferences. However, the tight relationship with industry guaranteed within the Action by industrial partners allows the dissemination and exploitation of the results within peers, policy makers, decision makers and managers.

More specifically, the dissemination plan aims to reach beyond researchers, professionals and to the general public. To address the widest possible audience, the dissemination activities will be flexible enough to encompass:

- PhD students and young researchers who will bring new and disrupting ideas to discuss, by their attendance to the WG meetings and by preparing documents where their research results will be harmonized to those of the other Action participants;
- Senior researchers from universities and industries can be interested in participating in Action Conferences and WG meetings;
- Professors who will bring their experience and will be the workforce of Training Schools. They will host researchers in the context of STSM and will attend Action Conferences and WG meetings;
- Industries may directly benefits from the scientific results of the Action and could allow the exploitation of the results within policy makers, decision makers and managers;
- Institutional bodies in Universities;
- European Union project partners working with similar goals;
- Involvement in the Action of standardization bodies.

H.2 What?

Confirmation of project findings and requirements will be reviewed and presented at Action Conferences open to consortium members and interested parties alike. These meetings will be used to disseminate project knowledge and gather opinions on the Action.
The announcement on Training Schools and Short Term Scientific Missions (STSMs) will be posted on COST website and in appropriate newsgroups on an international level, in particular dmanet and opt-net are the reference for Mathematical Optimization, and also on a national level in all countries of potentially interested candidate, specifically on the distribution lists of various national societies in Mathematical optimization and Operations Research and other relevant websites.
The Action will develop the project website and will ensure the proper operation of its various functionalities. This dynamic website will be the primary tool of communication for those involved in the Action and all information to be shared amongst the participants and also to the general public will be placed on this website. Dissemination will be achieved also through an intensive use of the project website (publication of technical reports and blogs) and ICT tools such as mailing lists and social networks.

Results and experiences throughout the course of the project will be published through the partner newsletters on a regular basis and articles will be available for download on the website.
At a high level the website will contain the following details:

- Objectives of the Action;
- Working Groups including the description of research activities, objectives and participants contacts;
- List of publications;
- Call for the participation to STSM and Training Schools;
- Newsletters;
- Links to the other relevant FP7, COST or National projects and other relevant websites;
- Scientific work carried out during the duration of the Action.

H.3 How?

Dissemination will be carried out using the following means:

- Public website, which will be set up at the beginning of the Action, and continuously updated, containing information for all audiences;
- Distribution of publicly available reports for discussion at Action's meetings, aiming at Action's participants;
- Joint as a result of the work put together in the Action, aiming at Action's participants as well as external parties;
- Contributions to standardization, authored by Action's participants, as a result of the work put together in the Action, aiming at external parties;
- Tutorials (half- or one-day long), adjacent to meetings, aiming at Action's participants, but open also to external parties;
- Collaboration with industries by inviting experts at meetings;
- Proceedings of Action Conferences aiming at both Action's participants and external parties;

- The final outcomes and the results from the work of the Action will be presented in a series of technical presentations organized into different sessions based on the themes of the Action. All the technical presentations will be made by members of the Action and invited external experts;
- A final publication will summarize and promote the contributions and achievements of the Action.