



Distributed Intelligence in Critical Infrastructures for Sustainable Power

ENK8-CT-2002-00673

Dissemination And Use Plan

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CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

The CRISP consortium consist of:

ECN	Principal Contractor & Coordinator	The Netherlands
ENECO	Principal Contractor	The Netherlands
INPGrenoble	Principal Contractor	France
Schneider Electric	Principal Contractor	France
EnerSearch AB	Principal Contractor	Sweden
Sydkraft AB	Principal Contractor	Sweden
Blekinge University of Technology	Principal Contractor	Sweden
ABB AB	Principal Contractor	Sweden

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable PowerControl Versions:

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1 **CRISP Overall Dissemination And Use Approach**

This chapter describes the general, consortium-wide dissemination and use approach and actions by the CRISP project as a whole. In the chapter that follows, the partner-specific dissemination and use activities are described for each individual project partner. Finally, the reader will find some samples of dissemination results in the Appendices.

1.1 **CRISP vision and value in brief**

The central objective of the CRISP project is to investigate, develop and test how the latest advances in distributed intelligence by information and communication technologies (ICT) can be exploited in novel ways for cost-effective, fine-grained and reliable monitoring, management and control of power networks that have high degrees of Distributed Energy Resources (DER).

The CRISP vision is that recent progress in intelligent ICT offers many novel opportunities to build new operating strategies for high-DER power networks:

- Parallel to the power grid, an extensive data-communication infrastructure emerges through various (and usually hybrid) means including fibre, telephone copper, wireless or the power line itself. This communication infrastructure covers different system levels of the power grid, even reaching the very fine-meshed level of individual customer equipment.
- Embedded real-time communication and computing processors enable to create smart equipment with “local intelligence” at increasingly affordable prices.
- New software technologies for building distributed online at-a-distance applications have become available, including intelligent agents, electronic markets, and other mechanisms for distributed intelligent information systems. Worldwide standards help to achieve this in a cost-effective way (e.g. IP).
- System integration using ICT creates new requirements on security and protection of information. But, safeguarding the systems must be motivated from a cost-benefit analysis.

However, it is our view that today the potential stemming from the rapid advances in industrial ICT is not yet fully known, explored and exploited by the utility industry. We believe that there is a lot of mileage to be gained by *combining the capabilities* delivered by two different critical infrastructures: the power grid and intelligent ICT networked systems. Precisely here lies the unique contribution and added value of the CRISP project.

The CRISP project thus intends to bridge the gap between the latest advances in intelligent ICT and their strategic use in applications optimising power networks. It sets out to deliver several innovative results to the utility sector:

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- Novel strategies and solutions for both normal and emergency operations in power networks with high DER penetration degrees, exploiting intelligent ICT.
- Software and simulation tools, with a library of e-market and intelligent agents algorithms and architectures for power applications.
- Validating “proof of concept” tests and experiments in different countries that cover a variety of network and customer situations.
- Practical recommendations and guidelines for the strategic use of intelligent ICT in high-DER power networks.

In sum, CRISP will greatly expand our insight into how emerging distributed intelligence technologies provide novel ways to assist the utility industry in the management of high-DER power networks.

1.2 CRISP dissemination and use strategy

The CRISP dissemination and use strategy is a combination of consortium-wide and partner-specific responsibilities and actions. Its major elements are the following:

1. For external information and promotion purposes by the consortium to the public at large, the above general summary of the CRISP goals and contributions have been laid down in a project flyer, a project slide presentation, and a project website.
2. “*Spreading the word*”: the interaction of distributed intelligence ICT technologies with their application to energy technology and engineering by the utility business requires a special extra effort to explain the general trends, challenges and issues in the area, and to transfer cross-disciplinary expert knowledge between these rather different and still quite separate technical fields.
3. For the industrial companies involved in CRISP, the focus of dissemination and use resides in learning from and exploiting successful results ensuing from the project, with a view to strengthen the business and enhance the relationships with relevant clients.
4. For the research and university partners in CRISP, the focus of dissemination and use is to strengthen collaboration with industry through practically relevant research results, publicize them professionally, and do so at a large scale wherever possible, and provide new contributions to academic and executive education and expert human resource development.
5. For the consortium as a whole, an active policy is followed of involvement in EU project cluster coordination in the area of Sustainable Energy Systems, whereby CRISP has a special contribution to make regarding ICT and distributed intelligence aspects.

Concerning the first and second points, a project flyer, a project slide presentation, and a project website have already been produced and will be maintained during the project (see also the Appendices to this DUP document). “Spreading the word” is furthermore catered for

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by our substantial activity in external talks, presentations and PR, as well as by active involvement in project cluster exchange and coordination (point 5).

Concerning the third and fourth points, Chapter 2 discusses the respective efforts of all partners in detail.

Concerning the fifth point, the CRISP project participates in the project cluster coordination activities on Integration of renewable energies and distributed generation into the European energy sector. The goals of this cluster are:

- Making stakeholders aware of the increasing importance of RES + DG compared to conventional systems.
- Removing technical, economical and regulatory barriers to grid connection of RES + DG.
- Acceptance of intermittent RES + DG grid solutions without risks in quality and safety.

Among present running projects and proposals under negotiation, this cluster currently includes the following EU projects:

Contract Nr.	Title
ENK5-CT-2000-20336	Investigation on Storage Technologies for Intermittent Renewable Energies: Evaluation and recommended R&D strategy. INVESTIRE NETWORK
ENK5-CT-2001-20528	European Network for Integration of Renewable Sources and Distributed Generation. ENIRDG net
ENK5-CT-2001-00522	Distributed Generation with High Penetration of Renewable Energy Sources. DISPOWER
ENK5-CT-2001-00577	Policy and Regulatory Roadmaps for the Integration of Distributed Generation and the Development of Sustainable Electricity Networks. SUSTELNET
ENK5-CT-2002-00610	Large-scale integration of microgeneration to low voltage grids. MICROGRIDS.
ENK5-CT-2002-00673	Distributed Intelligence in Critical Infrastructure for Sustainable Power. CRISP

New projects that may be funded in response to future EU Calls may join this cluster, or alternatively other appropriate additional structures may be set up.

The cluster will hold a number of meetings during the duration of the respective projects. Comments of the enlarged combined partnership will be welcomed to improve the content of the ongoing work in CRISP within the constraint of the available budgets. The cluster meetings will include presentations of CRISP results obtained, with a view to solicit comments of the cluster partnership in order to enhance the value of the results by further

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power analysis, experimentation, and/or use.

In addition to these consortium-wide dissemination actions, each individual partner is concerned with dissemination to and use by specific target groups. The company-specific dissemination and use plans are presented in the next Chapter.

2 Individual Partner Contributions To Dissemination And Use

2.1 ABB

Beside the formal reports and deliverables to CRISP, three dissemination activities are planned so far: a licentiate work at Lund University, a diploma work at Chalmers Institute of Technology, and a technical report submitted for the 2004 Cigré conference in Paris.

2.1.1 Licentiate work at Lund University

A licentiate thesis project entitled "Intelligent Load-shedding in Power Systems" has been defined at Industrial Electrical Engineering and Automation at Lund University. The CRISP work is very much supported by this thesis work, and all the results will be available for the CRISP project and a part of WP 1.5. The university academic level requirements ensure a high quality of this part of the CRISP project. The relation to the university also provides more possibilities to do detailed studies, e.g. by the means of diploma workers, and make the results easily available to the CRISP project. The Ph.D.-student, Zoran Gajic, is an employee of ABB, with a great practical experience in the area of substation automation, protection and control. Mr. Gajic is responsible for the field measurements, and the evaluation of the results. The layout for the licentiate thesis is as follows:

1. Introduction
2. Background
3. Detection of power system emergency conditions
4. Modelling of emergency conditions
5. Actions without communication
6. Actions with communication
7. Laboratory experiments
8. Field trails
9. Suggestions for future work
10. Conclusions

The project will start with literature studies and field measurements on the radially fed island of Öland, which also comprise a substantial amount of wind power generation.

2.1.2 Diploma work at Chalmers – Laboratory tests

Since it is very hard to study controlled power oscillations in real networks, a laboratory project for a diploma work has been set up at Chalmers University of Technology.

2.1.2.1 Laboratory equipment setup

The laboratory equipment at Chalmers comprises a DC motor drive, connected to a 400 V AC generator, six power line elements that can be freely connected in different structures, and a number of load models and objects. The total length of the line model is 900 km. The model can also be connected to the Nordel network. Two transformer models with tap-changers are also available. The model is shown in Figure 1.

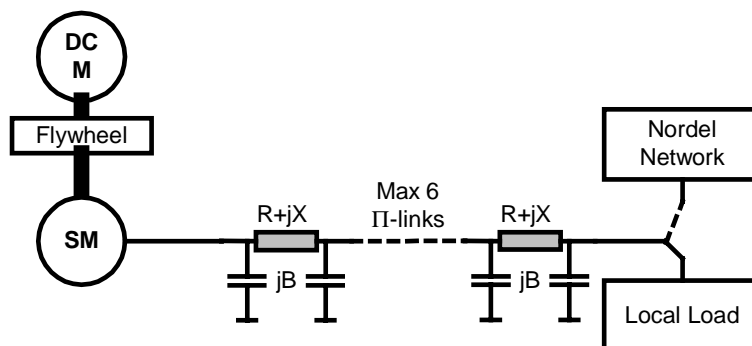


Figure 1: 400 V, 70 kVA laboratory system set up at Chalmers.

2.1.2.2 Diploma work specification

The aim of the diploma work is to derive algorithms to *detect* and *characterise* power oscillations, in the frequency band of 0.1-10 Hz. The algorithms shall be based on local measurements of P , Q , V and f , as well as on angle differences of the voltage vectors in different parts of the system. Also algorithms to damp these power oscillations by the means of

- voltage control on generators (AVR), SVC or TCSC,
 - shunt capacitor or shunt reactor switching,
 - governor control on generators, or load switching,
- are included in the study.

The analysis work could be based on the CIGRE Nordic32 model of the Nordic network, SIMPOW, PSS/E or Eurostag, and some system identification program, such as Matlab. Implementation and test of the theoretical results in the analogue network analyser is scheduled.

This diploma work will be conducted in co-operation with Solvina, in Gothenburg.

2.1.3 Cigré 2004 Synopsis

A synopsis for the Cigré 2004 Conference in Paris has been submitted. The Swedish National Committee, for publication, has also recommended the paper proposal. However, a message from Paris has been received that says that the proposal is not accepted. An

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investigation is going on about the situation. If not accepted for Cigré it will be published somewhere else.

2.2 *Blekinge University of Technology*

2.2.1 *Partner role and nature of intended results*

Blekinge Institute of Technology (BTH) has a focus on applied IT. This means that the institute has established research and education programmes with a focus on societal as well as scientific aspects. In effect, the strategy of the institute is modelled as a triple helix process based on research, applications and innovation systems.

Of specific strength of the institute are research and education programmes in Software Engineering and Computer Science at the department IPD. To support the knowledge transfer between research and education on one hand and industrial applications on the other hand we have two research laboratories. One laboratory SOCLAB is focusing on building tools and platforms, within the methodological framework Online engineering, in the area of Network Enabled Capabilities (applications include Network Based Defence, Distributed healthcare, and Critical infrastructures). Although trustworthy components can in principle be validated off-line, it is impossible, both in practice and theory, to validate trustworthy runtime behaviour off-line. In fact, this is the reason for our investigations in Online Engineering. The other laboratory, SecLab, focus on Security Engineering aspects. The knowledge creation and transfer is supported by iterative development of prototypes.

The role of Blekinge Institute of Technology in CRISP is threefold.

- Models of ICT-support of sustainable operations of power networks that have a high degree of DER. A crucial issue is the coordination of resources and demands from the electric grid with customer related demands. This coordination will take place in different abstraction levels as well as in different configurations. To allow this flexibility we are investigating and extending Semantic GRID architectures of services.
- Providing models of cost efficient protection of business processes. Integration different technologies give new opportunities as well as create new vulnerabilities. Protection of assets is an ongoing process that builds on trustworthy components and trustworthy execution environments. A specific topic in trustworthy systems is to provide means to ensure secure execution of insecure programs. This topic will be of specific interest in CRISP. However, there is always a trade off between how much security measures that are introduced and efficiency and costs. Development of models supporting a cost benefit analysis of business processes is therefore a difficult but important issue in CRISP.
- Participation in Field tests. Validation of systemic behaviour of complex systems can only be done in real settings. Setting up and evaluation of proper field test is therefore a crucial activity both for our academic research as well as for the industrial maturity of our research.

2.2.2 Target groups for dissemination and use

BTH has five target groups for dissemination and use.

- Industrial and academic partners in other projects on Network Enabled Capabilities. Knowledge creation and exchange in workshops.
- The CRIS network. BTH is responsible for the computer division of the CRIS institute.
- The scientific community. Papers in journals, books, and in conferences.
- Academic degrees.
- Impact on basic education in the area of Network Enabled Capabilities.

2.2.3 Dissemination and use actions up to September 2003

The ideas behind the CRISP project were communicated and discussed in the consortia in the preparation of the DeSIRE - Dependable Systems and Information Infrastructures Research and Exploitation - project proposal to EC FP6. In fact RES-based power application was chosen as a major test of the expected results of that project. Unfortunately, the EC did not at the end accept the proposal as such.

2.2.4 Planned future dissemination and use activities

We will address the specific target groups listed above in parallel activities as the project evolves.

2.3 ECN

2.3.1 Partner role and nature of intended results

ECN (Energy Research Centre of the Netherlands) is the leading institute for research and development of energy technology in the Netherlands. With a staff of about 900 persons working in the field of energy research, it works in close co-operation with other research organisations and industry, both national and international. R&D on the integration in energy systems is considered one of the core activities in the areas of renewable energy and clean fossil fuels. Research activities cover the areas of Solar Energy, Wind Energy, and Renewable Energy in Built Environment, Biomass, Clean Fossil Fuels, Fuel Cells, Policy Studies and Energy Efficiency in Industry.

ECN participates in a large number of EU projects in the field of Distributed Energy Resources including BUSMOD, DGNET, DISPOWER and INVESTIRE and is coordinator of CRISP and SUSTELNET.

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The research done by ECN in the CRISP project is focused on the development of intelligent ICT-applications and architectures for supply and demand matching. These solutions contribute to the transition towards a sustainable energy system in Europe.

In the CRISP project, ECN develops knowledge of new, cheap, reliable and widely applicable ICT solutions and architectures that will be disseminated to its clients in further R&D, field tests and consultancy projects. A major goal here is to support players on the energy market with their development of new products and services in a liberalised energy market.

As a co-ordinator of the CRISP project, ECN represents the CRISP project and it results in Europe-wide dissemination activities, such as the DG-cluster "Integration of Renewable Energies and Distributed Generation".

The mechanisms for dissemination are:

- Spin-off research and development projects
- Integration of gained results in other activities and projects
- Consultancy activities
- Scientific publications
- Conference contributions
- Talks regularly given to research colleagues and collaborating industries.

2.3.2 Target groups of the dissemination and use

For ECN, the main target groups are:

- Players on the energy market in Europe, such as: Utilities, Energy service companies.
- Suppliers to the energy market, such as: ICT developers, Manufacturers and Service Providers.
- Other R&D institutes active in the field of distributed generation.

2.3.3 Dissemination and use activities up to September 2003

The following dissemination and use activities have been executed to date (status 1 October 2003):

- Being the coordinator of the CRISP project, ECN has joined a number of cluster meetings that were organised and held in Brussels, Rome.
- The CRISP website has been set up, www.ecn.nl/crisp (see also the Appendix) which provides general information about the CRISP project to the public. Also the public

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deliverables can be downloaded from the site. A protected member-section is set up where internal project documents are stored and made available to the project members.

- Presentation of the CRISP project as part of the DG-cluster activities at the CIGRE conference, Barcelona, Spain, May 2003.
- Preparation of the CRISP-contribution to the US-mission that is organised by the DG-cluster and that will be executed in November 2003. The aim of the trip is to exchange results of R&D between Europe and the US, in order to identify areas for possible cooperation in the field of Distributed Generation.
- Electricidade de Portugal, contribution to an in-house workshop that was organised by EnerSearch, presenting intelligent ICT solutions for demand and supply issues, October 2003.
- Industry meeting with Labein, Bilbao, Spain at November 4, 2002, presenting the CRISP research.
- At different occasions with other ECN research groups, the CRISP project has been presented, in order to incorporate contributions from related research areas to the CRISP project.
- Participation in the PLMA and PLMA/IEA congress on Demand Response Resources in New York on September 8/9 and 9/10, 2003.
- Participation in the IEA expert workshop, held in New York on September 11 and 12, 2003, with the aim to develop a work plan for a new IEA DSM task on Demand Response Resources (DRR). ECN was invited as an expert in this field and contributed with the experiences of the CRISP project and other research in this workshop.
- Preparation of new project initiatives for follow-up and implementation of CRISP-results.

2.3.4 Planned future dissemination and use activities

ECN will continue to actively disseminate the CRISP project, with the following planned actions:

- Continuous contribution and involvement in the DG cluster "Integration of Renewable Energies and Distributed Generation" as co-ordinator of the CRISP-project.
- In a number of bilateral talks and industry meetings parties in the energy industry will be informed about the results.
- Participation in the US-mission that is organised by the DG-cluster in November 2003 to exchange results of R&D between Europe and the US and identify areas for possible cooperation in the field of Distributed Generation.

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- Contribution to the Distribution Europe 2004 conference, held in Amsterdam, 27/28 April 2004, focused on new solutions for European energy grids.
- Contribution to ISPLC2004, International Symposium on Powerline Communications and its Applications, Zaragoza, Spain, April 2, 2004.
- Contribution to PLMA/IEA conference on Demand Response Resources, September 2004 in California.
- Participation in the planned IEA task on Demand Response Resources (DRR), as Dutch coordinator and expert.
- Contribution to the IRED initiative, "Integration of Renewable Energy Sources and Distributed Generation into the European Electricity Grid" (EU Coordination Action).
- Regular internal exchange of project results among ECN research groups.
- Preparation of new project initiatives or contributions to further investigate, demonstrate and develop ICT applications for Supply and Demand matching.

2.4 ENECO

2.4.1 Partner role and nature of intended results

ENECO Energie specialises in the trade and supply of gas, electricity and heat and offers related services either through its own units or via ENECO subsidiaries. ENECO is headquartered in Rotterdam; its units and subsidiaries operate from various establishments elsewhere in the Netherlands. The company employs a staff of 5000 (year 2003). All ENECO shares are currently owned by 70 municipalities in The Netherlands.

ENECO Energie provides its services in the various market segments through a network to 3,6 million connections, comprising electricity and gas/heat connections. A total of approximately 4 million people use energy supplied by ENECO. ENECO offers a range of high-quality integrated energy services that help the organisation distinguish itself from competitors. Thanks to many establishments all over the country, ENECO Energie is able to offer a strong regional commitment. In the philosophy of ENECO Energie, energy services involve more than merely delivering energy on the customer's doorstep. ENECO Energie decided to specialise in the energy business in order to be able to help customers find solutions that fit their energy needs. We identify with our customers and suggest alternatives.

ENECO Energie has chosen to maintain energy as its sole core activity. ENECO Energie's strategy is targeted primarily at the sale and transportation of energy and secondarily on the supply of products and services that, on the one hand, stimulate the sale of energy and, on the other, make a positive contribution to the operating results. On the basis of its market vision, ENECO Energie has chosen the aggressive development of activities up to the meter. By 'activities up to the meter', ENECO Energie means the transport and supply of

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electricity, gas, heat, durable energy and the provision of services and information, such as invoicing, quotations and customer service. ENECO Energie intends to develop its market position further by excelling in these activities. ENECO Energie wishes to strengthen its position in the Netherlands still further and to become one of the leading energy companies in the Netherlands, by acquiring a strong national market position and by creating customer loyalty. From that position, ENECO looks for opportunities to co-operate with a major foreign partner.

Facts 2001: (combined ENECO Energie & REMU)

Commodity	Amount	Market share
Electricity:	17,100 GWh	25 % Dutch market
Gas	6,069 million m ³	27 % Dutch market
Heat	1,079 TJ	

In the horticulture segment ENECO Energy is market leader, owning a market share of 66 % of the Dutch market.

2.4.2 Target groups for dissemination and use

The main target groups for ENECO Energie are:

- The different divisions such as Energy Services, Business to consumers; Business to Business etc;
- Direct business partners of ENECO energie.
- Research organizations and individuals in the area of IT and Energy.

2.4.3 Dissemination and use actions up to September 2003

ENECO Energie has already carried out the following dissemination and use actions to date (status 1 September 2003).

ENECO Energie has presented and promoted the CRISP-related topics in:

- Internal talks with the ENECO Energy sustainable and trade units and the management
- External talks with the (possible) partners Sercom, Enatec, Enginion and Valliant.
- Publication in Abstract for "Distribution Europe 2004", Topic: 1.D Asset management - Managing decentralised generation

2.4.4 Planned future dissemination and use activities

Information and presentations will be given in different ENECO Energie units and in the management group. Information about the CRISP project will be released on the ENECO Energie intranet, ENECOplaza and in ENECO Breed, a customers' magazine.

2.5 EnerSearch

2.5.1 Partner role and nature of intended results

Enersearch AB is a Europe-wide industrial research consortium, headquartered in Sweden, with the mission to create and communicate knowledge in the field of *"Energy business strategy and ICT technologies in a liberalized market environment"*. It initiates, carries out cooperative research in project form, and transfers knowledge through collaboration with industrial, academic, public and customer partnerships on an international level. EnerSearch strives to be internationally recognized and accessed as a cutting-edge knowledge source of new ideas, cross-disciplinary expertise, and network alliance capabilities in linking R&D to applications of ICT in the energy industry sector of interest to stakeholders in energy markets, communities, and regulation. EnerSearch is organized as an SME limited company supported by major players as its shareholders. Its current shareholders are: IBM utility (UK), ABB (Sweden), E.on Energie (Germany), Sydkraft (Sweden), EDP (Portugal), ENECO (Netherlands), ECN (Netherlands), and Iberdrola (Spain). EnerSearch is also co-founder and shareholder of the worldwide institute for critical infrastructures CRIS, which is one of the dissemination channels for results of the CRISP project. For the general public interest it maintains a website (<http://www.enersearch.com>) where it publishes many of its research results as papers, reports and books.

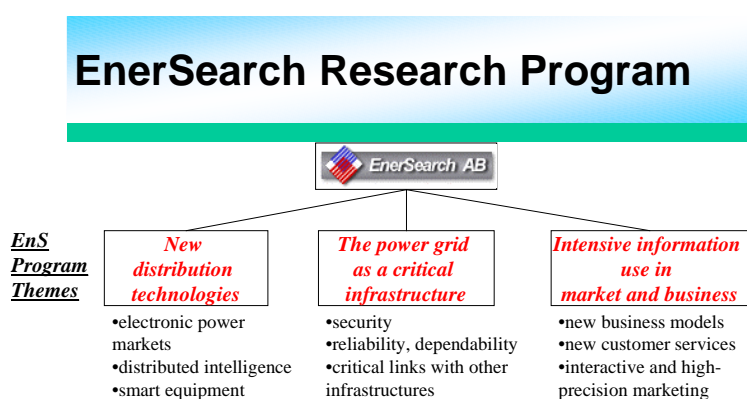


Figure 2: EnerSearch program themes.

The role of EnerSearch in the CRISP project is twofold:

1. At the technical side, EnerSearch has an important role in developing the electronic market and intelligent agent algorithms for distributed power applications.

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2. At the management side, EnerSearch is leading the Workpackage on dissemination and exploitation (WP IV).

It follows from the EnerSearch mission that dissemination of produced knowledge on IT and Energy is a key function for EnerSearch. The main mechanisms to do so are:

- Promoting awareness and knowledge exchange on business and technology trends and issues in IT in Energy. This is done through organizing a variety of events, meetings, talks, and publications targeted at stakeholders in industry, academia and policy-making.
- Publicizing recent advances in IT in Energy research and industrial innovation and enhancing their visibility through appropriate industrial, academic, and electronic public media.
- Playing an initiating and strengthening role in establishing RTD collaboration and exchange between industry and academia in Europe, crosscutting the traditional disciplinary and organizational boundaries existing in the fields of energy and IT.

These are also the main channels through which EnerSearch will disseminate the results of the CRISP project.

2.5.2 Target groups for dissemination and use

For EnerSearch, the main target groups for the dissemination and use activities are:

- Its own shareholding companies in the utility and IT industry.
- The energy and related IT industry sector in Europe.
- Research, technology, and policy organizations and individuals in the area of ICT and Energy.

2.5.3 Dissemination and use actions up to September 2003

EnerSearch has already carried out the following dissemination and use actions to date (status 1 September 2003).

To support the dissemination activities of the consortium as a whole, the CRISP *flyer* and a CRISP *project presentation* (slides) have been produced (see the Appendix).

First of all, EnerSearch is actively participating in the EU project *cluster coordination* meetings in the Sustainable Energy Systems field that are regularly held (Hans Akkermans, a.o. Brussels, Belgium, 6 March 2003). EnerSearch also participates in the *EU-mission to the US*, with the specific responsibility to represent and be the European contact point for the ICT aspects.

EnerSearch has presented and discussed the CRISP project with all its shareholding companies (listed above) at the EnerSearch general board meetings held on 8 October 2002

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

in Lisbon, Portugal, and on 23 May 2003 in Amsterdam, Netherlands.

EnerSearch is making strong efforts to present and promote the CRISP-related topics to a significant number of industries outside the project. These activities are very successful and attract a significant audience. Specifically we mention here:

- *Electricidade de Portugal*: as part of an in-house company workshop at EDP with over 50 attendees, EnerSearch has extensively discussed trends and issues in distributed intelligence as handled by CRISP (Hans Akkermans a.o.; Lisbon, Portugal, 9 October 2002).
- *EU-IST*: As part of the yearly EU-IST conference and exhibition, EnerSearch helped organize a special workshop on IT and energy as critical infrastructures (Hans Ottosson; Copenhagen, Denmark, December 2002).
- *ENI Tecnologie*: A keynote presentation on developments in distributed intelligence technologies was given on invitation to the internal conference “*Knowledge-Based Systems in the Energy Industry*” of ENI, the Italian oil company. The number of attendees was over 125; a summary of the presentation was published in the regular newsletter by ENI Tecnologie (Hans Akkermans; Milan, Italy, 12 December 2002).
- *Electricité De France*: EnerSearch has presented the CRISP project at the CRIS board meeting organized by EDF and the CRIS Institute (Hans Ottosson, Hans Akkermans; Guadeloupe, France, 18 December 2002).
- *Norwegian Research Council/CognIT*: an invited talk was given on distributed intelligence applications as part of the Semantic Web Seminar organized by the Norwegian Research Council jointly with the Internet company CognIT. The number of attendees was about 45 (Hans Akkermans; Oslo, Norway, 17 January 2003).
- *DISPOWER consortium*: EnerSearch has presented the future role of distributed intelligence for the utility industry and the CRISP project, as a special invited lecture at the plenary meeting of the DISPOWER project hosted by Iberdrola. Number of attendees was about 65, representing all partners involved in DISPOWER (Hans Akkermans; Madrid, Spain, 30 January 2003).
- *Philips Consumer Electronics*: CRISP issues have been presented and extensively discussed on invitation at an internal seminar of Philips, especially in the context of ambient intelligence as applied to innovative energy e-services in the residential (“smart homes”) sector. Number of attendees was about 50 (Hans Akkermans; Eindhoven, Netherlands, 19 March 2003).
- *EU-IST*: Business and technological innovation issues relating to emerging distributed intelligence technologies and applications were discussed in a series of lectures at the European PhD Summer School SSSW-03, organized by the EU-IST Network of Excellence OntoWeb and hosted by the Universidad Politecnica de Madrid. The number of attendees was about 75 (Hans Akkermans; Cercedilla, Spain, 20-26 July 2003).

In addition, there has been a wide range of individual contacts and meetings with companies including EDF, SAP, London Electricity, the Denmark transmission company, grid companies in Ireland, Slovenia and Poland, Amsterdam Power Exchange, Alstom,

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

Regiocom, Boeing, and others. These contacts indicate that there is a clear general interest in the ongoing work in distributed intelligence for DER.

2.5.4 Planned future dissemination and use activities

EnerSearch will actively continue its dissemination activities along the above lines.

The CRISP project results will be further disseminated to the EnerSearch owners in the board of directors meetings, and also to interested utility companies in workshops and seminars that are regularly organized by EnerSearch.

Also in the area of external promotion and publicizing we will continue our strong efforts. Specific actions that are already certain in the near future are:

- *Norwegian IT and Energy Conference*: Hans Akkermans has been invited to deliver the keynote speech at this conference, organized by the Norwegian Research Council and to be held in Bergen, Norway, 23-24 September 2003.
- *BNAIC-2003*: A technical paper on electronic markets for networked control applications (relating to CRISP WP II) written jointly with the Free University Amsterdam and ECN has been accepted for the Belgium-Netherlands Artificial Intelligence Conference. The paper will be published in the Proceedings and presented at the conference in Nijmegen, Netherlands, 23-24 October 2003.
- *German Energy and Communication Symposium*: EnerSearch will give an invited talk on intelligent systems, the Web and electronic energy services at this conference, organized by ISET in Kassel, Germany, 13-14 November 2003.

As many or even most of these activities are on invitation, we have no doubt that this form of dissemination will successfully continue.

Further, EnerSearch is striving to enhance the RTD collaboration between industry and academia. In the context of the CRISP project, building new expert human resources by supporting industrial PhD work is a concrete way to do this. Specifically:

- The technical work of EnerSearch in the project is partly carried out as part of PhD thesis work in cooperation between industrial project partners (especially Sydkraft and ABB) and Uppsala University, Sweden. It is expected that the PhD thesis can be successfully completed within the lifetime of the CRISP project.
- EnerSearch is planning to support new industrial PhD work in the area, in collaboration between ECN, ENECO (and others), and the Free University Amsterdam, Netherlands.

These activities help ensure that academic research is practically and industrially relevant, and in addition it helps to overcome the existing interdisciplinary gap between IT and energy research.

Finally, EnerSearch intends to step up its already active involvement in exchange and coordination of projects, clusters, and networks at the EU program level. Specifically, the following actions are foreseen:

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

- *IREC*: in the FP6 project cluster area of SUSTDEV/Sustainable Energy Systems, IREC is a new coordination action that is currently under negotiation. EnerSearch is partner in this Coordination Action with the specific responsibility to lead the work concerning the ICT-related aspects.
- *BRIDGE ICT-DER*: EnerSearch is planning to initiate a strategic support action and to coordinate a strong consortium, concerned with developing an EU-level strategy that addresses the key needs for RTD for IT in energy, gives authoritative recommendations on its major directions and research strategies, and establishes a bridge between the EU-SUSTDEV and EU-IST programs.

Our central aim here is to create a platform of strong players in Europe that are able to integrate and exploit the as yet untapped potential of current innovative ICT developments for the energy and utility sector.

2.6 INPG/LEG (year 1, then IDEA)

2.6.1 Partner role and nature of intended results

Institut National Polytechnique de Grenoble (INPG) is a technological university consisting of nine engineering schools. INPG's scope and influence, due to its excellence in teaching and research as well as its close links to the industry, have consistently expanded and now, INPG enjoys an international reputation as one of France's finest universities of technology.

The strong links between teaching and research at INP Grenoble is the guarantee of up-to-the-minute knowledge and its transmission to engineering students who benefit from the privilege of having access to outstanding research facilities. The majority of INPG-affiliated laboratories conduct high-level, fundamental research with a view to industrial applications; internal INP Grenoble organizations, acting in an advisory and logistical capacity, ensure the transfer of technology. The laboratories concentrate on four sectors:

- Computer Science and Applied Mathematics
- Mechanics and Mechanical Engineering
- Materials and Process Engineering
- Automation, Signal Processing, Microelectronics and Electrical Engineering.

Industrial systems are the fifth domain of research including conception, logistic, technology and process for industrial systems. The particular activity of power engineering is carried out at the Laboratoire d'Electrotechnique de Grenoble (LEG), (<http://www-leg.ensieg.inpg.fr/>): The Laboratoire d'Electrotechnique de Grenoble (LEG), depends from Institut National Polytechnique de Grenoble (INPG) and Université Joseph Fourier of Grenoble (UJF). It is a premier French research institution with the largest number of scientists working in the area of electrical power engineering. The LEG includes 4 administrative staff members, 20 engineers, 11 C.N.R.S. staff members, 38 teaching staff members, 57 graduate students

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

working on PhD. thesis, 71 graduate students and others (D.E.A.). The laboratory is subdivided into six groups:

- Electric systems and networks (SYREL)
- Power Electronics
- Electrical Machines
- Magnetic Material for Power Engineering
- Computer Modelling of Electrical Process
- Conception and Diagnostic Integration

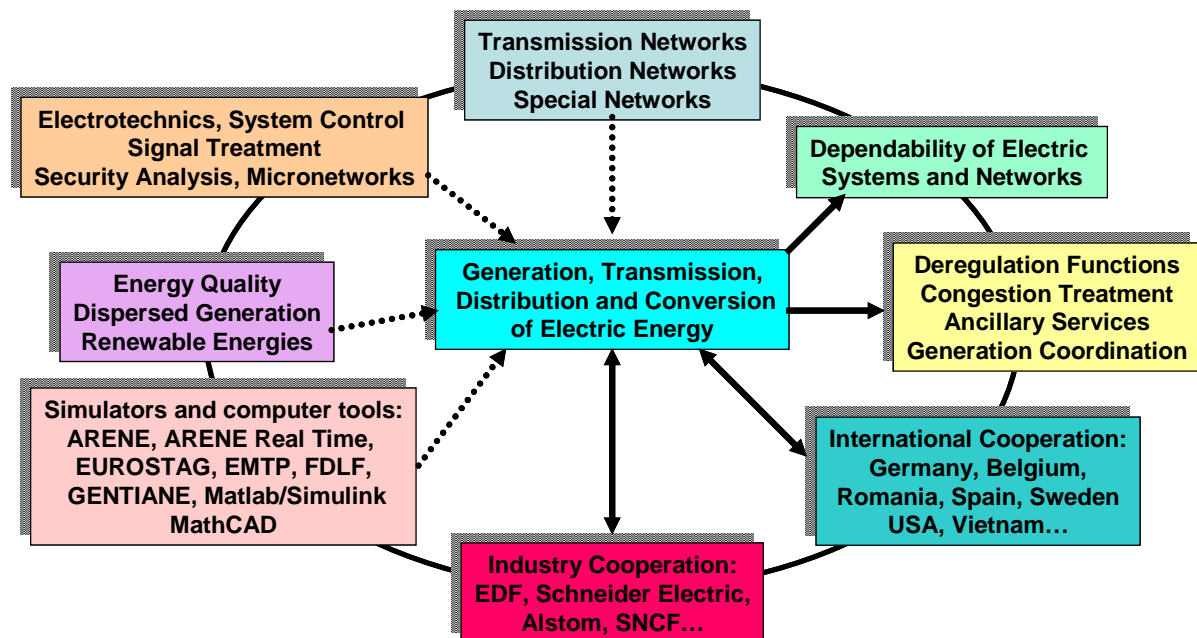


Figure 2: General research themes of INPG/LEG electric systems and networks Working group.

The laboratory works in co-operation with all the French companies, active in this area, especially Schneider Electric, Alstom, Jeumont- Schneider, Crouzet, Calor, EDF, ... On the international scene the laboratory is represented in the major meetings held in its field (IEEE, IEE...). It has established many co-operations with: Vietnam, Indonesia, Algeria, Poland, Italy, Switzerland, Egypt, Canada and USA.

It has been active in many EU projects, for example: FP5 RTD: **FEBUSS** (Fuel cell based generator system for transport and stationary applications), GROWTH Project GRD1 **POA** (Power Optimised Aircraft)...

The INPG has two main roles in the CRISP project:

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

- On the one hand, INPG is leading and managing the Workpackage on ICT-enabled scenarios and strategies for high-DG power networks (WP I)
- On the other hand, INPG is working on the enhancement of the robustness of the power system when faced with major disturbances using new distributed generation and renewable energy. In this technical side, INPG is also working on the fault detection, analysis and diagnostics in high-DG distribution systems. The INPG technical work for CRISP is special significant to reduce the dependency on transmission supply and avoid the social and economic impacts of a blackout.

2.6.2 Target groups for dissemination and use

For INPG/LEG the main target groups for the dissemination and use activities are:

- The integration of the last research and technology advances in the educational courses in order to spread and encourage the research works.
- The European industry sector in order to spread the last EU research works and applies them to the benefit of the society (i.e. blackout problems).
- Main international research conferences and reviews in the domain of the electric systems and networks.

2.6.3 Dissemination and use actions up to September 2003

INPG/LEG has already carried out the following dissemination and use actions to date (status 30 September 2003).

INPG/LEG has presented and promoted the CRISP-related topics in:

- Internal talks and presentations:
 - INPG PhD Students Working Day (Miguel Fontela, Grenoble, France, 7 November 2002)
 - LEG Scientific Conference (Aussois, France, 11-12 September 2003)

2.6.4 Planned future dissemination and use activities

See IDEA (Section 2.8).

2.7 Schneider Electric (year 1, then IDEA)

2.7.1 Partner role and nature of intended results

Schneider Electric is a world leader in Power & Control. The future is looking more and more electric, powered by growing demand, new types of generation, fresh applications and increasingly integrated and networked systems. Today, a new era is dawning, where electricity, automation and communication technologies will converge. Electricity-flexible, safe and clean-is more than ever the energy of the future.

General and detailed information about Schneider Electric is available in the website: <http://www.schneider-electric.com/>

Schneider Electric is composed of three main brands: Merlin Gerin, SquareD and Telemecanique. Four main markets are considered: Buildings, Energy and Infrastructure, Residential and Industry. The role of Schneider electric in the CRISP project is oriented on advanced knowledge and new solutions in Energy and infrastructure, especially for the case of DR (distribution resources) introduction in the Distribution EPS (electrical power system).

The Schneider Electric offers on Energy and Infrastructure markets cover an entire product line-up in electrical supply, electricity metering and quality, process control, utilities management (lighting, ventilation, elevators, intrusion control, etc.), multi-site remote management for power generation and distribution infrastructure, telecommunication networks, passenger and freight transportation, water, oil, and gas transport and water and waste treatment.

The Schneider Electric has two roles in the CRISP project:

- leading and reporting the Work-package 1.4 and the Work-package (3.1B, 3.2B) relative to fault detection and diagnostics. A specific tool adapted to DR is expected to be analysed and tested. Intensive exchanges with partners may allow us to propose a relevant solution combining EPS and ICT devices.
- Contributing with the partners to the other Work-packages, especially on the power system understanding and simulation, describing the ICT-enabled scenarios and expected strategies for high-DG power networks (WP I).

2.7.2 Target groups for dissemination and use

For Schneider Electric the main target groups for the dissemination and use activities are:

- The internal integration of the last research and technology advances in order to maintain a competitive and suitable offer for the future electrical power system.
- The European and international standard community in order to take into account the last EU research works and to enable a right application of the advanced technologies in the power system. Schneider Electric participates to technical committees in the electrical standard fields and also to large electrical manufacturer associations. By this way and for the suitable working groups, the public results of CRISP will be disseminated.
- Main international research conferences and scientific publication in the electro-

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

technical field. Schneider Electric is working close to technical university in the scope of CRISP, especially with the INPG (for instance IDEA in Grenoble combines inside a university environment INPG teachers and researchers, and Schneider Electric research engineers).

2.7.3 Dissemination and use actions up to September 2003

Schneider Electric has already carried out the following dissemination and use actions to date (status 30 September 2003)

Schneider has presented and promoted the CRISP-related topics in internal meetings. This first step has been done to clarify the internal knowledge on CRISP scope and to define the requirements for the ICT in the fault location application and experiment.

2.7.4 Planned future dissemination and use activities

See IDEA (Section 2.8).

2.8 IDEA (for year 1, see INPG/LEG and Schneider Electric)

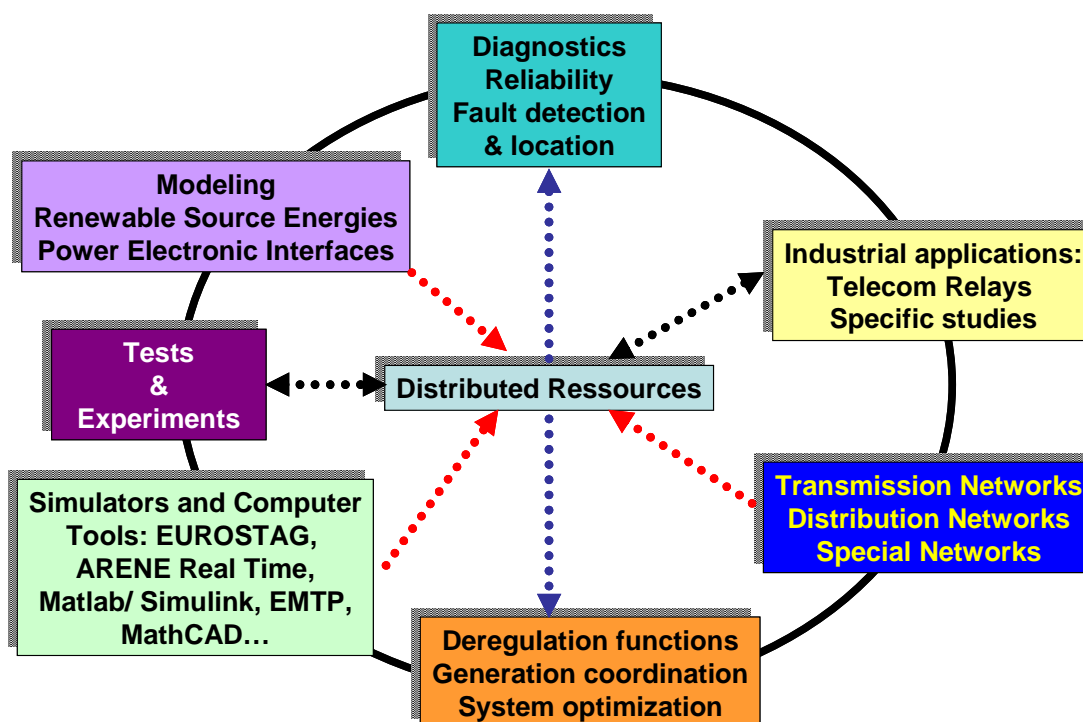
2.8.1 Partner role and nature of intended results

IDEA is a research consortium created in July 2001 by EDF (Electricité de France), Schneider Electric and INPG (Institut National Polytechnique de Grenoble). It is located in the LEG (Electrotechnical Laboratory of Grenoble) inside the university campus.

The aim of this research association is to “Invent the Electrical Distribution System of the Future”. These three partners have decided to create common resources in order to invent innovative solutions in the field of electrical energy distribution systems, in light of the arrival of new technologies in the areas of:

- The generation of distributed electricity (wind power, solar energy, fuel cells...)
- The storage of electrical energy (flywheels, super-capacitors, etc) and all the different cases taking into account the progress in the field of the Power electronics interfaces.

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

**Figure 2: IDEA research interests.**

Research in this field aims to anticipate significant changes in electrical distribution networks. These networks are likely to evolve because of a decentralized electrical system added on an essential traditional centralized network structure.

The IDEA has two main roles in the CRISP project:

- Leading and managing the Workpackage on ICT-enabled scenarios and strategies for high-DG power networks (WP I)
- Leading and reporting the Work-package 1.4 and the Work-package (3.1B, 3.2B) relative to fault detection and diagnostics. A specific tool adapted to DR is expected to be analysed and tested. Intensive exchanges with partners may allow us to propose a relevant solution combining EPS and ICT devices.
- Working on the enhancement of the robustness of the power system faced to major disturbances using new distributed generation and renewable energy. In this technical side, IDEA is also working on the fault detection, analysis and diagnostics in high-DG distribution systems. The IDEA technical work for CRISP is special significant to reduce the dependency on transmission supply and avoid the social and economic impacts of a blackout.
- Contributing with the partners to the other Work-packages, especially on the power system understanding and simulation.

2.8.2 Target groups for dissemination and use

For IDEA the main target groups for the dissemination and use activities are:

- The INPG education courses in order to spread and encourage new research works from the last research and technology advances.
- Schneider Electric in order to improve the power and control systems faced to an increasing capacity of sustainable energy.
- The European and international technical committee (standards on electrical power system) in order to spread the last EU research works and prepare standards a new deal combining ICT and the power system.
- Main international research conferences and scientific publications in the field of the electric power systems.

2.8.3 Planned future dissemination and use activities from October 2003

IDEA will continue to participate in the CRISP activities dissemination by the different actions:

- Publications in the main international conference related with electric systems and networks:
 - CIRED 2005: 18th International Conference and Exhibition on Electricity Distribution Summer 2005. It will be organised at Torino (Italy).
 - CIGRE (Conférence Internationale des Grands Réseaux Electriques). The conference is Bi-annual and it is organised at Paris. It is considered as one of the major industrial conference on Power Systems.
 - IEEE International conferences.
- Internal talks and presentations
 - IDEA Scientific Conference (Fréjus, France, 23-24 October 2003)
 - SYREL (LEG electric power and networks Working group) seminars (France, November 2003)
 - INPG PhD Students Working Day (France, starting November 2003)
 - Schneider Electric internal meetings (France, 3h/month)
- The technical tasks are carried out by different PhD and master degrees works, professors and assistant professors and Schneider Electric research engineers.
- IDEA will participate in the CIGRE group C6.04.02 about the Connection and Protection Practices for Dispersed Generation and in C6.05 about Technical and Economic Impact of DG on Transmission and Generation Systems.

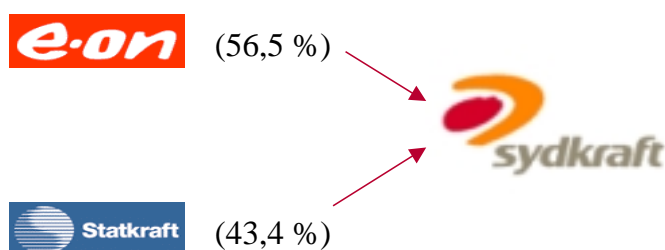
CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

- International and National scientific papers: in English (common technical language), in French (EU official language) and in Spanish.

2.9 Sydkraft AB

2.9.1 Partner role and nature of intended results

Sydkraft AB is a company within the E.ON group, which is one of the world largest energy companies. Sydkraft is with stable shareholders:



Sydkraft's business concept is to provide products and services in energy, the environment and communications that will increase the competitiveness, comfort and security of its customers in northern Europe.

The role of Sydkraft in the CRISP project is:

1. Put the distribution network at CRISP project's disposal. Sydkraft has a perfectly suited network on the island of Öland in the southern part of Sweden. This network will be used within the project to study for example Intelligent Load Shedding performed in cooperation with ABB.



Figure 3: Sydkraft's distribution area in Sweden

CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power

The Öland network will contribute to the ICT-enabled scenarios and strategies for high-DG power networks.

2. Sydkraft is a utility and therefore have a natural role in the CRISP project to take as the users role. All new techniques need to be accepted by end-users and Sydkraft wants to challenge this in a utility point of view.

2.9.2 Target groups for dissemination and use

For Sydkraft, the main target groups for dissemination and use activities are:

- Sydkrafts own different business sectors: distribution, production and marketing and sales.
- The energy sector in Sweden.
- Research organizations and individuals in the energy area.

2.9.3 Dissemination and use action up to September 2003

Activities carried out up to September 2003 are:

- Information within Sydkraft R&D management group (Hans Ottosson and Peter Sigenstam in Malmö, Sweden, 25 March 2003).
- Information about the CRISP project in the System Operation Department in Sydkraft Nät AB, which subsidiary company for network distribution (Daniel Karlsson ABB Malmö, Sweden, May 2003)
- Master Theses work (A study of the network on the island of Öland with present windpower generation and upcoming planed windpower generation) presentation and examination at Technical University of Denmark (DTU). Examiner was Henrik Weldingh and supervisor Arne Hejde Nielsen at DTU. Martin Randrup was the student and is now employed at Sydkraft and will participate in the CRISP project further on. The examination was performed at Copenhagen, Denmark, 27 August 2003.
- Master Theses work presented by Martin Randrup at Sydkraft in the Distribution business sector (Malmö, Sweden, 10 September 2003).

2.9.4 Planned future dissemination and use activities

A continues dissemination work will be done within Sydkraft. Information and speeches will be done in Sydkraft R&D management group. Information about the CRISP project will be published on the internal Sydkraft intranet.

Furthermore, information about the CRISP project will be spread to Elforsk which is the jointly owned R&D company for the Energy area in Sweden (www.elforsk.se).

3 Appendices

3.1 Checklist for dissemination and use activities

In the construction of the DUP, the following general checklist has been used for different types of activities that are relevant to dissemination and use:

- ⇒ Demos, exhibitions, industry events (e.g. industry fairs, conference exhibitions)
- ⇒ Publications (conferences, journals)
- ⇒ External talks and presentations
- ⇒ Internal meetings, presentations, knowledge transfer, promotion to transfer ideas and knowledge to other parts of the organization
- ⇒ News items (press releases, (items in) newsletters)
- ⇒ World Wide Web information and promotion, websites
- ⇒ Tutorials, courses, education (incl. executive education, PhD and MS degree work)
- ⇒ Contributions to standardization activities
- ⇒ Links to and exchanges with other relevant projects (incl. EU clusters, networks of excellence, other EU programs and activities, national projects and programs)
- ⇒ Multimedia promotion (video, CD-ROM)
- ⇒ Workshops, user groups, seminars
- ⇒ Client information actions, meetings with customers

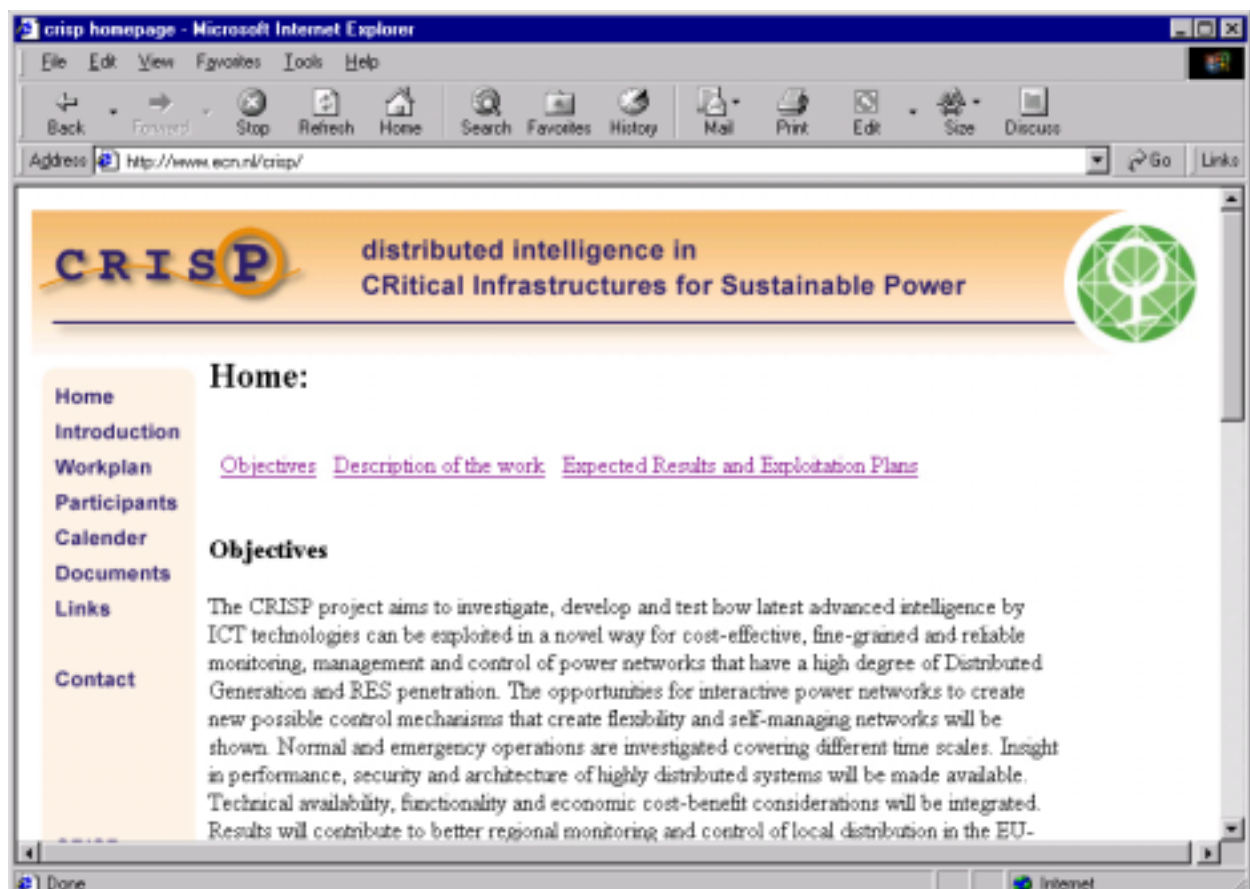
Following this checklist, the partner contributions to the DUP are structured as follows:

- Brief description of the role of the partner in the project, with the nature of the intended results following from the partner's work. Where appropriate, some general comments on partner-specific dissemination and strategy.
- Description of the partner's target groups for dissemination and use.
- Shortlist of concrete dissemination activities as actually carried out to date, including specifics such as type of action, target, place, date, etc. (see checklist above).
- List of planned dissemination activities for the future (following the checklist above).

3.2 CRISP website

The CRISP project website is at <http://www.ecn.nl/crisp>.

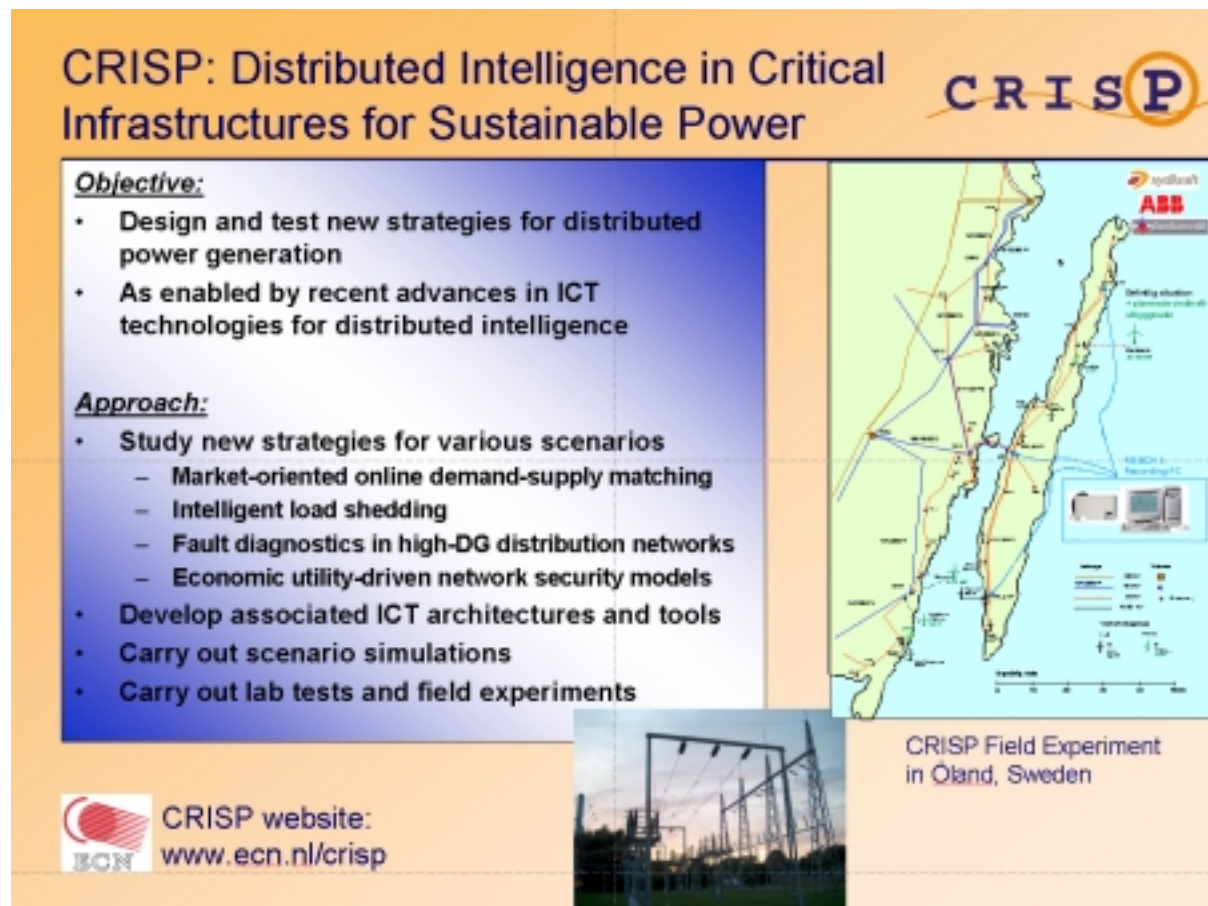
Below, a screenshot of the homepage of the project is shown.



3.3 CRISP project presentation (slides)

A CRISP project presentation has been made. It will be regularly updated according to the progress of the project.

The slide below is the summary slide of the CRISP project made for the EU-mission to the US, 2-11 November 2003. It is part of the EU project cluster overview prepared for the US mission.



CRISP: Distributed Intelligence in Critical Infrastructures for Sustainable Power


CRISP


Objective:

- Design and test new strategies for distributed power generation
- As enabled by recent advances in ICT technologies for distributed intelligence


Approach:

- Study new strategies for various scenarios
 - Market-oriented online demand-supply matching
 - Intelligent load shedding
 - Fault diagnostics in high-DG distribution networks
 - Economic utility-driven network security models
- Develop associated ICT architectures and tools
- Carry out scenario simulations
- Carry out lab tests and field experiments





CRISP Field Experiment in Öland, Sweden

 CRISP website: www.ecn.nl/crisp

3.4 *CRISP flyer*

A CRISP flyer has been produced for distribution at conferences, exhibitions, and other meetings.



Figure 4: The CRISP project team on site at the field test in Öland, Sweden (plenary project meeting, 16 September 2003).

Objectives

The central objective of the CRISP project is to investigate, develop and test how the latest advances in distributed intelligence by information and communication technologies (ICT) can be exploited in novel ways for cost-effective, fine-grained and reliable monitoring, management and control of power networks that have high degrees of DG/RES penetration.

The CRISP project bridges the gap between the latest advances in intelligent ICT and their strategic use in applications optimising power networks. It will thus deliver several innovative results to the utility sector:

- ▶ Novel strategies and solutions for both normal and emergency operations in power networks with high DG/RES penetration degrees, exploiting intelligent ICT.
- ▶ Software and simulation tools, with a library of e-market and intelligent agents algorithms and architectures for power applications.
- ▶ Validating “proof of concept” tests and experiments in different countries that cover a variety of network and customer situations.
- ▶ Practical recommendations and guidelines for the strategic use of intelligent ICT in high-DG power networks.

As a result, CRISP will greatly expand our insight into performance, safety and security of highly distributed power networks - through scenario analyses, simulations and field tests - in a way that not just looks at technical availability and functionality, but that integrates economic cost-benefit considerations as well.

Expected results

The consortium consists of 8 participants from 3 countries. Each partner a strong player in its own field, the consortium covers the full range of stakeholders able to deal with cutting-edge technology development and its business exploitation.

NL Energy Research Centre of The Netherlands ECN (co-ordinator)

NL ENECO

F INPG/LEG

F Schneider

SE EnerSearch

SE Sydkraft

SE Blekinge Institute of Technology BTH

SE ABB



<http://www.ecn.nl/crisp>



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Distributed Intelligence



in CRITICAL Infrastructures for Sustainable Power

CRISP

Background

The CRISP vision is that recent progress in intelligent ICT offers many novel opportunities to build new operating strategies for high-DG power networks:

- ▶ Parallel to the power grid, an extensive data-communication infrastructure emerges through various (and usually hybrid) means including fibre, telephone copper, wireless or the power line itself. This communication infrastructure covers different system levels of the power grid, even reaching the very fine-meshed level of individual customer equipment.
- ▶ Embedded real-time communication and computing processors enable to create smart equipment with “local intelligence” at increasingly affordable prices.
- ▶ New software technologies for building distributed online at-a-distance applications have become available, including intelligent agents, electronic markets, and other mechanisms for distributed intelligent information systems. Worldwide standards help to achieve this in a cost-effective way (e.g. IP).
- ▶ System integration using ICT creates new requirements on security and protection of information. But, safeguarding the systems must be motivated from a cost-benefit analysis.

The CRISP view is that the potential stemming from the rapid advances in industrial ICT is however not yet fully known, explored and exploited by the utility industry. There is a lot of mileage to be gained by *combining the capabilities* delivered by two different critical infrastructures: the power grid and intelligent ICT networked systems.

Work Packages

In WP I: *ICT-enabled scenarios and strategies for high-DG power networks*, innovative ICT-enabled strategies and scenarios are developed for: enhancing system robustness against disturbances, better demand-supply matching in a liberalized environment, fault detection and diagnosis, intelligent load shedding, network security models, and highly distributed network architectures.

WP II: *Intelligent distributed ICT developments and tools for power application*, develops distributed intelligence ICT software tools for the scenarios and strategies of WP I and the associated experiments and tests of WP III. They include a multi-agent tool for market-oriented distributed demand-supply matching, as well as simulation tools for fault detection/diagnosis and decision support for network security models. Electronic market and intelligent agent algorithms for power applications are defined.

WP III: *Implementation, Experiments and Tests*, includes experiments, laboratory and field tests in different countries (Netherlands, France, Sweden) according to the scenarios, tools and strategies developed for distributed intelligence in power networks in WP I and WP II.

WP IV: *Dissemination and Exploitation*, covers promotion, publications and exploitation plans.

WP V: *Project management*.

Duration: Oct. 2002 – Oct. 2005
Budget: EUR 3.1 Mio



Supported by the
European Commission
Project No. NNE5-2001-00906



The Project

The CRISP project will develop and test *new operating strategies for high-DG power networks enabled by the progress in intelligent ICT technologies*.

It focuses on specific practical scenarios:

- ▶ Market-oriented demand-supply matching to increase the cost-effectiveness of DG network operations, integrating demand-side and supply-side management through online agent-mediated e-markets that exploit real-time price information as well as knowledge of load/supply needs and profiles.
- ▶ Online distant supervision, fault detection and recovery of distributed generation networks, ensuring the robustness and performance of the system and including how “self-healing” of the network is possible under major disturbances through automatic reconfiguration by distributed intelligence.
- ▶ Intelligent load shedding in emergency situations such that cost-controlled and prioritised load shedding is done in much more fine-grained ways than currently possible.
- ▶ Multi-agent systems based methods for online integration and control strategies for RES supply, demand and storage that achieve bottom-up rather than the usual top-down optimisation.
- ▶ Architectures and requirements for distributed intelligence in high-DG power networks that cope with the fact that such networks contain different levels (end-customer devices, low-voltage last mile access and distribution, middle-voltage grid operations) and so are to be treated as networks of networks themselves.
- ▶ Intelligent decision support for risk and security analysis of distributed generation networks that not only includes maximum availability considerations but also integrates economic cost-benefit and priority analysis on an equal footing.



Distributed Intelligence in Critical Infrastructures for Sustainable Power

EU CRISP Project Consortium



Sustainable development, global change and ecosystems
Sustainable energy systems

September 2003

ENK8-CT-2002-00673

1

CRISP Project

2

Objective:

- To investigate and test how ICT-based distributed intelligence can be exploited for the management of power networks with high degrees of Distributed Energy Resources (DER) and renewable energy (sustainability)
- Duration: 3 years, Oct. 2002 – Oct. 2005
- Budget: EUR 3.1 M
- Effort: 22 person-years
- EU-EESD project No. ENK8-CT-2002-00673
- Website: <http://www.ecn.nl/crisp>

September 2003

ENK8-CT-2002-00673



CRISP Partners

3

Consortium:

- ECN (NL)
- ENECO (NL)
- INPG/LEG (F)
- Schneider (F)
- EnerSearch (SE)
- Sydkraft (SE)
- BTH (SE)
- ABB (SE)



September 2003

ENK8-CT-2002-00673



CRISP: Linking ICT & Energy - General Trends

4

- Energy: more and more becomes a decentralized network operation
 - DER, “distributed, virtual” utility
- Internet/Web: “everything” becomes part of it, including even home appliances (EU: “ambient intelligence”)
 - Equipment communicates, and is made “smart”
- Convergence: IT and Energy are distributed critical infrastructures that can beneficially be used together
- “Out of the box”: new systems thinking needed
 - Crossing traditional in-building/access/network boundaries gives interesting possibilities
- Technology *as well as* business aspects must be dealt with to make progress: innovation and its adoption

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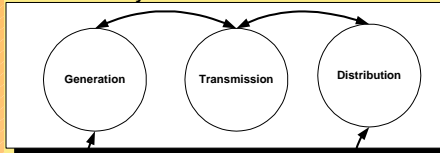
Setting the DER Scene

5

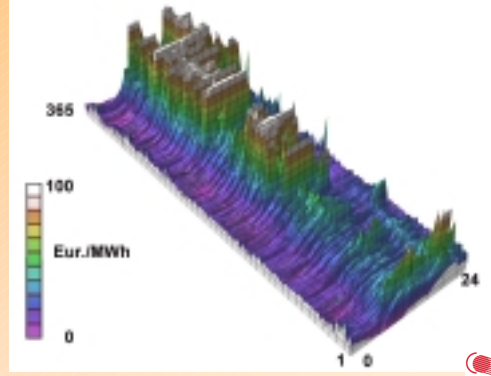
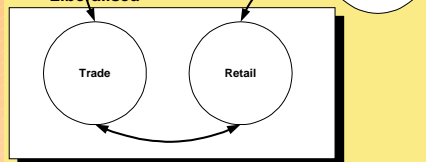
Highly mixed market situation

APX (NL) price spikes 2002

Secure delivery



Liberalised



(cut-off at > 100 €/MWh)

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CRISP: Development and Application of Distributed Intelligence

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- Exploit distributed intelligence for DER networks
 - Communicating smart equipment, decentralized network diagnostics and control, intelligent software agents, electronic power markets
- Demonstrate by realistic scenarios
 - E.g. optimized Demand-Side Management, intelligent load shedding
- And by experiments
 - NL (field test DER) , F (lab tests), SE (Öland operation)
- Bridge gap between latest ICT advances in ICT and their strategic use for power applications
 - Links EU-IST and EU-SUSTDEV programs
- Combine capabilities of two critical infrastructures: ICT and power networks

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CRISP Approach: Focus on Specific Practical Scenarios

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CRISP concentrates on specific practical scenarios:

- Market-oriented demand-supply matching to increase the cost-effectiveness of DER network operations
- Online distant fault detection and recovery, ensuring robustness and performance of high-DER networks
- Intelligent load shedding in emergency situations
- Multi-agent systems for online control of DER supply, demand and storage, providing bottom-up optimization strategies
- Intelligent decision support for risk and security analysis of DER networks, including cost-benefit and priority analysis

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CRISP: Intended Results

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- *New operating strategies for high-DER power networks enabled by recent progress in intelligent ICT*
- Demonstrated by specific practical scenarios
- Validated by field and lab experiments (NL, F, SE)
- Supported by corresponding advanced ICT tools
- Plus: guidelines for advanced ICT use in DER networks

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Field Experiment Öland, Sweden

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Wide-Area Measurements

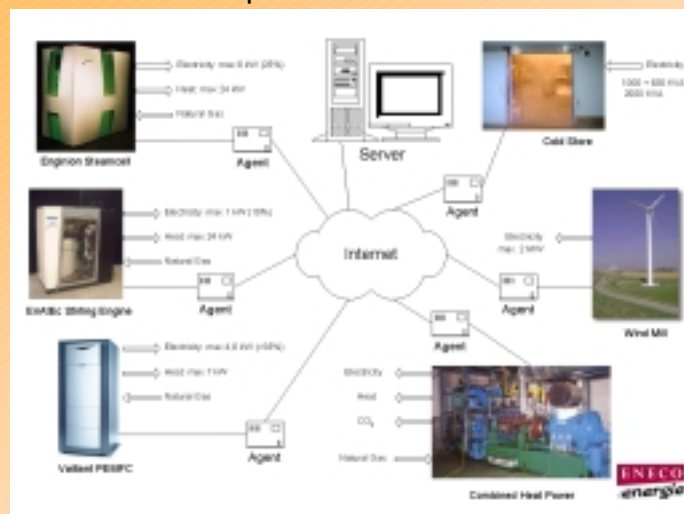


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Field Experiment Westland, The Netherlands

10

Several different μ -CHPs in a Virtual Power Plant



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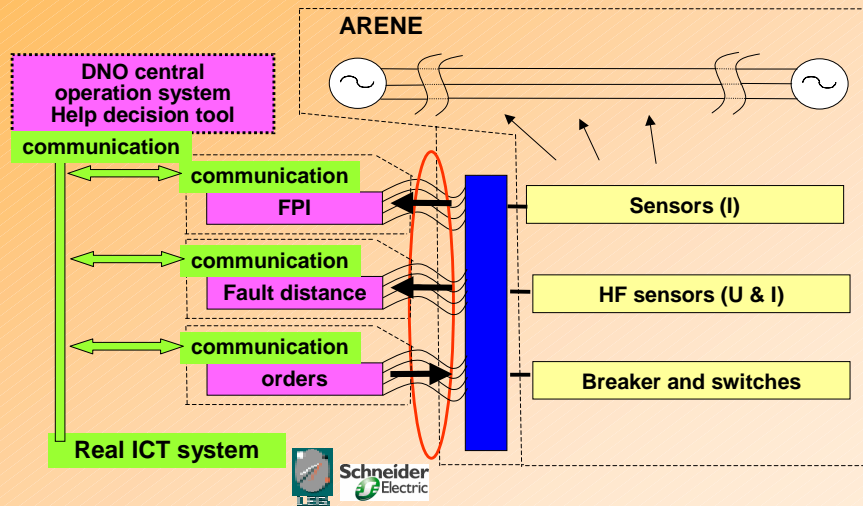
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Lab Experiments Grenoble, France

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Fault detection and location



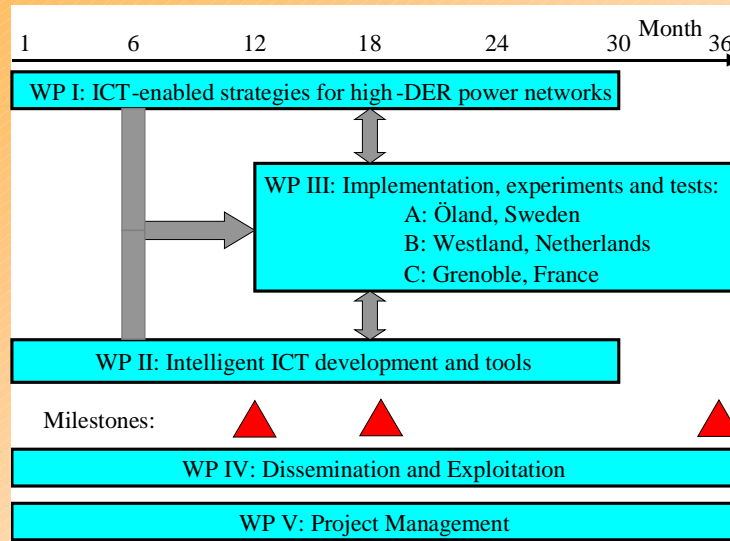
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CRISP

CRISP Workplan

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WP I: ICT-enabled scenarios + strategies for high-DER power networks (1/2)

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- **Functional specs of the grid with high degree DG**
 - modelling operative roles of players
- **Cost-effective distribution through market-oriented on-line demand-supply matching**
 - 15 min to 1 day ahead matching
 - cost terms + utilisation RES + security/reliability
 - multi-agent algorithms / micro-economic optimisation theory
- **Intelligent load shedding**
 - improve system stability and load shedding schemes
 - algorithms for detection disturbance +initiate shedding
- **DG as means to increase system robustness**
 - potential of DG for robustness in major disturbances
 - increase system autonomy / islanded supply
 - modular communication and control

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WP I: ICT-enabled scenarios + strategies for high-DER power networks (2/2)

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- **Fault detection, analysis and diagnostics in high-DER distribution systems**
 - improving islanding detection reliability
 - smart sensors, measurement, monitoring
 - Artificial Intelligence, fuzzy, real time processing
- **Network security models and their economics**
 - incorporate security models from information networking in protection systems
 - include risk analysis methodologies to protect value chains and business processes
- **Highly distributed network architectures and simulations**
 - “virtual utility”, modelling architecture and assigning functionality and roles to individual nodes
 - case study simulations using tools of WP II

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WP II: Intelligent distributed ICT Tools for Power Applications

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- **Multi-agent simulation tool for market-oriented distributed demand-supply matching**
 - competitive and co-operative scheduling, optimal use of deferrable load, scalability
 - implementation and library of e-market algorithms in power applications
- **Simulation tool for fault detection and diagnostics**
 - locate fault, investigate differences in type and criticism of faults
 - intelligent techniques used based on output of WP I
 - use as prototype for “off-line” tests
- **Decision support tool for network security models and their economics**
 - to identify proper safeguards at given risk/benefit level
 - cost/benefit analysis of value chains in business processes at risk
 - evaluation on different scenarios

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WP III: Implementation, Experiments and Tests

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- **Preparation, execution and evaluation of experiments**
 - Results of simulations of WP I with tools of WP II
 - Recommendations for strategic use of intelligent ICTs in power networks
- **3 experiments in 3 different countries**
 - Field test with 50 different CHP units in various segments (horticulture, industry, households), focussed on demand-supply matching (NL)
 - Lab-tests in industrial real-time simulator of power networks ARENE and analogue power system simulator, focussed on fault diagnostics (F)
 - Lab- and field test for testing load shedding scenarios, Öland (S)

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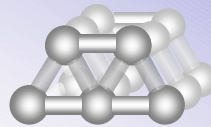
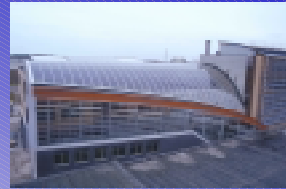


CRISP builds on earlier work

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For example:

- PALAS EU project
- Intelligent Internet solutions for building control and energy management, realized by agent-mediated e-markets
- SMART project: field experiment in office building (ECN, Petten, NL)
- New field experiments underway (ECN, NL)
- Advances in IT: e-markets and Internet agents



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For more information

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- CRISP flyer
- CRISP website: www.ecn.nl/crisp



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