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Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

TABLE OF CONTENTS:

1. INTRODUCTION

This is the fourth newsletter of ADINE-project. The project team will publish these brief summaries in six months periods to keep interest groups updated about the proceeding. The first newsletter was published in the end of March 2008.

ADINE comes from words Active Distribution Network, which summarises the idea of the whole project. Components in electricity distribution networks should be intelligent enough to interact with each other. The network should be active and alive as an intelligent machine which has no problems in plugging in any kind of distributed generators or loads.

This fourth newsletter explains the steps, which has been done in the project until the end of September 2009.

The names of the Partners in the Project are:

- Hermia Ltd, Finland
- Tampere University of Technology, Department of Electrical Energy Engineering, Finland
- ABB Oy Distribution Automation, Finland
- Lund University, Department of Electrical Measurements and Industrial Electrical Engineering and Automation, Sweden
- Compower AB, Sweden
- AREVA T&D Ltd, Finland
- AREVA Energietechnik GmbH, Germany

2. PROJECT GOALS AND STRUCTURE

The problem - need for the project is still the same
Considerable amount of renewable energy in Europe represents distributed generation (DG). However, the distribution networks have been designed without considering interconnection of DG. One of the main barriers to the penetration of DG at the distribution network level is the complexity of the interconnection process of DG into the network. Each planned interconnection requires accurate modelling, simulation and analysis to tackle potential problems concerning stability, protection and voltage control in the network. The main cause of complexity is the present methods for managing distribution networks as well as the features of the different DG components themselves which are not designed to enable an easy interconnection. Also customers´ expectations for extreme reliability and quality of power are increasing simultaneously with an increasing diversity of power generation methods. Therefore significant investments will be needed in the coming decades. It is now time to reconsider traditional network solutions in order to secure the efficiency, security and reliability of networks in the long run.

The solution developed in the project
ADINE develops demonstrates and validates a new method for the active management of a distribution network and the enabling solutions to support it. The solutions operate as active components in managing the network to enable an easy interconnection of different DG units. The solutions cover the protection of the network, planning and information systems, and voltage and reactive power control.

The extraordinary feature of this project is to develop and demonstrate the active network management method and the enabling solutions simultaneously. Either one alone would not solve the problem

described above. When interacting with each other according to the active network management method, the overall system operates better than it would by letting individual solutions interact randomly – which is the common practice today.

As the result ANM is increasing the security of distribution grids, improving the stability of the grid in fault situations and enhancing the optimal management of network. This adds value at European level by increasing the potential for renewable energy and by enabling more efficient management of distribution network assets for network owners.

The work flows from basic planning to demonstrations and monitoring so that best knowledge of the partners is involved in each stage. The results from the demonstrations of solutions are combined together in SP5 into one integrated simulation environment in order to demonstrate and validate ANM method.

Sub projects
SP1-Project management and dissemination
SP2-Protection of distribution network including distributed generation
SP3-Voltage control of distribution network including distributed generation
SP4-Flexible STATCOM for distribution network
SP5-Development of Active Network Management method

3. MANAGEMENT AND DISSEMINATION (SP1)

During last six months in the main task of management has been the reporting of the first period of ADINE project. In the spring we reported the first 18 months of ADINE to EU Commission. Our reports were accepted by Commission in the summer. During summer the coordinator make also papers to Commission about change of coordinator to Hermia Ltd.

There has been seven deliverables during the last six months. We have had small delay in deliverables but all deliverables, except deliverable D31Unit with voltage control, are now ready. Also the delayed deliverable D31 will be ready during autumn. The workflow of project has proceeded as planned.

The fourth face-to-face project meeting has been arranged in Konstanz, Germany in August 2009. In this meeting we have Steering Committee and Implementation Committee meetings, important conversation of essential issues, the situation in each Sub Project and visit to AREVA Energietechnik GmbH laboratory.

There have been changes in project consortium. The coordinator has been changed from Technology Centre Hermia Ltd to Hermia Ltd. The former project coordinator Mr Mika Huuhtanen has also moved to another position and now the project coordinator is Ms Mirva Seppänen.

In every month coordinator is organizing teleconference meetings to Implementation Committee. In teleconferences we follow the progress of the project. Agendas and memos are made of these meetings. They are in ADINE portal Implementation Committee Work Room Material Folder in certain category for each teleconference meeting.

Coordinator is offering the ADINE website infrastructure for use to everyone in the project. Mainly coordinator and every Sub Project leader are updating the content of the intranet continuously. Also other members of the Project, to whom Sub Project leaders has given the rights to the intranet and coordinator has made username and login with certain rights, they can add files and update content in the intranet pages and material folder.

After end of March 2009 representatives of consortium have taken part in

- Electricity Grid Projects, Brussels, Belgium, 2nd April 2009
- IFAC Symposium on Power Plants and Power Systems Control, 5–8 July 2009,Tampere Hall, Finland
- Nordic Wind Power Conference, September 10-11 2009, Denmark
- Design principles of network protection with DG, Workshop on DG and island operation at Lund University, 4 February 2009
- ERRIN Energy Working Group Brussels, Belgium 24th June 2009

4. PROTECTION OF DISTRIBUTION NETWORK INCLUDING DG (SP2)

ABB Distribution Automation in Finland is leading subproject 2, which consists of four work packages related to new protection systems of the electric distribution network. The development and demonstration work is based on products or prototypes from ABB.

In Work Package 2.1 research on DG effects on network protection and protection coordination has been conducted. Deliverables have been prepared according the plan. Deliverables 5 and 7 have been prepared and delivered to Commission.

In Work Package 2.2 New protection relay applications and in Work Package 5.2 Simulation environment there has been following activities:

- Using DSpace integrated to RTDS in real-time simulations has been analyzed and it seems to be a too challenging way for relay algorithm simulation
- Real protection terminals have been delivered and installed in RTDS laboratory. Part of the simulations is already executed.
- Several ABB's internal meetings and meetings with TUT have been arranged
- Deliverables have been prepared according the plan. Deliverables 6 and 15 has been prepared and delivered to Commission

In Work Package 2.3 New fault location solutions in distribution network there has been following activities:

- Several field tests with created real faults have been done (in Pori Wind park and at Suonenjoki substation of distribution company Savon Voima)
- Research on DG effects on relay operation
- Real time simulations in TUT RTDS laboratory for testing existing impedance based fault location algorithm
- Deliverables have been prepared according the plan. Deliverables 14 and 21 have been prepared and delivered.

In Work Package 2.4 New protection planning methods there has been following main activities:

- Specification work have been done mainly by TUT as planned
- The implementation environment at TUT has been prepared and implementation of the prototype has proceeded well.
- Deliverables have been prepared according the plan. Deliverables 7 and 9 have been prepared and delivered.

For more information contact Mr Matti Kärenlampi, first.last@fi.abb.com

5. VOLTAGE CONTROL OF DISTRIBUTION NETWORKS INCLUDING DG (SP3)

University of Lund in Sweden is leading subproject 3 dealing with new voltage control solutions also involving ABB, Compower and Tampere University of Technology.

In Work Package 3.1 Voltage control of the DG unit, the following activities have taken place:

- The microturbine prototype has been installed at the field test site in Kristianstad.
- Deliverable 16 on information on microturbine simulation model has been submitted.
- The simulation model of microturbine with voltage control and the MV/LV networks is ready.
- Matlab simulations of microturbine with voltage control have produced the main results.
- Hardware of the laboratory prototype of network interface with voltage control is ready.
- Programming of the laboratory prototype is ready and voltage control has been tested in the control functionality has been tested.
- Deliverable 32 on laboratory prototypes of microturbine and network interface with voltage control has been submitted.

Work Packages 3.2 Defining coordinated voltage control is finished after the following activities:

- The simulation network based on the test site has been defined (Deliverable 12)
- The co-ordinated voltage control algorithm has been specified (Deliverable 17)

In Work Package 3.3 Demonstrating coordinated voltage control a number of actions have been taken:

- The field test network has been selected.
- Voltage control in the network at present has been analyzed (Deliverable 10).
- The co-ordinated voltage control simulation model has been developed (Deliverable 22).
- Co-ordinated voltage control has been simulated in PSCAD [1], [2] and in RTDS.
- The implementation of the control algorithm for the field test has been tested with the network simulated in RTDS.

For more information on these issues contact Ass. Prof. Olof Samuelsson, first.last@iea.lth.se.

6. FLEXIBLE STATCOM FOR DISTRIBUTION NETWORK (SP4)

AREVA Energietechnik GmbH in Germany is leading subproject 4 with the focus on studying and demonstrating the intelligent solutions required for compatibility of new generation STATCOM converter with ANM method.

In Work Package 4.1 Development of new features of STATCOM have been done following main issues:

- A new space vector based PWM control method for three-level voltage source converter has been developed and tested in the laboratory. With this new method the dynamic power losses of the semiconductor valves (IGBT) could be reduced significantly. In the same time the quality of the output current and the dynamic response of the system could be improved.

- The internal (STATCOM) and external (load, network, DG) measurements were defined

- Macro-models for non-real-time and real-time simulations were developed.

- Non-real time simulations were performed. The deliverable Deliverable 13 has been prepared.

- The hardware and basic software for a prototype of a STATCOM control system was developed. The control system consists of a so called STATCOM Control Unit and a Master Control Unit. (Refer to deliverable Deliverable 25)
  After considerably testing in the laboratory, some minor issues could be identified. Within a second design step, the STATCOM control system is to be optimized.

- An initial real-time simulation of the STATCOM control system in combination with a PSCAD model was performed on a RTDS system. The general functionality of both STATCOM controller and real-time simulation model could be verified. The test results are described in Deliverable 23.

- A general structure for the communication between the STATCOM control unit and the Human-to Machine Interface (HMI) has been designed. This work package is not yet finished.

- The definition of the communication and remote surveillance which are compatible to ANM is not yet done.

In Work Package 4.2 Demonstrating the operation of new features of STATCOM has been done following main issues:

- The internal (STATCOM) and external (load, network, DG) measurements which were defined in WP4.1 have been verified and validated.

- The test procedure for the STATCOM control unit was specified and verified within laboratory tests. The report Deliverable 24 describes the test procedure in detail.

- Real-time RTDS/dSPACE performance testing simulations with control system has not yet started.

- Negotiations with potential subcontractors for the converter detail design and manufacturing are ongoing.

- Testing of HMI is not yet started.

- Designing the mechanical construction of the real-life-demonstration device is not yet started.

- Evaluating the potential test sites and defining the test site is in progress.

- Planning and execution of the factory tests is not yet started.

- Comparing factory test results with simulation results is not yet started.

- Supervision of the manufacturing the real-life demonstration device is not yet started.

- Planning, engineering, site assembling and running the real-life demonstration is not yet started.

- Study the performance of the real-life demonstration and analyzing the results is not yet started.

For more information contact Mr Ralf Jessler, first.last@areva-td.com.

7. DEVELOPMENT OF ACTIVE NETWORK MANAGEMENT METHOD (SP5)

Tampere University of Technology, Department of Electrical Energy Engineering is leading the subproject 5, where Active Network Management method is developed and demonstrated.

The development and demonstration of active network management method is strongly based on real-time simulations while the demonstrations of individual devices are based on field tests. The reason for this kind of arrangement is very simple: the lack of adequately versatile demonstration site for all different aspects included for the active network management method. The concept of active network management method developed in Adine project is very general and it is strongly based on existing network structure, operation philosophy and control tools [3]. The focus of development has been protection co-ordination in distribution networks including distributed generation, local and centralized voltage control based on distributed generation units, and power quality and fault-ride-through improvement based on STATCOM.

The hardware of real-time simulation environment includes two real-time digital simulators for power system (RTDS) and two real-time digital simulators for control systems (dSPACE). The first RTDS is utilized for network and distributed generator unit modeling and relay simulations, while the second RTDS is utilized for STATCOM simulations. dSPACE is utilized at simulations where detailed control system model of wind turbines, microturbines or STATCOM is needed. The environment includes also two amplifiers in order to connect real devices for simulators. The RTDS and the dSPACE are integrated through analog interface using signal synchronization in order to keep delay constant [4].

The simulation environment is applied to test protection relays, voltage controller of microturbine, and STATCOM controller. Tested protection relays are real devices from ABB: Feeder protection relay REF 615, Line differential relay RED 615, Distance protection relay REF 630, Loss-of-mains protection REF 630 and Fault location application REF 543. The relay to relay communication is considered in the simulations utilizing different kind of communication protocols like SPA, IEC 61850 and binary signal transfer. Microturbine controller is a Simulink model which is run in dSPACE during simulations. STATCOM controller is a real control board from AREVA or a Simulink model run in dSPACE. The simulations will prove the capability of STATCOM to mitigate voltage dip and flicker in wind farm. STATCOM simulations are done using giga-processor card thus all switching details may be studied.

The aim of the real-time simulations is to study the impact of distributed generation on protection relays, voltage control of microturbine and STATCOM. The impact of distributed generation may be fault current contribution, flicker, rapid voltage changes, etc. The models of distributed generation units are based on data from real hydro power, diesel power and wind turbine units. The synchronous and induction generators are modeled directly in RTDS while more complex generation units like full power converter permanent magnet wind turbine, double-fed induction generator wind turbine and microturbine are modeled in dSPACE. These wind turbine models include also a number of fault-ride-through options.

Besides the simulations of single devices the simulation environment is applied to study the interactions of local (protection and control) devices themselves and interactions of local devices and upper level control and management system. For example the coordination of feeder and loss-of-mains protection relays will be simulated using real protection relays. The idea of selective loss-of-mains protection based on communication (IEC 61850 GOOSE messages) is presented in Figure 1 [5]. The interaction of loss-of-mains protection and fault-ride-through capability of a wind turbine has been studied in [6]. The operation of parallel local voltage controllers in low voltage network will be studied with a microturbine. The co-ordination of centralized and local voltage controllers has already been simulated utilizing control algorithm in Matlab. The control algorithm is integrated to real-time simulation environment

through two interfaces: OPC interface to SCADA (ABB MicroSCADA) and file transfer to RSCAD software used for RTDS controlling and monitoring. The same demonstration will be implemented on Koillis-Satakunnan Sähkö Oy (distribution network company in Finland) control centre. The interactions of STATCOM and active network management method and loss-of-mains protection relay will also be simulated in the future. STATCOM controller will be communicating with SCADA using Modbus protocol.

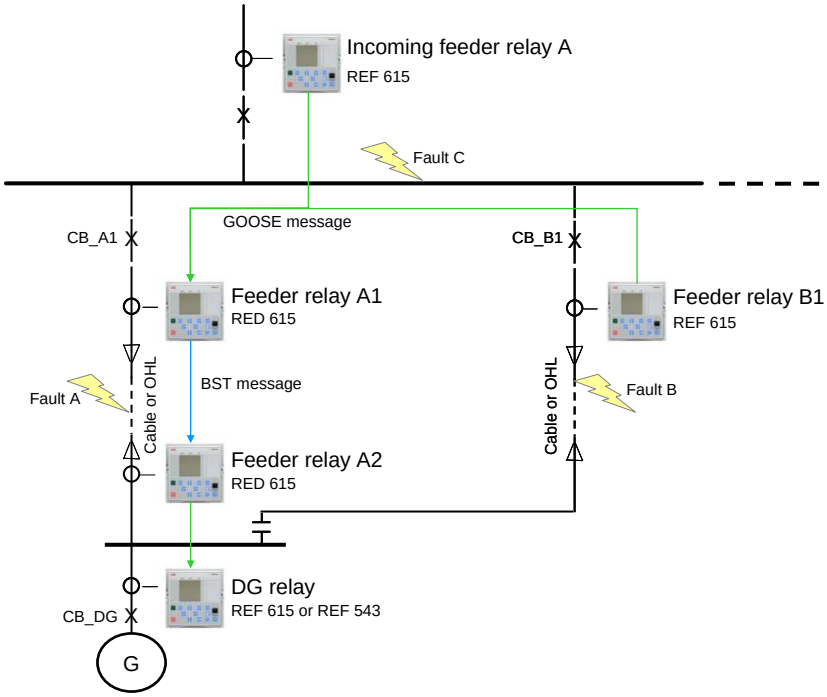

Figure 1. Selective loss-of-mains protection based on communication.

For more information contact Dr. Tech. Sami Repo, first.last@tut.fi, Dr. Tech. Kari Mäki, first.last@tut.fi or professor Pertti Järventausta, first.last@tut.fi.

8. DISSEMINATION OF THE RESULTS

ADINE wants to show that distribution networks could be managed in a more intelligent way than at present. Intention is to tell about the findings and results as early as possible to let other specialists in the field to contribute and refine ideas further. We try to gain attention in two arenas:

- Research groups working in the same field around Europe
- Distribution network owners and operators around Europe

At least following interfaces are arranged to allow easy information flow in and out of the project:

- www.adine.fi – project public web pages including all public materials at any time in any location
- Project mailing list, which anyone can join from www.adine.fi. We will send short alerts about public deliveries, workshops etc. to this list.
- Presentations in conferences and seminars
- Project workshops in Portugal, Spain and UK. First round of workshops for DSOs in these countries have been arranged between May and September 2008. The focus is in introducing the new ideas to real operators letting them to contribute and give feedback. Later on, when the

demonstration results are in hands, we will gather same persons together to discuss how the results should be adopted to the market.
- In February 2009 we will arrange seminar to other Smart Grid projects together our project meeting
- Second round of workshops in summer 2010 will be in Portugal, Spain, UK, Germany, Finland and Sweden. Focus of these workshops are in dissemination the results of ADINE.

We encourage you all to contact ADINE team members to discuss about new ideas!

9. REFERENCES

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