Anders Bro Pedersen - DTU Orbit (16/04/2018)

Organisations

Software Developer, Department of Electrical Engineering
20/05/2010 → present
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VIP

Center for Electric Power and Energy
06/11/2012 → present
VIP

Electric Energy Systems
25/02/2012 → 06/11/2012 Former
VIP

Publications:

Electric vehicle battery charging controller
The present invention provides an electric vehicle charging controller. The charging controller comprises a first interface connectable to an electric vehicle charge source for receiving a charging current, a second interface connectable to an electric vehicle for providing the charging current to a battery management system in the electric vehicle to charge a battery therein, a first communication unit for receiving a charging message via a communication network, and a control unit for controlling a charging current provided from the charge source to the electric vehicle, the controlling at least in part being performed in response to a first information associated with a charging message received by the first communication unit

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy resources, services and control
Authors: Pedersen, A. B. (Intern), Andersen, P. B. (Intern), Sørensen, T. M. (Intern), Martinenas, S. (Intern)
Publication date: 9 Jun 2016

Publication information
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Date: 09/06/2016
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Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2016087150
Publication: Research › Patent – Annual report year: 2016

A Method for Remote Control of EV Charging by Modifying IEC61851 Compliant EVSE Based PWM Signal
The Electric Vehicle (EV) has properties that can not only load but can elevate its value as a resource to the power system. An EV represents a high-power, fast-responding flexible demand unit, with an attached energy storage (battery) and the potential for bi-directional capabilities (V2G). These properties can be used in a number of power and energy services, which can support power system operation while lowering the cost of EV ownership. Such services depend on the support from the communications technologies and standards that connect controllers and logic in the EVs with those in the charging infrastructure- and back-end systems. To date, there is still no widely adopted standard that supports EV grid services, such as smart charging. This work proposes a solution that would allow any combination of charging spot and EV - individually lacking the logic, communication and controllability required for smart charging - to gain this ability by simply adhering to the widely supported IEC61851 standard. This paper describes the solution, demonstrates the implementation and discusses the potential it has for unlocking EV power- and energy services.
Electric vehicle data acquisition system

A data acquisition system for electric vehicles is presented. The system connects to the On-board Diagnostic port of newer vehicles, and utilizes the in-vehicle sensor network, as well as auxiliary sensors, to gather data. Data is transmitted continuously to a central database for academic and industrial applications, e.g. research in electric vehicle driving patterns, vehicle substitutability analysis and fleet management. The platform is based on an embedded computer running Linux, and features a high level of modularity and flexibility. The system operates independently of the make of the car, by using the On-board Diagnostic port to identify car model and adapt its software accordingly. By utilizing on-board Global Navigation Satellite System, General Packet Radio Service, accelerometer, gyroscope and magnetometer, the system not only provides valuable data for research in the field of electric vehicles, but also allows for experiments and investigation of other related topics.

Electric vehicle integration in a real-time market

This project is rooted in the EDISON project, which dealt with Electrical Vehicle (EV) integration into the existing power grid, as well as with the infrastructure needed to facilitate the ever increasing penetration of fluctuating renewable energy resources like e.g. wind turbines. In the EDISON project, the EV is introduced as an energy buffer used to store excess...
energy produced at off-peak hours, while at the same time potentially benefiting the consumer by offering cheaper charging. This role as a buffer, predominantly used for delayed charging, also known as “smart charging”, can also be used for ancillary services to help stabilize the grid at critical periods, e.g. by providing near instant up- or down regulation. The initial goal of this project is to develop the components for a simulation platform for large scale EV integration studies. By interfacing the EV simulation with an externally simulated model of the power grid, it is be possible, in real-time, to simulate the impact of EV charging and help to identify bottlenecks in the system. In EDISON the vehicles are aggregated using an entity called a Virtual Power Plant (VPP); a central server monitoring and controlling the distributed energy resources registered with it, in order to make them appear as a single producer in the eyes of the market. Although the concept of a VPP is used within the EcoGrid EU project, the idea of more individual control is introduced through a new proposed real-time electricity market, where the consumers will have direct access to the current price. As opposed to the hourly spot-price market of today, the real-time market see price updates as often as every couple of minutes. To allow the individual resources to react to these changes, independent of each other, so called “smart controllers” are needed at the device level. In order for this market to work, however, the proper ICT network- and server-infrastructure has to be developed. The primary goal of this PhD project, has been to investigate the scope of this ICT infrastructure, required to realise price-signal based charging of electric vehicles, in accordance with the EcoGrid EU market.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Department of Applied Mathematics and Computer Science, Software Engineering, IBM Research
Authors: Pedersen, A. B. (Intern), Østergaard, J. (Intern), Poulsen, B. (Intern), Gantenbein, D. (Ekstern)
Number of pages: 190
Publication date: 2014

Electric Vehicle Smart Charging using Dynamic Price Signal
With yearly increases in Electric Vehicle (EV) sales, the future for electric mobility continues to brighten, and with more vehicles hitting the roads every day, the energy requirements on the grid will increase, potentially causing low-voltage distribution grid congestion. This problem can, however, be resolved by using intelligent EV charging strategies, commonly referred to as "Smart Charging". The basic approach involves modifying the default vehicle charging scheme of "immediate charging", to a more optimal one that is derived from insight into the current state of the grid. This work proposed in this paper, involves a real-time control strategy for charging the EV using a dynamic price tariff, with the objective of minimizing the charging cost. Two different charging scenario are investigated, and the results are verified by experiments on a real Electric Vehicle. Finally, the costs of the proposed solutions are compared to the default charging scheme.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy resources, services and control
Authors: Martinenas, S. (Intern), Pedersen, A. B. (Intern), Marinelli, M. (Intern), Andersen, P. B. (Intern), Træholt, C. (Intern)
Number of pages: 6
Publication date: 2014
Generating Geospatially Realistic Driving Patterns Derived From Clustering Analysis Of Real EV Driving Data

In order to provide a vehicle fleet that realistically represents the predicted Electric Vehicle (EV) penetration for the future, a model is required that mimics people driving behaviour rather than simply playing back collected data. When the focus is broadened from a traditional user-centric smart charging approach to be more grid-centric, it suddenly becomes important to know not just when- and how much the vehicles charge, but also where in the grid they plug in. Since one of the main goals of EV-grid studies is to find the saturation point, it is equally important that the simulation scales, which calls for a statistically correct, yet flexible model. This paper describes a method for modelling EV, based on non-categorized data, which takes into account the plug in locations of the vehicles. By using clustering analysis to extrapolate and classify the primary locations where the vehicles park, the model can be transferred geographically using known locations of the same classification.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Department of Applied Mathematics and Computer Science
Authors: Pedersen, A. B. (Intern), Aabrandt, A. (Intern), Østergaard, J. (Intern), Poulsen, B. (Intern)
Number of pages: 6
Pages: 686-691
Publication date: 2014

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Publisher: IEEE
ISBN (Print): 9781479913008
Main Research Area: Technical/natural sciences
Conference: 2014 IEEE ISGT Asia Conference, Kuala Lumpur, Malaysia, 20/05/2014 - 20/05/2014
Electronic versions:
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Source: PublicationPreSubmission
Source-ID: 93263834
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

ICT Solutions to Support EV Deployment

Numerous studies and projects have proven that the electric vehicle can offer value and services that go beyond its function as a means of transportation. The value and services can, for instance, be the reduction of charging costs, adherence to grid constraints, or adjustment of charging behavior to renewable energy production. If these possibilities are considered and supported by information and communication technologies (ICT) in due time, a large potential can be exploited.

Specifically, the protocols and technologies spanning the open system interconnection stack need to support the various utilization concepts for EVs and be harmonized to obtain interoperability among numerous electric vehicle (EV) and electric vehicle supply equipment from original equipment manufacturers.

This chapter describes contemporary Smart Grid communication methods in terms of requirements and specific solutions and relates them to relevant standardization work and projects within the area.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Technical University of Denmark, Instituto de Engenharia de Sistemas e Computadores do Porto
Authors: Pedersen, A. B. (Intern), Andersen, P. B. (Intern), Skov Johansen, J. (Ekstern), Rua, D. (Ekstern), Ruela, J. (Ekstern), A. Pecas Lopes, J. (Ekstern)
Pages: 107-154
Publication date: 2013

Host publication information
Title of host publication: Electric Vehicle Integration into Modern Power Networks
Integrating Intelligent Electric Devices into Distributed Energy Resources in a Cloud-Based Environment

Until now the main purpose of Distributed Energy Resources (DERs) has been to compliment the power plants. However, if DERs are to play a larger role in the power grid of the future, then improved communication and cooperation between these resources and the system operators is necessary. Cooperation requires intelligence at the level of the DER as well as at the aggregator level, and in order to efficiently facilitate this, communication must be easily achievable.

This project presents a proof-of-concept plug-and-play cloud solution for next generation DERs, built upon the IEC 61850[15] standard, that enable easy communication and cooperation between DERs and system operators.

Utilizing a Flexibility Interface for Distributed Energy Resources Through a Cloud-Based Service

With governments around the world pushing for an ever increasing shift towards renewable energy production, large numbers of controllable distributed energy resources are starting to appear. Already a multitude of proposed control solutions have seen the light of day, but most are focused solely on the control itself and not the more practical network- and data management issues that follows trying to handle such huge portfolios. This papers covers a cloud based solution to the aforementioned issues, greatly aiding aggregators scale to meet future demands. It also includes a flexibility interface that are currently being researched by iPower, that is mapped to the well tested standard of IEC 61850 as additional sub-nodes. By mapping to existing standards, no major changes would be needed to adapt existing systems.
Implementation of an Electric Vehicle Test Bed Controlled by a Virtual Power Plant for Contributing to Regulating Power Reserves

With the increased focus on Electric Vehicles (EV) research and the potential benefits they bring for smart grid applications, there is a growing need for an evaluation platform connected to the electricity grid. This paper addresses the design of an EV test bed, which using real EV components and communication interfaces, is able to respond in real-time to smart grid control signals. The EV test bed is equipped with a Lithium-ion battery pack, a Battery Management System (BMS), a charger and a Vehicle-to-Grid (V2G) unit for feeding power back to the grid. The designed solution serves as a multifunctional grid-interactive EV, which a Virtual Power Plant (VPP) or a generic EV coordinator could use for testing different control strategies, such as EV contribution to regulating power reserves. The EV coordination is realized using the IEC 61850 modeling standard in the communication. Regulating power requests from the Danish TSO are used as a proof-of-concept, to demonstrate the EV test bed power response. Test results have proven the capability to respond to frequent power control requests and they reveal the potential EV ability for contributing to regulating power reserves.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy
Authors: Marra, F. (Intern), Sacchetti, D. (Intern), Pedersen, A. B. (Intern), Andersen, P. B. (Intern), Træholt, C. (Intern), Larsen, E. (Intern)
Number of pages: 7
Publication date: 2012

Numerical Comparison of Optimal Charging Schemes for Electric Vehicles

The optimal charging schemes for Electric vehicles (EV) generally differ from each other in the choice of charging periods and the possibility of performing vehicle-to-grid (V2G), and have different impacts on EV economics. Regarding these variations, this paper presents a numerical comparison of four different charging schemes, namely night charging, night charging with V2G, 24 hour charging and 24 hour charging with V2G, on the basis of real driving data and electricity price of Denmark in 2003. For all schemes, optimal charging plans with 5 minute resolution are derived through the solving of a mixed integer programming problem which aims to minimize the charging cost and meanwhile takes into account the users’ driving needs and the practical limitations of the EV battery. In the post processing stage, the rainflow counting algorithm is implemented to assess the lifetime usage of a lithium-ion EV battery for the four charging schemes. The night charging scheme is found to be the cheapest solution after conducting an annual cost comparison.

General information
State: Published
Organisations: Department of Electrical Engineering, Electric Components, Electric Energy Systems
Authors: You, S. (Intern), Hu, J. (Intern), Pedersen, A. B. (Intern), Andersen, P. B. (Intern), Rasmussen, C. N. (Intern), Cha, S. (Intern)
Prediction and optimization methods for electric vehicle charging schedules in the EDISON project

Smart charging, where the charging of an electric vehicle battery is delayed or advanced in time based on energy costs, grid capacity or renewable contents, has a great potential for increasing the value of the electric vehicle to the owner, the grid and society as a whole. The Danish EDISON project has been launched to investigate various areas relevant to electric vehicle integration. As part of EDISON an electric vehicle aggregator has been developed to demonstrate smart charging of electric vehicles. The emphasis of this paper is the mathematical methods on which the EDISON aggregator is based. This includes an analysis of the problem of EV driving prediction and charging optimization, a description of the mathematical models implemented and an evaluation of the accuracy of such models. Finally, additional optimization considerations as well as possible future extensions will be explored. This paper hopes to contribute to the field of EV integration by coupling optimized EV charging coordination with the EV utilization predictions on which the former heavily relies.

General information
State: Published
Organisations: Centre for Electric Technology, Department of Electrical Engineering, Center for Electric Power and Energy, Energy resources, services and control, Electric Energy Systems, Electric Components, Department of Informatics and Mathematical Modeling, Computer Science and Engineering, Software Engineering
Number of pages: 7
Publication date: 2012
Facilitating a generic communication interface to distributed energy resources: Mapping IEC 61850 to RESTful services

As the power system evolves into a smarter and more flexible state, so must the communication technologies that support it. A key requirement for facilitating the distributed production of future grids is that communication and information are standardized to ensure interoperability. The IEC 61850 standard, which was originally aimed at substation automation, has been expanded to cover the monitoring and control of Distributed Energy Resources (DERs). By having a consistent and well-defined data model the standard enables a DER aggregator, such as a Virtual Power Plant (VPP), in communicating with a broad array of DERs. If the data model of IEC 61850 is combined with a set of contemporary web protocols, it can result in a major shift in how DERs can be accessed and coordinated. This paper describes how IEC 61850 can benefit from the REpresentational State Transfer (REST) service concept and how a server using these technologies can be used to interface with DERs as diverse as Electric Vehicles (EVs) and micro Combined Heat and Power (μCHP) units.

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling, Centre for Electric Technology, IBM Research
Authors: Pedersen, A. B. (Intern), Hauksson, E. B. (Intern), Andersen, P. B. (Intern), Poulsen, B. (Intern), Træholt, C. (Intern), Gantenbein, D. (Ekstern)
Number of pages: 61
Publication date: 2010

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Main Research Area: Technical/natural sciences
Conference: First IEEE International Conference on Smart Grid Communications (SmartGridComm), 2010, Gaithersburg, USA, 01/01/2010
Energy resources, IEC standards, Power grids, Open systems
Electronic versions: 2D0FAF9Bd01.pdf
DOIs: 10.1109/SMARTGRID.2010.5622020
Links: http://www.itng.info

Bibliographical note
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Source: orbit
Source-ID: 264094
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Projects:

Across Continents Electric Vehicle Services
ACES intends to holistically investigate technical and economic system benefits and impacts by large scale electric vehicles integration in Bornholm, augmented by real usage patterns, grid data and field testing for across continents replicability.

A full scale penetration scenario of EVs in Bornholm will be simulated in order to assess how new aggregating functionality can support both technically and economically the successful integration of electric vehicles into the energy system.
It will also initiate a small scale pilot project involving up to 50 publicly and privately owned Nissan vehicles and V2G chargers for proving that EVs can be used for effectively balance the system.

The analysis, although focused on a Danish context, is enhanced also by comparing existing electricity market services in UK and in Japan, taking advantage by the strong collaboration established with the Japanese and UK based research centers of Nissan.

Department of Electrical Engineering
Center for Electric Power and Energy
Energy resources, services and control
Energy system operation and management
Nissan Motor Co.

Bornholms Energi og Forsyning
NUVVE Corporation
Period: 01/04/2017 → 30/09/2020
Number of participants: 8
Electric power system, Demand, Frequency control, Electric vehicles, Distributed energy resources, distribution system operation
Acronym: ACES
Number of related Ph.D. students: 1
Project participant:
Træholt, Chresten (Intern)
Sørensen, Thomas Meier (Intern)
Andersen, Peter Bach (Intern)
Hu, Junjie (Intern)
Zecchino, Antonio (Intern)
Thingvad, Andreas (Intern)
Pedersen, Anders Bro (Intern)

Project Coordinator:
Marinelli, Mattia (Intern)

Project

EcoGrid EU - Large scale Smart Grids demonstration of real time market-based integration of DER and DR
The EcoGrid EU project proposal offers Europe a “fast track” evolution towards Smart Grid dissemination and deployment in the distributed electricity grid.

The aim is to contribute to the European 20-20-20 goals by showing that it is possible to operate a distribution power system (on the Danish island of Bornholm) with more than 50 % renewable energy sources (RES) making active use of new communication technology and innovative market solutions.

The EcoGrid EU concept will contribute to the operation of the transmission system by offering the TSOs additional balancing and ancillary services. EcoGrid EU is a large-scale demonstration of a complete power system including the following key elements:
- The total distributed grid with all resources up to 60 kV, 28,000 customers, 55 MW peak load, 268 GWh electricity consumption and 500 GWh heat demand
- All distributed RES including wind power, photo voltaic, biomass, biogas, five units with heat accumulation tanks for district heating and electric vehicles (EVs)
- ICT systems and a new information architecture allowing all units of distributed energy resources (RES) and demand response (DR) to participate in the power market. There will be a communication and information system and new operational procedures
- Full market participation utilizing all parts of the existing power market and developing a new near real-time market for deliverance of ancillary services both from RES and DR
- “Smart” Meters, “Smart” Controllers and E-mobility by using electric vehicles as an integrated part of the total concept
- Storage of energy will be demonstrated using heat appliances as well as batteries of the electric vehicles

The EcoGrid EU-project will combine knowledge from previous EU funded projects into a large-scale demonstration where the outcome is substantial contribution to a “Road map for European Smart Grids deployment”.

Centre for Electric Technology
Department of Electrical Engineering
Electric Energy Systems

Center for Electric Power and Energy

Energy Analytics and Markets
Period: 01/04/2011 → 30/09/2015
Number of participants: 15
Acronym: EcoGrid EU
Project participant:
- Pedersen, Anders Bro (Intern)
- Ding, Yi (Intern)
- Feng, Donghan (Intern)
- Larsen, Emil Mahler (Intern)
- Nielsen, Arne Hejde (Intern)
- Pedersen, Rasmus Reeh (Intern)
- Pensini, Alessandro (Intern)
- Pineda Morente, Salvador (Intern)
- Rasmussen, Claus Nygaard (Intern)
- Hashemi Toghroljerdi, Seyedmostafa (Intern)
- Wu, Qiuwei (Intern)
- Yang, Guangya (Intern)
- Østergaard, Jacob (Intern)
- Pinson, Pierre (Intern)
- Le Ray, Guillaume (Intern)

Financing sources
Source: EU research programme (public)
Name of research programme: EU FP7
Amount: 178,725,000.00 Danish Kroner
Year of approval: 2011

Relations
Activities:
EcoGrid EU Market Concept: Large-scale Smart Grid demonstration of real time market-based integration of distributed energy resources (DER) and demand response (DR)

Press / Media items:
CLEAN REVOLUTION: Denmark is striving to become the world’s first carbon-neutral nation

Documents:
Fact sheet EcoGrid EU 2015

Electric vehicle integration in a real-time market

Department of Electrical Engineering
Period: 01/02/2011 → 18/03/2015
Number of participants: 7
PhD Student:
- Pedersen, Anders Bro (Intern)
Supervisor:
- Gantenbein, Dieter (Ekstern)
PhD Student:
- Poulsen, Bjarne (Intern)
Main Supervisor:
- Østergaard, Jacob (Intern)
Examiner:
- Wu, Qiuwei (Intern)
Examiner:
- Jørgensen, Preben (Ekstern)
Examiner:
- Kempton, Willett (Intern)

Financing sources
Source: Internal funding (public)
Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks

The EDISON project is an international research project partly publicly funded through the Danish transmission system operator (TSO) Energinet.dk's research programme FORSKEL. The total budget is approximately 49 million DKK, where 33 million come from FORSKEL.

In the EDISON project Danish and international competences will be utilised to develop optimal system solutions for EV system integration, including network issues, market solutions, and optimal interaction between different energy technologies. Furthermore, the Danish electric power system provides an optimal platform for demonstration of the developed solutions.

Electric vehicles (EVs) provide a unique opportunity to reduce the CO2 emissions from the transport sector. At the same time, EVs have the potential to play a major role in an economic and reliable operation of an electricity system with a high penetration of renewable energy. EVs will be a very important balancing measure to enable the Danish government's energy strategy, which implies 50% wind power penetration in the electric power system. An EV will be a storage device for smoothing power fluctuations from renewable resources especially wind power and provide valuable system services for a reliable power system operation. With the proper technology the cars can run on wind power and at the same time enable an increased share of RES in the power system for supply of the conventional electricity demand, and thereby, provide an overall economic, reliable, and sustainable energy system.

Department of Electrical Engineering
Center for Electric Power and Energy

Period: 01/09/2009 → 01/03/2012
Number of participants: 1
Acronym: EDISON
Project participant:
Pedersen, Anders Bro (Intern)

Activities:

IEC61850 and Interoperability in SmartGrid
Period: 11 Jun 2012 → 13 Jun 2012
Anders Bro Pedersen (Speaker)
Department of Electrical Engineering
Center for Electric Power and Energy

Description
The development towards a sustainable energy system in the electric power industry has led to the emergence of a set of market models and new concepts for optimized operation and control of power systems, e.g. Virtual Power Plants and Microgrid. In these new concepts, the traditional stakeholders are complemented by new actors that take roles such as aggregator, prosumer, dispatchable load etc. Common to all these concepts is that they assume a more flexible and loosely coupled ICT system architecture. In such architectures, ICT components communicate to implement optimization, control and protection functions.

Interoperability is a necessary pre-requisite for such an environment. While standards are a fundamental mean, and provide necessary ingredients they are not sufficient for achieving interoperability. Challenges include insufficient specifications, alternate options for implementation, vendor specific tools, difficulty in cross standard harmonization, integration with high level control and automation systems and steep learning curves for the workforce.

This course will provide fundamental knowledge to the interoperability issues in the Smartgrid, introduction to state of the art systems and technologies, and hands-on practice with relevant industry standard tools.

Talk titled "Virtual power plant for smart electric vehicle charging based on IEC 61850 VPP server"
Documents:
Event program
EDISON – ICT architectures for EV integration
Period: 19 Apr 2012
Anders Bro Pedersen (Speaker)
Department of Electrical Engineering
Center for Electric Power and Energy
Documents:
Event program

Smart Charging for Electric Vehicle (EV) Fleet Operators (FOs) and ICT Implementation using IEC 61850
Period: 5 Dec 2011
Anders Bro Pedersen (Lecturer)
Department of Electrical Engineering
Center for Electric Power and Energy

Description
Contents
1 Smart Charging for EV FOs
• EV charging management options
• Optimal EV charging management with minimum charging cost for EV FOs
2 Smart Charging with Day-Ahead Tariffs
• Congestion management techniques
• Day-Ahead Tariffs based on Locational Marginal Prices (LMPs)
• Optimal charging management for FOs with day-ahead tariffs
3 ICT Implementation for EV Smart Charging using IEC 61850
• Charging station and EV modeling
• Additions to IEC61850-7-420 for EV modeling
• Communicating the IEC61850 models
• Example/walkthrough of charging process (interactive demo)

Related event
2011 2nd IEEE PES International Conference and Exhibition on "Innovative Smart Grid Technologies" (ISGT Europe): ISGT-EUROPE 2011
05/12/2011 → 07/12/2011
Manchester, United Kingdom
Activity: Talks and presentations › Conference presentations