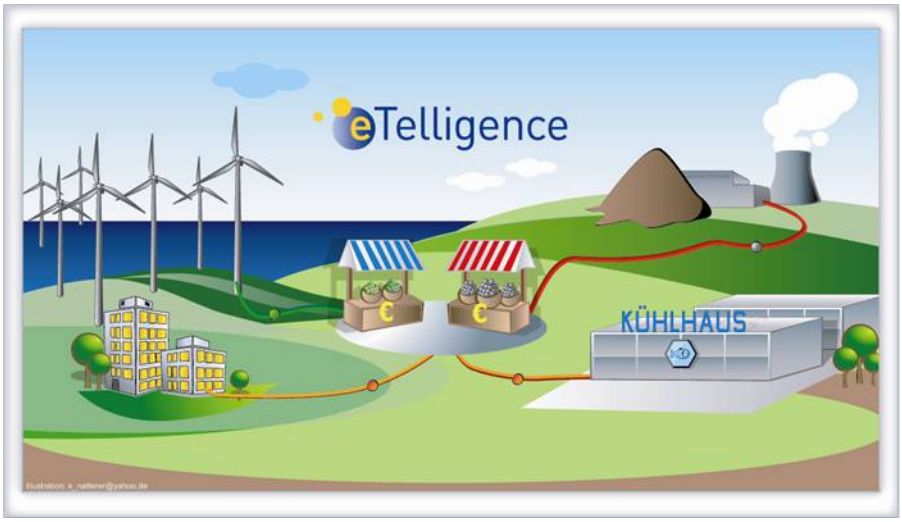
Project Summary
eTelligence

Project Description:

In an extensive field test eTelligence explores and demonstrates various approaches of using modern ICT and advanced operation to improve the current energy supply system and to enable broad integration of renewable energy sources like wind, photovoltaic and biomass.



One main aspect is the active distribution grid: We are currently putting up measurement equipment that allows us to "look into" the grid at low and medium voltage levels in real time. This information will be used to analyze and understand, as well as actively control the distribution system. E.g., the reactive power of CHP units shall be used to actively control the voltage gradients on the medium voltage lines. Furthermore, dynamic protection schemes will be developed and tested.

Other aspects cover the smart, market oriented operation of CHP units as well as large consumers (e.g. cold store houses with 0.5–1 MW each) and distributed generation (especially wind, biogas and PV). Virtual Power Plants will be used for aggregation of various consumers and renewable generation units.
Regarding the household customers, 2000 households will be equipped with latest smart meter technology and different feedback systems (paper, internet portal, iPod touch) to provide consumers with information about their electricity consumption.

To make all this possible, two ways of coupling are introduced:
(1) A regional marketplace shall match supply and demand including regional products that might be used by the grid operator for ancillary services.
(2) Modern ICT works as the "nervous system" to transmit measurements and control signals. A prototype implementation of this ICT-system will be built up; herein, the seamless usage of international standards (IEC 61850 and CIM (IEC 61970 and 61968)) play a crucial role.

Start Date: 2008-11-01	**End Date:** 2012-10-31	
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Project Participants:
EWE AG, Oldenburg, Germany (Utility, Lead Partner)
BTC AG, Oldenburg, Germany (IT Consulting and Software Development)
OFFIS e.V., Oldenburg, Germany (Research IT)
energy & meteo systems GmbH, Oldenburg, Germany (SME, Virtual Power Plant, energy meteorology)
Fraunhofer Energy Alliance, Freiburg and Ilmenau, Germany (Research CHP integration and distribution grid)
Öko-Institut (Research Evaluation)

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CE1 – Integration of multiple distributed resource types

Description & List:

- Integration of CHP (ranging from 1 kW to 1 MW), PV (photovoltaic), Wind (several MW), Biogas (~ 1 MW).
- Integration of demand response: several cold stores (consumption each ~ 500 kW) and wastewater treatment facility (consumption ~ 1 MW).
- These actors will be equipped with gateways converting the proprietary protocols and interfaces to IEC 61850 and/or CIM. Furthermore, these gateways will be used to connect the actors to a Virtual Power Plant or the eTelligence market place.
- Field Test: During the 1.5 years of field testing we will collect information about the operation of the whole system and its subsystems. The field test ensures the maturity of concepts and implementations.
- Widespread integration and scalability: The usage of international standards (IEC 61850 and CIM) will ensure that the demonstrated concepts can be applied in broad field. Standardization and plug-and-play interfaces will reduce the costs of integration and thus enable scalability and broad adoption.

Key Deliverables:

- Gateways using IEC 61850/CIM to several CHP units
- Gateways using IEC 61850/CIM to several DER units (PV, wind, biogas)
- Virtual Power Plant aggregating various demand response sites and renewable sources and selling on different regional and nationwide market places
- Field Test: Data and field test experience. Basis for evaluation of concepts and implementations.
- Report with evaluation of concepts and implementations.
- eTelligence reference ICT architecture
- Demonstration of reference architecture by the eTelligence implementation

CE2 – Incorporation of dynamic rates or other approaches for connecting retail customers with wholesale conditions

Description & List:

- Three different tariffs (TOU tariff combined with events, load variable tariff, tariff based on total consumption during billing period)
- Regional market place allowing access to day-ahead wholesale market via a market-maker.

Key Deliverables:

- Different feedback systems for household customers (paper, web portal, iPod Touch)
- Market platform for automatic market participation. Intraday bids are directly matched between field test participants. Day-ahead bids are aggregated by the market platform and then placed on the wholesale market by a market maker.
- Market agents coupling power plant controls and consumer controls to the market platform. These agents communicate bids to the platform using CIM-based communication.

CE3 – Integration into system planning and operations

Description:

- Deployment of cost effective permanent measurement equipment for voltage and current within the low voltage and medium voltage distribution grid. The sample rate of measurements is about six samples per second. However, most analysis requires one sample per second or minute. Measured data will be transferred from sensors to storage using IEC 61850.
- Load flow simulations allow for prediction of grid state in view of small-scale distributed supply. They are exemplarily used to either directly control power plants and loads or indirectly control them via a market platform allowing placement of bids for localized reactive power generation and consumption.

Key Deliverables:

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- Measurement equipment for low and medium voltage including multiple communication interfaces (fiber, CDMA, DSL).
- Infrastructure for communication and combined centralized / decentralized storage of measurements.
- Simulation algorithms for net flow analysis.
- Market agent for placing localized bids for reactive power on a market platform.

CE4 – Application of critical integration technologies and standards

Description & List of Standards:

- The eTelligence ICT architecture strongly relies on two international standard families: IEC 61850 is used for the field communication while CIM is used for communication on the business process level.
- Standard message bus technology to transfer information to subscribers within a distributed information processing platform. Most messages are conformant to CIM.
- CIM for modeling bids and transferring them to a market platform.
- CIM for communicating meter readings and grid sensor readings to an information processing platform.
- IEC 61850 for communicating control and state information between controllers on one hand and DER plants and consumers (industrial and commercial) on the other hand.
- IEC 61850 to communicate voltage and current sensor readings from local network stations to an information processing platform.

Key Deliverables:

- Implementation of eTelligence ICT architecture using CIM and IEC 61850.
- Generic eTelligence reference architecture using CIM an IEC 61850.
- High-level (object-oriented and platform independent) software capsule for IEC 61850 using MMS.
- IEC 61850 profiles for biomass plants, CHP plants and load control at consumer sites (e.g. cold store). These profiles will be introduced into the corresponding IEC working groups and publication is planned as IEC TR (technical report).

CE5 – Compatibility with EPRI Smart Grid initiative goals and approach

Description:

- Integration of distributed energy resources via a market with low barriers. It enables automatic market participation and access to the wholesale market is guaranteed via a market maker bundling bids.
- Integration of distributed energy resources by means of virtual power plants bundling resources and balancing fluctuating generation by incorporating consumers with shiftable loads.

Key Deliverables:

- Market platform and agents allowing for automated access to the platform
- Virtual power plant

CE6 – Leverage of additional funding sources

List:

- German Federal Ministry of Economics and Technology: approx. 10 Million Euros

Progress Summary (Conclusions, Recommendations):

- The project is progressing as planned.
- Current phase: Concept and implementation.
- ICT reference architecture and use cases are specified.
- Implementation architecture for the field test is specified. Implementation is in progress.
- Field test sites (commercial and industrial) are identified; first steps of integration are done. Further integration is in progress.
- Acquisition of 2000 household customers for field test is in progress.

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- First wave of field test will start 2010-07-01.
- End of 2011: End of field test and start of evaluation.
- End of 2012: End of evaluation. Final reports.

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Preferred Criteria		Description of Project Element (if applicable)
1) Does the project integrate multiple distributed resource types?		Yes
a	Demand Response	☒ Direct Load Control Program ☒ Demand Response Program ☒ Electric Vehicle Charging ☒ Thermal Storage for Electric Peak Shifting & DR Other: “Electric Vehicle Charging” is part of the research project “GRID-Surfer” (EWE, BTC, OFFIS and others). GRID-Surfer will connect to the eTelligence market place and uses the same basic ICT infrastructure and standards.
b	Electric Energy Storage	☐ Behind the meter Battery Storage ☐ Utility System Battery Storage <= 100kWh ☐ Utility System Battery Storage > 100kWh ☐ Flywheel Other: We use the coupling of thermal and electrical system (e.g. cold-store) as “virtual” storage.
c	Renewable Generation	☒ Solar PV (Customer Owned) ☒ Solar PV (Utility Owned) ☐ Concentrated Solar ☒ Wind Generation ☒ Biogas Other:
d	Distributed Generation	☐ Diesel Generator ☐ Microturbine ☒ Fuel Cell ☒ Combined Heat & Power ☐ Compressed Air Energy Storage Other:
e	Other	
2) Does the project apply critical integration technologies and standards?		Yes.

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a	Customer System Interfaces	☐ 6LowPAN ☐ ANSI C.12.xx ☐ BACnet ☐ DNP3 ☐ HomePlug ☒ IEC 61850 Family ☒ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ MODBUS or MODBUS/TCP ☐ oBix ☐ OpenADR / OASIS Energy Interop ☐ Smart Energy Profile (SEP) 1.0 or 2.0 ☐ ZigBee (802.15.4) Other: wireless LAN (IEC 802.11) for feedback system “iPod touch”
b	Distribution System Interfaces	☐ DNP3 ☐ IEC 60870 (ICCP) ☒ IEC 61850 Family ☒ IEC 61968 Family ☒ IEC 61970 Family ☒ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ MODBUS or MODBUS/TCP ☐ Multispeak Other: The eTelligence ICT architecture strongly relies on IEC 61850 and CIM (IEC 61968 and IEC 61970) over TCP/IP.

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c	Transmission System Interfaces	☐ DNP3 ☐ IEC 60870 (ICCP) ☐ IEC 61850 Family ☐ IEC 61968 Family ☐ IEC 61970 Family ☐ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ MODBUS or MODBUS/TCP ☐ Multispeak Other:
d	Aggregator/Service Provider System Interfaces	☐ ANSI C.12.xx ☐ Cellular Based (1xRTT, GPRS, EVDO, CDMA, etc.) ☐ DNP3 ☐ FixML ☐ IEC 60870 (ICCP) ☒ IEC 61850 Family ☒ IEC 61968 Family ☒ IEC 61970 Family ☒ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ Multispeak ☐ OpenADR / OASIS Energy Interop Other:

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e	Operations System Interfaces	☐ DRBizNet ☐ FixML ☐ IEC 60870 (ICCP) ☒ IEC 61850 Family ☒ IEC 61968 Family ☒ IEC 61970 Family ☐ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ Multispeak ☐ OpenADR / OASIS Energy Interop Other:
f	Energy Markets System Interfaces	☐ ANSI C.12.xx ☐ DNP3 ☐ DRBizNet ☐ FixML ☐ IEC 60870 (ICCP) ☐ IEC 61850 Family ☒ IEC 61968 Family ☒ IEC 61970 Family ☒ Internet Based (wired or wireless – IP, TCP, HTTP) ☐ Multispeak ☐ OpenADR / OASIS Energy Interop Other:

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g	WAN Communication Architecture	☐ AMI Infrastructure (Two-Way) ☐ RF Tower ☐ RF Mesh ☒ Public Internet ☒ Cellular Based (1xRTT, GPRS, EVDO, CDMA, etc.) ☐ Powerline Based ☐ WiMAX Other: Layer 3 VPNs will be used for most connections; either using CDMA/GPRS, DSL or optical fiber (up to the customer site)
h	Cyber Security	☐ Audit trails ☒ Authentication ☒ Certificates ☒ Encryption ☐ Intrusion Detection Other: A Security concept with limited scope will be developed and implemented.
i	Other	
3) Does the project incorporate dynamic rates or other approaches for connecting retail customers with wholesale conditions?		Yes.
a	Customer Diversity	☒ Residential Customers ☒ Commercial Customers ☒ Industrial Customers
b	Price Based	☐ Real-Time Pricing (RTP) ☐ Day Ahead Pricing ☒ Critical / Variable Peak Pricing ☒ Time of Use Rates ☒ Block (or Reverse Block) Rate Other: Different tariffs will be used and evaluated, e.g. load depending prices and rates motivating the customer to reduce his consumption.

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c	Incentive Based	☐ Emergency Demand Response ☒ Demand Bidding/Buyback ☐ Capacity Market ☐ Ancillary/Regulation Services ☐ Interuptible/Curtailable ☒ Direct Load Control Other:
d	Other	eTelligence market place will be open for local actors (consumers and producers) and incorporate them. The market place will also be coupled to other market places like EEX (national electricity market).
4) Does the project integrate with system planning and operations?		Yes.
a	Integration with System Operations	☐ Visibility of DER with Real-Time Sys Ops ☒ Integration with Distribution Management System Other: At least at a conceptual level. Online measurements at distribution level will give real-time information about DER feed-in.
b	Integration with System Planning	☐ Visibility of DER for future planning ☐ DER treated on equal footing as Generation Other: Integration of DER into system planning using the eTelligence market place. DER units will sell their produced electricity using various market segments (day ahead etc.).
c	Tools for Integration	☒ Modeling and/or Simulation Tools Other: Feed-in forecasts for photovoltaic and wind. Consumption forecasts for commercial/industrial customers and CHP sites.
d	Other	
5) Is the project compatible with EPRI's initiative and approach?		
a	Business case development	Yes. E.g. virtual power plants combining demand response and DER feed-in.
b	Use cases as documentation of important applications and requirements	Yes.

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c	Use of Standards in Utility Domains	☒ Customer Domain ☒ Distribution Domain ☐ Transmission Domain ☒ Aggregator/Service Provider Domain ☒ Operations Domain ☒ Energy Markets Domain
d	Enables Widespread integration of DER	☐ Public Sharing of Business Cases ☐ Public Sharing of Use Cases ☐ Public Sharing of Cost Benefit Analysis ☐ Public Sharing of Lessons Learned ☐ Working Directly with Standards Bodies ☐ Leveraging or Advancing Open Source Software Other: Integration of DER using regional market place and aggregation (virtual power plant). eTelligence reference ICT architecture and the usage of standards (mainly IEC) will enable widespread reuse of the developed concepts.
e	Other	
6) Does the project leverage additional funding sources?		Yes.
a	Leverage Additional Funding Sources	☒ Government (Local, State, Federal) ☐ Research Organizations besides EPRI ☐ Universities, Consortiums ☐ Vendors Other: The project is co-funded by the German Federal Ministry of Economics and Technology. About 50% of the funding is brought up by the industry partners.
b	Other	