

International Smart Grid Action Network (ISGAN)

9th ISGAN Awards of Excellence

*Recognizing excellence in
smart grid projects around the world*

**2023 Award theme:
Artificial Intelligence (AI) for Smart Grid**





The 9th ISGAN Awards of Excellence: **Winner**

FleXunity - Scaling-up Power Flexible Communities Business Models Empowered by Blockchain and AI Project



Project Location
Project Period
Lead Organisation
Partner Organisation

Portugal, Finland, United Kingdom, and Spain

2019-2022

CLEANWATTS DIGITAL, S.A.

Simples Energia de Espanã, S.L., Electric Corby CIC, Lappeenranta-Lahden Teknillinen Yliopistolut, Centro de Investigação em Energia - STATE GRID SA

Background and Objective of the Project

FleXunity aims to provide advanced tools and services to address the Energy Transition challenges. Its outcomes support renewable energy systems (RES) penetration while ensuring grid stability and lower balancing costs, improve energy efficiency for end-users and amplify investments in self-generation, storage and load management, giving more opportunities to consumers to capture value from their energy assets. The main goal was to develop and validate the virtual power plants (VPP) digital tools based on advanced AI, remote automatization and blockchain to optimize community energy flexibility.

Project Implementation

The FleXunity project successfully deployed two distinct large-scale pilot Energy Communities (EC) in different countries, that gave the necessary data inputs to establish a reliable VPP framework able to perform the management and control of a wide diversity of energy assets, enabling their participation in the different Energy Markets. The data collected from the implemented pilots served as input for the evaluation of the developed VPP platform and the different Business Models developed. The VPP platform validation tests performed with the different energy assets deployed demonstrated the technical feasibility of the final solution and its compliance with the identified legal requirements and with the FleXunity project requirements.

The Internet of things (IoT) devices architecture and the blockchain Platform application programming interface (API) specification were developed and implemented into the VPP platform, to be able to perform in a trustable way the registration of the energy trading for the peer-to-peer market participation.

The generic operational models for each type of flexible device were developed, with the complete workflow for an optimization process including the key data inputs and the mathematical models for the optimization of the demand-side flexibility and excess PV generation resources of energy community members. These generic models were tested and evaluated using the data collected on the pilots revealing that their usage in real-world conditions is effective.

The project developed a series of different stakeholders' dashboards, using a modular approach, allowing their constant updates and upgrades. The dashboards are being used now for the Renewable Energy Community management in Portugal, with potential implementations being analysed for other countries such as Italy, Spain, USA.

Accelerating progress on key aspects of smart grid policy, technology, and related standards

Given the nonexistence of a common legal framework across Europe, the results helped in the validation of the stakeholder benefits in close and open energy markets, which is enhancing the commercial roll-out of the solution. These envisaged innovative services will allow utilities to maximize their profit and enable new business models from managing multiple energy flexibility assets, introducing flexibility as a new tradable asset in their business portfolios, and allowing energy costs savings sharing with end-users, enhancing the use of renewables and support energy security and climate change challenges.

Project Outcome and Key Messages

FleXunity developed a VPP tool able to optimize the energy flexibility, resulting in a higher penetration of renewables, energy savings, and lower carbon footprint. The key project outcomes were tested and demonstrated in two distinct pilots with very different market conditions: UK energy market (open mature market); Iberia energy market (in transformation – opening to use flexibility from demand-side). Given the nonexistence of a common legal framework across Europe, this helps us to validate different stakeholder benefits in close and open energy markets, enhancing the full commercial roll-out.



The 9th ISGAN Awards of Excellence: **Runner-Up**

CartoLine – the New “Predictive Maintenance” Tool for ENEDIS

Project Location
Project Period
Lead Organisation

Paris, France
2019-2025 (ongoing)
Enedis, S.A.



Background and Objective of the Project

CartoLine is part of a larger project that aims to use the French “Linky” Smart Metering infrastructure for :

- Enhancing the performance of the network
- Identifying and addressing non-technical losses
- Detecting and diagnosing incidents in real-time for both high voltage (HV) and low voltage (LV) situations
- Improving the reliability of GIS for studies and planning to optimize the network and its capacity to accommodate various needs, especially to support new applications such as renewable energy and electric mobility.

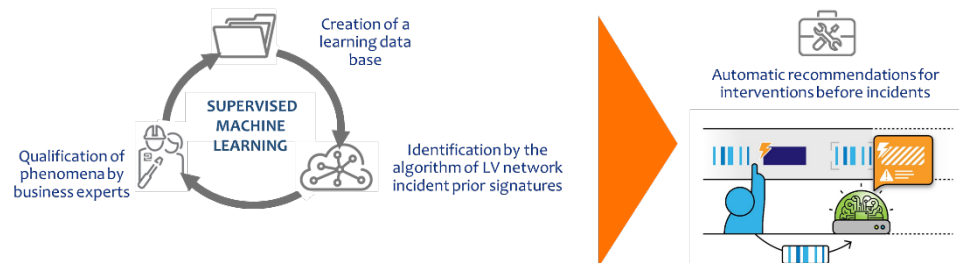
CartoLine is a tool for predictive maintenance. Before the incidents occur, it becomes possible to plan troubleshooting during regular office hours instead of having to deal with them during nighttime or weekends.

Project Implementation

During the experimentation of the new LV real-time incident detection solution, it became clear that some alarms were not the symptom of a real electrical failure, but the sign of a future incident, or even a simple temporary anomaly. How do you differentiate between these last two categories?

CartoLine is a supervised machine-learning solution, which classify - then request confirmation from technicians - quality of supply anomalies (surges, undervoltage, brief interruptions...) into two categories:

Intervention needed in a few days; No intervention needed. It also uses GIS description data (type of cable, overhead/underground grid...). CartoLine also offers a diagnosis of the incident cause, in order to facilitate this special kind of early troubleshooting.



With CartoLine, a new horizon is opening up for Smart Grids: the predictive maintenance, with, more than a concept, a real industrialized application.

Project Outcome and Key Messages

CartoLine enables more efficient operation of LV networks: not only do Smart Grids make possible to observe network in finer detail, but CartoLine takes full advantage of this new data.

As a supervised learning solution, it also places the expertise of field technicians at the heart of this intelligence, which is no longer artificial! CartoLine predicts 10% of LV incidents due to natural network wear and tear about three weeks before they occur.

Today, over 99% of its predictions are confirmed by business experts; its pre-diagnosis saves two hours of troubleshooting per incident. In many cases, customers don't even experience an outage!





The 9th ISGAN Awards of Excellence: **Honourable Mention**

AI-based Distribution Grid Load and Asset State Prediction System

Project Location
Project Period
Lead Organisation

Daejeon, Republic of Korea
2017 - 2021
Korea Electric Power Corporation, Research Institute (KEPRI)



Background and Objective of the Project

Background: To integrate more DER, Korea government decides to permit an unlimited connection of the DER (under 1 MW) in the distribution line. For this reason, the capacity of DERs in the distribution line is increasing daily, and the cost of investment in installing additional distribution lines for DER is also increasing. Therefore, KEPCO needs a cost-effective distribution asset optimization solution to integrate DER effectively.

Objective: The purpose of this project is to provide highly accurate load forecasting and facility state prediction results. Using these results, we can replace the facilities before failure and adopt more DER without additional distribution lines and upgrades.

Project Implementation

Approach: We developed a distribution grid load and asset state prediction system for automatically conducting the replacement decision procedure and high accuracy of the algorithm by relearning the data. We applied a hybrid multilayer perceptron (MLP) method and a non-parametric survival analysis method to predict the state of the facilities.

Project Implementation: We demonstrate these systems on an actual distribution grid system for the first time in the world. The target apparatus was a switchgear and transformer. Both systems are installed on the KEPCO cloud platform, which KEPCO employees can access. The distribution planning and operations standards were revised based on the forecasting results.

Alignment with ISGAN:

- (1) Smart grid policy support: This can forecast the load for each distribution line and analyze load patterns when the new DER is connected to the distribution line. Based on these results we can integrate more DERs without installing additional distribution lines.
- (2) Technology innovation: The prediction accuracy was improved by more than 10%p compared to the existing prediction results, and the prediction time for over 3 million main distribution facilities was less than 30 min.
- (3) Revised standards: We revised KEPCO standards using these technologies. We revised the distribution planning procedure document (Standard No.H0-distribution-procedure-0058) and DAS planning standard using the grid load forecasting method. And we revised the health index standard for the load break switch, gas-insulated switchgear, overhead transformer, and overhead distribution line by using the asset state prediction method.

Project Outcome and Key Messages

Project Outcome: We have developed two systems. The functions and performance of each system are as follows:

- (1) Asset state prediction system: This includes functions such as data pre-processing and monitoring, asset health index generation using the random forest method and survival analysis, and reporting of facilities replacement priority. The facility replacement cost can be reduced by over \$19.6 million per year (more than 15% of the replacement cost per year for decrepit distribution facilities) using this system.
- (2) Grid load forecasting system: This includes functions load forecasting for each distribution line using the hybrid MLP method, optimal locations for switchgear installation, and load forecasting with additional DERs. We decreased peak load improves the utilization rate by approximately 15% compared to the past using this system.

Key Messages: We can reduce work time and investment costs using these systems. In addition, we can improve the utilization rate of the distribution line using the prediction results of the peak/sectional load in the distribution grid and decrease the investment cost by up to 30%. Modular systems consist of an algorithm for each function. Therefore, it can easily be applied to other power utility grid systems with similar apparatuses.



The 9th ISGAN Awards of Excellence: **Honourable Mention**

AI/ML Powered Enterprise Analytics for Power Distribution Companies



Project Location
Project Period
Lead Organisation
Partner Organisation

UHBVN Haryana, India
September 2021 - Ongoing
IntelliSmart Infrastructure Private. Ltd.
SAS Institute (India) Pvt. Ltd.

Background and Objective of the Project

UHBVN is a distribution Licensee in the public domain and is responsible for Power distribution in the State of Haryana. UHBVN performs day-to-day activities including Energy Forecasting & Planning, Non-Technical Loss Detection, Billing & Collection and Trading of power involved in the distribution of power to consumers. The major objective of the project was to demonstrate how AI and machine learning (AI/ML) powered analytics can be leveraged to improve the financial and operational efficiency of state electricity distribution companies, with deliverables focused on Energy Theft Detection and Billing Data Analysis, developed on the basis of data captured from smart meter system and data from other enterprise applications such as ERP, GIS, CRM, etc.

Project Implementation

Phase 1: Discovery

AI/ML powered advanced analytics platform enables user in bringing out insights and driving results from the data that is available with the user. Therefore, it becomes critical for the service provider and the client to discover how best to avail the capabilities of such an analytics platform to drive the results that it intends to achieve. This discovery was carried out collectively among all the stakeholders by way of a workshop. Here, detailed discussions on the problem statements and corresponding capabilities in light of available data streams were carried out to formulate the use cases to be addressed and corresponding KPIs were identified.

Phase 2: Baseline & Data setup and implementation of the solution

On identification of KPIs, baseline values were documented corresponding to these KPIs using the existing processes followed by the discom. These were used to gauge the improvement observed through implementation of the AI/ML based solution. Meanwhile, the setting up of data integration was carried out for the provided data. Once set up, the solution was configured to analyse the data and not only provide actionable insights corresponding to the analysis, but also generate alerts with case management. The project therefore assisted the distribution company in meeting the objectives of not only the solution in consideration, but also that of Smart Meter Implementation along with AMI. Overall, it assisted the discom in significantly improving its performance on identified KPIs by transitioning from the existing inefficient methods to more efficient AI/ML powered methods.

Project Outcome and Key Messages

The pilot AI/ML based data analytics project in UHBVN enables discom for revenue maximization and opens up business opportunities in the form of optimisation of energy consumption, appliance energy tracking & analysis, consumption usage pattern, trends and forecasts, and theft detection among others. The pilot project has shown a potential to generate **INR 26.16 crores or ~USD 3 mn.** On the basis of the sample count, the analysis carried out showed that of 1027 identified cases of Anomaly/Theft detection, 252 were high-risk consumers who were causing a loss of **INR 66 lakh (USD 80.55K)** in September 2021 to the discom whereas 14,047 consumers which consumed 2,22,779 units were not billed for the month and caused **INR 9.24 crore (USD 1.12 mn)** of loss. Similarly, high bill generation, complaints default and defaulting high bill flagged customers led to the loss of **INR 16.26 crores (USD 1.98 mn).**

Our grateful thanks to the members of the 2023 ISGAN Award of Excellence jury for contributing their time and expertise to the evaluation process.

JUDGING PANEL

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- Chairman, Global Smart Energy Federation (GSEF)

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