Interreg Danube Region

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Danube DNA

Technical Manual of the Joint Solution

EM4Energy

Solution Title:	**EM4Energy**
Responsible Partner:	**CAMPUS 02 (PP10)**
Contributing Partners:	**VSTE (PP5)**
External experts:	
Period:	
Budget Allocation:	

1. Introduction

The Eco Adapt Energy Metering System is designed to measure the energy consumption of connected devices. This system is developed to support the Danube DNA project's objectives by providing a flexible and easy-to-install solution for energy sub-metering. The system's innovative data transmission capabilities ensure efficient monitoring and analysis of energy usage.

Eco-Adapt system provides an end-to-end energy monitoring and analysis solution built around the Power-Cloud platform and Eco-Adapt metering devices. The platform enables organizations to configure their monitoring environment, mirror their metering architecture, and analyze energy and machine-health data to guide high-impact efficiency actions. It organizes data within Organizations, Sites, and Areas to reflect real installations and support multi-site operations.

The system is configured to be retrofit to any power consuming device and therefore is applicable to most of the companies in the cooperation area of INTERREG DANUBE DNA project.

1.1 Background of the solution development

The development of the Eco Adapt Energy Metering System was driven by the need for a reliable and efficient method to monitor energy consumption in various production areas. The system's ability to transmit data wirelessly using the LoRaWAN protocol to a central gateway and subsequently to the cloud for analysis and visualization on a dashboard is a significant advancement in energy metering technology.

- The Power-Cloud was developed as a comprehensive platform to analyze energy consumption and, where applicable, the health and operation of rotating electrical machines, with structured tools for configuration, visualization, and analysis.
- The cloud platform also hosts energy monitoring tools from the Power-Adapt range, ensuring unified access to device data and analytics in one environment.

1.2 Aim of the solution development

The primary aim of developing the Eco Adapt Energy Metering System is to provide a flexible, cost-effective, and easy-to-install solution for energy sub-metering. The system is designed to optimize real estate in control cabinets, reduce installation time, and lower costs.

The solution aims to ensure that organizations can properly configure user and administrator rights, define Sites and Areas that reflect the physical layout of their installations, and build grouping objects that recreate the metering architecture. It then enables users to analyze data at different scales and in various formats—ranging from load curves to aggregated views—so they can identify efficiency opportunities and support decision-making through analyses and alerts .

1.3 Beneficiaries

The beneficiaries of the Eco Adapt Energy Metering System include industrial and commercial enterprises that require efficient energy monitoring and management. The system's flexibility allows it to be easily deployed in different areas of production, making it suitable for various applications.

- Organizations managing multiple sites seeking centralized, structured energy monitoring and analysis (Organizations, Sites, Areas).
- Technical users responsible for equipment configuration and data-driven maintenance.
- Energy managers and stakeholders requiring dashboards, detail views, and reporting to track consumption, costs, and operational KPIs

2. Technical specification of the solution

Provide a detailed specification of the solution.

2.1 Solution Description (key features and benefits)

The solution provides a structured cloud environment in which Organizations define Sites and Areas to mirror real-world installations, enabling focused analysis by building, line, or zone while maintaining an overall organizational view. Within this environment, equipment configuration covers general information, grouping attributes, and measurement parameters, with the ability to define offsets and factors to align displayed values with on-site metering and physical parameters. On the device side, the Power-Elec 6 supports multiple acquisition modes including single-phase and three-phase circuits, measures current, voltage, frequency, active and reactive power/energy, and power factor as standard, and extends to expert indicators such as total harmonic distortion, imbalances, sags, swells, overcurrent, and operating hours when licensed. The meter can handle up to six three-phase or

eighteen single-phase circuits, providing a compact and scalable submetering capability for new installations or retrofits.

2.2 System Architecture Overview

At the field layer, the Power-Elec 6 acquires voltage and current via terminal connections and opening CTs or Rogowski coils, supporting flexible single-phase and three-phase topologies across multiple feeders. The device offers wired protocols such as Modbus TCP/IP and BACnet over Ethernet, and Modbus RTU over RS485, and also integrates a LoRaWAN wireless interface for telemetry. At the platform layer, Power-Cloud hosts the energy monitoring and, where applicable, rotating machine analytics tools from the Power-Adapt ecosystem, providing dashboards, detail views, and long-term analysis to contextualize device data within organizational structures and operational workflows.

2.3 Technology Stack (Programming Languages, Frameworks, Databases, etc.)

The technology stack for the Eco Adapt Energy Metering System includes:

- Communication protocols: LoRaWAN, Modbus TCP, BACnet/IP, RS485 Modbus RTU
- Data formats: JSON for configuration files

2.4 Deployment Environment (Cloud, On-Premises, Hybrid):

The Eco Adapt Energy Metering System can be deployed in a hybrid environment. The metering data is transmitted to a central gateway and then to the cloud for analysis and visualization. The system supports both on-premises and cloud-based deployment options

3. Installation & Setup

- 3.1 Prerequisites (Hardware, Software, Network)

Before installation, a Power-Adapt device with suitable current sensors (opening CTs or Rogowski coils) and access to the electrical cabinet is required. The device must be mounted on a DIN rail and supplied with appropriate voltage

connections via the provided 4 pin connector, and it should be protected by a suitably placed upstream circuit breaker for safe isolation during installation. The device includes Ethernet interfaces for wired protocols and it also supports LoRaWAN for wireless telemetry.

Environmental and electrical constraints include a 110–230 VAC supply, overvoltage category II for power supply, and an operating temperature range from 0°C to 65°C, with IP30 DIN-rail form factor and low power consumption. Network prerequisites depend on the chosen telemetry path—wired fieldbus over Ethernet or RS485, or LoRaWAN for wireless transmission—configured according to site requirements.

Hardware:

- Eco-Adapt metering device (e.g., Power-Elec 6) with appropriate current sensors (CTs or Rogowski coils) and voltage connections.
- LoRaWAN connectivity (device radio service) as per deployment choice.

Network/Connectivity:

- LoRaWAN for device telemetry to cloud (as configured).
- Optional Ethernet for Modbus TCP/BACnet/IP and RS485 for Modbus RTU; device generates its own Wi-Fi network for configuration.

Environmental and electrical limits:

- Operating temperature 0–50°C, humidity constraints, CAT II measurement category, supply voltage 110–230V AC; other terminal voltage and transient specifications apply.

Safety and compliance:

- Installation by certified professional; adhere to rated ranges and local standards; consider surge protection if installed in surge category III circuits

3.2 Installation Steps

The meter must be installed in a mechanical and electrical, fire-resistant enclosure,

using a six-module DIN-rail footprint within the low-voltage switchboard or in a dedicated cabinet when space is unavailable. Transformers are supplied with adequate cable length to reach the meter from their mounting locations. An upstream circuit breaker must be installed for the meter power supply and measurement voltage connections, and it must remain easily accessible for isolation. The installer connects L1, L2, L3, and N to the 4 pin connector to power the meter and measure voltage, ensuring isolation before any work on this connector. When phases L2 and L3 are available in the switchboard, they should be connected even for single-phase metering; when they are not available, the neutral must be connected to terminals L2 and L3 as specified in the wiring diagrams. For three-phase metering, phases L2 and L3 must be connected and the sequence L1 → L2 → L3 respected. After wiring, the 4 pin connector is plugged into the meter to complete voltage acquisition. Throughout installation, the installer must maintain isolation between dangerous voltage conductors and connectors such as Ethernet, SMA, and USB, and must ensure that L1/L2/L3 terminals and connected external circuits are not reachable or linked to other reachable parts.

Physical installation and wiring:

- Mount the Power-Elec 6 in the electrical cabinet; connect voltage inputs and CTs/Rogowski coils per circuit specifics and terminal descriptions (6x RJ45 for current, terminal blocks for voltage/power).
- Follow all safety warnings and technical limits during installation.

Initial device configuration:

- Connect via the device’s generated Wi-Fi network for quick configuration; configure communication as required (LoRaWAN/Ethernet/fieldbus).
- Activate licenses as applicable (Standard/Expert) before enabling advanced indicators transmission.

Cloud/platform configuration:

- In Power-Cloud, set up Organization hierarchy (Sites, Areas), users, and mailing lists to mirror the real installation.
- Configure Equipments to associate device channels/measurements with the correct Areas and attributes.

3.3 Configuration and Setup Guidelines

Once powered, the device can be accessed via its integrated Wi Fi access point to perform initial configuration, and licenses can be activated from the system menu by uploading the corresponding license file to enable standard or expert features. The device can then be set to operate in single-phase or three-phase modes, bearing in mind that in single-phase mode up to three electrical inputs can be configured, while in three-phase configuration only one input is available for configuration. On the platform, equipment can be edited to define general information, grouping attributes, and measurement settings such as meter offset, conversion factor, and display units. For rotating machines, dedicated fields allow the selection of machine type to unlock specific functions such as pump monitoring, and entering or modifying kinematics can reset health scores and operating points where motor-related attributes are affected, with a confirmation step to summarize changes before validation.

Areas:

- Create Areas under each Site with name/description/surface; Areas group Equipments for analysis and imported data. Ensure Areas reflect buildings, lines, or floors to align analytics such as kWh/m².

Equipment:

- Edit Equipment general info (type, usage, Area, tags) and measurements (offset for meter sync, factor for conversion, display units, gauge bounds, standby threshold).
- For Predict-Adapt/rotating machines, select appropriate machine type to enable specific functions (e.g., Pump Monitoring).

User setup:

- Create users; upon creation, they receive confirmation and password creation emails. Changes made by a user take effect at next login or after the 24-hour auto-logout.

Device telemetry:

- For LoRaWAN, the device sends energy indexes every 10 minutes and (with Expert license) additional operational indicators; transmission frequency of expert data depends on connector configuration.

4. User Guide

- 4.1 Logging In & User Authentication

The platform is designed to let organizations configure user and administrator access rights, email lists, and organizational structures such as Sites and Areas, ensuring that users have appropriate permissions to access and operate the relevant equipment and analytics for their scope within the organization.

Users receive account creation emails and set passwords on first login. After modifications to a user account, re-login is required to apply changes immediately; otherwise, changes apply after the 24-hour automatic logout period .

4.2 Core Functionalities (Step-by-Step)

Users navigate from the dashboard to access consumption and device status summaries, where each equipment line presents the last ten-minute average active power or flow, the total energy index, consumption over the last twenty-four hours with cost if provided, comparisons with the previous period, and a display of attributes such as site, zone, category, usage, and tags. The dashboard also shows the distribution of consumption relative to other equipment in the same category and zone, and the communication status of the associated sensor, including the timestamp of the last transmission and a color indicator based on recency. From the dashboard, users can open the detail view to see the Energy Efficiency tab, which provides load curves, histograms of daily or weekly consumption, and long-term power trends with tools to select date ranges, validate analyses, download chart data, toggle series visibility, and switch metrics between consumption, carbon footprint, and cost. Additional tabs include Operational views presenting operating hours, restart cycles, operating regime analysis, and power distribution, and

environmental measurement tabs that display temperature, humidity, and CO2 trends where relevant sensors are deployed.

Navigating the platform:

- Use the home page menu for tools, the logo to return home, and the language selector; switch between Organizations via the top-right selector.

Dashboard:

- View equipment with last 10-minute average active power/flow, total energy index, 24-hour consumption and cost, comparisons, attributes, consumption distribution within category and Area, and sensor communication status with color indicators by last transmission time.

Detail view → Energy Efficiency:

- Access load curves, daily/weekly consumption histogram, and long-term power trends. Use date range tools, analyze button, CSV download, series toggle, and metric selection (kWh, kgCO2e, cost).

Detail view → Operational (where available):

- Review operating hours, restart cycles, operating regime analysis, and power distribution.

Additional tabs (where available):

- Temperature, Humidity, CO2 tabs show time curves and long-term trends for each measurement.

4.3 User Roles & Permissions

Within the organization's configuration, administrators define user and administrator rights to ensure that individuals can access the Sites, Areas, and equipment within their purview. The documentation emphasizes proper configuration of these rights as part of the initial environment setup, aligning access with organizational structures and analytical needs.

The platform supports user and admin access rights and permissions configuration; users must be granted rights to view data. Detailed role matrices are not specified in the provided extracts.

5. System Administration

5.1 User Management

Administrators manage user accounts and assign appropriate rights to reflect responsibilities across Sites and Areas, ensuring that users can view and operate the equipment and analyses pertinent to their roles within the organization's metering architecture.

Create or modify users via the administration interface; users receive confirmation and password setup emails. Changes by a user take effect on next login or after auto-logout; assign specific rights for data visibility.

5.2 Data Backup & Recovery

Provided by the system.

5.3 Security Settings & Access Control

Security configuration is centered on user and administrator access rights defined at the organization level, with the objective of safeguarding data visibility and control.

6. Integration & API Usage

6.1 Available APIs & Endpoints

Optimization of energy consumption.

6.2 Integration with Third-Party Systems

Integration capabilities on the device side include Modbus TCP/IP and BACnet over Ethernet, and Modbus RTU over RS485, which enable interoperability with industrial systems such as building management or SCADA platforms. The device also supports LoRaWAN at 868 MHz for wireless telemetry, allowing cloud integration within the Power-Cloud environment without relying on wired backbones where this is advantageous.

Device-side industrial protocol support:

- Ethernet: Modbus TCP and BACnet/IP.
- RS485: Modbus RTU.
- LoRaWAN: device telemetry to Eco-Adapt's cloud platform, including 10-minute energy indexes and expert indicators (license-dependent).

6.3 Data Exchange & Formats

For performance analysis and reporting, the platform supports the import of production data in CSV format with two columns, where the first column contains dates in the YYYY-MM-DD format and the second column contains the current value in specified units, with examples provided in the documentation. The load curve displays power or flow versus time and uses data aggregation rules to ensure legibility across different time ranges, with data often transmitted and displayed at ten-minute steps for recent periods and coarser aggregation for longer views.

Imported production data:

- CSV format with two columns: date (yyyy-mm-dd) and production value (specific units). Example lines use semicolon separator.

Load curve measurements vary by sensor configuration (e.g., active power only; active/reactive; expert with reactive +/−; PowerPulse flow or power based on equipment configuration).

Additional Notes:
The documentation describes LoRaWAN as a wireless output of the Power-Adapt and details the cloud-based nature of Power-Cloud, but it does not specify GSM transmission or provide information on programming technologies, API endpoints, or platform backup and recovery procedures. Where installation involves surge category III circuits, an upstream surge arrester must be installed, and the selection criteria for surge protection are provided to ensure protection levels and current handling are appropriate for the installation site.

7. Expected Impact of the solution

Detail the expected results and the impact of the developed solution. Include both quantitative and qualitative benefits.

7.1 Conclusions from the first Pilot Action implementation of the solution

Also well equipped companies can detect optimization potential.

7.2 Conclusions from the second Pilot Action implementation of the solution

The EM-System can be used very flexible - here it was used for welding station to monitor energy consumption as well as operating time and duration. Varius stations have been monitored with just one sensor box.