ecomatrix
wireless data exchange platform

Wireless data collection and processing system for energy consumption meters

based on the EcoMatrix wireless digital data transmission platform

2025

1. PURPOSE OF THE SYSTEM

During the operation of building-wide and individual energy consumption meters in residential, public, and industrial facilities, significant expenses are incurred—both for data collection and for subsequent processing and use. Moreover, the need to physically visit each site to retrieve meter readings leads to delays and makes it impossible to promptly detect emergencies, monitor resource delivery quality, or oversee the condition of water, heat, and electrical networks.

To address these and related challenges, a commercial metering system has been developed based on the EcoMatrix wireless digital data transmission platform. This is a fully wireless solution intended to automate commercial metering of energy resources - both at the building level and at the individual user level. The system supports metering of electricity, heat, hot and cold water supply, and gas.

The solution includes remote transmission of meter readings in automatic mode and their automated processing. This enables users of all categories to receive accurate, real-time consumption data and instant notifications about abnormal situations, indicating their location—leaks, equipment failures, unauthorized connections, unaccounted losses, and other incidents.

During the development of the system's hardware and software, the following factors were taken into account:
- organization of remote and automated data collection from metering devices;
- minimization of costs and time required to connect data transmission units to primary metering devices;
- ensuring data exchange with higher-level systems such as billing platforms, electronic document management systems, and others;
- definition of the content and volume of data to be transmitted at each system level;
- specification of the structure and characteristics of normative and reference information;
- creation of an information database with user-friendly screen forms and the ability to generate and print various reports.

In addition, the system provides for:
- control over the completeness and reliability of the collected data;
- verification of system component operability;
- centralized synchronization and, if necessary, adjustment of unified system time across all metering sites.
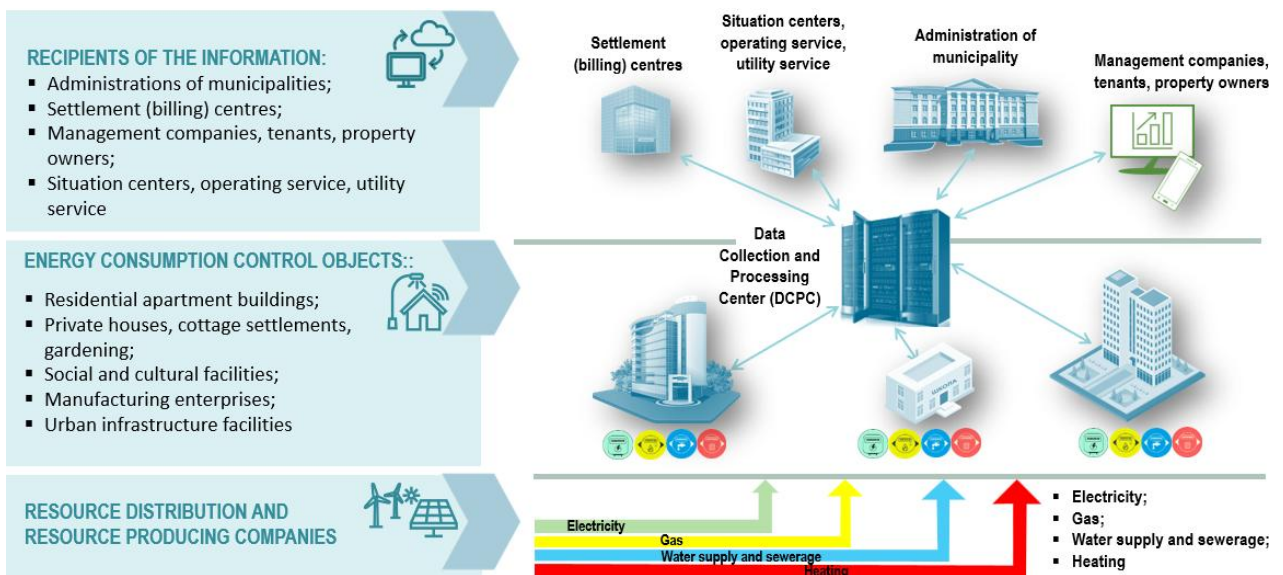
The implementation of energy metering systems based on the EcoMatrix platform in apartment buildings, cottage settlements, and industrial facilities has demonstrated high efficiency. The primary result is the reliable and timely acquisition of energy supply data at balance boundaries, significantly reducing energy resource losses by improving consumption monitoring and enabling prompt response to emergency situations.

The system's functionality allows quick response to the state of engineering networks. Utility services receive not only accurate, real-time consumption data but also alerts about emergencies occurring on the premises, including:

- pipe leaks and ruptures
- acts of vandalism
- attempts at unauthorized connection
- equipment failures and malfunctions.

Timely receipt of this data enables rapid intervention to minimize losses and enhance the overall reliability and energy efficiency of the infrastructure.

Information flow diagrams in the system:

RECIPIENTS OF THE INFORMATION:
- Administrations of municipalities;
- Settlement (billing) centres;
- Management companies, tenants, property owners;
- Situation centers, operating service, utility service

ENERGY CONSUMPTION CONTROL OBJECTS::
- Residential apartment buildings;
- Private houses, cottage settlements, gardening;
- Social and cultural facilities;
- Manufacturing enterprises;
- Urban infrastructure facilities

RESOURCE DISTRIBUTION AND RESOURCE PRODUCING COMPANIES

Settlement (billing) centres

Situation centers, operating service, utility service

Administration of municipality

Management companies, tenants, property owners

Data Collection and Processing Center (DCPC)

Electricity
Gas
Water supply and sewerage
Heating

- Electricity;
- Gas;
- Water supply and sewerage;
- Heating

Potential clients for the system may include:

- Property management and maintenance companies
- Construction companies
- Cottage communities and gardening cooperatives
- Industrial and commercial enterprises, as well as farms
- Utility providers (water, heat, electricity, gas)
- Municipal and sectoral governing bodies.

ecomatrix
wireless data exchange platform

Goals and advantages of implementing metering systems based on the EcoMatrix platform:

- Ensuring reliable and timely metering of utility consumption (electricity, heat, hot and cold water) across citywide multi-apartment residential buildings
- Creating a real-time digital model of energy supply systems based on actual consumption data
- Detecting and eliminating unaccounted losses, leaks, network failures, and unauthorized connections to utility systems
- Improving resource management efficiency through analytics, leading to reduced energy costs, lower personnel expenses, minimized equipment downtime, and decreased customer service overhead
- Enabling rapid response to deviations and emergency situations—system software provides automated alerts to responsible personnel and tools for monitoring and managing incidents throughout their entire lifecycle, from detection to resolution.

Thanks to its flexible and modular architecture, the system is easily adaptable to the specific needs of each client and can be deployed both at a single-site level and as part of large-scale urban or sectoral digitalization programs.

Highly efficient resource leak detection technology

One of the system's key and most effective functions is its built-in automatic resource leak detection technology, which is based on analyzing the imbalance between the volume of supplied resources and the total volume recorded by end consumers.
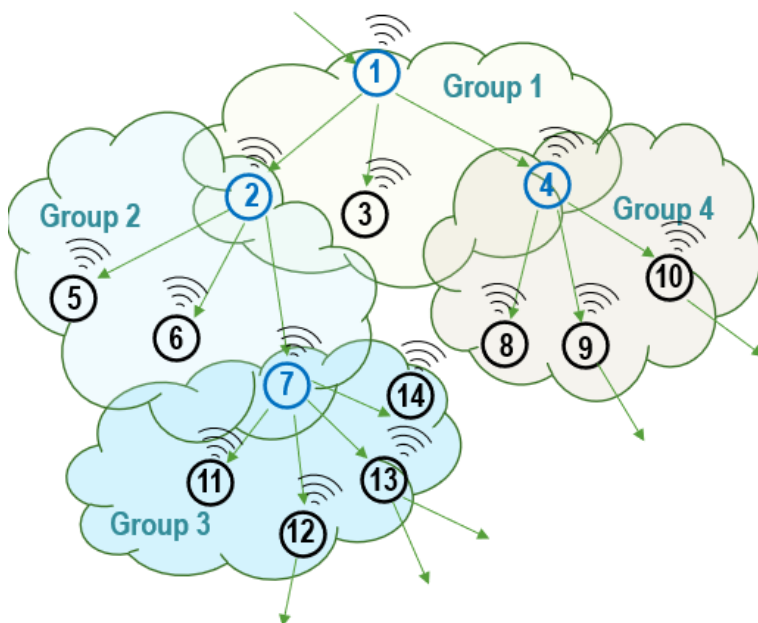
During system configuration, meters are grouped by assigning one main meter (to account for the resource supply) and several secondary meters (to monitor consumption within the facility or network). The software continuously compares the main meter reading with the sum of all secondary meter readings in real time

If the recorded deviation exceeds the user-defined threshold, the dispatcher immediately receives a notification indicating the respective meter group and the magnitude of the discrepancy.

According to global practices, timely detection and elimination of leaks can lead to annual water savings of **15–25%**, which is particularly relevant for utility services and property management organizations.

ecomatrix
wireless data exchange platform

Competitive Advantages of Energy Metering Systems Based on the EcoMatrix Platform:

Data transmission is carried out in real time via a radio channel within the permitted frequency bands of **433, 868, and 900 MHz,** and does not require a special license for radio frequency usage

Unlike cellular networks and LoRa-based networks (LoRaWAN, LPWAN), this solution does not require any traffic-related charges during operation

Unlike other networks, data is delivered directly to the customer's server without passing through intermediate "cloud" servers, ensuring secure and protected data storage

The inclusion of repeaters in the system architecture ensures wide-area coverage via a free-to-use radio channel and minimizes the required number of concentrators (base stations)

Capability to integrate system data into the customer's existing information and billing systems, as well as SCADA systems

Scalable Architecture and Broad System Capabilities

The architecture of metering systems based on the EcoMatrix platform enables the collection, transmission, and processing of data from a large number of metering devices distributed across different districts, cities, and regions. The system is easily scalable to suit facilities of varying complexity—from individual buildings to large municipal or industrial complexes.

The system can be used by both end consumers of energy resources (such as property management companies, cottage settlements, urban infrastructure facilities, industrial enterprises) and by suppliers of water, heat, electricity, and gas.

It operates efficiently in conditions where facilities are geographically dispersed and ensures centralized real-time data management.

2. GENERAL SYSTEM OVERVIEW

The energy resource metering system based on the EcoMatrix platform includes the following hardware and software components**:**

- **Metering devices** — water, heat, electricity, and gas meters of various types and manufacturers installed at facilities, with pulse outputs and standard interfaces (RS232/485/CAN), as well as EcoMatrix meters with built-in radio modules (see section 3);
- **Data transmission equipment** — EcoMatrix radio transmission modules (RF modules) of various types, either embedded in metering devices or externally connected to them (see section 4);
- **Data collection equipment** — EcoMatrix repeaters and concentrators ensuring reliable transmission of information from RF modules to the server (see section 5);
- **Network and server equipment**, as well as user workstations (computers) from various manufacturers (see section 6);
- **EcoMatrix software** — covering all levels: data collection, processing, visualization, report generation, and analytics.
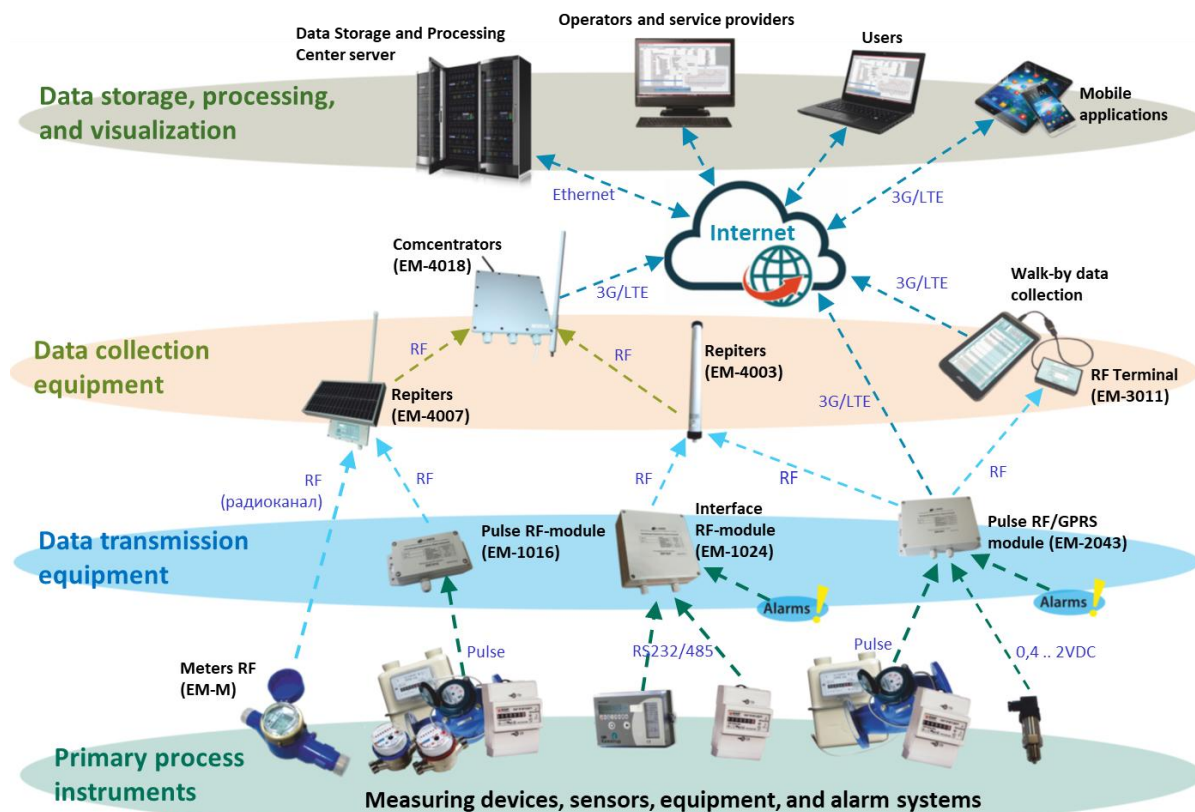
Data from metering devices is automatically transmitted via RF radio modules over a radio channel to repeaters, and then to one or more concentrators, depending on the scale and configuration of the system.

From the concentrators, data is sent via remote communication channels (Wi-Fi, 3G/LTE, Ethernet) to the upper level of the system — the Data Collection and Processing Center server, where it is further processed, stored, and displayed**.**

3. METERING DEVICES

Main types of measuring instruments used for monitoring energy resource consumption in metering systems based on the **EcoMatrix platform:**

❑ **Metering devices from various manufacturers** with pulse outputs:

**Water meters
SingleJet**

**Water meters
MultiJet, Turbo**

**Water meters
Waltman/Turbo**

**Electricity
meters**

Gas meters

Measured parameters for system transmission:
- Monitoring of quantitative consumption parameters
- Violation and anomaly alerts

❑ **Metering devices from various manufacturers** with RS232/485/CAN interface ports:

Heat meters

**Water meters
Magnetic, Ultrasonic**

Electricity meters

**Gas volume
correctors and other
related devices**

Measured parameters for system transmission:
- Monitoring of quantitative consumption parameters
- Monitoring of qualitative consumption parameters
- Monitoring of abnormal situations detected by metering devices.

❑ **EcoMatrix metering devices** with built-in RF (radio frequency) modules:

**Water meters Built-
in RF SingleJet**

**Water meters EM-S
SingleJet**

**Water meters
EM-M MultiJet**

**Electricity
meters EM-E**

Measured parameters for system transmission:
- Monitoring of quantitative consumption parameters
- Violation and anomaly alerts.

3.1. EM-M — MultiJet water meters with integrated RF module

Data logger with integrated RF module

Multifunction display

Meter housing with flow-through section
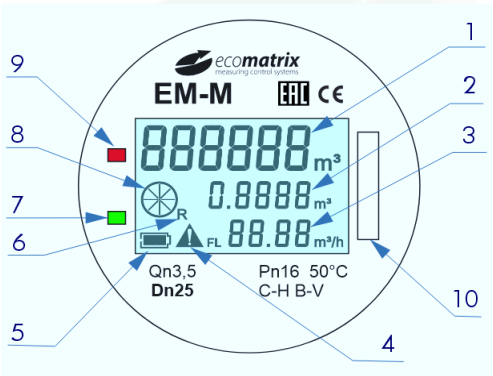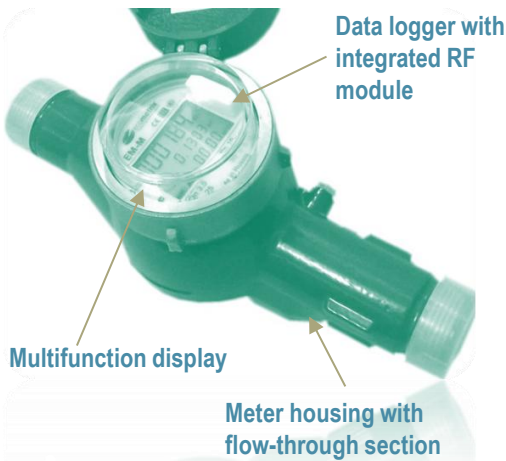
1, 2 – Accumulated volume (m³)
3 – Instantaneous flow rate (m³/h)
4 – Alarm indicator (magnet, reverse flow, etc.)
5 – Battery charge level
6 – Reverse flow detection
7 – Alarm – reception
8 – Flow direction
9 – Alarm – transmission
10 – RF module antenna position
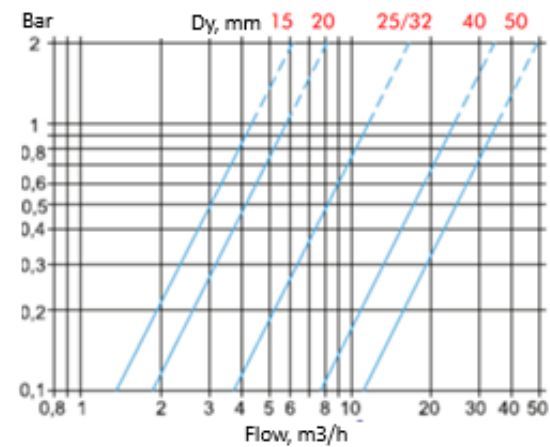
EM-M MultiJet water meters are designed for measuring, archiving, and wireless RF transmission of potable water volumes flowing through cold (0.1 to 50 °C, up to 16 bar) and hot (0.1 to 90 °C, up to 16 bar) water supply systems. Available nominal diameters (DN): **15, 20, 25, 32, 40, and 50 mm.**

EM-M meters are equipped with **anti-magnetic protection, IP68 protection class, and comply with metrological class C**. The EM-M meter's register includes an electronic unit with a built-in RF module, multifunction display, and a battery designed for long-term operation (**minimum 10 years**). An internal archive stores current, hourly, and daily readings for **up to 6 months**.

Operating modes are configured wirelessly via the **RF Terminal (EM3011)** and a dedicated software tool. The meter transmits data at preset intervals (from 5 seconds to 18 hours, typically 30 seconds), including: current meter reading, instantaneous flow at the moment of transmission, water consumption over the past hour and previous day, internal temperature, alerts and other signals. Data is automatically transmitted to a mobile **WalkBy reading system** or to **fixed data collection** modules.

Transmitted Parameters:

- Current reading (999999.999 m³) — cumulative volume
- Flow rate (999999.999 m³/h) — in the last hour
- Flow rate (999999.999 m³/h) — in the last 24 hours
- Instantaneous flow (99.99 m³/h) — real-time consumption
- Internal temperature (−99 to +999 °C) — temperature inside the meter register
- Alerts — magnetic tampering and other events

Pressure loss chart:

3.2. EM-S - SingleJet water meters with integrated RF module

Multifunction display

Data logger with integrated RF module

Meter housing with flow-through section

EM-S SingleJet water meters (DN15/20) for hot and cold water are battery-powered and equipped with built-in RF transmission modules from the **EcoMatrix platform**. Designed for individual consumption metering, they provide real-time radio transmission of both cumulative and instantaneous flow data, as well as alarms (**magnetic tampering, ambient temperature monitoring, vandalism, reverse flow**, etc.).

The **EM-S meter** features a multifunction display with a 10-digit cumulative reading and 4-digit instantaneous flow indicator. An integrated archive stores **current, hourly, and daily consumption** values along with alarm data for **up to 6 months**. Powered by a lithium battery with a service life of over **10 years** without replacement. **Metrological class: C**.

3.3. Built-in RF – Embedded RF modules for SingleJet water meters

Meter housing with flow-through section

Register mechanism

Module Built-in RF

Embedded RF transmission modules (Built-in RF) from the **EcoMatrix platform** are designed for installation on the housings of SingleJet cold/hot water meters from various manufacturers. The RF module measures and transmits in real time, via a radio channel, water consumption data and magnetic tampering alerts.

An integrated data logger stores current, hourly, and daily consumption values for up to 6 months.

The device is powered by a lithium battery with a service life of **over 10 years**. **Metrological class: B.**

3.4. EM-E electricity meters with built-in RF modules
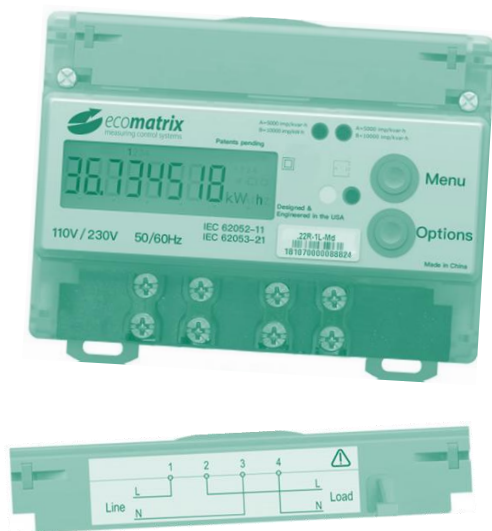
Static single-phase/three-phase **electricity meters with built-in RF transmission modules** from the **EcoMatrix platform** are designed to operate in two-wire AC networks with a nominal voltage of 110/230 V and frequency of 50/60 Hz, and to provide **real-time wireless transmission of consumption data and alerts** (magnetic tampering, vandalism).

An integrated archive stores current, hourly, and daily energy consumption values and alarm records for **up to 6 months.**

The RF module is autonomously powered by a lithium battery with a service life of **over 10 years.**

4. DATA TRANSMISSION EQUIPMENT

4.1. EM1016 – Pulse RF transmission module

Input signal terminals

The **EM1016 pulse RF module** is designed to collect, store, and transmit via radio channel consumption parameters (**current, hourly, and daily**) from water, electricity, and gas meters equipped with pulse outputs, as well as signals from alarm devices with digital outputs.

The module features **four pulse/digital inputs** for connecting signal sources. Powered by a built-in lithium battery, the EM1016 ensures continuous operation for **over 10 years.** An embedded data archiving system stores current values **for each input over 6 months** and allows transmission on request via RF in the form of lists of current, hourly, or daily readings for any selected period.

Configuration of EM1016 settings — both general and input-specific — as well as reading data archives, is carried out via radio using the **RF Terminal (EM3011)** and dedicated software.

4.2. EM1024 – Interface RF transmission module

Input signal terminals

The EM1024 interface RF module is designed to connect various metering devices and automation systems via standard **RS232/RS485/CAN interfaces**, as well as **discrete alarm signals**. EM1024 is an electronic unit that includes a microcontroller and RF transceiver. The microcontroller collects required data from connected devices and transmits it via radio to the central system.

In addition to parameters received over communication protocols, EM1024 features **dedicated digital inputs** for connecting sensors to **perform alarm functions** (e.g. **flooding, intrusion**, etc.).

The module's integrated **archiving system** allows remote retrieval, via RF, of stored values from the metering device for any selected period — in the form of **cumulative, hourly, or daily** parameter lists.

Data archive access and **configuration of EM1024** are carried out wirelessly using the **RF Terminal (EM3011)** and specialized software.
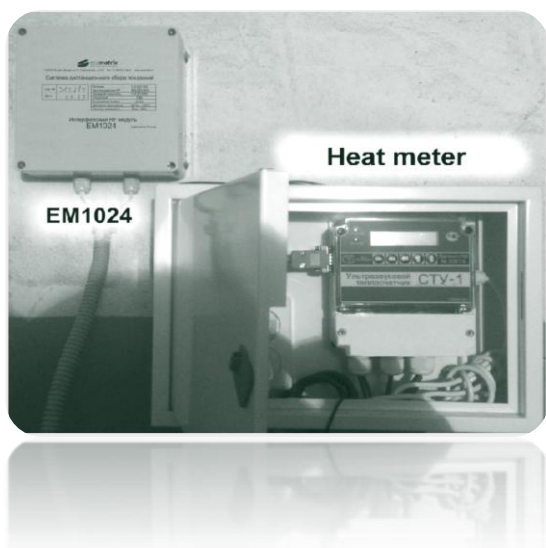
4.3. EM2043 – Pulse RF/3G/LTE transmission module

The EM2043 pulse RF/3G/LTE transmission module is designed for wireless data transmission via **RF channel** and/or **mobile networks (3G/LTE)** from water, gas, and electricity meters with pulse outputs, digital alarm sensors, and an analog pressure sensor.

The module is equipped with:
- 3 pulse inputs for connecting metering devices;
- 1 analog input (0.4...2 V or 0...10 V DC) for pressure sensors;
- 3 discrete inputs for level alarms or other safety-related sensors.
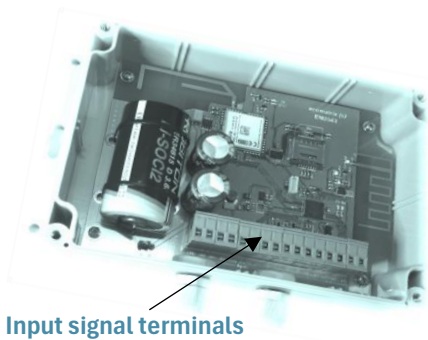
Input signal terminals

Power to the EM2043 module is supplied by a built-in **3.6 VDC lithium battery (18 A·h)**. The module provides autonomous operation for at least **6 years**, including powering the connected analog **pressure sensor**.

For reliable mobile communication, the module supports **operation with two SIM cards**, automatically switching from the primary to the **backup SIM** when needed.
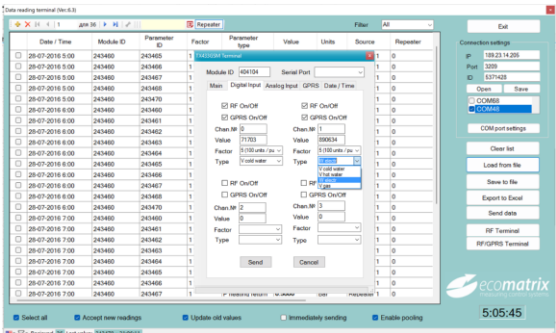
The integrated parameter **archiving system** allows remote retrieval via the RF channel of archived readings from the metering device for any selected period, including **cumulative, hourly, or daily values**.

Data archive reading is performed over RF using the **RF Terminal (EM3011)** and dedicated software.

5. DATA COLLECTION EQUIPMENT

Depending on the **method of data retrieval** from primary metering devices, the data collection equipment includes:

- Equipment for mobile meter reading systems (WalkBy);
- Equipment for real-time automatic meter reading systems.

The **WalkBy reading system** is a method of obtaining data whereby a user, moving along a predefined route, collects readings from the system's radio modules using a **tablet computer** connected to a **portable transceiver.**

In **real-time automatic reading**, repeaters and data concentrators are installed within the reception range of the system's RF transmission modules. These devices receive data from meters via RF and transmit it at specified intervals over various communication channels to the **central data collection and processing server**, for storage and further analysis.

5.1. Mobile meter reading system - RF Terminal EM3011 WalkBy

The WalkBy mobile reading system is a method of collecting data from various metering devices, in which the user moves on foot or in a vehicle along a defined route and receives information on a **tablet or notebook computer** connected to an **RF Terminal EM3011** and specialized software.

The collected data is then transmitted via the Internet to the **Central Data Collection and Processing Server** for further analysis. Archived data can also be saved locally in **MS Excel** format for further use in **external applications**.

This solution does not require access to premises where the devices are installed - data is captured within seconds from a distance of **50 to 200 meters**. The **RF Terminal EM3011**, along with the software, is also used via RF to **configure EcoMatrix devices** and to retrieve **archived parameter logs** from the RF modules.

5.2. Automatic meter reading system - concentrator GateWay RF EM4018

The **GateWay RF EM4018 data concentrator** is designed to **receive data via RF** from EcoMatrix radio modules and repeaters, **store it in non-volatile memory**, and **transmit it to the Central Data Collection and Processing Server** using various communication channels, including **GPRS/3G/LTE and Ethernet**.

The **GateWay RF EM4018 concentrator** features **high performance** and is capable of **collecting and processing data from up to 30,000 RF modules**, ensuring reliable and stable data transmission to the server **in real time** or according to a **defined schedule**.

GPRS antenna

RF antenna connection

Lithium battery

Power cable

Ethernet
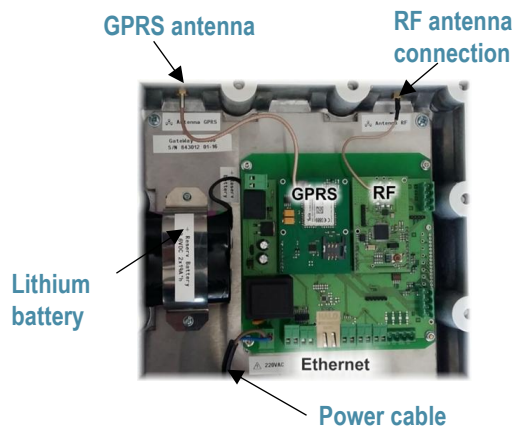
The **GateWay RF EM4018 concentrator** features built-in **power failure protection**. It is powered from a **110/220 VAC mains supply** and includes a **backup power option** via **3.6 VDC lithium batteries (38 A·h)**, ensuring **autonomous operation** during temporary power outages.

The concentrator is typically **installed in an attic space** and is equipped with an **external antenna** mounted on the building's roof.
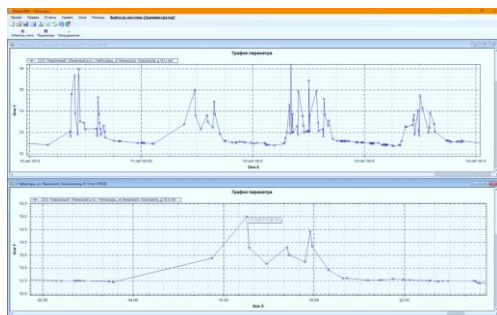
5.3. Automatic meter reading system - Solar Repeater RF EM4007

RF antenna

Accumulator

Solar panel connection
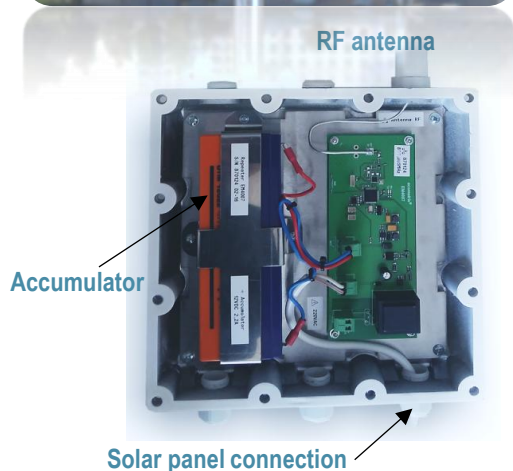
The **Solar Repeater RF EM4007** is designed to **extend the RF reception range** of GateWay RF concentrators in EcoMatrix automated data collection systems. It receives radio signals from RF modules connected to metering devices and equipment, and **forwards them to a remote GateWay concentrator**, ensuring **reliable long-range communication**, even in complex urban environments.

The repeater features a **universal power system** with **built-in 12 VDC 2.2 A·h rechargeable batteries**, automatically charged from a **110/220 VAC mains supply or solar panels**. This enables **flexible installation** and **autonomous operation** in locations without permanent power or where outages may occur.

To ensure **long battery life**, the repeater includes an **automatic power management system** that temporarily disables the load when battery voltage drops below normal and stops charging when voltage exceeds safe limits. Every **15 minutes**, the repeater transmits RF status data including **battery charge level, internal temperature, and operating state**, allowing centralized monitoring and timely fault response.

5.4. Automatic meter reading system - Repeater RF EM4003

The **Repeater RF EM4003** is designed to **extend the RF reception range** of GateWay concentrators in EcoMatrix automated data collection systems. It receives radio signals from RF modules connected to metering devices and equipment, and **forwards them to a remote GateWay concentrator**, ensuring **reliable long-range communication**, even in complex urban environments.

The **Repeater RF EM4003** is equipped with a **built-in power supply** operating from a **110/220 VAC mains source**.

Every **15 minutes**, the repeater transmits **radio data** containing **internal temperature and operational status**, enabling **centralized monitoring** and **timely response to potential faults**.

5.5. Automatic meter reading system - radio reception zones of concentrators and repeaters

The **quality of data exchange** via radio channel between components of the automated data collection system based on the **EcoMatrix platform** depends on multiple factors::

- **Types of antennas** used in the equipment (omnidirectional, sector, directional);
- **Location of objects,** urban density, and building height;
- **Various network topologies** for data collection and transmission;
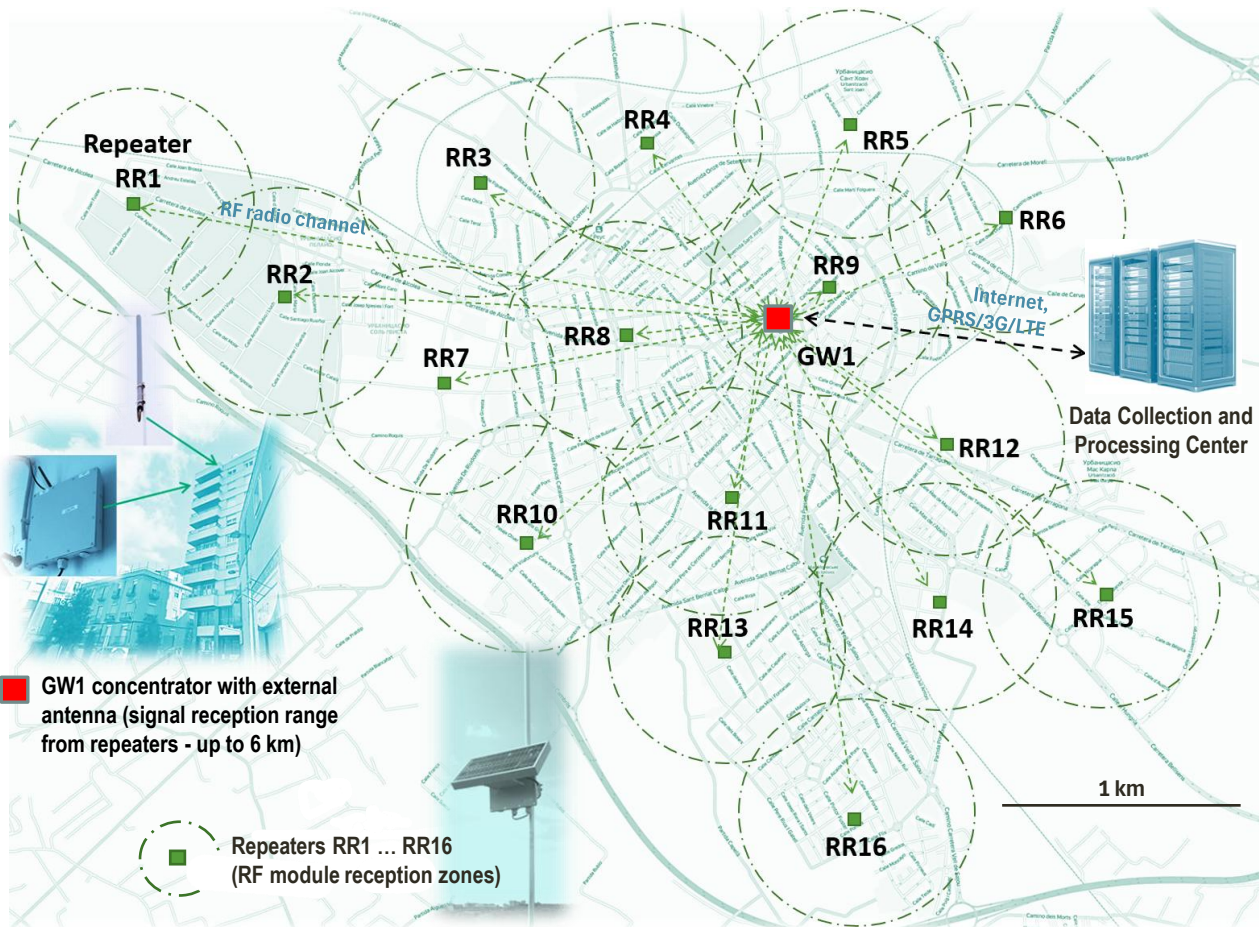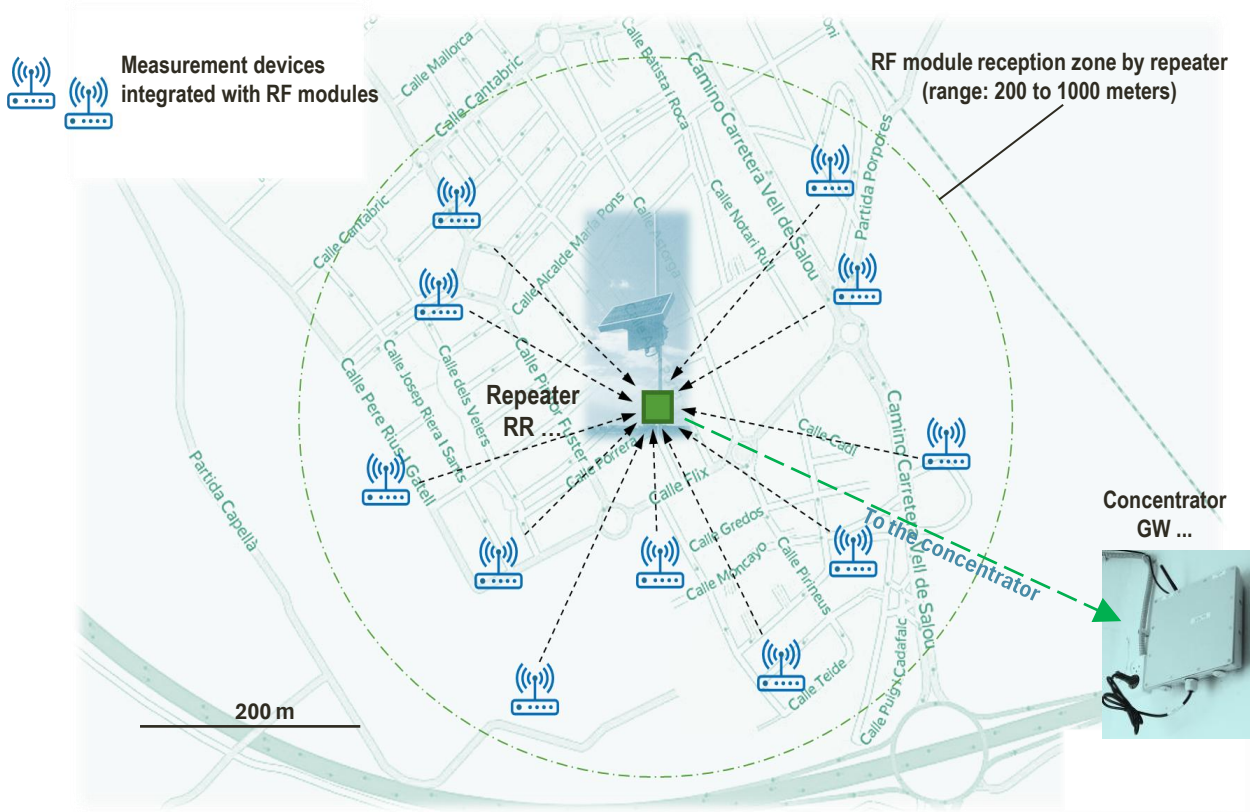- **Placement of repeaters and concentrators** - on facades, rooftops, attics, or masts**.**

During system design, it is crucial to correctly determine the **placement of equipment**, **considering building height**, **presence of metal structures**, etc. This ensures that during operation, the system can overcome signal shadow zones and expand areas of stable radio signal reception from RF modules in complex urban environments (courtyards, basements, dense construction, etc.).

⚙ **Transmission and reception parameters of repeaters and concentrators:**

- RF signal reception range by repeaters - **200 to 1000** meters;
- Data transmission range from repeater to concentrator- **1000 to 6000** meters.

ecomatrix
wireless data exchange platform

Measurement devices integrated with RF modules

RF module reception zone by repeater (range: 200 to 1000 meters)

Repeater RR

To the concentrator

Concentrator GW ...

200 m

Repeater RR1

RF radio channel

RR2

RR3

RR4

RR5

RR6

RR9

RR8

GW1

RR7

Internet, GPRS/3G/LTE

Data Collection and Processing Center

RR12

RR10

RR11

RR13

RR14

RR15

GW1 concentrator with external antenna (signal reception range from repeaters - up to 6 km)

RR16

1 km

Repeaters RR1 ... RR16 (RF module reception zones)

6. Top-Level System – Data Collection and Processing Center

The top-level system of the EcoMatrix platform is designed for the collection and processing of commercial and technical data received by the server via various communication channels from measuring instruments.

Thanks to its **flexible software architecture**, the system is suitable for both **large-scale projects** with multiple distributed sites and **smaller installations**, such as data collection from one or several buildings.

Main software components of the top-level system:

- Database;
- Data acquisition and processing system;
- Data Visualization System.
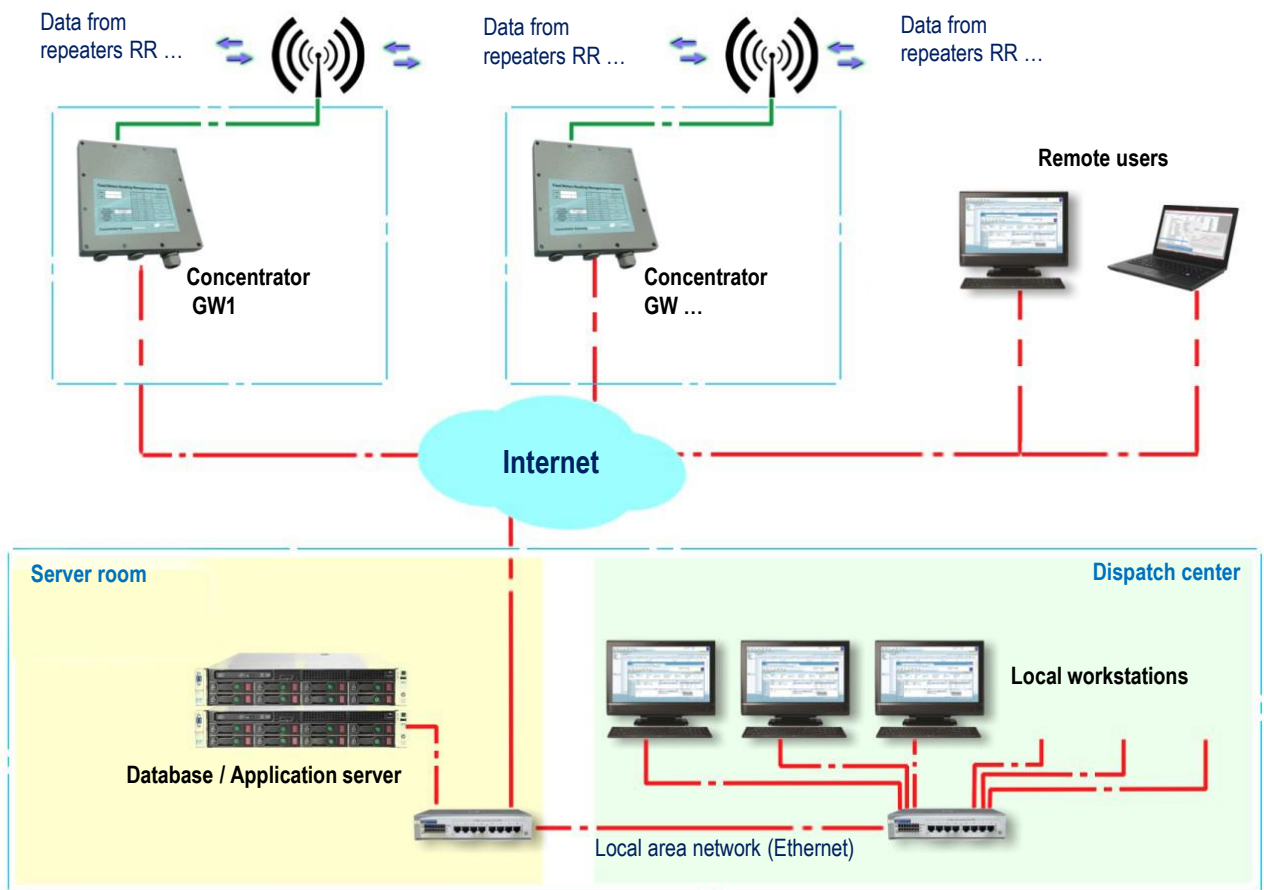
The **database** and the **data acquisition and processing system** are hosted on the **Database / Application** Server.

The **Data Visualization System** is installed on **local workstations** and on **remote user computers**. Additionally, system users can access and work with data via **mobile applications**.

6.1. Database and Information Processing System Architecture

The **data acquisition and processing system** is hosted on the **Database / Application Server**, which connects to:
- **Local workstations** (operator terminals) via the local area network
- **Remote user computers** via communication channels including **Internet, GPRS, 3G, and LTE.**

The server runs **Microsoft SQL Server DBMS**, which provides:
- Storage of **technological parameters** transmitted via communication channels;
- **Reference data**: client information, site addresses, equipment specifications, etc.

In addition to the database, the server includes the following components:
- **Data reception module – receives information from external communication channels and writes it to the primary database;**
- **Analysis and processing module – processes raw data and generates specialized tables for visualization and calculations;**
- **Report generation module – creates various types of reports (hourly, daily, summary, etc.)**

6.2. Data Visualization System

The **information display system** is installed on computers of users with authorized access to the system. User connections to the server can be established either via the organization's **internal local area network**, or **remotely** - through the **Internet** or a **distributed corporate network**.
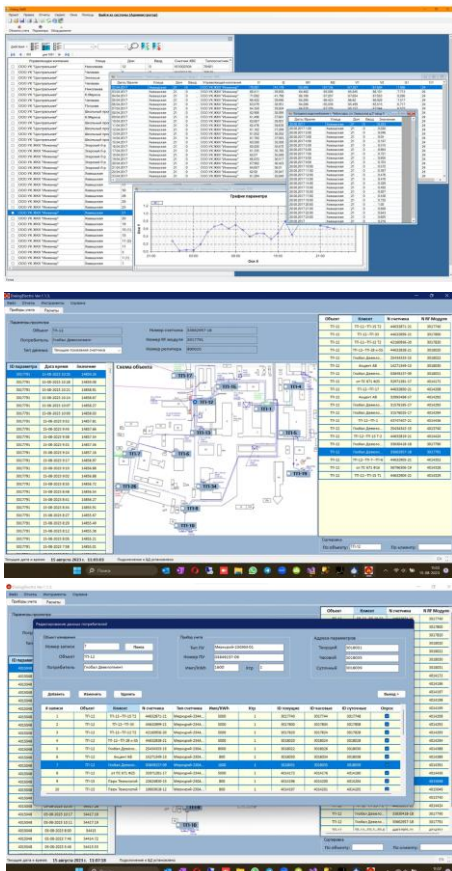
The system provides users with an **intuitive and visual interface** offering a wide range of reporting tools: tables, charts, violation logs, equipment fleet data, network maintenance records, and much more.

The software allows **exporting generated reports** into various file formats for further processing by third-party applications. It also supports **automatic data transfer to billing systems**.