

# Terms of reference (ToR) for the procurement of services below the EU threshold

CONFIDENTIAL

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| <b>Development of a production-grade IoT air quality monitoring system</b> | <b>Project number/<br/>cost centre:<br/>G-012388-001</b> |
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## 1. Context

QUIS - Better Goods and Services on Enhancing Company's Competitiveness through Quality Infrastructure' in Georgia (hereafter - QUIS) is a multi-donor project jointly co-financed by the European Union, the Federal Ministry Economic Development BMZ and Czech Development Cooperation (CDC) and implemented by GIZ and Czech Development Agency (CzDA). The project timeline is scheduled till January 31, 2027.

The overall objective of QUIS is to ensure safety and promote inclusive and sustainable economic growth in Georgia through improved competitiveness of the private sector and implementation of the DCFTA and its EU-related commitments, with a particular focus on business, trade, environment, and better skills matching.

Notably, QUIS targets the following outputs:

- **Optimised regulatory and policy framework for quality infrastructure in line with EU and international requirements that promotes competitiveness of the locally produced goods and services / Aspects that promote innovation and competition are incorporated into the regulatory and political framework of the quality infrastructure.**
- **Improved compliance with European and international standards and regulations of local firms / Georgian companies have the technical capacity to implement new quality requirements.**
- **Private companies' awareness on potential of private EU standards or state regulation raised / Georgian companies have become more aware of the potential that higher product quality offers**
- **Intensified cooperation between quality infrastructure institutions and private sector actors / Quality infrastructure institutions have intensified cooperation with relevant actors in the selected sectors**

Scope of output #3 targets quality enhancement of local production, encompassing in-house laboratory capacity development and adoption of ISO/EN standards. QUIS plans to allocate some funds for the private sector to incentivize taking measures towards quality improvement of their goods and services. For this reason, QUIS at GIZ supports local producer (industrial) companies intending to take measures towards compliance with international standards and EU norms.

## 2. Tasks to be performed by the contractor

Contractor shall develop **production-grade IoT air quality monitoring system for COMeter LTD**, designed for both type of consumers (e.g., residential, hospitality) and industrial (e.g., manufacturing, enterprise) applications. The aim is to provide stakeholders with a unified understanding of the technical, regulatory, and production-oriented requirements essential for successful project delivery.

The proposed system is a nationwide, distributed air-quality monitoring platform consisting of three primary layers: **the hardware sensing device, the cloud server infrastructure, and the user-facing applications**. Together, these components form an always-online, scalable, and reliable solution for real-time environmental data collection and visualization.

## 1. Hardware and Firmware Layer

Each hardware device functions as an autonomous air-monitoring unit equipped with multiple environmental sensors. The device integrates a low-power microcontroller unit (MCU) responsible for sensor data acquisition, preprocessing, and communication management.

A built-in Wi-Fi module provides continuous 24/7 connectivity to the internet. The device uses secure communication protocols (e.g., MQTT over TLS or HTTPS POST requests) to transmit sensor readings to the central server at configurable intervals. Local firmware performs basic filtering, error detection, and timestamp assignment to ensure data accuracy and integrity. The device is powered through a stable 5V power adapter. Automatic firmware update (OTA) capability allows remote maintenance and feature expansion.

As part of the modernization of our air quality monitoring infrastructure, we are transitioning to a more efficient and scalable communication protocol — **MQTT (Message Queuing Telemetry Transport)**. This lightweight protocol is ideal for real-time communication between our server and distributed monitoring devices.

The purpose of this project is to set up and configure a dedicated MQTT server to handle the **incoming sensor data** from air monitoring devices and to **send control commands back** to them securely and reliably, to create a robust, secure MQTT communication layer that serves as the foundation for real-time data exchange between air monitoring devices and the central platform, allowing for scalable, two-way communication that supports both data collection and remote device control.

### Objectives:

- **Bi-Directional Communication:** The MQTT setup must enable command-and-response capabilities.
- **Security & Authentication:** The new system must include user/device authentication, encrypted channels, and topic-level access control to prevent unauthorized access.
- **Performance Optimization:** Since the system will handle frequent data uploads (e.g., every minute from each device), the server must be optimized for high availability and low latency.
- **System Compatibility:** The MQTT server must be integrated seamlessly with the backend that stores data in InfluxDB and MySQL, and interacts with the management panel.
- **Device Compatibility:** The update server must follow the specific OTA protocols supported by ESP devices and be tested across multiple device versions.
- **Security:** Firmware files must be delivered over HTTPS, with verification using checksums or digital signatures to prevent tampering.
- **Scalability:** the system must handle simultaneous update checks efficiently.
- **Version Management:** Each device must receive the correct firmware version based on its model or deployment status, avoiding update conflicts.

## 2. Cloud Server and Backend Layer

The backend infrastructure is responsible for receiving, processing, storing, and analyzing sensor data from all deployed devices across the country. An API gateway handles incoming device communication, authenticates each unit, and routes data to data-processing pipelines.

Collected data is stored in a high-performance time-series database optimized for fast retrieval and historical analysis. A monitoring service continuously checks device health, uptime, network status, and sensor performance. The backend also provides a real-time streaming interface enabling live visualization of air parameters.

### Objectives:

- **Protocol Compatibility:** The new devices require support for dynamic configuration, bi-directional communication (e.g., MQTT), and secure device commands.
- **System Architecture Update:** Integrating device management requires redesigning part of the backend to handle authentication, device states, and command delivery — while ensuring the stability of the current data pipeline.
- **Security Requirements:** Remote-control features introduce new security concerns, such as device authentication, command authorization, and encrypted communication. These must be addressed without affecting the integrity of existing data services.
- **UI/UX Challenges:** The interface must be redesigned to incorporate control features (not just display data) in a way that is intuitive for users and compatible with various device types and versions.

## 3. Web and Mobile Application Layer

End users interact with the system through responsive web and mobile applications. These interfaces allow users to monitor live air-quality metrics in real time, view device locations on an interactive map, and analyze historical trends. Authorized users can remotely configure device settings, adjust reporting intervals, or receive alerts when thresholds are exceeded.

### Objectives:

- Secure login with user authentication
- Map-based visualization of air quality across Georgia
- Device integration to retrieve localized sensor data
- Real-time and historical air quality charts (hourly, daily, monthly, yearly)
- Recommendations based on pollution levels
- Rankings of air quality across Georgian cities and locations
- Info portal with articles and environmental news

### The proposed system will:

- Deliver accurate, real-time air quality measurements (e.g., PM, VOCs, NOx, O3 temperature, humidity).
- Adhere to all relevant EU environmental, safety, and quality regulations.
- Feature a modular sensor architecture to enable adaptable deployments.
- Be entirely manufactured within the European Union, ensuring supply chain traceability and quality control.

The prototype will be built using a **Sensirion SEN55 sensor** and an **ESP32-based PCB**, capable of measuring:

- Particulate Matter (PM1.0, PM2.5, PM10)
- Volatile Organic Compounds (VOCs)
- Nitrogen Oxides (NOx)
- Ambient temperature and relative humidity
- Atmospheric ozone
- Data is transmitted over Wi-Fi using the MQTT protocol at 15-minute intervals to a centralized backend.

### Planned Enhancements

To transition the existing prototype into a fully deployable product, the following upgrades are proposed:

- **Hardware Redesign**
  - Complete PCB redesign to optimize for EMI/EMC compliance
  - 4-layer board with dedicated ground planes
  - Use of industrial-grade components for continuous operation
- **Sensor Integration**
  - All sensors to be sourced from **EU-based manufacturers** with appropriate **EN certifications**
  - Sensor selection based on a balanced evaluation of cost and performance
- **Firmware Architecture**
  - Development in **ESP-IDF**
  - Automatic sensor detection using hardware identifiers
  - Config-driven operation to support flexible sensor setups
- **User Interface Enhancements**
  - Integrated display
  - Visual/audible alerts via LEDs and buzzer
- **Regulatory Compliance**
  - CE Marking (EMC + LVD directives)
  - Compliance with RoHS/REACH directives
  - EN certification for all integrated sensors

## In-Scope Activities

### A. Hardware Design and Development

- Complete PCB redesign
- Target operating temperature: –20°C to +60°C
- EMI/RF shielding and proper grounding
- Expansion headers for future sensor modules
- Support for sensor types per following standards:

| <u>Sensor</u>         | <u>EN Standard</u>     |
|-----------------------|------------------------|
| <u>CO</u>             | <u>EN 15058:2017</u>   |
| <u>TSP</u>            | <u>EN 13284-1:2017</u> |
| <u>NOx</u>            | <u>EN 14792:2017</u>   |
| <u>SO<sub>2</sub></u> | <u>EN 14791:2017</u>   |
| <u>VOCs</u>           | <u>N/A</u>             |
| <u>Temperature/</u>   | <u>N/A</u>             |
| <u>Humidity</u>       |                        |
| <u>Noise</u>          | <u>N/A</u>             |
| <u>CO<sub>2</sub></u> | <u>EN 16798-1</u>      |
| <u>O<sub>3</sub></u>  | <u>EN 14625</u>        |

- Power supply via DC adapter

### Firmware Development

- C/C++ implementation using ESP-IDF
- Sensor auto-detection
- MQTT data transmission
- Local storage of sensor data (up to 2 days in case of disconnection)
- User Interface:
  - Preferred: **Touchscreen** Language support: **English, Georgian**
  - Display of real-time air quality metrics and system status
- Additional features:
  - Wi-Fi configuration interface
  - OTA firmware update support

### Observation Period

After completing the hardware and firmware development, the device will undergo an observation period in real-life operating conditions. During this phase, the devices will remain online 24/7. We will continuously monitor device connectivity stability, sensor accuracy, data transmission reliability, as well as server performance and website functionality. This period allows us to identify issues that may not appear during laboratory testing. If any hardware,

firmware, server-side, or web platform bugs are detected, we will promptly refine and fix the issue to ensure long-term reliability, stability, and optimal performance.

Certain milestones, as laid out in the table below, are to be achieved during the contract term:

| Milestones/partial works   | Deadline/place/person responsible            | Criteria for acceptance |
|--|--|-------------------------|
| <b>Hardware and Firmware Layer</b> <ul style="list-style-type: none"> <li>Set up and configure a production-ready MQTT server (e.g., using Mosquitto, EMQX, or HiveMQ)</li> <li>Implement secure communication (TLS/SSL, authentication for devices)</li> <li>Integrate the MQTT broker with our existing backend system</li> <li>Handle both data ingestion and outgoing control messages (bi-directional communication)</li> <li>Ensure scalability to support 100+ devices publishing data every minute</li> <li>Create a secure server to host firmware binaries</li> <li>Implement an OTA update mechanism compatible with ESP32/ESP8266 devices</li> <li>Ensure version control and update policies (e.g., force update, staged rollout)<br/>Provide lightweight API endpoints for checking and downloading updates</li> <li>Secure update process with checksums, HTTPS, and optional authentication</li> </ul> | September 2026<br>Responsibility: Contractor | Approved by GIZ         |
| <b>Cloud Server and Backend Layer</b> <ul style="list-style-type: none"> <li>To build a user-friendly interface that enables administrators to register</li> </ul>   | November 2026<br>Responsibility: Contractor  | Approved by GIZ         |

|   |  |                              |
|---|--|------------------------------|
| and authenticate new monitoring devices <ul style="list-style-type: none"> <li>• Remotely configure and update device settings</li> <li>• Monitor device health and connectivity</li> <li>• Control device operations from the central platform</li> </ul>  |  |                              |
| <b>Web and Mobile Application Layer</b> <ul style="list-style-type: none"> <li>• Backend architecture, API endpoints, database setup, validation, error handling</li> <li>• Review, refine, and test backend processes</li> <li>• Integrate mapping services (Google Maps / Mapbox) with backend</li> <li>• Build historical data visualization</li> <li>• Average AQ per city with zoom aggregation</li> <li>• Pollution-based recommendation engine</li> <li>• Info portal with greenpole.org integration</li> <li>• Ranking feature for Georgian locations</li> <li>• System integration, user testing &amp; feedback integration</li> </ul> | January 2027<br>Responsibility: Contractor | Approved by GIZ              |
| <b>4. Final report submitted</b>  | January 2027<br>Responsibility: Contractor | Final report approved by GIZ |

In addition to the above specified tasks, the contract is responsible for:

- Selecting, preparing, training and steering the national experts assigned to perform the advisory tasks.
- Provision of equipment and supplies (consumables) and assumes the associated operating and administrative costs.
- Management of respective costs and expenditures, accounting processes and invoicing in line with the requirements of GIZ.
- Reporting to GIZ in accordance with the current AVB of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Period of assignment: from **July 2026 until January 2027**.

### 3. Concept

In the tender, the tenderer is required to show *how* the objectives defined in Chapter 2 (Tasks to be performed) are to be achieved, if applicable under consideration of further



method-related requirements (technical-methodological concept). In addition, the tenderer must describe the project management system for service provision.

Note: The numbers in parentheses correspond to the lines of the technical assessment grid.

### **Technical-methodological concept**

The tenderer is required to consider the tasks to be performed with reference to the objectives of the services put out to tender (see Chapter 1 Context) (1.1.1). Following this, the tenderer presents and justifies the explicit **strategy** (1.1) with which it intends to provide the services for which it is responsible (see Chapter 2 Tasks to be performed) (1.1.2).

The tenderer is required to present the actors relevant for the services for which it is responsible and describe the **cooperation** with them (1.2.1); and explain its approach to **steering** the measures with the project partners (1.3.1). The tenderer is required to describe the key **processes** (1.4) for the services for which it is responsible and create an **operational plan** or schedule (1.4.1) that describes how the services according to Chapter 2 (Tasks to be performed by the contractor) are to be provided.

### **Project management of the contractor (1.6)**

The tenderer is required to explain its approach (1.6.1) for coordination with the GIZ project. In particular, the project management requirements specified in Chapter 2 (Tasks to be performed by the contractor) must be explained in detail.

## **4. Personnel concept**

The tenderer is required to provide personnel who are suited to filling the positions described, on the basis of their CVs (see Chapter 7), the range of tasks involved and the required qualifications.

The below specified qualifications represent the requirements to reach the maximum number of points in the technical assessment.

### **Team leader - Hardware and PCB designer**

#### Tasks of the team leader

- Overall responsibility for the advisory packages of the contractor (quality and deadlines)
- Coordinating and ensuring communication with GIZ, partners and others involved in the project
- Personnel management
- Regular reporting in accordance with deadlines

### Qualifications of the team leader

- **Education/training** (2.1.1): Master's degree in computer engineering, computer Science, Informational Technologies and Electrical Engineering or related fields
- **Language** (2.1.2): C1-level language proficiency in English; Georgian – Native
- **General professional experience** (2.1.3): 5+ Years of Hardware Engineering Experience: Demonstrated expertise in designing, modeling, and validating complex electronics across the networking, data center, AI, and automotive electronics sectors.
- **Specific professional experience** (2.1.4): 5+ years of professional experience in High-Speed PCB Design & Layout Constraints: Deep experience utilizing Cadence Allegro, Altium Designer, and KiCad for constraint-driven layouts, floorplans, and high-speed routing, performing DFM, DFA, and DFT reviews with manufacturers, delivering fabrication-ready design packages, and managing BOMs and vendor transitions.
- **Leadership/management experience** (2.1.5): 5 years of management/leadership experience as project team leader or manager in a company;
- **Development cooperation (DC) experience** (2.1.7): 5 years of experience in DC projects
- **Other** (2.1.8): **SI/PI & 3D EM Modeling**: Proven capability running signal and power integrity simulations for DDR, PCIe, and SerDes interfaces operating above 100 Gbps, alongside PDN impedance analysis using ANSYS HFSS. Python, Embedded C, STM32, ATmega, ESP, and Raspberry Pi.

### Key expert 1 - Firmware developer

#### Qualifications of key expert 1

- **Education/training** (2.2.1): Bachelor's Degree in Computer Science, Informational Technologies and Electrical Engineering or related fields
- **Language** (2.2.2): B1 -level language proficiency in English, Georgian – Native
- **General professional experience** (2.2.3): 5 years of professional experience in embedded systems engineering, including embedded software development, electronic circuit design, PCB development, industrial automation, communication interfaces, networking technologies, and IoT-connected devices, including development, testing, deployment, and maintenance of commercial embedded products and automation systems.
- **Specific professional experience** (2.2.4): More than 5 years of experience developing embedded hardware and software solutions: Professional experience in embedded hardware and firmware development, including: Embedded C/C++ programming, Bare-metal firmware development using CMSIS, FreeRTOS-based embedded applications, Electronic circuit design and hardware development, PCB design and layout using KiCad, STM32, ESP32, AVR, and ARM microcontroller platforms, Embedded communication protocols including UART, SPI, I2C, Bluetooth, and USB, IoT device development and cloud-connected systems, TCP/IP, HTTP, MQTT, and TLS communication protocols, GSM/LTE, WinFi.
- **Development Cooperation** (DC) experience (2.2.7): 2+ years of experience in development cooperation projects, particularly private sector development support.
- **Other** (2.2.8): Product prototyping and transition to mass production, experience in the complete product lifecycle from concept and prototyping through testing, manufacturing, deployment, and long-term maintenance.

## Key expert 2 - **System architecture and firmware developer**

### Qualifications of key expert 2

- **Education/training** (2.2.1): Bachelor's Degree in Computer Science, Informational Technologies and Electrical Engineering or related fields
- **Language** (2.2.2): B1 -level language proficiency in English, Georgian – Native
- **General professional** experience (2.2.3): 5 years of professional experience in embedded systems engineering, including electronic hardware design, PCB development, embedded software development, industrial automation, Internet of Things (IoT) solutions, and product development.
- **Specific professional experience** (2.2.4): More than 5 years of experience developing embedded hardware and software solutions: Electronic schematic design and PCB layout, Embedded C/C++ firmware development, STM32, ESP32, and AVR microcontroller platforms, FreeRTOS-based embedded applications, Signal Integrity (SI) and Power Integrity (PI) analysis, High-speed PCB simulation using HFSS.
- **Development Cooperation** (DC) experience (2.2.7): 2+ years of experience in development cooperation projects, particularly private sector development support.
- **Other** (2.2.8): Product prototyping and transition to mass production, experience in the complete product lifecycle from concept and prototyping through testing, manufacturing, deployment, and long-term maintenance.

## Key expert 3 - **Software developer**

### Qualifications of key expert 3

- **Education/training** (2.2.1): Bachelor's Degree in Computer Science, Informational Technologies and Electrical Engineering or related fields
- **Language** (2.2.2): B1 -level language proficiency in English, Georgian – Native
- **General professional** experience (2.2.3): 7+ years of professional experience in software development, including web platforms, backend systems, databases, mobile applications, and cloud-hosted services. Experience includes development of large-scale web systems, public-facing applications, and long-term maintenance of production software used by thousands of users.
- **Specific professional experience** (2.2.4): More than 5 years of experience Backend architecture and API development, Database design and optimization, Real-time data collection and processing systems, Android and iOS application development, Data visualization and reporting dashboards, System administration and Linux server

management, Integration of third-party services and sensors, Long-term operation and maintenance of production applications.

- **Development Cooperation (DC)** experience (2.2.7): 2+ years of experience in development cooperation projects, particularly private sector development support.
- **Other** (2.2.8): Professional training in Web Programming (ITD Holding), including PHP, MySQL, HTML, CSS,

In addition to their specialist qualifications, the following qualifications are required of team members:

- Team skills
- Initiative
- Communication skills
- Socio-cultural skills
- Efficient, partner- and client-focused working methods
- Interdisciplinary thinking

**Company Experience (3.1):** The contractor must demonstrate proven organizational experience and capacities experience in delivering the above-described services. Specifically,

- 5+ years of experience in developing integrated hardware and software solutions for a diverse range of devices and control systems;
- Proven expertise in hardware design, firmware development, and backend system architecture, ensuring seamless integration;
- Demonstrated success in mobile application development and control panel management systems;
- Extensive collaboration with cross-functional teams, SMEs, and technology partners to deliver scalable, innovative solutions.

The contractor shall demonstrate **strong project management and quality assurance capacity**, including the ability to deliver complex assignments and coordinate with multiple stakeholders; and **availability and capacity to coordinate** of a qualified, multidisciplinary team with expertise in management and organizational components **(3.2)**.

## 5. Costing requirements

### Assignment of personnel

#### Specification of inputs

The following basic calculations for the contract for works are a reference value based on the acceptance criteria for each partial work/milestone specified in Chapter 2 (Tasks to be performed by the contractor).

Since the contract to be concluded is a contract for works, we would ask you to offer your services at a lump sum price.

In addition, the assessment of the financial bid is also based on the underlying daily rate. Please also provide the underlying daily rate. A breakdown of days is not required.

| Milestones/partial works         | Estimated expert days for orientation | Deadline/place/person responsible |
|----------------------------------|---------------------------------------|-----------------------------------|
| Hardware and Firmware Layer      | 75                                    | September 2026                    |
| Cloud Server and Backend Layer   | 70                                    | November 2026                     |
| Web and Mobile Application Layer | 43                                    | January 2027                      |
| Final report submitted           | 1                                     | January 2027                      |

All costs related to the work (e.g. telecommunication, transportation, printing) should be included in the total amount of contract.

The financial proposal should **exclude VAT**.

## 6. Requirements on the format of the tender

The structure of the tender must correspond to the structure of the ToR. In particular, the detailed structure of the concept (Chapter 3) should be organised in accordance with the positively weighted criteria in the assessment grid (not with zero). The tender must be legible (font size 11 or larger) and clearly formulated. It must be drawn up in English (language).

The complete tender must not exceed 10 pages (excluding CVs). If one of the maximum page lengths is exceeded, the content appearing after the cut-off point will not be included in the assessment.

In addition to the technical concept, the contractor should provide:

- Portfolio describing previous works that demonstrate the experience and capability of tackling this assignment and submission of high-quality deliverables.
- Work plan for the assignment.

The CVs of the personnel proposed in accordance with Chapter 4 of the ToRs must be submitted using the format specified in the terms and conditions for application. The CVs shall not exceed 4 pages each. They must clearly show the position and job the proposed person held in the reference project and for how long. The CVs can also be submitted in English.

Please calculate your financial tender based exactly on the parameters specified in Chapter 5 Quantitative requirements. The contractor is not contractually entitled to use up the days, trips, workshops or budgets in full. The number of days, trips and workshops and the budgets will be contractually agreed as maximum limits. The specifications for pricing are defined in the price schedule.

## 7. Outsourced processing of personal data

No personal data will be processed by contractor