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POWERBASE

D3.3 Business case and cost analysis

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About the document

This document presents the results of the Business Case and Cost Analysis conducted within the framework of the POWERBASE CSA project. It provides an in-depth assessment of the current energy supply systems used by civil protection stakeholders and evaluates the economic justification for investing in innovative, modular, and sustainable alternatives. The findings form the basis for estimating potential future investments and help define the path towards a future PCP process.

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Nature of the deliverable [1] | **R**

Dissemination level

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SEN	Sensitive, limited under the conditions of the Grant Agreement	
CL	Classified information under the Commission Decision No2015/444	

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[1] Deliverable types:
R: document, report (excluding periodic and final reports).
DEM: demonstrator, pilot, prototype, plan designs.
DEC: websites, patent filings, press and media actions, videos, etc.
OTHER: software, technical diagrams, etc.

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Abbreviations

BC & CA	Business Case and Cost Analysis
BoO	Base of Operation
CBRN	Chemical, Biological, Radiological or Nuclear Threats
CMINE	Crisis Management Innovation Network Europe
ERO	Emergency Response Organisation
EERO	External Emergency Response Organisation
ES	Emergency Shelter
GHG	Greenhouse gas
OMC	Open Market Consultation
PAB	Policy Advisory Board
PCP	Pre-Commercial Procurement
PERO	POWERBASE Emergency Response Organisation
PPI	Public Procurement of Innovative Solutions
REA	European Research Executive Agency
RFI	Request for Information
SEO	Search Engine Optimization

Executive summary

This deliverable presents the findings of the business case and cost analysis carried out within the framework of the POWERBASE project. The objective of this analysis is to assess the current state of energy supply systems used by emergency response organizations (EROs) and evaluate the justification for transitioning toward more sustainable alternatives. The study is grounded in data collected directly from operational partners across the consortium, who provided input by a questionnaire designed to capture both quantitative indicators and qualitative observations about their existing energy infrastructure and practices.

The analysis reveals that most organisations currently rely on conventional diesel generators to meet their energy needs during missions. These systems are widely used due to their established reliability despite negative effects. Due to that, they are increasingly recognised as insufficient to meet evolving requirements. Several key challenges faced by the demployment of diesel generators are reported. A strong interest among POWERBASE Consortium in exploring more innovative and adaptable energy solutions was expressed.

Following input collected and desk research, a cost analysis was conducted for the currently used solutions as well as the POWERBASE's one. The findings of the analysis underline the importance of a new system in order to bridge the gap between operational needs and the technological solutions available on the market, accounting for significant cost benefits.

In conclusion, this business case confirms that there is both a clear operational rationale and a strong financial justification for investing in the next generation of deployable energy systems. POWERBASE has successfully established a shared understanding of user needs and existing system limitations, offering a credible foundation for future innovation procurement planning. With continued collaboration between users and industry, the ground has been established for the development of innovative energy solutions that are smarter, cleaner, and better adapted to the realities of damaged infrastructure across Europe.

1. Introduction

1.1. Purpose of the Deliverable

In civil protection and humanitarian operations, access to reliable and sustainable energy supply systems is essential for ensuring safety, coordination, and continuity of services. No matter the energy is used for, it remains a critical enabler. However, current practices among civil protection actors continue to rely heavily on conventional diesel generators, which, while reliable in some respects, come with significant limitations in terms of efficiency, modularity, emissions, portability, and long-term cost-effectiveness.
The POWERBASE project seeks to address this gap by laying the groundwork for the potential procurement of next-generation energy supply systems for Base of Operations (BoO) and Emergency Shelters (ES), tailored to the needs of civil protection stakeholders. The project does not develop technological solutions directly but instead facilitates the processes needed to identify operational requirements, assess the state of the art, engage with the market, and build a strong, needs-driven business case for future innovation.
This deliverable, D3.3 Business Case and Cost Analysis, supports that objective by consolidating input from emergency response organizations regarding the systems they currently use, the challenges they face, and the costs associated with these technologies. It aims to assess the economic impact and viability of POWERBASE solutions. This is an important document to ensure that POWERBASE solutions will be marketable in the long-run. The business case will include the following information:

- Cost/benefit analysis comparing the economic impact of POWERBASE against existing solutions
- Market analysis with buying volume
- Financial evaluation grid

The content of this report that served as a living document to be updated over the course of the project, is based on data gathered through a questionnaire circulated among partners, along with insights derived from results of the needs assessment process, the SOTA and the functional requirements analysis conducted in Deliverable D2.2 and the Request for Information (RFI) completed by technology providers. The findings presented herein reflect the diversity of operational environments within the consortium and the collective ambition to move toward smarter, greener, and more interoperable power systems in the field.
Ultimately, this deliverable provides suggestions for the procurement strategy and a first step toward quantifying the value and necessity of transitioning to innovative energy solutions, supporting the long-term policy goals of more sustainable and resilient disaster response capabilities in Europe.

2. General context: Powerbase solution

2.1. The current situation

Across civil protection and emergency response operations, energy supply remains a persistent challenge. Organisations often operate in unpredictable, resource-constrained environments where access to grid power is unavailable or insufficient. In these contexts, mobile energy solutions become essential to ensure mission continuity and support for critical services.
Most organisations currently rely on conventional technologies – due to their widespread availability, familiarity, and ease of deployment. However, it is proved that several limitations associated with these systems have become increasingly apparent to emergency response organizations. They are associated with high emissions and contribute significantly to the carbon footprint of emergency operations. In addition, they produce considerable noise levels, which can be disruptive, particularly in sensitive or accommodation zones. The size and weight of the generators further complicate transport and setup, often requiring dedicated logistics arrangements and personnel. Fuel dependency, especially during crises when access to supply chains may be limited, adds to operational vulnerability.
Overall, while currently used technologies continue to be widely prefered, their limitations in terms of efficiency, environmental impact, and adaptability are becoming more visible. These challenges provide the context for exploring alternative energy systems better suited to the evolving needs and expectations of emergency response organizations and humanitarian actors. The following sections present findings collected from project partners to identify these challenges in more detail and inform the development of a future innovative solution under the POWERBASE project.

2.2. Powerbase solution

In order to understand and assess the current situation of power supply, a questionnaire on the business case (see POWERBASE deliverable D2.2) was distributed to the emergency response organizations of the consortium. All partners who responded reported that diesel generators remain their exclusive energy supply solution during missions. No one reported using intelligent energy monitoring tools, automated fault detection, or AI-based optimisation. The analysis of data proved that several limitations associated with these systems have become increasingly apparent to emergency response organizations:

- From an operational perspective, partners noted as far as their current power generation systems are concerned that: Mostly deployed for short-term missions, while most days of the year they are stored.
- Operational costs are mostly related to fuel consumption, particularly during missions. Maintenance is periodic but critical due to storage-related wear and fuel ageing.
- Noise and emissions negatively affect both the environment and working conditions on the ground.
- Low-load system that causes inefficiency due to operation in low capacity.
- Not being modular or scalable, makes them difficult to be adaptive in different mission scales.
- Difficult to transport due to their size.
- Lacking of smart features, such as automated load balancing or fault detection.

These findings confirm the need for innovation and the development of a new energy solution tailored to the dynamic realities of civil protection missions.
The POWERBASE solution envisions a modular, plug-and-play, and multi-source energy system that responds to the functional and operational limitations of current systems. Building on the

user requirements already analysed in Deliverable D2.2, the future system is expected to feature smart energy management, support for renewables, low environmental impact and adaptability to different mission contexts. Overall, **the lack of smart functionality, energy flexibility, and transport efficiency were identified as major drawbacks**. This operational baseline highlights the need for a new generation of energy solutions that are not only scalable and efficient, but also cover the needs of field operations in civil protection.

In addition, these limitations must be viewed in the wider policy context. The European Green Deal sets a target of at 55% reduction in greenhouse gas emissions by 2050, which requires public authorities to move toward greener, more energy-efficient solutions.

3. Methodology

3.1. Data Collection Approach

To better understand the current state of energy supply systems used in civil protection operations, a structured data collection process was designed and implemented. The aim was to gather both qualitative and quantitative information directly from the emergency responders as well as technology providers (suppliers).

Information collected from the Request for Information (RFI) to suppliers
During the POWERBASE Open Market Consultation data was collected through the Request For Information (RFI) questionnaire addressed to technology suppliers in an attempt to get information, *inter alia*, from the market on the gaps/ weaknesses of existing technologies and on required investment for adressing POWERBASE challenge and covering POWERBASE identified common needs.
The information requested to the suppliers on their technologies focus on the gaps and weakness the existing technologies fase with regards to the identified prelimary requirements and the capabilities of the suppliers to adress them.
The views of the suppliers are also asked as far as the necessary features and core technologies that POWERBASE solution shall encompass. Questions on the financial perspective, success and viability of the product to be developed as well as on the global investment are included. The experience and trust of the suppliers to R&D is questioned together with the innovation challenges of concern.

Information collected from questionnaire to PEROs
A questionnaire circulated internally, adressed to POWERBASE emergency responders, was developed to facilitate this process. The file was structured to allow each participating organisation to respond independently, capturing their inputs consistently and enabling consolidated analysis. The questionnaire addressed a broad range of topics, including:

- ✓ Types of energy supply technologies currently in use
- ✓ Key operational characteristics and typical deployment contexts
- ✓ Energy consumption patterns and system scalability
- ✓ Technical limitations and challenges faced during missions
- ✓ Cost-related factors, including ongoing usage costs and maintenance needs
- ✓ Perceptions of potential improvements and willingness to transition to more advanced systems.

To facilitate completion, a pre-filled example was provided to all partners. This helped clarify the level of detail expected and served as a reference for interpreting more technical or ambiguous questions.
The goal of this exercise was to capture real user experience, practical insights, and operational realities, so that the business case could be grounded in actual needs allowing for a more accurate assessment of the potential benefits, feasibility, and market relevance of the POWERBASE solution.
In total, input was received from all key operational partners. While the depth of responses varied depending on the internal structure and available data within each organisation, the collective dataset provided a reliable picture of the current energy supply landscape and key areas of convergence across different contexts.

3.2. Analysis of Existing Energy Supply Systems

The data collected through the questionnaire enabled a structured assessment of the technologies, operational patterns, and user experiences related to energy supply in the field. The analysis that follows is grouped into three key thematic areas: technologies used, cost and usage patterns, and challenges.

3.2.1. Types of Technologies Used

Across the consortium, diesel generators are by far the most used energy source and they transfer diesel to electricity. They are employed in a variety of mission types, from short-term urban deployments to extended rural operations.
Partners reported the following uses:

- ✓ Camps
- ✓ Bases of Operations & Shelters
- ✓ Specialised units (e.g WASH)
- ✓ Events not linked to Disaster Management such as music festivals
- ✓ Back up systems
- ✓ Fire services
- ✓ Medical infrastructure support

Examples of products used currently in operations are:

- ✓ Pramac P9000 (400V 50HZ) - covering BoO+EMT for 24/7 without peaks, MASE MPL 75ASX (e.g. MPL for 24/7 BoO + EMT) + 20 Liter Tank Diesel on site
- ✓ Diesel Generator 275 kVA (220 kW) / 400 V / 397 A - Model MOSA GE 275 FSX
- ✓ Genelec GHW-50, 50 kVA diesel power generator, trailer mounted
- ✓ Honda EG 3600 petrol powered generator, 3600 / 3200 Watt, mobile power unit
- ✓ Honda EU 22i petrol powered generator, 2200 / 1600 Watt, mobile power unit
- ✓ VM Motori SUN 3105 T

Figure 1: Examples of diesel generators currently in use by operational partners

The systems reported by partners vary in size and output, ranging from small portable devices to large diesel-based systems. This reflects the diverse operational contexts of civil protection deployments, where both small-scale and large-scale energy supply solutions are required. For that reason, in the cost analysis, averages have been estimated to ensure that the outcome remains both realistic and comparable across the consortium.

3.2.2. Operational and Cost Aspects

Generators are most frequently stored and maintained during non-deployment periods, with actual usage taking place during field missions. Partners noted that:

- Systems are often used well below their full load capacity, reducing fuel efficiency
- Refueling logistics can be challenging in remote areas or during long operations
- Noise and heat from generators can create discomfort or operational interference.
- The primary ongoing cost reported was fuel consumption. Other costs — such as logistics, maintenance, or transport — were noted but not consistently quantified across partners. Still, respondents made it clear that running costs, especially over longer missions, remain significant.

It is mentioned that most partners deploy energy supply systems only during missions, which can range annualy depending on the organisation. The annual fuel costs depend on usage intensity and on diesel price. The rest of the time, systems remain in storage — yet still require regular maintenance, fuel conditioning, and availability checks.

3.2.3. Challenges Identified

Several common operational challenges were highlighted by the partners in the questionnaire, reflecting a shared set of limitations with current power supply systems. One of the most frequently reported issues was **significant energy waste**, particularly during periods of low-load operation, where generators continue to consume fuel inefficiently. The **transport, storage, and setup** of conventional generators are occasionally identified as problematic, for the case of systems of considerable size and weight, which complicates rapid deployment and increases logistical burden. Another recurring theme was the limited **adaptability of existing systems to fluctuating energy needs** in the field as many units lack the flexibility to scale up or down based on real-time demand. Partners also expressed concern over the **difficulty of sourcing fuel** during crisis scenarios, especially in remote areas or when supply chains are disrupted, which in turn reinforces their heavy reliance on fossil fuels, that raises both environmental and transport related concerns. **High noise levels** from diesel generators were reported to negatively impact both comfort and operational coordination in the field, especially in specific places. Furthermore, the **lack of standardisation and interoperability** between different systems and devices makes it difficult to integrate various components or share energy across teams. Lastly, the **absence of performance monitoring tools** means that many organisations are limited to reactive rather than proactive maintenance, increasing the risk of unexpected breakdowns. These shared challenges closely reflect the capability gaps identified by the consortium and underscore the **pressing need for a new generation of power systems that are lightweight, modular, smart, and environmentally sustainable**.

3.3. Requirements Identified

The analysis of partner input revealed a common understanding of the limitations of existing energy systems and a strong interest in moving toward more efficient, intelligent, and sustainable solutions. While current systems are generally functional in basic terms, they fall short when assessed against evolving operational needs, environmental standards, and flexibility expectations. While the functional requirements have already been presented and analysed in detail in Deliverable D2.2 (POWERBASE, 2025a), this section refers at the most critical ones that were also mentioned through the partner feedback and cost analysis process. The aim is to highlight how the findings of this business case validate the requirements previously identified. The following categories summarize the core requirements identified across participating organisations.

Functionality and Operational Simplicity

Several partners reported that their current systems require manual setup, configuration, and fuel handling, which presents risks in high-stress deployment conditions. For example, generator operation often depends on trained technicians, which may not always be available in rapid-response contexts. The ability to plug-and-play, would substantially reduce deployment time and eliminate avoidable errors.

Additionally, tools that can autonomously monitor performance, issue early fault alerts, and adjust energy output based on demand would address recurring operational risks reported by at least four partners. Such features, often described under the umbrella of “smart” or “AI-supported” functionality, are entirely absent in current systems, as confirmed across all questionnaire responses.

Efficiency and Fuel Use

Fuel remains the largest single cost in all systems currently in use. Beyond the financial impact, fuel logistics dominate mission planning. Transport, refueling, and fuel quality assurance are recurring challenges. Generators often run at partial load, which reduces efficiency and increases wear-and-tear.

Powerbase’s emphasis on energy reuse (e.g. waste heat), hybrid sourcing (solar, wind, methane), and smart energy distribution would directly tackle this problem.

Modularity and Scalability

The lack of flexibility in today’s systems is a major throwback. The majority of users currently rely on fixed-size generator sets, which are often oversized for small operations and underpowered in large camps. This clearly validates the Powerbase principle of “Lego-like modularity” — the ability to configure units as needed, including micro-units for tents, mid-range systems for medical teams, and fully scalable grids for field bases. Modularity also reduces transport cost, which was the second-highest operational burden identified.

Interoperability and Standardisation

Compatibility issues were mentioned by several partners of the consortium, particularly regarding plug types, battery interfaces, and system voltages. In multinational deployments, the lack of standardised energy interfaces creates delays and inefficient intervention..

Durability and Maintenance

Numerous partners raised the issue of maintenance cycles for the equipment stored for long periods. Even when unused, generators require fuel stabilisation, battery cycling, and servicing. The Powerbase solution is designed for minimal maintenance, with self-diagnostic features, switchable components, and an expected lifespan.

This reduces cost but also boosts operational availability — a tool that works immediately without pre-deployment servicing is a major asset in crisis response.

Environmental and Cost Sustainability

Beyond operational efficiency, many partners indicated growing pressure to adopt greener, more sustainable technologies. However, the absence of reliable alternatives has kept diesel as the default. The Powerbase requirements — such as compatibility with renewables, recyclable materials, and lower noise/emissions — are not just aspirational: they reflect future procurement conditions, especially under national green transition policies.

From a financial perspective, the transition to long-life, low-consumption, low-maintenance systems offers the potential for significant cost savings over a 10–15 year lifecycle. This justifies early investment in development and market preparation. Nevertheless, a transition time of few years to allow for familirization with the new system and gradual replacement of the conventional power supply are requested.

4. Business Case and Cost Analysis

This section builds on the partner questionnaire responses to present a structured financial and operational comparison between existing technologies and the envisioned Powerbase-aligned solution. It addresses operational costs, improvement opportunities, market size, and evaluation mechanisms for future procurement.

4.1. Current Cost Analysis

The cost of energy provision in field operations remains a significant burden for emergency response organizations. The estimation for the daily operating cost per system varies depending on usage intensity and the size/ capacity of the generator . Fuel seems to be the dominant contributor, with frequent references to inefficient consumption due to generators running on partial loads. Additional equipment e.g. oil, filters might be needed with an estimated cost ~ 100 € per generator. The equipment is stored the biggest period of the year as it is only used during field missions, yet requires ongoing servicing and space, driving up storage-related costs. In these it is added the maintance cost that varies from 100 € – 700 €. When deployed, generators are often used at low load, which increases fuel consumption per unit of output and shortens system life.

Assumption:

- Fuel price: €1.70 per litre (diesel, EU average)
- Usage: Continuous operation (24 hours/day)
- Costs include: Fuel and logistics & maintenance (~€15–40/day depending on size)

Table 1 Current solutions' daily cost

Generator Model	Fuel Consumption (L/h)	Daily Fuel Use (L)	Fuel Cost per day (€)	Other Costs per day (€)	Total Daily Cost (€)
Pramac P9000	~2.1 L/h[2]	50	€85	€15	€100
MASE MPL 75ASX	~13.0 L/h[3]	312	€530	€30	€560

Based on input and the specific generator specifications, the estimated operational cost ranges from approximately €3,000 to €16,800 per system per year, depending on the size and type of generator used assuming an average deployment of 30 days of continuous operation annually. Over a 10-year period, this translates to a cumulative operational expenditure between €30,000 and €168,000—excluding acquisition and major overhauls—underscoring the long-term financial burden of current energy supply solutions.
While exact annual costs vary due to mission frequency and generator size, inputs indicate that fuel logistics are costly and resource-intensive, especially in remote areas.
Moreover, storage costs are often underestimated but were highlighted by several partners. Generators are typically kept in secured warehouses and require regular inspection and test runs, to ensure readiness. In disaster-struck or remote areas, the cost of fuel is much higher than the European average price per liter. Furthermore, the calculation does not account for environmental externalities. This environmental cost, combined with elevated logistics prices, makes the real operational cost of diesel systems even higher than the already made calculations.

[2] https://www.hampshiregenerators.co.uk/wp-content/uploads/2019/11/Pramac-P9000-230V-CONN-Datasheet.pdf
[3] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.cial.no/file/andre/mpl-83-ftp_ing.pdf

4.2. Expected Improvements in Future Solutions

The analysis of partner responses, combined with the functional requirements captured in Deliverable D2.2, demonstrates a strong consensus on the need for a more efficient, modular, and sustainable energy supply solution tailored to field operations. The future system envisioned under the POWERBASE framework is expected to deliver substantial improvements over conventional diesel-based generators, particularly in terms of cost efficiency, energy management, scalability, and sustainability.

A core area of improvement lies in fuel consumption. As indicated in Section 4.1, the daily operating cost of current solutions ranges from approximately €100/day for small generators (e.g., Pramac P9000) to €560/day for medium-capacity models (e.g., MASE MPL 75ASX).. The POWERBASE system is expected to significantly reduce this dependency.

Another key improvement is the **adaptability to demand**. Current systems often operate under low load, leading to inefficient fuel use and accelerated wear. By contrast, the POWERBASE system aims to adopt a modular approach, allowing energy provision to scale up or down based on actual need.

From a maintenance and readiness perspective, existing generators are stored for the majority of the year but still require regular inspection and servicing. For example, partners reported annual maintenance costs ranging from €100 to €700 per system — even if the systems are only used 20–30 days per year. The POWERBASE solution is expected to use components with fewer moving parts and predictive maintenance tools, reducing the frequency and cost of upkeep. It should be mentioned that these maintenance and logistics costs are not directly reduced by lower fuel consumption, but could be indirectly lowered over time due to less runtime of the system.

Furthermore, the **current systems lack remote monitoring capabilities**. The introduction of "smart" features in the POWERBASE prototype, such as AI-supported monitoring, energy fault detection, energy load management and real-time consumption tracking is expected to improve responsiveness, and optimise energy use. Such features directly address the inefficiencies highlighted by several partners, particularly in long deployments or operations in remote areas.

In addition, future systems should reduce logistical and environmental burdens. By shifting toward low-emission and multi-source energy architectures the POWERBASE system aims to reduce fuel logistics dependency of field missions as well as environmental impact quantifiable as CO2-Emission price.

Quantitatively, if a future system were to reduce average fuel consumption by just 30%, the fuel related daily cost savings could range from €30 (small system) to over €160 (mid-size system) — amounting to €900–€4,800 in annual savings per unit, depending on usage.

4.3. Cost/Benefit Analysis

The POWERBASE solution is expected to deliver significant long-term cost savings. Below is a basic comparative table for 30 operational days per year over 10 years:

Table 2 10 years costs of current solutions

System	Daily Cost (€)	10-Year Cost (excl. purchase)
Pramac P9000 (current)	€100	€30,000
MASE MPL 75ASX (current)	€560	€168,000
POWERBASE solution	€75–150*	€22,500–€45,000*

*depending the solution a minimum fuel cost is assumed.

Even a mid-range POWERBASE unit could result in savings up to €120,000 over a decade compared to legacy systems, particularly in high-usage cases like field hospitals or long-term base camps

In addition to financial considerations, the POWERBASE solution is expected to offer important environmental improvements. Traditional diesel generators are not only significant contributors to CO_2 emissions but also produce high levels of noise, which can be disruptive in field environments and add to the overall stress of emergency operations. Several partners highlighted concerns over noise levels during deployments. The POWERBASE solution, by integrating renewable energy components and operating more efficiently, aims to reduce both emissions and noise. This not only aligns with broader EU environmental goals but also makes the system more suitable for a wider range of mission types, including those taking place in populated or sensitive areas.
Moreover, the proposed solution lies in its enhanced mobility and adaptability to diverse field conditions. Unlike traditional generators, which are often bulky, heavy, and dependent on fuel supply chains, POWERBASE aims to provide a lightweight, modular system that can be easily transported when needed. This mobility is particularly valuable in operations where access is limited. The ability to quickly deploy a reliable energy solution without relying on large vehicles or extensive setup procedures is expected to significantly reduce response time and increase the self-sufficiency of field units, particularly in the critical early hours of an emergency.
Another key advantage is that the proposed solution allows for fast setup without requiring highly trained technical personnel. In emergency scenarios, where time and human resources are often limited, the ability to deploy a power system with minimal instruction significantly enhances operational readiness. By reducing the complexity of installation and configuration, the solution minimizes human error and ensures that energy can be made available quickly and reliably—even in high-pressure environments. This not only improves response efficiency but also contributes to lowering operational costs. Since the system does not require specialised technicians for deployment or supervision, organisations can reduce training expenses and reallocate personnel to other critical tasks, decreasing the total cost of use over time.

4.4. Market Analysis – with buying Volume

Partner feedback indicates a moderate to high potential demand for POWERBASE-like solutions:

- Many partners confirmed the need for an alternative power supply in at least some missions.
- With an assumption that response organisations might operate 3 units in their fleet across the consortium, this translates to an initial market volume of 21 units.
- Assuming a conservative uptake of 30% replacement over 5 years, 7 POWERBASE units could be adopted by consortium partners alone in the medium term. This demand may increase if the new solution proves effective in reducing operational costs, increasing modularity, or meeting regulatory/environmental requirements
- Scaling up to wider EU civil protection networks and the potential market could easily exceed 150–300 systems, even under moderate replacement strategies. Emergency energy needs are addressed not only by emergency response organisations and civil protection agencies in BoO and ES, but also during response operations. Similar needs are identified by armed forces, humanitarian NGOs, etc., who frequently operate mobile camps, temporary shelters, or even no emergency use — all requiring standalone energy systems.
- More sectors can also benefit from the new flexible, sustainable, cost effciient mobile power supply system, e.g. construction, entertainment, etc.

Given the scale of generator use across Europe's emergency response ecosystem, the POWERBASE solution could address **a clear operational gap in terms of cost efficiency, modular deployment, logistic advantages and environmental performance**. As the civil protection and humanitarian sectors increasingly seek adaptable and sustainable energy solutions, there is strong potential for POWERBASE solution to enter the market as an alternative to conventional diesel systems. Successful piloting within the consortium could be the reason for wider adoption.

4.5. Financial Evaluation Grid

To support a comparative financial assessment between currently used energy systems and the projected POWERBASE solution, a simplified financial evaluation grid has been compiled. This grid brings together key cost and performance indicators based on data provided by project partners.
The grid includes both direct cost metrics—such as fuel and maintenance—and functional characteristics relevant to operational efficiency and long-term sustainability. The POWERBASE solution details are not based on an existing prototype but it is an estimation from the functional requirements, particularly regarding modularity, smart monitoring, and reduced fossil fuel dependency.
the POWERBASE solution is designed to address limitations through a combination of technological innovation and operational flexibility. It is expected to reduce daily operating costs by improving energy efficiency and adapting power output to actual demand, thereby eliminating the inefficiencies associated with oversized, always on systems. The integration of smart control features and remote diagnostics in an integrated system that generates and stores energy will enhance reliability and enable predictive maintenance, reducing downtime and service costs. Its modular design allows for energy capacity to be scaled according to mission needs, avoiding unnecessary deployment of additional units. Together, these features contribute to a lower total cost of ownership and greater overall value across the full system lifecycle.
The table below summarises this comparison.

Table 3 Comparison of current genrators and Powerbase solution

Cost/Benefit Criteria	Current Generators	POWERBASE Solution
Fuel Efficiency	Low (partial load losses)	High (optimized demand-based use)
Fuel Cost per Day	€100–€1,590	€75–€150 (estimated)
Maintenance Cost per Year	€100–€700	€50–€250 (with predictive features)
Modular/Scalable	No	Yes
Emissions / Carbon Impact	High	Low–Moderate
Monitoring and Fault Detection	No	Yes (AI/sensor-enabled)
Transport & Setup Ease	Moderate–Low	High (lightweight, modular)
Training Multi-use	Limited	High
Lifecycle Operational Cost (10y)*	€30k–€160k+	€22.5k–€45k (est.)

*Assuming 30 deployment days/year and excluding acquisition costs.

This evaluation highlights the potential for substantial lifecycle savings with the POWERBASE approach—particularly for medium and high-consumption scenarios—and supports the business rationale for further investment, prototyping, and testing.

4.6. Estimated Cost for PCP Implementation

In support of future procurement planning and in line with the PCP requirements and the phased approach, this section outlines an indicative budget structure for the development of the POWERBASE solution under a Pre Commercial Procurement (PCP) to serve as a basis for Deliverable D3.4 (POWERBASE, 2025b). The estimation reflects the consortium's needs and experience, as well as input from the market during the POWERBASE OMC), which has been summarised in the annex. The cost structure reflects the different levels of complexity required for each phase.

For the actual purchase of the POWERBASE solution, the market provided the average amount of 1.4 million as an indicative price for developing the solution, distributed as follows:

- Phase 1 – Solution Design: €50,000
- Phase 2 – Prototype Development: €600,000
- Phase 3 – Operational Validation and Testing Scenarios: €750,000

This distribution follows an increasing intensity of effort and resource allocation. Phase 1 will primarily involve detailed design work and technical specifications, Phase 2 will focus on actual prototype development and integration, while Phase 3 will require field testing under real-world conditions and performance validation, which justifies the higher amount of the budget as it is the most demanding one.

In practical terms, this phased structure also defines the number of contractors and total budget per stage: Phase 1 is expected to engage at least six contractors (€300,000 in total), Phase 2 will continue with at least three contractors (€1,800,000 in total), and Phase 3 will involve at least two contractors (€1,500,000 in total).

This indicative breakdown also aligns well with financial estimations provided by technology providers through the RFI process, which placed the total investment required per system in the range of €1–1.5 million.

5. Conclusions

The cost analysis presented in this deliverable demonstrate the pressing need for a more efficient, sustainable, and operationally adaptive power supply system for use in civil protection missions. The current reliance on diesel generators—while proven and robust—results in high fuel consumption, significant storage and maintenance burdens, and limited scalability, especially in deployments where power demand varies or evolves dynamically.

Through data collection process and input from operational partners, it has been possible to generate a realistic and evidence-based view of the current energy supply landscape in civil protection operations.

The analysis confirms that most participating organisations are currently reliant on conventional diesel generators, which, despite being operationally reliable, are associated with significant financial, logistical, and environmental drawbacks. Through the collection of data from partners, it was possible to estimate the daily operating cost of existing solutions, ranges from approximately €100 to €560 per day, depending on generator size and use profile. These costs are largely attributed to fuel consumption and inefficient operation under partial load. When extended over the 10-year lifecycle of such systems, the cumulative operational cost can exceed €150,000 per unit, before storage and major servicing.

Against this backdrop, the Powerbase vision of a modular, intelligent, and multi-source energy system presents a strong case for future investment. The data indicates that such systems could reduce fuel use, maintenance and transport effort, support longer system lifecycles, enable broader use beyond emergencies and align with EU sustainability goals and innovation strategies. Expected benefits include fuel and maintenance cost reductions of up to 30–50%. This reduction is ambitious but realistic target and would allow to save an adequate amount of money.

These findings support the viability and desirability of preparing a new innovative system. The project can help bridging the gap between operational needs and market capabilities encouraging the development of energy solutions tailored to the real conditions of civil protection missions.

In terms of procurement planning, an indicative cost model for the PCP phases has been developed and is discussed in section 4.6. The indicative budget has been the outcome of consortium needs and experience and RFI's input, serving as the basis for the PCP budget included in the POWERBASE Call for Tenders

The POWERBASE solution aims not only to reduce costs, but to support more resilient, efficient, and environmentally sustainable civil protection operations across Europe, as it has successfully established a common foundation of understanding across users. With these insights, the project is ready to transition from strategic planning to procurement preparation, driving the innovation of energy systems that are modular and efficient.

6. Bibliography

POWERBASE (2025a). Deliverable 2.2 “Functional requirements report”, available online: https://www.powerbaseproject.eu/wp-content/uploads/D2.2_Functional-Requirements-Report_final.pdf

POWERBASE (2025b). Deliverable 3.4 “Tender documents”, in progress.

7. Annexes

1. Request For Information (RFI) responses on financial-related questions *(All answers and questions are included in the Annex of Deliverable 3.2)*

Question: From a financial perspective, how would you evaluate the investment required to deliver the expected innovation? Please provide an evaluation of both the global investment and the main cost items (project management, R&D, development, test and pilots, HR…)

The chart below presents the total cost estimates provided by suppliers in response to the RFI question regarding the investment required to deliver the POWERBASE solution. Most responses fall between €1 million and €1.5 million, with slight variations. That helped inform the internal planning estimate of €1.4 million per contractor used in the PCP framework. Below you can see analytically the relevant responses. Supplier responses are labeled A to J.

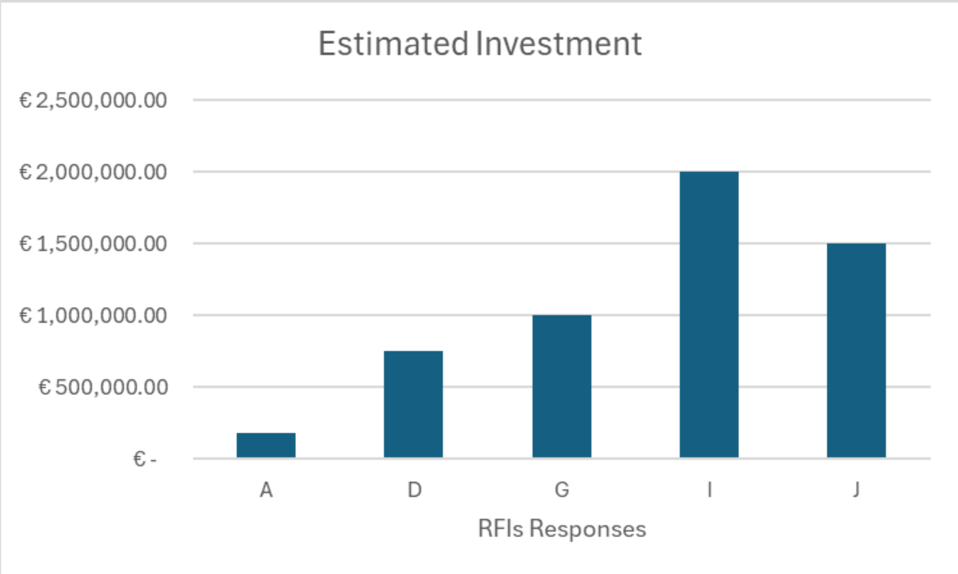

Figure 2: Estimated investment based on suppliers (A-J) responses to RFI

Supplier A) "At Volta Energy, our strength lies in our efficient company structure and hands-on manufacturing model, which allows us to manage innovation in-house with minimal overhead. As a result, the primary investment required from buyers or project stakeholders is the purchase of the system itself.
Our clean energy systems are available as fully developed, field-tested products ranging from €55,000 to €180,000, depending on the required power capacity (6 to 45 kVA), integrated solar capabilities, and additional features like advanced monitoring or hybrid backup support. Thanks to our skilled team and streamlined operations, we do not require additional investment in project management, external R&D, or complex development structures. We've built a robust internal framework where engineering, assembly, and system optimization are all handled under one roof—ensuring both quality control and cost-efficiency.
Therefore, for projects like POWERBASE, the innovation is ready and scalable, and the only cost to consider is the acquisition of the appropriate system configuration. Optional pilot testing, user training, and support services can also be provided at competitive rates based on specific deployment needs."

Supplier B) Investment depends on demand and volume of order.

Supplier C) If there is financial help for developing special prototypes for your three cases we would gladly be a part of this R&D Testing.

Supplier D) From a financial perspective, delivering the expected innovation will require a targeted investment strategy. Since our core technology is already functional in prototype form, the majority of the investment will go toward optimization, integration, and scaling.
We estimate a global investment of €750,000 to reach a deployable, modular system that meets the POWERBASE requirements. This budget would cover:
- Research & Development (~25%)
- Manufacturing Preparation (~20%)
- Project Management and Coordination (~20%)
- HR and Technical Staff (~20%)
- Testing and Pilots (~15%)

This investment aims to deliver a rugged, safe, energy-on-demand solution that is logistically simple and scalable, avoiding the complexity and costs of traditional systems. A key advantage is that no battery storage, hazardous goods handling, or complex electronics are needed.
We are confident that with the right partnership and funding structure, the return on investment will come from a clear gap in the emergency and remote energy market.

Supplier E) No Inventions needed due to commercial off-the-shelf.

Supplier F) Test and pilots.

Supplier G) 1. Total Investment and Cost Estimation

The total budget for the POWERBASE project is capped at 1 million euros, with the investment focused on the most critical areas necessary for the successful implementation of the innovations. The goal is to make optimal use of the available funds to accelerate the development phase and successfully complete the pilot projects.

2. Main Cost Items
a. Project Management Costs (approx. 10% of the budget)
Project management will account for about 10% of the total budget. These costs include project leadership, timeline management, resource allocation, and coordination between various partners. Efficient management is crucial to achieving project goals within the limited budget.
b. R&D (Research and Development) (approx. 40% of the budget).

A significant portion of the budget, around 40%, will be allocated to R&D, focusing on advancing technologies for modular energy storage (e.g., LTO batteries) and the hybrid energy management system. These investments are essential for ensuring the project's innovative potential and preparing the technology for real-world application.

c. Development and Prototyping (approx. 30% of the budget)
Approximately 30% of the budget will go toward developing prototypes and integrating technologies into a functional system. This includes building modular, transportable energy systems and conducting initial tests and pilot programs.
d. Pilot and Testing Programs (approx. 10% of the budget)
Around 10% of the budget will be allocated to pilot projects and testing, validating the technology in real-world environments. This includes field tests in remote and challenging conditions to ensure system functionality and reliability.
e. Personnel and Resource Costs (approx. 10% of the budget).
Approximately 10% of the budget will be reserved for skilled personnel and internal resources (engineers, technicians, project managers). Given the technical nature of the project, qualified staff will be essential for ensuring success.

3. Efficient Use of Resources and Goals
With a total budget of 1 million euros, the focus will be on maximizing resource efficiency and achieving rapid market readiness for the developed technology. Emphasizing R&D, prototyping, and testing allows the innovations to be validated quickly while ensuring the funds are used effectively for key project phases.

Summary of Financial Requirements:
Total Budget: 1 Million Euros.
Main Cost Breakdown: Research & Development (40%), Development & Prototyping (30%), Project Management & Personnel (20%), Testing & Pilot Programs (10%).
Goal: Maximize efficiency in fund usage, with a clear focus on developing innovative solutions and conducting pilot programs to bring the technology to market readiness quickly."

Supplier H) Right now, there are too many variables to properly provide an indication for the investment required.

Supplier I) "Financial assessment of the investments required to implement the expected innovations
The implementation of the technological innovations required in the POWERBASE project requires considerable but targeted investments. Based on our previous development experience in comparable areas, we estimate the total investment to be around 1.5 to 2.5 million euros, depending on the desired maturity level of the solution (TRL level), the extent of modularity and the number of prototypes and tests required.

Important cost factors at a glance:

Research & development (approx. 30–35%)

- Development of special PV designs (e.g. particularly lightweight, mobile or low-glare modules)
- Integration with battery storage systems, inverters and monitoring systems
- Adaptation to extreme environmental conditions

Testing & piloting (approx. 20–25%)

- Comprehensive environmental and stress tests
- Setup of test fields and mobile application scenarios
- Certification (e.g. IEC 63209, PID, UV, DH cycles)

Project management & coordination (approx. 10–15%)

- Interface with partners, scheduling, controlling

Personnel & skilled workers (approx. 20–25%)

- Interdisciplinary teams from engineering, product development, quality management

Production adjustments & logistics (approx. 10–15%)

- Tooling costs, packaging design, storage and transport solutions for mobile applications

Conclusion:

For a project such as POWERBASE, we see the need for targeted investments, which, however, will enable a stable return on investment in the medium to long term thanks to a high degree of technological differentiation, growing demand for resilient PV solutions and European value chains.

Supplier J) "From a financial perspective, the investment required to deliver the expected innovation in the POWERBASE project is substantial but aligned with the high-impact goals of developing resilient, mobile energy systems for emergency and disaster-response scenarios. Based on similar past initiatives, we estimate a global investment in the range of €1–2 million over the full project lifecycle (3–4 years).

- Main Cost Items:Research & Development (35–40%)

Includes technology scouting, component selection, system architecture, integration of PV and battery systems, and digital control innovations (fault detection, etc.). This phase also covers laboratory prototyping and iteration cycles.

- Testing & Pilots (20–25%)

Covers the setup of real-world test environments, deployment of pilot systems in simulated emergency contexts, durability testing under stress conditions, and data collection to validate performance and reliability. The pilots overall power/energy scale can significantly increase the budget required in this item.

- Human Resources (20–25%)

A significant portion is allocated to highly skilled staff, including engineers, scientists, and technicians working across hardware, software, and system validation activities.

- Project Management & Coordination (10–15%)

This includes partner coordination, administrative support, reporting, risk management, stakeholder engagement, and dissemination activities.

- Technology Scaling & Field Demonstration (10%)

Includes costs related to modular production optimization, logistics, compliance testing (ATEX, CE), and field deployment support.

This investment is justified by the opportunity to unlock high-value applications in civil protection, humanitarian aid, and remote energy access, with long-term scalability and commercial potential."