ARTES 4.0 Generic Programme Line Business Applications - Space Solutions
ACTIVITY DESCRIPTION

“Integrated Digital Solutions for the Energy Sector”

THEMATIC CALL FOR PROPOSALS

Prepared by	ESA
Reference	ESA-CICA-SOW-2025-2826
Issue/Revision	1.0
Date of Issue	28/01/25
Status	Final

Table of Contents

Table of Acronyms

5G	Fifth Generation
AI	Artificial Intelligence
AoF	Authorisation of Funding
APQ	Activity Pitch Questionnaire
AR	Augmented Reality
ARTES	Advanced Research in Telecommunications Systems
BASS	Business Applications - Space Solutions
CET	Central European Time
CfP	Call for Proposals
DSO	Distribution System Operators
ESA	European Space Agency
FP	Full Proposal
GNSS	Global Navigation Satellite Systems
IoT	Internet of Things
ML	Machine Learning
OP	Outline Proposal
OSIP	Open Space Innovation Platform
SatCom	Satellite Communication
SatEO	Satellite Earth Observation
SSE	SSE Renewables
VR	Virtual Reality

1. OVERVIEW

This document presents a new Thematic Call for Proposals entitled "Integrated Digital Solutions for the Energy Sector", issued under the ARTES 4.0 Generic Programme Line "Business Applications – Space Solutions", "Space Systems for Safety and Security" (4S) and "Space for 5G/6G and Sustainable Connectivity" Strategic Programme Lines, which aims at supporting the development of space-based services to enhance electricity grid resilience and promoting sustainable energy management.

2. BACKGROUND AND RATIONALE

The energy sector is undergoing a transformation driven by the integration of maturing digital technologies such as Internet of Things (IoT), artificial intelligence (AI), blockchain, augmented reality (AR), and virtual reality (VR). The maturation of new technology has led to new innovative digital tools such as the integration of IoT devices into digital twins and the creation of digital platforms such as the Metaverse. These new digital technologies are essential in enabling more efficient, sustainable, and resilient energy systems.

To fully harness their potential, these solutions require a communication infrastructure capable of supporting the vast data exchange, real-time analytics, and low-latency interactions these technologies demand. These technologies are inherently data-intensive, relying on real-time data analytics and large-scale device integration. This digital shift calls for high-speed, robust communication networks like 5G, which provide the necessary infrastructure to support smart grids, demand response mechanisms, and the efficient integration of renewable energy sources.[1]

The digitalisation of the energy sector is not just a trend but a necessity for achieving more sustainable, efficient, and resilient energy systems. Technologies like IoT, AI, digital twins, AR/VR are redefining how energy is generated, distributed, and consumed, and accelerating new market opportunities for innovative space-based solutions.

3. OBJECTIVES OF THE CALL

The objective of this Call for Proposals is to support the development of space-based solutions capturing the growing demand for advanced digital and communications technologies in the energy sector for smart grid management, demand response and energy

[1] https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/energy-resources/deloitte-cn-er-5g-empowerment-future-power-en-211130.pdf

storage optimisation, renewable energy integration, assets management and predictive maintenance.

The Call for Proposals is underpinned by the Task Force for Innovation in Energy Through Space (Energy Task Force) [2] which have guided the identification of the most relevant opportunities.

The Call for Proposals is conducted in collaboration with the ESA 5G/6G (NTN) Programme Office; it is envisaged to offer dedicated support and access to the 5G/6G Hub environment[3] capabilities to industrial contracts resulting from this Call for Proposals. The initial areas of interest include, but not limited to, the following ones.

Preventing energy grid congestions

Energy grid congestion occurs when a grid area becomes overloaded due to excessive supply or demand. This can result from sudden demand spikes, excess renewable generation, or supply-demand imbalances. Short-term effects include thermal overloads in power lines and transformers, leading to voltage drops. Long-term issues involve cable degradation and reduced equipment lifespan, which can be costly for Distribution System Operators (DSOs). Congestion also raises operational costs, greenhouse gas emissions, and the risk of blackouts. Therefore, mitigating these risks is crucial.

Smart grids underpinned by digital solutions can leverage real-time data from sensors and predictive analytics to enable dynamic load balancing and energy flow optimisation. Digital twins can provide real-time virtual replicas of physical assets, enabling energy operators to foresee issues, help predict where congestion may occur and optimise operations remotely. These digital solutions require massive IoT to collect data from energy network devices; hybrid terrestrial-satellite 5G networks are a key enabler as they make it possible to integrate and digitalise remotely located sensors and devices, irrespective from the availability of terrestrial communication networks.

Demand and response, and energy storage

AI and machine learning algorithms are revolutionising energy demand and response by predicting energy demand and automating responses to real-time signals from utilities. These systems rely on ultra-low-latency communication to make instantaneous adjustments, balancing supply and demand during peak periods. With 5G, demand and response systems

[2] https://business.esa.int/energy-task-force

[3] https://connectivity.esa.int/esa-5g6g-hub

can react almost instantaneously to events, helping utilities reduce strain on the grid and offering consumers the opportunity to lower energy bills by shifting consumption.[4]

Energy storage systems are critical to managing the variable nature of renewable energy. These systems rely on real-time data to monitor energy flows, optimise storage operations, and predict when energy should be stored or released. These solutions need a robust communication infrastructure to facilitate real-time data exchanges between storage systems and the grid. Digital twin technologies, when integrated with AR/VR platforms, can allow operators to visualise energy flows and simulate storage scenarios, leading to more informed decision-making processes.[5]

Predictive maintenance: enhancing grid observability is essential for DSOs and grid operators to improve their tactical awareness of grid conditions. This can be achieved by deploying IoT devices that provide granular-level measurements of energy networks and their critical components. Since distribution grids are often sparse and lack access to terrestrial cellular networks in remote areas, using IoT devices in conjunction with satellite communications offers a solution.

Data collected from these sensors support predictive maintenance by allowing the analysis of equipment condition, thus enabling operators to anticipate failures. This approach reduces downtime, lowers maintenance costs, and increases overall asset reliability. Digital twins can also be integrated with other digital technologies such as AR/VR or Metaverse interfaces which can facilitate more efficient maintenance processes. In addition, geo-location of these IoT devices is key to locate energy assets but to also ensure that they stay within an operational area (i.e. geo-fencing).

Construction and inspection:

The construction of renewable energy plants such as wind farms requires the transportation of large components, such as wind turbines, which involves careful route planning to avoid obstacles. The use of semi-automated vehicles for transporting these components can optimise the installation phase and reduce risks. Satellite imagery and 3D modelling can simulate routes in advance, identifying potential obstructions like trees or road elements. These models would support semi-autonomous truck navigation using satellite positioning and low-latency connectivity, improving safety, efficiency, and cost-effectiveness compared to current manual methods. In addition, visibility of logistical operations across the supply chain using digital verification tools such as blockchain technology would provide a transparent parts delivery and certification process, ensuring high quality parts and a lower risk of part failure.

---

[4] https://www.epri.com/research/products/000000003002016411

[5] https://www.epri.com/research/products/000000003002028496

The inspection of energy assets, during the construction and operational phases, is a key domain of interest to energy utilities. Due to the harsh operational environment, inspection of energy assets often requires unmanned solutions to minimize risks to human operators.

For instance, hydropower plants require regular inspections of both submerged and non-submerged structures, which can be conducted by subsurface robots and drones. Inspections of non-submerged infrastructure often rely on drone pilots to collect visual and ultrasonic data. There is a demand for enhanced unmanned inspections to allow for precise, repeated inspections at the same coordinates over time, enhancing efficiency and anomaly detection. Those improvements can be realised through high-accuracy positioning, low-latency connectivity, improved SLAM (Simultaneous Localisation and Mapping), and automated flight planning for drones. In addition, unmanned inspections services can be further optimized by using satellite imagery, feeding into digital twin models, to identify potential issues before confirming them with ground-based robotics or drones.

Thanks to the combination of satellite data and digital twins with autonomous systems, more accurate monitoring of asset health can be achieved, reducing the need for intervention, improving efficiency, and enhancing response times.

Renewable energy management

Innovative technologies such as predictive analytics and machine learning are reshaping the way renewable energy sources are integrated into the grid. These technologies require large amounts of real-time data to manage the intermittent nature of renewables like solar and wind energy. AI-driven systems analyse this data to improve forecasting and balance energy supply.

However, these capabilities depend on a robust communication infrastructure that can handle real-time data collection and ensure low-latency communication between dispersed renewable energy sites and grid operators. This will allow for better management of distributed renewable resources, ensuring efficient energy use and grid stability.

According to the Electric Power Research Institute (EPRI), real-time monitoring of renewable assets is vital for optimising their performance and ensuring their contribution to the grid. Technologies such as edge computing, supported by hybrid terrestrial-satellite 5G networks, can provide energy operators with immediate insights, enabling more effective integration of renewables into the grid.[6]

4. SPACE ASSETS

[6] 6 https://infiniticube.com/blog/12-key-advantages-of-implementing-5g-in-the-energy-industry/

Satellite Communication (SatCom): In areas without terrestrial network coverage, Satcom is indispensable for establishing reliable connectivity and transmitting data from IoT sensor networks. Satcom solutions provide global coverage, ensuring connectivity from any location. Additionally, Satcom systems are highly scalable, versatile, and easily integrated, enabling hybrid communication setups that combine satcom with terrestrial networks like 5G and IoT. This flexibility supports robust and continuous communication, essential for remote monitoring and control of energy infrastructure.

Internet of Things (IoT): IoT technologies play a vital role in enabling smart grids to optimise power flow and reduce energy consumption by adjusting loads to match real-time energy generation. IoT devices provide essential real-time data for managing congestion on transmission and distribution lines, ensuring that connected generation stations meet the necessary requirements for frequency and voltage control, thereby preventing instability. In the energy sector, IoT technologies enhance grid reliability through smart asset monitoring, prevent equipment failures, enable advanced energy monitoring, support automation, and ensure compliance with regulations. The benefits of IoT integration include process optimisation, resource efficiency, advanced analytics, intelligent grid management, cost savings, improved data handling, and greater sustainability.

Satellite Earth Observation (SatEO): SatEO data can complement IoT sensor networks by providing detailed analyses of environmental and geographical conditions over time. By integrating real-time IoT data with historical EO data for specific locations, comprehensive insights can be generated. For example, this integration can assess and predict the performance of a renewable sources supporting demand / response capabilities or analyse ground conditions and their potential impact on grid infrastructure.

Similarly, SatEO data can be used to guide and prioritize manned and unmanned maintenance operations by pinpointing potential risks requiring further analysis. This combined approach enables better-informed decision-making and operational strategies, particularly in remote or challenging environments.

In addition, SatEO is a key data source for digital applications in the Metaverse and AR/VR space. By overlaying SatEO images onto GIS maps, decision makers can make more efficient decisions due to new insights being provided by these innovative digital tools.

Global Navigation Satellite Systems (GNSS): Global Navigation Satellite Systems (GNSS) provide crucial positioning and timing information, supporting a wide range of applications.

GNSS are required for the navigation of robots, autonomous vehicles and drones, to provide georeferencing and geolocation, as well as for ensuring the accuracy and safety of flight operations.

In applications involving platforms that carry payloads such as cameras or LiDAR, GNSS provide precise geo- and timestamping of the collected data.

Artificial Intelligence (AI) and Machine Learning (ML): When combined with IoT technologies, AI and ML algorithms can predict power supply and consumption, enabling more effective management of energy demand. These insights allow for the creation of data-driven strategies for energy production, distribution, and storage. Notable examples include Virtual Power Lines (VPLs) and self-healing grids, which use AI and ML to anticipate and mitigate grid issues, enhancing the resilience and efficiency of energy infrastructure.

Digital Twins: Digital twin techniques can integrate SatEO and IoT data into digital models of energy assets and infrastructure such that effective and efficient decisions can be made. Through utilising visualisation technologies and AI/ML algorithms, further insights can be presented to decision makers which could not be shown before.

Augmented Reality (AR)/Virtual Reality (VR) and the Metaverse: AR and VR technologies are gradually maturing and are starting to appear in industries, including industrial utilities. This is due to the wide range of applications that AR/VR can unlock. Examples include the overlay of IoT/EO data over GIS maps of the energy network such that grid congestion events can be predicted.

5. SCOPE OF THE CALL

The proposals submitted under this Call for Proposal (CfP) shall target innovative and user-driven services which rely on advanced digital and communications technologies in the energy sector for smart grid management, demand response and energy storage optimisation, renewable energy integration, assets management and predictive maintenance.

The Bidder shall either address the (optional) use-cases included in the Annexes (available on the website) or address other use-cases and requirements related to the Call by other customers/ users directly involved by the Bidder. In the latter case, support of those potential customers shall be evidenced in letters of interest to be attached to the Outline Proposal (the second step in the application process). Proposals under both options will be considered equally.

The service provider shall be identified and be part of the bidding team to ensure the commercial operational roll-out of the proposed service following completion of a demonstration project.

This Call for Proposals covers two types of activities[7]:

1. **Feasibility Studies** provide the preparatory framework for identifying, analysing, and defining innovative, sustainable services. The applications and services proposed under Feasibility Studies must:
    - **Be customer - and user-driven**: Proposals should demonstrate a clear understanding of user needs and present a strong potential for sustainability.
    - **Leverage integrated space assets**: The proposed service must clearly illustrate the benefits of incorporating space technologies (e.g. Earth observation, satellite communications or navigation) into the solution.
    - **Include a comprehensive viability analysis**: This should assess the technical, commercial, and operational feasibility of the proposed service.
    - **Target market readiness**: The ultimate aim is to develop applications and services that can progress towards operational market deployment, potentially through a subsequent Demonstration Project following the successful completion of the Feasibility Study.

    Feasibility Studies offer an opportunity to de-risk and refine service concepts before advancing to full-scale implementation, ensuring their relevance, viability and alignment with user requirements.

2. **Demonstration Projects** focus on the implementation and pre-operational demonstration of services. The applications and services proposed must:
    - **Be customer- and user-driven**: Active user involvement is essential throughout the project, including their participation in defining requirements, validating results, and contributing to the pilot activities.
    - **Showcase the value of space assets**: Proposals must clearly demonstrate how the utilisation of space technologies provides a distinct advantage, with a strong potential for long-term sustainability.
    - **Deliver measurable socio-economic benefits**: The project should quantify its impact, highlighting improvements in efficiency, sustainability, or other key outcomes that align with user and societal needs.
    - **Ensure user participation**: Representatives from the target user communities must actively engage in the project, including participation in the pilot phases to ensure alignment with their requirements and expectations.

    The goal of Demonstration Projects is to validate pre-operational services in a real-world environment, paving the way for scaling and operational deployment.

[7] https://business.esa.int/funding/open-call-for-proposals-feasibility-studies-and-demonstration-projects

To apply to a demonstration project, the Bidder is required to have addressed the key technical and business risks associated with the proposed project, and to have established a solid business plan including clear support from prospective customers.

6. PROCUREMENT APPROACH

The proposals submitted in reply to the call shall be implemented in the context of ARTES 4.0 Generic Programme Line "Business Applications – Space Solutions", "Space Systems for Safety and Security" (4S) and "Space for 5G/6G and Sustainable Connectivity" Strategic Programme Lines in coordination with National Delegations.

The Bidder shall submit first an Activity Pitch Questionnaire, and following evaluation, may be invited to submit the Outline and Full Proposal. The Activity Pitch Questionnaire (APQ) template provided by ESA shall be used. This is considered as entry point for companies to submit their idea, providing a simplified and single point of access to the ESA ARTES framework.

The price of activities carried out in a given State are charged against the contribution of that State in the programme. A letter of Authorisation of Funding (AoF) from the relevant National Delegation is therefore required as part of the Full Proposal. The Bidder is however advised to inform the relevant National Delegation(s) when submitting the Pitch. The contact information of the National Delegates can be found here:
https://artes.esa.int/national-delegations.

The Agency will admit for evaluation only (Outline and Full) proposals from a bidding team composed of a company and/or organisation - be it as Prime or Subcontractor - residing in any of those states that subscribe to the Programme under which you wish to submit your proposal:

I. **for the ARTES 4.0 BASS Generic Programme Line - Component A**: Business Applications. To date, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Sweden, Switzerland and the United Kingdom have subscribed.
II. **for the ARTES 4.0 Space for 5G/6G and Sustainable Connectivity Strategic Programme Line**: Austria, Belgium, Finland, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Romania, Spain, Sweden, Switzerland, the United Kingdom and Canada have subscribed.
III. **for the ARTES 4.0 "Space Systems for Safety and Security" (4S) Strategic Programme Line:** Austria, Belgium, Czech Republic, Denmark, Estonia, Finland,

France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Norway, Portugal, Romania, Spain, Switzerland, the United Kingdom and Canada have subscribed.

7. PROCESS AND SCHEDULE

It is planned for the call for proposals to be opened on 13th February 2025 until the 2nd May 2025, 13:00 CET in in ESA's open space innovation platform (OSIP).

7.1. Timeline and Procedure

Bidders can respond to this thematic call by submission of a short Activity Pitch Questionnaire within the above timeframe.

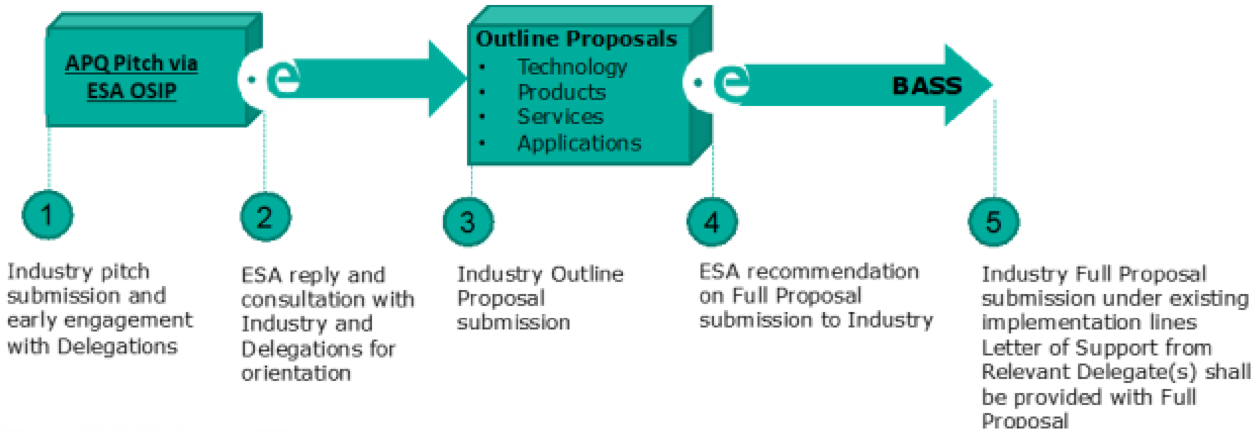

Figure 1: Procurement approach and timeline of the Thematic Call

The Call is planned to be implemented according to the following stepwise approach:

In **Step 1**, the interested Bidders are requested to submit their proposal(s) based on a short Activity Pitch Questionnaire (APQ) template made available by ESA that can be downloaded from the Thematic Call website. The pitch should provide the initial idea of what the Bidder would like to propose, elaborated on the basis of the thematic areas and either the use cases proposed by ESA's partners or others selected by the Bidder. If the Bidder has the relevant information available to them, they may consider completing the supplementary questions (AP5) in the APQ template as part of the APQ+, which may allow to skip Step 3 below, at ESA's discretion.

Should the bidder wish to cooperate with any of the listed partners in the annexes, they shall give to the Agency the authorisation to distribute the activity pitch questionnaire to these stakeholders by explicitly stating it in the Activity Pitch Questionnaire. Subject to such authorisation, the Agency will follow up distributing the APQ to the bidder's authorised stakeholder(s) and liaise with them to facilitate interactions with the Bidder.

The completed Activity Pitch Questionnaire (APQ) shall uploaded using the online web submitter, ESA's open space innovation platform (OSIP) in the channel named "APQ for ARTES Downstream Business Applications"

Multiple Pitches with different ideas can be submitted.

It is strongly recommended that the interested Bidder liaises from the beginning with the relevant ESA Member States Delegates.

In **Step 2**, following an assessment of the pitch by ESA, ESA will provide feedback to the company, aiming to provide a reply within 10 working days following the deadline for submission of the pitch.

It is recognised that some interactions with the Bidder may be required, and ESA may therefore consult with the Bidder and may offer support in providing further clarifications, aimed at better shaping the Outline Proposal(s). Dialogue sessions may be organised individually with potential partners prior to Step 3.

ESA might also consult, when necessary, with the relevant National Delegation(s) for orientation and will provide key information (e.g. title, cost, price, subcontractor) to the relevant National Delegation(s).

Subject to a positive evaluation of the pitch and the Bidder having informed the National Delegation(s), the Bidder will be notified by ESA and invited to submit an Outline Proposal. Note that the APQ+ can act as a substitute for the Outline Proposal, thus if having adequately answered the additional questions included in the APQ+, the Bidder may be able to skip Step 3.

In **Step 3**, the Bidder will submit the Outline Proposal, based on a template provided by ESA, with letter(s) of interest from users/stakeholders. The Outline Proposal expands upon the pitch with a more extensive level of details. The Bidder will be allowed 2 months from ESA's approval of the APQ to the submission of their Outline Proposal. The outline proposal shall be submitted on the OSIP platform under the channel "Outline Proposal for ARTES Downstream Business Applications – Feasibility Studies/Demonstration Projects".

In **Step 4**, subject to a positive assessment from ESA and in-principle support from the National Delegations, the Bidder will be invited to submit a Full Proposal on ESA-STAR in accordance with BASS programme line. The Bidder will be allowed 4 months from submission of their Outline Proposal to submit their Full Proposal on ESA-STAR.

In **Step 5**, the Bidder will submit a Full Proposal with the Authorisation of Funding (AoF) from the relevant National Delegation(s). Following a positive assessment by ESA the proposed activity will be approved for implementation.

7.2. Evaluation Criteria

The evaluation process is non-competitive, as each proposal will be assessed individually on its own merits, according to the evaluation criteria applicable for CALL FOR PROPOSALS FOR DOWNSTREAM APPLICATIONS IN ARTES 4.0 (esa star ref.: 1-10494).

More information for the assessment of the APQ and outline proposal stages can be found on the OSIP page "APQ for ARTES Downstream Business Applications".

More information on the evaluation criteria for the final proposals can be found within the document "Appendix 1 to AO/1-10494/20/NL/CLP (Issue 2.2)" which can be found on ESA-STAR and the activity webpage.

8. GENERAL CONDITIONS

The submissions and all correspondence relating to it shall be in English.

The tender shall not contain any Classified Information, whether in the pitch, Outline Proposal or in the Full Proposal. To avoid any confusion with Classified security markings, the unclassified protective marking used by the Tenderer in the proposal shall not contain the terms: "Restricted", "Confidential", or "Secret".

However, should the Tenderer consider necessary to include Classified Information in the tender, the Tenderer shall inform beforehand the ESA Security Officer.

The Tenderers are informed that Classified Information can be shared with ESA only in compliance with the Project Security Instruction (PSI) duly established by the Agency beforehand and subject to the approval by the ESA Member States.

The Agency will treat commercially sensitive or proprietary information confidentially and solely for the purpose of the assessment of the response.

Expenses incurred in the preparation and dispatch of the response to the announcement will not be reimbursed. This includes any expenses connected with a potential dialogue phase.

The announcement does not bind the Agency in any way to place a contract. The Agency reserves the right to issue amendments to the announcement.