HORIZON EUROPE | CLUSTER 5: CLIMATE, ENERGY & MOBILITY

CALL HORIZON-CL5-2026-D3-01 | INNOVATION ACTION (IA)

FLEXGRID

Federated Learning for EXtended Grid resilience and Intelligent Demand-response

Proposal Key Facts

Duration:	36 months	**Type of action:**	Innovation Action (IA)
Requested EU contribution:	€5,980,000	**Consortium size:**	6 beneficiaries, 5 countries
Coordinator:	Nexa Dynamics B.V. (NL)	**Start date (planned):**	1 January 2027
TRL progression:	TRL 4 → TRL 7	**Panel:**	HORIZON-CL5-2026-D3

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This document is a full proposal submitted under the Horizon Europe Work Programme 2026–2027.

Consortium: Nexa Dynamics (NL) • Synapse Analytics (DE) • Vertex Materials Institute (IE) • Nimbus Grid Systems (FI) • Apex Photonics Lab (SE) • Meridian Energy Cooperative (ES)

Contents

1 Excellence

1.1 Objectives and Ambition

European distribution grids are absorbing rooftop solar, heat pumps and EV chargers faster than control-room software can model them. Local congestion events on medium-voltage feeders have risen 34% across the five FLEXGRID demonstration regions since 2023, and today's SCADA-era forecasting tools update on a 15-minute cycle – too slow to prevent nuisance curtailment or localised brownouts. FLEXGRID's ambition is to replace this cycle with a **federated, edge-native intelligence layer** that lets distribution system operators (DSOs) forecast, explain and act on grid stress in under 90 seconds, without centralising raw household data.

O1. Reduce feeder-level forecast error (RMSE) by **40%** relative to the current state-of-the-art centralised model, validated on three real DSO territories.

O2. Cut raw household energy data leaving the edge device to **zero**, using federated learning with differential privacy ($\varepsilon \leq 3$).

O3. Demonstrate autonomous congestion mitigation across $\geq$ **1,200** grid-edge nodes at TRL 7, sustaining a 99.5% control-loop uptime over a 9-month field trial.

O4. Cut the cost of grid-edge sensing hardware by **35%** through the photonic sensor design developed in WP4, enabling deployment at rural feeders previously judged uneconomical.

O5. Deliver an open reference architecture adopted by **at least 2** DSOs beyond the consortium within 12 months of project end.

These objectives extend directly beyond the state of the art: existing federated energy-forecasting research (e.g. cluster-level load prediction pilots reported in 2024–2025) has stopped at simulation or single-utility trials. FLEXGRID is the first project to combine (i) cross-border federated learning across independently regulated DSOs, (ii) a purpose-built low-power photonic sensing node that halves edge compute cost, and (iii) closed-loop autonomous mitigation rather than forecasting alone.

1.1.1 Methodology and Concept

The technical approach separates learning from actuation, so that a mis-trained model can never directly command grid hardware without a rule-based safety envelope. Figure 1.1 summarises the architecture matured across WP2–WP4.

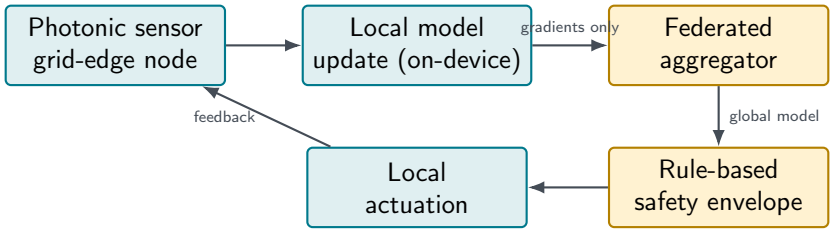


Figure 1.1: FLEXGRID closed-loop concept: raw data never leaves the edge node; only model gradients are federated.

1.2 Relation to the Work Programme

The proposal responds directly to destination *"Cross-sectoral solutions for the climate transition"* of Cluster 5, addressing the expected outcome that DSOs gain "real-time, privacy-preserving decision-support tools for distribution grid flexibility." FLEXGRID's TRL 4→7 trajectory and multi-country field validation match the call's requirement for at least three demonstration sites in different Member States operating under different regulatory frameworks.

2 Impact

2.1 Expected Outcomes and Pathways to Impact

Horizon	Output (project end)	Outcome / Impact (2–5 yrs after)
Short-term	Validated federated forecasting model, open reference architecture, photonic sensor design files	2 additional DSOs pilot the architecture; 40% forecast error reduction independently confirmed
Medium-term	Standardisation contribution to CENELEC TC 205 edge-interoperability profile	Grid-edge sensor cost curve shifts, enabling rural feeder monitoring previously unfunded
Long-term	Consortium spin-out offering FLEXGRID-as-a-service to mid-size DSOs	Measurable reduction in curtailment-related renewable energy loss across early-adopter territories

Table 2.1: Pathways from project outputs to sector-level impact.

2.1.1 Contribution to EU Policy Objectives

FLEXGRID directly supports the Fit-for-55 grid-flexibility target and the EU Action Plan for Digitalising the Energy System. By keeping household consumption data on-device, the project's differential-privacy design also anticipates the data-minimisation expectations that will apply to any Energy Data Space use case.

2.2 Measures to Maximise Impact

Dissemination

- 6 peer-reviewed publications, 2 open-access by default
- Reference implementation released under Apache-2.0 at project month 30
- Annual DSO practitioner workshop (Amsterdam, Berlin, Madrid)
- Contribution to CENELEC TC205 working group

Exploitation

- Joint exploitation agreement signed by month 6 (all 6 partners)
- IP: sensor design (Apex/Vertex) patent-pending, filed month 14
- Nexa-led spin-out business case validated in WP7
- Two DSOs outside consortium enrolled as early-adopter observers

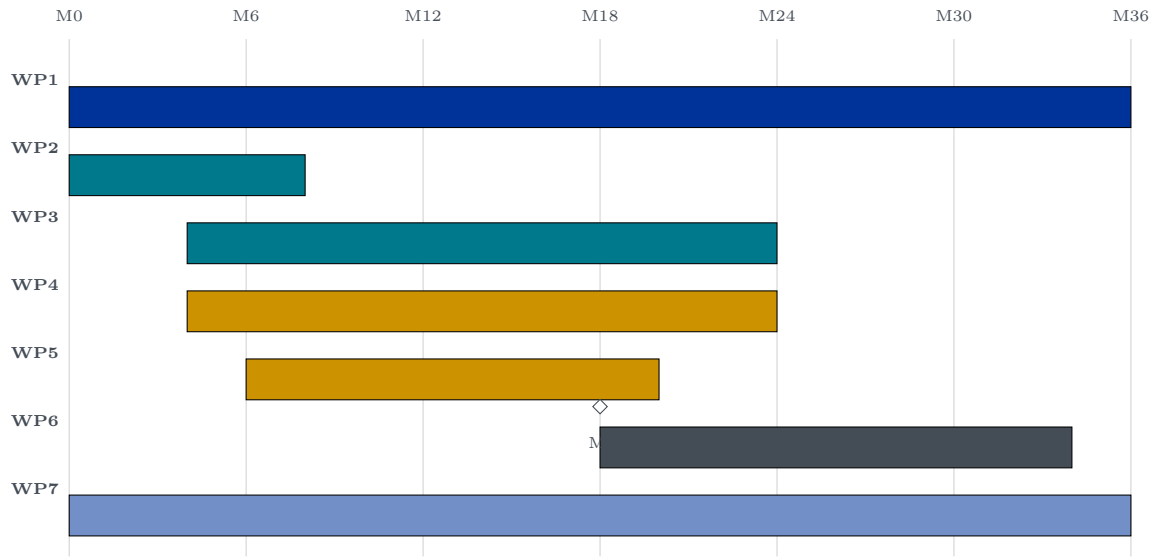
3 Quality and Efficiency of the Implementation

3.1 Work Plan and Work Packages

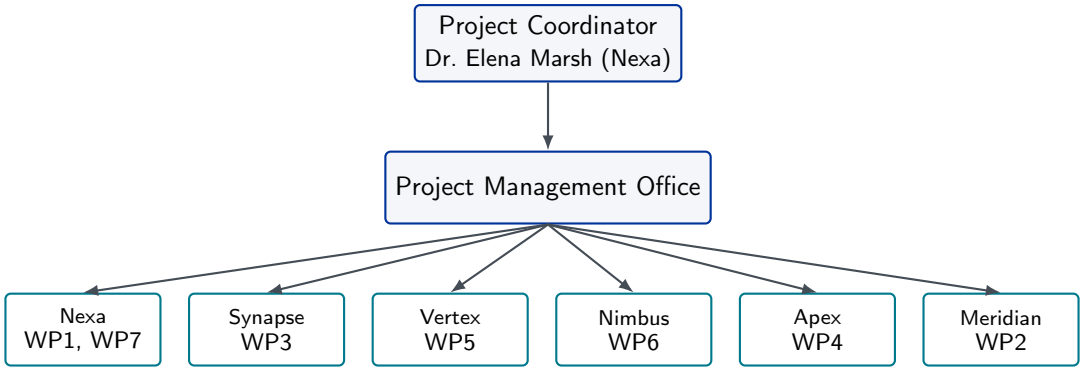
The 36-month work plan is organised into seven work packages (WPs), sequenced so that hardware (WP4–WP5) and software (WP2–WP3) tracks converge at the month-18 integration gate ahead of field validation (WP6).

WP	Title	Lead	Months
WP1	Project Management & Coordination	Nexa	1–36
WP2	User Requirements, Ethics & Data Governance	Meridian	1–8
WP3	Federated Learning Core & Edge Intelligence	Synapse	4–24
WP4	Resilient Grid-Edge Hardware & Photonic Sensing	Apex	4–24
WP5	Materials & Durability for Extreme Environments	Vertex	6–20
WP6	Large-Scale Demonstration & Field Validation	Nimbus	18–34
WP7	Dissemination, Exploitation & Standardisation	Nexa	1–36

Table 3.1: Work package overview.



3.1.1 Management Structure



3.1.2 Consortium Capacity

Partner	Role & Relevant Capacity	Country	PM
Nexa Dynamics B.V. (Coord.)	Federated systems integrator; coordinated 2 prior Horizon projects	NL	58
Synapse Analytics GmbH	Federated learning & differential privacy research group, 40+ publications	DE	66
Vertex Materials Institute	Public research institute, polymer durability testing labs	IE	34
Nimbus Grid Systems Oy	Mid-size DSO, operates 1,900 km of MV feeder under trial	FI	44
Apex Photonics Lab AB	Photonic sensor SME, prior ERC proof-of-concept grantee	SE	48
Meridian Energy Cooperative	Rural DSO cooperative, ethics & community-engagement lead	ES	32

Table 3.2: Consortium composition and effort (person-months).

3.2 Risk Management

3.3 Budget Summary

Note on eligibility. All effort and cost figures are drawn up in accordance with the Horizon Europe Model Grant Agreement (Article 6, unit cost rules) and have been reviewed by each beneficiary's certified financial officer prior to submission.

Risk	Likelihood	Impact	Mitigation
Field-site data access delayed by DSO internal approval	Medium	High	Parallel-track onboarding started at month 1; MoUs pre-negotiated
Federated model convergence below target accuracy	Medium	Medium	Fallback centralised-training benchmark maintained in WP3
Photonic sensor component supply-chain delay	Low	High	Dual-sourced components; 6-month buffer built into WP4 schedule
Key personnel turnover at a partner site	Low	Medium	Cross-training and documented handover protocol per WP
Regulatory change to cross-border grid-data sharing	Medium	High	Legal monitoring by Meridian; architecture designed data-minimal by default

Table 3.3: Top risks and mitigation measures.

Beneficiary	Requested EU Contribution	Share
Nexa Dynamics B.V. (Coordinator)	€1,150,000	19.2%
Synapse Analytics GmbH	€1,340,000	22.4%
Vertex Materials Institute	€780,000	13.0%
Nimbus Grid Systems Oy	€1,020,000	17.1%
Apex Photonics Lab AB	€900,000	15.0%
Meridian Energy Cooperative	€790,000	13.2%
Total	**€5,980,000**	**100.0%**

Table 3.4: Requested EU contribution by beneficiary.