Digital Energy Grid Hackathon - Design Document

FLEXLON

The flex point between compute and energy

1. Team Information

- Team Name: Mezzanine Hackers
- Institution / Organization: University of Cambridge, Imperial College London, Technical University of Munich
- Team Members (2–4):
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2. Problem Focus

Select one problem statement your solution addresses:

☐ ~~Problem 1: Utility Interface with Agentic Orchestration for Grid-Scale Demand Flexibility~~

☑ Problem 2: Compute–Energy Convergence in a DEG World

3. Solution Overview (max 150 words)

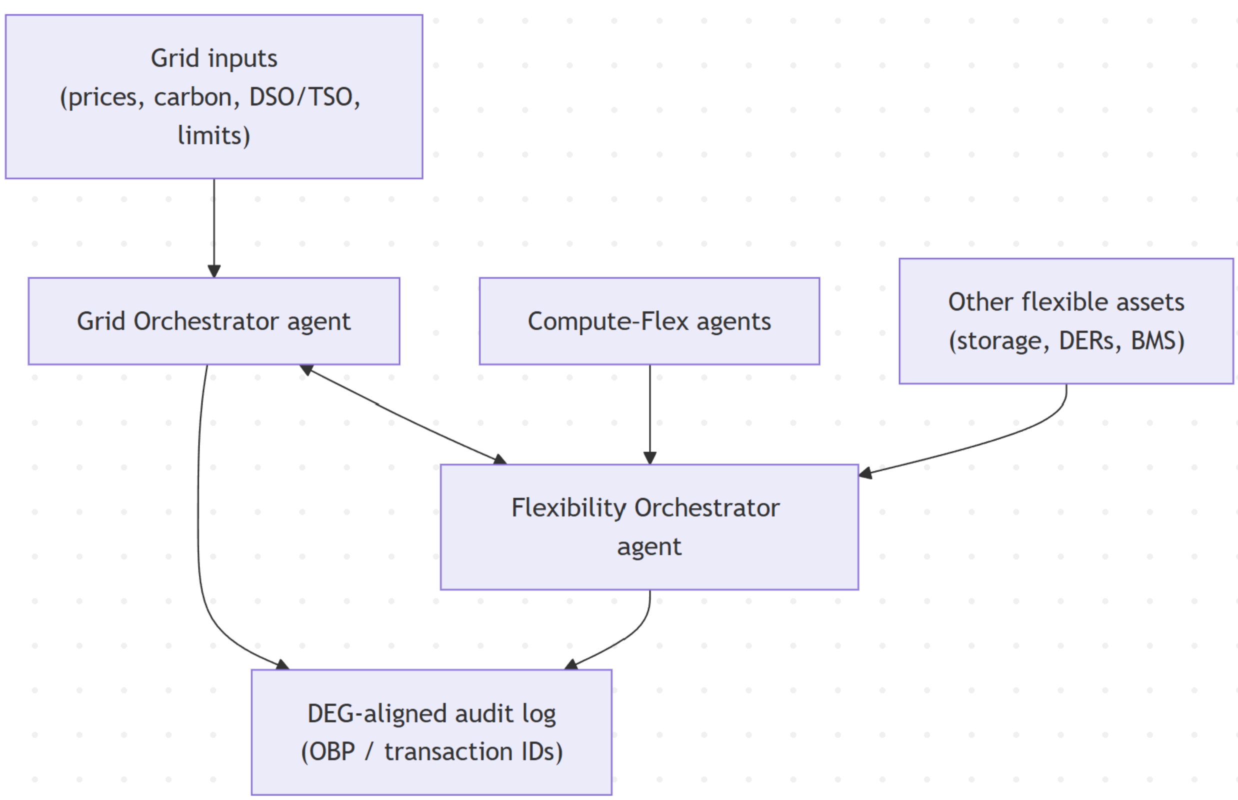
Our solution treats AI and data-centre workloads as flexible, grid-aware energy assets orchestrated through the Digital Energy Grid and Beckn Protocol. Compute-Flex Agents sit beside existing schedulers (Kubernetes/Slurm), continuously translating queued jobs and SLOs into machine-readable flexibility offers (deferral windows, power envelopes, locational options) published as Beckn catalog items. A Flexibility Orchestrator Agent then co-optimises these offers against grid signals (prices, constraints, carbon intensity) from a Grid Orchestrator, targeting minimum £ per inference under a carbon cap. Using standard Beckn order lifecycles (search → select → confirm → on_confirm → status), compute demand is shifted across time, sites, and behind-the-meter storage while preserving latency and network constraints. This turns data centres into first-class flexibility providers, unlocking new revenue streams, lowering energy OpEx, and delivering verifiable, DEG-aligned audit trails for settlement and regulation.

4. Technical Architecture (max 200 words or diagram)

Our **FlexLon** architecture comprises three main agent types:

- a Grid Orchestrator agent
- Compute-flex agents
- Flexibility Orchestrator agent

The Grid Orchestrator runs on top of the DEG/UEI network and Beckn Protocol, ingesting DSO/TSO constraints, day-ahead and intraday prices, carbon-intensity forecasts, and grid limits. Compute–Flex Agents sit alongside existing schedulers (Kubernetes/Slurm), ingest upcoming compute jobs (queues, SLOs, power envelopes) and translate them into machine-readable flexibility offers and constraints, published as Beckn catalog items and events *within* our customer firm. The Flexibility Orchestrator Agent acts as the optimisation core: it aggregates flexibility signals from Compute–Flex Agents and other flexible assets (storage/DERs, BMS/DERMS), and runs a hybrid optimisation engine (Python microservice using MILP plus heuristic or RL search) to minimise £ per inference under a carbon cap while respecting latency and network constraints. It then issues compute schedules and flexibility profiles back to the Grid Orchestrator via Beckn messages. The Grid Orchestrator evaluates system conditions and triggers activation by progressing the Beckn order lifecycle (select, confirm, on_confirm, status). All calls, grid signals, flexibility activations, and metered responses are written to a DEG-aligned audit log (OBP/transaction IDs) to support P444-grade settlement, compliance reporting, and ex-post verification.



5. Agent Workflow (max 150 words)

Describe how your agent works along with relevant Beckn protocol flows, where applicable in your context.

The Beckn Protocol is designed to facilitate the coordination of resource transactions in decentralised peer-to-peer networks, making it the ideal tool for our specific use case. Specifically, we want to build upon the Unified Energy Interface (UEI), a framework that has previously been implemented in the context of EV charging [1].

1. Discovery Stage
    - *Compute-Flex agents* model workloads as flexible energy demand, publishing available job slots or flexibility capacity to the network as Beckn catalogue items via the **on_search** callback action.
    - The *Grid Orchestrator Agent*, declaring its intent for flexible power or low-carbon computation, initiates a **search** request action to discover relevant service offerings that match its optimisation criteria (low cost, low carbon).

2. Order Stage
    - To monetize flexibility, the Flexibility Orchestrator Agent initiates the Beckn order lifecycle, starting with select to engage a Compute Agent's offer, and finalizing the transaction using confirm and on_confirm, which logs the agreement and triggers orchestration commands, such as workload deferral, shifting the compute region, or scheduling behind-the-meter storage discharge.

3. Fulfilment stage
    - …

4. Post-fullfilment

6. Business Model & Impact (max 150 words)

Our grid-aware compute orchestration system **FlexLon** enhances data-centre value creation across four strategic revenue generating or cost saving dimensions for our customers:

1) Reducing Energy Costs: Dynamic workload shifting to periods of lower wholesale prices reduces energy OpEx, which can represent up to 60% of enterprise data-centre operating cost. [2,3]
2) Monetising Flexibility: Participation in UK flexibility markets, such as demand-response and emerging P415 peer-to-peer trading, creates a new revenue stream. A reasonable estimate is £30-100k+ per MW-year for flexible assets based on analogous industrial programs [4,5]. UK data-centre load will reach 3.3–6.3 GW by 2030; if 30–50% becomes flexible, that's ~£30–315m/yr addressable just in compute-flex.
3) Sustainability Goals: Carbon-aware scheduling enables operators to cut embodied emissions by shifting workloads to low carbon intensity regions or time periods, supporting RE100-aligned decarbonisation

commitments.

4) Enhanced Resilience: By routing compute workload to alternative sites during grid stress, local outages, or thermal constraints, data center operators reduce downtime risks and avoid penalties or disruptions that could impact customer experience and brand reliability.

Together, these benefits position **FlexLon** as a strategic lever for delivering millions of pounds in savings, enhanced operational efficiency, sustainability leadership, and improved service reliability.

7. References

[1]: Dittrich, Y., Jørgensen, K. P., Prakash, R., Rafnsson, W., & Hinrichsen, J. K. (2025). Beyond Platforms—Growing Distributed Transaction Networks for Digital Commerce (No. arXiv:2504.18602). arXiv. https://doi.org/10.48550/arXiv.2504.18602

[2] "Impact of Geographic Location on Data Center Energy Costs", accessed 23.11.2025.https://www.datacenters.com/news/impact-of-geographic-location-on-data-center-energy-costs?utm_source=chatgpt.com

[3] "IDC Report Reveals AI-Driven Growth in Datacenter Energy Consumption", accessed 23.11.2025.https://www.datacenters.com/news/impact-of-geographic-location-on-data-center-energy-costs?utm_source=chatgpt.com

[4] Rabobank, *"Backup Power for Europe, Part 2: The UK's BESS Leadership and Evolving Revenue Stacks,"* Rabobank Research, Mar. 2025. Accessed: Nov. 23, 2025. Backup power for Europe - part 2: The UK's BESS leadership and evolving revenue stacks - Rabobank

[5] Modo Energy, *"GB BESS Index: Monthly Revenue Benchmarking for Grid-Scale Batteries,"* Modo Energy Insights, Jan. 2025. Accessed: Nov. 23, 2025. [Online]. GB BESS Index: battery energy storage revenues rise 33% in April 2024 - Research | Modo Energy

8. Declarations

- IP & Licensing: Submitted under MIT Commons License
- Submission Format: 1-2 page PDF uploaded via Dora Hacks
- Deadline: 23/11/25 17:00 GMT