ZenVolt — Design Document

1. Team Information

- **Team Name**: ZenVolt
- **Institution / Organization**: ZenVolt.tech
- **Team Members (2–4)**:
    - Abdur Razzak - AI Engineer & Backend Developer
    - Huijuan Kuang - Energy Analyst & Business Strategist
    - Nick Ng - Frontend/UX Designer & Backend Developer
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2. Problem Focus

Problem 2: Compute–Energy Convergence in a DEG World

3. Solution Overview

We propose **ZenVolt**, an intelligent multi-agent orchestration platform that turns AI data centres into flexible, grid-aware loads within the Digital Energy Grid. It coordinates compute jobs—training, batch inference, RAG pipelines—with live energy signals, shifting workloads in time and space to when power is cheaper and cleaner.

Using Beckn, ZenVolt models each data centre and utility as network participants. The ZenVolt Orchestrator (BAP) discovers offers from Grid and Compute Provider Platforms (BPPs), then co-optimises job placement to respect carbon caps, SLAs, and flexibility programmes.

This unlocks three benefits: **lower cost per inference**, **verifiable emissions reporting**, and **new revenue from demand-flexibility services** (e.g., P415-style programmes). The pattern scales from single operators to multi-tenant clouds, where different tenants' jobs compete for low-carbon slots while following open Beckn message flows. In a 40 kWh simulation, ZenVolt cut energy costs by 22% and emissions by 49% compared to a run-now baseline.

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4. Technical Architecture

We implement four Beckn-enabled agents in ZenVolt, see *Figure 1*.

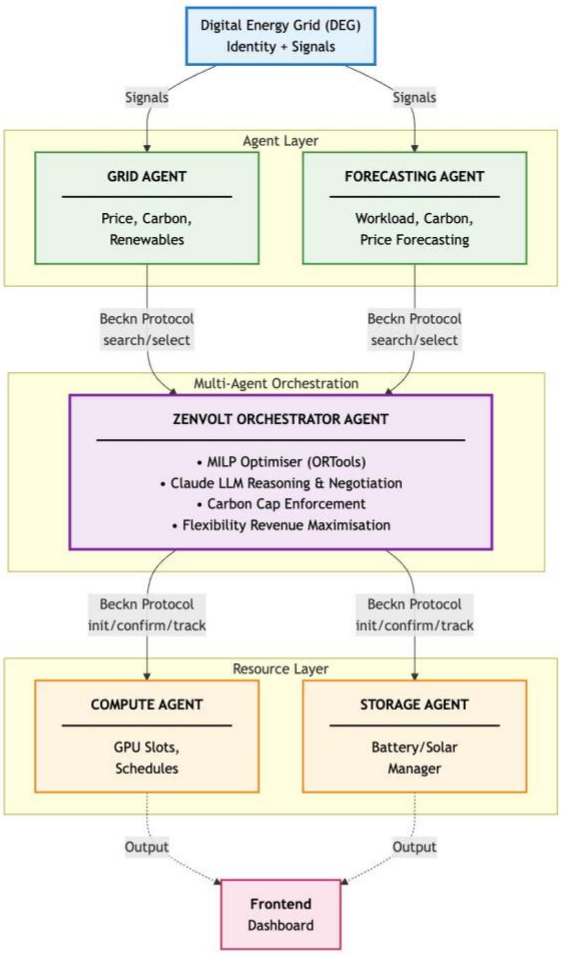

Figure 1: Problem 2 Architecture: AI Compute-Energy Co-Optimisation System

Innovation highlights Covered: Carbon-constrained optimisation; Multi-agent negotiation; Compute → flexible load transformation; Real-time Beckn-based orchestration

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5. Agent Workflow

Scenario: Monday 8:00 AM—a large AI training job arrives at the Compute Agent (12 MWh, 24-hour deadline, 0–16 hours deferrable).

- **Workload declaration:** The job is posted with its energy demand, deadline, and flexibility window.
- **Energy forecast:** Overnight (01:00–05:00) shows P = £35/MWh, C = 60 g CO_2/kWh versus immediate P = £50/MWh, C = 80 g CO_2/kWh.
- **MILP scheduling:** Orchestrator schedules 01:00–09:00 with E battery = 2 MWh and E grid = 10 MWh.
- **Results:** Cost reduced from £600 to £305 (49% savings); emissions reduced from 960 kg CO_2 to 720 kg CO_2 (25% reduction).
- **Beckn coordination:** $Search \rightarrow Select \rightarrow Init \rightarrow Confirm \rightarrow Track/on\_status$ flows coordinate capacity reservations.

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6. Business Model & Impact

Stakeholders & Value Capture:

- **Stakeholders:**
    - Data Centres
    - AI Labs
    - Energy Utilities (Octopus, NG ESO)
    - Battery Operators
    - Cloud Providers
- **Estimated Value Delivery:**
    - 20–40% lower compute energy costs
    - 40–60% carbon reduction
    - £10k–£100k annual flexibility revenue
    - Reduced peak demand stress on UK grid
    - Better renewable integration

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7. Innovation Highlights

Covered:

- Carbon-constrained optimisation
- Multi-agent negotiation
- Compute → flexible load transformation
- Real-time Beckn-based orchestration

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8. References / Inspiration

1. **Google Carbon-Intelligent Computing**: Temporal and spatial load shifting for data centers
2. **Microsoft Sustainability Calculator**: Carbon accounting for Azure workloads
3. **National Grid ESO Carbon Intensity API**: Real-time UK grid carbon data
4. **Meta Data Center Energy Optimization**: AI-driven cooling and workload management
5. **DEG Vision Paper** (FIDE, 2025): Compute-energy convergence framework
6. **UK P415 Flexibility Markets**: Demand-side participation mechanisms
7. **IEA Digitalization & Energy Report**: Global data center energy consumption trends
8. **Beckn Protocol Energy Spec**: API standards for energy service transactions

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9. Declarations

- **IP & Licensing**: Submitted under MIT Open Source License
- **Submission Format**: PDF via DoraHacks platform
- **Deadline Acknowledged**: 23/11/2025 18:00 GMT
- **Beckn Protocol Compliance**: All inter-agent communication via standard Beckn workflows

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10. Risk Mitigation & Feasibility

- Forecast errors → fallback to real-time signals
- MILP slowness → heuristic mode
- Beckn complexity → mocked catalog + lifecycle