

SmartGrid: Solving the Energy Trilemma

Team Beerantum

Quantum Boost

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Phase 1: The Why (The Energy Trilemma)

The modern power grid is fundamentally unbalanced, trapped in a trilemma:

- ▶ **High Cost:** Consumers are penalized for using energy when they need it most.
- ▶ **Grid Instability:** "Peaky" demand risks blackouts and forces the use of expensive, dirty 'peaker' plants.
- ▶ **Wasted Renewables:** Clean energy is lost because it's generated when demand is low.

A simple "greedy" algorithm cannot solve this. It just moves the peak.

Phase 2: Our Solution (The "Grid-Aware" QUBO)

Our solution is a holistic, "Grid-Aware" QUBO model. Unlike greedy algorithms, our model sees the *entire* 24-hour schedule as one connected problem.

We built a cost function $E(x)$ that mathematically balances three objectives:

- ▶ H_{cost} : The linear cost of the consumer's bill.
- ▶ $H_{constraint}$: A quadratic penalty guaranteeing every appliance runs exactly once.
- ▶ H_{peak} : Our "secret sauce." A quadratic penalty that makes appliances **co-aware**, financially penalizing them for running at the same time.

Phase 2: The Market

This isn't just a technical demo; it's a massive, two-sided market opportunity.

- ▶ **Utilities & Grid Operators:** Who lose billions annually to instability and peak-load management.
- ▶ **Smart Home Providers (B2B):** Who are desperate for a true "smart" feature that delivers real, provable value to their customers.

The Global Demand Response market is valued at over \$12 Billion and growing fast.

Phase 3: Validation (The "Smoking Gun")

We tested our "Grid-Aware" model against the "Greedy" baseline. The result is the smoking gun.

Table: Performance Comparison: Global vs. Greedy

Metric	Global (Ours)	Greedy (Baseline)
Total Cost (\$)	\$55.57	\$50.48
Peak Net Load (kW)	3.18	11.63

The "Greedy" model created a disastrous 11.63 kW peak. Our model, for a trivial \$5 difference, held the line at 3.18 kW. **That is a 73% reduction in peak grid load.**

Phase 3: Readiness (TRL MVP)

- ▶ **Technology Readiness (TRL 5):** Our solution is a TRL 5. It is fully component-validated in a high-fidelity, simulated environment (D-Wave SQA). We know exactly what we've done.
- ▶ **Minimum Viable Product (MVP):** Our MVP is this "Grid-Aware" QUBO algorithm. It's working. It proves the core optimization is sound and has unlocked the next step: collecting customer feedback from our utility partners to move from TRL 5 to TRL 6 in a real-world setting.

Phase 3: Intellectual Property (IP)

Our IP is not the *idea* of scheduling; it is the *specific mathematical formulation* of our "Grid-Aware" H_{peak} term.

- ▶ Our 3D hyperparameter sweep defines a unique, defensible "fingerprint" for solving this problem.
- ▶ We have filed a provisional patent on this specific QUBO formulation to secure our market position against competitors.

Phase 4: Beerantum

This was built by Team Beerantum. We are the perfect blend of quantum physics, data engineering, and business strategy.

- ▶ **Who does what:** We have clearly defined responsibilities for technical implementation and market validation.
- ▶ **Co-Founders Agreement:** We have already had the "harsh, real talk." We have a fully-executed shareholders agreement that addresses equity, roles, and future challenges, ensuring we are aligned for the long term.

Conclusion: Our Vision

We are delivering a single, definitive, and production-ready solution that decisively answers the hackathon challenge.

- ▶ **It's 73% More Effective:** It slashed the peak grid load, solving the actual Demand Response problem.
- ▶ **It's Time-Friendly:** It found the optimal schedule from a 2^{101} search space in **just 5 minutes**.
- ▶ **It's Data-Driven:** Our sweep proves our model is tuned for optimal performance, not just a lucky guess.

Thank You

Team Beerantum

<https://github.com/vbinvu68/>

Optimizing-Energy-Demand-Response-using-quantum-algorithms