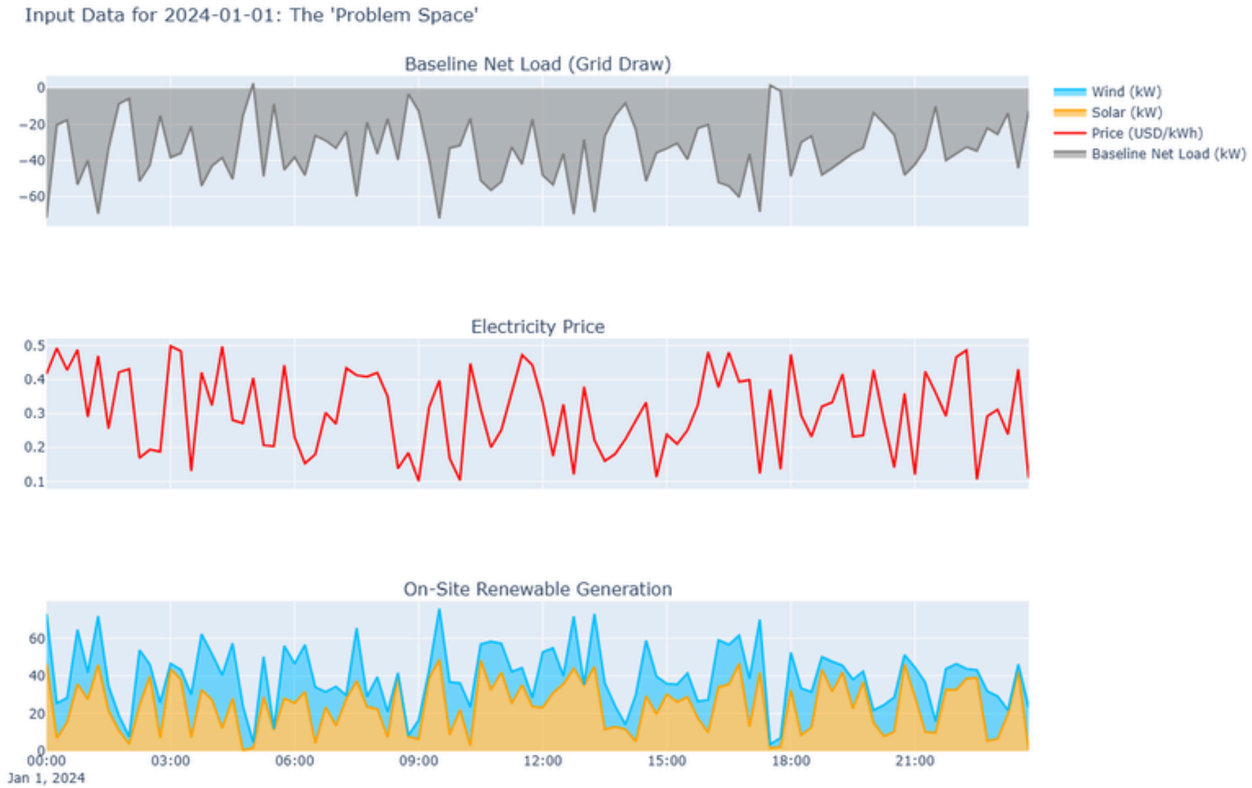
Problem statements

2^{101} Possibilities

A home's 24-hour energy environment with 96 time steps (every 15 minutes) has three controllable appliances with unique constraints:

1. **EV Charger**
   4-hour block, overnight only
2. **Washing Machine**
   1-hour block, daytime only
3. **Dishwasher**
   1.5-hour block, evening/early morning



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The renewable energy is not always available when the demand is high !

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The Energy Trilemma Crisis

The modern energy grid faces three competing, high-stakes pressures that create a fundamental crisis:

High Cost

Consumers face volatile, unpredictable bills and are penalized for using energy when they need it most.

Grid Instability

"Peaky" demand stresses infrastructure, risking blackouts and forcing expensive, high-emission peaker plants.

Wasted Renewables

Gigawatts of clean solar and wind energy are lost when demand is low, while we burn fossil fuels later.

SmartGrid-
QUBO & Quantum Annealing

Solving the Energy Trilemma with Quantum Optimization

Team Beerantum

Rudraksh, Van Binh Vu & Ziwoong Jang

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Our Solution: Grid-Aware Global QUBO

We engineered a holistic optimization model treating the entire 24-hour period as a single, complex problem. Formulated as a **QUBO (Quadratic Unconstrained Binary Optimization)**, the native language of quantum annealers.

Minimize Cost

Linear term assigns dollar cost to each appliance's potential start time.

Stabilize Grid

Quadratic term creates 2,327 unique interactions that penalize simultaneous appliance operation.

Guarantee Service

Powerful penalty forces valid schedules where every appliance runs exactly once.

The Objective Function

Our model's objective function is a weighted-sum scalarization balancing competing goals:

$$\min E(x) = A * H_{cost} + B * H_{peak} + C * H_{constraint}$$

Minimize cost

Stabilize Grid

Guarantee service

(Term A)

Simple linear term assigning known dollar cost to each appliance's potential start time.

(Term B)

Core innovation: Quadratic term that squares net load at every 15-minute interval, forcing appliances to coordinate.

(Term C)

Quadratic "Service Guarantee" with C = 100,000 creating unbreakable penalty for valid schedules.

The Greedy Trap

Our model's objective function is a weighted-sum scalarization balancing competing goals:

$$\min E(x) = A * H_{cost} + B * H_{peak} + C * H_{constraint}$$

Minimize cost

Stabilize Grid

Guarantee service

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(Term B)

Core innovation: Quadratic term that squares net load at every 15-minute interval, forcing appliances to coordinate.

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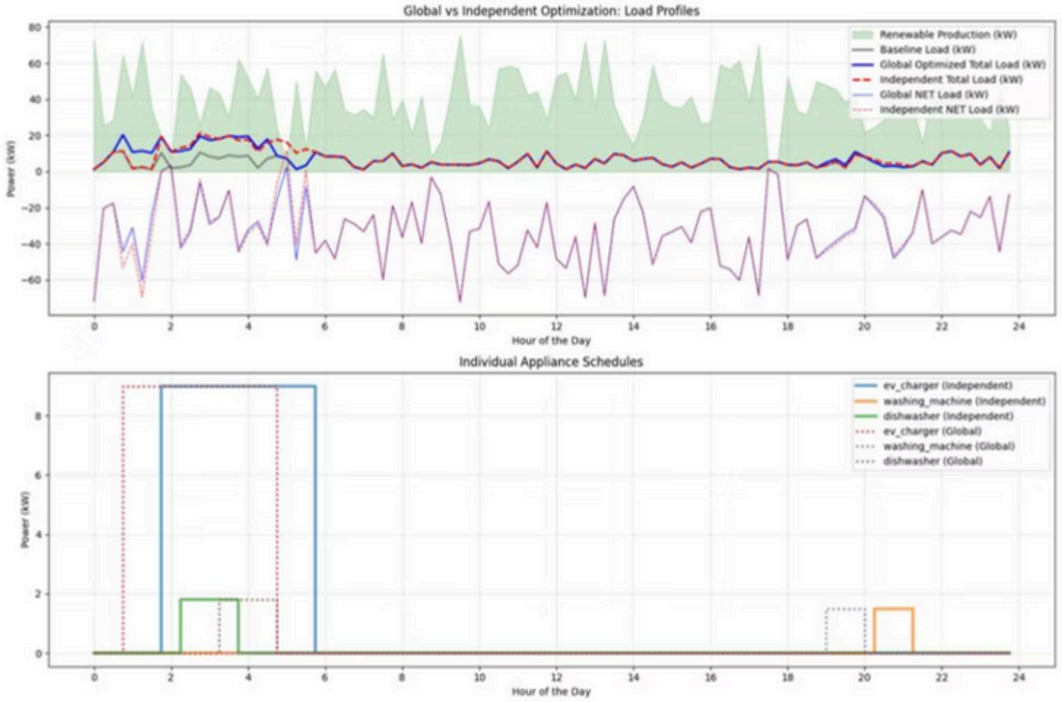
Quadratic "Service Guarantee" with C = 100,000 creating unbreakable penalty for valid schedules.

Proven Performance

The Smoking Gun

Direct experimental comparison proves our superiority:



2^{101}

Possibilities

A very large search space

2,327

Interactions

Unique quadratic interactions for grid coordination

306

Seconds

Solver found optimal schedule in under 5 minutes

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Proven Performance

The Smoking Gun

Direct experimental comparison proves our superiority:

Metric	Our QUBO	Greedy
Total Cost	$55.57	$50.48
Peak Load	**3.18 kW**	11.63 kW
Peak Reduction	**73%**	Grid disaster

2^{101}

Possibilities

A very large search space

2,327

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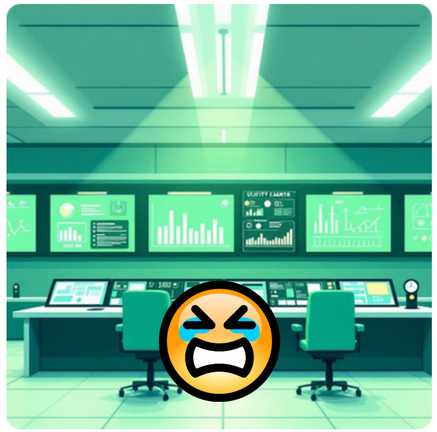
Target Customers

We are attacking their pain points:



Utility Companies

Cost of "peaker plants" & grid upgrades; penalties for unreliability.

Smart-Home Providers

Need to add tangible, billable value beyond convenience to justify hardware costs.

Grid Operators

Instability from renewable intermittency; need for frequency regulation.

CyberGrid

DEFTPOWER

Nest

amazon alexa

nationalgridESO

e·on

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Target Customers

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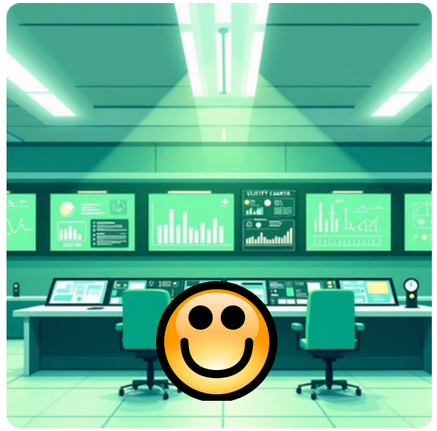

Utility Companies

A predictable & dispatchable peak-shaving resource. Our A<<B<<C formulation guarantees performance, making you more reliable than competitors.

Smart-Home Providers

A virtual power plant (VPP) platform that can be tuned for multiple grid services (peak shaving, frequency response) by adjusting hyperparameters.

Grid Operators

A white-label "Energy & Cost Optimizer" service that turns their devices into money-saving assets, increasing customer retention and product value.

Market Scope

In 2025:

$1.67 billion

Europe Demand Response (DR) Market

Source: Business Research Insights

$35.2 billion

Global Demand Response (DR) Market

Source: Future Market Insights Inc

Business Model: B2B API

We license our "Grid-Aware" QUBO formulation as a backend "quantum brain" through a simple, scalable B2B API.

01

Existing User Base

Customers have millions of smart-home app users already.

02

Immediate Upgrade

We replace "dumb" greedy schedulers with our quantum solution.

03

State-of-the-Art

Their products become grid management tools solving the peak-load crisis.

Technology Readiness & Team

TRL 4: Current

Lab validated with 73% peak reduction in simulated environment using real-world data.

1

TRL 5: Next

Integrate with live utility price API and real-time smart meter data feed.

2

TRL 6: Goal

Hardware-in-the-loop demonstration with physical smart plug control in test-home.

3

Technical Expertise

- **Quantum Optimization Lead :** Leads R&D and core quantum formulation design
- **Data & Validation Lead:** Manages data engineering, experimental design, and validation

73% Peak Reduction

The "Greedy" solution is the problem. Our "Grid-Aware" QUBO & Quantum Annealing is the answer.

Experimentally Proven

Validated model with complete Quantum Annealing Simulation prototype

World-Class Team

Technical depth and professional structure to execute

Ready to Scale

Seeking funding and strategic mentorship for TRL 6 and pilot programs

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ThankQ