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A Rolling-Horizon Optimal Selection Algorithm for Disaggregating Flexibility in Heterogeneous Asset Portfolios

Janez Gregor Golja,
dr. Tomi Medved

Laboratory of Energy Policy
University of Ljubljana

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Motivation & problem

Energy transition

Growing DER penetration creates need for flexibility to maintain grid balance

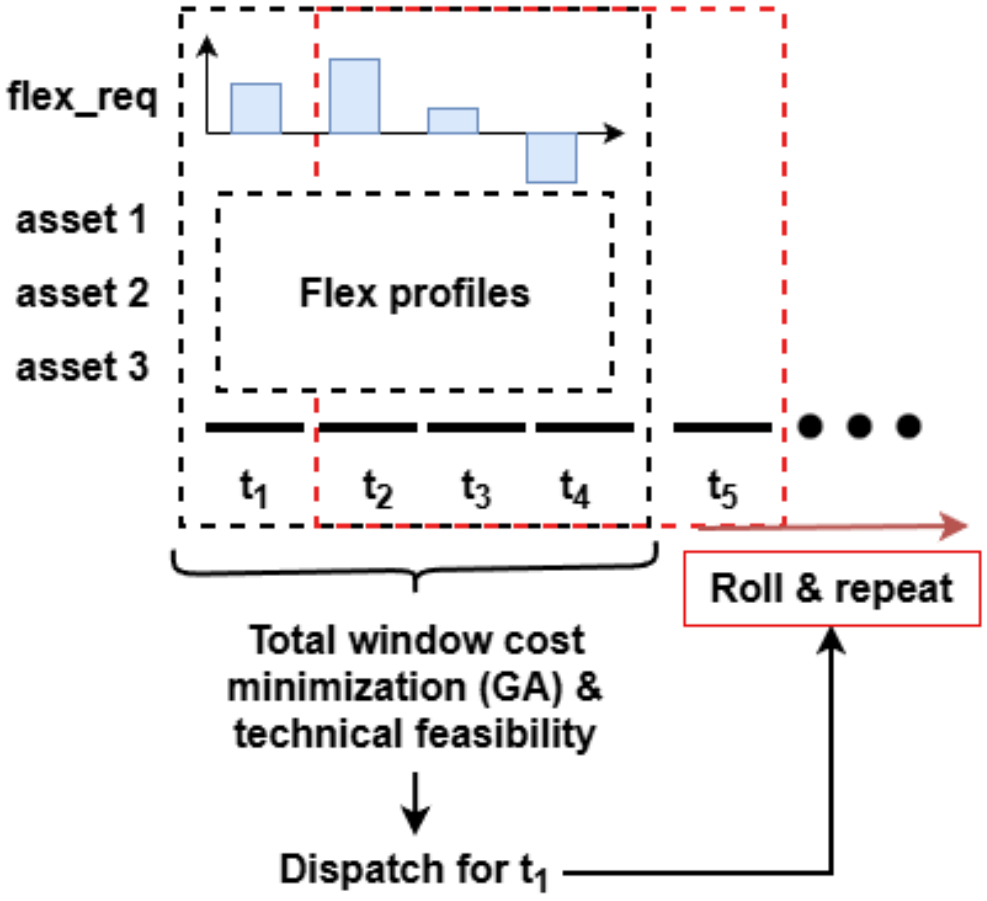
Role of the aggregator

Pool small assets to meet market minimum bid sizes and technical requirements

The challenge

Translate a market-level flexibility request into per-asset setpoints in real time

Rolling-horizon approach

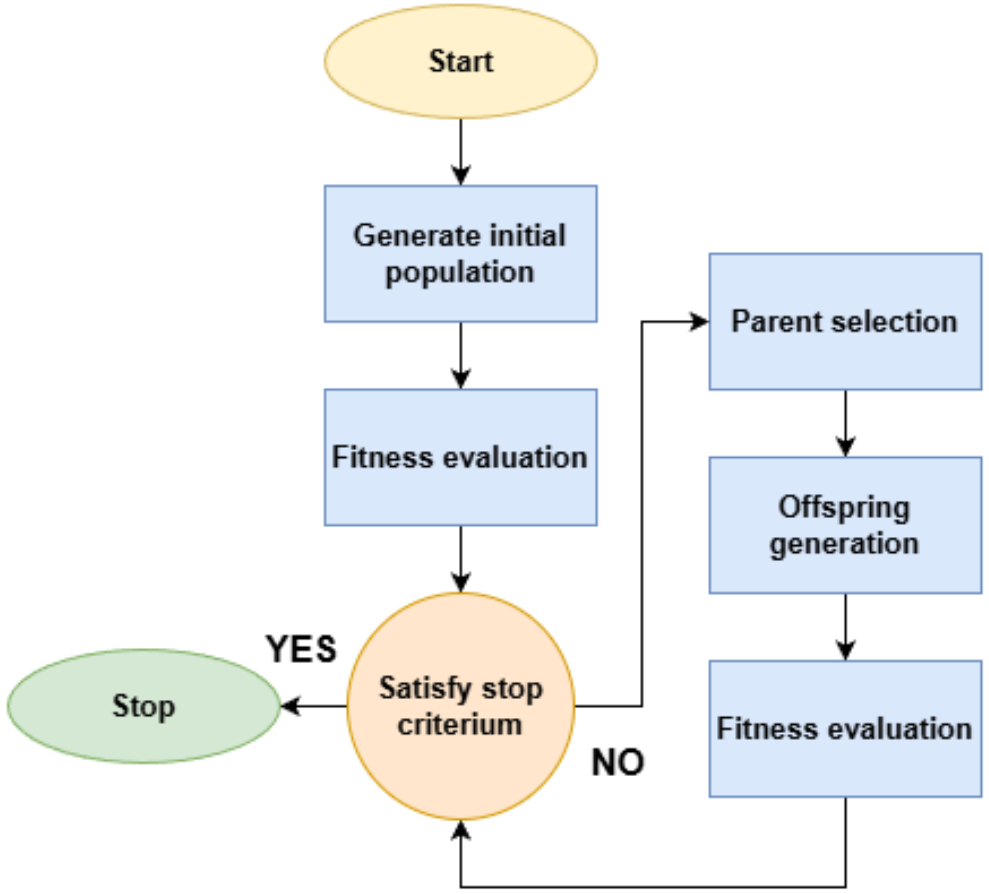


Objective

Minimize total activation cost over a rolling window, including penalty for unmet flexibility

1. Compute per-asset feasibility caps for the window
2. GA searches for lowest-cost dispatch plan
3. Execute only the first slot, update asset states
4. Shift window forward, repeat with fresh inputs

Cost model & genetic algorithm



Five-component marginal cost (€/kWh)

- **Energy** DA price arbitrage — current vs. future price
- **Opportunity** Lost PV export revenue (feed-in tariff)
- **Degradation** BESS cycle wear (replacement cost / cycle life)
- **Comfort** HVAC temperature deviation from comfort midpoint
- **Uncertainty** Forecast error risk — steers to reliable assets

Scenarios & asset types

EV Charging
UP only

Curtail active charging

BESS
UP + DOWN

Discharge / charge within SoC bounds

PV
DOWN only

Curtail generation

Heat Pump
UP + DOWN

Curtail / pre-heat within comfort band

Input profiles

- Measurements within the project
- PV and HP profiles from monitored households
- EV charging profile from car-sharing fleet from AVANTCAR
- Flexibility request profile generated via sampling portfolio capacity envelope

Two portfolio configurations

Baseline (4 assets)

1 EV + 1 PV + 1 BESS + 1 HP
Illustrates per-asset dispatch behaviour

Large portfolio (38 assets)

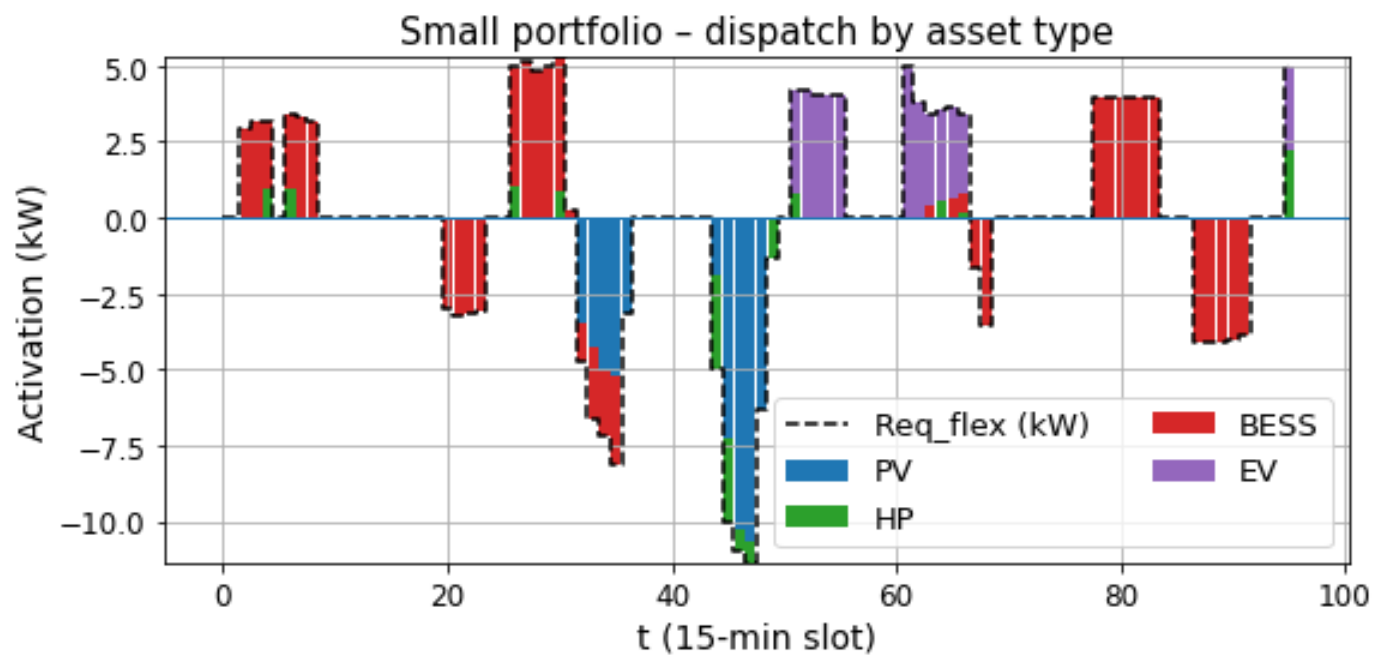
10 prosumer households (PV + HP + BESS)
2 commercial buildings (PV + HP)
1 large BESS (100 kWh / 30 kW)
3 EV charging locations

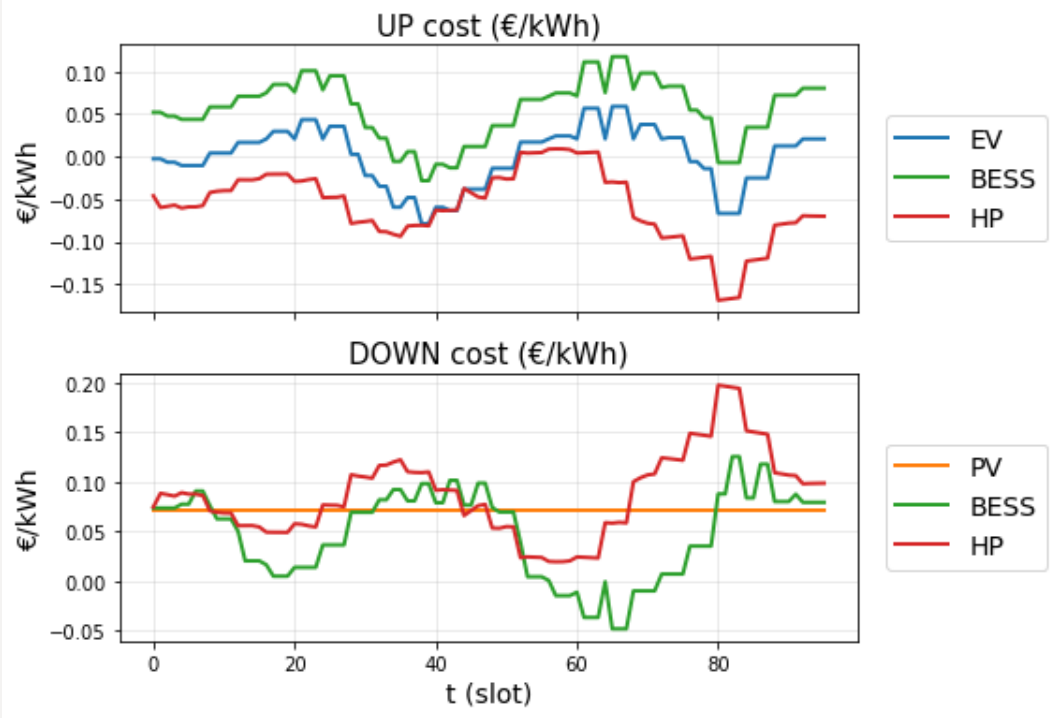
Cost parameters

Parameter (€/kWh)	EV	BESS	PV	HP
Energy (DA prices)	✓	✓		✓
Opportunity (FIT)			0.06	
Degradation c_deg		0.06		
Comfort κ				0.08
Uncertainty σ	0.30		0.05	0.12

These are **internal costs** — they encode the aggregator's preferences into a dynamic merit order, not actual settlement prices. The algorithm dispatches cheapest resources first.

Results: baseline portfolio

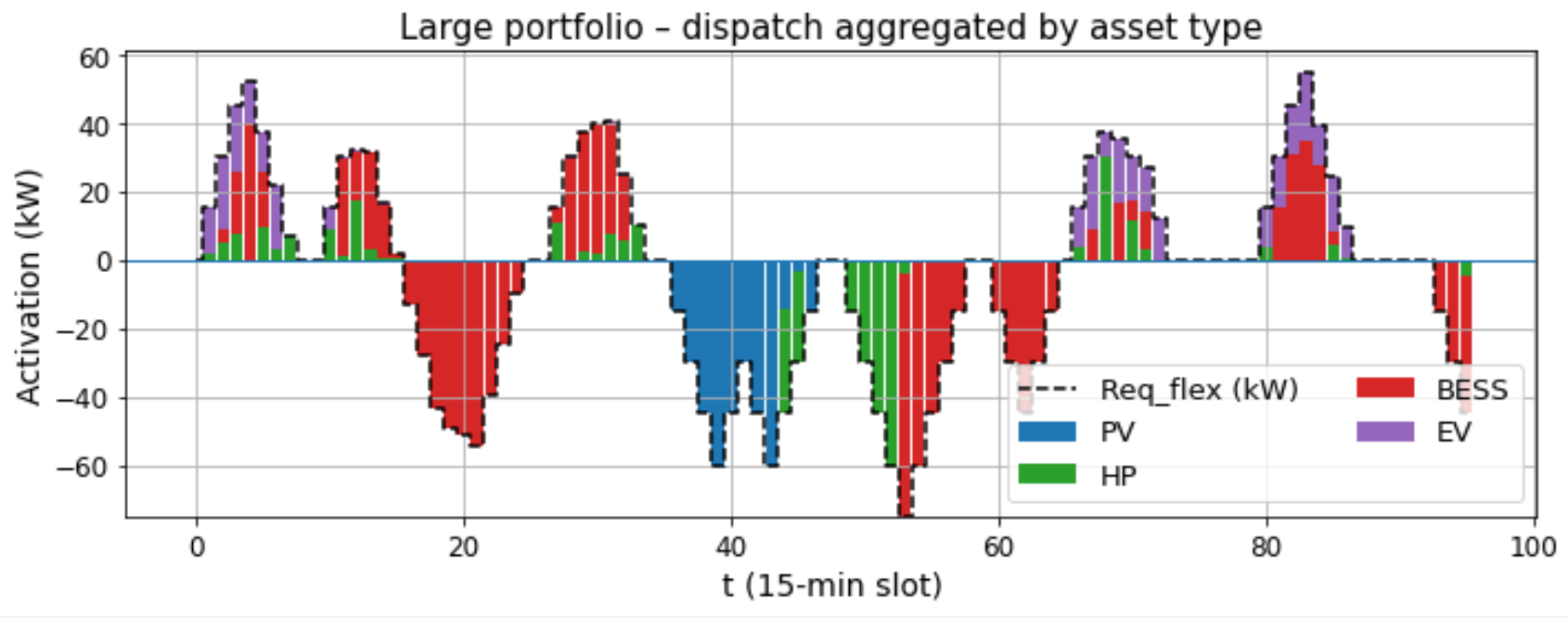




Contribution by type:

	BESS	EV	HP	PV
UP	56%	37%	7%	—
DOWN	41%	—	8%	51%

Results: large portfolio (38 assets)



Contribution by type:

	BESS	EV	HP	PV
UP	51%	33%	17%	—
DOWN	57%	—	16%	27%

HP doubles to 17% (12 units incl. 2 commercial)
3 EV locations spread UP flex across the full day
PV drops from 51%→27% as request extends beyond daylight

Key observations

- Cost-driven merit order scales well to larger portfolios
- BESS remains dominant — unconditional availability + bidirectional
- Dispatch smoother and more distributed across asset types

Conclusions & future work

1. Rolling-horizon GA achieves full delivery in both portfolio configurations
2. Unified cost framework creates a transparent, adaptive merit order
3. Asset prioritisation consistent with cost structures and availability
4. Approach scales from 4 to 38 assets without structural changes

Future directions

- → Portfolio-level smart meter feedback for real-time setpoint correction
- → Dynamic uncertainty weighting — self-tuning after each activation
- → Systematic cost parameter sensitivity analysis for aggregator calibration

THANK YOU.

Questions?

Janez Gregor Golja,
dr. Tomi Medved

janezgregorgolja@fe.uni-lj.si

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