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MicroGrid Resilience-Oriented Scheduling: A Robust MISOCP Model [1]

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Introduction

- **Aim:** Introduce a model for the resilience-oriented optimal scheduling of microgrids (MG).
- **Mathematical formulation:** Robust Mixed-Integer Second Order Cone Programming (MISOCP).
- **Objective 1:** Evaluate impact of power flow model [2] on optimal decisions.
- **Objective 2:** Evaluate impact of method used to tackle uncertainty [3] on optimal decisions.

Conclusions

Computational experiments showed that for the microgrid under study:

1. Failing to accurately account for power flow equations can result in a significant underestimation of the operational cost and different scheduling decisions.
2. Adjusting the level of uncertainty considered, the MG operator can achieve a sizable reduction in the day-ahead operational costs, compared to a fully robust (conservative) approach, while having a 0% probability of shedding additional loads than expected.

Case study/Model

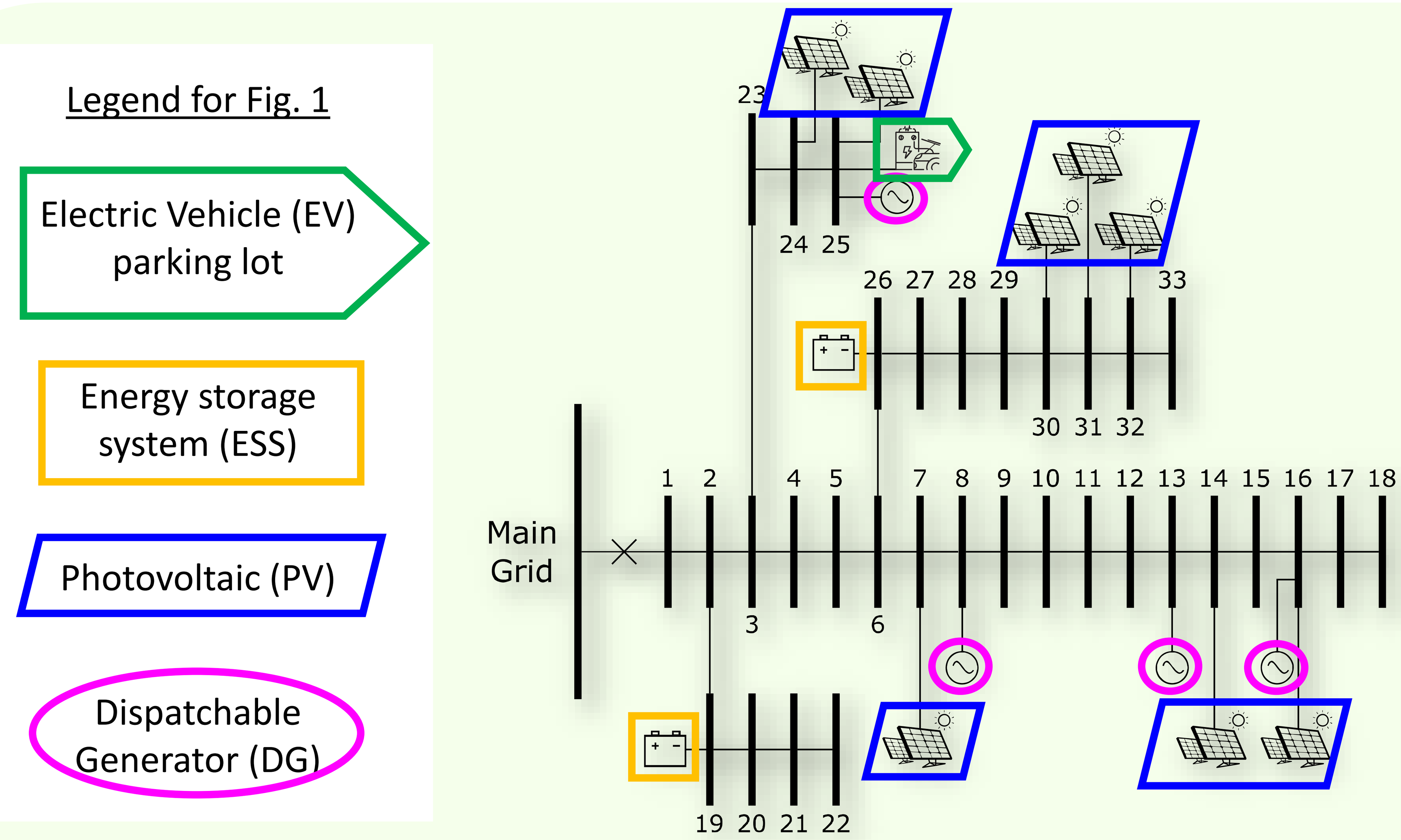

Fig. 1 Microgrid (MG) case study [1, 5].

Optimisation problem – Model description:

minimise *day-ahead operational cost = DG cost functions + start up/shut down cost + main grid import + load shedding*

subject to

- *Power flow equations [2]*
- *Unit commitment constraints*
- *ESS model*
- *EV parking lot model*
- *Market price, demand, PV, islanding uncertainty [3]*

Coded in GAMS & Solved using MOSEK solver [4].

Numerical results

Impact of power flow model

Comparing models: R-MISOCP & COMP

COMP: Power flow model of [5].

Table I: *Results for operational cost & losses*

	Operational cost	Real losses
R-MISOCP	£12 925	8.1 MWh
COMP	£11 443	.0046 ≈ 0

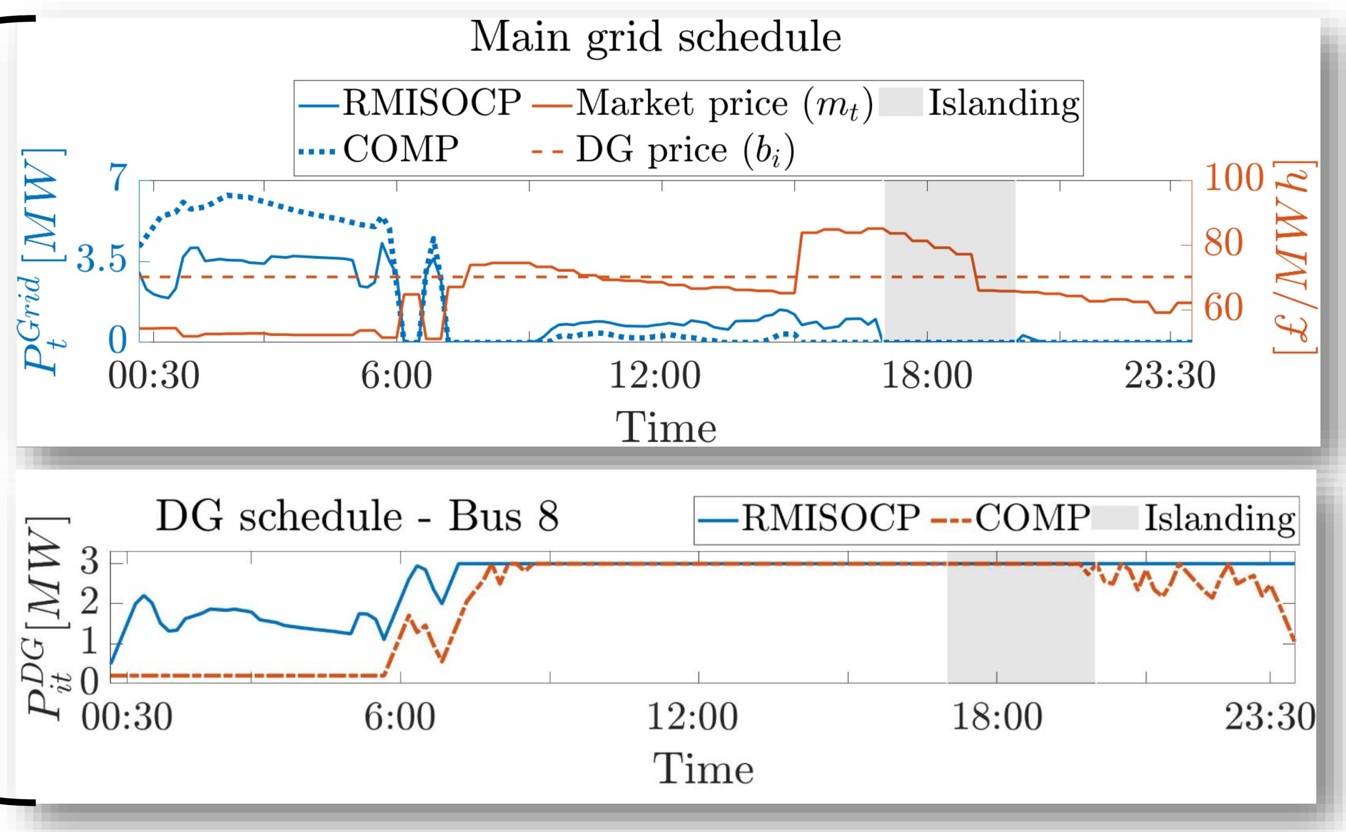

Fig. 2 Optimal schedules: Main grid & Bus-8 DG

Impact of uncertainty

TABLE II
POU($\Gamma^{\widetilde{M}} = 144, \Gamma_t^{\widetilde{RG}} = 1, \Gamma^{\widetilde{D}}, \Gamma^{\widetilde{I}}$)

$\Gamma_t^{\widetilde{D}}$	$\Gamma^{\widetilde{I}} = 0$	$\Gamma^{\widetilde{I}} = 3$	$\Gamma^{\widetilde{I}} = 6$ (max)
0	49.71%	49.59%	50.97%
0.001	43.46%	42.29%	42.57%
0.005	16.94%	16.51%	16.43%
0.01	3.32%	2.75%	2.62%
0.02	0.01%	0.02%	0.01%
0.03	**0%**	0%	0%
1 (max)	0%	0%	**0%**

TABLE IV
DAY-AHEAD COST FOR $\Gamma^{\widetilde{M}} = 144, \Gamma_t^{\widetilde{RG}} = 1$

$\Gamma_t^{\widetilde{D}}$	$\Gamma^{\widetilde{I}} = 0$	$\Gamma^{\widetilde{I}} = 3$	$\Gamma^{\widetilde{I}} = 6$ (max)
0	£13 031	£13 169	£13 342
0.001	£13 039	£13 182	£13 351
0.005	£13 077	£13 222	£13 393
0.01	£13 123	£13 272	£13 445
0.02	£13 217	£13 371	£13 550
0.03	**£13 310**	£13 471	£13 657
1 (max)	£15 849	£16 183	**£16 551**

R-MISOCP: £13 310

Fully robust case: £16 551

In both cases: PoU = 0% (Probability of Underperforming)

PoU = Probability of exceeding the day-ahead cost during the actual operation.

References

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