sweet swiss energy research for the energy transition

PATHFNDR

Electromobility + buildings

Enabling demand-side flexibility provision from e-mobility and buildings

Work package 2

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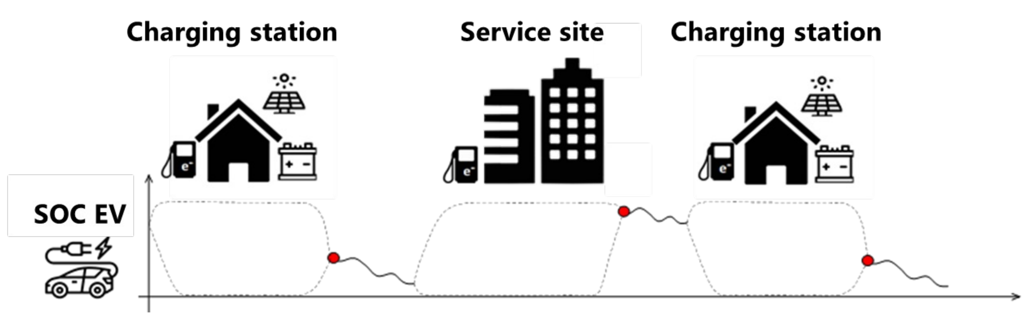
1 MOTIVATION

The rise in electric vehicles (EVs) challenges power system reliability but can also play a key role as a source of demand-side flexibility to manage operational uncertainty. In this work, a novel operational tool for vehicle-to-everything (V2X) operation of EV fleets with mixed-use buildings acting as charging station for demand-side flexibility provision is proposed.

Case studies on the NEST and move demonstrators at Empa, in Switzerland, and on an apartment building in Spain are used.



2 CONTRIBUTION TO PATHFDNR

This work contributed to Task T2.2.2 and T2.4.4 and is related to use-cases 2 and 3.

Link to WP1-WP2: To obtain the prices for national and local services.

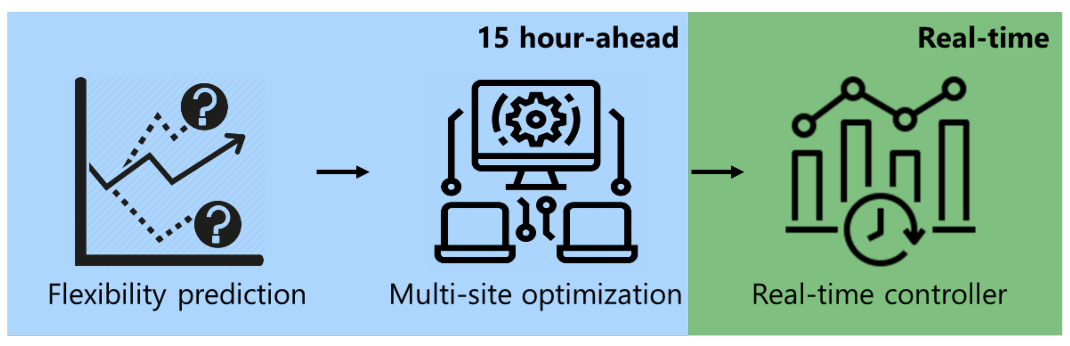
Link to WP3: To obtain the technology models.

Link to WP4: To obtain dynamic network tariffs.

Link to WP7: To provide insights on the necessary policies and market designs.

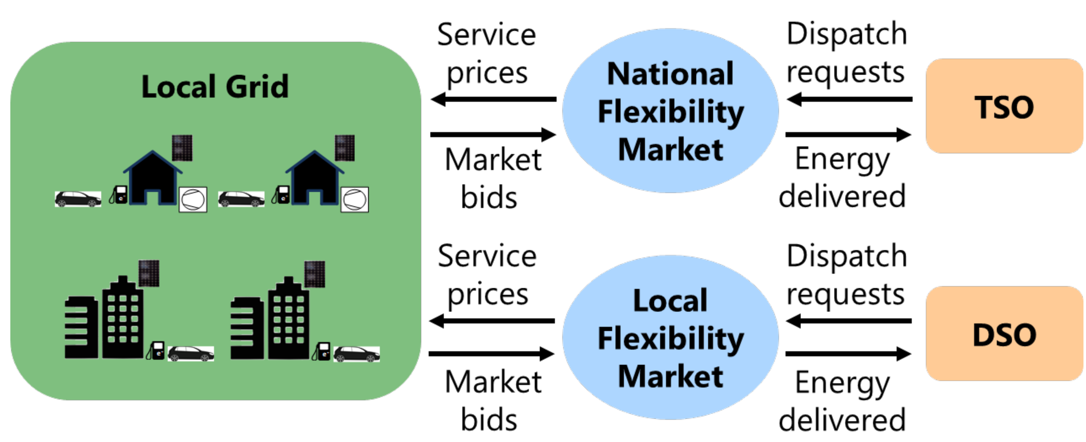
2 METHODOLOGY

The proposed approach includes three steps:



1) 15-hour ahead predictions of the charging station generation and load, EV arrival and departure times and energy demand;
2) Multi-site, chance-constrained optimizer that quantifies the available flexible energy capacity from the onsite battery (BESS), heat pumps (HPs) and the EV fleet to bid in intraday energy markets;
3) Real-time controller that adjusts the resource schedules based on real-time measurements and acceptance of the market bids.

Two flexibility markets, i.e. a local market for congestion management and a national market for frequency response services, are assumed:

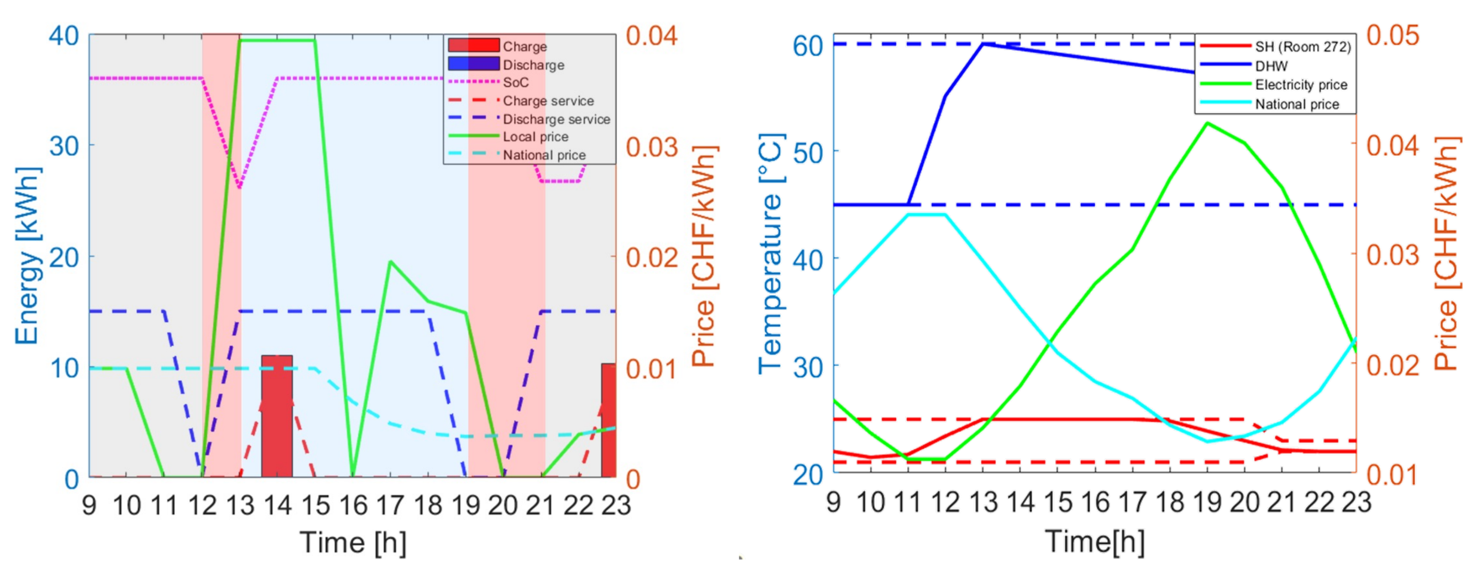


❖Transmission and distribution operators compete to procure the flexibility;
❖The flexibility providers participate in the most profitable market, i.e. higher availability prices per MWh of provided energy capacity.

3 RESULTS

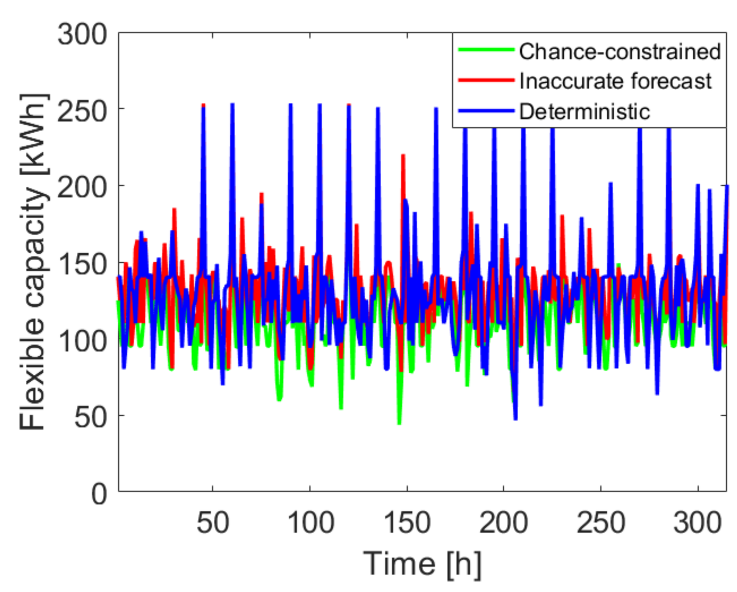
The two test systems representing the charging stations both included a 168 kWh BESS, 110 kWp PV systems, 4 charge-points and 4 EVs with V2G technology and 40 kWh battery each. Historical data for PV generation and load from February 2022 was used. In test system 1), there are two HPs for space heating (SH) and domestic hot water (DHW) for the UMAR residential unit with 3 rooms, while in test system 2), there are four HPs for SH servicing 8 rooms.

The daily optimal schedule for a single EV and room temperature



❖The EV was at the charging station, on a trip and at the service site in the grey, red and light blue box area;
❖The EV charged at the service site when the price for local service provision was higher;
❖The room temperature was increased when electricity price was low, allowing to provide higher energy capacity when price for national service provision was higher.

The flexibility envelope over a month



	Deterministic	Inaccurate Forecast	Chance-constrained
Net revenue [CHF]	1′582	1′772	1′542

	BESS	EV	SH	DHW
System 1 mix [%]	65.7%	34.0%	0.2%	0.1%
System 2 mix [%]	61.0%	32.0%	–	7.0%

❖The proposed approach resulted in more conservative estimates of available flexible energy capacity, preventing overbidding;
❖The net revenues from flexibility provision can offset the energy costs entirely under effective policies and market designs;
❖BESS and EVs offer substantial flexibility in mixed-use buildings, while the HP flexibility potential significantly increases in large residential units (multi-family houses).

REFERENCES

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