

DSO + Transactive (DSO+T) Simulation and Analysis Study

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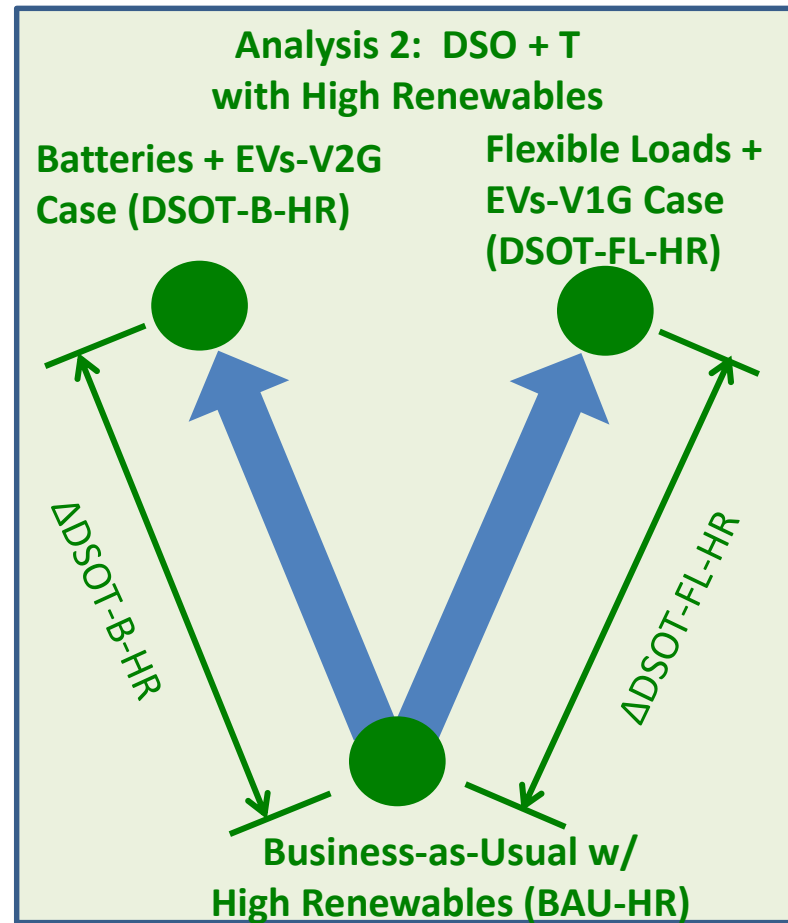
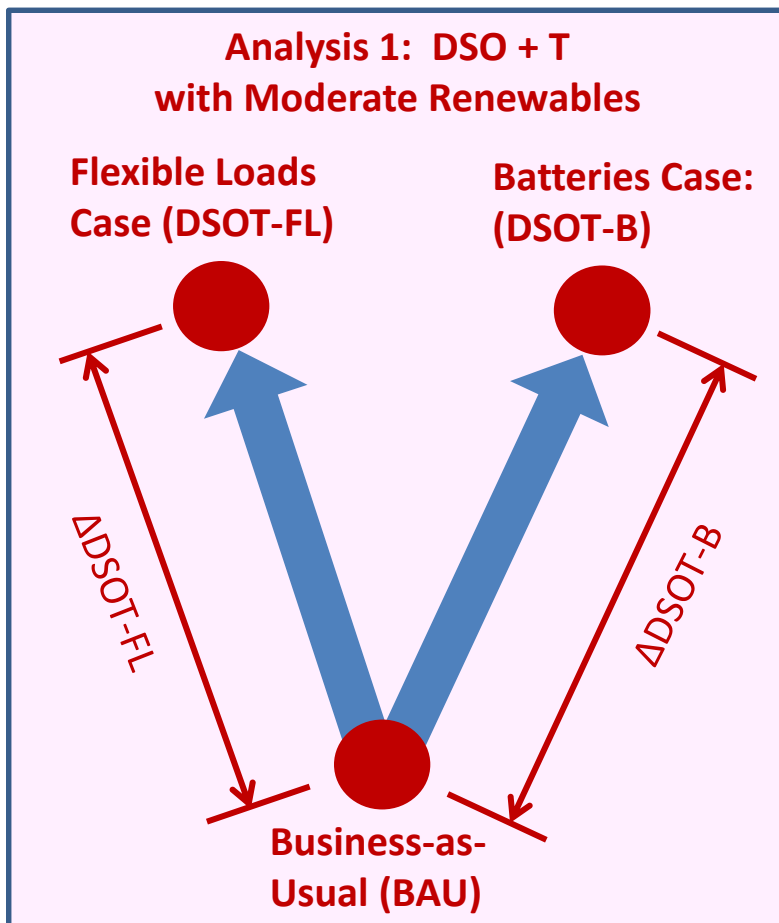
Design, simulate, and analyze a distribution system operator (DSO) combined with a transactive network to:

Produce a ***field-ready design of a DSO plus a transactive network*** capable of coordinating DERs deployed at scale for ***benefits at the distribution/retail and bulk system/wholesale-ISO levels***

Test the design with simulation and estimate the benefits of a national deployment at scale over a range of potential grid futures

Issue the simulation and valuation framework as an open challenge to industry and the transactive energy community to ***develop and improve their designs in preparation for field experiments***

Structure of the Study: Two Analyses and Primary Results



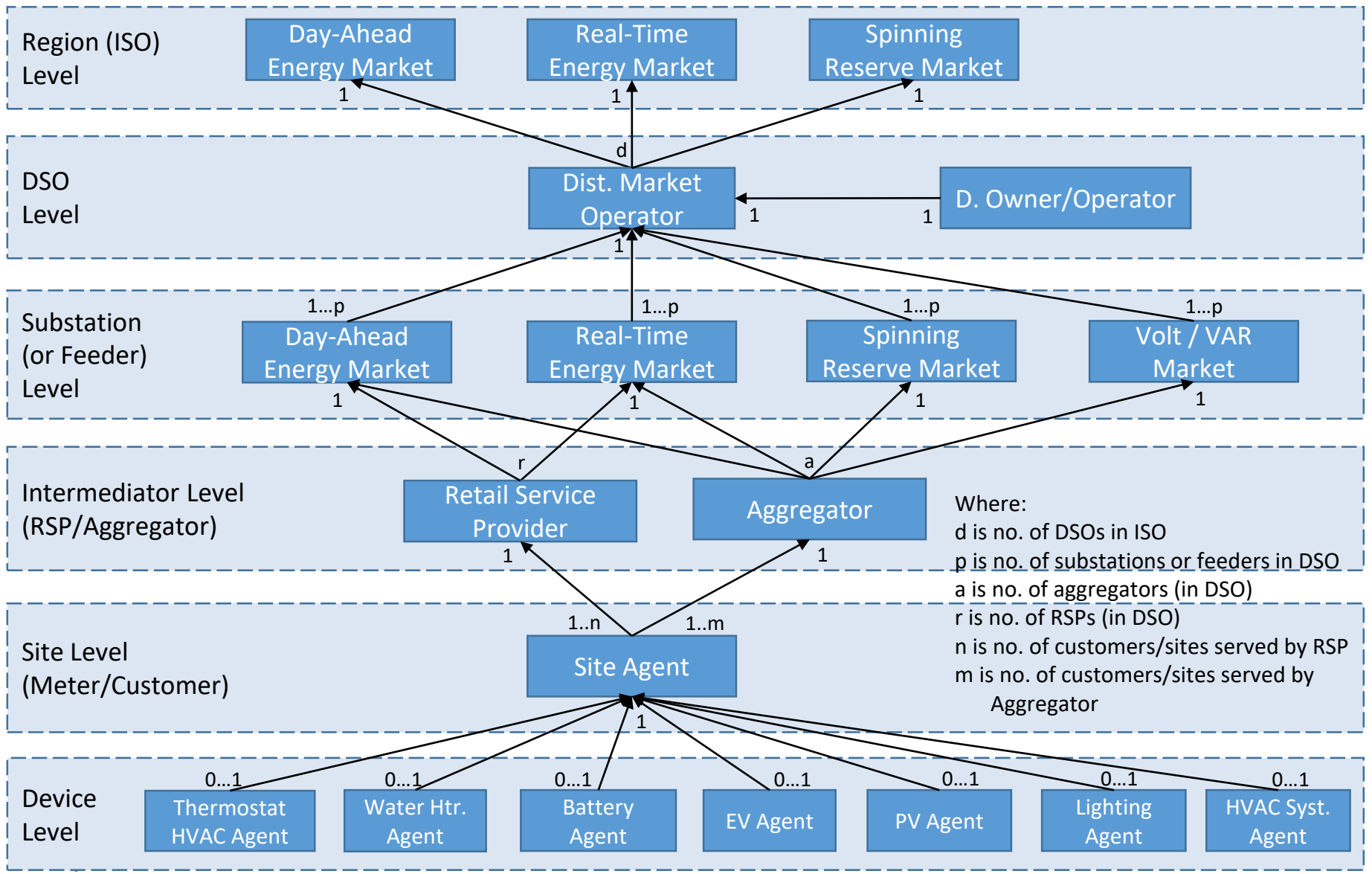
- $\Delta\text{DSOT-FL}$ = Value of DSO + Transactive + Flexible Loads (Moderate Renewables)
- $\Delta\text{DSOT-B}$ = Value of DSO + Transactive + Batteries (Moderate Renewables)
- $\Delta\text{DSOT-FL-HR}$ = Value of DSO + Transactive + Flexible Loads (High Renewables)
- $\Delta\text{DSOT-B-HR}$ = Value of DSO + Transactive + Batteries + EVs (High Renewables)

Key Characteristics of the Six Grid Scenarios in the Analysis

Customer Participation	Renewable Energy Penetration	
	Moderate	High
Base Case Scenarios (Business-as-Usual)	Base Case 1	Base Case 2
Renewable resource penetration [fraction of peak load]	15%	50%
Electric vehicle penetration [fraction of light-duty fleet]	0%	0%
Participating customers with flexible loads	0%	0%
Distributed battery energy storage capacity [MWh]	0	0
Flexible Loads Test Case Scenarios	Case 1A	Case 2A
Renewable resource penetration [fraction of peak load]	15%	50%
Electric vehicle penetration [fraction of light-duty fleet]	0%	0%
Participating customers with flexible loads	75%	75%
Distributed battery energy storage capacity [MWh]	0	0
Low-Cost Batteries Test Case Scenarios	Case 1B	Case 2B
Renewable resource penetration [fraction of peak load]	15%	50%
Electric vehicle penetration [fraction of light-duty fleet]	0%	35%
Participating customers with flexible loads	0%	0%
Distributed battery energy storage capacity [MWh]	*	*

* Total battery energy storage capacity set to approximately equal to that estimated for the flexible loads in Cases 1A and 2A.

A Total DSO with Aggregators and Unbundled Retail Service Providers



Modeling Aggregators and Retail Service Providers for the Study

DSO+T study assumes the following about aggregators & retail service providers (RSPs):

- ▶ Both use transactive mechanisms to engage customers & sites
- ▶ I.e., set up & operate their own set of transactive mechanisms
 - E.g., day-ahead, real-time, spinning reserve, & volt/var markets
- ▶ Their mechanisms perform with equal effectiveness & functionality as DSO's

Only one set of transactive mechanisms will be developed & simulated by the project

- ▶ Vastly simplifies simulation & analysis
- ▶ Rather than trying to represent realistic diversity of algorithms
- ▶ Equivalent to assuming one RSP & one aggregator at DSO-level, i.e., in combination, a load-serving entity (LSE)
- ▶ Single LSE provider assumed to remain regulated, bundled in DSO with distribution market operator & owner/operator

A Total DSO as Modeled: Bundled with a Regulated Load-Serving Entity

