

An Integrated Paradigm for the Management of Delivery Risk in Electricity Markets: From Batteries to Insurance and Beyond

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Context

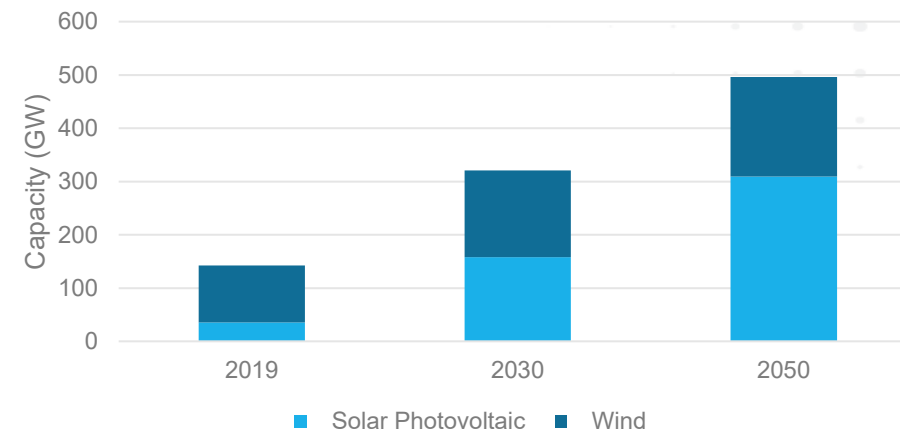
Challenge

- ❖ ~150 GW of intermittent generation in the USA as of 2019, projected to reach ~500 GW in 2050!
- ❖ Need for flexibility to address uncertainty
 - ❖ E.g., Forecast errors in the order of a few GWs (95% Coverage Interval) in CAISO

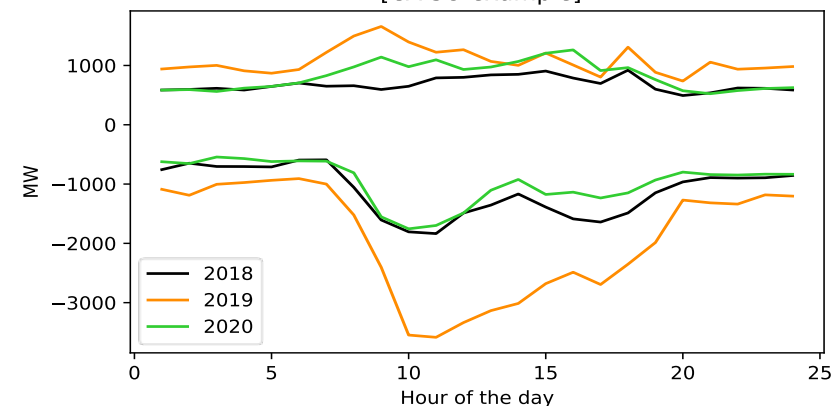
Opportunity

- ❖ Advances in forecasting: probabilistic forecasts of wind and solar generation
- ❖ Electrification and advances in controls/communications → flexibility from grid-connected resources at the distribution system
- ❖ Access to system-wide flexibility from grid-connected resources at the transmission system for economic hedging

Reference Case Projections
(EIA Annual Energy Outlook 2020)



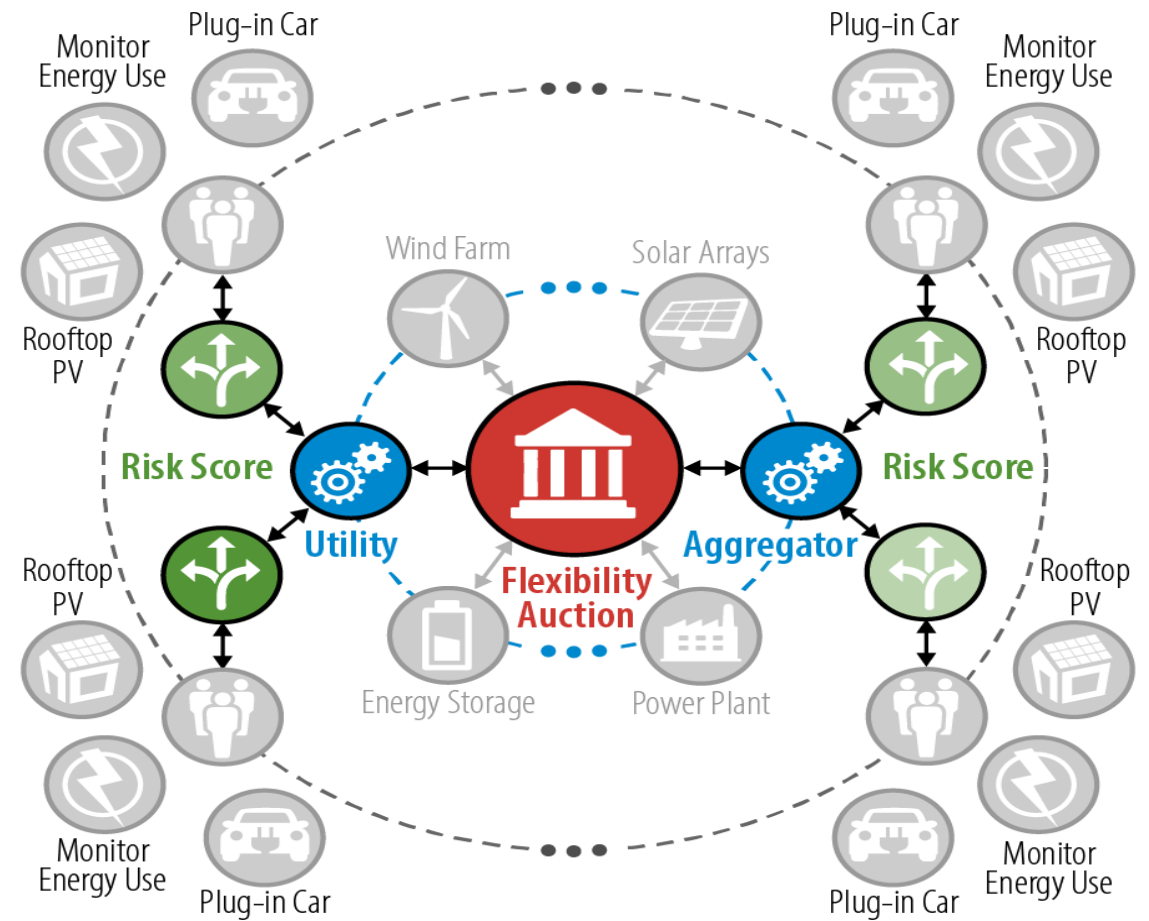
RTPD - DA forecast wind and solar
97.5 and 2.5 percentiles
[CAISO example]



Project Summary (1/2)

Objectives

- ❖ Quantify flexibility from distributed energy resources (DERs) through DER risk scores.
- ❖ Increase the number of hedging options for resources with uncertain output by tapping system-wide resources through a system-wide flexibility auction.
- ❖ Create transparent flexibility prices *ahead of time*, alleviating the need for forecasting of balancing prices.



Project Summary (2/2)

Novelty

- ❖ **DER Risk scores** will characterize flexibility from DERs
 - ❖ Magnitude
 - ❖ Probability of delivery
- ❖ **Auction for physical flexibility** accessible by all market participants for economic hedging of their uncertain output. The proposed auction will create a demand for flexibility that extends beyond reliability and will strike a balance between procuring flexibility and mitigating the need for it.

Outcome

- ❖ Save production costs induced by uncertainty
- ❖ Reduce frequency of scarcity conditions caused by uncertainty
- ❖ Integrate higher amount of DER flexibility

Target:

- Reduce uncertainty-induced costs by 40% or operating costs incl. penalties by 3%
- Increase bid-surplus for a DER portfolio manager by 10%

Team



Helyette Geman
Yuanye Ma
(Methodological Development)



Ben Hobbs
(Design Fundamentals)



Yajing Liu
Elina Spyrou
(Implementation and Data Analytics)



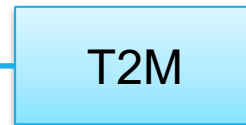
Mengmeng Cai
Elina Spyrou
(Modeling of Participants)



Paul Hines
Mads Almassalkhi
(Validation)



Yingcheng
Zhang



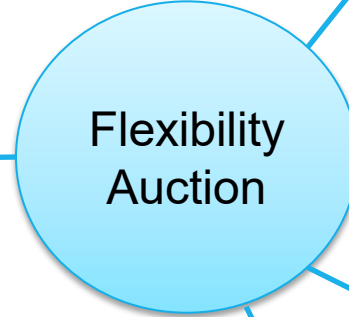
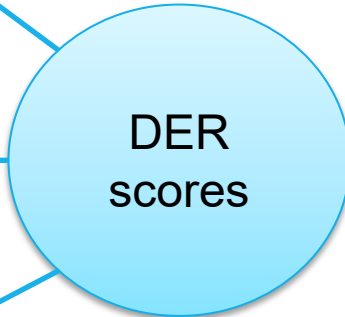
Industry advisors
CAISO
SMUD
SCE



Robin Hytowitz
Erik Ela
(Implementation and Large-scale Simulations)

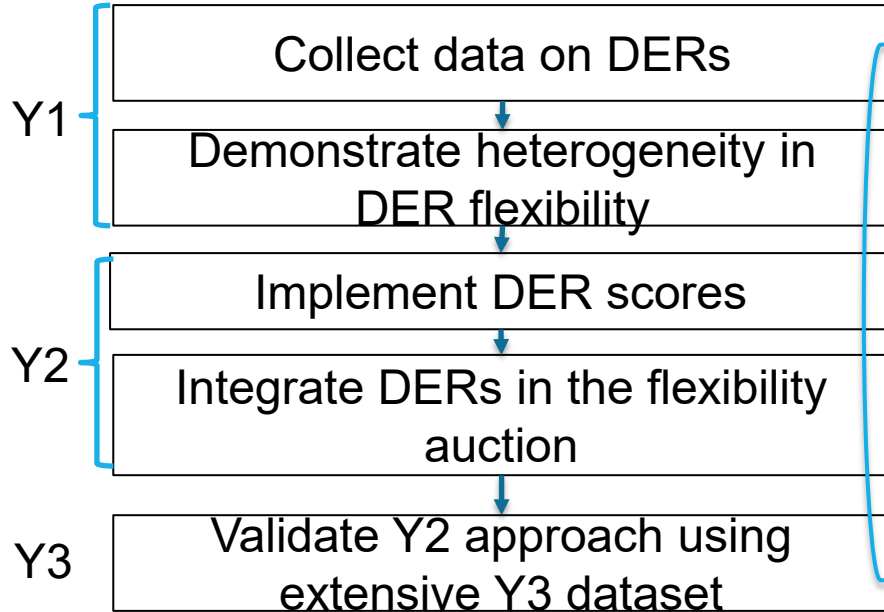


Jason Kaminsky
(Assessment of Aggregation Benefits)



Task Overview

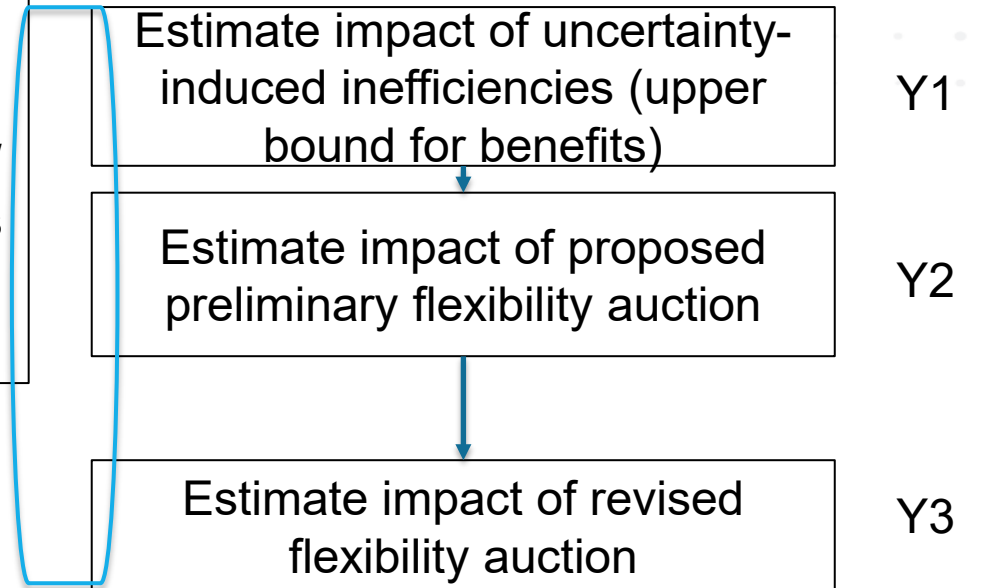
Task 1/3/5: DER scores



Task 7: T2M

- Collect feedback
 - Outline commercialization/adoption pathways
 - SWOT
 - Plan pilots

Task 2/4/6: Flexibility Auction



Path to Market

❖ Objectives:

- Have a flexibility auction that is “stakeholder process”-ready with analysis supported by open-source market simulation tools (e.g., FESTIV) on ARPA-E synthetic grid.
- Pilot-ready DER scores for utilities/aggregators.

❖ Industry engagement:

- EPRI forums, conferences, industry meetings
- Stakeholder workshops on annual/semi-annual basis

❖ Invitation/Question to other attendees

- Stakeholder workshop participants
- Input on definition of “stakeholder process”-ready and pilot-ready solutions

Impact Analysis

“Stakeholder process”-ready impact analysis: Simulations on ARPA-E Texas synthetic case study completed → Next step: Repeat simulations with data from ISO interested in adoption

- ERCOT 2018 , “Study of the Operational Improvements and Other Benefits Associated with the Implementation of Real-Time Co-optimization of Energy and Ancillary Services”
- N. Navid and G. Rosenwald, “Ramp capability product design for MISO markets”, MISO, 2013
- ISO-NE, “Energy Security Improvements Impact Assessment”, Analysis Group, 2020.
- CAISO, Analysis supporting straw proposals

Baseline simulations:
Existing market design

Simulations with the
Flexibility Auction

Compare

- Production costs
- Shortages
- Participant revenues/payments
- Price signals
- ...

Pilot-ready impact analysis: Simulations with historical data shared by partners and advisors → Next step: Pilot

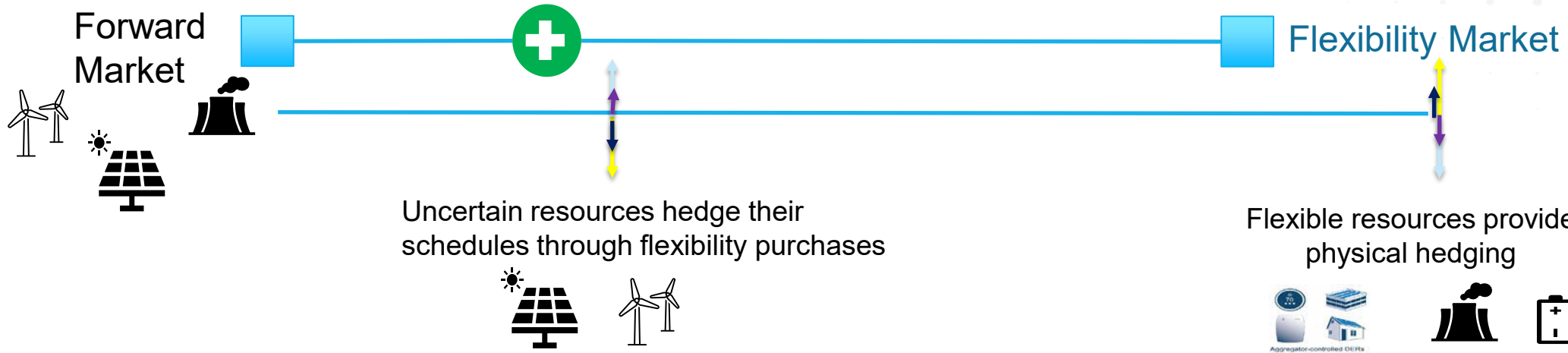
Simulation with existing practice
for DER scheduling

Simulation with DER-score
informed DER scheduling

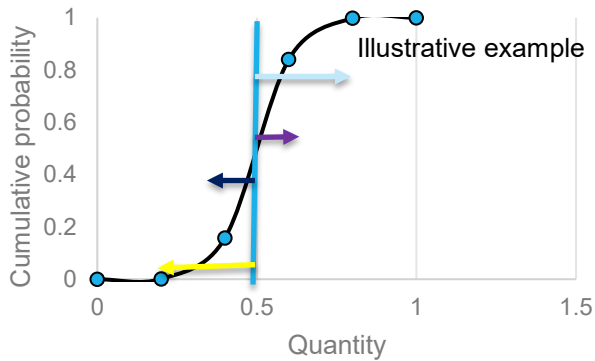
Compare

- DER aggregator revenues/payments
- DER probability of shortfall
- Magnitude of DER flexibility scheduled
- ...

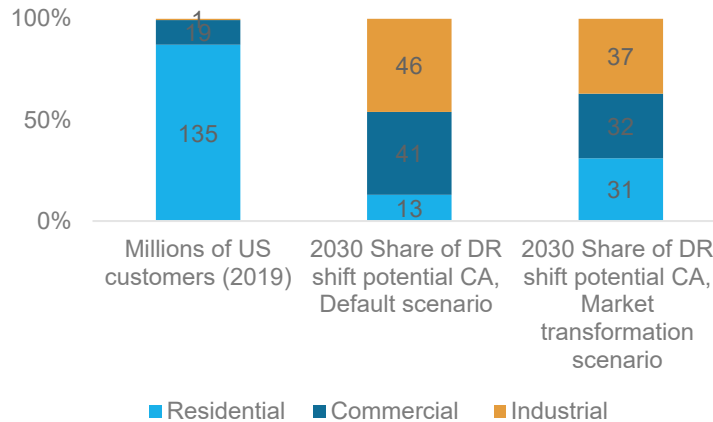
Technical Details



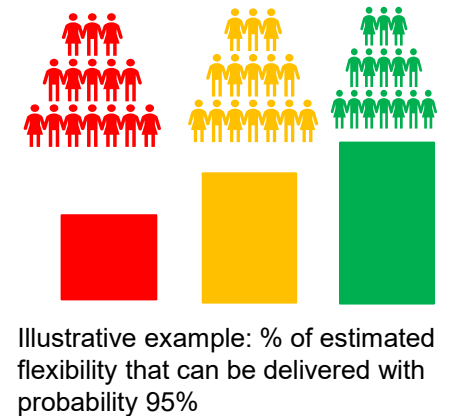
Use probabilistic forecasts of uncertain outputs to procure flexibility at different “tiers”



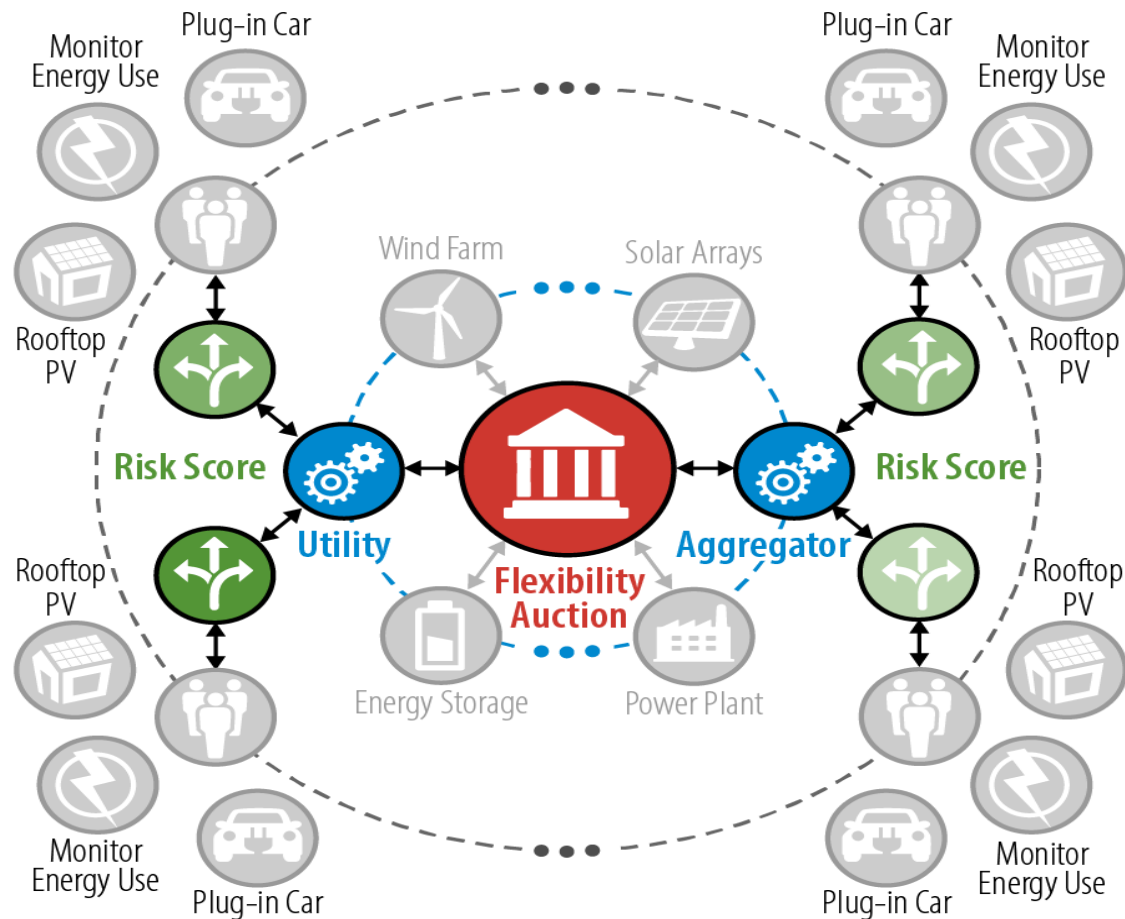
Include flexibility from large number of residential and commercial DERs



Automated approach based on scores



Summary



We aim to develop an operating paradigm that leverages flexibility from distributed and bulk resources to cost-effectively manage delivery risk of intermittent resources.

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Electric Industry

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