Multi-Dimensional Forward Contracts under Uncertainty for Electricity Markets

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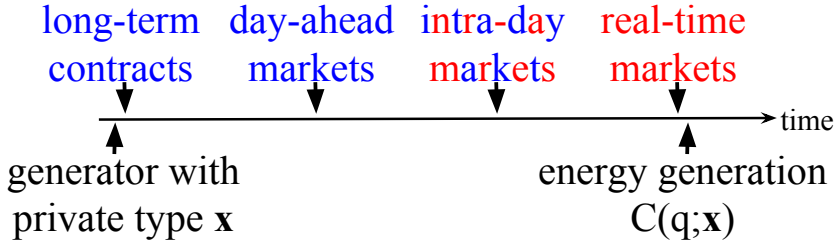
Electricity Markets under Uncertainty

- Conventional energy generators (*e.g* thermal)
  - Forward markets and real-time markets are similar



- Renewable energy generators (*e.g.* wind, solar)
  - Forward markets and real-time markets are different
- Renewable generators (3% share) participate in RT markets (5% share of markets)
- Gradually (required) participate in forward markets (95% share of markets)
- Need to rethink electricity market mechanisms
  - Non-strategic aspects: stochastic optimal power flow problem
  - Strategic aspects: market design & analysis

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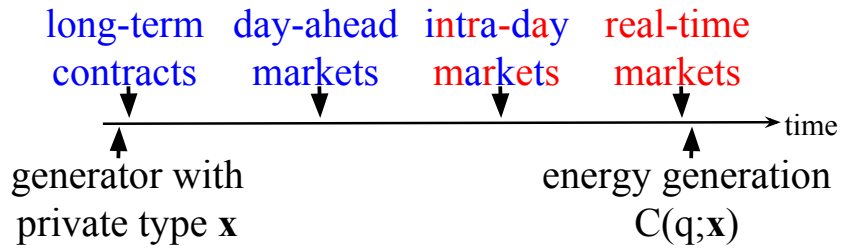

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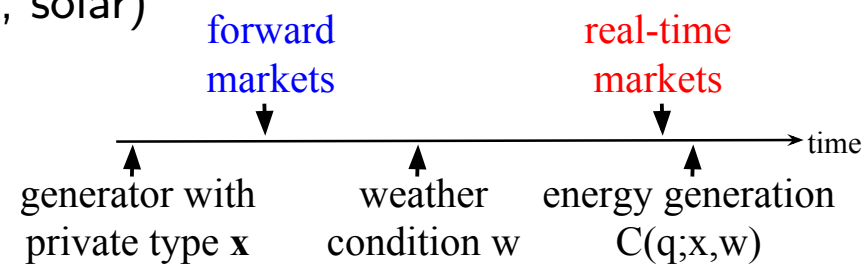

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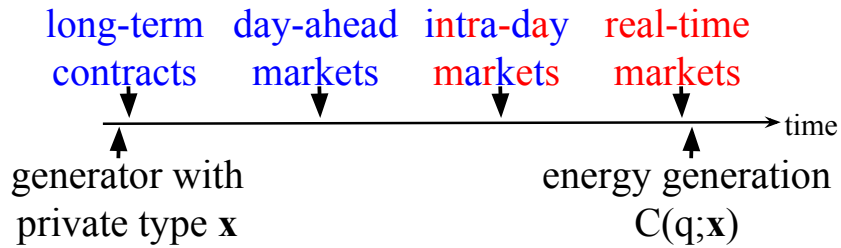

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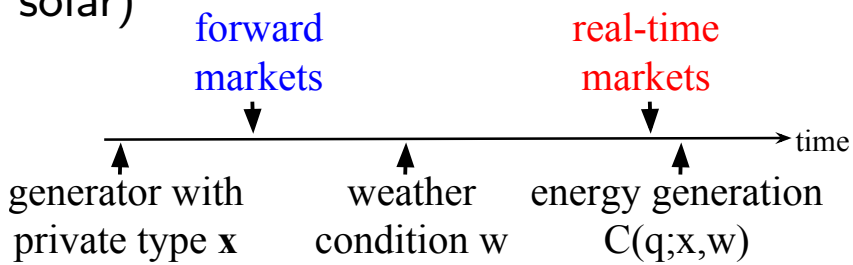

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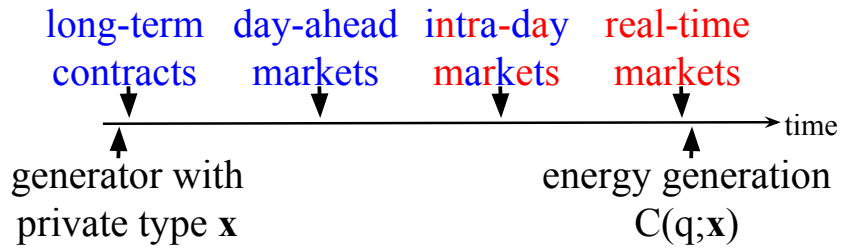

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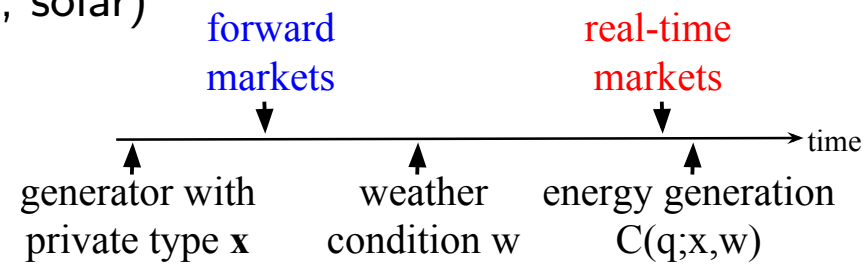

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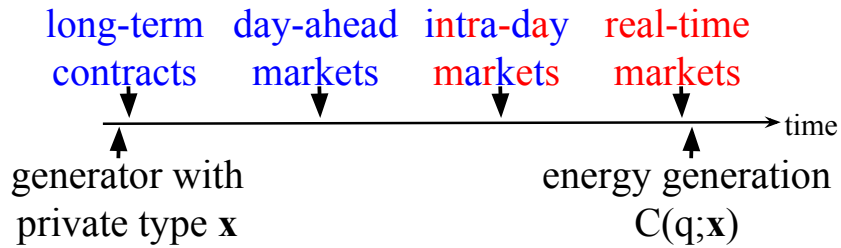

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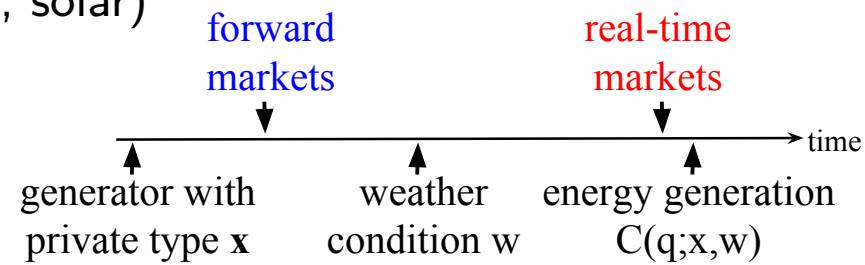

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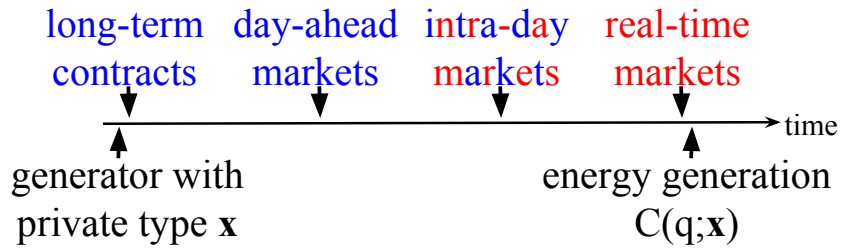

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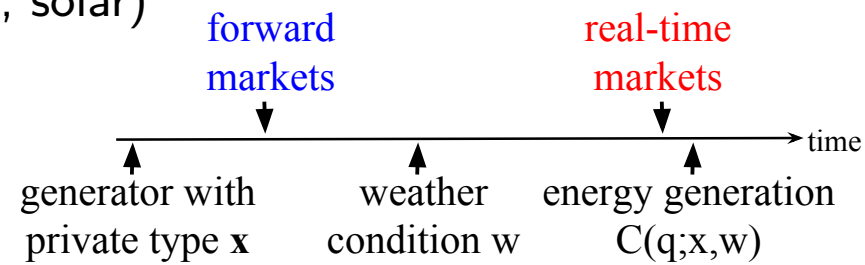

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Multi-Dimensional Forward Contracts under Uncertainty

- **Our approach**: contract design
  - Strategic behavior
  - Multi-dimensional private information
  - Uncertainty and satisfies
    - Interim voluntary participation (in expectation)
    - Ex-post voluntary participation (for every realization of uncertainty)
  - The optimal mechanism is a menu of pricing schemes: First, the buyer offers them and the seller chooses one Second, according to realization w of the uncertainty one point from the selected pricing scheme is implemented.
- Contract with deterministic allocation
  - Contract with incentive payments for demand response (DR) program
- Contracts with random allocation that depends on the uncertainty
  - Bilateral trade between a buyer and a wind generator

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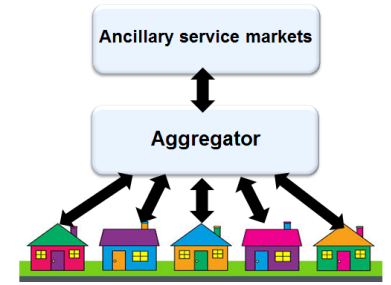

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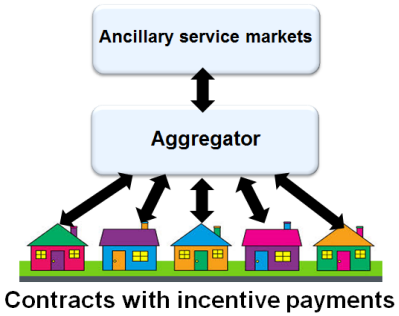

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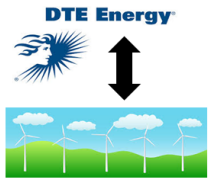

Bilateral trade

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