Stochastic Service Network and RexNet

for District Heating Networks with Multi-Dwelling Buildings

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Dec 3rd, 2019

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Stochastic Service System and RexNet

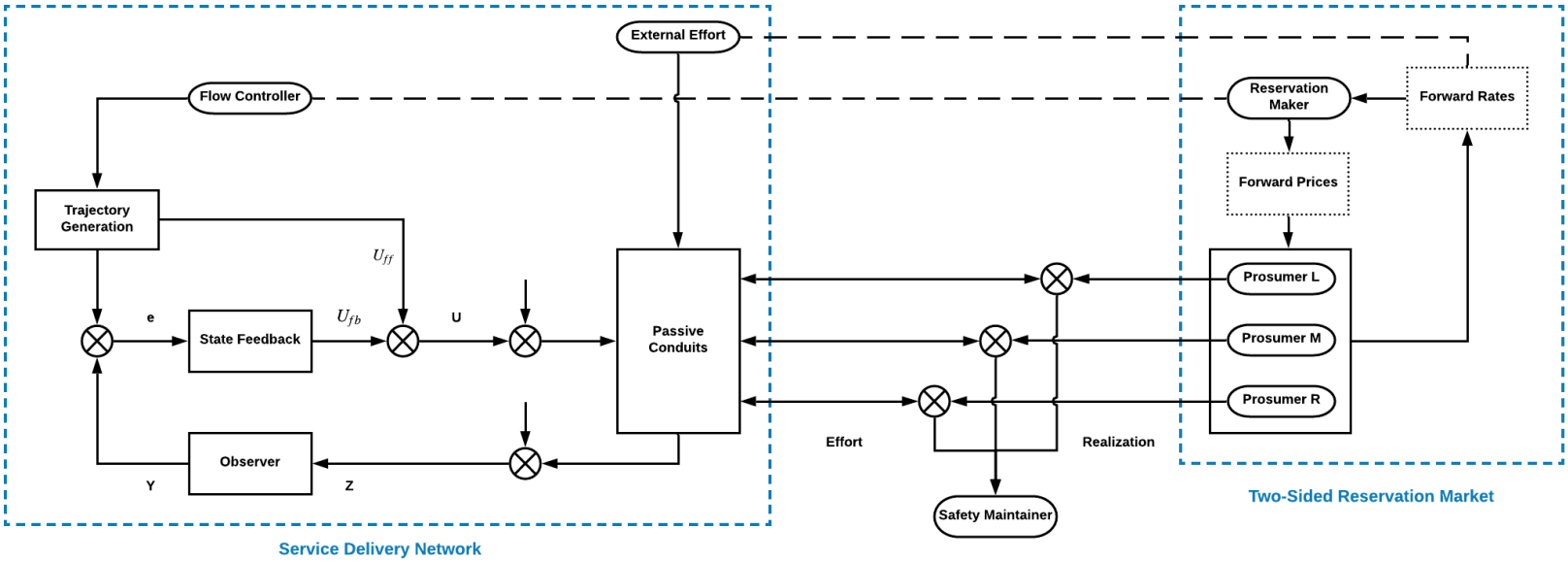

Figure: Illustration of a RexNet model

Object	Tool
Stochastic Service System	RexNet
Two-Sided Reservation Market	Reservation Exchange
Service Delivery Network	CEEFC
Passive Conduit	SpaceMeterNet

Table: Summary of relationships between stochastic service network and RexNet

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Reservation Exchange and Incumbent Electricity Markets

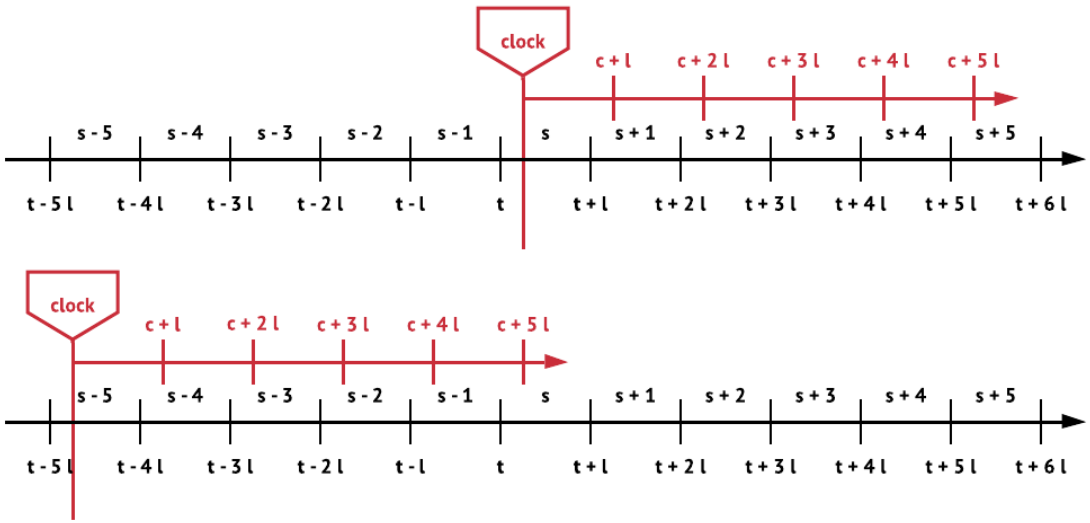

Figure: Two ways to think about the trading decisions

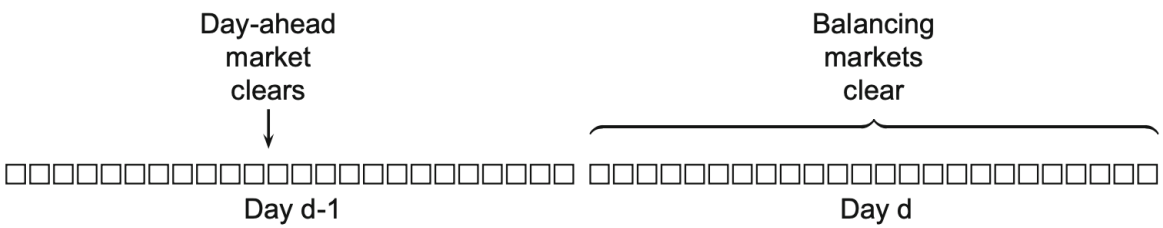

Figure: Market decision timeline in the incumbent electricity market families

1. Difference in volume and quantity, to eliminate the need for frequency regulation.
2. Exchange instead of one-time double auction

Exchange instead of One-Time Double Auction

The market clearing process for some target unit can be visualized by figure 4, which is the transaction process in stock exchanges.

Figure: Illustration of transaction process in stock exchange

1. Market makers in stock exchanges
2. Centralized contract maker in Reservation Exchange

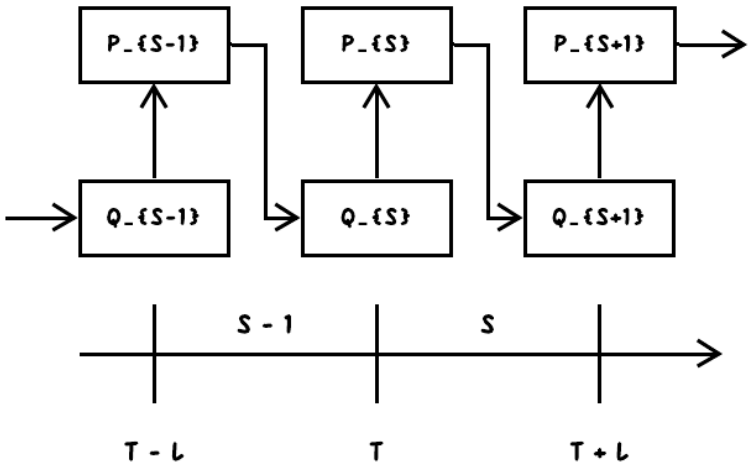

Figure: Illustration of updates of quantity and price under realistic condition

Sequential Game with Fixed End Point

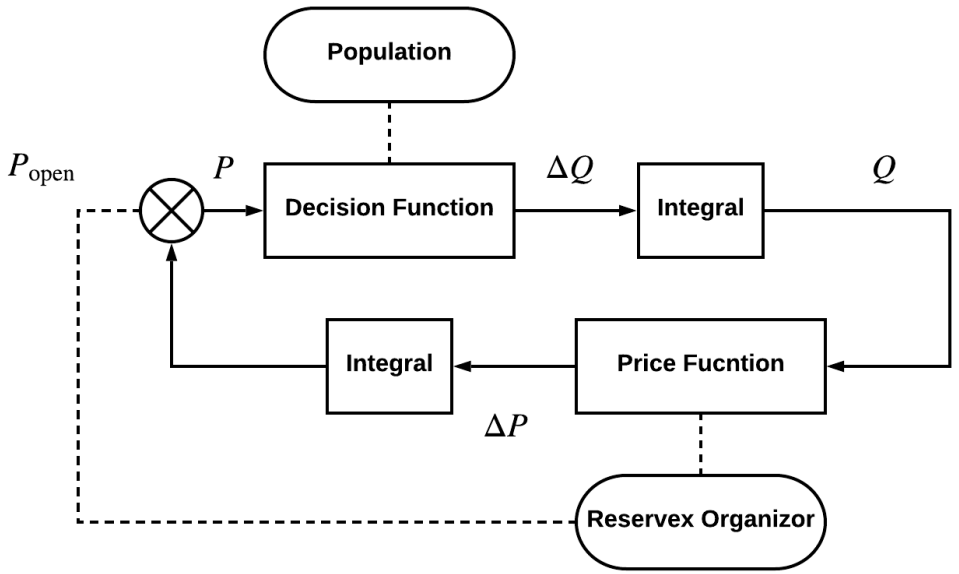

Illustration of Reservation Exchange as a stochastic feedback control system.
Two groups of decision makers:

1. Population consisting of all the prosumers
2. The contract maker

The following expressions can describe the transition from time unit i to time unit $i+1$.

$$\Delta \boldsymbol{P}_{i+1} = f_{i+1}(\boldsymbol{P}_i, \boldsymbol{E}_i) \tag{1}$$

$$\boldsymbol{P}_{i+1} = \Delta \boldsymbol{P}_{i+1} + \boldsymbol{P}_i \tag{2}$$

$$\Delta \boldsymbol{E}_{n,i+1} = g_{n,i+1}(\boldsymbol{p}_{n,i+1}, \boldsymbol{E}_{n,i}) \quad \text{for } n \in N \tag{3}$$

$$\boldsymbol{E}_{n,i+1} = \Delta \boldsymbol{E}_{n,i+1} + \boldsymbol{E}_{n,i} \quad \text{for } n \in N \tag{4}$$

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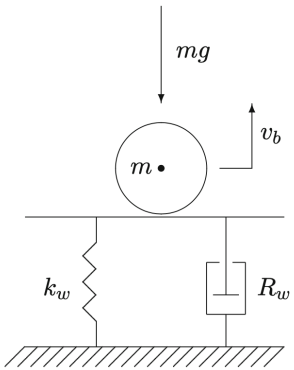
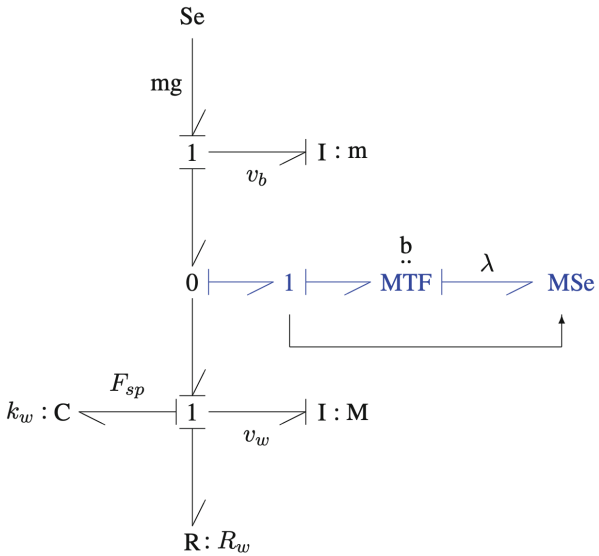
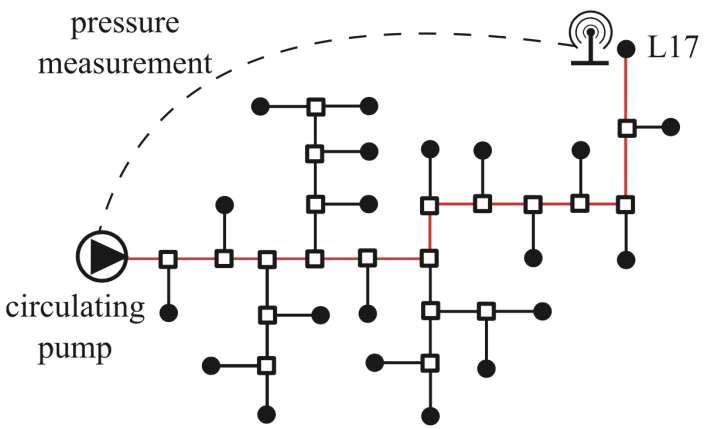
CEEFC and Bond Graph



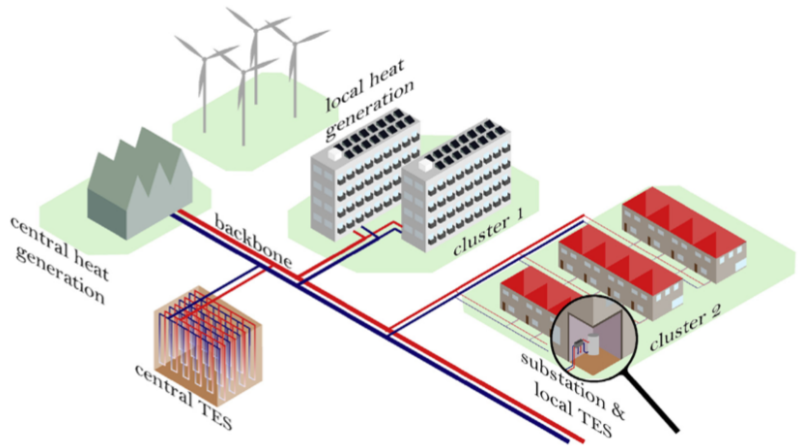


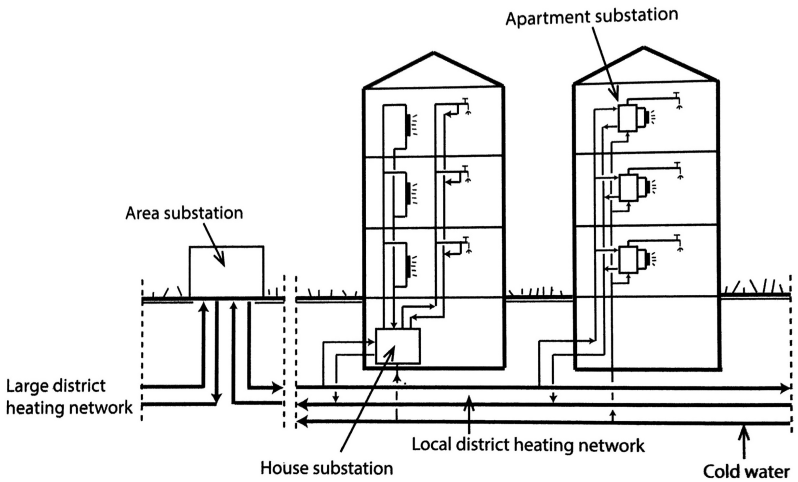


CEEFC to model and control of hybrid dynamical system

1. Conduit
2. Effort, negative or positive
3. Event
4. Flow
5. Control

Objects in this Project





Two kinds of networks.

1. Radial Network, without loops
2. Meshed Network, with loops

Overall, we can see the district heating networks as a radial network supplying heat. In a multi-dwelling building, the heat transfers between flats form a meshed network.

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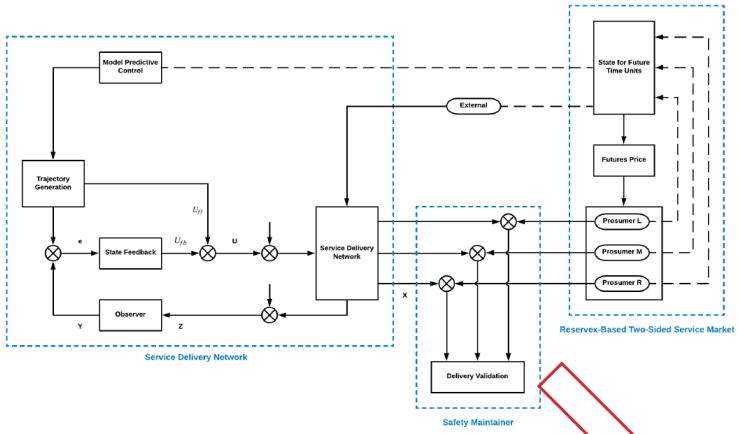
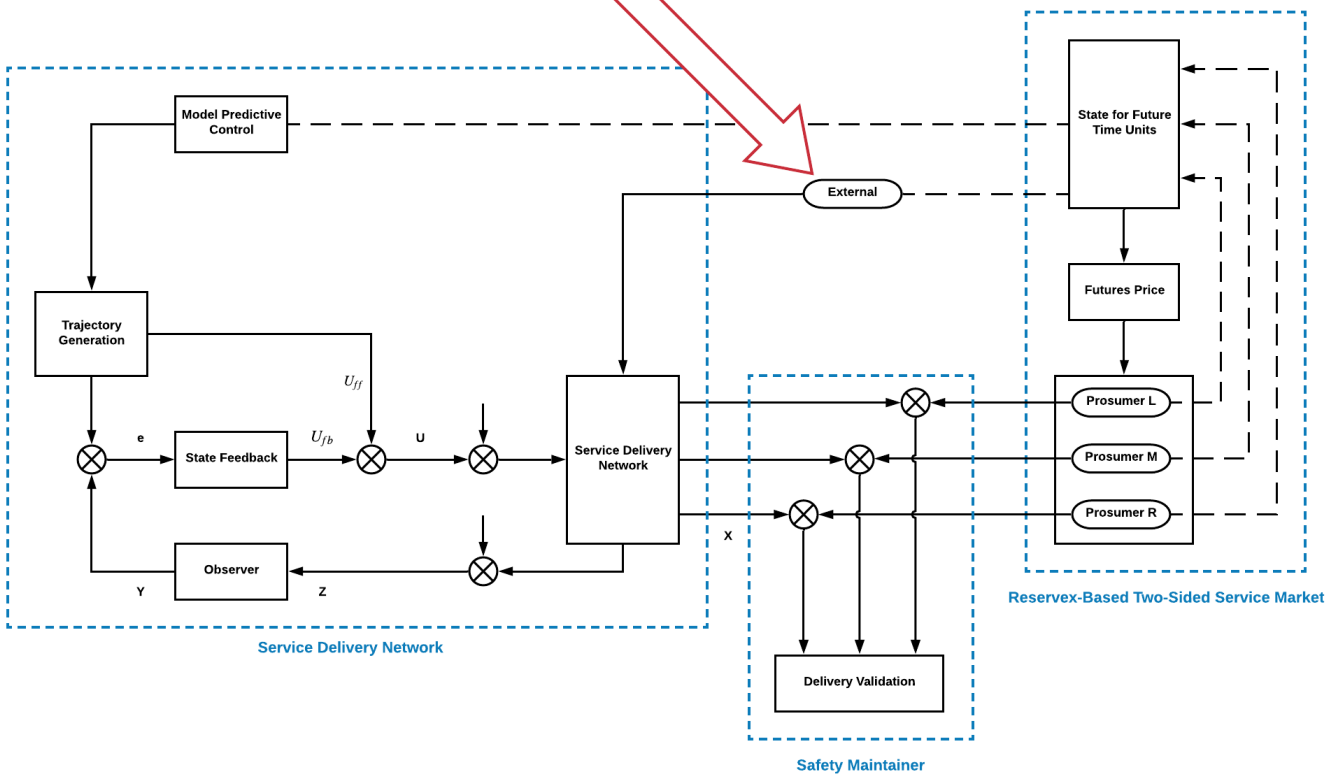
External Effort, Hierarchy and Scalability

Upper Level

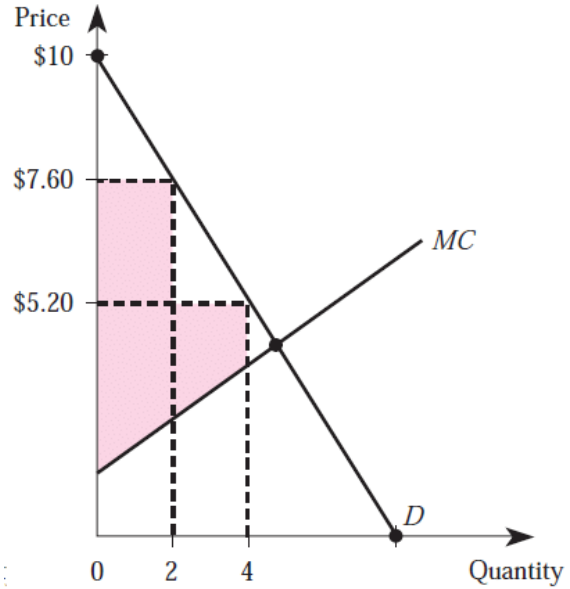


Lower Level



Nodal Pricing, Market Segmentation and Market Power

1. If there are m congested lines, there are only $m + 1$ independent prices. [biggar2014economics]
2. Network constraints increase opportunities for strategic bidding. [kirschen2018fundamentals] Because the thickness and liquidity is reduced.
3. Nodal pricing increase the level of price discrimination, and reduces the effect of market power.



Participant	Stochastic	Flexible
Demand Side	Anticipation	Demand Response
Supply Side	Forecast	Load Following
Prosumer	Lead	Follow

Figure: Summary of prosumers in the two-sided reservation market