# Architecture for Future Distribution Systems Including Active Consumers with Rooftop Solar Generation


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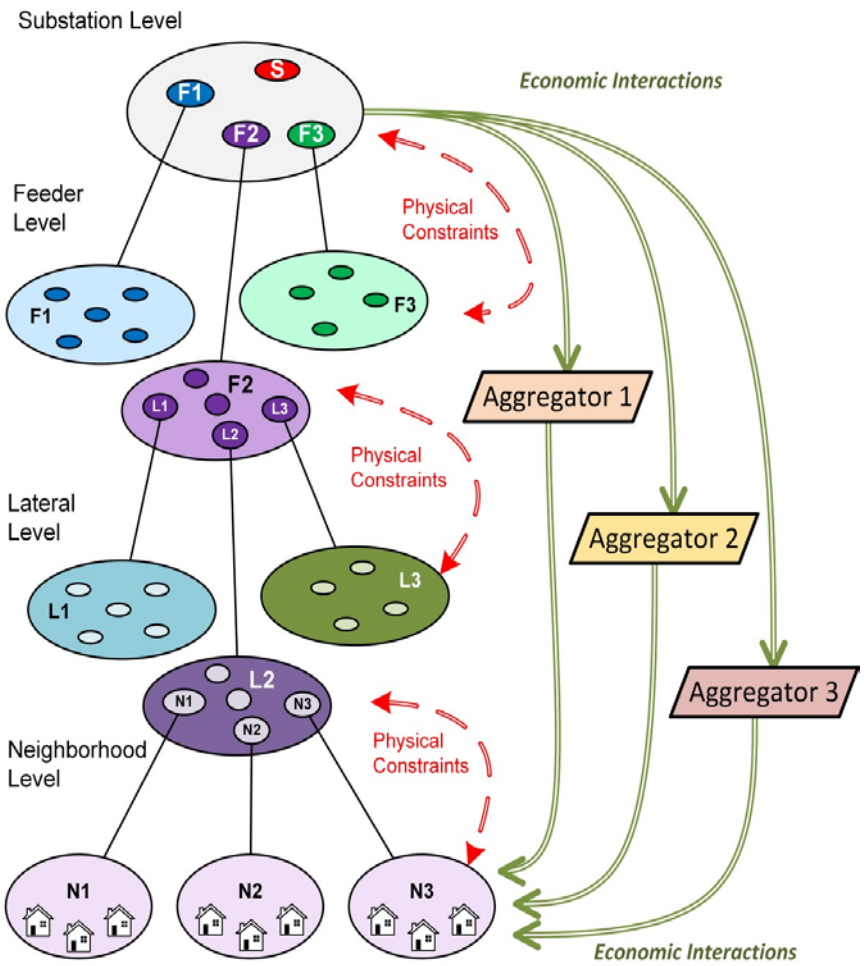
# Description

Architecture to support transactive energy market of "active consumers" engaged in buying and selling electricity (locally generated from resources such as rooftop solar photovoltaic) in response to real time electricity pricing.

1) An HMAS architecture for integrating the cyber and physical system aspects all the way from the consumer level to the power grid,
2) Stochastic models for consumer behavior that capture consumer preferences and reactions to changing electricity prices,
3) Distributed control actions the utility can take to mitigate adverse effects associated with active consumers and to proactively create conditions beneficial to consumers and the utility.



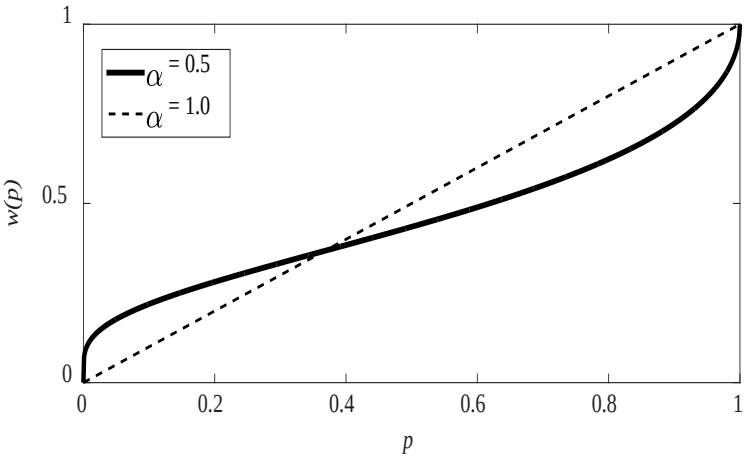
# Findings

$$\omega(p) = exp(-(-\log p)^{\alpha}), 0 \leq \alpha \leq 1$$

- **Prospect Theory** (D. Kahneman and V.L. Smith, 2002 Economics Nobel Prize): People over-weigh the low probability outcomes and under-weigh outcomes with moderate to high probabilities
- Price of electricity:

$$\rho \in \{\rho_1, \rho_2, \ldots, \rho_n\}$$

- Mixed Strategy: Probability distribution of electricity price: $\mathbb{P}(\rho)$
- Stackelberg leader-follower game
  - Aggregator - Leader
  - Active Consumer - Follower
- Rational consumers recognize higher expected price (blue) and reduce energy consumption. Irrational consumers change their energy consumption by a smaller amount.




Consumer actions for different coefficients of rationality