Competitive Energy Generation Scheduling in Microgrids

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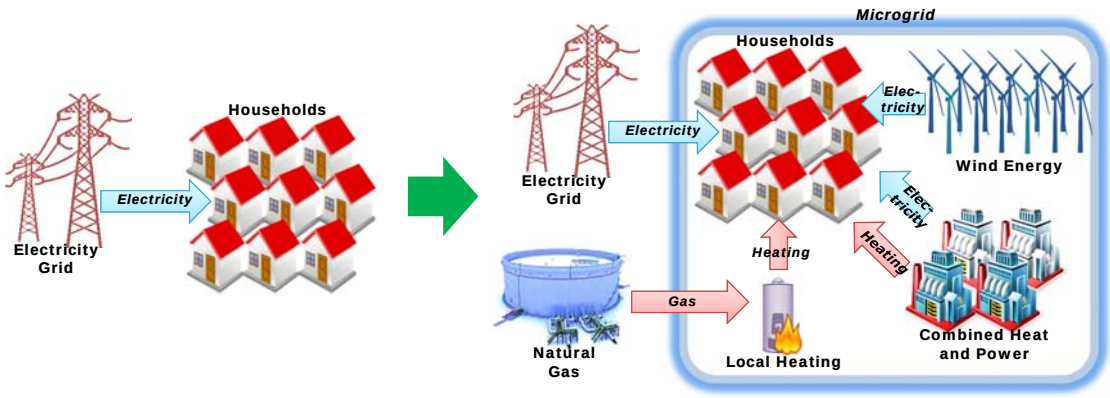
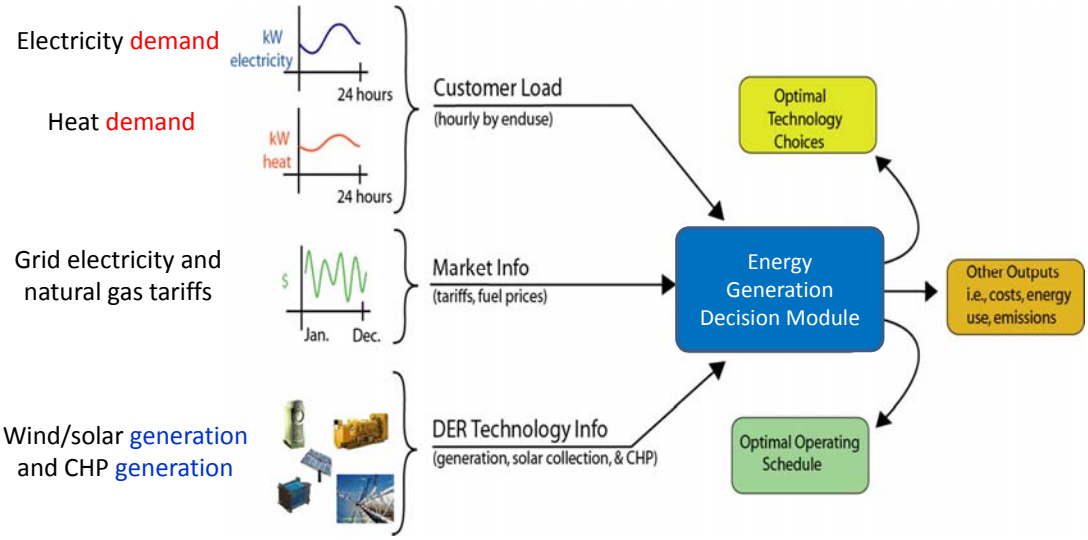
Microgrid: A New Paradigm



- Microgrid is a distributed power system that satisfies heat and electricity demand with two sources of supply:
  - External electricity and heat supply
  - Local generation (renewable, combined heat and power(CHP))

A Key Problem in Microgrid Operation

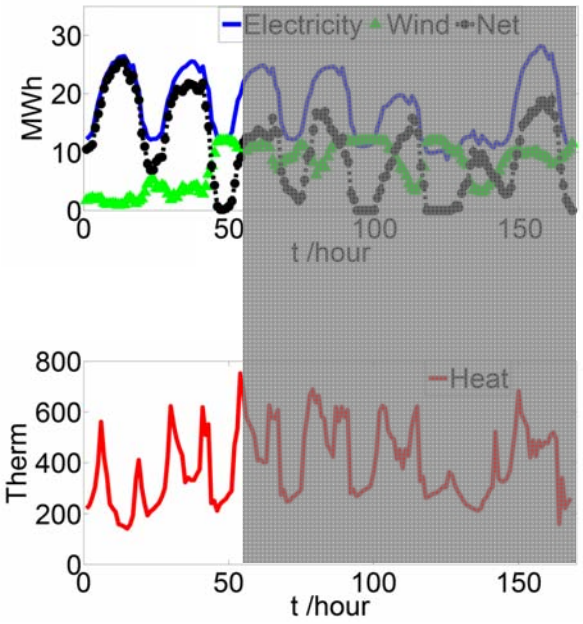
- *Real-time* balancing supply and demand with minimum cost
  - Electricity cannot be stored cheaply, yet



Picture source: Lawrence Berkeley National Laboratory, 2007.

Microgrid Demands Are Difficult to Predict: Prior Approaches Fail

- Prior assumption:
  - Demand is predictable
- Local (net) demands are difficult to predict
  - Net electricity demand inherits uncertainty from wind and solar
  - Electricity and heat demands express different uncertainty pattern

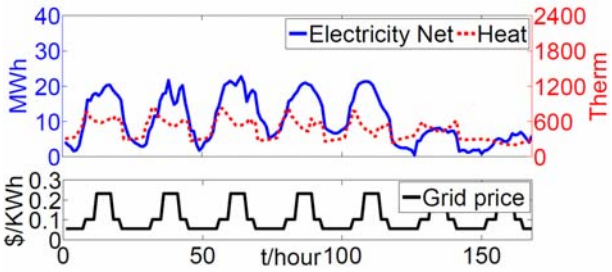


Our Contributions

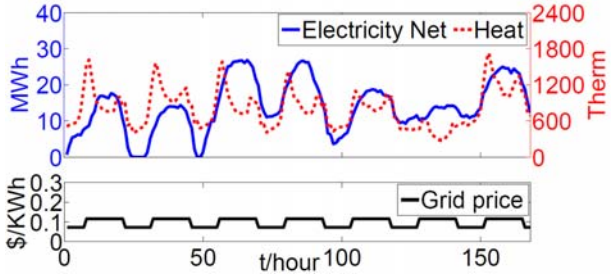
Prior Art: Offline	Our Paradigm-Shift Approach: Online – CHASE and rCHASE
Predict and optimize No performance guarantee in the presence of uncertainty	When future input is completely unknown: Competitive Ratio (CR)of $CHASE_{fast\text{-}resp.} < 3$ That is, for arbitrary input, $\frac{Cost\ of\ CHASE}{Minimum\ offline\ cost} < 3$ CR improves with look-ahead Randomized rCHASE achieves a CR of 2.13

CHASE – **C**ompetitive **H**euristic **A**lgorithms for **S**cheduling **E**nergy-generation

Case Study based on Real-world Traces



(a) Summer week

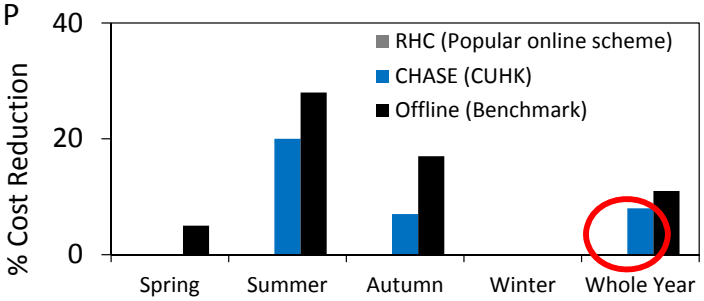


(b) Winter week

- Electricity/heat demand traces from a San Francisco college
- Power output from a nearby wind station
- Compare OFFLINE, CHASE, and an alternative RHC

CHASE Leads to 20% Cost Saving

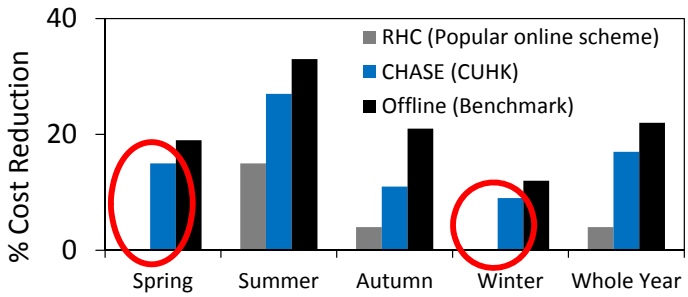
(a) Without CHP



RHC:
Perform badly, all zero

CHASE:
Closer to benchmark

(b) With CHP



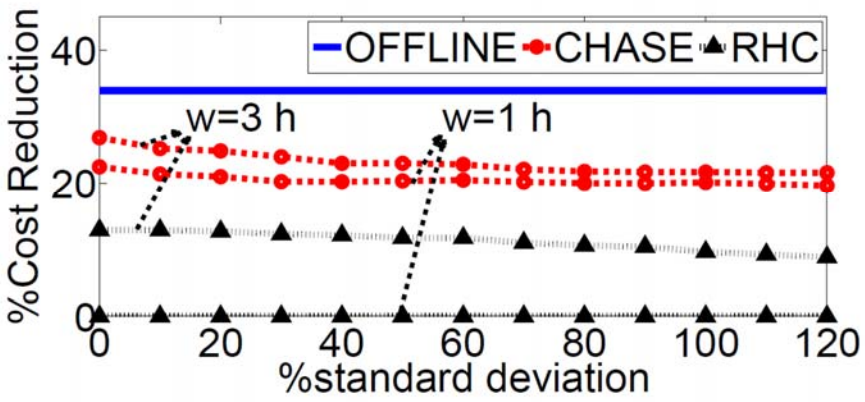
RHC: Some zero

CHASE:
~ 20% cost saving

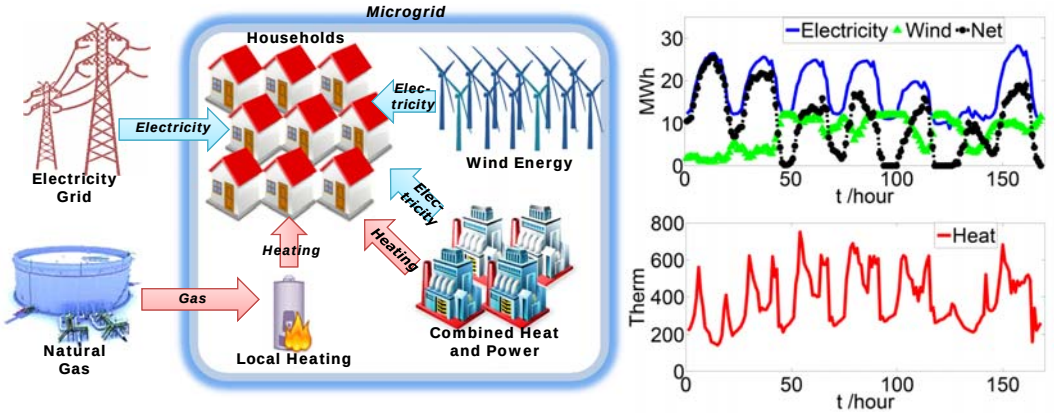
- CHP technology gives additional 10% cost saving

Benefit of Looking Ahead

- CHASE save 20% cost even without look-ahead
- CHASE is robust to prediction error



Conclusion



- We propose **CHASE**: a paradigm-shift solution for energy generation scheduling in microgrids
  - Does not rely on demand prediction
  - Achieves the provably best competitive ratio without look-ahead
  - Performance improves with look-ahead
  - Leads to 20% cost reduction in case studies