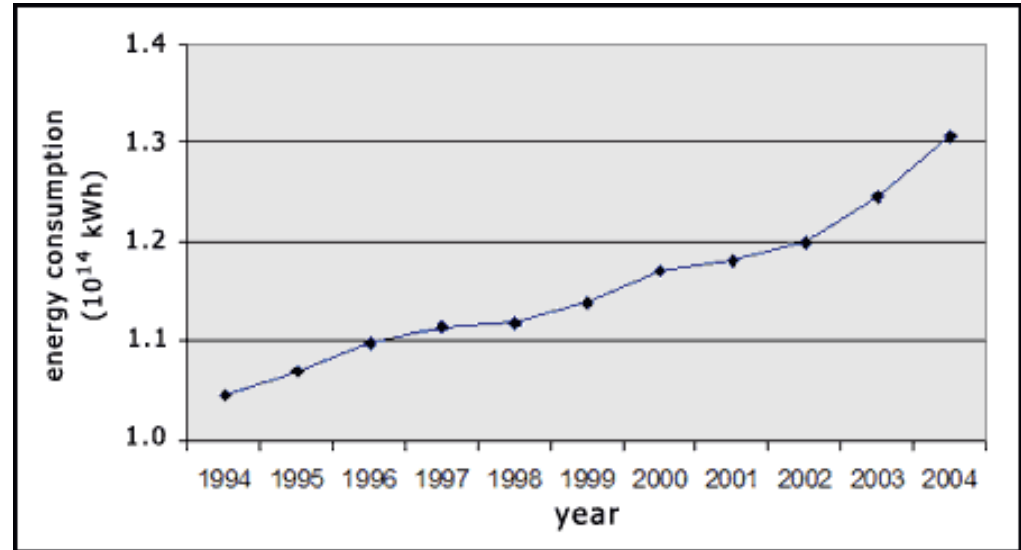# Demand-side Energy Management

Large-scale decentralized coordination and aggregation

Evangelos Pournaras MSc BSc

Challenges

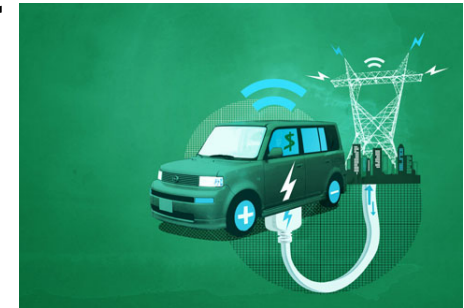Source: US Departement of Energy Information Administration

Scale

Demand-side energy Management

Demand-supply requirements and constraints
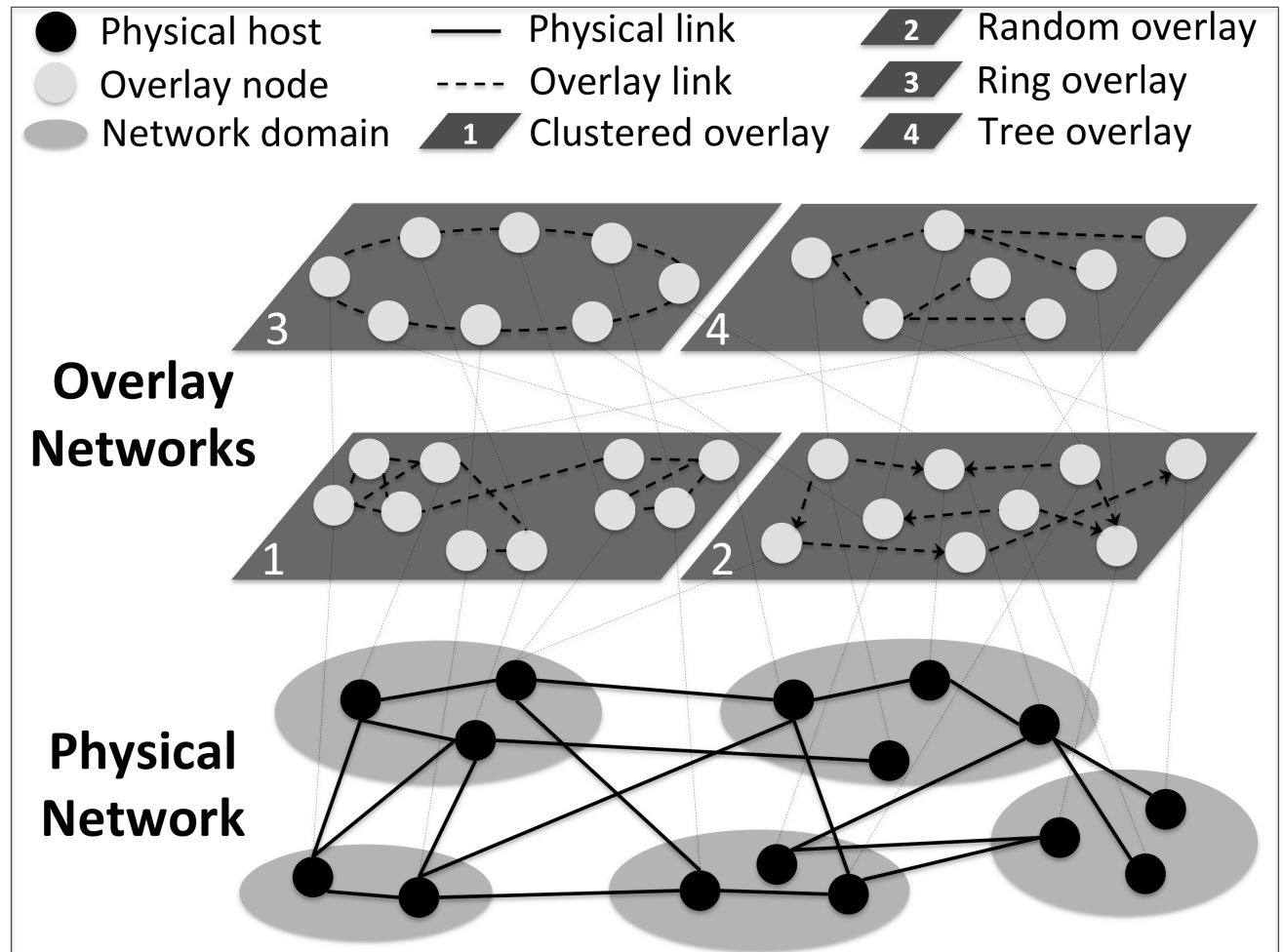
Decentralization/self-management

Different levels of user involvement

Approach

Network virtualization

Overlay networks and services

Outline

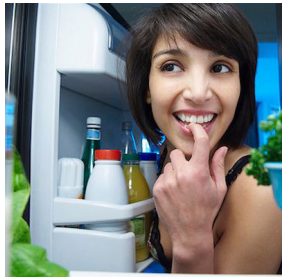**Consumerocracy**

Two levels of user involvement

1. Stabilization of energy consumption

2. Adjustment of energy consumption

Level 1: Consumption stabilization

Generation of alternative consumption plans for future time period

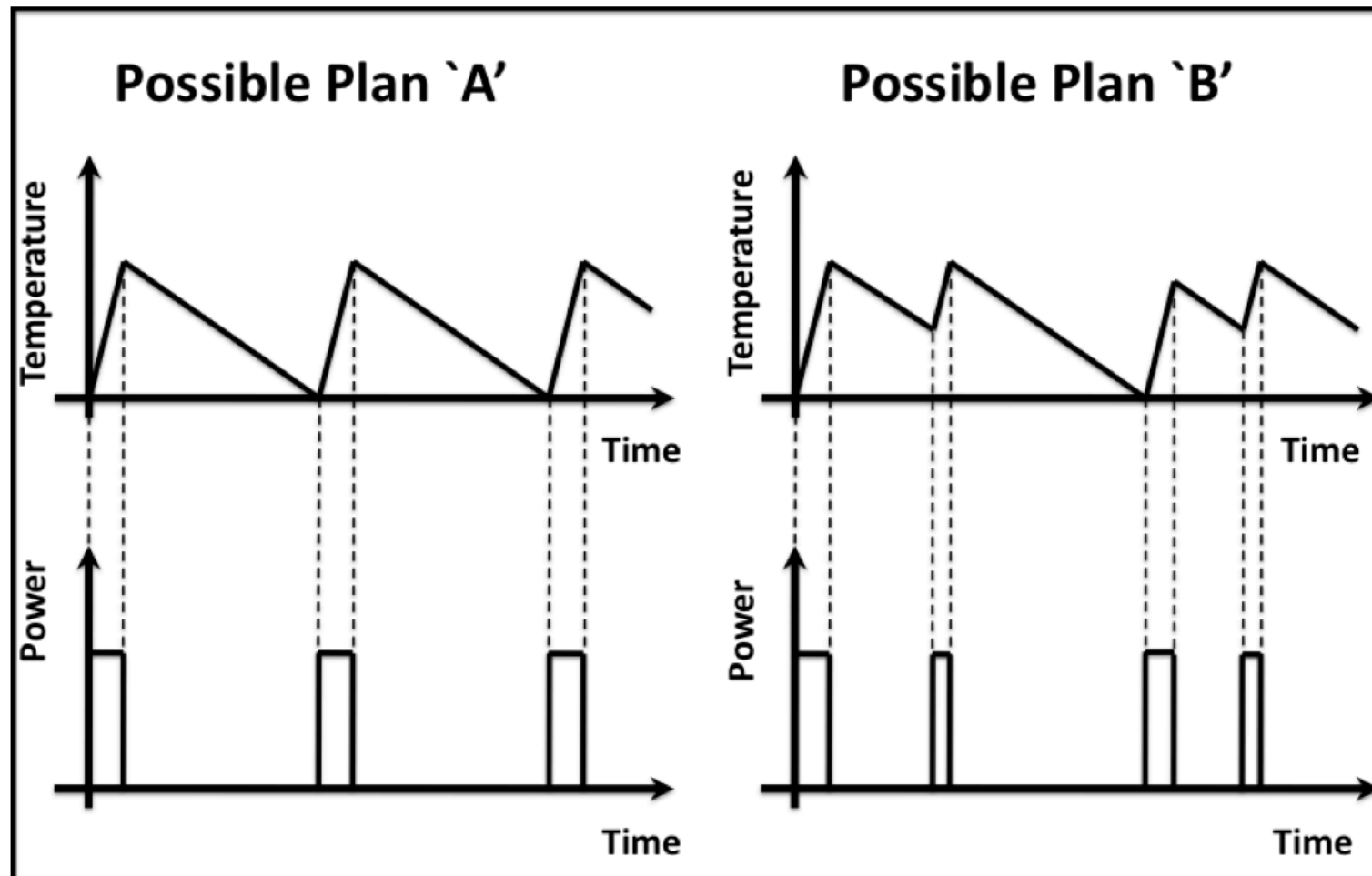Minimize deviations given an average energy consumption

EPOS – Energy Plan Overlay Self-stabilization

Control of thermostatically controlled devices – No user involvement

Consumption coordination: Selection of the most stabilized plan combination

Consumption plans

Technology

Is this possible?

LG introduces its first Smart Grid-Ready Refrigerator the DIOS

Category: *Environment Household* - *Tags:* *Household, Lg, Lge, Smart Adapt, Smart Grid, Wi-fi, Wifi*

Barely 24 hours Samsung's Smart Grid Ready fridge, LG is now announcing its very own connected Smart Grid-Ready DIOS Fridge in Korea. The new smart refrigerator offers updates and information that can be accessed via smartphones and tablets. It offers three powerful smart savings options: late night saving, preferable time saving and the Smart Grid-ready.

The smart fridge also comes with Smart Adapt, which allows owners to keep their refrigerator software up-to-date with the latest upgrades, features and options. The smart fridge is also a source of useful information as it keeps track of daily schedules and dispenses regular weather reports. And instead of having to jot notes on sticky memos, family members can turn the fridge's LCD screen into a note pad to leave messages for each another.

Via LGE   4 Comments

Category **ENVIRONMENT HOUSEHOLD**

Available Technologies

Grid Friendly Appliance™ Controller

Battelle Number(s): 12782-E, 13538-B
Patent(s) Issued
Available for licensing in all fields

Awards Won:
R&D 100 Award - 2008
FLC Award - 2007

Summary

The Grid Friendly Appliance controller developed at PNNL senses grid conditions by monitoring the frequency of the system and provides automatic demand response in times of disruption.

Within the North American power grid a disturbance of 60-Hz frequency is an indicator of serious imbalance

(click on image for full size)

A coin-sized integrated circuit developed by researchers at Pacific Northwest National Laboratory may help solve the nation's overworked electricity grid. Called The Grid Friendly™ Appliance Controller, the circuit board would turn normal household appliances into ones that would better regulate energy usage and help prevent local and national blackouts.

between supply and demand that, if unarrested, leads to a blackout. This simple computer chip can be installed in household appliances and turn them off for a few minutes or even a few seconds to allow the grid to stabilize. The controllers can be programmed to autonomously react in fractions of a second when a disturbance is detected, whereas power plants take minutes to come up to speed. They can even be programmed to delay restart instead of all coming on at once after a power outage to ease power restoration.
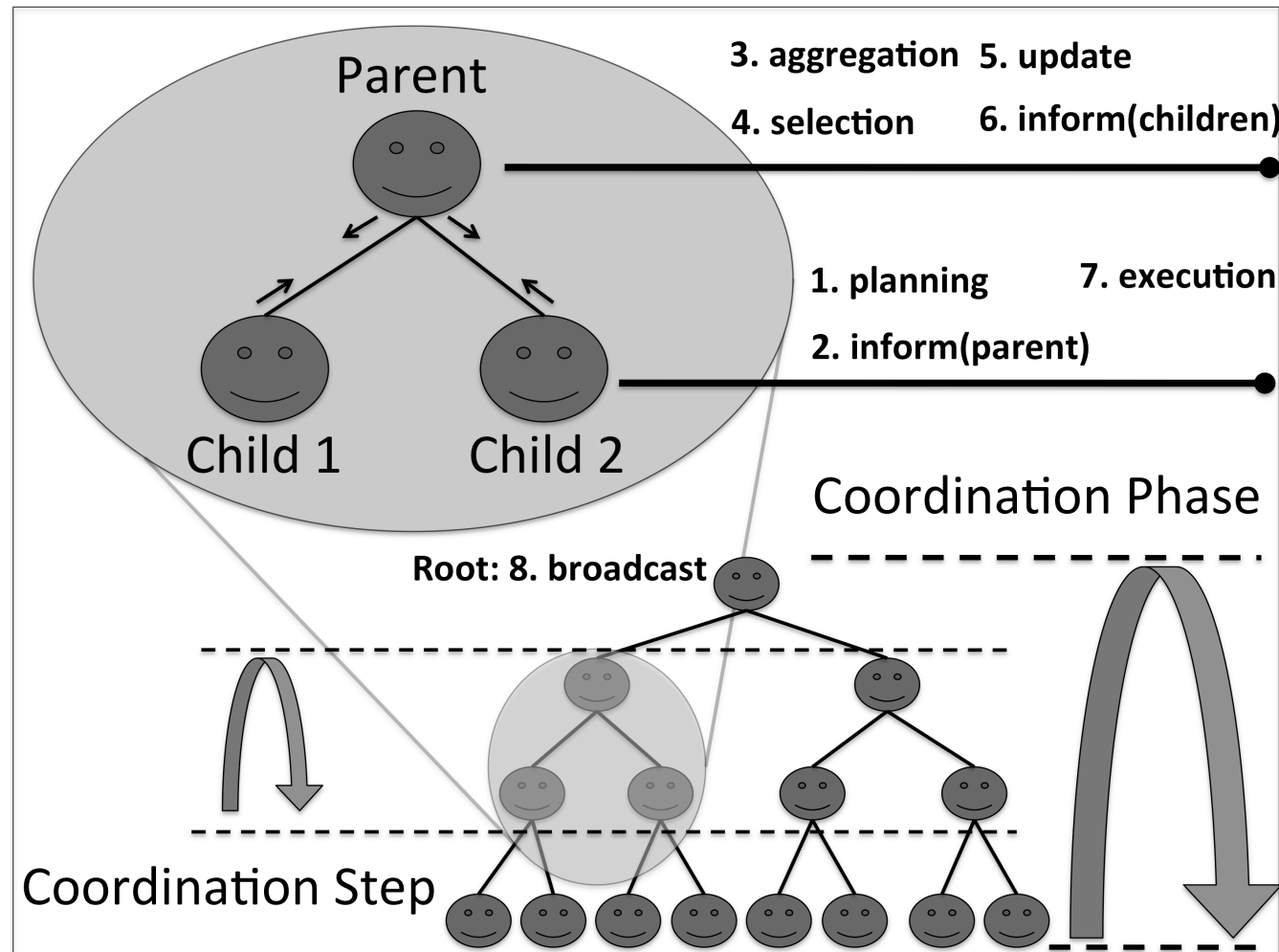
Advantages

- More reliable power grids are less costly to run
- Smaller electricity bills for consumers
- More efficient power plant use
- Inexpensive
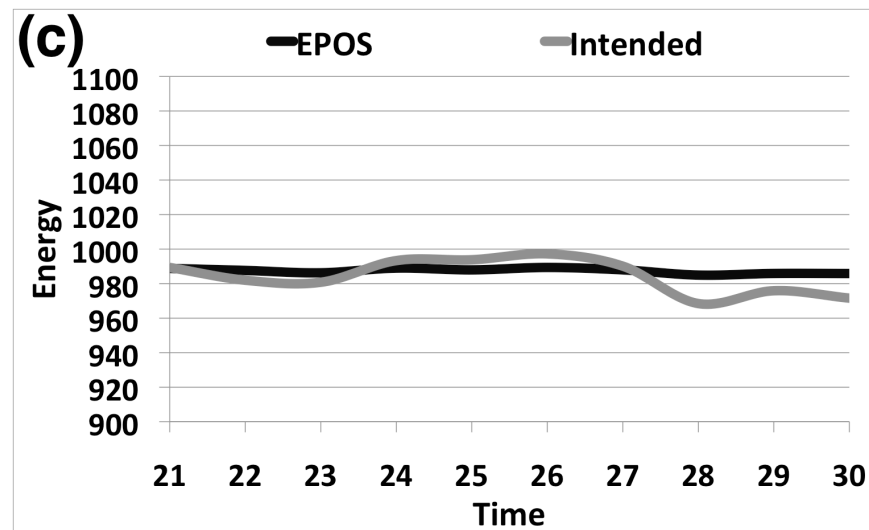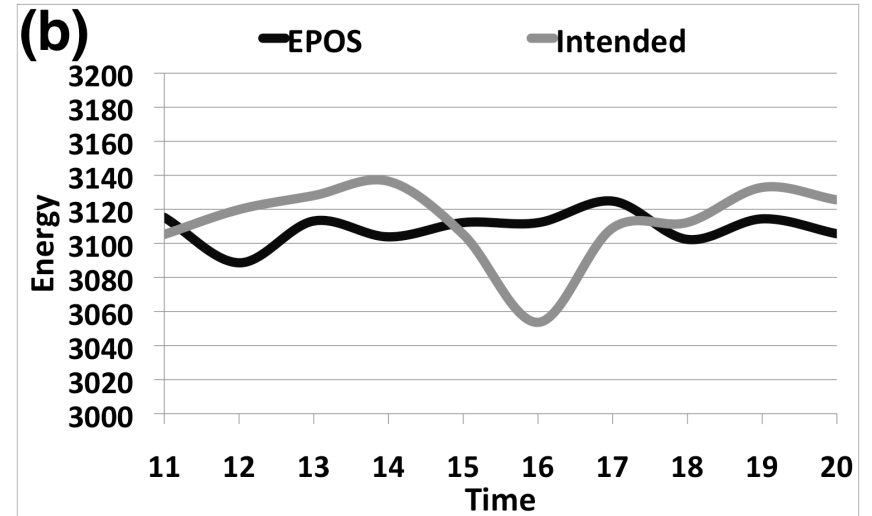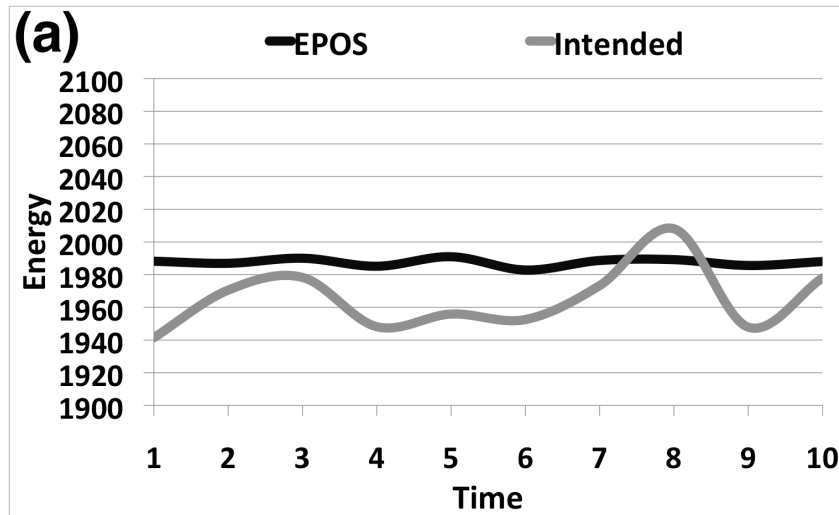- A foundation for future grid management

Selection
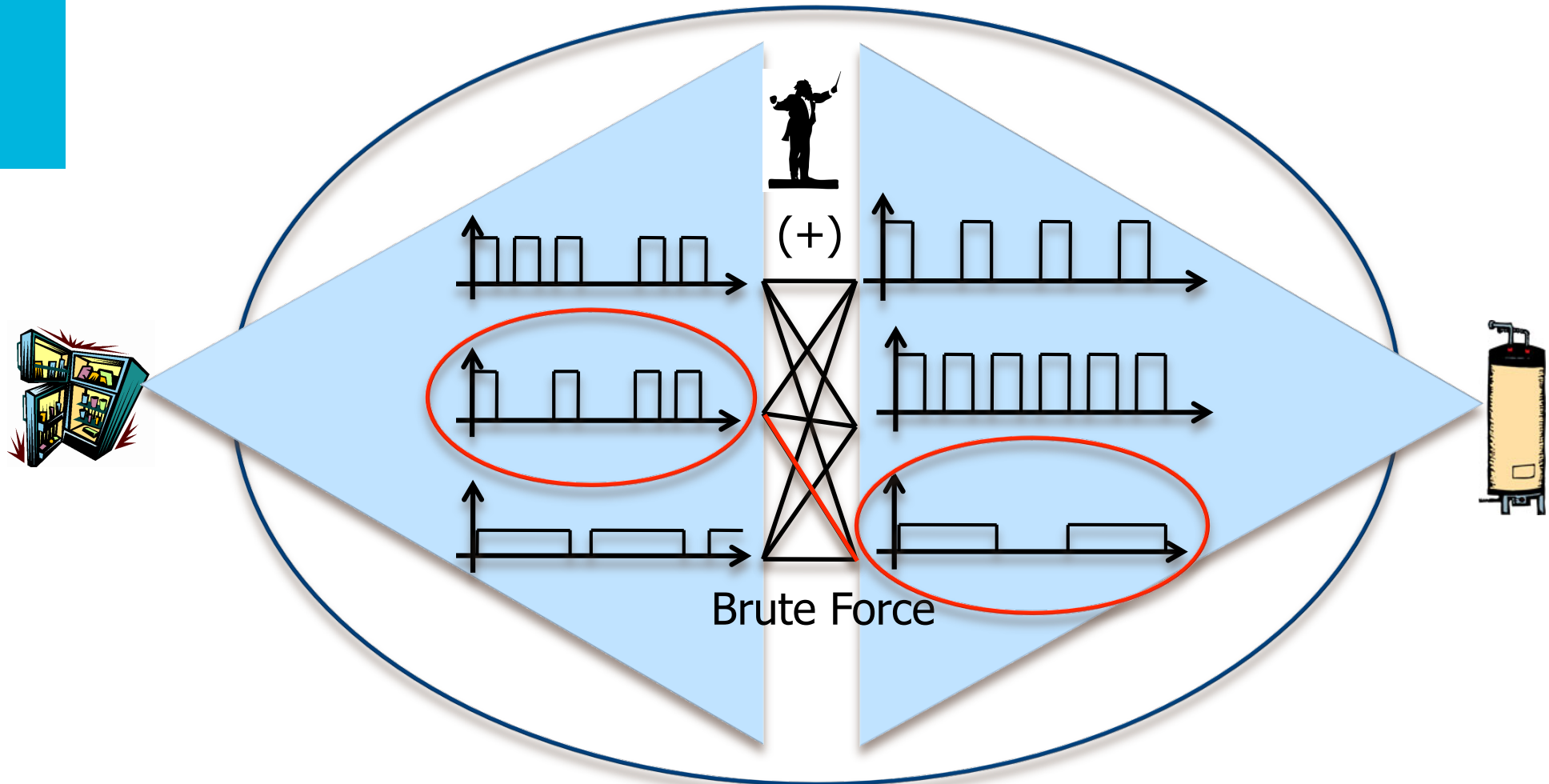
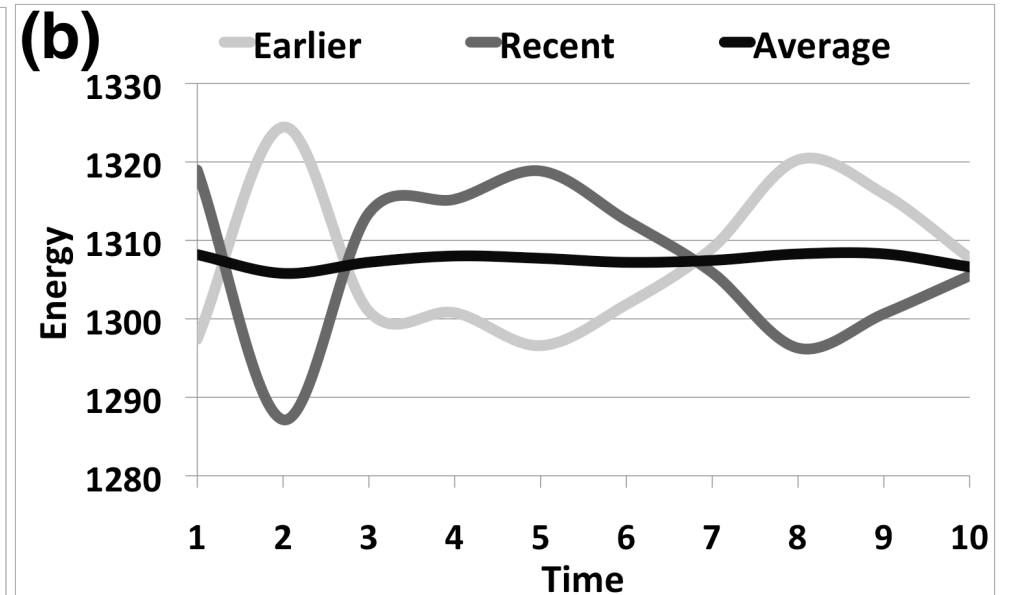**Complexity = # of possible plans$^{\text{# of devices}}$**
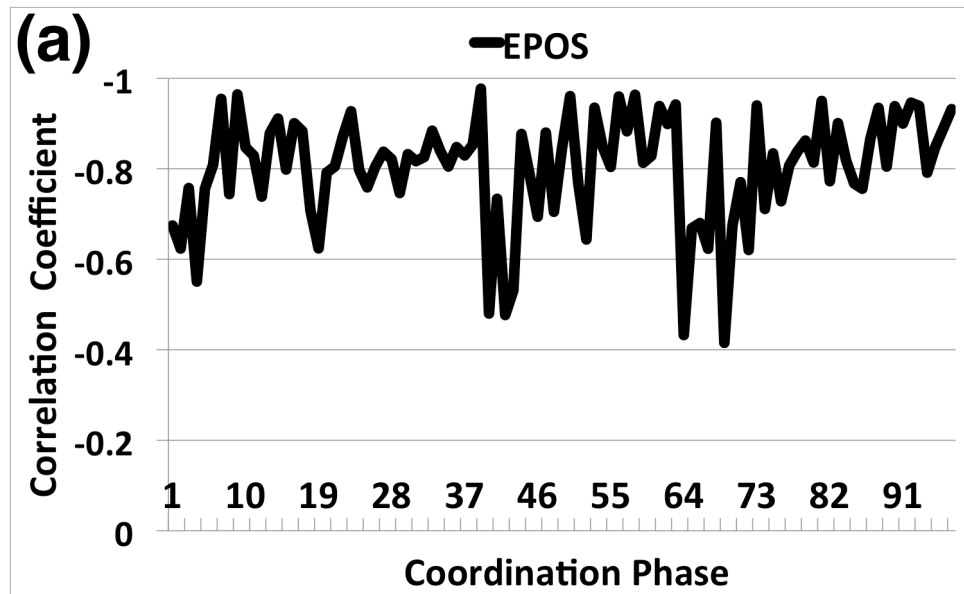
Coordination

Results

Results (Cont.)

Level 2: Consumption adjustment

Increase or decrease demand based on the availability of supply

Incentivized consumers selecting consumption profiles – comfort vs. economy
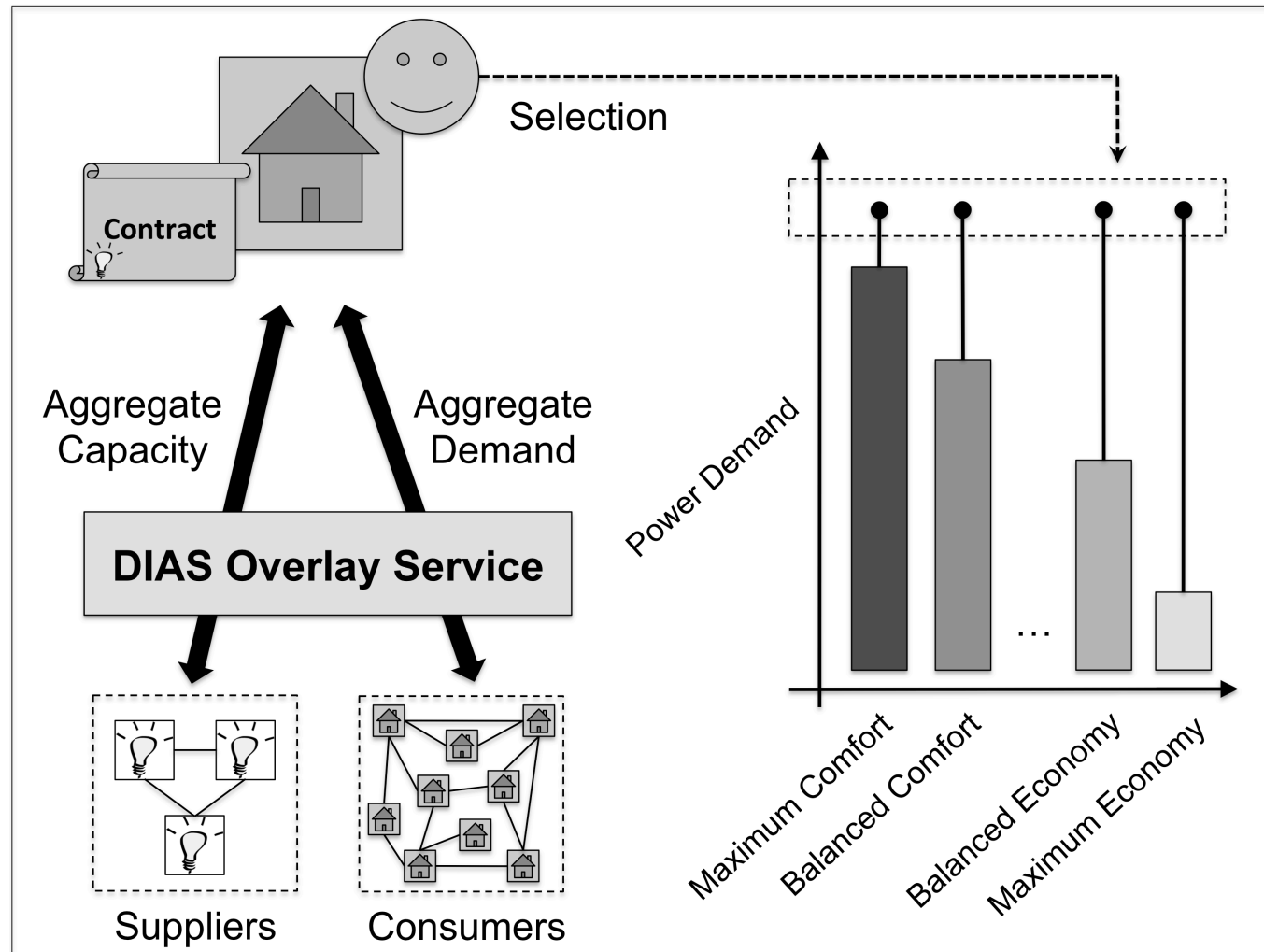
ALMA – Adaptive Load Management by Aggregation

Decentralized aggregation for self-awareness

Local changes of consumption profiles based on global demand

Requires utility contracts that reward certain user flexibility

System Overview

Case Study

Real data from 112 households during 03/2006-03/2007

Data collection every 5 minutes

Olympic Peninsula Smart Grid Demonstration Project

3 contract types: FIXED, TIME OF USE, REAL TIME PRICING + CONTROL group

Control of HVAC systems and water heaters

8 occupancy modes and 3 heating/cooling modes

Data Aggregation Analysis

Find **average consumption/day/consumer** for each occupancy mode, heating/cooling mode during the project year

Compute the maximum and minimum bound of average consumption/day/consumer **if the respective occupancy and/or heating/cooling mode selected**

Results
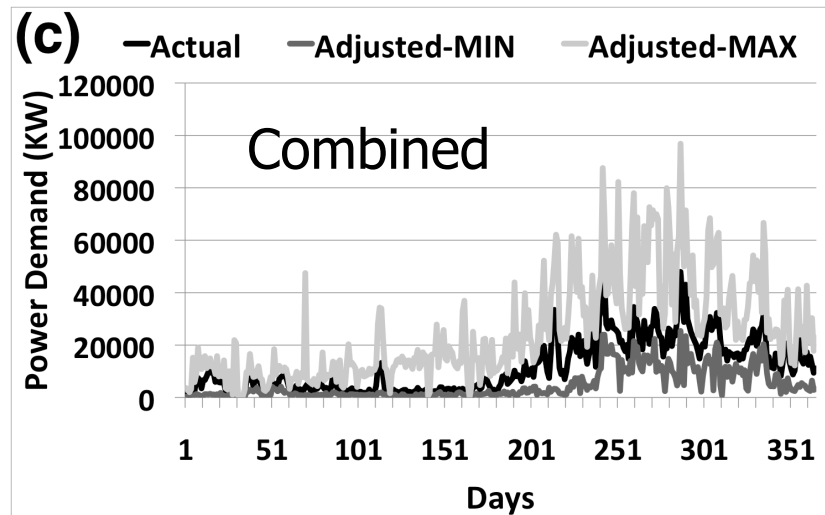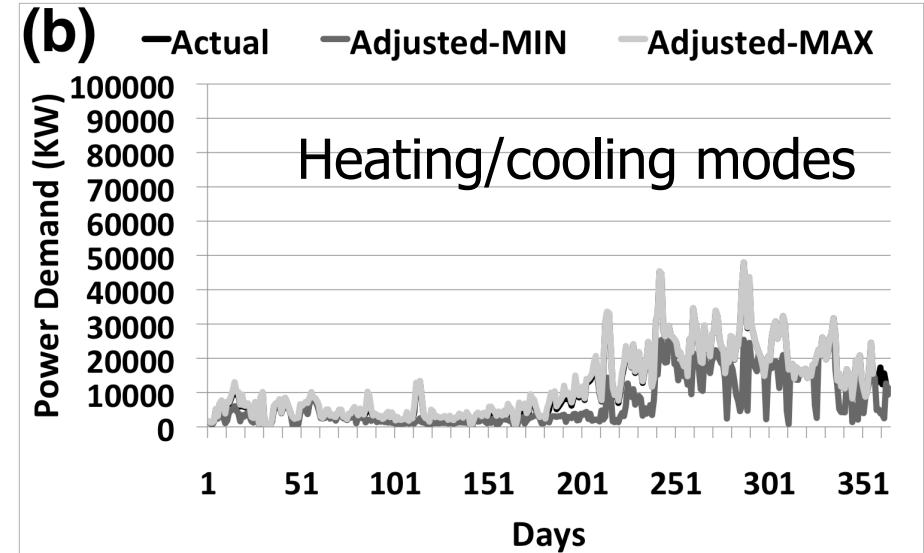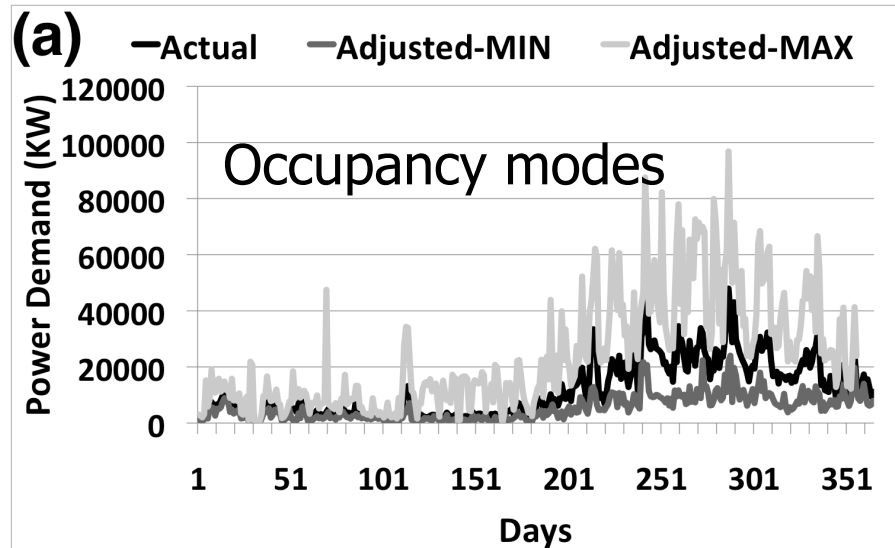
Conclusions

Overlay services for demand-side energy management:
coordination, aggregation

Consumerocracy

Improved demand stabilization and adjustment

Two incremental levels of user involvement

Questions?

More information

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