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Measuring and Controlling Unfairness in Decentralized Planning of Energy Demand

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TNO innovation for life

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Robustness in Smart Grids

Matching supply and demand

via…

demand-side energy management

demand planning

load-shifting

load-adjustment

shifting discomfort

adjustment discomfort

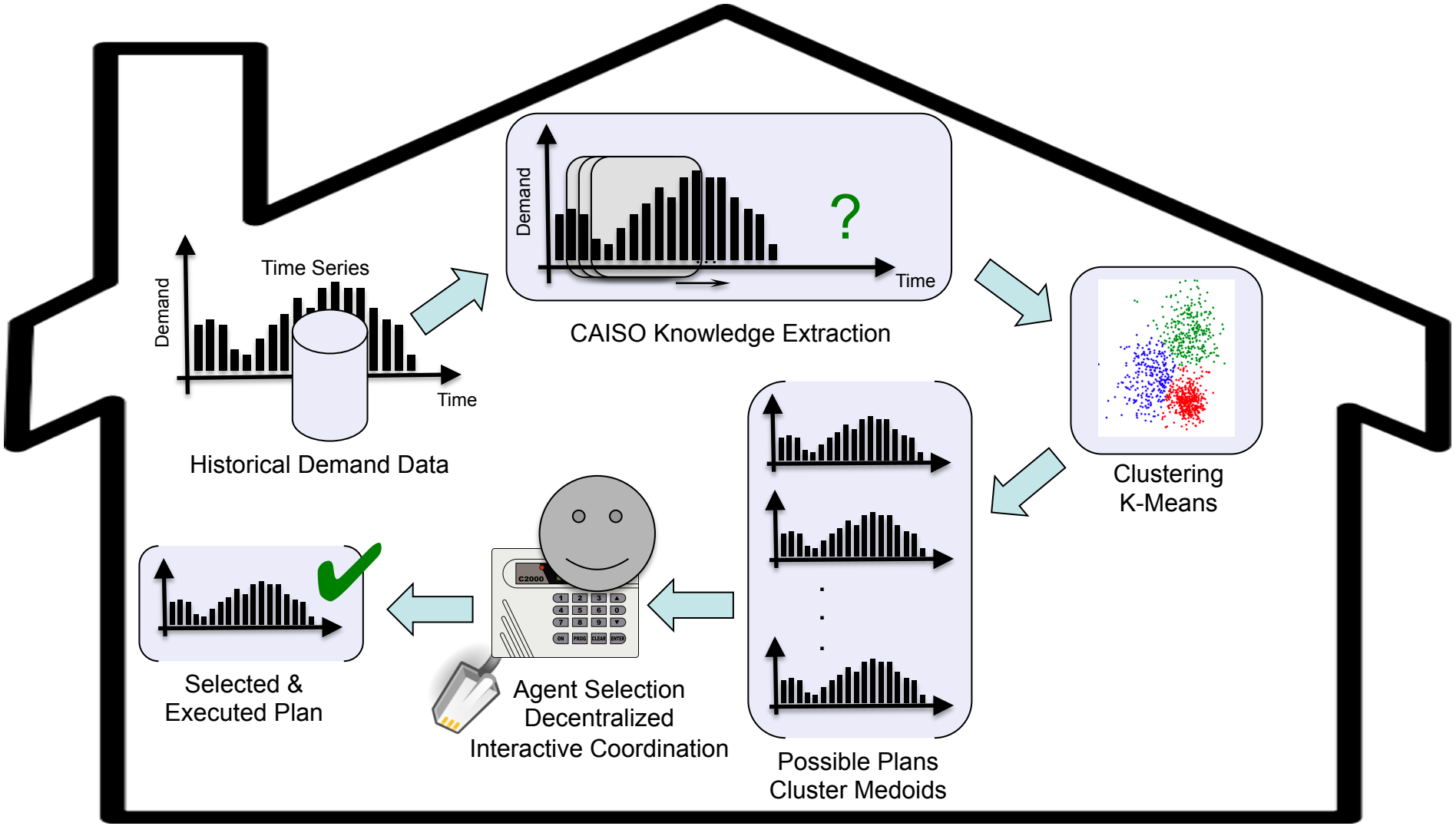
Fairness under Demand Planning

How **fair (or unfair)** is discomfort distributed among consumers that plan their demand to improve robustness in Smart Grids?

Can we **measure** unfairness?

Can we **control** unfairness?

Local Data-driven Approach



Measuring Unfairness

1. **Discomfort**: distance between planned and actual demand

2. How negative (1) **is perceived** by each consumer,
   e.g. Q: It is too inconvenient to reduce our usage of electricity

A posteriori measurements of unfairness

3. **Normalization** of discomfort values

4. **Standard deviation** of normalized discomfort values

Smart Grid Projects

1. Electricity Customer Behavior Trial project

782 consumers in Ireland from 01/2010 to 12/2010

2. Olympic Peninsula Smart Grid Demonstration project

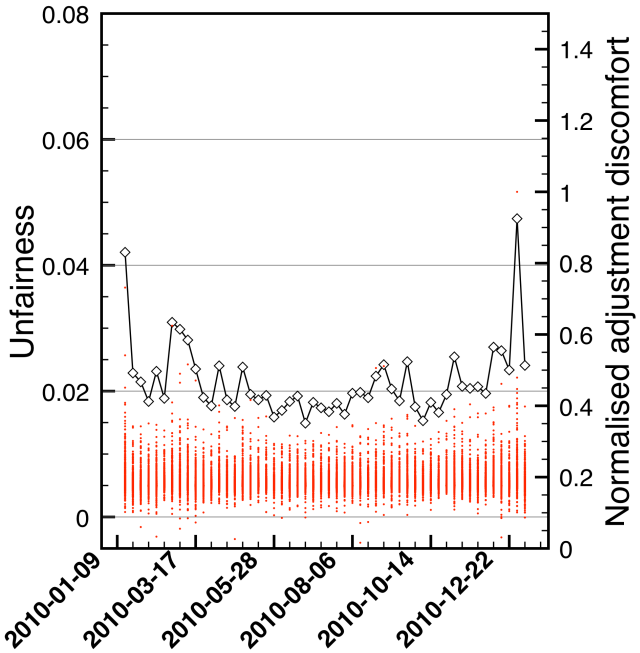
27 consumers in the USA from 11/2006 to 03/2007

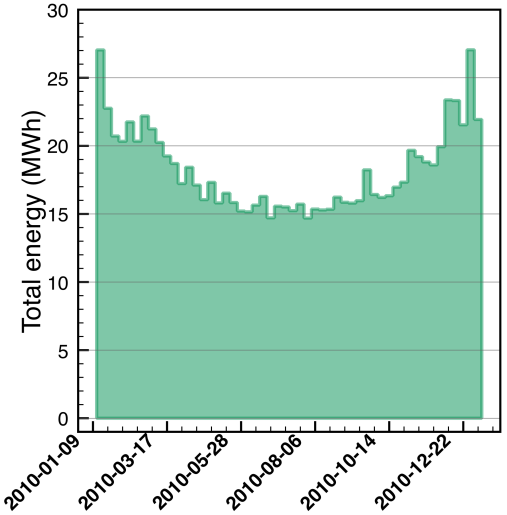
Realistic (i) **plan generation** & (ii) **discomfort measurements**

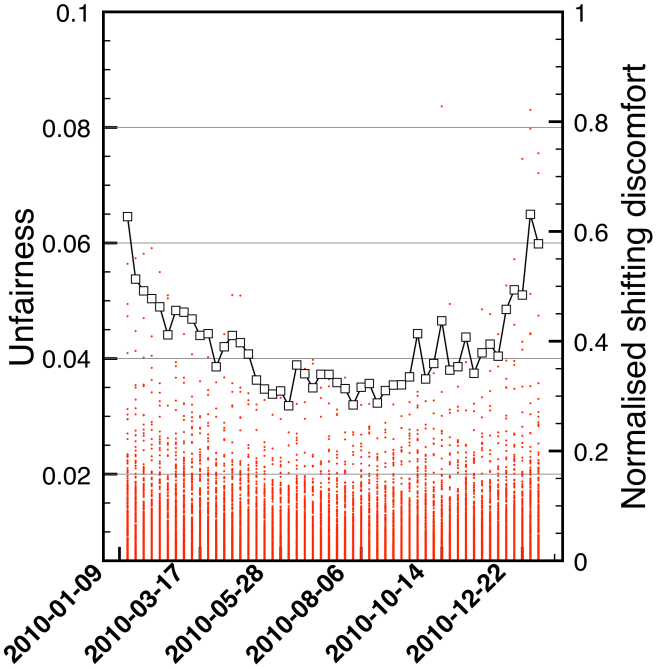
1. Survey question

2. Choices of thermostat setpoints

Temporal Influence

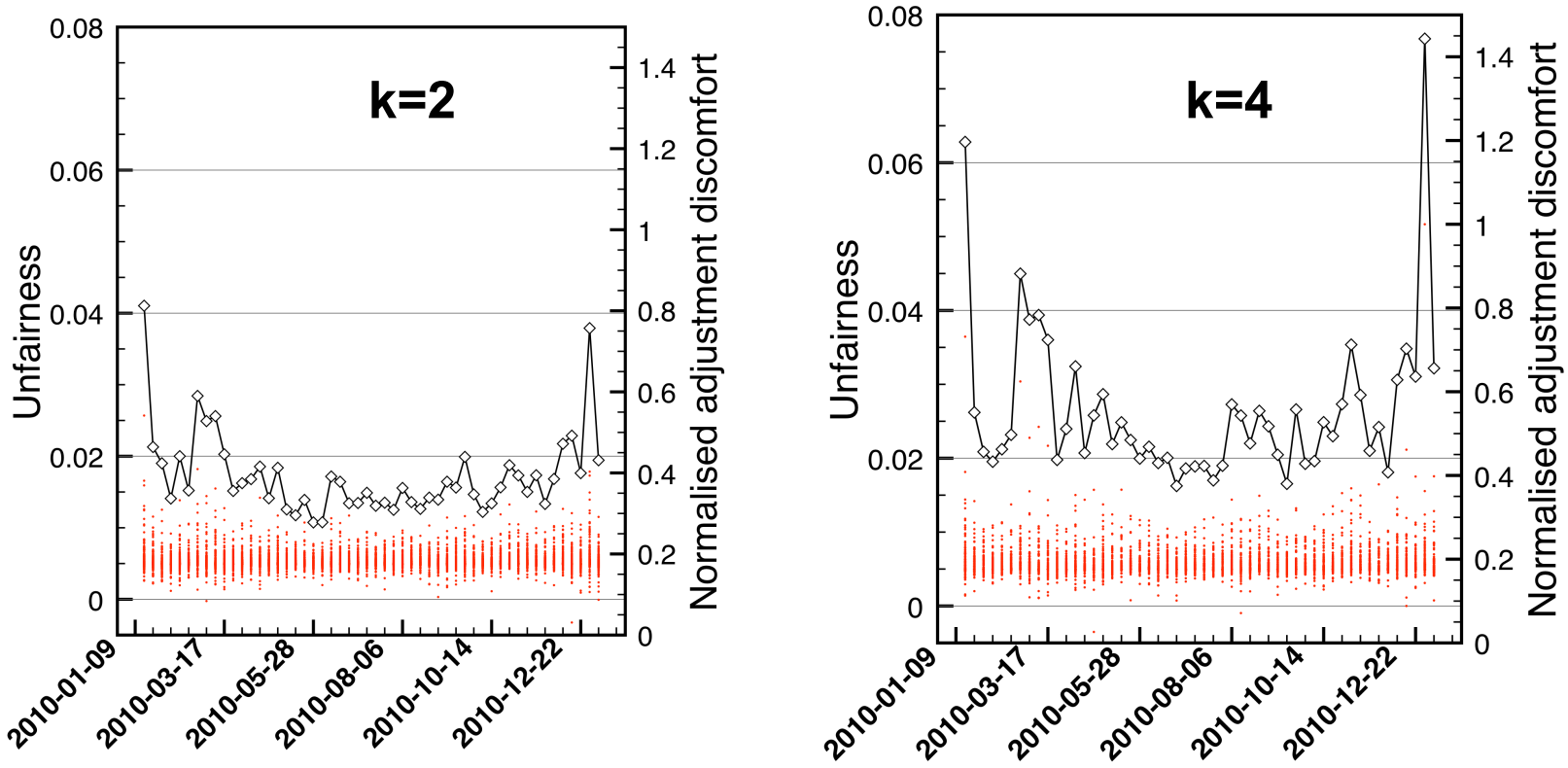






>0.8 correlation!

Control of Unfairness



Local management of unfairness by tuning the **number of generated plans**

Conclusions

1. Unfairness in demand planning in **temporally influenced**

2. Temporal influence is correlated with the **seasonal demand levels**

3. Unfairness is **locally controllable** by the number of generated plans

4. **Higher robustness** results in **higher unfairness**

Questions?

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