Energy Health Monitoring

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Recent report ECN

- *Buildings use approximately 40% of all energy in the world.*

- *Buildings emit about 50% of CO2 more than traffic or industry*

- *”Real estate owners need to invest 40 billion Euro to achieve goals of Energy agreement.”*

UvA 2014

- Energy use:
  - 3.2M m^3 gas
  - 36M kwh electricity
- Cost energy + water 2014: 8M EUR
- (Cost personnel: 375M EUR)

Main idea

Use data about building to detect malfunctions in installations that waste energy

Setting

- Building with installations for heating /cooling / ventilation / lighting and more

- Factors that determine energy consumption:
  - Use of building: open / people inside
  - Weather conditions

- Data → model (use + weather -> energy) = → “anomalies”

BMS (NL: GBS)

- System that controls climate and possibly other aspect of building
- Sensors: temperature (indoor/outdoor), humidity, CO2, sunlight, wind, presence of people
- Actuators: heating, cooling, fresh air, shutters, lights, ..
- Controller with simple programming language (BACNET)

Typical problems

- Errors in control settings

- Faults and broken parts (sensors, valves, ..)

Approach

- Collect historical data (with BMS)
- “enrich” (weather, use; KNMI, sensors)
- Find pattern
- Find deviations, anomalies
  - Past or online
  - 1 building or more
- Show to “experts”

Find pattern

- Use “Machine Learning”
- Use data:
  - weather, use/occupation, time of day, situation just + energy consumption
  - To automatically build “predictor”
  - Use this to predict Energy use

- If observed value is very different → alarm

SURFSara supported two projects

- by students!

1. Webservice for *gas consumption anomalies*

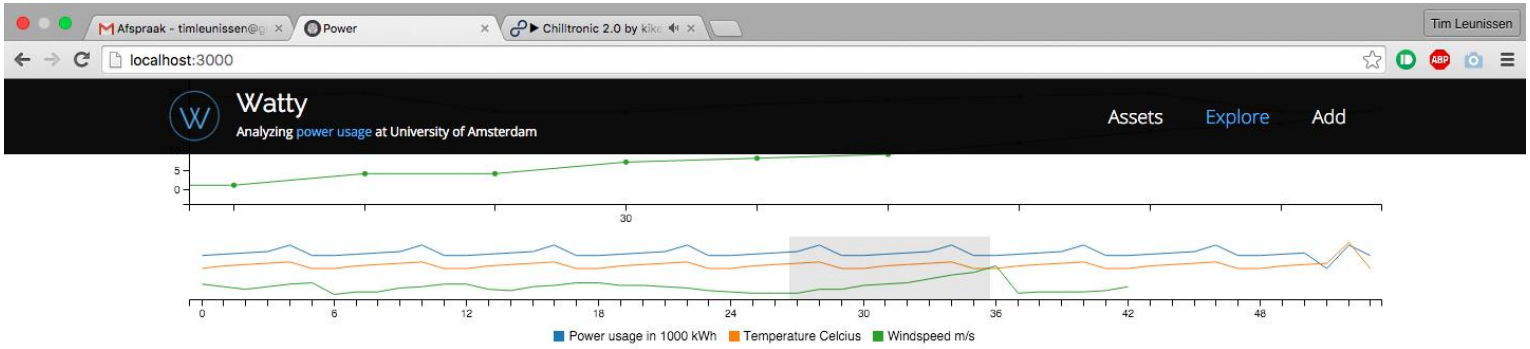
2. First experiment with *more complex BMS data*

Project 1: Webservice

- With Tim Leunissen
- Uses anomaly detection algorithm by Marco de Nadai

- Upload:
  - Your historical gas consumption data
  - Your postal code (→ historical weather data)
  - Your opening hours

- Gives: plot of gas consumption marking moments of anomalous gas consumption
- Could be adapted to online monitoring


Afspraak - timleunissen@g
Power
Chilltronic 2.0 by kike
Tim Leunissen
localhost:3000
Watty
Analyzing power usage at University of Amsterdam
Assets
Explore
Add
5
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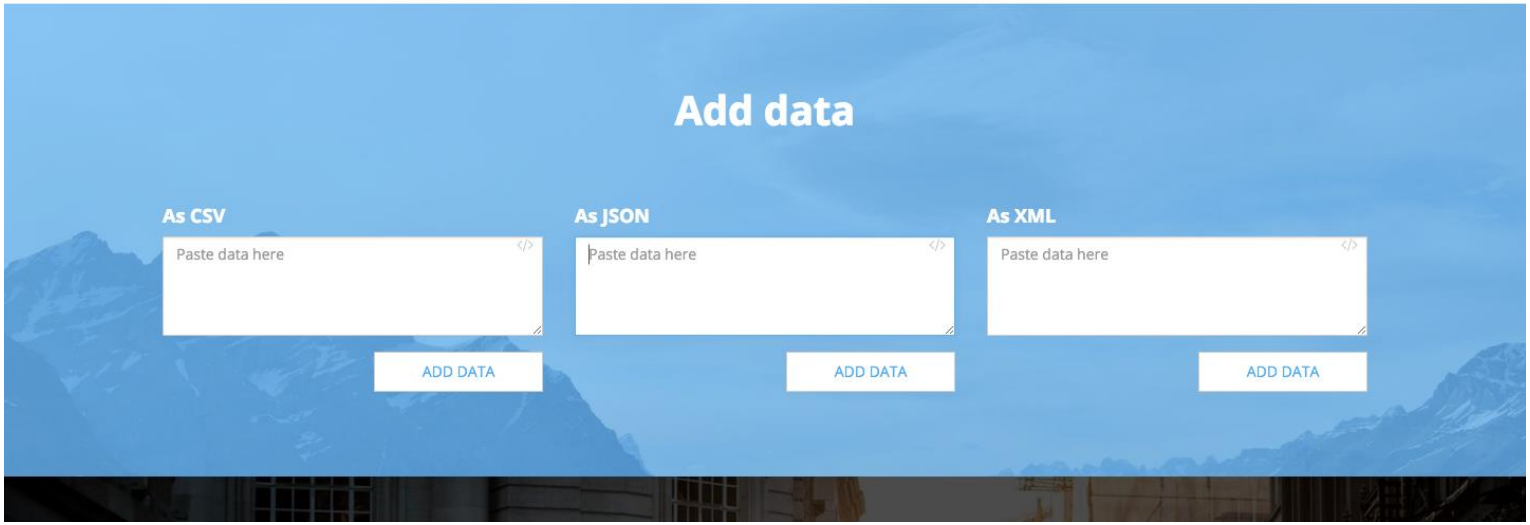
36
42
48
Power usage in 1000 kWh
Temperature Celcius
Windspeed m/s


Add data
As CSV
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ADD DATA
As JSON
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ADD DATA
As XML
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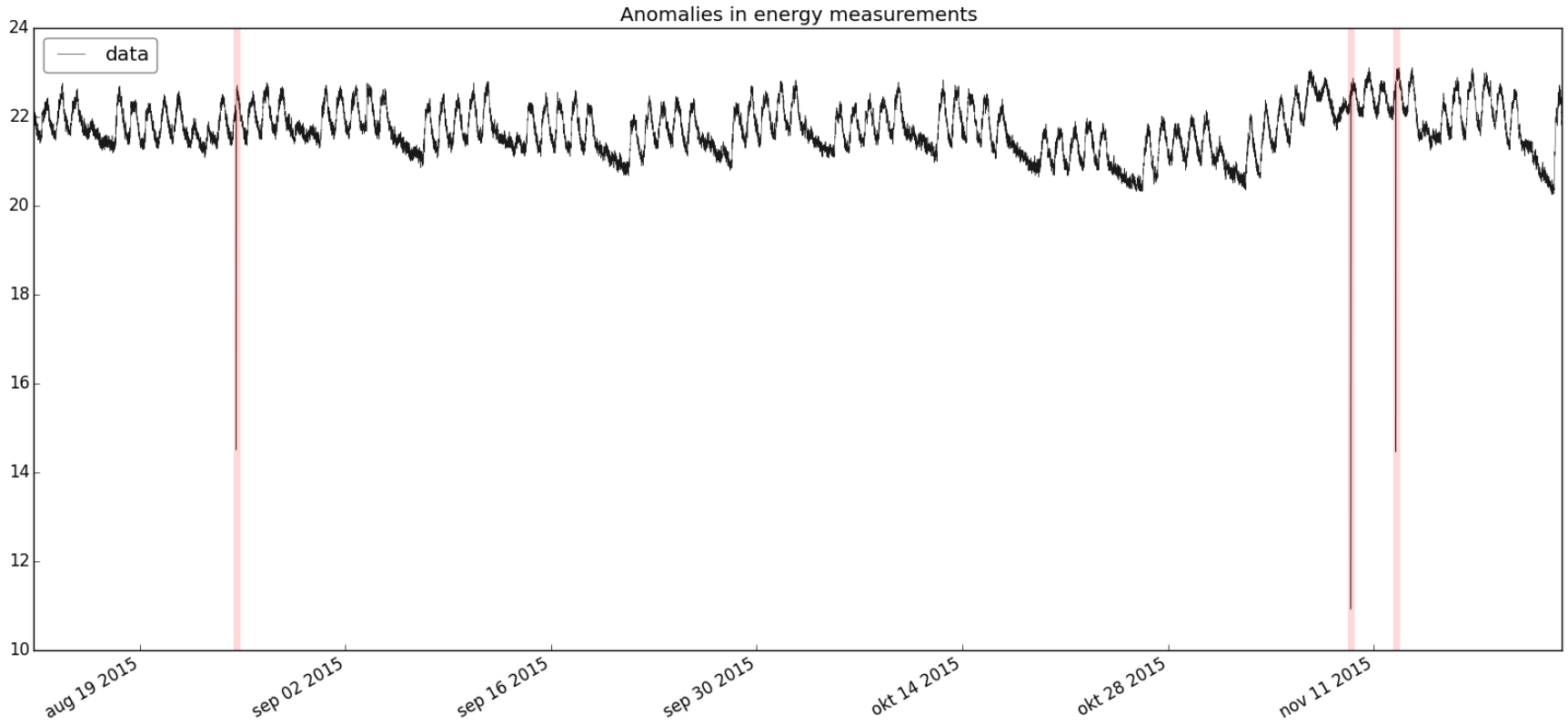
ADD DATA

2. BMS data

- With Olga Pietras, with help from UvA Facility Services

- Beyond gas consumption: find anomalies in more BMS variables
  - Energy consumption per floor
  - Temperatures, valve settings, etc etc

Example


Anomalies in energy measurements
data
24
22
20
18
16
14
12
10
aug 19 2015
sep 02 2015
sep 16 2015
sep 30 2015
okt 14 2015
okt 28 2015
nov 11 2015

Data

- Problem: BMS collects data only when there is a problem

- Used data from GBS of UvA building that had problems with HVAC installation (and were not deleted!)

- 6 Variables, about two years, every 10 min
- 5 serious anomalies indicated by expert

Does it work?

- Automatically detected all anomalies
- Found one “false positive” non-anomaly
- Needs more analysis

Does it save energy?

- Experiments suggest around 20% of energy (costs) can be saved
- Needs more data and analysis

Some hurdles

- Not easy to convince companies (and universities) that this is useful (energy is very cheap)
- Privacy limits data on use of parts of buildings
- Installation companies avoid standards to force clients to use their technology; need OPEN DATA

Some opportunities

- Integration toward “building automation”: include lighting, security, scheduling of rooms, solar panels, various sensors
- New UvA+VU Informatics building
- UvA now works towards unifying and storing *all* building/GBS data