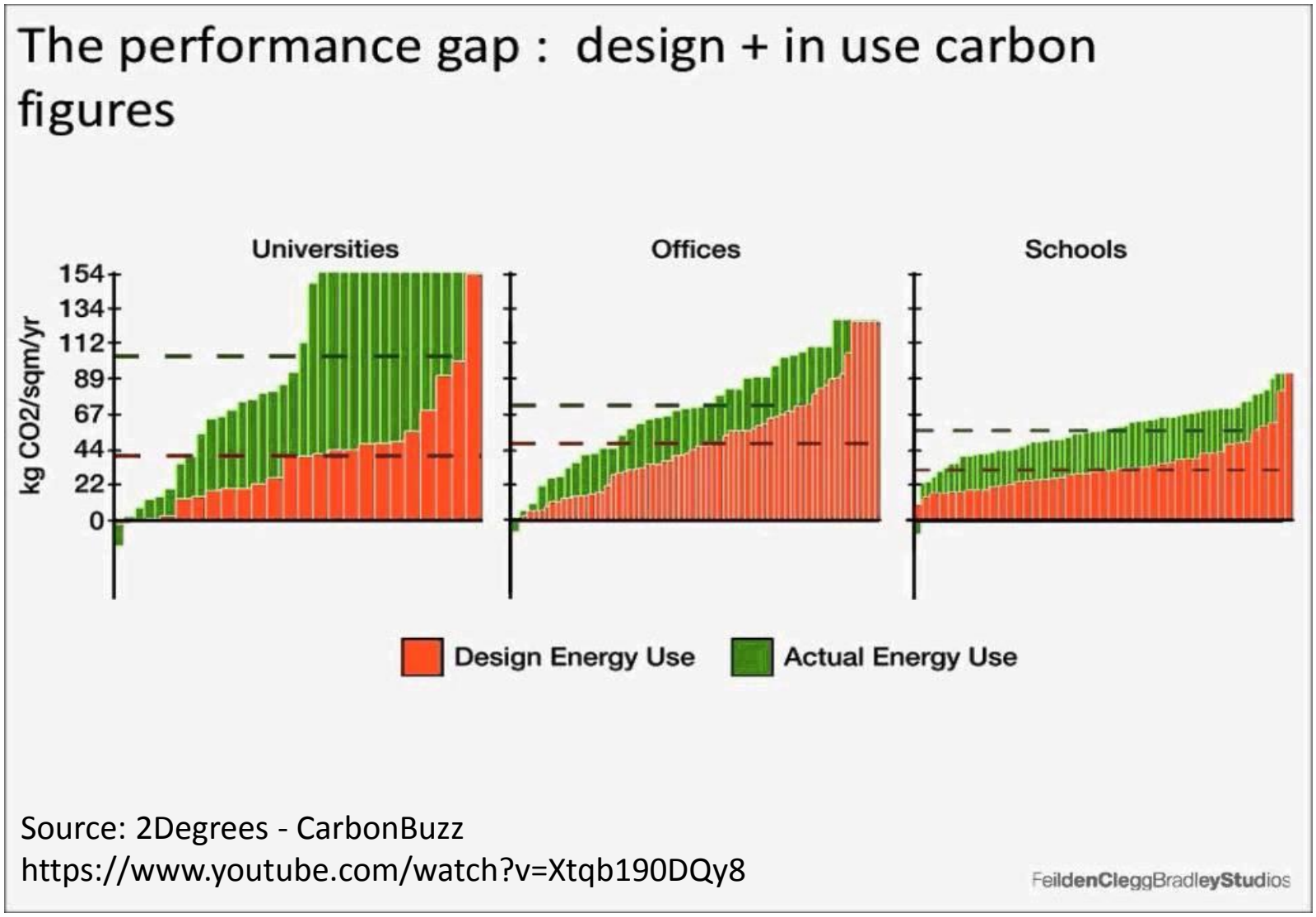
Continuous Energy Auditing

Dr. Alan McGibney, Dr. Susan Rea

The Energy Performance Gap?



Source: 2Degrees - CarbonBuzz
https://www.youtube.com/watch?v=Xtqb190DQy8

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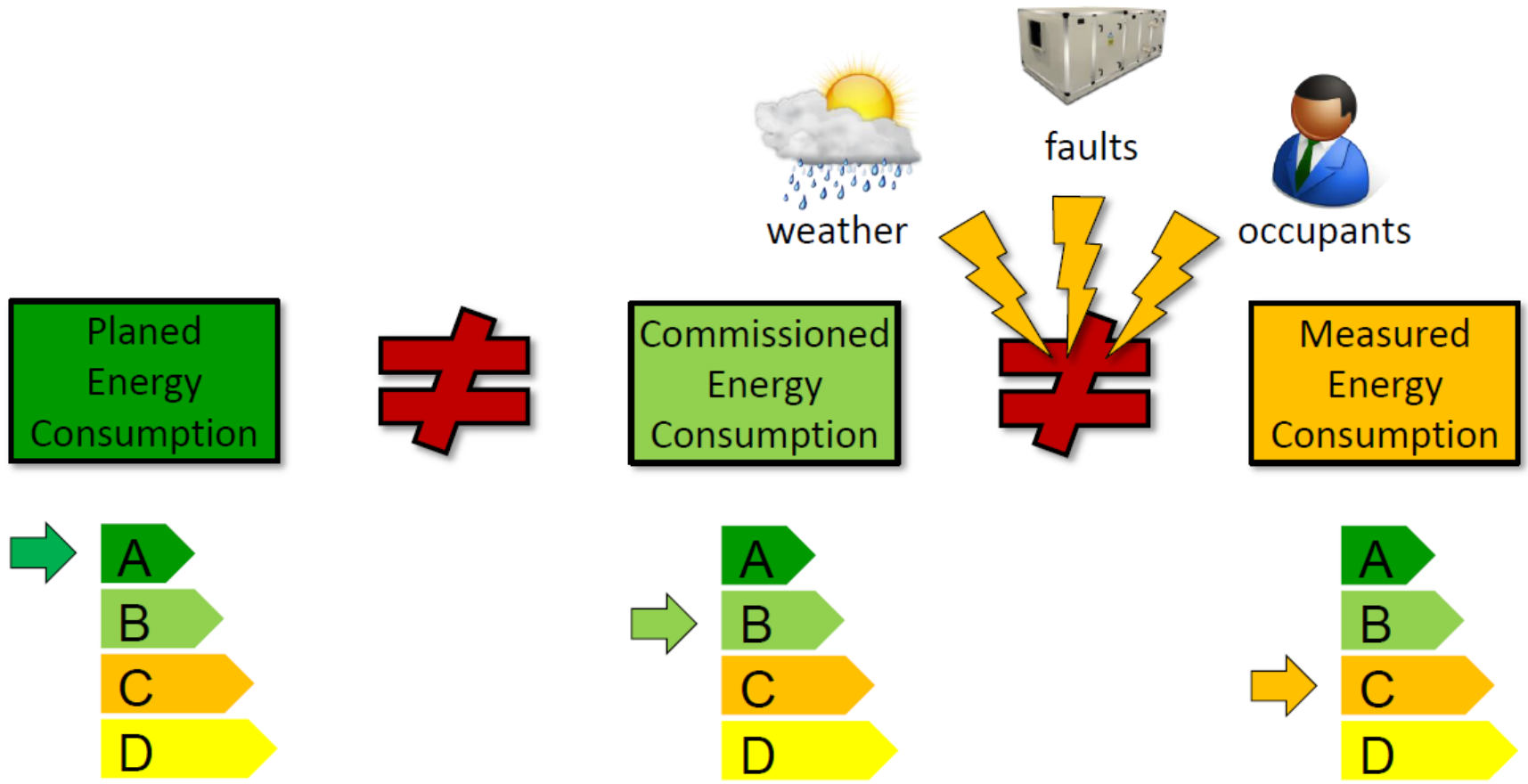
TOPAs Objectives



Building energy performance predictions show *major differences to measurements*.
This is even worse for building blocks.

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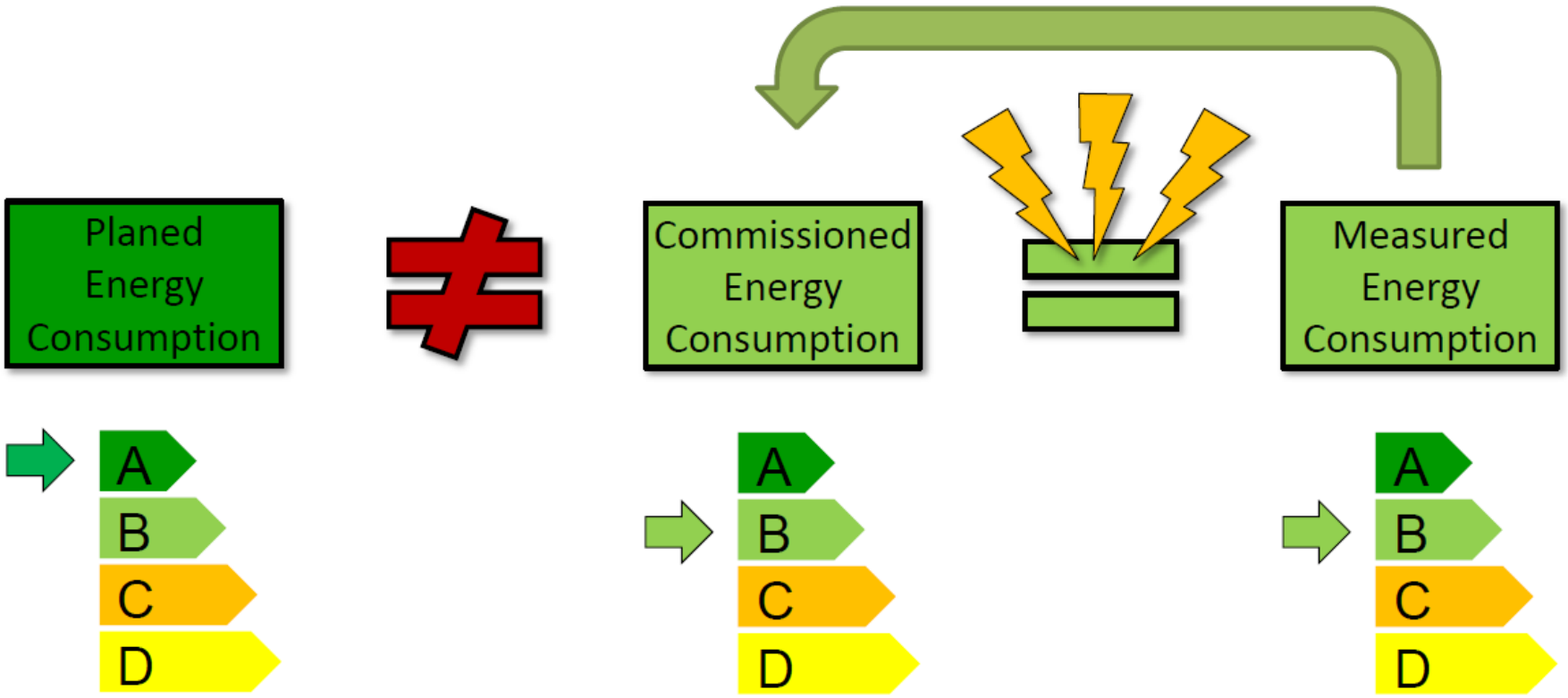
Challenges to be overcome

Continuous Performance Auditing



Tools and methods for measuring and analysing real building energy performance for FM and ESCOs.

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The TOPAs Cognitive Loop

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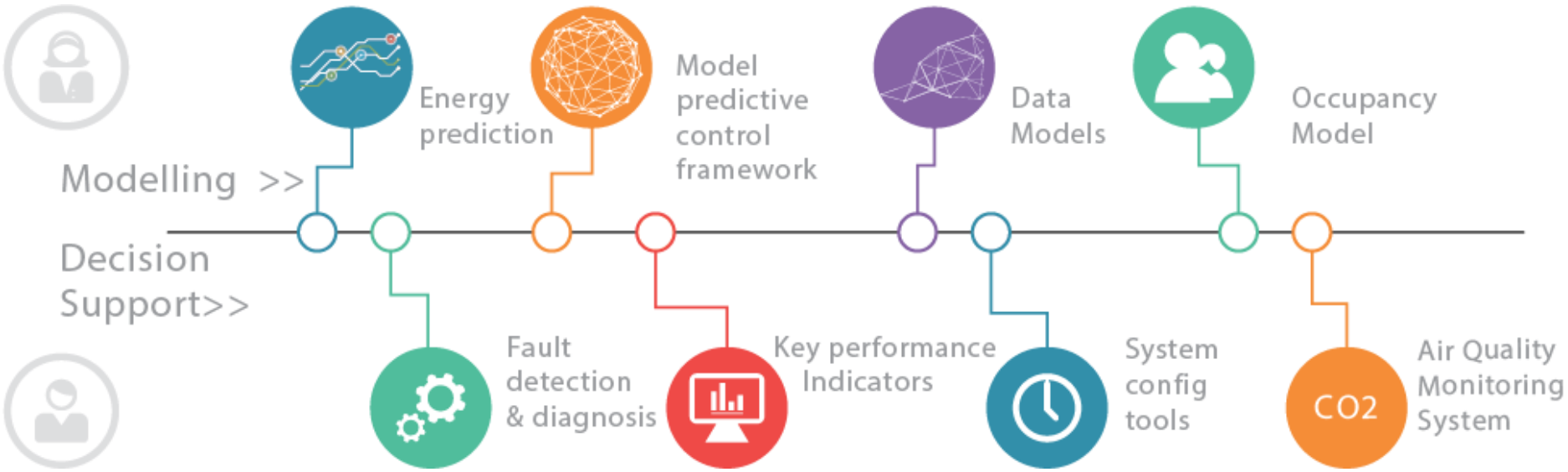
The TOPAs Cognitive Loop



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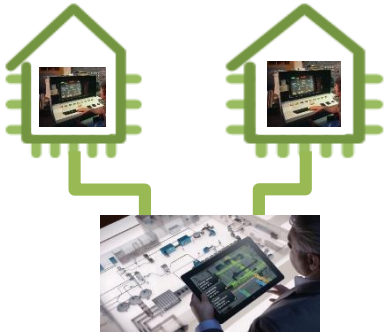
IoT Architectures & Internet of Buildings

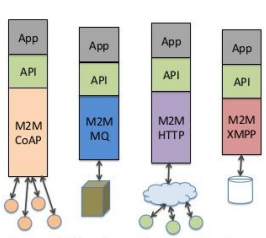
Standalone BMS



Managed Portfolio

Internet of Buildings

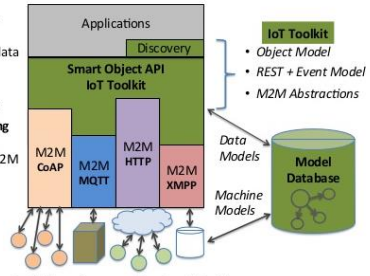
IoT 1.0 – Things Connected to Apps

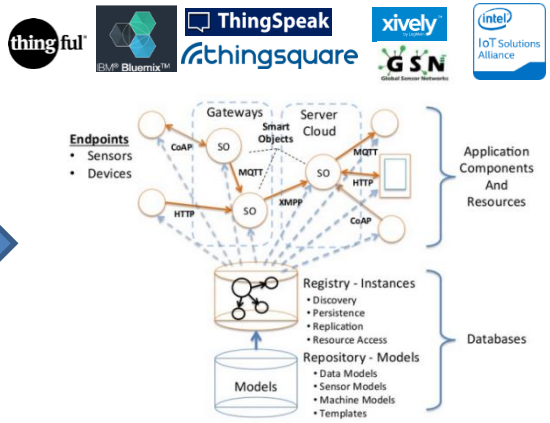


- App runs on single service – Single Points Of Failure
- Each app written to a custom API
- Diverse M2M is sometimes required but can inhibit interoperability
- Software, User data, and Things are trapped in **Silos**
- Difficult to connect new types of things and deploy new platforms
- Very difficult to share resources or connect across platforms
- Apps are not network-effect enabled

IoT 2.0 – Interoperability

- Easy to deploy new things and applications using data models
- Write once, run anywhere software
- **Any app** to **any thing** via **any M2M**, use-case appropriate M2M
- Network effect enabled





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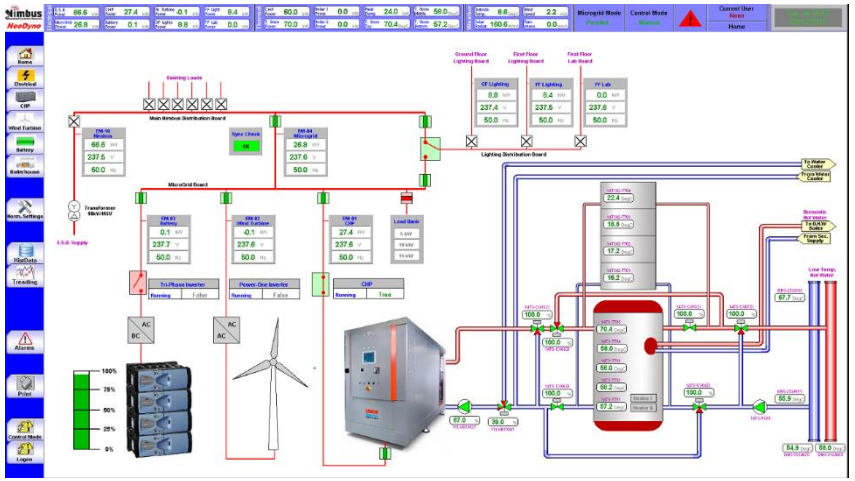
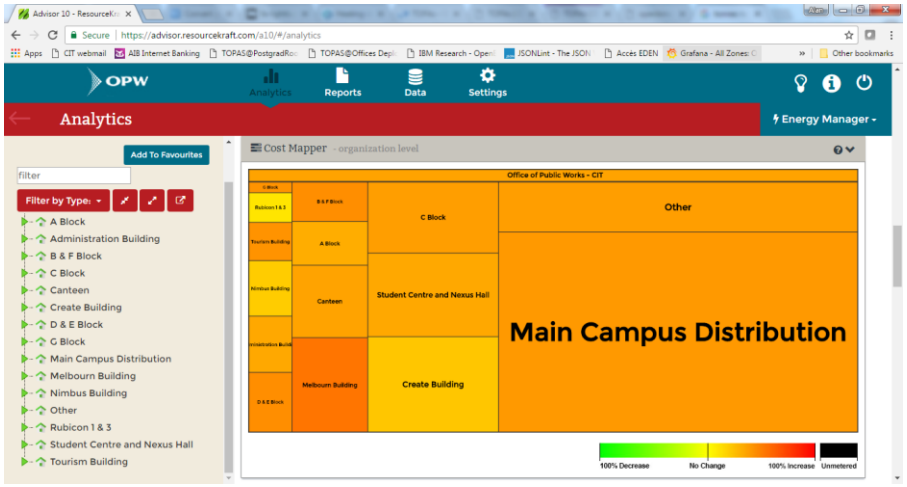
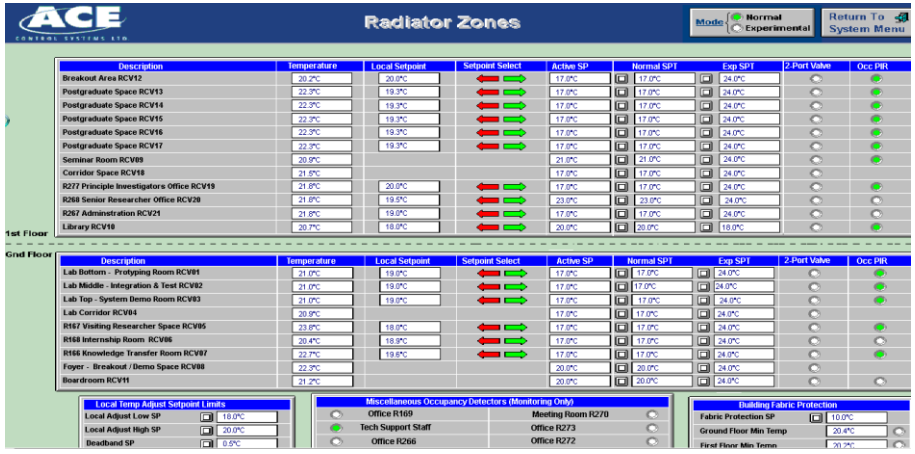
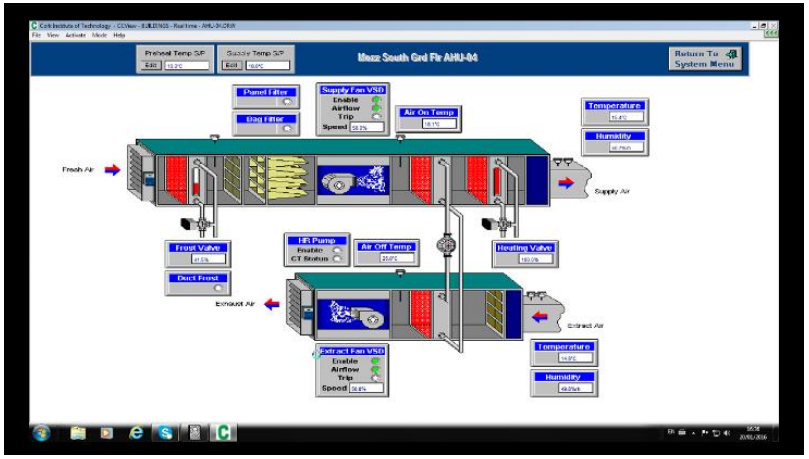
Edge Tier









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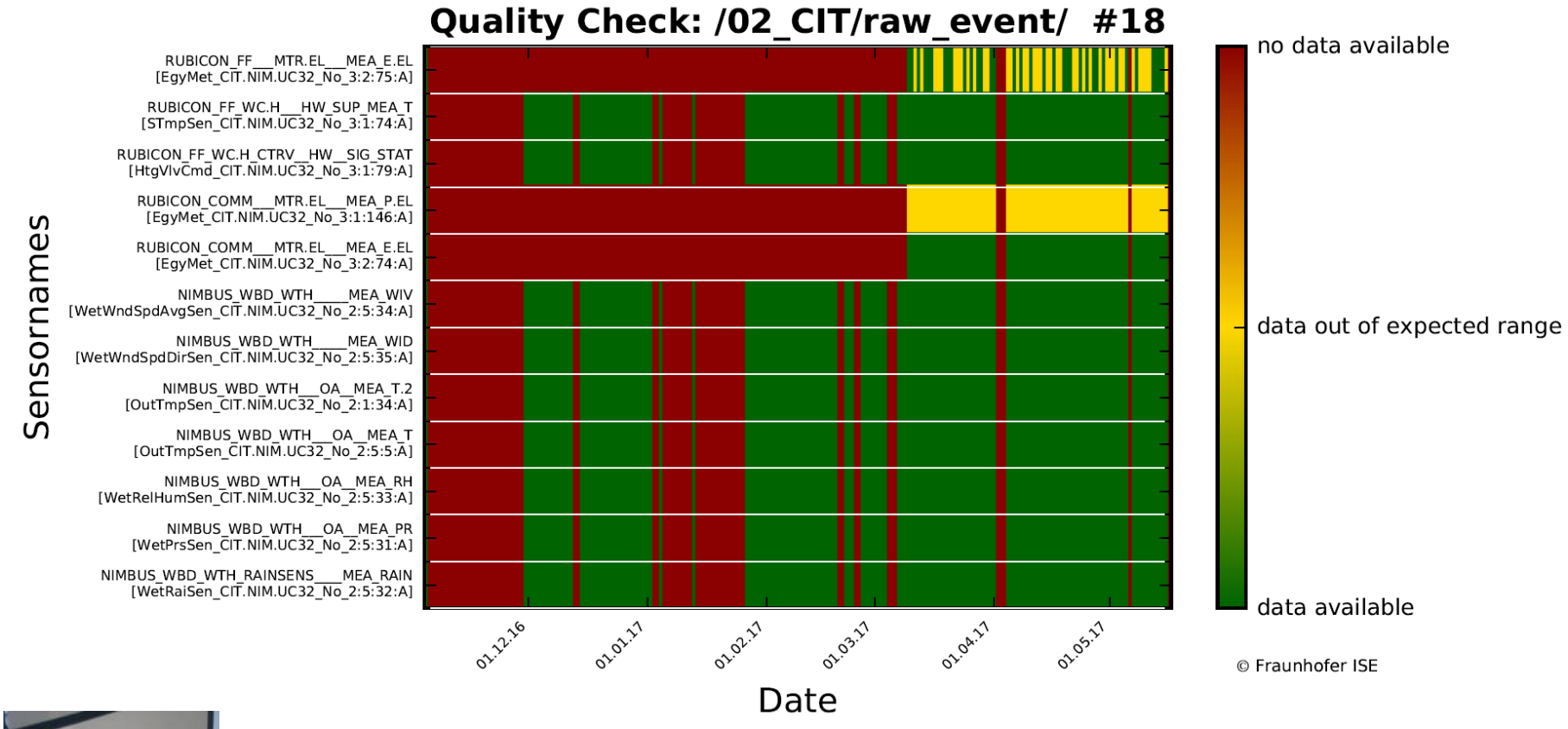
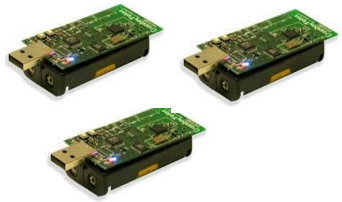
Poor Data = Poor Decisions





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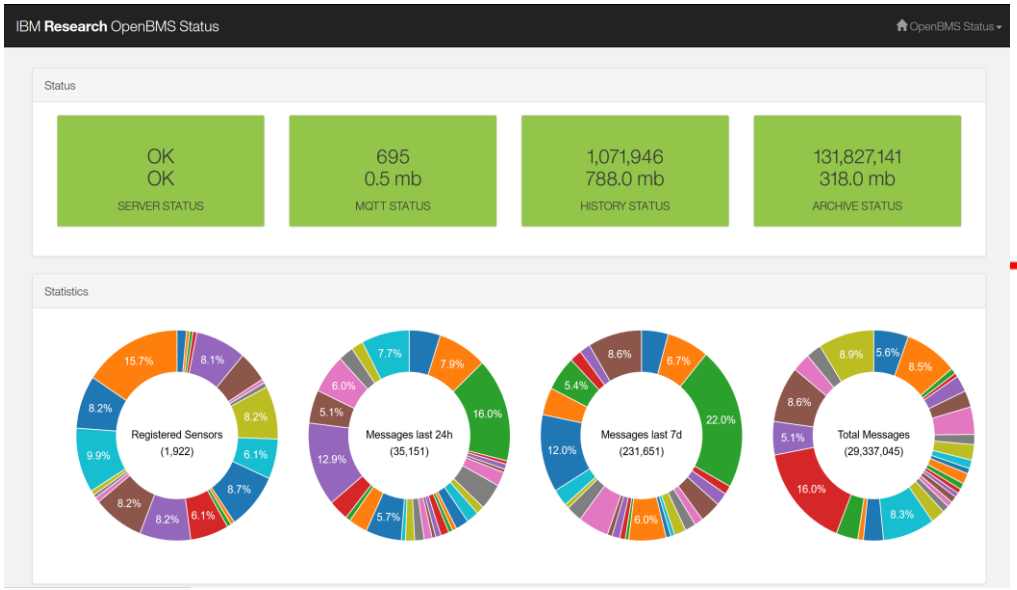
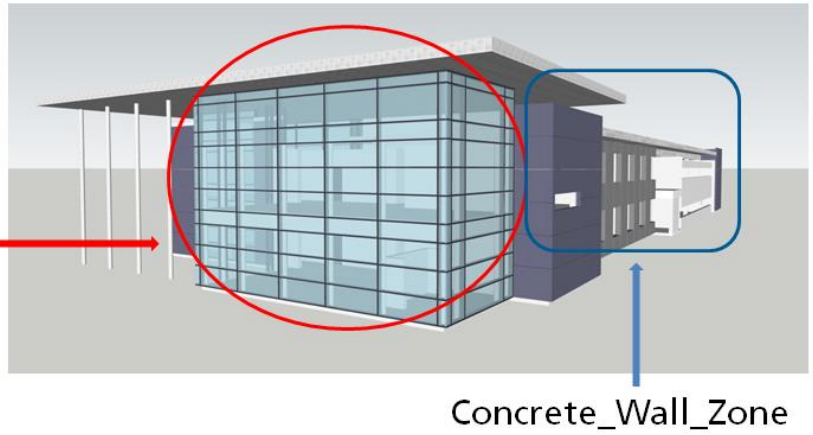
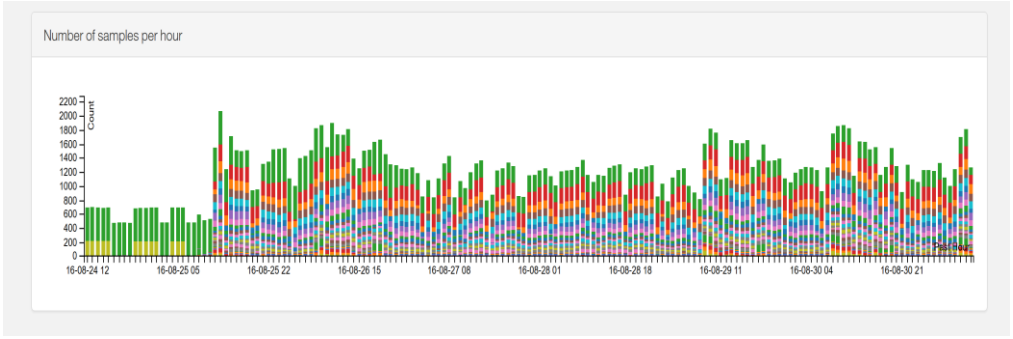
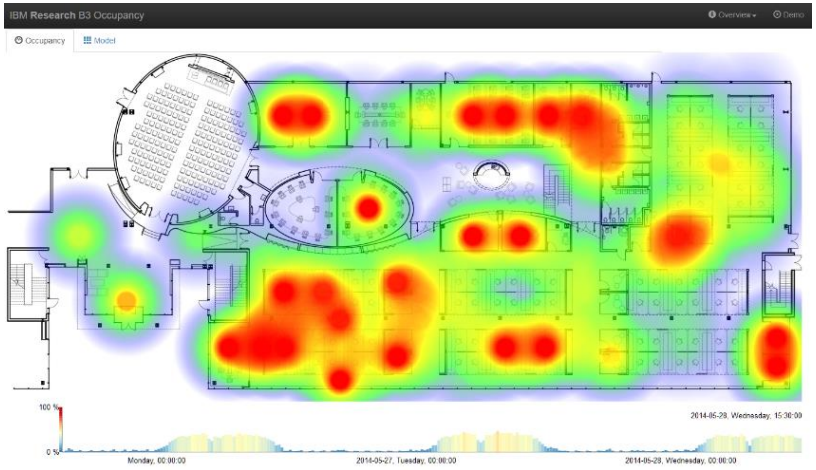
Platform Tier









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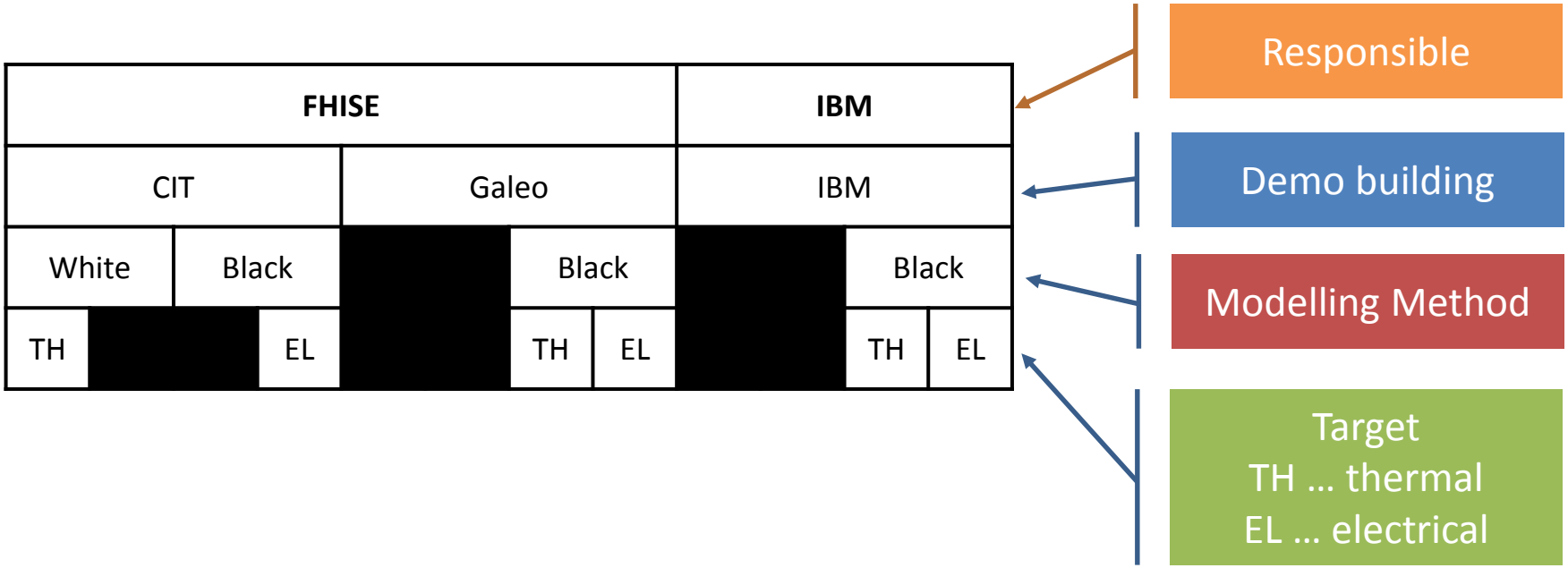
Modelling Methods



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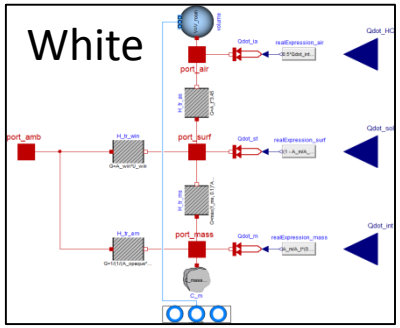
Modelling Methods

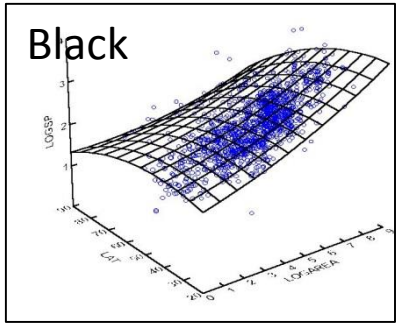
- White Box Models
  - Dynamic simulation (Dymola/Modelica)
  - Physical models
  - RC-networks
  - Characteristic curves
- Black Box Models
  - Gaussian Process Regression
  - Multi-Linear Regression
  - Support Vector Regression
  - Random Forests
  - K-nearest Neighbors

Parameters:
Building physics,
set points, …

Inputs

Weather
Occupancy
Windows
…





Outputs

th. energy
el. energy
Comfort
…

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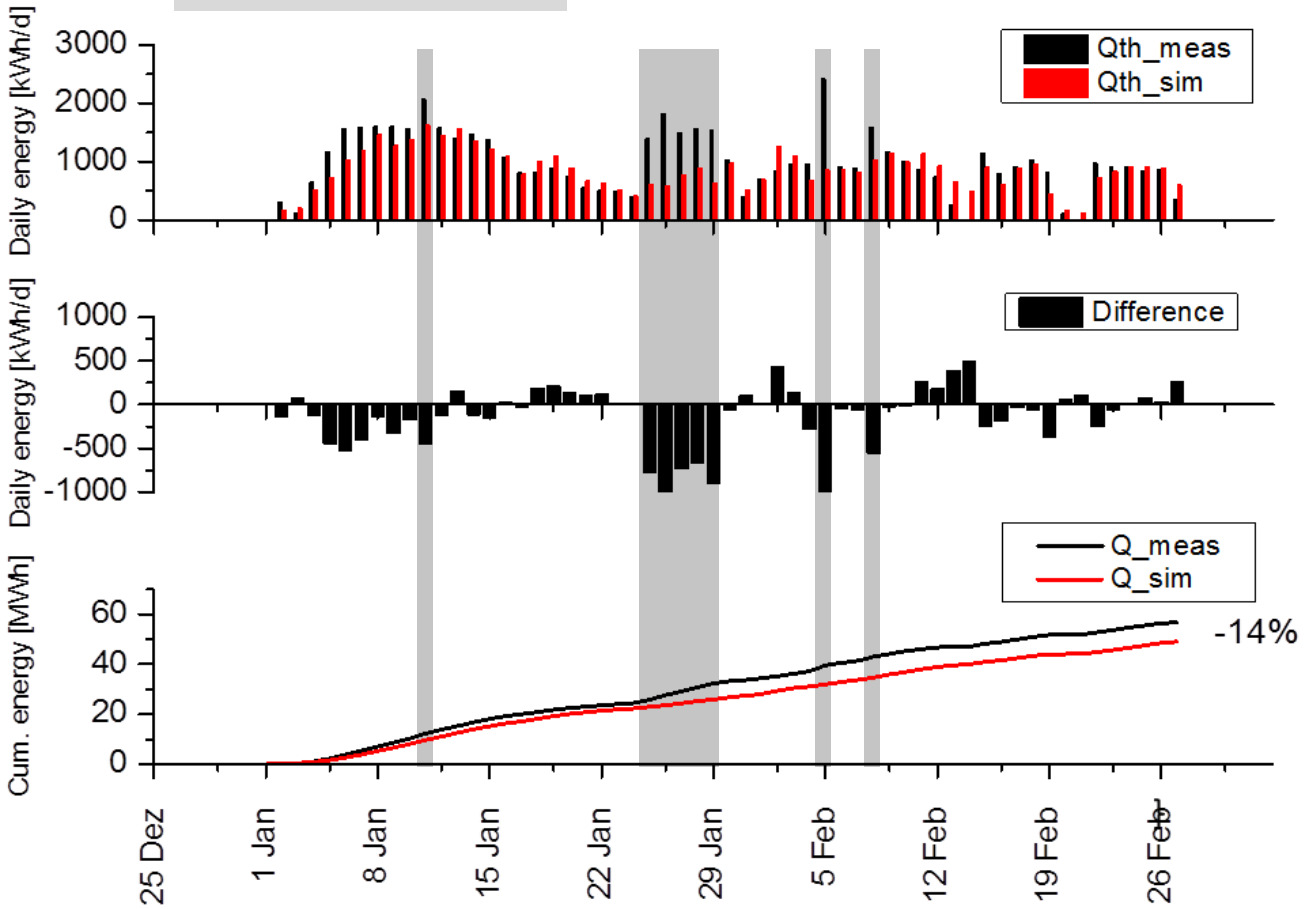
Model-based energy consumption prediction

Model Results

CIT			Galeo			IBM		
White	Black			Black			Black	
TH		EL		TH	EL		TH	EL

Unknown influences lead to increased energy consumption



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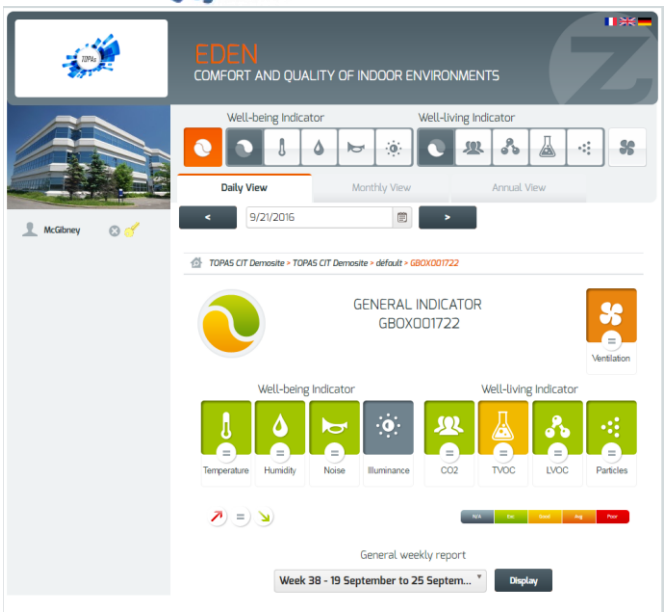
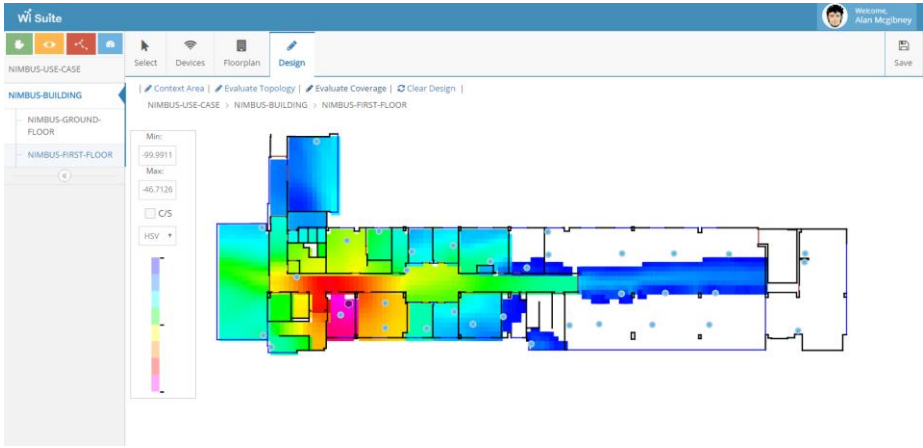
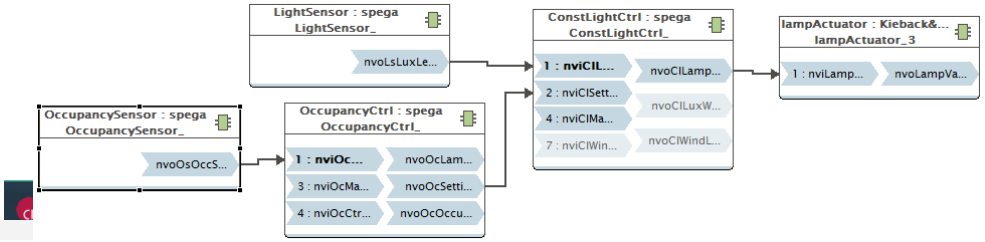
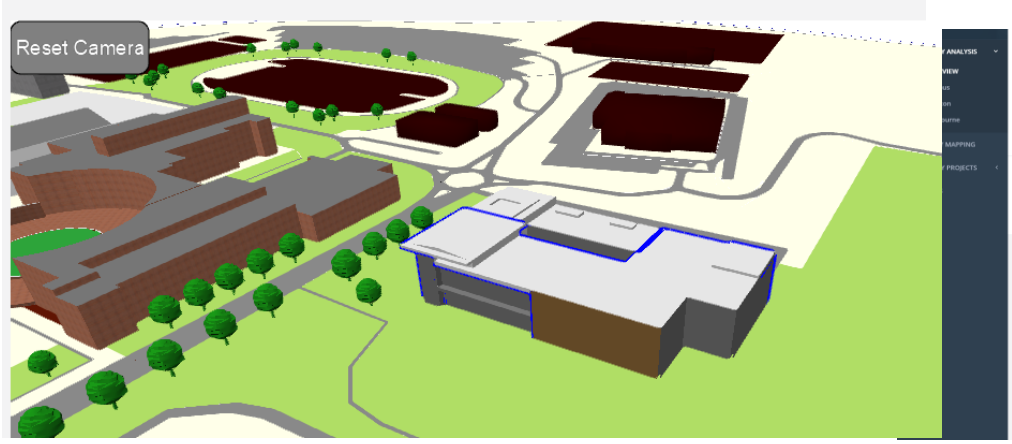
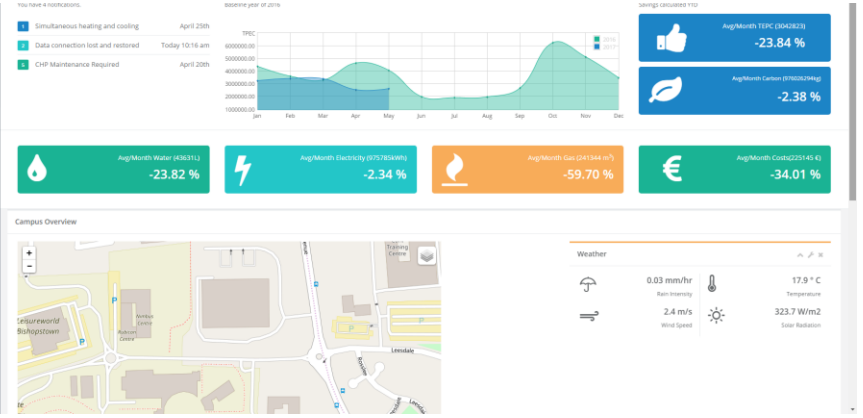
Enterprise Tier











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FDD rule-based system

CIT building

- Heat Generation with Combined Heat & Power (CHP) and Boilers

→ Low operation time of CHP

→ Sequencing fault between CHP, Boilers and Heat Rejection

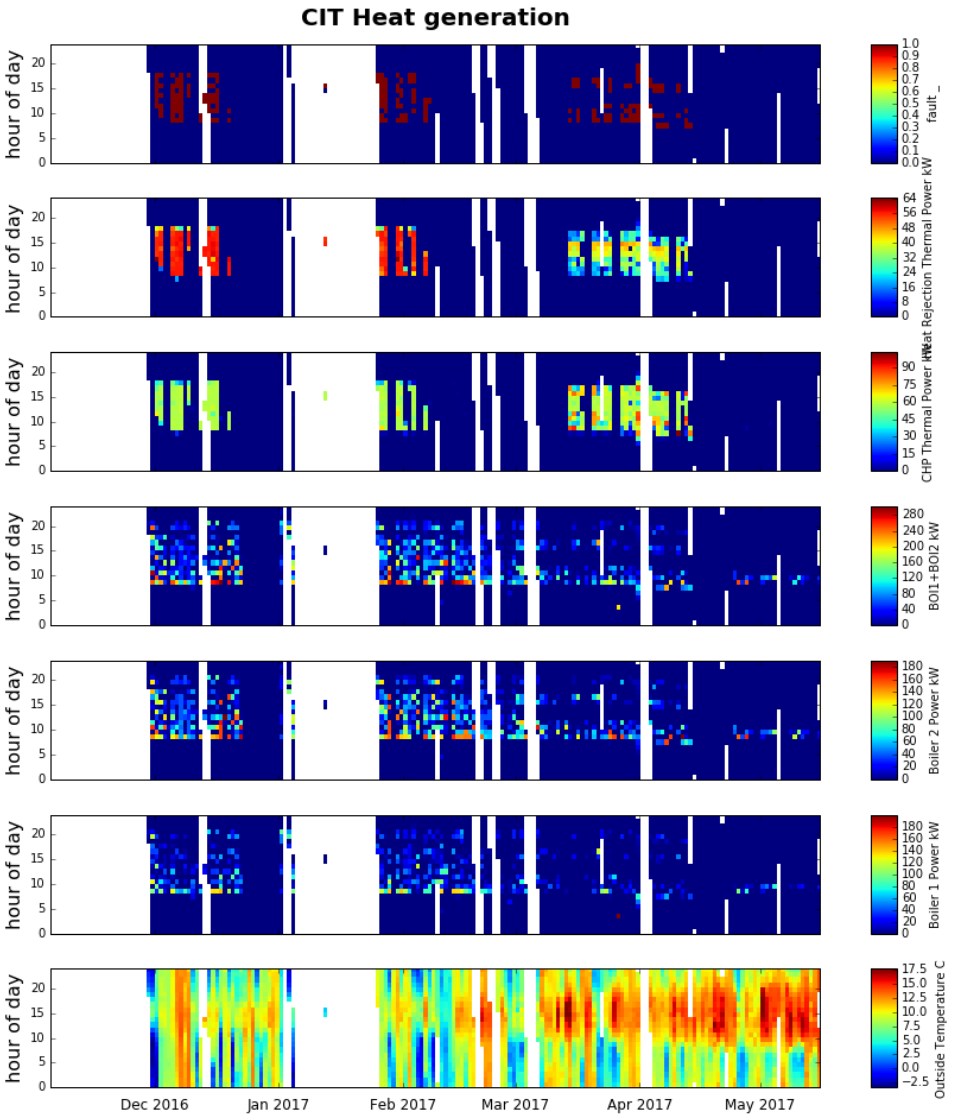
→ Pumps operating at low delta T

→ Too high return temperature to CHP

→ Also: overheating faults of thermal zones

↳estimated energy saving potential 5..10% (tbc)

↳ Organize Energy Conservation Measure with CIT Facility Manager



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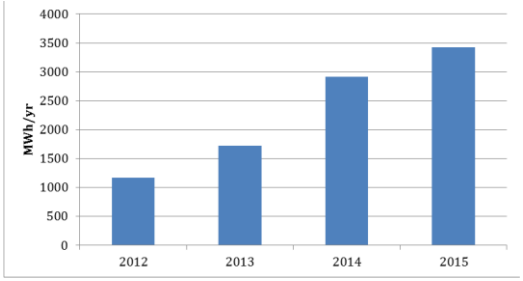
Demonstrator Sites Baseline Results

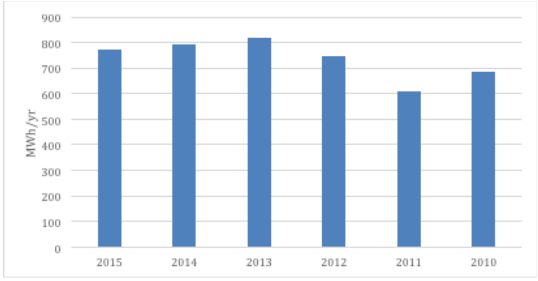
IBM Campus, Dublin

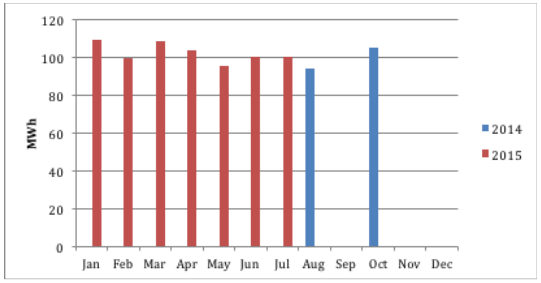
CIT Campus, Cork

Galeo, Paris

Baseline







Conclusions

- Improvements regarding the gas use in Building 3.
- Correlation between occupancy and energy consumption is evident
- Saving potential in out of hours night and weekend base load.

- Significant discrepancy between set points and actual temperature
- Need for continuous aligned control settings
- Saving potential in baseload and CHP heat dumping
- Microgeneration provides potential for load shifting

- There may be a potential to reduce the night time base load.
- Air Quality will be integrated in the control strategy.
- Further investigation and analysis is required

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- 10% Gap reduction between predicted & actual energy use
- 20% Energy savings through the use of the TOPAs solution

3 P's – Plant, Process & People

Plant:
Optimise the efficiencies of control systems, maximise the capabilities of automation systems, continuous auditing of equipment state.

Process:
Continually assess and analyse how energy is used in buildings, influence schedules, eliminate wastage and maximise potential for energy savings

People:
Consider people as "customers", easiest solution is to switch everything off but this will not help people, impact productivity and will not encourage responsibility for energy savings

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Live Demo

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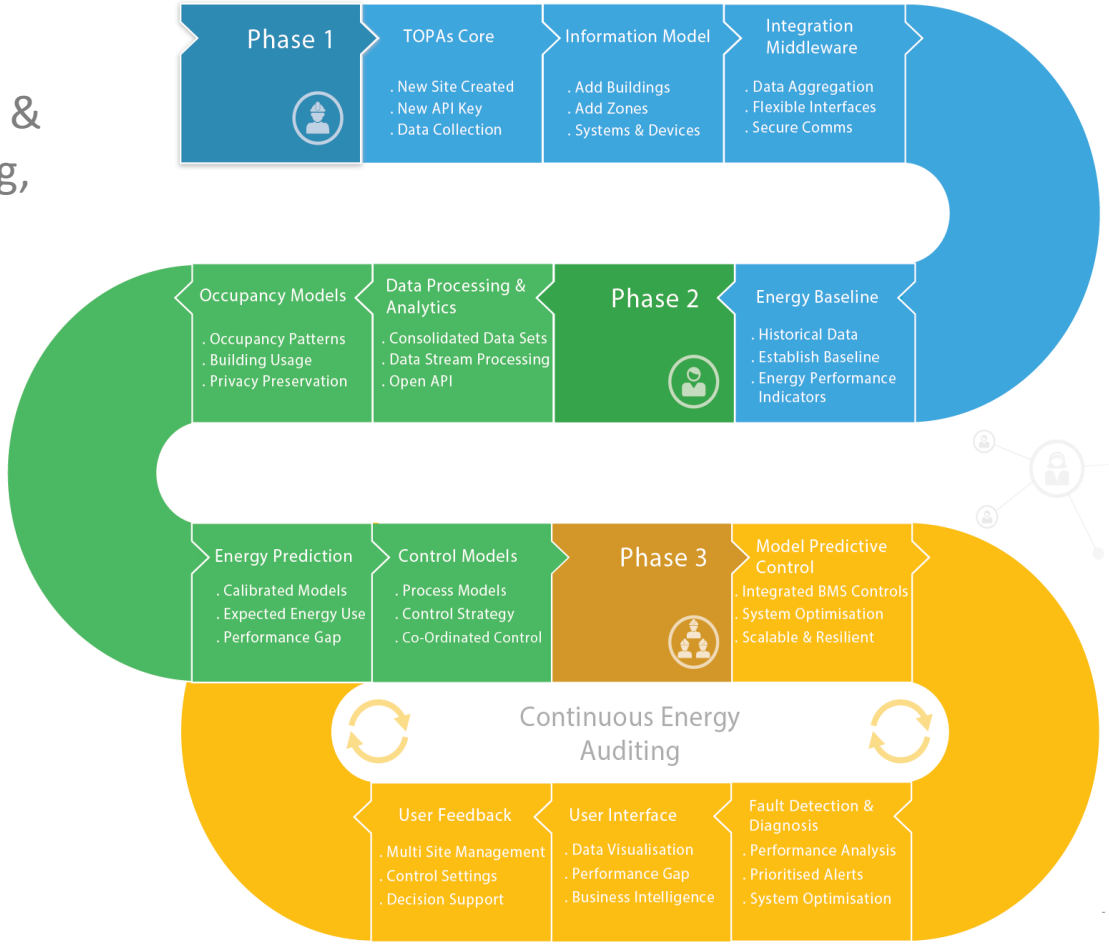
TOPAs Workflow

TOPAs in Action

- **Phase 1**: System/Building connection & connectivity, data sensing & collecting, data transport & access - **SENSE**
- **Phase 2**: Data analytics, APIs & processes, services - **LEARN**
- **Phase 3**: Applications & services: gap reduction, energy saving, FDD, data presentation, intelligent interfaces – **ACT & OPERATE**



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