



Low Carbon
Built Environment

Amgylchedd Adeiledig
Carbon Isel

APSE Housing and Building Maintenance Seminar 2021



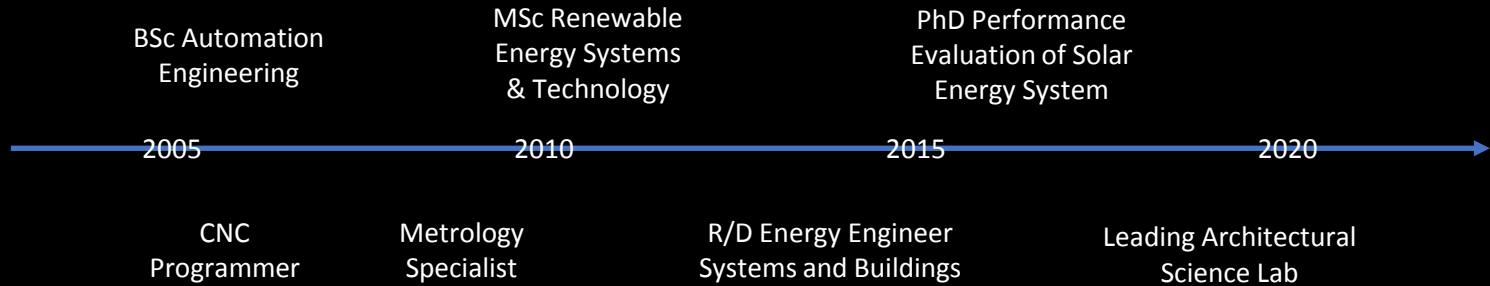
Delivering affordable and
sustainable homes in a
changing world

Buildings Performance
Evaluation
Monitoring Techniques

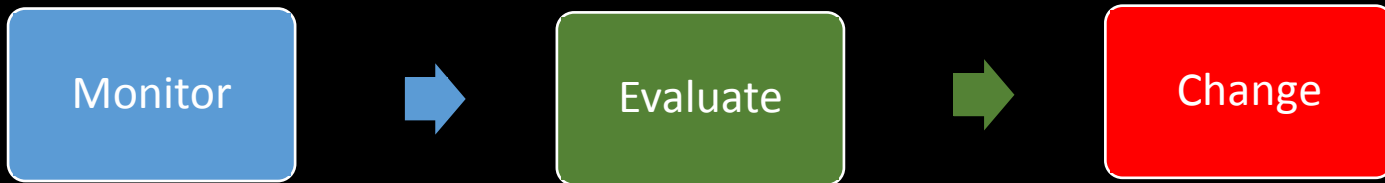
Emmanouil Perisoglou
October 2021

Emmanouil Perisoglou BSc MSc CEng MIET

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LIVING IN A CHANGING ENVIRONMENT



Monitor

Measure the progress or quality over a period of time



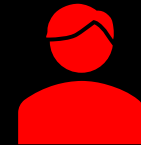
“How do Liverpool fans change a lightbulb?

They don't, they just talk about how good the old one was!”

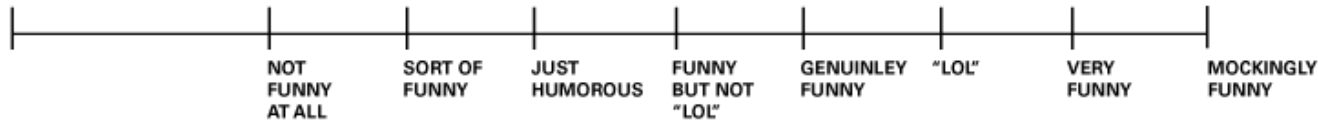
ha



hahahahah



hahahahah



High Precision LOLOMETER

Range of stakeholders in building performance

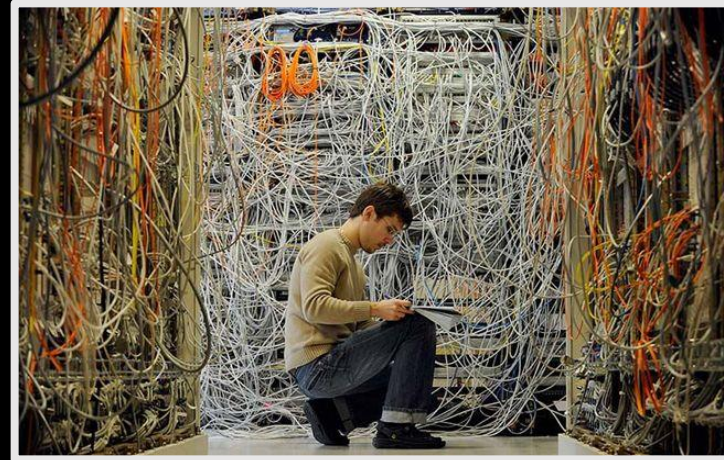


Why to monitor

- Part of the control system



- Part of the commissioning



- Part of an Energy Scheme



- Part of public/occupants awareness



Why to monitor

- Performance evaluation

R/D

Optimisation

Performance gap (real vs ideal)



Investigation in the Built Environment



Information



Static Data

Examples:

Specs
Dimensions
Regulations
Weather File

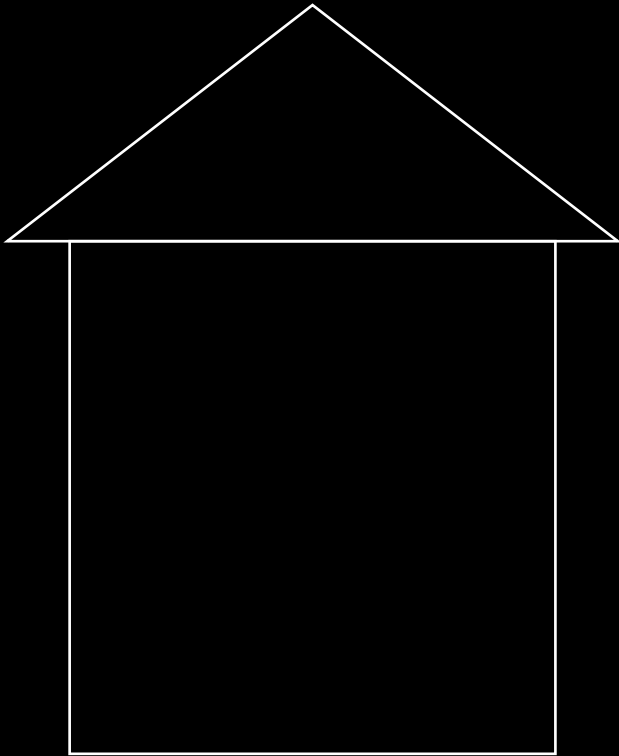
Monitored Data

Examples:

Temperature Variation
Energy consumption
Thermography
Lighting Levels

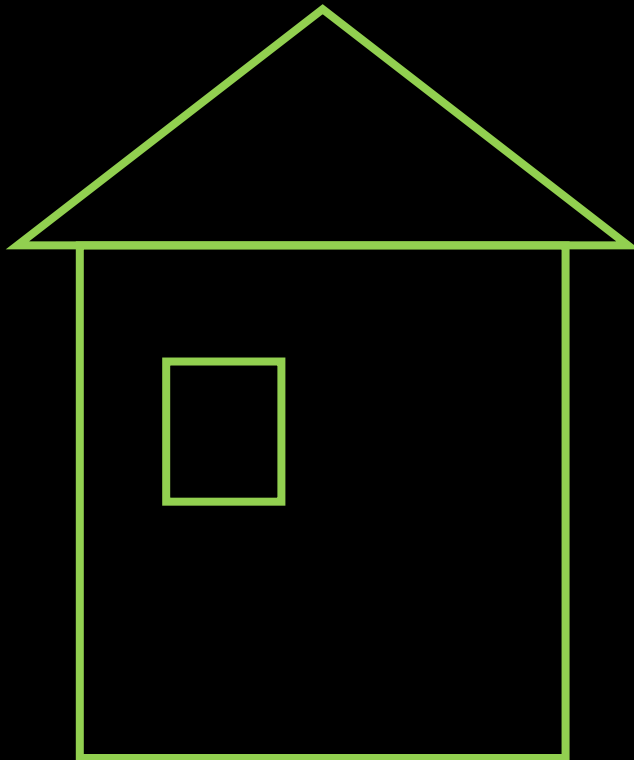
BUILDING AS A SYSTEM

Which are the main system variables?



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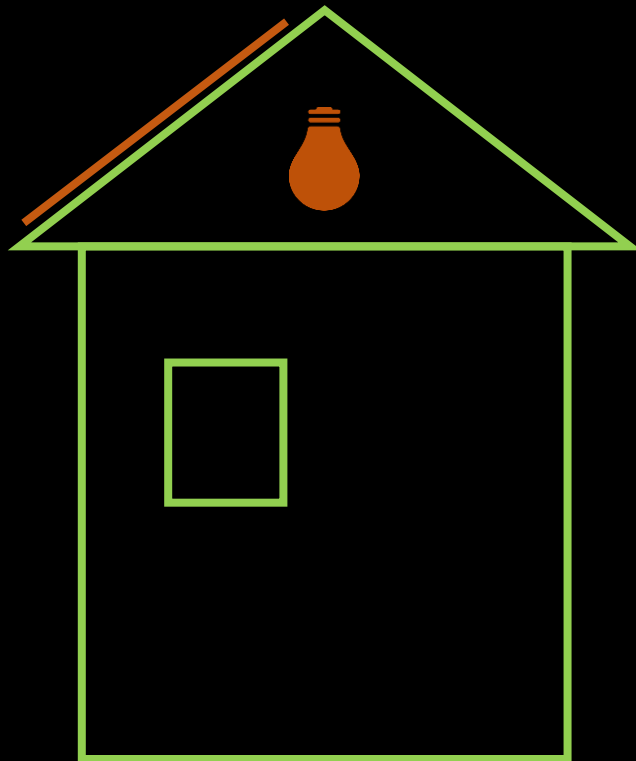


Building Fabric

Walls
Ceiling
Floors
Windows
Doors

BUILDING AS A SYSTEM

Which are the main system variables?



Building Fabric

Building Services

Energy supply

Heating

Cooling

Air condition

Appliances

Lighting

Water supply

Safety and Protection

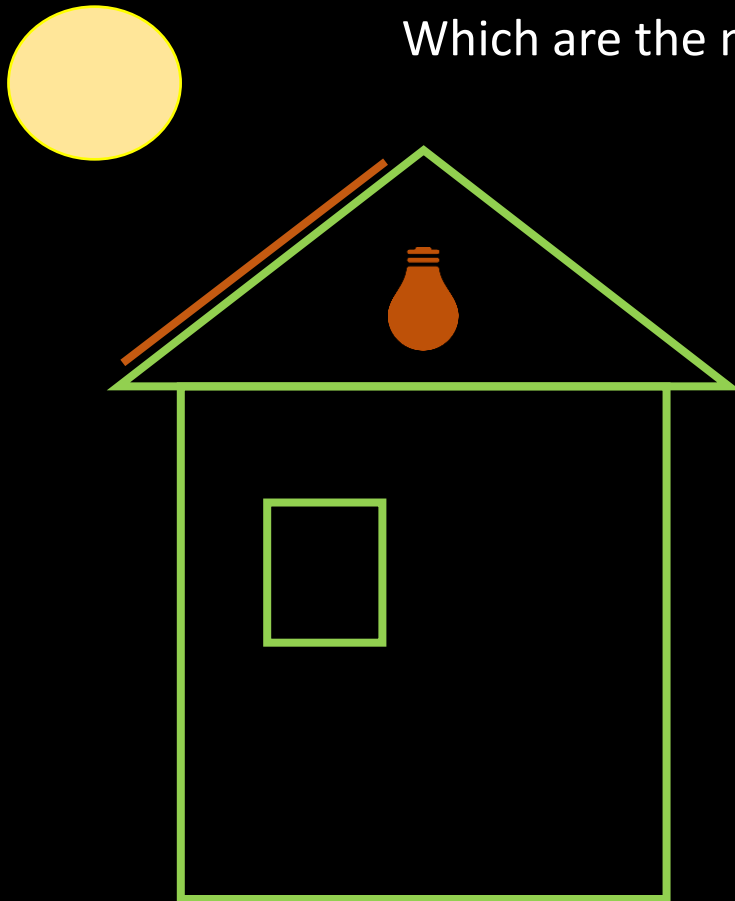
Automation and Controls

Info and Communication

HVAC

BUILDING AS A SYSTEM

Which are the main system variables?



Building Fabric

Building Services

Weather & Climate

External Temperature

Wind Velocity

Wind Direction

Sun path

Irradiation

Rain Precipitation

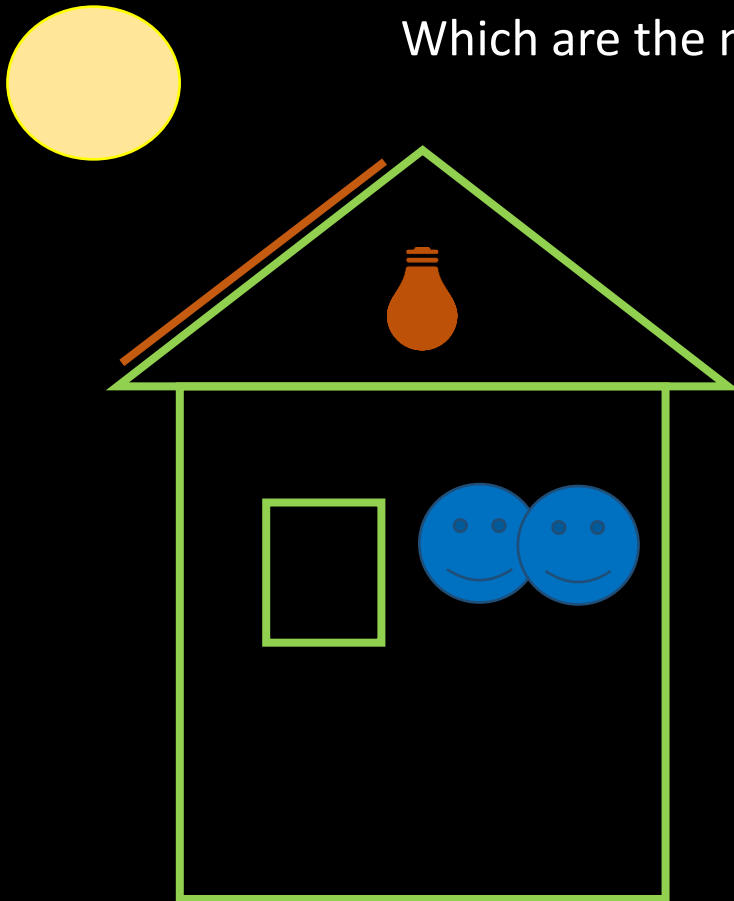
Pollution

Surroundings

Microclimate

BUILDING AS A SYSTEM

Which are the main system variables?



Building Fabric

Building Services

Weather & Climate

Occupancy

Number

Age

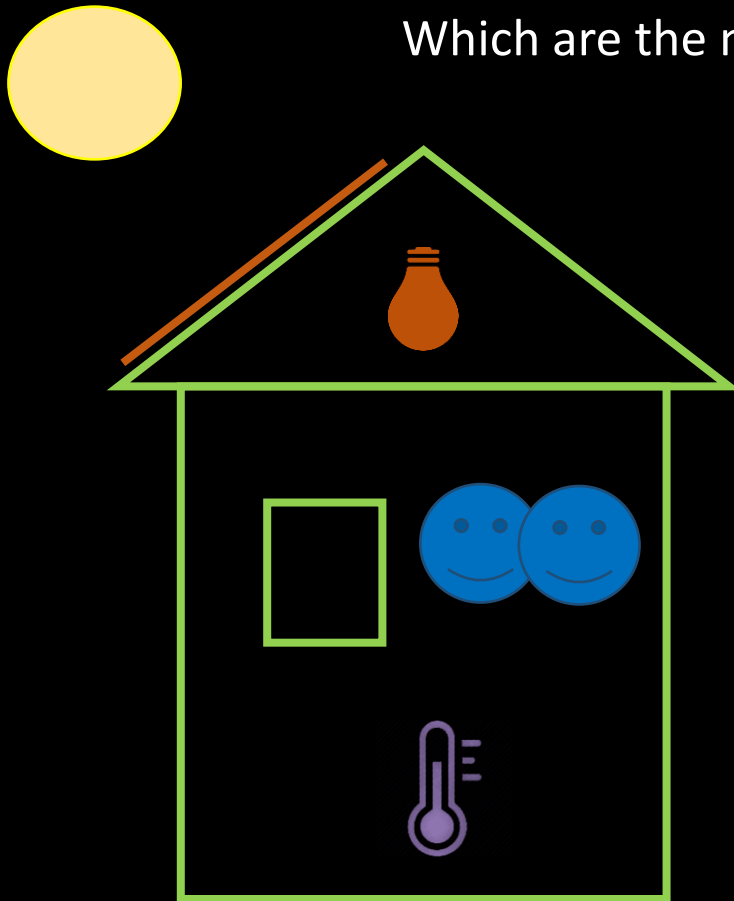
Schedule

Health

Preferences

BUILDING AS A SYSTEM

Which are the main system variables?



Building Fabric

Building Services

Weather & Climate

Occupancy

Indoor Conditions

Internal Temperature

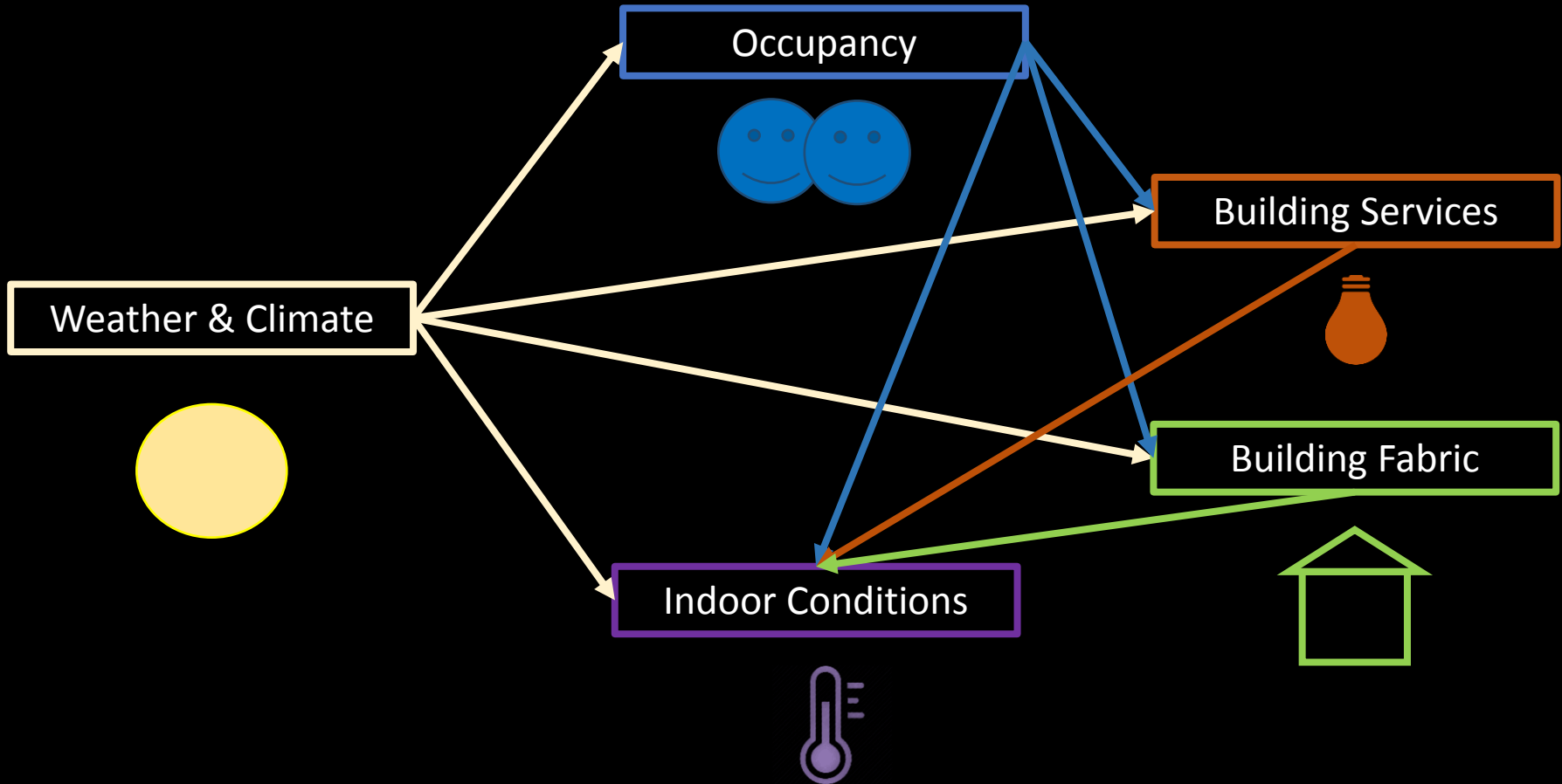
Internal Relative
Humidity

CO2 levels

Drafts

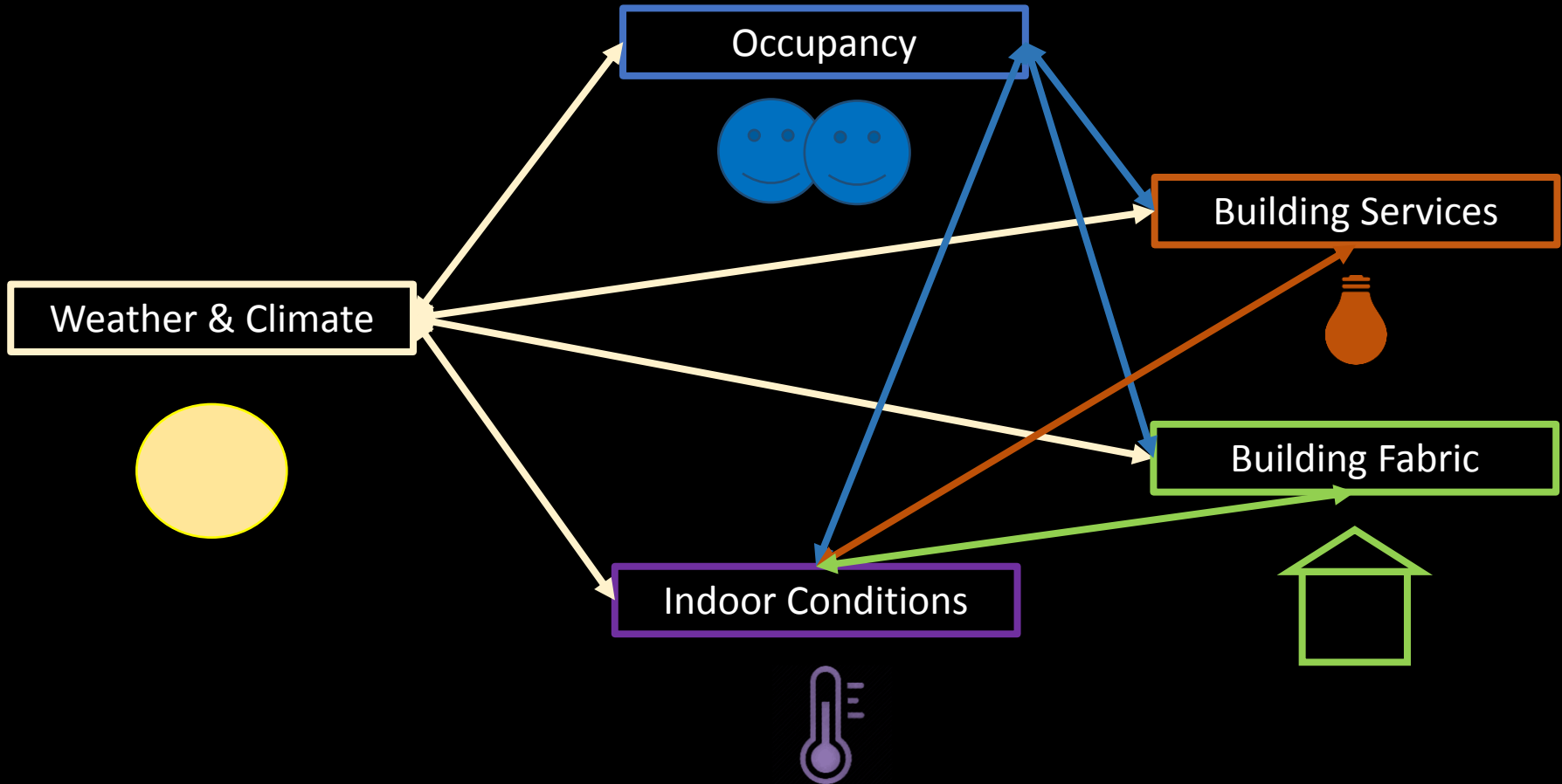
Lighting levels

SYSTEMS INTERACTIONS



Do building Fabric and Services respond to the Desirable Indoor Conditions?

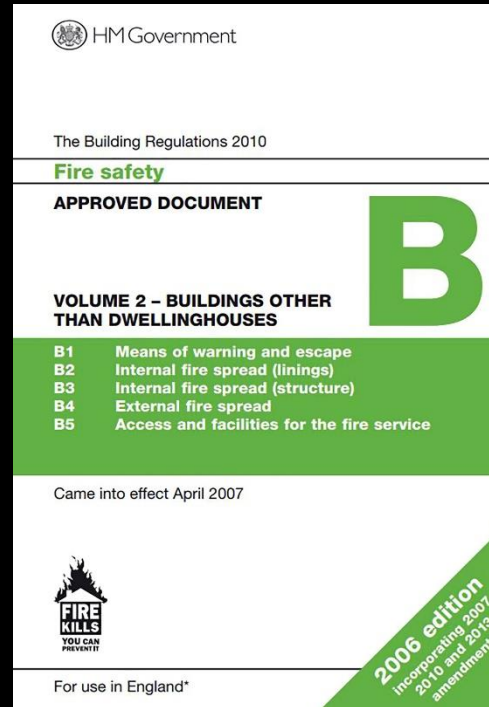
SYSTEMS DYNAMIC INTERACTIONS



Break down the interactions to quantifiable variables
And investigate by using the appropriate tools

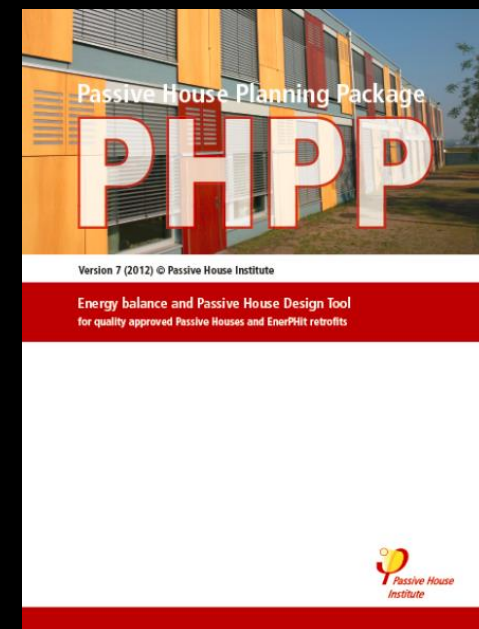
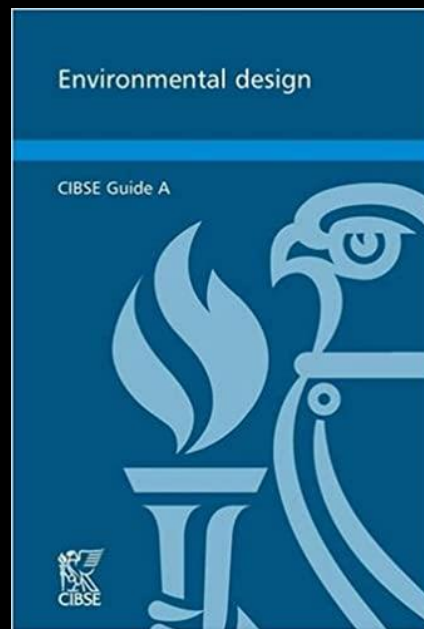
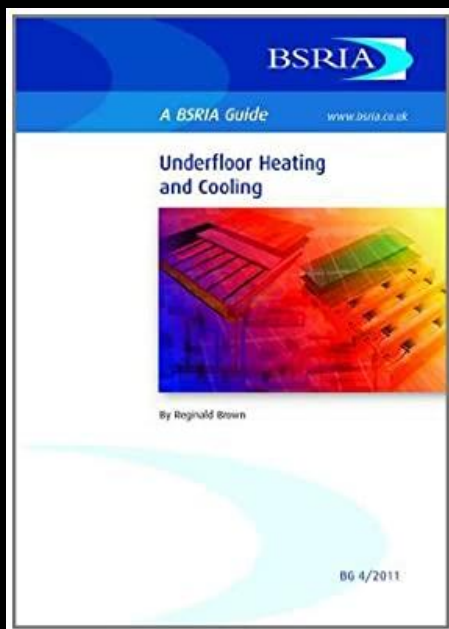
Before you measure, collect information

- Regulations-Planning e.g. The Building Regulations Part F – Ventilation, 2010



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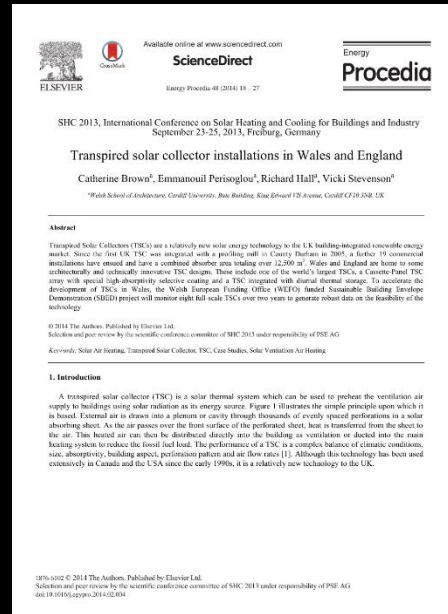
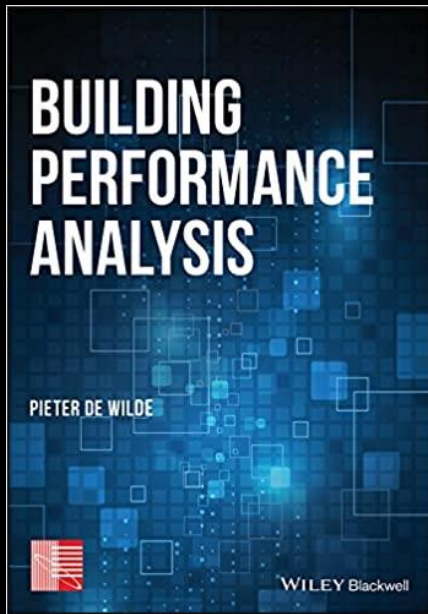
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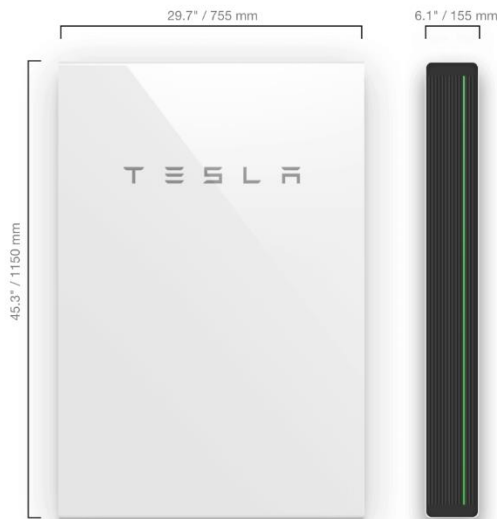
e.g. Environmental Design CIBSE Guide A, CIBSE, 2015

e.g. Building Performance Analysis, P. De Wilde, Wiley, 2018



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- Literature e.g. Environmental Science in building, Randall McMullan, 2017
- Market e.g. Tesla Powerwall 2, Domestic Battery, 2018



Usable Capacity
13.5 kWh

Depth of Discharge
100%

Efficiency
90% round-trip

Power
7kW peak / 5kW continuous

Supported Applications
Solar self-consumption
Back-up power
Time-Based control
Off-grid capabilities (coming soon)

Warranty
10 years

Scalable
Up to 10 Powerwalls

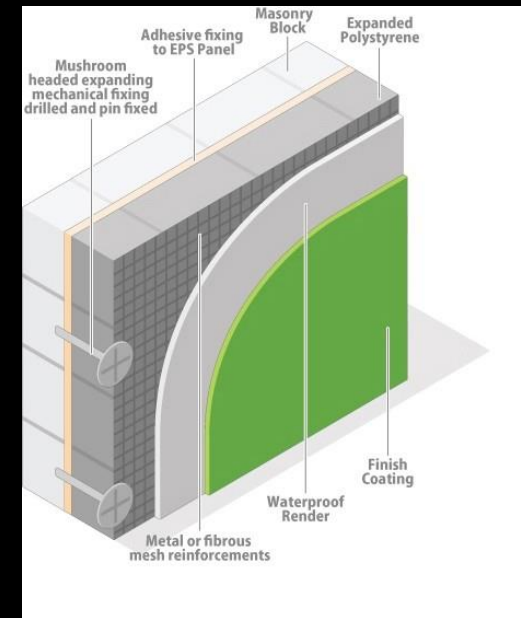
Operating Temperature
-4°F to 122°F / -20°C to 50°C

Dimensions
L x W x D: 45.3" x 29.7" x 6.1"
(1150 mm x 755 mm x 155 mm)

Weight
276 lbs / 125 kg

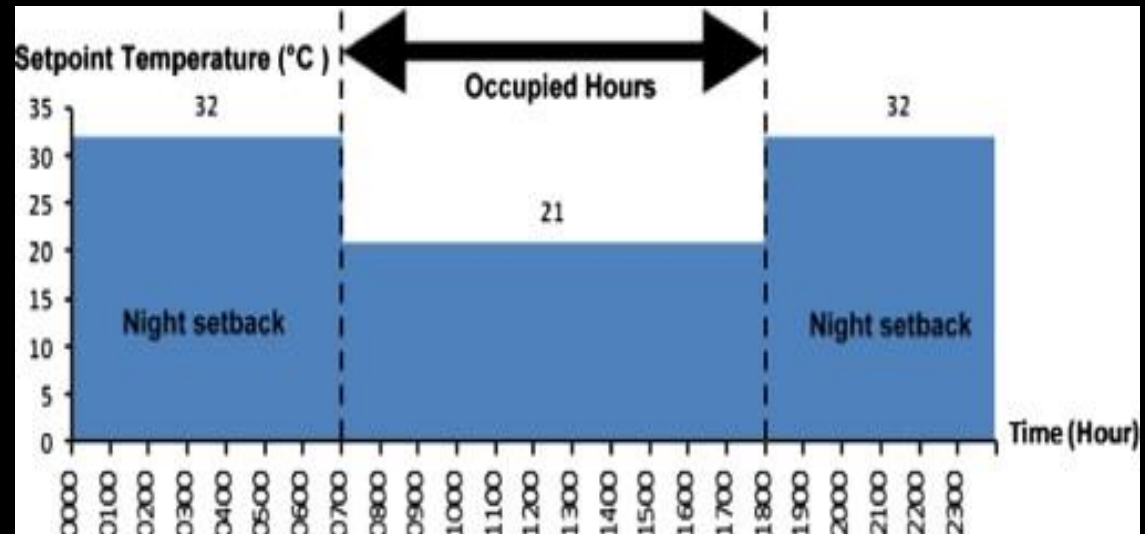
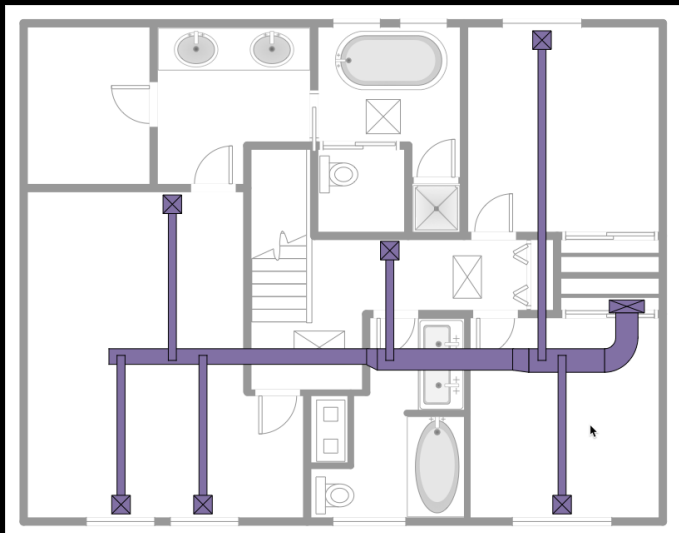
Installation
Floor or wall mounted
Indoor or outdoor

Certification
North American and International Standards
Grid code compliant



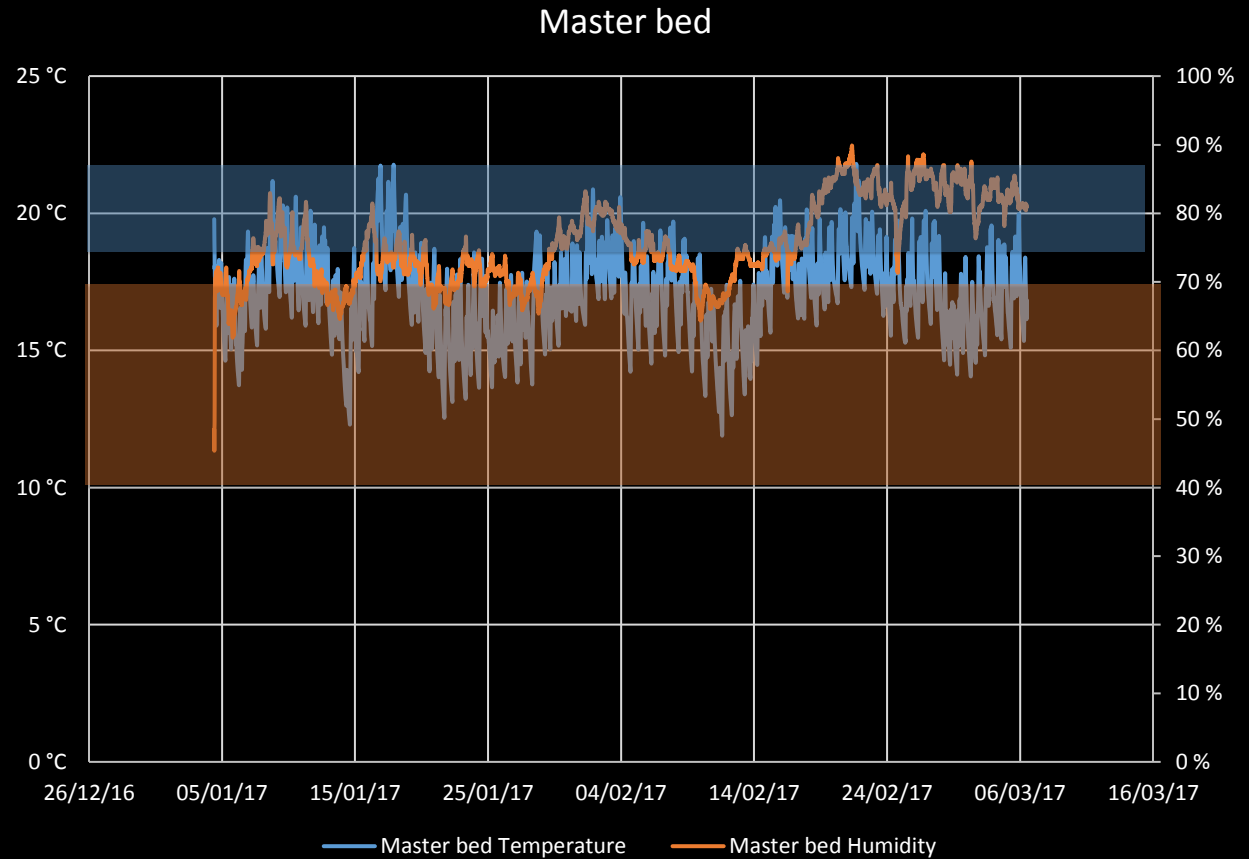
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- Market e.g. Tesla Powerwall 2, Domestic Battery, 2018
- Building e.g. Photos, Scheduling, Drawings, Building Manager

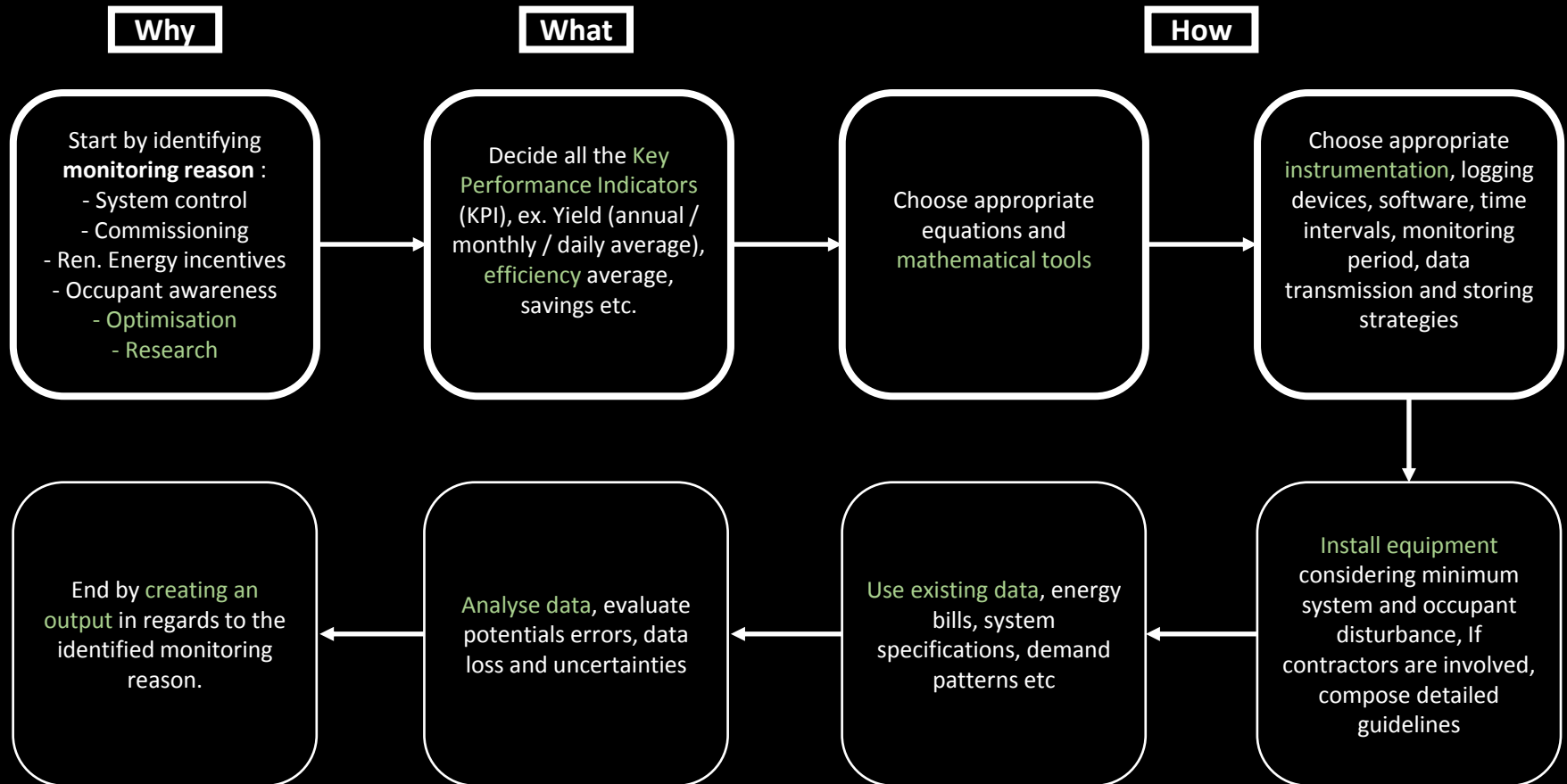


Initial evaluation - monitoring

- Site analysis
- Building Survey
- Questionnaires
- Fabric Testing
- Energy Monitoring
- Comfort Monitoring



Performance Evaluation Workflow

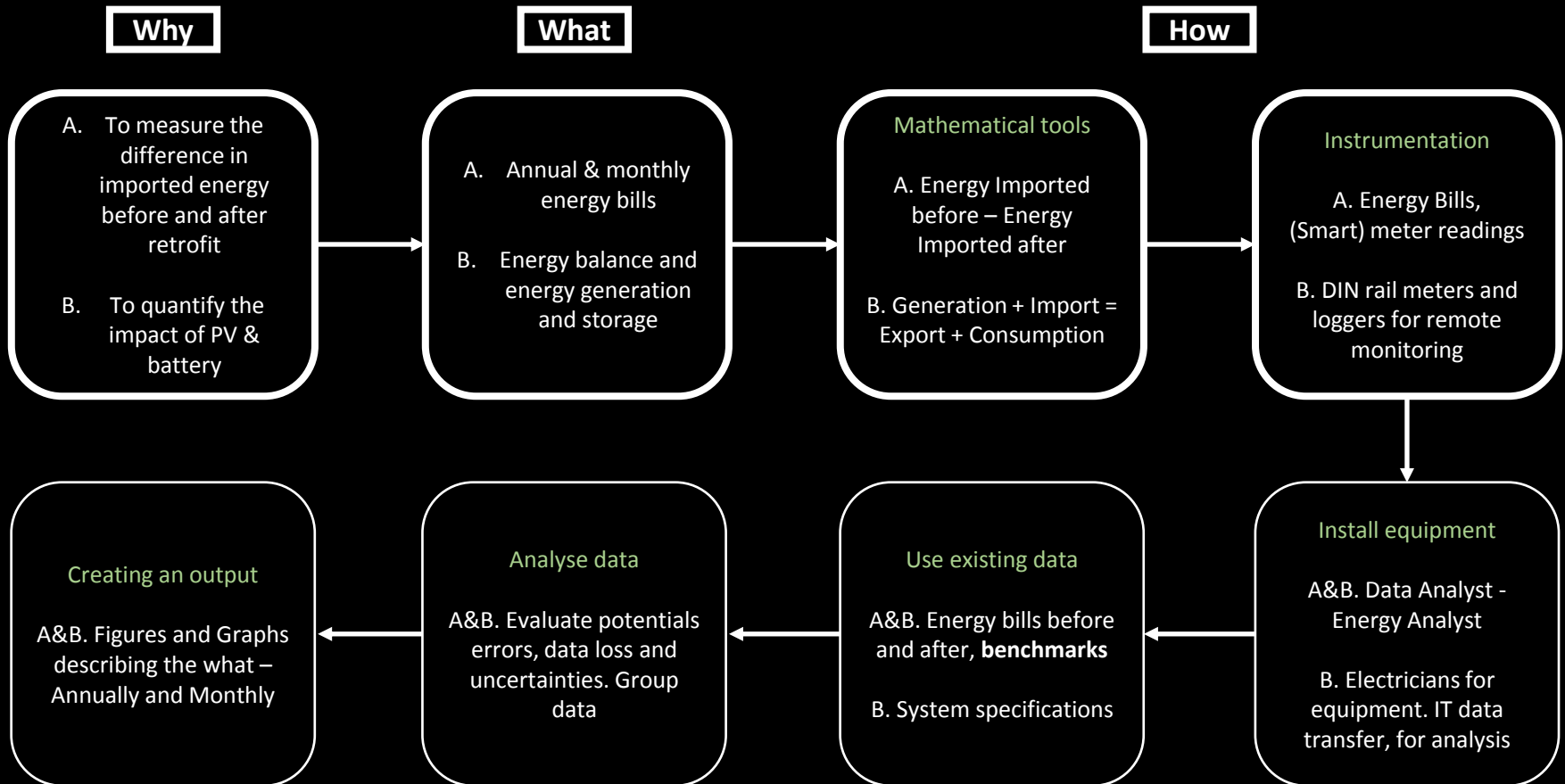


Performance Evaluation Workflow Example



- What is the reduction in grid imported energy?
- What is the contribution of the Photovoltaic Panel and Battery?

Performance Evaluation Workflow



A. What is the reduction in grid imported energy?

B. What is the contribution of the Photovoltaic Panel and Battery?

Thank you

Questions - Discussion