Module 10

Introduction to Quality Checks

Digitalisation in Construction

24 partners

12 countries

Date of Event

*Author/ **Institute***

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Introduction to quality checks | Summary

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To equip the learner with the basic knowledge and skills required to understand and know how digital tools can be used to support quality and compliance in construction.

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Introduction to quality checks | Objectives

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1. Define quality assurance in the construction of buildings.
2. Outline how the project team can be coordinated to ensure quality control on-site
3. Outline and demonstrate how to use digital tools to comply with national regulations for the building design, construction, operation and maintenance.
4. Discuss the use of the BIM methodology as a tool to support quality and compliance
5. Demonstrate with an example, the benefits of using digital tools for quality checks

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Introduction to quality checks | Content

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Topic 1 – Quality Controls and Checks

Topic 2 – Building Compliance

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Quality Controls and Checks

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Quality Control and Checks

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- What is Quality Assurance
- Quality Control and Checks for the design and installations for:
  - Building Envelope
  - Building Services
- Workers on site need to know these procedures also.
- Coordination of project team with the use of BIM for quality management
- The coordination of programming of tasks and trades can be recorded, analysed and communicated at intricate levels of detail.
- Complemented on-site, by using complete and accurate information which is in the hands of the right people, when they need it.

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QUALITY ASSURANCE

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What is Quality Assurance in Construction?

Quality assurance is a method of avoiding potential mistakes in a construction project by creating ‘rules’ about minimum quality while ensuring all decisions meet these standards.
Quality assurance covers things like:

- Materials used: Are they of the right standard, size, shape and material?
- Equipment: Will it work in the environment and is it safe?
- Agreed ways of measuring quality: What does ‘good’ look like?
- Project management: Timeframes, fair bidding processes, agreed budgets, etc.
- Certificates and skills: Do your people have the right skills for the job?

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What is Quality Assurance in Construction?

So, quality assurance is about preparation. By building quality into decision-making throughout your projects, you can be confident that you're ordering the right materials, using the correct equipment and everyone knows what to expect.

Quality assurance is different to quality control (although the two go hand in hand). Where quality assurance is about setting standards, quality control is about checking whether structures or elements meet those standards.

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Quality assurance is different to quality control (although the two go hand in hand).
Where quality assurance is about setting standards, quality control is about checking whether structures or elements meet those standards.

We will look at 5 Rules for Quality in Construction?

1. Clear definitions of ‘quality’

Everyone working on a project needs to clearly understand what is meant by ‘quality’ and what the expectations are for the project.

Document the details and explain these to all subcontractors, suppliers and project managers.

For example, it may be decided that especially high standards of thermal insulation is required (above the legal minimum requirements in new builds). Make sure all subcontractors are aware of this, when making purchasing decisions around insulation material.

Source: https://www.planradar.com/gb/quality-assurance-in-construction

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5 Rules for Quality in Construction?

2. Planning, design, and development of plans

Designers and project managers must conduct thorough assessments of plans, check for clashes and avoid cutting corners.

If these can be identified and all issues fixed early on, there is less chance of delays occurring during the build itself. Recently, BIM technology has been shown to help with quality in construction by automatically checking for clashes.

3. Material purchasing

It is vital to ensure that all materials and equipment purchased meet the required standards.

Buying cheaper, lower-quality materials may save money in the short term, but could result in problems later.

Quality assurance when buying, also involves verifying whether the suppliers are truly capable of meeting demand.

Source: https://www.planradar.com/gb/quality-assurance-in-construction

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5 Rules for Quality in Construction?

4. Continuous interaction during the build

All project team members must be able to communicate, discuss issues and verify progress.

Quality in construction relies on the site manager/supervisor constantly monitoring the works, ensuring it meets any pre-agreed definitions of quality.

5. Handover and snagging

Once the structure itself is practically completed, quality assurance also comes into play at the snagging and handover stage.

This is about conducting checks to ensure the as-built structure meets the expected quality standards.

Source: https://www.planradar.com/gb/quality-assurance-in-construction

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Keep in mind that:

1. Every material and construction product has its own, specific properties (Specifications).
2. Materials and products incorporated into building envelope must be compatible (Certified).
3. Every material and product should be used only for the purpose prescribed by producer (Fit for Purpose).

Not respecting these rules can result in structural damage and reduced performance outcomes

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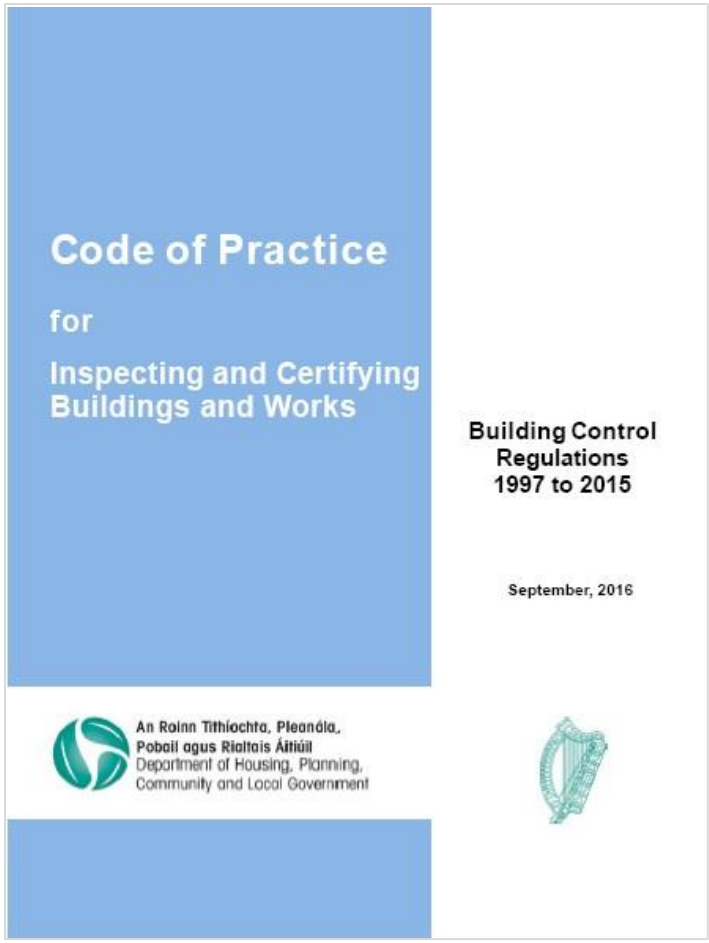
Absence of **Quality Control**
can sometimes lead to
Performance Gaps



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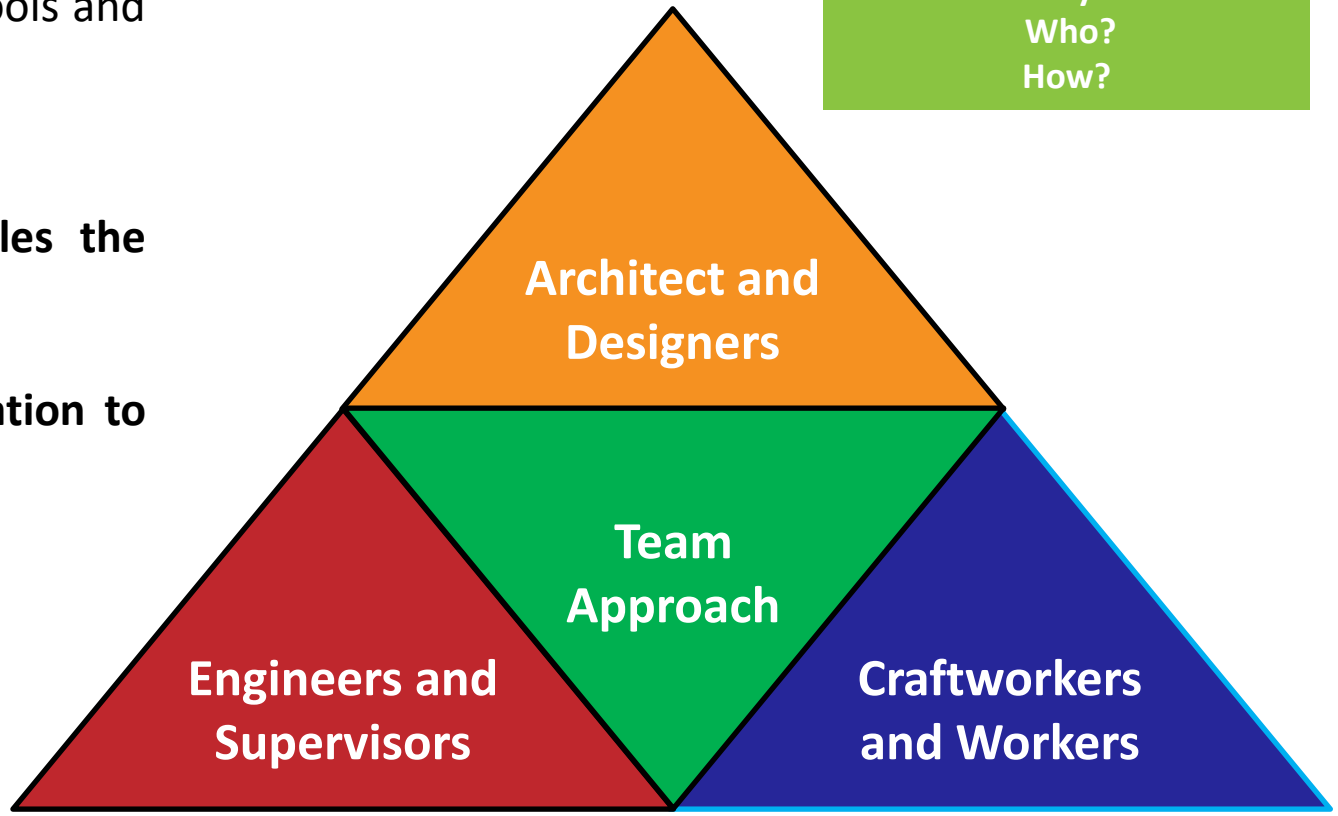
Most design teams have moved from paper to digital tools and software, to connect to all stakeholders
Workers on site need to follow suit.

BIM does not just design buildings, but also enables the scheduling of tasks, costs and people

BIM allows complete, real-time and accurate information to be accessed on-site

QUALITY CONTROL –
Why?
Who?
How?



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BIM approach to Quality Control and Checks

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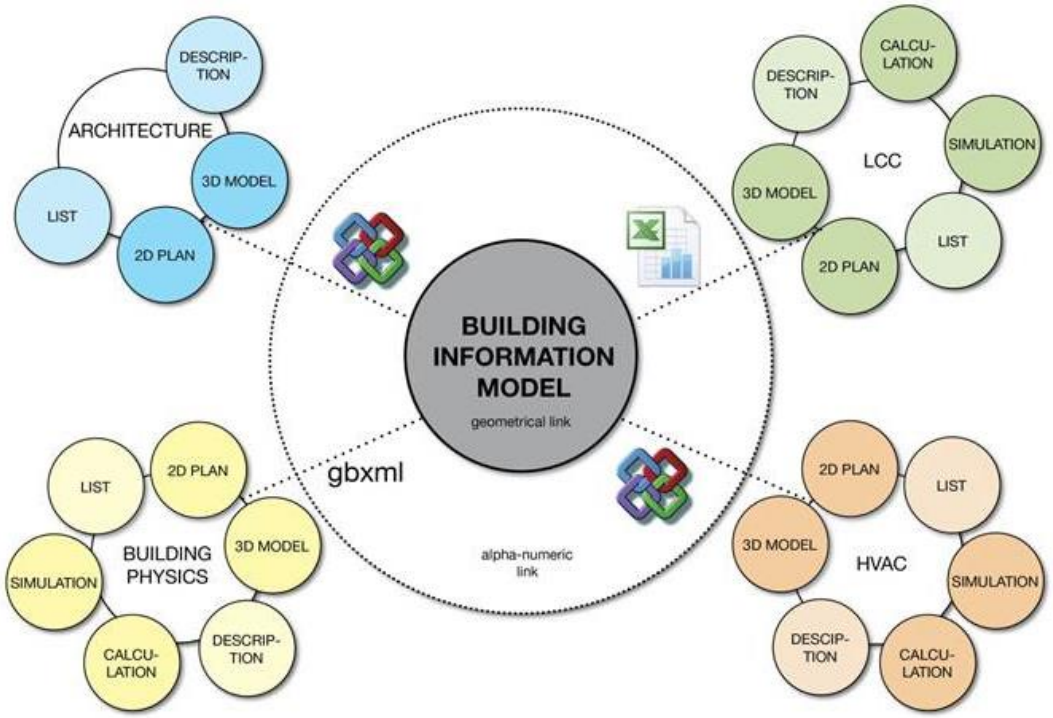
BIM (**Building Information Modeling and Information Management**) provides a platform for collaboration throughout the project's design, construction, operation and maintenance.

BIM can combine the following into one database/cloud :

- Design Information for all disciplines,
- Product and Material Information,
- Installation Instructions,
- Project Management Logistics.



Source: *Iva Kovacic, TU Wien, BIM_SUSTAIN*

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Quality Control: validation of models

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Objective of the BIM mode ⟶ to increase and ensure the quality of the construction process.

Three phases of BIM model validation for quality assurance:

- Internal audit of each actor focused on his assigned work or partial model and prior to the exchange of information with other participants.
- Audit when receiving or integrating partial models from other disciplines.
- Quality control of the federated model as a whole, integrating the work of all those involved so that it has internal coherence and that the information contained (graphic and non-graphic) is accurate before moving on to the construction phase.

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Quality Control: clash detection

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REQUIREMENTS OF QUALITY CONTROL PROCESSES

- Use of specific digital tools.
- Use of structured and hierarchical model data.
- Implementation of rule-based controls.
- Compliance with regulations, constructability of the project and integration between disciplines..

CATEGORIES FOR QUALITY ASSURANCE

- Checking → method that verifies the accuracy of the information contained in the BIM file, and which should be compared with a reference → detection of conflicts and interferences.
- Analysis → more extensive and detailed information, allowing for more accurate evaluation → e.g., cost analysis.

Some examples on Site

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It’s important to educate everyone on-site about the implications of shoddy workmanship.

Think of some examples on site, where you have experienced issues or seen issues with quality control and how was it resolved?

This is one example:
Poor quality work from a blocklayer ended up delaying the plumber, electrician and plasterer, this is a good example of how a team needs to pull together to avoid lost time and delayed earnings for everyone.
…..
…..

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How to use BIM to solve some of the issues

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A number of videos have been developed to show how BIM can assist with a number of issues.

Part 1. Federated Model and Navigate (Duration 6:51)

What is a Federated Model and how important is it in modern construction on-site?
Different professionals work on their own model, but can also work on a combined model known as a “Federated Model”.
“A Federated Model is a combined building information model that combines a number of BIM models from different disciplines into one”.
The main fields include models produced as Architectural + Structural+ Electrical+ Mechanical+ Civil and Sprinkler

Combining these individual models allow the BIM user to visualize, share, review, and validate BIM projects using 3D/2D information from a single file.
Using a Federated Model is so important in construction as it assembles all the elements of the building into one model, and can be viewed layer by layer or zoom into a specific area of the building.
Previously on site, numerous drawings were used (or still is) and changes had to be marked up by hand, causing errors, confusion and delays.

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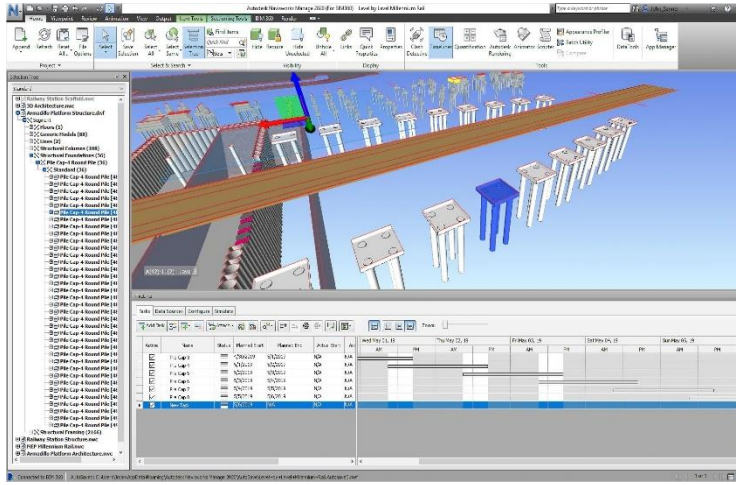
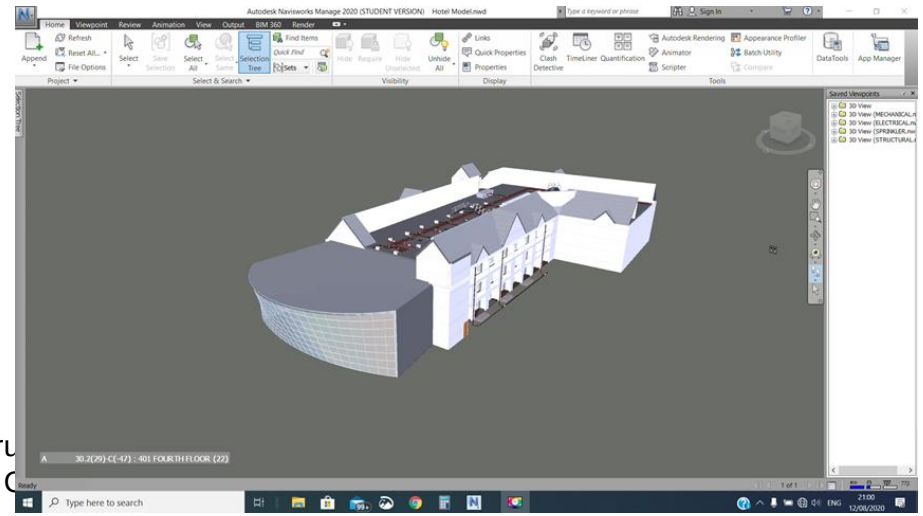
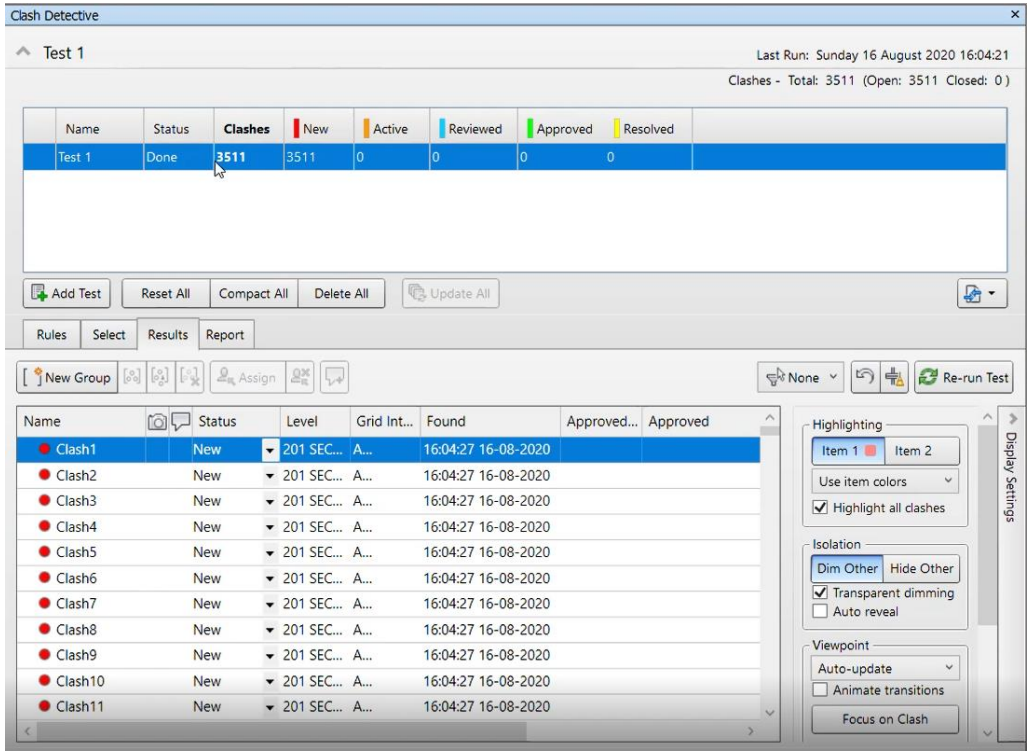
Part 2 Viewpoint and Review (Duration 9:06)



Part 3 Item Selection (Duration 4:26)



Part 4 Clash Detection (Duration 16:18)



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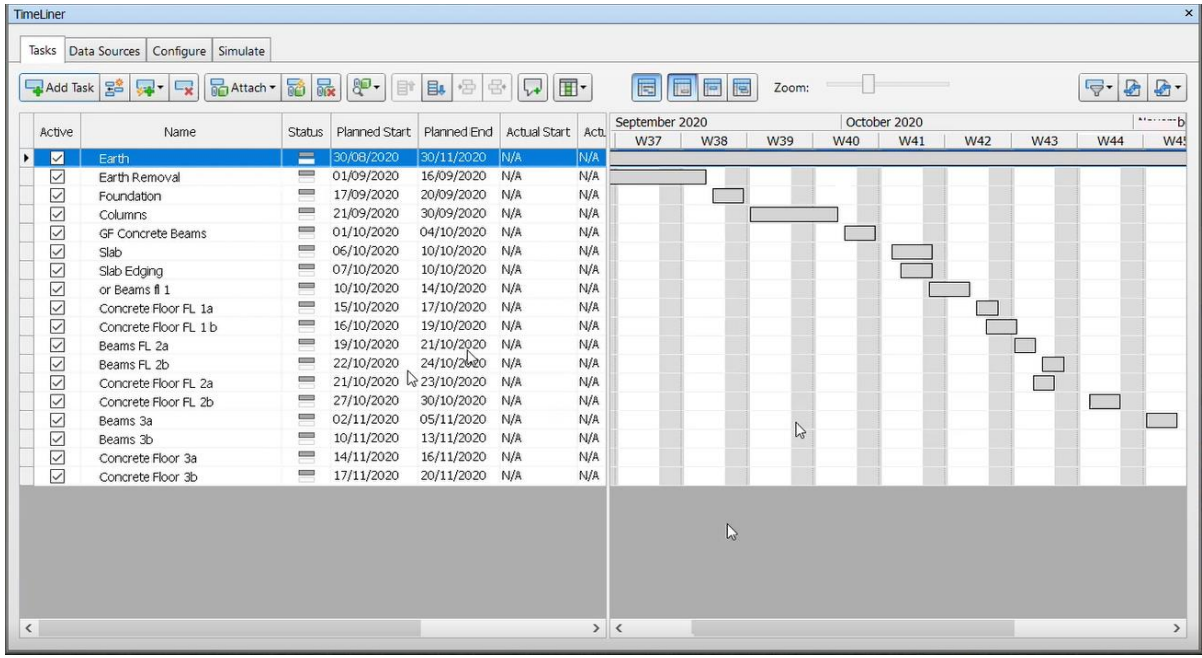
Part 5. Timeliner

BIM tools are not just for design or graphical purposes, but can assist with management sequencing.
Timeliner is available on Manage and Simulate
It is an ideal tool for project managers or the main contractor.
It enables time and cost planning management by setting out timeframes, tasks and costs associated to these tasks.
It is ideal for site supervisors to check for any gaps or deviations from the planned schedules or budgets and how many workers are needed to get the job completed on time and in budget.



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How to use BIM to solve some of the issues

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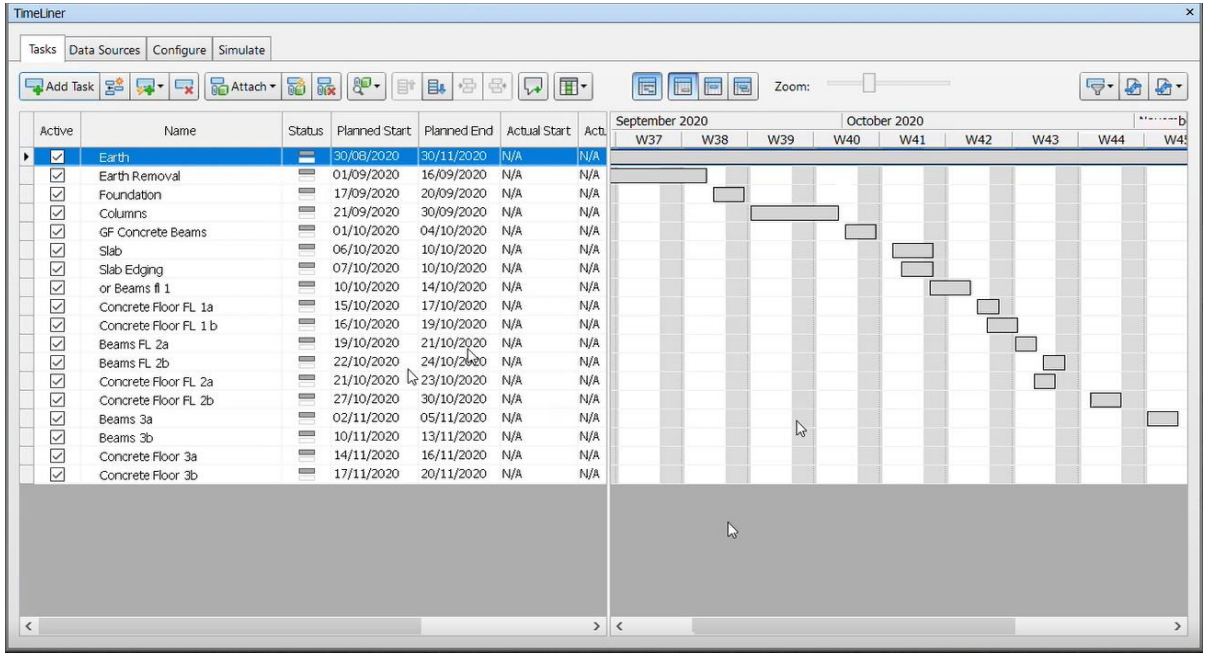
Part 5. Quantifications

This is one of the core functional features of Navisworks, creating a highly accurate quantity takeoff linked to the model.
It allows you to see items that have been accounted for—and those that have not—and make sure you produce accurate material estimates and quantities.
This is important as it allows for the extraction of key information from the model and project, to assess materials costs, quantities and order items when required.



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How to use BIM to solve some of the issues

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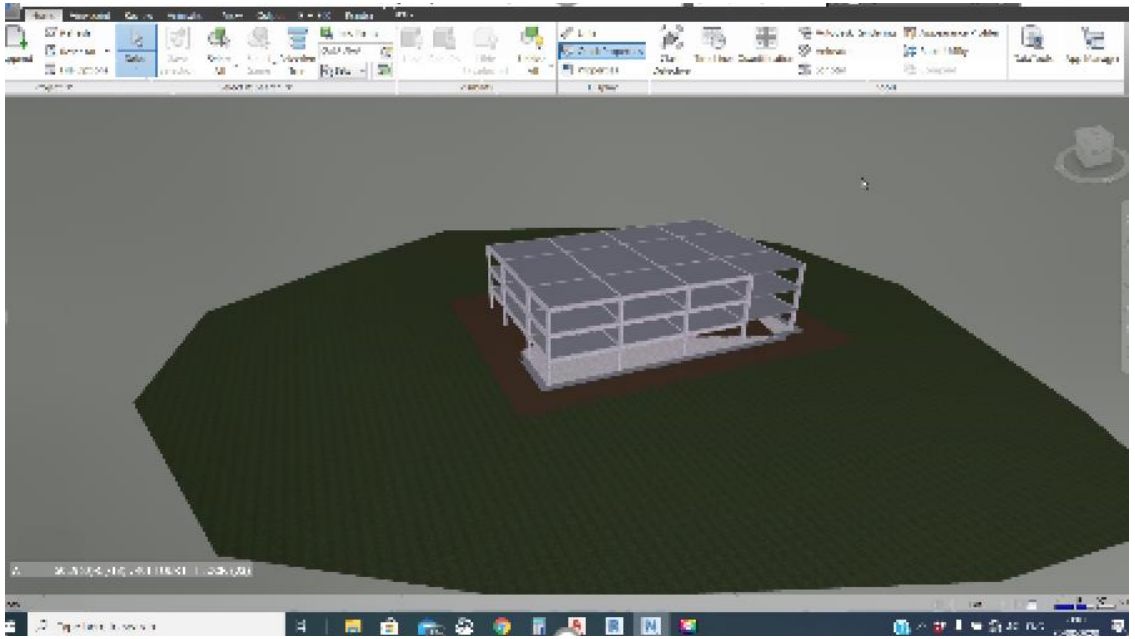
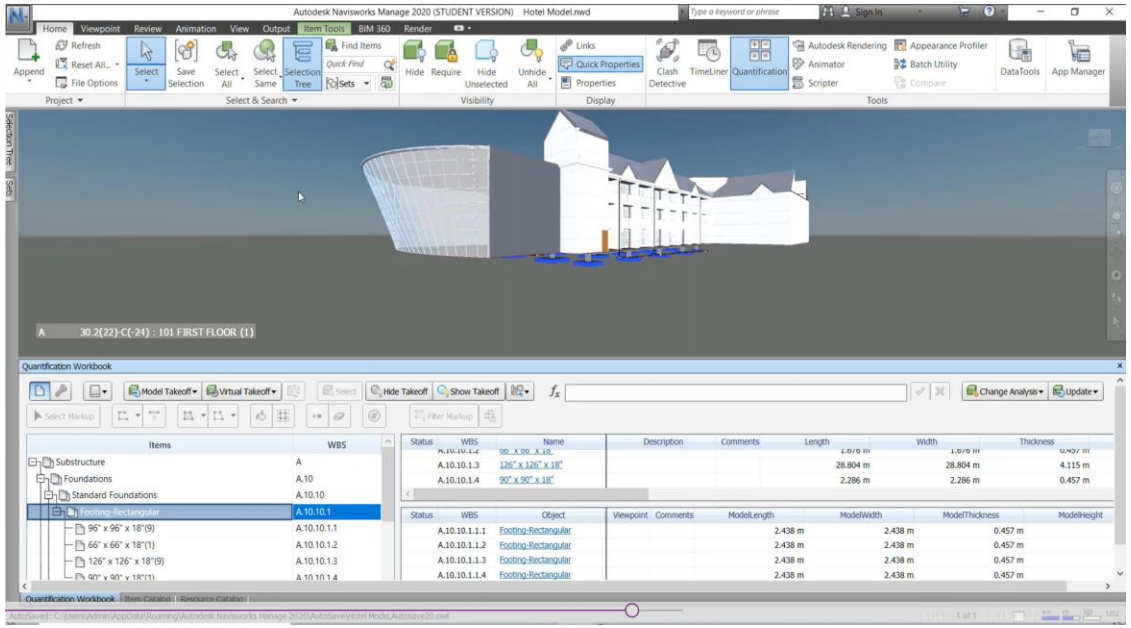
Part 5 Timeliner (Duration 15:14)



Part 6 Quantification (Duration 13.27)



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Building Compliance

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Complying with Energy Assessment Procedures

It is now a requirement for an Energy Performance Certificates to be produced for both domestic and commercial properties to demonstrate compliance with EU Energy Performance of Buildings Directives (EPBDs). These are examples from a number of countries:

- The Dwelling Energy Assessment Procedure (DEAP) is the **Irish** EAP
- In **Croatia** certificates are issued through the application of the Energy Certificate Information System
- In **Spain**, EAPS are regulated by Royal Decree 235/2013, using the LIDER/CALENER tool created to simulate and evaluate energy efficiency in Spanish buildings.
- For **Hungary** the assessment method uses calculation tools such as WInnWatt for the rating. The certificate is a technical document issued by an independent expert.

Are you familiar with your own countries' requirements?

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Building compliance - Ireland

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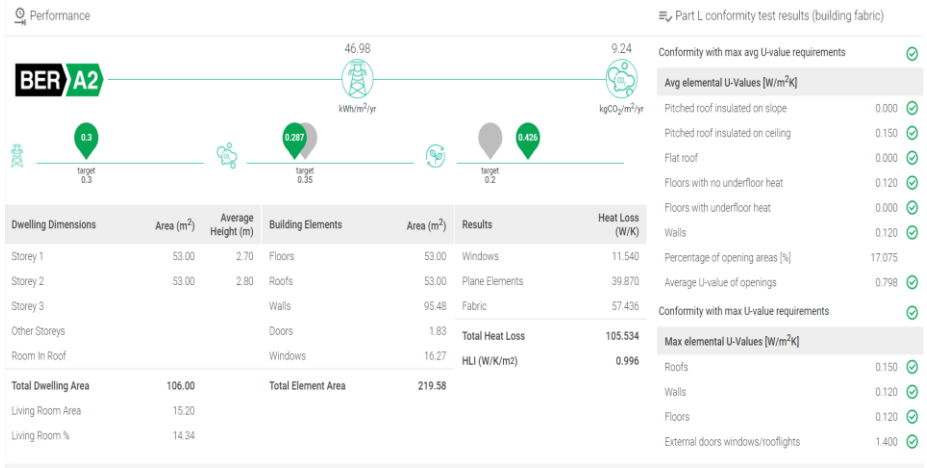
Let's look at an example in Ireland

Complying with Energy Assessment Procedures



Performance

BER A2

46.98 kWh/m²/yr

9.24 kgCO₂/m²/yr

Dwelling Dimensions	Area (m²)	Average Height (m)
Storey 1	53.00	2.70
Storey 2	53.00	2.80
Storey 3		
Other Storeys		
Room In Roof		
Total Dwelling Area	106.00	
Living Room Area	15.20	
Living Room %	14.34	

Building Elements	Area (m²)
Floors	53.00
Roofs	53.00
Walls	95.48
Doors	1.83
Windows	16.27
Total Element Area	219.58

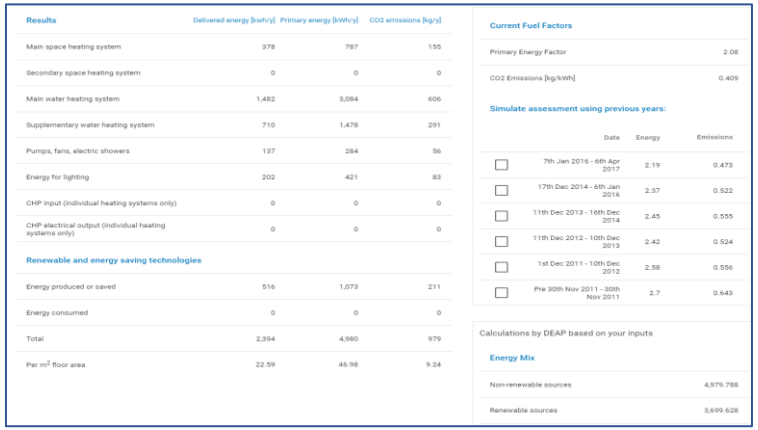
Results	Heat Loss (W/K)
Windows	11.540
Plane Elements	39.870
Fabric	57.436
Total Heat Loss	105.534
HLI (W/K/m2)	0.996

Part L conformity test results (building fabric)

Conformity with max avg U-value requirements	
Avg elemental U-Values [W/m²K]	
Pitched roof insulated on slope	0.000
Pitched roof insulated on ceiling	0.150
Flat roof	0.000
Floors with no underfloor heat	0.120
Floors with underfloor heat	0.000
Walls	0.120
Percentage of opening areas [%]	17.075
Average U-value of openings	0.798
Conformity with max U-value requirements	
Max elemental U-Values [W/m²K]	
Roofs	0.150
Walls	0.120
Floors	0.120
External doors windows/rooflights	1.400

illustrates energy balance of a dwelling

The (DEAP) online portal: left shows that a dwelling is compliant with the relevant Part L TGDs for the year of construction below



Results

	Delivered energy [kwh/y]	Primary energy [kWh/y]	CO2 emissions [kg/y]
Main space heating system	378	787	155
Secondary space heating system	0	0	0
Main water heating system	1,482	3,084	606
Supplementary water heating system	710	1,478	291
Pumps, fans, electric showers	137	284	56
Energy for lighting	202	421	83
CHP input (individual heating systems only)	0	0	0
CHP electrical output (individual heating systems only)	0	0	0
Renewable and energy saving technologies			
Energy produced or saved	516	1,073	211
Energy consumed	0	0	0
Total	2,394	4,980	979
Per m² floor area	22.59	46.98	9.24

Current Fuel Factors

Primary Energy Factor	2.08
CO2 Emissions [kg/kWh]	0.409

Simulate assessment using previous years:

Date	Energy	Emissions
7th Jan 2016 - 6th Apr 2017	2.19	0.473
17th Dec 2014 - 6th Jan 2016	2.37	0.522
11th Dec 2013 - 16th Dec 2014	2.45	0.555
11th Dec 2012 - 10th Dec 2013	2.42	0.524
1st Dec 2011 - 10th Dec 2012	2.58	0.556
Pre 30th Nov 2011 - 30th Nov 2011	2.7	0.643

Calculations by DEAP based on your inputs

Energy Mix

Non-renewable sources	4,979.788
Renewable sources	3,699.628

https://www.youtube.com/watch?v=I-ubz0X7u3E&ab_channel=SustainableEnergyAuthorityofIreland

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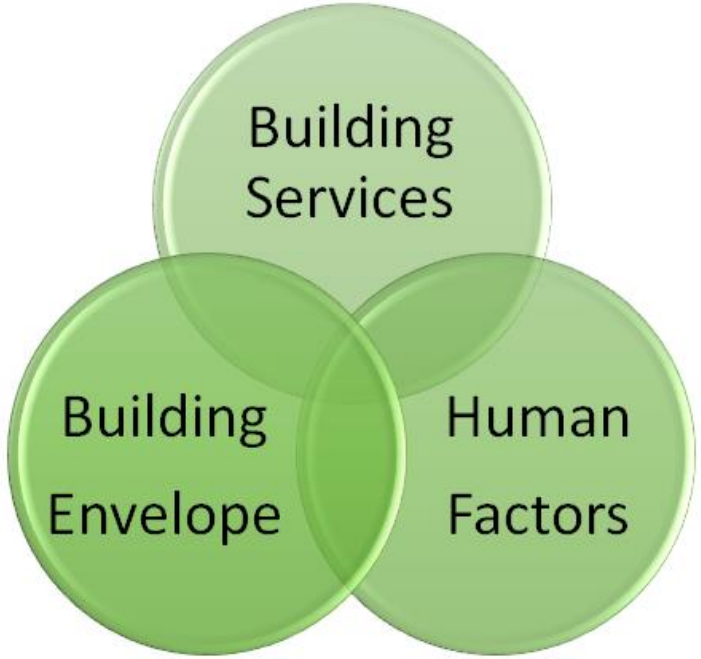
The Non-Domestic Energy Assessment Procedure (NEAP)

The Non-Domestic Energy Assessment Procedure (NEAP) is the software methodology for demonstrating compliance with Part L NEAP also generates the Building Energy Rating (BER) and advisory report for new and existing non-domestic buildings.

The software calculates the energy consumption, expressed as, kWh/m2.yr and CO2 emissions, kg CO2/m2.yr.



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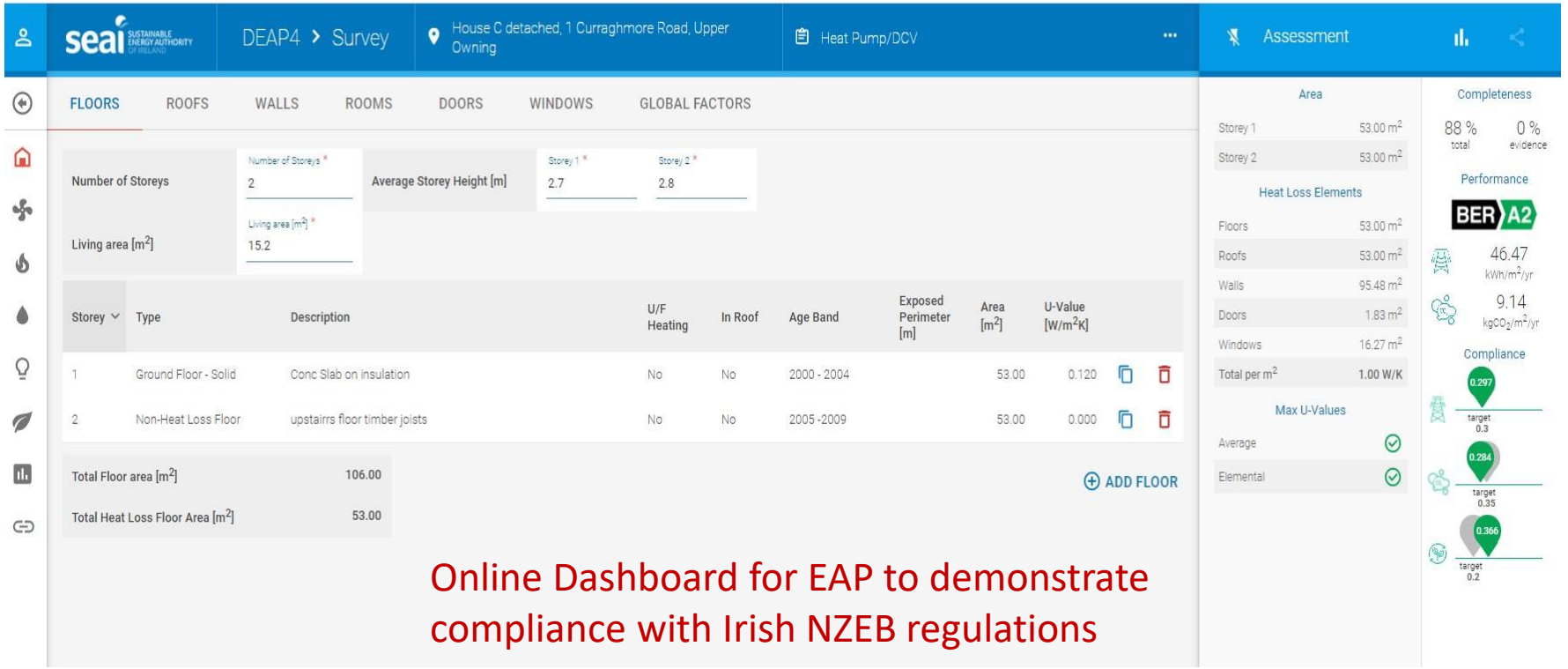
Complying with Energy Assessment Procedures



Online Dashboard for EAP to demonstrate compliance with Irish NZEB regulations

Checks for Compliance

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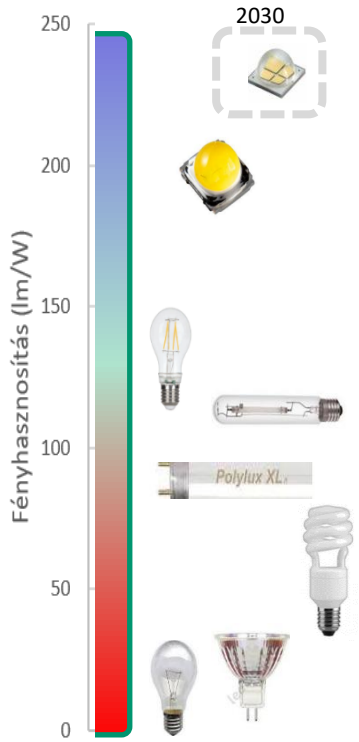
It is important to check the following

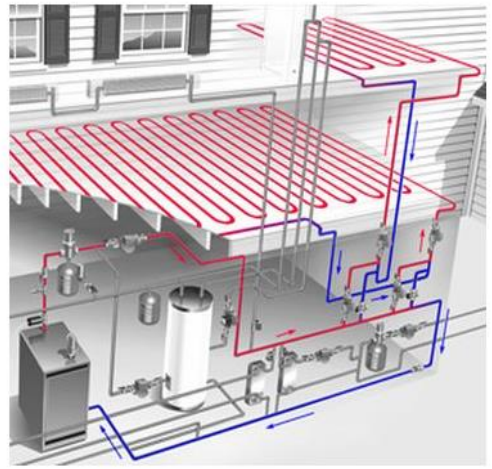
Envelope

1. U-values,
2. Insulations,
3. Thermal Bridging,
4. Air-tightness,
5. Wind-tightness,



Services

1. Controlled ventilation,
2. heating & cooling,
3. Renewables
4. Lighting
5. smart controls and sensors



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Checks for Compliance

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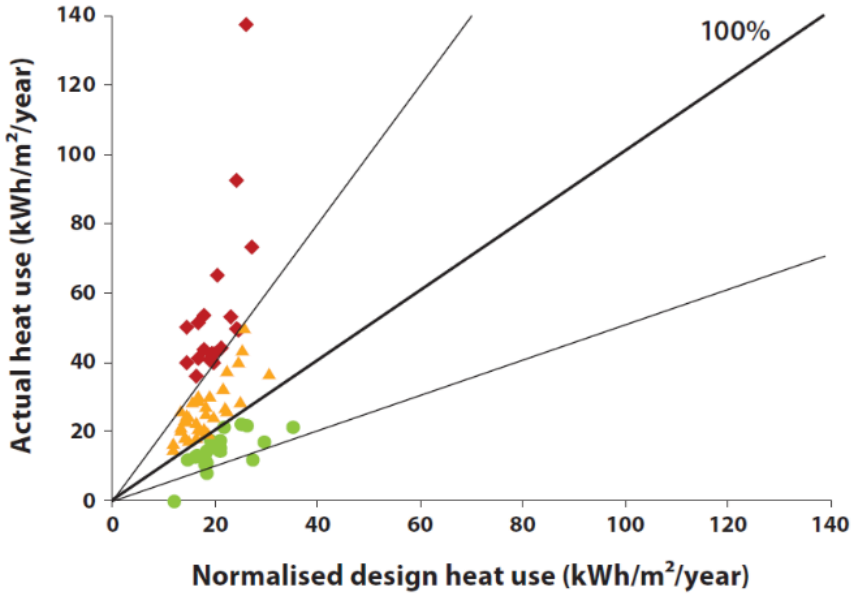
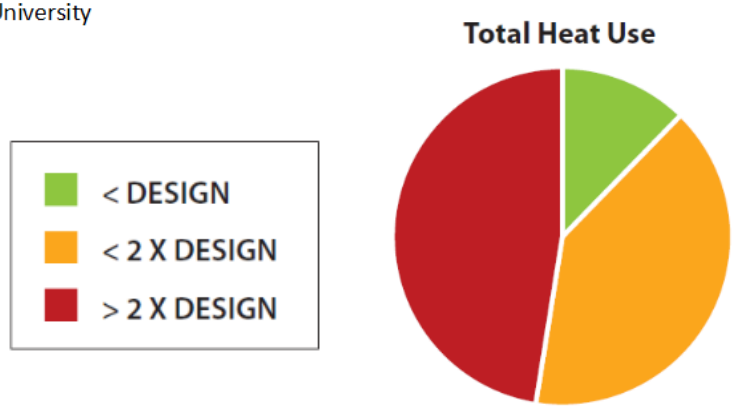
Mind the Gap – Why?

Some Reasons that many buildings on completion do not perform as predicted in the design.

- Design assumptions do not properly reflect the in-use performance of buildings.
- Discrepancies between design specification and the as-built specification and quality of works of installation.
- Poor feedback from site about what is, and what is not buildable.
- Site practices that may have been acceptable 20 years ago, no longer meet the required standards.



Source: Ghent University



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Checks for Compliance

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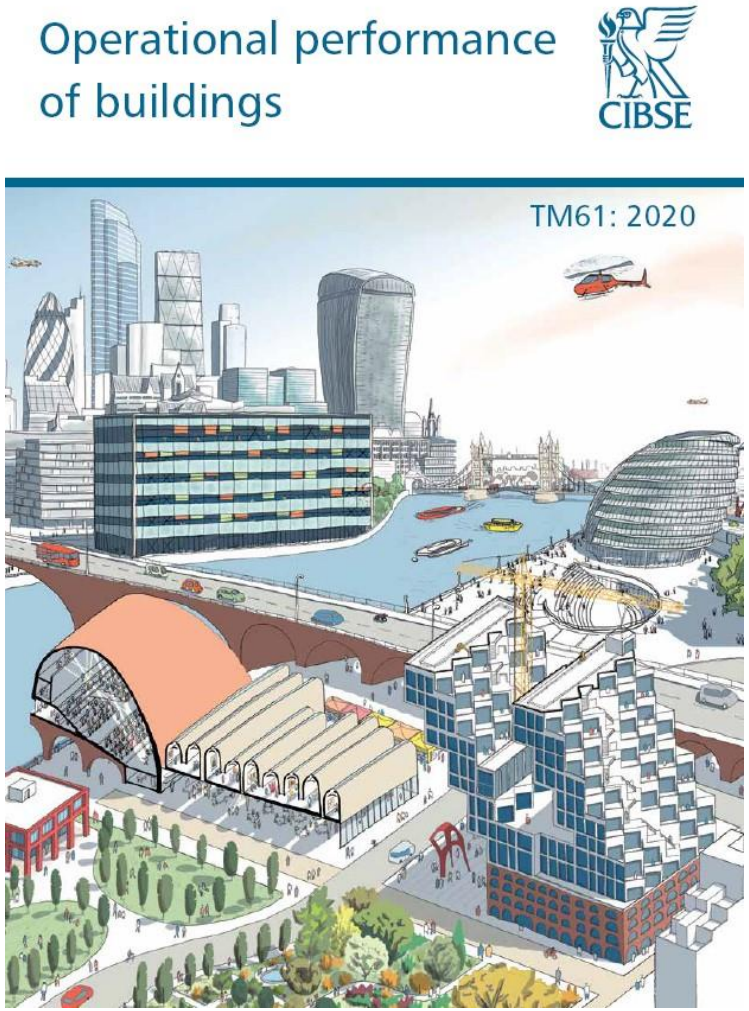
Performance Gap - the difference between predicted and actual performance.

There is significant evidence to suggest that buildings do not perform as well when they are completed as was anticipated when they were being designed. The difference between anticipated and actual operation is known as the **performance gap**.

Recent studies suggest that in-use energy consumption can 5 to 10 times higher than compliance calculations carried out during the design stage TM 61 provides insights into operational building performance



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Buildings do not always perform as well as expected. Completion of the buildings do not always match the model of the building at design stage. Known as the:

Performance gap - the difference between designed and actual performance.

Common Causes:

- Design assumptions do not properly reflect the in-use performance of buildings.
- Discrepancies between design specification and the specification and quality of works as-built.
- Poor feedback from site about what is, and what is not buildable.
- Site practices that may have been acceptable 20 years ago, no longer meet the required standards.

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Post Occupancy Monitoring

The energy model of a building can be calibrated through its lifecycle once in operation. This fine-tuning allows for much more refined analysis with real operating conditions and allows for capturing changes in energy use. This procedure allows for accurately identifying the variations between the design model and the actual performance of the building with a longitudinal perspective. Three energy modelling approaches and performance gaps could be distinguished:

- ***Regulatory performance gap*:** comparing compliance modelling data with measured energy use
- ***Static performance gap*:** comparing non-calibrated performance modelling data with measured energy use during a fixed period post-occupancy
- ***Dynamic performance gap*:** integrating measured energy use and performance modelling taking a longitudinal perspective

Resource - CIBSE TM61: Operational performance of buildings (2020)

Types of Monitoring

Energy: Each major energy source of the home is monitored to determine the energy use of appliances, heating and cooling system, lights and electronics. Based on this information, homeowners can determine how best to conserve energy and identify malfunctioning equipment.

Air Monitoring: The quality of air within buildings, regarding both health and comfort. Indoor air often contains a complex mixture of contaminants and common pollutants, including smoke, volatile organic compounds (VOCs) and moulds. The level of carbon dioxide (CO2) in indoor air also relates to IAQ, and is an accepted marker for the wider mix of potential air pollutants

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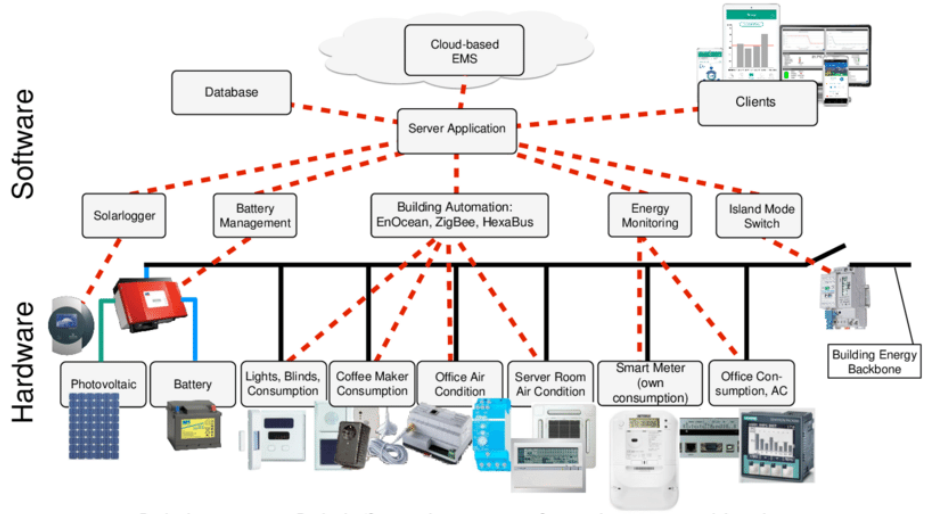
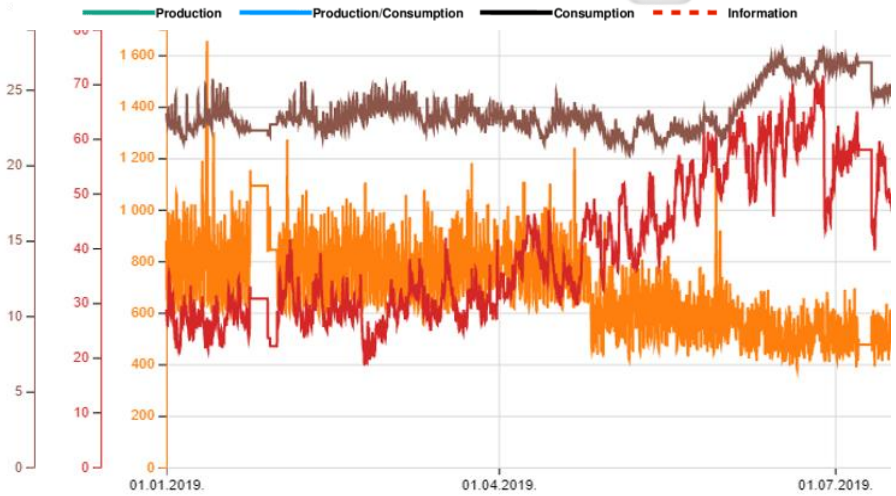
In-use performance measurements

- **In-use monitoring:**
  - Sub-metering is required for electricity, gas and hot- and cold-water utilities.
  - Sub-metering enables design team to provide a very good level of analytical aftercare for their clients.
- **To assess user comfort and health conditions**
  - Internal air temperatures, relative humidity and CO_2 levels can also be recorded
  - These can be analysed in conjunction with occupant surveys.
- **Weather stations accurately record the external conditions**
  - An important component of any in-depth monitoring.





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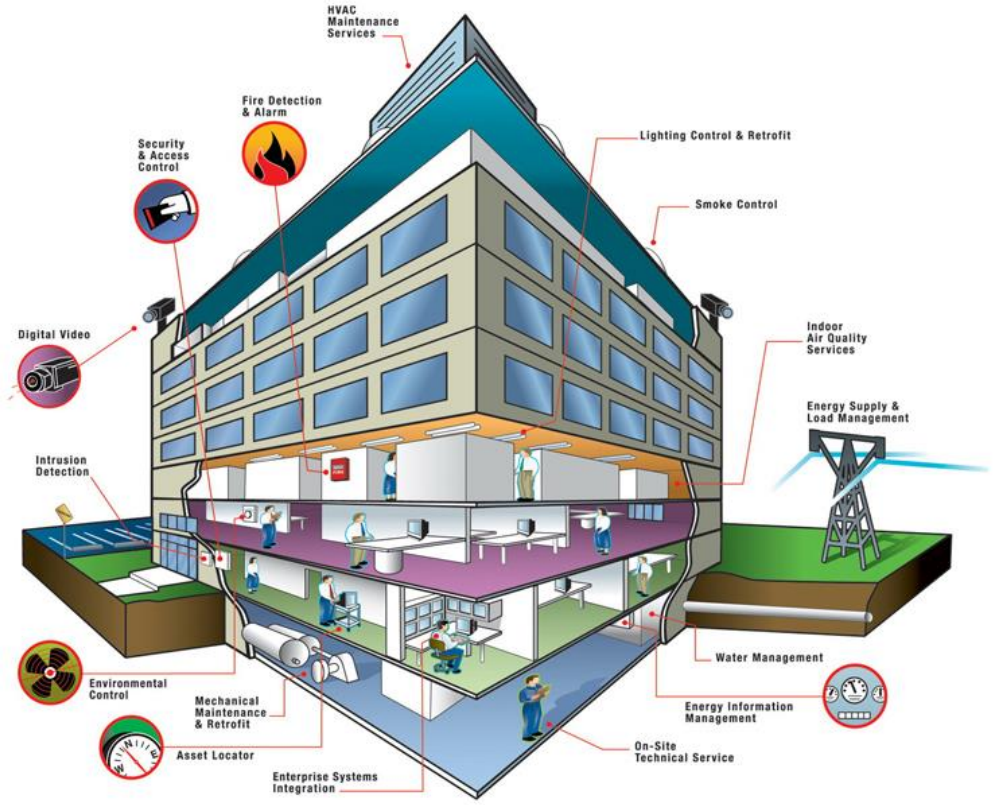
Use of BIM for Post Occupancy Monitoring and Building Management

Building Managers need to manage the daily activities by overseeing the maintenance and operations of NZEBs. It is crucial to **manage** the following in an as-built BIM model**:**

- thermal comfort
- quality of the indoor environment
  - humidity,
  - lighting,
  - sound, etc.
- the quality of services provided,
- building operating costs,
  - energy use, water use, recycling, and waste reduction.



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BIM and NZEB achievement

NZEB buildings require

- innovative design processes
- mixtures of technologies
- based on an integrated design approach
- constructed by work teams

Collaboration is essential between architects, engineers, technical experts, building managers, site supervisors, construction workers and building clients to achieve NZEB compliance and Quality of works.
Complemented on-site by complete and accurate information that resides in the hands of the right people when you need it

Assessment

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Thank You

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