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# ENERGY SHOW

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Rialtas na hÉireann
Government of Ireland

Edel Murray DHPLG: Overview of Part L

John Dolan, DoES: Schools

John Furlong, OPW: Leeson Lane

Frank Mills, ASHRAE: Net Zero Energy Buildings

An Roinn Tithíochta,
Pleanála agus Rialtais Áitiúil
Department of Housing,
Planning and Local Government

# SEAI Energy Show

## Part L and EPBD

Edel Murray

28th March 2019

# Overview


State Forensic Science Laboratory, Kildare

**Part L 2017: Conservation of Fuel and Energy – Buildings other than Dwellings**

- NZEB and Major Renovation

**2018 Amendments to EPBD (Energy Performance of Buildings Directive 2010/30/EU)**

- EV Charging
- Building Automation and Control Systems
- Cost Optimal

# NZEB – Buildings other than Dwellings


OPW Offices Leeson Lane

The **definition** for Nearly Zero Energy Buildings in the **EPBD 2010/30/EU** is as follows:
*'**Nearly zero-energy building** means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.'*

**Article 9 of the EPBD** requires that Member States ensure that:
*(a) by **31 December 2020, all new buildings are nearly zero-energy buildings**; and*

*(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.*

Ireland carried out a cost optimal analysis in 2013 to define NZEB requirements.

**NZEB for all new buildings is being implemented through Part L 2017**, Conservation of Fuel and Energy – Buildings other than Dwellings.

Part L of the Buildings Regulations defines the requirements in legislation.

Circular issued to Public Sector in December 2016 with NZEB Interim Specification for buildings commencing design.

## Energy Performance of Buildings Directive 2010/31/EU – Article 9

# NZEB – Buildings other than Dwellings

State Forensic Science Laboratory, Kildare

**Building Regulation Part L 2017**
**Conservation of Fuel and Energy – Buildings other than Dwellings**

- **TGD L 2017** Conservation of Fuel and Energy – Buildings other than Dwellings:

  - Published: December 2017
  - Application: January 1st 2019 (subject to transitional arrangements)
  - Provides detailed NZEB guidance
  - Includes Major Renovation performance requirements to cost optimal level


- **Consultation with Stakeholders:**

  - Public Consultation and Regulatory Impact Analysis
  - OPW, DoES, HSE, SEAI, CIC
  - RIAI, SCS, EI, ACEI, CIF, CIBSE, IGBC, IBEC, ESB, Bord Gais
  - Multiple industry workshops with circa 1500 professionals

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings

OPW Offices Leeson Lane

**TGD L 2017**
**Transitional Arrangements**

- **TGD L 2017** applies to works, or buildings in which a material alteration or change of use or major renovation takes place, where the work, material alteration or the change of use commences or takes place, as the case may be, on or after 1st January 2019.

- **TGD L 2008 ceases** to have effect from **31st December 2018**.

- **TGD L 2008** may continue to be used in the case of buildings:

  - where the **work**, material alteration or the change of use **commences** or takes place, as the case my be, on or **before 31st December 2018**, *or*

  - where **planning approval** or permission for buildings has been applied for on or **before 31st December 2018**, and **substantial work** has been **completed by 1st January 2020**.

'*Substantial work has been completed*' means that the structure of the external walls has been erected.


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017**
**Key Components of Performance Requirements**

- In the order of **60% improvement in energy performance** on the 2008 Building Regulations
- **Improved Fabric** Specification
- **Advanced Services and Lighting** Specification
- 20% requirement for renewable energy sources i.e. **Renewable Energy Ratio** (RER) of **20%** with flexibility to 10% where the building is more energy efficient than the Building Regulation requirement.
- **Major Renovation** performance requirements.


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


OPW Offices Leeson Lane

TGD L Section 1.1 Limitation of Primary Energy Use and $CO_2$ emissions calculated using NEAP methodology to achieve:

**MPEPC = 1.0**

**MPCPC = 1.15**

(equates to 60% reduction in energy performance)

+

TGD L Minimum Threshold level for Compliance:

**RER = 0.20**

**Improved Building Fabric:**

U-Value Backstops

Thermal Bridging ACDs

Air Tightness = $5m^3/(h.m^2)$

Limit Solar Gain

**Improved Building Services:**

Heat Generator Efficiency

Controls for Space Heating & Hot Water

ACMV System Efficiencies

ACMV Controls

Insulation of Storage Vessels, Pipes & Ducts

Lighting Efficiency & Controls

**Construction Quality & Commissioning of Services**

**User Information**

**Compliance with Part L Buildings other than Dwellings**


**Part L 2017**
**Achieving Compliance for New Buildings**

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings

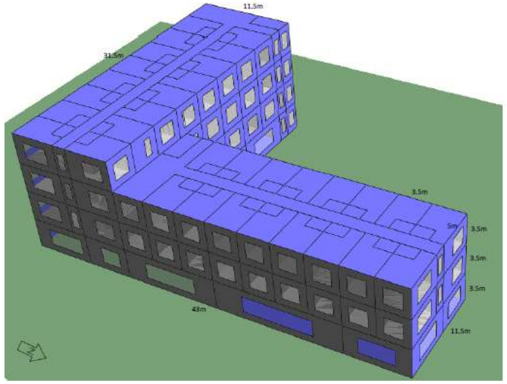

State Forensic Science Laboratory, Kildare

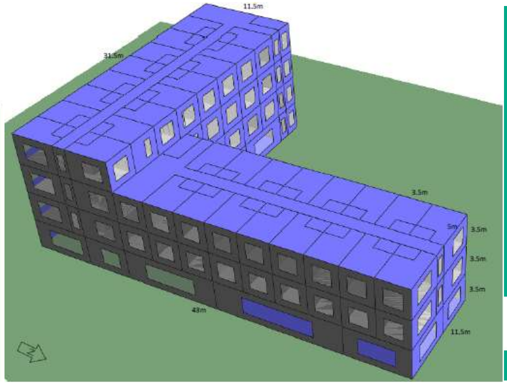
**TGD L 2017**
**Whole Building Compliance in NEAP**

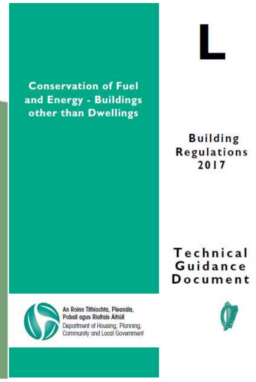
$$MPEPC = \frac{\text{Proposed Primary Energy Use}}{\text{Reference Building Primary Energy Use}} \leq 1.0$$

$$MPCPC = \frac{\text{Proposed Carbon Emissions}}{\text{Reference Building Carbon Emissions}} \leq 1.15$$

$$RER \geq 0.20$$








**Reference Building:**
Same Shape & Size as actual building
Advanced Fabric
Efficient Services
20% Renewables

**Actual Building:**
Same Shape & Size as reference building
Advanced Fabric
Efficient Services
20% Renewables

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings

State Forensic Science Laboratory, Kildare

**TGD L 2017**
**Reference Building Performance Requirements – Fabric Specification**

| Element | TGD L Reference Values |
|---|---|
| Total Floor Area & Building Volume | Same as actual building |
| Opening Areas | Offices & Shops: Windows and pedestrian doors are 40% of the total area of exposed walls |
| Walls | U-Value = $0.18W/m^2K$ |
| Roof | U-Value = $0.15W/m^2K$ |
| Floor | U-Value = $0.15W/m^2K$ |
| Thermal Bridging | Actual Length of Key Junctions x Advanced psi values |
| Air Permeability | $5m^3/(hr.m^2)$ Floor Area ≤ $250m^2$<br>$3m^3/(hr.m^2)$ Floor Area > $250m^2$ |
| Window | U-Value = $1.4W/m^2K$<br>G-Value = 40% |


L

Conservation of Fuel and Energy - Buildings other than Dwellings

Building Regulations 2017

Technical Guidance Document

# Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017**
**Reference Building Performance Requirements – Services Specification**

| Element | TGD L Reference Values/ Public Sector Specification |
|---|---|
| Heating Efficiency (Heating and hot water) | Gas Boiler 91% Efficiency |
| Cooling Seasonal Energy Efficiency Air conditioned Building Ratio (SEER) | SEER = 4.5/ SSEER = 3.6 |
| Lighting | 65 lm/circuit watt |
| Occupancy Control | Automated |
| Daylight Control | Automated |
| Central Ventilation SFP | 1.8 W/(l/s) |
| Variable Speed Control of Fans | Yes |
| Renewable Energy Ratio using PV | 0.2 |

# NZEB – Buildings other than Dwellings

OPW Offices Leeson Lane

**TGD L 2017**
**Renewable Energy Ratio (RER)**

- Renewable energy requirement included in TGD L is based on **ISO 52000** where energy from **renewable sources is produced on site** or nearly.

- Standard Renewable Energy Ratio (RER) of 20% with flexibility to reduce to 10% where energy performance of the building is more energy efficient than the Building Regulation requirement.

$$RER = \frac{E_{PREN}}{E_{Ptot}}$$

$E_{Ptot}$ is the total primary energy including renewable energy
$E_{Pren}$ is the renewable primary energy

- Renewable Energy Ratio Flexibility where:

| | | |
|---|---|---|
| MPEPC = 1.0 | MPCPC = 1.15 | RER ≥ 0.2 |
| MPEPC = 0.9 | MPCPC = 1.04 | RER ≥ 0.1 |

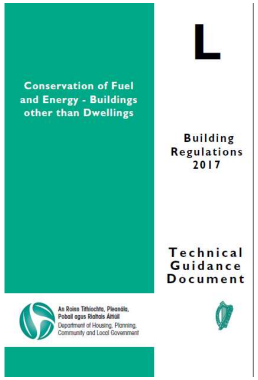

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017**
**Fabric**

- Airtightness backstop ≤ **5m³/(hr.m²)**
- **Air tightness testing is a requirement on building completion**. Alternative approach for confirming compliance is only permitted for large complex buildings with a building envelope area in excess of 160,000m².
- **Air tightness testers to be certified** by Irish National Accreditation Board (INAB) or National Standards Authority of Ireland (NSAI), **to I.S. EN ISO 9972**.
- **Overheating check in NEAP software**; and detailed checks to use CIBSE TM52.
- Solar gain reference case in NEAP is an east-facing façade with full width glazing to a height of 1m having a framing factor of 10% and a normal solar energy transmittance (G-Value) of 0.68.



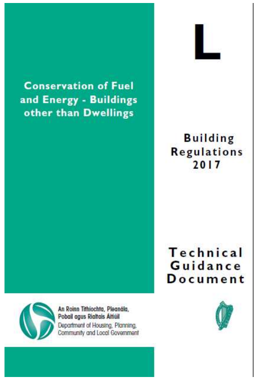

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


OPW Offices Leeson Lane

**TGD L 2017: Section 2**
**Existing Buildings**

- Works Categories:
  - Extensions
  - Material Alterations
  - Material Change of Use
  - Major Renovations




## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017: Section 2**
**Existing Buildings: Fabric**

- **Extensions** - Refer to **Table 1** (as per new buildings)

| Table 1 Maximum elemental U-value [1] ($W/m^2K$) | | |
|---|---|---|
| Column 1<br>Fabric Elements | Column 2<br>Area – weighted<br>Average Elemental U-Value ($U_m$) | Column 3 Average Elemental U-value Individual element or section of element |
| Roofs[2]<br>Pitched roof<br>- Insulation at ceiling<br>- Insulation on slope<br><br>Flat roof | <br><br>0.16<br>0.16<br><br>0.20 | 0.3 |
| Walls[2] | 0.21 | 0.6 |
| Ground Floors[2,3] | 0.21 | 0.6 |
| Other exposed floors[2] | 0.21 | 0.6 |
| External personnel doors, windows[4] and rooflights[,6] | 1.6[5] | 3.0 |
| Curtain Walling | 1.8 | 3.0 |
| Vehicle access and similar large doors | 1.5 | 3.0 |
| High usage entrance door[7] | 3.0 | 3.0 |
| Swimming Pool Basin[8] | 0.25 | 0.6 |


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


OPW Offices Leeson Lane

**TGD L 2017: Section 2**
**Existing Buildings: Fabric**

- **Material Alterations** – Refer to **Table 10** specific to this category

**Table 10 Maximum elemental U value ($W/m^2K$)[1,2] for Material Alterations**

| Column 1<br>Fabric Elements | Column 2<br>Area-weighted Average Elemental U-Value (Um) | Column 3<br>Average Elemental U-value – individual element or section of element |
|---|---|---|
| Roofs<br><br>Pitched roof<br>- Insulation at ceiling<br>- Insulation on slope<br><br>Flat roof | <br><br><br>0.16<br>0.25<br><br>0.25 | <br><br><br>0.35 |
| Walls<br>Cavity Walls[3]<br>Other Walls | <br>0.55<br>0.35 | 0.60 |
| Curtain Walls | 1.8 | 0.60 |
| Ground Floors | 0.45[4,5] | |
| Other Exposed Floors[5] | 0.25 | 0.60 |
| External doors, windows and rooflights | 1.60 | 3.0 |


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017: Section 2**
**Existing Buildings: Fabric**

- **Material Change of Use** – Refer to **Table 11** specific to this category

**Table 11 Maximum elemental U value (W/m²K)[1] for Material Change of Use for retained elements**

| Column 1<br>Fabric Elements | Column 2<br>Area-weighted Threshold Elemental U-Value ($U_t$) | Column 3<br>Area-weighted Average Elemental U-Value (Um) | Column 4<br>Average Elemental U-value – individual element or section of element |
|---|---|---|---|
| Roofs<br><br>Pitched roof<br>- Insulation at ceiling<br>- Insulation on slope<br><br>Flat roof | <br><br><br>0.16<br>0.35<br><br>0.35 | <br><br><br>0.16<br>0.25<br><br>0.25 | 0.35 |
| Walls<br>Cavity Wall [3]<br>Other Walls | <br>0.55<br>0.55 | <br>0.55<br>0.35 | 0.60 |
| Curtain Walls (frame and centre panels) | 3.6 | 1.8 | 3.0 |
| Ground Floors | -<br>0.45 | -<br>0.45[4,5] | - |
| Other Exposed Floors | 0.6 | 0.25 | 0.60 |
| External doors, windows and rooflights | 3.6 | 1.6[2] | 3.0 |


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings

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**TGD L 2017: Section 2**
**Existing Buildings: Major Renovation**

- Where more than **25% of the surface area of the building envelope** undergoes renovation the energy performance of the whole building should be improved to Cost Optimal level in so far as this is technically, functionally and economically feasible.

- Works to the surface area of the building include the following:

  - **Cladding** the external surface of an element

  - **Drylining** the internal surface of an element

  - **Replacing windows**

  - Stripping down the element to **expose the basic structural components** (brickwork/ blockwork, timberframe, steelframe, joists, rafters, purlins, etc.) and then rebuilding to achieve all the necessary performance requirements.


## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017: Section 2**
**Existing Buildings: Major Renovation**
The following **improvements** are normally **considered to be cost optimal** and will typically be economically feasible when more than 25% of the surface area of a building is upgraded:

- **Upgrading** oil, gas or biomass **heating systems** more than 15 years old and with an efficiency of less than that shown in Table 2;
- **Upgrading controls for direct electric space heating systems** to achieve the level of controls described in Table 5;
- **Upgrading cooling and ventilation systems** more than 15 years old and a cooling unit Seasonal Energy Efficiency Ratio less than that in the Eco-design Regulation referenced in par 1.4.3.11 and / or Specific Fan Power greater than that in Table 12 and by the provision of new plant; and
- **Upgrading general lighting systems** that are more than 15 years old or have an average lamp efficacy of less than 40 lamp-lumens per circuit-watt as defined in NEAP and that serves greater than 100m$^2$ to the guidance in section 2.2.7.

# NZEB – Buildings other than Dwellings


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**TGD L 2017: Section 2**
**Existing Buildings: Major Renovation**

| Table 13 Whole Building Cost Optimal Level | |
|---|---|
| **Building Type** | **Major Renovation - Cost Optimal Performance kWh/m²/yr** primary energy |
| Retail<br>Air Conditioned | 338 |
| Office<br>Natural Ventilated offices and other Buildings | 124 |
| Office<br>Air Conditioned | 180 |
| Hotel<br>Air Conditioned | 342 |
| Schools | 60 |
| Other Air Conditioned Buildings | 338 |
| Other Naturally Ventilated Buildings | 124 |

Alternatively where the **whole building** performance achieves the **primary energy performance levels as calculated in NEAP** and specified in **Table 13** where technically, functionally and economically feasible this can be considered the cost optimal level of performance.

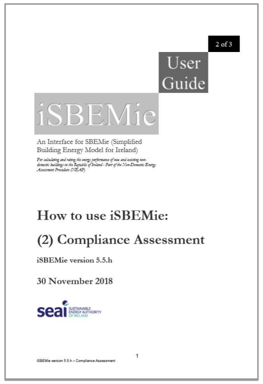

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# NZEB – Buildings other than Dwellings


State Forensic Science Laboratory, Kildare

**TGD L 2017**
**NEAP** (Non-Domestic Energy Assessment Procedure)

- NEAP is the **methodology for demonstrating compliance with Part L** of the Building Regulations and **publishing Building Energy Ratings** (BERs).
- The **NEAP software** in the form of the Simplified Building Energy Model for Ireland **(SBEMie)** has been updated to demonstrate compliance with NZEB and Part L of the Building Regulations. The new software **SBEMie version 5.5h** developed by BRE was made available to download from the SEAI website on 30th November 2018.
- HVAC **process loads capped for RER** calculation.
- **New schedules** included in SBEMie version 5.5h for **healthcare specialist areas**.
- **New schedules** included in SBEMie version 5.5h **for schools**.
- **Primary Energy Factor** (PEF) **is 2.08**
- **$CO_2$ Emissions** Factor is **0.409kg$CO_2$/kWh**


2 of 3
User Guide
iSBEMie
An Interface for SBEMie (Simplified Building Energy Model for Ireland)

How to use iSBEMie:
(2) Compliance Assessment
iSBEMie version 5.5.h
30 November 2018
seai

## Energy Performance of Buildings Directive 2010/31/EU - Implementation

# Overview


OPW Offices Leeson Lane

**2018 Amendments to EPBD (Energy Performance of Buildings Directive 2010/30/EU)**

- EV Charging
- Building Automation and Control Systems
- Cost Optimal

## Energy Performance of Buildings Directive 2010/31/EU & Amending Directive 2018/844 – Articles 8, 14 & 15

# EV Charging – EPBD Requirement in Building Regulations

**TGD L 2017: Amendment**
**EV Charging for New Buildings** – application date **10th March 2020**

| Scope | | MS Obligation |
|---|---|---|
| **New** Buildings and Buildings undergoing **Major Renovation** | **Non-residential** buildings with more than 10 no. parking spaces | • Ensure the installation of **at least 1 no. recharging point**<br>• Ensure the installation of **ducting infrastructure for at least 1 in 5 no. parking spaces** |
| | **Residential** buildings with more than 10 no. parking spaces | Ensure the installation of **ducting infrastructure for every parking space** |
| Existing Buildings * | **Non-residential** – all buildings with more than 20 no. parking spaces | Lay down requirement for the **installation of a minimum number of recharging points** – applicable from 2025 |

## Energy Performance of Buildings Directive 2010/31/EU & Amending Directive 2018/844 – Article 8

# BACS – EPBD Requirement in Building Regulations


State Forensic Science Laboratory, Kildare

**TGD L 2017: Amendment**
**BACS**

- EPBD **Definition**:
  '**Building Automation and Control System** means a system comprising all products, software and engineering services that can support energy efficient, economical and safe operation of technical building systems through automatic controls and by facilitating the manual management of those technical building systems'.

- EPBD **Requirement**:
  Member States shall lay down requirement to ensure that, where technically and economically feasible, **non-residential buildings with an effective rated output for heating systems or systems for combined space heating and ventilation of over 290kW are equipped with building automation and control systems by 2025**.

- The **requirement applies to all buildings i.e. new and existing** ones, when they meet the criterion on the effective rated output. The **290kW threshold applies to each system individually.**


## Energy Performance of Buildings Directive 2010/31/EU & Amending Directive 2018/844 – Articles 14 & 15

# BACS – EPBD Requirement in Building Regulations


OPW Offices Leeson Lane

**TGD L 2017: Amendment**
**BACS**

- The building automation and control systems shall be capable of:

  - continuously **monitoring, logging, analysing** and allowing for **adjusting energy use**;

  - **benchmarking the buildings energy efficiency**, **detecting losses** in efficiency of technical building systems, and **informing the person responsible** for the facilities or technical building management **about opportunities for energy efficiency improvement**; and

  - **allowing communication with connected technical building systems** and other appliances inside the building, and being **interoperable with technical building systems** across different types of proprietary technologies, devices and manufacturers.


## Energy Performance of Buildings Directive 2010/31/EU & Amending Directive 2018/844 – Articles 14 & 15

# Cost Optimality – EPBD Requirement in Building Regulations


State Forensic Science Laboratory, Kildare

**Cost Optimal**

- Each Member State has a responsibility to set minimum requirements for the energy performance of buildings and building elements. Those requirements are set with a view to achieving the **cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building**. The cost-optimal level must lie within the range of performance levels where the cost benefit analysis calculated over the estimated economic lifecycle is positive.
- Each Member State must regularly review their minimum energy performance requirements, i.e. **every 5 years**, for buildings in light of **technical progress**.
- Cost optimal calculations differentiate between **new and existing buildings** and between **different categories of buildings**.

- **TGD L 2017** building fabric and services performances were based on the results of the **2013 Cost Optimal Calculations**.

- **Cost Optimal Calculations 2018/ 2019** are in progress with a view to **publication in Q1 2019**. This has involved a detailed review of specifications for building fabric and services in conjunction with key stakeholders e.g. HSE, DoES, OPW, SEAI, etc.


## Energy Performance of Buildings Directive 2010/31/EU

# NZEB – Buildings other than Dwellings


**Thank you for your attention.**


An Roinn Tithíochta,
Pleanála agus Rialtais Áitiúil
Department of Housing,
Planning and Local Government

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**Building Regulations 2017 - Technical Guidance Document L - Buildings other than Dwellings (Operative w.e.f. 1 Jan. 2019)**

Building Regulations 2017 - Technical Guidance Document L - Buildings other than Dwellings (Operative w.e.f. 1 Jan. 2019) (1.89 MB)

**Category**
Housing

**Topic**
Building Standards

**Sub topic**
TGD Part L - Conservation of Fuel and Energy

*Website: www.housing.gov.ie*
*Email: Buildingstandards@housing.gov.ie*

# Delivering nearly Zero Energy Schools

John Dolan

Department of Education and Skills

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

# Delivering nearly Zero Energy Schools

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ENERGY SHOW

# Delivering nearly Zero Energy Schools

- **Our energy policy & design approach**
- **Research projects informing approach to achieving new energy regulation targets**
- **Delivery through TGD 033**
- **Implementation**

An Roinn Oideachais agus Scileanna
Department of Education and Skills

# Delivering nearly Zero Energy Schools

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- **Our energy policy & design approach**
-
-
-

***SEAI Sustainability in the Built Environment Award 2012***

WINNER
GREEN AWARDS 2012
The Overall Green Business Award

# Delivering nearly Zero Energy Schools

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Department of Education and Skills

- evolved from energy programme DART
  (Design, Awareness, Research & Technology)
- informed by building unit professional & technical staff & external partnerships
- driven by technical guidance documents
- updated by continued energy research & development
- disseminated via publications, conferences & annual report
- specific project support from SEAI
- acknowledged by national & international energy awards

# Delivering nearly Zero Energy Schools

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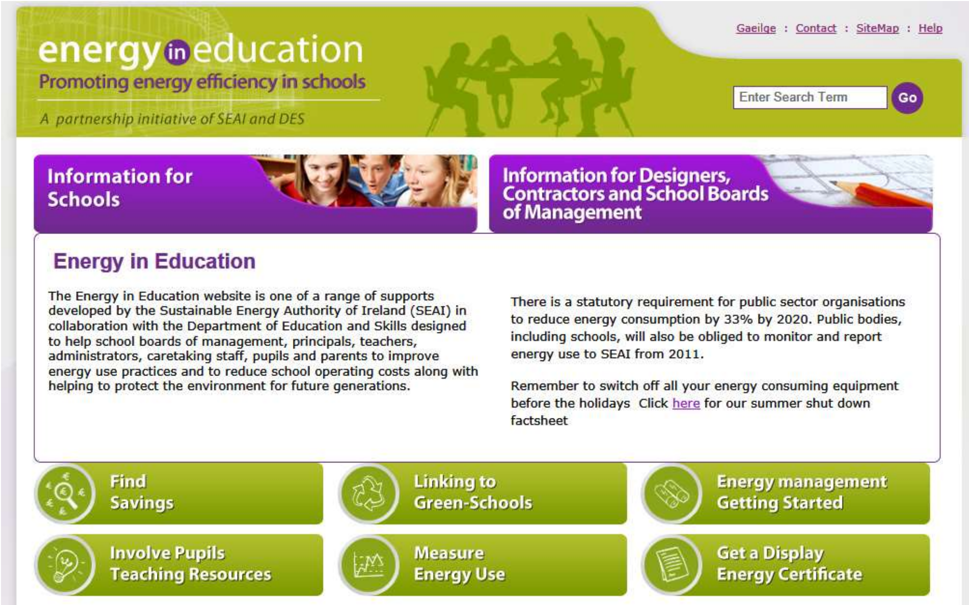
Department of Education and Skills

- schools needs: not same as domestic/ commercial market needs (different operational profiles)
- short hours of operation
- technical ability on site
- energy not core function
- solutions must be simple and robust

## *renewables in schools*

Solar Thermal → Biomass → Wind → PV




**www.energyineducation.ie.**

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Department of Education and Skills

# Delivering nearly Zero Energy Schools

- **Research projects informing approach to achieving new energy regulation targets**

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Department of Education and Skills

# Delivering nearly Zero Energy Schools

## *Energy Research Programme projects that informed approach*

Colaiste Choilm, Tullamore - 2007

Moynalty NS, Meath & Powerscourt NS, Wicklow - 2009

St Patrick's NS, Greystones - 2013

St Catherine's NS, Aughrim - 2016

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Department of Education and Skills

# Delivering nearly Zero Energy Schools

- **Delivery through TGD 033**

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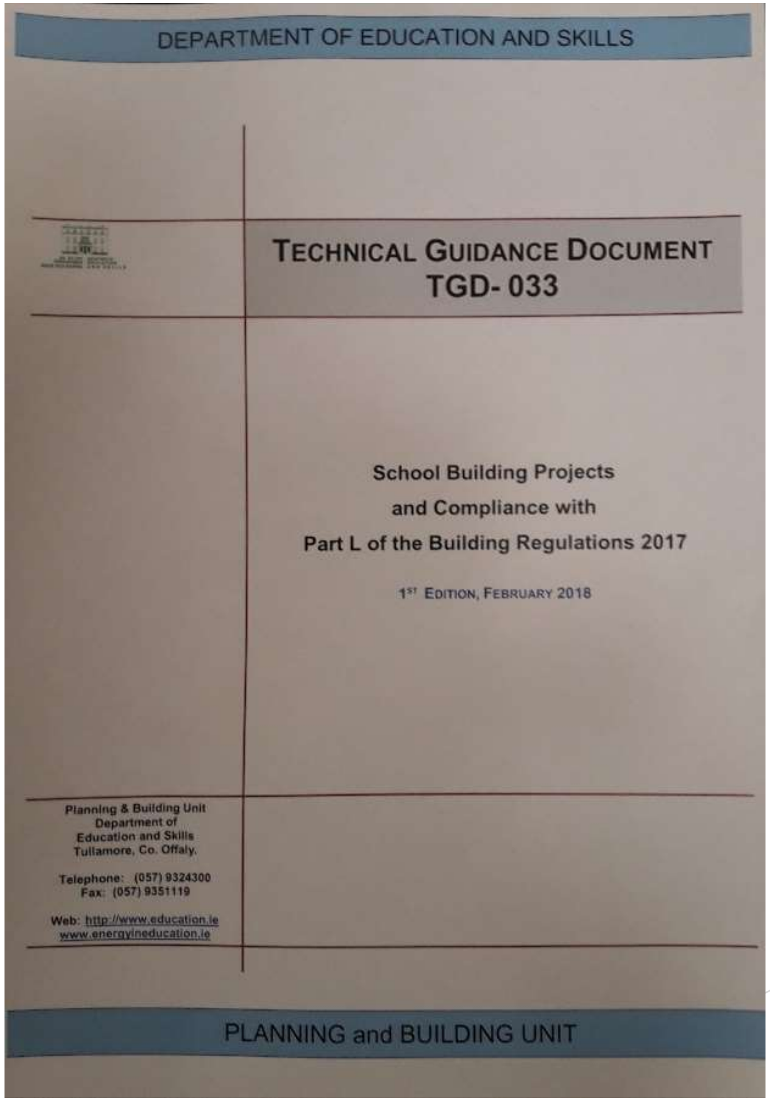
Department of Education and Skills

# Backstop v's Reference U values

*Delivery through TGD 033*



DEPARTMENT OF EDUCATION AND SKILLS

**TECHNICAL GUIDANCE DOCUMENT**
**TGD- 033**

**School Building Projects**
**and Compliance with**
**Part L of the Building Regulations 2017**

1ST EDITION, FEBRUARY 2018

Planning & Building Unit
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PLANNING and BUILDING UNIT

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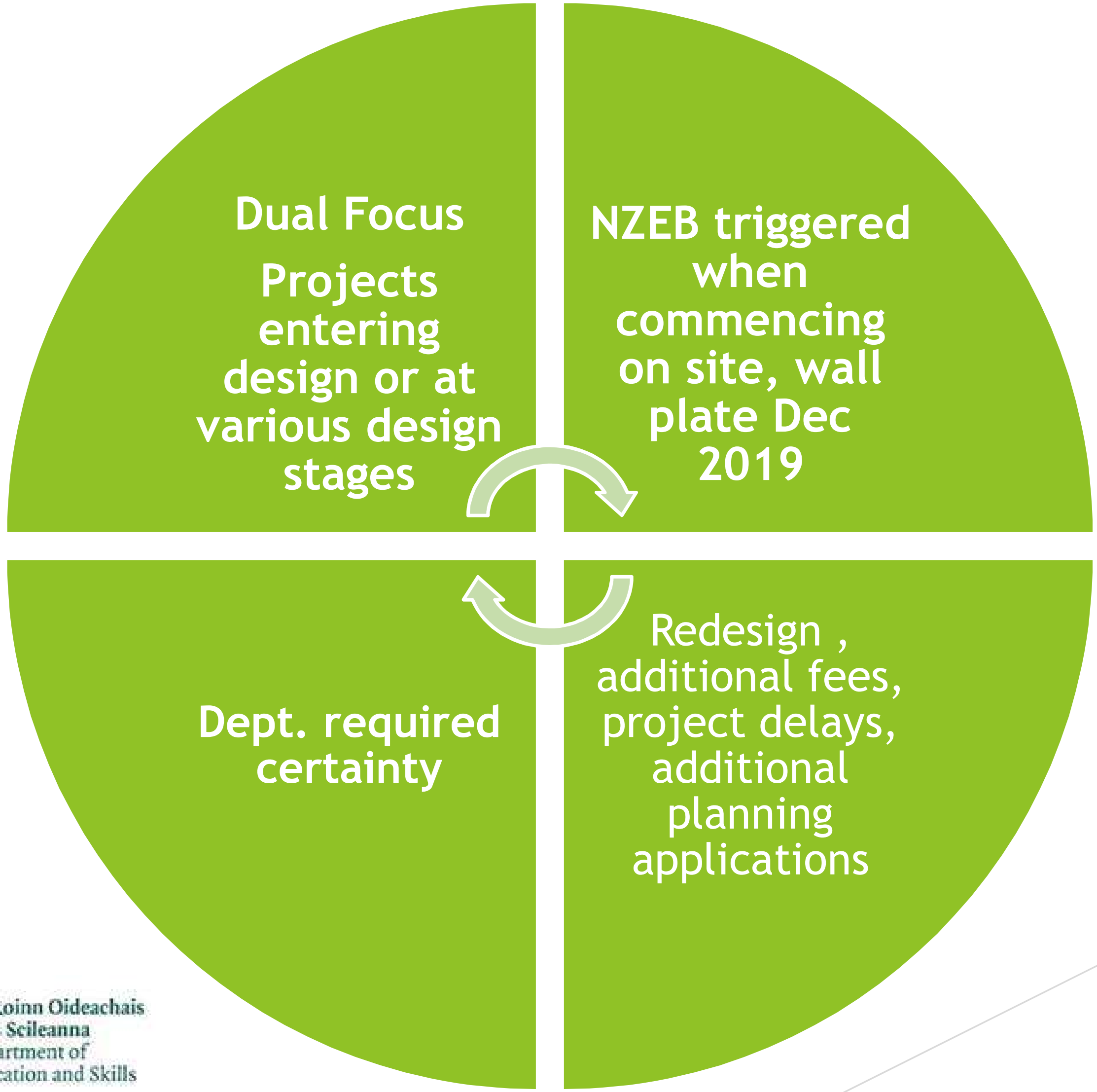
## *Delivery through TGD 033*

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NZEB design priorities

- Passive architectural design principles
- Energy efficient envelope and technologies
- Modelling & SBEM

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## NZEB design priorities

- Passive architectural design principles
- Energy efficient envelope and technologies
- Modelling & SBEM

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# Delivering nearly Zero Energy Schools

## Maximising Nature

- passive solar design
- daylighting
- quality ventilation

## Technologies

- enhanced U values
- air tightness
- lighting & controls
- heating & controls
- water efficiency

## Delivering nearly Zero Energy Schools

*Delivery through TGD 033*

### Maximising Nature

### Technologies

- enhanced U values
- air tightness
- lighting & controls
- heating & controls
- water efficiency
- enhanced glazing
- Condensation risk analysis
- Renewable Energy
- Thermal Bridging

# SBEM 3.5a compatibility with Irish Schools

- *hot water demand*
- *density ratios in classrooms*
- *occupancy hours*
- *occupancy rates*
- *internal design temperature*

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SBEM 3.5a compatibility with Irish Schools

- *hot water demand*
- *density ratios in classrooms*
- *occupancy hours*
- *occupancy rates*
- *internal design temperature*

SBEM 5.5h more compatible for Irish Schools

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## Delivering nearly Zero Energy Schools

- 
- 
- 
- **Implementation**

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# Delivering nearly Zero Energy Schools
## *Implementation*

*Roof Type Example:* Pitched roof (Insulation on Slope)

Metal Deck *on*
Open cell insulation *on*
Single membrane *on*
Support Deck

TGD 033 requirements for roofs equates to approx. 235mm thickness Mineral Wool insulation.

## Delivering nearly Zero Energy Schools
## *Implementation*

DoES policy is to minimise/ remove, where possible, roof penetrations and ext. equipment

New build

Roof design considerations

- Suitability of roof finish and fixing methodology for PV and potential for additional structural requirements

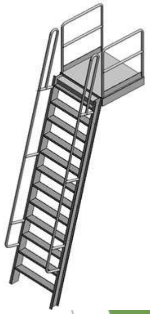
Retrofit

## Delivering nearly Zero Energy Schools
## *Implementation*

**Roof design considerations**

- Suitability of roof finish and fixing methodology for PV and potential for additional structural requirements
- Inspection/Maintenance requirements

Delivering nearly Zero Energy Schools
*Implementation*



## Roof design considerations

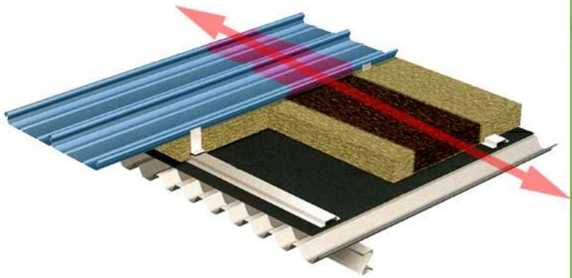
- Suitability of roof finish and fixing methodology for PV and potential for additional structural requirements
- Inspection/maintenance requirements
- Access to the roof / emergency escape

Delivering nearly Zero Energy Schools

*Implementation*

**Roof design considerations**

- Suitability of roof finish and fixing methodology for PV and potential for additional structural requirements
- Inspection/maintenance requirements
- Access to the roof / emergency escape from roof
- **Robustness of roofing specification for footfall on access zones: Impact on manufacturers warranties**



## Delivering nearly Zero Energy Schools
*Implementation*

**Roof design considerations**

- Suitability of roof finish and fixing methodology for PV and potential for additional structural requirements
- Inspection/maintenance requirements
- Access to the roof / emergency escape from roof
- Robustness of roofing specification for footfall on access zones: Impact on manufacturers warranties

- **Roof design and removal of risk of fall (parapet) Vs mitigation of risk of fall from height (fall arrest system)**

Avoid

# Delivering nearly Zero Energy Schools

A $CO^2$ monitor in all teaching spaces enabling the users to be aware of $CO^2$ levels enabling intervention to maintain the comfort levels and air quality

Vampire Load system automatically links the school electrical system to the intruder alarm & shuts down power to non-essential electrical power outlets when alarm is activated

# Backstop v's Reference U values

*Delivery through TGD 033*

## How low can we go !!!

**4% reduction in primary energy**

*the proportion of heat loss through these elements is low in a school building*

**Saving pa for opaque heat losses**

€89 for 16 class primary school

€303 for 800 pupil Post Primary

# Delivering nearly Zero Energy Schools

**Modelled School Building Energy improvement over the new 2017 Building Regulations.**

*800 pupil Post Primary school* *20%*

*16 Classroom Primary School* *18.5%*

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# Delivering nearly Zero Energy Schools

***John Dolan***
***BEng (Hons) M.Sc. Fire Eng***
***H.Dip CEng MIEI***
***Chartered Engineer***

***Planning & Building Unit***
***Tullamore***

***www.energyineducation.ie.***

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# Delivering a Commercial Nearly Zero Energy Building

John Furlong

OPW

## AGENDA

Pre-NZEB → NZEB

(1) Introduction

(2) Nearly Zero Energy Buildings (NZEB)

(3) Building Regulations TGD Part L 2017

(4) Case Study:

City Centre Office Building

(5) Conclusion

# AGENDA

**(1) Introduction**

(2) Nearly Zero Energy Buildings (NZEB)

(3) Building Regulations TGD Part L 2017

(4) Case Study:

City Centre Office Building

(5) Conclusion

# (1) INTRODUCTION

## Office Of Public Works

- Responsible for managing the property portfolio for central government.
  - Build, Lease
  - Operate & Maintain
- Energy Conservation Programmes delivered savings of more than 20 % in energy consumption.

# AGENDA

(1) Introduction

**(2) Nearly Zero Energy Buildings (NZEB)**

(3) Building Regulations TGD Part L 2017

(4) Case Study:

City Centre Office Building

(5) Conclusion

## EUROPEAN PERFORMANCE OF BUILDINGS DIRECTIVE RECAST & NZEB

**2010/31/EU Article 2 Definitions:**

'nearly zero-energy building'

"means a building that has a very **high energy performance**.

The nearly zero or very low amount of energy required should be covered to a very significant extent by **energy from renewable sources**, including energy from renewable sources produced on-site or nearby;"

What does this mean to you?

- Architects
- Structural Engineers
- Building Services Engineers
- Quantity Surveyors
- Main Contractors
- Mechanical Contractors
- Electrical Contractors
- Building Owners / Developers (Public and Private Sector)
- Building Occupants
- Facilities Management

# AGENDA

(1) Introduction

(2) Nearly Zero Energy Buildings (NZEB)

**(3) Building Regulations TGD Part L 2017**

(4) Case Study:

City Centre Office Building

(5) Conclusion

## (3) Building Regulations TGD Part L 2017

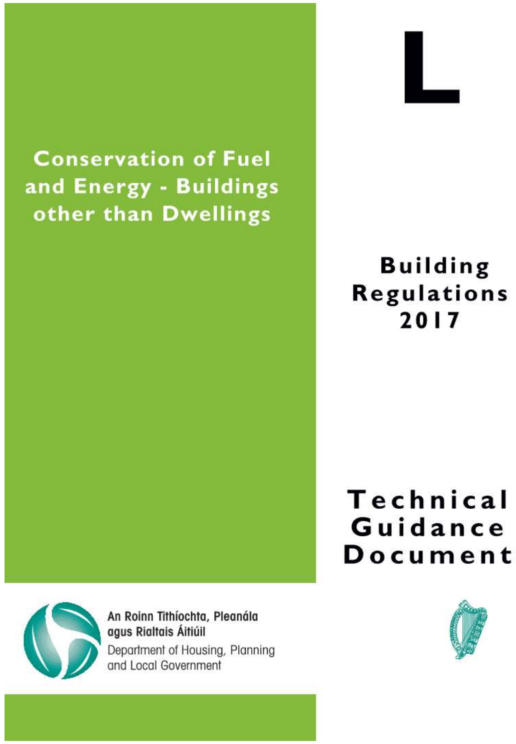
### Introduction

- Came into effect on the 1st January 2019

- Limit Primary Energy Consumption & related $CO_2$ emissions to a **Nearly Zero Energy Building (NZEB)** as calculated using the NEAP as published by SEAI and that the nearly zero energy is covered to a significant extent by renewable energy produced on site or nearby.

- Energy Performance Coefficient MPEPC = 1.0
- Carbon Performance Coefficient MPCPC = 1.15
- Renewable Energy Ratio RER = 0.2 or 0.1 (EPC=0.9)

- Equates to approx. an improvement in the order of 60 % over a Part L 2008 building with 20 % of its energy produced on site.



## (3) Building Regulations TGD Part L 2017

**Renewable Energy Technologies**

- Solar Thermal Systems,
- Photovoltaic Systems,
- Biomass Systems
- Systems using Bio Fuels
- Heat Pumps
- Combined Heat & Power
- Aerothermal
- Geothermal
- Hydrothermal
- Wind
- Biomass and Biogases and
- Other on site renewables

**Limiting the effects of solar gain in summer**

- Applies to all buildings to reduce the need for air-conditioning or to reduce the capacity of any air conditioned system that is installed.
- The solar gains in each space occupied or cooled aggregated from April to September are no greater than would occur through a given glazing system with a total solar energy transmittance (g-value).
  - E.g. A east facing façade with 1m high glazing and a g-value of 0.68

**Limiting Overheating**

The assessment of solar gain is not an assessment of internal comfort as there are many other factors to be considered and therefore CIBSE TM 52 should be used to ensure overheating is avoided for naturally ventilated spaces.

# AGENDA

(1) Introduction

(2) Nearly Zero Energy Buildings (NZEB)

(3) Building Regulations TGD Part L 2017

**(4) Case Study:**

City Centre Office Building

(5) Conclusion

## (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

- Leeson Lane: 6,500 $m^2$ (7 storey)

- Potential for Natural Ventilation

- Planning Stage 2016 (Pre NZEB)

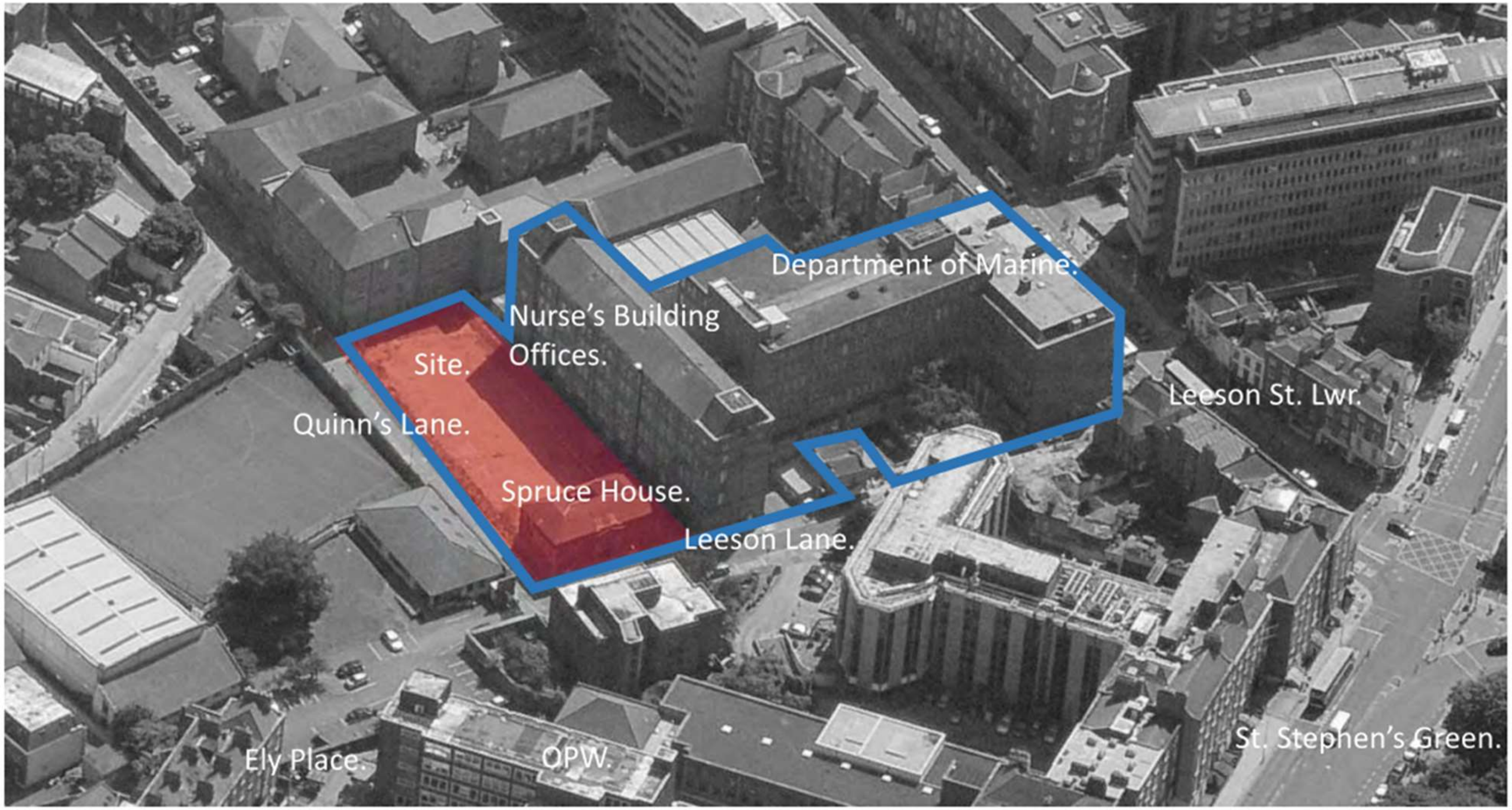
- Design Team Target to achieve 60 % reduction in energy without renewables

40 % is achievable with cost optimal building envelope and building services

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

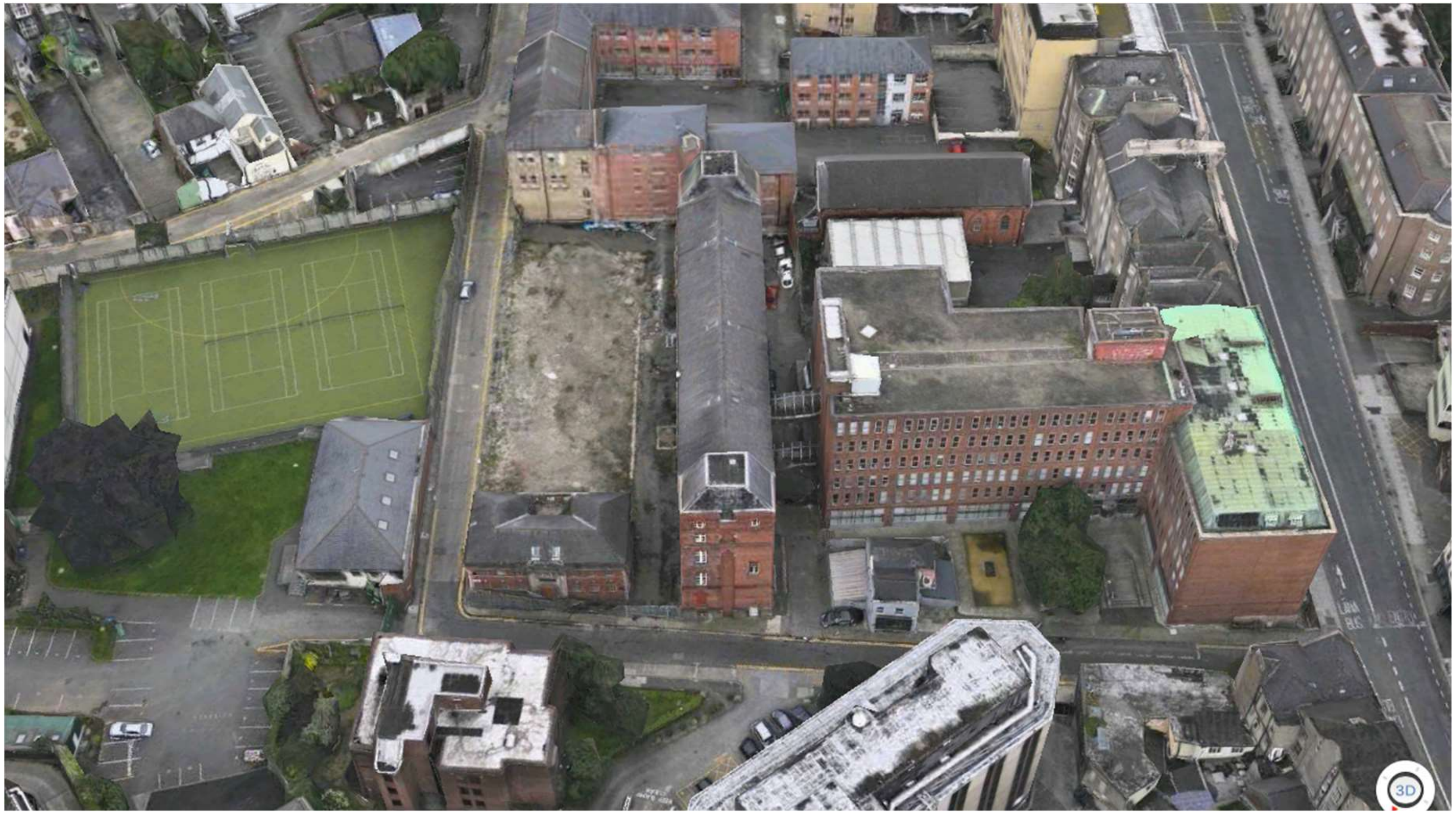

SITE AND CONTEXT

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING



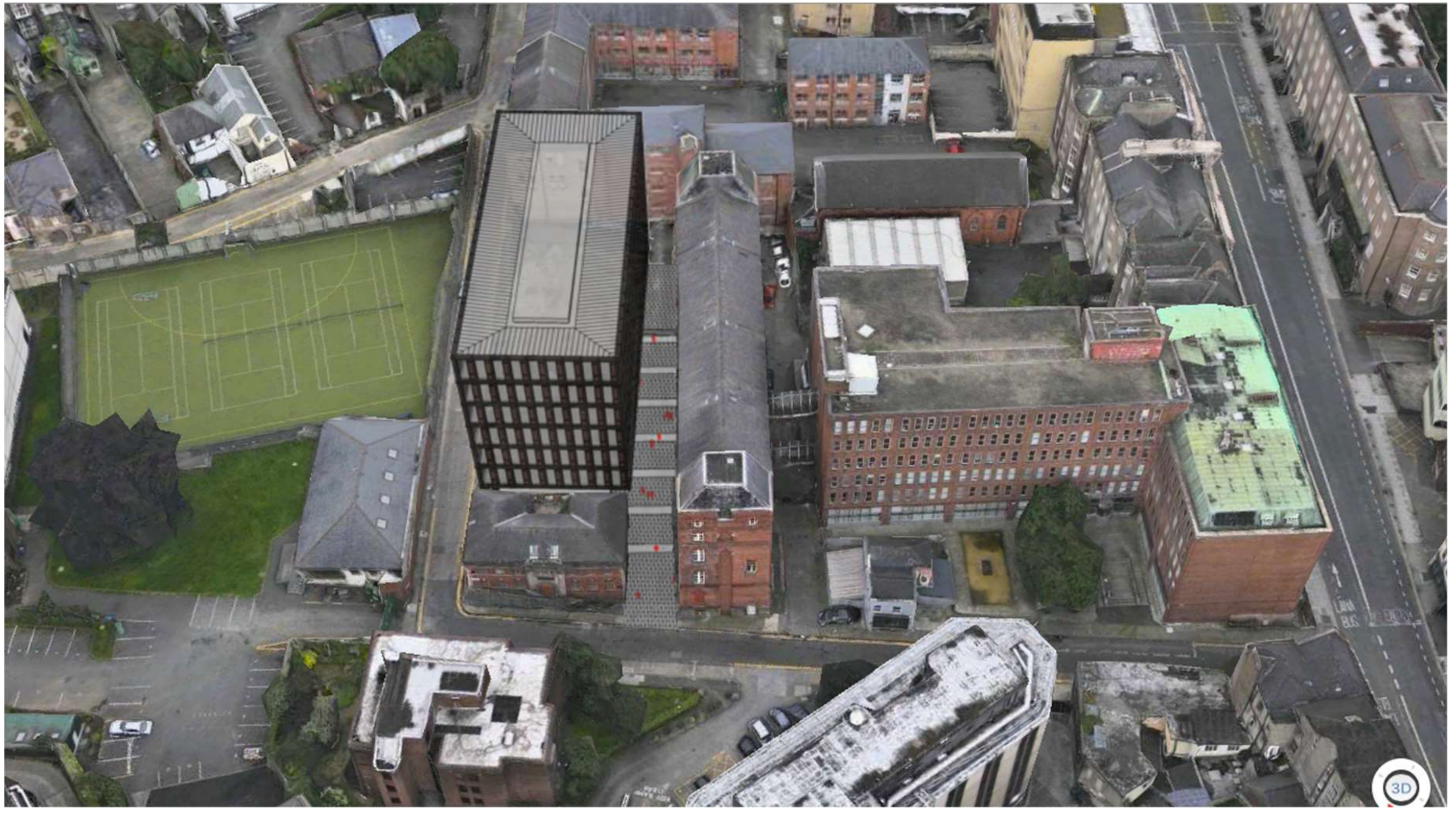

SITE AND CONTEXT

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING



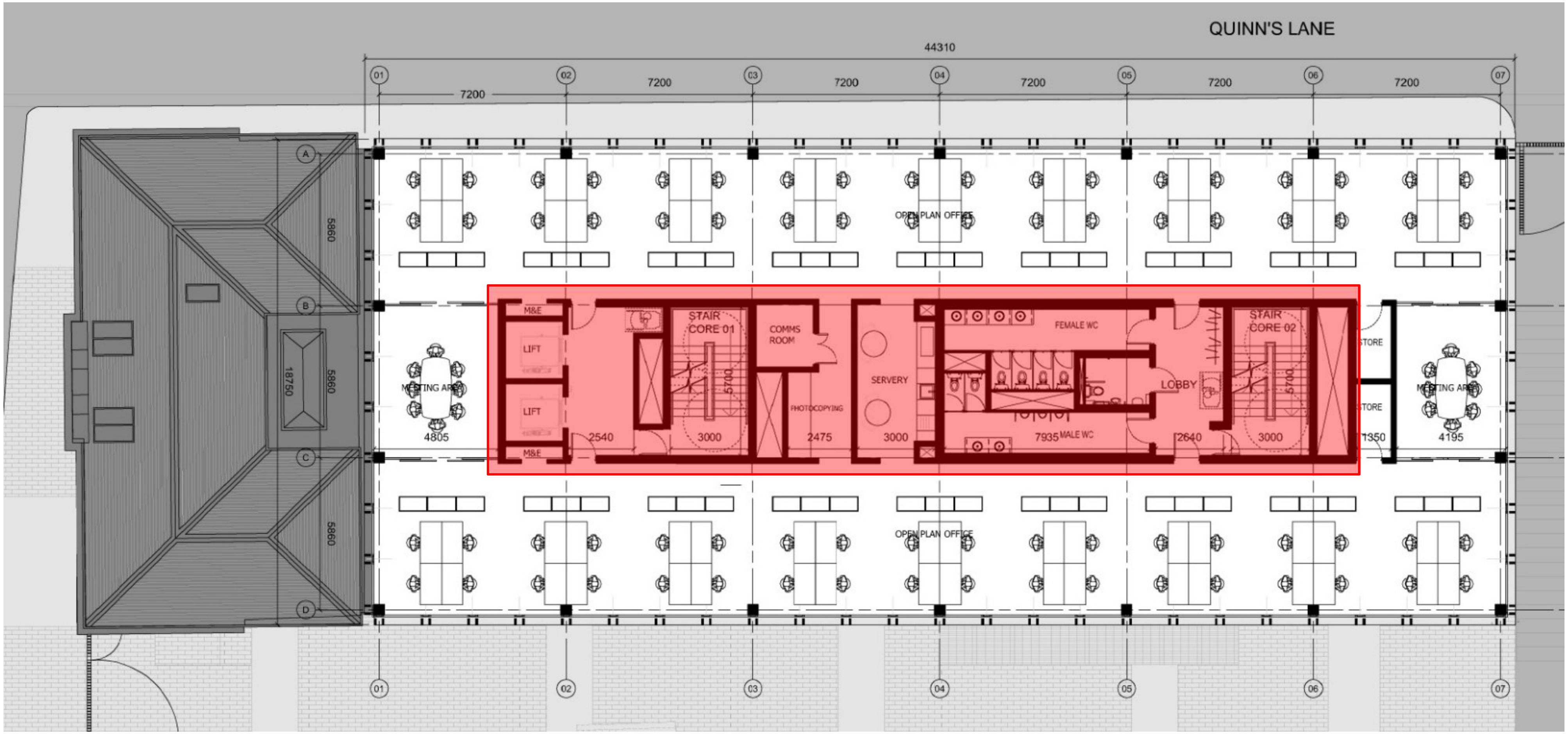
SITE AND CONTEXT

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




SITE AND CONTEXT

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




Shallow Plan and Flexible Layout

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# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

**Approach to Reducing Energy Consumption & CO2 Emissions:**

**(1)** Establish optimal Fabric, Facade and Building Envelope Design

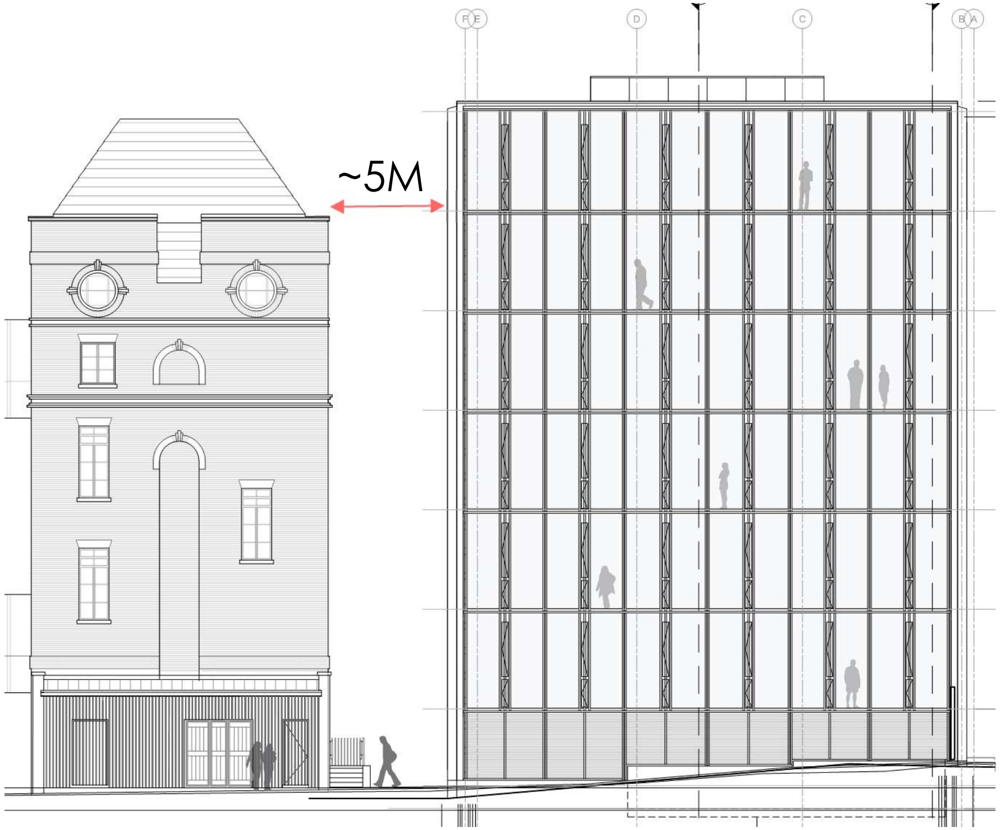
**(2)** Establish optimal Heating, Ventilation & Air Conditioning (HVAC) Strategy

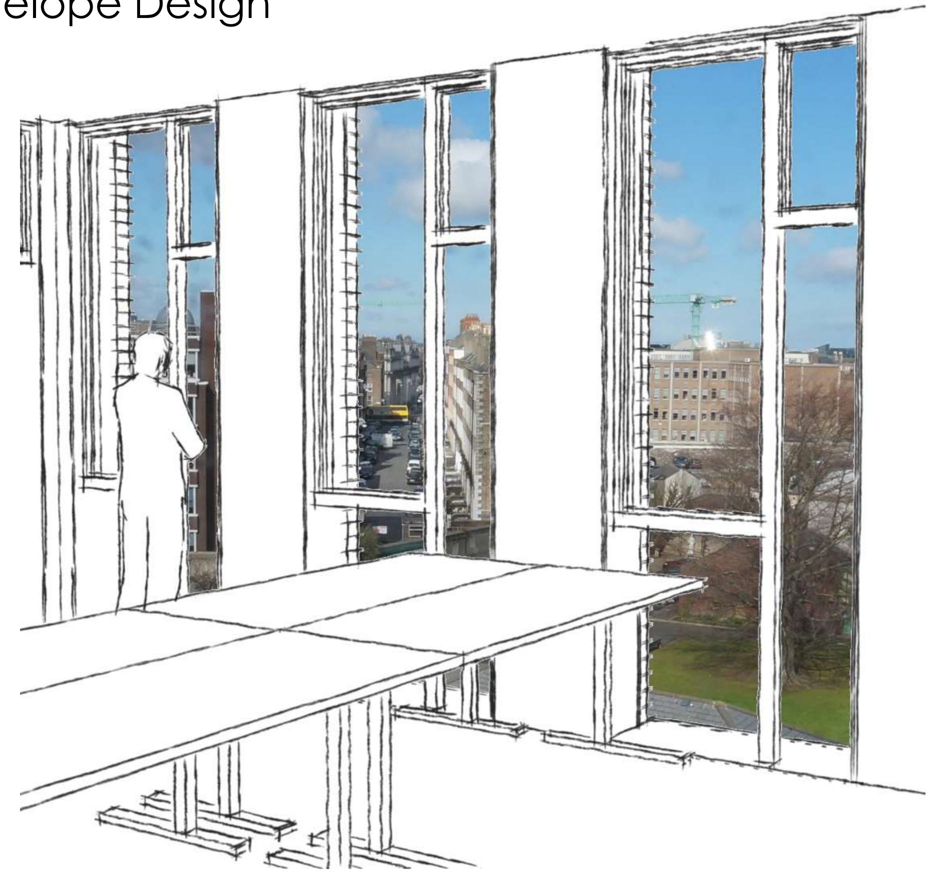
**(3)** Establish optimal Renewable Energy Strategy

Utilisation of Building Performance Modelling to assist in the strategies above.

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

(1) Establish optimal Fabric, Facade and Building Envelope Design

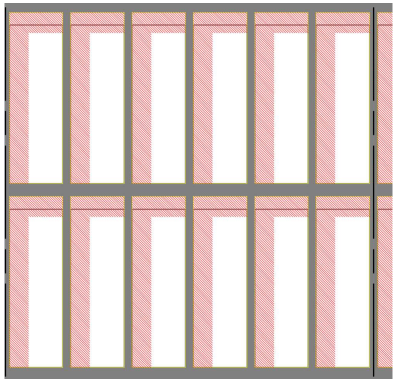


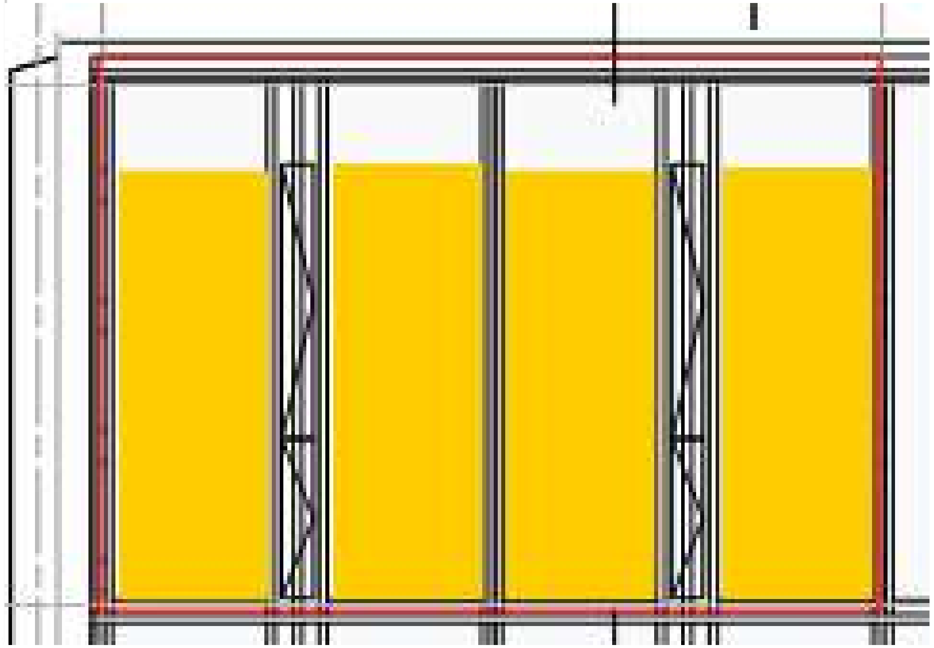



MAXIMISE DAYLIGHT – PARTICULARLY ON LOWER LEVELS ADJACENT TO THE NURSES BUILDING

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

## TAILORED FACADE DESIGN





75% Glass → 75% Glass with External Shading → 66% Glass set back by 300 mm with vertical fins, low e glazing, frit and insulated opaque panels

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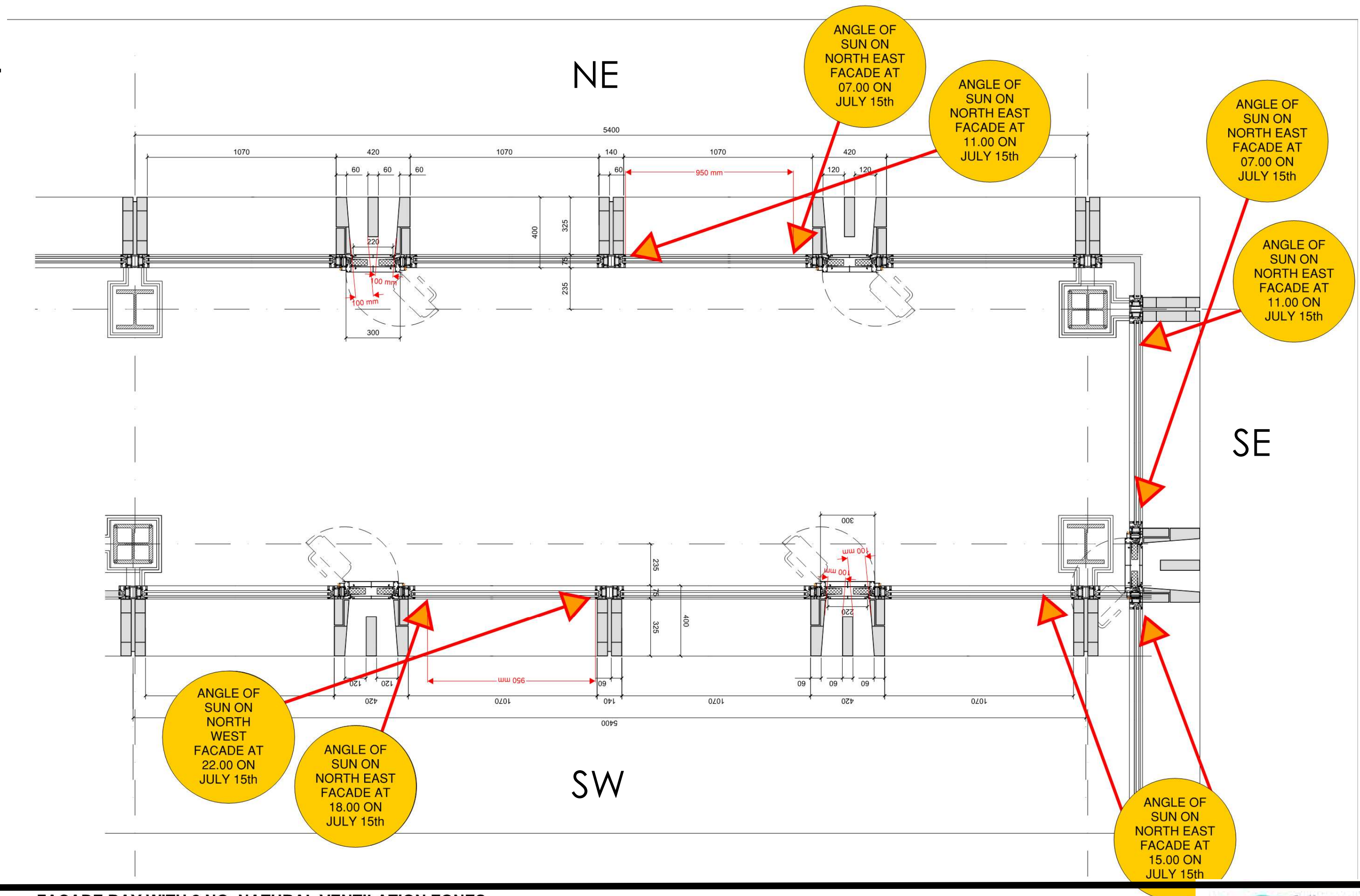
OPW The Office of Public Works / Oifig na nOibreacha Poiblí

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

## TAILORED FACADE DESIGN




FACADE BAY WITH 2 NO. NATURAL VENTILATION ZONES

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## (2) Optimum Heating Ventilation & Air Conditioning (HVAC) Strategy:

- Typical Building in Dublin.

- However Leeson Lane is not typical.

- Natural ventilation is a less energy intensive solution.

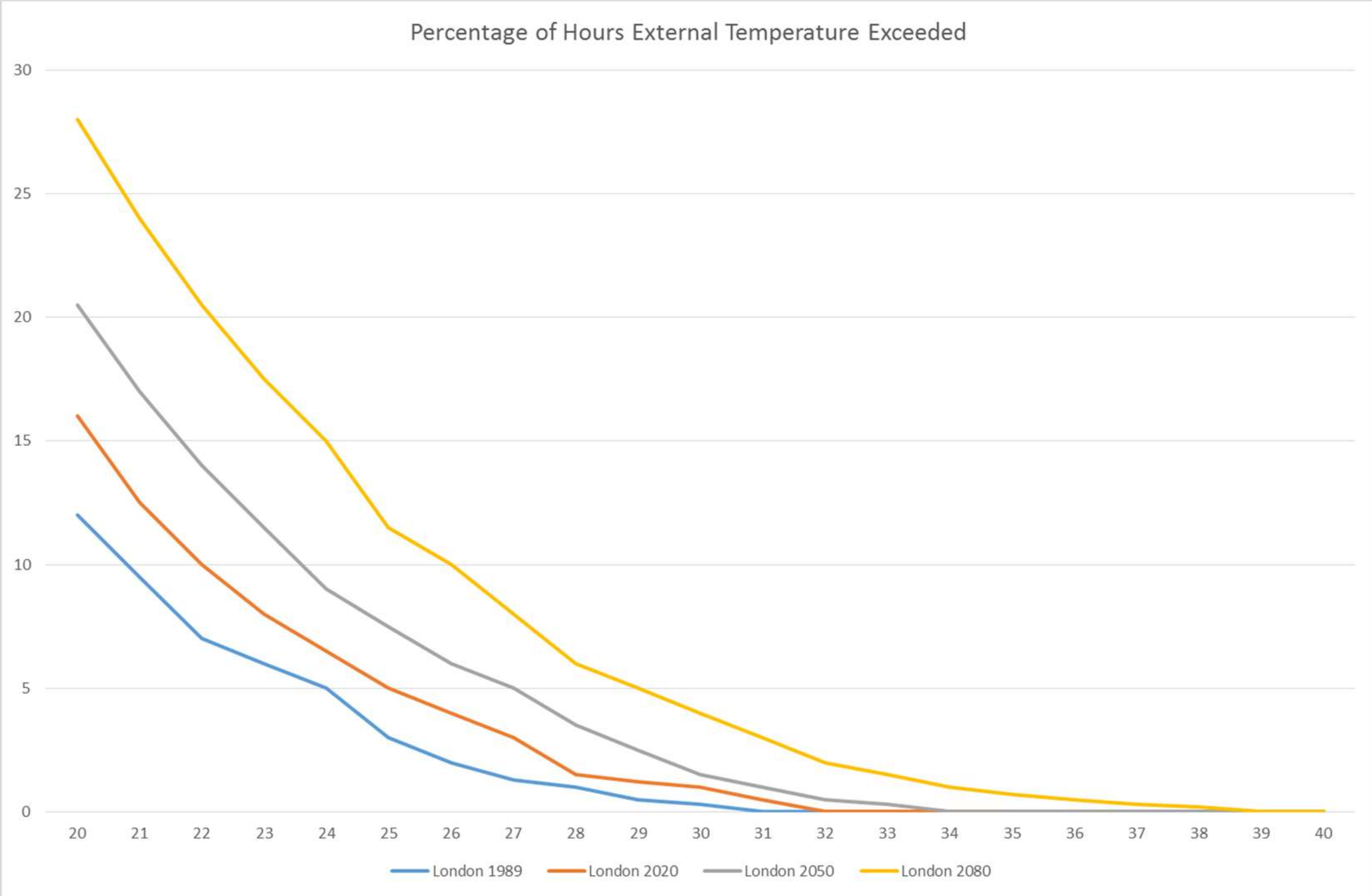
## (2) Optimum Heating Ventilation & Air Conditioning (HVAC) Strategy:

- Ability to open windows in buildings and connect with the outside is a benefit for the occupants.

- Direct control over their environment

Leeson Lane is essentially a shallow plan and all occupants are located within 4 – 5 m of a natural ventilation opening.

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




Percentage of Time Temperature exceeded:-

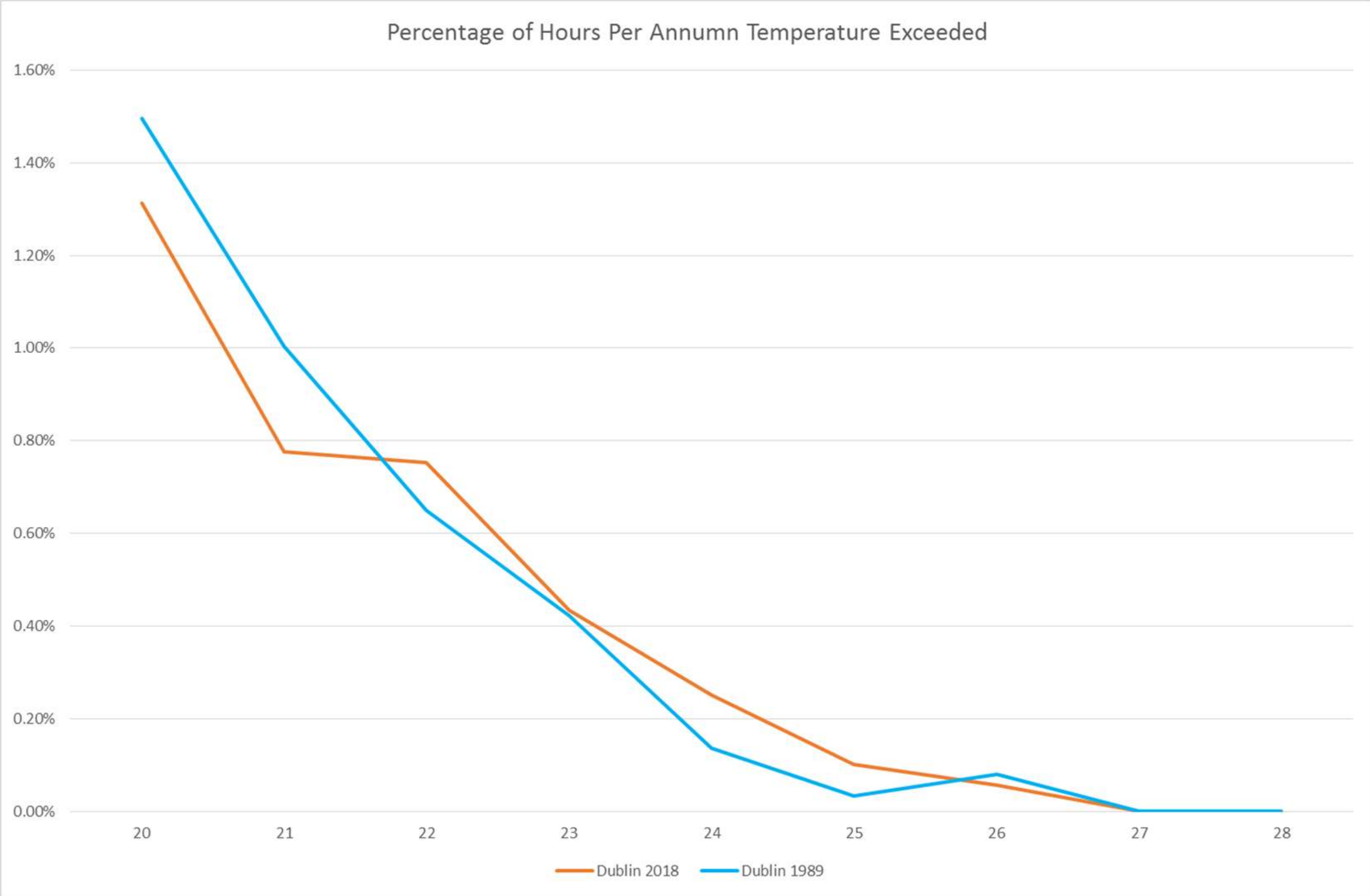
20 oC = 12 %
25 oC = 3 %

Highest Recorded Temperature =

38.1 oC
(2003, Kew Gardens)

Review of climate – London Versus Dublin

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




Percentage of Time Temperature exceeded:-

20 oC = 1.5 %
25 oC = 0.1 %

Highest Recorded Temperature =

28.1 oC
(1990, Dublin Airport)

Review of climate – London Versus Dublin

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

## Optimum Heating Ventilation & Air Conditioning (HVAC) Strategy:

**Option 1:** Natural ventilation with ceiling tile finish.

**Option 1A:** "Hybrid" ventilation with ceiling tile finish and night time purging using AHU's plus comfort cooling in meeting rooms.

**Option 2:** "Hybrid" ventilation with exposed concrete and a night time purging using AHU's plus comfort cooling in meeting rooms.

**Option 3:** "Hybrid" ventilation with embedded coils (i.e. to provide background cooling)

**Option 4:** Comfort Air conditioning with fan coil units (FCU's)

**Option 5:** Comfort Air conditioning with Active Chilled Beams

**Option 6:** Hybrid ventilation with ceiling mounted radiant panels for background cooling.

**Part L 2017: 1.3.6 Limiting Overheating:**

- Refers to CIBSE TM52 (2013) The Limits of Thermal Comfort – Avoiding Overheating in European Buildings, which is based on the adoption of EN 15251.

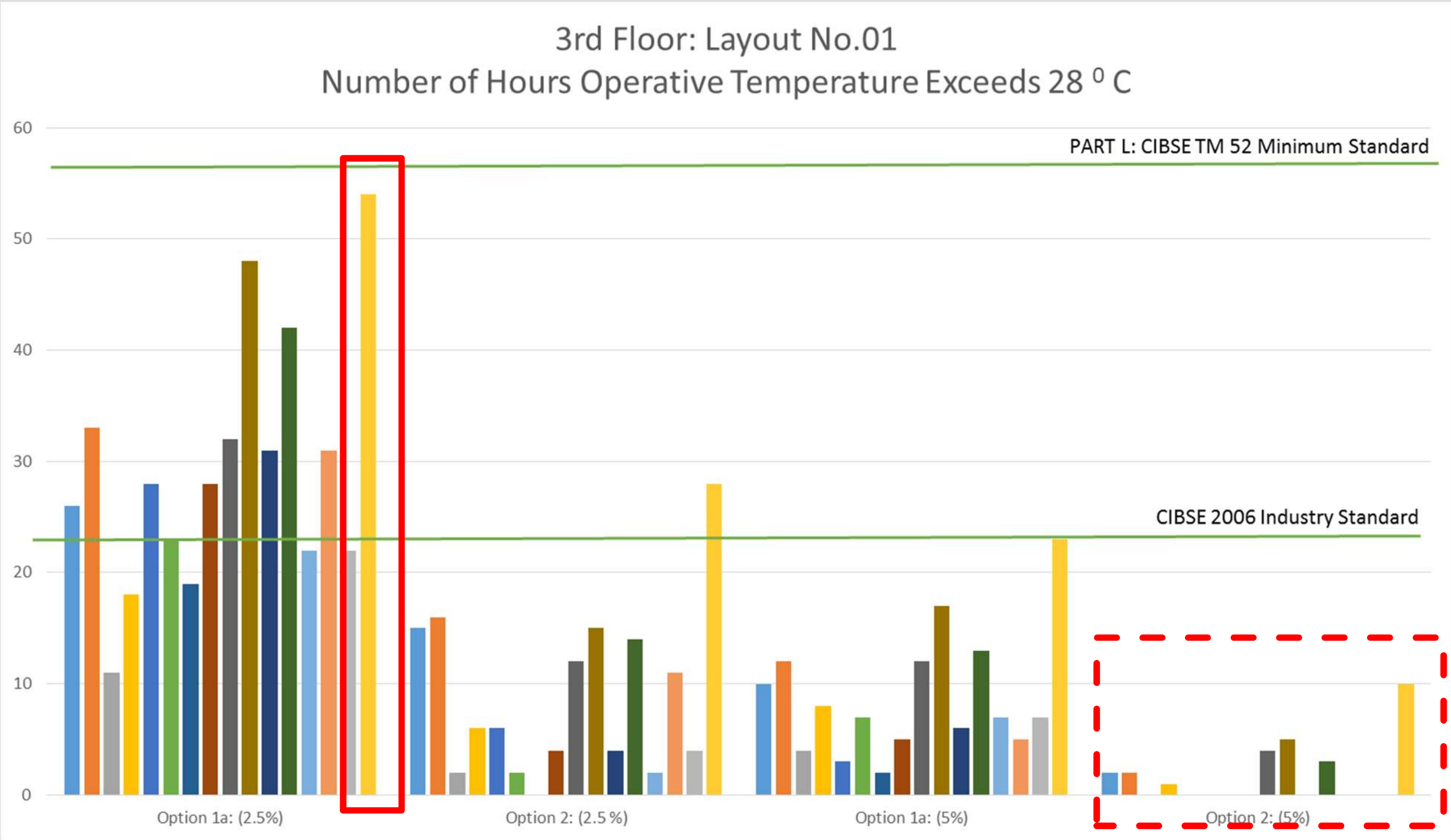
- This superseded a single temperature and fixed percentage of hours approach as given in CIBSE 2006 Guide A.

- The common industry standard was to apply a limit of 1 % of occupied hours where the internal temperature exceeded 28 oC and 5 % of the occupied hours where the internal temperature exceeded 25 oC.

- It was recognised that the single temperature approach did not work for all climates and buildings.

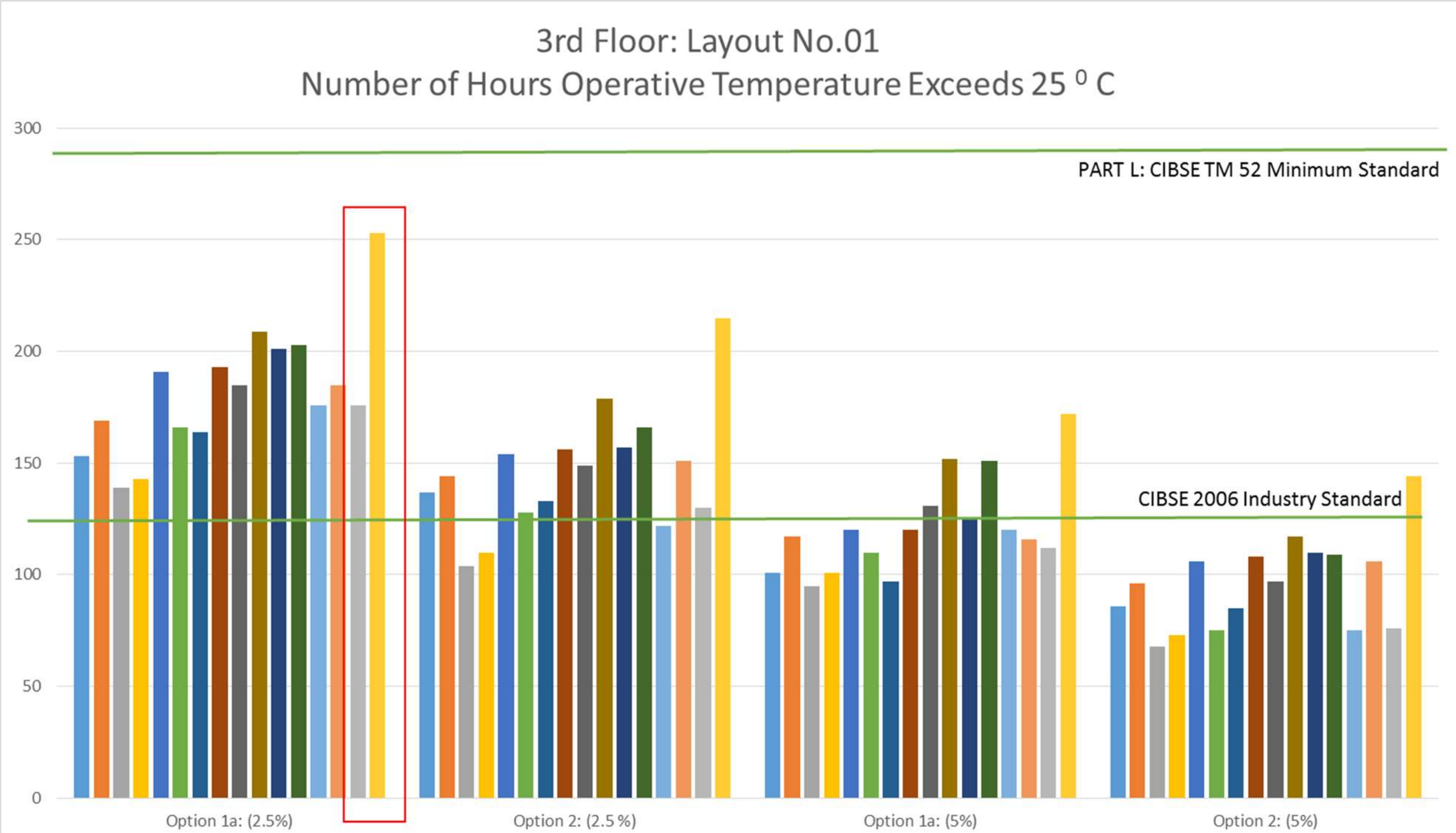
- Therefore the adaptive approach for "free running" buildings was introduced.

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




## CIBSE TM 52 versus CIBSE 2006

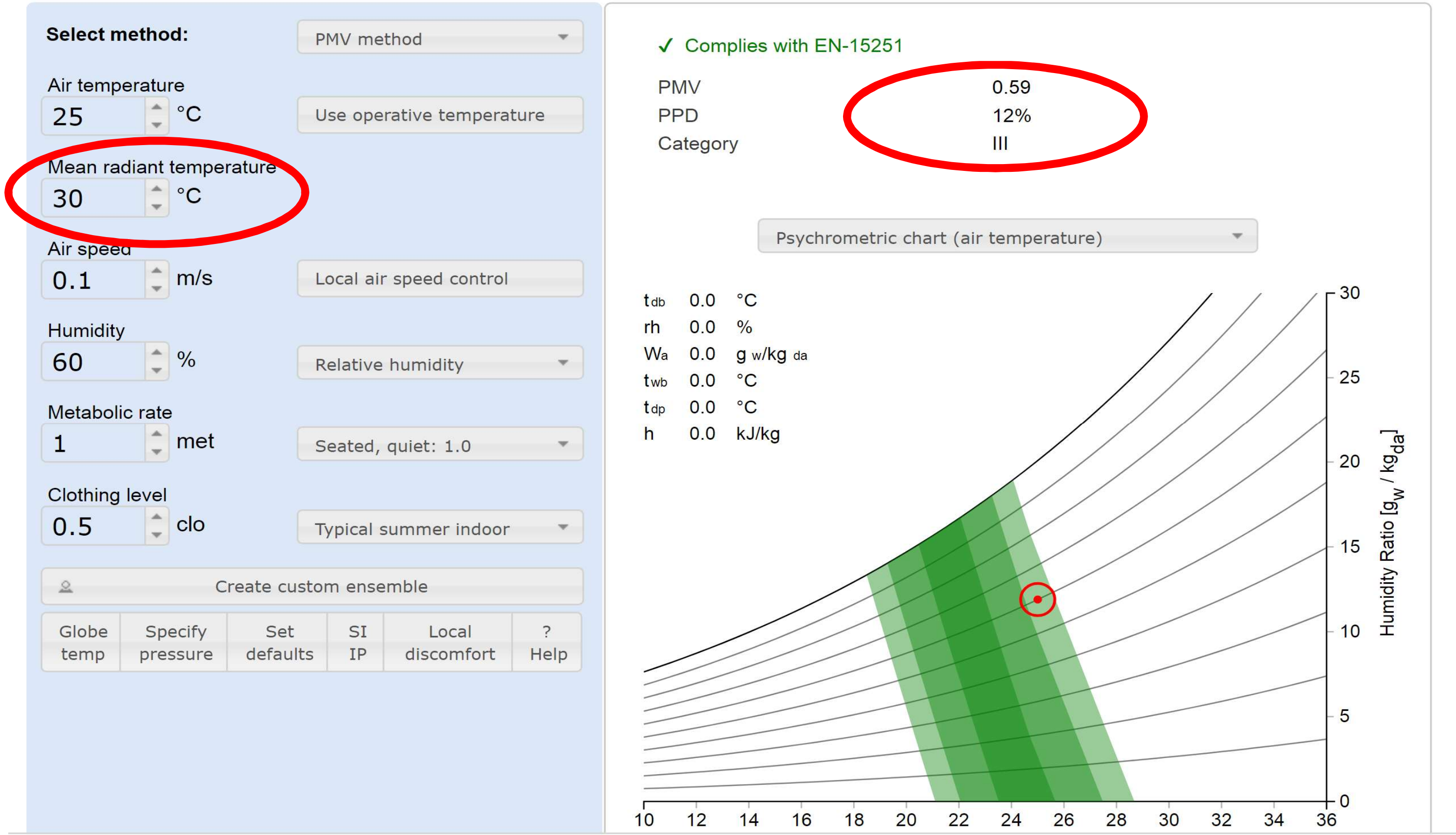
## (4) CASE STUDY: CITY CENTRE OFFICE BUILDING




**CIBSE TM 52 versus CIBSE 2006**

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

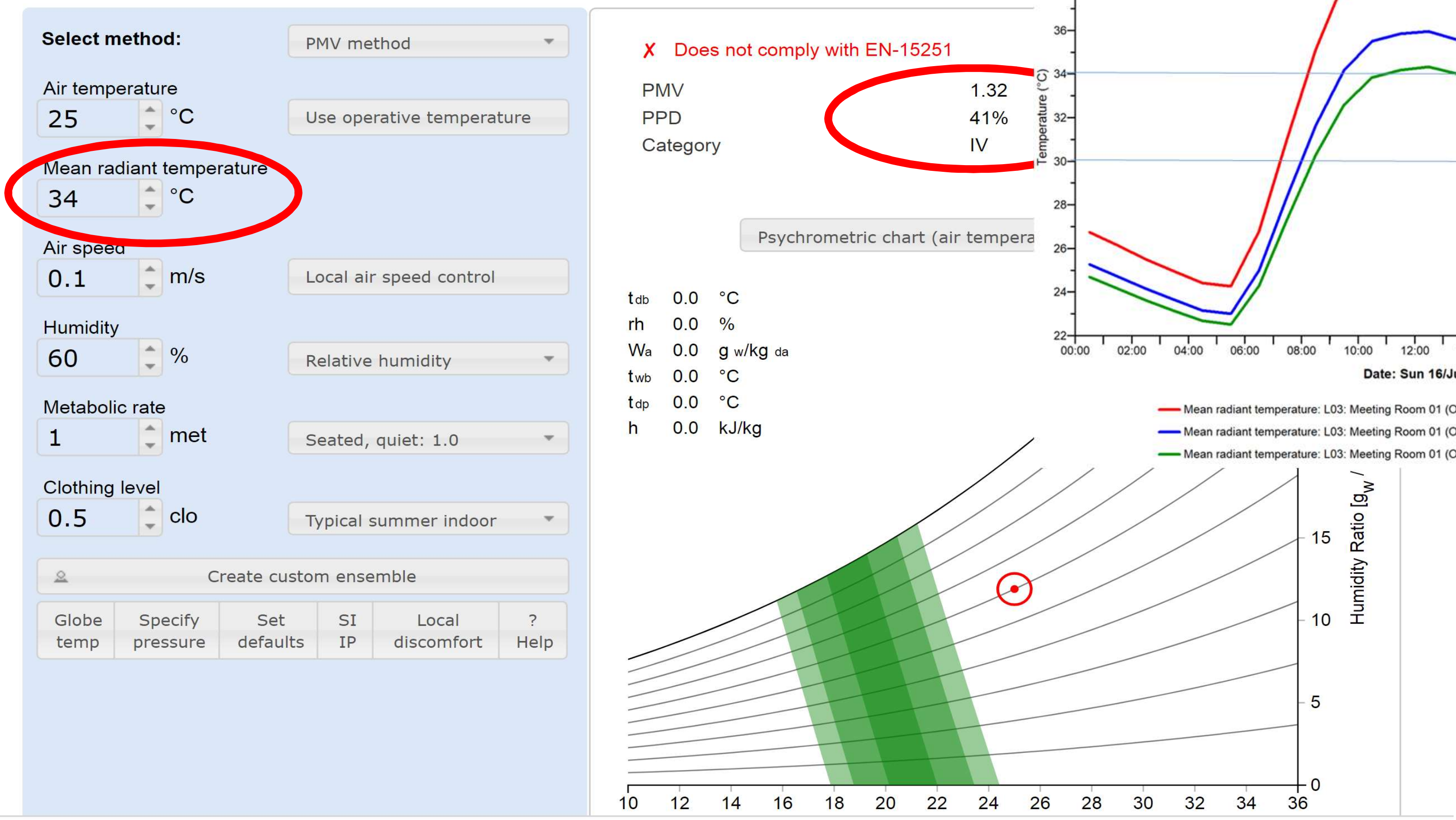
South West
Facing
Room
G-Value=
0.23
at 6.30 PM
on the 16th
July

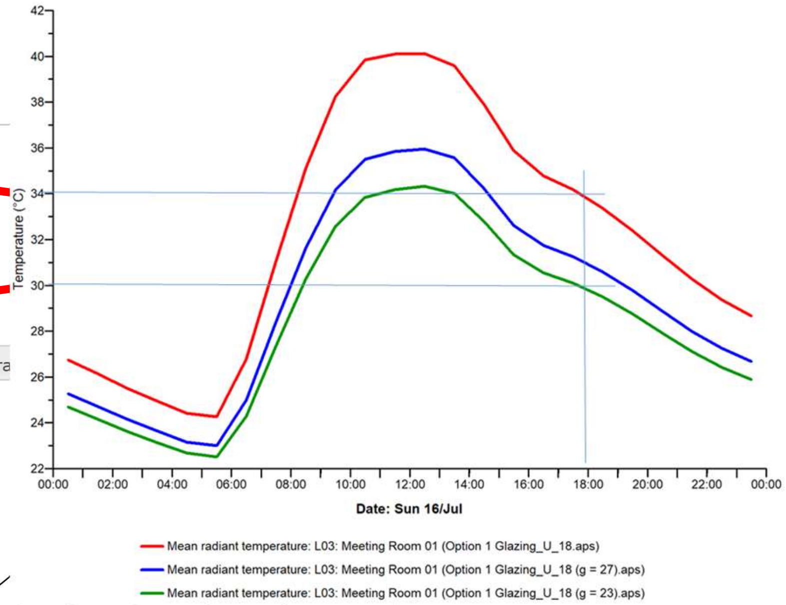



## Impact of g-value on internal comfort

# (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

South West Facing Room
G-Value= 0.37
at 6.30 PM on the 16$^{th}$ July



## (3) Review of Renewable Energy Options:-

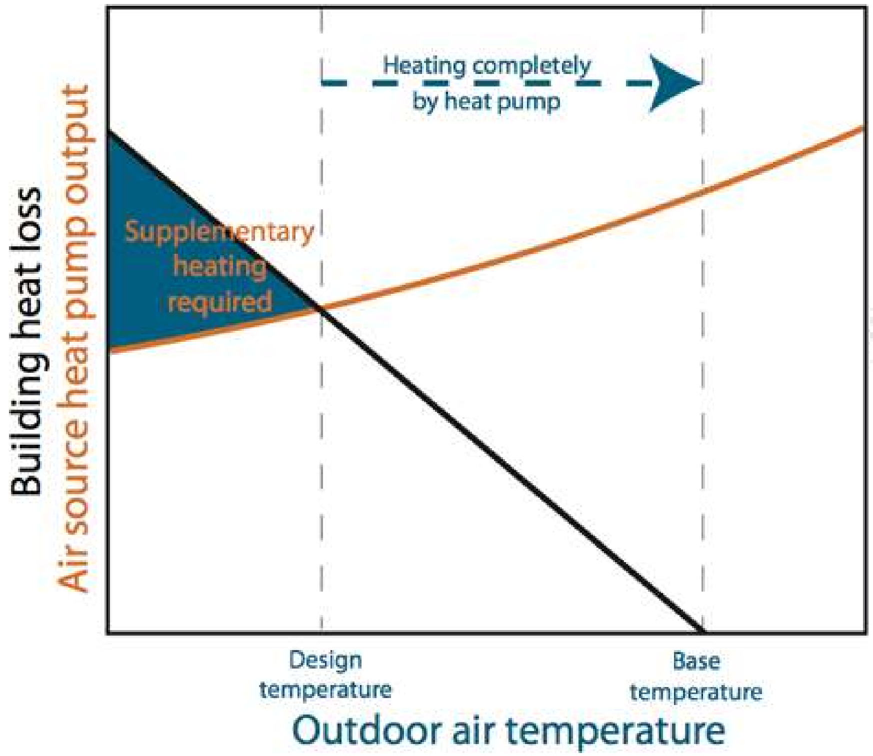
| Item | Description | Result | Comments |
|---|---|---|---|
| 1 | Gas Boiler & PV (242m2) | Fail | No planning & no space on roof for PV. |
| 2 | Gas Boiler & PV (242m2) | Fail | No planning & no space on roof for PV. |
| 3 | Heat Pumps & No PV | Pass | Heat Pumps meet the renewable requirement. |
| 4 | Heat Pumps & No PV | Pass | Heat Pumps meet the renewable requirement. |
| 5 | CHP | Fail | Assessed in 2017. |
| 6 | Solar Panel | Fail | Assessed in 2017 |
| 7 | Biomass | Pass | Assessed in 2017, not suitable for city centre location. |
| 8 | Biogas CHP | Pass | Assessed in 2017, lack of availability of Biogas. |
| | | | |

## Air Source Heat Pumps:-

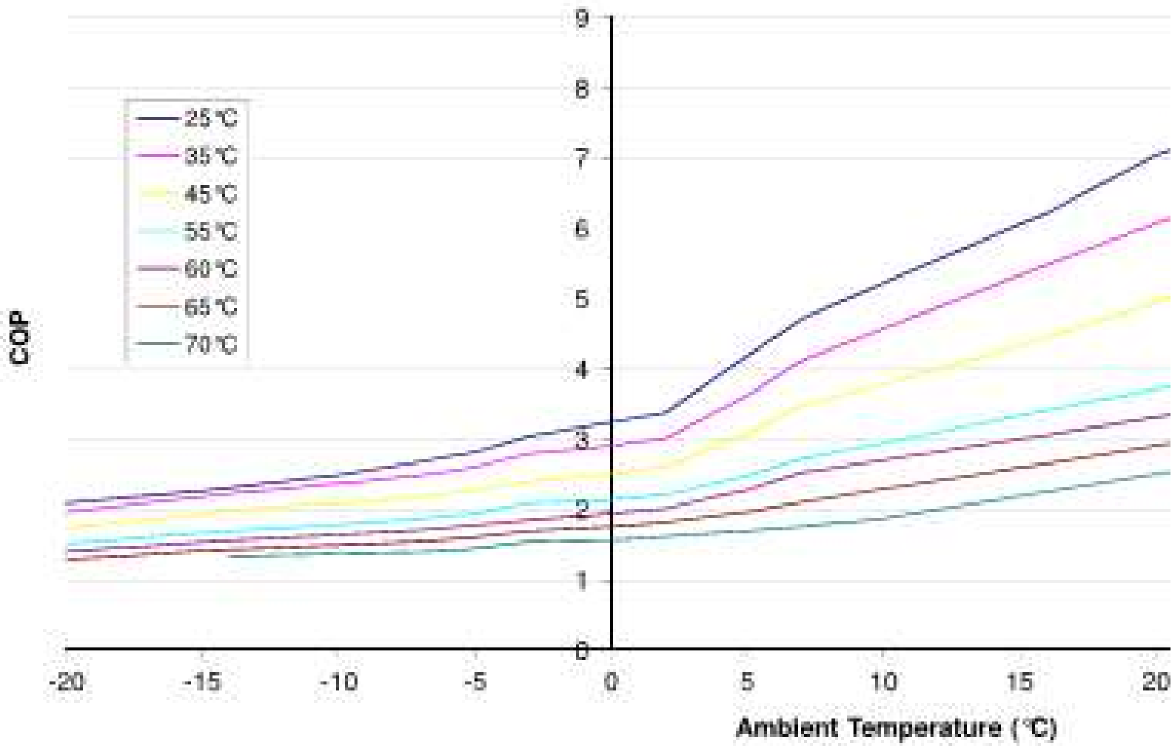
- Many options such as Heat Pump only, Heating and Cooling - 2 pipe and 4 pipe.
- Profiling heating and cooling loads and possible simultaneous use.
- Not a simple like for like replacement for traditional gas fired boilers.
- Produce low grade heat – Delta T, pipework and emitter sizing and pump power.
- Potential weakness: Heating capacity and efficiency diminish as the external temperature drops.
- Availability of manufacturers data (part load efficiency) and technical support.
- Use of bivalent systems – In England and Wales TGD under Part L4 Heat Pumps should only be used when the COP exceeds 2.2.
- Use of night rate electricity and thermal mass and or phase change systems.
- Plant space on roof versus basement and planning restrictions
- Maintenance, resilience and life cycle costs.

**Air Source Heat Pumps:-**

- Monovalent v's Bivalent Use




Efficiency (EN 14511 Full Load; Part Load: EN14825?)

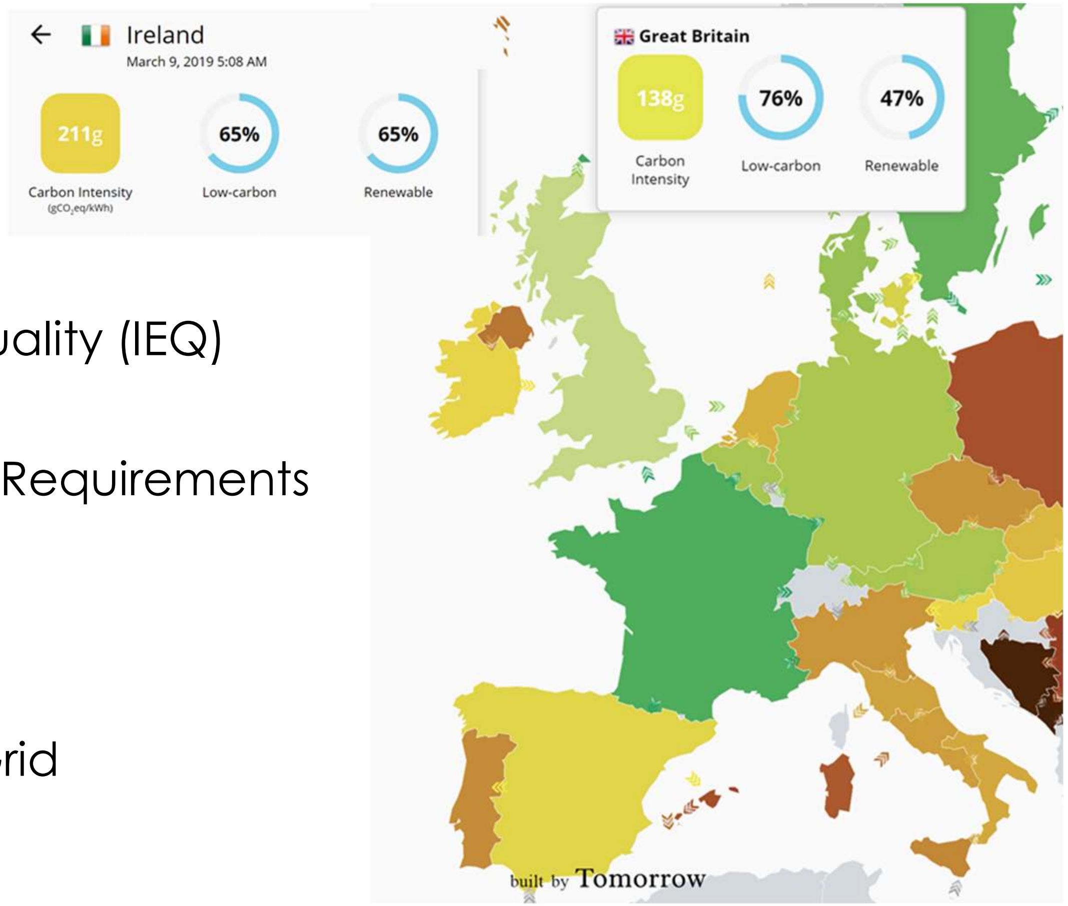


## (4) CASE STUDY: CITY CENTRE OFFICE BUILDING

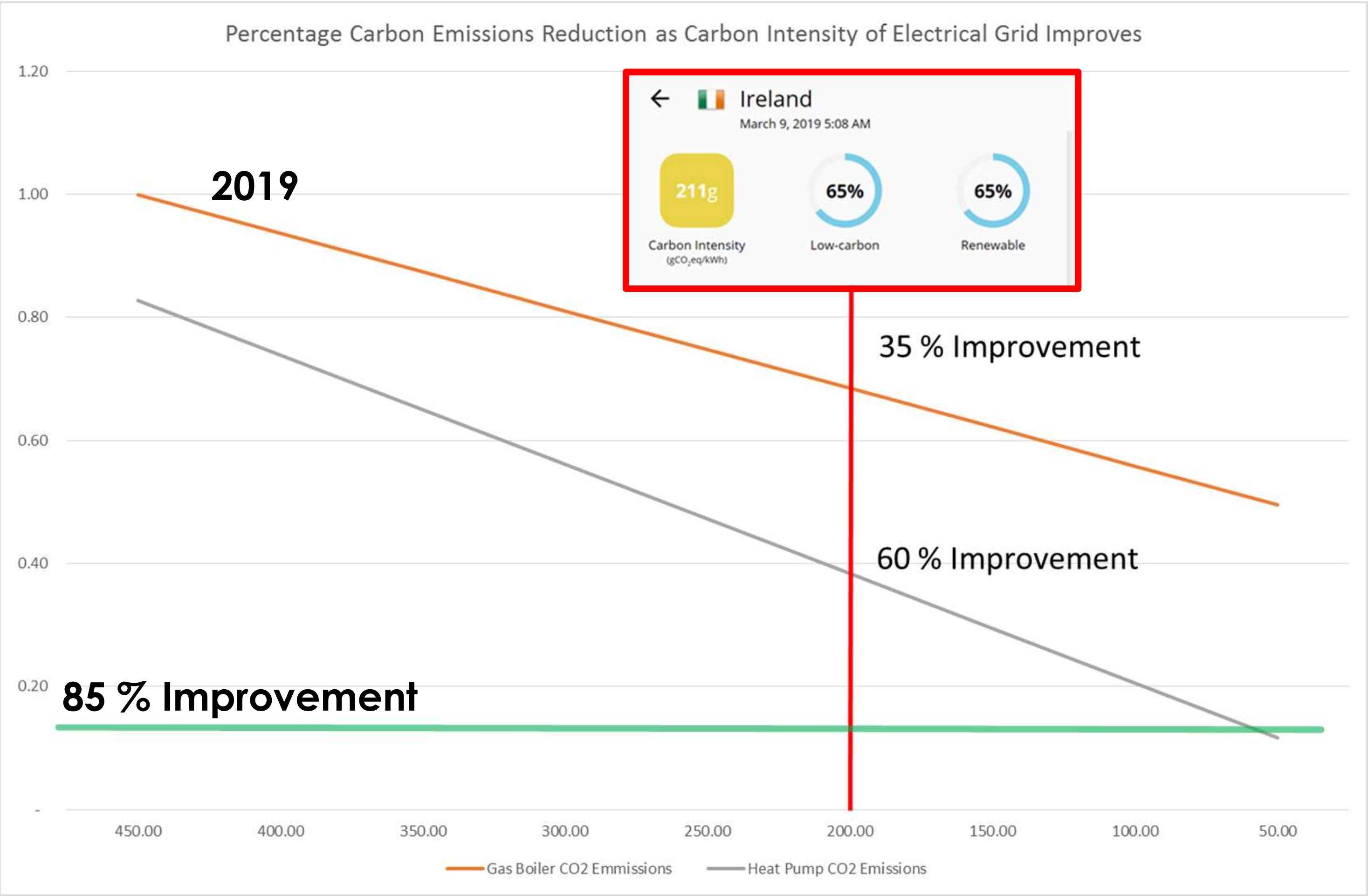
- **SBEM 5.5 h**
- Released in December 2018
- Integration into dynamic simulation packages is ongoing.
  - For example IES has yet to get their module validated.
  - Working with the Beta version is giving rise to some surprising results.
- Cannot be used to generate BER certificates.

## (5) CONCLUSION

- Integrated Design Approach
- Provide good indoor environmental quality (IEQ)
- TGD Part L: NZEB & Renewable Energy Requirements
- Carbon Emissions Reductions
    - Carbon Intensity of the Electrical Grid



# (5) CONCLUSION – PARTING THOUGHT



# Thank You!

# Questions

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*The Sustainable Energy Authority of Ireland is partly financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.*

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# International Perspective

Frank Mills

ASHRAE

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# Agenda

- Why Net Zero ?
- International Net Zero targets
- What is Net Zero ?
- Who have already completed Net Zero Buildings?
- Strategies to achieve Net Zero
- Hospitals – special case
- Zero energy cities
- Net Zero performance
- Conclusions – ASHRAE design tools

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# Why Net Zero ?

1. Energy costs rising—save money
2. Fuels running out—conserve, last longer - UK gas runs out in 2 years time
3. Health, well being, and pollution. Lots of data on life expectancy and health
4. Global warming impacts – disasters coming

# Heat or Eat Dilemma

- UK Households at risk of food and fuel poverty as "heat or eat" dilemma proves real
- Food banks are out of reach for some rural families
- Why have such a problem in a country which wastes so much energy

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# UK Wastes over £30 Billion Each Year by Heat Rejection from Power Stations


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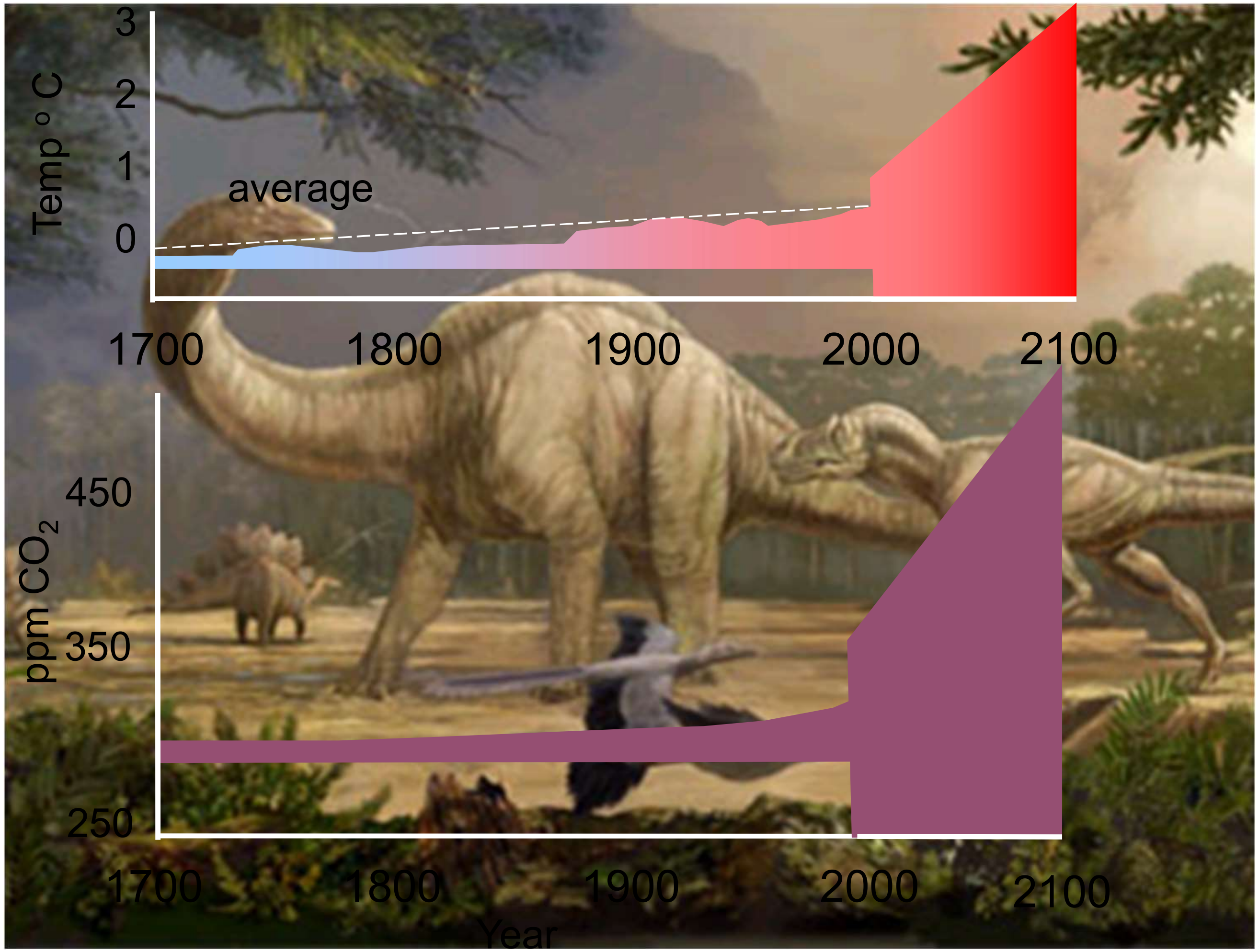
# $CO_2$ and Global Warming

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# Burning Up Fossil Fuels


Oil reserves exhausted in 40 years??

$CO_2$ levels will continue to rise for 100 years

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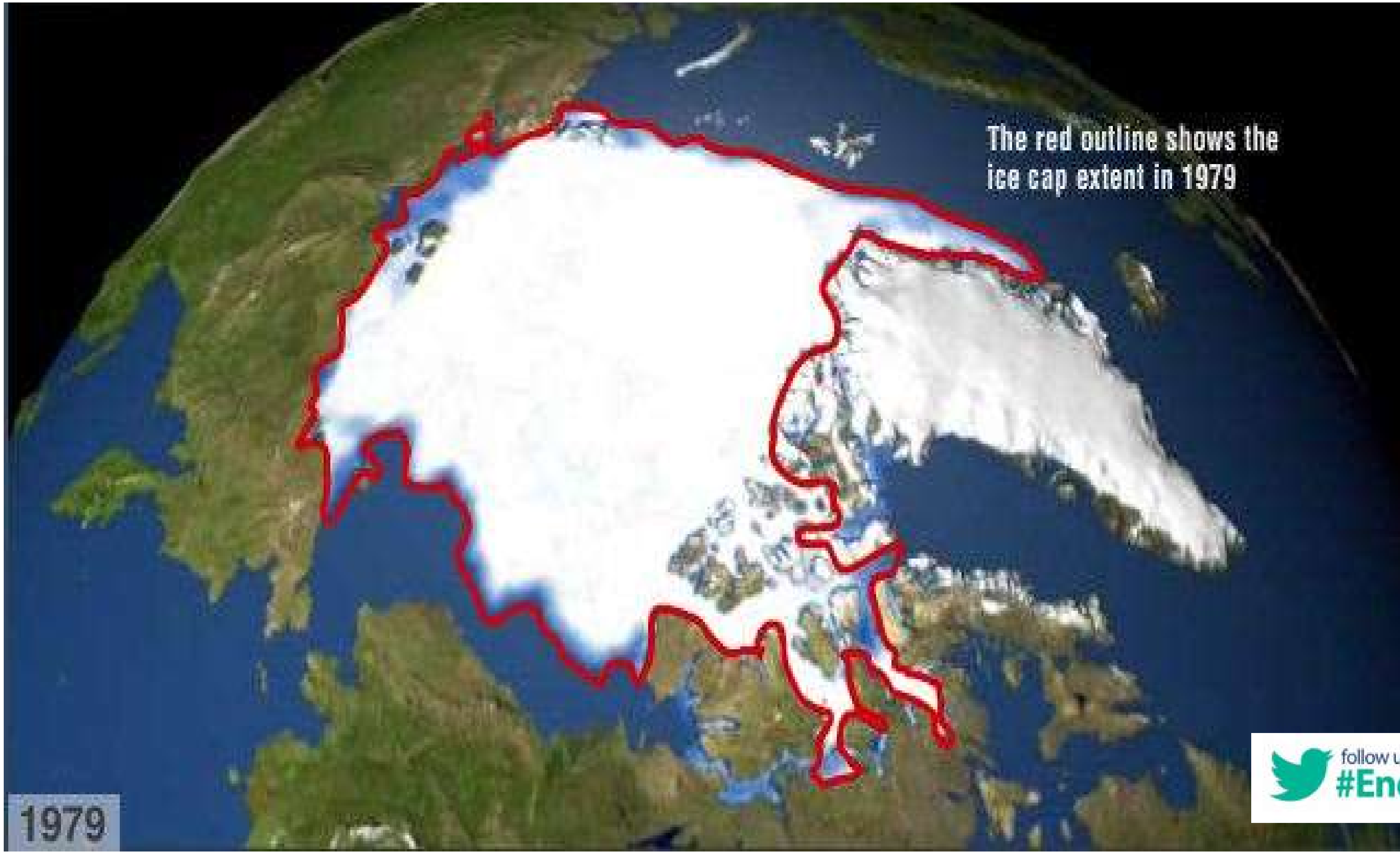
# Melting Ice Caps and Glaciers

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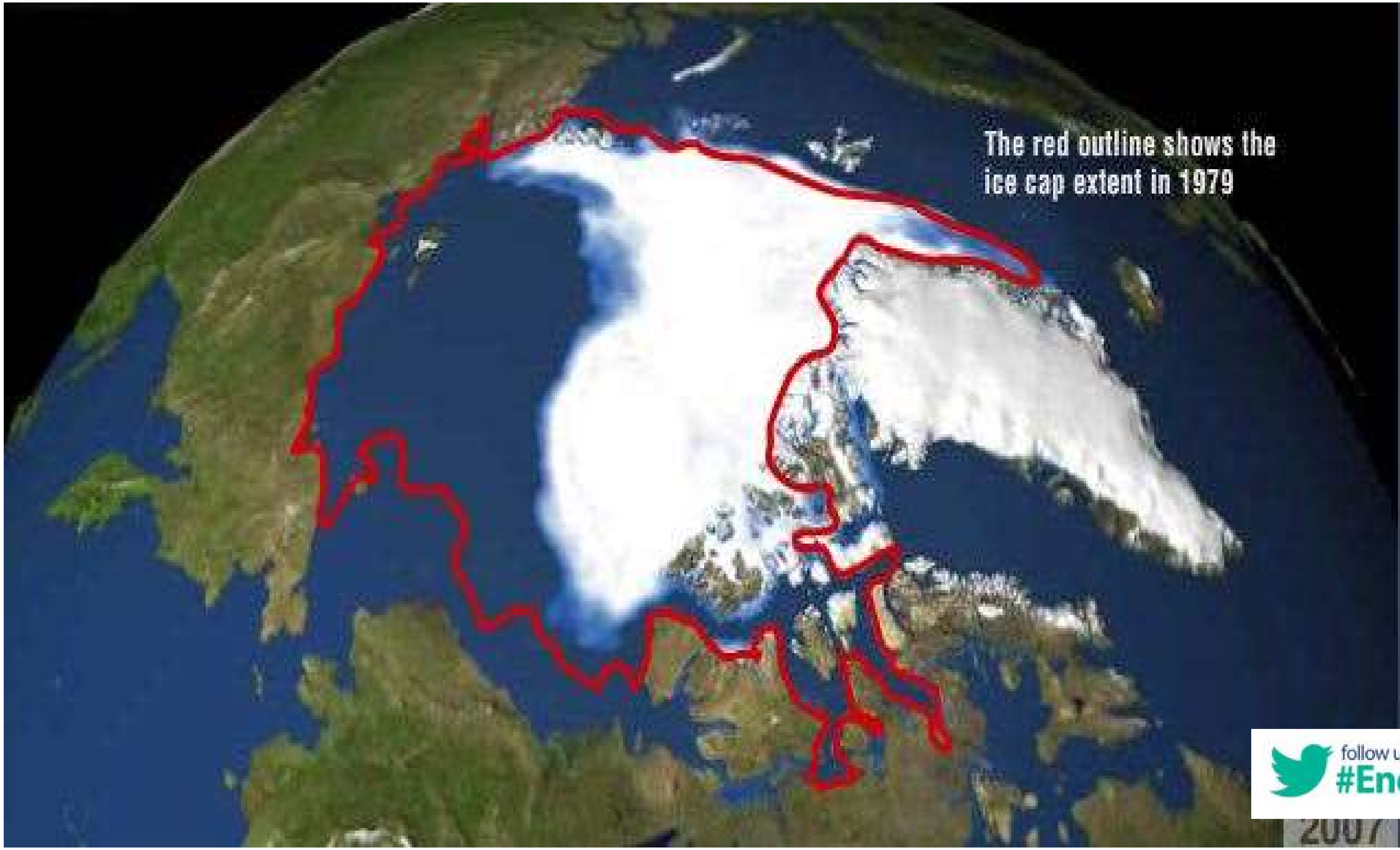
# Melting Ice Caps and Glaciers



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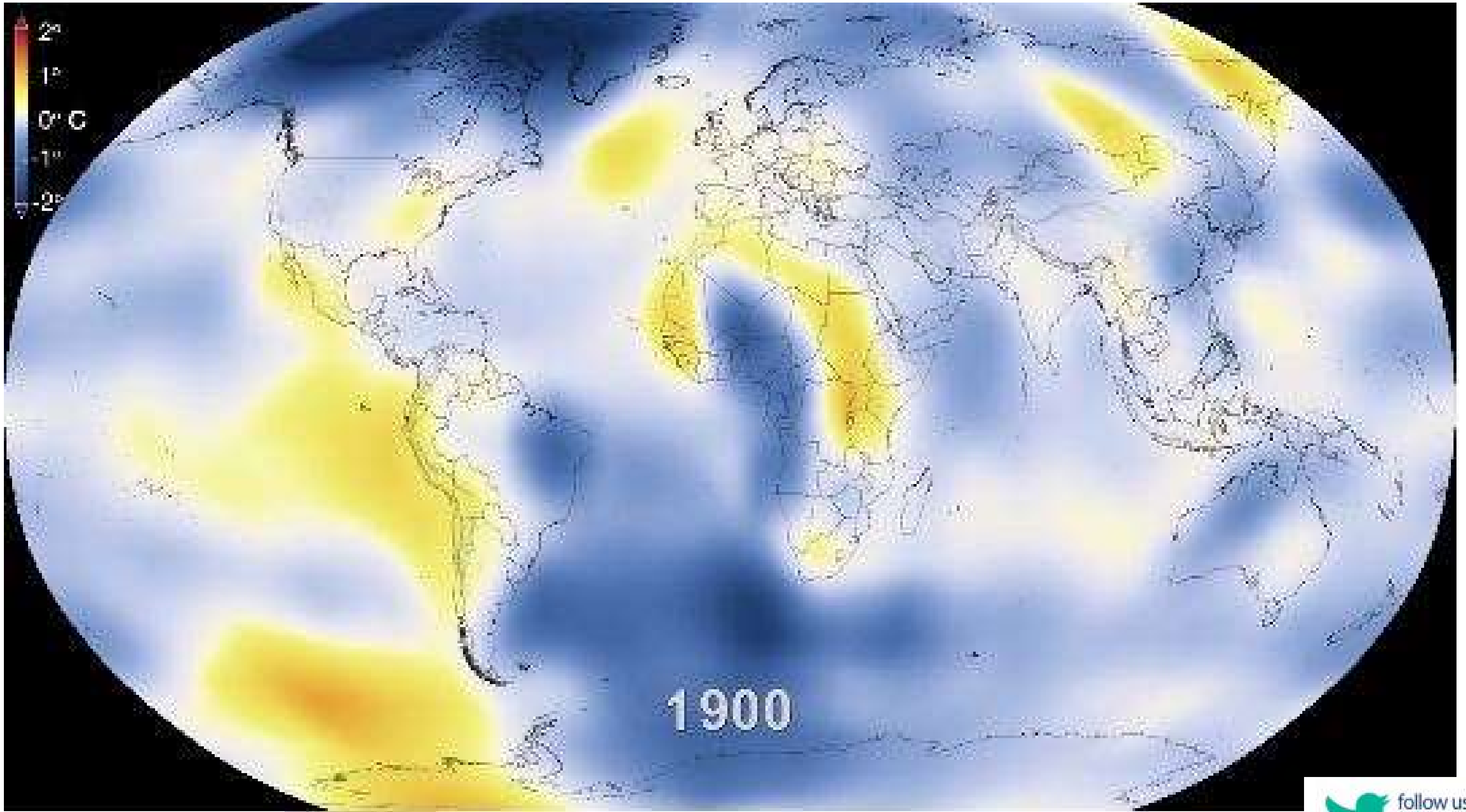
# Global Warming

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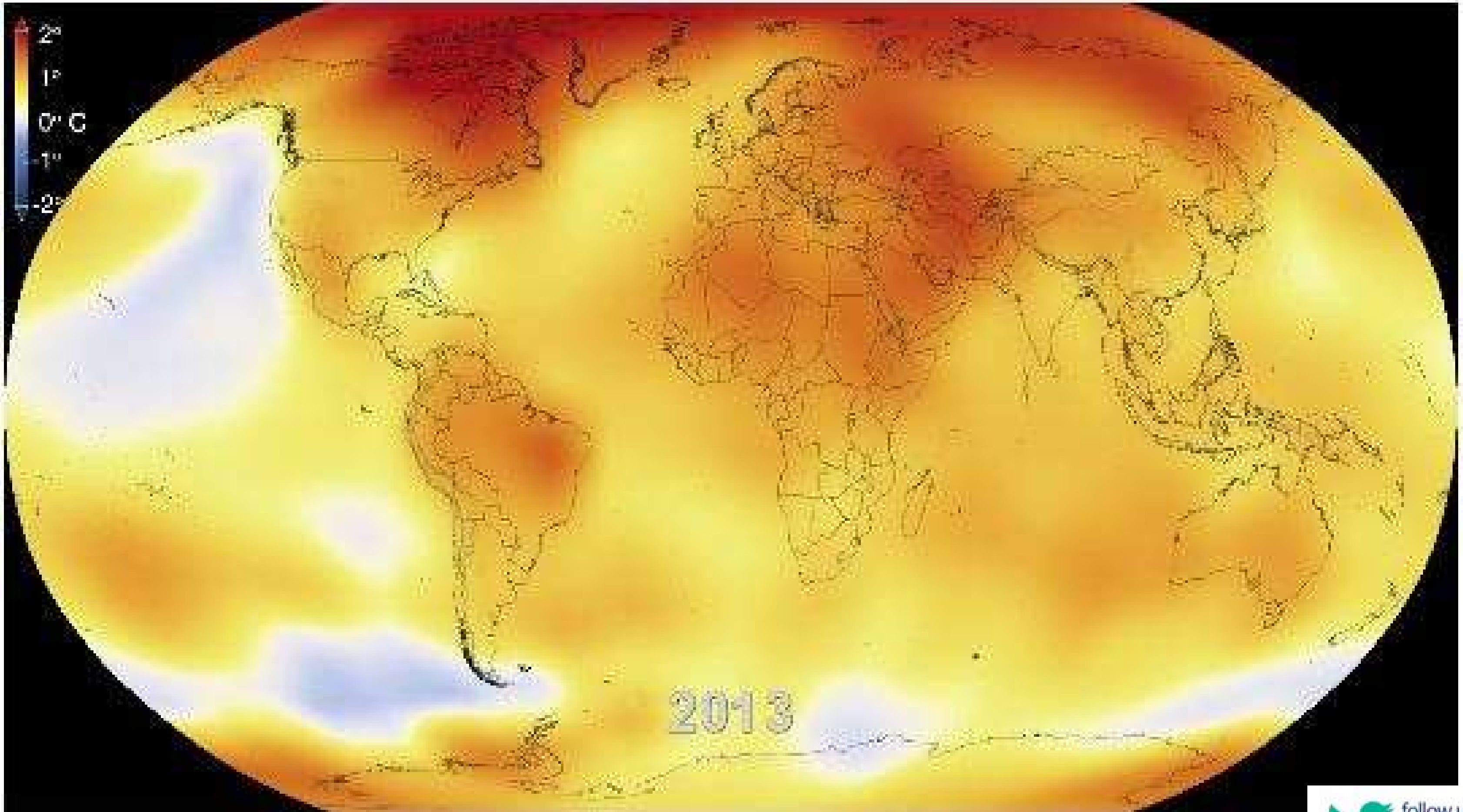
# Global Warming



# How High Will Sea Levels Rise?

Coastal cities like London and New York could sink?

# How High Will Sea Levels Rise?

Tampa, FL—1.5 m Sea Rise

New York City, NY—3-5 m Sea Rise

San Francisco, CA—2.25 m Sea Rise

Miami Beach, FL—1 m Sea Rise

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# NZEB – European definitions

National requirements given by the EPBD directive

From REHVA journal March 2014

Ireland included

**Table 1.** Overview of the NZEB numerical definition currently available in Europe.

| Zone | Country | EP-value | Unit | RES in the EP calc. | Metric | Energy uses included | Building type | | RES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zone 1-2 | Cyprus | 180 | kWh/m²y | NO | Primary energy | heating, cooling, DHW, lighting | | Residential | 25% | | | |
| | | 210 | kWh/m²y | NO | Primary energy | | | Non-residential | 25% | | | |
| Zone 3 | Slovakia | 32 | kWh/m²y | N.D. | Primary energy | heating, DHW | Apartment buildings | Residential | 50% | | | |
| | | 54 | kWh/m²y | N.D. | Primary energy | | Family houses | | 50% | | | |
| | | 60 | kWh/m²y | N.D. | Primary energy | heating, cooling, ventilation, DHW, lighting | Office | Non-residential | 50% | | | |
| | | 34 | kWh/m²y | N.D. | Primary energy | | Schools | | 50% | | | |
| Zone 4 | Belgium BXL | 45 | kWh/m²y | YES | Primary energy | heating, DHW, appliances | Individual dwellings | Residential | - | | | |
| | | 95 - 2,5*(V/S) | kWh/m²y | YES | Primary energy | heating, cooling, DHW, lighting, appliances | Office buildings | Non-residential | - | | | |
| | | 95 - 2,5*(V/S) | kWh/m²y | YES | Primary energy | heating, cooling, DHW, appliances | Schools | | - | | | |
| | Belgium Walloon | 60 | kWh/m²y | N.D. | Primary energy | heating, DHW, appliances | Residential buildings, schools office and service buildings | Residential/ Non-residential | 50% | | | |
| | Belgium Flemish | 30 | kWh/m²/y | YES | Primary Energy | heating, cooling, ventilation, DHW, auxiliary systems | | Residential | >10 kWh/m²y | | | |
| | | 40 | kWh/m²y | YES | Primary Energy | | Office buildings, schools | Non-residential | >10 kWh/m²y | | | |
| | France | 50 | kWh/m²y | NO | Primary energy | heating, cooling, ventilation, DHW, lighting, auxiliary systems | | Residential | - | | | |
| | | 70 | kWh/m²y | NO | Primary energy | | Office buildings non-air-cond. | Non-residential | - | | | |
| | | 110 | kWh/m²y | NO | Primary energy | | Office buildings air-cond. | | - | | | |
| | Ireland | 45 | kWh/m²y | N.D. | Energy load | heating, ventilation, DHW, lighting | | Residential | - | | | |
| | Netherlands | 0 | [-] | YES | Energy performance coefficient (EPC) | heating, cooling, ventilation, DHW, lighting | | Residential/ Non-residential | not quantified, but necessary | | | |
| Zone 5 | Denmark | 20 | kWh/m²y | YES | Primary Energy | heating, cooling, ventilation, DWH | | Residential | 51% - 56% | | | |
| | | 25 | kWh/m²y | YES | Primary Energy | heating, cooling, ventilation, DHW, lighting | | Non-residential | 51% - 56% | | | |
| | Estonia | 50 | kWh/m²y | YES | Primary Energy | heating, cooling, ventilation, DHW, lighting, HVAC auxiliary, appliances | Detached houses | Residential | - | | | |
| | | 100 | kWh/m²y | YES | Primary Energy | | Apartment buildings | | - | | | |
| | | 100 | kWh/m²y | YES | Primary Energy | | Office buildings | Non-residential | - | | | |
| | | 130 | kWh/m²y | YES | Primary energy | | Hotels and restaurants | | - | | | |
| | | 120 | kWh/m²y | YES | Primary energy | | Public buildings | | - | | | |
| | | 130 | kWh/m²y | YES | Primary energy | | Shopping malls | | - | | | |
| | | 90 | kWh/m²y | YES | Primary energy | | Schools | | - | | | |
| | | 100 | kWh/m²y | YES | Primary energy | | Day care centres | | - | | | |
| | | 270 | kWh/m²y | YES | Primary energy | | Hospitals | | - | | | |
| | Latvia | 95 | kWh/m²y | N.D. | Primary energy | heating, cooling, ventilation, DHW, lighting | | Residential/ Non-residential | - | [illegible] 09.07.2013 | [illegible] | [illegible] |
| | Lithuania | <0,25 | [-] | N.D. | Energy performance indicator C | heating | | Residential/ Non-residential | 50% | Building Technical Regulation STR 2.01.09:2012 | [5] | [1] |

REHVA Journal – March 2014

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# Net Zero: California unveils goal to achieve 'carbon neutrality' by 2045


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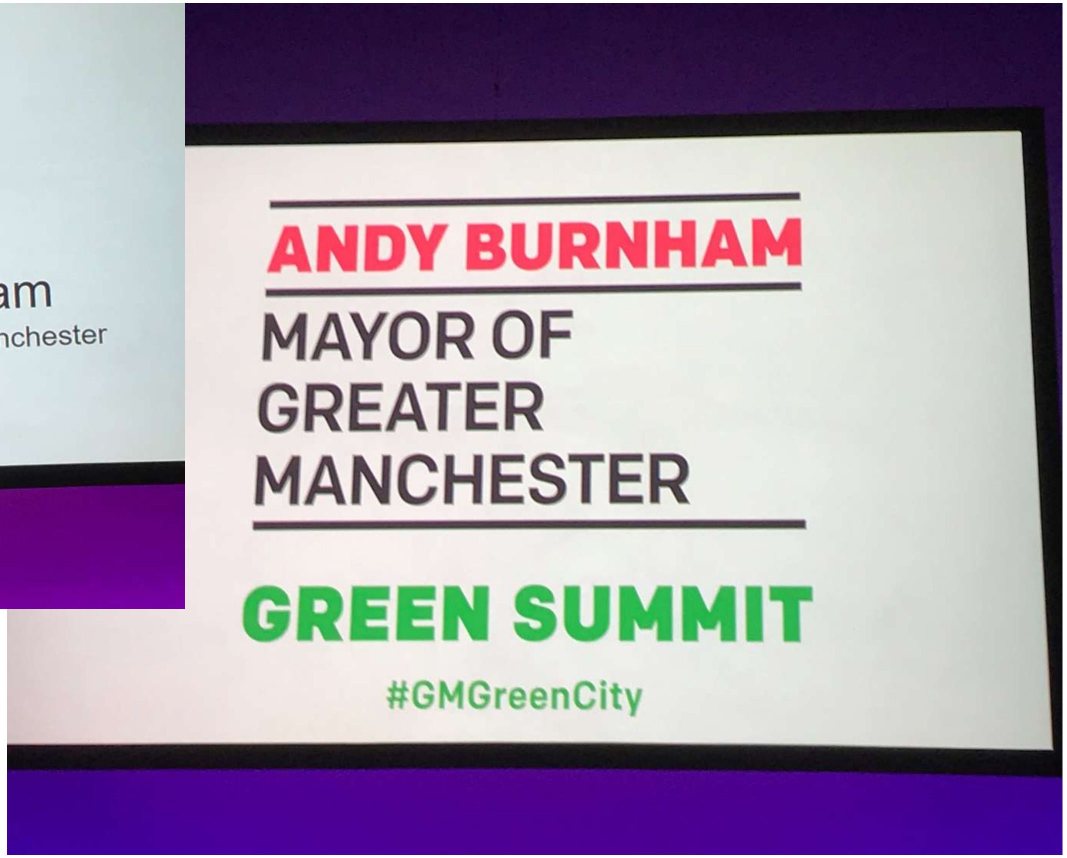
Welcome
dy Burnham
r of Greater Manchester


ANDY BURNHAM
MAYOR OF GREATER MANCHESTER
GREEN SUMMIT
#GMGreenCity

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# Manchester City, UK

**Vision 2050**

*Manchester is playing its full part in limiting the impacts of climate change, locally and globally. It is a thriving,* ***zero carbon, zero waste, climate resilient city*** *where all our residents, public, private and third sector organisations are actively contributing to and benefiting from the city's success.*

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# Green Summit March 2018

- Mayor sets target of NZ city by 2040
- Requires citizens and companies to pledge support
- Manchester Tyndall Centre leads Climate change research


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# Manchester
## Climate Change Strategy 2017-50

# Manchester
## Climate Change Strategy 2017-50

Implementation Plan 2017-22

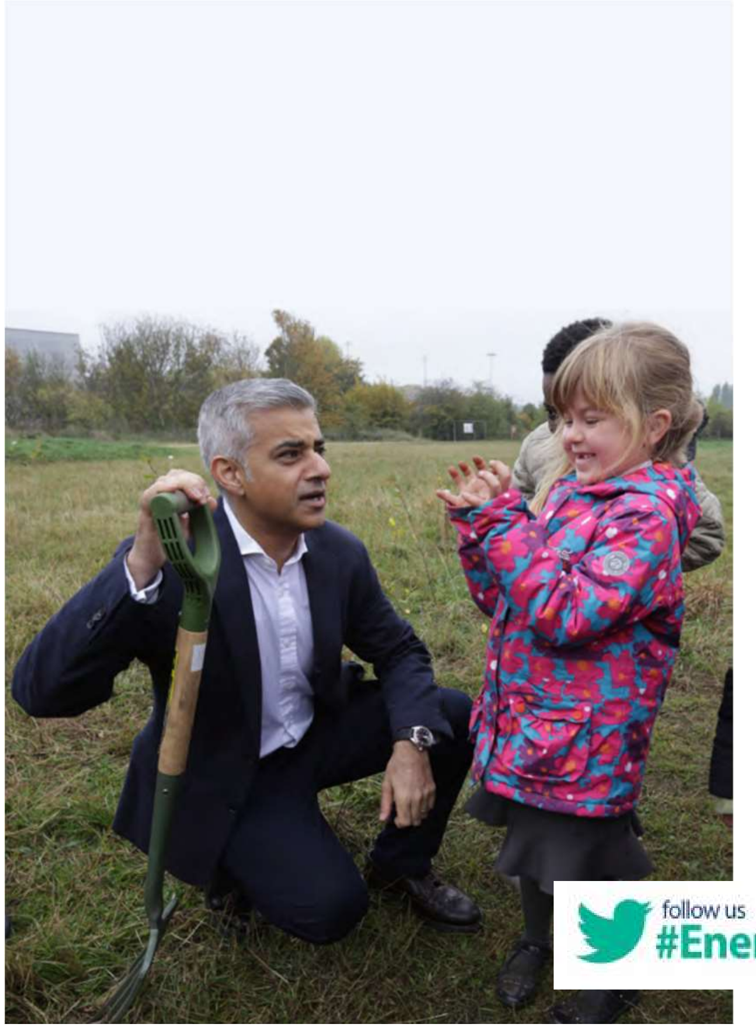
# Zero Energy as a Target—UK Schools

- UK—All new schools zero carbon by **2016 (not happening!)**
- Engagement
- Knowledge and skills
- Feedback on performance
- Low and zero carbon energy supplies
- Investment

# London Action Plan

**The mayor aims for London to be a zero carbon city by 2050, with energy-efficient buildings, clean transport, and clean energy.**

Make sure that new developments are zero carbon from 2019, with clean supplies of energy and high energy efficiency designed in from the start



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# How do we achieve Net zero carbon London

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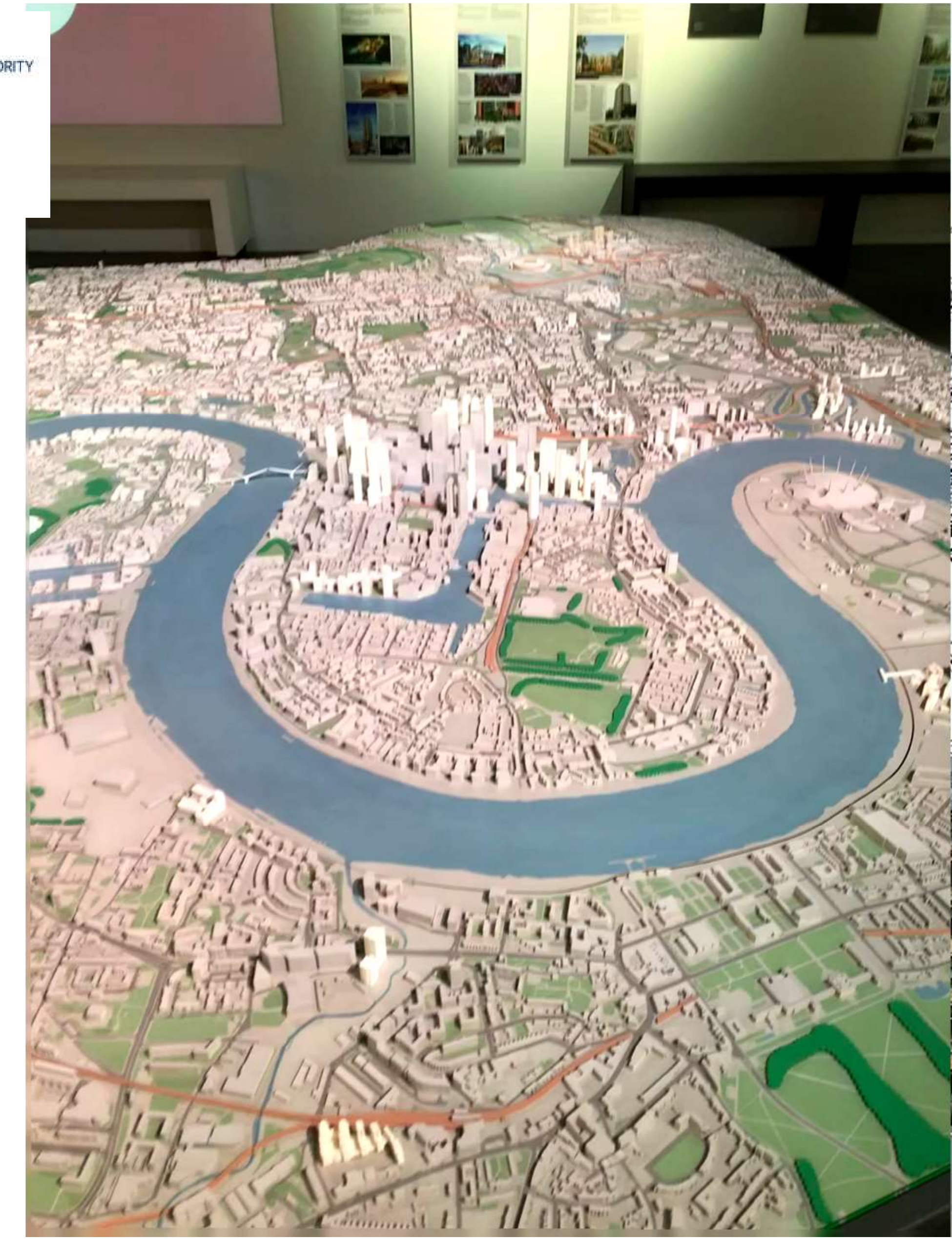

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# UK Construction in crisis

- Grenfell Tower disaster – Hackitt Enquiry
- UK engineers NOT registered
- CPD not mandatory yet !
- Certification of contractors limited and ineffective
- Building services courses closing
- BREXIT confusion


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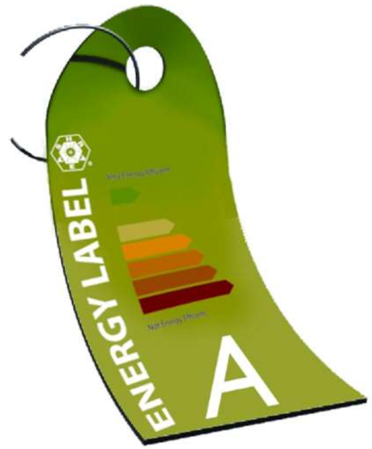
# Zero carbon means total carbon

- EU Directive and UK Building Regs only cover ‘environmental energy’
- Heat, Light, cooling, hot water, ventilation
- **Not plug loads**
- **Not process loads**
- **ASHRAE – and others – includes all use**
- Net Zero Energy Cost Building
- Net Zero Energy Emissions Building

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# Who is Already Doing Net Zero ?

- Environmental organizations
- Research centers
- Universities and schools
- Some engineered solutions which aimed to save costs and saved energy too

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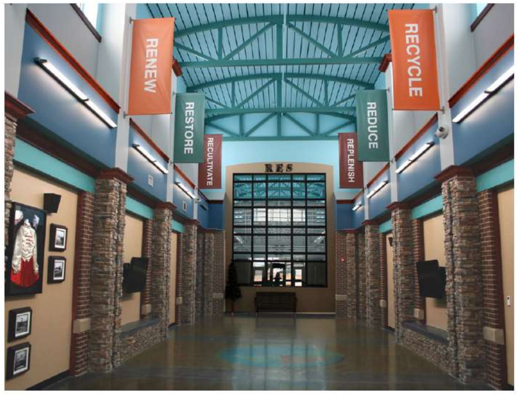
# Getting to Zero 2012 Status Update:

nbi new buildings institute

research report
March 2012




Getting to Zero 2012 Status Update:

A First Look at the Costs and Features of Zero Energy Commercial Buildings

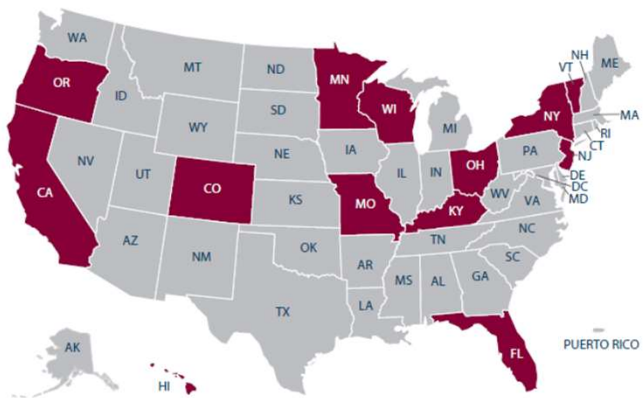
With support from:

NASEO National Association of State Energy Officials

ZERO ENERGY COMMERCIAL BUILDINGS CONSORTIUM CBC

- North American review of completed NZ buildings
- Location of 21 projects

Figure 2. Location of the 21 zero energy projects

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# Seattle—Bullitt Center

- Opened on Earth Day, April 22, 2013
- Greenest commercial building in the world
- Living building
- 6-story, 52,000 ft$^2$ (4800 m$^2$)
- Energy and carbon neutral
- $18.5 million, or $355 per ft$^2$ (2013 base)

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# Bullitt Center—Net Zero Energy

- Energy efficiency 83% better than a typical Seattle office
- Predicted EUI rating of 16 kBtu/ft$^2$/yr
- 242 kW photovoltaic array
- Ground-source geothermal heat exchange system
- Radiant floor heating and cooling
- Retractable external blinds to block heat before it warms the building
- Reduced plug loads



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# La Jolla Commons II, CoStar Group

- 13-story La Jolla Commons II office University Towne Centre
- Largest net zero energy building in United States
- 415,000 $ft^2$
- Biogas and onsite fuel cells
- Methane to electricity, tapping methane in landfills and wastewater plants.



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# DEWA to Build the Tallest Zero Energy Building

- Dubai Electricity and Water Authority's (DEWA) new headquarters (HQ) will be the tallest, largest, and smartest net zero energy building (ZEB) in the world once it's completed in 2019.
- Total renewable energy generated by the building will be over 5400 megawatt hours (MWh) annually.
- Al-Sheraa's design was inspired by the traditional houses in the UAE, where enclosed spaces overlook an open courtyard.

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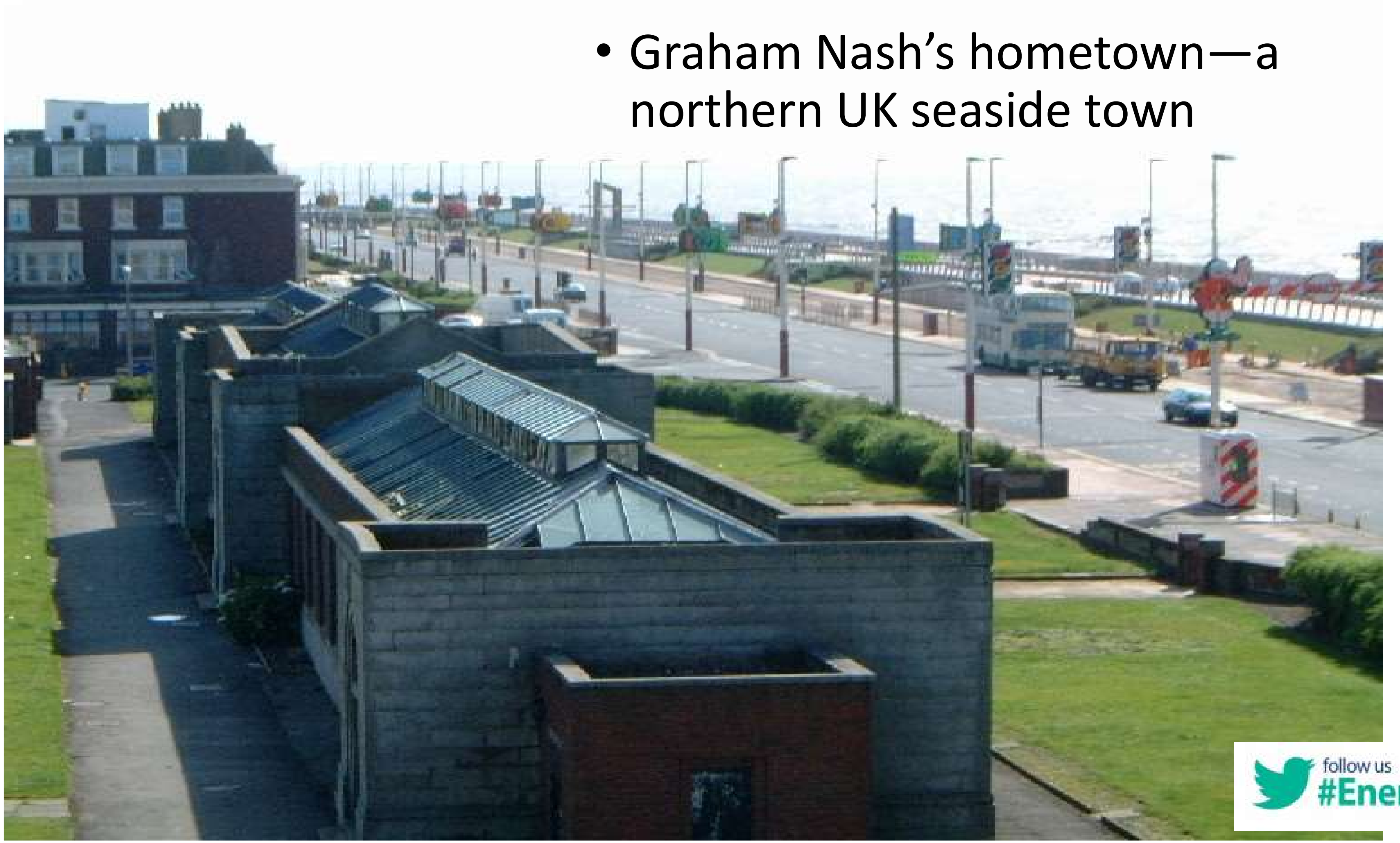
# Blackpool Council's Old Disused Solarium



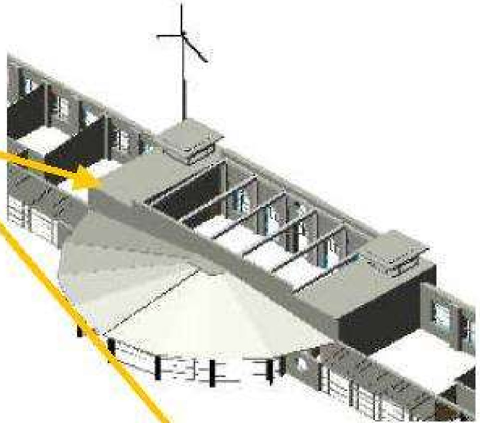
- Graham Nash's hometown—a northern UK seaside town

# Solaris Blackpool—A Zero Carbon Building

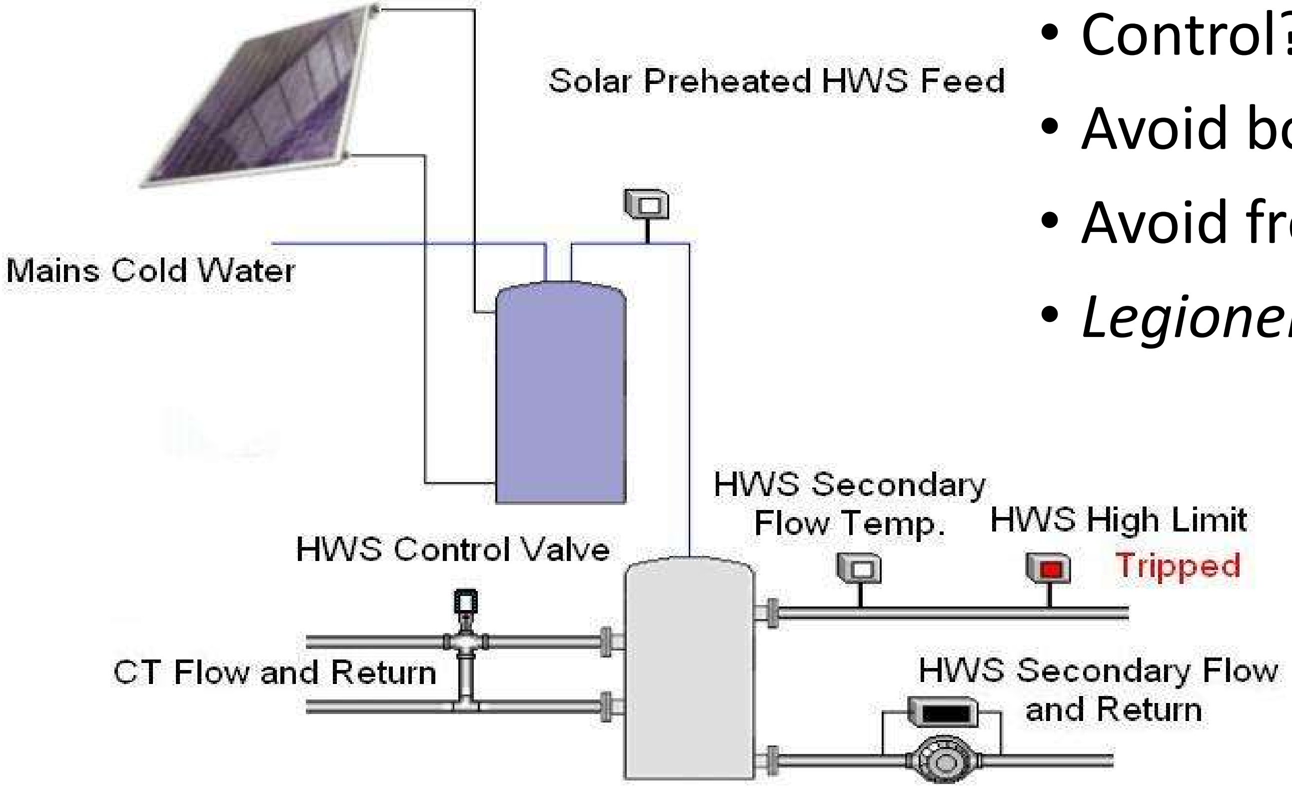
A Small Project by Frank Mills in 2002

# Renewable Energy Systems Used

Solar Panel is mounted on the South Tower, facing South at a 45 degree angle.



# Solar Hot Water




- Control?
- Avoid boiling
- Avoid freezing
- *Legionella*?

BMS – Solar Hot water Schematic

# Hot-Water Panel Solar Gains

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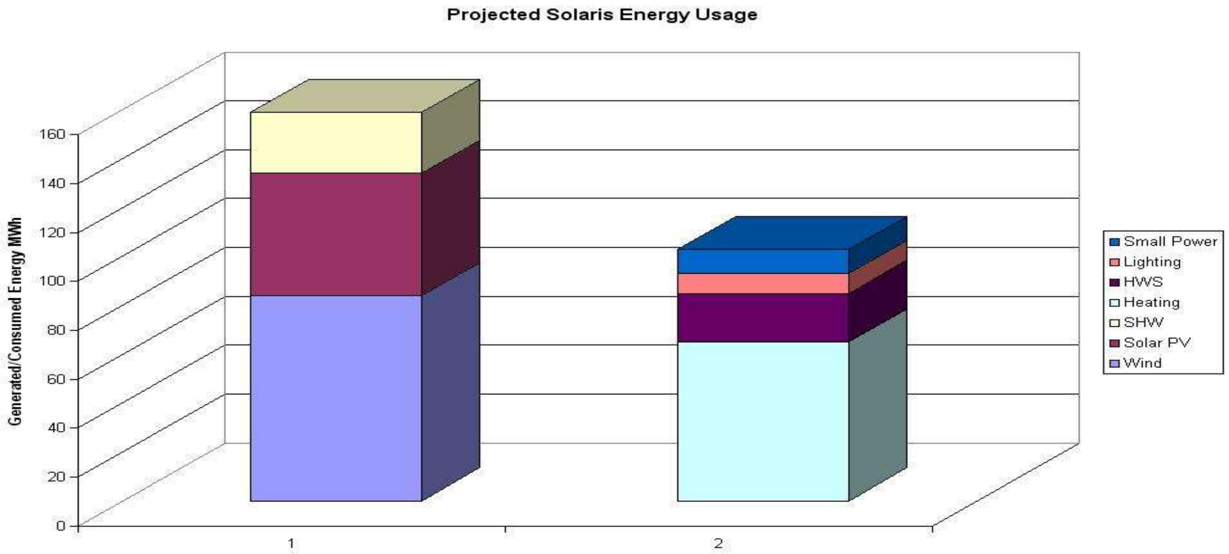
# Wind Turbine on Seafront

- 6 kW electrical
- Facing the sea

# Net Zero

- Generates more energy than used
- Net exporter
- Uses fossil fuels when necessary

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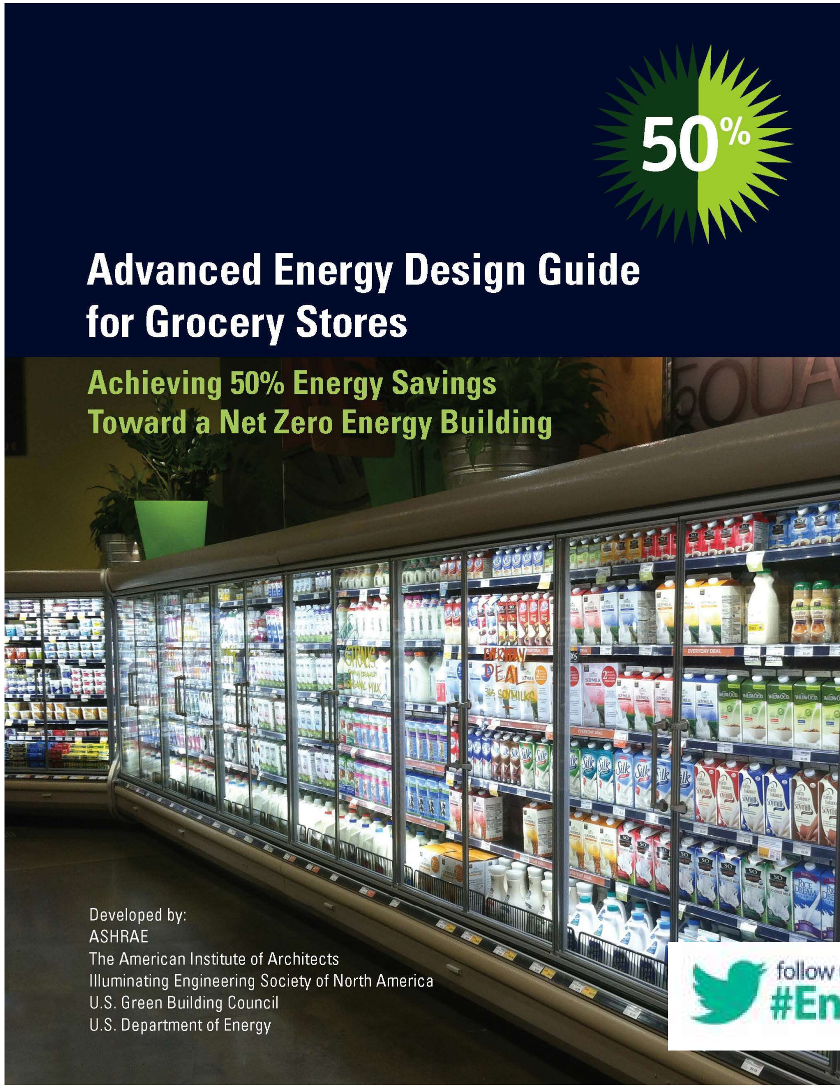
# Liverpool Sailing Club

- River Mersey
- Project budget £1M
- Remote location—no energy supplies
- New electric cable over £250k
- New gas main £250k
- Alternative renewables energy supplies only £200k
- 6 kW Wind turbine, 4 kW solar PV panels, biodiesel CHP unit, battery storage
- Integrated design—fabric/structure/services

# ASHRAE LOW CARBON GUIDES

- Ongoing publications
- Retail 50% guide now out
- Others in production
- Information on HVAC and R  and Electrical systems



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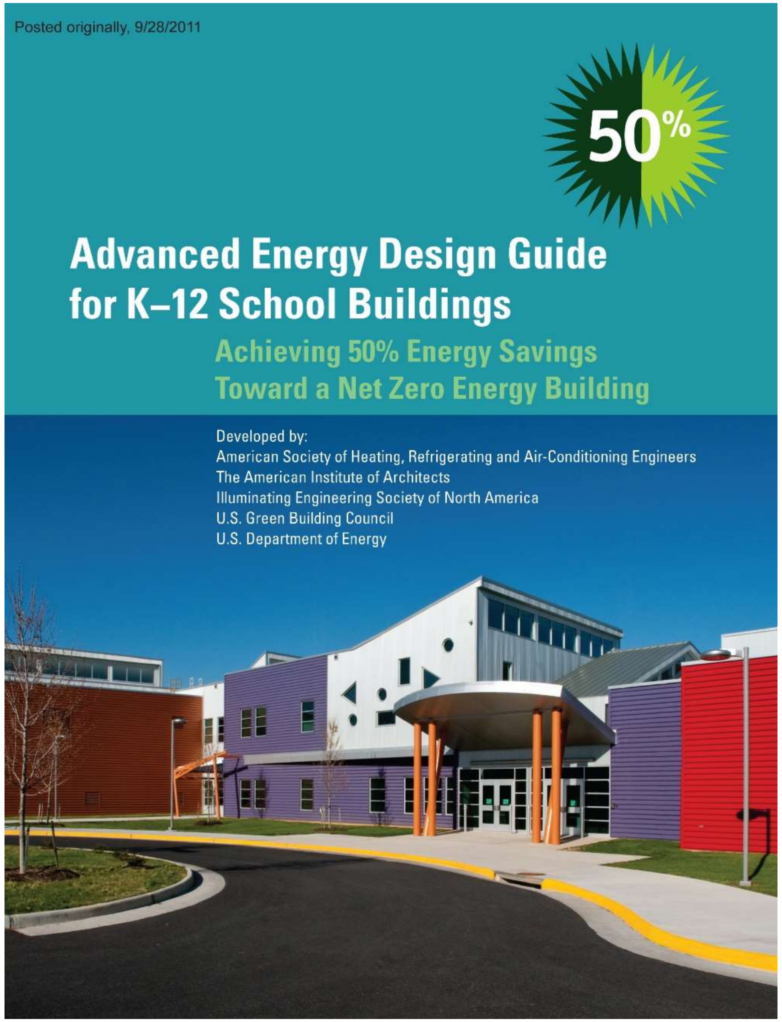
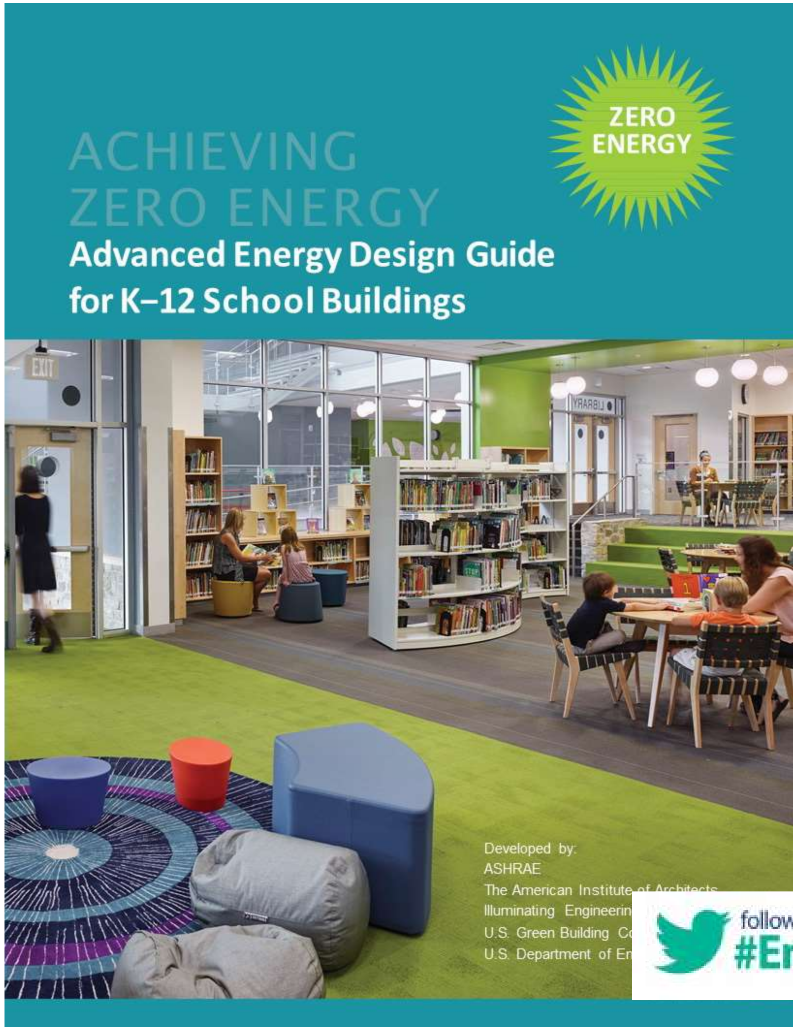
# ASHRAE 50% and NZ SCHOOLS GUIDES

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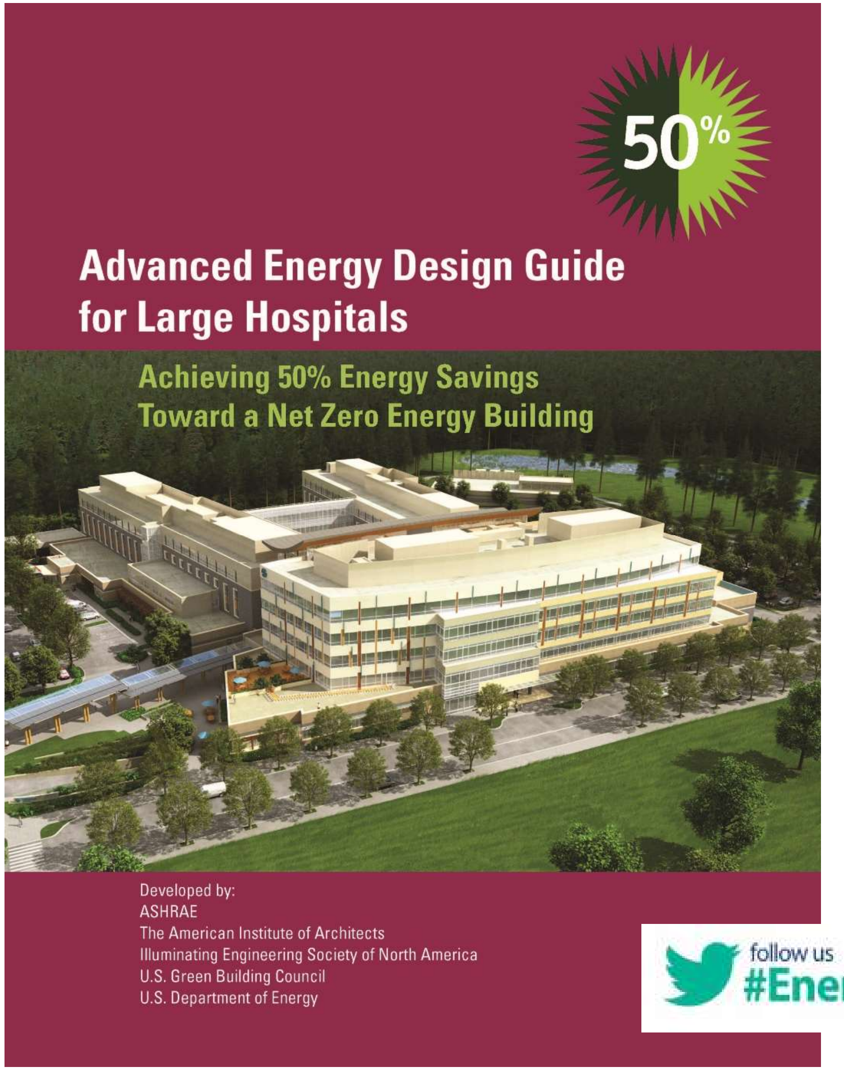
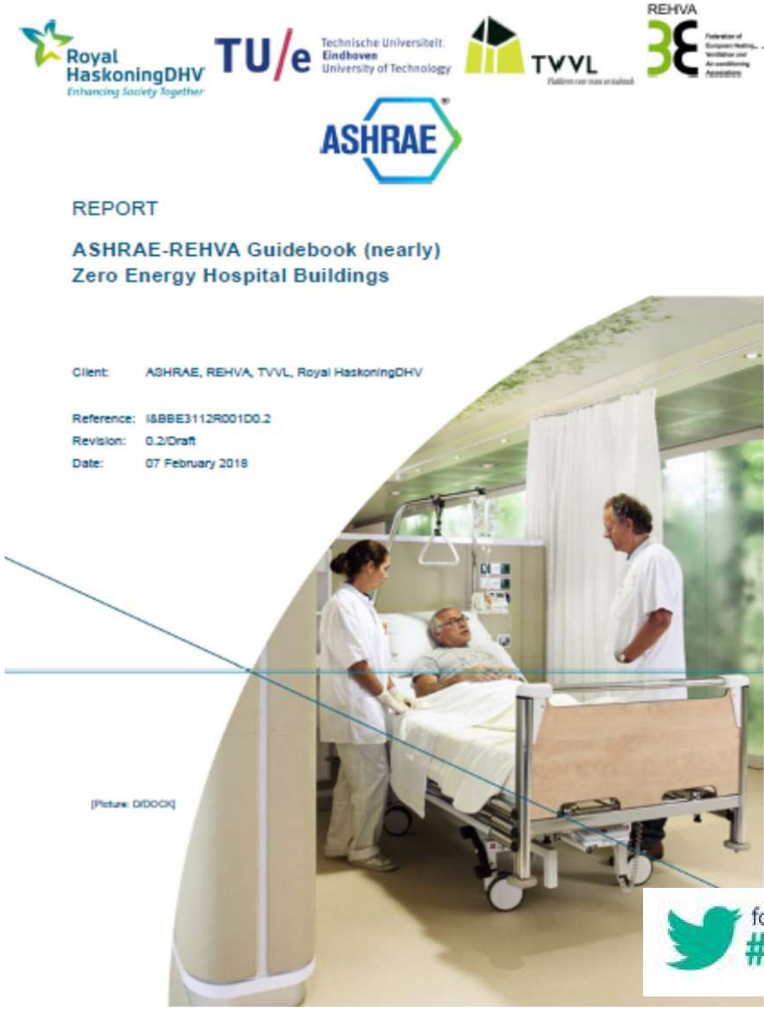
# ASHRAE HOSPITAL 50% GUIDE

- Hospital guide available



# ASHRAE and REHVA NZ Hospitals guide

- TC 9.6 lead
- REHVA initiative
- Dutch engineers taking the lead
- Supports EU and UK aspirations – as well as ASHRAE



REPORT

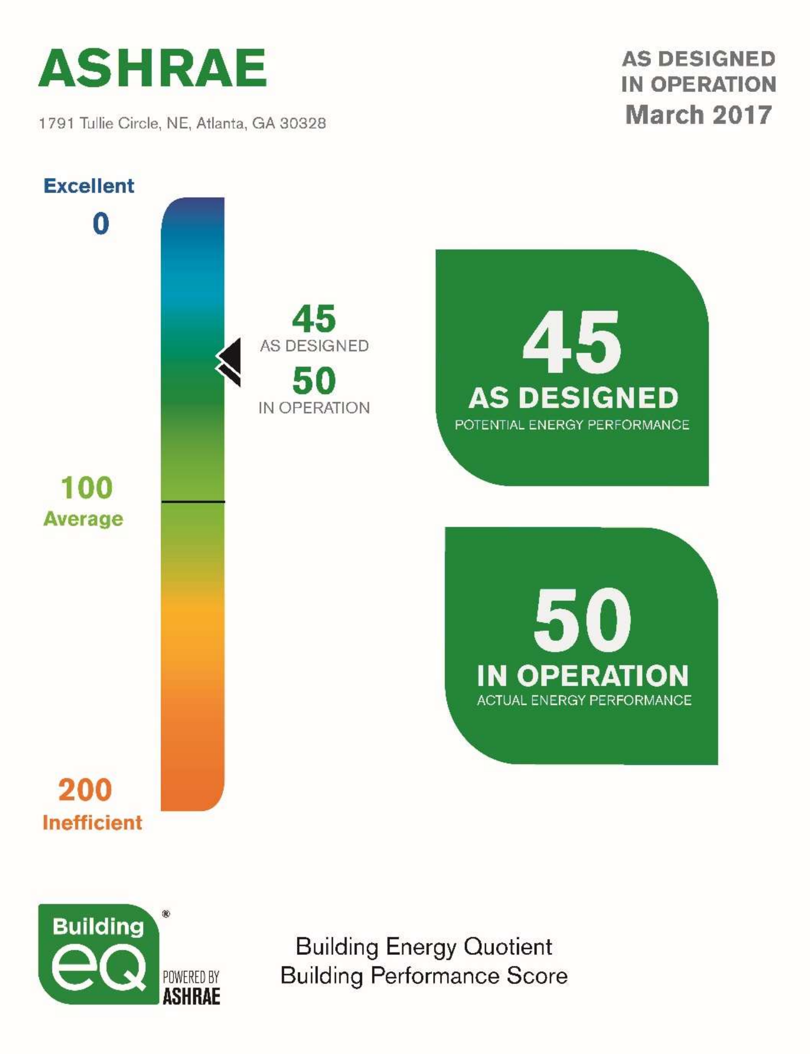
ASHRAE-REHVA Guidebook (nearly) Zero Energy Hospital Buildings

Client: ASHRAE, REHVA, TVVL, Royal HaskoningDHV

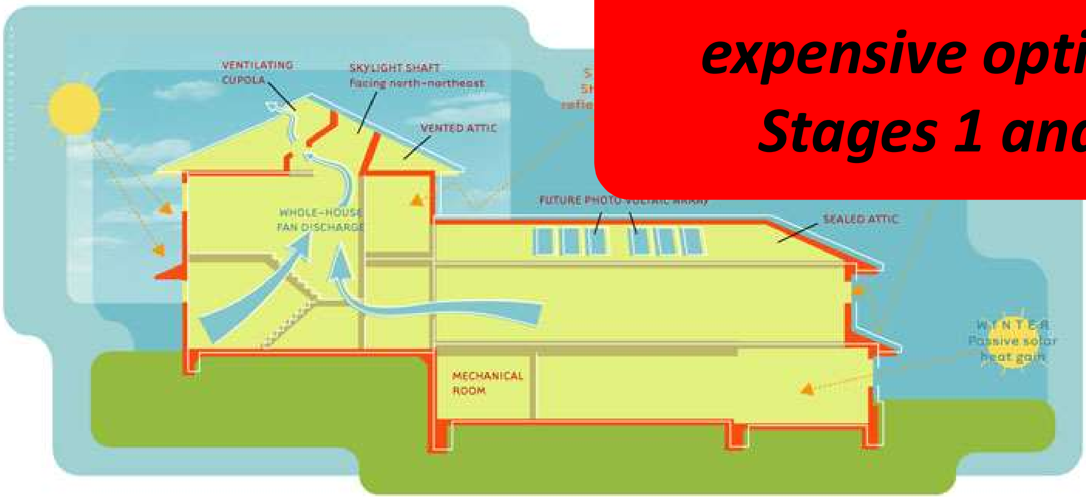
Reference: I&BBE3112R001D0.2
Revision: 0.2/Draft
Date: 07 February 2018

[Picture: DIDOCK]

# Design Standards  ASHRAE Beq



# Three Steps to Net Zero—Be Lean




***Renewables are generally most expensive option; therefore, use Stages 1 and 2 to maximum***

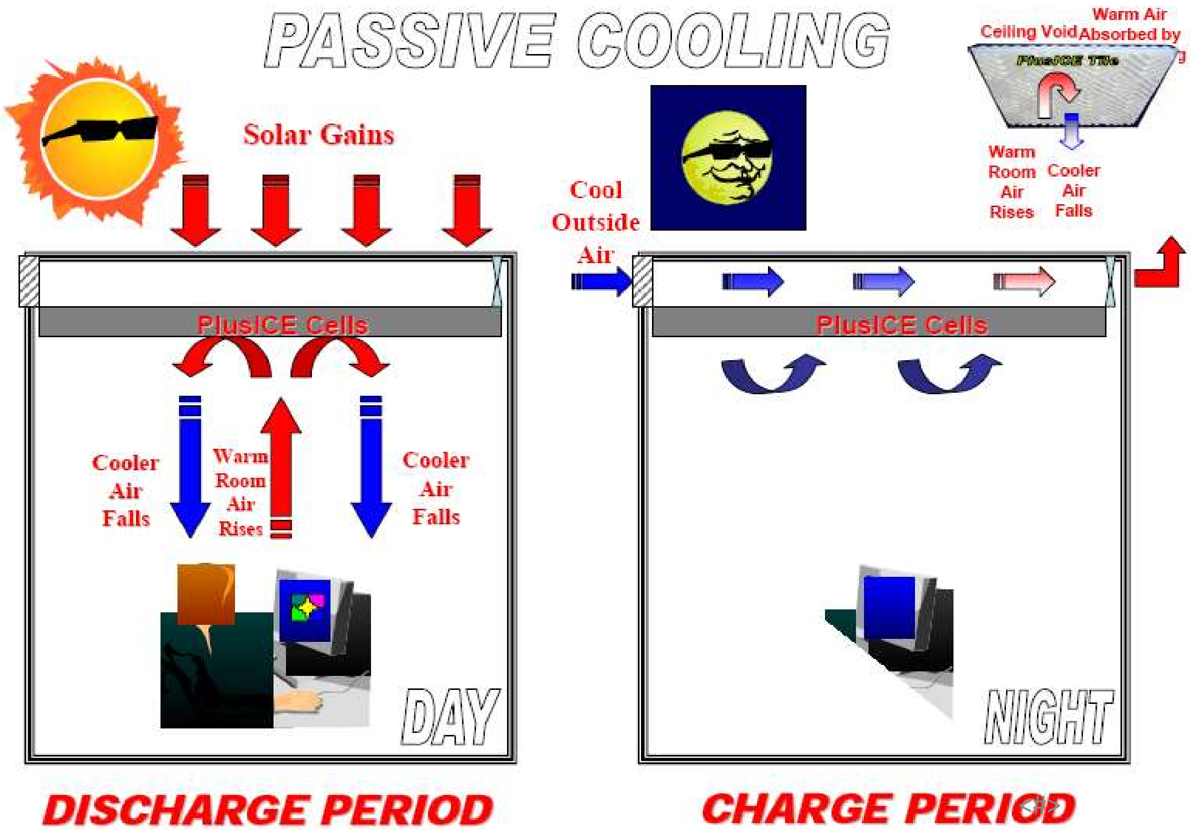
- **Stage 1 Building Envelope Measures**
  - *Energy Efficiency Measures*
  - *Renewable Energy Measures*



Courtesy of Otto Steiringer.

# Energy Efficiency—Passive Thermal Storage Using PCMs

## HVAC—Passive Cooling



# Energy Efficiency—Passive Thermal Storage Using PCMs

## HVAC—Passive Cooling

# Advanced Natural Ventilation

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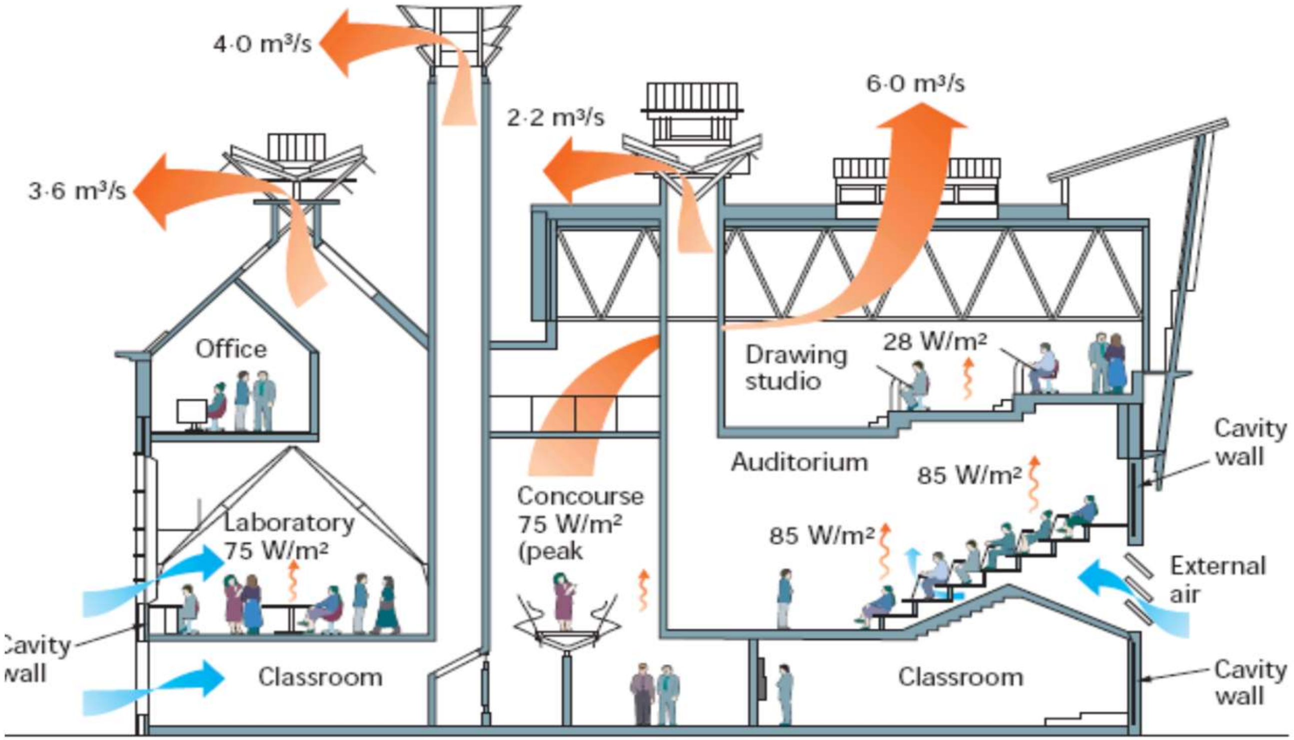
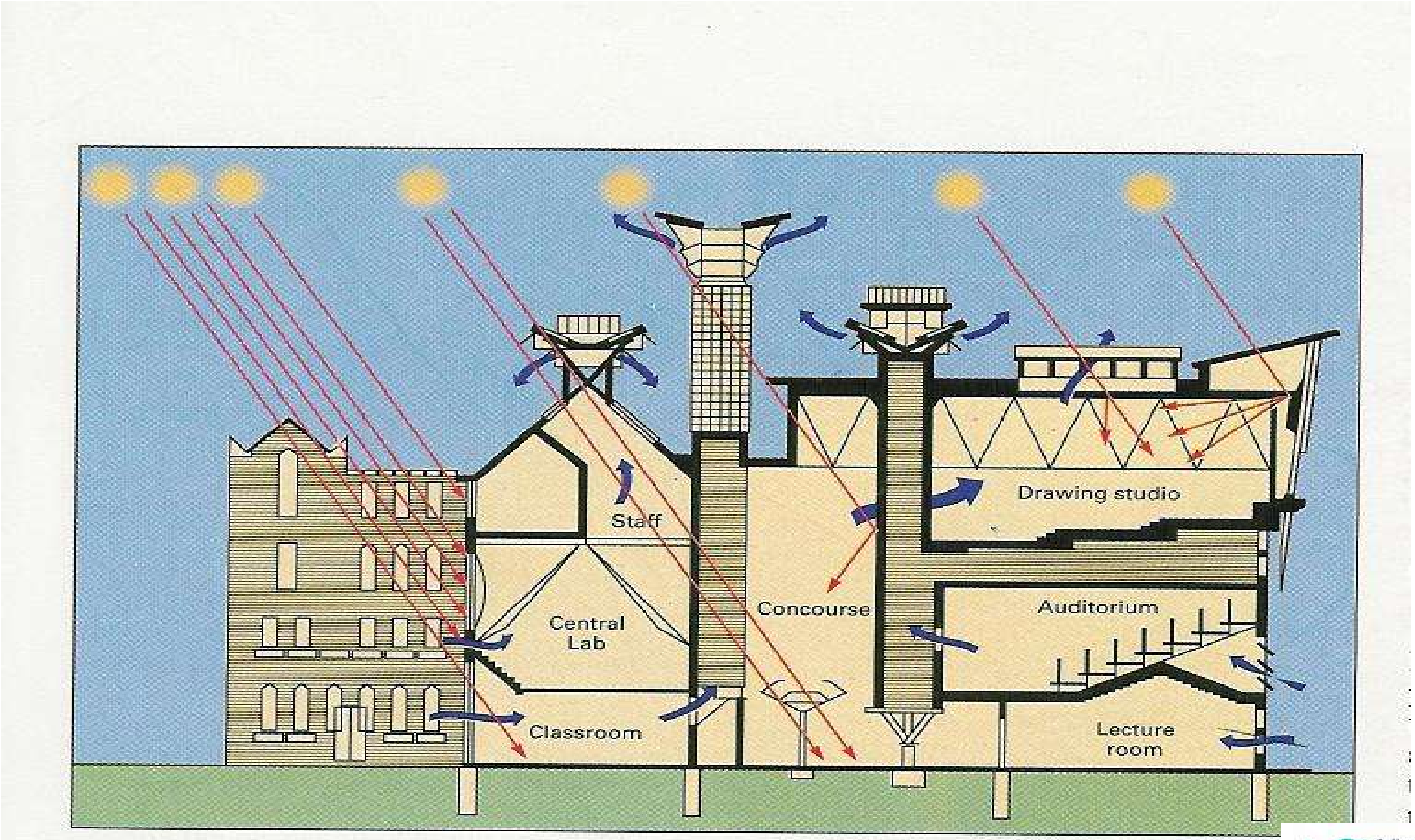
# DE MONTFORT UNIVERSITY

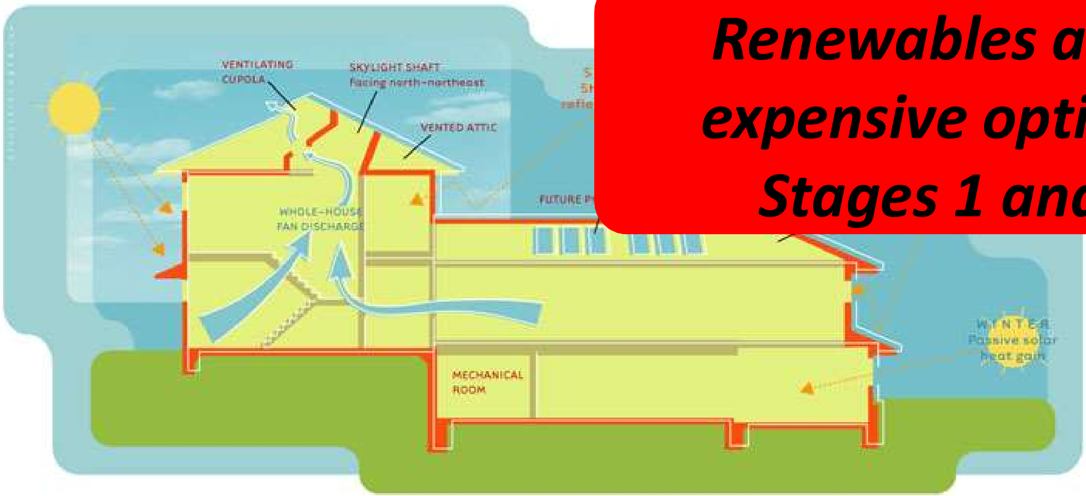


# DAYLIGHTING AND SUNLIGHTING



An auditorium from the concourse walkway. Note the glazed blocks in the walkway to aid daylight penetration and the exposed auditoria structure.

# Last Step to Net Zero—Stage 3 Renewable Energy Systems




***Renewables are generally most expensive option; therefore, use Stages 1 and 2 to maximum***

- *Building Envelope Measures*
- *Energy Efficiency Measures*
- **Renewable Energy Measures**

***Be Lean…Be Clean…Be Green***

Courtesy of Otto Steininger.

# Wind turbines can be a waste of money

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# Installed to meet Planning

- We need to engineer zero carbon solutions
- ‘Bolt on’ renewables to comply with Planning Waste of money – around £50k

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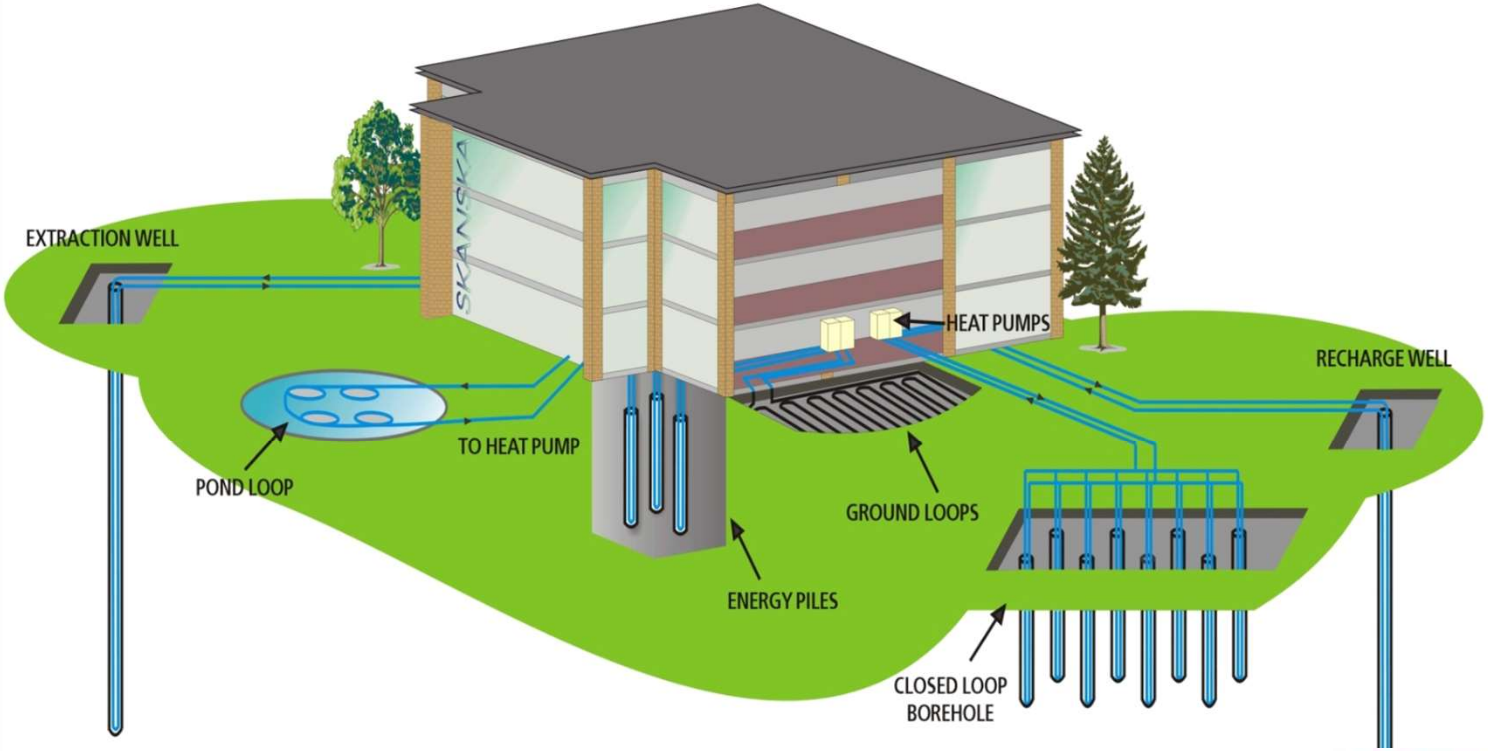
# Renewable Energy



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# Toronto – zero carbon cooling

# DEEP LAKE WATER COOLING SYSTEM

**Acknowledge the major Net Zero cooling system in Toronto**

The City of Toronto and Enwave Energy Corp.

ACCIONA

General Contractor, responsible for procurement; construction of intake pipelines, heat exchange plant, heat exchangers and valve chambers, equipment installation, testing and commissioning of the project

**Infrastructure**

Enwave's Deep Lake Water Cooling system

Completion date
2004

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# Bridlington and Hull Geothermal Study

1) Data Collection
2) Geology
3) Temperatures
4) Yield
5) Chemistry

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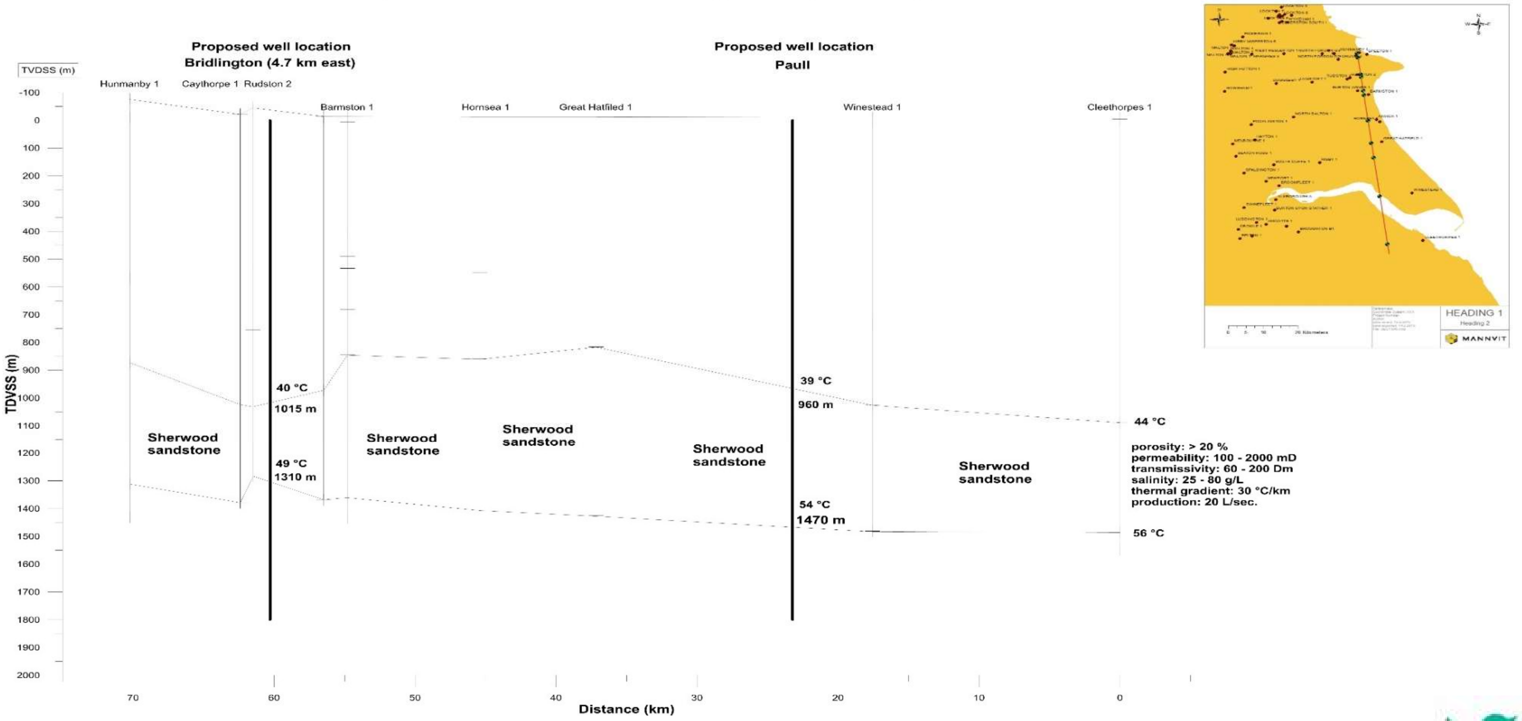
# Geology

**Geological cross section from Cleethorpes 1 (south) to Hunmanby 1 (north), see the map.**
**Lithology in wells through the Sherwood sandstone.**
**The depth values on the proposed well in Bridlington indicates upper and the lower depth of the Sherwood sandstone, assuning a uniform dip between Rudston 2 and Barmston 1 and the depth values on the proposed well in Paull indicates upper and the lower depth of the Sherwood sandstone, assuming uniform dip between Risby 1 and Winestead 1.**
**The temperature values are calculated using a 30 °C geothermal gradient.**

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# Water-Source Heat Pumps

- Liverpool Docks
- Stanley tobacco warehouse and other regeneration projects could use dock water for heating and cooling

# Renewable Energy from Water Sources

- Canals across the UK are being looked at as possible heat sources using heat pumps

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# Abandoned collieries could heat UK homes – 9th April 2018

© Getty Images A coal delivery to the Gorbals tenements in Glasgow, circa 1960. Future heat for the city's homes could be piped from colliery tunnels below

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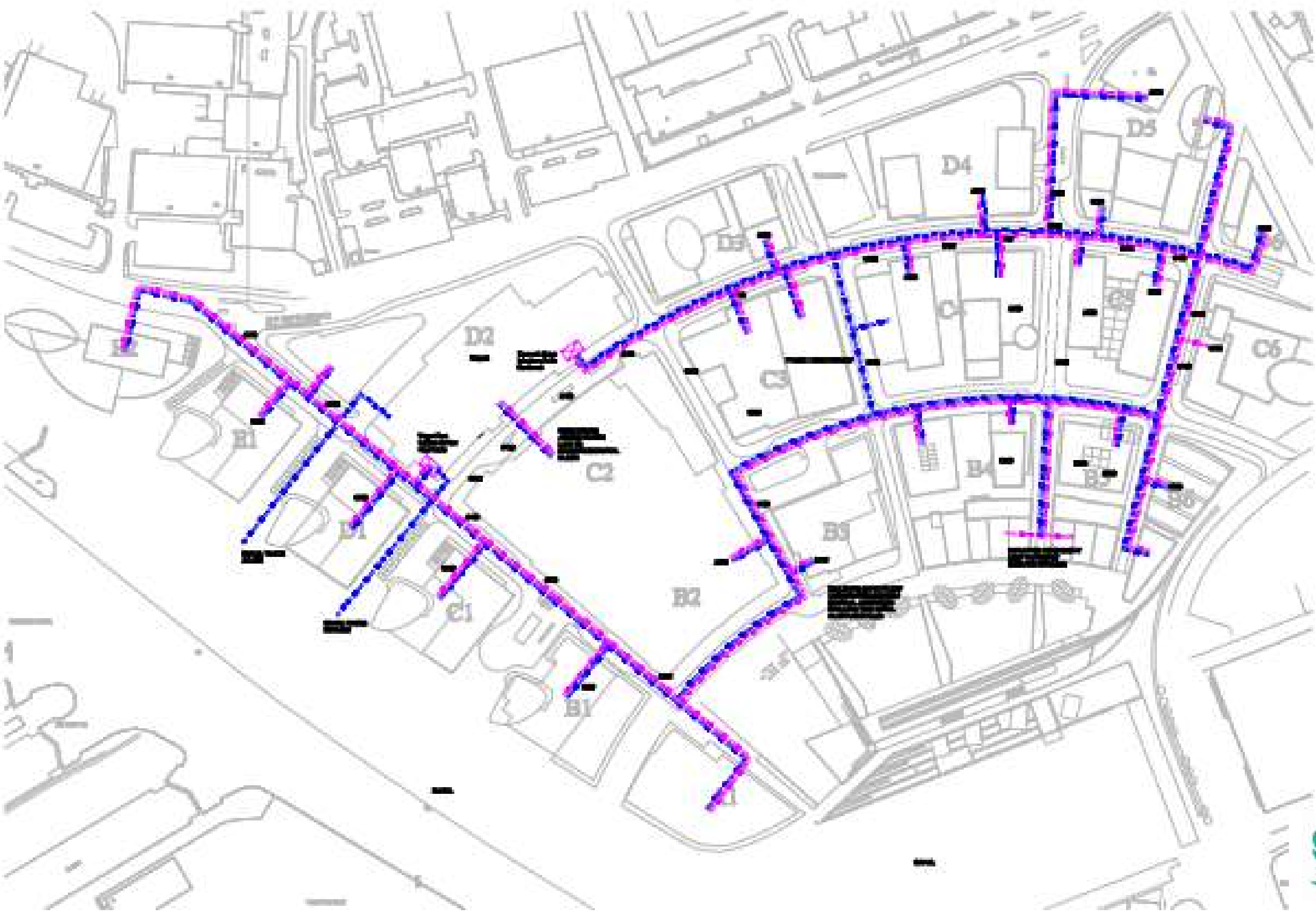
# Flooded coal mines in UK

1. UK coal industry closed down
2. All mines are disused and flooded.
3. vast reservoir of warm water fills a labyrinth of disused mines and porous rock layers underneath Glasgow
4. this subterranean store of naturally heated water could be used to warm homes in the city.
5. If successful, such water could then be exploited in other cities and towns across Britain's coal communities

# Zero Energy Cities

- District energy systems
- Use surplus ambient energy from one building to feed another
- Thermal storage needed to avoid waste
- Decarbonised grid
- Infrastructure investment
- Link new building to regeneration of existing to achieve overall zero energy use
- Energy profiles essential, good data required
- Mixed use presents variable loads, which optimizes energy plant use

# Zero Energy Cities



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# Conclusion

- Define the “zero” (site, source, carbon, or cost)
- Understand the microclimate of the site
- Design the siting, form, thermal mass of the building to maximize the use of natural energy flows and reduce external loads
- Minimize lighting energy use through effective daylighting
- Reduce plug loads as much as possible. Recover waste heat.
- Efficient HVAC systems - including natural ventilation and mixed mode
- Modelling of annual building energy consumption
- Provide renewable energy systems to offset resulting energy use
- Commission your systems and ensure proper handover to O&M staff
- Keep it working !

# Panel Discussion

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*The Sustainable Energy Authority of Ireland is partly financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.*

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