Implementation of the Energy Performance of Buildings Directive for non-residential buildings:

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Overview

- EPBD –requirements for non residential buildings
- Typical calculation parameters
- Actual test run calculations on local buildings
- The certification process
- Conclusions

What does the Directive require?

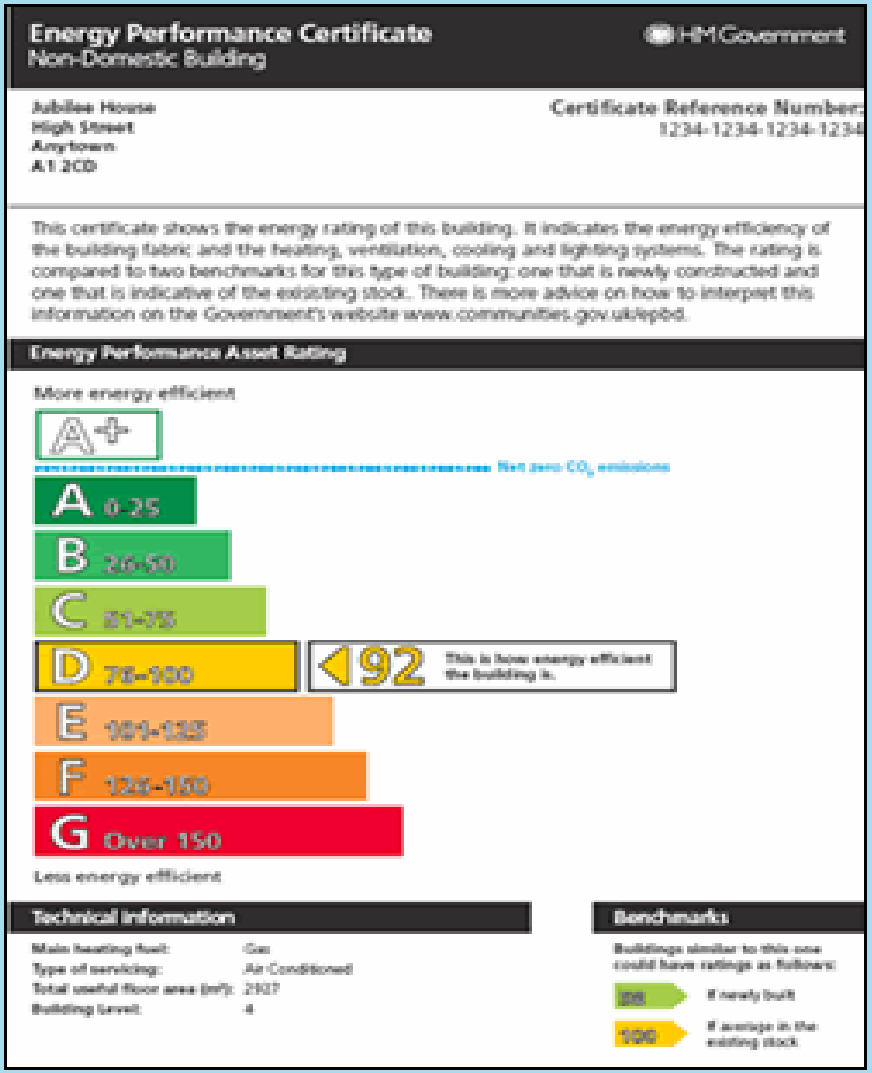
To apply to new buildings and major renovations (1000m^2)

- **Energy Performance Certification** on construction, sale or let
- Public display of Certificate for some buildings
- Certificates to be accompanied by recommendations for improvements
- Regular inspection of Boilers and Air-conditioning systems

General Principles

- The compliance requirement can be expressed in terms of **total carbon emissions or energy consumption per unit area**
- These are calculated for **standardised assumptions** of occupancy, ventilation, set-points, weather etc
- The calculated **compliance requirement** is compared against a baseline to issue a rating.
- There are also **minimum acceptable performance** requirements of insulation, systems etc

TYPICAL CERTIFICATE



What is special about Non-residential Buildings?

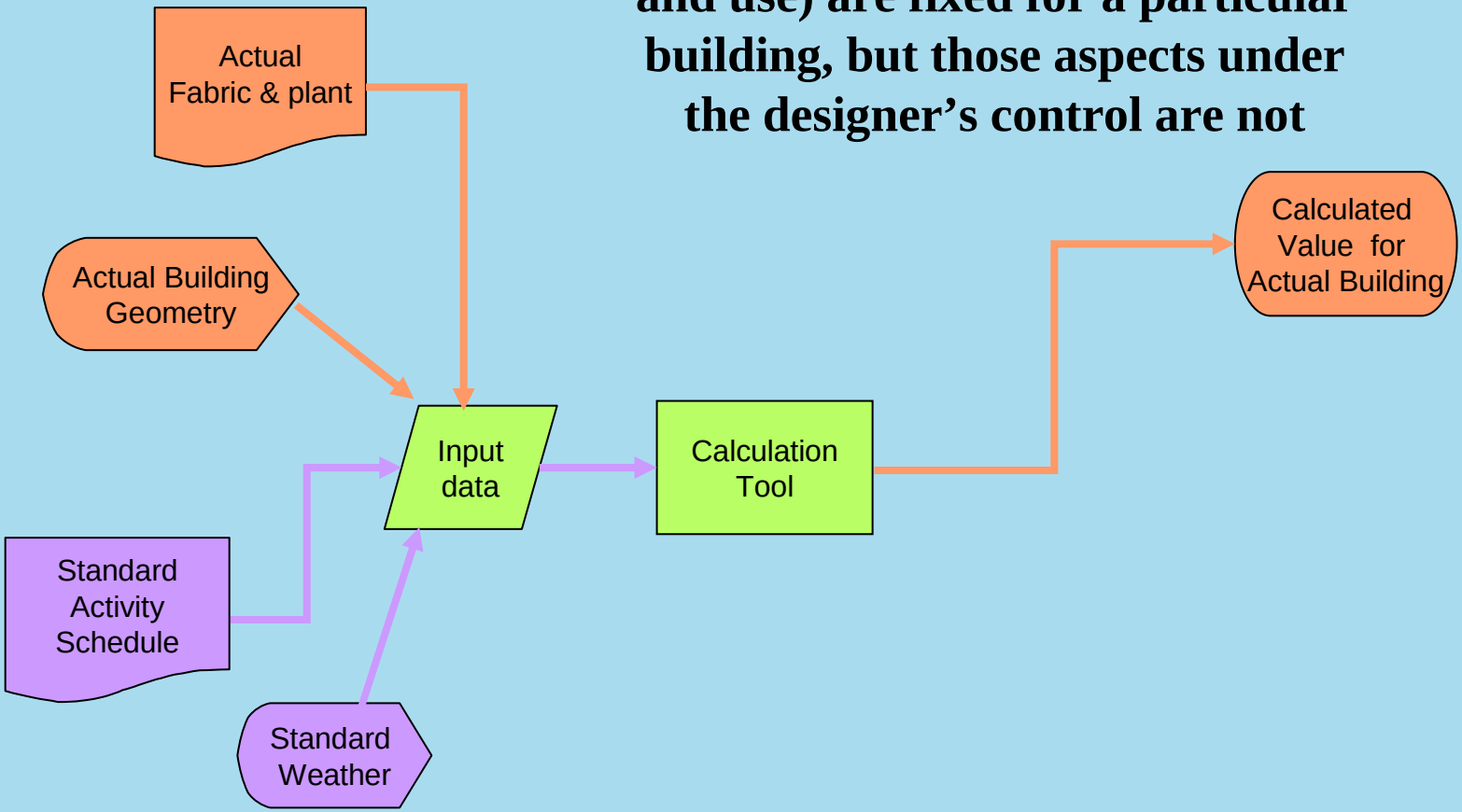
- Large range of sizes and geometries
  - But there are large dwellings too!
- More servicing options
  - Cooling, mechanical ventilation
  - Wider range of HVAC and lighting systems
- Wide range of activities and uses
  - Warehouses, shops, offices, sports centres……

Inputs

- Weather data requirements
- Fabric / building components
- Geometry
- Fuel / energy data
- Building services
- Activity data

Basic Calculation

The boundary conditions (weather and use) are fixed for a particular building, but those aspects under the designer's control are not



Standardised Activities

- Experience with benchmarking shows that apparently similar buildings can contain significantly different mixtures of activities
  - Hotels, for example
- Each **space** within a building has a specific **activity** assigned to it
  - Each activity has its own set of parameters

Examples of Activities

- Cellular office
- Open-plan office
- Sales area
- Lecture theatre
- Sports hall
- Hotel rooms
- Toilets
- Circulation

Some Activity Parameters

- Occupancy density
- Occupancy schedule
- Temperature set-points
- Ventilation rate
- Illuminance
- Equipment heat gains
- DHW requirement

- The values may vary between building types
  - A school office will have different occupancy times from a commercial office

Actual Calculation For Local Buildings

- Two different types of software analysed
  - EPA NR - developed as an EU project
  - iSBEM – developed by the BRE for use in the UK

Test Run

Commercial buildings

Four building types

- *Offices*
- *Retail*
- *Training / education*
- *24 Hour operation*

Main Differences

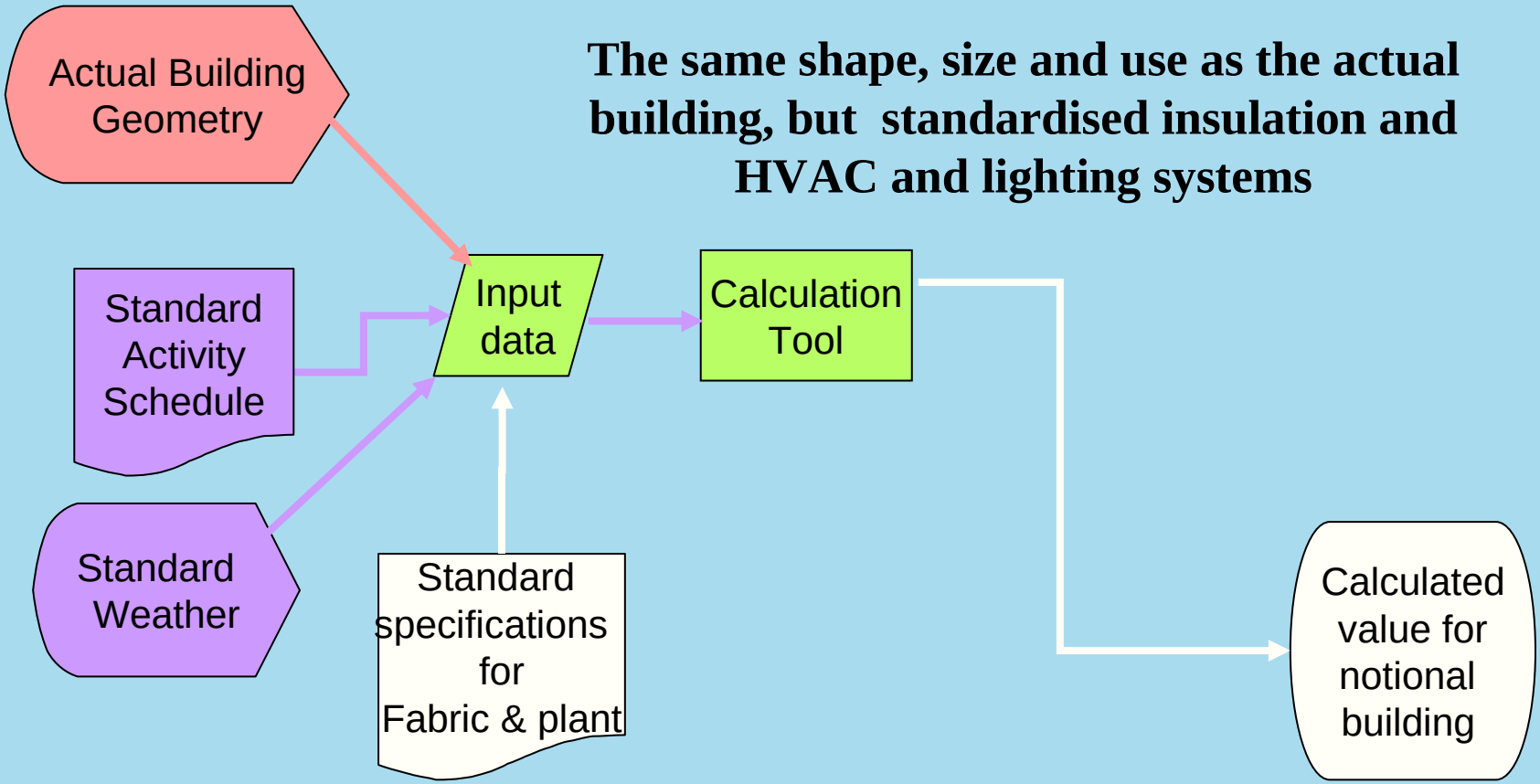
- Sophistication of input
- Ease of adaptation
- User base
- Back up support and documentation
- Quality of output

Output

- EPA – NR provides a numerical output e.g kWh/m^2 per year
- iSBEM provides numerical data in terms of energy use, CO_2 output
- iSBEM also does a compliance check for building regulations
- iSBEM produces a certificate in relation to a notional building

iSBEM output : the “notional building”

The same shape, size and use as the actual building, but standardised insulation and HVAC and lighting systems



The Notional or Reference Building

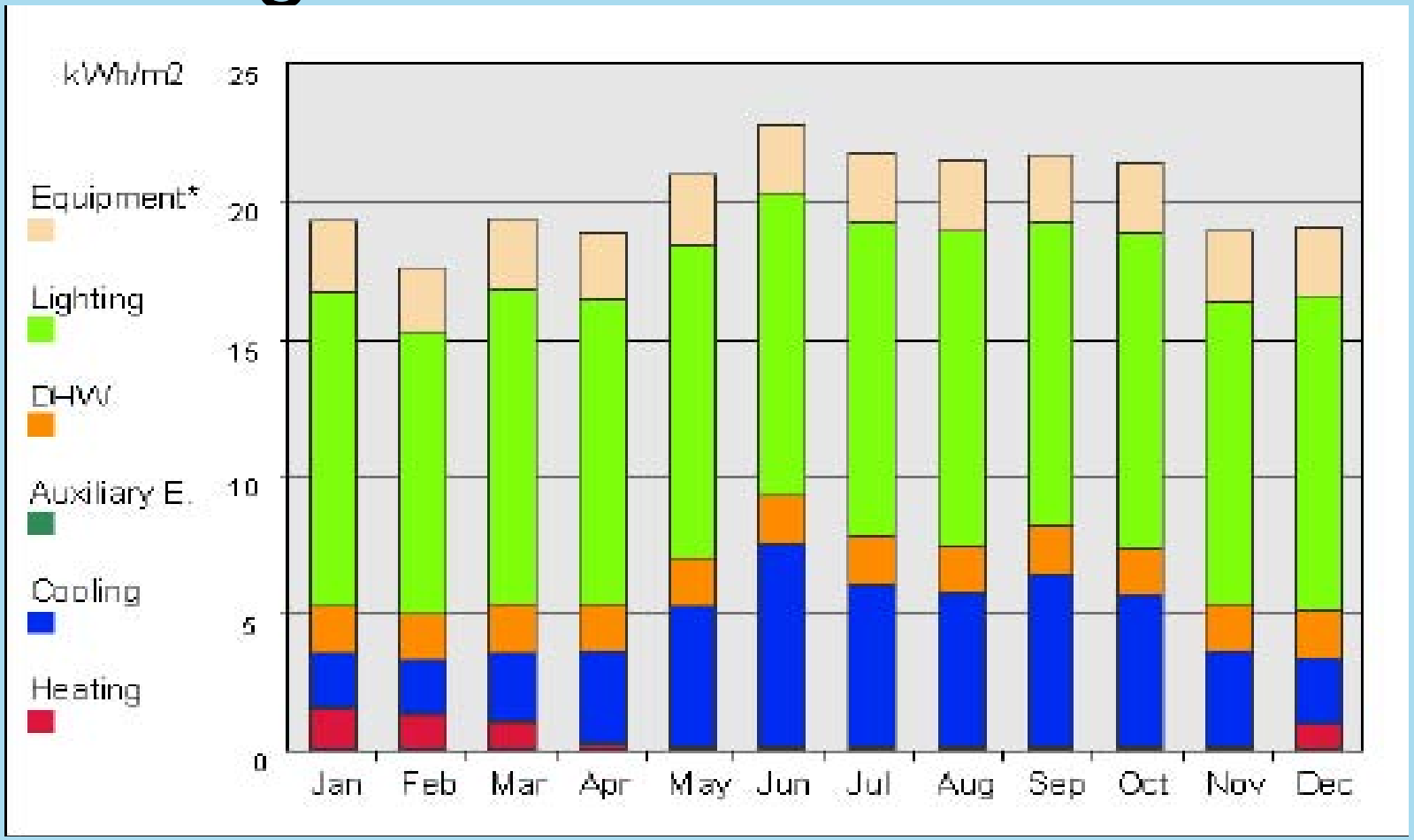
- The reference building is the same size and shape as the actual building
  - But has fixed values of U-values, system efficiencies etc
  - Basically compliant with the 2002 Regulations
- Carbon emissions of the actual building are compared to those of the same building designed to 2002 standards
  - This produces a “self-calibrating” scale
- Reduces sensitivity to dimensional accuracy
- But removes incentive to inherently efficient geometries

EPBD requires an Integrated Calculation Methodology

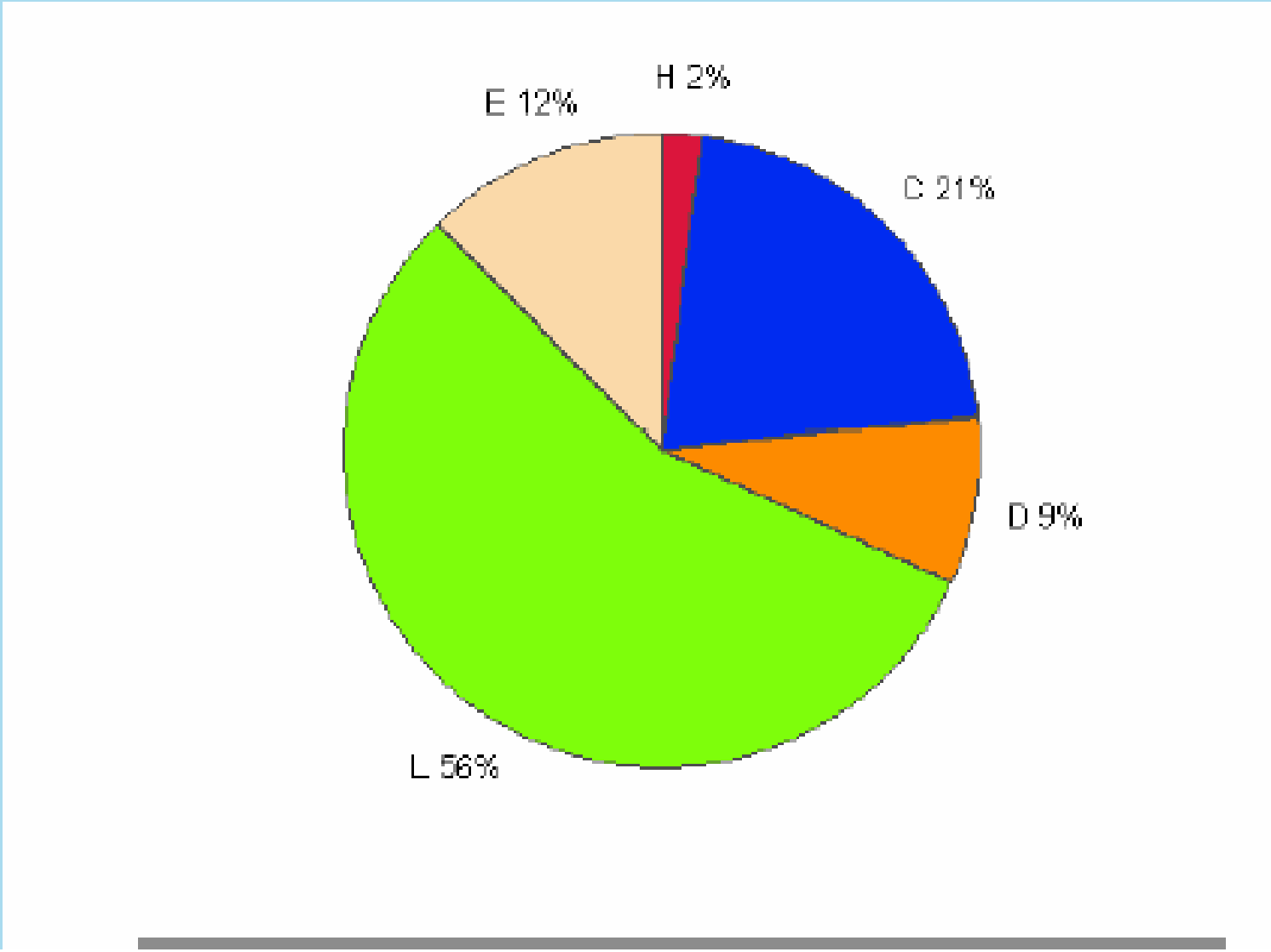
A methodology which calculates ‘integrated energy performance of buildings’ (EPBD Article 1),

- EPBD Annex requires inclusion of:
  - Indoor conditions
  - Fabric performance
  - HVAC and DHW
  - Lighting and daylighting
  - Position and orientation
  - Passive design features
  - Renewable and chp options
  - *Doesn’t specifically mention controls – but vital*

iSBEM Output - Retail Building



iSBEM Output - Retail Building



iSBEM Output - Retail Building

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

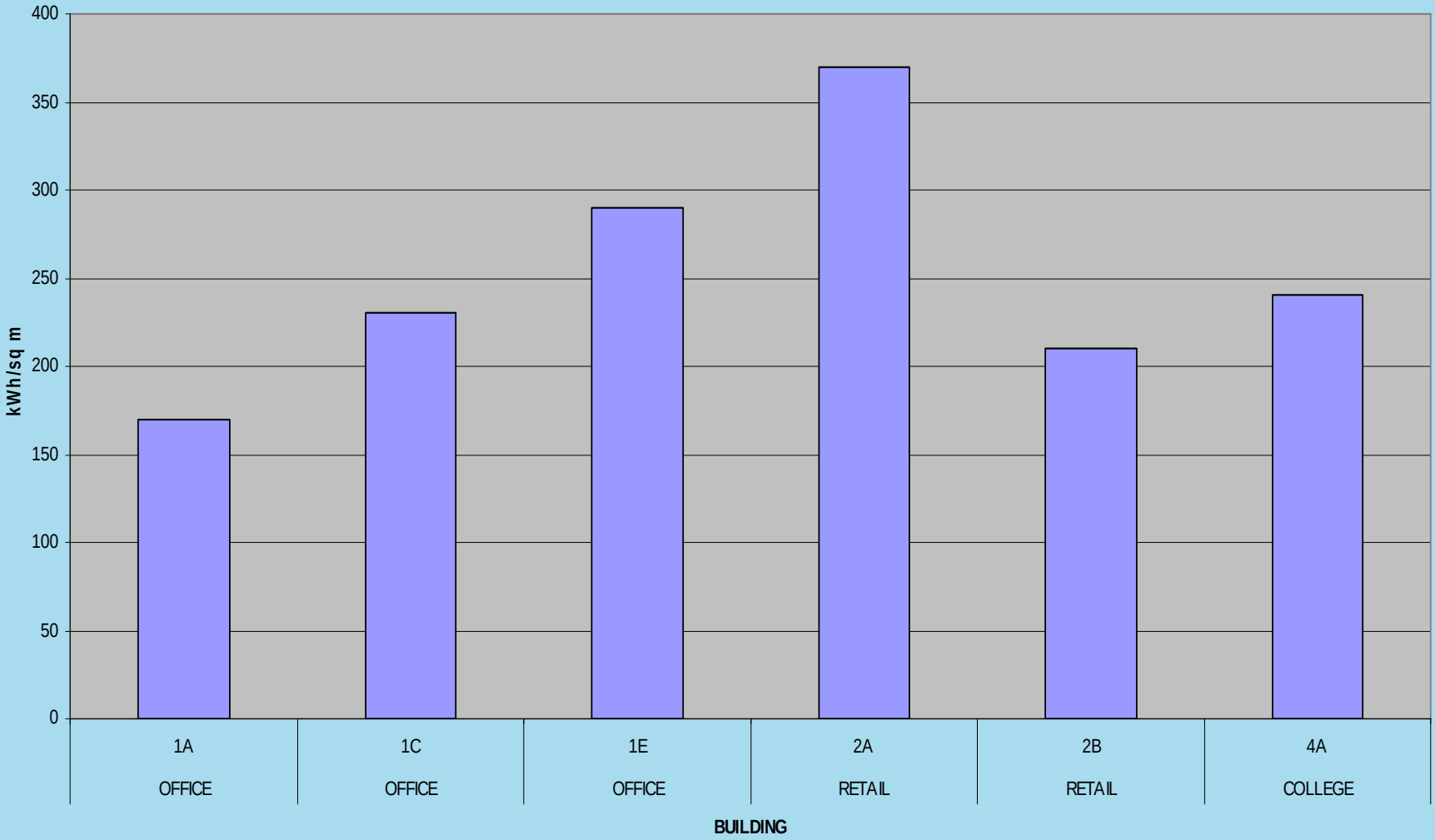
1.1	Calculated CO2 emission rate from notional building	113.6 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	81.8 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	89.3 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER > TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

EPA-NR Output - Retail Building

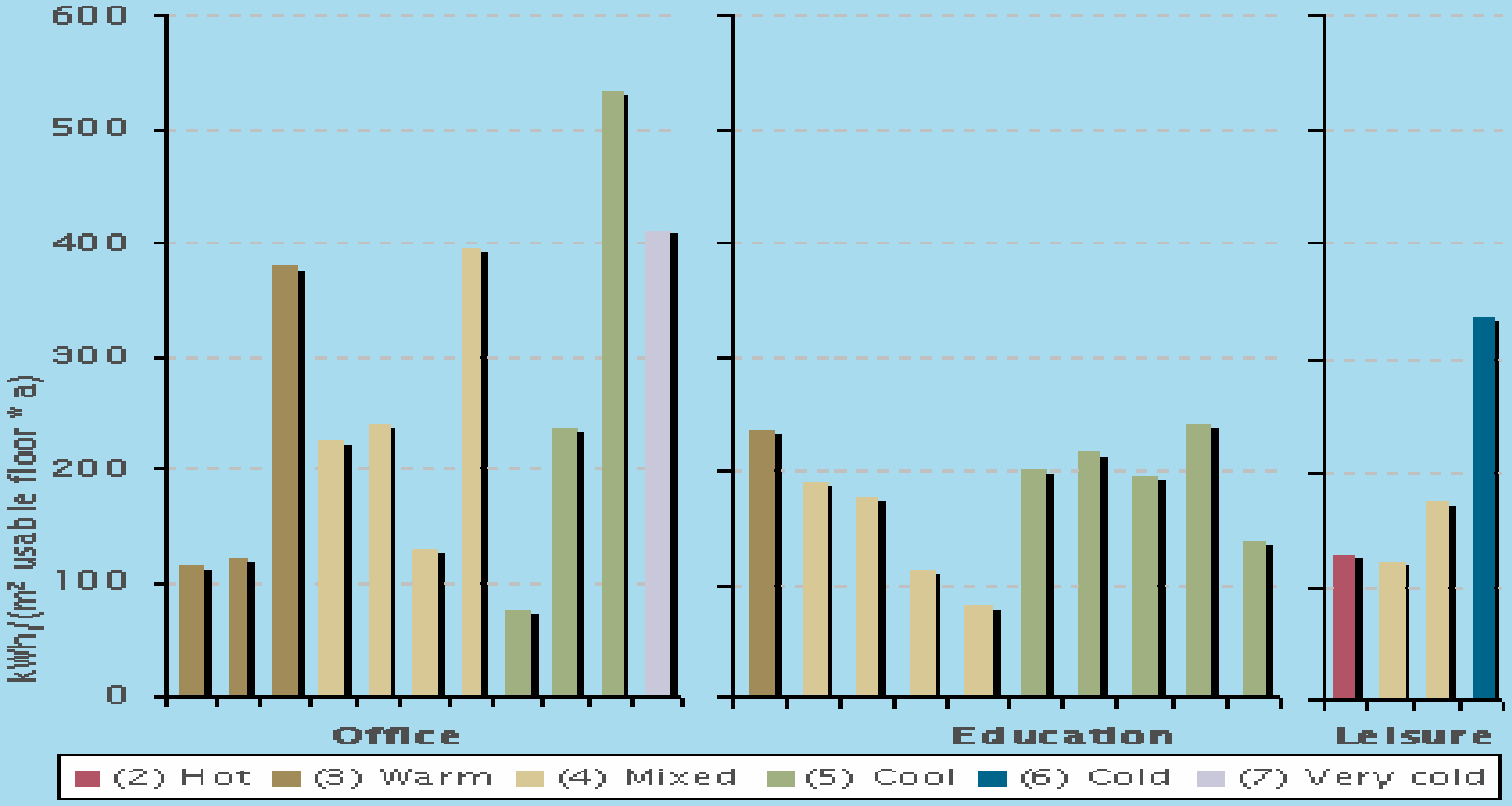
ENERGY NEED	kWh/m²
Heating	77.2
Cooling	73.1
Humidification	0
Hot Water	3.9

ENERGY USE	kWh/m²
Heating	0
- Cont. Solar Colectors	0.0
Cooling	14.2
Humidification	0.0
Hot Water	5.2
- Cont. Solar Colectors	0.0
Lighting	35.3
Aux. electricity	0.0
- Cont. Pv	0.0
Total	54.7

TYPICAL RESULTS



EULEB BUILDINGS



Calculation Process

- Calculates monthly demands for
  - Heat
  - Ventilation
  - Cooling
  - Lighting
  - Hot water
- Based on
  - Geometry
  - Construction
  - Activity schedules
- Calculates energy needed to meet demands, using
  - System types
  - System efficiencies
  - Control corrections, etc

Calculation process choice

- HVAC system efficiency calculation can be simple or complex.
- Calculation of heating and cooling *demands* and system energy *consumption* is closely linked
- EN 15243 allows *system* calculations to be monthly or hourly
  - EN 13790 allows *demand* calculations to be monthly or hourly
  - For systems, hourly time-steps are more natural

Contradictory requirements

- Credibility
  - Technical soundness
  - Produces realistic results
- Repeatability
  - Different users should get the same results
- Transparency
  - Both the data and the process should be auditable
- Discrimination
  - More efficient systems should give better figures
- Ease of Use
  - To reduce errors and cost
  - This includes data requirements

The most common decision

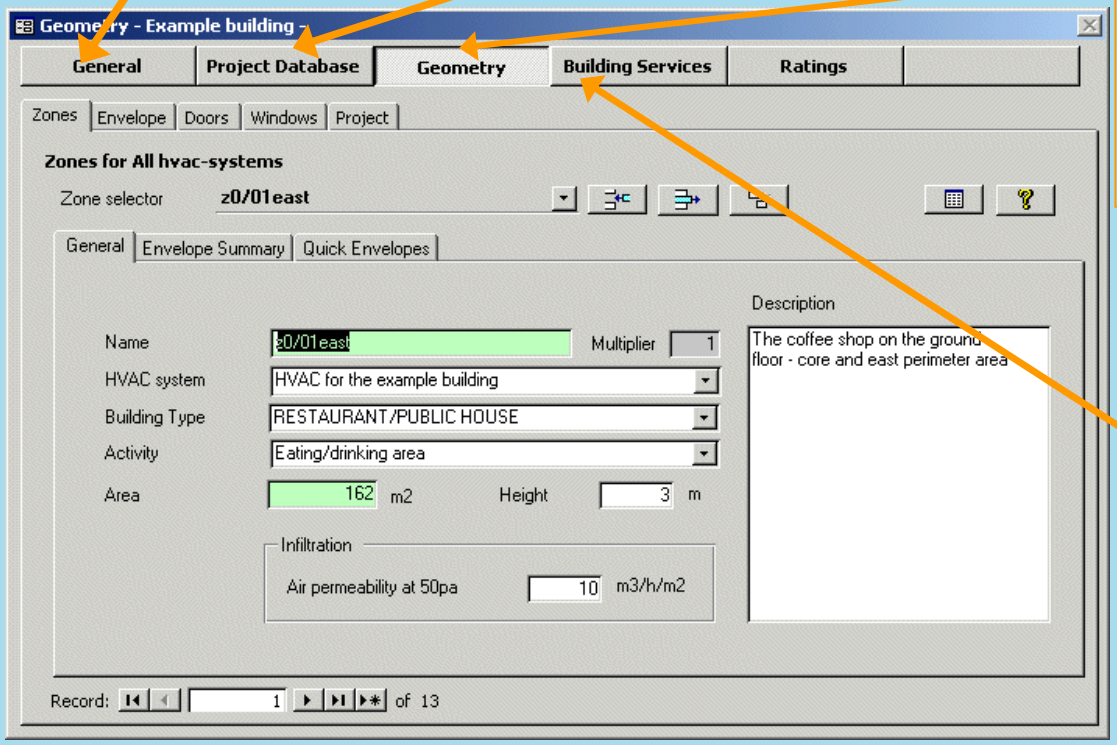
- Monthly calculation
  - Thermally, based on EN ISO 13790
- Probably the easiest to implement
- Simpler calculation than hourly, but
  - User doesn’t need to see the calculation engine
  - Less flexible than hourly calculation for unusual designs
- Other methods may be used

SBEM input data

1) General information about the building/certifier/owner etc.. *(entered into the **General** form)*

2) Building fabric – U-values and Cm values for all constructions *(entered into the **Project Database** form)*

3) Geometry of the building along with details of thermal bridges and air-permeability *(entered into the **Geometry** form)*



4) Building Services - details on the HVAC, DHW, lighting and Renewable and Low/Zero Carbon technologies *(entered into the **Building Services** form)*

Some Common Issues

- CONSISTENCY
- STANDARDISATION
- UNDERSTANDING THE SOFTWARE OPERATION
- COMPLETE PICTURE OF THE BUILDING USE

How Important is Precision?

- Inter-building comparisons cannot be strictly “like-for-like”.
  - Data are imprecise, especially for existing buildings.
  - Small differences between building ratings are not very meaningful
- So ratings scales are inevitably somewhat coarse
- Recommendations for improvements should not depend on fine detail of calculations

Time spent on different tasks – German Field Trials (source DENA)

Task	Observed time (hours)	Expected time after training (hours)
Initial meeting	4.9	4.0
Collection of data	44.5	31.5
Calculation	63.8	38.9
Explanation to customer	4.7	4.0

Our experience so far is that data collection and calculation require less time than this – typically 10 to 20 hours each (for simple buildings)

Where can methods be simplified?

- Calculation complexity
- Construction and servicing information
- Dimensions and geometry
- Activity area selection and location

Contributions to uncertainty

(Dutch information – but UK experience is similar)

- Typically
  - Data collection + / - 30%
  - Use of default values + / - 5%
  - Calculation method + / - 10%
  - Overall: + / - 15% to 20%

- Optimised (increased use of default values)
  - Data collection + / -15%
  - Use of default values + / - 15%
  - Calculation method + / - 10%
  - Overall: + / - 10% to 15%

Practical simplification

- **Calculation methods**: keep it simple, complexity of calculation not critical
- **Construction**: Use pick-lists and default values
- **Dimensions and geometry:** Can probably simplify with small loss of precision
- **Activity areas**: Difficult to simplify without losing precision
- **Operational Ratings**
  - Not as simple in practice as in theory
  - Could be good way of identifying when Asset rating is worthwhile

Certification for existing buildings

- Basic principles are the same as for new buildings
  - Data input from survey as well as drawings
  - “Pick lists” of options where possible
- SBEM includes default values based on inferences
  - Typically from age and type of building
  - Defaults are ungenerous in order to encourage better information

Actual use of the software

- 1. Changes from UK practice
  - Maltese weather
  - Maltese activity patterns
  - Adjustments for local construction traditions and practices
  - Use primary energy rather than carbon
  - More emphasis on air conditioning systems
  - Less emphasis on domestic hot water
  - Little or no information on thermal bridges
  - Little or no data on infiltration

Actual use of the software

- 2. Data Entry
- Full information was available for test buildings
- This simplified data entry considerably and reduced the time necessary for site inspection, etc.
- Test buildings were constructed and in use
- Data could be more realistic than at design stage

Final Thoughts

- The timescale for the Directive has forced us to
  - Work quickly towards an “adequate” solution
  - Rather than being focus on an ideal solution
- This is not necessarily a bad thing
  - We can have a procedure that works
  - And can be improved in the light of practical experience

Final Thoughts

- One of the main purposes of the building energy certification scheme is to increase awareness for building owners and users.

- If you can’t measure it, you can’t improve it.

The Khazzoom Brookes postulate

increased energy efficiency will lead to higher energy consumption

THANK YOU