Sustainable Design Seminar

14th September 2010

Technical Considerations for Sustainable Design and meeting Performance Targets

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Introducing…. BRE

- Formerly a government agency, privatised in 1997
- Building Research Establishment, based mainly in Watford with regional offices in Scotland (East Kilbride), Highlands (Inverness), and Wales.
- Extensive work with LAs, regional bodies, developers, industry, product development and building professionals
- 720 staff specialising in the Built Environment
- Owned by BRE Trust – Registered Charity
- Recognised throughout the industry
- BRE developed and administer BREEAM, Ecohomes, Code for Sustainable Homes, SAP, SBEM

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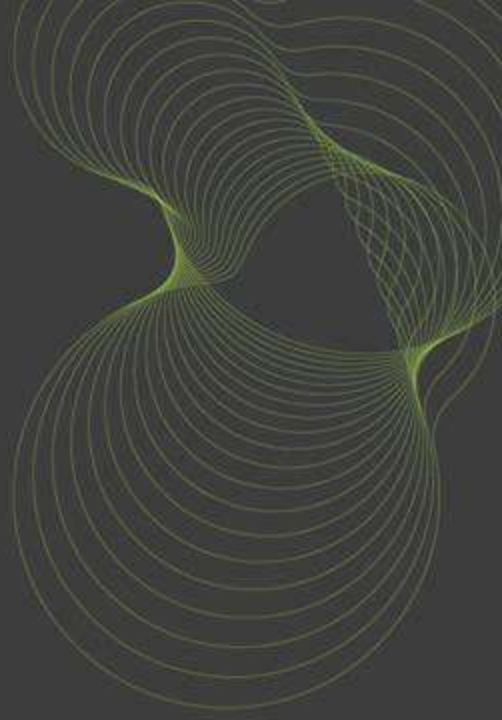
Agenda

- Key principles
- Design principles
  - Integrated Design
  - Orientation
  - Passive design
  - Thermal storage
  - Ventilation
- Low impact buildings
- Performance Considerations



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Key principles

Key Principals of Sustainability

The Triple Bottom Line

- Environmental Concerns and principles
- Social Concerns and Principles
- Economic Concerns and Principles

Environmental Concerns and Principles

- Use land wisely
- Use the least amount of energy and consider more environmentally friendly forms
- Limit the amount of water use
- Reduce the amount of road traffic
- Reduce the amount of raw materials
- Encourage the use of local materials
- Consider waste
- Protect and enhance biodiversity

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Social Concerns and Principles

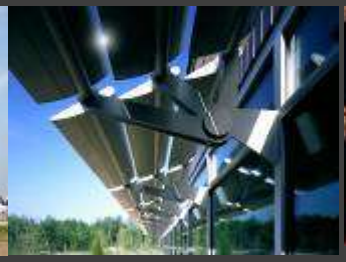
- A high quality build environment (one that the ‘majority of people find **attractive**, **safe** and **comfortable**)
- Mixed use developments
- Density
- Facilities
- Accessibility
- Domination of the Car
- Improved air quality
- High standard of urban design
- Green space
- Design out crime
- Reduce noise

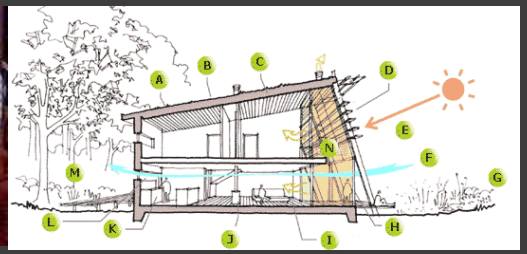
Economic Concerns and Principles

- Employment
- Intensity of land use
- Infrastructure links to other centres
- Supporting local trades
- Affordable running costs
- Consideration of maintenance and repair
- Building flexibility
- Whole life cost against capital cost

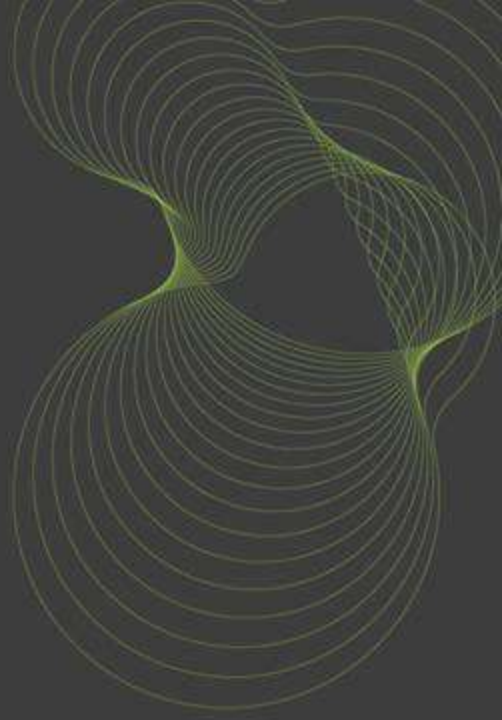
Change the way we build?

- Plan for Communities
- Plan for reduced transport use
- Plan for location of amenities
- Thermal performance regulation
- Design for carbon savings
- Passive design ethos
- Modern methods of construction
- Implementation of integrated energy solutions



How will this effect designs?



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Design Principles

Common problems

- Ever changing legislation
- Investment in new build declining due to economic concerns
- Poor workmanship
- Post construction does not match design
- Future upgrading
- Resourcing materials
- Skills shortage
- Over engineered design solutions
- Poor integration of Low and Zero Carbon Technologies

Integrated Design

- From Day 1
  - Requires effective collaboration of all stakeholders
  - Architects and engineers to work as an interdisciplinary team
  - Engineers (M&E and structural) seen as equal partners in the design process to optimise building performance
  - Include contractors (depending on procurement route)
  - Adopt a whole system approach
  - Intelligent buildings working with natural systems

Integrated Design

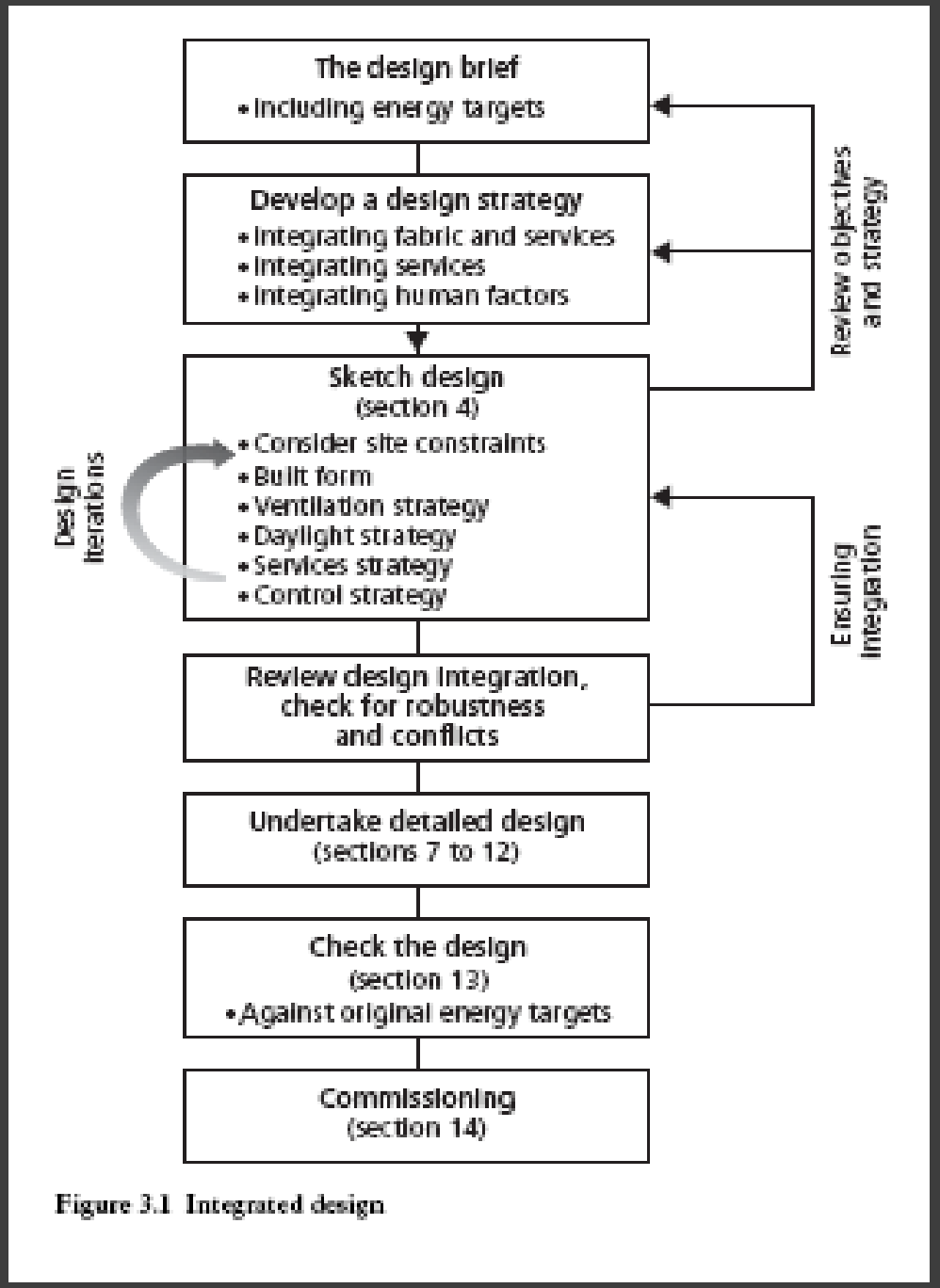

Figure 3.1 Integrated design

Reproduced from Energy efficiency in building: CIBSE Guide F

Strategy

- Choose appropriate materials
- Structural implications – can it be used as part of the solution
- Integrating fabric and services
- Integrating services and minimising their requirements
- Optimising internal heat gains
- Optimising natural ventilation
- Optimising daylighting
- Thermal storage
- Heat recovery
- ‘Free’ cooling
- Manage installed systems effectively
- Provide operational information

Benefits of integrated design

- Less design waste
- Knowledge transfer
- Capital cost saving
- Operation cost savings
- Energy savings
- Built-in rather than bolt on
- Encourages innovation

Building orientation

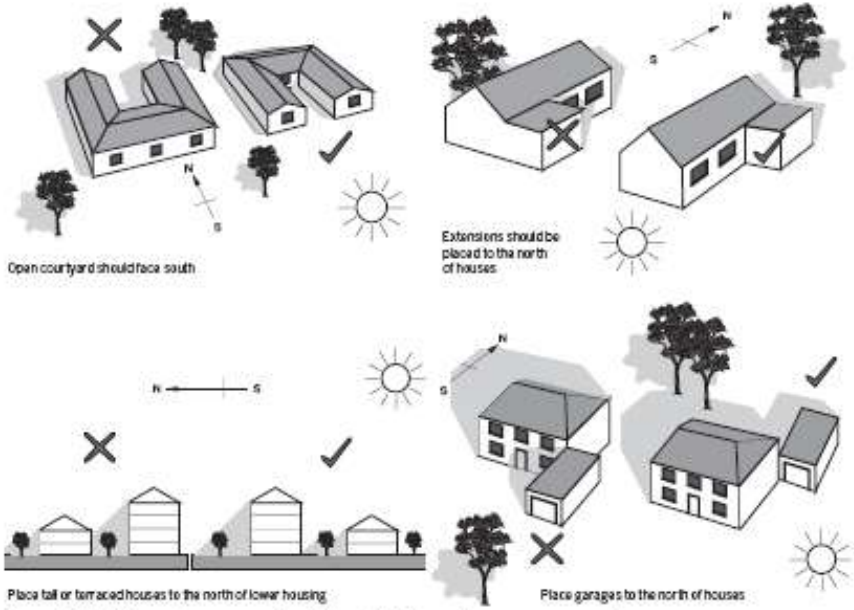

Figure 3.7 Techniques to ensure good sunlighting to buildings and open spaces around them

•Good sunlight to buildings where required

• Use of solid walls on prevailing weather face

• Use new structures to shelter main buildings.

• Effective control of solar gain in summer

• Care should be taken with East/West elevations to control solar gain during low summer sun angles.

• Appropriate shading to avoid over heating in the summer

• Roofs where ever practicable should be at 45º of south to allow for future incorporation of solar thermal or photo-voltaic panels

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Passive Design

- Optimising internal heat gains
- Avoiding summer overheating
- Thermal storage
- Natural ventilation
- Daylighting

Heat Gains

- Making use of ‘free’ heat gains can offset a large proportion of fabric and ventilation heat loss
- Advantages:
  - Reduces plant capacity and running costs
  - Requires good controls to respond to changes in gains to prevent overheating
  - Summer gains should be kept to minimum to allow passive control of summertime temperatures
- Disadvantages
  - Too much gain creates overheating issues
  - Energy intensive mechanical cooling
  - User discomfort

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Avoid Solar Overheating

- Good design should avoid solar overheating
  - Naturally ventilated spaces should not overheat when subject to moderate internal heat gains
  - Mechanically ventilated spaces should not require excessive mechanical plant
- This can be achieved via:
  - Appropriate specification of glazing
  - Incorporating passive measures such as shading
    - *Further info given in BRE R364*
  - Use of exposed thermal mass
  - Use of night ventilation if required

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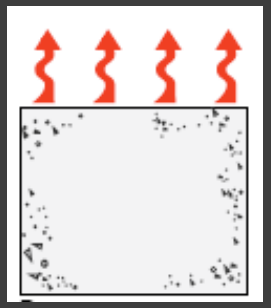
Thermal Storage

- Use of the building itself as a passive thermal store
- Design stage optimisation via a balance between:
  - Thermal Capacity of structure
  - Thermal Response of structure
  - Insulation levels
  - Complexity of controls



- The strategy must be matched to the predicted occupancy patterns and method of heating / cooling employed

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Ventilation

- Ventilation has two different functions
  - To supply fresh air for health
  - To provide cooling air for comfort

- Establishing a clear natural ventilation strategy is key to reaching an integrated energy efficient design. The strategy should provide:
  - Control over unwanted ventilation (air tightness / infiltration)
  - Correct quantity of fresh air for health / odour / moisture controls & rejection of heat gains
  - A driving force to move air in and around the building
  - A means of controlling the air movement to suit needs

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Forces that power natural ventilation

- There are 2 driving forces for natural ventilation
  1. The wind
  2. Buoyancy due to temperature difference

- These effects are more commonly called:
  1. Wind pressure effect (i.e. pressure driven)
  2. Stack effect (i.e. temperature driven)

- Wind forces are far greater than those generated by temperature difference, but
- Overheating is more prevalent in no wind days, therefore focussing only on temperature difference provides the worst case scenario for design purposes

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Natural Ventilation Strategies

- Natural ventilation strategies can generally be grouped into 3 categories:
  - Single sided ventilation
    - *Ventilation openings on only one external wall*
  - Cross ventilation
    - *Ventilation openings on opposite external walls*
  - Stack induced ventilation
    - *Purpose designed ‘stack’ to generate required pressure difference*

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Stack induced ventilation

- Strategies used to induce / maximise the ‘stack’ effect includes:
  - Sun rooms
  - Atria
  - Solar Chimneys
- Stack ventilation can be controlled by automatic vents at the top of the stack, operated by temperature sensors in the space - costly in housing
- Passive stack effects can be promoted through a sunspace which can also act as a buffer to reduce heat loss
- Sun spaces require careful sizing / locating of ventilator openings

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Low Impact Building

Low impact building - What?

- This is the generals public perception of a eco building
- Construction in an ecological manner
  - Use of locally sourced, traditional, natural and benign materials
  - Unprocessed
  - Site intensive
  - Labour intensive
  - Low embodied carbon
- Traditional construction techniques
- Breathing construction
- Currently a niche market for bespoke environmental and self build

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Vernacular architecture

- Vernacular architecture has a form and function which enables:
  - comfortable conditions to be achieved (often in very hostile climatic conditions)
  - optimum and sustainable use of indigenous materials
  - low environmental impact

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Traditional & natural Materials

- Unfired clay bricks
- Earth construction
- Untreated timber
- Lime mortars
- Rammed earth
- Straw bale
- Thatch
- Wattle & Daub
- Sheep’s wool
- Hemp

Pros and Cons

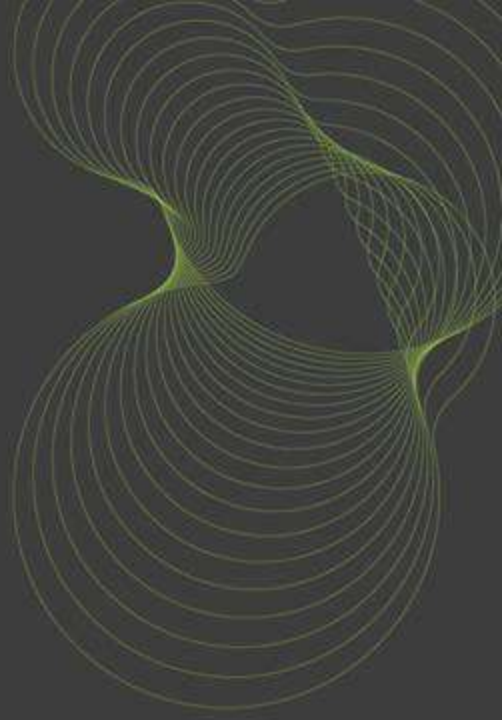
- Pros
  - Healthy buildings
  - Local resource and skill base
  - Low embodied energy
  - Low environmental impact
  - Community involvement
  - Self build potential
  - Low materials cost
  - One planet living
  - Incorporate reused/recycled materials
- Cons
  - Build programme
  - Materials quality and performance
  - Skills shortage
  - Labour cost for volume build
  - Security and quantity of materials supply
  - Fire risk
  - Infestation
  - Generally single storey construction

Barriers to Mass market entry

- Insurance
- Ability to finance and mortgage
- Warranty
- Product and Building life expectancy
- Product certification
- Showing compliance with building standards
- Planning restrictions
- Durability?
- Large physical footprint
- Adaptability

But?

- Substantial research now being undertaken to assess:
  - Viability for large scale delivery
  - Structural integrity
  - Certification of products
  - Durability
  - Thermal properties
- Towards embodied carbon zero
- Euro legislation for internal environment
- The theory behind the processes are sound



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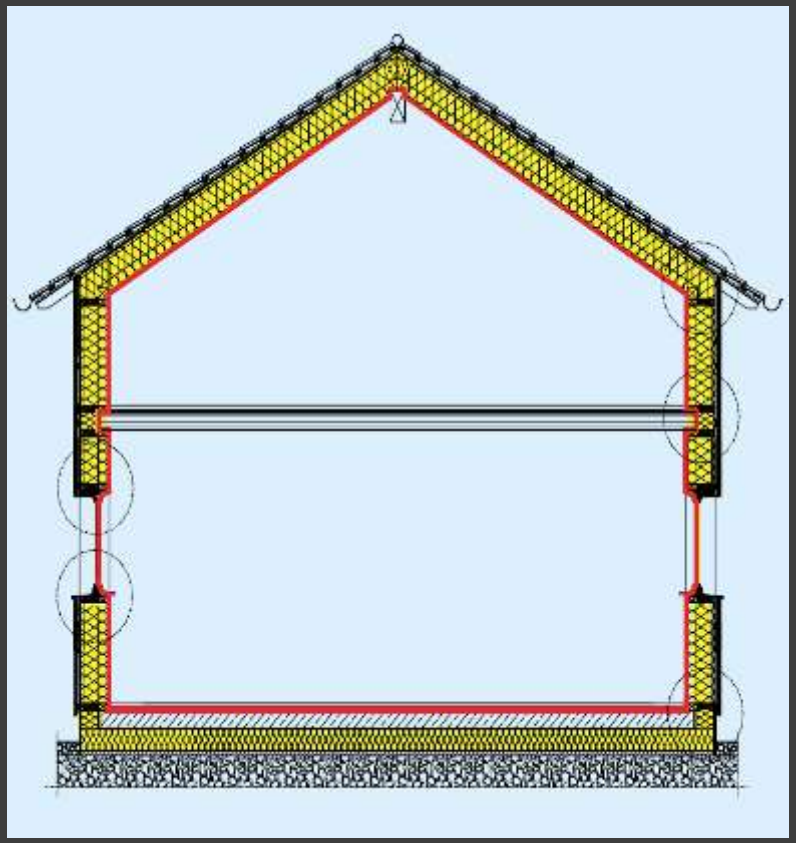
Performance Considerations

Key Considerations

Thermal Bridging

- Continuous Insulation
- The heavy pen
- Careful detailing
- Constructability



Airtightness

- Air permeability 10 m3/m2h at 50 Pa current limit
- 5 highly likely future maximum, 3 or less more typical. 1 generally needed for zero carbon homes
- Testing regimes required
- Relies on good site practice and inspection
- MMC?

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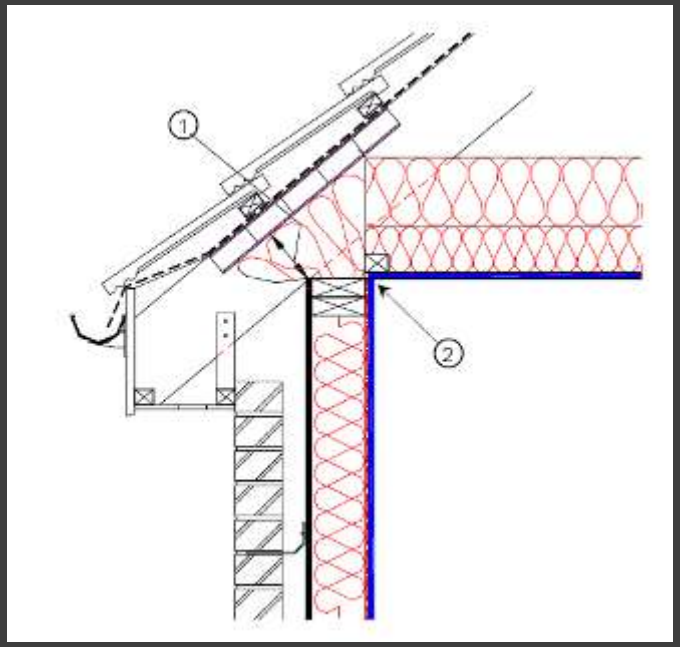
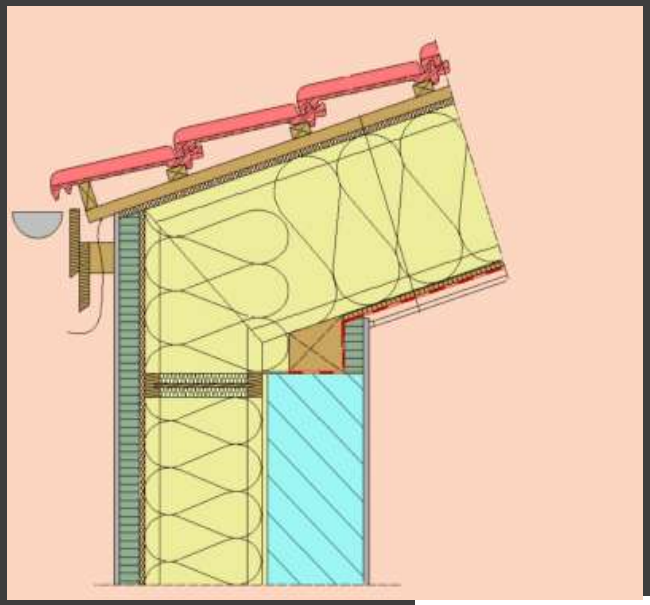
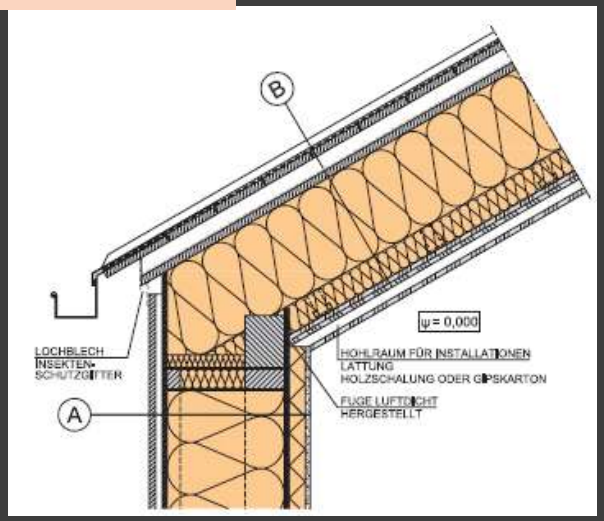
Rethinking details



Current Practice



Required Practice



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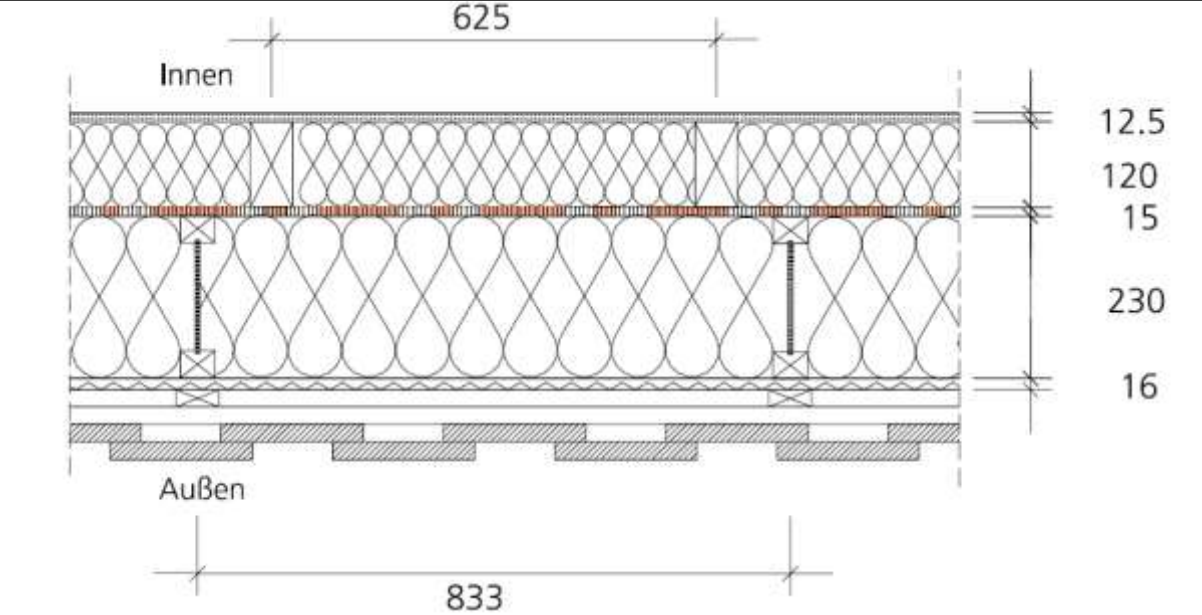
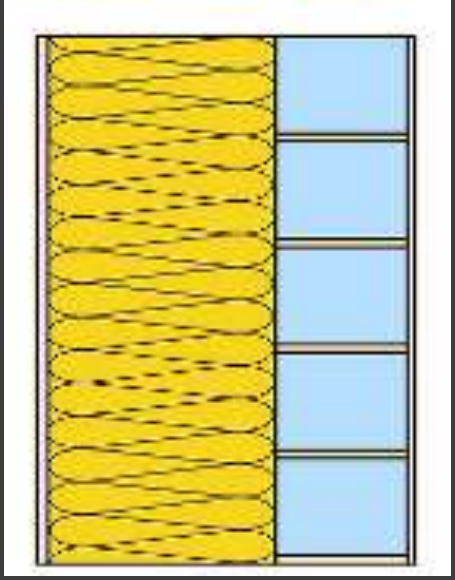
Walls, Roofs, Floors

- Substantial improvements to element U-values <= 0.15 W/m^{2}K?





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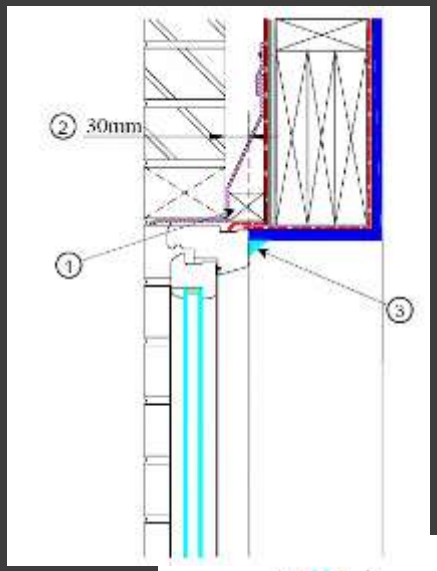

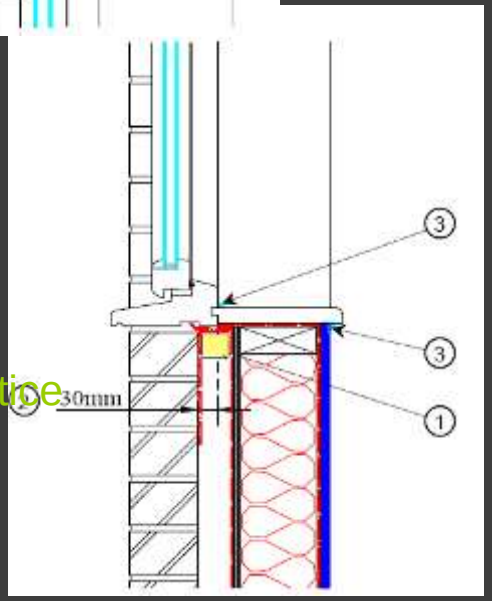

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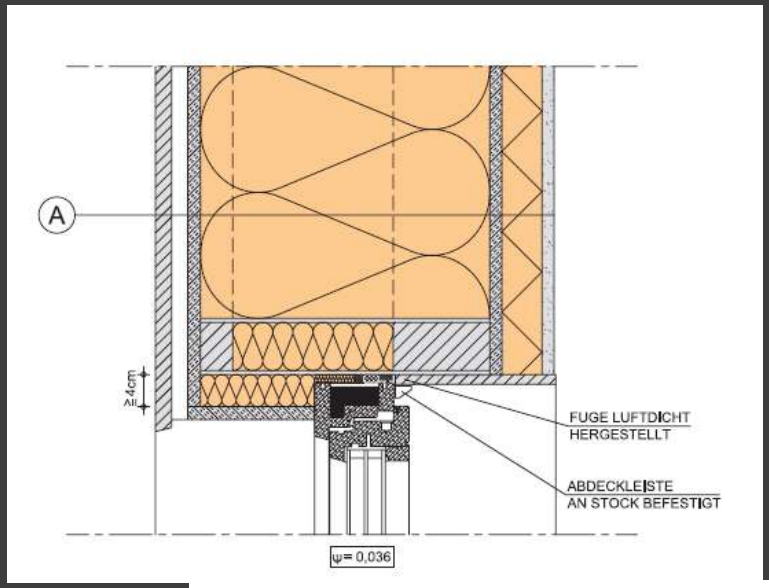

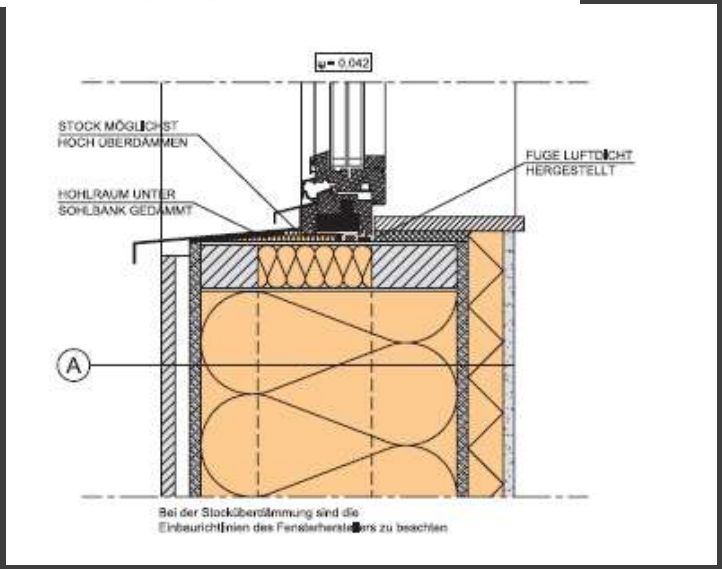

Required Practice

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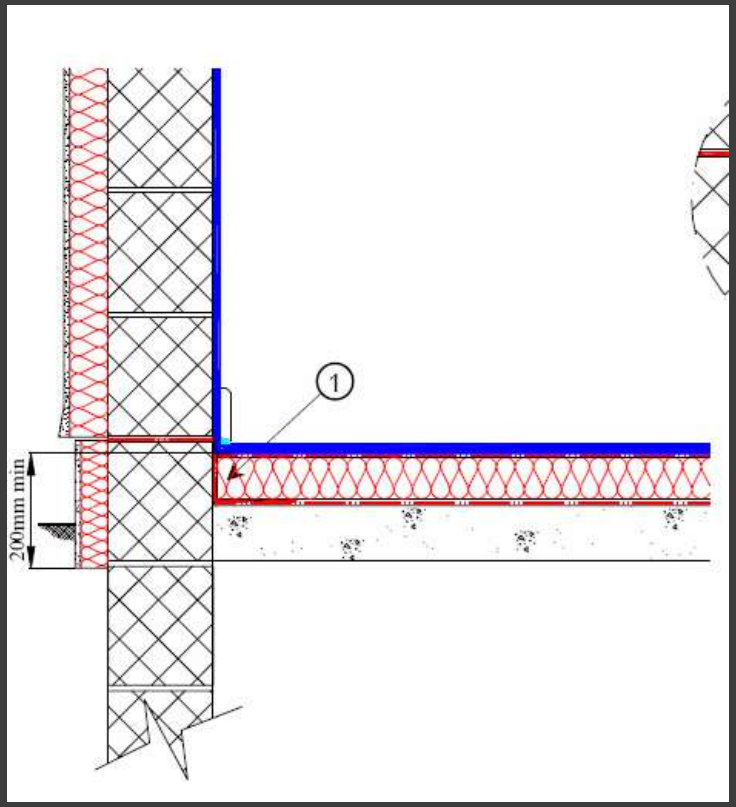

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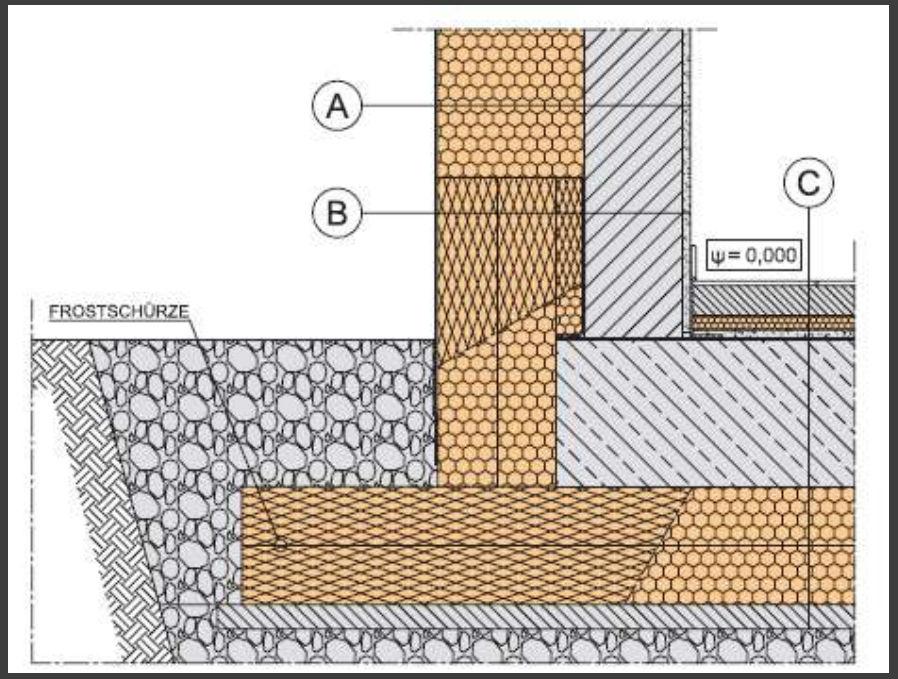
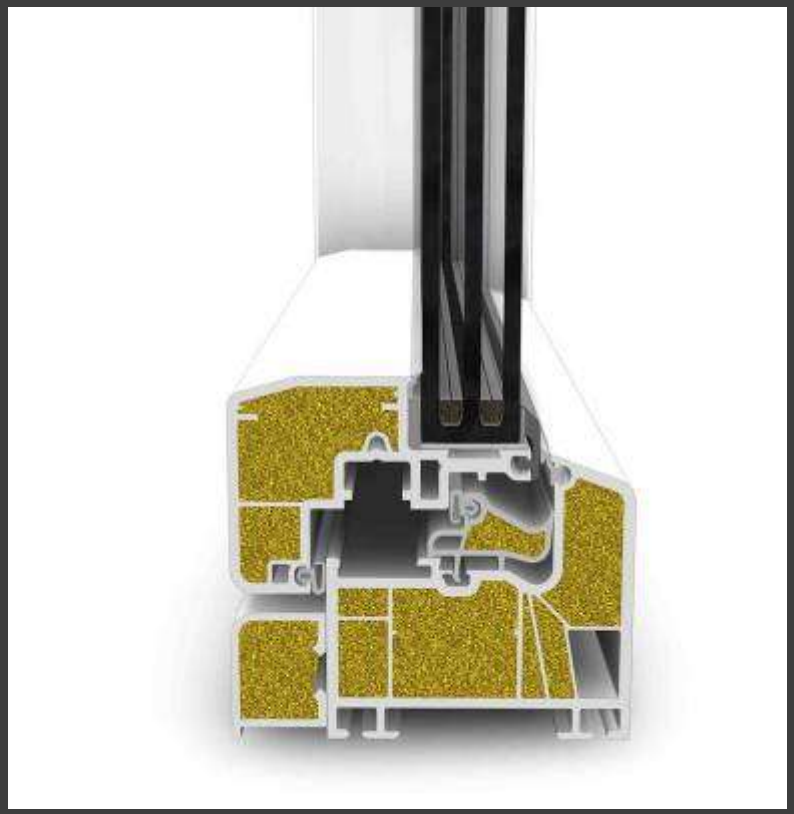
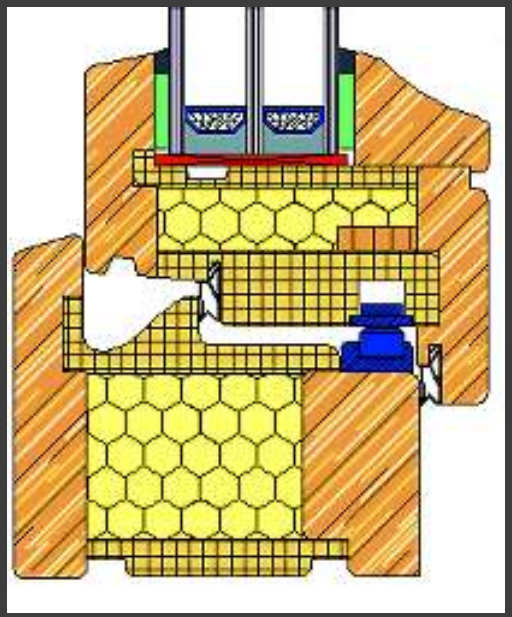


Required Practice

Windows and Doors

- U-value <= 0.85 W/m^{2}K?





Conservation vs Renewables

Conservation should always be ***1st Approach***!

- Insulation (building regs+), Appliances, Boilers, CFL Lights, Intellegent Controls, Behaviour
- Often cheap to apply - gives fast payback
- Requires smallest change in attitudes

Renewable Energy is 2nd Approach

- Solar, Wind, Hydro, Biomass, Heat Pumps, Tidal, Wave
- More investment required -> slower payback
- Requires larger shift in attitudes (oil prices help!)

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In summary - Do’s and don’ts

- Keep it simple
- Maximise envelope thermal performance
- Minimise heat loss
- Eliminate thermal bridging
- Eliminate condensation
- Ventilate but maximise air-tightness
- Integrate Low Carbon Technologies
- Affordability
- Climate Proofing
- Don’t over engineer design solutions
- Control site conditions and workmanship
- Inspect to ensure you get what was designed
- Consider future upgrading potential at design stage
- Consider end of life at design stage
- Material selection and quality

Close

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