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Low energy homes and construction systems

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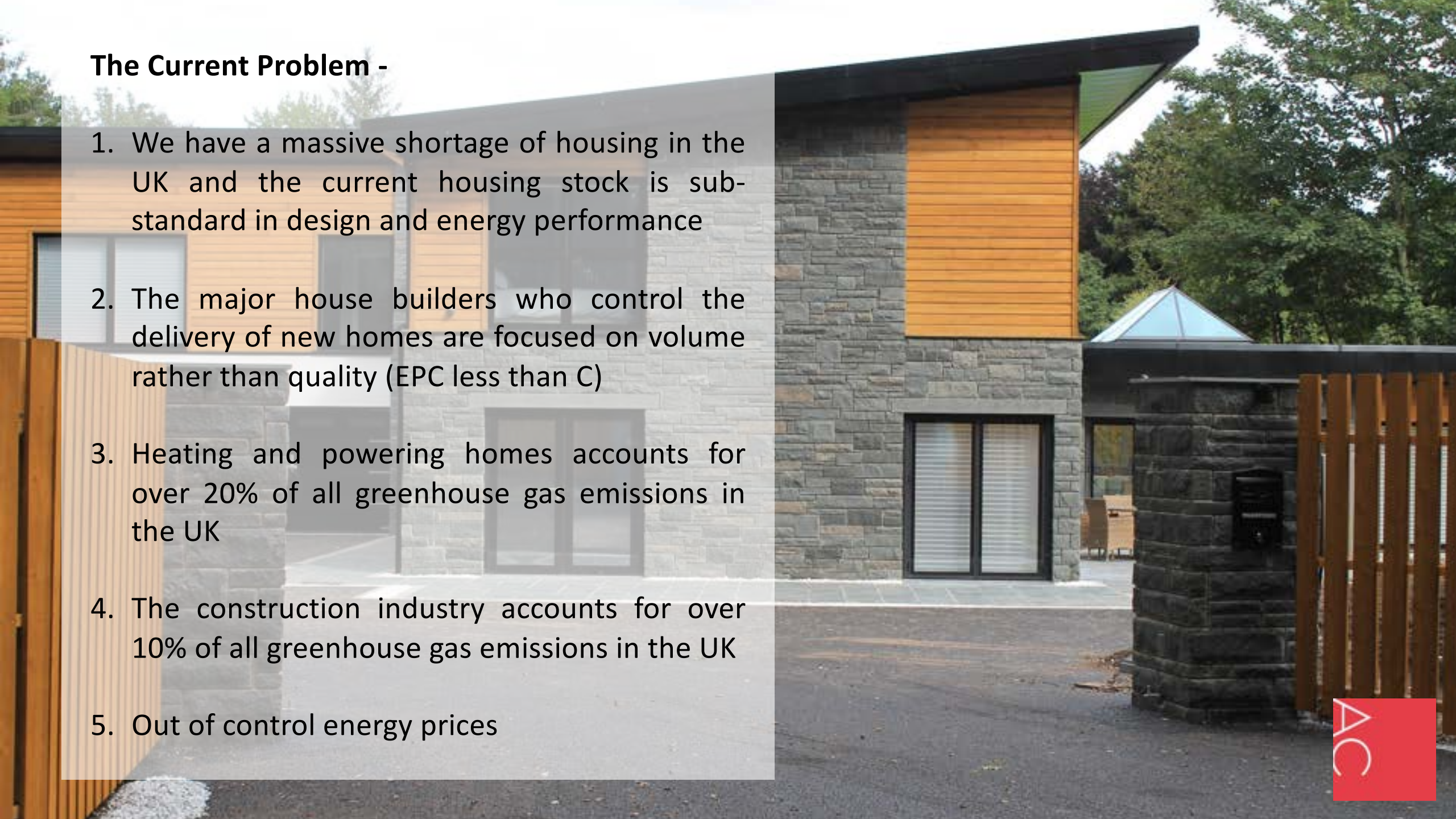
How to Build a Low Energy Home –

1. The current problem
2. The Future Homes Standard
3. The Fabric First Approach
4. The Design Process
5. Summary

The Current Problem



The Current Problem -

1. We have a massive shortage of housing in the UK and the current housing stock is sub-standard in design and energy performance

2. The major house builders who control the delivery of new homes are focused on volume rather than quality (EPC less than C)

3. Heating and powering homes accounts for over 20% of all greenhouse gas emissions in the UK

4. The construction industry accounts for over 10% of all greenhouse gas emissions in the UK

5. Out of control energy prices

"Put simply a green or low energy home that from design, technologies and construction method uses less energy, from any source, than a traditional or average new house."

What do we mean by a Low Energy Home

These are examples of low energy homes-


These are examples of low energy homes-


These are examples of low energy homes-


These are examples of low energy homes-

The Future Homes Standard

The Future Homes Standard -

1. We need 250,000 new homes per year

2. Custom & Self build's lead the way in design and energy performance

3. Future Homes Standard 2025 –
   - A major review of the Building Regs
   - Drive towards Net Zero Carbon dwellings
   - Remove fossil fuel boilers
   - Improvement in U values

4. RIBA Climate Challenge 2030 –
   - 50% Reduction in Operational Energy & Carbon Emissions
   - 40% Reduction in Embodied Energy & Carbon Emissions
   - 40% Reduction in potable water usage
   - Low Carbon Heating, no fossil fuel boilers

The Future Homes Standard -

1. Its better for the environment, by reduced carbon emissions during construction
2. Its better for the environment, during operation due to the reduced energy demand
3. Typically 40-80% betterment in building standards than current housing stock
4. Reduced running costs over the life of the house
5. Potential for zero or positive energy bills
6. A more comfortable, healthy built environment

”Is a back to basics approach where you concentrate on the fabric of the building before throwing eco bling, in order to make it work.”

The Fabric First Approach

Fabric First Design Principles -

1. Highly insulated building envelope with limited cold bridges

2. High specification windows & doors

3. Air tight membranes and tapes used to seal all external walls and penetrations

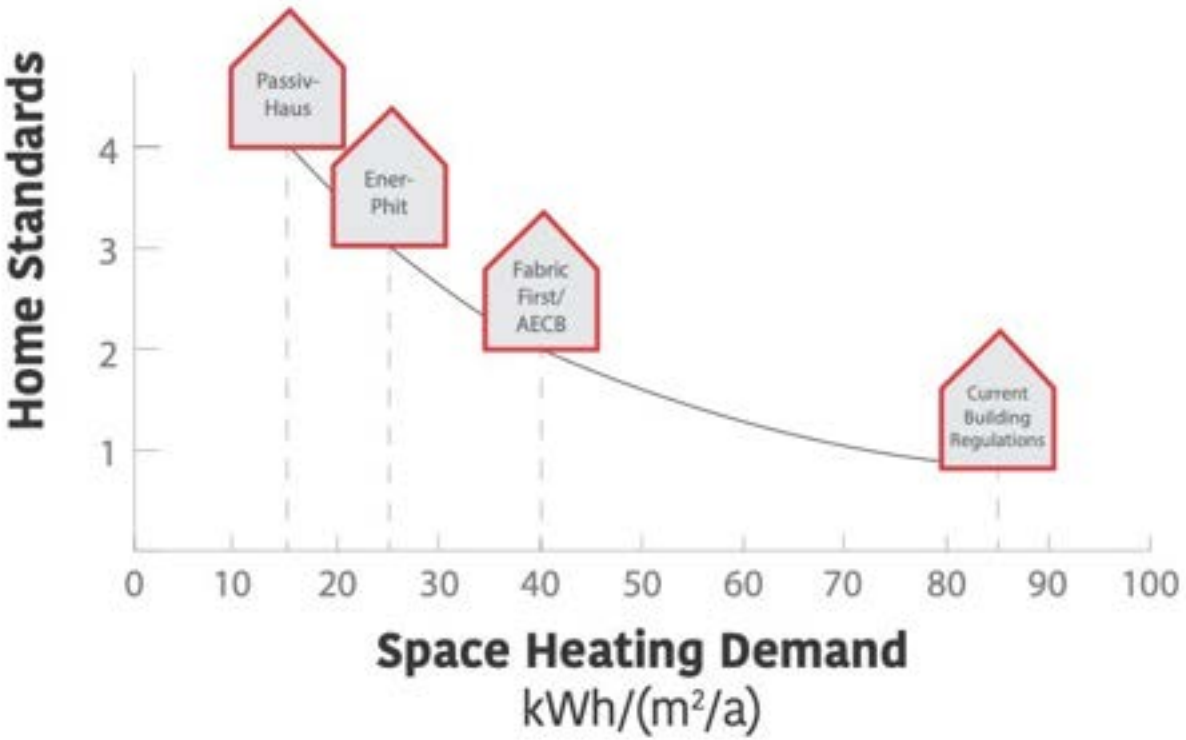
4. MVHR system providing fresh heated air throughout the home, potentially with a heating element

5. Maximise the natural solar gain through building orientation

6. Utilise a small renewable led heating system

Performance criteria – space heating demand

	Scotland / England / Wales Building Regulations	Fabric First Targets	EnerPhit Standard	PHPP Low Energy Standard	Passive House Standard
Space Heating Demand **kWh/m² per year**	85 kWh/m² per year No heating demand standard defined in Building Regulations/ Technical Handbooks	40 kWh/m² per year	25 kWh/m² per year	30 kWh/m² per year	15 kWh/m² per year



Performance vs Costs

Early decisions on performance criteria -

vital to allow efficient design at initial stages to accommodate the performance criteria

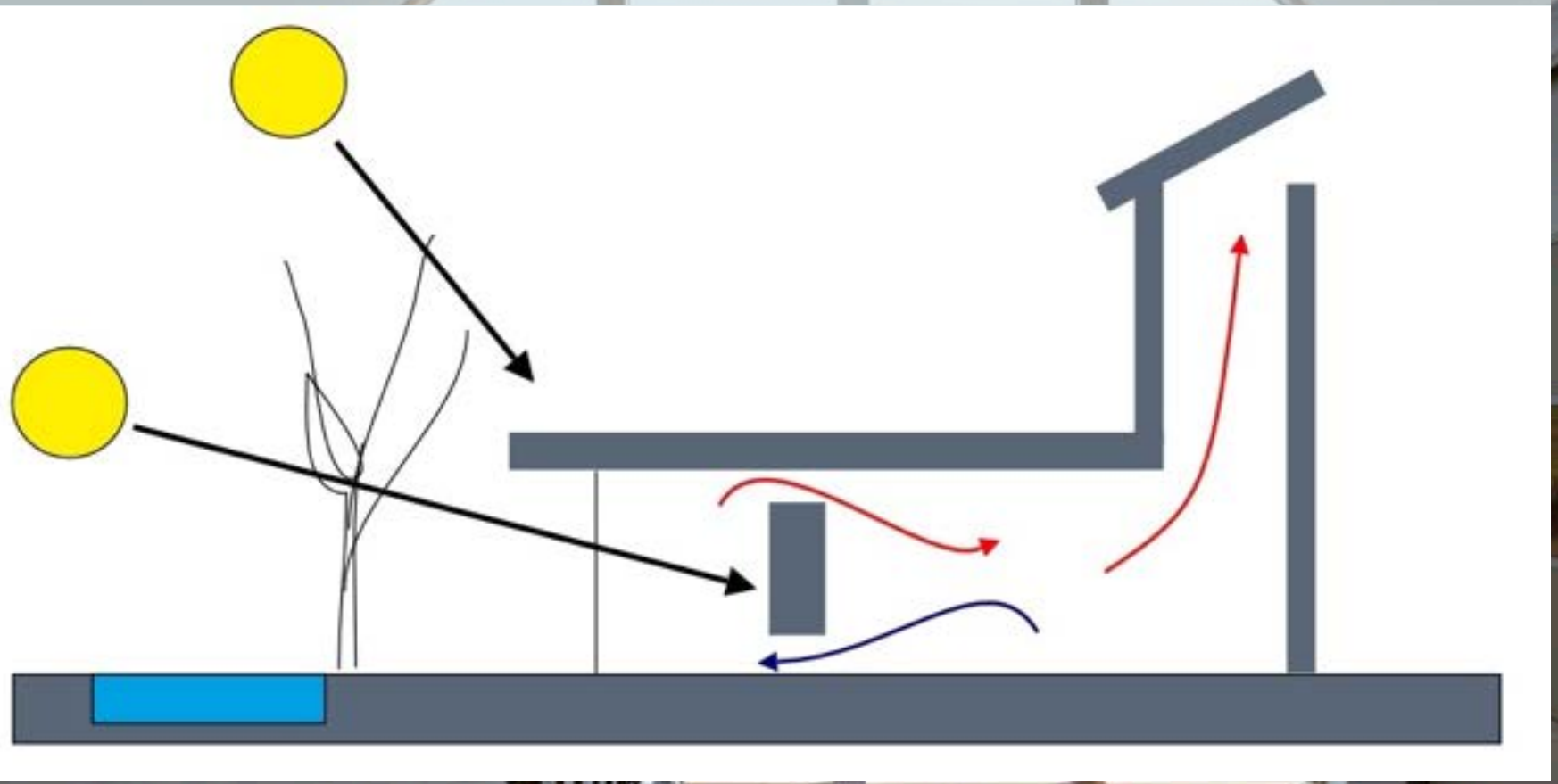
- Use professionals who specialise in energy efficient design, detailing and construction methods
- Use PHPP design tool from the initial design stages
- Choose a suitable construction method

THE KEY ELEMENTS

1. Solar Gain
2. Construction Type
3. Air Tightness
4. Limit Cold Bridging
5. Ventilation Strategy
6. Heating Systems

1. Solar Gain -

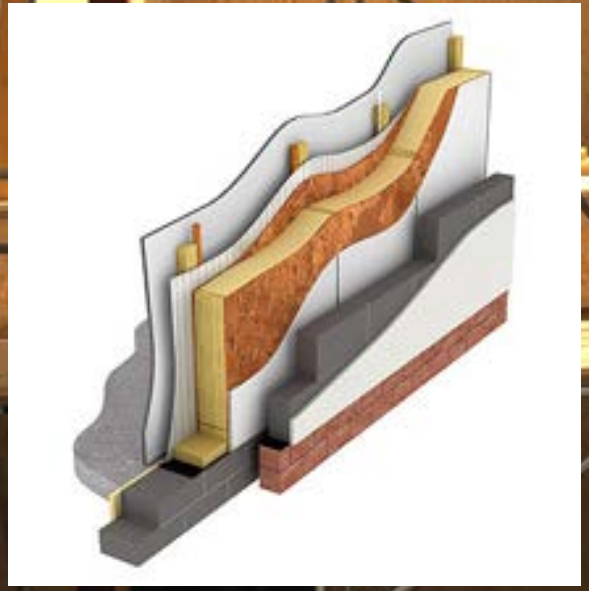
1. Consider orientation of the building to maximise gains
2. Large windows on Southerly elevations and small windows on the North
3. Accommodate shading or bries soleil to limit summer overheating – must be Part O compliant



2. Construction Types -

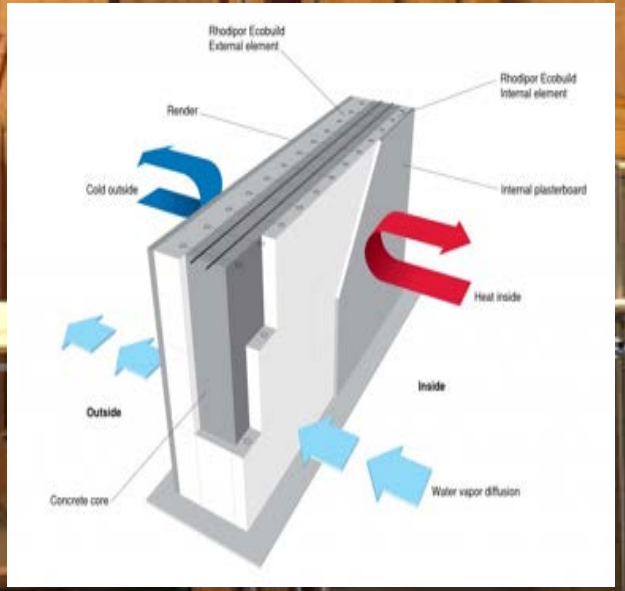
1. Choose a Construction type that is naturally airtight
2. Highly insulated
3. Ideally to a Factory tolerance
4. Can your choice be both low energy & sustainable?

Timber Frame



SIPS

ICF



All can achieve a U-value of 0.10 to 0.15 W/m2k

3. Air tightness -

1. Tape all external joints & around windows
2. Use airtight membranes and vapor control layers
3. Tape or seal all service penetrations

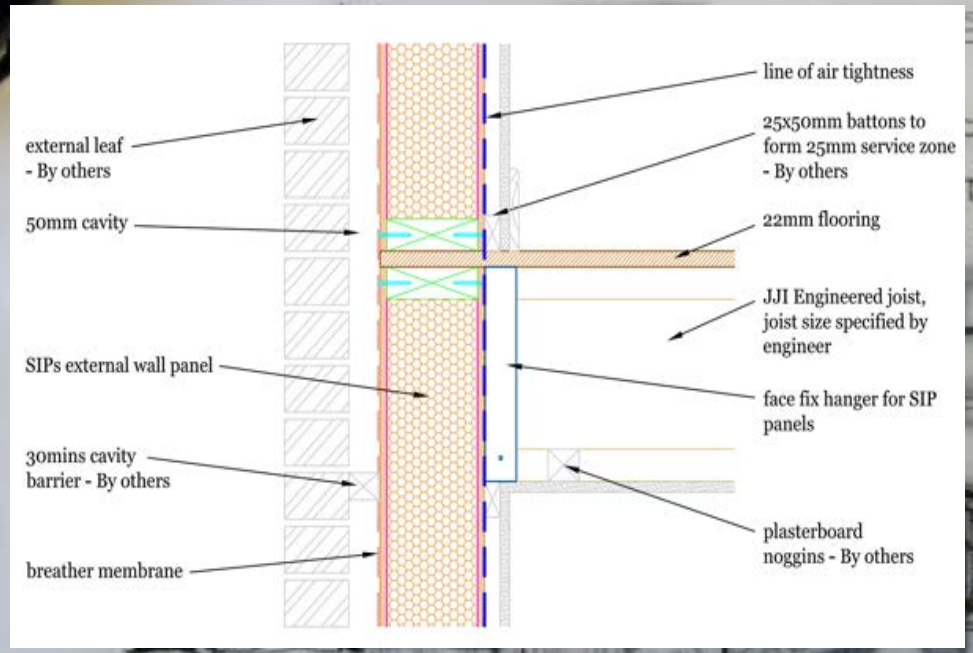
Proctor Wraptite breather membrane

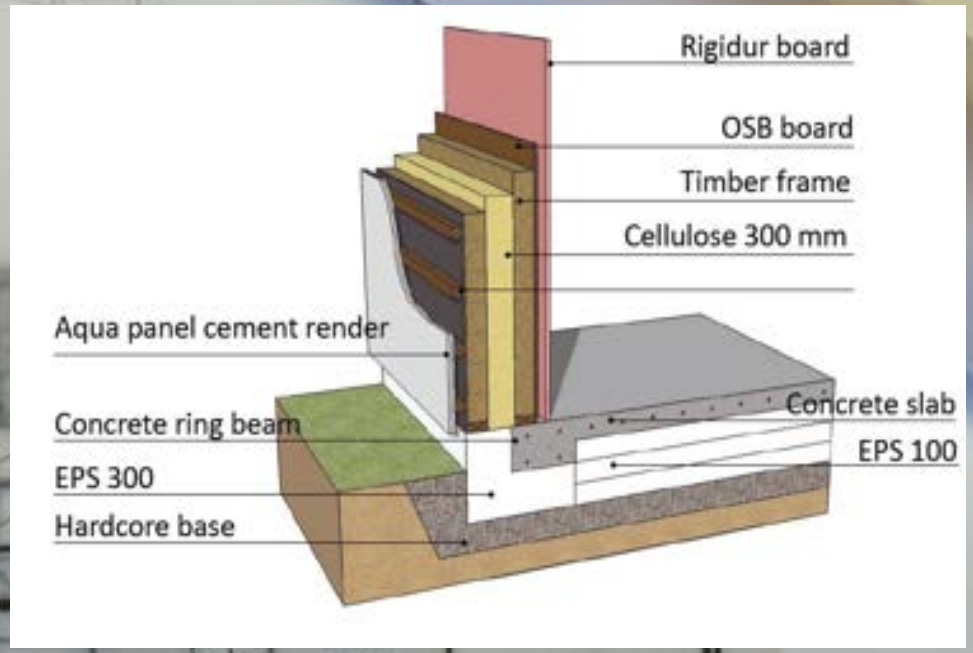
Internal airtight tape

Blower door test

4. Limit Cold Bridging -

1. Architect to detail all parts of the building's connections & linear cold bridging
2. If using timber frame try and increase centres from 600mm to 1,200mm cc
3. Poor detailing can cost up to 28% in SAP calculation





Construction Systems

The main considerations

Questions you have to ask yourself –

1. How much involvement are you having in the project?

3. What is your budget?

4. Is energy performance important to you?

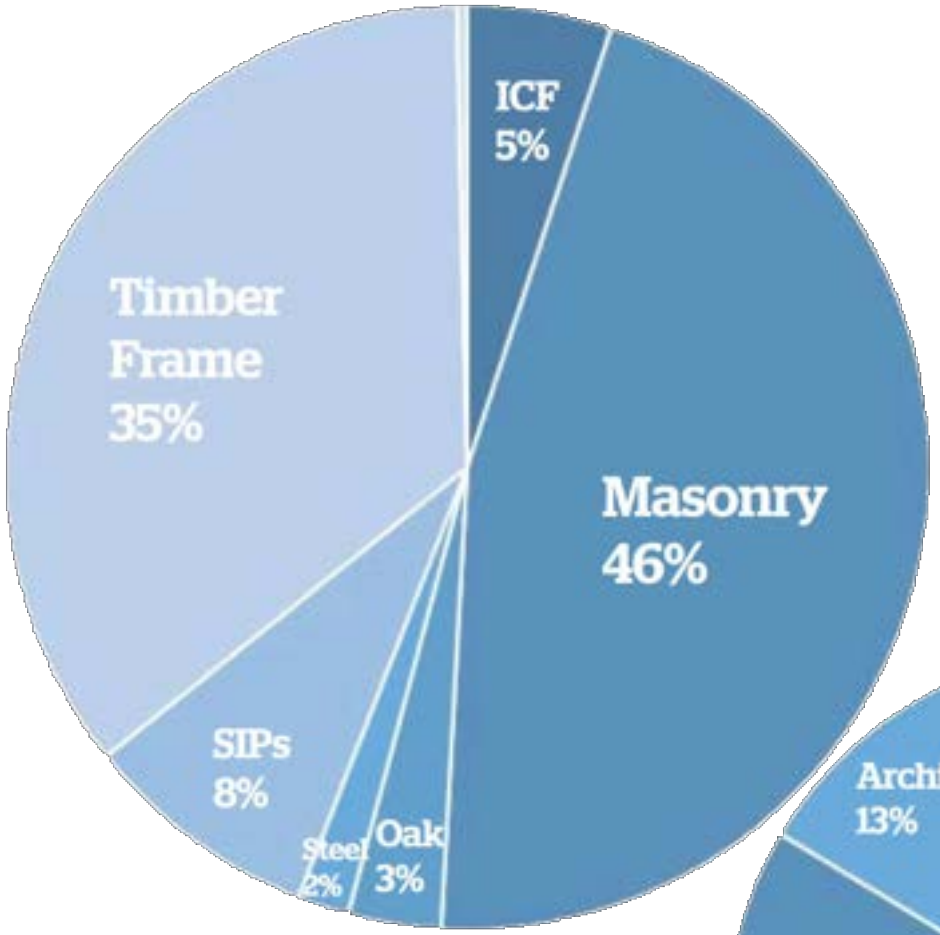
5. Is speed of build a factor?

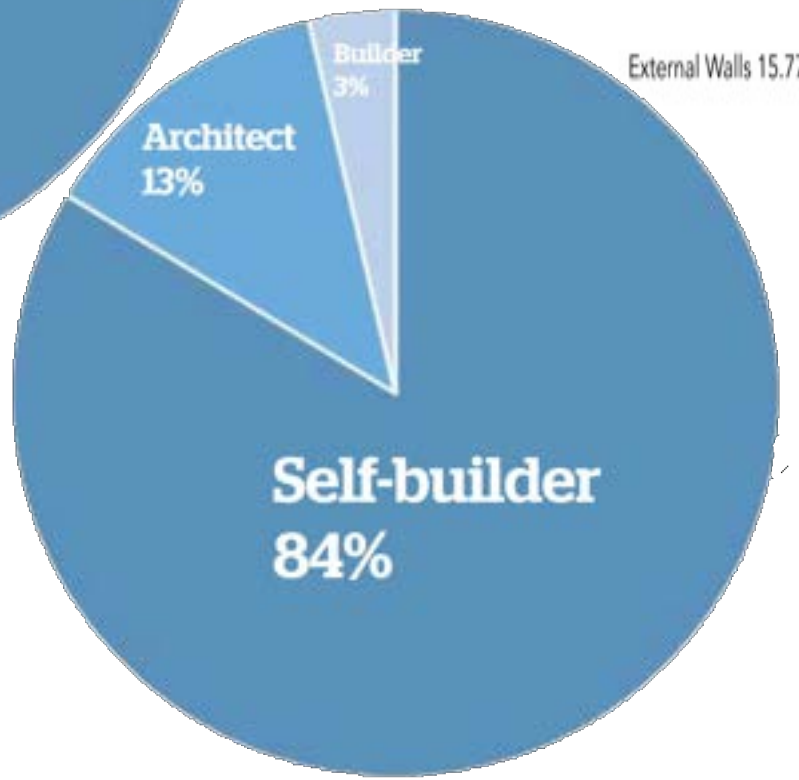
SAP – Standard Assessment Procedure

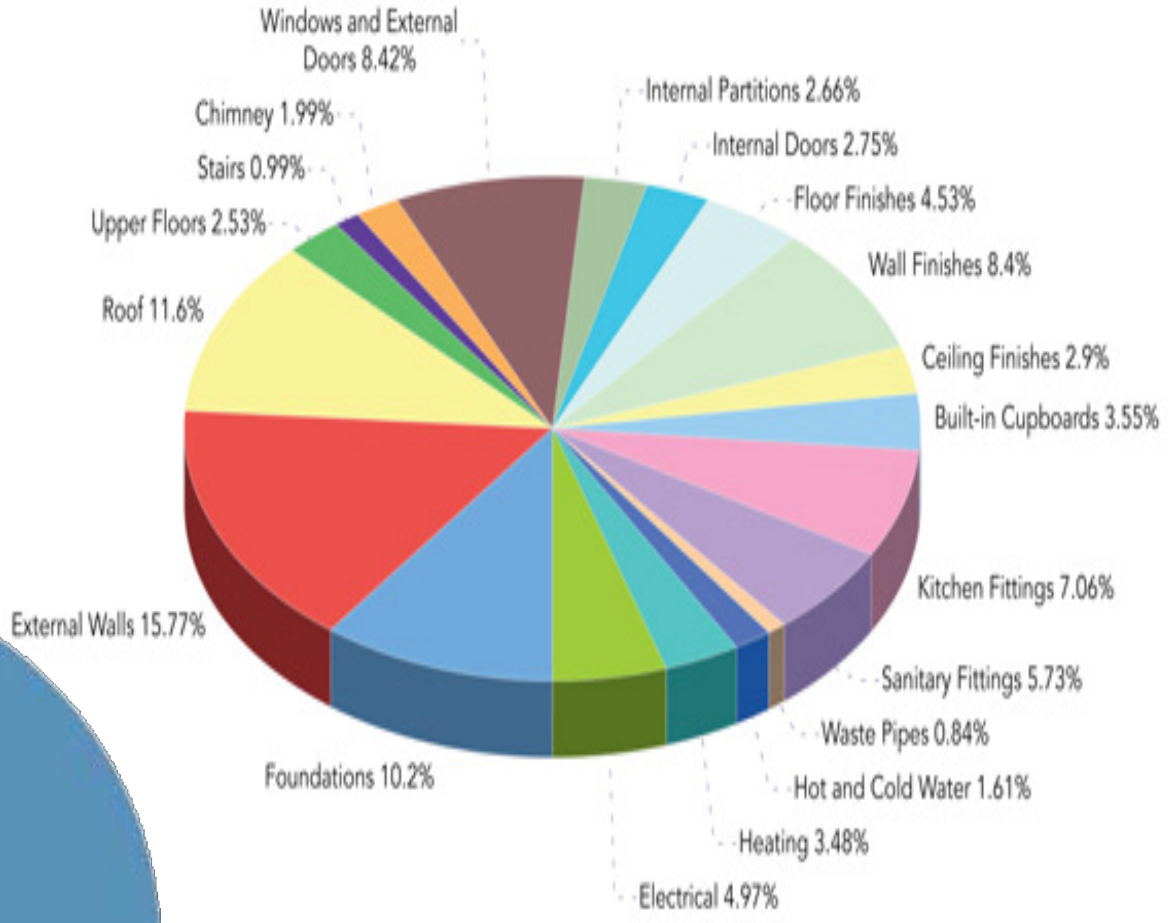
Basic Energy Performance Criteria

	England /Wales Section L	Scotland Section 6	Fabric First Targets	Passive House
Wall U-value (W/m^2K)	0.18	0.17	0.15	below 0.15
Floor U-value (W/m^2K)	0.13	0.15	0.15	below 0.15
Roof U-value (W/m^2K)	0.13	0.11	0.15	below 0.15
Windows/openings	1.4	1.4	1.2	1.0
Air permeability	5 ($m^3/hr/m^2$ at 50 Pa)	7 ($m^3/hr/m^2$ at 50 Pa)	1.5 - 3 ($m^3/hr/m^2$ at 50 Pa) MVHR required	0.6 air change rate @50 Pa pressure difference MVHR required

U – value – Measure the ease which a material or building assembly allows the heat to pass through. **The lower the U-value the better the insulation properties.**







Construction overview

1. Masonry

Details – brick outer skin, with cavity either full or partial fill insulation, aircrete block inner skin. Timber truss roof

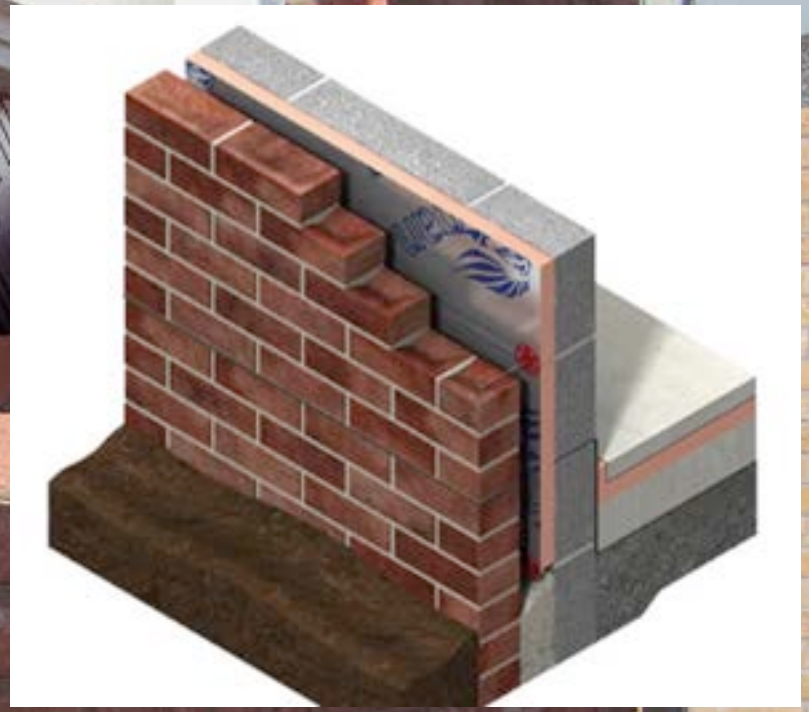
Market share - 46% (down from around 70%)

Time to wind & water tight – 20 weeks approx. [current market pushing to 27-30 weeks]

Cost – cheaper than off site alternatives

Pros – traditional solid and safe. No issues with building fire. Cost effective and its what most architects know.
Excellent thermal mass.

Cons – Very slow compared to off site
Not the preferred option for low energy homes. Thick build up



2. Timber frame

Details – timber studwork with an external OSB or plywood board nailed to it. Insulation friction fitted between the studs. OSB lined externally with a breather paper & internally with a vapour barrier.

Market share - 36%

Time to wind & water tight – 10 weeks approx

Cost – open panel system cheapest, comparable to masonry

Pros – fast and cost effective way of building, good insulation levels. Lots of suppliers and choice.

Has been the standard choice in Scotland for many years. No issues with insurance or mortgageability.

Cons – Perceived fire issues, can seem lightweight.
Settlement of timber can cause cracking

3. SIPs (Structural Insulated Panel)

Details – 2 skins of OSB are filled with either polyurethane (mix) or rigid polystyrene, infilled with timber to create closed panel. External breather membrane internal vapour barrier. Timber or mini SIPS structural splins. Wall & roof panels are the same.

Market share - 8%

Time to wind & water tight – 6 weeks approx

Cost – 10 - 15 % more expensive than timber frame

Pros – fast and cost effective if designed to panel sizes, excellent insulation levels. Airtight, ideal for fabric first or Passive House.

Huge spans, no roof trusses – vaulted ceilings. No issues with insurance or mortgageability.

Cons – Perceived fire issues, requires crane for roof.
More expensive than alternatives

4. ICF (Insulated Concrete Form)

Details – Lightweight hollow interlocking blocks, usually made from polystyrene or PU insulation. Dry stacked, reinforced with steel rebar and filled with concrete (floor by floor). Lego blocks for grown-ups

Market share - 5%

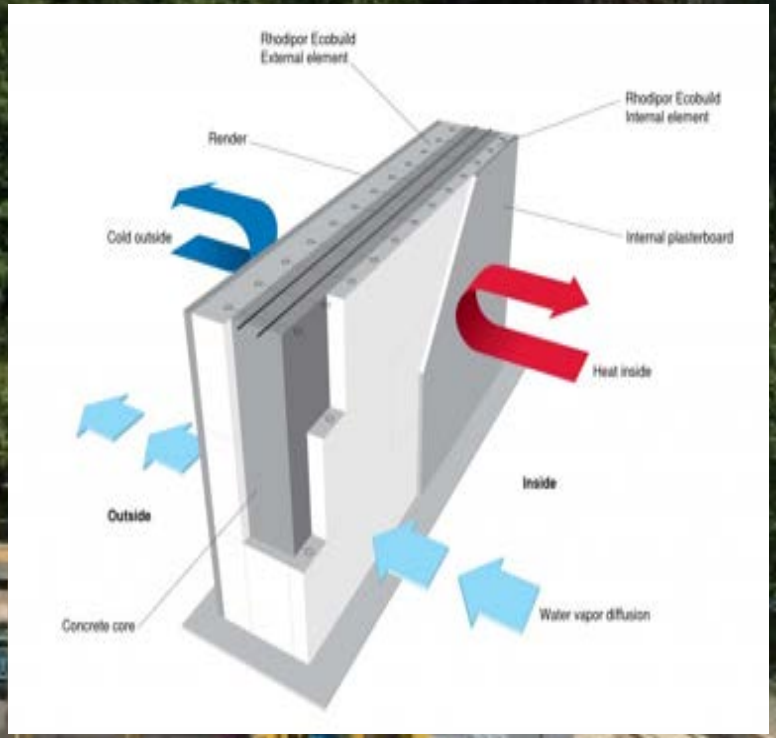
Time to wind & water tight – 10 weeks approx

Cost – 10 - 15 % more expensive than masonry.

Pros – fast and cost effective especially if you stack the blocks yourself. Excellent insulation levels. Airtight, ideal for fabric first and Passive House.

Ideal for basements. Rigid and solid. No issues with insurance or mortgageability.

Cons – The pour is critical (burst blocks), more expensive than block. Alterations, extensions can be difficult. No full house solution.



5. Oak Frame

Details – Green Oak frames are cut and shaped off site, & erected by experienced team on site. Structural frame is then encapsulated with an insulated envelope, often SIPS.

Market share - 3%

Time to wind & water tight – 10 weeks approx

Cost – The most expensive method.

Pros – can be relatively quick to erect kit & encapsulated. Perfect for more traditional designs. Can expose timber internally & externally. High performance given the right encapsulation.

Can use part frame in exposed areas.

Cons – expensive and you are doubling up on structural frame. Frame will move and shrink due to high water content, requires cleaning with Oxalic acid once erected. Specialist designers.

6. Solid Wood Construction

Details – Ecological Construction option. Solid wood modular construction method. Kit detailed offsite and arrives in small packages to site.

Time to wind & water tight – 12 weeks approx

Cost – 10 - 15% more expensive than timber frame

Pros – Low Carbon Footprint. Renewable raw material sustainable development. Carbon sink. Efficiency of production (processing). Natural ideal humidity.

Cons – Specialist design, limited providers.

7. Alternatives

How to Choose

1. Do your research & decide which construction method best suits your requirements – budget, speed, thermal performance etc
2. Then select and get at least 3 quotes from manufacturers of that construction method (builder or factory). Look around their factory, visit ongoing sites, speak to clients. Also check Companies House.
3. If you are using off site manufacturing, try and find a company that has everything in-house. i.e. drawings, manufacturing and site teams (not all outsourced).
4. Negotiate a fair price and agree on a fixed cost and timeframe. Make sure you go over the quote to understand all the details.
5. At the end of the day choose a company you feel comfortable with!