

The Future of Low Carbon Homes

Learning from Sigma[®] Home Monitoring & Occupancy Research

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Background

Sigma[®] Home - Research Findings

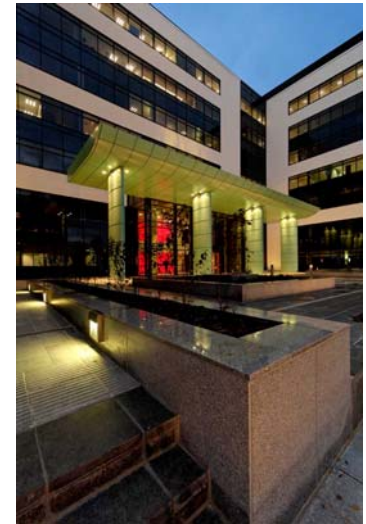
Moving Forward - Next Steps

Summary



Who we are...

- Top 20 UK Developer (5 Operations)
- Largest UK Timber Frame Manufacturer (Scotland / England)
- Top 5 Construction and Commercial Development in Scotland
- £450m Turnover
- Corporate Plan – Growth and Geographical Expansion



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Construction

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Developments

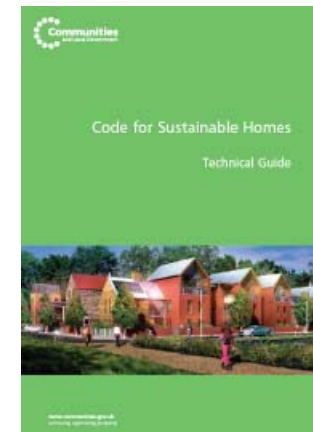
Stewart Milne
Homes

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Timber Systems

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Partnerships

Background: Opportunity or Threat

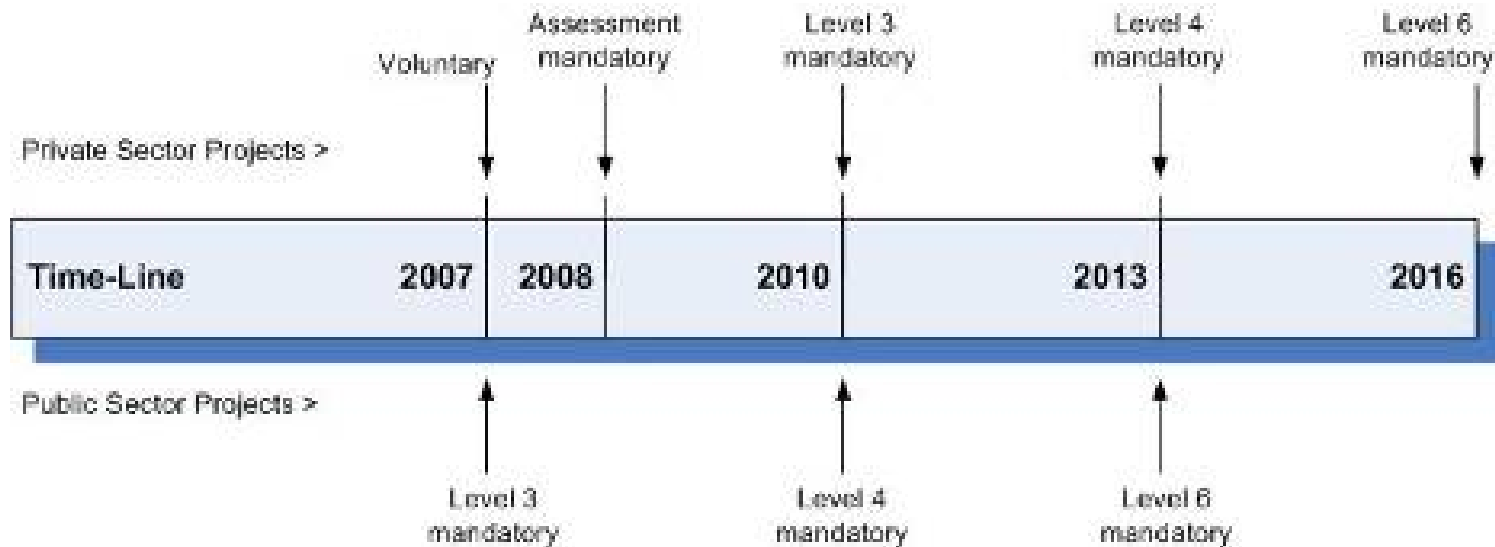
- New Environmental Standard - April 2007
- 9 Assessment Categories
- Route-map towards Zero Carbon by 2016
- Energy and Water Key Areas
- Rating System (Level 1 to 6)



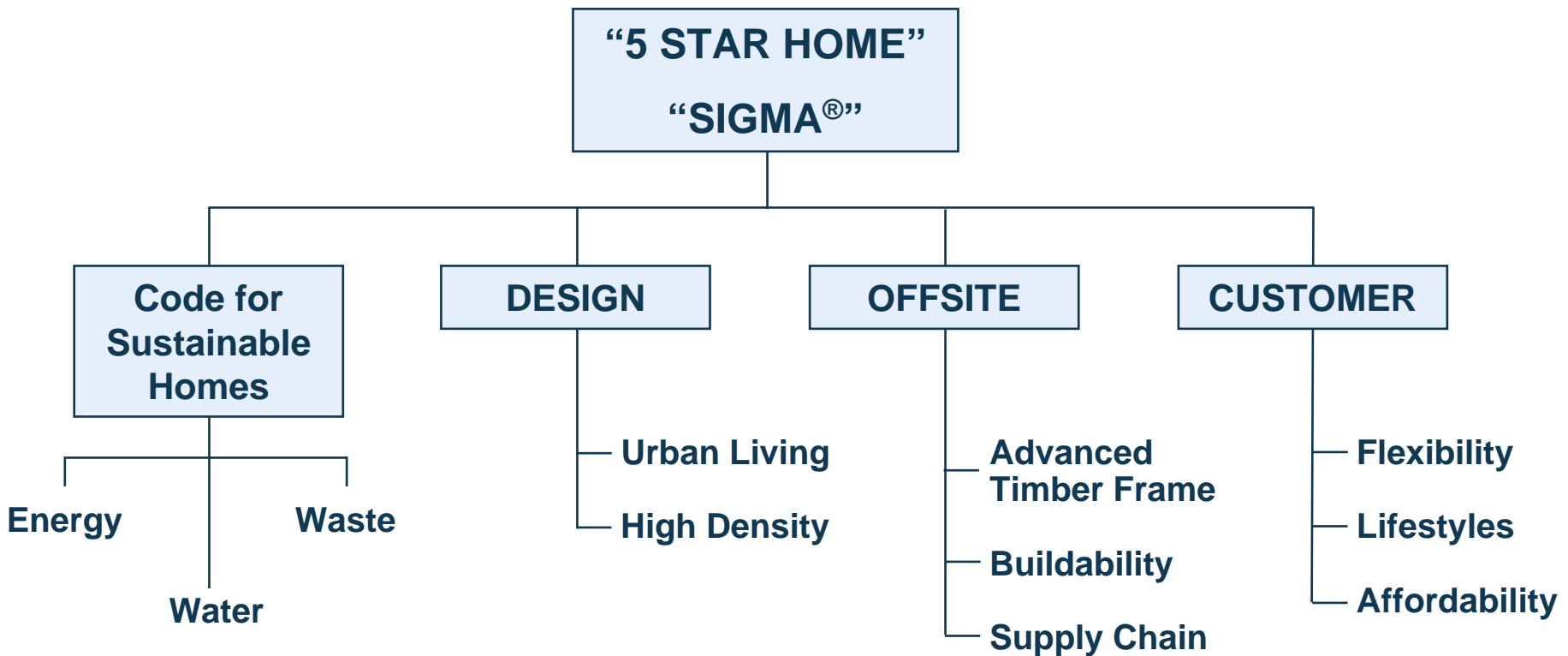
SCORING SYSTEM

			CO ² Emissions	Water Usage
Level 1	- 36 points	Eco Homes good	10%	120 ltrs
Level 2	- 48 points	Eco-Homes good/very good	18%	120 ltrs
Level 3	- 57 points	Eco-Homes very good/excellent	25%	105 ltrs
Level 4	- 68 points	Eco-Homes excellent +	44%	105 ltrs
Level 5	- 84 points	-	100%	80 ltrs
Level 6	- 90 points	-	Approx 145%	80 ltrs

Timelines



Sigma[®] Home - Principles



The UK's 1st 5 Star rated home under the Code for Sustainable Homes

Certificate presented by Yvette Cooper,
Minister for Housing
at OFFSITE 2007



Research and Development

Phase 1

Design & Build

Phase 2

Occupancy Testing and “As Built”

Performance Monitoring

Phase 3

Production Supply

Road Testing Cradle to Grave Approach



The Sigma[®] Home: Post Occupancy Evaluation

Dr. Fionn Stevenson
Oxford Brookes University



Research Methodology

- 2 week occupation periods for each season over a year
- Pre-selected family of 4: 2 adults, 2 children age 7 & 12
- Combination of monitoring, interviews, video and logging
- Logging = thermal comfort survey, activity sheets
- Field observations during walk-through visits
- Predicted and actual electricity and gas use
- Co-heating test



Energy/carbon performance - results

Actual energy use from grids

=140 kWh/m²/year

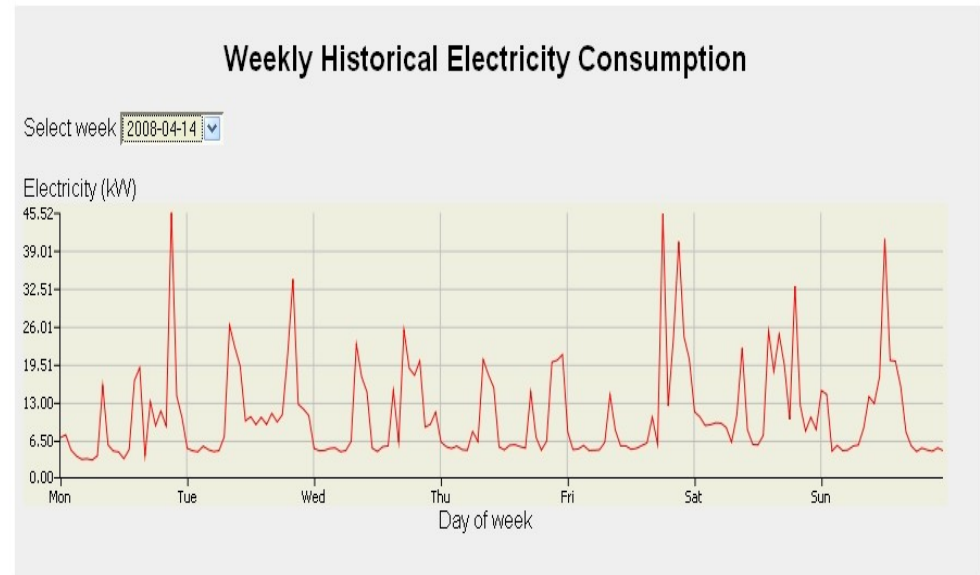
(4.176 tonnes/CO₂/year)

Design energy use (SAP 2005)

= 86 kWh/m²/year

Av. temperature = 19.3 - 21.7°C

(design temperature = 18.5°C)



Overall, energy usage was higher than designed aided by the use of home appliances such as plasma TV and tumble dryer

Fabric Heat Loss - results

Predicted heat loss coefficient = **98 W/K**

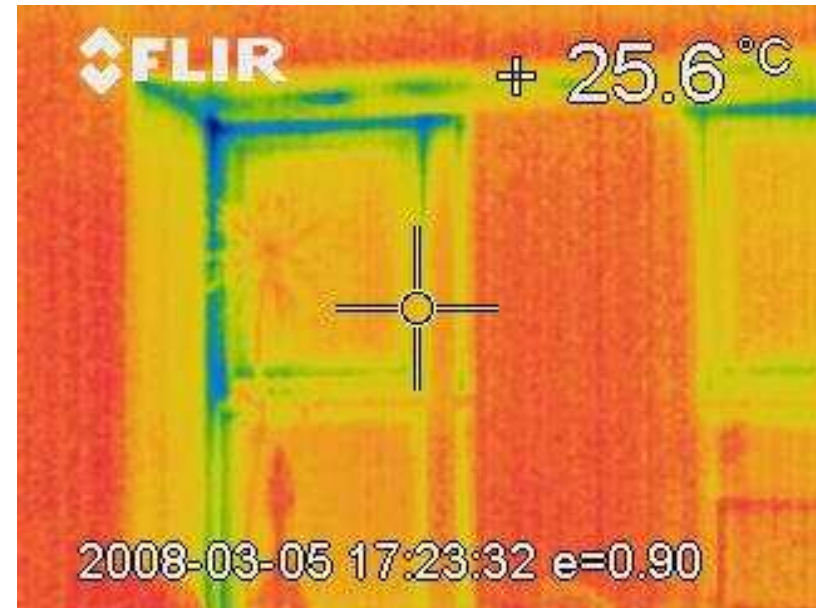
Airtightness = $2.72\text{m}^3/\text{h}/\text{m}^2$ @ 50 Pa

Actual heat loss coefficient = **144 W/K**

(nearly 50% higher)

Thermal imaging revealed key areas:

- Overly complicated envelope
- Air leakage at junctions
- Thermal Bridging



Thermal imaging = x-ray vision for homes

Reveals what you see is not what you get !



Micro-renewables

PV - blocked by adjacent building

Wind - turbine unstable on roof

Solar thermal - overheated and obsolete

Lack of user understanding

Issues: longevity, safety, repair and maintenance

Is this the best way forward?



Thermal comfort and health

- Highly comfortable and healthy home
- 1000+ samples over 4 x 2 week periods
- Residents 'comfortably warm'
- House - 1.5°C warmer than needed
- No problem with offgassing/CO₂ levels

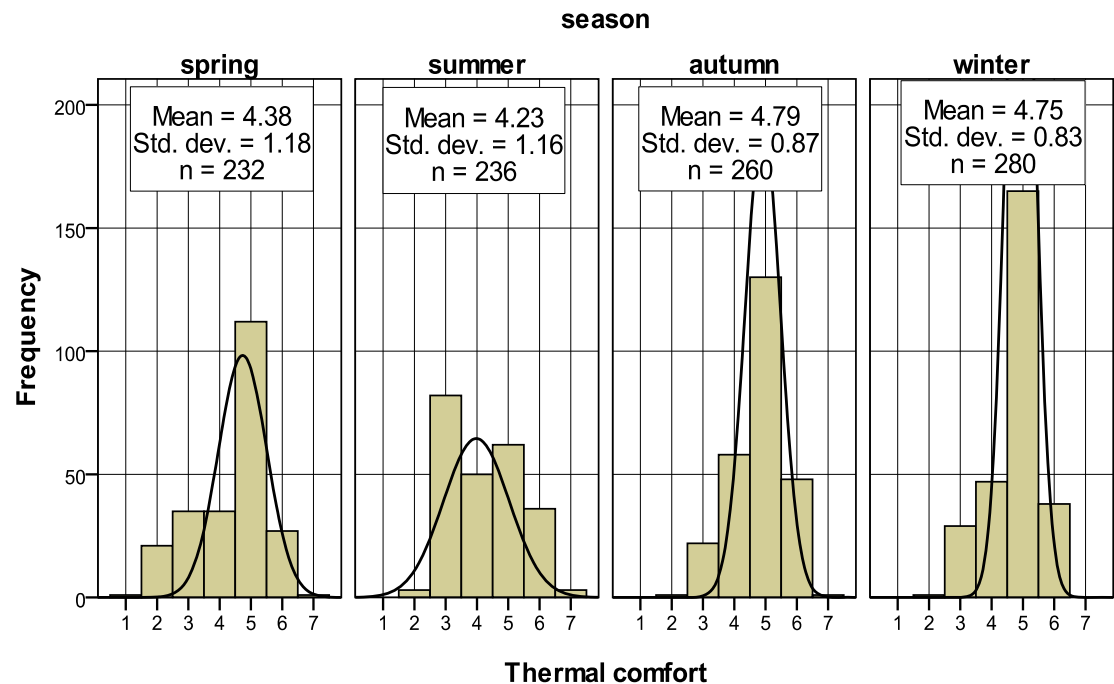
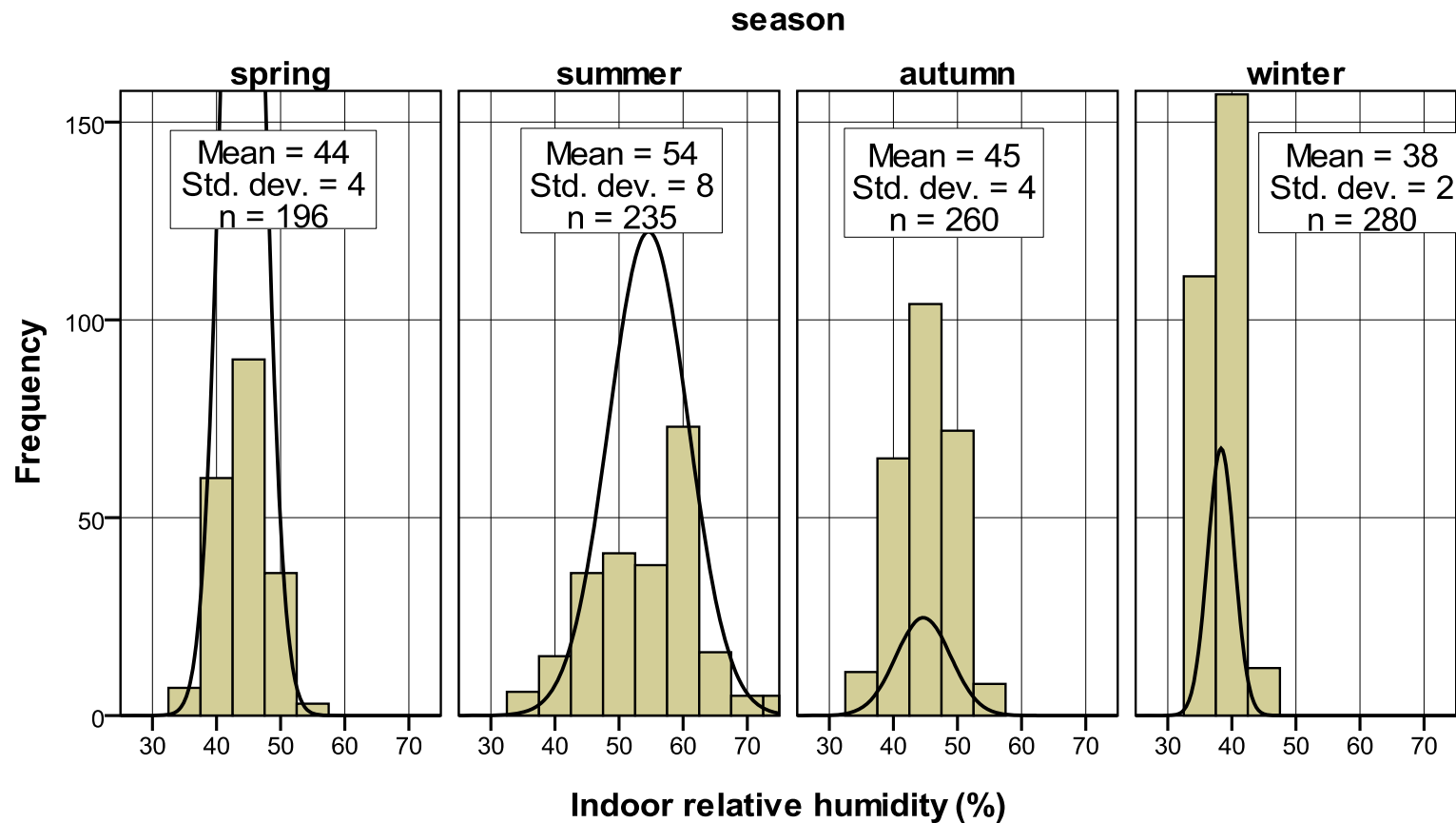


Fig 4. Occupants thermal comfort level

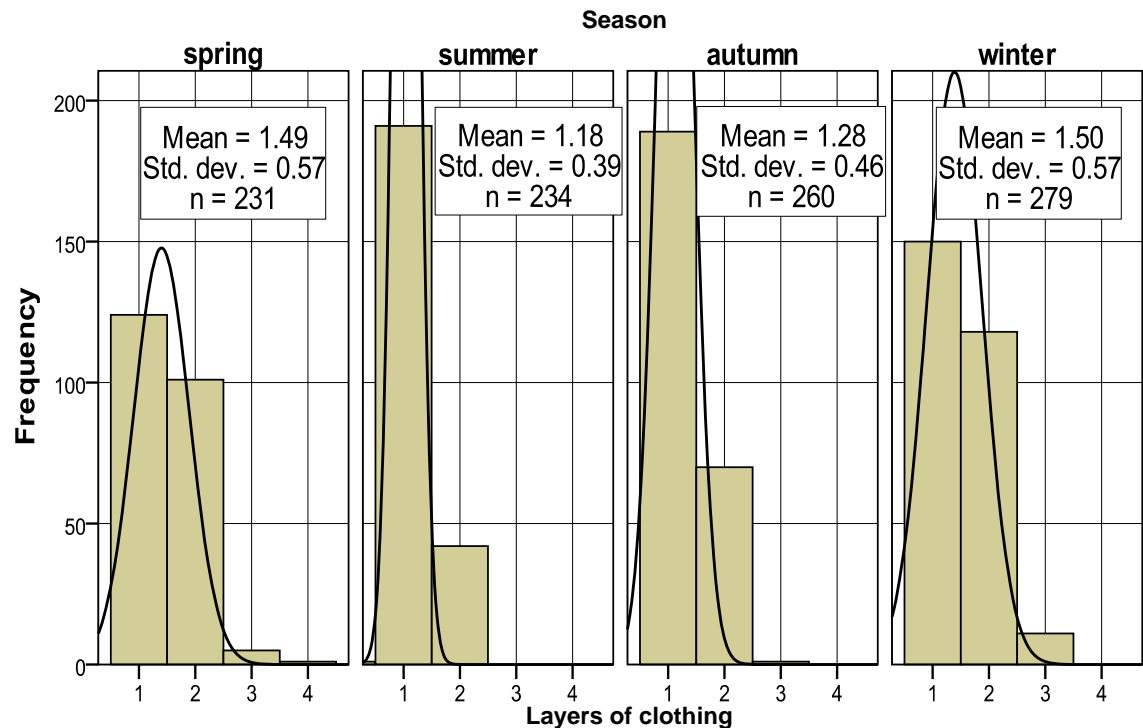
- | | |
|---------------------|-------------------------------------|
| 1. Too much cool | 2. Too cool |
| 3. Comfortably cool | 4. Comfortably neither warm or cool |
| 5. Comfortably warm | 6. Too warm |
| 7. Much too warm | |

Thermal comfort - humidity results



Thermal comfort - user behaviour

- Residents adjusted to temperatures
- Ventilation key aspect
- Need to take into account adaptive strategies
- Responsive needs of users



Thermal comfort - window/ MVHR use

- Overall ventilation good
- Windows open often in summer and little in winter
- Windows also open in spring and autumn - wasting energy
- MVHR worked well
- Passive solar stack useful



Home user induction/interfaces

- Review or home demonstrations and inductions
- Consumer behavioural change and understanding
- Permanent helpline/support
- Aftercare key to customer



Home user – Induction process

- Importance of an easy to use, easy to understand user manual
- Effective single source ‘Helpline’ beneficial
- Change in training for sales/site teams to ensure positive handover experience
- Technical information should be bespoke to each individual home
- Keep it simple stupid



Controls

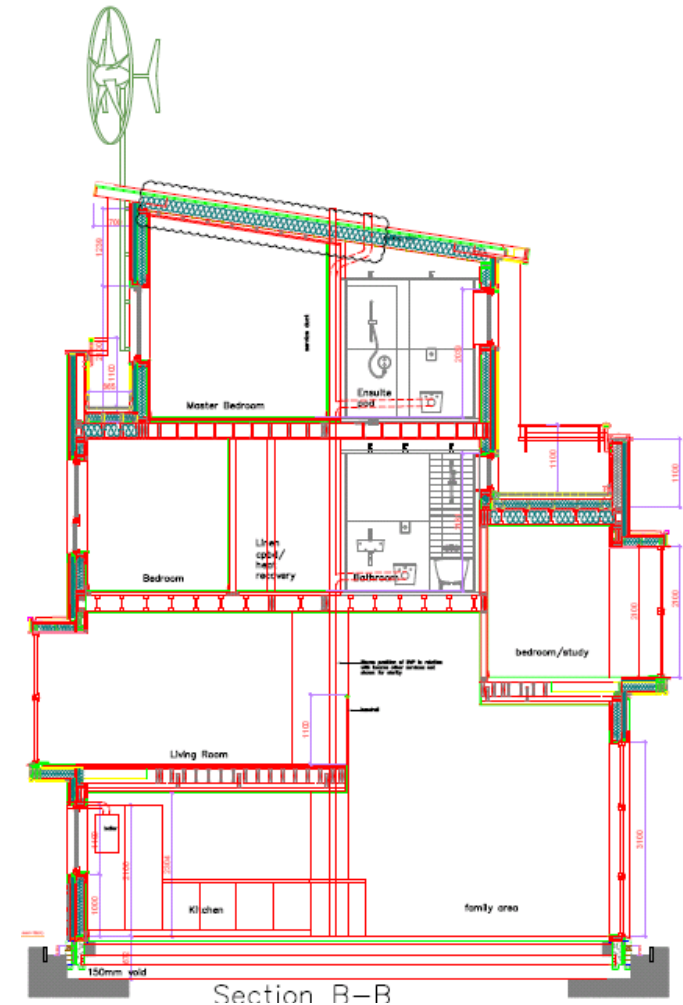
- Modern day living encourages energy usage
- Lack of user understanding contributed significantly to energy use
- Heating, lighting and ventilation controls are key
- Users adapted to heat rather than turning down thermostats

Plasma TV screen is major energy issue



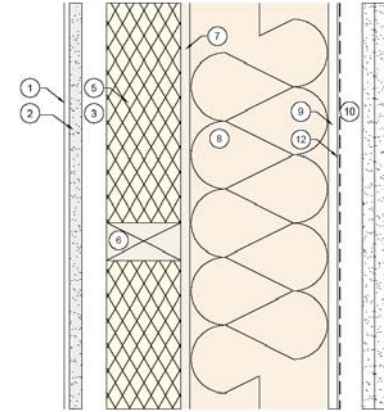
Build complexity

- Complex technology
- Multiple sub-contractors/suppliers
- Lack of integration
- Troubleshooting and repair
- Fabric solution – fit and forget



Next Generation – Sigma II

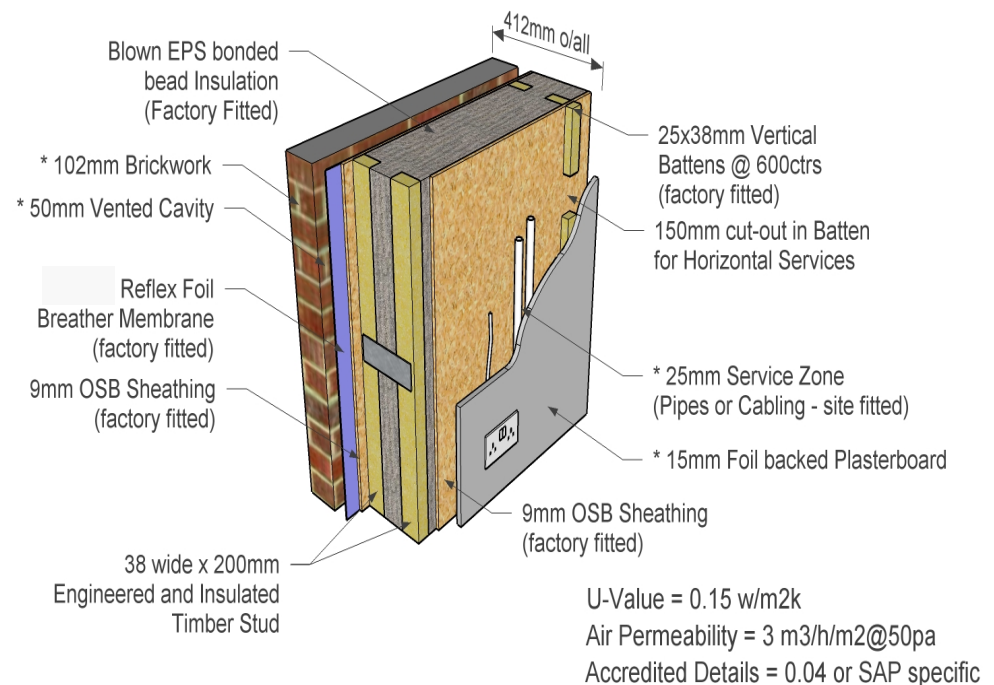
- Focus on fabric solution
- Avoid use of micro renewables
- Simplify
- Integrate suppliers
- Reduce risk and cost



Energy Performance

Fit and Forget – Fabric Solution

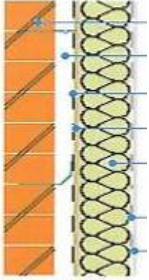
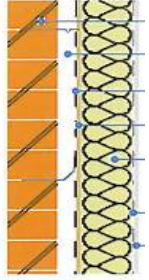
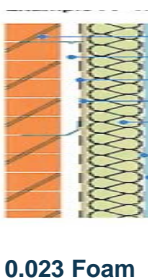
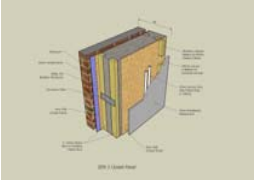
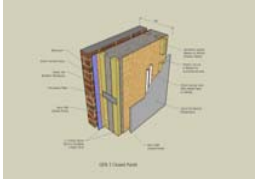
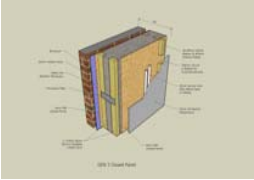
- Improved air tightness
- Reduced thermal bridging
- Conventional materials and skills
- 60 year design life
- Low energy – 1st priority (Level 3/4)



**Closed Panel Timber Frame (3)
(Advanced Specification)**

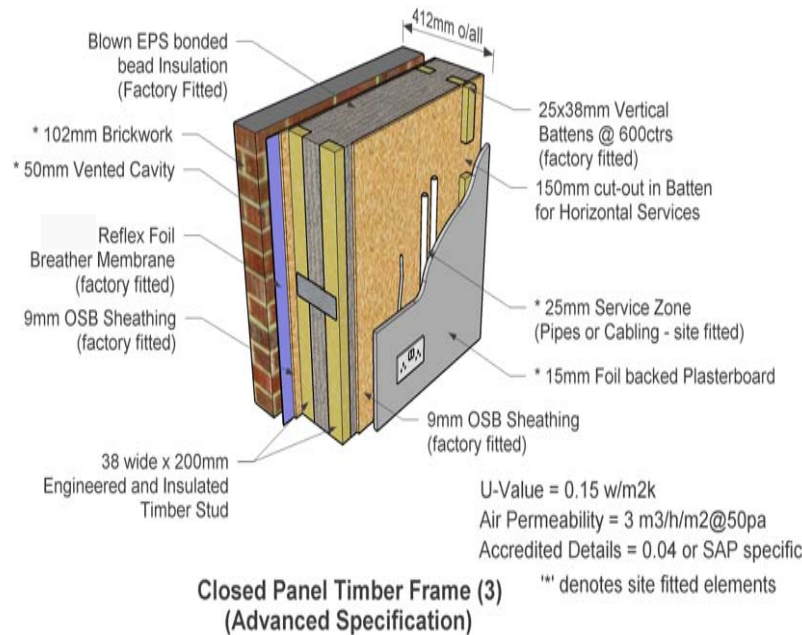
*1 denotes site fitted elements

Fabric Performance

CSH Level	1	2	3	4	5	6
TimberFrame (Public)			2010	2013		2016
TimberFrame (Private)			2008	2010		2013
CO ₂	10%	18%	25%	44%	100%	145%
U-Value	0.28	0.22	0.20	0.15	0.15	0.11
Airtightness	10	7	5	3	3	3
External Wall Width	315mm	315mm	335mm	412mm	412mm	412mm
				Sigma 2 Closed Panel : Cavity/Brick/Block		
Stewart Milne Group Solutions	Open/Closed Panel: Cavity/Brick/Block			Sigma 2 Closed Panel : Cavity/Brick/Block		
						
	0.040 Fibre Insulation 140mm Stud & Foil Paper	0.023 Foam Insulation (110mm) 140mm Stud & Foil Paper	0.023 Foam Insulation (110mm) 140mm Stud & Foil Paper + Thermal PB	200mm Stud 0.032 Insulation	200mm Stud 0.032 Insulation	200mm Stud 0.023 Insulation

Sigma II – Build System

- 'Space Stud' Technology →
- G/Floor and ceiling cassette (option) →
- Improved Detailing (Lock Joints) →
- Air Test after Kit Erection →
- Conventional Skills/ Process →



- (option)
- ← Air Seal Factory Fitted
 - ← Conventional 50m Cavity
 - ← Blown Insulation
 - ← Less Process On Site
 - ← Standard Bricks & Dry lining

↑
0.15 U-Value 3 Air Tightness
0.02 'Y-Value' Level 4+

Build Complexity

- Services design appreciation – “heart and lungs”
- Supply chain simplification - integration
- User interface, de-clutter
- Ventilation consider early on

“Keep it simple....”



Invertor Shutoffs



Underfloor Heating Manifolds



MVHR Ductwork

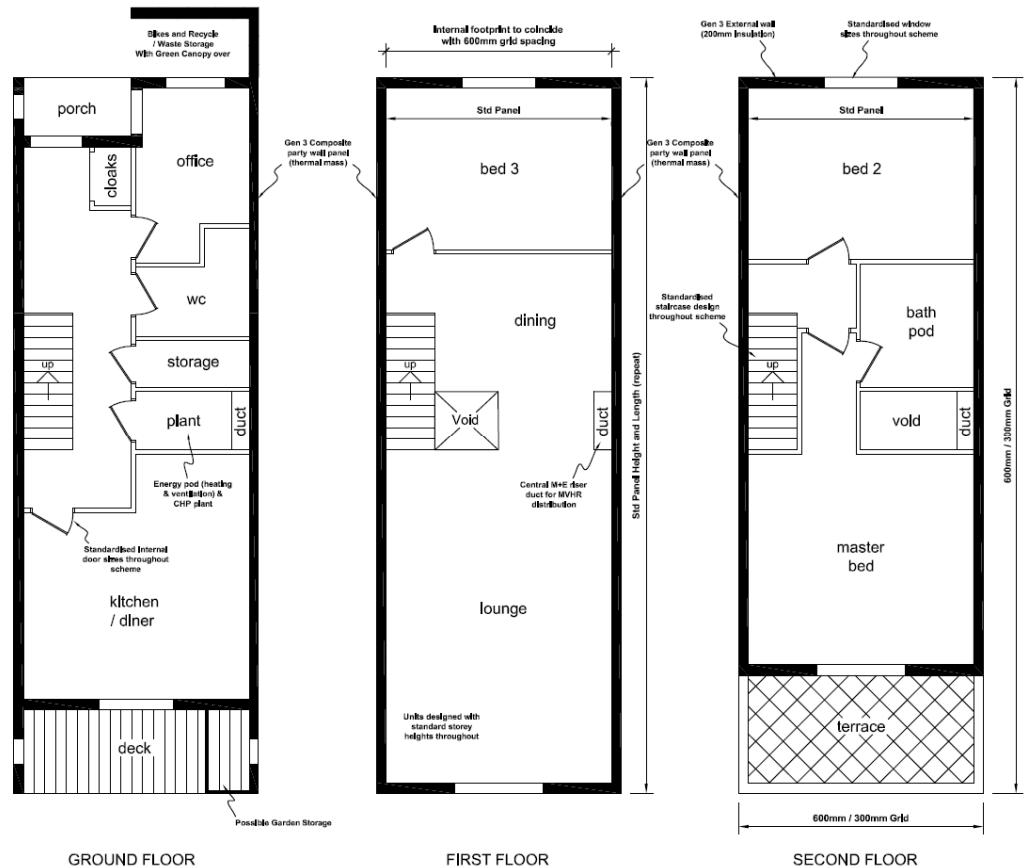
Design for Manufacture

- Simplification
- Home energy centre
- Service risers
- System approach
- Simple build Form
- Component repetition
- Cost efficiency



Off-site Build System

Sigma II House Range "Off Shelf"

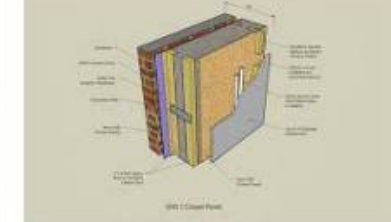


Construction Process

- Move to manufacture off site
- Build system – value engineered and quality driven
- Conventional materials and skills
- Technology blind
- User friendly



Internal Floor



External Wall



Thermal comfort and health

- Ventilation strategy
- Passive and natural cooling
- Solar gain & shading
- Surface density – finishes
- Balanced approach – all things considered



Fabric



Services



Fixtures & Fittings

Energy Provision

- Avoid the eco-bling – it fails
- Micro-renewables, not realistic
- Green the grid
- Energy providers – provide energy not developers

Wind Damaged Turbine



Outputs



Summary

- Kiss - Keep it simple stupid
- Fit and forget - fabric
- Level 4 - mainstream low energy - Step 1
- Green the grid
- Customer focused solutions - - not technology driven

