



# Low carbon development of large sites

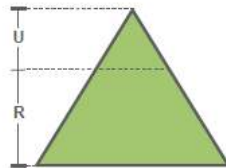
Chippenham, 12<sup>th</sup> December

Tony Norton

Head of the Centre for Energy and the Environment

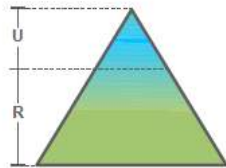


# Zero-Carbon Buildings



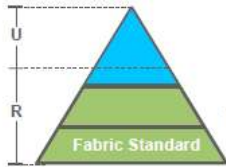
## Up to Mid 2008

All carbon emissions to be mitigated on site. (Code For Sustainable Homes Level 6). Essentially zero carbon achieved using energy efficiency and on site low and zero carbon technologies.



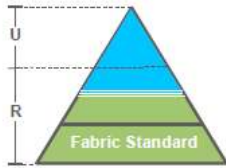
## Mid 2008

Concept of Allowable Solutions proposed after studies revealed that it would be impractical to achieve zero carbon on many sites using the Code 6 definition. No attempt yet to specify scope of Allowable Solutions.



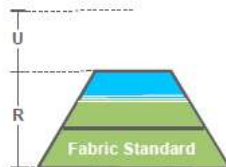
## Mid to late 2009

A 70% Carbon Compliance line is drawn by Government after initial consultation (note that this 70% reduction of emissions applies only to **Regulated** Energy use), leaving Allowable Solutions as the mechanism for mitigating about half of the carbon emissions from a typical home. In late 2009, a minimum Fabric Energy Efficiency Standard is proposed as part of Carbon Compliance.



## February 2011

Evidence-based recommendations identify more realistic Carbon Compliance levels for homes: approximately 60, 56 and 44% reduction over 2006 levels, depending on dwelling type. Allowable Solutions now required to mitigate significantly more than half of the emissions from a home. Carbon Compliance is to be based on actual performance.



## March 2011

Post Budget, the emissions from unregulated energy use are no longer in the definition of zero carbon. Allowable Solutions are still needed, however, to bridge the gap between the Carbon Compliance levels proposed for 2016 Part L and the zero carbon target (now defined as 'no emissions from **Regulated** energy use').



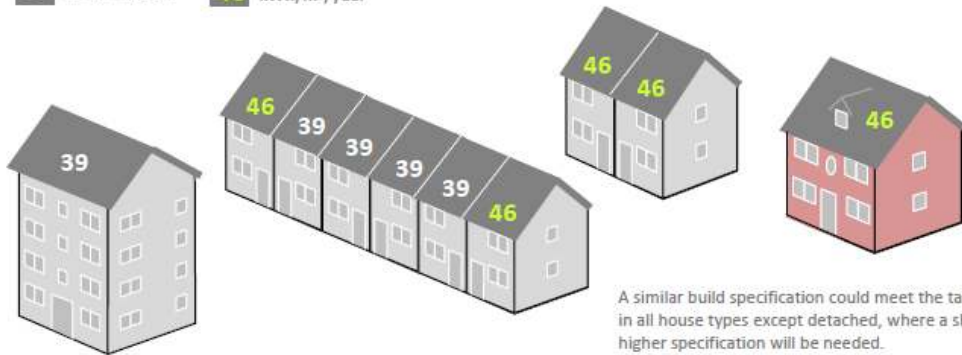
R = Carbon emissions from Regulated energy use (heating, hot water etc)

U = Carbon emissions from Unregulated energy use (eg plug in appliances)

# Energy Efficiency Standard

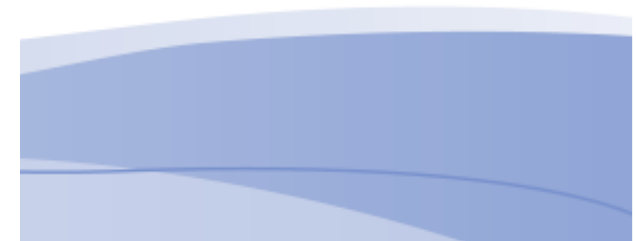
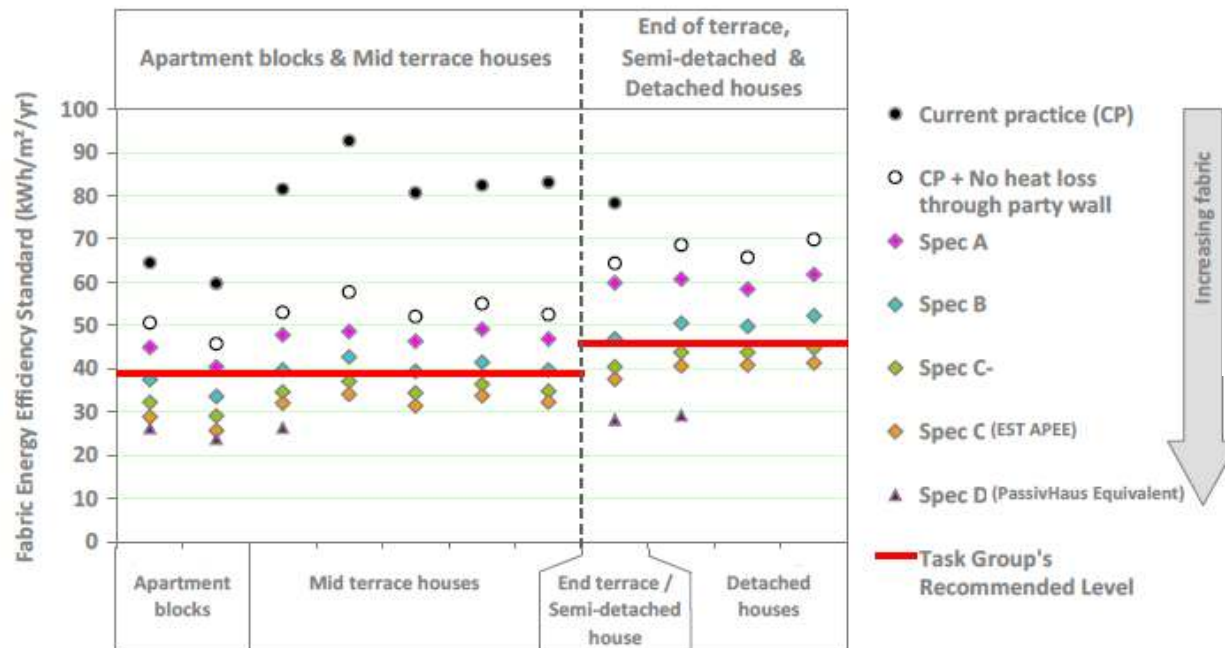
Fabric energy efficiency levels in the Standard

**39** kWh/m<sup>2</sup>/year    **46** kWh/m<sup>2</sup>/year



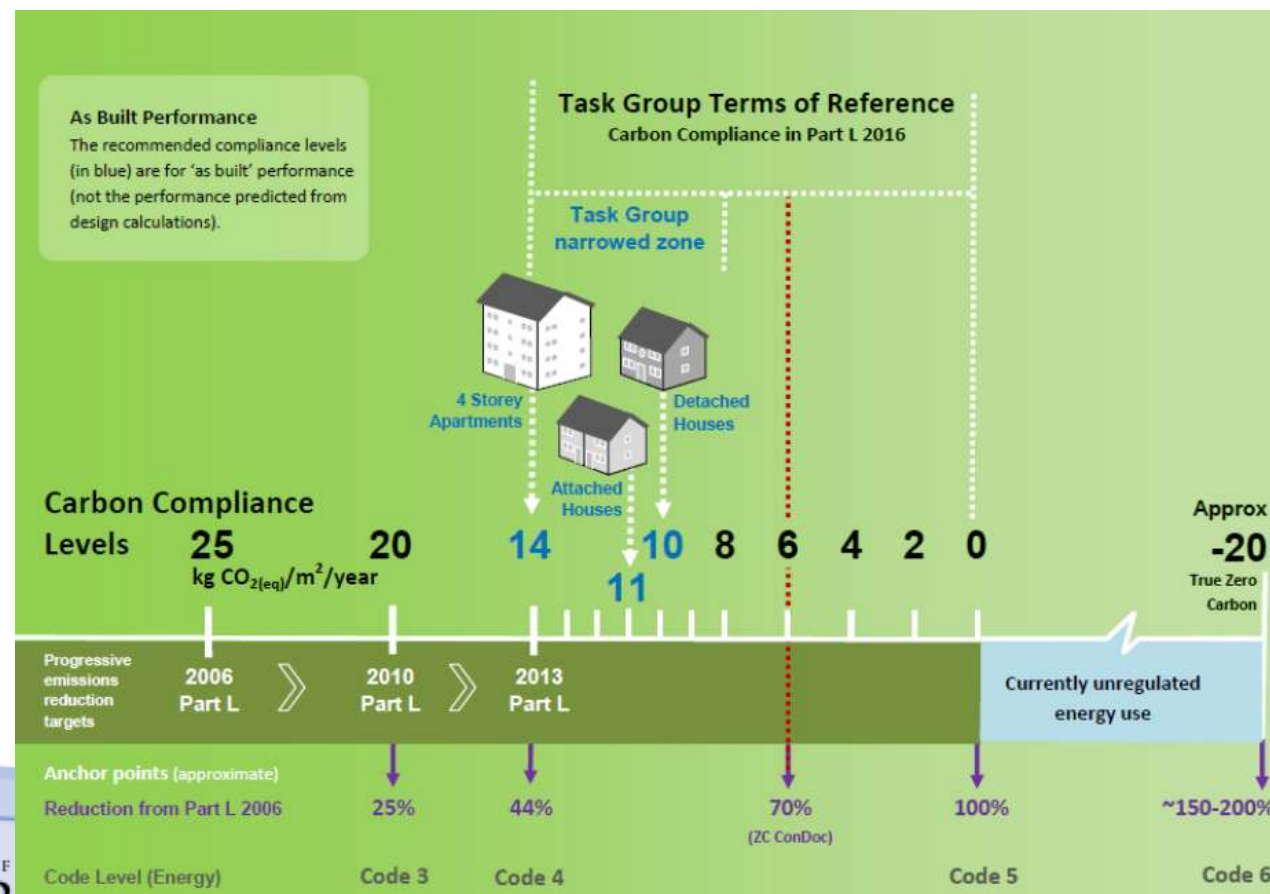
A similar build specification could meet the target in all house types except detached, where a slightly higher specification will be needed.

	Dwelling type			
	4-storey apt. block	Mid terrace	End terrace / Semi	Detached
Target Fabric Energy Efficiency Standard (kWh/m <sup>2</sup> /yr) <sup>f</sup>	39	39	46	46
Wall U-value (W/m <sup>2</sup> K)	0.18	0.18	0.18	0.18
Floor U-value (W/m <sup>2</sup> K)	0.18	0.18	0.18	0.14
Roof U-value (W/m <sup>2</sup> K)	0.13	0.13	0.13	0.11
Window U-value (W/m <sup>2</sup> K)	1.4	1.4	1.4	1.3
Air permeability (m <sup>3</sup> /m <sup>2</sup> /hr @ 50Pa)	3	3	3	3
Thermal bridging y-value (W/m <sup>2</sup> K)	0.05	0.05	0.05	0.04



# Carbon Compliance

Note: Carbon compliance levels based on national viability – could require better standards where local conditions are favourable e.g. *“Widespread use of biomass at dwelling and communal scale may also be constrained by clean air legislation, particularly in areas of high population density.”*



# Allowable Solutions: Now (indicative)

## 'On-site' options

- ◆ Installation of smart appliances
- ◆ Application of 'flexible demand' systems (supporting demand side management)
- ◆ Use of grid-injected biomethane linked to the site by Green Gas Certificates
- ◆ Installation of communal heat accumulator (site based heat storage)
- ◆ Home electric vehicle charging
- ◆ Electricity storage for the home (to store electricity generated from PV panels)
- ◆ On-site waste management (Vacuum waste collection systems)
- ◆ LED street lights for the site

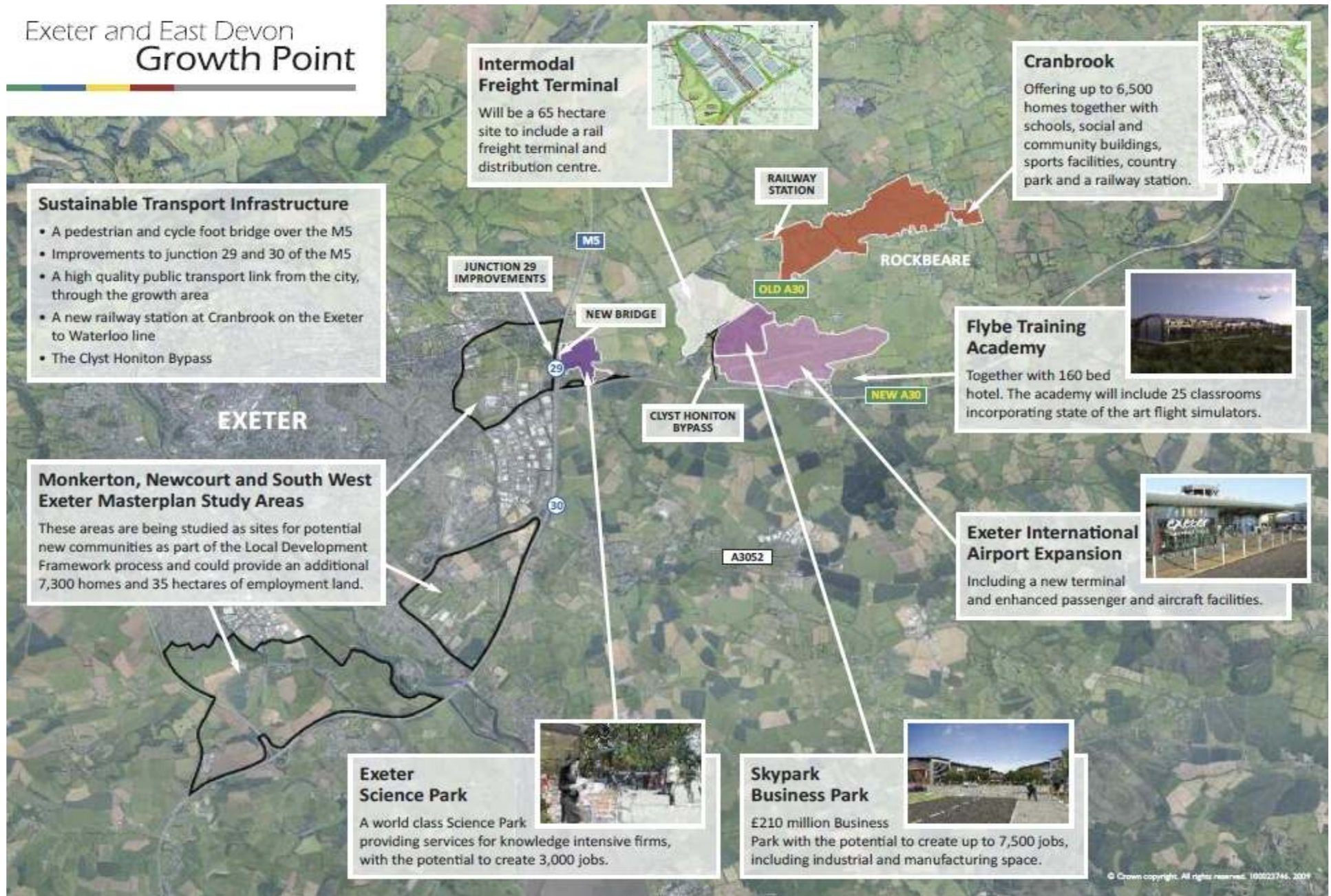
## 'Near-site' options

- ◆ Export of low carbon heat from site based district heating scheme (i.e. support for cost of pipe-work)
- ◆ Retro-fitting of low/zero carbon technologies to local communal buildings
- ◆ Investment in creation or expansion of locally planned sustainable energy infrastructure (e.g. district heating or on-site wind turbines)
- ◆ Investment in local electric vehicle charging infrastructure
- ◆ Investment in low carbon street lighting for local area
- ◆ Local micro-hydro schemes
- ◆ Communal waste management solutions
- ◆ Local energy storage solutions

## 'Off-site' options

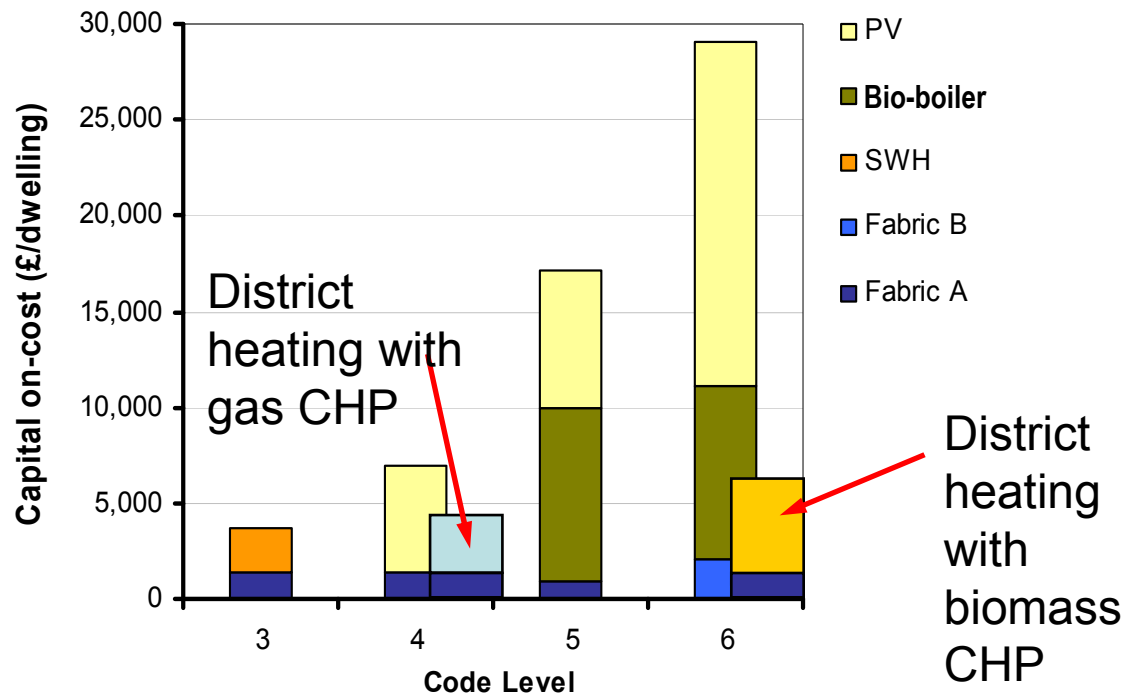
- ◆ Investment in Energy-from-Waste plants (e.g. Anaerobic Digestion and Pyrolysis/Gasification plants)
- ◆ Investment in low carbon electricity generation assets up to a maximum determined scale eg excluding large scale off shore generation
- ◆ Investment in district heating pipe-work to connect new loads to existing schemes or support new schemes
- ◆ Investment in retro-fitting of low carbon technologies to communal buildings
- ◆ Investment in embodied carbon reduction initiative
- ◆ Investment in low carbon cooling
- ◆ Investments in energy storage and demand-side management/flexible demand projects to counter intermittent renewables

# Exeter and East Devon Growth Point



# Cranbrook in 2007/8

1. Outline planning permissions granted December 2007 at CSH3 and 16% RE
2. Energy strategy completed mid 2008



3. Economic downturn stalls development



Source: Element Energy, July 2008

# Current economics vs future costs

## CRANBROOK SITE WIDE ENERGY SYSTEM CASHFLOWS 2.5 MWe steam-cycle biomass fuelled CHP system and site-wide district heating

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Capital costs (£'000s)</b>																
CHP plant costs (including energy centre, boilers etc)	-£6,093	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£61
District heating network costs	-£2,660	-£2,660	-£2,660	-£2,660	-£2,660	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Cost of heat exchangers	-£75	-£273	-£453	-£415	-£425	-£455	-£340	-£20	-£20	-£30	£0	£0	£0	£0	£0	£0
<b>Capital offsets (£'000s)</b>																
Boiler plant	£200	£752	£1,306	£1,206	£1,258	£1,412	£1,006	£103	£103	£155	£0	£0	£0	£0	£0	£0
Gas connections	£44	£154	£242	£220	£220	£220	£176	£0	£0	£0	£0	£0	£0	£0	£0	£0
<b>Operating costs (£'000s)</b>																
CHP fuel cost	£0	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270	-£1,270
Boiler fuel cost	£0.00	£0.00	£0.00	-£0.01	-£0.01	-£0.02	-£0.02	-£0.03	-£0.03	-£0.03	-£0.03	-£0.03	-£0.03	-£0.03	-£0.03	-£0.03
O&M cost	£0	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294	-£294
<b>Revenues (£'000s)</b>																
Revenue from electricity sales	£0	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786	£786
Revenue from sale of ROCs	£0	£1,490	£1,380	£1,198	£1,031	£787	£613	£478	£474	£472	£463	£463	£463	£463	£463	£463
Revenue from sale of heat	£0	£21	£97	£228	£346	£476	£618	£714	£720	£722	£733	£733	£733	£733	£733	£733
<b>Total cost in year (£'000s)</b>	<b>-£8,584</b>	<b>-£1,294</b>	<b>-£866</b>	<b>-£1,001</b>	<b>-£1,009</b>	<b>£1,661</b>	<b>£1,295</b>	<b>£496</b>	<b>£499</b>	<b>£540</b>	<b>£417</b>	<b>£417</b>	<b>£417</b>	<b>£417</b>	<b>£417</b>	<b>£478</b>
<b>Cumulative cost (£'000s)</b>	<b>-£8,584</b>	<b>-£9,878</b>	<b>-£10,743</b>	<b>-£11,745</b>	<b>-£12,754</b>	<b>-£11,093</b>	<b>-£9,798</b>	<b>-£9,302</b>	<b>-£8,803</b>	<b>-£8,264</b>	<b>-£7,846</b>	<b>-£7,429</b>	<b>-£7,012</b>	<b>-£6,594</b>	<b>-£6,177</b>	<b>-£5,699</b>
<b>Net present value (£'000s)</b>	<b>-£8,584</b>	<b>-£9,760</b>	<b>-£10,476</b>	<b>-£11,228</b>	<b>-£11,917</b>	<b>-£10,886</b>	<b>-£10,155</b>	<b>-£9,900</b>	<b>-£9,668</b>	<b>-£9,439</b>	<b>-£9,278</b>	<b>-£9,132</b>	<b>-£8,999</b>	<b>-£8,878</b>	<b>-£8,768</b>	<b>-£8,653</b>

Source: Element Energy, July 2008

# Cranbrook DH & CHP breakthroughs



- £28m public sector infrastructure funding package
- £4.1m HCA low carbon infrastructure grant
- Private sector ESCo proposition
- Renewable Heat Incentive (RHI)
- Skypark commercial development included in scheme



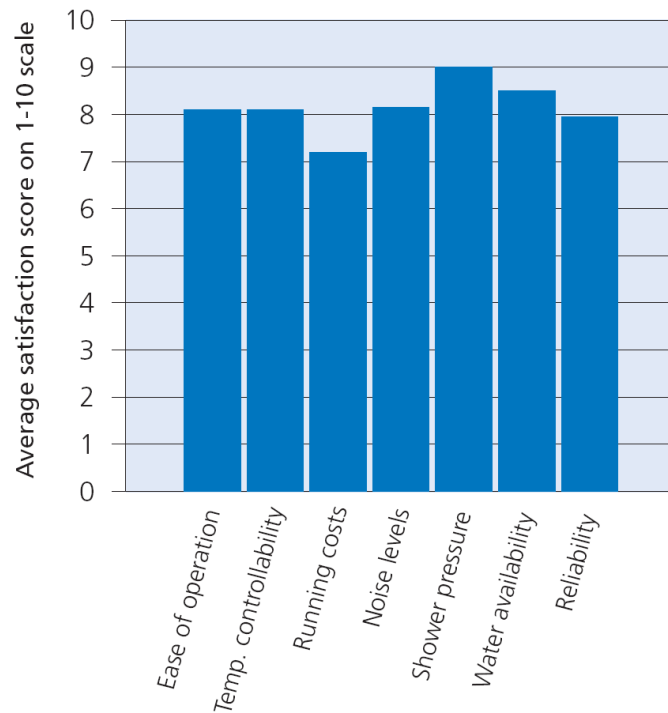
# Developer concern – DH schemes in operation in the UK



- Southampton
- Sheffield
- Nottingham
- London - Tower Hamlets
  - Pimlico
  - Southwark
  - Harrow
- Redhill
- Aberdeen
- Lerwick
- Oban
- Lisburn



# Developer concern - satisfaction/attitudes



Source: EST case study CE103, 2005

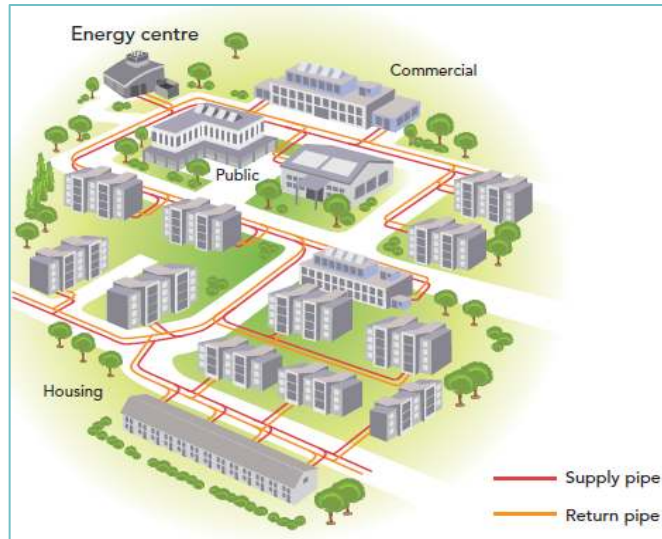


“71% of people thought that a district heating system could be better than the current individual systems in their homes”



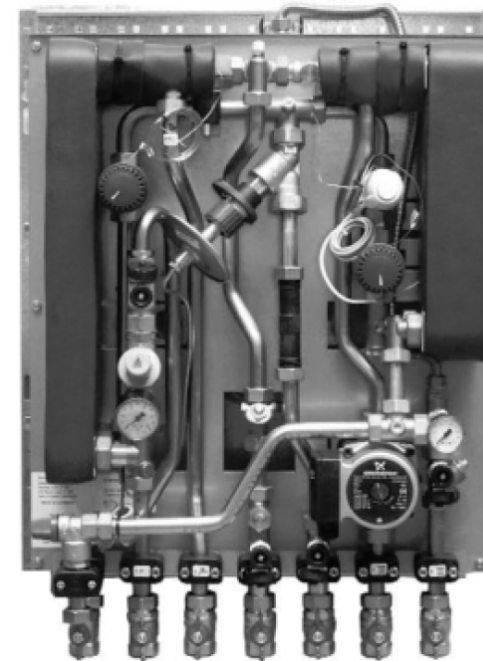
“The South West stands out as always being quite a lot more positive about green taxes”

# Developer concern - DH benefits and avoided costs



## AVOIDED COSTS

gas network, gas connections,  
gas meter etc., gas boiler,  
flue, hot water cylinder,  
immersion heater, plumbing



## BENEFITS

- space savings
- heat availability

# Developer concern - gas hobs

- District heating delivers low carbon heat for space heating and hot water displacing gas (where available) and the economics of district heating are assisted by the savings made from not running gas pipe work and installing gas boilers
- If gas is not provided households are required to cook using electricity  
Cooking accounts for only 3% of UK domestic energy use so changing from gas to electric cooking is not a significant contributor to CO<sub>2</sub> emissions
- There is a perception that consumers have a strong preference for cooking on gas hobs and that homes without gas hobs will not sell



**BUT**



- 35% of homes with gas cook using electric hobs
- Electric ceramic and induction hobs offer significant advantages for consumers
- Electric hobs are widely available and cost competitive
- In extremis, bottled gas is an alternative

# Cranbrook & Skypark Energy Solution



Image courtesy of eon



## District heating

Homes and commercial buildings connected by 75 km of heat pipes

## Energy Centre

- 1.4 MWe natural gas CHP units and five 4 MWth Natural Gas boilers
- Two advanced thermal gasification units linked to two 1.4 MWe CHP engines
- Thermal stores
- Output Capacity when fully operational 4.2 MW electricity and 25.4 MW heat
- c 13,000 t /year CO<sub>2</sub> savings per year

# Cranbrook & Skypark scheme benefits



- Reduce developers exposure to tightening CO<sub>2</sub> standards at little extra cost
- Demonstration of a private sector ESCo model
- Biomass CHP using recycled wood
- ~£45m low carbon investment

# Cranbrook - work underway 2011



# Cranbrook district heating pipework October 2011



# Cranbrook district heating pipework December 2011



# Cranbrook district heating pipework

December 2011



# Cranbrook district heating pipework December 2011



# Cranbrook district heating pipework December 2011



# Cranbrook district heating pipework December 2011



# Cranbrook district heating pipework December 2011



# Thank You

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