Geothermal Live – 30 April 2008

Session 2: Procuring and Specifying a GSHP

Planning and Contracting Processes:

A Route Map for Developers

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Contents

- **Legislation**
  - Planning legislation
  - Importance of CO_2
- **RIBA (1998) 'Outline Plan of Work'**
- **The Planning Stage**
  - Comparisons of different renewable technology
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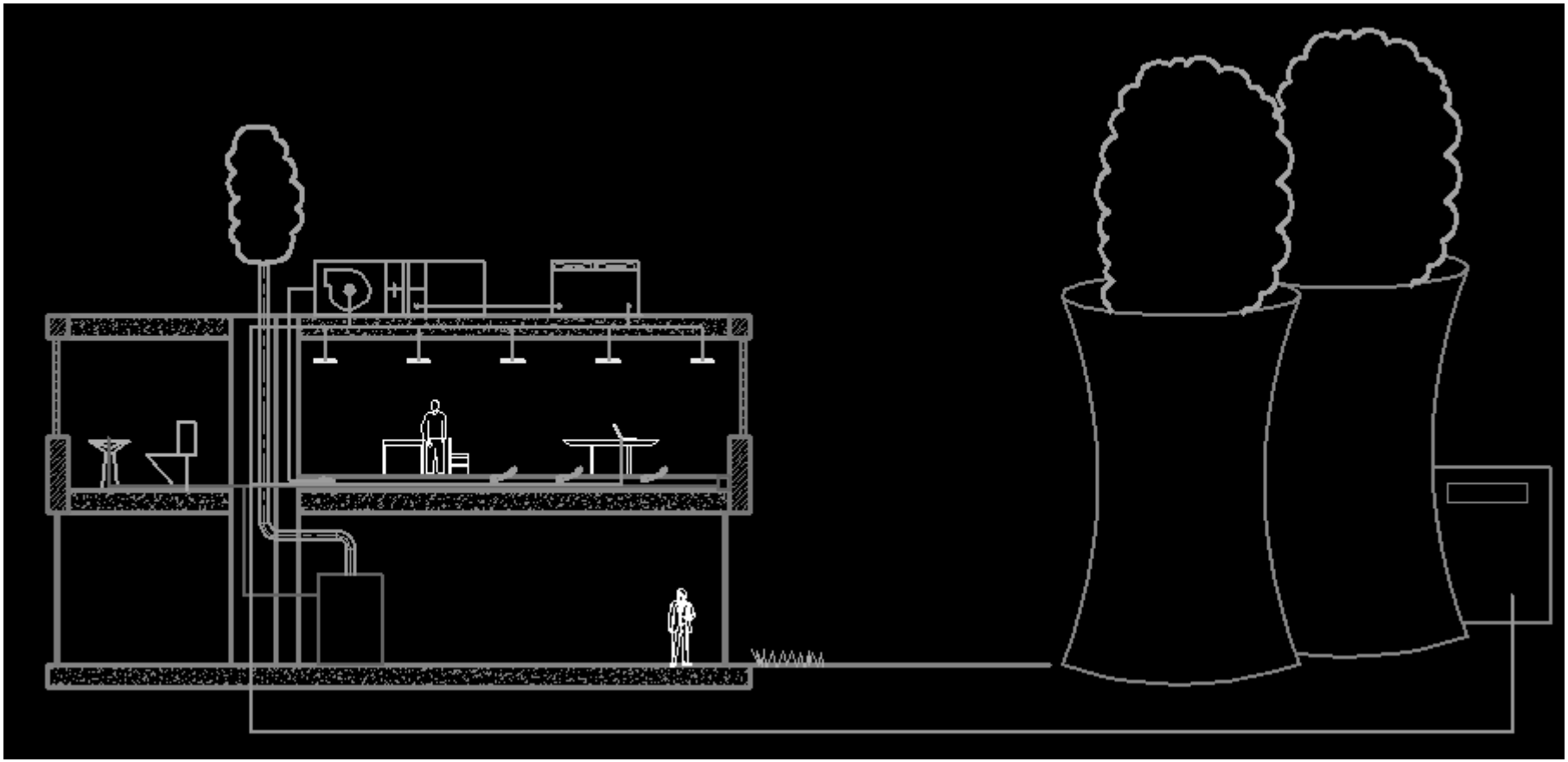
    - GSHP compared with other renewables
- **The Detailed Design Stage**
- **The Construction Stage**

Legislation

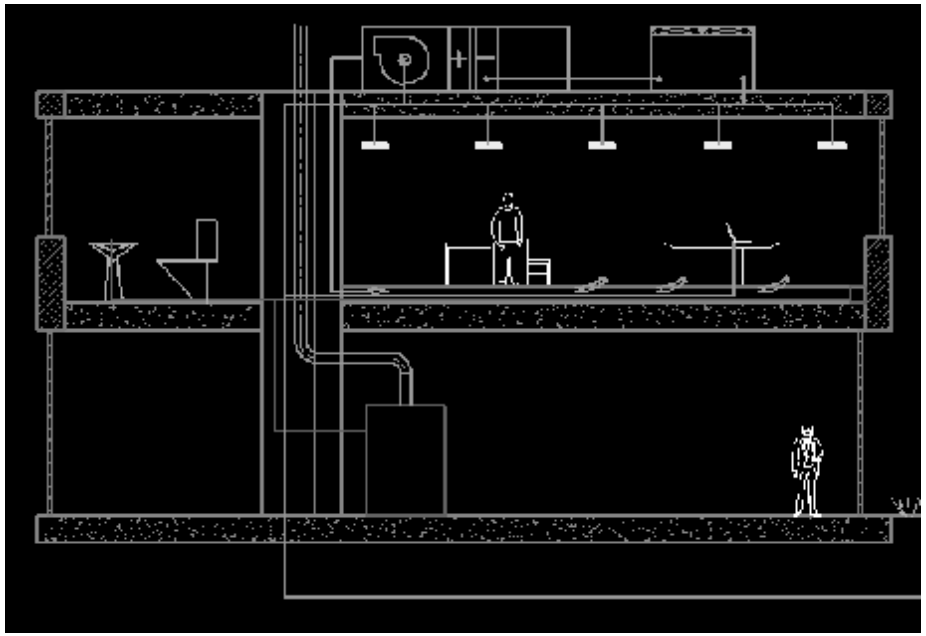
- **Town and Country Planning Act (1990)**
  - Planning Permission
  - Environmental Impact Assessment
- **Water Act**
  - Section 32 Consent (to drill and test a borehole)
  - Abstraction Licence/ Discharge Consent
- **Environmental Protection Act (1990)**
- **Control of Substance Hazardous to Health (COSHH)**
- **Construction (Design and Management) Regulations (CDM)**
- **Building Regs (Part L) – Carbon Emissions**

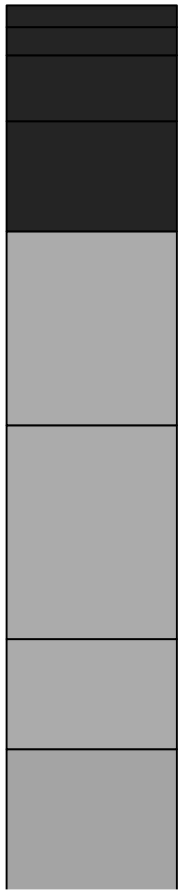
Sources of CO_2 Emissions

Electricity - Power Station Emissions



CO_2 Emissions From An Office





Miscellaneous Electrical
Catering
Computer Rooms
Office Equipment
Regulated
Lighting
Fans and Pumps
Cooling
Heating and Hot Water

UK Total Carbon Emission - 2006

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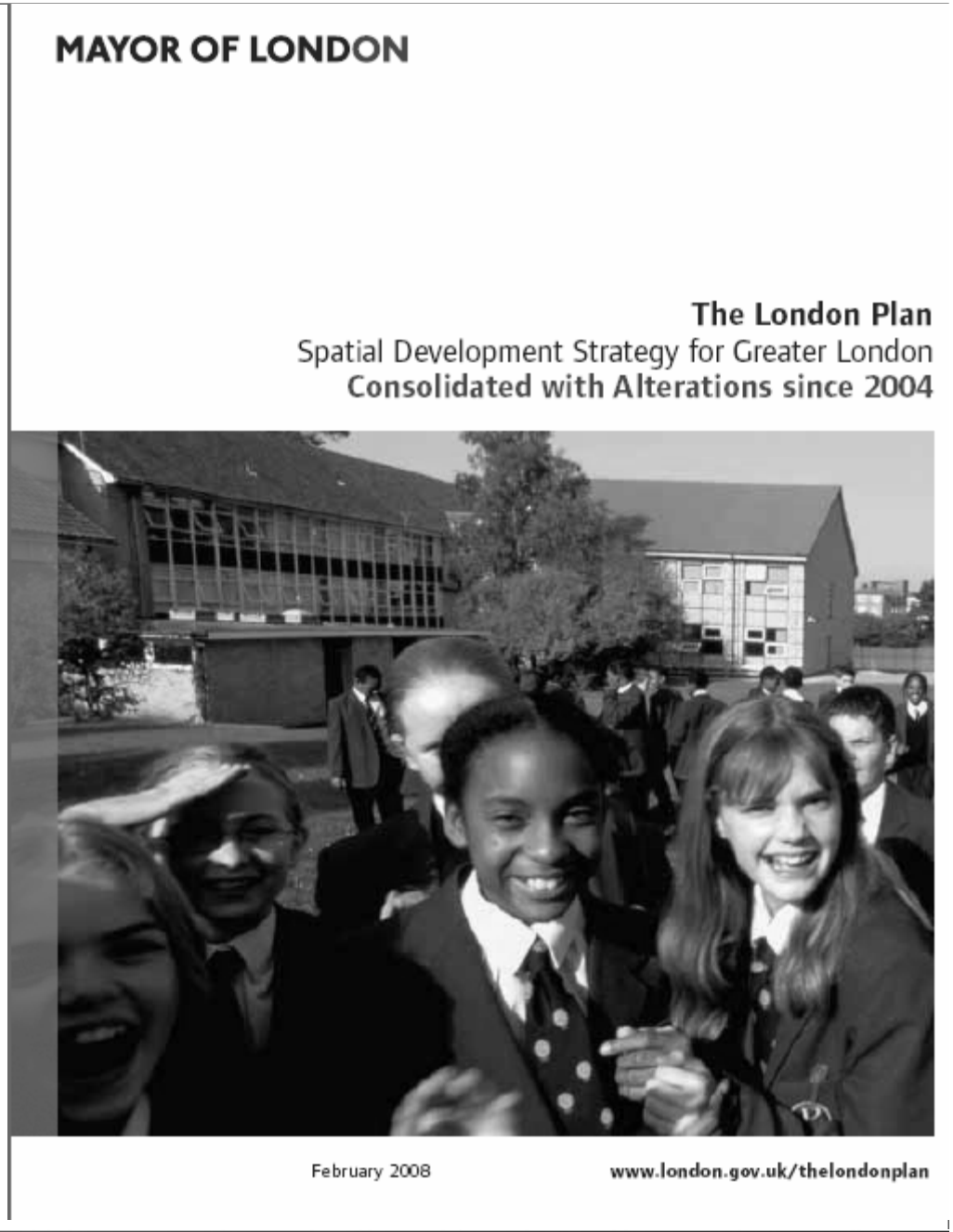
Carbon Emission Drivers

- **Part L 2006**
- **The London Plan**
- **Code for Sustainable Homes**
- **Code for Sustainable Buildings**

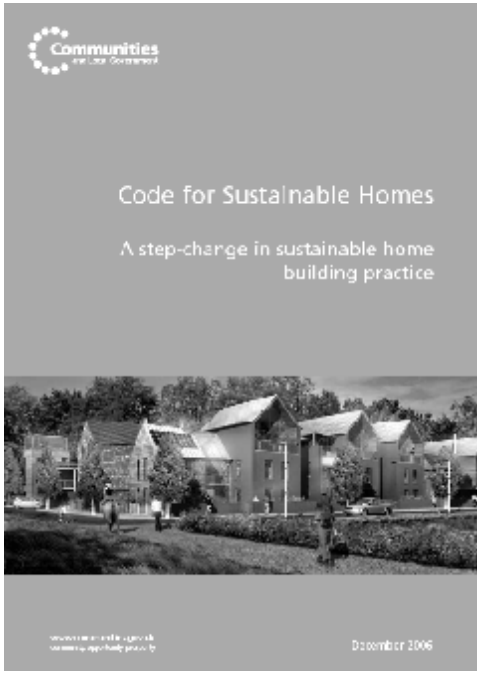
London Plan Increase in 2008

"The Mayor will, and boroughs should, in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from on site renewable energy generation"

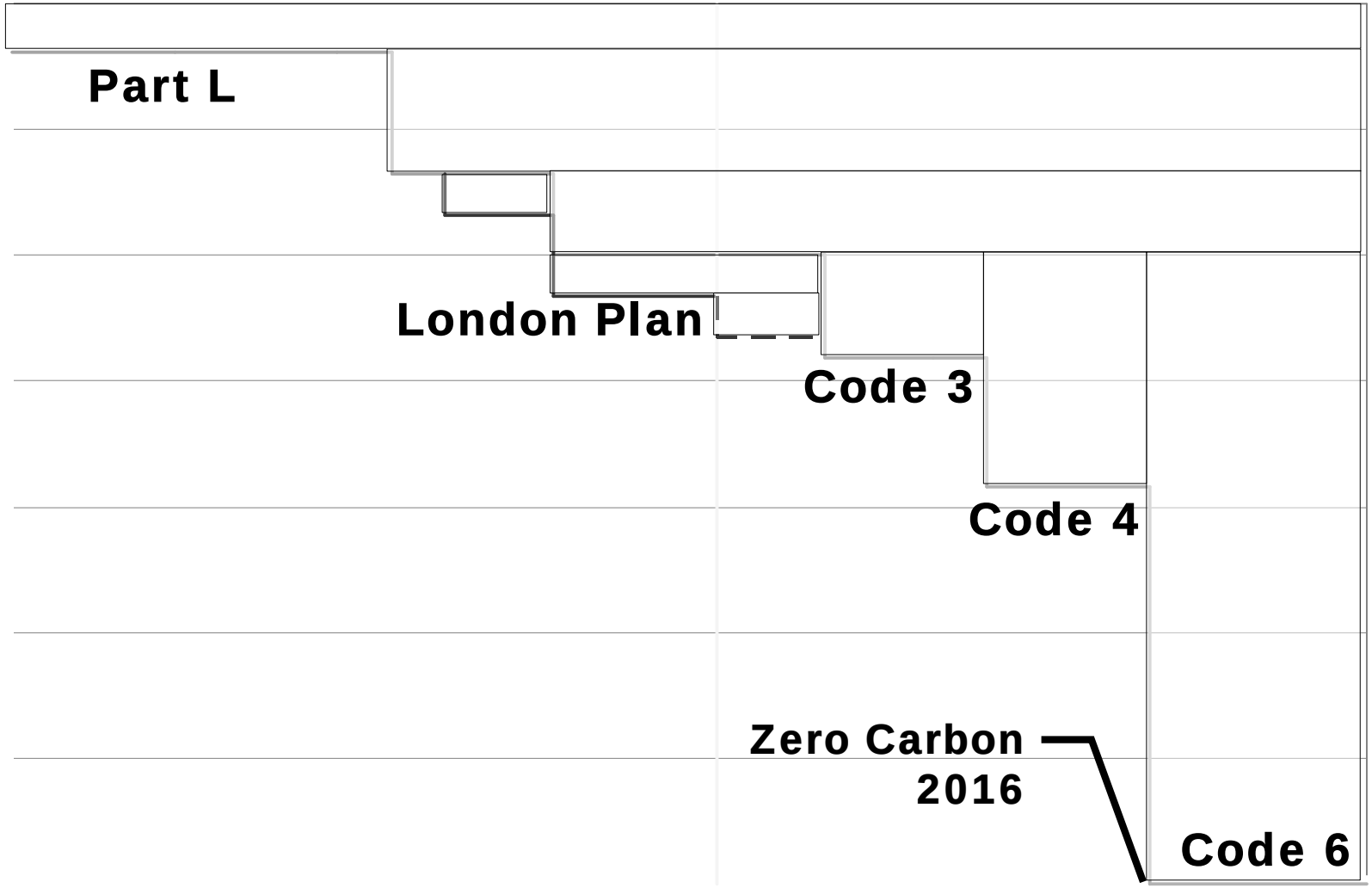


Code for Sustainable Homes

- **Introduced December 2006 as voluntary code replacing EcoHomes in England**
- **Owned by Dept for Communities and Local Government (DCLG)**
- **Live since April 2007**

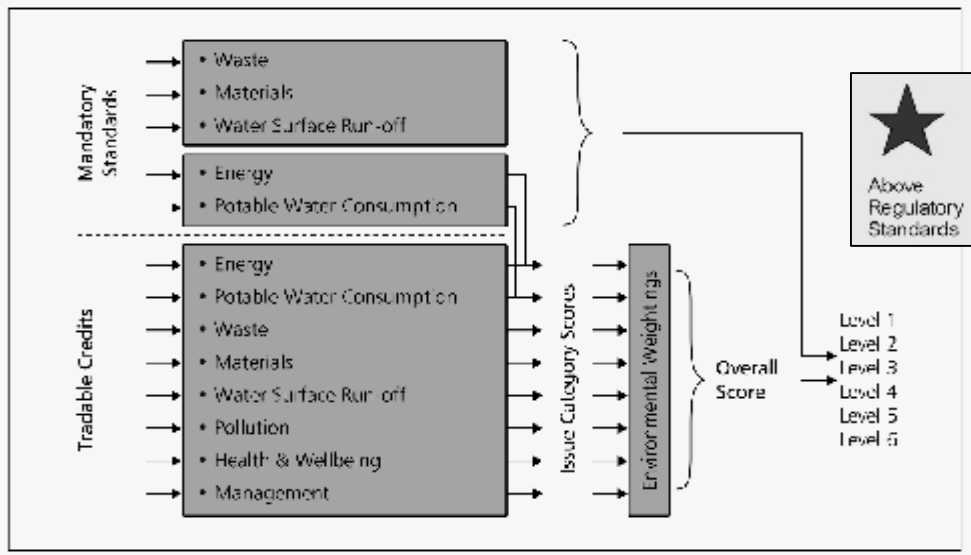


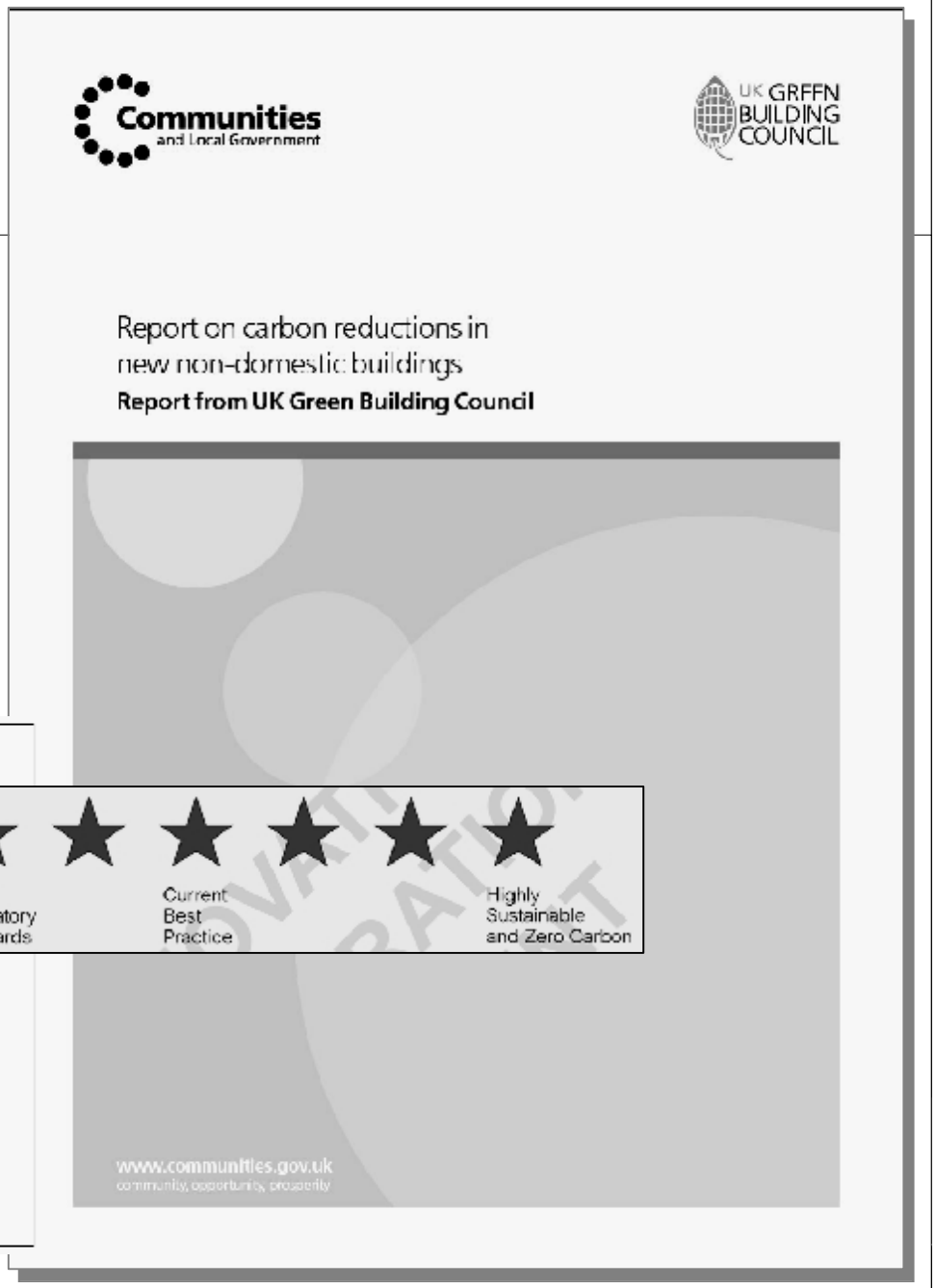
Domestic Carbon Emission Targets



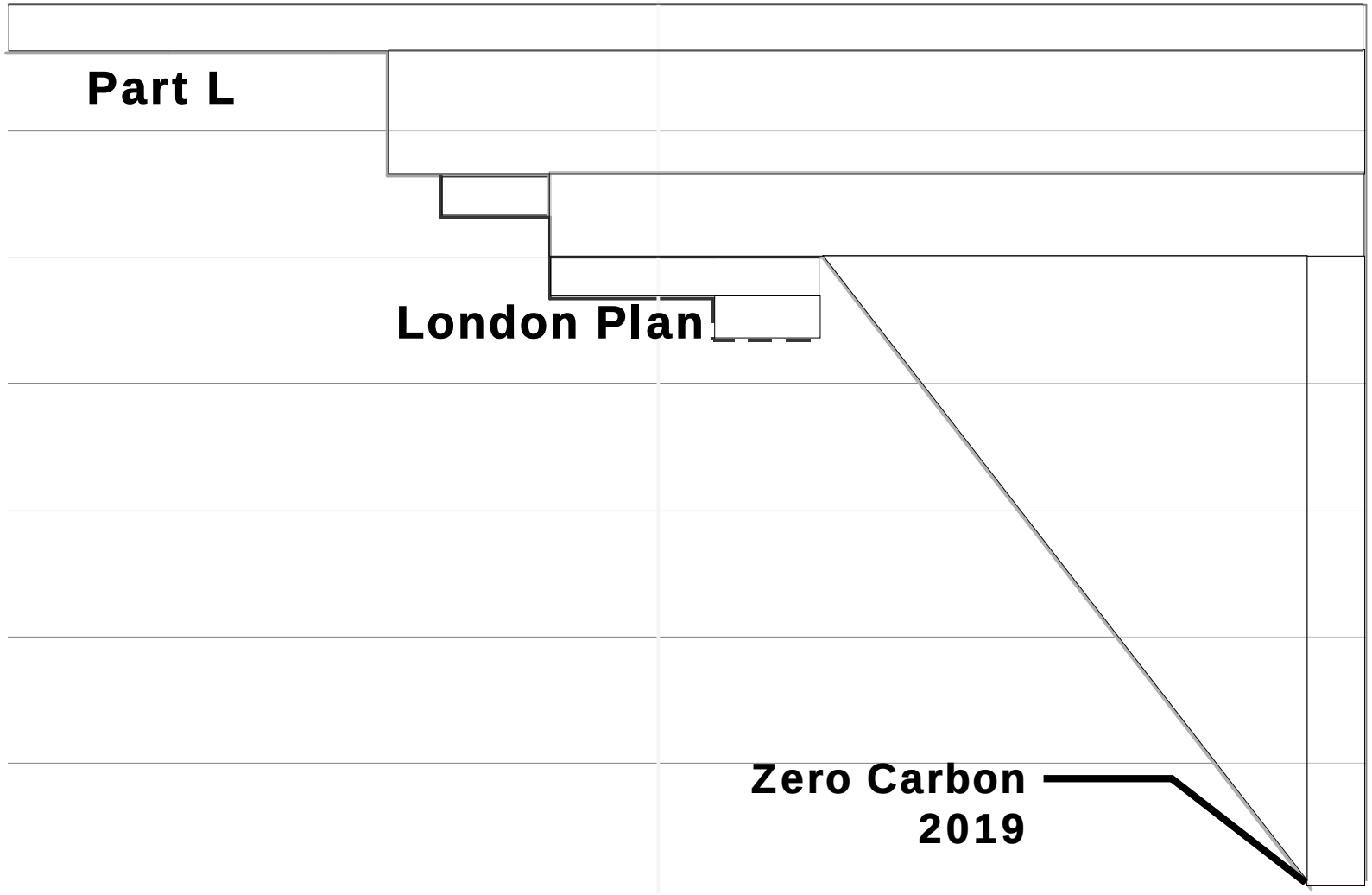
Code for Sustainable Buildings

- **Initial research coordinated by UKGBC**
- **Proposals for timeline to Zero Carbon**
- **Government announced 2019 target for all buildings in 2008 Budget**





Commercial Carbon Emission Targets



Plan of Work For Developers (RIBA, 1998)

Stages:

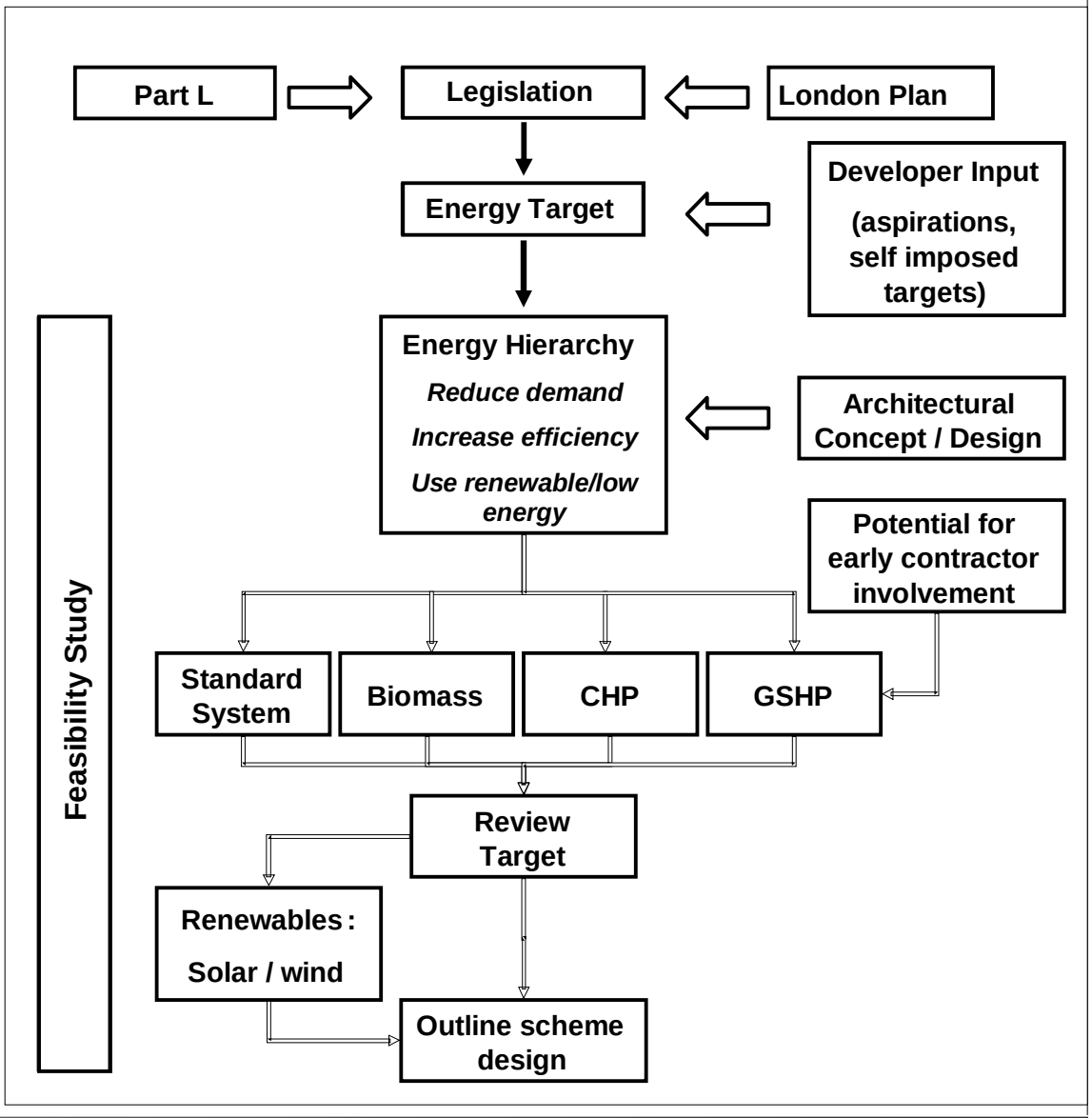
A. Inception **B. Feasibility** **C. Outline Proposals** **D. Scheme Design**	PLANNING STAGE
E. Detail Design **F. Production Information** **G. Bills of Quantities** **H. Tender Action** **J. Project Planning**	DETAILED DESIGN STAGE
K. Operations On Site **L. Completion** **M. Monitoring**	CONSTRUCTION STAGE

The Planning Stage – RIBA Stages A to D

Understanding developer aspirations – includes renewables!

- Feasibility study
- Preliminary designs
- Planning applications to Local Authority

- **Broad range of disciplines**
  - Mechanical and electrical
  - Building engineering
  - Ground engineering / groundwater



Low and Renewable Technologies Options

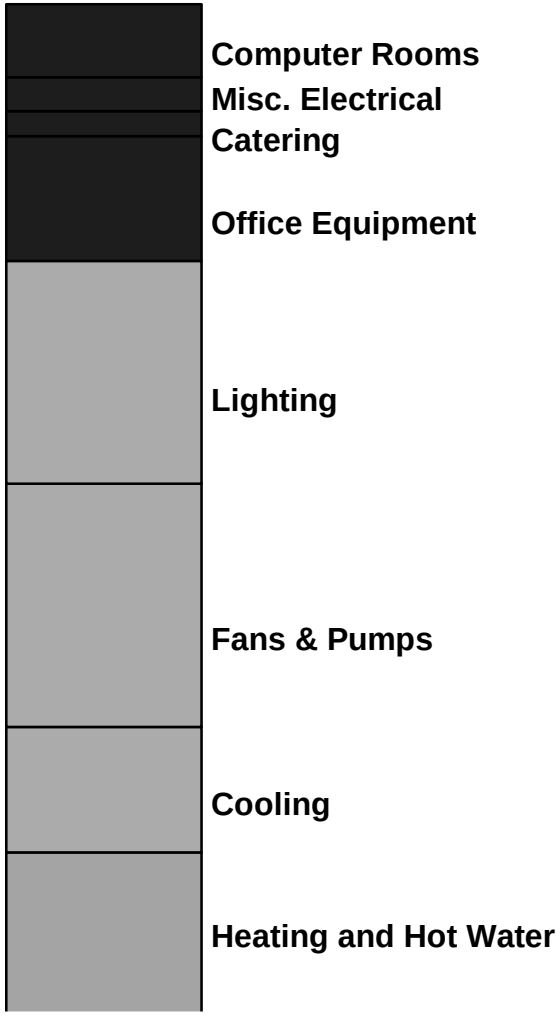
- Best design practice and beyond

- GSHP
- Biomass Boilers
- Photovoltaic Cells
- Wind Turbines
- Solar Water Heating

- Gas Fired CHP
- Biomass CHP

Typical New Build

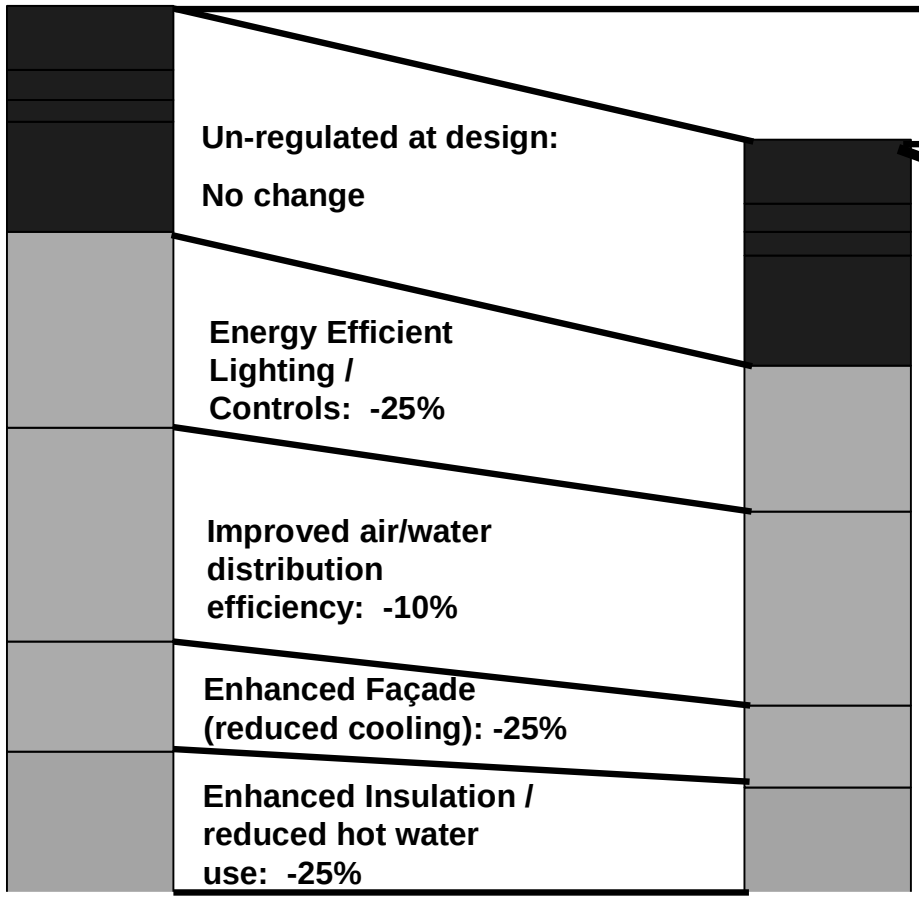
Carbon Emissions



Typical New Build (2008)

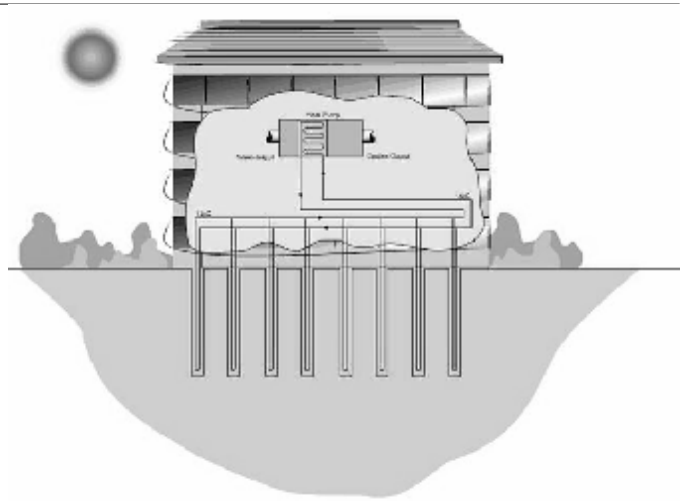
"Best Practice"

Beyond "Best Practice"

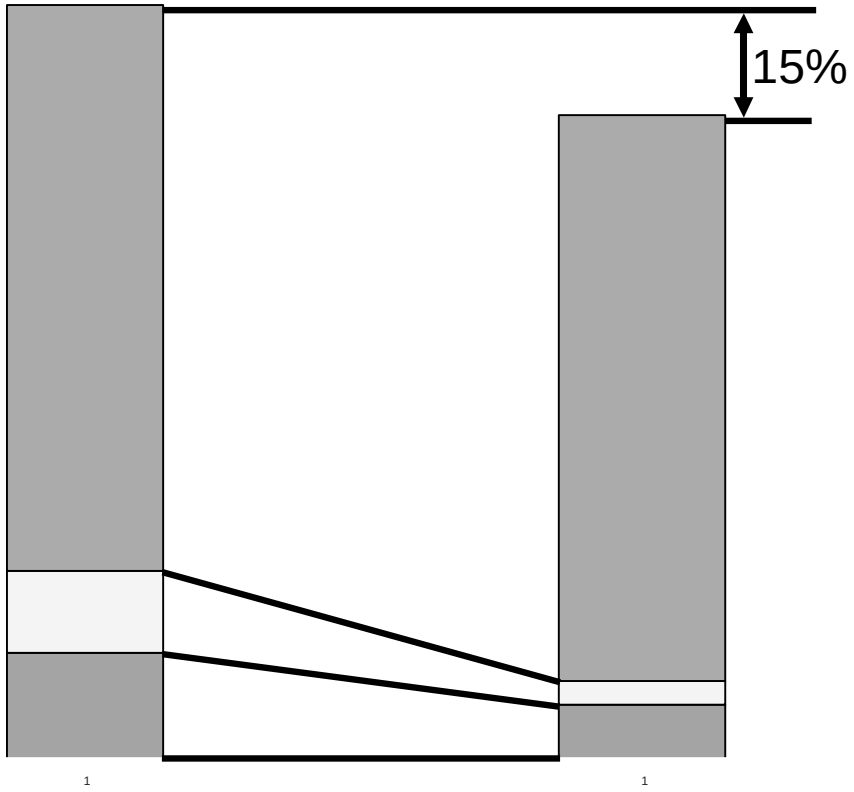


- **Change Expectations**
- **Natural Vent (mixed mode)**
- **Minimal cooling**
- **Reduced occupant energy demands**

Ground Source Heat Pumps



"Best Practice"



- Defined by GLA as Renewable
- Substantial improvement on heating and cooling efficiency
- Influence of electricity

Reducing Carbon from Electrical Supply

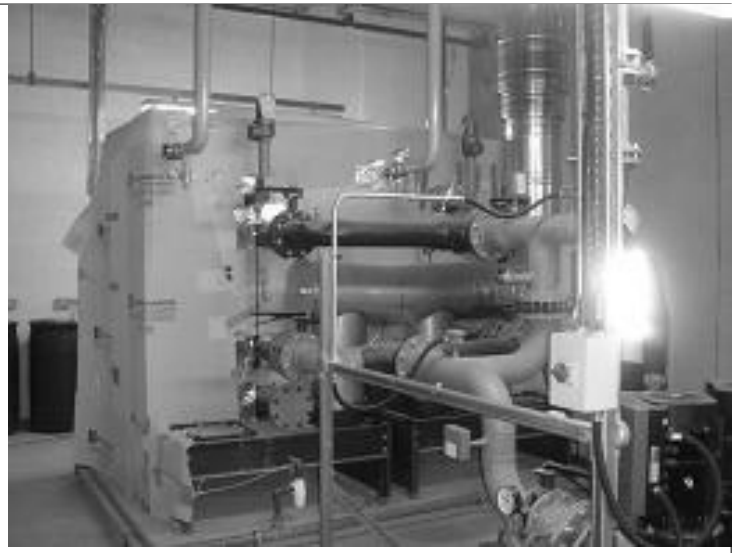
- **Current electricity to National Grid**
  - Coal fired power station 0.56kgCO2/kWhr
  - Blended Supply 0.43kgCO2/kWhr

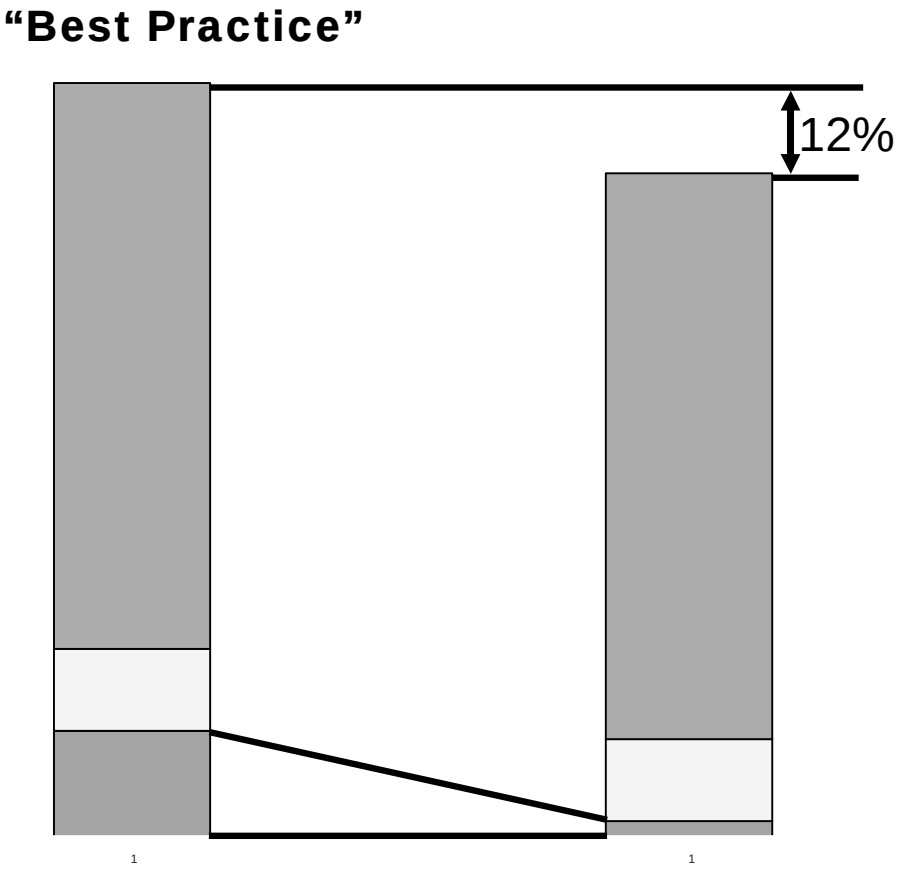
- **2025 estimate**
  - Blended Supply 0.2kgCO2/kWhr

- **This would halve the carbon emissions**

- **The carbon tax could reduce the emissions to zero.**

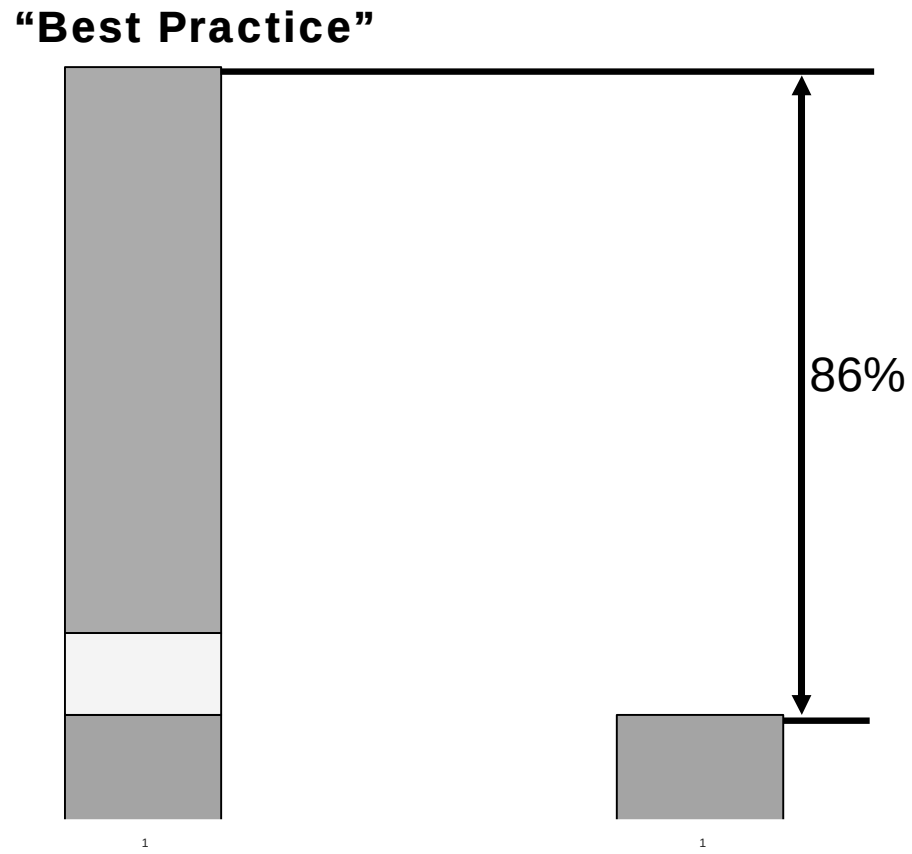
Biomass Boilers





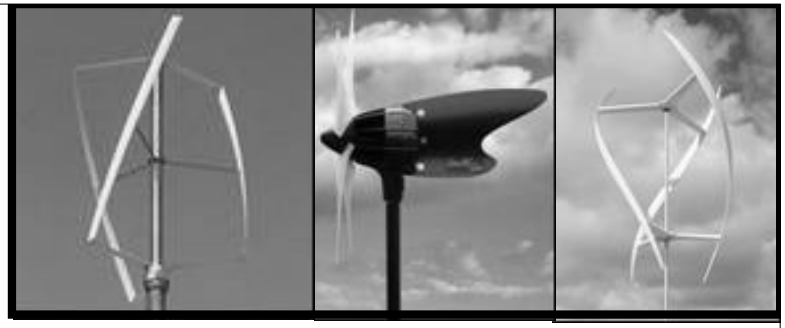
- **Biomass is "Conditionally" renewable**
- **Near zero carbon heat source**
- **Practical & logistical implications**

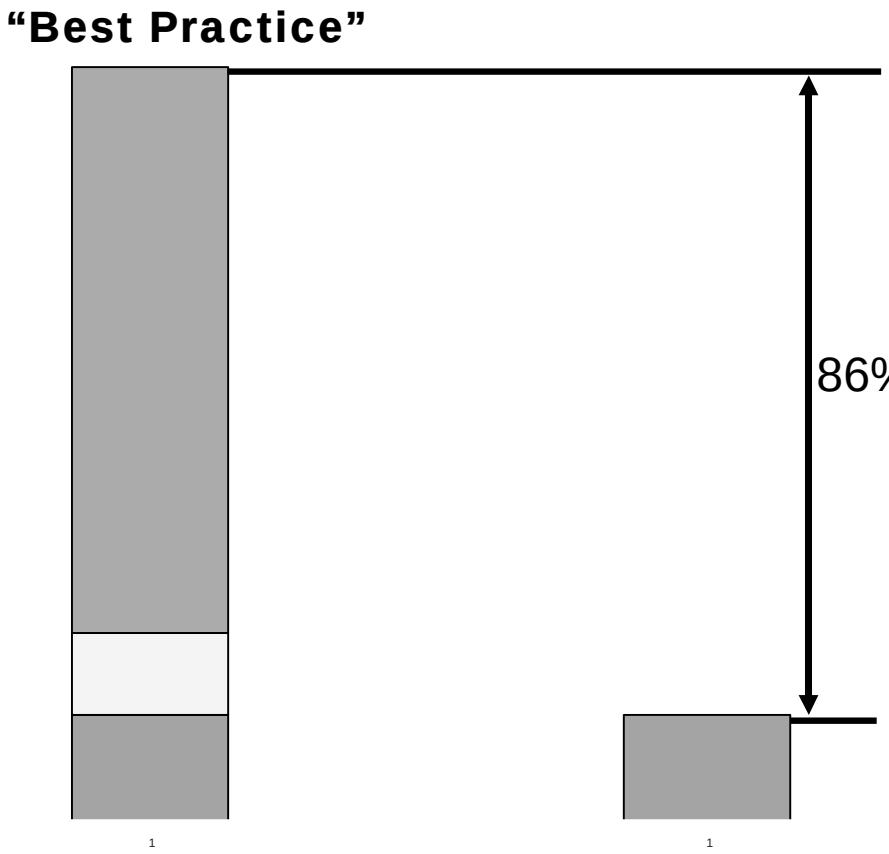
Photovoltaic Cells



- **Renewable Electricity from Sunlight**
- **Very high cost**
- **Often limited by available roof / façade area**

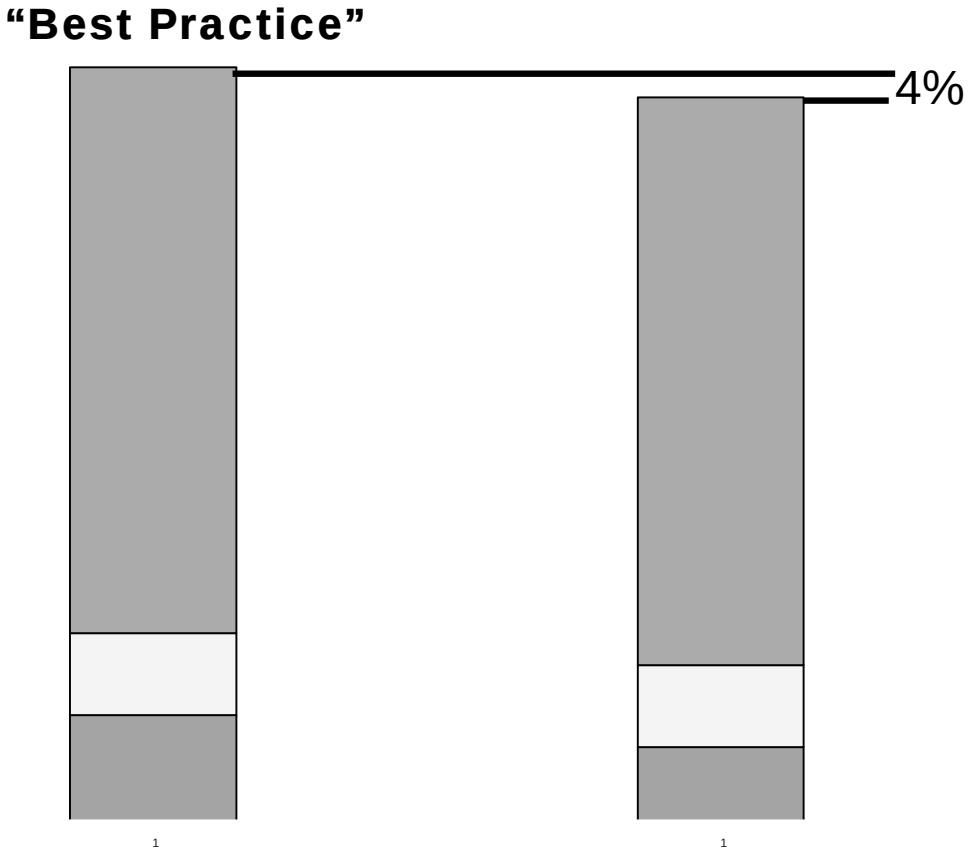
Wind Turbines

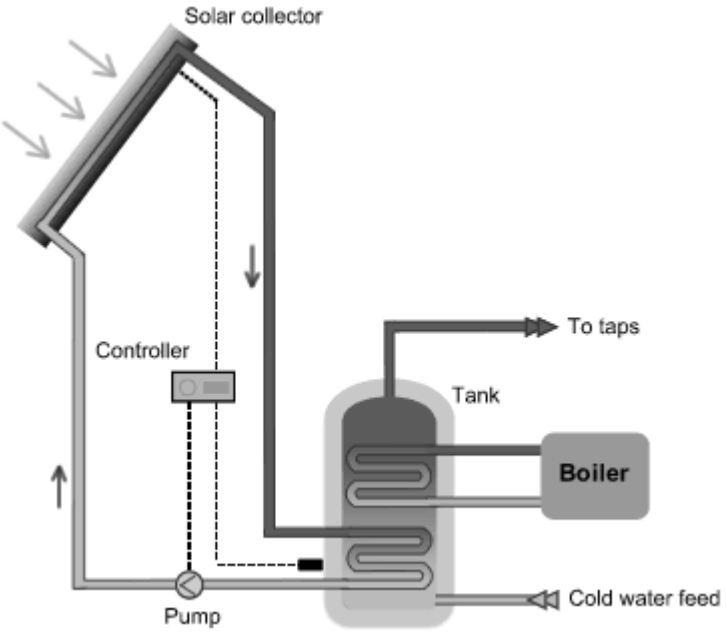




- **Renewable Electricity from Wind**
- **Limited resource in urban areas**
- **Aesthetic issues**

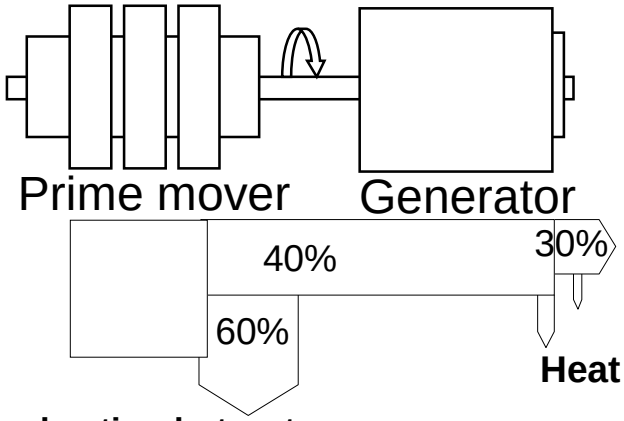
Solar Water Heating





- **Renewable heat from solar energy**
- **Impact limited to proportion of hot water generation**
- **Relies on central hot water storage**

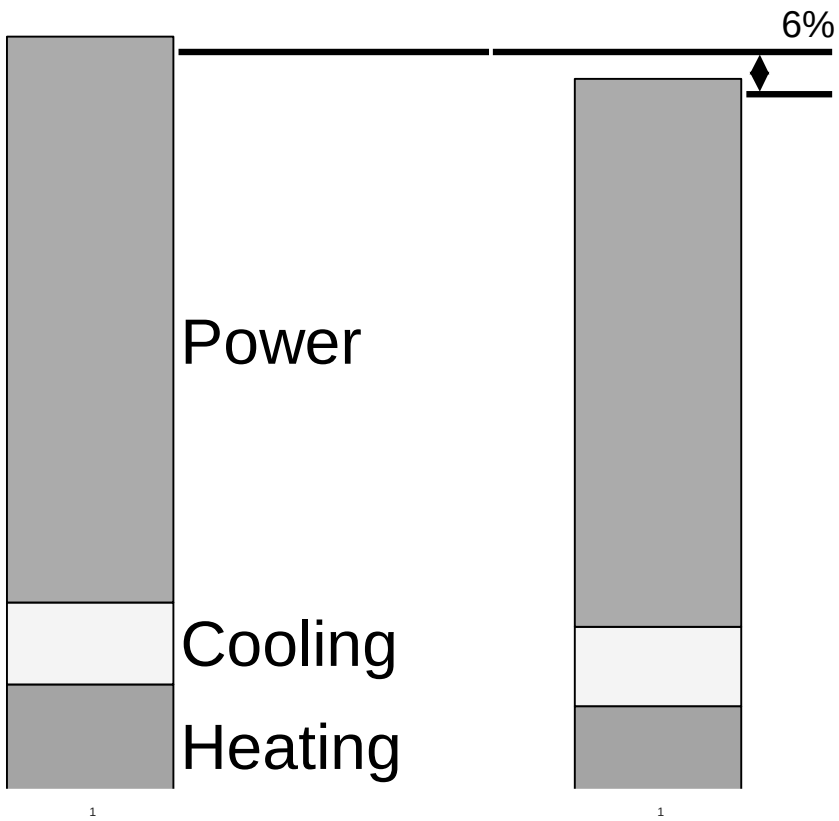
Gas-fired CHP



Heat for heating hot water or process

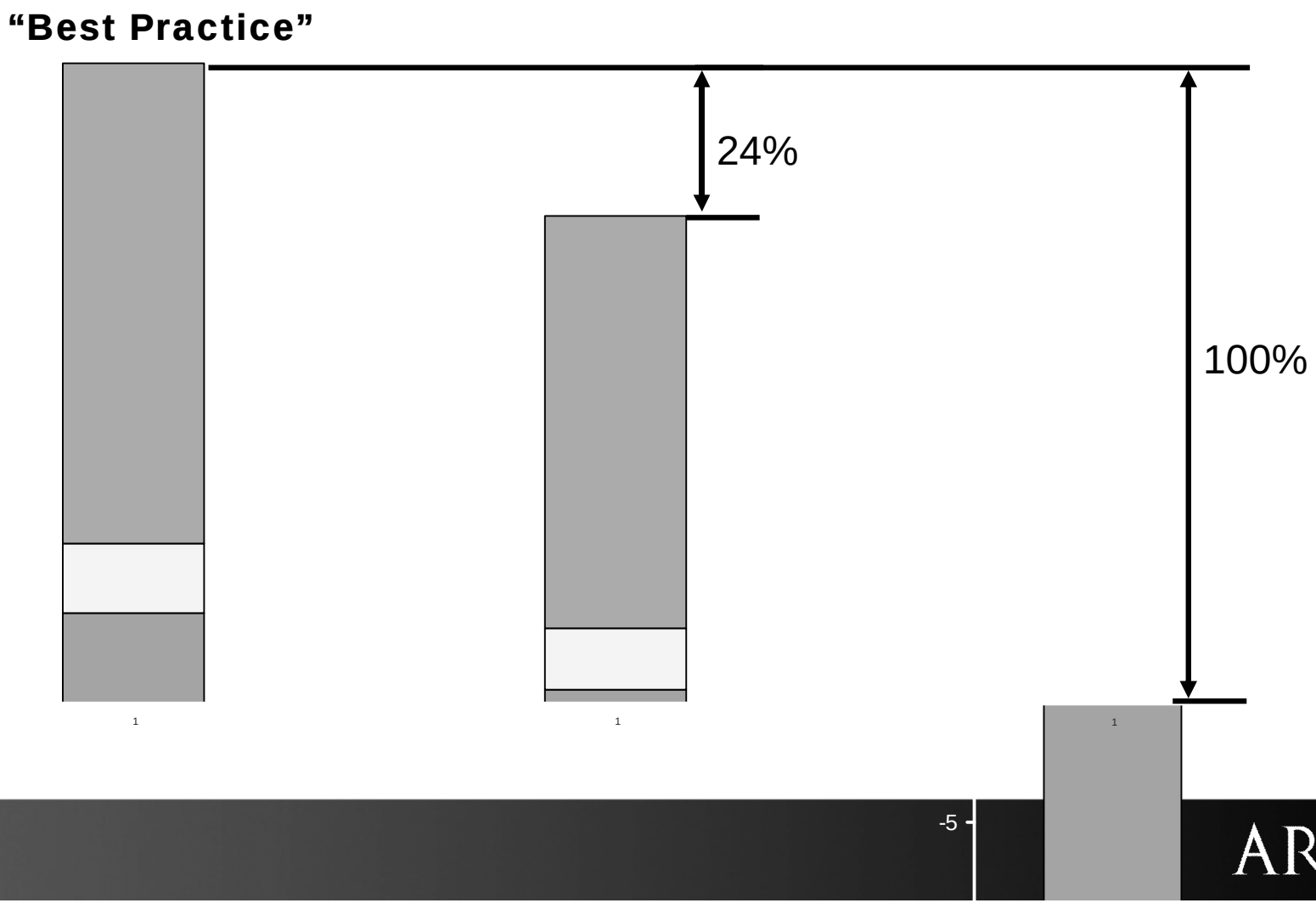
EFFICIENCY 90%+

"Best Practice"



- **Optimum use of fossil fuel (gas)**
- **Carbon savings compared with grid electricity**
- **Need to utilise heat limits impact**

Biomass CHP



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Renewable Technologies Cost Comparison

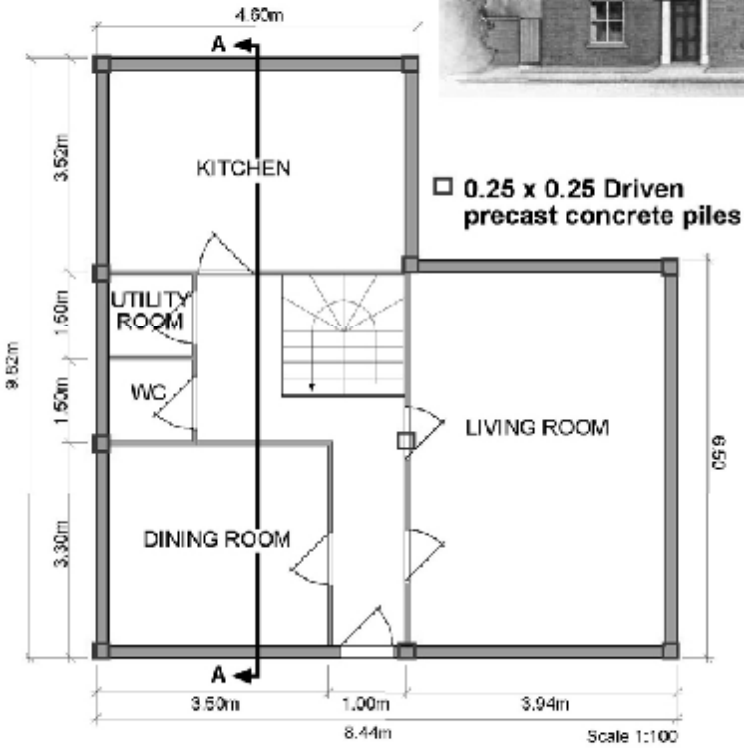
Partners In Innovation Project
Comparison of GSHP and Biomass

- **Partners in Innovation Study - 2002 to 2005**
  - Ground Storage of Building Heat Energy
    www.arup.com/geotechnics

- **Two Case Studies**
  - House – Four bedroom
  - Office Block – Energy efficient

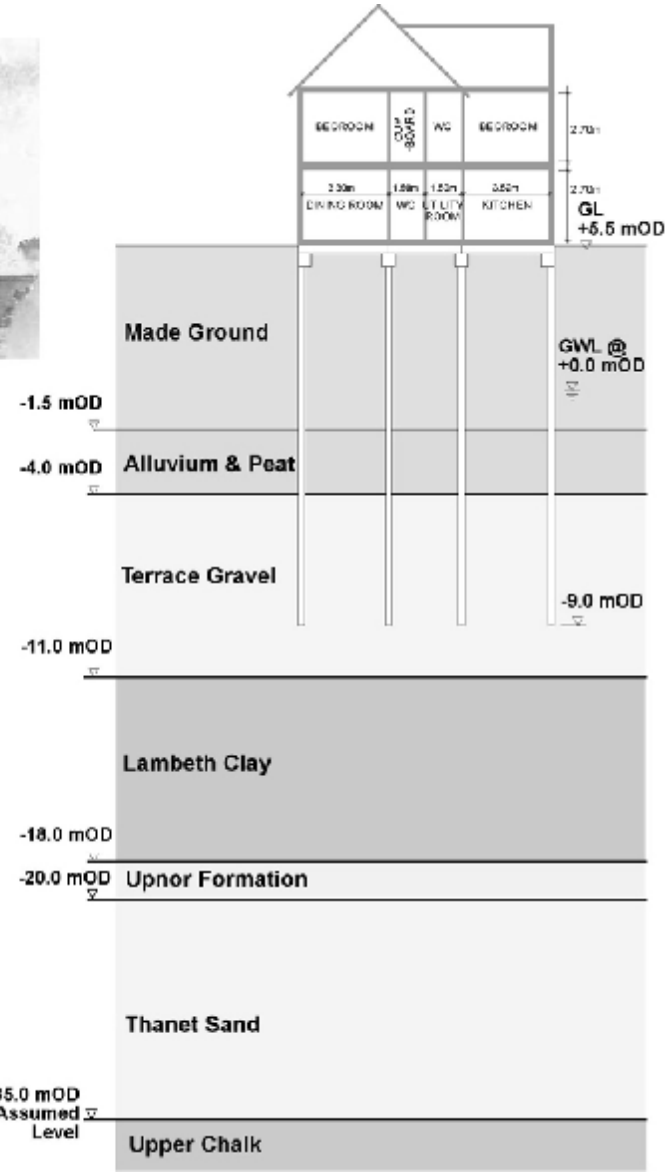
- **Designs for Biomass and GSHP systems**

House



□ 0.25 x 0.25 Driven precast concrete piles

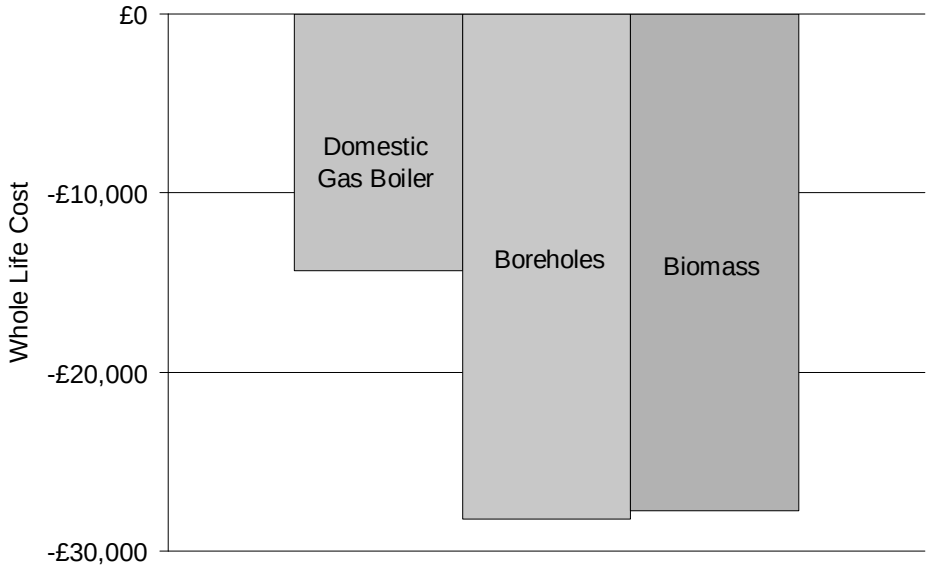
PLAN



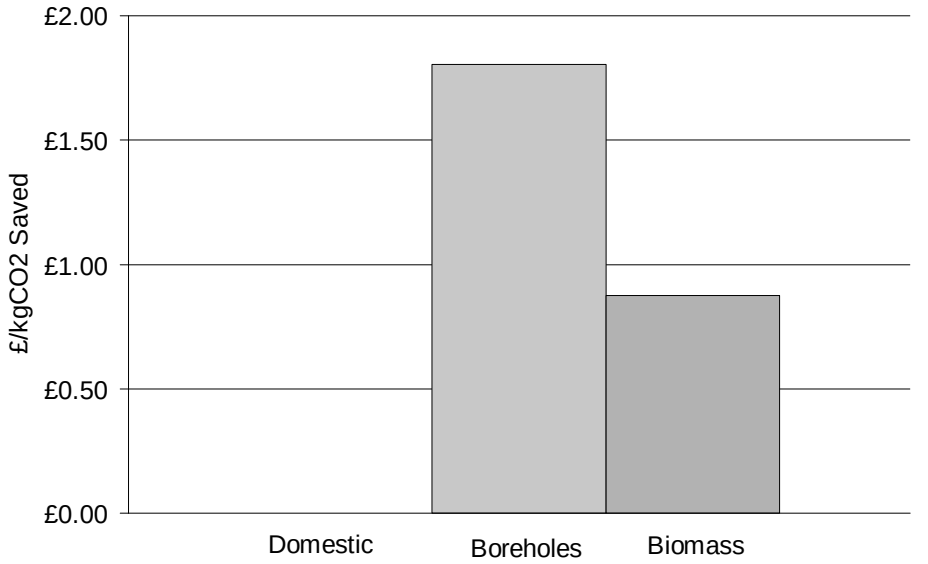
House with radiators

Comparison with Gas Boiler

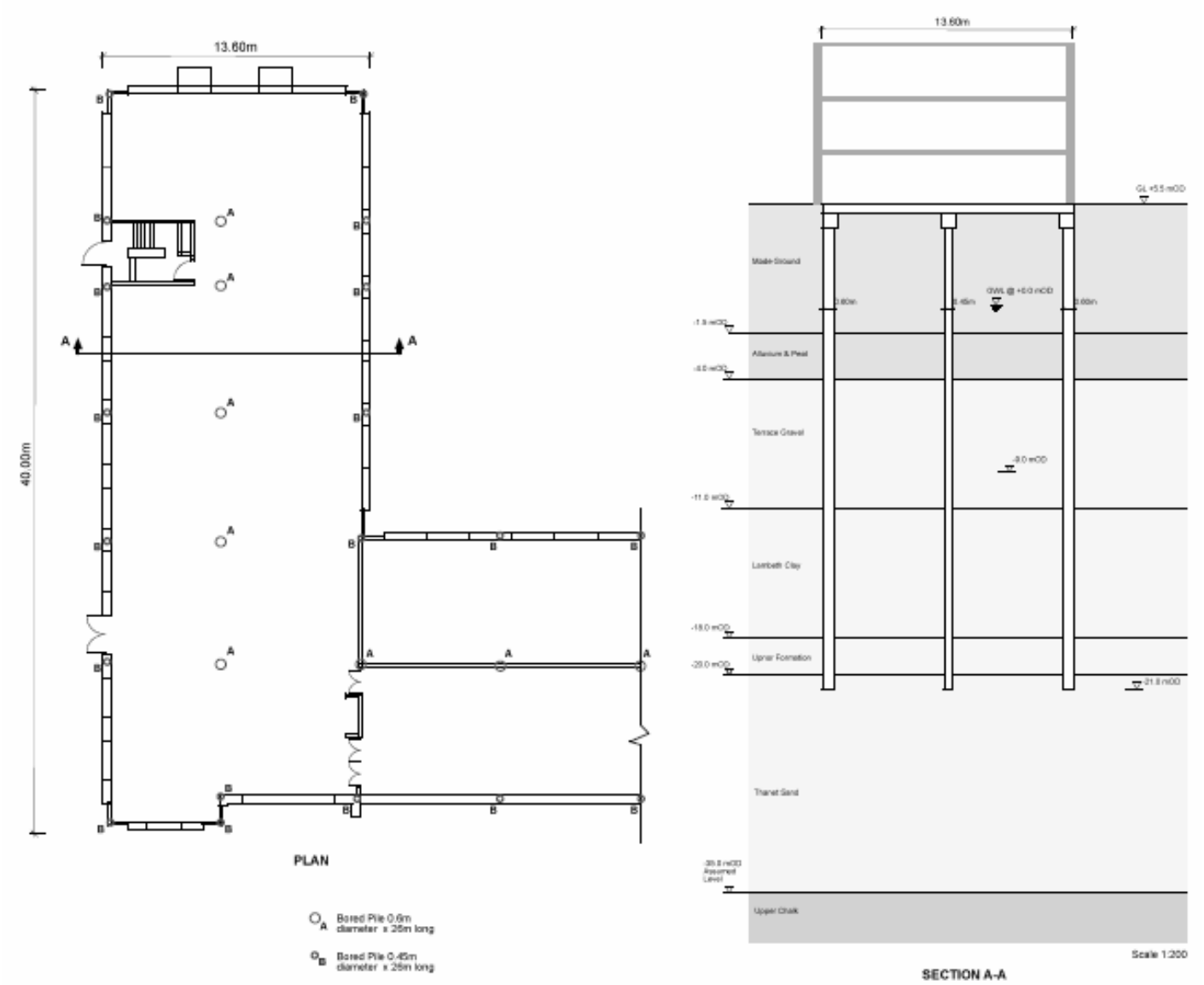
- Whole Life Costs For 15 yrs
- Biomass and GSHP are similar.



- £/kgCO2 Saved Over 15 Year
- Comparison with gas.
- Biomass is twice as effective at saving carbon



Low Energy Office



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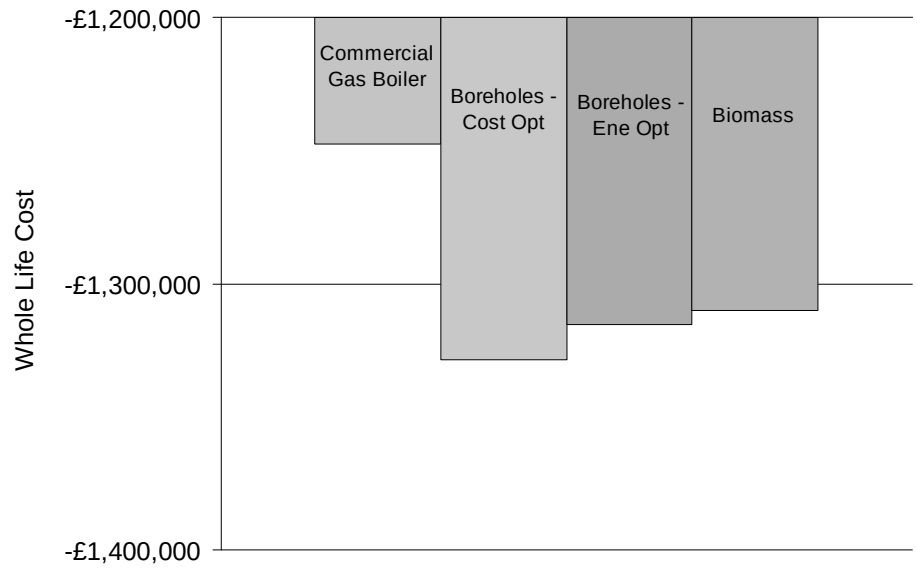
Low Energy Office

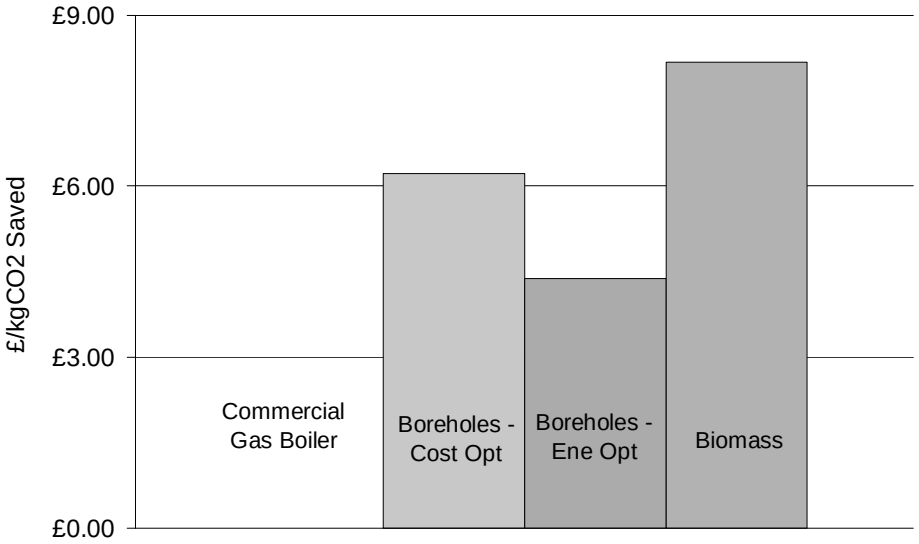
Whole Life Costs for 15 yrs

- Biomass Storage not included



£/kgCO2 Saved over 15 Years

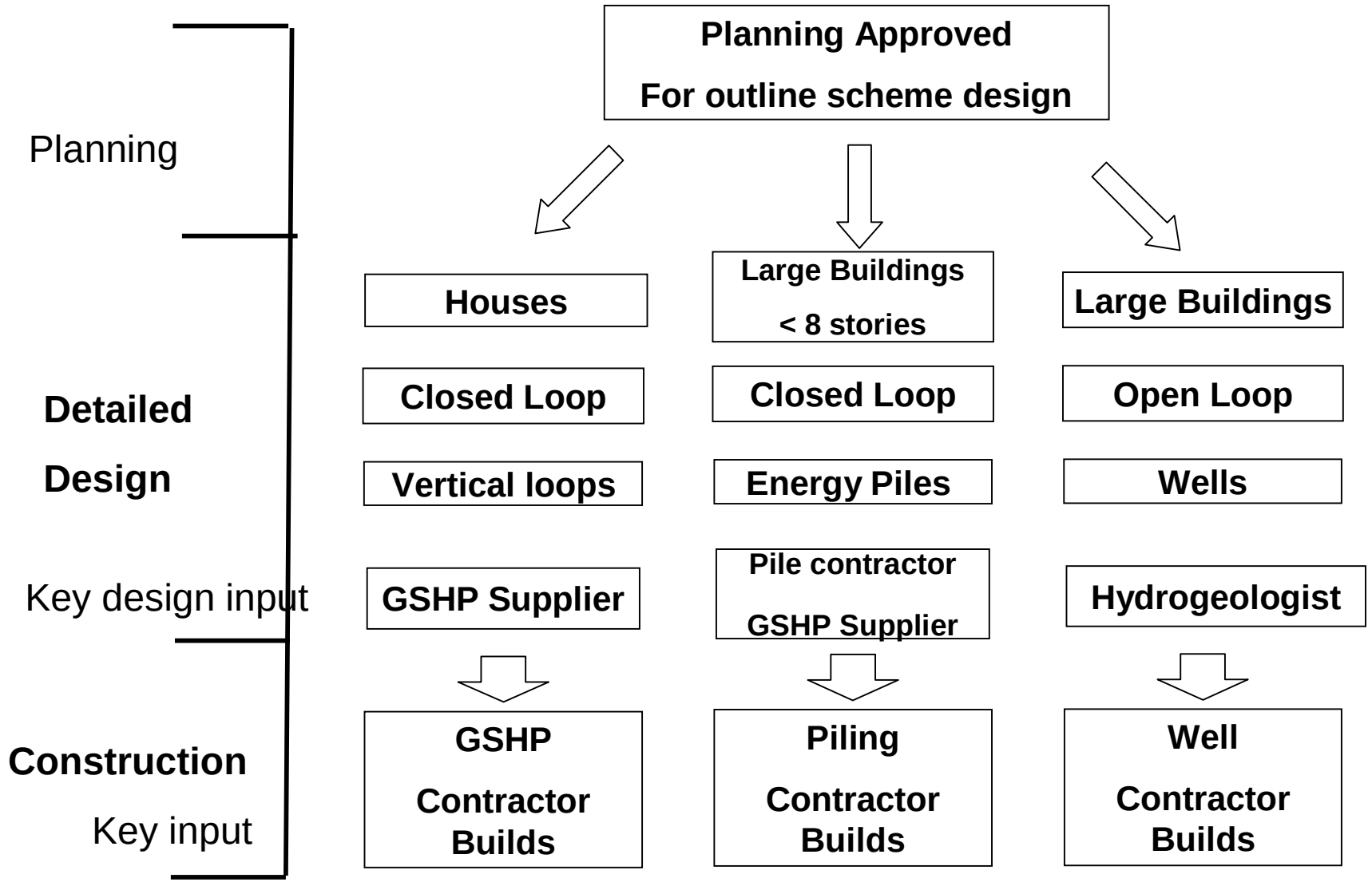
- GSHP effective because of balanced heating and cooling



Detailed Design Stage RIBA Stages E to G

- **Site Investigation**
- **Developer establishes team to design works**
- **Team is multi discipline :**
  - M and E
  - Structural
  - Geotechnical engineers
  - Geothermal specialist
  - Piling specialist
- **Important to finalise structural and thermal requirements for building ASAP**
- **Develop GSHP solutions in emerging market**

The Detailed Design Stage



Procurement Issues – many skills

- **Vertical Boreholes – closed loops**
  - Loops designed by GSHP supplier – and coordinates boreholes.
  - Developed market - D and B basis.

- **Energy Piles**
  - Piles designed by Consultant / Contractor.
  - Pile designer – Little experience with ground loop design.
  - Link with GSHP supplier /designer – M and E Eng ?
  - Currently one piling contractor offering energy piles - Design via partner GSHP Supplier.

- **Open Systems**
  - Wells designed by Consultant - Hydro-geologist.
  - M and E Eng designs heat pump - Balance heat and cool.
  - Well contractor builds wells – GSHP supplier provides heat pump.

The Construction Stage - RIBA Stages H to L

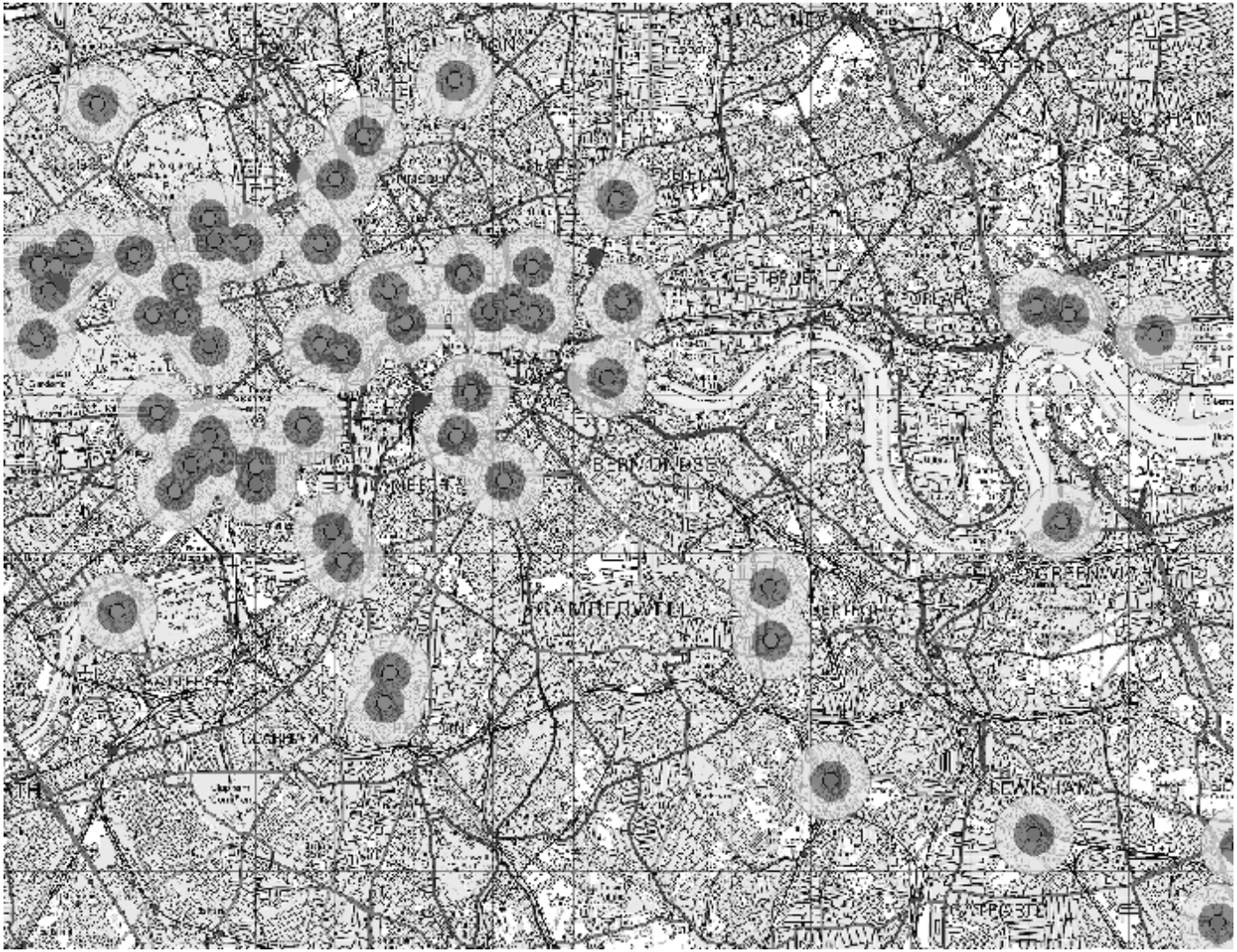
- **Specifications – international standards**
- **Tendering / Appointment - appropriate contractor**
  - Vertical Loops - GSHP supplier
  - Energy Piles - Piling contractor coordinates GSPH supplier
  - Open Systems -Separate Well contractor / Heat exchanger
- **Project Planning and Operations On Site**
  - Integration with above ground construction
  - Cooperation/ liaison with other contractors on site
- **Completion**
  - Handover and briefing of developer/ building occupant on system controls
- **Monitoring performance**

Conclusions

- **Legislation**
  - Importance of Carbon emissions
  - In Future driver is Zero Carbon
- **RIBA (1998) 'Outline Plan of Work'**
  - GSHP in Offices is more complex that Houses.
- **The Planning Stage**
  - Comparisons of different renewable technology
  - Balancing heating and cooling leads to efficiency
  - PII Project
- **The Detailed Design Stage**
  - How to link boreholes / energy piles open system designs
- **The Construction Stage**
  - Strong specifications

Thank you for your attention

Any Questions?



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Low Energy Office - CFA pile Option - expensive

	Conventional	Energy Piles	Boreholes	
			Cost Opt	Energy Opt
Total Build Cost	**£4,575,720**	**£ 4,690,166**	**£4,609,711**	**£4,658,111**
H+C System Cost	**£958,528**	**£1,016,696**	**£992,519**	**£1,040,919**
Additional over Conventional		**£58,168**	**£33,991**	**£82,391**
- Above Ground		**£1,891**	**£1,891**	**£1,891**
- Below Ground		**£56,278**	**£32,100**	**£80,500**
Additional % on overall cost		**1.3%**	**0.7%**	**1.8%**
Running Cost Saving		**£864**	**£900**	**£1481**

Summary of Results

	Annual Carbon Emissions (kgC/yr)	Annual Carbon Savings (%)
House With Radiators		
Conventional	625	-
Energy Piles	324	**48**
Boreholes	351	**44**
House With UFH		
Conventional	625	-
Energy Piles	250	**60**
Boreholes	284	**54**
Residential Flats		
Conventional	6,213	-
Energy Piles	3,724	**40**
Boreholes (Cost Optimised)	3,590	**42**
Boreholes (Energy Optimised)	3,223	**48**
Low Energy Office		
Conventional	6,888	-
Energy Piles	3,341	**51**
Boreholes (Cost Optimised)	3,252	**53**
Boreholes (Energy Optimised)	1,792	**74**
Standard Office		
Conventional	35,195	-
Energy Piles	-	-
Boreholes (Cost Optimised)	16,887	**52**
Boreholes (Energy Optimised)	14,960	**57**

Conclusions - Energy Modelling

- **Carbon emission savings above 40% in all cases**
- **Structural pile sizes and lengths provide heat exchange capacity for all building except the Standard Office.**

Conclusions - Cost Modelling

- **Large Annual Operating Cost Savings**
  - 20% - 50% depending upon building
- **Significant Additional Capital Expenditure**
  - Driven Pre-cast piles – Up tubes cast in to piles – (Unproven)
  - CFA Piles – 4 x T40 base to install tubes – (Doubles pile price)
  - Currently no economic payback within 20 years

Why is GSHP system used in other European countries?

Part L

- **Updated 2006**
- **Carbon reduction**