Module 3: Climate Change Planning for Renewable Energy

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Introduction to Low Carbon Technologies and Planning Policy

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What we will cover

- Some basic concepts
- Energy Evidence Base
  - Summary of regional and sub-regional RLCE potential capacity
- Energy systems and technologies
  - Understanding the role of renewable and low carbon energy systems in addressing the risk of climate change
  - Understanding different types and scales of RLCE systems
  - Understanding energy markets and supply chains
- Energy and Climate Change Policy
  - Reviewing the (new) policy context
  - Applying the Energy Hierarchy
  - Tests of Soundness

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Power versus Energy

- Human power pushing a rock up a hill = **1000 watts** (1kW)
- Energy to push a rock for 1 hour = **1kilowatt-hour** (kWh)
- Energy to push a rock for a year (8760 hours per year) = **8760kWh** (100% capacity factor)
- Energy to push a rock only during working hours = **1673kWh** (19% capacity factor)

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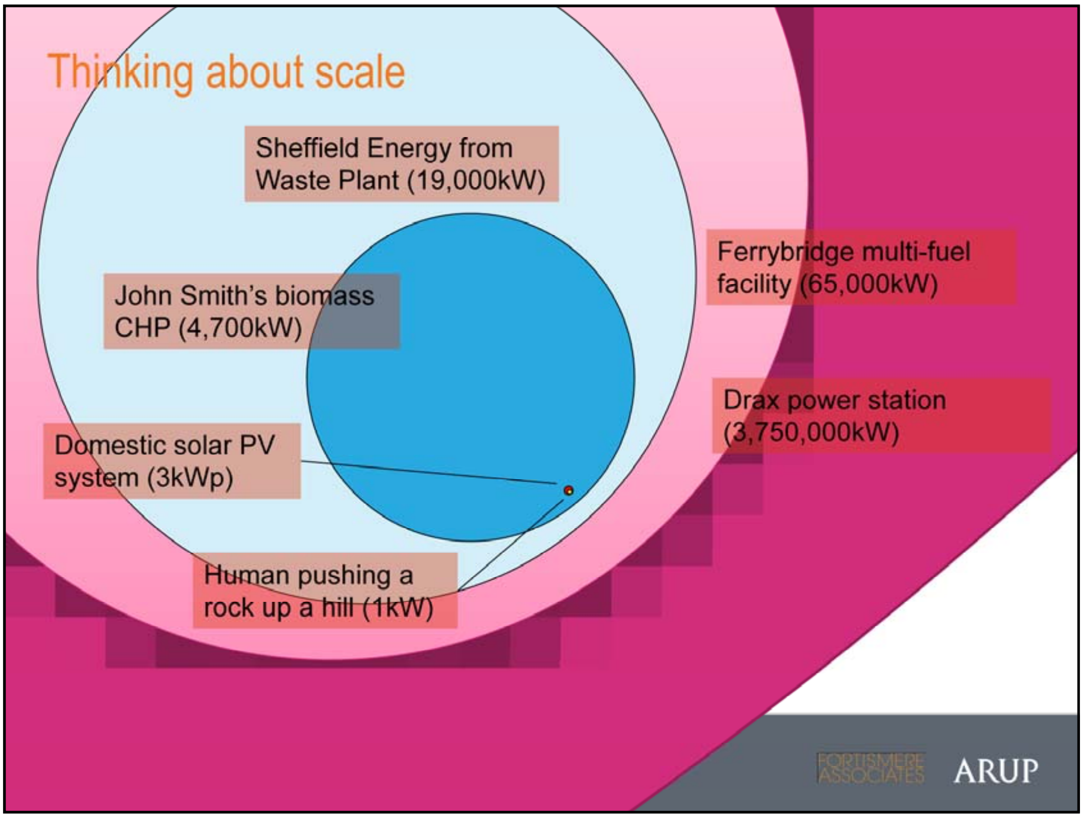
Key points:

• Power is the force being applied at any given moment. Normally expressed in watts (W), kilowatts (kW), megawatts (MW), gigawatts (GW) and terawatts (TW).

• Energy is force applied over time. Normally measured in watt-hours (Wh), kilowatt-hours (kWh), megawatt-hours (MWh), gigawatt-hours (GWh) and terawatt-hours (TWh).

• Capacity factor is not the same as efficiency. Capacity factor indicates how much of the time a generation device is running at its full potential, while efficiency indicates the amount of available energy contained with the resource (e.g. the fuel, the wind or sunlight) which the device can convert to usable energy.



The area of each of these circles equates to the rated or peak power output of selected energy generation facilities. It highlights the effect of scale and helps to keep a perspective on the ability of small-scale renewable energy to replace large-scale centralised power stations.

Current UK generation capacity: 85,000,000kW (85GW). National Grid anticipate that this will need to rise to over 100GW over the coming decades, taking account of rising demand and greater intermittency of generation from renewable energy installations.

Yorkshire and Humber 2012 energy context [Leeds CR]

Energy Type (power only)	Capacity factor	Yorkshire and Humber region		Leeds City Region
	%	MW	GWh	GWh
Coal & gas	85%	16,429	122,330	55,734
Onshore wind	25%	599	1,312	254
Biomass / EfW	85%	288	2,144	685
Solar PV	11%	7	7	4
Other	35%	5	15	3
Total generation		17,927	127,908	57,637
Total demand			110,646	50,411
% Renewable		5.2%	2.8%	

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These figures are taken the report “Low carbon and renewable energy capacity in Yorkshire and Humber, Final report”, issued in April 2011 by AECOM. The effect of a lower capacity factor for more renewables, compared with conventional fossil fuel generation technologies, is shown in the difference between the percent renewables in the region expressed in terms of power (5.2%) and energy (2.8%).

Yorkshire and Humber 2012 energy context [S Yorks]

Energy Type (power only)	Capacity factor	Yorkshire and Humber region		South Yorkshire
	%	MW	GWh	GWh
Coal & gas	85%	16,429	122,330	38,160
Onshore wind	25%	599	1,312	760
Biomass / EfW	85%	288	2,144	633
Solar PV	11%	7	7	0
Other	35%	5	15	0
Total generation		17,927	127,908	40,207
Total demand			110,646	34,515
% Renewable		5.2%	2.8%	

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Yorkshire and Humber 2012 energy context [Y&NH]

Energy Type (power only)	Capacity factor	Yorkshire and Humber region		York & North Yorkshire
	%	MW	GWh	GWh
Coal & gas	85%	16,429	122,330	16,342
Onshore wind	25%	599	1,312	151
Biomass / EfW	85%	288	2,144	380
Solar PV	11%	7	7	1
Other	35%	5	15	3
Total generation		17,927	127,908	17,157
Total demand			110,646	14,781
% Renewable		5.2%	2.8%	

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These figures are taken the report “Low carbon and renewable energy capacity in Yorkshire and Humber, Final report”, issued in April 2011 by AECOM. The effect of a lower capacity factor for more renewables, compared with conventional fossil fuel generation technologies, is shown in the difference between the percent renewables in the region expressed in terms of power (5.2%) and energy (2.8%).

Yorkshire and Humber 2012 energy context [H&HP]

Energy Type (power only)	Capacity factor	Yorkshire and Humber region		Hull & Humber Ports
	%	MW	GWh	GWh
Coal & gas	85%	16,429	122,330	38,160
Onshore wind	25%	599	1,312	760
Biomass / EfW	85%	288	2,144	633
Solar PV	11%	7	7	0
Other	35%	5	15	0
Total generation		17,927	127,908	40,207
Total demand			110,646	34,515
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Regional future renewable energy capacity [Leeds CR]

Energy Type	Yorkshire and Humber region		Leeds City Region
	MW	GWh	GWh
Onshore wind	2,869	7,506	2,705
Biomass / EfW	1,004	7,476	2,886
Solar PV	235	177	109
Hydro	26	88	68
Other (solar thermal / heat pumps)		896	478
Total onshore RE generation	4,134	15,247	5,768
Total power demand (Scenario 2)		107,311	48,892
Potential % from onshore renewables		14%	

These figures are taken the report "Low carbon and renewable energy capacity in Yorkshire and Humber, Final report", issued in April 2011 by AECOM. The effect of a lower capacity factor for non-thermal generation technologies, can be seen by comparing the respective power (MW) and energy (GWh) figures for biomass/EfW and Onshore wind.

Regional future renewable energy capacity [S Yorks]

Energy Type	Yorkshire and Humber region		South Yorkshire
	MW	GWh	GWh
Onshore wind	2,869	7,506	1,290
Biomass / EfW	1,004	7,476	955
Solar PV	235	177	44
Hydro	26	88	10
Other (solar thermal / heat pumps)		896	174
Total onshore RE generation	4,134	15,247	2,299
Total energy demand (Scenario 2)		107,311	22,663
Potential % from onshore renewables		14%	

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Regional future renewable energy capacity [Y&NH]

Energy Type	Yorkshire and Humber region		York & North Yorkshire
	MW	GWh	GWh
Onshore wind	2,869	7,506	2,109
Biomass / EfW	1,004	7,476	2,924
Solar PV	235	177	24
Hydro	26	88	34
Other (solar thermal / heat pumps)		896	193
Total onshore RE generation	4,134	15,247	5,091
Total power demand (Scenario 2)		107,311	
Potential % from onshore renewables		14%	

These figures are taken the report “Low carbon and renewable energy capacity in Yorkshire and Humber, Final report”, issued in April 2011 by AECOM. The effect of a lower capacity factor for non-thermal generation technologies, can be seen by comparing the respective power (MW) and energy (GWh) figures for biomass/EfW and Onshore wind.

Regional future renewable energy capacity [H&HP]

Energy Type	Yorkshire and Humber region		Hull & Humber Ports
	MW	GWh	GWh
Onshore wind	2,869	7,506	2,863
Biomass / EfW	1,004	7,476	2,097
Solar PV	235	177	25
Hydro	26	88	0
Other (solar thermal / heat pumps)		896	177
Total onshore RE generation	4,134	15,247	4,985
Total power demand (Scenario 2)		107,311	34,535
Potential % from onshore renewables		14%	

These figures are taken the report "Low carbon and renewable energy capacity in Yorkshire and Humber, Final report", issued in April 2011 by AECOM. The effect of a lower capacity factor for non-thermal generation technologies, can be seen by comparing the respective power (MW) and energy (GWh) figures for biomass/EfW and Onshore wind.

Key conclusions on regional evidence base

- Assessment of RLCE potential, not targets
- Main potential is from commercial wind (46%) and biomass (34%)
- Realising CHP potential requires co-location of generation and demand, and "is likely to be challenging."
- Data collection and maintenance is a key ongoing challenge

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Where next on the evidence base?

- Local studies to confirm specific low carbon resource opportunity areas and guide development to maximise potential
- Feasibility studies for specific schemes
- Development of a delivery model and a business case for investment – site or area-wide basis
- Infrastructure delivery plan – integration with CIL to provide funding stream
- Establish local delivery vehicles – essential action to ensure potential is realised

Energy Systems

- Major generation and transmission facilities
  - Nationally significant infrastructure projects
  - 50MW or greater
  - Approved under a Development Consent Order
- Decentralised energy systems
  - Onshore wind farms
  - Energy from waste facilities
  - CHP and district heating networks
  - Building integrated systems
  - Determined by local planning authority

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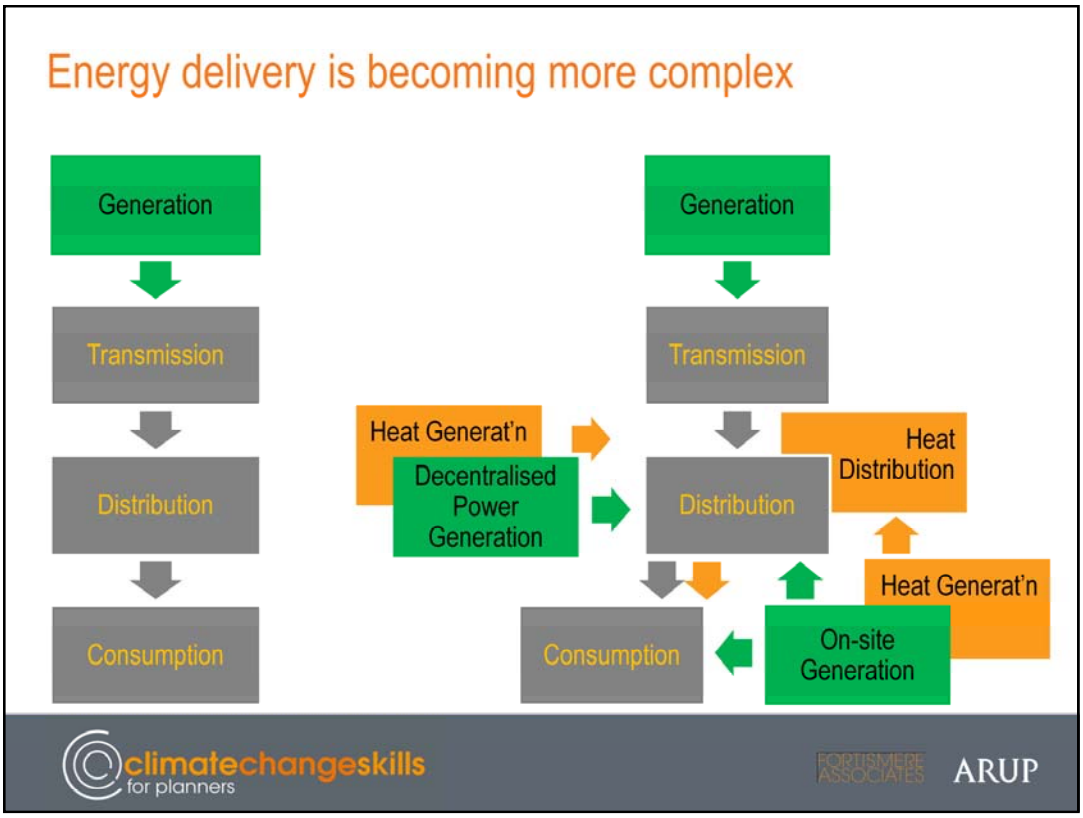

Decentralised energy generation - involving more smaller scale facilities located closer to where people live and work (i.e. where they use energy) – is expected to take a rising share of the total generating capacity in the UK. This is leading to more complex relationships and supply chains, with consumers becoming generators and with new local entrants in the generation market.

From a planning point of view this is a sign that energy development will become a more regular feature of the mix of development applications for local planning authorities.

Technology Review

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Commercial Wind

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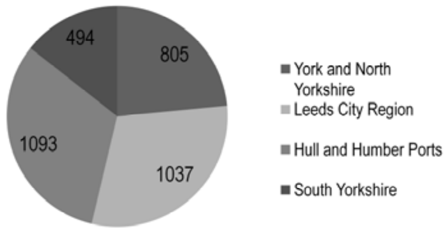
Commercial Wind

Opportunities

- 2,869MW potential resource electricity capacity in Yorkshire and the Humber



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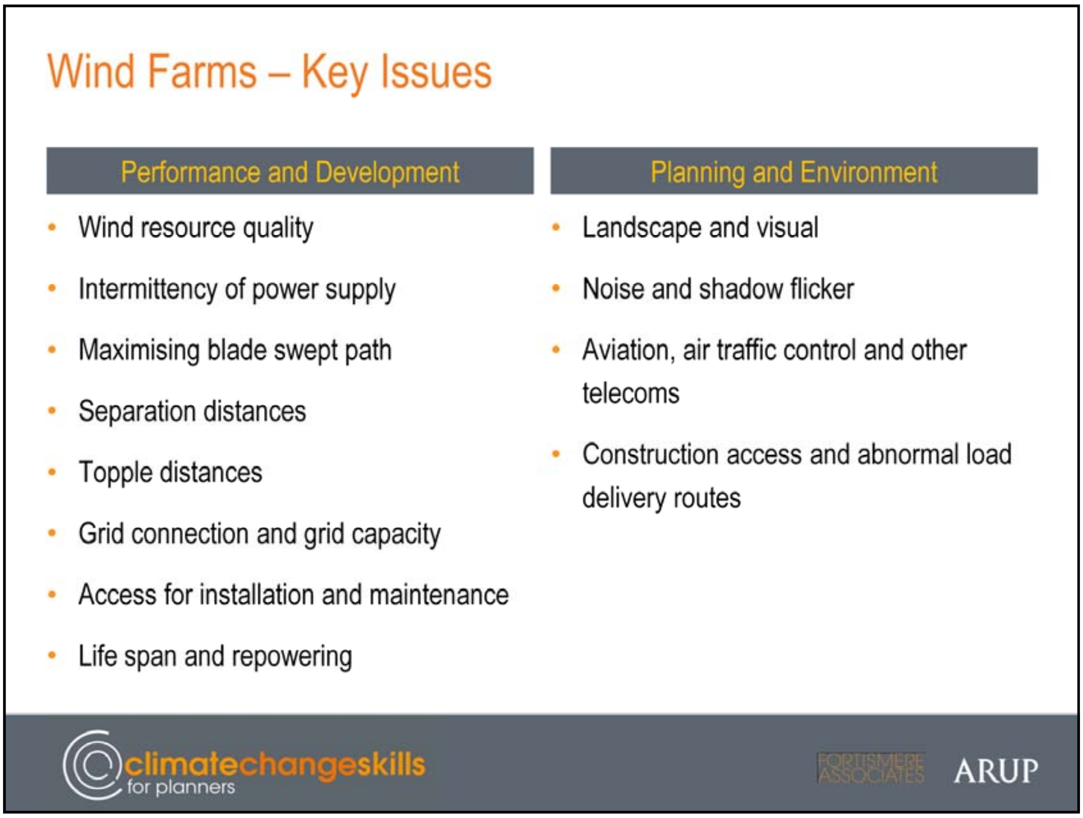


•Wind resource quality – the fundamental driver of siting wind turbines is the availability of a steady, strong wind. A consistent direction of wind is also valuable.

•Intermittency of power supply – by its nature the wind rises and falls. Turbines are designed to work within a certain wind speed range, and are optimised to a narrower band. Below or above this band, power output declines, and outside the range the turbines will cut out altogether.

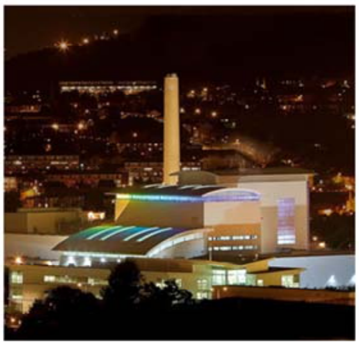
•Maximising blade swept path – a turbine blade describes a circle, and the energy resource contained in the wind which blows within that circle is a function of the cube of the radius of the circle. This means that a longer blade length can have a dramatic effect on the generation potential of a turbine, given the same conditions.

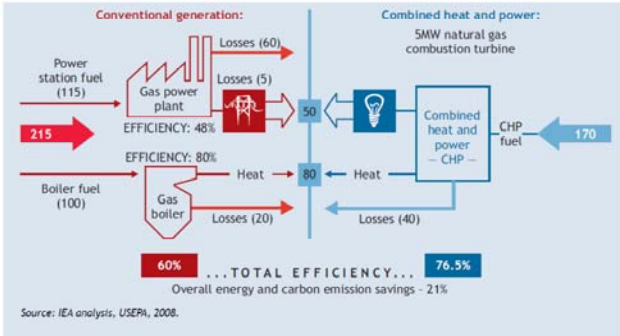
•Separation distances – turbines must be sited well away from each other and from other structures to reduce turbulence, which reduces the generation potential of the turbine.

•Topple distances – although designed to withstand very high winds, the risk of toppling must be taken account in siting turbines, and critical infrastructure or other vulnerable features.

•Grid connection and grid capacity – Larger wind turbines generally produce power at 11kV, and are connected via a cable connection to the local distribution grid. For remote installations the grid connection route can present a significant environmental risk and will form a major cost of the project.

Decentralised Heat and Power Systems





Decentralised Heat and Power Systems

Key Features	Key Issues
• Generation closer to where it is consumed • Opportunity to capture and use waste heat (thermal processes) • Greater diversity of generation – more resilient systems • Smaller operations (and operators) - lower barriers to entry	• Major capital investment with long horizon • Co-location of generation and demand is challenging • Closer to communities – more impacts and more objections • Need for more sites, and more complex mitigation • Integration of energy into spatial planning • Local impacts – air quality, noise, traffic

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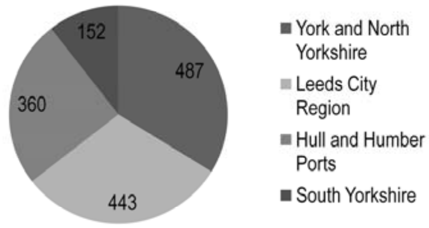
Biomass

Opportunities

- 1212 MW Potential resource energy capacity in Yorkshire and the Humber
- 917 MW heat / 295MW electricity



Key issues

- Sustainable fuel supply –
  - Avoiding conflict with food production
  - Multiple demands
  - Importing / exporting
- Storage space
- Air quality
- Transportation

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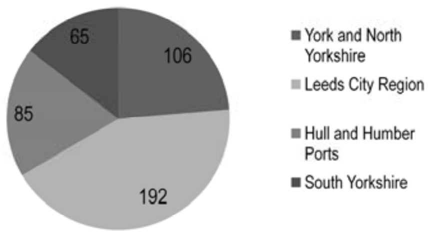
Energy from Waste

Opportunities	Key issues
• 383 MW Potential resource energy capacity in Yorkshire and the Humber • 214 MW heat / 169 MW electricity	• Locally generated resource • Consistency with Waste Hierarchy • Major community concerns • Identifying viable heat users • Air quality • Transportation



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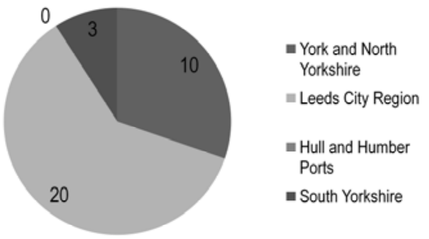
Hydropower

Opportunities

- 26 MW Potential resource electricity capacity in Yorkshire and the Humber



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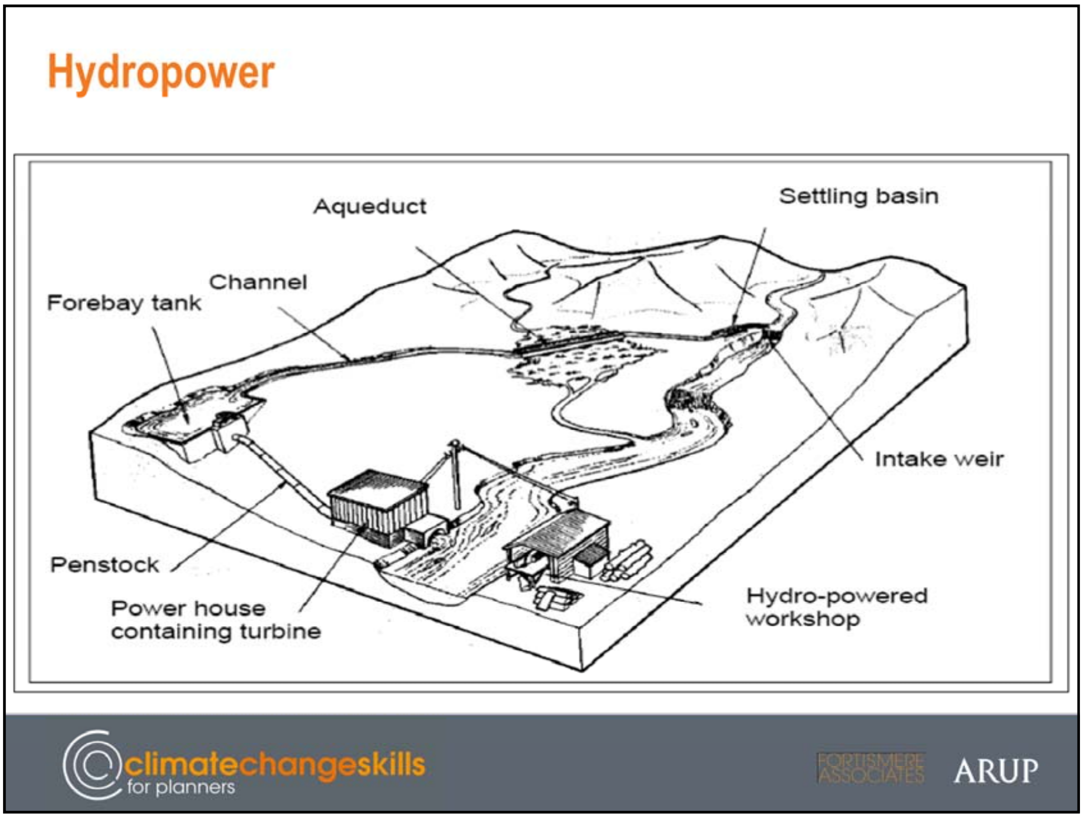


£1000-£2000 per kW

The UK is restricted in its availability of suitable sites for hydro power. High gradient and consistent seasonal flow are ideal. It's estimated that 1200MW of potential exists in the UK (for sub 5MW schemes), 200MW is existing. High gradient sites can be far from settlements.

Construction of water intakes structures can be problematic; a diversion may be required.

Sedimentation can block flow and damage turbines, therefore careful planning has to be given to remove debris from flow.

A large constraint is due to the rate at which the SEPA, Environment Agency and NIEA can respond to new applications. Even though all water is being returned to the river, a water abstraction license has to be applied for through the EA.

EA are mainly concerned with

-Limiting abstraction (1/3 of total flow is a rule of thumb)

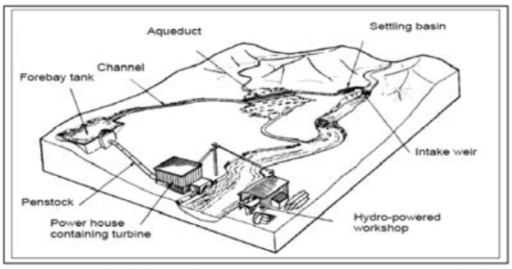
-Impoundment- Any potential increase in water levels as a result of weirs

-Flood risk

-Fish/eel passage

The situation is better now, but a few years ago there one only one Microgeneneration Certificate Scheme for the UK. Now there are 20 for Yorkshire Humberside.

Hydropower



- 1200MW of potential in UK
- Run-of-river schemes can minimise the environmental impact
- Limited economies of scale

- Technical issues
  - Suitability of sites – gradient, river flow rates
  - Distance to grid connection
  - Water off-take
  - Sedimentation
  - Increasing flood risk / impairing flood defences
  - Fish movements
  - Land ownership
- Other issues
  - Water abstraction license
  - MCS accreditation

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-Fish/eel passage

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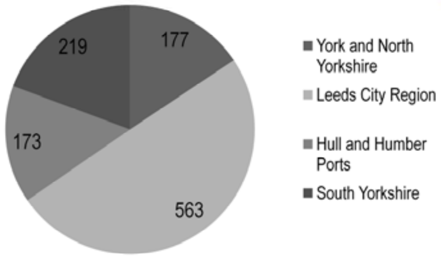
Micro-generation

Opportunities

- 996 MW Potential resource electricity capacity in Yorkshire and the Humber
- 761 MW heat / 235 MW electricity



Key Issues

- Network capacity
- Land designations – conservation and heritage
- Building / site capacity

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Solar PV

- Two main types; crystalline or thin film cells. Monocrystalline are the best commercially available.
- Can be put on any type of building facing south to achieve high output.
- High capital cost. Output depends on tilt, orientation, shading, and efficiency of the PV cell. Optimum positioning is required to maximise yield.
- Regular access needed for maintenance / cleaning.

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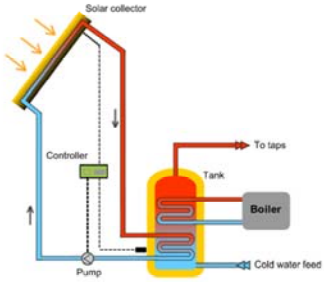
Solar Thermal

- Available in two forms, flat-plate and evacuated tube collectors. Flat plate less efficient but cheaper. This is a well tested, simple and robust technology.
- Suitable for buildings with a significant hot water demand - houses, sports complexes, hotels and hospitals. They should have accessible south facing roofs to maximise hot water output and allow for maintenance.
- Can be used for space heating as well as hot water.
- Efficiency depends on weather and seasons. Require large roof space and heat storage if heat demand is high.



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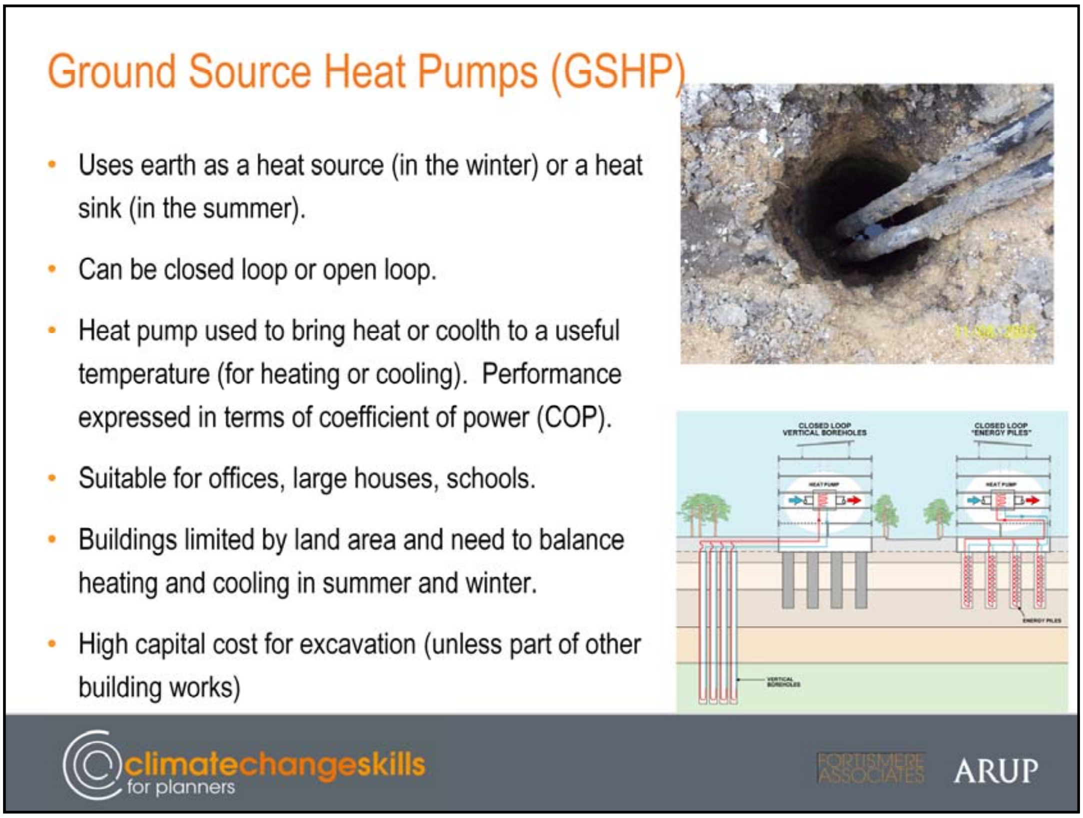

CoP = Coefficient of Power or Coefficient of Performance. This is the ratio between the heat generated and the electricity consumed by the heat pump.

Air Source Heat Pumps (ASHP)

- Use the atmosphere as a means of rejecting and scavenging heat. They upgrade heat captured from the air to heat the building, and reject heat to cool the building.
- Same principle as GSHP – lower COP but lower capital cost. Well suited to retrofit.
- Suitable for all building types with sufficient external plant space.
- Most suitable for sites that have mild weather.
- Efficiency of ASHP can vary greatly with outdoor air temperature (unlike GSHPs which have a reasonably constant efficiency).

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CoP = Coefficient of Power or Coefficient of Performance. This is the ratio between the heat generated and the electricity consumed by the heat pump.

National Policy Framework

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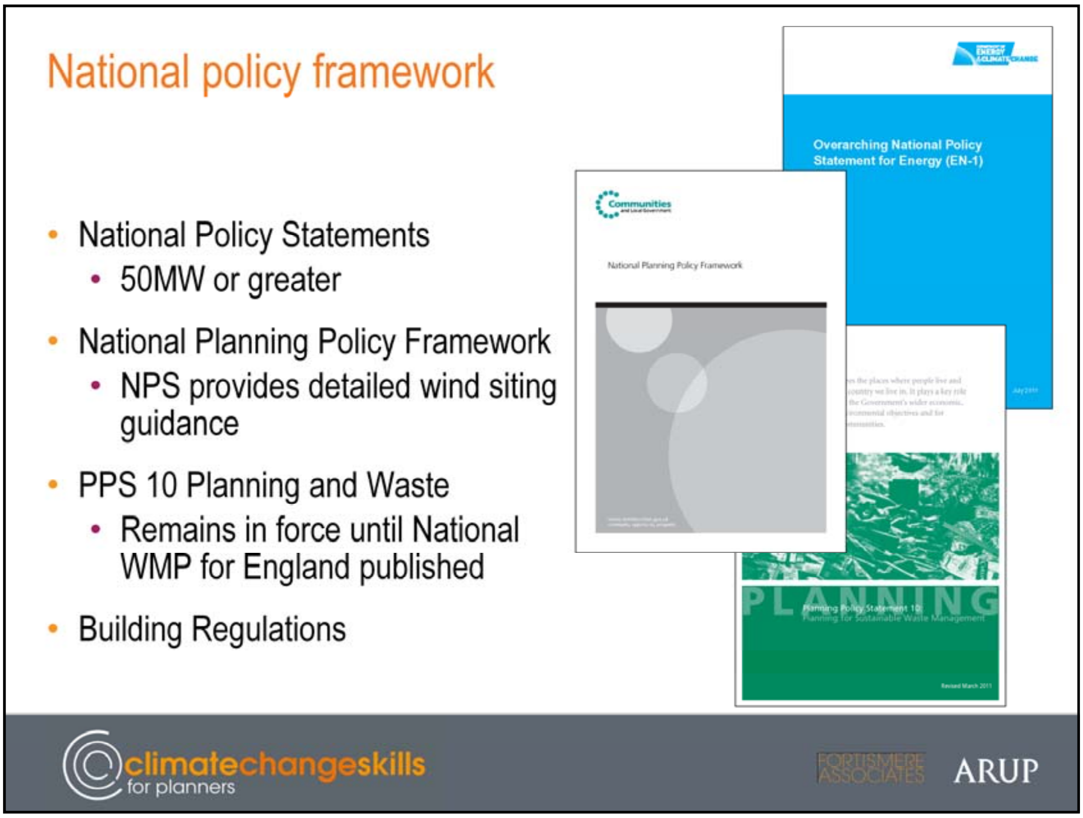

NPSs: "the Government has demonstrated" the need case

NPPF: the planning system should aim to secure "radical reductions" in greenhouse gas emissions

Building Regs:

•driving performance at building scale (regulated energy)

•trajectory towards a zero carbon standard by 2016/2019

Key message: Planning policies are generally moving to harmonise with Building Regulations, and from a technology focus (e.g. 10% renewables) to a carbon focus (e.g. 25% reduction in emissions below Part L 2010)

National Planning Policy Framework

- Principles for energy and climate change planning
  - Need case is already demonstrated (same as NPS)
  - Helping shape places to secure radical reductions in GHGs
  - Supporting the delivery of RLCE and associated infrastructure
  - Responsibility on all communities to contribute to RCLE generation
- Maximise RCLE while addressing adverse impacts, including cumulative impacts
- Identify suitable areas for RLCE sources and infrastructure
- Support community initiatives
- Identify DE and co-location opportunities

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National Planning Policy Framework

- Plan making
  - Plan location and ways of new development to reduce emissions
  - Support retrofit of existing buildings
  - Duty to co-operate, particularly on strategic priorities
  - New tests of soundness – Positively prepared; Justified; Effective; and Consistent with national policy
  - Neighbourhood planning – local priorities and opportunities
- Decision taking
  - Designs should work to minimise energy consumption
  - Pre-application engagement and front loading of process
  - System continues to be plan-led (but viability a material consideration)
  - Conditions and obligations subject to CIL Regulations

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National Planning Policy Framework

- References / additional guidance on energy
  - NPS-1 overarching energy statement
  - NPS-3 on renewable energy infrastructure
- Other references / guidance in the NPPF
  - PPS10 Planning and waste
  - Technical guidance on flood risk
  - Circular 06/2005 on biodiversity
  - English National Parks and the Broads: UK Government Vision and Circular 2010
  - Noise Policy Statement for England, March 2010
  - Separate Government technical guidance on minerals

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Experience from recent LDF examinations

- **Viability** is a key challenge to policy targets, particularly where targets exceed Building Regulations. Caveats should be included.
- Concern over the proper division between Planning and **Building Regulations**
- Policy aimed at **unregulated energy** is resisted
- Policy should be overtly **supportive of RLCE** , in suitable locations
- **Area designations** are encouraged – identifying locations suitable for different types of RCLE
- Policy should set clear standards for **impact mitigation**
- Local authority's **delivery role** emphasised by Inspectors

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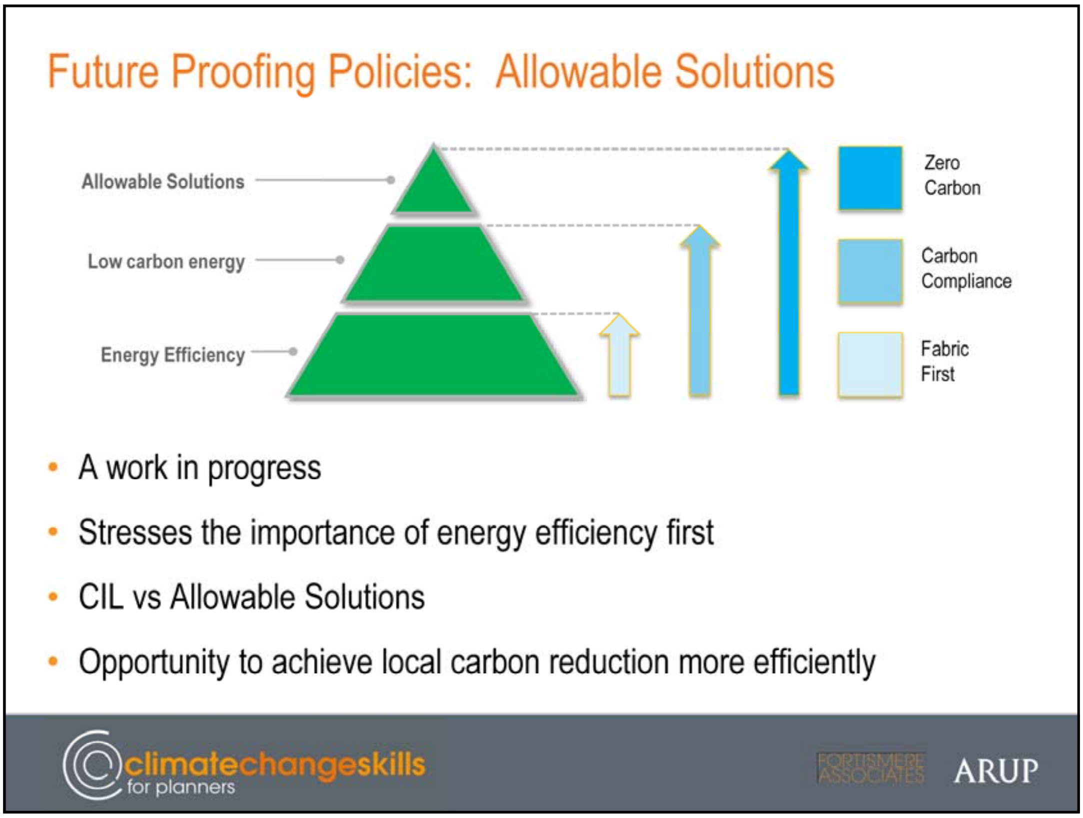

Future proofing Policy Allowable Solutions

Allowable Solutions are measures / options available to planners and developers that would reduce / offset carbon (CO2) emissions should on-site solutions not be feasible and / or viable when bringing forward new development.

In July 2011, the Zero Carbon Hub produced 'Allowable Solutions for Tomorrow's Homes - Towards a Workable Framework', an industry led study into the 'real world' delivery of zero carbon buildings. To comply with the 2016 Building Regulations, new zero carbon homes will have to meet on-site requirements for Carbon Compliance (achieved through the energy efficiency of the fabric, the performance of heating, coo ling and lighting systems, and low and zero carbon technologies). In addition, through Allowable Solutions, they will need to account for the carbon emissions that are not expected to be achieved on site through Carbon Compliance. Carbon Compliance and Allowable Solutions measures will both be needed to meet the zero carbon Building Regulations in 2016, and each will need to be submitted, checked and verified as part of Building Control approval.

However, there remains an inherent conflict between CIL, which excludes any other route for funding low carbon infrastructure, and an emerging Allowable Solutions regime, which would need to "ring fence" expenditure for low carbon investments. Arup recently completed a study for the London Borough of Waltham Forest which sought to balance these issues by setting a target for building energy performance which was close to the typical "carbon compliance" level. Above this level investment would be funded through CIL, leaving only the gap between the target and actual performance being covered by the Allowable Solutions charge.