Introduction to Low Carbon and Renewable Energy

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Content

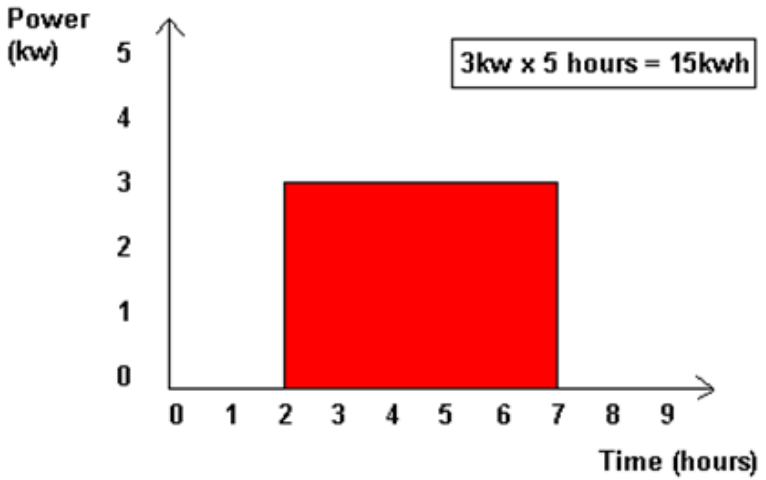
- Understanding Energy
- Overview of Technologies
- Financial Incentives

What is Energy and Power?

- Many different forms of energy, e.g.
  - electrical
  - thermal (heat)
  - light
  - mechanical
  - nuclear
  - chemical
- Energy can be transformed into another sort of energy, but energy cannot be created and it cannot be destroyed
- Power is a measure of how quickly energy is converted into another form of energy. e.g. the time it takes for an electric kettle to heat water (electrical energy into thermal energy)

Understanding Units

- Power rating: – measured in watts: kilowatts (kWp) and megawatts (MWp)
- Energy used / generated: – measured in time: kilowatt hours (kWh) and megawatt Hours (MWh)
  - 1 unit electricity = using 1kW of power for 1 hour (1kWh)
- Example: 3kW solar PV panel in 5 hour of direct sunlight on a summers day = 15KWh of energy generated:



- Carbon savings: – measured by volume (tonnes)

What is Renewable Energy?

- Zero Carbon – uses natural resources to generate energy
  - Solar
  - Wind
  - Hydro, tidal and wave
- Low Carbon – needs a small energy input to work or uses carbon neutral fuel
  - Heat pumps
  - Combined heat and power
  - Biomass
  - Nuclear

Understanding Capacity

- Most efficient coal gas fired power stations operate at around 40% -50% capacity.
- UK runs 1 power station on standby every day.

- Capacity matters when you are paying for the resource and when it is finite
- Renewable resources will never decrease or run out
- Capacity is not a relevant measure of the relative merits of renewable energy as we are not paying for the resource

Renewable Electricity Generation

Solar Photovoltaic (PV)

Wind turbines

Hydro turbine

Solar Photovoltaic

- Converts solar energy directly into electricity
- Roof mounted or free standing
- Generate electricity which is a high CO2-burden fuel
- Electricity can be used onsite or exported to grid
- Little maintenance required
- High capital cost - £3,000 - £4,000 per kWp
- Feed in Tariff (FiTs) making PV much more financially attractive

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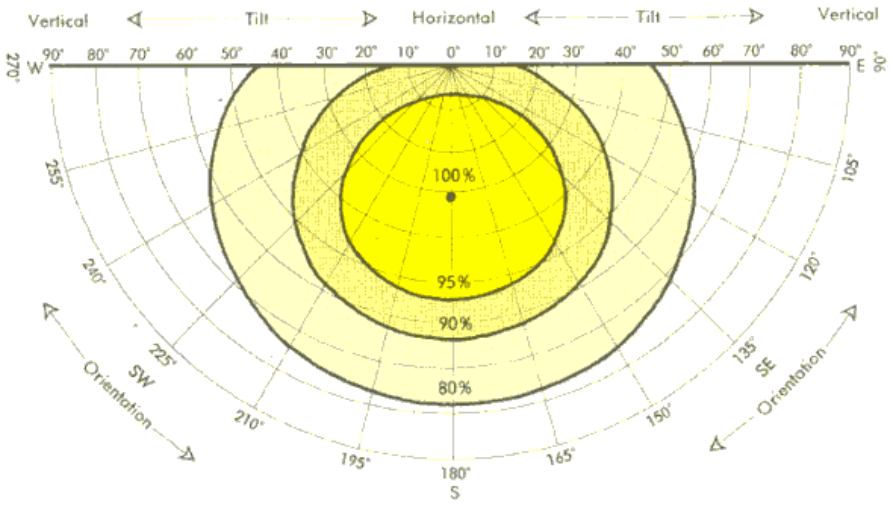
Solar Design Issues

- Roof Orientation – SE to SW ideal
- Angle from horizontal – 30°to 40° roof pitch ideal
- Surrounding shading – buildings, trees or chimneys
- Weight on supporting structure (16kg/m2)
- Access for maintenance
- Cable and pipe work routing
- Protection from damage
- Roofing suitability (asbestos?)



Small Wind

- A small wind turbine uses the power of the wind to create electricity
- Rated kWp power is generally at 11-12m/s
- Average windspeeds in UK 4-6m/s
- Windspeeds > 5m/s required to make turbine viable
- Understanding efficiency e.g. 11kW turbine
  - Optimum efficiency (i.e. wind blowing at 12m/s all year long) 11kW x 24hrs x 365day = 96,360 kWh per annum
  - Average windspeed 6m/s = 35,000kWh per annum
  - 35,000 / 96,360 x 100 = 36% efficiency

Small Wind considerations

- Planning permission required
- When siting a turbine, need to consider following impacts:
  - Noise and neighbours
  - Visual and landscape impacts
  - Wildlife (bats/birds)
  - Safety (roads, public rights of way)
  - Grid Connection (extra cables / connection upgrade = £££)

Micro Hydropower

- Hydro converts potential energy stored in water and converts it to electrical energy
- Needs a suitable location with sufficient flow and head height
- Age old technology: 300 years ago there were 30,000 micro hydropower schemes in England – now there are only 90
- Expensive (approx £10k per kWp), but efficient
- 70% typical efficiency
- Grid connections can be difficult in remote rural locations
- Planning and Permits required

Renewable Heat Generation

Solar Thermal (hot water)

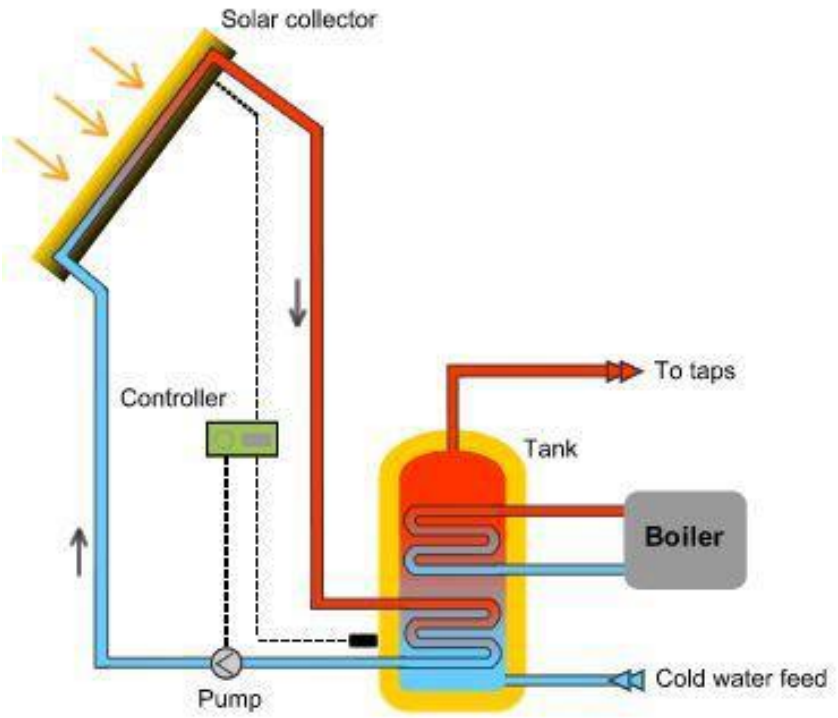
Air Source Heat Pumps

Ground Source Heat Pumps

Biomass

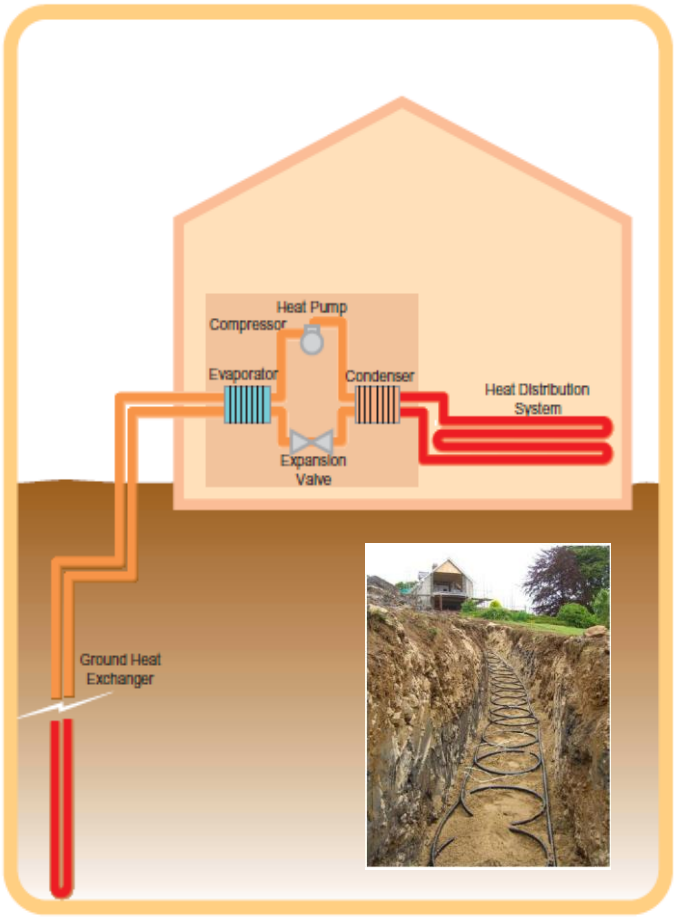
Solar Thermal

- Converts solar energy into heating for domestic hot water use
- Need hot water tank & thermal store
- Ideal when high day time demand for hot water
  - e.g. sports facilities / hotels
- Panels are heavy (25kg/m2) – roof needs to be suitable
- Avoid overshadowing (trees, buildings, chimneys)
- About £700/m2 for installed system



Ground Source Heat pumps

- Takes heat from ground / water source
- Concentrates and transfers heat from ground to inside buildings
- Needs electricity input
- Typical Co-efficient of Performance (CoP) of 4
  - 1kW electricity delivers 4kW heat
- Used for space heating or hot water
- Need thermal store
- May need heating upgrades – larger radiators or underfloor heating
- Needs extensive groundwork to lay cables
- Can also be used for cooling (transfers heat from house to ground)



Air Source Heat Pumps

- Works by taking heat from air, heat exchange increases the temperature and transfers heat into building
- Cheaper than Ground Source Heat Pumps, but has a lower CoP
- CoP of between 2.8 – 3.6
- Suitable for traditional wet heating systems or air heating
- Works best with underfloor heating

Biomass

- Biomass is term used for any plant or animal derived fuel
  - wood,
  - plants,
  - organic waste (food, paper etc)
- Biomass is burned to generate heat
- Boiler can be linked into standard domestic heating system or be used as a stand alone secondary heating source

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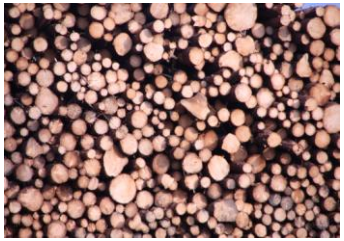
Biomass fuels

- Logs
  - Cheapest, but bulky and requires manual loading
- Wood Chip
  - Bulky boiler, suitable for industrial scale (>35kW)
  - Automated hopper, but needs large storage
- Wood Pellets
  - Most expensive
  - suitable for domestic > 9kW
  - Automated system
  - Less storage required



Feed in Tariffs Explained

- Guarantee a price for a fixed period for electricity generated using small-scale low carbon technologies:
  - Wind, Solar Photovoltaics (PV), Hydro, Anaerobic Digestion & non-renewable micro-CHP
- **Generation Tariff**: Payment for every kWh generated (technology specific)
- **Export Tariff**: Extra Payment for every kWh exported to grid (fixed at 3.1p per kWh)
- **Cost Savings**: Additional benefits from avoiding costs of buying in power from the grid
- Designed to give a **5-8% return** on investment

  * Payments Linked to RPI and last 20/25years (4.8% 2011/12)

  * Payments Derogated after 3 years

A Worked Example

Assume a 4kW PV array fitted before 2012 to a customer paying 12p/kWh for electricity. The system will generate 3,050Kwh per year of which 500kWh are exported to national grid

- Generation payment = (3050 x £0.433) = £1,321
- Value of avoidance costs = (2550 x 0.12p) = £306
- Value of exports = (500 x £0.031p) = £16
- **Total annual income** **= £1,643**
- Typical cost = £16,000
- Payback period (£16,000/£1,643) = 9.7 years
- ROI (£1,643/£16,000) = 10.25%
- Income & Savings (25 years) = £41,075
- **Profit** (not inc. RPI or energy cost increases) **= £25,075**

Renewable Heat Incentive (RHI)

- Guarantee a price for a fixed period for heat generated using small-scale low carbon technologies, including:
    - Biomass, Solar Thermal, Ground and Water Source Heat Pumps, on-site Biogas
- 1st phase due to commence on July 1st (non-domestic)
- 2nd phase scheduled for 2012 (domestic)
- Payment for every kWth generated – technology specific
- Heat must be supplied to meet an economically justifiable heat load, not purely created to claim RHI
- Eligible loads are space, hot water and process loads in a fully enclosed structure

Renewable Heat Incentive (RHI)

- Additional benefits from avoiding costs of buying less energy from the grid – cost savings
- Designed to give a 6-12% return on investment

  *Payments Linked to RPI and last 20years

  *Degression reviews from 2012 (avoid perverse outcomes

Domestic RHI

- Will not go live until 2012 and exact criteria are dependent on what is in the Green Deal for Homes
- As part of the first phase of support, **Renewable Heat Premium Payments** will be made to subsidise the installation of renewable heating equipment
- Focus on off-gas households
- Intend to implement in July 2011, and will make further announcements in May 2011
- Likely level of this payment is £950/unit for a biomass system

What can we do at home?
Follow the 'Energy Hierarchy'

Improve building fabric

- Reduce heat losses first, improve air tightness and make the building efficient

Use energy efficient equipment

- Look at design & consider life cycle costs over capital expenditure

Generate renewable energy

- Select the appropriate technology

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Thank-you

Questions?