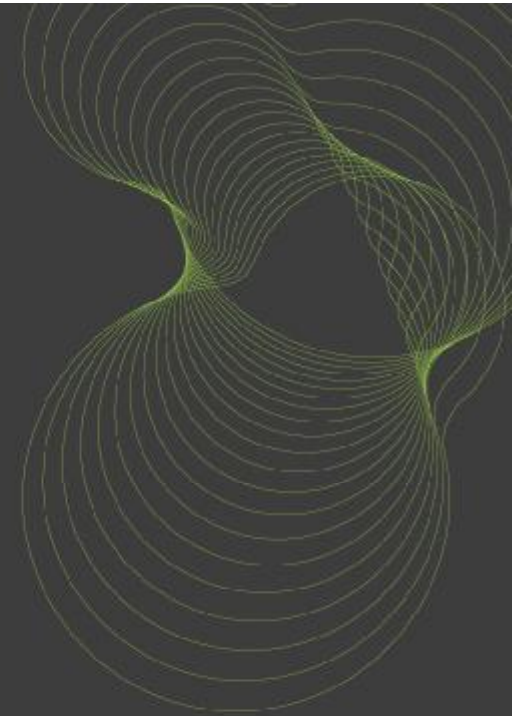


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# Intro to Renewables Technologies





# Photovoltaics

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# Photovoltaics - efficiency

- **Crystalline Silicon (mono- and poly- types )**
- **Amorphous Silicon (thin film)**

Efficiency (per cent)	Module type	Durability (yrs)
12-15	Monocrystalline	25-30
10-13	Polycrystalline	20-25
3-6	Amorphous	15-20



# Photovoltaic applications

- Mounted on roofs or walls
- Roof tiles
- Integrated into blinds or glazing
- Independent of the building
- Street furniture



Can be retrofitted to existing roofs. Potential economies in building integration and/or inclusion at design stage of new build

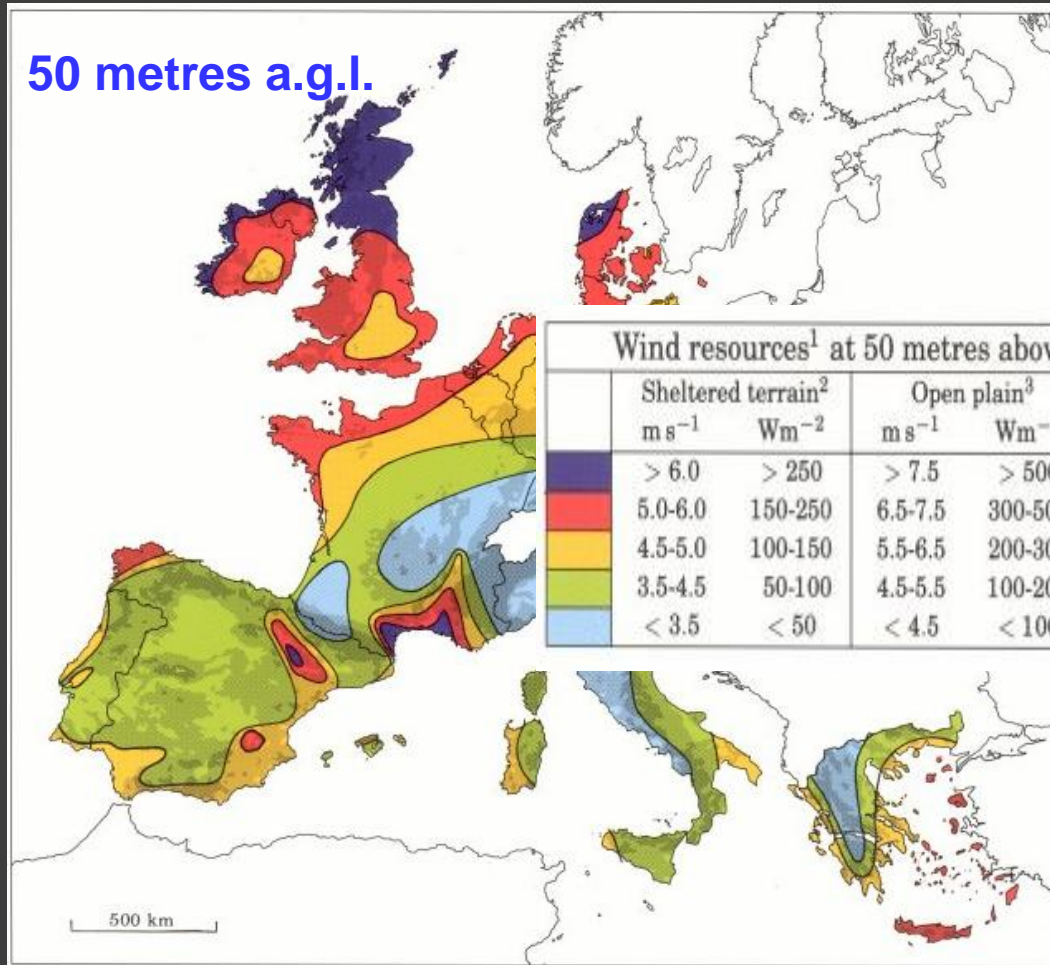


# Wind Turbines

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# The Wind – European Wind Resource

50 metres a.g.l.



40% of the onshore Europe's wind resource is in the UK

Wind resources<sup>1</sup> at 50 metres above ground level for five different topographic conditions

	Sheltered terrain <sup>2</sup>		Open plain <sup>3</sup>		At a sea coast <sup>4</sup>		Open sea <sup>5</sup>		Hills and ridges <sup>6</sup>	
	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>
Dark blue	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
Red	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
Yellow	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
Light green	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
Light blue	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

# Turbine Types – HAWT Multi-blade



- Lift machine
- High  $C_p$
- Self-starting
- Needs to yaw



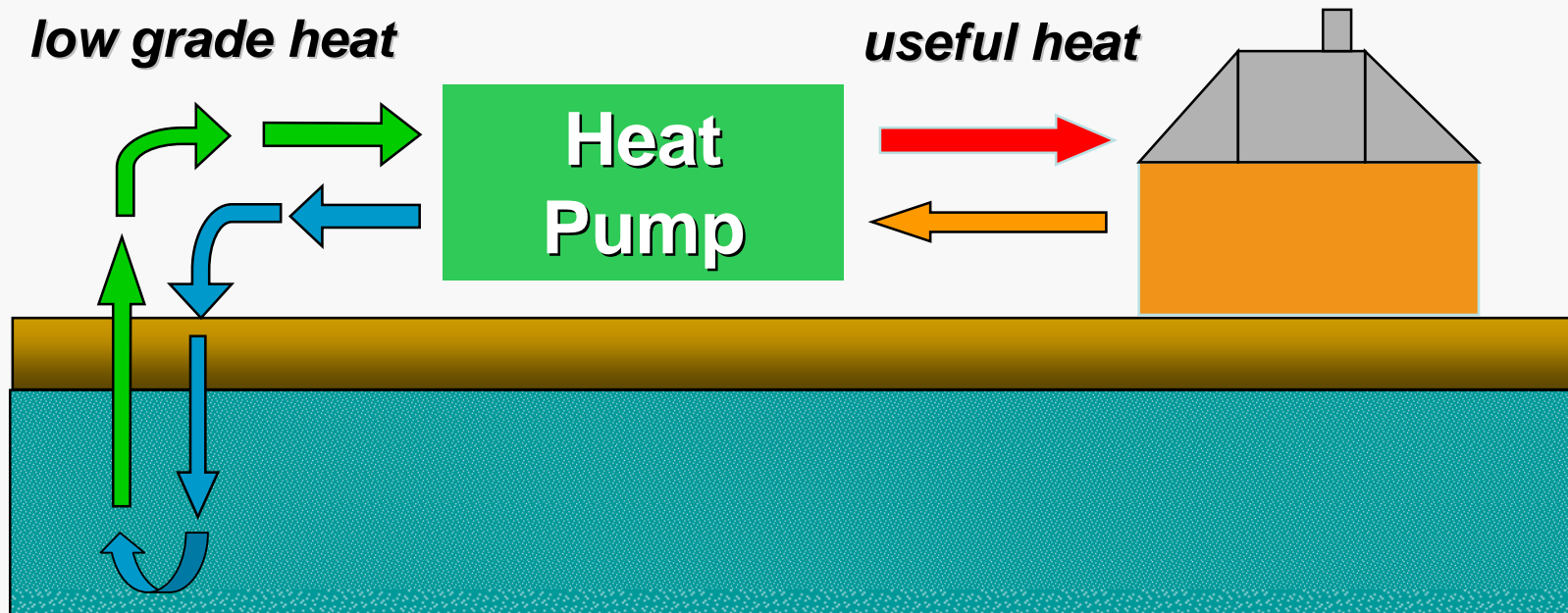


# Heat Pumps

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# Heat pumps

Natural temperature at >1 metre below surface is a constant +10 C.  
Plenty of heat energy – but at too low a temperature



Coefficient of Performance: can be better than 4.0



EarthEnergy Limited 2006

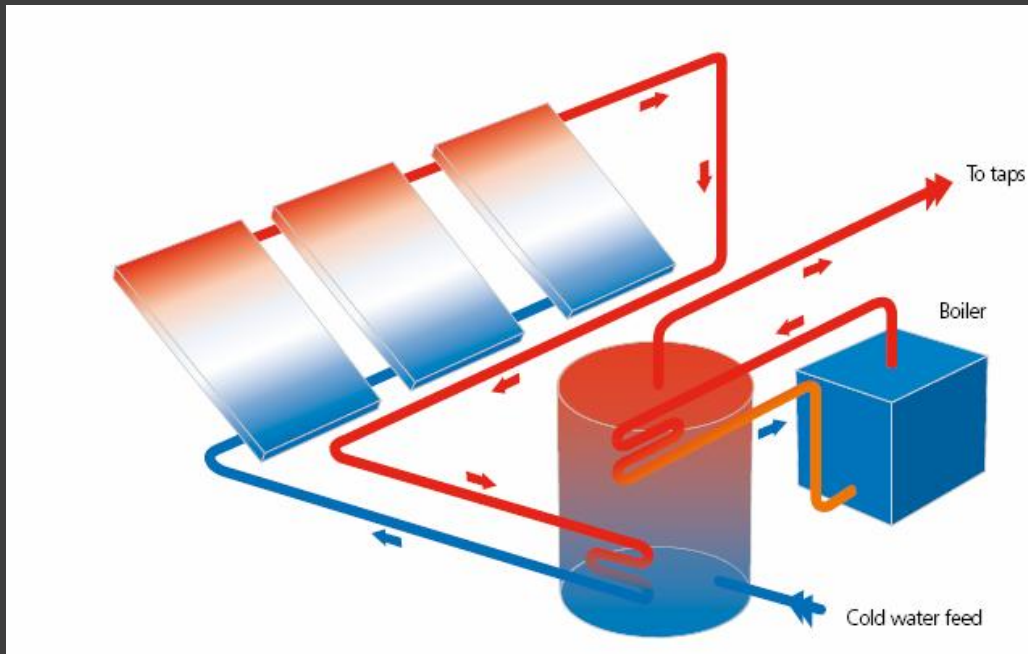




# Solar Thermal

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# Solar thermal hot water



# Collector types....



Evacuated tube



Flat plate



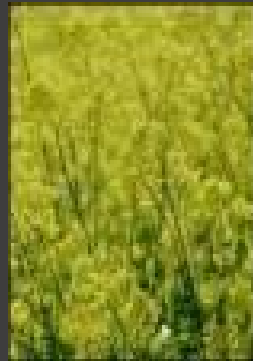


# Biomass

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# Biomass

- Woody biomass
  - Short rotation coppice (SRC) i.e. willow, miscanthus
  - Forest residue
  - Untreated wood waste
  - Crop residue, i.e. straw
- Non-woody biomass
  - Vegetable oil crops
  - Animal residues
  - Industrial waste



# Wood Pellet Boilers Vs wood chip

The fuel:

- Standard size, moisture, calorific value
- Sourced from seasoned waste e.g. from furniture manufacture



[From Welsh Biofuels website]



Hydro

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## Why mini-hydro?

- High efficiency
- High capacity factor
- Predictability
- Slow rate of change
- good correlation with demand

