Carbon Calculation Exercise - Ground Source Heat Pump

ANSWERS

A developer proposes to install a ground source heat pump to meet a planning requirement in a property off the gas grid to replace an oil heating system.

Data

Annual Energy Consumption of the development

		kWh
A	Oil	100,000
B	Electricity	50,000
C	Total	150,000

Annual Carbon Load of the development

		Kg CO2
D	Oil	28,400
E	Electricity	29,550
F	Total	57,950

Carbon Conversion Factors

	Fuel	kgCO2/kWh
G	Heating Oil	0.284
H	Grid Electricity	0.591

The GSHP has a **Coefficient of Performance of 2.5** i.e. for every 1kWh of electricity used to run the pump, 2.5kWh of heat are produced.

The oil boiler replaced has an efficiency of 90%, so the GSHP needs to provide 90% x 100,000 kWh of heat **= 90,000 kWh heat.**

1. 10% Energy Savings

The developer is required to supply 10% of the energy demand of the development through low carbon energy sources. Calculate the energy saved.

		SUM	kWh
I	Oil saved	= A	100,000
J	Heat produced by Heat Pump	= A x 0.9	90,000
K	Electricity used by Heat Pump	= J / 2.5	36,000
L	Energy saved	= I - K	64,000
	% energy saved	= L / C	43%

2. 10% Carbon Savings

The developer is required to supply 10% of the carbon load of the development through low carbon energy sources. Calculate the CO2 saved.

		SUM	Kg CO2
M	Oil carbon savings	= D	28,400
N	Electricity carbon load	= K x H	21,276
O	Carbon saved	= D - N	7,124
	% carbon saved	= O / F	12%

Notes

Equation I
Remember, the ground source heat pump will completely replace the proposed oil central heating system.

Equation J
The amount of heat you need in the house is less than the amount of oil used, because the boiler wastes 10% of it in turning the oil into heat. The heat pump therefore only needs to produce this amount of heat to replace the oil burnt.

Equation K
The house still requires heat, but now the heat comes from the ground source heat pump.
The heat pump is 250% efficient when compared to other forms of electric heating (COP 2.5).
Therefore it will produce 2.5 kWh of heat for every 1 kWh of electricity it uses.
How much electricity will be needed to supply the amount of heat that the development consumes?

Equation L
You're saving one form of energy (Oil) but using another (Electricity). What is the total saving in terms of energy (kWh used)?

Equation M
You are no longer consuming oil. How much carbon is saved?

Equation N
You have replaced your consumption of a certain amount of oil, with a certain amount of electricity, which you worked out in Equation K. How much carbon is produced by this amount of electricity?

Equation O
You're saving carbon from one form of energy (Oil) but producing carbon from another (Electricity). What is the total saving?

Conclusion
You can save a lot of energy by replacing one fuel with another.
However, different fuels produce different amounts of carbon.
If you replace a *large* amount of *carbon-light* energy with a *small* amount of *carbon-heavy energy*, you don't save much carbon at all.

Important Note on Fuel Replaced

If the fuel replaced had been gas, the system would actually increase the carbon load, because gas has a lower carbon content than oil. For the same system the energy savings would be the same, but the carbon savings would be:

		SUM	Kg CO2
M	Gas carbon savings	= D	20,600
N	Electricity carbon load	= K x H	21,276
O	Carbon saved	= D - N	**- 676**
	% carbon saved	= O / F	**- 1%**