

Sustainable Energy at Scale

January 23, 2010 — David J.C. MacKay

Transport, heating, electricity; wind

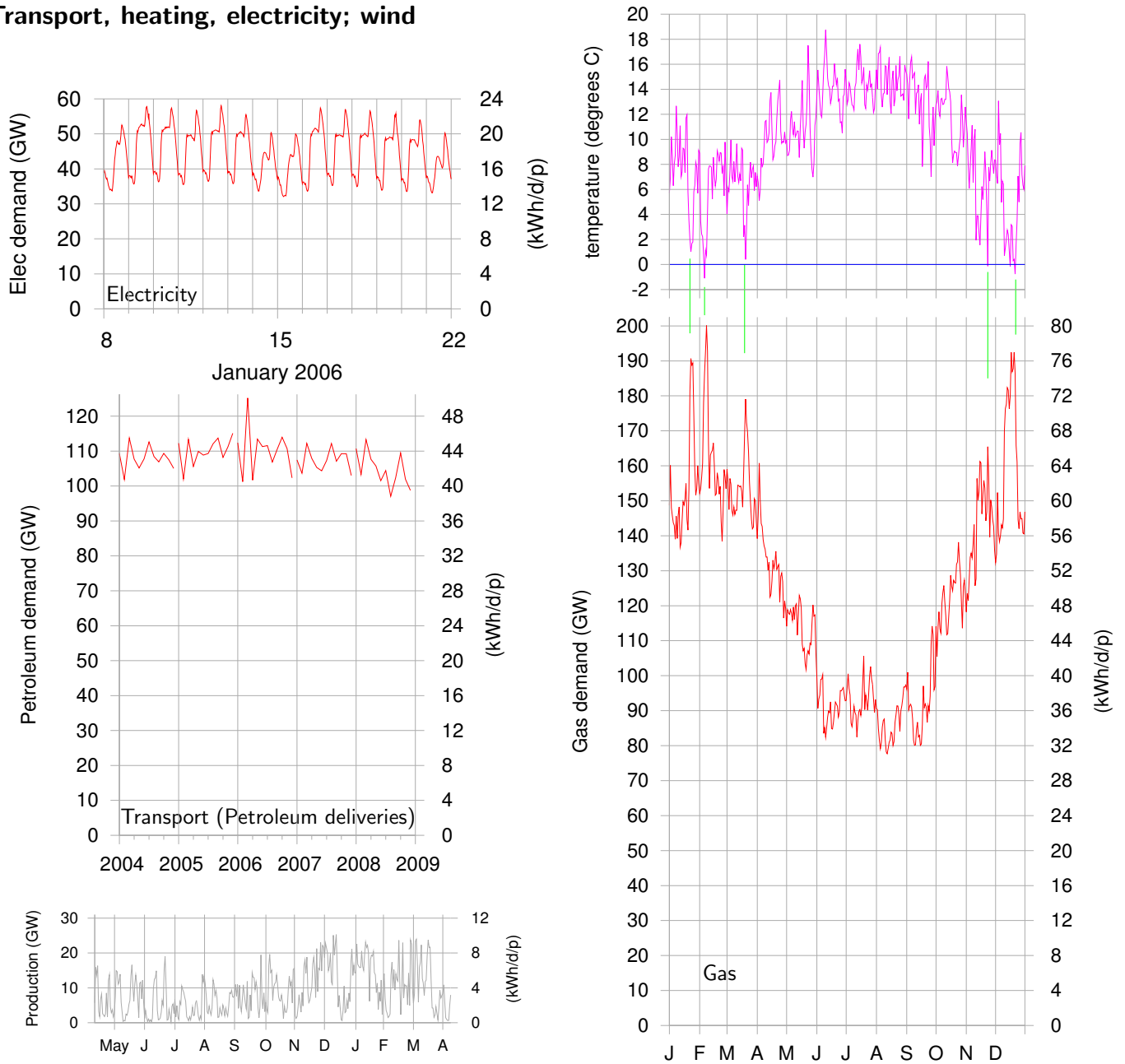


Figure 1. Electricity, gas, and transport demand; and *fictional* wind (assuming 33GW of capacity), all on the same vertical scale.

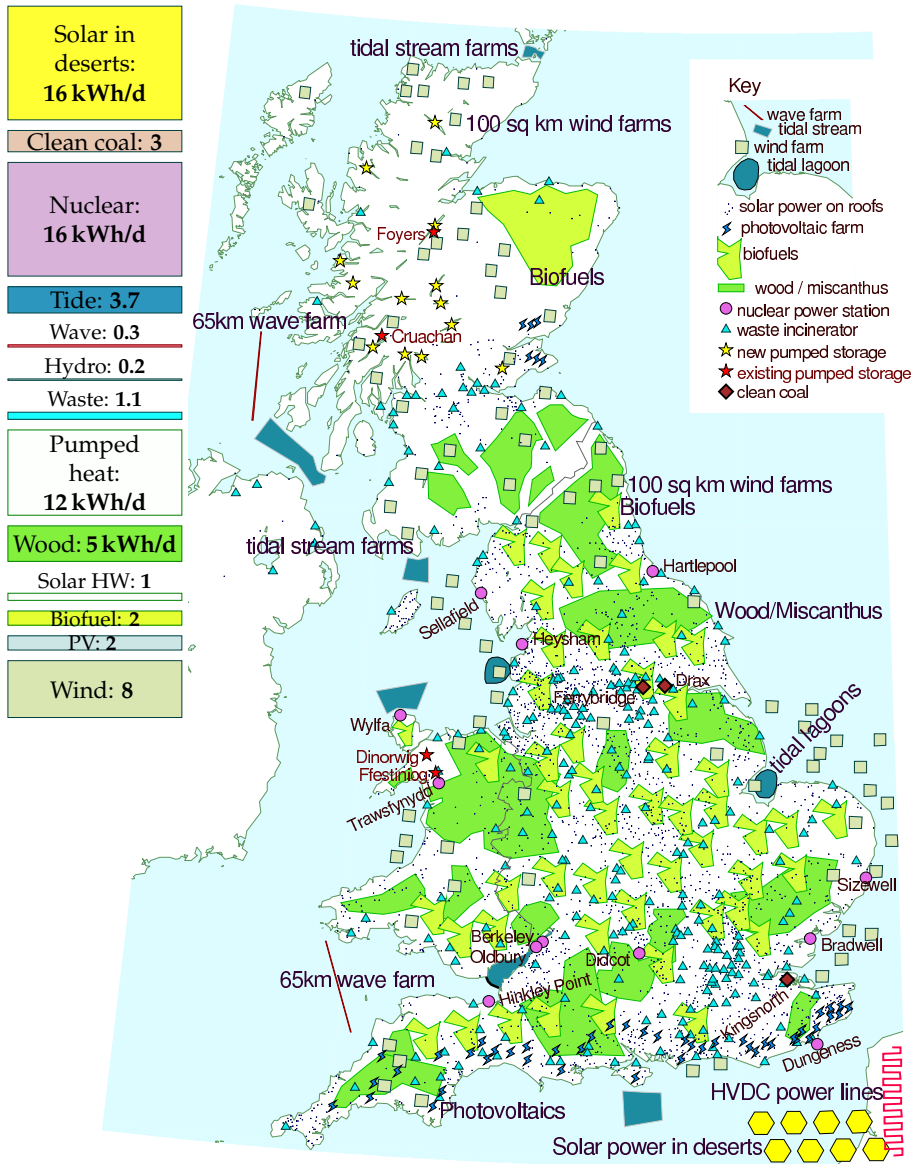


Figure 2. Plan M. A plan that adds up, for Scotland, England, and Wales, assuming electrification of most surface transport, electrification of most building-heating with heat pumps, and little lifestyle change. This plan, *not all parts of which are recommended*, features a *diversity* of sources, to help visualize choices and exchange-rates.

The grey-green squares are wind farms. Each is 100 km² in size and is shown to scale.

The red lines in the sea are wave farms, shown to scale.

Light-blue lightning-shaped polygons: solar photovoltaic farms – 20 km² each, shown to scale.

Blue sharp-cornered polygons in the sea: tide farms.

Blue blobs in the sea (Blackpool and the Wash): tidal lagoons.

Light-green land areas: woods and short-rotation coppices (to scale).

Yellow-green areas: biofuel (to scale). Small blue triangles: waste incineration plants (not to scale).

Big brown diamonds: clean coal power stations, with cofiring of biomass, and carbon capture and storage (not to scale).

Purple dots: nuclear power stations (not to scale) – 3.3 GW average production at each of 12 sites.

Yellow hexagons across the channel: concentrating solar power facilities in remote deserts (to scale, 335 km² each).

The pink wiggly line in France represents new HVDC lines, 2000 km long, conveying 40 GW from remote deserts to the UK.

Yellow stars in Scotland: new pumped storage facilities.

Red stars: existing pumped storage facilities.

Blue dots: solar panels for hot water on all roofs.

Sources, further information for page 1.

Electricity demand in Great Britain during two winter weeks of 2006. The left and right scales show the demand in national units (GW) and personal units (kWh/d per person) respectively.

Transport demand, in GW, monthly, 1998–2008. Source: Petroleum Deliveries for Inland Consumption, DUKES, DECC.

Total output of Irish wind farms scaled up by a factor of 33/0.745 to represent the output of 33 GW of UK wind capacity. (Ireland's wind "capacity" in 2007 is 745 MW, dispersed in about 60 wind farms.)

Gas demand (lower graph) and temperature (upper graph) in Britain during 2007.

Further reading.

Sustainable Energy – without the hot air: 380-page book available free online from www.withouthotair.com. Paper copies are available, compliments of DJCM, from CSA's office, DECC, 3 Whitehall Place.

synopsis10.pdf – ten-page synopsis of *Sustainable Energy – without the hot air*.

PlanC.pdf – *A plan with a time-line*: a rough UK decarbonization plan that is technically buildable.