Sustainable Energy at Scale

January 23, 2010 — David J.C. MacKay

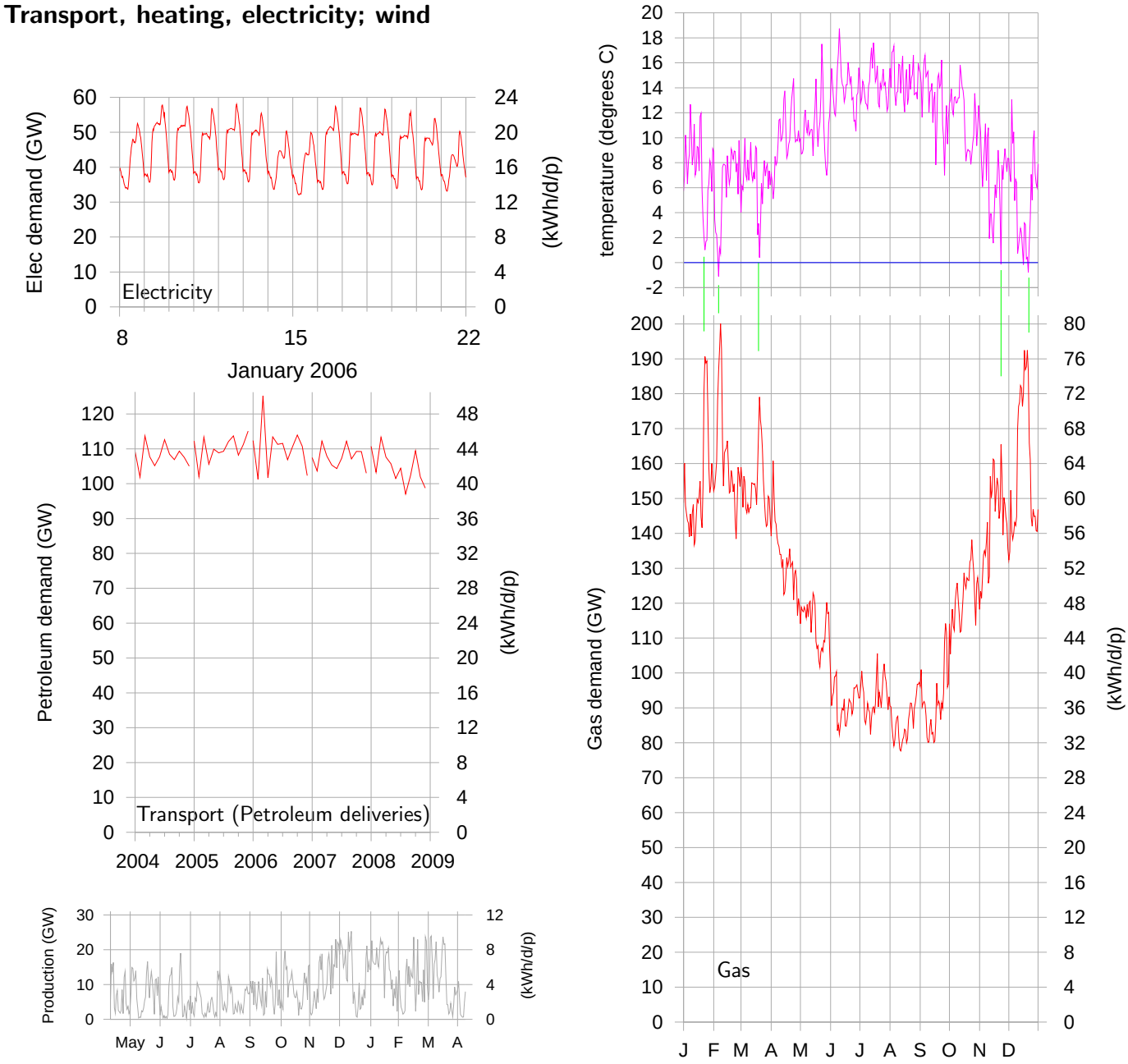

Figure 1. Electricity, gas, and transport demand; and *fictional* wind (assuming 33 GW of capacity), all on the same vertical scale.

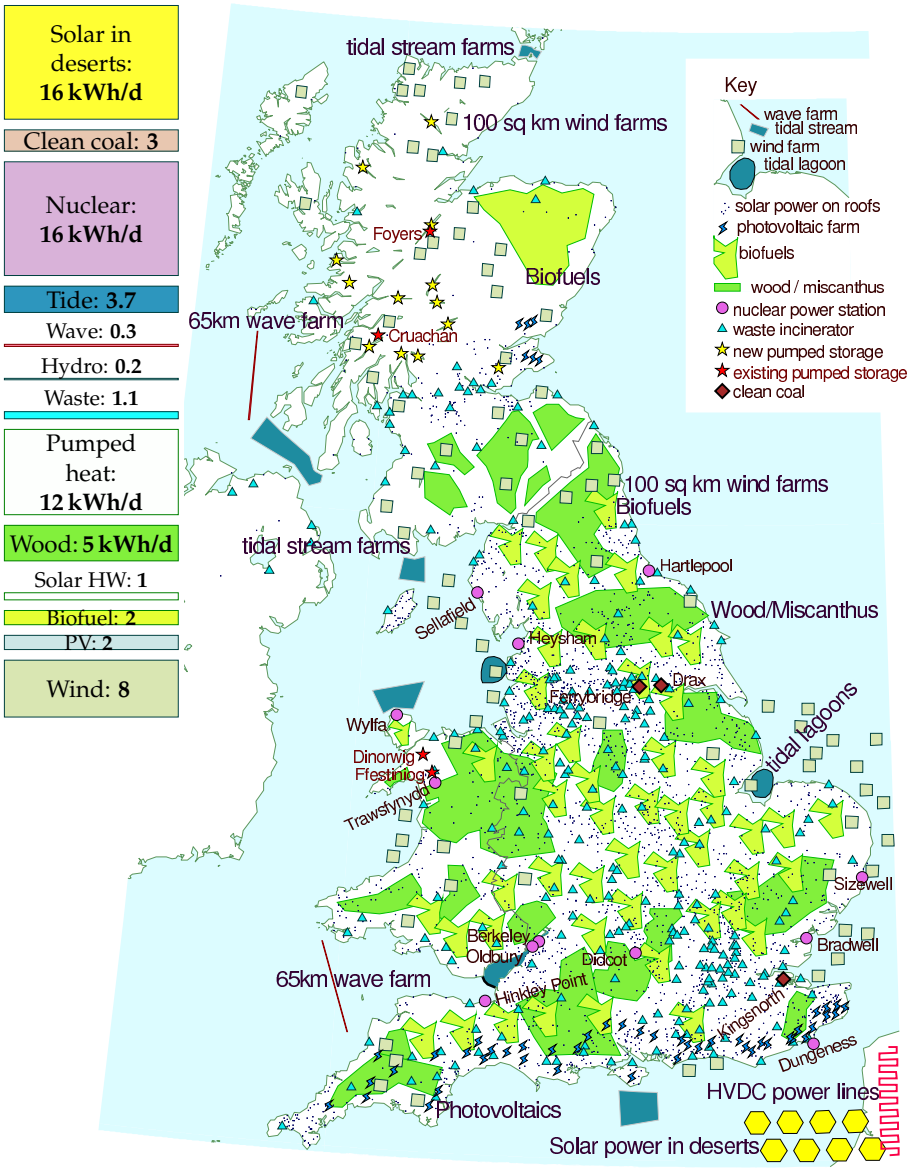

Figure 2. Plan M. A plan that adds up, for Scotland, England, and Wales, assuming electrification of most surface transport, electrification of most building-heating with heat pumps, and little lifestyle change. This plan, *not all parts of which are recommended*, features a *diversity* of sources, to help visualize choices and exchange-rates.
The grey-green squares are wind farms. Each is 100 km^2 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 km^2 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 km^2 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.