

Bridgwater 6th May 2014

UK Nuclear Pathways

Re-justification and Public re-consultation ?

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- **Nuclear in perspective - hardly a climate solution**
- **globally, nuclear supplies just 2.6 % of current global energy use - falling to 1.3 % by 2050 at current output**
- **Red Book uranium resources (5.3 > 12.9 mt) could supply 1.3 % for 190 years, or 2.6 % for 85 years**
- **WNA estimate 4 % by 2050 presumably IF 'fast' (breeder) reactors, are proven by 2035**
- **Thorium Gen IV (fast) reactors - IF and WHEN ?**
- **Renewables - several billion years**

- **UK nuclear reactors have averaged around 3.6 % of UK energy demand (18 % electricity)**
- **a ‘replacement’ (16 GW) programme would supply about 8 % of 2050 UK energy (120 / 1,500 TWh/y)**
- **A ‘replacement’ nuclear programme was subject to public consultation in 2006-07 and a re-consultation in 2007 as the first was judged ‘misleading, flawed and procedurally unfair’**
- **a new nuclear programme was justified by SoS Huhne in Oct 2010**

- then - in 2013 statements by ministers and the ad-hoc group of chief civil service advisers and **HMG 'Nuclear Pathways' report** made it clear that :
- 'the 16 GW programme was a **'first tranche'** and that up to **55 GW** or possibly **75 GW** was being considered'
- **55 GW** would supply ~ **30 %** of UK energy
75 GW would supply ~ **40 %** of UK energy
- few people or the media noticed !
- should the public **NOT** question such an significant escalation in UK nuclear energy ?

2007 Broad consensus that UK needs sustainable energy :

affordable low-carbon secure

- **energy efficiency (insulation, appliances etc)**
- **Combined Heat & Power (CHP) district heating**
- **renewable energies (seven or more significant sources)**

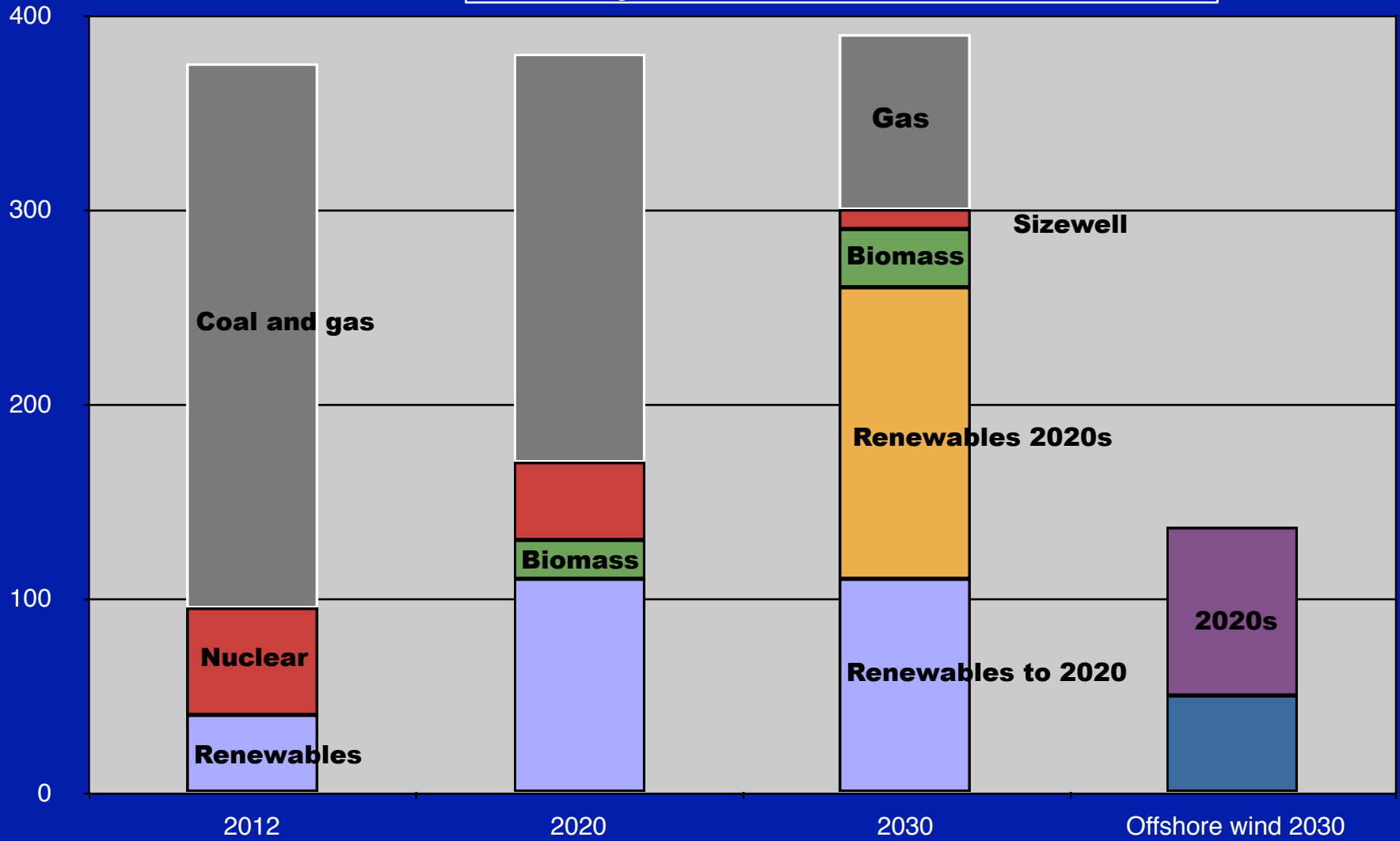
- **Gen III+ nuclear (Light Water Reactors ‘LWRs’)**
- **Gen IV nuclear (‘fast’ / breeder reactors 2035 ?)**

- **CCS (carbon capture & storage) on gas and coal**
- **industrial emitters + BECCS (biomass + CCS)**

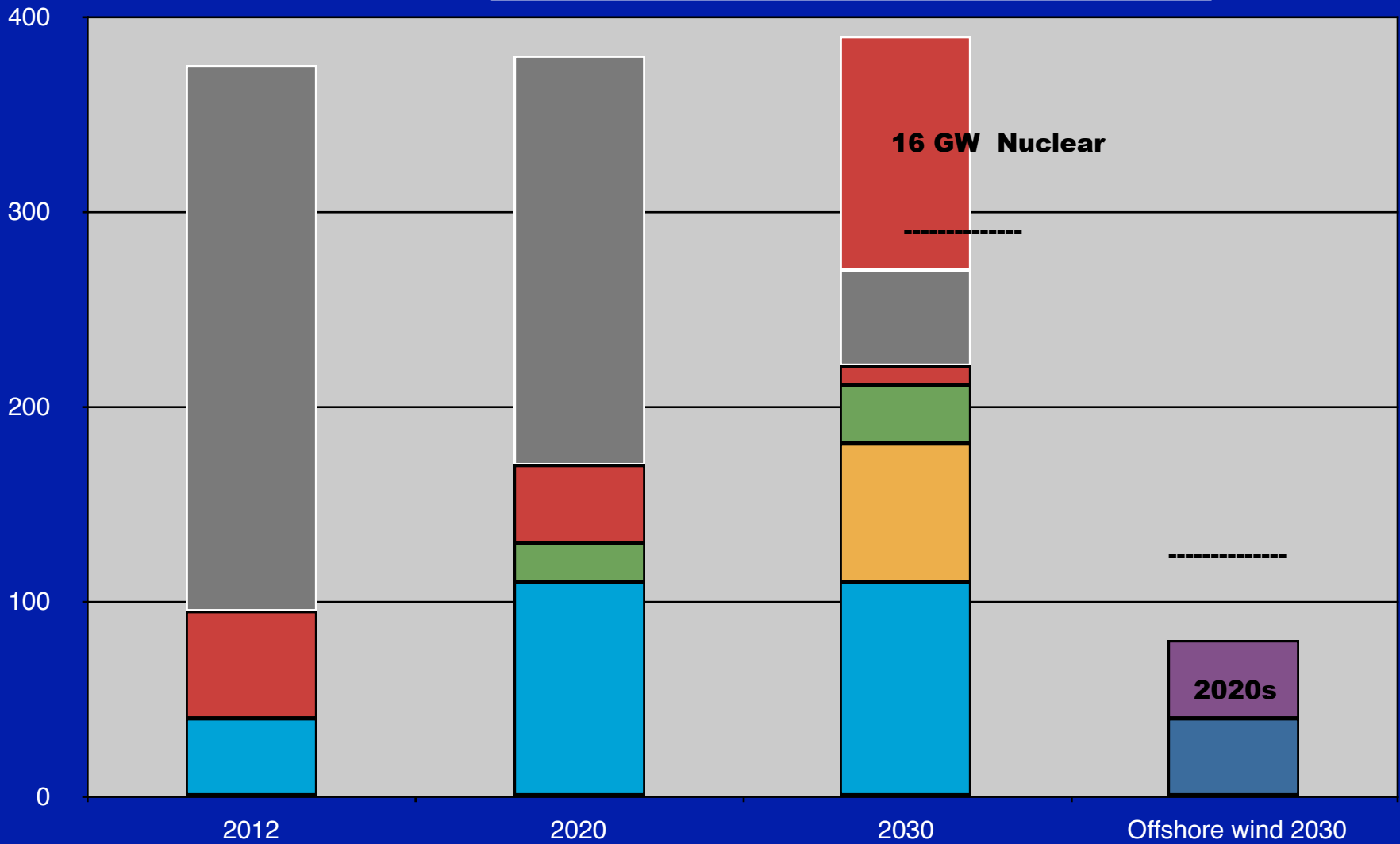
- **the 2007 public consultation was about a 'replacement' (11 GW morphed to 16 GW) nuclear programme - and one geological repository**
- **CCS was considered unproven despite a full chain scheme working in Dakota since 2000, or that EPR and AP1000 reactors were and are still unproven**
- **in Oct 2010 SoS Huhne 'justified' new nuclear - 'benefits outweigh the health risks' :**
 - **much lower estimated cost than renewables**
 - **less gas from Russia (forgetting Norway / LNG)**
 - **security-of-supply (baseload, uranium storable)**

- **Since 2010, the Government drew up a policy for Electricity Market Reform (EMR) in an Energy Bill which received Royal Assent on Dec 2013**
- **By 2013 the Committee on Climate Change (CCC) was recommending electricity sector 'decarbonisation' to cap CO2 emissions from power generation**

Non-nuclear 2030 scenario (390 TWh/y demand)

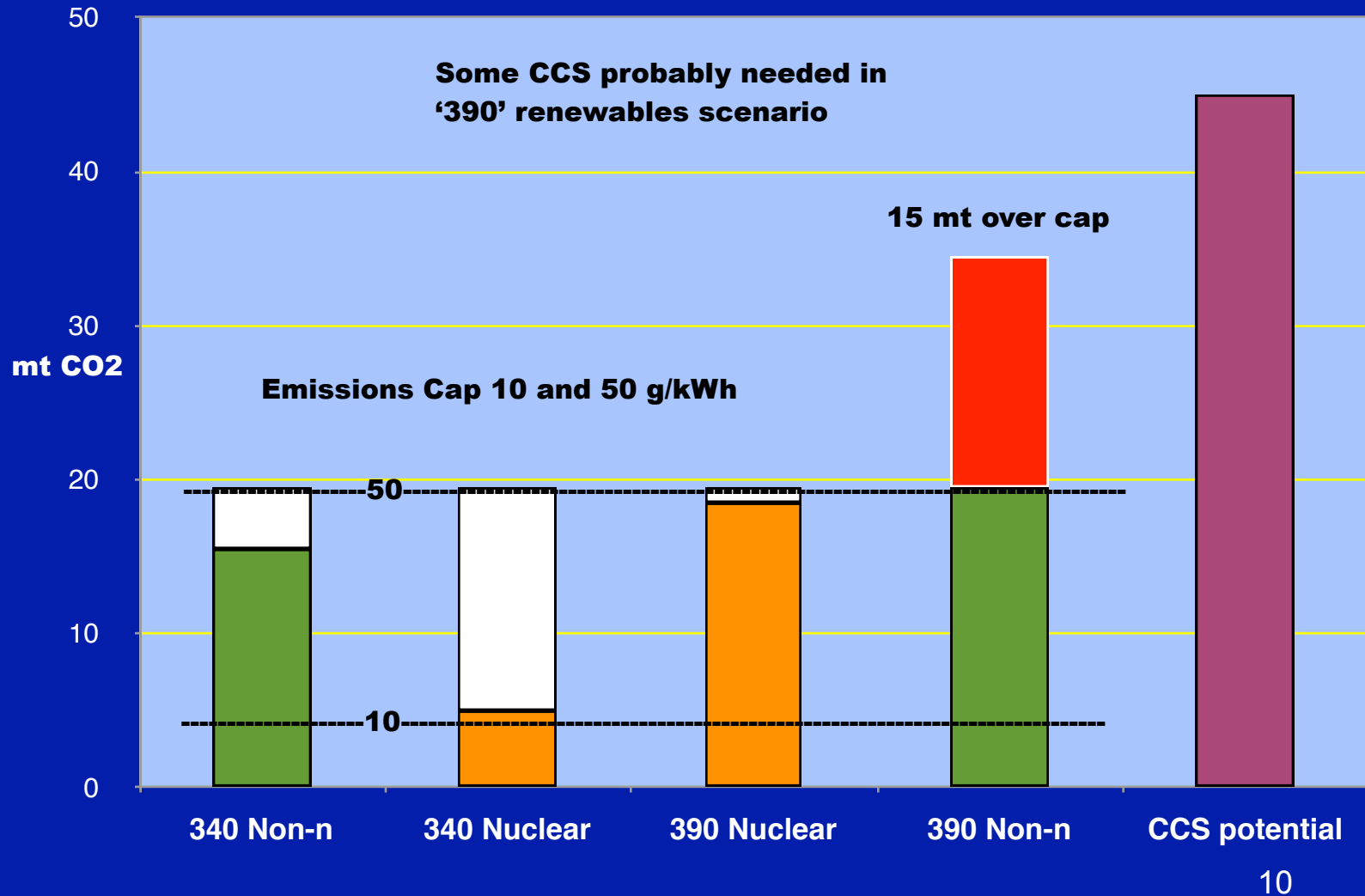


New nuclear 2030 scenario (390 TWh/y demand)



Electricity sector CO2 emissions in 2030

CO2 emissions from electricity demand 340 and 390 TWh/y



- **HMG 2013 Nuclear Pathways report - uranium ?**
- **contemplates a significant escalation of nuclear power in UK 3.5 to 4.7 x first tranche**
- **30-40 % energy dependence on nuclear power**
- **national security - high energy dependency on imported uranium 0.6 mt by 2100 and Red Book resources are ~7 mt (to twice current price)**
- **UK uranium imports up to 11 x global 'equal-share' (per person) and still 5 x if significant new uranium sources become available**

- **HMG Nuclear Pathways report - waste ?**
- **legacy waste amounts to ~ 87 mTBq and a repository (GDF) footprint would be 3-4 km²**
- **16 GW new would produce 244 mTBq (high burn-up) itself requiring a footprint of ~11-16 km²**
- **55 GW would produce 840 mTBq requiring a footprint of 37-54 km² or 9-13 legacy-scale GDFs**
- **In Dec 2013 Cumbria rejected the 1 proposed GDF - near Sellafield - derailing Coalition plans, and questions 'fixed share of waste costs'**

- **55 GW of LWR's would require 11-17 coastal sites (3-5 GW each) - not Scotland**
- **each site's Interim Store could reach 50-80 mTBq or 55-90 % that of legacy waste stored at Sellafield**
- **Fast reactors (on same sites ?) need reprocessed plutonium from the LWRs to get them started - and could 'burn' the longer-lasting accumulated waste - to what ?**
- **Government should say what 'fast waste' arising would comprise and where stored**

- **Small Modular Reactors (SMRs)**
- **future nuclear tranches could comprise much smaller self-contained reactors (50-300 MW) built inland (no need for river or seawater cooling)**
- **a 30 GW SMR deployment (225 TWh/y) could comprise anything from 100 to 600 buried units dotted around edge-of-city developments, industry and refinery sites and rural areas**
- **all linked by occasional but routine armed fuel and waste removal convoys to Interim Stores and GDFs**

- **Should there not be at least a **Public Consultation** about such a possible nuclear escalation ?**
- **Should there not be a **Re-justification** about such a possible nuclear escalation ?**
- **SoS Ed Davey said as recently as the Glasgow Lib Dem conference in Sept 2013 that new-nuclear would produce '**far less waste**' - he's fallen for the old volume (not radioactivity) trick - as Blair did.....**
- **despite detailed analysis is Davey mis-informed about non-nuclear scenarios ?**

- **Offshore wind**
- a major UK resource (North Sea, Irish Sea)
- fixed and floating structures - resource > UK energy !
- British technology / industry leads > exports
- Cost estimates < £ 100 / MWh by 2023
- **55 GW nuclear** (410 TWh/y) = sea area of 1.4 - 2.2 size of Wales or **7-11 % of sea area around UK** (0.45m km²)



- **Solar PV potential**
- **quickly becoming very cost-competitive and some British innovations**
- **covering most southern-facing roofs in UK with higher-efficiency PV could supply about 50 % a 55 GW nuclear programme (~ 200 TWh/y)**
- **solar farms in the countryside could add significantly to the supply from buildings - depending on acceptable landscape impact**
- **PV (buildings + farms) = 30 GW SMRs (225 TWh/y)**

- **Net energy system costs / benefits to 2050 - 'out of model, out of mind'**
- **DECC 2011 nuclear = £ xx billion net saving**
- **DECC nuclear estimate = £ 90>80 /MWh**
- **offshore wind + back-up 2023 = £ 95-105 ?**
- **offshore wind + PV + other RE by 2030 = £ ?**
- **proliferation/foreign policy implications = £ 0 /MWh**
- **possible mega-terrorism events = £ 0 /MWh**
- **uranium import dependency, security = £ 0 /MWh**
- **public health risk (accident / routine discharge) = £ 0 /MWh**
- **intractable waste issues for future generations = £ 0 /MWh**
- **British RE / CCS tech leads, jobs, exports = £ 0 /MWh**
- **additional armed services budget = £ 0 /MWh**
- **additional visual impact (coast scapes) = £ 0 /MWh**

- **Call for Re-justification ?**
- **"new and compelling evidence affecting the balance of benefits and detriments"**
- **significant escalation in scale 3.5 to 4.5 x**
- **system cost benefits - not significant, if any (PV, offshore wind, CCS)**
- **no clear low-carbon benefit**
- **adverse security of uranium supply**
- **multiple GDF's needed, not one site found**
- **recent health evidence**

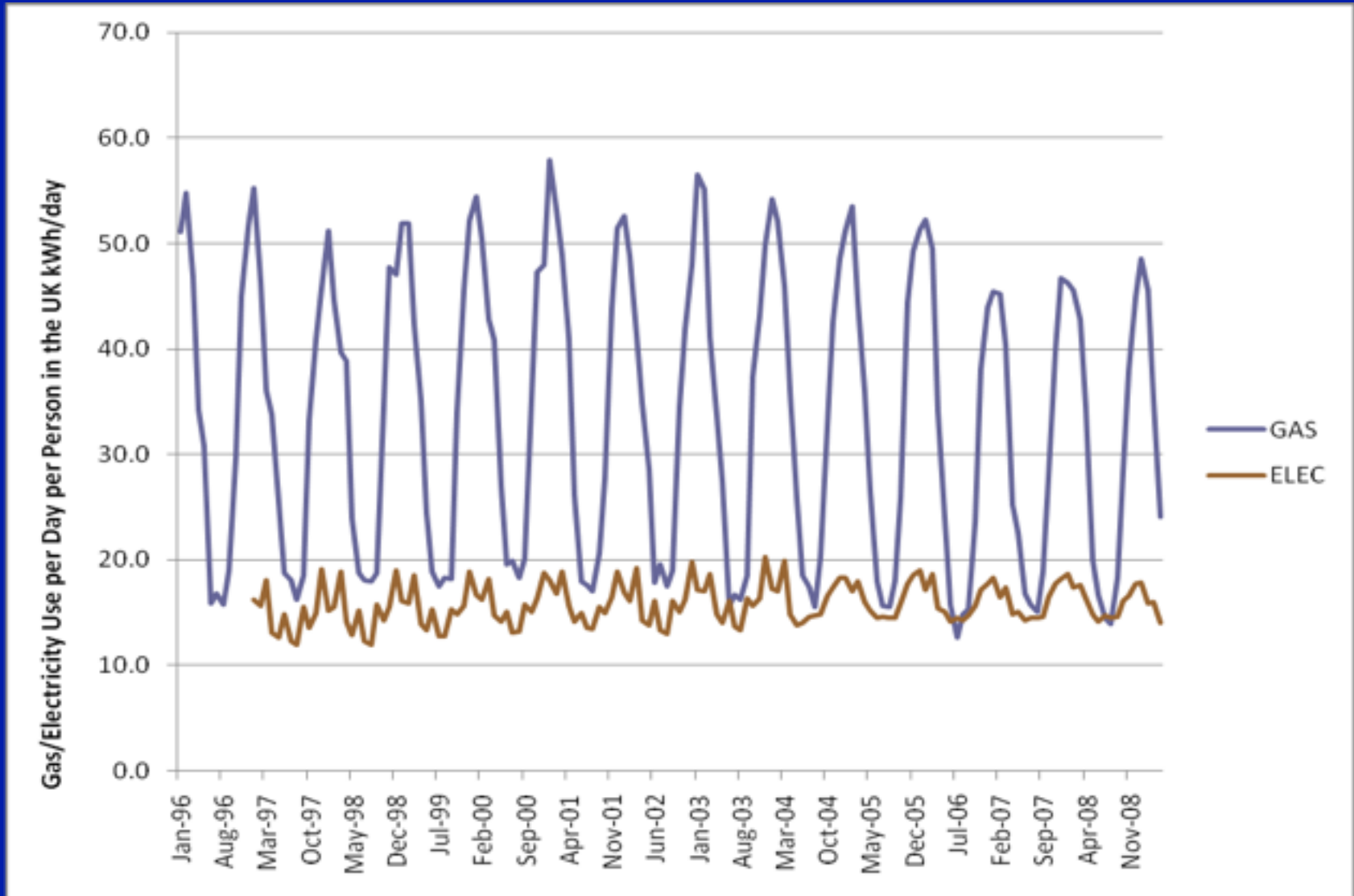
- **Call for Public Re-Consultation ? - 'lead by the nose'**
- **Tory manifesto : fundamental national duties of 'energy sovereignty' and 'energy security'**
- **2007 consultation - 'replacement' (then 11 GW) rising to 16 > 55 > 75 GW, very low-cost !, one GDF far less waste, 'balanced mix' (then 5%) rising to 30- 40 % energy including most electricity)**
- **wider issues of proliferation, vulnerability to terrorism, high dependency on uranium imports, damage to British renewables and CCS technologies, jobs, exports, indigenous energy**

- **Thank you for listening**

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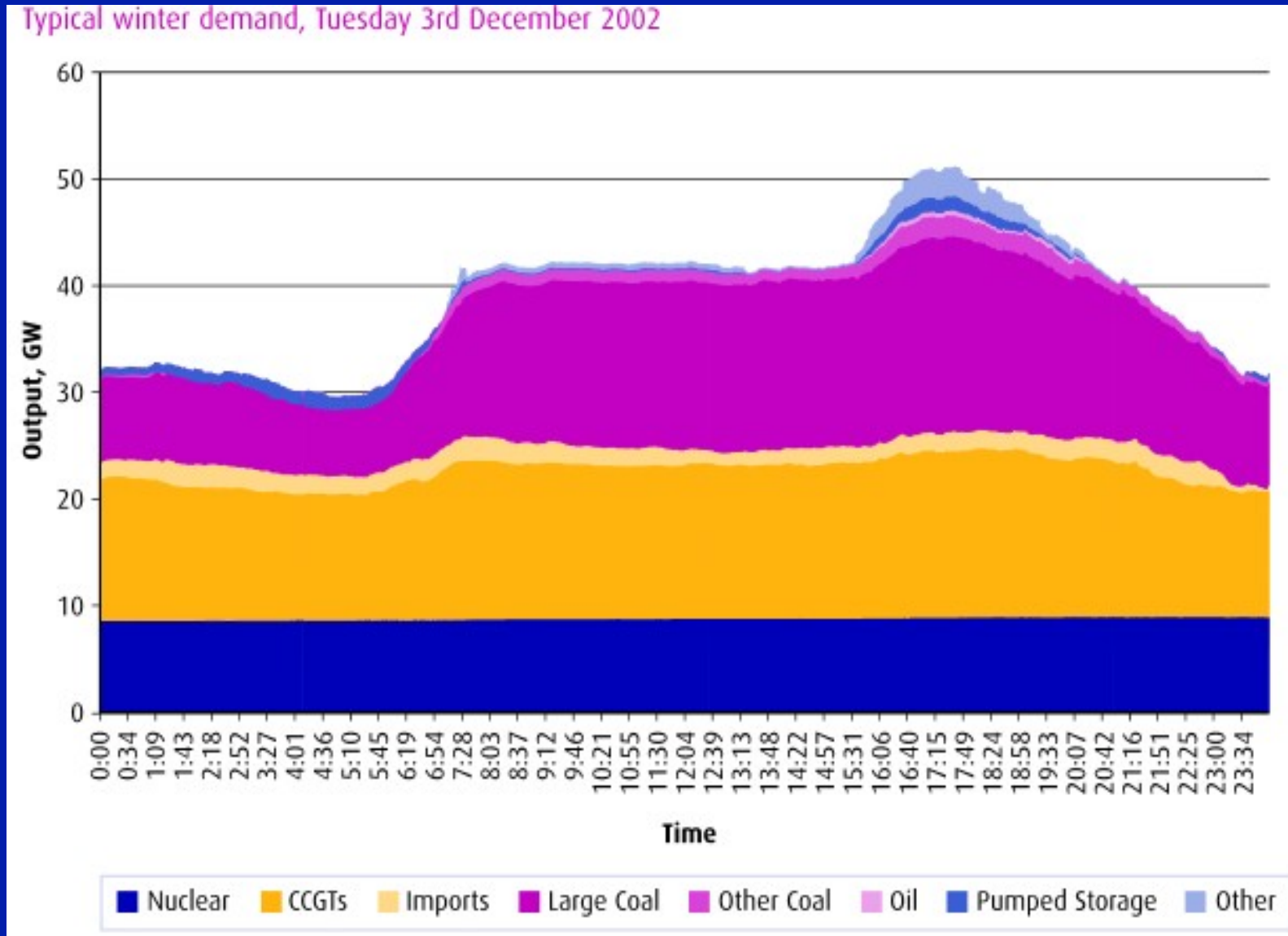
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- * gas peak 3 times electricity peak
- * 340 TWh Grid + 700 TWh gas in 2011

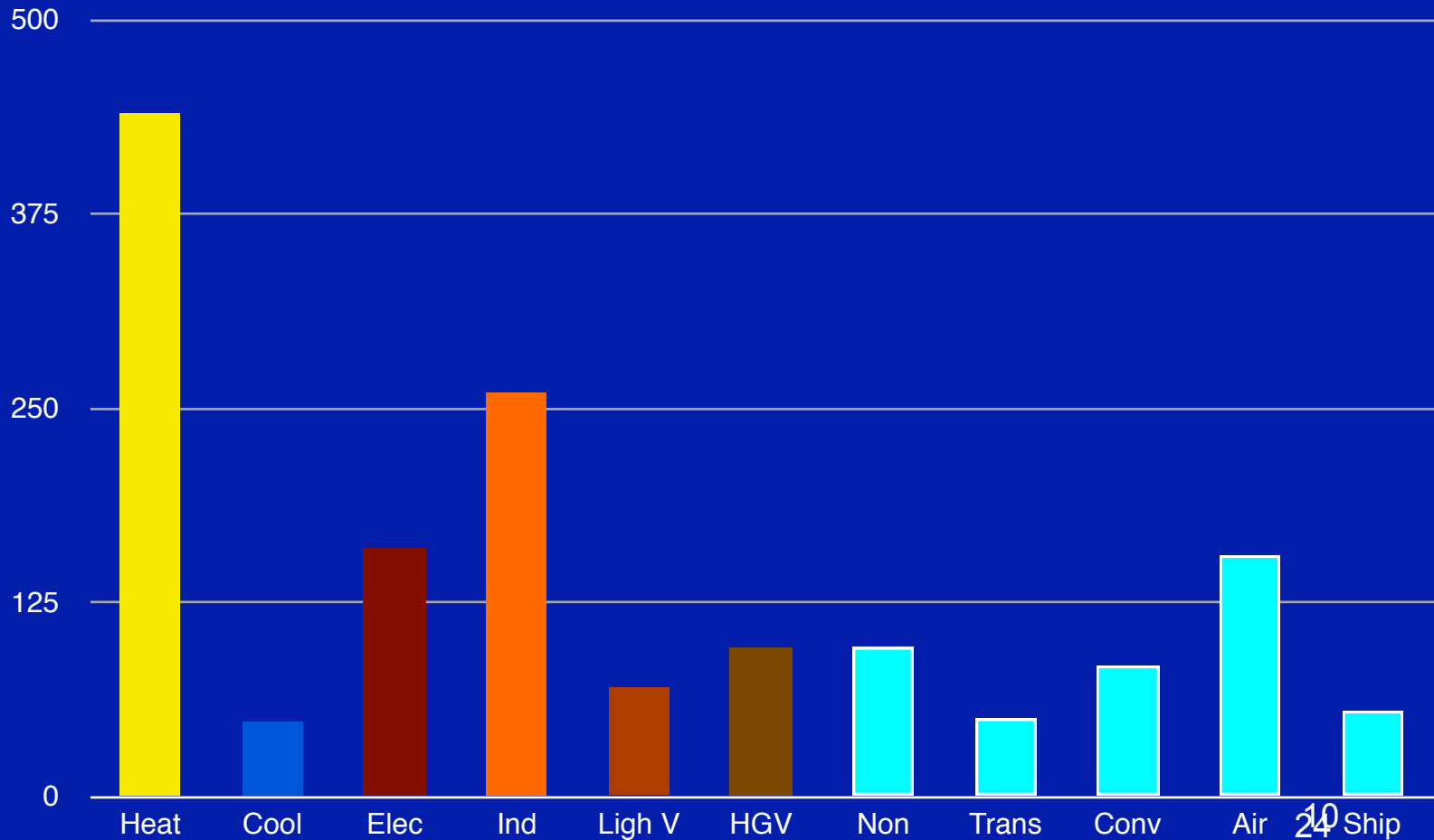


* **Electricity Grid 30–50 GW daily variation**

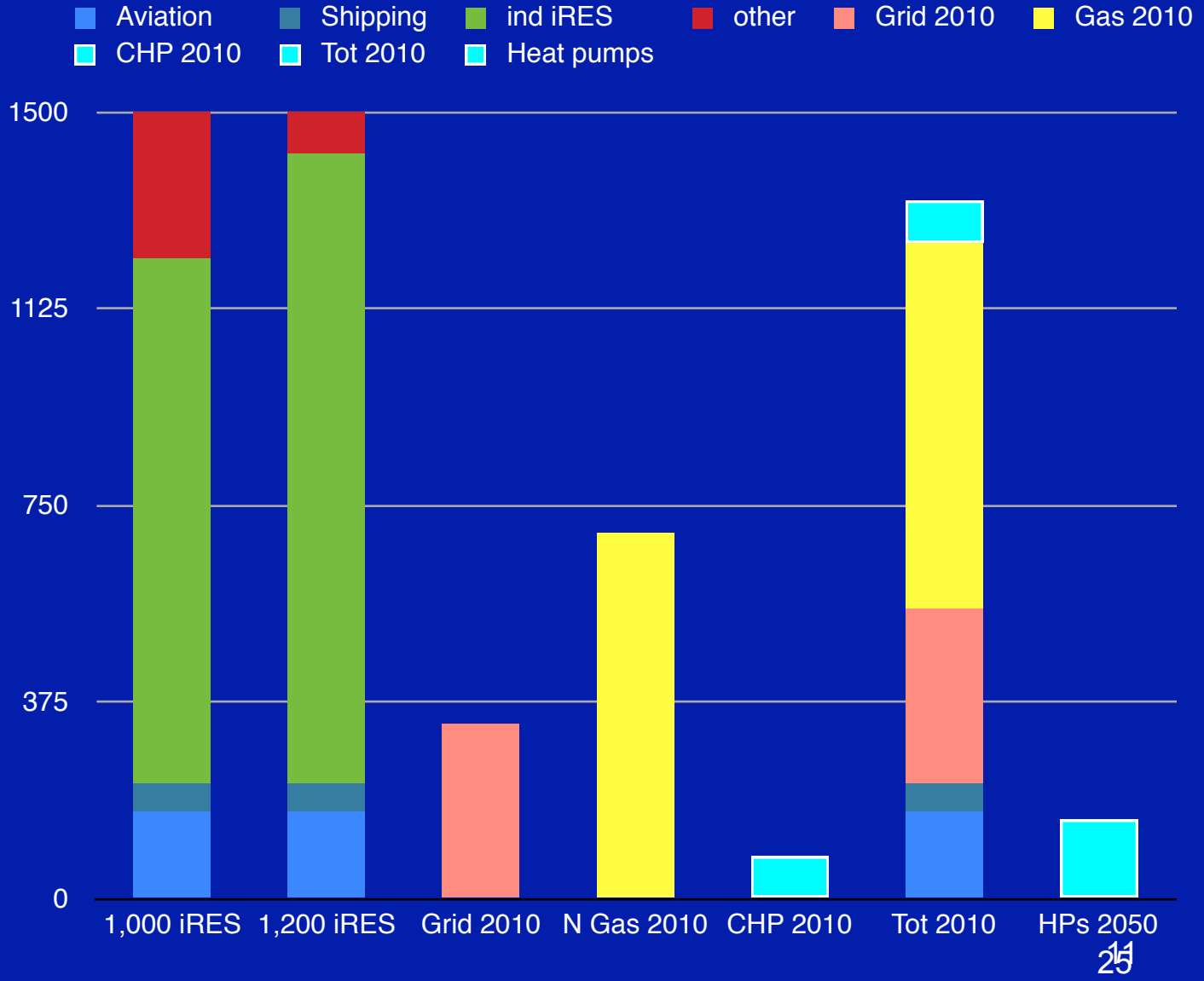
* **350 TWh in 2009 DECC 700 TWh in 2050 ?**



2050 UK energy by sector 1,500 TWh/y



• 2050 Energy supply / transmission



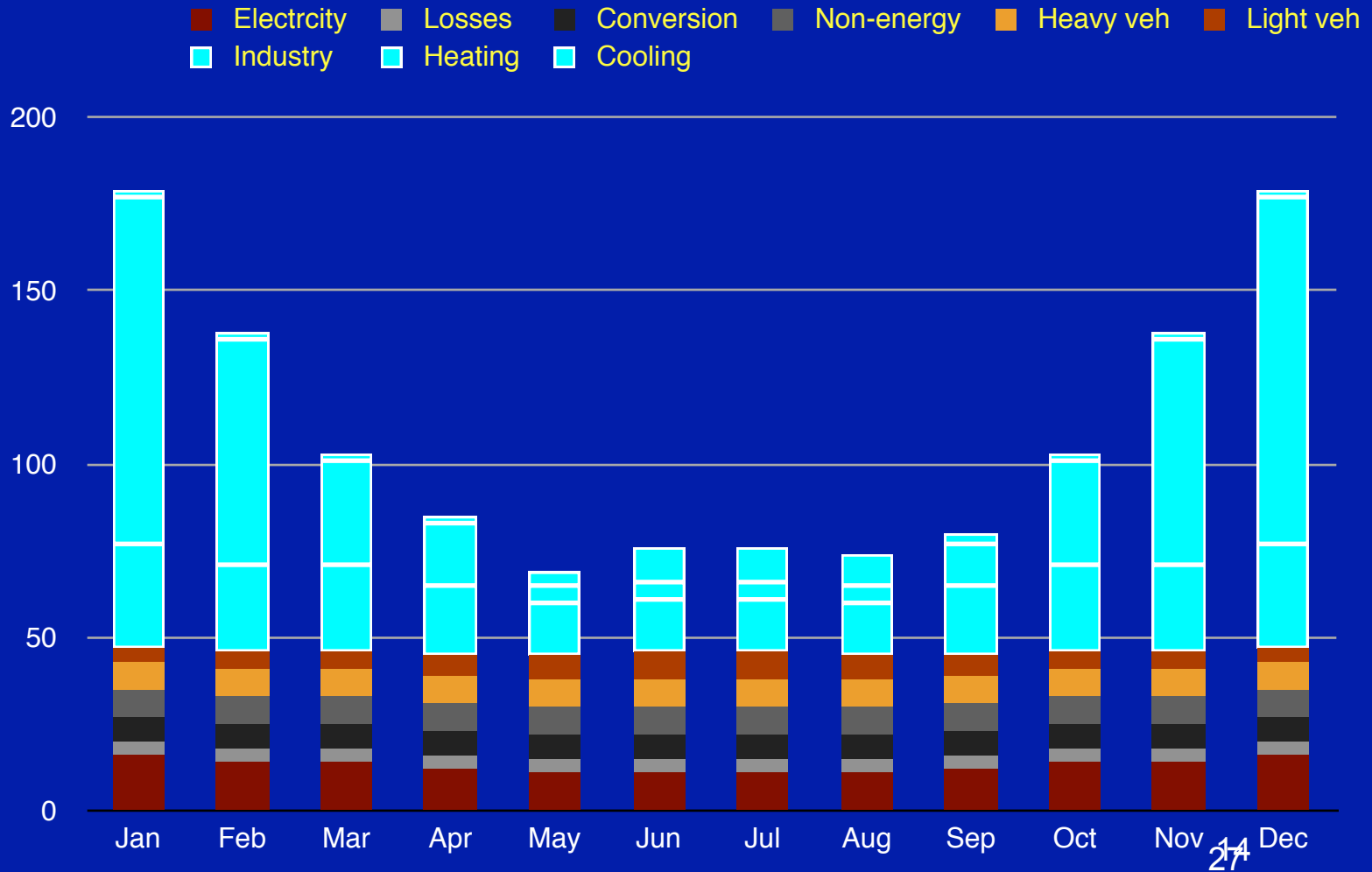
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2050 UK ENERGY scenario 1,500 TWh/y

1,200+ TWh/y of indigenous intermittents (iRES) + 200+ TWh/y bio fuels

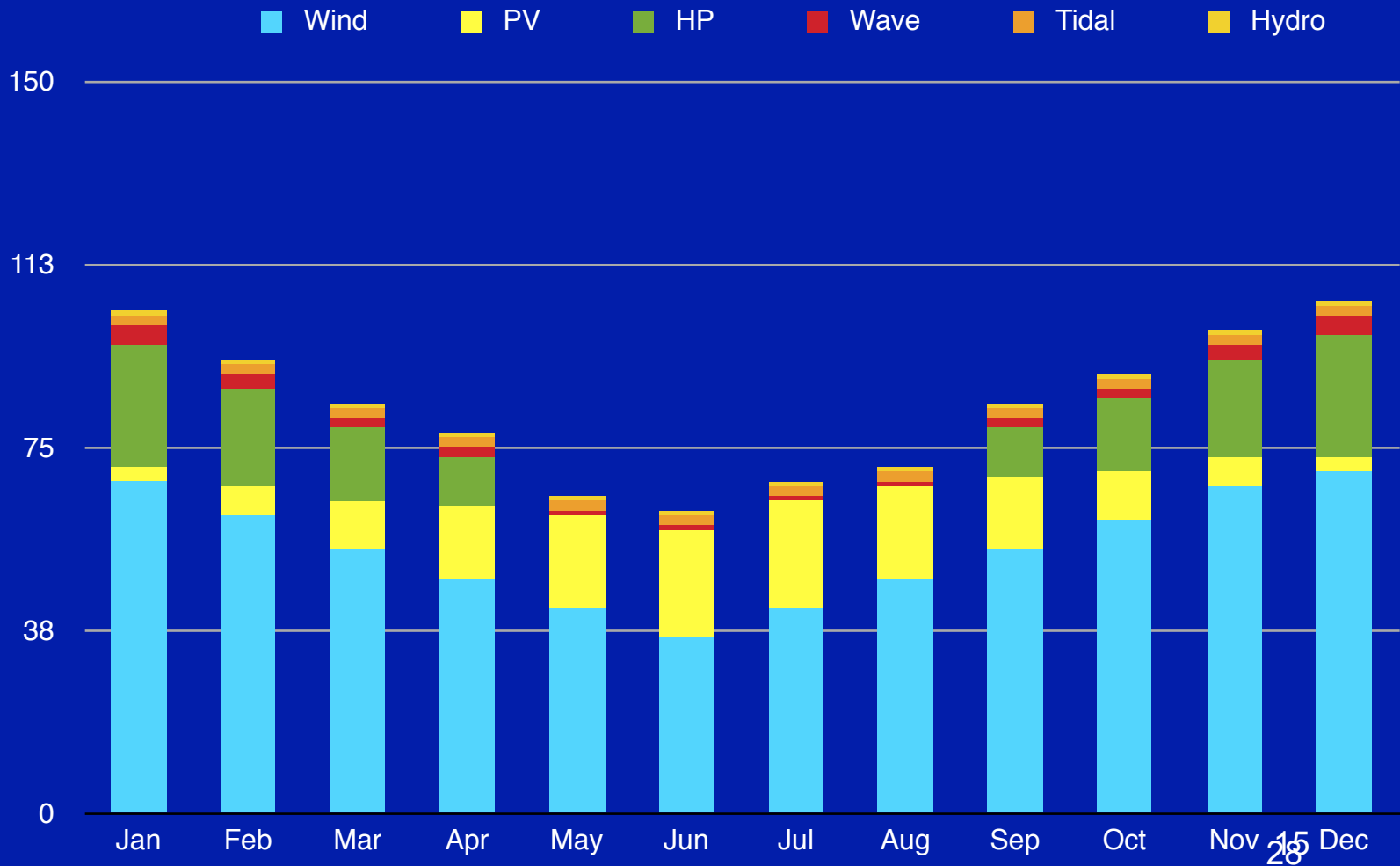
- **onshore wind 20 GW @ 28%** < 50
- **offshore wind 180-210 GW @ 38%** 600-700+
- **Solar PV+ therm (most roofs 20%)** 150-250
- **tidal range (Severn mainly)** 10 ?
- **tidal stream (Mon, Severn)** 15 ?
- **wave** 25 ?
- **heat pumps (CoP 3:1 50% buildings)** 150 max ?
- **bio-fuels (75 % conversion eff)** 220+ sust ?
- **other RES : hydro / geo** 10+ ?
- **other fossil : CCS, imports (HVDC, H/Cs)** to balance

- **2050 UK energy demand**
- **1,500 TWh/y (1,280 + A&S 220)**



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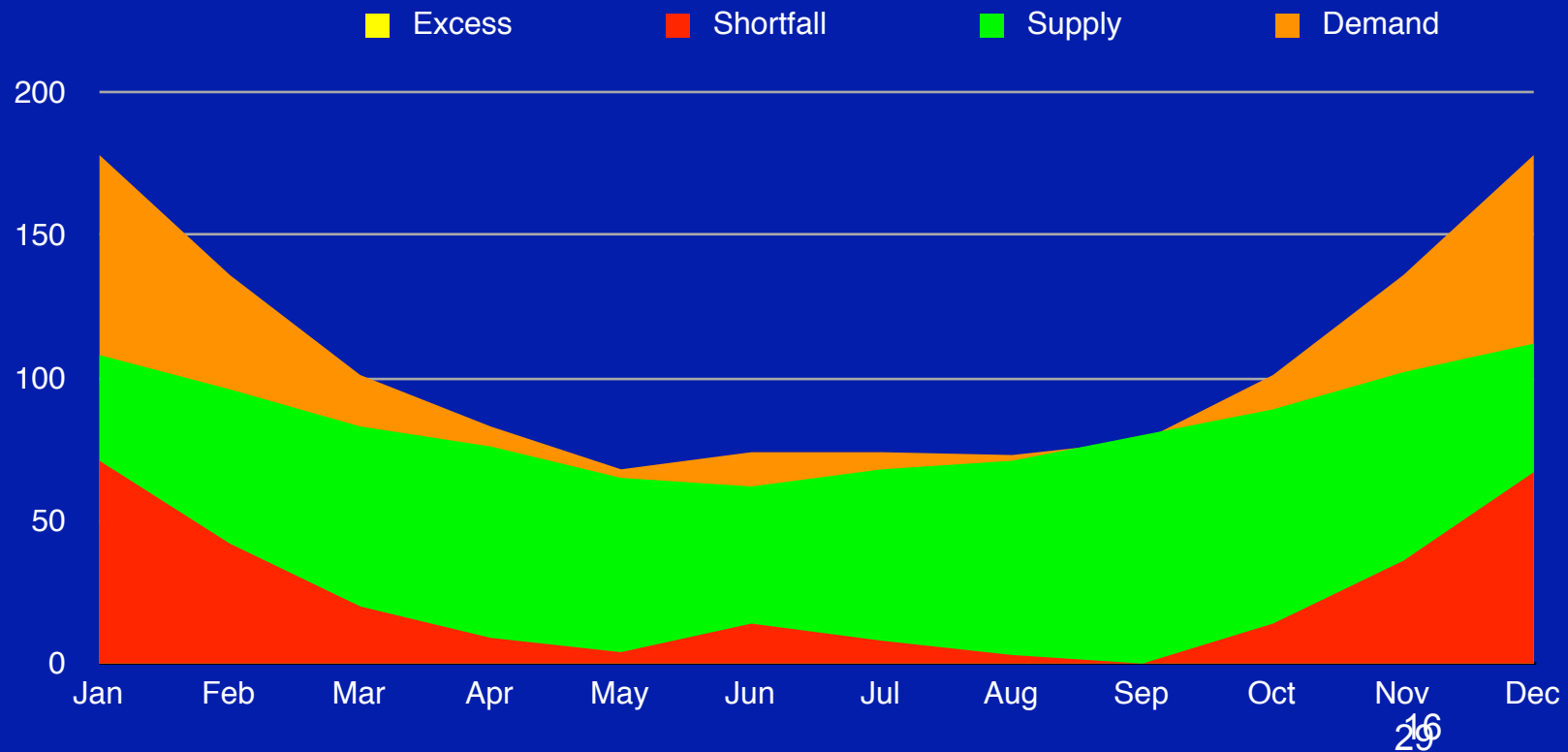
- **2050 Energy supply iRES 1,000 TWh/y**
- **offshore wind 600, PV 150, HPs 150**



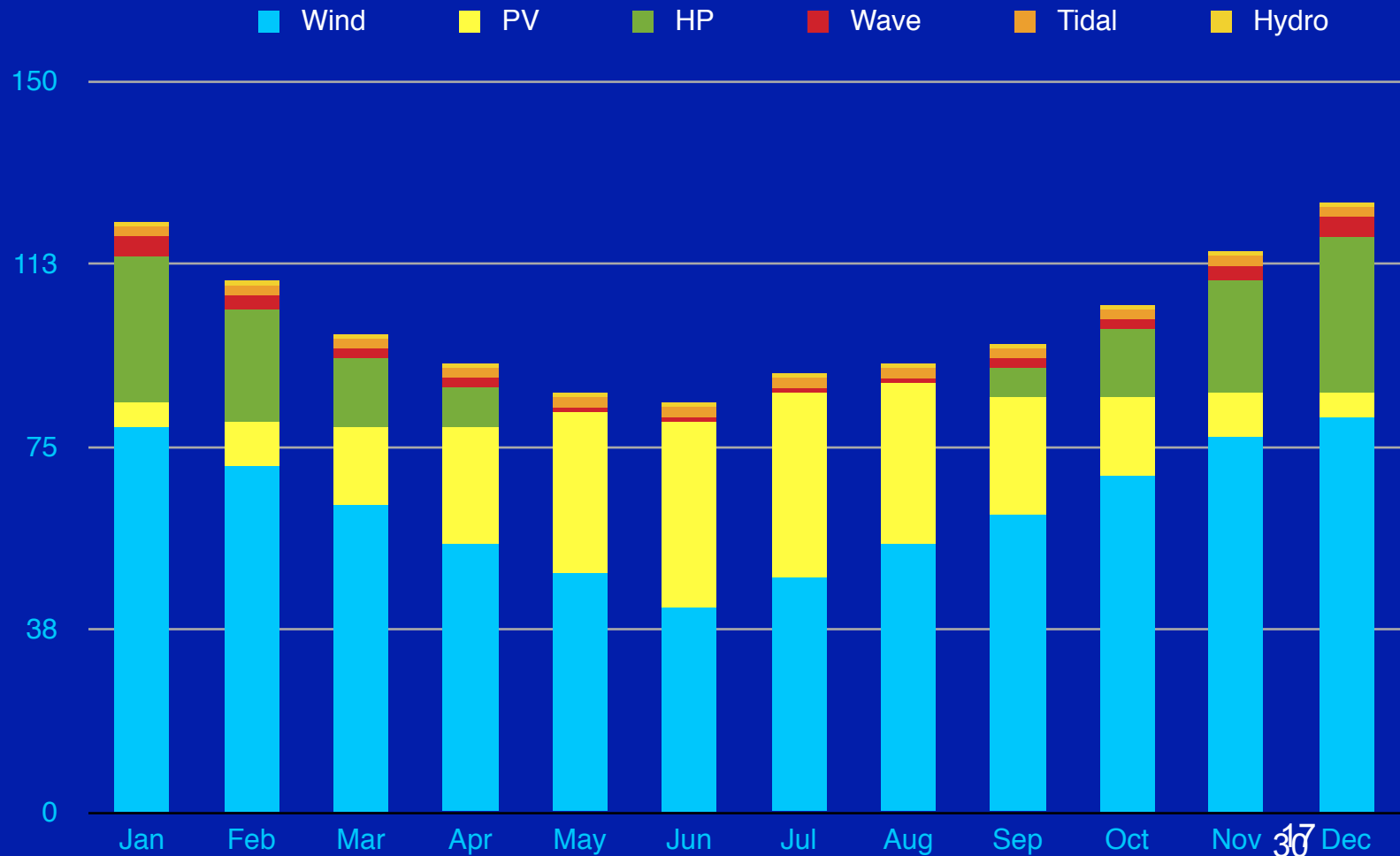
2015

2050 : intermittent RES 1,000 TWh/y

- **shortfall (ex A&S) ~ 270 TWh/y mostly in winter**
- **bio-energy + imports (HVDC / gases / liquids /etc)**
- **gas / coal CCS or nuclear (flexibility ?)**



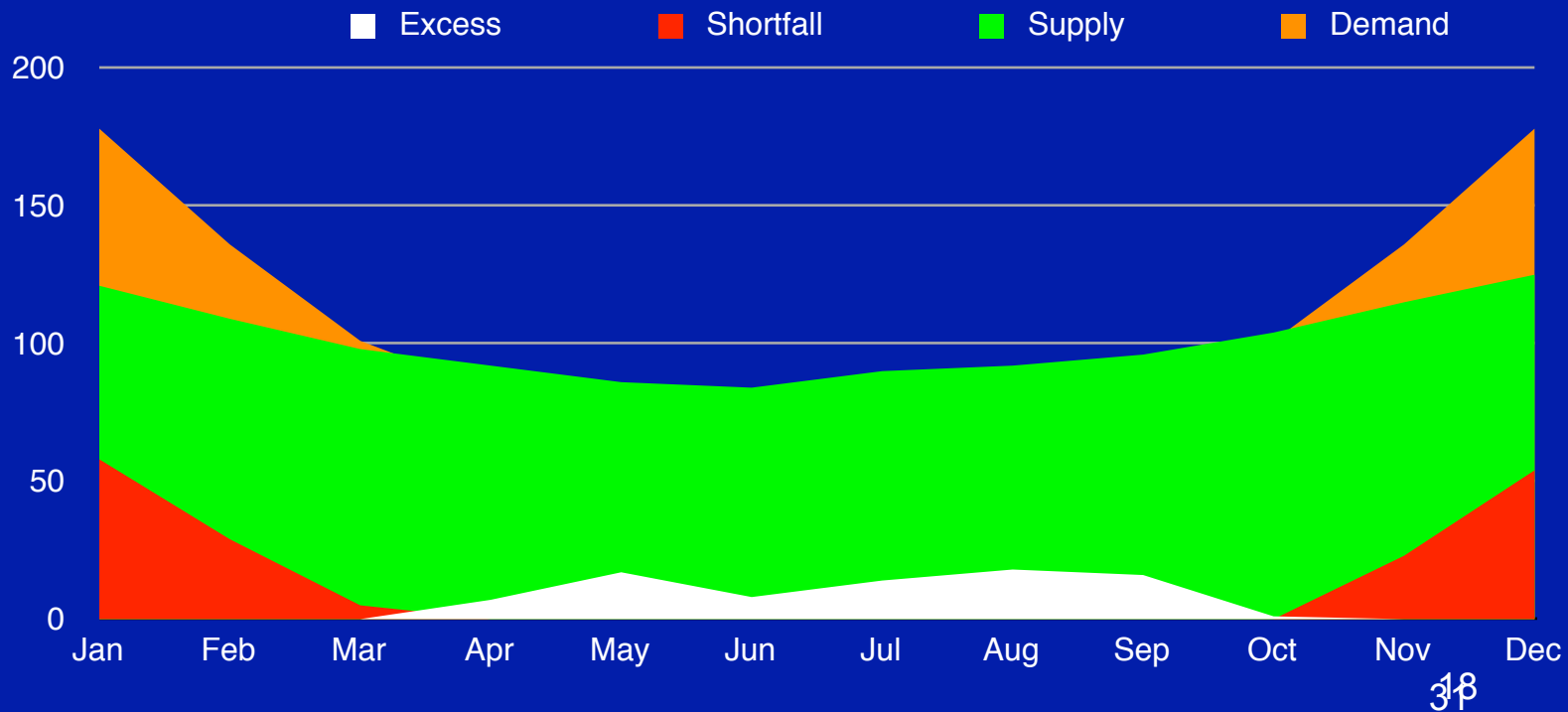
- **2050 intermittent RES 1,200 TWh/y**
- **offshore wind 700, PV 250, HPs 150**



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2050 intermittent RES 1,200 TWh/y

- **summer excess 90 TWh/y, winter shortfall 170**
- **inter-seasonal hydrogen / other storage needed**



Bio-refineries

- **CCS industrial clusters > biogenic synthetic natural gas (bio-SNG) + AD bio-methane for gas network > CHP**
- **towards 2050 > bio-kerosene for aviation + bio-diesel for shipping + hydrogen for industry and GW fuel cells**
- **only about half the carbon in the bio-feedstock ends up in the fuel - so add CCS = BECCS > 'carbon-negative' fuels**



Is CHP-district heating needed ?

- **gas-generated electricity < 100 TWh/y by 2030
so 0-80 TWh/y reject heat, minimal by 2040**
- **electric heating /heat pumps (DECC), urban
areas ? transmission peaks in cold-snaps ?**
- **future H&HW heat demand 30% eff : 150 TWh/y
urban, 170 TWh/y sub-urban = 300+ TWh/y**
- **future industry : move electric ? + high-temp
process heat (molten salt stores, SOFCs)**

Future CHP and district heat networks

- **Low-carbon heat transmission, renewable heat sources + thermal storage**
- **heat of electrolysis (green hydrogen for storage), fuel cell reject heat, solar & geothermal = up to 100 TWh/y**
- **plug-in large-scale urban GSHPs (eg from adjacent fields + ASHPs = ~ 150 TWh/y**
- **BECCS reject heat (eg Drax or SNG sites) = 10s TWh/y > carbon-negative cities**

Energy storage & management & security

- **thermal storage for daily peaks - winter evening peaks / cold-snaps : 150+ GWh in six hours (electricity just 40 GWh cold eve)**
- **storage of excess Grid iRES, wind/PV peaks 200 GW ? (electrolysers, immersion, molten salts, other reject)**
- **inter-seasonal energy storage - large ?**
- **heat networks very secure / safe 70 C**