

Best Available Solution for Sustainable UK Energy Supply

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Background - Human race's future existence: Is global threat urgent as well as important?

- Global population, economic aspiration & net migration increasing
- Global CO2 emissions, pollution, deforestation, soil erosion, water demand & meat consumption rising
- Global rainfall distribution changing & biodiversity decreasing
- Increasing tension between democracies, anocracies & authoritarian regimes
- Increasing AI capability– beneficial /detrimental “owners” – governments & increasingly dominant technology companies
- Unequal distribution of individual quality of life, freedom, life opportunities & depth of understanding of global risks
- Nuclear power – capacity & geographic distribution, major accident & weapons risks, and long term toxic /radioactive waste increasing

UK & Global Challenge

- Enable economic growth with cost effective, adaptable sustainable energy supply
- The Challenge Objectives are:
 1. Lowest possible &, ideally, world-leading weighted average electricity tariff for UK;
 2. Short & low risk implementation timescale;
 3. Zero /minimal public sector funding requirement;
 4. 100% electricity generated from renewable sources;
 5. Beneficial /minimal negative impact on global warming, air pollution, biodiversity, conflict for scarce resources & toxic waste products resulting from electricity generation; and
 6. Zero /minimal technology development required to achieve cost effective implementation
- At least one country needs to demonstrate that this challenge is addressable to provide sufficient time for rest of world to follow before it is too late for human race

Sustainable UK Energy Supply Solution

- Readily available renewable natural resources
- Proven, cost effective technology
- Resilient supply of 100% renewable electricity at lowest, unsubsidised price (approx. 4 p/kWh) in world to satisfy requirements for:
 - current electricity uses;
 - air source heat pump replacement of existing energy supply for domestic & commercial space heating & hot water; and
 - EV replacement of internal combustion engines for road transportation.

Sustainable Community Grids (SCGs)

- Optimal mix of roof-mounted solar PV systems & onshore wind turbines for each SCG with complementary generation seasonality to balance electricity supply & demand through year
- Distributed roof-mounted solar & onshore wind generation will minimise load on existing electricity distribution network infrastructure
- V2G, V2H & V2B-enabled EV (cars, vans, lorries & buses) battery storage & supply capacity will provide dynamic, short term electricity supply to cover any temporary generation shortfalls vs demand

Sustainable Community Grids (SCGs) - continued

- Demand Response measures to be implemented if multiple consecutive days forecast with both low daylight intensity & low wind speed
- SCGs will be proactively managed by community Electricity System Operators (ESOs):
 - continuously monitor current electricity demand & supply
 - maximise total storage at all times in V2G EV batteries
 - implement Demand Response measures, if required
 - make use of Interconnect Agreements with National Grid, if required

National Electricity Grid

- National Grid ESO will actively manage:
 - electricity demand–supply shortfalls & surpluses amongst SCGs connected to National Grid;
 - installation & operation of bi-directional interconnectors with other countries; and
 - set up & use (if required) renewable & non-renewable (last resort for resilience) electricity export /import electricity supply agreements.

UK – current & future electricity demand

Forecast total UK electricity demand after transitioning to 100% Air Source Heat Pumps & 100% EVs is 526 TWh pa comprising:

- 104 TWh pa existing domestic electricity usage;
- 192 TWh pa existing commercial electricity usage;
- 110 TWh pa potential electricity required for 100% Air Source Heat Pumps in domestic & commercial properties for space heating, hot water & other processes requiring heat energy; and
- 120 TWh potential electricity demand for 100% EVs for road transportation.

UK – existing renewable electricity generation

Total existing UK renewable electricity generation is 90 TWh pa comprising:

- 7 GW roof-mounted & 6 GW ground-mounted solar PV systems generating 7 TWh pa & 6 TWh pa respectively;
- 14 GW onshore & 10 GW offshore wind turbines generating 35 TWh pa & 41 TWh pa respectively;
- 2 GW hydro-electric systems generating 7 TWh pa; and
- Less 6 TWh pa National Grid transmission losses.

UK – required additional renewable generation capacity

Total generation required from additional renewable generation capacity is at least 436 TWh pa

- 130 GW onshore wind turbines to generate 342 TWh pa
- 100 GW commercial roof-mounted solar PV (covering approx. 80% total available commercial roof space) to generate 87 TWh pa
- 26 GW domestic roof-mounted solar PV (covering approx. 9% total available domestic roof space) to generate 21 TWh pa
- Expected total electricity generation by additional renewable capacity exceeds minimum requirement by 14 TWh pa

Sustainable Community Funds (SCFs)

Each SCF will use 100% private sector finance to fund required investments (UK total shown below) in:

- roof-mounted solar PV systems (£98bn total) on commercial (£75bn) & domestic (£23bn) properties;
- Onshore wind turbines (£163bn);
- EVs (£1,316bn total) for 100% replacement of ICE cars (£960bn), vans (£176bn), HGVs (£150bn) & buses (£30bn);
- air source heat pumps (£196bn in total) for 100% space heating, hot water & other processes requiring heat energy in domestic (£165bn) & commercial (£31bn) properties + required improvements (£111bn in total) in loft (£3bn), cavity wall (£6bn) & solid wall insulation (£96bn) & in secondary glazing (£6bn) for domestic properties with deficient insulation & /or glazing.

Sustainable Community Funds (SCFs)

- SCFs for all UK Communities will deliver a competitive investment return
- Forecast pre-tax IRR = approx. 5% pa on total £1,885 billion total investment spread over 10 years duration investment programme for debt funders & equity investors
- Total SCF investment required will be reduced by self-funding domestic & commercial property owners and road transport vehicle owners

Sources of energy generation which will NOT be required after transition to “Best Available Solution” for Sustainable UK Electricity Supply

- Fossil fuels – coal, natural gas & oil – CO₂ & methane emissions
- Nuclear (large scale & modular) – high & increasing electricity & plant decommissioning costs; serious operating & waste storage accidents are unlikely, but potentially catastrophic; waste products are toxic & highly radioactive for centuries
- Biomass, biofuel & biogas – CO₂ released by combustion; reduce biodiversity & total CO₂ absorption capacity
- Combined Heat & Power (CHP) – high cost if heat energy not fully used; CO₂ emissions
- New, unproven (in cost effectiveness terms) high cost technologies including wave, tidal & nuclear fusion
- Waste-to-energy /electricity: organic - CO₂, methane & hydrogen sulphide emissions; inorganic - various toxic gases
- Green hydrogen generated heat energy & electricity - complicated & inefficient end-to-end process from electricity generation to electrolysis to hydrogen compression & distribution /transportation to combustion (boiler /power station) /electrochemical reaction (hydrogen fuel cell)
- Carbon Capture & Storage (CCS) combined with non-renewable sources – high cost & long term risk of significant future accidental CO₂ releases

Procurement for implementation of “Best Available Solution” for Sustainable UK Energy Supply

- ESO will manage procurement for each SCG to benefit from Community purchasing power
- ESO for each SCG will ensure that all purchases by SCG are correctly specified and procured cost effectively based upon competitive tenders from suitably-qualified suppliers, contractors & service providers
- 10 year duration implementation programme will benefit from increasing economies of scale over time combined with design development & manufacturing process improvements

Benefits of “Best Available Solution” to UK Energy Users

Post-transition to “Best Available Solution” for Sustainable UK Energy Supply:

- weighted average UK electricity tariff = 4.1 p/kWh (3.3 p/kWh onshore wind; 6.1 & 7.9 p/kWh for commercial & domestic roof-mounted solar PV systems) vs current 21 & 14 p/kWh current National Grid supplier tariffs for domestic & commercial property owners;
- Air source heat pump net heat energy tariff will be 4.1 p/kWh vs approx. 4.8 p/kWh for usable heat energy from gas boilers (assuming average efficiency = 80% & domestic natural gas tariff = 3.85 p/kWh)
- Annual cost saving per vehicle with switch from ICE to EV vehicle is approx. £100, £200, £8,000 & £1,200 for cars, vans, HGVs & buses respectively.

Next Steps for “Best Available Solution”

- Peer review of “The Challenge Objectives”, “Best Available Solution” & supporting analysis for Sustainable UK Energy Supply by EIBF
- EIBF submits EIBF peer-reviewed (& possibly updated) “Best Available Solution” & supporting analysis to RAEng for peer review
- RAEng performs consultation (3 months duration) on RAEng peer-reviewed (& possibly updated) “Best Available Solution”
- RAEng submits RAEng peer-reviewed (& possibly updated) “Best Available Solution” & supporting analysis to BE&IS
- BE&IS performs wide-ranging consultation (6 months duration) on “Best Available Solution” for UK
- BE&IS requests RAEng to update (if necessary) “Best Available Solution” based upon consultation report conclusions

Next Steps for “Best Available Solution” -continued

- BE&IS & RAEng prepare draft customised “Best Available Solutions” for each Sustainable Community Grid (SCG; cities, counties & regions)
- BE&IS sends draft customised “Best Available Solutions” for SCGs to city /regional mayors & county council leaders for review
- BE&IS agrees updated, customised SCG “Best Available Solutions” with relevant SCG leaders for implementation
- BE&IS & SCG leaders manage implementation of SCG “Best Available Solutions”