Stephen Browning - Energy Strategy Mk IX.

We need an Integrated solution to get the best result as regards Fuel Burn, Emissions and cost with adequate capacity, security and stability of Energy supply to customers (the Trilemma). We also need to maintain diversity of Fuel sourcing.

Low/Negative Carbon Synthetic Natural Gas (L/NCSNG) can be produced from a variety of fuel sources, including Trash and incorporating a low cost/low energy sequestration process.

Better use of Gas by proper Integration of Distributed Energy Resources (Demand and Generation) and more efficient combined production of Electricity and Heat is needed... This also provides flexibility to buffer variable renewables.
The 'Big + Little' Picture

- Resurrect the British Gas Lurgi (BGL) Gasifier and HiCom Methanator mechanism. Eats Coal, Biomass, Trash and produces Synthetic Natural Gas (SNG) - Methane and High pressure Carbon Dioxide. The Carbon Dioxide can be easily sequestrated. It can be further processed with Hydrogen (say from electrolysis using excess Electricity or Biogas) for more Methane. Low/Negative Synthetic Natural Gas. The original BGL-HiCom development was a full production system. BGL is in use in Chemical industries today. Johnson Matthey hold the patents for HiCom. For Transport, Compressed Synthetic Natural Gas in large vehicles is an option.

- Gas storage and flexibility is awesome - the GB Gas National Transmission System Linepack (Gas in pipes) alone is 3.5TWh and can release and recover up to 10% during a day. Explicit storage has reduced but is still @14TWh. By my original analysis Gas can handle Power movements from @150GW to @250GW and back during a day. Even higher rates of Power movement (50GW to 300GW) have been presented recently.

- Use the Gas better - Combined Heating Power and Cooling (CHPC). Large premises plant room systems up to District Power and Heating.

- At domestic level (with small commercial where adjacent) Set up Energy Hub CHP units (up to 500kVA) at Distribution substation level. Heating Flow and Return Water 'Plug compatible' with conventional Radiator systems. Target difficult to heat areas, especially with bad Air Exchange rates in 'leaky' dwellings where increasing insulation is not effective against the overall heat loss.

- Also large premises, where justifiable (due to lower/more erratic heat demand and need for Cooling)... @280000 Large (Peak demand >100kW) and some other non Domestic premises all have hhr meters, each with a dedicated but underutilised comms circuit (usually PSTN) for data collection (usually by daily dial up). At these sites we need an Integrated CHP+C System

- Larger premises with hhr metering (includes existing Community DH systems) could take simple time band tariffs Peak/Plateau/Trough, Weekday different Sat and Sun, different Summer to Winter. Larger CHPC systems also (up to Community level with District Heating) also of course have HHR meters.
This encourages demand shift and running CHP units at high price times.

- This should also justify larger CHP units than the current practice in larger premises where they are sized just to cover minimum Electricity or Heat demand.
It does require larger Heat stores - but low tech hot water storage is well developed and relatively inexpensive technology.

- The CHP Hubs at Final Distribution level will also have to be Half hour metered and thus there is a comms route for management of said systems.

- Both Internal Combustion CHPC and CCGTs provide Inertia, although that from IC Engines may be low unless extra flywheels can be fitted. IC CHPC can be very efficient (Power and Heat provision) at Full and Part load.
We set up the units thus….
ICEngine-Clutch-Flywheel-Alternator/Motor-Fluidrive-MechanicalHeatPump.
And a Thermal Store and Absorption Chiller
Mode 1 – High Price Grid Electricity. IC Engine Generating with Heat Recovery Delivery, also for Storage and Chilling as required.
Mode 2 – Low Price Grid Electricity. Motored Heat Pump, IC Engine shut down.
Mode 3 – High or Low Grid Electricity Price, High Heat Requirement. IC Engine and Heat Pump running.
Mode 4 – Synchronous Compensation. IC Engine and Heat Pump Shut down. Flywheel and Alternator Spinning (Synchronised).
Please see the diagram at the end of this document.
In all 4 modes we can provide Inertial Damping, Response (if IC Engine or Heat Pump running), Reaction and Reserve (Fast start IC if not running).
The on course the machines can be instructed in Dispatch, Timing (Sync-Desync) and Commitment Timescales.
Also, with the Alternator Synchronised we can of course provide MVAr Export and Import to stabilise Local and Grid Voltages.

- We are effectively using Synthetic Natural Gas and Heat Storage to provide Electricity storage.

- Need to progress from simple tariffs to add Interactive working between Retail Customers, their Supplier and the DSOs and SO (Market and Matching Mechanism Timescales).

- We need a Standard Framework/protocol interface but with Flexible data content (Industry and Customers will be learning how to interact). This also improves visibility of generation, accuracy of SO Matching and of SO and DSO stability and security management. Uncertainty breeds excess cost (and fuel burn and emissions and risk) due to inefficient operation.

- That all needs a hierarchical Aggregation/Dissemination data structure to make it manageable - Premises-Microgrid (inc hubs and community systems) - GSP - DSO - SO. With of course the Supplier and ESCO interface at the appropriate level…. Noting that the DSO's obviously have the (time based) database of Supplier - Premises assignment (MPANs) .

- This enables proper participation of Retail Demand and Generation at from Market timescales down. Including the system requirements (reactive power, stability) and the enabling of active participation in Ancillary services provision. As the Information revolution develops this is a major practical application of the Internet of Things.

- Note that if, by any method of engagement, we enable large scale customer demand reaction to buffer say Wind variability, we will destroy our current top down forecasting system (my FPS 20). May need to rebuild from bottom up using the distributed data framework.

- To manage Generation in this way (lots of little plant plus the main Generation) would be the biggest logistical change to operation since 1933 when the Grid was commissioned (7 Areas) and the main plant was scheduled in strict cost order (whoever owned it). Also this 'Big+Little' approach is unique as far as I am aware.

- and…. a number of our CCGTs are built on the last of the old Municipal Power Station sites; Peterborough, Rye House (N London), Staythorpe, Corby, Shoreham, etc etc. The old Stations were decommissioned by the late 80's, thus the CCGT developers has a set of ready made sites with Electrical Connection, Cooling Water and Gas (the Gasworks was usually next door).
There has been a heated debate as to whether we could recover the latent heat of condensation from the Steam Turbine exhaust as that is what effectively (via the Cooling water heat exchange) gets dumped in Ocean, River or up the Cooling Towers and is the main part of the 40+% Heat loss on (fully loaded) CCGTs. Heat Extraction rather than a conventional Condensing mechanism is needed; the Danish CHP Turbines run with both and can switch… However, it is a major support structure and plumbing change to an existing Steam turbine installation; new build is easier than retrofit. Lots of heat though which would suit DH.

• What we are effectively doing here is using Low/Negative Carbon Synthetic Natural Gas and the big but relatively inexpensive storage mechanisms of Gas and Heat to provide flexibility to Electricity Supply.

• and..... All these Heat systems (Premises/Energy Hubs up to Microgrid up to District Heating), with their large storage, would of course be suitable to be fed by Heat Pumps if we move forward in the long run with large scale renewables and the big upgrade to Distribution (100000+ miles of circuits + Transformers, substations, Var compensators etc etc). For the moment the IC-CHP-C and CCGT-CHP-C ideas use Gas better - Natural and Low/Negative Carbon SNG (AD and Trash fed +CCS).

• Sorry about the length of this but we need an co-ordinated Integrated solution. All the elements need to be progressed together.
If we can get can get this to work the export potential is incredible. The GB Energy system delivers 1000TWh/annum of Gas and 360TWh (sent out) of Electricity per year. We burn @52million tonnes of coal per annum.

As regards other countries with major Coal based Electricity Production

• China's Electricity supply alone is over 7000TWh/annum and they dig up 5+ billion tonnes of Coal per annum. @1100GW of Coal generation producing @4500TWh. They currently also use @250bcm of Natural Gas/Annum while importing 100bcm/annum.

• Thus there is scope for Gasification-Methanation plus managed CHP+++ to deal with the Emissions and other Pollution. China already has some BGL plants for chemicals production and is looking at Coal Gasification.
Noting that the Coal supply from the Northern Province of Nei Mongolia mainly travels via the Grand Canal southwards from Beijing, past the cities of the Eastern Seaboard. Where there should be lots of Trash to combine with it to feed a fleet of Gasifier-Methanators.

• The existing Coal fired Stations in South, Central and East China could initially have Gas burners fitted to the boilers (in the bottom Ash hoppers) and also have the Boilers and Coal handling plant replaced by Gas fired GTs and Heat Recovery Steam Generators. Such conversion to CCGT mode has already been carried out on one 500MW Unit at Peterhead in Scotland and is proposed at the Drax 6 * 600MW Biomass/Coal fired station in Northern England.

Stephen Browning - Energy Strategy Mk IX.

- This may be regarded as a 'Get out of jail for the moment' approach as regards Strategy.
Hopefully we will get a big jump in material technology as regards Electricity storage (with high speed reaction capability) to enable more serious penetration of Renewables without Fossil 'buffering'.

- My 22 articles on Future Power Systems are accessible via www.eleceffic.com.
FPS1,2 and 3 have a partly unique analysis of the Balance principle, tightness of the Matching requirement, synchronism and the nature of instantaneous Electrical Power, Generation, Transport and Delivery (each AC system is a giant machine).
FPS 4 covers renewables impact and has a new diagram to show the effect of forecasting uncertainty on the big ramps caused by wind variability (Page 7). This is crucial to demonstrate that these movements are much more difficult (if not impossible) to handle than the regular demand ramps.
FPS 5-7 tackle future distribution (esp active), FPS8-14 the customer to utility interface while FPS15-19 examine customer data and participation issues.
FPS 20 covers the Smart Enterprise with the warning about forecasting methods
FPS 21 covers the Smart Customer with various salient points. Make retail end systems automatic, progress one step at a time, have a fallback in place each time you change the commercial interface, etc
FPS 22 looks at the modelling required to determine Strategy and Value.