WHEN WILL ENGINEERING REALITY ENTER THE UK ENERGY POLICY

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CIR Smart Grids and Cleanpower
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http://bit.ly/cleanpower

Sources:

- A Pragmatic Energy Policy for the UK, Fells Associates (2008) – quoted extensively
- British energy policy and the threat to manufacturing industry, Lea and Nicholson (2010)
- A low carbon world – is it realistic? A-M Warris , Lloyds Register (2010)
- Generating the Future (RAEng 2010)
- HMG Reports from BIS, DECC, HMT, …
- http://www.ref.org.uk/Files/ref.elec.crisis.

Situation Today (1)

- Winter 2007-8:
  - Generating capacity75GW,
  - Operating Capacity 65GW
  - Peak demand >60GW
- Winter 2008-9
  - Peak demand 59GW (in spite of recession)
- Winter 2009-10
  - Data not expected until next month

Situation Today (2)

- Two nuclear plants (Heysham and Hartlepool) (2.4GW) off line for 2 years, and two others (Hunterston and Hinkley) on reduced output.
- Characteristic of aging fleet.
- Planned decommissioning of 7.4GW by 2030 and 9.8GW by 2023, leaving only Sizewell B (10% and 13% of current

The Nuclear Fleet Today and Tomorrow

Power Station	Type	Net MWe	Construction started	Connected to grid	Commercial operation	Accounting closure date
Oldbury	Magnox	434	1962	1967	1968	2010
Wylfa	Magnox	980	1963	1971	1972	2012
Dungeness B	AGR	1110	1965	1983	1985	2018
Hinkley Point B	AGR	1220	1967	1976	1976	2016
Hunterston B	AGR	1190	1967	1976	1976	2016
Hartlepool	AGR	1210	1968	1983	1989	2014
Heysham 1	AGR	1150	1970	1983	1989	2014
Heysham 2	AGR	1250	1980	1988	1989	2023
Torness	AGR	1250	1980	1988	1988	2023
Sizewell B	PWR	1188	1988	1995	1995	2035

Situation Today

- Also: 12GW (15% of capacity) of coal- and oil-fired generating plant due to close by 2016 as a part of the 2008 EU Large Combustion Plant Directive (LCPD) which aims to cut emissions.
- In total: 23GW (30% of capacity) will need replacing by 2020 and 30-35GW by 2027.
- Renewables only provide 5% of UK

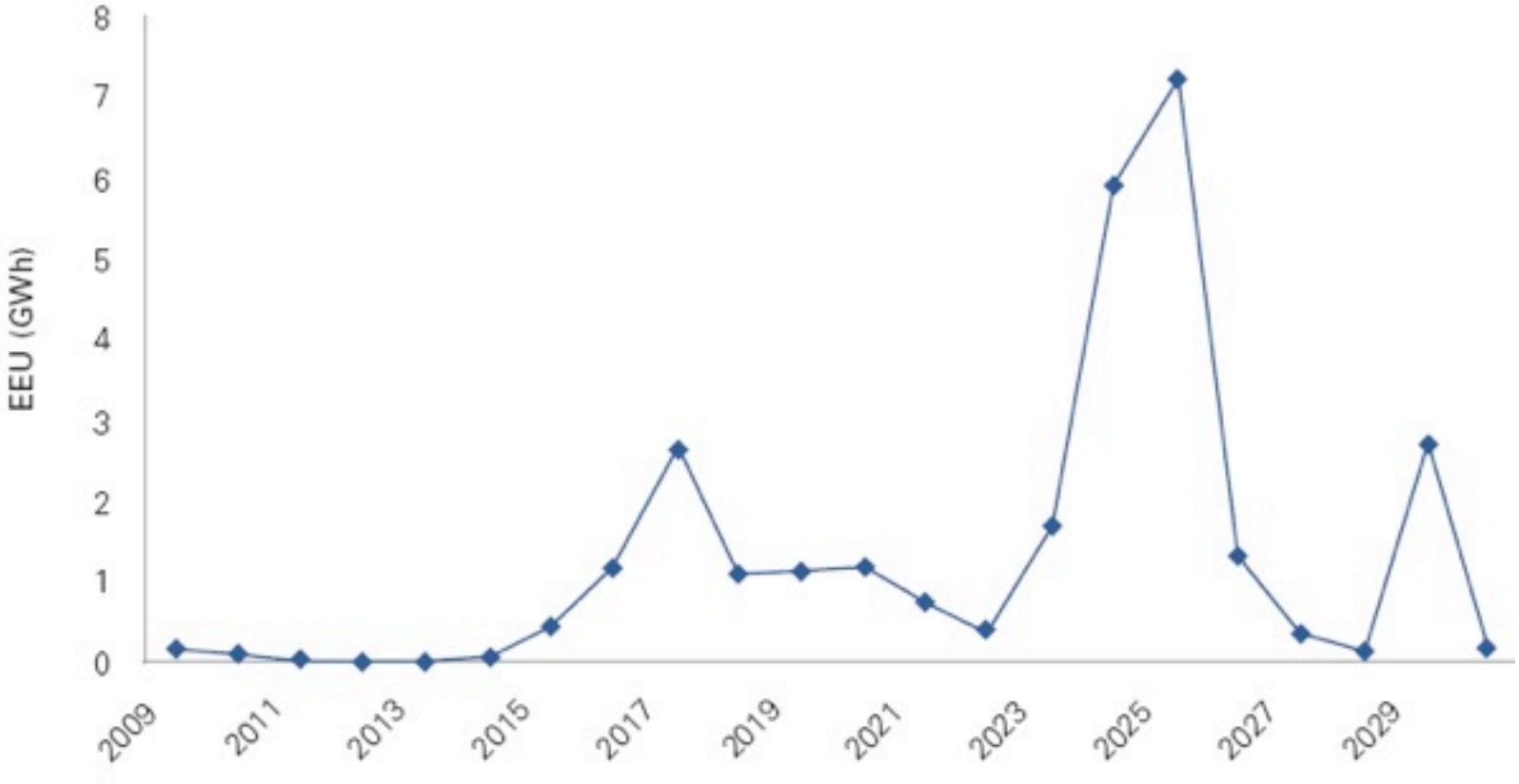
HMG Quote: one of many

- “At home it is likely that the UK will need around 30-35GW of new electricity generation capacity over the next two decades and around two thirds of this capacity by 2020. This is because many of our coal and most of our existing nuclear power stations are set to close. And energy demand will grow over time, despite increased energy efficiency, as the economy expands.”

HMG Quote 2

Chart 25

Expected Energy Unserved (GWh) under 29% large scale renewable electricity generation



Source: Redpoint (2009)

Source: Analytical Annex, the UK Low Carbon Transition Plan, Chart 25 p86; DECC, 2009.

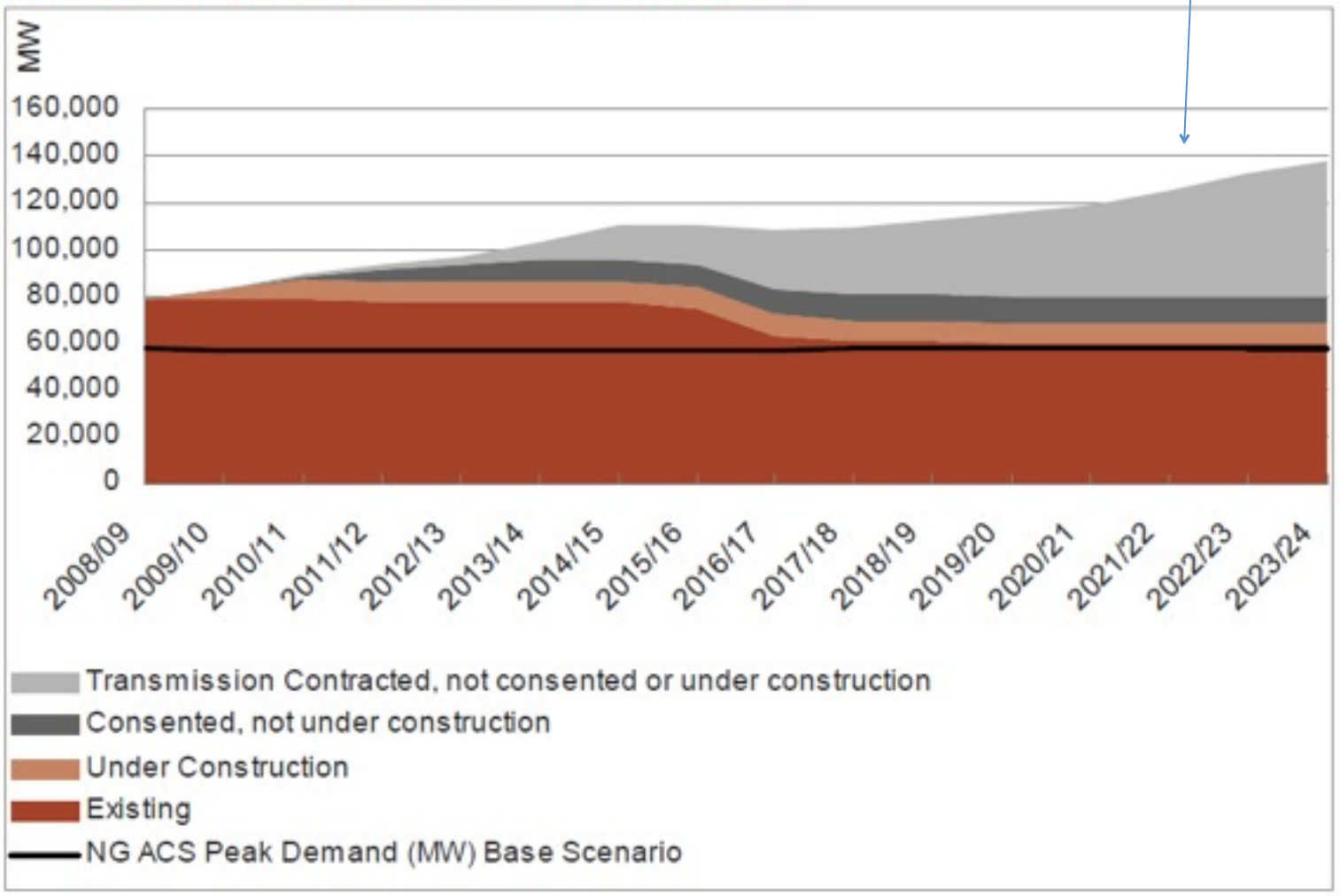
Any yet:

- From a 2010 Treasury Report
- http://www.hm-treasury.gov.uk/budget2010_energymarket.htm
- 'The Government is confident that the current arrangements will continue to deliver secure supplies of electricity over the next decade.‘
- Significant new investment, is however planned in onshore and offshore wind generation and gas generation that will be enough to replace the closing plant. Under current investment plans around 10GW of new gas and renewable generation is under construction and a further 11GW has the necessary planning consents. Many more gigawatts of generation have permission to connect to the electricity network although do not yet have planning consent, as shown in Chart 2.A. This shows that there will be significant capacity above the peak demand line. The Government believes this will ensure that an appropriate level of security of electricity supply will be maintained in the period to 2020. While risks to the capacity margin increase nearer to 2020, UK electricity supplies have delivered robust security of supply since liberalisation and if demand forecasts were to increase

And Yet:

Huge Wedge

Chart 2.A: Existing and planned electricity capacity



Source: Energy Markets Outlook December 2009

Renewable Energy Foundation (2008) (1)

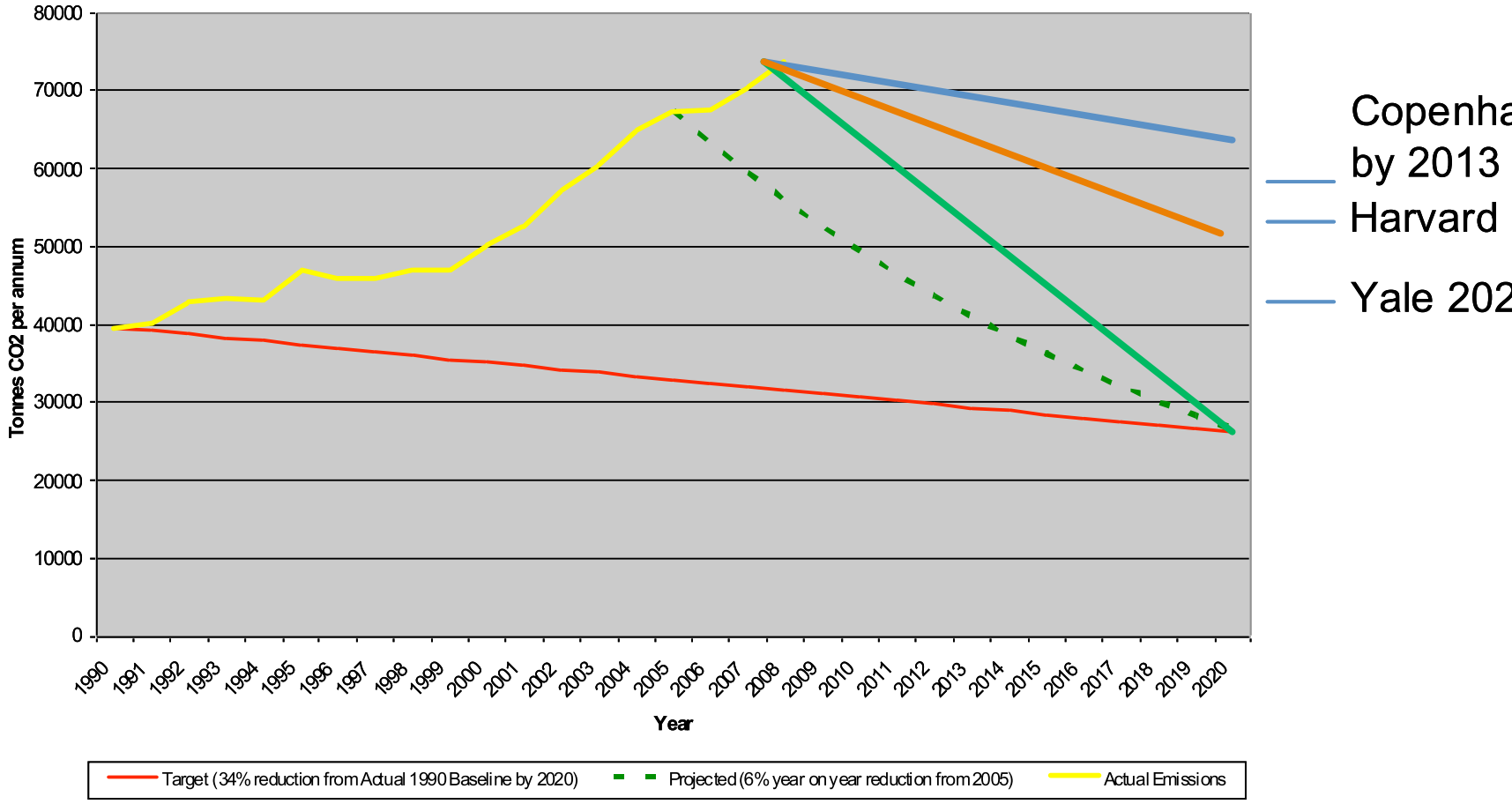
EXECUTIVE SUMMARY

- **The UK now faces an imminent shortfall of firm, reliable, electricity capacity, as some** 40% of our conventional generators are being rendered illegal by EU legislation affecting emissions of sulphur dioxide (SO2) and nitrogen oxides (NOx).
- System stress is already evident in very high wholesale prices, and in the weak response to the major blackout on the 27th of May 2008.
- **The politically constrained market reaction to these difficulties is, primarily, a new dash for gas.**
- The secondary reaction, driven by subsidy, is a very large wind turbine fleet, which provides supplementary energy (MWh), but no firm capacity (MW). **At other than modest levels wind power causes and compounds greater gas dependency rather than alleviating it.**
- Some 20 GWs of gas plant is now planned, which by 2020 would result in a firm portfolio consisting overwhelmingly of gas (around two thirds of peak load).
- **Gas dependency on this scale is economically and geopolitically dangerous.** The UK will be importing 50% of its gas by 2010, and 80% by 2020. The increasingly reluctant Norwegians can supply only 15% of this

Renewable Energy Foundation

- **Atlantic basin gas prices will be set by doubling Asian demand,** largely for Liquefied Natural Gas (LNG), and Russia will not only benefit from these high prices, but also exert a controlling interest through the supply of pipeline gas at times of scarce or unaffordable LNG.
- Thus, **from 2010 to 2015 onwards the UK faces a high probability of insufficient firm capacity and, or, very expensive gas, at best resulting in price shock, and in all probability blackouts both scheduled and unpredicted. In either case the UK will be gravely** weakened economically, socially, geopolitically, and militarily.
- **Political prevarication is not now an option; emergency measures are needed to mitigate gas dependency and address its consequences, for example:**
- Rapid construction of extra gas storage facilities;
- Repudiation of unachievable and distorting EU renewable energy targets;
- Unlimited co-firing of biomass in coal-fired power stations;
- Dedicated biomass generation at major ports (fuel from UK and Canada);
- Facilitation of the use of domestic coal resources;

Progress on the Home Front



US Perspective of 25 May

- **World Energy Use Projected to Grow 49 Percent Between 2007 and 2035**
- U.S. Energy Information Administration
- WASHINGTON, DC – World marketed energy consumption grows 49 percent between 2007 and 2035, driven by economic growth in the developing nations of the world, according to the Reference case projection from the International Energy Outlook 2010 (IEO2010) released today by the U.S. Energy Information Administration (EIA). "Renewables are the fastest-growing source of world energy supply, but fossil fuels are still set to meet more than three-fourths of total energy needs in 2035 assuming current policies are unchanged," said EIA Administrator Richard Newell.
- The global economic recession that began in 2007 and continued into 2009 has had a profound impact on near-term prospects for world energy demand. Total marketed energy consumption contracted by 1.2 percent in 2008 and by an estimated 2.2 percent in 2009, as manufacturing and consumer demand for goods and services declined. In the Reference case, as the economic situation improves, most nations are expected to return to the economic growth rates that were projected prior to the downturn. Total world energy

Forward projections (EIA)

Figure 2. World marketed energy use by fuel type

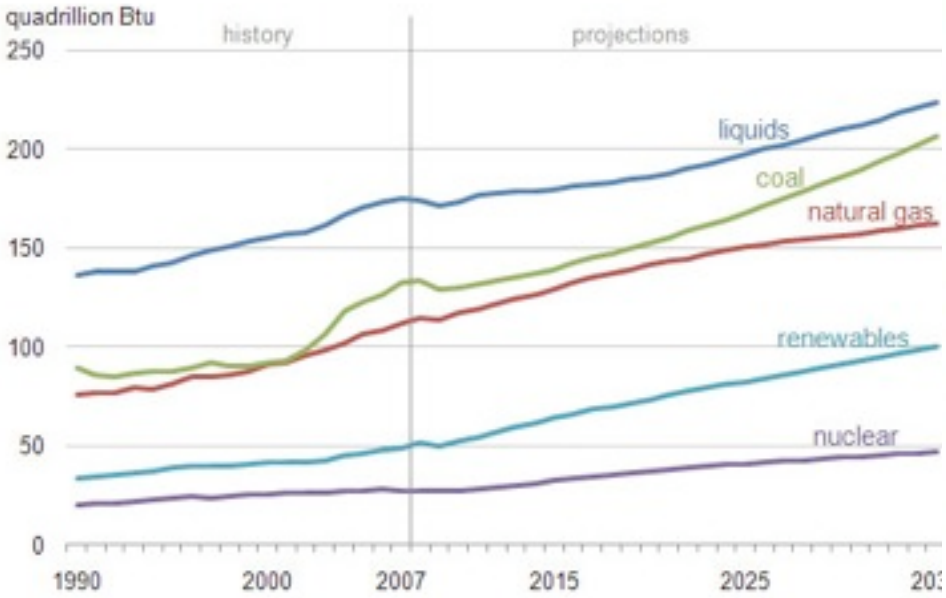
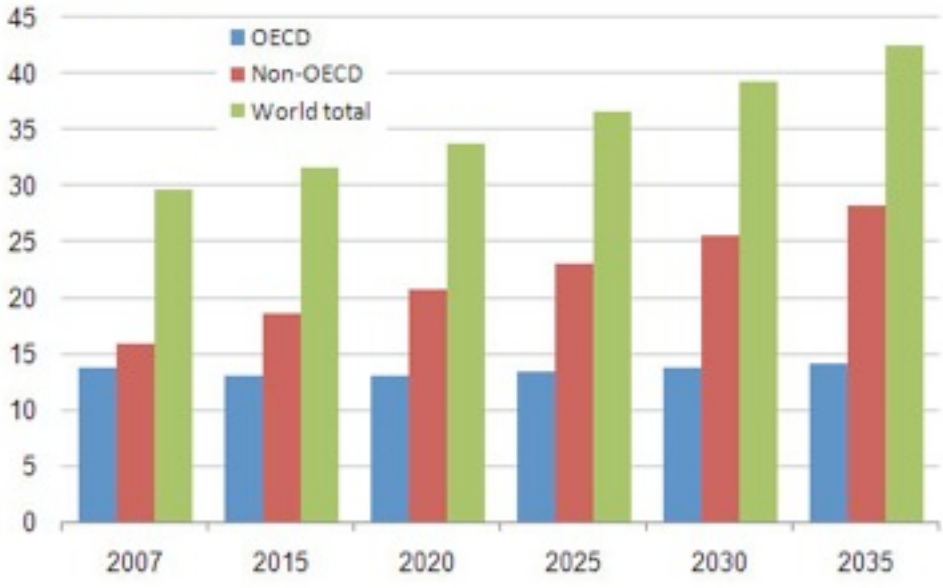
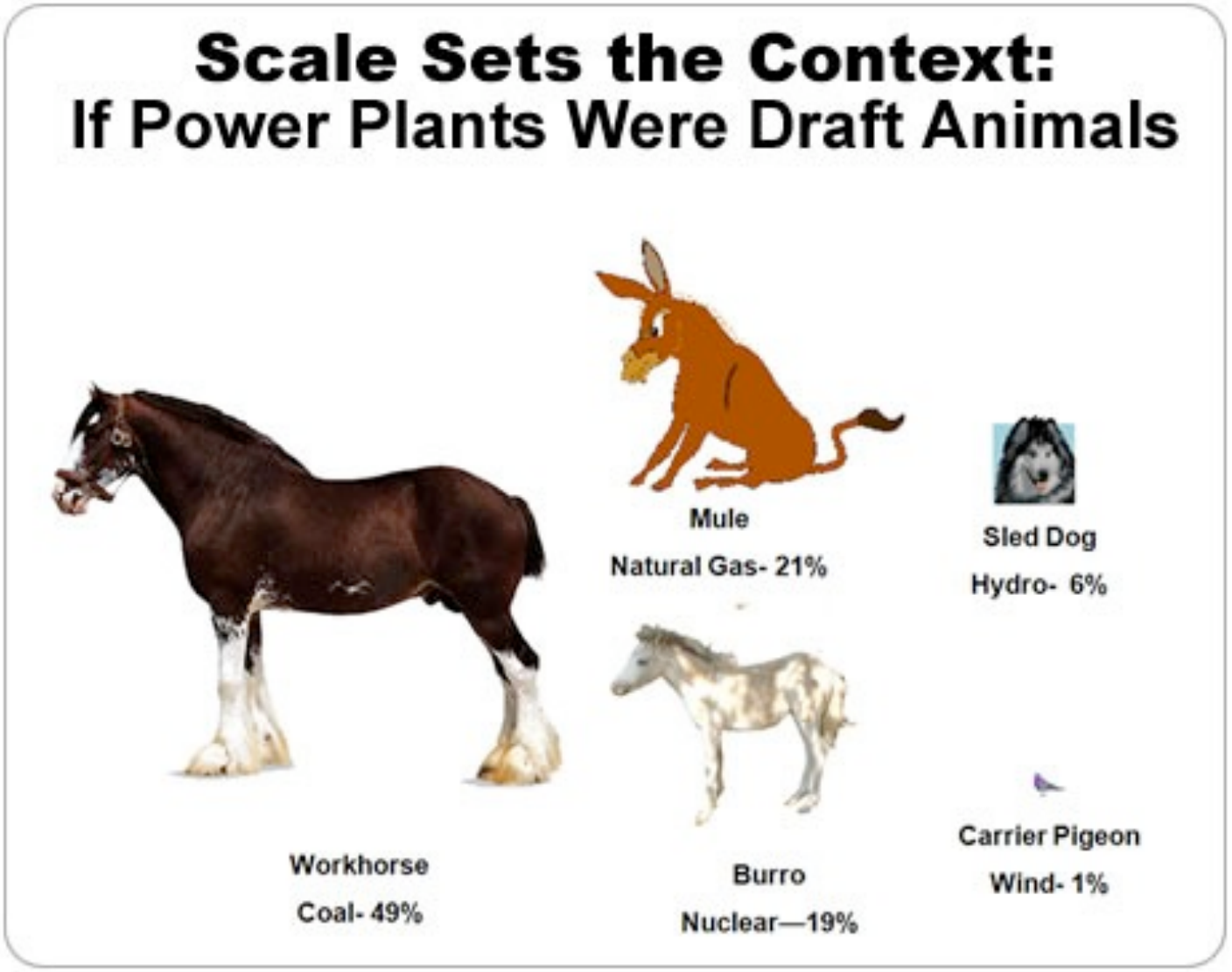


Figure 10. World energy-related carbon dioxide emissions



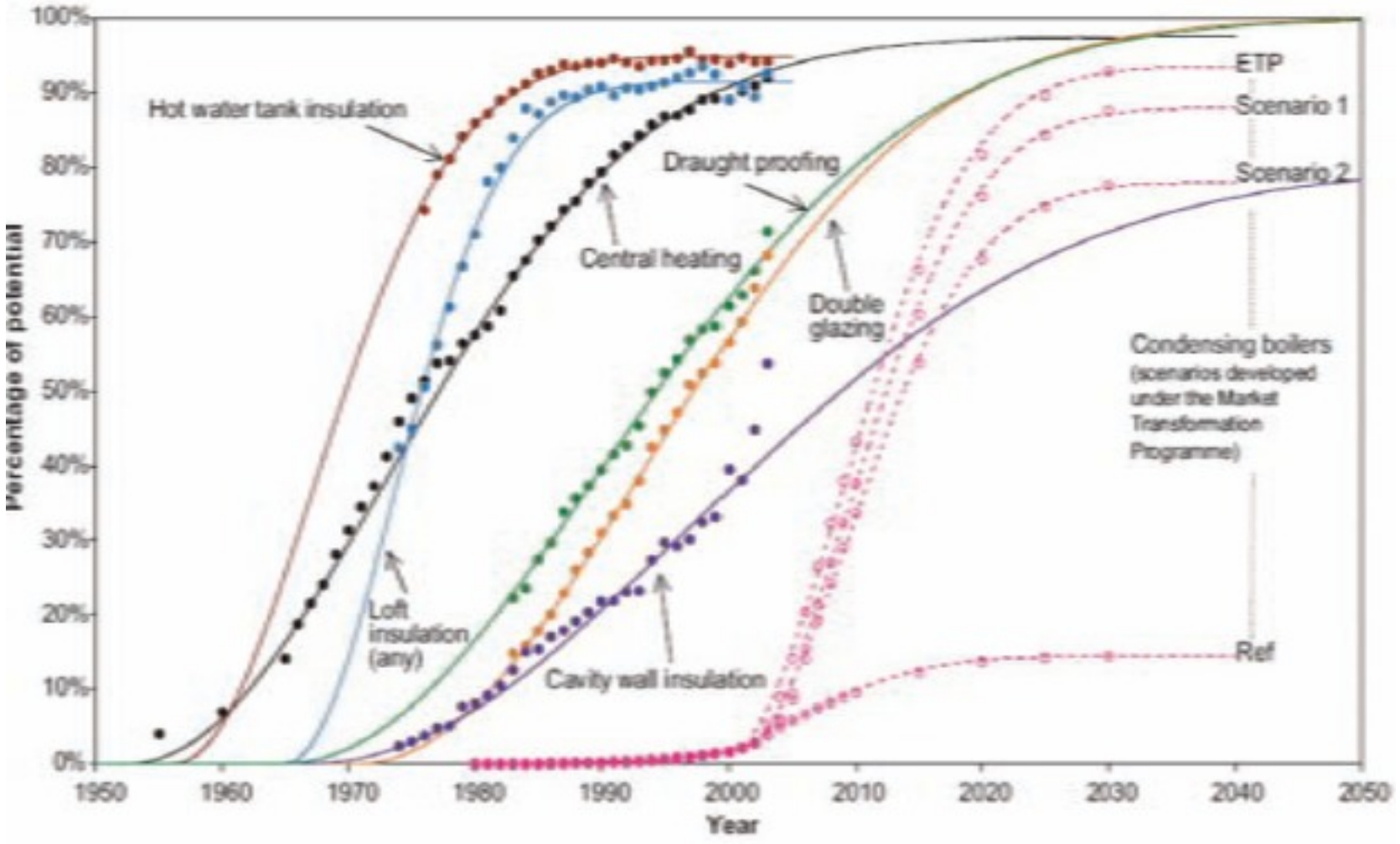
A Comparison Picture



National Targets

- 3000 windmills in the North Sea by 2020
  - One every day until 2020
  - Current installation – 1 every 22 days
- Housing sector CO2 emissions: see next slide
  - Fell 4% net between 1990 and 2005
  - 12% increase in houses + rise in home electronics
  - Need to fall 20% between 2006 and 2020
  - Where is the evidence of X5 effort

Demand Reduction



Two Summary Points

(1) Security of energy supply must take precedence over everything else, including climate change. UK imports of gas and oil are increasing, just as instabilities in Russia and Middle East become more apparent and the UKM heads towards losing 33% of its capacity over the next 10 years!

(2) Nuclear power is the 'known known' in Rumsfeld's terms. Compared with renewables, we know both the upsides and the downsides. Wind farms need 90% back-

Let us get real

No professional engineer with a decade or more of commercial project management experience will contradict the following statement:

“We will only meet our 2020 climate obligations if we are prepared to tolerate large-scale brown-outs in electricity.”

Short Term Measures for Capacity ↗

- Extend all existing nuclear power plants due to come off-line between 2010 and 2023 (3-4GW)
- Extend the lives of coal-fired stations due to be retired by 2015 due to LCPD (11GW)
- Quick builds: gas-fired stations e.g. 850MW at Uskmouth (unavoidable derailing of CO2 targets), and also coal-fired as Kingsnorth
- Increase interconnector capacity: to France from 1 to 3GW, and Norway 1.2GW.
- Increase use of domestic waste for

Other short-term measures
(Ian Fells)

- Strengthen connection to Scotland
- Strengthen grid to take more distributed energy sources
- More gas storage facilities using depleted North Sea fields
- Pumped storage sites expanded (included with tidal barrages) to overcome temporary shortages
- Demand reduction – retrofit, efficiency, …
- What is the practical alternative?

Practical Engineering Lesson
(from Royal Academy of Engineering Report – Generating

- Updating the 2000 RCEP report that came up with the original 60% CO2 reduction by 2050
- Will the end of 80% reduction in CO2
- Start with demand reduction
- Make one high level assumption
- Produce the mix
- Note: not optimum engineering practice

Generating the Future (2)

- Process

  1. Set the demand level of each category of energy demand relative to the current level
  2. Choose the primary sources of energy supply
  3. Balance supply and demand by adjusting the levels of supply
  4. Calculate the carbon emissions
  5. Repeat steps 2 and 3 until carbon emissions have reduced by 80%

- Scenarios
- Scenario 1 Level demand
  Fossil fuel prioritised for transport
- Scenario 2 Medium demand reduction
  Fossil fuel prioritised for low grade heat
- Scenario 3 Medium demand reduction

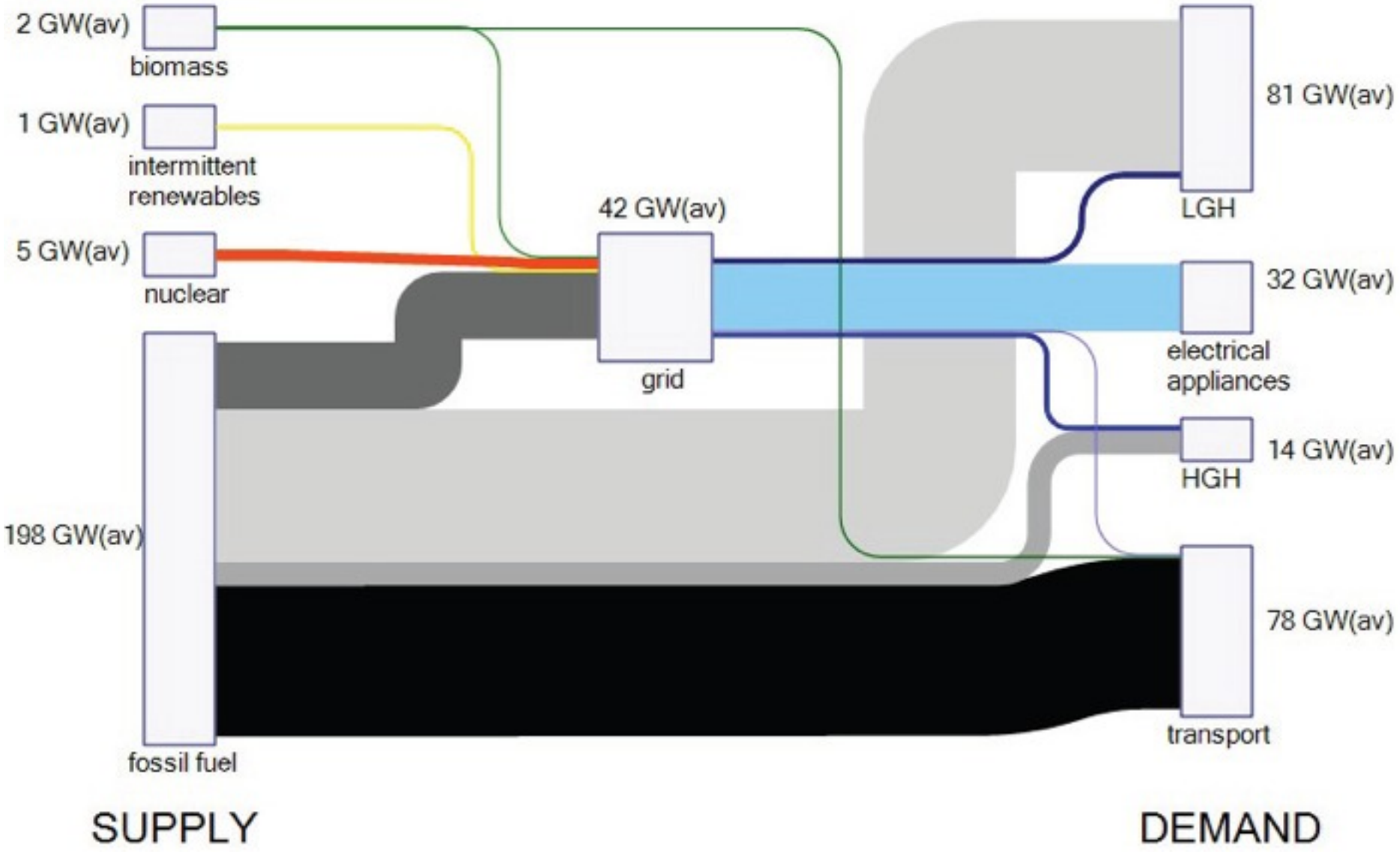
Assumed Demand Inputs

Percentage reduction	Level Demand	Medium Demand Reduction	High Demand Reduction
Low grade heat	0%	40%	66%
Electrical appliances	0%	20%	33%
High grade heat	0%	20%	33%
Transport	0%	20%	33%

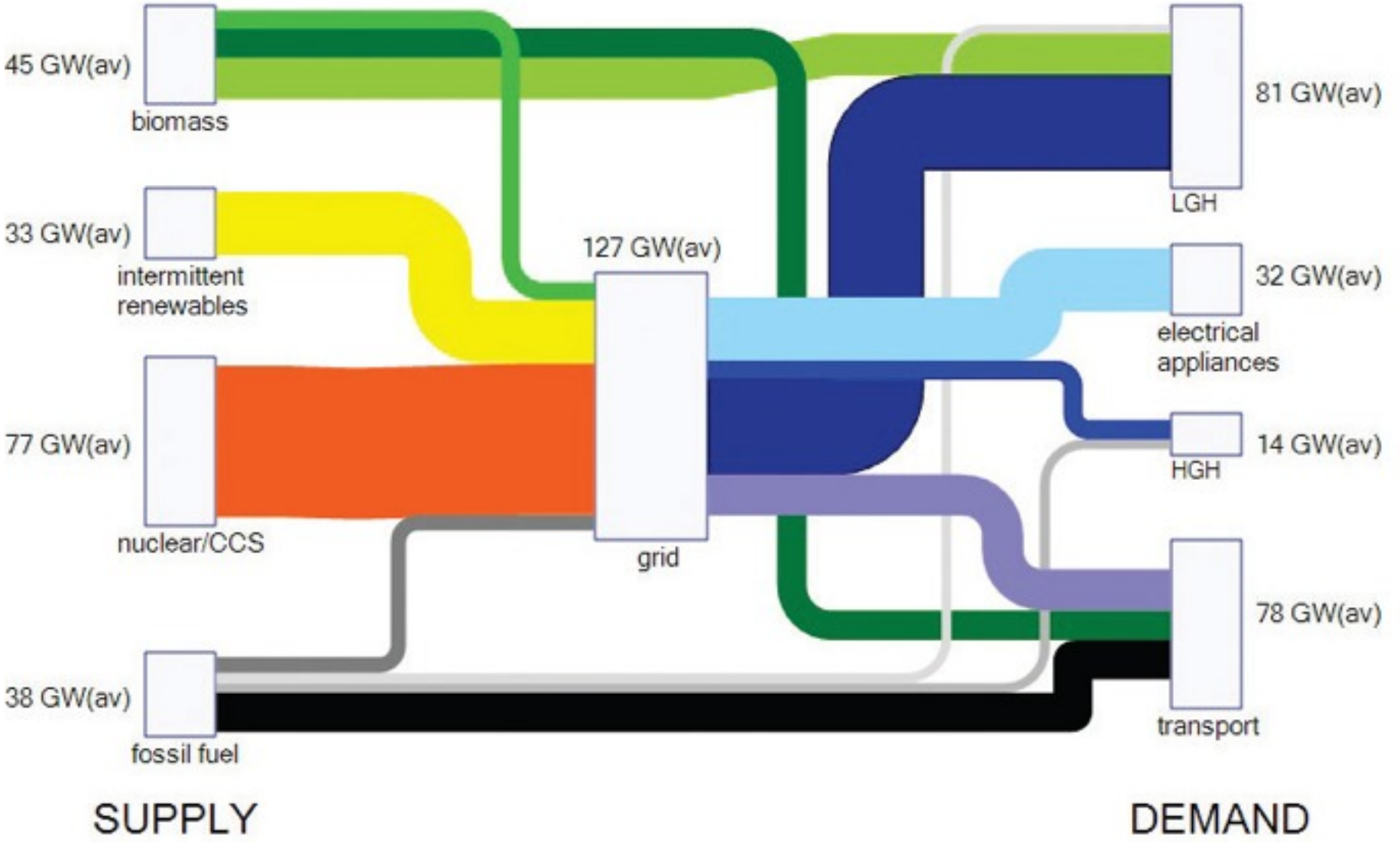
Summary Supply Outcomes

GW(av)	Current	S1	S2	S3	S4
Total Renewables	3.6	78	59	59	53
Nuclear/CCS	5.4	77	30	39	13
Fossil Fuels	199	38	49	43	45
Total average power supply	207	193	138	141	111
Total electric supply	42	127	80	78	56
Total CO2 reduction		79%	81%	80%	81%

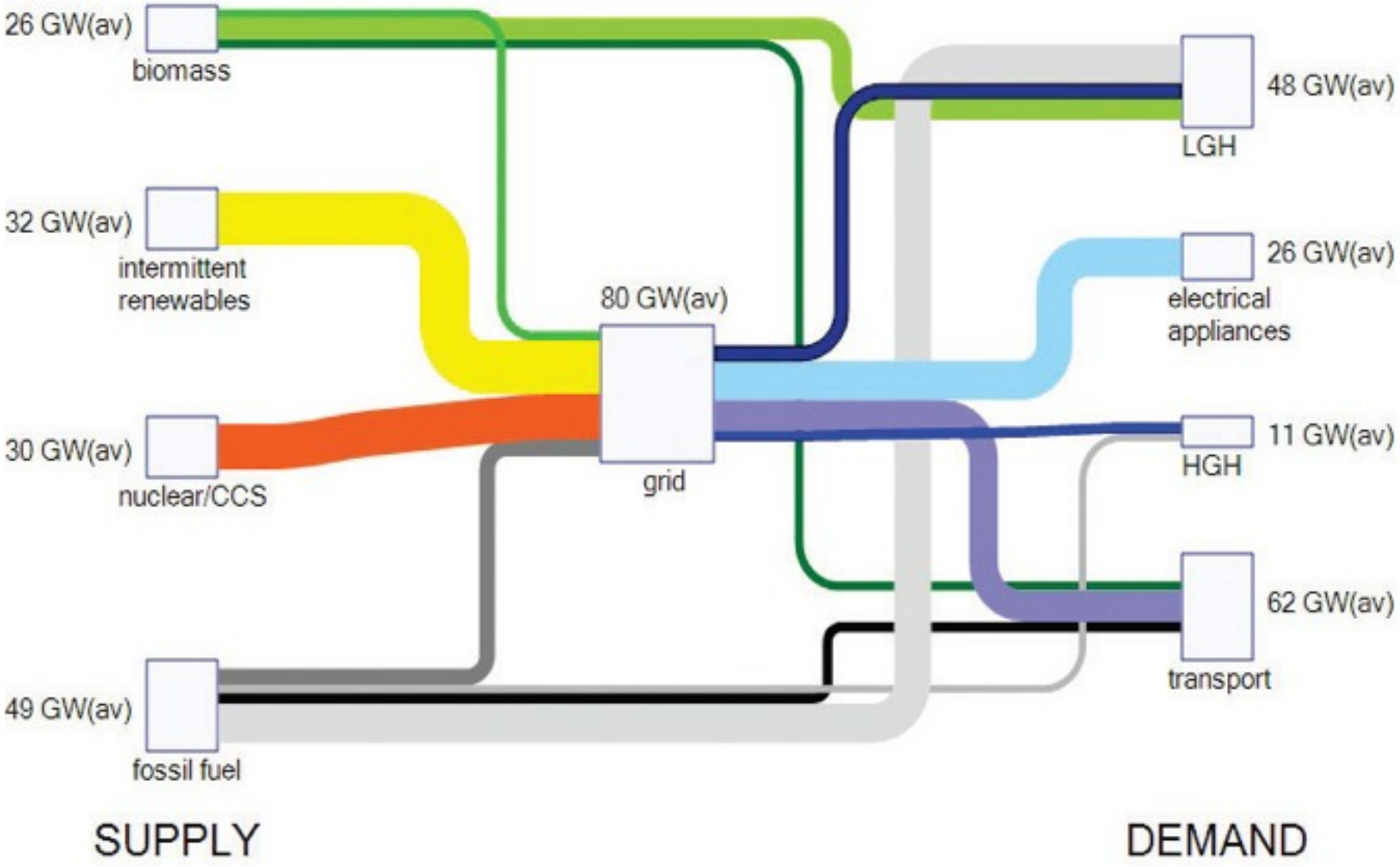
Today's Energy Flows (2008)



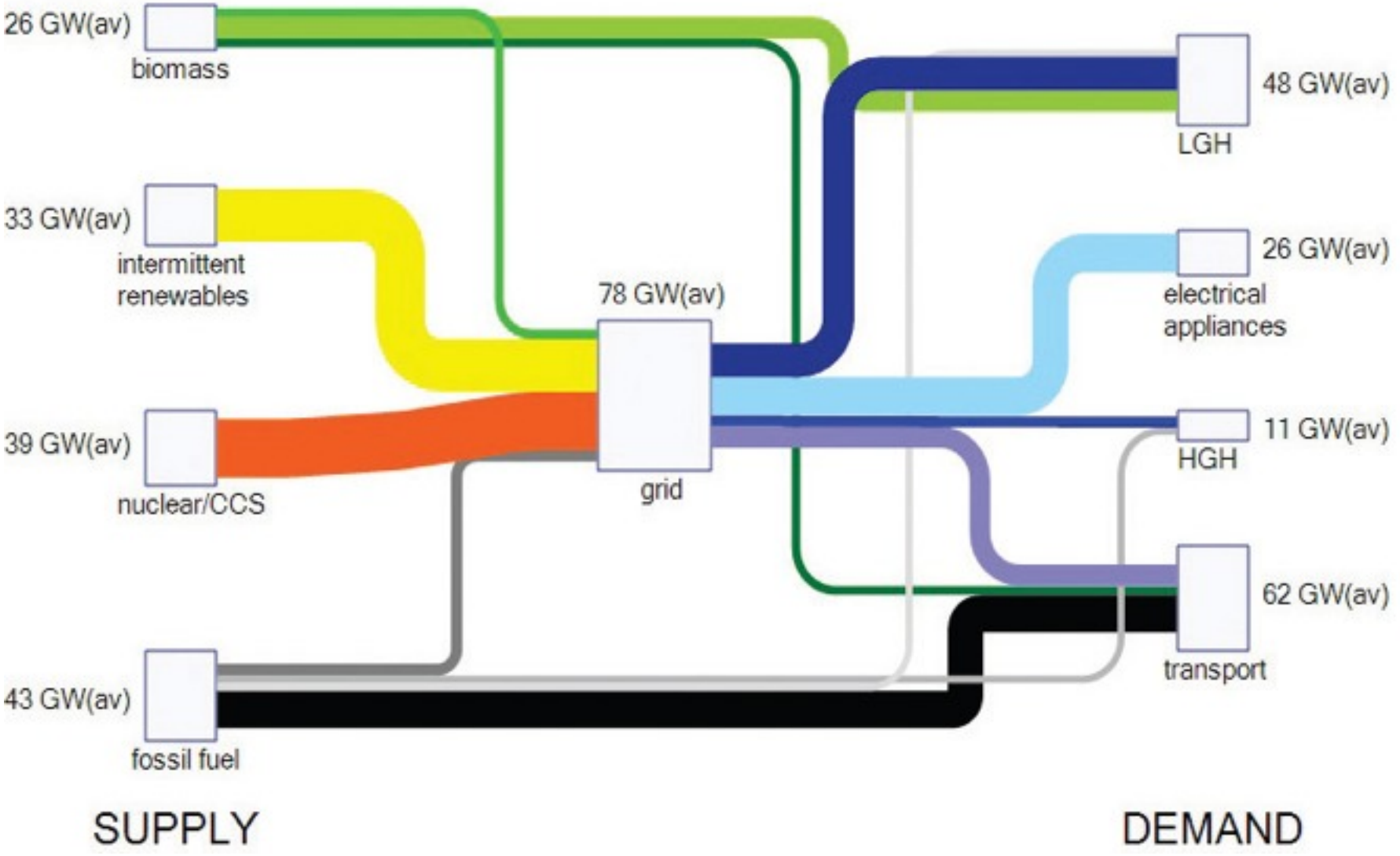
Scenario 1: Level demand



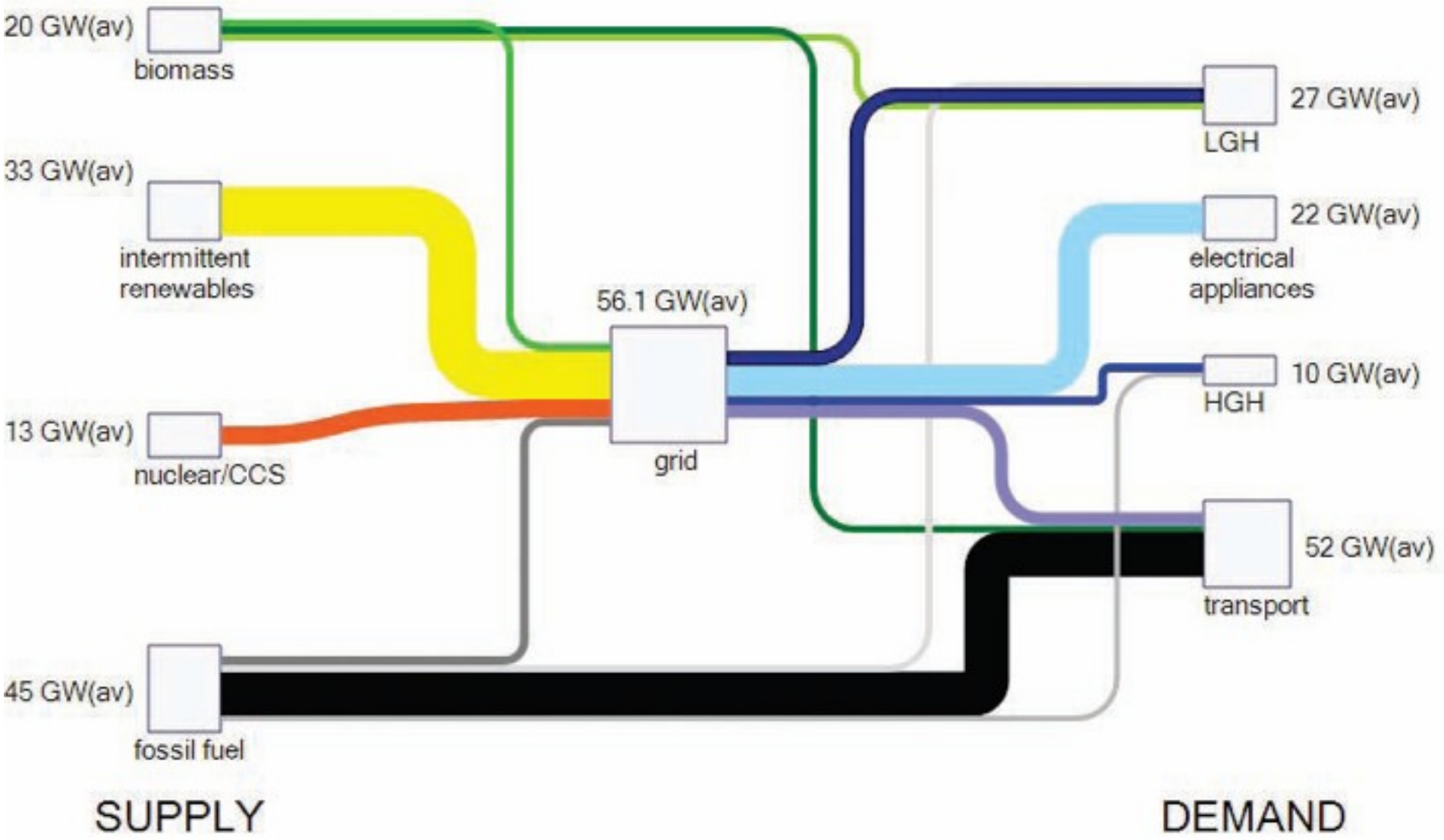
Scenario 2: medium reduction, electrified transport



Scenario 3: medium reduction, electrified low grade heat



Scenario 4: high demand reduction



Four Main Messages

- There is no single ‘silver bullet’ that will achieve the required cuts in emissions.
- Demand reduction across all sectors of the economy will be essential.
- The full suite of low-carbon energy supply technologies will be needed.
- The scale of the engineering challenge

RAEng Conclusion

The experience of engineers shows that implementing fundamental changes to a system as large and complex as the UK's energy system to meet the 2050 greenhouse gas emissions targets will bring with it many challenges for government, business and industry, engineering and the public alike. Turning the theoretical emissions reduction targets into reality will require more than political will: it will require nothing short of the biggest