

**Table 2 - A Model of Boiler, Micro-CHP, and DH-CHP, by Gordon Taylor, 1 November 2002**

|                                                  |            | <b>Boiler</b> | <b>Micro-CHP</b> | <b>Boiler</b> | <b>Micro-CHP</b> | <b>Fuel Cell</b> | <b>DH-CHP</b> |
|--------------------------------------------------|------------|---------------|------------------|---------------|------------------|------------------|---------------|
| Heating by                                       |            | Nat. Gas      | Nat. Gas         | Hydrogen      | Hydrogen         | Hydrogen         | Hot Water     |
| Energy Carrier                                   |            |               |                  |               |                  |                  | Fruttschi     |
| Author                                           |            |               |                  |               |                  |                  | ABB Rev. 5/96 |
| Reference                                        |            |               |                  |               |                  |                  | ABB GT24      |
| Plant Name                                       |            |               |                  |               |                  |                  | GTCC          |
| CHP Unit Type                                    |            |               |                  |               |                  |                  |               |
| <b>Power Cycle</b>                               |            |               |                  |               |                  |                  |               |
| Top Temperature                                  | T1 - C     |               |                  |               |                  |                  | 1000          |
| Top Temperature                                  | T1 - K     |               |                  |               |                  |                  | 1273          |
| Bottom Temperature - Cond.                       | T2 - C     |               |                  |               |                  |                  | 10            |
| Bottom Temperature - Cond.                       | T2 - K     |               |                  |               |                  |                  | 283           |
| Carnot Efficiency - Cond.                        |            |               |                  |               |                  |                  | 0.78          |
| Carnot Factor - Cond.                            |            |               |                  |               |                  |                  | 0.78          |
| Thermal Efficiency - Cond. - NCV                 |            |               |                  |               |                  |                  | 0.61          |
| Electricity Generation Efficiency                |            |               |                  |               |                  |                  | 1             |
| Electricity Efficiency - Cond - NCV              |            |               |                  |               |                  |                  | 0.61          |
| Electricity Output - Cond.                       | MWe        |               |                  |               |                  |                  |               |
| Bottom Temperature - BP                          | T2 - C     |               |                  |               |                  |                  | 68            |
| Bottom Temperature - BP                          | T2 - K     |               |                  |               |                  |                  | 341           |
| Carnot Efficiency - BP                           | Fraction   |               |                  |               |                  |                  | 0.73          |
| Carnot Factor - BP                               | Fraction   |               |                  |               |                  |                  | 0.78          |
| Thermal Efficiency - BP - NCV                    | Fraction   |               |                  |               |                  |                  | 0.57          |
| Electricity Efficiency - BP - NCV                | Fraction   |               |                  |               |                  |                  | 0.57          |
| Electricity Output - BP                          | MWe        |               |                  |               |                  |                  |               |
| Delta Electricity Efficiency - NCV               | Fraction   |               |                  |               |                  |                  | 0.04          |
| Heat + Electricity Effy. - BP - NCV              | Fraction   |               |                  |               |                  |                  | 0.86          |
| Heat Efficiency - BP - NCV                       | Fraction   |               |                  |               |                  |                  | 0.29          |
| Electricity Efficiency - BP - GCV                | Fraction   |               | 0.15             |               | 0.15             | 0.4              | 0.51          |
| Heat + Electricity Effy. - BP - GCV              |            |               | 0.9              |               | 0.85             | 0.85             | 0.77          |
| Heat Efficiency - BP - GCV                       | Fraction   |               | 0.75             |               | 0.7              | 0.45             | 0.26          |
| Heat Output                                      | MWth       |               |                  |               |                  |                  |               |
| COP Heating (delta power basis)                  | Ratio      |               |                  |               |                  |                  | 8.13          |
| Thermo. heat effy (delta power basis) - NCV      | Ratio      |               |                  |               |                  |                  | 4.64          |
| Thermo. heat effy (delta power basis) - GCV      | Ratio      |               |                  |               |                  |                  | 4.18          |
| <b>Heat Pump Cycle</b>                           |            |               |                  |               |                  |                  |               |
| Heating Flow Temperature                         | Tmax - C   |               | 70               |               | 70               | 70               | 90            |
|                                                  | Tmax - K   |               | 343              |               | 343              | 343              | 363           |
| Heating Return Temperature                       | Tmin - C   |               | 50               |               | 50               | 50               | 68            |
|                                                  | Tmin - K   |               | 323              |               | 323              | 323              | 341           |
| Carnot COP Heating                               | Ratio      |               | 17.15            |               | 17.15            | 17.15            | 16.5          |
| Carnot Factor                                    | Fraction   |               | 0.33             |               | 0.33             | 0.33             | 0.5           |
| COP Heating (cycle basis)                        | Ratio      |               | 5.72             |               | 5.72             | 5.72             | 8.25          |
| Thermo. heat effy (cycle basis) - NCV            | Ratio      |               |                  |               |                  |                  | 4.71          |
| Thermo. heat effy (cycle basis) - GCV            | Ratio      |               | 0.86             |               | 0.86             | 2.29             | 4.24          |
| Heat to Electricity Power Ratio - 1/alpha        | Ratio      |               | 5                |               | 4.67             | 1.13             | 0.51          |
| Electricity to Heat Power Ratio - alpha          | Ratio      |               | 0.2              |               | 0.21             | 0.89             | 1.98          |
| <b>Boilers Displaced</b>                         |            |               |                  |               |                  |                  |               |
| Domestic Heating by Gas 2001 B                   | mtoe       | 30.26         | 30.26            | 30.26         | 30.26            | 30.26            | 30.26         |
| Domestic Heating by Gas 2001 B                   | TWh        | 351.94        | 351.94           | 351.94        | 351.94           | 351.94           | 351.94        |
| Average Heat Efficiency - GCV                    | Fraction   | 0.65          | 0.65             | 0.65          | 0.65             | 0.65             | 0.65          |
| Domestic Heat (useful) Net                       | TWh        | 228.76        | 228.76           | 228.76        | 228.76           | 228.76           | 228.76        |
| Heat Distribution Efficiency                     | Fraction   | 1             | 1                | 1             | 1                | 1                | 0.87          |
| Domestic Heat Useful Gross                       | TWh        | 228.76        | 228.76           | 228.76        | 228.76           | 228.76           | 262.94        |
| <b>Heat-Only Boiler</b>                          |            |               |                  |               |                  |                  |               |
| Heat Only Boiler Energy Fraction                 | Fraction   | 1             | 0.1              | 1             | 0.1              | 0.1              | 0.1           |
| Heat Only Boiler Heat                            | TWh        | 228.76        | 22.88            | 228.76        | 22.88            | 22.88            | 26.29         |
| Boiler Efficiency - GCV                          | Fraction   | 0.65          | 0.9              | 0.65          | 0.85             | 0.85             | 0.8           |
| Gas for Heat Only Boiler                         | TWh        | 351.94        | 25.42            | 351.94        | 26.91            | 26.91            | 32.87         |
| <b>CHP Unit</b>                                  |            |               |                  |               |                  |                  |               |
| Cogenerated Heat M                               | TWh        | 0             | 205.88           | 0             | 205.88           | 205.88           | 236.65        |
| Gas for Heat & Cogenerated Elec M                | TWh        | 0             | 274.51           | 0             | 294.12           | 457.52           | 910.02        |
| Cogenerated Electricity M                        | TWh        | 0             | 41.18            | 0             | 44.12            | 183.01           | 467.71        |
| Electricity Distribution Efficiency M            | Fraction   | 0.93          | 1                | 0.93          | 1                | 1                | 0.93          |
| Gas for HOB & CHP M                              | TWh        | 351.94        | 299.93           | 351.94        | 321.03           | 484.43           | 942.89        |
| Hydrogen Production Efficiency                   | Fraction   | 1             | 1                | 0.7           | 0.7              | 0.7              | 1             |
| Gross Gas for HOB & CHP M                        | TWh        | 351.94        | 299.93           | 502.76        | 458.61           | 692.04           | 942.89        |
| <b>Electricity Only Plant</b>                    |            |               |                  |               |                  |                  |               |
| Electricity Distribution Efficiency B            | Fraction   | 0.93          | 0.93             | 0.93          | 0.93             | 0.93             | 0.93          |
| Matching Electricity B                           | TWh        | 0             | 44.47            | 0             | 47.64            | 197.63           | 467.71        |
| Gas to Electricity Generation Efficiency B - GCV | Fraction   | 0.55          | 0.55             | 0.55          | 0.55             | 0.55             | 0.55          |
| Gas for Matching Electricity B                   | TWh        | 0             | 81.4             | 0             | 87.21            | 361.76           | 856.14        |
| <b>Savings v Gas</b>                             |            |               |                  |               |                  |                  |               |
| Net Gas for Heat M                               | TWh        | 351.94        | 218.53           | 502.76        | 371.4            | 330.28           | 86.75         |
| Gas Saving for Heat B - M                        | TWh        | 0             | 133.4            | -150.83       | -19.47           | 21.66            | 265.19        |
| Specific Carbon Emissions for Gas                | gC/kwh gas | 54.5          | 54.5             | 54.5          | 54.5             | 54.5             | 54.5          |
| Carbon Emissions for Gas Heat & Elec. M          | MtC        | 19.18         | 16.35            | 27.4          | 24.99            | 37.72            | 51.39         |
| Carbon Emissions for Gas Heat & Elec. B          | MtC        | 19.18         | 23.62            | 19.18         | 23.93            | 38.9             | 65.84         |
| Carbon Savings v Gas Heat and Elec B             | MtC        | 0             | 7.27             | -8.22         | -1.06            | 1.18             | 14.45         |
| Sp. Carbon Savings v Gas Heat and Elec B         | gC/kWh th  | 0             | 31.78            | -35.93        | -4.64            | 5.16             | 63.18         |
| <b>Savings v Gas &amp; Mix</b>                   |            |               |                  |               |                  |                  |               |
| Specific Carbon Emissions for Mix Elec B         | gC/kwh el  | 121.3         | 121.3            | 121.3         | 121.3            | 121.3            | 121.3         |
| Carbon Emissions, Gas Heat & Mix Elec B          | MtC        | 19.18         | 24.57            | 19.18         | 24.96            | 43.15            | 75.91         |
| Carbon Savings v Gas Heat & Mix Elec B           | MtC        | 0             | 8.23             | -8.22         | -0.03            | 5.44             | 24.53         |
| Sp. Carbon Savings v Gas Heat & Mix Elec B       | gC/kWh th  | 0             | 35.97            | -35.93        | -0.15            | 23.77            | 107.21        |

**Table 4 - A Model of Boiler and Industrial-CHP, by Gordon Taylor, 31 October 2002**

| Energy Carrier                                                                                                                                                                |            | <b>Boiler</b> | <b>Ind-CHP</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|----------------|
|                                                                                                                                                                               |            | Nat. Gas      | Hot Water      |
| Author                                                                                                                                                                        |            |               | Frutschi       |
| Reference                                                                                                                                                                     |            |               |                |
| When assessing Industrial CHP schemes, the Boilers Displaced Effy is set to 0.8, the Heat-Only Boiler Fraction to zero, & the Heat and Elec Distribution Efficiencies to one. |            |               |                |
| <b>Power Cycle</b>                                                                                                                                                            |            |               |                |
| Top Temperature                                                                                                                                                               | T1 - C     |               | 1000           |
| Top Temperature                                                                                                                                                               | T1 - K     |               | 1273           |
| Bottom Temperature - Condensing                                                                                                                                               | T2 C       |               | 10             |
| Bottom Temperature - Condensing                                                                                                                                               | T2 - K     |               | 283            |
| Carnot Efficiency - Condensing                                                                                                                                                | Fraction   |               | 0.78           |
| Carnot Factor - Condensing                                                                                                                                                    | Fraction   |               | 0.78           |
| Thermal Efficiency - Condensing - NCV                                                                                                                                         | Fraction   |               | 0.61           |
| Electrical Generator Efficiency                                                                                                                                               | Fraction   |               | 1              |
| Electricity Efficiency - Condensing - NCV                                                                                                                                     | Fraction   |               | 0.61           |
| Bottom Temperature - Back Pressure                                                                                                                                            | T2 - C     |               | 50             |
| Bottom Temperature - Back Pressure                                                                                                                                            | T2 - K     |               | 323            |
| Carnot Efficiency - Back Pressure                                                                                                                                             | Fraction   |               | 0.75           |
| Carnot Factor - Back Pressure                                                                                                                                                 | Fraction   |               | 0.78           |
| Thermal Efficiency - BP - NCV                                                                                                                                                 | Fraction   |               | 0.58           |
| Thermal Efficiency - BP - GCV                                                                                                                                                 | Fraction   |               | 0.53           |
| Electricity Efficiency - BP - NCV                                                                                                                                             | Fraction   |               | 0.58           |
| Delta Electricity Efficiency - NCV                                                                                                                                            | Fraction   |               | 0.02           |
| Total Heat + Elec Efficiency - BP - NCV                                                                                                                                       | Fraction   |               | 0.86           |
| Heat Efficiency - BP - NCV                                                                                                                                                    | Fraction   |               | 0.28           |
| Electricity Efficiency - BP - GCV                                                                                                                                             | Fraction   |               | 0.53           |
| Heat + Electricity Efficiency - BP - GCV                                                                                                                                      | Fraction   |               | 0.78           |
| Heat Efficiency - BP - GCV                                                                                                                                                    | Fraction   |               | 0.25           |
| COP Heating (Delta Power Basis)                                                                                                                                               | Ratio      |               | 11.34          |
| Thermo. Heat Effy (Delta Power Basis) - NCV                                                                                                                                   | Ratio      |               | 6.6            |
| Thermo. Heat Effy (Delta Power Basis) - GCV                                                                                                                                   | Ratio      |               | 5.94           |
| <b>Heat Pump Cycle</b>                                                                                                                                                        |            |               |                |
| Heating Flow Temperature                                                                                                                                                      | Tmax - C   |               | 70             |
| Heating Flow Temperature                                                                                                                                                      | Tmax - K   |               | 343            |
| Heating Return Temperature                                                                                                                                                    | Tmin - C   |               | 50             |
| Heating Return Temperature                                                                                                                                                    | Tmin - K   |               | 323            |
| Carnot COP Heating                                                                                                                                                            | Ratio      |               | 17.15          |
| Carnot Factor                                                                                                                                                                 | Fraction   |               | 0.5            |
| COP Heating (cycle basis)                                                                                                                                                     | Ratio      |               | 8.58           |
| Thermo. Heat Effy (cycle basis) - NCV                                                                                                                                         | Ratio      |               | 4.99           |
| Thermo. Heat Effy (cycle basis) - GCV                                                                                                                                         | Ratio      |               | 4.51           |
| Heat to Electricity Power Ratio - 1/alpha                                                                                                                                     | Ratio      |               | 0.48           |
| Electricity to Heat Power Ratio - alpha                                                                                                                                       | Ratio      |               | 2.09           |
| <b>Boilers Displaced</b>                                                                                                                                                      |            |               |                |
| Industrial Low Temp. Heating Gas 2001 B                                                                                                                                       | mtoe       | 13            | 13             |
| Industrial Low Temp. Heating Gas 2001 B                                                                                                                                       | TWh        | 151.19        | 151.19         |
| Average Heat Efficiency - GCV                                                                                                                                                 | Fraction   | 0.8           | 0.8            |
| Industrial Heat (useful) Net                                                                                                                                                  | TWh        | 120.95        | 120.95         |
| Heat Distribution Efficiency                                                                                                                                                  | Fraction   | 1.00          | 1.00           |
| Industrial Heat (useful) Gross                                                                                                                                                | TWh        | 120.95        | 120.95         |
| Heat-Only Boiler                                                                                                                                                              |            |               |                |
| Heat-Only Boiler Heat Energy Fraction                                                                                                                                         | Fraction   | 1.00          | 0.00           |
| Heat Only Boiler Heat                                                                                                                                                         | TWh        | 120.95        | 0.00           |
| Boiler Efficiency - GCV                                                                                                                                                       | Fraction   | 0.80          | 0.80           |
| Gas for Heat-Only Boiler                                                                                                                                                      | TWh        | 151.19        | 0.00           |
| <b>CHP Unit</b>                                                                                                                                                               |            |               |                |
| Cogenerated Heat M                                                                                                                                                            | TWh        | 0.00          | 120.95         |
| Gas for Cogenerated Heat & Cogenerated Elec                                                                                                                                   | TWh        | 0.00          | 482.18         |
| Cogenerated Electricity M                                                                                                                                                     | TWh        | 0.00          | 253.34         |
| Gas for Cogenerated Electricity M                                                                                                                                             | TWh        | 0.00          | 482.18         |
| Electricity Distribution Efficiency M                                                                                                                                         | Fraction   | 1.00          | 1.00           |
| Gas for HOB & CHP M                                                                                                                                                           | TWh        | 151.19        | 482.18         |
| Hydrogen Production Efficiency                                                                                                                                                | Fraction   | 1.00          | 1.00           |
| Gross Gas for HOB & CHP                                                                                                                                                       | TWh        | 151.19        | 482.18         |
| <b>Electricity Only Plant</b>                                                                                                                                                 |            |               |                |
| Electricity Distribution Efficiency B                                                                                                                                         | Fraction   | 0.93          | 0.93           |
| Matching Electricity B                                                                                                                                                        | TWh        | 0.00          | 273.58         |
| Gas to Electricity Generation Efficiency B                                                                                                                                    | Fraction   | 0.55          | 0.55           |
| Gas for Matching Electricity B                                                                                                                                                | TWh        | 0.00          | 500.79         |
| <b>Savings v Gas</b>                                                                                                                                                          |            |               |                |
| Specific Carbon Emissions for Gas                                                                                                                                             | gC/kWh gas | 54.50         | 54.50          |
| Carbon Emissions for Gas Heat & Elec. M                                                                                                                                       | MtC        | 8.24          | 26.28          |
| Carbon Emissions for Gas Heat & Elec. B                                                                                                                                       | MtC        | 8.24          | 35.53          |
| Carbon Savings v Gas Heat and Elec                                                                                                                                            | MtC        | 0.00          | 9.25           |
| Sp. Carbon Savings v Gas Heat and Elec                                                                                                                                        | gC/kWh ht  | 0.00          | 76.51          |
| <b>Savings v Gas &amp; Mix</b>                                                                                                                                                |            |               |                |
| Specific Carbon Emissions for Mix Elec B                                                                                                                                      | gC/kwh el  | 121.30        | 121.30         |
| Carbon Emissions, Gas Heat & Mix Elec B                                                                                                                                       | MtC        | 8.24          | 41.43          |
| Carbon Savings v Gas Heat & Mix Elec                                                                                                                                          | MtC        | 0.00          | 15.15          |
| Sp. Carbon Savings v Gas Heat & Mix Elec                                                                                                                                      | gC/kWh ht  | 0.00          | 125.23         |

Table 5 - Biofuels for Transport, Gordon Taylor, 9 September 2002  
This is to assess crop production, conversion to biofuel, and economy of use

| Biofuel                                        | Richards, Levington |                |               |
|------------------------------------------------|---------------------|----------------|---------------|
|                                                | Bioethanol          |                | Biodiesel     |
|                                                | Units               | Winter wheat   | Oil Seed Rape |
| Crop                                           |                     |                |               |
| Fertiliser etc                                 |                     |                |               |
| Energy for seed                                | MJ/ha               | 925            | 35            |
| Usage of Nitrogen fertiliser                   | kgN/ha              | 195            | 180           |
| Energy for Production of Nitrogen fertiliser   | MJ/ha               | 7410           | 6840          |
| Usage of Phosphorus fertiliser                 | kgP/ha              | 60             | 50            |
| Energy for Production of Phosphorus fertiliser | MJ/ha               | 210            | 150           |
| Usage of Potassium fertiliser                  | kgK/ha              | 45             | 40            |
| Energy for Production of Potassium fertiliser  | MJ/ha               | 450            | 200           |
| Energy for agrochemicals                       | MJ/ha               | 1045           |               |
| Energy equivalent of packaging                 | MJ/ha               | 485            | 282           |
| Fuel for Transport of fertilisers etc          |                     |                |               |
| Energy for transport of fertilisers etc        | MJ/ha               | 160            | 112           |
| Sub-total for Fertiliser etc.                  | MJ/ha               | 10685          | 7619          |
| Farming                                        |                     |                |               |
| Biomass yield                                  | t/ha                | 8.96           | 4.08          |
| Biomass yield                                  |                     |                |               |
| Associated straw (dry-matter basis)            | t/ha                | 6.5            | 4             |
| Fuel for Farming of biomass                    | l/ha                | 111            | 115           |
| Energy for farming                             | MJ/ha               | 4773           | 4945          |
| Fuel for Transport of biomass                  |                     |                |               |
| Energy for Transport of biomass                | MJ/ha               | 1341           | 611           |
| Fuel for transport of straw                    |                     |                |               |
| Energy for transport of straw                  | MJ/ha               | 648            | 399           |
| Sub-total for Farming                          | MJ/ha               | 6762           | 5955          |
| Production                                     |                     |                |               |
| Yield of biofuel                               | kg/t                | 276            | 370           |
| Yield of biofuel                               |                     |                |               |
| Energy of biofuel                              |                     |                |               |
| Energy of biofuel                              | MJ/ha               | 74189          | 54346         |
| Energy for D.M. Production of ethanol          | MJ/ha               | 50810          | 17251         |
| Energy for D.M. Production of ethanol          | MJ/kg eth.          | 20.55          |               |
| Energy Balance                                 |                     |                |               |
| By-product bran                                | kg/t                | 35             |               |
| Energy credit for straw                        | MJ/kg               | 15             |               |
| Energy credit for straw                        | MJ/ha               | 97500          | 60000         |
| Energy of biofuel & straw                      | MJ/ha               | 171689         | 114346        |
| Sub-total of bioenergy cost                    | MJ/ha               | 68257          | 31162         |
| Energy Surplus (Straw - Cost)                  | MJ/ha               | 29243          | 28838         |
| Energy Balance (Fuel + Straw - Cost)           | MJ/ha               | 103432         | 84500         |
| Output energy of ethanol & straw/input energy  | Ratio               | 2.52           | 3.67          |
| Yield of biofuel                               | l/ha                | 3130           | 1776          |
| Carbon intensity (in terms of oil)             | tC/toe              | -0.34          | -0.45         |
| Solar Relations                                |                     |                |               |
| Solar income of 920 kWh/m <sup>2</sup> ,y      | MJ/ha               | 33120000       | 33120000      |
| Energy of biofuel/Solar income                 | fraction            | 0              | 0             |
| Energy Surplus/Solar Income                    | fraction            | 0              | 0             |
| Energy Balance/Solar income                    | fraction            | 0              | 0             |
| Gross Biofuel & Straw/Solar income             | fraction            | 0.01           | 0             |
| Potential                                      |                     |                |               |
| Land area of the UK                            | ha                  | 24488000       | 24488000      |
| Possible Land Area for biofuel at 0.2 of UK    | ha                  | 4,897,600      | 4,897,600     |
| Possible Production of biofuel                 | t/y                 | 12,111,569     | 7,393,417     |
| Possible Production of biofuel                 | l/y                 | 15,331,099,868 | 8,698,137,600 |
| Possible Production of biofuel                 | mtoe/y              | 8.7            | 6.4           |
| Possible Carbon Saving from biofuel (v Oil)    | MtC/y               | 7.4            | 5.4           |
| Road Transport fuel for UK, 2000               | mtoe                | 41.4           | 41.4          |
| Possible Biofuel/Road Transport fuel for UK    | fraction            | 0.21           | 0.15          |
| Possible Energy Surplus in UK                  | mtoe/y              | 3.4            | 3.4           |
| Possible Energy Surplus in UK                  | TWh/y               | 39.8           | 39.2          |
| Possible C Saving from Energy Surplus (v Gas)  | MtC/y               | 2.2            | 2.1           |
| Possible Biofuel & Energy Surplus in UK        | mtoe/y              | 12.1           | 9.7           |

Table 11 - UK Energy Use and Carbon Emissions in 2050, Gordon Taylor, 12 Sept 2002  
Data from 'Energy Consumption in the United Kingdom'. 'ecuk.pdf'. DTI & NS. July 2002

|                                        | Total Final | Final 2001 | Scale Fac | Final Gas | Useful Heat | Final Elec | Fuel for Cent | Final H Fuel | Final T Fuel | C Intensity | C Emissions |
|----------------------------------------|-------------|------------|-----------|-----------|-------------|------------|---------------|--------------|--------------|-------------|-------------|
| Transport                              | mtoe        | mtoe       |           | mtoe      | mtoe        | mtoe       | mtoe          | mtoe         | mtoe         | MtC/mtoe    | MtC         |
| Rail                                   | 1.2         | 1.2        | 1.00      |           |             | 0.76       |               |              |              | 0.44        |             |
| Road                                   | 41.45       | 41.45      | 1.00      |           |             |            |               |              |              | 41.45       |             |
| Water                                  | 0.8         | 0.8        | 1.00      |           |             |            |               |              |              | 0.8         |             |
| Air                                    | 11.4        | 11.4       | 1.00      |           |             |            |               |              |              | 11.4        |             |
| Total                                  | 54.85       | 54.85      |           |           |             |            |               |              |              |             |             |
| Domestic                               |             |            |           |           |             |            |               |              |              |             |             |
| Space heating                          | 27.4        | 28.4       | 1.00      | 22.3      | 14.5        | 2.2        |               | 3.9          |              |             |             |
| Water Heating                          | 11.1        | 11.5       | 1.00      | 9.0       | 5.9         | 0.9        |               | 1.6          |              |             |             |
| Lights & Appl.                         | 6.1         | 6.3        | 1.00      |           |             | 6.3        |               |              |              |             |             |
| Cooking                                | 2.3         | 2.4        | 1.00      |           |             | 2.4        |               |              |              |             |             |
| Total                                  | 46.9        | 48.6       |           |           |             |            |               |              |              |             |             |
| Industrial                             |             |            |           |           |             |            |               |              |              |             |             |
| High Temp. Process                     | 6.9         | 8.6        | 1.00      |           |             |            |               | 8.6          |              |             |             |
| Low Temp. Process                      | 8.69        | 10.8       | 1.00      | 10.8      | 8.7         |            |               |              |              |             |             |
| Drying/Separation                      | 3.1         | 3.9        | 1.00      | 1.9       | 1.5         |            |               | 1.9          |              |             |             |
| Space heating                          | 2.84        | 3.5        | 1.00      | 3.5       | 2.8         |            |               |              |              |             |             |
| Motors                                 | 2.15        | 2.7        | 1.00      |           |             | 2.7        |               |              |              |             |             |
| Compressed Air                         | 0.88        | 1.1        | 1.00      |           |             | 1.1        |               |              |              |             |             |
| Lighting                               | 0.24        | 0.3        | 1.00      |           |             | 0.3        |               |              |              |             |             |
| Refrigeration                          | 0.58        | 0.7        | 1.00      |           |             | 0.7        |               |              |              |             |             |
| Other                                  | 2.78        | 3.5        | 1.00      |           |             |            |               | 3.5          |              |             |             |
| Total                                  | 28.16       | 35.1       |           |           |             |            |               |              |              |             |             |
| Services                               |             |            |           |           |             |            |               |              |              |             |             |
| Catering                               | 2.14        | 2.3        | 1.00      |           |             | 2.3        |               |              |              |             |             |
| Hot Water                              | 1.98        | 2.1        | 1.00      | 2.1       | 1.7         |            |               |              |              |             |             |
| Heating                                | 11.56       | 12.2       | 1.00      | 12.2      | 9.7         |            |               |              |              |             |             |
| Lighting                               | 3.06        | 3.2        | 1.00      |           |             | 3.2        |               |              |              |             |             |
| Computing                              | 0.48        | 0.5        | 1.00      |           |             | 0.5        |               |              |              |             |             |
| Cooling, Ventilation                   | 0.63        | 0.7        | 1.00      |           |             | 0.7        |               |              |              |             |             |
| Other                                  | 1.17        | 1.2        | 1.00      |           |             |            |               | 1.2          |              |             |             |
| Total                                  | 21.02       | 22.1       |           |           |             |            |               |              |              |             |             |
| Grand Total Final                      | 150.93      | 160.6      |           |           |             |            |               |              |              |             |             |
| Totals for each energy form            |             |            |           |           | 44.8        | 24.0       | 15.2          | 5.5          | 54.1         |             |             |
| Demand Reduction Factor                |             |            |           |           | 0.7         | 0.7        | 0.7           | 0.7          | 0.7          |             |             |
| Total Useful Heat                      |             |            |           |           | 31.4        |            |               |              |              |             |             |
| Total Final Electricity                |             |            |           |           |             | 16.8       |               |              |              |             |             |
| Total Final Gas for Hi Temp Heat       |             |            |           |           |             |            | 10.6          |              |              |             |             |
| Total Final Rural Dom. Htg. Fuel       |             |            |           |           |             |            |               | 3.8          |              |             |             |
| Total Final Transport Fuel             |             |            |           |           |             |            |               |              | 37.9         |             | 100.5       |
| Total Final Demand - TWh/y             |             |            |           |           | 365         | 195        | 124           | 44           | 440          |             |             |
| Electric heating fraction              |             | 0.00       |           |           | 2.1         | -2.1       |               |              |              |             |             |
| Demand adjusted for electric htg.      |             |            |           |           | 33.5        | 14.6       |               |              |              |             |             |
| District Heating fraction              |             | 1.00       |           |           | 0.0         |            |               | 0.0          |              |             |             |
| Extra fuel for domestic Non-DH         |             |            |           |           |             |            |               | 0.0          |              |             |             |
| Demand adjusted for DH                 |             |            |           |           | 38.5        |            |               | 10.6         |              |             |             |
| Elec Heat for DH etc                   |             |            |           |           | 0.0         |            |               |              |              |             |             |
| Elec for DH etc.                       |             |            |           |           |             | 0.0        |               |              |              |             |             |
| Elec Rural Heat                        |             |            |           |           |             |            |               | 0.0          |              |             |             |
| Elec for Rural Heat                    |             |            |           |           |             | 0.0        |               |              |              |             |             |
| Heat Only Boiler Heat for DH etc       |             |            |           |           | 3.9         |            |               |              |              |             |             |
| Fuel for HOB Heat for DH etc           |             |            |           |           |             |            |               | 4.8          |              |             |             |
| Cogen Heat for DH etc                  |             |            |           |           | 12.6        |            |               |              |              |             |             |
| Fuel for Cogen Heat=Heat/THE           |             |            |           |           |             |            |               | 3.0          |              |             |             |
| Cogen Electricity=Heat*Alpha           |             |            |           |           |             | 23.0       |               |              |              |             |             |
| Fuel for Cogen Elec=Elec/Effy          |             |            |           |           |             |            |               | 48.4         |              |             |             |
| Total Fuel for Centrals etc            |             |            |           |           |             |            |               | 66.9         |              |             |             |
| Wastes for Rural Dom. Heat             |             |            |           |           |             |            |               | 3.8          |              |             |             |
| En. Crop for Cents. @ 5.3 toe/ha,y     |             |            |           |           |             |            | 0.0           |              |              | 0.918       | 0.0         |
| Oil for Non-Road Transport             |             |            |           |           |             |            |               |              | 8.8          |             |             |
| Fuel for Road Transport                |             |            |           |           |             |            |               |              | 29.0         |             |             |
| Oil for R T Fuel Blends at 0.1         |             |            |           |           |             |            |               |              | 2.9          |             |             |
| Ethanol for R T Fuel Blends at 0.9*0.9 |             |            |           |           |             |            |               |              | 26.1         |             |             |
| Bioeth. at 1.771 toe/ha,y + 0.394      |             |            |           |           |             |            | 3.4           |              | 8.6          |             |             |
| Imported ethanol                       |             |            |           |           |             |            |               |              | 15.6         |             |             |
| Synthetic ethanol                      |             |            |           |           |             |            |               |              | 1.9          |             |             |
| Available C from Centrals at 0.9       |             |            |           |           |             |            |               |              |              |             | 39.4        |
| C needed for ethanol synthesis         |             |            |           |           |             |            |               |              |              |             | 1.4         |
| Energy flows for ethanol synthesis     |             |            |           |           | 22.1        | 24.3       | 6.4           |              | 11.75        |             |             |
| Spare Electricity from CHP             |             |            |           |           |             | -15.9      |               |              | 0.00         |             |             |
| Renewable Elec for Heat & Synth.       |             |            |           |           |             | 17.2       |               |              | 0.00         |             |             |
| Net Oil for Transport                  |             |            |           |           |             |            |               |              |              |             |             |
| Net Oil for Rural Heating              |             |            |           |           |             |            |               | 0.00         |              |             |             |
| Excess Oil                             |             |            |           |           |             |            |               |              | 0.00         |             |             |
| Total Oil Required                     |             |            |           |           |             |            |               |              | 13.06        | 0.855       | 11.2        |
| Net Ethanol for Trans. & R. Htg.       |             |            |           |           |             |            |               |              | 0.00         |             |             |
| Net Gas for HOB, CHP, and Eth. Synth.  |             |            |           |           |             |            | 73.5          |              |              | 0.595       | 43.8        |
| Land Use Change                        |             |            |           |           |             |            |               |              |              |             | 4.0         |
| Target Carbon Emissions for 2050       |             |            |           |           |             |            |               |              |              |             | 62          |
| Total Carbon Emissions                 |             |            |           |           |             |            |               |              |              |             | 58.9        |
| Gas 2050/Gas 2001 - ratio              |             |            |           |           |             |            | 0.773         | 73.54        |              |             |             |
| Oil 2050/Oil 2001 - ratio              |             |            |           |           |             |            |               |              | 0.171        | 13.06       |             |
| Fraction UK for Energy Crops etc       |             |            | 0.200     | 4.88      |             |            |               |              |              |             |             |
| Cogen Elec Cap. at LF 0.5 - GWe        |             |            |           |           |             | 61.2       |               |              |              |             |             |
| Renewable Elec - TWh/y                 |             |            |           |           |             | 200.0      | 17.20         |              |              |             |             |
| Ren. Elec. Cap. at LF 0.38 - GWe       |             |            |           |           |             | 60.1       |               |              |              |             |             |
| Total Primary Energy                   |             |            |           |           |             |            |               |              |              |             | 135.3       |
| Total Final/Total Primary              |             |            |           |           |             |            |               |              |              |             | 0.743       |
| Total Renewable Energy                 |             |            |           |           |             |            |               |              |              |             | 48.7        |
| Total Renewable/Total Primary          |             |            |           |           |             |            |               |              |              |             | 0.360       |