



METREX Metropolitan Mitigation Manual

A manual outlining an effective greenhouse gas (GHG) mitigation process through which metropolitan areas can achieve international targets for the reduction of their emissions and safeguard their longer-term low carbon energy futures



METREX
125 West Regent Street
GLASGOW G2 2SA
Scotland UK
T. +44 (0) 1292 317074
F. +44 (0) 1292 317074
secretariat@eurometrex.org
<http://www.eurometrex.org>

METREX Metropolitan Mitigation Manual

Preface

This Manual outlines an effective greenhouse gas (GHG) mitigation process through which metropolitan areas from both sides of the Atlantic can achieve national and international targets for the reduction of their emissions and safeguard their longer-term low carbon energy futures.

The Manual has been prepared by METREX, in consultation with Manchester University and the Glasgow and the Clyde Valley Structure Plan Joint Committee (GCVSPJC). The GCVSPJC led the InterMETREX Interreg III C project and its extension, InterMETREXplus, which piloted the use at the European metropolitan level of the Greenhouse Gas Regional Inventory Project (GRIP) model and process developed by Dr. Sebastian Carney, of the Tyndall Centre and CURE (Centre for Urban and Regional Ecology) Manchester University.

EUCO2 80/50 and USEUCO2 projects

The EUCO2 80/50 project, under Interreg IVC, which METREX has promoted and which will be led by the Metropolregion Hamburg, aims to extend the use of the GRIP model and process across metropolitan Europe. The USEUCO2 project seeks to add a transatlantic dimension through its use by U.S metropolitan areas.

The population of the EU is some 490 million and of the U.S some 301 million. The 100 major metropolitan areas in the EU and the 100 in the U.S comprise about 60% of their respective populations. The 200 EU/U.S metros have a combined population of about 475 million within their areas of influence.

EU and U.S GHG emission levels are currently of the order of 11tCO_{2e}pc (tonnes carbon dioxide equivalent per capita) in the EU and 24tCO_{2e}pc in the USA. On this basis the 200 EU/US metros could be responsible for some 7200m tonnes of GHG emissions annually or some 30% of the 23000m tonnes of global GHG emissions.

If transatlantic metropolitan action could be initiated to successfully make the 80% reduction required then this would mitigate some 24% of global GHG emissions. This could be the longer-term impact of the USEUCO2 partnership.

Global action on climate change has been focused at the international level, through the UN Framework Convention on Climate Change and the related Kyoto Protocol, and on personal persuasion to act responsibly. Action at the metropolitan level has the potential to make a significant contribution in its own right.

Mitigation and Adaptation

Whilst this Manual concentrates on mitigation measures, it is recognised that there is an overlap with the adaptation measures that will be required to cope with the climate change that is now inevitable. For example, measures of all kinds to reduce energy use will mitigate the "urban heat island effect" whilst enabling urban areas to adapt to warming more easily.

As the costs of failure (to mitigate) are without limit, the only cost-benefit ratio relevant to this whole process results from understanding that we have to solve the problem of climate change faster than we are causing it.

Aubrey Mayer, author of the international mitigation concept of Contraction and Convergence

Contents

- 1 **Metropolitan mitigation strategy making process**
- 2 **Metropolitan Governance**
- 3 **Stakeholders**
- 4 **Emission Scenarios to 2050 and backcasts to 2030**
- 5 **Low carbon futures**
- 6 **GRIP model and process** (see also Appendix 1)
- 7 **GRIP scenario tool and integrated Metropolitan Mitigation Strategies**
- 8 **Mitigation measures** (see also Appendix 2)

Appendix 1 - GRIP model data requirements

See also related EUCO2 80/50 Information Notes **1 - IPCC 4th Report on Mitigation**, which identifies 90 mitigation measures, and **2 - European low carbon futures** (www.euco2.org)

1 Metropolitan mitigation strategy making process

The EUCO2 80/50 project uses the GRIP (Greenhouse Gas Regional Inventory Project) model and process, developed through the Tyndall Centre (UK), to enable metropolitan areas to assess their greenhouse gas emissions and to explore mitigation scenarios to make the very substantial reductions required by the imperatives of global warming. The current EU target is for an 80% reduction in GHG emissions, over 1990 levels, by 2050. This process will also, importantly, enable metropolitan areas to move to low carbon futures and to safeguard their longer-term energy supplies.

However, for this process to be successful, metropolitan areas will have to identify and give early consideration to the "stakeholder" interests that have a contribution to make to the preferred Metropolitan Mitigation Strategy and its implementation. In effect, metropolitan areas will have to set up an integrated mitigation strategy making process with the full involvement, from start to finish, of the key stakeholders.

The purpose of this Manual is to summarise for metropolitan authorities and bodies and their stakeholders, a Mitigation Strategy process that can be informed by the use of the GRIP model.

The GRIP model enables mitigation/energy policy choices to be measured and their relative contribution towards reduction targets to be assessed. The EUCO2 80/50 project will give greater understanding of the collective effect of the metropolitan mitigation measures available and in prospect. It will enable metropolitan policy makers to take more informed judgements about mitigation and to adopt a Metropolitan Mitigation Strategy that can achieve its goals.

It is important to recognise that a GHG reduction target of 80% over 1990 levels by 2050 only serves to illustrate the scale of change needed. The real issue is the amount GHG emissions in this period, the so-called "cumulative emissions". The longer effective action is delayed the more severe the problem will become for future generations to mitigate, and adapt to. In effect, the capacity of the atmosphere to absorb greenhouse gases without raising global temperatures to levels that prejudice life on earth has almost been reached. There is a short "window of opportunity" within which effective mitigation measures must be put in place and this does not extend much beyond 2020/2030.

The suggested Metropolitan Mitigation strategy formulation process can be summarised as follows.

- Step 1** Establishment of metropolitan **Stakeholder Groups** (possibly 8, see below) and an overall representative **Metropolitan Mitigation Strategy Group**, with representatives from all individual Stakeholder Groups
- Step 2** Stakeholder Group GRIP model and process **briefing sessions**
- Step 3** Preparation of appropriate **Briefing Notes**, by each Stakeholder Group, setting out the present position and looking to 2020 and 205. The Briefing Notes on Climate Change futures and Socio-economic futures can provide a context for all other Stakeholder Groups
- Step 4** **Data collection** and completion of a metropolitan **GHG Inventory** using the **GRIP Inventory** model. This then gives the level of emissions in the baseline years (1990/2000/2005)
- Step 5** Clarification of the **metropolitan mitigation issues**, arising from the GRIP Inventory. This will help to set the agenda for the subsequent scenario exploration and strategy adoption
- Step 6** **Public awareness** raising process to ensure the widest possible understanding of the metropolitan climate change issues involved and, in due course, the reasons for the adoption of the preferred integrated Mitigation Strategy. Public involvement continues through the whole process
- Step 7** Stakeholder Group meetings to run the **GRIP Scenario** tool and explore **mitigation options** from their perspective
- Step 8** Metropolitan Mitigation Group meetings to run the **GRIP Scenario** tool and explore **integrated mitigation options**, collectively
- Step 9** Metropolitan Mitigation Group meetings to consider the **specific mitigation measures** that could be adopted and implemented within the **context of international and national mitigation initiatives**, for example, through a Copenhagen Protocol (2009) within to the existing UN Climate Change Framework
- Step 10** Metropolitan Mitigation Group meetings to consider the programme of **specific mitigation measures** that could be adopted and implemented at the **metropolitan level**
- Step 11** Metropolitan Mitigation Group meetings to explore and adopt an integrated **Metropolitan Mitigation Strategy for period to 2050, backcasted to 2020.**
- Step 12** Regular **monitoring, review and updating** of the Strategy by the Mitigation Group to check on progress and any initiate any necessary action to maintain its effectiveness

2 Metropolitan Governance

The process described above will have to interact with the form of metropolitan governance that exists or is put in place. This may be a statutory Authority, with a wide range of powers and resources, or with selected powers and limited resources. It may also be a joint body, or voluntary grouping, of the existing Authorities in a metropolitan area. It will be important for the process described above to be responsible to whatever model of metropolitan governance is in place, or is put in place for the purpose of adopting and implementing an integrated Metropolitan Mitigation Strategy. This will give the necessary political dimension to the process and help to ensure that the political will to achieve the mitigation targets to 2030 and 2050 is sustained. This may require policy to be informed and subsequently implemented at the local, metropolitan and national levels to deliver the necessary emission reductions.

3 Stakeholders

It can be anticipated that metropolitan stakeholder interests will include,

- 1 **Climate change** specialists capable of exploring the longer-term drivers of change and their potential implications for particular regions (including warming, storms and wind, rainfall and flooding)
- 2 **Socio-economic** bodies capable of exploring the longer-term drivers of change. For example, population and household futures (including demographic and migration change) and economic futures (including sectoral change and consumer expenditure).
- 3 **Energy suppliers** (including the providers of network and generation/production services)
- 4 **Economic** interests (including key service (particularly retailing) and manufacturing sectors)
- 5 **Social and welfare** interests (including health and education)
- 6 **Transportation** interests (including the providers of network and modal services (road, rail, air and maritime))
- 7 **Infrastructure** services (including the providers of networks and water and waste water services and waste/recycling services)
- 8 **Environmental** interests (including the bodies and agencies with responsibilities for ecological management and conservation)
- 9 **Developer** interests, particularly the house-building industry but also including industrial and business developers

The Manual considers how stakeholder involvement might be managed in more detail in later sections but at this stage it is clear that,

- 1 Each of these **Stakeholder Groups** should be set up as soon as possible and should consider, in due course, the selection of a representative to participate in the production of an overall integrated Metropolitan Mitigation Strategy, using the GRIP process.
- 2 **Climate change and Socio-economic futures** need to be considered as soon as possible, to provide a **common context** within which all other stakeholder groups can work.
- 3 Each Stakeholder Group should aim to produce a **Briefing Note** in order to provide a foundation of best available knowledge and understanding for colleagues in other groups. Such Briefing Notes should include a summary of the present situation and a view to 2050, backcasted to 2020. Some Groups will have to produce several Briefing Notes.

4 Emission scenarios to 2050 and backcasts to 2020

Climate change is fast in global terms but appears distant and uncertain in human terms.

The EUCO2 80/50 project is not about forecasting specific levels of warming and their consequences but about avoiding the risk to future generations of irreversible man made climate change.

At present a level of 450 ppm (parts per million) of GHG in the atmosphere is associated by the IPCC (International Panel on Climate Change) with an average rise in global warming of 2 degrees Celsius. Global warming is now inevitable but might be stabilised if warming can be kept to this level. Beyond this the carrying capacity of the globe and its ability to support life will be progressively diminished and at risk.

It is in this context that the GRIP process requires metropolitan areas to consider Climate change and Socio-economic futures to 2050. Just thinking back 40 years to the 1960's, and considering the changes, shows how difficult this will be. Many of the socio-economic changes resulting from innovation could not have been foreseen but the rise of globalisation and the development of eastern economies was.

Looking ahead to 2050 and to the end of low cost carbon energy, it could be concluded that regional economies might once again supply more of the goods and services they require. If global goods and services are priced in financial and carbon terms then local sources may become more competitive.

There could be pressure for continued innovation in consumer goods and transportation to take advantage of technological advances. Continued high levels of personal consumption, based on high levels of recycling of raw materials, could become more sustainable. However, the need to do more with less is likely to be a key driver of change to a low carbon world.

Looking ahead to a world affected by climate change it could also be concluded that, in the period to 2050, there will be regions whose climatic conditions and renewable energy resources will make them more attractive and competitive as locations in which to live and work. It could be anticipated that there will be consequential movements in people and investment.

Such considerations will have to form part of the judgements made now. However, there will clearly be levels of uncertainty involved in forecasts to 2020 and 2050 horizons.

In general terms, public and private investment programmes have short (5 years), medium (10-15 years) and longer (15-25 years) term horizons. Many items of consumer expenditure have short life spans and will be renewed many times in the period to 2050. At the other extreme, major infrastructure, such as Power Stations, may have a life of 25 + years. When considering the investments needed to meet the challenge of climate change it is important to remember that much existing capital investment will be replaced in the period to 2050. The important thing will be to ensure that it contributes to a low carbon energy future.

The costs of mitigation, and potentially of adaptation, need to be considered, in relative terms, against these replacement costs.

The GRIP scenario process requires the formulation of related low-carbon and socio-economic scenarios to 2050, backcasted to 2020. Metropolitan Mitigation Strategies will have to set out their assumptions on these matters in order to explain the basis on which they are founded and the associated uncertainties. With medium to longer term forecasts the important thing is to recognise broad directions of change and orders of magnitude as a guide to policy making.

5 Low carbon futures

Global prosperity, through the industrial and the technological revolutions of the last 200 years, has been founded on cheap energy provided from the inherited carbon fuels on the planet. Global futures will depend on the use of the daily effects of the sun and moon on the planet and the use of the renewable energy available from solar radiation, wind, tides and water. New technologies for solar capture and wave power will work with the more traditional windmills and dams for hydro power. The technological challenges will be for renewable energy capture, storage and distribution.

There will also be intermediate technologies, such as Carbon Capture and Storage (CCS), which could enable the impact of the continued use of carbon fuels, such as coal, gas and oil, to be mitigated. Such technologies will have a significant role to play to 2050 as carbon fuels continue in use.

Low carbon futures will be achieved by action on energy supply and demand. Both of these aspects will require to be considered at the metropolitan level.

Energy can be supplied through national networks, such as electricity grids or gas pipelines, transportation networks or, potentially, produced and supplied more locally. There are transmission losses that can be avoided by using energy from local sources. Metropolitan areas will be concerned to assess their medium and longer term energy needs and to consider the extent to which these can be met locally from renewable sources. This may also help with considerations such as security of supply.

Energy demand can be reduced through many measures including efficiency savings and behavioural change. Such savings can range across the whole spectrum of urban activities from the domestic to the industrial and from leisure to health and education. Transportation is a key sector where a shift from personal to public transport can mitigate energy demand and where efficiency savings through technological development will affect future demand for energy. Metropolitan areas will be concerned to assess the scope for demand reduction through behavioural and technological change.

Beyond metropolitan areas, at the international and European levels, innovation and technological change will offer increasing opportunities of achieving a low carbon future. It will be important for metropolitan areas to maintain an awareness of such emerging prospects and to have regard to them in their longer-term thinking. For example, it appears that the technology for producing low cost printed solar capture panels could shortly become available (see METREX EUCO2 80/50 project Information Note 2 on Low carbon futures).

In the longer term energy supply may become more hydrogen than carbon orientated. If hydrogen is produced, by electrolysis, through the use of renewable electrical energy resources, then it could replace gasoline and diesel for propulsion.

Experience with GRIP mitigation scenarios shows that an 80% reduction in GHG emissions is feasible at the metropolitan level. Past scenarios (all of which are stakeholder derived) have reflected a "greening" and decentralising of the electricity supply from national grids and an increasing emphasis on regional and local renewable energy supplies. National grids will require replacement with new infrastructure to reduce transmission losses.

Within metropolitan areas a particular additional issue to consider as part of the planning process may be the "urban heat island" effect, with urban areas locked into a cycle of heat retention requiring greater cooling and consequential energy use, which in turn can generate more heat. Energy conservation has a role to play as well as an emphasis on non-mechanical cooling.

Nuclear power is already the main source of electricity in France. Other countries, such as the UK, are intending to replace existing plants (on the same sites) or build new ones. Nuclear will be part of low carbon futures in some countries and on some grid systems.

6 GRIP model and process

The GRIP model and process can be viewed in full at www.grip.org.uk The GRIP Inventory tool can be accessed through www.carboncaptured.org.uk

The data required to produce a metropolitan greenhouse gas emissions Inventory accords with the requirements for national reporting to the UN under the Framework for Climate Change (UNFCCC). Data may be sourced nationally or regionally and be extrapolated or location specific. The GRIP Inventory shows the data sources by colour code, allowing the degree of confidence in it to be clear.

The metropolitan GHG Inventory produced by the model enables stakeholders to form a clear common understanding of the sources, scale and significances of emissions. This gives a quantified starting point from which to consider mitigation measures and the priorities for action to achieve the reductions required. It is helpful for Inventories to take 1990 as their base date in order to be able to measure progress in achieving an 80% reduction by 2050. Emissions may have increased since this date, making the mitigation task greater.

A metropolitan GHG Inventory for 1990/2000/2005 will provide an estimate of GHG emissions from which explore mitigation scenarios in an informed way and on a realistic basis. It will enable the key metropolitan mitigation issues to be identified for stakeholder consideration.

Data - 1990/2000/2005

The **Inventory data requirements** are summarised below and shown in detail in **Appendix 1**. the Appendix illustrates the comprehensive and specific nature of the assessment.

- 1 **Demographics and economy**
- 2 **Energy**
- 3 **Industrial processes**
- 4 **Waste**
- 5 **Agriculture**

Data for more recent years, such as 2000 or 2005, is likely to be significantly better than the data for 1990. A balance has to be struck between the base year (which is often confused in different targets) and the quality of the data. 2005 is likely to be the year for which the best data is available at the metropolitan level as demand for this data has only recently existed.

The summary GHG Inventory for metropolitan Glasgow, arising from the InterMETREXplus project, which piloted the application of the GRIP model at this level, is shown below as an example.

InterMETREXplus GRIP pilot Study

The InterMETREX plus Pilot Study can be downloaded in full from www.grip.org.uk. The study included metropolitan Bologna, Glasgow, Stockholm and Veneto to give a broad representation of European climatic conditions (N|W|S). The emissions from Bologna, Glasgow and Veneto followed a similar pattern, with domestic, industry and transport energy use contributing 20-30% of emissions each depending on local circumstances. Road transport was the main contributor to transport emissions. The service sector was also significant in all three areas.

Stockholm had a different pattern of emissions because of its well-developed district heating systems and the use of CHP, which is biomass based. Stockholm has already almost achieved the low carbon future being sought by the rest of Europe. Transport emissions comprise over half of emissions, because of low emissions from other sectors. Road transport is again the main source of transport emissions.

The Pilot Study demonstrated the practical value of the GRIP model and process. In particular, the Pilot Study Inventories show the main target areas for emission reductions.

In metropolitan Glasgow the GRIP Scenario tool was also piloted and this experience is documented in the Study. Partners in the EU CO₂ 80/50 and USEU CO₂ projects will find the summaries of the scenario process, which took place over three days, to be a useful introduction to the key issues that need to be considered and explored.

GHG Inventory for metropolitan Glasgow

Table 4 GCV area – Total emissions (x1,000 tonnes) ¹								
		CO ₂	CH ₄	N ₂ O	HFC	PFC	SF ₆	CO ₂ e
Energy sector	Total	12,199	40.44	0.25	0	0	0	13,126
Domestic		4,666	1.53	0.10	0	0	0	4,729
Industry		2,247	0.25	0.08	0	0	0	2,277
Services		1,479	0.18	0.04	0	0	0	1,495
Fugitive Emissions / Energy Transformation		412	38.40	0.00	0	0	0	1,218
Transport		3,395	0.07	0.03	0	0	0	3,406
Industrial sector	Total	0	0	0	242.86 ²	2.65 ²	0	322
Waste sector	Total	12.50	23.20	0.4	0	0	0	750
Agriculture sector	Total	0	14.24	1.37	0	0	0	606
Total (all sectors)		12,211²	77.88²	2.02²	242.86²	2.65²	0	14,719
GCV Population: 1,747,080								
Per capita (tonnes)		6.99	0.04	0	0.14	0	0	8.42
GVA: €42,954.2m								
Per unit GVA		0.28	0	0	0.01	0	0	0.36
¹ These figures have been estimated using a combination of national, regional and local data and although they are deemed to be the most accurate data available currently, the results carry a degree of uncertainty.								
² Figures for HFC and PFC relate to GWP100 rather than kilo tonnes.								

Source - <http://www.gvcvcore.gov.uk/downloads/GCVGreenhouseGasInventory.pdf>

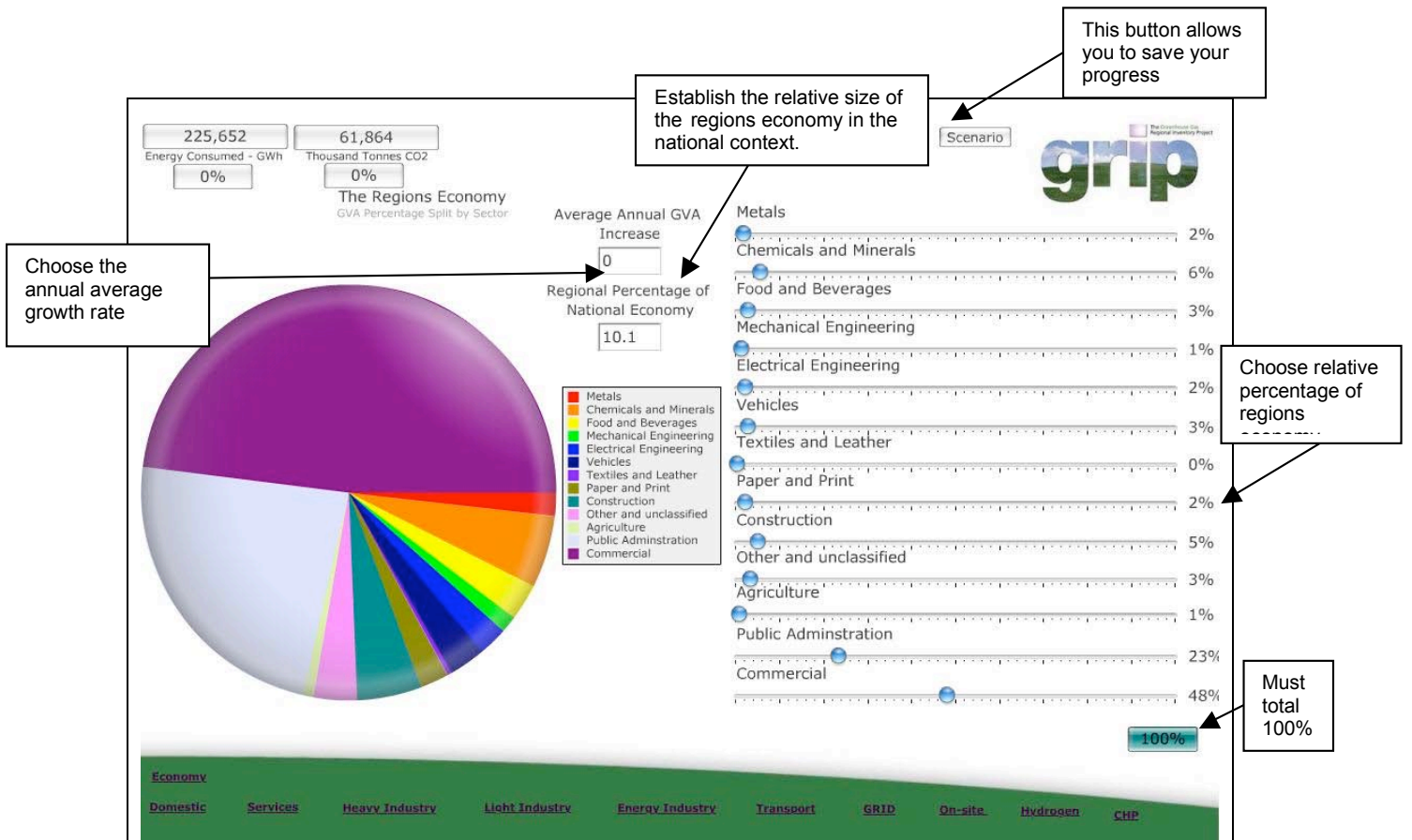
7 GRIP scenario tool and integrated Metropolitan Mitigation Strategies

The GRIP Scenario tool can be viewed in full through www.grip.co.uk The tool operates through the input of reasoned assumptions, derived through the work of Stakeholder Groups, to the consideration of futures (2050 and backcasted to 2020) for the following sectors.

- 1 **Metropolitan economy**
- 2 **Domestic** energy use
- 3 **Services** energy use
- 4 **Light industry** energy use
- 5 **Heavy industry** energy use
- 6 **Energy industry** energy use
- 7 **Transportation** energy use
- 8 **Electrical** energy supply
- 9 **On site renewables** energy supply
- 10 **Hydrogen** production technology
- 11 **Combined Heat and Power (CHP)** input fuel mix

The interactive GRIP Scenario tool input panels can be viewed on laptop computers by participating stakeholders, who can explore options individually or collectively. In the EUCO2 80/50 project Scenario sessions will be facilitated and recorded by the Tyndall Centre.

Scenario tool panels for the 11 sectors above are shown on the following pages. A short commentary suggests some of the matters that Stakeholders could consider when exploring mitigation scenarios and reflect in their Briefing Notes.

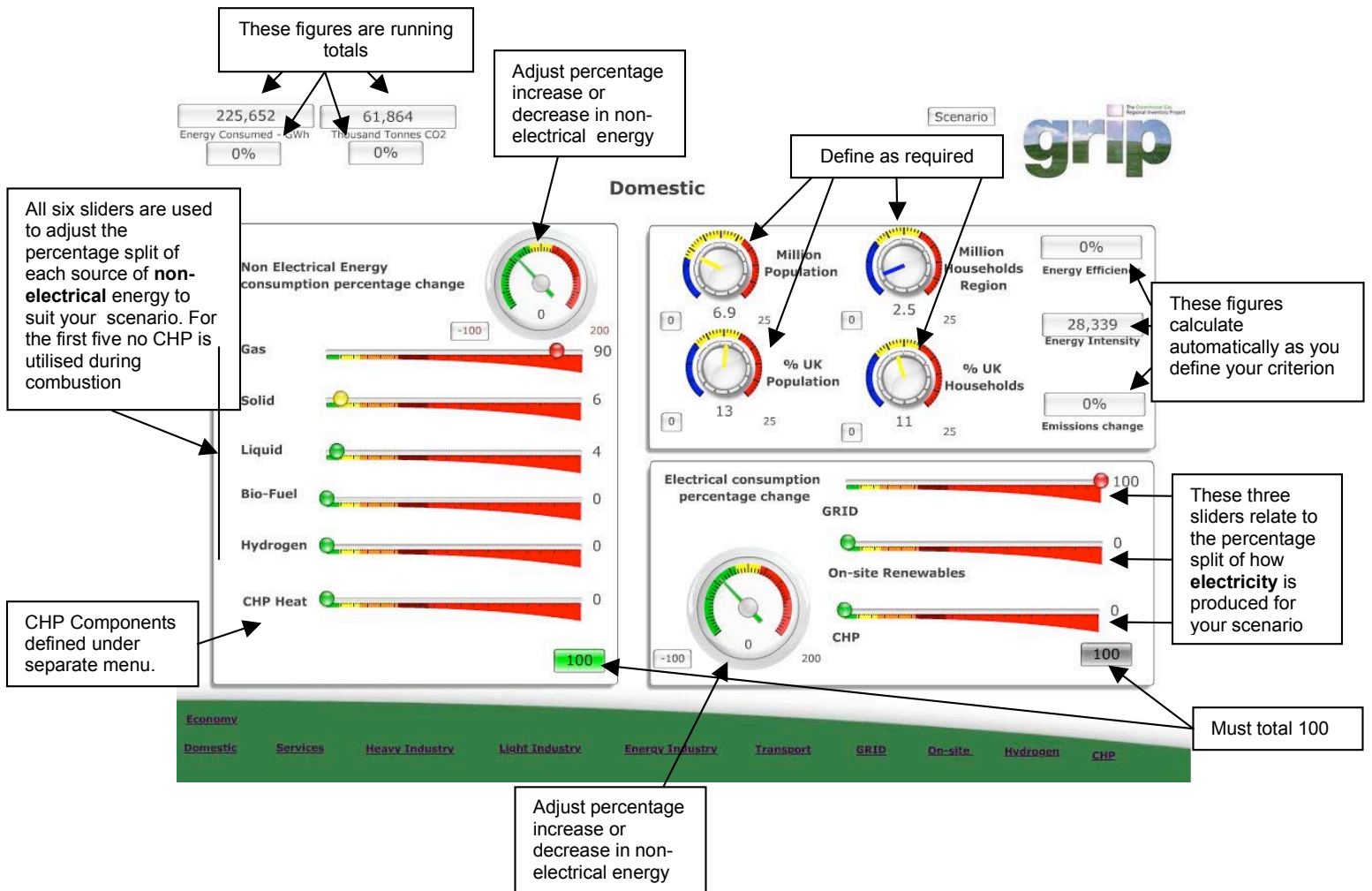


1 Metropolitan economy

Preparatory considerations and steps

Stakeholders will need to review the economic base of their metropolitan area and the prospects for structural change in the medium term, to 2020, and to 2050. Such a view will then need to be set in the wider national context. This will require stakeholders to also take a view of national economic prospects and the future relationship of their metropolitan economy to these.

Such medium and longer term economic assessments could be the substance of a **Briefing Note** prepared by **Stakeholder Groups 1 - Climate change futures** and **2 - Socio-economic drivers of change**.



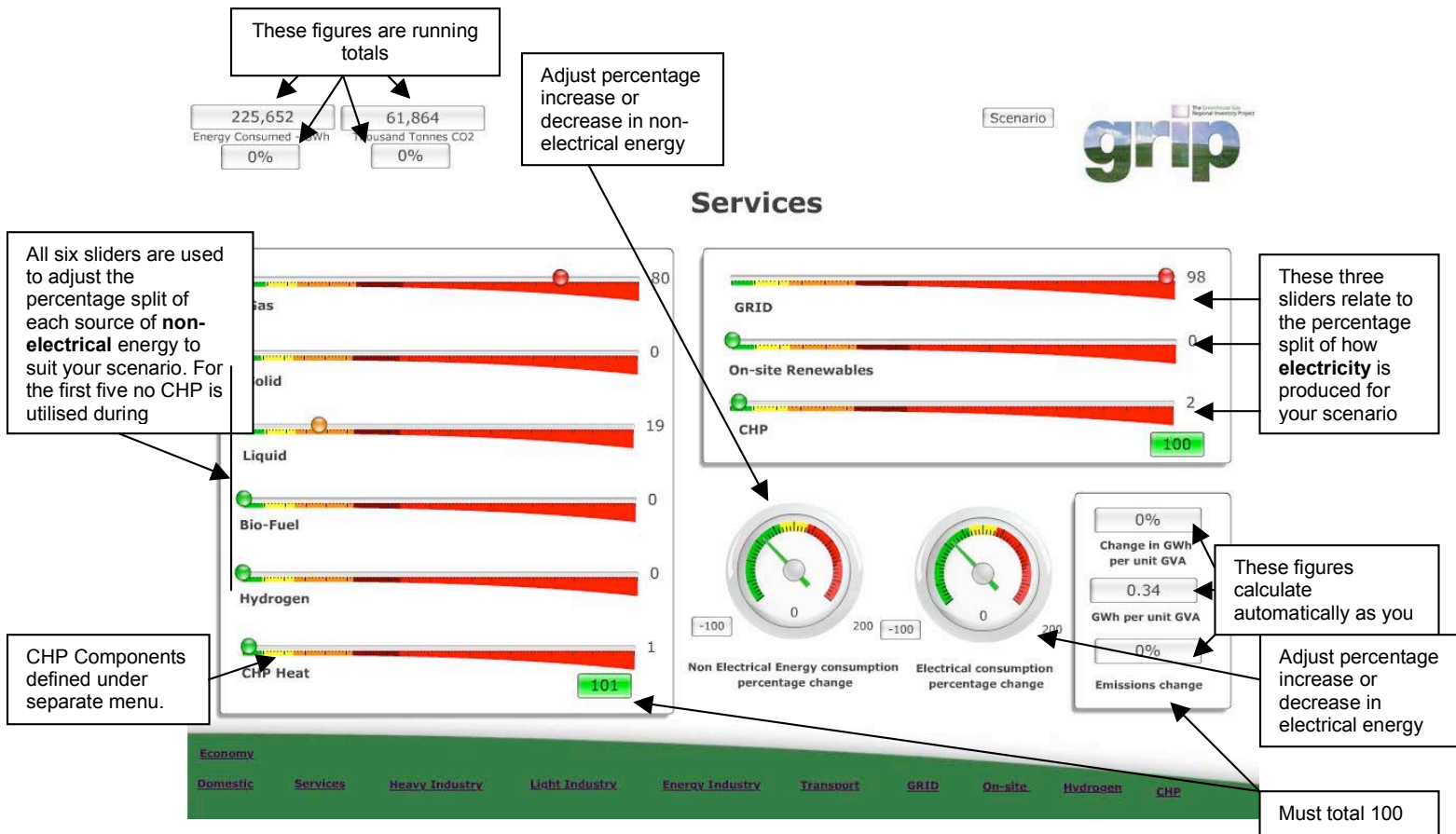
2 Domestic energy use

Preparatory considerations and steps

Stakeholders will be required to consider the future mix of domestic non-electrical energy supplies in their region. Gas is currently a major source of domestic supply in Europe, from the North Sea and Russia. It is used primarily for heating. The widespread introduction of CHP (Combined Heat and Power or Combined Cooling Heat and Power) domestic boilers would increase the efficiency of continued gas usage.

Electricity may have a larger role to play in domestic energy supply, including for heating/cooling, if it is supplied from renewable sources.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Groups 3 - Energy supply futures** and **6 - Developer interests**



3 Services energy use

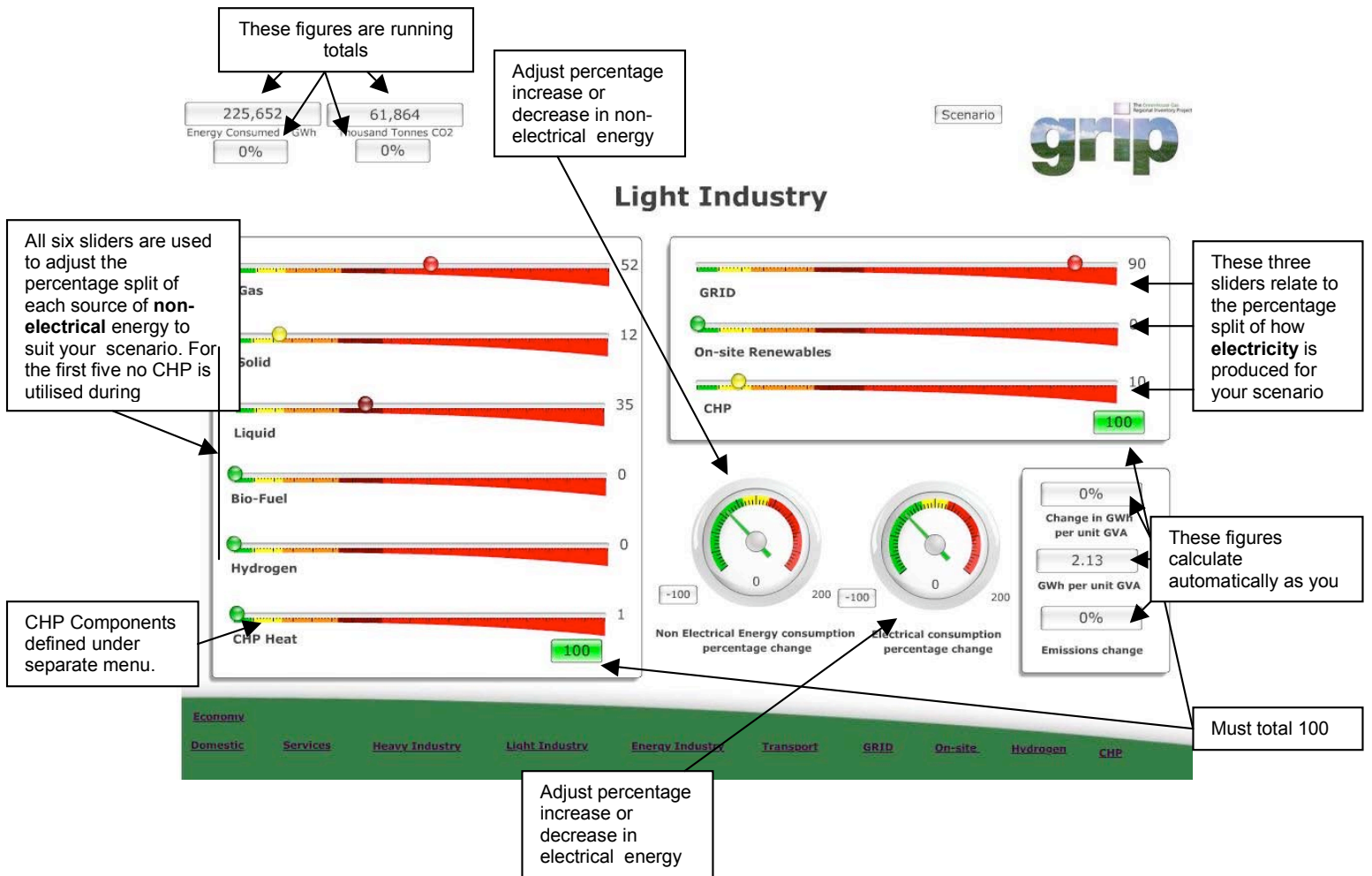
Preparatory considerations and steps

The services sector has grown to be the primary source of economic activity and employment in many metropolitan economies. This has often been in the public sector through the growth of government, higher education and health services.

The growth of tourism has been sustained by low cost transportation, particularly by air, and by the growth of car ownership. Low carbon technologies will be needed to sustain such activity in the future. Financial services have grown in many of the larger metropolitan areas in parallel with financial liberalisation and the rise of the global economy. A low carbon global economy may see the rise of new business/manufacturing opportunities, for example, in the renewable energy sector.

Continued global specialisation may also be paralleled by the renewal of regional and local service opportunities, for example, in tourism and innovatory service enterprises.

Such medium and longer term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Groups 4 - Economic interests, 5 - Social and welfare interests and 9 - Developer interests**



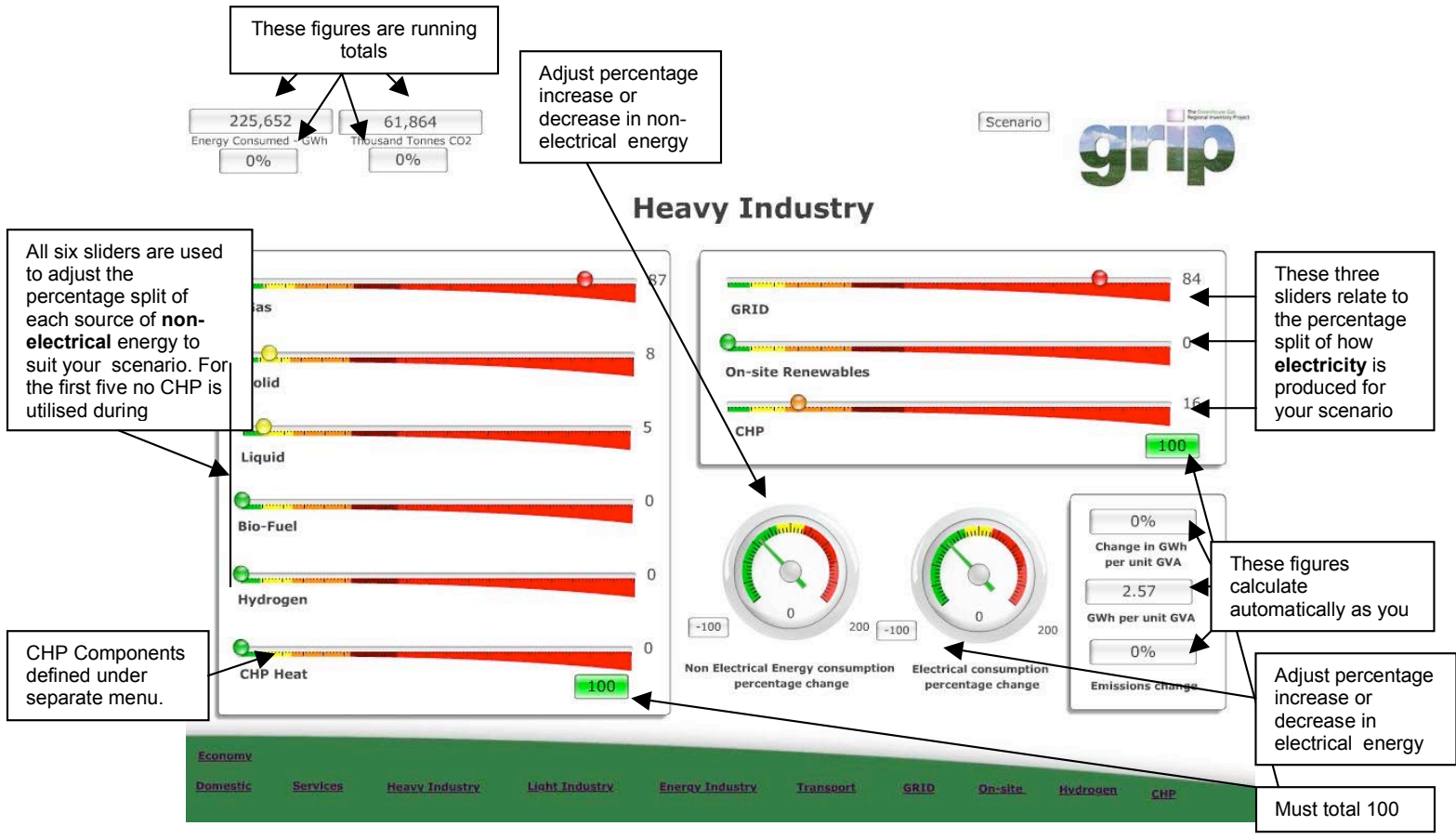
4 Light industry energy use

Preparatory considerations and steps

Light industry may have a promising future if it can take advantage of regional and local low carbon energy supplies to give a competitive advantage. As with domestic energy supplies, combined heat and power (CHP) could also be expected to offer efficiency savings.

Technological innovation and the use of recycled materials could offer new manufacturing opportunities.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Groups 4 - Economic interests** and **9 - Developer interests**

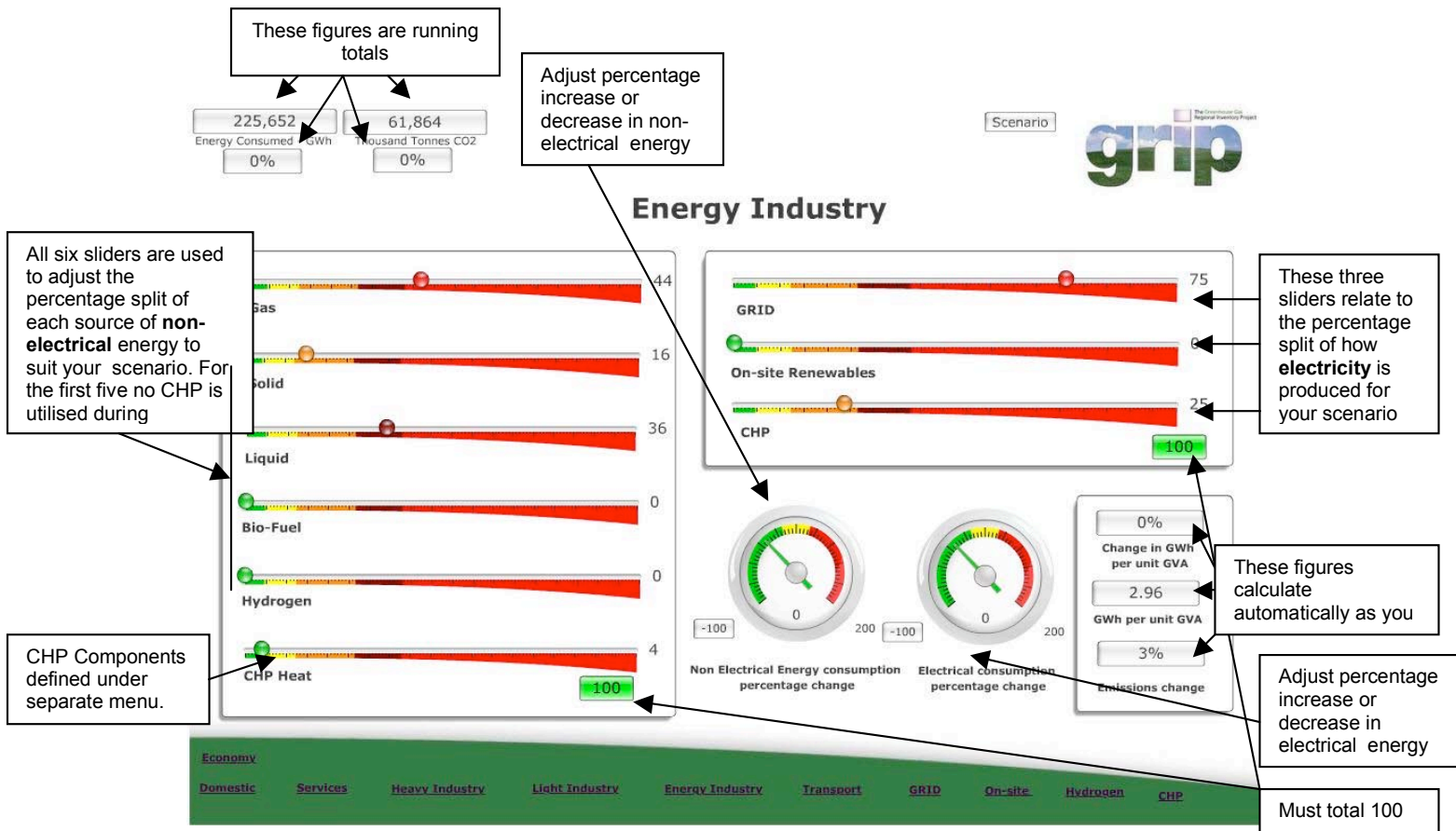


5 Heavy industry energy use

Preparatory considerations and steps

The transition from a carbon based to a hydrogen-based economy could offer opportunities for the production of hydrogen, where renewable energies supplies are available. High electricity using industries may find such supplies advantageous. Maritime access for the import of raw materials and export of products may offer a locational advantage. On-site renewables could offer economies of scale.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 4 - Economic interests**.

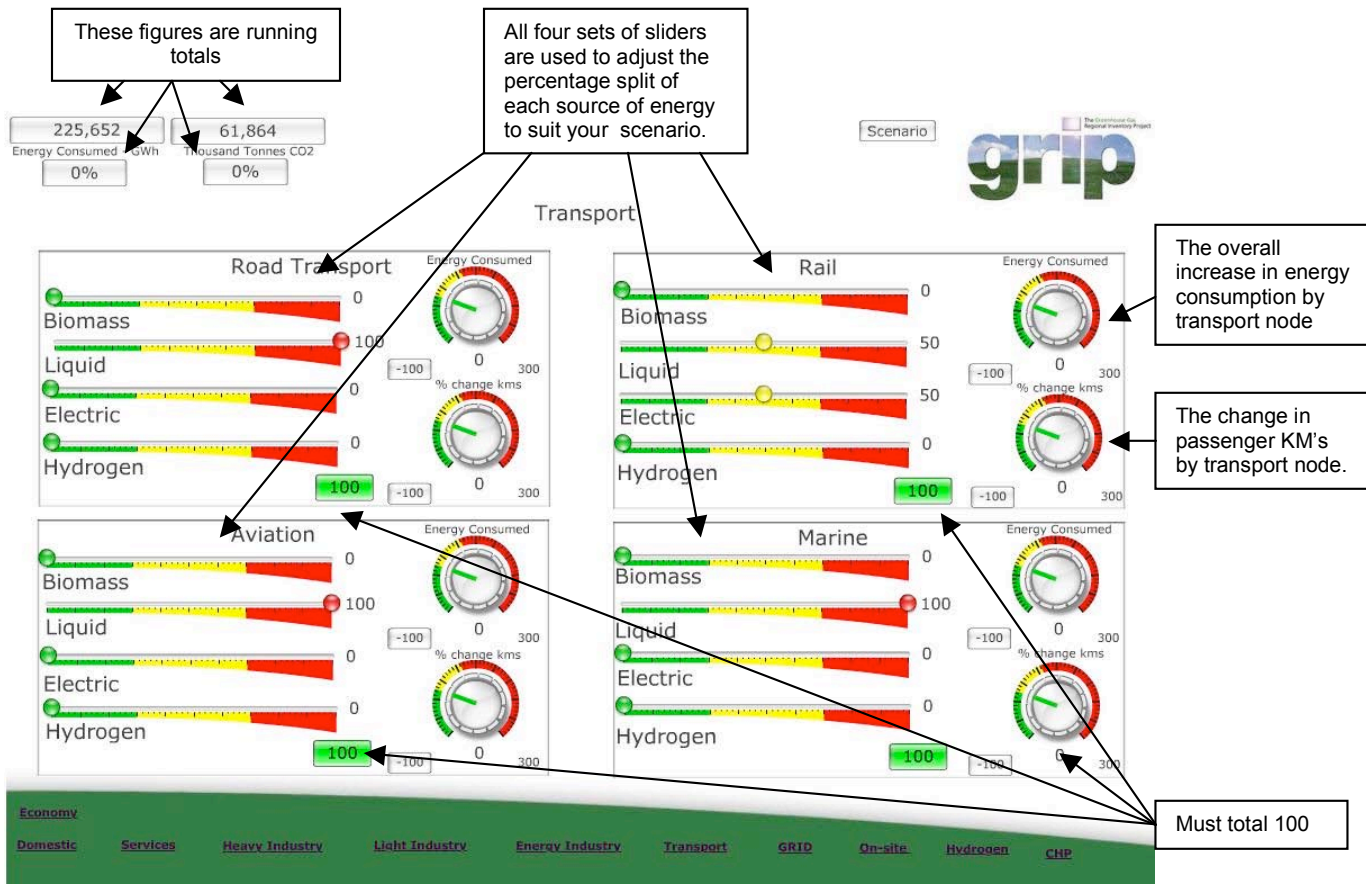


6 Energy industry energy use

Preparatory considerations and steps

It may be expected that the energy industry, as with heavy industry, will take advantage of the economies of scale offered by on-site renewables. As hydrogen becomes a primary source of energy it will also use hydrogen for its own needs. Other energy industries could be expected to use CHP from their own resources. The use of the grid may reduce but a "greened" grid may offer competitive economies of scale.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 3 - Energy supply futures**



7 Transport energy use

Preparatory considerations and steps

Transportation is a key energy-using sector and fundamental changes can be expected as a result of a shift from high to low carbon fuel use.

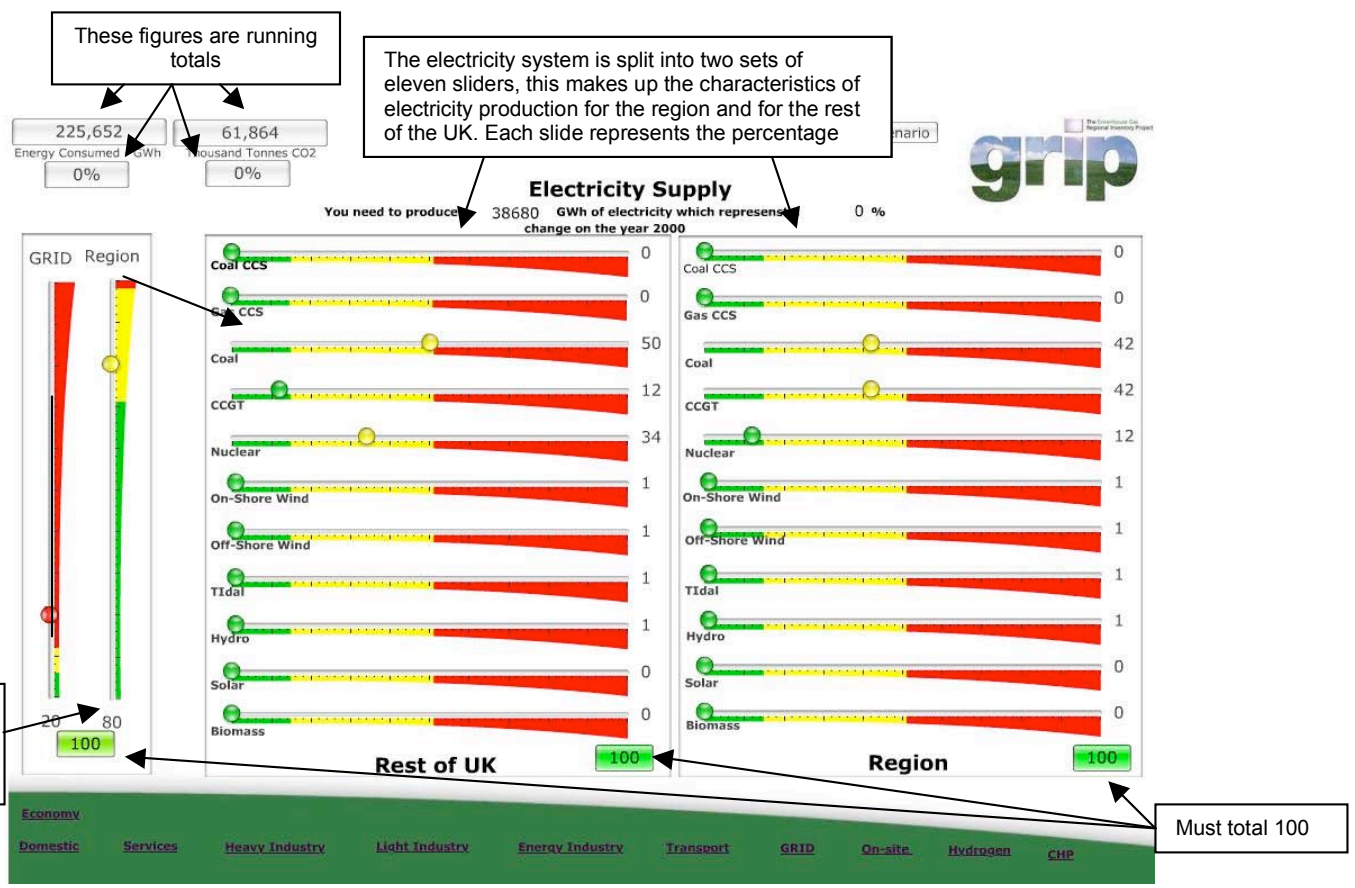
Rail networks may be electrified and diesel power replaced by other energy forms such as hydrogen. Metropolitan areas can support a modal shift to public transport through integrated provision with other modes and planning strategies. Road and parking management and pricing will have roles to play.

Maritime transport may also make the transition to hydrogen power, perhaps with a greater use of wind assistance and bio-fuels. Nuclear powered ships are technically proven but may be regarded as vulnerable. The future of maritime transport is linked to air travel and it is conceivable that travel by sea will increase. Maritime transport currently has more potential for low carbon fuel use than aviation. This is a particularly important issue for freight.

The Aviation sector has grown dramatically in certain parts of Europe, which, if it continues, will have but has a disproportionate effect on GHG emissions. Given carbon costing and a cap and trade approach to emission limitation in the future it may be that air travel will again become a high cost form of travel or it may somehow become low carbon. Studies are being made into hybrid or hydrogen powered short-haul planes (see METREX EU CO₂ 80/50 project Information Note 2 on Low carbon futures).

Road transport is already making the transition to electrical, hybrid or hydrogen power. Heavy goods vehicles and buses can carry hydrogen tanks but the necessary supply and service infrastructure needs to be put in place. The public sector can help with hydrogen vehicles and supply and service stations.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 6 - Transportation futures**



8 Electrical energy supply

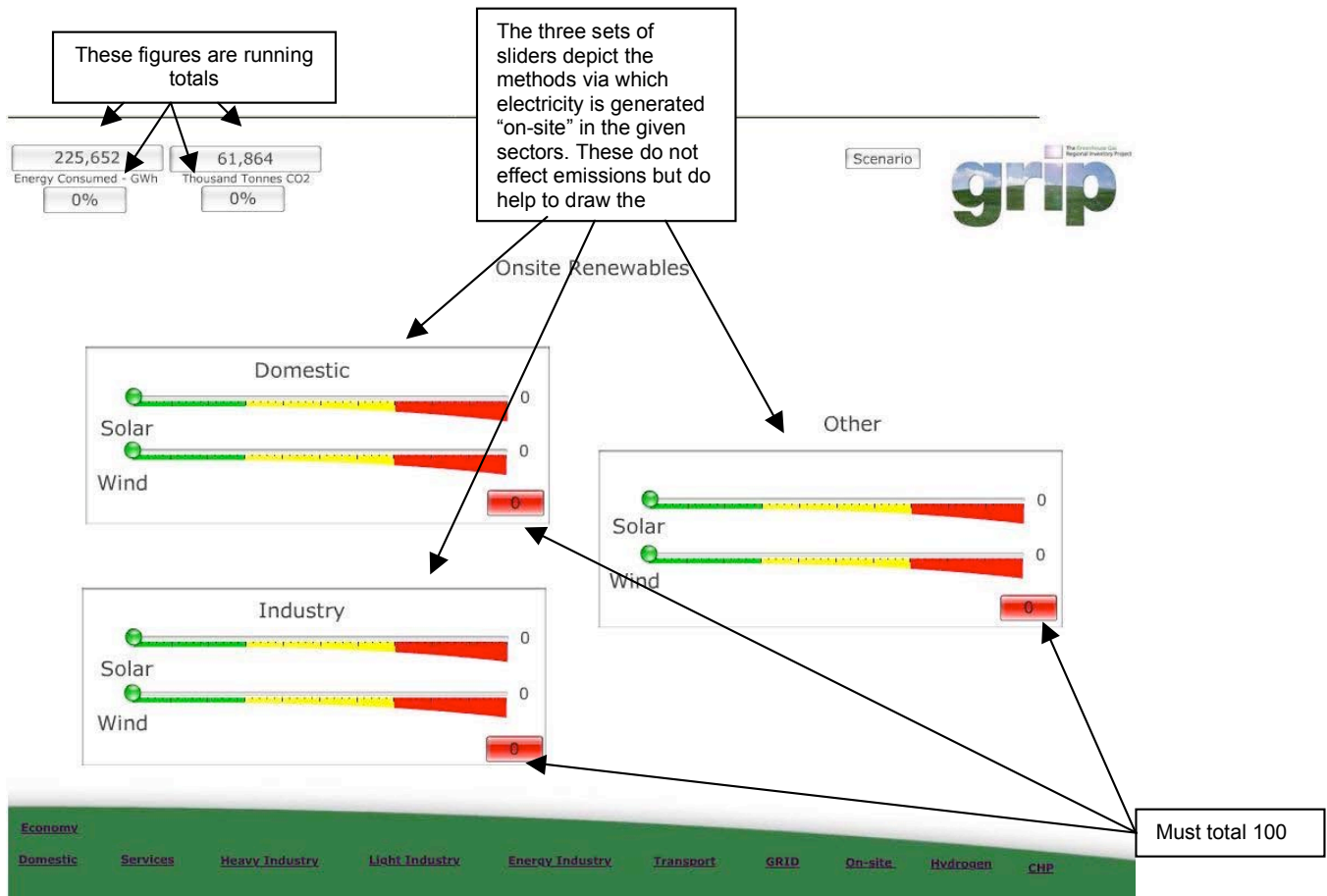
Preparatory considerations and steps

It could be assumed that the context for future electricity supply will be the "greening" of the grid, though the greater use of renewables, and an increasing emphasis on regional and local electricity supply from renewables or CHP. The mix of renewables between solar, wind, biomass and hydro will be influenced by future climatic conditions and geography.

Europe has the potential to draw on strategic renewable energy supplies from southern Europe and northern Africa (solar), Iceland (geo-thermal) and its Atlantic coast (wind) (see METREX EUCO2 80/50 project Information Note 2 on Low carbon futures). This would require major Europe wide grid investment, possibly using DC (direct current) technology.

Nuclear is already a major source of electrical energy supply in France and the UK intends to add to its capacity. Nuclear is regarded as a component in the electricity supply mix in many countries but not yet the primary source.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 3 - Energy futures**

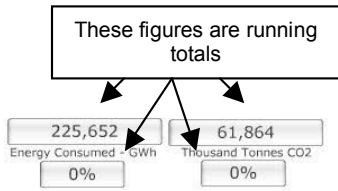


9 Onsite renewables energy supply

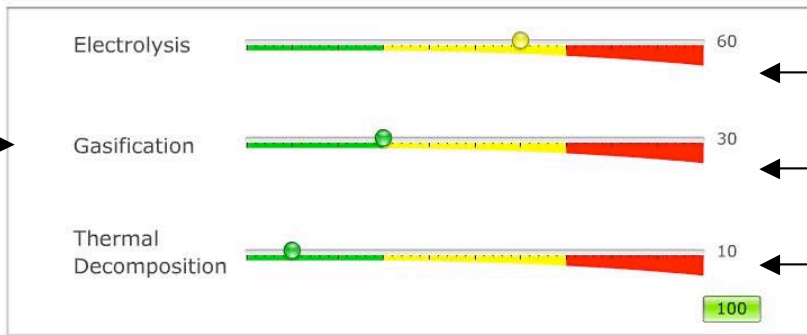
Preparatory considerations and steps

The transition to a low carbon future will depend, in large part, on the extent to which regional and local renewable energy supplies can be developed. At the metropolitan level it has been assumed that the main contribution will come from efficiency savings on land and in buildings. Historically, cities led the way in the development of gas and electricity companies and these were often municipal. Energy supply companies are now major global and European businesses. However, metropolitan areas could develop regional and local renewable energy strategies in partnership with energy companies at the plant or domestic level. Major energy users, such as industrial plants, could also be involved.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 3 - Energy futures**



Hydrogen Production



Electrolysis is deemed to utilise electricity produced by the GRID.

These three sliders relate to the percentage split of how hydrogen is produced for your scenario

Must total 100

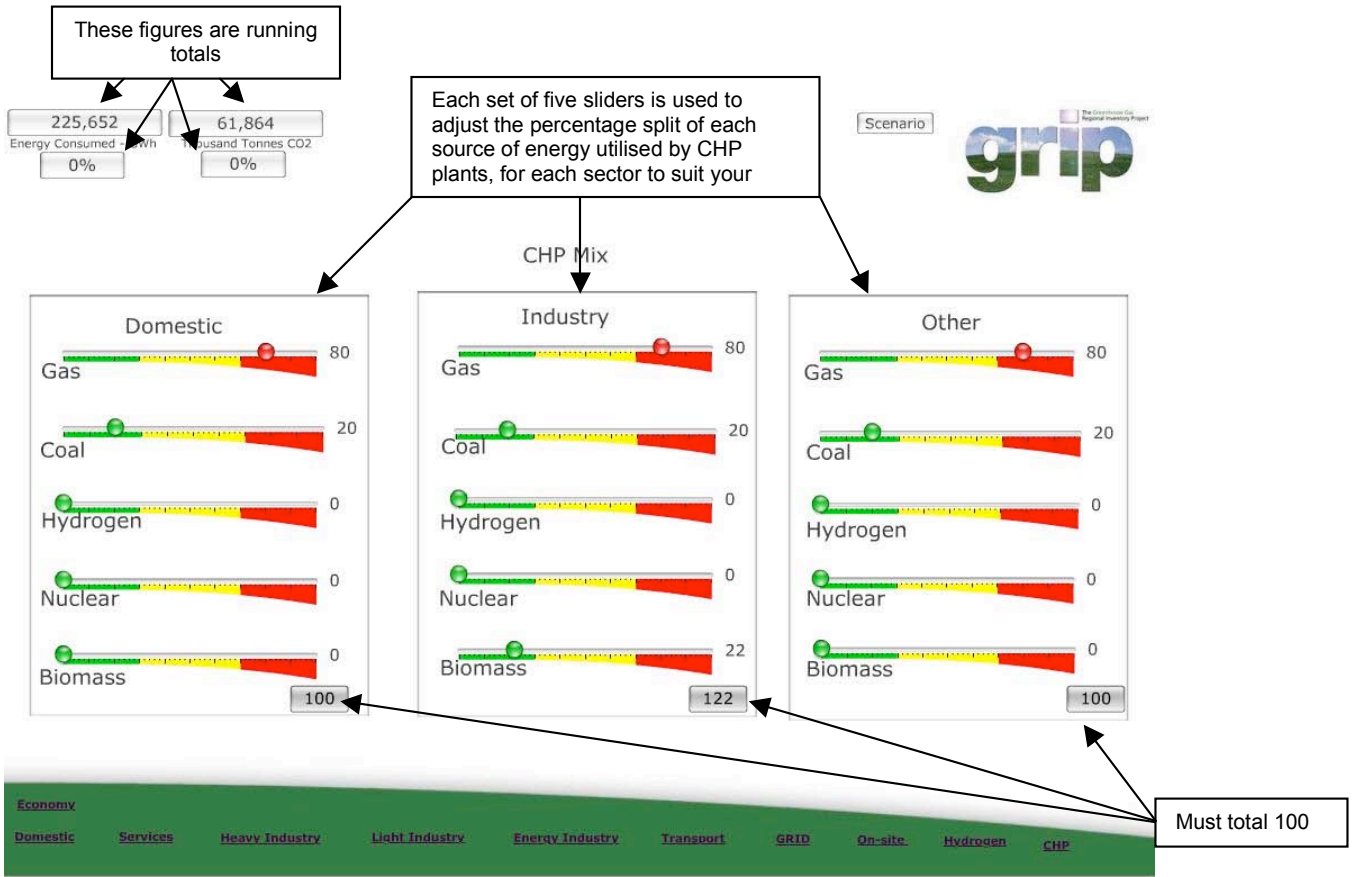


10 Hydrogen production

Preparatory considerations and steps

It appears that hydrogen could become a primary energy source in the future, if it can be produced through the use of renewable energy. Areas with a hydrogen production capability may have a competitive advantage. A hydrogen infrastructure could be established through public investment in hydrogen-powered vehicles and supply and service centres.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 3 - Energy futures**



11 Combined Heat and Power (CHP) mix

Preparatory considerations and steps

Combined heat and power gas boilers could bring financial benefits and energy savings for domestic users, where gas is a primary source of energy for heating. Industrial users may also benefit where gas is used in production processes. Whatever the primary source of energy supply at the domestic and industrial levels in the future, it will be important to achieve the highest possible level of energy utilisation. Combined heating/cooling and power offers such efficiencies and can be expected to be a standard installation as boilers and plants are progressively renewed.

Such medium and longer-term energy supply considerations could be reflected in a **Briefing Note** prepared by **Stakeholder Group 3 - Energy futures**

8 Mitigation measures

See also related EU CO₂ 80/50 Information Notes **1 - IPCC 4th Report on Mitigation**, which identifies 90 mitigation measures, and **2 - European low carbon futures** (www.euco2.org)

Potential metropolitan mitigation measures for integrated metropolitan mitigation strategies

When considering the specific mitigation measures that might be adopted within an overall Metropolitan Mitigation Strategy, stakeholders could have regard to those that might be also be adopted at the international and national levels.

The IPCC 4th Report on Mitigation Measures and Policies contains a checklist of 90 potential mitigation measures. These are shown in **Appendix 2**. Such potential measures form a context for metropolitan action.

Metropolitan measures that might be considered by stakeholders could include the following.

Energy supply measures - changing to carbon light sources of supply

- Increase renewable energy supply sources for electricity production
- In particular, increase solar powered urban lighting, heating and cooling
- Reduce dependency on energy inefficient central electricity supply and distribution systems as systems are renewed and replaced
- Increase local embedded electricity generation from hydrogen fuel cells
- Generally shift from carbon heavy to carbon light sources of energy for buildings and plants

Conservation measures - reducing energy demand

- Increase higher density mixed use urban development
- Increase the potential for the use of combined heat/cooling and power (CH/CP)
- Progressively restructure urban areas to integrate land use and transportation to reduce the need to travel
- Progressively restructure urban areas to facilitate increased integrated walking, cycling and public transport
- Urban micro-climate management to improve urban cooling and reduce the heat island effect

Efficiency measures - using energy more effectively and less wastefully

- Improve energy management systems and insulation in buildings through building regulations
- Generally manage the use and reuse of energy within buildings more efficiently through design standards
- Progressively shift public road transport from oil-dependency to bi-fuel and hydrogen powered vehicles
- Progressively shift from short haul aviation to high-speed trains (below 450km)
- Progressively power rail transport from renewable energy supply sources of electricity rather than carbon based fuels (e.g. diesel)
- Progressively power water supply plants from local hydro, solar and wind power sources
- Progressively power waste water and waste treatment plants and networks from local biogas sources

Appendix 1 - GRIP model data requirements

Data for more recent years, such as 2000 or 2005, is likely to be significantly better than the data for 1990. A balance has to be struck between the base year (which is often confused in different targets) and the quality of the data. 2005 is likely to be the year for which the best data is available at the metropolitan level as demand for this data has only recently existed.

For full details see www.carboncaptured.org.uk

1 Demographics and economy

1.1 General

- Total GDP or GVA
- Population
- Households
- Cars registered
- Flights take off

1.2 GVA by sector

- Iron and steel
- Non-ferrous metals
- Chemicals
- Paper, Pulp and Print
- Food and Beverages
- Agriculture
- Services (Commercial/Institutional)

1.3 Residential

- Expenditure on fuels per household
- Tonnes of waste per household
- Miles or Km travelled per person
 - Car
 - Train
 - Plane

1.4 Waste

- Waste (tonnes per household)
 - % landfill
 - % incinerated
 - % recycled

2 Energy

2.1 Secondary generation

- Electricity and heat
- Petroleum refineries
- Coke manufacture

2.2 Industry

- Iron and steel
- Chemicals
- Non ferrous metals
- Food and beverages
- Paper, pulp and print
- Other industry

2.3 Other sectors

- Residential
- Services
- Agriculture

2.4 Transport

- Road transport
- Rail transport
- Marine transport
- Domestic and LTO aircraft

2.5 Fugitive

- Coal mines and Distribution losses
- Offshore oil and gas

3 Industrial processes

3.1 Mineral products

- Cement production
- Lime production
- Limestone and dolomite use
- Soda ash production and use
- Asphalt roofing
- Road paving with asphalt
- Other
- Glass production

3.2 Chemical industry

- Ammonia Production
- Nitric Acid Production
- Adipic Acid Production
- Carbide Production
- Carbon Black
- Ethylene
- Dichloroethylene
- Styrene
- Methanol
- Titanium Dioxide Production
- Propylene
- Caprolactam
- Other non-specified

3.3 Metal production

Iron and Steel Production
Ferroalloys Production
Aluminium Production
SF6 used in Aluminium and Magnesium Foundries
Silicium Production

3.4 Production of halocarbons and SF6

By-product Emissions
Production of HCFC-22
Other
Fugitive Emissions
Other (as specified in the inventory details)

3.5 Consumption of halocarbons and SF6

Refrigeration and Air-Con Equipment
Foam Blowing
Fire Extinguishers
Aerosols/Metered Dose Inhalers
Solvents
Other applications using ODS(3) substitutes
Semiconductor Manufacture
Electrical Equipment
Other (as specified in the inventory details)

4 Waste

Solid waste disposal on land
Waste water handling
Waste incineration
Other

5 Agriculture

5.1 Agriculture and animals

Animal numbers (by specified type)
Animal waste management systems

5.2 Other agriculture

Rice cultivation
Burning of savannas
Field burning and agricultural residues