grip for Europe

The Greenhouse Gas Regional Inventory Project

A Pilot Study

A new approach to GHG inventory formation for Europe's Metropolitan Regions.
Tested in Stockholm County, Veneto, Bologna Province and Glasgow and the Clyde Valley.

A proposed mechanism for emissions scenario formation, tested in Glasgow and the Clyde Valley.

North East South West INTERREG IIIC

PROJECT PART-FINANCED BY THE EUROPEAN UNION

METREX The network of European Metropolitan Regions and Areas

CO_2 80/50

grip for Europe The Greenhouse Gas Regional Inventory Project

Tyndall°Centre MANCHESTER

Foreword, METREX

There are about 100+ "metropolitan" areas in Europe, meaning the major urban areas and their areas of influence, with populations over 500,000. They include probably 60-70% of Europe's population of 490 million. They are the main source of Europe's greenhouse gas emissions.

METREX is the Network or European Metropolitan Regions and Areas. It was founded in 1996 with the support of the European Commission. It now has members from 50 metropolitan areas. Its purpose is the exchange of knowledge on metropolitan issues between practitioners, that is, politicians, officials and their advisers.

In 2005 the Network met in Granada to consider the issue of Climate change/Urban change. The Tyndall Centre presented the issue and the Network recognised that it would have to consider seriously the contribution that metropolitan areas could make to the major reduction in emissions that is required to avoid the risk of global warming that would prejudice life on earth, as we know it.

The InterMETREX project was promoted by METREX in 2005 under the Interreg IIIC programme of the European Union. Its outcome was a Benchmark of effective metropolitan spatial planning practice. Spatial planning is the term now used in Europe to describe the integrated social, economic and environmental planning process that has been found to be necessary to foresee and respond to change, particularly at the metropolitan level. It is only at the metropolitan level that many of the strategic issues facing Europe can be addressed effectively, such as energy use, greenhouse gas emissions and urban life.

The European Union has now published its Energy Policy for Europe, which acknowledges the need for greenhouse gas reductions in industrialised countries of 60-80% by 2050. METREX recognised that this target presented a challenge to metropolitan areas that they would have to respond to, both because of the imperatives of global climate change and the necessity to move to low carbon, sustainable, energy futures. Energy is the key resource for metropolitan economies and ways have to be found to sustain these whilst making the emission reductions required.

The Tyndall Centre brought the GRIP (Greenhouse gas Regional Inventory Project) model and process to the attention of METREX. The InterMETREX project was extended to pilot the use of GRIP to enable metropolitan areas to assess their emissions (through the production of emission inventories), explore mitigation strategies and move to mitigation strategies. Four InterMETREX project partners from North, West and South Europe, agreed to explore the use of GRIP in these varied climatic circumstances. It was concluded that GRIP offered the best available methodology through which to quantify metropolitan mitigation measures and their potential contribution to the European target of an 80% reduction by 2050.

The GRIP model enables emissions inventories to be produced from readily available socio-economic and energy data. Informed metropolitan policy stakeholders are enabled to explore, collectively, mitigation scenarios of changing energy supply and demand and to reach quantified conclusions on the most effective mitigation strategy. Such strategies then need to be embodied in their various sectoral (energy, economic development, social services, environmental services, transportation, spatial planning etc.) and corporate policies and plans.

This brochure summarises the outcomes of the InterMETREX project extension. It will be helpful to all metropolitan areas now considering participation in the EUCO2 80/50 project or being associated with it. It will give them all a better understanding of how the GRIP model and process works in practice and what they can expect from its use.

Europe's mitigation target will not be achieved other than through mitigation action in its major urban areas. The use of GRIP is the way to the informed choices that have to be made.

Dr B Steinacher
President

Roger Read
Secretary General

The Tyndall Centre and GRIP

The Tyndall centre is the UK network of excellence for generating sustainable responses to climate change, based on world-class interdisciplinary analysis and innovative forms of stakeholder dialogue

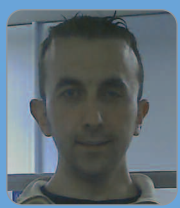
In support of this vision, Tyndall Manchester's three core objectives are:

- to seek, evaluate and facilitate sustainable responses to climate change that will minimize its adverse effects and stimulate policy for the transition to a more benign energy and mobility regime;
- to develop, demonstrate and apply new methodologies for integrating climate change related knowledge;
- to promote informed and effective dialogue across society about the options to manage our future climate.

The Tyndall centre is unique in the UK in undertaking interdisciplinary research in support of sustainable responses to climate change, not only by covering the whole spectrum of geographical, time and human scales, but also by linking research efforts across disciplines in an integrated way.

Tyndall Manchester research incorporates cultural, political and institutional factors along with technical, economic and scientific analyses, with an emphasis in international decarbonisation over the next 50 years. We are developing comprehensive and systems level approaches to decarbonisation both within the UK and within an international framework, working from the level of national energy systems, regional and local policy, to carbon intensive sectors, and to the household level and personal behaviour. We listen carefully to business, government and international trade organisations.

The combined GRIP approach to GHG inventory and scenario formation was developed by Dr Sebastian Carney at Tyndall Manchester through funded research between the Tyndall Centre and the UK's Environment Agency. This approach was first applied in the North West Region of England. This brochure represents a development of GRIP, through a pilot study conducted at Tyndall Manchester in partnership with METREX. The outputs show both a need and widespread desire for further development of this work so that the combined GRIP approach can be rolled out across the rest of Europe to aid and inform policy makers seeking to achieve carbon light futures.



Dr Sebastian Carney

The GRIP Europe Inventory, Methodology and Tool

There were two main aims of the GRIP for Europe pilot study: 1) To develop GRIP GHG inventory methodology and tool so that can be applied to the pilot regions; and 2) Test the GRIP scenario tool at the metropolitan regional scale. This section of this brochure contains the results produced in fulfiling this first aim.

There is a broad spectrum of organisations engaged in GHG inventory formation, this has led to a variety of methodologies being developed to calculate them. As a consequence making comparisons between the results of these inventories is convoluted. The Tyndall study showed examples of inventories that excluded certain emissions sources, some that allocated emissions in differing ways. Some inventory calculations use detailed data sets, whereas others use an entirely top down approach – where national data is disaggregated to the regional scale using scaling factors such as employee numbers or population.

These differences are magnified by the different data sets available in regions and the differences in the depth of understanding regarding emissions and their sources. The GRIP for Europe inventory approach had to recognise and embrace these issues. Without this embracement, and without a clear methodology trust in the resulting figures could be restricted. This is highlighted by the fact that the pilot regions felt that any resultant inventory should not only be comparable to their respective national inventory but also to enable comparisons between the regions and between years, with all of this being done in a visually clear manner.

As a consequence the GRIP for Europe methodology employed the same format as the original GRIP inventory methodology applied in the UK. This format comprises three different levels of methodology to calculate each emissions source.

This is similar in format to the approach provided by the IPCC for countries to form national inventories. Indeed, the methods chosen for use in GRIP for Europe are congruent with these international standards.

This new methodology maintains the following five criterion of its predecessor:

1) It is timely in its approach
2) Adaptable to differing data sets
3) Transparent in nature
4) Easily replicable, and
5) It has a clear reporting structure.

The methodology provides a framework and a web based tool that ensures no double counting of emissions takes place, and that there is a concrete flexibility to enable comparisons between regions to be conducted without ambiguity. Each level of methodology relies on a different level of data availability. The GRIP for Europe Level 1 approaches are the most accurate, with level 3 approaches having the highest level of uncertainty associated with them. The key benefit of GRIP is that every emissions source identified in it has three methodological levels associated with estimating its significance. This means that whilst data may be limited for a given emissions source in a region e.g. dairy cattle and thereby necessitating a level 3 approach for that year – a region may have detailed data for another source e.g. Industrial fuel consumption, thereby enabling a more accurate level 1 approach to be employed.

The GRIP for Europe tool presents these results in a colour coded format, to a high level of specificity.

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This takes the following format: emissions estimated using a level 1 approach are presented in green, level 2 approaches in orange and finally level 3 approaches are presented in red. This means that a reader can immediately draw comparisons between the accuracy of an emissions source and make quick sensible comparisons of that source between not just regions and years, but also the respective country's national emissions inventory. The same colour coding applies to the inventory tool, where red boxes symbolise the data required for level 3 approaches, orange for level 2 and green for level 1.

By implementing the GRIP for Europe approach, the regions within METREX and beyond permit themselves to monitor their emissions year on year. This will enable them to gauge the effectiveness of mitigation policies and gain insight into emissions drivers. This is all provided in a very low cost format.

The tool can be seen below. Instructions on its use and the tool itself are available at www.grip.org.uk.

A fuller description of the methodology is available directly from Sebastian Carney (see contact details on the rear page)

The following eight pages contain the inventory results from each of the four pilot regions: Bologna Province, Glasgow and the Clyde Valley, Stockholm County and Veneto. Each of the inventories includes the six main greenhouse gas emissions that emanate from the energy, industrial processes, waste and agricultural sectors.

The data sets used to produce the inventories have been either sourced locally from the partner region or by Tyndall Manchester. The inventories were produced for the latest year for which data were available, for Bologna Province, Glasgow and Clyde Valley and Veneto this was 2004 and for Stockholm County this was 2003.

RegioneEmilia-Romagna

Bologna Province Greenhouse Gas Emissions Inventory 2004

Bologna Province covers an area of 140km^2 -and sits within the region of Emilio-Romagna, Italy. It is home to 0.9m people accommodated in 0.46m households.

The Gross Domestic Product (GDP) of the region in the year 2004 (the year of the inventory) was valued at €29.4Bn. This level of economic activity equated to GDP per capita of €32,142, above the Italian average of €22,678. The level of economic activity within the region of Emillia Romagna is 25% above the Italian average and this is in part due to the Bologna Province.

Different industrial sectors and activities have differing levels and types of emissions associated with them. Some industries are highly carbon- and energy-intensive (iron and steel, for example) due to the amount and type of fuel they consume. Other industrial groups (such as cement and chemical manufacturing) are associated with high levels of "process emissions". Process emissions occur as a result of the nature and rate of a given activity and may result from, among other possibilities, chemical reactions or as a direct consequence of product use. The agricultural sector is also particularly important due to its contribution to both CH_4 and N_2O emissions which arise both from the use of fertilisers and from animals.

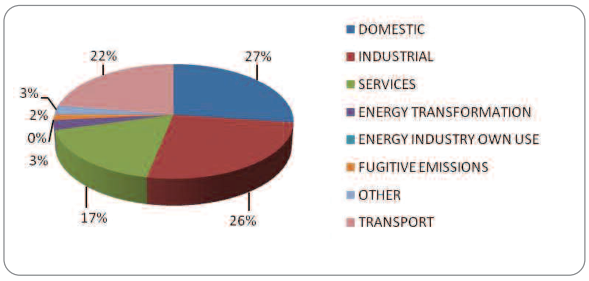
The region houses a large amount of heavy and polluting industrial activity (34% GDP). In the year 2004, the region accounted for just under 10% of Italy's manufacturing output. The region's agricultural industry was responsible for 4% of the region's GDP in 2004.

The Bologna province holds both the most important motorway and rail interchanges in Italy. These carry the majority of traffic passing between north and south Italy. Of the 1,080 industrial areas within the region 85% of them are within 8km of the principal road network. The main railway line departing from the region is electrified, which results in lower direct emissions than a non-electrified route. Bologna Province also has two main airports, Bologna, and Bologna Forli.

Emissions from Bologna

The energy sector, including domestic, industrial energy consumption, transport and fugitive emissions, accounts for 99.9% of regional CO_2 emissions (8,175kt CO_2), with CH_4 and N_2O emissions adding an additional 742kt CO_2 Eqv, making a total of 8,917kt CO_2 Eqv for the year 2004. The chart above shows the breakdown of Bologna GHG emissions, from the energy sector in the year 2004.

Direct domestic emissions occur from the combustion of solid, liquid and gaseous fuels, burned in households across the region. Indirect emissions occur through the consumption of



electricity. A home in the region may be heated by gas- or liquid-fired central heating, electric heating or indeed a combination of these. Emissions per household in Bologna Province are 4.9t CO_2 emissions per person are 2.47t CO_2. Total domestic emissions were 2,438kt CO_2 Eqv.

Total emissions from the energy consumption by commercial, public administration and agricultural sectors in Bologna Province for the year 2004 were estimated to be 1,341kt CO_2. Total emissions from the energy consumption of the industrial sector were estimated to be 1,809kt CO_2. There are no petroleum refineries, coke manufacturers, blast furnaces or oil and gas extraction taking place in this or any of the other pilot regions. Total emissions from other fugitive sources in the Bologna Province region for 2004 were estimated to be 290kt CO_2 Eqv.

Analysis of the emissions figures show that road transport is the largest contributor to transport emissions in Bologna Province emitting 2,159kt CO_2 in 2004. However, it should be noted that emissions produced during the 'cruise' part of international flights from Bologna's air ports are not included in the analysis in accordance with IPCC emissions accounting guidance and may therefore under-represent the contribution of this transport source.

According to tool data sources our communication with Bologna Province, there are no industrial process emissions released that are covered under international standards (such cement and chemical manufacturers).

The largest source of agricultural methane emissions arise from enteric fermentation followed by emissions from the management of animal waste. The levels of emissions are dependent on the number and type of farm animals, with dairy cattle being the most significant as well as the methods of waste management employed. The largest source of N^2O from agriculture is from agricultural soils resulting from the application of nitrogen fertilizers. The emissions in Bologna Province from the agricultural sector amount to 716kt CO_2 Eqv.

The management of waste from Bologna Province was responsible for the emission of 253kt of CO_2 Eqv in 2004. Overall the emissions for the Bologna Province region are estimated at 10.9tCO_2 Eqv per person, and 0.34ktCO_2 Eqv per unit of GVA.

BOLOGNA PROVINCE EMISSIONS

Source		Kt CO_2	Kt CH_4	Kt N_2O	Kt HFC	Kt PFC	Kt SF_6	GWP_{100}
Energy	TOTAL	8,175	5.83	2				8,917
Domestic		2,265	0.1	0.55				2,438
Industrial		1,809	0.12	0.3				1,905
Services		1,341	0.08	0.4				1,467
Energy Transformation		220	0.02	0.15				267
Energy Industry Own Use			0.00	0.01				3
Fugitive Emissions		157	5	0.09				290
Other		224	0.01	0.5				379
Transport		2,159	0.51	0.03				2,179
Industrial Processes	TOTAL	0	0	0	69	3		72
Waste	TOTAL	3	11	0.06				253
Agriculture	TOTAL		13	1.43				716
TOTAL		8,178	29.84	3.52	69	3	0	9,958

GLASGOW AND THE CLYDE VALLEY
STRUCTURE PLAN JOINT committee

Glasgow and Clyde Valley Greenhouse Gas Emissions Inventory 2004

The Region covers an area of 3,405 km^2 - in Scotland, UK, and includes the City of Glasgow. It contains 0.79m households, just under half of which are located in the Glasgow City area. The population of the region in the year 2004 stood at 1.75m and it is one the most densely-populated regions in Scotland.

The Gross Domestic Product (GDP) of the region in 2004 was valued at £29.3Bn. This relatively low level of economic activity equated to GDP per capita of £16,791, below the UK average of £17,344.

The level of economic activity of Glasgow and the Clyde Valley (GCV) is heavily dominated by the Glasgow City area. The economy within Glasgow has changed greatly over recent years, from one that was dominated by ship building and imports to one that is dominated by the service industry. Elsewhere within the region there continues to be a contingent of heavy and polluting activity. The region also contains a large amount of coal mining. In 2004, the region accounted for 32% of Scotland's manufacturing output.

The region has an agricultural industry holding approximately 2% of the UK's animal population in 2004. The impact of events such as BSE and Foot and Mouth have led to changing farming practices in recent years, and these changes have had a subsequent effect on releases of methane (CH_4) and nitrous oxide (N_2O) from the agricultural sector.

The region has one airport, Glasgow International. It is the largest and busiest airport in Scotland, handling 8.5m passengers in 2004.

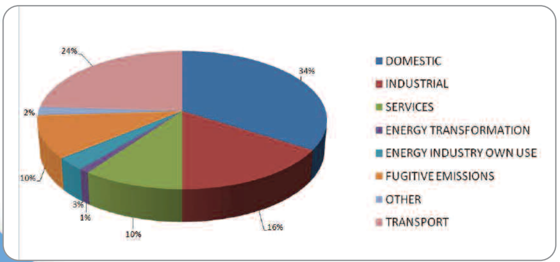
Glasgow Prestwick Airport despite its name is located just outside the region it is much smaller than the international, but handles 2.2m passengers. It has experienced enormous expansion (from 0.7m passengers in 1999) and is expected to increase further with the activity of budget airlines.

The main railway line departing from the region is electrified, which presents less direct emissions than a non-electrified route. Despite the line being electrified, a small number of diesel trains continue to use the routes. On a smaller scale, there is the Glasgow City underground system. The road network joins up areas of habitation in the region. In 2004, approximately 593,500 cars were registered in the region.

Emissions Results

The energy sector, including transport and fugitive emissions, accounts for 99.9% of regional CO_2 emissions (12,827kt CO_2), with CH_4 and N_2O emissions adding an additional 937kt CO_2 Eqv, making a total of 13,764kt CO_2 Eqv for the year 2004.

The Chart below shows the breakdown of GCV GHG emissions, from the energy sector in the year 2004.



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Households in the Glasgow region consume a slightly higher than average amount of energy due, possibly, to the weather and the level of insulation in homes among other factors. Domestic emissions per household are 5.93t CO_2 and per person are 2.67t CO_2.

Additional emissions reported within the energy sector include 1,346kt CO_2 Eqv from the energy consumed by the commercial, public administration and agricultural sectors and 2,275 ktCO_2 from the GCV region's industrial sector. Total Fugitive emissions from other energy sources in the GCV region for 2004 were estimated to be 1,210kt CO_2 Eqv.

These figurative sources include Methane released from the gas distribution network, electricity losses from the grid and Methane leakage from coal mining.

The inventory shows that within the transport sector, road transport accounts for the largest proportion of emissions in the GCV with 3,395kt CO_2 in 2004 cars. The GCV emissions from transport sources accounted for 2.7% of total road transport emissions within the UK. This is higher then its population would indicate. Waste disposal in GCV emitted 559 ktCO_2 Eqv and emissions from agriculture were estimated at 721 kt CO_2 Eqv. There are no industries in the GVC regions which emit 'process emissions'.

Overall the emissions for the GCV region are estimated at 8.8 tCO_2 Eqv per person, and 0.36 ktCO_2 Eqv per unit of GVA.

GLASGOW EMISSIONS

Source		Kt CO_2	Kt CH_4	Kt N_2O	Kt HFC	Kt PFC	Kt SF_6	GWP_{100}
Energy	TOTAL	12,827	40.49	0.28				13,764
Domestic		4,668	1.53	0.11				4,734
Industrial		2,245	0.25	0.08				2,275
Services		1,330	0.18	0.04				1,346
Energy Transformation		90	0.02	0.01				94
Energy Industry Own Use		396	0.04	0.01				400
Fugitive Emissions		404	38.4	0.0				1,210
Other		297	0.01	0.0				297
Transport		3,395	0.07	0.03				3,406
Industrial Processes	TOTAL	0	0	0	242.86	2.65	0	246
Waste	TOTAL	12.53	24.1	0.13				559
Agriculture	TOTAL		14.24	1.36				43
TOTAL		12,840	78.8	1.77	243	2.65	0	14,611

Regionplane- och trafikkontoret

Regional Planning and Urban Transportation
Stockholm County Council

Stockholm County Greenhouse Gas Emissions Inventory 2004

The Stockholm County Region covers an area of 6,519 km² in Sweden and is divided into 26 municipalities. The region contains 0.88m households with a population of approx. 1.89m in 2003 (the year of the inventory).

It is the most densely-populated region in the country with 285 people per km², against the national average of 22. The Gross Domestic Product (GDP) of the region in 2003 accounted for approximately 29.1% of the Swedish economy. Stockholm has an established R&D strength, advanced business, logistical and financial services. The Stockholm County region is one of the highest ranked OECD regions in terms of high-tech patent activity.

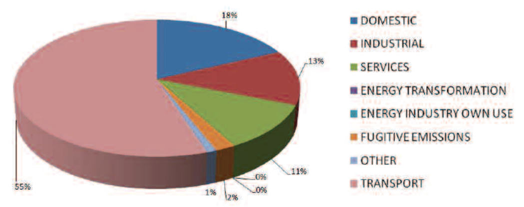
The region contains a variety of seaports and a large international airport – this makes it an important commercial centre in Northern Europe and the Baltic Sea Region. The international airport is the largest and busiest airport in Sweden accounting for more than half of all Swedish flights and passenger numbers it handled 16m passengers in 2003. These passenger numbers have nearly doubled since 1990. The region has a diversified transportation system that includes; buses, commuter trains, light rail and boats. The rail based transport is primarily electric.

The region's population is distributed around the transportation system to permit easier access to work, however, transport provision has struggled to keep pace with population growth. In 2003, there were approximately 760,000 cars registered in the region.

Emissions from Stockholm

The energy sector, including transport and fugitive emissions, accounts for 99.9% of regional CO_2 emissions (6,770kt CO_2), with CH_4 and N_2O emissions adding an additional 143kt CO_2 Eqv, making a total of 6,913kt CO_2 Eqv for the year 2003. The chart shows the breakdown of Stockholm County's GHG emissions from the energy sector in the year 2003.

The consumption, extraction and transformation of energy within the region in 2003 produced 6,990kt CO_2 Eqv, comprising: 1,263kt CO_2 Eqv from domestic energy consumed; 898kt CO_2 Eqv from industry energy consumed; 802kt CO_2 Eqv from services energy consumed; 108kt CO_2 Eqv from energy consumed in the energy industry and emissions from fugitive sources; and 3,778kt CO_2 Eqv from transport.



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Households in the region are generally heated by liquid-fired central heating or district heating or indeed a combination of these. Stockholm's domestic emissions per person on per household (0.63kt CO_2 and 1.36 kt CO_2 respectively) are far lower than the other study regions. This is largely due to district heating being biomass based.

Total emissions from energy consumption by the commercial, public administration and agricultural sectors in Stockholm County for 2003 were estimated to be 800 ktCO_2. Total emissions from the industrial sector's energy consumption were estimated to be 898kt CO_2.

The inventory shows that within the transport sector, road transport accounts for the largest proportion of emissions with 3,767kt CO_2 in 2003 (again this does not take into account international aviation's, cruise or shipping emissions).

The high proportion of dairy farming that takes place in the Stockholm County compared to other regions in Sweden is the main contributor to the region's agricultural emissions of 220kt CO_2 Eqv. Waste disposal accounted for 472 kt CO_2 Eqv.

Overall emissions from the region work out at 4.6t CO_2 Eqv per person, this is below the national average and reflects the region's economic make up. The region is by far the lowest emitting of the pilot regions, this is primarily driven by its higher propensity to combust biomass rather than fossil fuels.

STOCKHOLM COUNTY EMISSIONS

Source		Kt CO_2	Kt CH_4	Kt N_2O	Kt HFC	Kt PFC	Kt SF_6	GWP_{100}
Energy	TOTAL	6,770	1.5	0.36				6,913
Domestic		1,211	0.55	0.13				1,263
Industrial		874	0.26	0.06				898
Services		746	0.58	0.14				802
Energy Transformation								0
Energy Industry Own Use								0
Fugitive Emissions		108						108
Other		64	0.01	0.00				64
Transport		3,767	0.1	0.03				3,778
Industrial Processes	TOTAL	0	0	0	289	0.39	0	289
Waste	TOTAL	16.15	20.99	0.05				472
Agriculture	TOTAL		3.1	0.5				220
TOTAL		6,786	25.59	0.91	289	0.39	0	7,895

REGIONE DEL VENETO

Veneto Greenhouse Gas Emissions Inventory 2004

The Region of Veneto covers an area of 18,390 km² in Italy and is divided into seven provinces. There are 1.85m households within the region and in 2004 (the year of the inventory) the population was 4.7m.

The Gross Domestic Product (GDP) of the region in the year 2004 was valued at €121Bn. This level of economic activity equated to GDP per capita of €25,796, above the Italian average of €23,114. The region has been growing economically at a faster rate than the rest of the country.

The level of economic activity of Veneto Region is in transition, as service sector continues to grow at the expense of the industrial sector. The economy within the region has struggled in recent years in line with a downturn in Italy and other parts of Europe. Whilst industry has declined there does continue to be a contingent of heavy and polluting activity. The region also contains cement manufacturers, a carbon intensive activity.

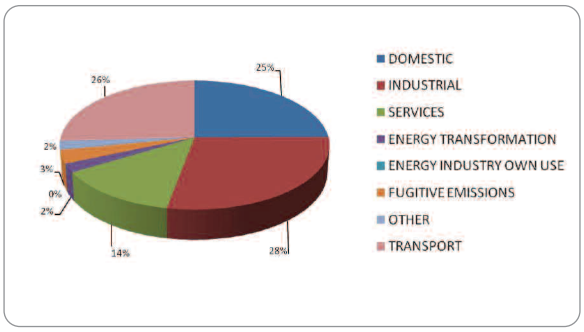
In the year 2004, the region accounted for 12% of Italy's manufacturing output. Italy is one of the largest exporters of products in Europe, and the region plays its part in this. There are several ports and airports, the region accounts for just under 10% of Italian flights.

The region has an agricultural industry which in 2004, contained 66,283 farms. The farming industry is diverse and is one of the most famous regions for wine production.

Emissions from Veneto

The energy sector, including transport and fugitive emissions, accounts for 96% of regional CO_2 emissions (41,816kt CO_2), with CH4 and N_2O emissions adding an additional 2,298kt CO_2 Eqv, making a total of 44,186kt CO_2 Eqv for the year 2004. This is the lowest percentage share that the energy sector holds in each of the pilot regions and is due mostly to the process emissions of CO_2 from cement manufacturers in the region.

The chart below shows the breakdown of Veneto GHG emissions, from the energy sector in the year 2004.



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Using the GRIP methodology, total CO_2 emissions from the domestic sector in the region for the year 2004 were estimated to be 10,594kt CO_2. This total equates to domestic emissions per household of 5.7t CO_2, and 2.3t CO_2 per person.

Total emissions from the energy consumed by the commercial, public administration and agricultural sectors in Veneto region for the year 2004 were estimated to be 5,556kt CO_2 fugitive energy sources in the Veneto region for 2004 were estimated to produce 1,486kt CO_2 Eqv.

Road transport is the largest contributor to transport GHG emissions within the Veneto region, however, as is the case for all of the pilot inventories this is distorted by the omission of the cruise phase emissions of international flights using the region's airports.

The region's agricultural is also responsible for the production of an estimated 4,688kt CO_2 Eqv and the disposal of waste generated in Veneto during 2004 is responsible for 887 kt CO_2 Eqv.

Emissions per person from the Veneto region are 11.25 tonnes CO_2 Eqv and per unit of GVA 0.43ktCO_2 Eqv.

VENETO EMISSIONS

Source		Kt CO_2	Kt CH_4	Kt N_2O	Kt HFC	Kt PFC	Kt SF_6	GWP_{100}
Energy	TOTAL	41,816	29.2	5.3				44,114
Domestic		10,594	0.5	1.2				10,977
Industrial		11,576	0.64	2.5				12,364
Services		5,556	0.33	1.2				5,935
Energy Transformation		895	0.08	0.21				962
Energy Industry Own Use								0
Fugitive Emissions		899	25					1,424
Other		948	0	0.09				976
Transport		11,347	2.7	0.07				11,425
Industrial Processes	TOTAL	2,000			361	15.5	0.01	2,616
Waste	TOTAL	16	36.91	0.31				887
Agriculture	TOTAL		88	9.16				4,688
TOTAL		43,831	154.2	15	361	15.5	0.01	52,304

Emissions Scenarios

Scenarios come in various guises and have been applied in a broad range of sectors including academia, business, industry and government. Their purpose is to provide an insight into how the future might unfold. These insights can be used to aid and inform strategic decisions taken in the present.

A scenario is not a single static vision of the future, but rather a logical sequence of images that make up the future (IPCC 2000). Kahn and Weiner (1967) defined scenarios as: "…hypothetical sequences of events, constructed for the purpose of focusing attention on causal processes and decision points". A scenario is not prediction of how the future will unfold but rather a picture of how it may unfold. Furthermore, while the degree of uncertainty associated with a scenario may be of particular interest to policy-makers, scenarios do not allow for the production of a sensible, quantifiable level of uncertainty.

Scenarios, when used within the field of climate change research, are often made up of one or more of the following three elements: 1) climate change impacts; 2) GHG emission levels and associated mitigation approaches; and 3) adaptation to the effects of climate change. The purpose of a scenario exercise undertaken within the climate change arena determines which of these elements is included.

For example: 1) is the purpose of the scenario exercise to explore the different ways in which a GHG emissions reduction can be achieved? If so, is it by a particular amount?; 2) is the scenario examining the kind of impact on human behaviour a rise in temperature, severe weather events, or even rainfall could have?; or 3) is the aim of the scenario to see what changes in global levels of anthropogenic emissions will have on atmospheric concentrations of GHGs and the associated impact on the climate?

In the first case, the purpose of scenario development which the GRIP scenario tool supports, the scenario will need to focus on the mechanisms necessary to achieve a reduction in GHG emissions. In the second case, an understanding of global atmospheric concentrations is required, together with an understanding of technologies available to deal with such changes. In the last example, all three aspects would be included to provide a detailed and iteratively developed scenario. All of these scenarios should, for completeness, also include a detailed perspective of social, economic, and wider environmental issues within them.

The use of scenarios at a regional scale can enable the development of individually-tailored, specific plans and policies that will meet the requirements of central, devolved and regional government, and promote the consideration of the wider global community within such plans (Rotmans et al, 2000;). With this in mind, more targeted approaches to both GHG mitigation and climate change adaptation can be taken locally that recognise regional characteristics and understand current physical, social and economic issues. Additionally, it becomes possible to consider a region as being capable of establishing its own strategies for GHG mitigation.

The "GRIP Scenario Tool" or decision aid allows an individual or group of participants to explore the impact of potential greenhouse mitigation measures on a region's total emissions. The only constraints on the scenario exercise are the purpose of the scenario and an individual's own imagination. The scenario tool bridges the gap between a qualitative storyline that an individual holds its associated quantified variables in terms of energy demand and supply and the emissions associated with that storyline.

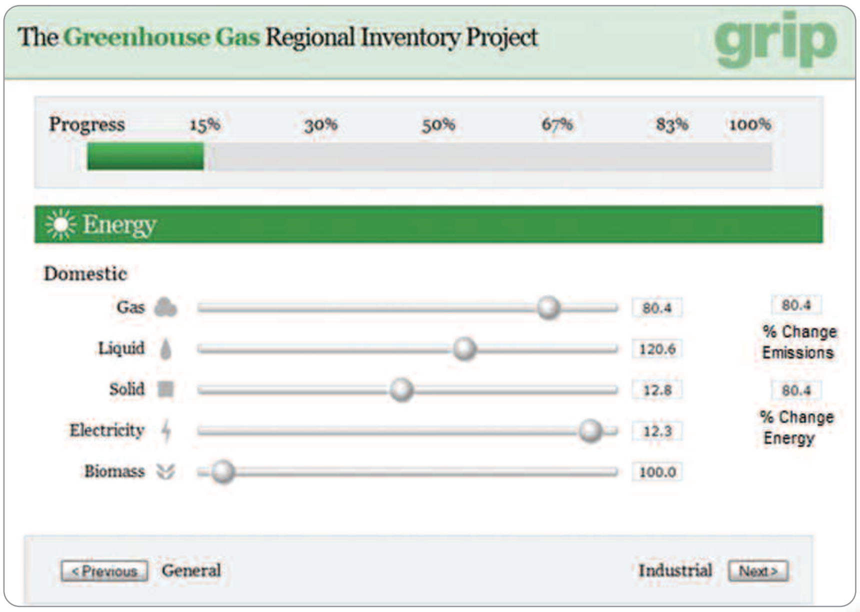
Within the scenario process undertaken using GRIP, the stakeholders (decision-makers) are free to explore different energy options, revise their views, the structure of their images (perceptions of the future), or even the goal of the exercise (the 80% reduction) as they feel necessary. With the GRIP scenario tool, there lies the potential to produce a number of scenarios in an organic, iterative and exploratory manner, evolving with the stakeholder as knowledge, beliefs and attitudes change that extends well beyond this report and the process undertaken so far (Yeoman 2005).

The GRIP Scenario Tool enables the user in particular to:

- monitor changes in GHG emissions caused by proposed energy policy decisions;
- receive instant feedback on the effects of a policy;
- gain an insight into a holistic approach to the energy system in both the medium and long term.

To manipulate the tool, the user is asked to input a variety of data, including fuel choices for the relevant sector and electricity sources. The tool is the front-end face of a complicated energy system model, which through interactions with the supporting programme, provide the user with immediate feedback in terms of emissions, efficiency and energy consumption within the Domestic, Services, Light Industry, Heavy Industry, Energy System and Transportation sectors. The final output from the tool provides the stakeholder with an emissions estimate for the scenario, a total figure for energy consumption and an assessment of the required efficiency improvements necessary to deliver such a future. The scenario tool can be used by individuals or by larger groups.

The original scenario tool can be viewed at www.grip.org.uk The proposed new scenario tool tailored to the EU Region can be seen below. This when fully evolved will provide an intuitive mechanism via which to explore energy futures out to 2050. The following pages contain the three scenarios produced for the Glasgow and The Clyde Valley region. They are called **Day 1, Day 2 and Day 3** scenarios. The scenarios are written from a perspective of 2050 looking back at 2004. The next six looking back to 2004. Each scenario exercise attempted to achieve an 80% reduction in emissions, backcast to 2025.



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The Day 1 Scenario

Summary

This scenario is characterised by an average annual level of economic growth above that of the nation together with strong levels of governance, across the local, regional, national and international realms. The near term realisations of climate change seen early on this century meant that the importance for quick emissions reduction and changes in behaviour were recognised and implemented. CO_2 emissions in this scenario reduced by 78%. End user energy consumption reduced by 37%.

Population

The population of the region fluctuated during the period since 2004, a decline was originally experienced followed by a gradual increase. This change was in line with the structure plan formed in the early part of the century. In accordance with this, a trend increase in household numbers was seen to ensue, which meant that there was a growing desire to live in single occupancy homes. These demographic characteristics continued throughout the first part of the 21st century.

Economic and Social Development

The average level of economic growth over the past 46 years was above both the national and UK average. There were many driving forces behind this, these included a shift in focus of growth from the south-east of England to a more even spread across the rest of the UK. The growth in the region was primarily driven by the retail and financial service sectors. A more progressive approach to employment saw the male / female balance in the employment market taking place.

This level of growth led to increased congestion on the transportation infrastructure, and placed increased pressure on office space. This phenomenon was also experienced in comparative areas such as Manchester, Liverpool, and Newcastle. The strategies for growth in the GCV were formed in collaboration with counterparts in Edinburgh through the manager appointed for inter-regional collaboration. This made the GCV the key "region within the nation". The level at which trade and manufacturing needed to support the GCV took place shifted from a focus on China and India to a focus on the EU trading block – which became stronger. Due to the main areas of growth in the region being financially based the physical proximity of the region became less of an issue – with tele-working being an established form of working.

Political pressures to reduce CO_2 emissions came from National, European and International sources. These pressures focused on carbon intensity. Overall there was an increase in the quality of life of GCV inhabitants, with an increase in life expectancy, particularly amongst males.

Energy and Technology

The efficiency of new products within homes and businesses in the GCV has improved greatly, with only the most efficient being used. The political structure has limited the level of rebuilding, this created concerns for low quality building stock – where energy consumption remained higher despite retro-fitting. The homes built after 2015 are lower energy consumers then those built prior to this period, although this took mostly a heat focus. The political system learnt in the early parts of the century that more drastic local policies were required. This lead to a shift in planning requirements for onsite renewable schemes. Owing to a shift back to older attitudes to heating, were putting on a jumper rather than the central heating became normal once again, as perceptions of comfort altered – these were mostly driven by cost pressures rather than altruistic behaviours.

Combined Heat and Power (CHP) technologies did come into place, and early on. This was mostly focused on new build properties and flats. This is mostly natural gas based, where it is used more efficiently. Regional use of MSW incineration led to low carbon electricity and heat production. Within the service sector CHP implementation was originally driven by public administration on a local scale, whilst measures did come into the commercial sector these took longer and the private sector focused on costs. Within industry a quicker shift towards CHP took place – as the costs of fuel and emissions trading placed additional pressure on organisations.

The generation of electricity from the national grid continued to be dominated from outside of the region, whilst on-shore wind did develop. Hydro electric power continued at current levels. Coal, the most carbon intensive fuel, continued to be combusted for electricity generation but this only took place in combination with carbon capture and storage technologies. Owing to increased political unease, relating to energy security coal mines within the UK were reopened.

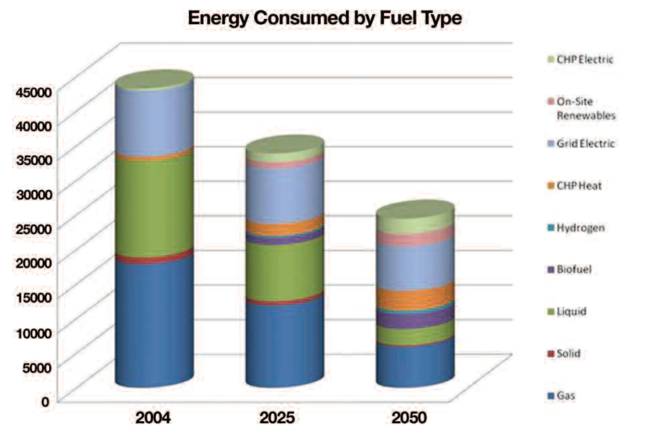
Transport

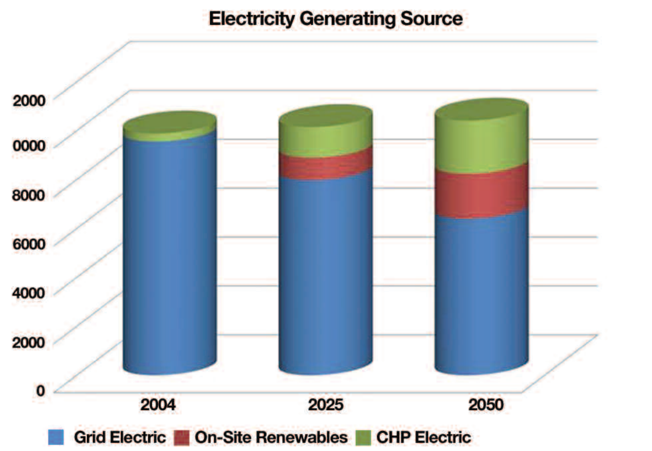
The location of Loch Lomond just 40mins away made the region an attractive location to live, accessibility to the loch is provided by electric buses. Climate change led to large alterations in the way in which vehicles are propelled and how the transportation structure was formed. A variety of innovative approaches coming predominantly from the agricultural sector were used as fuels. On an urban scale both electric and hydrogen fuels were used. The EU set more stringent standards for vehicle efficiency – this came as a result of pressures from local governance. Regionally, propelled by national changes in policy, road pricing measures came into place early on. This was necessary to stay within the boundaries set out by cumulative emissions.

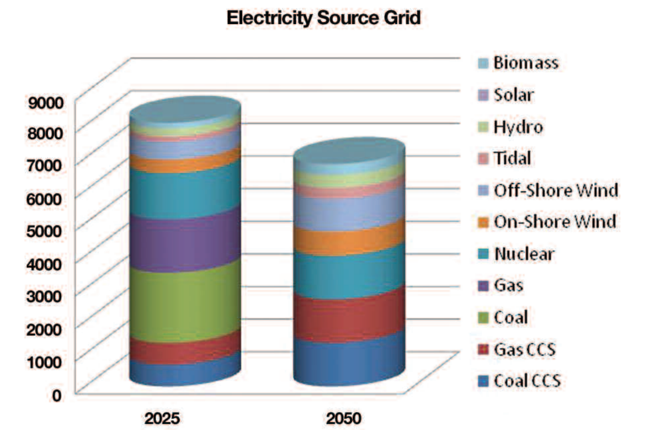
Hydrogen was first seen in the transportation sector, with flagship approaches on public transport – such as hydrogen buses leading the way early on. Otherwise hydrogen was used as a form of storage on a distributed national grid.

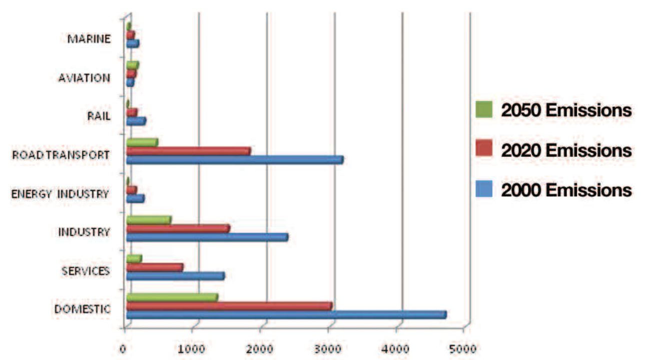
Environment

Climate change has occurred, the region is at least 2 degrees warmer. This has placed additional pressures on energy requirements as the building stock has not been sufficiently equipped to deal with the higher temperatures.









The Day 2 Scenario

Summary

The “Day 2 Scenario” is characterised by a good level of economic growth bolstered by the use of regional renewable capacity. Governmental intervention has been strong and took hold early on particularly in building design. These policy measures have were seen mostly in the domestic and transportation sectors. CO_2 emissions in this scenario reduced by 77%. End user energy consumption reduced by 29%.

Population

The population of the region experienced a gradual increase over the past two generations. This was due to an increased birth rate, and migration balance. There was no dramatic changes in the make-up of the region. There continues to be foreign workers, who come to the region for short periods of time for work – this bolstered regional population. The high quality of life in the region brought about by a low population density, good transport links and surrounding scenery meant that people stayed within, and were attracted to the region.

Economic and Social Development

The GCV’s economic development was developed strategically in co-operation with Edinburgh. Between the two regions they became a force on a European stage. The infrastructure developed in the early decades of the century led to a single labour market that spanned both regions. The high levels of unemployment experienced in the early part of the century was seen as an advantage and was seized upon. This led to a variety of new businesses. Despite this there was a continuing trend of “power shifting East”. The benefits and lessons learned in relation to economic development in the Dublin Area during the 90’s were used as a benchmark for development within the GCV. The tourist, retail, and leisure industries continued to develop throughout the past 50 years. Elsewhere, high knowledge intensive industries such as those found within the chemical sector continued to be developed. This focus on knowledge was displayed across the economy, with growth in financial services and a constriction in public administration. The impacts of climate change have been felt, and these have impacted the economy – extremes in weather have led to more intuitive approaches to entertaining tourists, whilst the loss of snow has led to a demise in the ski and snow industry. The otherwise growing economy has led to more single people choosing to live on their own.

In addition health improvements particularly amongst Glaswegian males led to an increased life expectancy from one of the worst in Europe to more like the average. This has led to more pressure on the housing stock, and subsequent development – the building requirements for this development changed drastically in the early part of the century – with a particular focus on heating and cooling efficiency. This was recognised as vital, given that nearly all the properties built at the beginning of the century is still in existence today. This efficiency of the building stock has been a key component of reducing energy consumption. The transport linkages between Glasgow and Edinburgh have led to an increased urban sprawl, but also a variety of homes built for family life. Home working has never taken off culturally, the team atmosphere, commitment and performance continued to be better served by people working together. The most energy intensive industries moved overseas due, amongst other reasons problems in labour.

Energy and Technology

The domestic building stock consumes 40% less heat energy today than it did in 2004. This has been driven primarily from improvements in design – due to large scale retro-fitting and stringent requirements of new builds that came into place in the first decade of the 21st century. In addition Scottish policy altered, with minimum energy standards of buildings set. This policy stated that unless homes met these standards they could neither be let nor sold. The impacts of climate change were also felt, this impacted the heating side of the buildings but also had an additional effect as some opted to cool their homes. These housing orientated policies often saw the implementation of onsite renewables (OSR), this began with a select few at the beginning whom emerged as trend setters – but the implementation of policy led to certain onsite renewable being as noticeable as double glazing, and satellite dishes previously were. Localised production of electricity for such public facilities as street lighting became standard by 2025, at the same time light pollution was also addressed.

CHP schemes were brought into place, lessons taken from such areas as Stockholm showed what is possible in a relatively short period. As a consequence of this area wide CHP schemes were introduced. This was bolstered by small scale CHP schemes such as the early Stirling engines. The schemes were fuelled by a variety of means, but mostly biomass. The heat distribution networks were aided by the collation of waste heat energy from industrial sites. The public sector led the way early on, as when replacing boilers a more cohesive approach was taken – that recognised the need to show what was possible.

Electrical energy consumption has remained relatively stagnant over the period, as whilst devices have become more efficient there are more of them. Simple measures actually led to a reduction in demand of 10%, a growing awareness and focus on energy led to changes in best practice – and more widespread implementation of emissions trading initiatives increased the focus on energy demand reduction. On the supply side, the grid remains strong although bolstered by local production. Within the region there was an increased utilisation of the wind capacity available – this formed a ring of wind turbines around Glasgow, in combination with this pumped storage remained strong in the region. Despite these measures Glasgow still imports electricity to meet its needs. The additional renewable capacity of Scotland led to more renewable schemes then elsewhere in the UK, this is similar to past trends were power stations were located close to resources – such as coal and gas. This, however has led to substantial employment opportunities as companies harness these carbon light options to lower their carbon emissions and thereby making their products cheaper.

Transport

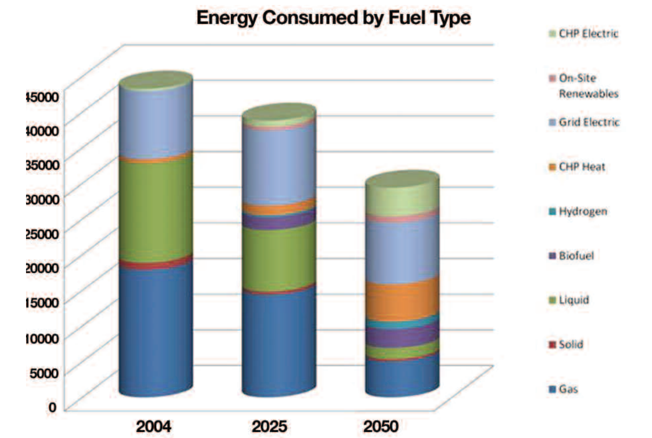
Over the past fifty years the desire for car ownership has remained strong, however due to policy measures the amount of vehicle miles travelled has remained relatively similar. The largest changes in emissions have come from strong policy on minimum standards imposed on a central European basis. These standards were set early on and European policy meant that by 2012 every car sold had to emit less then 120g CO_2 per km. The rail links within the region were extended early in the 2nd decade of the century with the Airdrie and Bathgate line being opened. In general a more joined up approach to planning policy was implemented with design focused on accessibility for both public and private means. The use of large 4x4 vehicles in urban areas was seen as antisocial. Indeed school runs were targeted with an increased focused on health and walking. In general walking was seen as more of a transportation option then previously within planning policy. The use of hydrogen within the private vehicle fleet only became more prevalent in recent years. However, early adopters of the technology (mostly public transportation) overcame many of the obstacles and led to larger net emissions savings (due to subsidies mainly).

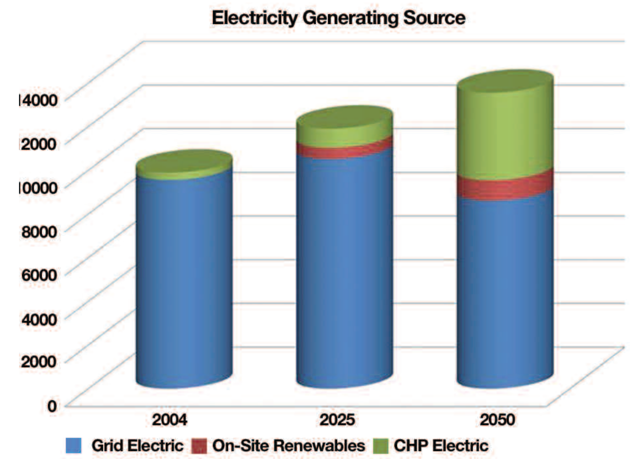
Rail stations saw their platforms extended, with operations management regarding rail being improved. This saw more carriages during peak times. An extension of the transport system in the form of light rail. With super high speed links connecting Edinburgh (20mins), Aberdeen and the South (London in 2.5hours) this displaced much domestic aviation, albeit largely unchanged between Glasgow and Belfast.

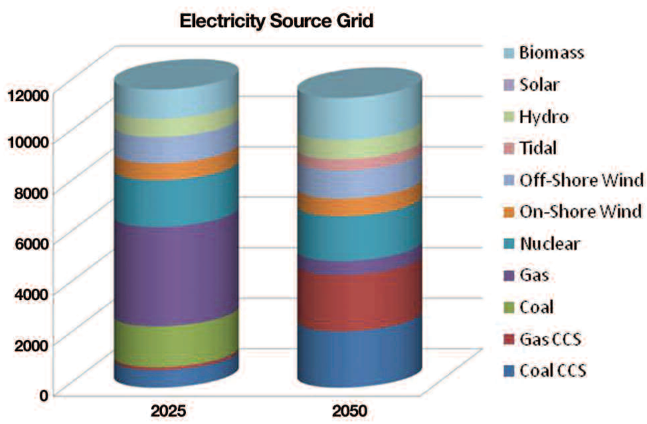
Passenger miles on planes increased as the aviation sector continued to grow – this has offset a lot of the emission gains and are not included in the overall figures here. However, average loads of the aviation fleet increased to over 90% (across all carriers). Improvements in the efficiency of planes have led to emissions increasing at a faster rate then they may otherwise have done. Constrictions on technology meant that lock-in to kerosene remained throughout most of the century so far. There continued to be much freight being transferred by plane. There has been no change in the capacity of marine ports in the GCV region as the region was reliant on imports landed in Ayshire.

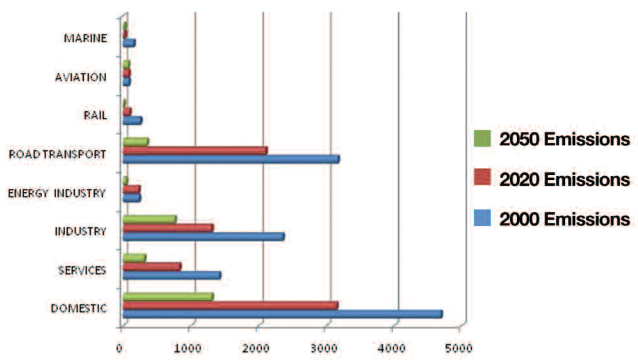
Environment

Climate change has been experienced and there has been a general warming, in fact it has extended beyond 2 degrees C. This has led to regrets, if policy was more stringent in the earlier parts of this and last century comfort levels would be more easily achieved.









The Day 3 Scenario

Summary
The "Day 3 Scenario" is based upon a stable economy, with a reducing population. Measures to reduce emissions are primarily policy led being implemented by several levels of governance. CO_2 emissions in this scenario reduced by 78%. End user energy consumption reduced by 34%.

Population
The indigenous population of the region has reduced, this is due to a low birth rate albeit partially offset by an ageing population. Migration to the region has helped offset this population decline and led to a partial stabilization. In general where the population has increased this has tended to be in urbanised areas which have subsequently become more population dense. Despite a lower baseline there has been limited improvements to health and equality, whilst the overall UK population has grown. The housing stock has further increased, as people continue to want to live on their own and there remains a high level of rented homes; some of these increased households are in place to offset fractured families, here it is common to see "two semis per family". The region remains to be comparatively less expensive than others within the UK.

Economic and Social Development
In a society where 'fractured families' are the norm it is quite plausibly multiple electronic devices such as Playstations (now version 34) (albeit not on simultaneously). The turnover of the building stock has, and continues to be moving at the rate of 1% pa and has for some time been built to a much higher heating standard. Growth within the region has on average been in line with the UK as a whole. This was partly due to the south-east reaching a 'saturation point', this has led to the wealth gap being smaller (although not significantly). The economy has become even more focused upon financial services and other service based industries, the oil industry has declined, whilst traditional industry continued to move east. The percentage share of the employment market taken up by public administration grew as the cost of office space is far lower in the GCV than in England. There has been a general improvement in health and this has led to an improved life expectancy, particularly amongst men. Many policies have become more EU centric. Schemes such as DTQ's (domestic tradeable quotas) were considered, but did not take off due to the necessary leap in educational awareness. The political structure of the region made some proposals, such as congestion charging, too difficult to implement.

However, wider success through the EU-ETS (Emissions Trading Scheme) did successfully lead to carbon reductions, and it continues to function well. In addition, and again on an EU scale, trading rules regarding the carbon footprint of products were implemented prior to 2025. The region has become a more attractive place to live, quality of life has improved and there are many two households families. Whilst many companies relocated their HQs to Scotland many of these have ended up in Edinburgh.

Energy and Technology
The approach to reduction in energy demand has, and remains to be focused on the product rather than the consumer. This has led to ongoing drives towards innovative efficient solutions. However, due to the supply structure and demand constraints blackouts have become normal. Supermarkets were influential in getting the carbon message across – mostly through carbon labelling of products. Within homes and businesses, intelligent control systems are in place – these continually monitor energy consumption and provide feedback to the electricity supply network. Homes are designed to minimise energy consumption and contain such basic devices as motion sensors as standard. Micro CHP became the minimum standard boiler to be implemented into people's homes and businesses from 2015. District CHP, where it does exist is fuelled by biomass – which is also the fuel of choice. The same fuel choices for CHP also exist for services and industry air conditioning although now required during the summer months is not perceived to be needed as much as it is in the rest of the UK.

Planning regimes have altered to recognise the need for on-site renewable and despite some perceived maintenance issues, their use in social housing and community schemes set examples for the private sector to follow. Within the region, new wind turbines were built in the period between 2010-2020 and have been maintained and replaced in the time since. The use of CCS is in place, and has been for the past three decades, but safety associated with it is questioned by many. Many other renewable technologies, particularly wave and tidal, have been put into place and utilised along the national distribution network. Nuclear power makes up a reasonable proportion of the "National Grid" balance which is largely due to it being "pushed through". Losses of electricity from the national have remained the same, partially due to the perceived visual impact of super HV lines.

Within businesses and industry there has been replacement and large scale retrofitting of current offices although this has been on a comparatively smaller scale than within the domestic sector.

This has been partially driven by tightening of the building regulations. A more structured energy orientated approach to planning was installed near to the turn of the century this has led to a more easily managed distribution of companies. Knowledge intensive (fine and precision manufacturing) Industry/retail sites and science parks are now clustered this led to an increase in CHP usage. Fossil based oil products have been displaced from the agricultural sector in favour of bio-fuels. Fortunately renewable forms of heat were given as much priority as electricity, this is not a trend mirrored elsewhere.

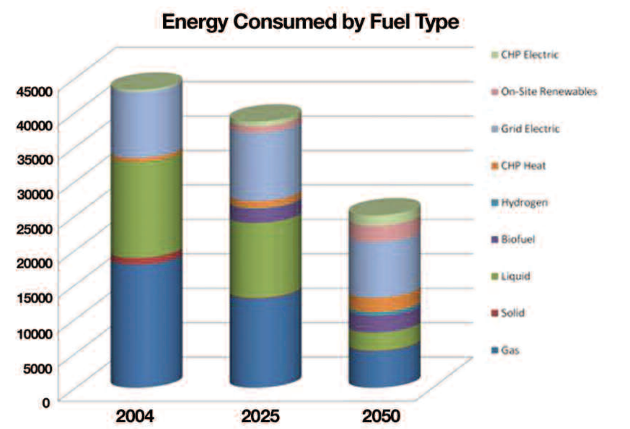
Transport

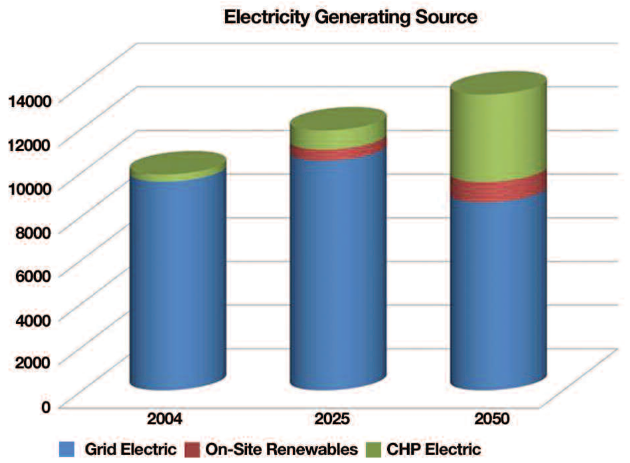
The use of "Smart" low energy consuming cars took off in the early part of the century, this has led to road vehicles in Europe being generally highly efficient. In addition women and "the urban young" in particular have chosen to move to electric cars. In combination with this societal change in demand policy measures including road pricing have helped to introduce the large reductions in road transport emissions within the GCV.

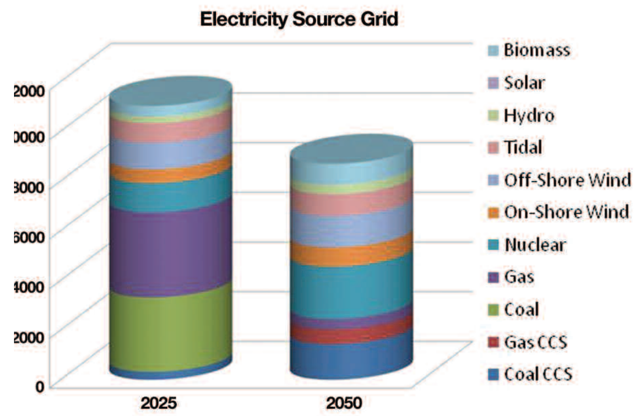
This road charging included a congestion charge that was imposed during 2025, this was an innovative initiative that permitted 'sectorising' this spread out the traffic passing through the city over the course of the day. There has been some growth in car ownership but balanced by good public transport links. Hydrogen is common place in public transportation, in electricity storage and is transported in much the same way as petrol was previous (in tankers). The aviation sector has expanded and efficiency improvements have remained much the same (1% pa). Whilst the majority of domestic flights have been replaced by rail, more long haul and European flights are taking place. The Railways now feature as an even larger component of travel, with urban light rail particularly increasing. Mainline trains are now longer and platforms have been extended. Some of the lines have been electrified, however many of these trains are less efficient on an energy unit basis. The marine sector has seen the Clydebank docks expanding from low a base into medium sized fleet.

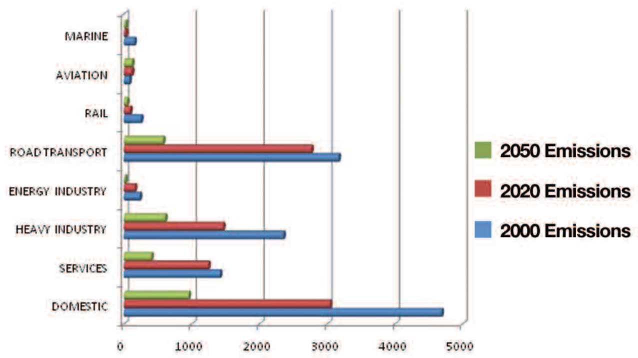
Environment

The environment has changed, there are more erratic weather patterns and the temperature has increased by approximately 2 degrees.









Where to next?

Following the success of the GRIP for Europe pilot project, it is proposed to continue the working arrangement between Tyndall Manchester and METREX. This further partnership will develop the work undertaken in the pilot project so that it can be extended across Europe. This project entitled EUCO2 80/50 (80 to symbolise the 80% reduction in GHG emissions and 50 to symbolise the target year 2050) has already attracted interest from the Metropolitan Region's of Europe. Currently the project will take the following form.

The project will be progressed through 8 Inter-regional Mitigation Areas (IMA), within which there will be a series of 3 workshops. These will involve some 8 metropolitan policy stakeholders representing, for example, energy, economic, social, environmental, transportation and spatial planning interests.

IMA Workshops will use the GRIP model and process, developed by the Tyndall Centre for Climate Change Research, UK, (see www.tyndall.ac.uk) and piloted through an extension to the InterMETREX project (see www.euco2.org). GRIP will be used to enable all partners through the Workshop programme, to input specific energy, social and economic data for their metropolitan areas and to receive Greenhouse Gas(GHG) emissions assessments and inventories as outputs.

Utilising this knowledge base, partners and stakeholders will be able to use the GRIP scenario model interactively in workshops, to test various mitigation scenarios to achieve the EU emission reduction target of 80% by 2050. This may lead to a preferred Metropolitan Mitigation Strategy being selected and adopted.

Europe's 100+ metropolitan areas contain some 60%+ of Europe's population of 490m. They are the primary source of Europe's GHG emissions. Without informed and quantified Metropolitan Mitigation Strategies Europe will not be able to meet its target. The metropolitan contribution is essential and the use of the GRIP process will enable partners to make the informed decisions that are required. Furthermore, by moving to low carbon economies, metropolitan areas will be able to secure their sustainable energy supplies for the future

The benefits of participation will include individual and particular metropolitan GHG assessments and inventories, scenarios and strategies and the exchange of practical knowledge and experience with others. Knowledge transfer, enabled by GRIP, will be at the heart of the project.

Following the publication of the Interreg IVC Programme Manual it is concluded that EUCO2 80/50 could be a successful Regional Initiative Project (RIP) under Priority 2 "Environment and risk prevention - Natural and technological risks (including climate change)".

Of the original project Dr Grahame Buchan (Manager GCVSPJC) concluded:

"The initial pilot work through InterMETREXPlus has provided the Glasgow and the Clyde Valley Joint Committee with the first ever substantive analysis of the metropolitan sources of greenhouse gas emissions through Sebastian Carney at Tyndall Manchester, and its innovative engagement of partners and stakeholders in GRIP scenario workshops provided a broad consensus on what can and what needs to be achieved. This work has demonstrated the validity of broadening the scope of the work to engage with a wider range of stakeholders. It is acknowledged that one authority, region or country cannot go it alone on Climate Change and that trans-national co-operation will be a necessity. The initial work provides a solid basis for starting to develop and share spatial planning responses with partner organisations and countries."

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