InterMETREX

Project Extension

A new approach to Greenhouse Gas Inventory Formation for Europe's Metropolitan Regions and a proposed mechanism for emissions scenario formation.

grip for Europe

The Greenhouse Gas Regional Inventory Project

North East South West INTERREG IIIC

PROJECT PART-FINANCED BY THE EUROPEAN UNION

METREX
The network of European Metropolitan Regions and Areas

GLASGOW AND THE CLYDE VALLEY STRUCTURE PLAN JOINT committee

Tyndall°Centre MANCHESTER

Introduction

The InterMETREX project was promoted by METREX under the INTERREG IIIC of the European Union; it ran from 2003 to 2006 to provide a benchmark of effective European spatial planning and development 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 quality of life.

There are about 100 "metropolitan" urban areas and their hinterlands in Europe with populations over 500,000. The current estimates are that 74% of Europe's population of 490 million live in such metropolitan areas and by 2020 it is projected that 80% of the Europe population will reside in such areas. Metropolitan areas are recognised as the main source of Europe's Greenhouse Gas (GHG) emissions.

The InterMETREX project recognised that the key issue of climate change would need to be included and addressed by Metrex Partners in Spatial Planning. INTERREG IIIC funding was subsequently approved to facilitate an extension to the InterMETREX project entitled InterMETREXPlus from October 2006 to June 2007. It was concluded that the application of the Greenhouse Gas Regional Inventory Project (GRIP) model, developed by the Tyndall Centre (UK), offered the best available methodology to quantify metropolitan mitigation measures.

The twin aims of the InterMETREXPlus project extension were:

1. To develop the GRIP GHG inventory methodology and tool so that it could be applied to all the pilot regions; and
2. Test the GRIP scenario tool at the metropolitan regional scale: Glasgow and the Clyde Valley.

Spatial planning policy responses to Climate Change focus on two categories of response:

- Adaptation – adapting spatial planning strategy so that Climate Change is integral to thinking i.e. 'climate-proofing';
- Mitigation – produce a spatial planning strategy that seeks to reduce GHG emissions.

The InterMETREXPlus focussed on the mitigation approach, seeking to communicate through its results the need for spatial planning strategies to build-in mechanisms to reduce GHG.

The GRIP GHG Inventory Tool was subsequently piloted by four InterMETREX project partners from North, West, East and South Europe who agreed to explore the use of GRIP in varied climatic circumstances: Glasgow and the Clyde Valley, Stockholm County Council, Regione Emilia-Romagna, and Regione del Veneto.

During the project the Commission of the European Communities (2007:1) published the final version of "An Energy Policy for Europe" which seeks to achieve a 20% reduction in GHG emissions by developed countries compared to 1990 levels by 2020. The policy paper also recognise that once a new international commitment exists, post-Kyoto protocol, the EU will need to increase the target to a 30% reduction by 2020 and a 60-80% by 2050. The EU Energy Policy also seeks to secure Europe's energy supply, stimulate the economy through technological development and secure more jobs for its citizens. This policy initiative provided an analytical framework and context for the GRIP Scenario Tool.

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Project Partners

METREX is the Network of European Metropolitan Regions and Areas. It is a network of practitioners, that is, politicians, officials and their advisers, concerned with the spatial planning and development at the metropolitan level.

Region of Emilia-Romagna:
Provincia di Bologna is one of the provinces of Emilia-Romagna for which the inventory has been performed.

Glasgow and Clyde Valley Structure Plan Joint Committee
The GCVSPJC is a Local Government Joint Committee comprising eight separate Local Authorities in the Glasgow metropolitan area working together on strategic development planning matters.

Stockholm County Council
Stockholm County Council's mandate is to ensure that its residents have access to healthcare and public transport as well as preventing health problems. Important elements of the County Council's operation are long-term traffic planning and regional spatial planning for the Stockholm Metropolitan area.

Region of Veneto
The Metrex partner of the "Regione Del Veneto" is the organisation with responsibility for regional spatial planning and is the first-level administrative authority for the metropolitan areas of Verona, Vicenza and Venezia.

The Tyndall Centre
Is the UK network of excellence for generating sustainable responses to climate change, based on world-class interdisciplinary analysis and innovative The Tyndall Centre brings together scientists, economists, engineers and social scientists, who together are working to develop sustainable responses to climate change through trans-disciplinary research and dialogue on both a national and international level - not just within the research community, but also with business leaders, policy advisors, the media and the public in general. The Tyndall Centre is governed by a number of advisory and management councils, to give a spectrum of views and expertise in its guidance

INTERREG IIIC is designed to strengthen economic and social cohesion in the European Union (EU) by promoting interregional co-operation. With INTERREG IIIC, interregional co-operation between regional and other public authorities across the entire EU territory and neighbouring countries was be promoted. It allowed regions without joint borders to work together in common projects and develop networks of co-operation.

The co-operations under INTERREG IIIC gave access to experience of other actors involved in regional development policy and create synergies between "best practice" projects and the Structural Fund's mainstream programmes. The overall aim is to improve the effectiveness of regional development policies and instruments through large-scale information exchange and sharing of experience (networks) in a structured way.

The GRIP for Europe Inventory, Methodology and Tool

There were two main aims of the Intermetrex Plus 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 fulfilling 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. Some inventory calculations use detailed data sets, whereas others use an entirely top down approach – here national data is disaggregated to the regional scale using scaling factors such as employee numbers or population. This is the reason why the "GRIP for Europe" inventory methodology was developed – to enable regions to produce emissions inventories in a low cost, consistent and comparable fashion.

The reporting of a GHG inventory's results is a key aspect in its output. The GRIP for Europe approach is similar to national inventory reporting formats, and uses a visually clear colour coded format. This uses 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 methodological 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. There are three levels of methodology to estimate each emissions source in the Grip for Europe methodology. 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.

There are six main direct greenhouse gases considered in an inventory. These are often referred to as the "Kyoto basket of six". These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydroflurocarbons (HFC), perflurocarbons (PFC), sulphur hexafluoride (SF_6). The different gases vary in their contribution to anthropogenic global warming and can be compared using their global warming potential (GWP). The GWP of a gas may be considered over 20, 50, 100 or 500 years, however it is most common to focus on the 100 year time frame. The GWP of a GHG is usually expressed in terms of its potency in comparison to the reference gas CO_2. Below Table A shows the GWP_{100} of the six gases, by multiplying the weight of a gas released by its GWP_{100} its carbon dioxide equivalent value can be drawn. The data shows that under the latest GWP_{100} calculations methane is 21 times more potent than carbon dioxide, with nitrous oxide being 310 times more potent. In this document the GWP_{100} is used to express the CO_2 equivalent values.

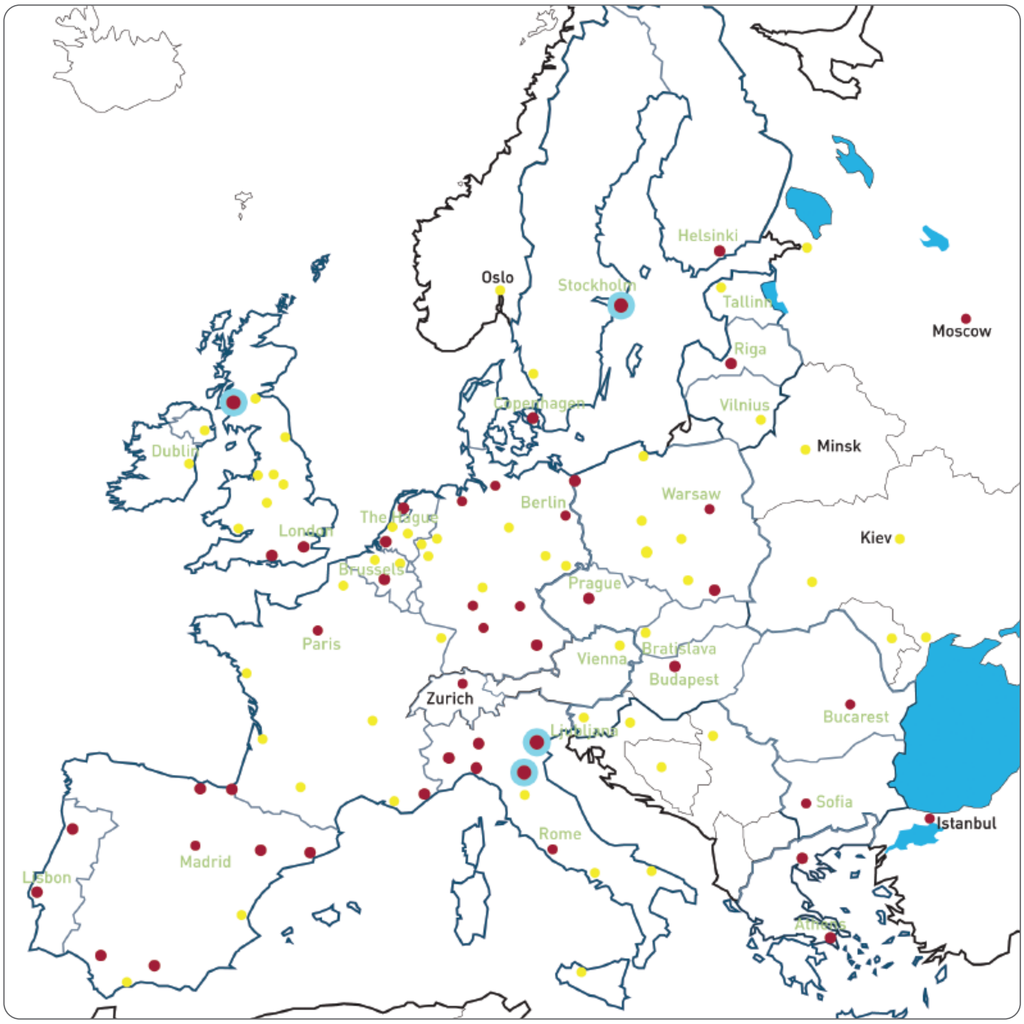
The inventory methodology utilises a mix of data sets to form an activity and emissions output. These may be either directly measured or based upon an inferred value. These data sets include: regional energy consumption and supply statistics, the respective country's national inventory, regional agricultural statistics, regional waste disposal data – as well as a range of social and economic data relating to both the region and host nation. The key issues when forming a GHG inventory is to make the best use of the data that you have available, and to maintain a clear record of how you formed the inventory. Whilst in the first instance it may not be possible to produce a highly accurate inventory (due to current data availability) it is more important to make a start.

A sceenshot of the tool can be seen below and the basic data needed to form an inventory is available from the inventory section of www.grip.org.uk.

Table A

Greenhouse Gas	GWP_{100}
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
Hydroflurocarbons	Between 140-12,100
Perflurocarbons	Between 6000-9,200
Sulphur Hexafluoride	23,900

Metrex Map



Key

- Metrex Metropolitan Regions
- Non-Metrex Metro Regions
- Intermetrexplus Partners

Map sourced from METREX.

Summary of partners GHG Emissions inventories

Tables i-iv below show the total amount of emissions released by sector. Included in the tables are the CO2eqv values (GWP100). The tables show considerable differences in the emissions released from each region. This is a function of the nature and type of activities occurring within each region.

These emissions can also be considered on a per capita basis, and per unit of economic activity (among other approaches) to make more meaningful comparisons. When considered on a per capita basis the emissions of CO2eqv are highest in Veneto at 11.25t and lowest in Stockholm at 4.6t per person, the emissions from Glasgow and the Clyde Valley were 8.8t and Bologna Province 10.9t. The CO2eqv emissions per unit of economic activity (GVA) were also highest in Veneto at 0.43t and again lowest in Stockholm; the emissions from Bologna were 0.34t, and Glasgow and the Clyde Valley 0.36t.

The figures here represent the totals for each sector. The following eight pages include a more detailed compare and contrast of the emissions estimates from each sub-sector within each region.

Table i: Bologna Province

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	CO_2eqv
Energy	8,180	5.83	2				8,922
Industrial Processes	0	0	0	70	3	0.002	121
Waste	3	11	0.06				253
Agriculture		15.6	1.43				771
Total	8,183	32	3	70	3	0	10,067

Table ii: Glasgow and the Clyde Valley

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	CO_2eqv
Energy	12,490	40.49	0.28				13,427
Industrial Processes	0	0	0	243	2.65	0	246
Waste	12.53	23.2	0.14				543
Agriculture		14.24	1.37				724
Total	12,503	78	2	243	3	0	14,940

Table iii: Stockholm County

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	CO_2eqv
Energy	6,959	1.5	0.36				7,102
Industrial Processes	0	0	0	289	0.4	0.001	313
Waste	16.5	20.99	0.05				472
Agriculture		3.1	0.5				220
Total	6,975	26	1	289	0	0	8,108

Table iv: Regionale del Veneto

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	CO_2eqv
Energy	41,822	29.2	5.3				44,078
Industrial Processes	2,000			362	15.5	0.01	2,617
Waste	16	36.86	0.34				895
Agriculture		105.11	9.16				5,047
Total	43,838	171	15	362	16	0	52,637

Inventory Comparisons

The following four greenhouse gas emissions (GHG) inventories have been produced using the newly adapted "GRIP for Europe methodology". To fully understand an emissions inventory an understanding of a region's characteristics is required. As a consequence the following section includes a comparative overview of the four pilot regions, following this emission sources and the methods used to estimate them. This is the first application of this methodology to the regions.

The inventories for Bologna, Glasgow & the Clyde Valley and Veneto have been conducted for the year 2004; the emissions inventory for Stockholm County focuses on 2003, these years were chosen simply because they represented the most recent year that data was provided locally. Each inventory includes the six main greenhouse gas emissions that emanate from the energy, industrial processes, waste and agricultural sectors.

Table 1: Regional Characteristics Summary

	Glasgow	Stockholm	Bologna	Veneto
Area(km^2)	3,405	6,519	3,701	18,390
Population	1,747,000	1,900,000	915,000	4,700,000
Households	787,000	880,000	455,100	1,852,900
GDP	€41BN	€66.5BN	€29.4BN	€121Bn
GDP per capita	€23,502	€35,000	€32,142	€25,796

Each of the pilot regions exhibits differing characteristics which include the following: the land areas which the regions occupy - these are displayed in Table 1 above. The population and household numbers in each of the regions meant that there was a varied level of population density and average numbers of occupants per household.

The Gross Domestic Product (GDP) of the regions also varied, as did the GDP per capita. In each case the regions' economies are dominated by the service industry, albeit to varying degrees. However, the percentages of the working population that are unemployed are fairly consistent between the regions.

In the GRIP methodology there are four sections, and these are: Energy; Industrial Processes; Waste; and Agriculture. A brief overview of the emissions sources included in each of these sections, together with the results of each inventory, is presented over the following pages.

Energy

The energy sector is responsible for the majority of CO_2 emissions globally. The emissions from this sector arise mostly from the combustion of fuels, with some additional emissions from the distribution and extraction of fuels. There are three greenhouse gases associated with this sector CO_2 (carbon dioxide), CH_4 (methane) and N_2O (nitrous oxide). In "GRIP for Europe" this sector includes emissions from the Domestic, Industrial, Service, and Transportation sectors, as well as fugitive emissions and emissions from energy transformation. In the GRIP approach the emissions associated with the production of electricity and heat for distribution are allocated to the consumer of each. This is done so that policy can be formed on kerbing demand and increasing efficiency.

Table 2: Domestic Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity & Heat	4,060	1,896	11,833	512	1,185	443	5,175	1,937
Gas	12,766	2,397	77	4.6	7,667	1,537	39,533	7,927
Solid	377	106	0	0	2	0.7	8	3
Liquid	990	267	2,558	682	515	284	2,855	727
Total	18,193	4,666	14,468	1,198	9,369	2,265	47,571	10,594
Households	786,768		880,000		455,100		1,852,900	
Per Household	23	5.93	16.44	1.36	20.6	4.9	25.6	5.7
Population	1,747000		1,900000		915,000		4,700000	
Per Capita	10.4	2.67	7.65	0.63	10.23	2.47	10.12	2.3

Table 2 above shows the CO_2 emissions from the Domestic sector for each region by type of fuel. Included in the table is the total figure as well as the emissions per household and per capita (person). The figures show that both the emissions and energy consumption are fairly consistent in Glasgow and the Clyde Valley, Bologna and Veneto; whereas in Stockholm they are much lower. This is mostly due to the low carbon fuels that are used in the public distribution systems in Stockholm, as well as the fact that the biomass burnt in homes within the regions are not included in the figures above. The main factors that affect energy consumption and associated emissions in the Domestic sector are the efficiency of the home, the amount of energy - consuming products in the home, the fuels used to heat and cool homes, as well as the cultural attitudes to energy consumption.

The Service Sector (Including agricultural energy consumption)

Emissions from these sub-sectors, as with the domestic sector, arise directly through the combustion of (fossil-based) solid, liquid, and gaseous fuels and, indirectly, from the consumption of electricity and heat. The service sector here includes both commercial outlets and public administration within each region.

Table 3: Services Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity& Heat	2,230	1,042	7,843	551	1,663	622	6,826	2,555
Gas	1,412	265	412	87	3,495	701	14,648	2,937
Solid	1	0.5	0	0	0.14	0.3	0.6	0.2
Liquid	71	19	1,472	108	243	18	242.5	18
Total	3,720	1,331	9,727	746	5,401	1,341	21,717	5,510

Table 4: Agricultural Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity& Heat	126	59	117	6.5	105	39	526	197
Gas	82	17	9.4	1.97	42	9	170	36
Solid	1	0.5			0	0	0	0
Liquid	218	58.5	1,472	108	669	176	2,724	715
Total	444	148	1,598	116	816	224	3,420	948

Tables 3-4 show the relative contribution that service and agricultural sectors make on energy-based GHG emissions between the four pilot regions. The data underpinning these calculations includes estimations of the quantity of energy consumed by these sub-sectors. Table 3 shows CO_2 emissions from the service sector is lowest in Stockholm and highest in Veneto.

This data, when analysed in conjunction with the next section relating to industry, highlights the disparity between the service sector (low-carbon intensity) and industry (high-carbon intensity). In particular, the data clearly illustrates how much more GHG the industrial sector emits than the services sector. These findings, however, should not be seen as a justification for reducing emissions by pushing out industry in favour of the service sector. GHG emissions are a global problem and if the products are manufactured elsewhere, their production will still consume energy and there may well be additional energy required for their subsequent transportation, which may cause further increases in overall world emissions. Thus it is important to see regional (or any other) emissions inventories within their wider context.

The agricultural element discussed in this section relates only to emissions from energy consumption associated with agricultural activities. We look at the non-combustion activities of the agricultural industry that may give rise to GHGs under the section Agriculture. These two areas are presented separately to maintain consistency with other inventory approaches. Interestingly these are highest in Bologna and Lowest in Veneto. The data used to tabulate these emissions are not purely bottom-up and, therefore, entail a higher degree of uncertainty than measured data would. The figures displayed above use the apportioning methods within “GRIP for Europe” to allocate energy consumption to the respective sectors.

Industrial Energy Emissions

There are too many sub-sectors in the industrial category to list them all below; as a consequence the total emissions from industry are presented. The emissions below include those resulting from the combustion of solid, liquid and gaseous fuels and indirectly from the use of electricity and heat within industry. The colour coding only works at the higher levels of specificity, however all methods used to estimate emissions were at least GRIP level 2.

Table 5: Total Industrial Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity & Heat	2,878	1,408	3,510	247	2,213	829	17,117	6,407
Gas	3,172	596	307	65	2,975	597	16,149	3,238
Solid	433	109	0	0	1,245	319	5,046	1,290
Liquid	1,821	134	2,174	563	215	65	2,125	641
Total	8,304	2,247	5,991	875	6,648	1,810	40,437	11,576
GVA Industry €m	10,450	10,450	10,779	10,779	8,669	8,669	41,165	41,165
Per Unit GVA	0.79	0.22	0.56	0.08	0.77	0.21	0.98	0.28

In terms of emissions per unit of Gross Value Added (GVA) these are highest in Veneto, and lowest in Stockholm. The GCV region emits the medium amount of emissions from industry per unit of GVA of the four regions. All of these figures are determined by the nature and type of industry activity within each region, and the fuels that they consume. Some industries, for example the Chemical industry, and Iron and Steel, consume a lot of energy per unit of economic value. There are additional emissions associated with industry: these arise mainly from chemical reactions in production processes, and are considered under the section entitled “Industrial Processes”.

These figures have been estimated using a combination of top-down and bottom-up data. This falls under GRIP level 2 and, although they are deemed to be the most accurate data currently available, the results carry a degree of uncertainty. Nevertheless, by using this data, policy makers are given a real insight into the emission levels associated with industrial activity located in the Stockholm County area. With this level of information, a more targeted approach to mitigation becomes possible.

Energy Industry

The energy industry emission figures presented below include those from the following sub-sectors:

- petroleum refining;
- coal extraction;
- coke manufacture;
- blast furnaces;
- pumped storage energy consumption;
- oil and gas extraction.

Emissions from the sub-sectors under GRIP are assigned to the region according to where the level of activity is based. There are no petroleum refineries, coke manufacture, blast furnaces or oil and gas extraction taking place in the any of the four pilot regions.

Table 6: Energy Industry Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity	0	0	0	0	0	0	0	0
Gas	25	5	0	0	0	0	0	0
Solid	16	3	0	0	0	0	0	0
Total	41	8	0	0	0	0	0	0

The fact that there are no emissions from these energy industries is indicative of the absence of the sites within the region. The GRIP approach separates the emissions by fuel type and activity, so that the results enable a more informed and targeted understanding of emissions within the region. The uncertainty surrounding the results for this sub-sector in this inventory run is quite low as they have all been calculated using GRIP level 1. The emissions from Glasgow relate to the coal extraction there.

Fugitive emissions from the energy sector

Fugitive greenhouse gas emissions occur unintentionally as a result of particular activities. Under GRIP, the fugitive emissions that are considered are those resulting from venting and flaring of natural gas and oil; leakages from the gas distribution network; electricity losses; and methane released during coal extraction. The GCV region is the only one of the four regions that has any coal mining activity, which accounted for 15% of the UK’s coal extraction in 2004.

Fugitive losses of natural gas, CH_4, (this is gas lost during its transmission) is estimated on the basis of throughput of gas within the region; the level of leakage is different within each country and this is reflected in table 7 below. The emissions relate to the fuel lost in the transmission of energy. These are considered separately as they are a potential mitigation source in themselves.

Table 7: Fugitive Emissions the Four Regions

Fuel	Glasgow		Stockholm		Bologna		Veneto	
	Consumption (GWh)	CO_2 eqv	Consumption (GWh)	CO_2 eqv	Consumption (GWh)	CO_2 eqv	Consumption (GWh)	CO_2 eqv
Electricity	865	404	1,544	109	420	157	2,401	899
Methane	38.4	806.4	1	21	5	105	25	525
Total	903	1,287	1,545	132	425	272	2,426	1,474

Transport

Emissions from transport are considered in two categories under GRIP: firstly, emissions from the direct combustion of petroleum-based liquid fuels (motor spirit , DERV, natural gas, marine fuel, aviation spirit and aviation turbine fuels); and secondly, electricity consumption, mostly in the railway network.

Under the GRIP approach, road transport includes: cars (private and business); buses; light goods vehicles (LGVs); heavy goods vehicles (HGVs); motorcycles; and airside support vehicles.

The data for the inventories is based upon data sets taken from the email correspondence with representatives in the respective regions. Whilst the figures are considered to be the best and most consistent available, the data does present uncertainties. This is due in part to the level of GRIP used to estimate the emissions, but can also be due to inaccuracies in national representation – especially in terms of aviation and marine energy consumption and emissions.

Under international standards, emissions from aviation are reported, estimated on the basis of a combination of fuel consumed by domestic flights and international take-off and landings under altitudes of 3000 feet. This approach is mirrored in GRIP, the figures do not include international aviation cruise emissions and are therefore far lower then may be expected. Without international emissions, which are not included in the totals provided to the guidelines, a true picture of transport emissions may not be drawn. However, when conducting an emissions inventory on this scale the mechanism via which to allocate these emissions to a given area becomes contentious. For example, allocating all emissions of a plane's flight to a set region ignores the fact that some or all of the passengers, and freight, may originate from an entirely different region. In addition if a region has no airport, does this mean that its inhabitants who fly and therefore create the demand that causes the emissions are ignored?

Marine-based emissions in the national inventory include all transport that takes place on inland waterways and within 19.3km of shore. These emissions are those that are associated with harbour operations and inland waterways. International marine emissions may also be significant but are not included. Bunker fuels, whilst stated nationally, are not included in emissions totals, and are expected to under represent emissions figures due to tankering . Under GRIP only the former emissions are presented (although it can be extended to include these).

In national inventories only liquid fuel-based emissions from rail-based sources are included. This is because the emissions associated with electricity usage on railways (light and mainline) are captured within the power production section. The GRIP methodology however includes these emissions associated with rail-based electricity consumption.

Table 8: Road Transport Fuel Consumption and Emissions the Four Regions

Fuel	Glasgow		Stockholm		Bologna		Veneto	
	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Petrol&Diesel	12,204	3,178	12,544	3,251	7,841	2,041	39,883	10,356
Natural Gas	0	0	32	6	79	16	79	16
Total	12,204	3,178	12,576	3,257	7,920	2,057	39,962	10,372

Table 9: Rail Transport Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity	122	57	1,093	77	90	34	368	138
Diesel	184	49	109	29	30	9.5	122	39
Total	306	106	1,202	106	120	43.5	490	177

Table 10: Marine Transport Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Diesel/Marine Diesel	101	26.47	767	202	0	0	2,085	559
Total	101	26.47	767	202	0	0	2,085	559

Table 11: Aviation Transport Fuel Consumption and Emissions the Four Regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Kerosene	326	84	1,086	286	231	59	940	239
Total	326	84	1,086	286	231	59	940	239

The results show, when considered on a per person basis that road-based emissions are highest in Bologna, followed by Veneto and Glasgow and the Clyde Valley; Stockholm County's emissions per person are the lowest. This lower level of emissions per person in Stockholm is reflected in the higher level of public transport use.

Industrial Processes

Industrial process emissions result from chemical reactions (from industrial sites) that release GHG and from the consumption of GHGs directly (in products such as air conditioning units). They do not include those emissions that occur as the result of the combustion of fossil fuels: these are dealt with under the energy sector above. Estimates of emissions from industrial processes within GRIP are made in relation to individual sites or groups of activities. This is done so as to be in keeping with international standards. Within each of the countries studied in the pilot phase, the operators of IPPC Part A (large emitting sites) regulated plants are required to supply emissions estimates to the relevant national and/or regional regulatory bodies on an annual basis. These estimates may be based on fuel use, mass balances, direct measurement or other methodological approaches. The industrial processes sector is the only one that includes the six main GHGs.

Based on communication with the regions Veneto was the only region identified as having any industrial sites releasing these emissions. These all emanated from "cement production", together these sites were estimated to release 2,000MtCO_2 (GRIP level 2).

All regions were deemed to be releasing emissions from the direct consumption of HFCs & PFCs, these were all estimated using the GRIP level 1 approach. As these data tables are quite large only the totals are included below.

Table 12: Industrial Processes Emissions Summary

Sub-sector and region	Kt PFC (CO_2eqv)	Kt HFC (CO_2eqv)	Kt SF_6
Consumption of Halocarbons and SF6 –Bologna Province	70	3	0.002
Consumption of Halocarbons and SF6 – Glasgow & Clyde Valley	243	2.65	0
Consumption of Halocarbons and SF6 – Stockholm County	289	0.4	0.001
Consumption of Halocarbons and SF6 – Regione del Veneto	362	15.5	0.01

When considering emissions from the Industrial Processes sector, as with all sectors they need to be considered in terms of their national and worldwide context. If we require cement, windows, metals or chemicals products, then the emissions associated with them will occur somewhere regardless of the locations at which the products are used. Therefore, any emissions mitigation strategy needs to be considered in terms of what is practical and necessary. This will be determined by the cost and availability of mitigation technologies, as well as alternative products. Removing the sites from a region may decrease regional and, potentially, national emissions, but their relocation elsewhere will have no effect on worldwide emissions, and, indeed, it may even increase them, particularly if they are situated in countries with a lower level of environmental regulation . In addition, if these products are produced elsewhere, they may need to be transported back to the given region, which are likely to further increase overall worldwide GHG emissions.

Agriculture

Emissions from agricultural soils and animal activities are very important due to their contribution to overall GHG levels and, subsequently, calculation of emissions has been considerably extended. Generally speaking (in a national emissions inventory) emissions of N_2O are most significant in this sector.

The largest source of agricultural methane emissions arise from enteric fermentation with emissions from animal wastes coming second. The levels of emissions in a given year are dependent on the number and type of farm animals, with dairy cattle being the most significant.

In terms of manure management, methane emissions from manure management are considered separately to emissions from enteric fermentation, as the method by which the excreted waste is treated directly affects the emission level. Where the animal waste is deposited, it is directly related to the emissions levels. Separating the sources in this way also gives a more detailed picture of the agricultural sector.

Emissions from agricultural soils are considered in terms of the level of nitrogen applied to the soils through fertilizers. This nitrogen is then considered in terms of where it is released, including: direct emissions from soils; indirect emissions associated with atmospheric deposition; and nitrogen leaching and run-off.

Agricultural emissions occur as the result of the activities that provide our sustenance and are an unavoidable aspect of our lives. We can, however, take steps to minimise them as well as emissions associated with them. However, a wider understanding of agriculture is required, one that encapsulates regional, national and worldwide issues.

Being a series of regions within affluent westernised countries, we have become used to a year-round supply of agricultural produce that is out of synchronisation with our own production abilities. We have grown used to our trips to the supermarket yielding a plentiful supply of apples or bananas, no matter whether it is the middle of winter or at the height of summer. The origin of these products is often portrayed in a positive light and their availability is seen as a good thing even if they have been shipped or flown in from the other side of the world (thereby creating emissions). This transportation would not occur if it were not for the demand for these products.

The levels of emissions from agriculture are climate-related, with particular crops, such as rice, only being produced in particular environments. Different levels of heat create different levels of emissions. Combating emissions from agriculture requires thought of both supply and demand. By creating a fixed year-round demand for agricultural produce, most particularly for perishable and air-freighted goods e.g. exotic fruits, we are increasing worldwide carbon emissions from transport. The desire for such products is a fairly recent one that has developed as a result of cheaper transport and has led to concern over ‘foodmiles' (DEFRA 2005).

Table 13: Agricultural Emissions Summary

	Glasgow		Stockholm		Bologna		Veneto	
	Kt CH_4	Kt N_2O	Kt CH_4	Kt N_2O	Kt CH_4	Kt N_2O	Kt CH_4	Kt N_2O
Enteric Fermentation	12.48		3.1		12.		88	
Manure Management	1.76		0.043		2.7		15.1	
Animal Waste Management		0.07		0.03		0.2		1.21
Agricultural Soils		1.3		0.47		1.2		7.95
Total	14.24	1.37	3.1	0.5	15.6	1.4	103.11	9.16
Total GWP	724		220		762		5,004	

Waste

The waste sector in the GRIP inventory covers emissions from landfill operations, as well as GHG releases from other waste treatment and disposal activities, such as waste incineration without energy recovery and sewerage treatment. Under the GRIP methods, if any waste imported into the region for treatment or disposal gives rise to GHG releases, the emissions are assigned back to their original locality. And conversely, if any waste is exported by the region to other regions for treatment and disposal, the associated emissions are assigned to the focus region. In other words, the emissions are assigned to the region that produces the waste, not the region that treats it or disposes of it.

Methane emissions from landfill sites occur as a result of the degradation of biodegradable waste, although some of this methane is recovered and put to other uses. Emissions are calculated on the basis of total waste deposited to landfill sites in a given year, in line with national and international standards. The results show, when considered with the population, that Veneto emits the least emissions per capita, followed by Stockholm, and Bologna with Glasgow emitting the most per capita.

Table 14: Waste Management Emissions Summary

	Bologna			Glasgow			Stockholm			Veneto		
	Kt CO_2	Kt CH_4	Kt N_2O	Kt CO_2	Kt CH_4	Kt N_2O	Kt CO_2	Kt CH_4	Kt N_2O	Kt CO_2	Kt CH_4	Kt N_2O
Solid Waste Disposal on Land		9			18.9			21			28.1	
Wastewater Handling		1.7	0.05		4.26	0.4			0.05		8.84	0.3
Waste Incineration	3.1	0	0	12.5			16			16.02	0.01	0.04
Total (CO2eqv) GWP100	3.1	224.7	15.5	12.5	487	124	16	441	15.5	16.02	776	105.4

Conclusions

The results presented here represent the most detailed and consistent inventories carried out across regions on this scale. The methods allow direct comparability with each region; the validity of such comparisons will increase over time and as more regions take part. The results here are based on calculations that use the best and most consistent data currently available. The results show the relative contributions of the Energy sector, Industrial Processes sector, Agricultural and Waste sectors to emissions within the four regions. The emissions estimates that the inventories provide form a platform on which subsequent analysis can be based, over the near-, medium- and long-term. Such work is important, as it can provide an insight into the potential effects that differing policies, taken at European, national, regional and local government level, may have on regional scale emissions (Lindley, 1999). The data behind each of these inventories can be used to populate the “GRIP scenario tool” for each region to use. The data for the Glasgow and the Clyde Valley Regional Inventory was used for this purpose. In the next few pages how this scenario tool was used is discussed, and the results from the scenario exercises are presented.

Scenario Workshops

The results from the GCV GHG inventory provided the quantitative platform for the GRIP scenario model, which through its user interface, was used by regional policymakers to develop GHG regional mitigation scenarios at three workshops held between 30th April and 2nd May in Glasgow. A list of scenario workshop partner organisations and their organisational responsibilities are set out below:

Organisations attending Scenario Workshop:

- Glasgow and the Clyde Valley Structure Plan Joint Committee: Strategic Development Planning Joint Committee (www.gcvcore.gov.uk),
- East Dunbartonshire Council: Local and Strategic Development Planning Authority (www.eastdunbarton.gov.uk),
- East Renfrewshire Council: Local and Strategic Development Planning Authority (www.eastrenfrewshire.gov.uk),
- Glasgow City Council: Local and Strategic Development Planning Authority (www.glasgow.gov.uk),
- Inverclyde Council: Local and Strategic Development Planning Authority (www.inverclyde.gov.uk),
- North Lanarkshire Council: Local and Strategic Development Planning Authority www.northlan.gov.uk),
- Renfrewshire Council: Local and Strategic Development Planning Authority (www.renfrewshire.gov.uk),
- South Lanarkshire Council: Local and Strategic Development Planning Authority (www.southlanarkshire.gov.uk),
- West Dunbartonshire Council: Local and Strategic Development Planning Authority (www.wdcweb.info),
- Scottish Government: Devolved government for Scotland (www.scotland.gov.uk),
- Transport Scotland: National Transport Agency (www.transportscotland.gov.uk),
- Forestry Commission Scotland: National Forestry Department (www.forestry.gov.uk/scotland),
- Scottish Environment Protection Agency: National Environmental Regulatory and Advisory organisation (www.sepa.org.uk),
- Scottish Natural Heritage: National natural heritage organisation (www.snh.gov.uk),
- Communities Scotland: National Regeneration agency (www.communitiesscotland.gov.uk),
- Scottish Enterprise: National economic development agency (www.scottish-enterprise.com),
- Network Rail: National Rail Infrastructure Organisation (www.networkrail.co.uk),
- Strathclyde Partnership for Transport: Regional Transport Planning Authority (www.spt.co.uk),
- BAA Glasgow: Operating company of Glasgow Airport (www.glasgowairport.com),
- Glasgow Chamber of Commerce: Organisation of Glasgow businesses (www.glasgowchamberonline.org).

Kahn and Weiner (1967) defined scenarios as: "…hypothetical sequences of events, constructed for the purpose of focusing attention on causal processes and decision points" (Kahn and Wiener 1967). In a similar fashion, Rotmans (2000) viewed scenarios as representing a plausible, internally consistent and recognisable story, designed to explore paths into the future. While these definitions appear to suggest that scenarios offer a set of predictions or forecasts, this should never be considered the case.

A scenario is not a prediction of how the future will unfold but rather how it might unfold and this process enables the potential consequences of scenarios to be explored and planned for in terms of assessing the need for adapting current human behaviour and mitigating the impacts.

The aim of the workshops was for participants to explore the possibility of reducing regional CO_2 emissions by around 80% by the year 2050. The percentage reduction figure and target date are not arbitrary; they are linked to atmospheric carbon futures identified by the Intergovernmental Panel for Climate Change (IPCC) Fourth Assessment Report (2007) and is seen as the best possible scenario, given previous global emissions, if globally the world is to avoid a 450 ppmv atmospheric concentration and a 2 degree rise in global mean temperature, which are suggested as the 'tipping-point' for the global climate (Commission of the European Communities, 2007: 2).

Subsequently, the 80% target is also in line the non-mandatory figure set out in the Scottish Executive's proposed draft Climate Change Bill in June 2007 (Cook, 2007).

The second aim of the scenario exercise was to backcast these GHG mitigation scenarios to 2025, in order to establish the perceived energy requirements of the GCV region of each scenario at the end of the Glasgow and Clyde Valley spatial development plan timescale. These medium-term targets can then be used for further qualitative analysis of the current climate change impact of the Glasgow and Clyde Valley 2006 Alteration and potentially identify the requirements for policy changes in the GCV area if the 80% target is to be met by 2050. It is important to recognise the need for interim targets, as mitigating climate change is not purely about what is emitted in 2050 – but what we emit between now and then. This has been referred to as our "carbon budget" or "cumulative emissions".

The scenario process consisted of semi-structured group interviews in which stakeholders were asked to reach a consensus quantitative and qualitative vision whilst inputting their own personal quantitative perspective into the GRIP model scenario tool on their own PC unit in terms of:

- A percentage change in energy demand by sector relative to the base year (restricted to a 100% decrease and a 300% increase),
- The fuel composition in percentage splits for each sector (non-restricted),
- The secondary energy-generating technologies and percentage splits (non-restricted),
- Annual average economic growth (non-restricted),
- Economic structure (non-restricted),
- Demographic change (non-restricted).

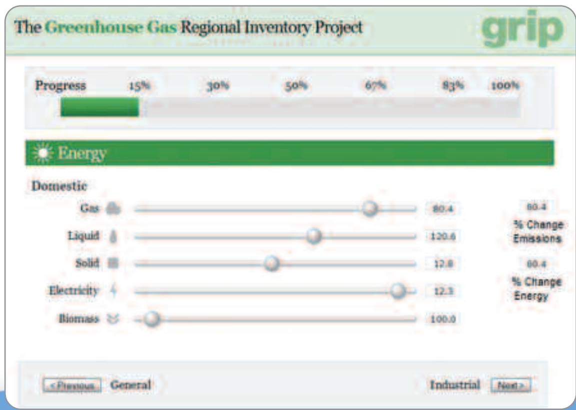
This led to the production of thirty different quantitative visions, and three quantitative and qualitative scenarios. These latter three scenarios are presented and discussed over the next eight pages.

The three workshops each reached a consensus on the emissions reduction possible by 2050, the resultant reduction in energy usage was then calculated:

- Day 1 2050 – Emissions reduction 78%; Energy consumption change -37%,
- Day 2 2050 – Emissions reduction 77%; Energy consumption change -29%,
- Day 3 2050 – Emissions reduction 78%; Energy consumption change -34%.

Overall, none of the workshops managed to reach the stated aim of an 80% reduction and each workshop took a slightly different approach to reaching the target in terms of differing proportions of the overall GHG emissions reduction being sourced from: energy efficiency measures or increasing proportion of energy supplies of less-carbon intensive energy sources and using less energy overall.

(Screenshot below). The "GRIP Scenario Tool" or decision aid, adapted for the GCV region allowed the participants to "act as God", where the only constraints on the scenario exercise were the purpose of the scenario and the individual's own beliefs. The scenario tool, therefore, achieves its purpose as a means by which to bridge the gap between a qualitative storyline that an individual holds and their associated quantified variables in terms of energy needs and resources. Within the scenario process undertaken the stakeholders (decision-makers) were free to explore different energy options, without revising their views, the structure of their images (perceptions of the future), or even the goal of the exercise (the 80% reduction). With the 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).



Scenario Workshops (continued)

The following policy documents were published when stakeholders were discussing the formulation of scenarios and gave a general context to their discussions:

The GCVSPJC 2006 Structure Plan, is the regional spatial planning document, which sets out a strategic vision for Glasgow and the Clyde Valley to become amongst the most attractive business and residential locations in Europe because of the improved quality of the transport system, the labour force and the physical environment.

The 2006 Structure Plan sets out an Agenda for Sustained Growth, which aims to achieve a major shift in the competitive position of the Glasgow and the Clyde Valley area. This agenda is based on a faster rate of development than was assumed in the previous spatial land-use planning document in 2000 and is based on sustaining the rate of improvement of the economy which has been experienced in recent years. In the short-term to 2011, the planning aim is to provide for 53,000 additional households and 30,000 extra jobs in the area and to 2018, a further 56,000 and 40,000 respectively (see Table below).

Table B: Scale and Phasing of Agenda for Sustained Growth

	2002	2011	2018
Jobs	850,000	880,000	920,000
Households	777,000	830,000	886,000

In the Draft UK Climate Change bill was published by the UK government in March 2007 and proposed a 2050 60% reduction target by 2050. The draft bill was not in line with the Intergovernmental Panel for Climate Change (IPCC) recommendations and the European Parliament's high-end reduction target to limit global temperature increases to 2 degrees Celsius and so limit the impacts of climate change (Commission of the European Communities, 2007: 3; Intergovernmental Panel for Climate Change, 2007)

A key piece of Scottish Government policy has also been published in March 2007 Scottish Planning Policy 6 (SPP6): Renewable Energy. This document outlines Scottish Minister's target of generating 40%, quantified as six gigawatts, of Scotland's electricity from renewable sources by 2020. SPP6 outlines that the planning system used be used to support and encourage the continued growth of all renewable technologies and in particular development plans should set out a spatial approach for considering wind farm proposals over 20 megawatts.

At the local government level the need to address climate change has been identified and has resulted in January 2007 in all 32 local authorities in Scotland signing Scotland's Climate Change declaration. The declaration expresses Scotland's local authorities intent and it outlines a commitment to take action against climate change. Various actions are outlined including reducing greenhouse gas emissions through their own operations, identifying measurable targets and timescales, incorporating adaptation measures into plans and encouraging local communities to take adaptation and mitigation action.

These local, regional and national policy developments complemented the recent Commission of the European Communities (2007:2) An Energy Policy for Europe which seeks to achieve a 20% reduction in greenhouse gas emissions by developed countries compared to 1990 levels by 2020. The European Union (EU) also recognise once a new international commitment exists that Europe will need to increase the target to a 30% reduction by 2020 and 60-80% by 2050. The EU Energy Policy also seeks to secure Europe's energy supply, stimulate the economy through technological development and secure more jobs for its citizens.

Lessons Learnt

The testing of the GRIP for Europe GHG methodology and GRIP scenario tool has identified a number of issues to be addressed in future applications.

There was a tendency during the InterMETREXPlus project to have mostly public sector agencies represented at the GCVSPJC scenario workshops. This was due to the short timescale available to organise the project workshops once continuation funding and local government political approval had been obtained. This potential bias towards the public sector perhaps resulted in a consensus being reached which might have been challenged by other private sector interests if they had been available to attend.

In future, the process of developing mitigation scenarios and a favoured mitigation strategy will require high-level participation, whether from senior management of stakeholder organisations or from local, regional and national politicians, if the best use of the GRIP Scenario tool is to be made. The GRIP tool is an integration tool for corporate management, whether public or private, The InterMETREXPlus project was attended by middle-level managers of the various stakeholder organisations, but it was recognised that if a favoured scenario, i.e. strategy were to be implemented, it would require further political buy-in from higher-level decision makers within and outwith the Glasgow and Clyde Valley area.

In the context of any future work on the spatial planning response to Climate Change, whether through the EUC0_2project, if INTERREG IVC funding is awarded, or through a specific metropolitan study, and acknowledging the need for wider participation, the GCVSPJC have made initial approaches to the Climate Change Business Delivery Group (CCBDG) in order that a better balance of sectoral views can be achieved. The CCBDG is a private-sector discussion forum, with Government observers, which enables members to share ideas and challenge Scottish businesses to do more to tackle climate change (Scottish Government, 2007).

The InterMETREXPlus project extension has also highlighted the strategic nature of the model and the potential linkages to other localised implementation specific emissions assessment tools. The project has led to initial discussions between GCVSPJC and the Sustainable Scotland Network (SSN) about exploring further the linkages between these tools. There is the potential for creating a hierarchical network of tools, with GRIP seeking to provide the strategic direction and other tools monitoring in detail the implementation of climate change policies.

The discussions emerging from the GRIP model process have also highlighted the role that GRIP could play in providing baseline data for the Climate Change objectives of the Strategic Environmental Assessment (SEA) of spatial planning documents as required by European Directive 2001/42/EC. This approach could provide a clear and consistent baseline dataset and agreed C0_2 mitigation strategies adopted by a variety of stakeholders, including relevant experts from the SEA Consultation Authorities, running in parallel with and informing further the spatial planning process.

It is also important to highlight that the GRIP model did demonstrate clearly its contribution to all five stages of the preparation of spatial planning strategies which incorporate mitigation. Table C below shows how regional planning strategies could effectively consider climate change mitigation.

Table C: Stages in climate change policy preparation

Stage	Mitigation
1	Establish robust baseline data GHG emissions
2	Detailed analysis of the potential impacts of new policy options assessed against baseline conditions
3	Establish transparent GHG reduction trajectories
4	Policy action to reduce emissions in line with reduction targets. This should emphasise delivery and consider all available mechanisms.
5	Effective monitoring and review

Source: adapted from Shaw (2007)

The InterMETREXPlus project has enabled the Joint Committee to complete Stage 1 of the above process and has provided the basis for the further investigation of new policy options as outlined in Stage 2. In relation to Glasgow and the Clyde Valley, it also demonstrated the spatial implications of some of the sectoral aspects of the energy scenarios developed by stakeholders. The scenarios have also enabled broad GHG reduction trajectories through the backcasting of GRIP scenario targets to 2020, as identified in Stage 3 of Table C. This will enable the beginning of a discussion on Glasgow and Clyde Valley regional policy action under Stage 4. The GRIP model methodology also has enabled the monitoring and review of the climate change policy under Stage 5 by undertaking another GHG inventory in a future base year and repeating the process, thus facilitating monitoring of previous strategy.

The Day 1 Scenario

$C0_2$ emissions change	reduced by 78%
Energy Emissions change	reduced by 37%

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.

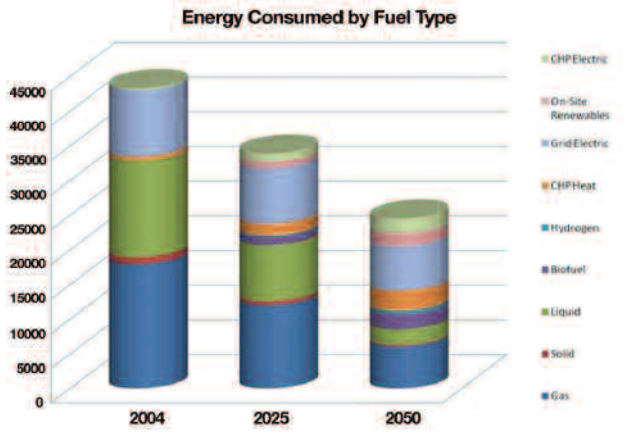
Transport

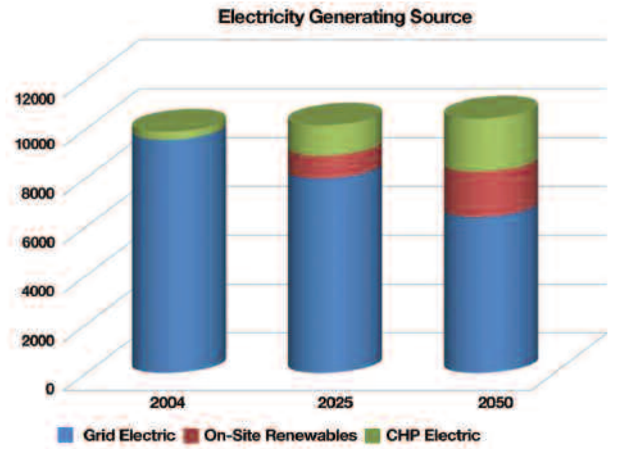
The location of Loch Lomond just 40mins away made the region an attractive location to live, accessibility to the loch is provided by electric buses. Climate change led to large alterations in the way in which vehicles are propelled and how the transportation structure was formed. A variety of innovative 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.

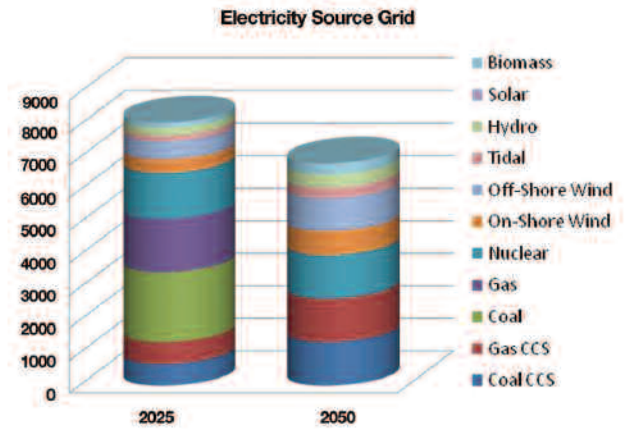
Hydrogen was first seen in the transportation sector, with flagship approaches on public transport – such as hydrogen buses leading the way early on. Otherwise hydrogen was used as a form of storage on a distributed national grid.

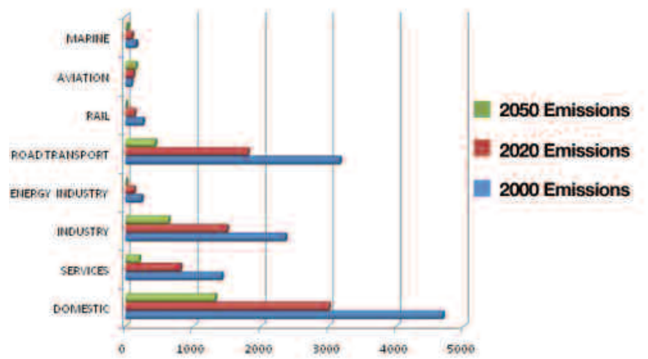
Environment

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

$C0_2$ emissions change	reduced by 77%
Energy Emissions change	reduced by 29%

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

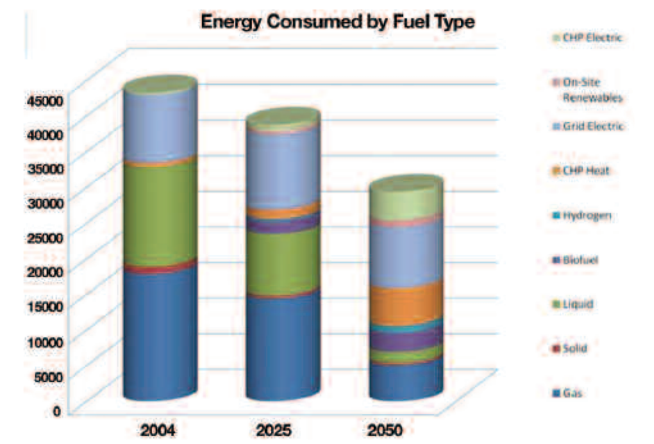
Over the past fifty years the desire for car ownership has remained strong, however due to policy measures the amount of vehicle miles travelled has remained relatively similar. The largest changes in emissions have come from strong policy on minimum standards imposed on a central European basis. These 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).

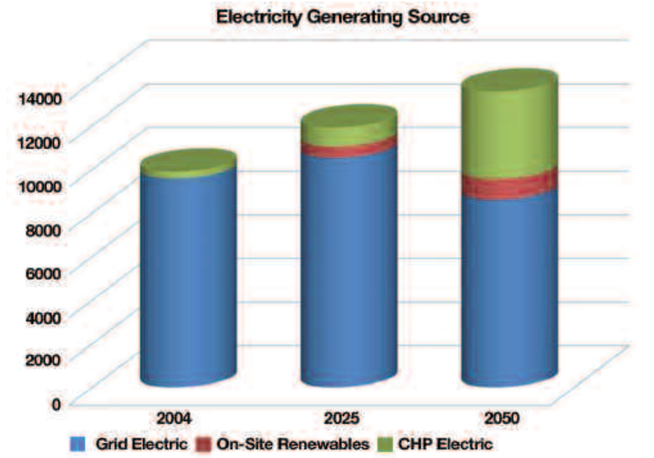
Rail stations saw their platforms extended, with operations management regarding rail being improved. This saw more carriages during peak times. An extension of the transport system in the form of light rail. With super high speed links connecting Edinburgh (20mins), Aberdeen and the South (London in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

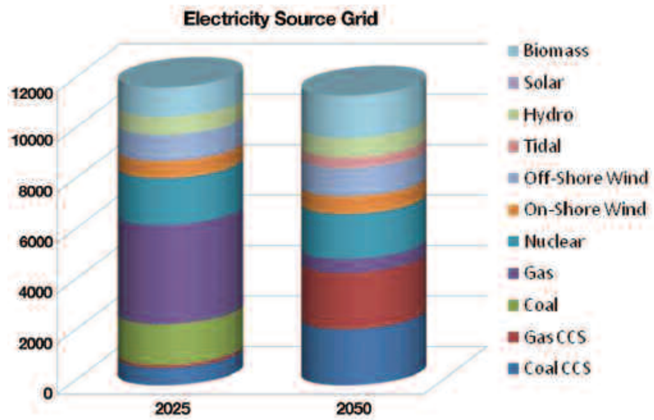
Passenger miles on planes increased as the aviation sector continued to grow – this has offset a lot of the emission gains and are not included in the overall figures here. However, average loads of the aviation fleet increased to over 90% (across all carriers). Improvements in the efficiency of planes 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.

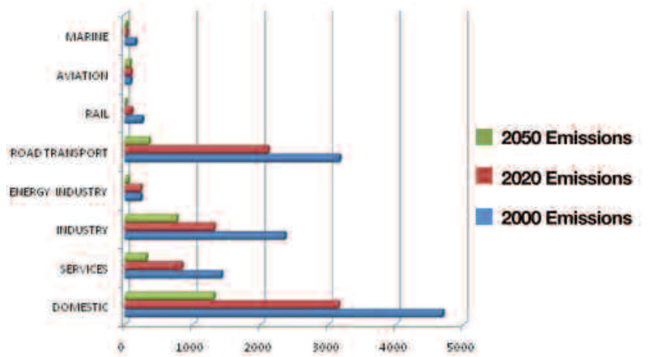
Environment

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

CO_2 emissions change	reduced by 78%
Energy Emissions change	reduced by 34%

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.

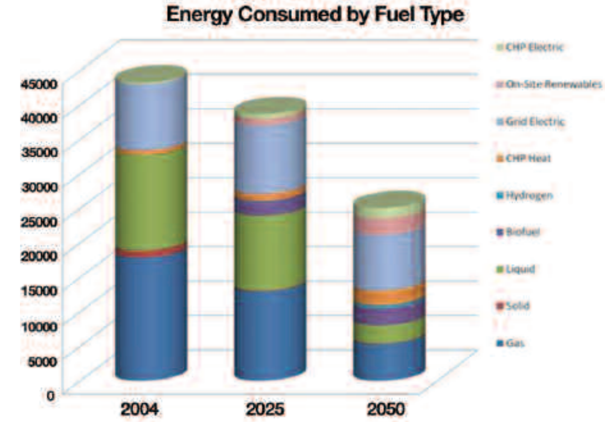
Transport

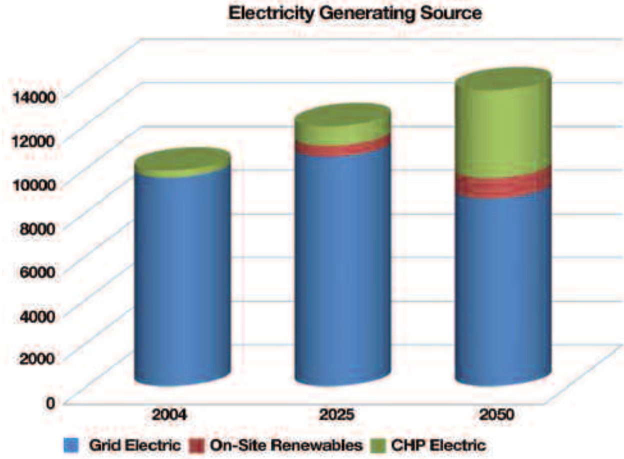
The use of "Smart" low energy consuming cars took off in the early part of the century, this has led to road vehicles in Europe being generally highly efficient. In addition women and "the urban young" in particular have chosen to move to electric cars. In combination with this societal change in demand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

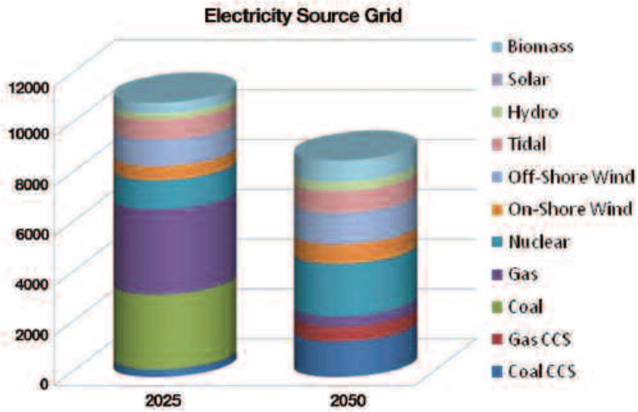
This road charging included a congestion charge that was imposed during 2025, this was an innovative initiative that permitted 'sectorising' this spread out the traffic passing through the city over the course of the day. There has been some growth in car ownership but balanced by good public transport 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.

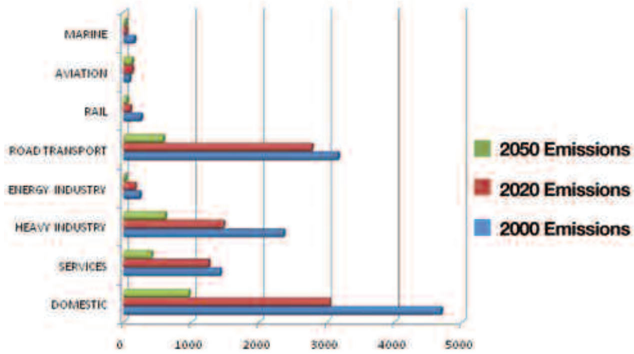
Environment

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









Policy Analysis

The outputs from the three stakeholder scenario workshops has since been the subject of further analysis to determine the spatial planning implications of the GHG emissions mitigation scenarios and possible consequences for the GCV Metropolitan Development Strategy.

Two areas where Metropolitan regions (through policy measures) can restructure their existing urban form in order to reduce emissions and increase sustainability are:

- Reducing the need to travel,
- Increasing opportunities to use low carbon energy.

One of the current priorities for Planning in Scotland is better integration between transport and land-use planning, as detailed in Scottish Planning Policy 17: Planning for Transport. Transport planning is also a sector where high-resolution spatial modelling facilities are available. Therefore, this paper takes forward potential policy responses to reducing the need to travel and increasing opportunities to use low carbon energy in a transport planning context.

Spatial planning policy can seek to enable a reduction in travel of its inhabitants by providing development which facilitates multi-purpose trips and/or shorter travel distance through higher densities, mixed uses, multi-purpose centres with excellent public transport connections, teamed with planning regulation and incentives. Also, spatial planning can seek to provide the framework for the delivery of integrated low carbon transport, enabling a sustained level of movement for metropolitan residents, but with lower emissions. Public and private sector could also offer incentives to use lower carbon transport. However, in the current context, some of these measures will achieve only efficiency savings, but not the structural changes needed to meet emissions targets for 2050. Road transport is such a dominant mode of personal movement that dis-incentives to its use will be required to generate significant emissions reductions, as evidenced by cities where road user charging, in its various forms, have been introduced.

Policy Option Analysis: Road Transport

The Glasgow and Clyde Valley regional transport authority, Strathclyde Partnership for Transport (SPT), in association with the GCVSPJC, has developed the Strathclyde Strategic Transport Model (STM) and associated integrated land-use/economic model (DELTA) into an integrated land-use – transport modelling tool (SITLUM) to assist policy development for the Glasgow and Clyde Valley area. Therefore, it was identified that this strategic transport model could enable a detailed analysis of the potential impacts of new policy options for road transport assessed against baseline conditions. Consequently, the 2025 reduction scenarios for road transport, generated by each workshop group through backcasting from 2050 to 2025, have been analysed by comparing them to the outputs of the regional transport model for a series of transport scenarios to 2021, which is the current end year of SPT Strategic Transport Model.

The backcast emissions targets for road transport to 2025 from the three workshops have been calculated and an average reduction in emissions by 2025 has been identified. Road transport requires a 30% reduction in emissions by 2025, if the average of all scenarios is taken. The workshop scenarios for 2025 ranged from a high of 43% reduction in emissions by 2025 to a low of 13%.

Table D below details the nineteen (19) separate policy tests undertaken using the strategic transport model to analyse the impact of different policies within the wider socio-economic context for the region in terms of population, employment and greenhouse gas emissions.

Table D: SPT Strategic Transport Model Policy Test Results 2001-2021

Test No.	Description	Population (%)	Jobs (%)	CO_2 (%)
Cordon Charging Policies				
B6	Glasgow Conurbation, Inbound and through £1, AM and Inter peak, Inception Year 2007	1.0	0.3	-1.3
B7	Glasgow Conurbation, Inbound and through £3, AM and Inter peak, Inception Year 2007	1.7	0.2	-3.6
B8	Glasgow Inner conurbation, Inbound and through £1, AM and Inter peak, Inception Year 2007	1.7	0.7	-3.2
B9	Glasgow Inner conurbation, Inbound and through £3, AM and Inter peak, Inception Year 2007	5.1	0.9	-6.4
J8	City Centre Only, Inbound and through £3, AM and Inter peak. Inception Year 2007	-1.4	1.9	-11.6
	Cordon Charging Policy Average Total	**1.6**	**0.8**	**-5.2**
Road User Charging				
B4	20 pence per Kilometre, SPT wide, AM and Inter peak, Inception Year 2007	1.8	1.5	-25.1
B5	40 pence per Kilometre, SPT wide, AM and Inter peak, Inception Year 2007	3.5	-0.3	-44.3
I9	5 Regions, doubling charge between 2011- 2019, Region 1 - 4 pence by 2019 to Region 5 – 40 pence by 2019	0.5	3.2	-25.2
	Road User Charging Average Total	**1.9**	**1.4**	**-31.6**
Road User Charging & Cordon Charging				
J2	Same as I9 + Inner conurbation through charge of £2 from 2009, £3 from 2015	5.5	2.7	-24.6
J3	Same as I9 + Inner conurbation inbound cordon charge of £2 from 2009, £3 from 2015	1.5	3.8	-28.8
J4	Same as I9 + Inner conurbation inbound and through cordon charge of £2 from 2009, £3 from 2015	6.7	2.5	-27.4
J5	Same as I9 + Conurbation 2 through cordon charge £2 from 2009, £3 from 2015	0.8	3.1	-26.2
J6	Same as I9 + Conurbation 2 Inbound cordon charge £2 from 2009, £3 from 2015	0.9	3.2	-25.8
J7	Same as I9 plus Scotland Charge as Region 1, Edinburgh area as Region 4	0.9	2.1	-26.3
J9	Same as I9 plus Scotland charge as Region 1, Edinburgh Inner as Region 4, Edinburgh Central as Region 5	0.9	1.9	-26.3
	Road User Charging & Cordon Charging Average Total	**2.4**	**2.7**	**-26.4**
Public Transport Policies				
G5	Bus: Fares 10% Decrease, Speed 10% Increase, Service Level 10% Increase	0.2	0.4	-0.6
G6	Rail: Fairs 10% Decrease, Speed 10% Increase, Service Level 10% Increase	0.1	0.1	0.4
H1	Low Carbon Public Transport Combination Test 2	0.4	0.6	-2.1
	Public Transport Average Total	**0.2**	**0.3**	**0.6**
Combination PT and Road User Charging				
H5	Low Carbon PT Combination Test 2 plus 25 pence per Km Road User Charge.	2.6	2.1	-32.4
	Average of all Policies tested	**1.7**	**1.4**	**-19.2**

Applying the scenario results

Only certain broad suites of policies are forecast to achieve the emissions reductions identified as required by scenario workshop stakeholders for 2025. Clearly it is the “stick” effect of road charging and road cordons which are the main policy instruments if serious impact upon the behaviour of people are to be achieved and CO_2 reductions are to be achieved in this field. These coercive policies are currently politically unpopular and are unlikely to be implemented in the short-term, meaning if/when implemented charges have to be introduced, they will require to come in at an higher level to achieve the emissions reductions by the same date. Therefore, the control imposed by the various coercive models are the minimum required by 2025 and leave a significant emissions reduction requirement to be achieved post-2025.

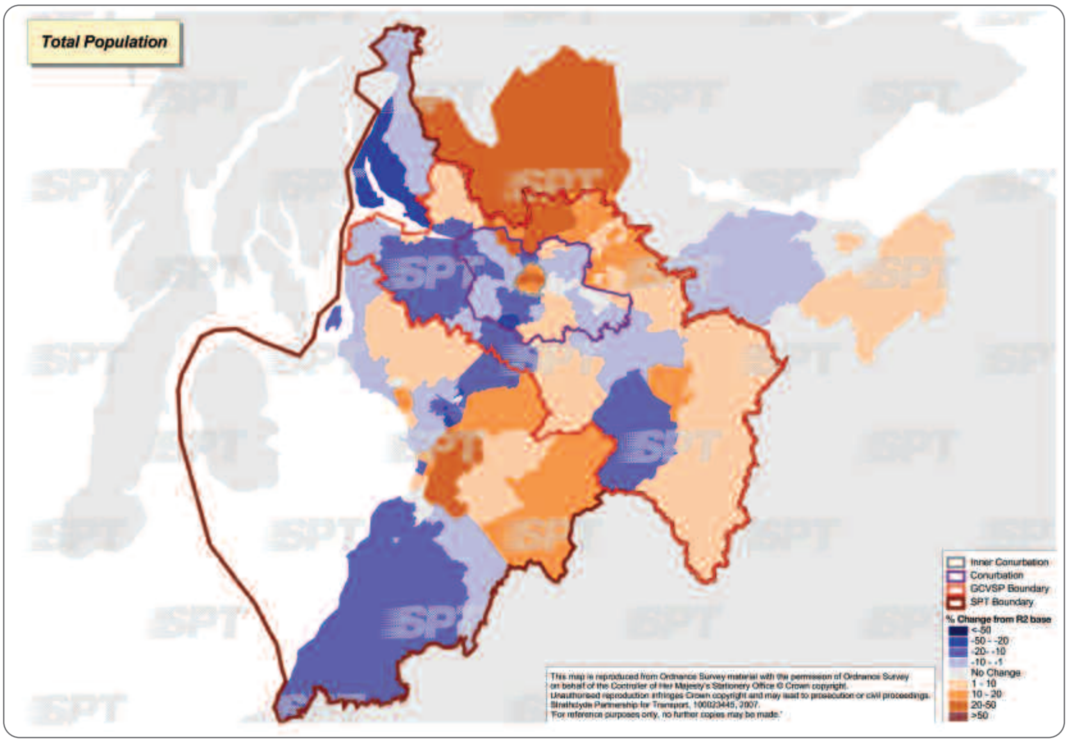
Also, the other spatial planning implications of these policy instruments may be a slower growth in jobs growth up to 2021, which is most of the planning period of the 2006 Structure Plan. The Agenda for Sustained Growth of the GCVSPJC 2006 Structure Plan outlines a 70,000 (8%) increase in jobs to 2018 from the 2002 level of 850,000. Only certain road-user charging and cordon charging policies are forecast to enable the region to achieve half this growth in jobs. The development of various forms of regional infrastructure outlined in the GCVSPJC 2006 Structure Plan Alteration is predicated on sustaining the rate of improvement of the regional economy which has been experienced in recent years.

The negative impacts of mitigation policy on the Plan’s Agenda for Sustained Growth could lead to a major shift in the economic competitive position of the area. However, the road transport GHG mitigation policies tested were solely focused on the Glasgow and Clyde Valley area and it is unlikely that any metropolitan region would act unilaterally in introducing any form of coercive mitigation policies, if they slow economic growth and affect regional competitiveness. Therefore, a multi-lateral implementation of various GHG mitigation policies is necessary and as such would not give other metropolitan regions a competitive advantage over each other or lead to a migration of economic activity between them. Also, introducing GHG mitigation policies of any form may indeed have potential agglomeration benefits, the effects of which cannot be modelled within the context of this project. These could include knowledge economy benefits from installing or developing new forms of technology or infrastructure, offsetting any associated negative economic impacts. Indeed, early introduction of mitigation policies may even enable a metropolitan region to gain a comparative economic advantage.

The InterMETREXPlus project focused on the mitigation approach whilst recognising the linkage between effective adaptation and the longer-term response of mitigation. Indeed, Walsh and Hall (2007 p.1) observe that “further research is needed to identify the synergies and conflicts that exist between mitigation and adaptation agendas”. It may be counterproductive to force integration of the two strategies. However, many adaptation options can also act as pathways to effective and long-term mitigation, like-wise mitigation options can facilitate planned adaptation”. This report highlights some of these linkages in discussion of its case study example.

The detailed spatial modelling of one of the most relevant coercive policy scenarios (Test J4) shows that there could be an increased demand for the concentration of population (red/orange colours on page 29 map) within the inner conurbation and in the lowest charging zones under the J4 test pricing regimes. . Increased demand for inner city development may increase densities in the city

Spatial Modelling of Projected Population Movement under Policy Test J4



centre, potentially increasing the heat island effect by more heat loss from buildings or buildings acting as heat sinks. Also, increased demand for inner-city development and brownfield land development may mean less greenspace can be provided within urban areas, which potentially has implications for adaptive policies seeking to improve thermal comfort of metropolitan regions in the light of existing levels of climate change.

The requirement to reduce emissions could lead to a requirement for only land to be released which is in close proximity to existing transport hubs, whether this land is brownfield or greenfield. This could require a change in the current policy presumption for brownfield land. In addition, further development of the existing transport network could be required. Following the strategic greenfield land release for the 2006 Structure Plan, there are not many significant sites remaining around current transport corridors which could be considered for future housing sites if demographic trends demand further release. Therefore, the development of new rail lines and stations will be required, whilst also investing in adapting current infrastructure to expected climate changes in temperature, precipitation, soil moisture and sea level (Shaw, 2007).

The policy requirements for all sectors e.g. economic development, environmental and transport on top of existing land-use planning strategy of concentrating development within the existing urban fabric or predicated on release close to major transport hubs, demonstrates to all stakeholders the significant steps required to meet emissions reduction targets.

Conclusion

The InterMETREX project extension has achieved its twin aims, enabling the 4 participating partners to develop a substantive and methodology sound GHG emissions inventory for their own regions and piloted the GRIP scenario tool at the metropolitan scale in Glasgow and the Clyde Valley, with which the impact of spatial planning policies can be assessed.

The Commission of the European Communities (2007:1) Green Paper 'Adapting to Climate Change in Europe – options for EU Action' highlights the key role of spatial planning in linking sectors of the urban environment, and highlights a specific role for regional spatial planning.

"Spatial planning could provide an integrated framework to link up vulnerability and risk assessment with adaptive capacities and adaptation responses, thus facilitating the identification of policy options and cost-efficient strategies".

It could be argued also that spatial planning has similar potential to facilitate the capacity for mitigation, identifying policy options and cost-efficient strategies. The framework provided by the GRIP model enables the identification of a robust emissions baseline Stage 1 of the mitigation process and the scenario workshops a broad outline of Stage 3 as set out in Table C on page 19 and the spatial planning process enables the subsequent development of policy options through Stages 2-5. Informed and targeted spatial planning helps to reduce the risk of the aforementioned conflicts between mitigation and adaptation agendas (Walsh and Hall, 2007).

Indeed, the Stern Review Report on the Economics of Climate Change (2006) highlighted the role of spatial planning in implementating adaptation and mitigation measures, stating that a series of decisions will need to be taken over approximately the next ten years to stabilise the current increases in greenhouse gas emissions and move towards low carbon technologies for power, heat and transport. This raises the need for discussions on new large developments to incorporate combined heat and power systems, balancing renewable energy developments with environmental resources, biodegradable waste being used as biomass for CHP purposes. The spatial planning system is an obvious channel for these discussions and decisions.

This work has demonstrated the validity of broadening the scope of the InterMETREXPlus project to engage with a wider range of stakeholders. The InterMETREXPlus partners recognise that one authority, region or country cannot go it alone on tackling climate change and that trans-national co-operation will be necessary. This initial work provides a solid basis for starting to develop and share spatial planning responses with partner organisations and countries and the Joint Committee looks forward to working with its partners in developing this work further through the INTERREG IVC programme if the funding proposal is successful.

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