METREX
The **network** of
European Metropolitan Regions and Areas

Dangerous climate change and urban decarbonisation

A metropolitan response

Insight for Policy Makers

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Third Industrial Revolution*

METREX Hamburg City Climate Conference - November 2009

.....the same design principles and smart technologies that made possible the internet, and vast "distributed" global communication networks, are just beginning to be used to reconfigure the world's power grids so that people can produce renewable energy and share it peer to peer, just like they now produce and share information, creating a new, decentralised form of energy use.

We need to envision a future in which millions of individuals can collect and produce locally generated renewable energy in their homes, offices, factories, and vehicles, store that energy in the form of hydrogen**, and share their power generation with each other across a Europe-wide intelligent intergrid.

The question is often asked as to whether renewable energy, in the long run, can provide enough power to run a national or global economy?

Just as second generation information systems grid technologies allow businesses to connect thousands of desktop computers, creating far more distributed computing power than even the most powerful centralised computers that exist, millions of local producers of renewable energy, with access to intelligent utility networks, can potentially produce and share far more distributed power than the older centralised forms of energy – oil, coal, natural gas and nuclear – that we currently rely on.

** Keynote Address - Jeremy Rifkin*

*** Hydrogen is a universal storage medium for intermittent renewable energies; just as digital is a universal storage mechanism for text, audio, video, data and other forms of media*

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** EU Energy 2020*

RR/TP/METREX/Glasgow/March/April 2013

1 Introduction

Purpose of this Report

METREX is not a research body. It is Network of practitioners (politicians, officials and their advisers) with a common interest in metropolitan affairs and a core interest in spatial planning and development.

METREX has taken a deep interest in the related issues of dangerous climate change, decarbonisation and urban renewable energy generation because energy is a key factor of sustainability. Metropolitan competitiveness and cohesion depend on secure renewable energy supplies at stable prices.

As Europe 2020 says,

Energy is the life-blood of our society. The wellbeing of our people, industry and economy depends on safe, secure, sustainable and affordable energy.

A high level of renewable energy self-sufficiency and decarbonisation are European, national and metropolitan goals.

METREX has produced this Report to demonstrate that these goals are conceivable, feasible and achievable at each of these levels. It is confident that the fundamentals of the argument, in terms of orders of magnitude and the speed and direction of travel, are sound. This is the "METREX approach".

The data* used is "fit for purpose" in providing indicators of magnitude and direction at the European and national levels. However, METREX foresees that the focus of action must be at the level of the large urban areas of Europe, its metropolitan regions and areas.

It is for this reason that the Network has devised and promoted reMAC, a calculator for the exploration of practical routes to decarbonisation and high levels of urban renewable energy self-sufficiency.

The METREX approach has been used in this Report at the European and national levels. reMAC has been used at the metropolitan level, in 10 major European metropolitan regions and areas, to demonstrate the validity of the approach and the practical value of the calculator.

The outcome is Insight for Policy Makers at the European, national and metropolitan levels.

** Eurostat, the UNECE and Europe's Energy Portal*

2 EU Energy 2020*

Energy 2020 Communication

Energy is the life-blood of our society. The wellbeing of our people, industry and economy depends on safe, secure, sustainable and affordable energy. At the same time, energy related emissions account for almost 80% of the EU's total greenhouse gas (GHG) emissions.

The energy challenge is thus one of the greatest tests that Europe has to face.

It will take decades to steer our energy systems onto a more secure and sustainable path. Yet the decisions to set us on the right path are needed urgently as failing to achieve a well-functioning European energy market will only increase the costs for consumers and put Europe's competitiveness at risk.

- ***Over the next ten years, energy investments in the order of €1 trillion are needed, both to diversify existing resources and replace equipment and to cater for challenging and changing energy requirements.***

The central goals for energy policy are now laid down in the Lisbon Treaty.

- *Security of supply*
- *Competitiveness*
- *Sustainability*

The European Council adopted in 2007 ambitious energy and climate change objectives for 2020, which the European Parliament has continuously supported.

- ***Reduce greenhouse gas emissions by 20%, rising to 30% if the conditions are right***
- ***Increase the share of renewable energy to 20%.***
- ***Make a 20% improvement in energy efficiency***

The European Council has also given a long-term commitment to the decarbonisation path with a target for the EU and other industrialised countries.

- ***80 to 95% cuts in GHG emissions by 2050***

Currently, nearly 45% of European electricity generation is based on low-carbon energy sources, mainly nuclear and hydropower. Parts of the EU could lose more than a third of their generation capacity by 2020 because of the limited lifetime of these installations.

We urgently need far-reaching changes in energy production, use and supply.

** Communication from the European Commission to the European Parliament, the Council, the EESC and the CoR. Energy 2020. A strategy for competitive, sustainable and secure energy. 2010.*

2 EU Energy Efficiency Plan 2011

A new plan for energy efficiency

Energy efficiency is at the heart of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy.

Energy efficiency is one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants.

In many ways, energy efficiency can be seen as Europe's biggest energy resource.

This is why the Union has set itself a target for 2020 of saving 20% of its primary energy consumption compared to projections, and why this objective was identified in the Commission's Communication on Energy 2020 as a key step towards achieving our long-term energy and climate goals.

Substantial steps have been taken towards this objective – notably in the appliances and buildings markets. Nonetheless, recent Commission estimates suggest that the EU is on course to achieve only half of the 20% objective. The EU needs to act now to get on track to achieve its target.

Responding to the call of the European Council of February 2011 to take "determined action to tap the considerable potential for higher energy savings of buildings, transport and products and processes", the Commission has therefore developed this comprehensive new Energy Efficiency Plan.

Public sector stock

Publicly owned or occupied buildings represent about 12% by area of the EU building stock. The Commission will therefore present a legal instrument under whose provisions public authorities will be required to,

- ***Refurbish at least 3% of their buildings (by floor area) each year – about twice the currently prevailing rate for the European building stock***

Dwellings, offices, shops and other buildings

Nearly 40% of final energy consumption is in houses, public and private offices, shops and other buildings. A large energy saving potential remains untapped.

- ***Techniques exist to cut existing buildings' consumption by 50-75% and to halve the energy consumption of typical appliances***

Manufacturing industry

About 20% of the EU's primary energy consumption is accounted for by industry.

- ***This is the sector where progress in energy efficiency has been greatest with a 30% improvement in energy intensity over 20 years. Nevertheless, worthwhile energy saving opportunities remain***

These targets indicate the scale of change that is needed. This Report demonstrates that they are conceivable, feasible and achievable at the European, national and metropolitan levels if Europe's urban potential for energy saving and generation is realised.

3 Insight for Policy Makers - *We urgently need far-reaching changes in energy production, use and supply**

European energy demand and supply

Europe produces only about 50% of its gross energy demand of 19806MGwh.**

35%, 33% and 15% of gas imports are from the Russian Federation, Norway and Algeria respectively and 35%, 33% and 15% of oil imports are from OPEC, the Russian Federation and Norway respectively.

Some EU nation states are more dependent on energy imports than others. For example, Denmark is a net exporter of energy, the UK imports only 20%, having its own North Sea oil and gas supplies, France imports about 50%, having nuclear energy supplies, but Italy imports almost 90% of its energy supplies. Germany imports 70% but is developing its own renewable energy supplies.

However, renewable energy supplies meet less than 1% of gross energy demand and the question remains how to meet the EU target of 20% by 2020.

World energy demand and supply

Although the overall level of European demand for energy has stayed much the same since 1990, and is not projected to increase substantially above this level to 2030 and beyond, world energy demand is expected to double from its 1990 level by 2030.

Carbon energy prices have reflected this growing demand, and the increasing cost of carbon energy sources of supply, and have increased accordingly.

For example, oil prices are now around $100+ a barrel as against $20 during the1990's.

Lisbon Strategy energy and climate change goals

In order to meet the Lisbon Strategy energy goals of security of supply, competitiveness and sustainability, and the climate change goal of decarbonisation, is clear that Europe needs to increase substantially the proportion of its supply that is generated by renewable energy.

This can be achieved in two ways. Firstly, by reducing energy consumption through efficiency savings, particularly in the urban building stock, and secondly, by meeting this reduced demand from urban renewable energy sources.

Whilst the energy saving potential within the European building stock has long been recognised, but not quantified, the energy generation potential of Europe's major urban areas has not been neither recognised, nor quantified.

This Report aims to offer Insight to Policy Makers on both the energy saving and energy generation potential of urban Europe and, in particular, its metropolitan regions and areas.

** Communication from the European Commission to the European Parliament, the Council, the EESC and the CoR. Energy 2020. A strategy for competitive, sustainable and secure energy. 2010.*

*** Final energy demand is about 66% of gross energy demand. 34% of demand is for energy supply.*

4 Insight for Policy Makers - the METREX approach

The metropolitan dimension to the related issues of decarbonisation and the avoidance of dangerous climate change

Europe's 127 recognised metropolitan regions and areas (Eurostat and the Urban Audit) contain some 60% of the population of the EU and are responsible for comparable proportions of its energy use and greenhouse gas emissions.

It is for this reason that Europe's metropolitan regions and areas have to be at the forefront of initiatives to achieve effective urban decarbonisation and the avoidance of dangerous climate change.

METREX commends the METREX approach to all levels of government in the EU, including the Parliament, Commission, constituent Nation States and all levels of governance for metropolitan regions and areas.

The METREX approach

- Most urban energy is carbon energy and 40% of urban energy is wasted.
- Dangerous climate change is actually being exacerbated by waste and, in times of austerity, money is being wasted in making things worse.
- This must be an unacceptable situation.
- If wasted energy could be substantially reduced then lower energy consumption could be met to a great extent from the generation of urban renewable energy.
- Although the need to reduce waste energy is recognised policy at all levels of government, the potential to fund urban renewable energy generation from energy saving has not yet been appreciated.
- Urban renewable energy generation has a major contribution to make to European, national and metropolitan energy supplies as established power plants come the end of their economic lives.
- A decentralised supply of this kind reduces transmission losses and enables the grid, and pipelines, to be used as a balancing and storage mechanisms as much as systems of energy distribution from major power plants.

This is the route to decarbonisation and the achievement of the EU target of an 80-95% reduction in urban greenhouse gas emissions, well before 2050.

The argument for the METREX approach is, therefore, first and foremost economic. Funding investment from savings and benefitting from win/win/win situations in terms of economic, decarbonisation and dangerous climate change outcomes.

Europe's metropolitan areas can become the green power stations of the future with all the implications this could have for European energy and climate change policy.

4 Insight for Policy Makers - the METREX approach

The METREX approach

The METREX approach is also the route to,

- Substantial energy self sufficiency and sustainability
- Security of energy supply
- Energy supply price stability
- Self funding energy generating investment from energy saving and efficiencies
- Medium term employment creation
- Increased locational advantage and economic competitiveness
- Increased disposable and investment incomes, after the pay back period
- Substantial decarbonisation

This Report assesses the outcomes of a METREX approach at the European, national and metropolitan levels (using reMAC) and their implications for climate change and energy policy at these levels. It provides Insight for Policy Makers.

5 Insight for Policy Makers - METREX approach at the European level

Contribution of urban energy saving

GWh	Residential	Industry	Services	Transport	Others	Total
EU Gross energy consumption*	4,805,305	5,055,931	2,476,256	6,415,584	684,373	19,437,448
EU Final energy consumption*	**3,171,501**	**3,336,914**	**1,634,329**	**4,234,285**	**451,686**	**12,828,716**
EU Energy savings	**0**	**740,124**	**367,229**	**1,693,714**		**2,801,067**
Sector %	**0%**	**22%**	**22%**	**40%**		**22%**
34% decentralised energy saving*	0%	8%	8%	14%		7%
EU 2020 efficiency target						20%

Note that these figures differ slightly from related Appendices Table 16 due to rounding

On the basis of progressively retrofitting the EU dwelling stock to Passivhaus standards, continuing to make efficiency gains in the industrial and services building stock at the rate of the past 20 years and moving to electromobility there is the realistic possibility of driving down EU energy demand by 29% over the period to 2030. As centralised energy generation and distribution is 34% of gross energy consumption, reducing energy demand by 29% will bring additional savings of some 10%. This would more than meet the EU efficiency target of 20% by 2020.

Insight for Policy Makers

This confirms the conclusions of the EU Energy Efficiency Plan 2011 that, in many ways, energy efficiency can be seen as Europe's biggest energy resource. It also confirms this aspect of the METREX approach.

Contribution of urban energy generation

GWh	Residential	Industry	Services	Transport	Others	Total
EU Final energy consumption	**3,171,501**	**3,336,914**	**1,634,329**	**4,234,285**	**451,686**	**12,828,716**
EU urban energy generation	**563,518**	**822,324**	**277,936**			**1,663,778**
Sector %	**18%**	**25%**	**17%**			**13%**
34% decentralised energy saving*	6%	8%	6%			4%
EU 2020 renewables target						20%

Note that these figures differ slightly from related Appendices Table 16 due to rounding

At the moment renewable energy provides some 15%, or 1.9mGWh, of Europe's final energy demand and solar provides only 4%, or 70,500GWh, of this. Europe's urban photovoltaic (PV) energy generation potential could provide an additional 1.7mGWh of energy, almost equal to the whole of current EU renewable energy production and some 13% of Europe's final energy consumption. It would meet 60% of Europe's current demand for electricity. With decentralised energy saving it would approach the EU 20% by 2020 renewables target alone.

Insight for Policy Makers

Europe's urban areas can become the green power stations of the future.

Energy self-sufficiency and security of supply at stable prices

GWh	Residential	Industry	Services	Transport	Others	Total
EU Final energy consumption	3,171,501	3,336,914	1,634,329	4,234,285	451,686	**12,828,716**
EU Energy savings	959,740	740,124	367,229	1,693,714		**3,760,808**
Reduced Final energy demand	**2,211,761**	**2,596,790**	**1,267,100**	**2,540,571**		**9,067,908**
EU urban energy generation	**563,518**	**822,324**	**277,936**			**1,663,778**
Sector %	**25%**	**32%**	**22%**			**27%**

Note that these figures differ slightly from related Appendices Table 16 due to rounding

Europe's energy demand can be reduced by 29% from urban energy saving and 27% of this reduced demand can be met by urban generation from PV alone. This means that Europe can achieve 27% energy self-sufficiency and consequent security of supply at stable prices through this source of urban renewable energy by itself. The PV estimates have been made on conservative assumptions of only 50% of available urban roof space (residential, industry and services) being available and only 50% of this being used. In effect, only 25% of roof space being used for PV. There will be significant contributions that can also be made from urban biomass and waste, particularly for heating, and wind, particularly for electricity generation.

Insight for Policy Makers

Urban energy saving and urban renewable energy generation, through PV alone, can make a major contribution to urban energy self-sufficiency and security of supply at stable prices.

Implications for decarbonisation

GWh	Residential	Industry	Services	Transport	Others	Total
EU Final energy consumption	**3,171,501**	**3,336,914**	**1,634,329**	**4,234,285**	**451,686**	**12,828,716**
Less existing renewables						10,922,345
EU Energy savings	**959,740**	**740,124**	**367,229**	**1,693,714**		**3,760,808**
EU urban energy generation	**563,518**	**822,324**	**277,936**			**1,663,778**
Sector %	**48%**	**47%**	**39%**	**40%**		**42%**
Less existing renewables						50%

Note that these figures differ slightly from related Appendices Table 16 due to rounding

Europe's final energy consumption can be decarbonised by 42% through urban energy saving and urban solar generation alone. If existing renewables are taken into account it can be decarbonised by 50%. This would be a major contribution to the EU target of an 80-95% reduction in greenhouse gases by 2050.

Insight for Policy Makers

Urban energy saving and urban renewable energy generation, through PV alone, can decarbonise urban energy use by 50% by 2030.

Implications for greenhouse gas emissions

GWh	Residential	Industry	Services	Transport	Others	Total
EU Final energy consumption	3,171,501	3,336,914	1,634,329	4,234,285	451,686	**12,828,716**
GHG emissions 1000tCO2/GWh	**585,829**	**961,665**	**301,888**	**931,786**		**4,729,879**
GHG % energy use (ex transport)	12%	13%	6%			
GHG % industrial processes		7%				59%
GHG % transport				20%		
Energy savings and generation	48%	47%	39%	40%		42%
GHG reductions 1000tCO2/GWh	**281,371**	**450,282**	**119,173**	**372,714**		**1,223,541**
Sector %	**6%**	**10%**	**3%**	**8%**		**26%**

Note that these figures differ slightly from related Appendices Table 16 due to rounding

Urban energy demand, for residential, industrial, services and transportation use, amounts to about 59% of final energy use. Urban energy saving and urban solar energy generation can reduce final energy demand by 42%. The implication would be a reduction of 26% in greenhouse gas (GHG) emissions (42% of 59%).

Insight for Policy Makers

Urban energy saving and urban renewable energy generation, through PV alone, can meet 26% of the EU 2050 greenhouse gas reduction target of 80-95%, by 2030.

Financial benefits

2011/2030	Energy saving €	Employment at 17/€m*
	Residential	
EU (27 countries)	80,280,670,313	1,364,771
	Ind/services	
EU (27 countries)	71,741,990,571	1,219,614
	Transport**	
EU (27 countries)	112,959,822,492	
Totals	264,982,483,376	2,584,385
Possible 100% multiplier effect suppliers and service providers		2,600,000

** BPIE Report - Europe's buildings under the microscope Figures for residential retrofitting*

*** Transport employment replacement?*

The potential financial benefits of the urban energy saving and urban generation approach, summarised above, are very significant. They would progressively deliver some €265bn, to be used to fund the retrofitting and renewable energy investments needed. Funding for such a package could be through private, commercial and public investment, including loans or grants. Commercial investment can be with energy companies, possibly funded through energy bills or mortgages, or with the public sector, possibly funded through local property taxes. Benefits can be shared.

In the medium term an urban retrofitting and generation programme would create direct and indirect employment. For example, direct employment through retrofitting has been estimate at about 17 jobs per €1m invested*. On this basis, and having regard to the multiplier effect of income expenditure and supplier expenditure, there might be of the order of 2.6m direct and 2.6m indirect jobs created and supported by such a programme.

After the investment period, perhaps by 2030 at the latest a sum of some €265bn would then become available for further investment, in the industrial and service sectors, disposable income in the residential sector and investment and disposable income in the transportation sector.

The pay back times in each of Europe's metropolitan areas can only be assessed more accurately through the use of reMAC, which enables the full spectrum of potential urban energy savings and renewable energy resources to be explored, priced and programmed.

Insight for Policy Makers

Urban energy saving can fund urban energy generation, create significant employment in the medium term and significant investment and disposable income in the longer term

5 Insight for policy makers - METREX approach at the national level

Sustainability and decarbonisation

2030	Sustainability					Decarbonisation	
	Final energy demand less renewables GWh	**Energy saving GWh** Dwellings, Industry, Services and Transportation	**Energy generation GWh** Dwellings, Industry, and Services	**Reduced final demar** GWh	**Reduced final demand %**	**GHG emissions** 1000tCO2	**Reduced emissions** 1000tCO2
1 Austria	315743	98589	27931	189223	**40**	84594	33897
2 Belgium	450651	129152	35958	285542	**37**	132459	48530
3 Bulgaria	84196	30501	27442	26253	**69**	61427	42273
4 Cyprus	21283	6066	4694	10523	**51**	10838	5479
5 Czech Republic	282016	87672	40747	153597	**46**	139158	63367
6 Denmark	170484	47122	18048	105314	**38**	61065	23343
7 Estonia	33064	14133	3289	15642	**53**	20517	10811
8 Finland	292820	87735	15525	189559	**35**	74556	26292
9 France	1719205	443857	229059	1046289	**39**	522373	204462
10 Germany	2406274	759845	260200	1386228	**42**	936544	397011
11 Greece	216318	94657	19632	102029	**53**	118287	62496
12 Hungary	189220	63118	37345	88757	**53**	67679	35933
13 Ireland	125511	67108	8821	49582	**60**	61314	37093
14 Italy	1410056	354257	256910	798889	**43**	510318	221190
15 Latvia	46311	19310	4863	22138	**52**	12077	6304
16 Lithuania	54614	20583	7905	26127	**52**	20810	10855
17 Luxembourg	49672	16358	1804	31509	**37**	12075	4415
18 Malta	5187	1604	1937	1647	**68**	3035	2072
19 Netherlands	588827	150594	50633	387600	**34**	210053	71784
20 Poland	755785	256162	115092	384532	**49**	400865	196911
21 Portugal	200711	51410	55387	93914	**53**	70599	37565
22 Romania	262559	84968	88488	89102	**66**	121355	80172
23 Slovakia	125092	44130	18565	62397	**50**	45982	23046
24 Slovenia	57417	19288	8558	29571	**48**	19522	9468
25 Spain	990690	245805	169498	575388	**42**	355898	149194
26 Sweden	373974	105479	27935	240561	**36**	66232	23628
27 United Kingdom	1533904	434318	199741	899846	**41**	590247	243986
Calculation	**12761584**	**3733820**	**1736004**	**7291760**	**43**	**4729879**	**2027304**

The outcome of the METREX approach at the national level is significant in terms of sustainability and decarbonisation. Most countries would be able to reduce their final energy demand by 40% and many by more than this. It is significant that some countries facing population decline could benefit from reductions in the range 50-70%.

The reduced European energy demand of some 5.5m GWh is equivalent to 625GW of generating capacity or 625 1GW power plants. Over the period to 2030 Europe will need to replace aging centralised generating capacity and the urban retrofit/renewables generation decentralised approach would be much more cost effective, and beneficial, to Europe and nation states.

Insight for Policy Makers

Major reductions in final energy demand, at the national level, will bring a range of significant benefits, including, lower energy costs, investment funds, increased disposable income and greenhouse gas emission reductions. A decentralised approach to future generating capacity will be more cost effective in economic and environmental terms.

5 Insight for policy makers - METREX approach at the national level

Financial benefits

2030	Residential energy saving €pa	Industry energy saving €pa	Services energy saving €pa	Total economic investment saving €pa	Transport energy saving €pa
		Investment income after pay back			
1 Austria	**3,051,252,593**	1,260,319,578	502,448,397	**1,762,767,975**	None
2 Belgium	**3,772,781,290**	1,674,965,258	668,263,796	**2,343,229,054**	**3,845,909,371**
3 Bulgaria	**508,178,645**	256,265,475	131,898,944	**388,164,419**	**1,619,310,326**
4 Cyprus	**53,547,171**	13,690,390	63,942,660	**77,633,050**	None
5 Czech Republic	**2,203,815,544**	1,139,132,691	529,342,751	**1,668,475,442**	**1,221,403,117**
6 Denmark	**1,869,249,493**	526,258,805	449,385,967	**975,644,773**	**1,908,951,350**
7 Estonia	**362,704,729**	104,567,233	88,395,409	**192,962,642**	**288,690,733**
8 Finland	**3,220,367,124**	1,428,413,209	301,229,091	**1,729,642,300**	**3,206,069,494**
9 France	**8,949,415,957**	3,500,227,546	2,811,146,898	**6,311,374,444**	**33,916,560,749**
10 Germany	**18,176,693,390**	14,332,226,454	7,560,029,847	**21,892,256,301**	**10,220,403,055**
11 Greece	**775,150,777**	830,839,619	1,096,317,848	**1,927,157,467**	**3,394,354,133**
12 Hungary	**2,218,458,957**	414,790,587	474,566,130	**889,356,716**	**795,412,079**
13 Ireland	**981,946,037**	1,364,094,125	895,567,573	**2,259,661,698**	**1,579,997,366**
14 Italy	**7,259,790,417**	4,718,350,814	2,917,920,283	**7,636,271,096**	**607,257,434**
15 Latvia	**497,985,708**	108,914,751	108,571,005	**217,485,756**	**172,680,663**
16 Lithuania	**437,648,484**	177,550,698	138,749,162	**316,299,860**	**83,771,821**
17 Luxembourg	**112,982,173**	75,491,697	49,021,207	**124,512,904**	**1,184,499,309**
18 Malta	None	25,882,234	34,077,620	**59,959,853**	None
19 Netherlands	**2,391,556,093**	1,975,183,621	1,346,215,817	**3,321,399,438**	**8,174,539,942**
20 Poland	**6,010,375,582**	2,182,816,088	1,385,435,741	**3,568,251,829**	**4,589,304,128**
21 Portugal	None	829,951,664	442,535,232	**1,272,486,896**	**2,221,004,461**
22 Romania	**2,176,650,191**	126,936,304	38,726,427	**165,662,730**	**2,017,482,566**
23 Slovakia	**849,231,465**	864,687,641	430,352,890	**1,295,040,531**	**12,772,801**
24 Slovenia	**547,765,151**	187,564,913	85,110,899	**272,675,812**	**803,562,001**
25 Spain	None	3,013,066,936	2,164,990,064	**5,178,057,000**	**6,876,268,416**
26 Sweden	**4,563,475,416**	1,577,264,515	677,979,592	**2,255,244,106**	**6,088,046,357**
27 United Kingdom	**9,289,647,927**	2,123,537,049	1,516,779,430	**3,640,316,479**	**18,131,570,820**
Calculation	**80,280,670,313**	44,832,989,893	26,909,000,679	**71,741,990,571**	**112,959,822,492**

The energy saving funds that would become progressively available could begin by funding generating investment and, after this stage, become available for other forms of productive economic investment in the industrial, services and transportation sectors (public and private) and offer increased disposable income in the residential sector. The use of reMAC enables these possibilities to be evaluated in detail at the metropolitan level and pay back periods to be explored.

A key issue will be the relative cost of carbon fuels and renewable energy. There can be little doubt that the cost of carbon fuels will increase as sources of supply become more expensive. Carbon taxes will also affect price. Renewable energy technologies are likely to reduce in price as production capacity is increased. The cost effectiveness of an urban retrofit/urban generation approach is, therefore, likely to improve with time.

A further key issue will be the extent to which rising demand for energy is offset by efficiency savings, for example, in new industrial equipment, new services technologies and new domestic appliances. As and example, the European Environment Agency (EEA) has found that, over the last 20 years, residential energy consumption has increased by 8% but that this was offset by efficiency gains of 24%. Such trends would only increase the financial benefits of an urban retro fitting/generation approach by lowering demand even further.

Insight for Policy Makers

The METREX approach looks at urban energy firstly from an economic point of view but recognises that this is also the route to successful decarbonisation and GHG reduction.

5 Insight for policy makers - reMAC approach at the metropolitan level

Sustainability, decarbonisation, investment, payback

		Sustainability					Decarbonisation	
		Final energy demand less renewables	**Energy saving** Dwellings, Industry, Services and Transportation	**Energy generation** Dwellings, Industry, and Services	**Reduced final demand**	**Reduced final demand %**	**GHG emissions**	**Reduced emissions**
	2030	GWh	GWh	GWh	GWh	**%**	1000tCO2	1000tCO2
1	Amsterdam							
2	Glasgow							
3	Hamburg							
4	Napoli							
5	Stockholm							
6	Stuttgart							
7	Vienna							
9	Madrid							
10	Lisboa							

			Investment income after pay back				Pay back periods	
		Residential energy saving €pa	Industry energy saving €pa	Services energy saving €pa	**Total economic investment saving €pa**	**Transport energy saving €pa**	**Residential investment**	**Economic investment**
	2030	**€pa**	€pa	€pa	**€pa**	**€pa**		
1	Amsterdam							
2	Glasgow							
3	Hamburg							
4	Napoli							
5	Stockholm							
6	Stuttgart							
7	Vienna							
9	Madrid							
10	Lisboa							

METREX is in the process of rolling out the use of reMAC across Europe's metropolitan regions and areas because it recognises that it is the most effective way in which to implement the METREX approach to dangerous climate change and decarbonisation. Ten metropolitan areas are in the process of running reMAC and the results will be reflected in the above table.

Insight for Policy Makers

reMAC is the most effective tool available to demonstrate the costs, benefits and pay back periods for an urban retro fitting/generation approach to dangerous climate change and decarbonisation.

Pay back periods have already been shown to be in the range 10-15 years, after which the significant investment and disposable income benefits become available.

Appendix 1

METREX approach at the European and national levels - 2012/2030*

Residential

Step 1	Population
Step 2	Households
Step 3	Occupied dwellings by dwelling type (flats, detached houses, semi-detached houses)
Step 4	Residential energy consumption
Step 5	Residential energy saving potential
Step 6	Value of residential energy saving
Step 7	Residential renewable energy generation potential
Step 8	Cost of residential energy generation investment
Step 9	Investment payback time in years from savings
Step 10	Level of decarbonisation
Step 11	Level of greenhouse gas emission reduction
Step 12	Value of increased disposable income after payback

Industrial and Services sectors

Step 1	Employment
Step 2	Employment by sector
Step 3	Notional Industrial and Service floorspace
Step 4	Industrial and Services energy consumption
Step 5	Industrial and Services energy saving potential
Step 6	Value of Industrial and Services energy saving
Step 7	Industrial and Services renewable energy generation potential
Step 8	Cost of Industrial and Services energy generation investment
Step 9	Investment payback time in years from savings
Step 10	Level of decarbonisation
Step 11	Level of greenhouse gas emission reduction
Step 12	Value of Industrial and Services investment funding after payback

Transportation

Step 1	Transportation energy consumption
Step 2	Transportation energy saving potential from electro/hydrogen mobility in the road transport sector
Step 3	Level of decarbonisation
Step 3	Level of greenhouse gas emission reduction
Step 4	Value of Transportation energy saving for investment funding

Energy

Step 1	Urban renewable energy generation capacity
Step 2	Level of decarbonisation
Step 3	Level of greenhouse gas emission reduction

** The socio-economic data used readily available from the Eurostat web site. The web site of the UN Economic Commission for Europe (UNECE) provided data on employment sectors. The data is generally for 2012, with some information for 2011 or 2010 where the differences are not material to the margins in the calculations. Europe's Energy Portal provided energy data.*

Appendix 2

reMAC approach at the metropolitan level

Using reMAC

reMAC has been produced for the use of those involved in the strategic planning of metropolitan areas to enable them to demonstrate that energy saving, through the elimination of waste and increased efficiency, can lower urban energy demand to the point where it can be met, substantially, from urban renewable energy generation.

Urban energy saving can fund the investment needed in urban renewable energy generation. Metropolitan areas can move towards substantial decabonisation well before 2050.

The best way to be convinced of this argument is to use reMAC.

Using reMAC will confirm the broad orders of magnitude involved in energy saving and investment costs, the consequent pay back times and the broad level of decarbonisation that could result. Given the social and economic uncertainties in looking forward towards 2030 and the pace of change in renewable energy technologies and their costs reMAC does not attempt go beyond these parameters.

reMAC is, essentially, a scoping and feasibility tool for metropolitan policy makers.

Its use will enable them to take the first steps towards renewable energy self-sufficiency with some confidence. They can do this in the knowledge that they will improve the competitiveness of their metropolitan areas and the well being of their citizens whilst moving towards decarbonisation and a significant contribution to the reduction of dangerous greenhouse gas emissions.

reMAC uses readily available socio-economic, urban, energy and greenhouse gas emission data. The sources are central and local government published information and building and energy industry publications. Much of this is available on the Internet.

reMAC enables users to input their own data but the algorithms linking this to outcomes and outputs are internal to the model.

** Planning for Energy is an urban planning function and needs to be distinguished from Energy Planning, which is a function of the energy industry in running and investing in energy technologies, systems and networks.*

Data input

The following are the 5 on-line data input panels that reMAC users will see at www.regenerative-energy.org

1 **Socio-economic data**

Population and households
Generational cohorts
Employment

2 **Domestic data**

Dwellings by type
Non-electrical energy use by energy source
Electrical energy use by source

3 **Services and industry data**

Non-electrical energy use by energy source
Electrical energy use by source

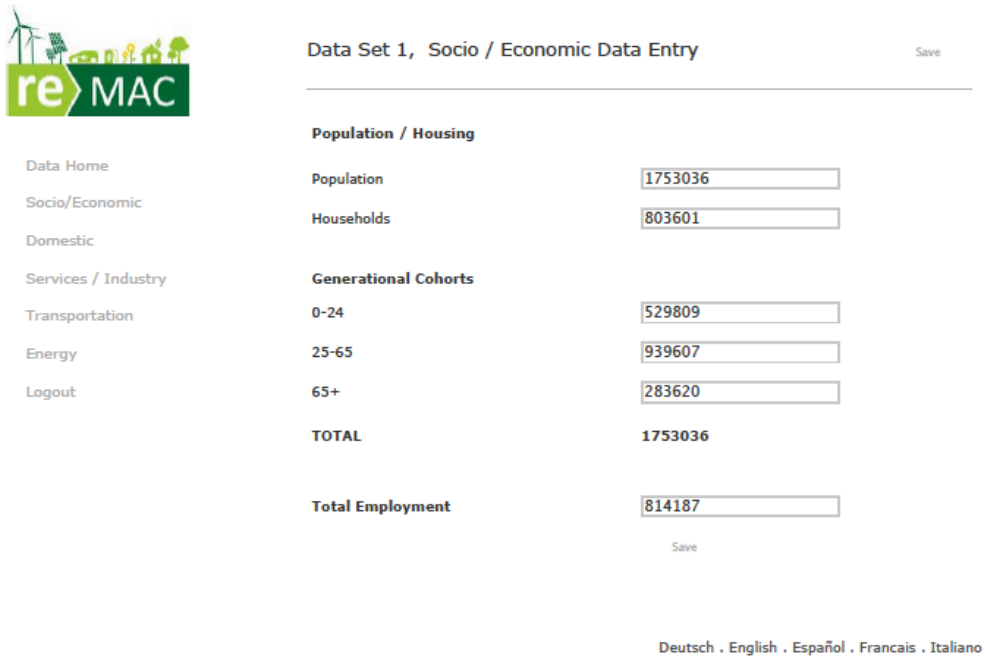
4 **Transportation data**

Private road transport by energy source
Public road transport by energy source
Freight road transport by energy source
Rail transport by energy source

5 **Energy data**

Regional energy generation by energy source

The following is an example of an on-line panel in reMAC. reMAC is available in EN|FR|DE|IT|ES



Scenario panels

The following are the 14 operational panels that reMAC users will see at www.regenerative-energy.org

1-3 Change 2050 (3)

4-5 Domestic (2)

6-7 Services/Industry (2)

8-9 Transportation (2)

10-13 Financial outcomes (4)

14 Decarbonisation and energy self-sufficiency (3)

The following is an example of a panel in reMAC. reMAC is available in EN|FR|DE|IT|ES

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reMAC has been devised and developed by Regenerative Energy for METREX. The use of reMAC is free to METREX Members and can be used by other public or not for profit bodies for a Regenerative Energy user fee. Contact www.regenerative-energy.org

Appendix 3

Summary of METREX involvement with the related issues of dangerous climate change and urban decarbonisation 2005-2013

Timescale

This Report brings to a conclusion an eight-year commitment by METREX to the related issues of dangerous climate change and urban decarbonisation.

2005 METREX Granada Conference addressed by the Tyndall Centre on the issue of dangerous climate change.

2007 Extension of the existing InterMETREX Interreg IIIC project to include the issue of dangerous climate change.

Piloting of the GRIP (Greenhouse Gas Regional Inventory Process) process in Glasgow and the Clyde Valley.

2008 Interreg IVC Application for the EUCO2 80/50 Project to explore greenhouse gas mitigation scenarios in 14 European metropolitan areas.

Rejected, under strong protest from METREX and the Lead Partner, the Metropolregion Hamburg, as amounting to funding for a normal METREX networking activity.

2009 EU Greenhouse gas mitigation targets have moved progressively from 60%, to 80% to 80-95% by 2050 (compared to 1990 levels).

This means effective decarbonisation, having regard to the industrial processes for which there are, as yet, no decarbonised alternative.

2010 Support funding of €250k given to the EUCO2 80/50 Project by ecomagination, a Division of General Electric (GE).

2011 EUCO2 80/50 Project concluded at the METREX Hamburg Conference. EUCO2 80/50 report published.

2011 METREX reMAC on-line calculator launched at the METREX Athens Conference to enable European metropolitan regions and areas to explore routes to effective urban decarbonisation.

2012 Roll out of reMAC across Europe and beyond

2013 METREX final Report on "Dangerous climate change and urban decarbonisation - A metropolitan response - Insight for Policy Makers".

Appendix 4

Acknowledgments

Support and commitment

METREX would not be in the position to publish "Dangerous climate change and urban decarbonisation - A metropolitan response - Insight for Policy Makers" with out the support and commitment of a number of valued colleagues over the years since 2005.

- **Asher Minns**, of the Tyndall Centre, who first inspired METREX, at the 2005 Granada Conference, to make the necessary commitment to the issue of dangerous climate change.

- **Dr. Sebastian Carney**, who was introduced to METREX by the Tyndall Centre, and whose deep knowledge of climate change realities, and commitment to the EUCO2 80/50 project, was instrumental in raising the Network's awareness and understanding of greenhouse gas emissions and their consequences for dangerous climate change.

  Dr. Carney devised and promoted the use of the GRIP, the Greenhouse Gas Regional Inventory Process, as the basis for the EUCO2 80/50 Project.

- **Rainer Scheppelmann**, Head Coordination Centre for Climate Issues, Ministry for Urban Development and Environment, Metropolregion Hamburg, who led the EUCO2 80/50 Project and has since been instrumental in rolling out the reMAC tool (Regenerative Energy for Metropolitan Areas and Cities) for metropolitan use.

- **Tim Page**, Head of Communications, Computing and Information Technology (CCIT) for METREX, who devised and developed the reMAC decarbonisation and renewable energy generation tool.

- **The fourteen metropolitan partners in the EUCO2 80/50 Project**, without whom the Network would not have gained the insight and experience to realise "Dangerous climate change and urban decarbonisation - A metropolitan response".

- **ecomagination**, a Division of General Electric (GE), that had the foresight and belief to support the EUCO2 80/50 project from which METREX was able to develop the reMAC approach demonstrated in this Report.