

MSc Architecture: Advanced Environmental and Energy Studies

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CAN THE DESERTEC CONCEPT AND THE PROPOSED EU-MENA SUPERGRID FACILITATE CONTRACTION AND CONVERGENCE OF CARBON EMISSIONS BETWEEN THE NATIONS INVOLVED?

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For the attention of Melissa Taylor

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Introduction

This essay relates to Lecture 3 (Introduction to Renewable Energy) of Module A1.

In the year 2007 the atmospheric concentration of CO₂¹ was 383 ppmv², compared to pre-industrial levels of 280 (Tans, P and Conway, T 2008). 380 ppmv is roughly equivalent to CO₂E³ levels of 430 ppmv (Stern, N 2006).

The Stern review has shown that a temperature rise of 2 degrees centigrade could cause climate change tipping points such as “the melting of ice-sheets, the loss of major rainforests” and that this level of warming could occur if concentrations rise above 450ppmv CO₂E (Stern, N 2006, P. 300).

The DESERTEC concept and the proposed EU-MENA supergrid

TREC⁴ is a network of collaborating politicians, scientists and engineers amongst countries in the EU-MENA⁵ region. TREC was founded to provide “clean, cost efficient energy for EU-MENA as soon as possible and based on economic cooperation between the countries in the region.” (Straub, M 2008).

The **DESERTEC** concept aims to exploit the huge potential of the MENA deserts for the production of solar electricity and integrate it into the electricity supply of nations in the EU-MENA region, transmitted amongst the countries by the means of a High Voltage Direct Current (HVDC) **supergrid** (Straub, M 2008). Electricity from other renewable sources throughout the region would also be integrated into the supergrid. (DLR⁶ 2006)

¹ Carbon Dioxide

² Parts per million by volume

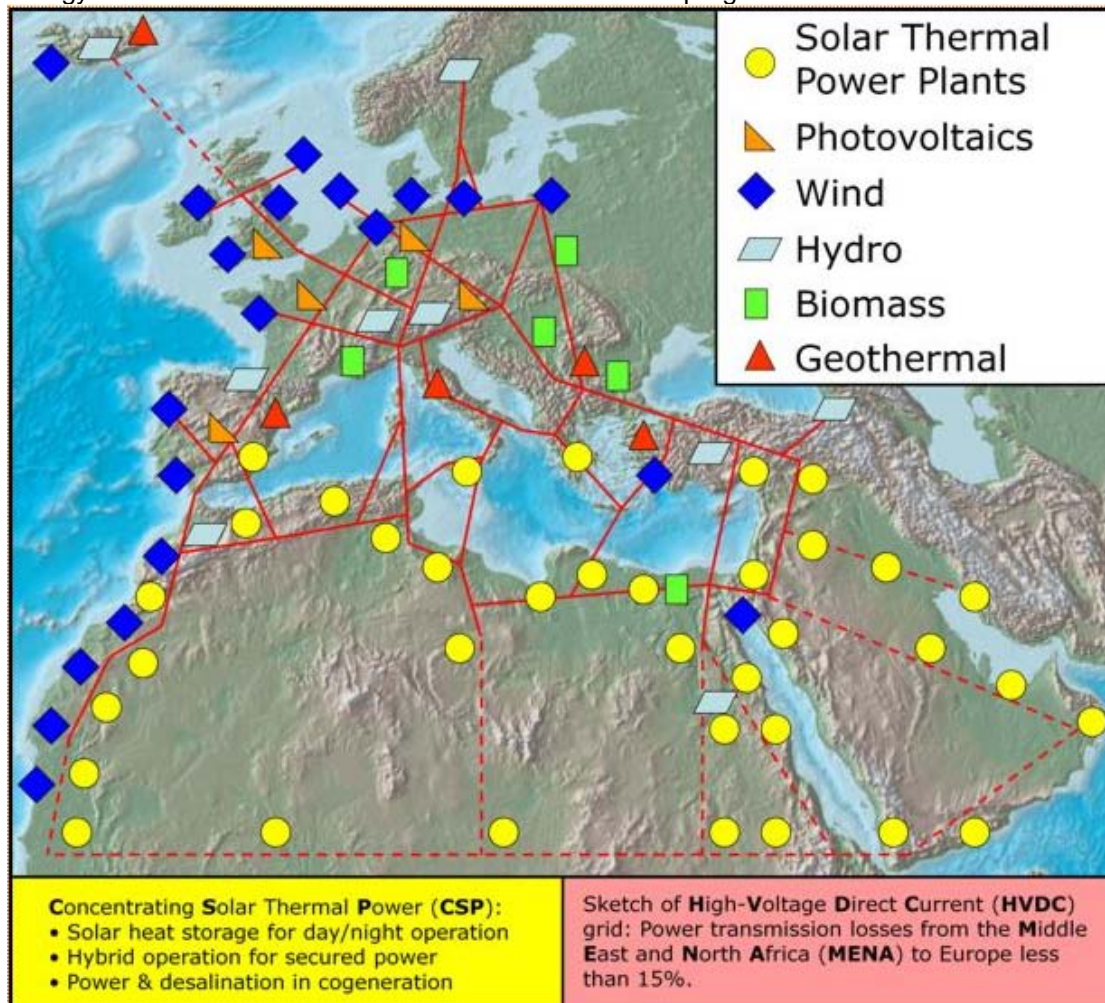
³ Carbon Dioxide Equivalent.

⁴ The Trans-Mediterranean Renewable Energy Cooperation

⁵ Europe, the Middle East and North Africa. See [Appendix 1](#) for nations

⁶ Deutsches Zentrum für Luft- und Raumfahrt - German Aerospace Centre

Figure 1. Power generation with Concentrating Solar Thermal Power and other renewable energy sources and transmission via future EU-MENA supergrid



Source: Club of Rome, 2006 <http://www.desertec.org>

The DLR was commissioned to conduct studies to evaluate renewable energy and future power requirements in EU-MENA until 2050 and “issues relating to the construction of an electricity transmission grid connecting the EU and MENA.”

(Straub, M 2008) This essay is concerned with data from the following studies:

1. **MEDCSP** analysed the potential of renewable technology, particularly Concentrating Solar Thermal Power (CSP), used in deserts to supply energy and water in Southern Europe, North Africa, Western Asia and the Arabian Peninsula. (DLR, 2005).
2. **TRANSCSP** analysed the potential of renewable electricity in Europe, including import of solar generated electricity via HVDC and whether it could be used to supply power on demand. (DLR 2006)

Contraction and Convergence

The Global Commons Institute (GCI) proposed the concept of contraction and convergence (C&C). It is a framework for reducing (contraction) greenhouse gas emissions to a safe level that is equal on a per capita basis for all countries (convergence). The idea is that eventually everyone would have an equal share of carbon emissions. C&C “is now at the core of the UN Framework Convention on Climate Change, has been approved by the European Parliament and many other governments” (Meyer, A 2004).

Data Examined

Table 1. Data sources examined.

Data Source	Produced by	Data
MED-CSP_Data.xls (2005) TRANS-CSP_Data.xls (2006).	DLR	Actual and extrapolated electricity usage ⁷ and carbon emissions ⁸ (from electricity production alone) for each nation in the two studies from the year 2000 until the year 2050 factoring in population growth ⁹ .
ccv8_6.xls (2003) The GCI created an excel workbook ¹⁰	GCI	Actual and predicted population ¹¹ and actual and predicted carbon emissions ¹² for 200 countries for each year from 2000 until 2200. (GCI, 2003) The workbook also contained numerous macros that allowed several scenarios of C&C to be explored producing tables of estimated CO2 ppmv, total carbon emissions, temperature rises and carbon allocations per nation and per capita throughout the 200 year period.

The purpose of this essay is to examine the data generated by the DLR studies alongside the population and carbon emissions defined by the CGI and ascertain whether the savings in carbon emissions predicted will allow the nations involved to converge and contract to sustainable levels defined by the C&C r350 scenario (GCI, 2003), which will be described in the next section.

⁷ Actual data taken from eia world energy statistics <http://www.eia.doe.gov/> Source: World Total Net Electricity Consumption, 1980-2002, June 2004. Future use predicted by DLR.

⁸ Figures taken from eia world energy statistics <http://www.eia.doe.gov/> Source: World Total Net Electricity Consumption, 1980-2002, June 2004

⁹ from middle variant of UN's World Population Prospect, Revision 2002 (/Stat. BA 2003/ p.188f.)

¹⁰ <http://www.gci.org.uk/model/dl.html>

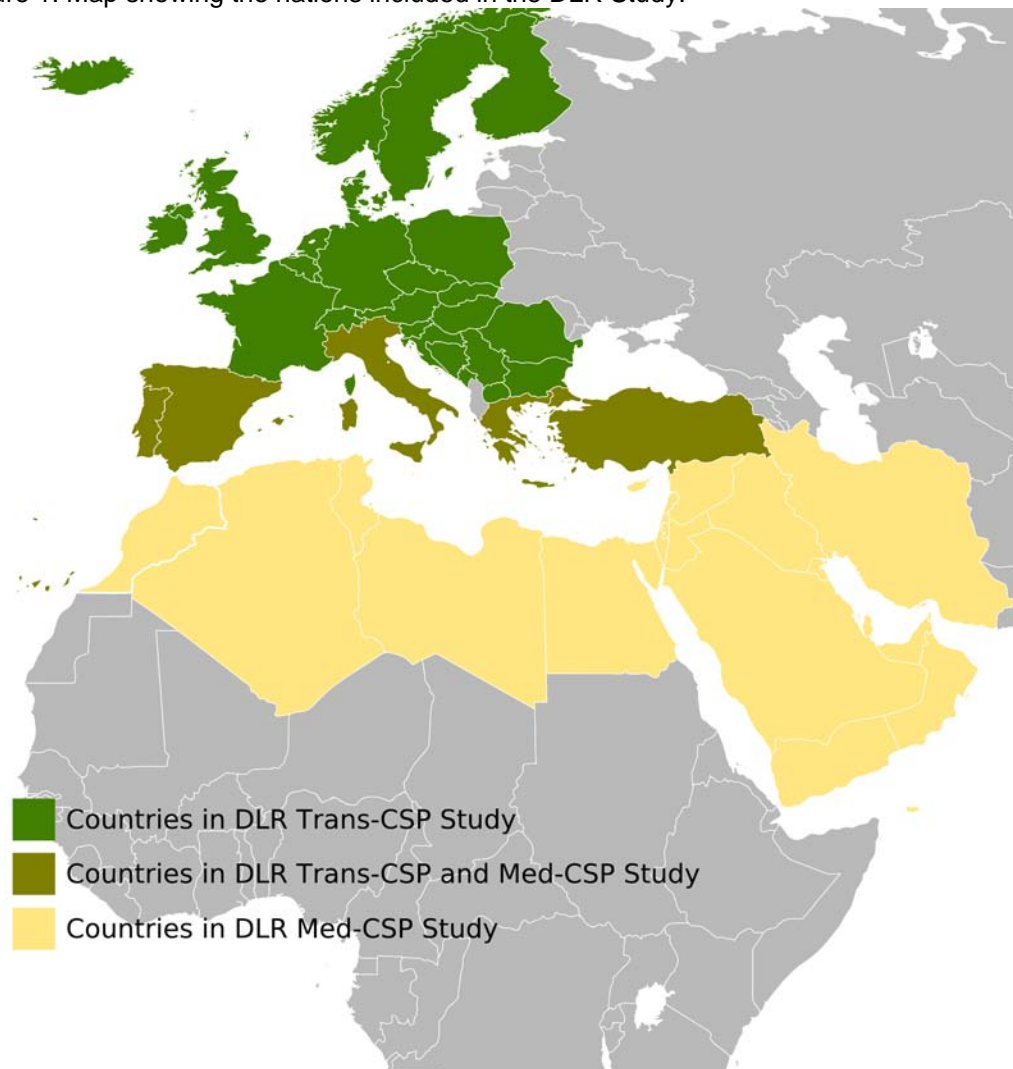
¹¹ figures taken from the UN median projections as of 2003 <http://www.un.org/esa/population/unpop.htm>

¹² carbon emissions were sourced from the Carbon Dioxide Information Analysis Center (CDIAC) in 2003 <http://cdiac.ornl.gov/>

Critical Analysis

The TRANS-CSP and MED-CSP reports show that using a combination of CSP with other technologies the nations in the TRANS-CSP¹³ study can cut CO2 emissions from electricity generation by 75% by the year 2050, and phase out nuclear power at the same time and the nations in the MED-CSP, despite large increases in electricity consumption, can cut CO2 emissions from electricity production by 40% (DLR 2005 and 2006) [Appendices 2](#) and [3](#). The countries included in the DLR study include most EU¹⁴ and several MENA¹⁵ nations. [Appendix 1](#)

Figure 1. Map showing the nations included in the DLR Study.



Source: User created map based on Canuckguy
<http://commons.wikimedia.org/wiki/Image:BlankMap-World6.svg>

¹³Greece, Italy, Spain, Portugal and Turkey were in both the TRANS-CSP and the MED-CSP studies.

¹⁴ European Union – See [appendix 1](#)

¹⁵ Middle East and North Africa See [appendix 1](#)

GCI C&C Scenario r350

The r350¹⁶ scenario aims to stabilise atmospheric CO2 levels at 380 ppmv by 2200.

Convergence Year. This is the year in which all the world's nations per capita carbon emissions will converge. So in the year 2040 everyone in the world will be permitted to emit the same amount of carbon.	2040
Population cut off year. This is the year in which nations with growing population are no longer allocated extra carbon rations per capita. So if a country's population grows after the year 2040 it will receive no extra carbon permits to issue to the additional people and hence its per capita allowance will reduce in relation to a country with a stable population.	2040
Emissions Growth Rate in 2000.	1.50%
Contraction year. This is the year in which all nations must begin to contract.	2050
Emissions decline rate in contraction year	2.50%
Contraction level of emissions	20%
Planned total 110-year emissions	325 Gigatonnes of carbon
Target concentration in 2200	350 ppmv
Per capita allowance in 2040	0.248 tonnes carbon
Per capita allowance in 2050	0.142 tonnes carbon

Source: Global Commons Institute¹⁷, 2003

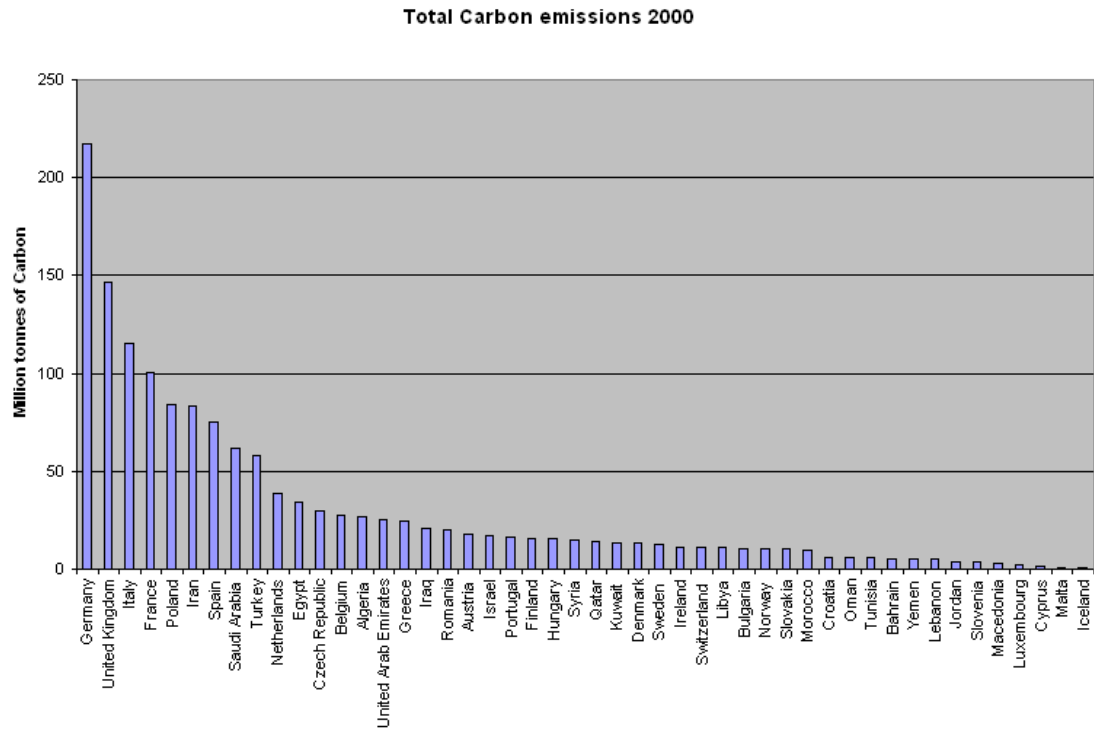
¹⁶ The GCI note that it doesn't seem feasible to construct a scenario that gets the concentration down to 350ppmv by 2200, so their "r350" scenario only brings it back down to 380 ppmv. This scenario was chosen as it was the most stringent and hence the least likely to force the climate through a tipping point.

¹⁷ Values taken from the 'Scenarios' datasheet of the GCI excel spreadsheet: ccv8_6.xls

Individual Nations

Total carbon emissions from all sources in the countries in the DLR studies in the year 2000 ranged from Germany's 217 megatonnes to Iceland's 0.579 megatonnes.

Graph 1 Total carbon emissions from all sources. Data: [Appendix 4](#)

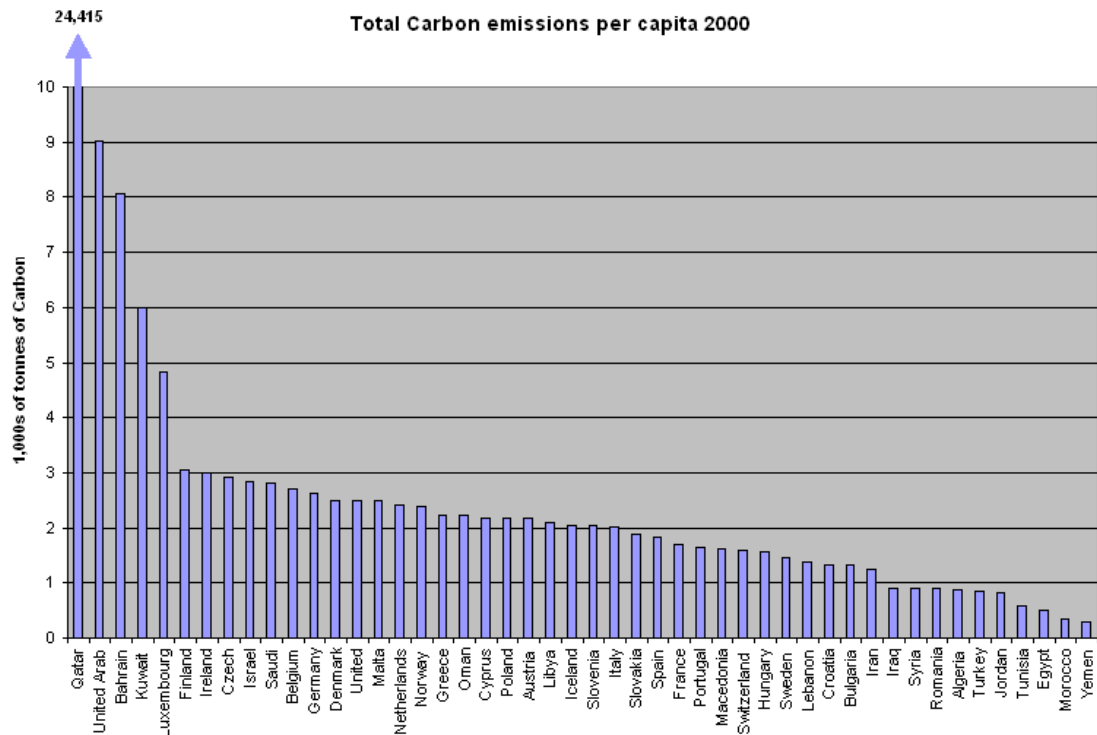


Source data: Global Commons Institute¹⁸, 2003

¹⁸ Data taken from the 'AllocatedCO2' datasheet of the GCI excel workbook ccv8_6.xls. NB the data in the *AllocatedCO2* and *ActualCO2* datasheets was incorrectly labelled as CO2 instead of Carbon. Confirmed via e-mail by Aubrey Meyer.

When expressed as emissions per capita, Qatar was the largest emitter with 24 tonnes per person. The lowest Yemen emitted 0.284 tonnes per person.

Graph 2 Total carbon emissions per capita from all sources. Data [Appendix 5](#)



Source data: Global Commons Institute¹⁹, 2003

Carbon reductions required

Under contraction and convergence every nation with the exception of Yemen would need to make cuts in the amount of the carbon they emit between 2000 and 2050.

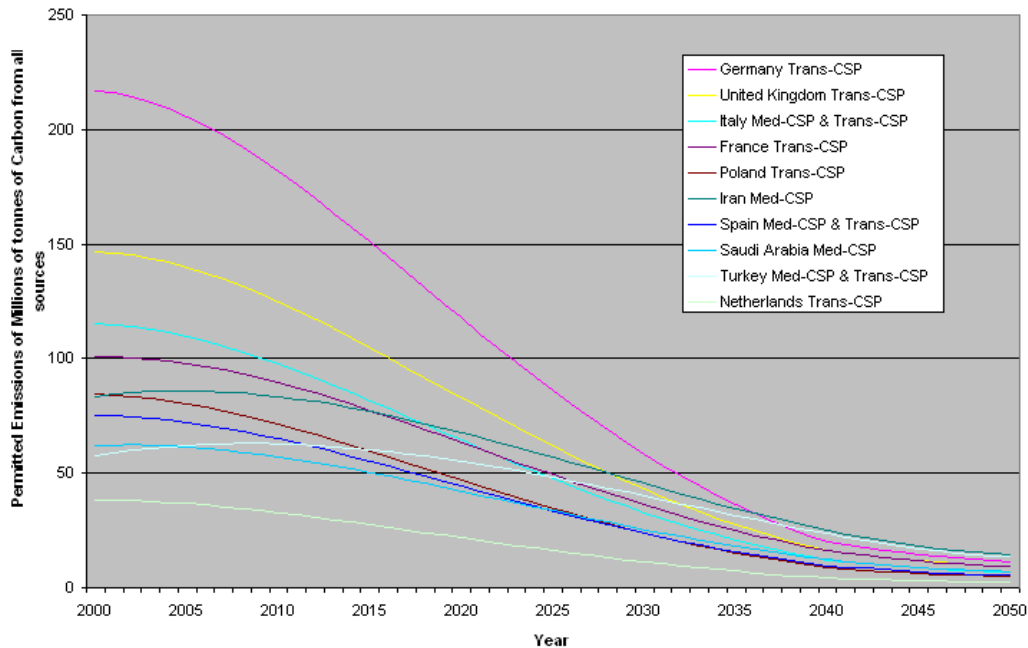
Germany would need to reduce carbon emissions by nearly 95% from 217 to below 12 megatonnes. Qatar would need to reduce emissions by over 99%. Yemen would be permitted to nearly double national emissions to nearly ten megatonnes a year.²⁰

¹⁹ Data taken from the 'Per capita' datasheet of the GCI excel workbook ccv8_6.xls

²⁰ Data [Appendix 4](#).

Graph 3 National carbon allocations under C&C to the current ten most carbon emitting nations in the DLR study from 2000 to 2050 Data [Appendix 4](#)

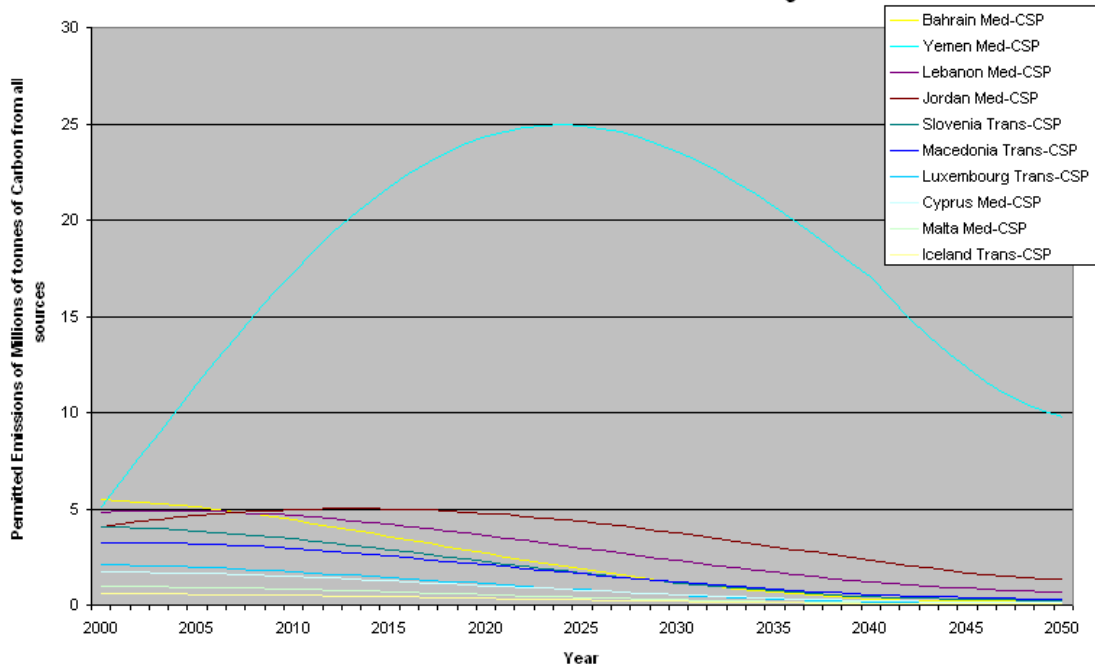
Carbon allocations to the current ten most Carbon emitting nations in the DLR study from 2000 until 2050 under Contraction and Convergence



Source data: Global Commons Institute²¹, 2003

Graph 4 National carbon allocations under C&C to the current ten least carbon emitting nations in the DLR study from 2000 to 2050 Data [Appendix 4](#)

Carbon allocations to the current ten least Carbon emitting nations in the DLR study from 2000 until 2050 under Contraction and Convergence



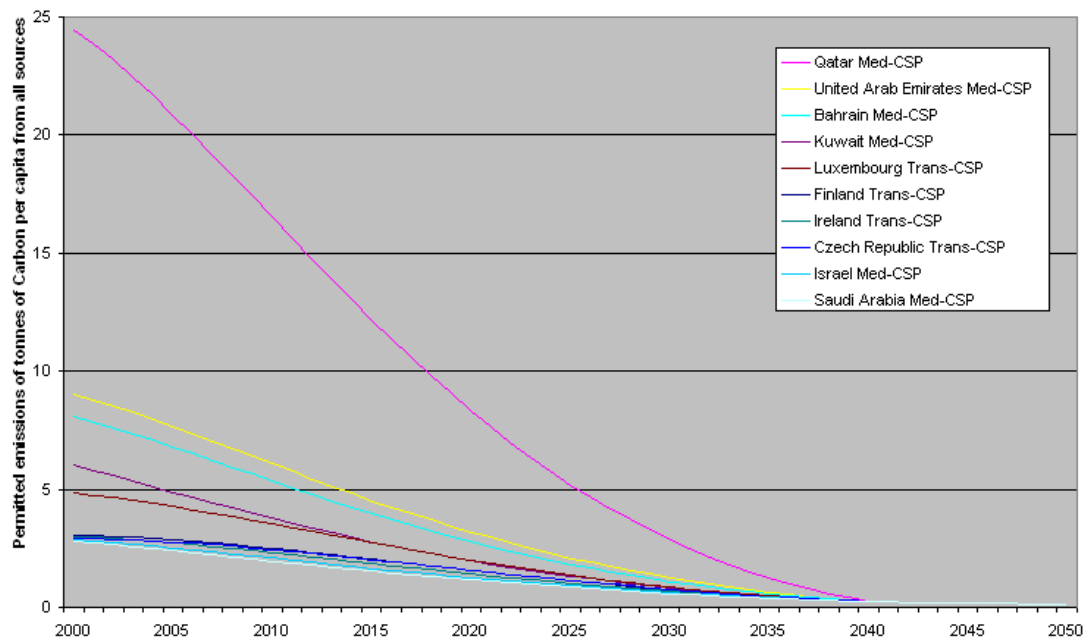
Source data: Global Commons Institute²², 2003

²¹ Data taken from the *AllocatedCO2* datasheet of the GCI excel spreadsheet: ccv8_6.xls

The highest per capita emitting nation, Qatar, would need to reduce carbon emissions per capita by a massive 99.42% to below 0.142 megatonnes. Even Yemen, due to the fastest growing population of the nations studied, would need to make per capita cuts in carbon emissions of nearly 50% from 0.284 to 0.142 tonnes – following initial permitted increases.

Graph 5 Carbon allocations per capita under C&C to the current ten most emitting nations in the DLR study from 2000 to 2050 Data [Appendix 5](#)

Carbon allocations per capita to the current ten most Carbon emitting nations in the DLR study from 2000 until 2050 under Contraction and Convergence

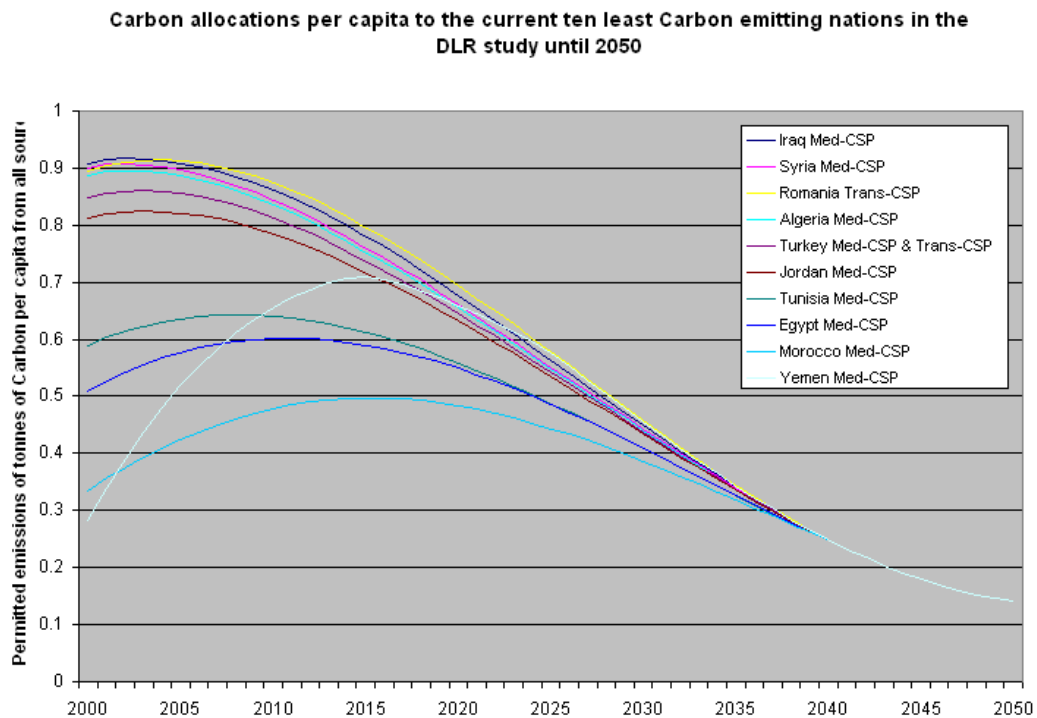


Source data: Global Commons Institute²³, 2003

²² Data taken from the *AllocatedCO2* datasheet of the GCI excel spreadsheet: ccv8_6.xls

²³ Data taken from the *Per capita* datasheet of the GCI excel workbook ccv8_6.xls

Graph 6 Carbon allocations per capita under C&C to the current ten least emitting nations in the DLR study from 2000 to 2050 Data [Appendix 5](#)



Source data: Global Commons Institute²⁴, 2003

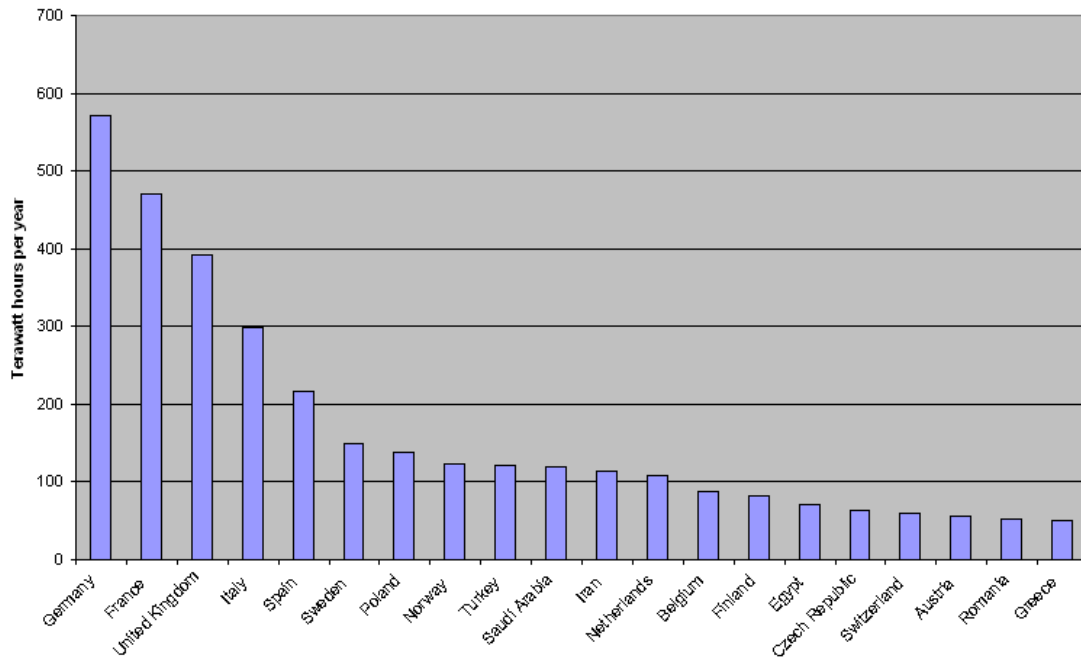
Electricity Production

The DLR studies shows that the requirement for electricity will grow in total over the fifty-year period of the study, at different rates within the different countries. Some nations will have reduced electricity requirements throughout the fifty-year period and some will have hugely increased requirements. Germany will be replaced by Egypt, as the most electricity hungry nation. (DLR, 2005 and DLR, 2006) Franz Trieb and Uwe Klann used a 'simple empirical method for the modelling of the future electricity demand of national economies in very different stages of economic development' (2006).

²⁴ Data taken from the *Per capita* datasheet of the GCI excel workbook ccv8_6.xls

Graph 7 Electricity consumption of the twenty most consuming nations in the DLR studies in the year 2000. Data [Appendix 6](#).

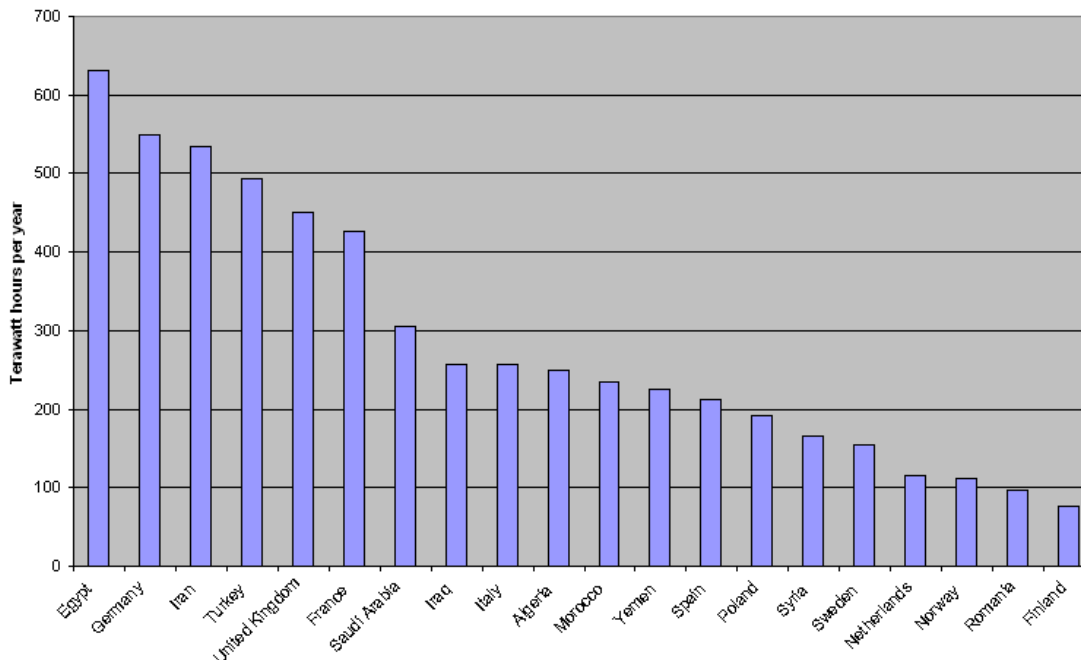
Electricity consumption of the twenty most consuming nations in 2000



Source data: DLR²⁵, 2005 & 2006

Graph 8 Electricity consumption of the twenty most consuming nations in the DLR study in the year 2050 Data [Appendix 6](#).

Predicted electricity consumption of the twenty most consuming nations in 2050



Source data: DLR²⁶, 2005 & 2006

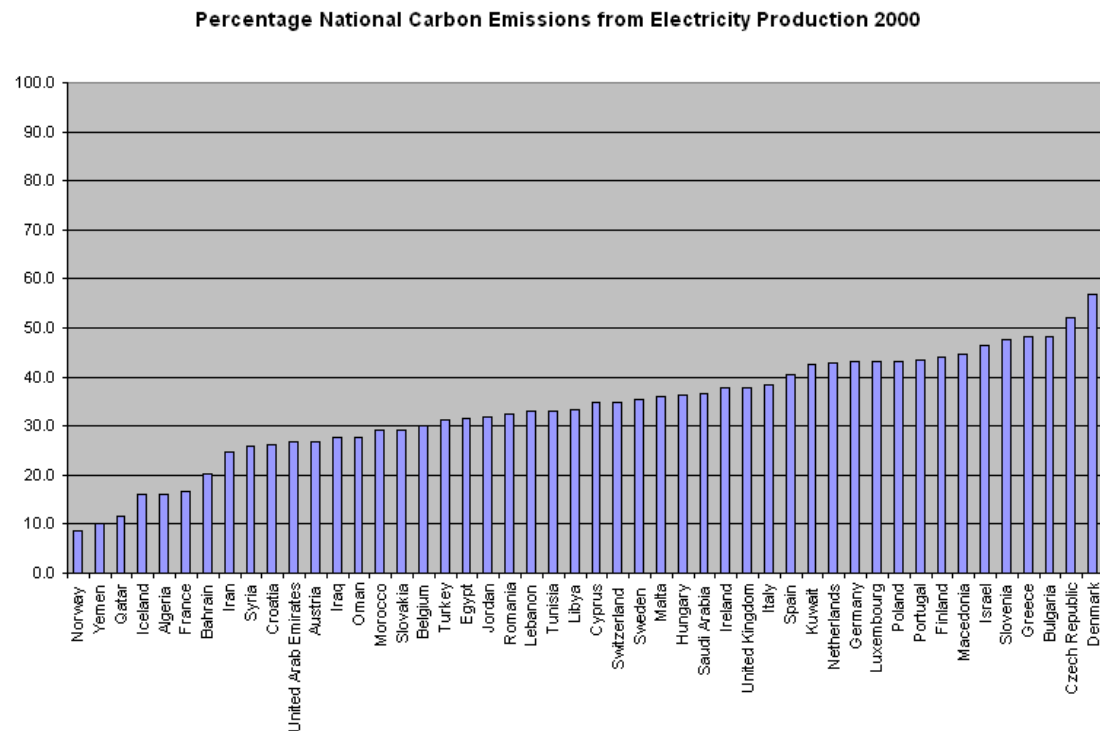
²⁵ Cons1 datasheet of DLR produced workbook MED-CSP_Data.xls and Cons1 datasheet of DLR produced workbook TRANS-CSP_Data.xls

²⁶ Cons1 datasheet of DLR produced workbook MED-CSP_Data.xls and Cons1 datasheet of DLR produced workbook TRANS-CSP_Data.xls

What proportion of a nation's carbon emissions come from electricity production?

The DLR studies deal only with reducing carbon from the production of electricity. Of course nations emit carbon from other sources too, such as transport and cement production.

Graph 9 Percentage carbon emissions from electricity production for the countries in the DLR studies in the year 2000. Data [Appendix 7](#).



Source data: DLR²⁷, 2005 and 2006

²⁷ Data taken from individual country datasheets in DLR produced spreadsheets MED-CSP_Data.xls and TRANS-CSP_Data.xls.

Models Investigated

Three author-defined models of potential carbon emissions by the EU-MENA nations from 2000 to 2050 were created and evaluated to determine whether carbon emissions predicted by the DLR projects would meet carbon allowances under C&C.

Table 3 Summary of models investigated			
	Model 1 All carbon emissions come from electricity production via methods outlined in DLR studies.	Model 2 Production of electricity via methods outlined in the DLR studies, with volumes of other emissions of carbon remaining static at year 2000 levels.	Model 3 Production of electricity via methods outlined in the DLR studies, with volumes of other emissions of carbon changing in proportion to changes in electricity use compared to year 2000 levels.
Method of calculation	Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity only according to predictions in the DLR study.	Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity ONLY according to the DLR study minus carbon emissions from other sources in the year 2000.	Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity ONLY according to the DLR study minus carbon emissions from other sources extrapolated from year 2000 electricity use figures.
Data	Appendix 8	Appendix 9	Appendix 10
C&C data for scenario r350	✓	✓	✓

Table 3 continued Summary of models investigated			
Worked example using values for Germany for the year 2030			
Carbon emissions permitted under C&C ²⁸	58,245,013 tonnes	58,245,013 tonnes	58,245,013 tonnes
Predicted carbon emissions from the production of electricity ²⁹	83,317,339 tonnes	83,317,339 tonnes	83,317,339 tonnes
Carbon emissions from other sources in the year 2000 ³⁰	Not applicable to model	123,682,444 tonnes	123,682,444 tonnes
Electricity consumption for the year 2000 ³¹	Not applicable to model	Not applicable to model	571.55 terawatts
Predicted electricity consumption for the year 2030 ³²	Not applicable to model	Not applicable to model	654.41 terawatts
Percentage increase in electricity consumption from the year 2000 to 2030	Not applicable to model	Not applicable to model	14.4984908%
Extrapolated total carbon emissions from other sources for the year 2030	Not applicable to model	Not applicable to model	141,614,532 tonnes (1.144984908 x 123,682,444)
Total	-25,072,326 tonnes	-148,754,769 tonnes	-166,686,858 tonnes
Therefore in the model described, in the year 2030	Germany emits 25 megatonnes more carbon from electricity production alone than its total allowance of carbon emissions under C&C for that year.	Germany emits nearly 150 megatonnes more carbon than its allowance of carbon emissions under C&C for that year.	Germany emits nearly 167 megatonnes more than its allowance of carbon emissions under C&C for that year.

²⁸ data taken from the *AllocatedCO2* worksheet of the GCI excel workbook: ccv8_6.xls

²⁹ compiled from Data taken from individual country datasheets in DLR produced spreadsheets MED-CSP_Data.xls and TRANS-CSP_Data.xls

³⁰ calculated from data taken from the *AllocatedCO2* worksheet of the GCI excel workbook: ccv8_6.xls and data taken from individual country datasheets in DLR produced spreadsheets MED-CSP_Data.xls and TRANS-CSP_Data.xls

³¹ data taken from the *Cons1* datasheet of DLR produced workbook MED-CSP_Data.xls and *Cons1* datasheet of DLR produced workbook TRANS-CSP_Data.xls

³² data taken from the *Cons1* datasheet of DLR produced workbook MED-CSP_Data.xls and *Cons1* datasheet of DLR produced workbook TRANS-CSP_Data.xls

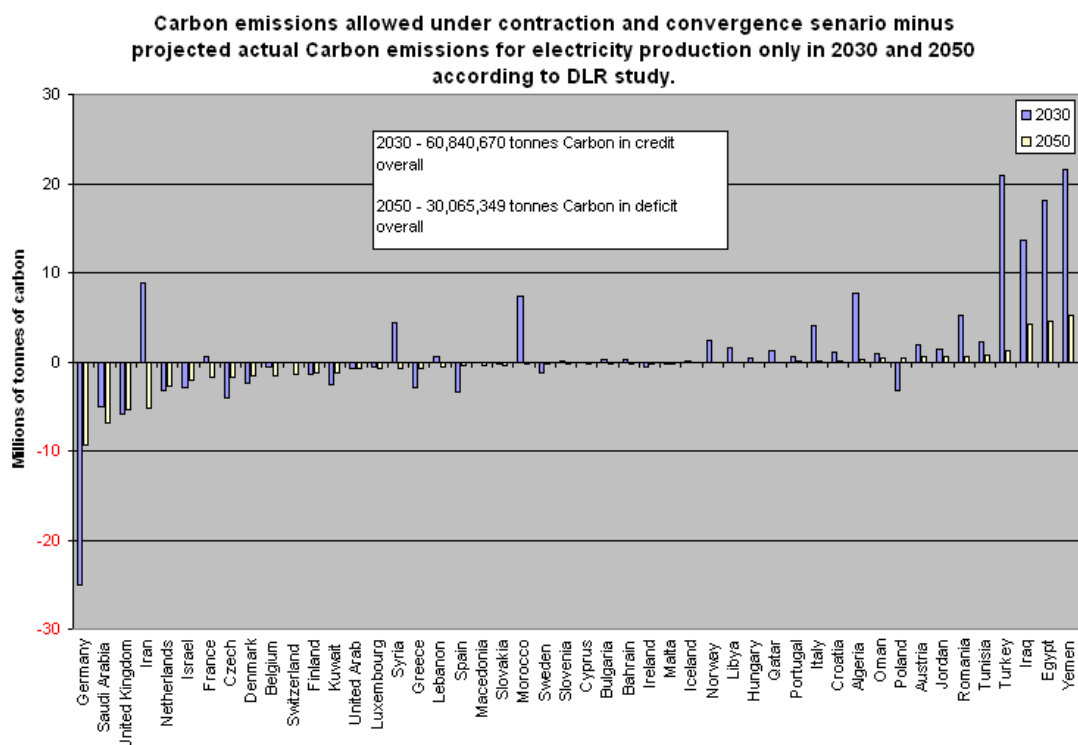
Analysis of results of author-defined models

Model 1. All carbon emissions come from electricity production.

This first model is unrealistic, but it will be used to show the theoretical limits of the DLR study. Over the period of the study the nations involved emit carbon from the production of electricity. The proportion emitted from burning fossil fuels to produce electricity diminishes but never drops to zero. This is due to the fact that fossil fuels are still used as back up. This model assumes, incorrectly, that none of the countries in the study emit any other source of carbon.

Graph 10 shows that if the Carbon balance is in credit, i.e. not a negative number, the country has met its contraction and convergence requirement. The results show that even in this completely unrealistic model the nations in the DLR study exceed their combined carbon allowance by over thirty megatonnes in the year 2050. Of the nations studied, only Yemen, Egypt, Iraq, Turkey, Tunisia, Romania, Jordan, Austria, Poland, Oman, Algeria, Croatia, Italy and Portugal emit less carbon in 2050 than allowed under their C&C quota.

Graph 10 Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity only according to predictions in the DLR studies. Data [Appendix 8](#)



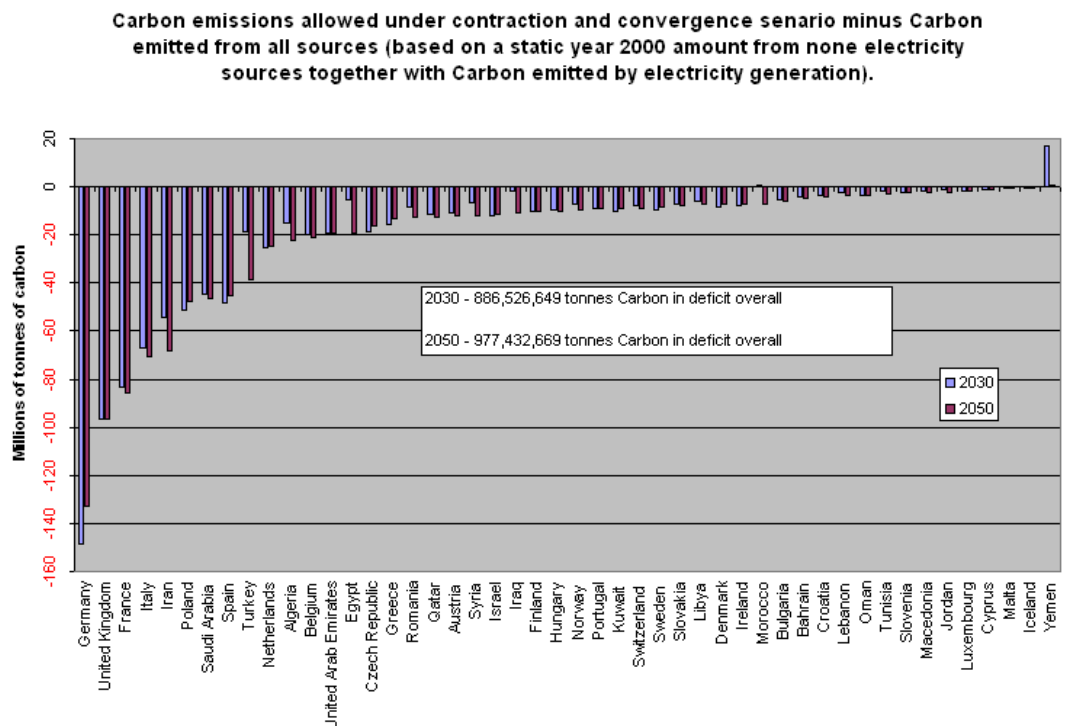
Source data: DLR, 2005 and 2006 and GCI, 2003

Model 2. As electricity use changes in the nations in the DLR study from 2000 to 2050, other emissions of carbon remain static at year 2000 levels.

The DLR study assumes that electricity use grows in the developing nations in the study due to rising gross domestic product. The study does not investigate other sources of carbon emissions. This author-defined model assumes that the percentage of carbon emissions from sources other than electricity production remains static at year 2000 figures. This is also an unlikely scenario as an increase in population and affluence in the MENA region that lead to increased electricity use will probably mean increases in other sources of carbon too.

Graph 11 shows only Yemen emits less carbon in 2050 than allowed under its C&C quota. In total the nations involved in the DLR study exceed their allowance by nearly one gigatonne of carbon in 2050.

Graph 11 Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity according to the DLR studies minus carbon emissions from other sources in the year 2000. Data [Appendix 9](#)



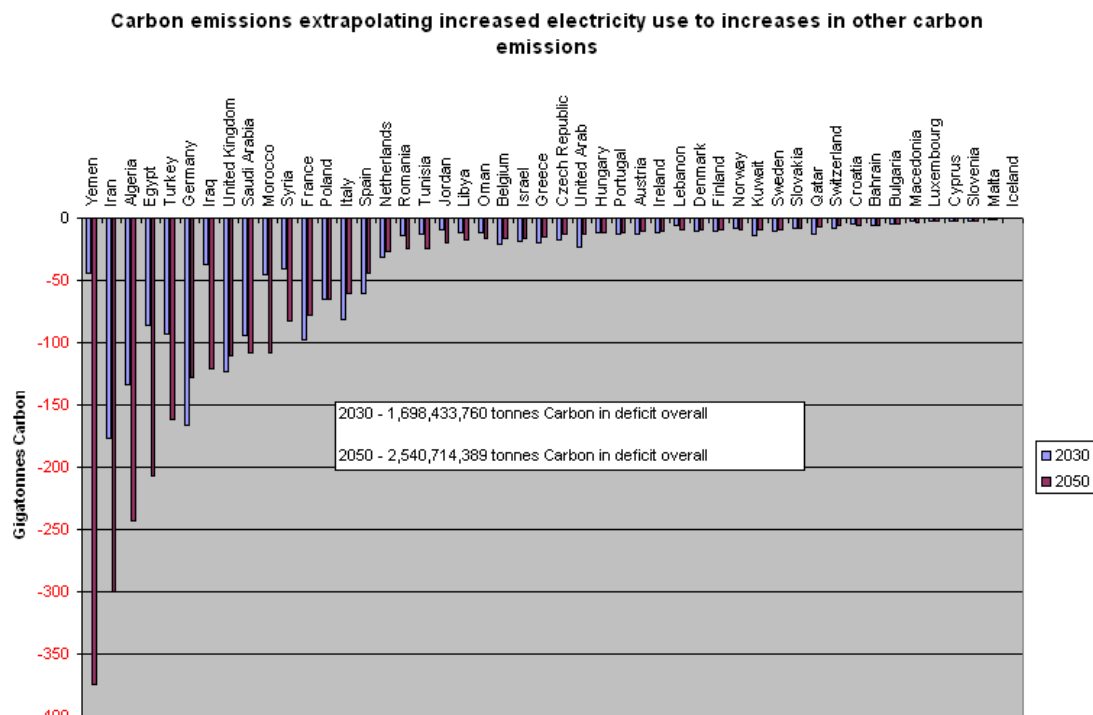
Source data: DLR, 2005 and 2006 and GCI, 2003

Model 3. As electricity use changes in the nations in the DLR study, other emissions of carbon change in proportion to changes in electricity use compared to year 2000 levels.

Model 2 was optimistic about carbon emissions. It is likely that carbon emissions from other sources, such as transport, will rise in the countries in the MENA region will rise in correspondence to rising electricity use. For example, according to the DLR study, if Yemen's electricity requirements in 2050 are more than 8000% the requirements in 2000, is it likely that the CO2 emissions from other sources will have risen too. This model is a worst-case scenario for carbon emissions.

Graph 12 shows that this model results in an excess of over 2.5 gigatonnes of Carbon in 2050, with Yemen the greatest polluter from the study. This excess would use the entire world's carbon allowance of 1.56 gigatonnes under r350 C&C for 2050.

Graph 12 Carbon emissions permitted under C&C minus predicted carbon emissions from the production of electricity ONLY according to the DLR study minus carbon emissions from other sources extrapolated from year 2000 electricity use figures. Data [Appendix 10](#)



Source data: DLR, 2005 and 2006 and GCI, 2003

Conclusion

Summary of case the made

The DESERTEC concept and the proposed EU-MENA supergrid will enable great cuts to be made in carbon emissions from developed nations, and reduce projected carbon emissions from developing nations. But the results show that the current DLR studies rely too much on fossil fuel for back up. [See Appendices 2](#) and [3](#).

The reductions in carbon emissions for electricity production will not allow the EU-MENA nations examined to contract and converge to safe levels of total carbon emissions. As model 1 showed, even without considering other sources of carbon emissions, the DLR proposals will not meet contraction and convergence targets due to an over reliance on fossil fuel as a back up in this scheme.

It's clear from the third model that the poorer developing nations in the study such as Yemen must develop along a different path to that of wealthier nations. They must adopt the process of 'leapfrogging' whereby they adopt new technologies and skip the outdated fossil-fuel-based development model (Steffen, A 2008 p. 292-295.), becoming Eco-affluent (Martin, J 2007, p.16-17). Concurrently the wealthy nations must pursue a paradigm shift in their current non-electrical energy use - such as transport.

Existing Orthodoxy

The C&C scenario is seen as a just way of distributing carbon emissions equally. However this essay, particularly model 3 has shown that it is a potentially dangerous way of encouraging increased carbon emissions.

Human population growth has major environmental impacts. Under C&C the EU nations are penalised for stabilising and reducing their national populations, while the MENA nations are rewarded for their irresponsible approach to family planning.

Social issues must be tackled along with technological issues. Yemen's

unsustainable total fertility rate³³ of 6.41 in 2005 and Saudi Arabia's rate of 3.89 in 2005 are contributing to the unsustainable population rises in the region. (CIA, 2008). Arguably carbon emissions should be allocated on a per capita basis as of the year 2000.

Limitations of the essay

This essay concentrated on carbon emissions. It did not deal with CO₂ equivalents whereby "emissions of gases other than CO₂ are translated into CO₂ equivalents using global warming potentials" (GWP). These include Methane with a GWP of 21 (EPA 2005), which caused 14% of CO₂E emissions in 2000 (Stern, N 2006).

There are limitations in the electricity generation scenario chosen. A critique of the method used by the DLR states "The authors of these papers assumed, without any justification, that the value of a coefficient related to the GDP/cap could linearly decrease with time instead of exponentially." (L. Possoz, L and Jeanmart, H). The authors conclude that the electricity demand in the MENA region will be much larger than anticipated.

The GCI data is limited in that it does not incorporate the possibility that due to damaged carbon sinks, the earth's capacity for mitigating Anthropogenic climate change may be reduced. According to the Ecologist magazine, "the Met Office has warned that by 2030, the total carrying capacity of the biosphere to absorb carbon will have reduced from the current 4 billion tonnes a year, to 2.7 billion" (Da Costa, A 2006).

The datasets used by the DLR and the GCI are outdated now. There are discrepancies in the extrapolated population figures from the C&C study and the CIA factbook (CIA, 2008) for the year 2008. Overall the nations had a lower population.

See [Appendix 11](#).

The author-defined models were simplistic and served to show the limitations of the DLR study. Accurately predicting total potential carbon emissions, including from

³³ The average number of children born per woman. Two is the replacement level and indicates a steady

sources such as transport and the building industry would require a larger piece of work.

Due to shifting national boundaries and disputed territories, not all countries were represented in all figures. For example Serbia and Montenegro split into two nations. The Palestinian authority³⁴ were included as territory of Israel.

Further research

This essay would benefit from more recent data for current and predicted population growth, electricity use and carbon emissions in the EU-MENA region. This would require repopulating the GCI and the DLR workbooks.

Predicted carbon emissions from sources other than electricity production would allow more accurate user-defined models to be created.

Further studies could include evaluating the potential of those countries directly below the North African countries that have huge territories in the Sahara such as Mali, Niger, Chad and Sudan ([See Appendix 12](#)). Indeed a study could be extended to incorporate all of Africa and the greater Middle East into the scheme.

Studies should be made without the reliance on fossil fuel backup.

population. Above two will lead to a population rise and below two a population fall (CIA, 2008).

³⁴ The West Bank and the Gaza strip

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Appendices

Appendix 1. EU members and MENA nations and others included in the DLR Studies.

Country	EU Member	MENA Nation	DLR ³⁵ Study
Algeria		Yes	Med-CSP
Austria	Yes		Trans-CSP
Bahrain		Yes	Med-CSP
Belgium	Yes		Trans-CSP
Bosnia and Herzegovina			Trans-CSP
Bulgaria	Yes		Trans-CSP
Croatia			Trans-CSP
Cyprus	Yes		Med-CSP
Czech Republic	Yes		Trans-CSP
Denmark	Yes		Trans-CSP
Egypt		Yes	Med-CSP
Finland	Yes		Trans-CSP
France	Yes		Trans-CSP
Gaza Strip		Yes	Med-CSP
Germany	Yes		Trans-CSP
Greece	Yes		Med-CSP & Trans-CSP
Hungary	Yes		Trans-CSP
Iceland			Trans-CSP
Iran		Yes	Med-CSP
Iraq		Yes	Med-CSP
Ireland	Yes		Trans-CSP
Israel		Yes	Med-CSP
Italy	Yes		Med-CSP & Trans-CSP
Jordan		Yes	Med-CSP
Kuwait		Yes	Med-CSP
Lebanon		Yes	Med-CSP
Libya		Yes	Med-CSP
Luxembourg	Yes		Trans-CSP
Macedonia			Trans-CSP
Malta	Yes		Med-CSP
Montenegro			Trans-CSP
Morocco		Yes	Med-CSP
Netherlands	Yes		Trans-CSP
Norway			Trans-CSP
Oman		Yes	Med-CSP
Poland	Yes		Trans-CSP
Portugal	Yes		Med-CSP & Trans-CSP
Qatar		Yes	Med-CSP
Romania	Yes		Trans-CSP
Saudi Arabia		Yes	Med-CSP
Serbia			Trans-CSP
Slovakia	Yes		Trans-CSP

³⁵Deutsches Zentrum für Luft und Raumfahrt (German Aerospace Centre)

Slovenia	Yes		Trans-CSP
Spain	Yes		Med-CSP & Trans-CSP
Sweden	Yes		Trans-CSP
Switzerland			Trans-CSP
Syria		Yes	Med-CSP
Tunisia		Yes	Med-CSP
Turkey			Med-CSP & Trans-CSP
United Arab Emirates		Yes	Med-CSP
United Kingdom	Yes		Trans-CSP
West Bank		Yes	Med-CSP
Yemen		Yes	Med-CSP

Source data: DLR, 2005 and 2006

Appendix 2. Total CO₂ emissions from electricity production for countries in the TRANS-CSP Study

Mt/y EU30	2000	2010	2020	2030	2040	2050
Wind	0.28	2.07	5.96	8.01	8.92	9.37
Photovoltaics	0.02	0.53	2.64	6.31	8.28	9.23
Geothermal	0.48	0.61	1.17	1.52	2.61	4.01
Biomass	3.35	5.77	10.63	15.21	25.25	33.68
CSP Plants	0.00	1.15	1.03	2.08	1.48	1.83
Wave / Tidal	0.00	0.03	0.10	0.24	0.43	0.67
Hydropower	10.47	10.92	11.37	11.82	12.27	12.72
Oil	146.57	113.02	78.04	37.99	4.77	0.00
Gas	238.01	320.75	334.20	357.69	266.99	92.42
Coal	950.57	970.13	912.05	792.77	509.21	163.52
Nuclear	48.51	40.21	26.87	12.98	3.11	0.00
Import Others	144.95	132.44	119.76	107.07	88.44	70.15
Import Solar	0.00	0.00	0.84	3.23	6.62	9.91
Total	1398.25	1465.18	1384.92	1249.85	849.93	337.35
Avoided	0.00	89.88	333.43	667.01	1114.47	1477.24
Avoided	0.00	85.62	269.68	554.20	893.08	1240.19
CO ₂ -Seq.	0.00	4.26	63.74	112.80	221.38	237.05
RUE	-0.00	108.85	206.20	287.53	392.88	544.38
Percentage reductions in CO ₂ Emissions compared to year 2000		-4.79	0.95	10.61	39.21	75.87

Source: DLR, 2006

Appendix 3. Total CO2 emissions from electricity production for countries in the MED-CSP Study

CO2 Emissions Mt/y	2000	2010	2020	2030	2040	2050	
Total	775.78	903.36	1006.62	986.73	723.90	464.25	
Wind	0.09	0.60	1.24	1.90	2.61	3.42	
Photovoltaics	0.00	0.60	2.77	7.74	11.30	13.11	
Geothermal	0.38	0.47	1.00	1.30	2.25	3.46	
Biomass	0.44	2.50	4.84	7.44	10.25	13.23	
CSP Plants	0.00	1.67	4.76	20.42	23.11	32.84	
Wave / Tidal	0.00	0.01	0.02	0.05	0.09	0.14	
Hydropower	2.62	2.73	3.01	3.46	4.08	4.87	
Oil / Gas	566.73	683.66	782.17	753.10	518.38	268.87	
Coal	205.52	211.12	206.82	191.32	151.82	124.32	
Total	775.78	903.36	1006.62	986.73	723.90	464.25	
Percentage reduction in CO2 emissions			-16.45	-29.76	-27.19	6.69	40.16

Source: DLR, 2006

Appendix 4. Tonnes of Carbon emissions allowed under contraction and convergence from 2000 to 2050.

Country	2000	2010	2020	2030	2040	2050	%age Change
Qatar	14,185,100	11,002,282	6,255,158	2,328,810	210,748	120,693	-99.15
United Arab Emirates	25,396,000	20,199,014	12,028,795	5,021,549	1,014,317	580,890	-97.71
Greece	24,300,900	19,403,206	11,634,598	4,932,842	1,066,126	610,561	-97.49
Bahrain	5,462,300	4,404,820	2,687,076	1,182,594	294,806	168,833	-96.91
Czech Republic	29,930,700	24,651,807	15,577,466	7,356,493	2,270,528	1,300,310	-95.66
Luxembourg	2,098,000	1,733,292	1,100,710	524,694	165,910	95,015	-95.47
Finland	15,791,700	13,066,331	8,317,853	3,983,045	1,273,965	729,588	-95.38
Kuwait	13,494,800	11,202,604	7,168,900	3,466,218	1,135,389	650,227	-95.18
Germany	217,018,500	181,628,328	117,724,979	58,245,013	20,129,510	11,527,984	-94.69
Belgium	27,714,900	23,212,643	15,063,069	7,467,797	2,592,718	1,484,825	-94.64
Denmark	13,336,200	11,244,020	7,371,206	3,719,709	1,341,974	768,536	-94.24
Poland	84,290,100	71,247,110	46,887,679	23,816,755	8,711,070	4,988,749	-94.08
Slovenia	4,057,500	3,432,180	2,261,244	1,150,784	422,549	241,990	-94.04

Italy	115,293,900	97,569,104	64,325,587	32,773,784	12,062,219	6,907,921	-94.01
Malta	968,900	820,769	541,940	276,823	102,415	58,652	-93.95
Ireland	11,452,000	9,708,593	6,417,817	3,284,576	1,219,949	698,653	-93.90
Austria	17,633,500	14,974,011	9,923,326	5,099,948	1,910,170	1,093,937	-93.80
Netherlands	38,419,800	32,709,243	21,759,861	11,254,421	4,268,518	2,444,540	-93.64
United Kingdom	146,488,100	124,737,216	83,003,849	42,949,408	16,303,703	9,336,980	-93.63
Norway	10,644,600	9,094,913	6,082,572	3,173,371	1,223,911	700,923	-93.42
Slovakia	10,208,600	8,810,585	5,979,457	3,193,324	1,285,852	736,395	-92.79
Spain	75,104,900	64,982,547	44,260,675	23,770,246	9,667,008	5,536,206	-92.63
Cyprus	1,713,400	1,484,953	1,013,842	546,495	223,687	128,104	-92.52
Hungary	15,547,600	13,475,690	9,201,450	4,960,732	2,031,092	1,163,187	-92.52
Bulgaria	10,688,500	9,309,221	6,400,380	3,487,014	1,453,617	832,473	-92.21
Switzerland	11,412,600	9,943,256	6,839,568	3,728,983	1,556,383	891,326	-92.19
Israel	17,163,000	14,972,848	10,318,134	5,641,104	2,365,419	1,354,654	-92.11
Iceland	579,300	507,275	351,411	193,632	82,253	47,105	-91.87
Portugal	16,468,500	14,425,958	9,998,272	5,513,111	2,344,655	1,342,762	-91.85
France	100,565,100	89,495,304	63,377,521	36,050,986	16,100,479	9,220,595	-90.83
Croatia	5,922,100	5,271,510	3,734,327	2,125,173	949,769	543,924	-90.82
Macedonia	3,264,400	2,922,652	2,086,384	1,200,128	544,975	312,102	-90.44
Sweden	12,860,800	11,569,712	8,311,313	4,822,170	2,217,314	1,269,835	-90.13
Saudi Arabia	62,091,400	57,052,907	42,104,921	25,312,419	12,223,364	7,000,207	-88.73
Libya	11,026,300	10,132,917	7,479,319	4,497,338	2,172,376	1,244,100	-88.72
Romania	20,093,100	19,130,967	14,731,945	9,327,415	4,804,816	2,751,673	-86.31
Lebanon	4,842,200	4,644,245	3,606,366	2,305,440	1,200,991	687,796	-85.80
Oman	5,779,700	5,599,616	4,397,640	2,847,331	1,504,925	861,856	-85.09
Iran	83,435,100	83,406,713	67,741,063	45,474,900	24,992,254	14,312,832	-82.85
Turkey	57,924,900	62,851,354	55,218,569	39,979,399	23,635,986	13,536,110	-76.63
Algeria	26,843,600	29,618,575	26,403,949	19,363,597	11,578,532	6,630,918	-75.30
Syria	14,919,100	17,573,370	16,515,867	12,652,256	7,848,118	4,494,544	-69.87

Tunisia	5,614,300	6,765,065	6,466,721	5,019,512	3,146,419	1,801,925	-67.90
Jordan	4,083,900	4,962,813	4,773,224	3,722,363	2,341,897	1,341,183	-67.16
Iraq	21,091,300	26,264,283	25,700,747	20,301,655	12,900,144	7,387,793	-64.97
Egypt	34,513,100	49,595,526	53,012,370	44,470,660	29,518,263	16,904,835	-51.02
Morocco	9,758,000	16,241,725	18,663,016	16,346,320	11,166,015	6,394,673	-34.47
Yemen	5,116,000	17,310,709	24,347,127	23,522,183	17,030,487	9,753,202	90.64

Source data: Global Commons Institute, 2003

Appendix 5. Tonnes of Carbon emissions per capita allowed under contraction and convergence from 2000 to 2050.

Country	2000	2010	2020	2030	2040	2050	%age change required.
Qatar	24415	16514	8338	2869	248	142	-99.42
United Arab Emirates	9006	6075	3195	1255	248	142	-98.42
Bahrain	8068	5346	2780	1087	248	142	-98.24
Kuwait	6006	3763	1970	834	248	142	-97.63
Luxembourg	4823	3523	1998	859	248	142	-97.05
Finland	3050	2495	1574	758	248	142	-95.34
Ireland	2999	2314	1416	690	248	142	-95.26
Czech Republic	2915	2436	1568	765	248	142	-95.12
Israel	2841	2085	1261	632	248	142	-94.99
Saudi Arabia	2804	1958	1162	588	248	142	-94.93
Belgium	2704	2237	1436	710	248	142	-94.74
Germany	2637	2208	1432	711	248	142	-94.61
Denmark	2506	2085	1351	681	248	142	-94.33
United Kingdom	2496	2069	1333	668	248	142	-94.30
Malta	2491	2038	1308	663	248	142	-94.29
Netherlands	2417	1987	1284	654	248	142	-94.12
Norway	2380	1966	1271	648	248	142	-94.02
Greece	2229	1779	2125	3443	248	142	-93.62
Oman	2215	1615	1012	545	248	142	-93.58
Cyprus	2188	1782	1157	609	248	142	-93.50
Poland	2180	1862	1242	649	248	142	-93.48
Austria	2176	1859	1238	645	248	142	-93.47
Libya	2105	1603	1020	553	248	142	-93.25
Iceland	2054	1687	1105	590	248	142	-93.08
Slovenia	2039	1763	1194	635	248	142	-93.03
Italy	2004	1740	1187	635	248	142	-92.90
Slovakia	1894	1628	1104	598	248	142	-92.49

Spain	1843	1587	1086	594	248	142	-92.28
France	1696	1455	998	558	248	142	-91.62
Portugal	1644	1442	1007	566	248	142	-91.35
Macedonia	1613	1385	958	545	248	142	-91.18
Switzerland	1591	1411	991	561	248	142	-91.06
Hungary	1553	1414	1012	573	248	142	-90.84
Sweden	1452	1297	922	533	248	142	-90.21
Lebanon	1392	1174	824	495	248	142	-89.79
Croatia	1332	1219	893	530	248	142	-89.32
Bulgaria	1320	1248	930	547	248	142	-89.23
Iran	1256	1094	786	482	248	142	-88.68
Iraq	908	861	677	449	248	142	-84.34
Syria	901	844	661	442	248	142	-84.22
Romania	894	874	694	458	248	142	-84.09
Algeria	888	836	656	441	248	142	-83.98
Turkey	848	812	646	438	248	142	-83.24
Jordan	811	785	633	434	248	142	-82.47
Tunisia	590	641	559	409	248	142	-75.89
Egypt	509	602	549	409	248	142	-72.07
Morocco	335	478	484	387	248	142	-57.58
Yemen	284	656	659	454	248	142	-49.92

Source data: Global Commons Institute, 2003

Appendix 6 Predicted electricity requirements in terawatts.

TWh/y	2000	2010	2020	2030	2040	2050	Total Change	% Change
Germany	571.55	604.66	640.32	654.41	625.87	548.82	-22.73	-3.98
France	471.08	507.35	542.37	550.23	513.13	425.99	-45.09	-9.57
United Kingdom	391.69	430.73	476.87	506.77	501.19	451.23	59.53	15.20
Italy	298.71	336.36	360.72	360.88	325.01	256.21	-42.50	-14.23
Spain	216.60	248.83	269.24	276.51	258.57	212.45	-4.15	-1.91
Sweden	150.09	155.09	160.71	163.79	161.74	153.66	3.58	2.39
Poland	138.83	142.00	153.24	178.40	196.17	190.90	52.07	37.50
Norway	123.68	129.63	132.65	130.91	123.88	112.05	-11.63	-9.40
Turkey	120.55	154.75	230.13	344.59	452.99	494.22	373.67	309.96
Saudi Arabia	118.70	168.39	214.04	268.08	308.05	304.47	185.76	156.49
Iran	113.77	154.57	221.87	335.37	462.34	534.44	420.67	369.75
Netherlands	108.56	120.01	131.43	136.94	132.15	116.05	7.49	6.90
Belgium	88.35	91.21	93.34	91.32	82.68	67.03	-21.32	-24.13
Finland	82.17	83.00	83.94	84.75	82.35	76.40	-5.78	-7.03
Egypt	70.71	102.76	171.52	311.67	495.74	631.31	560.61	792.88
Czech Republic	63.65	62.00	60.18	61.26	59.34	51.72	-11.93	-18.74
Switzerland	60.21	63.42	64.32	60.82	52.19	39.37	-20.84	-34.61
Austria	56.25	63.67	66.43	65.71	59.89	48.99	-7.26	-12.91
Romania	51.42	53.00	57.79	74.63	91.21	96.13	44.71	86.94
Greece	49.57	55.78	61.59	65.75	64.34	55.46	5.89	11.89
Portugal	41.66	49.45	55.73	60.09	58.86	50.58	8.93	21.43
Hungary	38.47	39.00	40.46	44.85	46.87	43.87	5.40	14.05

Israel	38.18	50.79	59.86	66.18	65.94	56.57	18.38	48.14
Denmark	36.74	43.60	48.80	52.41	53.24	51.12	14.38	39.14
Bulgaria	36.18	32.00	28.10	28.72	29.18	26.50	-9.68	-26.74
Serbia & Montenegro	35.80	36.50	37.00	39.85	46.91	49.19	13.39	37.41
United Arab Emirates	35.70	43.87	45.62	43.25	35.60	23.58	-12.11	-33.93
Iraq	31.22	40.01	57.85	104.43	182.60	257.03	225.81	723.24
Kuwait	30.07	38.84	43.36	44.81	40.84	30.15	0.08	0.27
Slovakia	28.10	28.20	28.23	30.49	31.57	29.46	1.36	4.82
Ireland	23.96	29.70	35.06	38.36	38.15	33.97	10.01	41.76
Algeria	23.04	41.03	80.62	145.21	213.30	248.96	225.92	980.44
Syria	22.60	31.94	51.96	90.98	138.46	166.29	143.69	635.93
Libya	19.18	23.06	27.15	33.99	41.36	43.90	24.72	128.90
Morocco	15.18	26.76	57.17	115.75	187.44	235.07	219.90	1449.00
Croatia	14.76	15.00	15.84	18.57	20.63	20.31	5.56	37.64
Slovenia	12.31	12.20	12.10	12.09	11.28	9.35	-2.96	-24.04
Tunisia	9.78	14.51	24.27	40.17	56.92	65.87	56.09	573.41
Bosnia-Herzegovina	9.41	10.00	11.23	14.66	17.72	17.79	8.38	89.06
Lebanon	8.75	10.01	12.31	16.96	22.23	24.64	15.89	181.61
Qatar	8.68	10.12	10.07	9.41	7.66	5.01	-3.67	-42.28
Oman	8.42	12.41	17.46	24.72	31.80	34.58	26.16	310.61
Iceland	7.73	7.85	8.02	7.89	7.40	6.55	-1.17	-15.20
Macedonia	6.93	7.20	7.45	9.11	10.91	11.49	4.57	65.93
Luxembourg	6.90	8.78	10.31	11.23	11.41	10.94	4.03	58.46
Jordan	6.86	9.83	15.46	26.67	40.86	50.55	43.69	636.86
Bahrain	5.82	7.46	8.16	8.64	8.37	6.87	1.05	18.05
Cyprus	3.12	4.01	4.74	5.36	5.50	4.94	1.82	58.41
Yemen	2.74	4.75	12.52	39.46	106.32	225.81	223.07	8152.99
Malta	1.77	2.67	2.94	3.08	2.88	2.33	0.56	31.32

Source data: DLR, 2005 and 2006

Appendix 7. Proportion of a nations CO2 emissions generated from electricity production in 2000

Country	Percentage
Norway	8.6
Yemen	10.2
Qatar	11.7
Iceland	16.0
Algeria	16.2
France	16.7
Bahrain	20.3
Iran	24.7
Syria	25.8
Croatia	26.1
United Arab Emirates	26.8
Austria	26.9
Iraq	27.7
Oman	27.8
Morocco	29.0
Slovakia	29.1
Belgium	30.1

Turkey	31.3
Egypt	31.4
Jordan	32.0
Romania	32.5
Lebanon	33.0
Tunisia	33.1
Libya	33.2
Cyprus	34.7
Switzerland	34.8
Sweden	35.4
Malta	36.0
Hungary	36.3
Saudi Arabia	36.5
Ireland	37.7
United Kingdom	37.9
Italy	38.5
Spain	40.4
Kuwait	42.5
Netherlands	43.0
Germany	43.0
Luxembourg	43.1
Poland	43.2
Portugal	43.5
Finland	43.9
Macedonia	44.5
Israel	46.4
Slovenia	47.7
Greece	48.1
Bulgaria	48.1
Czech Republic	52.2
Denmark	56.7

Source data: DLR, 2005 and 2006 and GCI, 2003

Appendix 8. Carbon emissions (tonnes) permitted under C&C minus predicted carbon emissions from the production of electricity only according to predictions in the DLR study in tonnes.

	2000	2010	2020	2030	2040	2050
Germany	123,682,444	78,354,461	19,940,841	-25,072,326	31,679,227	-9,376,137
Saudi Arabia	39,431,770	27,567,877	9,514,146	-5,038,721	11,625,080	-6,779,292
United Kingdom	90,997,671	64,258,045	25,063,499	-5,800,100	17,377,856	-5,427,459
Iran	62,834,528	57,426,785	34,881,256	8,819,161	1,226,679	-5,176,043
Netherlands	21,903,728	14,707,917	5,456,253	-3,237,932	-5,635,684	-2,776,485
Israel	9,193,986	5,034,115	-277,410	-2,884,576	-3,390,937	-2,082,207
France	83,768,327	68,744,261	36,566,459	639,662	12,288,921	-1,745,050
Czech Republic	14,306,543	10,943,177	3,420,362	-4,122,105	-5,869,820	-1,658,818
Denmark	5,772,181	3,490,793	478,429	-2,383,525	-3,090,224	-1,651,088

Belgium	19,364,457	14,994,436	6,489,107	-605,129	-3,369,775	-1,532,649
Switzerland	7,444,080	5,792,867	2,574,862	-83,316	-1,611,256	-1,425,374
Finland	8,856,423	6,709,328	2,838,177	-1,362,825	-3,067,607	-1,246,250
Kuwait	7,754,984	4,343,808	348,553	-2,517,125	-3,108,604	-1,175,971
United Arab Emirates	18,582,115	12,451,438	4,831,483	-704,467	-2,480,097	-754,060
Luxembourg	1,194,474	693,956	9,096	-531,266	-795,522	-703,264
Syria	11,071,382	12,456,017	9,151,627	4,429,936	2,013,728	-695,899
Greece	12,615,490	8,040,008	1,192,687	-2,849,672	-3,292,439	-672,537
Lebanon	3,246,297	2,964,645	1,780,836	646,667	-369,887	-594,020
Spain	44,743,880	32,577,079	14,124,075	-3,308,792	-9,367,140	-447,660
Macedonia	1,811,032	1,587,322	891,717	-27,999	-565,122	-407,343
Slovakia	7,233,035	5,705,099	2,641,754	-187,076	-1,305,662	-371,717
Morocco	6,924,918	12,244,394	11,146,794	7,298,828	3,496,147	-315,943
Sweden	8,309,526	4,814,570	1,992,075	-1,242,372	-1,612,993	-281,004
Slovenia	2,120,123	1,929,543	1,199,338	18,341	-515,589	-273,742
Cyprus	1,118,635	788,994	284,344	-153,399	-329,518	-256,373
Bulgaria	5,544,305	4,883,757	2,703,941	314,365	-1,177,722	-232,646
Bahrain	4,351,059	3,088,696	1,415,540	165,920	-447,696	-207,680
Ireland	7,129,194	4,736,836	2,056,178	-578,225	-1,335,701	-186,113
Malta	619,682	336,118	55,296	-177,790	-254,859	-182,711
Iceland	486,338	442,661	262,256	83,625	-72,658	-163,400
Norway	9,725,852	7,853,530	5,060,783	2,411,944	407,295	-162,902
Libya	7,365,531	6,141,760	3,550,519	1,594,090	119,981	-108,514
Hungary	9,908,935	7,683,929	3,433,204	351,388	-1,469,446	-91,356
Qatar	12,528,658	9,215,206	4,673,540	1,161,811	-448,316	-44,074
Portugal	9,306,545	7,656,400	3,938,888	512,559	-996,143	41,020
Italy	70,945,824	54,478,693	26,875,735	4,086,608	-4,209,166	59,989
Croatia	4,377,478	3,924,023	2,650,168	1,010,237	101,755	98,014
Algeria	22,497,093	22,752,851	15,093,411	7,609,049	3,082,875	240,918
Oman	4,171,883	3,469,373	1,916,275	887,080	493,117	473,565
Poland	47,876,471	37,524,119	17,215,072	-3,227,202	-7,866,206	492,899
Austria	12,885,042	9,883,574	5,268,295	1,857,240	56,685	592,089
Jordan	2,778,127	3,269,855	2,508,442	1,476,712	792,767	597,932
Romania	13,555,950	14,139,979	10,144,875	5,141,818	1,601,785	652,365
Tunisia	3,758,372	4,433,201	3,422,486	2,286,214	1,525,409	706,017
Turkey	39,777,633	45,235,269	38,182,481	20,873,584	6,012,703	1,178,492
Iraq	15,240,409	19,664,982	18,009,140	13,599,850	8,505,330	4,254,864
Egypt	23,661,205	34,829,943	31,837,052	18,093,561	7,135,558	4,581,082
Yemen	4,593,704	16,680,311	23,522,062	21,566,359	13,093,683	5,171,186
Total	947,367,320	780,946,001	420,336,002	60,840,670	91,361,373	-30,065,349

Source data: DLR, 2005 and 2006 and GCI, 2003

Appendix 9. Carbon emissions (tonnes) allowed under contraction and convergence scenario minus carbon emitted from all sources (based on a static year 2000 amount from non electricity sources together with Carbon emitted by electricity generation).

	2000	2010	2020	2030	2040	2050
Germany	0	-45,327,983	-103,741,602	-148,754,769	-155,361,670	-133,058,581
United Kingdom	0	-26,739,627	-65,934,172	-96,797,771	-108,375,527	-96,425,130
France	0	-15,024,066	-47,201,868	-83,128,665	-96,057,248	-85,513,377
Italy	0	-16,467,130	-44,070,089	-66,859,216	-75,154,990	-70,885,835
Iran	0	-5,407,743	-27,953,272	-54,015,367	-61,607,849	-68,010,571
Poland	0	-10,352,352	-30,661,400	-51,103,673	-55,742,678	-47,383,572
Saudi Arabia	0	-11,863,893	-29,917,624	-44,470,491	-51,056,850	-46,211,062
Spain	0	-12,166,801	-30,619,805	-48,052,671	-54,111,019	-45,191,540
Turkey	0	5,457,636	-1,595,152	-18,904,050	-33,764,930	-38,599,141
Netherlands	0	-7,195,811	-16,447,475	-25,141,660	-27,539,412	-24,680,213
Algeria	0	255,758	-7,403,682	-14,888,044	-19,414,217	-22,256,175
Belgium	0	-4,370,021	-12,875,350	-19,969,586	-22,734,232	-20,897,106
United Arab Emirates	0	-6,130,678	-13,750,633	-19,286,583	-21,062,213	-19,336,175
Egypt	0	11,168,738	8,175,847	-5,567,644	-16,525,647	-19,080,124
Czech Republic	0	-3,363,366	-10,886,182	-18,428,648	-20,176,363	-15,965,361
Greece	0	-4,575,482	-11,422,803	-15,465,162	-15,907,930	-13,288,027
Romania	0	584,029	-3,411,075	-8,414,132	-11,954,166	-12,903,585
Qatar	0	-3,313,452	-7,855,118	-11,366,847	-12,976,974	-12,572,732
Austria	0	-3,001,468	-7,616,747	-11,027,802	-12,828,356	-12,292,952
Syria	0	1,384,635	-1,919,755	-6,641,446	-9,057,654	-11,767,281
Israel	0	-4,159,871	-9,471,396	-12,078,562	-12,584,922	-11,276,193
Iraq	0	4,424,573	2,768,731	-1,640,559	-6,735,079	-10,985,545
Finland	0	-2,147,095	-6,018,246	-10,219,248	-11,924,030	-10,102,673
Hungary	0	-2,225,006	-6,475,731	-9,557,547	-11,378,382	-10,000,291
Norway	0	-1,872,322	-4,665,068	-7,313,907	-9,318,557	-9,888,754
Portugal	0	-1,650,145	-5,367,657	-8,793,986	-10,302,688	-9,265,525
Kuwait	0	-3,411,176	-7,406,431	-10,272,109	-10,863,588	-8,930,954
Switzerland	0	-1,651,213	-4,869,217	-7,527,396	-9,055,336	-8,869,454
Sweden	0	-3,494,956	-6,317,450	-9,551,898	-9,922,518	-8,590,530
Slovakia	0	-1,527,936	-4,591,280	-7,420,111	-8,538,696	-7,604,752
Libya	0	-1,223,771	-3,815,012	-5,771,441	-7,245,551	-7,474,046
Denmark	0	-2,281,388	-5,293,752	-8,155,706	-8,862,405	-7,423,269
Ireland	0	-2,392,358	-5,073,016	-7,707,418	-8,464,894	-7,315,307
Morocco	0	5,319,476	4,221,876	373,911	-3,428,771	-7,240,861
Bulgaria	0	-660,547	-2,840,364	-5,229,940	-6,722,026	-5,776,951
Bahrain	0	-1,262,363	-2,935,519	-4,185,139	-4,798,755	-4,558,739
Croatia	0	-453,456	-1,727,310	-3,367,241	-4,275,723	-4,279,464
Lebanon	0	-281,652	-1,465,461	-2,599,630	-3,616,184	-3,840,317
Oman	0	-702,510	-2,255,608	-3,284,803	-3,678,766	-3,698,318
Tunisia	0	674,829	-335,886	-1,472,158	-2,232,963	-3,052,355
Slovenia	0	-190,581	-920,785	-2,101,782	-2,635,713	-2,393,866
Macedonia	0	-223,710	-919,316	-1,839,032	-2,376,154	-2,218,375
Jordan	0	491,728	-269,685	-1,301,415	-1,985,360	-2,180,195

Sweden	-10,310,675	-8,788,716
Slovakia	-8,035,039	-7,953,675
Qatar	-12,418,250	-7,275,705
Switzerland	-7,602,843	-6,293,051
Croatia	-4,497,817	-5,927,170
Bahrain	-6,295,536	-5,344,058
Bulgaria	-4,086,785	-4,294,188
Macedonia	-2,411,513	-3,412,377
Luxembourg	-2,474,323	-2,596,061
Cyprus	-2,079,125	-2,028,394
Slovenia	-2,064,695	-1,884,266
Malta	-1,253,242	-996,460
Iceland	-412,875	-575,822
Total	-1,698,433,760	-2,540,714,389

Source data: DLR, 2005 and 2006 and GCI, 2003

Appendix 11. Extrapolated population figures from the C&C study and the CIA factbook population figures (CIA, 2008) for the year 2008

Country	DLR Study	C&C Population estimates 2008 from 2003 figures	CIA Population Estimate 2008	Difference in Population	Percentage Difference in population
Iran	Med-CSP	74,267,379	65,875,224	-8,392,155	-12.74
Bahrain	Med-CSP	794,175	718,306	-75,869	-10.56
Kuwait	Med-CSP	2,830,068	2,596,799	-233,269	-8.98
Yemen	Med-CSP	24,714,285	23,013,376	-1,700,909	-7.39
Turkey	Med-CSP & Trans-CSP	75,510,627	71,892,808	-3,617,819	-5.03
Bulgaria	Trans-CSP	7,585,141	7,262,675	-322,466	-4.44
Cyprus	Med-CSP	822,778	792,604	-30,174	-3.81
Iraq	Med-CSP	29,027,469	28,221,180	-806,289	-2.86
Algeria	Med-CSP	34,380,618	33,769,668	-610,950	-1.81
Greece	Med-CSP & Trans-CSP	10,900,734	10,722,816	-177,918	-1.66
Macedonia	Trans-CSP	2,091,902	2,061,315	-30,587	-1.48
Syria	Med-CSP	19,960,077	19,747,586	-212,491	-1.08
Spain	Med-CSP & Trans-CSP	40,882,823	40,491,052	-391,771	-0.97
Germany	Trans-CSP	82,214,651	82,369,552	154,901	0.19
Tunisia	Med-CSP	10,347,824	10,383,577	35,753	0.34
Finland	Trans-CSP	5,222,505	5,244,749	22,244	0.42
Poland	Trans-CSP	38,320,562	38,500,696	180,134	0.47
Oman	Med-CSP	3,294,506	3,311,640	17,134	0.52
Belgium	Trans-CSP	10,344,897	10,403,951	59,054	0.57

Czech Republic	Trans-CSP	10,143,610	10,220,911	77,301	0.76
Ireland	Trans-CSP	4,118,682	4,156,119	37,437	0.90
Slovakia	Trans-CSP	5,405,699	5,455,407	49,708	0.91
Malta	Med-CSP	399,848	403,532	3,684	0.91
Norway	Trans-CSP	4,594,029	4,644,457	50,428	1.09
Libya	Med-CSP	6,102,955	6,173,579	70,624	1.14
Romania	Trans-CSP	21,988,120	22,246,862	258,742	1.16
Luxembourg	Trans-CSP	480,337	486,006	5,669	1.17
Saudi Arabia	Med-CSP	27,728,811	28,146,656	417,845	1.48
Sweden	Trans-CSP	8,904,021	9,045,389	141,368	1.56
United Kingdom	Trans-CSP	59,935,509	60,943,912	1,008,403	1.65
Austria	Trans-CSP	8,060,688	8,205,533	144,845	1.77
Netherlands	Trans-CSP	16,338,096	16,645,313	307,217	1.85
Denmark	Trans-CSP	5,376,763	5,484,723	107,960	1.97
Jordan	Med-CSP	6,059,984	6,198,677	138,693	2.24
Israel	Med-CSP	6,949,282	7,112,359	163,077	2.29
Iceland	Trans-CSP	296,810	304,367	7,557	2.48
Slovenia	Trans-CSP	1,954,207	2,007,711	53,504	2.66
Egypt	Med-CSP	79,454,496	81,713,520	2,259,024	2.76
Lebanon	Med-CSP	3,858,258	3,971,941	113,683	2.86
Hungary	Trans-CSP	9,623,761	9,930,915	307,154	3.09
Italy	Med-CSP & Trans-CSP	56,329,159	58,145,320	1,816,161	3.12
Croatia	Trans-CSP	4,345,180	4,491,543	146,363	3.26
Morocco	Med-CSP	32,975,263	34,343,220	1,367,957	3.98
France	Trans-CSP	61,051,505	64,057,792	3,006,287	4.69
Portugal	Med-CSP & Trans-CSP	10,001,325	10,676,910	675,585	6.33
Switzerland	Trans-CSP	7,070,413	7,581,520	511,107	6.74
Qatar	Med-CSP	648,897	824,789	175,892	21.33
United Arab Emirates	Med-CSP	3,222,466	4,621,399	1,398,933	30.27
Total for region				-1,311,237	

Source data: CIA, 2008 and CGI, 2003

Appendix 12 – Map showing MENA region and other North African countries with territories in the Sahara desert.



Source: User created map based on:
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