UNAM/CRIM & AFES-PRESS

First Sustainability Transition & Sustainable Peace Workshop

Towards a Fourth Sustainability Revolution and Sustainable Peace: Visions and Strategies for Long Term Transformative Change to Sustainable Development in the 21st Century

From DESERTEC to NAFSOLTEC:

Macro Projects for a Transition towards Renewable Energies in Europe, the MENA Region, in North America ands in Mexico

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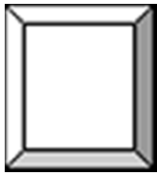


Abstract

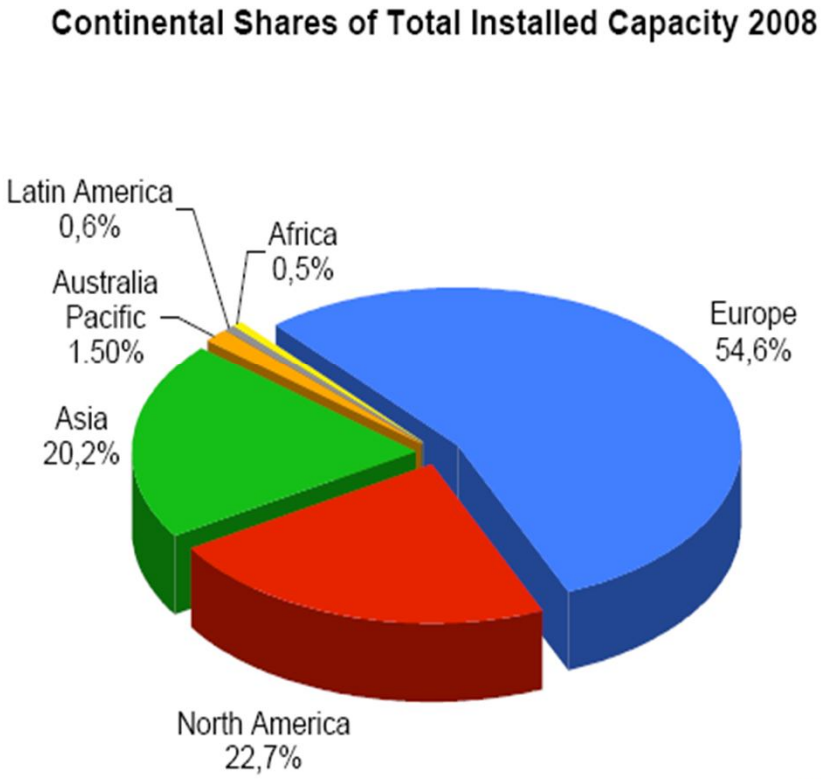
- Sustainability transition research (STR) deals with both the soft features (attitudes, preferences, value systems, behaviour, lifestyles, ways of life) and the hard characteristics of environmental innovation in the energy, transportation, and production sectors as well as in housing and patterns of consumption. The response to unsustainable lifestyles and patterns of production and consumption may be small-scale, local, and bottom-up, or it may be large-scale and top-down from the national or international level. This paper deals with a large-scale industrial project called DESERTEC that aims to produce renewable energy from the deserts of the Middle East and North Africa region to satisfy local needs and to export fifteen to twenty per cent towards the electricity demand of European countries by 2050. The paper suggests a similar approach for NAFTA countries, who could meet a significant part of their energy demand from renewable energy sources, including solar energy from the deserts of the USA and Mexico. After briefly reviewing the causes of anthropogenic climate change, the paper compares the performance of EU and NAFTA countries in complying with their commitments to GHG reduction under the Kyoto Protocol (KP), and discusses the IEA's Annual World Energy Reports and its two scenarios (business-as-usual and an ecological scenario aiming for a stabilization at 450ppm) for energy-related GHG emissions by 2030 and 2050. This is followed by a brief review of the EU's climate change targets for 2020 and its Energy Roadmap 2050 that aims at a reduction in GHG emissions of more than eighty per cent by 2050 and an assessment of the European Mediterranean Solar Plan and the Desertec industrial initiative (Dii), launched in July 2009. The last three parts of the paper shift the focus to the three NAFTA countries (Canada, USA, Mexico) and their implementation of the goals of the UNFCCC and the KP. It confronts the opposition of the climate sceptics with the technical potential of a NAFSOLTEC initiative that could significantly reduce GHG emissions for electricity generation and make the USA less dependent on imports of hydrocarbon energy sources. The paper then demonstrates the opportunities such a macro NAFSOLTEC initiative as well as small-scale bottom-up projects could offer Mexico and its economic, social, and environmental development. The paper concludes by arguing that such a sustainability transition in the energy sector would make it necessary to overcome the present worldviews of energy specialists and the mindset of decision-makers in the economic sector and in the state.

Contents

1. Introduction

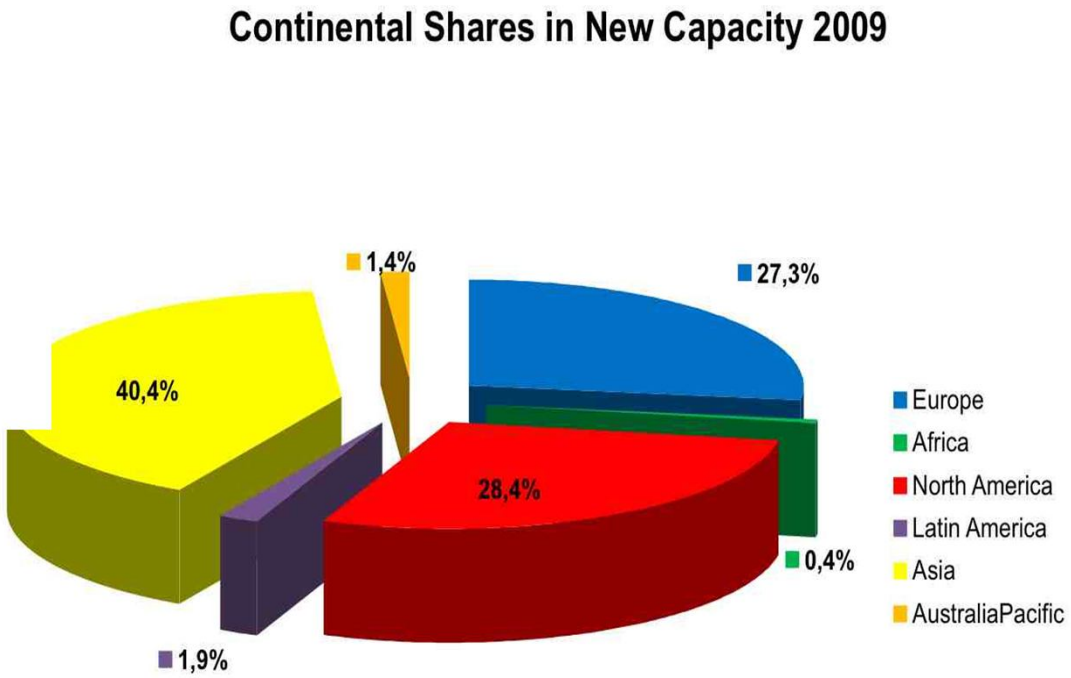
- This paper deals with selected ‘hard features’ of unsustainable ways of life and patterns of production and consumption in the energy sector. These have been primarily responsible for about two-thirds of global greenhouse gas (GHG) emissions since the start of the industrial revolution, when humankind gradually replaced the pre-industrial solar age with the use of fossil energy sources (coal, gas, and oil).
- This paper addresses only the macro-level of regions, e.g. the European Union (EU), the Middle East and North Africa (MENA), and the North American Free Trade Association (NAFTA). On the national level this papers offers examples from the USA, Mexico, Germany, and the UK to contrast different political cultures in which changes in climate change and energy policies have evolved over the past two decades.

1.2. global shares of renewable and wind energy sources (2009)



Continental Shares of Total Globally Installed Capacity of Renewables

- Continental Shares of Wind Source: World Wind Energy Report 2009 (10 March 2010)



1.3. Bottom-up vs. Top Down

- Energy transition has started globally & accele-rated since 2009: China major producer
- Energy transition in Germany: 1990-2012
  - State set the legal framework (national renewables)
    - Electricity Feed-In Law
    - Renewable Energy Law (2000)
  - Customers: Investment in Wind and Solar Power
- Top-down: Macro Scale Proposal:
  - Import of renewable electricity from the desert
  - As part of a co-development strategy between Europe and MENA Region

1.4. My own approach & evolution

- 1988: Winter/Nitsch: Hydrogen as an energy provider: EU-MENA link
- 1993: AFES-PRESS discussion with Spanish colleagues: on Confidence building in the Mediterranean: Howw can we help them to help us
- 1997: Energy Policy in North Africa: A vision on Andalucia: which has benn realized 15 years later
- 1999: Study of a Workshop of the German Physical Society: Knies/Czisch/ Brauch (Ed.): Renewable Electricity for Europe by Long-distance Transmission of Electrical Energy
- Knies became a key promoter of the TREC concept that was endorsed by the Club of Rome
- 2002: joint meeting of Boell Foundation & Terin in New York: launched idea of a survival pact: linking food & renewables as part of a codevelopment strategy
- 2010: In a paper for the Spanish EU Presidency developed this vision wider
- 2012: In a chapter policy response to Climate Change for MENA region I discussed: the EU Solar Plan & DESERTEC
- April 2012: ISA in San Diego: I launched the concept of NAFSOLTEC as a hypothetical solution and as an illustration of a macro scale sustainability transition in the energy sector

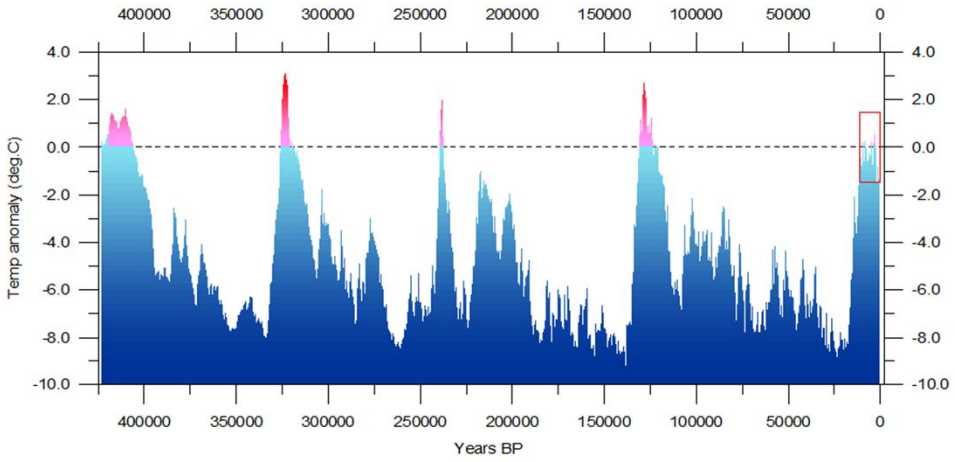
1.5. Structure of the Paper

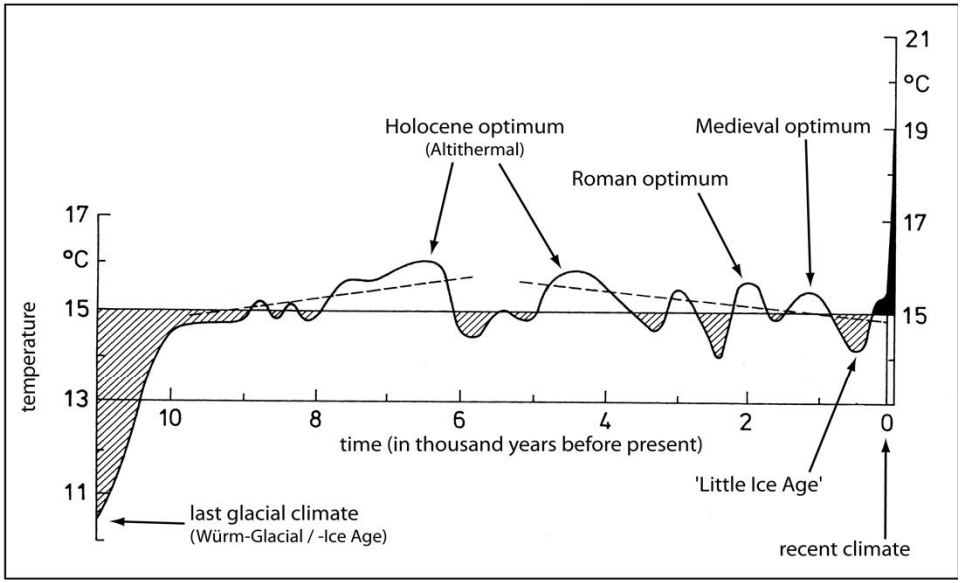
- In the next nine parts first the causes & impacts of anthropogenic climate change are reviewed, in particular the transition from the pre-industrial solar energy system to a fossil energy system. This was the basis of rapid economic development in Europe, especially England, since the late eighteenth century, in continental Europe since the early to mid-nineteenth century, in the USA from 1865, in Japan after the Opening, in the Soviet Union since the 1920s, and in the rest of the world since 1945.
- This is followed by a brief comparison of the climate change performance of the EU (EU-15 and EU-27) and of the three NAFTA countries (Canada, Mexico, USA) from 1990 (or 1994) to 2010 and by a reference to global energy scenarios and projections up to 2030 and 2050 published by the International Energy Agency (IEA).
- The next three parts (5–7) deal with the policy response of the EU countries in coping with global climate change by clear legally binding goals of reducing their GHG emissions by the triple 20-20-20 amount by 2020, the development of the European Mediterranean Solar Plan (MSP), and the proposed Desertec Industrial Initiative (Dii). Part 8 tries to interpret why the NAFTA countries have failed to achieve their GHG reduction targets (1990–2012) and have so far not adopted effective political strategies, and why there has been such an ideological backlash against climate policy efforts, especially in the USA but also in Canada.
- Part 9 addresses the scientific and technical potential for a possible transformation of the energy sector towards renewables in the framework of a ‘thought experiment’ through a visionary NAFSOLTEC project. In the concluding part, the paper argues why ST could offer benefits for SD in the energy sector of Mexico, by creating hundreds of thousands of new jobs in new industrial facilities and in installing, maintaining, and repairing these systems.
- The paper ends with a consideration of how Mexican governments have addressed concerns about climate change in the past with action by combining bottom-up and top-down approaches.

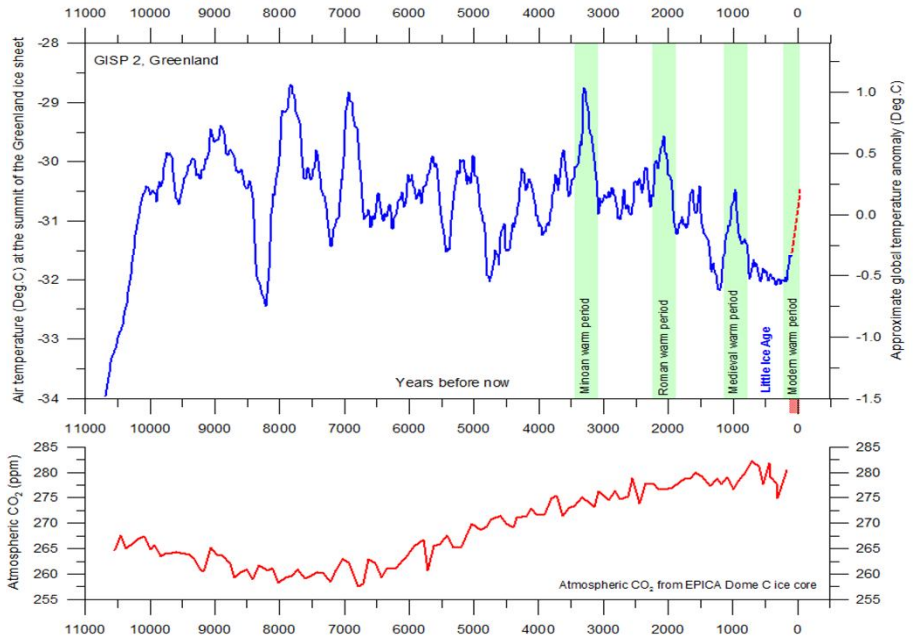
2. Causes of Anthropogenic Climate Change: Alternatives to Fossil Energy

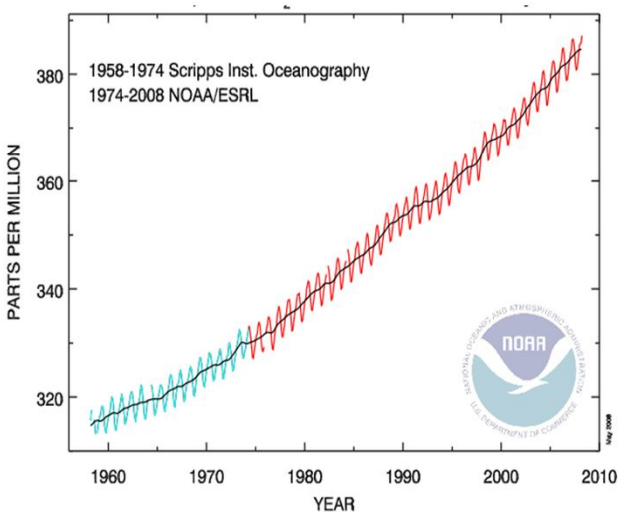
- Past large-scale transformations due to three technical revolutions during Holocene (past 12.000 years)
  - Agricultural or neolithic revolution (10-6000 years ago)
  - Industrial revolution (1750/1782-1890/1920)
  - Energy, Transportation, IT Revolution (1890/1920-today
- Past technical transitions have resulted in warfare
  - Industrial revolution: industrialization of warfare (WWi, WWII)
- Second change: Holocene to the Anthroprocene
  - Major precondition of industrial revolution: was cheap fossil energy: that provided the cause for the increase of GHG in the atmosphere
  - Crutzen referred to this transition as the transition from the Holocene to the Antrhopocene

2.1 Climate Variability & Anthropog. Climate Change









- **GHG concentration in the atmosphere**
- **1750: 279 ppm, 1987: 387 ppm**
- **1/3: 1750-1958: 279 to 315 ppm**

208 years:36ppm

- **2/3: 1958-2012: 315 to 395 ppm**

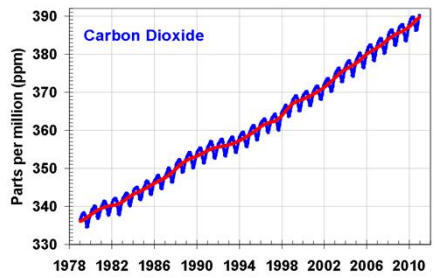
54 years:+80ppm

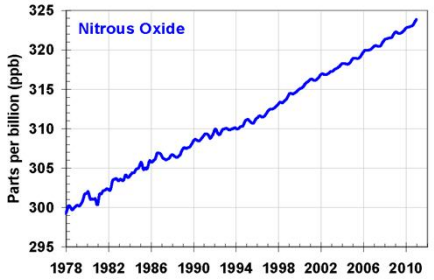
- **1.4.2012: 395.3**
- **1.4.2002: 374.5**

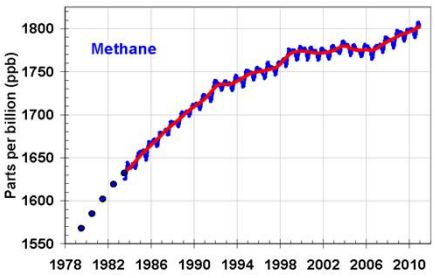
10 y.:+20.8ppm

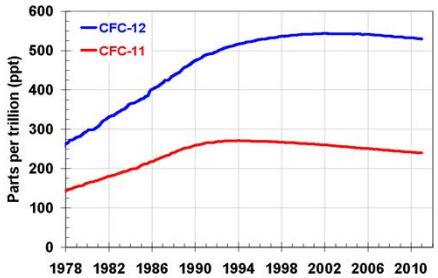
1 year: ca. 4ppm

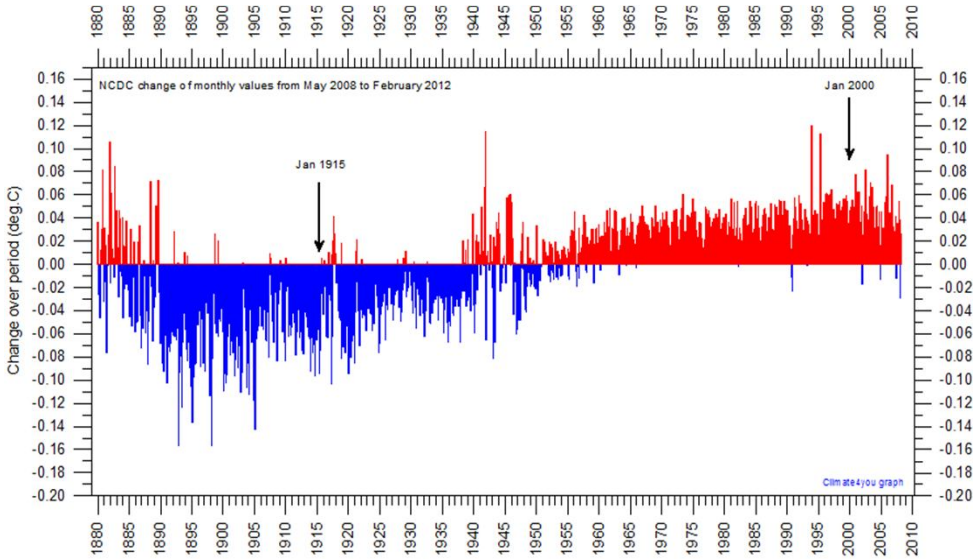
2.2 Anthropogenic CC: Temperature

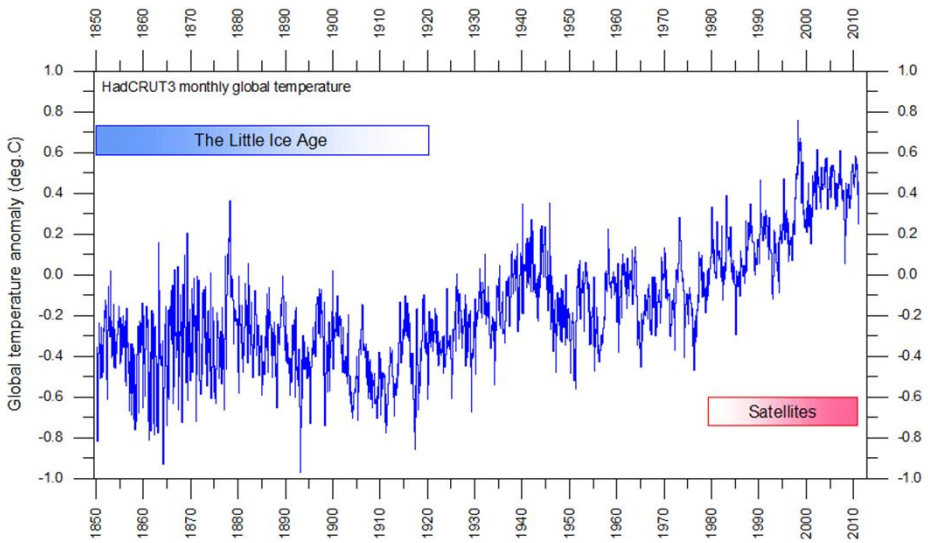


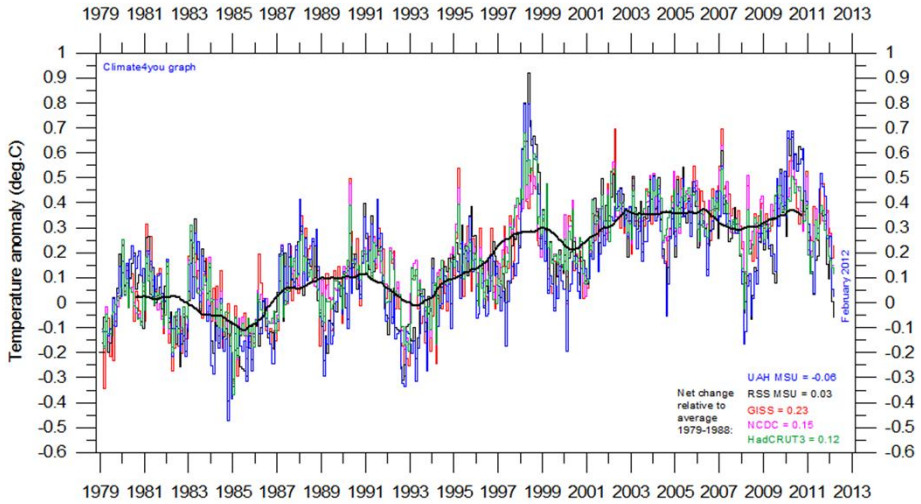












2.3. Historical Emissions

Table 1: Top ten annual energy-related CO_2 emitters for the year 2009. **Source:** International Energy Agency, 2011: *CO_2 emissions from fuel combustion: highlights* (Paris: IEA).

Country	% of global total annual emissions	Tons of GHG per cap.
People's Republic of China	23.6	5.13
United States	17.9	16.9
India	5.5	1.37
Russian Fed.	5.3	10.8
Japan	3.8	8.6
Germany	2.6	9.2
Isl. Rep. Iran	1.8	7.3
Canada	1.8	15.4
South Korea	1.8	10.6
UK	1.6	7.5

Table 2: Top ten cumulative energy-related CO_2 emitters 1850–2008. **Source:** World Resources Institute, 2011: *Climate Analysis Indicators Tool: Indicators: GHG Emissions: Cumulative Emissions* (Washington DC: WRI).

Country	% of world total	Metric tonnes CO_2 per person
United States	28.5	1,132.7
People's Republic of China	9.36	85.4
Russian Fed.	7.95	677.2
Germany	6.78	998.9
UK	5.73	1,127.8
Japan	3.88	367
France	2.73	514.9
India	2.52	26.7
Canada	2.17	789.2
Ukraine	2.13	556.4

3. EU vs. NAFTA: Comparative Climate Change Performance (1990-2010)

- All G8 members are Annex I (UNFCCC) and Annex B (KP) countries. Among the G20, two additional OECD members (Australia, Turkey) and the EU belong to Annex I, and only Australia and the EU to Annex B. Table 3 gives an overview of the commitments of G8 and G20 countries under the UNFCCC and KP and of their performance between 1990 and 2009 based on data from Eurostat (2011), IEA (2011), and UNFCCC (2011) for only those countries listed in Annex B. The table does not include the 175 parties to the UNFCC and the 172 parties to the KP who contribute about 20–25% to global GHG emissions.

Table 3: Commitments of the state parties under the UNFCCC and the KP. **Source:** Compiled b
the author from the relevant annexes to both documents.

Country	UNFCCC (1992)	Kyoto Protocol (1997)	National Communications under the UNFCCC					Reduction goal (%)	EU Reduction goal (%)	Performance (1990–2009) GHG reductions in % 1990 (base year)		
G8 countries	Annex 1 (Annex 2)	Annex B (transition)	1	2	3	4	5			EU Eurostat (2011) IEA (2011)	UNFCC (2009) Land use change and forestry (LULUCF) Excl.	Incl.
1) USA	X	X	X	X	X	X	X	-7		+6.7	+7.2	+5.6
2) Canada	X	X	X	X	X	X	X	-6		+20.4	+17.0	+29.8
3) Japan	X	X	X	X	X	X	X	-6		+2.7	-4.5	-5.0
4) Germany	X	X	X	X	X	X	X	-8	-21	-25.4	-26.3	-23.0
5) UK	X	X	X	X	X	X	X	-8	-12.5	-27.1	-26.9	-27.7
6) France	X	X	X	X	X	X	X	-8	0	-8.3	-7.7	-12.9
7) Italy	X	X	X	X	X	X	X	-8	-6.5	-5.0	-5.4	-13.3
8) Russia	(X)	(X)	X	X	X	X	X	0		-29.7	-36.9	-57.2
G20 countries												
9) Australia	X	X	X	X	X	X	X	+8		+51.8	+30.4	+29,9
10) Turkey	X	-	X					-		+102.0	+97.6	+102.0
11) EU (15)	X	X	X	X	X			-8	-8	-13.7		
EU (27)						X	X			- 17.4	-17.4	-20.2
12)South Korea	-	-	X	X	X			-		+124.8		
13) Mexico	-	-	X	X	X	X		-		+50.9		
14) China	-	-	X					-		+206.5		
15) India	-	-	X					-		+172.3		
16) Brazil	-	-	X	X				-		+73.9		
17) South Africa	-	-	X	X				-		+45.0		
18) Argentina	-	-	X	X				-		+66.0		
19) Indonesia	-	-	X	X				-		+164.7		
20) Saudi Arabia	-	-	X	X				-		+158.4		

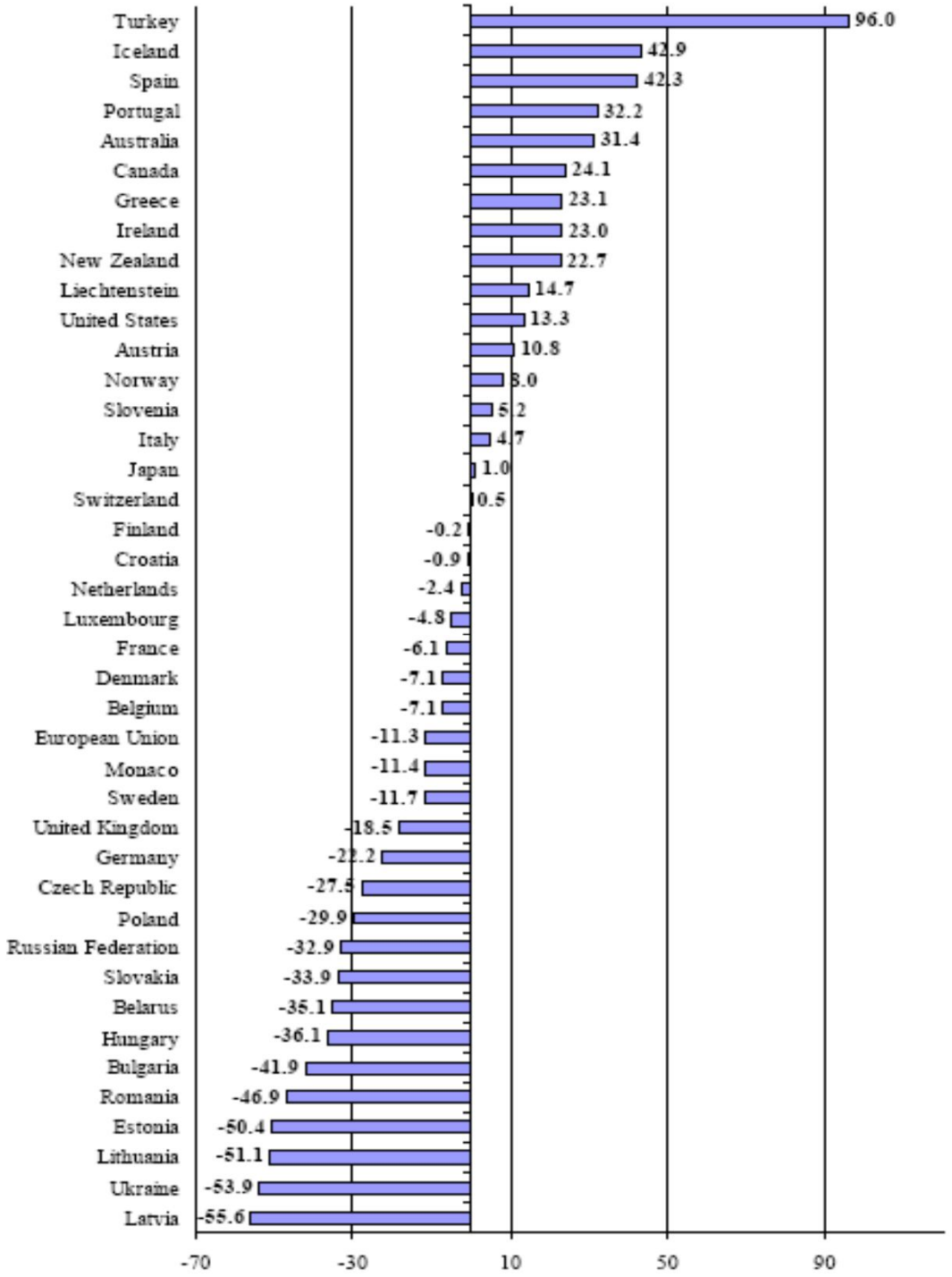
3.2. GHG Reduction Implementation Gap

QELRO, Kyoto Protocol

- EU countries: -8%
- Canada: -6%
- USA: - 7% (no party KP)
- Japan: -6%
- Australia: +8%

Changes in GHG Emissions: Annex I Part., 1990–2008 (exc. [incl.] LULUCF (%).

- EU countries:-11.3 [-11.3]
- Canada: + 24.1 [+33.6]
- USA: +13.3 [+15.3]
- Japan: +1% [-0.2]
- Australia: +31.4 [+33.1]
- Turkey: +96.0 [101.1]



3.3. Failure of Climate Negotiations to Adopt Post Kyoto Regime

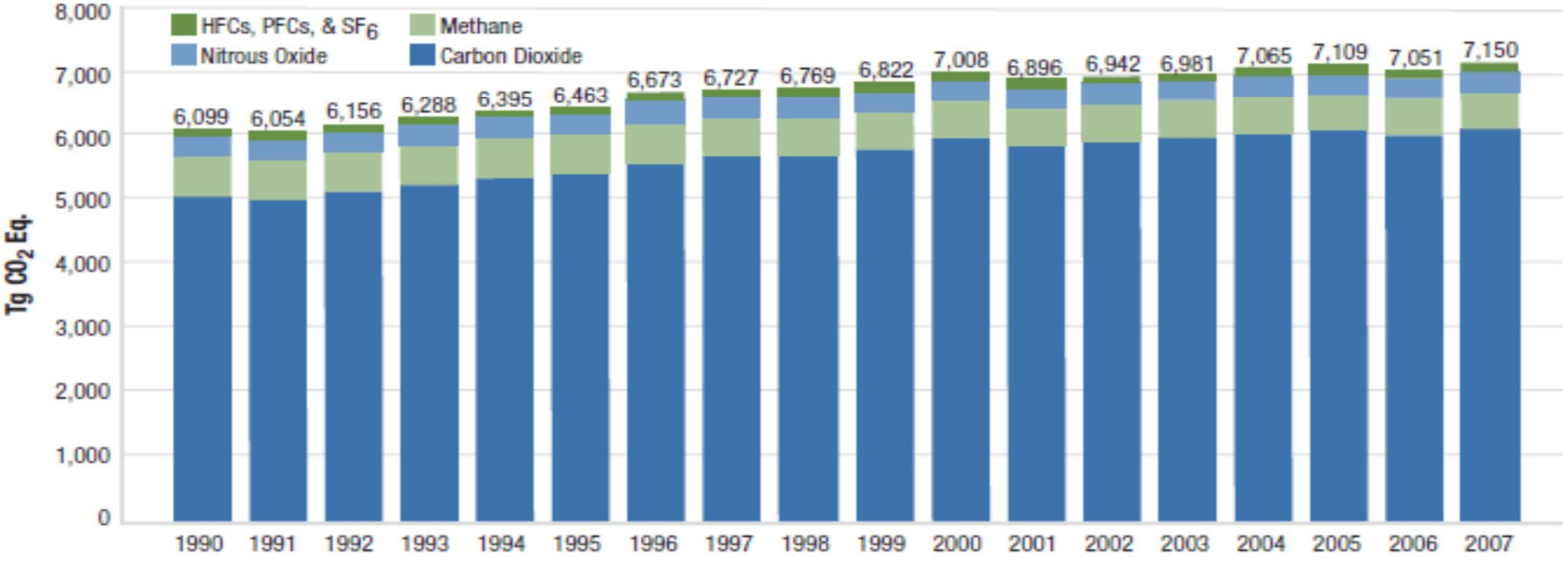
- **Obstacles in major industrialized countries due**
  - Economic opposition of interest groups (lobbies)
  - Short-term interest of policy makers (re-election)
  - Lack of public awareness partly due to manipulation of media
- **Lack of political will of parliaments and governments to implement policies (in USA)**
  - Bush Administration adopted 50-80 reduction goals
  - But no legally binding reduction targets for US
  - Obama: proposal -17% (now), -5% (1990) until 2020

3.4 Climate Policies of NAFTA Countries: US Performance

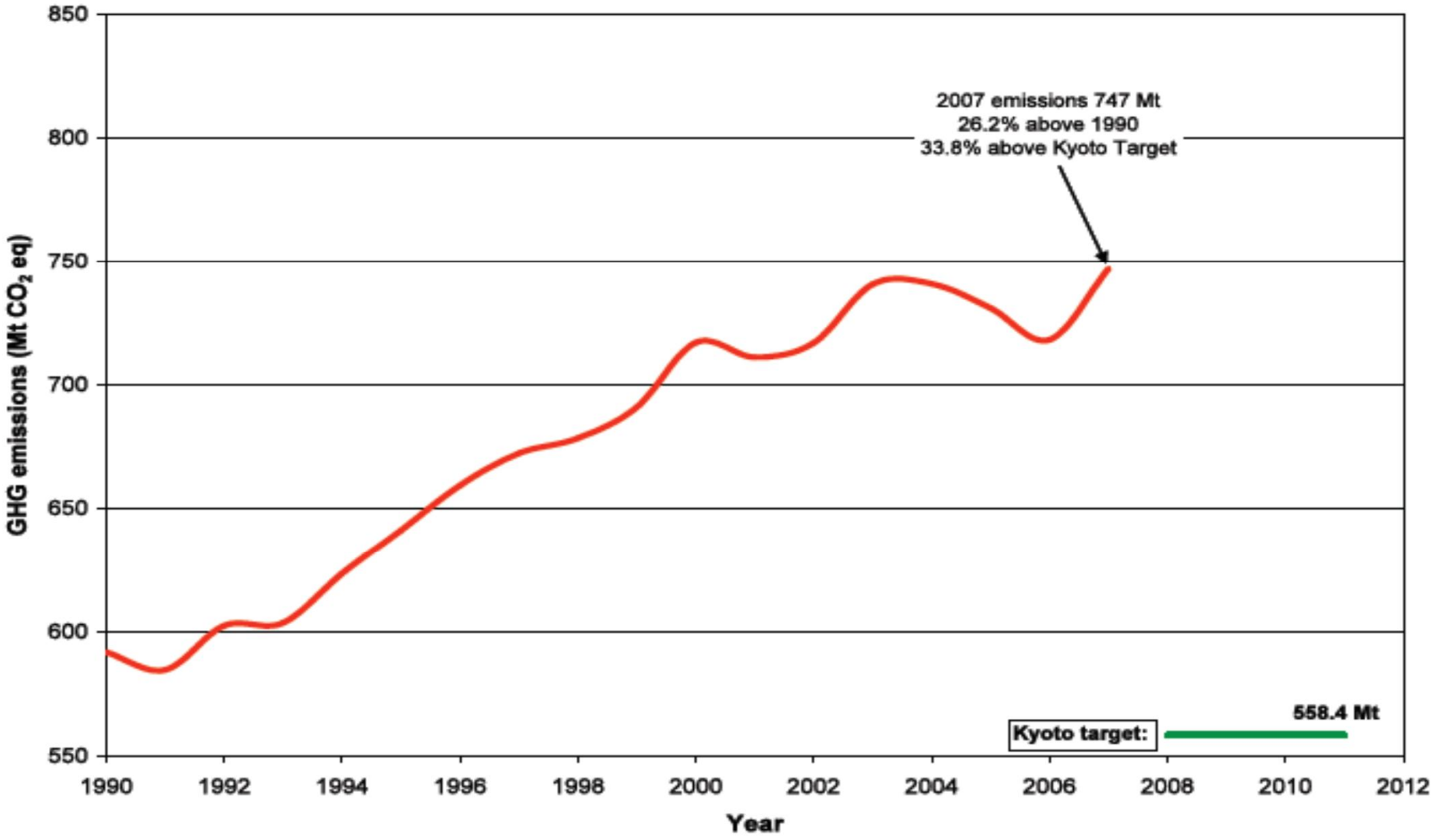
- **President Obama:** The threat from climate change is serious, it is urgent, and it is growing. Our generation's response to this challenge will be judged by history, for if we fail to meet it—boldly, swiftly, and together—we risk consigning future generations to an irreversible catastrophe (CAR 2010).

Figure 3-1 **Growth in U.S. Greenhouse Gas Emissions by Gas: 1990–2007**

In 2007, total U.S. greenhouse gas emissions rose to 7,150.1 Tg CO_2 Eq., which was 17 percent above 1990 emissions, and 0.6 percent above 2005 emissions.

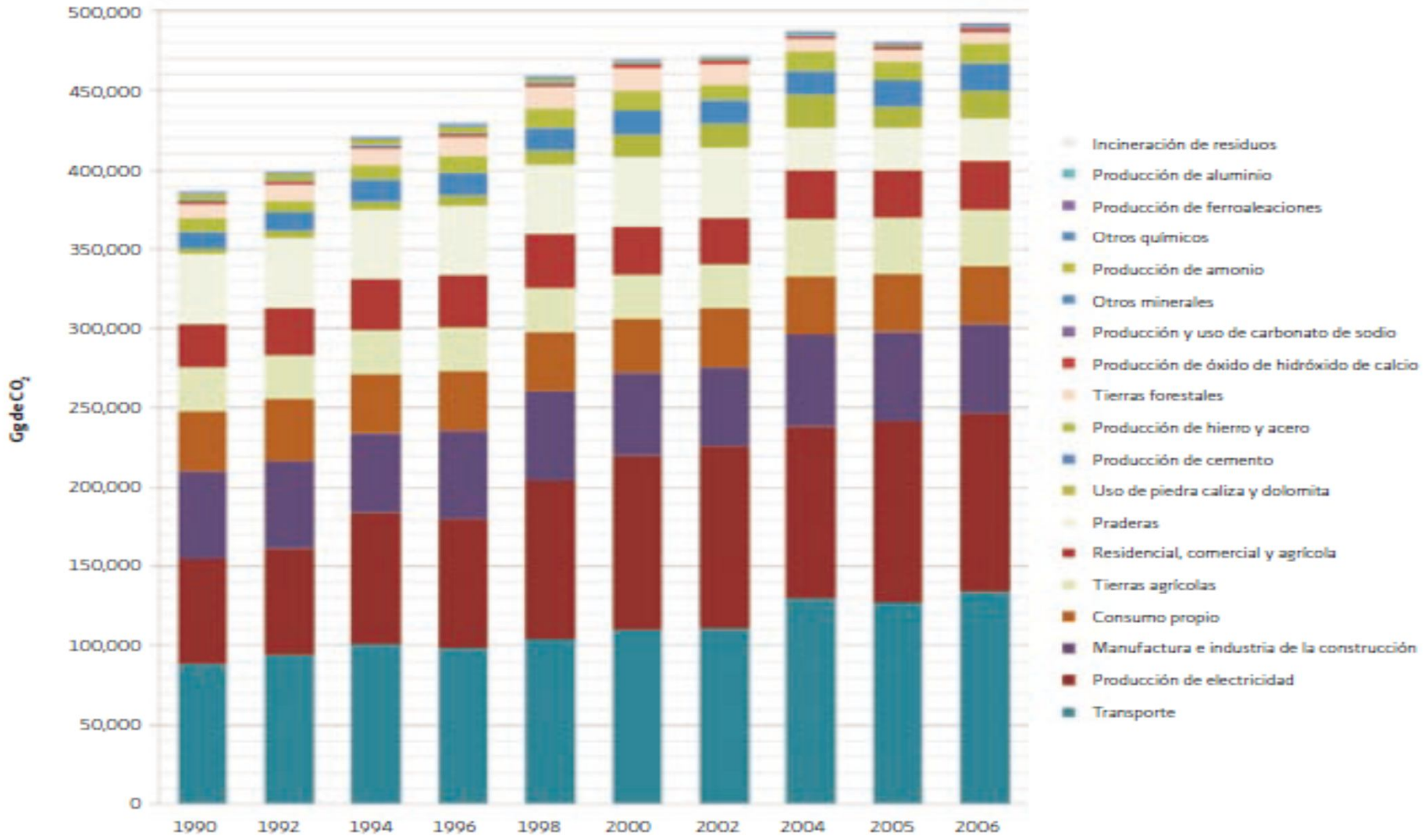


3.5 Climate Policies of NAFTA Countries: Performance of Canada



3.6 Climate Policies of NAFTA Countries: Performance of Mexico

Figura II. 3 Emisiones por sector en Gg de CO_2, 1990-2006



4. IEA's Global Energy Projections to 2030/2050

- The G20 countries are now responsible for eighty per cent of global GHG emissions, while the remaining 175 countries account for the remaining twenty per cent. The International Energy Agency (IEA) in its annual World Energy Outlook (WEO) has released scenarios of energy-related CO2 emissions up to 2030 and 2050, which indicate a significant change in the GHG emission trends for OECD countries and the four BRIC states (Brazil, Russia, India, and China).
- In IEA's reference scenario, the combined global share of the USA, EU-27, and Russia is projected to decline from forty per cent in 2007 to thirty-two per cent by 2020, while the global share of China and India is projected to increase from twenty-five per cent to thirty-three per cent.
- The USA is projected to still have the highest CO2 emissions per capita (figure 2) by 2030, but according to the reference scenario and IEA's 450 scenario (green growth), which aims at a stabilization of GHG concentrations at 450 ppm,
- China's total CO2 emissions are projected to be twice those of the USA by 2030 . The extension of both scenarios to 2050 (figure 4) demonstrates that significant emission reductions would be needed by both the OECD countries and by the BRIC countries, and most particularly by China, India, and Brazil.
- For this reason, the ST debate in the energy sector must include legally binding GHG emission targets, and no longer just for the old industrialized countries (Annex 1 of UNFCCC; Annex B of KP).

4.1 IEA's Global Energy Projections to 2030/2050

Figure 2: IEA estimates and projections of energy-related CO_2 emissions per capita from 1990 to 2030. **Source:** IEA at: <http://www.eea.europa.eu/data-and-maps/figures/iea-estimates-and-projections-of-energy-related-co2-emissions-per-capita-from-1990-to-2030>.

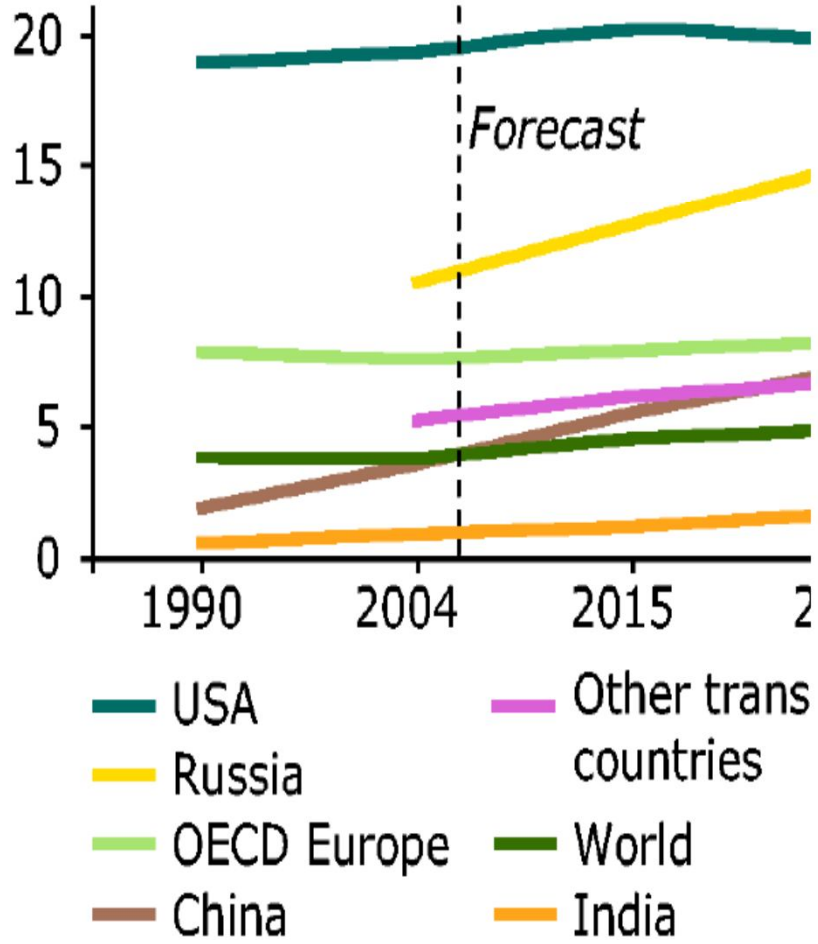
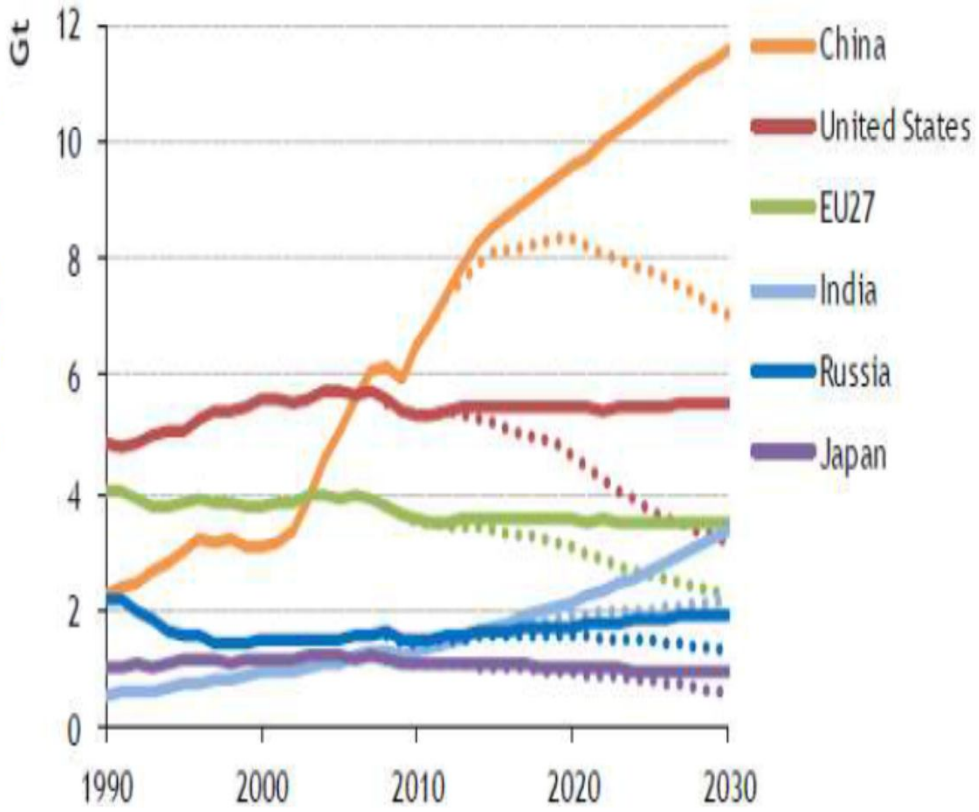
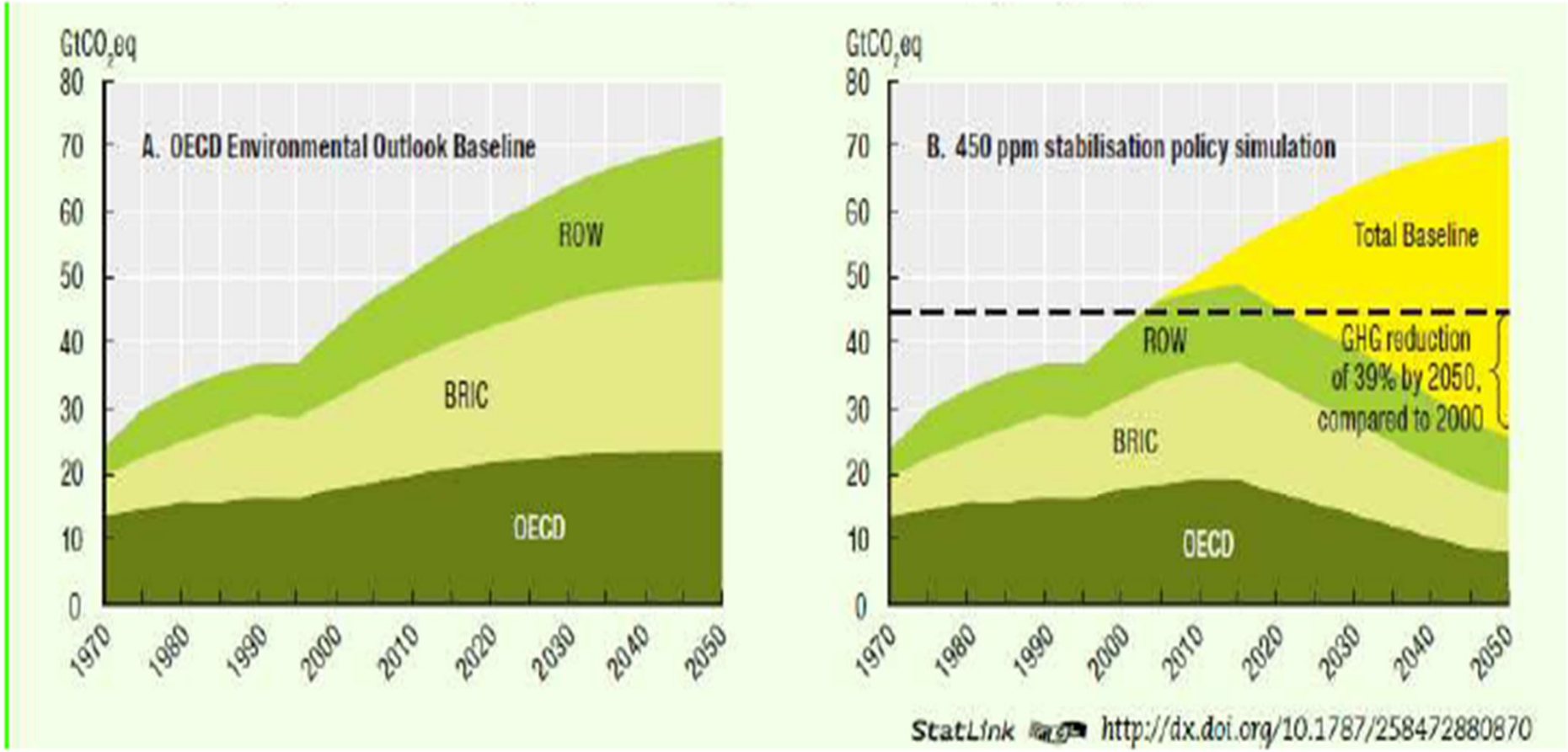


Figure 3: Energy-related CO_2 emissions by reference scenario and a 450 scenario of green growth for the EU-27, USA, Japan, Russia, China, and India (1990–2030). **Source:** IEA: *World Energy Outlook 2009* (IEA 2010).



4.2. IEA/OECD: Energy projections & GHG emissions until 2050: 2 scenarios

Figure 4: Total greenhouse gas emissions (by region), 1970-2050. **Source: IEA**



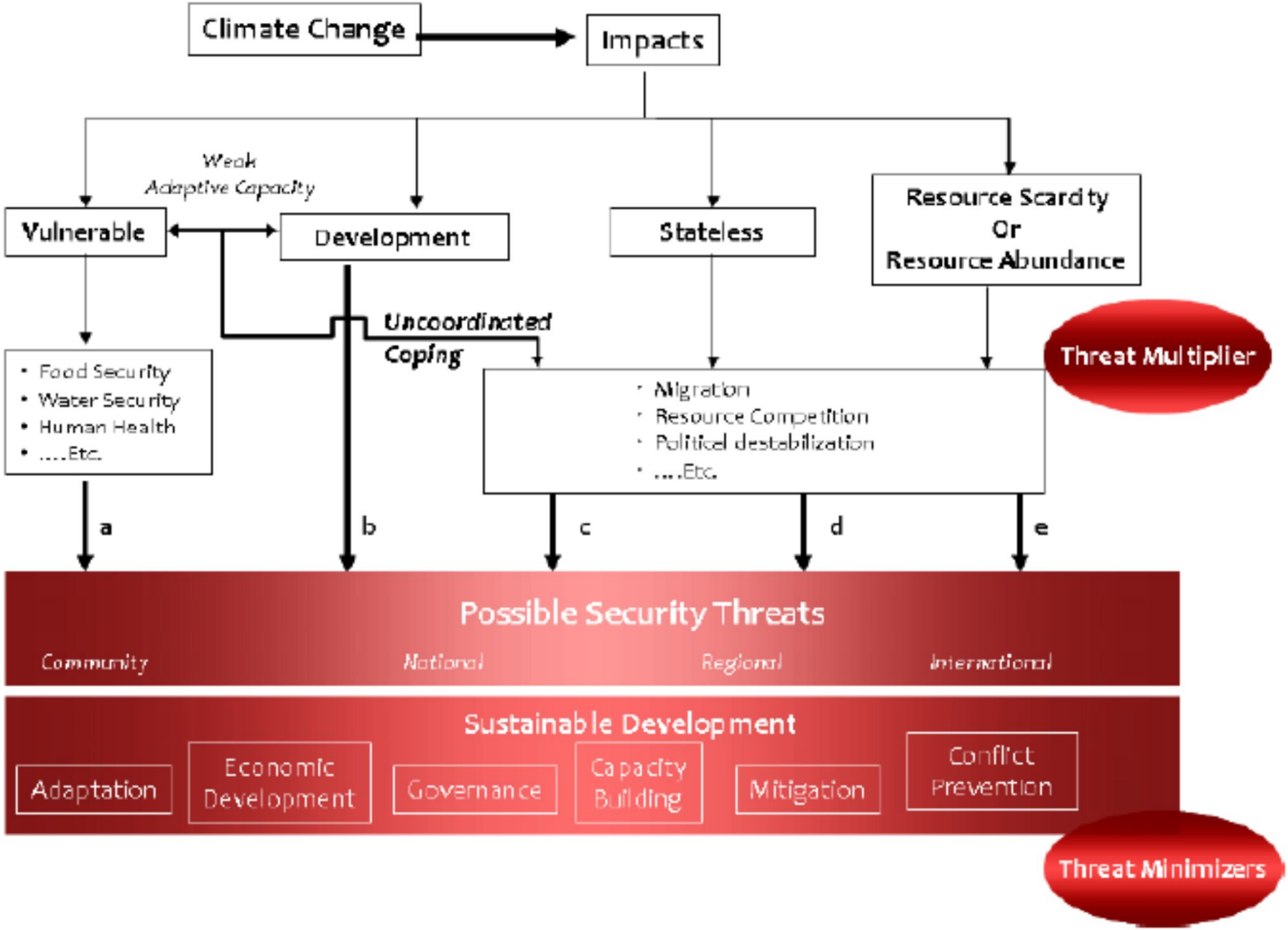
4.3. From a 2°C to a 4°C World by 2100

- Many scientists agree that the goal of the stabilization of global average temperature at 2 °C above the pre-industrial level by the year 2100 is becoming increasingly unlikely. An increase of 2–4 °C is becoming more probable.
- This may result in a ‘dangerous climate change’, and an increase of 4–6 °C above pre-industrial levels is becoming possible by 2100; this could result in a ‘catastrophic climate change’.
- In September 2009, a conference addressed the impacts of a world experiencing the impacts of “four degrees and beyond” (New 2011), while Mark Lynas (2007) discussed Six degrees: Our future on a hotter planet. New, Liverman, Schroder and Anderson (2011: 6–7) noted that there were only few studies “that assess the potential impacts and consequences of a warming of 4 °C or greater in a systematic manner.”

4.4. Impacts for Sustainability Transition Research

- Thus, STR is to contribute to the development of strategies, policies, and measures that minimize these potential threats, and that aim at making climate-related conflicts and wars—as problems of international, national, and human security—unlikely during the twenty-first century, at the same time aiming at policies of sustainable peace.
- STR is to address the threat minimizers in the context of policies aiming at the realization of the goal of sustainable development during the 21st century. Thus, our goal is to prepare a peer reviewed volume to cpmlement the Vol. Hexagon VIIIby Scheffran et al.

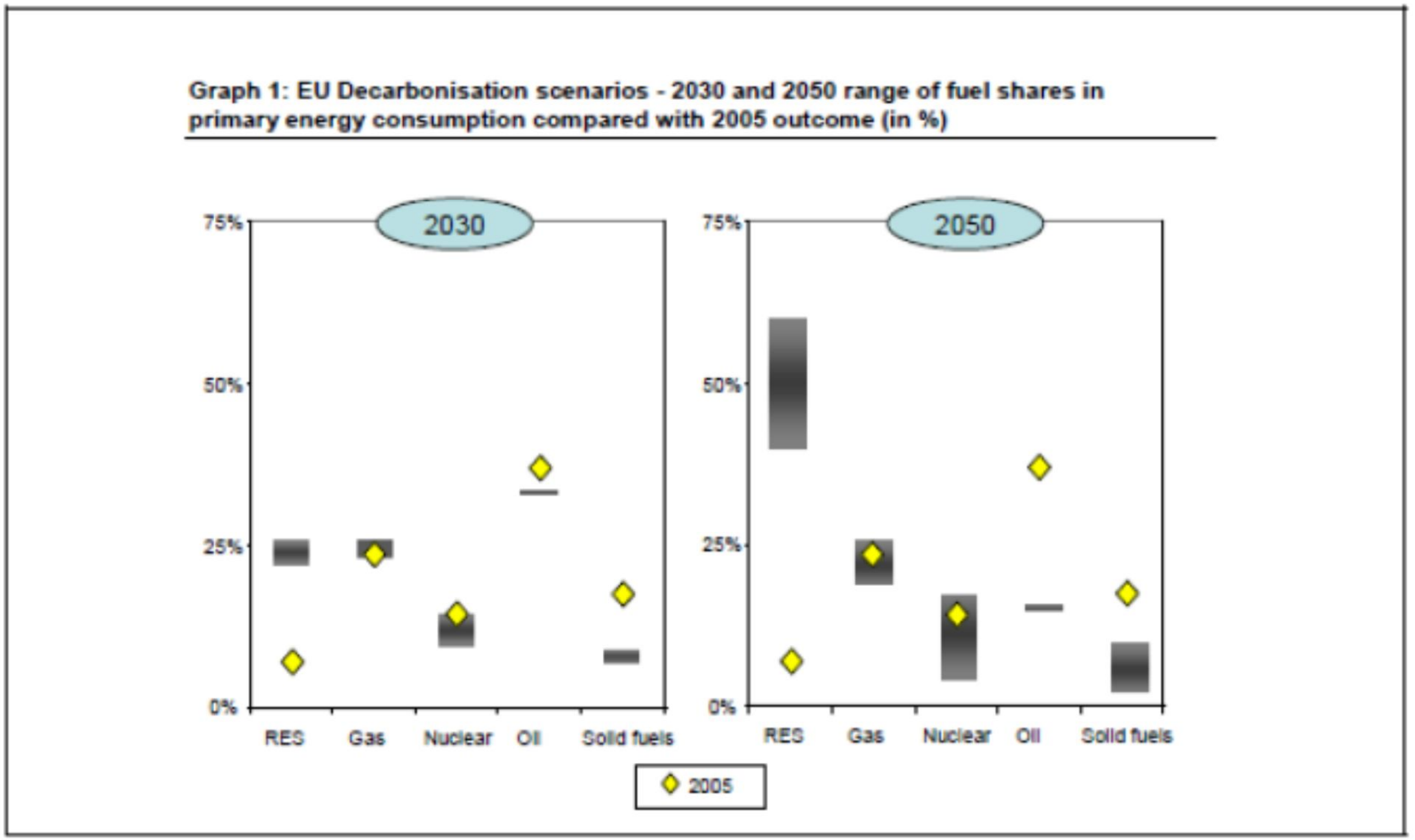
Figure 5: Channels of threat multipliers and threat minimizers. **Source:** UN-SG (2009: 7).



5. European 2020 Climate Goals and the Energy Roadmap for 2050

- Among EU-27 **Germany, UK, France & Italy: 54.9% of GHG** weighted emissions in CO2 equivalents who complied with their EU reduction targets.
- Among the 27 EU countries several laggards missed their reduction targets under Annex B of the KP and EU-15 'burden-sharing' approach, **Spain (+37.7/+11.8%), Portugal (+35.3/-3.0%), Ireland (+32.4/-0.8%), Greece (28.6/-10.5%);** their combined share of the EU-27 was 13.7% in 2009.
- EU-27 are the global leaders in implementing their commitments under KP.
- **In March 2007**, the European Council decided for a 20/20/20 target by 2020:
  - reduction in EU GHG emissions 20% cent below 1990 levels;
  - 20% of EU energy consumption to come from renewable resources;
  - 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.
- On 10–11 December 2009, the European Council offered to increase its emissions reduction to thirty per cent if other major emitting countries would commit to significant reductions under a global climate agreement.
- **On 15 December 2011 the European Commission (2011) released its Energy Roadmap 2050**

Figure 6: EU Decarbonization scenarios – 2030 and 2050 range of fuel shares in primary energy consumption compared with 2005 outcome (in %). **Source:** EU Commission (2011: 5).



6. European Mediterranean Solar Plan

- EU Commission's Energy Roadmap 2050 claimed that "wind and solar power from the Mediterranean countries could deliver substantial quantities of electricity".
- This idea was developed in the European Solar Plan (2008), adopted as one of the six initial projects in the Union for the Mediterranean (UfM), launched by the European Council on 13 July 2008; these were to rely heavily on concentrated solar plants using both solar thermal and photovoltaic systems.
- Since the 1990s, I have suggested that to reduce GHG emissions in the energy and transport sectors, it would be necessary to develop a cooperative political framework for a long-term Euro-Mediterranean 'survival pact' linking the two commodities essential for life and work, sustainable food and energy production

6.1 Mediterranean Solar Plan

- February 2010, a strategy paper specified 2 targets:
  - developing 20 GW of new renewable energy capacities,
  - achieving energy savings around Mediterranean by 2020.
- The development of the master plan was to take place in close collaboration with a team from the technical assistance project on “Paving the Way to the Mediterranean Solar Plan”, with other EU cooperation initiatives, and with the MED-REG Association of Energy Regulators. On 2–3 June 2010 in Cairo, the Sixth Euro-Mediterranean Ministerial Conference on Energy and Renewable Energy noted the important role of financial institutions.

6.2 First Project in Morocco

On 16 July 2012, the EU supported:

- a project focused on solar energy in Ouarzazate, Morocco. … The first phase, carried out by the **Moroccan Agency for Solar Energy (MASEN),** is funded partly by the **Euro-Mediterranean Investment and Partnership** (FEMIP) **and by loans from the European Investment Bank and several EU Member States**.
- The **World Bank and Clean Technology Fund (CTF)** are also supporting **Morocco's solar plans with loans for $200 million and $97 million,** respectively, to finance Phase I through a public private partnership. Solar power station of **Ouarzazate** will be one of the **largest concentrated solar power (CSP) systems in the world with a capacity of 500 MW.**
- Four years after the launch of the UfM and its MSP, the UfM was still moving slowly, but the DESERTEC Industrial Initiative (Dii) has been far more ambitious.

7. DESERTEC Project: From Concept to Realization?

- Initial conceptual & technical ideas for using physical energy potential of eserts resulted in the Trans-Mediterranean Renew-able Energy Cooperation (TREC) concept. Several experts involved in the TREC project developed the DESERTEC concept from 2003 onwards; since 2009 this has been within the framework of the Desertec Foundation.
- The Dii was launched in Munich on 13 July 2009 with the goal: “to analyse and develop the technical, economic, political, social and ecological framework for carbon-free power generation in the deserts of North Africa”.
- Its planning entity includes the DESERTEC Foundation, which is to contribute to the realization of this concept, and which works “for creating a global alliance to ensure security of energy supplies, to promote economic development, and to stabilize the world’s climate”. The MSP could offer a framework for the DESERTEC concept that refers to

7.1. Desertec Concept

- A close cooperation between EU and MENA for market introduction of renewable energy and interconnection of electricity grids by high-voltage direct-current transmission are keys for economic and physical survival of the whole region. … The DESERTEC White Book describes a scenario of electricity demand and supply opportunities by renewable energy in the integrated EU-MENA region up to the middle of the century. Among the Dii's main goals are the drafting of concrete business plans and associated financing concepts, and the initiating of industrial preparations for building a large number of networked solar thermal power plants distributed throughout the MENA region. The initiative's clear focus on implementation is set out in the Dii Principles for all future Dii shareholders. Besides the business opportunities for the companies, there are other economic, ecological, and social potentials:
  - greater energy security in the EU-MENA countries;
  - growth and development opportunities for the MENA region as a result of substantial private investment;
  - safeguarding the future water supply in the MENA countries by utilizing excess energy in seawater desalination plants; and
  - reducing carbon dioxide emissions and thus making a significant contribution to achieving the climate change targets of the European Union and the German Federal Government

7.2. Desertec Role in Morocco

- Dii will not make any investments itself, nor will it build or operate any power plants. During the planning phase (until late 2012), a suitable framework for the long-term development of renewable energies will be set up to invest in generation plants and power grids. Dii will launch several reference projects to demonstrate the fundamental viability of the Desertec vision. In spring 2011, the Moroccan Agency for Solar Energy (Masen) and Dii signed a Memorandum of Understanding (MoU) concerning a reference project, and they jointly plan:
  - installed capacity: 400 MW solar thermal power station, 100 MW photovoltaic plant;
  - output: approximately 1.4 – 1.6 TWh of renewable energy;
  - export: eighty per cent to Europe, of which approximately 1 TWh of energy to Germany;
  - percentage of energy supplied locally: twenty per cent;
  - a contribution towards achieving the 2020 environmental protection objectives.

7.3. Other Desertec Projects in MENA

- Investment required by this project is estimated at between €1.7 billion and €2 billion.
- In spring 2011, Dii & STEG Energies Renouvables also initiated a feasibility study for solar and wind energy projects in Tunisia.
- In summer 2012 Dii was initiating reference projects in Morocco, Algeria, & Tunisia amounting to 2.5 gigawatts of installed capacity, with Morocco accounting for 500 megawatts (MW).
- Half of this project has already been specified, with 150 MW solar thermal energy and 100 MW photovoltaic and wind energy. Power will first be produced by these plants in 2014.
- The current plans for Algeria and Tunisia involve 1 gigawatt per country.
- By August 2012 Dii had grown to twenty-one shareholders and thirty-six associated industrial partners three years after its foundation. In June 2012 Dii released its study Desert Power 2050.

7.4 IPCC Special Report

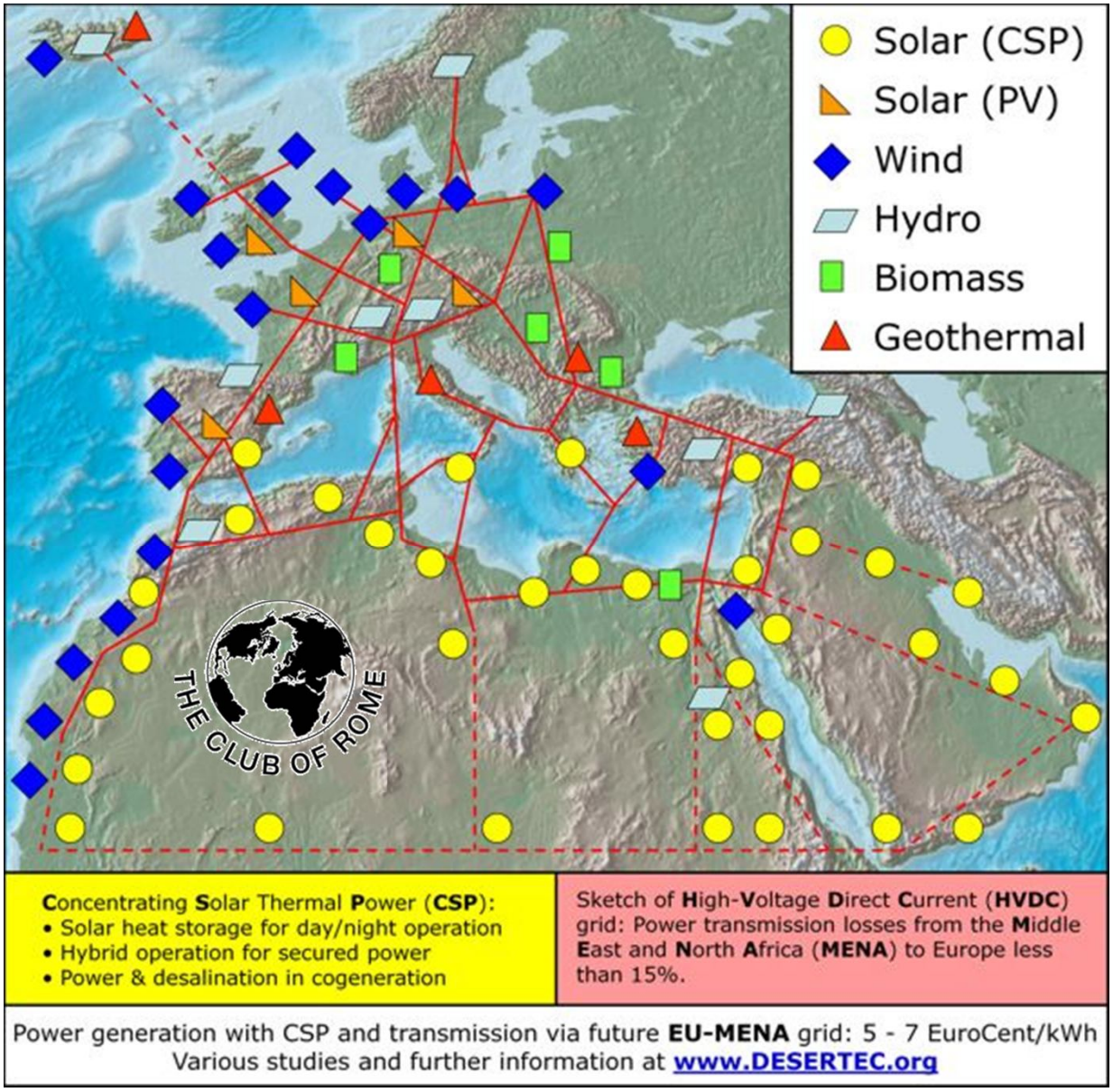
- According to the IPCC (2011), the total annual technical potential of solar energy for the world would be between a minimum EJ (exajoules) of 1,575 and a maximum EJ of 49,837.
- Western Europe would account only for a minimum of 25 EJ and a maximum of 914 EJ, while the Middle East and North Africa offer a minimum technical potential of 412 EJ and a maximum potential of 11,060 EJ, compared with the global primary energy supply in 2008 of 492 EJ.
- Thus, the minimum technical solar potential of the MENA region (412 EJ) could have supplied eighty per cent of the global primary energy supply in 2008, while its maximum potential could have supplied 22.5 times the energy supply in 2008.

According to the IPCC Special Report on Renewables (2011), in 2007

- the first major CSP plants came on line with Nevada Solar One (64 MWe, USA) and PS10 (11 MWe, Spain). In Spain, successive Royal Decrees have … have stimulated the CSP industry ... As of November 2009, 2,340 MWe of CSP projects had been preregistered for the tariff provisions of the Royal Decree. In the USA, more than 4,500 MWe of CSP are currently under power purchase agreement contracts. The different contracts specify when the projects must start delivering electricity between 2010 and 2015. More than 10,000 MWe of new CSP plants have been proposed in the USA. More than 50 CSP electricity projects are currently in the planning phase, mainly in North Africa, Spain and the USA.

7.5. System of Solar Electricity Generation
SEGS, California, USA (354 MW, since 1985)
ANDASOL 1, Spain (50 MW, 7h storage, 2009)

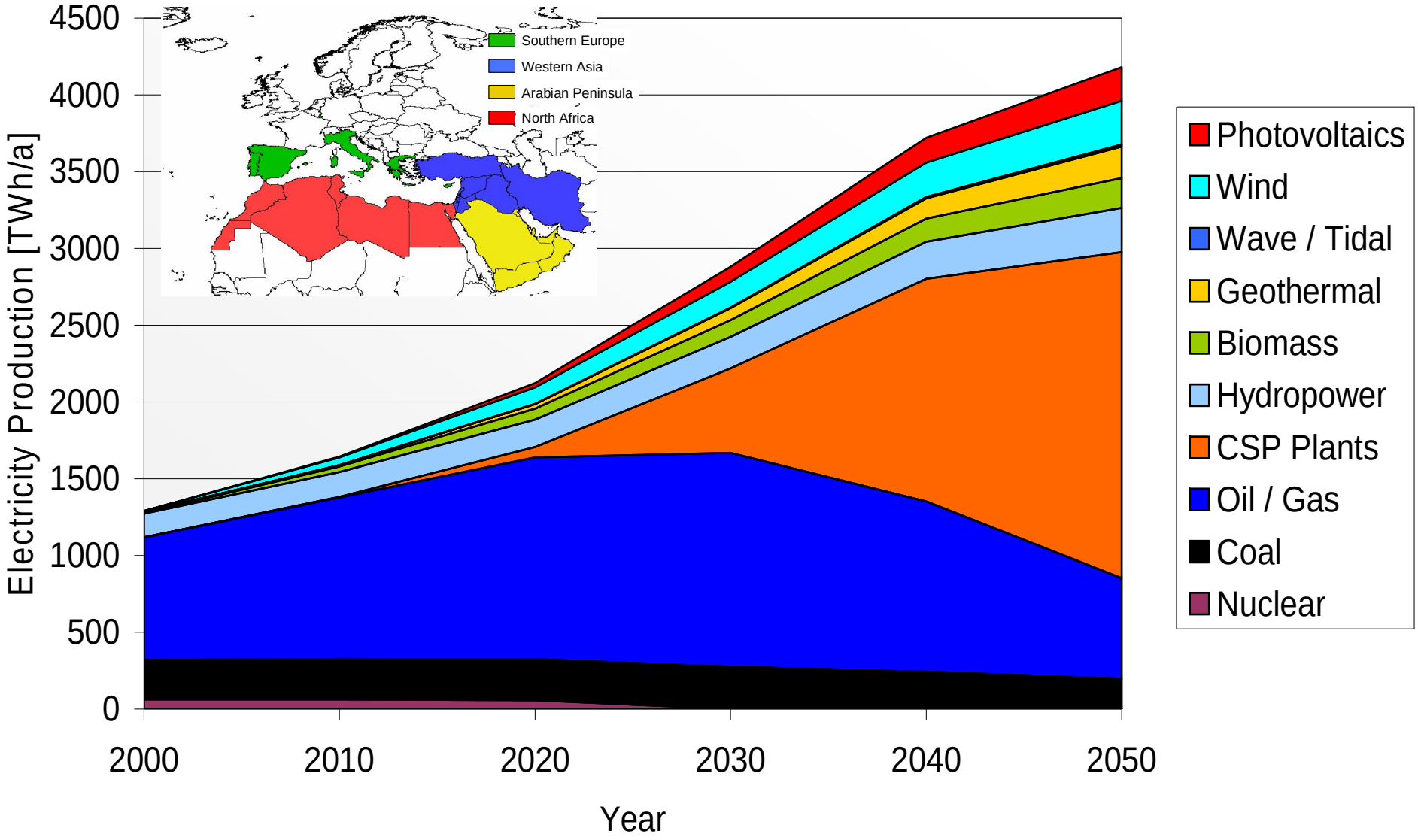
7.6. Mediterranean Renewable Energy Potential



Trans-Mediterranean **R**enewable **E**nergy **C**ooperation (**TREC**) is an initiative that campaigns for the transmission of clean power from deserts to Europe.

Since 2003 TREC has developed the **DESERTEC Concept**.

7.7. Annual electricity demand & generation within the countries analysed in the MED-CSP scenario



DESERTEC FOUNDATION

An initiative of THE CLUB OF ROME

TREC Clean Power from Deserts

7.8. Desertec Vision: An Intercontinental Mega Project

7.9 Towards Energy transition in the EU-27 and the MENA region

- Since 2010, Spain has become the leading country for the deployment of CSP but is projected to be overtaken by 2015 by the USA, with several MENA countries (Israel, Jordan, Egypt, Algeria, Morocco, Tunisia, and Abu Dhabi) in equal third place and China in fourth. If the DESERTEC scheme is implemented after 2012 following pilot projects in Morocco, Tunisia, and Egypt, the MENA Region could become the major region for a massive build-up of the new solar thermal and PV. CSP systems. Both initiatives, the MSP of the UfM and the Dii, could thus become conceptual components of an EU-MENA Survival Pact (Brauch 2002, 2010, 2012) linking food or ‘virtual water’ and sustainable solar energy or ‘virtual sun’.

8. NAFTA: Overcoming Economic, Ideological and Political Obstacles

- During the 1980s and early 1990s, the USA was a political leader in international environment policy and, against EU opposition, it pushed through the international agreements to eliminate ozone depletion. Ronald Reagan put climate change on the agenda of the G7 in Toronto in June 1988, and in June 1992 George M. Bush signed the UNFCCC and the United Nations Convention on Biological Diversity (UNCBD) during the first Earth Summit in Rio de Janeiro in June 1992.
- But since the mid 1990s, when the Republicans gained a majority in the US Congress in 1994 and 1996, they prevented the ratification of the Kyoto Protocol and cut funding to implement it. While in 2007 and 2008 climate change had become a key concern for US citizens, this bipartisan consensus was successfully attacked by an intensive campaign by climate sceptics and ideologues against a proclaimed Climate Coup (Michaels 2011) and The False Promise of Green Energy (Morris/ Bogart/Meiners/Dorchak 2011).

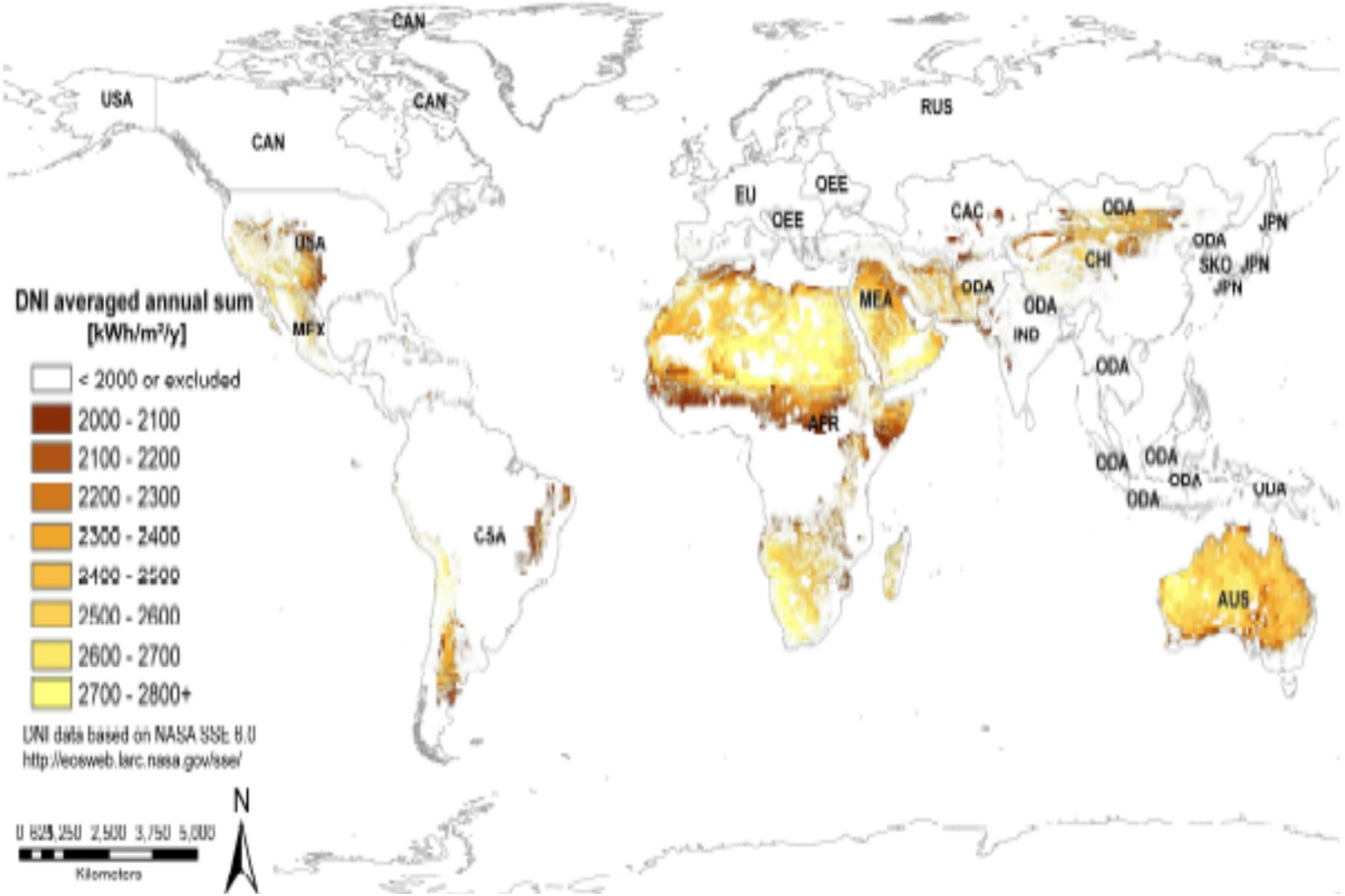
8.1 Climate Implementation Deficit of NAFTA Countries

- Under the impact of the global economic and financial crisis, GHG emissions from 1990 to 2009 have increased by 50.9% (Mexico), 20.4% (Canada), and 6.7% (USA), partly due to initiatives undertaken in the USA and Canada at the state and city levels. While the climate sceptics have had a growing influence on their parliaments and governments in the USA and Canada, Mexico, in the declaratory politics of the Calderon presidency, remained a strong supporter of multilateral climate diplomacy, especially during COP 16 in Cancun in 2010, where it successfully resisted US pressure. Despite the adoption of many legal instruments (climate law, renewable energy law, electricity feed-in tariff etc.), Mexico has so far lacked effective policies and instruments for monitoring the implementation of its policy goals or a deliberate programme to expand its share of renewable energy sources.

8.2. **NAFTA Proposal for a Sustainability Transition in the Energy Sector**

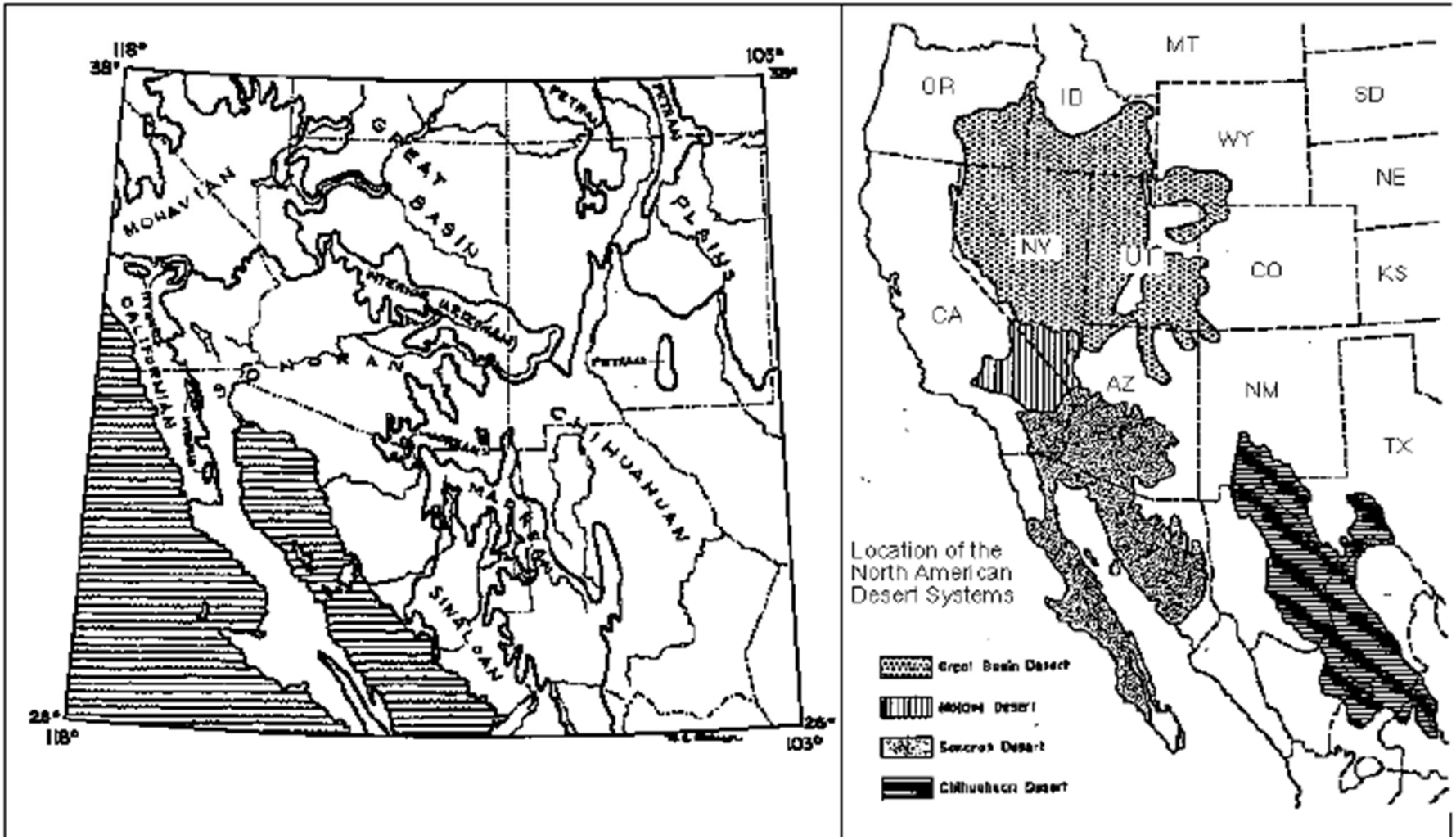
- Change in public perception of Climate change has occured in the US/Canada since 2007
- Lobby Groups & Climate skeptics (Heartland Institute, Tea party, Fox News, WSJ)
- Climate change policy blockades in US Congress
- Analogue to Desertec Industrial Initiative for the EU-MENA region a **NAFSOLTEC concept** (solar energy from deserts of US & Mexico) is suggested below
- Shift in legitimization is suggested: **climate change** as a threat to an **opportunity** (millions of new jobs in RES) for NAFTA countries, enhanced competitiveness

8.3. World Solar Potential



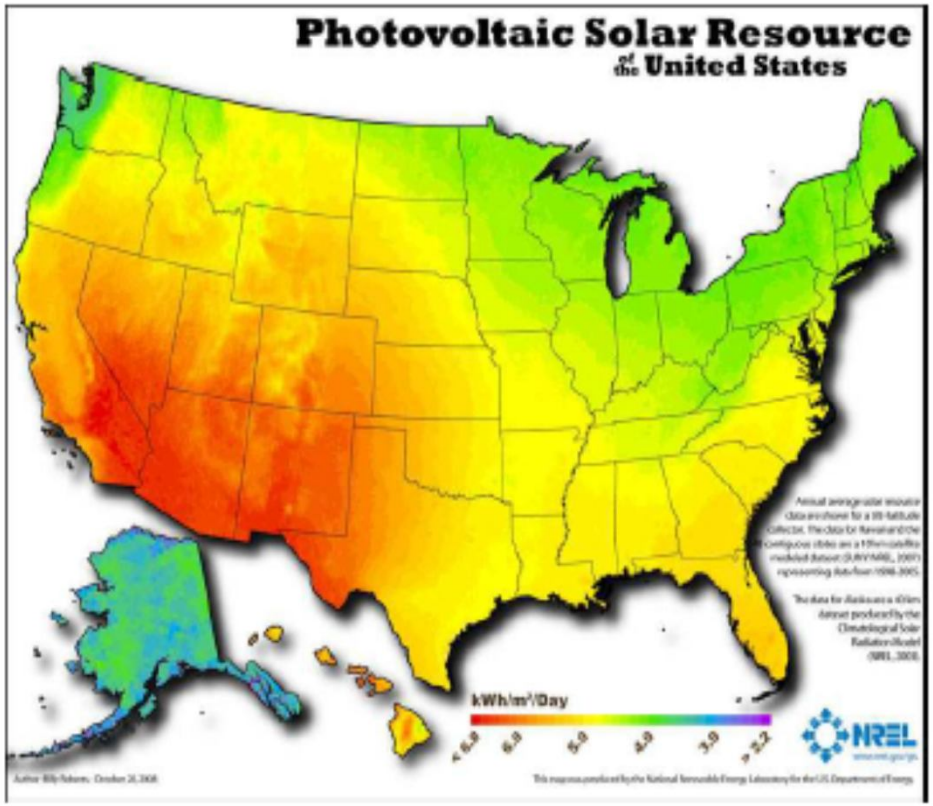
8.4 Deserts of North America

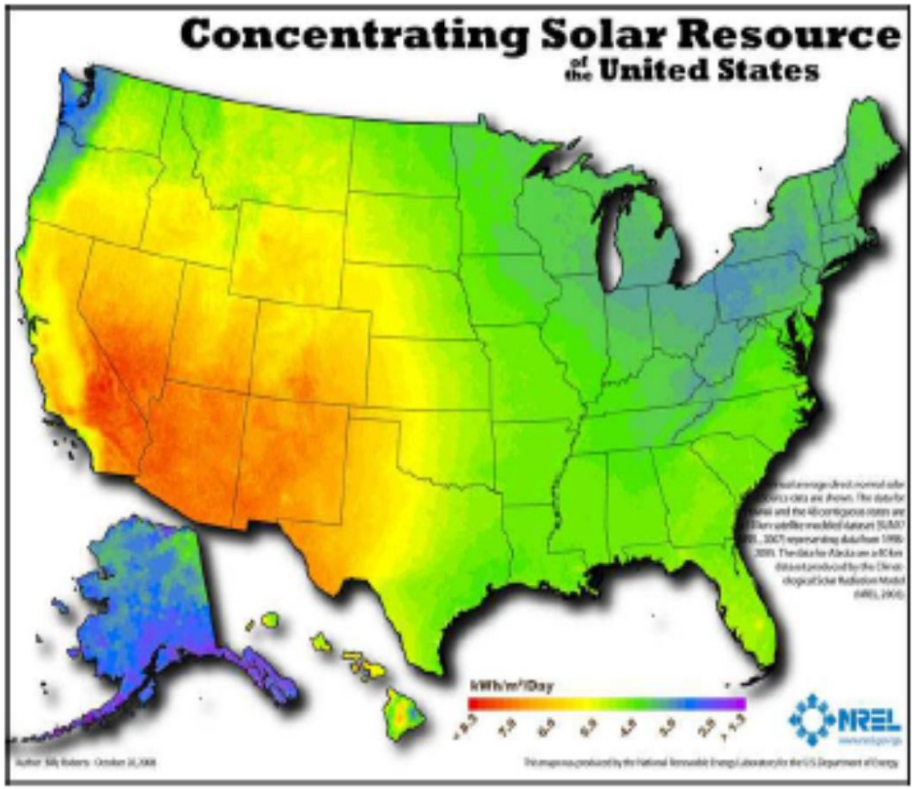
Figure 9: Deserts of North America. **Source:** "deserts of North America"; at: <http://instruct.uwo.ca/biology/320y/ namdes.html>.



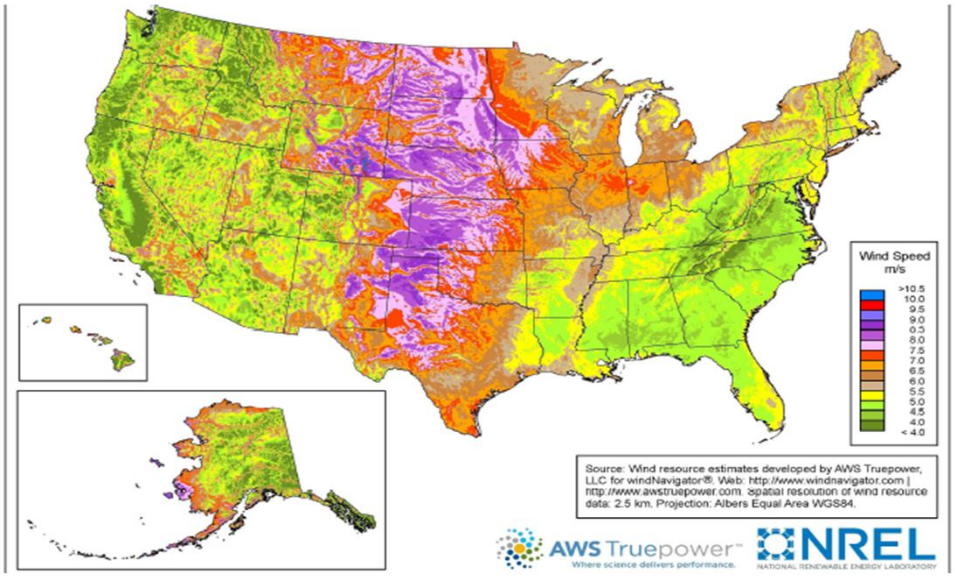
8.5. Solar Potential of the USA

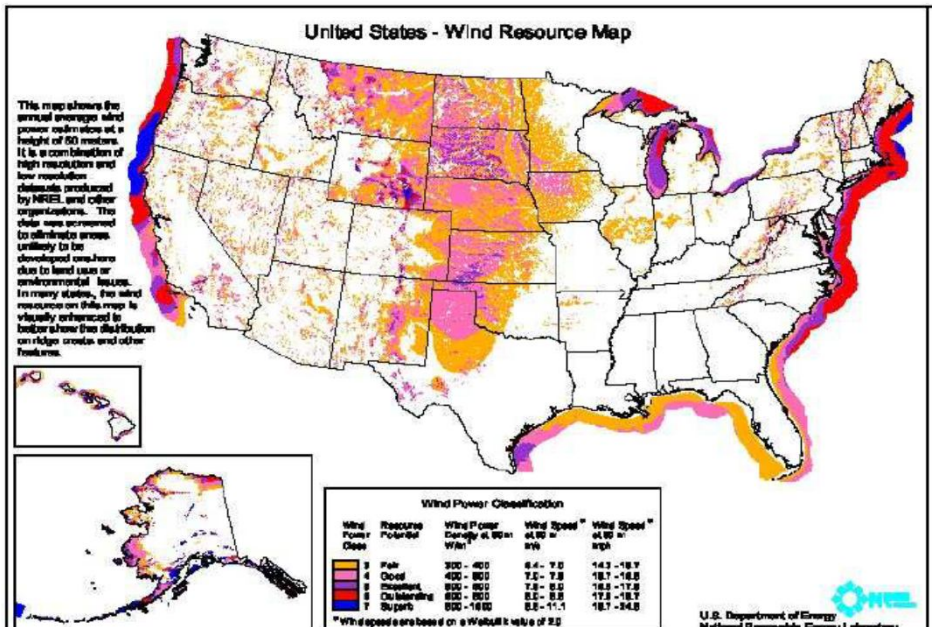
- While physical solar potential is better in the Sahara, geopolitical situation for a suggested NAFSOLTEC project is better than in the Mediterranean because only two or three countries would cooperate
- Figure 11 offers data on photovoltaic and concentrating solar resources of the US that overlap with the deserts in the Southwestern part of the US.





8.6. Wind Potential of the USA





- US also has very good wind power conditions in the great plains and in the Mid West & offshore on both the Atlantic & the Pacific Coast .
- There are superb, out-standing and excellent conditions along both coasts and good and fair conditions in the Great Plains.

8.7. Requirements of NAFSOLTEC

- Major improvements of energy efficiency across all sectors in North America to reduce the energy demand to be increasingly satisfied by renewables.
- Determined decision of the governments of the USA, Mexico & Canada to shift towards a sustainable energy policy & to gradually replace coal, gas & oil as a source of electricity generation with gradually declining subsidies that guarantee investors a calculable rate of return;
- To require renewable energy sources for both cooling (air conditioning) and heating;
- To move from a petrol based transportation system to alternative renewable fuels what would require the buildup of a new infrastructure within the continental USA, Canada and Mexico;
- To develop new tools of financing that make it attractive for investors to enter the field
- To develop a redundant infrastructure for energy distribution systems that enable the feed-in of renewable energy components taking the demand and demand peaks into account.

8.8. Enviromental & Securiy Advantages

Environmental advantages:

- It would reduce the reliance on new fossil fuel sources from offshore oil platforms in the Gulf of Mexico, from ecologically sensitive regions in Alaska and from oil sands from Alberta in Canada;
- It would permit the USA, Canada and Mexico to significantly replace the fossil component in the energy balance and thus enable all three countries to drastically reduce their emissions of CO2, the major source of GHG emissions.

Security advantages:

- NAFSOLTEC project would reduce the import dependence of the US on fossil fuels – from conflict areas, as the Middle East – that will intensify in the future due to the growing energy demand on the world market (e.g. by China, India and many other threshold and developing countries, and the gradually declining supply (peak oil);
- This project would reduce the military resources needed to guarantee the access to fossil fuels in major conflict areas, e.g. in the Middle East, where the US has been involved in costly wars since the end of the Cold War (Kuwait 1991, Iraq, 2003-2011);

8.9. Economic Advantages

Economic advantage:

- The development of the technical components, their production, installation as well as the needed new infrastructure for energy distribution systems will create millions of new and permanent jobs

Counter ideologues & shift of political awareness raising:

- The climate skeptics supported by the Heartland Institute, the Tea Party and many rightwing or conser¬vative media (e.g. Fox News) have argued that climate change destroys 100.000s of American jobs and threatens the US (or Canadian) economic competitiveness.
- The message of the promoters of a sustainable energy transition should be that NAFSOL¬TEC will create millions of new highly competitive jobs.
- The establishment of a NAFSOLTEC project would create an economy of scale that will bring the prices down and create a new export market for North American products and thus would necessarily compete with European, Chinese and Indian exports in the renewable energy sector.

9. NAFTA: Technical Potentials of Renewables for a Development Strategy

- Hence US climate and renewable energy policies present a puzzle. The USA has many of the best governmental (NOAA) and university research institutions, and has been a leader in solar and wind power since President Carter launched Project Independence in 1977 to respond to the Arab oil shocks of the 1970s.
- One unique project has been a solar thermal plant, established in the Mojave Desert in southern California with a capacity of 354 MW. This technology was later developed further in the framework of a long-term cooperative project between Spanish (CIEMAT) and German (DLR) research agencies.
- This technology is one of several being considered by the MSP and DESERTEC. However, during the Reagan administration many of these initiatives were discontinued for economic and ideological reasons, and many of the new companies went bankrupt or were bought by European and Japanese competitors.

9.1. NAFTA Proposal for a Sustain-ability Transition in the Energy Sector

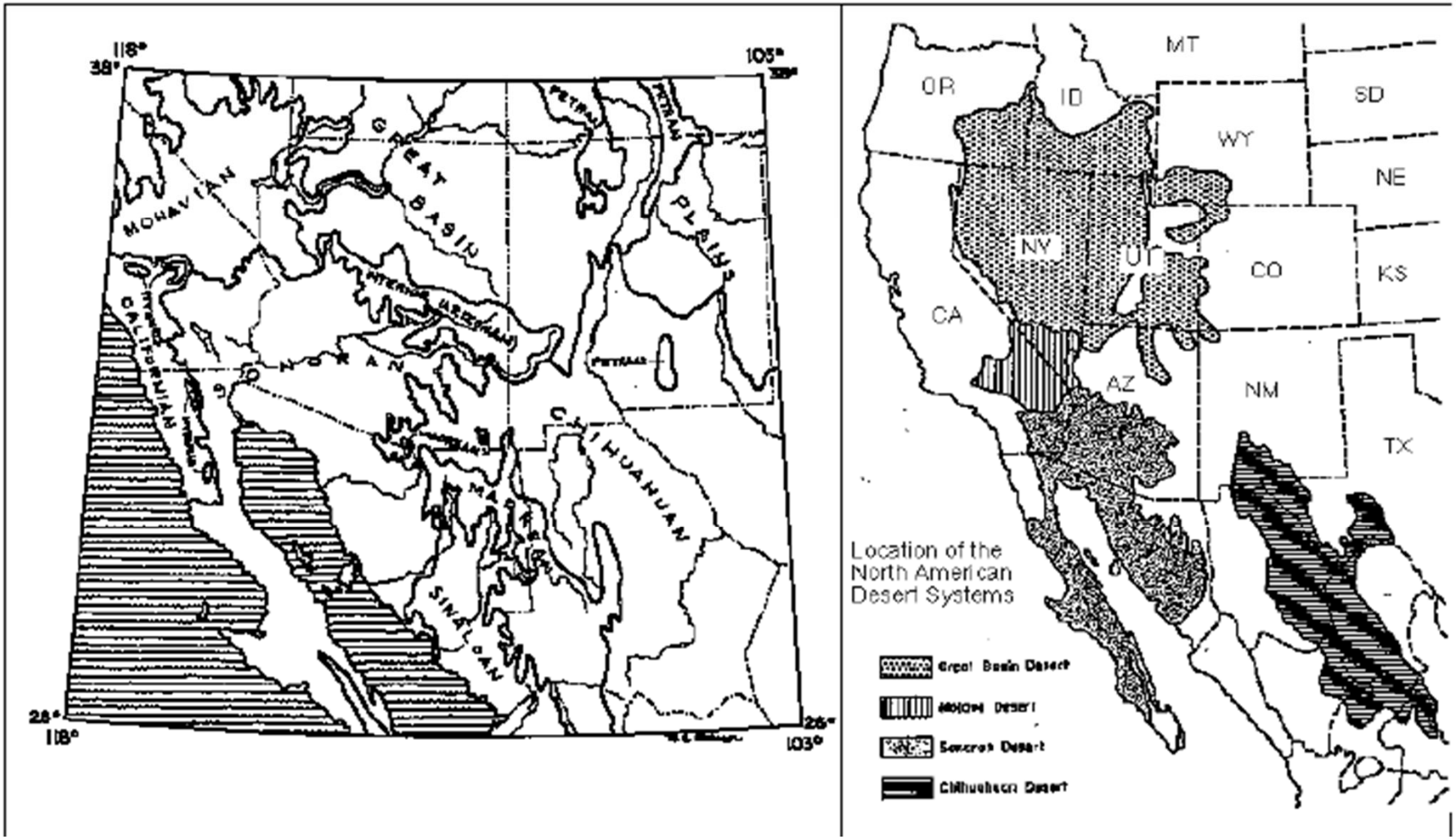
- Analogue to **Desertec Industrial Initiative** for the EU-MENA region I suggest a **NAFSOLTEC concept** (US/Mexico deserts)
- Determined decision of the governments of the USA, Mexico & Canada to shift towards a sustainable energy policy & to gradually replace coal, gas & oil as a source of electricity generation with gradually declining subsidies that guarantee investors a calculable rate of return;
- Renewable energy sources for air conditioning and heating;
- From a petrol based transportation system to renewable fuels: new infrastructure in the continental USA, Canada and Mexico;
- Develop new tools of financing attractive for investors
- Redundant infrastructure for energy distribution systems that enable the feed-in of renewable energy components taking the demand and demand peaks into account.

9.2 Deserts of North America

- Conceptually there are many parallels between the EU-MENA and the NAFTA regions. Both have several deserts.
- In the MENA region there is the desert belt from the Sahara, to the deserts in Sinai/Negev and, the deserts in Israel, Syria, Jordan, Iraq, Kuwait, and along the Arab/Persian Gulf. In North America, the four major deserts in the USA and Mexico the four major deserts offer unique physical solar potentials.
  - Chihuahua (in north central Mexico and the south-western USA in Arizona, New Mexico, and Texas, 455,000 km2, with a high plateau covered by stony areas and sandy soil with many mountains and mesas);
  - Great Basin (in the western United States in Idaho, Nevada, Oregon, and Utah, 411,000 km2, mountains, ranges, basins, salt flats, Great Salt Lake);
  - Sonora (south-western USA in Arizona and California and parts of Mexico in Baja California and, Sonora, 312,000 km2, covered sand, soil, gravel);
  - Mojave (south-western USA in Arizona. California, and Nevada, 65,000 km2).

9.2. Deserts of North America

Figure 9: Deserts of North America. **Source:** "deserts of North America"; at: <http://instruct.uwo.ca/biology/320y/ namdes.html>.



9.3 Technology & Geopolitics

- At selected and suitable sites within these four North American deserts the most modern solar technologies for electricity generation could be used: a) Concentrating Solar Power Technologies; b) Fresnel concentrators; c) Parabolic trough (400–600 °C); d) Solar tower concept with surrounding heliostat field (1200 °C, up to 50 MW); e) Solar dish (for small applications up to 50 kW); and f) Concentrated solar PV technologies—these have been employed with major backup systems already operating in Andalucía.
- While the physical solar potential is much higher in the Sahara, the geopolitical situation for a suggested NAFSOLTEC project is less complicated than that in the Western and Eastern Mediterranean where there are many unresolved conflicts, since only two or three countries would be cooperating in the NAFTA framework. Figure 10 provides data on the photovoltaic and concentrating solar resources of the United States overlapping with the deserts of the south-western region of the USA.

9.4. Renewables in USA & Germany

- The USA also has very good wind power conditions on the Great Plains and in the Midwest, as well as offshore on both the Atlantic and Pacific coasts.
- But so far, despite an increase in the growth rate during the Obama administration, the renewable energy potential of the USA has only been marginally harnessed. Between 2002 and 2011, the percentage contribution of renewables to electricity generation only increased from 8.9% (2002) to 12.67% (2011), but in 2010, hydro power alone accounted for 8.7%, wind power for 3.5%, and solar energy (solar thermal, PV, and CSP) for 0.07%.
- In contrast, in **Germany the share of electricity produced by renewables** has increased from **6.3% in 2000 to 25% in June 2012**, and the goal of the **Merkel government is to increase this share to 35% by 2020 and to 80% by 2050.**
- Hence many economic, ideological, & political obstacles must be overcome and awareness and interest within the US business community raised before the functional equivalent of DESERTEC emerges in North America.
- as part of a thought experiment, a visionary **NAFSOLTEC project will be introduced as a possible large-scale, top-down project**.

10. Sustainability Transition in the Energy Sector: Opportunity for Mexico?

- Mexico has high public and political awareness of the impacts of climate change, and as the only Latin American country Mexico has submitted 4 national communications on climate change to the Secretariat of the UNFCCC in Bonn.
- Unlike Brazil, Argentina, and many other countries in South America, Mexican diplomacy has repeatedly addressed the international, national, and to a lesser extent also the human security implications of the physical effects of global climate change. As the only Latin American country, Mexico passed a climate change law in 2012 and has previously passed laws to further the market introduction of renewables in the future.
- Among the three OECD countries with no legally binding reduction obligations under Annex B of the KP between 1990 and 2009, Mexico had the lowest increase in GHG emissions (+50.9%), followed by Turkey (+102.0%) and South Korea (+124.8%), but the highest within NAFTA.
- Mexico was a leader in international climate change diplomacy; at COP 16 in Cancun (2010) it put multilateral climate diplomacy back into the UN framework, in opposition to the USA that had tried to bypass this process at COP 15 in Copenhagen.
- Mexico also has a high scientific potential for renewables, e.g. with UNAM's Institute for Renewable Energy (IER) in Temixco (Morelos) and the Institute for Electricity in Cuernavaca (Morelos). Mexico has unique scientific and technical potential for renewable and a very high solar potential for decentralized solar systems (solar thermal components for heating water) and for photovoltaic electricity generation, as well as for large centralized installations (wind farms, solar thermal and CSP plants).

10.2 Mexico in Need of a Strategy for ST

- Major obstacle has been translating declared policy goals into development strategies that are actively monitored and implemented, and exploiting the high renewable energy potentials of solar, wind, and geothermal sources; as well as these, there has been a major lobby for hydro power, but also much opposition because of high seismic activity. With a determined political will and effective implementation by the next government, during the next six years Mexico could become a leader who converts technical potential and the scientific capacity into economic opportunity.
- Mexico needs a political strategy, policy, and measures to merge these components into a middle- and long-term strategy for a sustainable energy transformation. This new growth sector of the economy could create several hundreds of thousands of new jobs for Mexican engineers and workers. This requires an effective legal framework with regulations, private inducements, and public subventions. A precondition for such a deliberate strategy for a sustainable transition of the energy sector requires a strategy for the training of specialists and workers (craftsmen) to build, maintain, and repair these new decentralized energy systems. Such an ST strategy must be an inherent part of a regional development strategy for the rural, highly desertified areas that have a very high renewable wind and solar potential.

10.3. From Business as usual to ST

- In the three NAFTA countries, the gradual transition towards a low-carbon energy future will require not only scientific and technical solutions but above all major changes in the mindset of not only policymakers, business leaders, and societal opinion leaders, but also in the media. This could overcome the change in basic culture that Klein (2011, 2012) has ably sketched with regard to the shift in climate change discourse in the USA.
- Oswald Spring and Brauch (2011) in: “Coping with Global Environmental Change—Sustainability Revolution and Sustainable Peace” argued that:
  - The vision of business-as-usual with minimal reactive adaptation and mitigation strategies will most likely increase the probability of a ‘dangerous climate change’ or catastrophic GEC, with both linear and chaotic changes in the climate system and their sociopolitical consequences; this vision represents a high-risk approach.
  - To avoid these consequences the alternative vision and sustainability perspective requires a change in culture (thinking on the human-nature interface), world views (thinking on the systems of rule, e.g. democracy vs. autocracy and on domestic priorities and policies, as well as on interstate relations in the world), mindsets (the strategic perspectives of policymakers), and new forms of national and global governance.

10.4. From Knowledge to Action

- The four key concepts in this alternative vision of a new fourth ‘sustainability revolution’ are a radical change in culture, world view, mindset, and participative governance in thinking and action on sustainability.
- An alternative development path must be laid out, with a total transformation of productive and consumptive processes aiming at equity, social justice, and solidarity with the most vulnerable and marginal people and with the poorest countries.

10.5. Concluding Remark

- As these four concepts show, all dominant paradigms have been socially constructed, but are deeply involved in the complex process of civilization of global society; therefore a mere ‘paradigm shift’ is not enough. One shortcoming of the debate in the natural sciences so far has been that the political dimension and the emerging thinking in the social sciences, e.g. the postmodern approaches in philosophy, sociology, and political science, and specifically in the programmes for peace, security, development, and environment have not been taken up in the discourses in the natural sciences, while their conceptual suggestions are only gradually being considered in the debate in the social science communities on GEC, on natural hazards, and on security (Brauch/Oswald Spring 2011).
- An isolated approach from the natural or social sciences alone will not be able to develop the required revolutionary changes in thinking and policy (Held/Hervey 2009). Therefore, we need a ‘Fourth Sustainability Revolution’ where material and immaterial processes, beliefs, and behaviours are changed, including power relations and control mechanisms. The transformation in the thinking on the human intervention into the Earth System must be accompanied by fundamental changes in the cultural, social, and political systems.

10.12. NAFSOLTEC: An Enlightening Policy Vision Whose Time Has Come!?

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