Trans-Mediterranean Renewable Energy Cooperation "TREC"

A Powerful Partnership for Development, Climate Stabilisation and Good Neighbourhood

The TREC Development Group[1]

Formed by initiative of the German Ass. Club of Rome, and of the Hamburg Climate Protection Foundation HKF. Contacts: Malek Kabariti malek.kabariti@nerc.gov.jo, Uwe Möller moeller@clubofrome.org, Gerhard Knies knies.gerhard@t-online.de

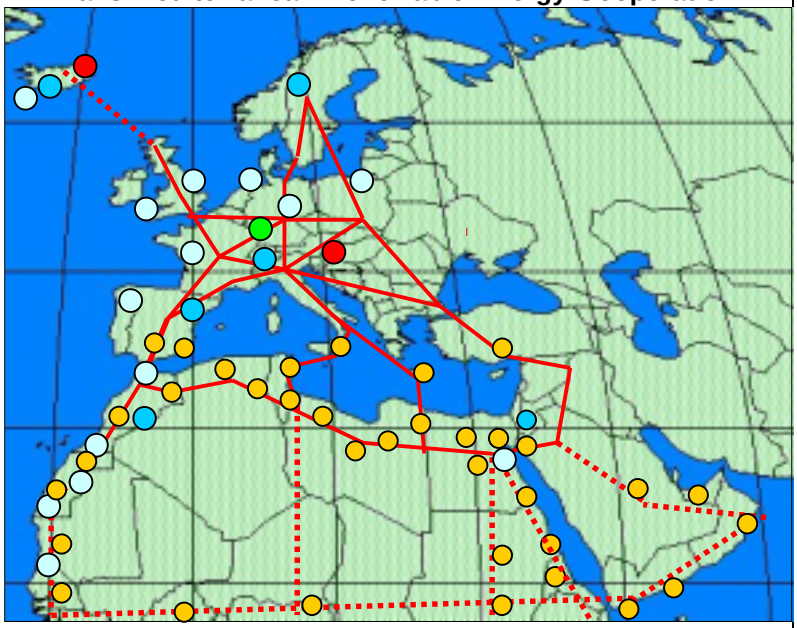
1. Sustainability and renewable energies

In the coming decades humankind is facing the great challenge of coping with the ever-increasing demands of the growing world population. Only by closing the crucial gap between rich and poor will we have a chance of preventing the many potential conflicts threatening the future of humankind. This of course will lead to a huge increase in energy demand, which cannot and must not be covered by fossil and nuclear fuels. We are not only facing finite reserves of fossil energies, but also have to deal with the growing climate risks arising from their use. In a "new solar age" we can solve this dilemma by employing today's technologies to exploit the enormous potentials of renewable energies, and by using the manifold opportunities for increasing the energy efficiency with new technological solutions. Simultaneously, modern transmission and communication technologies and the process of globalisation provide new options of trans-regional cooperation with substantial synergies for climate security and economic development. We are proposing a project along these lines.

2. Trans-Mediterranean Renewable Energy Cooperation "TREC"

An important step towards a stable, sustainable and peaceful world could be made by a Trans-Medi-terranean Renewable Energy Cooperation. Fig.1 shows the basic idea:

Trans-Mediterranean Renewable Energy Cooperation



A Powerful Partnership for

- Global climate stabilisation
- Industrial and economic development in NA/NE region
- Power and fresh water for NA/NE
- Supply of secure & clean power & H_2 to Europe at stable costs
- Good EU-NA/NE neighbourhood by economical integration

Infrastructure for Sustainability

Solar thermal power & desalination, plants, agriculture & new settlements,

wind,

hydro, power and storage

biomass,

geothermal,

High-voltage direct current transmission grid (HVDC), stage 1 and future extension.

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Figure 1: Renewable energy optimisation by long-distance power interconnections and synergy exploitation of resources in Europe and North Africa/Near East (hereafter: NA/NE).

The TREC project would initiate a common market and an interconnection infrastructure for renewable energies among the countries surrounding the Mediterranean Sea. The technologically highly developed European countries in the North are using fossil fuels heavily for their energy demands, thereby excessively burdening the global atmosphere with greenhouse gas (GHG) emissions. The countries to the south and east of the Mediterranean have vast but unused sites offering superior solar and wind energy resources. High-voltage direct current (HVDC) interconnections enable low-loss transmission to be made over great expanses at low cost. Existing pipelines can already transport hydrogen from renewable electricity as an admixture to natural gas. Combining wind and solar power from large and from far distant regions can significantly reduce fluctuations by compensating effects.

- If Europe decides to buy a substantial volume of its energy as solar and wind electricity from the less developed countries in North Africa and Near East (hereafter referred to as NA/NE), and
- if the NA/NE countries develop the capability and capacities of producing renewable electricity from sun and wind, with technical and financial support from Europe

then the proposed Trans-Mediterranean Renewable Energy Cooperation could

- turn the formerly contradictory goals of *climate protection* and *economic development* into mutual reinforcing objectives by making clean energy production in NA/NE for both local and European markets a motor of industrial and socio-economic development in NA/NE countries
- help transform the Mediterranean from a region of various divisions and conflicts into a region of harmonised socio-economic development, cooperation and good neighbourhood.

3. Present status of renewable energy use.

The technologies required for the proposed TREC are already available. Wind energy converters and concentrating solar thermal power stations have been successfully developed in Europe and in other parts of the world. Their functionality and reliability have been proven in many years of practical application, and their production costs have continuously decreased. Information on wind and on solar radiation is available from satellite and terrestrial measurements for most regions of the world. At the most productive solar and wind sites in the NA/NE region, they would already be nearly cost competitive with energies from fossil fuels if financial conditions were adapted to their specific long-term investment needs. After future anticipated cost reductions due to economies of scale and continuing technological refinements, they will become economically viable and competitive at more and more sites in Africa and other regions in the world. On-shore wind and solar energy potentials in NA/NE are superior to the European sites in terms of quality (intensity by factors up to 3) and of quantity (size and availability of sites), as visible in Figures 2 and 3. The solar power potential (Fig. 2) of the good (green) areas in the Sahara amounts to ca. 250 GWh/km²/y. It exceeds the EU consumption of ca. 2500 TWh/y by a factor >300.

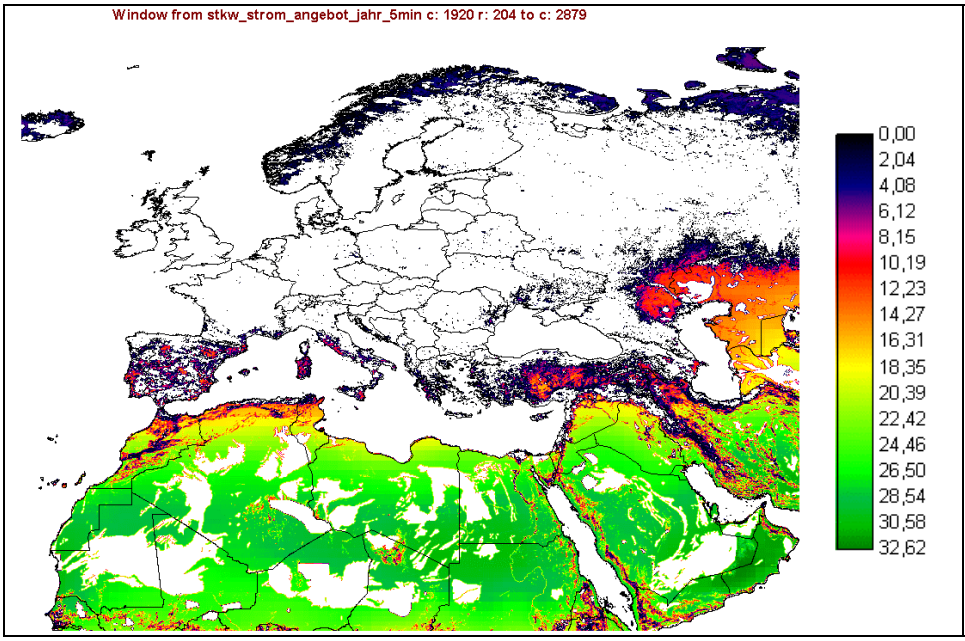

Figure 2: Average electricity generating potential of concentrating solar thermal power plants, in MW/km². Data averaged over an area of 5x5 km² and over 10 years. For annual production per km² (MWh/km²/ y) multiply colour code numbers with 8760 h/y. White areas are excluded due to other land use and land cover. Source: DLR, ISET; production potential calculated from data of ECMWF and NCEP/NCAR.

The trade winds in North Africa (Fig.3) are very steady and almost without lulls, with a potential of many times EU demand. Wind and solar potentials harmonise seasonally with European off-shore sources of wind power that are strongest in winter, while sun and wind in the NA/NE regions are stronger in summer. Special sites with extremely good wind conditions have been found along the Saharan Atlantic coastline and in Egypt along the Gulf of Suez, yielding 4000 to 6000 full load hours

(FLH) per year. They do not show up properly in the coarse grid of Fig. 3. Here electricity production costs would be below 3€c/kWh. This compares favourably with the 1500 to 2500 FLH typical for on-shore sites in Germany.

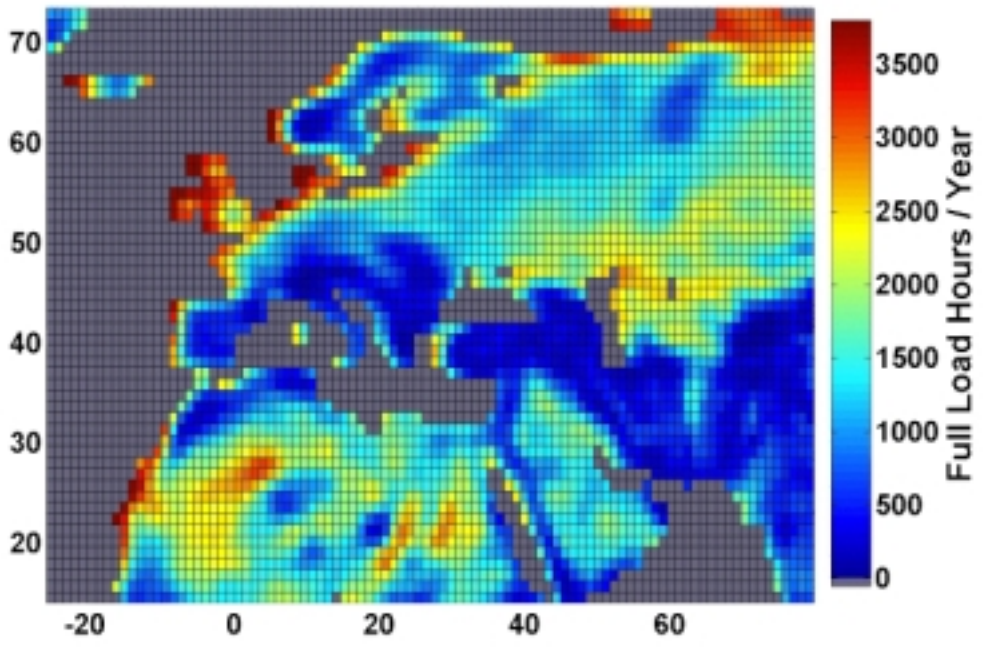

Figure 3: Yield of a variable speed wind turbine at 80m height in terms of full load hours per year for a spatial resolution of 1.125°x1.125°, corresponding to 125kmx110km at Sahara, (125kmx 70km at North Sea), averaged over 15 years. For annual production multiply with rated power of the turbine. Source: ISET; derived from ECMWF data.

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Detailed studies have shown that a Trans-Mediterranean interconnection of renewable energy resources as outlined in Fig. 1 employing an efficient combination of decentralised and centralised structures could already provide a supply of "clean enough" electricity, i.e. electricity with a share of more than 80% from clean renewable sources, on demand throughout the year using existing technologies, at costs not exceeding the current tariffs. With existing hydropower installations, mainly in Scandinavia, the Alps and the Pyrenees, electricity can be stored equivalent to more than 1 month of EU power consumption. In view of foreseeable price reductions for renewable energy technologies, the TREC project is a gateway to clean and low-cost power for Europe and NA/NE on a long term and inexhaustible basis. The sooner this transition, the sooner these benefits will be realised.

The initial phase of TREC would need some financial and a great deal of political support. Wind energy is already cost competitive at especially good locations. At the excellent sites in southern Morocco, an initial project could already demonstrate the entire TREC concept. Solar thermal power needs preferential financing during the start-up phase; however the required support would be significantly lower than the 7-10 billion Euro continuously spent every year for coal and nuclear power subsidies in the OECD, and not longer than about 5 years. For solar energy this time period has been estimated to be sufficient for breaking even with oil at around 25$/bbl. Costs for solar and wind electricity will continue to fall while those for fossil fuels will ultimately rise, leading to growing savings for national economies in the future. The proposed Trans-Mediterranean Renewable Energy Cooperation could trigger such a development.

4. Development in NA/NE through clean energy production for Europe

By this cooperation, NA/NE countries could take advantage of their superior solar and wind potentials and generate clean electricity as a competitive industrial product for export to the European market. The developmental circuit with flow of clean power and hydrogen from NA/NE to Europe and with flow of technology, know how and capital from EU to NA/NE countries is sketched in Fig. 4. The production of electricity from solar radiation and wind energy requires greater manufacturing efforts and equipment installations than necessary for extracting crude oil or natural gas. The widespread industrial activities and technological developments involved will create many jobs at different levels of skills and qualification.

In the future, hydrogen produced by clean power may also become an important item for export to the world market. Surplus power at times of high production and low demand could be used to generate hydrogen, which would be fed into existing pipelines. This decarbonisation of natural gas would reduce the climate impact of its use, while gradually building up a hydrogen infrastructure.

As a "by-product" of solar power generation and export to Europe, huge amounts of sea water could be desalinated in cogeneration to overcome the expected shortages of fresh water in the NA/NE countries. Additional fresh water for drinking,

industry and eventually for irrigation purposes constitutes an indispensable precondition for further development. Thus, the proposed TREC project would expand the perspectives for human and socio-economic development in the NA/NE countries.

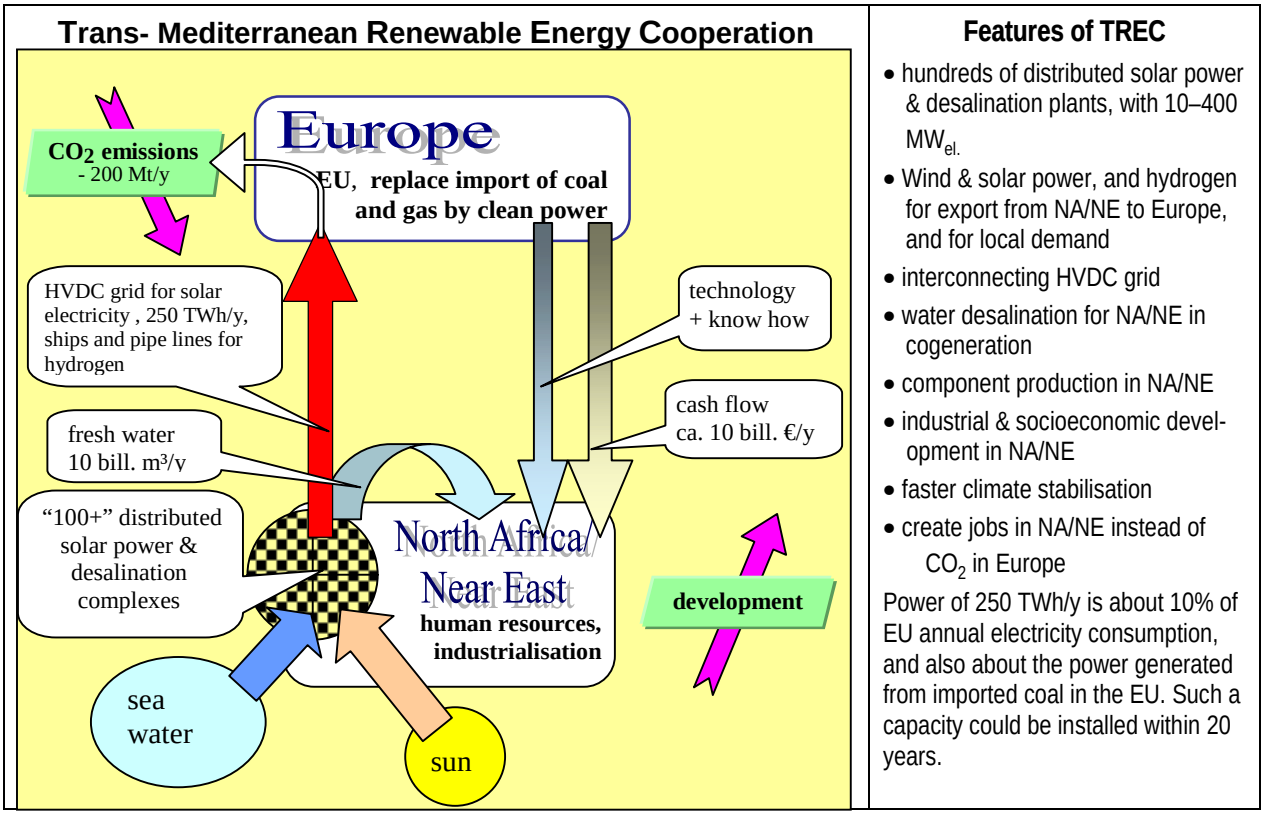

Figure 4: Circuit of development. CO_2 reduction in Europe fosters development for North Africa/Near East.

5. Worldwide impact of the TREC project

The impact of TREC would extent far beyond the regions adjacent to the Mediterranean. Firstly, any contribution to climate protection and to political stabilisation is clearly of worldwide benefit. Secondly, the greatest energy resource worldwide is solar radiation. The technology of solar steam production for power generation using concentrating collectors such as parabolic trough or flat mirror arrays (Fresnel collector) is suitable for all arid and desert regions of the world, which also provide abundant free space for their deployment. After cost reductions to the level of fossil fuels or even less will have been achieved by the TREC project, solar collectors could also be used to produce clean power in North and South America, North and South Africa, India, China and Australia, i.e. for more than 90% of the world's population. Thus the TREC project could make wind and solar power an essential element of timely climate stabilisation.

Together with the full spectrum of conversion technologies, significantly enhanced energy and resource efficiency (as proposed e.g. in the "Factor 4" to "Factor 10" concepts), proper supply and demand management, indirect solar energy resources, notably wind, hydropower and biomass along with geothermal heat, clean, reliable, affordable and inexhaustible electricity could be supplied to practically the entire world population. This objective could be achieved within a few decades, if regarded as a global goal for humanity, and not as a matter of investment decisions by the present fossil and nuclear energy industries.

6. Relation to global developmental goals

The proposed project directly corresponds with three out of the eight development goals proclaimed for the new century in the UN Millennium Declaration by the world leaders:

- Goal 1, eradicate extreme hunger and poverty
- Goal 7, ensure environmental stability (which includes timely climate stabilisation)
- Goal 8, develop a global partnership for development

Furthermore, the objectives of TREC are in line with the development goals for Africa as proclaimed by NEPAD, the New Partnership for African Development, and the project itself coincides largely with a model project proposed by the Scientific Advisory Board on Global Change to the German government.

The global community has largely accepted that ensuring climate security requires action. The Kyoto process is an indispensable means of giving climate protection the quality of international law. However, at present the quantitative

achievements for greenhouse gas reductions are insufficient for climate security. The large-scale use of renewable energies is required. The goal of TREC is to accelerate significantly the use of renewable energies, ultimately to the extent that is needed to comply with the requirements of the Intergovernmental Panel on Climate Change (IPCC) for climate security.

7. Summary on "Why renewable energies ?"

1. Global benefits from a rapid and progressive transition to renewable energies:
   (1) Global climate stability is a precondition for sustainable development. Renewable energies provide a timely gateway to global greenhouse gas emissions reduction. According to the assessments of the IPCC, global emissions must begin to decrease at around 2030 to achieve global *climate security.*
   (2) Sustainable development requires sufficient and low-cost energy supplies. Renewable energies provide worldwide secure access to inexhaustible energy resources, some already at low and all at further decreasing costs: *energy security*.
   (3) Sustainable development is only possible with access to sufficient water. This is a worldwide problem. Renewable energies provide, particularly in the arid regions, the additional energy resources for needed large-scale water desalination projects.
   (4) Fossil fuel reserves are limited, in particular those of cheap oil. In the coming decades, global energy shortages, rising prices, and risks of conflicts for resources undermining *international security* are imminent. Renewable energies can mitigate such threats.
   (5) Renewable energies allow elimination of nuclear power and the continuing dangers of nuclear weapon proliferation: *strategic security*.
   (6) Renewable energies require the use of a variety of resources and many technologies: increased diversity for greater *supply security*.
   (7) Economy and reliability of supply can be improved by inter-regional exchange: Enhanced cooperation will lead to understanding and peace rather than to armed conflicts.
   (8) Renewable energies will reduce the dependence on a few oil and gas exporting countries and thus enhance *geopolitical stability.*
   (9) Renewable energies allow preserving the scarce resources of oil and gas for their important non-energetic applications in the future.
   (10) Renewable energies can help to avoid the tremendous costs of climate change such as by damage from extreme weather events, health impairments (more malaria…) and safety provisions (higher dikes…).
   (11) Renewable energies offer to countries in transition the chance of leapfrogging in development: straight into renewable technologies instead of detouring through intermediate fossil fuel capacities.
   (12) Technology transfer "North – South" and clean energy transfer "South – North" will interlink and stimulate these economies: partnership for mutual development.

2. Regional benefits in the TREC project:
   (1) Synergy effects from complementary resources: Europe has the technology, capital and power consumption for large-scale CO_2 reduction. NA/NE has superior wind and solar energy conditions, vast regions for deployment, and low-cost labour for construction, maintenance and operation.
   (2) Political relations between European and Arab regions will profit by this cooperation.
   (3) An inexhaustible and sustainable product from NA/NE for a large, expansive market in EU.
   (4) Support for development in NA/NE by cooperative projects with Europe ("express train to development"), as for engineering and production capacities in NA/NE countries.
   (5) The use of renewable energies creates qualified job opportunities. This may reduce emigration and brain drain from developing countries.
   (6) Access to large-scale water desalination opportunities in NA/NE countries in line with their growing demand.
   (7) Cooperative projects among NA/NE countries
   (8) Cost-effective, rapid compliance of Europe with greenhouse gas reduction requirements.
   (9) Transfer of technological cost-reduction benefits achieved in NA/NE region to lesser developed sub-Saharan countries.

8. Steps into the future

   (1) Showcase the potential of renewable energies in initial projects to highlight the attractiveness of the entire approach (bottom up support for the whole scheme)
   (2) Devise a master plan for implementing TREC (top down support for individual projects).

9. A master plan for implementation of TREC – preliminary version

The TREC project is complex. It requires a close and structured cooperation of various players in a region that calls for peaceful relations. A number of synchronised preconditions in the fields of politics and economics must be developed jointly. This will not come about by accident. A master plan is indispensable for a coordinated approach. The TREC team with experts in renewable energies and in developmental matters, with members from Benin, Egypt, Germany, Jordan, Morocco and at the EU level has been formed at the initiative of the German Association for the Club of Rome and of the Hamburg Climate Protection Foundation. Members from further countries are highly welcome.

The master plan is not intended to be a prescription that has to be followed exactly, but rather to prove that there is at least one realistic concept for bringing the TREC into existence. It has the purpose of identifying open questions and initiating work for their solutions. Also, it is intended to encourage and attract further supporters, to become a platform for like-minded individuals, to unleash synergies and to inform and to stimulate the public. The master plan is intended to be ready for presentation at the International Conference on Renewable Energies 2004 in Bonn. Here the emerging structure:

A : Global issues: (*Harry Lehmann*)

Topic	*With contributions by*
1. The potential of renewable energies for global energy demands.	*H. Lehmann, G. Czisch, F.Trieb*
2. (Europe + NA/NE) as an unbeatable team for a clean and secure energy future	*G. Knies, A. Bennouna, M.Kabariti, (+ oil/gas expert)*
3. Relevance of TREC for global developmental goals: climate security, equitable development, poverty mitigation, and peaceful relations	*U. Möller, M.Jicha, H-J Fell(?), A. Wijkman(?), Arab Thought Forum (?),*
4. International Agreements and Requirements for Climate Security	*C.-D. Schönwiese*

B : Issues for North Africa/Near East: (*Franz Trieb*)

1. Objectives of development in participating countries.	*K. Benhamou, +?*
2. Power and water demands for development in NA/NE countries	*A. Bennouna, H. El Kholy*
3. Clean power manufacturing industry in NA/NE	*H. Nokraschy, K. Benhamou, K.P. Lehmann, H. El Kholy*
4. Importance of clean power exports for NA/NE trade balances	*A. Bennouna, M. Kabariti*
5. Importance of co-generative desalination, integrated energy farm	*N. El Bassam, H. Nokraschy*
6. Impact on Sub-Sahara Africa	*H. Satoguina, NEPAD*

C : Issues for Europe: *(Khalid Benhamou)*

1. European CO2 reduction obligations and Kyoto agreement	*A. Michaelowa*
2. Integrating clean power from NA/NE into European energy strategies; what wind can contribute, what solar radiation can contribute, energy storage	*G. Czisch, F. Trieb, H. Lehmann, K. Benhamou,*
3. Cost reduction of EU climate protection	*G. Czisch, A. Haas(?)*
4. Options for efficient EU climate protection	*H. Lehmann, M. Fischedick*

D : Common issues: *(Malek Kabariti, 1-5; Gerhard Knies 6-10)*

1. Trans-Mediterranean power transmission (as infrastructure for peace and sustainability)	*G. Czisch, M. Kabariti, T. Hasni*
2. Initial projects to demonstrate the feasibility (bottom up)	*K. Benhamou, J. Brügmann, N. El Bassam , H. Nokraschy*
3. The role of hydrogen for climate protection	*M. Fischedick,*
4. The political frame to support the projects (top down)	*P. Metz, EU, NEPAD, NANE*
5. International financial arrangements in support of implementation	*P. Metz, NANE*
6. CDM and certificate support for RE in EU-NA/NE projects	*A. Michaelowa*
7. Express-scenario for wind power capacity build up	*K.P. Lehmann, K. Benhamou*
8. Express-scenario for solar power capacity build up	*J. Brügmann, H. Nokraschy*
9. Express-scenario for desalination capacity build up	*F. Trieb, +??*
10. Solar Science Education	*A. Bennouna, F. Trieb, +?*