



RED PAPER

AN OVERVIEW OF THE DESERTEC CONCEPT



An initiative of



We thank His Royal Highness Prince Hassan bin Talal and our sponsors:



Within 6 hours deserts receive more energy from
the sun than humankind consumes within a year.

A handwritten signature in dark blue ink, reading "Dr. Gerhard Knies". The signature is fluid and cursive, with a long, sweeping underline.

Dr. Gerhard Knies
Chairman of the Supervisory Board of the DESERTEC Foundation
Member of the German Association CLUB OF ROME
(Deutsche Gesellschaft CLUB OF ROME)

INTRODUCTION

THE PROBLEMS ASSOCIATED WITH GLOBAL DEVELOPMENT

In the coming decades, global developments will confront mankind with unprecedented challenges: climate change, a population growth far beyond Earth's present carrying capacity, the global striving for prosperity, and increasing demands for energy and water, are the core problems we are faced with. 200 years of global industrialization has resulted in an unparalleled standard of living and an increased life expectancy for part of the world's population. However, all this has been and is still being achieved at a price: alarming environmental destruction as well as climate change which can no

longer be ignored. These things will mean dramatic changes to life on Earth in the future.

To this day, our industry-based economy is mainly based on the use of fossil fuels. Within an unusually short space of time (from a geological point of view), the combustion of these fuels has led to a significant increase in the concentration of CO_2 in the atmosphere. This is the undisputed cause for increases in global temperatures and changes in the world's climate that are now in progress.

Meanwhile, more than 6.5bn people consume far more natural resources and produce far more pollution than the Earth can accommodate. The human population's so-called ecological footprint is already larger than the Earth can sustain. The average temperature rise in the atmosphere, the melting of the polar ice caps as well as the increase in extreme weather events worldwide are obvious signs that we are putting too great a strain on the Earth. If we do not change our behaviour with determination and stop the accumulation of CO_2 in the atmosphere, we will be faced with

BY 2050, THREE EARTHS WILL BE NEEDED TO MEET HUMAN DEMANDS.



disastrous consequences. The melting of the Greenland ice sheet, for instance, would lead to an increase in sea level of several metres. As a consequence, many areas would be flooded and would thus become uninhabitable. Other areas would be too arid to live in. These two phenomena — flooding and desertification — would spark off mass migration on an unprecedented scale.

regarding access to natural resources — in particular water and energy — will be aggravated, changes in the climate will accelerate and the prerequisites of life for a majority of the world's population will be in serious danger. In view of these alarming possibilities, the main question today may no longer be whether or when we will begin to reduce the strain on Earth. It should, instead, be:

„How can we reduce the strain on the earth starting today

2050: UP TO 10 BILLION PEOPLE

By 2050, around 10bn people will inhabit the Earth. And they will want to provide themselves with food, water, energy and other necessities. Yet, even today, one third of the world's population has only limited access to the basics of living - and many others have even less. On the basis of current economic conditions, it will be impossible for the economically leading nations to maintain or even increase their level of prosperity while, at the same time, several billion people will be pursuing a comparable level of prosperity. Conflicts

■ *so that in 40 years, up to 10bn people will be provided with sufficient food, water and energy;*

■ *in order to stop global warming and the changes in living conditions that that will entail?“*

HOW CAN WE MANAGE WITH UP TO 10 BILLION PEOPLE BY 2050 LIVING ON THIS ONE, IRREPLACEABLE EARTH?



POTENTIALS

CLEAN ENERGY IS AVAILABLE IN ABUNDANCE

Our Sun offers a way out: Within the space of six hours, the world's deserts receive more energy than all the people in the world consume in a year. The only question we have to answer is:

„How can this radiant energy be economically transformed into useful energy and transported to consumers?“

The DESERTEC Concept provides a solution to this. In fact it simultaneously tackles efficiently all the global challenges of the upcoming decades mentioned before: shortage of energy, water and food as well as excessive emissions of CO₂. At the same time, this concept offers new options for the prosperity and development of regions that have so far, from an economic point of view, been scarcely

developed — as well as promising new opportunities for the economically leading countries.

Studies by the German Aerospace Center (DLR) show that, within 40 years, solar thermal power plants in particular will be capable of generating economically more than half of the electricity needs of the EUMENA region (Europe, the Middle East, North Africa) at that time.

In order to meet today's global power demand of 18,000 TWh/year, it would suffice to equip about three thousandths of the world's deserts (about 90,000 km²) with solar collectors of solar thermal power plants. About 20 m² of desert would be enough to meet the individual power demand of one human being day and night (see below) - all this absolutely CO₂ free. Given the political will, it would be possible to achieve a worldwide realisation of the DESERTEC Concept in less than 30 years.

THE EARTH'S DESERT BELT

North and south of the equator, deserts span the Earth. Over 90% of the world's population could be supplied with clean power from deserts by using technologies that are available today.



THE DESERTEC CONCEPT A MAJOR GLOBAL OPPORTUNITY

The DESERTEC Concept will allow most people in the world to access solar and wind power from the energy-rich desert areas. This would be a useful addition to the renewable energy resources of each region. By using **H**igh-**V**oltage **D**irect **C**urrent transmission lines (HVDC), it is possible to transfer power with losses of no more than 3 percent per 1,000 kms. Given the relatively high intensity of sunlight in desert regions and the relatively small variations between summer and winter, the benefits of generating electricity in desert regions will more than outweigh the cost of long-distance transmission. More than 90% of the people in the world live within 3000 km of a desert and may be supplied with solar electricity from there.

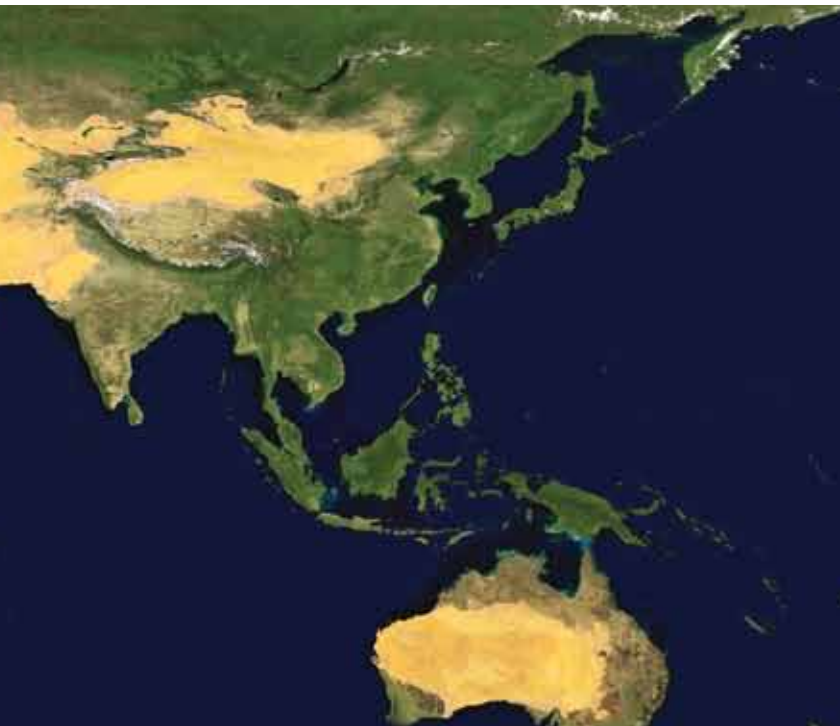
Compared with photovoltaics (PV), Concentrating Solar-Thermal Power Plants (CSP-Plants) have the advantage that solar heat may be stored cheaply and efficiently so that CSP plants can generate power at night or on cloudy days. Also, gas or biofuels may be used as a stop-gap source of heat when there is not enough sun. These things mean that CSP plants may deliver power on demand whenever it is required.

That kind of ability to respond flexibly to peaks or troughs in demand is invaluable in helping to maintain the stability of power grids. Thus CSP plants can reduce the need for such wasteful and inefficient practices as keeping coal-fired plants on „spinning reserve“ between peaks in demand.

Solar-thermal power plants have been in use commercially for several decades in the deserts of California (USA). The first plants have been operating in Kramer Junction in California since the mid-1980s and new plants have come on stream recently in Spain and Nevada. With the right framework of laws and regulations, the development of CSP plants may be ramped up fast. Also, HVDC transmission lines have been in commercial use for decades and manufacturing capacity may be expanded as required.

There are two important features of HVDC transmission lines that will help win their acceptance by the public: Firstly, HVDC transmission lines, by contrast with HVAC lines, produce hardly any electro smog. Secondly, for a relatively small increase in cost compared with overhead lines, it is possible to lay HVDC transmission lines under ground or underwater, thus minimising their visual impact and speeding up planning applications

At present, the cost of power generated by solar-thermal power plants including its transport via HVDC transmission lines amounts to 10 to 20 euro cent per kilowatt-hour – depending on the location, technology and form of operation. However, these costs will drop significantly with economies of scale and refinements in the technologies. If environmental and hidden costs are properly accounted for, it is likely that electricity from CSP plants is already cheaper than electricity from coal-fired or nuclear power plants.



DESERTEC CONNECTS A CONCEPT FOR THE EUMENA REGION

The EUMENA region (Europe, the Middle East, North Africa) can profit to a great extent from realizing the DESERTEC Concept. Imagine the following scenario: On favourable sites, countries on the Southern and Eastern shores of the Mediterranean Sea, including the Arabian Peninsula, would meet most of their soaring power requirements from solar power plants in deserts, supplemented by wind and hydro power. In addition, they would produce energy for much-needed desalination of sea water and they would generate export earnings for the foreseeable future by supplying power to Europe.

The development and trading of energy from renewable sources will boost economic development in these regions and creates local jobs in the production of collectors as well as in the construction of solar power plants: For example, the construction of only **one** 250 MW parabolic trough power plant requires 1,000 workers and engineers for a period of two to three years. In this way, MENA countries, including those with oil and gas resources, may establish a new economy with new jobs and a reduction in the brain drain. In turn, the European states will achieve their goals of reducing CO₂ emissions relatively quickly and relatively cheaply, since CSP imports provide a good substitute for power from fossil fuels. As a result, the whole of EUMENA would benefit from the trade in clean power from deserts.

SOLAR POWER IMPORTS AND SECURITY OF SUPPLY - EXEMPLIFIED BY EUROPE

Many frequently asked questions centre round the security of supply: „Aren't we making our energy supply too dependent on other

countries?“ „What if the transmission grid is disturbed by natural phenomena, accidents, sabotage or boycott?“

Energy security needs to be taken seriously. It is important to point out that the DESERTEC Concept does not rely exclusively on power from deserts — that source of energy is merely one of a range of renewable sources of power. By importing clean power from deserts, European countries could increase their range of renewable energy sources and thus reduce their dependence on imports of fossil fuels such as natural gas and coal. Instead of relying on relatively few large „mega transmission lines“ that are the rule with oil and gas supplies, it would be possible under the DESERTEC scenario to increase security by obtaining supplies via a relatively large number of medium-capacity transmission lines. Damage to power plants and transmission lines can be repaired easily. The system has sufficient redundancy to compensate for any failure related breakdowns of transmission lines. An orchestrated suspension of power supplies would lead to a loss of income in the producing countries - as opposed to the case with fossil energies which can be saved and sold later, and perhaps at a higher price. Beyond that, producers would lose the confidence of their costumers and future investors with such a boycott and thus do damage to themselves.

AT A GLANCE

- Around the world, renewable energy is available in abundance.
- DESERTEC aims to harness the largest source of energy on earth: solar power from deserts.
- More than 90% of the world's population live within 3,000 km of a desert and may receive clean power from there.
- DESERTEC offers an integrated solution to global problems of the coming decades: climate change and associated shortage of energy, water and food.
- All the necessary technologies are proven and can be put in place forthwith.

THE TIME HAS COME CREATING THE POLITICAL FRAMEWORK

*„The technology is ready to go, and investors are interested.
What are we waiting for?“*

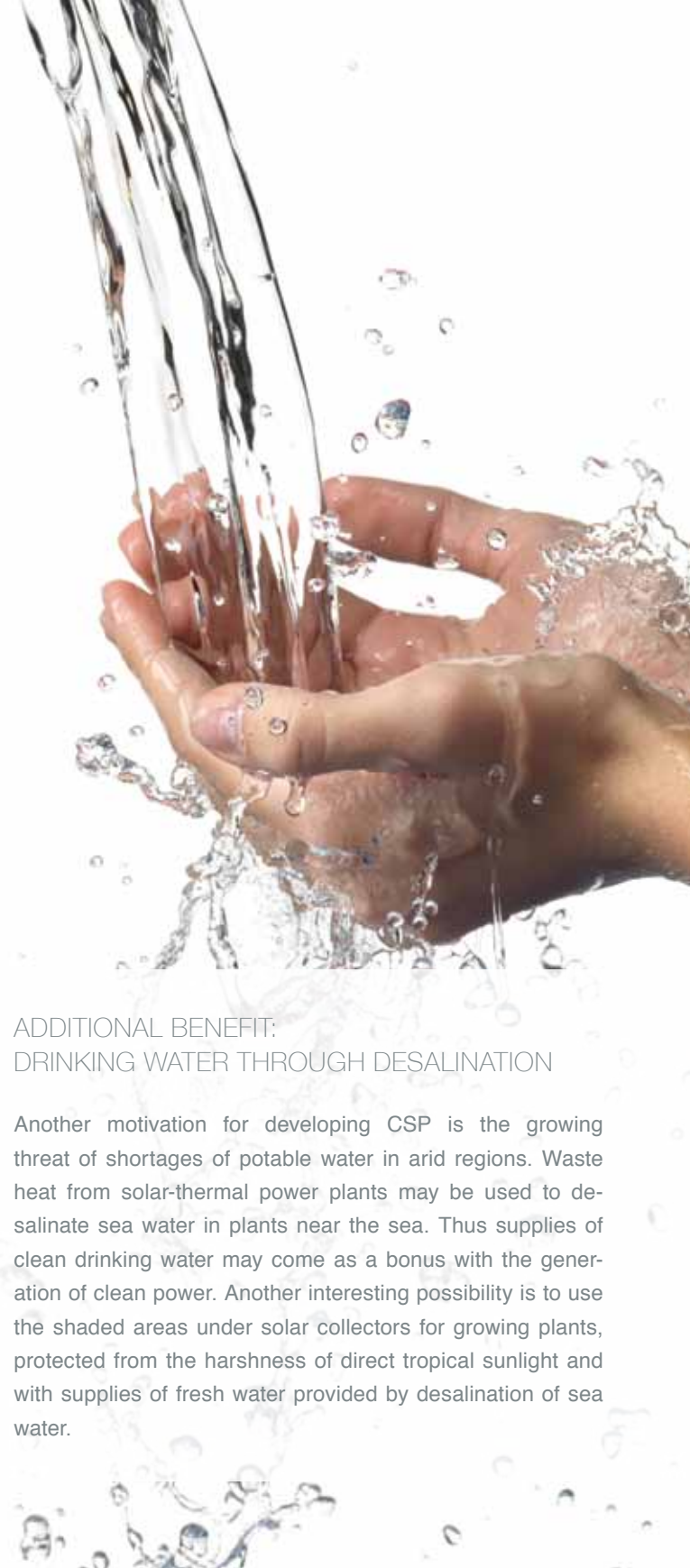
Very simple: in the sunbelt countries and in client countries, changes are needed in government policies and in the relevant laws and regulations to create a favourable commercial environment for DESERTEC developments.

Creating that favourable commercial environment is relatively easy in countries like Australia, China, India and the USA, where there is only one government involved, and it is harder to achieve when different countries have to co-operate (as in the EU and nearby sunbelt countries). However, with the right political will, these problems are soluble everywhere. It is in everyone's interests that political leaders throughout the world take the necessary steps to facilitate DESERTEC developments.

An international „DESERTEC Programme“ is a major opportunity to secure a sustainable future for mankind.

ADDITIONAL BENEFIT: DRINKING WATER THROUGH DESALINATION

Another motivation for developing CSP is the growing threat of shortages of potable water in arid regions. Waste heat from solar-thermal power plants may be used to desalinate sea water in plants near the sea. Thus supplies of clean drinking water may come as a bonus with the generation of clean power. Another interesting possibility is to use the shaded areas under solar collectors for growing plants, protected from the harshness of direct tropical sunlight and with supplies of fresh water provided by desalination of sea water.



FOCUS EUMENA

TAKING CONCRETE STEPS TOWARD THE GOAL

An effective political framework provides three things: It offers investment incentives to potential investors and operating companies, it ensures long-term stability in planning, and it creates transparency in markets.

There is a need for a single market in electricity throughout the EUMENA region so that, for example, any customer in Germany or the UK may buy electricity directly from any supplier in North Africa or the Middle East. To facilitate the efficient operation of that single market, there is a need for a new high-voltage direct-current transmission (HVDC) grid throughout the EUMENA region. However, with some modest upgrading of the existing grid to remove bottlenecks, the trading of electricity throughout EUMENA may begin quite soon. As volumes increase, transmission capacities may be increased by converting HVAC lines to HVDC, by building new HVDC lines, and by the installation of smart electronics.

The DLR has estimated that the cost of 20 transmission lines of 5 GW each would be approximately 45bn Euros.

By means of appropriate feed-in tariffs, solar power from deserts can be made competitive with immediate effect. These instruments have proved to be successful in Germany and Spain. The need for this kind support will be reduced or eliminated if subsidies for coal-fired and nuclear electricity are removed, if their environmental and hidden costs are fully internalised, and if the current upward trend in their costs continues into the future. Meanwhile, the cost of CSP is likely to fall with refinements in the technologies and economies of scale.

Other kinds of support could be useful to speed up the construction of grids and power plants: for example, support of investments via moneys raised from the auctioning of emission certificates or

from public investment programs for climate protection that are yet to be created, or via government guarantees on investments in foreign countries. It has already been accepted that imports of renewable energy into the EU would count towards the target of 20% of European energy coming from renewable sources by 2020. A logical next step would be to introduce further feed-in tariffs in European countries that apply to imports of solar power from the MENA region.

In the future, in the interests of fair competition, the price of energy from fossil fuels must include charges for CO₂ emissions — something that has not yet been properly achieved by the European Emissions Trading Scheme. With proper charges for CO₂ emissions, solar and other renewable sources of energy would be competitive even today.

In any case, overt and hidden subsidies for non-sustainable energy sources have to be done away with, as they give incentives for damaging investments. Every year, about several hundred billion US dollars pass into subsidies for energy production from fossil or nuclear energy sources worldwide.

Those who hold on to fossil energy sources with the argument of securing jobs overlook the fact that even more jobs could be created in the new renewables industries, where consumption of fossil resources is replaced by manufacturing of equipment.

THE FOLLOWING PROJECTS AND MEASURES ARE NEXT ON THE AGENDA

- Full utilization of the possibilities of cooperation arising from the new „Union for the Mediterranean“ between the EU and ten of the states on the southern and eastern borders of the Mediterranean Sea. The flagship project, the „Mediterranean Solar Plan“, should, in particular, be planned and realized with the priority of an emergency programme to fight climate change.
- An immediate start of negotiations with the aim of building partnerships between EU and MENA countries for the purpose of implementing the DESERTEC Concept.



■ An information campaign covering all EUMENA countries with the purpose of disseminating the DESERTEC Concept and the possibilities of its practical implementation.

■ Creation of a „solar radiation atlas“ specially designed for solar-thermal power plants which is open to the general public and shows a comprehensive breakdown of insolation in desert areas with regard to place and time.

■ Immediate preparation of feasibility studies to clarify political, organizational, financial, technical and ecological issues still pending with regard to the implementation of the DESERTEC Concept.

■ The start of a 1-GW kick-off programme with the aim of demonstrating the practical feasibility of CSP developments in interested MENA states. For humanitarian reasons, a solar power and drinking water plant located on Egyptian territory for supply of the Gaza Strip would be an ideal pilot project. The

improvement of living conditions in the Gaza Strip which this measure would entail might also lead to a reduction in conflicts in that region.

■ A programme to support industrial and human „capacity building“ for the construction of solar-thermal power plants and solar collectors, thus promoting industrial development in the participating countries.

■ Long-term binding purchasing agreements on the part of EU countries which stipulate appropriate conditions and minimum quantities with regard to the import of clean power from the MENA region.

■ A „closure premium“ for inefficient written-off coal-fired power plants in south-European countries if their capacities are replaced with the import of clean power from deserts.

THE DESERTEC FOUNDATION TASKS AND GOALS

So far, the development and dissemination of the DESERTEC concept has been based primarily on great efforts put in by volunteers. With the increasing interest among politicians and the general public, the tasks of the proponents of the concept have also become more demanding. The DESERTEC Foundation was founded in order to meet these demands.

The founders of the DESERTEC Foundation, the Deutsche Gesellschaft CLUB OF ROME (German Association CLUB OF ROME) and members of the TREC network, based on four

continents, have become increasingly conscious of the fact that introducing clean power from deserts and other clean sources of energy, and doing these things soon, will require a powerful and independent organization.

The DESERTEC Foundation is an ambassador for and supporter of the DESERTEC Concept. The core of this concept is securing the essential requirements of mankind, based on sustainable supplies of energy that are conducive to development and help to reduce the risk of conflict.

The DESERTEC Foundation bundles political, economic and social interests in energy and climate security and thus increases their political influence. The Foundation is promoting the DESERTEC Concept by awareness-raising activities and it aims to gain support from many organisations and individuals.. In addition, the Foundation is working with politicians at national and supranational levels in Europe, the MENA area, and elsewhere around the globe, aiming to advance the realisation of the DESERTEC Concept, and to gain support amongst legislators and influential opinion makers.



OPPORTUNITIES AND PROSPECTS

THE FOUNDATION WELCOMES SUPPORT FROM COMMERCIAL ORGANISATIONS

Transition to clean sources of energy will make great demands on many companies but, at the same time, it will create great opportunities. Even companies with business models that are focussed on the provision and use of fossil fuels can benefit from these new developments.

DESERTEC WILL BE ESPECIALLY BENEFICIAL TO COMPANIES THAT

- conceive, design or produce solar-thermal power plants and HVDC transmission lines;
- are looking for sustainable investment opportunities in the infrastructural sector;

- consume large amounts of power or are engaged in energy-intensive industries, and wish to have access to clean power at stable prices;
- conceive, design or produce sea-water desalination plants;
- produce or use hydrogen, and wish to reduce or eliminate emissions of CO₂;
- are looking for sustainable possibilities in order to extend the scope of their business.

The work of the DESERTEC Foundation can open up many new opportunities for business. In order to make the concept a success, the Foundation welcomes financial support and other forms of support from commercial organisations.

If you feel this work is important, please support it and contact us:

E-mail	partner@DESERTEC.org
Phone	+49 (0)40 - 32 507 795
Contact person	Michael Straub



A TASK FOR ALL OF US

HERE'S HOW I CAN PERSONALLY CONTRIBUTE TO THE SUCCESS

The success of the DESERTEC Concept also depends to a large extent on support by the general public. The more people understand the big picture and the scope for individual action the more quickly the concept can become reality.

Each one of us can make a contribution here. Each individual supporting the concept helps in making it known to others, thereby finding further supporters. You can obtain information on facts and developments on a regular basis by subscribing to our newsletter. In addition, you can register under www.DESERTEC.org/yourvoice to confirm your approval of the concept.

The DESERTEC Foundation is a non-profit foundation that relies on financial support in the form of donations from many organisations and individuals in order to secure its independence. Donations of money or other resources will be very welcome.

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Editors

Dr. Gerhard Knies
Dr. Gerhard Timm
Friedrich Führ
Dr. Gerry Wolff
Max Schön
Michael Straub
Hani Nokraschy
Dr. Oliver Steinmetz

Design & Layout

Tobias Morell
Tim Hufermann
Stephan Schoenen

Morell PR-Beratung
JUNGMUT Advertising & Consulting
JUNGMUT Advertising & Consulting

Responsible acc. to press law: Dr. Gerhard Timm

Contact

DESERTEC Foundation
Initiative of the CLUB OF ROME
Hamburg Office
Ferdinandstr. 28-30
20095 Hamburg, Germany

Phone +49 (0)40 - 32 507 795
Fax +49 (0)3212 - 10 10 860
E-mail foundation@DESERTEC.org
Website www.DESERTEC.org

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Veitstr. 42
13507 Berlin, Germany

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The DESERTEC Concept has been developed by the Trans-Mediterranean Renewable Energy Cooperation (TREC), a global network of scientists and engineers, together with the German Association CLUB OF ROME.

The DESERTEC Concept is one of the most effective means of tackling the problem of climate change. It is underpinned by three detailed studies carried out by the German Aerospace Center (DLR) on behalf of the German Federal Ministry for the Environment.



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PROTECTING THE CLIMATE IN GOOD TIME IS THE ULTIMATE IQ TEST FOR THE HUMAN SPECIES.