1. The DESERTEC Concept

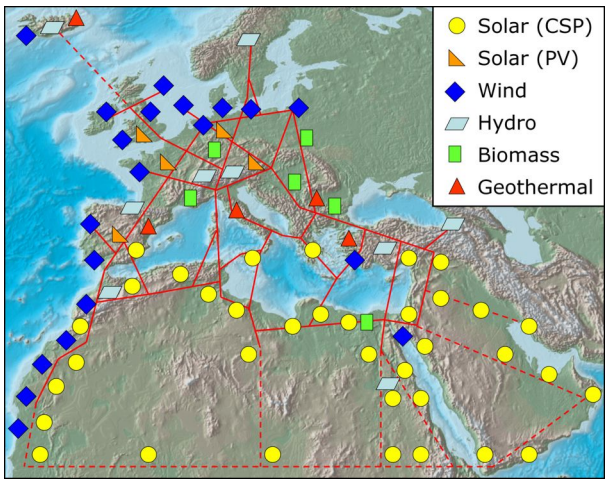
The DESERTEC Concept of TREC brings deserts and technology into service for global security of energy, water and the climate. To this end we propose that the regions of **Eu**rope, the **M**iddle **E**ast and **N**orth **A**frica (**EU-MENA**) begin to cooperate in the production of electricity and desalinated water using concentrating solar thermal power plants and wind turbines in the MENA deserts. These technologies can supply the growing demands for power and seawater desalination in the MENA region, and produce clean electrical power that can be transmitted via **H**igh **V**oltage **D**irect **C**urrent (**HVDC**) transmission lines to Europe (with overall transmission losses of about 10-15%). From a political point of view, implementing DESERTEC in countries like Australia, China, India and the USA, will be even easier.

The technologies that are needed to realise the DESERTEC Concept are already developed and some of them have been **in use for decades**. Several studies by the German Aerospace Center (**DLR**) confirm the viability of this concept and the advantages of realising it very soon. All that is needed now is the political will and the right framework of incentives.

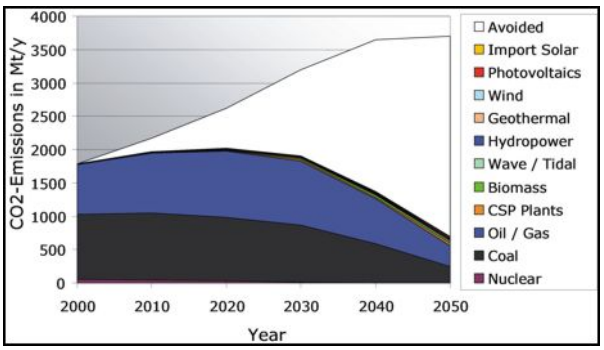
2. The TREC Network

Since the **T**rans-Mediterranean **R**enewable **E**nergy **C**ooperation (**TREC**) was founded in 2003 by The Club of Rome, the Hamburg Climate Protection Foundation and the National Energy Research Center of Jordan (NERC), it has developed the **DESERTEC Concept** and completed the necessary research in cooperation with the German Aerospace Center (**DLR**). Now TREC is making this concept a reality in cooperation with people in politics, industry and the world of finance.

The core of TREC is an international network of scientists, politicians and other experts in the field of renewable forms of energy and their development. The members of TREC (about 60 in number, including *His Royal Highness Prince Hassan bin Talal of Jordan*) are in regular contact with national governments and with private investors, aiming to communicate the benefits that may be obtained from the cooperative use of solar energy and wind energy. TREC is also developing concepts and promoting specific projects in this field. Regional DESERTEC networks disseminate the ideas in their home countries.



Euro-Supergrid with a EU-MENA-Connection: **Sketch** of possible infrastructure for a sustainable supply of power to **EU-MENA**.



CO2-emissions from electricity generation expected for all the EU-MENA countries (in millions of tons per year) assuming vigorous efforts to increase efficiency.
Upper curve: With an electricity generation mix equivalent to that of the year 2000.
Second curve from top: For the scenario described in the TRANS-CSP study with emissions reduced by the use of renewable sources and the transmission of clean power from MENA to Europe.

TREC

Clean Power from Deserts
Trans-Mediterranean
Renewable Energy Cooperation
An Initiative of The Club of Rome

THE CLUB OF ROME

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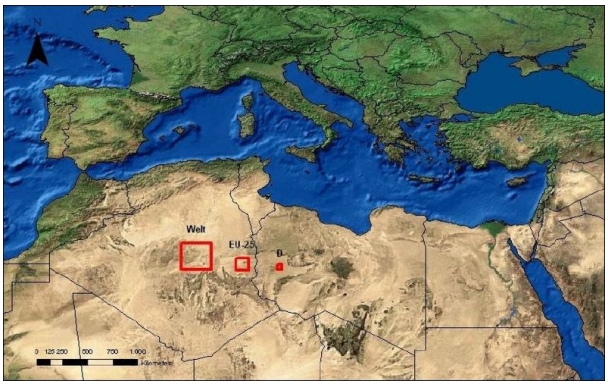
3. Three Studies by DLR

TREC was founded with the goal of providing clean energy for Europe and for sunbelt countries quickly and economically through a cooperation between the countries of EU-MENA. **Power from deserts, as a supplement** to European sources of renewable energy, can speed up the process of cutting European emissions of CO_2 and it can help to increase the security of European energy supplies. At the same time, it can provide self supply with electricity, jobs, earnings, drinking water and an improved infrastructure for people in the **M**iddle **E**ast and **N**orth **A**frica (**MENA**).

TREC has been involved in the conduct of **three studies** which have evaluated the potential of renewables in MENA, the expected needs for water and power in EU-MENA between now and 2050 and the potential for an **electricity transmission grid** connecting the EU with MENA (a **EU-MENA-Connection**).
Those three studies were commissioned by the German Federal Ministry for the Environment, Nature Conversation and Nuclear Safety (BMU) and have been conducted by the **German Aerospace Center (DLR)**. The '**MED-CSP**' study was produced in 2005 and the '**TRANS-CSP**' study was completed in 2006. The '**AQUA-CSP**' study about the needs, the potential and the consequences of solar desalination in MENA was completed in 2007.

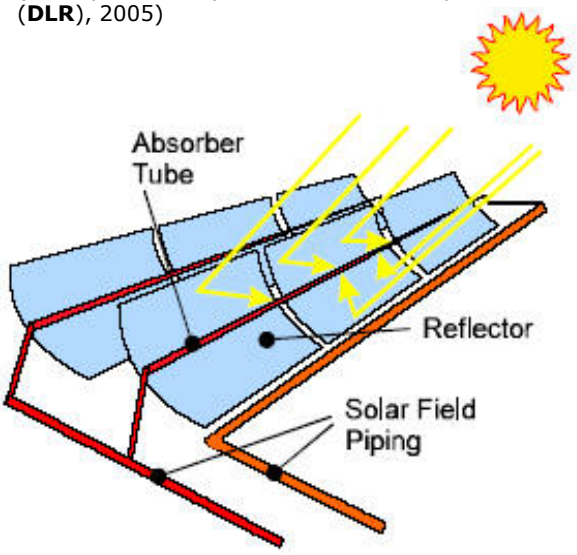
Satellite-based studies by the German Aerospace Center (DLR) have shown that, using **less than 0.3% of the entire desert areas** of the MENA region, **solar thermal power plants** can generate enough electricity and desalinated seawater to supply current demands in EU-MENA, and anticipated increases in those demands in the future. **Harnessing the winds** in Morocco and on land around the Red Sea would generate additional supplies of electricity. Solar and wind power can be distributed in MENA and transmitted via **H**igh **V**oltage **D**irect **C**urrent (**HVDC**) transmission lines to Europe with transmission losses that would be no more than 10-15%. Countries like Algeria, Egypt, Jordan, Libya, Morocco and Tunisia have already shown an interest in this kind of cooperation.



For illustration: Areas of the size as indicated by the red squares would be sufficient for Solar Thermal Power Plants to generate as much electricity as is currently consumed by the World, by Europe (EU-25) and by Germany respectively. (Data provided by the German Aerospace Center (**DLR**), 2005)

4. The Technologies

The best solar power technology for providing secure power output is solar thermal power plants (also called **C**oncentrating **S**olar Thermal **P**ower, **CSP**). They use mirrors to concentrate sunlight and create heat which is used to raise steam to drive steam turbines and electricity generators. Excess heat from additional collectors can be stored in tanks of molten salt and used **to power steam turbines during the night** or when there is a peak in demand. In order to ensure uninterrupted service during overcast periods or bad weather (without the need for expensive backup plants), the turbines can also be powered by oil, natural gas or biomass fuels. Waste heat from the power-generation process may be used (**in cogeneration**) to **desalinate seawater** and to generate **thermal cooling** – useful by-products that can be a great benefit to the local population.



Sketch of a **parabolic trough collector**
(A simplified alternative to a parabolic trough concentrator is the linear **Fresnel** mirror reflector.)

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Using **H**igh **V**oltage **D**irect **C**urrent (**HVDC**) transmission lines, loss of power during transmission can be limited to only about 3% per 1000 km. The **high solar radiation** in the deserts of MENA (twice that in Southern Europe), outweighs by far the **10-15% transmission losses** between MENA and Europe. This means that solar thermal power plants in the deserts of MENA are more economical than the same kinds of plants in Southern Europe. Although hydrogen has in the past been proposed as an energy vector, this form of transmission is very much less efficient than HVDC transmission lines.

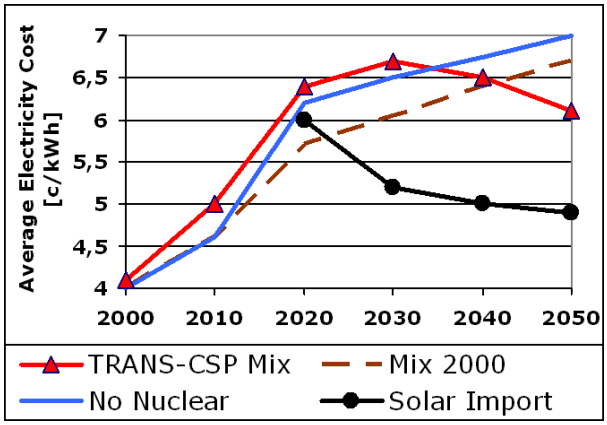
The technologies that are needed to realise the DESERTEC concept are already developed and some of them have been **in use for decades**. HVDC transmission lines up to 3 GW capacity have been deployed over long distances by ABB and Siemens for many years. In July 2007 Siemens accepted a bid to build a 5 GW HVDC System in China. At the World Energy Dialogue 2006 in Hanover speakers from both the companies just mentioned have confirmed that the implementation of a Euro-Supergrid and a **EU-MENA-Connection** is, technically, **entirely feasible**.

Solar thermal power plants have been in use commercially at Kramer Junction in California since 1985. New solar thermal power plants with a total capacity **of more than 2000 MW** are either planned, under construction, or already in operation. The Spanish government guarantees a feed-in tariff of **about 26 EuroCent/kWh for 25 years** and this has established favourable business conditions for CSP. Because of the higher solar radiation at good sites in the USA or MENA it is now possible to use lower rates in feed-in tariffs. The DLR has calculated that, if solar thermal power plants were to be constructed in large numbers in the coming decades, the estimated cost would **come down to about 4-5 EuroCent/kWh.**

Parabolic trough collector field for the solar thermal power plants in Kramer Junction, California

Year		2020	2030	2040	2050
Transfer Capacity GW		2 x 5	8 x 5	14 x 5	20 x 5
Electricity Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24	35
Land Area km x km	CSP	15 x 15	30 x 30	40 x 40	50 x 50
	HVDC	3100 x 0.1	3600 x 0.4	3600 x 0.7	3600 x 1.0
Investment Billion €	CSP	42	143	245	350
	HVDC	5	20	31	45
Elec. Cost €/kWh	CSP	0.050	0.045	0.040	0.040
	HVDC	0.014	0.010	0.010	0.010

Capacity, Costs & Space:
Development of the EU-MENA-Connection (marked 'HVDC') and Concentrating Solar Thermal Power (CSP) in the TRANS-CSP scenario between 2020 and 2050.



An example (Germany) of the **estimated cost of electricity in the future**, comparing the energy mix in the year 2000 with the TRANS-CSP Mix and showing the role of imported solar power.

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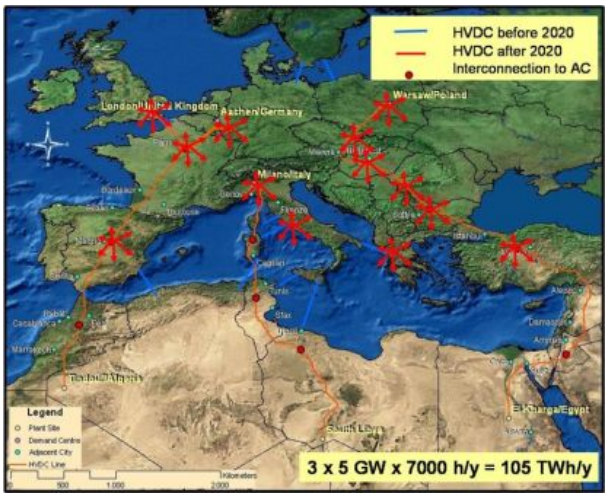
5. Measures to implement the DESERTEC Concept

Construction of new concentrating solar thermal power plants **has begun already** in Spain and in the USA (Andasol 1 & 2, Solar Tres, PS10, Nevada Solar One). Projects are in progress in Algeria, Egypt and Morocco and further plants are planned in Jordan and Libya. **Morocco is implementing a feed-in law** to support renewables (wind in particular). Discussions about the construction of a HVDC-Supergrid across Europe (a **Euro-Supergrid**) have started in the EU and plans for offshore wind farms are taking shape. The Union for the Mediterranean plans to realise a Mediterranean Solar Plan and could provide the framework to implement DESERTEC in EU-MENA.

In order to establish, **by 2050**, **a capacity of 100 GW of exportable solar power in MENA**, over and above the domestic needs of sun-belt countries, only a **few governmental supporting measures** would be sufficient to make the construction of the power plants and the necessary transmission grid more attractive to investors, both private and public. To boost the construction of solar thermal power plants and wind turbines in MENA, **the EU should support a campaign to inform** MENA governments that, calculated over the lifetime of those plants, they would be a cheaper source of power than electricity generated from oil or natural gas. This would reduce the domestic use of fossil fuels (which are continuing to increase in price) and, at the same time, it would enable the sun-belt countries to produce clean power from their own deserts for local use and for export.
Further reductions in costs would be necessary to make CSP a profitable export option from MENA. Growth in the construction of those plants and EU support for the **Euro-Supergrid with a EU-MENA-Connection** will help to drive down costs in the period up to 2020. Towards that goal, it would be useful if the EU would provide advice and support for the possible introduction of **feed-in regulations in MENA** countries along the lines of the German and Spanish Renewable Energy Laws. **International guarantees** for the local feed-in contracts or power supply agreements would help to boost the construction of solar plants and wind turbines.

It is very important that **talks begin soon on the** development of the proposed **Euro-Supergrid with a EU-MENA-Connection.** This would facilitate the optimal integration of all renewable sources of energy from Europe with renewables from MENA. In itself, the initiation of the EU-MENA-Connection for the transmission of clean power from deserts to Europe would create a boom of investments in renewable sources of energy in MENA countries and would give Europe access to cheap, clean and inexhaustible electricity. The construction of **HVDC grids** for the first **10 GW**, as described in the TRANS-CSP scenario, would cost about **5 billion Euros**. If the EU-MENA-Connection is to start transmission by 2020, talks within the EU and with the governments of MENA (e.g. in the Union for the Mediterranean) must begin as soon as possible.



EU-MENA-Connection: existing and planned HVDC transmission lines before 2020 (blue) and three traces researched by DLR (orange)

As compared to power from "domestic" new fossil and nuclear plants (curve "Mix 2000" on page 1), **solar power from North Africa will be cheaper** in Southern European countries like Spain and Italy with transmission beginning in 2020. With further cost reduction and EU-MENA grid expansion this will become so in most other European countries latest in 2030. The power cost reducing EU-MENA-Connection as studied in the TRANS-CSP scenario will require an investment of 45 billion Euros until 2050, and **yield annual savings of up to 10 billion Euros**. Lean cost clean power from deserts will become the least cost option and setting up the EU-MENA-Connection appears as a "must" for European economies.

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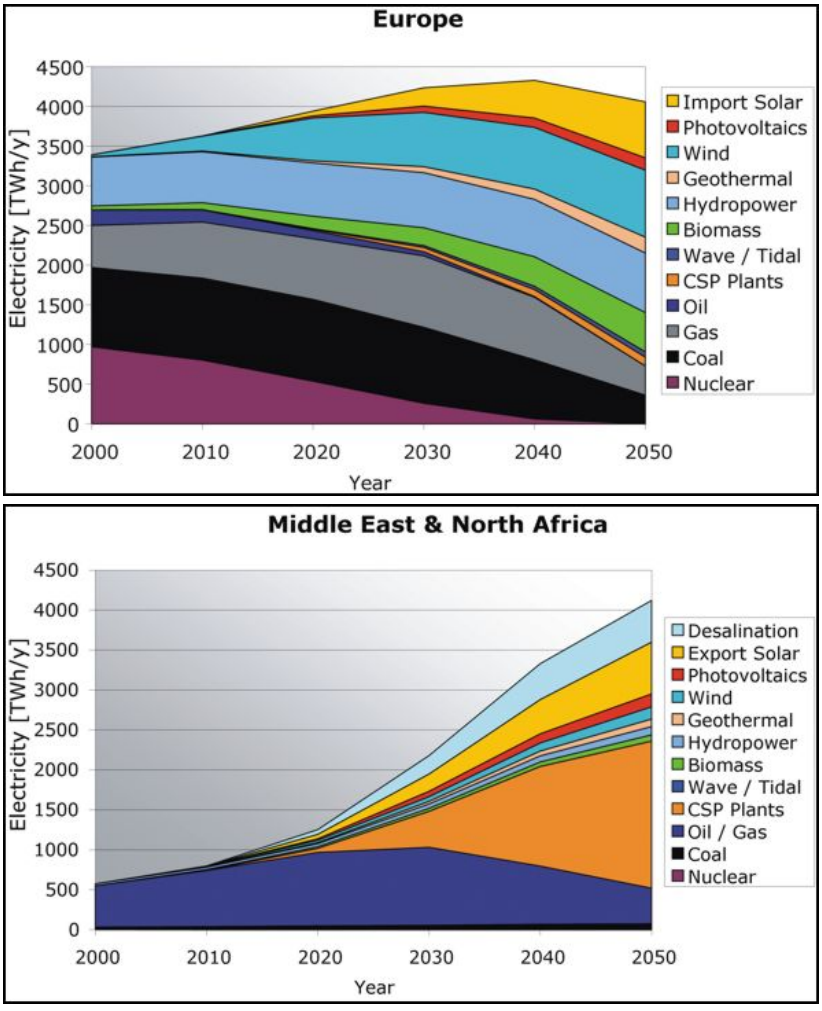
In addition to these direct supporting measures, TREC proposes **two projects** to help bring down the cost of CSP and to alleviate pressing social and political problems at the same time. Both projects are technically possible, but require political and financial support:

1. **Gaza Solar Power & Water Project:** To **build CSP plants for the combined generation of electricity** (1 GW in total) **and desalination of sea water**. These plants, part of a potential international recovery programme for Gaza, could be **located in the Egyptian Sinai coastal region**. With the provision of appropriate water and power lines into the Gaza strip, these facilities could provide supplies for 2-3 Million people. This project could mark **a turning point in the currently disastrous social and economic development** of Gaza, in the regional conflicts for water and in the stalled peace process between Israel and Palestine. The total investment required would be about **5 billion Euros**.

2. **Sana'a Solar Water Project:** To build desalination and power plants near the Red Sea for the Yemenite Capital Sana'a which is facing the exhaustion of its ground water reserves in about 15 years. These plants, powered by solar energy, would generate **fresh water for Sana'a** and, at the same time, would produce the power needed to pump the fresh water through a pipeline to the city of Sana'a at an altitude of 2200 meters. This Sana'a project could **avoid a looming humanitarian disaster and social unrest in Yemen**, and would save a cultural heritage of world-wide significance. Moving 2 million people from Sana'a to new settlements would cost about 30 billion Euros. This is very much more expensive than the **5 billion Euros** needed for the alternative plan: to let people to stay in Sana'a and build solar power plants and a pipeline to supply them with water.

The TRANS-CSP scenario is **a viable path**. Together, the countries of the EU-MENA region have **more than enough potential to make a complete change** in favor of renewable energy for the power supply and transport sectors.

By the middle of the 21st century, the **MENA countries** could have converted their deserts to become inexhaustible sources of clean energy; overcome limits of growth caused by shortages of fossil fuels and **developed to become a second Europe**. At the same time they could sell clean power to European countries, thus helping to bring European emissions of greenhouse gases **quickly down to a sustainable level** and **to phase out nuclear power** at the same time. There would also be long-term reductions in the cost of electricity.



TRANS-CSP **climate and supply security mix** in EU-MENA

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6. Answers to frequently asked questions

"Will Europe exploit Africa again? What are the benefits for MENA?!?"

- The **current situation is an exploitation** of gas and oil, but **solar energy** is practically unlimited and **can't be "exploited"**.
- **In the period up to 2050, MENA will develop into a second Europe** and urgently **needs renewables** for the generation of **electricity and drinking water** (considered in the TRANS-CSP study).
- **Saving fossil fuels** in the subsidized energy supply of MENA will allow them to be sold more profitably on the world market.
- **Earnings from export** of electricity by using the unused potential of renewable energies
- **Jobs** for and jobs especially in construction of solar **collectors ==> income ==> building a middle class, instead of the emigration of well-qualified engineers.**
- **Consequences of climate change** produced by Europe will hurt the MENA region first, so it's only **fair if Europe supports** the introduction of renewables in MENA
- **Technology transfer** and development of **training programs and studies** for renewables in MENA is explicitly promoted by the European side in the framework of the Union for the Mediterranean

"Europe will be dependent from abroad, danger of terrorism and major corporations!"

- The electricity mix of the TRANS-CSP scenario in Europe in 2050: 65% European renewable energies, **17% solar electricity imports, 18% fossil fueled backup and peak load power plants ==>** Even the **loss** of all 20 HVDC lines from MENA **can be compensated** till they are repaired or till a political solution has been found
- There **won't be even one huge solar power plant**; there will be hundreds of solar power plants in a network of renewables, spread over several continents.
- Using inexpensive and inexhaustible supplies of solar energy, there is also the possibility of **charging batteries** or generating **hydrogen** as a possible substitute for fossil fuels for transport. Furthermore there would be the possibility to use **biomass** better for transport instead of to generating electricity.
- **Solar energy** is virtually unlimited and is **getting cheaper by an increased use** (instead of getting more expensive as with other energy sources) **==> no competition and conflicts** over regionally and quantitative limited resources, as oil, gas or uranium.
- **Oil, gas or uranium** can be sold **more expensive after a suspension of deliveries ==> interruption of electricity exports** with renewables only leads to **loss of revenue** at continuing costs.
- Interruption of electricity exports from a supplying country leads to **loss of confidence** in that country **==> less investment ==> fewer export earnings and less jobs** in future.
- See EU: **interdependence** rather than autonomy **ensures peace and cohesion**
- **Both public and private, small and large investors** can / should / want to invest into power plants and transmission lines
- **Time is short**: Climate change and price avalanches threaten us **==> decentralized and internationally connected renewables complement each other**

"Your approach includes only North Africa. What about the rest?!?"

- For a cooperation and integration into the European grid, MENA is – **because of the proximity** – obviously more suitable, than Central or South Africa
- Renewables in general and CSP in particular, **are also suitable for the rest of Africa** and it will profit by the cost reductions developed in the north.
- **Central Africa has large hydropower resources** considered by the North African countries (eg. Egypt) as a strategic reserve for its electricity supply. If North Africa, however, uses its own solar resources, Central Africa remains its most important resource.
- We also campaign there and in **China, Australia, the USA and India** for a realisation of DESERTEC "Clean Power from Deserts," but our resources are limited.
- That is why we are founding **regional DESERTEC Networks**, which can benefit from our know-how and the studies.

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