The International Solar Mobilization Fund (SMF)

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Abstract

The SMF is an international revolving fund trading in electricity, water, and CO_2 emission rights. The SMF purchases electricity, water, and CO_2-certificates from the companies who exploit CSP-desalination plants in developing countries by means of long-term fixed-priced contracts. The SMF sells electricity and water to local utilities for (in the first phase) lower prices. The SMF bears most of the specific risk of investments in developing countries. This way, companies who want to invest in CSP-plants can negotiate the moderate to low project interest rates that are needed for the global development of solar energy. The SMF is the most powerful method for deploying solar energy on the world and for making a credible transition towards a 100% renewable economy, it mobilizes the economic capacity in the world to achieve this transition.

Abbreviations and definitions:

CDM:	the Clean-Development Mechanism (CDM) of the Kyoto Protocol.
Concern:	the (in many cases Western) concern owning one or more Projects
CSP:	Concentrating Solar Power
DLR:	Deutches Zentrum für Luft- und Raumfahrt (German Aerospace Institute)
DNI:	Direct Normal Irradiation, the average amount of sunshine in a year falling on a plane perpendicular to the direction of the sun
Donor Country:	country that is financing the International Solar Mobilization Fund
Government:	local and national authorities governing the country that is hosting the CSP-plant.
HVDC:	High-Voltage Direct-Current transmission line for cheap long-distance transport of electricity
IGSEC:	International Governmental Solar-Energy Conference
MENA:	Middle East and North Africa
PPA:	power purchase agreement between SMF and Project

Project:	the project company owning and managing one specific CSP-desalination plant
PSA:	Power Selling Agreement between SMF and Utility
SMF:	the International Solar Mobilization Fund, an international organization which may purchase electricity and water from the Project, and sell it to the Utility.
TREC:	Trans-Mediterranean Renewable Energy Cooperation, a network of European scientists and scientists from MENA
Utility:	the company or governmental organization that consumes the electricity and/or the water produced by the CSP-plant

I. Introduction

A. Massive-scale sources of renewable energy

The reader is assumed to be aware of the necessity to develop massive sources of renewable energy in order to solve the global climate problem and the global energy-shortage problem. The only renewable-energy source that suffers from no physical and economical limitation whatsoever is the exploitation of solar energy in the sunbelt countries of the world, Ref.1. The most appropriate technique is CSP: Concentrating Solar Power. In a conventional electric power station the heat from burning fossil fuel (coal, oil, gas), or from fissioning uranium, is replaced by solar heat that is concentrated by means of mirrors, Ref.2. In California a number of CSP-plants were built between 1985 and 1991. These stations, having a total peak capacity of 350 MW, are still in full operation, selling the electricity to the local grid regulator on the basis of a 30-years Power Purchase agreements (PPA). After a period of stagnation, lasting 15 years, many new solar thermal power plants are under construction, mainly in Spain and the USA, and in 2007 the global CSP capacity will increase by 75 MW at least.

The waste heat from solar thermal power stations can be applied for the desalination of sea-water. So CSP-desalination plants at the coasts in MENA (=Middle East & North Africa) produce two commodities: electricity and fresh water, Ref.3.

Another abundant source of renewable energy is wind power in those regions in the world where stable trade-winds are blowing almost continuously.

B. Subsidizing renewable electricity.

The production costs of all renewable sources of electricity are higher than the current commercial prices for electricity (accept for hydro-power). Therefore in a pure liberal, capitalistic economy renewable sources will not be developed as long as the commercial tariffs for electricity remain as low as they are today. This will change as soon as the price for electricity is increased substantially because of the increased

prices for fossil fuels and the charging for environmental damage. However, the transition from a fossil-fuel based electricity supply towards a solar economy is a major economic revolution which will need many decennia of heavy endeavors and investments. When the world continues its current wait-and-see policy we can expect huge energy crises in the coming half century because of acute shortages in the electricity supply, because it will be impossible to build the necessary numbers of solar power stations in the demanded short period of time.

In order to serve the clear common interest of an uninterrupted supply of electricity for the current and the forthcoming generations, the renewable energy sources, and especially the solar thermal power stations, should be developed energetically, starting today. This cannot be achieved without an intelligent policy of subsidizing renewable electricity in order to attract companies and investors earlier into the business of renewable electricity generation than otherwise. Any subsidizing of economic activities should meet two demands:

1. the activity serves a clear common interest, and would not be started without subsidy,
2. there is a clear perspective that the activity will become economically viable.

The introduction of CSP in the MENA countries can be compared with the introduction of wind energy in North-Western Europe. Wind turbines contribute to the electricity production in Northern Germany, Denmark, The Netherlands and the United Kingdom. All these countries have favorable climatecal conditions for the exploitation of wind turbines. However, the density of wind turbines is much larger in the first two countries than in the last countries mentioned. The main reason is the difference in subsidizing systems between Germany en Denmark on one hand and The Netherlands and Great Britain on the other. Apparently the subsidizing system of the first countries, the Feed-In system, is highly effective for the renewable production of electricity to be delivered to the public grid.

C. The Feed-In system for subsidizing renewable electricity generation.

There are two ways to subsidize economic activities, by means of

1. subsidizing investments and giving tax reductions
2. guaranteeing the purchase of the product for fixed prices.

The Feed-In system follows the second way, the best example is the German "Einspeisegesetz". This is a law for regulating the commercial relations between a company that is producing renewable electricity and the local grid company that is transporting this electricity to the costumer. The law forces the grid company to give for instance a farmer, who wants to install a number of wind turbines, a power purchase contract with the following items:

1. the grid company accepts all electricity at any time of delivery
2. the purchase price for the electricity is fixed at p_y €cent/kWh for a long period of time.

The electricity purchase price p_y for new projects is settled by law, depending on the technology and the climatecal circumstances. As each technology is gradually becoming cheaper due to the learning curve, p_y is gradually given lower values. In 2004 the value for electricity from land-based turbines in Northern Germany was p_{2004} = 9.1 €cent/kWh for the first 12 years and 6.19 cent afterwards. Existing wind parks in Germany sell their electricity for different prices p_y to the grid companies, depending

on the year of construction y. The grid companies generally make a loss on electricity which they purchase from wind farms, as their tariffs to the customers are based on electricity from cheap coal or nuclear plants. However, they are allowed to compensate these losses in their overall tariffs. So wind energy in Germany is subsidized by the electricity consumers, and not by the German government.

The Feed-In subsidy system is tailored to the needs of the companies (and the private persons) who want to produce renewable electricity. The main costs are investments, and these costs depend on the interest rate. The higher the risk, the higher the interest rate that has to be paid to the investors and to the banks. One of the main risks of any enterprise is the uncertainty of being able to sell the product for a profitable price. The Feed-In subsidy system removes this major risk from the renewable electricity producing company. Therefore the overall risk is reduced substantially, and the interest rate is reduced as well, resulting in a big reduction of the cost of the renewable electricity. The Feed-In system enables the deployment of renewable electricity sources, and at the same time brings about optimum financial conditions for decreasing the costs of the clean electricity. The practice of wind energy in Europe proves that the Feed-In system is very beneficial to the heavily needed transition towards the economy based on renewable energy.

D. Definition of the problem

Solar energy is abundant in the world, but many regions that are excellently suitable for solar energy are situated in developing countries with their specific handicaps. Especially for Europe and surrounding regions the situation is complex. The only region in Europe with a reasonable potential for CSP technology is Southern Spain. Thanks to a good Feed-In law in Spain (the Royal Decree 436/2004, with p_y = 22 €cent/kWh), a 11 MW CSP-plant was completed in 2007 in Sevilla and solar power plants with a total capacity of 120 MW are under construction in the autumn of that year. A new law (DR) has increased the feed-in tariff to p_y = 26 €cent/kWh. Many new CSP-investment plans have been announced. However, because of lack of space in Spain, most European electricity will be imported from the MENA region when the solar economy has become reality, Ref.3. It is therefore of common interest to the MENA countries as well as to the European countries that an ambitious program is started for building CSP stations in MENA. These stations will produce electricity for Europe, and electricity together with fresh water for MENA.

A typical Feed-In law for subsidizing solar power is a national law, forcing the national grid authorities to cooperate with companies (national or foreign) who want to exploit a CSP plant. New solar power plants will be constructed only if the prices for the delivered solar electricity and solar fresh water are substantially higher than the local prices, because the CSP technology is still an expensive technology. For instance, the first generation of CSP-desalination plants in Egypt will produce electricity and water for higher costs than the consumers are willing and able to pay. A Feed-In law in Egypt, resulting in a large CSP capacity, would force the Egyptian population as a whole to pay more for electricity and water. Considering the low standard of living of the Egyptian population it is doubtful whether the Egyptian

government would have the courage to increase the daily cost of living for the sake of solving global problems.

So we are facing now the following dilemma.

1. It is absolutely necessary that the global climate distortion problem and the global energy shortage problem be solved.
2. The best way for solving the problems is deploying CSP in the sun-belt countries.
3. CSP needs to be subsidized, and the best method is the Feed-In system, in which the population as-a-whole subsidizes the new, expensive technology.
4. However, many sun-belt countries, like Egypt, have a poor population.
5. It is not fair that a poor people like the Egyptians bears the full load of solving global problems.

We have come to the conclusion that foundation of the International Solar Mobilization Fund is the best way to solve this dilemma.

II. Description of the International Solar Mobilization Fund (SMF)

A. Eleven articles that define the International Solar Mobilization Fund.

1. SMF and Project make a PPA (Power Purchase Agreement) for a fixed price and a period of 20 years (inflation correction is allowed, the currency is open to negotiation). The negotiated price depends on the state of the art of the CSP technology, on the amount of solar radiation at the site, and on other local factors. The price should be such that Project can make a modest profit, that will be limited by a fully open competition between the Concerns that want to run new Projects.
   When SMF is not able to sell the electricity and the water, for instance because of a conflict between SMF and Utility, and the production has to be interrupted, Project will be 100% financially compensated by SMF. For each new Project a new PPA will be negotiated. Conflicts on running PPA's are solved by the courts in the country that is hosting the Concern and/or an international court, and not by courts in the hosting country.

2. SMF and Utility make a PSA (Power Selling Agreement) for the local commercial price for electricity and water. The electricity price must have a reasonable relation to world-market prices for fossil energy. The Utility and the Government are encouraged to reduce and to stop subsidies on electricity and water to the local consumers and the local industry, in order to promote rational behavior with respect to these base commodities. Conflicts on running PSA's are solved by the local courts in the hosting country and/or an international court.

3. The economical operations of Project (purchase of land, hiring of personnel, negotiations for building permits, establishment and exploitation of mirror factories, etc.) are to the full responsibility of Project, out of control of SMF, and submitted to local law. However, the international treaty establishing SMF may give SMF certain rights to intervene in possible conflicts between Project and Government, and Project and Utility.

4. Project and SMF are free to include in their PPA the purchase of the CO_2-certificates that are earned by Project in the framework of CDM.

5. SMF sells these CO_2-certificates on the international market.

6. Each Project has the freedom to make a PPA with SMF or to neglect SMF and to sell electricity and water directly to Utility and/or to sell the electricity to other countries. No Government can oblige a Project to deal with SMF.

7. In the first years SMF will make losses. The fund could for instance be financed from an extra taxation on electricity consumption in the Donor Countries. These Donor Countries are assumed to be willing to finance SMF for the following reasons: *i.* To create business opportunities for their CSP companiesm, *ii.* Because of their responsibility for solving the climate problem in the most efficient way.

8. SMF is autonomous, and serves only one goal: the full market introduction of solar energy in the world.

9. SMF is independent on all Companies.

10. SMF is independent on all Donor Countries.

11. SMF is independent on all Governments and Utilities.

B. Explanation of these articles:

1. *Article 1, which is the essence of SMF, gives the Concern the same security as in the case of an investment in a safe European country having a Feed-In law. A Feed-In law, enabling the establishment of long-term power purchase contracts, solves the main problem of any company: how to sell all its products for a profitable price. With this problem solved, the risk of the project is reduced tremendously. Investors will be content with a much lower return-on-equity, and banks will demand a much lower rate of interest. As the total project interest rate plays a crucial role, a Project that is dealing with SMF instead of Utility has lower production costs, and can be content with lower prices.*
   Another risk factor is may be the unreliable behavior of the Government and the Utility in the country that is hosting the CSP-plant. This risk is now taken over by SMF to a large extent. This will reduce further the interest rate and the premiums for insurance.
   The risk for Project of being cheated by corrupt authorities can be reduced by the condition that not the local judge is competent, but the judge in the country of the Concern, or an international judge.

2. *For a (economically) weak country is safer to deal with a respectable international organization like SMF than with a powerful international concern. The currency of the PSA will be the local currency, except for the case the hosting country is an important oil-exporting country.*

4,5 *The Clean-Development Mechanism (CDM) of the Kyoto Protocol is intended to promote investments in CSP-plants. However, the prices are expected to fluctuate heavily, which means risk, and therefore high capital costs. When SMF would purchase from Project the CO_2-certificats that are produced in*

the CSP-plant for a fixed price, the CDM would become the effective tool that it was originally meant to be.

7. *When the Feed-In law would be applied to introduce CSP in for instance Morocco, all Moroccan consumers of electricity, or all state-owned Moroccan utilities would be forced to subsidize the new CSP plants. For a poor country like Morocco this would not be fair. It is better that the European electricity consumers will be forced to subsidize CSP in the period that it is not yet completely economically viable. The way to organize this is the establishment of the SMF, which is fed by rich Donor Countries. If the speed of investment in CSP-desalination plants is that of the TREC-DLR-scenario, the maximum debt of SMF to the Donor Countries will be less than 2 billion euros, Refs.4,5.*

8-11 As SMF is dealing with big money, its independence and absolute immunity with respect to bribery should be without discussion.

III. Two representative examples

The International Solar Mobilization Fund operates in a complex environment with entities like power plant operators, utility authorities, local governments, and donor countries. The SMF trades in three different comodities: electricity, water, and CO_2-certificates (see note 2). We now give two representative examples, which could be realized within five years from now, in order to clarify this complex matter to the reader.

A. A solar thermal power station in Egypt.

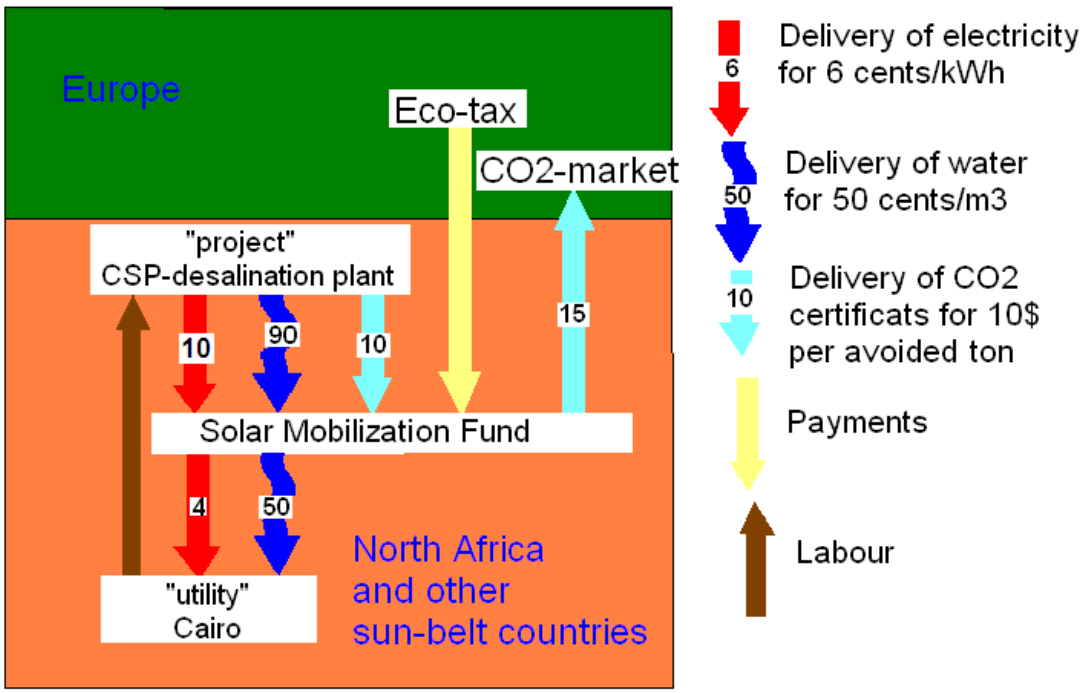

Figure 1
Solar power station in Egypt with SMF-trading

Let us assume an initiative for building and exploiting a solar thermal power station with sea water desalination somewhere along the coast of the Red Sea. A company is established to perform this task. This company can be a local initiative with Egyptian management and engineers, and Egyptian equity, or a daughter of an internationally operating (solar) energy concern, with European management and a mixed crew of European en Egyptian engineers and workers, or some mixture of these extreme situations. In this paper we call this company “Project”, see Figure 1. The plant does not need to be a pure solar power station, a restricted amount of fossil-fuel co-firing should be subject to negotiation.

The products of “Project” are bought by the municipal electricity company and the municipal drinking water company of Cairo. In this paper we call these organizations “Utility”. “Utility” and “Project” are dealing with each other on technical matters (organization of current and water transport and delivery), but not on financial matters.

At first “Project” starts negotiations with the Solar Mobilization Fund with the following 20-years contract as result: electricity will be sold to SMF for 10 cents/kWh, (see note 1), water will be sold for 90 cents/m^3 and CO_2-certificates will be sold for 10 $/ton. Then “Project” presents its business plan to the investors and the banks and negotiates a modest interest rate because of the favorable selling conditions of its products. At the same time “Utility” starts negotiations for purchasing electricity and water from the SMF. Generally these negotiations will result in rather short-term contracts. Figure 1 gives for instance the situation five years after the start of the plant. Electricity is purchased for 4 cents/kWh and water for 50 cents/m^3.

In the example of Figure 1 the Solar Mobilization Fund is losing money on trading electricity and water, and making profit on the CO_2-certificates. Generally the SMF will loose, especially in the first decennium. So the SMF has to be financed from other sources. In the case of Egypt it is obvious that these sources are of European origin. In the post-fuel age Europe’s main source of electricity will be solar, and most of this will be imported from North Africa. Egyptian investments in solar thermal power stations are therefore in the interest of Europe.

The fourth party is called “Government”, that are the local and national authorities whose laws are to be obeyed. “Project” is supposed to deal directly with “Government” in all matters concerning building licences, labour-conditions, environmental permissions, etc. without a specific role for the Solar Mobilization Fund. However, certain internationally accepted minimum environmental and social standards should be satisfied. The SMF could be given an inspection task on these issues.

B. A solar thermal power plant in Morocco.

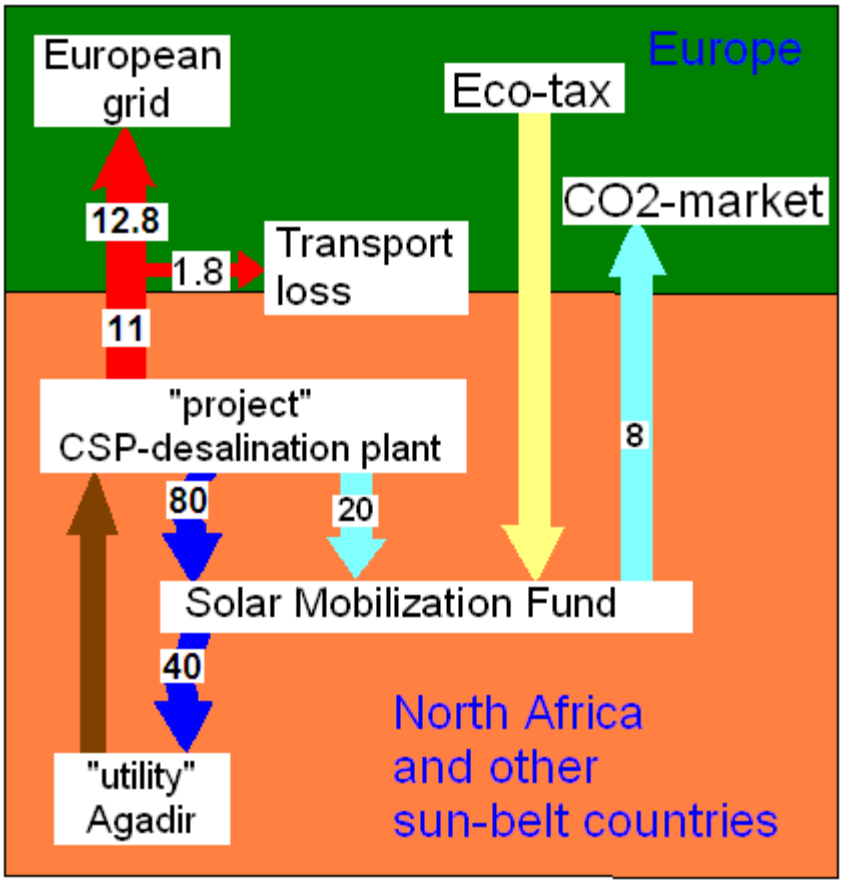

Figure 2.
Solar power station in Morocco with partly trading with SMF.

A "Project" wants to build and to exploit a CSP-desalination plant at the Atlantic coast near Agadir. It is assumed that there exists already a High-Voltage Direct-Current (HVDC) transmission line of sufficient capacity connecting Southern Morocco to Central Europe. At first "Project" negotiates a 20 years power purchase contract with a German grid company for 12.8 cents/kWh and a 20 years power transport contract with the company that is operating the HVDC line for 1.8 cents/kWh, resulting in an effective yield of 11 cents/kWh, see Figure 2. Next "Project" negotiates with the Solar Mobilization Fund, with the following 20-years contracts as result: water will be sold for 80 cents/m^3 and CO_2-certificates for 20 $/ton. All these long-term contracts with reliable partners like the SMF and a European grid company enable "Project" to negotiate a modest interest rate with the banks.

The Solar Mobilization Fund sells the water to the municipal water company in and around Agadir for 40 cents/m^3, see Figure 2. The prices for CO_2-certificates on the world certificate market are expected to fluctuate heavily. In the situation of Figure the price is only 8 $/ton, and the SMF is loosing money not only in trading water, but also in trading CO_2-certificates.

IV Simplified graphical representation of the TREC-DLR scenario with the crucial role of SMF.

The international network TREC (Trans-Mediterranean Renewable Energy Cooperation) and the German Aerospace Institute DLR have defined an ambitious scenario for establishing large quantities of solar thermal power stations including seawater desalination along the Southern coasts the Mediterranean, the Red Sea, the Gulf, etc. Ref.4. The first generations of CSP plants will deliver electricity to the local grids. Following generations will generate electricity for the European market. The International Solar Mobilization Fund can play an important role in creating the favorite conditions for financing the CSP pants, especially in the first two decades from now.

The figures 3-5 show representative examples of CSP-desalination plants in the Middle East and North Africa and the monetary flows for the delivery of electricity and the payments of interest and dividend. Not shown are the payments that are related to the delivery of water, selling of CO_2 emission rights, taxes, insurance premiums, etc.

A. Systematics.

The "Utilities" are paying the Solar Mobilization Fund for the electricity which they obtain from the "Projects". The prices are equal to the local, commercial prices. The "Utilities" A, D, E, and G are located in countries where most of the electricity is generated from burning oil and gas. These fuels are becoming more and more scarce, resulting in a gradual increase of the commercial electricity price, from 6 cents/kWh in 2010 to 6.4 cents in 2020 and finally 7.5 cents in 2030. The "Utilities" B and C are located in countries where most of the electricity is generated from burning coal. Coal is cheaper than oil, and less scarce, so in this simplified scenario the commercial price for electricity is assumed to stay constant at 4 cents/kWh.

The production costs of CSP-desalination plants depend on two factors: the amount of sunshine, given by the parameter DNI, and the year of construction. Like any technology in its starting-up phase the costs of CSP will decrease rapidly due to increased experience, increased competition and more optimal scale effects. In the figures 3-5 we show this effect in the costs during the first 20 years of the "Projects" a, c, d, f, g, and h. All these "Projects" have equal solar conditions, DNI = 2500 kWh/m^3/year. The costs decrease from 8 cent/kWh in 2008, via 6 cents in 2014 to 4.5 cents in 2024. When the debts to the banks and the investors are fully paid, after 20 years, these costs decrease considerably

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B. The situation in 2010.

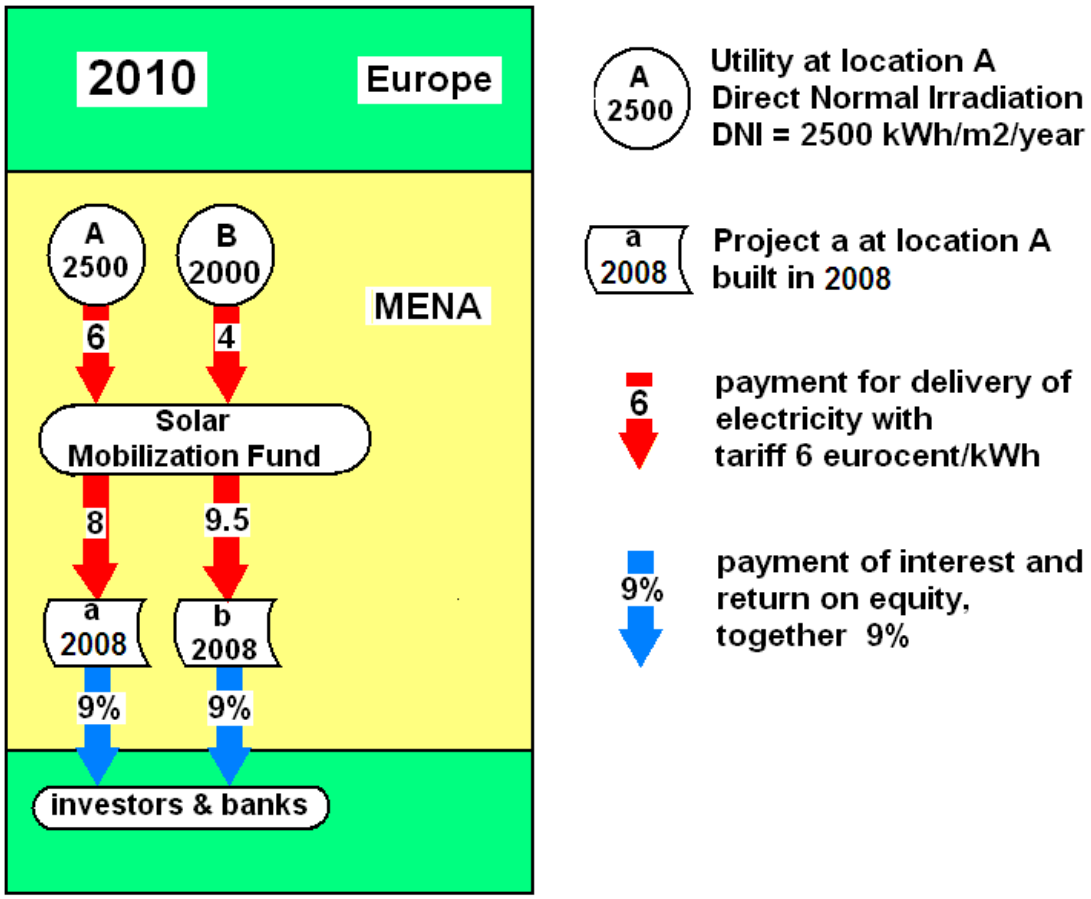

Figure 3.
The situation in 2010.

Project a receives more solar radiation than Project b, therefore the production costs are lower for a than for b. The electricity market in the country A is dominated by oil and gas; the market in B is dominated by coal. Therefore the commercial electricity price is higher in A than in B. The SMF compensates for these effects, giving both projects an equal, fair chance.

C. The situation in 2020

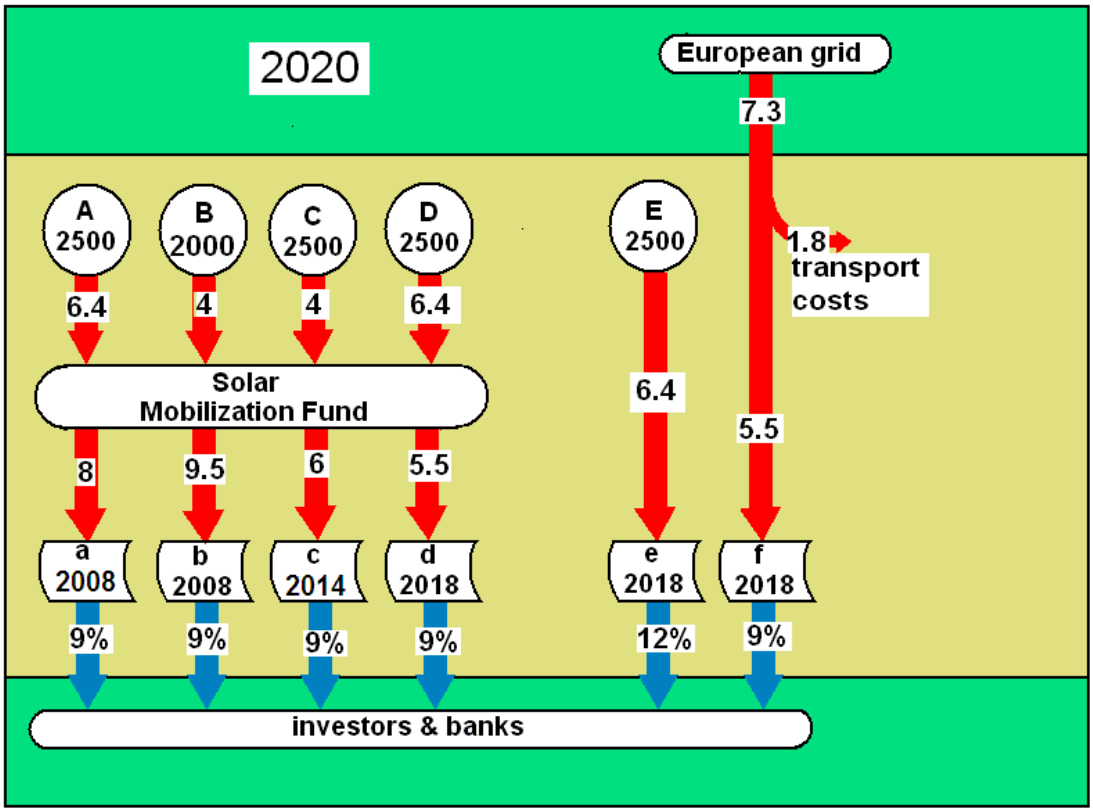

Figure 4.
The situation in 2020

In 2018 the projects d and e made different choices. Project d chooses for stability and low profits, whereas e choose for adventure by dealing directly with Utility E. Because of the greater risk, e has to pay a higher rate of interest, but is compensated for these higher costs by the higher price for the delivered current. Project f is exporting electricity to an European grid regulator by means of a long term power purchase contract, which is considered to have a low risk for the investors and the banks. Therefore the interest rate is low. Project f sells water to SMF (not shown in the figure). Because of the transport costs (losses included), the European grid regulator has to pay 1.8 €ct/kWh more than f is receiving.

D. The situation in 2030

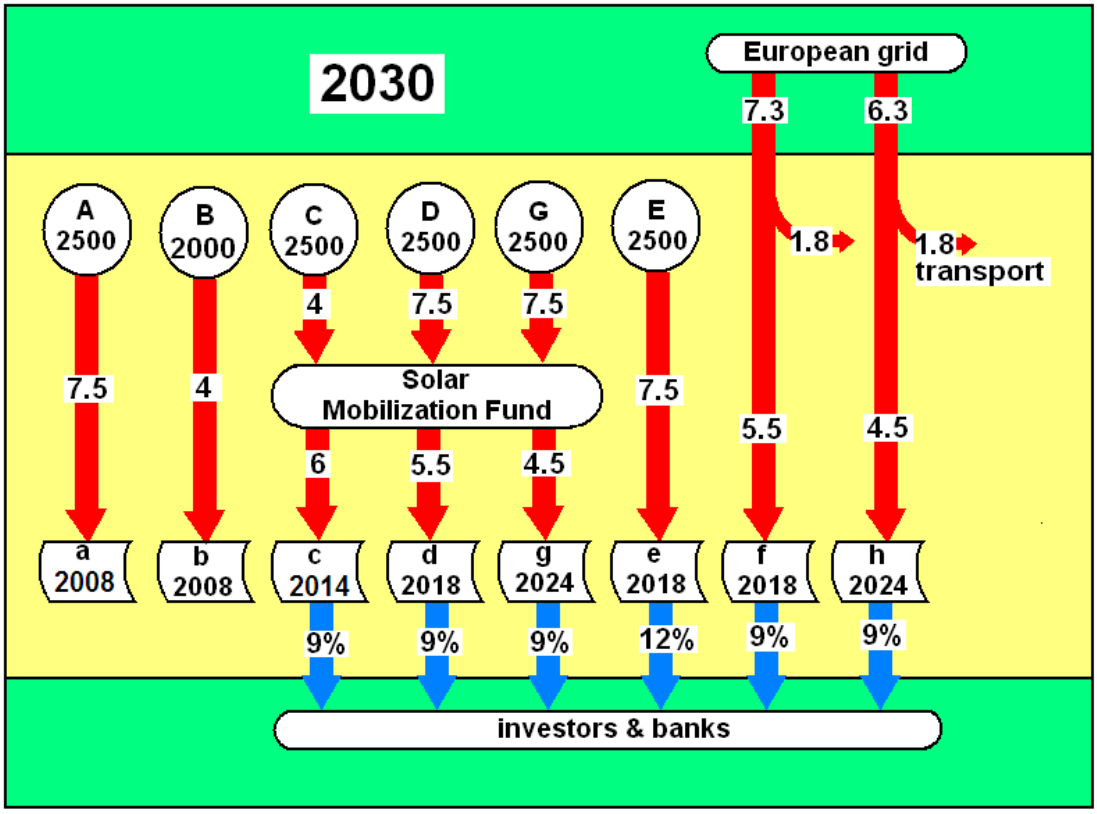

Figure 5.
The situation in 2030

New projects decided to deal with SMF, like g, or to deal with Europe, like h, or to deal with a utility (not shown). The projects a and b are amortized in 2028. In 2030 these projects have very low costs and are making big profits by dealing directly with the Utilities.

E. The viewpoint of the SMF.

In 2010 the Solar Mobilization Fund is making loss on all projects. In 2020 the fund is dealing with the maximum number of Projects; a, b, and c are causing losses, but Project d is causing profit for the SMF. In 2030 the SMF is becoming less important. Project c is causing loss, but the Projects d and g are causing profit.

V. The International Governmental Solar-Energy Conference (IGSEC)

Europe has not sufficient sources of energy on its own soil. North Africa and the Middle East (the MENA-region) have unlimited amounts of solar energy. When both regions start to cooperate with respect to solar energy, many economical (and therefore political) problems can be solved:

- The shortage of water in MENA
- The future shortage of energy in Europe and in MENA
- The unemployment problem in MENA (a huge labor force is needed in MENA, producing mirrors etc., building power stations, and operating them)
- The global climate problem and the global energy problem (other continents will copy a successful development in MENA, leading to a solar world economy)

This cooperation should start at an international conference were European governments and the European Commission assemble with governments from North-African and Middle-East countries. The sole subject of the conference should be the implementation of big-scale solar-energy plants combined with desalination, using CSP technology. The two main concrete points of the conference are:

- The establishment of the Solar Mobilization Fund (SMF)
- The financing of large Solar Water Projects, solving acute shortages of water in for instance Sana'a (Yemen) and Gaza (Palestine), Ref.3.

The European countries have to start a co-operation with countries that have been hostile in the past. Such cooperation is a big challenge, comparable to the cooperation between Germany and France after centuries of warfare. That cooperation started in the fifties of the last century with the European Community for Coal and Steel, which concerned energy too.

VI.Conclusions.

We experience we know that the feed-in system for stimulating investments in renewable sources of energy can be very succesfull. However, many countries having a favorable climate for exploitation of solar thermal power plans cannot afford yet to pay the still rather high prices of solar electricity. Most countries in North-Africa and the Middle-East (MENA) belong to this cathegory. It is, however, in the interest of Europe that massive investments in CSP plants are made in these countries, because in the future a large fraction of the electricity in Europe will be generated in solar thermal power plants in these countries. The International Solar Mobilization Fund (SMF) creates the stable and secure economical conditions that are necessary to attract massive private capital investments in countries that are considered to be risky. An international conference should be organized, in which countries from Europe and

MENA and the European Commission establish the International Solar Mobilization Fund and garantee its working capital.

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Note 1:
All prices in this paper, coming mainly from the DLR-TREC-scenario, Ref.4, are indicative only as they depend on many factors that are not dealt with in this document. That is why we do not specify whether we are dealing with dollar cents or euro cents. The purpose of the figures is to demonstrate certain economical systematics and the beneficial role of SMF for the market introduction of solar power.

Note 2:
Trading in CO_2-certificates does not play an essential role for SMF. In the unfortunate case that the CDM turns out not to be continued after 2012 the SMF remains an important tool in the transition towards a solar world economy.