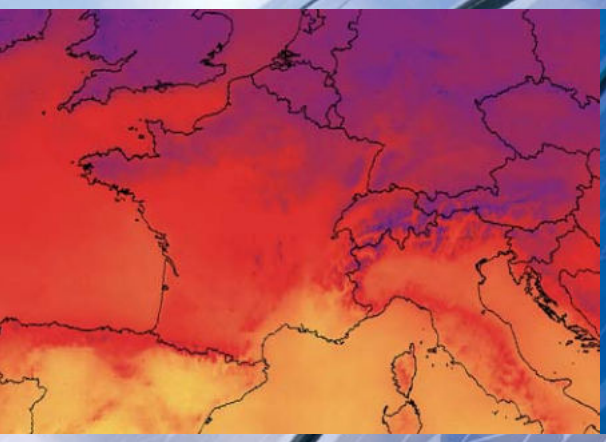


ENVI SOLAR

SPACE-BASED ENVIRONMENTAL INFORMATION FOR SOLAR ENERGY INDUSTRIES

EARTH OBSERVATION MARKET DEVELOPMENT

esa

ENVI
SOLAR

Contents

Preface

ENVISOLAR aims to increase the use of satellite based solar radiation information for the solar energy sector. Solar energy technologies are currently turning from an idealistically driven to a financially driven market. Therefore, investment assurance and the integration of a larger share of solar energy in the electricity grid is necessary. Exact knowledge about the varying solar resource can be derived from earth observation.

ENVISOLAR services provide the required support in different areas:

Services for Investment Decision

Site assessment allows the investor to find the best site for a planned power plant and to optimise the financial yield. The financing of solar power plants is based largely on loans, and financial institutes and insurers expect precise audits in the planning stage.

Services for Plant Management

Plant monitoring of individual solar power plants assures good benefit from the investment. To meet different demands, the scale of service varies. Small solar energy systems need low cost monitoring with a performance check while large solar energy systems need detailed monitoring with automatic fault detection routines.

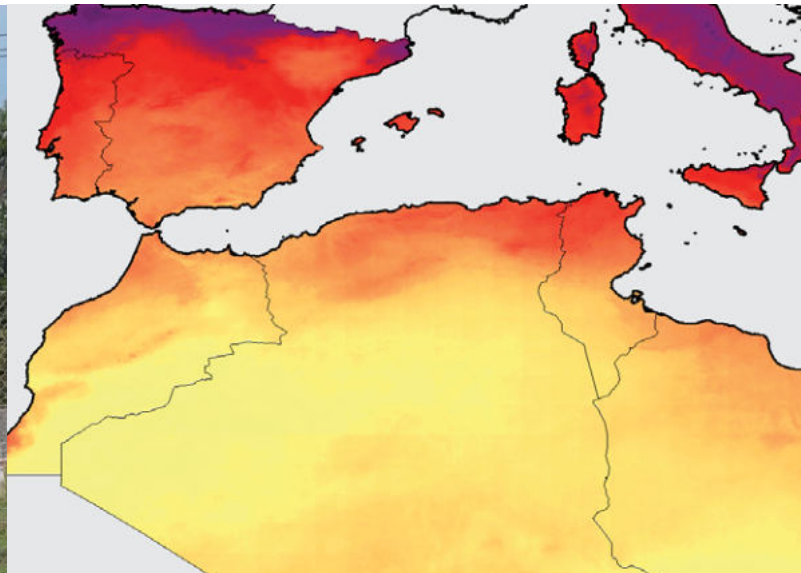
Services for Utilities

Both energy supply and demand require information on the solar resource. Scheduling of large power plants needs precise knowledge of the expected load. Besides temperature, irradiance is the major environmental influence on electricity demand.

On the supply side electric power transmission systems collect power from conventional plants as well as from different renewable sources like solar PV plants and deliver it to the final users. A fundamental aspect in managing such a complex grid system is an accurate forecast of the solar power generated.

Time-Series Services for Science and Consulting

Time series, maps and statistics of irradiance, including its direct, diffuse and spectral components (e.g. illumination) are provided to planners, architects and scientists.

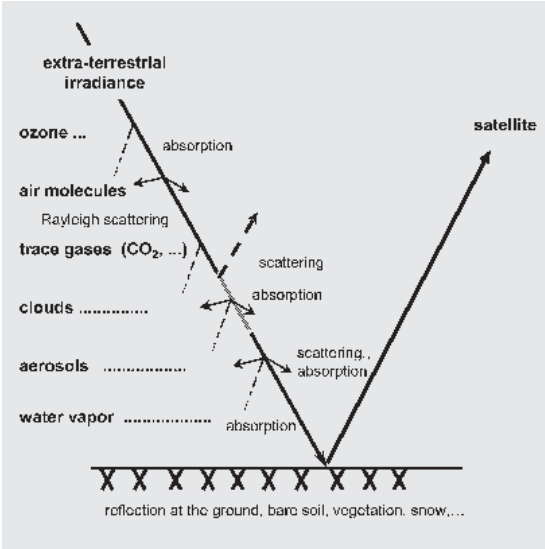


Satellite use

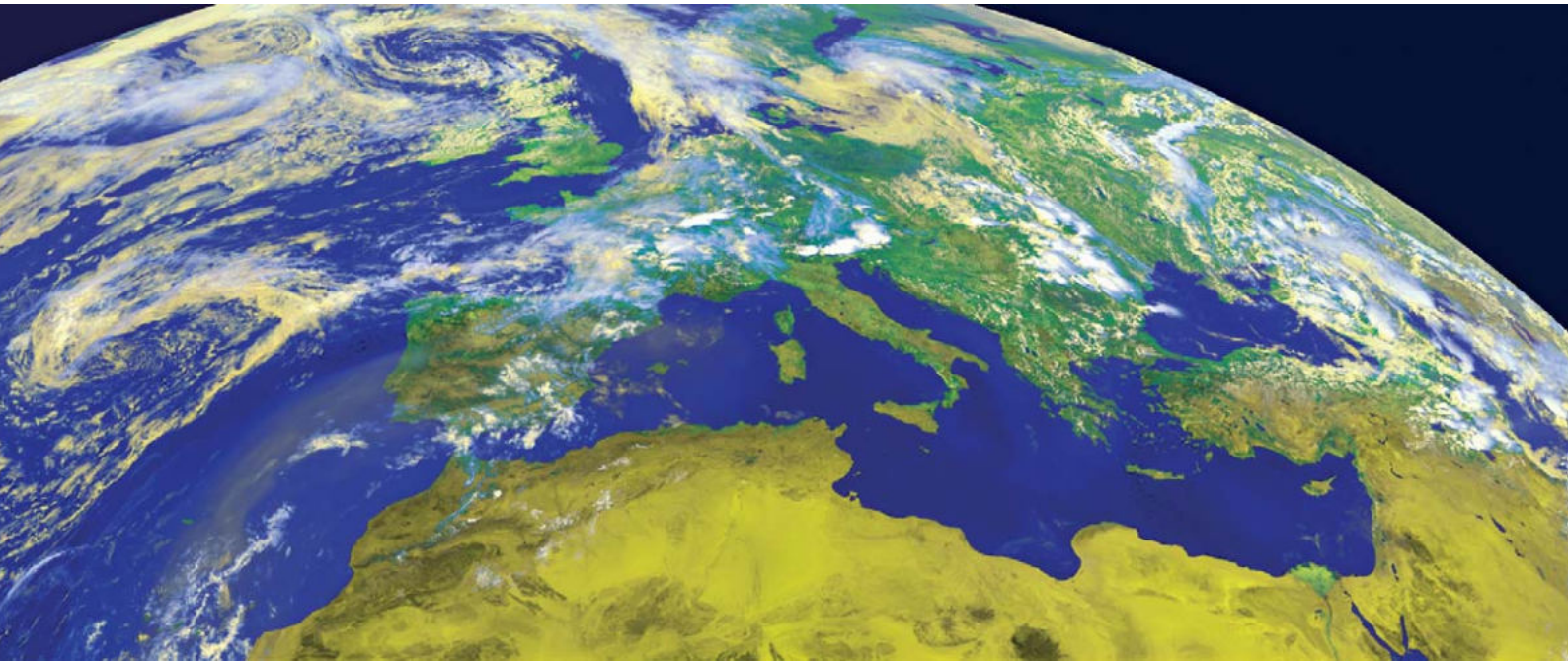
Basic information for the solar energy market is the amount of solar radiation. Global, diffuse and direct irradiance are needed, and spectral distribution of irradiance will be required in future.

An important function of meteorological satellites such as METEOSAT is detecting cloud fields and monitoring their evolution in time over extended regions of the world. Clouds being the main modulator of daily and hourly solar irradiance, it is obvious that radiance measurements from space are a unique data source for geographically continuous assessments of the solar resource at the earth's surface.

In addition to cloud information, detailed knowledge about atmospheric parameters like aerosols particles, water vapour, trace gases and air molecules involved in scattering and absorption of sunlight is a further necessity. Such information is taken from climatologies, atmospheric modeling, or atmospheric satellite measurements.

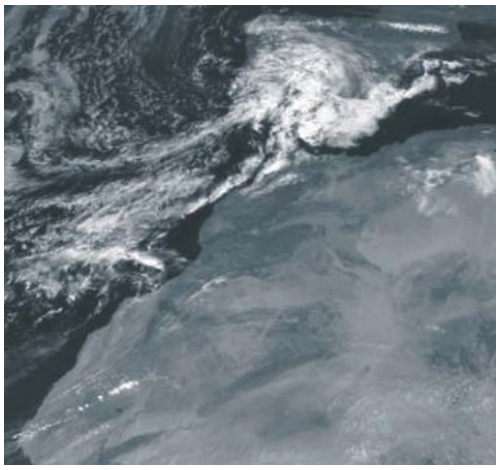


Extinction processes in the atmosphere



Clouds and aerosols as seen from the METEOSAT satellite series on 23 July 2004, 12:00 UTC, DLR/EUMETSAT

Principle of satellite retrieval



Visible channel METEOSAT image

Satellite raw data from METEOSAT satellites are used to derive reference values representative for cloud-free surfaces for each location in the satellite image. Clouds have maximum reflectivity, while the ground shows minimum reflectivity.

The cloud index is a measure of cloudiness. It is calculated as the difference between the actual satellite image and the cloud-free reference image derived above.

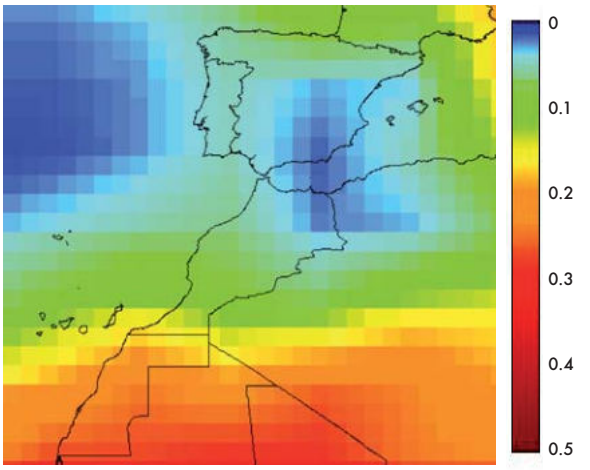
The clear sky index describes the transmission through the atmosphere. Atmospheric extinction through aerosols and water vapour is needed as auxiliary information.

Aerosols reduce direct irradiance through scattering and absorption processes, while water vapour absorbs parts of the extraterrestrial incoming solar radiation.

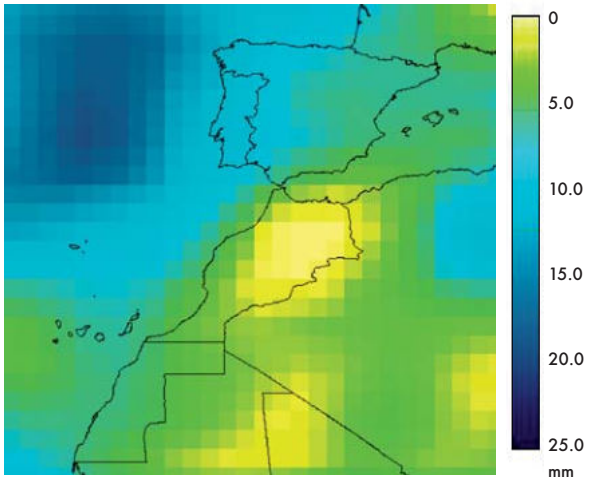
Finally, irradiance at the surface is calculated based on the principles of radiative transfer in the atmosphere.

Results of the radiative transfer calculation can be the direct, diffuse, global and spectral components of the irradiance.

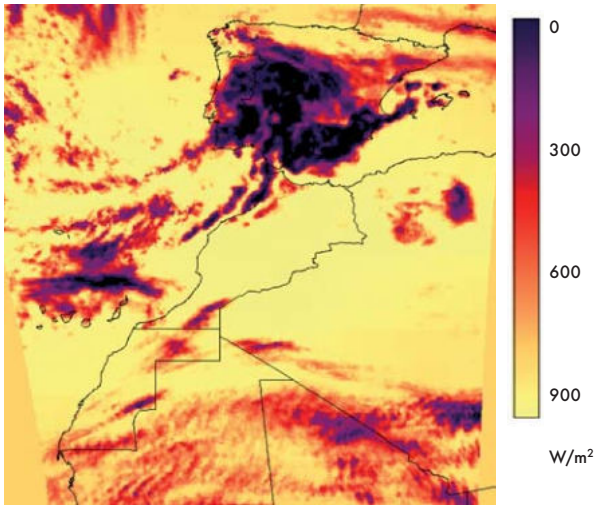
Spatial resolution up to one kilometre and temporal resolution up to 15 minutes are possible.



Aerosol

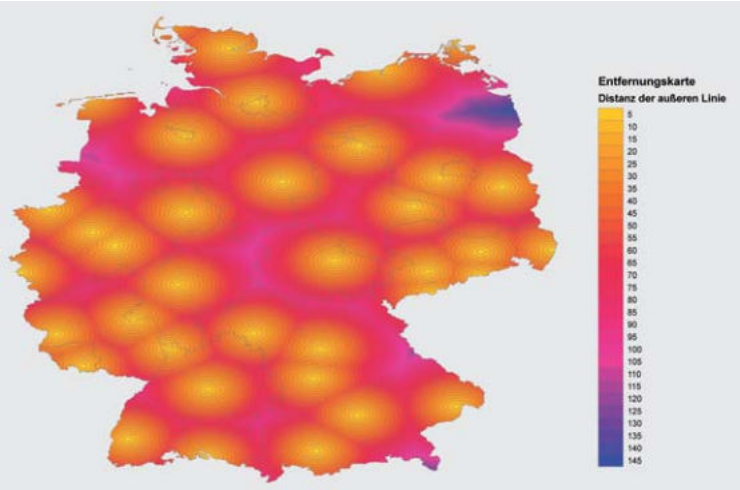


Water vapour



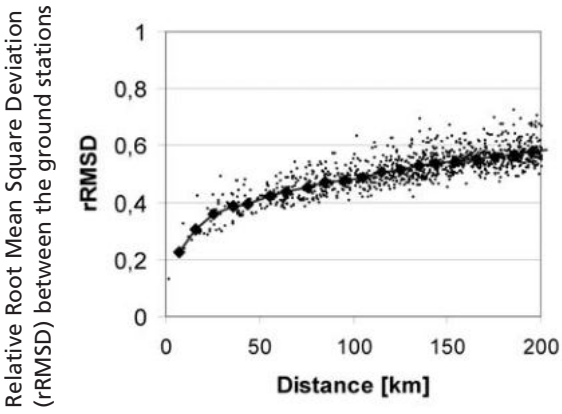
Direct normal irradiance

Accuracy of satellite-based irradiance values



Distance to the next DWD global irradiance measurement station in Germany.

Meteorological measurements are seldom near a solar system site, as the density of the meteorological network is rather low. In Germany, for example radiation data is only available at 42 weather stations of the Deutscher Wetterdienst (DWD). Having in mind the country's area of approx. 360 000 km² this means that on average 8 500 km² are represented by data from a single station. For many other countries this ratio is even worse. Therefore, it is necessary to use another information source with better spatial coverage. Satellites offer data with a high spatial resolution of a very few kilometres, which is therefore more representative for a specific location.



Variogram analysis for German weather stations for the period 1 Jan. – 31 Dec. 2005 using hourly global irradiance values

Satellite data is more accurate than ground measurements if the distance between site and weather station is more than about 20 km. This is shown by variogram analyses which assess the agreement between ground measurements as a function of distance between these ground measurements.

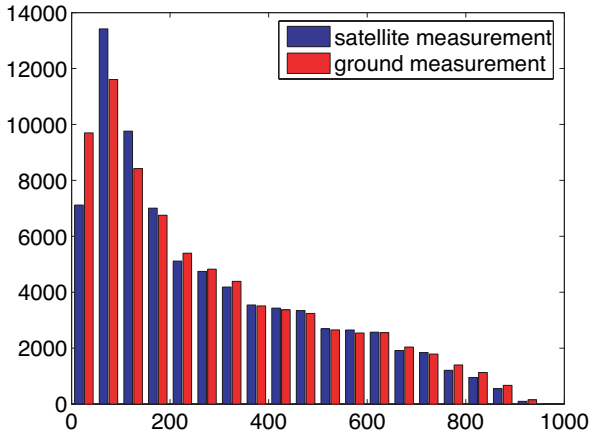
	hourly (RMSD)	daily (RMSD)	monthly values (RMSD)
Global irradiance	15-20%	~ 10 %	~ 5 %
Direct irradiance	~ 35 %	~ 20 %	~ 15 %

based on different validation studies in Germany, Switzerland, USA, Spain and Northern Africa

For many solar applications like photovoltaic power grid interaction studies or larger solar energy systems, pinpoint irradiance reading is much less relevant than irradiance integrated over a pixel-size ground area (e.g., 5x5 km). Satellite data may thus prove considerably more useful and accurate than the conventional 15-20% RMSD estimate for hourly values might suggest.

Frequency distribution of hourly global irradiance values

For solar energy technical simulations, hourly irradiance data with a correct frequency distribution are needed as a basis for accurate technology simulations. A comparison of the frequency distribution of hourly global irradiance measured from ground measurements in Germany in 2005 and from METEOSAT satellites shows good agreement for all global irradiance values.



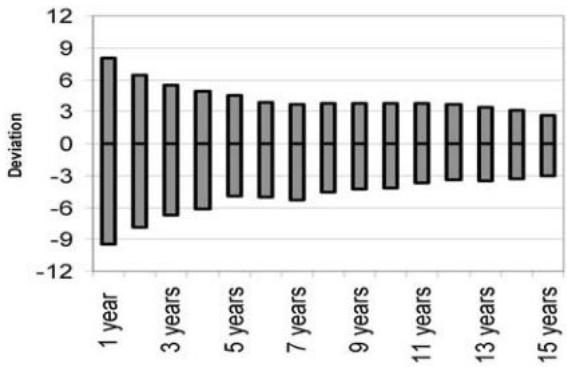
Frequency and global irradiance in W/m²

Long term variability of yearly means

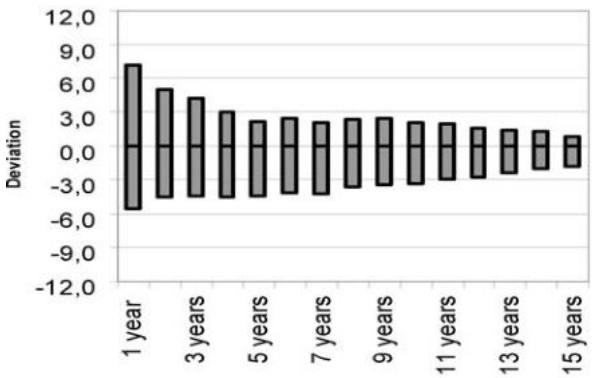
In solar power plant project development, ground-based irradiance measurements for a location of interest are typically taken over a 1-2 year duration. Due to natural variability in local climate conditions, the question arises whether the measured year is a typical year. For the few existing ground stations with long term measurement time series this question can be adressed. The annual mean can be calculated for different numbers of years. The variablitity of e.g. the annual mean in 1995-2000 and 1996-2001 etc. can be compared.

It turns out that for the Freiburg (Germany) case, an average of at least five years is needed to be sure to be within ±5% of the long term average, while in Madrid, Spain, a 3 year mean already reaches this level.

Having up to 20 years of satellite measurements allows a similar analysis for each location within the satellite field of view.



Deviation in % of yearly mean global irradiance derived from time series of different lengths for Freiburg, Germany



Deviation in % of yearly mean global irradiance derived from time series of different lengths for Madrid, Spain

Services for Investment Decision

Premium Site Audit for large solar power plants

Photovoltaic system "Petersen Allpa" (Germany) planned on the basis of premium site audits, source Enecolo AG

Site analysis and optimisation allows finding the best site for a planned power plant. Two types of data are needed. Maps of the average long term radiation are used to find suitable sites. If a site is found, time series are needed for the power plant design. For small systems monthly values are often sufficient; for larger systems hourly time series for detailed simulations are needed.

Premium site audits are done mainly for large solar plants and consist of an individually and manually performed audit. Input data for such an audit are satellite-based time series of the solar resource (direct or global surface irradiance, up to 20 years of data in up to hourly resolution) together with local surface conditions (e.g. surface orientation and albedo) and technological information for the solar system planned.

MINES PARIS ParisTech

CARL VON OSSIETZKY universität OLDENBURG

enecolo energy ecology

mc meteo control Energy & Weather Service

Services for Investment Decision

User feedback

S.A.G. Solarstrom AG is a large German solar energy enterprise quoted on the stock market. The company builds and operates photovoltaic installations of different sizes and provides entire financial investments in photovoltaics to its customers.

Dr. Benedikt Ortmann, Chief Financial Officer of the company, stated, "Looking at our huge investment we have to be sure that we minimize the risk. Solid solar radiation is the basis for that."

Uwe Ilgeman, Chief Executive Officer, stated that he cannot set satellite-derived data aside when building and operating systems. "Especially with regard to the future markets like Spain, we need solid information for investment decisions. The resolution of ground-based data is too coarse – for example, in Spain only 30 sites are available at the moment. Here, satellite derived data could help a lot."

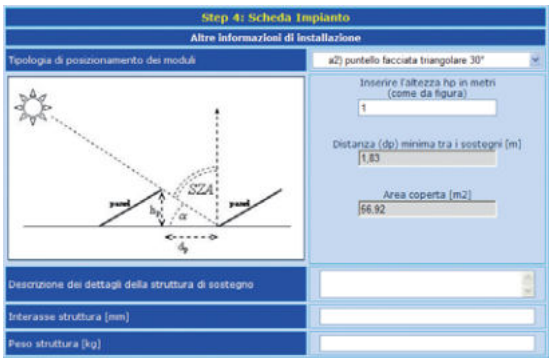
PV system "UBS Genf" operated by Edisun Power AG, source Enecolo AG

PV system "Jasminweg" in Zürich, operated by Edisun Power AG, source Enecolo AG

Edisun Power AG, the largest contractor of PV plants in Switzerland, orders site evaluations based on earth observation data. Site evaluations for PV systems are of high importance for the investor, as the location is one of the factors that decides about the profit or loss of a PV plant. Before irradiance values from satellite were available, reliable yield estimations for many regions remained wishful thinking as no irradiation information was available. Robert Kröni, director of the contracting company Edisun Power AG confirms: "The comparison with existing PV installations, the best source for site evaluation, is only available for regions where the contractor has already a sufficient number of PV installations. When a new market is opened, this source is not available, as usually PV operators do not publish their production values. We are now expanding into countries like Germany, Italy and Spain where we have no operation experiences. It is planned to invest in 1 to 2 MWp every year, which means investment costs of about 5 to 12 million euros. To assure the returns on these investments we must be sure that we build the PV systems at locations with enough solar radiation. Therefore, we need satellite derived irradiance data."

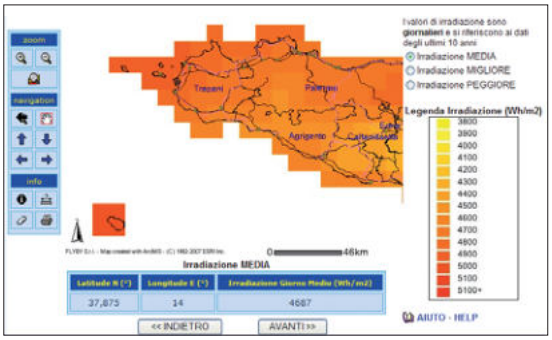
Services for Investment Decision

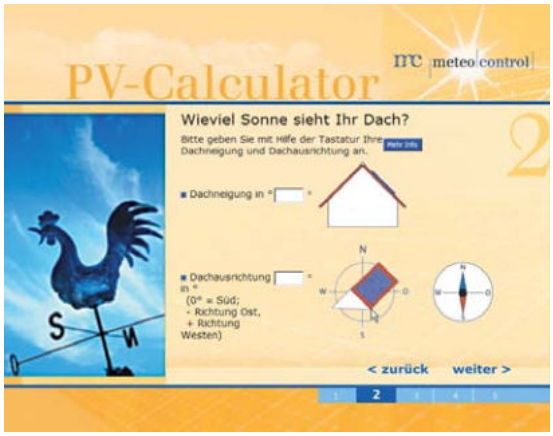
Solar' Webservice and SolarSAT PV-Planner



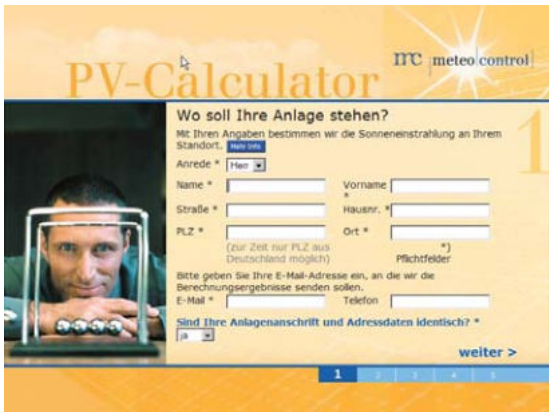
Example of SolarSAT
PV-Planner as operated for Italy by Flyby

Also for the small solar energy systems market an estimate of the expected yield is required by the private investor to minimise the risk of investment and to compare the offers of different hardware suppliers. As the customer does not pay for this service at this stage of the selling process, the yield estimate has to be very cost effective. As the number of offers is high, access to this kind of yield estimation has to be easy and fast. Therefore, a web-service based yield estimation is used, which offers a cost-effective and automatic way to estimate the expected yield for smaller plants.





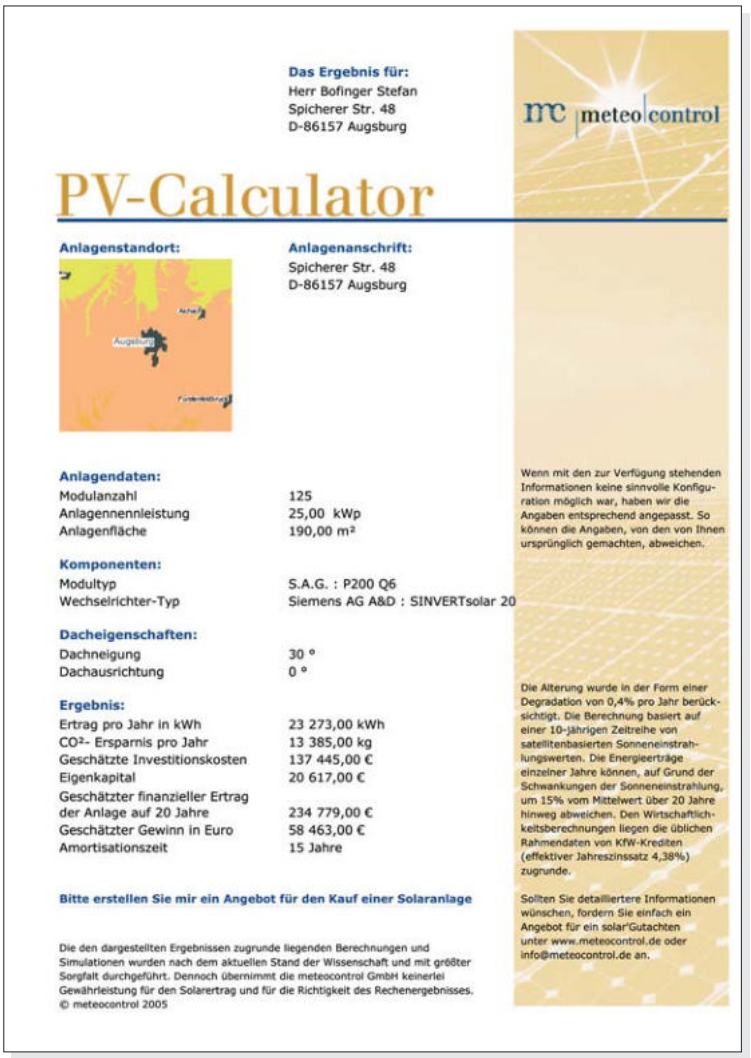
The PV-calculator web-based tool as operated by the company Meteocontrol



User feedback

Tau Solar with its office in Madrid, Spain, is specialised in building and operating PV installations and providing financial investments in photovoltaics to its customers. Jose Manuel de la Iglesia, general manager of Tau Solar states: "When we install photovoltaic plants, we need a solid and detailed report on the predicted energy yields at alternative sites in order to make the most profitable decision. The decision for an optimal site may differ from one kilometre to another. Therefore, we need very detailed irradiation data for our calculations. Unfortunately, the Spanish database is very weak."

In Spain, no reliable irradiation database exists. The data available on the market may be one value for an entire region. Or data is derived from the average of too many values."There simply is no reliable database that provides us with precise data. With the irradiation data of Meteosat, we have found a goldmine. We get the most precise data, even in hourly resolution for every place in Spain. Furthermore, data is reliable as we are provided with long-term time series. We even may choose between global, diffuse and direct irradiation! There is no comparable irradiation database in Spain."



Das Ergebnis für:
Herr Bofinger Stefan
Spicherer Str. 48
D-86157 Augsburg

meteo|control

PV-Calculator

Anlagenstandort:

Anlagenanschrift:
Spicherer Str. 48
D-86157 Augsburg

Anlagendaten:

Modulanzahl	125
Anlagennennleistung	25,00 kWp
Anlagenfläche	190,00 m²

Komponenten:

Modultyp	S.A.G. : P200 Q6
Wechselrichter-Typ	Siemens AG A&D : SINVERTsolar 20

Dacheigenschaften:

Dachneigung	30 °
Dachausrichtung	0 °

Ergebnis:

Ertrag pro Jahr in kWh	23 273,00 kWh
CO^2- Ersparnis pro Jahr	13 385,00 kg
Geschätzte Investitionskosten	137 445,00 €
Eigenkapital	20 617,00 €
Geschätzter finanzieller Ertrag der Anlage auf 20 Jahre	234 779,00 €
Geschätzter Gewinn in Euro	58 463,00 €
Amortisationszeit	15 Jahre

Bitte erstellen Sie mir ein Angebot für den Kauf einer Solaranlage

Die den dargestellten Ergebnissen zugrunde liegenden Berechnungen und Simulationen wurden nach dem aktuellen Stand der Wissenschaft und mit größter Sorgfalt durchgeführt. Dennoch übernimmt die meteocontrol GmbH keinerlei Gewährleistung für den Solarertrag und für die Richtigkeit des Rechenergebnisses.
© meteocontrol 2005

Wenn mit den zur Verfügung stehenden Informationen keine sinnvolle Konfiguration möglich war, haben wir die Angaben entsprechend angepasst. So können die Angaben, von den von Ihnen ursprünglich gemachten, abweichen.

Die Alterung wurde in der Form einer Degradation von 0,4% pro Jahr berücksichtigt. Die Berechnung basiert auf einer 10-jährigen Zeitreihe von satellitenbasierten Sonneneinstrahlungswerten. Die Energieerträge einzelner Jahre können, auf Grund der Schwankungen der Sonneneinstrahlung, um 15% vom Mittelwert über 20 Jahre hinweg abweichen. Den Wirtschaftlichkeitsberechnungen liegen die üblichen Rahmendaten von KfW-Krediten (effektiver Jahreszinssatz 4,38%) zugrunde.

Sollten Sie detailliertere Informationen wünschen, fordern Sie einfach ein Angebot für ein solar'Gutachten unter www.meteocontrol.de oder info@meteocontrol.de an.

An example of the PV-Calculator output for a case in Germany.

S.A.G. Solarstrom

meteo|control
Energy & Weather Service

Services for Investment Decision

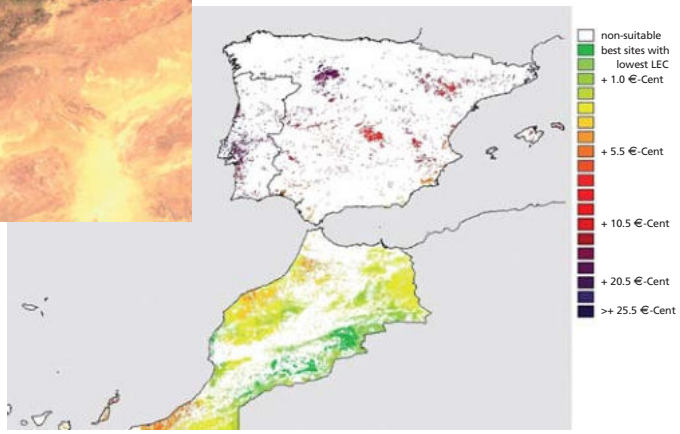
STEPS – a GIS based site assessment and analysis tool

Maps can be the basis for assessing the potential of solar technologies in larger regions, e.g. for governments if they want to support the market introduction of a technology or for investors to see if this region is interesting for them. In this case maps are processed in a Geographical Information System (GIS) together with such geological conditions as land use and slope information and available infrastructure databases such as feed-in points and existing power lines.

STEPS is used for two purposes: to assess potentials of solar technologies and to rank sites. For the first application, maps which exclude nonsuitable sites are created in a GIS. Exclusion criteria can be land cover, hydrography, protected areas, topography, etc. Areas where the solar resource derived from satellite information reaches the level required for technical or economical operation, are the basis for potential assessments. Depending on the level of the available resource, power production cost can also be estimated to find the most economical site.
GIS systems like the STEPS system have been used in e.g. in the MED-CSP study (Concentrating Solar Power for the Mediterranean Region) to asses the solar energy potential in Mediterranean countries. Maps of solar resources have been prepared for the SWERA (Solar and Wind Energy Resource Assessment) coordinated by UNEP.

Technical data of solar energy systems

Land features



Levelized cost of electricity production

Scheme of STEPS decision support tool

Geographical Information System (GIS)

↓

Earth Observation Data:
Land features
Solar irradiance (SOLEMI)

↓

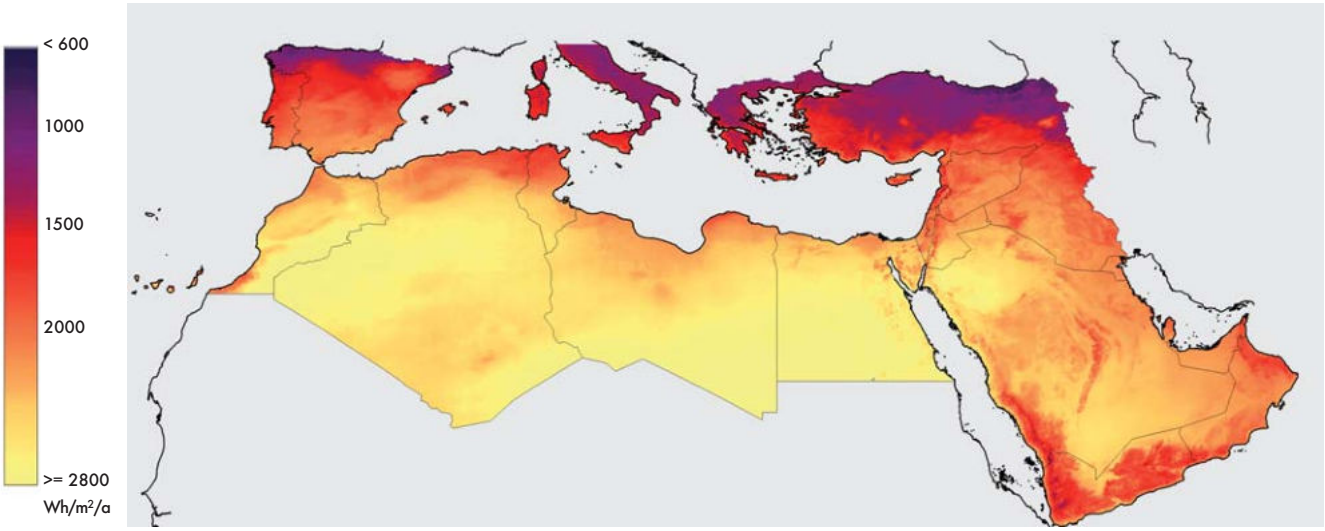
Geographical Analysis based on hourly meteorological data:
STEPS

Services for Investment Decision

User feedback

"In developing countries all over the world we have removed some of the uncertainty about the size and intensity of the solar and wind resource," said Klaus Toepfer, UNEP's Executive Director. "These countries need greatly expanded energy services to help in the fight against poverty and to power sustainable development. SWERA offers them the technical and policy assistance to capture the potential that renewable energy can offer," he said.
"As energy planners seek cleaner energy solutions using renewable energy technologies, the availability of reliable, accurate, and accessible solar and wind energy information is critical and can significantly accelerate the deployment of these technologies."
According to Klaus Toepfer, SWERA is a good example of international cooperation that can produce a range of positive environmental and social outcomes. "In the case of renewable energy," he concludes, "knowledge is literally power."

Gerhard Knies, the Trans-Mediterranean Renewable Energy Cooperation (TREC) coordinator: "I would like to inform you that the radiation maps for the MENA region are an important tool for the efforts of TREC to create interest in solar thermal power and desalination projects in the MENA region. The most recent case is our proposal for the Gaza Solar Water&Power Source, that TREC could present to the FORUM2000 conference in Prague on October 14th 2005, on water security in the Middle East, as a joint Egyptian-Palestinian project. Thanks to existing radiation and land-use maps we could demonstrate the virtues of an Egyptian-Palestinian cooperation for the feasibility of a solar desalination solution in terms of a combined power and water plant for reducing the Gaza-Israel conflict over traditional fresh water resources for Gaza."



Annual sum direct normal irradiance for 2002, source DLR

UNEP

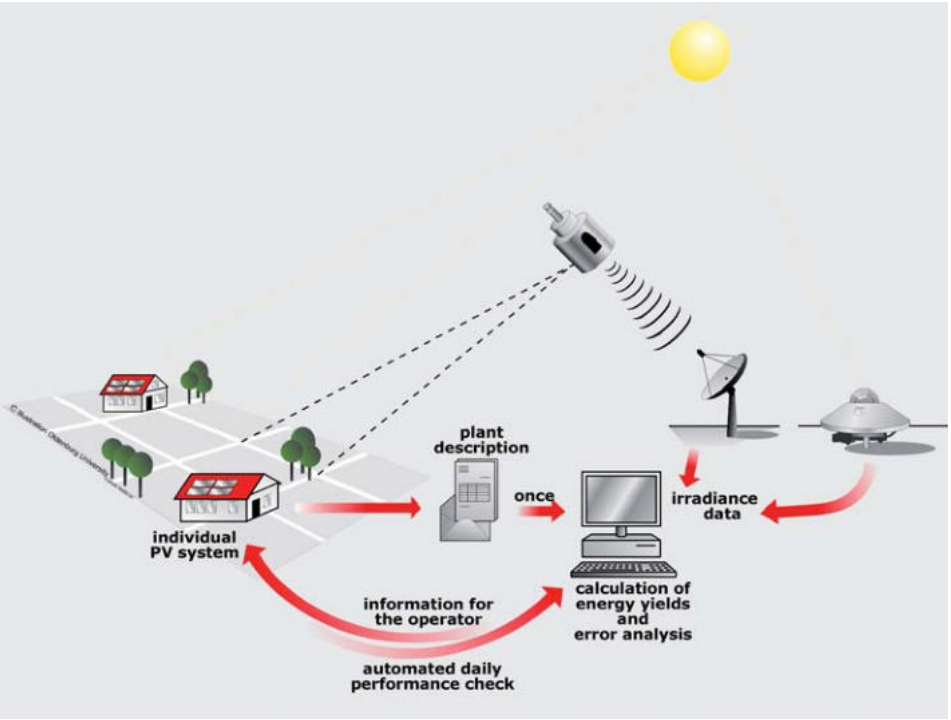
TREC
Clean Power from Deserts
Trans-Mediterranean
Renewable Energy Cooperation

Services for Plant Management

Safer'Sun, SolarSAT PV-Controller and SPYCE

Besides services for investment decision, a service line for plant management is needed once a solar energy system is built. It needs to cover two main aspects. Automatic fault detection and performance control allow reliable alarms and assure the validity of the investment, while a performance check for smaller plants gives first estimates of performance and failures. To meet different demands, the scale of service can vary. Smaller solar energy systems need low cost monitoring ("performance check"); large solar energy systems need detailed monitoring with automatic fault detection routines describing the probability of different error sources. Both services aim at a reduction of down time and fast ("automated") detection of faults.

The key to reliable performance checks is knowing the available solar radiation at the plant site. Satellite data offer a unique chance to receive the local solar radiation in near real time. Through comparison between the effective energy production and the corresponding solar energy at the array plane, the proper functioning of the solar power plant can be monitored in defined time intervals. This will usually be in daily intervals. Hourly values may be used for error analysis. In this case, the client will not only receive the message that the plant does not work properly; he also will receive an information about the possible reason for the malfunction. Among other benefits this reduces costs for repair.



Principle of satellite-based solar system monitoring as developed in the EU PVSAT-2 project, source Oldenburg University

MINES PARIS
ParisTech

enecolo
energy ecology

CARL VON OSSIETZKY universität OLDENBURG

mc meteo control
Energy & Weather Service

Services for Plant Management

User feedback

Robert Kröni from Edisun Power explains: "Plant monitoring is a crucial factor for the profitability of a PV plant. Although we put much effort into plant monitoring at the moment we assume that in case of a malfunction we may lose about 5-10% of the yearly energy yield of the PV plant. Early recognition and identification of malfunctions will help us to keep the yearly energy losses due to technical malfunctions below the current 1%."

Peter Toggweiler of Enecolo AG tells of their problems with plant monitoring: "As engineering consultants we're mandated to monitor more than 30 PV plants with a total installed power of about 2.5 MW. The PV plants are distributed all over Switzerland and the southern part of Germany. The PV plants differ widely in installed power, module types, inverters – and monitoring procedure. Most PV systems are provided with a device that allows connection to the inverter. But for each type of inverter, another software and data logger is needed and another type of data is provided. Some inverters give alarm via email or fax if they break down. And for most PV systems we receive the monthly energy yield via fax or email. All these data are then manually collected and analysed. This procedure is very time consuming and not effective. As we only receive monthly data, it can last in the worst case up to 31 days before we recognise a malfunction. Failures that don't lead to a complete outage but only to a minor reduction of the energy yield often are not detected at all or only after several months. At the moment we check the PV systems annually on site.
With the satellite-based service plant monitoring will be facilitated and more efficient: hourly data of the energy yield of the PV plant is automatically collected on the server and provided to the operators of the PV system on the Internet. Thus no time intensive manual collection of the data is necessary any more. The data is updated every day, so it is possible to detect malfunctions within one day instead of within one month."

Snow detection is needed to avoid false alarms in situations of snow cover.
Here an example of MODIS snow cover on 20 Dec. 2003 over the alps is given.
Copyright DLR

Services for Plant Management

Safer'Sun, SolarSAT PV-Controller and SPYCE

Example of SaferSun web portal, source Meteocontrol

Example of SPYCE portal, source Enecolo AG

Based on the earth observation and meteorological data input, the theoretical energy production is calculated using a simulation tool. The result of this estimate is then compared with the real production measured on site. As long as both values are within a defined error ratio, no further steps are initiated. The data are stored on a web server and they are permanently accessible to clients.

A fault detection routine analyzes the pattern of energy loss and creates a profile of the actual failure. This profile is compared with predefined profiles for such situations as string defect, shading, soiling, etc. Magnitude, duration, and structure of differences, as well as correlation with radiation, temperature, and time of day are taken into consideration in order to determine the type of failure. Depending on the degree of correlation between actual and predefined failure profile, the likelihood of different failure causes can be derived. Then the owner and/or operator of the system can be informed about the reason for the detected malfunction of the PV system.

Today approx. 6 000 PV plants with a total installed power of about 300 MWp are monitored by the consortium members.

applied research solutions
Flyby

enecolo
energy ecology

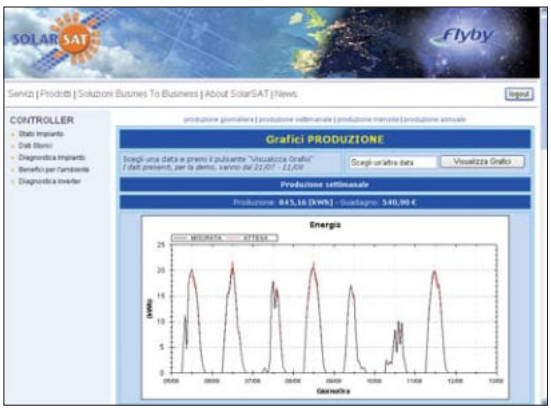
meteo control
Energy & Weather Service

User feedback

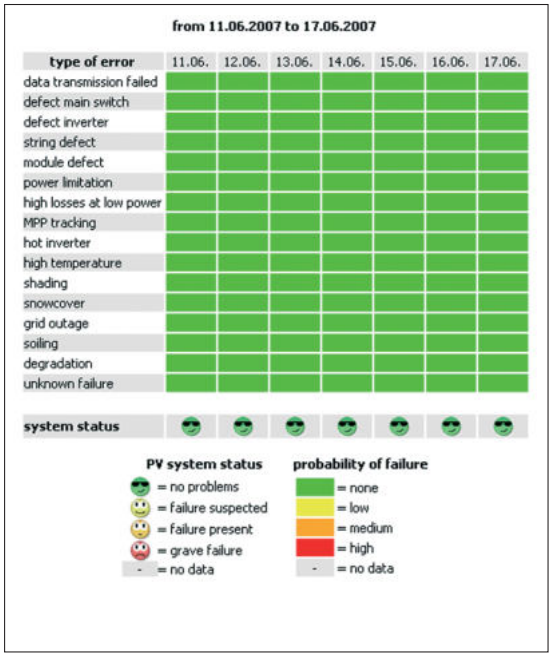
Enel SpA is the Italian market leader for energy production and distribution.

In the solar photovoltaic plant field, Enel is present with a commercial company – Enel.Si – covering about 30% of the market and selling PV plants in more than 300 shops distributed all over Italy.

Mr. Riccardo Felicioli – responsible for Enel.Si – says: "The exploitation of the satellite network of the European Space Agency allows for the check of a PV plant, assessing whether the plant is working at its maximum performance or not, i.e. whether or not it is exploiting the whole solar energy available at that moment. This allows us to operate the PV plant practically in real time to obtain the best results."
(source: Corriere delle Comunicazioni – 15th Jan. 2007)



Example of SolarSAT PV-Controller, source Flyby



from 11.06.2007 to 17.06.2007

type of error	11.06.	12.06.	13.06.	14.06.	15.06.	16.06.	17.06.
data transmission failed							
defect main switch							
defect inverter							
string defect							
module defect							
power limitation							
high losses at low power							
MPP tracking							
hot inverter							
high temperature							
shading							
snowcover							
grid outage							
soiling							
degradation							
unknown failure							
system status							

PV system status	probability of failure
= no problems	= none
= failure suspected	= low
= failure present	= medium
= grave failure	= high
- = no data	- = no data

Typical SPYCE output with automatic error detection, source Enecolo AG

Enel.si
L'ENERGIA CHE TI ASCOLTA.

Services for Utilities

Weather Portal for load and solar yield forecasting

ECMWF Forecast

↓

MOS for Weather Stations

↓

Spatial Interpolation

↓

Simulation for PV Systems

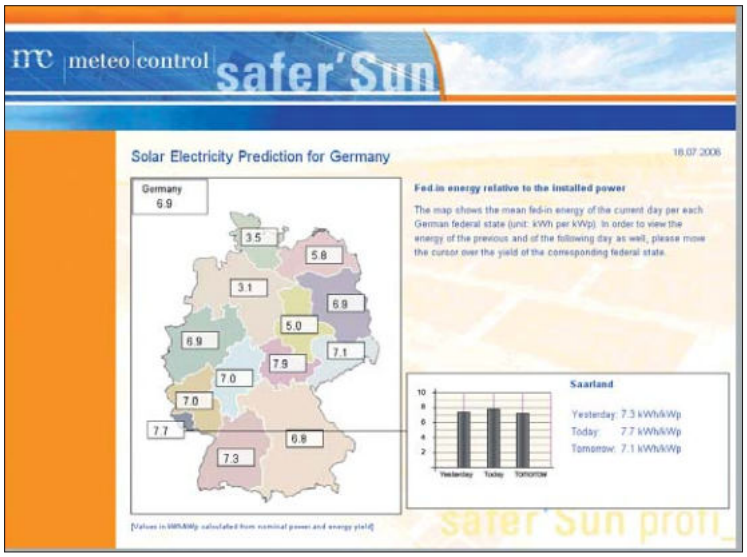
↓

Energy Yield per System

Forecast flow as operated by the company Meteocontrol

Another emerging market for the use of earth observation is forecasting the electricity load for electric utilities. Both, scheduling of power plants and overall grid management needs precise knowledge of the load. Because of liberalised markets a highly accurate load forecast is necessary to achieve good prices in energy spot markets. Besides temperature, irradiance has a major environmental influence of up to 10% on electricity demand.

Just as load is to be forecasted, solar irradiance needs to be forecasted. Currently, this is done using model output statistics based on numerical weather prediction. Satellite-based irradiance values from the previous day are used as input for these model output statistics besides other parameters.



Example of solar electricity prediction forecast for the current day.
Mean fed-in energy of the current day per each German federal state in kWh per kWp.

CARL VON OSSIETZKY universität OLDENBURG

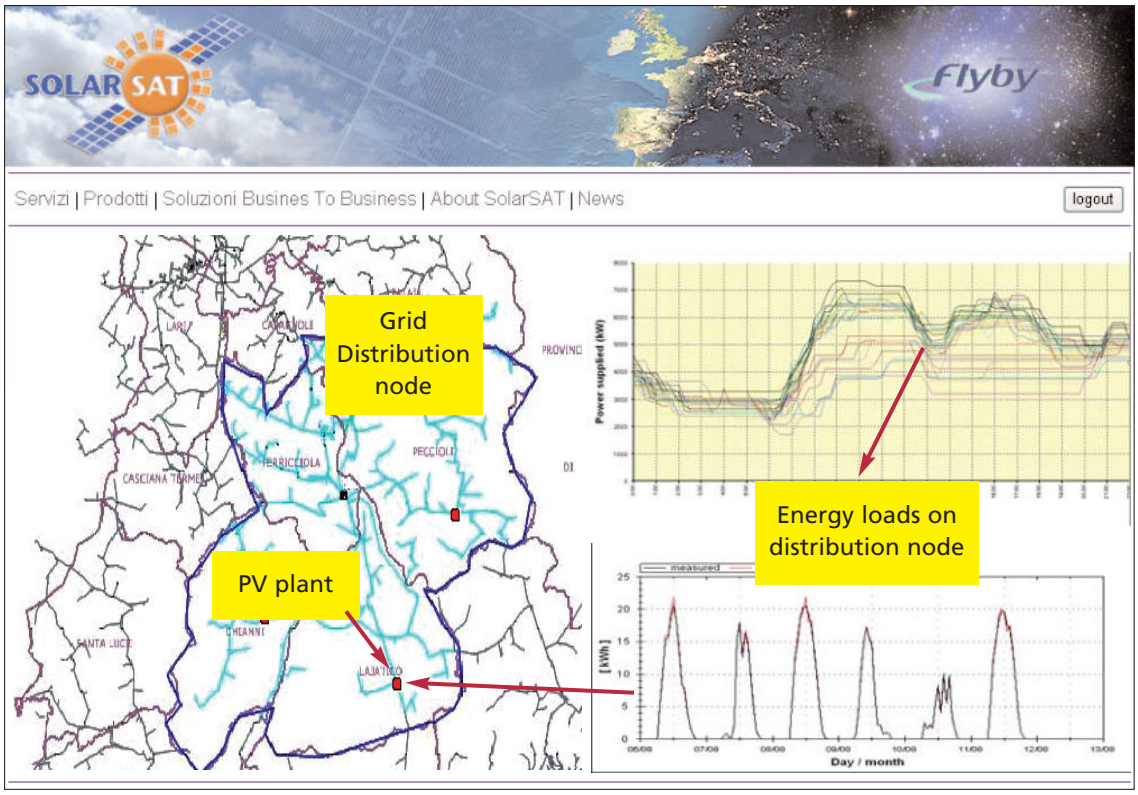
meteo control
Energy & Weather Service

Services for Utilities

SolarSAT GridManager for nowcasting solar yield

Electric power transmission systems collect power from conventional plants as well as from different renewable sources like solar PV plants and deliver it to the final users.
At the same time, they collect electrical power produced by the final users themselves, e.g., from industries and private households equipped with small-scale generation plants, as is, on a small scale, already occurring in several European countries.
The combination of public and small-scale private generation units and the ongoing European integration of regional electricity grids requires more and more sophisticated management in order to achieve higher reliability and efficiency.
Fundamental aspects for the management of such complex grid systems are accurate forecast of electrical load and of the power generated by the renewable energy supply systems, and decentralized control and management.

The SolarSAT GridManager service provides real time energy assessment for verifying of the effective status of PV plants connected on grid in a given geographical region. It also delivers nowcasting of the energy balance (consumption with respect to delivery) for a given area of the grid, taking into account the users' energy needs and the nowcasted atmospheric and solar cell operating conditions.



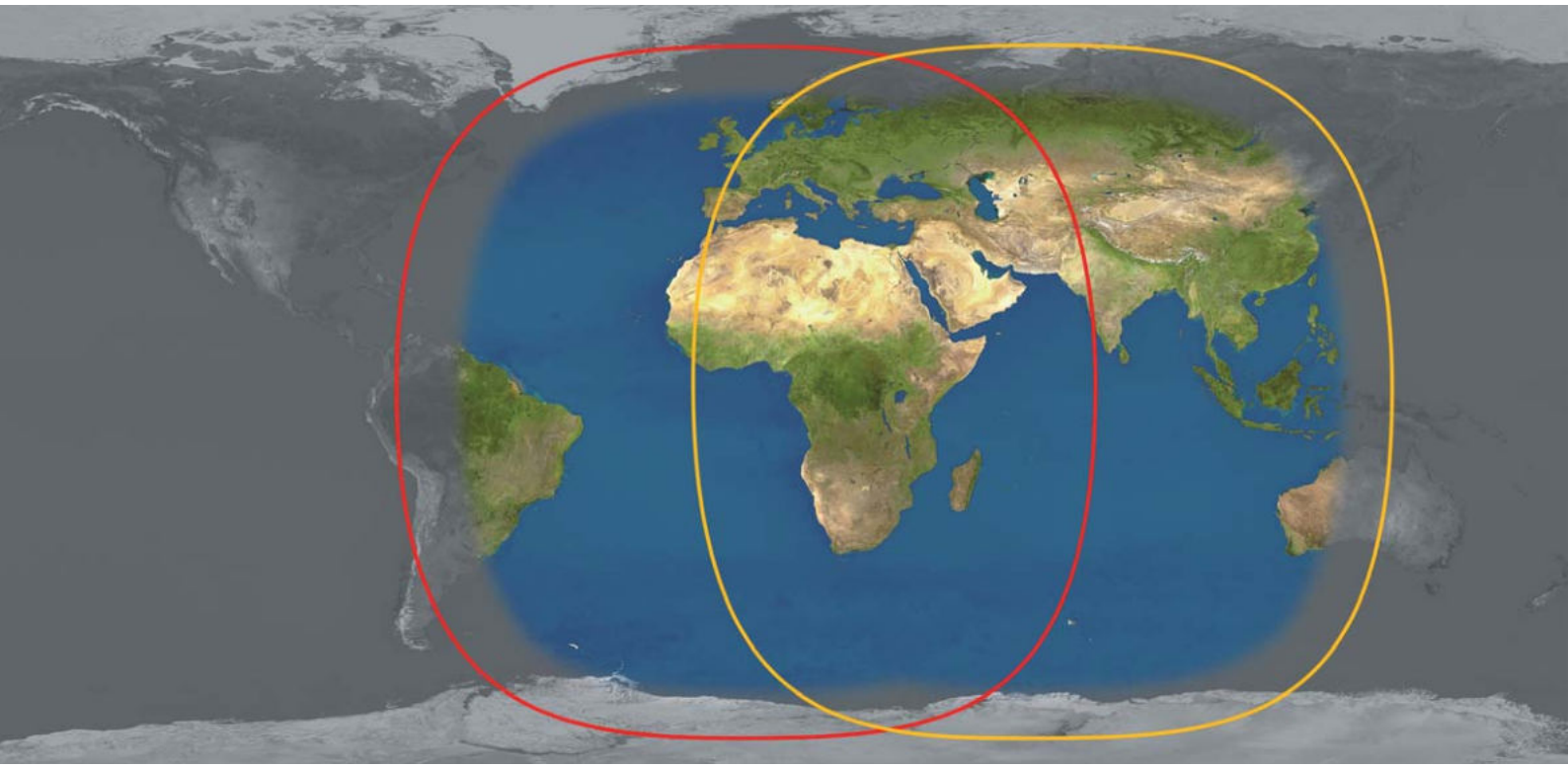
Sample page from the SolarSAT GridManager website

Services for Science and Consulting

SOLEMI for irradiance time series

Time series are used to calculate the expected yield from solar thermal and photovoltaic power plants. Furthermore they can be used to estimate light and heat within buildings for architectural purposes. Time series are a semifinished product on which other products build but there is also a market for raw time series. In general, planners, architects and scientists are the key customers for this sector.

The SOLEMI services provides time series in hourly resolution and at a spatial resolution of up to 2.5 km with a time series extending up to 20 years over Europe, Africa and the Middle East. Asia is also covered with a time series of up to 8 years.



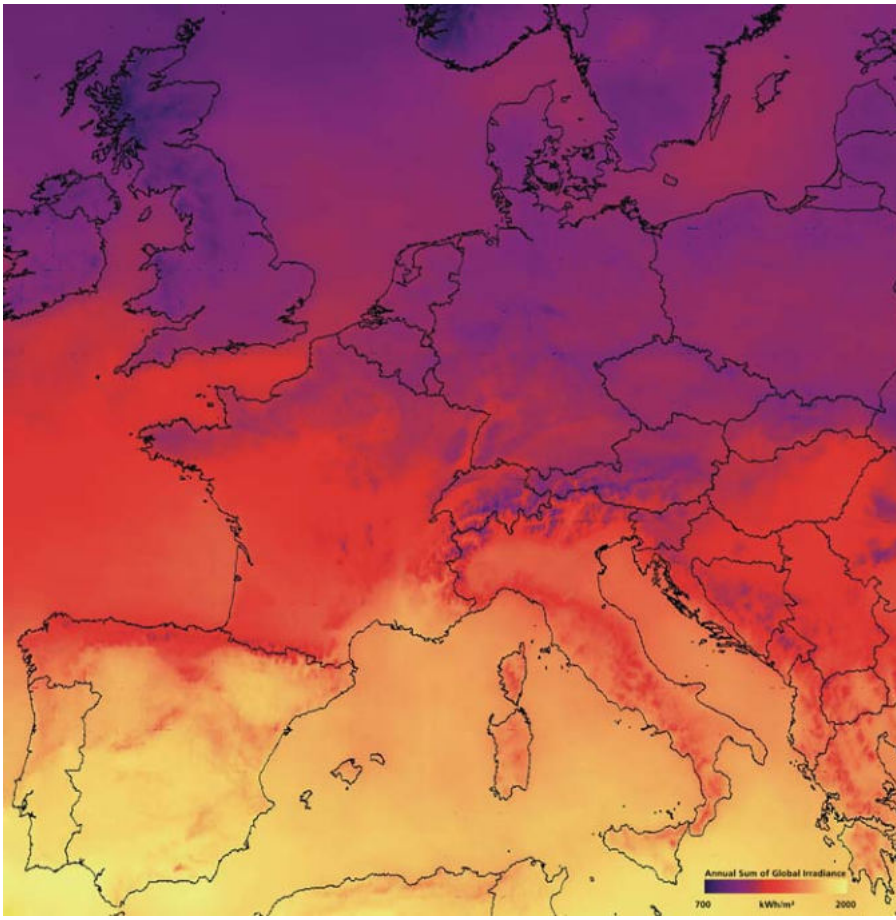
Spatial coverage of the SOLEMI service,
http://www.solemi.de

Services for Science and Consulting

User feedback

Dr Henner Gladen, Solar Millenium AG:
"Solar radiation time series delivered by DLR so far were used for planning eight projects with a total peak power of 360 MW. This corresponds to an estimated investment of about 1.400 MW, considering some solar plants with an oversized solar field for integrated thermal storage. We are in the process of planning further large solar thermal power plants worldwide.
The field of large solar thermal power plants is an evolving market with projected worldwide investment in the order of some 10 billion € within the next 10 years. For better economical analysis we want to make further use of satellite based solar irradiance data. From our experience with the data delivered so far and from other data sources we learn that this has the great advantage that we can receive reliable maps showing the distribution of solar energy in regions of interest for further projects."

Jürgen Kern, Kernenergien:
"Thank you for the supply of radiation data and maps of Jordan.
We are favoring the satellite data mainly because of the low investment, and the good results and for various reasons:
– many selected sites and large areas at once (with a resolution of up to 5x5km²)
– for many years (up to 20 years)
– for the time period onwards and also for archived historical data
– fast access and preparation
Therefore, satellite radiation data are not only an alternative to ground measurement data as many of the above mentioned benefits can only be achieved using satellites."



Annual sum of global irradiance in 2004 derived from the SOLEMI database. Source: DLR

kernenergien
the solar power company

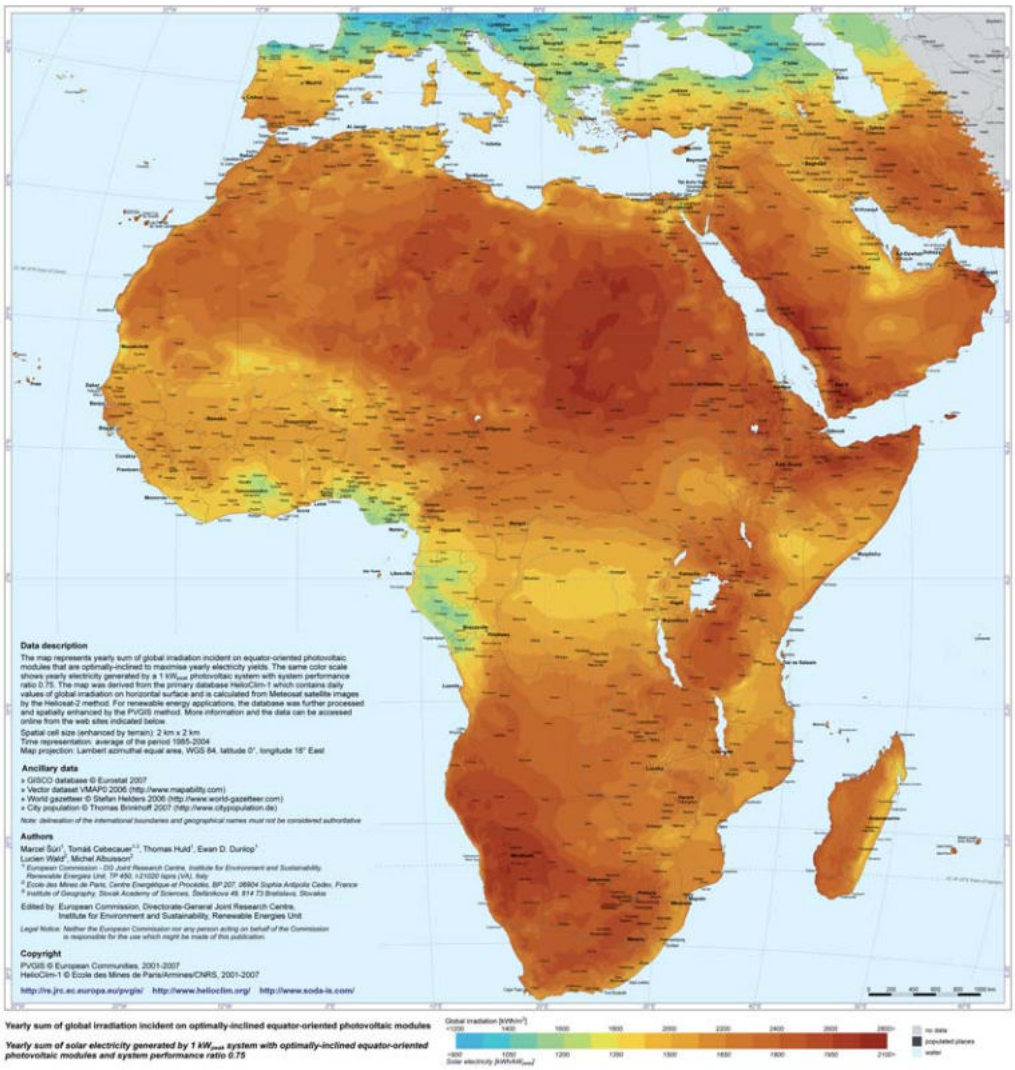
Solar Millennium

Services for Science and Consulting

SoDa for customer-specific irradiance maps and time series

The web-based SoDa service provides time series based on Meteosat and MSG. Hourly, daily, monthly or yearly values of global and direct irradiances from 1985 to yesterday are combined with other meteorological parameters such as air temperature. SoDa provides an interface to distributed data sets related to solar energy and other fields like building enegineering, meteorology, agriculture, human health, and material sciences.

The GIS-based tool PV-GIS is operated by the Joint Research Centre (JRC) and specifically used for the estimation, verification, and management of photovoltaics. PV-GIS is a research and policy support instrument for Europe in the context of integrated management of solar electricity generation. It uses SoDa databases to generate photovoltaic solar electricity potential analyses for the African continent.



Photovoltaic solar electricity potential in the Mediterranean Basin, Africa, and Southwest Asia, source JRC

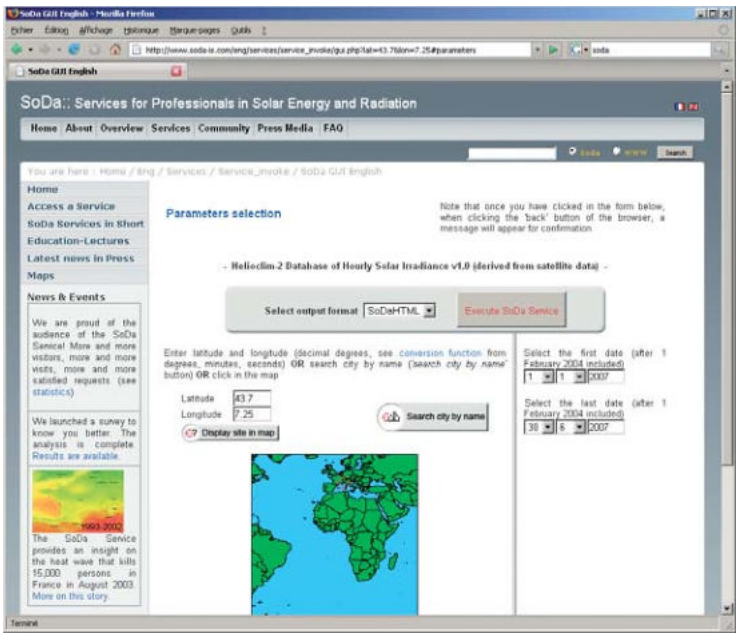
MINES PARIS
ParisTech

Services for Science and Consulting

User feedback

The German company Lahmeyer International provides technologies and services for energy infrastructure development. Mathieu Sarran writes "Our consulting activties in rural electrification by means of solar energy request accurate data on solar radiation. In Africa, such data are inexistent in underdeveloped regions. Accordingly, Lahmeyer International itself installs measuring stations. This induces costs and presence of local teams for data collection and maintenance. The availability of radiation data that can be accesssed through the SoDa Service is a real advantage for our company. The first benefit is that they are available at any site: there are more data than we can install stations. The second benefit is that archives are available instantaneously while our measuring stations should work two full years before delivering a consistent and reliable time-series. Advantages are fast access to information, reliability of information, large geographical coverage, dramatic decrease of costs for study and planning. By exploiting these data, projects can be realised quicker, more reliably, more completely and more competitively."

Daniel Mugnier, engineer at Tecsol S.A.:
"Satellite data is very useful for TECSOL for several purposes. These include the use of hourly values for modelling, monthly averages data for planning, short term forecast for fuzzy logic control of solar domestic hot water systems, and daily values for checking the control of the solar system. In the last case, these satellite meteo data could replace the need for on-site PV sensors which costs now for each site nearly 300 € including material, wiring and installation. To be really usable at short term, it seems to be compulsory to know the level of accuracy of each type of satellite times series. This knowledge of the accuracy is especially necessary as far as precise spacial localisation is concerned. Thanks to the new small resolution of the last generation satellite data, it should be possible to take into account microclimates with a good precision. The market in France of all these applications is still difficult to appreciate because of the lack of visibility on the rapidity of developpment of the solar systems market (narrowly depending on politics). When thousands of large PV plants and thermal solar systems – at an horizon of 2-5 years – will be installed in the country, the high cost created by using an irradiance sensor in each plant will permit the developpment of satellite data use. The main target customer should be solar system planners and operating companies which are responsible of the monitoring of the solar installations. The number of potential customers can be estimated to several hundreds within 3-5 years."



Web interface for the SoDa service.

LAHMEYER INTERNATIONAL

tecsol

ENVISOLAR Environmental Information Service for Solar Energy Industries

ENVISOLAR is an international project funded by the European Space Agency, Earth Observation Market Development Program (EOMD)
2003-2007

It relies on previous developments in the European Commission projects PVSAT-2 and Heliosat-3.

The main focus of ENVISOLAR is to support the industrial use of earth observation based information in the solar energy sector.

Earth observation data providers have teamed with market players using earth observation data and providing end user services. Key customers using such services as basis for their downstream businesses are also involved in the consortium.

Earth observation data is taken mainly from meteorological satellites of the METEOSAT series. Geophysical parameters exploited are cloud cover and cloud height, aerosols, water vapor and snow cover. All these parameters are used to assess the surface solar irradiance as the solar resource for energy production.

Services building on an accurate description of solar irradiance are dedicated to planning solar energy systems, system design, performance monitoring, grid integration and load forecasting.

Challenges were the creation of an integrated service chain from earth observation data providers to market players, the generation of sample customer products, and market trials performed with key customers.

ENVISOLAR addressed these challenges by setting up a varlety of user-specific services and assessing the value of its products when used by end users for their activities.

Some 50 users were involved in market trials. Their feedback was collected and serves as basis for further improvements of the services.

Partner

Ecole des Mines de Paris /Armines
Les Presses
60 boulevard Saint Michel
F-75272 Paris cedex 6
http://www.armines.net

Ecole des Mines de Paris /Armines
Centre d'Energétique -
Groupe Télédétection & Modélisation (T&M)
BP 207
F-06904 Sophia Antipolis cedex
http://www.ensmp.fr

Enecolo AG
Lindhofstrasse 52
CH-8617 Mönchaltorf
http://www.enecolo.ch

Flyby s.r.l.
Via Puini 97, int. 26
I - 57128 Livorno
http://www.flyby.it

German Aerospace Center (DLR)
German Remote Sensing Data Center (DFD)
Oberpfaffenhofen
D-82234 Wessling
http://www.dlr.de/caf

German Aerospace Center (DLR)
Institut für Physik der Atmosphäre
Oberpfaffenhofen
D-82234 Wessling
http://www.dlr.de/ipa

German Aerospace Center (DLR)
Institute of Technical Thermodynamics
Pfaffenwaldring 38-40
D-70569 Stuttgart
http://www.dlr.de/tt

MeteoControl GmbH
Stadtjägerstr. 11
D-86152 Augsburg
http://www.meteocontrol.de

MeteoSwiss
Federal Institute of Meteorology and Climatology
Climatological Branch
Kraehbuehlstrasse 58
CH-8044 Zurich
http://www.meteoswiss.ch

Oldenburg University
Institute of Physics
Energy and Semiconductor Research Laboratory
D-26111 Oldenburg
http://ehf.uni-oldenburg.de

Key customers:

Edisun Power AG
Technoparkstrasse 1/71
CH-8005 Zürich
http://www.edisun.ch

ENEL Produzione
Via G. Matteotti 2
I- 64046 Montorio al Vomano
http://www.enel.it

Enercity Stadtwerke Hannover AG
OE1172
Glockseestraße 33
D-30169 Hannover Jürgen Grotelüschen
http://www.enercity.de

SAG Solarstrom Franchisegesellschaft mbH
Bereich Services
Sasbacher Str. 5
D-79111 Freiburg
http://www.solarstromag.net

Stromaufwärts GmbH
Alemannenstraße 49
A-6830 Rankweil
http://www.stromaufwaerts.at

TECSOL S.A
105, Rue Alfred Kastler – BP 434
F-66 004 Perpignan Cedex
http://www.tecsol.fr

ENVI
SOLAR

Published by:
Deutsches Zentrum für Luft- und Raumfahrt (DLR) e.V.
Deutsches Fernerkundungsdatenzentrum (DFD)
Oberpfaffenhofen
D-82234 Wessling

Funded by:
European Space Agency (ESA)

Editor and scientific coordinator:
Marion Schroedter-Homscheidt

Authors:
Stefan Bofinger, Silvia Dekorsy, Carsten Hoyer-Klick,
Thomas Scheidsteger, Marion Schroedter-Homscheidt,
Sandra Stettler, Peter Toggweiler, Lucien Wald

Layout and Cover:
Karlheinz Rau
Stephan Souza-Reiniger
Nils Sparwasser

Production:
Verlagsservice Rau, Munich

Printer
Gotteswinter, Munich

August 2007

Images:
Cover BMU / Bernd Müller, cover map DLR,
Cover inside: left DLR; right BMU / Bernd Müller,
p. 1 left BMU / B.Hiss, p. 1 right DLR, p. 2 DLR,
p. 3 DLR, p. 4 upper DLR, p. 4 lower Meteocontrol,
p. 5 upper Univ. Oldenburg,
p. 5 middle and lower Meteocontrol, p. 6 Enecolo,
p. 7 Enecolo, p. 8 left Flyby, p. 8 right Meteocontrol,
p. 9 Meteocontrol, p. 10 DLR, p. 11 DLR,
p. 12 Univ. Oldenburg, p. 13 DLR, p. 14 Meteocontrol,
p. 15 left Enecolo, p. 15 right Flyby,
p. 16 Meteocontrol, p. 17 Flyby, p. 18. DLR,
p. 19 DLR, p. 20 JRC, p. 21 Armines

DLR

MINES PARIS ParisTech

ARMINES

meteocontrol Energy & Weather Service

CARL VON OSSIETZKY universität OLDENBURG

enecolo energy ecology

applied research solutions Flyby

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss