

DESERTEC Foundation
Principles, Criteria and Indicators
for the
Evaluation of Renewable Energy Power Plants

Version 1.0

Preamble

A major objective of the DESERTEC Foundation is the global transformation towards a green economy with a particular emphasis on the use of renewable energies. The DESERTEC concept identifies areas with particularly sunny conditions as preferred sites for solar and solar-thermal power plants. Its originators suggest employing huge solar-thermal power plants for the provision of societies and industries in the respective countries with clean electricity. They furthermore point out that a fraction of the electricity demand of highly industrialised countries should be covered by imports from sun-rich regions to compensate for fluctuations of locally available renewable resources. Solar-thermal power plants are particularly suitable because they offer the option to store energy with minimal loss and thus to provide dispatchable electricity also at night.

A number of organisations have pointed out that large-scale electricity production in sunny and arid regions must contribute to the energy supply and socio-economic development within these regions (KLAWITTER & SCHINKE 2011; also: Technology Roadmap, see box below).

“Such projects need to result in win-win situations. It would seem unacceptable, for example, if all solar electricity were exported overseas while local populations and economies lacked sufficient power resources. Newly built plants will have to fulfil the needs of the local population and help develop local economies. Meanwhile, the returns from exporting clean, highly valued renewable electricity to industrialised countries could help cover the high initial investment costs of CSP beyond the share devoted to exports.”

Technology Roadmap Concentrating Solar Power, OECD/IEA, 2010, [Web Link](#).

Two measures have to be taken to ensure local benefits. A sustainability framework needs to be developed and it needs to be implemented with the strongest possible leverage on project developers and operators. This document provides a first version of principles, criteria and indicators originating from a working group of the DESERTEC Foundation and a small round of expert consultations. It is intended to serve as a starting point for an extended stakeholder dialogue, which is the basis for a comprehensive sustainability framework.

Purpose, scope and limits of this document

This document contains a set of principles, criteria and indicators, which are based on suggestions of a DESERTEC Foundation working group and which have been amended through the consideration of comments from a first round of expert consultations.

The principles, criteria and indicators in this document are not derived from a stakeholder dialogue. They address major aspects of the DESERTEC concept like renewable resources, security, water, socio-economic impact / local benefits and environmental responsibility.

The document is intended to serve as a starting point for an extended stakeholder dialogue.

The current set of PCIs partially lacks the measurability of indicators and it does not give reference values, because the technical background knowledge and insight of stakeholders active in the field is essential to specify realistic values.

The current set of PCIs is most likely to form part of a modular PCI framework, which will contain or refer to other established standards. It therefore does not address financial aspects, since they will be covered by other standards. The degree of modularity as well as the external standards will be decided upon in the further process development.

Definitions

The PCIs mentioned in this document adhere to the following definitions [KLAWITTER (2010) according to VAN CAUWENBERGH et al. (2007)]:

Principles: general conditions and concepts for achieving the final goal of sustainability (environmental, economic, social).

Criteria: “[...] essentially indicate how the sustainability principles can be achieved”.

Indicators: “[...] function by simplifying complex phenomena and information into quantifiable measures that can be readily communicated”; “[...] can also measure changes of criteria over a certain time period, can be used to determine compliance; balance between complexity and usability.”

Process layout and document history

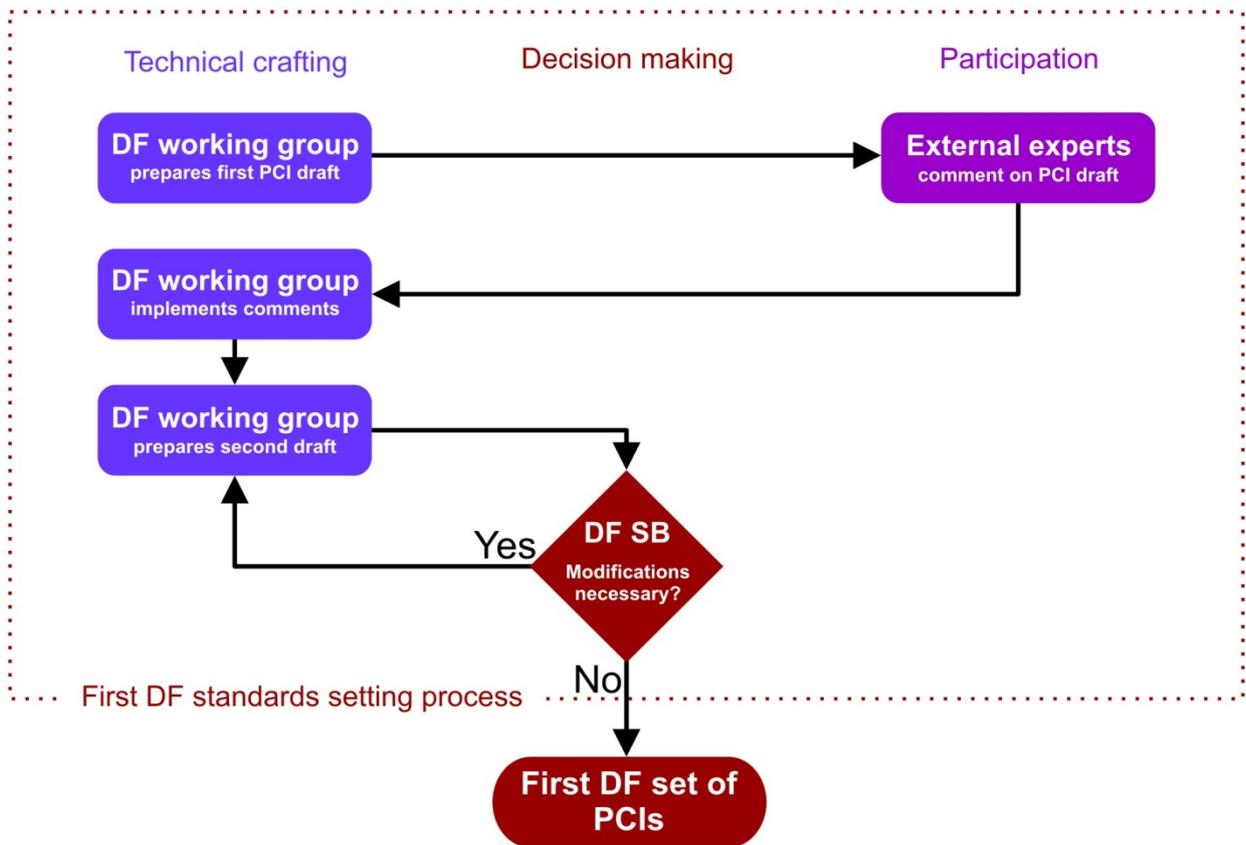
A schematic drawing (below) illustrates the document workflow. The underlying process consists of steps, which are subordinated to the areas of technical crafting, decision making and participation, respectively. The corresponding process structure of the Forest Stewardship Council partially functioned as a blueprint for the design of the DF process.

The process has been developed, moderated and edited by Sebastian Gallehr (co-founder of the DESERTEC Foundation) and Wolfgang Dörner (head of projects and services, DESERTEC Foundation).

The version 1.0 of this document and of the PCIs has been approved by the supervisory board of the DESERTEC Foundation (DF SB).

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References

van Cauwenbergh, N., Biala, K., Biolders, C., Brouckaert, V., Franchois, L., Garcia Ciudad, V., Hermy, M., Mathijs, E., Muys, B., Reijnders, J., Sauvenier, X., Valckx, J., Vanclooster, M., van der Veken, B., Wauters, E., Peeters, A. (2007): SAFE - A hierarchical framework for assessing the sustainability of agricultural systems. *Agriculture, Ecosystems and Environment*, 120:229–242.

Klawitter, J. (2010): Towards a Sustainability Framework for the Desertec Concept. Master thesis at the University of Applied Sciences in Eberswalde, Germany.

Timeline

- A first draft of PCIs has been prepared by an internal working group of the DESERTEC Foundation in October 2011.
- The first draft has been sent to external experts in October 2011.
- Comments from external experts have been reviewed and implemented into a second draft.
- The second draft has been sent to members of the DF supervisory board in June 2012.
- Comments from members of the DF supervisory board have been collected and implemented.
- The current version has been approved by all members of the supervisory board.

PCIs

Introductory remark: The current set of PCIs focuses on environmental, socio-economic and technical aspects of power plants based on renewable energies. Aspects of safety, security, and peace and conflict resolution are touched in Criterion 2.1.

The further development of criteria and indicators will include a stakeholder dialogue.

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Principle 1: Electricity from renewable resources

Power plants provide electricity based on renewable resources. In the case of solar-thermal power plants, a solar share of at least 95% of their electricity output has to be achieved at their final construction phase.

Introductory remarks: The requirements for power plants concerning energy system services have to be considered from a general system perspective. Nevertheless, power plants able to provide services like dispatchability are of higher value to the DESERTEC concept.

Basic requirement: Power plant data sheet with preliminary layout and specifications, analysis of local, regional or national power demand.

Criterion	Indicators and guidance
Criterion 1.1: The use of renewable energy in standard operation mode is maximised from at least 50% initially to 95% at their final construction phase.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Schedule of measures to increase the contribution of solar energy. <p>Guidance:</p> <p>This criterion only applies to solar-thermal power plants. The power plant may initially generate up to 50% (annual average) of its electrical power from fossil fuels.</p> <p>After two years, the part of power produced with fossil fuels must be reduced to 10%. After a further two years, the part of power produced with fossil fuels must be reduced to 5%. After a further two years, the part of power produced with fossil fuels must be reduced to 0% in standard operation mode.</p> <p>Prototype power plants and innovative technologies with the intention to provide 100% renewable energy in commercial use are excluded.</p>

Criterion	Indicators and guidance
Criterion 1.2: Technological appropriateness.	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Description of the local renewable energy resources (e.g. DNI, WPD). ➤ Description of current electricity production and demand for electricity in the host country. ➤ Description of the local load profile. ➤ Description of the local / national grid. ➤ Outline of the intended local and export shares. ➤ Preliminary power plant and power line / grid layout. ➤ Anticipated power output profile. ➤ Estimated capacity factor. ➤ Expected annual electrical power production. <p>Guidance</p> <p>In the case that the power plant is intended to provide electricity mainly or exclusively for the local or national consumption, there should be a very good match between the respective load profile and the power output profile.</p> <p>In the case that most or all electricity is produced for exports to Europe, the selected system should provide dispatchable electricity.</p>

Principle 2: Reliability of electricity supply

The planning and design of the power plant takes into account potential risks and grid instabilities and mitigates their consequences.

Criterion	Indicators and guidance
Criterion 2.1: The downtime is minimized and its consequences mitigated.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Identification of major technical factors that could cause downtime of the power plant.➤ Identification of major non-technical risks of downtime.➤ Proposals of protective measures to avoid major risks and if applicable to mitigate their consequences on electricity production. <p>Guidance:</p> <p>Risks for the undisturbed operation may arise from</p> <ul style="list-style-type: none">➤ the freezing of molten salt within storage systems or damage due to sand storms,➤ shortages in component supplies,➤ maintenance issues,➤ vulnerable infrastructure,➤ political instabilities. <p>The planned plant layout should withstand an extended stand-still period without severe damage.</p>

Principle 2: Reliability of electricity (continued)

Criterion	Indicators and guidance
Criterion 2.2: Interconnectivity and grid stability.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Description of the existing electricity infrastructure.➤ Outline of the envisaged electrical power distribution.➤ Identification of quality indicators for grid stability.➤ Identification of quality indicators for measures to maintain stability.➤ Emergency plan for grid instabilities.➤ Evidence for the proper communication of possible negative impacts on grid stability to local and national stakeholders.➤ Evidence for the proper communication of the envisaged electrical power distribution to local and national stakeholders. <p>Guidance:</p> <p>If applicable, the power plant design should offer or at least not rule out the option to provide electricity for international and intercontinental power lines.</p>

Principle 3: Water use

Particularly in arid regions suffering from water scarcity, power plants are designed for lowest possible and feasible water consumption.

Criterion	Indicators and guidance
Criterion 3.1: The use of water is minimized and the water balance should be positive or at minimum neutral.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Description of local water sources and water use.➤ Preliminary scheme to minimize water consumption and to recycle the used water. <p>Guidance:</p> <p>Efforts should be made towards water neutrality. For water-cooled systems with a high fresh water consumption for example, at least double of the fresh water amount which is irreplaceably consumed through evaporation, leakage or consumption during operation has to be replenished by seawater desalination with process heat or by provision of electricity for desalination plants.</p> <p>The option to provide fresh water for the local population should be assessed.</p>
Criterion 3.2: The power plant project contributes to the mitigation of water scarcity.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Description of the local and national demand for fresh water.➤ Outline of the planned contribution of the project to the mitigation of water scarcity.

Principle 4: Socio-economic impact / Local benefits

The power plant project contributes to the improvement of livelihoods and to economic stability.

Introductory remarks: The following criteria address several aspects of the DESERTEC concept. For technical and economic reasons it is unlikely that a single power plant project will cover all of them to the desired extent. It thus seems reasonable to establish a system of credits and to define a threshold for project categories.

Basic requirement: Social impact assessment.

Criterion	Indicators and guidance
Criterion 4.1: The power plant provides the local and / or national population and industry with electricity.	<p>Indicators:</p> <ul style="list-style-type: none">➤ Description of current electricity production and demand for electricity in the host country.➤ Description of the current legislation concerning feed-in from private companies.➤ Quantification of the required area for the plant and of the total area with suitable solar conditions available in the host country.➤ Estimation of the development of electricity demand, costs and pricing.➤ Contribution of the project to the provision of electricity to the local and national population. <p>Guidance</p> <p>Electricity should be made available to the local or national population and industry under conditions common to the host country if the current national or local legislation allows the off-take and if the current national or local demand for electricity or the expected future demand for electricity justifies the additional supply.</p> <p>If, for legal reasons or those of the current electricity demand, it is not possible or appropriate to supply the local population with electricity, it has to be assured that enough space with comparably good solar conditions remains available for the future in the case that more solar power plants will be needed to satisfy the local demand.</p>

Principle 4: Socio-economic impact / Local benefits *(continued)*

Criterion	Indicators and guidance
<p>Criterion 4.2: The power plant project provides education and training for the local and / or national population.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Description of the current education and qualification level of the local workforce. ➤ Description of the required qualifications and numbers of workers for plant construction and maintenance. ➤ Outline of planned educational trainings.
<p>Criterion 4.3: The power plant project creates jobs for the local and / or national population.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Description of production facilities relevant to component production for the power plant. ➤ Estimation of the number of jobs created on a short term for component production, distribution, construction and maintenance of the plant. ➤ Estimation of the number of jobs created on a long term for component production, distribution, construction and maintenance of the plant.
<p>Criterion 4.4: The power plant project contributes to an improved educational and training infrastructure for the local and / or national population.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Outline of planned new schools or educational or training facilities.
<p>Criterion 4.5: All socio-economic impacts are communicated to and evaluated by the national and local public.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Evidence for round table events and workshops addressing local and national stakeholders. ➤ Evidence for a close collaboration with local stakeholders in order to optimize local value creation depending on the local capacities. ➤ List of impacts and their evaluation by the national and local public. ➤ Transparent documentation of events and materials for stakeholder information in order to prevent blackmailing and bribery. ➤ Documentation of financial investments and returns. ➤ Evidence for the implementation of a conflict management system if negative impacts have been identified.

Principle 5: Environmental responsibility and conservation of natural resources and biodiversity

The design of the power plant project aims at the avoidance of negative environmental impacts. Unavoidable negative impacts are mitigated.

Principle 5 contains three criteria, which have been taken from the “RSPO Principles and Criteria for Sustainable Palm Oil Production” (October 2007) and adapted to match the DESERTEC requirements.

Basic requirement: Environmental impact assessment.

Criterion	Indicators and guidance
<p>Criterion 5.1: Aspects of power plant project that have environmental impacts are identified, and plans to mitigate the negative impacts and promote the positive sustainable ones are made.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Environmental impact assessment. ➤ List of impacts and their evaluation by the national and local public. <p>Guidance:</p> <ul style="list-style-type: none"> ➤ Environmental impact assessment should cover the following activities, where they are undertaken: <ul style="list-style-type: none"> ○ Plant construction, building new roads, power lines or other infrastructure. ○ Disposal of effluents. Environmental impacts may be identified on soil and water resources, air quality, biodiversity and ecosystems, and people’s amenity, both on and off-site. ➤ Environmental impacts have to be communicated, evaluated and moderated by the national and local public. ➤ Where the identification of impacts requires changes in current practices, in order to mitigate negative effects, a timetable for change should be developed

Criterion 5.1 is based on Criterion 5.1 of the “RSPO Principles and Criteria for Sustainable Palm Oil Production” (October 2007). It has been adapted to match the DESERTEC requirements.

Principle 5: Environmental responsibility and conservation of natural resources and biodiversity (*continued*)

Criterion	Indicators and guidance
<p>Criterion 5.2: The status of rare, threatened or endangered species and high conservation value habitats, if any, that exist on the site or that could be affected by the power plant management, shall be identified and their conservation taken into account in management plans and operations.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Information should be collated that includes both the power plant area itself and relevant wider landscape level considerations (such as wildlife corridors). This information should cover: <ul style="list-style-type: none"> ○ Presence of protected areas that could be significantly affected by the power plant. ○ Conservation status (e.g. IUCN status), legal protection, population status and habitat requirements of rare, threatened, or endangered species that could be significantly affected by the power plant and power grid. ○ Identification of high conservation value habitats, such as rare and threatened ecosystems, that could be significantly affected by the power plant. ➤ If rare, threatened or endangered species, or high conservation value habitats, are present, appropriate measures for management planning and operations will include: <ul style="list-style-type: none"> ○ Ensuring that any legal requirements relating to the protection of the species or habitat are met. In the case that stricter regulations are in place within the European Union, these requirements should be met. ○ Avoiding damage to and deterioration of applicable habitats. ○ Developing responsible measures to resolve human-wildlife conflicts. <p>Guidance:</p> <p>This information gathering should include checking available biological records and consultation with relevant government departments, research institutes and interested NGOs if appropriate. Depending on the biodiversity values that are present, and the level of available information, some additional field survey work may be required.</p>

Criterion 5.2 is based on Criterion 5.2 of the “RSPO Principles and Criteria for Sustainable Palm Oil Production” (October 2007). It has been adapted to match the DESERTEC requirements.

Principle 5: Environmental responsibility and conservation of natural resources and biodiversity (*continued*)

Criterion	Indicators and guidance
<p>Criterion 5.3: Waste is reduced, recycled, reused and disposed of in an environmentally and socially responsible manner.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Identification of all waste products and sources of pollution. ➤ Identification of the current waste management in the region and breakdown of the expected challenges. The main kind of these facts must be communicated, matched and adjusted. ➤ Outline of a waste management and disposal plan to avoid or reduce pollution. <p>Guidance:</p> <p>The waste management and disposal plan should include measures for:</p> <ul style="list-style-type: none"> ➤ Identifying sources of waste and pollution. ➤ Improving the efficiency of resource utilisation and recycling potential wastes. ➤ Appropriate disposal of hazardous chemicals and their containers.
<p>Criterion 5.4: The power plant will be responsibly decommissioned and materials will be recycled after the operational period.</p>	<p>Indicators:</p> <ul style="list-style-type: none"> ➤ Outline of decommissioning plan including recyclable material amounts and management of non-recyclable materials.

Criterion 5.3 is based on Criterion 5.3 of the “RSPO Principles and Criteria for Sustainable Palm Oil Production” (October 2007). It has been adapted to match the DESERTEC requirements.