Gesto ENERGY SOLUTIONS

Solar Consulting Services

CSP Services
Concentrating Solar Power Services

CONSULTING SERVICES AFRICA

SIJ | SOLAR-INSTITUT JÜLICH
FH AACHEN
UNIVERSITY OF APPLIED SCIENCES

CSP TECHNOLOGY OVERVIEW
NAMIBIA SOLAR RESOURCE AND DNI ANALYSIS
ENVIRONMENTAL ANALYSIS AND SITE SELECTION
TOP 5 SITES SELECTION AND GROUND MEASUREMENTS
FINANCIAL ANALYSIS AND CSP BUSINESS MODEL
CSP DEVELOPMENT AND IMPLICATIONS FOR NAMIBIA

Program for CSP master courses

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Overview

- The content of university degrees for CSP capacity building will be described briefly
- The detailed program topics can be taken from the report itself
- Three important lecture sections should be established for CSP
  - Solar radiation properties (as a pre-lecture)
  - Power plant engineering
  - CSP technology
    - Parabolic trough
    - Power towers
    - Linear Fresnel
    - Dish systems
    - Thermal energy storage systems
    - Maintenance and quality control
    - Hybridization
    - Augmentation
    - Economic comparison among CSP technologies & CSP to renewable energies

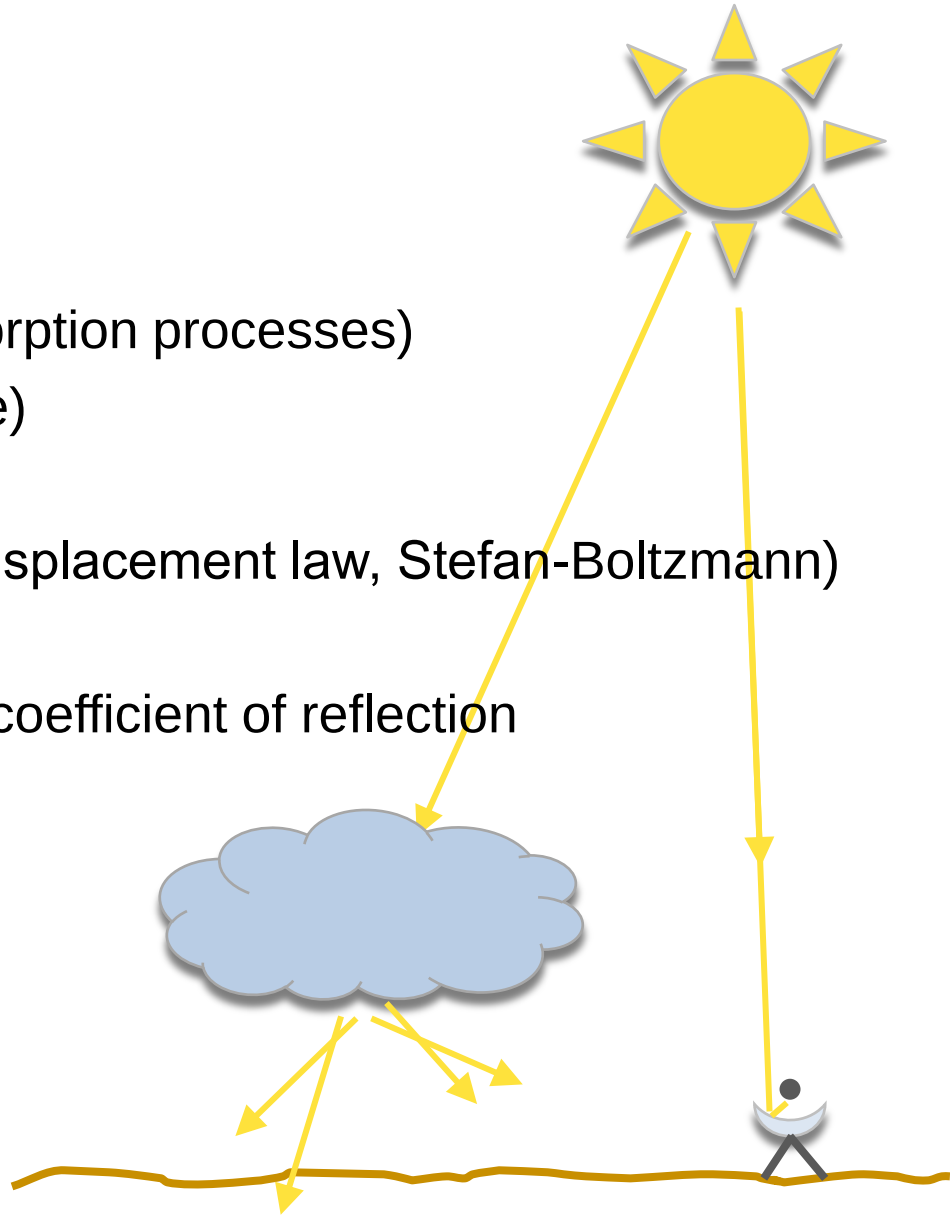
Source: SIJ


www.solarmillennium.de


http://millernagan.com/3135/abb-buys-35-percent-shares-of-german-solar-company/

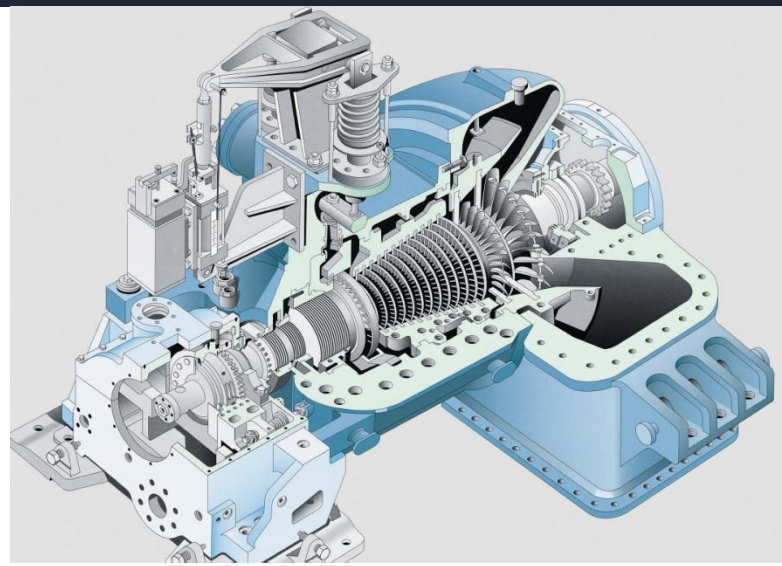
Training / capacity building program design

- Solar radiation properties
  - Basics of astronomy
  - The sun
  - Solar constant
  - Solar radiation (including scattering and absorption processes)
  - Types of solar radiation (global, direct, diffuse)
  - Measurement of solar radiation
  - Thermodynamics of solar radiation (Wien's displacement law, Stefan-Boltzmann)
  - Concentration ratios
  - Composition of materials for mirrors and the coefficient of reflection
  - Solar potential for CSP in the world



Training / capacity building program design

- Power plant engineering
  - Boilers / steam generators and heat exchangers
  - Feedwater tank and deaerator assembly
  - Condenser technology
  - Steam turbine technology
  - Gas turbine technology
  - Cooling technology
  - Water treatment facilities, water and steam quality
  - Electric generator



www.siemens.com

www. aalborgcsp.com

Training / capacity building program design

- Parabolic trough
  - Trough types, designs, sizes and applications
    - Parabola form
    - Trough sizes
    - Designs
    - Applications
    - Sun tracking
    - Collector types on the market
  - Heat collector elements (HCE)
    - HCE (evacuated tube, absorber)
    - Common design
    - Selective surfaces
    - Loss mechanisms
    - Hydrogen capture techniques

http://www.solarmillennium.de/deutsch/download/index.html

Training / capacity building program design

- Parabolic trough
  - Heat transfer fluids (HTF)
    - Available HTF in plants
    - Limitations
    - Decomposition
  - Description of existing plants
    - Description with more details and all systems
    - Thermal oil as HTF
    - Direct steam generating plants
  - New technology outlook
    - Research in molten salt as HTF
  - Operation experience from existing plants

Training / capacity building program design

- Power towers
  - Heliostat field
    - Sizes, frames and glass materials
    - Heliostat field losses
    - Costs
    - Types and shapes of heliostat fields
    - Heliostat patterns
    - Heliostat field layout tools
    - Aiming strategies
    - Sun tracking
    - Heliostat market analysis
    - Examples
  - Receiver types
    - External tube receiver
    - Open and pressurized volumetric receiver
    - Mass and energy balance calculations

Source: SIJ

Training / capacity building program design

- Power towers
  - Heat transfer fluids (HTF)
    - Air, molten salt, water/steam
    - Comparison of HTF
  - Description of existing and planned plants
  - New technology outlook
    - New receiver and heliostat designs
    - Operation experience from existing and commercial and demonstration plants

Training / capacity building program design

- Linear Fresnel
  - Reflector types, designs, sizes and applications
    - Principle of the Fresnel technology
    - Components of a linear Fresnel plant
    - Limits due to astigmatism
    - Sun tracking
  - Absorber tube and secondary concentrator
    - Working principle of the secondary concentrator
  - Heat transfer fluids (HTF)
  - Description of existing plants / market analysis
  - New technology outlook
    - Development of evacuated absorber tubes
  - Operation experience from existing commercial and demonstration plants

http://millernagan.com/3135/abb-buys-35-percent-shares-of-german-solar-company/

Training / capacity building program design

- Dish systems
  - Stirling cycle and Stirling engine
    - Stirling cycle
    - Types of engines
    - Principle of operation
  - Dish system sizes and designs
    - Paraboloid form
    - Size of existing dish systems
    - Designs (e.g. multi facetted stretched membrane)
    - Loss mechanisms
  - Description of existing plants / market analysis
  - New technology outlook
    - HTF: e.g. direct steam generation process
  - Operation experience from existing commercial and demonstration plants

http://www.mtholyoke.edu/~wang30y/csp/ParabolicDish.html
(c)International River

Training / capacity building program design

- Thermal energy storage systems
  - Thermal energy storage systems for sensible heat
    - Indirect storage systems
      - 2-tank molten salt indirect storage
      - Packed-bed thermal energy storage (Regenerator)
      - Sand storage
      - Concrete storage
    - Direct storage systems
      - 2-tank molten salt direct storage
      - Single tank thermocline storage
      - 2-tank oil storage
    - Storage media for sensible storage systems

http://www.eurotecnica.it/Images/TES-andasol-3.jpg

Training / capacity building program design

- Thermal energy storage systems
  - Thermal energy storage systems for latent heat
    - Latent-heat storage systems
    - Possible HTF for latent-heat storage systems
  - Steam accumulator
    - Types of steam accumulators
  - Thermo-chemical energy storage
    - Theory and suitable materials
  - Solar multiple
  - Storage capacity

Training / capacity building program design

- Maintenance
  - Required heliostat field and power block maintenance
  - Optical measurement methods for analyzing the geometrical properties of collectors
- Hybridization of CSP plants
  - Hybridization with gas turbine or gas boiler
  - Alternative to storage systems
  - ISCC (integrated combined cycle) plants (combination of conventional power plant with solar thermal power plant)
- Augmentation of CSP power plants
- Economic comparison
  - Between different CSP technologies
  - To other renewable energy technologies
- Short courses should be taught to technicians


Thank you for your attention!