German Academy of Digital Education

SOLAR ELECTRIC ENERGY SYSTEMS

COURSE OVERVIEW

CREATING CHANCES

TABLE OF CONTENTS

Which innovation will power the growth of solar? I think that there are certainly some more challenges, such as grid stability or the simple question of political will. Let's explore some answers with our course.

WELCOME TO DADB
German Academy of Digital Education

During my many journeys and projects in various corners of the world, I have learned that education and renewable energies are two essential elements in giving people unprecedented prospects for their future. Consequently, I have made it my mission to take both elements out into the big wide world.

In a world where the need for sustainable and renewable energy sources is increasingly urgent, solar electric energy is establishing itself as a promising solution. But what exactly are Solar Electric Energy Systems? Simply put, they are systems that convert sunlight directly into electrical energy. They are usually composed of solar cells, inverters and several other components that can store and distribute energy efficiently.

I welcome you, and encourage you to explore the course and contribute to a sustainable future in India and abroad!

Torsten Herfert
Managing Director
DADB German Academy of Digital Education GmbH

ABOUT DADB

As a global player in the digital education market, DADB offers industry-relevant online courses in the sustainable technologies sector, bringing German engineering know-how to the world.
Our vision is to become India's leading provider of high-quality German Engineering and Industrial Education, by making international standards of learning accessible to Indian students through innovative, hands-on, and affordable online learning experiences.

The idea emerged out of a lecture tour in India, when our Managing Director Dr.-Ing. Carsten Schröder was asked "Can we bring German professors to India and share German engineering know-how with students here?"

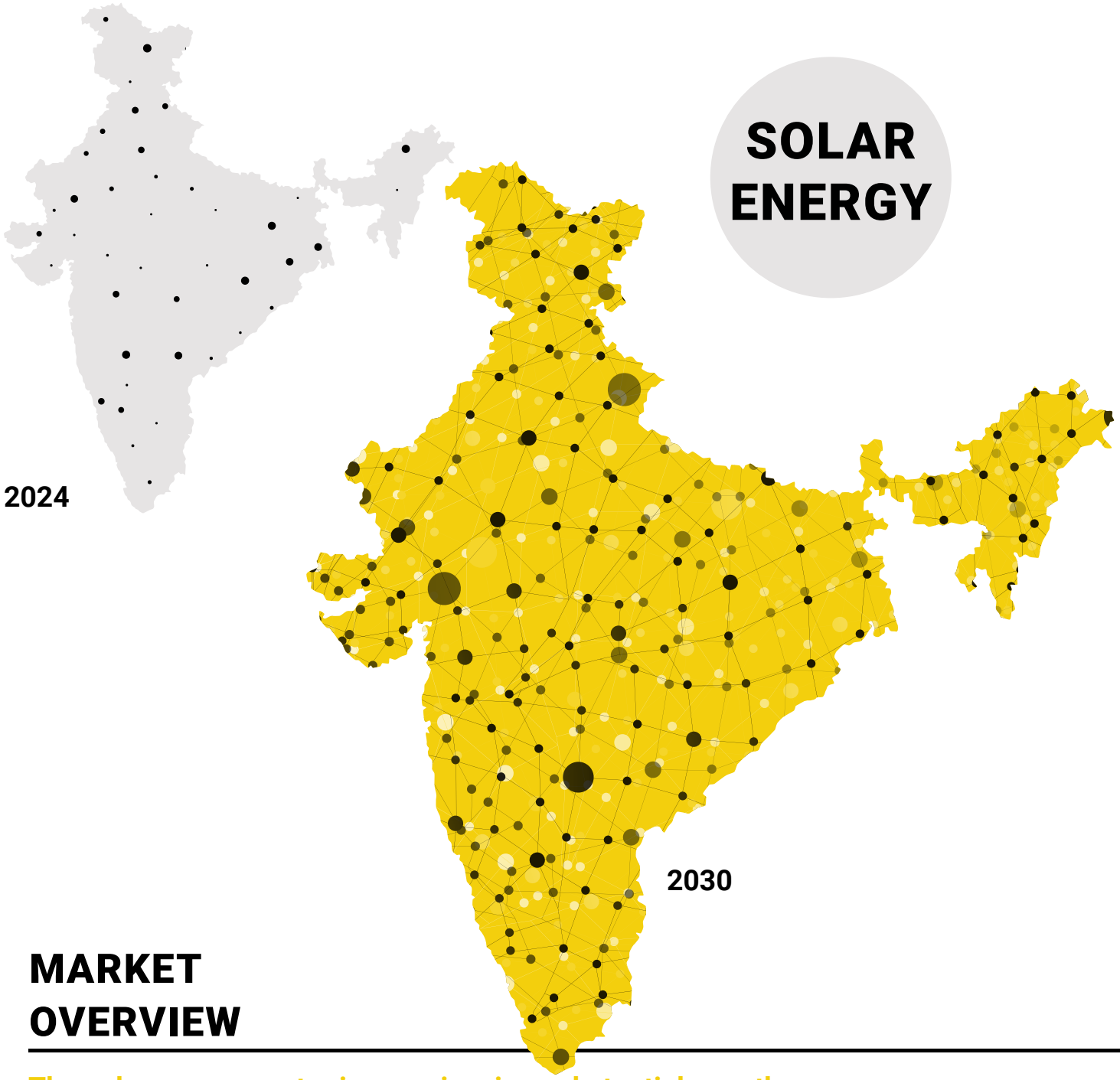
Back in Berlin, the idea was conceived to make professors' lectures available online rather than via their own classrooms. Immediately, it became apparent that online learning had very special requirements. A new learning format has been developed to integrate students interactively into the lectures and provide insight into practice from industry experts.

We are convinced that social responsibility does not exclude economic efficiency. Over the years, we have nurtured successful partnerships with industry, universities, colleges, and skills councils, aiming at one goal – making **Made in Germany** technical education accessible for the world's younger generations. This is why our claim – **Creating Chances** – strongly represents our belief that education is essential.

DADB courses are created in close cooperation with university professors and industry experts in Germany. The digital materials are geared towards the needs of teachers and students, with clear learning objectives and innovative course content that are responsive to industry requirements and the demand for well-educated talent.

CONNECTING. COLLABORATING. COOPERATING.

SOLAR ENERGY



MARKET OVERVIEW

The solar energy sector is experiencing substantial growth, supported by government policies and investments aimed at increasing renewable energy capacity.

Projected Revenue by 2030 in India **USD 24.9 BILLION**

The market is expected to double, driven by continued investments in solar infrastructure and technology.

Projected **REVENUE GROWTH 13.4%** from 2024 to 2030

THIS STEADY GROWTH RATE REFLECTS THE INCREASING INTEGRATION OF SOLAR ENERGY INTO INDIA'S OVERALL ENERGY STRATEGY.

JOB PERSPECTIVES

Key skills needed are technical knowledge of.

SOLAR TECHNICIAN

Solar Energy Technicians, also known as Photovoltaic (PV) Installers, play a crucial role in the deployment of solar energy solutions. As the demand for renewable energy sources rises, these technicians are integral in installing, maintaining, and repairing solar panel systems to ensure they operate efficiently and effectively.

SOLAR PROJECT MANAGER

Solar Project Managers coordinate all of the workers and materials involved in solar installation, managing time and budgets, and translating between engineers, system designers, and installers in the field.

SOLAR DESIGN ENGINEER

Solar design engineers utilize various solar design and simulation software to create and analyze solar energy system models, shading analysis, and energy production forecasts. These tools aid in effective solar system planning, performance optimization, and resource utilization.

SOLAR QUALITY ASSURANCE INSPECTOR

As part of the clean energy economy, Quality Assurance Inspectors conduct routine and non-routine analyses of in-process materials, raw materials, environmental samples, or finished solar components and interpret test results, compare them to established specifications and control limits, and make recommendations on the appropriateness of data for release.

SOLAR ENERGY CONSULTANT

A Solar Consultant is responsible for providing advice and guidance to clients about solar energy systems, including the installation and maintenance of photovoltaic panels and other solar energy systems.

SOLAR ELECTRIC ENERGY SYSTEMS COURSE

MERGING ACADEMIA AND INDUSTRY

The DADB course goes beyond looking only at theory. It provides in-depth training in both the fundamentals and advanced concepts of solar technology.

LEARNING OBJECTIVES

- **Understand the role solar energy can play as a renewable energy source**
- **Learn the theoretical background of photovoltaics**
- **Know relevant photovoltaic and ancillary technologies**
- **Appreciate costs and other factors driving the PV market**
- **Be able to make informed decisions on energy storage and plant design**

LEARNING OUTCOMES

Upon completion of this course, the students will be able to

1. **Have a 'sun-to-user' understanding of photovoltaic energy**
2. **Consider use cases for on-grid and off-grid scenarios**
3. **Calculate necessary parameters, such as system relevant dimensioning**
4. **Understand the challenges associated with successful photovoltaic implementation**
5. **Make decisions about which storage technologies would be most beneficial for given use cases**
6. **Engage in planning and commissioning of utility scale solar energy projects**

LEARNING EXPERIENCE

A SERIES OF LECTURES BY GERMAN PROFESSORS

Using online technology, we create lectures by renowned German professors.

INTERACTIVE EXCERSICES AND APPLICATIONS

A variety of interactive applications are included in our courses. By practicing and applying their skills in a controlled digital environment, students gain hands-on experience.

INDUSTRY EXPERTS

We connect theory and practice with the expertise of German and international industry experts. As a result, theoretical knowledge is tested on practical showcases.

A LEARNING CONTROL

Students can monitor their progress on an ongoing basis with our self-assessment tools.

ASSESSMENTS

During the course, students take up to two intermediate exams and a final exam created in collaboration with the German professor and monitored using various proctoring tools.
Upon passing the exam, students receive a blockchain-verified certificate of completion.

INNOVATIVE LEARNING PLATFORM

Our fast and interactive learning platform enables students to learn anytime and anywhere.


c Grade Silicon
ic Grade Silicon
silicon atoms
hydrogen gas

Prof. Dr.-Ing. habil.
Stefan Krauter

COURSE INSTRUCTOR

Prof. Dr.-Ing. habil. Stefan Krauter is a leading German expert in renewable energy, specializing in photovoltaics.

- Studied electrical engineering and information technology at the Technical University of Munich
- Earned his doctorate at the Technical University of Berlin
- As an entrepreneur, Stefan Krauter was co-founder of Solon AG, Germany's first listed company for solar technology.
- His international commitment is reflected in his work as an organizer for the RIO World Climate & Energy Events

INDUSTRY EXPERTS AND SHOWCASES

- Rehfelde EigenEnergie
- Reiner Lemoine Institut
- Renergy
- Schletter AG
- SMA
- SUNOTEC

MODULES OVERVIEW

MODULE 1
Introduction to Solar Energy, Solar Irradiance and Semiconductors

MODULE 2
PV Cells

MODULE 3
PV Modules, Measurement and Mounting

MODULE 4
DC Hardware and Inverters

MODULE 5
PV Installations

MODULE 6
Energy Storage and Large-Scale Installation Planning

A self-study learning module includes an introduction, learning objectives, content chapters, and additional resources, including learning control exercises, study notes, and quizzes.

MODULE 1

Introduction to Solar Energy, Solar Irradiance and Semiconductors

01 Introduction to Course and Solar Energy
- Overview of solar energy use
- Discussion of greenhouse emissions
- Solar energy as a renewable resource

02 Solar Irradiance 1
- Solar irradiance from the sun to the earth
- Types of solar irradiance
- Location dependency of solar irradiance and location

03 Solar Irradiance 2
- Irradiance measurement
- Shading
- Energy basics and the solar spectrum

04 Solar Irradiance 3
- Solar declination
- Local solar time
- Calculation of direct irradiance

05 Semiconductors 1
- Atomic structure as relevant for solar cells
- Electron transitions, crystal structure and semiconductor materials
- Energy bands and structures

06 Semiconductors 2
- Charge transport and diffusion currents
- Charge carriers
- Diode behavior

MODULE 2

PV CELLS

07 Manufacture of Silicon Cells 1
- Light absorption
- Direct and indirect semiconductors
- Managing reflection

08 Manufacture of Silicon Cells 2
- Manufacture of electronic grade silicon
- Manufacture of ingots and wafer
- Overview of PV cells

09 PV Developments
- Off grid markets and Feed in Tariffs (FITs)
- Trends in costs and prices
- Regional differences in PV Market growth

10 Electrical characteristics of PV cells 1
- Silicon and silver
- Glass-glass modules
- Electric characteristics

11 Electrical characteristics of PV cells 2
- Electron flow and photocurrent theory
- The characteristic curve and equivalent circuit of solar cells
- Key parameters of solar cells

12 Electrical characteristics of PV cells 3
- One and two diode models
- Theoretical limits
- Maximum current and voltage

13 Electrical characteristics of PV cells 4
- Minimizing optical and electrical losses
- Transmission, electrical, and recombination losses
- High efficiency cell technologies

14 PV Characteristics
- Voltage, current and PV Output
- What is meant by Standard test conditions
- How this varies in real world conditions

15 Non-standard Cell types 1
- Amorphous Silicon Thin-Film Cells
- The Staebler-Wronski Effect in a-Si Solar Cells
- Stacked and Micro-Morph Tandem Cells and Integrated Series Interconnection in Thin-Film Solar

16 Non-standard Cell Types 2
- Chalcopyrite based cells
- Cadmium telluride-based cells
- Multijunction Cells, Dye-Sensitized, and Organic Solar Cells

17 Non-standard Cell Types 3
- Perovskites
- Solar Cell Concentrator Systems
- Environmental considerations, recycling and material availability challenges

MODULE 3

PV Modules, Measurement and Mounting

18 Manufacture and Characteristics of Solar Modules 1
- Manufacture of Solar Modules
- Characteristics of Solar Modules
- Buck and boost Converters

19 Manufacture and Characteristics of Solar Modules 2
- Bypass diodes and hotspot prevention
- Voltage matching in solar systems
- MPP Tracking and a module case study

20 Manufacture and Characteristics of Solar Modules 3
- Half-cell modules
- Shading
- Wiring best practices

21 Optimizing PV Power
- Minimizing Mismatch and Shading Losses
- Real World Conditions and Transmission
- Spectrum, Heat and Efficiency and performance enhancement

22 Potential Induced Degradation (PID)
- Defining Potential-induced degradation
- PID and Electroluminescence measurement
- Voltage-induced Degradation

23 Measurement
- Peak power measurement
- Infrared thermography
- Other thermography methods

24 Mounting
- Mounting and foundations
- Roof, Façade and floating installations
- Agri-PV

25 Costs and MPP tracking
- Electroluminescence measurement
- Balance of System (BoS) costs
- Energy Payback Time and Greenhouse Gas Emissions for PV Production

MODULE 4

DC Hardware and Inverters

26 DC Hardware and Inverters 1
- DC Installations
- inverters
- Voltage and phase management

27 DC Hardware and Inverters 2
- Optimizing inverters
- Inverter configurations and micro-inverters
- Inverter technology and pulse width modulation

28 Transformers and Inverter Efficiency
- Three phase and multi-string inverters
- The European Efficiency Standard
- Inverter sizing

29 Grid connection
- Inverter-Grid compliance
- Feed in limits, reactive power and loads
- Basics of grid stability

30 E-Mob 1
- Lithium-ion car batteries
- E-vehicle batteries
- Inverters needed for e-mobility

31 E-Mob 2
- Charging basics
- Charging restraints
- Charging infrastructure

MODULE 5

PV Installations

32 Manufacture and Characteristics of Solar Modules 1
- Manufacture of Solar Modules
- Characteristics of Solar Modules
- Buck and boost Converters

33 Types of PV Installation 1
- Off grid systems and how to dimension them
- Off grid system use cases
- Home storage

34 Types of PV Installation 2
- Commercial PV installations
- Standalone systems
- Diesel PV hybrid systems

35 Solar Thermal Installations
- Solar concentrators
- Power flow, losses and efficiency variations
- Thermosiphons

36 Introduction to Wind Energy
- Basics of Wind Energy
- Overview of Wind Turbine Components
- Wind Energy Challenges and how Wind PV integration

37 Green Hydrogen 1
- Understanding electrolysis
- Electrolysis thermodynamics
- Temperature and enthalpy

38 Green Hydrogen 2
- Polymer Electrolyte Membrane Electrolysis (PEM)
- Alkaline Electrolysis (AEL)
- High temperature electrolysis and biological processes

MODULE 6

Energy Storage and Large-Scale Installation Planning

39 Energy Storage Overview and Mechanical Energy Storage
- Types of energy storage
- Parameters, characteristics, and comparison of storage types
- Hydropower and pumped storage

40 Mechanical Energy Storage
- Examples of pumped storage
- Compressed air storage
- Flywheels

41 Chemical Energy Storage and Battery Technology 1
- Hydrogen from the viewpoint of energy storage
- Power to gas
- Lead acid batteries

42 Chemical Energy Storage and Battery Technology 2
- NiCads and supercaps
- Lithium-Ion batteries
- Intercalation, materials and costs for Lithium-Ion batteries

43 Chemical Energy Storage and Battery Technology 3
- How to get the best out of your cell-phone battery
- Sodium Sulphur batteries
- Redox flow batteries

44 Planning Large scale PV installations 1
- Technical and non-technical aspects
- The process and process phases
- Concept, pre-feasibility and feasibility checklists

45 Planning Large scale PV installations 2
- Detailed design of PV modules
- Detailed design with respect to inverters
- Detailed design of transformers and mounting structures

46 Planning Large scale PV installations 3
- General design checklists
- Contracting and construction, common mistakes in construction and documentation
- Plant operation and optimization

WE HAVE MORE

Step into the world of boundless knowledge with our comprehensive range of courses. At DADB, we believe in offering a diverse array of educational opportunities that cater to various interests and career aspirations.
From courses in renewable energies to the latest 5G technology, our offerings are thoughtfully designed to empower you on your learning journey. We invite you to explore the next page to discover the rich tapestry of possibilities that await, providing you with the tools and insights needed to excel in today's dynamic digital landscape.

DADB COURSES

INTERNET OF THINGS (IoT)
Prof. Dr.-Ing. Norbert Gronau
University of Potsdam

5G TECHNOLOGY
Prof. Dr.-Ing. Axel Sikora
Offenburg University of Applied Sciences

HYDROGEN TECHNOLOGY
Prof. Dr.-Ing. Thomas Schmidt
University of Applied Sciences Münster

ACCESS OUR COURSES
ACCESS YOUR POTENTIAL
ACCESS THE FUTURE

DA DB German Academy of Digital Education

707, Lodha Supremus,
Senapati Bapat Marg,
Lower Parel West,
HDFC Bank House,
Mumbai City, Mumbai,
Maharashtra, India, 400013

+91 739-666-3644
customersupport@dadb.com
www.dadb.com