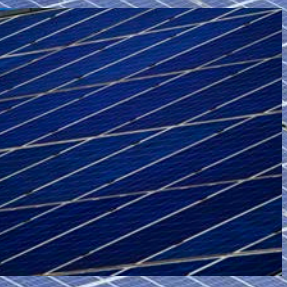
renac
renewables academy

Online Training Programme

Certified PV Professional




CONTENT

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DATE: 26/10/2022

PROGRAMME SUMMARY

Photovoltaic (PV) power generation is rapidly growing as part of the global drive to reduce greenhouse gas emissions, but some of its potential is being held back by not having enough qualified professionals at every level of the PV supply chain. This online programme aims to contribute to solving this problem by upskilling future PV professionals.

The first three courses in the programme provide basic knowledge on PV system components, configuration and sizing, as well as on the economics of various types of PV systems. The following four courses expand on these topics and explore how PV power plants and PV-diesel systems are planned and operated. Additionally, the programme also contains optional courses on energy and electricity topics, making the it suitable to participants with less experience in the energy sector as well.

Certified by

Staatliche Zentralstelle zugelassen zfu Nr. 7422622 für Fernunterricht

TARGET GROUPS

This programme suits you if:

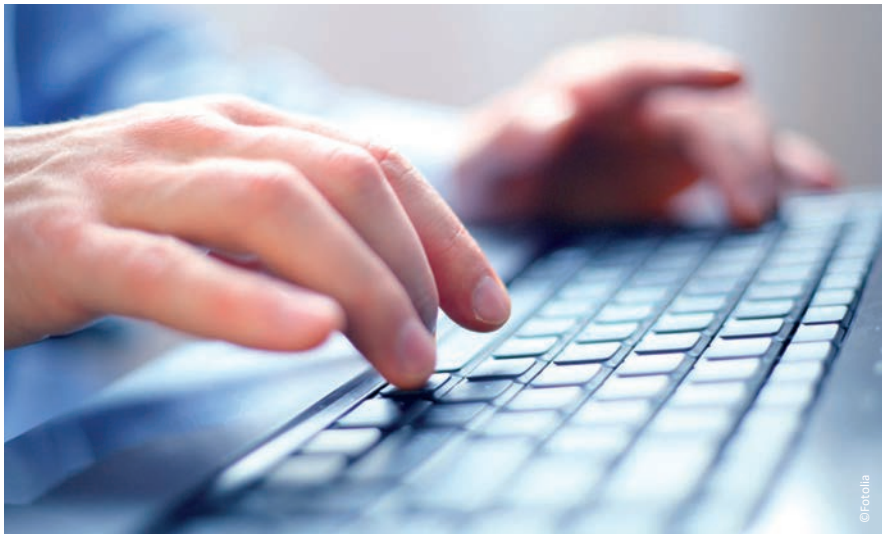
- you are an electrician or an electrical engineer;
- you are starting out in the PV field;
- you would like to install your own PV system; or
- you are interested in rural electrification using solar PV.

To successfully complete this programme, participants should have a basic understanding of financial management, business administration and PV technology. Additionally, an interest in PV and the energy transition are beneficial.

LEARNING OUTCOMES

After completing this programme, participants should be able to:

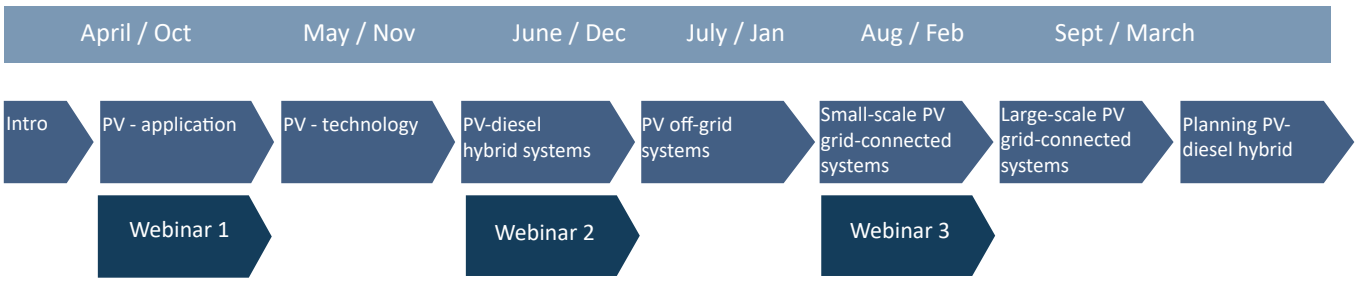
- determine optimal PV system sizes and estimate their corresponding energy yield;
- categorise PV-diesel hybrid systems and evaluate their viability;
- identify the PV system type (off-grid, grid-connected or hybrid) best suited to any given setting; and
- define the planning and implementation steps to ensure the success of a PV project.



PROGRAMME STRUCTURE

MANDATORY COURSES 150 hours	OPTIONAL COURSES 40 hours	EXAM AND CERTIFICATE 2 hours
The compulsory courses that must be taken in order to be eligible to sit the final exam and that make up its content are the following: ▪ PV - application ▪ PV - technology ▪ PV-diesel hybrid systems ▪ PV off-grid systems ▪ Small-scale PV grid-connected systems ▪ Planning of large-scale PV grid-connected systems ▪ Planning of PV-diesel hybrid systems	Participants have access to a range of short introductory courses on energy and electricity topics to learn or revise the basics. These courses are not compulsory, and will not be covered in the exam. ▪ Introduction to energy ▪ Introduction to electricity ▪ Introduction to the solar resource ▪ Introduction to electric grids	▪ Exam and retake covering mandatory courses ▪ Evaluation considering final exam and assignments ▪ Certified PV Professional ▪ Certificate of Attendance

Spring semester / fall semester



Introduction Webinar

INTRODUCTION TO RENAC ONLINE

First week of the semester (1 hour)

The programme will begin with a webinar where participants will meet the managers of RENAC's e-learning platform, get to know the functions of the Moodle platform, and get an introduction to the forum for questions and answers. Programme details and activities, such as assignments, the exam, deadlines, and scheduling, will also be discussed. The webinar is not mandatory, but participation is strongly recommended.

Live virtual lectures

Two live online lectures are part of the online training programme. These live events are not mandatory, but participation is strongly recommended. The lectures cover:

ENERGY YIELD OF RENEWABLES

Midsemester (1 hour)

PV PLANNING ASPECTS

About a month before the end of the semester (1 hour)

Assessment and certificates

RENAC Online Academy programme final marks comprise the marks obtained on the programme's final exam and those from programme assignments, with a weighting of 90% and 10% respectively. The passing mark is 70%. Assignments are short written essays (approximately 500 words) on important course topics.

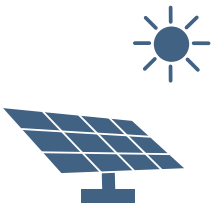
For the exam to be computed in the overall mark, it must also have been passed (i.e. the exam mark must also be over 70%). RENAC certificates and certificates of attendance are sent to participants as PDF files via email. To be prepared for the exam, participants should have covered the courses' content and be able to answer their self-test questions. Participants who do not pass the exam the first time will have the opportunity to take it again once more at a later date. Exam dates and dates for retaking it will be announced during the introductory webinar.

Participants who successfully complete the programme shall receive a RENAC certificate specifying their final score. Participants that complete the programme but do not meet the passing requirements may request a certificate of attendance, provided they have covered the course material.

PLEASE NOTE

RENAC uses plagiarism detection software to detect its presence in submitted assignments. Plagiarism, using someone else's work or ideas as if they were your own, is unacceptable. When completing assignments, participants must acknowledge any work by others that has been included in their answers by referencing its authors.

PV APPLICATION



After completion of this course, participants will be able to:

- describe a range of grid-connected and off-grid PV applications and how they are useful;
- visualise how onsite PV electricity generation can meet daily electricity demand;
- describe solar irradiation around the globe;
- calculate the required spacing between PV module rows to avoid self-shading;
- calculate the basic energy yield from a PV system using peak sun hours and performance ratios;
- explain which factors influence the capital and operating expenditures of PV systems and provide examples of system costs around the world; and
- perform basic calculations of payback times and unit cost of electricity for grid-connected and off-grid PV systems.

Content

Grid-connected PV applications

- Residential PV systems
- Commercial and industrial (C&I) PV systems
- Utility-scale PV power plants

Off-grid PV applications

- Solar home systems
- Telecom towers
- Street lightning
- Refrigeration
- Mobile phone charging
- Water pumping

Energy flow and metering options

- Energy generation profiles
- Metering options
- Energy flow in grid-connected systems with and without storage
- Providing backup power or going off-grid
- Connecting storage systems and the importance of energy efficiency

Solar irradiation and space requirements

- Solar irradiation around the globe and on inclined surfaces
- Space required for the PV array

PV system energy yield

- Peak sun hours (PSH) and performance ratio (PR)
- Energy yield calculations for grid-connected systems
- Available energy for end-users of PV systems with storage

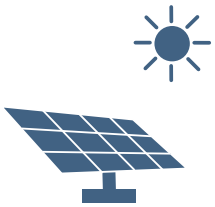
Economics of PV systems

- Capital expenditure, operating expenditure, payback and unit cost of electricity
- Economics of grid-connected PV systems
- Economics and financing of off-grid PV systems

PV TECHNOLOGY

After completion of this course, participants will be able to:

- explain the principles of photovoltaic electricity generation;
- identify the key components of PV and storage systems and explain their interdependence;
- evaluate the quality of a PV system; and
- contribute to the successful realisation of PV projects.



Content

Photovoltaic cells and modules

- The photovoltaic effect and PV cells
- Standard and yield-optimised PV modules
- PV module data sheets
- The impact of shading and temperature

PV inverters

- Inverter types
- Inverter functions
- Inverter string sizing

Battery storage

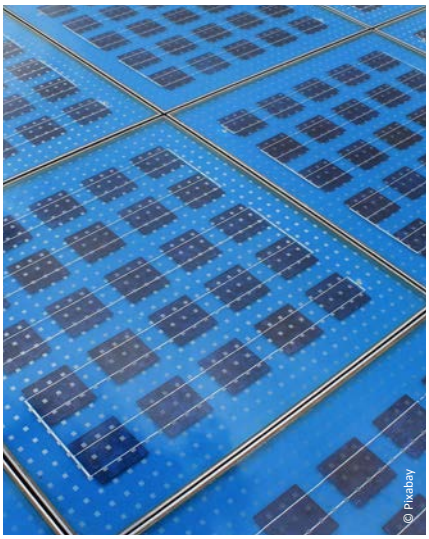
- Storage system functions
- Battery storage technology and applications
- Storage system components

Other PV system components

- Mounting structures
- Electric components
- Monitoring components

Implementing a good PV system

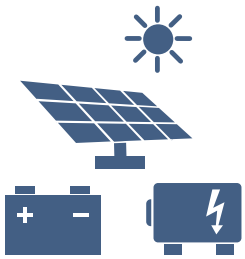
- Engineering phase
- Procurement phase
- Construction and operation



PV-DIESEL HYBRID SYSTEMS

After completion of this course, participants will be able to:

- estimate the potential of, and identify suitable locations for, PV-diesel hybrid systems;
- describe the main PV system components and what they are used for;
- explain the basic parameters for system sizing and dynamic system behaviour; and
- evaluate PV-diesel hybrid systems from an economic perspective.



Content

Basics of PV-diesel hybrid systems

- Access to electricity
- Micro and hybrid power systems
- Grid extension costs
- Categories of PV-diesel hybrid systems

System components

- Structure of small hybrid power systems
- Diesel generators: technical basics, energy transformation process, operation and efficiency
- Balance of systems
- SMA fuel save controller components

System sizing

- Load profile
- Peak load
- Penetration rate
- Energy share
- Generator minimum loading

Dynamic system behaviour

- Behaviour on a sample day
- Different set-ups
- Adding storage
- Energy efficiency and demand side management

Economic analysis

- Lifetime of components
- Cost structure of hybrid systems
- Levelized cost of electricity (LCOE) from pure diesel generator systems
- Levelized cost of electricity (LCOE) of hybrid systems
- Mini-grid vs. single household systems

Case studies

- Vava'u, Kingdom of Tonga
- Palladam, India

PV OFF-GRID SYSTEMS

After completion of this course, participants will be able to:

- distinguish between different off-grid PV system applications and configurations;
- name and explain the required components for off-grid PV systems;
- manage the design, sizing, installation and commissioning of an off-grid PV system; and
- analyse the economic viability of off-grid PV systems.

Content

Applications

- Typical applications and appliances
- Application examples: telecommunications and solar water pumping

System configurations

- Small off-grid PV systems
- Mini-grid and hybrid configurations

System components

- PV modules
- Charge controllers: functions, types and selection
- Maximum Power Point Trackers (MPPTs)
- DC- DC converters
- Inverters: battery inverters, inverter-chargers for DC-coupled off-grid systems, grid-forming battery inverters for AC-coupled off-grid systems and grid-connected PV inverters for off-grid systems
- Batteries: battery types, capacity, rate of discharge (C-rate), depth of discharge (DoD), cycle life
- Batteries: lead acid battery types and their properties and configurations, lithium-ion (Li-ion) battery types
- Mounting structure requirements for off-grid systems and mounting structure types

System design and sizing

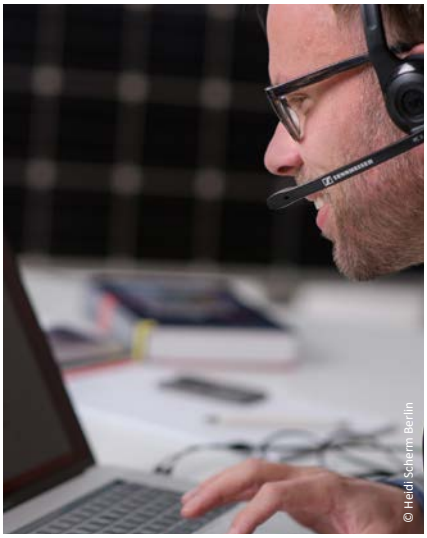
- General steps in system design and sizing
- Load assessment and solar resource assessment
- Orientation, tilt angle and shading
- Design concept and sizing methodology

Installation, commissioning, operation and maintenance

- PV module installation: good and bad practice
- Cable sizing and installation: good practice
- Earthing/grounding: good practice
- Fuses and circuit breakers: good practice
- Lightning/surge protection
- Battery installation: good and bad practice
- Inspection, testing and commissioning
- Operation and maintenance
- Monitoring devices

Economics of off-grid PV systems

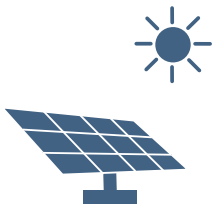
- System costs
- Example: unit electricity cost of an off-grid PV system
- Viability of off-grid PV and advice for policy makers



SMALL-SCALE PV GRID-CONNECTED SYSTEMS

After completion of this course, participants will be able to:

- distinguish between Feed-in-Tariffs (FiTs) and Net-metering remuneration schemes for PV systems;
- name and explain the required components for grid-connected PV systems;
- manage and supervise the design, sizing and installation of a grid-connected PV system; and
- describe the tasks during commissioning, operation and maintenance of a grid-connected PV system.



Content

Introduction to small- and medium-scale grid-connected PV systems

Feed-in tariffs and net metering

Components of grid-tied PV systems

- Photovoltaic modules and mounting systems
- Grid-connected inverters for small- to medium-sized PV systems
- Inverter efficiency
- Inverters with and without transformers
- Other components: cables, fuses/ circuit breakers, disconnects/ isolators, junction/combiner boxes, meters and surge protection

Design and sizing of grid-connected PV systems

- Site surveys and shade analysis for grid-connected systems
- Energy yield, performance ratio and energy losses
- Inverter selection and sizing
- Array-to-inverter sizing factor and sizing considerations
- Cable sizing
- Design, sizing and simulation software

Installation of grid-connected PV systems

- Health and safety considerations
- Installation guidelines, tools, instruments, and other equipment
- Installing PV modules on buildings
- Inverter installation
- DC and AC cable installation
- Module interconnections and interconnectors
- Monitoring equipment
- Earthing/grounding requirements

Commissioning grid-connected PV systems

- Commissioning pre-conditions, safety precautions and instruments
- The commissioning process and system inspection
- Electrical testing and performance testing safety
- System handover, documentation and user training

Operation and maintenance of grid-connected systems

PLANNING OF LARGE-SCALE PV GRID-CONNECTED SYSTEMS

After completion of this course, participants will be able to:

- list and describe the main components making up a PV power plant;
- describe the contracts, studies and permissions required for PV project development;
- list the main project steps from project planning through to system operation; and
- describe the key tasks in assessing and supervising the implementation of a large-scale PV power plant.

Content

Project mission

- Commercial viability of large PV systems
- Supply options

Main system components

- PV modules: PV module standards and certification, limits of module testing, and consequences of mismatching PV modules in PV array strings
- Inverter concepts
- Transformers: types and relative costs
- Switchgear
- Monitoring and control
- Irradiation measurement

Project development

- The life cycle of a large PV plant
- Feasibility studies: site assessment and estimating yield and costs
- Contracts

Project planning

- Yield assessment: solar radiation data sources, landscape topology, technical availability of PV systems, yield assessment and project bankability
- Legal and regulatory issues: permits and licenses, access to the grid and access to the electricity market
- Environmental considerations for site selection
- Infrastructure

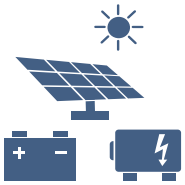
Construction and installation

- Construction and installation planning
- Practical aspects of construction and installation
- System commissioning procedures and documentation
- PV plant decommissioning and dismantling

Operating PV plants

- Monitoring and power output control
- Operating modes

PLANNING OF PV-DIESEL HYBRID SYSTEMS



After completion of this course, participants will be able to:

- distinguish between different system designs and understand their most suitable applications;
- lead a feasibility study to integrate PV into an existing diesel power system;
- explain the functioning of a PV-diesel hybrid system's components, its operating strategies and its optimising potential; and
- assess and supervise the planning and implementation of a PV-diesel power plant.

Content

Introduction to PV-diesel power stations

- Diesel power plants: applications and characteristics
- Global distribution of diesel plants
- Off-grid sectors and target groups for hybridisation projects
- PV-diesel hybrid systems: conditions for economic attractiveness

Assessing project feasibility

- The importance of accuracy in data collection and processing
- Typical load profiles and their monitoring and assessment
- Load profile projections
- Diesel engines and generators, electric generators, and operational limits of diesel gensets
- System stability in diesel-based mini-grids
- Example study

Technical aspects of conversion from diesel-only to PV-diesel hybrid

- PV-diesel hybrid system control and mini-grid internal communication infrastructure
- Sensors and actuators
- Active and passive control systems
- Load-driven control in mini-grids: spinning reserves and N+1 criteria
- PV-diesel hybrid system limitations
- Electrical protection in mini-grids and operational strategies
- Effects of PV-hybridisation on diesel generator operation and effect of hybridisation on diesel generator working lives
- PV-diesel hybrid system dynamics and fluctuating PV power output
- Frequency deviations, voltage fluctuations and inrush currents on mini-grids

Additional options to optimise systems

- The impact of a diesel generator setup on mini-grid performance
- Storage technologies for mini-grids
- Lead-acid and lithium-ion batteries
- Battery integration, management and control
- System stability and energy storage

Financial analysis – key parameters

- Cash flow structure and LCOE for diesel-only and PV-diesel hybrid systems
- Influence of financing costs on cash flows

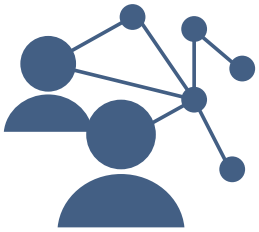
Installation, commissioning, operation and maintenance

- Pre-Installation checklist
- Installation and preparation for commissioning
- Commissioning
- General plant maintenance
- System operation, control and monitoring

RENAC ONLINE

The Renewables Academy (RENAC) AG is a leading international provider of training, educational, and capacity building services on renewable energy technologies and energy efficiency. Since 2008, more than 25,000 participants from over 160 countries have taken part in RENAC training courses and programmes. We are convinced that knowledge and skills are the key to the sustainable development of clean and secure energy supplies and it is our mission to provide this knowledge and skills to as many people as possible.

As part of this mission, our Online Academy was founded in 2019. Today, RENAC´s Online Academy offers over 30 short courses and programmes, with participants learning with us from the comfort of their own homes around the globe.



RENAC Online helps you:

- Boost your professional career
- Study with flexibility following your own schedule
- Learn at any time and from any location

RENAC Online staff are:

- Certified e-learning trainers
- Experienced professionals
- In direct contact with industry

CERTIFIED EUROPEAN E-LEARNING MANAGER

Demo course

- We invite you to visit our online platform demonstration course:
- http://renewables-online.de/blocks/demologin/logindemo.php?course=Demo

"My experience in attending Renac training is that it greatly enhances and validates my insights about solar PV plants and everything about it."

Aripriantoni Harmanto, Certified PV Professional, 2020

LEARNING WITH RENAC ONLINE

Learning with RENAC Online is done asynchronously in two steps. First, participants work through each course's content, and then get the opportunity to apply the newly acquired knowledge and skills, consolidating them in their minds. In practice, both steps are accomplished in several ways. Programmes also contain written assignments with feedback from RENAC that not only further reinforce learning outcomes but may also complement their exam marks.

Text and images

Courses are organised into short, instructional chapters with illustrations. Learners are guided through the material step by step.

Online Forum

A discussion forum helps to support students and foster communication between them and with RENAC. This forum is monitored by RENAC staff and experts who can provide technical assistance and discussion about course topics.

Assignments

Programmes contain written assignments with individual feedback from RENAC.

Self-tests

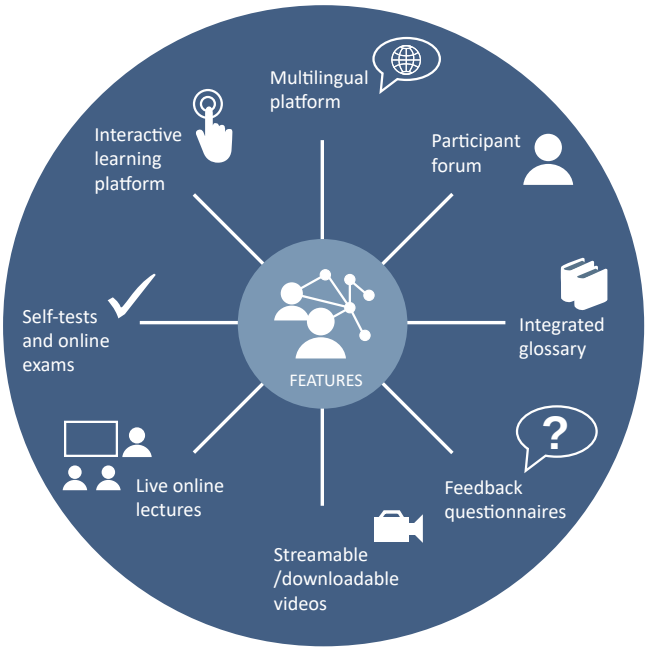
Self-tests within each course help participants assess their knowledge.

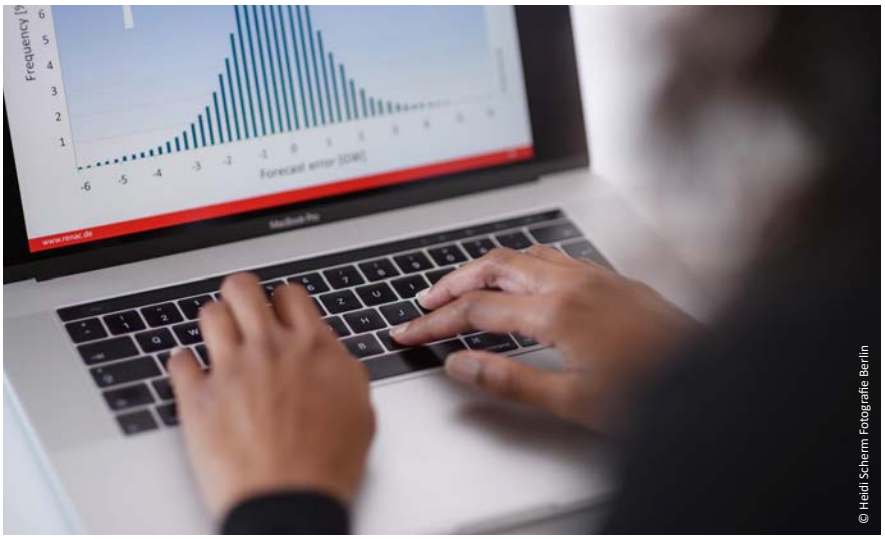
Videos

Recorded lectures cover some of the most important topics in a visual and engaging way.

Live virtual classroom

It is recommended that participants attend live virtual lectures, which are given by RE experts. During and after lectures, participants are invited to chat about topics and issues in the live online forum.

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Practical Information

START DATES

1 April / 1 October

Spring semester and fall semester each year

RECOMMENDED STUDY TIME

About 150 hours in total.

DURATION

3–5 weeks per course

6 months to complete the entire programme

ASSIGNMENTS

Programmes are designed for a continuous participation, from the beginning of the semester until the final exam, and contain short assignments.

Assignments are short written essays or exercises involving other multimedia elements that need to be handed in by deadlines so they can count to improve the final grade of the exam.

TECHNICAL INFORMATION

You need to provide an email address in order to register and create your account, where you will receive course updates and feedback. You need access to a device with a reliable internet connection (at least 2 Mbit/s). This may be a mobile device, but we recommend using a computer. Live virtual lectures and orientation take place on Zoom, so you also need a headset or speakers to listen to the presentations.

REGISTRATION

You can register online at:
www.renac.de/online-academy

REGISTRATION DEADLINE

30 September / 31 March

FEE

EUR 1,380.00 including 19 % of German VAT

DISCOUNTS

Early bird 10%; group (2 or more) 5%; combination of both 15%; Alumni 10%

EARLY BIRD DISCOUNT DEADLINE

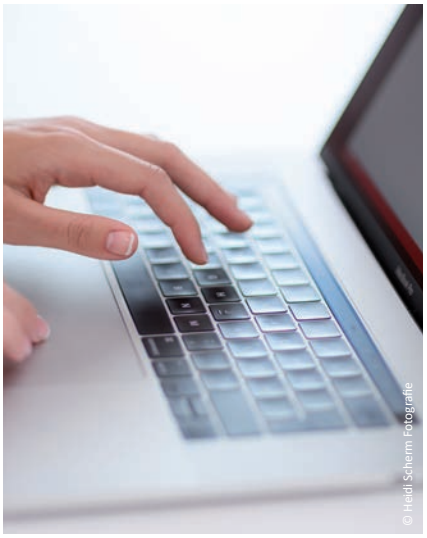
20 August / 20 February

PAYMENT METHODS

VISA, MasterCard, PayPal, American Express, or bank transfer

Q1

Start of semester:
1 April and
1 October



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