renac
renewables academy

Renewables Academy Online

Certified ReGrid® Manager (CRGM)

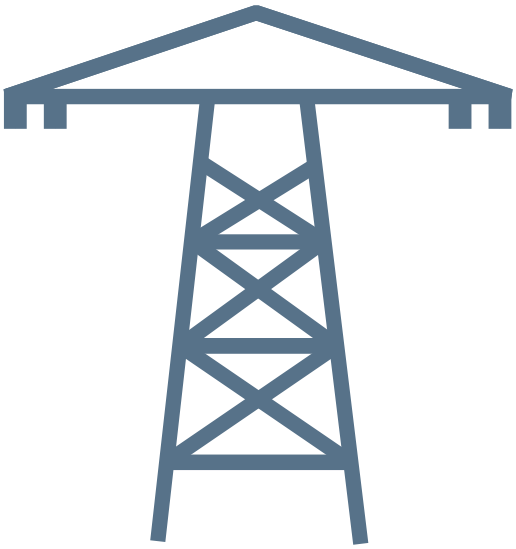
Online training on Grid Integration of Renewable Energy







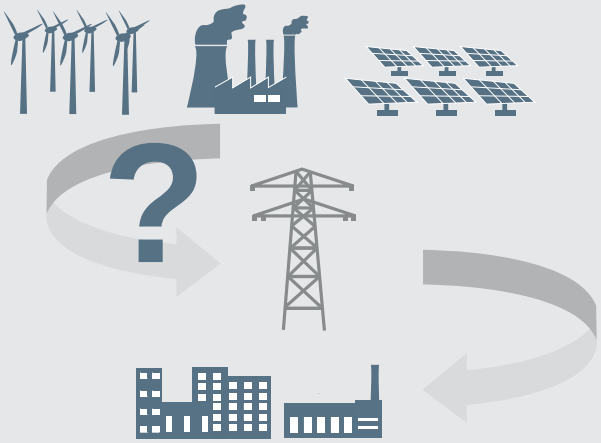
Certified ReGrid® Manager (CRGM)



What is “ReGrid®”?

This online training demonstrates how a high amount of variable renewable energy (wind and solar) can be safely integrated into the electricity supply. It shows which steps are essential for the power system transformation.

The online training was developed within the ReGrid® programme on „Capacity Building on Integration of Large Amounts of Renewable Energy into the Electricity Grids“ within the German International Climate Initiative (ICI) from 2011 to 2013. Since then, RENAC offers this training to interested professionals worldwide and regularly updates the training material. More than 250 experts working for grid operators, energy supply service companies, energy ministries, regulators, project developers or consultants in more than 10 countries have successfully completed the training.



Who should join the „Certified ReGrid® Manager (CRGM)“ online training?

This training suits you if you

- plan or operate power systems with an increasing share of wind and solar
- need to manage resulting transformation processes in the energy system
- are involved in other aspects of VRE grid integration, e.g. calls for tender, development of grid codes or grid connection studies for renewables
- are a master student and want to complement your studies in electrical engineering or other engineering fields

The main target group for the seminars are professionals in the energy sector with an engineering background. If you are not an engineer but have working experience in the context of power systems, you are also invited to participate: You will learn how engineers solve grid integration problems and acquire the background knowledge for successful communication with technical staff.

Prerequisites

Are you new to renewables?

Within the Renewables Academy Online, „Applying Renewable Energy – large scale systems“ is a good preparation for this online training. It can be booked by those who would like to build up or refresh their knowledge on photovoltaic, wind, and concentrating solar power (CSP) technologies. Participants who are enrolled in “Applying Renewable Energy” can get early access to the „Certified ReGrid(R) Manager (CRGM)“ courses of the following semester.

Renewable energy technologies covered by Applying Renewable Energy

Optional courses on grid integration and financial aspects of renewable energy

Large-Scale Systems (3 courses)

Fee: 460 Euro
Duration: approx. 2 – 3 months
Study time: approx. 60 hours

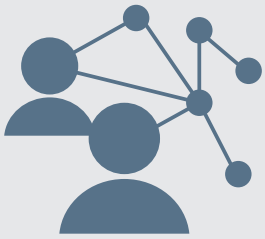
Prerequisites (math)

The courses on generator concepts, grid codes, and grid integration studies cover advanced engineering topics.

To be able to understand the content of these courses, participants should be familiar with mathematical concepts (complex numbers, matrix algebra, differential and integral calculus, sine and tangent function, phasor/vector diagrams). However, to solve the exercises in these courses, and to pass the exam, participants do not have to actively perform this type of calculations, and they do not have to program models.

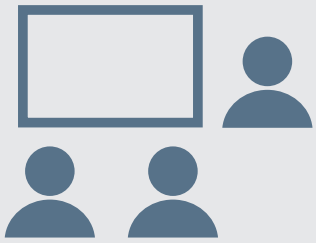
Certified ReGrid® Manager (CRGM)

RENAC Online



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 offers extensive support & interactive learning:

- Videos
- Graphics
- Exercises for self-evaluation
- Discussion forum
- Virtual classrooms

RENAC Online staff are:

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

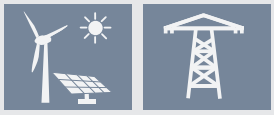
CERTIFIED EUROPEAN E-LEARNING MANAGER

Learning objectives

After the online training, participants will be able to:

- identify challenges and solutions for grid operation with large shares of VRE
- discuss different flexibility options (in grid, storage, generation and demand)
- name the regulatory requirements for large shares of VRE
- manage resource assessment, grid expansion and grid impact studies

Courses



Introductory courses

Each participant will have access to short introductory courses on energy and electricity topics to learn or revise the basics. These courses are not mandatory, and will not be covered in the exam.

Two course intakes per year:
1 April and 1 October!

CRGM courses

The online training comprises of eight courses:

- Highly resolved scenarios for grid integration of wind and solar power
- Short term prediction of wind and solar power generation
- Generator concepts for renewables
- Balancing power for grid integration of renewables
- Grid codes for renewables
- Generation expansion planning for a high share of wind and solar power
- Grid integration studies and system integration studies
- Energy storage

Fee: 2.210 Euro
Duration: 6 months (3 weeks per course)
Study time: 5 – 10 hours per week, approx. 200 hours in total

Schedule

The courses will be online:

Spring and fall semester each year
Start date: 1 April / 1 October

Recommended study time:

5 – 10 hours per week
approx. 20 hours per course

Resulting duration:

3 to 5 weeks per course, 3 to 6 months for the entire training depending on the number of courses.

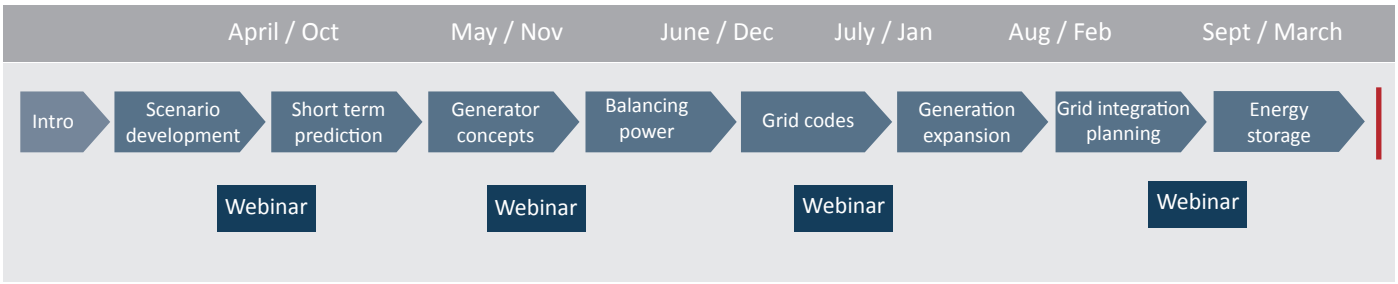
Assignments:

The courses are designed for a continuous participation from the beginning of the semester until the exam. There is an assignment for each course, which counts towards the final grade. Participants are asked to write a short statement regarding an important topic of each course. Assignments need to be handed in by the deadlines.

Scheduled exam dates:

Participants can take the exam after 4, 5 or 6 months

Spring semester / fall semester



Live Virtual Classrooms (Webinars)

Four live virtual classroom sessions (1 hour each) are part of the CRGM online training. These live events are not mandatory, but participation is strongly recommended.

Webinar 1
Introduction to RENAC Online
First week of the semester
(1 hour)

Webinar 2
Introduction to the CRGM Online Training
Mid of semester (1 hour)

Webinar 3
Energy yield of renewables
Mid of semester
(1 hour)

Webinar 4
Residual load calculation
End of semester
(1 hour)

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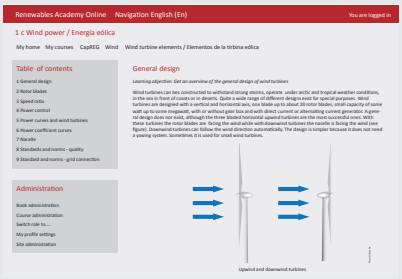
Why choose RENAC Online?

Self-study material

1 Text and Images

Courses are structured in small, illustrated units of instruction; learners are guided through the material step-by-step.

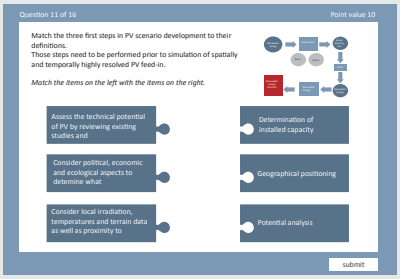


2 Videos

Video lectures explain some of the most important topics in a visual and entertaining way.

3 Tests

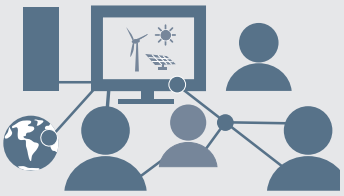
Many self-assessment tests within each course help participants to test their knowledge.



Extensive support

1 Forum

Support and communication take place in a discussion forum. RENAC monitors the forum constantly. RENAC experts are ready to give assistance and discuss the course topics.



2 Assignment

After studying each course, participants are asked to answer an assignment question. RENAC gives individual feedback for these assignments.

3 Virtual classroom

Participants should attend the live virtual classroom sessions (webinars). These are conducted by renewable energy experts. During and after the presentation participants are invited to discuss in the live chat.

Certificate

All participants who score above 70% in the final online exam will receive a printed RENAC certificate. All others will receive a certificate of attendance per e-mail.

For Spanish-speaking participants (upon request):

- Course texts and self-tests in Spanish
- Videos with Spanish subtitles
- Support by a Spanish-speaking tutor

Live virtual classrooms (webinars) for the whole class and exams are held in English language only.

Learning objectives and content of the courses

Highly resolved scenarios for grid integration of wind and solar power

Learning objectives

- Understand how temporal/spatial highly resolved feed-in time series for PV, wind, CSP are developed
- Learn how to develop a simulation environment for PV, wind, and CSP .

Content

Aims and tools for scenario development

- Basics of future scenario analysis
- Characteristics of fluctuating renewable energy supply
- A future scenario example – Germany's Grid Development Plan
- A future scenario example
- Tools and methods for developing feed-in time series

Scenario development for wind

- Introduction: how to develop a wind scenario for wind turbines
- Meteorological data for the simulation model
- Physical model for wind turbines

Scenario development for PV

- Introduction to scenario development steps for PV
- Data requirements
- Solar geometry and calculation of global irradiation on a tilted surface
- Basics of PV power output calculations
- Calculation of the power output for a specific module or/and capacity in a certain regions

Scenario development for CSP

- Introduction to scenario development steps for CSP
- Potential analysis for CSP, meteorological data
- Solar differential fraction models
- Physical model of a CSP plans

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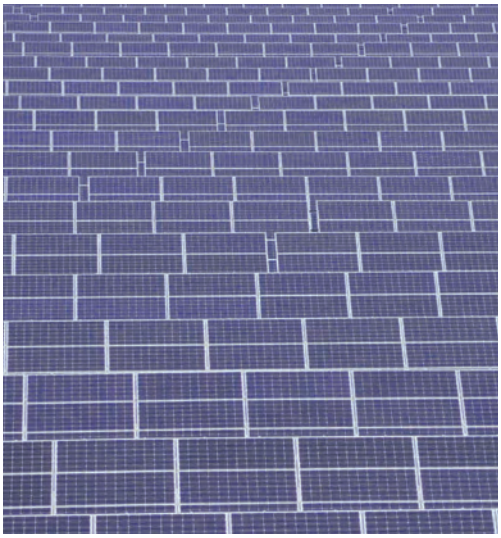

Short term prediction of wind and solar power generation

Learning objectives

- Explain the forecasting of RE generation and flexibility of power plants,
- Distinguish different renewable power forecasting systems and
- Define and calculate forecast errors.

Content

Purpose and area of application

- Introduction to purpose and area of application
- Scheduling
- Forecasting (for grid operation, construction and maintenance and trading of PV and wind power)

From weather prediction to power prediction

- Introduction
- Weather data, weather to power
- Numerical Weather Prediction (NWP)
- Weather-to-Power model
- Forecast errors

Forecast for a grid control centre

- Introduction
- Implementing a forecast
- Lessons learned
- Conclusions

Generator concept for renewables

Learning objectives

- Explain AC power generation concepts for grid connected fixed and variable speed generators
- Describe wind turbine concepts, market shares, advantages and disadvantages
- Present PV systems (DC generators, main components, single phase and three phase inverters)

Content

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Balancing power for grid integration of renewables

Learning objectives

- Explain the necessity of balancing power and the role of the grid operator
- Distinguish concepts of primary reserve, secondary reserve and minute reserve
- Determine balancing power requirements with probability functions
- Describe auctioning procedures and the Merit Order concept

Content

Balancing power: purpose, types and definitions

- Purposes of balancing power
- Types of reserves: short, medium, long-term

Calculation model

- Combining stochastically independent discrete density functions
- Variable renewable energy
- Power plant outage models

Supply of balancing power

- Restrictions (technical, regulatory framework, prequalification criteria, market design)
- Merit order and balancing power provision from RE

Grid codes for renewables

Learning objectives

- Describe the purpose, use and content of grid codes
- Distinguish Point of Connection (POC) and Point of Common Coupling (PCC)
- Explain frequency range of operation and voltage range of operation
- Aanalyse power quality aspects (e.g. reactive power capability)

Content

Development and purpose

- Purpose and need for grid codes
- Grid codes and renewable generation

Grid code structure

- Overall structure
- Point of Connection (POC) and Point of Common Coupling (PCC)

Technical requirements

- General considerations
- Frequency range of operation
- Voltage range of operation (during normal operation)
- Power quality aspects
- Reactive power capability
- Voltage/reactive power control requirements
- Frequency response/active power control requirements
- LVRT/HVRT Capability
- Reactive current support during LVRT/HVRT situations
- Active/reactive power requirements during voltage recovery
- Grid code compliances

Generation expansion planning for a high share of wind and solar power

Learning objectives

- Describe the purpose of generation expansion planning
- Explain factors influencing the Capacity Credit of VRE
- Illustrate load duration and Residual Load Duration Curve
- Name standard software tools: WASP model and PLEXOS model

Content

Generation adequacy

- Introduction: The Generation Adequacy problem
- Reliability indices and analysis methods
- Reserve margin

Capacity credit of variable renewable energies

- Introduction
- Definition of the capacity credit of VRE
- Capacity Credit of VRE
- Factors influencing the capacity credit of VRE
- Capacity credit of individual VRE plants
- Regional capacity credit
- Definition of reserve margin in systems with a high share of VRE

Impact of VRE on generator dispatch

- The unit commitment/generator dispatch problem
- Load duration and residual load duration curve
- Modelling approaches for the inclusion of wind and PV generation
- Load duration and residual load duration curves

Standard software tools for generation expansion planning

- The WASP model
- The PLEXOS model

Grid integration studies and system integration studies

Learning objectives

- Explain different types of grid and system integration studies,
- Name relevant aspects and relevant time frames of such studies and
- Paraphrase study methodologies to explore the impact of wind/PV plants on the grid and on power system operation

Content

Purpose and typical topics

- Scope and time frame of studies
- Technical content of grid and system integration studies

Grid integration studies

- Modelling aspects
- Case definition
- Generator dispatch
- Impact on thermal component rating
- Limiting wind plant output
- Impact on voltages
- Voltage variation and voltage stability
- Short circuit studies
- Power Quality Studies
- Rapid voltage changes, flicker
- Harmonic impact studies

System integration studies

- Reliability – Security – Stability – General definitions
- Impact of wind and PV generation on system security
- System stability - background
- Frequency stability
- Impact of wind and PV generation on frequency stability (Inertia, control)
- Frequency stability and FRT
- Impact on voltage stability

Typical scope of work for grid and system integration studies

- Example 1: Grid impact study for a single wind farm
- Example 2: System impact study for numerous planned wind and PV farms
- Summary of typical scope of work
- Frequency stability and FRT
- Impact on voltage stability

Energy storage

Learning objectives

- Present the purpose of energy storage and its future role
- Classify storage technologies
- Calculate specific costs and compare different economic aspects
- Explain complementarities of storage systemsn

Content

Introduction, terminology and parameters

- Motivation and purpose
- Storage requirements and magnitude
- Energy density
- Terminology and parameters

Applications

- Introduction to applications
- Classification of storage technologies
- Short-term storage
- Medium-term storage
- Long-term storage
- Island grids
- Electromobility, heat storage, residential energy storage, industrial energy storage and Uninterruptible Power Supply (UPS)

Mechanical energy storage systems

- Introduction to mechanical energy storage
- Flywheels
- Compressed Air Energy Storage (CAES) systems
- Pumped hydro storage
- Summary of mechanical energy storage

Electrical and thermal energy storage systems

- Introduction to electrical energy storage
- Super Capacitors (SuperCaps)
- Superconductive Magnetic Energy Storage (SMES)
- Summary of electrical energy storage
- Thermal energy storage systems (high temperature)

Chemical energy storage systems

- Introduction to chemical energy storage
- Internal storage systems: Lead acid battery, lithium-Ion batteries, sodium sulphur battery (NaS)
- External storage: Redox flow batteries, gas storage - hydrogen, gas storage - methanation

Economics of energy storage systems

- Introduction to Economics
- Costs for energy storage
- Competition of technologies

Wind and PV Grid Integration

Learning objectives

- Explain the use and development of time series for variable renewable energy
- Present the basics about power system operation, scheduling and forecasting
- Describe the purpose and types of balancing power and management of grid congestion
- Discuss capacity planning methodologies, grid codes and the development of grid studies

Content

Time series of variable renewable energies

- Characteristics of renewable energies, development steps for time series
- Time series for wind energy, metrological data for wind
- Accounting for wake losses in a wind park
- Time series for PV, data requirements for PV time series
- Solar geometry

System Operation: Scheduling And Forecasting

- Introduction to system operation
- Residual load and scheduling
- Forecast for: Scheduling, grid operation, trading, horizons, forecasting systems
- Wind forecasting – physical and statistical approach, PV forecasting
- Forecast errors – Types and examples

Balancing Power Calculation Methodology

- Purpose and types of balancing power
- Quantification of balancing power
- Restrictions in balancing power supply

Management Of Grid Congestion

- Definitions; load flow calculation methods
- Prevention and adjustment of congestion
- Dynamic line rating

Capacity Planning

- Generation adequacy
- Reliability indices
- Analysis with residual load duration curve
- Capacity credit for variable renewable energies

Grid Code Development

- Purpose and need for grid codes
- Grid codes for renewables, elements of a grid code
- Frequency range of operation considering renewables
- Voltage and reactive power control considering renewables

Grid And System Integration Studies

- Purpose and general considerations
- Questions to ask
- Typical content, case definition and selections

Certified ReGrid® Manager (CRGM)

Registration and discounts

Registration:

You can register for the Applying Renewable Energy online training via the registration form at:

www.renac.de/trainings-services/trainings/open-trainings/produkt/certified-regridr-manager/

Deadlines:

Early bird deadline: 20 August / 20 February

Registration deadline: 22 March / 22 October

Participants who are not able to finish the online training in one semester can book an extension of 6 months (following semester) at a 80% reduced course fee

Discount:

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

Payment:

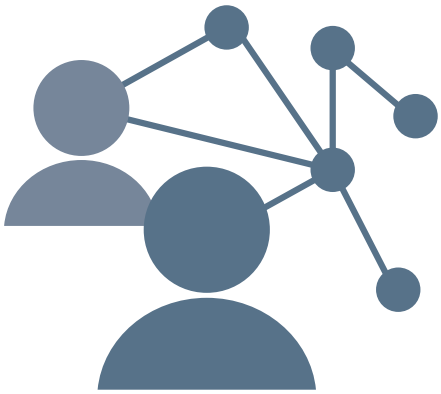
VISA, MasterCard, American Express, invoice

Technical information

You need to provide an e-mail address, which you check regularly. Furthermore you need a computer with a stable internet connection (at least 2 Mbit/s). For webinars, the AdobeConnect add-in or app should be installed, and a headset or speakers are required to listen to the presentation.

Demo course

For a first impression of our online platform, have a look at:
http://renewables-online.de/blocks/demologin/logindemo.php?course=Demo



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