renac
renewables academy

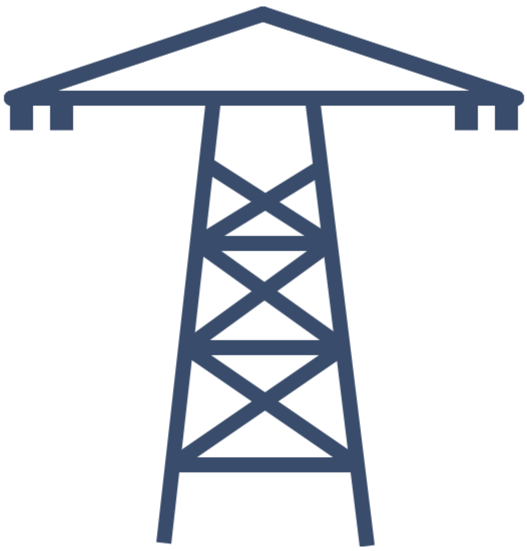
EnerTracks

Renewables Academy

EnerTracks Online Training

“Energy Transformation Expert”

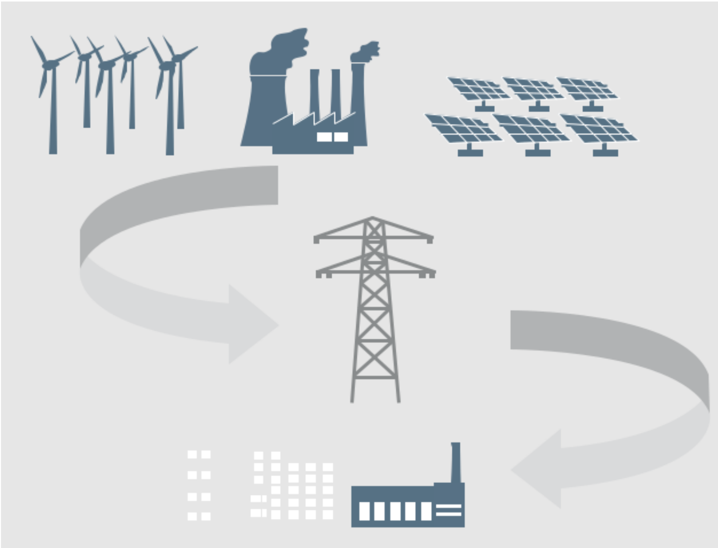
Table of Content



1 What is "EnerTracks Online Training"?

This online training will prepare a large number of participants to manage the challenges connected to power system transformation and decarbonization better. The online training was developed within the wider scope of the EnerTracks project held in conjunction with our partners AGORA Energiewende.

The online training is part of the EnerTracks project and is supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety through the German International Climate Initiative (IKI).



1.1 Who should join the „EnerTracks Online Training"?

This training suits you if you:

- are a citizen of one the eligible countries
- are working in the energy sector and willing to work on decarbonisation and increased flexibility of power systems
- have a sincere interest in tackling climate change issues and the energy transformation in your home country

1.2 Learning objectives

After the online training, participants will be able to:

- Explain technical, economic and organisational principles of power systems
- Analyse suitable policies and mechanisms for a low-carbon power system transformation
- Distinguish and compare different technical flexibility options suitable for power systems to compensate fluctuating power generation from renewable energy systems
- Evaluate the impact and suitability of current trends in the energy sector regarding power system transformation

2 Who will receive the certificate "Energy transformation expert"?

- Candidates who complete all four modules successfully will receive an additional certificate under the title "*Energy transformation expert*".
- Each of the four modules will end with an exam. All participants who score above 70% in the final online exam will receive a RENAC certificate. All others will receive a certificate of attendance per e-mail.
- Candidates who work through the online assignments in each module will receive a 5% bonus for the exam.
- Candidates who missed module 1 and 2: RENAC will open the modules again at the beginning of 2020. This shall give persons who joined the programme at a later date the chance to be certified as an "*Energy transformation expert*".

3 Courses

The online training of the EnerTracks programme comprises four modules. These modules can be taken as a consecutive programme, but also individually, as each module stands for itself. Module 1 offers a general introduction to power system transformation while Module 2 explores on the economic and political frameworks surrounding energy transitions. Module 3 delves into more technical aspects such as grid integration of renewable energy systems and flexibility options. Finally, module 4 will bring the online training segment to a close with a look at new trends and their potential to shape future power systems.

3.1 Module 1: Introduction to power systems

Section	Warm-up	Power system components			Flexibility concepts		System design			
Week	1	2	3	4	5	6	7	8	9	10
Course	Introduction to energy Introduction to electricity	Introduction to electric grids (10h)	Overview of power generation technologies (10h)		Flexibility options for power systems (10h)		Introduction to power systems and markets (10h)			Final test
Live events	Introduction								Power Systems	
Assignments										

Course: Introduction to electric grids

Learning objectives:

Upon completion of this course, participants will be able to

- explain the basic technological terms and principles governing the operation of electrical power
- systems,
- explain the importance of frequency and voltage stability for electric grid operation,
- describe the parameters that affect frequency and voltage stability in electric power grids and
- distinguish impacts that conventional power plants and RE power plants have on the operation of a power grid.

Content:

- Structure of electricity grids
  - Elements, voltage, AC vs. DC, conventional power plants, new paradigm
- Secure operation of electricity grids
  - Quality and security of supply, operating states, frequency and voltage stability

Course: Overview of power generation technologies

Learning objectives:

Upon completion of this course, participants should be able to:

- describe how different thermal power and renewable energy generation technologies work in principle
- compare power generation technologies based on different cost aspects
- explain global trends of power generation technologies in terms of investments

Content:

- Conventional power generation technology
    - Nuclear power plants, coal power plants, open cycle gas turbines and combined cycle gas turbines
- Renewable electricity generation technologies
    - Hydropower and pumped storage, wind energy, photovoltaic (PV), concentrated solar power (CSP), biomass (solid biomass and biogas) and geothermal power
- Cost comparison of power generation technologies
    - Metrics for cost comparison, LCOE, marginal cost, external cost and grid parity

Course: Flexibility options for power systems

Learning objectives:

Upon completion of this course, you should be able to

- explain the key role of flexibility in successful power system transformation
- describe different flexibility options and name important measures
- formulate the framework for a cost-effective power system transformation

Content:

- Power system transformation
    - Impact of variable renewable energy (vRE), value of flexibility and optimised management of vRE development
- Flexibility options
    - Grid infrastructure and management, storage, demand-side integration, dispatchable generation and flexible thermal power plants
- Cost of flexibility
    - Levelised cost of flexibility, transmission grids, distribution grids, storage, small-scale DSI, large-scale DSI, dispatchable generation and flexibility investment plan
- Market frameworks
    - Role of short-term markets

Course: Introduction to power systems and markets

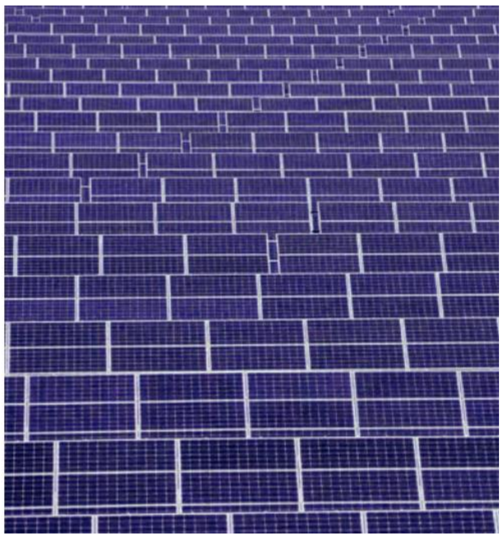
Learning objectives:

Upon completion of this course, you should be able to

- describe the elements of a power system
- distinguish and characterise the five models of power system design
- explain what role competition plays in each of the five models
- identify principles of power market design, architecture and respective rules

Content:

- Key elements of electricity system
  - Planning, dispatch, system operation and pricing
- Current structures of the power sector models
  - Characteristics of vertically integrated market model, single-buyer model, partially unbundled (unbundling) model, whole sale market model and retail competition model
  - Further characteristics: reliability standards and options, energy only market and capacity market



3.2 Module 2: Policies supporting energy transformation

Section	Warm-up	International frameworks	National policy frameworks	Focus on carbon	
Week	0	1 2	3 4 5 6	7 8 9	10
Course	Introduction to energy Introduction to electricity	International climate policy and national implementation (10h)	Policy frameworks for RE power generation (20h)	Carbon pricing mechanisms (20h)	Final test
Live events		Introduction	(live event)	(live event)	
Assignments			(assignment)	(assignment)	

Course: International climate policy and national implementation

Learning objectives:

Upon completion of the course, you should be able to:

- understand the basics of climate science behind the Paris Agreement
- know important milestones in the history of the road to the Paris Agreement
- know the basic elements and architecture of the Paris Agreement (goals, nationally determined contributions (NDCs), transparency framework and global stocktake)
- understand how international agreements like the Paris Agreement with its core elements, the NDCs and sustainable development goals (SDGs), promote RE development
- understand the linkages between SDGs and NDCs
- understand the implications of a country's NDC
- understand how international climate policy can help to integrate and mainstream national climate policy options to support renewable energy deployment
- relate the periodic elements of the Paris Agreement to national policy processes with respect to key components such as national implementation, procedure of monitoring, reporting and verification (MRV) and revision/update of subsequent NDCs
- reflect about the role of Co-Benefits in the Paris Agreement and the SDGs

Content:

- IPCC reports (climate impact scenarios and pathways to 1.5°C /2°C)
- UNFCC, UN sustainable development agenda
- Paris Agreement (goals, NDCs, transparency framework and global stocktake)
- NDCs – means of implementation (finance, technology, capacity building)
- Key actors, participatory processes
- Measuring progress
- Understand national enabling political environments and policies

Course: Policy frameworks for renewable energy power generation

Learning objectives:

Upon completion of the course, you should be able to:

- analyse the most widely used support mechanisms for renewable energy (feed-in tariff, net-metering, auction, etc.)
- analyse and design the most widely used support mechanisms for renewable energy (feed-in tariff, net-metering, auctions and other schemes)
- determine conditions to design successful support mechanisms or regulatory policies
- discuss suitability of policy regulations for different phases of the energy transition

Content:

- Introduction to renewable energy policy and target setting
    - Objectives of renewable energy policies, renewable energy target setting, categorisation of support mechanisms
- Net-metering for distributed generation
    - Cost development, grid parity, net metering and risks of self-consumption policies
- Feed-in tariffs for distributed generation and large-scale projects
    - Feed-in tariff (FiT) design, tariff calculation, tariff degression, capacity caps and feed-in premiums
- Competitive procurement/auctions for large-scale projects
    - Auction results, auction design, procurement schedule, price-finding mechanism, penalties for non-compliance, pre-qualification and selection criteria
- Additional incentives
    - Tax incentives, tax credits, accelerated depreciation, low-interest loans, quota-based mechanisms, corporate power purchase agreements (PPAs) and general framework conditions
- Policies for smooth technical and market integration of renewable energy
    - Location-specific FiTs and auctions, renewable energy curtailment and system integration and priority dispatch of renewable energy

Course: Carbon pricing mechanisms

Learning objectives:

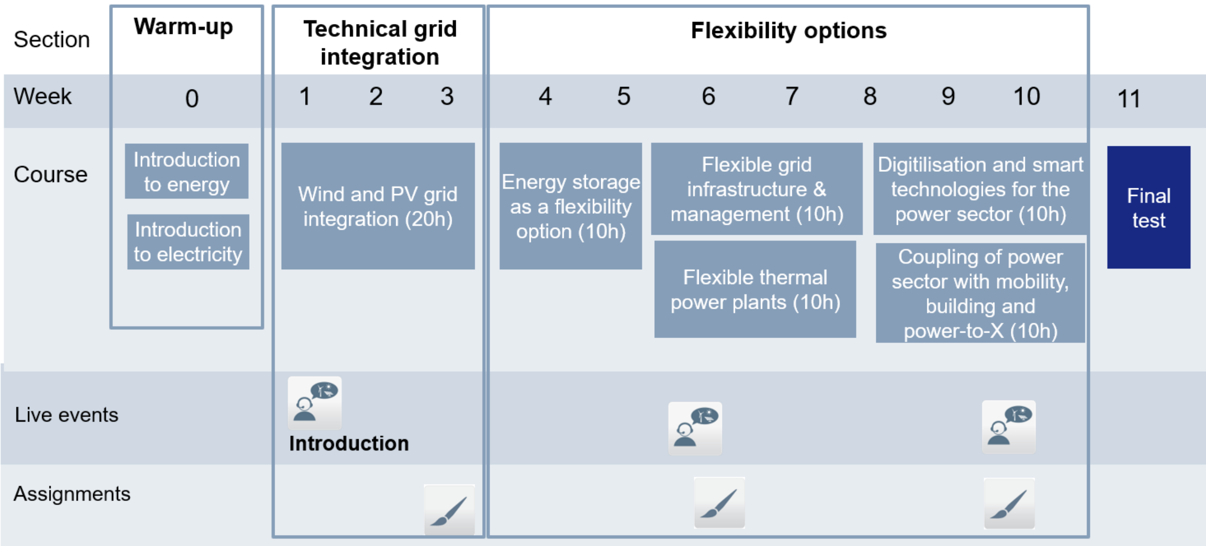
Upon completion of the course, you should be able to:

- comprehend the rationale for economic instruments in the context of climate change (carbon pricing mechanisms)
- explain major historical developments in carbon pricing and illustrate the global landscape of carbon pricing mechanisms
- understand and explain the different basic design features and principles of carbon pricing mechanisms (i.e. carbon tax and emission trading schemes and offsetting mechanisms)
- discuss major barriers to, key success factors of, and prospects for carbon pricing mechanisms in the economy and energy projects
- know how to get started with carbon pricing (i.e. identify and select respective instruments and partners)

Content:

- Introduction to carbon pricing mechanisms
  - Global landscape of GHG emissions, comparing GHG emission reductions, rationale for putting a price on carbon, carbon pricing mechanisms and their basic principles, relevance for national energy transition and emission performance standards
- Evolution of carbon pricing mechanisms
  - Emissions trading: the EU emissions trading scheme, other emissions trading schemes, carbon taxes in the OECD countries and emerging markets, clean development mechanism (CDM) and joint implementation (JI), corporate carbon pricing, global landscape, trends and outlook of carbon pricing
- Principles of emissions trading schemes
  - Anticipated effects of an emissions trading scheme, design features of an emissions trading scheme, allocation methods in emissions trading, trading of emissions under an emission trading system (ETS), deriving a carbon price for emissions trading, challenges of the EU-ETS, cases in which an emissions trading is useful
- Principles of carbon taxes
  - Anticipated effects of a carbon tax, design features of a carbon tax, defining the coverage of a carbon tax, deriving a carbon price for the tax, use of tax revenues, implementing a carbon tax, cases in which a carbon tax is useful
- Principles of offsetting mechanisms
  - Anticipated effects of offsetting mechanisms, calculating emission reductions, transparency and accounting for GHG emissions, deriving a carbon price for offsetting, trading carbon credits, the offsetting project cycle and cases in which offsetting is useful
- Analysing the effectiveness of carbon pricing mechanisms
  - Emissions trading, carbon tax and offsetting (key lessons learned, barriers and success factors, impact on energy projects)
- Further orientation on carbon pricing
  - Understanding the role of carbon pricing mechanisms in your country, further reading on emissions trading and carbon taxation, getting started with offsetting opportunities and best practice example for RE/EE projects

3.3 Module 3: Technical aspects of energy transformation



Course: Wind and PV grid integration

Learning objectives:

Upon completion of the course, you should be able to:

- 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:

- planning methods regarding fluctuating renewable energies
- time series for fluctuating renewable energies which are required for planning of the power systems or investment decisions
- principles on scheduling, forecasting and forecasting errors
- balancing power systems required for secure grid operation in relation to minimum capacity requirements and grid congestion management
- capacity planning methods and evaluation indicators for generation adequacy and capacity credit for variable generators
- grid code
- grid impact and system integration studies

Course: Energy storage as a flexibility option

Learning objectives:

Upon completion of the course, you should be able to:

- describe the purpose and future role of energy storage systems (ESS)
- classify storage technologies
- calculate specific costs and compare different economic aspects of ESS
- explain how different energy storage technologies complement each other

Content:

- progress and challenges of energy storage systems
- advantages and disadvantages of principal contemporary ESS options
- the following ESS will be described in detail:
  - mechanical storage (e.g. compressed air energy storage (CAES) or pumped hydro plants)
  - electrical storage (e.g. superconductive magnetic energy storage (SMES))
  - thermal storage (TES)
  - electro-chemical storage (batteries)
  - chemical storage (e.g. hydrogen)

Course: Flexible grid infrastructure and management

Learning objectives:

Upon completion of the course, you should be able to:

- explain which grid infrastructure components allow to transmit and distribute high shares of vRE generation across the power system
- analyse congestion management procedures in the context of decarbonisation efforts

Content:

- Grid operation: purpose and definitions, thermal limits of grids, stability limits of grids, what happens in case of errors
- Infrastructure improvements to enable high vRE shares (e.g. high-temperature wires, monitoring of transmission wires and substations with phase shifters)
- Congestion management, online services and data management for the grid control centre, dispatch hierarchy, re-dispatch mechanism and load flow management

Course: Flexible thermal power plants

Learning objectives:

Upon completion of the course, you should be able to:

- explain what flexible operation of thermal power plants means
- describe important technical measures facilitating this mode of operation
- determine key success factors for operating flexible thermal power plants in an economically viable way

Content:

- transition from baseload to flexible operation regime that is characterised by cycling operation, steep ramps and low minimum loads
- market and framework conditions that support the flexible operation of thermal power plants

Course: Digitalisation and smart technologies for the power sector

Learning objectives:

Upon completion of the course, you should be able to:

- determine different applications of digitalisation in the power sector
- analyse benefits of increasing digitalisation across the power sector
- discuss new trends which are built upon digitalisation of the power sector

Content:

- definitions and technology: digitalisation (ICT, data, analytics, connectivity), real time metering, smart metering
- smart supply side and virtual power plants
- smart transmission and distribution: smart grids and grid operation with digital tools
- smart demand side management and energy efficiency in industry
- smart markets, trading, aggregators, peer-to-peer trade and block chain
- cyber security

Course: Coupling of power sector with mobility, building and power-to-X

Learning objectives:

Upon completion of the course, you should be able to:

- explain how the electricity-, transport- and building sector can be coupled
- compare status of available technologies for power sector coupling

Content:

- introduction, why sector coupling?
- power to X, mobility sector, heating / cooling in residential sector and heating / cooling in industrial / commercial sector
    - characteristics
    - technology
    - applications
    - cost development

3.4 Module 4: Future trends in the power sector

Section	Warm-up	Costs and balancing power		Planning and market design		
Week	0	1 2	3 4	5 6 7	8 9	10
Course	Introduction to energy Introduction to electricity	The Integration costs of wind and solar power (15h)	Balancing power system design for low carbon power systems (10h)	Integrated power system planning (20h)	Measures for competitive power markets and for single-buyer markets(10)	Final test
Live events		Introduction				
Assignments						

Course: The integration costs of wind and solar power

Learning objectives:

Upon completion of the course, you should be able to:

- explain what aspects are covered by the term integration costs
- introduce how to quantify grid costs
- explain how to calculate balancing costs
- distinguish economic effects on existing conventional power plant utilisation
- describe the total system cost approach

Content:

- definition of integration costs
- grid costs and balancing power costs
- effects on existing power plant utilisation: residual load duration curves, residual load analysis with modelling tool, cost of reduced power plant utilisation, shift from base load to mid-merit and peak load power stations, capacity requirement for dispatchable thermal power plants
- total system cost (approaches, questions, limitations and lessons learned from case studies)

Course: Balancing power system design for low carbon power systems

Learning objectives:

Upon completion of the course, you should be able to:

- explain the necessity and purpose of balancing power mechanisms
- distinguish different concepts of balancing power as well as types of reserves
- describe different financial and physical relationships involved in balancing power systems
- apply concepts for dynamic balancing power dimensioning
- develop concepts how balancing power systems should be designed to be compatible with increasing shares of variable renewable energy

Content:

- balancing power (purpose, types and definitions)
- supply of balancing power
- probabilistic approach

Course: Integrated power system planning

Learning objectives:

Upon completion of the course, you should be able to:

- distinguish between traditional and advanced power system planning (PSP) approaches
- compare tools used for power system planning and how co-benefits can be used during the planning process
- explain how selected co-benefits of renewable energy, e.g. tackling climate change and the human health effects of ambient air quality and affect the outcome of power system planning

Content:

- integrated power system
- power System Planning (PSP) – the time horizon perspective
- indicators and co-benefits in power system planning (PSP)
- traditional integrated power system planning methodology (TIPSP)
- advanced power system planning methodology
- advanced integrated power system planning methodology (AIPSP)
- comparison of planning tools
- power system planning case studies with and without co benefits

3.5 Course: Measures for competitive power markets and *for single-buyer markets*

Learning objectives:

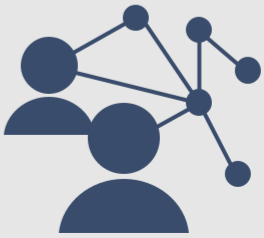
Upon completion of the course, you should be able to:

- Understand and discuss major differences how flexibility measures and ancillary services measures that were developed for competitive markets could be introduced in single-buyer markets

Content:

- Flexibility measures
  - central power plant dispatch versus day-ahead and real-time/ intraday markets,
  - long-term PPAs versus flexible PPAs
  - reserve margin versus balancing circles / balancing power markets
  - central congestion management versus flexibility markets (flexibility potential on TSO and DSO-level)
- Ancillary services
  - spinning reserve for frequency control centrally provided by grid operator and by balancing power markets
  - reactive power for voltage control centrally provided by grid operator / large power and distributed generation

4 RENAC Online

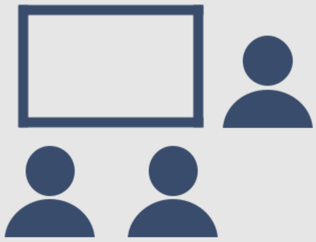


RENAC Online helps you:

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 for question and answers

Virtual classrooms

RENAC Online staff are:

Certified e-learning trainers

Experienced professionals

In direct contact with the industry

CeLM

Certified European e-Learning Manager

4.1 Live Virtual Classrooms (Webinars)

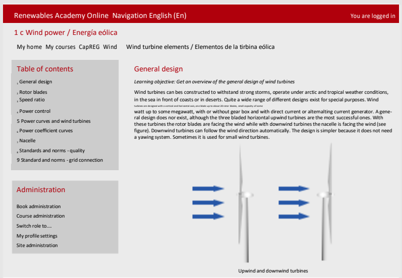
There will be at least 2 virtual classrooms per module during the EnerTracks online training. These live events are not mandatory, but participation is strongly recommended. These sessions will give you the opportunity to interact with experts within the field as well as authors of the courses. Moreover, you will be able to pose any questions you might have on the topic.

4.2 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.

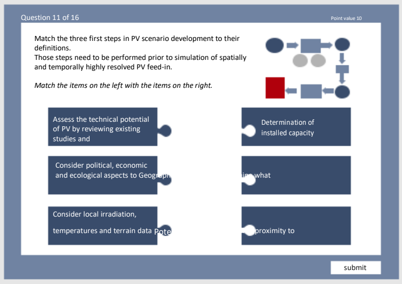


2 Videos

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.

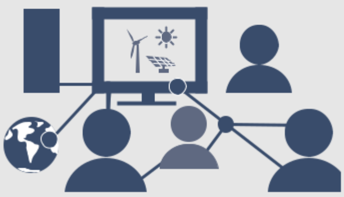


Extensive support

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 RENAC certificate. Participants will get a bonus for each assignment. All others will receive a certificate of attendance per e-mail.

Registration

Registration:
You can register for the EnerTracks online training via the registration form at:

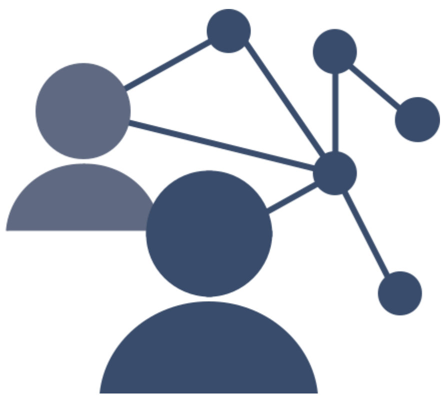
Deadlines:

Registration deadline: 30 November 2019

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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EnerTracks Online Training

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