

# GRID INTEGRATION OF RENEWABLES

Capacity Building on Integration of Large Amounts of  
Renewable Energy in Electricity Grids (ReGrid)

## Outline



<b>1</b>	<b>General information about ReGrid .....</b>	<b>5</b>
1.1	What is the ReGrid scholarship program? .....	5
1.2	What will the ReGrid scholarship program offer?.....	5
1.3	Where do I find the online application forms? .....	5
1.4	Why apply for a scholarship under the ReGrid program?.....	5
1.5	Which topics does ReGrid cover?.....	6
1.6	What will the ReGrid scholarship program finance?.....	6
1.7	Target groups and requirements for participants ? .....	6
1.8	Where do I find the terms of reference? .....	7
1.9	Information to Berlin .....	7
<b>2</b>	<b>ReGrid online – distance learning modules.....</b>	<b>8</b>
2.1	Introduction.....	8
2.2	Dates.....	8
2.3	Target groups .....	8
2.4	Objective and seminar plan.....	9
2.5	Language, certificates and seminar evaluation.....	10
2.6	Requirements for participants .....	10
2.7	Material and support.....	10
<b>3</b>	<b>Seminars for experts with management tasks .....</b>	<b>12</b>
3.1	Introduction.....	12
3.2	Location .....	12
3.3	Content.....	12
3.4	Target groups .....	12
3.5	Objectives and seminar plan .....	12
3.6	Language .....	13
3.7	Requirements for participants .....	14
3.8	Seminar dates and deadlines for application .....	14
<b>4</b>	<b>Seminar for experts with engineering-technical tasks.....</b>	<b>15</b>
4.1	Introduction.....	15
4.2	Location .....	15
4.3	Content.....	15
4.4	Target groups .....	15
4.5	Objectives and seminar plan .....	15
4.6	Language .....	16
4.7	Requirements for participants .....	16
4.8	Seminar dates and deadlines for application .....	17

<b>Seminar plan for experts with management tasks .....</b>	<b>18</b>
<b>Seminar plan for experts with engineering-technical tasks .....</b>	<b>20</b>
<b>Terms of reference .....</b>	<b>22</b>
<b>ReGrid seminar in Berlin (attachment to application form) .....</b>	<b>22</b>
<b>ReGrid online (attachment to application form) .....</b>	<b>24</b>

The project is part of the International Climate Initiative (ICI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports the initiative following a decision of the German Bundestag.

Supported by:



Federal Ministry for the  
Environment, Nature Conservation  
and Nuclear Safety

based on a decision of the Parliament  
of the Federal Republic of Germany

Dear Reader,

What can we do to reduce CO<sub>2</sub> emissions? How can we meet the rising demand for energy? Renewable energy provides the answer to both challenges. In contrast to conventional power plants, the electricity generated by wind turbines and solar power plants is sustainable and free of carbon emissions. These systems are making an increasingly important contribution to climate protection.

The countries of the Middle East and North Africa (MENA) possess excellent preconditions for renewable energy sources. Expanding the share of renewable energy in the overall energy supply will develop new value-added chains and thus create new local jobs. A recent study commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) confirmed that in 2010 about 370,000 people were employed in the renewable energy sector in Germany. At the same time, the rising demand for energy can be covered sustainably and potential for exporting climate-friendly energy can be tapped.

In order to support the transformation process towards sustainable energy systems in the MENA region, the International Climate Initiative (ICI) is striving to build and strengthen strategic partnerships with these countries. The ICI was introduced in 2008 by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and has since funded several innovative projects in developing and newly industrialising countries. It focuses on low-carbon economies, adaption to climate change and the conservation of biological diversity.

One of the most significant challenges in this regard is the grid integration of massive amounts of electricity from renewable sources. The fluctuating character of these sources necessitates long-term strategies to ensure the permanent security of supply.

“Capacity Building on Integration of Large Amounts of Renewable Energy into the Electricity Grids” (ReGrid) is a scholarship program geared to ensuring the exploitation of the major potential in the MENA region. Central objectives of ReGrid are grid integration of renewable energies and the development of a favourable framework regarding the energy sector and energy policies. The project offers the transfer of know-how and strengthening of networks for professionals in the MENA region. Through ReGrid, we hope to unleash the vast potential of these countries and increase their opportunities – economic and ecological.

Federal Minister for the Environment  
Nature Conservation and Nuclear Safety

## 1 General information about ReGrid

### 1.1 What is the ReGrid scholarship program?

ReGrid "Capacity Building on Integration of Large Amounts of Renewable Energy into the Electricity Grids" is a capacity building program within the German International Climate Initiative (ICI). The Renewables Academy AG is commissioned by the Ministry for the Environment, Nature Conservation and Nuclear Safety to facilitate the ReGrid program.

The program offers different kinds of trainings, networking and exchange of experiences for professionals in Algeria, Egypt, Jordan, Lebanon, Morocco, Libya and Tunisia.

ReGrid will demonstrate how a high amount of renewable energy can be safely integrated into the electricity supply and which steps are essential for implementation. To achieve a maximum of effectiveness, the capacity building program will combine seminars in Berlin, online seminars (webinars), a mobile exhibition and a final workshop.

### 1.2 What will the ReGrid scholarship program offer?

- Seminar for experts with management tasks, 10 places for each country
- Seminar for experts with technical-engineering tasks, 10 places for each country
- Distance learning modules (webinars) in the internet, 40 places for each country
- Information boards for rent
- Final workshop

### 1.3 Where do I find the online application forms?

- For seminars in Berlin: please apply online and sign the terms of references (<http://www.renac.de/en/projects/regrid/seminar-application/> )
- For distance learning modules: please apply online and sign the terms of references (<http://www.renac.de/projekte/regrid/webinar-application/> ).

### 1.4 Why apply for a scholarship under the ReGrid program?

- Learn more about technical and financial aspects of grid integration of renewables in order to design suitable political and legal frameworks
- Learn from senior experts
- Get specific information for professionals with management tasks and for professionals with operational / technical tasks
- Learn more about methodologies to plan and run electricity systems with large amounts of wind energy, photovoltaic (PV) or concentrating solar power (CSP)

#### Information for application:

- Ms. Laura Scharlach
- Tel.: +49 (0) 30-526 895 871
- Fax: +49 (0) 30-526 895 899
- E-Mail: [regrid\(at\)renac.de](mailto:regrid@renac.de)

#### Information about seminar content:

- Mr. Albrecht Tiedemann
- Tel.: +49 (0) 30-526 895 870
- Fax: +49 (0) 30-526 895 899
- E-Mail: [regrid\(at\)renac.de](mailto:regrid@renac.de)

#### Website:

<http://www.renac.de/en/projects/regrid/>

#### Link to seminar application:

<http://www.renac.de/en/projects/regrid/seminar-application/>

#### Link to webinar application

<http://www.renac.de/en/projects/regrid/webinar-application/>

- Overcome barriers and hurdles to integrate renewable energy into your electricity system
- Be prepared to develop long term lasting strategies
- Receive a certificate from the Renewables Academy
- Be part of a growing international network of experts

## 1.5 Which topics does ReGrid cover?

The capacity building program will transfer knowledge on a wide range of issues. It is designed to empower the participants to cope with high volumes of renewable energy in the form of grid connected

- Wind energy
- Photovoltaic
- Concentrating solar power (CSP)

For further details see following chapters (2, 3 and 4) and attachments.

## 1.6 What will the ReGrid scholarship program finance?

- Fees for seminar in Berlin (lectures, laboratories, exercises, field trips), lunch, coffee breaks and seminars in the internet
- Travel costs for participants: ReGrid will reimburse 75 % of travel costs against submission of receipts (75 % of economy flight to/from Berlin (maximum reward 425 €) and 75% up to 14 nights in a hotel in Berlin (maximum reward 52.50€/night), means participants will cover at least 25% of their hotel and their flight ticket costs themselves)). Examples: RENAC will reimburse 30€/night if the hotel costs of 40€ per night, 52.5€/night if the hotel costs 70 €/night and 52.5€ if hotel costs 100 €/night
- Fees for seminar in the internet
- Transport costs for information boards

## 1.7 Target groups and requirements for participants ?

Target groups for ReGrid are professionals from Algeria, Egypt, Jordan, Lebanon, Morocco, Libya and Tunisia who work in

- Energy service companies particularly grid operators with technical tasks and responsibilities in the operation of electricity grids
- Ministries and administrations responsible for the strategic development of appropriate energy policy frameworks
- Companies/ organisations that develop, operate or finance renewable energy projects
- Financing institutions, law firms and non-governmental organizations (NGO), interested in the topics of grid integration of Renewables

- Further requirements:

Criteria	Online seminars in the internet	Seminars in Berlin for staff with management tasks	Seminars in Berlin for staff with engineering technical tasks
General	Professionals working in the energy sector of Algeria, Egypt, Jordan, Lebanon, Morocco, Libya or Tunisia		
Knowledge of electricity systems	basics	basics	advanced
Educational level	High school	University	University / technical discipline
Internet access	✓ and voice over IP	----	----
Registration	Online registration at RENACs website; download terms of reference from RENAC’s website, sign form and send it (via FAX or scanned via email) to RENAC		
Travel and accommodation	----	75% refunded by RENAC	75% refunded by RENAC
Seminar fees	scholarship	scholarship	scholarship

**1.8 Where do I find the terms of reference?**

The terms of reference for seminars and for webinars are attached to this document and can be downloaded from the website <http://www.renac.de/en/projects/regrid/>(see at the end of each online-application tool) send mail to [regrid@renac.de](mailto:regrid@renac.de) .

**1.9 Information to Berlin**

You will find some information on the wide variety of Berlin’s cultural attractions at the following websites: Berlin Tourist Information: [www.visitberlin.de](http://www.visitberlin.de) or Berlin’s English Magazine: [www.exberliner.com](http://www.exberliner.com)

## 2 ReGrid online – distance learning modules

### 2.1 Introduction

Besides seminars held in Berlin the ReGrid program provides modules on the internet for distance learning. It consists of live seminars (webinars) and a self study section. After a general introduction to the contents and procedure of the distance learning course and its concept and the market development of wind and solar power (live webinars), students can study the online modules by themselves for three months. The modules cover the technical and economical basics of grid-connected wind power, photovoltaic (PV), concentrating solar power (CSP) and voltage/frequency control in energy systems. Participants have to solve exercises and answer questions (multiple choices). The distance learning course concludes with live webinars highlighting important aspects of wind, PV and CSP. Finally participants will receive a certificate from the Renewables Academy (RENAC).

### 2.2 Dates

You can attend the introduction webinar, the self study online seminars and the live final webinar, in English or French.

Deadline for application: 31.12.2012			
No.	Language	Name	Dates
Web-Intro-En	English	Introduction	20.11.2012, 14:00 – 15:30 CET
Web-Intro-Fr	French	Introduction	21.11.2012, 14:00 – 15:30 CET
Web-Self-En	English	Self study	20.11.2012 – 11.02.2013
Web-Self-Fr	French	Self study	20.11.2012 – 11.02.2013
Web-Final-En	English	Final	05.02.2013, 14:00 – 15:30 CET
Web-Final-Fr	French	Final	06.02.2013, 14:00 – 15:30 CET
Web-Test	English	Test	12.02.2013, 14:00 – 15:30 CET
Web-Test	French	Test	12.02.2013, 14:00 – 15:30 CET

### 2.3 Target groups

The target groups for the seminars are professionals in Algeria, Egypt, Jordan, Lebanon, Morocco, Libya and Tunisia who have the following engineering-technical or management responsibilities:

- Development and implantation of strategies to integrate large amounts of renewable power into the existing electricity supply system
- Design and operation of electricity systems, grid planning, development of grid codes and grid connection studies for renewables.
- Professionals working in the following institutions / companies:
  - Ministries and administrations



- Electricity provider/generators
- Transmission grid operators and distribution grid operators
- Energy service companies/utilities of the energy sector
- Companies/ organisations developing, implementing, running or financing renewable energy projects
- Financing institutions, law firms and non-governmental organizations (NGOs) interested in the topics of grid integration of renewables
- Persons who would like to attend the [ReGrid-seminars in Berlin](#)

## 2.4 Objective and seminar plan

- The distance learning modules will enhance the thorough understanding of the fastest growing power generation industries worldwide
- Participants learn technical and economical fundamentals of wind power, Photovoltaic (PV), Concentrating Solar Power (CSP) and how to integrate them successfully into the energy system
- Participants learn technical terms, as well as the most important physical and electro-technical fundamentals. They understand common concepts of and applications for renewable electricity generation and grid integration
- Persons who like to attend the [ReGrid-seminars in Berlin](#) should register for the distance learning modules, because the provided content is a prerequisite for these forthcoming seminars.

### Live Introduction webinar (module: Web-Intro-En and Web-Intro-Fr)

- Global development of grid connected wind power and solar power
- Overview of the self study modules
- Explanation of the procedure
- Practical questions

### Self study modules (Web-Self-En and Web-Self-Fr)

#### Basics of wind power

- The wind as a resource
- Physical basics
- Wind turbine generators and electrical systems
- Wind farm design
- Power curves
- Energy yield calculation
- Capacity factor and full load hours

#### Basics of photovoltaic (PV)

- The solar resource
- Physical basics
- Components of a PV plant
- Inverter (function, types, efficiency, grid-controlled vs. self-controlled, specification data)
- System configuration

- Plant design
- Energy yield simulation

### Basics of concentrating solar power (CSP)

- Site selection
- CSP technologies (parabolic trough collectors, solar tower, linear Fresnel, dish)
- Generators
- Storage technologies
- Cooling
- Energy yield calculation
- 

### Basics of voltage und frequency control

- Definitions
- Theory voltage control
- Theory frequency control
- Quality and security of energy supply
- Voltage control with wind and solar
- Frequency control with wind and solar

### Final live webinars (Web-Final-En and Web-Final-Fr)

- Outlook on further development of grid connected wind and solar power
- Highlighting of important aspects from self study phase
- Summary

(RENAC might adapt the seminar plan to participants' requirements)

## 2.5 Language, certificates and seminar evaluation

- Introduction webinars will be held in English, in French and in Arabic (module: Web-Intro-En and Web-Intro-Fr)
- Self study materials are available in English and in French (module: Web-Self-En and Web-Self-Fr)
- RENAC will provide online support in English
- Final webinars will be held in English and in French (module: Web-Final-En and Web-Final-Fr)
- Participants passing a test will receive a RENAC-certificate
- Participants will get the chance to evaluate the quality of the seminar at the end of the distance learning phase

## 2.6 Requirements for participants

- Participants should have a basic knowledge of electricity systems
- Participants should be willing to find solutions in a self-study distance learning course
- Participants have to register online or fill in the application form, sign its attachment and send both to RENAC.
- Participants will be responsible for ensuring their internet access (access via standard browser and ability to use Voice over IP applications).

## 2.7 Material and support

- Participants have access to online modules for about 3 months

- Live modules will be recorded and will be available until the end of the distance learning phase
- RENAC will support participants to answer/solve upcoming questions

### 3 Seminars for experts with management tasks

#### 3.1 Introduction

The seminar “Grid Integration of Renewables – Seminar for Experts with Management Tasks” will focus on important aspects of grid integration of renewables into all voltage levels of the transmission and the distribution grid. Strategies and approaches as well as strategy development will be in the focus. Also experts with management tasks need to understand how and why to develop scenarios with high temporal and spatial resolution. They will learn how to implement power forecasts, handle balancing needs, cover peak load, develop and implement advanced grid codes, adjusting the investment in and operation of fossil power plants to accommodate fluctuating renewable energy sources and how to implement data control centres for Renewables. Managers will be informed about economic and technical implications of large amounts of renewable power in the national grids.

#### 3.2 Location

The seminar location for all target countries is Renewables Academy AG, Schönhauser Allee 10 – 11, 10119 Berlin, Germany.

#### 3.3 Content

The two week seminar teaches fundamentals and advanced aspects of grid integration of large amounts of wind power, photovoltaic and concentrating solar power (CSP) in energy systems. The emphasis lies on understanding important approaches, strategies as well as methodologies and technologies. It will focus on the economics of measures, best practice examples and drafting strategies necessary for the implementation of procedures. Practical exercises, group work and field trips complement the theoretical material to ensure an optimized learning outcome.

#### 3.4 Target groups

The target group for the seminar consists of professionals in Algeria, Egypt, Jordan, Lebanon, Morocco, Libya and Tunisia who have management responsibilities from the following backgrounds:

- Professionals with responsibility for development and implantation of strategies to integrate renewables in energy systems.
- Professionals working in the following institutions/companies:
  - Ministries and administrations
  - Energy provider / generators
  - Transmission grid operators
  - Distribution grid operators
  - Energy service companies
  - Companies/ organisations that develop, operate or finance renewable energy projects
  - Financing institutions, law firms and non-governmental organizations (NGO) interested in the topics of grid integration of Renewables

#### 3.5 Objectives and seminar plan

- At the end of the 10-day seminar participants have a fundamental understanding of important strategies to enable a secure energy supply with large amounts of renewables

- Participants will be familiar with the various aspects of grid integration of renewables in order to design suitable political and legal frameworks
- Participants are able to plan grid integration measures for renewables and to implement them in the electricity system
- Participants will be competent to evaluate essential steps to keep voltage and frequency constant even if the amount of fluctuating generation exceeds 20% in transmission grids and/or in distribution grids
- Participants will gain an overview on how to integrate power forecast in the data control centre
- Participants will be able to overcome barriers and hurdles to integrate renewable energy into the electricity system
- Participants will receive a certificate from the Renewables Academy (RENAC)
- Participants will broaden their network to experts that have experiences in developing and operating a distribution grid and/or a transmission grid with high amounts renewables. They are part of a growing international network of experts



RENAC might adapt the seminar plan to country-specific / participants' requirements. For details see attachment.

### 3.6 Language

- Course materials are provided in English
- Lecturers will present in English
- The seminar will be simultaneously translated English / French or English/Arabic

**3.7 Requirements for participants**

- Participants should have a basic knowledge of the electricity system and should be interested in planning of ancillary services, dispatch of power stations, implementation and development of strategies for the energy supply system and/or regulating energy markets
- Participants have a university degree
- Participants should be willing to find solutions through group work, to present results and to discuss solutions
- Good technical English is an advantage

**3.8 Seminar dates and deadlines for application**

<b>Management Level</b>			
<b>No.</b>	<b>Target country</b>	<b>Seminar dates</b>	<b>Application deadline</b>
Sem-TN-M	Tunisia	16.04. – 27.04.2012	16.02.2012
Sem-MA-M	Morocco	18.06. – 29.06.2012	18.04.2012
Sem-DZ-M	Algeria	08.10. – 19.10.2012	08.08.2012
Sem-JO-M	Jordan	05.11. – 16.11.2012	05.09.2012
Sem-LB-M	Lebanon	27.05 – 07.06.2013	25.03.2013
Sem-EG-M	Egypt	17.06. – 28.06.2013	17.04.2013
Sem-LY-M	Libya	30.09 – 11.10.2013*	30.07.2013*
* preliminary dates			

## 4 Seminar for experts with engineering-technical tasks

### 4.1 Introduction

The seminar “Grid Integration of Renewables – Seminar for Persons with Engineering-Technical Tasks” will focus on important aspects of grid integration of renewables into all voltage levels of the transmission and the distribution grid. The seminar covers tools and methodologies to calculate or develop scenarios with high temporal and spatial resolution, power forecasts and forecast errors, balancing power and balancing energy, peak load coverage and capacity credit calculation. The seminar participants will also learn modelling and simulation of power networks with renewable energy sources, advanced grid codes and power quality requirements or advanced technological solutions for grid integration.

### 4.2 Location

The seminar location for all target countries is Renewables Academy AG, Schönhauser Allee 10 – 11, 10119 Berlin, Germany.

### 4.3 Content

The two week seminar teaches fundamentals and advanced aspects of grid integration of large amounts of wind power, photovoltaic and concentrating solar power (CSP) into energy systems. The emphasis lies on the understanding of important methodologies, approaches and technologies, economics, best practice examples and drafting steps necessary for the implementation of procedures. Practical exercises and field trips complement the theoretical material to ensure an optimized learning outcome.

### 4.4 Target groups

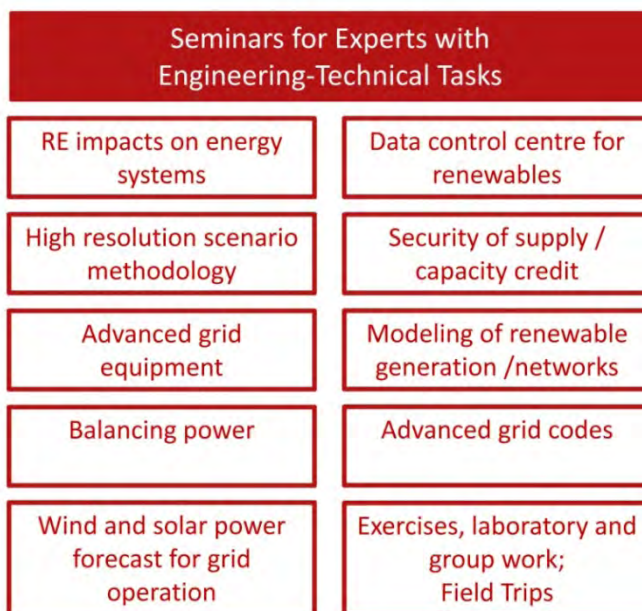
The target group for the seminar consists of professionals from Algeria, Egypt, Jordan, Lebanon, Morocco, Libya and Tunisia who have engineering-technical responsibilities from the following backgrounds:

- Professionals with responsibility for the design and operation of electricity systems, grid planning, development of grid codes and grid connection studies for renewables.
- Professionals working in the following institutions/companies:
  - Transmission grid operators
  - Distribution grid operators
  - Energy providers/generators
  - Energy service companies
  - Ministries and administrations responsible for the strategic development of appropriate energy policy frameworks
  - Companies/organisations that develop, operate or finance renewable energy projects
  - Financing institutions, law firms and non-governmental organizations (NGO) interested in the topics of grid integration of renewables

### 4.5 Objectives and seminar plan

- At the end of the 10-day seminar participants should have a fundamental understanding of important topics to enable a secure energy supply with a large amount of renewables
- Participants will be able to plan grid integration measures and to implement them in the electricity system

- Participants will have the competency to carry out the essential steps to keep voltage and frequency constant, even if the amount of fluctuating generation exceeds 20% in transmission grids and/or in distribution grids.
- Participants will gain an overview of different software programs for power forecasts
- Be part of a growing international network of experts. Participants will broaden their network to experts who have practical experiences in operating a distribution grid and/or a transmission grid with high amounts of wind, PV or CSP
- Participants will be able to overcome barriers and hurdles to integrate renewable energy into the electricity system
- Participants will be familiar with the various aspects of grid integration of renewables in order to successfully put their gained knowledge to practical use
- Participants will receive a certificate from the Renewables Academy (RENAC)



RENAC might adapt the seminar plan to country-specific / participants' requirements. For details see attachment.

#### 4.6 Language

- Course materials are provided in English.
- Lecturers will present in English.
- The seminar will be simultaneously translated English / French or English/Arabic

#### 4.7 Requirements for participants

- Participants will need to have an advanced knowledge of the physics of electricity grids and modelling of systems
- Participants should have a university degree in a technical discipline or should have experience in the topics
- Participants should be willing to find solutions through group work, to present results and to discuss solutions
- Good technical English is an advantage



#### 4.8 Seminar dates and deadlines for application

<b>Engineering-Technical Level</b>			
<b>No.</b>	<b>Target country</b>	<b>Seminar dates</b>	<b>Application deadline</b>
Sem-TN-T	Tunisia	20.02. – 02.03.2012	16.12.2011
Sem-MA-T	Morocco	19.03. – 30.03.2012	09.01.2012
Sem-DZ-T	Algeria	02.07. – 13.07.2012	02.05.2012
Sem-JO-T	Jordan	10.09. – 21.09.2012	10.07.2012
Sem-LB-T	Lebanon	11.03. – 22.03.2013	10.01.2013
Sem-EG-T	Egypt	15.04 - 26.04.2013	14.02.2013
Sem-LY-T	Libya	19.08 – 30.08.2013*	09.07.2013*
* preliminary dates			

## Seminar plan for experts with management tasks

(RENAC might adapt the seminar plan to country-specific / participants' requirements.)

### Introduction to grid integration strategies

- Methodologies
- Grid integration strategy overview

### High resolution scenario methodology

- Methodology and tools for development of renewable electricity generation scenarios with very high temporal and very high spatial resolution

### Balancing power

- Future balancing needs with high amount of renewables in energy systems
- Methodology of balancing power prediction
- Balancing power markets and economics
- Provision of balancing power with wind energy, PV and CSP
- Best practice examples

### Security of supply / capacity credit

- Security of supply at peak load time
- Methodology to calculate the capacity credit of renewables in an energy system
- Possibilities to increase the capacity credit of wind power, CSP and PV in energy systems

### Grid codes

- Advanced generator concepts for wind power
- Advanced converter concepts for PV
- Theory and requirements for advanced grid codes for renewables
- Static and dynamic voltage support
- Active power management
- Harmonics and flicker

### Conventional power plants and renewables

- Structure and operation of power systems with renewable generation
- Technical issues related to system integration of renewables
- Conventional power plant operation
- Adjusting the operation of fossil power plants to accommodate fluctuating renewable energy sources
- Investment planning and economics

### Storage

- Grid connected storage technologies overview and development (chemical, electrochemical, electrical, mechanical, thermal)
- Mass storage options and economics
- Balancing of forecast errors

- Ancillary services and economics

## Efficiency potentials in system operation

- Planning of system development and grid extension
- Congestion management
- Interactive grids, private and industrial end-user involvement, load profile homogenization
- Power electronics
- Dynamic line rating
- Coupling of energy markets and wholesale energy markets

## Exercises and group work

- Scenario strategy exercise: data provision for scenario development
- Power forecast service exercise: step by step approach to implement forecast into work of grid operators; call for tender requirements
- Balancing power exercise: calculation of balancing power needs for wind energy, CSP and PV
- Capacity credit exercise: calculation of capacity credit for wind energy, CSP and PV
- Strategy development: Preparation of high-level strategy to integrate high amount of renewable generation into the complete power system (short / medium / long term perspective); organising strategy development process
- Group work, presentation and discussion of results

## Field trips:

- Up to two days
- Large multi-megawatt wind and/or PV projects
- Transmission grid operators and/or distribution grid operators

## Soft- and hardware

- Balancing power software tool
- Capacity credit software tool
- Excel

## Seminar plan for experts with engineering-technical tasks

### Impacts of renewables on energy systems

- Wind and solar resource specific aspects
- Technical impacts on energy system

### High resolution scenario methodology

- Methodology and tools for development of renewable electricity generation scenarios with very high temporal and very high spatial resolution
- Best practice examples

### Wind and solar power forecast for grid operation

- Theory of physical and statistical models and combinations for day-ahead and short-term ahead forecasts
- Best practice examples
- Criteria to evaluate different forecast providers
- Agreements with forecast providers
- Economics

### Balancing power

- Future balancing needs with high amount of renewables in energy systems
- Methodology of balancing power prediction
- Provision of balancing power with wind energy, PV and CSP
- Economics and best practice examples

### Security of supply / capacity credit

- Security of supply at peak load time
- Methodology to calculate the capacity credit of renewables in an energy system
- Calculation of residual load
- Possibilities to increase the capacity credit of wind power, CSP and PV in energy systems
- Best practice examples

### Advanced grid codes

- Generator concepts and best practice examples for wind and CSP (type 1, 2, 3 and 4 concepts; doubly-fed induction generators, fully converted generators, synchronous generators, induction generators)
- Advanced converter concepts for PV
- Theory and requirements for advanced grid codes for renewables
- Active and inductive / capacitive reactive power generation and consumption
- Static and dynamic voltage support
- Active power management
- Harmonics and flicker

### Advanced grid equipment

- Theory and best practice examples for advanced technological solutions for grid integration of renewables

- Concepts and best practice examples for data control centres for renewables
- Power electronics (STATCOM, integrated gated control thyristor (IGCT), insulated gate bipolar transistor (IGBT), line commutated converters (LCCs), Voltage Source Converter (VSC), multilevel-converter topologies, super capacitor energy storage system (SCESS), etc)
- Dynamic line rating

## Modelling of renewable generation /networks

- Modelling of a wind turbine with doubly-fed induction generator
- Modelling of a wind turbine with fully rated converter
- PV farm, CSP power station and wind farm modelling for grid compliance/design studies
- Load flow analysis, fault ride through analysis, short circuit analysis
- Active and reactive power

## Data control centre for renewable

- Monitoring of wind power, PV power and CSP at dispatch centres
- Purpose and function of data control
- Software and hardware communication protocols (SCADA, Telemetry)
- Demonstration projects

## Exercises, laboratory and group work

- Scenario exercise: calculation of smoothing effects of distributed generation; strategy development: data provision for scenario development, steps for simulations
- Power forecasts services exercise: criteria development, application and evaluation; call for tender aspects
- Balancing power exercise: calculation of balancing power needs for wind energy, CSP and PV
- Capacity credit exercise: calculation of capacity credit for wind energy, CSP and PV
- Laboratory with wind turbine-grid simulator: Exercises on physical fundamentals “from wind to wave”, doubly-fed asynchronous wind generator, varying wind force levels and regulating the output voltage and frequency, optimum operating points under changing wind, operating response during mains malfunctions “fault ride through”
- Group work, presentation and discussion of results

## Field trips

- Up to two whole days, large multi-megawatt wind and/or PV projects
- Transmission grid operators and/or distribution grid operators

## Software and hardware

- Balancing power software tool, capacity credit software tool
- Excel, Integrated power system analysis / simulator for engineering software Power Factory
- Laboratory transmission grid simulator with DFIG wind generator

## Terms of reference

### ReGrid seminar in Berlin (attachment to application form)

Please sign the attachment and send this and the following page via Fax to 0049 30 526 895 899 or send scanned document via Email to [regrid@renac.de](mailto:regrid@renac.de) before deadline for application

ReGrid is a scholarship program; the seminar places available are limited. Therefore RENAC needs to ensure the attendance of the participants selected for coming to Berlin. For this reason RENAC asks all candidates to confirm the following statement.




---

**Please fill in name of ReGrid seminar (abbreviation) and date of ReGrid seminar in Berlin**

I herewith agree that

#### Selection of participants:

- RENAC tries to provide as many places in the programme as possible. However, RENAC is in charge of the final decision of who may participate. There is no legal entitlement to participation.
- RENAC will put candidates on a waiting list if too many persons apply for the scholarship. In case that places are available RENAC will inform me as soon as possible that I can attend the seminars.

#### Seminar Fees:

- RENAC will inform me at least 6 weeks before the start of the seminar whether I am selected for a scholarship for the seminar in Berlin.
- The seminar fees for my participation in the two week seminar in Berlin (printed handouts, exercises, laboratories, fieldtrips, Monday to Friday: lunch and tea / coffee) are financed by the ReGrid program.
- If I get a scholarship for the ReGrid seminar I will attend all lectures given in the two-week ReGrid seminar in Berlin. If I need to cancel my scholarship due to sudden illness, I will inform RENAC immediately and send a medical certificate or other written confirmation stating the reason of failure to participate. Otherwise, I understand I will have to pay the costs for the seminar (575 EURO per day).

#### Health insurance:

- RENAC will provide me with a health insurance for the time of the seminar (14 days) in Germany. RENAC will send a confirmation of the insurance prior to my arrival in Germany. All other insurances will need to be arranged by myself.

#### Visa:

- RENAC will send an invitation letter as a pdf via Email to my business address 6 weeks before the seminar starts.
- I apply for VISA to Germany myself.

#### Travelling costs:

- I organise and book the travel to/from Berlin and the hotel in Berlin as well as other travel arrangements myself.
- RENAC will provide information about hotels situated near the Renewables Academy AG in Berlin.
- I will forward the original receipts for an economic return flight and for the hotel accommodation in Berlin to RENAC not later than 3 weeks after the end of the seminar.
- RENAC will reward 75% of costs of an economic return flight between Tunisia, Morocco, Algeria, Jordan, Lebanon, Egypt or Libya and Berlin (maximum 425€). The participants will cover at least 25% of ticket costs.
- RENAC will reward 75 % of hotel costs in Berlin (up to 14 nights, maximum 52.5€ per night). The participants will cover at least 25% of hotel costs.
- RENAC will refund costs after receiving the receipts, but not later than 3 weeks after receiving the receipts.

**Liability and Force Majeure:**

- RENAC shall only be liable to pay compensation - regardless of the legal grounds and regardless of whether the damage is direct or indirect - if the damage was caused by wilful intent or gross negligence on RENAC’s part or on the part of a vicarious agent or in the case of culpable damages to life, body or health or if RENAC has maliciously concealed a defect.

**Intellectual Property and RENAC Material:**

- All intellectual property used and distributed in the programme exclusively belong to RENAC. The participants of the program are not entitled to reproduce, copy, alter, distribute, sell etc. materials, logos etc. belonging to RENAC.

**Forum and Governing Law:**

- The Programme is governed by German Law. The court of arbitration shall be Berlin, Germany.

**Correctness of information:**

- I am conscious of the fact that by sending this application form to RENAC I confirm the correctness of all provided information in the application form.

█

---

**Name of participant**

█

---

**Name of organisation / company**

█

---

**Place and date**

**Signature**

## Terms of Reference

### ReGrid online (attachment to application form)

Please sign the following page and send this and the following page via Fax to 0049 30 526 895 899 or as a scanned document via Email to [regrid@renac.de](mailto:regrid@renac.de) before deadline for registration (17 October 2011)

ReGrid is a scholarship program and the webinar places available are limited. Therefore RENAC needs to ensure the attendance of the participants selected for the webinars. For this reason RENAC asks all candidates to confirm the following statement.

I herewith agree that

#### Selection of participants:

- RENAC tries to provide as many places in the programme as possible. However, RENAC is in charge of the final decision of who may participate. There is no legal entitlement to participation.
- RENAC will put candidates on a waiting list if too many persons apply for the scholarship. In case that places are available RENAC will inform me as soon as possible that I can attend the webinars.

#### Webinar Fees:

- RENAC will inform me at least 3 weeks before the start of the webinar whether I am selected for a scholarship.
- My webinar fees (live and online seminars for self study) are financed by the ReGrid program.
- If I get a scholarship for the ReGrid webinar I will attend all lectures. If I need to cancel my scholarship due sudden illness or any other reason I will inform RENAC immediately.

#### Liability and Force Majeure:

- RENAC shall only be liable to pay compensation - regardless of the legal grounds and regardless of whether the damage is direct or indirect - if the damage was caused by wilful intent or gross negligence on RENAC's part or on the part of a vicarious agent or in the case of culpable damages to life, body or health or if RENAC has maliciously concealed a defect.

#### Intellectual Property and RENAC Material:

- All intellectual property used and distributed in the programme exclusively belongs to RENAC. The participants of the program are not entitled to reproduce, copy, alter, distribute, sell etc. materials, logos etc. belonging to RENAC.

#### Forum and Governing Law:

- The Programme is governed by German Law. The court of arbitration shall be Berlin, Germany.



**Correctness of information:**

- I am conscious of the fact, that by sending this application form to RENAC I confirm the correctness of all provided information in the application form.



---

**Name of participant**



---

**Name of organisation / company**



---

**Place and date**

**Signature**

Renewables Academy (RENAC) AG

Schönhauser Allee 10-11

10119 Berlin (Germany)

Tel: +49 (0) 30-52 689 58 70

Fax: +49 (0) 30-52 689 58 99

E-Mail: [regrid@renac.de](mailto:regrid@renac.de), December 2012



**ReGrid**  
grid integration  
of renewables

Supported by:



Federal Ministry for the  
Environment, Nature Conservation  
and Nuclear Safety

based on a decision of the Parliament  
of the Federal Republic of Germany.