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SMAGRINET

POWERING SMART GRID EXPERTISE IN EUROPE

his project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 837626

CONTACT US
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Manual for
CONNECTION PLANNING IN SMARTGRIDS MODULE

PROGRAMME
H2020

CONTRACT NUMBER
837626

DURATION
30 Months

START
April 2019

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Contributors

Name	Organisation
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INDEX OF CONTENTS

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1. Introduction

Based on the material prepared for the blended programme the trainers manual for the short-term programmes have been developed under the SMAGRINET project.

The methodological manual package includes support for the trainers for the up-take of the capacity building programme (module).

These manuals are available as online resources for the enrolled universities and representatives and are easily accessible for the Trainers and universities that have joined the SAMGRINET HUB.

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2. Objective of the module

2.1.1. Learning outcomes

- Describe the distribution network structure and control.
- Know the fundamentals about generation and planning of renewable energies.
- Describe the distribution network structure and perform three-phase-power-flow analysis.
- Explain the approach to modelling of distribution network elements.
- Develop a distribution network model.
- Know different demand characteristics and define the terms consumer and prosumer.
- Evaluate the impact of energy storage possibilities and multi-energy smart grids.
- Evaluate the impact of electric vehicles on distribution network operation.
- Evaluate the impact of renewable sources on distribution network operation.
- Evaluate the impact of virtual power plants, in particular the day-ahead and intraday operation.
- Use modern distribution-network control approaches.

2.1.2. Aims as a lecturer

1. Motivate students to develop their abilities to analyse and understand the state of the art topics on smart grid
2. To give students knowledge about the modern grid planning media: computers, app, video conferences, CAD;
3. To inspire students to partake in the discussions on the smart grid planning topic for them to be comfortable on these subjects in the future.
4. To deepen the students' analytical capability to systematize the assumptions of the background systems for the development of smart grid, to predict the outcomes;
5. Encourage students to perform soft skill training: team orientation and cooperation, presentation in oral and in writing, project-orientation with scheduling

3. Teaching material

3.1.1. Lecture register

1. General characteristics of distribution network
2. Distributed generation
3. Rayleigh statistics
4. Load and distributed generation forecasting
5. Demand charachteristics of consumers and prosumers
6. Allocation of distributed generation
7. Integration of energy storages
8. Optimization
9. Electric vehicle impact on the distribution network
10. Smart grid technologies

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11. Power quality
12. Virtual powerplant
13. Power flow
14. Planning of distributed network expanion by modelling equipment
15. Planning of distributed network expansion by power flow and protection

3.1.2. Types of materials and methods used in the lecture

10 lecture files will be provided to you after the completion of traind-the-trainer program and contractual agreements between the SMAGRINET consortium and the faculty of your University.

- Oral examination forms 40% of the grade.

Lectures (2 hrs/occasion)

2 projects

- Prosumer modelling
- Simulation of the AC/DC/AC power conversion system

SMAGRINET can provide assistance but the final material is provided by the course representative.

In addition to lectures, the recommended text books including web based materials are available in the indexes of lectures.
You may also use the vídeos from the SMAGRINET Youtube channel or other vídeo recordings if they are available and help with the illustration of the material.

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3.1.3. Timeframe or preparation

SIX MONTHS PRIOR

- Familiarise the module or course goals and re-determine course content.
- Begin reviewing your arsenal of possible supportive material such as:
  - The latest EU policy summaries of new directives.
  - Relevant material regarding your national trends and comparative material with the EU.

THREE MONTHS PRIOR

- Begin to develop course schedule and syllabus.
- If you have had prior experience re-evaluate your teaching methods and tools at your disposal (excel, CAD and others)
- Determine the dates when you will evaluate student learning: you're your assignments and exams accordingly.
- Organise updated text(s) and other materials, including films, videos.
- If planning to use instructional technology or multimedia equipment, reserve a classroom that has all the necessary components.
- If possible for seminars – contact guest speakers.
- If possible – arrange field trips and other activities

One Month Prior

- Refine the course syllabus for the concrete semester (might have moved).
- Seek training or consult with SMAGRINET on the possible developments the on how to use updated instructions or other related topics.

DURING AND AFTER

- Take a few, brief notes after every class session; these notes will remind you of what went well and what you would like to change after the course has concluded for next year.
- Review student evaluations.
- Refine the course design, responding to student evaluations and reflecting on your own evaluation of the course.

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3.1.4. Guidance for the Teacher related to the material

Renewable Generation + Distribution Network I

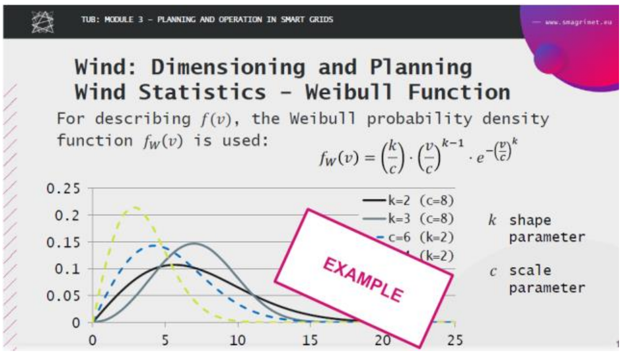
Content:

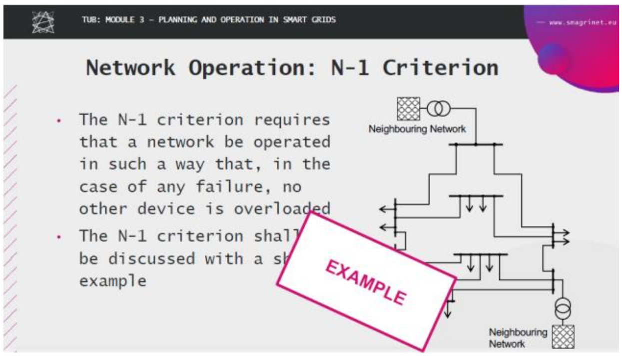
Renewable Energies
- **Photovoltaics: Generation, Planning, and Measurement**
- **Wind: Generation, Planning, and Measurement**

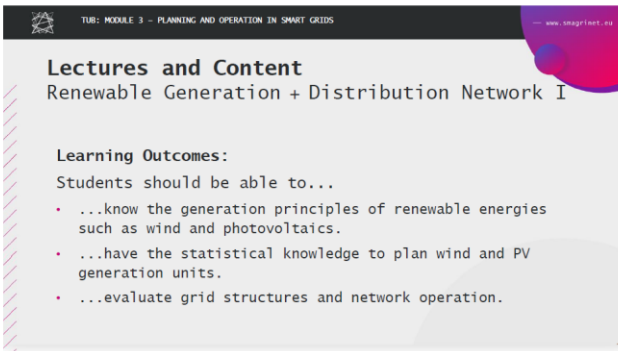
Network Structure Basics
- **Properties of Electric Energy Networks**
- **Network Operation**

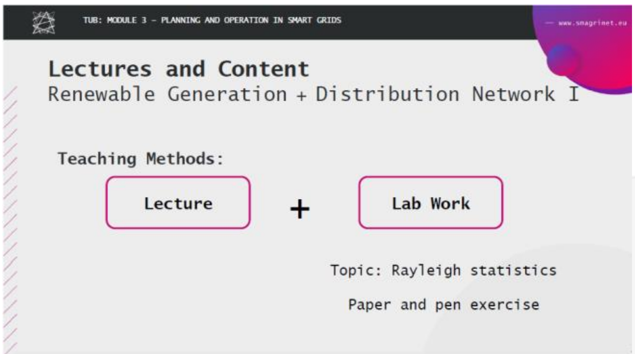
LEARNING OUTCOMES

Students should be able to:
- know the generation principles of renewable energies such as wind and photovoltaics.
- have the statistical knowledge to plan wind and PV generation units.
- evaluate grid structures and network operation.









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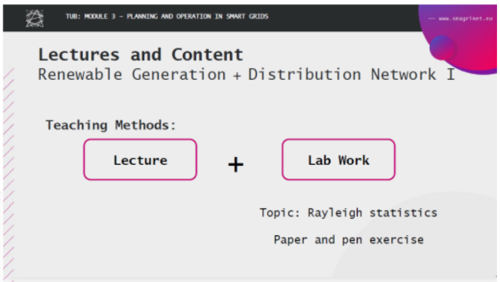


Distribution Network II

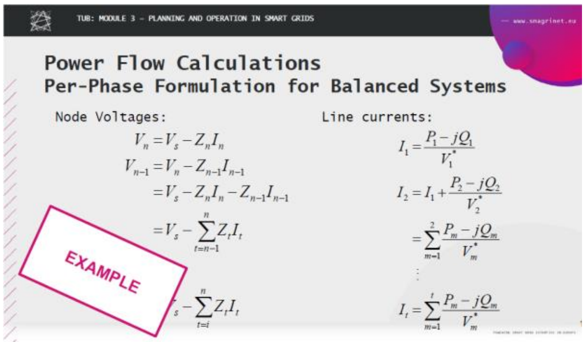
Content:

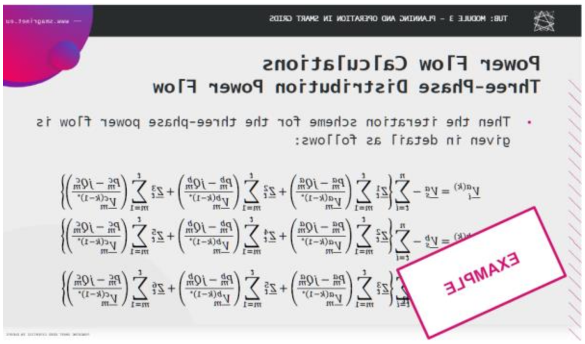
- **Motivation for Power Flow Calculations**
- **Per-Phase Formulation for Balanced Systems**
- **Gauss Method**
- **Three-Phase Power Flow Formulation**
- **Three-Phase Load and Line Model**
- **Three-Phase Distribution Power Flow**

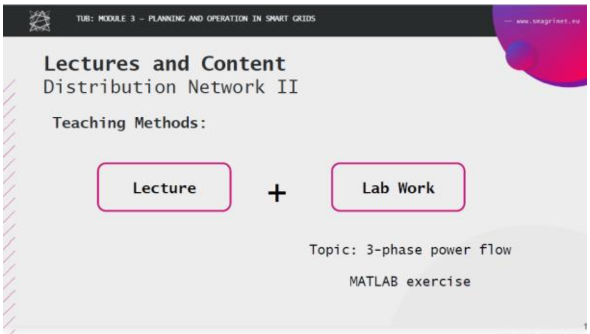
LEARNING OUTCOMES

Students should be able to:

- explain the importance of three-phase power flow calculations in the distribution network.
- understand the per-phase formulation of three-phase power flow equations.
- use the Gauss method.
- perform a three-phase power flow.







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Demand Characteristics

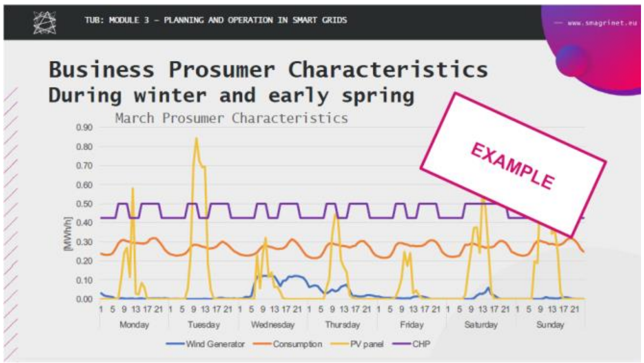
Content:

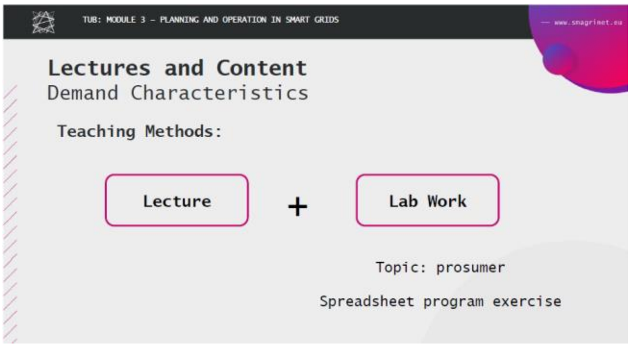
- **From Consumer to Prosumer**
- **Household Energy Demand and Production**
- **Business Prosumer Characteristics**
- **Industry Prosumers**
- **Energy Passport**

LEARNING OUTCOMES

Students should be able to:

- know the difference between consumer and prosumer and why the focus is shifting.
- understand different demand characteristics, as observed in households, businesses and industry.
- evaluate the European energy passport approach.





Demand Characteristics

Content:

- **Energy Systems in Transition**
- **Energy Storage in Smart Grids**
- **Multi-energy Smart Grids**
- **Modeling Framework for Planning and Control of Multi-energy**
- **Systems**
- **Modeling of Selected Resources**
- **Introduction to Optimization**

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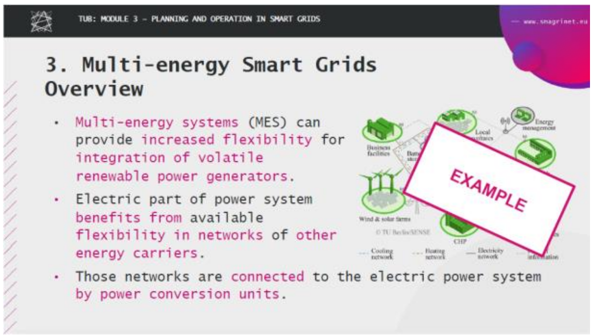
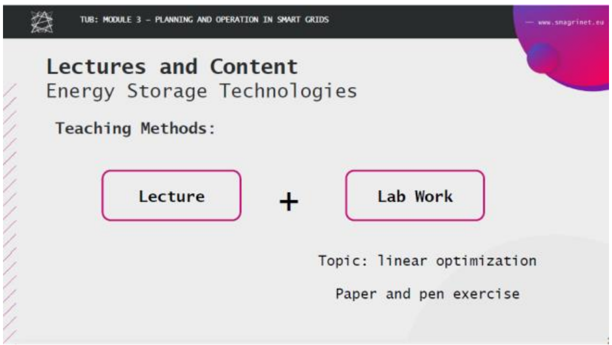
- **Research Project „Energy Network Berlin Adlershof“**

LEARNING OUTCOMES

Students should be able to:

- explain the importance of energy storage in smart grids.
- describe the concepts of multi-level storage and multienergy smart grids.
- set up a model for multi-energy smart grids.
- formulate optimization problems including objective function, constraints and bounds.





Virtual Power Plant

Content:

- **Necessity for Virtual Power Plants**
- **Structure of Virtual Power Plant**
- **Modelling and Market Integration of Resources**
- **Provision of System Services: Congestion Management in Distribution Networks**

LEARNING OUTCOMES

Students should be able to:

- understand the role of a virtual power plant for the market integration of small distributed energy resources.
- comprehend the operation of a virtual power plant and account for uncertainties in the renewable power generation forecasts in different time frames, in particular the dayahead and intraday operation.
- understand the role of a virtual power plant for the

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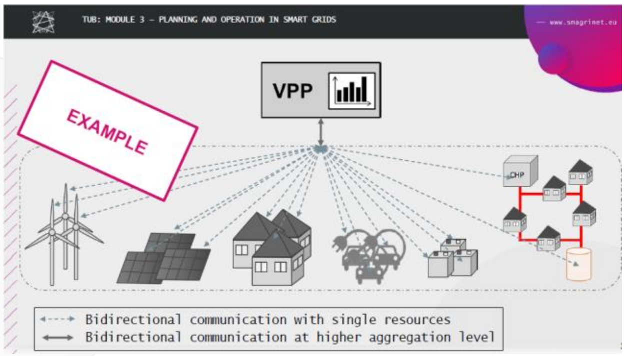
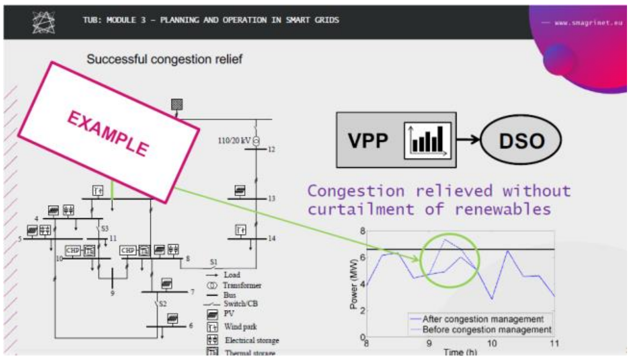
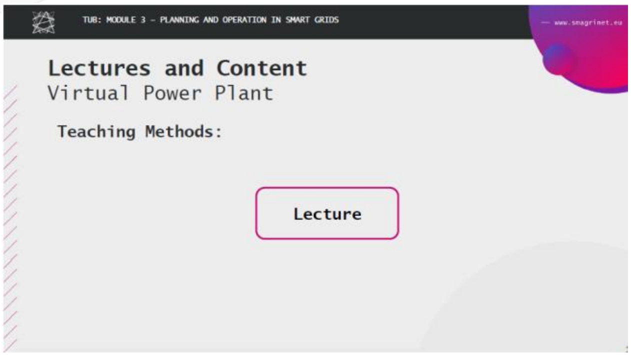
- provision of a congestion relief service to the distribution system operator.







Forecasting

Content:

- **Definition and use of forecasting**
  - **The need for forecasting in modern power systems**
  - **Load, generation, electricity price forecasting**
- **The concept of forecasting process**
- **Description of some forecasting methods**
  - **Statistical methods, AI methods, Knowledge Based Expert Systems, Hybrid techniques**
- **Description the basis of time series forecasting (ARIMA)**
  - **Stationarity, autocorrelation**
  - **AR, MA, ARMA and ARIMA models**
  - **Evaluation of forecast accuracy**

LEARNING OUTCOMES

Students should be able to:

- understand the forecasting process and its importance in electric power systems
- Understand the basics of basics of time-series forecasting

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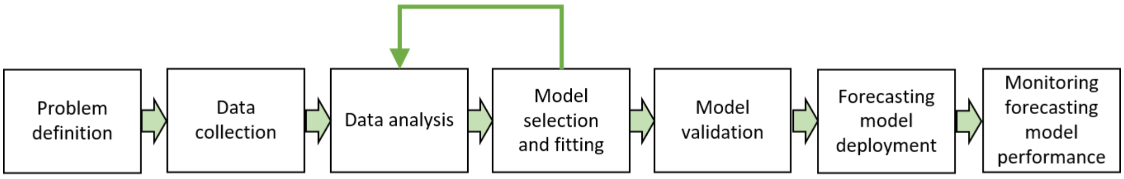
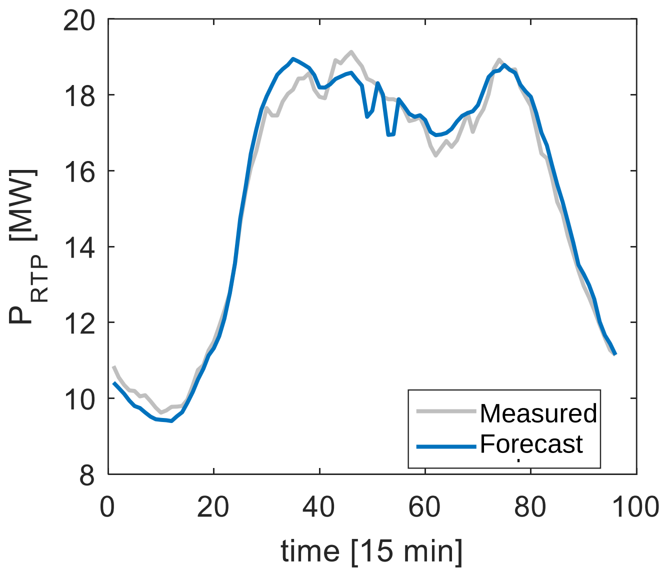
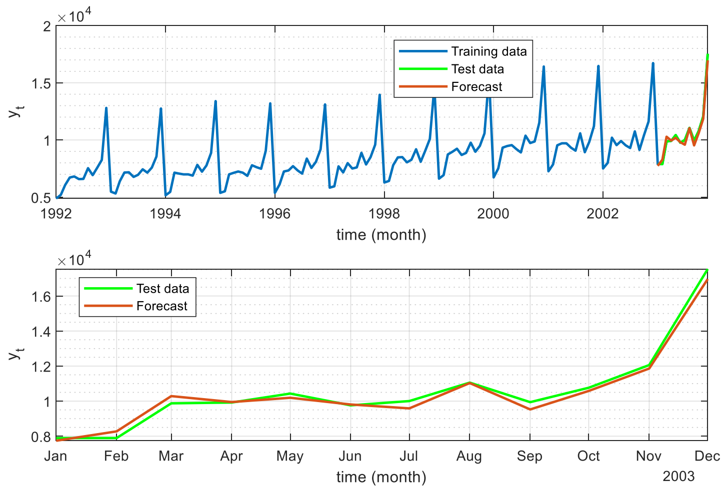




EXERCISE

Exercise to train students on time series forecasting:

- Determine the components of time series,
- Identify an appropriate ARIMA model,
- Calculate forecast.
- Comparison of a forecast and actual data
-



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State estimation

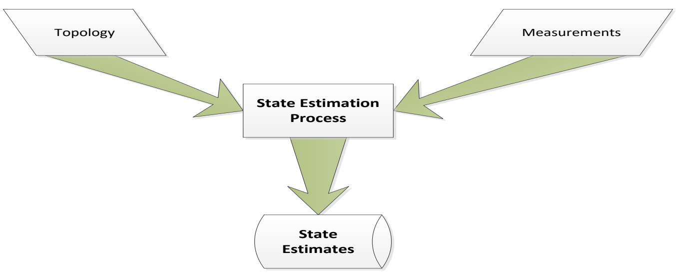
Content:

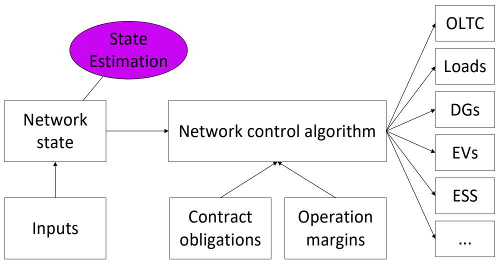
- **Overview of distribution network operation**
  - **Low observability of distribution networks**
- **Distribution networks of the past and those of the (near) future**
- **Distribution system State Estimation approaches and techniques**
  - **Weighted least squares**
- **Challenges, related to general data unavailability**
  - **Robustness, bad data detection**

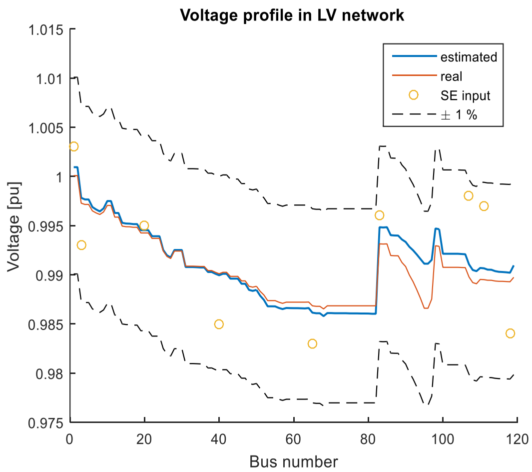
LEARNING OUTCOMES

Students should be able to:

- understand the importance of advanced voltage control in modern distribution networks
- understand the role of State Estimation in voltage control
- understand the basic framework of the State Estimation algorithm







EXERCISE

Exercise supporting the students in the process of the state estimation concept internalisation by:

- Recognition of the state estimation goal.
- Application of WLS method to the estimation problem.
- Step-by-step state estimation of the simple network.

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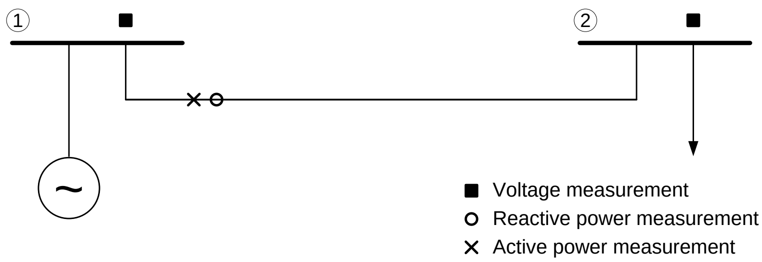


$$\hat{\mathbf{x}} = \begin{bmatrix} \hat{x}_1 \\ \hat{x}_2 \\ \hat{x}_3 \end{bmatrix} = \begin{bmatrix} \hat{\delta}_2 \\ \hat{V}_1 \\ \hat{V}_2 \end{bmatrix} = ?$$

Electric vehicle

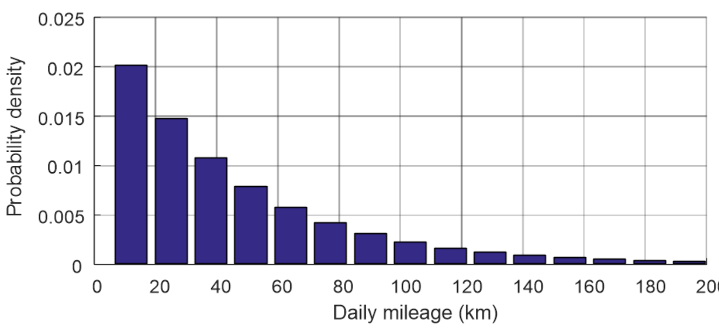
Content:

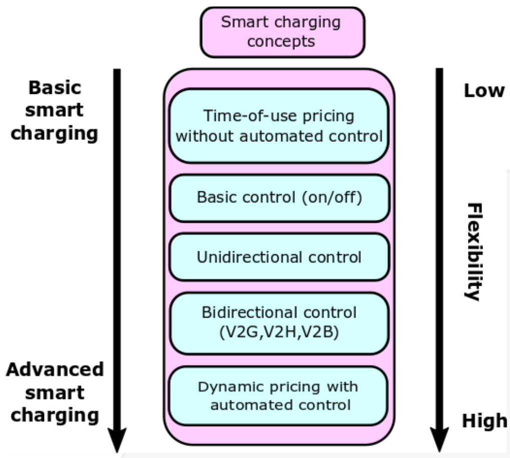
- **Describing electrical vehicle as electrical load:**
  - **Battery size, SOC, vehicle consumption…**
  - **User behavior observed trough statistical data**
    - **travelled distances, start and end of journeys**
    - **start of charging times**
- **Probabilistic analysis of EV-integration**
  - **Sampling of distributions**
  - **Monte Carlo approach to definition of EV as a load**
- **Influence of electric vehicles on network elements and on networks' operation**
  - **overloading, voltage levels, voltage unbalance…**
- **Presenting different concepts of smart charging and their advantage**

LEARNING OUTCOMES

Students should be able to:

- understand the characteristics of EV as electrical load and the impact of EV on distribution grid





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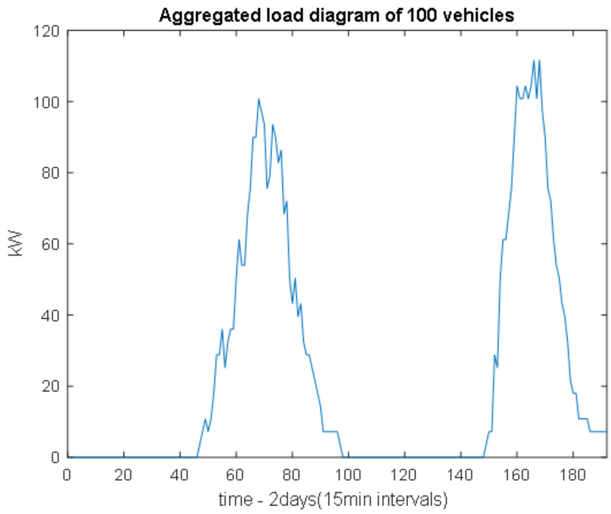
EXERCISE

Students had to determine charging diagram of electric vehicle using MATLAB. Necessary data was provided. To determine simplified EV charging diagram following approaches were required:

- Sampling of data from the provided statistics of the traveled distances,
- Defining probability distribution function for start of charging times,
- Calculate vehicle consumption
- Determine charging time of electric vehicle



Smart grid technologies

Content:

- **Overview of EU electricity generation and energy policy**
- **Challenges of modern power systems**
- **Traditional distribution network operation**
- **Presentation of smart grids**
    - **Upgrade of a traditional grid -> efficient use of existing infrastructure**
    - **Advanced voltage control, VPP, DR, network services**
- **A stochastic modelling approach of electric power systems for network planning**
  Monte Carlo simulations approach, confidence interval

LEARNING OUTCOMES

Students should be able to:

- understand the impact of renewables and new loads on distribution networks
- understand the basics of traditional distribution network operation
- understand the concepts encompassed by smart grids

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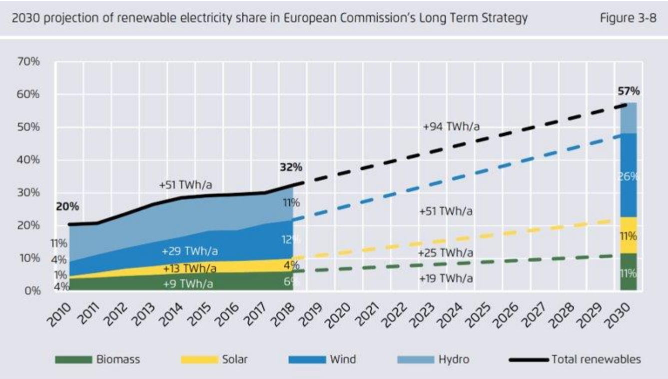
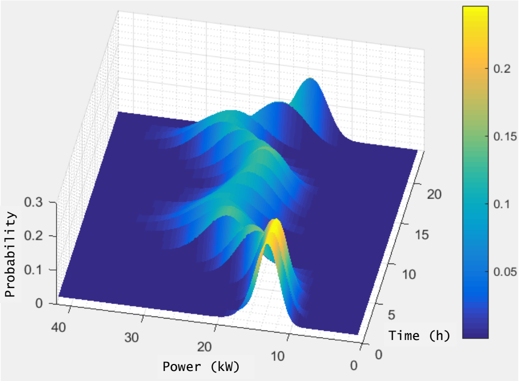




Power quality

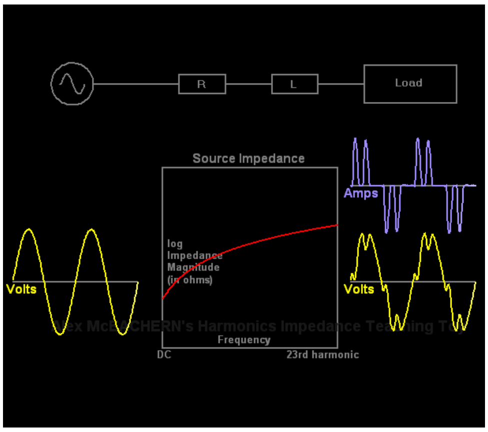
Content:

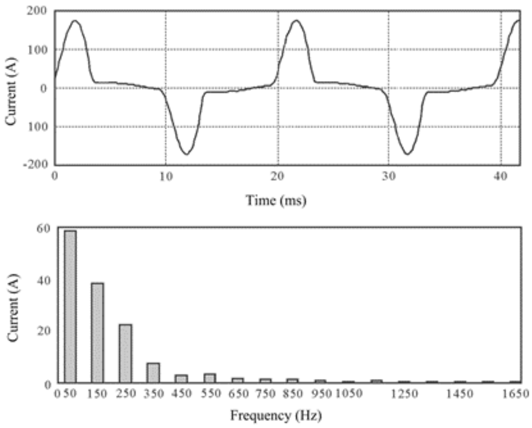
- **Basic terms and definitions of power quality.**
- **Definition of harmonics and their reflection on the network.**
- **Definition of flicker with the description of flicker sources and its consequences in the network.**
- **Definiton of voltage sag, its characteristics and causes.**

LEARNING OUTCOMES

Students should be able to:

- understand the main sources of network distortion and
- the consequences of the distortions in power system





Planning of distributed network expansion

Content:

Models of components of power grids are presented.
Symmetrical components transformation is derived.
Three-phase power line, transformer model, load model and power line model are explained.

LEARNING OUTCOMES

Students should be able to:

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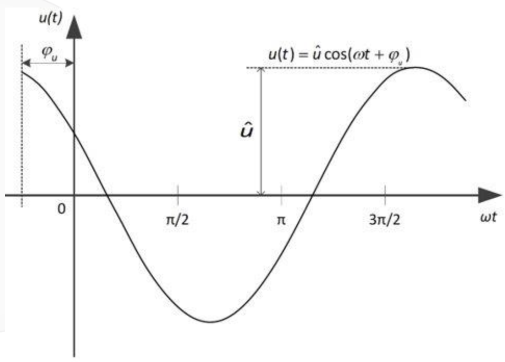
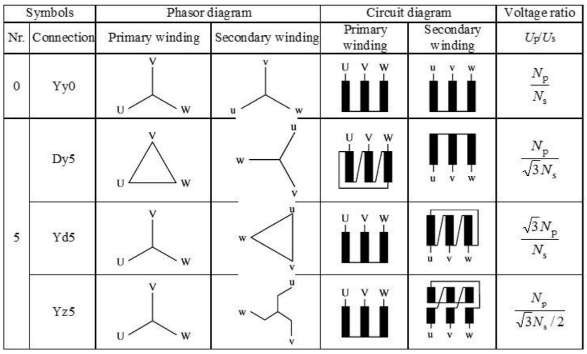
- understand the reasons for usage of symmetrical components in computations.
- understand the meaning of the formulas in the models.
- Understand the difference between multiple models for one grid component (when to use one).

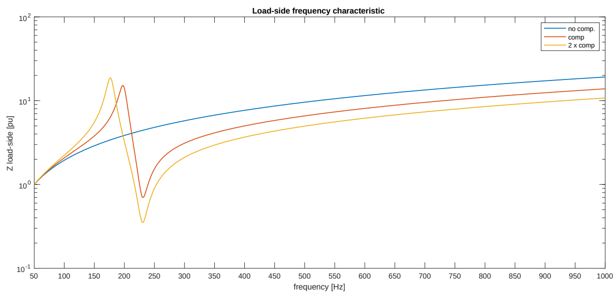




EXERCISE

Exercise giving the students an insight of the process of harmonic study that is executed in three steps:

- Definiton of harmonic sources.
- Study of harmonics propagation through a network.
- Mitigation approaches (harmonic compensation).



EXERCISE

Exercise providing insight in difference between two different line models:

- Calculation of power and voltages for all elements/nodes.
- Two examples: heavily loaded and lightly loaded line.
- Comparison of results and discussion of the reasons for differences.

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4. Teaching model

4.1.1. Teaching with the lectures method

The SMAGRINET lectures are an immensely effective tool for your classroom as they have been previously piloted in the classroom, allowing you as an instructor to provide an overarching theme with pre-organizes material in an illuminating and interesting way.
You as the instructor must take care, however, to shape the lecture for the specific audience of students who will hear it and to encourage those students to take an active and immediate part in learning the module.

CREATE A COMFORTABLE, NON-THREATENING ENVIRONMENT.
Introduce yourself and explain your interests in the topic on the first day. Encourage questions from the outset. For example, require each student to submit a question about the course during the first day or week. Students can submit these questions via an online discussion forum, such as that which is available on Moodle.

REVIEW AND PRACTICE THE LECTURE BEFORE CLASS BEGINS.
After writing the lecture, leave at least 30 minutes before your class to organize your thoughts and gather any material you need. Practicing the lecture will help you identify points where you will want to slow the pace, pause, or offer a summary or a question.
.
Make sure your tech works
If you do not have an assigned classroom or have had prior bad experience with projectors at your assigned classroom, especially regarding connecting them – make sure that you have somebody at hand or you are there early enough to get the nuisance of connection problems out of your way.

If you have chosen to do your lectures online – makes sure that you send the invitation of the digital online class with a 15 minute spare time prior to the agreed start time of the lecture. This allows for students to get into the lobby of the online platform that you are using and they are able to work out their audio-visual problems that might occur. This gives you vital time to make sure that your own microphone is working and your presentations are ready to be presented.

INTERACT WITH YOUR STUDENTS.
Arrive to class early, especially on the first day, and greet students who are already in the room. Students will feel more comfortable asking you questions and will feel more engaged in the topic of the course if they have an opportunity to interact with you in this way. If time does not permit for students to approach you for questions before or after the lecture, encourage them to see you during office hours.
The more an instructor interacts with the students during a lecture, the more active the learning will be. The judicious use of questions throughout a class session can move the lecture forward, engage the students, increase the use of higher-order thinking processes, and make the lecture more interesting.

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4.1.2. Suggestions

PREPARING

- Create a comfortable, non-threatening environment.
- Organize the lecture like a good speech.
- Prepare notes that will serve as a “road map” rather than a script to be read verbatim.
- If you are team-teaching, talk with co-instructors or TAs often to ensure coherence among lectures, discussions sessions, and office hours.
- Review and practice the lecture before class begins.
- If you plan to use tech for your lectures – make sure they work

DURING THE LECTURE

- Interact with your students.
- Provide students a clear sense of the day’s topics and their relation to the course as a whole.
- Show passion for the subject.
- Focus on communicating with your audience: speak clearly; move around the room, and use gestures to engage student attention.
- When asking questions, do not be afraid of silence.
- Demonstrate respect for, and interest in, student ideas and questions.

10 COMMON MISTAKES TO AVOID

- Trying to cover too much material in one class session.
- Not including opportunities for questions or active learning.
- Waiting until the last two minutes of class to ask and answer questions.
- Answering your own questions or asking more than one question at once.
- Assuming students are learning the material if they are not asking questions.
- Assuming that students will identify and understand the important points of each lecture.
- Reading your notes or the content of your slides when using slide-ware such as PowerPoint.
- Not looking at the students when you are lecturing; looking only at your notes or the chalkboard.

4.1.3. Grading and feedback

You should diligently follow the grading criteria, procedures, and policies developed by SMAGRINET. In addition, you should keep in mind that you will be on the “front line” for student questions and concerns about grading. Therefore, it is essential that you communicate early and often with the course instructor about all aspects of the grading process, so that you can answer questions and concerns that are likely to be posed by students.

GRADE FORMULATION FOR CONNECTION PLANNING IN SMARTGRIDS:

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WRITTEN TEST WEIGHT AND GUIDELINE

1. The formulated test makes up 50% of the total grade
2. 80 minutes for performing the test
3. Focus on paper and pen and spreadsheet exercises, as well as general knowledge questions
4.

PROJECT WEIGHT AND GUDIELINE

1. Independent student work, 2-3 students per project group
2. Given task to be solved with research, MATLAB simulation, and result analysis

   Preliminary presentation:
   - 15% of total grade
   - 10 minutes presentation

   Written report:
   - 35% of total grade
   - 15-40 pages

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5. Relatable context to the subject

It has been taken into account that the need to add some readings and classroom discussions help students understand their vital role in the learning process.

In order to avoid problems with attendances, uncompleted reading assignments, and student focus on grades rather than learning it is important to make sure that students recognize the value of what they are learning.

One of the safest ways of connecting and providing insight to students is to reference each topic back to The Green Deal. The Green Deal provides the course for the EUs economy and at the end of the day it will directly affect the industry, society and the environment physically around the students.

5.1.1. The Green Deal

The European Green Deal provides an action plan to:

- boost the efficient use of resources by moving to a clean, circular economy
- restore biodiversity and cut pollution

The plan outlines investments needed and financing tools available. It explains how to ensure a just and inclusive transition.

The EU aims to be climate neutral in 2050. It has been proposed at the European Climate Law level to turn this political commitment into a legal obligation.

Reaching this target will require action by all sectors **which your students will be fulfilling** and play a part in the following years to come:

- **investing in environmentally-friendly technologies**
- **supporting industry to innovate**
- **rolling out cleaner, cheaper and healthier forms of private and public transport**
- **decarbonising the energy sector**
- **ensuring buildings are more energy efficient**
- **working with international partners to improve global environmental standards**

• The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy. This is called the Just Transition Mechanism. It will help mobilise at least €100 billion over the period 2021-2027 in the most affected regions.

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All in all, the Green Deal asks your students to be bold and take action as they are educated and if they are educated, they should know that if they understand the flow of the future in the energy and enviromental sector they will have a bright future.

5.1.2. Renewing the EU electricity grid: the Best Paths towards energy transition

Integrated system planning is essential for developing reliable pathways to net-zero emissions. Equally important is the development of an electrification roadmap which fully takes into account geographical differences and technological advances – a valuable contribution to furthering our knowledge. While it is clear that electrification based on renewable energy sources is a fundamental pillar of the decarbonisation efforts, it is also increasingly necessary to identify future users of green gases and to develop compelling incentives for them. Actions and investments related to the European Green Deal and the Recovery Plan for Europe have to be designed and implemented to support energy system integration, enable the participation of individual consumers and acknowledge the role of the electricity grid as the backbone of the energy transition

The availability of clean energy is necessary for industrial and economic growth and the creation of European jobs.

Accelerating and aligning the energy transition with economic growth at the European level requires cooperation between a variety of stakeholders. Speakers emphasised the need to increasingly engage with industry, small- and large-scale consumers, and civil society to speed up the transition and reach net zero emissions. In particular large industrial consumers with ambitious sustainable energy targets drive the transition forward by connecting investment priorities to the reliable supply of renewable electricity. A suitable example for the shift in demand priorities was offered by Google, which highlighted their ambition to match their hourly electricity demand with carbon-free energy from the regional grids in which they operate. In addition, the company is developing a system to shift the timing of certain computing tasks to match the availability of low-carbon power sources.

Circular economy principles and ecosystem restoration should play a significant role in the energy transformation.

Decarbonising our economies entails opportunities for environmental protection. Adopting an integrated system approach at the planning stage can contribute to resource efficiency, thus leading to a more resilient environment, a more efficient and affordable energy system, and faster decarbonisation. This approach is particularly relevant for the development of large-scale renewable energy projects, such as offshore wind and power grids. In this context, it is necessary to develop sustainable technologies and infrastructure, as well as processes for deployment and sourcing that take into account circular economy principles. The planning of energy infrastructure should be based on robust scientific principles of environmental protection. In addition, the precautionary and the ‘do no harm’ principles should be applied already at the planning stage. European regulation also plays an important role, in particular in aligning

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stakeholders' interests and ensuring that ecosystem restoration is part of the overall vision.

5.1.3. Energy Transition of the EU Building Stock

EU energy renovation market is estimated at EUR 109 billion in 2015 and 882,900 jobs. It shows that the size of the EU energy renovation market could increase by almost half the current energy renovation market if a 40% energy savings target is adopted for 2030. This would lead to more than one million additional jobs.

Increasing the size of the emerging EU energy renovation market would require the design of an overarching, integrated and streamlined framework for buildings based on the "Efficiency First" principle. Such an overarching framework would, as required by the better regulation package, streamline reporting and ensure coherence between the investment-climate-energy provisions currently included in at least 14 EU policy instruments. It would also simplify implementation for Member States, avoid double-counting and facilitate compliance checking. The first step towards this transformation is to address the gaps and loopholes identified in the 14 existing EU instruments aiming to increase investments in reducing energy consumption in buildings and their related GHG emissions. The report suggests a specific recommendation for each of the identified gaps and loopholes.

The "Efficiency First" investment-climate-energy proposed framework for buildings would require new governance structure at EU level including setting-up an EU Energy Renovation Facilitator and an EU Risk Sharing Facility. This would give industry confidence to invest in the industrialisation of energy renovation which would unleash the 4th industrial revolution in Europe. The report suggests the first steps towards the design of such a framework.

5.2. Sustainable transport

Europe's transport system has been a huge success, connecting people across the continent and reducing journey times. As we have all become more mobile, so the carbon footprint of our transport activities has grown. Transport currently accounts for a quarter of the EU's greenhouse gas emissions and this figure continues to rise as demand grows. The European Green Deal seeks a 90% reduction in these emissions by 2050. Moving to more sustainable transport means putting users first and providing them with more affordable, accessible, healthier and cleaner alternatives.

A key objective is to boost considerably the uptake of clean vehicles and alternative fuels. By 2025, about 1 million public recharging and refuelling stations will be needed for the 13 million zero- and low-emission vehicles expected on European roads. The Commission is supporting and financing the deployment of recharging and refuelling points where persistent gaps exist, notably for long-distance travel and less densely populated areas.

Achieving the ambitious climate goals also requires a shift to more sustainable transport modes such as rail and inland waterways. For this to happen, the capacity of both modes will need to be both extended and better managed.

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Multimodal transport – the combining of various transport modes throughout a journey – can also increase the use of sustainable transport modes, but needs a strong boost. The Combined Transport Directive is important here – it is designed to support multimodal freight operations involving rail and waterborne transport, including short-sea shipping.

Improving efficiency across the whole transport system is crucial. Digital technologies enabling automated mobility and smart traffic management systems, for example, will help with efficiency while also making transport cleaner. Smart applications and 'Mobility as a Service' solutions will also play an important role. In aviation, the Single European Sky initiative should significantly reduce aviation emissions at zero cost to consumers and companies by reducing flight times.

The negative environmental and health costs of transport – also known as externalities – are not generally reflected in prices. To rectify this, the Commission envisages extending emissions trading to the maritime sector and reducing the EU Emissions Trading System allowances currently allocated to airlines for free. This will be coordinated with action at global level, notably at the International Civil Aviation Organization (through CORSIA) and the International Maritime Organization. Other EU action in support of the 'polluter-pays' principle includes effective road pricing in the EU, as well as ending subsidies for fossil fuel.

It is in cities that pollution is felt the most. A combination of measures is needed to address air quality, emissions, urban congestion and noise. These include improving public transport and promoting active modes of transport such as walking and cycling. The EU will pay particular attention to reducing pollution in EU ports as well as the pollutants emitted by aeroplanes and airport operations.

The Commission supports the transition to sustainable mobility through the Connecting Europe Facility (CEF). Committed to spending 60% of the budget on infrastructure projects with a link to sustainability, CEF will be important in creating a European network of charging infrastructure for alternative fuels, and in enabling a highly performing, interoperable European railway network.

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6. Motivation of the students

Some students worry about grades; others need to satisfy a course prerequisite. Still others want to learn and explore ideas. In fact, many students are probably motivated to learn and to succeed by a combination of intrinsic and extrinsic elements. The key for us as teachers is to understand what we can do to build students' motivation to learn in our classroom, and to nurture the intrinsic motivation that will guide future learning.

Teachers often assume that, because they are"teaching," students must be learning. Students assume that, because they have read their textand memorized facts, they have learned something.

We know that students respond positively to three elements in most classes:

- A well-organized course;
- A teacher who is enthusiastic about the material and about teaching;
- A teacher who shows he or she cares about the students and their learning.

Communicate high but attainable expectations and goals. Most students want to be challenged and feel that they are directing their energies toward a worthwhile experience.

This means that they will work to achieve challenging goals if they view the goals as within their reach. True, some students are motivated by the fear of the daunting "killer test," but you will lose more students than you gain, and those you gain will not retain their motivation outside of the classroom.

6.1.1. Motivation during your module

Create a learning community in your classroom

Interaction, particularly with peers, is an important motivator for many students. There are several easy steps you can take to create an environment where students see themselves as part of a community of learners rather than as isolated individuals.

Things maybe looked upon from different point of views

Reward success publicly. This does not need to be an elaborate effort. Thank students for their comments, compliment good points by saying "good point," and refer back to individual students for their contributions when you can.

Share exemplary work with students

Copy, distribute (without names and with permission) and discuss outstanding research papers or assignments. This helps students see your standards and it recognizes students who do outstanding work.

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Use collaborative/cooperative learning groups

Students respond to interaction with their peers. Putting students in groups can therefore promote their learning.

Know your students and their interests

If you know who your students are and what they are involved in, you can adjust your class to connect with their interests. This can help them see the relevance of the material and motivate them to engage in class.

Some students can't be motivated

When you feel this way (and you will), it is important to remember that, for students, our course is one small component of their lives (Luce, 1990).

They are taking other courses, making friends, participating in activities, working to pay their way through school, and even taking care of families. In short, they are leading complex lives that affect how much energy and attention they can give to our classroom.

There is a limit to just how much we can actually motivate students. But it is also important not to stop trying because you may find that they actually will appreciate the efforts you have made.

6.1.2. Simple tips

There are simple solutions for quickly motivating and supporting students during the modules:

1. State clearly and explicitly what students need to do to receive an "A" in your course.
2. Get to class early and talk with your students about what they are doing in school, what they hope to learn, and what they are really enjoying.
3. Find simple ways (a comment to the class, a remark to a student after class, an e-mail) to recognize student contributions and excellent work.
4. Give students examples of ways in which class concepts relate to "real world" matters.

6.1.3. Lecturer suggestions during class sessions

Arrive early, start on time, and end on time.

Showing your respect for everyone's time will encourage your students to do the same. Arriving at the classroom early will allow you not only to set up for class but also to talk with students informally. This informal interaction will help you establish a rapport with your students, which will in turn help them feel confident to participate in class and to ask for help when they need it.

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INTERACT WITH STUDENTS; INCLUDE OPPORTUNITIES FOR ACTIVE LEARNING.

Demonstrate from the first class that you are interested in what students are thinking. Include plenty of opportunities for students to ask and answer questions. While a lecture course will provide fewer opportunities for interaction than a discussion course, you will find that students will be able to learn and retain more material if you pause every 15-20 minutes to ask questions or to ask students to apply a theory, solve a problem, or discuss a debated point.

SHOW PASSION FOR THE SUBJECT AND FOR YOUR STUDENTS' LEARNING.

One of the most effective ways to inspire your students to learn is to show that you are truly interested in, and excited about, the course content and their learning.

BE FLEXIBLE.

Be prepared to have good days and bad days in the classroom. If you are not getting good results teaching in a particular way, try something new. For example, if the students in your discussion or recitation section are extremely quiet, break them up into smaller groups to solve a problem or answer a set of questions.

IF STUDENTS APPEAR BORED, INCLUDE MORE OPPORTUNITIES FOR ACTIVE LEARNING.

Pause in the middle of class to have students ask and answer questions, provide examples, or solve problems. Do not assume that students look bored because they know the material and then decide to speed up your pace; it may be instead that they are having trouble understanding what you are presenting to them. It may also be that they are sleep-deprived, as college students often are.

IF YOU DO NOT KNOW THE ANSWER TO A QUESTION, SAY SO.

Tell the students that you will find an answer, and then get back to them. Present the answer to the entire group during the next class; do not let the matter drop. You do not need to be all-knowing to maintain your credibility. One way to lose it, in fact, is to bluff by giving an answer of which you are unsure and that students may later find out to be untrue. Model intellectual curiosity and honesty. Your enthusiasm to learn something new will inspire your students to follow your example.

WHEN ASKING QUESTIONS, DO NOT BE AFRAID OF SILENCE.

Often, silence means that students are thinking. Do not give in to the temptation to end the silence by answering your own questions, which will only convince students that if they wait long enough, they will not have to think because you will supply the answers for them. Wait 5-10 seconds for an answer. If, at that point, you are getting blank stares and quizzical expressions, rephrase your question.

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7. Supporting material

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- For introduction and general information about the current use of electric vehicles and deployment of charging infrastructure:
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  - https://ec.europa.eu/clima/policies/transport/vehicles
  - https://www.eea.europa.eu/
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- Electric vehicle as electrical load and impact on distribution network:
  - https://www.sciencedirect.com/science/article/pii/S2590116819300062
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  - https://www.sciencedirect.com/science/article/pii/S1364032119300516
  - https://www.sciencedirect.com/science/article/pii/S2590116820300230
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www.ttu.ee

SLOVENIA
www.fe.uni-lj.si

GERMANY
www.tu-dresden.de

PORTUGAL
www.loba.cx

ESTONIA
www.civitta.com

LITHUANIA
www.ktu.edu

GERMANY
www.sense.tu-berlin.de

ESTONIA
www.elektriliit.ee

FRANCE
www.welcome.univ-lorraine.fr

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