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edutrans
education & energy transition

Handbook

Edutrans project

Education & energy transition

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Table of contents

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1. Introduction

Energy transition
"Energy transition", the transformation of how energy is produced and consumed, has emerged in Europe from the conviction that in order to address existing climate challenges we must both reduce energy consumption and replace fossil fuels with renewable energies. Challenges in engineering and ICT are increasingly entering the domain of energy transition. The primary challenge is to accommodate energy transition in the existing electrical power system. Available technologies are e.g. nuclear fuel (uranium) and the renewable energy sources wind, hydropower, solar power, geothermal, and hydro energy. Energy transition requires innovation in business and industry, developing new technologies and products. This will have an impact on companies involved as producers, but also on consumers of energy, both private and public. New technologies require new knowledge and production methods, thus having a great impact on vocational education.

The relevance of Edutrans programme
Within this project VET teachers will be better equipped to train future students, where companies will benefit from innovative approaches of training and upskilling staff for rapid developments in energy transition. Seven VET partners from 4 countries (The Netherlands, Germany, Denmark and Spain, Basque Country included) have cooperated closely to develop educational material about energy transition on levels 2 through 5 of VET/HVET, using modern didactic methods in a hybrid educational environment, joining forces of education and business to contribute to upskilling, reskilling and innovation.

Handbook
VET students and teachers will not only have to be aware of developments and know about technical innovations, but they will also have to be able to use and innovate them. In this project educational content and the curriculum is developed in co-creation between VET institutions and companies, while further developing the concept of hybrid education. This handbook is the quick start guide for VET schools who would like to know more about the Edutrans project or who would like to use the educational content and models that were developed for this project.

Technical models
The partners have developed prototypes for 14 technical models with accompanying learning materials. The modules are done in a way that all partners and other schools can work with them. These models will be usable for levels 2, 3 and 4, and where feasible level 5 (from VET/HVET). In the next chapter you will find more background information about the Edutrans project, the ECVET principles and hybrid learning. The third chapter starts with an overview of the models and will further on provide a one-page description about each model with a link to more detailed information. In the attachments you can find a list of the participants and their contact information.

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2. The Edutrans project

In this chapter the principles and concepts are described that are used during the Edutrans project. Despite the great differences between VET Schools in Europe these are overarching themes that can be applied everywhere in Europe in one or another way. In chapter 2.4 there is a full description of the learning materials that are developed during the project.

2.1 ECVET principles

The European Credit System for Vocational Education and Training (ECVET) is a technical framework for the recognition and transfer of individuals' learning outcomes across Europe. The use of ECVET during formal education prevents duplication of already reached goals or qualifications. In this way, the mobility of European students, also facilitating lifelong learning, is encouraged, because their learning outcomes achieved abroad can be translated into the system of their home institution. In the Edutrans project ECVET is a set of tools which can be implemented in many different ways as long as the principles of mutual recognition and transparency are respected.

Learning outcomes

Learning outcomes can be defined as: "statements of what a learner knows, understands and is able to do on completion of a learning process" (Recommendation on the European Qualifications Framework - EQF, 2014). We use the terms of knowledge, skills and competence to describe our learning outcomes.

Knowledge: 'the students knows / is familiar with / is able to name or describe…'

Skills: 'the student can / is able to…'

Competences: ''The student is responsible for/ is able to apply/evaluate…'

Assessments

An assessment is a method or process to establish the extent to which a learner has in fact attained the skills, knowledge and competences described in the learning outcomes. After a positive assessment the outcomes can be translated into credits / grades / point by the home institution.

In the ECVET manual for Edutrans you can find more background information about the use and origin of ECVET. It will also provide a lot of examples of learning outcomes and assessment forms.

Source: ECVET manual for Edutrans. This manual was originally developed for EMEU - Engineering Mobility in Europe (See: www.em-eu.eu)

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2.2 Hybrid learning in the Edutrans project

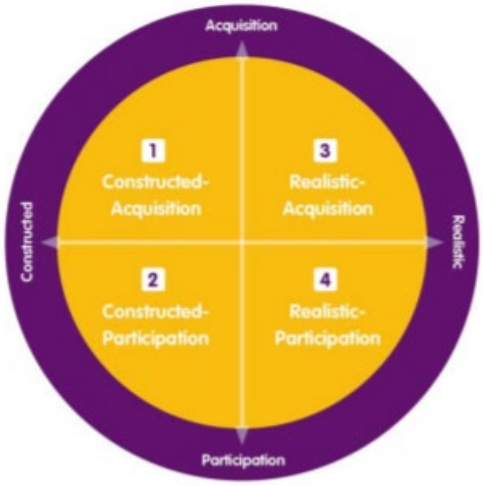
The concept of hybrid learning

When we talk about learning and education, we can make a distinction between learning in an educational environment and learning in a workplace environment. To prepare students for their future as a professional, first of all we need to have a smooth transition between education and the workplace. Furthermore, we need to educate for flexible professionals. Students must be equipped with necessary skills (21st century skills) to stay employable for their professional career. Lastly, students have to develop an integrated knowledge base, with theory, skills, attitudes and practical knowledge. Therefore we need to integrate aspects of school-based settings and workplace experiences in so called 'hybrid learning environments'.

In hybrid learning environments school-based learning is merged with learning in a workplace environment. Therefore we need strong cooperation between vet schools and companies. Students are learning and working on authentic tasks and working processes, coached by a teacher. By using real projects and authentic tasks, preferable working behaviour and innovation is elicited. In these hybrid learning environments the students get theoretical knowledge that they can use directly in the realistic or real workplace.

To operationalise the hybrid learning environments, the framework below can be used. There are two dimensions: constructed-realistic and acquisition-participation. Together they form four quadrants, with specific learning situations. For a hybrid learning environment, each of the four quadrants should be represented and be aligned with each other.

For example there will be (1) lectures to present theoretical knowledge, (2) group assignments or simulations to practice in an up-to-date save environment, (3) discussion or presentations about work experiences to explicit learning experiences and (4) working in a realistic context with actual, external clients from within a school-based setting or with professionals in real-life workplaces.



Source: Zitter, I. and A. Hoeve (2012), "Hybrid Learning Environments: Merging Learning and Work Processes to Facilitate Knowledge Integration and Transitions"

Benefits of hybrid learning environments

The most important benefit of integrating learning and working, and align theory with practice, is that the transition between education and the workplace is more smooth. Besides that, by working on authentic

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tasks in realistic environments together with companies and with other students, the learning environment is more innovative and inspiring for students. In hybrid learning environments we can equip students to be successful professionals in continuously changing industries.
While working on authentic tasks in a realistic context, it must be taken into account that the tasks are sequenced from peripheral to full participation and from low accountability to high accountability. Point of attention is that students must still be able to learn. Teachers have a more coaching role by mentoring the learning processes in these hybrid learning environments.

Hybrid learning in the Edutrans project
Hybrid education as it is developing requires different forms of project-based learning, in strong cooperation between VET schools and companies. New technologies require new knowledge and production methods, thus having a great impact on vocational education. VET students and teachers will not only have to be aware of developments and know about technical innovations, but they will also have to be able to use and innovate them.
Most partners have already been experimenting with this form of education. We'll be building on concepts already developed. The networks already in place will be informed about the project, and asked to contribute actively. Educational content will be created in co-creation with the companies and by taking into account the four quadrants of hybrid learning environments.

2.3 21st Century Skills

21st Century skills are the abilities that today's students need to succeed in their further careers. There are 12 skills, divided over 3 categories:

A. Learning skills
1. *Critical thinking:* Finding solutions to problems
2. *Creativity*: Thinking outside the box
3. *Collaboration*: Working with others
4. *Communication*: Talking to others

B. Literacy Skills
5. *Information literacy*
6. *Media literacy*
7. *Technology literacy*

C. Life Skills
8. *Flexibility*: Deviating from plans as needed
9. *Leadership*: Motivating a team to accomplish a goal
10. *Initiative*: Starting projects, strategies, and plans on one's own

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11. *Productivity*: Maintaining efficiency
12. *Social skills*: Meeting and networking

The main focus of these skills is the ability to adapt to change. Students have to know how to react and work in a changing industries, otherwise they'll be left behind.

More information can be found on: https://www.aeseducation.com/career-readiness/what-are-21st-century-skills

2.4 Learning materials

The main goal of the Edutrans project is the development of educational material. Each participant has developed two technical models with accompanying learning materials consisting of:

- Technical guide
- Teachers guide
- Student materials

The aim of the project is that the output can be disseminated among other schools. The physical models are not available, but technical drawings and buildings instructions will be provided so each school can build the models for themselves.

Technical models

In order to make the models suitable for all VET schools we set some guidelines:

- The models should be applicable for at least 2 EQF* levels.
- Students from different disciplines or different levels could work together on the models.
- Higher level students can instruct and coach lower level students
- Each model can be used by at least 4-5 students.

*The European Qualifications Framework (EQF) is a translation tool that helps understand and compare qualifications awarded in different countries and by different education and training systems. Its eight levels are described in terms of learning outcomes: knowledge, skills and competences. For more information: https://ec.europa.eu/ploteus/nl/node/1440).

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Technical guides

In the technical guide you can find an overview of the following subjects:

- Description of the model
- Estimated time to build the model
- Component description
- Estimated budget to purchase the materials
- Part list for buying the needed elements in the construction of the model
- Functional scheme
- Mounting instructions
- Setting up instructions
- Maintenance instructions
- Safety instructions
- Graphics of the model (photo, video)
- Technical drawings of the model (2D and 3D)

Teachers guide

The teachers guide will provide an outline of the model and the accompanying educational material. It will give a short description of the model and the goal of the module, an overview of the sustainability goals and an overview of the 21st century skills (See chapter 2.3). Furthermore, the learning outcomes are described in terms of knowledge, skills, competences, based on the ECVET principles.

Student materials

The students manual provides students an introduction to the model and related subject. And includes assignments for the different EQF levels. An assessment is added as part of the student materials.

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3. The models

In this chapter you will find a short overview of each of the models that are developed in the Edutrans project. For more information, teacher templates, building instructions and student information you can click on the link or go to our website http://www.edutrans-project.eu. Detailed contact information about the authors can be find in attachment 1.

Number	Title	Author		EFQ Levels				
				1	2	3	4	5
1	Heat pump	Xabec	Spain			x	x	x
2	Autonomous photovoltaic	Usurbil	Spain		x	x	x	x
3	Photovoltaic	Hans-Sachs-Berufskolleg	Germany		x	x	x	x
4	Smart office	Aarhus TECH	Denmark			x	x	
5	Energy storage	Roskilde Technikal College	Denmark			x	x	x
6	Vertical farming	Da Vinci College	Netherlands		x	x	x	
7	Turning water into energy	Deltion College	Netherlands			x	x	x
8	Ventilation control with Arduino	Xabec	Spain			x	x	x
9	Grid connnected photovoltaic	Usurbil	Spain		x	x	x	x
10	Smart building	Hans-Sachs-Berufskolleg	Germany			x	x	x
11	Green versus traditional insulation material	Aarhus TECH	Denmark		x	x	x	
12	Wave energy	Roskilde Technikal College	Denmark			x	x	x
13	Heat pump & aquathermal energy	Da Vinci College	Netherlands		x	x	x	x
14	Solar thermal	Deltion College	Netherlands		x	x	x	x

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3.1 Model 1: Heat Pump EFQ Level 3, 4 and 5

1. **Subjects** – Heat pump

- Safety
- Energy
- Efficiency


2. Authors – Xabec, Spain

3. Description

After following this module students are familiar with the basic knowledge of main function of a heat pump and its application on energy resources. They can describe how it works, and how to adjust depending on the energy demand (hot water, heating and cooling). They will work with the whole process of the heat pump: start up, measure, adjust and solving failures. The students should work safely and taking care of the environment. This module will explore the possibilities of connection to another energy resources (solar panels) so the efficiency will increase. Finally the student will get awareness of the energy transition, since the model is affordable for most people.

4. **Summary of learning outcomes**

After following this module students:

a. know how to use the different measurement tools and schemas.
b. are familiar with the use and management of the machine and how to set different parameters.
c. know the safety rules.
d. are able to work with different components of the machine.
e. can measure different parameters in the correct places where they have connected the measuring tool.

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f. can work safely preventing damage in the whole processes, identifying the most damaging moments or places.
g. are responsible for the correct working of the machine or recognize mistakes if they exist.
h. are able to evaluate the tested measures, and warn when a mistake might occur.
i. are responsible for the security of the whole process.

5. Additional information / knowledge

Pre-knowledge about heat pumps: basic components, how the refrigerant moves and basic electricity connections

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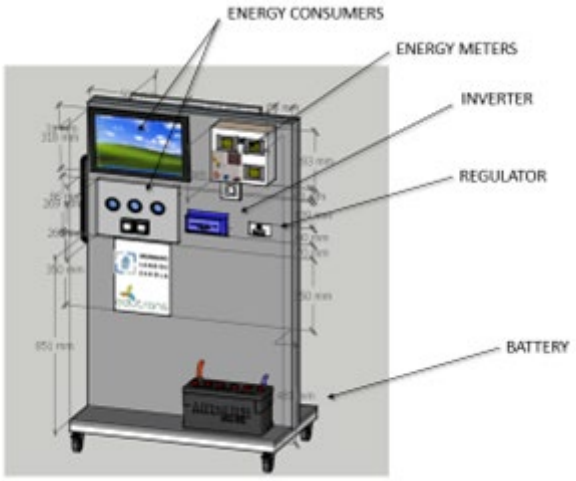
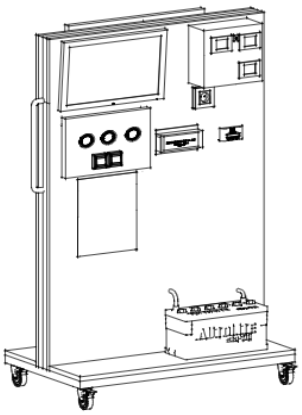
3.2 Model 2: Autonomous photovoltaic EFQ Level 2, 3, 4 and 5





1. **Subjects** – Autonomous Photovoltaic
   - Electrical installations and maintenance.
   - Renewable energy generation: photovoltaic energy and storage.

2. **Authors**: Usurbil, Spain

3. **Description**

With this model, the students are familiarised with the basics of a photovoltaic system. The structure, the required components and the function of a photovoltaic system. They learn about and measure the electrical values of the individual components.

4. Summary of learning outcomes

After following this module students:

a. know about the configuration and operation of photovoltaic solar installations. Isolated installations.
b. are familiar with basic electrical engineering related to photovoltaic solar installations.
c. are able to describe basic concepts of solar radiation.
d. know about basic concepts of storage and accumulation systems: batteries and accumulators.

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e. are able to use and connect equipment and constituent elements of photovoltaic solar installations: support and anchors, panels, inverters, accumulators, regulation and control equipment.
f. are able to use basic concepts of protective devices in electrical circuits.
g. are able to recognize and interpret electrical and technical diagrams, symbology and graphic representation of photovoltaic installations.

5. Additional information / knowledge

Energía Fotovoltaica (lhusurbil.eus)
https://www.aisolar.com/en/services/self-production/
https://www.intechopen.com/chapters/68852

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3.3 Model 3: Photovoltaic EFQ Level 2, 3, 4 and 5

1. Subjects: Photovoltaic

- Energy efficiency
- Sustainability
- Applications

2. Author: Hans-Sachs-Berufskolleg, Germany

3. Description:

After working this module students can (depending on their previous knowledge and EQF level):

- name advantages of renewable energies in comparison to fossil fuels.
- identify the individual components of a PV system and describe their function within the system.
- make a statement about the mechanical construction and justify the influence of the respective orientation on the output of the system.
- carry out measurements of the electrical quantities voltage and current, with or without help, properly and professionally within the system.
- based on the measured values, identify and replace faulty components in the system.
- use the measured values to calculate the efficiency of the individual components and of the system as a whole and thus make a statement about the overall efficiency.

4. Summary of learning outcomes

After following this module students:

a. can recognize the possibilities of PV and use it effectively.
b. understand the technical function. With this knowledge it is possible to optimize the planning.
c. are also able to calculate the profitability up to the TCO and know about funding opportunities. The students have sufficient knowledge to apply the technical and legal regulations.
d. are able to recognize errors (in planning and operation) and to find solutions.
e. see PV as part of energy generation and know the strengths and weaknesses of this type of generation.
f. know the product portfolio of the individual components and can guarantee a good composition.

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5. Additional information / knowledge

Safety instructions: The short-circuit current of a solar module can become very large. When working and measuring on the solar module, care must be taken to ensure correct wiring.

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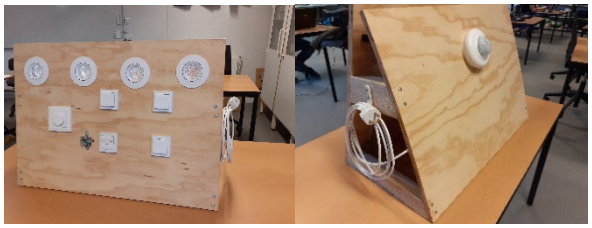
3.4 Model 4: Smart office EFQ Level 3 (4)

1. Subjects: Smart office

- Lowering energy consumption
- Automated processes
- Eco-sustainable
- Economy-sustainable



2. Author: Aarhus Tech, Denmark

3. Description:

After following this module students are familiar with a firm understanding of environmental consequences related to energy- and material production. They will be able to present solutions to light related energy optimization and an understanding there off. Students will have a basic knowledge of how a dimmer and PIR sensor work and how they can use a DALI system. Furthermore, they will have a basic knowledge of how they can use Building Management systems to control light and they have the ability to calculate cost of energy in relevant currency.

4. Summary of learning outcomes

After following this module students:

a. know how to use common tools needed to construct this model.
b. are familiar with the basic (practical/workshop based) work methods in field of the electrician.
c. have basic knowledge about health and safety regulations.
d. are able to use common tools needed to construct this model.
e. are able to choose the right components based on the instructions for this model.
f. are able to read and understand instructions and drawings for this model.
g. can plan and implement a task/activity or solve a problem in routine and/or known situations and surroundings - alone and in cooperation with others.
h. want to familiarize her or himself with the program's fundamental knowledge and skills areas and to develop responsibility and develop the basis for continued learning.
i. begin to establish independence in problem solving.
j. show the ability to independently familiarize her or himself with more complex tasks/"problems" and to communicate with others about their solution.
k. to show understanding of certain quality standards in relation to evaluate the model.

5. Additional information / knowledge

A sound understanding of fundamental electrical principals. (Ohm's Law, effect in terms of Watt, Joules etc.) A basic understanding of automation (the ability to control certain processes using electrical components.) Safety in regards to working on electrical systems.

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3.5 Model 5: Energy storage EFQ Level 3, 4 and 5

1. Subjects: Energy storage

- Sustainability
- Energy Efficiency
- Innovative thinking
- Building mode

2. Author: Roskilde Technical College, Denmark

3. Description

After following this module students are familiar with the basic knowledge of Renewable energy storage and its use. They can describe some of the different renewable energy methods, and how they work. They will work on a small-scale version of the HT-TES, and understand how it works.
This module will show the students how we can reuse and store the renewable energy we are over producing. The students will also get more knowledge about pros and cons with this type of storage.

4. Summary of learning outcomes:

After following this module students:

a. Can understand the theory energy storage
b. Are able to test different energy solutions
c. Are familiar with and understand the important of energy transition
d. Are able to measure energy and calculating
e. Are able to build an energy storage
f. Are able to make an Energy calculation exercises.
g. Are familiar with innovative thinking.
h. Are able to understand the newest- and technology in energy storage

5. Additional information / knowledge

For more information about this energy solution go to: (in Danish and English)
https://www.danskenergi.dk/nyheder/smaa-sten-kan-vaere-loesning-paa-stor-udfordring
https://energilager.nu/eng

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3.6 Model 6: Vertical farming EFQ Level 2, 3 and 4

1. Subjects: Vertical indoor farming: functional use of resources to optimize crop production

- Sustainable energy
- Growing process of vegetables
- Control software (Arduino or PLC)
- Applications

2. Author: Da Vinci, Netherlands

3. Description:

The goal of this module is that students will learn how to build a mobile vertical indoor farming 'production space' in which they will experiment with influencing different climatological parameters. The students will learn how to design the prototype, build the model by drawing and install and test the system.

4. Summary of learning outcomes:

After following this module students:

a. Are able to build the model
b. Are able to install and test the system
c. Are able to install and test the product
d. Are able to maintain the product
e. Are able to guide activities
f. Are able to manufacture the electrotechnical and mechatronical products
g. Are able to guide and lead the work process
h. Are able to control and test the products
i. Are able to install and modify the subproducts
j. Are able to design prototypes of the products

5. Additional information / knowledge

- Basic knowledge about reading mechanical and electrical drawings.
- Know how to use the neccesary machines and equipment safely.

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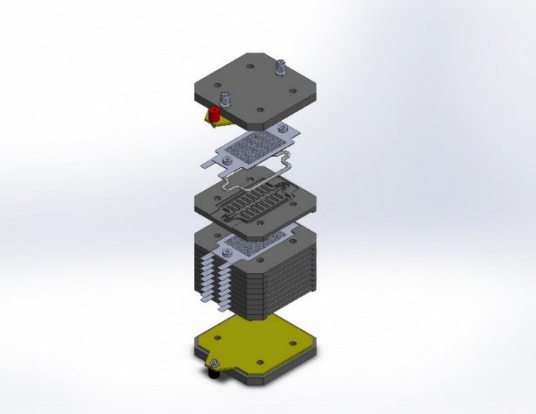
3.7 Model 7: Turning water into energy EFQ Level 3, 4 and 5

1. Subjects - Hydrogen

- Safety
- Chemistry
- Sustainability
- Efficiency
- Applications



2. Authors – Deltion College, Netherlands

3. Description

After following this module students are familiar with the basic knowledge of hydrogen and its use. They can describe how hydrogen reacts physically and chemically. They will work with a fuel cell and therefore understand the process of decomposing of water and the structure of the cell. Next to the chemical reaction there is a focus on the risks and safety issues connected to working with hydrogen. This module will explore the possibilities of transporting the gas and the applications gas combined with combustion engines. Finally the student will get awareness of the sustainable options to produce hydrogen.

4. Summary of learning outcomes

After following this module students:

a. Can give basic information about hydrogen and its use.
b. Knows the different components and their use.
c. Has knowledge of the structure of the system.
d. Can explain the functions of all measurement equipment and is able to work with it.
a. Is able to describe how hydrogen reacts physically and chemically.
c. Knows about the process of decomposing of water and the structure of the cell.
d. Has an understanding of the safety issues related to working with hydrogen and can perform a full safety check.
e. Can explain how basic chemistry is used.
f. Knows the divergence between molecules and atoms.
g. Is aware of our energy transition and the opportunities with hydrogen.

5. Additional information

Knowledge on combustion engines is recommended, but not necessary. The same with basic chemistry.

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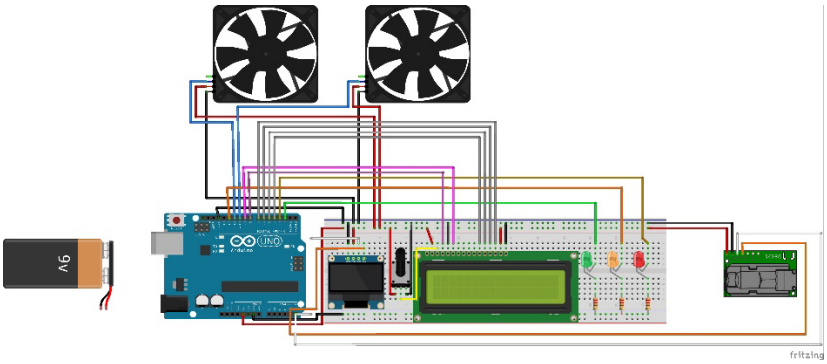
3.8 Model 8: Ventilation control with Arduino EFQ Level 3, 4 and 5

1. Subjects: Ventilation, Programming with Arduino

- Ventilation.
- Healthy atmosphere.
- Efficiency.
- Arduino.



2. Authors – Xabec, Spain

3. Description

In many countries, ventilation systems are still being controlled taking into account just the airflow and not the air quality. By using a simple Arduino program and a couple of sensors, this problem can be solved and the system would be much more efficient.

The model is about how to improve a simple ventilation system, adding an Arduino controller, based on co2 levels, to measure the air quality. Students will be learn about its functions and how it works, introducing HVAC tecs into the IoT world.

4. Summary of learning outcomes:

a. Recognise the parts and components of vent installation also the Arduino electronic parts including the main board and peripherals.
b. Figure out different system adjustments to improve the efficiency
c. Test the global function.
d. Work on it, as a basis for further projects or developments, like heat recovery systems or heat systems comparison

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e. Develop different programs by coding them.

5. Additional information / knowledge

- Basic understanding about programming with Arduino
- Knowledge about statistics and work in different scenarios

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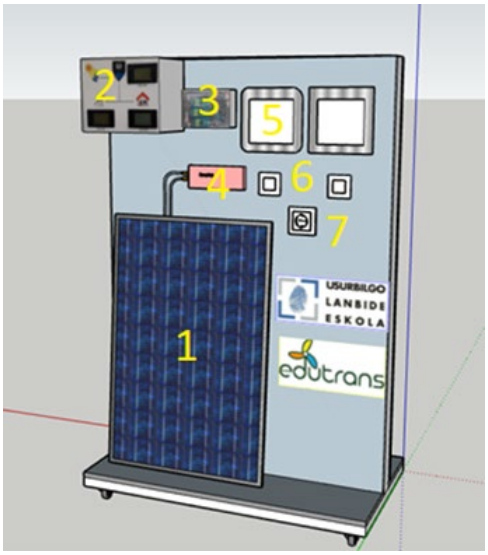
3.9 Model 9: Grid connected photovoltaic EFQ Level 2, 3, 4 and 5

1. **Subjects**: grid connected photovoltaic

   - Electrical installations and maintenance
   - Renewable energy generation: grid-tied photovoltaic energy.



2. **Authors** – Usurbil, Spain

3. **Description**

With this model students will work on solar photovoltaic energy which is connected to the electrical grid. Students learn to about the general assembly of grid-connected photovoltaic installations, and the elements needed which are: photovoltaic panel, inverter, energy consumer systems and other materials like cables, panel anchors and solar panel connectors. This model includes a smart energy counter, based in IoT technology, with which the energy flow can be measured and seen locally and remotely.

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4. Summary of learning outcomes:

After following this module students:

a. know about the configuration and operation of grid-tied photovoltaic solar installations.
b. are familiar with basic electrical engineering related to grid-tied photovoltaic solar installations.
c. are able to describe basic concepts of solar radiation.
d. are able to use and connect equipment and constituent elements of grid-tied photovoltaic solar installations: supports and anchors, panels, inverters, regulation and control equipment.
e. are able to use basic concepts of protective devices in electrical circuits.
f. are able to interpret electrical and technical diagrams, symbology and graphic representation of grid-tied photovoltaic installations.

5. Additional information / knowledge

https://www.acciona.com/renewable-energy/solar-energy/photovoltaic/

Energía Fotovoltaica (lhusurbil.eus)

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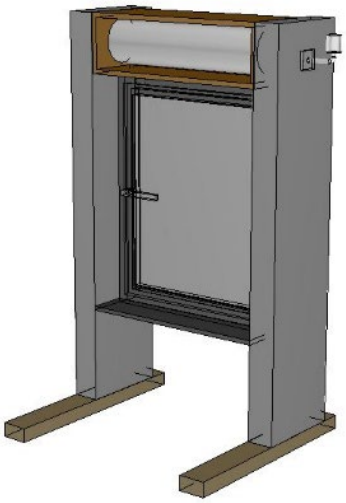
3.10 Model 10: Smart building EFQ Level 3, 4 and 5

1. Subjects: Building automation



- Building automation
- Energy saving
- Comfort gain
- More security
- Elderly-friendly living

2. Authors – Hans-Sachs-Berufskolleg, Germany

3. Description

After completing this module, students are familiar with the basics of building automation. They are familiar with the installation and programming of intelligent bus systems and are able to solve simple tasks independently. They know the difference between classic building installation and installations with intelligent bus systems. They will be able to distinguish the components used in terms of their function and explain their individual tasks in the overall system.

The students will learn a lot about the advantages and disadvantages of intelligent building systems.

4. Summary of learning outcomes:

After following this module students:

a. understand the structure of an intelligent bus system for building automation in theory
b. describe the advantages and disadvantages of a building automation system
c. are able to assign the devices used to their function
d. Know how to configure a system and program small scenarios independently
e. will have the opportunity to learn and deepen innovative and logical thinking
f. understand the state of the art and technology in building automation

5. Additional information / knowledge

N.A.

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3.11 Model 11: Green vs traditional insulation material EFQ Level 3, 4 and 5

1. Subjects: Model for measuring and recording humidity and temperature in two different insulation materials

- Insulation
- Comfort (temperature and humidity)
- I/0 List Input Output signals
- Critical considerations in choosing insulation materials

2. Authors: Aarhus tech, Denmark

3. Description

These two models will show and compare two different insulation materials insulation capacity and their ability to absorb and emit humidity. These are two different insulation materials, a sustainable natural product is measured against one of the many years used products on the market. The newer product is a wood fibre product which is made from residual materials for sustainable forestry which is 100% biodegradable. This material is compared to one of the materials known on the market for many years. This material is a rock wool product known as ROCKWOOL.
We have made simplified measurements, partly for temperature drops which are very accurate.
In addition, will have measured on moisture uptake and release, this is not done with hygrometer but with ordinary physical touch.

4. Summary of learning outcomes:

After following this module students:

a. recognize the key components based on electrical and/or automation designs and diagrams.
b. know the most common drawing symbols on a construction site.
c. are able to acquire and use information related to his/her vocational field and present it understandably both orally and in writing.
d. are able to choose and **use** tools, other utensils and materials according to documents and instructions.
e. can maintain equipment, appliances and instruments (under instruction).

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f. choose appropriate materials for the product or product ideation (under instruction) and uses them economically (under instruction).
g. use the most essential work equipment and materials in familiar work situations (but requires occasional guidance).
h. follow the instructions provided on work safety; does not cause danger to him/herself or others.
i. work as an active member of a group and adapts to the work community.
j. calculate material consumption and makes a cost estimate of the material expenses (under instruction).
k. plan his/her work (under supervision).
l. have achieved the ability to disseminate the knowledge achieved.

5. Additional information / knowledge

www.bæredygtigtbyggeri.dk

www.rockwool.com

https://www.dti.dk/specialists/green-lab-for-energy-efficient-buildings-gleeb/building-level-new-buildings-and-energy-renovated-buildings/33855,4?cms.query=buildings

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3.12 Model 12: Wave energy

EFQ Level 3, 4 and 5

1. Subjects: Wave energy, understanding wave energy.

- Sustainability
- Energy Efficiency
- Innovative thinking
- Theory behind wave energy

2. Authors Roskilde Technical College

3. Description

This model will simulate wave energy and the possibilities for an energy source.
The model simulates how Wave power is produced by the up and down motion of floating devices placed on the surface of the ocean. In other words, wind produces waves, and then waves produce energy. As the waves travel across the ocean, it Capture the natural movements of ocean currents and the flow of swells to generate power.

4. Summary of learning outcomes:

After following this module students:

a. Are able to understand the important of energy transition
b. Are able to measure energy and calculating
c. Are able to build an energy storage, wave solution
d. Are able to n make an Energy calculation exercises.
e. Are familiar with Innovative thinking.
f. Are familiar with the newest- and technology in wave energy
g. Are able to build the wave energy model, after the instructions
h. Are able to come up with improvement and suggestions for wave energy model

5. Additional information / knowledge

https://www.conserve-energy-future.com/waveenergy.php
https://www.andrico.dk/Kapitel%203.pdf (danish)
https://projekter.au.dk/havet/forloeb/forloebsoversigt/havets-energi/boelgekraft/energi-i-boelger/

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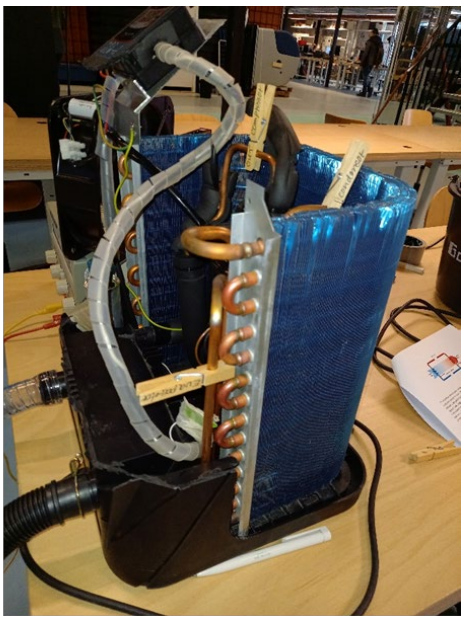
3.13 Model 13: Heat pump & aquathermal energy EFQ Level 2, 3 4 and 5

1. Subjects: heat pump, working of aqua thermal energy, efficiency in cooling and warming houses

2. Authors: Da Vinci College



3. Description

In this module about heat pumps and aqua thermal energy, students will learn about the principles and working of a heat pump and the technique of aqua thermal energy. Students will learn how the efficiency of the heat pump can be influenced and how it can be used to warm and cool homes. They will also learn about the basics of aqua thermal energy and how it can be used for houses.

4. Summary of learning outcomes:

After following this module students:

a. Know about the theory of sustainable energy
b. Can explain the theory of heat pumps and aquathermal energy
c. Know about the different parameters in the heatpump (temperature and pressure), how to influence them and what is the effect on the efficiency

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d. Are able to define the different components
e. Are able to (de-)assemble the different components
f. Are responsible for the rebuilding of the heatpump
g. Are responsible for the start-up and adjustment of the installation and testing of the sensors and wiring
h. Are able to do a prescripted testing procedure
i. Are able to convert the air cooling into water cooling

5. Additional information / knowledge

Pre-knowledge:
The students are able to read technical drawings
The students are familiar with the materials used and their appliance
The students are familiar with safety in regard to working on electrical systems

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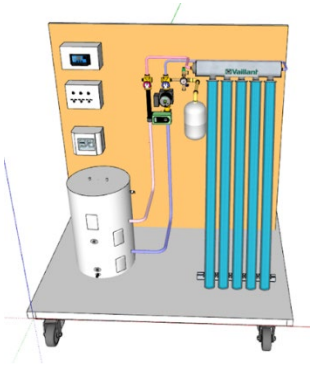
3.14 Model 14: Solar thermal — EFQ Level 2, 3, 4 and 5

1. Subjects:

- Thermal installations and maintenance.
- Renewable energy generation: solar thermal energy.



2. Authors: Deltion, The Netherlands

3. Description

With this model you will work on solar thermal energy, heating water directly from the sun, and the elements needed that will be:

- Solar thermal panel
- Pump
- Thermal primary circuit and security and measurement elements: over pressure valve, expansion vessel, and others.
- Thermal energy accumulation.
- Regulation
- Other materials: piping, isolation, fixing elements.

4. Summary of learning outcomes:

a. The student knows about the configuration and operation of Solar thermal installations.
b. The student is familiar with basic thermal engineering related to solar thermal installations.
c. The student is able to describe basic concepts of solar radiation.
d. The student is able to use and connect equipment and constituent elements of solar thermal installations: supports and anchors, panels, expansion vessels, accumulators, security, regulation and control equipment.
e. The student is able to use basic concepts of protective devices in thermal installations.
f. The student is able to recognize and interpret thermal and technical diagrams, symbology and graphic representation of THERMAL installations.

5. Additional information / knowledge

Energía Solar Térmica (Ihusurbil.com)
Solar thermal energy - Wikipedia

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