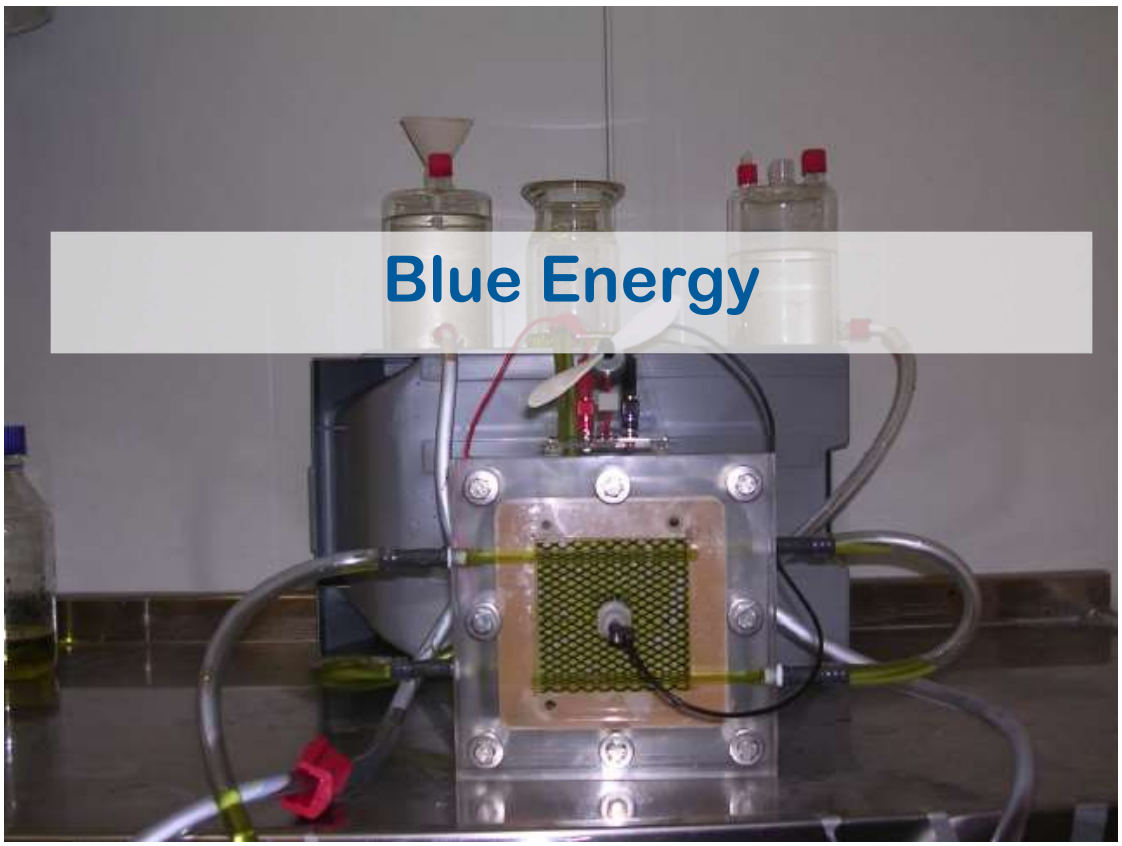
# Teachers' Card



# Blue Energy

# Index





EIT RawMaterials is supported by the EIT, a body of the European Union

# General Introduction & Background Info

The solution to environmentally friendly energy generation may be closer than we think. The traditional ways of generating sustainable energy are well known: tidal, solar and wind energy. What is less well known is that mixing fresh river water with salt seawater releases an enormous amount of energy. The technology required for this is still being developed, but it is likely that in the future households in the northern Netherlands will obtain their electricity from a power station on the Afsluitdijk. This power station would be located at the sluices where IJsselmeer water flows into the Wadden Sea. Blue Energy - as we call this form of energy - at such a location can provide a capacity of 200 MW, 200 million watts! If Blue Energy is deployed on a global scale, an amount of energy is generated that is estimated to be 20% of the total current energy consumption.

Blue Energy- Sustainable Energy from water - could help decreasing the use of batteries. Most of the batteries we use nowadays are environmentally toxic, they contain heavy metals and are dangerous if stored together. Examples of these batteries are Li-ion batteries, Lead-acid batteries and Nickel-Cadmium batteries. With the use of Blue Energy, less of these batteries will be needed and so the depletion of the raw materials needed for these batteries is decreased. The next step will be the Blue Battery, in which the generated energy will be stored in a sustainable way. Researchers at Wetsus are exploring the possibilities for this kind of techniques.

The central questions of this module are: What is Blue Energy, how can we generate it and how can it be used to solve the energy problem and raw materials depletion?

Blue Energy is the generation of electricity from the mixing of fresh and salt water. This can be done with so-called "reverse electrodialysis. The salt and fresh water are brought into contact with each other, separated by membranes. The difference in concentration pushes the ions from the salt water through the membrane into the fresh water. The resulting charge transport can be used to produce electricity. Sustainable production, because the sun is used as a source of energy. And no greenhouse gases (such as CO2, NOx and SOx) are released in the process. Moreover, the raw materials are free and virtually unlimited.

To answer this questions, you will look at the underlying principles of Blue Energy. Using the theory you get insight into the technique and process of Blue Energy. Then you will investigate the factors that influence the energy production, the design of the installation and the effect of scaling up. In addition, you will determine the optimal geographical location of a power plant.

This toolkit consists of background theory about Blue energy, a manual about how to build the Blue energy stack and a module about how to calculate on the stack. The students will build their own Blue Energy stack on which they will perform experiments. They will formulate their own research question (e.g. *What is the effect of the concentration of salt on the generated power?* or *What is the effect of the amount of membranes on the generated power?*. The students can work on the toolkit in groups of 3. The set-up itself can be used to perform a demonstration in front of the whole class, but we recommend to let the groups work on it separately. It is suitable for a high school research project, students often have to do at the end of their High School career.



EIT RawMaterials is supported by the EIT, a body of the European Union

# Teachers' Card

**The targeted audience** is age 15 or higher. In the module some complex chemistry and physics is explained, so the students need background information about force, pressure, electricity, energy, power and the General Gas Law. Also Redox reactions, chemical equilibrium, the unit mole, salt chemistry and the molar gas volume should be known. The should be able to calculate with logarithms.

**Key words:** *Sustainable energy, semi-permeable membranes, osmotic pressure, energy source, raw materials in batteries*

### Appendix 1 – Theory on Sustainable Energy from Water

# Learning Outcomes

By the end of the activity the students will be able to:

- Explain how Blue Energy could help to use less raw materials
- Give physical and chemical explanations for the phenomenon that energy is released when fresh and salt water mix
- Describe how and where this energy can be converted into useful electrical energy.
- Know how to perform an experiment, in which you measure and calculate your energy potential

# Key Competence European Framework

*the competences that can be acquired by doing this activity are:*

| **Literacy competence** |
|---|
| S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form. |
| S2. Ability to express concepts, feelings, facts or opinion in written and oral form. |
| S3. Ability to interpret the world and relate to others. |
| **Multilingual competence** |
| S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form. |
| S2. Ability to express concepts, feelings, facts or opinion in oral and written form. |



EIT RawMaterials is supported by the EIT, a body of the European Union

| |
|---|
| S3. Ability to interpret the world and relate to others. |
| S5. Knowledge of vocabulary, grammar and language. |
| S7. Ability to use technical language accordingly to the field of work. |
| **Mathematical competence and competence in science, technology and engineering** |
| S1. Ability to use constructed thinking in order to solve a problem in every situation. |
| S2. Understanding of mathematical term and concept and know how to apply it. |
| S3. Ability to model mathematically a situation from the real world and to transfer mathematical expertise to non mathematical contexts. |
| S4. Readiness to address new problems from new areas. |
| S5. Capacity for quantitative thinking. |
| S6. Ability to extract qualitative information from quantitative data |
| S7. Ability to formulate problems mathematically and in symbolic form so as to facilitate their analysis and solution. |
| S8. Ability to design experimental and observational studies and analyse data resulting from them. |
| S9. Ability to formulate complex problems of optimisation and decision making and to interpret the solutions in the original contexts of the problems |
| **Digital competence** |
| S1. Critical use of information technology for work |
| S2. Basic skills in ICT |
| S4. Ability to use and handle technological tools and machines |
| **Personal, social and learning to learn competence** |
| S3. Ability to gain process and assimilate new knowledge, skills and qualification required for career goals. |
| **Citizen competence** |
| S1. Ability to effective interaction with other people |
| S3. Ability to work effectively and collaborate with other team members |
| **Cultural awareness and expression competence** |
| S1. Ability to turn idea into action |
| S2. Creativity/innovation |
| S3. Ability to plan and manage tasks |
| S4. Independence, Motivation and Determination |

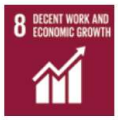


EIT RawMaterials is supported by the EIT, a body of the European Union

# Teachers' Card

# United Nations' Sustainable Development Goals

The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. *Goals linked to this activity:*

| | | | |
|---|---|---|---|
| |   Enable access to basic services | |  Equal access to global expertise |
| |  Safe medical devices | ✓ |  Sustainable urbanization |
| |  Access to education | ✓ |  Responsible consumption and production |
| |  Less hardship, more opportunities | ✓ |  Strengthen resilience, reduce disaster impact |
| |  Safe and affordable water | ✓ |  Reduce marine pollution |
| ✓ |  Energy – the golden thread | |  Sustainable use of terrestrial ecosystems |
| ✓ |  Safety of workers and economic growth | |  Promote peaceful and inclusive societies |
| ✓ |  Resilient infrastructure and sustainable industrialization | |  Better access to technology and innovation |

# Contents – Theoretical principles

*See* **Appendix 1 – Theory on Sustainable Energy from Water**

**Appendix 2 - Background Contents**



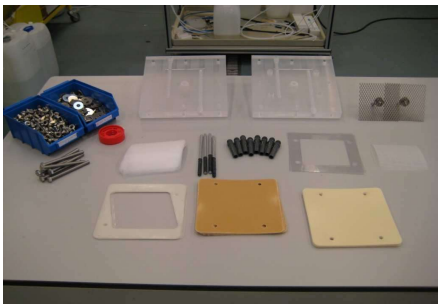
EIT RawMaterials is supported by the EIT, a body of the European Union

Teachers' Card

# Lab Procedure/Activity

*See*

**Module 1 - How to build the Blue energy stack**
*(Manual Blue Energy Stack)*



# Learning Pathway

***Step 1- Time & Activity:*** Students work through Theory document and do the assigned assignments, so they learn the basics of Blue Energy and how to calculate with it.

Time frame: e.g. 20 hours.

***Step 2- Time &Activity:*** Students build the Blue Energy Stack with the Manual and perform their own experiments. They can adjust variables to their research question.

Time frame: e.g. 10 hours

# Description of Student's Cards

*To be distributed among students:*

**Module 1 - How to build the Blue energy stack**

**Appendix 1 – Theory on Sustainable Energy from Water**
**Appendix 2 - Background Contents**
**Appendix 3 – Student's Assignments**

# Evaluation

**Appendix 3 – Student's Assignments**



EIT RawMaterials is supported by the EIT, a body of the European Union