| 1.12 | Energy - today and tomorrow |
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**Short Description:**

With this Demonstrator students are learning in a learning environment about renewable energies. The learning environment consists of two parts: an analog free-work learning cycle (preparation) and the Demonstrator itself, which means working with an online simulation about the turnaround from fossil to renewable energy.

Content of the preparatory learning cycle:

- The learners need to know why investigation in renewable energies is needed. So they have to learn about the problems that emerge from the use of fossil fuels. That's on one side the climate change caused by burning fossil raw materials and on the other the limitedness of exploitable fossil resources.
- Students need options for action. So we show them how they can save energy and also use energy more effective. For this purpose the concept of energy has to be clarified and examples of daily life have to be shown. With the help of the provided material and information, learners are able to find out e.g. which activity needs most energy in their life and how to use energy effectively.
- To become responsible citizens, students have to know about the different possibilities to produce renewable energy, related opportunities and risks.

Content of Demonstrator:


- The used simulation can also be seen as a serious game. It´s a landscape in the year 2013 where people are using mainly fossil and nuclear energy. Aim of the game is to substitute all fossil and atomic power plants with renewable energies until year 2022. Additional challenges are to ensure a continuous power supply, the satisfaction of the citizens and public finances. Learners have to invest in buildings of sustainable power plants, citizens' information and research in new technologies, power saving campaigns etc. The success is measured by social, ecological and economical factors.

Students work with the simulation in two phases: At first they have to orientate themselves

and get to know the software. This is followed by the second step when they try to meet the challenges of the simulation.

**Aims:**

Students get an insight into economic, ecologic and social aspects of the turnover from fossil to renewable energies.
Students become aware of issues that have to be considered when people foster big changes in society.
Students get an overview over characteristics of different types of power plants.
Students improve their ability to assess learning material (in this case the simulation).

**Fostered Skills:**

Communication (student work in pairs), reading skills, self-directed learning, self-paced learning, dealing with large numbers

**Connection to the curriculum:**

***General topics mentioned repetitive topics in Bavarian high school curriculum:***
Sustainable development
Environmental protection
Basis for live on earth (atmosphere, photosynthesis, warmth etc.)
Agriculture

**Physics**
Energy conversion, Efficiency, Finding answers to energy issues for the future of mankind , Energy supply: resources and responsible use , Power engineering: types of power plants, power generation, environmental issues

**Biology:**
Importance of sunlight for material cycle on earth, Importance and danger for ecosystems: sustainable management, Biotechnology and agriculture

**Chemistry:**
Problem of raw material and energy supply, Exploitation and production of hydrocarbons from mineral oil, importance of fossil raw materials in daily life, Carbon cycle, Greenhouse effect, Dependence of civilization on limited resources and importance to find alternative energy sources

**Geography:**
The anthropogenic greenhouse effect as global challenge, Limited resources: limited raw materials and sustainable management, World energy consumption: importance and availability of fossil raw materials, Substitution on fossil raw materials: recycling, renewable energies and raw materials, Characteristics of sustainable development

## Implementation of the Demonstrator

Students are working in pairs.
As preparation for the simulation, students do a free-work learning cycle (content see above).

*1st learning activity: Orientation and Asking questions (~10 minutes)*
Students open the program and get to know different functionalities. They can use supportive material. Aim of this activity is the orientation in the learning environment and to find the challenge of the game.

*2nd learning activity: Analysis and Interpretation (~5 minutes)*
Students indentify possibilities how to respond to this challenge. If students need help, they can use supporting questions provided.

*3rd learning activity: Planning and Investigation (~20 minutes)*
Students work with the simulation. By the following hints the simulation gives to the user or by trial and error (students can restart the simulation if there is a GameOver), they find out how to get good social, economic and ecological scores.

*4th learning activity: Analysis and interpretation (~5 minutes)*
Students analyse their game result and explain how it was achieved.
(An exemplary part of the result analysis form students get from the simulation, you can see below)

**Abschlussbilanz**

Schade! Du hast es zwar bis in dieses Jahr geschafft,
aber leider sind folgende Punktekonten auf 0 Punkte gefallen: Ökonomie

| | |
|---|---|
| SpielerIn | Gast |
| Punkte Innovationsgrad: | 828.97 |
| Punkte verbleibende Lebensdauer: | 11651.40 |
| Punkte Konstanz in der Stromversorgung: | 0.00 |
| Gesamtpunkte Soziales: | 7064.93 |
| Gesamtpunkte Ökonomie: | 3049.51 |
| Gesamtpunkte Ökologie: | 5212.42 |
| Gesamtpunkte: | 27807.24 |
| Gesamtverschuldung: | 34041.83 Millionen Euro |
| durchschnittl. Strompreis: | 11.03 Cent/kWh |
| Strom-Unterversorgung: | 0 Tage |
| durchschnittliche verbleibende Lebensdauer der Kraftwerke: | 30.18 Jahre |
| gesamte $CO_2$-Emission: | 29606947.03 Tonnen |
| Radioaktiver Abfall: | 6495.77 Kubikmeter (m3) |
| eingelagerter radioaktiver Abfall: | 0.00 Kubikmeter (m3) |
| Atomendlager verfügbar: | nein |

Strommix installierter Leistung:



*Figure 4: Part of the closing balance sheet*

*5thlearning activity: Conclusion and evaluation (~5 minutes)*
Students conclude what they learned while playing the game, reflect on their learning pathway and assess the quality of the simulation.
Example questions for students that are not trained in reflecting their learning progress are

e.g.:
How did you feel during the game?
What happened during playing the game and why?
Which strategies have been successful?
Which aspects of the game are unrealistic?

| **Domain:** | **Big Idea of Science:** | **Age group:** | **Time needed:** |
|---|---|---|---|
| Biology, Physics, Geography | 4;5 | 12-15<br>15-18 | Introduction to the subject two didactical hours<br>**Demonstrator:** One didactical hour (45 Min) |
| **Languages available:** | **Equipment needed** | **Involved actors** | **Used eTool and link:** |
| German, Assigned Material: German, Translation into English is planned | 1 computer per 2 persons | Students and one teaching assistant for technical questions and supervision | Energiespiel Bayern, https://www.ich-schaffe-die-energiewende.de/ |

# Quality Characteristics of the Demonstrator

**Characteristic I**
how Demonstrator follows an **inquiry based approach**

- working with real-world problems,
- working in a collaborative setting,
- learners reflect on their own learning process
- learning program fosters domain specific and domain independent competencies
- cognitive activity of learner
- work self-paced and student-centered

**Characteristic II**
how Demonstrator integrates **eLearning element**

The whole Demonstrator is based on the simulation “Wir schaffen die Energiewende”. With the simulation the very complex relationship between economics, environment and society can be shown over a time of 9 years.
The introduction, the supporting questions and the information are provided on paper. The communication between students happens face to face.

**Characteristic III**
how Demonstrator follows a **Big Idea of Science**

**Ideas of science:**
**The total amount of energy in the Universe is always the same but energy can be transformed when things change or are made to happen:** The power we use in daily life has to be made available by power transformation at first. This happens e.g. in power plants.

**The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate:** That´s one reason why mankind needs to reduce the emission of $CO_2$, because $CO_2$ intensifies global warming. To lower $CO_2$ emission, the burning of fossil raw materials needs to decrease. That's the reason why alternative energy sources are needed.

**Ideas about science:**
**Science assumes that for every effect there is one or more causes:**
Economic, ecological and social aspects can influence the success of the energy turnaround.

**The knowledge produced by science is used in some technologies to create products to serve human ends:**
Research helps to find new ways of power generation or saving energy.

**Applications of science often have ethical, social, economic and political implications:**
What happens with the nuclear waste we produce?
Is it ok to grow maize for the use in a biomass power plant?
Can we put offshore wind-parks in the sea without caring about the plants and animals that are living there?
What happens to the people who have worked in the nuclear power plant after the shut down?

**Characteristic IV**
how Demonstrator is connected to a **real world problem**

Energy supply is necessary for keeping the living standard of the students. Electric energy and also energy from fossil fuels for transportation or heating are parts of the daily life of students and teachers.
Every day, energy turnaround is a topic in the newspapers and television in Germany.

**Experiences with the Demonstrator?**

Not yet. The presented lesson is part of the evaluation programme of ISE and will be analysed as case study.