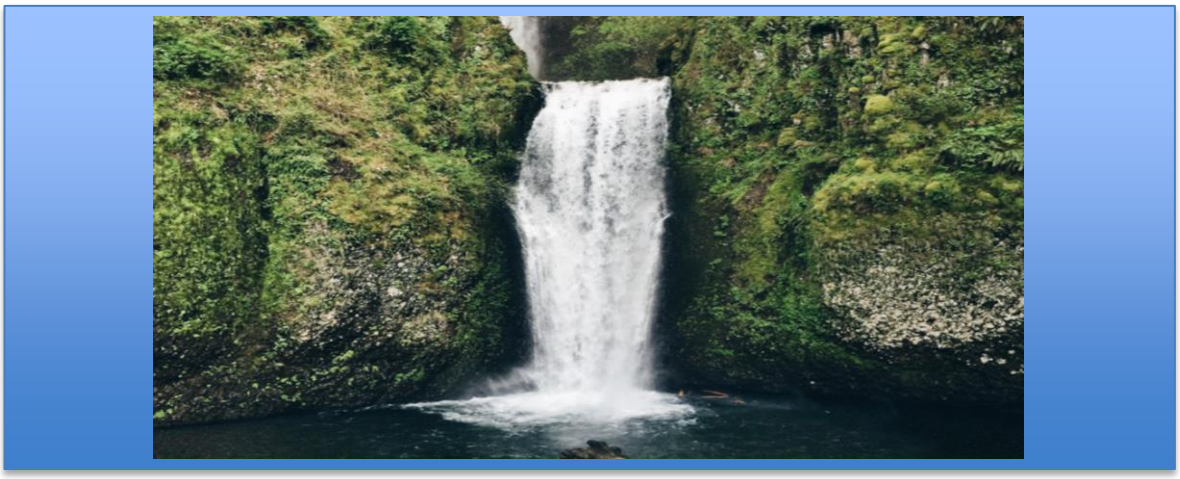

Title: Water Potential

Author of the teaching scenario: Helena Ivanac-Perutka
Subject title: Renewable Energy Sources
Grade: 3rd or 4th grade
Level of performance complexity: medium

Research method: WebQuest

Stages of the research method:
determining the initial and known state, asking problem questions, choosing the way to solve the problem, finding the necessary data, presentation of research results

Key words:
renewable energy sources, water energy, types / parts of turbines, flow / geodesic range of turbine use, turbine power, reaction / action turbines, radial / axial / tangential water flow, The Green Deal

Correlations, interdisciplinarity and cross-curricular topics (CCT):
Power Electronics, Power Engineering, Technical Mechanics, Machine Elements, CCT: Learning to Learn, Personal and Social Development, Use of ICT and Sustainable Development

Learning outcomes:
- recognize the potential of water as an energy source (A, B, C, D)
- define different types of turbines to exploit water potential (A, B, C, D)
- explore and collect data on the concepts, sizes and parameters for a given type of turbine (B, C)
- process data obtained by research (B, C)
- interpret issues and research results (C, D)

Cross-Curricular topics expectations:

Learn how to learn:
- Information management; The student independently seeks new information from various sources, transforms it into new knowledge and successfully applies it in solving problems.
- Precisely defines the problem and all its elements, 2. Applies and tests different strategies and selects those that will effectively lead to a quality

solution, 3. Critically analyses the problem-solving process and identifies opportunities to use newly acquired knowledge and skills in other situations.
- Planning; The student independently determines the learning goals, chooses the approach to learning and plans the learning.
- Self-evaluation / self-assessment; The student self-evaluates the learning process and its results, assesses the progress made and plans future learning based on that.

Personal and social development:
- He manages his educational and professional path.
- Collaborative learns and works in a team.
- Collaborates, organizes, performs its task, sets hypotheses, develops its role in the team, makes decisions.

Use of ICT:
- The student analytically decides on the selection of the appropriate digital technology.
- The student takes responsibility for their own security in the digital environment and the construction of a digital identity.
- The student independently conducts complex research with the help of ICT.
- The student independently and responsibly manages the collected information.
- The student independently or in collaboration with colleagues presents, creates and shares new ones.
- The student independently or in collaboration with others creates new content and ideas or reshapes existing digital solutions by applying different ways to encourage creativity.
- The student presents, creates and shares ideas and works on a complex topic with the help of ICT.

Sustainable development:
- It critically reflects on the impact of our actions on Earth and humanity

Evaluations:

For learning:
- supervision of students by professors during work (A, B, C)
- presentation of research by students (C)

As learning:
- comparing other people's research methods with one's own (B, C)
- assessment of one's own and others' work and team work (peer evaluation and self-evaluation) (B, C)
- discussion of students with other students and the teacher (A, B, C)

Learned:
- analysis of students' research work (B, C)
- presentation skills of students (C)

Activity description:

A Introductory lecture and discussion

The teacher starts the lesson with the following question:

"What countries in Europe are rich in water?"

and with which it encourages students to think and introduces the teaching unit "Water Potential". The teacher continuously leads the direction of the discussion, giving relevant advice and in case the students cannot think of the correct answer, he gives them a solution, which reads: according to the abundance of water (https://www.eea.europa.eu/data-and-maps/figures/proportion-of-classified-surface-water-6).

The next part of the class consists of reading with comprehension of the article which can be found at the following link: https://www.eea.europa.eu/highlights/soer2020-europes-environment-state-and-outlook-report

A sustainable future is still possible: **where to take action?**

It serves as a motivator for students' reflection on the use of water resources (potentials) within their own country and as the starting point of next discussion on the water potential.

B Research learning

The teacher begins with a lecture on the use of water potential from the point of view of mechanical engineering, presenting the concepts of energy and power of water, water turbines and their parts, which directly builds on the information presented in the previous lecture.
Information can be found at the following link:

- https://www.energy.gov/eere/water/types-hydropower-turbines
- https://www.energy.gov/eere/water/how-hydropower-works
- https://www.energy.gov/eere/water/types-hydropower-plants
- https://www.usgs.gov/special-topic/water-science-school/science/hydroelectric-power-advantages-production-and-usage?qt-science_center_objects=0#qt-science_center_objects

In this way, students get all the necessary information to start a discussion that leads to a research question:

"Why are there different types of turbines to harness the potential of water?"

After asking the research question, students are instructed to contribute to the basic research question, relevant sub-questions, which would encourage them to think and discuss further and facilitate and complete their final answers.

Examples of possible sub-questions are:

- **In which areas of flow / geodetic heights are they used and why in those areas?**
- **What are the largest and smallest turbine applications?**
- **What part of the turbine is crucial for harnessing water energy?**
- **What are all the energy conversions inside turbines?**

Activity can be carried out with digital tool (https://miro.com/app/), which serves as a class board in digital form.

Following the lecture on the exploitation of water potential by turbines and the research question, the teacher formed 3 research groups: **Peltoni**, **Francisi** and **Kaplani**. Research groups are formed by the teacher himself, and in order to ensure optimal mutual cooperation and respect among students of different abilities. In this way, more advanced students have the opportunity to help their less talented team members to conduct research on a given topic.

After the division into teams, students have the opportunity to change them in case they strongly disagree with the assigned team. Then teacher will adjust the research groups, all the time taking into account the talent / willingness to work of different students.

Research learning will take place over a period of for example: two weeks. In the first week students collect information from sources presented by the teacher as relevant. During the second week, students form a coherent entity in the form of PowerPoint presentations that will be presented to other groups, which will represent their entire research work and the answer to the research question.

Each of the groups has the task of answering a research question, respecting their given turbine, which correlates with the name of their groups and using sub-questions as a guide. The goal is to come up with an answer that includes the following:

- the basic parts of a given turbine and how they are specific to its area of application,
- turbine use of flow area,
- geodetic heights of turbine use,
- geographical area of use of a given type of turbine, taking into account the types of rivers in the country and world level,
- curiosities with the possibility of presenting historical development.

Research learning then begins, and the teacher encourages daily collaboration through online platforms such as Zoom, Teams, Yammer and others.

C Half time

In the first weeks of the day, students are encouraged to collect relevant information from the pages offered by the teacher in order to avoid incomplete, irrelevant or inaccurate information, and to better answer the research question. After the first week, there is a discussion within the groups with the teacher in order to direct the groups towards appropriate thinking, potentially present new

sources of information and check the general peer cooperation. During the mentioned discussion, the teacher listens to the students, gives suggestions and encourages the students depending on the course of work of a certain group.

The second part of the lesson is based on explaining how to present work using PowerPoint presentations. The teacher uses the following table (Table 1.) to draw students' attention to the relevant factors by which students will be assessed.

Table 1: Evaluation table for teachers

Evaluation criteria	Poor (0 points)	Average (1 point)	Excelet (2 points)	Score by group				
				1.	2.	3.	4.	5.
PPP length:	*less than 10 slides*	*more than 10 slides*	*10 slides*					
Title slide:	*No title or author names.*	*It contains the title, name and surname of the authors.*	*It contains the title, name and surname of the authors, name of the institution, place and date of the presentation.*					
Introduction:	*The student did not introduce himself and the topic at the beginning of the presentation..*	*The student presented the topic, but not himself.*	*The student clearly presented himself and the topic of the presentation.*					
Content display:	*Too much text on slides, too many different fonts, too many different animations. Dark or crowded background.*	*Some slides are readable, but some are difficult because the font size is small, the paragraphs are too long, or there is a lack of contrast with the background.*	*The text on each slide is of appropriate length, clues are used. Fonts are easy to read and the size is different for titles and text. The background and colour of the text enhance the readability of the text.*					
Images:	*No pictures.*	*Images are not intended to clarify text.*	*The images are well chosen and support the basic message.*					
Content knowledge:	*The content is presented in an uncertain and confusing way. The presenter looked at the notes, monitor, or canvas most of the time.*	*The content is presented in an understandable way, but a lack of self-confidence is seen in some parts of the presentation. Occasionally looks at notes, monitor, or canvas.*	*The presentation was easy to follow, the content was presented with certainty, in a clear and understandable way. He rarely uses notes, monitor or canvas.*					
Voice, volume:	*Quiet voice and / or insufficient emphasis, monotonous and boring.*	*The presenter is well heard in class. Some words and information are highlighted as important.*	*The presenter is well heard, tries to emphasize everything that is important for understanding the presentation, uses different volume.*					
Communicating with the audience:	*No class involvement.*	*Limited class involvement, 1-2 questions asked.*	*The class asks appropriate questions and actively participates.*					
			Total points: X / 16					

Students were also presented with a mutual assessment table (Table 2.) which is shown below, and the results of which will be included in the formation of the final grade of the research team.

Table 2: Evaluation table for students

Research group:		
Scoring elements	**Points range**	**Points awarded**
The research information is presented in an understandable and interesting way.	1-5	
The research information is relevant.	1-5	
The group answered a research question.	1-5	
Overall impression of the research group.	1-5	
Total number of points of the research group:		

D Presentation and evaluation

After two weeks of preparation, the presentation of the results of three groups begins: Peltoni, Francisi, Kaplani, during the class time.

Each group selects its representative who presents the results of the research of the whole group and after the formal presentation the whole group is invited to contribute comments on their way of working, potential problems / difficulties they encountered and the positive aspects of this way of working. The teacher evaluates the quality of the presentation and the presented information with the help of the previously mentioned table (Table 1.) while the peers use the table for intermediate assessment (Table 2.).

E Knowledge test

After the presentations, the students were introduced to the link, which will direct them to a short test of knowledge of about 10 minutes in order to check what they have learned from independent research and peer presentations.

The knowledge test will be held using the digital tool Testmoz (https://testmoz.com), where students' results are obtained immediately with the ability to save the result or delete the same after entering grades.

The final grade of the research work for students is formed from the following criteria: group presentations, evaluation tables for teachers (Table 1.), for students (Table 2.) and final knowledge tests. The teacher determines the point thresholds that will correspond to a certain grade.

Additional literature, content and links:

How to present:

- https://thinkscience.co.jp/en/articles/effective-presentations
- https://www.skillsyouneed.com/present/presentation-tips.html
- https://virtualspeech.com/blog/how-to-structure-your-presentation

Support procedures

Before performing the activity, check students with disabilities if the understand and explain it again if its necessary. With the agreement, students are provided with enough time to complete the task and are not limited in time in the presentation. Each student with disabilities gets on the team a gifted student who will have the role of mentor.

Gifted students who need less time for a given topic can be given an additional question to research, mentor role, and are presenting their results among the first. Such students can receive an additional grade in the activity for their effort and engagement.

Additional literature, content and links:

Students can be introduced to relevant sources of information, which include the following links:

- „International Energy Agency – Energy and Water", https://www.iea.org/
- „Britannica - Turbines", https://www.britannica.com/technology/turbine
- YouTube kanal: 3D-knowledge, https://www.youtube.com/watch?v=AT7B7IWmOtU

Students are also encouraged to independently find sources they deem relevant, including books, articles, videos, etc. Each source of information must be listed and used under teacher supervision.

Also, students can be introduced to links with which they can learn more about how to successfully present their presentation, which include the following links:

- „Top Tips for Effective Presentations", https://www.skillsyouneed.com/present/presentation-tips.html
- „How to Give a Killer presentation", Harvard Business School, https://hbr.org/2013/06/how-to-give-a-killer-presentation
- „Easy 3 Step Method To Awesome Presentation Content", https://www.youtube.com/watch?v=jOYH8aWB-6Q

Support procedures

Before performing activities, students with disabilities need to be explained in detail how to work and check their understanding of the same. By agreement, students are provided with sufficient time and are in no way limited in time. The teacher selects the groups in such a way as to provide students with disabilities with a friendly and pleasant environment within which they work with more gifted peers who continuously guide and help them.

All gifted students who express interest in the topic of research teaching are provided with independent work, ie additional research on the following concepts: cavitation and different types of HPPs, in order to encourage the continuation of successful learning and reward motivation.