European Commission

NATURE-BASED SOLUTIONS LEARNING SCENARIO

Green infrastructure and NBS in dialogue: How to integrate NBS in your technical classes

Research and Innovation

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Green infrastructure and NBS in dialogue: How to integrate NBS in your technical classes

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ABSTRACT

The purpose of this learning scenario is to introduce students, especially those at technical and vocational high schools, to Nature-Based Solutions (NBS), using the concept of green infrastructure applied to a practical project.

To begin with, the teacher presents NBS and their benefits and discusses them with students, with an eye to local issues. After laying the foundations of NBS and related challenges, students' approach (urban) problems and how to address them through green infrastructures, i.e. infrastructures integrating nature.

Followingly, the teachers propose a challenge that students must solve practically by modelling a solution involving green infrastructures. Students divide into groups and work on their project, considering design, planning, NBS, financing and civic engagement through co-creation. Finally, students present what they created to their classmates, as if they were public and private stakeholders, trying to gain support and funding.

Though this LS, students can reflect on the increased social, economic, and environmental value of infrastructures that include NBS. They also develop a sense of how to get a project funded, and they practise pitching a project to relevant stakeholders. Thus, students not only expand on their knowledge and vocabulary, but they also acquire communication skills by addressing real-life problems. Most-prominently, they understand the relevance of combining STEM with NBS and the feasibility of including sustainability in their future projects and plans.

Keywords

NBS, City of 21 century, Green Engineering, Green Infrastructure, Green Transportation, Governance

1. Introduction

> *"Nature-based solutions (NBS) are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions."* *https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en*

To use this Learning Scenario more effectively, teachers are encouraged to:

- Check out the list of recent EU publications on Nature-Based solutions
- Read about Nature-based solutions: Transforming cities, enhancing well-being (also available as a PDF)
- Contact local NBS practitioners or scientists working in their area (they can be found through Oppla).
- Use the "Ask Oppla" service to request help in case of any technical/scientific question on NBS.

2. Overview

Overview	
Subject	*Engineering related subjects in vocational/technical high schools, Extracurricular activities,*
Topic	NBS in infrastructures
Age of students	*15–20 years old*

Overview	
Preparation time	*60 min*
Teaching time	*180 min (4 lessons of 45 min)*
Online teaching material	Platforms such as Kahoot, Padlet, Prezi, Youtube. Any software needed to implement the proposed projects.
Offline teaching material	Laptop/notebook with software, LED screen or projector, flipchart, markers, Laptop/notebook with internet for students
NBS resources used	NBS resources will be found linked throughout the Activities section. These extra resources can be navigated and used to enrich the introduction to NBS: • https://www.naturebasedsolutionsinitiative.org • https://www.nature-basedsolutions.com • https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions

3. Integration into the curriculum

The learning scenario aims to offer a theoretical framework for the introduction of NBS in technical/engineering classes in high schools. Students will broaden their knowledge both of strictly STEM subjects and green thinking as applied to various technical topics. They will increase their vocabulary and understanding of social and environmental challenges, and possible solutions using nature, such as green infrastructure. Students will also practice how to address these issues practically, analysing and modelling them, and proposing their solutions, with a look to participatory planning and governance. Additionally, they will learn how to search and use online information sources in a foreign language, which is also a crucial element of the national curriculum.

4. Aim of the lesson

Students will:

- Learn about NBS, specifically as integrated with technical applications (such as infrastructures)
- Develop STEM skills, for examples as it relates to physics, biology, ecology
- Work on their transdisciplinary skills, among which system thinking, planning, communication, media literacy
- Understand the possibilities for connection and enrichment between disciplines
- Practice using concrete case studies and possibly software and tools
- Navigate information in a foreign language
- Navigate information on unfamiliar topics (governance and management, for example)
- Enrich their vocabulary connected on infrastructures, biological engineering, climate change, sustainability

5. Outcome of the lesson

The lesson will result in an understanding of how to open technical subjects to social and environmental concerns using NBS. This result will be achieved both thanks to theoretical classes and hands-on projects as devised by the teacher. The practical activities will focus on solving a climate change concern using green design with NBS, fostering participatory planning. In addition to the tangible result of their project, students taking part to this LS will strengthen multiple (STEM) skills; they will venture outside their field of knowledge; they will understand the role of interdisciplinarity and green thinking; they will broaden their language abilities. We are living in a time of serious climatic changes. It is then a much-needed skill for future engineers/technicians to know how to devise innovative solutions linking engineering with nature. Working on a small project stimulates creativity in a young technician and equips her for joining a greener workforce.

6. Trends

- NBS and sustainability education
- Project-Based Learning
- STEM learning
- Green infrastructures
- Collaborative Learning
- Participatory planning
- Hands-on learning
- ICT tools

7. 21st century skills

- Creativity and Innovation – Students create innovative solutions in engineering and work creatively with others
- Critical Thinking and Problem Solving - Students analyse a real-life problem using both STEM and green thinking, and they model comprehensive solutions to the problem
- Communication – Students formally present their ideas to peers and teachers, and informally discuss and collaborate with fellow students while working in groups
- Collaboration – Students work in pairs or small groups to a common project, and share responsibility for this work
- ICT Literacy – ICT tools can be used to research, organise, communicate, and evaluate information for the projects
- Media literacy – Students learn how to navigate resources they are not familiar with and in a foreign language to identify relevant information

8. Activities

Name of activity	Procedure	Time
Stage 1		
Introduction To NBS, climate change and sustainability	Introducing students to the theoretical foundations of NBS: what are NBS, why we use NBS, what kind of problems do the address? To achieve this, relevant information can be found on the European Commission web page on NBS, and in the following publications: NBS and Climate Change; Climate Problem, Urban Nature Solution?; Biodiversity and nature-based solutions; Key barriers to and factors for improving the successful implementation of nature-based solutions. This way, students confront topics of climate change, environmental degradation, (urban) sustainability. If this LS is implemented online, students may fill in a survey on what they know about these subjects before the first discussion. The introduction to NBS might be preceded by the following preliminary activities to strengthen awareness on broad topics of climate change (please be aware this will mean that the introduction is longer than the 12 minutes assigned): 1. Doing a preliminary study on students' knowledge using a quiz platform such as Kahoot 2. Watch the movie *"A 12 year-old girl made the world silent for 6 minutes"*: https://www.youtube.com/watch?v=yrhjbQQpa8 3. Share additional information on topics of climate change and social/environmental issues: • Reasons Why Studying Climate Change • Climate Change Impacts in Europe Students can also reflect on individual contributions to climate change with the Carbon Footprint Calculator	15’

Name of activity	Procedure	Time
Uncovering information on NBS	Discussion: after being introduced to the topics, students browse freely on the internet to further understand the role of NBS for biodiversity, cities, pollution, water management, etc. Students should be direct towards Oppla.eu and Naturvation.eu, where they can identify local NBS. After this activity, an open discussion with the teacher will address students' doubts and will correct possible inaccuracies.	15'
Discussion and brainstorming: NBS in the local context	Writing down the most relevant information about NBS: what, how, why, what issues they address. Searching the problems of your city/region that can be solved through NBS, discuss the kind of problems and the possible solutions.	15'
Stage 2		
Making connections: NBS and engineering	Followingly the introduction, NBS are approached from the technical perspective: how do we see NBS integrated into more technical subjects? Students explore urban problems, such as pollution, urban heat-island effects, the negative effect of grey infrastructure on biodiversity, ill-health, and lack of movement. From there, they look at what is green infrastructure, its benefits to urbanized contexts, they analyze the role of integrating NBS in planning, for instance, for risk management, water management, mitigation of the impacts of weather- and climate change-related natural hazards. This way, they make the connection between STEM, specifically engineering, and sustainability, specifically NBS. A Padlet can be created prior to this topic to understand how much students already know about green engineering and infrastructure, and if they have ever thought about it. A suggested question could be "*To what extent do you see engineering and its technical application inspired by nature, based in nature, collaborating with nature? Use concrete examples of buildings, infrastructure, etc. you are familiar with*"	40 min
Debriefing	Debrief with students on what was addressed in class (, nudging them towards a reflection on interdisciplinarity and integration of sustainability/green thinking in STEM. Students can be asked questions such as: ➢ *How can designing and building infrastructures integrate nature?* ➢ *What benefits do you see in this integration? Social, environmental, landscape-wise, recreational, etc.?* ➢ *To what extent do you think you should learn how to use nature in engineering?* This serves as a prompt for Stage 3.	5 min
Stage 3		
Lab groups	As a preliminary action for this stage, teachers choose an engineering-related local problem/issue/proposal they would like to address with students in class (they can also identify it together with students, which will require more time in class). Students will watch videos such as New vision of City and explore cases studies like Utrecht - NBS for for urban resilience and citizens' wellbeing to get inspired about existing and potential solutions for the development of sustainable urban environments. Students will be divided into small groups, and they will have to devise a solution to the given problem by integrating NBS. They will have to account for: ➢ Design and location of the solution in the urban context (DESIGN - PLANNING) ➢ How NBS is integrated and with what purpose (NBS OPTION) ➢ Costs of the integration (FINANCING)	35 min

Name of activity	Procedure	Time
	➢ Eventual management needs (PLANNING) ➢ Citizen engagement: how can planning this solution be made more participatory? How can citizens/users be involved? (CO-CREATION) To help students understand "Financing", which they might not be familiar with, the following resources will prove useful: Impact-Driven Financing And Investment Strategies For Urban Regeneration, Valuing & Investing in Nature-Based Solutions for Urban Sustainability, Financing Green Roofs, The Economic Value Of Nature-Based Solutions In European Cities, Financing and Business Models To help students understand the significance of participation and "co-creation", the video "Elisa Maceratini - Participatory urban planning: Lessons from the field" and this page "Training module on participatory planning and management" As an example, the author worked on "*Eco-transport in Grudziądz*", integrating green roofs (NBS) for biodiversity on sheds for solar-charged bikes. You can take a look at the project in Annex 1	
Challenges Assessment	The challenge is to integrate nature into urban design and planning to improve the environment, societies, human health, and wellbeing in a *participatory manner*. Projects should highlight clear social, environmental, and biodiversity-related benefits of the proposed green infrastructure. Students must decide on the best place and the best materials for the infrastructure to bring about the NBS benefits. They will consider the role of financing to support their project, with the idea to convince authorities and private stakeholders to accept and fund the projects. They will take local co-creation into account, also reflecting on the role of officials (school board, management, local council, and other agencies) and citizens.	10 min
Stage 4		
Creation	Creation of the project (Designing, Planning, Financing, Co-creation, NBS options), weaving all parts into one comprehensive narrative.	40 min
Project Closure	Each group of students presents the project to the class in a Mock-Presentation to Stakeholders. The students should keep in mind that they should present as if in front of relevant stakeholders: they must prove their solution is valid and should be implemented, they should be convincing. This can be done in different formats, including PowerPoint, Prezi, but also with a digital/physical model (depending on the project decided by the teacher) and can include even more creative ways to display it. For each presentation, the students elaborate on each of the involved processes, and explain their rationale. After the presentation, it would be good to follow up with a Q&A session. Students will then receive feedback on their presentation.	5 min
Final/extra outcome	If that is possible, the project can be presented to local authorities and/or NBS professionals. The latter could also provide feedback and advice for improvement, or even select the best projects in terms of feasibility, design, NBS integration, inclusive planning. Eventually, the projects could be displayed to the public in an open exhibition to bring the community closer to NBS and engineering.	

9. Assessment

After the introductory classes, the teacher will plan a test on NBS topics.

After completing the LS, each student draws up a report on her work during group-work classes based on their acquired knowledge, notes, and access to websites. The students will send the report and final group project to the teacher's email address. The teacher will evaluate them, as well as the final presentation of the project.

When possible, the following can happen: the most efficient project will be published on the school website with a related hashtag (for the original LS: #RoboticTeamGrudziądz).

10. Student feedback

Students will be asked feedback for the teacher on which elements of the class require more emphasis/time. They will reflect on the added value of the LS and what they have learnt from taking part in it.

11. Teacher's remarks

The most relevant innovation of this LS is the integration of sustainability thinking and NBS with future technological innovations. In current fast-changing societies, interdisciplinary innovative solutions are crucial to address socio-environmental problems. And students should be aware not only of how to plan but also find funds and present these solutions captivatingly. To me, the most positive achievement is that students were enthusiast to work analysing various cases, conducting discussions, determining challenges (e.g. ownership of land for construction). Also, the creation of the projects went extremely well. Students developed comprehensive projects considering existing terrain conditions, access to utilities, location in sunny places, etc. And a preliminary visualisation of the object was carried out using Fusion360. During the presentation, many interesting ideas emerged. Students expressed their opinions and proposed sources of potential financing, facility management, and they put forward the idea of involving young people in a student cooperative association.

Annex 1: Project concept

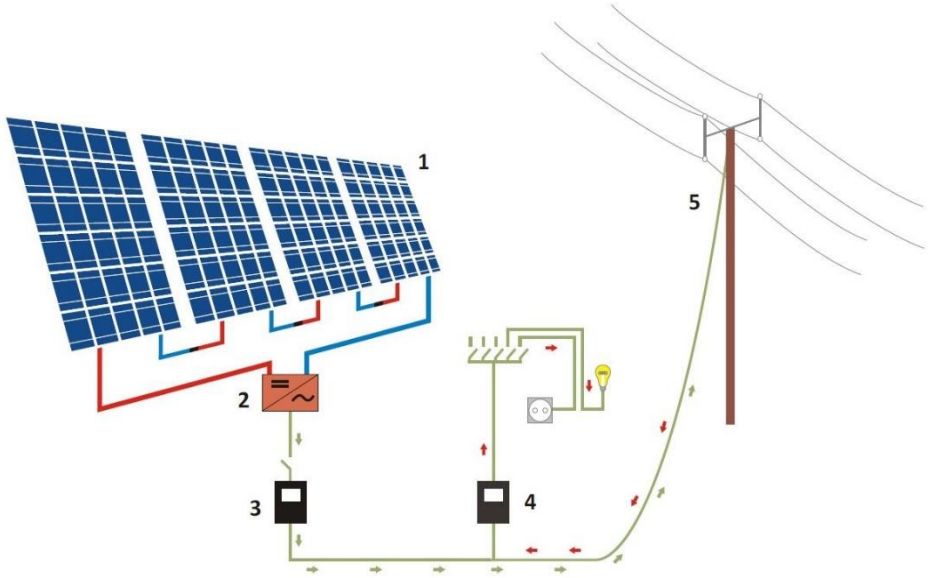
Note: All visualisations, drawings, diagrams and wiring diagrams were made by students at the Mechatronic Technical High School, as part of a classwork or homework, under a CC-BY licence.

PROJECT CONCEPT

1. Concept and location of the charging station

The concept assumes the construction of modular PV charging stations for small urban transport. One module is designed for 10 electric bicycles/scooters, with the possibility of extension by another. If energy is not used for charging, it will be transferred to the municipal power grid.

1.1. PV installation diagram



Legend/description:

1 - PV Panels

2 - Inverter

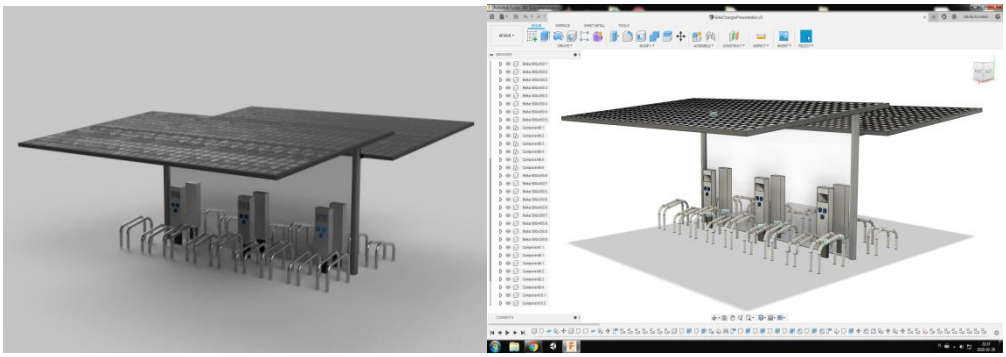
3 - Main switch and meter of generated energy

4 - Meter of used energy

5 - Power system

1.2. PV Eco-Charger visualisation

The PV Eco-Charger will incorporate green walls and green space into its design and surrounding. This will reduce heat-island effects, improve air quality and support the biodiversity in the area.



This photo shows how this has been done prior. In this project the plants would go on the sides and not on the roof of the charging station.

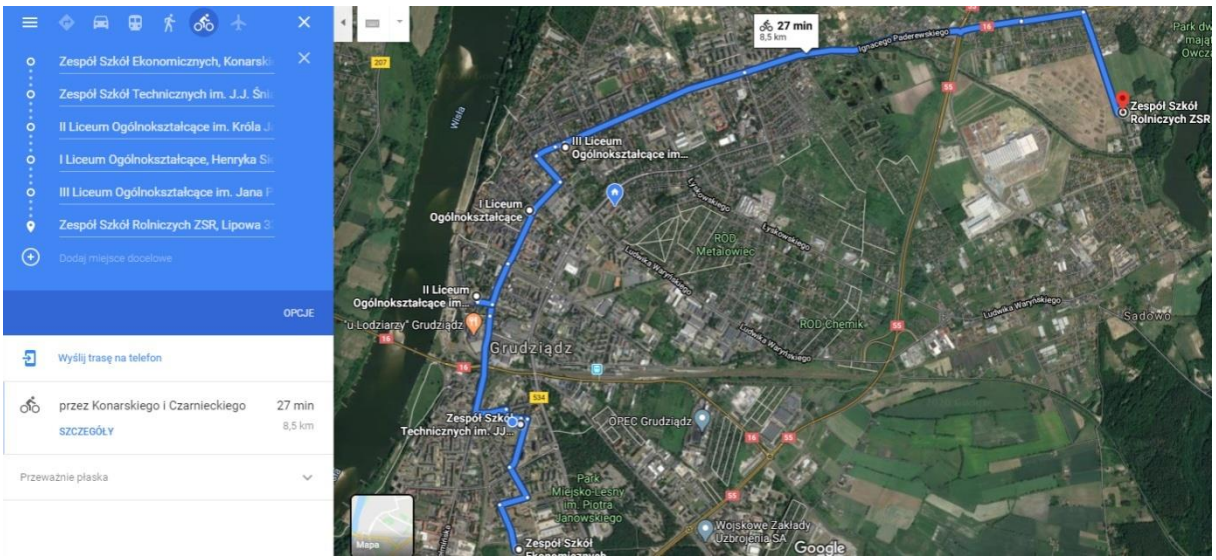
Figure 1: Example of green roof (permission to use picture provided by author Green Roof Shelters Ltd - UK)

1.3. Location of PV Eco-Charger

During the mini debate (governance and planning participation), it was agreed that the facilities were located in school areas (most potential recipients are young people). It was also established that the planned construction would cover the entire city, and cover them evenly and in accordance with the expected number of potential recipients (e.g. in the vicinity of the Technical Complex there are three large secondary schools).

There are plans to build six charging stations in the city in secondary schools (areas belonging to the city of Grudziądz with good sunlight):

- Complex of Technical Schools,
- Complex of Economy Schools,
- 1 high school (liceo),
- 2 high school (liceo),
- 3 high school(liceo),
- Complex of Agroculture Schools.



2. Financial resources

This section presents various options for obtaining funds for the investment.

- EU funds under the Operational Programs of the Kuyavian-Pomeranian Voivodeship,
- Prosumer 2,
- Grudziadz Civic Budget,
- Local Initiative Grudziądz,
- Local Action Group "Granary of Grudziądz",
- Public-Private Partnership with a company that supports e-scooters,
- Local Environmental Fees.
- Co-Creation Plan and Co-Design of Solutions in CALs (examples of green roof and wall projects in Milan, London, and Hamburg)
- Impact-driven financing and investment strategies for urban regeneration
- CLEVER Cities guidance on co-creating nature-based solutions

The PV Eco-Charger facility will be the property of the Municipality of Grudziądz and the management and service will be provided by the Eco-SCA - student cooperative association.

3. Equipment management and service

The eco-chargers management and service will be handled by a student cooperative association (Eco-SCA) that employs students of Grudziądz Schools, mainly technical areas. Employing learners in Poland allows for large social security and tax reductions, which will be another profit. I will engage the local student community to work together, bring profits for the entire city (better air, less exhaust, less traffic, less cars, more free parking spaces) and earnings for working students.

4. Development of the eco-charger project

The development of the system can be carried out at any time by adding more modules in existing places or building new chargers as needed in the city.

5. Management by application

The system of chargers will be managed through the created management and payment application for mobile devices. IT class students employed as part of a student cooperative association (Eco-SCA) will take care of creating the application and its service.

6. First PV Eco-Charger

The first PV Eco-Charger is planned at the Complex of Technical Schools in Grudziadz using existing panels and PV equipment, which is available as part of equipping the school's renewable energy laboratory.

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About the NBS project

The NBS project is initiated and funded by the European Commission Directorate-General for Research and Innovation and coordinated by PPMI, in collaboration with European Schoolnet (EUN). PPMI (www.ppmi.lt/en) is a leading European research and policy analysis centre, aiming to help public sector and civil society leaders from around the world, presenting evidence in a way that is simple, clear and ready to use. European Schoolnet (www.eun.org) is the network of 34 European Ministries of Education, based in Brussels. EUN aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. Find out more about nature-based solutions: https://ec.europa.eu/research/environment/index.cfm?pg=nbs and all the NBS Learning Scenarios created in this project as well as the overall reports can be found at http://www.scientix.eu/pilots/nbs-project

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The purpose of this learning scenario is to introduce students, especially those at technical and vocational high schools, to Nature-Based Solutions (NBS), using the concept of green infrastructure applied to a practical project.
To begin with, the teacher presents NBS and their benefits and discusses them with students, with an eye to local issues. After laying the foundations of NBS and related challenges, students' approach (urban) problems and how to address them through green infrastructures, i.e. infrastructures integrating nature.
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Studies and reports

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