



IMPLEMENTATION VARIATIONS

CONTENT OF THE DOCUMENT: This document presents four alternative variations for implementing the teaching program for “Energy Usage and Green Public Transportation in Future Smart Cities.”



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The implementation variation document is an intellectual output of EUGPUT Project - Energy Usage and Green Public Transportation in Future Smart Cities: An Innovative Teaching Program for Students, Stakeholders and Entrepreneurs (2020-1-TR01-KA203-094242) funded by Erasmus Plus K203 Strategic Partnership.

In the EUGPUT Project - *Energy Usage and Green Public Transportation in Future Smart Cities: An Innovative Teaching Program for Students, Stakeholders, and Entrepreneurs* funded by Erasmus Plus K203 Strategic Partnership, we developed a one-week teaching program made up of 7 teaching modules and one supporting module. Teaching and Lecture Notes are prepared as supplementary materials.

A short content description for each module can be stated as follows:

- **Module 1:** serves as the supporting module for the project members to develop an innovative curriculum and use innovative teaching and assessment methods.
- **Module 2:** introduces learners to concepts such as digital transformation and technology use, smart mobility and a green future, the role of a smart society, and managerial issues related to assuring a green future.
- **Module 3:** introduces learners to smart grids and trends in energy use in transportation and presents the transition to different renewable energy sources and how to incorporate them into the energy system.
- **Module 4:** introduces learners to current public transportation technologies, air pollution problems caused by the vehicles used in current public transportation, alternative green transportation technologies, information systems, and efficient tools in green public transportation network planning of future smart cities.
- **Module 5:** introduces learners to Configurations of Intermodal Public Transport Networks, Modelling Intermodal Public Transport Networks, and Planning Intermodal Public Transport.
- **Module 6:** introduces learners to an overview of technologies and information systems across various green public transportation modes.
- **Module 7:** introduces learners to the economic determinants of public transport, externalities, how fiscal policies and subsidies can be used to promote green technologies, and alternative financing methods.
- **Module 8:** introduce learners to intellectual property rights, patent search, business plans, and financial opportunities for green entrepreneurship.

We believe that the full or reduced content of the program can also be implemented in alternative formats. We proposed four variations: (1) a 7-day face-to-face (on-site) program; (2) a 5-day face-to-face (on-site) program; (3) a blended (face-to-face and online) program; (4) a one-day face-to-face (on-site) program. These variations would be beneficial for universities with different needs. This document presents information regarding these four implementation variations, along with module owners' comments and suggestions for future implementations.

IMPORTANT DISCLAIMER:

- (1) Universities can select among these variations based on their learners' needs and the amount of time they have for implementation.
- (2) The target group for all variations is learners with a basic knowledge of the subject. Please note that experienced learners might have different expectations. Therefore, if experienced learners are included in this program, the program content might be revised accordingly.

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- (3) Some of the learning and teaching activities presented in the Teaching Notes of the original program can be utilized in these variations. Please refer to the module owners' insights given at the end of this document.

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VARIATION 1: ONE-WEEK FACE-TO-FACE PROGRAM

Target Group: learners who have a basic knowledge of the subject

Mode of Delivery: ☒ Face-to-face ☐ Online ☐ Blended

Time required: 7 days, 56 hours

Day	Topics and/or Activities	Time required (in hours)
Day 1	Introduction and Pre-test Module 2a-Smart Mobility and Other Smart Parts Assuring Green Future Module 4-Green Vehicles and Green Public Transportation Network Design	8 hours
Day 2	Module 5-Intermodal Green Public Transport Planning	8 hours
Day 3	Module 3-Energy Related Smart Grids	8 hours
Day 4	Module 6-Information Systems and Technologies for Green Public Transportation	8 hours
Day 5	Module 2b-Smart Mobility and Other Smart Parts Assuring Green Future Module 7-Economics of Green Public Transportation Systems	8 hours
Day 6	Module 8-Entrepreneurship Opportunities for Smart City Public Transportation	8 hours
Day 7	Presentations and Field Trip Wrap-Up and Post Questionnaire	8 hours

VARIATION 2: 5-DAY FACE-TO-FACE PROGRAM

Target Group: learners who have a basic knowledge of the subject

Mode of Delivery: ☒ Face-to-face ☐ Online ☐ Blended

Time required: 5 days, 35 hours

Day	Topics and/or Activities	Time required (in hours)
Day 1	Introduction and Pre-test Module 2a-Smart Mobility and Other Smart Parts Assuring Green Future Module 4-Green Vehicles and Green Public Transportation Network Design	1 hour
		2 hours
		4 hours
Day 2	Module 5-Intermodal Green Public Transport Planning Module 3-Energy Related Smart Grids	3 hours
		4 hours
Day 3	Module 6-Information Systems and Technologies for Green Public Transportation Module 2b-Smart Mobility and Other Smart Parts Assuring Green Future	5 hours
		2 hours
Day 4	Module 7-Economics of Green Public Transportation Systems Module 8-Entrepreneurship Opportunities for Smart City Public Transportation	2 hours
		5 hours
Day 5	Presentations and Field Trip Wrap-Up and Post Questionnaire	5 hours
		2 hours

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VARIATION 3: BLENDED PROGRAM

Target Group: learners who have a basic knowledge of the subject

Mode of Delivery: ☐ Face-to-face ☐ Online ☒ Blended

Time required: 14 hours (8 online and 6 face-to-face off-site)

Mode	Topics and/or Activities	Time required (in hours)
Online	Introduction and Pre-test	10 minutes
Online	Module 2a-Smart Mobility and Other Smart Parts Assuring Green Future	1 hour
Online	Module 4-Green Vehicles and Green Public Transportation Network Design	2 hours
Online	Module 5-Intermodal Green Public Transport Planning	1 hour
Online	Module 3-Energy Related Smart Grids	2 hours
Online	Module 7-Economics of Green Public Transportation Systems	1 hour
Online	Module 8-Entrepreneurship Opportunities for Smart City Public Transportation	1 hour
On-site	Module 6-Information Systems and Technologies for Green Public Transportation	2 hours
On-site	Module 2b-Smart Mobility and Other Smart Parts Assuring Green Future	1 hour
On-site	Module 8-Entrepreneurship Opportunities for Smart City Public Transportation	2 hours
On-site	Wrap-Up and Post Questionnaire	1 hour

VARIATION 4: ONE-DAY FACE-TO-FACE (ON-SITE) PROGRAM

Target Group: learners who have a basic knowledge of the subject

Mode of Delivery: ☒ Face-to-face ☐ Online ☐ Blended

Time required: 8 hours

Topics and/or Activities	Time required
Introduction and Pre-test	30 minutes
Module 2a-Smart Mobility and Other Smart Parts Assuring Green Future	30 minutes
Module 4-Green Vehicles and Green Public Transportation Network Design	1 hour
Module 5-Intermodal Green Public Transport Planning	1 hour
Module 3-Energy Related Smart Grids	1 hour
Module 6-Information Systems and Technologies for Green Public Transportation	1 hour
Module 2b-Smart Mobility and Other Smart Parts Assuring Green Future	30 minutes
Module 7-Economics of Green Public Transportation Systems	1 hour
Module 8-Entrepreneurship Opportunities for Smart City Public Transportation	1 hour
Wrap-Up and Post Questionnaire	30 minutes

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MODULE OWNERS COMMENTS*

This section includes insights from the Module Owners, lessons learned from the project implementations, and suggestions for future instructors.

MODULE 2:

In variation 1, a full implementation following the teaching and lecture notes is possible. Since everything is face-to-face, all activities can be introduced and implemented. It is important to give learners enough time to focus on their in-class assignments. Regarding the assignment “preparation of the strategy for specific city/community to become leading smart mobility city/community in the region including the aspects of green future,” it is essential to emphasize the jigsaw method described in the Teaching notes. Face-to-face is ideal for this method, and learners can benefit from learning from each other and even improve their strategies, ideas, and solutions. Future instructors should follow the teaching notes since they are designed to cover all topics in this variation. However, if needed, instructors may shorten or modify some parts of the module and extend either the time for final discussion or discussions during the module. Future instructors can always replace some part of the content with the video presentation based on their choice and/or modified according to learners’ background knowledge or profile.

Variation 2 presents a halved full implementation. An option is to follow teaching notes and shorter each part. Our suggestion is not to shorten the beginning discussions and also not to shorten learners’ activities during the module in order to maintain learners’ attention and involvement. Rather content related parts (explaining definitions, the concepts) should be shortened or just summarized based on the discussion. The final assignment, “preparation of the strategy for specific city/community to become leading smart mobility city/community in the region including the aspects of green future,” has to be shortened (prepare a short version) without using the jigsaw method. In this implementation, learners should work in their own groups only, focusing on fewer solutions. Preparing a strategy can be skipped, and rather focusing on developing ideas may be emphasized. Also, in this variation, the instructors may even shorten or modify some parts of the module and extend either the time for final discussion or discussions during the module. Future instructors can always replace some part of the content with the video presentation based on their choice and/or modified according to learners’ background knowledge or profile.

In variation 3, we suggest that future instructors, based on their expertise, select only a few topics from the teaching and lecture notes. Since the second part of this module is on-site, we suggest that the final assignment, “preparation of the strategy for specific city/community to become leading smart mobility city/community in the region including the aspects of green future,” is implemented in the same/similar way as in Variation 2, meaning a short version without using the jigsaw method. Also, in this implementation, learners should work in their own groups only, focusing on fewer solutions. Preparing a strategy can be skipped, and rather focusing on developing ideas may be emphasized. We suggest that based on the future instructor’s expectations regarding the proposed solutions, these themes are given more emphasis in the first part of the module, implemented online. In the first online part, we suggest covering some aspects of the green future, digital transformation, and smart cities.

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No discussion or activities from the learners' side are expected, but rather only an instructor's presentation of the topics. Also, in this variation, future instructors can always replace some part of the content with the video presentation based on their choice and/or modified according to learners' background knowledge or profile.

In variation 4, only the basics of each topic should be covered. Despite the limited time, we still encourage to use of some short discussions at the beginning of the module to engage learners. However, the focus should be on briefly presenting all concepts in this module, namely presenting some definitions of green future, digital transformation, smart cities, smart mobility, etc. Future instructors can still follow the lecture notes, however, only to give the learners the basics. In this variation, the final assignment regarding the preparation of the strategy can be completely omitted and replaced with content presentation. By this approach, all the content from the Module Syllabus can still be briefly introduced to the students. However, an option is also to omit some of the content and have a short discussion (related to the final assignment regarding the preparation of the strategy) at the end. We suggest that learners don't form groups in this short implementation but rather present their ideas and solutions and further develop these ideas in other modules. Also, in this variation, future instructors can always replace some part of the content with the video presentation based on their choice and/or modified according to learners' background knowledge or profile.

MODULE 3:

In variation 1, 8 teaching hours is assigned for the implementation of the module 3. The teaching and lecture notes are prepared for such a scope of implementation. This variant allows the entire module to be conducted in a face-to-face format, which allows for more opportunities for learner interaction. At the same time, this is an opportunity to adapt to the interests and pace of the learners and to spend more or less time on certain activities than is provided for in the teaching notes. In terms of content, the module begins with an overview of the material to be covered and an introduction to the concept of the electrical grid. In the second hour, learners learn about current energy usage and the different types of renewable energy sources, as well as the concept of the smart grid. The third hour focuses on smart meters and the role of the active energy consumer in the energy market. The fourth hour of the course focuses on the process of feeding renewable energy sources into the power grid, with an emphasis on photovoltaics. In the fifth hour, students learn about the growing trend toward e-mobility and electric vehicles and the various battery technologies that support these modes of transportation. The sixth hour of the course covers the concept of "smart charging," which refers to the intelligent management of electric vehicle charging in order to optimize the use of renewable energy and reduce the load on the power grid. In the last two hours of the course, learners work in groups on a final project in which they apply the concepts learned during the module to a real-world problem or scenario related to the power grid and renewable energy.

The implementation variation 2 is similar to the original variant 1, with the difference that only 4 teaching hours are allocated for the implementation of the module. The content of the module is smaller in this case, but some materials and topics must be omitted. Compared to the original 8-hour version, we suggest to:

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- combine the topics of hour 1 and parts of the topics of hour 2 by shortening the overview of the module and the introduction to the traditional power grid, and adding an also shortened overview of current energy usage and renewable energy sources (both from hour 2 of the original version),
- exclude topics on smart meters and active energy consumer (hour 3 in the original variation),
- combine topics of hours 5 and 6, by spending less time on statistics about electric vehicles and excluding the topic of battery technologies,
- Since the strength of this variation is that it is still entirely face-to-face, we suggest that the final group project still be included, but shortened to one hour.

In this way, the main objectives of the module can still be achieved within 4 teaching hours. Depending on the prior knowledge of the learners, the instructor can choose the topics and concepts to focus on.

The variation 3 provides 2 teaching hours for the implementation of module 3. The first part is conducted online, the second on-site. Therefore, we suggest that in the first part, conducted online, basic concepts such as traditional and smart grids are explained. Based on the learner's background and knowledge instructor can choose which topics and concepts to focus on. More interactive activities are instead included in the second part of the implementation. In order to set the groundwork for the on-site part of the implementation, learners are divided into groups and given a small homework assignment (e.g., finding different real-world examples of the concepts) which they have to present at the beginning of the on-site implementation. The on-site implementation is all about interactive tasks. For example, we propose a presentation of the problem of integrating renewable energy sources into the power grid and the phenomenon of the duck curve, and then a group work to find solutions to this problem. The instructor may choose other group work activities from the module, such as a shortened form of the final project group.

In variation 4, only one teaching hours is assigned for the implementation of module 3. Therefore, it does not make sense to introduce or mention all the important basic concepts in this variant of the module. Therefore, we suggest that this variant focuses on a single topic and includes some interactive activities. For example, we propose to introduce the concept of electric vehicles and smart charging. Here we present a real-world example of smart charging implementation in the Dutch city of Utrecht. The materials for this example are already included in the original learning materials. After this example, learners are divided into groups and given a short task on smart charging. Instructors may of course also choose to focus on some of the other concepts and examples included in this module.

MODULE 4:

Module 4 introduces green vehicles and green public transportation network design. By the completion of eight hours, learners will be able to;

- explain current public transportation technologies
- increase sensitivity about the problems related to energy usage and air polluting amounts of current public transportation technologies
- increase awareness about greener fuel types, the current status of green public road transportation in Europe
- compare current and future public transportation technologies

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- discuss the integration of green and intelligent public transportation vehicles.

More extended versions of Module 4 should include a detailed version of current and green public transportation literature by following the teaching and lecture notes. In addition, simulations and games are effective instructional methods to increase learners' engagement. Therefore, a more extended version of Module 4 includes a word limit game to improve the knowledge about green vehicles and green public transportation. Also, we recommend having in-class activity about calculating the CO₂ emissions of green and traditional public transportation vehicles to realize the benefits of green public transportation in terms of CO₂ emissions.

The project implementation has shown that the theoretical part can be taught online if necessary. Discussion questions for theoretical hours are suggested to capture learners' interest and motivation through the subject. We recommend using active learning tools to increase the effectiveness of online classes. For example, a Mentimeter will be used to collect and store words for the word limit game. In addition, the theoretical part will be supported by real examples from different countries, especially in European cities, for current and green public transportation technologies.

Shorter versions of Module 4 should cover only the basics of each topic, such as the goals and quality of public transport systems and green transport means. Also, we recommend using short discussion questions at the beginning of the module to encourage the participation of learners. Due to time limitations, the content should be supported with only in-class activity without using word limit game. Also, team-based techniques through the in-class activity will be used to increase the engagement of participants.

MODULE 5:

Module 5 introduces core concepts of intermodal public transport and different intermodal services as sustainable mobility solutions. The project implementation demonstrated that the first part of Module 2, "Smart mobility and other smart parts assuring green future," and then Module 4, "Green Vehicles and Green Public Transportation Network Design," represent a strong background for topics introduced by Module 5, namely:

- Domains of the mobility system performance,
- The role of intermodal public transport in smart cities,
- Complementary relationships between different categories of transport and mobility services,
- Transport network design problem.

Furthermore, issues included in Module 5, i.e.,

- Levels of integration for intermodal urban mobility development
- Measures to enhance public transport accessibility through intermodal technologies
- Characteristics and management of the intermodal hubs,

represent a good introduction and a link to topics presented by Modules 6, 7, and 8.

In Module 5, learners will gain an understanding of the criteria to assess options for intermodal mobility services. The concepts, models, examples, and case studies included in Module 5 cover a wide range of intermodal solutions appropriate for different dimensions of cities (and, consequently, different levels of complexity of urban public transportation systems) and links between hierarchical levels of transportation networks (local, regional, national). The overall content of Module 5 (lecture

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and teaching notes) is planned considering that the participants in the addressed group have various experiences in mobility offerings and distinct interests in planning urban mobility solutions (e.g., the participants are from different small, medium, and large cities, and/or from different countries).

But if participants have similar experiences in mobility offerings (e.g., most participants are from the same city or region), the lecture content and teaching activities should be selected accordingly to learning interest. E.g., if participants are from a large city with a complex urban public transport system (including several public transport modes – metro, tram, bus), then the activities implemented in Module 5 should focus on solutions envisaging integration of complementary collective and individual mobility services at the urban level. If participants are from a small or medium city with urban collective public transportation provided only by bus lines, then the activities implemented in Module 5 should focus on solutions envisaging integrating the urban mobility system and regional/national transport and mobility services.

MODULE 6:

Since module 6, in effect, contains three separate parts (each corresponding to one of the three learning outcomes), it can be decomposed should there be a need.

First of all, the mid-part of the module related to Foresight in planning smart city services in the mobility segment: Scenario Exploration System (SES) by JRC of the European Commission could be used as a debriefing exercise, i.e., as a wrap-up of the whole program when the learners have had the chance to familiarise themselves with the challenges in the (future) green public transportation throughout all the modules (this including financing, infrastructure, organizational and other issues, this including data collection and processing, an issue that is emphasized in Module 6). In that regard, the learning purpose of SES (the role-playing game) can be extended beyond the one foreseen in the program planning stages. On the other hand, it could be used as an introductory exercise with professional/advanced users coming from different backgrounds, as it is envisioned as a role-playing exercise. In this regard, it could be used to detect the issues and topics of interest to these types of users that could be emphasized in the program implementation.

The segment related to using a solution/tool for optimizing and managing public services in the urban surrounding is, at the moment, specific to public service of route optimization in waste collection. The examples could vary in the implementation as it is possible to use any open data to demonstrate the need and opportunities for operation optimization and decision support in green public transportation. It would be a good practice to combine the lesson and practical exercises with Module 2b (Smart mobility and other smart parts assuring a green future), addressing business intelligence and data-related issues in this domain.

General concepts, technologies, and information systems addressing the role and functions of underlying IoT and AI technologies in supporting green public transportation systems with examples of dashboards and information systems across various green public transportation modes could be shortened or extended depending on the interest of the learners and can precede or follow the Module 7 (Economics of Green Public Transportation Systems) should there be need.

MODULE 7:

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Module 7 introduces an understanding of the economics of green public transportation systems. By the completion of four hours, learners will be able to explain how relative prices can be used to promote green public transportation, discuss how fiscal policies can be used to promote new green technologies in the transportation system, and analyze how new and alternative finance methods can be used to invest in green transportation technologies.

Specifically, Module 7 introduces the demand and supply side dynamics of public transportation and explains alternative policy tools to promote green transportation. Demand and supply dynamics (via pricing mechanisms) are the two basic concepts to understand the economics of public transportation. Therefore, the shortest version of Module 7 should include these two topics. Longer versions of Module 7 should also include fiscal policy tools that can be used to promote green public transportation. In addition, alternative ways of financing green public transportation should be covered in the longer version of Module 7. As this is a relatively advanced topic, the background of learners should be considered while teaching this part.

The project implementation has shown that the theoretical part can be taught online if necessary. Short in-class activities for each hour are recommended to keep learners interested in the subject and to provide some practical application. During online classes, technologies for online courses should be used effectively. For example, digital whiteboards can be used while explaining demand and supply side dynamics. By the completion of four hours, learners will be able to explain how relative prices can be used to promote green public transportation, discuss how fiscal policies can be used to promote new green technologies in the transportation system, and analyze how new and alternative finance methods can be used to invest in green transportation technologies.

For the face-to-face one-week program, we recommend having case study presentations in addition to the written report. For the shorter implementation and online version, we suggest applying only the written report. The overall content of Module 7 is planned, considering that the participants don't have prior knowledge of economics. However, if participants have a certain background, the lecture content and teaching activities should be selected accordingly to learning interests. If learners come from different countries or cities, case study questions can be customized based on those particular places.

MODULE 8:

During the variation 1 of the training program, "Module 8 - Entrepreneurship Opportunities Considering Smart City Public Transportation" aims to;

- introduce to the learners what Intellectual Property Rights (IPR) is and the role and effect of IPR on development of new ideas to create new product/service/process,
- provide general knowledge about entrepreneurial ecosystem and the relation between IPR and entrepreneurial ecosystem in terms of technological developments and economic growth,
- gain knowledge about Business Models which are plans to describe the instruments and strategies oriented in managing activities of the corporation to generate income
- prepare a simple Business Canvas Model for their new idea and a simple Business Plan
- transfer information about projecting their idea and prepare a project application proposal

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With the information conveyed to the learners within the scope of Module 8, they will be able to gain knowledge about IPR, its types, how they can exploit IPR to create and also protect the output of their mind, evaluate their potential to be an entrepreneur, explain the advantages and disadvantages of IPR for entrepreneurs. Moreover, the learners will be able to develop their creative idea and prepare a simple Business Canvas Model and a Simple Business Plan to evaluate the potential of their idea and have the opportunity to see the big picture by developing and documenting their ideas before putting them into practice.

In the scope of the second variation, the content of Module 8 is planned to;

- transfer general knowledge about IPR;
- inform about free patent search tools and how they can benefit from these tools while developing new idea,
- give point of view about entrepreneurial ecosystem
- create an environment in order to establish a bridge between IPR and entrepreneurial ecosystem
- introduce Business Canvas Model which is one of types of Business Models to describe the instruments and strategies oriented in managing activities of the corporation to generate income
- prepare a simple Business Canvas Model for their new idea

General know-how about IPR, free patent search tools and IP & Technology Commercialization

Instruments will be provided in the scope of Module 8 within the third variation during two hours.

For the last variation, the content will include general knowledge about IPR and its types during one hour.

