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VET EcoLume

EMPOWERING **SUSTAINABLE ENERGY EDUCATION** THROUGH **VOCATIONAL TRAINING**

Eco Lume Instruction Manual: Enhancing Education on Sustainable Energy through Vocational Training

Reference number VET – 101183327

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01 Introduction

This manual has been developed as a tool for teachers and trainers responsible for implementing the curriculum of the **"VET-EcoLume: Education for Light Pollution Mitigation"** program. The guide is intended to clearly accompany the proposed learning modules, strengthening the role of the trainer as a key agent in the development of green and digital skills applied to the night environment.

The VET-EcoLume curriculum is part of an international collaboration strategy focused on responding to environmental challenges. In this case, it proposes the training of a Specialist in Light Pollution Mitigation, capable of diagnosing, monitoring, educating, and applying sustainable solutions to the impacts of poorly managed artificial light.

The program's curriculum consists of 29 hours designed to address the global challenge of light pollution in regions such as Europe and Latin America. This manual provides detailed instructions to facilitate the program, as each module is divided into pedagogical sessions with participatory activities, visual resources, real case studies, field observations, evaluation sheets, digital materials, and active learning proposals.

To understand the context of the program, it begins with **Module 1:** Introduction to Light and Light Pollution, which establishes the fundamentals of light and the multifaceted challenge of pollution. This is followed by **Module 2:** Diagnosis and Monitoring of Light Pollution: Key Concepts and Tools, where participants acquire the skills to use physical and digital tools for measurement and mapping related to light pollution. **Module 3:** Assessing the Environmental and Health Impacts of Light Pollution focuses on classifying environmental sensitivity and analyzing the effects of screen use and circadian rhythms on health. The program moves toward practical application with **Module 4:** Technical Solutions and Designing Sustainable Nighttime Spaces, which covers light urbanism and the Urban Lighting Plan. Finally, **Module 5:** Community Action and Multilevel Governance provides tools for leadership, strategic communication, and structuring proposals for collective action against light pollution. The last section of this instructional manual details the development of these modules in greater precision.

This manual is designed to be flexible and adaptable to various educational contexts, with the possibility of being used in formal technical education programs, continuing education initiatives, or informal training in different countries.

02 Purpose and scope

The purpose of this manual is to provide a clear tool to facilitate the implementation of the VET-EcoLume curriculum in Vocational Education and Training (VET) contexts. It seeks to strengthen the pedagogical capacity of trainers and teaching teams to effectively transfer the knowledge necessary to address the growing problem of light pollution. Through conceptual guidance, pedagogical resources, and concrete examples, the manual provides guidelines for understanding training initiatives focused on mitigating artificial light, with an emphasis on addressing the problem of light pollution.

The scope of the manual covers various educational contexts, both formal and informal. It is designed to adapt to multiple levels of teaching experience and teaching modalities. Its flexible approach allows it to be integrated into different training strategies, from specific curriculum units to public awareness initiatives, promoting transformative and situated education that contributes to protecting dark skies as a common good.

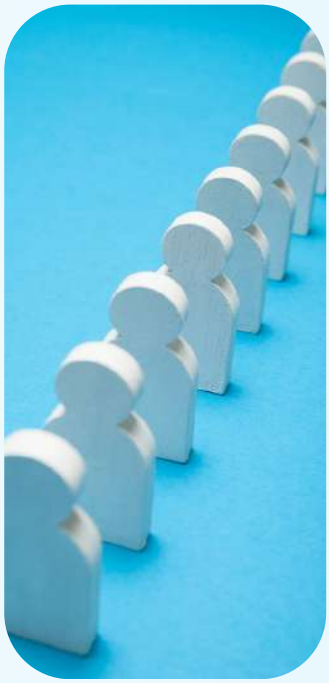
03 Target group

This manual is aimed at teachers, trainers, and instructors involved in vocational education and training (VET), especially in areas such as the environment, energy, urban planning, and sustainable tourism.

Its objective is to strengthen the capacities of those who seek to integrate content on light pollution and dark skies into educational processes.

It is also designed for environmental educators, community monitors, and workshop leaders who work in diverse territorial contexts, both urban and rural, and who develop training or awareness-raising activities related to the night landscape.

Finally, the manual may be useful for trainer trainers and technical professionals who include educational components in their work.



04 Context Light Pollution

The night sky is an environmental, scientific, and cultural heritage of fundamental importance to all humanity. Over millions of years of evolution, the cycle of day and night has shaped the behavior of both diurnal and nocturnal animal and plant species, playing a crucial role in the balance of ecosystems. In addition, universal access to the sky and the contemplation of the starry firmament have been central to the worldview of all cultures, including indigenous peoples. In the modern era, dark skies are vital for direct observation and scientific study of the universe, allowing science to advance in answering fundamental questions about the origin of the universe, the laws that govern it, and the future of our planet.

The context of light pollution is understood from what the scientific community calls "the end of the night." Over the past 150 years, access to the night sky for humans and other species has been systematically reduced due to the increase in artificial lighting. Although humans benefit from artificial light to extend working and recreational hours, this expansion has covered the planet's surface with a massive network of outdoor lighting. Light emitted in inappropriate colors, quantities, and directions is scattered throughout the atmosphere, resulting in an increase in the brightness of the night sky.

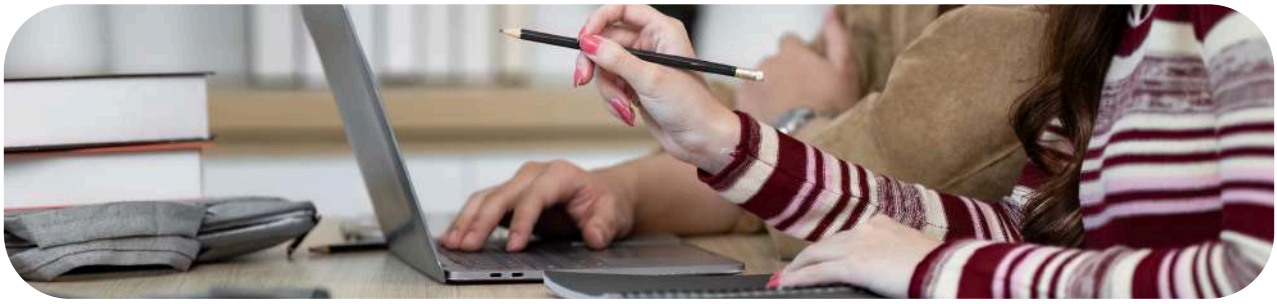
This phenomenon has reached alarming global proportions. Today, more than 80% of the world's population (and more than 99% in highly developed regions such as Europe and the United States) lives under skies that show measurable levels of light pollution. As a result, more than a third of the planet's inhabitants (reaching 60% in Europe and 80% in North America) have lost the ability to observe the Milky Way. This night scene, which was commonplace for our ancestors and fundamental to the worldview of indigenous peoples, is virtually impossible to experience for those who live in urban centers. The sustained increase in this pollution is affecting natural darkness conditions in both cities and remote locations.
The impacts of light pollution are significant and varied. In terms of human health, exposure to artificial light at night has the potential to cause changes in people's circadian cycles, particularly by altering the secretion of the hormone melatonin, which regulates these cycles. This alteration is linked to adverse health effects such as sleep disturbance, increased risk of breast and prostate cancer, and heart or metabolic diseases such as obesity and diabetes. With regard to biodiversity, light that is incorrectly installed or has high emissions in the blue band of the visible spectrum affects various nocturnal species. It is estimated that about 30% of vertebrates and over 60% of all known invertebrates are nocturnal. The introduction of artificial light into these habitats alters the natural conditions of the environment, directly impacting their circadian cycle. The effects recorded include changes in the behavior, reproduction, feeding, and migration patterns of species, altering the existing natural balance. Light pollution generated by outdoor lighting in coastal areas also affects marine environments.

The relevance of this context is such that the La Palma Declaration states that observing the sky without light pollution should be considered a universal right of all people.

Session 1

Creating a **conducive learning environment**

01 Understanding the learning environment



Creating a supportive learning environment and thoroughly understanding its components are fundamental and essential steps at the beginning of any vocational education and training (VET) program. A supportive and inclusive learning environment is broadly described as the safe, effective, and fair use of appropriate disciplinary practices that promote positive outcomes for the learner and the trainer's practice. This approach is particularly crucial in VET, where practical learning is emphasized, allowing for a wide range of teaching methods, activities, and tools. At the beginning of the program, trainers should establish a welcoming and respectful environment, emphasizing the importance of mutual trust and collaboration. Adult learners are more engaged when they understand the purpose and expected outcomes of their learning, so it is essential to clearly communicate the objectives and competencies. Trainers are also encouraged to begin by gathering participants' expectations, prior knowledge, and personal experiences related to artificial light and sustainability, and to use these to shape and actively integrate them into the training process.

The proposed teaching framework is aligned with the European Qualifications Framework (EQF) and emphasizes the development of integrated competencies. This includes knowledge of the ecological, technological, and social aspects of light pollution, providing skills to measure, analyze, and design solutions for sustainable lighting. Attitudes of responsibility, critical thinking, and advocacy for environmental sustainability are encouraged.
Practical activities such as light audits, measurements with simple tools, use of mobile applications, or the design of awareness campaigns are key to transforming concepts into applied skills.

In addition, the learning environment must be inclusive, accessible, and diverse. The program recognizes that adult students come from different sociocultural backgrounds and levels of digital literacy. Therefore, it is suggested that the pace, materials, and dynamics be adapted to the reality of the group, avoiding judgments and promoting a respectful space.

Finally, understanding the learning environment also involves taking care of the pedagogical structure of the sessions. To this end, it is recommended to start with icebreaker activities that connect personal experience with the topic, clearly communicate the rules of collaboration, offer constant support during the activities, and close each meeting with a reflective moment that allows participants to link what they have learned with their personal or work reality. In this sense, the educator assumes the role of guide and trainer, promoting autonomous learning, the exchange of knowledge, and a transformative educational experience.

02 Stakeholder participation

In the context of Vocational Education and Training (VET), the main purpose is to equip students with the technical, practical, and attitudinal skills that enable them to successfully learn about light pollution and apply it to the world of work in order to advance their professional careers. To this end, the role of those who provide training goes far beyond the simple transmission of content: it involves the responsibility of coordinating all the actors who influence the participants' professional development process. This task takes on special relevance when we talk about adult education, where the group of students is often diverse in age, academic experience, and work experience.

A good start to any teaching and learning process requires knowing who will be participating in it. To this end, personalized strategies that recognize each student's strengths, weaknesses, and goals are an effective way to generate commitment from the outset. Developing individual development plans, tailored to professional profiles and aspirations, allows each person to feel that their uniqueness is taken into account. Before addressing technical or conceptual content, it is advisable to provide initial moments of preparation and planning, as well as tools detailed in this manual and in the curriculum that facilitate progress monitoring and encourage self-reflection. In this sense, the use of templates for individual development plans (such as the one proposed in the curriculum) represents a valuable resource that can be implemented directly or adapted to specific contexts.

One element that enhances student engagement is the establishment of feedback channels. Anonymous surveys at the end of each module collect students' opinions on the relevance of the content, the clarity of the teaching, the quality of the resources, and the usefulness of the practical activities. This allows trainers to gather feedback on the curriculum, the methodologies used, and the resources provided, as well as improving the learning experience and enabling continuous improvement of the training program. More deliberative instances, such as the closing session that includes a reflection activity, offer spaces for dialogue where students can share their perceptions, suggestions, or concerns regarding the training received.

VET programs are constantly evolving due to the dynamic nature of the productive environment, driven by digital transformation and new market demands. They focus on building professional networks as an essential component of interaction with the real world of work, where students can access valuable opportunities for their future.

This synergy between the educational world and the professional sphere also generates benefits for those who teach. By interacting with industry experts, trainers can update their knowledge, incorporate new approaches, and adjust their teaching strategies to current challenges. This type of external feedback strengthens the quality of the training offered and ensures that the teaching staff also remains at the forefront, in tune with emerging trends, technologies, and issues in each productive sector.

Together, these practices not only improve the learning experience for students, but also transform VET spaces into dynamic, relevant environments that are aligned with the real needs of society and the labor market. This link with the environment translates into greater opportunities for students to enter the labor market in their own communities, providing concrete solutions adapted to their reality. Therefore, when vocational training is aligned with the challenges and opportunities of the territory, sustainable development at the local level is enhanced.

Various community actors can enrich these processes. From a community action and multilevel governance perspective, non-governmental organizations or public organizations such as municipalities, for example, can contribute not only with financial resources, but also with technical advice, innovative methodologies, coordination, and connections to broader support networks. In turn, territorial groups or neighborhood committees can collaborate on communication strategies, facilitate access for traditionally excluded groups, and promote community ownership of training programs. These types of partnerships make it possible to build more equitable, accessible, and sustainable learning environments, where VET is not limited to the classroom but expands into the social fabric.

Ultimately, the active inclusion of the community in all stages of the design, implementation, and evaluation of VET programs ensures not only their immediate relevance but also their long-term sustainability. Vocational education thus becomes a collective, participatory, and transformative process, where the classroom and the environment provide each other with constant feedback.

03 Fostering a culture of continuous learning

Fostering a culture of continuous learning is essential to ensure that participants in vocational education and training (VET) programs remain competitive and able to meet the demands of their local industries and environments. This commitment goes beyond the mere acquisition of new knowledge and involves the constant updating of skills, adaptability to new technologies, and a commitment to personal and professional growth.

01 The Andragogical Foundation and Relevance

The plan is fundamentally based on the application of the principles of andragogy (the science and art of adult education). This approach ensures that the teaching and learning process is meaningful, practical, and closely related to the real lives of participants.

Clarity of Objectives: Adult learners are more engaged when they understand the purpose and expected outcomes of their learning. They learn best when they clearly see why the knowledge is important to them.

Use of Prior Experience: Adults are not "blank slates." The curriculum actively encourages participants to use their prior experience and share observations about light (such as daily contact with artificial lighting or discomfort with intrusive light) to relate them to theoretical knowledge.

02 Active and Experiential Methodology

To integrate the principles of lifelong learning, the EcoLume curriculum employs an approach that promotes autonomy and practical application:

- **Self-Directed and Active Learning:** Learners are encouraged to take ownership of their learning journey. Rather than passive listening, the program emphasizes self-directed and active learning; participants investigate, observe, and analyze their own environment, for example, by mapping local light pollution or reflecting on their personal screen usage habits.
- **Interdisciplinary Approach:** The program guides adult learners to recognize the interdisciplinary links between artificial light and circadian rhythms, between lighting habits, urban policies, and global ecological consequences.

- **Development of Applicable Skills:** Hands-on activities are essential for transforming abstract concepts into applicable skills. This includes tasks such as:

1. Measuring light pollution.
2. Auditing lighting in public spaces.
3. Designing awareness campaigns.

- **Collaboration:** Incorporating project-based learning and collaborative work into the curriculum helps students develop the ability to learn from their peers. Interactive methods such as debates, simulations, and role-playing are highly recommended.

03 Reflection, Evaluation, and Adaptability

To sustain this culture, the learning process does not stop in the classroom, but continues in practice. This is achieved through continuous reflection and a framework for constant improvement:

- Constructive Feedback: Each session should end with a reflection activity that allows participants to connect new knowledge with their professional and personal lives. The educator, acting as the trainer, provides continuous and constructive feedback.
- Long-Term Impact Assessment: The program incorporates long-term impact assessment to monitor the quality and success of the program. This includes:
- Conducting follow-up surveys 3 to 6 months after program completion.
- Collecting success stories and case studies that show how participants have applied EcoLume principles in their professional or community contexts.
- Continuous Improvement: All data collected from evaluations is systematically analyzed. Based on these findings, the curriculum undergoes cycles of continuous improvement, adapting content, methods, and resources to the future needs of students.

Teaching and learning approach

The curriculum combines guided learning, work-based practice, and independent study. Each module is based on real-world situations related to light pollution (urban lighting, health effects, biodiversity protection), allowing participants to see the direct relevance of their learning. The use of interactive methods such as debates, simulations, role-playing (e.g., a "light pollution court"), and collaborative projects is strongly encouraged.

Participants are not passive recipients of knowledge, but active co-creators of the learning process. Their previous professional and personal experiences should be systematically integrated through reflective discussions, peer exchanges, and case studies drawn from their own environments.

Practical and competency-based approach

Following the European Qualifications Framework (EQF), the program emphasizes the development of competencies:

- Knowledge of the ecological, technological, and social aspects of light pollution.
- Skills to measure, analyze, and design solutions for sustainable lighting.
- Attitudes of responsibility, critical thinking, and advocacy for environmental sustainability.

Practical activities, such as measuring light pollution, auditing lighting in public spaces, and designing awareness campaigns, are essential. These practical experiences transform abstract concepts into applicable skills.

Structure of the sessions

Trainers are encouraged to:

- Start with icebreaker activities and personal introductions that connect personal experiences to the topic of light pollution.
- Define and communicate clear objectives and rules for collaboration (respect, listening, constructive feedback).
- Provide step-by-step guidance for independent tasks and explain assessment methods transparently.
- Use formative assessment (quizzes, group reflections, peer feedback) throughout the modules, ensuring continuous learning support.
- Close each session with a reflection activity, allowing participants to connect new knowledge with their professional and personal lives.

Role of the educator/trainer

The educator acts primarily as a trainer and guide, not just a transmitter of information. Their role is to encourage autonomous learning, create opportunities for knowledge exchange, and provide constructive feedback.

By balancing professionalism with empathy and flexibility, educators help transform the EcoLume curriculum into a transformative learning journey.

04 Inclusive and adaptable learning spaces

The development of inclusive and adaptable learning spaces is an essential pillar of Vocational Education and Training (VET), especially since the EcoLume VET program is designed according to the principles of andragogy (adult education). Inclusivity is defined as the creation of environments where all students, regardless of their background, abilities, or circumstances, have equal access to learning opportunities and are supported to reach their full potential. In this context, teaching must be inclusive, supportive, and adaptable, ensuring that students feel respected, appreciated, understood, and empowered, which is a critical factor in increasing their participation and motivation. A supportive learning environment is crucial, as it helps reduce stress and mitigate the challenges faced by adult learners, ensuring that the educational process is enjoyable and encourages positive reinforcement.

To achieve this inclusivity, the physical, social, and psychological factors of the learning environment must be addressed. The physical factor requires that the space be accessible to all students, regardless of their abilities. This involves ensuring ramps and wide doors for wheelchair users, providing adaptable tools and machinery for people with physical disabilities, and offering visual or auditory aids for students with sensory disabilities. In addition, the work environment and classroom should be comfortable enough for students to enjoy being there. The table and classroom layout should allow everyone to see the trainer and the whiteboard, and it is essential to have internet access, sufficient natural light, and a quiet area. Trainers also have a responsibility to remind students of safety protocols, especially when they are handling tools or machinery.

An adaptable learning environment should respond to the diverse needs and learning styles of students. Instead of a traditional one-way teaching approach, a variety of inclusive methods should be employed that promote the development of social skills such as teamwork and collaboration. The methodology should be flexible and incorporate discussions, simulations, role-playing, and collaborative projects. A multisensory approach, combining practical activities such as fieldwork or lighting audits with resources such as eLearning (online materials, videos, applications, virtual simulations), allows for personalized learning experiences. It is recommended to design flexible and modular learning spaces that can be easily reconfigured to support different activities. In addition, an adaptable environment takes into account the different learning rhythms of adult learners and their varying levels of digital literacy.

On the social and psychological side, inclusivity requires the development of cultural competence and respect for diversity. The trainer must be aware of cultural differences and leverage them as an advantage. Diversity encompasses factors such as race, ethnicity, gender, sexual orientation, age, and socioeconomic status.

Curricula should include culturally relevant content that reflects the diverse backgrounds of students. Encouraging collaboration through group work and strong social interactions helps build a sense of community and foster mutual respect. In addition, by creating a psychologically supportive environment where students feel valued and heard, their motivation and self-esteem increase. Educators must set clear expectations for behavior and a safe environment so that students feel comfortable expressing their ideas.

The educator plays the central role of trainer and guide, not just as a transmitter of information. Their role is to ensure ongoing support, which includes providing clear step-by-step guidance for independent tasks and explaining assessment methods transparently. To ensure the relevance and inclusiveness of Vocational Education and Training (VET) programs, VET providers need to engage the community and stakeholders.

This involves establishing a support network that can extend beyond the classroom, including consultations with disability advocacy groups to obtain information on how to make facilities more accessible. Finally, as with the rest of the curriculum, continuous feedback is used to conduct ongoing assessment of the environment, leading to cycles of continuous improvement, adapting content, methods, and resources to the future needs of learners.

Appendix I

INDIVIDUAL DEVELOPMENT PLAN

Student's name:

SKILLS ASSESSMENT (completed by the student)			
STRENGTHS		**INTERESTS**	
GOALS			
LONG-TERM CAREER GOALS YOU WISH TO PURSUIT AND HOW YOU WILL ACHIEVE THEM			
What interests you?	Find a job opening for a career that interests you. What skills do you need to develop?	What gradual steps will you need to take to reach your ultimate goal?	Objective Completion Date
SHORT-TERM NEEDS TO DEVELOP SKILLS AND INTERESTS			
Prioritize the skills you need to develop. What can you achieve first, or what is absolutely necessary?	Specifically, how are you going to acquire these skills? (Training, courses, teaching, job shadowing, informational interviews)	Where can you develop these skills? Are there several places?	Objective Completion Date
OTHER FACTORS TO CONSIDER			
What professional pressures are you currently experiencing?	What kind of environment would you like to work in? Are there certain factors that are non-negotiable?	What questions do you have about your chosen career?	List three inspiring people you could contact for informational interviews or career follow-ups.
COACH/MENTOR COMMENTS			

Appendix II

TRAINER PREPARATION CHECKLIST

Use this checklist to ensure you include all relevant factors before and during the delivery of your educational program. Each section has additional lines so you can add your own items based on the curriculum and the needs of your students.

PHYSICAL ELEMENTS	
Everyone has access to the classroom.	
The tables and classroom layout allow all students to see the trainer and the whiteboard.	
The classroom has sufficient natural light and windows/doors for fresh air to circulate.	
Students have enough space to move around the modular classroom.	
The classroom has sufficient power outlets for students to use laptops.	
The classroom has internet/Wi-Fi access.	
Visual aids and screens are ready.	
A quiet zone has been created.	
All tools and equipment are ready.	
Safety measures have been implemented.	

DIVERSITY OF METHODS IN THE CURRICULUM AND MODULES	
Theoretical contributions	
Group discussions	
Simulations/role-playing	
Self-reflection	
Individual sessions with students	
E-learning (online materials, videos, applications, virtual simulations, etc.)	
Case studies	
Project-based activities	
Guest speakers	
Send comments	

ELEMENTS OF A SUPPORTIVE LEARNING ENVIRONMENT	
Sense of belonging	
Positive reinforcement	
Emotional security	
Conflict resolution	
Clear expectations	
Constructive feedback	

Session 2

Development and **implementation** of **transfer plans**

01 Planning for effective transfer of knowledge and skills

Needs assessment

This process is based on the curriculum being grounded in an understanding of the specific knowledge and skill gaps that exist among professionals and the workforce in relation to light pollution. First, there is a need for fundamental knowledge about the nature of light as electromagnetic radiation, including mastery of technical concepts such as the light spectrum, units of measurement (lumen, lux, candela), and Correlated Color Temperature (CCT), as the choice of CCT has important implications for human comfort and ecological impact. Second, there is a need for in-depth knowledge of the impacts of artificial night light (ALAN); this includes understanding how blue-rich light from LEDs disrupts the human circadian system, suppressing melatonin production and increasing the risk of sleep disorders and other diseases. It is also crucial to address the need to classify environments according to their environmental sensitivity (such as national parks or residential areas) to light pollution, understanding the effects on biodiversity such as the disorientation of nocturnal species.

The inclusion of training on the use of various tools and methodologies to assess the scope and impact of ALAN was promoted, from field studies and audits to the use of satellite data (such as VIIRS) and the Leopold Matrix for environmental impact assessment. Finally, the need for collective action is addressed through skills development and strategic communication, enabling participants to structure compelling proposals and create effective awareness campaigns that mobilize communities and policymakers. In this way, the curriculum integrates continuous needs assessment by promoting andragogy, which encourages participants to share their personal experiences with light (such as insomnia or discomfort from intrusive light) at the beginning of the program, using this prior knowledge to shape and validate the transfer of technical knowledge, ensuring that learning is practical and relevant to their lives.

Defining objectives

Setting clear and precise objectives is a fundamental component of the pedagogical planning of the EcoLume VET curriculum, as it guides the transfer of knowledge and the development of skills in each module of the training process. The objectives not only outline the expected learning outcomes, but also provide guidance for content design, methodology selection, and competency assessment. In the context of adult vocational training, communicating these objectives from the beginning of each module and session is essential to promote active student involvement. When participants understand the purpose and goals of the training process, their motivation, sense of belonging, and commitment to learning increase.

The curriculum primarily aims to train Light Pollution Mitigation Specialists, equipped with ecological and digital skills to diagnose, monitor, and apply sustainable solutions to the impacts of poorly managed artificial light. Specifically, the objectives seek to increase critical awareness of the impact of misdirected light on biodiversity, human health, and the night sky; train participants to use physical and digital tools to diagnose light pollution in their territories; and promote the design and application of sustainable solutions based on the principles of responsible lighting (utility, control, direction, intensity, and color). Communicating these goals is essential to promoting active involvement and commitment to learning among adult students.

Teaching strategies

The choice of teaching strategy is fundamental in the transfer of knowledge about light pollution, especially in the context of adult education. Strategies should be selected considering the characteristics and needs of the audience, integrating andragogical methods that encourage active participation. It is recommended that the curriculum use observation exercises, practical activities, collaborative work, case studies, and problem solving related to artificial lighting and its impacts. Teaching is reinforced with visual resources, dynamics, and spaces for reflection that facilitate the understanding of concepts. These strategies allow for better assimilation of content and concrete application of the content.

Allocation of resources

The allocation of resources is essential to ensure effective teaching on light pollution within the EcoLume VET curriculum.

To achieve the educational objectives of each module, it is necessary to identify and have access to appropriate teaching materials, technical equipment, digital resources, and trained and qualified staff.

Assessment and evaluation

It is essential to have appropriate assessment methods in place to evaluate understanding and knowledge transfer on light pollution within the EcoLume VET program. A combination of formative and summative assessment can be used in the modules to monitor progress and the development of technical, ecological, and digital skills. Formative assessment strategies can include quizzes, group reflections, peer feedback, and applied throughout the modules, ensuring continuous learning support. On the other hand, summative assessment strategies focus on measuring the achievement of objectives at the end of each module or stage of the program, such as final assessments, practical projects (e.g., light pollution audits or awareness campaigns), and theoretical tests. These confirm that the expected competencies have been acquired.

02 Curriculum design and development Principles of curriculum design for light pollution.

Curriculum design principles for light pollution

https://noirlab.edu/public/es/blog/dark-sky-protection/
https://noirlab.edu/science/news/announcements/sci24029
https://www.lightpollutionmap.info/
https://www.arcgis.com/home/item.html?id=edabcbb5407547f5bc883018eb6e7986
https://cieloschile.cl/contaminacion-luminica/

Principle of results-based education

The curriculum design is based on the principle of outcomes-based education, which means that all components of the educational process, from objectives to assessment, are geared toward the achievement of clearly defined competencies. This approach emphasizes what students are able to do at the end of each module, rather than the methods or number of hours spent on instruction.

Learning outcomes are formulated in a specific and measurable way, and each module seeks to develop knowledge, skills, and attitudes related to understanding artificial light, identifying forms of light pollution, assessing environmental impact, designing sustainable solutions, and community action.

This approach ensures that students not only acquire theory but can also demonstrate specific competencies. In addition, it allows for the use of flexible pathways to achieve the objectives, adapting to different learning profiles. This enables graduates to be prepared to act effectively in the face of light pollution challenges in their communities and professional contexts.

Principle of relevance and contextualization

A key principle guiding the development of the curriculum is the relevance and contextualization of the issue of light pollution.

This varies according to the environment, whether urban, rural, or natural, as well as according to the regulations and sociocultural characteristics of each location.

Therefore, the curriculum must be designed in a way that is meaningful to the context of the participants and applicable to their realities and environment.

Thus, the relevance must be technical, social, environmental, and educational.

It is recommended to:

- Involving local actors, such as institutions or organizations that validate the implementation of the program.
- Use examples, case studies, and local or real issues related to light pollution.
- Align content with local and/or national standards and regulations. In the absence of regulatory frameworks, seek international references and best practices.
- Use teaching materials adapted to the language and technical terminology of the context, prioritizing the production of educational resources that are relevant to the territory and culture.
- Incorporate the local language, examples from the territory, and ideally the regulations, if any, of the place where the plan is printed.

Ensuring the relevance and contextualization of the program curriculum enhances students' appropriation of knowledge and facilitates the effective transfer of skills for light pollution mitigation in their own territories.

Principle of an interdisciplinary approach

Light pollution is a complex issue that cannot be addressed solely from a technical perspective, as it involves environmental, social, cultural, regulatory, and public health dimensions. For this reason, the EcoLume VET program curriculum must be based on an interdisciplinary approach that integrates knowledge from different fields such as the physics of light, nocturnal ecology, human health, astronomy, urban planning, lighting design, and environmental education.

Throughout the modules, a holistic understanding of the phenomenon of artificial light and its impacts is promoted, requiring students to combine technical knowledge with critical analysis skills and communication skills. For example, to diagnose light pollution in an environment, it is necessary to combine knowledge of spectrum and color temperature with environmental observation tools, satellite map interpretation, data management, and biodiversity impact assessment. Likewise, in the development of sustainable lighting proposals (as in Module 4), principles of urban design, environmental regulations, and community participation are articulated.

During the teaching-learning process, activities and methodologies that encourage collaboration between disciplines are incorporated: real-case analysis exercises, night walks integrated with technical measurements and social reflections, intervention projects that combine technical design with citizen perception, and debates on the social and ecological effects of artificial light.

In terms of assessment, students are expected to demonstrate their ability to mobilize knowledge from multiple disciplines, analyzing problems systemically and proposing integrated solutions.

This interdisciplinary approach not only enriches technical training but also prepares future light pollution mitigation professionals to act in real-world scenarios where collaboration between different fields of knowledge is key to designing sustainable and effective responses.

Principle of sustainability and ethics

The principle of sustainability is integrated across the program's curriculum design, guiding training toward light pollution mitigation through responsible, durable solutions aligned with environmental, social, and economic well-being. This principle not only guides the program's content and methodologies but also establishes an ethical basis for the conscious use of artificial light.

This principle is specifically articulated through the Principles of Sustainable Lighting, which establish guidelines for the responsible design of artificial light. These principles require that light be used only where and when necessary (utility), that it be directed precisely downward using full-cut luminaires, avoiding glare and light intrusion, and that intelligent control be incorporated through sensors and regulators that dynamically adjust light levels. In addition, the light intensity must be the minimum required for each task, and a warm light color (low CCT) must be prioritized, reducing the emission of blue light, which has adverse effects on wildlife and the human circadian cycle.

The application of these principles not only allows for the development of sound technical criteria among participants, but also strengthens institutional and community capacities for effective light management, promoting a culture of lighting sustainability based on care, environmental justice, and shared responsibility.

Principle of flexibility and adaptability

The principle of flexibility and adaptability is central to the pedagogical and technical design of the curriculum, as teaching about light pollution responds both to the diversity of audiences and to constant changes in technologies, regulations, and urban dynamics. This approach allows the program to be adjusted to different educational, social, and territorial contexts, ensuring relevant, accessible, and up-to-date training.

From a pedagogical standpoint, it is based on andragogical principles that recognize the previous trajectories, learning styles, and different levels of digital literacy of adult participants. The incorporation of flexible digital platforms allows for face-to-face, virtual, or hybrid teaching modalities, expanding the program's scalability and adaptability. Added to this is the pedagogical autonomy of the trainers, who have a methodological framework that they can creatively adapt to their reality, while respecting the established learning objectives and outcomes.

On a technical level, this principle translates into intelligent control of sustainable lighting, one of the key foundations of the approach. This control allows artificial light levels to be dynamically adjusted using sensors, regulators, and timers, ensuring that light is used only when and where it is needed. This lighting adaptability not only optimizes energy consumption but also allows for a response to the real needs of mobility, safety, and habitability of the nighttime space, taking into account the changing behavior of people and natural cycles.

This dimension promotes a flexible and evolutionary design of nighttime environments, capable of incorporating cultural, ecological, and social variables into their planning. Together, curricular flexibility and technical adaptability strengthen the EcoLume VET program's ability to train professionals prepared to face changing challenges with creative, relevant, and sustainable solutions.

03 Teaching strategies and andragogical techniques

Effective teaching methodologies for adult learners

The effective teaching framework is based on a blended learning approach that combines theoretical foundations with guided, work-based learning and independent study, ensuring a comprehensive and practical educational experience. The following pedagogical methodologies should be adopted to ensure effective knowledge transfer to adult learners.

Content-based teaching approach

This consists of first presenting key ideas using clear, everyday language, before gradually incorporating technical terminology related to artificial light, the effects of the electromagnetic spectrum, luminance measurement, impacts on biodiversity, and the principles of sustainable lighting design. Given that light pollution is a multidisciplinary topic that includes terms unfamiliar to those who do not come from scientific or technical fields, it is essential that trainers adapt the content to the different levels of training of the participants, ensuring that learning is built from the concrete to the abstract, and from the experiential to the conceptual. This approach improves understanding, reduces barriers to accessing technical knowledge, and allows all participants to take ownership of the content and apply it in their real-world environments.

Interactive learning

This approach is aimed at strengthening the active participation of adult learners in the training process. It is implemented through a blended learning model that combines theoretical foundations with guided experiences and applied work, thus promoting a deep and contextualized understanding of the content. Interactivity is encouraged through various teaching strategies such as reflective debates, simulations, role-playing games (e.g., forming a night governance team), and collaborative projects such as participatory mapping of light pollution or the collective design of community awareness campaigns.

These activities not only facilitate the appropriation of technical concepts, but also allow knowledge to be applied to specific situations, connecting learning with the everyday reality of the participants.

In addition, this methodology recognizes the diversity of rhythms, trajectories, and levels of digital literacy among adult students, and therefore aims to ensure an inclusive, flexible, and meaningful learning process in which each participant can actively engage based on their experience and build learning relevant to their context.

Problem-based learning

This methodology is developed around collaborative work in small groups, encouraging debate, the collective construction of knowledge, and the practical application of content in contexts familiar to the participants. Students address specific problem situations, such as identifying poor lighting practices in urban spaces, participatory mapping of neighborhoods to detect critical points of light pollution, or simulating decision-making processes in nighttime governance through role-playing games. These dynamics not only strengthen technical understanding, but also allow participants to structure viable and contextualized intervention proposals.

The role of the educator in this approach is that of a trainer, providing progressive guidance, promoting group autonomy, and delivering constructive feedback throughout the process. Each activity culminates in structured reflection spaces, where students share learnings, exchange perspectives with their peers, and connect the solutions they have worked on with their own personal and professional experiences.

This methodology enhances the development of critical, communication, and problem-solving skills, which are essential for addressing the challenges of sustainable lighting.

Blended learning

The model systematically combines three complementary modalities: (i) the development of theoretical foundations for conceptual understanding, (ii) guided, work-based learning that integrates practical activities, simulations, and problem solving, and (iii) independent study, which allows participants to explore, deepen, and reflect on the content at their own pace. This structure promotes the progressive acquisition of technical, digital, and ecological skills, adapting to students' different levels of experience and prior training.

The use of flexible digital platforms broadens the accessibility of the curriculum, allowing for remote participation, the delivery of audiovisual materials, and asynchronous interaction between trainers and students.

This approach is based on principles of andragogy, promoting inclusive, empathetic teaching that is adaptable to different learning rhythms and levels of digital literacy. In this context, the role of the educator is redefined as a learning facilitator, providing continuous support, clear guidance, and encouraging autonomy at each stage of the training process.

Digital innovation and digital tools

The use of digital technology focuses on the diagnosis and monitoring of light pollution, requiring participants to analyze remote sensing data and satellite images and explore online light pollution maps to identify global and regional patterns, often involving advanced computational analysis. Secondly, sustainable technical solutions and design systems are applied through the use of smart lighting systems, which employ sensors (motion, daylight) and dimmers to dynamically adjust light levels in real time, which is essential for optimizing energy efficiency and mitigating light pollution. Finally, digital tools are used for job-based learning, training professionals to develop participatory diagnostic maps and use mobile applications to link theoretical knowledge with real-world monitoring practices.

Visual aids

Visual aids transform abstract concepts into applicable knowledge, increasing understanding, retention, motivation, and ownership of learning. In this context, the program draws on a wide range of carefully designed and aesthetically refined resources.

Digital presentations and graphic examples are used to explain fundamental concepts such as the visible light spectrum, photometric units (lumens, lux, candelas), and Correlated Color Temperature (CCT). These materials support the progression from the concrete to the abstract, facilitating technical learning for people without prior training in lighting.

Visual aids play a key role, particularly in the light pollution diagnosis modules. Satellite images (such as VIIRS), interactive online maps, photographs of urban skies, and comparative resources are used to identify real cases of sky glow, light intrusion, and glare. In addition, pictograms are integrated to illustrate the impacts on human health, as well as analog materials such as sticky notes, cards, and flipcharts to facilitate participatory mapping exercises, causal analysis, and the collaborative creation of resources such as the "circadian clock," which allows the relationship between light and biological cycles to be represented graphically.

In the modules focused on Light Urbanism and Light Art, printed maps, templates, and translucent materials (such as wax paper or cellophane) are provided to allow participants to draw lighting redesign proposals, experiment with color filters, and create scale prototypes of sustainable interventions.

This approach stimulates creativity and emotional connection to the nighttime environment.

Finally, the contextual relevance of visual aids is emphasized, encouraging trainers to incorporate local examples, real images of the neighborhoods or communities where participants live, and symbolic representations that reflect their cultural, urban, and natural environment.

In this way, learning becomes not only understandable, but also meaningful, situated, and empowering.

04 Resource allocation and management

The quality of adult learning depends both on the content and on the adequate availability, contextualization, and use of resources, encompassing human, material, technological, and temporal dimensions.

Firstly, human resources play a fundamental role. Educators or trainers act as guides in the learning process, adopting an inclusive, empathetic, and flexible approach that adapts to the diversity of participants' backgrounds, paces, and levels. In addition, the curriculum is built on intercultural collaboration between institutional partners in Europe and Latin America, integrating diverse territorial experiences. Students themselves are also recognized as bearers of valuable knowledge, which is why peer exchanges, reflective debates, and collective knowledge building are promoted.

In terms of material and physical resources, pedagogical implementation requires tangible tools that stimulate active participation and collaborative work. In the area of technological and digital resources, the curriculum is based on flexible platforms that allow for greater access and scalability of the program. For the activities, there are tools that allow participants to carry out practical exercises in data collection and analysis.

Resource management is directly linked to the curriculum's time planning, which covers a total of 29 hours and 30 minutes. These hours are distributed evenly across three blocks: theoretical foundations, guided and work-based learning, and independent study.

This time structure ensures an effective combination of conceptual acquisition, practical application, and independent reflection, which are essential elements for achieving the program's educational objectives.

TRANSFER OF KNOWLEDGE AND SKILLS - TRAINER PREPARATION RECORD

The following elements can be consulted before each knowledge and skills transfer session to ensure adequate trainer preparation.

Teaching Skills Assessment (Completed by the trainer)		
	STRENGTHS	WEAKNESSES
What are your strengths and weaknesses when teaching the subject?		
PEDAGOGY		
Physical elements required: What physical teaching and learning materials would you, as a trainer, need for effective knowledge transfer? What do you expect your students to have for effective learning?		
Required technologies: What technological aids would you need in the process of transferring knowledge and skills? How competent are you in using such aids? What challenges do you foresee and how prepared are you to face them?		
Practical integration requirement: Does the topic require practical lessons? How prepared are you to carry out the practical activities? Have you already practiced the practical activity? Are there enough materials for the activities?		
Instructional strategies: Which instructional techniques will best suit the transfer of knowledge and skills? Will they help to easily achieve the instructional objective? How often have you used this strategy?		
Climate-smart strategies: What climate-smart strategy will you implement in the knowledge transfer process? How relevant is it to the achievement of learning objectives?		

REFLECTION
What is your overall assessment of the knowledge and skills transfer process with respect to the lesson you just taught? Did it meet the instructional objectives?
How well did the students understand the most important part of the lesson? How often did they ask questions?
How enthusiastic were the students about the lesson?
What concepts did you feel might require further clarification? How did you deliver it? Why did you feel it needed clarification? What instructional strategy did you use? Do you plan to modify it?
Will you need to improve your strategy for transferring knowledge and skills? Did you encounter any challenges with the current instructional strategy? What instructional strategy did you feel could be useful in delivering the lesson?
Were there any aspects of the lesson that were not covered effectively? To what extent were they covered? How will you ensure that they are covered completely next time?
How well did you allocate your resources during the knowledge and skill transfer process?
Did you have adequate resources? Were the resources sufficient for the students?

Session 3

Evaluating the **Results** of **Knowledge** and **Skill Transfer**

This section provides specific guidance for light pollution program trainers to effectively design, implement, and evaluate knowledge transfer and skill development in adult learners. Properly evaluating learning outcomes is critical to ensuring that participants not only understand the theoretical fundamentals of lighting and light pollution, but are also able to apply this knowledge in practical ways in their local and professional environments.

01 Designing assessment tools

The types of formative assessment present are manifested through various specific interactive methodologies and activities, combining quantitative and qualitative approaches:

7.1.1. Continuous Observation and Active Participation:

- Participation in guided activities and group discussions is a method of ongoing assessment. Trainers monitor active participation in discussions and mini-lectures.
- The quality of ideas shared and the diversity of associations during icebreaker exercises and initial activities are evaluated.
- Group collaboration and the clarity of reasoning and logic applied during simulations and role-playing games, such as in the governance role assignment exercise, are observed.

7.1.2. Comprehension Checks and Classroom Questions:

- Class comprehension questions are used to ensure the assimilation of technical concepts, such as the light spectrum and units of measurement.
- Question and answer sessions are held after the presentation of the theoretical foundations to verify that the basic concepts of light pollution are clear to participants.

7.1.3. Peer Feedback and Reflective Discussions:

- The curriculum promotes the use of peer feedback and group reflection. For example, after exercises identifying cases of light pollution, peers are encouraged to give feedback to the group.
- The assessment includes participants' contributions to group discussions on the application of sustainable lighting principles at the local level or on the risks of screen use.
- Peer teaching (feedback between groups) is encouraged so that students can share their conclusions and clarify any points.

7.1.4. Informal Review of Tasks and Practical Projects:

- Informal review of written reflections is used, such as the individual assignment on reflecting on lighting technology.
- The accuracy of qualitative observations made during sky quality estimation exercises and the relevance of observations in the "My Night Environment" exercise are evaluated.
- The accuracy and completeness of the characterization sheets and the group's ability to apply sustainability principles in the creation of diagnostic maps are evaluated.
- In the governance and proposal sessions, the instructor continuously reviews the groups, guiding the process and offering comments during the activity, before the final presentation.

7.1.5. Reflection and Self-Assessment Activities:

- All sessions should close with a reflection activity that allows participants to connect new knowledge to their professional and personal lives. For example, participants are asked to share "One idea I have learned" and "One way I can use this session with my students or in my work environment."
- Reflection journals and short self-assessment forms are used to gather participants' learning experiences and confidence in applying the competencies.
- In Module 3, assessment includes the personal action plan, where participants share a strategy they commit to implementing, the clarity and relevance of which is reviewed in an informed manner.

7.1.6. Criteria for selecting appropriate methods

The criteria are based on the principles of adult education (andragogy) and are designed to ensure that learning is practical, meaningful, and tailored to the diverse needs of professionals.

The main criteria for methodological selection are:

- Alignment with Andragogy: Methods must ensure that the teaching and learning process is engaging, inclusive, and aligned with the principles of adult education.
- Adaptability and Inclusivity: Teaching should be inclusive, supportive, and adaptable to the diversity of adult learners, taking into account different learning paces, backgrounds, and levels of digital literacy.
- Transparency: Clear objectives and collaboration rules must be defined and communicated, with a transparent explanation of assessment methods, using formative assessment on an ongoing basis to support learning.

02 Implementation of assessments

Monitoring and evaluation:

Monitoring and evaluation are essential components of the EcoLume curriculum, as they ensure that the program remains relevant, effective, and in line with European vocational training standards. Assessment methods focus on both the quality of delivery and the impact on learners, combining quantitative and qualitative approaches.

Participant feedback

- **Anonymous surveys** at the end of each module should gather learners' opinions on the relevance of the content, the clarity of the teaching, the quality of the resources, and the usefulness of the practical activities.
- **Reflection journals** and short self-assessment forms should be used to gather participants' learning experiences, personal progress, and confidence in applying the skills.
- **Focus group discussions** can provide deeper insight into how learners perceive the program and where improvements may be needed.

Feedback from educators and trainers

- Trainers should complete structured reports on the challenges, strengths, and observed participation of learners, as well as provide suggestions for improvement.
- Peer feedback from educators can be used to compare methodologies and exchange best practices.

Monitoring learning outcomes

- **Formative assessment**: Continuous checks through quizzes, group reflections, and small projects ensure that learners achieve the intended outcomes during the modules.
- **Summative assessment**: Final assessments, such as practical projects (e.g., light pollution audits or awareness campaigns) and theoretical tests, confirm that the expected competencies have been acquired.
- **Skills mapping:** in relation to the European Qualifications Framework (EQF) ensures alignment with vocational training standards.

Quality of program implementation

- Review of teaching materials and their compliance with accessibility and sustainability guidelines.
- Analysis of organizational aspects: scheduling, duration, technical conditions, and learning environment.
- Assessment of the level of commitment: attendance rates, timely submission of assignments, and active participation in collaborative activities.

Long-term impact assessment

- **Follow-up surveys** (3-6 months after program completion) to assess the transfer of knowledge and skills to professional or community contexts.
- Collection of **success stories and case studies** from participants who have applied EcoLume principles in their workplaces, schools, or municipalities.
- **Feedback from stakeholders** (e.g., partner organizations, employers, or community leaders) on how program outcomes contribute to broader sustainability and environmental education goals.

03 Data analysis and reporting

The evaluation of the implementation and impact of the EcoLume curriculum is based on a combination of quantitative and qualitative analysis techniques, which are essential for the development of the feedback cycle and the continuous improvement of the program.

Quantitative Analysis

Quantitative analysis is used to measure the scale and scope of the light pollution problem and to confirm students' knowledge acquisition and engagement.

- In Training (Summative Assessment): Quantitative assessment is used through questionnaires or theoretical tests to confirm that participants have acquired the expected competencies.
- In Light Diagnosis: Quantitative measurement requires the use of physical tools such as the Sky Quality Meter (SQM) and mobile applications. In addition, satellite data analysis (such as VIIRS) allows participants to perform calculations, such as determining the percentage of emissions from a municipality in relation to its total area.
- In Program Management: Attendance rates, timely submission of assignments, and active participation are evaluated to measure the level of commitment and quality of implementation.

Qualitative Analysis

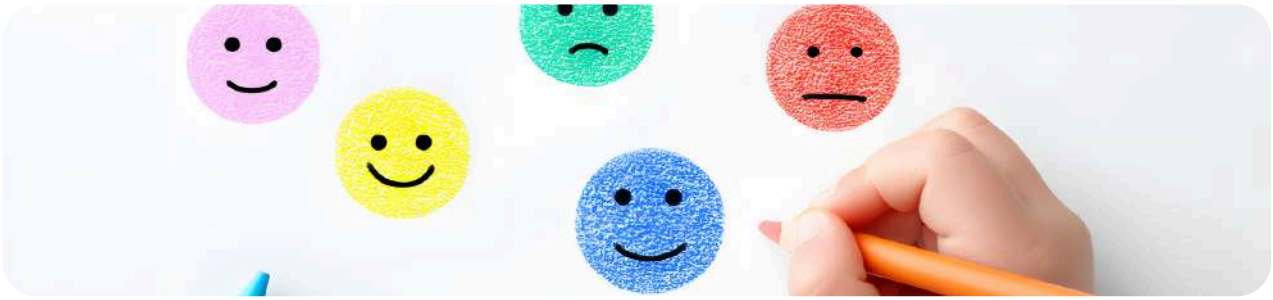
This focuses on the interpretation of observations, reasoning, and evaluation of the content of the modules. Trainers evaluate participants' qualitative observations during exercises such as estimating sky quality using observation methods that complement other instruments. The qualitative evaluation focuses on reviewing practical projects and presentations of group activities. The clarity of the logic applied, the group's ability to identify patterns and limitations in real scenarios, and the classification of artificial light based on reasoning are evaluated.

This analysis is compiled through reflection sessions and group discussions on learning experiences, personal progress, and confidence in applying skills.

Finally, the following points should be considered in the data analysis:

- All data collected through surveys, evaluations, and reports should be systematically analyzed to identify trends, strengths, and areas for improvement.
- The results should be summarized in an annual evaluation report, which will be shared with project partners, educators, and stakeholders, ensuring transparency and compliance with Erasmus+ and EU Vocational Education and Training (VET) quality standards.
- Based on these findings, the curriculum should undergo cycles of continuous improvement, adapting content, methods, and resources to the future needs of learners.

04 Providing feedback



Effective feedback mechanisms for continuous improvement in the EcoLume curriculum are essential components of program monitoring and evaluation, designed to ensure that training is relevant, effective, and in line with adult vocational training standards. These mechanisms establish a systematic cycle that combines quantitative and qualitative approaches.

1. Participant Feedback (Formative and Quality Assessment)

Gathering feedback from learners is essential to understanding their learning experience, personal progress, and confidence in applying their skills.

- Anonymous Post-Module Surveys: Anonymous surveys should be conducted at the end of each module to gather feedback on the relevance of the content, the clarity of the teaching, the quality of the resources, and the usefulness of the practical activities.
- Reflection Tools: Reflection journals and short self-assessment forms should be used to collect participants' learning experiences and assess their personal progress and confidence in applying their skills.
- Focus Groups and Discussions: Focus group discussions can provide deeper insight into how learners perceive the program and where improvements may be needed.
- In-Session Reflection: The methodology encourages participants to share their professional and personal experiences through reflective discussions and peer exchanges. In addition, each session should be closed with a reflection activity, allowing participants to connect new knowledge to their professional and personal lives.

2. Educator Feedback and Implementation Analysis

Educator-focused mechanisms ensure that teaching is of high quality and tailored to the diverse needs of learners.

- Structured Trainer Reports: Trainers should complete structured reports on the challenges, strengths, and observed participation of learners, as well as provide suggestions for improvement.
- Peer Feedback: Peer feedback from educators is used to compare methodologies and exchange best practices.
- Quality Monitoring: Organizational aspects (such as scheduling and technical conditions) and the level of student engagement, including attendance rates and timely submission of assignments, are evaluated.
- Review of Materials: Teaching materials are checked for compliance with accessibility and sustainability guidelines.

3. Long-Term Impact and Stakeholder Assessment

To measure success and the transfer of knowledge into practice, long-term monitoring mechanisms are implemented.

- Follow-up Surveys: Follow-up surveys are conducted (3-6 months after program completion) to assess the transfer of knowledge and skills to professional or community contexts.
- Compilation of Success Stories: Success stories and case studies are collected from participants who have applied EcoLume principles in their workplaces, schools, or municipalities.
- Stakeholder Feedback: Feedback is collected from stakeholders (such as partner organizations, employers, or community leaders) on how the program's results contribute to broader sustainability goals.

4. Development of the Continuous Improvement Cycle (Data Analysis and Reporting)

Continuous improvement is the direct result of managing and analyzing feedback:

- Systematic Analysis: All data collected through surveys, evaluations, and reports should be systematically analyzed to identify trends, strengths, and areas for improvement.
- Annual Reports: Results should be summarized in an annual evaluation report, which will be shared with project partners and stakeholders, ensuring transparency.
- Curriculum Adaptation: Based on these findings, the curriculum should undergo cycles of continuous improvement, adapting content, methods, and resources to the future needs of students.

This feedback process ensures that if a deficiency is identified (e.g., students do not apply the principle of "Control" properly), the curriculum can be continuously adjusted, maintaining its practical purpose and professional relevance.

05 Details by module

The facilitator's approach in each module focuses on active, experience-based learning. Begin with icebreaker activities that connect participants' personal experiences to the topic, and close each session with a reflection activity so that they can connect their new knowledge to their personal or professional lives.

The facilitator's approach and key tools for each module of the curriculum are detailed below:

Module 1: Introduction to light and light pollution

Gathering feedback from learners is essential to understanding their learning experience, personal progress, and confidence in applying their skills.

- Anonymous Post-Module Surveys: Anonymous surveys should be conducted at the end of each module to gather feedback on the relevance of the content, the clarity of the teaching, the quality of the resources, and the usefulness of the practical activities.
- Reflection Tools: Reflection journals and short self-assessment forms should be used to collect participants' learning experiences and assess their personal progress and confidence in applying their skills.
- Focus Groups and Discussions: Focus group discussions can provide deeper insight into how learners perceive the program and where improvements may be needed.
- In-Session Reflection: The methodology encourages participants to share their professional and personal experiences through reflective discussions and peer exchanges. In addition, each session should be closed with a reflection activity, allowing participants to connect new knowledge to their professional and personal lives.

Key tools:

- Case identification:The facilitator welcomes participants and invites them to reflect on the importance of light. "Light perception cards" with open-ended questions are used to generate a key observation that is shared with the group.
- Understanding light and presentation with graphics:Facilitate the division of groups (Human Health vs. Environment) so that they can draw a simple cause-and-effect chain (Source ALAN → Mechanism → Key Impacts) on a flipchart, and summarize their conclusions in simple language. The facilitator should emphasize that education and awareness are crucial for long-term success.
- Case studies: Presentation of real-life examples of sustainable lighting (such as Augsburg, Germany, or Freiburg, Germany) to demonstrate the principles of responsible lighting (Utility, Direction, Control, Intensity, and Color).

Module 2: Diagnosis and monitoring of light pollution: key concepts and tools

The trainer should train participants to measure, analyze, and characterize light pollution. The approach is based on hands-on learning to transform abstract concepts into applicable skills. They should guide learners in the use of diagnostic tools and the development of participatory diagnostic maps.

Key tools:

- Group research on impacts:Divide participants to research and present the impacts of light pollution in three areas: Human Health (e.g., circadian rhythm, chronic diseases), Environmental/Ecological (e.g., wildlife, urban ecosystems), and Economic/Urban (e.g., energy consumption, planning). Provide examples of case studies (e.g., IGB in Germany, VIIRS studies in Colombia).
- Analysis of satellite maps and SQM:The facilitator guides the exploration of online tools: LightPollutionMap.info (to identify global patterns) and VIIRS (Visible Infrared Imaging Radiometer Suite) data (to analyze nighttime radiation). The use of the Sky Quality Meter (SQM) and mobile applications is also introduced (although less accurate, they are valuable for citizen science).
- Activity: "Light Detectives" and characterization sheets:Start with the "Light Detectives" activity to encourage critical analysis of existing lighting. Present the key elements of luminaires (beam angle, optics, CCT, energy efficiency) and their impact. Groups complete characterization sheets for simulated scenarios, analyzing whether they comply with the principles of responsible lighting.

Module 3: Assessment of the environmental and health impact of light pollution

The trainer should promote informed reflection on the physiological and ecological effects of artificial light.

It is crucial that participants develop the ability to classify environments according to their sensitivity to light (national parks, observatories, residential areas).

Key tools:

- Leopold Matrix:Divide participants into groups and assign a virtual walk (360° video or Google Maps). Groups should mark observed sources of light pollution and their potential impacts directly on the Leopold Matrix Form. Conclude with a discussion of impressions and the use of the Matrix as a diagnostic tool.
- Detailed process of "My life on screen": Brainstorm to record screen activities and create a "screen wall" to visualize total usage. Guide exploration by area (eyes, sleep, emotions) explaining the effects. Use case study cards for a rotating discussion on health effects. Conclude by asking participants to share a personal strategy (Personal Action Plan) for healthier use.
- Step-by-step circadian rhythm activity: Open the session with a breathing exercise and personal timing to introduce self-awareness. Introduce the concept of the "circadian cycle" and the metaphor of the "internal clock" synchronized by light. Draw a 24-segment "circadian clock" on the board and ask participants to place their typical activities and feelings on it. Conclude with a discussion of factors that confuse the clock (e.g., screen use/blue light), and collect practical tips for ensuring good sleep (e.g., avoiding bright light before bedtime).

Module 4: Technical solutions and sustainable nighttime space design

The trainer should guide the application of sustainable lighting principles through light urbanism and the Urban Lighting Plan (ULP).

The goal is to develop participatory and creative lighting proposals that balance social use, ecological protection, and urban identity.

Key tools:

- Urban Lighting Plan (ULP): Introduce Light Planning as a strategic vision that shapes the nighttime identity of the city, beyond technical utility. Teach the four key steps of the ULP: Diagnosis and analysis, Vision and objectives, Lighting master plan, and Implementation and management.
- Night Mapping (PLU Tool):Guide the Night Mapping activity (Session 1) using printed maps and nighttime photos of a neighborhood. Participants should mark light and dark areas, landmark buildings, transportation access, and areas perceived as safe or unsafe. This exercise constitutes the initial diagnosis for planning.
- Types of Lighting: Differentiate between the four types of urban lighting, emphasizing that the design of the Ecological Structure (parks, gardens) should be sensitive to wildlife, using low light levels and warm CCT (below 3000 K).
- Urban Acupuncture with Lighting:Present this tool as a small-scale strategic intervention strategy to have a significant impact. The facilitator should guide the groups in drawing on images and maps. Participants should define a lighting concept, marking colors, contrasts, directions, and intensities, and delimiting the areas that should remain dark.
- Light Art:Lead a light art project in small groups to create a collaborative work of art based on light that symbolizes a poetic solution to a public space problem (e.g., safety, isolation). The process includes assigning specific roles, building a small-scale prototype, and testing lighting configurations (angles, filters, intensity). Conclude with a mini-gallery to reflect on how light transforms the message.

Module 5: Community Action and Multilevel Governance

The trainer acts as a catalyst for collective action. They should teach participants to use "plain language" to translate complex technical issues into accessible narratives and to structure compelling proposals to mobilize communities and policymakers.

Key tools:

- Communication strategies and campaign templatesTeach the importance of "plain language" to translate technical concepts. Use the printable communication campaign template to structure proposals around the five key points (purpose, message, target audience, channel, call to action), analyzing real examples (such as *The Lighting Police* or *ARUP*).
- Governance roles: Present the five main functions of night governance and lead the Role-playing Exercise (using role cards and the Role-playing Template) where groups define a common goal and the contributions of each actor (e.g., night mayor, astronomer).
- Tone training: Explain Marshall Ganz's Public Narrative framework, which connects personal history, our history, and the history of the present to motivate action. The facilitator guides the individual structuring exercise using the printable Public Narrative Format to create an assertive speech
- Guidelines for drafting proposals Guide the structuring of proposals (regulation, competition, or project) using the "Structure a proposal" format to address the six key points (problem statement, goals, activities, budget, etc.). Analyze real examples of instruments (such as the Chilean Regulation).

Session 4

Improving transfer methods

01 Objective of Improvement

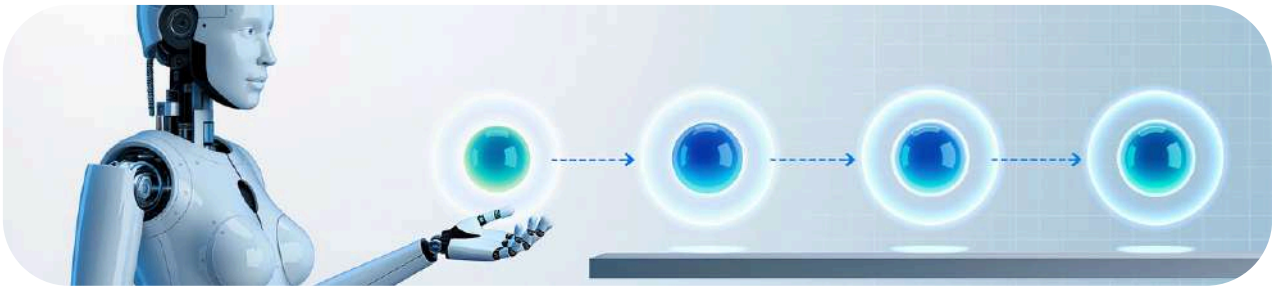
The main objective of improving transfer methods in the EcoLume curriculum is to strengthen the capacity of adult participants to acquire, apply, and transfer technical knowledge about light pollution in a meaningful, contextualized, and lasting way, through andragogical teaching strategies that are adapted to their previous trajectories, levels of digital literacy, learning rhythms, and territorial realities.

Given that there are no previous consolidated references in vocational training programs on light pollution, EcoLume is a pioneering initiative, facing for the first time the challenge of systematizing content, methods, and tools in this emerging field.

For this reason, continuous improvement takes on a strategic character, allowing us to identify which methodologies and resources are truly effective, which lessons translate into action, and which opportunities for adjustment or innovation may arise from direct experience in the field.

Visualizing what works and detecting gaps becomes essential to ensuring a transfer of knowledge that is relevant, sustainable, and replicable in different contexts.

02 Transfer methods



The Improvement of Transfer Methods in the EcoLume curriculum is an adaptive management process designed to ensure the quality, effectiveness, and ongoing relevance of the Vocational Training (VT) program. This process is based on a robust feedback cycle that combines quantitative and qualitative analysis, ensuring that the curriculum remains in line with European vocational training standards and the principles of andragogy. The central objective is to refine teaching methods to facilitate the practical application of knowledge in professional and community contexts, ensuring that adult learners develop interdisciplinary skills.

The improvement focuses on making teaching inclusive, supportive, and adaptable to the diversity of adult learners, considering their different learning paces, backgrounds, and levels of digital literacy. Educators, who act primarily as trainers and guides, are responsible for using feedback to encourage autonomous learning and help transform the curriculum into a meaningful learning journey.

I. Rationale and Objectives of the Improvement

The improvement of transfer methods is driven by a commitment to making learning meaningful, practical, and closely related to real life. Since the target group is composed of adults, the curriculum applies the principles of andragogy, which makes prior experience and practical application central to success.

- **Alignment with Standards and Practical Approach:** The improvement framework verifies alignment with the European Qualifications Framework (EQF) and promotes an emphasis on practical activities (such as measuring light pollution or designing awareness campaigns), as these experiences transform abstract concepts into applicable skills.
- **Adaptation to Learner Needs:** Trainers are required to adapt to different learning paces and use methods that reinforce collaboration. Trainers should gather participants' expectations and prior knowledge regarding artificial light and sustainability and use them to shape the learning process.

II. Incorporating Feedback to Improve Transfer

Improving knowledge transfer methods is not a static process, but a continuous practice based on incorporating feedback gathered throughout the training process.

This feedback, obtained from facilitators and participants, is transformed into strategic input to adjust content, methodologies, visual and digital resources, and facilitation dynamics, in order to reinforce the effectiveness of teaching and learning in adults.

Feedback mechanisms, such as anonymous surveys, reflective journals, self-assessment forms, and facilitator reports, act as diagnostic tools that generate concrete evidence about which elements of the educational process are working effectively and which present barriers to learning. This evidence allows us not only to detect specific failures, but also to identify structural patterns that may compromise the effectiveness of the program as a whole.

Thanks to this feedback system, improvements in transfer are expressed in three dimensions: (1) the reformulation or adjustment of content that is difficult to understand or has low applicability; (2) the optimization of visual and digital resources to ensure clarity and accessibility; and (3) the adaptation of teaching strategies to the different paces, levels of digital literacy, and sociocultural contexts of the participants. Together, these adjustments strengthen the appropriation of knowledge, ensuring that teaching is not limited to exposition but translates into meaningful learning and concrete action.
In this way, feedback not only measures results but also acts as a lever to reinforce the effectiveness of the training process, ensuring that the transfer of knowledge about light pollution remains relevant, accessible, and transformative.

III Educator Feedback and Implementation Analysis

Trainers, as the main agents of transfer, provide structured data for improvement:

- Structured Reports: Trainers must complete structured reports on the challenges, strengths, and observed participation of students, as well as provide suggestions for improvement.
- Exchange of Good Practices: Peer feedback from educators is used to compare methodologies and exchange good practices.
- Implementation Monitoring: Evaluation verifies the quality of program implementation, including analysis of organizational aspects (scheduling, duration, technical conditions) and review of teaching materials and their compliance with accessibility and sustainability guidelines.

IV. Analysis and Diagnosis for Adaptation

The analysis step transforms feedback data into a concrete action plan for improvement.

- Systematic Data Analysis: It is mandatory that all data collected through surveys, evaluations, and reports be systematically analyzed to identify trends, strengths, and areas for improvement.
- Transparency and Reporting: The results must be summarized in an annual evaluation report, which is shared with project partners, educators, and stakeholders, ensuring transparency and compliance with EU VET quality standards.
- Continuous Learning Assessment: The framework uses formative assessment through continuous checks (questionnaires, group reflections, small projects) to ensure that learners achieve the expected outcomes during the modules, allowing for real-time methodological adjustments.

Assessment frameworks

The importance of educational assessment:

The importance of educational assessment in the EcoLume curriculum is fundamental, as it serves as a comprehensive mechanism for ensuring the quality, consistency, and relevance of the adult vocational training (VET) program. Assessment ensures that the curriculum remains aligned with the principles of andragogy and European vocational training standards, verifying that transfer methods are effective and adaptable. This process includes monitoring the quality of delivery (analyzing scheduling, duration, and technical conditions) and reviewing teaching materials to confirm their compliance with accessibility and sustainability guidelines.

In addition, it establishes a framework of transparency and accountability by requiring that assessment methods be explained transparently and that results be systematically analyzed and summarized in an annual assessment report for partners and stakeholders.

Data analysis also assesses the level of learner engagement, including attendance rates, timely submission of assignments, and active participation in collaborative activities.

In addition to validating the quality of the program, assessment is crucial to support and confirm the acquisition of competencies by learners.

Formative assessment plays a vital role by providing ongoing learning support throughout the modules, using tools such as quizzes, group reflections, and peer feedback to ensure that learners achieve the intended outcomes.

On the other hand, summative assessment, carried out through practical projects (such as light pollution audits or awareness campaigns) and theoretical tests, is essential to confirm that the expected competencies have been acquired.

Measuring success extends to long-term impact, evaluating the transfer of knowledge and skills to professional or community contexts through follow-up surveys and the collection of success stories.

Finally, evaluation feeds into a cycle of continuous improvement, as the conclusions of the analysis are used to adapt content, methods, and resources to the future needs of learners.

The most important components and steps of the evaluation framework

The EcoLume curriculum evaluation framework is designed to ensure that adult vocational training (andragogy) is engaging, inclusive, and relevant, focusing on both the quality of teaching and the impact of the skills acquired. The most important components and steps of this assessment framework, according to the information contained in the sources, are presented below:

1. Setting Objectives

The objectives of the assessment are set at various levels, from the overall mission of the project to the specific outcomes of each session:

- **Program Objectives (Mission):** The primary objective is to develop a specialized professional curriculum for light pollution mitigation specialists, equipping them with ecological and digital skills. It also seeks to improve the employability of students and promote the adoption of sustainable lighting practices in communities.
- **Pedagogical Objectives:** Trainers must define and communicate clear objectives and collaboration rules and the expected competencies. Specific objectives include participants being able to describe the main characteristics of light, use physical and digital tools to diagnose light pollution, classify environments according to their sensitivity, and structure mitigation proposals.
- **Connection with the Student:** The objectives are aligned with andragogy, ensuring that learning is meaningful, practical, and closely related to real life.

2. Success Indicators

The indicators measure success in the acquisition of competencies, the quality of implementation, and long-term impact:

- **Learning Outcomes (Skill Acquisition):** Students are evaluated on their acquisition of the expected skills, including knowledge of ecological and technological aspects, the ability to measure and analyze solutions, and attitudes of responsibility and critical thinking.
- **Specific examples of success:** The accuracy and completeness of the lighting characterization sheets, the group's ability to interpret and compare satellite map data, the clarity and relevance of the communication campaign proposals, and the logic of the assignment of responsibilities in the governance role-playing game.
- **Commitment and Quality of Implementation:** Attendance rates, timely delivery of assignments, and active participation in collaborative activities are monitored. The relevance of content, clarity of teaching, and quality of resources are also evaluated.
- **Regulatory Compliance:** The alignment of competencies with the European Qualifications Framework (EQF) is verified.
- **Long-Term Impact:** Success is measured by the transfer of knowledge and skills to professional or community contexts after program completion.

3. Data Collection Methods

Data collection is multi-source to obtain a comprehensive view of performance and quality:

- **Observation and Participation:** The trainer collects data by observing participation and the diversity of associations shared during initial exercises. Group collaboration and reasoning during practical activities are also evaluated.

- **Reports and Questionnaires:** Anonymous surveys are used at the end of each module, as well as theoretical tests or questionnaires (such as the 4-question quiz at the end of Module 4).
- **Reflection and Self-Assessment:** Qualitative data is collected through reflection journals and short self-assessment forms. In addition, all sessions end with a reflection activity to connect learning to personal life.
- **Trainer Documentation:** Trainers must complete structured reports on the challenges, strengths, and observed participation of learners, as well as provide suggestions for improvement.
- **Post-Program Follow-Up:** Follow-up surveys are conducted 3-6 months after the program, and success stories and case studies are collected.

4. Types of Assessment

The curriculum uses a combination of approaches to ensure continuous learning and final validation of competencies:

- **Formative Assessment:** These are ongoing checks (through questionnaires, group reflections, and peer feedback) that ensure learners achieve the expected outcomes during the modules. It is used to verify understanding of technical concepts and the application of the Personal Action Plan for Screen Use.
- **Summative Assessment:** This consists of final assessments (practical projects, theoretical tests) that confirm that the expected competencies have been acquired at the end of the module or program. This includes the evaluation of lighting proposals, awareness campaigns, and the qualitative evaluation of group activity presentations.
- **Implementation Assessment:** The quality of the program's implementation is reviewed, analyzing organizational aspects (scheduling, technical conditions) and the compliance of teaching materials with accessibility and sustainability guidelines.

5. Analysis and Interpretation

Data analysis uses dual approaches to obtain meaningful conclusions:

- **Systematic Analysis:** All data collected through surveys, evaluations, and reports must be systematically analyzed to identify trends, strengths, and areas for improvement.
- **Quantitative Analysis:** Used to measure the results of theoretical tests (questionnaires), attendance rates, and level of engagement.
- **Qualitative Analysis:** Focuses on interpreting students' reasoning, the clarity of their visual summaries, and their ability to identify patterns and limitations in real-world scenarios. It is essential for evaluating the quality of group collaboration.
- **Reporting:** Results should be summarized in an annual evaluation report, which is shared with project partners and stakeholders to ensure transparency.

6. Feedback and Improvement

Feedback closes the evaluation cycle, driving continuous improvement of the curriculum:

- Continuous Improvement Cycles: Based on the conclusions of the analysis, the curriculum should undergo cycles of continuous improvement, adapting content, methods, and resources to the future needs of students.
- Constructive Feedback: Feedback provided by the educator/trainer (acting as a facilitator and guide) should be relevant, immediate, objective, useful, confidential, respectful, tailored, and encouraging. This helps transform the curriculum into a transformative learning journey.
- Exchange of Methodologies: Peer feedback among educators is used to compare methodologies and exchange best practices.
- Application of Adaptations: Improvement involves reinforcing interactive methods (debates, role-playing) and ensuring that teaching remains inclusive, supportive, and adaptable to the diversity of adult learners.

Conducting the evaluation

The assessment model

The model is structured around continuous formative assessment, summative assessment of competencies, and assessment of long-term impact.

1. Reaction and Learning Assessment (Formative and Summative):

The program uses formative assessment (ongoing checks with questionnaires, group reflections, and peer feedback) to ensure that students achieve the expected outcomes during the modules. Summative assessment (practical projects and theoretical tests) is used to confirm that the expected competencies have been acquired. In addition, participant feedback is collected through anonymous surveys at the end of each module on the relevance of the content, the clarity of the teaching, and the quality of the resources.

2. Implementation and Behavior Assessment (Transfer):

The framework assesses the quality of program implementation by analyzing organizational aspects, reviewing teaching materials, and evaluating student engagement (attendance rates, timely assignment submission). Crucially, it includes the assessment of long-term impact through follow-up surveys (3-6 months later) to evaluate the transfer of knowledge and skills to professional or community contexts.

3. Evaluation of Results and Impact:

The program measures long-term success by collecting success stories and case studies from participants who have applied EcoLume principles. Feedback is also sought from stakeholders (such as employers or community leaders) on how program outcomes contribute to broader sustainability and environmental education goals.

This comprehensive evaluation framework feeds into a cycle of continuous improvement, where all data collected is systematically analyzed to identify trends and areas for improvement, ensuring that the curriculum adapts to the future needs of students.

The most important components and steps of the evaluation framework

1. Setting objectives Every successful evaluation begins with clearly defined objectives. What is the educational activity intended to achieve? For trainers, these objectives may include the following examples:

- Increasing critical awareness of the impact of poorly directed artificial light on biodiversity, human health, and the night sky.
- Train participants in diagnosing light pollution in their territories using participatory and digital tools.
- Promote the design and implementation of sustainable solutions based on the principles of responsible lighting (utility, control, direction, intensity, and color).
- Strengthen students' ability to communicate and raise awareness in their communities about the effects of light pollution.

Appendix:

Training materials package

Module 1: Introduction to light and light pollution

TOTAL DURATION OF THE MODULE:
4 hours

Session 1: Fundamentals of light and its evolution

PURPOSE:
To establish a common understanding of light, its technological evolution, and fundamental technical concepts.

ACTIVITY 1.1: ICEBREAKER: MY PERCEPTION OF LIGHT (15 MIN)

GUIDE FOR THE FACILITATOR
The facilitator welcomes participants and encourages participation. Divide participants into small groups (3-4 people). Distribute the "Light Perception Cards" (with open-ended questions or prompts, e.g., describe a place where artificial light was inappropriate) to generate discussion. Each group should share one key observation with the whole group to connect personal experiences to the central theme.

KEY TOOLS
Printed or digital light perception cards.

ACTIVITY 1.2: A JOURNEY THROUGH LIGHTING TECHNOLOGIES (40 MIN)

GUIDE FOR THE FACILITATOR
Give an interactive mini-lecture (25 min) reviewing the evolution: from natural sources (Sun, Moon) and fire, to gas lamps and incandescent lighting (electrical revolution). Emphasize the LED era (SSL), pointing out its exceptional energy efficiency (up to ten times greater than previous technologies), but warning about the "rebound effect" (low cost leads to an increase in total light consumption, which exacerbates light pollution). Conclude with a guided discussion on the initial impacts (15 min).

KEY TOOLS
Digital presentation (PPT, Canva, flipchart with ICT) with historical and comparative images.

ACTIVITY 1.3: UNDERSTANDING LIGHT: SPECTRUM, UNITS, AND CCT (35 MIN)

GUIDE FOR THE FACILITATOR
Explain the key concepts (20 min): Light spectrum (highlighting the strong blue light peak in many LEDs, which intensifies sky glow and disrupts circadian rhythms and melatonin secretion). Units of light (Lumen, Lux, Candela). Correlated Color Temperature (CCT), measured in Kelvin, explaining that lower values (2700 K-3000 K) are "warm" light and higher values (5000 K-6500 K) are "cool" light and are associated with greater light pollution.

KEY TOOLS
Presentation with graphics (visualize spectra, units, and CCT scale). Optional demonstration with luminaires of different CCTs.

Session 2: Light pollution: forms, impacts, and solutions

PURPOSE:
Identify forms of light pollution, understand their impacts, and apply mitigation principles.

ACTIVITY 2.1: MANIFESTATIONS OF LIGHT POLLUTION (40 MIN)

GUIDE FOR THE FACILITATOR

Present light pollution (ALAN) as the excessive or inappropriate use of artificial light that alters natural darkness. Explain the three forms: Skyglow (increased brightness of the sky due to atmospheric scattering), Light Intrusion (unwanted light), and Glare (excessive brightness that reduces visibility, exacerbated by high-intensity LEDs). Case Identification: Divide into pairs to identify and classify these types of pollution in a series of images.

KEY TOOLS

Visual presentation with photographic examples of each type of pollution.

ACTIVITY 2.2: SUSTAINABLE LIGHTING AND EXAMPLES OF APPLICATION (25 MIN)

GUIDE FOR THE FACILITATOR

A. Principles of Sustainable Lighting: Present the five key principles: Utility (light only what is necessary), Direction (downward, "full cut"), Control (sensors, regulators), Intensity (minimize excess), and Color (prioritize warm CCT). B. Hands-on Learning with Case Studies (15 min): Divide participants into three groups (one case per group). They should briefly research their assigned example and discuss: "What benefits were achieved?", "What are the impacts of this approach?" and "What can we learn?". Each group will present a summary (2-3 min).

KEY TOOLS

Case Studies 1, 2, and 3.

ACTIVITY 2.3: THE IMPORTANCE OF EDUCATION AND PUBLIC AWARENESS (25 MIN)

GUIDE FOR THE FACILITATOR

Divide participants into groups (Human Health (H) and Environment/Biodiversity (E)). Provide impact cards (e.g., circadian system disruption, migration interference) and guide them to draw a simple cause-and-effect chain (Source ALAN → Mechanism → Impact) and create a summary sentence in plain language. Finish by jointly creating a 30-second awareness-raising action (e.g., social media post, poster) and reflecting on how long-term success depends on an informed society.

KEY TOOLS

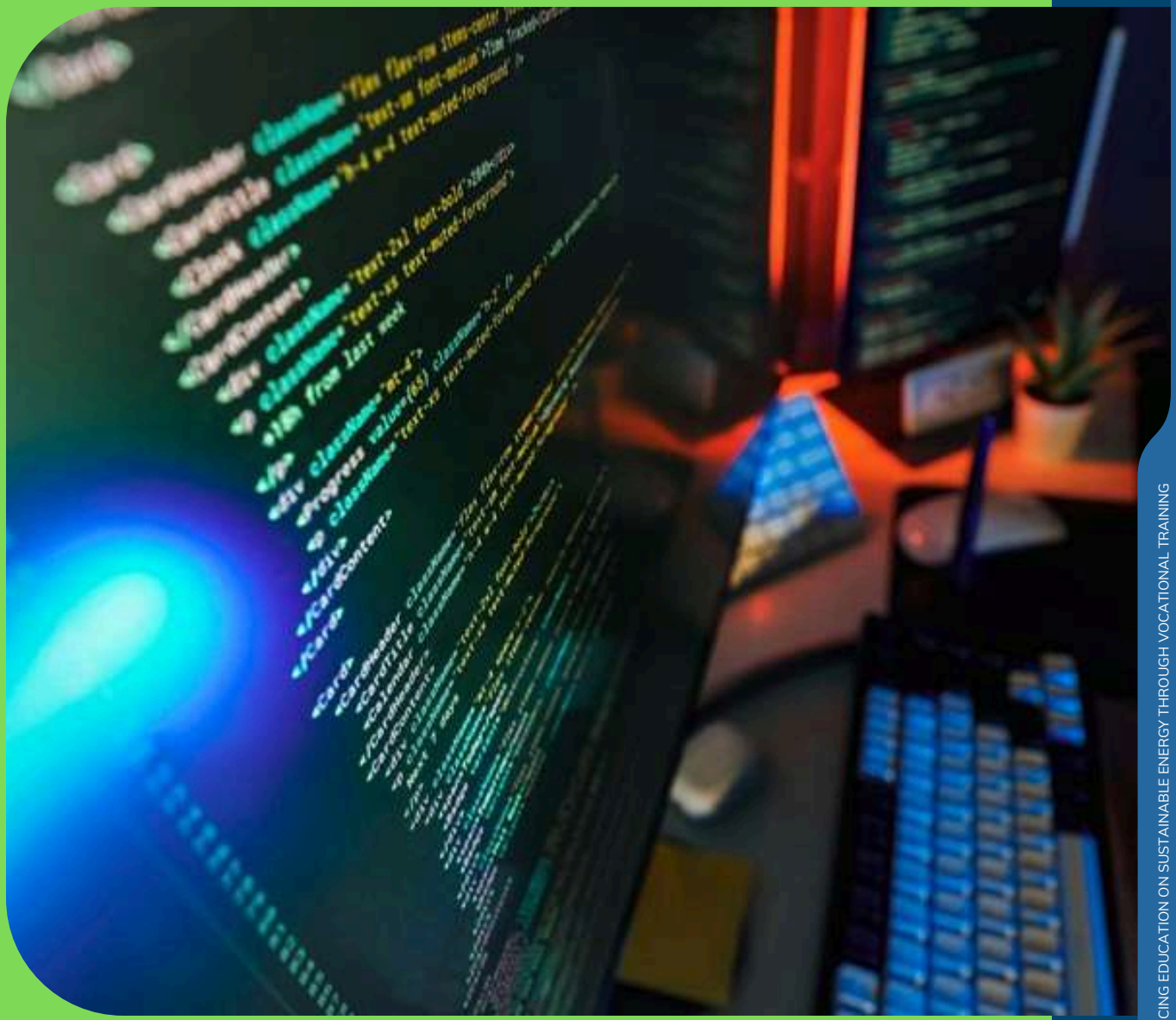
Flipcharts, sticky notes, and H and E cards with descriptions of impacts.

Specific Instructions for Case Studies (Activity 2.2)

The goal is for participants to understand that LED technology alone does not guarantee sustainability, but rather that mitigation is based on design decisions (CCT, direction, control).

Case Study	Strategic Emphasis for the Facilitator	Key Lessons
Case 1: Augsburg, Germany	Demonstrate the balance between heritage preservation and modernization. Emphasize the choice of very warm LEDs (2200–2400 K) to reduce blue emission. Explain the concept of motion-based dimming (adaptive systems) to reduce light when there is no traffic.	The combination of low CCT, full shielding, and motion-sensitive controls can reduce skyglow by approximately one-third and energy savings by up to 40%.
Case 2: Freiburg, Germany	Highlight the "Green City" strategy that integrates lighting directly with nature and insect protection. Show how lighting policies go beyond energy savings.	Efficient LEDs are used that direct light downward and ensure that the housing remains cool (below 40°C) to avoid attracting and killing nocturnal insects, achieving a 73% reduction in electricity consumption.
Case 3: Jelsa and Lastovo, Croatia	Show the leadership of small communities in protecting dark skies. Compare the strategies of coastal and protected communities. Emphasize the value of astro-tourism.	Implementation of fully shielded luminaires (ULOR 0% in Lastovo) with very low CCT (2200 K in Lastovo, ≤3000 K in Jelsa). This controls diffuse light (preventing spillage into the sea and sky), reduces skyglow, and achieves significant energy savings (more than 50% in Lastovo).

Appendix:
Training materials package



Module 2: Diagnosis and monitoring of light pollution

TOTAL DURATION OF THE MODULE:
6 hours and 30 minutes

The facilitator should guide the process, transforming theoretical foundations into applicable skills through the practical use of these tools. **Below are instructions for the facilitator on the use and development of the key materials in this module:**

SESSION 2 MATERIALS: DIGITAL AND PHYSICAL TOOLS FOR MEASUREMENT

This session focuses on the collection of diagnostic data, both through simple observation and through technological tools.

1. Qualitative Assessment of the Night Sky

OBJECTIVE:
To teach participants how to estimate the quality of the night sky without the need for specialized instruments, based on observation.

INTRODUCTION TO OBSERVATION

GUIDE FOR THE FACILITATOR
The facilitator explains that qualitative observation is a first step in diagnosis and can be used by citizen scientists. Distribute the Reference Sheet to participants.

KEY TOOLS
Reference Sheet.

REVIEW OF INDICATORS

GUIDE FOR THE FACILITATOR
Review the three key indicators: Star Visibility (how many stars are visible in known constellations), Presence of Artificial Light (whether there are domes, reflections on clouds, or glare), and Local Lighting Environment (type and direction of nearby light sources).

KEY TOOLS
Indicators 1, 2, and 3.

SIMULATED ASSESSMENT

GUIDE FOR THE FACILITATOR
Use the Observation Sheet together with a series of photographs showing different night skies (indoor simulation). Ask participants to work in pairs to use the overall rating scale (1–5) (where 1 is very dark and 5 is very polluted) to rate each image and justify the visible characteristics that influence their rating.

KEY TOOLS
Night Sky Observation Sheet and Overall Night Sky Rating Scale (1–5).

2. Light Pollution Map.docx (Satellite Analysis)

OBJECTIVE:
For participants to explore global and regional patterns of light pollution using remote sensing data.

ACCESS AND EXPLORATION

DEVELOPMENT FOR THE FACILITATOR

Assign groups the task of accessing LightPollutionMap.info. Guide them to select the nighttime radiance layer (e.g., VIIRS data) to analyze patterns.

Ask groups to choose a region of interest.

KEY TOOLS

Quick Guide: Using LightPollutionMap.info.

STRUCTURED ANALYSIS

DEVELOPMENT FOR THE FACILITATOR

The facilitator should use the Analysis Template – Satellite Data.

Groups should record Observed Patterns (bright areas, light corridors, islands of darkness) and their possible explanations (density, economic activity, etc.).

KEY TOOLS

Analysis Template – Satellite Data.

DISCUSSION ON LIMITATIONS

GUIDE FOR THE FACILITATOR

Conclude the activity by discussing the limitations of satellite data.

Mention that satellite resolution or the difficulty of detecting horizontally emitted light (typical of certain LED lights) may underestimate the actual impact.

KEY TOOLS

Discussion of limitations (such as resolution or type of light emission).

3. My Night Environment.docx

OBJECTIVE:
To encourage critical observation of one's personal nighttime environment and compare subjective perception with instrumental measurement.

ADVANCE PREPARATION

DEVELOPMENT FOR THE FACILITATOR
Ask participants in advance to bring at least three photographs of their nighttime environment (home, neighborhood, or workplace) that show the sky, streetlights, and problematic or pleasant lights.

KEY TOOLS
Preliminary instructions for participants.

DESCRIPTIVE ANALYSIS

DEVELOPMENT FOR THE FACILITATOR
Participants use the Observation Checklist to analyze their own photos.

They should classify the scene according to the type of environment, the main light sources, the apparent type of lighting fixtures (warm, neutral, or cool), the direction of the light, and the visible effects (glare, halos, over-illumination).

KEY TOOLS
Observation Checklist "My Night Environment."

COMPARISON (OPTIONAL)

GUIDE FOR THE FACILITATOR
If participants used light measurement apps (lux meters) on their smartphones, the facilitator should use the Comparison Form.

This form allows them to compare the value measured by the app with their Subjective Brightness Rating (1–5) and their Personal Comments on comfort, safety, and atmosphere.

KEY TOOLS
Comparison form (photo – app – perception).

SESSION 3 MATERIALS: CHARACTERIZATION AND MAPPING OF LIGHT POLLUTION

This session focuses on identifying the key elements of luminaire design and their relationship to impacts.

4. Light Detectives.docx

OBJECTIVE:
To encourage observation and critical analysis of different lighting scenarios, applying the principles of responsible lighting.

WARM-UP

GUIDE FOR THE FACILITATOR
Show images of different light fixtures or outdoor lighting scenes.

KEY TOOLS
Activity: "Light Detectives."

CRITICAL EVALUATION

GUIDE FOR THE FACILITATOR
Participants work in pairs or groups to complete the evaluation sheet – "Light Detectives." They must decide whether the lighting is Responsible or Problematic.

KEY TOOLS
“Light Detectives” Evaluation Sheet.

APPLICATION OF CRITERIA

GUIDE FOR THE FACILITATOR
The facilitator ensures that participants justify their answer using the observed Criteria and the Criteria Guide provided.

The criteria are based on Direction (full, semi, or no cut-off), Color (CCT: warm vs. cool), Intensity, and Effects (glare, intrusion, skyglow).

KEY TOOLS
Criteria Guide and Mini-technical sheet of key concepts.

5. Practice with Characterization Sheets.docx

OBJECTIVE:
Apply the principles of sustainable lighting through technical and impact analysis of simulated or real lighting scenarios.

CHARACTERIZATION PRACTICE

GUIDE FOR THE FACILITATOR

Participants, in groups, use the Luminaire Characterization Sheet to analyze specific scenarios (photos, videos). They must describe the luminaire based on Type, Light Direction (e.g., full cut-off), Color Temperature (CCT), and Control (shielding).

KEY TOOLS

Lighting Characterization Sheet.

IMPACT ANALYSIS

GUIDE FOR THE FACILITATOR

Groups must evaluate how luminaire characteristics influence impacts (skyglow, light trespass, glare) and determine perceived efficiency. They must conclude whether it is an acceptable example of responsible lighting or problematic light pollution.

KEY TOOLS

Questions about impact (skyglow, light trespass, glare).

CONNECTION TO PRINCIPLES

GUIDE FOR THE FACILITATOR

The facilitator emphasizes that the characterization must verify compliance with the principles of responsible lighting (Utility, Direction, Control, Intensity, Color).

KEY TOOLS

Compliance with principles (row of the characterization sheet).

PRESENTATION EVALUATION

GUIDE FOR THE FACILITATOR

If the groups present their characterizations, the facilitator can use the Simple Rubric to evaluate the clarity of the technical description, the correct use of concepts, the critical analysis of the impact, and the proposals for improvement.

KEY TOOLS

Simple rubric for evaluating characterization presentations.

Appendix:

Training materials package

Module 3: Assessment of the environmental and health impact of light pollution

TOTAL DURATION OF THE MODULE:
6 hours

This module is designed to train participants to assess environmental sensitivity to artificial light (ALAN) and analyze the effects of light pollution on ecosystems and human health. The facilitator should use a practical approach to classify environments, apply impact assessment tools, and reflect on personal habits of light exposure.

Below is a guide for the facilitator, organized by sessions:

Session 1: Classification of environmental sensitivity (85 minutes)

OBJECTIVE:

To understand that the impact of artificial night light is not uniform and to classify different environments according to their ecological and functional vulnerability.

CLASSIFICATION OF ENVIRONMENTAL SENSITIVITY (35 MIN)

GUIDE FOR THE FACILITATOR

Divide participants into groups of up to 5 people. Hand out a set of cards representing environmental elements (e.g., nocturnal wildlife habitat, astronomical observatory, residential area, agricultural land). Ask the groups to rank the cards from most sensitive to least sensitive to light pollution and justify their ranking. Conclude by comparing the rankings and highlighting factors such as ecological integrity and the presence of nocturnal species.

KEY TOOLS

Set of cards (environmental elements) and flipcharts

IMPACT NETWORK: HOW FAR DO THE IMPACTS REACH? (60 MIN)

GUIDE FOR THE FACILITATOR

Keep the groups together and assign each one an impact category (e.g., human health, nocturnal animals, energy waste, astronomical research). Ask each participant to write one consequence of light pollution in their assigned category on a sticky note. Guide the construction of a network of consequences on a whiteboard, with the goal of extending each line of impact as far as possible. Conclude by discussing what they learned and where and how they could apply this knowledge.

KEY TOOLS

Sticky notes (Post-its) and whiteboard/flipchart

Session 2: Light Pollution Walk (80 minutes)

OBJECTIVE:

Apply the Leopold Matrix as a systematic framework for diagnosing and prioritizing the impacts of observed light pollution.

WALK AND LEOPOLD MATRIX (80 MIN)

GUIDE FOR THE FACILITATOR

Step 1. Preparation: Divide participants and provide the Leopold Matrix Form.

Step 2. Walk: Conduct a virtual walk (5 min) using a 360° video or Google Maps Streetview, asking participants to identify sources of pollution (streetlights, billboards).

Step 3. Identification and Marking: Participants mark the sources observed and their potential environmental and social impacts on the Matrix, repeating the video if necessary (30 min).

Step 4. Discussion: Lead a discussion on the results and initial impressions of using the Matrix as a diagnostic tool (30 min).

Step 5. Summary: Ask how they could reduce the impact of the identified sources (15 min).

KEY TOOLS

Leopold Matrix Form and 360° Video/Google Maps

Session 3: My life on screen: healthy strategies (90 minutes)

OBJECTIVE:

Analyze the influence of screen time on sleep, vision, and mental well-being, and propose healthy strategies.

MY LIFE IN FRONT OF THE SCREEN (40 MIN)

GUIDE FOR THE FACILITATOR

Start with a question about estimated daily screen time. Ask participants to write down on sticky notes each activity they do with screens on a typical day. Build the "Screen Wall" by sticking the notes on it to visualize total usage.

KEY TOOLS

Sticky notes (Post-its) and Whiteboard

GUIDED EXPLORATION BY AREA (50 MIN)

GUIDE FOR THE FACILITATOR

Step 1. Impact: Divide the board with pictograms (eyes, sleep, emotions) and guide the discussion on how screen use affects each area (e.g., blue light and melatonin suppression, digital eye strain, nomophobia).

Step 2. Case Study: Use case cards in groups of up to 4 people to discuss what health effects the characters might be experiencing. You can use a rotating discussion where one moderator remains fixed.

Step 3. Summary: Conclude by generating ideas for healthy strategies (e.g., avoiding screens 1 hour before bedtime, using "night mode") and ask participants to share a personal action plan.

KEY TOOLS

Drawings/Pictograms (eyes, neck/back, brain, emotions) and Case Cards

Session 4: Circadian Cycles (95 minutes)

OBJECTIVE:
To understand the central role of light as a synchronizer of the biological clock and learn how to maintain a robust circadian rhythm.

CIRCADIAN CYCLE MAPPING (60 MIN)

GUIDE FOR THE FACILITATOR

Step 1. Timing: Begin with a breathing exercise and ask participants to count two minutes mentally to introduce awareness of time.

Step 2. Concept: Introduce the term "circadian cycle" (approximately 24 hours) and the metaphor of the "internal clock," emphasizing that light is the main synchronizer.

Step 3. Drawing and Mapping: Draw the 24-segment "circadian clock" on the whiteboard. Participants place their daily activities and sensations (sleep, meals, energy) on the corresponding hours of the clock. Highlight key points (e.g., melatonin and cortisol secretion).

KEY TOOLS

Timer, Whiteboard, and Post-it Notes/Cards

CONSEQUENCES AND TIPS (35 MIN)

GUIDE FOR THE FACILITATOR

Lead a discussion on factors that confuse the internal clock (e.g., screen use/blue light, irregular schedules, late dinners). End with a brainstorming session to gather practical tips for ensuring good sleep (e.g., maximize exposure to natural light in the morning and avoid screens/bright or white lights at night).

KEY TOOLS

Whiteboard

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Training materials package

Module 4: Technical Solutions and Designing Sustainable Nighttime Spaces

TOTAL DURATION OF THE MODULE:
6 hours

The fundamental objective is for participants to understand and apply the principles of sustainable urban lighting, balancing social use, ecological protection, and urban identity. The facilitator should use guided, work-based learning to transform the analysis of nighttime environments into viable design proposals.

Below is a guide for the facilitator on how to approach key activities and use the specific materials for Module 4:

Session 1: Urban lighting: from origins to planning (3 hours)

OBJECTIVE:

To understand urban lighting and conduct an initial diagnosis for the Urban Lighting Plan (ULP).

NIGHTTIME CARTOGRAPHY (1 HOUR)

GUIDE FOR THE FACILITATOR

Step 1: Preparation. The facilitator should select a neighborhood familiar to most participants and provide printed maps and nighttime photos.

Step 2: Mapping Tasks. Divide participants into groups and assign them the task of marking key points on the maps: green spaces, landmark buildings, light and dark areas, public transportation access points, and identifying areas perceived as safe or unsafe.

Step 3: Conclusion. Lead a discussion on the information collected on the maps (Slide 5), analyzing how people use and interact with light and dark spaces.

KEY TOOLS

Printed maps of the neighborhood, nighttime photos, colored markers, paper

URBAN LIGHTING PLAN (ULP)

GUIDE FOR THE FACILITATOR

The facilitator should introduce the concept of light urbanism, explaining that light shapes a city's nighttime identity. Present the four key steps of an ULP:

1. Diagnosis and analysis
2. Vision and objectives
3. Lighting master plan
4. Implementation and management. Emphasize that the ULP is crucial for preventing light pollution, saving energy, and promoting nightlife.

KEY TOOLS

Key concepts (light urbanism), case studies (e.g., Lyon)

Session 2: Types and strategies of urban lighting (3 hours)

OBJECTIVE:

To differentiate between types of lighting and apply sustainable design intervention strategies (Acupuncture and Light Art).

TYPES OF URBAN LIGHTING

GUIDE FOR THE FACILITATOR

The facilitator reviews the four types: 1. Functional (road safety, governed by regulations); 2. Architectural/Monumental (enhances heritage, requires artistic balance); 3. Ecological Structure (parks and green areas); and 4. Light Art (urban revitalization). In the Ecological Structure type, it is essential to emphasize that low light levels, full cut-off luminaires (0% upper hemispheric emission), and warm color temperatures (not exceeding 3000 K) should be used to protect wildlife.

KEY TOOLS

Slides of the four types

URBAN ACUPUNCTURE WITH LIGHTING (1 HOUR)

GUIDE FOR THE FACILITATOR

This activity is recommended for groups with advanced design skills. The facilitator presents acupuncture as a small-scale strategic intervention to address urban problems. The groups' task is to draw on the maps of the neighborhood analyzed, choosing an emblematic place (square, park) and defining a lighting concept. They must mark the direction, contrasts, colors, and intensities, and delimit the areas that should remain dark. Conclude with a collective exhibition of the drawings for discussion and feedback.

KEY TOOLS

Images and Maps from Session 1, Colored Markers

ART WITH LIGHT (1 HOUR)

GUIDE FOR THE FACILITATOR

Step 1: Conceptualization. Explain that the goal is to create a collaborative work of art based on light that symbolizes a poetic solution to a public space problem (e.g., nighttime safety, isolation). Step 2: Group Formation and Roles. Divide participants and assign specific roles (e.g., problem cartographer, lighting director) to practice teamwork. Step 3: Prototyping and Testing. Groups build a small-scale model or vignette and test different lighting configurations (moving lights closer/further away, adding color filters) to observe how the message and contrast change. Step 4: Mini-Gallery. Each group presents the problem, the poetic solution, and demonstrates how light transforms the work.

KEY TOOLS

Small-scale prototyping materials (cellophane, LED strips, cardboard), role cards

Appendix:
Training materials package

Module 5: Community Action and Multilevel Governance

TOTAL DURATION OF THE MODULE:
6 hours and 30 minutes

Empowers participants to become agents of change in light pollution mitigation by providing tools for leadership, strategic communication, and proposal structuring.

The facilitator should implement a guided, work-based learning (WBL) approach so that participants develop practical skills and apply the knowledge they have acquired through simulations and writing exercises.

Below is a detailed guide for the facilitator on how to use the materials and develop the key sessions of Module 5, which has a total duration of 6 hours and 30 minutes:

Session 1: Brief overview (1 hour)

OBJECTIVE:

To consolidate the basic concepts of light pollution (ALAN) learned in previous modules to establish the context for collective action.

ICEBREAKER AND CONCEPT SUMMARY

GUIDE FOR THE FACILITATOR

Step 1: Start with an icebreaker: ask participants to introduce themselves and describe light pollution in one word.

Step 2: Present the definition of light pollution and review the four main types (sky glow, glare, light intrusion, and blue light spectrum).

Step 3: Conclude with a question and answer session to ensure that the basic concepts are clear, asking for local examples of light pollution.

KEY TOOLS

Printed or digital images of the 4 types of light pollution

Session 2: Communication campaigns (1 hour and 30 minutes)

OBJECTIVE:

Design an assertive communication campaign, translating complex technical concepts into simple language to mobilize action.

PRINCIPLES OF COMMUNICATION

GUIDE FOR THE FACILITATOR

The facilitator explains the meaning of "plain language" as the art of translating technical concepts in a clear and accessible way for the public. Present the five key points for structuring a campaign (purpose, message, target group, channel, and call to action).

KEY TOOLS

Concept of "plain language"

EXAMPLES OF CAMPAIGNS

GUIDE FOR THE FACILITATOR

Present real-world case studies. Highlight how "The Lighting Police" uses simple sketches and a collaborative platform to explain technical concepts, and how ARUP combines technical information with simple graphics for diverse audiences.

KEY TOOLS

"The Lighting Police" (use of simple sketches), ARUP Report ("Cities Alive").

COMMUNICATION CAMPAIGN FORMAT

GUIDE FOR THE FACILITATOR

Groups design their own campaign. They must complete the five key points in the left section of the format and draw/write their visual proposal in the right section. The facilitator guides the presentation of proposals and feedback.

KEY TOOLS

Printable format (suggested print size: 70 cm x 50 cm),

Session 3: Governance and functions (1 hour and 30 minutes)

OBJECTIVE:

Analyze nighttime management structures and simulate intersectoral coordination to mitigate ALAN.

NIGHTTIME GOVERNANCE

GUIDE FOR THE FACILITATOR

The facilitator explains the concept of nighttime governance and the need for collective action. Present the five main functions (e.g., nighttime mayors, astronomical agencies, community leaders). Analyze examples such as the Northern Chile Sky Quality Protection Office (OPCC) or the Noche Zero project.

KEY TOOLS

Nightlife advocacy map (nighttime.org), Five key functions

ROLE-PLAYING EXERCISE

GUIDE FOR THE FACILITATOR

Participants randomly select a role card (e.g., night mayor, lighting designer). Using the Role-Playing Format, the group must define a common goal for ALAN mitigation, determine how each role will contribute, and record the main agreements.

KEY TOOLS

Printable role cards (letter size), Role-playing format (70 cm x 50 cm),

Session 4: How to structure a proposal? (1 hour and 30 minutes)

OBJECTIVE:

To translate mitigation objectives into structured intervention proposals, whether for regulations, competitions, or projects.

KEY POINTS OF THE PROPOSAL

GUIDE FOR THE FACILITATOR

Present and review the six key points that every effective proposal should include: Problem statement, Goals and objectives, Proposed activities, Expected results and impacts, Budget and resources, and Monitoring and evaluation.

KEY TOOLS

Six key points for structuring

EXAMPLES OF TOOLS

GUIDE FOR THE FACILITATOR

Analyze examples that illustrate different mitigation instruments. Highlight how the "Collective Light for Rural Africa" project focused on community governance and design to avoid light pollution.

KEY TOOLS

Chilean Regulation, VI Lighting Standard Competition, "Collective Light for Rural Africa" Project

"STRUCTURING A PROPOSAL" FORMAT

GUIDE FOR THE FACILITATOR

Groups use the format to structure a proposal (project, regulation, or competition), completing the six key points. In the right-hand section, they detail the specific tool chosen, ensuring feasibility and connection to sustainability principles.

KEY TOOLS

Printable format (70 cm x 50 cm) and complementary tool sheets (letter size)

Session 5: Creating an assertive presentation (1 hour)

OBJECTIVE:

Develop leadership and advocacy skills by structuring an emotionally resonant speech using Public Narrative.

PUBLIC NARRATIVE

GUIDE FOR THE FACILITATOR

The facilitator introduces the practice of Public Narrative as a leadership exercise to motivate others to action. Explain the three interconnected components: Personal Story (Why do I feel called to lead?), Our Story (What is our common purpose?), and Now Story (Why must we act now?).

KEY TOOLS

Marshall Ganz Framework

PUBLIC NARRATIVE FORMAT

GUIDE FOR THE FACILITATOR

Participants work individually to structure their speech. They should ensure that the speech connects the three stories into a cohesive and emotionally resonant call to action. Conclude with 2-3 minute speech presentations and a final reflection on the experience.

KEY TOOLS

Printable format (letter size),

Co-funded by
the European Union