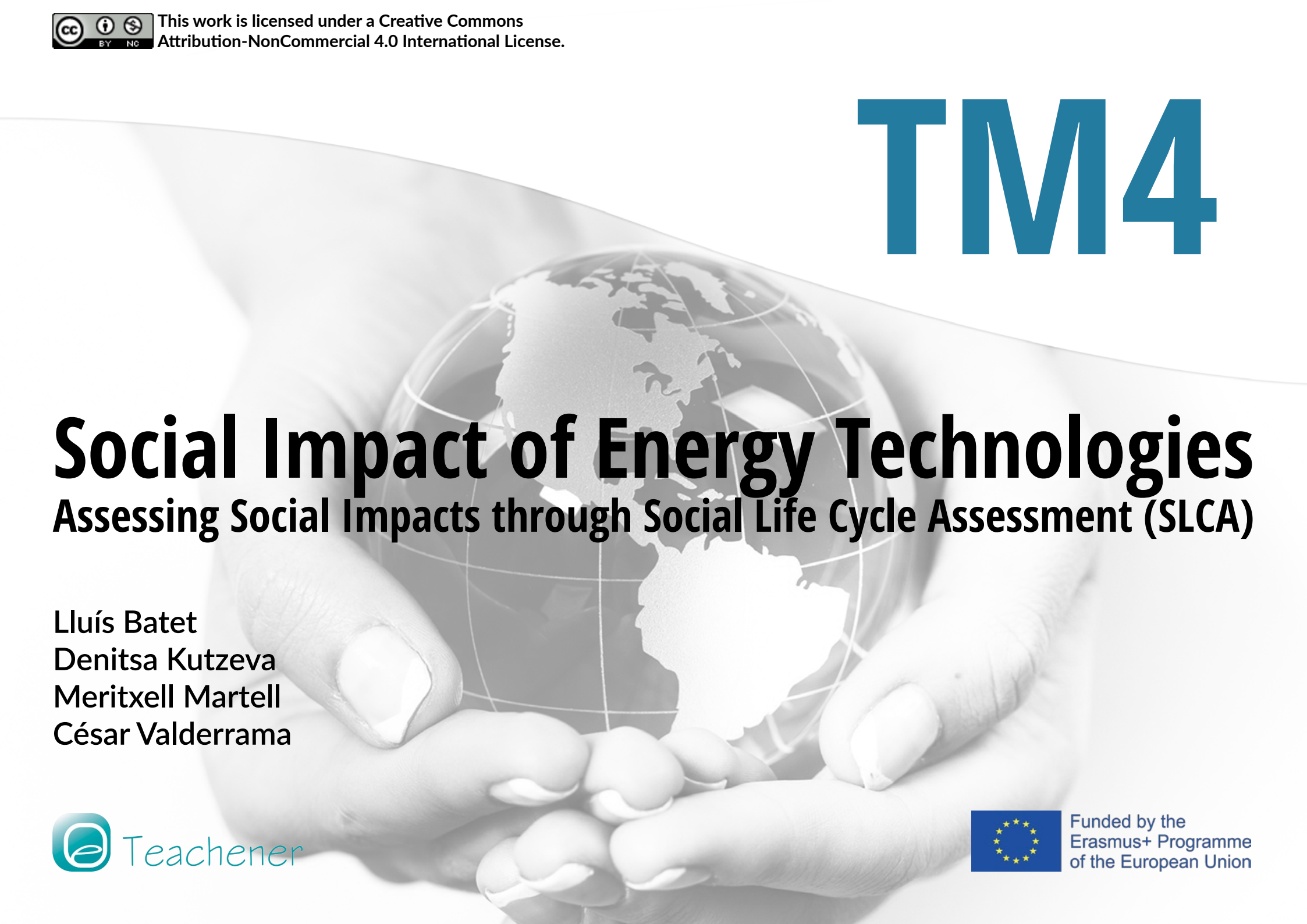
TM4

Social Impact of Energy Technologies

Assessing Social Impacts through Social Life Cycle Assessment (SLCA)

Lluís Batet
Denitsa Kutzeva
Meritxell Martell
César Valderrama



Teachener

Funded by the
Erasmus+ Programme
of the European Union

Introduction

The main goal of this module is to introduce the Social Life Cycle Assessment (SLCA) methodology to the students and make them aware of the importance of the social criteria by assessment of the local and global social impact related to energy projects.

» *The increasing demand for energy has been one of the most significant factors in the acceleration of global warming. It has required developing strategies on the local and global levels to enhance energy security and sustainability through innovative energy policies and measures.*

The need for building further effective ways to navigate the future with practical and sustainable solutions has initiated the developments of sustainability measurement tools, such as Life Cycle Assessment (LCA). The role of LCA is to assess the environmental impact of processes/systems/products associated with all stages of their life-cycle perspective. Life Cycle Assessment (LCA) was developed over the last years as a tool enabling the identification and assessment of the environmental impacts associated with a product, process, or activity by quantifying raw materials, energy and waste it releases into the air, water and soil. For instance, in the case of Industrial Minerals, LCA covers the extraction, processing, manufacturing, distribution, use and disposal steps, including transportation, along the entire supply chain (i.e. upstream and downstream).

As a step further, social criteria may also be included in the sustainability assessment analysis, through a tool inspired on the LCA: the Social Life-Cycle Assessment (SLCA).

» ***SLCA** is a tool that analyses the impact on society of products or services throughout their life-cycle, assessing the actual and potential positive and negative impacts.*

Research on standardization of a methodology for conducting SLCA is limited compared to LCA but it is still ongoing.

This module aims to introduce the SLCA methodology as a tool to measure the main social impacts of energy projects through a life cycle perspective. Through it, students will be able to grab the importance of SLCA and contextualize this methodology; students will learn the steps needed to design and conduct an SLCA and will glimpse the difficulties in defining suitable sustainability indicators in what regards social aspects and in obtaining values for those indicators.

Social indicators are currently being considered for energy projects, along with the technical, economic and environmental aspects. However, the overall social impact on a local and global scale is hardly addressed by most currently used methods for social evaluation in the energy field. That is why this TM focuses on SLCA.

The teaching module is composed of 2 successive sessions:

1

Session 1: Introduction to SLCA
consists mainly of an introductory lecture to present the context framing SLCA. A specific discussion is planned on indicators, their role in the sustainability science, their desirable characteristics and how to choose them. Finally, the first session will introduce the case study that will be the basis of the work to be developed by students grouped in teams during the second session.

90 minutes

2

Session 2: SLCA practical application
is devoted to developing an SLCA based on the case study introduced at the end of the first session. Students are grouped in teams of ideally four or five people. Teams of students are randomly formed (alternatively, the teacher decides who will be the members of each group) at the end of the first session. Each member is involved in developing a presentation between the two sessions based on the information provided on the case study. One of the teams is randomly chosen (or decided by the teacher) to present the case study at the beginning of the second session. Once the case study is presented in class, teams start working on the analysis step by step with the guidance of the teacher. The aim of the learning method is to ensure the interaction among students in order to develop a comprehensive assessment.

135 minutes

Session 1:
Introduction to Social Life Cycle Assessment (SLCA)

a) Session objectives

This session intends to provide the students with a basic understanding of Social Life Cycle Assessment (SLCA), framing it within the Sustainability Assessment tools and, more precisely, within the Social Assessment tools. The session will raise students' awareness of tools needed and of the complexity of this kind of assessments, with a focus on the difficulties of developing a suitable set of indicators. Students are introduced to Life Cycle Assessment methods as a necessary step to comprehend the SLCA methodology.

b) Session scope

Sustainability Assessment

From a broad perspective, Bond et al. (2012) define Sustainability Assessment as "any process that directs decision-making towards sustainability". Waas et al. (2014) define it as "any process that aims to:

- Contribute to a better understanding of the sustainability and its contextual interpretation (interpretation challenge);
- Integrate sustainability issues into decision-making by identifying and assessing sustainability impacts (information-structuring challenge);
- Foster sustainable development policies (influence challenge)."

The three challenges refer to the relationship between sustainability and decision making: sustainability is to be interpreted in a given context, sustainability's complexity requires of an adequate organization and communication of the information (e.g. by means of indicators), and that information should influence decision making (Waas et al. 2014).

Ness et al. (2007) proposed a framework for the sustainability assessment tools based on the temporal characteristics of the tool along with the object of its focus and its capacity of integrating nature-society systems. As for the temporal dimension, tools can be either retrospective (indicators and indices), prospective (integrated assessment tools) or both (product-related assessment tools). The object of focus can be a proposed change in policy in a given area (indicators/indices and integrated assessment), or at the product level (product-related assessment). Finally, some of the tools are able to integrate nature-society systems in a single evaluation (e.g. Human Development Index).

The indicators/indices provide information, from a retrospective point of view, about long-term sustainability trends; information that may allow short-term projections and decision making for the future.

» *INTEGRATED ASSESSMENT TOOLS ARE USED FOR SUPPORTING DECISIONS RELATED TO A POLICY OR A PROJECT IN A SPECIFIC REGION; THEY HAVE AN EX-ANTE FOCUS AND NORMALLY ARE PERFORMED THROUGH SCENARIOS.*

Many of these integrated assessment tools integrate nature and society aspects. They are divided into three sub-categories (Dizdaroglu 2007): M**ulti-Criteria Analysis**, to compare policy options; **Cost Benefit Analysis**; and **Impact Assessment** tools.

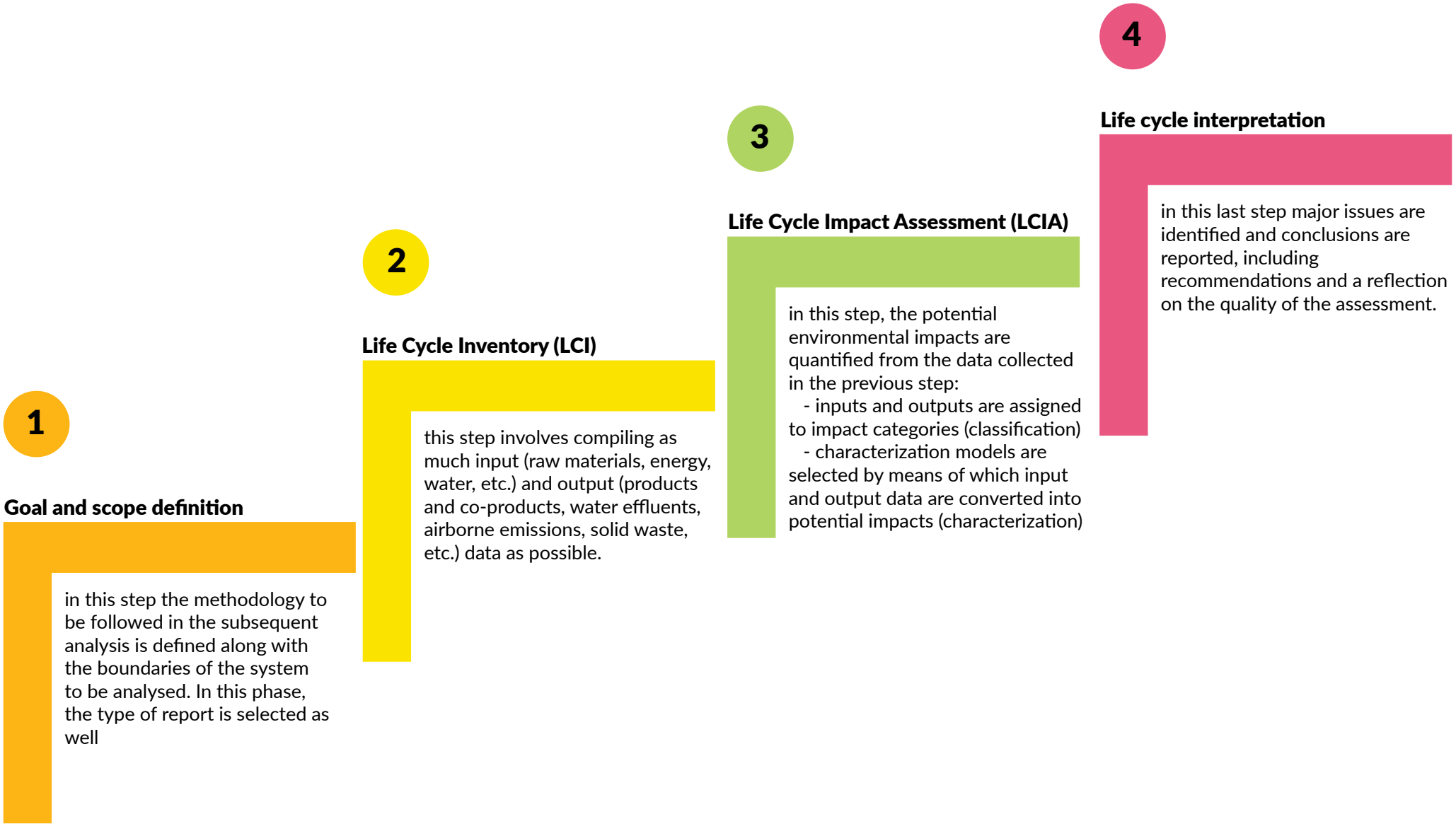
Finally, product-related assessment tools focus on the resource use and environmental impacts of a product or service from a life cycle perspective, allowing both retrospective and prospective assessments.

Introduction to Life Cycle Assessment

Life Cycle Assessment (LCA) is the most developed of the product-related assessment tools. It aims to quantify the environmental impact of a product, a process or a service, from "Cradle to Grave". For each of the stages considered, LCA accounts for all consumed resources and all emissions in the environment. A typical LCA takes into account several thousands of substances emitted into air, water and soil. Then, this substance inventory is translated into different environmental impacts (carbon footprint, water footprint, energy consumption, acidification, resource depletion, etc.). ISO standards 14040 and 14044 provide a standardized methodology for conducting multi-media, life-cycle environmental assessments (EPLCA web site):

- ISO 14040 "Life Cycle Assessment – Principles and Framework" 1997
- ISO 14044 "Life Cycle Assessment – Requirements and Guidelines" 2006

There are 4 main steps to be considered while conducting an LCA:
Goal and scope definition: in this step the methodology to be follow



Social Assessment Methods. Social Life Cycle Assessment (SLCA)

Sustainable Development can be thought of as having three dimensions: environmental, economic and social. Social aspects can be assessed through a variety of tools, either as part of the sustainability assessment or as specific assessments. One of these tools is Social Life Cycle Assessment (SLCA).

» *THE INCLUSION OF SOCIAL THEMES IN THE LIFE CYCLE ANALYSIS ALLOWS TO EXPRESS A PREFERENCE FOR PRODUCTS THAT ARE MORE SOCIAL-FRIENDLY AND TO IDENTIFY POTENTIAL IMPROVEMENTS IN THE PROCESSES AND SUPPLY CHAIN.*

The life cycle perspective provides SLCA (among other social impact assessment methodologies) with an overarching vision of the social impacts.

In any case, the assessment allows to compare different alternatives in order to identify the best one of them and, this way, support policymaking.
Moreover, there is a growing public sensitivity of social aspects and, so, an interest in identifying social hotspots.

> *"Social hotspots are unit processes located in a region where a situation occurs that may be considered a problem, a risk or an opportunity, in relation to a social theme of interest. The social theme of interest represents issues that are considered to be threatening social well-being or that may contribute to its further development.*
> *Social themes of interest include but are not restricted to: human rights, work conditions, cultural heritage, poverty, disease, political conflict, indigenous rights, etc." (UNEP/SETAC 2009)*

SLCA methodology is still being developed: guidelines need further development and more case studies are required. Other limitations of the SLCA methodology are:

- It is quite subjective and allows much freedom of choice to the researcher.
- Some important social themes can only be measured qualitatively.
- In any case, indicators for social themes need to be defined.

Social Life Cycle Assessment Methodology

Social Life Cycle Assessment (SLCA) aims to assess the social and socio-economic aspects of products and services and their potential

positive and negative impacts along their life cycle (supply chain, including the use phase and disposal). SLCA methodology is based on the LCA methodology introduced above and follows as well the ISO 14044 framework. The four major phases of the methodology (goal and scope, inventory analysis, impact assessment, and interpretation) will be briefly introduced next. For a Historical development of SLCA, from the end of the 20th Century, see the introduction to the chapter written by E. Rosenbaum in Sala et al. (2015).

The Guidelines for Social Life Cycle of Products (UNEP/SETAC 2009) provide tools for social impacts assessment in relation to an area of protection, such as human well-being. They suggest five stakeholder categories: workers, local community, society, consumers and value chain actors. Every stakeholder category is associated with a number of impact subcategories, such as child labour, fair salary, health and safety, local employment, cultural heritage and corruption, human rights, working conditions, governance and socioeconomic repercussions. The Methodological Sheets for Subcategories in Social Life Cycle Assessment (UNEP/SETAC 2013) provide a framework for every different stakeholder including subcategories' definition, policy relevance, directions on how to assess data and examples of indicators.

Goal and Scope. As a starting point of a Social Life Cycle Assessment, the purpose of it must be set: "Why is an S-LCA being conducted? What is the intended use? Who will use the results? What do we want to assess?" (UNEP/SETAC 2009).

The scope comes next: what are the depth and breadth of the study? The scope defines the boundaries of the study and the amount and quality of data to be collected and processed.

To define the scope, an ideal system should first be defined (i.e., an accurate definition of the complex network of the existing interrelations between the different parts of the system), and then a model of the actual system should be built (purposely simplified, to make it suitable for assessment). Finally, it should be decided which processes should be characterized by specific (local) data and which ones by generic data. The definition of the scope may have a large impact on the results of the analysis.

Life Cycle Inventory analysis consists mainly of collecting data for: 1) prioritization, 2) hotspots assessment (see above for a definition of the hotspot), 3) site specific evaluation and 4) impact assessment (characterization). Data needs to be validated. After gathering the information, some refinement or redefinition of the system boundaries is needed.

Life Cycle Impact Assessment consists mainly of classifying, aggregating and characterizing the data according to performance reference points (i.e., indicators are constructed) for the different impact categories selected. One of the issues that are more complex in the development of a Social Life Cycle Assessment (SLCA) framework is the choice of social indicators.

Impact Categories "represent social issues of interest that will be expressed regarding the stakeholders affected and may cover health and safety, human rights, working conditions, socio-economic repercussions, cultural heritage and governance." (UNEP/SETAC 2009) Subcategories are significant social themes which can be classified according to the impact categories but are more practically grouped according to the stakeholder categories. Subcategories are assessed by means of indicators (see Figure 1 and Table 1)

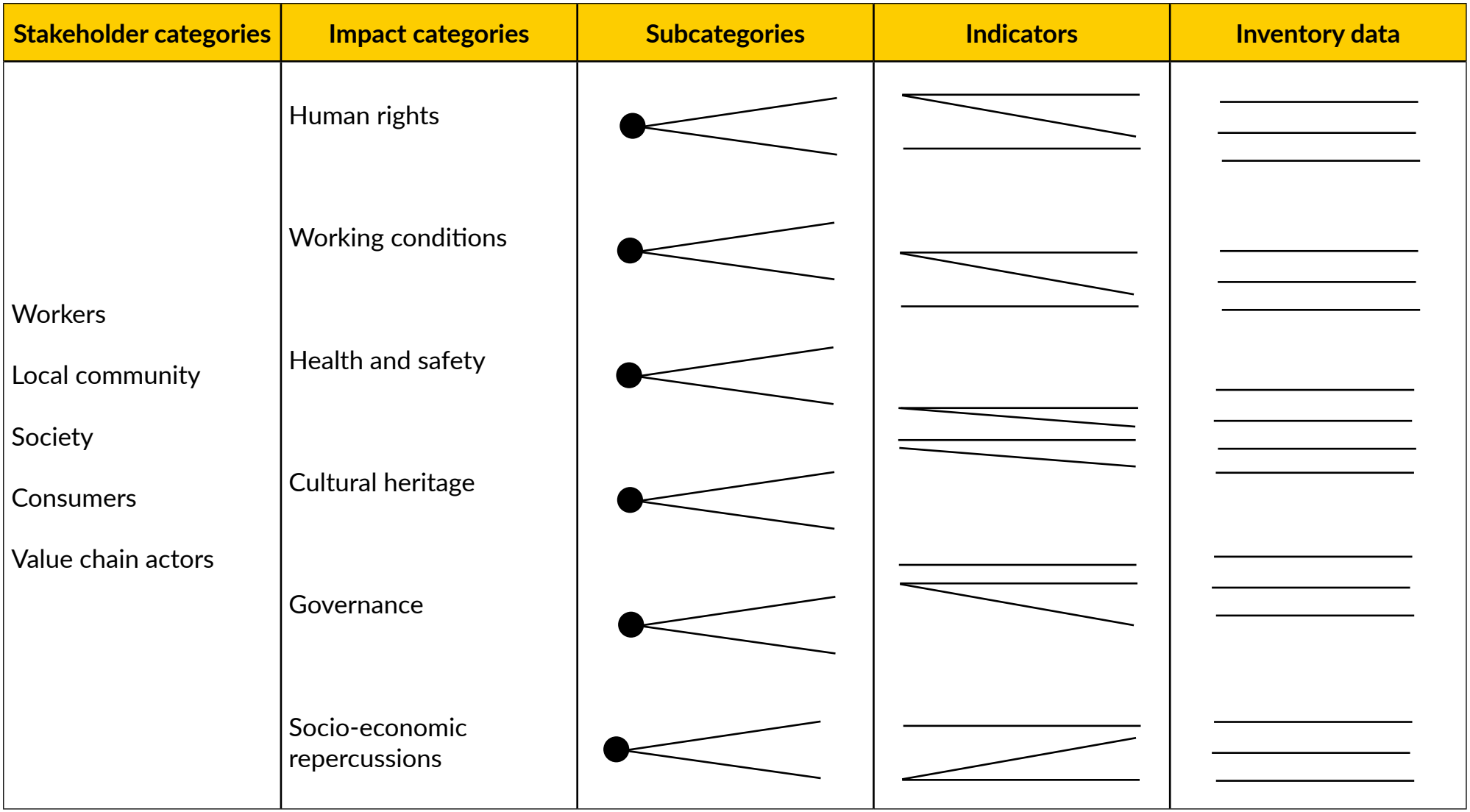


Figure 1. SLCA assessment system adapted from UNEP/SETAC (2009)

Stakeholder categories	Subcategories
Workers	• Freedom of Association and Collective Bargaining • Child Labour • Fair Salary • Working Hours • Forced Labour • Equal opportunities/Discrimination • Health and Safety • Social Benefits/Social Security
Consumers	• Health & Safety • Feedback Mechanism • Consumer Privacy • Transparency • End of life responsibility
Local community	• Access to material resources • Access to immaterial resources • Delocalization and Migration • Cultural Heritage • Safe & healthy living conditions • Respect for indigenous rights • Community engagement • Local employment • Secure living conditions

Society	• Public commitments to sustainability issues • Contribution to economic development • Prevention & mitigation of armed conflicts • Technology development • Corruption
Value chain actors	• Fair competition • Promoting social responsibility • Supplier relationships • Respect for intellectual property rights

Table 1. Stakeholder categories and subcategories (UNEP/SETAC 2009)

Life Cycle interpretation has the following objectives: assess the results in order to obtain conclusions, explains the limitations of the analysis, provides recommendations and report adequately. One relevant aspect to consider in the report is the involvement of the stakeholders (UNEP/SETAC 2009).

EXAMPLE OF APPLICATION OF SLCA

SLCA of palm oil biodiesel: a case study in Jambi Province of Indonesia (Manik et al. 2013).

The goal of the study is to assess the social implications of an existing palm oil production system. The following specific questions are answered:

- *What are appropriate social criteria that should be used to assess the sustainability of biofuels, particularly palm oil biodiesel life cycle?*
- *How do stakeholders appraise the achievement of those criteria based on their own experience in the selected case?*
- *What are the social sustainability hotspots within palm oil biodiesel that need further research and policy?*

The scope of the study covers all stages of palm oil biodiesel supply chain that exist in the area, which includes the land clearing, palm plantation, palm oil milling, and transportation of crude palm oil from the mill to a seaport. Hence, the biodiesel conversion process in

the importing countries is excluded from this study. The case study follows the UNEP/SETAC methodology.

A panel of experts provided weighting factors for the criteria within the categories. After that, a series of questions were asked to the 120 participants in a survey, two questions per criterion: one to sense their expectation, and the other to sense their perception. Questions were gauged using a 1-7 scale. The gaps between expected and perceived quality of each criterion were used as a proxy to assess the stakeholders' perspectives.

Results obtained are summarised in the figure: "Exploitative labour relations, alienation, and other negative impacts on the well-being of local/tribal communities are the most noticeable social hotspots that prevent the sustainability of palm oil biodiesel." "If palm oil biodiesel is to be produced sustainably, these significant social impacts must be addressed." (Manik et al. 2013).

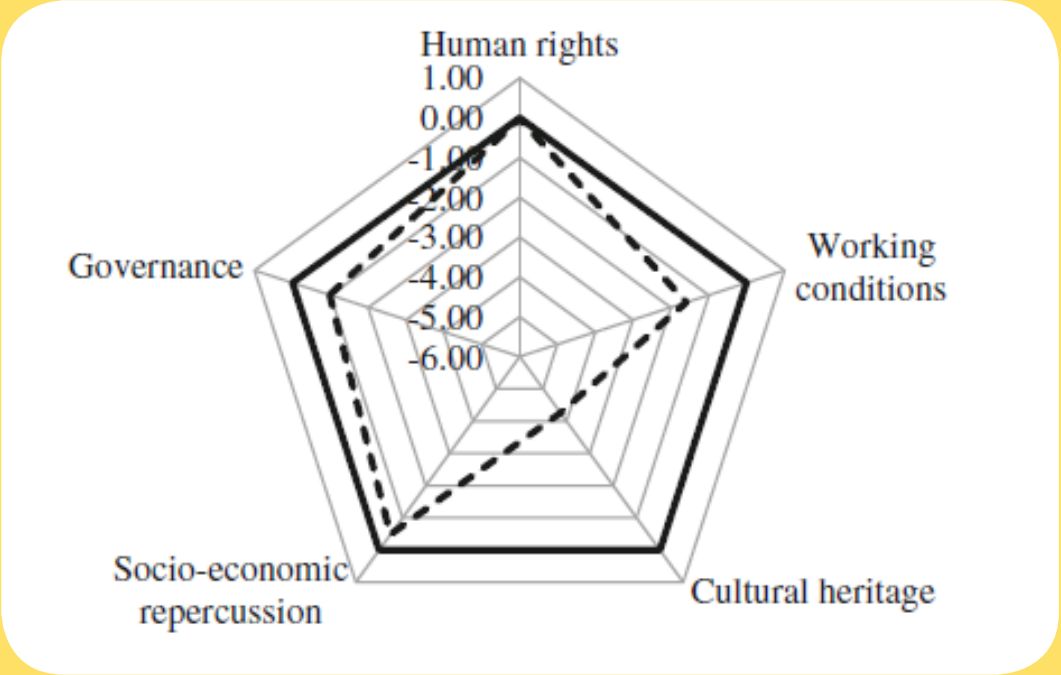


Figure from Manik et al. (2013).

c) Pre-reading

No.	Author and title	Description
1.	UNEP-SETAC. 2009. Guidelines for social life cycle assessment of products. UNEP/SETAC Life Cycle Initiative. United Nations Environment Programme. http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines_sLCA.pdf	It is the basic document introducing the methodology. This document can be found as TM4-S2-RM2
2.	Bhandari, Ramchandra, Lena Ganda Saptalena, Wolfgang Kusch. Sustainability assessment of a micro hydropower plant in Nepal. "Energy, Sustainability and Society" 2018, Vol. 8, Issue 3. DOI: 10.1186/s13705-018-0147-2	The case study is used in the indicator group work. A summary of it can be found as TM4-S1-AM3
3.	Manik, Yosef, Jessica E. Leahy, Anthony Halog. Social life cycle assessment of palm oil biodiesel: a case study in Jambi Province of Indonesia. "The International Journal of Life Cycle Assessment" 2013, Vol. 18, pp. 1386–1392. DOI: 10.1007/s11367-013-0581-5	The case study used to highlight the importance and usefulness of SCLA.

d) Session activities

Activity 1:

Introductory lecture

Methods	Interactive lecture
Keynotes	None

Materials	**TM4-S1-AM1-Introduction - SLCA (slides 1-7)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA**
Required accessories	Computer + projector
Time allocation	10 min
Learning outcomes	Understanding the basic concept of sustainability assessment (SA) and being aware of the main tools for SA

The purpose of this activity is to introduce the concept of sustainability assessment. After presenting the whole module and its structure the teacher addresses an open question to students (what is Sustainability Assessment?) and, after discussing their answers, provides the definition.

Activity 2:
Presentation on indicators

Methods	Interactive presentation
Keynotes	None
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 8-12)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA**
Required accessories	Computer, projector
Time allocation	10 min
Learning outcomes	Understanding of social indicators

The teacher stresses the importance of sustainability indicators. An adequate selection of indicators is needed in order to assess the outcome of policies implemented and provide feedback.
The teacher asks the students what are the characteristics of a good indicator. Students are made to discuss the topic in pairs (for example turning towards the nearest student) before the teacher explains the criteria to select suitable indicators (see Dizdaroglu 2017, table 9).

Activity 3:
Group work on indicators

Methods	Interactive presentation, group work, discussion
Keynotes	The case study for this activity (TM4-S1-AM3) should be given to students before the session.
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 13-18)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA** **TM4-S1-AM3. Sustainability assessment of a micro hydropower plant in Nepal** **TM4-S1-AM4. Template for assessing the social dimension of sustainability of a micro hydropower plant in Nepal**
Required accessories	Computer, projector
Time allocation	20 min
Learning outcomes	Understanding of social indicators

In this activity, students will be divided into groups and they will need to be acquainted with one specific case study of the application of Sustainability Assessment in the energy field in a specific country. The analysis will be undertaken using the template provided by the teacher.

The case study for this activity is presented in the document TM4-S1-AM3 (Sustainability assessment of a micro hydropower plant in Nepal), that should be given to the students before the session. The main facts for the case study are first presented by the teacher, as

a reminder. The teacher then divides students into groups of 4-5 people and gives each group a copy of document TM4-S1-AM4 (Template for assessing the social dimension of sustainability of a micro hydropower plant in Nepal). Students are presented with the different "dimensions" considered in the case study but are instructed to focus on the Social Theme. The students are given some 15 minutes to fill in at least one indicator per "dimension" in the Social Theme. The teacher is attentive to the students' discussions within the groups, answers their questions and provides guidance

After the discussion, the teacher introduces the actual indicators used in the case study (Bhandari et al. 2018). Students may have some comments after comparing their results with the indicators of the article. Students will be aware of the need to identify good, simple and measurable indicators when conducting an assessment of the social impact of energy technologies.

Activity 4:

Introduction to Life Cycle Assessment

Methods	Interactive lecture
Keynotes	None
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 19-24)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA** **TM4-S1-RM1 Video on LCA**
Required accessories	Computer, projector
Time allocation	10 min
Learning outcomes	Being aware of the sustainability assessment tools, in this case: LCA

Life Cycle Assessment (LCA) is a widely used product-related assessment tool. It aims to quantify the environmental impact of a product, process or service, accounting for all of the resources consumed and all of the emissions over the several stages of its life cycle.

The purpose of this activity is to provide an overview of the LCA as a sustainability assessment tool. Understanding LCA is basic to understand SLCA. TM4-S1-RM3 is a short video briefly portraying LCA.

Activity 5:
Social Assessment Methods. Social LCA

Methods	Interactive lecture
Keynotes	None
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 25-28)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA**
Required accessories	Computer, projector
Time allocation	5 min
Learning outcomes	Being aware of the social assessment tools, in this case: SLCA

The social assessment toolbox is composed of different families aiming at different goals. These families may include: analytical tools, procedural and management tools, monitoring tools, reporting tools and communication tools (UNEP/SETAC 2009: 30 et seq.).
The teacher provides a non-comprehensive indication of what techniques and tools are available (differences among categories are somewhat diffuse) without going into any detail.

The purpose of this activity is to frame the Social Life Cycle Assessment within the Social Assessment tools.

Activity 6:
Social Life Cycle Assessment Methodology

Methods	Presentation
Keynotes	None
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 29-41)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA**
Required accessories	Computer, projector
Time allocation	15 min
Learning outcomes	Understanding of the SLCA methodology and its features

This activity is a lecture on SLCA given by the teacher, who deepens into the four steps in SLCA:

- Goal and Scope;
- Inventory analysis;
- Impact assessment;
- Interpretation.

Then, the data tools used in SLCA are briefly introduced.

There are some tools that can be used for SLCA development. Mainly some databases which include social indicators. According to Mancini et al. (2018), the two available SLCA databases are:

- PSILCA, a software developed by Greendelta, which provides social indicators for a list of stakeholders and impact subcategories based on the UNEP/SETAC Guidelines (Ciroth, Eisfeld 2016), and
- Social Hotspot Database (SHDB) with the largest amount of social datasets.

Activity 7:
SLCA case studies in the energy field

Methods	Presentation
Keynotes	None
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 42-49)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA**
Required accessories	Computer, projector
Time allocation	10 min
Learning outcomes	Exemplifying the usefulness of SLCA through a case study

Examples of the SLCA analyses performed in the energy field are listed. One case study is presented in detail, SLCA of palm oil biodiesel: a case study in Jambi Province of Indonesia (Manik et al. 2013).

The teacher can stress here the usefulness of the SLCA framework: social hotspots are identified that should be addressed. Here the teacher may want to highlight the difficulties of the methodology as well, for instance the difficulties to obtain clear numerical indicator through a survey with questions about perception and expectation using a scale 1-7, and weighting factors for the criteria within an impact category obtained from subjective appreciation of several “experts” representing the different stakeholder categories.

Activity 8:
Instructions for session 2

Methods	Presentation, discussion
Keynotes	The next session will be SLCA practice and for that, the students need to read the document TM4-S2-RM1. Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.
Materials	**TM4-S1-AM1-Introduction - SLCA (slides 50-52)** **TM4-S1-AM2 Class guide and notes for Session 1: Introduction to SLCA** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.**
Required accessories	Computer, projector
Time allocation	10 min
Learning outcomes	Understanding of the task for the next session

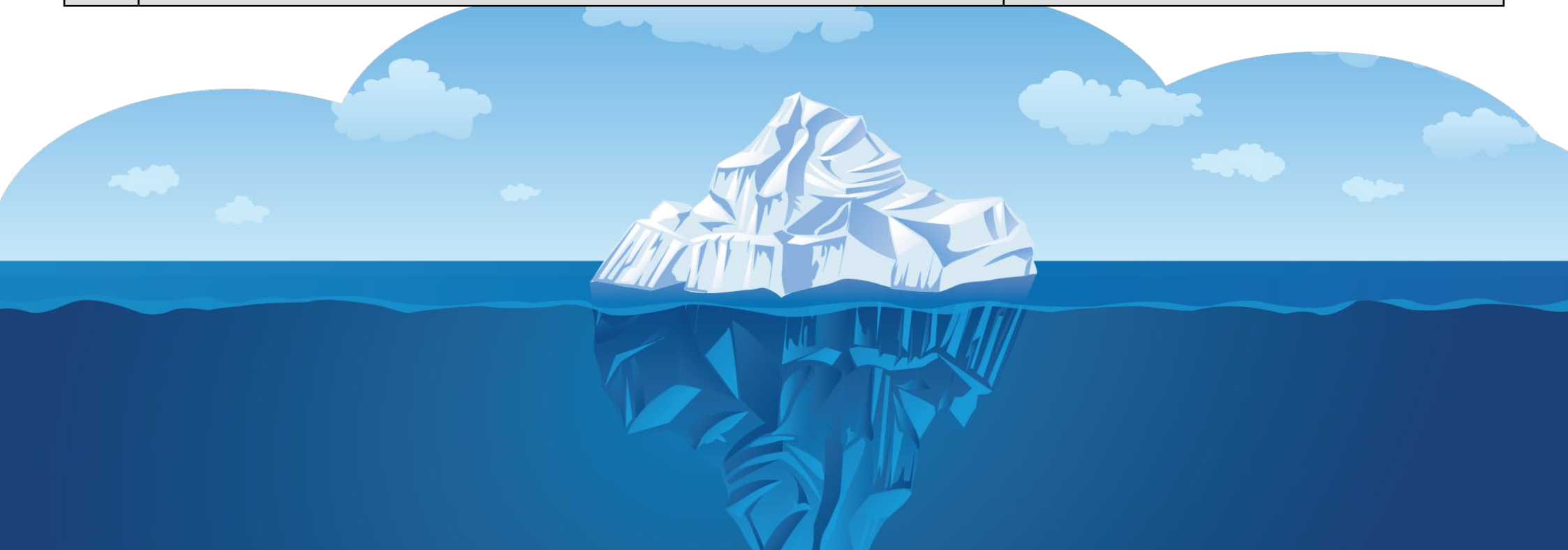
Session 2 will be an SLCA practice. Students need to prepare for it by reading the document "TM4-S2-RM1. Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology". They also would have to skim through "TM4-S2-RM2. Guidelines for Social Life Cycle Assessment of Products." and "TM4-S2-RM3. The Methodological Sheets for Sub-categories in Social Life Cycle Assessment", which are given as additional literature.

As homework, students are asked to prepare, in groups of 4-5 people, a presentation of the case study that will be the basis for the work to be conducted in the second session.

e) Additional resources

No.	Author and title	Description
1.	Petti, Luigia, Monica Serreli, Silvia Di Cesare. Systematic literature review in social life cycle assessment. "The International Journal of Life Cycle Assessment" 2018, Vol. 23, Issue 3, pp. 422–431. DOI: 10.1007/s11367-016-1135-4	A recent review on the SLCA development.
2.	Traverso, Marzia et al. Towards life cycle sustainability assessment: An implementation to photovoltaic modules. "The International Journal of Life Cycle Assessment" 2012, Vol. 17, Issue 8, pp. 1068–1079. DOI: 10.1007/s11367-012-0433-8	One of the case studies used as an example in the slides.
3.	Weldegiorgis, S. Fitsum, Daniel M. Franks. Social dimensions of energy supply alternatives in steelmaking: Comparison of biomass and coal production scenarios in Australia. "Journal of Clean Production" 2014, Vol. 84, Issue 1, pp. 281–288. DOI: 10.1016/j.jclepro.2013.09.056	One of the case studies used as an example in the slides.
4.	Ren, Jingzheng et al. Prioritization of bioethanol production pathways in China based on life cycle sustainability assessment and multicriteria decision-making. "The International Journal of Life Cycle Assessment" 2015, Vol. 20, Issue 6, pp. 842–853. DOI: 10.1007/s11367-015-0877-8	One of the case studies used as an example in the slides.
5.	Ekener-Petersen, Elisabeth, Jonas Höglund, Göran Finnveden. Screening potential social impacts of fossil fuels and biofuels for vehicles. "Energy Policy" 2014, Vol. 73, pp. 416–426. DOI : 10.1016/j.enpol.2014.05.034	One of the case studies used as an example in the slides.

No.	Author and title	Description
6.	Rugani, Benedetto et al. Towards prospective life cycle sustainability analysis: exploring complementarities between social and environmental life cycle assessments for the case of Luxembourg's energy system. "Matériaux & Techniques" 2014, Vol. 102, Issue 6-7, p. 605. DOI: 10.1051/mattech/2014043	One of the case studies used as an example in the slides.
7.	Freudenburg, R. William. Social impact assessment. "Annual Review of Sociology" 1986, Vol. 12, pp. 451-478. DOI: 10.1146/annurev.so.12.080186.002315	Literature review on social impact assessment (SIA).
8.	Fan, Yi et al. 2015. A Review of Social Life Cycle Assessment Methodologies. In: Muthu, S. Subramanian (ed.). Social Life Cycle Assessment. Springer, Singapore, pp. 1-24. DOI: 10.1007/978-981-287-296-8_1	A summary of the state of the art in sLCA methods.



Session 2:
SLCA practical application

a) Session objectives

The session provides a practical overview of the four steps of the Social Life Cycle Assessment by means of a case study. Students will gain an insight of the UNEP/SETAC methodology (UNEP/SETAC 2019) and will face the complexity that practitioners experience when using such methodology.

b) Session scope

This session aims to exemplify the use of SLCA methodology by attempting the assessment of a case study - Evaluation of the social impacts of a Smart Grid implementation in the resort city of Albena, Bulgaria. The students are divided into teams and develop the SLCA step by step following the methodology proposed by UNEP/SETAC (2009), which is used as a framework in most SLCA case studies. The teacher will be providing instructions during the session, guiding the students through several steps.

Case Study: Evaluation of the social impacts of a Smart Grid implementation in the resort city of Albena, Bulgaria using the SLCA methodology

The resort city Albena is located 30 km north of Varna – the Sea capital of Bulgaria. The resort Albena, owned by Albena JSCo, covers an area 140 ha with 3.5 km long and 150m wide beach. There are 34 hotels built in different years with a different star ranking. It is a predominantly summer resort, with one hotel operating during winter since 2017, with a total peak potential to accommodate around 20,000 people (including personnel). There are 7 football stadiums, 19 outdoor and 3 indoor tennis courts, over 25 pools, a horse riding centre and more. Most facilities in the resort are owned by Albena Holding JSCo, including the middle voltage electric grid of 20KV, infrastructure, transport systems within the resort. The resort has been rewarded with the blue flag for being an ecologically clean area.

The A Albena JSCo group consists of several companies operating in diverse industries under the same management, one of them, Perpetum Mobile BG PLC is in the bio-energy industry with 1MW Biogas power plant, located 10 km from the resort.

As an organization, Albena has expressed the willingness to become energy independent for its operations, as well as increasing its revenue stream through implementing year-long operations and marketing the green image of the resort. Figure 1 shows the monthly electricity consumption variation in the resort for the year 2017.

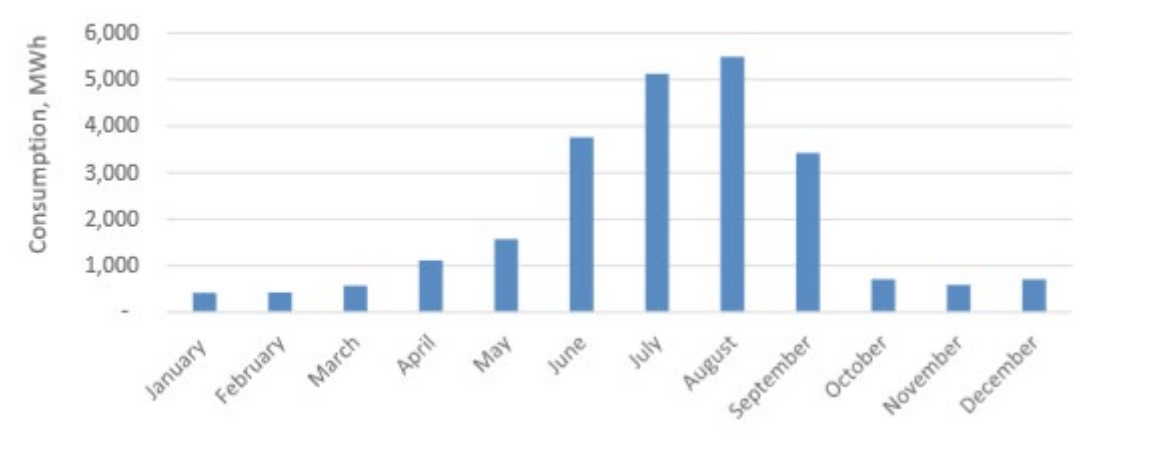


Figure 1. Monthly Electricity Consumption in Albena's resort in 2017

The constant increase in the electricity price for Albena, from 85.0 €/MWh in October 2016 to 99.4 €/MWh in October 2017, makes an investment in energy projects increasingly interesting.

So, a Smart Grid implementation has been considered in Albena, using the same infrastructure but installing additional components such as Smart meters, a SCADA monitoring system, rooftop photovoltaics, Li-ion battery storage and an Electrical Vehicle charging station.

By 2035, as assessed in the SEASON-ALL project (Figure 2), Albena could become an Independent Market Operator and (with a good share of both predictable and fluctuating renewables in the form of Solar, Biogas and also use of heat energy generation) could achieve an 84.6% reduction of electrical power consumption from the external grid.

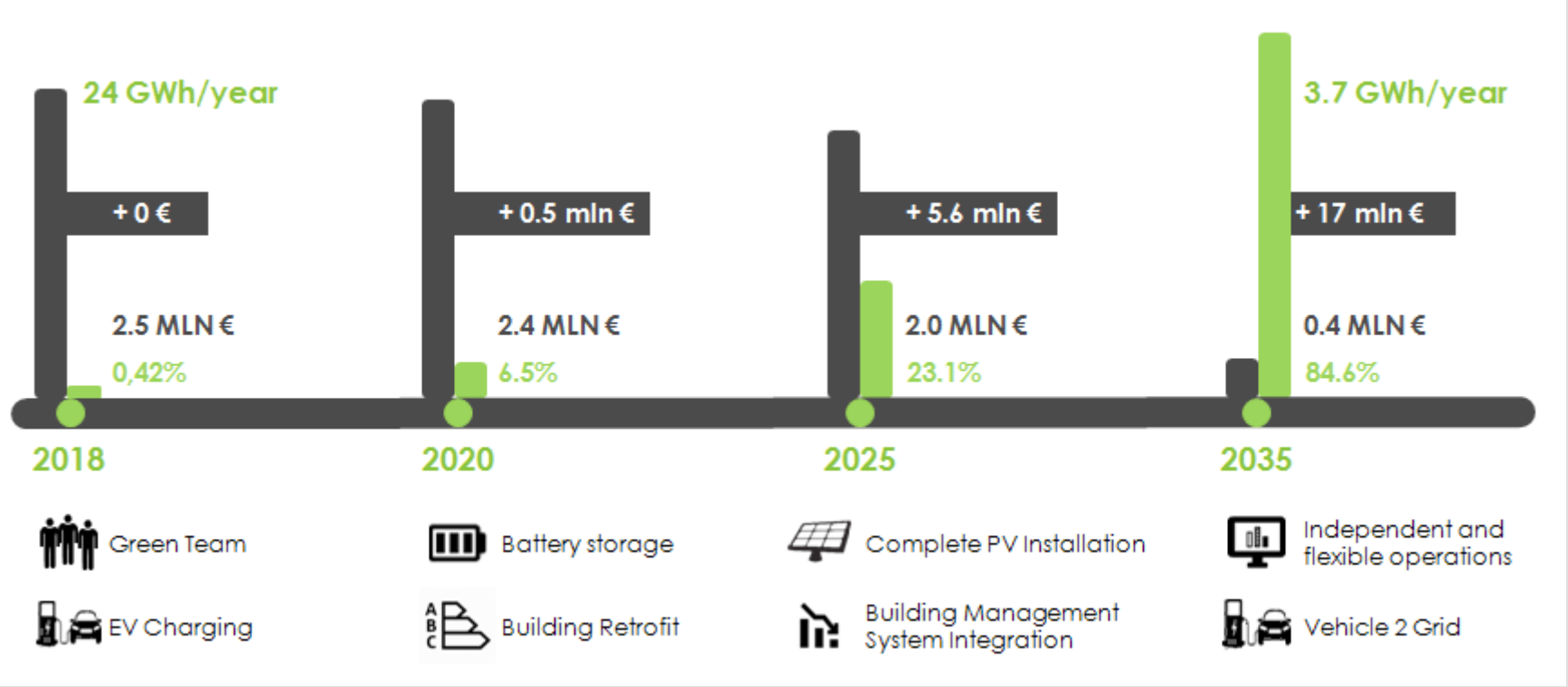


Figure 2. SEASON-ALL project forecasted results for ALBENA (source: D. Kuzeva et al., "SEASON-ALL, Strategies for Energy Autonomy and Seasonal Operations of Albena, Bulgaria," 2018.)

c) Pre-reading

No.	Author and title	Description
1.	Kuzeva, Denitsa. 2018. Evaluation of the social impacts of a Smart Grid implementation in the resort city of Albena, Bulgaria using the SLCA methodology. Code: TM4-S2-RM4	This case study is the basis of Session 2. It is unpublished and it can be found in the support materials.

No.	Author and title	Description
2.	UNEP-SETAC. 2013. The methodological sheets for subcategories in Social Life Cycle Assessment. Code: TM4-S2-RM3	It contains useful examples of the application of the methodology. It is part of the reading materials.

d) Session activities

Activity 1:

Introductory presentation of the case study

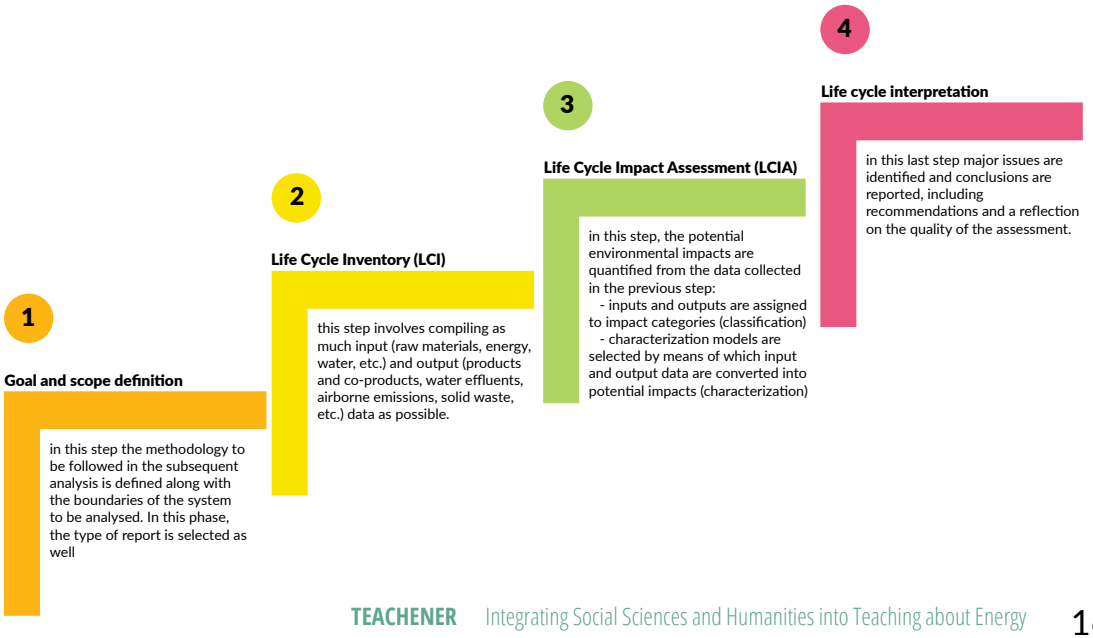
Methods	Presentation, discussion
Keynotes	One group of students is chosen to present their homework for this activity.
Materials	**TM4-S2-AM1 SLCA – practical application (slides 4-8)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application**
Required accessories	Computer + projector
Time allocation	20 min
Learning outcomes	Understanding the case study

After introducing the session's objectives, the teacher chooses a team to present their homework. The students in that group present their slides followed by discussion and clarification of any doubts by the teacher. The teacher can refer to the slides in the presentation to conclude this activity with a brief summary of the case study or can skip these slides if the students' presentation is sufficient.

Activity 2:
Basic steps in the SLCA methodology

Methods	Interactive lecture
Keynotes	None
Materials	**TM4-S2-AM1 SLCA – practical application (slides 9-10)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application**
Required accessories	Computer + projector
Time allocation	5 min
Learning outcomes	A reminder of the basic steps in SLCA

The students are briefly reminded of the basic steps of the Social Life Cycle Assessment methodology (UNEP/ SETAC 2009).



Activity 3:
Definition of scope: boundaries

Methods	Workshop, discussion
Keynotes	None
Materials	**TM4-S2-AM1 SLCA – practical application (slides 11-16)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.** **TM4-S2-RM2 UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products.**
Required accessories	Computer + projector
Time allocation	10 min
Learning outcomes	Understanding how to define goal and scope in SLCA

The teacher introduces the goal and scope definition process. Teams of 4-5 student work together and discuss it for the given case study. The students stay together in their group as per the homework for the whole session. Teams need first to define the boundaries of the analysis, that is, what stays in the modelled system and what is kept out of the analysis.
After some time, the teacher presents a proposal for system boundaries.

Activity 4:
Definition of scope: stakeholders

Methods	Workshop, discussion
Keynotes	None
Materials	**TM4-S2-AM1 SLCA – practical application (slides 17-18)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.** **TM4-S2-RM2 UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products.**
Required accessories	Computer + projector
Time allocation	15 min
Learning outcomes	Understanding how to define goal and scope in SLCA

The teacher asks students to brainstorm in their team and write on paper the potential stakeholders, based on the guidelines.
Students try to identify the stakeholders of the project. A discussion follows: students discuss their findings lead by the teacher.
The teacher then presents how the author of the case study defines the stakeholders. In order to proceed further, the students may use their own results to continue the analysis or the results of the author of the case study at all times, as they prefer.

Activity 5:
Inventory analysis

Methods	Interactive lecture
Keynotes	None
Materials	**TM4-S2-AM1 SLCA – practical application (slides 19-24)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application**
Required accessories	Computer + projector
Time allocation	15 min
Learning outcomes	A reminder of the main features of the Life Cycle Inventory Analysis.

The teacher presents the main steps in the Inventory Analysis and provides some clues on how to select the impact categories, subcategories and indicators, in order to prepare for the next activity.

In order to produce an SLCA, a large amount of data should be gathered at this point, which is not available or it is not reasonable to be dealt with within this exercise. Some of the data should come from databases, some other should be collected directly (surveys, interviews), some other should be provided by experts. The teacher advises the students that the Impact Assessment that follows intends only to exemplify the method.

Activity 6:
Impact assessment: subcategories and indicators

Methods	Workshop, discussion
Keynotes	Teacher advises the students that the Impact Assessment activity intends only to exemplify the method.
Materials	**TM4-S2-AM1 SLCA – practical application (slides 25-33)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.** **TM4-S2-RM2 Guidelines for Social Life Cycle Assessment of Products.** **TM4-S2-RM3 The Methodological Sheets for Sub-categories in Social Life Cycle Assessment** **TM4-S2-AM3 Template for impact assessment of the case study**
Required accessories	Computer + projector
Time allocation	20 min
Learning outcomes	Understanding how to select subcategories and indicators for local impact in SLCA.

After introducing the concept of Life Cycle Impact Assessment and explaining that, for the sake of simplicity, from now on the analysis will focus only on site-specific indicators, the teacher launches the activity by asking the students to: 1) select impact subcategories for the given stakeholder's categories; and 2) find adequate indicators (at least one per subcategory) for the selected subcategories. After some time, the teacher projects one possible solution, the one given by the author of the case study (TM4-S2-RM4) just to give an example. Students are instructed to keep their answers for the subsequent activity.
To deal with generic indicators, the use of some databases would be necessary (e.g. Social Hotspot Data Base), which is out of reach.

Activity 7:
Impact assessment: weighting factors

Methods	Workshop, discussion
Keynotes	The teacher advises the students that the purpose of the activity is merely illustrative
Materials	**TM4-S2-AM1 SLCA – practical application (slides 34-41)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.** **TM4-S2-AM3 Template for impact assessment of the case study** **TM4-S2-AM4 Template with the rainbow diagram**
Required accessories	Computer + projector
Time allocation	15 min
Learning outcomes	Practising the aggregation of indicators in SLCA

This activity illustrates one of the ways in which the information can be organised. The teacher advises students that this kind of operation requires the concurrence of experts in the field of analysis and that it has a large degree of subjectivity so that good practice is to involve as many experts as possible and average the scores each of them provides.

The teacher instructs the students to score the indicators they found relevant for every local stakeholder.

Impact	Score
very high	8
high	**6**
medium	4
low	2

To do so, students use the template (TM4-S2-AM3) used in the previous activity, filling the columns A, B, C, etc., where the letters stand for each of the local-stakeholders considered (in Activity 2). The scored values are to be added vertically (per stakeholder) and horizontally (per indicator) for different communication purposes.

STAKEHOLDER CATEGORY	SUB-CATEGORIES	INDICATORS	STAKEHOLDERS					
			A	B	C	D	E	F
WORKER								
CONSUMER								
LOCAL COMMUNITY								
SOCIETY								
VALUE CHAIN ACTORS								

The students will work in teams and then teams will compare the results and will discuss among them with the teacher.

After some time, the teacher projects one possible solution, the one given by the author of the case study (TM4-S2-RM4), just to give an example.

Students are free to propose any kind of aggregation, and weighting strategy. Using the weighting factors obtained for the different local stakeholders, students would be able to rank them by being more or less impacted by the project or being more or less influential in the project. Students may use a Rainbow diagram to communicate their findings (using the template TM4-S2-AM4). Alternatively, students may assume an "expert" role in assessing the "affecting/affected" rates of the different stakeholders and build the rainbow diagram on their own criteria. In this case, weighting factors can be obtained from the rainbow diagram which can be used to refine the scores previously obtained.

Activity 8:

Impact assessment: getting values for the indicators

Methods	Workshop, discussion
Keynotes	None
Materials	**TM4-S2-AM1 SLCA – practical application (slides 42-45)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application** **TM4-S2-RM1 Case study: Evaluation of the social impacts of a smart grid implementation in the resort city of Albena, Bulgaria, using the SLCA methodology.** **TM4-S2-AM3 Template for impact assessment of the case study.** **TM4-S2-RM5 Bulgarian National Statistical Institute web site** **TM4-S2-RM6 Forecast of Bulgarian social indicators done by the Pardee Center for International Futures**
Required accessories	Computer + projector

Time allocation	20 min
Learning outcomes	Understanding on how to assess the local impact in SLCA

Finally, the students should use the information from the Bulgarian National Statistical Institute (TM4-S2-RM5) and check for the data available regarding the indicators selected. The teacher should stress the difficulty in finding relevant local data.

In order to quantify the impact of the Albena case study, students might want to quantify the change in some of the indicators after the project is finished, by comparing indicators prior and after (e.g. 2018 vs 2030 forecast). Students should report the value for the current indicator and the potential benefit by 2030.

To estimate values for 2030, for instance, they can take as a reference the potential impact of the deployment of renewable energy by 2030 according to the International Renewable Energy Agency (IRENA 2016). According to this reference, doubling the presence of Renewable Energies in the energy mix would lead to an increase of the GDP of 0.4% and a 3.7% increase of welfare in the new European countries (EU13, which include Bulgaria) in respect to the business as usual (reference) case in 2030.

Another source of information students may use is the web of the Pardee Center for International Futures (Denver University), where some social indicators forecasted for Bulgaria in 2030 can be found (TM4-S2-RM6).

Before proceeding to the next activity, teams compare the indicators and values they have worked in.

Activity 9:
Results, discussion and conclusions

Methods	Workshop, discussion
Keynotes	A group report is to be developed after this session for the final evaluation.

Materials	**TM4-S2-AM1 SLCA – practical application (Slides 46-50)** **TM4-S2-AM2 Class guide and notes for Session 2: SLCA practical application**
Required accessories	Computer + projector
Time allocation	15 min
Learning outcomes	Identify lessons learnt

The teacher explains the interpretation step. Open class discussion on the meaning of the results and limitations of the assessment follows. The teacher summarises the discussion and the whole Teaching Module. Finally, students are asked to prepare a group report of the Session 2 activity within a certain deadline.

Assessment methods and final assignment

The students are asked to prepare a group report of the Session 2 activity within a certain deadline. The groups are graded based on the report and the homework from session 1.

Glossary

CERES	Coalition for Environmentally Responsible Economies
CSR	Corporate Social Responsibility
EPLCA	European Platform On Life Cycle Assessment
GRI	Global Reporting Initiative
LCA	Life Cycle Assessment
LCI	Life Cycle inventory
LCIA	Life Cycle Impact Assessment
NGO	Non-Governmental Organization
PMFA	Product Material Flow Analysis
PSILCA	Product Social Impact Life Cycle Assessment
RM	Reading Material
SA	Sustainability Assessment
SETAC	Society of Environmental Toxicology and Chemistry
SHDB	Social Hotspot Database
SLCA	Social Life Cycle Assessment
TM	Teaching Module
UNEP	United Nations Environment Programme

Attachment: Syllabus

1. Name of the Teaching Module

Social Impact of Energy Technologies. Assessing social impacts through Social Life Cycle Assessment (SLCA)

2. Brief description of the subject matter

Strategies are being developed on the local and global levels to enhance energy security and sustainability through innovative energy policies and measures. The need for practical and sustainable solutions has led to the development of sustainability measurement tools, such as Life Cycle Assessment (LCA). Life cycle assessment (LCA) is widely used for decision support, but it is mainly limited to environmental impacts and fails to address the other dimensions of sustainability - social and economic concerns - in the product life cycle.

As a step further, social criteria may also be included in the sustainability assessment analysis, through the Social Life-Cycle Assessment (SLCA), a tool that analyses the impact on society of products or services throughout their life-cycle, assessing the actual and potential positive and negative impacts. Research on standardization of a methodology for conducting SLCA is limited compared to LCA but it is still ongoing.

The module aims to introduce the SLCA methodology as a tool to measure the main social impacts of energy projects through a life cycle perspective.

3. Complete SSH problems description

- Social indicators are currently being considered for energy projects, along with the technical, economic and environmental aspects. However, the overall social impact on local and global scale is hardly addressed by most currently used methods for social evaluation in the energy field.
- Although some Social Assessment tools exist, most of them lack the global perspective of considering the whole Life Cycle of the product or service.
- Social Life Cycle Assessment, a tool that fills the gap, doesn't have yet an established methodology. Research on the standardization of a methodology for conducting SLCA is going on but still incipient.
- Very few cases of application of SLCA framework to the provision of energy services and in to the energy sector in general

- For SLCA, quantitative and qualitative social impact indicators are needed which are usually difficult to obtain and most of the times subjective.

4. Prerequisites and context

Students can benefit of a previous familiarity with LCA methodology, though it is not essential.

This module is complementary of the 'Technology Assessment' module developed by UFZ, where SLCA is explained and an exercise proposed for students based on developing a SLCA for geothermal energy application. The Technology Assessment module provides a general overview of LCA which may be useful to undertake before this module if students are not familiar with LCA.

5. Learning outcomes

a) Knowledge

a. students will be able to grab the importance of SLCA and contextualize the methodology;

b. students will learn the steps needed to design and conduct a SLCA;

c. students will be able to explain the characteristics of a suitable sustainability indicator framework;

d. students will be aware of the difficulties in obtaining values for indicators on social themes;

e. students will be able to provide compelling examples of the importance of social issues in real energy projects at different scales.

b) Skills

a. Students will be able to understand the design of a SLCA;

b. students will be able synthetize the findings in a report;

c. students will be able to define a number of sustainability indicators;

d. students will be able to estimate values for social indicators.

c) Social competencies

a. Students will be able work in teams in a collaborative atmosphere;

b. students will be able to discuss/debate ideas with an open mind.

6. Form of classes

This module is divided into two sessions.

1. The first session (1 h 30') is a lecture introducing SLCA, which contains a group work on social indicators

2. In the second session (2 h 15'), the students working in teams will develop a SLCA based on a case study introduced at the end of the first session.

Students will read some aspects of the case study using the provided reading material between the two sessions and will prepare, in teams, a presentation to be shown at the beginning of the second session.

At the end of the second session, students need to compile, as a homework, their analyses in a report.

7. Teaching methods

- Lecture
- Power Point Presentation
- Group work
- Discussion.

8. General classes plan

1. ***Session 1: Introduction – SLCA (2x45 min):*** Sustainability Assessment, Social Assessment Methods, Indicators, Introduction to Life Cycle Assessment, Social LCA methodology, SLCA case studies in the energy field,

i. 10 min introduce of the concept of sustainability assessment by the teacher, stressing its important in the energy field.

ii. 30 min Presentation and group work on indicators.

iii. 30 min Introduction to Life Cycle Assessment, to the Social Assessment Methods, and to the SLCA Methodology.

iv. 15 min SLCA case studies in the energy field, which exemplify the usefulness of the approach.

v. 10 min preparation for session 2

2. Session 2 Develop a S-LCA analysis (3x45)

i. 20 min presentation of the case study (by a team of students)

ii. 5 min remainder by the teacher of the basic SLCA steps.

iii. 95 min Workshop on SLCA development following the main framework (group work on different aspects, and open discussions)

iv. 15 min final discussion on the quality of the work done and the limitations of the methodology.

Material needed

Power point presentation + computer + additional files provided with the TM

Printed Handouts for the activity in the first session (if students don't bring their laptops)

For the second session students should bring at least one laptop per team (in this case, all the handouts can be used in their electronic form).

9. Literature and other materials

Sustainability assessment

1. Bhandari, Ramchandra, Lena Ganda Saptalena, Wolfgang Kusch. Sustainability assessment of a micro hydropower plant in Nepal. "Energy, Sustainability and Society" 2018, Vol. 8, Issue 3. DOI: 10.1186/s13705-018-0147-2

2. Dizarglu, Didem. The role of indicator-based sustainability assessment in policy and the decision-making process: A review and Outlook. "Sustainability" 2017, Vol. 9, Issue 6. DOI: 10.3390/su9061018

3. Freudenburg, R. William. Social impact assessment. "Annual Review of Sociology" 1986, Vol. 12, pp. 451-478. DOI: 10.1146/annurev.so.12.080186.002315

4. Ness, Barry et al. Categorising tools for sustainability assessment. "Ecological Economics" 2007, Vol. 60, Issue 3. DOI: 10.1016/j.ecolecon.2006.07.023

5. Waas, Tom et al. Sustainability assessment and indicators: Tools in a decision-making strategy for sustainable development. "Sustainability" 2014, Vol. 6, Issue 9. DOI: 10.3390/su6095512

Social Life Cycle assessment

1. Ciroth, Andreas, Franziska Eisfeldt. 2016. A Product Social Impact Life Cycle Assessment database. PSILCA Understanding social impacts. https://nexus.openlca.org/ws/files/9062

2. Ekener-Petersen, Elisabeth, Jonas Höglund, Göran Finnveden. Screening potential social impacts of fossil fuels and biofuels for vehicles. "Energy Policy" 2014, Vol. 73, pp. 416–426. DOI : 10.1016/j.enpol.2014.05.034

3. Fan, Yi et al. 2015. A Review of Social Life Cycle Assessment Methodologies. In: Muthu, S. Subramanian (ed.). Social Life Cycle Assessment. Springer, Singapore, pp. 1-24. DOI: 10.1007/978-981-287-296-8_1

4. Kuzeva, Denitsa. 2018. Evaluation of the social impacts of a Smart Grid implementation in the resort city of Albena, Bulgaria using the SLCA methodology. It is unpublished and it can be found in the support material: TM4-S2-RM4

5. Manik, Yosef, Jessica E. Leahy, Anthony Halog. Social life cycle assessment of palm oil biodiesel: a case study in Jambi Province of Indonesia. "The International Journal of Life Cycle Assessment" 2013, Vol. 18, pp. 1386–1392. DOI: 10.1007/s11367-013-0581-5

6. Petti, Luigia, Monica Serreli,Silvia Di Cesare. Systematic literature review in social life cycle assessment. "The International Journal of Life Cycle Assessment" 2018, Vol. 23, Issue 3, pp. 422–431. DOI: 10.1007/s11367-016-1135-4

7. Ren, Jingzheng et al. Prioritization of bioethanol production pathways in China based on life cycle sustainability assessment and multicriteria decision-making. "The International Journal of Life Cycle Assessment" 2015, Vol. 20, Issue 6, pp. 842–853. DOI: 10.1007/s11367-015-0877-8

8. Rugani, Benedetto et al. Towards prospective life cycle sustainability analysis: exploring complementarities between social and environmental life cycle assessments for the case of Luxembourg's energy system. "Matériaux & Techniques" 2014, Vol. 102, Issue 6-7, p.

605. DOI: 10.1051/mattech/2014043

9. Sala, Serenella. 2015. Social Life Cycle Assessment – State of the art and challenges for supporting product policies. JRC Technical Report. DOI: 10.2788/253715.

10. Traverso, Marzia et al. Toward s life cycle sustainability assessment: An implementation to photovoltaic modules. "The International Journal of Life Cycle Assessment" 2012, Vol. 17, Issue 8, pp. 1068–1079. DOI: 10.1007/s11367-012-0433-8

11. UNEP-SETAC. 2009. Guidelines for social life cycle assessment of products. United Nations Environment Programme. http://www.unep.org/pdf/DTIE_PDFS/DTIx1164xPA-guidelines_sLCA.pdf

12. UNEP-SETAC. 2013. The methodological sheets for subcategories in Social Life Cycle Assessment. https://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf

13. Weldegiorgis, S. Fitsum, Daniel M. Franks. Social dimensions of energy supply alternatives in steelmaking: Comparison of biomass and coal production scenarios in Australia. "Journal of Clean Production" 2014, Vol. 84, Issue 1. DOI: 10.1016/j.jclepro.2013.09.056

14. International Renewable Energy Agency. 2016. Renewable Energy Benefits: Measuring The Economics. IRENA, Abu Dhabi. https://www.irena.org/documentdownloads/publications/irena_measuring-the-economics_2016.pdf

Additional resources

1. Bond, Alan, Angus Morrison-Saunders, Jenny Pope. Sustainability assessment: The state of the art. "Impact Assessment and Project Appraisal" 2012, Vol. 30, Issue 1. DOI: 10.1080/14615517.2012.661974

2. Botelho, Anabela et al. Social sustainability of renewable energy sources in electricity production: An application of the contingent valuation method. "Sustainable Cities and Society" 2016, Vol. 26. DOI: 10.1016/j.scs.2016.05.011

3. Carneiro, Aurora et al. Sustainability, Energy and Development: A Proposal of Indicators. "International Journal for Infonomics" 2012, Vol. 5, Issue 1/2. Online. DOI: 10.20533/iji.1742.4712.2012.0060

4. Colantonio, Andrea. 2009. Social sustainability: a review and critique of traditional versus emerging themes and assessment methods. In: Horner, Malcolm et al. (eds.). Sue-Mot Conference 2009: Second International Conference on Whole Life Urban Sustainability and Its Assessment: Conference Proce. Loughborough University, Loughborough.

5. EPLCA European Platform On Life Cycle Assessment https://eplca.jrc.ec.europa.eu/

6. GRI. 2011. Sustainability Reporting Guidelines. Global Reporting Initiative https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-Protocol.pdf

7. Hirschberg, Stefan et al. 2007. Environmental, economic and social criteria and indicators for sustainability assessment of energy technologies. NEEDS FP6 project. New Energy Externalities Developments for Sustainability. http://www.needs-project.org/RS2b/RS2b_D3.1.pdf

8. IAEA. 2005. Energy indicators for sustainable development: guidelines and methodologies. https://sustainabledevelopment.un.org/content/documents/Pub1222_web.pdf

9. Jorgensen, Andreas et al. Methodologies for social life cycle assessment. "International Journal Life Cycle Assessment" 2008, Vol. 13. DOI: 10.1065/lca2007.11.367

10. De Luca, Anna Irene et al. Social Life Cycle Assessment and participatory approaches: a methodological proposal applied to citrus farming in Southern Italy. "Integrated Environmental Assessment and Management" 2015, Vol. 11, Issue 3. DOI: 10.1002/ieam.1611

11. Mancini, Lucia et al. 2018. Social assessment of raw materials supply chains: A life-cycle-based analysis. JRC Technical reports. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC112626/social_risk_technical_report_third_review_round_final_18_01_19_online.pdf

12. Popovic, Tamara et al. Quantitative indicators for social sustainability assessment of society and product responsibility aspects in supply chains. "Journal of International Studies" 2017, Vol. 10, Issue 4. DOI: 10.14254/2071-8330.2017/10-4/1

13. Santoyo-Castelazo, Edgar, Adisa Azapagic. Sustainability assessment of energy systems: integrating environmental, economic and social aspects. "Journal of Cleaner Production" 2014, Vol. 80, Issue 1. DOI: 10.1016/j.jclepro.2014.05.061

14. Shiau, Tzay-An, Ji-Kai Chuen-Yu. Developing an Indicator System for Measuring the Social Sustainability of Offshore Wind Power Farms. "Sustainability" 2016, Vol. 8, Issue 5. DOI: 10.3390/su8050470

15. Whitton, John et al. Conceptualizing a social sustainability framework for energy infrastructure decisions. "Energy Research & Social Science" 2015, Vol. 8. DOI: 10.1016/j.erss.2015.05.010

16. Wolf, Marc-Andree et al. 2012. The International Reference Life Cycle Data System (ILCD) Handbook. JRC Reference Reports. https://

eplca.jrc.ec.europa.eu/uploads/JRC-Reference-Report-ILCD-Handbook-Towards-more-sustainable-production-and-consumption-for-a-resource-efficient-Europe.pdf

17. Wu, Ruqun, Dan Yang, Jiquan Chen. Social Life Cycle Assessment Revisited. “Sustainability” 2015, Vol. 6, Issue 6. DOI: 10.3390/su6074200