

Team Assignment, 28870 E19

In this assignment, you will select a geographical study area and develop a scenario and a plan for substantial improvements to the energy system and/or related sectors within this area. In addition, you will make a simplified sustainability assessment to determine how your proposed improvements may influence the sustainability of the assessed system.

Why carry out the Assignment?

Imagination of a desirable future is a tool to shape the future rather than letting the future shape us. Engineers are responsible for future technological developments and, therefore, you have to obtain skills in imagining an ideal future, designing strategies towards its accomplishment and evaluating its potential success using your technical knowledge. Today, technologies and energy services are often compared and evaluated by their performance with respect to resource use and environmental impact. As an engineer, it is important that you are able to critically use these results in your own work without necessarily knowing all the details of the sustainability assessment methods.

In the assignment, you will critically apply principles and results from different kinds of sustainability assessment, for evaluating energy systems and the development hereof. Furthermore, the ability to formulate and discuss your own results is an essential general engineer competence, which will be trained and evaluated when pitching, presenting a poster and writing a technical paper. Finally, you will challenge your own perceptions of sustainability in discussions with group mates with different technical and cultural backgrounds. The assignment is based on the open question:

How will your team select and develop a system related to the production and/or consumption of energy services in a limited geographical area in a more sustainable direction?

The aim of the assignment is to understand the challenges of sustainable development and some of the qualitative and quantitative sustainability assessments tools that may be applied for its support. Specifically, this implies being aware of sustainability issues of present-day societies and energy technologies, and applying the concepts presented in lectures based on qualified assumptions.

The overall structure of the assignment:

- 1) Select a geographical area and a system for production of products or services within this area that you want to work with. This is called your reference case (see below).
- 2) Develop ideas for improvement of your reference case in a more sustainable direction
- 3) Present your reference case and your ideas in a Pitch competition
- 4) Based on your ideas and feedback from the pitch you should develop a future scenario for your system. You may use established methodologies for development of sustainable frameworks, or your own innovation processes. Make sure to relate your development to sustainability principles.
- 5) Compare your reference case and the scenario quantitatively and by means of indicators and present the work on a poster at a student poster conference.
- 6) Quantify potential improvements and possible drawbacks of your scenario compared to the reference case using simplified sustainability assessments in a life cycle perspective.
- 7) Present the results in a technical paper.

General terms used in the assignment:

The reference case: The reference case is how your investigated area and system looks today. The reference case is limited by various system boundaries, including geographical boundaries and system functions. A reference case can be e.g. "Tomato production in Tarragona 2018" or "Private heating of apartment buildings in east Berlin 2017"

The scenario: The scenario is a future version of the system described in the reference case. The scenario should be more sustainable than the reference case and should describe the most desirable future for this system that you can think of. The temporal scope of the scenario is an important parameter and should be included as an essential part of the study. A scenario could be e.g. "Sustainable tomato production in Tarragona 2035" or "Private heating of apartment buildings in east Berlin 2050 using sustainable energy sources".

3-part study:

The study is divided into 3 parts:

- 1) **PITCH: A case and a set of ideas.** A pitch showing your reference case and ideas for a sustainable version of this case, deadline Wednesday 09/10-2019 08:00
- 2) **POSTER: Developing scenarios and quantifying indicators.** A visualization of your reference case compared to your future scenario in a poster, deadline Monday 11/11-2019 08:00
- 3) **PAPER: Sustainability assessment.** A sustainability assessment study, quantifying essential differences of your scenario compared to the reference case in a life cycle perspective and presented in the form of a technical paper and an appendix data set. Deadline Wednesday 04/12-2019 08:00

The Pitch:

In the pitch, the aim is to set the scene for your study, present your ideas and get feedback from a panel of people with competences within energy production and sustainability assessment.

Task 1: Choose an area which you want to study, based on the knowledge in the group. The area should be of limited size and could be e.g. a city, region or island.

Task 2: Based on your geographical area, you should decide on a system for production and/or use of products or services related to the energy sector that you want to investigate. Try to describe how this system encompasses production/use of some product or services related to the energy sector (electricity, fuel, heat, food, water, transportation, shelter, entertainment etc.), use/reuse of key resources (e.g. wood, waste, steel, atmospheric carbon etc.), and essential impact indicators (e.g. eutrophication, greenhouse gas emissions, loss of critical raw materials etc.). The production system can be many things like a factory, a heating system, a housing community, a gas grid, a tourist organization, a transport system and so on.

Task 3: Make a preliminary investigation into the situation of this system today.

Task 4: Develop ideas how to make the system more sustainable. Consider which sustainability criteria you want to embrace and which are actually influenced by your solution. Use e.g. UN's sustainability goals.

Task 5: Prepare a presentation of your reference case – area and system, and some of your ideas for a sustainable development.

The Poster:

In the poster challenge, the main goal is to define and visualize a future scenario proposing a more desirable future for your reference case with respect to the selected key criteria.

Note about Guiding Questions: If you want feedback to your project development at this stage, then make a 1-2 page summary of the 12 guiding questions and send them by email to jeah@kt.dtu.dk no later than the 6th of November 2019 at 10:00.

Task 1: Implement the comments from the pitch into your study description. This may mean that you e.g. make smaller changes to the system boundaries or the proposed ideas, that you select new impact indicators to focus on or even that you decide to start all over.

Guiding questions part 1:

- 1) *What is a clear definition of your geographical area*
- 2) *What is a clear definition of the system you are examining in the reference case as well as the solution you are proposing in your scenario*
- 3) *What is the proposed time perspective of your scenario? Could the scenario become even more sustainable if the time of implementation was postponed?*

Task 2: Make a more detailed investigation into the situation as it is today in your reference case. Analyse the status of your system of interest. Include a description of the historical development of at least five different kinds of important impact indicators relevant for the study and the geographical area. These indicators may be intensive as well as extensive and can include e.g. kg CO₂-eq/year, TOE/\$, kg P per capita, t steel/MW, m³ H₂O/hour and many others. Use this to identify critical sustainability issues, assets and technologies you have available, and opportunities for change.

Task 3: Develop your scenario: Envision a desirable future for the chosen study area and system. Focus especially on the investigated impact indicators, but try to address a broader range of potential positive effects. Describe the sustainable vision in accordance with selected sustainability principles and limited by local as well as global resources (energy, raw materials and people) but not by e.g. political restrictions. Quantify the scenario compared to the reference case and address influence on the assessed impact indicators. In this task it may be beneficial to use (or be inspired from) established backcasting methods within development of sustainable frameworks e.g. the UN global goals action plan, the Natural Step and the ABCD process or the Wayfinder (see Module 8 slides).

Guiding questions part 2:

- 4) *What are the main strengths of your proposed scenario compared to the reference case?*
- 5) *What are the main weaknesses of your proposed scenario compared to the reference case?*
- 6) *What indicators will you focus on when quantifying the benefits of your scenario compared to the current reference? Energy metrics? Greenhouse gas emissions? Depletion of limited resources? Health related issues (e.g. Toxicity indicators)? Something else?*
- 7) *How does the selection of impact indicators you are focusing on, correspond to the sustainable development you are aiming to achieve?*
- 8) *Which improvements would it not be possible to quantify the effect of – and why. Can you qualitatively characterize these improvements?*

Task 4: Develop a plan for how the reference case can be developed into your desirable future scenario. Determine (qualitatively) how this development contributes to a more sustainable society in your area. Which aspects of sustainable development does it influence? Evaluate the gap between today and the vision and use the conclusions from e.g. a SWOT analysis to identify actions/initiatives/investments that could be relevant for you as engineers to move your system in the study area towards your vision. Imagine and develop at least four initiatives/actions to implement to facilitate your plan for a sustainable development. Explain:

- i. How each action moves the development in the right direction towards the vision. Does it contribute to dematerialization or substitution?
- ii. How each action is a stepping stone towards the vision and flexible such that it does not lead to a dead end
- iii. How each action may support further sustainable development with an adequate return on investment (environmentally, socially and economically)

The plan should be described briefly in the Paper (part 3 of the assignment).

Guiding questions part 3:

- 9) *What barriers could you imagine that there would be towards development and implementation of your scenario? Economical? Technical? Political? Cultural? Social?*
- 10) *Have you considered scale, quantity and quality of your main resources? how much is there? Is it seasonal? Is it practical to utilize/collect? Can it be efficiently sorted/divided/lightly upgraded into more valuable fractions?*
- 11) *Is there a match between your solution and the current infrastructure? Does your solution require a lot of additional infrastructure? Does this influence the temporal scope of the scenario?*
- 12) *Which negative and/positive consequences (burden-lifting >< burden-shifting) does your solution provide in other sectors? Other areas? Other countries? To future generations?*

Task 5: Prepare a poster (A0) with visualization of the sustainable development you have designed for your area, showing changes between the reference case and the future scenario. The poster should be self-explanatory, i.e. to be understood without a presenter. The poster should include Tables, Figures, and only little text. When designing the poster, you should use your creativity to give the viewer an impression, which he/she will remember.

File type is power point or pdf. Remember to define the poster size in the setup. If possible, make the pdf file with the option "Press Quality" if using Acrobat Pro (check carefully that you get the result that you expect). The poster will be uploaded on 'Assignments' under 'Poster' with the name 'Team xx poster' and all Team members are to accept the content on DTU Inside. We will print the poster for you.

Task 6: Present the poster at a 28870 student poster conference on the 13st of November. There will be approximately 15 minutes available for presentation of each poster incl. questions and feedback.

- Presentation of the poster should take 8 minutes
- Posters are presented in small groups of students and teachers
- Everyone has to present the poster once

The Paper:

In the paper, the main goal is to analyse and quantify environmental impacts of your scenario compared to the reference case.

Task 1: Implement comments from the poster conference in your work to an extent that you find relevant and practically possible. Define/re-define the system (reference case + scenario) including production of products and services, relevant impact indicators etc. that you want to focus on.

Task 2: Draw simplified system diagrams for your reference case and your scenario with relevant energy- and material flows. Select which energy- and material flows in your two diagrams that you will focus on in the quantitative sustainability assessment. It will not be possible to include everything in the calculations.

Task 3: Conduct a quantitative sustainability assessment in the form of a combined Life Cycle Assessment (LCA) and Net Energy Analysis (NEA) to try to determine the benefits and drawbacks of your developed scenario compared to the reference case. The LCA study may be carried out using appropriate LCA software or spreadsheet calculations. Regardless of method, the LCA should include the following steps:

Step 1: goal and scope are described including all steps as presented in the lecture. Use your system diagrams from Task 2 and 3 to describe the energy and materials flows and distinguish which data you wish to collect and include.

Step 2: Establish an appropriate Life Cycle Inventory (LCI) for the two systems

Step 3: Conduct a Life Cycle Impact Assessment (LCIA), relevant for investigating the sustainability of your scenario compared to the reference.

Step 4: Try to pinpoint hotspots in your systems, and normalize results if relevant.

Based on your LCI and relevant assumptions/simplifications you should also conduct a Net Energy Analysis. Calculate EROI without credit for by-products and with allocation based on energy content if possible. Specify clearly, what is included in the investments (input from society). In the LCA as well as the NEA, principles and assumptions are more in focus than perfect data (which probably do not exist anyway).

Task 4: Prepare a technical paper about your study. The paper may be in the form of a manuscript for a scientific article or as a technical summary for decision makers. Focus on the quantitative analysis conducted in Task 3 above. The plan developed in "Poster - Task 4" should be included, short and precise. The most essential content in this paper are descriptions of the system and assessment methods, relevant considerations and the consistency of the overall analysis. Make sure that you consider how your scenario encompasses sustainable development within a broad range of sustainability principles and criteria. You should also discuss if your solution is scalable beyond your case area, and if the results could be used in different geographical and societal contexts worldwide (perspectives).

The paper should be short and precise and as easy to read as possible. It is recommended to find comparable LCA/NEA studies to find inspiration for the layout and structure. Keeping to the point and cutting to the core are important parts of this assignment. Therefore, the manuscript may be no longer than 4000 words. An appendix spreadsheet may be handed in with the manuscript.

Remember to refer to all sources that you include in your work: submitting someone else's work as your own is plagiarism. The manuscript is automatically scanned after submission.