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Vietnam and Denmark, DE3 Output 2

Guidance for Pre-Feasibility Studies under the EE Incentive Scheme for energy intensive industries in Vietnam

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Aim and content of a pre-feasibility study

This document is a guideline to develop pre-feasibility studies for industrial Energy Efficiency (EE) projects in Vietnam. The guideline is prepared in the context of the Energy Partnership Program between Vietnam and Denmark ~~(DEPP3)-and~~.

The pre-feasibility study is a step towards a final management decision regarding allocating funds for investments – a work sequence that usually comprises several phases:

1. An initial energy audit or screening identifies ~~potentials~~potential to improve energy efficiency and/or reduce ~~CO₂-emissions~~CO₂ emissions from the company's operations.

Separate detailed guidelines for energy audits, feasibility studies and for application for loans for EE projects have been developed and can be downloaded from the DEPP3 webpage.

2. The purpose of a pre-feasibility study is to define relevant alternative technical solutions to obtain a certain energy efficiency potential, and to specify each solution in more detail with regards to financial, environmental and other aspects, such as legal aspects, impacts on production output and product quality etc. Based on such comprehensive assessment, the management will be in a position to decide on a preferred solution, which can then be further detailed in a feasibility study.

The pre-feasibility report is usually for internal purposes only, but for large investment projects, the report might be very useful for a dialogue with possible investors as well as authorities already at this stage.

3. A feasibility study is carried out to precisely define the preferred solution with regards to ~~all -major~~all major uncertainties remaining from the pre-feasibility study, for example in terms of scope, technical solution, investments (CAPEX) and operating costs (OPEX) or other. Based on the feasibility study, the management of the company can finally decide on allocating funds for carrying out the project (Final Investment Decision – FID). A guideline to feasibility studies can be downloaded from- the DEPP3 webpage~~DEPP3-webpage~~.

4. Next step would be a tendering phase. In the tender document, the approved solution is defined ~~into~~in an even greater detail to ensure the desired features and quality of the proposals provided.

5. A contracting phase, where contracts for installations and related works are signed and performance guarantees for the planned project are defined and settled in the contract(s).

6. Project implementation and commissioning.

The guideline is structured according to proposed structure of the pre-feasibility study report.

The pre-feasibility guideline is sought to be aligned with the current regulation e.g., the construction law 2020, article 53 and 54.

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1 Summary

The summary shall report ~~main~~the main findings and conclusions from the pre-feasibility (pre-fs) study of particular relevance to the enterprise management and possible external stakeholders.

The summary should outline the alternative solutions investigated and summarize the features of each solution, including all the characteristics of major importance for ~~the decision~~decision-making on any next steps.

The section should provide a strategic overview of the results of the individual sections of the report, including key financial indicators as well as other important impacts, such as:

- Impacts on the competitiveness of the enterprise in the market, for example as a result of a reduced environmental footprint of the production process
- Impacts on the pollution levels in the local environment
- Impacts on ~~working~~the working environment

The summary must also make clear the level of risks and uncertainty of the findings. ~~If~~if, for ~~example~~example, the project involves a novel application of ~~a specific~~specific technology or if there is a considerable uncertainty ~~around~~about investment costs and similar, such information should be provided in the summary.

Based on this information, the summary should provide a recommendation for ~~selection~~the selection of preferred ~~solutions~~solutions as well as ~~next~~the next steps. Especially when developing complex projects, the pre-fs may still leave several issues open regarding the preferred solution. These should be clearly listed, and if relevant, a feasibility study could be recommended in order to resolve these issues.

2 Background, purpose and scope of project

As basis for the pre-feasibility study, the background, specific purpose and scope of the project shall be described.

2.1 Background

The background section of the pre-fs should include at least the following elements:

Justification of the study

This section should briefly summarize the background for the decision to undertake the pre-fs, for example findings of a preceding energy audit or screening etc.

Existing situation

Brief introduction to the part of the enterprise relevant to the pre-fs, including

- o Process diagram(s),
- o Technologies used (observations regarding age, efficiency etc.)
- o Operation schedule (number of hours per day/week/year)
- o Availability of ~~the existing~~the existing system: Planned and unplanned outages
- o Possible issues with capacity, quality of product output, working environment or others.

Expected enterprise developments relevant to the project

The section should outline the development plans of the industrial enterprise. Such plans could have an important impact on the feasibility of a given energy efficiency project. If for example the enterprise plans to expand the production capacity to an extent where the capacity of the current boiler will not be sufficient, it might not be relevant to upgrade the existing boiler, even if it is very inefficient. On the other hand, ~~replacement~~the replacement of an existing boiler with a new, bigger and more efficient would provide two benefits: increased capacity and reduced energy supply costs. This would increase the attractiveness of such investment significantly.

The chapter should also briefly explain the policy and priority given to energy efficiency.

Outline of relevant alternative interventions

In many cases, a given set of objectives, including increased energy efficiency, may be obtained ~~en~~ in various different ways. For example, a drier system can be optimized in several different ways.

~~First~~The first step should be to consider whether ~~the steam~~steam consumption could be reduced. This could be achieved from such measures as improved process control, insulation of hot surfaces, or use of waste heat from other sources, such as air compressors.

In some cases, the use of steam can be efficiently replaced by other processes. For example, low-temperature processes may more efficiently be supplied by heat from a heat pump.

If ~~steam will~~steam will still be needed, the option of improving the efficiency of the boiler, or ~~replace~~replacing it ~~by~~with another boiler with higher energy efficiency and possibly for use of a different fuel (such as biomass) ~~could be considered~~.

As shown, many different solutions can contribute to the same aim, but with very different implications. In some cases, the best solution is more or less obvious, but in other cases, the choice of solution needs ~~a closer~~closer investigation.

The pre-fs should take a full-system perspective on the opportunities to unfold all relevant opportunities and to be able to identify the best solution. For example, if the heat supply system is inefficient, the analysis should not only include an optimization of the heat supply system. It needs to consider also the consumption of heat:

- Are the thermal processes in the facility efficient? – consider energy losses and assess based on expert experience and of needed: measurements and analysis
- Could the process temperatures be reduced, for example through improved process control?
- Could part of the process heat be met by use of waste heat from other parts of the facility?
- Could input materials be modified (for example with reduced water content)?
- Etc.

If such ~~assessment~~an assessment identifies important improvement opportunities in the process itself, the solutions suggested should include both the heat supply system as well as the thermal processes supplied.

When identifying alternative interventions, due consideration should also be given to not only energy efficiency but also the possible non-energy benefits. For example, replacing a boiler with heat pumps would eliminate emissions of SO_x and NO_x into the environment, helping to comply with current environmental ~~regulation~~regulations. Improving the control system of a drier could reduce drying time and perhaps improve product quality.

From this analysis, the report will list the options that could be relevant to consider – based on expert experience. At this stage, each option will be described just very briefly to be ~~sure~~sure that all relevant options have been taken into consideration.

The ~~rapport~~report will then select 1-3 options, which at this point in the analysis could all be preferred options, depending on the results of the more detailed analysis.

From this list, the report will identify one as the preferred solution to be examined in detail first as the base case.

In some cases, the preferred solution could be obvious. In such ~~cases~~cases, the analysis should consider possible variations over the solutions. If for example it is obvious that there is no alternative to steam supply for the

processes, and if the current boiler needs to be replaced, alternative options could include such elements as selection of fuel, implementation of a heat exchanger to recover waste heat in the process etc.

3 Analysis of baseline project

The level of detail of the description of the business case should be decided based on the situation. Remember that the purpose of the pre-fs is to allow the enterprise to decide whether to invest in a feasibility study of one selected solution. The analysis should only take the steps necessary to facilitate such a decision.

The analysis should be designed to reduce the level of uncertainty regarding the costs and benefits of the project. If, for example, the preferred solution has already been implemented in several other facilities and if the data on costs etc. are available, this could be key information, possibly supplemented with analysis of possible specific concerns if implemented in the enterprise. On the other hand, if there is no strong reference case, the pre-fs may have to involve quite detailed analysis of the entire process to establish the capacities needed, investment costs, the energy consumption required, maintenance costs etc.

3.1 Purpose of project

What are the reasons behind and origin of the project, i.e. for which purpose is the project proposed, for example

- improved energy efficiency
- replacement of existing worn-out equipment
- capacity expansion
- reduced CO₂ emissions or other environmental objectives
- Etc.

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Often energy efficiency projects will meet several of such purposes. The defined purpose of the project should guide the pre-fs, and the conclusions of the report should include an assessment of how well the proposed solutions meet the purposes.

3.2 Scope of the project

The scope of the project includes all physical and logistic elements that will be affected by the proposed project.

- List all the main areas, installations etc. to be affected by the project, such as indoor or outdoor space, equipment etc.
- List the utilities (electricity, water, heating, cooling, ventilation, compressed air) that could be affected by the project, for example changes in the need for utilities.
- List the adjoining processes, buildings etc. that might be affected by the project.
- List any possible relation to development plans of the enterprise, (expansion; new products or processes etc.).

If the project has a major impact on systems supplying other parts of the enterprises, such as a cooling system, compressed air systems etc., it should be considered to expand the scope of the project to include the whole of such system, not only the supply to the project area. For example, the new project might involve a reduced temperature requirement on a refrigeration plant, possibly enabling an increase in cooling compressor suction pressure, which in turn would increase efficiency of cooling throughout the plant.

3.3 Design basis for the project

Any development of energy efficiency projects shall at best be founded on a clear and solid understanding of current and future energy consumption and operating situation for a facility (baseline situation), assuming that the project under investigation in the **pre-fs** report will not be undertaken.

The pre-feasibility study as such shall present a design basis for the project in the following areas.

Present and projected capacities

Depending on the character of the proposed project, an expected future production volume for the facility and the impact from this on the project area in focus should be described.

This might be a question of ~~capacity~~**the capacity** of relevant processes and equipment, but it might also be a question of introducing new ~~process~~**processes** and utility parameters to meet a future energy demand.

Present and projected baseline data

The pre-fs report shall describe current and projected energy and projected consumption and – if relevant – also water consumption at the facility in total and for the specific project area in focus.

First the total annual consumption of each fuel / energy carrier (electricity, steam) should be summarized for the last 3 years and – if needed data is available – the projected energy consumption for the coming years.

Then, for the area and installations to be affected by the project, all relevant costs to be affected by the project **should be listed**.

Next to direct costs for energy and water, other operating costs for the area in focus might be relevant for the project development, for example, costs of labor, maintenance, raw materials, utilities, taxes etc.

Regarding projection of energy prices, it might be relevant to include an assumption on prices of carbon credits, which are expected to be implemented from 2028.

In addition, the baseline data should include current and projected CO₂ emission data, including direct emissions from combustion of fossil fuels as well as indirect emissions from electricity consumption. MONRE updates annually the average CO₂ emission factor for electricity¹.

If relevant, also other greenhouse gas emissions should be accounted for, such as methane or refrigerants with high global warming potential.

Table 1 outlines how this data could be presented in the report.

	2023	2026	2030
Annual product output (tons)			
Annual operation hours (hours)			
Fuel consumption			
Electricity consumption			
Water consumption (m ³)			
Cooling consumption (MWh)			
Compressed air consumption (Nm ³)			

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¹ -Final Report on the Study and Development of Emission Factor for Vietnamese Electrical Grid in 2018, prepared by Ozone Layer Protection and Low Carbon Economy Development Center, Department of Climate Change, MONRE. Access link: https://vepg.vn/wp-content/uploads/2020/09/Final_Report_Emission_Factor_EN.pdf
https://www.google.com/url?sa=t&rl=j&g=&src=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKewiDefGC-baFAxW62QIHdHdHKDG8QFnoECBIQAQ&url=http%3A%2F%2Fwww.dcc.gov.vn%2Fupload%2Fservices%2F1352148718_4.%2520Bao%2520cao%2520cuoi%2520cong_EF2022.pdf&usg=AOvVaw107535cGjvXERbxbnJIXMt&opi=89978449

Fuel price (VND/ton)			
Electricity price (VND/MWh)			
Water price (VND/m ³)			
Annual fuel costs (million VND)			
Annual water costs (million VND)			
Annual utility costs (million VND)			
Annual labor costs (million VND)			
Annual maintenance costs (million VND)			
(Other costs affected by the project) (million VND)			
Annual CO ₂ emissions (tons)			

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Table 1-. Outline of summary of projected product output and related costs of energy, utilities and other costs.

The current and projected situation is to be considered as a baseline for the project.

Other relevant data

The key process data should be reported when relevant. These are parameters critical to the process itself, which should be maintained (and – if relevant optimized) in the proposed project. Such parameters could include pressure, temperature, mass flow etc.

Other relevant data might include possible expected upcoming ~~regulation, regulations~~ that could affect the facility, such as environmental regulation, international market developments and many more.

The areas listed above might not be complete and will depend highly on the project in focus.

Other relevant environmental impacts

Typically, EE projects would have ~~a number of several~~ environmental impacts, which could be grouped into the ~~below categories~~ categories below. For any given project, only a few of the categories may be of relevance.

Pollution of air: This relates to emissions of dust, particles, carbon monoxide, NOx and other substances potentially harming the health of people in the facility as well as in the surroundings and/or plants and animals.

Pollution of water: This relates to harmful substances into water streams or into the ground. ~~Also~~ Also, thermal pollution in the form of heating up water in a stream, for example when using this water for process cooling, can be harmful to life in the stream.

Impacts on extraction / production of raw material / input material: If the project involves adding or removing input material, which have considerable environmental impacts during production and transport, such impacts should be at least mentioned in the report. ~~In many cases~~

4 Solution description

The planned project (base case) should be described in more detail. If there is more than one possible solution to be assessed, one specific solution should be selected for detailed assessment. The alternative solutions should then be described by the ways in which they differ from the main solution (chapter 5).

For the base case, the following should be described:

- The solution principle
- Main equipment and installations to change and/or install

- Assessment of necessary investments (CAPEX)
- Assessment of changes in operating costs (OPEX)
- Assessment of environmental impacts
- Assessment of non-energy benefits

In addition, the project's impact on other areas and activities in the facility should be described.

4.1 Solution principle

The overall principle of the base case should be described and outlined graphically, indicating the main installations as well as the main ~~operation~~operating parameters, see example in figure 1.

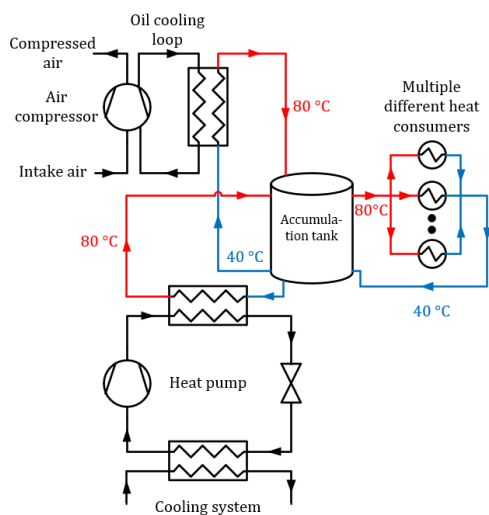


Figure 1. Example of principle diagram for heat recovery project

4.2 Key equipment

A summary of the key equipment to install or change should be provided to describe key elements of the project – ~~first of all~~first for the solution itself, including process equipment, utilities, process control systems etc., ~~secondly~~secondly for other works regarding electrical installations, buildings construction, foundations etc.

An overview table with key equipment and capacities and data for each of these can establish a good overview of the project.

Equipment	Technology	Capacity	Operating data	Comment
New boiler	Steam boiler	8 ton/hour	6 bars	Additional capacity needed and with a new boiler the energy efficiency will increase
Building modifications	-	-	-	Necessitate changes in the building for installing the new boiler.
New stack				New stack for condensing operation and including noise reduction

New steam distribution	Supply to new workshop
Water treatment	Additional capacity needed and a better water quality is desirable
Project costs				Management, design, construction sites insurance etc.

Table 2. Example of summary of key elements for project (example new larger boiler installation)

Often energy efficiency projects necessitate changes in other areas than the key equipment itself, i.e. electrical works, changes of control and automation systems etc. An overview of such implications shall be presented in this section of the pre-fs report.

4.3 Assessment of necessary investments (CAPEX)

Based on the overview of the solution and related works as summarized above, an estimate for the expected investment level (CAPEX) shall be established, as illustrated in table 3.

Equipment	CAPEX (Mill. VND)	Source of information	Level of certainty of assessment	Comments
New boiler	30,000	Quotation	+/- 5%	Cheapest from three bidders
Building modifications	2,000	Estimate	+/- 40%	Own estimate
New stack	4,000	Quotation	+/- 5%	Quotation from one vendor
New steam distribution	6,000	Budget prices	+/- 25%	From one contractor based on a site visit
Water treatment	5,000	Quotation	+/- 5%	Cheapest from two bidders
Project costs	5,000	Estimate	+/- 25%	Estimation of all costs related to the project
Contingency	6,000			Chosen greater than uncertainty
Total	58,000		+/- 11%	Weighted uncertainty

Table 3. Example of overview of CAPEX-elements (hardware)

The sources of this information can be inputs from suppliers of equipment, ~~experiences~~experience from previous facility projects, inputs from service partners and electricians etc. or inputs from experienced specialists and consultants.

No matter what, the project has not been engineered in detail at this stage and uncertainties should therefore be included in the CAPEX-budget as "contingencies".

Next to expected hardware costs, it is however important also to include an overview of other project related costs, by example:

- Own resources for project management
- Assistance from consultants and specialists
- Fees and costs related to approvals etc.
- Other non-energy related cost impacts

The total costs of the project (CAPEX) should be presented with an accuracy of +/- 25% or better at this stage of the project. In any case, the level of accuracy must be indicated in the report.

4.4 Energy savings

Information about energy consumption after implementation of the base case project may again be obtained from reference cases. If such are not available, the report must provide an assessment based on assumptions regarding efficiency and other key parameters. Again, the report should clearly state the assumptions and indicate the level of uncertainty.

Energy cost savings

Future energy costs should be calculated based on the projected energy prices as outlined in chapter 3. The energy cost savings should be assessed for the economic lifetime of the project (the number of years of writing off the investment). Often, assumptions regarding future energy prices may have a significant impact on the financial viability of the project. In such [easesa case](#), the report should show a few different scenarios of price development (sensitivity analyses), indicating how they affect the cost savings.

Assessment of changes in operating costs (OPEX)

Most often, energy efficiency and CO₂-reduction projects aim at reducing energy consumption and therefore are associated with a cost saving and a payback period/return of investment.

As a result of the pre-fs work, results for change of operating costs (OPEX) should be reported summarizing all major elements of the cost picture, i.e.:

- Savings from reduced energy consumption (Mill. VND/year)
- Changed costs from change of energy supply source (Mill. VND/year)²
- Changed maintenance costs, within as well as outside of the project area, such as utilities
- Savings from reduced consumption of water (Mill. VND/year)
- Etc.

Quantification of the value of non-energy benefits

An energy efficiency project might have a number of non-energy benefits, for example:

- Improved sustainability profile - Reduced CO₂ emissions might increase the competitiveness of the enterprise in a market where clients are expecting sustainable manufacturing. Possibly the market division of the enterprise can quantify the value of this.
- Reduced outage hours - Replacement of outdated equipment may reduce planned or unplanned outage hours of the production. The value of this may be quantified by the enterprise.
- Competences – a solution might necessitate new skills and competences of operators, purchasers of raw materials etc., which should be stated as a part of the basis for the project. The associated costs should be quantified.

To the extent that the value of these impacts can be quantified, those values should be included in the financial analysis of the project.

² In case fossil fuel is substituted with electricity for heat pumps, an increased cost for energy can be seen. This could be offset by cost savings from improved product quality, increased production capacity and others.

4.5 Financial analysis of the solution

In order for the management to be able to evaluate the financial benefits of the project, the pre-fs should make a calculation of the key financial indicators: Simple pay-back period, Net Present Value (NPV) and Internal Rate of Return (IRR). In addition, the analysis could show the cash flow, but this may not be required at the pre-fs stage.

A detailed guide to financial analysis can be found in the Guidance for [Feasibility Studies, chapter 33](#). [\(insert link to the guideline\)](#)

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4.6 Other non-energy benefits

In addition to the above-mentioned non-energy benefits that can be valued, there may be a number of impacts which cannot easily be monetized, but which may nevertheless be of great importance to the final decision on how to move forward.

Examples of such impacts are:

- Capacity gains directly on the specific system, but also on related systems
- Quality gains
- Flexibility improvements
- ~~Space requirements~~
- Reduced labor costs
- Future expansion opportunities
- Extension of lifetime
- Reduced waste
- Compliance with regulation
- Space requirements – new installations might require more or less space
- Etc.

More details regarding non-energy benefits can be found in this guideline³.

5 Alternative solution strategies

It is a central part of a pre-fs project to consider and document alternative solutions strategies:

- Are widely different solution technologies available seen from a “helicopter view”?
- Is the scope of the project defined ~~too~~ narrowly?
- Are solutions with higher energy efficiency available?
 - o In terms of boundaries for the project?
 - o In terms of solution scope?
 - o In terms of auxiliary equipment (motors, fans etc.)?
- Can capacity demand for energy-using equipment be reduced by expanding project scope?
 - o Is the project scope too narrow to also include efficiency in related processes and equipment
- Can new technologies (BAT) be considered to cover the whole or parts of the project scope
- Etc.

The assessment of each of the alternative solutions should follow the same principles as described in chapter 4.

The summary should present any relevant alternative solution strategy and which impact this will have on the business case with special attention to investment costs, long-term operating costs and net-present value: NPV, IRR

³

<https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bd4f4af7&appId=PPGMS>

and payback period. The key-data for alternative solutions should be compared directly to the base-case ("no project situation").

Scenario	Investment costs /CAPEX (VND)	Operating costs /OPEX (VND/year)	IRR (VND)	NPV (VND)	CO ₂ emission reductions compared to baseline	Other impacts compared to base case
Main solution						
Alternative A						
Alternative B						
...						

Table 1. Economic and CO₂-comparison of alternative solution strategies

5.1 Other project development questions

Depending on the character of the project, many other questions might be relevant to address in the pre-feasibility phase. Below, some of these are described.

Risk assessment and sensitivities

For the preferred base case and – if relevant – selected alternative scenarios, risks associated with the business case shall be assessed – i.e. if the business case will be significantly impacted by:

- Changes in energy prices
- Changes in production volumes and production mix
- Introduction of CO₂-abatement costs
- Increasing complexity
- Introducing new technology
- Education of staff or lack of knowledgeable staff
- Etc.

For the most important areas, sensitivity analysis should be carried out to assess to which degree the business case will be affected by changing pre-conditions.

The project may also involve certain other risks that the management needs to be aware of before making a decision. For example, there could be ~~technology~~technological risks associated with the new technology, if the application of the technology is not tested under ~~the specific~~specific conditions. Such risks could include impact on the product quality, the costs and time for maintenance and more.

For long-term investments, there may be the risk that the market situation makes the technology obsolete before ~~end~~the end of economic lifetime.

The pre-fs should carefully address all such risks that could be foreseen.

Stakeholders and permits

The pre-feasibility report shall report any relevant stakeholder question that ~~need~~needs to be addressed in the feasibility study, for example, any question related to:

- Neighbors
- Customers
- Supply chain
- Local and governmental authorities

Stakeholder questions can be related to:

- Increased emissions of dust
- Wastewater
- Noise
- Traffic

For certain projects, required building permits, environmental permits etc. should be assessed in the pre-feasibility phase and described in the report.

6 Financing strategy

For large projects, a financing strategy shall be assessed if the company cannot cover investments via its own funds.

The project developer should be aware that sustainability projects with high CO₂-saving potentials might have access to more attractive loan-schemes in banks than projects based on fossil fuels.

7 Conclusions on ~~preferred~~the preferred solution and further steps

The conclusions from the pre-feasibility phase shall be described, first to conclude on a preferred project scope and the most attractive alternative solutions.

Along with these conclusions, recommended further work shall be described, comprising by example:

- Plan for further activities and technical clarifications
- Which resources are necessary in the feasibility phase
- Which competences are to be involved in further work
- Should external experts and specialists be involved
- Should preferred suppliers take a role in further project development
- Final decision on project scope
- Clarification of financing questions
- Dialogue with stakeholders and authorities regarding approvals and permits
- Clarification of own resources and funds for project development
- Clarification of internal milestones and approvals
- Clarification of internal project owner in further project development
- Etc.

An expected time schedule for further project development shall be presented.