



MEMO

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Summary of changes to Version 4

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1. Introduction

The purpose of this memo is to provide the necessary guidelines for the usage of the template dedicated to the collection of green technologies suitable for application into SuperGreen project, distributed among the beneficiaries participating to Work Package WP3.

The following categories of technologies have been taken into account:

- Engines and propulsion systems;
- Fuels and energy sources;
- Cargo handling and transfer technologies;
- Cargo preparation technologies;
- Heating and cooling technologies;
- Innovative loading units and their treatment (cleaning, etc);
- Vehicles;
- Navigation technologies;
- Best practices of technologies integration.

The template is a Microsoft Excel workbook, including one sheet for each of the above mentioned technology groups. For each category a set of indicators and information to be provided has been defined, in order to identify the most relevant characteristics to be used for their assessment. Each set of indicators includes indications which are common to all the technology groups identified, and additional information specific to a single category.

The following sections provide a detailed description of each technology category taken into account in the scope of the project, and the necessary indications to fill in both the common and the specific indicators in the template.

2. General suggestions for template usage

The information to be provided in the template will represent the basis to assess the potential technologies reported, in order to select the final set of innovative technologies which will be proposed for application in the scope of SuperGreen. In order to ensure an effective application of the template, it is suggested to focus only on the technologies considered as the most relevant and promising, rather than indicating all those available for a given category.

Some of the reported indicators (e.g. Readiness level, Time to market...) can be filled in by choosing between a set of pre-defined values; in this case the template includes a drop-down list to facilitate the selection of the most appropriate values.

The other indicators request the provision of hard quantitative data, whose precise value might be not known by the user filling in the template. Should this be the case, two possible approaches are suggested:

- Where possible, provide the best estimation of the quantitative value, accordingly with user's experience. In this case, it is requested to include a comment in the Excel cell containing the value, to indicate that the provided value is estimated;
- Provide at least a qualitative estimation of the indicator, based on a scale from 1 to 5. The meaning of the values in such scale will depend on the characteristics of the considered indicator; as general rule, it is suggested to make reference to the a well-known technology already present on the market, indicating with 1 that the performance of the innovative technology, related to the considered indicator, is much worse than the reference case. Also in this case a comment to the relevant Excel cell shall be added, to provide a brief description of the numeric value reported.

In case neither of the proposed approaches can be applied to a specific indicator, please include anyway the relevant technology in the template, leaving the corresponding cell blank. In any case, please report in the template all promising technologies you consider relevant, even if you are not able to find or estimate some indicators for it.

Finally, the definition of some indicators, as for instance polluting emissions, energy consumption or life cycle cost, might depend on common assumptions or standards. More precise indications will be included in the indicators' description reported in the following sections.

3. Green Technologies Categorization

3.1 Engines and propulsion systems

In this category shall be reported innovative technologies concerning engines and propulsion systems in general, which can be applied to any kind of transport modes on Green Corridors.

3.2 Fuels and energy sources

This category includes technologies related to energy production, including for instance solar panels, wind turbines and other renewable energy sources; furthermore innovative fuels will also be reported.

3.3 Cargo handling and transfer

This category reports technologies related to loading or unloading or cargos, transfer of loading units between different transport modes, internal handling of transport units.

3.4 Cargo Preparation technologies

This category is relevant to all the technologies used to prepare the cargo before it is transported, such as preservatives for perishable goods, packaging, sealing, etc.

3.5 Heating and cooling technologies

This category includes innovative heating or cooling technologies embedded into transport vehicles, implemented into warehouses or used during handling and transfer operations.

3.6 Innovative loading units and their treatment

This category includes new loading units able to reduce and optimize time requested for loading/unloading and transfer operations, as well as energy consumption and pollution emissions in case they embed heating/cooling devices. It also considers any ancillary technology needed for pre or post transport treatment of the loading unit.

3.7 Vehicles

New vehicle concepts with the purpose of improving transport time and reducing pollution emissions shall be reported in this category.

3.8 Navigation technologies

This category is referred to technologies facilitating vehicles navigation during transport, including tracking/tracing, and automatic vehicles identification (AVI).

3.9 Best practices

This category is dedicated to the identification of best practices derived from real use cases, related to the integration of innovative technologies on transport systems, with particular reference to their impact on energy and carbon footprint reduction, and their potential for exportability on different frameworks.

4. Definition of indicators

4.1 Common information

A set of common information to be reported for each considered technology group (with the exception of the “Best practices” category) has been identified, as reported in the following list:

- Technology name;
- Transport mode;
- Short description;
- Provider/Manufacturer;
- Technology readiness level;
- Time to market;
- Needed supporting measures;
- Proposed by.

4.1.1 Technology name

This field has to be filled with the registered name of the technology, or the name with the technology is commonly known.

4.1.2 Transport mode

This field has to be filled with the transport mode(s) related to the considered technology. An automatic list is included in the template to facilitate the selection of the correct value; the following entries are available:

- Maritime;
- Inland Waterway;
- Railway;
- Road;
- Multimodal.

In case the technology is referred to more than a single transport mode, they have to be reported separately in different rows.

4.1.3 Short Description

In this field a brief textual indication of the main characteristics of the considered technology has to be provided.

4.1.4 Provider/Manufacturer

It indicates the company(ies) owing the patent for the considered technology; if referred to a technology not completely developed and released to the market, it indicates the company(ies) or organization(s) which are involved in the research and/or technological development activities.

4.1.5 Technology readiness level

Technology Readiness Level (TRL) is a measure used by some United States government agencies and many of the world's major companies (and agencies) to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to their incorporation into a system or subsystem.

Generally speaking, when a new technology is first invented or conceptualised, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement, and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/subsystem.

The readiness level is identified through a range of values from 1 to 9, as detailed in the following table:

Technology Readiness Levels (Source: Defence Acquisition Guidebook)	
Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Example might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is "low fidelity" compared to the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include 'high fidelity' laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and 'flight qualified' through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.

Technology Readiness Levels (Source: Defence Acquisition Guidebook)	
Technology Readiness Level	Description
9. Actual system 'flight proven' through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.

The Technology Readiness Level field in the template has to be consequently filled in with a value between 1 and 9. A dedicated list is made available in the file, allowing to select the correct value among the pre-defined range.

4.1.6 Time to market

This indicator represents the time (expressed in years) necessary for completing the development of the technology and make it available on the market. An automatic list is included in the template to facilitate the selection of the correct value; in case the foreseen time to market is lower than 1 year, the first value of the list (i.e. "<1") has to be selected.

4.1.7 Needed supporting measures

The implementation of a given technology might request the realization of additional measures (e.g. modification of existing infrastructures, introduction of new working procedures, implementation of other technologies, etc), to be reported in this field.

A brief textual description shall be provided for each foreseen supporting measure; if no supporting measures are needed, it is requested to indicate "N.A." into this field.

4.1.8 Proposed by

Indicates the partner who proposed the technology.

4.2 Engines and propulsion systems

4.2.1 Energy Source

This indicator specifies if the propulsion system is based on the usage of electrical power or fuel, and the typology of fuel used.

4.2.2 Nominal power

Maximum power generated by the propulsion system during normal working conditions, expressed in kilo Watts (kW). This nominal value is normally be made available by the technology manufacturer, accordingly with specific industrial standards.

4.2.3 Efficiency

For electrical propulsion systems, the efficiency is represented by the ratio between the nominal power generated and the power consumed as input. Concerning thermal propulsion systems, the parameter is expressed by the ratio between the amount of energy generated, and the total energy contained in the fuel consumed.

The efficiency parameter is expressed as percentage.

4.2.4 Polluting emissions

The following categories of polluting emissions have to be taken into account:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

Polluting emissions of engines and propulsion systems are calculated as emissions after the exhaust pipe, i.e. including eventual catalytic converters and other pollution abatement processes.

The mentioned indicators are referred to the energy produced by the propulsion system, and have therefore to be expressed in grams per kiloWatt-hours (g/kWh).

4.2.5 Mean Time Between Failures (MTBF)

The MTBF represents the predicted elapsed time between two consecutive failures in operation of the propulsion system, providing an indication of the reliability of the system. It is expressed in hours, and it is normally made available by the manufacturer, accordingly with specific industrial standards.

4.2.6 Life Cycle Cost

The life cycle cost represents the total sum of all costs incurred for the usage of a propulsion system, from its purchase to its disposal, including maintenance costs, operational costs, renewal/revamping costs, etc..

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

In order to take into account the different size (power) of the considered propulsion system, this indicator shall be calculated by dividing the total cost calculated by the nominal power expressed by the system; the indicator is therefore expressed in euros per kW (€/kW).

4.3 Fuels and sources of energy

4.3.1 Energy source produced

It indicates the category of energy made available by the considered source (e.g. electrical, chemical).

4.3.2 Renewable

It indicates whether the considered energy source is renewable or not; the values “Y” or “N” can be selected from the drop-down list included in the template.

4.3.3 Life Cycle Cost

The life cycle cost represents the total sum of all costs incurred for the usage of energy generation systems, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc.

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

In order to take into account the different size (power) generated by the considered system, this indicator shall be calculated by dividing the total cost calculated by the nominal power generated; the indicator is therefore expressed in euros per kW (€/kW).

4.3.4 Polluting emissions

The following categories of polluting emissions have to be taken into account:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

Emissions of primary energy sources, if not directly known, can be derived from tables made publicly available by the European Commission and by Member States, which indicate the average emissions by country or at EU level.

The mentioned indicators are referred to the energy produced by the system, and have therefore to be expressed in grams per kiloWatt-hours (g/kWh).

4.4 Cargo handling and transfer technologies

4.4.1 Average loading cycle time

This parameter represents the maximum number of moves which can be performed by the handling or transfer system in one hour, and is therefore expressed in moves/hour.

4.4.2 Cost per move

This parameter represents the total cost related to a single handling/transfer procedure, divided by the number of necessary moves, and is therefore expressed in €/moves.

4.4.3 Mean Time Between Failures (MTBF)

The MTBF represents the predicted elapsed time between two consecutive failures in operation of the propulsion system, providing an indication of the reliability of the system. It is expressed in

hours, and it is normally made available by the manufacturer, accordingly with specific industrial standards.

4.4.4 Power supply

It indicates the energy source (e.g. electrical, fuel) used by the system.

4.4.5 Energy consumption

This parameter represents the amount of energy consumed per each tonne moved by the system. It is measured in kW/ton.

4.4.6 Polluting emissions

The following categories of polluting emissions have to be taken into account:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

In case the considered technology makes use of electrical power, the emissions shall be calculated referring to the primary energy source. Average values of polluting emissions produced by primary sources can be obtained from tables made publicly by the European Commission and Member States.

The mentioned indicators are referred to the operations performed by the system, and have therefore to be expressed in grams per tonne moved (g/ton).

4.4.7 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of handling/transfer systems, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc.

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

In order to take into account the different operational capacities of the considered systems, this indicator shall be calculated by dividing the total cost calculated by the total volume moved by the system; the indicator is therefore expressed in euros per tonne (€/ton).

4.5 Cargo Preparation technologies

4.5.1 Type of packaging allowed

It indicates all the typologies of packaging (e.g. pallets, boxes) which can be handled by the considered technology. In case the same technology is able to handle different typologies if

packaging, they have to be indicated in separated rows. If different packaging types can be handled at the same time (e.g. pallets+boxes), it also has to be indicated in a separated row.

Figure 1 below provides a visual example on how to fill in the template in case of technologies handling multiple technology types.

ID	Technology name	Short Description	Owner	Technology Readiness Level	Time To Market	Needed supporting measures	Type of packaging allowed	Possibility to recicle	Special procedures allowed	Life Cycle Cost (€)
CP01	Preparation technology 1	First example of cargo preparation technology	Company 1	8	<1	N.A.	Pallets	Y	Treatment of explosive goods	10000
							Boxes	N		
							Pallets+boxes			
CP02		Second example of cargo preparation technology	Company 2	4	3	N.A.	Boxes	N	N.A.	8000
CP03										
CP04										
CP05										
CP06										
CP07										
CP08										
CP09										
CP10										
CP11										
CP12										
CP13										
CP14										
CP15										
CP16										
CP17										
CP18										

Figure 1: Example of Cargo preparation technologies

4.5.2 Possibility to recycle

This parameter indicates whether the considered packaging type can be recycled or reused for several transport. In case the related technology is able to handle different packaging typologies, this indication has to be repeated for each single typology, while it is not necessary for combinations.

The values “Y” or “N” can be selected from the drop-down list included in the template.

4.5.3 Special procedures applied

It reports particular handling procedures allowed by the considered technology, e.g. for treating goods implying risk of explosion, of dangerous gases emissions, release of polluting substances, etc.

4.5.4 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of cargo preparation technologies, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc. It is expressed in euros.

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

4.6 Heating and cooling technologies

4.6.1 Size

This parameter expresses the maximum energy exchange capacity of the system, expressed in kilo-Watt (kW). It is a nominal value made available by the technology manufacturer accordingly with specific industrial standards.

4.6.2 Efficiency

Efficiency is expressed by the ratio between the heating or cooling power produced and the power absorbed, and it is represented as percentage.

4.6.3 Power Supply

It indicates the energy source (e.g. electrical, fuel) used by the system; values “Y” or “N” can be selected from a list already included in the template.

4.6.4 Polluting emissions

The following categories of polluting emissions have to be taken into account:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

In case the considered technology makes use of electrical power, the emissions shall be calculated referring to the primary energy source. Average values of polluting emissions produced by primary sources can be obtained from tables made publicly by the European Commission and Member States.

The mentioned indicators are referred to the heating or cooling capacity of the considered technology, and have therefore to be expressed in grams per kilo Watt (g/kW).

4.6.5 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of heating/cooling systems, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc. It is expressed in euros.

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

4.7 Innovative loading units and their treatment

4.7.1 Dimensions

Indication of the spatial dimensions (expressed in millimetres) of the loading unit, as indicated by the technology manufacturer.

Such information has to be reported in the following format:

Width x Height x Length

4.7.2 Weight

Maximum weight which can be carried by the unit, expressed in tonnes (ton), as indicated by the technology manufacturer.

4.7.3 Space productivity

Amount of back-up land occupied per transported tonne, expressed in square meters (m²).

4.7.4 Heating/cooling unit

It indicates whether the considered loading unit embeds a heating or cooling system; the template allows to choose automatically between “Y” or “N” value.

4.7.5 Power supply

Source of power supply used for heating or cooling system (if present); the indication “Y” or “N” has to be provided, by selecting the right value from the list included in the template.

4.7.6 Energy consumption

Energy consumed by the heating or cooling system (if present), by tonne of goods transported; it is expressed in kW/ton.

4.7.7 Polluting emissions

Polluting emissions have to be indicated only if a heating or cooling system is present.

The following categories of polluting emissions have to be taken into account, in case a heating/cooling system is included into the loading unit:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

In case the considered technology makes use of electrical power, the emissions shall be calculated referring to the primary energy source. Average values of polluting emissions produced by primary sources can be obtained from tables made publicly by the European Commission and Member States.

The mentioned indicators are referred to the total amount of goods transported by the loading unit, and have therefore to be expressed in grams per tonne moved (g/ton).

4.7.8 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of innovative loading units, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc. It is expressed in euros (€).

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

4.8 Vehicles

4.8.1 Mass

Maximum allowable mass of the full loaded vehicle, expressed in tonnes (ton), as indicated by the technology manufacturer.

4.8.2 Capacity

Maximum loading capacity of the vehicle, expressed in cubic meters (m³), as indicated by the technology manufacturer.

4.8.3 Propulsion

Typology of engine used by the considered vehicle (e.g. electrical, diesel).

4.8.4 Loading units transported

List of all loading units which can be transported by the considered vehicle.

4.8.5 Energy consumption

Energy consumed by the considered vehicle per tonne of transported goods, expressed in kilowatt-hour per tonne (kWh/t).

4.8.6 Polluting emissions

The following categories of polluting emissions have to be taken into account:

- Carbon footprint (CO₂ emissions);
- Sulphur emissions (SO₂);
- Nitrogen emissions (NO_x);
- Dust and particles (PM₁₀).

Polluting emissions of vehicles systems are calculated as emissions after the exhaust pipe, i.e. including eventual catalytic converters and other pollution abatement processes.

The mentioned indicators are referred to the path travelled by the vehicle, and are therefore expressed in grams per kilometre (g/Km).

4.8.7 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of vehicles, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc.

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

In order to take into account the different capacities of the considered vehicles, this indicator shall be calculated by dividing the total cost calculated by the total weight of goods transported; the indicator is therefore expressed in euros per tonne (€/ton).

4.9 Navigation technologies

4.9.1 Coverage

This parameter indicates the maximum distance between the transmitting source and the receiver which allows a clear and complete reception of the signal. It is expressed in Kilometres (Km).

4.9.2 Tracking/tracing allowed

It indicates if the considered technology allows the tracking and tracing of a vehicle; the templates allows the automatic selection between the values “Y” and “N”.

4.9.3 Automatic identification

It indicates if the considered technology allows the automatic vehicle identification (AVI); the templates allows the automatic selection between the values “Y” and “N”.

4.9.4 TLC media

It indicates the communication media used by the technology to trace the position and communicating information from and to the vehicle. In case more than a single communication media is used, they have to be reported in separated rows.

4.9.5 Life cycle cost

The life cycle cost represents the total sum of all costs incurred for the usage of the considered navigation technology, from their purchase to their disposal, including maintenance costs, operational costs, renewal/revamping costs, etc. It is expressed in euros (€).

A precise calculation of Life Cycle Cost would require to take into account interest rates and taxation in the country where the technology will be applied. As is it would be difficult to define a precise estimation of the evolution of those parameters in the near future, it is suggested to calculate the LCC considering non discounted costs.

4.10 Best practices

4.10.1 Geographical coverage

It provides information concerning the area covered by the considered case, defining if it is relevant at local/regional level, national level or European level. This indication can be selected from a pre-defined list included in the template.

4.10.2 Transport modes involved

List of the transport modes involved by the considered use case. If more than a single transport mode is used by the considered use case, they have to be listed in separated rows.

4.10.3 Technologies involved

List of innovative technologies involved by the considered use case. If more technologies mode are implemented in the considered use case, they have to be listed in separated rows.

4.10.4 Energy consumption reduction

It is necessary to provide at least an estimation of the energy consumption reduction allowed by the considered practice, taking into account all typologies of energy sources involved. It is expressed as percentage.

4.10.5 Carbon footprint reduction

It is necessary to provide at least an estimation of the carbon footprint (CO₂ emissions) reduction allowed by the considered practice, taking into account all sources of pollution emissions involved. It is expressed as percentage.

4.10.6 Potential for transferability

This parameter provides an estimation of the possibility to replicate the procedures applied in the considered best practice into other real use cases, in order to obtain similar advantages in terms of energy consumption and carbon footprint reduction. It has to be assessed by means of the following set of values:

- Not possible: none of the procedures applied in the considered use case can be replicated in a different situation;
- Low: it indicates that it is possible to replicate only a minor part of the procedures applied in the use case, or that the replicable procedures are the less significative (i.e. having a minor impact on energy and/or carbon footprint reduction);
- Medium: it indicates that most of the applied procedures can be replicated in a different case, but at least one of the most relevant (i.e. having a major impact on energy and/or carbon footprint reduction) can not be transferred;
- High: it indicates that all the considered procedures, or at least all the most relevant ones, can be replicated in an alternative case.

The mentioned values can be selected by means of a drop-down list included in the template.