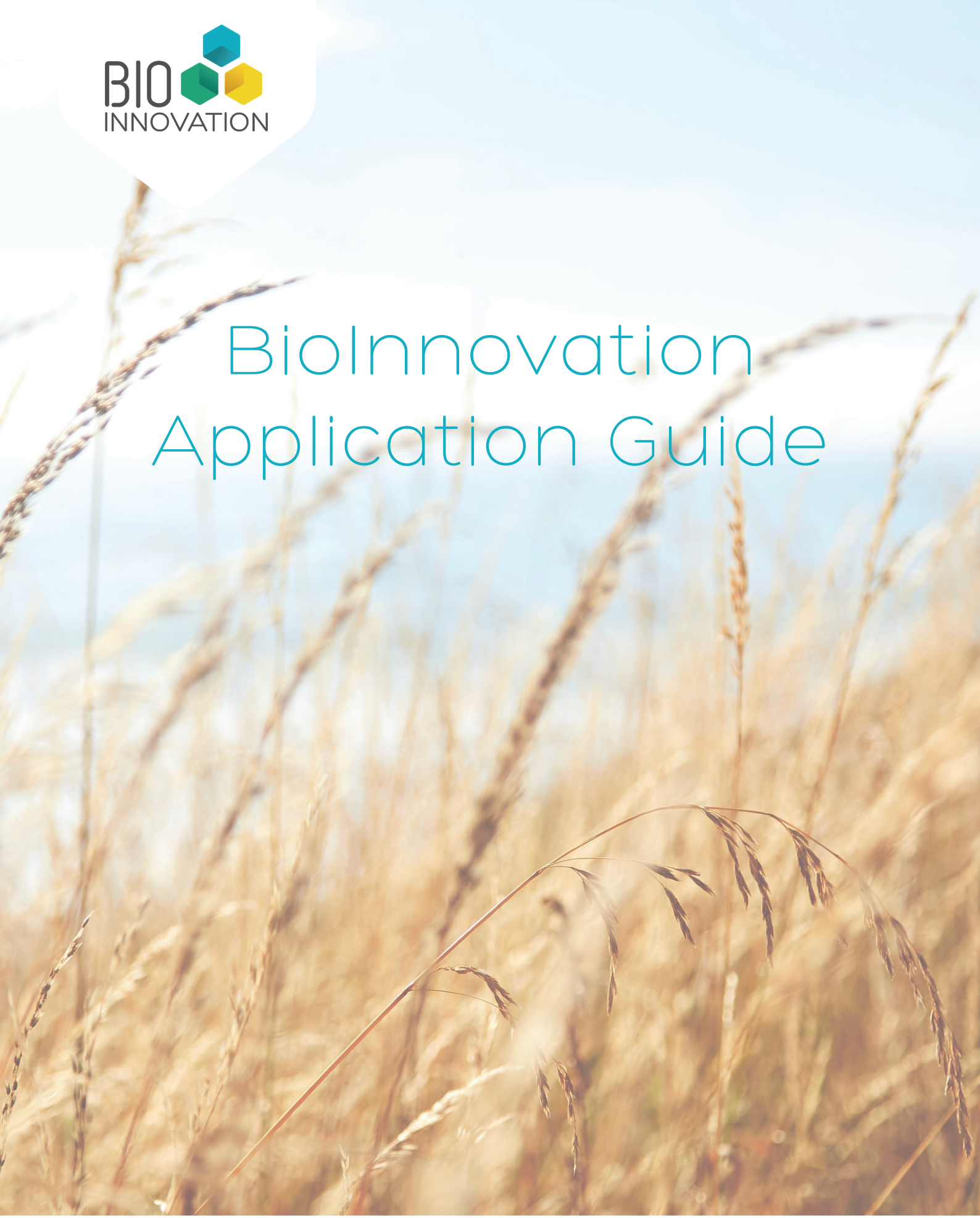
BIO INNOVATION

BioInnovation Application Guide



With support from

VINNOVA Sweden's Innovation Agency

Swedish Energy Agency

FORMAS

Strategic innovation programmes

Initiated by:

Skogs Industrierna

IKEM Innovation and Chemical Industries in Sweden

TEKO SVERIGES TEXTIL- & MODEFÖRETAG

BioInnovation

BIOINNOVATION APPLICATION GUIDE

BioInnovation is a strategic innovation program that aims to strengthen the Swedish competitiveness and contribute to the conversion to a circular biobased economy. Projects for development of biobased products, materials and chemicals funded from the program need to pay attention to three important aspects – Technology, Market and Sustainability – to best contribute to increasing the added value in the Swedish biobased sector.

Purpose and target group

The aim of the BioInnovation Application Guide is to support those who work with an application for one of our calls for proposals, and the external assessors whom Vinnova uses in evaluating applications.

The document defines several key concepts so that they can be interpreted and used in a similar way in applications and by assessors, and it provides suggestions for tools for describing applications' ambition regarding technology, market and sustainability.

BioInnovation's calls for proposals include a call text and an application template. The call text is published on Vinnova's website and sets out the conditions for each call. The call text should be read very carefully. Associated to the call text is an application template – it determines which parts of the application guide are applicable for each call.

General advice to applicants

- Read the call text carefully – read the call text and the application template before the application guide
- Take the TRL, MRL and SRL descriptions seriously – sweeping wording is not enough, but claims must be strengthened and have objective grounds
- Strengthen the credibility of descriptions and arguments, for example through key diagrams / key figures with references
- Only state what the application template requests – long additional descriptions do not ease the assessment

More information

If you have questions of an administrative nature for your application, we recommend that you contact Vinnova's administrator. If you have questions of a different nature, such as content, you are welcome to contact BioInnovation's program manager or officers at Vinnova. Contact information can be found at www.bioinnovation.se.

BioInnovation 2021-11-01.

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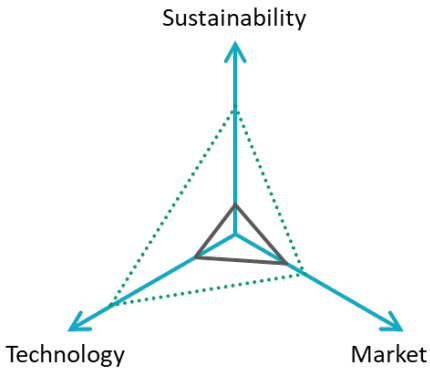
Projects in BioInnovation shall make a transfer in three aspects

Projects in BioInnovation shall realize opportunities in the bioeconomy by contributing to and benefitting from the conversion to a circular biobased economy. A clear effect of a project in BioInnovation shall be a transfer with respect to the aspects Technology – Market – Sustainability. The transfer is described with the scales TRL, MRL and SRL that are introduced on the following pages.

The use of TRL aims to state which technological maturity level is the starting point of the project, and to state which TRL gap the project will bridge.

The use of MRL aims to state which commercial maturity level is the starting point of the project, and to state which MRL gap the project will bridge.

The use of SRL aims to state which maturity level in sustainability assessments is the starting point of the project, and to state which SRL gap the project will bridge.



EXAMPLE OF A PROJECT'S EXPECTED TRANSFER WITH RESPECT TO THE ASPECTS TECHNOLOGY – MARKET – SUSTAINABILITY FROM STARTING POINT (SOLID BLACK LINE) TO END POINT (DOTTED GREEN LINE).

Of course, the three aspects are not independent of each other, and it may even be that an increase in two of them may result in a decrease in the third. It is important to clearly describe the effects of the expected transfer.

The three aspects are discussed in the following sections, as well as how a desired transfer in them should be described. It is, of course, the case that an individual actor or organization may find it difficult to take a position on or describe all three aspects in the way that is requested. That might be an indication that the consortium needs to be expanded to cover the breadth of competencies the project needs for successful implementation.

Note that the concepts TRL, MRL and SRL in the call text and application template always refer to the descriptions in this application guide, even if other descriptions can be found on the Internet.

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The aspect Technology

The aspect Technology is described with Technology Readiness Level (TRL) according to the EU commission definition[1] in the table below. This TRL scale must be used, and the applicant should as far as possible concretize how the respective TRL level is achieved and who made the assessment. This can be done in different ways. A good example of how to provide such information is given by the US Department of Defense. It is briefly described in the section Examples of TRL tools below.

TRL	**Description**
TRL 9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)
TRL 8	System complete and qualified
TRL 7	System prototype demonstration in operational environment
TRL 6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 4	Technology validated in lab
TRL 3	Experimental proof of concept
TRL 2	Technology concept formulated
TRL 1	Basic principles observed

[1] Annex G of the General Annexes to the Horizon 2020 Work Program 2016/2017

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The aspect Market

The aspect Market is described with Market Readiness Level (MRL) according to a subjective estimate of the project's understanding of customer and market based on a *Market Value Proposition*.

There are relevant tools to use to assess and describe MRL levels. NABC and KTH Innovation Readiness Level™ are two examples of such tools. They are briefly described in the section Examples of MRL tools below. You can use them or other tools. The applicant must always strengthen his claims.

MRL is not an unambiguous and generally accepted scale, and BioInnovation uses the table below. Note that all lower levels must be met to reach a higher level.

MRL	**Understanding of customer[2] and market based on a Market Value Proposition**
MRL 9	Product testing or test sales in progress Process in use
MRL 8	Attractive sales opportunities demonstrated based on a documented business and pricing model A business concept has been confirmed to several potential customers and has an estimated successful commercial potential
MRL 7	Opportunity to take a significant share of the market has been proven Collaborations that confirm unique characteristics or functions of the innovation have been established
MRL 6	A detailed picture of the market size / volumes is described The opportunities for commercialization have been developed and demonstrated Potential obstacles have been identified
MRL 5	Critical functions for a solution or product have been delivered to and tested on potential need owners A business concept has been described according to e.g. the NABC model Market needs have been confirmed through interviews or practical tests
MRL 4	The competitive situation and alternatives are analyzed Market acceptance has been tested on a smaller scale
MRL 3	An overview of the market and size / volumes is described Some competitors have been identified
MRL 2	Existing solutions / products on the market are known An IP strategy is formulated, including the right and opportunity for commercialization
MRL 1	A hypothesis about the need owners and the market's needs is formulated

The MRL concept seeks to describe the commercial maturity of a product, process or solution. This includes business strategy, business modeling, marketing, sales, aftermarket support and the like. To achieve success, you need to include this thinking as early in your development process as possible.

[2] The term customer in the table above should be interpreted broadly and refers to the one to which the offer is directed. The customer is thus the one who has the need that the offer is intended to satisfy, and who is prepared to pay or invest. Customer does not have to be an end customer.

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The aspect Sustainability

The aspect Sustainability is described with Sustainability Readiness Level (SRL) according to a subjective estimate of how the project's results contribute to a more sustainable society based on a *Sustainability Value Proposition*.

There are relevant tools to use to assess and describe SRL levels. Some are briefly described in the section Examples of SRL tools below. You can use them or other tools. The applicant must always strengthen his claims.

MRL is not an unambiguous and generally accepted scale, and BioInnovation uses the table below. Note that all lower levels must be met to reach a higher level.

SRL	**Understanding of customer and market based on a Sustainability Value Proposition**
SRL 9	The solution is in use, and a sustainability concept is confirmed from a social, economic and environmental perspective
SRL 8	An extensive system analysis has been carried out with identified sustainability perspectives and commercial opportunities
SRL 7	The opportunity to increase the proportion of products on the market with a positive sustainability perspective has been identified and is considered significant
SRL 6	A detailed analysis of the possibility of increased sustainability has been developed and demonstrated Improvements to the process for increased sustainability have been made Potential obstacles have been identified
SRL 5	Critical functions for a solution or product have been delivered to and tested on potential need owners A sustainability concept has been described, which provides a concrete basis for demonstrating contributions to increased sustainability Sustainability aspects have been confirmed through interviews or practical tests
SRL 4	The solution is assessed and validated on a lab scale, and the results are evaluated from a sustainability perspective Critical factors that affect sustainability have been identified
SRL 3	A general analysis has been carried out from a sustainability perspective, and has been compared with some competing solutions
SRL 2	Existing solutions / products on the market are known from a sustainability perspective
SRL 1	A hypothesis about how the solution / product contributes to increased sustainability is formulated

The SRL concept seeks to describe how a product, process or solution contributes positively to improved sustainability from a social, economic and environmental perspective. To achieve success, you need to include this thinking as early in your development process as possible. To assess design for sustainability in a fair way, you need to include the entire value chain or life cycle in your assessment.

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About BioInnovation

BioInnovation is a strategic innovation program with focus on a Swedish circular bioeconomy. All the program's efforts should contribute to and benefit from such a development. The road there goes through broad collaboration, and winners are both climate and environment as well as Swedish competitiveness and exports.

Vision and mission

The program’s vision is that Sweden has made the conversion to a circular biobased economy by 2050.

To achieve this, the program's mission is to create the best conditions for increasing the added value in the Swedish biobased sector.

Raw materials

BioInnovation funds projects whose raw materials come from the forest, fields, water or residual streams.

Delimitations

Projects within BioInnovation are largely expected to bridge a TRL gap that lies within the span TRL 2-7. There are no delimitations for MRL and SRL.

BioInnovation has made the strategic choice not to fund projects that manly aim to develop animal feed, food or medicines, nor projects that mainly work with primary raw material supply (cultivation, management and harvesting of bio-raw materials).

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Basic concepts

Biobased economy

BioInnovation follows the definition of biobased economy formulated by the Swedish Research Council Formas[3]:

The conversion to a biobased economy involves a transition from an economy that is largely based on fossil raw materials to a resource-efficient economy based on renewable raw materials produced through the sustainable use of ecosystem services from land and water.

A biobased economy is an economy based on:

- *Sustainable production of biomass to enable increased use in a number of different societal sectors. The purpose is to reduce the climate impact and the use of fossil raw materials.*
- *An increased added value of biomass, while minimizing energy consumption and utilizing nutrition and energy from the end products. The purpose is to optimize the value of ecosystem services and contributions to the economy.*

BioInnovation usually uses the shorter term bioeconomy, rather than the longer biobased economy.

Circular economy

In the definition of circular economy, BioInnovation is inspired by a report from the Investigation on circular economy ("Utredningen cirkulär ekonomi") [4], and formulates this definition:

Circular economy is an economy where waste in principle does not occur and which has the potential to be ecologically, economically and socially sustainable.

A circular economy is an economy based on:

- *Keeping resources in the society's cycle as long as possible by circulating products, components and materials. The purpose is to optimize resource utilization.*
- *Managing finite resources, balancing the use of renewable resources, and returning resources to nature's own cycles in a sustainable way. The purpose is to preserve and strengthen the natural capital.*
- *Designing processes, products and materials for reuse and recycling. The purpose is to help man act circularly.*

Circular business models

BioInnovation borrows the definition of circular business models from Linder and Williander[5].

The term *business model* refers to how a company creates and captures economic value. Value is created by proposing a solution to a problem of a customer at a cost less than the value of the solved problem. The value is captured by charging the customer a price for the solution to the problem. It is common to iteratively refine and test a new business model before and during a gradual and small-scale market launch, and then heavily invest in scale once key assumptions have been verified.

[3] Forsknings- och innovationsstrategi för en biobaserad samhällsekonomi, Formas, Report R2:2012 (*Only available in Swedish*)
[4] Från värdekedja till värdecykel – så får Sverige en mer cirkulär ekonomi, SOU 2017:22 (*Only available in Swedish*)
[5] Linder, M and Williander, M., "Circular Business Model Innovation: Inherent Uncertainties", Business Strategy and the Environment 26 (2015), pp 182-196

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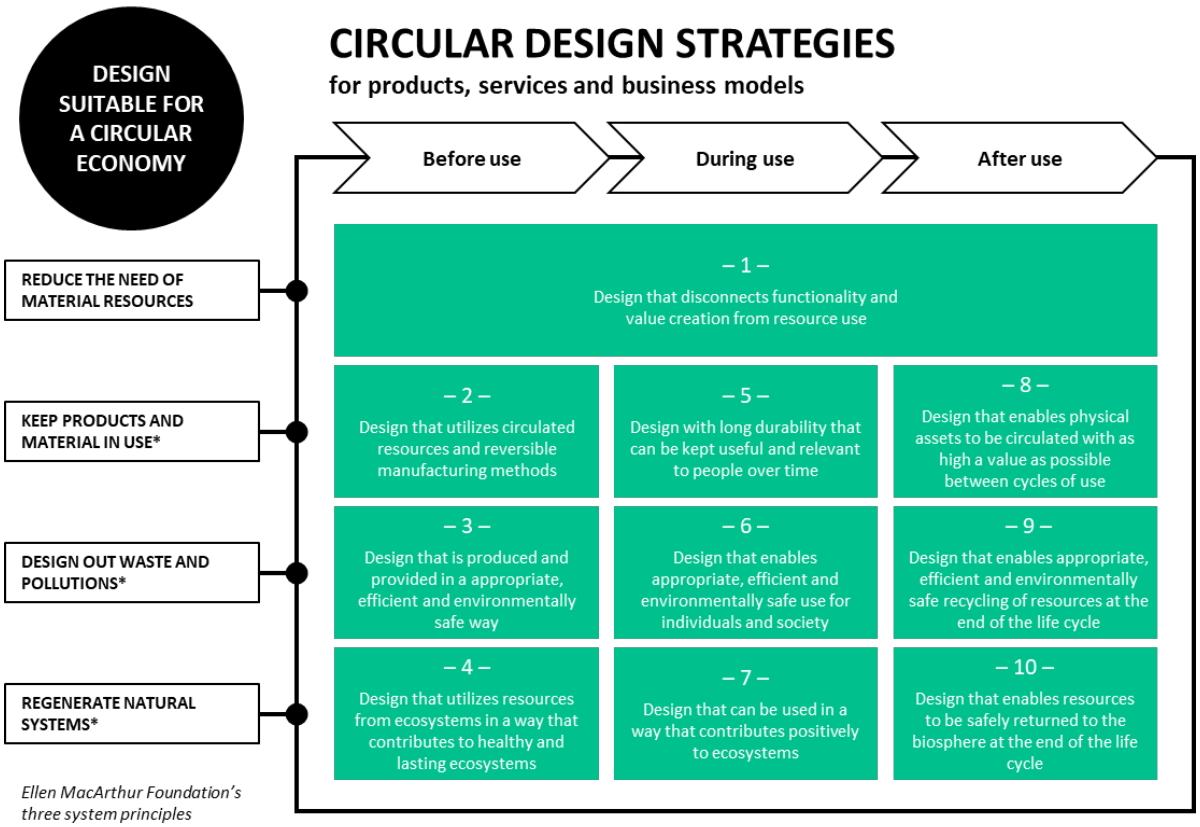
We define a *circular business model* as a business model where value creation is based on new offers utilizing the economic value retained in products after use. A circular business model strives for closed resource loops to minimize resource needs and resource leakage.

Circular design strategies

BioInnovation agrees with the descriptions in the final report from the Expert Group for Circular Design Principles[6].

The expert group has developed a framework for circular design strategies that is partly based on the Ellen MacArthur Foundation's three system principles for a circular economy. The framework has been developed to function as support and inspiration for those who want to concretize their work with design for circular economy.

The framework comprises a matrix with a total of ten design strategies that describe characteristics that make a certain design (product, service or business model) suitable for a circular economy. The design strategies should be seen as indicative – although they are all important for a circular economy, some will be more relevant for certain sectors than others.



Ellen MacArthur Foundation's three system principles

The expert group's final report contains explanations of the concepts used, as well as clear descriptions of each of the ten circular design strategies.

[6] Selvefors, "Final report for the Expert Group for Circular Design Principles" (2020), part of the *Delegation for Circular Economy* appointed by the Swedish Government (*Only available in Swedish*)

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APPENDIX: EXAMPLES OF TRL, MRL AND SRL TOOLS

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Examples of TRL tools

Technology Readiness Assessment Guidance

The U.S. Department of Defense has developed an in-depth description of the TRL levels, and supplemented it with examples of which supporting information can be used to substantiate alleged TRL levels[7]. This is the starting point for their assessment and development decisions.

TRL	Definition	Description	Supporting Information
9	Actual system 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 (OT&E). Examples include using the system under operational mission conditions.	OT&E reports.
8	Actual system completed and 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 (DT&E) of the system in its intended weapon system to determine if it meets design specification.	Results of testing the system in its final configuration under the expected range of environmental conditions in which it will be expected to operate. Assessment of whether it will meet its operational requirements. What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before finalizing the design?
7	System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).	Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?

[7] Technology Readiness Assessment (TRA) Guidance. U.S. Department of Defense, April 2011 (full report: https://www.gao.gov/assets/680/679006.pdf, summarizing table: https://www.ncbi.nlm.nih.gov/books/NBK201356/)

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TRL	Definition	Description	Supporting Information
6	System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of 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 a simulated operational environment.	Results from a laboratory testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?
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 they can be tested in a simulated environment. Examples include “high-fidelity” laboratory integration of components.	Results from testing laboratory breadboard system are integrated with other supporting elements in a simulated operational environment. How does the “relevant environment” differ from the expected operational environment? How do the test results compare with expectations? What problems, if any, were encountered? Was the breadboard system refined to more nearly match the expected system goals?
4	Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively “low fidelity” compared with the eventual system. Examples include integration of “ad hoc” hardware in the laboratory.	System concepts that have been considered and results from testing laboratory-scale breadboard(s). Reference to who did this work and when. Provide an estimate of how breadboard hardware and test results differ from the expected system goals.
3	Analytical and experimental critical function and/or characteristic proof of concept	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	Results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. References to who, where, and when these tests and comparisons were performed.

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TRL	Definition	Description	Supporting Information
2	Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.	Publications or other references that outline the application being considered and that provide analysis to support the concept.
1	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.	Published research that identifies the principles that underlie this technology. References to who, where, when.

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Examples of MRL tools

NABC

NABC is a systematic method developed at Stanford Research Institute to support development, assessment and presentation of ideas and innovations. It consists of four parts that together define the approach's *Market Value Proposition*.

NABC: An important customer or market need addressed by a unique approach with compelling benefits when compared against the competition or alternatives.

Need	What are the customer's needs? A need should relate to an important and specific customer or market opportunity, with market size and end customers clearly stated. The market should be large enough to merit the necessary investment and development time.
Approach	What is the compelling and unique solution to the specific customer need? As the approach develops through iterations, it becomes a full proposal or business plan, which can include market positioning, cost, staffing, partnering, deliverables, a timetable and intellectual property (IP) protection.
Benefits (per cost)	What are the customer benefits of the approach? Each approach to a customer's need results in unique customer benefits, such as low cost, high performance or quick response. Success requires that the benefits be quantitative and substantially better - not just different.
Competition	Why are the benefits significantly better than the competition? Everyone has alternatives. You must be able to tell the customer why the solution represents the best value. To do this, you must clearly understand the competition and the customer's alternatives. You must be able to clearly state why the approach is substantially better than that of the competition. The answer should be short and memorable.

It is not enough to fill in an NABC with sweeping formulations – it must be confirmed against potential customers and the claims must have factual grounds. Short, factual and quantitative information is preferred.

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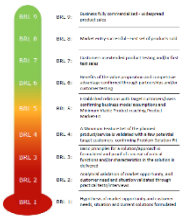
KTH Innovation Readiness Level™

KTH Innovation at the Royal Institute of Technology has developed a model, KTH Innovation Readiness Level™ [8], that assesses innovation development in six key areas, each with a scale 1-9 that resembles the TRL scale. The image gives an indication of how the scale is designed.



Questions to support the assessment of MRL

In addition to the above-mentioned examples of MRL tools, you can benefit from a set of structured questions to make your own assessment of MRL.

- **Overall market overview**: Will environmental performance and financial metrics throughout the value chain be positive or better than competing alternatives?
- **Trends**: Are there market trends that contribute to the attractiveness of the solution? Are there requirements from authorities that contribute positively to the market potential?
- **Market potential**: How big is the market – existing and forecast? What are the conditions for a significant market share within 3-5 years?
- **Use of biobased and circular raw materials and resources**: Will the use of biobased and circular raw materials and resources make the market react positively and the proportion of products increase faster than the general GDP (gross domestic product)?
- **Competitors and competing systems**: What are the main competitors and competing solutions on the market?
- **Base of need owners**: Is the intended base of need owners identified, including volume / size?
- **Target group (needs owner)**: Can the new solution be easily sold with good contacts?

[8] https://kthinnovationreadinesslevel.com/about/

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Examples of SRL tools

Global Reporting Initiative and UN Global Compact

A solid material has been produced jointly by the Global Reporting Initiative, which issues standards for the design of sustainability reporting, and the UN agency United Nations Global Compact. The material is based on the UN's 17 goals for sustainable development (Sustainable Development Goals, SDGs) and its 169 targets. The purpose of the material is to show how sustainability can be business-driving and how sustainability reporting can be an effective way of communicating in line with SDGs.

The document *Business Reporting on the SDGs: An Analysis of the Goals and Targets*[9] analyzes all 17 SDGs and 169 targets, and provides a uniform mechanism for sustainability reporting in a comparable and effective way.

The document *Integrating the SDGs into Corporate Reporting: A Practical Guide*[10] offers a structured approach to help companies choose which SDGs and targets to report on and how reporting can be used to drive action.

The documents are intended to be used together to support a structured and effective selection that communicates intentions and results in sustainability issues. The documents are thus also valuable sources of description of sustainability arguments for new products and services – this by providing support in the selection of relevant SDGs and targets, as well as examples of business-driving sustainability communication.

Sustainability assessments from a life cycle perspective

A life cycle analysis (LCA) is a decision basis for the development of existing products and processes. There are many environmental issues to consider, and a life cycle analysis makes it possible to deal with several of them in parallel. To be able to make relevant comparisons, it is very important that functional units and system boundaries are chosen correctly. A complete LCA forms the basis for an environmental product declaration, and provides a complete picture of the entire life cycle. The Swedish Life Cycle Center[11] is a good entrance to the LCA area.

In development work, a sustainability assessment from a life cycle perspective should be made, where sources with the greatest environmental impact are identified, and where assumptions are made for things that are not yet known. As you learn more about the product or process, the sustainability assessment can be refined.

[9] https://www.unglobalcompact.org/library/5361
[10] https://unglobalcompact.org/library/5628
[11] https://www.lifecyclecenter.se/lca-data-base/

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Questions to support the assessment of SRL

In addition to the above-mentioned examples of SRL tools, you can benefit from a set of structured questions to make your own assessment of SRL.

- **Overall**: Will environmental performance and financial metrics throughout the value chain be positive or better than competing alternatives?
- **Trends**: Is there policy development related to sustainability that contributes to the attractiveness of the solution?
- **Toxicity and ecotoxicity**: Is the new solution considered to contribute significantly to the reduction of toxicity or ecotoxicity?
- **Energy efficiency**: Will the energy use be more efficient than for existing solutions?
- **Use of biobased and circular raw materials and resources**: Will the use of biobased and circular raw materials and resources be more resource efficient than for existing solutions?
- **Emissions and waste**: Will the amount of emissions and waste decrease compared to existing solutions?
- **Transports**: Will the new solution contribute to reduced transportation compared to existing solutions?

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APPENDIX: RISK ANALYSIS

A simple risk analysis is done by identifying the most significant risks and describing them in words. Thereafter, probability and consequence for these are estimated in order to obtain a risk value as a color and/or number. Finally, measures taken to reduce the greatest risks are identified and described.

Below is a risk analysis table filled in with some simple examples with estimated probability (P) and consequence (C).

Risk description	**P x, C x**	**Risk reduction measures**
Material deliveries cease	P 3, C 3	Sign agreements with several suppliers
Key person quits	P 2, C 4	Educate more people with key knowledge
Business-critical data is stolen	P 1, C 4	Store data on servers without an Internet connection

Below is a matrix for risk assessment where risk value – as a color or number – is obtained based on estimated probability and consequence.

4. Serious consequence The project cannot be carried out	4	8	12	16
3. Tangible consequence Parts of the project can not be completed	3	6	9	12
2. Mild consequence Probably not endangering the project	2	4	6	8
1. Negligible consequence Insignificant impact on the project	1	2	3	4
	1. Unlikely There is no indication that the event will occur	**2. Low probability** There are single or ambiguous signs that the event will occur	**3. Significant probability** There are several and clear signs that the event will occur	**4. Very high probability** The event will occur sooner or later

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Initierat av: Skogs Industrierna, IKEM, TEKO Sveriges Textil- & Modeföretag, BIOINNOVATION