greenSME

DRIVING MANUFACTURING SME TRANSFORMATION TOWARDS GREEN, DIGITAL AND SOCIAL SUSTAINABILITY

Deliverable 3.1
The greenSME Sustainability Assessment Tool and ASAP definition method

This project has received funding from the European Union's Horizon Europe Programme under grant agreement No 101058613

DELIVERABLE INFORMATION	
Author(s)/ Organisation(s)	Oscar Revilla & Jaione Agirre (Tekniker) & Nelli Kononova & Max Juraschek (TUBS)
Document type	Report
Document code	D3.1
Document name	The greenSME Sustainability Assessment Tool and ASAP definition method
Status	Version 1.0
Work Package / Task	WP3 / Task 3.1 & Task 3.4
Delivery Date (DoA)	M5 (31.10.2022)
Actual Delivery Date	M6 (07.11.2022)

DELIVERABLE HISTORY			
Date	**Version**	**Author**	**Summary of main changes**
28.10.2022	1.0	TEK	

LIST OF CONTRIBUTORS			
Date	**Version**	**Contributor**	**Summary of main changes**
26.09.2022	1.0	TEK	Document structure
26.10.2022	1.0	TEK	Intro and Sustainability Assessment points
28.10.2022	1.0	TUBS	ASAP method points

LIST OF REVIEWERS			
Date	**Version**	**Reviewer**	**Summary of main changes**
03.11.2022	1.0	SA&AM	Refinement of descriptions

DISSEMINATION LEVEL		
PU	Public	**X**
PP	Restricted to other programme participants (including the EC services)	
RE	Restricted to a group specified by the consortium (including the EC services)	
CO	Confidential, only for the members of the consortium (including the EC)	

greenSME partners

Funded by the European Union

DISCLAIMER

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

GreenSME ● Grant Agreement: 101058613 ● 2022 – 2025 | Duration: 36 months

Topic: HORIZON-CL4-2021-RESILIENCE-01-29

Executive Summary

The vision of greenSME is to strengthen SMEs' capacity for advanced technologies adoption to foster manufacturing industry sustainability shift. This vision will be deployed through the **SME sustainability transformation pathway** which gathers the whole process of guidance that will be provided to the SMEs to support them in their shift towards sustainability.

The SME sustainability transformation pathway starts by evaluating the degree of awareness and maturity of the SMEs regarding sustainability and Advanced Technologies (AT) deployment, to finally identify sustainability related hotspots. In addition, a specific SME might require additional support in its sustainability shift. In such case, an Advanced Sustainability Action Plan (ASAP) will be designed as a sustainability roadmap for the SME.

Work package 3 "Sustainability Assessments and ASAP definition" aims to strengthen manufacturing SMEs capacity for Advanced Technologies adoption for improving its social, environmental and economic sustainability. At this stage of the project development, the following **Advanced Technologies** have been identified to be promoted:

Table 1. List of 16 Advanced Technologies (6 Key Enabling Technologies plus 10 Digital Technologies)

Advanced Manufacturing	**Big Data**	**Industrial Biotechnology**	**Nanotechnology**
Advanced Materials	**Blockchain**	**Internet of Things (IoT)**	**Photonics**
Artificial Intelligence	**Cloud Computing**	**Micro- and Nanoelectronics**	**Robotics**
Augmented & Virtual Reality	**Connectivity**	**(IT for) Mobility**	**(Cyber)Security**

This deliverable **D3.1 The greenSME Sustainability Assessment Tool and ASAP definition method**, describes:

- The "Sustainability Assessment Tool".
- The "Advanced Sustainability Action Plan definition method".

in terms of the tool´s purpose, methodology and scheduled output, by its own, and the relation between the two methods within the SME pathway to sustainability.

This document is intended for the consortium members as to ensure common understanding of the main tools for SME support to be applied in the project.

Funded by the European Union

Table of contents

List of acronyms

AI	Artificial Intelligence
ASAP	Advanced Sustainability Action Plan
AT	Advanced Technology
ATI	Advanced Technology for Industry
EU	European Union
HR	Human Resources
IP	Intellectual Property
IT	Information Technology
KET	Key Enabling Technology
LCA	Life Cycle Assessment
ROI	Return Of Investment
R&I	Research & Innovation
SME	Small and Medium-sized Enterprise

List of greenSME partners

Consortium partner	**Expertise and role in greenSME**
AFM	Cluster organisation for advanced manufacturing & machine tool industry in Basque Country
CIM4.0	Competence centre & innovation HUB for digital (4.0) and technological development of manufacturing industry in Piemonte
Danish Board of Technology (DBT)	Social innovation and participation in the technological & sustainable development of society. HUB strategy and concept development, community building
F6S	Communication and digital solutions
MESAP	Cluster organisation for smart manufacturing in Piemonte
SA&AM	Cluster organisation for the automotive sector in Silesia
TEKNIKER	Research and technology centre specialised in Advanced Manufacturing, Surface Engineering, Product Engineering and ICTs technologies
Technical University of Braunschweig (TUBS)	University, department for Sustainable Production and Life Cycle Engineering
Technical University of Dortmund (TUDO)	University, social innovation research centre for SMEs in regional and sectoral ecosystems and sustainability roadmap

List of Figures

List of Tables

1. Introduction

The vision of greenSME is to strengthen SMEs' capacity for advanced technologies adoption to become competitive and climate neutral, maximizing the benefits for all parts of society, starting from the upskilling and reskilling of workers toward a sustainable EU manufacturing industry, with greater adaptability and resilience.

This project vision implies SMEs to develop a strategic approach to sustainability. It handles the following challenges:

(i) Increase SMEs awareness and knowledge about sustainability´s role in their business.
(ii) Strengthen manufacturing SMEs capacity for advanced technologies and social innovation uptake for economic, social and environmental sustainability.
(iii) Strengthen EU sustainable manufacturing ecosystem, by developing a roadmap for the existing clusters in Europe to develop strategies to support sustainable businesses.

Manufacturing SMEs are the project main target group to accelerate the sustainability adoption, but also a public engagement approach will ensure that any development is inclusive and fair within a strong EU manufacturing ecosystem.

In this context, **Work package 3 "Sustainability assessments and ASAP definition**" aims to strengthen manufacturing SMEs capacity for Advanced Technologies (AT) adoption for sustainability by assessing their current sustainability development stage and supporting them defining a sustainability pathway.

Sustainability must be addressed within the three key pillars: social, economic and environmental. SMEs sustainability transformation pathway, developed in greenSME (Figure 1), will guide SMEs to identify the key issues to be considered to become more sustainable, define their sustainability action plan and provide the necessary technological expertise and financial support to achieve it.

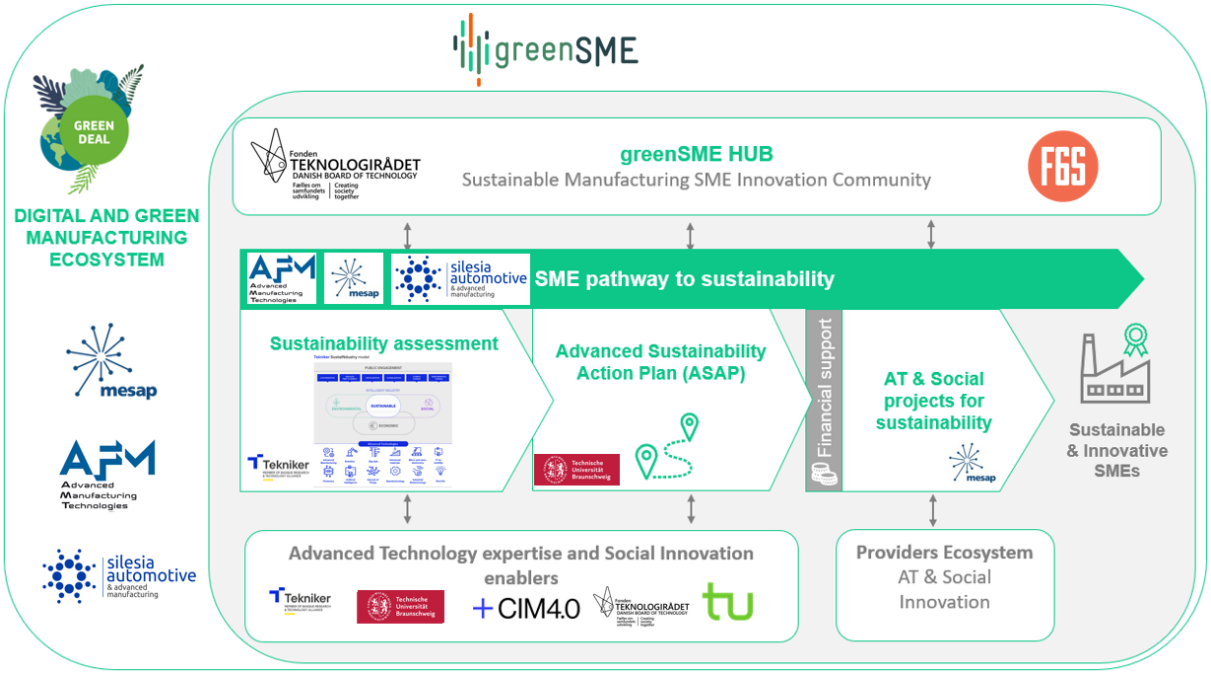


Figure 1: greenSME project diagram

The pathway includes sustainability advisors service to support SMEs into their 3-pillar based sustainability strategies assessment, advanced action plan definition and project deployment. To do so, the advisors, who will be trained within the project and provided with tailored tools, will guide SMEs to have access to the appropriate expertise for sustainable manufacturing field.

This deliverable **D3.1 The greenSME Sustainability assessment tool and ASAP definition method, describes the "Sustainability assessment tool" and the "Advanced Sustainability Action Plan definition method" in terms of the tool´s purpose, methodology and scheduled output, by its own, and the relation between the two steps within the SME pathway to sustainability.**

1.1. Sustainability transformation pathway

The SME sustainability transformation pathway gathers the whole process of guidance that will be provided to the SMEs to support them in their shift towards sustainability.

It starts by evaluating the degree of awareness and maturity of the SMEs regarding sustainability and Advanced Technologies deployment, to finally identify sustainability related hotspots.
Moreover, SME might require additional support in their sustainability shift, and an Advanced Sustainability Action Plan (ASAP) will be designed as a sustainability roadmap for the SME.

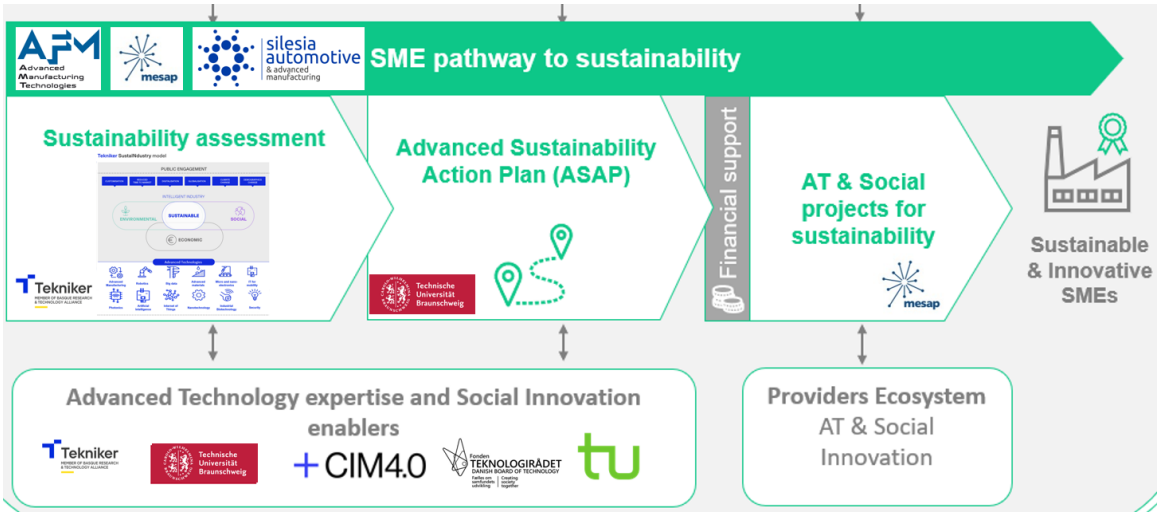


Figure 2: greenSME sustainability transformation pathway

The sustainability assessment has been based on SustaINdustry model (©Tekniker, 2020), a qualitative model that guides industrial companies through economic, environmental and social sustainability pillars review in order to seek unbalances and growth opportunities.
To emphasize social perspective, the SustaINdustry model has been upgraded by the consortium into the greenSME Sustainability Assessment Tool. TEK, CIM4.0, TUBS, and TUDO have a broad experience in innovation and sustainability assessment processes and sustainability roadmaps definition with and for industrial SMEs.

This sustainability assessment will be mandatory for further Advanced Sustainability Action Plan (ASAP) development, and to be eligible for the financial support to deploy one of the prioritized projects devoted to achieve significant improvement of SME's sustainability.

The types of activities for SME's sustainability assessment that can be funded by greenSME Open Call have been also detailed by the consortium (Table 2). The sustainability projects will involve the application of Advanced Technologies and/or Social Innovation topics. The SMEs will require the involvement of Advanced Technologies (AT) and/or Social Innovation providers for sustainability deployment. The matching between SME needs and suitable AT provider (or Social Innovation provider) will be possible through the greenSME HUB platform once the SME has identified possible fields of action (or hotspots) and has already prioritized and selected at least one project and defined the type of activity (or activities) to be implemented.

Table 2. Type of activities supported by greenSME Open Call

Type of activity to foster sustainability (Projects for greenSME support in the Open Call)
Feasibility study (markets, planning, risks, implementation costs, finance, ROI…)
Prototyping (new product, service design, simulations, 3D printing, ….)
Pilot testing (small-scale study…)
Demonstrating (mock-up…)
Consultancy services (Business model, LCA, carbon footprint, ISO 14001, energy savings, water/waste management, recycling, Ecodesign, innovation….)
Coaching services (identify skills, training, corporate culture, transformation process, economic/financial advice, technological support….)
Definition and/or adaptation of business processes (strategy + governance, HR, value/supply chain, logistics, marketing, compliance, reporting….)
Use testing facilities (free access and support)
New IT solutions (planning, configuration, programming, training…)

If SME requires additional support, an Advanced Sustainability Action Plan (ASAP) will be designed as a sustainability roadmap for the SME. It might include Advanced Technologies (AT) expertise knowledge to define proof of concept, investment readiness, adaptation to standards, adaptation to environmental rules, design management, skills development, partner(s) search or collaboration with the Horizon IP Scan Service, an IP advisory service lead by the European Commission to support EU SMEs to efficiently manage and valorise IP in R&I efforts project definition.

1.1.1. Advanced Technologies

EU's ongoing project Advanced Technology for Industry (ATI[1]) focuses on advanced technologies that will enable and help industries to successfully manage a shift towards a low-carbon and knowledge-based economy. The following 16 Advanced Technologies have been identified, highlighted in green those of particular interest for the green sustainability transformation for the SMEs:

Table 3. List of ATI's 16 Advanced Technologies

Advanced Manufacturing	**Big Data**	**Industrial Biotechnology**	**Nanotechnology**
Advanced Materials	**Blockchain**	**Internet of Things (IoT)**	**Photonics**
Artificial Intelligence	**Cloud Computing**	**Micro- and Nanoelectronics**	**Robotics**
Augmented & Virtual Reality	**Connectivity**	**(IT for) Mobility**	**(Cyber)Security**

[1] *https://ati.ec.europa.eu/*

This set of advanced technologies has been obtained by aligning two previous initiatives, one based on Key Enabling Technologies or KETs (Advanced Materials, Advanced Manufacturing technologies, Industrial Biotechnology, Nanotechnology, Micro- and Nanoelectronics and Photonics) and the other based on Digital Technologies (Artificial Intelligence, Augmented & Virtual Reality, Big Data, Cloud Computing, Cybersecurity, Blockchain, Internet of things, (IT for) Mobility, Connectivity and smart Robotics), and bearing in mind the industry as user of these technologies.

Some definitions for these Advanced Technologies are:

1. **Advanced Manufacturing Technology**

Advanced manufacturing technology encompasses the use of innovative technology to improve products or processes that drive innovation. Some typical examples of Advanced Manufacturing are the Additive Manufacturing (or 3D printing), the automation (mainly with collaborative robots), the Laser Manufacturing (for cutting or welding), and the use of 3D simulations, IT networks, Artificial Vision, Advance Materials or Nanotechnology for manufacturing improvement.
So it can be defined as the use of innovative technologies to refine existing products, and the creation of new products, including production activities for improving quality, productivity and practices that depend on information, automation, computation, software, sensing and networking.

2. **Big Data**

Big Data is a term describing the continuous increase in data, and the technologies needed to collect, store, manage and analyse it. It is a complex and multidimensional phenomenon, impacting people, processes and technology.
From a technology point of view, Big Data encompasses hardware and software that integrate, organise, manage, analyse, and present data which is characterised by "four Vs": volume (size of the data sets), velocity (high speed of data processing), variety (different types and sources of data used), and veracity (high quality of analysed data).

3. **Industrial Biotechnology**

Industrial Biotechnology or white biotechnology is the application of biotechnology for the industrial processing and production of chemicals, materials and fuels.
It includes the practice of using microorganisms or components of micro-organisms like enzymes to generate industrially useful products in a more efficient way (e.g. less energy use, or less by-products), or generate substances and chemical building blocks with specific capabilities that conventional petrochemical processes cannot provide.

4. **Nanotechnology**

Nanotechnology is an umbrella term that covers the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometer scale.
Nanotechnology holds the promise of leading to the development of smart nano and micro devices and systems and to radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing.

5. **Advanced Materials**

Advanced materials lead both to new reduced cost substitutes to existing materials and to new higher added-value products and services. Advanced Materials offer major improvements in a wide variety of different fields, e.g. in aerospace, transport, building and health care.
They facilitate recycling, lowering the carbon footprint and energy demand as well as limiting the need for raw materials that are scarce in Europe.

6. **Artificial Intelligence**

Artificial Intelligence (AI) is a term used to describe machines performing human-like cognitive functions (e.g. learning, understanding, reasoning or interacting…).
It comprises different forms of cognition and meaning understanding (e.g. speech recognition, natural language processing…) and human interaction (e.g. signal sensing, smart control, simulators…). In terms of its technology base AI is a very heterogeneous field. While some aspects like sensors, chips,

robots as well as certain applications like autonomous driving, logistics or medical instruments refer to hardware components, a relevant part of AI is rooted in algorithms and software.

7. Augmented/Virtual Reality

Augmented reality devices overlay digital information or objects with a person's current view of reality. As such, the user is able to see his or her surroundings while also seeing the AR content. Virtual reality devices place end users into a completely new reality, obscuring the view of their existing reality. Augmented reality is enhanced by computer-generated perceptual information across multiple sensory, visual or auditory modalities. The user experience is closely interwoven with the physical world and is perceived as an immersive aspect of the real environment.

8. Blockchain

Blockchain is a digital, distributed ledger of transactions or records, in which the ledger stores the information or data and exists across multiple participants in a peer-to-peer network. Distributed ledgers technology allows new transactions to be added to an existing chain of transactions using a secure, digital or cryptographic signature. Blockchain protocols aggregate, validate, and relay transactions within the blockchain network. Blockchain technology allows the data to exist on a network of instances or "nodes," allowing for copies of the ledger to exist rather than being managed in one centralized instance.

9. Cloud Computing

Cloud computing includes the delivery of tools and applications like data storage, servers, databases and software based on a network of remote servers through the Internet. Cloud computing services enable users to store files and applications in a virtual place or the cloud and access all the data via the Internet. Public cloud services are available on public networks and open to a largely unrestricted universe of potential users, designed for a market, not a single enterprise.

10. Connectivity

Connectivity refers to all those technologies and services that allow end-users to connect to a communication network. It encompasses an increasing volume of data, wireless and wired protocols and standards, and combinations within a single use case or location.

Standard connectivity includes Fixed Voice and Mobile Voice telecom services to allow fixed or mobile voice communications, but also Fixed Data and Mobile Data services to have access and transfer data via a network.

Advanced connectivity that is in the focus of the ATI project refers to the rise of Internet of Things scenarios, where connectivity technology boundaries expand beyond wired and cellular (e.g. 4G, 5G) services to Low Power Wide Area Network (LPWAN), Satellite, and Short Range Wireless technologies (e.g. Bluetooth, ZigBee).

11. Internet of Things

The Internet of Things (IoT) refers to the network of smart, interconnected devices and services that are capable of sensing or even listening to requests. IoT is an aggregation of endpoints that are uniquely identifiable and that communicate bi-directionally over a network using some form of automated connectivity. The Internet of Things relies on networked sensors to remotely connect, track and manage products, systems and grids. The Industrial Internet of Things (IIoT) – a subset of the larger Internet of Things – focuses on the specialized requirements of industrial applications, such as manufacturing, oil and gas, and utilities.

12. Micro- and Nanoelectronics

Micro and nanoelectronics deal with semiconductor components and/or highly miniaturized electronic subsystems and their integration in larger products and systems. They include the fabrication, the design, the packaging and test from nano-scale transistors to micro-scale systems integrating multiple functions on a chip.

13. (IT for) Mobility

Mobility technology is more than just autonomous vehicles, ride hailing and e-scooters and e-bikes. It also includes electrification (electric vehicles, charging/batteries), fleet management and connectivity (connectivity, data management, cybersecurity, parking, fleet management), auto commerce (car

sharing), transportation logistics (freight, last-mile delivery), and urban air mobility. So IT for Mobility covers a large number of different technology areas and markets, but also includes all kinds of technologies that make people more mobile (like for example mobile phones etc.). These, however, consist of a large set of sub-technologies that are hard to capture at the same time.
The enterprise mobility market is made up of a conglomeration of mobile solutions and technologies, including hardware, software and services, empowering a borderless workforce to securely work anywhere, at any time and from any device, but also all the tools and applications for transforming key processes, from internal operations to operations with customers and suppliers, all the way from the shop floor to the top floor and from the back office to the end customers.

14. Photonics

Photonics is a multidisciplinary domain dealing with light, encompassing its generation, detection and management. Some typical uses are the Laser Manufacturing, the Optical sensors, the high-power LEDs and the Solar or Photovoltaic cells.
Among other things it provides the technological basis for the photovoltaic conversion of sunlight to electricity which is important for the production of renewable energy, and a variety of electronic components and equipment such as photodiodes (in optical fibre or optical sensors), LEDs (in displays and lighting) and lasers for manufacturing (in cutting or welding).

15. Robotics

Robotics is a technology that encompasses the design, building, implementation, and operation of robots. Robotics includes applications designed to conduct a specific task or series of tasks for commercial purposes. These robots may be stationary or mobile but are limited in function as defined by the intended application. Multipurpose robots are capable of performing a variety of functions and movements determined by a user that programs the robot for tasks, movement, range, and other functions and that may change the effector based on the required task. These robots function autonomously within the parameters of their programming to conduct tasks for commercial applications and may be fixed, "moveable," or mobile. Cognitive robots are capable of decision making and reason, which allows them to function within a complex environment.

16. (Cyber)Security

Security products are tools designed using a wide variety of technologies to enhance the security of an organization's networking infrastructure — including computers, information systems, internet communications, networks, transactions, personal devices, mainframe, and the cloud — as well as help provide advanced value-added services and capabilities. Cybersecurity products are utilized to provide confidentiality, integrity, privacy, and assurance. Through the use of security applications, organizations are able to provide security management, access control, authentication, malware protection, encryption, data loss prevention (DLP), intrusion detection and prevention (IDP), vulnerability assessment (VA), and perimeter defence, among other capabilities.

Fostering the use of Advanced Technologies in greenSME

Focusing on the spectrum between the manufacturing sector, green sustainability, technological and social innovation, greenSME will promote any of the listed technologies in order to contribute to a shift towards climate neutral manufacturing. However, as the HUB develops and relations and synergies between different technologies and sustainability solutions are identifiable, it is possible that the practical use of technologies are specified throughout the project.

Technologies marked in green in the table above (Table 3) have been categorised as particularly interesting for use in the green sustainability transformation for the SMEs in manufacturing sector – focusing on the three cluster regions of the project, SA&AM cluster – located in Silesia, Poland (automotive & advanced manufacturing), MESAP innovation cluster of Piemonte region – located in Italy (smart manufacturing) and AFM cluster in Spain (advanced machine tool manufacturing). It is

possible that further specifications of most relevant technologies for greenSME project is made during the coming months of the project.

1.1.2. SME eligibility

The vision of greenSME project is to strengthen SME capacity for Advanced Technologies and/or Social Innovations adoption to become competitive and climate neural. Therefore, the project has defined an eligibility criteria to involve targeted industry companies.
The following table (Table 4) shows the SME eligibility criteria for financial support

Table 4. SMEs eligibility criteria

SME eligibility	
Eligible SMEs to participate into the transformation pathway	Companies with a workforce of 10 to 250 employees, turnover up to €50 million and/or balance sheet total up to €43 million, located in the EU and which carry out industrial activities, services related to industry, the information and communications society and logistics.
Other requirements	Register into the greenSME HUB and fulfil identification company information.
Eligible SME to receive funding	It is mandatory that SME completes the greenSME sustainability assessment, to opt for financial support within the project. SMEs that have developed a greenSME sustainability assessment and have a project idea considered in greenSME.
greenSME label to validated SMEs	SME will receive a greenSME label which certificates that the SME is working in its sustainability pathway.

2. Sustainability Assessment Tool

2.1. Sustainability Assessment Framework

Sustainability Assessment Tool Background

The greenSME Sustainability Assessment Tool is based on previous SustaINdustry assessment tool (©Tekniker, 2020). The SustaINdustry assessment tool was co-created (co-design and validated) between Tekniker and industrial companies, and it is a qualitative tool to guide SME to assess their current sustainability development and make a guided exploration about technology and sustainability.

This qualitative tool, which had produced good results with the industrial SMEs, required wide expertise on the side of the adviser and significant amount of time to be devoted to the companies.

The greenSME Sustainability Assessment Tool is an evolution of the previous model, and it has included the missing social area and it has been enhanced with business model assessment in order to ensure sustainability fits into SME strategy. Moreover, the greenSME Sustainability Assessment Tool has been developed as a web-based tool, within the private space for SMEs in the greenSME HUB, will enable SME to obtain a sustainability assessment and the identification of hotspots or areas of improvement.

2.1.1. Sustainability Assessment Tool Structure

First step for development of the greenSME Sustainability Assessment Tool was to define a framework to better understand and organise the areas where industrial sustainability should be assessed.

The assessment framework, which is explained later in this chapter, provides a structured conceptual map of the key areas to be evaluated within a SMEs with regard to their green transformation, along with details on the main topics that should be addressed in each of the areas (and their relationship with other topics on the framework).

As earlier pointed out, the greenSME Sustainability Assessment has been based on the former SustaINdustry model (©Tekniker, 2020), so for the new framework definition the consortium developed a mind map over several brainstorming sessions (Figure 3) to identify as much as possible ideas or issues, rank them according to their relevance to the greenSME goals, and finally group them into main blocks for the SMEs sustainability assessment.

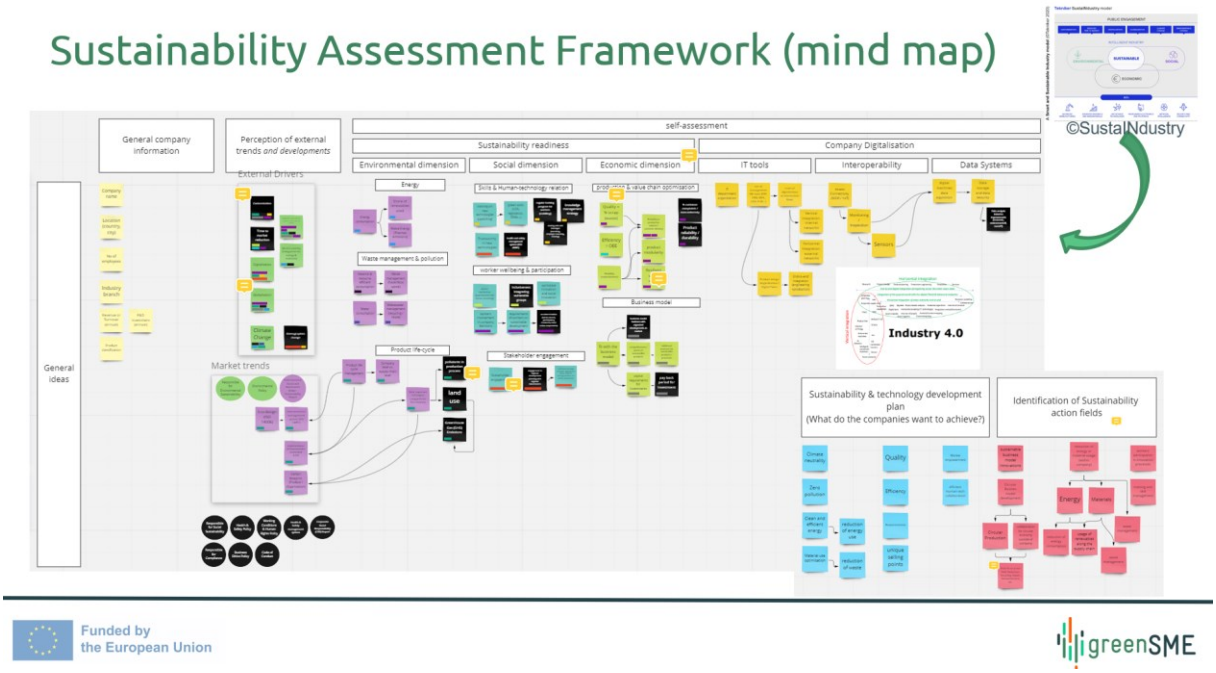


Figure 3: Mind map board for the Sustainability Assessment Framework

During the new framework definition process, the consortium also dealt with a better understanding of what SMEs want to achieve when going towards sustainability transformation, which further led to the identification of some possible fields of action common to most manufacturing companies to achieve long-term sustainability.

2.1.2. Hotspots definition

The final list of hotspots or predefined list of fields of action agreed by the consortium is the following (Figure 4): ENERGY, MATERIALS, WATER, WASTE MANAGEMENT, PRODUCT(S) LIFE-CYCLE, PROCESS(ES) AND PRODUCTION, VALUE / SUPPLY CHAIN ,WORKERS (SKILLS & TRAINING), WORKPLACE (WELLBEING & TECHNOLOGY RELATION), STAKEHOLDERS' ENGAGEMENT, SUSTAINABLE BUSINESS MODEL INNOVATION.

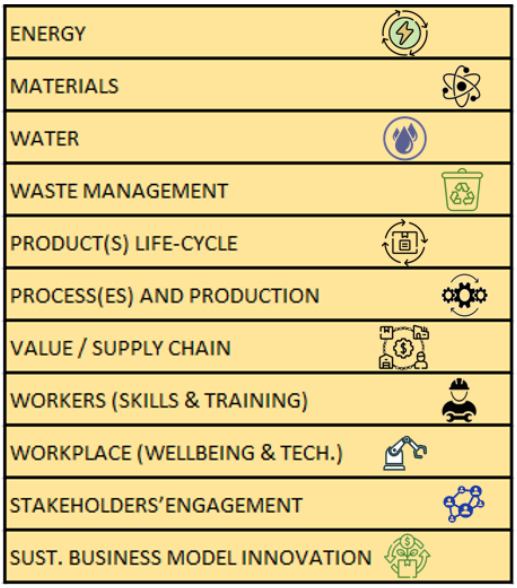


Figure 4: List of 11 Hotspots

In total, 11 hotspots have been identified for a green transition. Energy, materials & related waste management and products life-cycle are more under the scope of the environmental dimension. Likewise, production, value chains and business model are more under the scope of the economic dimension, and workers, workplace and stakeholders' engagement issues are more under the social dimension.

Sustainability Assessment Tool Framework

Based on greenSME project the main goal of fostering sustainability, the Sustainability Assessment Tool must address the three key pillars of the sustainability, that are the economic, social and environmental, but also other key areas emerged from the internal discussions during the Sustainability Assessment Framework definition (Figure 5).

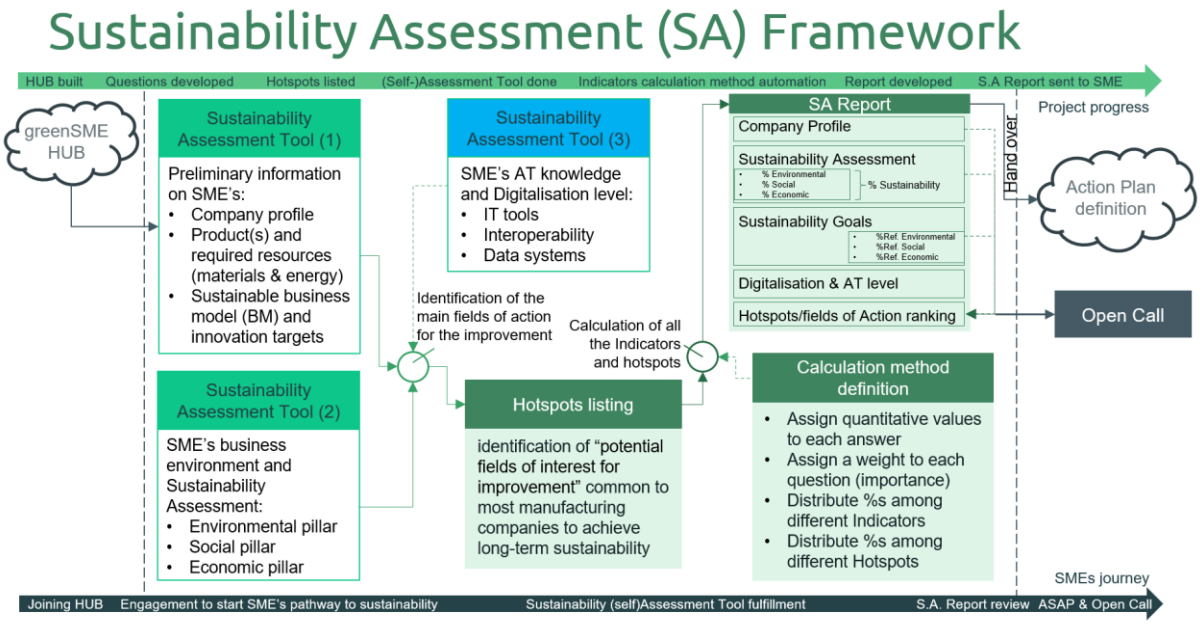


Figure 5: Sustainability Assessment Framework

First is the need to get enough information to create a company profile, namely general company information (name, country). Besides the required identification of the company, other key issues to better understand possible sustainability requirements are the company size (by number of employees and turnover), its industrial branch or sector, the type of products manufactured (for selling or service providing), and the main types of resources (materials and energies) used for that. Although this information to create a basic profile of the company is delivered earlier by the SME during the registration to the greenSME HUB, it is relevant for the sustainability assessment, so it is also included in the framework.

Once the company activity and sectorial environment are known, it is also important to get some insight into the company business strategy, getting some feedback about its current business model to respond to strategic social and environmental issues and its medium-term targets to make it more sustainable.

Another key area to assess the company is to know about the business environment in which the company works, so the framework also includes market trends or external drivers for sustainability development. This block mainly focusses on the impact from four issues, namely the ongoing digitalisation on the sector, the socio-economic globalisation, the climate change effects, and the

stakeholders' requirements both on social and environmental sustainability. This business context should be used as the reference to set the goals for the company on its sustainability transformation.

The current status of the company on each of the three sustainability pillars is also addressed in the framework with blocks specifically dealing with several aspects of its internal management, namely the sustainability management, the supply chain, the energy, the materials, and the environmental management within the SME.

And to cope with the full overview of the company capacity for the Advanced Technologies (AT) adoption to become more sustainable, it is also important to know or assess its background on the use of such these technologies as well as the existing digitalisation level on the SME.

And finally, the specific assessment of each sustainability pillar, i.e. environmental, social and economic, for the identification of the main weaknesses of the company regarding the predefined list of fields of action or hotspots.

In the following figure it is show a summary of the main areas of the defined Sustainability Assessment Framework ordered in a logical pathway for the evaluation of the SMEs.

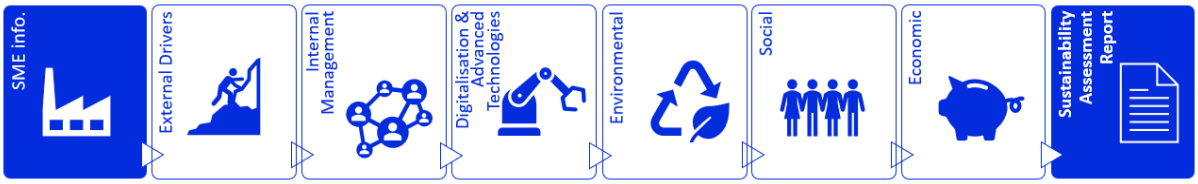


Figure 6: greenSME Sustainability Assessment Framework areas

2.2. Assessment Tool description and use

The purpose of the Sustainability Assessment Tool is to identify the key issues to be taken into account to achieve sustainability in industrial SMEs (strengthen SMEs' capacity for Advanced Technologies adoption), and to provide some indicators to place them within the sustainability transformation pathway.

The diagnostic assessment is performed by an online survey, through a questionnaire to be filled out by each SME willing to go into the sustainability transformation pathway. At first the design of the tool was thought as a guidance (qualitative) tool where the target company needed the support of an experienced sustainability advisor, by means of several interviews, to be able to provide responses to the questions in a way so that valuable results can be extracted. But later it was transformed into a self-assessment tool, with questions easier to respond by the SME on its own and that could be evaluated in a more quantitative way.

The final questionnaire also facilitates its development as a web tool because the range of possible answers for each question are already predefined in most of the cases. The aim of the consortium was to facilitate the use of the Sustainability Assessment Tool by the SMEs in general, and to spread its use as much as possible through the greenSME HUB website in the future.

Finally, there are 101 questions in total to assess the 8 main areas of the Sustainability Assessment Framework (Figure 5). There is at least one question addressing each topic that was included previously in the framework (Figure 3), grouping all the questions of the same area in different sections within the questionnaire.

Additionally, the questionnaire pursues following goals: To develop the Sustainability Assessment Report in a quick and easy way for the sustainability indicators calculation and the hotspots identification, to create a company profile (including preliminary information on SME's sustainable business model innovation and potential fields of interest) and to set sustainability *status quo* of the company for the Advanced Sustainability Action Plan (ASAP) development (Figure 7).

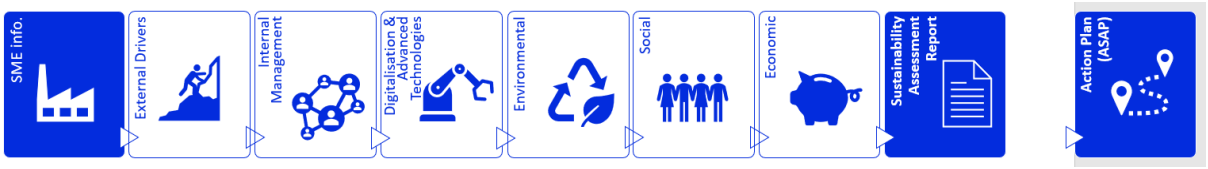


Figure 7: Sustainability Assessment Tool and ASAP method development

The Sustainability Assessment Tool questions are grouped in 12 sections, 5 of them corresponding to subsections for the Internal Management block of the framework. The headings for the sections in the tool are:

1) General company information
   - ✓ Now Including (Sustainable) Business Models innovation
2) External Drivers for Sustainability development
   - ✓ Digitalisation / Globalisation / Climate Change / Stakeholders
3) Internal Management:
   1. Sustainability mngmt.
   2. Supply Chain mngmt.
   3. Energy mngmt.
   4. Materials mngmt.
   5. Environmental mngmt.
4) Company Digitalisation
   - ✓ IT tools / Interoperability / Data systems
5) Advanced Technologies knowledge
6) Environmental assessment
7) Social assessment
8) Economic assessment

The last 3 sections correspond to the 3 pillars of the sustainability assessment regarding to the identification of the hotspots or potential fields of action for the improvement.

'General company information' needed to create a basic company profile (country, sector, number of employees and turnover), by using text boxes, radiobuttons and dropdown lists for the answers, as well as the type of products manufactured, and the types of resources used (materials and energies), by using multi-choice checkboxes for the answers, are already asked to any SME joining the greenSME HUB on the platform registration form. Besides, this section also includes few questions regarding sustainable business model innovation, both for environmental and social sustainability, as well as the potential interest of the company in making it more sustainable in short-term, by using radiobuttons with predefined answers on this category.
These questions are not asked again the Sustainability Assessment Tool questionnaire, but their responses from the greenSME HUB registration form are very useful in twofold. Business model responses are mainly oriented to the Advanced Sustainability Action Plan definition, but also contribute to environmental and social indicators for the SME. Company profile info will be used in the future to create SME's Advance Technologies adoption statistics and might also improve the recommendations of the action plan. Products, materials and energies in the SME can be used to

highlight some of the predefined hotspots, mainly those related to energy, materials, products life-cycle, production and value chain.

Questions in the 'External Drivers' section deal with four main topics, namely the digitalisation of company's sector, the globalisation of the markets, the climate change effects and the stakeholders' requirements for the company. Each topic has three to five subtopics detailing specific aspects of each topic, by using radiobuttons with the same predefined answers for all the subtopics (as a Likert scale). The answers in this section are mainly oriented to the definition of the goals or reference levels for each of the sustainability pillar, but also can be used to highlight the predefined hotspots.

Question grouped within 'Internal Management' deal with five main sustainability topics, namely sustainability management, supply chain, energy, materials and environment issues, by using radiobuttons with the same predefined answers for all the questions in this category.
The answers in this section are mainly oriented to the assessment of SME's current sustainability development stage on each of the 3-pillar approach to sustainability, but also can be used to highlight the predefined hotspots.

The 'Company Digitalisation' section has 11 questions to evaluate the existing digital maturity of the SME. This part is included in the assessment tool because smart use of clean digital technologies can serve as a key enabler for green transition on industry, which has come to be called the Industry 5.0.
Questions in this section only contribute to Digitalisation level indicators for the SME, composed of a general indicator and three specific indicators for different aspects related to IT-based technology: IT tools, Interoperability and data systems.
Taking advantage on these questions, the assessment tool also includes a section to ask about SME's previous knowledge on the use of Advanced Technologies and express future intentions of application. The answers related to the Digital Technologies (Artificial Intelligence, Augmented & Virtual Reality, Big Data, Cloud Computing, Cybersecurity, Blockchain, Internet of things, IT for Mobility, Connectivity and smart Robotics) also contribute to Digitalisation level indicators.

Finally, the questions on the last 3 sections dealing with 'Environmental / Social / Economic assessment' are intended to highlight the predefined list of hotspots. 'Environmental assessment' mainly for those related to energy, materials, water, waste management, products life-cycle, production and value chain. 'Social assessment' mainly for those related to workers, workplace and stakeholders' engagement. And 'Economic assessment' mainly for those related to waste management, production, supply chain and sustainable business model innovation.
But taking advantage on the correspondence of these sections to the 3 sustainability pillars, the answers in these sections are also used on the assessment of SME's sustainability indicators.

Sustainability Assessment Tool calculation method is explained later in this document, on the section for the Assessment Tool Report (chapter 2.2.2).

2.2.1. Assessment Tool implementation

The implementation of the Sustainability Assessment Tool on the greenSME project (Figure 8) has been distributed within the greenSME HUB platform, developed by F6S, and the internal platform of Tekniker for response data analysis and development.

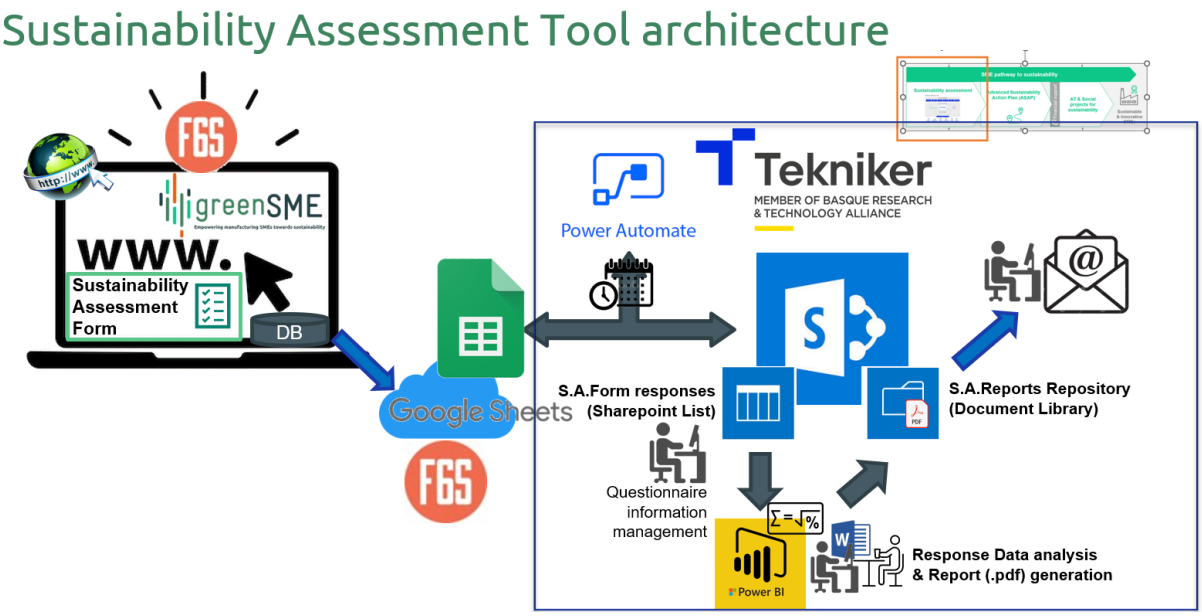


Figure 8: Sustainability Assessment Tool architecture

As all greenSME users' interactions in the HUB, the Sustainability Assessment Tool questionnaire form is being integrated in the greenSME website in order to engage, interactive and visually appeal such that people staying on the greenSME community.

Meanwhile, the questionnaire has been also implemented by means of MS Forms tool for the pilot testing (Figure 9) of the Sustainability Assessment Tool with specific SMEs. At least one SME has been selected by each Cluster to contrast the understanding of the concept and the clarity of the questions, as well as the usability of the assessment tool. Feedback from pilot tests has been used to better organise or adjust some questions on the form prior to final Sustainability Assessment Tool release.

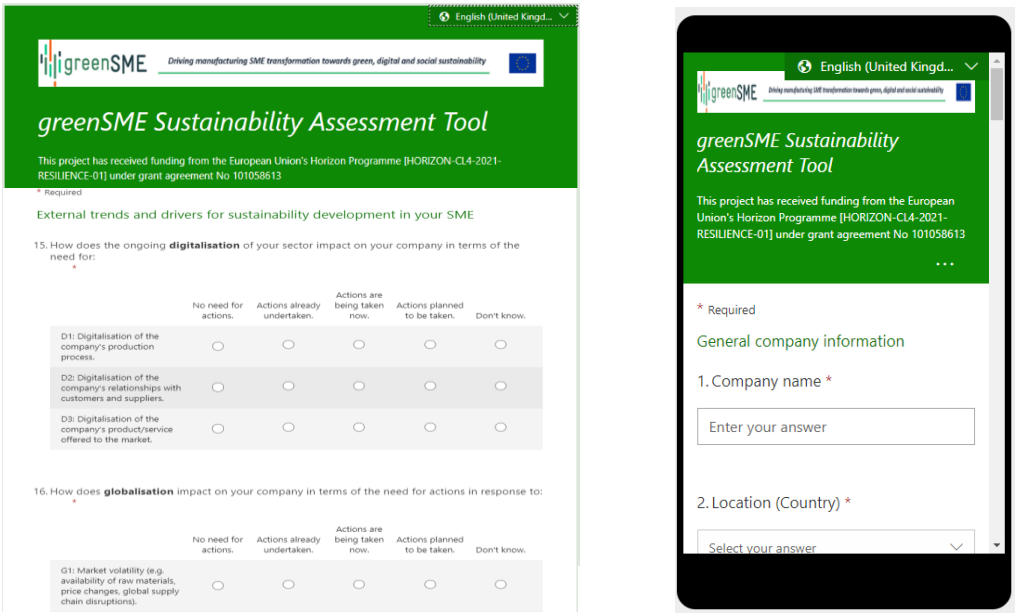


Figure 9: Web-form for the Sustainability Assessment Tool (website and mobile style)

After questionnaire completion, the responses are stored by F6S in a spreadsheet on the cloud to be shared with all sustainability advisors under strict security protocols for access.

Tekniker is leading the Sustainability Assessment Report development and the related indicators calculation, so it periodically checks the spreadsheet looking for new responses. If new answers are

detected, an automatic process starts by using Power Automate tool to import that data to a Sharepoint list, on a Tekniker server, also adding extra columns to manage the indicators calculation and the reply to the SME.
As explained before, the assessment indicators show sustainability status in general and in each of the 3 pillars (environmental, social and economic) compared to reference values on each pillar, the digitalisation level in general and in each of its 3 aspects (IT tools, interoperability and data systems), and the ranking for the 11 hotspots for the identification of potential fields of activity on each SME.

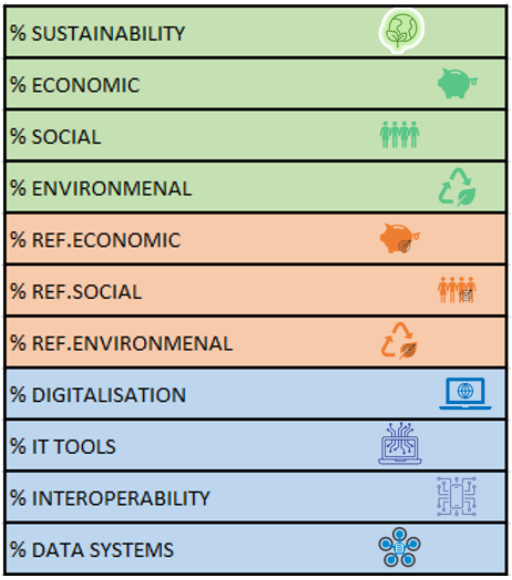


Figure 10: List of Sustainability and Digitalisation indicators

Questionnaire information management is not fully automated to date, but it only requires a minor manual intervention from the sustainability advisor to calculate the sustainability indicators and develop the corresponding Sustainability Assessment Report for the SME.
The calculation method for all report indicators has been automated with Power BI tool, which allows not only to transform survey answers into quantitative values but also to generate the corresponding graphs or charts for indicators presentation.

The results from Power BI are manually integrated in the Sustainability Assessment (SA) Report template, and then a PDF report is generated and stored in a Sharepoint Document Library linked to the assessment answers. This final SA Report could be directly sent to the SME by email or stored in a private space on the HUB to be reviewed by the SME and other sustainability advisors anytime.

Besides, manual questionnaire information management allows a personalised follow-up on SMEs sustainability assessment pathway, and also an additional analysis on each assessment result if there were any need to manually adjust some indicator or double check the answer to some question. This way the calculation method can be also improved at this stage of the project based on real sustainability maturity assessments of manufacturing SMEs.

2.2.2. Assessment Tool Report

Sustainability Assessment Tool calculation method

This section provides a basic insight on the SA calculation method for the sustainability and digitalisation indicators defined by Tekniker (Figure 11).

Starting from the questions defined for the assessment form and the list of predefined answers proposed by the tool, the calculation method assigns a quantitative value to each possible answer (always in the range from 0 to 1).

Then each question is rated in comparison to their topic, assigning a weight to each question based on its importance regarding other similar question within each section. As it can be seen in Figure 11, all the questions on the section for 'Sustainability Management' have been weighted with 1 point (with a yellow background), except the last question that is optional. All the weights in that column are added up together to get the total weight score for that section.

In parallel, 100% are distributed among the 3 sustainability pillars (economic, social and environmental) according to the effect of each question in each of them. All the shares in those columns are added up together to get the total percentage score for that section (by column).

Finally, to get the share of each sustainability pillar for each question, the weight in yellow is multiplied by the percentage in each column and divided by the total percentage score for that column.
For the share of the general sustainability score for each question, it's only needed to divide the weight in yellow by the total weight score for that section.
The final value to be taken into account for the calculation of each indicator is done by multiplying the quantitative value for the answer by the share calculated for each column, and then sum all of the column together.

									% SUSTAINABILITY		% ECONOMIC	% SOCIAL	% ENVIRONMENAL
General company information													
#1	QUESTION	ANSWERS	ACTION						100%		100%	100%	100%
Sustainability Management				13	SCORES	1.5	1.5	10					
#3	QUESTION	ANSWERS	ACTION			ECONOMIC	SOCIAL	ENVIRONMENAL					
19	Does your company have a management person responsible for Environmental Sustainability?	[RADIOBUTTONS] No Yes In-progress Don't know	[choose 1] No = 0; Yes = 1; In-progress = 0,3	1				1	1	8%	0%	0%	10%
20	Does your company publish an Environmental, Social and Governance (ESG) or Sustainability Report?	[RADIOBUTTONS] No Yes In-progress Don't know	[choose 1] No = 0; Yes = 1; In-progress = 0,3	1		0.3	0.4	0.3	1	8%	20%	27%	3%
21	Does your company have a regular training program on the topic of sustainability for workers?	[RADIOBUTTONS] No [GO TO #23] Yes In-progress Don't know [GO TO #23]	[choose 1] No = 0; Yes = 1	1			0.8	0.2	1	8%	0%	53%	2%
22	Please, provide which training measures do you provide for your workers.	[TEXT BOX]	Required field						0				
4													
Supply Chain Management													
#4	QUESTION	ANSWERS	ACTION			ECONOMIC	SOCIAL	ENVIRONMENAL					
23	Does your company have a formal environmental policy, which includes a commitment to legal compliance, continuous measurement and continuous improvements (with sustainability goals) in environmental performance?	[RADIOBUTTONS] No Yes In-progress Don't know	[choose 1] No = 0; Yes = 1; In-progress = 0,3	1				1	1	8%	0%	0%	10%
24	Does your company have set ESG, sustainability or green requirements towards suppliers?	[RADIOBUTTONS] No [GO TO #26] Yes In-progress Don't know [GO TO #26]	[choose 1] No = 0; Yes = 1; In-progress = 0,3	1		0.4	0.3	0.3	1	8%	27%	20%	3%

Figure 11: Sustainability Assessment indicators calculation method

This calculation method has been also applied to the indicators of the 3 reference values (or goals) for the 3 sustainability pillars, as well as for the indicators related to the digitalisation maturity level assessment (a general indicator and specific indicators for the 3 aspects evaluated: IT tools, interoperability and data systems.

The figures obtained by this calculation method for each answer on each question have been translated to a final table for the calculation of all the indicators (Table 5). This table also includes developed weights for each hotspot based on each question topic and possible answer.

Funded by the European Union

Table 5. Final table for indicators calculation

Nº	QUESTION	Nº	*Required TYPE	ANSWERS	% SUSTAINABILITY	% ECONOMIC	% SOCIAL	% ENVIRONMENTAL	% REF. ECONOMIC	% REF. SOCIAL	% REF. ENVIRONMENTAL	% DIGITALISATION	% IT TOOLS	% INTEROPERABILITY	% DATA SYSTEMS	ENERGY	MATERIALS	WATER	WASTE MANAGEMENT	PRODUCT(S) LIFE-CYCLE	PROCESS(ES) AND PRODUCTION	VALUE / SUPPLY CHAIN	WORKERS (SKILLS & TRAINING)	WORKPLACE (WELLBEING & TECH.)	STAKEHOLDER ENGAGEMENT	SUST. BUSINESS MODEL INNOVATION
				TOTAL SUM BY GROUP MAX. VALUE	262%	159%	146%	277%	100%	100%	100%	100%	100%	100%	100%	179%	100%	138%	174%	141%	273%	151%	181%	197%	215%	260%
43	Does your company incorporate EcoDesign principles in your products?	60	[RADIOBUTTONS]*	Yes	8%			10%																		
				In-progress	2%			5%																		
				Don't know																10%			4%			
44	Does your company put Circular Economy principles in practice?	61	[RADIOBUTTONS]*	No																5%			2%		2%	2%
				Yes	8%	10%		10%																		
				In-progress	4%	5%		5%																		
				Don't know																10%			4%		4%	4%
45	Does your company implement (new) products environmental Life Cycle Assessment (LCA)?	58	[RADIOBUTTONS]*	No																5%			2%			
				Yes	8%			10%																		
				In-progress	2%			5%																		
				Don't know																10%			4%			
46	Does your company assess the Carbon Footprint of your products or organisation?	59	[RADIOBUTTONS]*	No																5%			2%	5%		
				Yes	8%			10%																		
				In-progress	2%			5%																		
				Don't know																10%			4%	10%		
6																										
	27																									
Company Digitalisation																										
##	QUESTION			ANSWERS																						
47	How is your IT team organised?	62	[RADIOBUTTONS]*	Internally								5%	10%		10%											
				Externally								3%	5%		5%											
				Internally with external support								1%	3%		3%											
				Don't know																						
48	How is your data security (e.g. data storage) organised?	63	[RADIOBUTTONS]*	Internally								5%	5%		15%											
				Externally								3%	3%		10%											
				Internally with external support								1%			5%											

As it is shown in the next figure (Figure 12), the sections on the questionnaire correspond to each of the areas of the Sustainability Assessment Framework (Figure 5) oriented to the SME's evaluation on its green transformation. Therefore, the indicators for the Sustainability Assessment Report should be calculated accordingly, linking them to the sections of the questionnaire.

1) General company information
   - ✓ Now Including (Sustainable) Business Models innovation
2) External Drivers for Sustainability development
   - ✓ Digitalisation / Globalisation / Climate Change / Stakeholders
3) Internal Management
   1. Sustainability mngmt.
   2. Supply Chain mngmt.
   3. Energy mngmt.
   4. Materials mngmt.
   5. Environmental mngmt.
4) Company Digitalisation
5) Advanced Technologies knowledge
6) Environmental assessment
7) Social assessment
8) Economic assessment

Sustainability Assessment

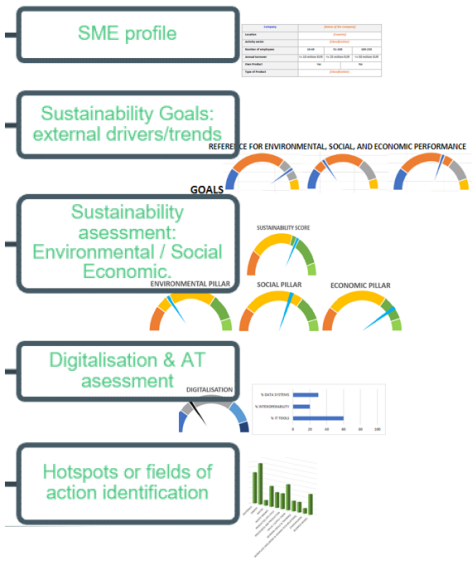


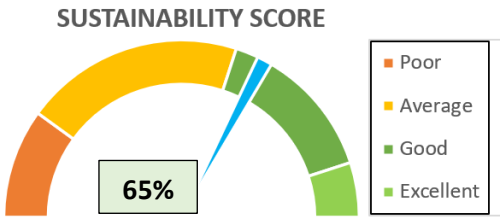
Figure 12: Relation between questionnaire sections and groups of indicators

Sustainability Assessment Report

Further on an example of each indicator is shown in the same order that they appear in the Sustainability Assessment Report for the SME.

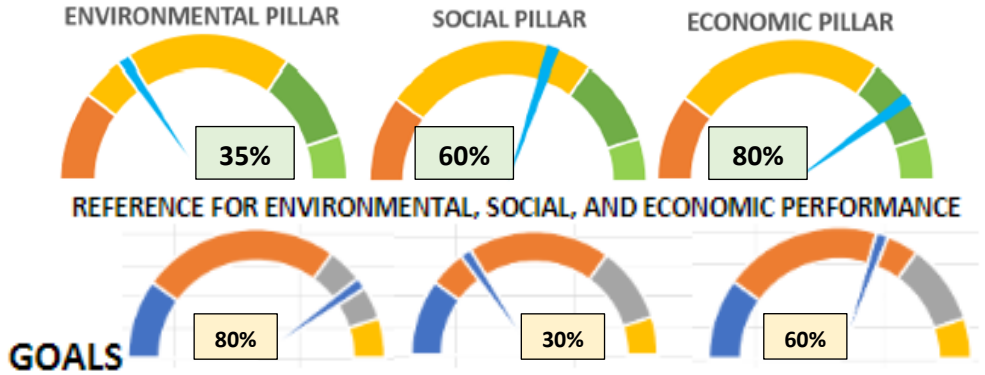
Following the company identification and a short introduction of the greenSME Sustainability Assessment Tool, the first indicator that is shown to the SME is its general score regarding sustainability.

After that, a small table summarising the main SME profile information provided in the questionnaire.

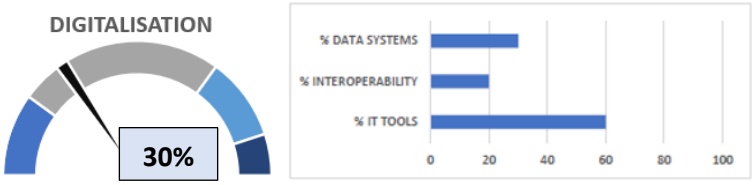


Company	[Name of the Company]		
Location	[Country]		
Activity sector	[Classification]		
Number of employees	10-49	51-100	100-250
Annual turnover	<= 10 million EUR	<= 25 million EUR	<= 50 million EUR
Own Product	Yes	No	
Type of Product	[Classification]		

Then the indicators for the specific score of the SME in each of the 3 sustainability pillars, followed by the indicators of the reference values calculated for each pillar.

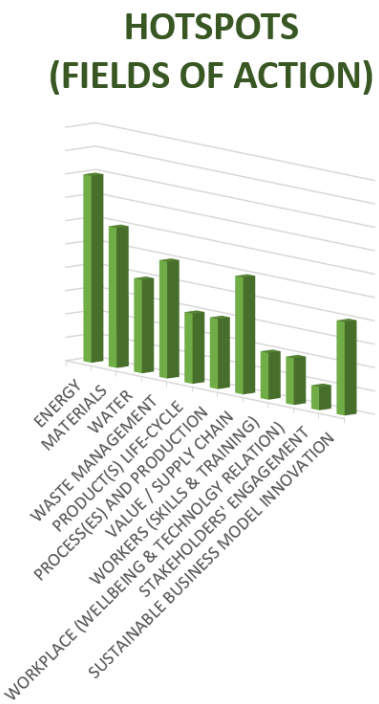


The digitalisation maturity level of the SME is also represented by means of a general indicator for the score on this topic, followed by specific indicators for the main aspects evaluated in the questionnaire.



The Sustainability Assessment Report ends with a bar chart representing the ranking of identified hotspots or potential fields of action for the sustainability improvement on the SME. This chart will be useful for the SME on the prioritization and selection of possible projects to be implemented thanks to the greenSME support.

The score for each hotspot, as well as the responses for the questions on the assessment tool, will also be very useful for the ASAP development, as it is explained in section 3.



Funded by
the European Union

3. ASAP method

The “Advanced Sustainability Action Plan” (ASAP) serves as support for SMEs in their transformation process towards becoming more sustainable. With the structured description of actions, SMEs will be able to find providers for advanced technologies and social innovations to participate in the open call. At the same time, the ASAP documents the results of the process and can be used as one element in a transformation strategy towards sustainability.

The aim of the ASAP is to provide elements for a roadmap for technological upgrading of a company to support environmental and social sustainability. Simultaneously, integrating advanced technologies and social innovation enables improvements in productivity and product quality. The plan is supported by a holistic sustainability framework encompassing economic, social and environmental dimensions. While looking for improvement of product quality, process and resource efficiency and strengthened responsiveness to external disruptions, SMEs on the transformation pathway towards sustainability strive to foster workers’ wellbeing, competencies, motivation and productivity.

3.1. ASAP Framework

To derive actions for SMEs to support their green transformation, it is first important to analyse which factors drive industry towards sustainability. As visualized in Figure 13, these drivers can be divided into internal and external pulls and pushes.

From the outside, a company can experience a regulative push, for instance by the introduction of laws with stricter environmental regulations. A society push can be caused by changing expectations regarding a company’s actions and behaviour, for instance triggered by discussions on climate change. The availability of new technologies with a higher efficiency or improved process execution can lead to a technology push for implementation. Internally, shareholders push a company towards value creation, for instance by raising their return on investment (ROI).

At the same time, they can be pulled towards sustainability transformation. A vision pull can be exerted by the formulation and communication of a company’s strategy and goals regarding environmental impacts. Subsidies and incentives for implementing environmentally friendly technology and processes can lead to a regulative pull. A market pull can be experienced by rising cost pressure, for instance on specific energy sources, or by customer expectations. Internally, stakeholders’ requirements, for instance regarding product quality, can result in a stakeholder pull.
This framework enables a broad understanding of different drivers an SME can experience in order to pursue transformation towards more sustainable actions.

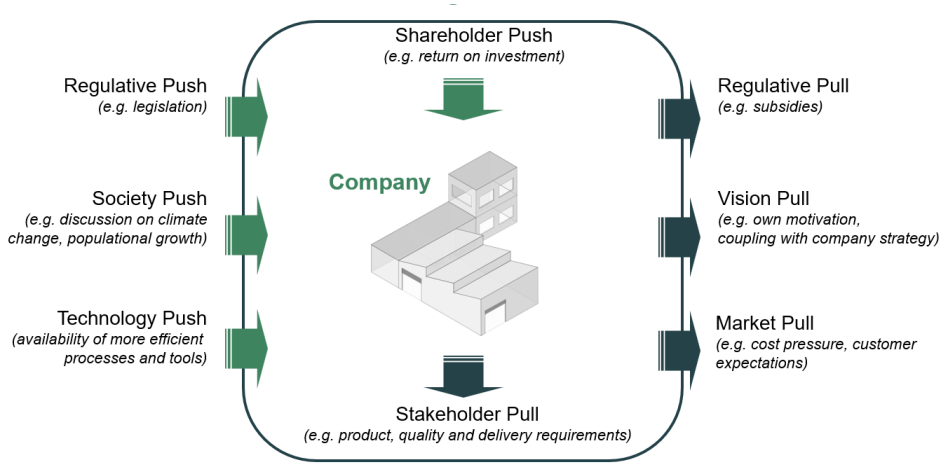


Figure 13: Factors towards sustainability for a company

As reaction to these various push and pull factors, sustainability strategies are frequently utilized as a tool and formulated. These strategies generally contain and combine elements from three different approaches, which are visualized in Figure 14: efficiency, consistency (effectiveness) and sufficiency.

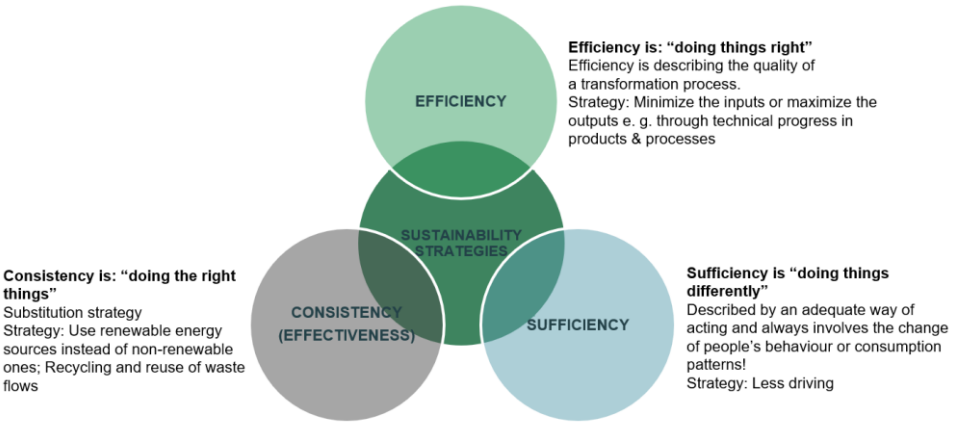


Figure 14: Sustainability strategies example

The efficiency strategy aims at minimizing inputs or maximizing outputs of a process – e.g., using less material for manufacturing of the same number of products - "doing things right". Effectiveness is a substitution strategy -" doing the right things". This could mean replacement of conventional sources of energy or used materials for renewable ones (e.g., recycling of wastes, using electric vehicles instead of those with internal combustion). The third strategy of sufficiency can be described as "doing things differently" and involves change in peoples' behaviour, e.g. driving less.
As the company has less control on customer behaviour but more regarding their products and processes, the ASAP is focussed on actions linked to efficiency and consistency.

3.1.1. ASAP Structure

The ASAP serves several purposes in supporting the transformation process of SMEs and is thus intended to be used by various stakeholders: The SME itself, advanced technology and social innovation providers as well as sustainability advisors. It is developed as a document, that is centred on the considered SME and structured in four sections as visualized in Figure 15: Information about the company on its profile and business model, results of the status quo analysis, goals and vision description of where the SME wants to develop and proposed actions with expected impacts.

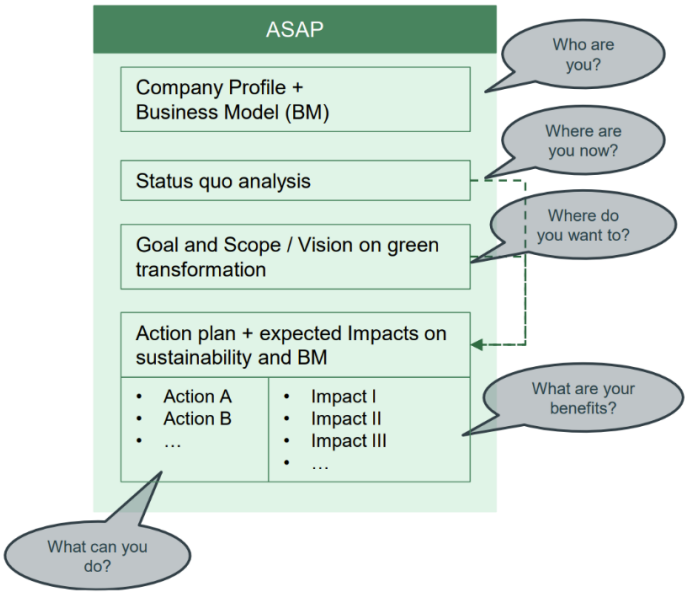


Figure 15. Advanced Sustainability Action Report Structure with indication of central elements

3.1.2. Action definition

As each SME has individual starting points and specific characteristics, identifying potential actions is a challenging task, as actions should be proposed in a concrete enough form to be assessable and implementable. At the same time, only limited information is available from the results of the self-assessment and basic company data. To cope with these contradicting goals, actions are divided into general action types and advanced technologies or social innovations respectively. In order to choose the actions that can be offered by providers from the greenSME HUB, the action types (e.g. coaching, implementation, consulting, etc.) of providers are to be matched with the particular technology or social service that they can offer (e.g. advanced materials, business model revision, etc.). The combination of types with technologies and innovations provides the basic action description for the action plan (Figure 16).

For the first development and implementation stage, the action types and technologies/innovations are pre-defined based on the project outline and input from the project partners. In a second stage during the overall project development, information provided by registered providers of technologies/innovations regarding their capabilities will be integrated in this process.

Funded by the European Union

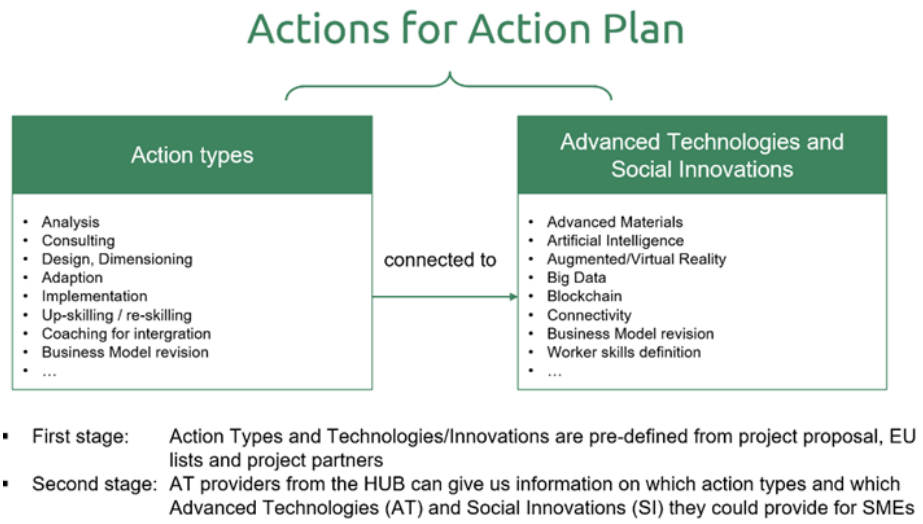


Figure 16. Actions for the action plan are combined from universal action types with advanced technologies and social innovations

3.2. ASAP method description and use

The Advanced Sustainability Assessment Plan (ASAP) contains information that will be gathered at different stages of the pathway of the SME towards the sustainability transformation process. The steps and sequence of the ASAP method are visualized in Figure 17 as the "ASAP method framework". As a first step of the journey after joining the greenSME community, the main information on the company profile is gathered within the HUB. Then, sustainability self-assessment is conducted and the report on its results generated as describes in detail in chapter 2.

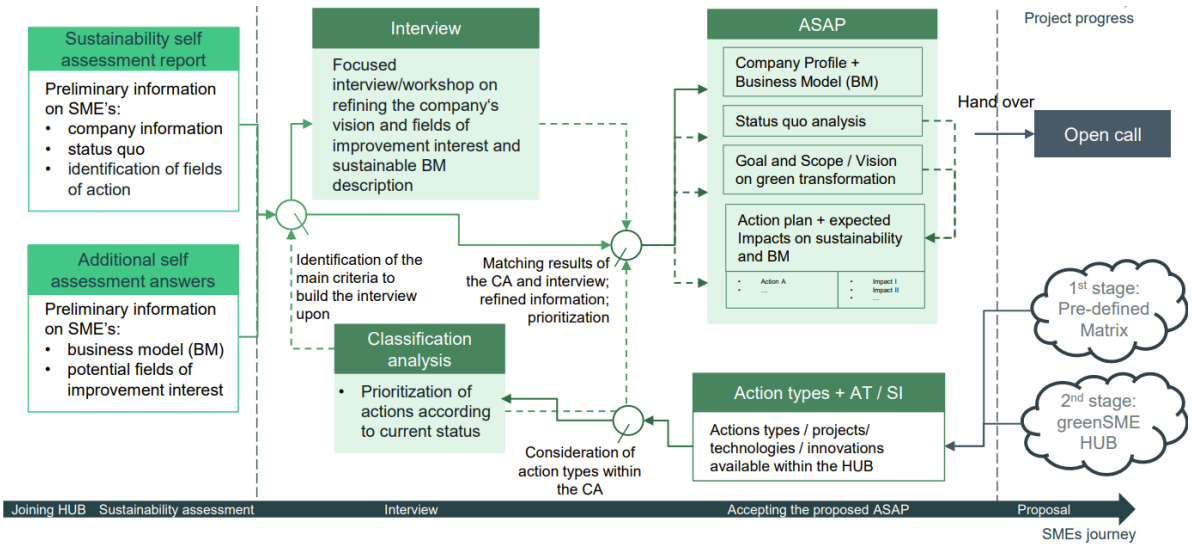


Figure 17: ASAP method framework

For the ASAP development both the answers from the assessment and the report results are used to identify promising fields for improvement. A classification analysis is applied to evaluate the results from the self-assessment and link the specific situation of the SME with suitable action types. This process is explained in more detail in the following chapter and provides a set of generally described actions. To elaborate the results from the analysis and link the prioritized action fields that go along with the SMEs goals, an interview is offered to the company to be conducted by a sustainability advisor.

In a structured interview, the company's vision and fields of interest for improvement can be refined and the potential actions tailored to the specific situation of the company.

The actions identified with the ASAP method will finally be refined and made available to the SME, AT/SI provider and sustainability advisor in a one-page format. This concentrated description form fulfils several purposes as shown in Figure 18. For the SME, the curated actions are a summary of concrete steps that can be taken in its transformation process. It provides a base for decision making and together the actions can act as building block or starting point for the development of a comprehensive sustainability strategy. From the perspective of technology and service providers, the defined actions provide information on the potential pathway of the SME and thus an entry point for applying their technologies or services. They can be used for creating applications in the following open call.

For the SME:

- Summarize and inform about potential actions and their impacts
- Provide a base for decision making on the selection of actions
- Building blocks of strategy development towards green transformation

For technology and service providers:

- Summarize and inform about actions an SME wants to pursue
- Convey sufficient information for proposing a joint action
- Provide the starting point for the open call application

Figure 18. Main purposes of action descriptions for the SME and technology and service providers

3.2.1. ASAP method implementation

For the ASAP method implementation, the required classification and calculation steps have been conducted locally in calculation sheets requiring manual data input and processing of the results to achieve a proof of concept in the development phase of the ASAP method. As a starting point, the information provided by the self-assessment answers and the sustainability assessment report are used as input data. As visualized in Figure 19, these answers are transferred into a classification table for a weighted scoring on the linkage to the "solution elements": advanced technologies and social innovations, the fields of actions and the action types. The process is organized in a three-step sequence and based on numerical values awarded for specific congruence of input data and solution elements.

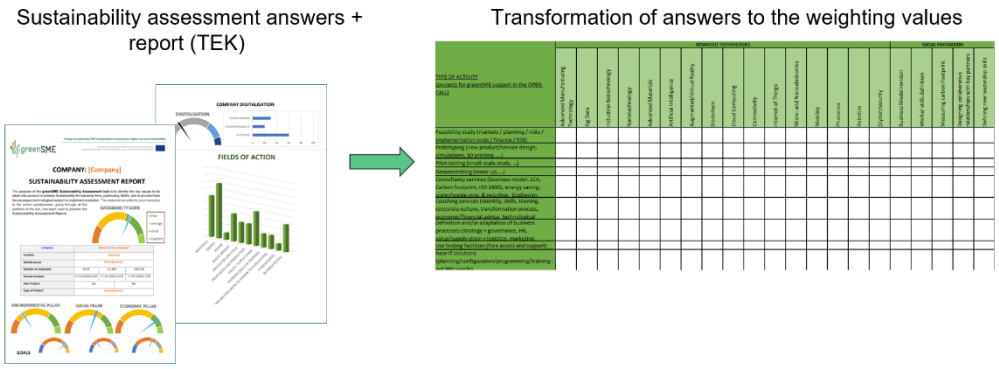


Figure 19. The Sustainability Assessment Report and further individual answers of the self-assessment are used as input data for a scoring and weighting method to identify potentially suitable actions

Funded by the European Union

Figure 20 shows the initial evaluation matrix linking the action types with advanced technologies. The input data is inserted in the blue and grey row and originates from the self-assessment question #58 “Does your company use any of the following Advanced Technologies?”. The answer options are assigned with numerical values for further calculation:

Table 6. Numerical values for answers regarding use of advanced technologies

Answer option	Numerical value
No	0
Yes	1
Planning to use it	2
No, but could consider using it in the near future	3

Based on the numerical values for each technology or service, a classification is conducted to evaluate the potential suitability of the action types. For instance, if a company is considering to use a technology in the near future, feasibility studies or prototyping will be the most likely action types for this case and assigned with the highest class-rating. Potentially suitable and thus assigned with a slightly lower class-rating for consideration in this example are pilot testing, demonstration and consultancy service. Unlikely action types are coaching services, adaption of business models and the use of testing facilities due to the background that the technology in question is not in use at the company yet. These action types are assigned with a low class-rating. Very unlikely is the action type of developing the IT-systems for this technology that is not existent at the moment at the company and thus assigned with the lowest class-rating. As a result, the classification matrix provides a visual overview on the action types for each advanced technology and social innovation that can be interpreted as heatmap, in which the green fields highlight potential technologies and action types of interest for the specific case.

			ADVANCED TECHNOLOGIES															
			Advanced Manufacturing Technology	Big Data	Industrial Biotechnology	Nanotechnology	Advanced Materials	Artificial Intelligence	Augmented/Virtual Reality	Blockchain	Cloud Computing	Connectivity	Internet of Things	Micro- and Nanoelectronics	Mobility	Photonics	Robotics	(Cyber)Security
From Self Assessment (0:No, 1:Yes, 2: Planning, 3:Interested)			1	1	0	0	2	3	3	2	1	2	1	1	0	0	1	2
Feasibility study (markets / planning / risks / implementation costs / finance / ROI)			0	0	0,5	0,5	1	2	2	1	0	1	0	0	0,5	0,5	0	1
Prototyping (new product/service design, simulations, 3D printing, ...)			0	0	0	0	1	2	2	1	0	1	0	0	0	0	0	1
Pilot testing (small-scale study, ...)			0	0	0	0	2	1	1	2	0	2	0	0	0	0	0	2
Demonstrating (mock-up, ...)			0	0	0	0	2	1	1	2	0	2	0	0	0	0	0	2
Consultancy services (business model, LCA, Carbon footprint, ISO 14001, energy saving, water/waste mng. & recycling, EcoDesign, innovation, ...)			1	1	0	0	2	1	1	2	1	2	1	1	0	0	1	2
Coaching services (identity, skills, training, corporate culture, transformation process, economic/financial advise, technological support, ...)			1	1	0	0	2	0,5	0,5	2	1	2	1	1	0	0	1	2
Definition and/or adaptation of business processes (strategy + governance, HR, value/supply chain + logistics, marketing, compliance, reporting, ...)			1	1	0	0	1	0,5	0,5	1	1	1	1	1	0	0	1	1
Use testing facilities (free access and support)			0,5	0,5	0	0	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0	0	0,5	0,5
New IT solutions (planning/configuration/programming/training - not HW supply)			0,5	0,5	0	0	0	0	0	0	0,5	0	0,5	0,5	0	0	0,5	0

Figure 20. Initial evaluation matrix for identification of potential actions linked to the Advanced Technologies

In the sustainability self-assessment report, fields of action are assigned with values equivalent to expected improvement potential. These fields of action include materials, energy, water, waste management, product life-cycle, processes and production, value/supply chain, workers, workplace, stakeholders and sustainable business model innovation, as well as digitalization.

In the second step of the ASAP classification process, the data input is a numerical value for each field of action. The higher the value, the higher is the expected improvement potential in this area. These values are added up in a total sum and then assigned with a percentage equivalent to its relative value.

Funded by the European Union

These percentages are multiplied with a pre-defined impact matrix that provides values between 0 and 3 for each combination of a field of action with a technology or innovation. For instance, advanced manufacturing technology has potentially a high impact on the field of action "processes and production" and "materials", and these combinations are thus assigned with the highest value of 3. The results of the impact scoring for an exemplary case-study are visualized in Figure 21.

			ADVANCED TECHNOLOGIES															
			Advanced Manufacturing Technology	Big Data	Industrial Biotechnology	Nanotechnology	Advanced Materials	Artificial Intelligence	Augmented/Virtual Reality	Blockchain	Cloud Computing	Connectivity	Internet of Things	Micro- and Nanoelectronics	Mobility	Photonics	Robotics	(Cyber)Security
Materials	6	0,17	0,50	0,00	0,17	0,17	0,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,17	0,17	0,17	0,00
Energy	8	0,22	0,67	0,22	0,00	0,00	0,22	0,22	0,22	0,00	0,00	0,00	0,22	0,00	0,00	0,00	0,22	0,00
Water	1	0,03	0,08	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03	0,00
Waste Management	4	0,11	0,33	0,22	0,11	0,11	0,33	0,22	0,22	0,22	0,00	0,00	0,11	0,00	0,22	0,00	0,11	0,11
Product(s) Life-Cycle	3	0,08	0,17	0,17	0,00	0,00	0,17	0,08	0,08	0,17	0,08	0,08	0,08	0,00	0,17	0,00	0,08	0,17
Processes and Production System	3	0,08	0,25	0,17	0,08	0,08	0,25	0,25	0,25	0,17	0,17	0,17	0,25	0,08	0,17	0,17	0,25	0,25
Value / Supply Chain	2	0,06	0,06	0,17	0,00	0,00	0,06	0,11	0,06	0,17	0,06	0,06	0,06	0,00	0,17	0,00	0,00	0,17
Workplace Quality	1	0,03	0,08	0,00	0,00	0,00	0,03	0,03	0,06	0,00	0,00	0,00	0,00	0,00	0,03	0,00	0,08	0,03
Stakeholders	4	0,11	0,11	0,22	0,00	0,00	0,00	0,11	0,11	0,22	0,11	0,33	0,11	0,00	0,11	0,00	0,00	0,22
Digitalisation	4	0,11	0,33	0,33	0,00	0,00	0,00	0,33	0,33	0,33	0,33	0,33	0,33	0,11	0,00	0,22	0,11	0,33

Figure 21. Exemplary numerical scoring of results from the assessment report with advanced technologies

In the third and final step, the scores for the combinations of the advanced technologies and social innovations with the action and with the fields of action are put through a weighted multiplication to result in the final action identification heatmap, of which an example is shown in Figure 22.
A threshold value generates a colour code that helps to visually identify potentially suitable actions. In this example, for instance, a feasibility study on or prototyping with augmented/virtual reality are among the identified actions.

			ADVANCED TECHNOLOGIES															
			Advanced Manufacturing Technology	Big Data	Industrial Biotechnology	Nanotechnology	Advanced Materials	Artificial Intelligence	Augmented/Virtual Reality	Blockchain	Cloud Computing	Connectivity	Internet of Things	Micro- and Nanoelectronics	Mobility	Photonics	Robotics	(Cyber)Security
Feasibility study (markets / planning / risks / implementation costs / finance / ROI)			0,0	0,0	0,2	0,2	1,6	2,7	2,7	1,3	0,0	1,0	0,0	0,0	0,5	0,3	0,0	1,3
Prototyping (new product/service design, simulations, 3D printing, ...)			0,0	0,0	0,0	0,0	1,6	2,7	2,7	1,3	0,0	1,0	0,0	0,0	0,0	0,0	0,0	1,3
Pilot testing (small-scale study, ...)			0,0	0,0	0,0	0,0	3,2	1,4	1,3	2,6	0,0	1,9	0,0	0,0	0,0	0,0	0,0	2,6
Demonstrating (mock-up, ...)			0,0	0,0	0,0	0,0	3,2	1,4	1,3	2,6	0,0	1,9	0,0	0,0	0,0	0,0	0,0	2,6
Consultancy services (business model, LCA, Carbon footprint, ISO 14001, energy saving, water/waste mng. & recycling, EcoDesign, innovation, ...)			2,6	1,5	0,0	0,0	3,2	1,4	1,3	2,6	0,8	1,9	1,2	0,2	0,0	0,0	1,1	2,6
Coaching services (identity, skills, training, corporate culture, transformation process, economic/financial advise, technological support, ...)			2,6	1,5	0,0	0,0	3,2	0,7	0,7	2,6	0,8	1,9	1,2	0,2	0,0	0,0	1,1	2,6
Definition and/or adaptation of business processes (strategy + governance, HR, value/supply chain + logistics, marketing, compliance, reporting, ...)			2,6	1,5	0,0	0,0	1,6	0,7	0,7	1,3	0,8	1,0	1,2	0,2	0,0	0,0	1,1	1,3
Use testing facilities (free access and support)			1,3	0,8	0,0	0,0	0,8	0,7	0,7	0,6	0,4	0,5	0,6	0,1	0,0	0,0	0,5	0,6
New IT solutions (planning/configuration/programming/training - not HW supply)			1,3	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,6	0,1	0,0	0,0	0,5	0,0

Figure 22. Exemplary numerical scoring result of action types with advanced technologies with consideration of action fields extracted from the sustainability self-assessment report (above) and selected action fields from a case study (below)

Funded by the European Union

3.2.2. ASAP method Report

General actions

As it was described in the previous section, several action types with advanced technologies and action fields can be identified as potential areas for improvement resulting from the ASAP method. The collection of these for each specific SME is the first stage of the ASAP report providing general, potentially suitable actions as shown in Figure 23. Each segment provides the area of improvement, in which an SME has development potential according to the results of the self-assessment, and technology considered with a positive impact in this area.

Figure 23. General action list for sustainability advisor as supplementary information for the interview

Action plan

For the participation in the open call, these general actions need to be refined and adapted to the actual implementation case. If a company is confident and able to accomplish this refinement step by itself, the general actions serve as a starting point and provide headlines that can be developed into a detailed project description. If this is not the case and the SME requires support towards developing a proposal, sustainability advisors can establish contact and offer guidance. In this process, the first stage list with actions that ensure availability of a broad spectrum of solutions can be narrowed down according to specific goals and characteristics of the SME to a refined action list as shown in Figure 24.

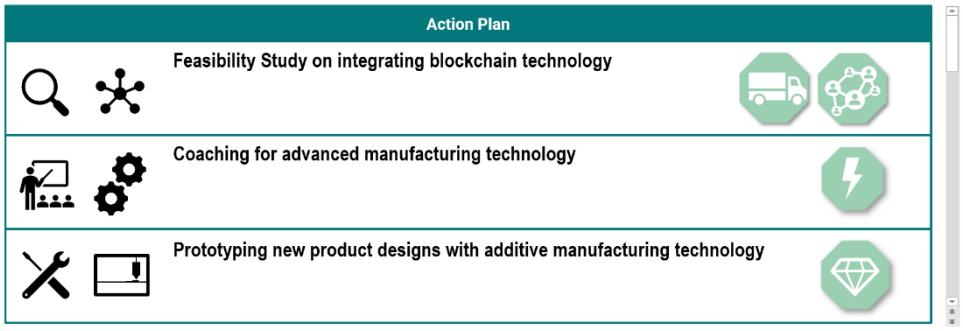


Figure 24. Refined action list as a result of the sustainability consultancy

The detailed description includes important elements to judge the feasibility and economic viability of a specific action for the SME. It includes a description, the expected impact, expected costs, timeline for implementation and connected KPIs.

For the process of refining the general actions towards the detailed action plan, advisory guidelines are to be developed including step-by-step explanations and easy-to-use forms. Currently, the ASAP method is implemented requiring manual data processing in locally stored files. With the establishment of the digital online HUB, the method will be at least partly automated and available online by utilizing the website infrastructure.

4. Conclusions

Deliverable D3.1 - the greenSME Sustainability Assessment Tool and ASAP definition method - comprises the detailed definition of the greenSME sustainability transformation pathway for manufacturing SMEs, starting from its self-assessment through the Sustainability Assessment Tool, followed by additional roadmap on Advanced Sustainability Action Plan (ASAP) definition, and introducing the types of activities to define the projects that can be funded thanks to the Open Call to 'third party financing' of greenSME project.

In the next figure (Figure 25) there is a summary of the complete process to define a suitable project for a SME, supported by an external provider to boost the uptake of Advance Technologies and/or Social Innovations, leading to a shift on SME sustainability maturity.

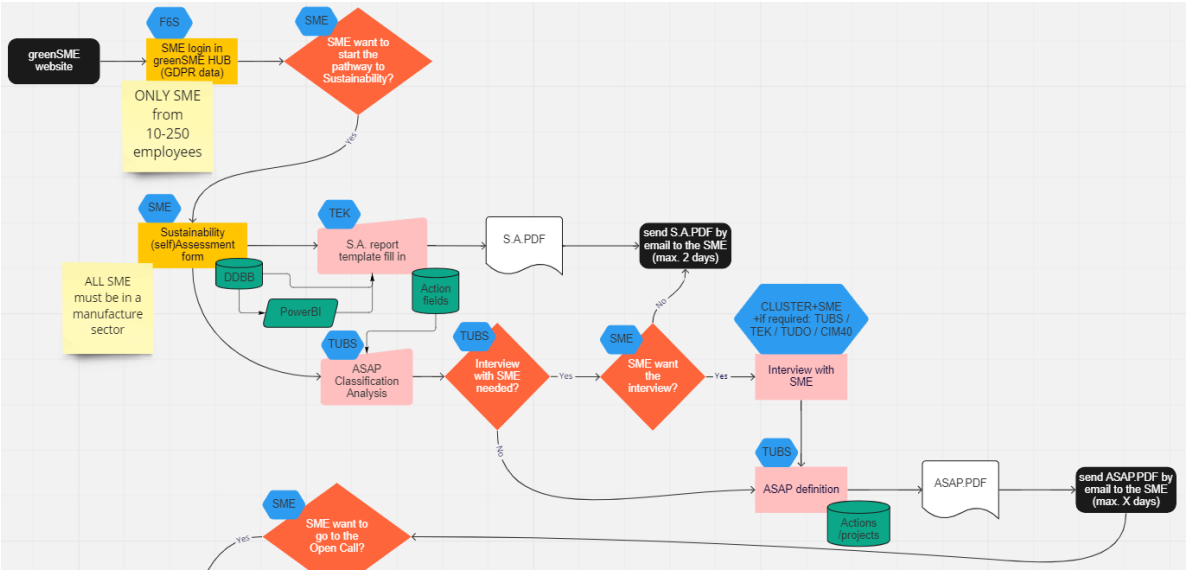


Figure 25: Workflow for the Sustainability Assessment Tool and ASAP method

The work developed within the WP3 "Sustainability assessments and ASAP definition" is strongly linked to the WP2 where the greenSME HUB and community is created, and that is used as the entry point both for the SMEs and service providers to the sustainability transformation pathway.

It is also strongly linked to the WP4 where the Open Call for SME proposals will allow the competition of the selected activities of interest, if they meet the eligibility criteria, and if they are positively evaluated for a significant improvement on SMEs sustainability.

Annexes

Sustainability Assessment Form

Preliminary version of the webform on MS Form can be found here:
https://forms.office.com/r/vLBZgg9U1T
To access it through a mobile device it is necessary to read the following QR code:

The complete list of questions of the Sustainability Assessment Tool are in the following document:

greenSME
Sustainability Assess