



D2.5 NextGen Water in the CE re-design toolbox final version

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¹ PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

Document history

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1	06/05/2021	ICCS	Vassilis Psaltopoulos
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Updates from previous version

Comments from reviewer	Revisions
The deliverable provides mostly a description of the architectural design of the toolbox and refers to the integration of feedback from the CoPs which is however not further elaborated or specified.	The deliverable has been fully restructured to show 3 well-defined sections: the design and functionality of the Toolkit, the content of the Toolkit and a manual to the user of the Toolkit. The feedback received from the partners during the CoP meeting has been further elaborated in the section 3.1 Inputs from partners .
User experience is not on par with web applications in general and looks like a project site.	Explanation regarding the appearance of the Toolkit and further integration with the Marketplace is included in section 2 Development of the Toolkit .
Even though it is mentioned that this deliverable can serve as a user manual, a real user manual would require a different level of information. More clarification is needed regarding • Who for, i.e. what roles are considered as users • what is the planned life cycle of the toolbox • who will have final commercial ownership and development responsibility for the toolbox	The user manual has been reconstructed to address all the information required from potential users of the Toolkit. Separated chapters from 4.1 to 4.7 , reflect the necessary steps a user should follow, starting from registration and moving on with all relevant functionalities. - Detailed information regarding the roles who are considered as users, is found in section 2.1 Main Toolkit users . - The planned life of the Toolkit - and the final commercial ownership are described in the introductory section of the section 2 Development of the Toolkit .
According to the GA, the toolbox should be designed as an interactive recommender system based on machine learning. However, it does not substantially go beyond providing links to existing products, software and services related to the circular economy.	A dedicated section 2.3.1 Building the recommender system has been added to the deliverable, thoroughly explaining the general design of recommender systems, the Machine Learning approach, and the selection of specific technologies. It serves as a state of the art, before introducing the Toolkit's recommender system, its design and functionalities. The sophisticated methodology is also described in the Annex .
It is not sufficiently self-explanatory or clearly structured in order to guide potential users to relevant solutions.	The deliverable has been restructured and all sections have been enhanced with additional information to guide potential users to relevant

	solutions. The users may find answers to relevant questions by navigating to sections 4.1 to 4.7 of section 4 User manual .
During the review meeting it was explained that the recommender system was integrated in the market place (WP5).	This information has been included and further elaborated in section 2 Development of the Toolkit .
The deliverable should be revised by better specifying how stakeholder feedback was integrated in the development of the toolbox.	The deliverable has been revised and section 3.1 Inputs from partners has been added to serve this purpose.
Furthermore, it should be reviewed in terms of user-friendliness and regarding its purpose of a user manual.	The entire deliverable has been restructured and section 4 User manual has been significantly improved to ensure it stands as a user-friendly guide for the Toolkit users. The user-friendliness of the report has been enhanced in all sections of this deliverable.



Summary

This deliverable demonstrates the findings around Task T2.4 aiming to create a freeware web application that collects, improves, and demonstrates all instruments and methods developed within the scope of the NextGen project. The NextGen Toolkit supports decision-making by presenting the appropriate tools for individual solution assessment, system-wide evaluation, and stress testing. It also comprises information on outputs of the models, databases, KPIs relationships based on user experience, etc. The Toolbox has been created in close cooperation with user groups from the NextGen Communities of Practices (CoPs).

The Toolkit has been developed as a web application, complying with the NextGen theme, that upon finalization will be integrated to the Marketplace and later on provided to Water Europe for further curation. Its main elements described thoroughly in the deliverable, refer mainly to the storing of information from its users, the recommendation system, and a user manual to guide the user towards these functionalities.

The deliverable is constructed to have an introduction in the first section, followed by a close examination of the NextGen Toolkit's users, its functionalities and architectural design, and the technologies employed to design and develop the application. Also, in section 2, emphasis is given in the recommender system design and specification. In section 3, the inputs from the partners are elaborated and the tools and that the Toolkit currently contains are presented. Information is also given regarding the type of data that can be inserted to the Toolkit. Finally, section 4, stands as a practical user's manual with instructions and guidelines to ensure a smooth use of the Toolkit. The Annex at the end presents technical information on the recommender system.

Accompanying D2.5, the Toolkit (which is the key result of task T2.4) can currently be accessed through the following URL <https://tk.nextgenwater.eu/>. Alternatively, the NextGen Toolkit can be accessed through the Marketplace URL (<http://mp.nextgenwater.eu/>).

Disclaimer

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Glossary

Acronym	Meaning
CA	Consortium Agreement
CO	Confidential
CoP	Community of Practice
DoA	Description of Action
EC	European Commission
GA	Grant Agreement
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
ORM	Object-Relational Mapper
PPR	Project Progress Report
PSB	Project Steering Board
PU	Public
QA	Quality Assurance
QC	Quality Control
STC	Scientific and Technical Committee
TEB	Technology Evidence Base
WP	Work Package
UI	User Interface
UX	User experience
CE	Circular Economy
IP	Interactive Platform



1. Introduction

1.1. Purpose of the document

The present document serves as a technical report describing the implementation aspects and functionalities of the final version of “NextGen Toolkit” developed software block, as a web application. It covers the toolkit as it is described in Task 2.4 of the DoA as part of the overall “NextGen Interactive Platform” which consists of the Marketplace, the Technology Evidence Base and the Toolkit. The Toolkit is freeware and its general purpose is to collect, improve and demonstrate all instruments and methods developed within the scope of the NextGen project and support decision-making through presentation of the appropriate tools for individual solution assessment and system-wide evaluation and stress testing, while also compromising information on e.g., outputs of the models, databases, KPIs relationships based on user experience, etc.

1.2. Intended readership

The deliverable is marked as public; therefore, it is not only intended for Consortium partners but other stakeholders as well. After the project’s lifecycle, the under-development software tool (NextGen Toolbox) will be openly accessible to anyone interested in the field of ICT tools around Water Circular Economy. The present document serves as supporting documentation of the actual software.

1.3. Relationship with other NextGen tasks/WPs

Task 2.4 “NextGen Toolkit development” serves as the starting point of this report. Since this task is very closely connected to Work Package 5 and more specifically to Task 5.2 “Marketplace”, the resulting complete NextGen Marketplace solution has the Toolkit embedded and most of the functionalities of the Interactive Interface integrated under its umbrella. The Toolkit contains information from other tasks within WP2 and is related closely to the Technology Evidence Base (WP1).

1.4. Document’s structure

The document consists of four basic chapters. The first chapter is the introductory one, outlining the purpose of the document, the targeted audience and the relation of the Interactive Platform and the Toolkit with other project tasks.

Chapter 2 describes the basic functionalities of the Toolkit, and the conceptual data model paired with relations with other components (Marketplace and TEB). The same chapter includes the architectural design of the system, the development technologies and the tools contained as well as a thorough explanation of the recommender system. The third chapter serves as a user’s manual with a

picture tour and steps to be followed around the software application. Finally, the last chapter is conclusive, reporting the primary outcomes and future work. The Annexes section contains the conceptual data model and the recommender's algorithm.



2. Development of the Toolkit

The Toolkit describes a collection of tools and methods, collected, improved and demonstrated in the duration of the NextGen project and aims at supporting decision-making of its users through its functionalities which are presented below. The Toolkit has been designed as a web application part of the overall “NextGen Interactive Platform” and will be used as the main Marketplace platform in other EU funded projects as well (B-WaterSmart and Ultimate). Therefore, the main User Interface of the application has the NextGen logos and other references and acknowledgements. Although some references to the supporting projects will remain, other attributes will be removed before the official launch of the Marketplace and User Experience will be revised to meet the general requirements. The Toolkit, as part of the Marketplace should be designed in close collaboration with Water Europe (WE, formerly known as WssTP) and be tailored to the needs of WE, which will then use it and curate it beyond the end of the project. Upon finalization of the Toolkit, it should be fully integrated as a component of the Marketplace and its separated entity won’t be further supported as it will be merged to the larger platform (see Deliverable 5.5¹ for more information on the Marketplace).

2.1. Main Toolkit users

The users of the Toolkit, are the same assumed for the marketplace (see deliverable 5.5¹) since it remains a component of it. From the three key players represented in a marketplace for the CE and equally represented in the Toolkit follow:

Problem owners who are often utilities, authorities, or industries, seeking to find the best solution to turn linear processes within their organisation into circular ones, reducing waste and reusing resources. A problem owner may be seeking advice on appropriate technology or be interested in identifying suitable partners to transfer, adjust or upscale. Looking at the Marketplace (and thereafter the Toolkit) as a place where demand meets supply for resources that can be reused, a problem owner can be a buyer as well as a supplier. In the quest of a tool, or the need to offer one, with specific characteristics (price, quantity, quality, efficiency, etc.) the Toolkit offers specific functionalities to support the process (i.e., recommendation of tools, ability to insert thorough information to attract the right audience, etc.).

Solution providers are usually Research and Technology Organisations (RTO), commercial entities, offering a technology or a service as part of a CE enabling portfolio. Similarly, the Toolkit allows the offered tool to meet the demand, through a selection of relevant tools in the dashboard and the attraction of interest through the recommendation.

Investors seeking opportunities to maximize investment revenues. They can be part of the non-registered community of the Toolkit. However, by becoming a registered member they will be able to receive targeted information and contact other stakeholders over the platform.

¹D5.5. G. Karavokiros, V. Psaltopoulos, A. Roubini. The NextGen Online Marketplace.

Next to the above key players, there are other stakeholders that may have an interest in participating in a marketplace and consequently to the Toolkit, each of them from their own perspective, such as representatives of regulatory bodies, state administration, NGOs and academics.

2.2. Functionality

2.2.1. General Information

The NextGen Toolkit is part of the Interactive Platform (IP), which also consists of the Marketplace and the Technology Evidence Base (TEB), sharing a common database that allows querying across tables of all components of the IP. The main components of the IP and their interrelations are presented in Figure 1.

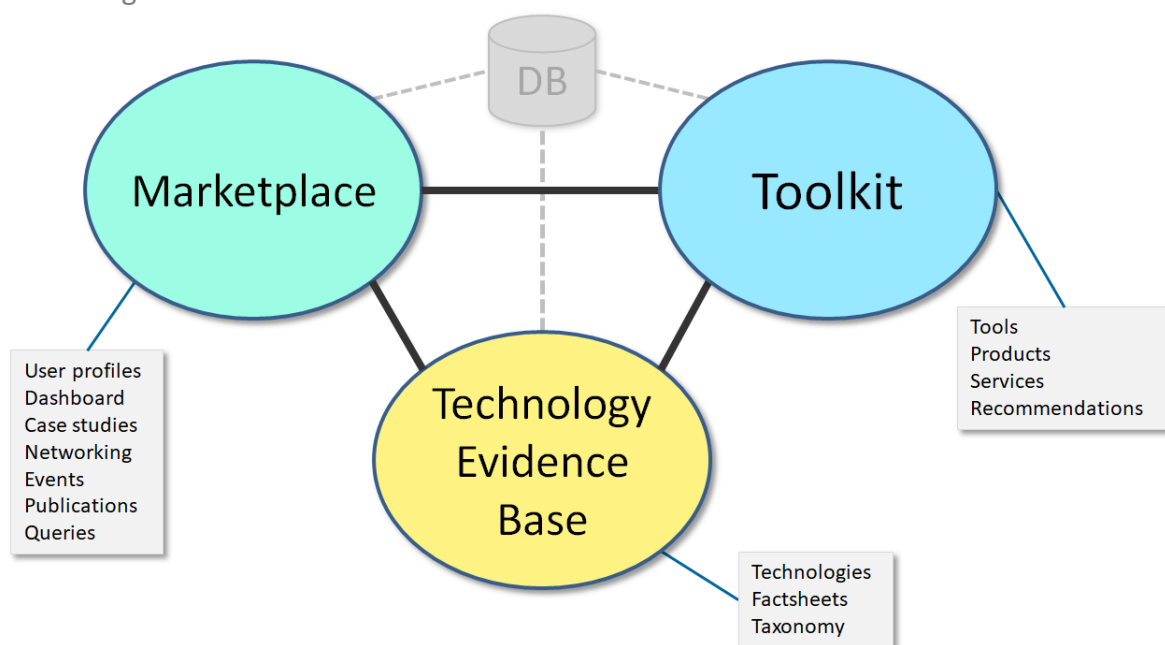


Figure 1 Main components of the Interactive Platform

The Toolkit documents tools, products, services and methods related to the CE that have been developed for or applied within the context of the NextGen project for individual solution assessment and system-wide evaluation and stress testing.

Within the scope of the Toolkit, the term "tool" describes the following:

- A piece of software supporting the CE
- A hardware product or a technological device around the CE
- A service offered as part of a CE-enabling portfolio
- A methodology or a process related to the CE

The Toolkit provides information that allows interested readers to perceive what a tool is about, how it is used in the CE, and if they can apply it in their own case under specific conditions. It allows professionals to contact the developers/owners of the tool and through the Marketplace promoting cooperation and partnerships. It does not give access to download software or any code.

At this initial stage, the Toolkit contains only products that have been created or are being applied by project partners in the NextGen case studies. It will be gradually enhanced with information on other products and tools provided by the Marketplace registered users/members as it is expandable by design. The Recommender System uses the declared preferences and interests of users to technologies and other tags to recommend products and tools that might be of interest to the user of the IP.

2.2.2. Accessing the Toolkit

A URL (<http://tk.nextgenwater.eu/>) has been registered that can be used to access the NextGen Toolkit independently from other components of the Interactive Platform. Alternatively, the NextGen Toolkit can be accessed through the Marketplace URL (<http://mp.nextgenwater.eu/>).

A dedicated user-friendly interface (front-end) for the Toolkit has been developed, in alignment to the Marketplace's overall design and colour palette. The user interface of the Toolkit presents its content in form of cards, providing the user with filtering options, such as hardware, software, service, methodology, and the licence type associated with the tool/product, to narrow down the selection. Figure 2 shows the main page of the Toolkit, presenting examples of products, tools and services around the CE.

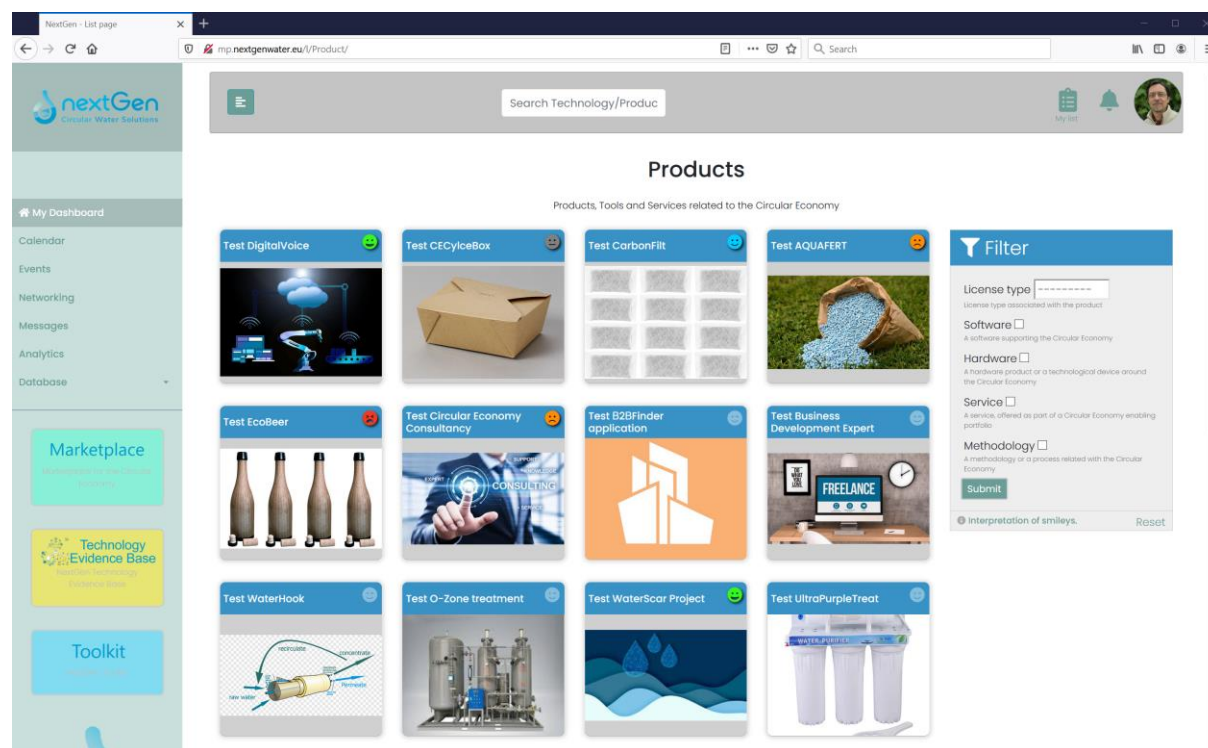


Figure 2 Main page of the Toolkit

2.3. Architectural design

The NextGen Toolkit, follows the architectural design proposed in D2.4 “NextGen Water in the CE re-design toolbox initial version” following the logic of classical Content-based recommender systems². The application recommends a set of tools (i.e., software, hardware, service or process) to a certain user based on the description of the item (basically from the metadata tags) and the user’s interests (from the user’s profile). Figure 3 demonstrates the overall architecture design of the Interactive Platform.

The Toolkit primarily interacts with the user’s profile to fetch valuable information such as their interests and related tags, which capture their knowledge and interest about an entity. Relying on a lightweight recommender system, it matches the user profiles with their presumed preferences and interests and eventually it chooses which info, tools and recommendations match to the user profile guiding the user based on input data in the following categories:

- Components of the physical system
- Flows of water, energy and materials
- Actors involved, including water utilities, industries, technology providers, end-users
- Roles of the actors and their interactions

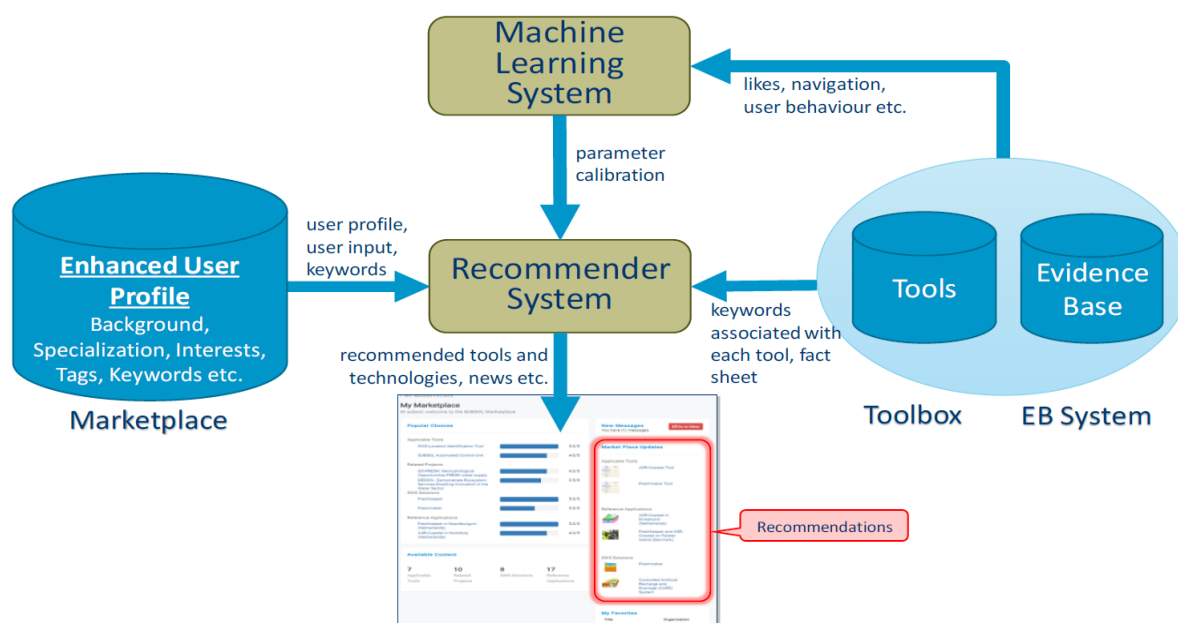


Figure 3 The NextGen Interactive Platform Architecture

² (2017) Content-Based Filtering. In: Sammut C., Webb G.I. (eds) Encyclopedia of Machine Learning and Data Mining. Springer, Boston, MA

2.3.1. Building the recommender system

Recommender systems may be designed using various approaches. These approaches range from heuristics such as domain-specific, expert-knowledge driven systematic classification of products, and user interests, and identification of pertinent matchings between respective keywords and tags, to more general machine learning approaches utilizing methods like association rules and k-nearest neighbours³. Each approach has its own merits and disadvantages.

Regardless of the employed methodology, most recommender systems suffer from a cold-start, which describes the lack of initially available data on user ratings. Therefore, they cannot be used to confidently infer the potential preferences of neither new nor recurring users. In this case, employing heuristic rules based on domain specific knowledge seem to be the most effective approach⁴.

As soon as pertinent data starts to accumulate in large numbers, it becomes difficult even for an expert to detect, identify and track statistically significant patterns in (potentially time varying) user preferences. This is where machine learning and/or data mining tools come at play. Such an example, is the association rule mining, commonly referred and as "market basket analysis", via e.g. the Apriori algorithm which enables the system to automatically detect and assess the statistical significance of simple if-then rules which reflect patterns of actual user behaviour⁵. These rules can subsequently be used for making recommendations. As another example, a simple nearest neighbours approach infers the most probable preferences of a relatively new user, by looking at the preferences of older users that show some degree of similarity with the new user⁶.

During the development of the Toolkit's recommender system, a combination of domain-specific heuristics, user feedback on each potential product of interest and the nearest neighbours technique were used to surpass the cold-start. The recommender system was designed to ask for the user's general interests, initially suggesting relevant products in decreasing order of popularity. The ratings of each user for each product are stored in the database.

2.3.2. The recommender system design and specifications

The two main components of the architectural design of the NextGen Toolkit are presented in Figure 4: the recommender (or recommendation) system and the user interface (UI) that allows the user to interact with the software and provide their input. The output refers to the recommendations of the algorithm based on the user's input and are described in more detail later in this chapter.

³ Deuk Hee Park, Hyea Kyeong Kim, Il Young Choi, Jae Kyeong Kim. A literature review and classification of recommender systems research. *Expert Systems with Applications*, Volume 39, Issue 11, 2012, 10059-10072.

⁴ Aggarwal, Charu C. *Recommender Systems: The Textbook*. Springer, 2016

⁵ Jiawei Han Micheline Kamber Jian Pei, *Data Mining: Concepts and Techniques*, Chapter 6. Morgan Kaufmann 2011.

⁶ Wei Dong, Charikar Moses, and Kai Li. 2011. Efficient k-nearest neighbor graph construction for generic similarity measures. In *Proceedings of the 20th international conference on World wide web (WWW '11)*. Association for Computing Machinery, New York, NY, USA, 577–586

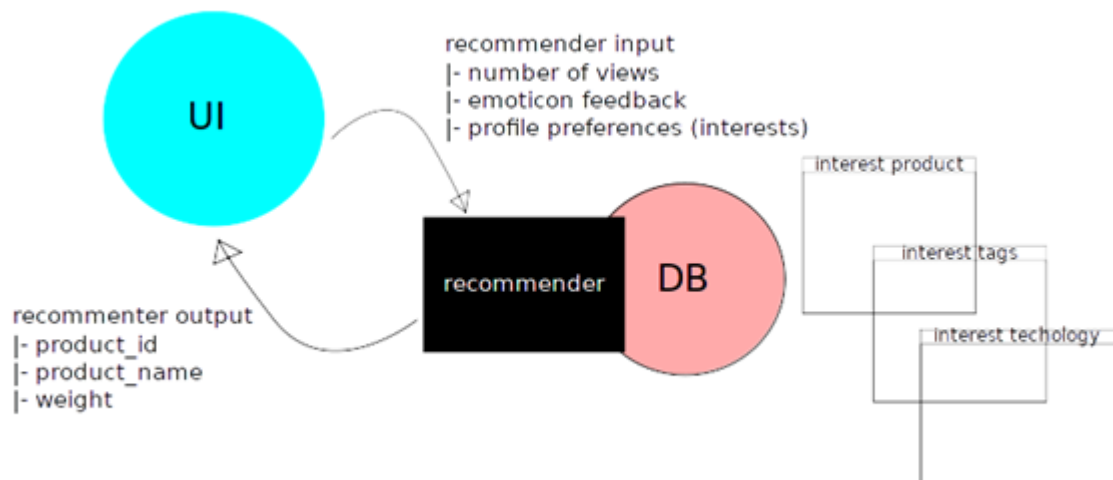


Figure 4 Toolkit in more detail

The recommendations algorithm is implemented in SQL and the web application (that enclosed the user interface) is built in Python. It is kept separate from the UI. The **web** application provides data to a so called “black box” (the recommender system) and calls for the results. In this way the recommender is flexible enough to be developed as a separate module by itself. The recommender has been developed and deployed in the Toolkit, to provide personalised information to the users on products, tools and services around CE. The Recommender System is relying on the NextGen Taxonomy of CE Technologies and other related information collected and stored in the database, to identify tools that might be of interest for the users. Its methodology is based on the specificities of a user, assigned either during the profile creation, when the user declares preferences (interests in technologies and tags) (to be discussed further in 4.2), or during the input provided through the direct expression of interest for a tool (to be discussed further in 4.5). Tools inserted in the Toolkit also contain relevant information to be used in the recommendation process (to be further discussed in 4.4). Thereafter, the methodology is based on the evaluation of all direct or indirect relations between users and tools uploaded in the Toolkit and generates the matches. A scoring system quantifies the strength of each match and tools with top scores appear in prominent place on the dashboard of the user (to be further discussed in 4.3). The data collection process is performed directly through the web interface.

In summary, the following items are taken into consideration during recommendations:

- The user’s preferences derived from the corresponding profile in the relevant database
- The user’s number of views on a certain tool (visits on the product’s page).
- The feedback provided through the emoji system, presented in the following sections, on a certain product.

The recommended tools (i.e., software, hardware, service or process) for a certain user according to their preferences appear in the user’s dashboard page. All tools/products are represented in cards, in a user-friendly way as shown in Figure 5.

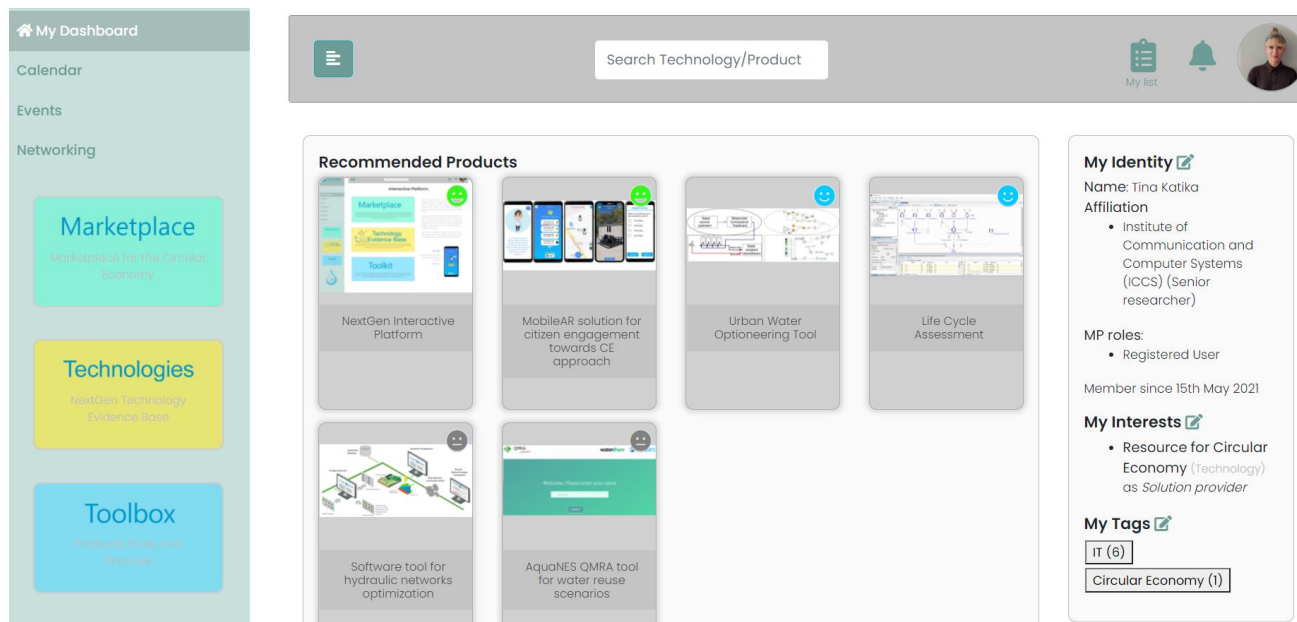


Figure 5 Tools/products presented as cards. It should be noted that tools of highest relevance (marked with the green emoji) appear first, while the blue and grey emoji-labelled tools appear later.

2.3.3. Development Technologies

The two major programming languages utilized for the development of the Toolkit were **Python**⁷, a general-purpose coding language, and **SQL** for the database communication and management. The Toolkit application is developed with the web framework **Django**⁸ and powered by the RDBMS PostgreSQL⁹.

Django, being a flexible, reliable and scalable open-source framework for web applications based on **Python**, is considered as an ideal solution for the development of the Toolkit, supporting a modular design based on the [object-relational mapper](#) (ORM).

On the front-end part, **jQuery**¹⁰ was chosen to make the use of JavaScript easier, since it is a lightweight and feature-rich JavaScript library constructed and based on the principle "write less, do more".

Furthermore, the overall UI design was based on **Bootstrap**¹¹, the front-end open-source powerful framework for responsive web pages (written in **HTML**, **CSS** and **JavaScript**).

PostgreSQL was also carefully selected by taking into consideration scalability and extensibility factors, since it can be later adapted easily to support the increasing volume of data, for example with new indexes, views and functions.

The proper selection of development technologies, which came side by side with the developers' experience on them, allowed for quick and robust development of the Toolkit and ensured compatibility with the NextGen Marketplace.

⁷ <https://www.python.org/>

⁸ <https://www.djangoproject.com/>

⁹ <https://www.postgresql.org/>

¹⁰ <https://jquery.com/>

¹¹ <https://getbootstrap.com/>

3. Information presented in the Toolkit

3.1. Inputs from partners

The NextGen Toolkit has been developed according to the requirements described in the DoA but has also received feedback during two meetings as well as the Water Market Europe Event (WMEE) in March 2021. The functionality of the Toolkit was presented in a stakeholder workshop (M1), conducted on the 21st of February 2019, in Athens. A second assessment around the Toolkit's functionalities was conducted on the stakeholder workshop (CoP meeting), held virtually due to the pandemic situation on the 5th of November 2020.

Upon demonstration of the Toolkit's design and functionality, the audience of the meetings shared feedback and comments, which were either discussed ad-hoc or in separated discussions initiated after these meetings. The stakeholders expressed their suggestions and feedback based on the live demonstration and not their own use. The suggestions and feedback were then translated to user stories to assist the development efforts and communicate the user needs to the development team. To integrate all user stories, two agile iterative rounds were performed to ensure fast development of both UI and extra features. The development efforts (which are further explained in section 4) were accompanied by internal user testing and quality checks to ensure that the Toolkit is user friendly and does not contain bugs and other errors preventing its use. Table 1 presents the high-level user stories from this process, including suggestions for the flow, new features, and UX/UI improvements.

Table 1 The users stories reflecting the inputs from stakeholders, used during the development of the Toolkit

User stories
As an end-user adding a new tool in the Toolkit, I want to be able to attach publications and other relevant documentation when uploading a tool to the Toolkit.
As an end user, I want to have access to a User Manual describing the functionalities and tool insertion process.
As an end user, I want to access the main Toolkit functionalities regardless of their registration state (both registered and unregistered users)
As an end-user adding a new tool in the Toolkit, I want to be able to change the owner of the tool in case this status changes, through the factsheet without contacting the administrator of the platform.
As an end- user, I need to be able to filter the tools in my dashboard based on their type (e.g., software, hardware, service or methodology).
As a registered end- user, I want to be able to easily update my interests and tags to improve the recommendation process.

3.2. The Toolkit tools and methods

Upon the development of the alpha version of the Toolkit, integration of the user stories, and the first quality assurance round, login information was shared to the partners via email. The email included detailed instructions, explaining the process and steps to be followed to insert the required information regarding the Tools generated within the context of the NextGen project. Most partners found the process straightforward and required very little to zero additional help demonstrating the user-friendliness of both the Toolkit and the instructions presented (now included in section 4). The following list reflects a short overview of the tools already entered in the system:

- CircularAR
 - CircularAR is the NextGen Augmented Reality mobile app for end-user engagement, developed by ICCS. It is applied on selected NextGen demo cases aiming to drastically increase the learning value of the showcases by making visible ‘hidden’ or ‘intangible’ elements of the cycle and demonstrated solution to visitors.
- UWOT
 - The Urban Water Optioneering Tool, developed by NTUA, consists of a model that simulates the generation and routing of urban water demands from the source to the customer and down to the wastewater plant, facilitating planning and performance assessment of urban water systems.
- Hydroptim
 - Hydroptim, developed by ADASA, is a decision support tool for the optimization of the operation of hydraulic/hydrologic systems, based on the mathematical minimization of the system cost function, including energy, water sources, treatment costs, etc, which minimizes the cost function, while satisfying water demand and respecting physical constraints.
- Serious game (SG)
 - The NextGen Serious Game, developed by UNEXE, allows citizens to visualize and understand options, scenarios, opportunities and challenges in a more circular approach to water management, while supporting advice provision, role-playing and negotiations between stakeholders of the water value chain. The SG is applied on specific demonstration sites and influenced by their major local characteristics of interest regarding water in the CE, but will be generic enough to be played beyond these cases and indeed beyond NextGen.
- LCA (Life Cycle Assessment)
 - The Life Cycle Assessment tool, developed by KWB, is a standardized methodological framework for assessing the potential environmental impacts of a product or service customized for the project’s purposes. It assesses the entire life cycle of a product or



service, i.e. including next to the core system under study also all upstream and downstream processes that are connected to the core system.

- QMRA - QCRA
 - The quantitative microbiological risk assessment (QMRA) tool and the quantitative chemical risk assessment tool (QCRA), developed by KWB, for human health and/or ecosystems are capable of identifying potential hazards that can emerge from closing water and material cycles. For water reuse sites and recycling of materials the tools apply a risk assessment/risk management approach based on combining expert knowledge with monitoring data.

3.3. The tools and owners' specifications

3.3.1. The tools' attributes

Products, tools, and services of the Toolkit (see previous section: 3.2) have attributes that are essential to describe them. Table 2 presents the chosen attribute names, their description, their type, and an indication whether each field is mandatory or not. In the comment section, additional information is provided e.g. regarding the insertion of these attributes from the user.

Table 2 Products, tools, services attributes

Name	Description	Attribute type	Mandatory	Comments
Name	The tool's name (i.e., software, hardware, service or process)	Text	Yes	
Description	Information on the tool (i.e., software, hardware, service or process)	Rich Text	Yes	
Acronym	The acronym of the tool (i.e., software, hardware, service or process) (if available)	Text	No	
URL	URL providing further information on the tool (i.e., software, hardware, service or process)	Text	No	
Environment	Operating environment in which the tool/application runs e.g., Microsoft Windows (if applicable)	List	No	Select one or more options
Links	Other URLs related to the tool, product or service	Rich Text	No	
Version	Current stable version number or version code of the tool (i.e., software, hardware, service or process)	Text	No	
Costs	Description of the costs and conditions for purchasing of the license of the tool (i.e., software, hardware, service or process)	Rich Text	No	
Target audience	Profile of users who would find the tool (i.e., software, hardware,	Rich Text	No	

	service or process) useful or/and are qualified to use it.			
Innovation	Description of the innovative elements of the tool, product or service	Rich Text	No	
TRL	The Technology Readiness Level (TRL) giving an estimate of the technology maturity of the related tool, product or service	List	No	Select one
Technical requirements	Technical requirements to run the tool (i.e., software, hardware, service or process)	Rich Text	No	
Initial release	Year of the initial release of the tool (i.e., software, hardware, service or process)	Integer	No	
Publications	Publications related with the tool (i.e., software, hardware, service or process)	Rich Text	No	
License type	General license type (free or commercial)	List	No	Select one or more options
License	If applicable, name the license associated with the tool (e.g., GPL 3 or MIT).	Rich Text	No	
Timestamp_version	Last update of the version information	Date & Time	No	Timestamp is updated automatically. May also be set by the user.
Timestamp_costs	Last update of the cost's information	Date & Time	No	Timestamp is updated automatically. May also be set by the user.
Timestamp_trl	Last update of the TRL information	Date & Time	No	Timestamp is updated automatically. May also be set by the user.
Timestamp_license	Last update of the license information	Date & Time	No	Timestamp is updated automatically. May also be set by the user.
Contact details	Name of the contact person, email etc.	Text	Yes	Field will be pre-filled with the user data. The user will be able to change the contact data.

3.3.2. Relationships between tools and other data categories

Each tool (i.e., software, hardware, service or process) has a specific owner, typically an organisation that has created or developed the tool, and relates to one or several CE technologies. These fields are mandatory and the data can be modified through the dedicated custom form (see 4.4). A set of tags to be used in the matchmaking/recommendation process and its technology are also inserted. Finally, each tool may be associated with case studies and images of the tool. Table 3 lists all relationships of tools to other entities, and Table 4, shows the attributes related to the organizations.

Table 3 Tools' relations with technologies and use cases

Name	Description	Mandatory	Cardinality	Comments
Owner	The organization/company/entity that owns the tool (i.e., software, hardware, service or process)	Yes	1,1	Further information regarding the organisation will be requested if not already known (see sheet Organisation)
Technologies	What (NextGen or CE) technologies does the tool (i.e., software, hardware, service or process)	Yes	1,n	For each technology an assigned weight is required representing relevance of the technology for this tool. Experts will be requested to select the relevant technologies from a given list.
Tags	Keywords that capture knowledge about the specific tool (i.e., software, hardware, service or process)	Yes	1,n	For each keyword, a weight is required representing relevance of tag for this tool. Experts will be able to select from the list of tags or insert new ones
Case Studies	Case studies, in which a tool (i.e., software, hardware, service or process) has been applied	No	0,n	Data about project case studies can be collected at a later stage of the project
Images	Characteristic images or schematic representations of the tool (i.e., software, hardware, service or process). All known formats, which are supported by web browsers, up to a certain size, are accepted (e.g. jpeg, png).	No	0,n	Caption needs to be provided for each illustration in textual format, as well as its reference.

Table 4 Organization's attributes

Name	Description	Attribute type	Mandatory	Comments
Name	Name of the organisation	Text	Yes	
Description	Short description of the organisation and its main activities	Text	No	
Address	Address of the organisation	Text	No	
Url	URL of the official website of the organization	Text	No	
Logo		Image	No	
Legal entity type		List	Yes	Select from the list. Select only one.
Country	Country, where the organization is located	List	No	

3.3.3. Reference lists

The Technology readiness level provides an estimate of the technology maturity of the related tool and is being inserted in the addition of a new tool to the Toolkit. Each of the tools inserted, may operate at a different environment and multiple selections are possible during registration. Similarly, the owner of a tool (an organisation characterized by its legal entity type) is requested to specify the license type of its product. Table 5 documents all possible options in the aforementioned reference list.

Table 5 Reference lists

Environment	License type	TRL		Legal entity type	
		Level	Description	Abbreviation	Name
SaaS - Web application	Free and/or open source (CC)	Level 1 - Basic Research: basic principles are observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include fundamental investigations and paper studies.	GOV	Government Organisation
Windows	Commercial	Level 2 – Applied Research: technology concept and/or application formulated	Once basic principles are observed, practical applications can be formulated. Examples are limited to analytic studies and experimentation.	IGO	Intergovernmental Organisation
Linux	Free/open source and commercial versions	Level 3 – Critical function, proof of concept established	Active research and development are initiated. Laboratory studies aim to validate analytical predictions of separate components of the technology. Examples include components that are not yet integrated or representative.	NGO	Non-Governmental Organisation
macOS		Level 4 – Laboratory testing of prototype component or process	Design, development and lab testing of technological components are performed. Here, basic technological components are integrated to establish that they will work together. This is a relatively “low fidelity” prototype in comparison with the eventual system.	NPO	Non-Profit Organisation
Android		Level 5 – Laboratory testing of integrated system	The basic technological components are integrated together with realistic supporting elements to be tested in a simulated environment. This is a “high	RTO	Research and Technology Organisation

iOS
Other

	fidelity" prototype compared to the eventual system.		
Level 6 – Prototype system verified	The prototype, which is well beyond that of level 5, is tested in a relevant environment. The system or process demonstration is carried out in an operational environment.	COM	Large Enterprise (from 250 employees)
Level 7 – Integrated pilot system demonstrated	Prototype is near, or at, planned operational system level. The final design is virtually complete. The goal of this stage is to remove engineering and manufacturing risk.	SME	Small and Medium Enterprise (up to 250 employees)
Level 8 – System incorporated in commercial design	Technology has been proven to work in its final form under the expected conditions. In most of the cases, this level represents the end of true system development.	Other	-
Level 9 – System ready for full scale deployment	Here, the technology in its final form is ready for commercial deployment.		
Level beyond 9 - Market introduction	The tool (i.e., software, hardware, service or process) is launched commercially, marketed to and adopted by a group of customers (including public authorities).		

4. User manual

The Toolkit, as a component of the Interactive Platform, supports two types of users, registered and those who prefer to navigate in the platform anonymously. The registered users can register to this freeware application through the Marketplace (see deliverable D5.5¹). Even though unregistered users can view its content, for the users of the Marketplace to take full advantage of the Toolkit's capabilities (e.g., personalized recommendations), it is recommended that they first login to the system.

4.1. Login and registration

The Login/Registration page for the Toolkit coincides with the Marketplace's. At the first step of the registration process, the user is asked to fill in a valid e-mail address, a password, a name, and read and accept the NextGen's privacy policy. All sensitive data is saved in an encrypted form.



The screenshot shows the NextGen Registration form. The form is titled "Registration form" and is part of the "Marketplace" section. It includes a sidebar with navigation links: "Homepage", "Database", "Marketplace", "Technology Evidence Base", and "Toolkit". The main content area contains a "Personal information" section with the following fields:

- Email address *
- Password *
- First name *
- Last name *
- Consent * ☐ I consent to the Privacy Policy

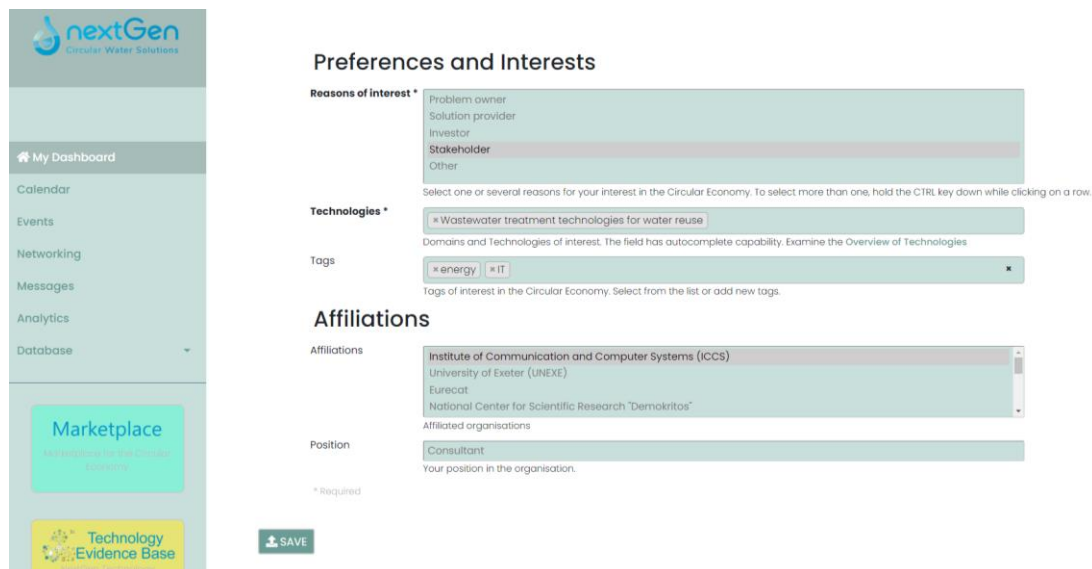
Below the consent field, there is a note: "(*) Required fields". A "Submit" button is located at the bottom right of the form. The footer of the page includes the European Union flag, the text "The NextGen project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 776541", and links for "Project | About | Privacy policy | Contact | Disclaimer".

Figure 6 Registration form

4.2. User profile creation

Following this step, the first time the users log in, and they are directed to the preferences and affiliations page where they are asked to complete the registration by filling in their interests related to the CE and the affiliations to organizations fields. Each field in this step prompts the user to select

from a predefined list of selections. In case they neglect this step, a reminder will be positioned in a banner at the top of the page. The recommender system (presented in section 2.3) makes use of the information, such as interests and associated tags, to propose tools (i.e., software, hardware, service or process) to the users according to their profile.



nextGen
Circular Water Solutions

My Dashboard

Calendar

Events

Networking

Messages

Analytics

Database

Marketplace
Applications for the Circular Economy

Technology Evidence Base

Preferences and Interests

Reasons of interest *

Problem owner
Solution provider
Investor
Stakeholder
Other

Select one or several reasons for your interest in the Circular Economy. To select more than one, hold the CTRL key down while clicking on a row.

Technologies *

Wastewater treatment technologies for water reuse

Domains and Technologies of interest. The field has autocomplete capability. Examine the Overview of Technologies

Tags

energy IT

Tags of interest in the Circular Economy. Select from the list or add new tags.

Affiliations

Affiliations

Institute of Communication and Computer Systems (ICCS)
University of Exeter (UNEXE)
Eurecat
National Center for Scientific Research "Demokritos"

Affiliated organisations

Position

Consultant

Your position in the organisation.

* Required

SAVE

Figure 7 User preferences and interests

4.3. The Toolkit main page

The main page of the Toolkit (**Error! Reference source not found.**) can be freely accessed without registration from the landing page of the Marketplace by clicking on the Toolkit pane or directly through the following URL:

<https://mp.nextgenwater.eu/tk/>

It shows a list of products, tools and services, represented by their name and a characteristic image (if available) and a filter, through which the user can narrow down the selection of tools. When clicking on a tool's image, the user is directed to the tool's factsheet (see section 4.6).

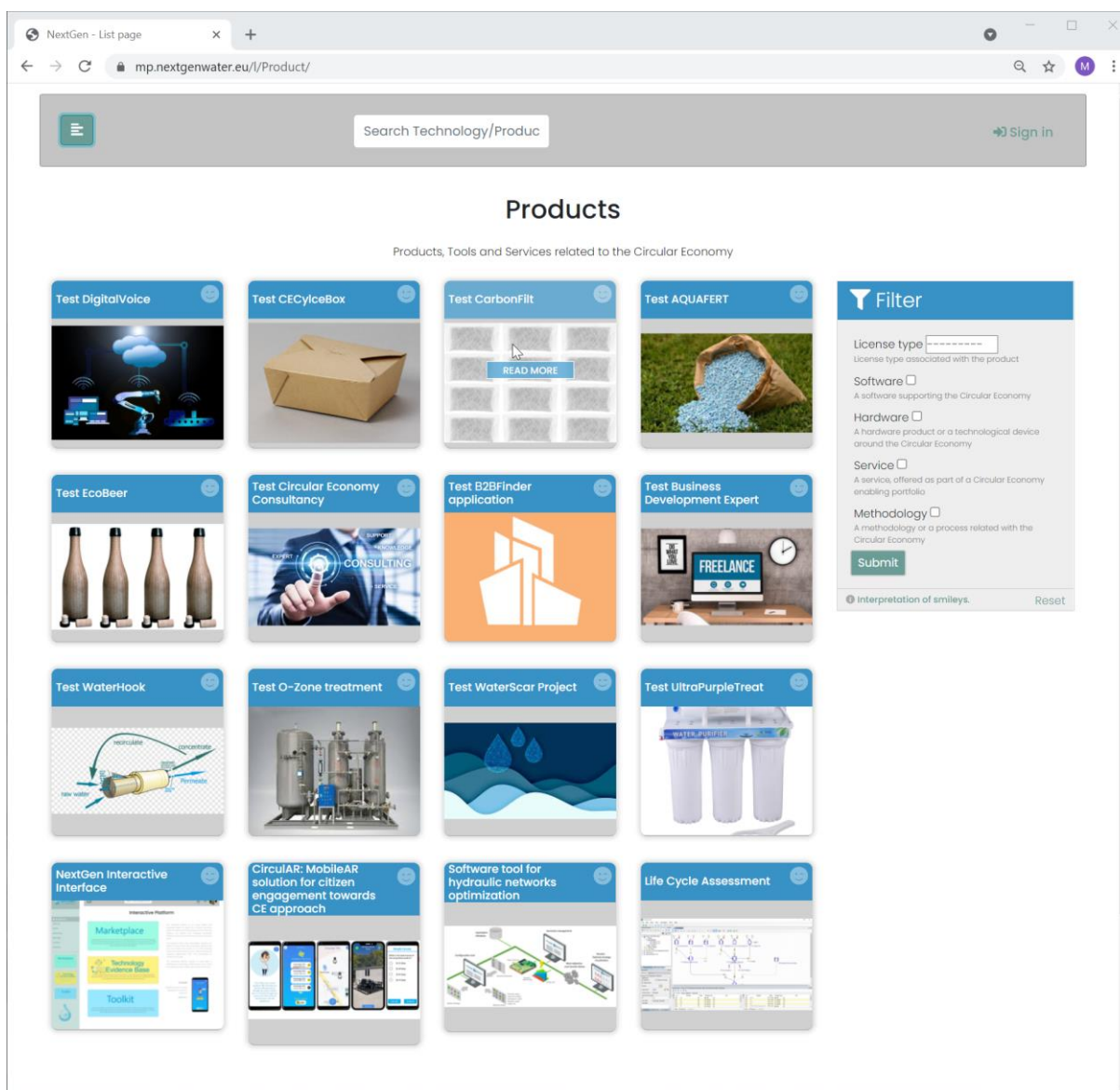


Figure 8 Main page of the Toolkit

4.4. The user dashboard

Each user has now access to a personalized dashboard that can be accessed from the left panel of the main page. The Dashboard of each user, is demonstrated in Figure 9. It features a list of recommended tools (i.e., software, hardware, service or methodology) related to the CE, based on the user's declared interests and tags inserted during the registration process and the user's behavior when navigating through the platform. The products on the list, support an emoji-based feedback system, which allows the users to express the relevance of the recommended results with respect to their interests and feed the algorithm of the recommended system with additional data.

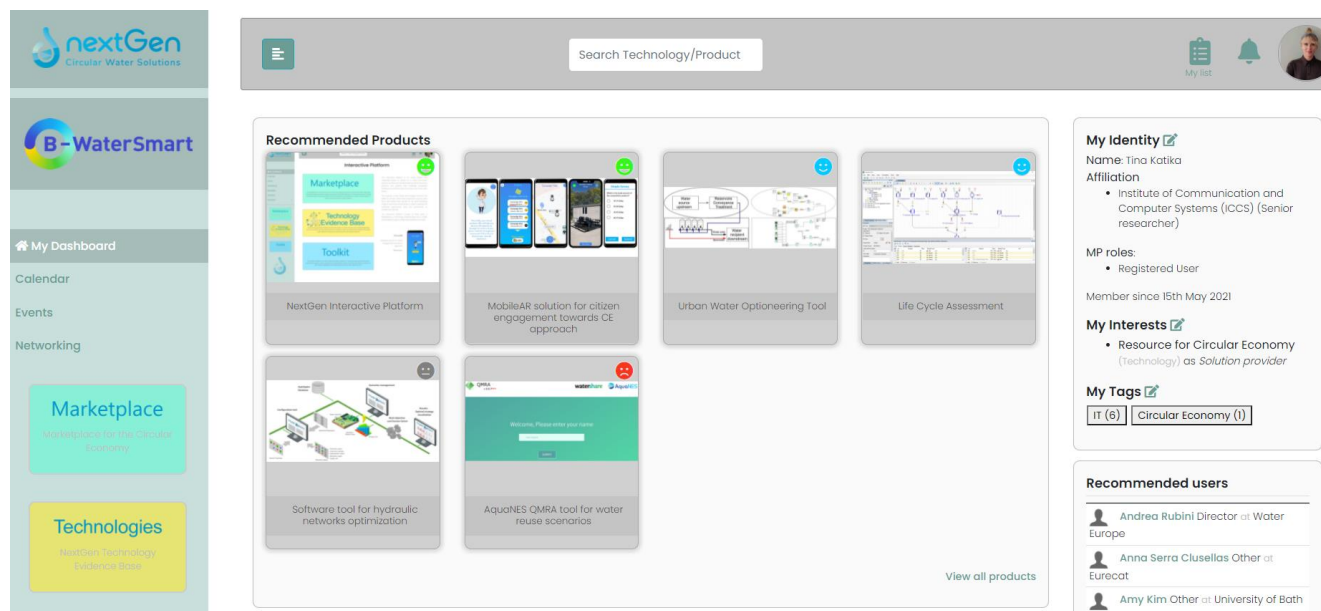


Figure 9 The user's dashboard

4.5. Inserting a tool

Upon scrolling down the dashboard, the user has now access to the view of their own products, referring to tools (i.e., software, hardware, service, methodology) that they have inserted to the Toolkit. Figure 10 shows the cards of the products belonging to the users themselves offering the ability to insert new ones. At the top left corner of each card the user has access to the number of pageviews which is a useful metric demonstrating the relevance of the tool through its traffic, while other relevant information appears below the image of the product. Upon selection of the “add new” button the user is directed to a data entry form (Figure 11). Hints and answers to frequently asked questions guide users on how to fill in the factsheet (to be further explained in 4.6). Upon submission of the form, the data are automatically validated and in case of rule violations (e.g. wrong data type or missing mandatory information) the user is notified and requested to correct the form and resubmit.

To ensure that the data of a tool, product or service are up-to-date, a data manager is appointed through the “contact details” section of the form. The data manager of a product, can easily appoint another person to become data manager in their place, by selecting them in the product edit page. The new person to be appointed has to be related to one of the organizations that the previous data manager is affiliated to. By transferring the data management to another person, the previous data manager, automatically loses this role.



Figure 11 The form each user has to fill when inserting a tool in the Toolkit. Each section has a detailed description and instructions to assist the process.

4.6. The tool's factsheet

The user of the Toolkit has access to the following products through their dashboard: tools, products, and methodologies. Depending on the product's type (software, hardware, service, methodology), and the amount of non-mandatory information that the product's owners have shared (see section 2.1), the factsheets may differ slightly. Typically, a tool's factsheet provides the following information (see also Figure 12):

- Title, images and a short statement to best describe a tool at a first glance
- Description - General information on the product, its components and the scope of application
- Actors, roles and interactions - Information related to the actors involved (e.g. water utilities, industries, technology providers, end-users), their roles and their interactions
- Relationships
 - Organisations - Organisations that own the tool, product or service
 - Technologies – CE Technologies related with the tool, product or service. The user may select from the list
 - Tags (related to the tool, product or service) - Users select from the list or add new tags
 - Data manager - User responsible for the data management of this product. The user may select from the list or type a name to transfer the data management to another person
- Basic information
 - Name - Name of the product
 - Abbreviation - Abbreviation, model or acronym of the product
 - Contact - Name and data of the contact person
 - Target audience - Profile of users who would find the product useful or/and are qualified to use it
 - Costs (if applicable) - The costs and conditions for purchasing the product, obtaining a license or providing the service
 - URL - URL providing further information on the product
- Additional information
 - Unique selling points, added value and innovation elements of the tool, product or service
 - Technical requirements to obtain, install or run the tool, product or service
 - Publications related with the product
 - Case studies applying the tool
- Technology readiness level
- Relevance of the tool for the specific user based on an emoji system

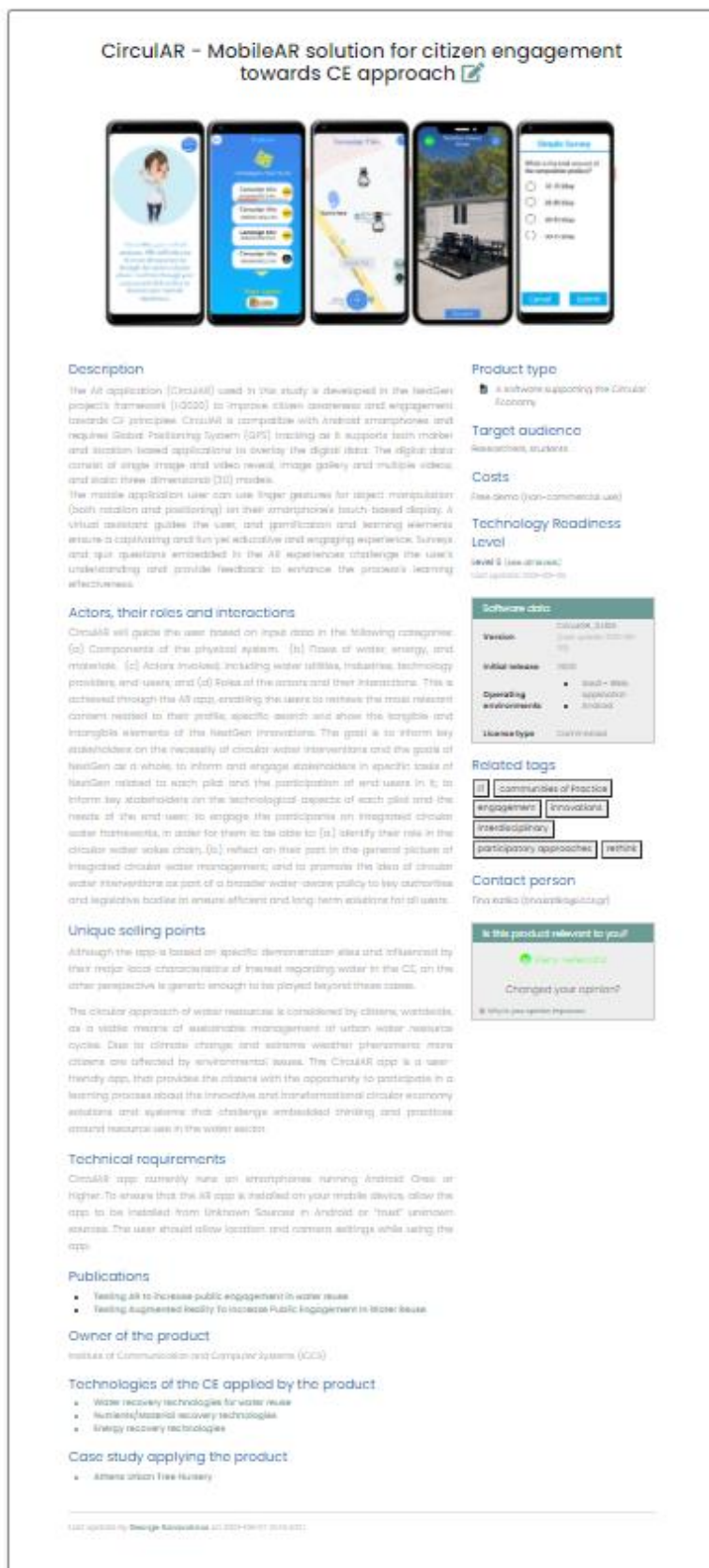


Figure 12 Factsheet example of a MobileAR solution.

4.7. Expression of interest

The users are able to express the relevance of the proposed tool to them from one of the following pages: a) the Toolkit main page as seen in Figure 8, b) the detailed page of each tool as seen in Figure 9 or c) the recommendations in the dashboard (Figure 13). Hovering the mouse over the emoji at the top right corner of each card, a tooltip prompts the user to select the emoji that best describes the relevance of the product. The five emojis – ranging from red for complete irrelevance to green for full relevance – feed the recommender system with information based on the user preferences (Figure 14).

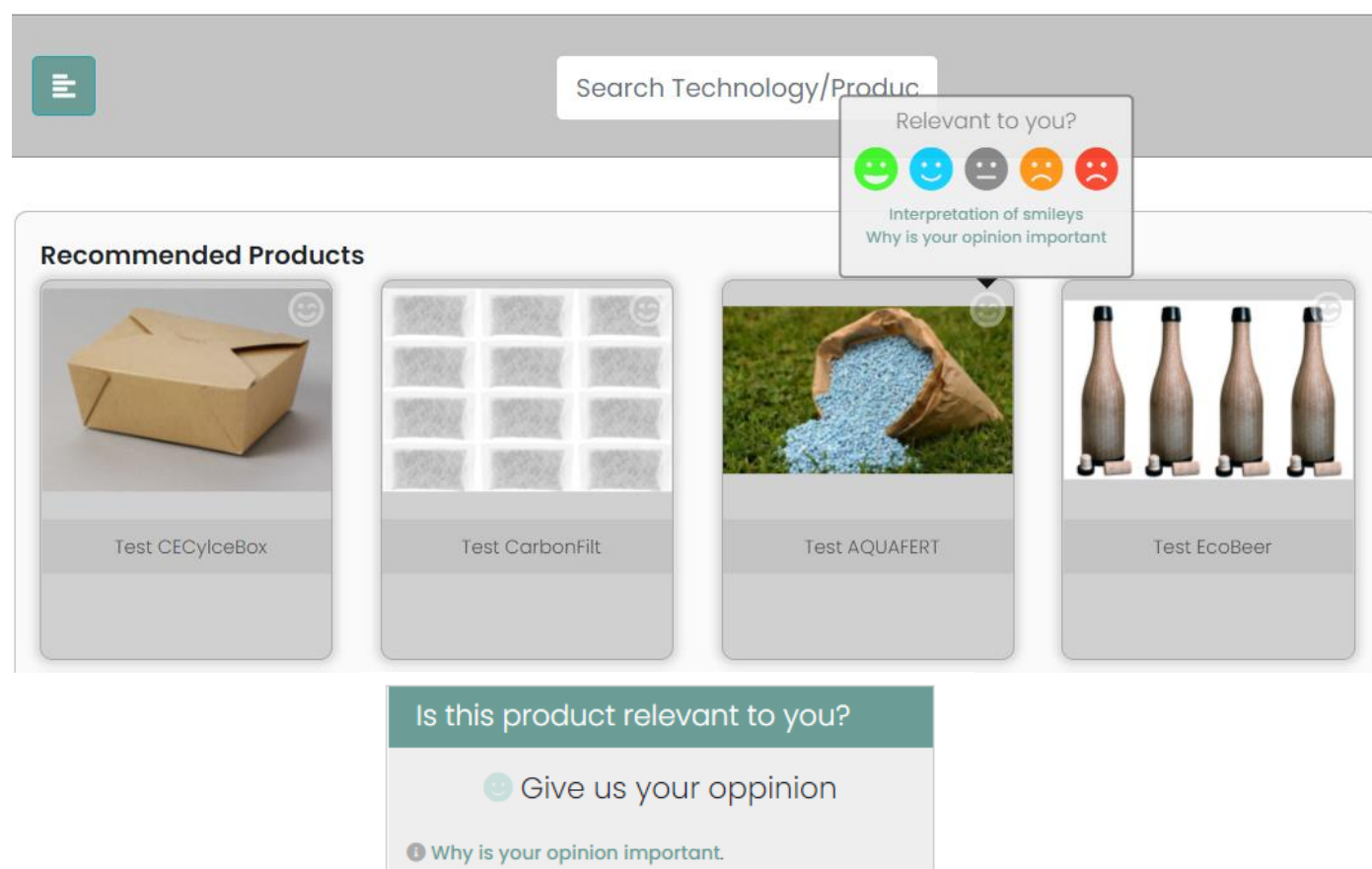


Figure 13 The emoji system used prompting the user to declare relevance.

Interpretation of emojis:



Very relevant



Relevant



Somehow relevant

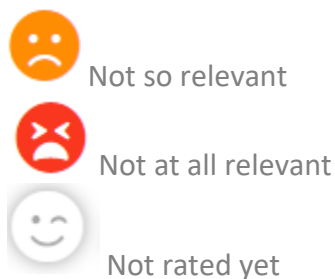


Figure 14 Interpretation of emojis used in the emoji system

The declared relevance of products with respect to the user's interests will be used to promote high rated and similar products in the dashboard and personal listings of the specific users. The rating of one user has no effect to others. In the absence of the user's opinion, the recommender system will suggest products based on other information, such as the declared preferences on technologies, tags and keywords or may be primarily influenced by chance.

5. Conclusions

The NextGen Toolkit has been developed according to the requirements described in the DoA and the feedback received from the two CoP meetings (Athens and virtual) as well as the Water Market Europe Event. The feedback has been integrated to the Toolkit through iterative agile rounds. The Toolkit is constructed as part of an overall web application called Interactive Platform and is also accessible as a standalone web platform. The present report summarizes the functionalities of the toolkit and serves as a user's manual for the end users. It also describes the main building blocks around the Toolkit, providing also the algorithmic logic on the recommender system. Furthermore, it demonstrates the technologies that have been used in the development phase and briefly refers to the tools that the application includes.

The Toolkit performs advanced matchmaking through a lightweight, user friendly, and reliable recommender system supporting the overall project's actions, expandable and reusable for further exploitation around the field of CE after the project's closure. Data, relevant for the matchmaking process is being collected from the users during the registration process, when users specifically declare their interests for technologies, tags and tools and by analysing their browsing behaviour on the platform.

Registered users are able to upload information on their products, access their dashboards and receive recommendations through a user-friendly web application that currently can be accessed through the following URL <https://tk.nextgenwater.eu/>.

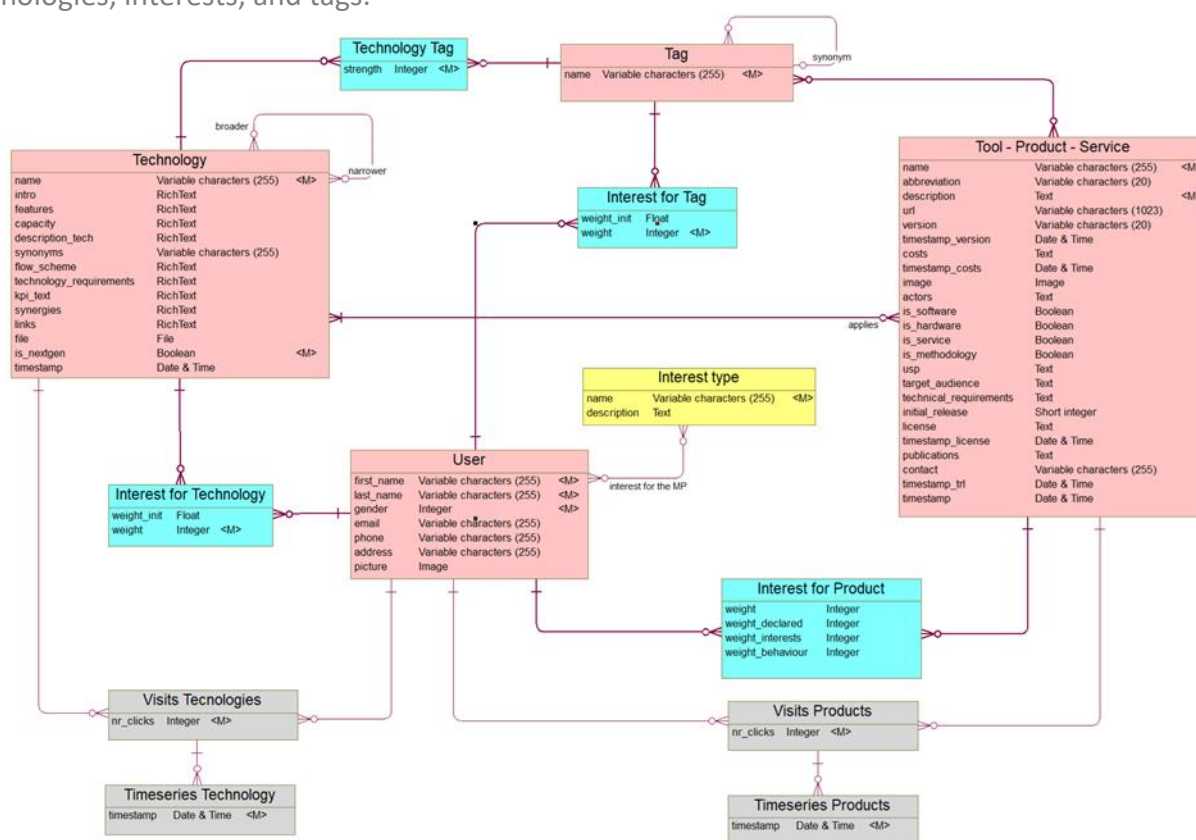


Annexes

On this section, we present the entity – relationship diagram and the conceptual data model of the recommendation system, i.e. tables, attributes and relationships of the Toolkit followed by the operating algorithm’s logic.

A. Recommender System ER

The entity–relationship model (ER model) describes the interrelated concepts of interest in the recommender system. More specifically, it describes the intercorrelations among the users, tools, technologies, interests, and tags.



B. Recommender System Conceptual Data Model

The following sections describe the entities, in the Toolkit as they are a part of the Conceptual data model that is included in the Marketplace.

Entities

I.1 Description

Entities of the Toolkit, which are essential for the recommender system.

I.1.1 List of entities

Name	Comment
Affiliation	Affiliations of users
Interest for Product	Estimated interest of a user for a product
Interest for Tag	Interest by a user for a specific tag
Interest for Technology	Interest by a user for a specific technology
Interest type	The type of interest of a related item, e.g. solution provider, problem owner, investor etc.
Product View	Pageviews of users for product factsheets.
Tag	Any user-defined index term that captures knowledge about an entity such as technology, case study, publication and legislation. It can be used to search information related to a certain keyword or to relate two different entities with each other through a tag. Tags may have synonyms.
Technology	Taxonomy of Technologies capable to support the CE
Technology Tag	Intermediate entity that gives the strength of the relationship between the related technology and tag
Technology View	Pageviews of users for technology factsheets.
Timeseries Product	Timeseries of user pageviews for product factsheets.
Timeseries Technology	Timeseries of user pageviews for technology factsheets.
Tool - Product - Service	Products, services or tools related to the CE
User	Registered user, administrator or a user having another role in the platform.

I.1.2 Interest for Product

I.1.2.1 Description

Estimated interest of a user for a product

I.1.2.2 Attributes

Name	Comment	Data Type	Mandatory
weight	Current estimation of user's interest taking into account all factors (e.g. his	Integer	FALSE

	declared interests, his behaviour in the system, results from the recommender system, number of times the product has been recommended)		
weight_declared	Declared interest for a product, expressed through emoticons by the user	Integer	FALSE
weight_interests	Estimated interest for a product, calculated based on the direct or indirect expression of interests by the user	Integer	FALSE
weight_behaviour	Estimated interest for a product, calculated by the browsing behaviour of the user	Integer	FALSE

I.1.2.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
User	Interest for Product	0,n	1,1	Interest expressed by the user
Tool - Product - Service	Interest for Product	0,n	1,1	The product for which the user has expressed interest

I.1.3 Interest for Tag

I.1.3.1 Description

Interest by a user for a specific tag

I.1.3.2 Attributes

Name	Comment	Data Type	Mandatory
weight_init	Declared initial user interest, expressed in a weight	Float	FALSE
weight	Current estimation of user's interest taking into account all factors (e.g. his declared interests, his behaviour in the system, results from the recommender system, number of	Integer	TRUE

	times the product has been recommended)		
--	---	--	--

I.1.3.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
User	Interest for Tag	0,n	1,1	
Tag	Interest for Tag	0,n	1,1	
Interest type	Interest for Tag	0,n	0,n	

I.1.4 Interest for Technology

I.1.4.1 Description

Interest by a user for a specific technology

I.1.4.2 Attributes

Name	Comment	Data Type	Mandatory
weight_init	Declared initial user interest, expressed in a weight	Float	FALSE
weight	Current estimation of user's interest taking into account all factors (e.g. declared interests, behaviour in the system, results from the recommender system, number of times the product has been recommended)	Integer	TRUE

I.1.4.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
User	Interest for Technology	0,n	1,1	

Technology	Interest for Technology	0,n	1,1	
Interest type	Interest for Technology	0,n	0,n	

I.1.5 Interest type

I.1.5.1 Description

The type of interest of a related item, e.g. solution provider, problem owner, investor etc.

I.1.5.2 Attributes

Name	Comment	Data Type	Mandatory
name	Name of the item	Variable characters (255)	TRUE
description	Description of the item	Text	FALSE

I.1.5.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
Interest type	Interest for Tag	0,n	0,n	
Interest type	Interest for Technology	0,n	0,n	
Interest type	User	0,n	0,n	

I.1.6 Product View

I.1.6.1 Description

Pageviews of users for product factsheets.

I.1.6.2 Attributes

Name	Comment	Data Type	Mandatory
nr_clicks		Integer	TRUE

I.1.6.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment

		Cardi nality	Cardi nality	
Tool - Product - Service	Product View	0,n	1,1	
User	Product View	0,n	1,1	
Product View	Timeseries Product	0,n	1,1	

I.1.7 Tag

I.1.7.1 Description

Any user-defined index term that captures knowledge about an entity such as technology, case study, publication and legislation.

It can be used to search information related to a certain keyword or to relate two different entities with each other through a tag. Tags may have synonyms.

I.1.7.2 Attributes

Name	Comment	Data Type	Mandatory
name	Name of the item	Variable characters (255)	TRUE

I.1.7.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardi nality	Entity 2 -> Entity 1 Role Cardi nality	Comment
Tag	Case Study	0,n	0,n	Tags characterizing the case study
Tag	Publication	0,n	0,n	Tags characterizing the publication
Technology Tag	Tag	1,1	0,n	
Tag	Tag	0,n	0,1	Synonym
Tag	Tag	0,n	0,1	Synonym
Tag	Legislation or Regulation	0,n	0,n	Tags characterizing the Legislation/Regulation in the CE
Tool - Product - Service	Tag	0,n	0,n	Tags related with the tool, product or service

Tag	Interest for Tag	0,n	1,1	
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I.1.8 Technology

I.1.8.1 Description

Technologies capable to support the circular economy.

I.1.8.2 Attributes

Name	Comment	Data Type	Mandatory
name	Name of the item	Variable characters (255)	TRUE
intro	Introductory paragraph at the top of the factsheet	RichText	FALSE
features	Unique selling points and features of the technology	RichText	FALSE
capacity	Facts related to the capacity of the technology	RichText	FALSE
description_tech	Description of the technology	RichText	FALSE
synonyms	Other terms that are commonly used for the same technology	Variable characters (255)	FALSE
flow_scheme	Flow scheme of the technology	RichText	FALSE
technology_requirements	Technology requirements and operating conditions	RichText	FALSE
kpi_text	Key performance indicators	RichText	FALSE
synergies	Synergetic effects and motivation for the implementation of the technology	RichText	FALSE
links	Links to related topics and similar reference projects	RichText	FALSE
file	Factsheet of the technology as PDF file	File	FALSE
is_nextgen	Is this technology developed or applied in the NextGen project?	Boolean	TRUE
timestamp		Date & Time	FALSE

I.1.8.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
Technology	Case Study	0,n	0,n	Technologies applied in the case study
Technology	Publication	0,n	0,n	Publications related with the technology

Scale	Technology	0,n	0,n	Typical spatial scales of technologies
Temporal Scale	Technology	0,n	1,n	Period of time that is typically needed until the technology and has been installed and is ready to go into operation
Technology Costs	Technology	0,n	0,n	Approximate costs for purchase, installation, application and maintenance of the technology
Technology	Technology Tag	0,n	1,1	
Illustration	Technology	0,n	0,1	Illustration of the technology
Technology	KPI assessment	0,n	1,1	The technology that has been assessed
Technology	Illustration	0,n	0,1	Characteristic illustration of the technology
Technology	Technology	0,n	0,n	Domains to which the technology belongs
Technology	Technology	0,n	0,n	Domains to which the technology belongs
Technology	Tool - Product - Service	0,n	1,n	Tool, product or service applying NextGen technology
Technology	Reuse of Resource	0,n	0,1	The technology, which uses by-products of another technology
Technology	Reuse of Resource	0,n	0,1	The technology, which produces by-products that can be used in another technology
Technology	Event	0,n	0,n	
Technology size	Technology	0,n	0,1	Size of implementation
Technology	Interest for Technology	0,n	1,1	
Technology View	Technology	1,1	0,n	

I.1.9 Technology Tag

I.1.9.1 Attributes

Name	Comment	Data Type	Mandatory
strength	An integer value indicating how strongly the tag is related to the technology from 1 (very weak) to 100 (very strong)	Integer	TRUE

I.1.9.2 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role	Entity 2 -> Entity 1 Role	Comment

		Cardi nality	Cardi nality	
Technology Tag	Tag	1,1	0,n	
Technology	Technology Tag	0,n	1,1	

I.1.10 Technology View

I.1.10.1 Description

Pageviews of users for technology factsheets.

I.1.10.2 Attributes

Name	Comment	Data Type	Mandatory
nr_clicks		Integer	TRUE

I.1.10.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardi nality	Entity 2 -> Entity 1 Role Cardi nality	Comment
Technology View	Technology	1,1	0,n	
Technology View	User	1,1	0,n	
Technology View	Timeseries Technology	0,n	1,1	

I.1.11 Timeseries Product

I.1.11.1 Description

Timeseries of user pageviews for product factsheets.

I.1.11.2 Attributes

Name	Comment	Data Type	Mandatory
timestamp		Date & Time	TRUE

I.1.11.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role	Entity 2 -> Entity 1 Role	Comment

		Cardi nality	Cardi nality	
Product View	Timeseries Product	0,n	1,1	

I.1.12 Timeseries Technology

I.1.12.1 Description

Timeseries of user pageviews for technology factsheets.

I.1.12.2 Attributes

Name	Comment	Data Type	Mandatory
timestamp		Date & Time	TRUE

I.1.12.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardi nality	Entity 2 -> Entity 1 Role Cardi nality	Comment
Technology View	Timeseries Technology	0,n	1,1	

I.1.13 Tool - Product - Service

I.1.13.1 Description

Products, services or tools related to the circular economy

I.1.13.2 Attributes

Name	Comment	Data Type	Mandatory
name	Name of the item	Variable characters (255)	TRUE
abbreviation	Abbreviation of the product (if available)	Variable characters (20)	FALSE
description	Description of the item	Text	TRUE
url	Related URL, providing further information	Variable characters (1023)	FALSE
version	Current stable version number or version code of the product	Variable characters (20)	FALSE
timestamp_versio n	Last update of the version information	Date & Time	FALSE
costs	Description of the costs and conditions for purchasing the product, obtaining a license or providing the service	Text	FALSE

timestamp_costs	Last update of the costs information	Date & Time	FALSE
image	Filename of the illustration. Valid file formats are all formats supported by web browsers, such as png, jpeg, gif etc.	Image	FALSE
actors	Actors involved (e.g. water utilities, industries, technology providers, end-users), their roles and their interactions	Text	FALSE
is_software	A software supporting the Circular Economy	Boolean	FALSE
is_hardware	A hardware product or a technological device around the Circular Economy	Boolean	FALSE
is_service	A service, offered as part of a Circular Economy enabling portfolio	Boolean	FALSE
is_methodology	A methodology or a process related with the CE	Boolean	FALSE
usp	Unique selling points, added value and innovation elements of the tool, product or service	Text	FALSE
target_audience	Profile of users who would find the product useful or/and are qualified to use it	Text	FALSE
technical_requirements	Technical requirements to obtain, install or run the tool, product or service	Text	FALSE
initial_release	Year of the initial release	Short integer	FALSE
license	The name of the license associated with the tool (e.g., GPL 3 or MIT) and description of the conditions for purchasing the product, obtaining a license or providing the service	Text	FALSE
timestamp_license	Last update of the License information	Date & Time	FALSE
publications	Publications related with the tool (i.e., software, hardware, service or process)	Text	FALSE
contact	Name and data of the contact person	Variable characters (255)	FALSE
timestamp_trl	Last update of the TRL information	Date & Time	FALSE
timestamp		Date & Time	FALSE

I.1.13.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
Technology Readiness Level	Tool - Product - Service	0,n	0,1	The technology readiness level of the tool, product or service
Tool - Product - Service	Organization	1,n	0,n	The organization that owns the tool, product or service
Tool - Product - Service	Publication	0,n	0,n	A publication related with the tool, product or service
Tool - Product - Service	Case Study	0,n	0,n	Case studies, in which a tool, product or service has been applied
Tool - Product - Service	Tag	0,n	0,n	Tags related with the tool, product or service
Technology	Tool - Product - Service	0,n	1,n	Tool, product or service applying NextGen technology
User	Tool - Product - Service	0,n	0,1	User who last updated the product data
License type	Tool - Product - Service	0,n	0,1	
Illustration	Tool - Product - Service	0,1	0,n	Characteristic illustrations of the product
User	Tool - Product - Service	0,n	1,1	User who manages the product record. It is often the one that created this record.
Tool - Product - Service	Interest for Product	0,n	1,1	The product for which the user has expressed interest

Tool - Product - Service	Illustration	0,1	0,n	
Environment	Tool - Product - Service	0,n	0,n	
Tool - Product - Service	Product View	0,n	1,1	

I.1.14 User

I.1.14.1 Description

Registered user, administrator or a user having another role in the platform.

I.1.14.2 Attributes

Name	Comment	Data Type	Mandatory
first_name		Variable characters (255)	TRUE
last_name		Variable characters (255)	TRUE
gender		Integer	TRUE
email	Email of the contact person of the entity	Variable characters (255)	FALSE
phone	Phone of the contact person of the entity	Variable characters (255)	FALSE
address		Variable characters (255)	FALSE
picture	A portrait picture of the user	Image	FALSE

I.1.14.3 Relationships

Entity 1	Entity 2	Entity 1 -> Entity 2 Role Cardinality	Entity 2 -> Entity 1 Role Cardinality	Comment
User	Case Study	0,n	0,n	One or several contact persons for the case study
User	Interest for Product	0,n	1,1	Interest expressed by the user
User	Affiliation	0,n	1,1	
User	Tool - Product - Service	0,n	0,1	User who last updated the product data

Event	User	0,n	0,n	Participants of the event
User	Event	0,n	0,1	Event coordinator
User	User	0,n	0,n	Connection between members of the Marketplace
User	User	0,n	0,n	Connection between members of the Marketplace
Event	User	0,n	0,n	Subscribers to the event
User	Tool - Product - Service	0,n	1,1	User who manages the product record. It is often the one that created this record.
User	Interest for Technology	0,n	1,1	
User	Interest for Tag	0,n	1,1	
Interest type	User	0,n	0,n	
User	Product View	0,n	1,1	
Technology View	User	1,1	0,n	



C. Algorithm of the recommender system

In this part, the recommendation algorithm is presented with the aid of the recommender system's ER diagram from Annex A.

The recommender system is designed to include the user's input from multiple sources of the application. It stores three different values of interest per product distinguished as: the user's direct declaration of interest for a product (weight_declared), calculated interest by the recommender system (weight_interest) and estimated interest for a product based on the user's browsing behaviour (weight_behaviour).

A total weight is calculated from the above and products are put in a list of descending weight. The final products that are presented to the users, are picked from that list: the highest rated products along with a pseudorandom product. The latter is either a product that does not interest the user at all or one from lowest rated in the list.

The Users interest is expressed through the relations:

- User - Technology – Product (indirect interest)
- User - Tag – Product (indirect interest)
- Technology – Tag – Product (indirect interest)
- Technology – Technology - Product (indirect interest)
- User – Product (direct interest)
- User – Visits (direct interest)

1. User - Technology – Product, User - Tag – Product

In the initial phase, the Users create their profile and declare their interest for technologies and tags in their preferences. As technologies and tags relate with products, this is considered an indirect interest for products.

2. Technology – Tag – Product

Technologies are associated with tags with a weight. This will influence the result of the recommender system. The design takes into account the possibility of the strength itself to be later readjusted by the statistics of the recommender system.

Technologies are associated with other technologies in a parent-child relation. Child technologies are of a narrower field of their parent, so the Users might be interested in a product of a child, but not in a product of the wider technological field of the parent.

3. User – Product, User – Visits

In the next phase, the Users interact with the web application of the Marketplace. They navigate to product pages and technologies pages to learn more about them. These clicks on pages are

considered a form of interest and they are captured and stored in the DB. Also, the users can leave feedback on the product/technology in the form of an emoticon. These are direct interest for a product.

The emoticon expresses five levels of relevancy. The users are encouraged to leave feedback in order for the recommendations to become more relevant to their interests.

As the marketplace grows new products are added and the recommendation algorithm runs periodically to update the user's interest (weight_interest).

