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WP 6 Exploitation and Business Plan

D6.3 100KTREEs Business models for commercialisation

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Grant Agreement No. **101082551**	Acronym **100KTREEs**		
Full Title	Decision toolbox for cities to improve air quality, biodiversity, human wellbeing and reduce climate risks by planting more trees.		
Topic	**EUSPA-HE-2021-SPACE-02-05** EGNSS and Copernicus for applications fostering the European Green Deal		
Funding scheme	Horizon: EUSPA-2021-SPACE		
Start Date	December 1st, 2022		
Duration	36 months		
Project URL	https://www.100ktrees.eu/		
Project Coordinator	DHI		
Deliverable	**D6.3 100KTREEs Business models for commercialization**		
Work Package	WP6 Exploitation and Business Models		
	M24	Version 1	
Actual Delivery Date	<04/12/2024>		
Nature	Doc	Dissemination Level	PU
Lead Beneficiary	NDC		
Authors	Nina Costa [NDC]		
Quality Reviewer(s):	Nora van Cauwenberg [VUB], Nahad Rezazadeh Helmi [BitaGreen]		
Keywords	Business models, 100KTREEs services, 100KTREEs toolbox, commercialization, target markets, business channels, Business model canvas		

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Document history

Ver.	Date	Description	Author(s) name
0.1	01/10/24	ToC	Nina Costa [NDC]
0.2	21/10/24	First draft	Nina Costa [NDC]
0.3	02/12/24	Critical review	Nora Van Cauwenbergh [VUB], Nahad Rezazadeh Helmi [BitaGreen]
0.9	03/12/24	Quality check	Birgitte Holt Andersen [CWARE]
1.0	03/12/24	Final version	Nina Costa [NDC]

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List of Acronyms	
3 30 300 rule	The 3-30-300 rule offers benchmarks for cities to promote equitable nature access. It dictates that individuals should see three trees from their dwelling, have 30 % tree canopy in their neighbourhood, and live within 300 m of a high-quality green space.
B2B	Business to business
B2C	Business to consumers
B2G	Business to governments
BM	Business Model
BMC	Business Model Canvas
BP	Business Plan
CAME	Correct, Adapt, Maintain, Explore
CBA	Cost benefit analysis
CS	Citizen science or crowd science
EC	European Commission
ESRD	European Sustainability Reporting Standards
ESS	Eco system Services
ESG	Economic, social and governance
GA	General Assembly
GIS	Geographical Information System
HR	High resolution
IPCC	Intergovernmental Panel on Climate Change
LAI	Leaf Area Index
MVP	Minimum Viable Product
RS	Remote sensing
SAM	Served available market
SOM	Serviceable and obtainable market

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SWOT	Strengths, Weaknesses, Opportunities, Threats
TAM	Total addressable market
UR	User Requirement
VA	Value Add
VHR	Very high resolution
WP	Work Package
WTP	Willingness to pay
UC	Use Case
UR	User Requirement

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Executive Summary

In this report we present a recap of the value-add that the 100KTREEs project is striving to offer our key customers – city authorities and municipalities. The services that we are developing for urban greening by trees, aims to deliver pain-relievers and gains to the municipal departments that are responsible for the city's green strategy and nature-based solutions for climate adaptation. This value-add forms the basis of our development of proposed services, that include:

- Tree mapping - location, tree type, and including a selection tool to calculate no. of trees, extent of city greening and inputs from CS app (ground truthing of location and tree type)
- Change detection (seasonal, annual, etc.)
- Tree inventory - tree type, and tree health
- Candidate tree planting areas
- Ecosystem services maps & hot spot identification
- Economic value (ESS) of individual tree, existing trees, and candidate trees
- IPCC scenarios and future hotspots

A wide range of business models (BM) have been analysed for the commercialisation of these services in the 100KTREE toolbox. As a result, 8 types have been identified to be applicable to the provision of such digital services. The pros and cons of each of these have been detailed. This is followed by an individual analysis of each of the 8 services listed above, and a discussion of the best way to commercialise each of these. In addition, commercialisation of the100KTREEs toolbox/web platform via a subscription service is considered, as well as selling or licensing of various components of the toolbox (e.g. modelling package or the 100KTREEs app).

Overall, the team's current sales approach is best represented by a hybrid BM, including:

- Digital GIS data sales of land cover, land use, and tree maps on a one-off basis. This could include seasonal change monitoring or long-term change monitoring if required by the city.
- Access to the 100KTREEs toolbox by subscription for a fixed time period.
- Consultancy services by the team, for custom analytics and reporting on specific topics.

The Business Model Canvas (BMC) presented 6 months ago in D6.4, has been updated to reflect our new ideas regarding how best to serve the municipalities and sell the services that have been developed for them.

Our approach to the best BM and commercialisation routes are likely to be revised during the last year of the project. We expect a deeper understanding on our part will arise from deployment of the use case studies over the next 3 months, and from discussions with new cities that will take place in 2025.

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1 Aim of deliverable

The purpose of this document is to provide an overview of the current thinking of the 100KTREEs team regarding future commercialization of the 100KTREEs toolbox and services, and the business models that will support this approach. Although the report is public the audience that will use the report is primarily internal.

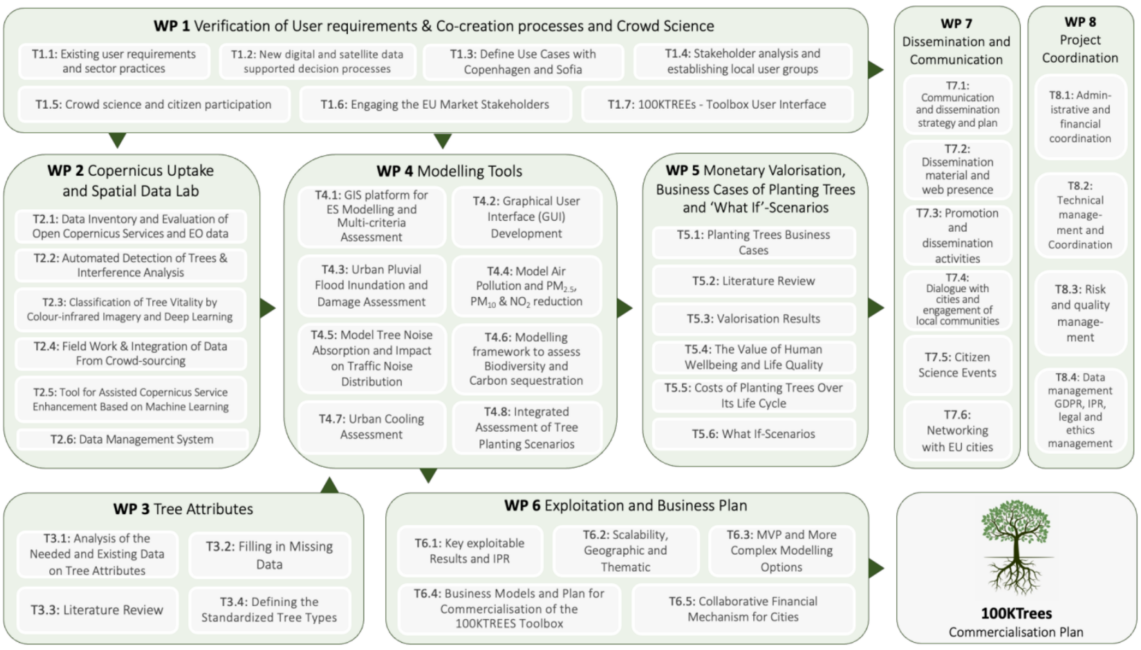
This report is based on discussions with our stakeholders during two rounds of workshops held in the cities of Copenhagen and Sofia. The first round focused on discovering their requirements, while the second round covered their feedback on initial demonstration of some of the 100KTREEs services, i.e. alpha testing. More detailed descriptions of these discussions will be reported in D1.2 (User feedback reports from alpha and beta testing rounds, due March 25). The team is confident that additional information will be collected from our users during the execution of the 3 planned use cases in each of our pilot cities. These use cases are currently under discussion with interested parties from Copenhagen and Sofia and will be deployed by the end of Jan 25.

This report D6.3 - Business models for commercialization, forms part of a number of deliverables under WP 6 – Exploitation and Business Plan. D6.4 - Draft final business plan – has already been delivered at M18, and this report compliments and updates D6.4.

1.1 Relation to other activities

D6.3 relates directly to Task 6.4 and also to T6.2. The potential business models that can be utilized by 100KTREEs represent important considerations for commercialisation and inputs to the Final Business Plan.

Figure 1-1 Relation to other activities



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1.2 Structure of the document

The structure of the document is as follows:

Chapter 2 gives a recap on the value-add (VA) of the 100KTREEs proposed services.

Chapter 3 presents a wide range of potential business models for digital products and services, and identifies the ones best suited to the commercialisation of 100KTREEs.

Chapter 4 presents the 8 proposed 100KTREEs services individually and discusses the best way of selling these services separately, or in bundles.

Chapter 5 includes the updated BMC for 100KTREEs.

Finally, Chapter 6 covers the Conclusions for this report.

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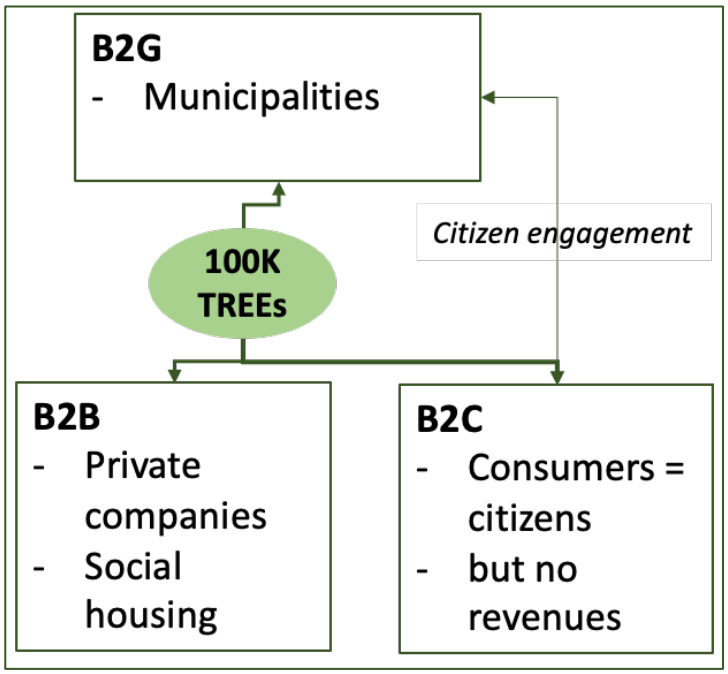
2 Target customer groups and value-add (VA)

2.1 Customer groups

Our target customer groups fall into 3 main categories – city or municipal authorities, citizens and private companies. This is illustrated in the figure below, where we as a business will be selling to governments (B2G), or to consumers (B2C) and to private companies (B2B). It should be noted that we do not expect to receive revenues from citizens, but we will offer this channel with the 100KTREEs CS app. We envisage that through the app, the municipalities will benefit from engaging citizens in their greening programs, and this will add value to our service offerings.

Figure 2-1 Business channels



These potential business channels have been highlighted here as the business models we choose will depend on which group we are targeting. Governments and private industry have different budgetary constraints and procurement processes that we should take into consideration.

In this report, we focus on our primary target group – that of urban authorities/municipalities (B2G). However, we have not lost sight of selling to private industry as well (B2B) and we aim to host a webinar for this customer group during 2025.

Over the last year of the project, we will investigate selling to the private sector as well with a focus on private companies of various ilk's:

- Landscaping companies, including those contracted to municipalities
- Urban planners and civil engineering companies, including those contracted to municipalities
- Large manufacturing companies that are serious about ESG reporting, improving biodiversity and social impacts
- Social housing associations.

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2.2 Customers' PAINs and GAINs

According to the business model framework[1], the product/service should offer customers VALUE for getting their jobs done – either by offering them GAINS or through problems that can be avoided, PAIN RELIEVERS. In this section, we will focus on our primary customer segment – that of the city authorities, planners & politicians – either directly or indirectly through contractors (e.g. landscaping or urban planning companies).

After discussions with our stakeholders during two rounds of co-creation workshops, the team agreed that their PAINS and GAINS can be summarised as shown in the table below on the right-hand side (pink column), together with an overview of their 'jobs' (as they relate to urban greening). Following the methodology outlined in the diagram above, the left-hand, blue column gives a high-level summary of the 100KTRESS value proposition and how it answers the pains and gains of the city administrations for tree planting initiatives.

Table 2-1 100KTREE value proposition and Customer pains and gains

<table>
<tr><th colspan="2">100KTREEs value proposition</th><th colspan="2">Customer profile</th></tr>
<tr><td colspan="2"><u>Service description:</u>

100KTREEs is a decision toolbox (based on mapping, tools and models) for city administrations to improve air quality and biodiversity, and to reduce climate risk by planting more trees.

Urban tree planting is a nature-based solution for climate adaptation.

100KTREEs offers tools and models to substantiate the positive societal impacts of the additional trees versus the costs of planting them.</td><td colspan="2"><u>Customer jobs:</u>

City authorities are responsible for urban maintenance and development, but also have legal responsibilities for environmental monitoring & citizens health.

Urban planning needs to adopt an adaptation agenda in the face of climate change and to find nature-based solutions.

Politicians set the agenda for the city to become carbon neutral by a certain date, while city administrations have to substantiate the value of activities that they propose to achieve this (like planting urban/street trees). Thus, political pressure to deliver on greening goals.</td></tr>
<tr><td>GAIN creator</td><td>100KTREEs is a data-supported decision tool

100KTREEs offers a substantiated socio-economic case for city investment in additional trees

100KTREEs supports city authorities in finding financing or sponsorship to help pay for their tree planning campaigns.</td><td>GAINS</td><td>To have a tree inventory tool and data-supported decision tool

The green transition needs finances and hence a socio-economic case for investment in additional trees

Financing of the trees comes from social impact investors and/or collaboration with non-profit 'tree planting' organisations</td></tr>
</table>

[1] Taken from Strategyzer

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	CS app for citizens and field experts alike		Greater citizen awareness of city greening and tree planting
PAIN reliever	100KTREEs collates maps and data layers on trees, air quality, heat islands, flood risks, noise and biodiversity. 100KTREEs identifies possible to planting areas to improve air quality and biodiversity, reduce heat islands, flood risks, and noise. Monitoring of the urban trees on seasonal or annual basis (In its current form, 100KTREEs cannot effectively deliver a tree maintenance service. This requires inputs from tree and in-field specialists from the municipalities or contracted landscapers.)	PAINS	Challenging to acquire city wide data on tree locations that are up to date Challenging to identify new areas suitable for tree planting Challenging to acquire information on ESS (Ecosystem Services) offered by trees ID trees that need maintenance and which pose a security risk in light of an increasing number of storms and storm severity.

This table and this chapter merely serve as a recap of the origins of this project and the teams' ideas for commercialisation of value-add services that offer our customers PAIN relief or GAINS in their working practices.

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3 Potential business models

3.1 Introduction

To return to basics - a business generates value for its customers, and a business model is a specific method used to create and deliver this value.

According to Harvard Business School Online[2], there are 8 types of business models: Product, Service, Shared assets, Subscription, Lease/rental, Insurance, Reselling, and Agency/promotion. However, these seem to be based on more traditional manufacturing and marketing. In the current digital age, the following digital and hybrid business models seem more appropriate[3]:

- **Subscription model** - offering a service that requires ongoing payment, usually in return for a fixed duration.
- **Fee-for-service** - this business model may charge an hourly rate or a fixed cost for a specific agreement.
- **Freemium service** - to attract customers by introducing them to basic, limited-scope service. The aim is to convert customers to a more premium, advance product that requires payment.
- **Product-as-a-Service (PaaS) model**, where there is a shift from traditional **product** ownership to a model focused on experiences, sustainability, and recurring revenue.
- **Bundling** – the company bundles services to sell multiple to a single client.
- **Marketplace** – the business receives compensation for hosting a platform for business to be conducted.
- **Advertising**- providing free content or services while generating revenue through ads, e.g. Google
- **Licensing**: Selling the rights to use a product or intellectual property to another party, e.g. Microsoft software licensing.
- **Crowdsourcing**: Leveraging the collective effort of a large group to gather ideas or funding. (e.g. Kickstarter).
- **Affiliate** – this is based on the marketing and broad reach of a specific entity or person's platform (e.g. influencers). The entity received compensation, either as a fixed payment, a percentage of sales, or both.
- **Pay-as you-go** - where the amount charged by the business depends on how much of the product or service was used.
- **Brokerage** – a business model that connects buyers and sellers without direct sales themselves. Brokerage companies often receive a percentage of the amount paid by the customer.
- **Hybrid**: Combining multiple business models to maximize revenue streams. E.g. Amazon, which sells products, offers subscriptions (Prime), and has a marketplace.

[2] https://online.hbs.edu/blog/post/types-of-business-models
[3] https://www.investopedia.com/terms/b/businessmodel.asp

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This list, which was sourced from various references, also includes more standard business models such as Retailer/direct sales, Manufacturer, Franchise, Razor Blade[4] and Reverse Razor Blade[5], but these have not been included in the list as they do not really apply to 100KTREEs.

With the advent of cloud computing, Infrastructure as a Service (IaaS) and Software as a Service (SaaS) are business models that rely on IT infrastructure for running applications and workloads in the cloud, or cloud-hosted application software that is ready-to-use and on-demand.

There is another aspect to buiness models as it applies to whom the business sells its products or services – B2B, B2C or B2G. B2B is short for "business to business." It's a business model in which the companies involved create products and services for other businesses and organizations. C2C stands for "consumer to consumer" or "customer to customer"; it's a business model often used in an online environment. B2G stands for 'business to government' where the focus is on selling to public authorities (which often have procurement procedures for the sellers to adhere to). It is likely that 100KTREEs will sell is services to municipalities (B2G), but also to landscaping companies (B2B). Only the crowd science app will directly involve citizens customers (B2C) even if there will be no exchange of payment.

3.2 100KTREEs

Here are several business models that could be used by the 100KTREEs project, focusing on the integration of mapping and modeling tools for urban tree planting and ecosystem services. At this stage of the project, it is not year clear which would be the best BM for 100KTREEs and this will be further explored during the implementation of the Use Cases and during the beta demonstrations with potential customers.

Product-as-a-Service (PaaS)

At first glance it is not clear how 100KTREEs can be a product, but the toolbox (portal and platform) could be sold as a stand-alone web product. Having said that, it is not clear if any economies of scale can be achieved, and the toolbox (merely as a software tool for web sales) can also be easily duplicated. The value-add in 100KTREEs definitely lies in the services offered via the toolbox- i.e. the mapping and modelling services, and thus the product-aspect of 100KTREEs is unlikely to be commercially viable.

Subscription service

A subscription is a type of program in which a user pays a recurring fee for access to a recurring provision of products or services. Consequently, this model may be more applicable to 100KTREEs where the services offered are key, and where customers will pay for services that offer skills that they can't or don't want to do themselves. If the team have a skill in high demand or a skill that very few others have, the business can charge a fair price for its time and expertise. On the downside, if the business cannot charge enough for the services, it may not be very lucrative in the long run.

[4] sell a durable product below cost to then generate high-margin sales of a disposable component needed to use that product (e.g. printers and cartridges)

[5] sell a high-margin product upfront, then to use the product, low or free companion products are provided (e.g. iPhone and apps)

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Services can be maketed in different ways:

- A subscription for data as a service (DaaS) which offers access to the toolbox with its mapping and/or ecosystem services modeling components on a subscription basis aimed at customers from cities, social housing, and private companies (e.g. landscaping).
- License the mapping and modeling tools to other organizations or municipalities for a fee.

Consulting Services

These can be aimed at municipal staff that are not necessarily interested in getting familiar with and using the toolbox themselves and would rather commission a report on a specific topic either on a regular (annual, bi-annual, etc.) or ad-hoc basis. Such consulting services could include:

- One-off mapping of the city and its green spaces for reporting on the state of the urban environment, e.g. % green areas and canopy cover, and biodiversity indicators.
- Assist cities and/or organizations in creating business cases/CBA for tree planting initiatives, highlighting economic and environmental benefits.
- Custom analytics - provide tailored reports and analytics (e.g. what-if scenarios) for organizations looking to understand the impacts offered by urban trees.

This could be a supplementary service offered by the team, beyond access to the toolbox.

Marketplace

A market place is a shared resource that many people can use and such resources allow the business to create (a web platform for example) and then charge customers for its use. This could apply to the toolbox that the 100KTREEs project team have developed, where access to the toolbox can be charged for and through which the services can be delivered. This can be achieved by leasing, where one company/entity owns the platform/toolbox and the other partners lease the use of the toolbox for the provision of their individual services to customers. Alternatively, the toolbox could be opened to third-party service providers (SPs) and they ca be charged a percentage of sales gained through the toolbox. For the moment, we have not considered these options.

Eco-Credit Marketplace

This is an alternative marketplace idea, where 100KTREEs participates in the carbon credit market by quantifying the carbon sequestration of urban trees and selling credits to businesses seeking to offset their emissions, or trade in biodiversity credits based on tree planting. In light of the limited number of trees in an urban environment, the carbon credits are not expected to be vast, but the biodivesity credits could be significant.

Public-Private Partnerships

These partnerships pertain to our proposal for collaborative finanacial mechanisms for cities (task 6.5). where 100KTREEs work with municipalities and third-party organisations to co-fund tree planting initiatives, and/or engage local businesses to sponsor specific tree planting projects in exchange for 'green credits' on their ESG balance sheets. This will be done in parallel to commercialisation of the 100KTREEs services.

Community Engagement and Crowdfunding

Last but not least, we must not forget the aspect of community engagement even if we do not expect

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financial revenues from this BM. Citizen inolvement is facilitated by our CS app where citizens can report on tree health and conditions, fostering community engagement and data collection. But this could be extended to include a tree adoption programme for individuals and individuals and businesses to adopt trees, by providing funding for their planting and upkeep. We could also consider crowdfunding where we use the 100KTREEs website to to raise funds for specific tree planting, allowing community members to invest directly in their local environment.

Hybrid

The team does not necessarily have to choose only one model. By combining elements from these models, 100KTREEs can generate diverse revenue streams while promoting urban sustainability and community involvement.

Assessing the future service delivery perspective for 100KTREEs services, we consider several factors that are likely to shape the emerging business models. Key considerations include the maturity of and demand for the various services, decisions by the partners to remain involved post-project, long-term commercial aims for those who do and possible revenue sharing options between providers.

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4 100KTREEs services and toolbox

To recap from D1.4 and D6.4, the user and functional requirements have driven the identification of the 100KTREEs services. The team identified 54 service elements (functionalities), and these have been categorised into 8 service options. In this context, a service element offers a single functionality (e.g. map or model), while a service is a combination of tools offering the necessary information for the customer.

The eight service categories are shown in the table below, with traceability to the user requirements (UR) from WP1 - in no specific order:

Table 4-1 Categories of 100KTREEs services

#	Service category name	Traceability
S0	Land cover, land use maps (base maps)	*Note: this was not requested by users, but is essential for all services*
S1	Tree mapping - location, tree type, and including a selection tool to calculate no. of trees, extent of city greening and inputs from CS app (ground truthing of location and tree type)	UR 2, 4, 6, 7, 10, 11
S2	Change detection (seasonal, annual, etc.)	UR 5, 7
S3	Tree inventory - tree type and tree health	UR 2, 3
S4	Candidate tree planting areas	UR 8, 9
S5	Ecosystem services maps & hot spot identification	UR 12, 13, 15, 17
S6	Economic value (ESS) of individual tree, existing trees, and candidate trees	UR 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 30
S7	IPCC scenarios and future hotspots	UR 26

In this section, we will focus on each of these 8 services and review the best way of commercialising each of them according to our current understanding of the market. This bottom-up approach might lead to new insights that we have not yet considered in our previous top-down analysis.

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4.1 S0 – land cover, land use map (base map)

Functional requirement	Responsible partner	Service description & resolution	Tool needed (to supply service)	Info stored Where?	Update frequency	Data source/s 1. easy/med/hard to obtain	Pricing per km^2 low/med/high	Ease of scalability to other cities
Land cover, land use map for city	**DHI**	Mapping land cover classes (Water, Trees/forest, Grassland/shrub, Impervious surfaces, and bare soil) based on Sentinel 2 10 m imagery.	API, DB, GIS platform	DB	Annually	Existing free and open datasets or data production based on Sentinel 2 imagery. (Easy)		Easy – especially if cities have existing maps
Custom OSM	**OTF**	Special stylized version of OSM.	GeoServer or MapBOX	GeoServer or MapBOX	Annually	OSM & GeoServer easy	low	easy
ID muddy areas	**DHI**	Identification of muddy areas based on the bare soil class of the land cover classification. This could be combined with a Sentinel based surface water frequency (SWF) dataset to determine correlation with bare soil and surface water occurrence.	API, DB, GIS platform	DB	Annually	Existing free and open datasets or data production based on Sentinel 1 and 2 imagery. (Easy)		Easy

This service refers to the basic mapping of the city and municipal areas. This represents a one-off activity for new client cities. Our original thinking was to offer this 'onboarding' on two levels. One based on existing free and open datasets – e.g. global datasets such as ESA World Cover, Dynamic World, the Copernicus HRL's or Corinne Landcover, and if more detail is requested, a second level that includes finetuning and Sentinel 2. Whatever datasets the city has at hand (e.g. tree maps, 3D maps, DEM), can also be utilised to keep the price on onboarding lower. The functional requirement of 'identification of muddy areas' came from the Sofia stakeholders and overlaps with the 'bare soil' land use

class in the first row, and again this can be locally finetuned for more advanced analysis. These two levels of analysis will be priced accordingly under the 'one-off mapping' for new clients.

4.2 S1 – Tree mapping - location and a selection tool to calculate no. of trees, extent of city greening and inputs from CS app (ground truthing of location)

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
2 D tree map	**DHI**	Identification of tree points and number of trees based on commercial VHR satellite imagery or aerial images where available.	API, DB, GIS platform	DB	Depending on customer needs	Satellite VHR scenes or aerial imagery must be available or purchased		Medium Easy if cities have existing tree maps
3D tree map	**ES**	Calculation of tree attributes such as location, crown diameter, height based on 3D aerial survey data (LiDAR or stereo imagery).	GIS platform	ES DB	Dependent on the frequency of LiDAR or stereo image capture of the city. (Maximum once a year update of the 3D tree map.)	3D data (LiDAR or stereoimages) must be available		Feasible if 3D data is available for the particular city
Ground-truth of tree location, tree type, features and damages	**OTF**	Public access to tree map, tree type & information on tree vitality	CS app	OTF DB	Real time	none	low	Medium
Ground-truth of tree vitality	**OTF**	Semi-automated recognition of changes in tree vitality, verified by experts based on data on tree	CS app	OTF DB	Real time	It depends on the activity of citizen engagement and requires remote	low	Medium

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
		characteristics and damage, collected on a crowdsourcing basis.				verification by experts in tree vegetation.		
Calculate distance from tree to middle of the road	**DHI** **ES**	The derived tree locations and a shapefile of the road are used to calculate the distance to the middle of the road for each tree	API, DB, GIS platform	ES DB	Dependent when new updates of the tree locations or the roads are available	Road map to be provided by municipality		Easy
On map of planting spots calculate distance to underground infrastructure	**ES**	Calculate interference of potential tree spots with the underground infrastructure such as cables and piping	GIS platform	ES DB	Dependent when new updates of the planting spots or the underground infrastructure are available	Infrastructure map to be provided by municipality		Difficult since accurate underground infrastructure data is difficult to obtain

This tree mapping service is a key service for 100KTREEs, and is essential to assess the extent of greening of a city as well as the extent of canopy cover. This represents the current or baseline greening situation in the city, and is essential for the calculation of the baseline value for ecosystem benefits in the city. The service of ground-truthing of the tree location, tree type, tree vitality and damages (if any) relies strongly on inputs from citizens or field experts through the CS app. The last two functional requirements, relating mainly to street trees (distance to road and underground infrastructure), rely completely on the availability of data from the municipality. Initially, this will be one-off tree mapping (during onboarding) for clients, but if the municipalities are interested in increasing their canopy cover and number of trees, they will need S4 – candidate tree planting areas, S5 – Ecosystem services maps, and to monitor the new trees in the longer term, S2 – our change detection service.

4.3 S2 – Change detection (seasonal, annual, etc.)

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
2D tree cluster change monitoring	**DHI**	Will be part of the land cover classification under S0. 10 m resolution with Copernicus.	API, DB, GIS platform	DB	As needed	As this service will be based on Copernicus Sentinel imagery with a 10 m resolution, only larger patches of trees will be detected. For tree monitoring at individual tree level, the 2d or 3d tree maps above should be proposed instead.		Easy
3D tree cluster change monitoring	**ES**	presence or absence of tree	GIS platform	ES DB	Based on the frequence of when a new 3D tree map is created (max. once a year)	Only reliable for single trees where the crown diameters do not touch each other. Considerable errors on trees where the tree crowns touch.		Feasible if 3D data is available for the particular city
Tree attribute changes	**OTF**	Automatic recognition and visualization on demand by the end user of changes in the attribute values in the data for urban trees, collected in the field by	CS app	OTF DB	Adhoc (at request of the municipality)	It depends on the activity of citizen engagement in	low	Easy

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
		citizens. Change detection can be monitored via citizen-science app				mapping urban trees.		

This service is important for cities that want to monitor the changes in the extent of urban canopy cover, either due to growth and/or planting of new trees. It will be up to the municipalities on the regularity of this monitoring – perhaps annual monitoring for extent of canopy cover and new plantings, or every 5 years for assessment and updating of ecosystem benefits. Again, note that the 'tree attribute changes' component relies completely on inputs from citizens and field experts. Thus, this service is most likely to fall under the custom monitoring and analytics consultancy. In some of the use cases, the city of Sofia would like the team to assess the increase in number of trees and tree growth over the last 5-6 years, to help assess the impact of these recently planted trees.

4.4 S3 – Tree inventory – tree type and tree health

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Canopy size	**DHI**	Canopy cover will be part of the land cover analysis. Canopy size (at individual tree level) cannot be reliably extracted from Sentinel 10 m data. But canopy size can be extracted from VHR satellite imagery or aerial images, as part of the 2D tree mapping product.	API, DB, GIS platform	DB	As needed	Satellite VHR scenes or aerial imagery must be available or purchased		Medium
Crown vitality through NDVI	**ES**	Calculation of the NDVI per tree based on SUMMER orthophotos of the city and the individual tree database	GIS platform	ES DB	Based on the availability of SUMMER	The availability of a NIR-band in the		Feasible if SUMMER orthophotos

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Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
					orthophotos of the particular city	input data is required.		are available for the city
Crown vitality through LAI	**ES**	Calculation of the LAI per tree based on SUMMER orthophotos of the city and the individual tree database	GIS platform	ES DB	Based on the availability of SUMMER orthophotos of the particular city	The availability of a NIR-band in the input data is preferred.		Feasible if SUMMER orthophotos are available for the city
Crown vitality through Machine Learning	**ES**	Calculation of different categories of crown vitality based on SUMMER RGB(Ir) – orthophotos and the individual tree database	GIS platform	ES DB	Based on the availability of SUMMER orthophotos of the particular city	The availability of a NIR-band in the input data is preferred.		Feasible if SUMMER orthophotos are available for the city
CS monitoring of tree health	**OTF**	Public access to tree changes	CS app	OTF DB				
Tree type	**DHI**	Tree species detection (limited by non(availability) of sufficient representative training data) based on multitemporal VHR satellite images.	API, DB, GIS platform	DB	As needed	Satellite VHR scenes or aerial imagery must be available or purchased		Hard
Data collection of tree attributes by experts on terrain	**ES**	Tree experts from the 100k trees consortium collect data (tree type, tree dimensions, tree health) of 3000 trees in the city	DB GIS platform	ES DB	Will be determined in consultation with the city			Easy

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Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Tree info inputs by tree experts into CS app as functionality	**OTF**	Convenient and reliable professional tree observations through fieldwork using the CS app	OTF App Tree database for Sofia	OTF DB	Adhoc	None	Med (price dependant on number of users and desired functionalities by the user)	Moderate

Under this service of tree inventory, type and health, a number of functionalities have been requested by users – some are easier to provide than others. Canopy size is something that can be detected by satellite images, albeit very high resolution. Crown vitality is a bit more of a challenge since it relies on an orthophoto campaign over the months when the trees are in full leaf (summer). Again, this is a costly exercise for the cities. The best-case scenario will be if the cities undertake orthophoto campaigns regularly. It is not straight forward to identify tree type from satellite images, but it might be possible with machine learning. Tree health is an area that the team is not sure to deliver as it strongly relies on data collection on the ground by citizens and field experts. At this stage it is unclear if 100KTREEs will be able to provide this service, or a tree maintenance service. To avoid over-promising services that cannot be properly realised, the tree maintenance service (S8) mentioned in previous deliverables, has been removed.

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4.5 S4 – Candidate tree planting areas

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Identification of new planting areas	**DHI**	Land cover map filtered by size of area available types (e.g. bare soil/grasslands). Based on existing land cover datasets (e.g. ESA Worldcover or CLMS Urban Atlas)	API, DB, GIS platform	DB	As needed	Existing free and open datasets or data production based on Sentinel 1 and 2 imagery. (Easy)		Easy
Identification of new planting areas	**DHI**	Overlay tree map with AQ (where available in sufficient resolution), heat islands (in 30 m resolution), noise (where available), env indicators (as available) to identify area where trees could be useful at 10-30 m resolution. Based on third party datasets from cities (preferably high resolution datasets supplemented by free and open ones), or Sentinel 2 data.	Existing free and open datasets or data production based on Sentinel 1 and 2 imagery. (Easy)	DB	Annual	Existing free and open datasets or data production based on Sentinel 1 and 2 imagery. (Easy)		Medium-Hard
Identification of new planting areas	**(city inputs)**	Identification of new planting areas				Needs discussions with city		
Identification of new planting areas	**ES**	Identification of available planting areas through GIS analyses of different data layers. Based on different available geographical data layers	GIS platform	ES DB		Inputs from municipalities to ID 1. areas that are NOT available (parking		Feasible if enough data is provided by the municipality

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
		representing city infrastructure or elements that allow for trees to be planted, that make tree planting difficult, or that make tree planting sheer impossible.				areas, buildings, etc.), as well as 2. candidate muddy/brown areas, parks, streets without ground infrastructure, etc. So the accuracy of the planting spots depends on the data delivered by the cities.		
Public access to map of available spots	**OTF**	Allowing public to visualise new planting areas (as identified through four functions above) through the CS app.	GIS platform	DHI DB				

This service is the main focus on the project, and entails satellite image filtering and analysis of land cover maps to identify grass, bare soil, and/or sealed surfaces. This is only the first step. Subsequently, this service requires close collaboration with the municipalities as they need to identify which of the possible areas are actually suitable or candidates for new tree planting, especially with regard to zoning in the city and sealed surfaces (pavements, car parks, etc.). Thus, this will form part of the 100KTREEs consultancy services. Importantly, this service will be enhanced by S6 – the economic value of candidate trees as it will offer the cities a 'cost benefit analysis' for the planting of new trees in terms of the economic and social benefits that will accrue over the long-term. Especially in the context of this service, the 100KTREEs app represents a valuable tool for municipalities to engage citizens as well as communicating their greening strategies.

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4.6 S5 – Ecosystem services maps & hot spot identification

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Low resolution (10m) environmental exposure baseline (Air quality, noise at night and day)	**BITAGREEN**	Spatial maps for identification of concentration of air pollution (NOx, PM10 and PM2.5) at low resolution (purpose = screening)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	yearly	Land cover, DTM/DSM, traffic	low	med
High resolution (2m) environmental exposure baseline (Air quality, noise at night and day)	**BITAGREEN**	Spatial maps for identification of concentration of air pollution (NOx, PM10 and PM2.5) at high resolution (purpose = decision making)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	yearly	LULC, Tree inventory, DSM/DTM, traffic	med	med
Map city temperature & identify heat islands and flood risk	**BITAGREEN**	See detailed description in the specific boxes, this is an aggregated function	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output	yearly	LULC, DSM/DTM	med	med

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
				pulled from BitaGreen)				
Biodiversity and carbon sequestration map	**BITAGREEN**	10m resolution assessment of habitat and carbon sequestration	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	yearly	LULC, Tree inventory	high	med
Annual change map of AQ, noise, heat, biodiversity, flood attenuation	**BITAGREEN**	Year on year assessment of performance improvement (or decline) based on different what if scenarios	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Annual		high	easy (if exposure maps available)
Hot spot identification for AQ, noise, biodiversity	**BITAGREEN**	Identification of top 10 percentile of high exposure areas for the different environmental services	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Annual		med	easy (if exposure maps available)

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Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Hot spots for flooding	**BITAGREEN**	Identification of top 10 percentile of high exposure areas for flood risk BITAGREEN	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	yearly		high	easy (if exposure maps available)
Different tree planting formations for air pollution and cooling	**BITAGREEN**	Differential models for street trees and pockets of trees (user can assess scenarios)	API, DB (BitaGreen), GIS platform (OTF)			OTF to provide user generated tree scenario (geojson)	high	med

This package of services is aimed at those municipalities that want to tackle certain, known issues in their urban areas e.g. air quality & noise along busy roads, or heat islands. These services could be requested separately for a known eco-issue rather than in a bundle covering all topics. The latter might apply if the municipality wants to carry out an investigative assessment of hotspots in general, and then the low resolution 10m service will suffice. For known eco problems, the customers will probably use the higher resolution (2m) service for a specific topic. Again, these assessments are likely to fall under custom analytics. One of the aspects that are still under research in the 100KTREEs project, is the differential (if any) between the impacts of street trees vs numerous trees in localized area (e.g. a municipal park) vs 'pocket parks'. Pocket parks would typically be a small group of trees (3-10 trees in less than $1000m^2$) that are planted in, for example school grounds or open-air sports facilities. The impact of pocket parks will be assessed in one of the use cases in Sofia in support of Sofia's 'My Green School Programme'.

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4.7 S6 – Economic value (ESS) of individual tree, existing trees, and candidate trees

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Estimate air quality improvements due to trees	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on air quality (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Yearly	Needs map of new trees Needs information on traffic (higher resolution input will give better results)	med	med
Estimate extent of noise abatement by trees	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on noise (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Yearly	Needs map of new trees Needs information on traffic (higher resolution input will give better results)	med	med
Visualise cooling due to trees	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on air temperature (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input	Yearly	Needs map of new trees	med	med

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
				(and output pulled from BitaGreen)				
Estimate value of reduction in heat islands by trees	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on air temperature (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Yearly	Needs map of new trees	med	med
Estimate value of increased biodiversity due to trees (component of NBS for climate change adaptation)	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on habitats (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Yearly	Needs map of new trees	med	med
Calculate the CO2 sequestration of trees in the city	**BITAGREEN**	Spatially aggregated assessment of what if scenarios – impact on carbon sequestration (district level or higher)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Yearly		med	med

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Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Impact of single tree on temperature, noise, humidity, air quality	**BITAGREEN**	Assessment of tree impact on ES at scenario level (2m resolution)	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	On demand		high	hard
Impact of tree planting on environmental indicators	**BITAGREEN**	Impact map - ideally every 2 years, mandatory every 5 years	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	On demand		high	med
Impact of tree planting on environmental indicators within a specific area	**BITAGREEN**	Spatially aggregated result of maps made above (ideally based on 2m results) - aggregation at district level or polygon defined by user	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	On demand		high	med
Impact of trees on flood attenuation	**BITAGREEN**	Detailed assessment of urban flood risk (pluvial, including sewer) at high resolution and assessment of attenuation by trees	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output	On demand	Need sewer data for full results	high	hard

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
				OTF DB for input (and output pulled from BitaGreen)				
Impact of trees during different seasons	**BITAGREEN**	Based on seasonal tree maps (see S2 – Change detection)		BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)				med
Calculate the socioeconomic outcomes of existing trees and new trees	**CWARE**	Data is based on literature from across the world.	Needs to be integrated into the Bitagreen model	Unit cost in CWare and results of the model at Bitagreen	Adhoc – a few years in between	No	low	Easy
Benefits to landowners	**CWARE** **(OTF)**	Estimate number of trees (output of tree database) and calculate overall value of trees on private lands & Visualisation for public (**OTF**)	Needs to be integrated into the Bitagreen model	Unit cost in CWare and results of the	Adhoc – a few years in between	Municipality needs to provide cadastre map showing private land, or landowner can use selection tool to designate area of interest?	low	easy

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
CBA of replacing parking areas with trees	**CWARE**	Calculate loss of parking income, citizen inconvenience vs overall benefits of number of possible trees - on request	Needs to be integrated into the Bitagreen model	Unit cost in CWare and results of the	Adhoc	no	low	easy

The provision of this service (S6), relies heavily on the ESS for a single standard tree, and then this will be multiplied up to calculate the impact of the actual number of trees and/or potential impact of a certain number of new trees. This service can give an assessment of the value of current urban trees as well as future trees, the former being important if property developers are requesting the felling of some trees, or elimination of parks or green areas for new residential or office buildings. The evaluation of the EES that will be lost is also important information for the councils that are faced with such a decision and finding the right balance between increased availability of housing or commercial business and the environmental loss, or the reduction of car parking vs socio-environmental benefits. This service will also give private landowners of parks (and assuming ample trees) an improved assessment of the value of their land including its urban natural capital. Besides reporting on biodiversity, the estimation of ESS can also support ESG or ESRD (European Sustainability Reporting Standards) reporting in terms of social actions and benefits (improved human wellbeing in the cities through air quality improvements, noise and heat island reduction, as well as the improvements in the 3-30-300 benchmark for equitable nature access in cities.

4.8 S7 –IPCC scenarios and future hotspots

Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
Risk assessment of heat islands in	**BITAGREEN**	Utilize IPCC scenarios for increases in city temperatures	API, DB (BitaGreen),	BitaGreen DB (AWS storage)	5 year (climate), 1 year (LULC)	Need updated LULC maps	high	easy

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Functional requirement	Responsible partner	Service description, data source & resolution	Tool needed (to supply service)	Info stored where?	Update frequency	Issues with input data source/s	Pricing per km^2 - low/med/high	Ease of scalability to other cities
view of climate change		Modelling of tree cooling effects	GIS platform (OTF)	for output OTF DB for input (and output pulled from BitaGreen)				
Advanced scenario planning	**BITAGREEN**	On request from municipality	API, DB (BitaGreen), GIS platform (OTF)	BitaGreen DB (AWS storage) for output OTF DB for input (and output pulled from BitaGreen)	Demand based (recommended yearly)	Need updated LULC maps	high	med

This service involves advanced analytics based on modelling of climate change through the use of IPCC scenarios. It is targeted at cities that are concerned about increased heat stress or precipitation (leading to floods) in the future, and how they can mitigate these effects. This will form part of advanced consultancy services undertaken by the team.

One issue which has only been indirectly addressed are services for ESG reporting of companies, which now include biodiversity goals – companies will need to report on their actions either towards zero change in biodiversity or improvements in biodiversity. Since biodiversity is one of the impacts that will be assessed in 100KTREEs, together with actions to address social benefits, this service and that of S5 – Ecosystem services - could be tailored towards ESG reporting.

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4.9 Overview of service provision

Here we present an overview table of the proposed 100KTREEs services and how these could be offered and sold to clients. For those customers that have GIS experts in-house, the services can be accessed via the Toolbox, but for those (probably smaller cities) that do not want to carry out the analyses themselves, we can offer them custom analytics in report form through our consultancy services, or a hybrid combination of the two.

Where key inputs are needed from the clients, this has been flagged in column 8, while those that will benefit from ground truthing via the CS app are listed under 'CS inputs'. To be realistic, the extent of citizens' contributions is a big unknown and cannot be guaranteed by the 100KTREEs team. Thus the onus of firstly, community engagement and secondly, the commissioning of field surveys, by local field and tree experts, lies solidly with the municipalities. However, the 100KTREEs CS app will be promoted strongly as a way to enable this process of data collection and integration of the 'ground' data into the toolbox database, as well as facilitating communication with the citizens and their engagement.

Table 4-2 Overview of proposed 100KTREEs services and inputs required

100KTREEs Service	One-off	Repeat monitoring	Access through Toolbox	Customisation available	CS inputs	Custom analytics	Inputs from customers	Builds on
S0 – land cover, land use maps	✓		✓	✓ 2m resolution				
S1 – Tree mapping	✓	✓ for tree vitality	✓	✓ 3D map	useful		LIDAR or stereo images	
S2 – Change detection		✓	✓		useful			S1
S3 – Tree inventory	✓	✓	✓	✓ Crown vitality using NDVI/LAI	useful		Summer orthophotos Tree species	S1

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100KTREEs Service	One-off	Repeat monitoring	Access through Toolbox	Customisation available	CS inputs	Custom analytics	Inputs from customers	Builds on
S4 – Candidate tree planting areas	✓			✓	useful		✓	S0
S5 – ESS maps and hot spot identification	✓	✓	✓	✓ 2m resolution		Individual EES or bundled		S0, S1
S6 – Economic value of ESS	✓	✓	✓	✓		Individual EES or bundled		S1, S3
S7 – IPCC scenarios	✓			✓		ESG reporting		S1, S4

At the moment, it is not clear which service groups will be chosen by the customer. In theory, services can be sold separately, but it is more likely that they would be sold in bundles depending on the questions that the city would like answered regarding urban trees and their ESS. This will be elucidated during further discussions with our partner cities and the 6 use cases that will be deployed in Denmark and Sofia.

4.10 100KTREEs toolbox and modules

Our initial thinking was to offer 3 levels of subscriptions to those companies or municipalities that prefer to work online with the toolbox - Basic, Basic+ and Premium. This was based on our initial understanding of the costs of data that the project team will face to offer these services, where:

- the Basic subscription is the cheapest and this will be offered when the city has the required data sources, like recent aerial images, LIDAR campaigns and VHR satellite data.
- the Basic+ subscription is for cities that do not have all the data required and thus the purchase of additional data is necessary. Subsequently this subscription will cost more.
- the Premium subscription will be the most expensive subscription as it includes customisations and scenario planning according to the needs of the client.

However, our understanding of what the cities want is improving, especially after a workshop with the city of Genoa in November 2024. After extensive internal team discussions (following this meeting), we have changed our approach to an offer of a subscription that allows access to the toolbox (with limited modelling and scenario analysis) for a fixed duration. Note that this needs to be preceded by onboarding of the land use and tree maps for a fixed price, with the onboarding price linked to the spatial resolution and complexities of the maps. With access to their land cover maps, the city staff will be able to identify bare soil or grass land for new planting areas and GIS delineation of potential areas by the city staff themselves. They will be able to carry out hotspot identification and run tree planting scenarios with respect to ESS evaluation. For more complex modelling (e.g. IPCC scenarios) or higher resolution modelling, the 100KTREEs will offer a complementary Premium consultancy service.

Alternatively, after onboarding, customers can simply request customs analytics or ad-hoc reports from the team to answer their specific questions.

Thus, the following service levels better reflect our current approach to sales:

- The Basic onboarding will the cheapest and is offered when the city has the required data sources, like recent aerial images, LIDAR campaigns and VHR satellite data.
- The Basic+ onboarding is for cities that do not have all the data required and thus the purchase of additional data is necessary, and this will cost more.
- Season change monitoring of the trees (to observe changes in ESS between summer and winter), if required.
- Updates of land use and tree maps as required (we estimate every 5 years or so). This should be less costly to deliver than the original maps.

These represent a 'data sales' approach, at least initially, with the modelling and CBA analyses to follow as a separate, complementary offerings, such as:

- Access to the toolbox by subscription for a fixed time period.
- Consultancy services by the team, at a simple or Premium level. These will be priced according to the extent and depth of the analysis required.

Another approach to selling services has also come to the attention of the team - some city clients might be interested in purchasing or licensing only some modules of the 100KTREEs project. For example, a city that already has an extensive tree database and tree maps, might want to purchase/licence the modelling module only - to estimate the value of the benefits of their trees, or purchase/license the 100KTREEs app to more effectively engage and communicate with their citizens.

These new commercialisation options of course lead to a complex matrix of data sales, subscriptions and consultancy, as well as service sales and licensing, but would seem to be a more pragmatic approach. The team will take all these options into consideration, and this will be discussed with our users in the 6 case studies.

It has also been suggested that due to budgetary constraints of public authorities in general, the best way to attract new cities and clients to 100KTREEs will be through a 'Freemium' option. This will be possible if the cities already have a good GIS map of their urban extent, that can be integrated into our toolbox. However, if this map is lacking and the team needs to obtain an even simple map of a new city using satellite data, at a minimum using free 10 m Sentinel data, this cost needs to be recouped. Alternatively, the team could consider this initial cost as a business development 'loss' if a freemium offer is imperative – but this would have to be evaluated at a later stage once the costs to the team are clearer.

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5 Business Model Canvas (BMC) for 100KTREEs

The key elements of a Business Model (BM) are well known through the extensive use of the Business Model Canvas (BMC) as a blueprint for how a business operates. It details the value proposition, the target market, revenue streams, cost structure, distribution channels, customer relationship, key resources and activities as well as key partnerships. It is agreed that a clear business model provides the necessary framework for creating sustainable growth and value.

An initial BMC was presented in D6.4 (May 24). Here, we present an updated version targeting municipalities as our primary customer segment. The key differences related to how we envisage earning revenues in the future. In discussions with representatives of the municipalities, they have expressed more interest in the need for consultancy services offered by the 100KTREEs team, rather than access and subscription to the toolbox for in-house investigation.

We have not included revenue figures at this stage. The service providers in the team are currently working on their cost figures - this will in fact be highlighted in the Kolding use case. These cost figures and an assessment of the willingness to pay (WTP) on the part of the municipalities, will put the team in a better position to set a price point for the various 200KTREEs services and toolbox access.

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Table 5-1 100KTREEs Business Model Canvas (BMC)

KEY PARTNERS

- Eurosense, DHI, Bitagreen, OneTree, CWare

Responsibilities for the modules:

- Copernicus Enhancer Tool (DHI)
- Automated tree analytics (Eurosense)
- Modelling tool (Bitagreen)
- Crowd science app (OneTree)
- Business case development for city administrations & institutional investors (CWare)

KEY ACTVITIES

- Engagement with city administrations and institutional investors
- Maintain and operate the 100KTREES toolbox
- Collaborative working on 'what if' scenarios with customers
- Accommodate additional requests for tailoring from customers
- Marketing to new cities
- Customise toolbox for new cities

KEY RESOURCES

- 20 person months for operations and support
- 9 person months for customer engagement and scenario development
- 2 person months for business case development
- 2.5 person months for marketing
- Web-based distribution

VALUE PROPOSITION

- Data-based justification for cities to address CC challenges and mitigation strategies
- A decision toolbox to support the location of planting new trees
- A business case assessment to demonstrate the business case of urban tree planting
- A map of trees sponsored by third-party companies (to avoid accusations of 'greenwashing')
- Follow-up monitoring service for tree growth, tree health and any illegal felling

CUSTOMER RELATIONSHIP

- Direct engagement with representatives of city administrations
- Mass media promotion to citizens (website, social media, newspaper)
- Gain support of social media environmental influencers
- Gain support of private sector to invest in greening of cities
- Target city councillors and local politicians

CHANNELS

- Collaborative working with city administrations and private companies on 'what-if' scenarios
- Online communications (website, social media)
- Networking with city or major associations
- Promotion of city greening to private industry

CUSTOMER SEGMENTS

Primary segments

- City administrations or representative associations to city administration
- Involved citizens (through mobile app) and citizen interest groups
- Sponsorship of trees by third-party investors from the private sector (who want to improve their CSR or more balanced bottom lines for their support of environmental projects)

Potential segments (B2B)

- Private building owners and property developers (for greening areas around their buildings and cost savings)
- Certification groups (e.g. German Sustainable Building Council)

COST STRUCTURE

- Annual cost of hosting, operating and maintaining 100KTree software, including Infrastructure costs (approx. €20,000 per year), and total personnel costs (2.6 FTE)
- Acquisition and ingestion of new data for new cities (one-off cost per city)
- Marketing and admin costs (approx. 10% of OPEX per year)

REVENUE STREAMS

- Onboarding of new cities (one-off data sales) for land use and tree maps
- Change monitoring – seasonal or every 5 years
- Subscription to toolbox for a fixed duration, offering low resolution ESS and simple scenario development.
- Custom analytics and reporting – price per analysis from basic to Premium

6 Conclusions

In conclusion, the team's current sales approach is best represented by a hybrid BM, including:

1. Data sales, that includes:
    - The Basic onboarding will the cheapest and is offered when the city has the required data sources, like recent aerial images, LIDAR campaigns and VHR satellite data.
    - The Basic+ onboarding is for cities that do not have all the data required and thus the purchase of additional data is necessary, and this will cost more.
    - Seasonal change monitoring of the trees (to observe changes in ESS between summer and winter), if required.
    - Updates of land use and tree maps as required (we estimate every 5 years or so). This should be less costly to deliver than the original maps.

2. Subscription to the toolbox for a specified duration. This will give access to the land cover maps, allowing city staff to identify bare soil or grass land for new planting areas and GIS delineation of potential areas themselves. In addition, it will offer hotspot identification and run tree planting scenarios with respect to ESS evaluation.

3. Consultancy services by the team, at a basic or Premium level. These will be priced according to the extent and depth of the analysis required.

4. Consideration of selling or licensing of certain modules of the toolbox separately, e.g. ESS modelling component or the 100KTREEs app.

6.1 Next steps

These commercial ideas will be discussed with the users during the setting up and deployment of the 6 use cases, which should be completed by Q1 2025. In one use case (the new city of Kolding in Denmark), we are specifically looking at the business case – with a focus on the costs from our side and the BM for commercialisation from the city's perspective. This will allow us to refine our approach to commercialisation, to adapt our service offerings to better match the customers' needs. In addition, we will be promoting 100KTREEs to new cities over the next 6 months and this will also give us an opportunity to explore and expand our commercial approach.

As mentioned before, we will also investigate expansion to B2B offerings, as landscaping companies or urban developers could benefit from services like economic valuation and tree inventory. In addition, we are of the view that for the long-term, the BM of an Eco-Credit Marketplace should be considered, given the growing focus on carbon and biodiversity credits.

The team have identified some issues that we need consider in our sales/commercialisation strategy:

- We need to clarify the pricing per km^2 for mapping and other services and how the pricing will be communicated and justified, particularly for cities with varied budgets.
- For client onboarding it would be advantageous to outline some example pricing tiers and specific data requirements to clarify the differentiation between basic and basic+ onboarding, as well as premium services. This would help potential clients understand what best fits their

needs. In addition, we need to identify typical customer acquisition costs for the primary segments and adjust the marketing and sales costs accordingly.

- For the Custom Analytics services, the team should define clearer pathways for municipalities that lack GIS expertise, offering "light-touch" analytics packages as a stepping stone and possibly training on then using the 100KTREEs toolbox.

Taking these all into account it is very likely that our approach will change over the last year of the project and this will be reflected in our final deliverable D6.5 - 100KTREEs Final Business Plan.

[END OF DOCUMENT]

Funded by
the European Union