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Enabling investment into conservation, climate and communities.

National Trust: Urban Forest Accelerator

Urban Greening Toolkit for Private Finance

July 2024

National Trust

www.finance.earth

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Table of contents

Toolkit overview

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Toolkit overview

This toolkit aims to provide local authorities with an overview of the key steps that they can take to develop urban green infrastructure (GI) projects and identify new sources of private funding to support these projects.

Parks and urban trees in the UK have historically been funded via local authorities' public budgets with support from grants. However, the creation and maintenance of urban green spaces is often costly in a time when **public budgets are declining**.[1] Internal competition for funds and lack of ringfenced funding for green spaces within many local authorities makes urban park budgets a target for cuts, and **the UK has seen an overall decline in the quality of green spaces** within the last decade.[1, 2]

There is therefore a need to set out a picture of the investment case for urban GI, including the value of benefits (termed ecosystem services or ES) delivered by urban trees and the costs associated with them. While there is often funding available for urban tree planting, **managing trees into maturity is expensive and local authorities have limited budgets** available for the maintenance of urban GI. As a result, new sustainable income streams and funding models need to be evaluated to support urban GI projects.

This toolkit has been broken out into two sections:

1. **Initial project scoping** – This section covers how to evaluate ES provided by urban GI and the typical cost/benefit profile associated with urban trees. This section also highlights common funding models for urban GI projects and assesses the applicability of existing ecosystem service markets (ESM) to support urban GI.
2. **Developing payment for ecosystem service models** – This section describes how local authorities can develop alternative payment for ecosystem service (PES) models that are suited for engaging with private finance. The section focuses on how ES can be quantified and sold to buyers and how different delivery mechanisms could be used to finance urban GI projects.

(1) From 2016 to 2021, cumulative park budgets for local UK authorities decreased by £190 million and the number of parks and green spaces rated in good condition are steadily declining (Association for Public Services. (2021). State of UK Public Parks 2021).
(2) Commission for Architecture and the Built Environment (2006). Paying for Parks: Eight models for funding urban green spaces.

1. Initial project scoping

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Introduction

To develop and successfully fund urban GI projects, local authorities must understand the ES provided by a project and the potential value of these ES to funders.

- **Urban GI projects face unique barriers and challenges due to the small size of most projects and the higher costs** associated with projects in urban settings. However, the urban location of these projects is also a key strength, as **densely populated areas increase the total benefits for human well-being and quality of life** (also known as ecosystem services) provided by a project.
- As a result, it is important that **local authorities understand the ES provided by urban GI and develop projects with a goal of maximising the ES relevant** to local populations. These ES are complementary in many cases and can be bundled together to increase the total impact of a project. Additionally, several projects can be aggregated at city, regional or national levels to access larger sources of funding.
- The value of the ES provided by urban GI is significant (est. £91.3bn for London alone),[1] but can be difficult to quantify, notably due to a lack of agreed methodologies. **While GI provides clear benefits to urban populations, converting theoretical value into tangible additional funding streams remains a challenge.**
- Given the scarcity of grant funding and limited park budgets available to finance GI projects, **there will often be a funding gap that will need to be met through public or private funding sources.** If a project's ES have been quantified, **it may be possible to sell these ES to buyers**, providing an additional funding source separate from traditional tax and donation models.
- However, **existing ecosystem service markets typically have eligibility criteria tailored to rural projects, making them less suitable for urban GI initiatives.** As a result, local authorities may need to develop new PES models to generate funding for their projects.

(1) Vivid Economics. (2017). Natural capital accounts for public green space in London.

Barriers and challenges to urban greening

Several key challenges for urban greening projects have been identified over the course of the project.

Quantification and attribution	**ES from GI are significant** (est. £91.3bn for London alone)(1) but tying benefits to interventions is difficult, and the **precise value of ES provided by a project can be difficult to quantify**, especially when benefits are indirect and standardised methodologies have not been agreed upon.
Maintenance Expenditures	Grant funding and corporate social responsibility (CSR) contributions for tree planting are common, but these **funding sources rarely cover long-term maintenance costs**. Since **older trees provide more ES than young ones**, securing funding to maintain existing tree stocks should be a higher priority.
Lack of Green Skills	Getting enough **experienced people with the right skills and qualifications** to install and manage GI well is as a real issue across the sector. **Experienced tree officers are usually capacity constrained,** and normal grounds maintenance workers often lack the skillset needed to perform the work of tree officers.
Lack of Applicable Funding Models	**Existing funding models** such as the sale of carbon or biodiversity credits **are not a good fit** for urban environments in their current form (usually due to space constraints and land availability) **and are oriented towards rural projects** where population density is low.
Lack of Tree Equity and Social Support	**GI tends to be in more affluent areas,** creating a need to secure funding streams for projects in less affluent areas where the impact may be the highest. **Tying projects back to community interest is fundamental** to embed social benefits and stewardship and prevent vandalism.

(1) Vivid Economics. (2017). Natural capital accounts for public green space in London.

Developing green infrastructure projects

The feasibility of a specific GI project can be better assessed by undertaking data collection, cost modelling and site baselining as part of the initial scoping of a project.

Steps	1. Gather key characteristics of projects	2. Model the costs and benefits of intervention	3. Identify existing sources of funding	4. Evaluate funding shortfall	5. Assess potential funding models
Activities	• Creation vs. enhancement • Location & size • Land ownership • Hard vs. soft landscape • ES provided	• Cost estimates (if available) • Quotes from urban green space contractors • Value the impact of ES	• Planting grants (EWCO, Urban Tree Challenge Fund) • Donations • Local authority budgets	• Based on calculations from stages 2 & 3, estimate funding shortfall to be covered by private finance	• Produce baselines and projections • Evaluate potential funding models • Engage with funders to assess demand for project ES
Expertise	Tree Officer + Landscape Architect	Tree Officer + Landscape Architect + Cost Modelling Tool	Tree Officer + Cost Modelling Tool	Tree Officer + Cost Modelling Tool	Ecologist + Local authority employees

Green infrastructure and ecosystem services

There are a wide range of potential GI interventions such as the ones noted below. Local authorities could benefit from coordinating GI interventions in a strategy, as set out in the Natural England GI Framework.[1]

Street trees
Trees planted along city managed streets. Can also be fitted with open tree pits to better retain rainwater.

Pocket parks
Smaller open spaces (often <0.5ha) within urban areas. May include amenities like playgrounds or dog parks.

Sustainable urban drainage systems (SuDS)[2]
Green drainage solutions that hold and store water, such as rain gardens, tree pits, basins and ponds.

Green corridors
Strips of trees and vegetation connecting larger green spaces, often running along drainage lines or streets.

Street trees

Pocket parks

SuDS

Green corridors

[1] Natural England GI Framework. GI Home (naturalengland.org.uk)
(2) See Appendix III for more details on SuDS

ES provided by GI

Urban GI provides a variety of ES for cities and local inhabitants.

Carbon capture – Individual trees store an estimated 10 kg/year of carbon dioxide during the first 20 years of life[(1)] with mature trees capable of sequestering 20-40 kg/year.[(2)]

Air pollution reduction – A single mature tree can remove 0.25-1.5kg of particulate air pollution each year, depending on tree size.[(2)]

Flood risk reduction – Urban trees and green spaces reduce runoff by holding and absorbing water, reducing the risk of flash flooding and sewage overflow.

Urban heat island reduction – Green spaces within UK cities are 3-5°C cooler than surrounding areas[(3)] and adding trees to shade buildings can reduce building energy usage by up to 7.2%.[(4)]

Improved mental & physical health – Prevalence of depression could be reduced by 7-9% with 30-minute visits to green spaces. Close park proximity increases exercise by 5.4 hours/week.[(5)]

Other benefits – Biodiversity, increased property values, water pollution reduction, recreational value, workplace recruitment and retention.[(6)]

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(1) Bernet, R. (2021). How Much CO2 Does A Tree Absorb? One Tree Planted. Available at: https://onetreeplanted.org/blogs/stories/how-much-co2-does-tree-absorb.
(2) Nowak, et. al (2006). Assessing urban forest effects and values, Washington D.C.'s urban forest (usda.gov).
(3) Friends of the Earth. The cooling effect of trees and green spaces in cities. [online] Available at: https://friendsoftheearth.uk/climate/cooling-effect-trees-and-green-spaces-cities.
(4) Nowak, D.J. et al. (2017) Residential building energy conservation and avoided power plant emissions by urban and community trees in the United States.
(5) Wilson, J. and Xiao, X. (2023). The Economic Value of Health Benefits Associated with Urban Park Investment. 20(6), pp.4815–4815.
(6) Centre for Sustainable Healthcare. (2020). Space to breathe: valuing green space at NHS sites for staff wellbeing.

Mapping ES to interventions

Private funding for GI can be generated through the sale of ES. These ES will vary depending on the type of GI used and the characteristics of the project area.

Selected ES

Health, heat island reduction

Flood risk mitigation

Pocket parks

Sustainable drainage systems

Street trees

Bee hives and insect banks

Selected ES

Heat island reduction, carbon sequestration

Biodiversity, pollination

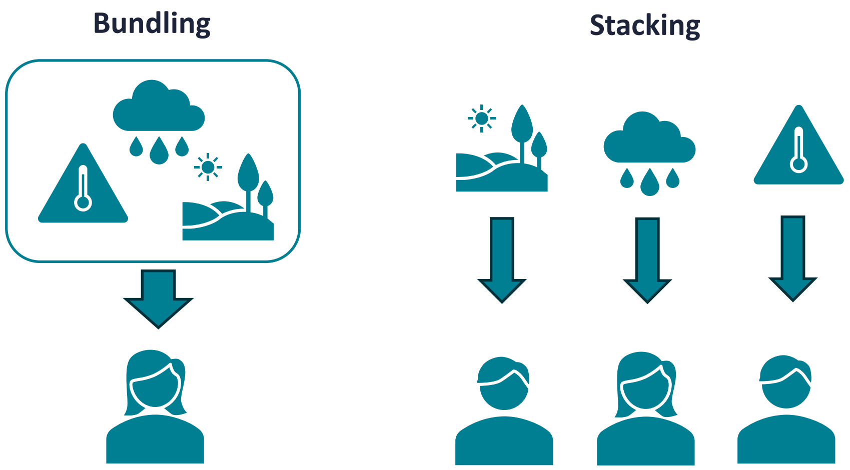
Bundling ES

Individual ES are generally too small in an urban context to generate meaningful cash flows. Therefore, an approach that bundles interventions or ES is more appropriate for urban GI projects.

Stacking and bundling[1]

Stacking – Multiple ES on the same land, sold to different buyers under different contract arrangements

Bundling – The bringing together of multiple ES from a landholding in a single transaction



Potential benefit bundles for urban green space

1 'Climate Adaptation' Bundle

- **Key ecosystem services:** reduction of urban heat islands, flood risks reduction, water pollution reduction
- **Potential payors:** utilities and insurance companies

2 'General' Bundle

- **Key ecosystem services:** environmental benefits (carbon sequestration, biodiversity), social benefits (access to green spaces, health)
- **Potential payors:** financial institutions & other corporates

3 'Health' Bundle

- **Key ecosystem services:** mental health (stress reduction, improved cognition), physical health (less heat strokes, respiratory conditions, etc.)
- **Potential payors:** health insurance (private or NHS), schools, corporates

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(1) Aggregation is frequently discussed alongside stacking and bundling, but it is a distinct concept. In finance, aggregation involves pooling several urban GI projects to achieve economies of scale, enabling large funders to deploy more capital at a lower cost while benefiting from risk diversification across a portfolio of projects.

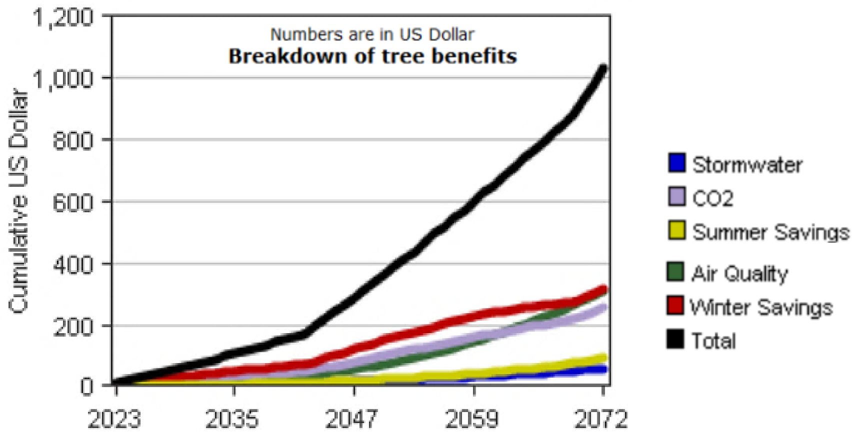
Assessing ES

While urban trees provide significant ES on a city-wide basis, per tree ES are often low. Project proponents should consider targeted plantings & additional complementary interventions to increase impact.

- Tree planting should adhere to a **'right tree, right place'** methodology:
  - Tree species should be **well suited to the planting location**
  - Tree **attributes should match benefits sought** (e.g. large canopies for intercepting water or shading buildings).
- Tree ES grow exponentially from the point of planting and **mature trees have the highest benefits**.
- However, **the total value of ES from a single tree is often small** (<£100 annually) even when strategically planted.
- **Urban trees can be paired with other interventions** (such as rain gardens, vegetation, bodies of water and permeable surfaces) to increase impact and materiality of ES.

Tree ES in Greater London[1]	
Number of trees	8,421,184
Avoided annual run off value	£1,191,821
Run off value per tree	**£0.14**
Annual energy savings	£315,477
Energy savings per tree	**£0.04**

Single tree ES over time[2]

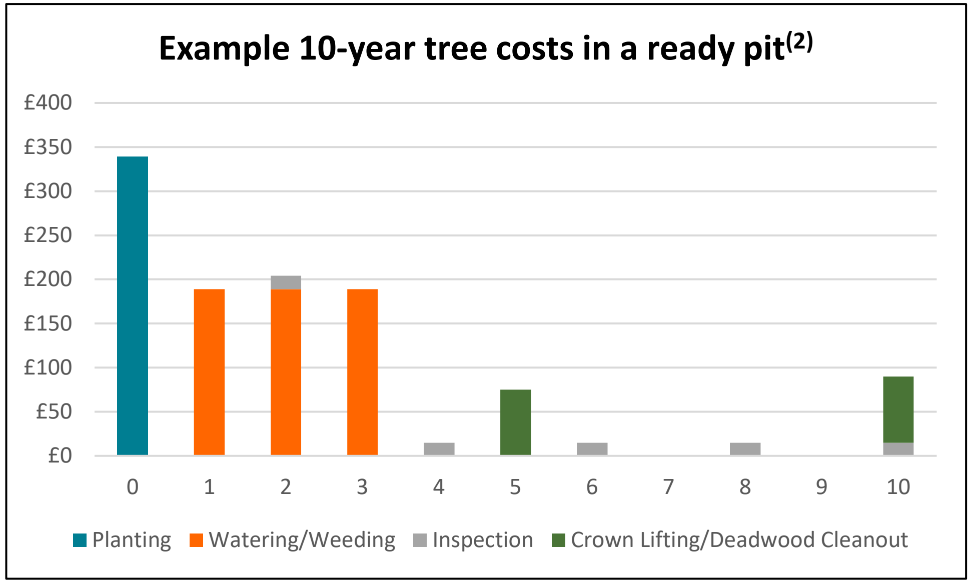


[1] Valuing London's Urban Forests (2015). Treeconomics.
[2] Modelled in i-Tree Design for a London Plane Tree.

Understanding project costs

Project costs for urban trees are frontloaded during the planting and establishment phases and limited to smaller but recurring maintenance costs in later years. To support the development of urban GI projects, Finance Earth has developed an Urban Tree Cost Model to help estimate these costs.(1)

- **Urban tree costs are frontloaded** during the planting & establishment phases (years 0-3).
- **Planting and establishment costs are highly variable** depending on location and whether the tree is being planted into a hard or soft landscape (e.g. planting in a sidewalk vs. grass in a park).
  - **Soft landscapes are cheaper** (typically the tree + anchoring and watering systems). **Hard landscapes are more expensive** and may involve civil engineering, tree pit and highway access costs.
  - **Individual trees are relatively inexpensive** compared to planting and maintenance costs (often £100 or less depending on depending on type and root status).
- **Maintenance costs are smaller but are recurring** over the lifetime of the project (e.g. inspection and deadwood cleanout). Later-life maintenance costs can be reduced by good preparation and establishment early on.



Example 10-year Costings	Cost	Percent
Establishment Phase (years 0-3)	£921	81%
Maintenance Phase (years 4-10)	£210	19%
Total	£1,131	100%

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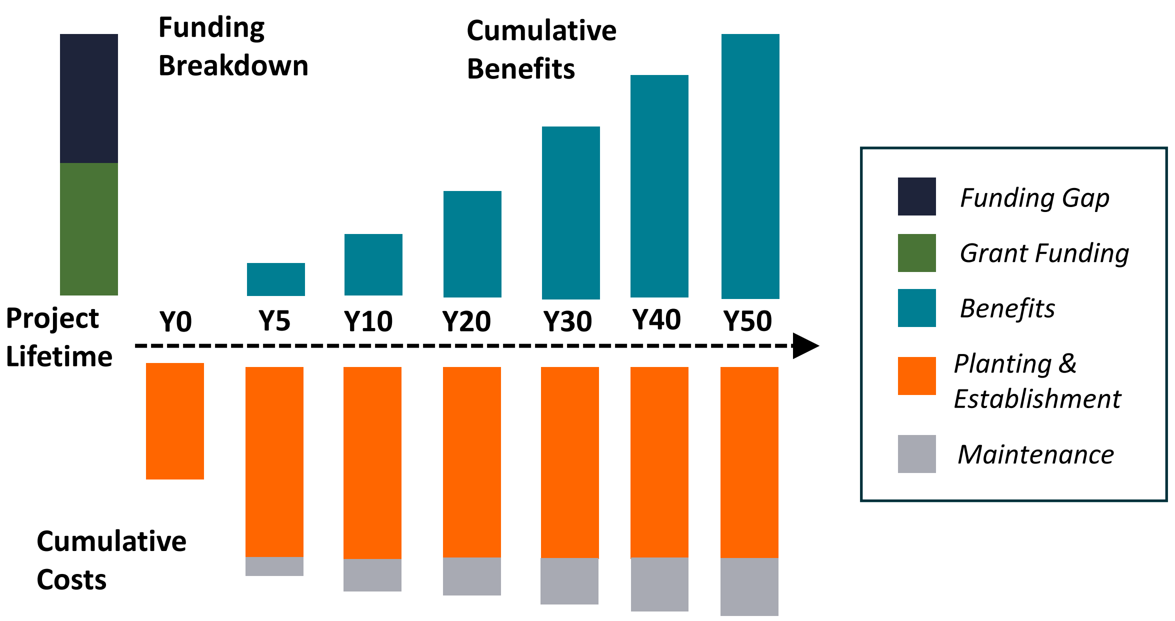
(1) [Link to Urban Tree Cost Model Tool]
(2) Planting and watering costs taken from Urban Tree Challenge Fund costs, assuming no trial pit is needed (Urban Tree Challenge Fund - GOV.UK (www.gov.uk)). Inspection and maintenance costs taken from FE Cost Model assuming inspection every 2 years and deadwood cleanout every 5 years. Actual costs may vary from this case.

Evaluating funding shortfalls

The revenues generated from the sale of GI ES must generate sufficient revenues to cover a material portion of project costs.

- Grant funding often available for urban tree planting and establishment costs[1] but is **rarely available for long-term maintenance**. As a result, a funding gap will exist for most GI projects.
- Urban tree benefits generation:
  - Bigger tree = more benefits
  - Benefits accumulate slowly over time
- **Project breakeven for new plantings will likely occur several decades after trees are planted** (often from year 25+), making tree maintenance a key consideration.
- **Timing mismatches between costs incurred and benefits** generated may create a need for upfront funding and prepayments for expected benefits.

Example street tree project costs and benefits[2]



[1] E.g. Urban Tree Challenge Fund

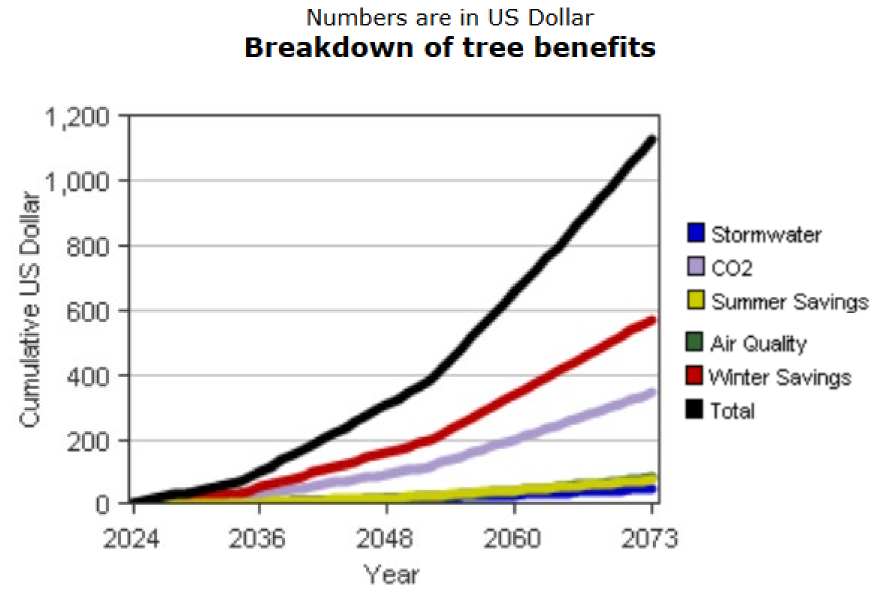
[2] Costs and benefits modelled based on Urban Tree Challenge Fund and Green Blue Urban information (Urban Tree Challenge Fund - GOV.UK (www.gov.uk) GBU_Street-Tree-Cost-Benefit-Analysis-2018.pdf (treeconomics.co.uk))

Valuing existing tree stock

Since older trees provide significantly more benefits than younger trees, projects that support the health and maintenance of existing tree stocks should be given equal footing with new projects, and management of existing tree stocks should be done proactively.

- While new plantings may take decades to reach breakeven in terms of cost/benefits, **maintenance funding for mature trees provides a quicker payback period due to the higher value of ES provided.**
- For example, ES generated by a standard white oak tree in i-Tree Design were $281 in years 1-25 and $817 from years 25-50.[1]
- Since the **cost of planting and establishment has already been incurred** and older trees have limited maintenance requirements, **the cost of maintaining existing trees is much lower.**
- In addition, **ES provided by existing trees are better aligned with costs**, limiting the need for upfront financing.
- Tools such as **the i-Tree suite, can be used to value existing tree stock** and estimate ES for new projects.[2]

Single tree ES over time[1]



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[1] Modelled in i-Tree Design using a white oak tree
[2] See the 'Developing payment for ecosystem service models' section of the toolkit for more detailed information around ES quantification

Funding models for GI

When grant funding does not wholly cover the cost of a project, other funding sources, such as tax revenues or corporate payments for ES, will be needed to cover the gap.

Traditional sources of funding for urban GI

Tax Models

e.g. Business Improvement Districts or municipal green/blue debt[1]

- Increases in tax revenues are allocated to fund GI projects
- When debt is used, it is ultimately repaid through the taxes a local authority collects
- Citizens may voluntarily increase taxes to fund GI, though this only tends to happen in affluent areas or for a more limited period.

Donation Models

e.g. Corporate Social Responsibility budgets or sponsorship models

- Donations to fund GI are provided on a non-repayable basis
- Valuable source of funds, but difficult to secure and limited by CSR budgets
- Often uses simple metrics to evaluate impact, such as the number of trees planted

Potential sources of funding for urban GI

Existing ES Markets

e.g. Woodland Carbon Code or Biodiversity Net Gain

- Projects are typically financed by the sale of credits or outcomes to payors based on their commercial value
- May involve debt depending on level of grant funding and timing of project validation
- Poor fit for most small urban GI projects, but could make sense for larger projects

Other PES Models

Model outside of a code tailored to meet the needs of projects or payors[2]

- Projects seek to sell ES outside of the framework of a code
- More flexible than existing codes, but more time and resource intensive to develop
- May need to be tailored to the needs of a funder to ensure support

Even when PES models are not being used, more rigorous benefits quantification can be valuable as it allows GI projects to better compete for traditional sources of funding and potentially displace funds going exclusively to grey infrastructure projects.

[1] E.g. Miami Forever Blue Bond investing in coastal and marine infrastructure (refer to the annexes for case study).
[2] E.g. token models like the Plymouth Seagrass Token currently in development (refer to the annexes for case study).

Tax and donation funding models

If the quantification and attribution of ES is not possible or desirable (e.g. does not attract more funding), local authorities can consider models that do not rely on ES monetisation.

Green business districts

- Defined areas where local businesses have voted to invest together (through taxes and levies) to improve their environment in a commercial area. There are currently over 200 business improvement districts (BIDs) in the UK
- Provide improved services based on business needs such as safety, cleaning, training, education and environmental measures (street trees, SuDS etc.)
- BIDs have limited potential to improve tree equity since commercial and low-income residential areas rarely overlap(1)

Victoria Business Improvement District(2)

- Businesses voted to establish BID and those with a ratable value of £150k+ pay levy
- Assessed opportunities for GI in BID area through audit
- Added new gardens, street trees and green walls in BID, including the Diamond Garden (right)

Donation and symbolic token models

- Projects are funded through donations from businesses and the public
- Tokens, certificates or other identification are used to highlight the impact provided by the donor, but do not have a monetary value
- Raising funding depends on the project's story, image and marketing, which can be difficult given the number of similar projects on the market

Heal Rewilding[3]

- Donors sponsor a 3x3 square that will be rewilded for a small fee (£20-100)
- Funding is used on-site for plant regeneration, soil formation and nutrient cycling
- Heal uses what3words to assign a unique ID to plots that people can visit on site

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(1) Similarly, affluent neighborhoods may willingly support voluntary tax increases to fund urban GI (see appendix II), but these projects are unlikely to contribute to tree equity if projects occur in already affluent areas.

(2) Victoria BID has produced a GI best practice guide for other BIDs to reference: BestPracticeGuide_A4-10.pdf (victoriabid.co.uk).

(3) Heal Rewilding | nature recovery, climate action

Existing ES markets

Urban green spaces and trees generate a wide range of ES, but there is no established market for most of them, and their eligibility within existing market solutions is limited.

Established local or national markets

Ecosystem services	Selected potential payors	Existing markets and solutions	Example
Carbon sequestration	Corporates with net-zero ambitions	Woodland Carbon CO_2de	Plymouth City Council Community Forests
Biodiversity	Property and infrastructure developers with offsetting obligations	Department for Environment Food & Rural Affairs – Biodiversity Net Gain	Plymouth City Council Ocean City Biodiversity Vehicle[1]
Flood risk reduction	Water companies, disaster insurers, local businesses	Payments for avoided costs	The Aire Resilience Company and the Wyre Catchment Company[2]
Urban heat island reduction	Energy companies, local businesses, corporates, residents	No established market/solution	Stuttgart TreesAI project by Dark Matter Labs[3]
Air quality improvements	Healthcare insurer and providers	No established market/solution	City Forest Credits[1]
Improved mental & physical health	Healthcare insurer and providers, employers	No established market/solution	Green Social Prescribing[4]

[1] See Appendix II for more details on these case studies
[2] https://www.greenfinanceinstitute.com/gfihive/case-studies/the-wyre-river-natural-flood-management-project/
[3] TreesAI is implementing location-based scoring in Stuttgart | by Dark Matter | Dark Matter Laboratories (darkmatterlabs.org)
[4] NHS England » Green social prescribing

Existing ES markets

There are several ESM operational within the UK, facilitated by the establishment of codes and metrics, as well as regulation. However, the eligibility of urban green spaces for these markets is constrained.

	Woodland Carbon Code (WCC)	Wilder Carbon	Peatland Code (PC)	Biodiversity Net Gain (BNG)	Natural Flood Management (NFS)	Natural England Nutrient Mitigation Scheme
Interventions	Creation of woodlands	Biodiversity restoration and carbon sequestration	Restoration of degraded peatlands	Habitat creation and enhancement of habitats such as grasslands, woodlands, ponds, rivers and hedgerows	Interventions such as building leaky dams, planting trees, ploughing land, building swales	Fallow land to reduce nutrient inputs and creation of wetland for nutrients filtration
Average project size	> 1 hectare[1]	>10 hectares	> 10 hectares[2]	> 1 hectare[1]	Catchment scale[3]	Varying
Other eligibility criteria	Minimum 400 stems per hectares and expected canopy cover > 20%	Must utilise Defra BNG metric	Minimum peat depth 30 cm, water table requirements	-	-	Requires agricultural land
Applicability to urban green spaces	**Limited** (depends on tree density and planted area)	Limited (no examples of urban projects)	**Limited** (depending on presence of peatlands)	**Applicable** (with some conditions of minimum viable area)	**Applicable** (SuDS interventions in urban areas)	**Limited** (agricultural land is rare in urban areas)
Applicability to trees	**Yes**	**Yes**	**No**	**Limited** (BNG metric not favourable for trees)[4]	**Yes** (trees can be integrated into SuDS)	**No**

[1] There is no stated minimum project size for the WCC and BNG but small projects are usually less economically viable and usually require aggregation to be economically viable.
[2] Only one Peatland Code validated project < 10 hectares out of >150 projects as of March 2024.
[3] NFM and SuDS projects usually require co-ordinated interventions in a large area such as a river catchment to be effective.
[4] Urban trees have a 27-year maturity in the metric, which limits the value of upfront credit sales. Foot traffic also tends to reduce habitat quality, which is an issue for small urban parks.

Developing other PES models for GI funding

When operating outside existing ESM, project developers will need to quantify ES from a project on their own and then sell these services to a buyer.

Standard structure: intervention-based model

- Contributors are mostly driven by 'qualitative' factors such as the project's story, image and marketing
- Contributors rely on simple metrics such as the number of trees planted. Funding is provided without expectation of returns

Quantification of benefits

Potential structure: PES model

- Buyers seek to purchase 'quantified' ES that are backed by science-based measurement methodologies and monitored on a regular basis
- Buyers seek to make claims, reduce costs, and potentially receive financial returns from projects

Example: Camden Old Rail Line fundraising model

Heat island reduction, flood risk reduction, air quality improvements, etc.

Example: DC Water Environmental Impact Bond(1)

Additional details on developing PES models outside of standard ESM and codes can be found in the 'Developing payment for ecosystem service models' section of the toolkit.

(1) The DC Water Environmental Impact Bond was used to finance the deployment of green urban infrastructure to absorb and slow stormwater runoff during periods of heavy rainfall. DC Water committed to share the savings if this new GI achieved a reduction in costs associated with floods.

Conclusions

While urban GI provides clear benefits to urban populations, converting theoretical value into tangible additional funding streams remains a challenge, one that current ESM struggle to address effectively.

- **Local authorities should work to understand the ES provided by urban GI** projects so that existing GI is appropriately valued, and new projects target appropriate benefits.
- **GI works best when multiple ES are bundled together** as individual ES streams are small and generated over a long period of time**.**
- **Urban GI projects can combine tree planting with other interventions** (such as rain gardens, swales or vegetation) to make the value of ES derived from a project more material.
- **A large proportion of the costs of urban trees are incurred during the first few years of the tree's** life (i.e. planting and early establishment costs), while most ES accumulate over decades from the time of planting. As a result, **maintaining mature trees is more cost-effective than planting new ones** within GI projects, and local authorities should communicate the benefits of funding the maintenance of tree stocks when engaging with potential funders.
- While PES models offer a way to fill financing gaps created by limited grant funding and park budgets, **many existing ecosystem service markets are not well tailored to urban GI projects.** Local authorities may need to work with funders to develop alternative PES models that are well suited to potential payor needs.

2. Developing payment for ecosystem service models

Introduction

Parks and urban trees[1] in the UK have historically been funded via local authorities' public budgets with support from grants. However, the creation and maintenance of urban green spaces is often costly, and these spaces are difficult to maintain in a time when public budgets are declining.[2]

- Payment for ecosystem service **(PES) models offer an alternative to traditional tax and corporate social responsibility (CSR) funding models** by selling quantified benefits to commercial payors. **These benefits are termed ES (ES), which are often traded in ecosystem service markets** (ESM) such as the Woodland Carbon Code or Biodiversity Net Gain.
- While several ESM exist within the UK, **these markets are not a good fit for most urban green infrastructure (GI) projects** due to minimum size and tree density requirements, limiting their applicability as potential PES models.
- Where urban GI projects fall outside of established codes, **it still may be possible to develop alternative PES models if there is sufficient data and adequate quantification methodologies available**. Several tools exist that can help local authorities gauge the ES provided by their project and communicate the value of these ES to funders and buyers.
- **ES can be sold to buyers in a variety of ways**, including via token models, impact funds, direct payments, and sustainability-linked bonds. **Given the small size of most urban GI projects and low levels of market infrastructure available, tokens have been identified as one potential funding models for urban GI projects**, though this may change over time as the market infrastructure develops.

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(1) Termed GI (GI)**,** which is defined as a network of multi-functional green and blue spaces capable of delivering a wide range of benefits for nature, climate, and communities.

(2) From 2016 to 2021, cumulative park budgets for local UK authorities decreased by £190 million and the number of parks and green spaces rated in good condition are steadily declining (Association for Public Services. (2021). State of UK Public Parks 2021).

Existing ecosystem service markets

There are several ESM operational within the UK, facilitated by the establishment of codes and metrics, as well as regulation. However, the eligibility of urban green spaces for these markets is constrained.

	Woodland Carbon Code (WCC)	Peatland Code (PC)	Biodiversity Net Gain (BNG)	Natural Flood Management (NFS)	Natural England Nutrient Mitigation Scheme
Interventions	Creation of woodlands	Restoration of degraded peatlands	Creation and enhancement of habitats such as grasslands, woodlands, ponds, rivers and hedgerows	A range of interventions such as building leaky dams, planting trees, ploughing land, building swales and bunds	Fallow land to reduce nutrient inputs and creation of wetland for nutrients filtration
Average project size	> 1 hectare[(1)]	> 10 hectares[(2)]	> 1 hectare[(1)]	Catchment scale[(3)]	Varying
Other eligibility criteria	Minimum tree density of 400 stems per hectares and expected canopy cover > 20%	Minimum peat depth 30 cm, water table requirements	-	-	Requires agricultural land
Applicability to urban GI	**Limited** (depends on tree density and planted area)	**Limited** (depending on presence of peatlands)	**Applicable** (with some conditions of minimum viable area)	**Applicable** (SuDS interventions in urban areas)	**Limited** (agricultural land is rare in urban areas)
Applicability to trees	**Yes**	**No**	**Limited** (BNG metric not favourable for trees)[(4)]	**Yes** (trees can be integrated into SuDS)	**No**

Other emerging standards such as Wilder Carbon offer alternative routes to private funding. However, these standards are also better suited to rural areas than to densely populated urban areas.

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[(1)] There is no stated minimum project size for the WCC and BNG but small projects are usually less economically viable and usually require aggregation to be economically viable.
[(2)] Only one Peatland Code validated project < 10 hectares out of >150 projects.
[(3)] NFM and SuDS projects usually require coordinated interventions in a large area such as a river catchment to be effective.
[(4)] Urban trees have a 27-year maturity in the metric, which limits the value of upfront credit sales. Foot traffic also tends to reduce habitat quality, which is an issue for small urban parks.

Developing other PES models

PES models are an alternative to the intervention-based models that are more typical for GI. Quantification of ES enables engagement with new funders on commercial terms and creates opportunities for repayable finance structures.

Standard structure: Intervention-based model

- Contributors are mostly driven by ‘qualitative’ factors such as the project’s story, image and marketing
- Contributors rely on simple metrics such as the number of trees planted. Funding is provided without expectation of returns

Example: Camden Old Rail Line fundraising model

Quantification of benefits

Heat island reduction, flood risk reduction, air quality improvements, etc.

Potential structure: PES model

- Buyers seek to purchase ‘quantified’ ES that are backed by science-based measurement methodologies and monitored on a regular basis
- Buyers seek to make claims, reduce costs, and potentially receive financial returns from projects

Example: DC Water Environmental Impact Bond[1]

[1] The DC Water Environmental Impact Bond was used to finance the deployment of green urban infrastructure to absorb and slow stormwater runoff during periods of heavy rainfall. DC Water committed to share the savings if this new GI achieved a reduction in costs associated with floods.

Quantifying ecosystem services

PES models outside of existing ESM may be difficult to develop due to difficulties with quantifying ES. Local authority capacity constraints may limit the viability of these models, especially for small scale projects.

Quantification - Need robust methodologies to measure direct ES (such as CO_2 and heat reduction) and indirect ES (such as health, property prices)

- e.g. accurately accounting for the impacts of shading and transpiration for heat island reduction(1)

Attribution - How can a measured ES be attributed to GI?

- e.g. local property prices are driven by many factors, not just the presence of GI

Costs - How much does it cost to collect the data? Are costs commensurate with potential revenue generation?

- e.g. verification of run-off reduction relative to the number of urban trees planted

Delivery/uncertainty risk - Future performance depends on a range of factors that cannot be ascertained

- e.g. droughts, heat, local growing conditions, improper maintenance

(1) Vaz Monteiro, M. et al. (2016). 'The impact of greenspace size on the extent of local nocturnal air temperature cooling in London', Urban Forestry & Urban Greening, 16, pp. 160–169. Available at: https://doi.org/10.1016/j.ufug.2016.02.008.

Assessing other funding models

Given the difficulties associated with quantifying outcomes, it may be more practical to move from intervention-based models to quantified PES models over several stages.

Qualitative Impacts → **Quantitative Impacts** → **Verified Quantitative Impacts**

1 Targeting Interventions

Funders and implementors target specific interventions (usually planting a certain number of trees)

e.g. the company funded the planting of 40 street trees

2 Targeting Impacts

Principles are developed to implement interventions in a targeted manner that better achieves ES sought

e.g. 4 pocket parks with playgrounds were added in low income areas to improve mental and physical health

3 Quantifying Outcomes

ES are quantified using standardised methodologies but are not subject to a formal verification process

e.g. the added trees will intercept 20,000 gallons of rainfall a year

4 Developing a Code

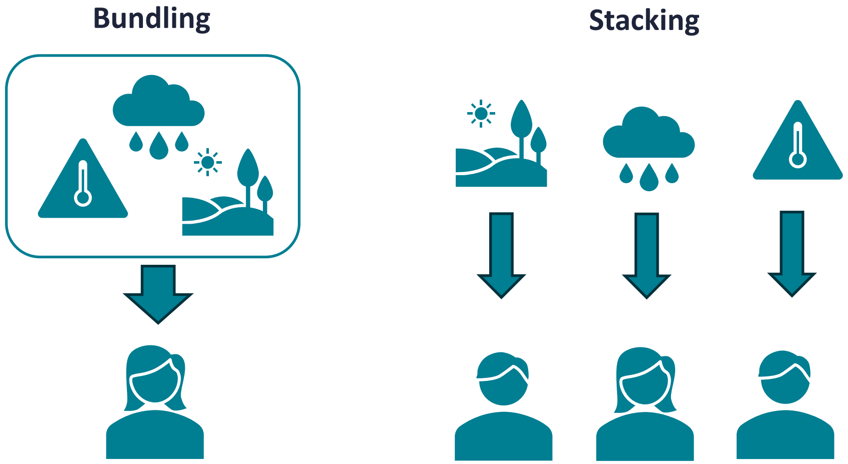
A science-backed code is developed that projects must adhere to. Results are mapped to monetary benefits and monitored over time

e.g. the project sequestered 280 tonnes of carbon, and credits valued at £7,000 were issued

Bundling ES

Even when quantified, individual ES are generally too small in an urban context to generate meaningful cash flows. Bundling project ES together is one way to ensure benefits are material to funders.

Stacking and bundling(1)
Stacking – Multiple ES on the same land, sold to different buyers under different contract arrangements **Bundling** – The bringing together of multiple ES from a landholding in a single transaction



Potential benefit bundles for urban green space

1 'Climate Adaptation' Bundle

- **Key ecosystem services:** reduction of urban heat islands, flood risks reduction, water pollution reduction
- **Potential payors:** utilities and insurance companies

2 'General' Bundle

- **Key ecosystem services:** environmental benefits (carbon sequestration, biodiversity), social benefits (access to green spaces, health)
- **Potential payors:** financial institutions & other corporates

3 'Health' Bundle

- **Key ecosystem services:** mental health (stress reduction, improved cognition), physical health (less heat strokes, respiratory conditions, etc.)
- **Potential payors:** health insurance (private or NHS), schools, corporates

(1) Aggregation is frequently discussed alongside stacking and bundling, but it is a distinct concept. In finance, aggregation involves pooling several urban GI projects to achieve economies of scale, enabling large funders to deploy more capital at a lower cost while benefiting from risk diversification across a portfolio of projects.

Ecosystem service bundles

Some promising ES bundles identified via funder engagement over the course of the project are further described below:

	Benefits targeted		Observations
1	**'Climate resilience' (heat/flood)**		• **Climate resilience benefits** (e.g. tackle urban heat island and flood risks) and associated secondary benefits such as **improved health outcomes** and **energy savings** • **Heat and flood tend to be complementary** (e.g. paved urban areas tend to be hotter and have a higher risk of flooding due to runoff) • **Outcome payers** could include utility providers / businesses / insurers
2	**General bundle of standardised outcomes**		• Relying on **quantification of a range of GI ES** (carbon, air quality, water, recreational value, etc.) • Workshop participants pointed to the need for **user-friendly and cost-effective benefit quantification methodologies** (e.g. Liverpool John Moores model, CAVAT model, i-tree model) • Less stringent benefit quantification might be better suited for CSR buyers (individuals and corporations)
3	**'Health' outcomes (heat/air quality/ access to green spaces)**		• **Avoided health costs** and **improved health outcomes** based on the heat reduction, air quality, access to green spaces for mental health, etc. • Avoided health costs are **difficult to attribute** to green spaces and some health benefits **are hard to quantify** (e.g. air quality improvements depend varying factors such as prevailing winds, etc.) • **Broader green initiatives** and public realm interventions could be **used to focus test** different ideas for funding (e.g. 'clean air/health zones' with trees, traffic measures, grass verges & SuDS)

Ecosystem service quantification metrics

ES from urban trees and GI are calculated based on tree attributes and location factors.

Ecosystem service	Typical Indicator	Description/Key Factors
Carbon Sequestration	CO_2e/yr.	• Carbon sequestered by a tree as it grows • Based on size of tree (typically diameter at breast height, DBH) and growth rates
Biodiversity	Biodiversity units[1]	• Based on uplift from baseline given habitat attributes and interventions
Energy Usage	MWH	• Reduced energy usage due to shading (summer) and windbreak (winter) • Based on tree size/canopy, location, distance to building and local climate conditions
Climate Regulation (Urban Heat Island)	Ha of UGS/ Cooling (°C)	• Avoided costs of temperature regulation based on mortality and lost productivity • Based on the amount of cooling provided, which can vary from city to city based on local climate conditions and type of green space
Water Attenuation & Flood Risk Reduction	M^3 of water/yr.	• Stormwater attenuation resulting in avoided water treatment and flooding • Based on tree attributes (canopies and root storage), ground permeability and local climate conditions • Hydraulic modelling is needed to fully assess flood risks given complexity of environmental interactions
Air Pollution Reduction	PM2.5 removal/yr.	• Fine particulate matter filtered by a tree • Based on tree size and species as well as city pollutant figures
Physical Health & Mental Health	Active visits	• Increased visits over a baseline by those receiving health benefits (increased activity or mental health risk) • Monetary value based on avoided treatment costs

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(1) Calculated based on the Defra Statutory Biodiversity Net Gain metric: Statutory biodiversity metric tools and guides - GOV.UK (www.gov.uk)

Ecosystem service quantification models

Several quantification models that estimate the value of ES from GI projects exist and could be applied to develop PES models.

i-Tree Eco	Model developed by the USDA that is commonly used by local authorities and tree officers covering a suite of benefits	i-Tree
Vivid Economics	Model developed by UK-based Vivid Economics covering multiple benefits but focusing on valuing health, wellbeing and recreation, and understanding how best to model these benefits	:vivideconomics
eftec	Estimates both the monetary value of benefits and the confidence in each calculation, with some methodologies designed in-house	eftec economics for the environment
WRI VWBA[1]	Complex water-specific model that accounts for runoff, water quality and attenuation in both rural and urban contexts	World Resources Institute
Tree Equity Score UK	Mapping software that shows local inequalities for heat and health and estimates the monetary value of these benefits using i-Tree, at no cost to the user	Tree Equity Score UK
LJMU EcoservR	Detailed model developed by Liverpool John Moores University with a focus on green spaces >1ha that provides output reports highlighting intervention impacts	Liverpool John Moores University
Defra BNG Metric	Statutory Biodiversity Net Gain (BNG) metric used to calculate unit generation for BNG projects	Department for Environment Food & Rural Affairs

(1) World Resources Institute Volumetric Water Benefit Accounting

Mapping ecosystem service quantification

The models identified all calculate the value of different ES:

Model	Carbon	Biodiversity	Energy Usage	Climate Regulation	Water/ Flooding	Air Quality	Physical Health	Mental health
i-Tree Eco	✓		✓		✓	✓		
Vivid Economics	✓			✓			✓	✓
eftec	✓			✓		✓	✓	✓
WRI VWBA					✓			
Tree Equity Score UK				✓		✓	✓	
LJMU EcoservR	✓			✓	✓	✓	✓	✓
Defra BNG Metric		✓						

Assessing demand for ES

Understanding the motivations of funders to contribute to GI projects is important. Local authorities and project developers can engage with potential buyers to understand preferences and gauge willingness to pay.

ES	Potential payors[1]
Flood Risk and Water Pollution Reduction	• Water companies • Disaster insurers • Local businesses (Severn Trent)
Climate Regulation and Energy Usage	• Energy companies • Local businesses • Corporates (Workspace, SSE)
Air Pollution Reduction	• Healthcare insurers • Healthcare providers (Bupa, Aviva)
Improved Mental & Physical Health	• Healthcare providers • Local schools/universities • Employers (CBI, University of Plymouth)

(1) Listed potential payors for illustrative purposes only and do not reflect these organisations' willingness to participate in funding GI.

Understanding payor motivations

Stakeholder engagement highlighted heat mitigation, flood risks and health as key ES valued by payors and suggested that there is support for quantification of ES within this group.

Corporate support for GI projects is driven by CSR strategies and commercial benefits

- Payors engaged want to support projects aligned with their CSR, nature & biodiversity strategies
- GI projects offer a way to increase asset values, manage business risks and avoid costs

There is stakeholder support for shifting towards quantified ES

- Payors expressed support for quantified ES as well as a shift towards PES models
- Funder interest could develop once a standardised model to trade ES has been developed

Heat, health and water ES appear to have the most traction with buyers

- Heat reduction, flood risk reduction and health ES were most cited during stakeholder engagements
- Well-being, community engagement, carbon sequestration, and aesthetics were also discussed in interviews

Barriers exist that need to be addressed to generate support for PES models for GI

- Questions around ownership, ES measurement, certification structure and maintenance periods remain
- One stakeholder highlighted that corporates need upskilling and are hesitant to serve as first movers

Key stakeholders engaged

Lloyds Banking Group, CBI, Trees for Cities, Severn Trent, Workspace, England's Community Forests

Delivery mechanisms for PES models

Once a buyer has been found, ES can be sold in a variety of ways. Several possible delivery mechanisms for PES models have been identified over the course of the project.

	Description of the mechanism	Examples
Tokens	• Multiple benefits (qualitative and quantitative) can be bundled together and sold as a single token • Often linked to a specific asset (e.g. a 3x3 square of rewilded land using what3words geolocation as seen developed by Heal Rewilding) but can also be linked to an outcome (e.g. 1 tonne of CO2)	Plymouth Seagrass Tokens[1]
Impact Funds	• A structure that aggregates investor capital to invest into a variety of projects • Projects are selected based on the fund's investment criteria and may or may not provide returns depending on the projects funded	Plymouth City Council 'Ocean City' Vehicle[1]
Direct Payment	• A buyer and a seller sign a contract to contribute to a project with some outcome-based incentives for the seller to deliver outcomes to the buyers • Must be of sufficient scale/benefit to justify upfront costs of contract creation and negotiation	Wyre Catchment Natural Flood Management[2]
Sustainability-linked bonds	• A debt instrument used to finance environment and/or social outcomes • Bonds can take different forms such as green/blue bonds used to borrow and invest in eligible projects, and impact bonds in which the financial return depends on the delivery of an outcome	Washington DC Impact Bond[1]

[1] See Appendix II for more details on these case studies
[2] https://www.greenfinanceinstitute.com/gfihive/case-studies/the-wyre-river-natural-flood-management-project/

Evaluating delivery mechanism viability

Given the small scale of many urban GI projects, limited applicability of existing nature markets and less standardised quantification methodologies, a token model is currently the most viable delivery mechanism.

Model	Required Scale	Complexity	Level of Quantification	Replicability
Token	Low – Can be as small as a single project (e.g. Plymouth Seagrass token)	Moderate – Depends on the level of quantification and the indented tradability of the token	Variable – Depends on the level of benefits sought by buyers. May not require quantification	High – Once the token system is created, it can be adapted to be reused by projects
Impact fund	Moderate/High – Requires scale to justify significant development and operating costs	Moderate/High – Simple structure if funds are non-repayable, but repayable capital will require a more complex structure	Variable – Depends on the funders' requirements	High – Can aggregate substantial capital from diverse sources
Direct payment	Moderate – Will likely require at least 1 large project to deliver material benefits to a payor and justify development costs	Moderate – Depends on the terms of the contract, but will likely require significant negotiation with payor	Variable – Level of quantification would depend on the funders' requirements	Low – Negotiation of custom contracts will likely limit replicability opportunities
Sustainability-linked bond (Impact Bond)	High – Some scale required to interest potential funders and justify high transaction costs	High – May involve numerous investors and significant structuring considerations	High – Requires strong science-based quantification and attribution for projects funded	Low – Custom outcome-based structure limits replicability potential

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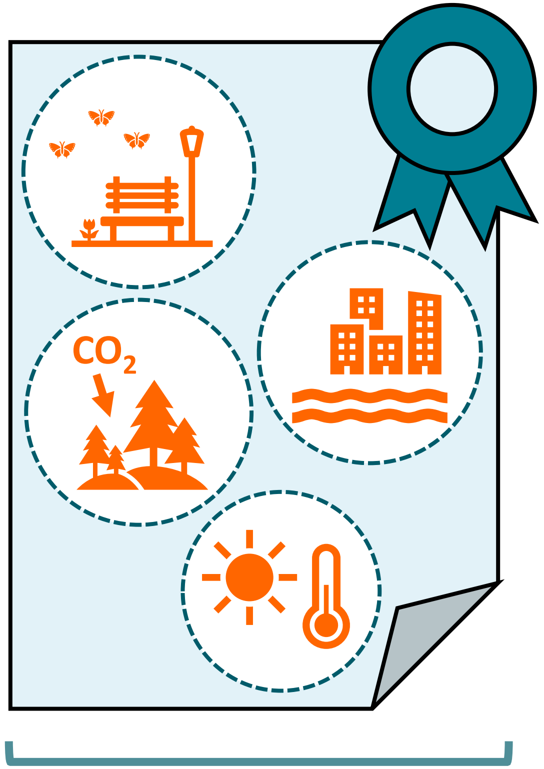
Token delivery mechanism

Tokens can be used as a standalone delivery model representing project ES that could be purchased by local stakeholders (businesses and individuals).

Benefits represented:

- Carbon sequestration
- Biodiversity
- Water quality services
- Climate regulation



One 'Urban Tree Token'

- Create a sellable certificate representing one street tree or one sqm of green space, along with the associated ES
- Buyers can purchase tokens to support action in their local area and pre-fund tree maintenance
- Value of the token could be linked to maintenance costs (e.g. 'sponsor a tree' model)
- Project partners will need to clearly agree target outputs, tokenisation methodology and division of ES

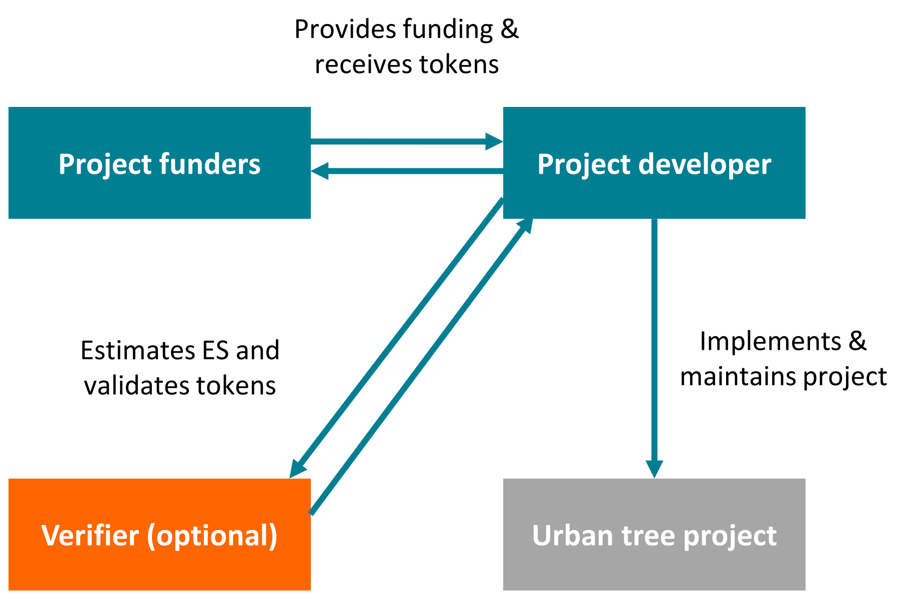
Pros and cons of tokens

A token of ES that is being delivered by a GI project could be promoted and sold by a local authority directly.

Pros
▲ Less reliant on precise ES attribution
▲ Can cater for a broader buyer base (incl. individuals)
▲ Cheaper option to implement (especially when no verification or accreditation is sought) since limited monitoring requirements reduce costs
▲ Local authorities could partner with an organisation to develop a token model and progressively improve quantification.

Cons
▼ Demand would be CSR driven initially, which could limit scale
▼ Many competing token models, especially where ES are qualitative and verification requirements are minimal.[1]

Possible token model structure



[1] For example, this model is similar to sponsorship models such as those implemented by Trees for Cities: https://www.treesforcities.org/our-work/trees-for-streets

Developing token models for GI

Tokens initially representing qualitative impacts could be transitioned to a PES model over time, depending on the degree of quantification and market infrastructure available.

One-off grant-based funding for a project

Sale of *Qualitative* 'bundle' of ES

Sale of fully verified *quantified* credits for ES

1 Traditional grant/local authority driven model

2 Sale of a *qualitative* token

To be sold as a *qualitative* bundle of benefits such as carbon sequestration, biodiversity, water quality benefits, social benefits.

CO_2

3 Sale of *quantified* but *unverified* token

Benefits are quantified using standardised methodology but are not subject to a formal verification process.

4 Sale of a *verified* token under a code

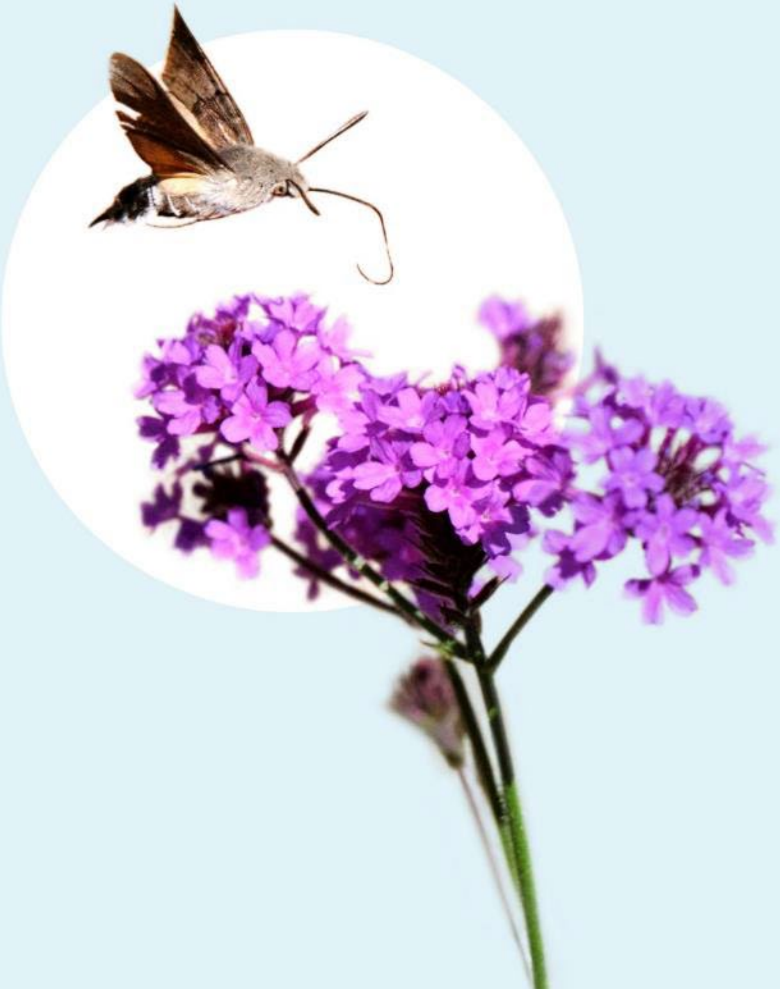
Sale of credits independently verified under standardised methodologies.

Conclusions

Quantifying the ES provided by urban GI projects is the key to developing PES models that private funders will be interested in.

- When working outside of existing ESM, this quantification process can be complex. **Intermediary steps may be needed to transition from traditional intervention-based models to PES models**, and the level of verification required may differ from funder to funder.
- Several **tools exist that can help local authorities quantify ES** provided by urban GI. **These ES can be bundled together and sold** to different groups of payors based on their interests and preferences.
- Stakeholder engagement with potential payors suggests that **there is support for quantification of ES** within this group. This **engagement also highlighted heat mitigation, flood risk mitigation and health benefits as key ES** valued by payors.
- **Given the small scale of many urban GI projects, limited applicability of existing nature markets and less standardised quantification methodologies, a token model could be used as an intermediary step towards a more advanced delivery mechanism**. Since tokens can be sold on a non-quantified or quantified basis, they are a good mechanism for transitioning toward PES models.
- To support the development of urban GI projects**, local authorities should look to quantify ES for projects and develop strategies for engaging with potential funders that educate investors** in the wider quantifiable benefits of GI.

Appendices



Appendix I: Glossary

- **Attenuation** – The process of holding and slowly releasing water into a sewer system or body of water, limiting the risk of flooding.
- **Benefit districts** – Areas within cities where additional taxes are paid by residents to fund improvements within that area.
- **Bundling:** Multiple ES from a single project are brought together and sold to a single buyer**.**
- **Corporate social responsibility (CSR):** A self-regulating business model that helps a company be socially accountable to itself, its stakeholders and the public.
- **Ecosystem services (ES):** The direct and indirect contributions ecosystems (known as natural capital) provide for human well-being and quality of life.
- **Ecosystem service market (ESM)** – A transparent system for purchase and sale of ES through payments made to service providers. These markets are usually underpinned by a code that sets standards for ecosystem service quantification and minimum project requirements.
- **General obligation (GO) bond** – A type of municipal bond backed by the taxation powers of a municipality rather than revenues from a specific project.
- **Green infrastructure (GI):** A network of multi-functional green and blue spaces and other natural features, urban and rural, which is capable of delivering a wide range of environmental, economic, health and well-being benefits for nature, climate, local and wider communities and prosperity.
- **Nature-based solutions (NBS)** – The use of natural features and process to tackle socio-environmental issues.
- **Payment for ecosystem services (PES):** The name given to arrangements through which the beneficiaries of environmental services reward those whose lands provide these services with subsidies or market payments.
- **Stacking:** The provision of multiple ES on the same land, sold to different buyers under different contract arrangements.
- **Sustainable drainage systems (SuDS)** – Drainage solutions that provide alternatives to traditional pipe networks by holding and slowly releasing rainwater through natural processes.
- **Tax increment financing** – A public financing method where investment in an area is repaid with future property taxes from that area.
- **Urban heat island** – Areas within cities that are warmer than surrounding rural areas due to lack of vegetation and the prevalence of dark, paved surfaces.

Appendix II: Case studies

City Forest Credits in Austin

Location	Austin, USA
Type of NBS funded	Urban forests & green corridors
Income streams	Multi-benefit token
Key outcome payers	Private individuals & corporations

Challenge: The city of Austin sought to increase tree plantings in the city to reduce carbon emissions and support a long-term water resource plan for the city.

Initiative: The city chose to fund this initiative by issuing Carbon + Credits through City Forest Credits. The project involved a combination of individual tree plantings, larger tree canopy projects, and the development of riparian buffers along rivers to intercept rainfall. Credits were valued based on carbon sequestration as well as avoided costs tied to rainfall interception, air quality improvements, and avoided heating and cooling costs. Avoided costs were estimated at $4,287/year once the trees reach age 25.

Outcome: The project was implemented as planned, with 1,250 trees planted in the city. All credits issued to date have been sold.

Appendix II: Case studies

Plymouth Seagrass Token

Location	Plymouth, UK
Type of NBS funded	Seagrass Restoration
Income streams	Payments for tokens
Key outcome payers	Businesses and individuals

Challenge: The city of Plymouth is interested in financing a 4-hectare seagrass restoration site near Jennycliff, which will improve biodiversity, sequester carbon and improve water quality. However, existing ESM are not a good fit for the project, limiting the financing options available.

Initiative: Funded by NEIRF, Finance Earth and Plymouth City Council set out to identify how benefits from seagrass habitats could be monetised to support restoration. The project identified the sale of unverified seagrass tokens as a way to fund seagrass restoration at Jennycliff with limited upfront costs.

In the short term, the project team expected to designate the seagrass token as donative with benefits ‘recognised’ rather than sold. Costs to deliver restoration, protection and monitoring of the site were estimated at £729k, which would be divided into 444 tokens with unique IDs using what3words.

The project team envisaged that the seagrass token work will create opportunities to collect further scientific data around seagrass ES and build evidence for the protection and policy needs of UK seagrass habitat.

Outcome: The project remains early-stage and has not yet been delivered, though initial payor engagement suggested support for the seagrass token structure.

Appendix II: Case studies

Plymouth SuDS NEIRF Project

Location	Plymouth, UK
Type of NBS funded	SuDS
Income streams	Payments for outcomes
Key outcome payers	South West Water

Challenge: Modelling undertaken by South West Water (SWW) indicated that 59% of surface water needs to be disconnected from the sewerage system in Plymouth to comply with legal commitments under the Environment Act 2021, to reduce discharges from the 58 combined sewer overflows (CSOs) in Plymouth. Traditionally, these issues have been addressed through the deployment of 'grey' infrastructure solutions. SuDS present an alternative solution.

Initiative: A pipeline of approximately 400 SuDS interventions – which could be deployed in two neighborhoods of Plymouth to meet surface water separation requirements was identified. Based on indicative cost estimates, SuDS presented a more cost-effective solution compared to "grey" infrastructure.

Outcome: Given the relatively unproven nature of SuDS, an Environmental Impact Bond was proposed to SWW to finance these interventions, allowing SWW to share a level of performance risk with the investor(s). The level of outcome payment required from SWW would be dependent on the performance of the interventions in reducing the frequency and duration of CSO spills. A decision has yet to be made.

Appendix II: Case studies

DC Water Environmental Impact Bond

Location	Washington DC, USA
Type of NBS funded	SuDS
Income streams	Payments for outcomes
Key outcome payers	Water utility company

Challenge: Washington DC's sewer authority, DC Water, was interested in implementing SuDS to reduce runoff, but was concerned with the performance risk of SuDS compared to traditional sewage infrastructure.

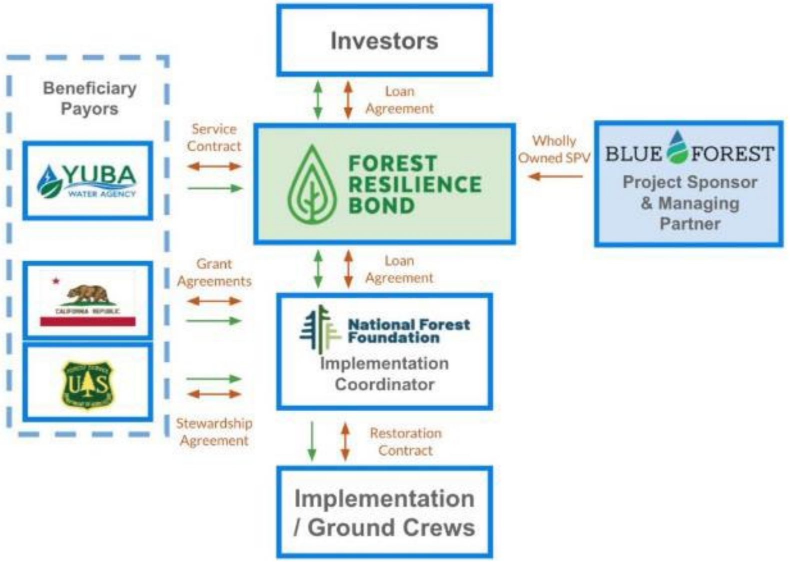
Initiative: DC Water structured the $25 million Environmental Impact Bond so that performance risk was shared with investors via three distinct outcome scenarios. The bond had a fixed interest rate of 3.43%, with DC Water required to make an additional $3.3m payment to investors if runoff reduction exceeded expectations. If runoff reduction was below expectations, investors were required to make a $3.3m payment to DC Water. Runoff reduction was calculated by an independent verifier over 5 years.

Outcome: Runoff reduction from SuDS met expected estimates, verifying the effectiveness of the intervention. The bond was repaid in 2021. Similar models are being considered in the UK (e.g. Plymouth SuDS NEIRF project).

Appendix II: Case studies

Forest Resilience Bond in California

Location	**California, USA**
Type of NBS funded	**Forest Restoration**
Income streams	**Payments for outcomes**
Key outcome payers	**Government agencies, state and local governments, water and electric utilities**



Challenge: Wildfires are increasingly common in California due to climate change, resulting economic damage and decreased water quality. However, public authorities and private landowners lack the capital necessary to implement forest restoration measures that reduce the risk of wildfires.

Initiative: WRI, along with several other groups, launched a $4 million Forest Resilience Bond as part of a public-private partnership. Private capital provided by the bond will be used for forest restoration activities such as forest thinning, to increase tree growth and reduce fire risk, as well as biodiversity improvements through meadow restoration. These actions will result in fire suppression and water quality benefits, with beneficiaries making payments to repay the bond based on these outcomes.

Outcome: Restoration work began in 2019 and a second $25m bond with a similar structure was launched in 2021.

Appendix II: Case studies

Green Benefit Districts in San Francisco

Location	San Francisco, USA
Type of NBS funded	Street trees & pocket parks
Income streams	Property taxes
Key outcome payers	Private individuals & property developers

Challenge: City spending in San Francisco neighbourhoods was insufficient to add and maintain green spaces desired by residents.

Initiative: The city of San Francisco introduced a new Green Benefit District (GBD) to help residents support local green spaces. Property owners in individual neighbourhoods can vote to establish a GBD where property taxes are increased to provide additional services such as street trees, sidewalk gardens, and park improvements. These additional taxes must be used within the GBD and must be used to augment baseline city services rather than replace them.

Outcome: Dogpatch & New Potrero Hill established the first GBD in 2015, which is ongoing and covers 1,403 properties. Several other neighbourhoods are in the process of evaluating support and viability for implementing GBDs.

Appendix II: Case studies

Miami Forever Bond

Location	Miami, USA
Type of NBS funded	Urban forests, SuDS, pocket parks
Income streams	Property tax
Key outcome payers	Local government

Challenge: The city of Miami sought to fund public parks and improve climate resilience without directly raising taxes.

Initiative: The city of Miami issued a $400 million general obligation bond that is backed by the credit and taxing power of the city. Rather than increase taxes, property taxes currently collected by the city were earmarked for the bond. Funding was allocated to projects in five categories: Sea-Level Rise and Flood Prevention, Roadways, Parks and Cultural Facilities, Public Safety, and Affordable Housing. Of the amount raised, $78 million was allocated to parks and cultural facilities, with the goal of renovating existing parks, restoring capital assets and reducing runoff.

Outcome: The bond was approved by voters in 2017 and 57 parks received funding from the first tranche of the bond.

Appendix III: Sustainable Urban Drainage Systems (SuDS)

SuDS are nature-based water management solutions that seek to reduce flood risk by capturing and storing rainwater.

- Paved urban areas have low surface permeability, increasing the risk of flash flooding during heavy rain. SuDS hold water and slowly release it over time, reduce this risk.
- SuDS also improve water quality by reducing pollutants entering bodies of water via runoff.
- SuDS can be integrated into other NBSs such as street trees and pocket parks, making them ideal for urban areas where space is limited.
- While SuDS are generally cost effective compared to piped drainage, high retrofit costs and difficulties engaging water utilities can limit their usage.
- Additionally, local authorities are reliant on local flood authorities and often lack the in-house capabilities to implement SuDS on their own.

SuDS Examples

Rain gardens

Swales

SuDS-focused Tree Pits

Retention Ponds

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Enabling investment into conservation, climate and communities.

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