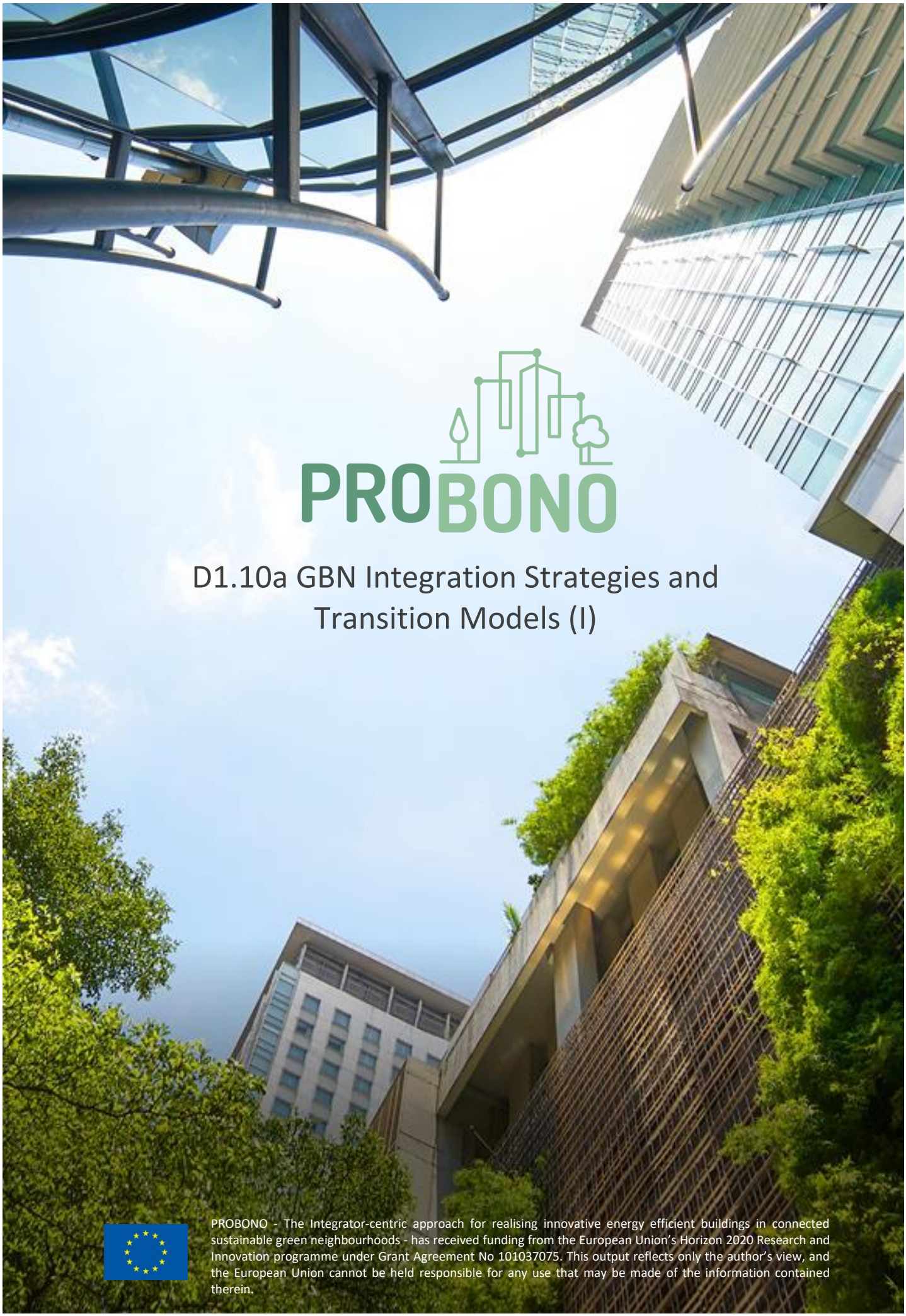

PROBONO

D1.10a GBN Integration Strategies and Transition Models (I)

PROBONO - The Integrator-centric approach for realising innovative energy efficient buildings in connected sustainable green neighbourhoods - has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 101037075. This output reflects only the author's view, and the European Union cannot be held responsible for any use that may be made of the information contained therein.

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Author:	**SERCO – Laurence Marzell;** **AU – Aliakbar Kamari;** **TUC – Nikos Kampelis;** **RES – Martin Capitaine;** **SIN – Sidsel Bruun;** **MM – Luc Jonveaux**

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Contributors:

Partner	Contributor
SERCO	Laurence Marzell
RES	Martin Capitaine; Sissa Bekombo Priso; Nicolas Ziv
SIN	Sidsel Bruun
TUC	Nikolaos Kampelis
MM	Luc Jonveaux
AU	Aliakbar Kamari

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GBC Croatia	Ivan Fratric

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DEFINITIONS[1]

A Green Building (GB) (new or retrofit) is a building that, in its whole life cycle; design, construction and operation, reduces or eliminates negative impacts, and can create positive impacts, on climate, health, social, and natural environment. GBs preserve precious natural resources and improve quality of life[2]. Specifically, this means that GBs should be very energy efficient, use extensively the potential of locally available renewable energy sources, use sustainable materials, and aim for a low environmental and health impacts over the entire life cycle. GBs offer their users and residents a healthy climate and a high quality of life, they are resilient e.g., to environmental change and contribute to social inclusion.

Green Neighbourhood aligned with the European Green Deal[3], is a set of buildings over a delimited area, at a scale that is smaller than a district, with potential synergies, in particular in the area of energy. A green neighborhood is a neighborhood that allows for environmentally friendly, sustainable patterns and behaviours to flourish e.g., bioclimatic architecture, renewable energy, soft and zero-emission mobility etc. Green neighbourhoods are the building blocks of Positive Energy Districts (PEDs)[4] by implementing key elements of PED energy systems. For example, the energy production and exchange of energy between buildings increases the share of local self-supply with climate-neutral energy and system efficiency. They also provide the technical conditions to enable Citizen Energy Communities[5] and Renewable Energy Communities[6] to be implemented.

Green Buildings and Neighborhoods (GBN) in PROBONO are GBs integrated at delimited area or district level with green energy and green mobility management and appropriate infrastructure supported by policies, investments and stakeholders' engagement and behaviours that ensures just transition that maximize the environmental, economic and social co-benefits considering a district profile (population size, socio-economic structure, and geographical and climate characteristics). Delivered in the right way, GBN infrastructure is a key enabler of inclusive growth, can improve the accessibility of housing and amenities, reduce poverty and inequality, widen access to jobs and education, make communities more resilient to climate change, and promote public health and wellbeing.

[1] Please refer to the last submitted reports for the latest status of the definitions

[2] https://www.worldgbc.org/what-green-building

[3] European_Green_Deal_EN_200710_fin

[4] SET-Plan Action 3.2: https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf

[5] Internal Electricity Market Directive (EU) 2019/944 5 Renewable Energy Directive (EU)

[6] Renewable Energy Directive (EU) 2018/20012018/2001

DGNB certification serves as a quality stamp ensuring the state of the building for investors. The Green Building Council Denmark (2010) established the German certification DGNB System meaning 'German Society for Sustainable Buildings'. The Danish version of DGNB was created to obtain a common definition of what sustainability is and making it measurable. A consortium of experts was established from all parts of the construction sector. DGNB had to be reshaped for the Danish standards, practice, traditions, and laws but is now available to certify any construction project. They chose DGNB as an innovation-forward and sustainable future guarantee. DGNB diversifies itself by focusing on whole life cycle in terms of sustainability of buildings and not just the environmental impacts. DGNB creates a standardised framework for the construction operations conditions and creates a common language for buildings sustainability assessment which facilitates communication between professions and helps organize and prioritize the efforts in long and complicated development phases.

Life cycle assessment (LCA)[7] is a methodology used for the systematic quantitative assessment of materials used, energy flows and environmental impacts of products or processes throughout their life cycle. LCA assesses various aspects associated with development of a product and its potential impact throughout a product's life (i.e., cradle to grave) from raw material acquisition, processing, manufacturing, use and finally its disposal. In PROBONO, LCA represents the statement of a building's total energy, resource consumption and environmental impact in the manufacture, transport, and replacement of materials and for its operation over its expected life. Social life cycle assessment (S-LCA)[8] is a method to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle. Life-cycle costing (LCC)[9] considers all the costs incurred during the lifetime of the product, work, or service.

[7] https://op.europa.eu/en/publication-detail/-/publication/16cd2d1d-2216-11e8-ac73-01aa75ed71a1/language-en

[8] https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca/

[9] https://ec.europa.eu/environment/gpp/lcc.htm

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Abbreviations and Acronyms

Acronym	Description
BIM	Building Information Model
CEC	Citizen Energy Community
DGNB	German Sustainable Building Council
DSS	Decision Support Tools
DT	Digital Twin
EU	European Union
GB	Green Building
GBN	Green Building Neighbourhood
GBNC	Green Building Neighbourhood Committee
IOT	Internet of Things
IT	Information Technology
JTF	Just Transition Fund
KG	Knowledge Graphs
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LL	Living Lab
PED	Positive Energy District
RACI	Responsible, Accountable, Consulted and Informed
REC	Renewable Energy Community
WP	Work Package
WPL	Work Package Leader

Executive summary

This document covers the concepts, practices and procedures of WP1 within the remit of T1.5, needed to both create or sustain a functioning GBN (Green Buildings and Neighbourhoods).

The series of D 1.10 reports (I, II, and FINAL), will be intrinsically linked to the Living Labs by the recently established GBNC (Green Buildings and Neighbourhoods Committee), to provide the findings to successfully implement a GBN for interested stakeholders.

This first report focuses on defining and explaining what GBNs are, how they are made and the relevant stakeholders. All essential in understanding and implementing integration and transition of neighbourhoods to become a GBN. It does not at this stage analyse single task results but instead, provides the basis for an understanding of the findings from T1.5 and sub-tasks at this month 12 stage; along with the relationships and patterns that exist between them.

All organisations and entities need multiple capabilities and functions to operate. A GBN is no different. This report emphasises the understanding and management of these capabilities and functions, namely: *Governance, People, Process, Technology, Information* and *Infrastructure* which must operate and interact together. This report breaks down exactly what a GBN is, how it works, and how to define it cohesively. Thus, this (M12) report provides the basis for future deliverables, to maintain familiarity with the concepts for readers throughout all deliverables.

This D1.10 (i) report covers other WPs which support implementation of GBNs. This includes from the Living Labs and the data and understanding to create a GBN. Key Performance and Sustainability Indicators, Life Cycle Assessment, and Circularity Gap Analysis all of which provide the essential metrics for GBN integration and transition. The Digital Twin, social and behavioural understanding and assessment, the Internet of Things, Knowledge Communities and Graphs, RACI analysis, and Citizen and Renewable Energy Communities are covered. This D1.10 (i) straddles not only WP1 but also interaction between WPs1, 2, 3, 5, 6, 7 and WP9.

This report finds that to implement a GBN Target Model, the integration and transition plans must be contextualised to the maturity of different factors of: *Governance, People, Process, Technology, Information* and *Infrastructure.* These are covered in the main body but of these, the most critical if not necessarily the most obvious, is that of *People* and the maturity of understanding and knowledge vested in the many varied and different stakeholders involved. Without a shared and common consensus and buy-in, gaining traction to plan and implement a GBN becomes extremely difficult when different views, expectations and approaches often conflict.

1. Introduction

The aim of this report is to set out the basis for the research and innovation activities in *Task 1.5* entitled *GBN Integration Strategies, to manage and sustain GBN Transitions* in the scope of interconnected tasks and work packages within PROBONO. The Task objective sets out that:

> GBNs are part of a larger, dynamic system of systems. Across the building lifecycle, co-ordination of the many different stakeholders, suppliers and interested parties is vital. This Deliverable 1.10 for Task 1.5, specifies roles and tasks for this coordination and will develop clear strategic plans for the implementation of the LL Target Model GBNs. This includes decision support reference models for the LLs for use in new GBNs to implement PROBONO innovations.

To achieve this objective, this deliverable includes several Sub-tasks of T1.5 which address specific activities, namely: *GBN Stakeholder Models; GBN Integration Models & Transition Strategies; Commissioning, Procurement and Financing the Transition towards GBNs.* These are covered in greater detail in Section 2.4.

1.1 Mapping PROBONO Outputs

Purpose of this section is to map PROBONO's GA commitments, both within the formal Deliverable and Task description, against the project's respective outputs and work performed.

GA Component Title	GA Component Outline	Respective Document Chapter(s)	Justification
TASKS			
T1.5 GBN Integration Strategies, to manage and sustain GBN Transitions [M1-M48]	GBNs are part of a larger, dynamic system of systems. Across the building lifecycle, co-ordination of the many different stakeholders, suppliers and interested parties is vital. This task specifies roles and tasks for this coordination and develops clear strategic plans for the implementation of the LL Target Model GBNs. This includes decision support reference models for the LLs for use in new GBNs to implement PROBONO innovations.		

T1.5 GBN Integration Strategies, to manage and sustain GBN Transitions [M1-M48]	**ST1.5.1 GBN Prototypical Stakeholder Models.** Through the use of a Responsible, Accountable, Consulted, and Informed (RACI) Matrix, this subtask will define the different roles, responsibilities, constraints, and accountabilities of each GBN actor against the activities within each building lifecycle stage. This will define prototypical roles, in addition to a more detailed definition of the GBN integrator role and its application in different scenarios, based upon those developed in T1.1.3. These roles will be characterised by a set of Personas, supported by the real-life experience of stakeholders elicited in WP2; and delivered as an output to support future implementations**.**	Sections 2 & 3	A preliminary background study to the entirety of T1.5 and its Sub-tasks 1.5.1, 1.5.2 and 1.5.3 setting out the background, context and provisional thinking that supports the entirety of the task as well as the specific focus on stakeholders for this first of 3 D1.10 reports. Showing the overall relationship of this task and sub-tasks to both the Probono project overall as well as the role and positioning of T1.5 within WP1. The entirety of the content in this report will be matured and expanded within the next deliverable**.**
T1.5 GBN Integration Strategies, to manage and sustain GBN Transitions [M1-M48]	**ST1.5.2 GBN Integration Models & Transition Strategies.** Define Integration models and transition strategies in the Target Models for specific GBN Scenarios, using Enterprise Architecture. These models will capture how WP2 -WP5 innovations will be handled to meet stakeholder requirements and achieve project goals. Areas for consideration aside from building renovation or construction, includes IT Management, Mobility, Asset and Facilities Management, Building Use and Behaviours, Sustainable Procurement, and the Circular Economy. Different strategies for migration to and embedding the Target Models will be considered; plus, mapping expected challenges or enablers.	Sections 2 & 3	A preliminary background study to the entirety of T1.5 and its Sub-tasks 1.5.1, 1.5.2 and 1.5.3 setting out the background, context and provisional thinking that supports the entirety of the task as well as the specific focus on stakeholders for this first of 3 D1.10 reports. Showing the overall relationship of this task and sub-tasks to both the Probono project overall as well as the role and positioning of T1.5 within WP1. The entirety of the content in this report will be matured and expanded within the next deliverable.
T1.5 GBN Integration Strategies, to manage and sustain GBN Transitions [M1-M48]	**ST1.5.3 Commissioning, procurement and financing the transition towards GBNs.** Enable the transition of green buildings and GBNs in the PROBONO LLs, by determining how the different components are financed, commissioned, and procured, considering, for example public/private partnerships, public procurement, and other types of green financial and investment levers. This will build on the outputs from ST 1.2.2 to elicit both new and existing methods, models and governance frameworks that support the economic viability of GBNs. Consider in consultation with stakeholders, Taxonomy Regulation, ESG, Insurance, Carbon Credits, Green Taxes, Transition Finance, and other forms of sustainable financial levers, especially in the context of the latest EU disclosures. The outputs will directly feed into implementing and operationalising the LLs.	Sections 2 & 3	A preliminary background study to the entirety of T1.5 and its Sub-tasks 1.5.1, 1.5.2 and 1.5.3 setting out the background, context and provisional thinking that supports the entirety of the task as well as the specific focus on stakeholders for this first of 3 D1.10 reports. Showing the overall relationship of this task and sub-tasks to both the Probono project overall as well as the role and positioning of T1.5 within WP1. The entirety of the content in this report will be matured and expanded within the next deliverable**.**
DELIVERABLE			
D1.10: GBN Integration Strategies and Transition Models (I) [SERCO] [A=M12] A) Stakeholder Model with integrator role definition.			

Table 1: Adherence to PROBONO's GA Deliverable & Tasks Descriptions

1.2 Deliverable Overview and Report Structure

This and all of the D1.10 reports, contain a reprise of the Probono project overall, as well as of WP1 and the Green Buildings & Neighbourhoods. This is to ensure a persistent reference point for the reader. PROBONO T1.5 includes three deliverables as follows:

D1.10: GBN Integration Strategies and Transition Models (I) [A=M12] A) Stakeholder Model with integrator role definition;

D1.11: GBN Integration Strategies and Transition Models (II) [B=M24; C=M36] B) 1st Draft of Integration Models; **C)** Final draft prior to implementation, including commissioning and procurement models

D1.12: GBN Integration Strategies and Transition Models (FINAL) [D=M48] D) Validated Models including Persona's.

Each deliverable has a focus on a very specific aspect of GBN development, as seen by the report titles. Each however, will set that specific focus in the context of the overall Whole System Approach to planning, developing and implementing a GBN and the transition and integration strategies and approaches employed. This maintains a cohesive and coherent narrative for users across the entire set of deliverables as they undertake their GBN journey.

This D1.10 report, *GBN Integration Strategies and Transition Models (I)* whilst providing the focus of Stakeholder Model with integrator role definition, sets the narrative for how it sits with the role and need for the GBN Integration Strategies and Transition Models as part of the wider WP1 Framework lifecycle. The *WP1 Framework Lifecycle* and the positioning for this set of D1.10 reports, are seen in Figure 1.

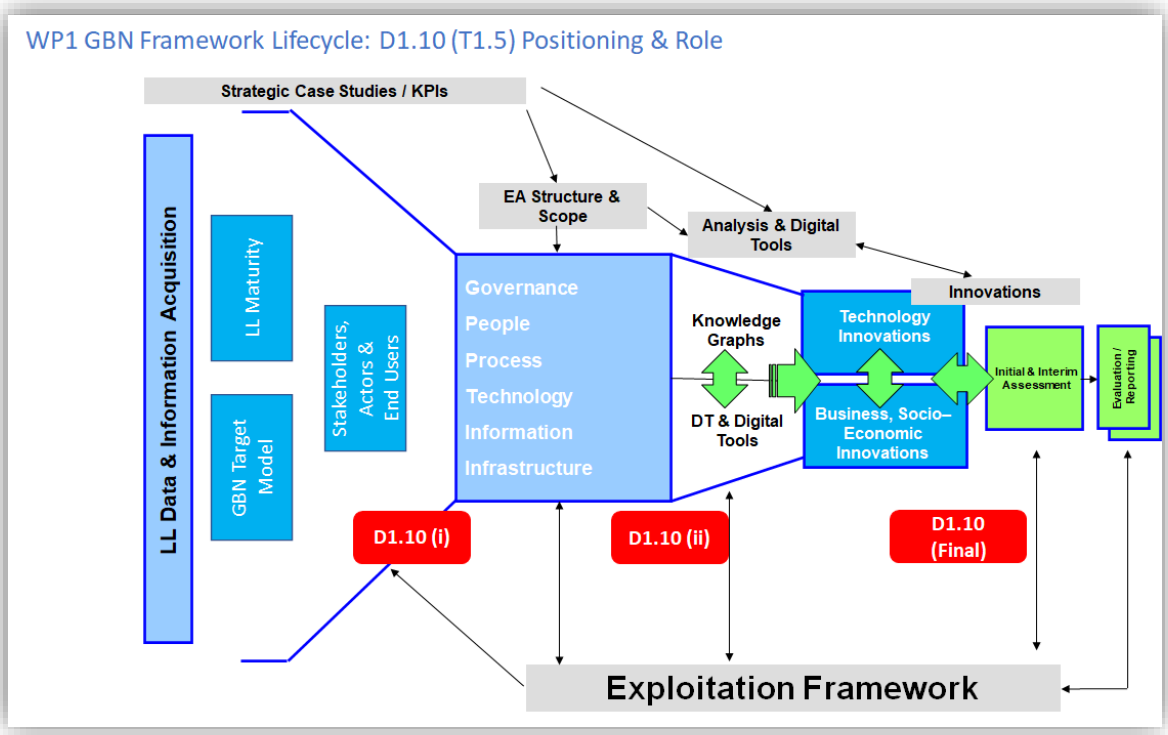

Figure 1: WP1 Framework Lifecycle - D1.10 Positioning

1.2.1 Linking T1.5 / D1.10 reports to the Living Labs

The LLs are specifically focussed on implementing and testing their chosen technology innovations to meet the Probono impacts and objectives, within their 'pre-Probono' renovation development plans. The integration strategies and transition models that are the scope of this series of three D1.10 reports, are, as expected, unsynchronised with the timings of the technology testing and implementation within the LLs. The usefulness in supporting a LL understand how their technology innovations support the journey of integration and transition towards a GBN, in advance of their testing and implementation within the LL, are thus, naturally restricted.

In addition, with the renovation plans of the LLs already in an advanced state prior to the Probono project start, the ability of LLs to meaningfully adopt the findings from these and other deliverables focussed on GBN development, is also limited. Thus, linking T1.5 and the series of

D1.10 reports to the LLs is one of retrospective analysis. Whereby concepts and assumptions outlined here, whilst based upon known and gathered LL requirements, are iteratively tested and refined with the LLs during the course of the project and LL development. Creating a 'Lessons Identified Lessons Learnt' basis for LL end users and stakeholders, to build an evidence-based manual for future GBN development. One of the mechanisms to be used for this, is through the use of the Knowledge Graphs, being designed in WP 3.

To achieve this, the GBNC – *Green Building Neighbourhood Committee* has been formed within Probono, functioning horizontally across project WPs, to ensure GBN focussed outputs and deliverables align with and support the 'Lessons Identified Lessons Learnt' approach for future GBN development. The GBNC will also, as part of the inter-project collaboration, create synergies with the variety of other H2020 projects funded by the EC under the Green Deal, to share outcomes, exchange findings and align GBN related outputs such as definitions and vision.

To achieve this, coordination between the GBNC and these projects will take place primarily through the Green Deal Projects Support Office[10]. To support the realisation of the European Green Deal, the European Commission has funded 73 research and innovation projects that will contribute to accelerating a just and sustainable transition to a climate-neutral Europe by 2050.

The Green Deal Projects Support Office was established to support the projects funded under the Green Deal Call and to help facilitate collaboration, share best practice and increase their impact. These 73 projects can be seen here.

[10] Green Deal Projects Support Office | Research and Innovation (europa.eu)

1.3 PROBONO – vision [GA – Grant agreement]

The PROBONO vision is a people-focused European construction industry working in harmony with the broader community of stakeholders including public authorities and citizens to deliver *scalable*, *sustainable*, and *viable energy positive* and *zero-carbon* ***Green Buildings and Neighbourhoods (GBN)***. PROBONO will contribute to this vision by providing five *GBN Transition Acceleration Enablers* seen in Figure 2, deployed in six high impact and people-focused real-life large-scale Living Labs (LLs) (leveraging existing projects and/or approved renovation plans). LL outputs will be feeding into a transferability and innovation replication framework that will enhance the transition capabilities of local communities.

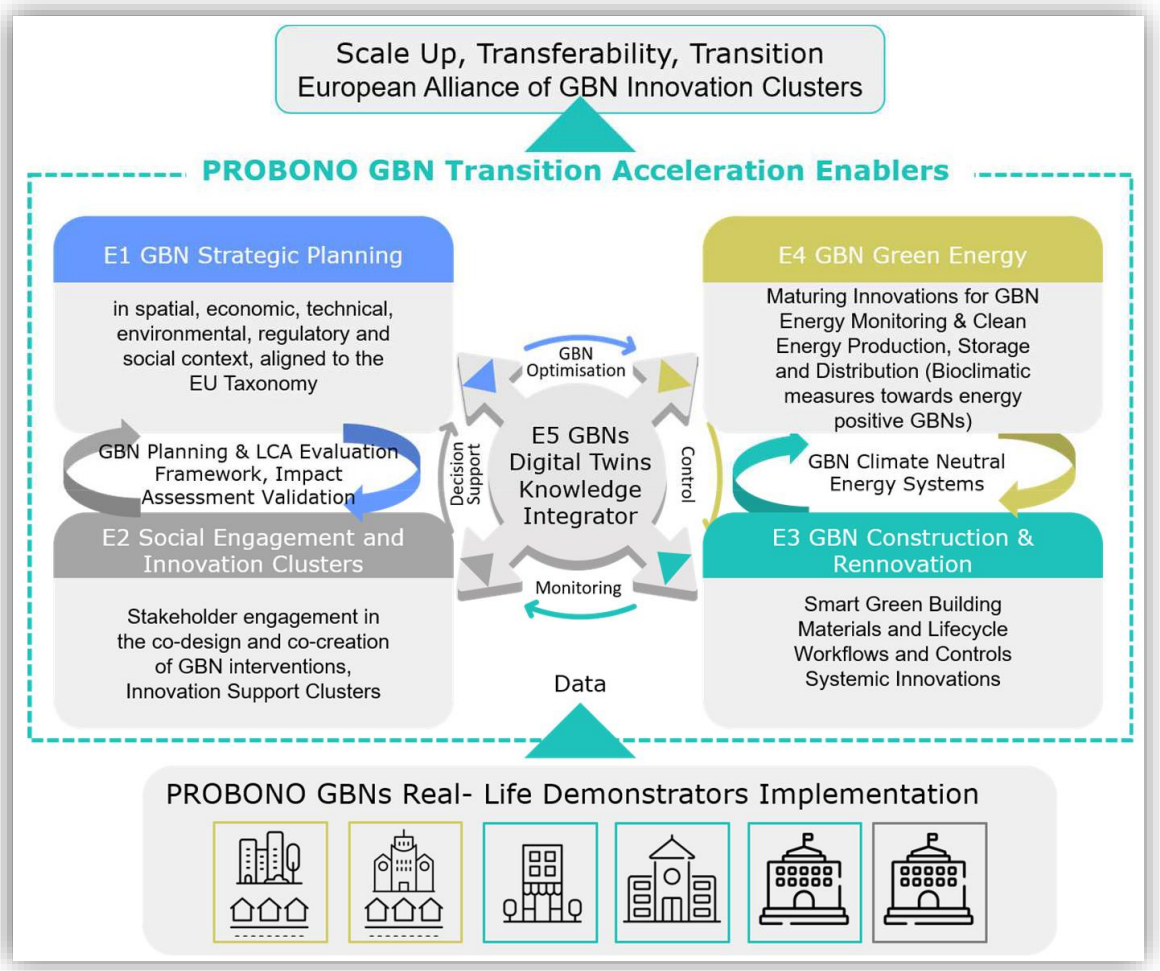

Figure 2: GBN Transition Acceleration Enablers

1.4 PROBONO WP1 [GA – Grant agreement, and SERCO]

From the grant agreement, PROBONO WP1 is named "Macro-Knowledge Base and GBN Framework". It has the following five objectives:

1. Provide value-oriented analysis tools and decision support system enabling GBN Stakeholders to:
    a. Specify value-adding sustainability perspectives, drivers, and concerns to these GBN Strategic Planning themes: (a) architectural transformation, (b) human health and comfort, (c) green construction management and productivity, d) management, function, sustainment, and operation of building and users.
    b. Use advanced data-driven tools for rapid GBN scenario generation and evaluation of multiple KPIs e.g., Energy Consumption, Indoor Thermal Comfort, Air Quality, Investment, etc.
2. Provide tools assisting the GBN initiators in producing a *GBN Strategic Vision and KPIs Formalisation*.
3. Provide data-driven tools (DGNB) for rapid GBN scenario generation and evaluation.
4. Scope the transition roadmap(s) from the Target Model(s) detailing the current maturity for each Living Lab, from which innovation testing and evaluation within the *Digital Twin(s)* can be executed, prior to physical testing and use.
5. Define the GBN Integration Strategies, to manage and sustain GBN Transitions aligning to *Governance, People, Process, Technology, Information* and *Infrastructure* needs of a connected Europe, society, and environment.

The aim of WP1, executed through the 6 Probono LLs and the creation of the strategic case studies, is to identify and understand the common characteristics that underpin the creation of the GBNs in multiple different settings and contexts. Setting the conditions for an achievable GBN vision, or Target Model. Then, through a set of tools and methodologies developed, tested and evaluated across the project, demonstrate how the construction and renovation of Green Buildings (GBs) and their implementation of technical, building, and business and socio-economic innovations within our LLs, can be a catalyst to drive forward the GBN vision. The overall structure of the WP1 “Macro-Knowledge Base and GBN Framework” in context to the overall Probono project and other work packages, is seen in Figure 3. In terms of operational outputs for WP1, these can be seen through the GBN Framework Lifecycle in Figure 4.

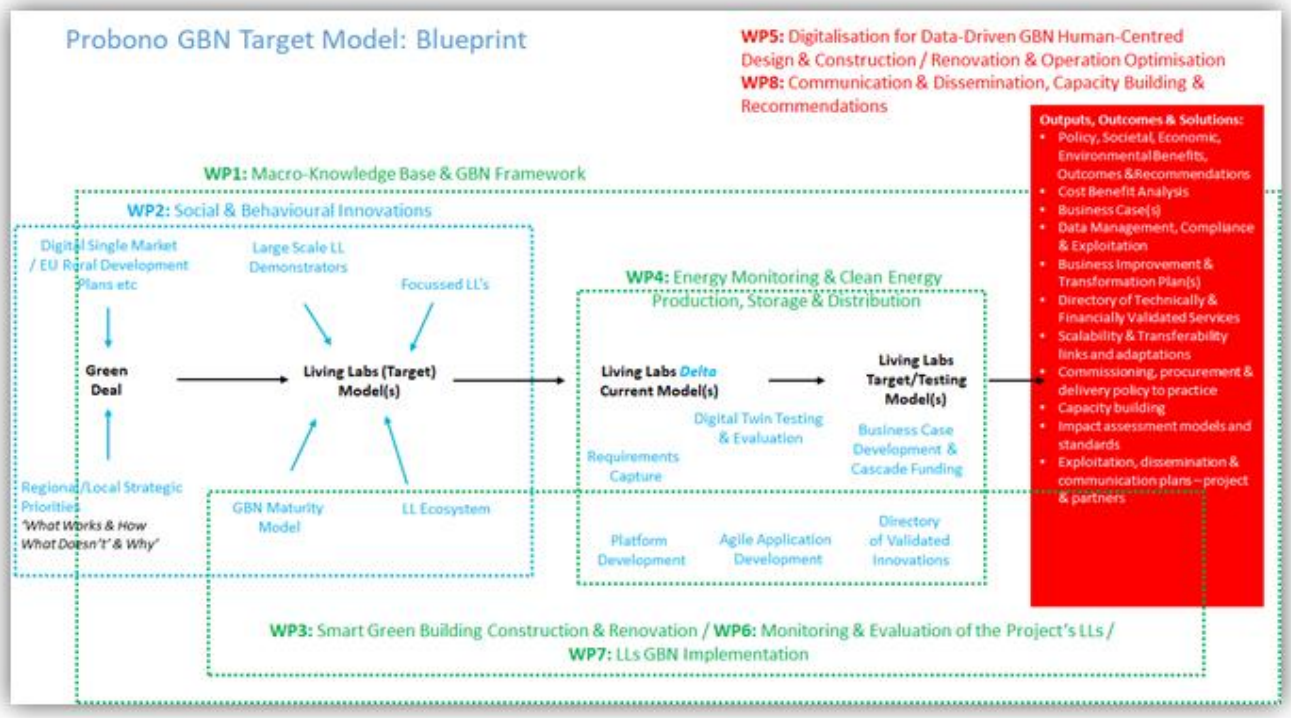

Figure 3: WP1 Macro-Knowledge Base & GBN Framework

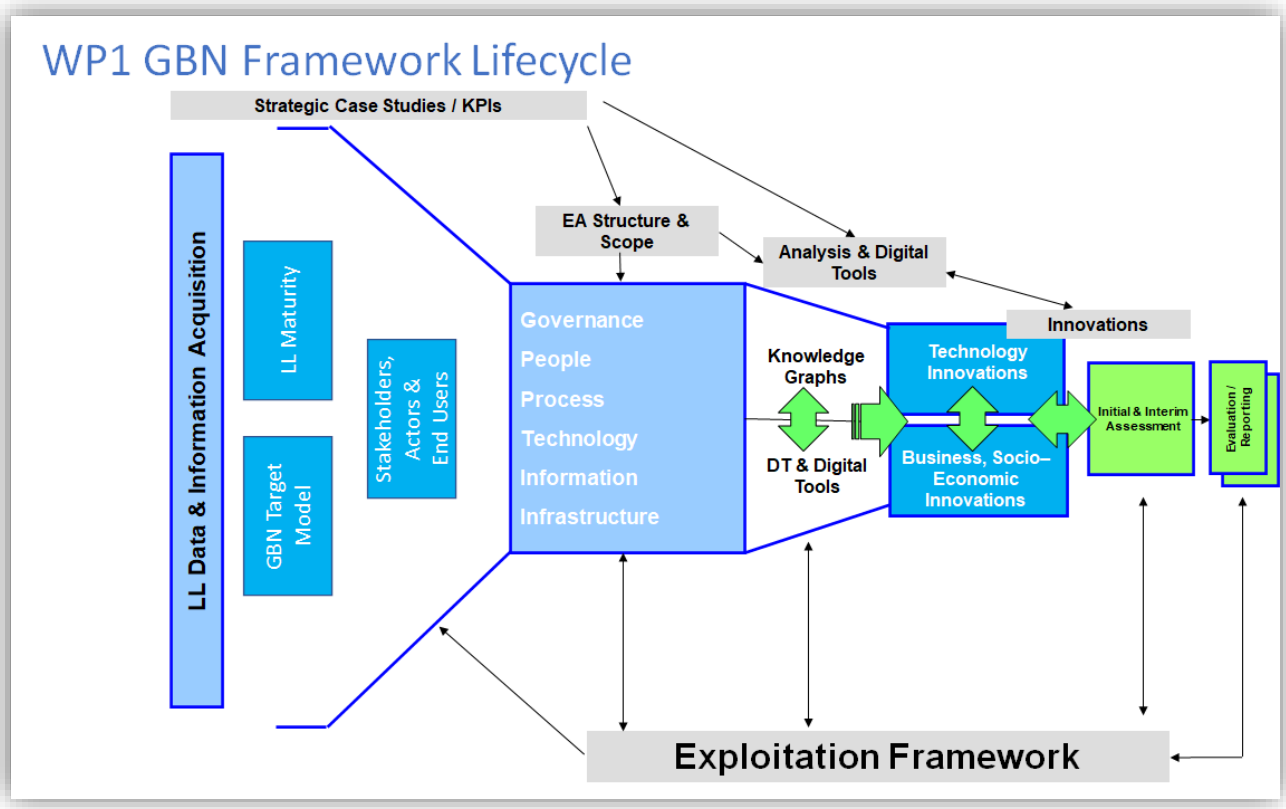

Figure 4: WP1 GBN Framework Lifecycle

1.5 PROBONO T.1.5 [GA – Grant agreement]

This section describes Task 1.5, which this series of three D1.10 reports relate to, within the wider WP1 *"Macro-Knowledge Base and GBN Framework"*.

Within both WP1 and the wider project, T1.5 is a pivotal task. It provides the understanding and basis for how GBNs are understood, planned and implemented, either as brand-new projects or, into existing developments, through the mechanism of GBN *Integration Strategies and Transition Models*.

GBNs are part of a larger, dynamic system of systems. An ecosystem that embraces the *Natural, Physical, Technical* and *Social* aspects that combine together to underpin a GBN. Across the building lifecycle, then the far lengthier GBN lifecycle, co-ordination of the many different stakeholders, suppliers and interested parties is vital. It is however a significant challenge. This D1.10 deliverable, relating to the results and outputs from Task 1.5, specifies roles and tasks for this coordination and develops clear strategic plans for the implementation of the LL GBN *Target Model*. This includes decision support reference models for the LLs for use in new and transitioning GBNs, to implement PROBONO innovations.

Through the use of a *Responsible, Accountable, Consulted*, and *Informed* (RACI) Matrix, subtask 1.5.1 GBN *Prototypical Stakeholder Models* will define the different roles, responsibilities, constraints, and accountabilities of each GBN actor and stakeholder against the activities within each building and GBN lifecycle stage. This will define prototypical roles, in addition to a more detailed definition of the GBN integrator role, the accompanying and complementary GBN Mediator role, and their application in different scenarios, based upon those developed in T1.1.3. These roles will be characterised by a set of Personas[11], supported by the real-life experience of stakeholders elicited in WP2; and delivered as an output to support future implementations**.**

The definition of *Integration Strategies and Transition Models* sits within the Sub-Task 1.5.2 in the *Target Models for specific GBN Scenarios*, using *Enterprise Architecture*[12]. These models will capture how WP2 -WP5 innovations will be handled to meet stakeholder requirements and

[11] Personas | Usability.gov The purpose of personas is to create reliable and realistic representations of your key audience segments for reference.

[12] Enterprise architecture (pwc.co.uk) Enterprise Architecture (EA) aims at optimising legacy or fragmented processes, information and technology into an integrated environment that facilitates easy decision making and change implementation.

achieve project goals. Areas for consideration aside from building renovation or construction, includes IT Management, Mobility, Asset and Facilities Management, Building Use and Behaviours, Sustainable Procurement, and the Circular Economy. Different strategies for migration to and embedding the Target Models will be considered; plus, mapping expected challenges or enablers.

The Commissioning, procurement and financing of the transition towards GBNs is accounted for in Sub-task 1.5.2. This seeks to enable the transition of green buildings and GBNs in the PROBONO LLs. This is by determining how the different components are financed, commissioned, and procured, considering, for example public/private partnerships, public procurement, and other types of green financial and investment levers. This will build on the outputs from Sub-task 1.2.2 to elicit both new and existing methods, models and governance frameworks that support the economic viability of GBNs. Considered in consultation with stakeholders will be the aspects of ESG, Insurance, Carbon Credits, Green Taxes, Green Loans, Transition Finance, and other forms of sustainable financial levers, especially in the context of the latest EU disclosures and the Taxonomy Regulation[13]. The outputs will directly feed into implementing and operationalising the LLs.

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852

2 Green Building Neighbourhoods (GBNs)

This chapter provides a background and overview to Green Building Neighbourhoods (GBNs), the main focus of the PROBONO project. It elaborates upon the deconstruction of the T1.5 objective, set out in section 2.3 including key aspects and elements, for example the GBN vision and definition, the stakeholders involved, the sustainability challenges and opportunities and the transition and integration to GBNs. It highlights the role that varying different levels of maturity have on all of these aspects. This provides a prerequisite for the development of GBNs and the application of next generation (realistic) analysis tools and decision support systems that facilitate GBN development and uptake.

2.1 GBN definitions

As described further in section 2.3, GBNs are still very much conceptual. It is the aim of the Probono project to bring this concept to operational reality. Definitions for what a GBN is do exist, but these need to be matured, simplified, tested and adapted as our project progresses. It is needed to make the GBN concept easier to understand and by greater numbers of people, especially general population; thus, facilitating a greater awareness of GBNs, and the opportunity for exploitation and commercial uptake of the outputs and findings from Probono. We have developed a simplified, citizen-centric working definition of a GBN, now in use on the Probono website. This is:

As society becomes increasingly urban and ever dependent on technological innovations, it is vital to ensure that people and planet are put at the very heart of this development in a way that is sensitive to and encourages the protection, expansion or re-introduction of sustainable space amongst the urban sprawl.

This is the aim of the Probono project. Probono has an initial focus on renovating existing urban buildings and locations in a resource and energy efficient way. Applying technology, business and socio-economic innovations to stimulate a transition to nett-zero and energy positive buildings, leading to a better understanding of how these sustainable renovations can be a catalyst to create a wider, more sustainable Green Building Neighbourhood and thus, thriving and sustainable community.

Probono will show how a people-centred, green and sustainable approach to renovation, however small, can stimulate sustainable neighbourhoods and the well-being of communities. Sustaining both nature and humanity in natural balance to our mutual benefit and shared future.

Underpinning this external and simplified citizen definition of a GBN, sit original definitions from the EC Green Deal and from the initial Probono proposal. These are followed by a significantly enhanced definition, essential for integration and transition, seen in the following Section 3.

2.1.1 GBN definition according to EU

Under the European Green Deal call H2020-LC-GD-2020 (topic LC-GD-4-1-2020), "green neighbourhood" is defined as follows:

> *"The term 'neighbourhood' refers to a set of buildings over a delimited area, at a scale that is smaller than the one of a district, with potential synergies, in particular in the area of energy. A 'green neighbourhood' is a neighbourhood that allows for environmentally friendly, sustainable patterns and behaviours to flourish (e.g. soft and zero-emission mobility, renewable energy, bioclimatic architecture, etc.)"* [14]

From this base definition, the initial Probono proposal provided the following extended definition.

2.1.2 GBN definition in PROBONO project proposal

GBNs in PROBONO are Green Buildings (GBs) integrated at delimited[15] area or district level with green energy and green mobility management and appropriate infrastructure. They are supported by policies, investments and stakeholders' engagement and behaviours that ensures just transition[16] that maximise the economic and social co-benefits considering a district profile (population size, socio-economic structure, and geographical and climate characteristics). Delivered in the right way, GBN infrastructure is a key enabler of inclusive growth, can improve

[14] source: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/faq/14273

[15] Having fixed boundaries or limits.

[16] The Just Transition Mechanism: making sure no one is left behind | European Commission (europa.eu)Just Transition is a key tool to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind.

the accessibility of housing and amenities, reduce poverty and inequality, widen access to jobs and education, make communities more resilient to climate change, and promote public health and wellbeing. A valuable visual aid to this description can be seen in Figure 5 from the Probono proposal. Here, the Business & Socio-Economic cluster formed by the Brussels, Aarhus/Prague and Sonae (Porto) LLs, provides a useful working image of the high-level components that feed into and will make-up the construct of a GBN.

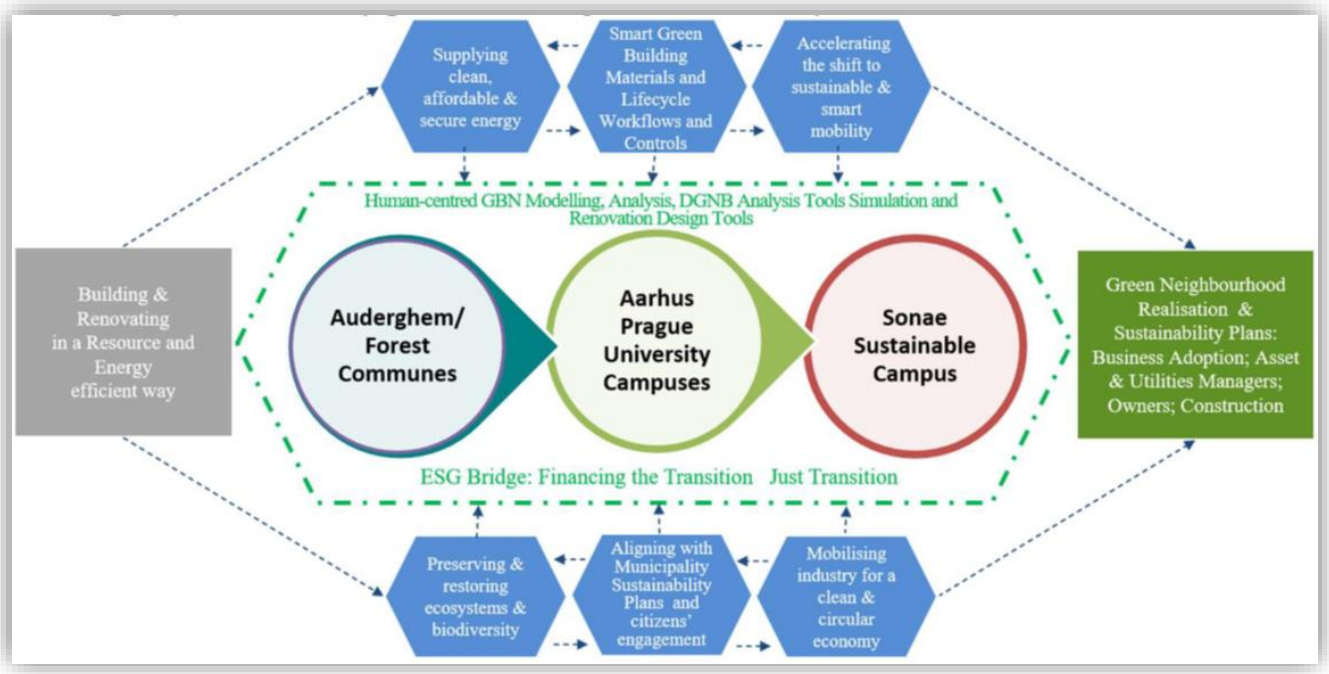

Figure 5: Business & Socio-Economic LL Cluster

This description and image however, can only give a high-level guide to set the conditions for how GBNs should work in practice. On the ground, the principal determining factors of what makes a GBN are highly specific to location; to the context within which they sit, and; to a range of factors exerting influence both upon and within that location. These factors are highly interconnected and interdependent and address attributes which provide the foundations upon which any single, or multiple set of organisations or conurbations function; namely, the attributes of: *Governance; People; Process; Technology; Information;* and *Infrastructure.*

3 The GBN vision, related indicators and Context for Integration and Transition

In support of the previous descriptions of a GBN, it is important to understand what is actually meant by the use of the word green when used in the context of green strategies or *'being green'*. Used colloquially, this is the idea of implementing solutions which actually benefit the natural world, ensuring little or no damage by human technology to the natural habitats within which we coexist (and more often than not, clash).

To do this, one of the most valuable, forward thinking and strategic ways of promoting GBNs, green buildings, urban ecosystems and ecologies within them, is to work in line, in harmony with the natural world as opposed to against it; which unintentionally, refers to much of how modern society has developed so far. Therefore, the definition of green can be expanded and embraced by PROBONO for this project and for the GBNs, to not only mean solutions which mitigate damage to the natural world through reduced energy use, resource extraction and decarbonisation but also, to those which have a net positive impact on it. Operating in line with the patterns and interconnections seen in natural ecosystems to create both the concept and reality on the ground, of urban ecosystems or urban ecologies, set within the construct of a GBN. Thus, avoiding or mitigating the clash between humans and nature not only through minimising the impact on the natural world through reduction in energy and materials as they move toward zero carbon but also, because the GBNs operate along the same lines and are synergistic with the natural environment, adapted to the built environment.

In adopting the term urban ecosystem to better describe the functioning of a GBN, it is important also to understand what actually is an ecosystem?

As originally termed in biology, an ecosystem[17] is the interconnected food web between all parts of the natural world in a discreet differentiable territory such as a savannah, grassland, or wooded area.

[17] Ecosystem | National Geographic Society

3.1 Urban Ecosystems

However, in modern built environments it isn't relevant to apply these models directly to urban environments; yet little alternatives exist. Leading to a socially constructed barrier in the human psyche between the built and natural environments beyond the simple use of the natural world for energy resources.

By applying the term *'urban ecosystems'* to the desired *Target Model* for a GBN, we recognise the built environment requires different modelling to the natural world, but nevertheless, as a complex adaptive system, it can be thought of in a similar way. A way in which all of the attributes upon which modern society is built, described earlier as *Governance, People, Process, Technology, Information* and *Infrastructure* are interdependent and interface with each other, as does an ecosystem within the natural world.

And using *'urban ecosystem'*, accompanied by a clear description recognises both conceptually and in practice, that human activity and our built environment needs to work in line with the natural world, over and above that of energy, material and carbon reduction; thus, removing or mitigating the clash between humans and nature to the benefit of both. The development and renovations of green buildings in our LLs is a catalyst for this change. Fostering an understanding towards the real value of *urban ecosystems* and a stimulus for GBN creation through which PROBONO can alter perception and drive real change.

The many parts of natural ecosystems evolve over time, organically and in harmony with each other. Recognizing this isn't possible for our GBN *urban ecosystems*, which are themselves complex adaptive systems, means that we need to adopt an approach that provides deep understanding of how a GBN *urban ecosystem* functions and the benefits they provide as we grow, scale and transfer them through our transition roadmaps and exploitation strategy. Each of our LLs is centred on a clearly identified and specific development project(s), which is likely to be the case elsewhere as Probono's outputs achieve uptake.

3.1.1 Borders and Boundaries

Enabled through the identification and use of a series of different borders and boundaries, used to describe the extent of the GBN 'urban ecosystem', the focus of any one or multiple areas of activity described by the PROBONO scenarios and strategic case studies, is accommodated. Enabling modelling and understanding of the different pathways of resources, activities energy and information flows which interact with each other within and across the borders and

boundaries in all directions. These can be physical – geographical, technical or informational as well as abstract such as social and relational to directly show the interactions, interfaces and interdependencies between the differing components.

These constitute the 5 underlying components of a GBN and would be described through the scenarios and use cases, with the extent to which the GBN *urban ecosystem* is determined, being through a set of ecosystem boundaries, each based on need, context and defined measures.

These ecosystem boundaries would include, but are not limited to: a Risk Boundary; Resilience Boundary; Legislative Boundary; Operational Boundary; Jurisdictional Boundary; Social Boundary and Shared Interests Boundary. As seen in Figure 6 the *WP1 GBN Framework Lifecycle*, these boundaries interface with and overlap the GBN *Enterprise Architecture Structure & Scope* of: *Governance, People, Process, Technology, Information* and *Infrastructure*.

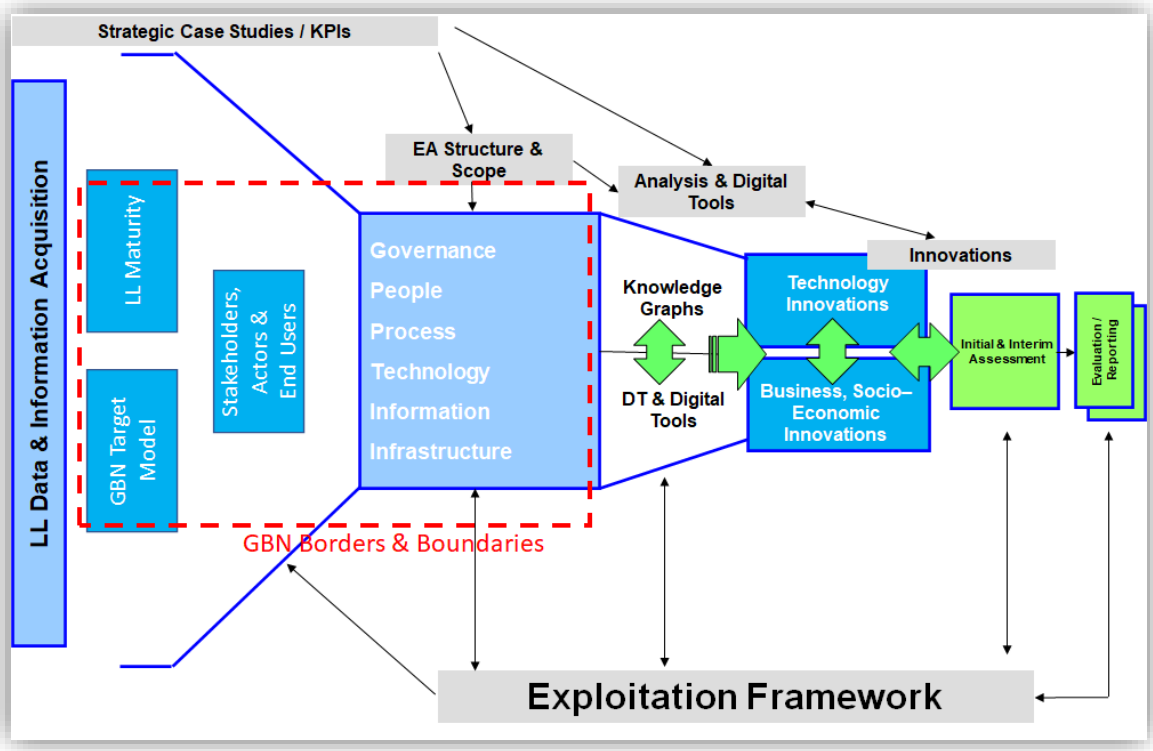

Figure 6: GBN Borders & Boundaries

3.1.2 Foundations of the GBN Vision (Target Model)

The developed strategic case studies for each LL, can be deconstructed - broken down, to produce a comprehensive understanding of how a GBN and its *urban ecosystem* will actually work in practice.

From such an understanding, comes the ability to determine the level of maturity of the many aspects that make up a desired GBN location. Taking into consideration a variety of different contexts, or development projects that the location has, or is considering. From this, an *integration strategy and transition model* for how a location can transition to a GBN urban ecosystem can occur. This is actioned through the various PROBONO tools and methodologies developed in the WPs and executed in our LLs; these would be determined against the variable

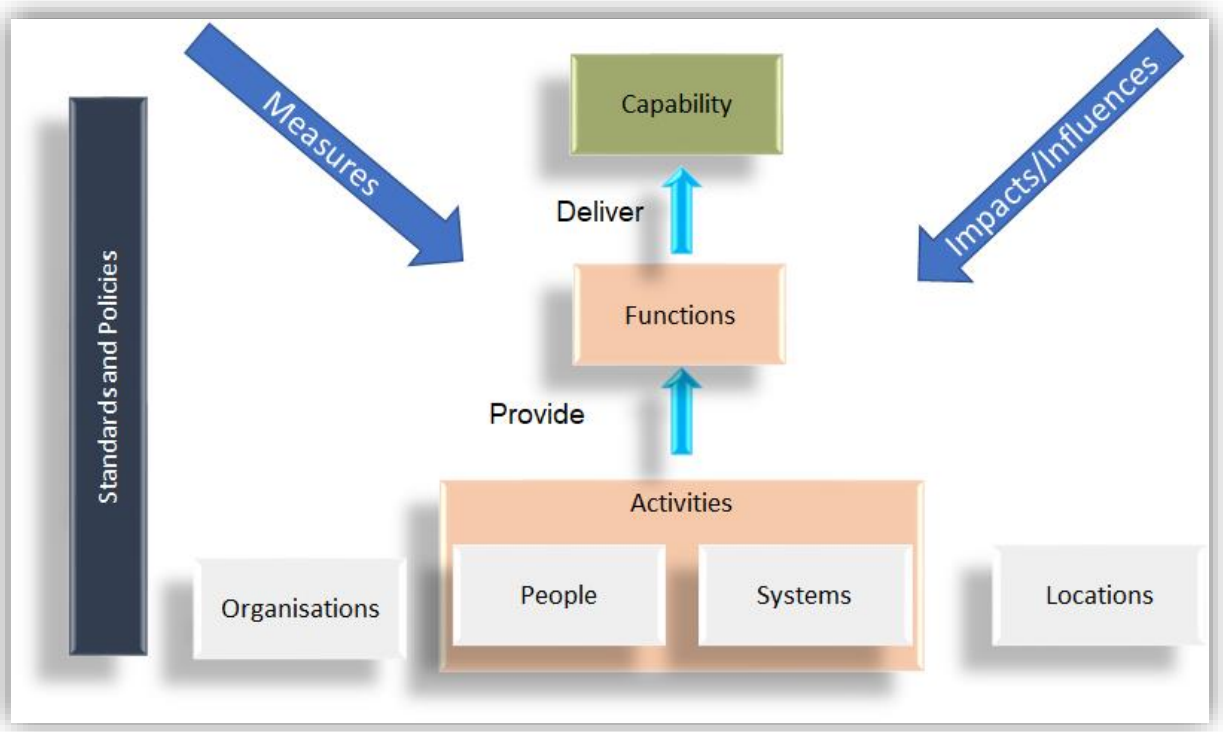

Figure 7: Base Enterprise Architecture for WP1 GBN Macro-Knowledge-Base

indicators and measures adapted to that location and its specific context. Together, these form the basic constituent parts of the overarching *GBN Framework*. The simplified, base Enterprise Architecture structure that underpins the *WP1 GBN Macro-Knowledge Base* and thus, the Task 1.5 outputs, can be seen in Figure 7.

Data and information acquisition from the LLs is the key starting point that feeds all other activities and tasks in PROBONO.

The extent and variety of data and information required to achieve a GBN *urban ecosystem* is significant in both volume and complexity. Having it properly structured from start to finish to reflect the needs of end users and decision makers to support GBN transition is vital. To achieve this, and importantly support adaptability and transferability for the PROBONO outputs under its exploitation activities, the *WP1 Framework* and associated methodologies adopt the

manageable and logical stages seen in Figure 8. The *GBN Capability Domains* at the top of the Figure 8 chart, being taken directly from the WP1 objectives, each being an intrinsic aspect of every Probono LL and of any subsequent GBN development.

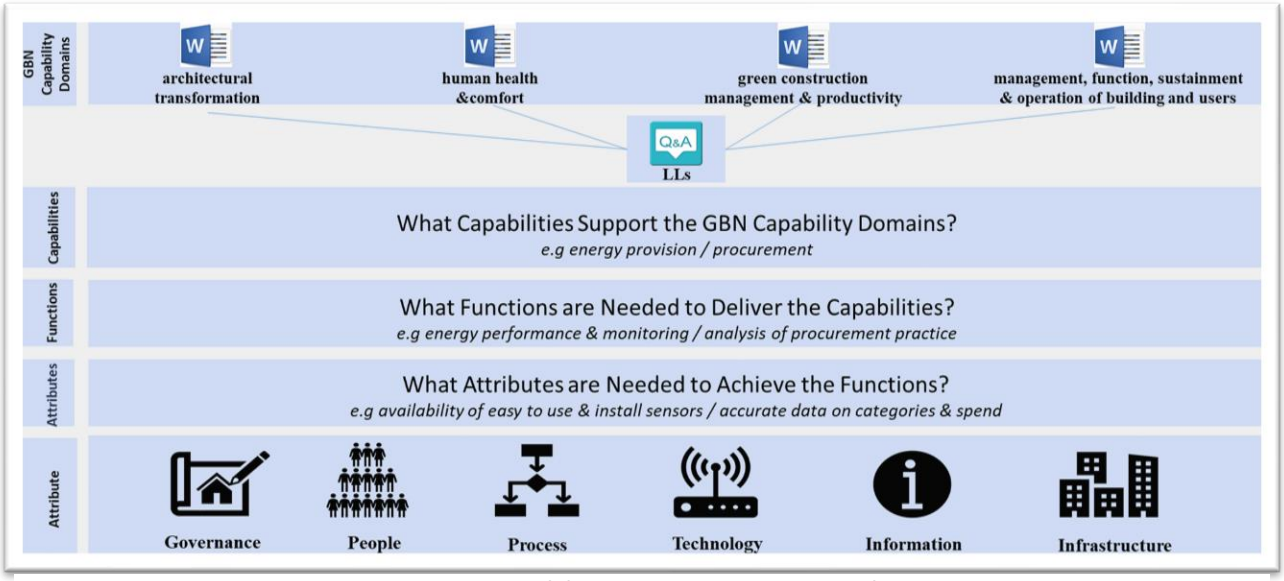

Figure 8: GBN Capability Domains, Functions & Attributes

3.1.3 Strategic Case Studies

To aid the acquisition of relevant and meaningful data and information, a range of strategic case studies, or scenarios, is created; articulating a narrative from which both technical and non-technical end users alike, can draw upon in their design of and transition towards a GBN *urban ecosystem* from whichever context or project they are approaching it. These starting points, sat within the borders and boundaries applied to describe the operating limits of the GBN *urban ecosystem*, are narrated through the strategic case studies. Aligned to these are Key Performance Indicators (KPIs)[18], across a range of measures both qualitative and quantitative – technical and social, from which goals and progress towards a GBN can be determined.

The strategic case studies, facilitating the narrative to drive the exploration towards a GBN, populate the structure and scope of the *GBN Framework*; the Enterprise Architecture being used in WP1 to build the *GBN Macro Knowledge Base*. This structure and scope as seen in Figure xx,

[18] What is a Key Performance Indicator (KPI)? - KPI.org

show how a comprehensive understanding is developed of how a GBN *urban ecosystem* will function in practice and how the attributes of *Governance, People, Process, Technology, Information* and *Infrastructure* work together to deliver the Integration and Transition to a GBN *urban ecosystem*.

3.1.4 GBN Indicators

Whilst a GBN as a concept still needs to be matured, as further described in section 2.3, so as to move it from concept to reality, many of the component parts that contribute towards a GBN *urban ecosystem* and how it is assessed and measured, do. We have mentioned previously in the opening definitions section of this D1.10 report, the use of DGNB as our baseline approach for the measurement of the GBNs. This is reprised below. Together with the various other complementary research projects and studies, sustainability initiatives, and existing and emerging standards, will provide a robust basis for understanding and measuring GBN success. Whilst not an exhaustive list, the following provides an excellent starting point for Probono to build upon, either through collaboration or analysis, as the project builds its maturity of understanding of GBN *urban ecosystems* and, the robustness of the *Integration Strategy and Transition Models* required to achieve them.

- DGNB[19] certification system serves as a quality stamp ensuring the sustainability performance of the building for buyers. The Green Building Council Denmark (2010) established the German certification system DGNB meaning 'German Society for Sustainable Buildings'. The Danish version of DGNB was created to obtain a common definition of what sustainability is towards and making it measurable. A consortium of experts was established from all parts of the construction sector. DGNB had to be reshaped for the Danish standards, practice, traditions, and laws but is now available to certify any construction project. They chose DGNB as an innovation-forward and sustainable future guarantee. DGNB diversifies itself by focusing on sustainability performance of buildings, their health impacts and not just the environment. DGNB creates a standardised framework for the construction operations conditions and creates a common language which facilitates communication between professions and helps organize and prioritize the efforts in long and complicated development phases

[19] DGNB – German Sustainable Building Council

- **ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life[20].** ISO 37120 provides cities with quantitative, globally comparable and independently verified local level data. Having standardized data enables any city, of any size, to measure and compare its social, economic, and environmental progress internally year over year, and also in relation to other peer cities locally and globally.
- **The United for Smart Sustainable Cities (U4SSC)[21]**. A global UN initiative coordinated by ITU, UNECE and UN-Habitat. U4SSC provides an international platform for information exchange and partnership building to guide cities and communities in achieving the UN Sustainable Development Goals.
- **mySMARTLife H2020 project**[22]. Transition of EU cities towards a new concept of Smart Life and Economy.
- **CITYKEYS Project[23]**. CITYKEYS will develop, and validate, a holistic performance measurement framework for future harmonized and transparent monitoring and comparability of the European cities' activities during the implementation of Smart City solutions.
- **Research Paper:** Selection of key performance indicators (KPIs) in the transition towards low-carbon urban communities[24].
- **The Circularity Gap Report 2022[25].** draws on five years of analysis to show the power of the circular economy to equitably fulfil our global needs and wants, with radically fewer materials and emissions.

[20] ISO - ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life

[21] United for Smart Sustainable Cities (U4SSC) – United for Smart Sustainable Cities (U4SSC) (itu.int)

[22] mySMARTLife - MySMARTLife

[23] Smart City performance measurement system | CITYKEYS Project | Fact Sheet | H2020 | CORDIS | European Commission (europa.eu)

[24] Result #1736308 - Selection of key performance indicators (KPIs) in the transition towards low-carbon urban communities - Cristin

[25] Circularity Gap Report 2022: five years of analysis by Circle Economy | European Circular Economy Stakeholder Platform (europa.eu)

Of the above cited indicators, of particular interest and value to Probono's objectives in developing GBNs, are that relating to the Circular Economy[26]; one of the key components that contribute to a GBN. Understanding the level and extent of circularity within the defined area for a GBN, is part of the crucial data needed for setting up a GBN, as well as for managing the communications and collaborations between various different GBNs, whether these are within the one Member State (MS) or, across national or international borders.

As stated previously, the GBN model is one which relies on data, such as that found within The Circularity Gap Report. This being just one part of the wider picture of data which can be used to ensure GBN set up and operation is efficient and sustainable. Providing real, on the ground metrics for what is and isn't working within a given GBN, as the exact contributors to circularity can also be monitored through in-depth research into aspects that a high circularity area, such as a country, does in comparison to a less circular economy.

Identifying, understanding and employing these type of data sets and indicators, a part of the WP6 objectives, is a core component in support of the GBN vision. A comparative analysis of sustainability certification systems, including that of DGNB, will be found in section 3 of the D1.5 report, the deliverable from T1.3.

3.1.5 Introduction to GBN transition [RESAL]

GBNs as part of sustainable building initiative, provide answers to the climate change challenge we are experiencing. Throughout previous years, we have seen the impacts of this phenomenon on our daily lives. Consequently, we have decided to act upon it by adapting to it.

In order to face the transition from a rather stable and known climate to a more intense and extreme one, we have to transition to a way of living from that we currently know, to one that is better fitting to these new circumstances. With GBNs including appropriate infrastructures, mobility policies, energy resources and consumption that can support the transition toward a more sustainable way of living, such a change impacts upon all of the various aspects of a community as presented in Figure 9.

As we transition, every aspect of the life of a community will also have to shift. But as the process is taking its course, the original purpose of community, should not be forgotten.

[26] Circular economy: definition, importance and benefits | News | European Parliament (europa.eu)

Like most industries, the building industry is mostly led by short termism and cost reduction. This doesn't always align with the objective of a GBN. However, in the face of recent years, we experienced higher temperatures, droughts, intense rainfalls, floods, landslide and more events, there is an emphasis to create living systems that are more resilient to these phenomena; and in so doing, create less CO2 emissions, consuming less energy through optimised use.

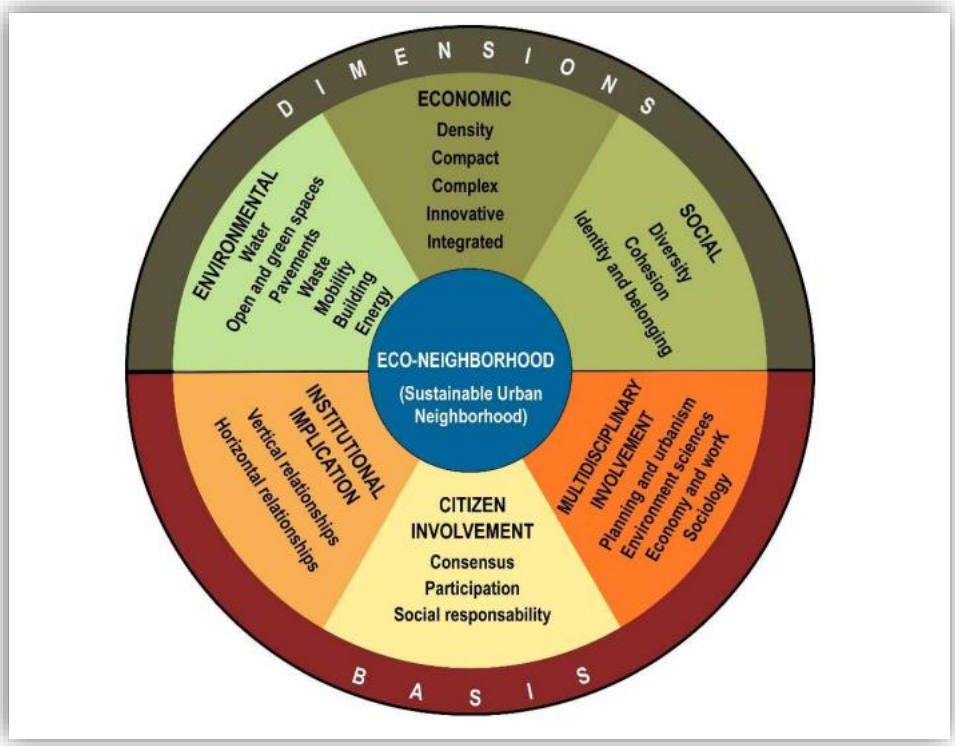

Figure 9: Aspects of an Eco-Neighbourhood

European Union Commissioner for Energy Kadri Simson[27] said:

> " Buildings are the single largest energy consumer in Europe, using 40% of our energy, and creating 36% of our greenhouse gas emissions. That is because most buildings in the EU are not energy efficient and are still mostly powered by fossil fuels. We need to do something about this urgently, as over 85% of today's buildings will still be standing in 2050, when Europe must be climate neutral. Improving our homes is also an effective response to high energy prices – the worst-performing buildings in the EU consume many times more energy as new or properly renovated ones. And it's often the most vulnerable who live in the least efficient houses and

[27] Kadri Simson | European Commission (europa.eu)

therefore struggle to pay the bills. Renovation reduces both the energy footprint of buildings and the energy costs for households, while also boosting economic activity and job creation."

At the scale of the European Union, the 2020 approved Green Deal[28] as shown in Figure 10, is a set of policies which aims at making the European Union climate neutral by 2050. With a 30 year long action window, the European Union plans on reducing the greenhouse gas emission by working on several action levers such as circular economy, building renovation, biodiversity, innovation and more.

Figure 10: The European Green Deal

[28] McPHIE Tim, CRESPO PARRONDO Ana, " European Green Deal : Commission proposes to boost renovation and decarbonization of buildings " , December 15th 2021, European-Comission – Press realease

In most cases, emissions reductions initiatives in the building and construction sector were focused on the buildings' operational phase, whereas in the Green Deal one of the key initiative is to achieve energy efficiency by renovating both public and private sector. The "Renovation Wave"[29] as it is presented on the Green Deal page of the European Commission website, stated the following objectives in order to enhance the quality of life for people living in it while creating additional jobs in the sector:

- Tackle energy poverty and worst-performing buildings
- Decarbonising heating and cooling systems
- Renovate public buildings and social infrastructures

Furthermore, the European Commission supports research and innovation in this sectors through different programmes such as :

- **The BUILD UP initiative**[30] which promotes knowledge sharing on energy-efficient building
- **The BUILD UP Skills initiative**[31] which emphasizes on the number of professionals across Europe specialized in high energy performance renovation
- **The 4RinEU project**[32] which presents innovative tools and strategies encouraging large scale innovation of existing buildings and also promotes the use of renewable energies

Several countries in Europe have also started to implement legal frameworks setting buildings codes and CO2 emissions. As examples [33] :

- **Netherlands** - CO2 limits for all new residential and non-residential buildings
- **Denmark** - introduced CO2 limits for all new buildings over 1 000 m²

[29] Renovation wave (europa.eu) Renovating both public and private buildings is an essential action, and has been singled out in the European Green Deal as a key initiative to drive energy efficiency in the sector and deliver on objectives.

[30] The EU BUILD UP initiative - briefing — EUbusiness.com | EU news, business and politics

[31] BUILD UP Skills - Strategies and training interventions enabling a decarbonised building stock (europa.eu)

[32] 4RinEU project | Renovation of Residential buildings in EU – Robust and Reliable technology concepts and business models for triggering deep Renovation of Residential buildings in EU.

[33] Ruther Broer, Jelena Simjanovic, Zsolt Toth, *Implementing the Paris Agreement and Reducing Greenhouse gas emissions throughout the life cycle of buildings : European Public Policies, Tools and Market initiatives*

- **France** - introduced CO2 limits for all new buildings
- **Finland and Sweden** - planning to introduce CO2 limits for all new buildings

When it comes to Green Buildings Neighbourhood itself, some countries in Europe have already started to experiment this transition. As mapped examples[34], there are among many :

- **BedZed in Sutton, United Kingdom**[35]. This 2002 neighbourhood was created with the objective of designing a housing complex which consumes zero fossil fuels during its life period by combining solar panels, triple-glazed windows and 50-centimetre-thick walls filled with natural insulating materials.
- **BO01 in Malmö,Sweden**[36] is a neighbourhood 100% powered by renewable energy sources and linked by a network of electric buses.
- **Zac de Bonne in Grenoble, France**[37] gathers low-consumptions buildings powered by solar thermal panels that are shared between social housing, a school, a nursery, a cinema and a shopping center.

As a result from those experimental implementations, multiple countries in Europe have individually created their label identifying sustainable neighborhood to promote those initiatives. For example, in France there is the “EcoQuartier” label, when Belgium works with the “Quartier Durable” label. Just as a brand name, these labels promote transition towards this new model of neighborhoods at the scale of the country they are implemented in.

As we move forward, it becomes clear that a synergy of information, knowledge, good practices and guidelines is mandatory to achieve this common goal. As for now we identified numerous innovative practices, methodologies, standards and certifications. Yet, a detailed and joint book

[34] Renault Group, Eco-neighbourhoods to discover in Europe, March 24th 2021, https://www.renaultgroup.com/en/news-on-air/news/6-eco-neighbourhoods-to-discover-in-europe/

[35] BedZED | Sutton | One Planet Living framework | sustainable development | Carbon Copy

[36] Bo01, Malmö, Sweden | Urban green-blue grids (urbangreenbluegrids.com)

[37] ZAC de Bonne (21stcenturydevelopment.org)

of standard policies stating which criteria to respect and performance to achieve must be consider to ease this transition and help channel the momentum in the fit direction.

Moreover, the topic of funding and therefore the implementation of the new standards and policies aligned with more sustainable buildings are also at the core of this transition. As an example, the Just Transition Fund (JTF)[38] is a tool to promote transition towards climate neutrality for the countries that are the most impacted by climate change. This fund was created under shared management and aims economic stability, jobs creation and protection but also the transformation of existing carbon-intensive facilities and a significant emission reduction.

Practically however, some tensions around the allocation of the JTF arose in the years following its creation, highlighting the complexity of the implementation of this transition at a large scale.

3.2 Integration and Transition: Context, Rationale and Use

In understanding the purpose of this deliverable and the task to which it relates, it is important to set out the Context, Rationale and Use for the outputs described in this first of three deliverables; and understand the objective that has been set in T1.5 and the reasoning for it.

To do so, deconstructing the objective into its principal parts provides an effective means of explanation. To reprise the objective:

> GBNs are part of a larger, dynamic system of systems. Across the building lifecycle, co-ordination of the many different stakeholders, suppliers and interested parties is vital. This Deliverable 1.10 for Task 1.5 specifies roles and tasks for this coordination and will develop clear strategic plans for the implementation of the LL Target Model GBNs. This includes decision support reference models for the LL's for use in new GBNs to implement PROBONO innovations.

Deconstruction focusses onto the following terms within the objective, which when described, provide the basis for a greater understanding for the Context, Rational and Use for this D1.10 and T1.5 outputs. Deconstructed terms are:

[38] Just Transition Fund | Fact Sheets on the European Union | European Parliament (europa.eu)

- Dynamic System of Systems
- Building Lifecycle
- Coordination of the many Stakeholders
- Roles & Tasks of Coordination
- Strategic Plans for the Implementation
- LL Target Model of GBNs
- Decision Support Reference Models
- Implement PROBONO Innovations

3.2.1 Dynamic System of Systems

This relates to the definition, structure and operation of a GBN. A dynamic System of Systems, can also be described as an *'urban ecosystem*'. Understanding and defining the extent of a GBN and the *'urban ecosystem'* to which it relates, provides a critical means to determine its value and benefit to the neighbourhood; as well as to the citizens and of course, to sustainability and the natural environment in which it sits. This understanding and definition is achieved through determining the various borders and boundaries within which it is contained. This also goes some considerable way to answering the often-raised question of "what is the system"?

These borders and boundaries, contribute to the dynamic nature of a GBN. They include: geographic, social, political, organisational, environmental and legislative boundaries which flex and adapt to the changing landscape with which they interact. All are dependent upon local context and need. This report sets out the both the extant of these borders and boundaries, how they interact with each other and thus, the evolving definitions of a GBN and *'urban ecosystem'* from which it results.

3.2.2 Building Lifecycle

The Building Lifecycle is an important factor in developing and transitioning to a GBN. Green Buildings form an integral part of a GBN, but as standalone entities, do not themselves make a GBN. Understanding the impact and effect they have in meeting both their specific and the wider GBN sustainability targets is a key measure. This would include from initial inception and design, through their construction and/or renovation phases, throughout their management, operation and use, and then on to eventual decommissioning, deconstruction and/or further renovation.

Understanding and mapping sustainability outcomes to this whole Building Lifecycle, as well as to the lifecycle of the GBN *'urban ecosystem*', is critical to all aspects of GBN development and transition.

3.2.3 Coordination of the many Stakeholders

GBNs as dynamic System of Systems or *'urban ecosystems'*, have a wide ranging and varied set of public, private, community and citizen stakeholders and actors across the entire lifecycle of GBN design, development and operation. This creates a complex and sometimes conflicting landscape of differing views, understanding, experiences and objectives which need careful and sensitive coordination and management if the core objectives for a GBN are to be achieved. Some stakeholders will be directly participating and benefiting from a GBN and thus, exerting

Significant levels of 'end user' influence upon the GBN development and the outcomes sought. Others, will be indirectly involved and their levels of influence dependent upon their roles and the interaction and influence with other stakeholders and the mechanisms by which GBNs can develop. Mapping and understanding these varying roles and influences is critical. As are the mechanisms and means throughs which stakeholders are engaged and how they are communicated with; specifically, how this engagement and communication is adapted to meet their differing levels of maturity in understanding what GBNs are and how they need to function.

3.2.4 Roles & Tasks of Coordination

Expert coordination of the many stakeholders and actors is critical. Within Probono, we have identified at proposal stage and seek to test and validate within the project, two influential roles that address this complexity of coordination. These are the *GBN Integrator* and *GBN Mediator*. The *Integrator* provides the business and technically focussed coordination role, working across and with the professional, business and official organisations and institutions involved in a GBN; the *Mediator*, providing the citizen centric focus, aligned to and reflecting the views and needs of the community, whom understandably, might exert a lesser influence through their lack of knowledge and resource.

3.2.5 Strategic Plans for the Implementation

Development and implementation of a GBN has to be considered in context to several factors. Many of these are determined by the understanding of the GBN System of Systems / *'urban ecosystem'* and the borders and boundaries from which it is made.

Of critical importance in determining implementation is GBN maturity; or rather, the maturity of the various constituent parts that could contribute and count toward an area being described as a GBN. This understanding of maturity has multiple aspects, not least, maturity of: *stakeholder knowledge and understanding*; *status of development planning*; *status of physical construction or renovation*; *technological advancement and desire*; *current and future sustainability plans*; *political will and capacity*; *citizen and community engagement*; *resource and financial capability*.

A strategic plan for developing or transitioning to a GBN is critical, enabling the subsequent and requisite roadmap of the what, of the where, of the why and of the who for delivering a GBN to be identified, understood and managed. Understanding these starting points, or in other words, the various levels of maturity of each of the aspects described, provides the basis for such a strategic plan for the GBN implementation.

3.2.6 LL Target Model of GBNs

GBNs in their fullest sense do not currently, physically exist. Technical and conceptual descriptions of them however do. One such example can be seen in Figure 11 from the US Green Building Council[39]. One of the principal objectives of Probono, is not simply to define and create an agreed and clearly understood (by citizens and practitioners alike) GBN definition but also, to show how it manifests itself in practice through the renovations and innovations taking place in our 6 Living Labs. Such a definition and the practical manifestation of a GBN, will need to be described in clearly understood terms and at different levels of understanding and maturity.

These different levels are described firstly through the five principal constructs that contribute to the make up a GBN. They are: Technical, Physical, Social, Natural and Hybrid.

[39] USGBC | U.S. Green Building Council

These constructs help to define the core focus from which a GBN derives its vision and they are intrinsically linked to the levels of maturity described in this report. Each of the five constructs may provide a principal focus and will be clearly supported by some or all of the others. Together, these form the basis for creating the *Living Lab Target Model of GBNs*, the desired vision, concept and outcomes for a GBN. Thus, describing the constituent parts that contribute to it and how they are integrated, interdependent, supported by or supporting each other towards achieving the Target Model.

Figure 11: US Green Building Council - Building a Greener Community

Each of our 6 Living Labs are carrying out innovations which would contribute towards the concept of a GBN, but none can currently be described as being a GBN. The *LL Target Model of a GBN* will set out the characteristics that constitute the totality of a GBN. The understanding of maturity for each LL in each of the five constructs described above, outlining the contribution

that each LL as a whole, as well as the innovations both individually and collectively, make toward being a GBN, informing the *Decision Support Reference Models* and, subsequently *GBN Integration Strategy and Transition Model*.

3.2.7 Decision Support Reference Models

The many different stakeholders involved in the development of, or transition to, a GBN, create a complex and dynamic coordination challenge. With their differing perceptions and sometimes conflicting views and needs, how decisions are made and by whom, becomes pivotal if GBNs are to be created and succeed. The need to better inform decision makers, especially in complex stakeholder environments, through appropriate and clearly understood evidence-based models becomes paramount.

By using a series of *Decision Support Reference Models*, enabled through the Probono *Digital Twin(s)* and described through the strategic use cases and scenarios, the ability to reflect at a high-level the *Technical, Physical, Social, Natural* or *hybrid* construct of a desired GBN, becomes possible. Providing the practical references that decision-makers need, whether these decision-makers are more mature in their understanding and professional expertise. Or, whether they are citizens, seeking clear and understandable examples to improve their well-being and those of their neighbours and surroundings in which they live through the achievement of their GBN.

3.2.8 Implement PROBONO Innovations

We reference previously the *Technical, Physical, Social, Natural* or *Hybrid* structure of a GBN. What is meant by this?

In any planned or transitioning GBN, there will likely be a bias, an emphasis, depending upon a range of factors, to whether the GBN is focussed on:

- applying **Technical** innovations to achieve its aims;
- carrying out significant **Physical** construction works;
- implementing a range of **Social** and people centric initiatives;
- designing **Natural** and nature-based solutions, or;
- including some or all of these in equal measures as a **Hybrid**.

Whichever the emphasis, as with the renovations under way at our 6 Living Labs, any innovations to be implemented, need to be considered within the framework of an overarching development and renovation plan.

The LL renovations and the innovations under trial do not make GBNs in themselves. But they are an important contribution to them. These innovations and their role in the LL, whilst of specific value to meet sustainability metrics, also need to be understood, planned and implemented with consideration to their wider role and contribution, both individually and collectively, towards achieving the *GBN Target Model*.

Such an understanding and implementation, requires not only a joined up and coherent view of how the previous sections described work together but also, how these and subsequent innovations – whether *Technical, Physical, Social, Natural* or *Hybrid* are integrated into legacy and future developments.

This is the role of the *Integration Strategy and Transition Model*. Providing a clear definition of how innovations need to work with both the legacy and future construct of the LL; and, how they support and provide value to the *GBN Target Model*.

3.3 The need for GBN Integration & Transition

Creating a GBN from afresh or transitioning to one from an existing or planned development, is a challenge with multiple complex, interacting and dynamic parts. A GBN - the combination of a *Green Building(s) and Green Neighbourhood*, is the culmination of a journey from a baseline starting point, to that of a desired *GBN Target Model*.

Baseline starting points vary depending upon a range of different factors, contexts and metrics. Thus, transition plans vary too, depending upon the level of maturity of the baseline starting point. Where a baseline starting point is relatively immature, the level of existing elements to be considered within the transition plan and with which integration of new innovations needs to occur, will be less than should the baseline starting point be more mature.

A more mature baseline, with legacy developments in place, whilst needing a more comprehensive integration plan, will likely have a shorter transition plan. Both need to consider a range of factors, both need to recognise that where multiple different organisations are involved, the factors to consider become increasingly more difficult to align the less an agreed and shared vision and objective has been pre-determined. These factors and integration challenges, most commonly based upon a risk assessment, are seen in Figure 12.

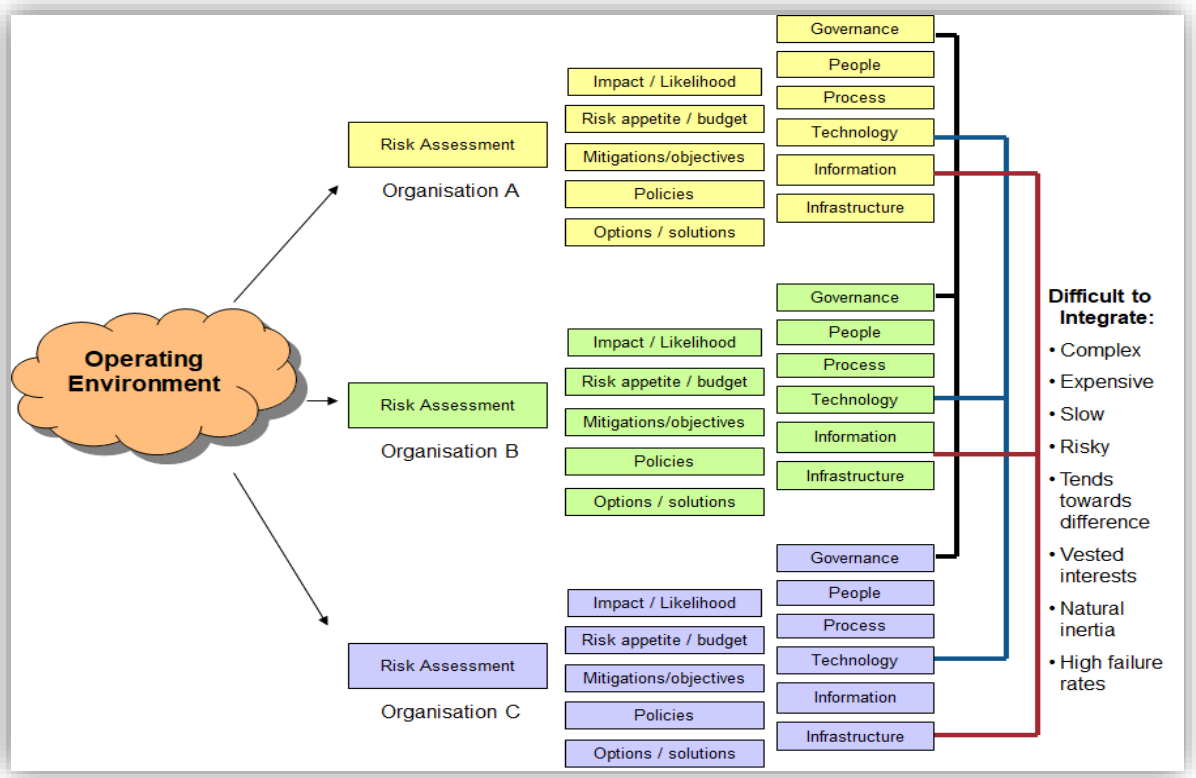

Figure 12: Risk Based Integration Challenges

In addition to these risk factors shown in Figure 12, the 6 previously mentioned attributes of *Governance, People, Process, Technology, Information* and *Infrastructure* upon which any one single, or set of multiple organisations working together to achieve shared outcomes are also shown. These need to be taken into consideration. The relative strengths of these, per organisation, or per their maturity of understanding in these aspects, are a critical factor when planning, preparing and implementing the integration and transition. An example of how these relative aspects of maturity might be described, are shown in Figure 13.

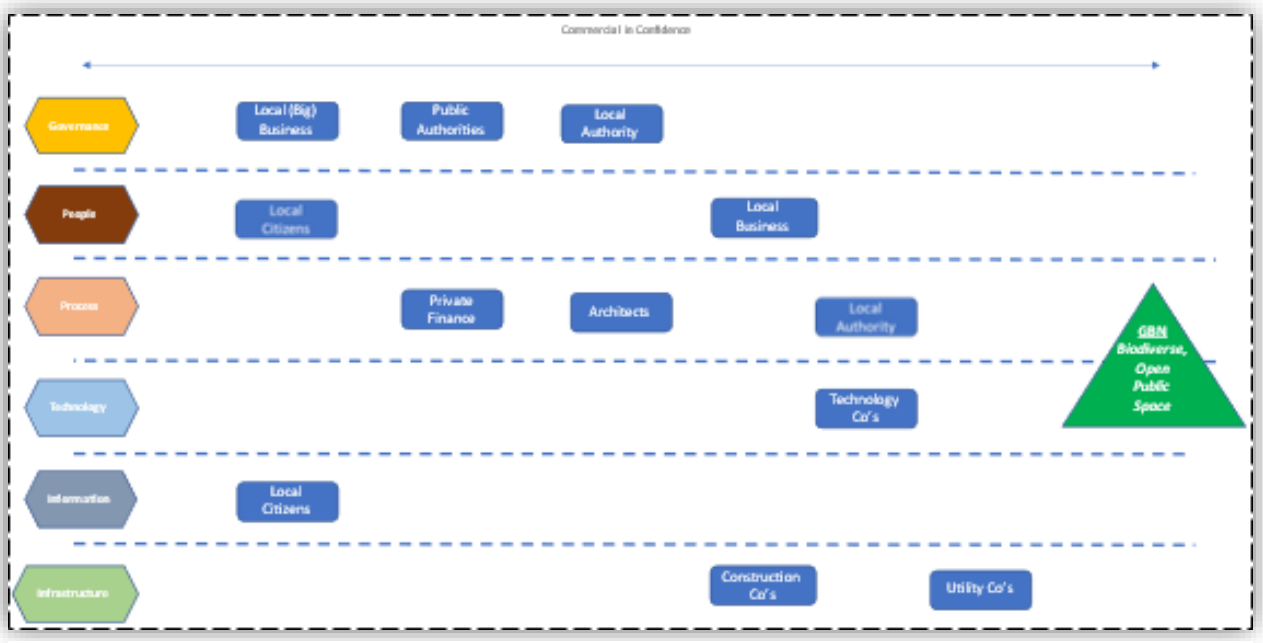

Figure 13: Stakeholder Maturity / Expertise

One example of how a well-planned and implemented *Integration Strategy and Transition Model* can be effectively utilised to address the challenge of the complex coordination of stakeholders in a neighbourhood seeking to transition to a GBN, is through the use of a Citizen Energy (CEC) or Renewable Energy Community (REC)[40]. An approach we are pursuing in the Brussels LL due to the complexity of the stakeholders and political landscape encountered in Brussels.

In December 2018, the revised Renewable Energy Directive 2018/2001/EU[41] entered into force, as part of the Clean Energy for all Europeans Package, aimed at keeping the EU a global leader

[40] Energy communities (europa.eu)

[41] Renewable energy directive (europa.eu)

in renewables and, more broadly, helping the EU to meet its emissions reduction commitments under the Paris Agreement. In particular, the EU sets a target of at least a 32% share for renewable energy by 2030 and to reach this; it puts consumers at the centre of the energy transition with a clear right to produce their own renewable energy[42]. As per the Clean Energy for all Europeans package, citizens and energy communities across the EU now have a number of guarantees that ensure their ability to invest in renewables and that they benefit from the energy transition. In particular, by acknowledging their right to produce, consume, sell and store renewable energy. As part of this initiative, *Citizen Energy Communities (CEC)*[43] and *Renewable Energy Communities (REC)*[44] are legislated. They involve groups of citizens, social entrepreneurs, public authorities and community organisations participating directly in the energy transition by jointly investing in, producing, selling and distributing renewable energy. There are many benefits for the communities involved, including economic development, the creation of new jobs, cheaper energy, self-sufficiency, community cohesion and energy security[45].

The **Clean Energy for all Europeans Package** (CEP) enabled a more active role of prosumers (producers and consumers) in electricity markets. This starts from individual self-consumers or jointly active renewables self-consumers and leads to the option to create an energy community to be entitled to perform renewables self-consumption[46]. A mix of social capital, civic-minded behaviour, environmental concerns, and interpersonal trust is **motivating prosumers to join energy communities**[47]. Within the context of *RECs and CECs*, the ability to become a renewable energy self-consumer or an active prosumer is a right that each member of an energy community has. The CEP also gives the possibility that the Member States allow energy communities to manage distribution networks in their area of operation, which enables the

[42] "Renewable Energy Directive Fact Sheet," [Online]. Available: https://ec.europa.eu/energy/en/content/renewable-energy-directive-factsheet.

[43] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019L0944

[44] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32018L2001

[45]"A Policy Brief from the Policy Learning Platform on Low-carbon economy," [Online]. Available: https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/2018-08-30_Policy_brief_Renewable_Energy_Communities_PB_TO4_final.pdf.

[46] Frieden, D.; et al. Are We on the Right Track? Collective Self-Consumption and Energy Communities in the European Union. Sustainability 2021, 13, 12494

[47] Bauwens, T., 'Explaining the Diversity of Motivations behind Community Renewable Energy', Energy Policy, Vol. 93, 2016, pp. 278–290.

community to optimise the local demand, supply, and power flows in general and leads to more efficient use of the installations by using local resources locally.

Energy communities can supply energy or provide aggregation or other commercial energy services. Some of these activities require the cooperation of the utilities with energy communities to facilitate the operation and also the integration of the community in the upcoming flexibility markets. Besides the enormous opportunities that *RECs and CECs* represent, technical and social barriers are present, exacerbated by differences in available information and knowledge, goals, and preferences between members of the energy community[48]. The lack of technical, regulatory, organizational and economic expertise to manage the complex operation in daily activity creates the need to provide members with innovative tools and tailored solutions. A high-level structure for developing a *CEC and/or REC* as a transition stage towards a GBN, as a means to address the coordination challenge, is seen in Figure 14.

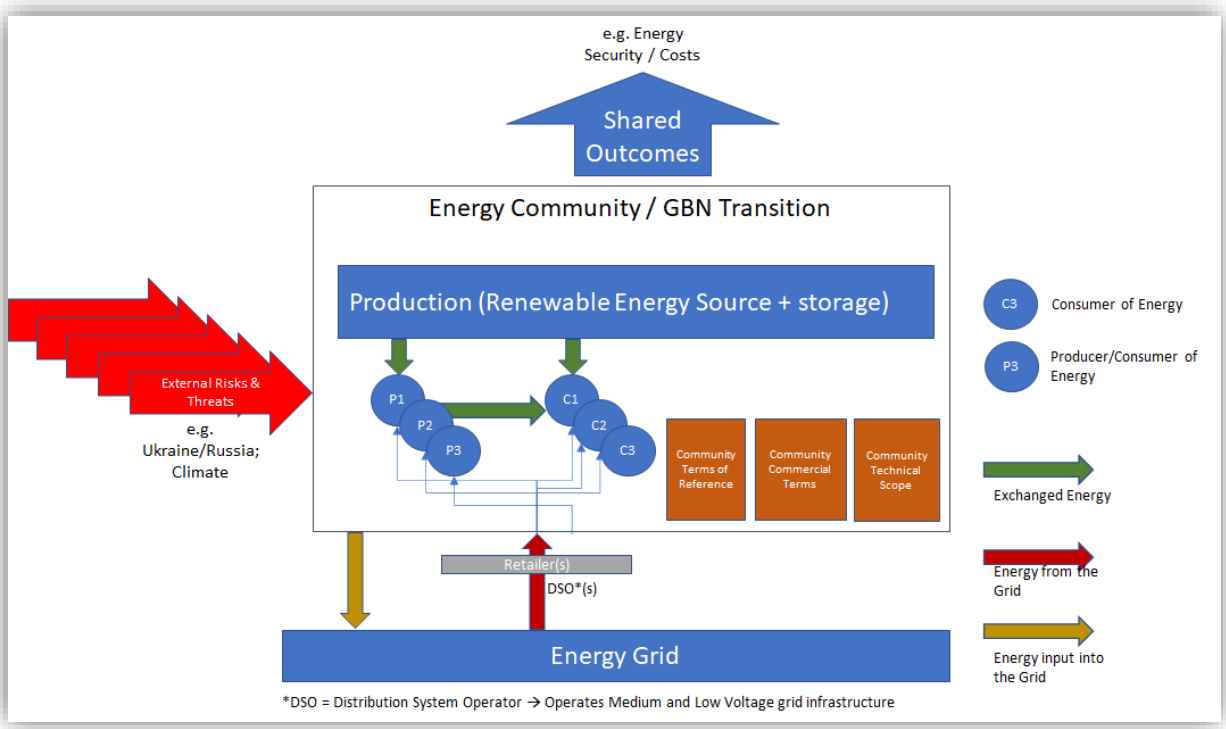

Figure 14: Structure for CEC/REC Development

For Probono, in our LLs and for the complex challenge we face bringing communities and neighbourhoods together around the currently abstract concept of a GBN, a *CEC or REC* provides

[48] Caramizaru, E. and Uihlein, A., Energy communities: an overview of energy and social innovation, EUR 30083 EN, Publications Office of the European Union, Luxembourg, 2020

a clearly articulated and evidence-based approach to bring disparate and fragmented stakeholders together around two critical and contemporary outcomes: *Energy Security and Energy Cost.* Once a neighbourhood is collaborating to achieve these outcomes, alongside that of building renovation, then the ability to introduce other aspects of a GBN, through the mechanism of the CEC or REC, such as a micro or mobility strategy, becomes infinitely easier and a part of an organic development.

3.3.1 Introduction to GBN maturity and scope [SERCO, MM]

To realise the GBN vision, evidenced through the adaptability and transferability of both this vision and the practical application of its tools and methodologies to locations elsewhere, a set of multiple and variable indicators will be further developed from those already set out in the PROBONO proposal, adaptable to desired use and maturity of location and context. Together, the intent is to support the uptake and wider adoption of the PROBONO outputs and further the advancement of GBNs and their *urban ecosystems* in support of the Green Deal.

An aim of WP1 in PROBONO, including that of Task 1.5, executed through its 6 Living Labs and creation of strategic case studies, is to identify and understand the common characteristics that underpin the creation of GBNs and their *urban ecosystems* in multiple different settings. Setting the conditions which form the basis of an achievable GBN vision, or *Target Model*; aligning to and bringing to life the *urban ecosystem* through the principles set out in the high-level description.

Then, through a set of tools and methodologies developed, tested and evaluated across the project, demonstrate how the construction and renovation of Green Buildings (GBs) and their implementation of technical, building and business and socio-economic innovations within our LLs, can be a catalyst to drive forward the GBN vision and subsequent *urban ecosystems*. The understanding of the different and varying levels of maturity for each of these aspects is key to identify, understand and implement a successful integration strategy and transition model.

As previously described, Foundations of the GBN Vision (Target Model), the EA that supports the *GBN Macro-Knowledge Base*, is structured in such a way that the Capabilities, Functions and Attributes that make up the structure of a GBN, as per the example shown in Figure 15, can be used to support the analysis and understanding of maturity of any of the given components, individually or collectively, that come together to create a GBN.

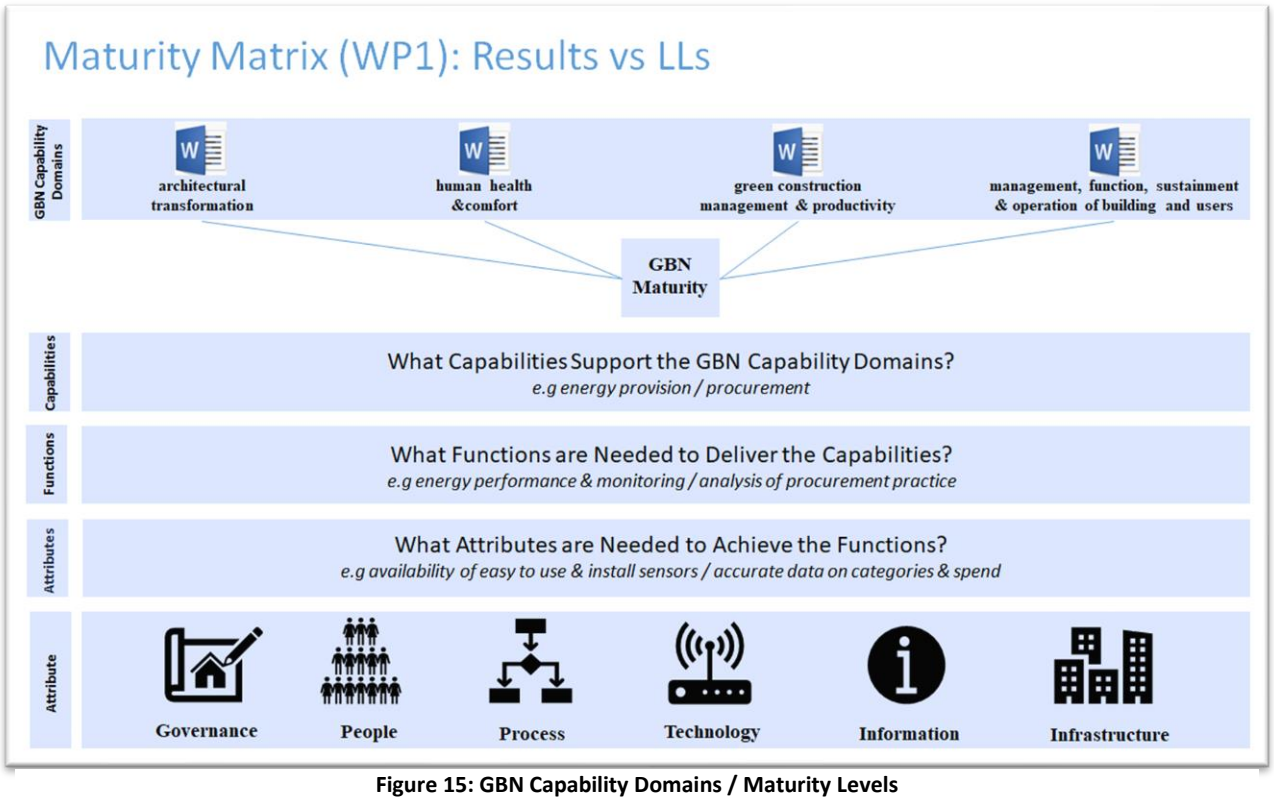

Figure 15: GBN Capability Domains / Maturity Levels

By way of illustration, the analysis and understanding of maturity for one of the components shown in Figure 15, the functions of energy performance & monitoring / analysis of procurement practice (two separate but interlinked functions), would follow the Enterprise Architecture structure seen in Figure 16. The visualised analysis of which is seen in the Maturity Matrix in Figure 17.

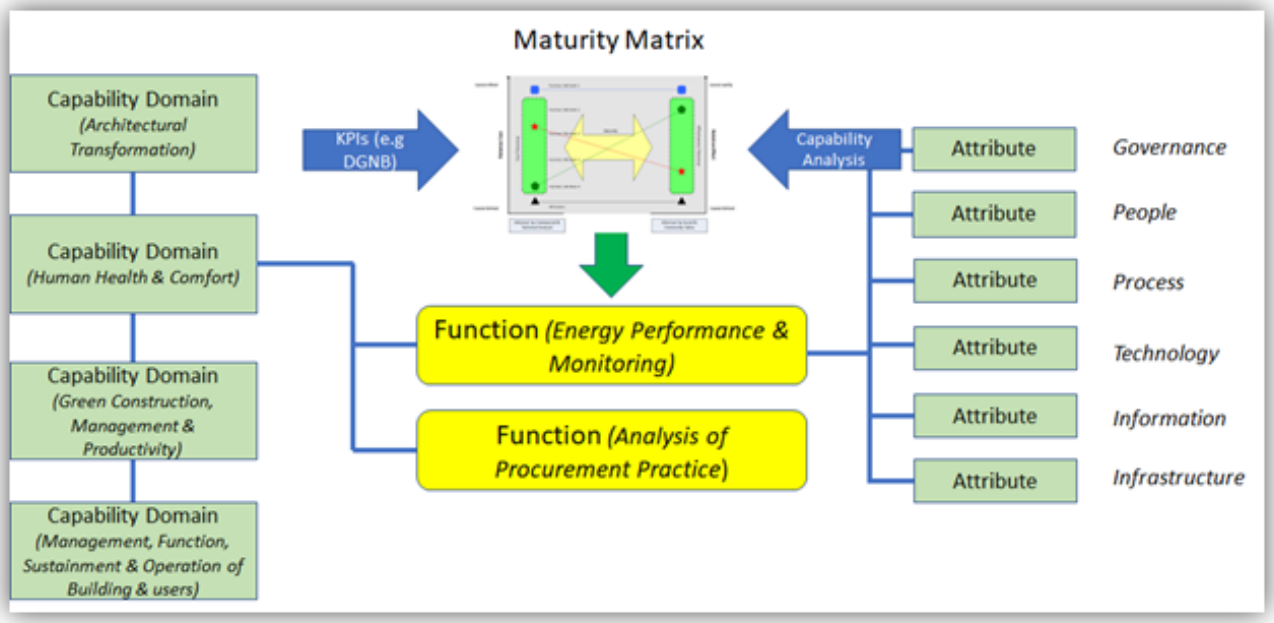

Figure 16: Enterprise Architecture Structure for GBN Functions

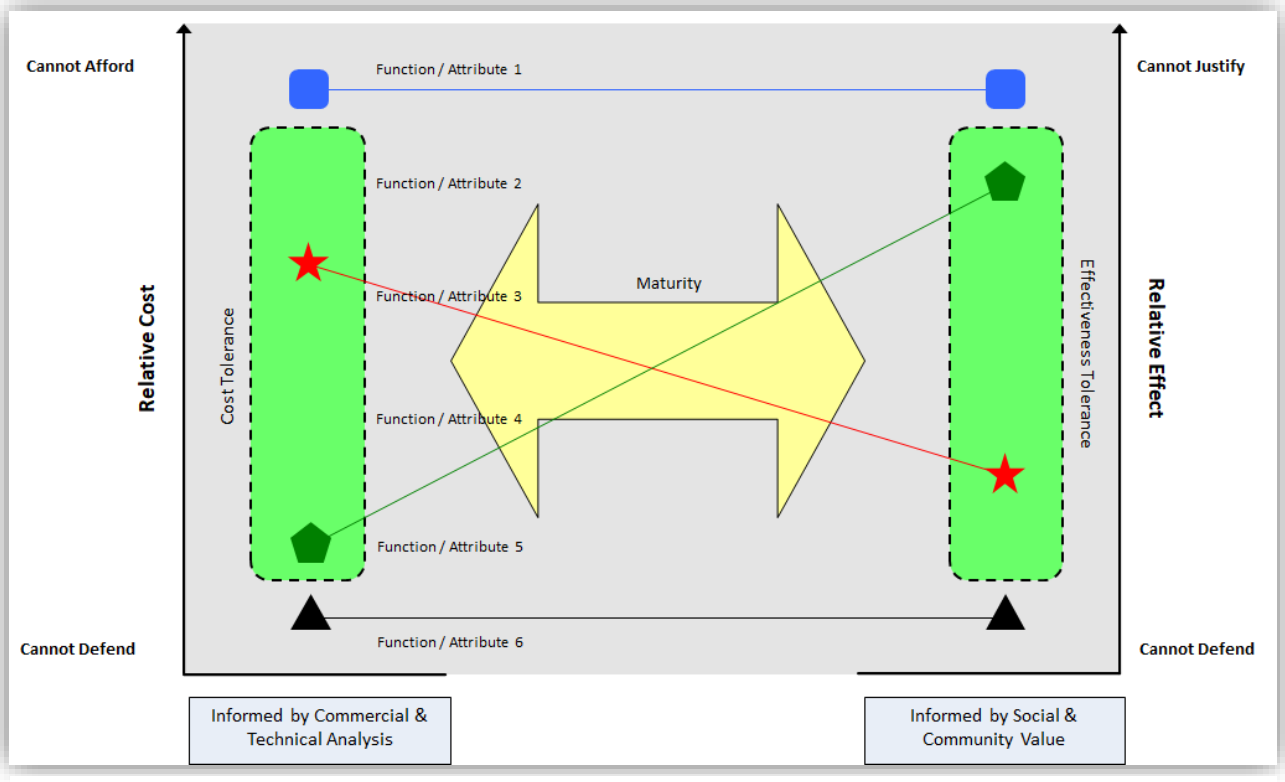

Figure 17: Maturity Matrix GBN Function Analysis

4 Sub-Tasks of T1.5 and their Role in Supporting the Objectives

Three Sub-tasks support the overall objective of Task 1.5. Each, relating to a subsequent D1.10 report. These are as follows and are described in more detail in the following section, along with additional supporting content for each:

- **ST1.5.1 GBN Prototypical Stakeholder Models.**
- **ST1.5.2 GBN Integration Models & Transition Strategies.**
- **ST1.5.3 Commissioning, procurement and financing the transition towards GBNs.**

4.1 Sub-task 1.5.1 GBN Prototypical Stakeholder Models.

Through the use of a *Responsible, Accountable, Consulted,* and *Informed (RACI*) Matrix, this subtask will define the different roles, responsibilities, constraints, and accountabilities of each GBN actor against the activities within each building lifecycle stage. This will define prototypical roles, in addition to a more detailed definition of the *GBN integrator* role and its application in different scenarios, based upon those developed in T1.1.3. These roles will be characterised by a set of Personas[49], to be developed between M12 and M24 and included in the next D1.10 (ii) report, supported by the real-life experience of stakeholders elicited in WP2; and delivered as an output to support future implementations.

4.1.1 Introduction to GBN stakeholders [SIN]

As part of the project proposal writing phase, a preliminary map of GBN stakeholders was drafted see Figure 18. This preliminary map was created from previously identified roles and responsibilities of the principal stakeholders within any given neighbourhood, involved in developing, implementing and managing aspects that impact upon the daily lives of citizens and communities in terms of quality of life, well-being, sustainability and resilience. They were further developed for the PROBONO proposal, now the Grant Agreement, through the addition of the two roles of the *GBN integrator* and the *mediator* which is commented on below. As the

[49] Personas | Usability.gov The purpose of personas is to create reliable and realistic representations of your key audience segments for reference.

development, implementation and subsequent operation of a GBN needs a high degree of collaboration, coordination and collective effort across all of those stakeholders involved in, impacted upon and eventually benefiting from a GBN, the two roles ensure that the *Combined Effect of the Collective Effort* is optimised to deliver maximum effect.

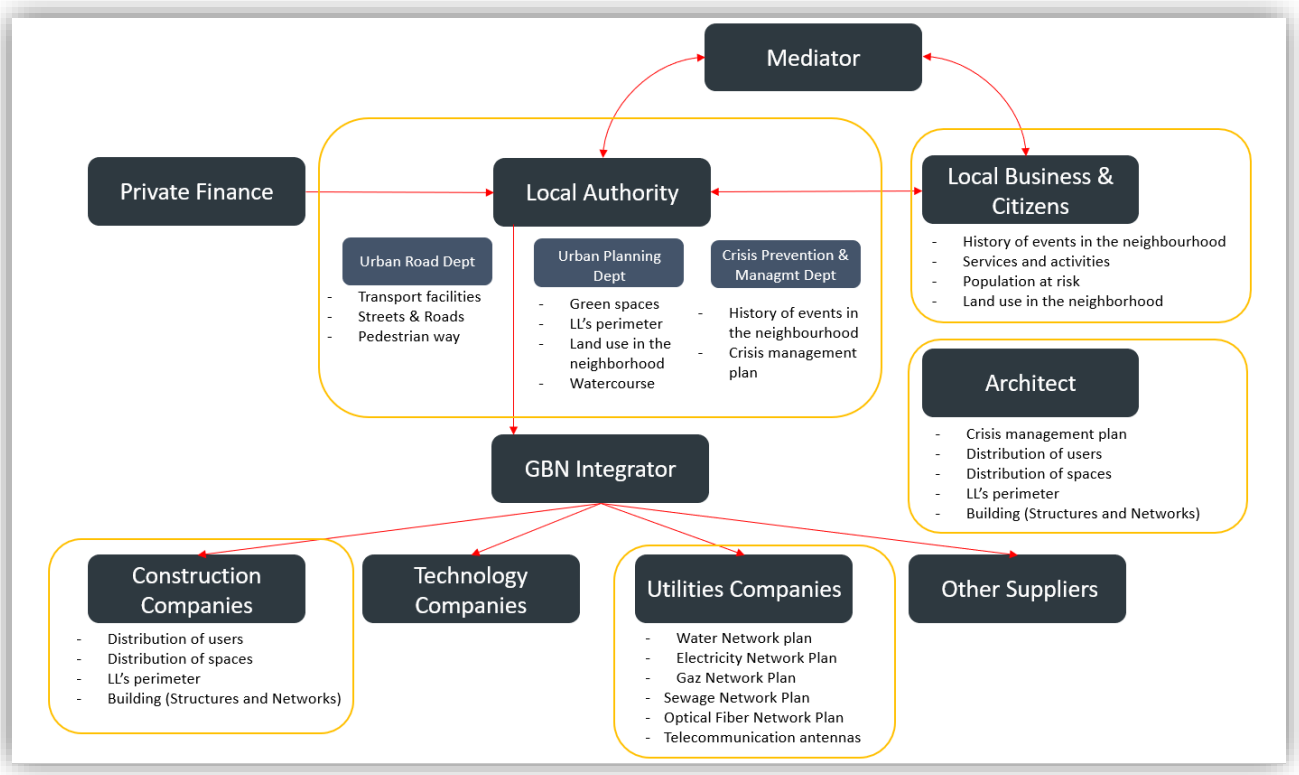

Figure 18: Map of GBN stakeholders

As part of a GBN analysis tool this stakeholder map offers a good starting point for identifying relevant stakeholders in any given GBN. Mapping out relations on the dimension of information flow, represented by the arrows linking the stakeholders on the map. The map offers a first draft of a framework and, the stakeholders currently represented at the map is as follows: *Local authority, private finance, mediator, local business* and *citizens, architects, construction companies, technology companies, utilities companies, other suppliers* and, the *GBN integrator* and the *mediator.* As part of the PROBONO project, this framework will be tested against reality (that is, the six living labs), developed, and refined to be included as part of the overall GBN analysis tools.

This points to a close link with WP2 which has as its first task a stakeholder analysis for each of the six PROBONO LLs. The purpose of these stakeholder analyses is to support the development and implementation of relevant engagement strategies for each LL. However, it is also part of a

bottom-up approach to refining the overall *GBN stakeholder map* with knowledge gathered from practical implementations of GBN. This process will be described in the following.

In the scope of WP2, online interviews with representatives for each LL have been set up (at this moment, four out of six interviews are conducted). One purpose of these interviews is to start breaking down the categories of the GBN stakeholder map into details by adding organisations, departments, and persons relevant to the given LL to the map. To facilitate this, a Miro board[50] was prepared, displaying the *GBN stakeholder map* as seen in Figure 18. In addition, colour-coded sticky notes with the stakeholders identified by living lab leaders in the scope of D7.1 was prepared.

The details and the output of this methodology will be elaborated in D2.1 (due in M12). This process provided some interesting insights for refining the stakeholder map for the GBN analysis tool. As the GBN setup is very different across living labs, the mapping exercise with the living lab representatives has so far brought about different perspectives on the overall *GBN stakeholder map*.

In the following section, we will comment on some of the doubts, inconsistencies, and questions raised during the four interviews undertaken thus far. This is a work in progress and the analysis will be developed during the coming months. For the current purpose we will not go through all categories but discuss some examples showcasing how the bottom-up approach can inform the further development of the *GBN stakeholder map*.

- Local authorities

"Local authorities" refer to an administrative body in the local government. This was also how most living lab leaders understood the term, although the placement at the centre of the map caused some confusion. For instance, it caused some discussion in the interview with the representatives from the SONAE Maia Campus living lab. This living lab is constituted by a private corporation managing a wide portfolio of companies. As the decision-making power is (primarily) in the hands of the corporation, the living lab leader identified the local authorities as the SONAE corporation.

- Local business and citizens

[50] The Visual Collaboration Platform for Every Team | Miro

The *GBN stakeholder map* has on its top right corner a placeholder with "Local business and citizens". In the interviews with living lab leaders, we defined this as any group of people in the neighbourhood who will be affected by or can affect the GBN, such as residents, students, and business owners. One point to be made based on the interviews so far, is the benefit of splitting this up into "citizens" and "local business", maybe even breaking this category down into 'local business, corporate' (e.g., international retailers such as ALDI as in the case of the Brussels living lab) and "local business, small" (e.g., a small local greengrocer). This points to the question of whether the necessary categories are on the map or if further elaboration is needed.

4.1.2 GBN stakeholders and the GBN Integrator [SIN, SERCO]

While the majority of the stakeholder categories displayed on the GBN map Figure xx represent organisations or institutions that are easily identifiable in practice, the role of the *GBN integrator* is different. As it is not a pre-defined, well-known institution or organisation it is necessary to ask not only who it could be, but also what features qualify this role. The role of *GBN Integrator* is intended as an organisation, or group of organisations able to understand, coordinate and bring together the components of a GBN from the Business-to-Business and Business-to-Government viewpoint, including those within the public sector i.e., the non-citizen and public-facing aspects of a GBN. When discussing this role across LLs it appears that further exploration is needed. The discussions thus far raise questions such as:

- Is a GBN integrator always needed?
- How will the role as GBN integrator be formalised and, is it necessary?
- What will be the responsibilities of the integrator?
- Who will appoint a specific organisation as the integrator?
- Who and how will the responsibilities and possibly power associated with this role be delegated?

The following Figure 19 shows the role of the *GBN Integrator* in the context of the overall GBN structures and outcomes.

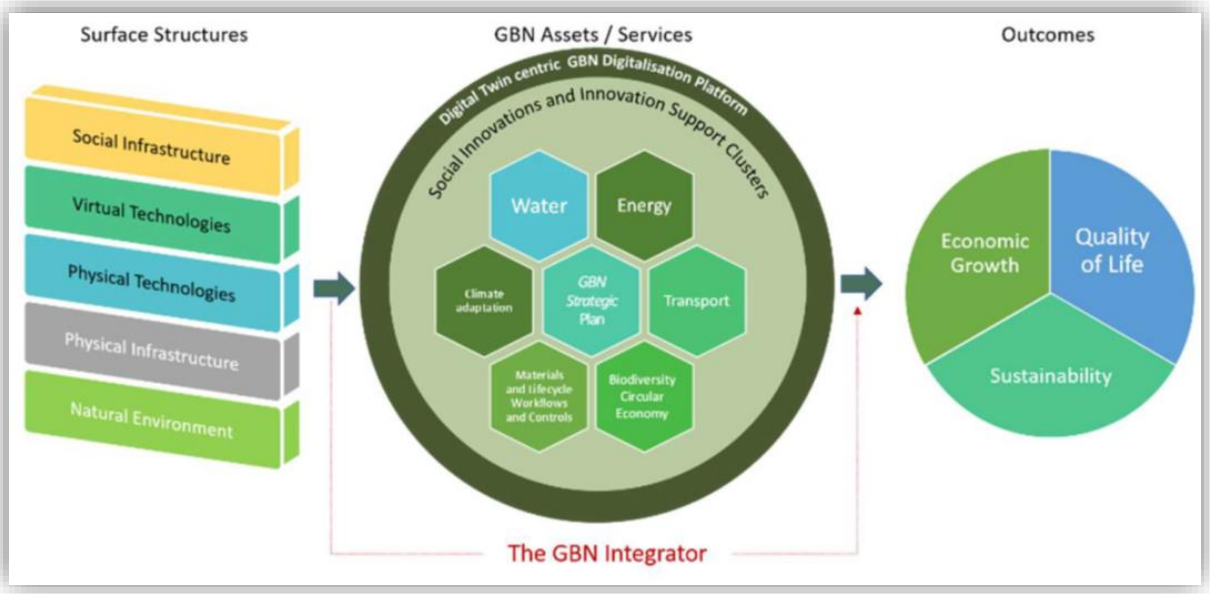

Figure 19: The GBN Integrator

- The mediator

Many of the points made about the *GBN integrator* are valid for the role of *GBN mediator* too. As it is not a well-known institution or a category associated with clearly defined characteristics, some thoughts need to be put into what or who it could be. On the *GBN Stakeholder Map*, the *Mediator* is intended to be an organisation, individual or collective body, present and trusted within a neighbourhood and community. Such an entity must represent citizen and community interests in relation to the GBN and provide a focussed point of reference and contact between the *GBN integrator's* business and professional focus and that of citizens and the public. Some questions raised based on the insights from the interviews with the LLs are worth considering when refining the *GBN Stakeholder Map*:

- Under what circumstances does it make sense to institutionalise the Mediator role?
- How should this role be related to other stakeholders? That is, should the arrows on the map be redefined?

- Timeline

A *GBN stakeholder map* can help identify what stakeholders you would most likely need to engage when designing and implementing a GBN but does not tell you *when* to involve and engage the different stakeholders. As such, it does not provide a roadmap with a timeline. The

question of when to engage the stakeholders is relevant to consider. However, at this stage, we do not foresee that it will be possible nor beneficial to set up general guidelines such as "engage stakeholder A in month X". The question of when to engage stakeholders may very well depend on circumstances such as who the initiator is; what the spatial areas are (public or private); what kind of buildings will be included (public, private, residential, commercial?), and the societal context in which it is situated (e.g., is the level of trust to public authorities and fellow citizens high or low?).

Although it needs further consideration, one way to approach the need for guidelines on timing would be to develop a set of questions to help initiators design a GBN-specific roadmap. The development of LL specific engagement strategies developed in WP2 could feed into this work with a bottom-up perspective.

- Refining the GBN Stakeholder Map

To sum up the discussions above, we suggest three general points to guide the development of a GBN stakeholder analysis tool. *First*, the questions and doubts raised during the first round of interviews with the LL representatives point to the need for defining the characteristics of the stakeholder categories more clearly. One example is to split up "local business and citizens." *Secondly*, the visual design of the map, meaning the placement of the categories, might also be refined for it to be more intuitive to read and understand, for instance, by putting the *GBN Integrator* at the centre of the map. This leads to the *third* point about how the arrows should link the stakeholders and, what the arrows represent. During the interviews, it became apparent that some links between stakeholders are probably missing, such as between the integrator and the mediator.

Moving on, knowledge derived from the stakeholder analysis of WP2 will be used to refine and develop a *GBN Stakeholder Map*.

4.2 Sub-task 1.5.2 GBN Integration Models & Transition Strategies.

This Sub-task defines *Integration Models and Transition Strategies* in the *GBN Target Models* for specific GBN Scenarios, using *Enterprise Architecture*. These models will capture how WP2 -WP5 innovations will be handled to meet stakeholder requirements and achieve project goals. Areas for consideration aside from building renovation or construction, include: *IT Management, Mobility, Asset* and *Facilities Management, Building Use* and *Behaviours, Sustainable Procurement, Just Transition, Green Finance/ESG* and the *Circular Economy* amongst others.

Different strategies for migration to and embedding the *Target Models* will be considered; plus, mapping expected challenges or enablers.

4.2.1 The GBN Transition & Integration Model [SERCO]

To create a *GBN Target Model*, one of the first considerations must be to determine what, within the area of interest – i.e. the *GBN Urban Ecosystem* are those components which benefit from and/or add value to, the shared GBN objectives and outcomes; and what, should remain in the remit of individual stakeholders, through the creation of both *Shared or individual Sustainability Plan(s)*. Figure 20 shows the shared vs individual pyramid as a generic example.

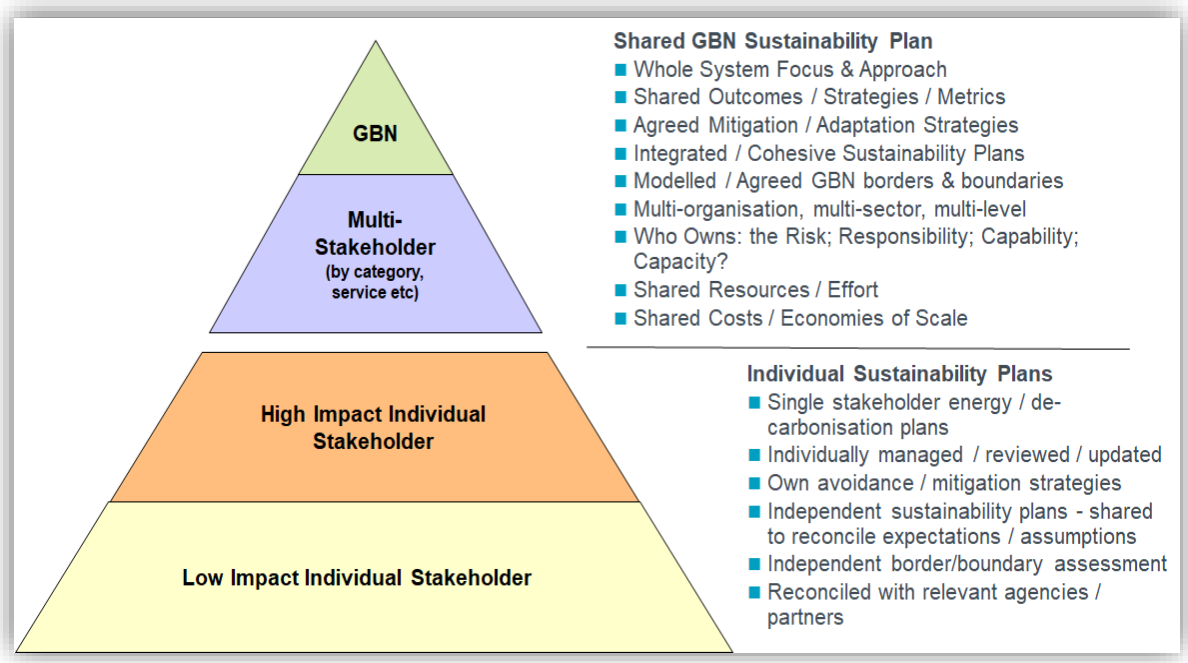

Figure 20: Shared / Individual Sustainability Pyramid

From this, collaboration and integration of the collective and shared aspects that make up a GBN, relative to those that remain as individual responsibilities, articulated through both *Shared and Individual Sustainability Plans*, is achievable. This leads to far easier, effective and efficient collaboration between the various different stakeholders, aligning their respective individual aims and objectives and different approaches from Governance to Budgets to Risk.

This is shown in Figure 21 and provides the basis for the creation of the scenarios and case studies through which needs and outcomes to transition to and achieve a GBN are understood, tested and validated.

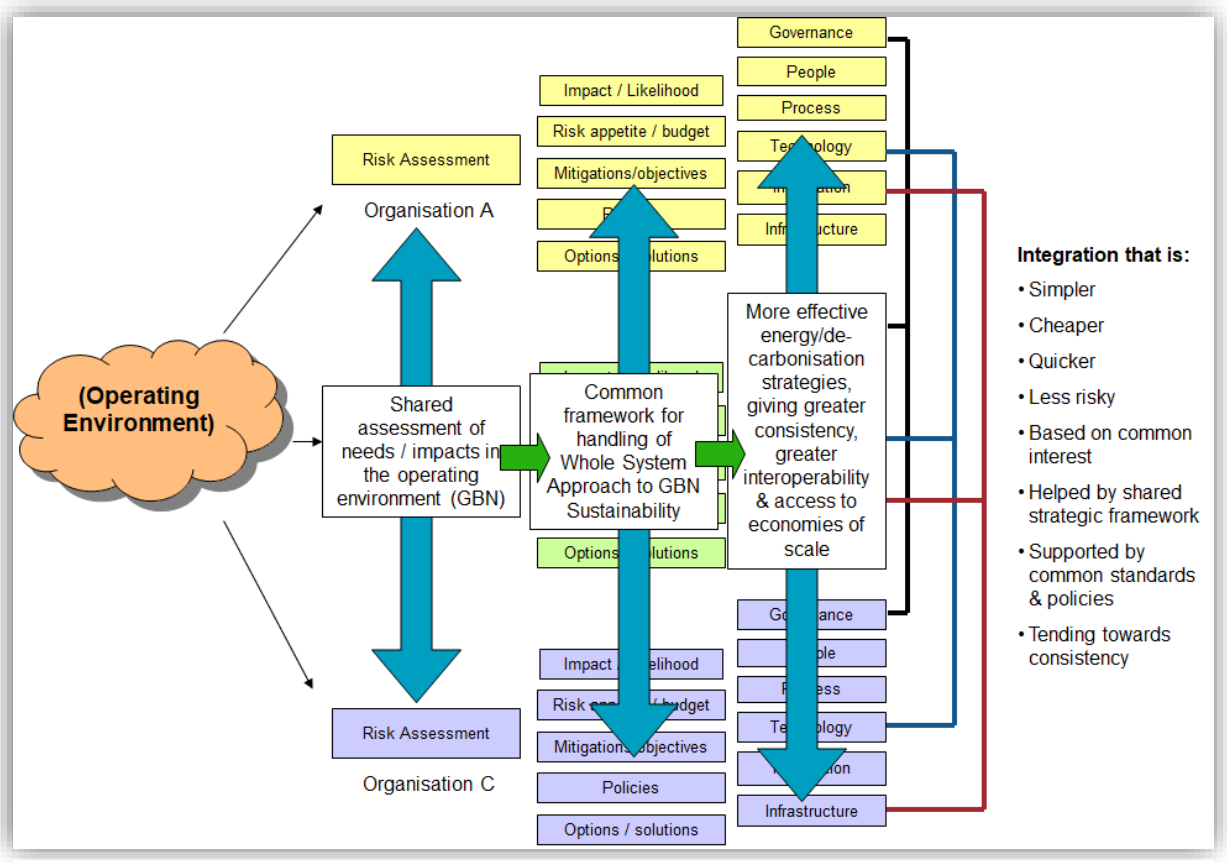

Figure 21: GBN Integration / Shared and Common Approach

The GBN Transition and Integration Model as described here, would be brought to life through the use of the GBN Scenarios and Strategic Case studies, detailed in section 4.2.2 below. These would incorporate and articulate all of the key inputs and outputs – the aims, objectives and outcomes that stakeholders and decision-makers wish to see from their GBN. These would embrace the spectrum of attributes of: *Governance, People, Process, Technology, Information* and *Infrastructure*.

4.2.2 The Role of GBN Scenarios and Strategic Case Studies in Transition and Integration [SERCO]

As mentioned, the GBN Transition and Integration Model as described, needs to be brought to life through the use of the GBN Scenarios and Strategic Case Studies. These will set the narrative and context for the what; the how; the who; and, the where of all of the key elements that need

to be included and the actions that need to be taken and by whom to make the GBN happen. Once these scenarios and strategic case studies are played out – exercised and tested with the stakeholders, through either table-top style workshops or within the Digital Twin, a better-informed understanding by those stakeholders and decision-makers can be achieved from which subsequent integration strategies and transition models can be drawn up in detail. These will embrace and incorporate all of the desired innovations, the required activities and actions and, the expected impacts across the attributes and functions as previously mentioned of: *Governance, People, Process, Technology, Information* and *Infrastructure.*

However, before these transition and integration strategies can be drawn up, Probono through its LLs, needs to define and communicate a coherent and meaningful vision and message to its target stakeholder constituencies. This is essential to support the development and uptake of the emerging GBN proposition. This will achieve:

a) an increased awareness and use of LL and GBN outputs, and;

b) transition from where sustainable renovations and developments currently are in terms of maturity toward a full and comprehensive GBN.

This desired GBN proposition, the future *Target Model* that Probono and the EC seeks, needs to be described to the various stakeholder constituencies and the wider market in terms which are clear and succinct, with the value and benefit that GBNs bring to end users well-defined and measurable. This is the role and purpose of the GBN Scenarios and Strategic Case Studies.

Presently, the LLs have a range of innovations to be tested and deployed, specific to their individual needs and objectives. In terms of what is a GBN, what's its purpose and what is the value in transitioning to one, there is a lack of cohesion between these different innovations and outputs and the emerging GBN proposition and how to transition to one. The critical questions this exposes and that the GBN *Scenarios and Strategic Case Studies* will address, to both existing and future end users and wider stakeholders is "Why should I use transition to a GBN; what's the value and benefit in doing so, and; why is this a desired objective over other sustainable development methods"?

To achieve this positioning and a coherent and credible GBN proposition, we must first internally and comprehensively describe the GBN proposition amongst the project partners and wider involved stakeholder groups so as to define what the GBN offer actually is; how it's going to be achieved, and; how it aligns to market and end user needs. As mentioned, this is the purpose and objective of the GBNC.

One of the most efficient and effective ways to do so, is through the use of scenarios and use cases. Put simply, the scenarios represent a set of end user driven stories, like a script in a play, providing a narrative for what and how end users of potential GBNs, want to achieve and get from their GBN transition. These will provide the basis for the more detailed set of user requirements for what is sought from the GBNs and the innovations to be incorporated. As we are undertaking within the LLs, these are co-created with the end users and their various collaborative partners and stakeholder constituencies, to arrive at an operationally focussed and 'real-world' narrative of the desired end results and outputs of a GBN.

These scenarios are then deconstructed, tested, evaluated and refined in an agile and iterative way thus, creating the desired model of future operations i.e how does a GBN work and what and who is involved. These outputs would feed into the transition strategies and integration models to be further tested and evaluated before being incorporated into the final plans for implementation. From these, more detailed and focussed use cases – the strategic case studies can be drawn to show the operational effect and benefit of GBNs in practice and real terms.

An important mechanism by which to ensure alignment between the DGNB measurement criteria we have chosen as our baseline approach for GBN certification and that of the Strategic Case Studies, can be seen through the analysis and mapping carried out in T1.3. An example of this T1.3 analysis and mapping for the Brussels LL is seen in Figure 22.

LL Strategic Case Studies		
2. Community-based Energy Generation & Operation (REC) Enabling energy communities has been identified as a key driver for change in the Brussels LL.		
In parallel with the technology and construction innovations set out for the ACE renovation ACE will, in parallel with the other LL Cluster locations at Aarhus and Porto, **identify and map a baseline of its business and socio-economic aspects for the management, use and operation of the building.** This includes but is not limited to: **Facilities Management, sustainable procurement, circular economy** approaches and the **behaviours and use of the building by staff, pupils, and visitors alike.** From this, ACE and PROBONO will determine the levels of maturity of each of these functions, both individually and collectively, and the impact they have on sustainability relative to the target indicators for achieving a Green Building.		
DGNB Criteria relevance		
PRO 1.9 Governance	PRO 1.7 Participation	PRO 1.2 Integrated Design
TOC 2.1 Energy infrastructure	SOC 1.6 Open Space	SOC 3.2 Social and functional mix
PRO 1.7 Participation / TOC 2.4 Smart infrastructure	PRO 1.9 Governance	PRO 3.5 Quality assurance
TOC 3.1 Mobility infrastructure - motorised transportation TOC 3.2 Mobility infrastructure - pedestrians and cyclists	SOC 1.9 Noise, exhaust and light emissions	SOC 3.3 Social and commercial infrastructure

Figure 22: Strategic Case Studies Mapped to DGNB

Figure 23 as seen in the Probono proposal, shows the underlying construction and approach for *Scenario Based Development* for how all of these elements are brought together, narrated through the scenarios and strategic use cases, to achieve the comprehensive and robust understanding of what makes a GBN *urban ecosystem.* Including how it functions and achieves the outcomes and objectives set out.

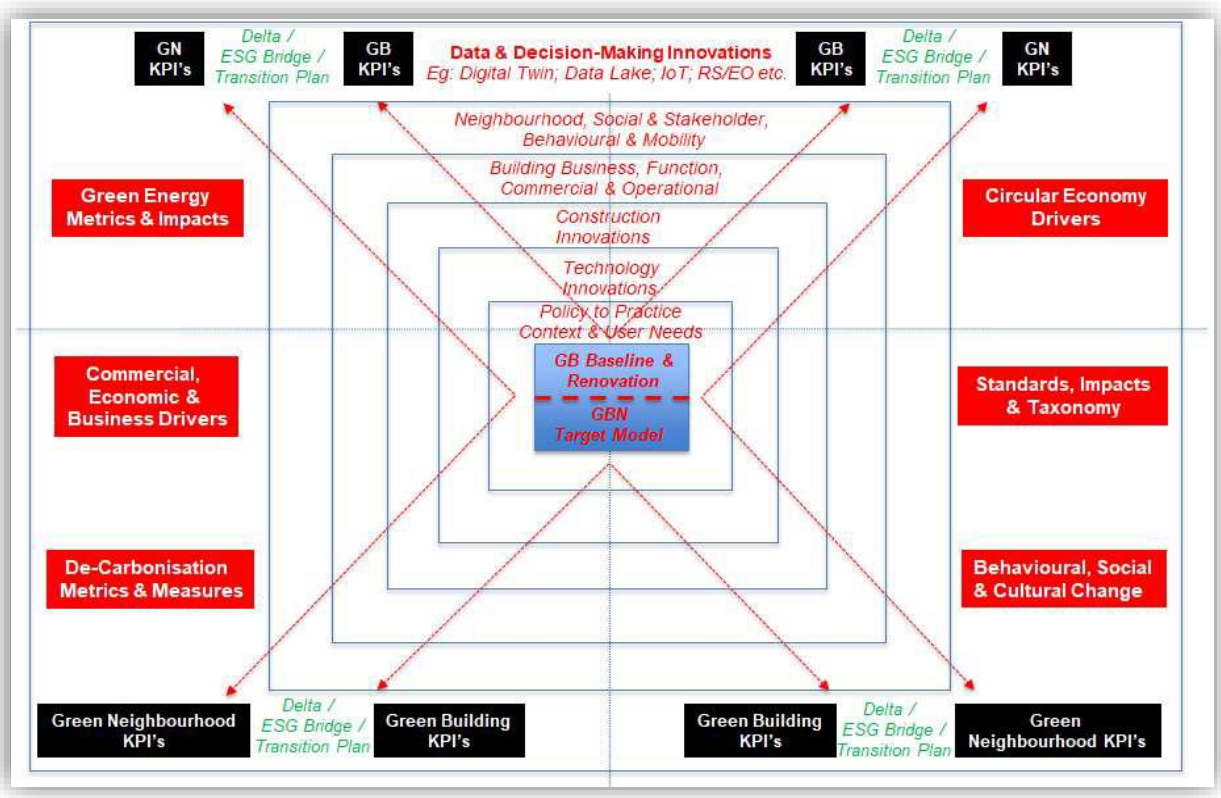

Figure 23: GBN Scenario Based Development Approach

4.2.3 The Role of Knowledge Graphs

Knowledge Graphs (KG)[51] are being developed in WP3, T3.6 as part of the Decision Support Tools to describe interdependences amongst physical and digital components and to describe the individual state of operations of each GBN system component. The DSS and thus the KGs, are used in in different stages of a building's lifecycle, for different stakeholders/ end-users to support the building management and deal with future challenges (Kazak & van Hoof, 2018).

[51] knowledge-graphs-pov.pdf (deloitte.com)

They will be developed to support the development, management and operation of the *GBN urban ecosystem*.

Knowledge graphs are part of Semantic Web technologies[52], which are included in DSS and focus on enhancing *Internet of Things (IoT)* data and *Building Information Model (BIM)* data exchange, as well as cloud analysing and storing (Parisi, Mangini, & Fanti, 2020). The WP1 GBN Macro-Knowledge Base and all of its subsequent analysis and outputs from the various tasks and sub-tasks, aims to employ the KGs as the visualisation of choice to show the structure and mechanics of a GBN and how and where the *GBN Integration and Transition Models* interrelate, interface

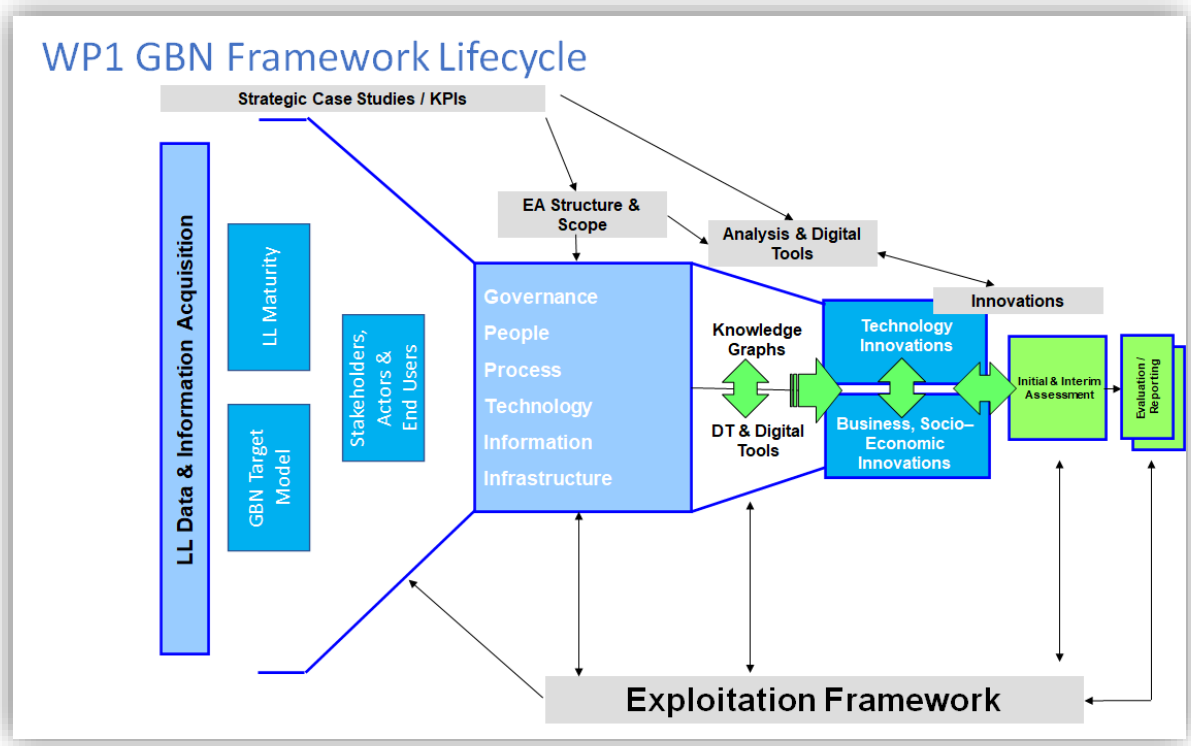

Figure 24: WP1 GBN Framework Lifecycle - Knowledge Graphs Role

and are interdependent in all of their operational aspects across *Governance, People, Process, Technology, Information* and *Infrastructure*. The positioning and role of the KGs within the *WP1 GBN Framework Lifecycle* is seen in Figure 24.

[52] Semantic Web - W3C

4.3 Sub-task 1.5.3 Commissioning, procurement and financing the transition towards GBNs.

This Sub-task will enable the transition of green buildings and GBNs in the PROBONO LLs, by determining how the different components are financed, commissioned, and procured, considering, for example public/private partnerships, public procurement, and other types of green financial and investment levers. This will build on the outputs from ST 1.2.2 to elicit both new and existing methods, models and governance frameworks that support the economic viability of GBNs. Consider in consultation with stakeholders, ESG, Insurance, Carbon Credits, Green Taxes, Transition Finance, and other forms of sustainable financial levers, especially in the context of the latest EU disclosures. The outputs will directly feed into implementing and operationalising the LLs.

The following Figure 25, a *Strategic Blueprint for the Probono GBN Target Model*, provides a good illustration for how and where the commissioning, procurement and green financing outputs of the project sit, in context to the rest of the WPs and tasks. Figure 26 is an expanded view of the red panel in which these aspects are detailed. Of course, with regard to the existing Probono LLs, the findings and outputs from this Sub-task 1.5.3 will need to be considered as a retrospective action, given the status and maturity of the LL developments, to see what, if any, of these findings can be incorporated into these mature LL developments. With regard to the plans for new GBNs, these findings will of course form a core part of the Integration Strategies and Transition Models.

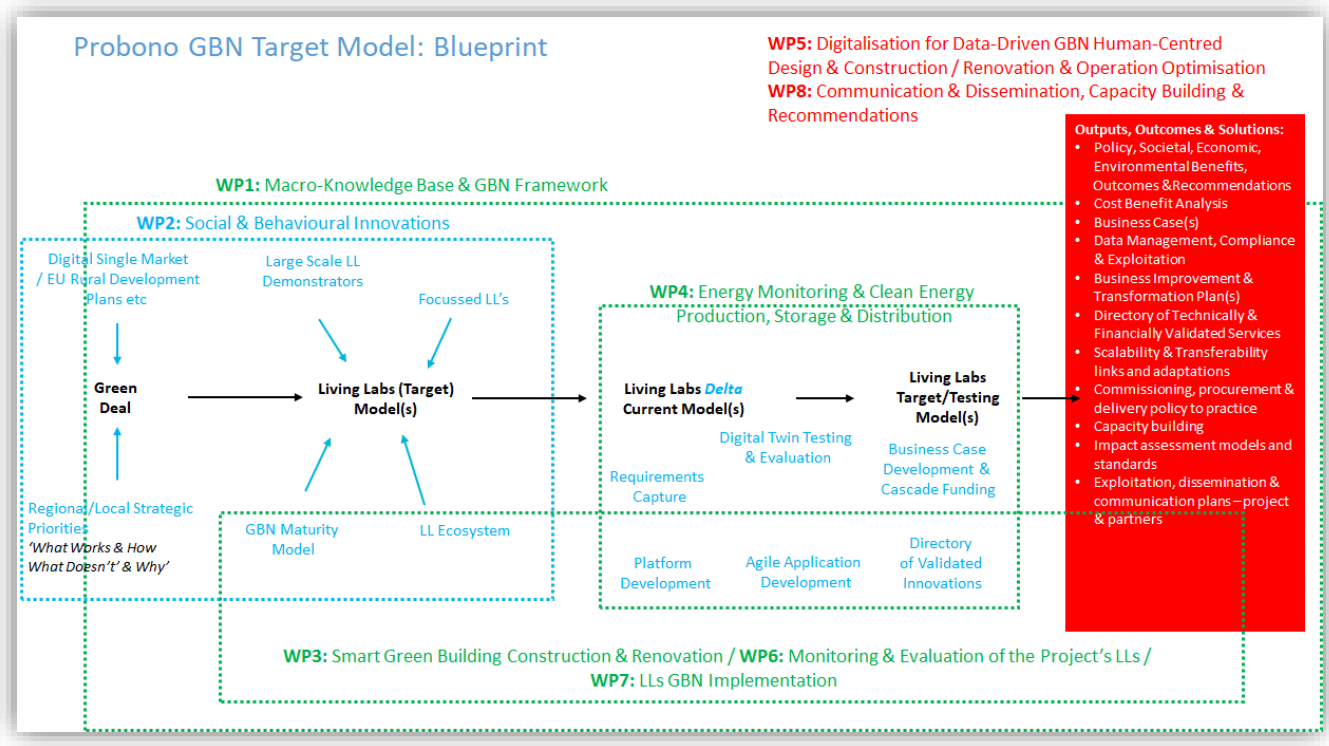

Figure 25: GBN Target Model Blueprint

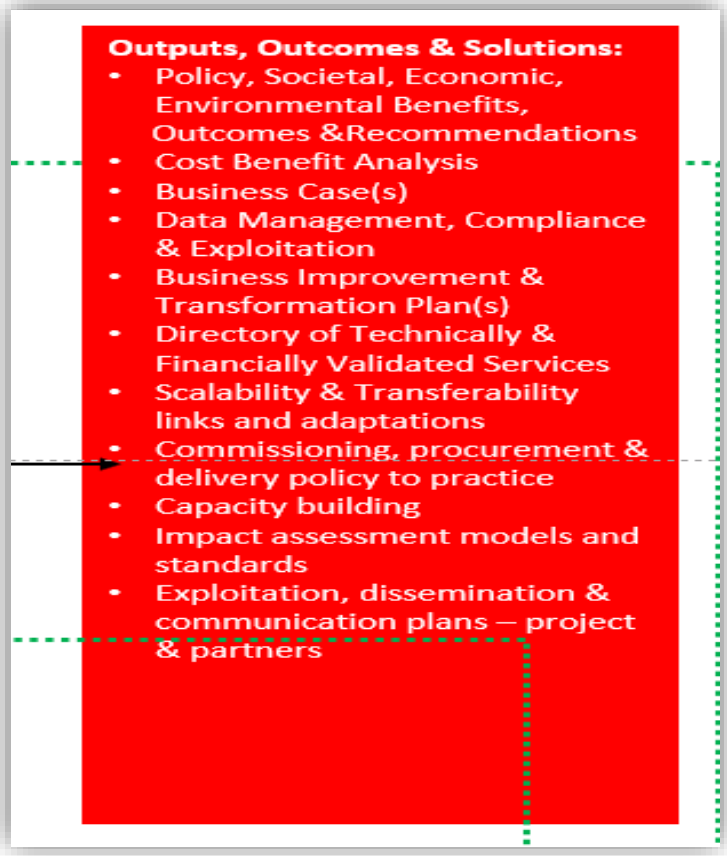

Figure 26: Expanded Outputs / Outcomes & Solutions

5 Conclusions and Future Actions [SERCO]

This D1.10 report, the first in a series of 3 for T1.5, has provided a broad-ranging insight into the challenges, assumptions and enablers associated with putting together an Integration Strategy and planning a Transition Model for neighbourhoods and communities seeking to create or become a GBN.

As per the report title, there has been a focus on stakeholders and the challenges of collaboration and the needs of integration of sustainability innovations into a dynamic and complex landscape; inherent in all communities seeking to develop a shared initiative. There has also been an emphasis within this report on the need to understand, plan and manage the underlying attributes and functions which any one, or multiple set or organisations need in place to function, namely: *Governance, People, Process, Technology, Information* and *Infrastructure.* The same attributes and functions needed to underpin a GBN. There has also been comprehensive coverage of the GBN definition and what a GBN is; essential knowledge and messaging to ensure a wide uptake of GBNs within the general public.

Whilst wide-ranging in its scope of integration and transition aspects covered, this report sets the basis for a future, more comprehensive analysis and understanding for what and how a GBN Integration Strategy and Transition Model works in practice; along with the steps that decision-makers seeking to create a GBN need to follow.

In conclusion, the content and aspects covered in this D1.10 report provide a solid basis for GBN integration and transition, but this needs expanding upon, testing and validating with the Probono Living Labs as well as a broader audience. These will constitute the next actions going forward. Between the submission of this report in Month 12, and that of the next report submission in month 24, all of the topics covered will be broadened and deepened. Then, thoroughly and iteratively tested with the 6 Probono Living Labs before being brought together within a draft end-user focussed and easy to understand ‘user manual’ for GBN integration and transition.