CrAFt

NEB Impact Model

Initial Version

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Creating Actionable Futures

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Authors	Han Vandevyvere, Annemie Wyckmans (NTNU)
Contributors	Elisa Junqueira de Andrade (NTNU)
Lead Beneficiary	NTNU
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30.08.2022	v.01	Han Vandevyvere, Annemie Wyckmans (NTNU)	Initial version.
24.09.2022	v.02	Han Vandevyvere, Annemie Wyckmans (NTNU)	Integration of feedback.
31.10.2022	v.03	Han Vandevyvere, Annemie Wyckmans, Elisa Junqueira de Andrade (NTNU)	Integration of additional feedback, formatting.
30.11.2022	v.04	Han Vandevyvere, Annemie Wyckmans (NTNU)	Inclusion of learnings from the CrAFt Cities' kick-off and addressing of co-benefits.
30.06.2023	V1.0	Han Vandevyvere, Annemie Wyckmans, Elisa Junqueira de Andrade (NTNU)	Integration of feedback and learnings from CrAFt, NEB-STAR and Re-Value. Restructuring of content. Reworked graphics.

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Executive Summary

In this deliverable, you will read how we have developed CrAFt's NEB Impact Model, together with CrAFt partners and Cities, as part of the project's Work Package 1.

CrAFt's NEB Impact Model is an **assessment and guidance tool geared at a whole systems approach for use in complex urban interventions**. The whole systems approach fully integrates the New European Bauhaus triple bottom line of realising sustainability, beauty and inclusion.

The Impact Model can be optimally put to work at the district and urban scale levels of intervention.

It is a 'tool to talk', rather than a strictly organised indicator system.

It is built in such a way that cities can use their existing indicator sets and monitoring processes as building blocks for the integrated planning, steering, monitoring, and evaluation goals of the Impact Model.

In this way the Impact Model is:

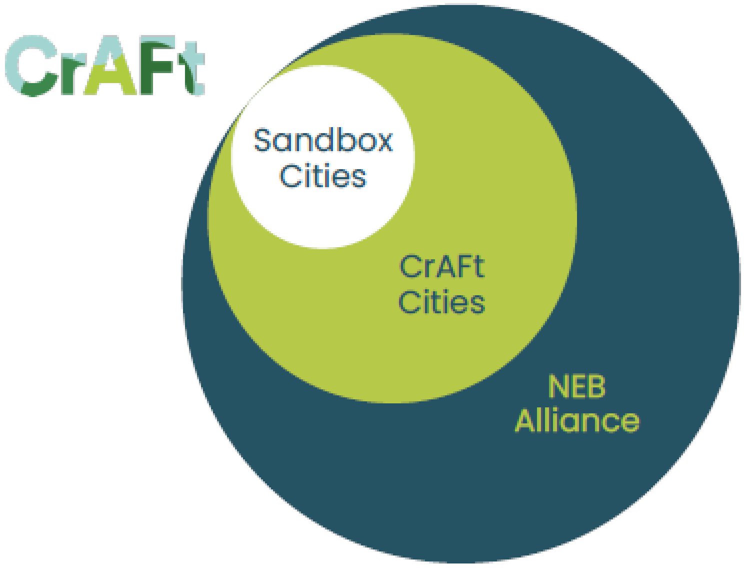
- building an evidence base: providing insights and collecting stories and data, with a special focus on documenting co-benefits;
- a tool to cooperate: to talk, discuss, negotiate, and discover – together;
- open, flexible and context sensitive: existing assessment and guidance tools can be plugged into it;
- filling gaps: complementing cities' pre-existing indicator sets;
- helping to identify blind spots: cross-disciplinary, experiential, qualitative, process-related or other;
- and ensuring that an overarching, whole systems approach is being adopted.

The Impact Model will thus help identify **essential leverage points for systemic change towards climate neutrality and resilience**, by including all aspectual layers of sustainability (ecological, infrastructural, social, cultural, economic, aesthetical, legal, etc.) into innovative models for **local collaborative governance and value creation** that optimally use the co-benefits between the different sectors and minimise potential conflicts.

By functionally linking environmental aspects (materials, energy, water, health, pollution, biodiversity, …) to the cultural, social, economic, legal and governance aspects in one perspective, the Impact Model allows to integrate cross-sectoral co-benefits from the early phases onwards, and thus to reduce the risk of suboptimal, unilateral or siloed approaches.

Furthermore, many climate-neutral and resiliency solutions have less attractive business cases, and financial aspects are usually discussed rather late in the process. Integration of financial aspects and co-benefits from the beginning will help to exploit **new value chains** and business opportunities.

CrAFt develops the Impact Model internally and beyond the project borders, experimenting with cities and other projects, and with a broader link to the European Commission's Joint Research Centre and strategic platforms through a NEB Alliance[1] of NEB and Missions projects, initiatives and communities (as described further in this deliverable).



To ensure the holistic approach of the Model, CrAFt will also actively engage with students (through the STEAM Teams in the Sandbox Cities) and with the art and culture sector (through the networks of the partners ECF and ELIA).

The results from these prototypes and dedicated sessions will be incorporated into the final version of the Impact Model, due in M36 (April 2025), including best practices and detailed indicators.

[1] NEB Alliance: https://craft-cities.eu/first-meeting-of-the-new-european-bauhaus-policy-alliance/

1. Aims and scope of CrAFt's NEB Impact Model

1.1 What is the Impact Model about?

In the present context, an Impact Model is an instrument to uncover the web of interlinked outcomes that a project, process or intervention generates.

We can use the metaphor of a fishing net. If you lift a single node of the net, the connecting threads cause other nodes to be lifted as well. Nodes closer to you move up more, while nodes further away move up less. Note that there will always be a web of lifted nodes as a result of acting on a specific node, whether we intend to do so or not: no intervention goes isolated. Hereby the impact on other nodes is affected by the distance from the intervention point.

Reversely, you may intend to lift several nodes at the same time and take advantage of the fact that these are interlinked. In this case, you exploit the coupling opportunities that exist between separate interventions: more nodes are being lifted with less overall effort, as each node automatically pulls on several other ones.

Sticking with this analogy, an Impact Model can also be used to steer complex interventions by understanding and listing the web of interlinkages on beforehand, so that one can leverage on desired co-benefits. At the same time, unwanted side-effects can be charted as well. Their negative impact can then be prevented or, at least, mitigated.

CrAFt's NEB Impact Model is designed for these functional characteristics.

1.2 Aims and scope of CrAFt's NEB Impact Model

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1.3 The New European Bauhaus as an overarching framework for urban interventions

The European Commission states the mission of the New European Bauhaus (NEB) as follows[2]:

'The New European Bauhaus initiative connects the European Green Deal to our daily lives and living spaces. It calls on all Europeans to imagine and build together a sustainable and inclusive future that is beautiful for our eyes, minds, and souls.

The New European Bauhaus is a creative and transdisciplinary movement in the making!

- It is a bridge between the world of science and technology, art and culture.
- It is about leveraging our green and digital challenges to transform our lives for the better.
- It is an invitation to address complex societal problems together through co-creation.

By creating bridges between different backgrounds, cutting across disciplines and building on participation at all levels, the New European Bauhaus inspires a movement to facilitate and steer the transformation of our societies along three inseparable values:

- **sustainability**, from climate goals, to circularity, zero pollution, and biodiversity
- **aesthetics**, quality of experience and style, beyond functionality
- **inclusion**, from valuing diversity, to securing accessibility and affordability

The New European Bauhaus brings citizens, experts, businesses, and institutions together to reimagine sustainable living in Europe and beyond. In addition to creating a platform for experimentation and connection, the initiative supports positive change also by providing access to EU funding for beautiful, sustainable, and inclusive projects.'

Within CrAFt, **a NEB Impact Model is developed to support the implementation and follow-up of the NEB principles on the ground in our cities.**

[2] Cited from https://europa.eu/new-european-bauhaus/about/about-initiative_en

1.4 CrAFt's NEB Impact Model at a glance

The Impact Model considers **5 main intervention domains, called 'pillars',** and **17 impact categories**.

The 5 pillars consist of the well-known triple bottom line for sustainable development (planet, people, prosperity) complemented by a pillar on quality of life and one on governance.

The 17 impact categories refer to essential aspects of integrated sustainable development (ecological, infrastructural, social, cultural, economic, aesthetical, legal, etc.). In order to achieve a balanced approach towards integrated sustainability, inclusivity and beauty, we recommend that all 17 categories are taken into consideration. As one can observe, there is no distinct category for "physical space". Indeed, in CrAFt's NEB Impact Model, physical space is handled as a cross-cutting category, serving as a carrier for all the other functions, including urban governance and development processes.

NEB pillars and basic impact categories		
Governance		Space
1	Integrity	
2	Participation and co-creation	
3	Process quality	
Economic performance		
4	Legal certainty and future economic value	
5	Total societal cost of ownership	
6	Sustainable local embeddedness	
Social-cultural performance		
7	Cultural sustainability	
8	Sociability	
9	Affordability and inclusivity	
10	Effectiveness of services	
Healthy living		
11	Indoor environmental quality	
12	Outdoor environmental quality	
Environmental performance		
13	Sustainable mobility	
14	Sustainable land use	
15	Healthy, secured water cycles	
16	Circularity - Materials	
17	Climate neutrality - Energy	

Figure 1: The 5 pillars and 17 impact categories of the Impact Model.

Within the 17 impact categories, we have identified a variety of relevant indicators, based on both methodological research and dialogues with the CrAFt Cities and their stakeholders. The Impact Model suggests **a list of 46 indicators, intended as an indicative set** of primary Key Performance Indicators (KPIs) that are already largely known and used by most cities. The list is intended to guide the selection of indicators from existing sets and reporting tools already in use by the city, the project or the process at stake. At the same time, the pillars, impact categories and suggested indicators help to **detect possible gaps as well as additional opportunities**.

Typical gaps we identified among the CrAFt Cities thus far are indicators related to social and cultural sustainability, experiences and processes; these are often considered as “subjective” and “qualitative” and hence are not properly taken into account in decision making. In addition, the CrAFt Cities have identified the urgent need to be able to document the added value of cross-disciplinary cooperation, i.e., how the indicators interact with each other. This type of information would support cities to better discuss co-benefits and trade-offs across municipal units and with societal stakeholders.

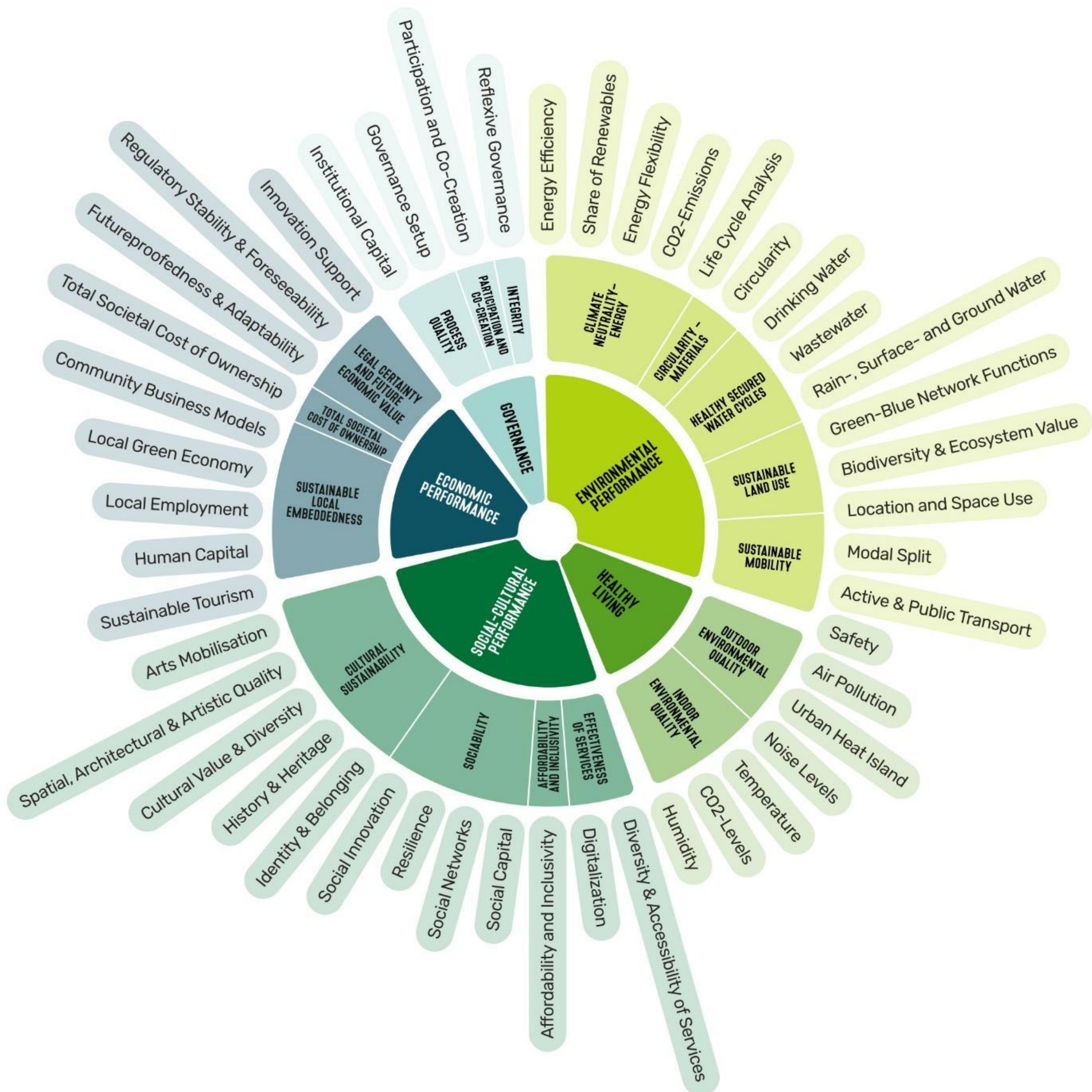


Figure 2: CrAFt’s NEB Impact Model with 5 pillars, 17 impact categories and 46 suggested indicators.

The nature of the indicators varies from strictly quantitative (like CO_2-emissions or the modal split of passenger travel) to highly qualitative (like reflexive governance). For many indicators, a composite assessment based on the evaluation of several additional indicators will be recommended. Furthermore, indicators may be evaluated by using proxies, until a better indicator is found or developed. For example, a proxy for the accessibility of a service may be the average distance to that service. Indicators may be assessed by a mix of quantitative and qualitative additional indicators. For example, social network quality in a district may be assessed both by counting the number of neighbourhood associations and community events, and by asking residents and users for a qualitative judgement of the social networks in that given neighbourhood.

Some aspects like education or health care do not appear in the indicative set. This is intentional, in order not to overburden the assessment framework. However, related effects are being assessed. For example, the output of education is reflected in local human capital, while quality of life indicators directly influence public health (and thus reduce the burden on health care).

Importantly, the Impact Model can also be used without having all data for the indicators available. This can be the case in new areas, where data is not available, where it is not available at a district level, or for other reasons. The Impact Model then can draw from its knowledge base to serve as a conceptual tool to still discuss and reflect about urban interventions and their co-benefits in a structured manner.

It is up to the user to decide how elaborate the evaluation of the indicators will be, and which particular indicators will be used. In order to avoid that such an approach leads to user bias, the Impact Model foresees an integrity check at the level of governance. Through self-reflection, the group of stakeholders engaged in a given project or process is expected to check compatibility with overall NEB-inspired goals, completeness of the assessment, proper alignment of agendas and stakeholder interests, and adequate selection of relevant indicators.

The Impact Model is grounded in a knowledge theory called Multimodal System Analysis (MMSA)[3].

[3] A description of MMSA can be found in: Vandevyvere, H. (2011), *How to cut across the catchall? A philosophical-cultural framework for assessing sustainability*, in: International Journal of Innovation and Sustainable Development, Vol. 5, No. 4, p. 403-424

1.5 The importance of co-benefits

In order to boost investments for the integration of NEB principles into urban transitions towards climate neutrality and resilience (hereafter referred to as NEB urban transitions), identifying and quantifying both direct and indirect benefits of the envisaged intervention is instrumental. This can apply to municipalities developing and prioritising their projects, local community groups, NGOs, private investors, crowdfunding initiatives, or other groups.

1.5.1 Mapping and quantifying co-benefits

Certain co-benefits that create an added value can be reasonably estimated, like increased real estate value through energy-retrofit of existing buildings. However, co-benefits like decreased social and health care costs through more healthy living environments may be very difficult to quantify. In addition, the beneficiary of those co-benefits is often not (only) the project initiator or the investor.

For this reason, we suggest a balanced business case by adopting a 'total cost of ownership for society' perspective. Total cost of ownership for society requires that multiple actors covering the entire return spectrum participate in developing the project (how this can be done will be covered extensively by CrAFt's upcoming CookBook). Alternatively, a redistribution mechanism can be put in place – one could think of, e.g., a tax rebate for helping to realise a more healthy environment, based on tangible indicators.

1.5.2 Co-benefits in the realm of urban climate neutrality and resilience

Sustainable urban development and climate action planning enable a broad set of co-benefits. There are obvious co-benefits one may expect to realise when setting up interventions in an urban (re)development context, like building retrofit, sustainable new-built, mobility infrastructure interventions, projects dealing with green-blue infrastructure or RES production; in addition, we explore co-benefits that are currently less documented, originating from cultural and artistic interventions, the impact of identity, belonging, and ownership among residents and other local stakeholders, and educational and recreational projects.

Furthermore, there is a second sphere of broader societal co-benefits that go beyond specific projects or interventions, such as:

- **Higher energy independence** through the provision of local RES and other sustainable energy sources like recovered waste heat;

- **Reduced energy poverty** through both increased energy efficiency and RES production;
- **Reduced social and health expenditure** due to higher well-being and health in sustainably conceived living and working environments or in properly retrofitted buildings[4] and infrastructures;
- **Less pollution, better and safer living environments, and thus higher quality of life** through better indoor- and outdoor environmental conditions;
- **Increased physical/crime safety and traffic safety** through properly designed public spaces and mobility infrastructures;
- **Higher employee productivity, less absenteeism, better recovery in hospitals, etc.** through healthy, comfortable and pleasant indoor environments in buildings, providing appropriate indoor air quality and (natural) ventilation, applying low-emission building materials, providing daylight access, solar control (both allowing or blocking the sun depending on conditions), attractive outside views, green outdoor spaces at short walking distance;
- **Less traffic congestion with related economic costs and health gains from active transport modes** while realising a modal shift towards sustainable transport modes, including reductions in health expenditure;
- **Higher real estate value** of energy-efficient (renovated) residential and non-residential buildings including 'futureproofedness' regarding future (energy) requirements. These gains may be direct (related to the building itself) or indirect (related to its environment). An example of the latter aspect is the higher price of real estate in streets with trees, compared to the same type of buildings in streets without trees[5];
- **Better, more social and beautiful public spaces**: in particular by reducing the reliance on private car or motorbike use – meaning both a reduction of travelling and parked cars or motorbikes – public space can regain a multitude of qualities, restoring it as a place for encounter, playing and relaxing. This comes in addition to related safety and health benefits stemming from reduced private car and motorbike use;

[4] A rare example where project actors have assessed the (mental) health co-benefits of living in healthier and more energy-efficient, retrofitted homes is Warm Homes Oldham: https://www.theguardian.com/society-professionals/2016/nov/30/guardian-public-service-awards-2016-sustainability-winner-warm-homes-oldham

[5] See e.g. https://greenblue.com/gb/how-trees-increase-property-values/

- **Reduction of the urban heat island** by green-blue infrastructures in cities, reducing ambient temperatures in the urban tissue while at the same time diminishing the active cooling loads in buildings and transport. In a similar vein, green-blue networks can improve **flood risk management,** help to **replenish groundwater tables**, increase local **biodiversity** and improve **air quality** if properly designed[6]**.** They thus play an important role in climate adaptation. In addition these green-blue assets increase the mental well-being of citizens apart from the primary functions for which they were designed (parks, recreational areas, gardens, green façades, canals, sports fields, …);
- **More local employment in green sectors** (energy-efficient building renovation, renewable energy production, public transport, local food production based on sustainable agricultural methods, …); hence less financial flows outwards ('money leaks') and more **re-injection of resources** into the local economy;
- **Increased opportunities for the circular economy**, where many lower-skilled jobs can also be created in disassembly, recovery, repair and revaluation;
- **Less critical dependence on international supply chains and thus more resilience** by closing loops locally as much as possible, e.g. through urban mining and circular economy;
- **Less dependency on process water,** for example for energy production: 'Renewable resources such as solar and wind need little or no water resources when compared to fossil fuel power generation which needs water for cooling purposes. This could make a huge difference to water scarce countries that rely on freshwater for cooling in power generation.' [7]

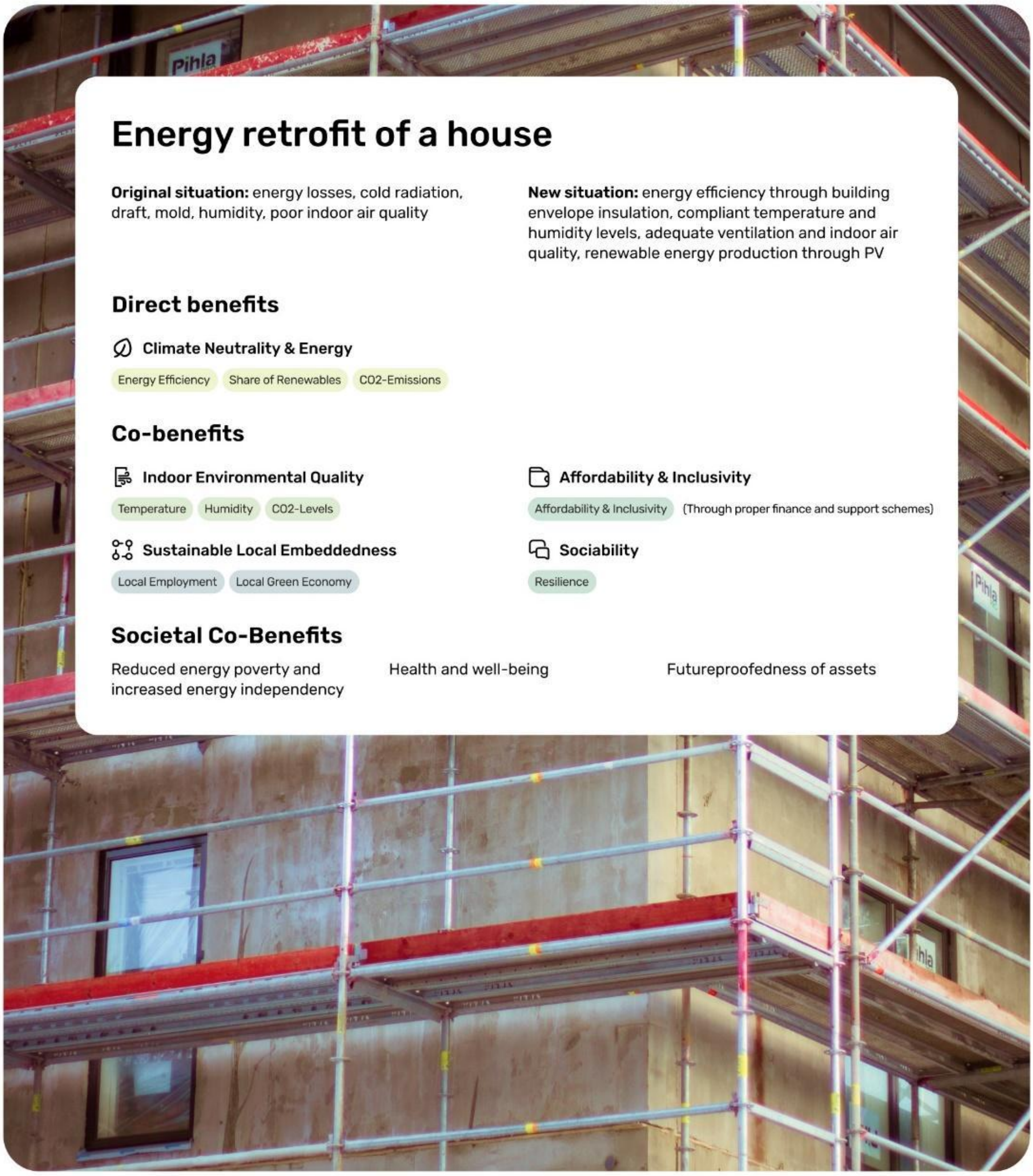
1.5.3 Three examples of impact chains and co-benefits

Three selected cases illustrate how CrAFt's NEB Impact Model can be used to identify co-benefits, together with decision makers and stakeholders. The set of identified co-benefits in the examples is not necessarily exhaustive, and we believe that future projects could realise even more such co-benefits, building on the experiences within their own or other cities.

[6] E.g. trees in narrow streets may rather contain air pollution in those streets, so both the mobility design as well as the greenery design must account for such risks.
[7] Channell, J. et al. / Citigroup (2015), Energy Darwinism II: Why a Low Carbon Future Doesn't Have to Cost the Earth, p. 36, available at https://www.ourenergypolicy.org/wp-content/uploads/2015/08/ZTGI.pdf

Example 1: Energy retrofit of a house

Energy retrofit of a house not only results in energy and CO_2-emission savings, the house also becomes more comfortable and healthy to live in (indoor environmental quality), more affordable in terms of energy bills, and better secured against energy poverty. This implies increased health and well-being for the inhabitants, and thus corresponding health care cost savings for society as a whole. Renewable energy production may be applied as a retrofit measure, adding to the win-wins. This also holds for society, as both energy efficiency and renewable energy production increase energy autonomy. The retrofit works support the local economy and employment; because that local economy grows in a greener direction, human capital and sustainable local embeddedness can be leveraged in that direction too. The overall building stock is being future-proofed, adding to its sustainable asset value.



Energy retrofit of a house

Original situation: energy losses, cold radiation, draft, mold, humidity, poor indoor air quality

New situation: energy efficiency through building envelope insulation, compliant temperature and humidity levels, adequate ventilation and indoor air quality, renewable energy production through PV

Direct benefits

Climate Neutrality & Energy

Energy Efficiency · Share of Renewables · CO2-Emissions

Co-benefits

Indoor Environmental Quality

Temperature · Humidity · CO2-Levels

Affordability & Inclusivity

Affordability & Inclusivity (Through proper finance and support schemes)

Sustainable Local Embeddedness

Local Employment · Local Green Economy

Sociability

Resilience

Societal Co-Benefits

Reduced energy poverty and increased energy independency

Health and well-being

Futureproofedness of assets

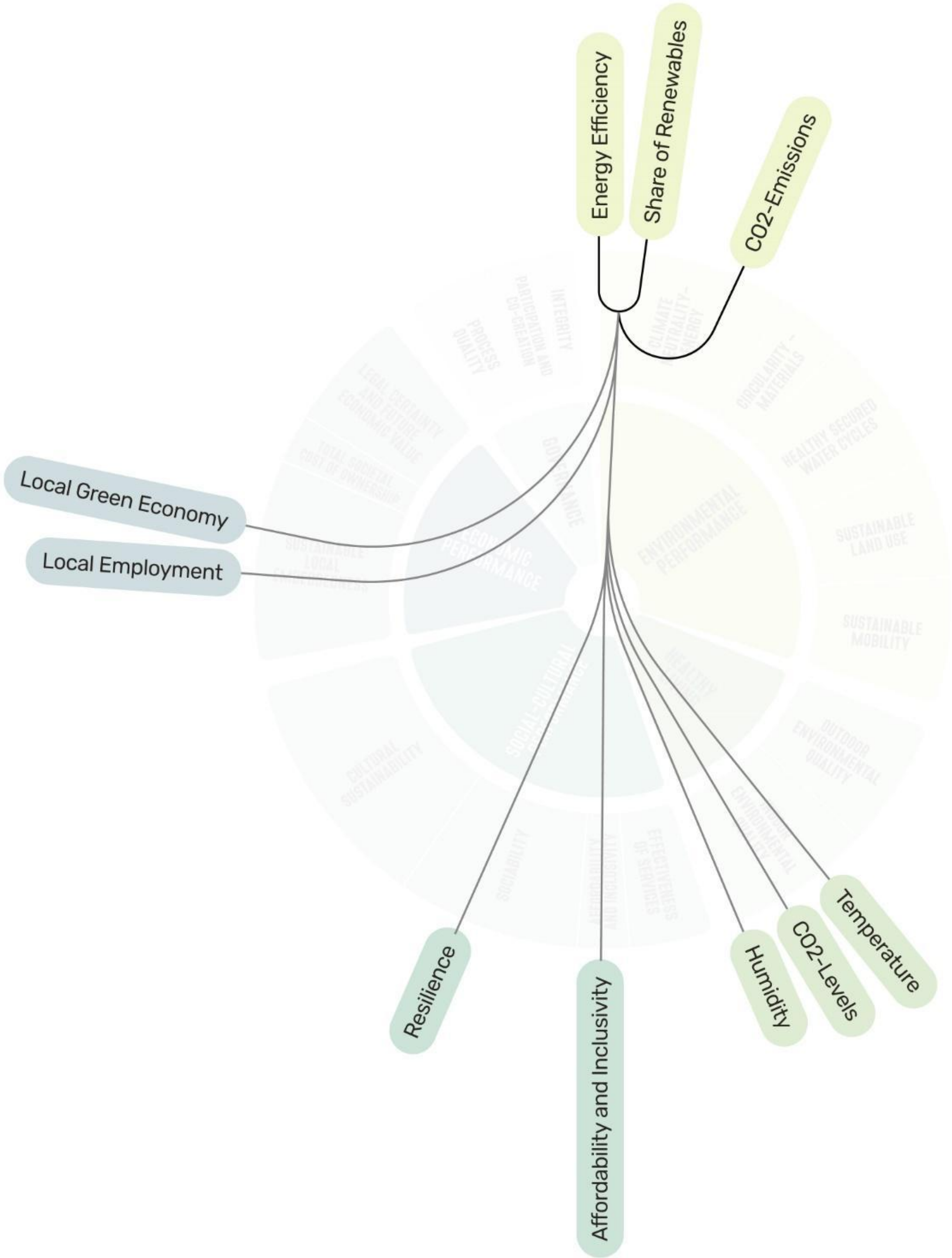
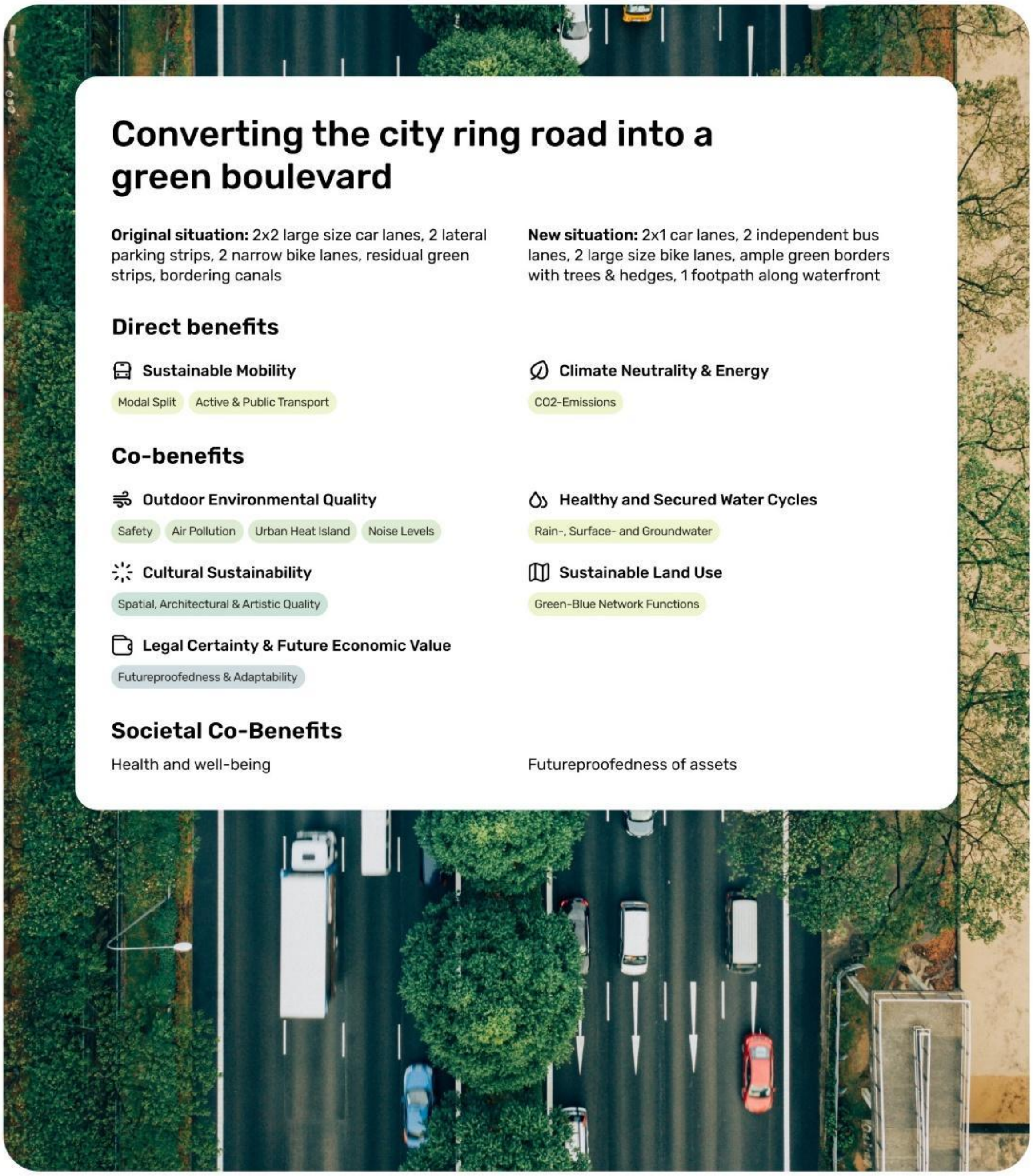


Figure 3: Summary box and interference diagram for retrofit of a house.

Example 2: Converting the city ring road into a green boulevard

Converting the city ring road into a green boulevard: imagine we transform the 2x2 wide car lanes, the car parking strip on each side, 2 narrow biking paths plus the strips of residual green of a cities' ring road into an urban boulevard with 2x1 narrow car lanes, 2 separate bus lanes, 2 wide cycle paths and all of that bordered by rows of trees, shrubs and hedges. This improves sustainable mobility: less space for cars, better conditions for walking, biking and public transport. CO_2 emissions go down. It also increases physical/traffic safety because the volume and speed of cars is reduced. Air quality improves. Noise levels go down. Land use is greener, allowing for biodiversity to increase. Green-blue networks are better valued. Rainwater can better penetrate the ground. The greening operation also helps to reduce the urban heat island: asphalt is a heat collector; green is the opposite. Landscape quality and scenic beauty are increased, and public space becomes more sociable.



Converting the city ring road into a green boulevard

Original situation: 2x2 large size car lanes, 2 lateral parking strips, 2 narrow bike lanes, residual green strips, bordering canals

New situation: 2x1 car lanes, 2 independent bus lanes, 2 large size bike lanes, ample green borders with trees & hedges, 1 footpath along waterfront

Direct benefits

Sustainable Mobility

Modal Split | Active & Public Transport

Climate Neutrality & Energy

CO2-Emissions

Co-benefits

Outdoor Environmental Quality

Safety | Air Pollution | Urban Heat Island | Noise Levels

Healthy and Secured Water Cycles

Rain-, Surface- and Groundwater

Cultural Sustainability

Spatial, Architectural & Artistic Quality

Sustainable Land Use

Green-Blue Network Functions

Legal Certainty & Future Economic Value

Futureproofedness & Adaptability

Societal Co-Benefits

Health and well-being

Futureproofedness of assets

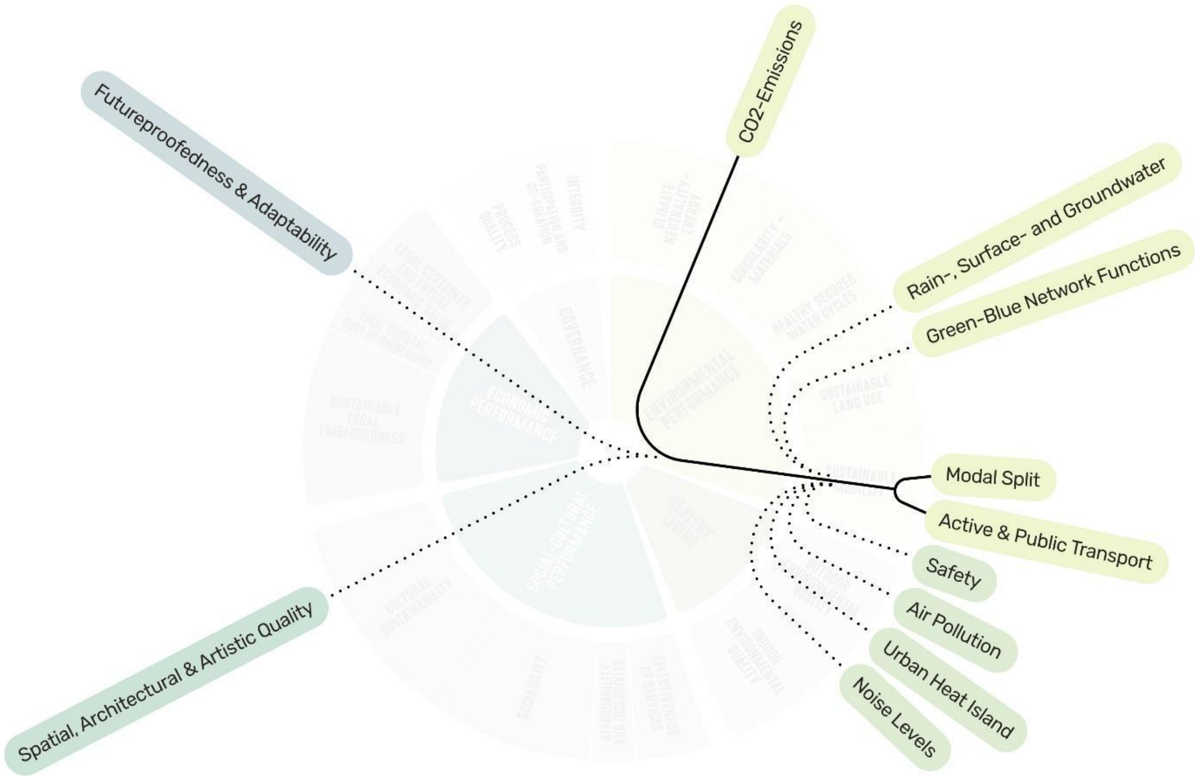


Figure 4: Summary box and interference diagram for converting a city ring road into a green boulevard.

Example 3: Rolling out renewable energy infrastructures

Rolling out renewable energy infrastructures not only helps to reduce CO_2 emissions and increase energy autonomy, doing so also requires a local skilled workforce to build, exploit and maintain the infrastructure. By not spending money on fossil fuels, a money leak outward of the local economy is stopped and the financial benefits can thus be re-injected in the local economy, supporting an upward spiral. The local economy needs capacity for this, thus creating demand for more local human capital. Both highly and lowly skilled workforce is needed, increasing the inclusivity of the economy. Affordability of energy is better guaranteed by the local RES assets. Future-proofedness and asset value also increase by realising the RES infrastructures, and in a greener and future-proofed city the general health and well-being levels will increase. An energy cooperation or energy community to manage the assets may further support community business models, which in turn provide for stronger local anchoring, co-creation and social inclusion.

Rolling out renewable energy infrastructures

Original situation: dependency on foreign fossil fuels

New situation: local, community based renewable energy production

Direct benefits

Climate Neutrality & Energy

Share of Renewables | CO2-Emissions

Co-benefits

Affordability & Inclusivity

Affordability & Inclusivity (Through proper finance and support schemes)

Sociability

Resilience

Sustainable Local Embeddedness

Local Employment | Local Green Economy | Community Business Models

Cultural Sustainability

Identity & Belonging

Legal Certainty & Future Economic value

Futureproofedness & Adaptability

Participation and Co-Creation

Participation and Co-Creation

Societal Co-Benefits

Reduced energy poverty and increased energy independency

Health and well-being

Futureproofedness of assets

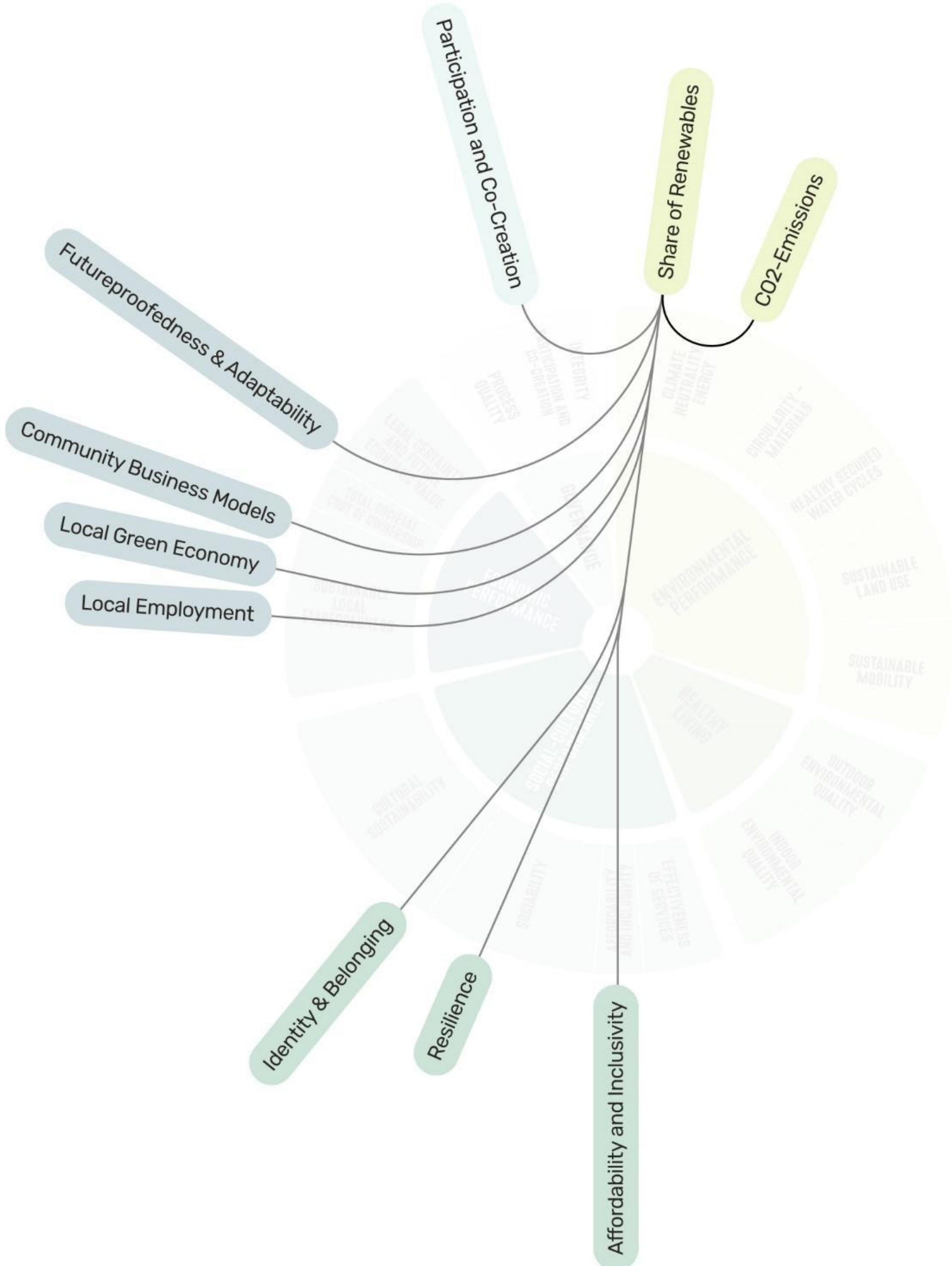


Figure 5: Summary box and interference diagram for rolling out renewable energy infrastructure through a community initiative.

2. Where to start?

The Impact Model is preferably set to work from the **early programming phases** of a project, process or intervention.

In this way, project actors and stakeholders can chart a maximum of potential co-benefits and coupling opportunities; while conflicting interests can be identified early for developing a solution. At that moment, the program brief can still be reviewed to allow for adjustments; and a more integrated project can be built from there.

In line with the suggestions from CrAFt's CookBook/ the Smart Cities Guidance Package[8], performing a preliminary mapping exercise is therefore a good starting point. A more profound understanding of the intervention's goals, challenges and opportunities can be acquired. The broader physical and socio-economic context, as well as the concerned stakeholders, can be charted. At this stage, the Impact Model will help to assure the exhaustivity of the mapping exercise by referring to all the project's possible impacts and interlinked effects.

While performing the mapping process, it is recommended to consult all relevant stakeholders about the project or intervention. After this consultation, key stakeholders can be identified and invited to further explore and co-create solutions.

In the subsequent deliberation and co-creation process, the Impact Model can continue to help identify all aspects that need to be addressed, to support the necessary trade-offs, and to exploit interlinkages for realising a maximum of co-benefits.

Both the mapping exercise and the subsequent development process require a proper governance format in order to be successful.

2.1 From small to big: selecting a governance format

For large scale interventions, setting up a well-thought governance process will make a substantial difference.

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[8] The upcoming CrAFt CookBook is created based on the 2019 Smart Cities Guidance Package, and updated with input from the CrAFt Cities and NEB Alliance, to align with NEB values of beauty, inclusiveness, sustainability and local collaborative governance. A summary of the original 2019 version of the Smart Cities Guidance Package is available at https://smart-cities-marketplace.ec.europa.eu/insights/solutions/smart-cities-guidance-package-summary

Hereby, 'Nearly all successful climate-neutral and smart city projects are founded upon mutual collaboration between local administrations, research institutes, industry, and citizens, local businesses and other local actors.' [9]

Good management of this collaboration is paramount. The leading person(s) for this process may, for example, be city administrators with a politically approved mandate for organising cross-silo collaboration, a project intendant, or the manager(s) of a special purpose vehicle.

Depending on the scale level of the intervention, a set-up with dedicated working groups like thematic cells, climate tables or work benches may be instrumental. Process facilitators can enhance the effectivity of these working formats; hereby the facilitators should themselves have sufficient understanding of the challenges and opportunities at stake so that they can guide participants throughout the co-creation process.

Examples of governance vehicles created for this type of city-level work are Sonderborg's Project Zero[10] and Leuven's climate action platform Leuven 2030[11].

For smaller projects or interventions, a leaner process design will suffice. However, the same principles of good process design hold. All concerned stakeholders must have the possibility of contributing in a proper way, considered from their position; while persons in charge of the process must have a cross-domain competence in order to facilitate the development of an integrated project that is more than the mere sum of its parts.

Extensive guidance for the set-up of NEB-inspired interventions can be found in CrAFt's CookBook. The forthcoming CookBook deals with all stages of the process, beyond the initial steps described here.

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[9] Cited from Borsboom-van Beurden, J. et al. (2020), Climate-neutral & smart city guidance package - a summary, Smart Cities Marketplace, p. 11

[10] Sonderborg's Project Zero: https://www.projectzero2029.dk/en/

[11] Leuven's climate action platform Leuven 2030: https://www.leuven2030.be/

3. The Impact Model in detail

The following table summarises the overview of 5 pillars, 17 impact categories and 46 suggested indicators.

The top-down sequence in this list corresponds to the clockwise order in the graphical diagram of Figure 2.

A green number indicates that an indicator is on the edge of its own impact category and the previous or next one (indicated in brackets), and is therefore related to both. In the graphical diagram, this indicator is positioned between the corresponding impact category sectors.

NEB basic impact category		Indicators
(Space)		
Environmental performance		
1	Climate neutrality - Energy	Energy efficiency
		Share of renewables
		Energy flexibility
		CO_2-emissions
2	Circularity - Materials	Life cycle analysis (1)
		Circularity
3	Healthy, secured water cycles	Drinking water
		Wastewater
		Rain-, surface- and groundwater
4	Sustainable land use	Green-blue network functions
		Biodiversity & ecosystem value
		Location & space use (5)
5	Sustainable mobility	Modal split
		Active & public transport

Healthy living		
6	Outdoor environmental quality	Safety (5)
		Air pollution
		Urban heat island
		Noise levels (7)
7	Indoor environmental quality	Temperature
		CO2-levels
		Humidity
Social-cultural performance		
8	Effectiveness of services	Diversity & accessibility of services
		Digitalization
9	Affordability and inclusivity	Affordability and inclusivity
10	Sociability	Social capital
		Social networks
		Resilience
		Social innovation
11	Cultural sustainability	Identity & belonging
		History & heritage
		Cultural value & diversity
		Spatial, architectural & artistic quality
		Arts mobilisation
Economic performance		
12	Sustainable local embeddedness	Sustainable tourism (11)
		Human capital

		Local employment
		Local green economy
		Community business models
13	Total societal cost of ownership	Total societal cost of ownership
14	Legal certainty and future economic value	Futureproofedness & adaptability
		Regulatory stability & foreseeability
		Innovation support
Governance		
15	Process quality	Institutional capital
		Governance setup
16	Participation and co-creation	Participation and co-creation
17	Integrity	Reflexive governance

Table 1: CrAFt's NEB-inspired Impact Model basic impact categories and suggested indicator set.

The next paragraphs briefly explain what the indicators (can) stand for. As stated earlier, the set is aiming to be inspirational. Project actors can work with their own corresponding indicators; while additional indicators can be brought in to refine both the assessment and the steering (see also Section 4: Putting the model to work).

More indicators than the 46 listed above are already included in the discussion. Hereby the additional indicators represent evident extensions of the basic set, as the 46 must be regarded as the 'minimum viable product': less indicators would start to jeopardise the integrity of the assessment if we are aiming at integrated sustainability.

The discussion of the indicators is qualitative. No baseline or target values are listed yet. The latter can best be established for a specific location and context, or they can be adapted from existing strategies, standards or monitoring systems that are in use in cities[12].

3.1 Impact Category 1: Environmental Performance

3.1.1 Climate neutrality – Energy

Additional key concepts: energy efficiency, renewable energy, flexibility, storage, positive energy districts.

Full climate neutrality is difficult to define and to assess, as it concerns all energy, material and water streams with their direct and indirect contributions to the greenhouse gas emissions of a project, development or activity. Hereby conventional system boundaries indicate where such assessment stops to include further downstream impacts of the project or activity under scope.

Energy includes (1) the amount of energy used in buildings, infrastructures and transport and (2) its environmental quality. The first parameter is optimised by reducing energy use to a level that is environmentally optimal while, as much as possible within the current economic paradigm[13], being economically feasible or profitable. This is the '**energy efficiency** first' principle. The second parameter is optimised by moving to 100% **renewable and/or sustainable energy sources**.

[12] A completely worked out example, similar to the present indicator set and based on MMSA can be found in: Vandevyvere, H. (2010), Strategieën voor een verhoogde implementatie van duurzaam bouwen in Vlaanderen. Toepassing op het schaalniveau van het stadsfragment (Strategies Towards Increased Sustainable Building in Flanders. Application on the Scale of the Urban Fragment), PhD Dissertation, K.U.Leuven, https://lirias.kuleuven.be/bitstream/123456789/269336/1/ManuscriptLirias.pdf. An English summary is available in: Vandevyvere, H. (2013), Evaluating the Sustainable Performance of an Urban District: Measured Score or Reflexive Governance?, in: International Journal of Sustainable Development & Planning, Vol. 8, No. 1, p. 36–58, https://doi.org/10.2495/SDP-V8-N1-36-58.

[13] In an ideal scenario, environmental and economic boundary conditions are fully aligned towards the same goals (carbon neutrality, circularity). This could imply, for example, that 'externalities' are fully accounted ('internalised') in the price of products and services, guaranteeing that no burden shifting towards the environment or towards weaker socio-economic groups occurs.

Taking into account thermodynamics and urban metabolism principles, a third principle of (3) **cascade use** can be introduced[14]. Hereby waste energy from one application can be used as input energy for another application, thus reducing overall primary energy demand and introducing another optimisation step.

And last, (4) **flexibility** is an optimisation mechanism that makes use of energy buffering/storage, exchange of energy streams, demand side management and sector coupling (heat & cold versus electricity) to further optimise the energy use in a district, city or region.

Current work on an EU-wide definition framework for *Positive Energy Districts* explicitly addresses the three principles of energy efficiency, renewable energy input and flexibility[15]. Aspects of cascade use are hereby implicitly included, e.g. through sector coupling and the exchange of energy streams; it may however be recommendable to explicitly address cascade use because thermodynamic optimisation of energy systems (assessing energy quality beyond mere carbon neutrality) is important as a complement to considering energy quantities[16].

The present approach minimises **CO_2-emissions related to energy use** in an indirect way, by optimising the energy use with a cocktail of strategies (efficiency, renewable production, cascading, flexibility). In this way it is, through application of the four strategies, a richer approach than considering energy use from a carbon intensity point of view alone.

A more complete emission assessment, mostly applicable to city-wide interventions, considers all **greenhouse gas emissions**, among which the most important are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the F-gases. Accounting can be performed according to NetZeroCities' guidelines

[14] This leads to a revised *trias energetica* as described in Tillie, N.; van den Dobbelsteen, A.; Doepel, D.; de Jager, W.; Joubert, M.; Mayenburg, D. (2009), REAP Rotterdam Energy Approach and Planning: Towards CO_2- Neutral Urban Development.
[15] JPI Urban Europe: https://jpi-urbaneurope.eu/ped/; Vandevyvere, H.; Ahlers, D.; Wyckmans, A. (2022), The Sense and Non-Sense of PEDs—Feeding Back Practical Experiences of Positive Energy District Demonstrators into the European PED Framework Definition Development Process. Energies, 15, 4491. https://doi.org/10.3390/en15124491
[16] Vandevyvere, H., Stremke, S. (2012), Urban planning for a renewable energy future: methodological challenges and opportunities from a design perspective, in: Sustainability, Vol. 4, No. 6, p. 1309-1328

and indicator set[17], the Greenhouse Gas Protocol[18], and/or to the standard in use by the local, regional or national authority (defined in turn by EU directives on emissions reporting[19]).

3.1.2 Circularity - Materials

Additional key concepts: urban mining, urban metabolism, doughnut economics.

In a similar vein as for climate neutrality, full circularity involves a complex interplay of direct and indirect aspects of materials (and energy plus water) use. Different rules apply to different streams; e.g. water effluent should not necessarily be as limited as possible, but certainly as clean as possible.

In a more narrow sense, **circularity** can be reached by assuring that all material loops under scope are fully closed. The goal is to minimise the negative environmental impact of materials use, and to arrive at a maximum of circularity within the urban metabolism. This implies locally respecting the limits imposed by the global ecological (and spatial) carrying capacity. In addition to reducing, reusing and recycling materials (and designing them to optimise these strategies), urban mining can be used to extract raw materials from used products, buildings and infrastructures.

Circularity is one possible means of minimising environmental impact, but not necessarily a goal in itself for this aspect. Assessment of material streams with regard to environmental impact is indeed best served through an **LCA (life cycle analysis)** and/or MFA (material flow accounting) analysis. However, circularity also targets resource scarcity, conservation, materials independency, etc. which are goals extending beyond the mere environmental impact as assessed through an LCA[20].

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[17] Work Package 2 of NetZeroCities: https://netzerocities.eu/results-publications/; and in particular https://netzerocities.eu/wp-content/uploads/2023/01/D2.4-Comprehensive-indicator-framework_v3.pdf

[18] Greenhouse Gas Protocol: https://ghgprotocol.org/ - also referred to by NetZeroCities

[19] https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-made-cutting-emissions/emissions-monitoring-reporting_en

[20] For a discussion of the extension of the scope of LCA to resource depletion, see e.g. Klinglmair, M., Sala, S. & Brandão, M. Assessing resource depletion in LCA: a review of methods and methodological issues. Int J Life Cycle Assess 19, 580–592 (2014). https://doi.org/10.1007/s11367-013-0650-9

Doughnut economics[21] are a model that combines ecological carrying capacity with socially responsible servicing (a basic level of service for all, social justice, 'leaving no one behind' in Green Deal terms). The doughnut model is used by cities like Sydney, Berlin, Melbourne, Brussels and Amsterdam[22]. Similarly, **Social LCA (S-LCA)**[23] includes social impacts of production and consumption processes as a complement to evaluating the mere environmental impacts. Combined methods like doughnut economics and S-LCA provide for integrated assessments, guaranteeing a more holistic approach for assessing sustainability.

3.1.3 Healthy, secured water cycles

Additional key concepts: soil-, surface- and groundwater quality, climate adaptation, nature restoration, buffering and infiltration, flood risk control, nature-based solutions.

Healthy, secured and sustainable water cycles include 2 main aspects: (1) responsible use and management of drinking water, rainwater, and greywater, and (2) accommodating for climate change adaptation, nature restoration and buffer capacity in order to mitigate the negative effects of both extreme rainfall and extreme drought.

Drinking water consumption expressed as use per person per day is to be minimised without jeopardising required servicing levels. **Rainwater** use is to be maximised (in applications where it replaces the use of drinking water) without jeopardising supplies to nature and to underground aquifers. Disconnecting rainwater from the sewage system is always recommended; direct use or resupply to nature/the underground can thus be maximised. **Greywater** (from residential use, from industry) can be recycled or upcycled, and any residual heat can be extracted for reuse into the built environment. An optimisation will need to identify scale advantages: is it environmentally and economically preferable to purify water at a community plant or at the scale of individual buildings? This can be clarified through LCA and LCC (life cycle cost) assessment.

Climate adaptation measures regarding water include the use of **green-blue networks and absorption and buffering capacity** in order to mitigate the adverse effects of both extreme rainfall and drought. Taking measures to **improve the**

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[21] Raworth, K. (2017), Doughnut economics : seven ways to think like a 21st-century economist.

[22] https://doughnuteconomics.org/stories/93

[23] E.g. https://www.social-lca.org/ and https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca/

quality of surface water and to feed groundwater tables are equally recommended.

3.1.4 Sustainable land use

Additional key concepts: urban density, brownfield redevelopment, location choice, nature-based solutions, biodiversity, nature restoration and regeneration, ecosystem services, soil sealing, blue-green infrastructures, flood control, water quality

Land use in this context refers to the characteristics of the project site (and not to land use for e.g. extracting building materials). It includes (1) location - the right function or mix of functions at the right place; (2) space use; and (3) quality of local ecosystems.

Location refers to the inherent sustainability of the project location: appropriateness, centrality and accessibility. Is it the right programme at the right place? Is it reachable by sustainable transport modes?

Space use regards the redevelopment rate, where (brownfield) redevelopment is preferred over greenfield development, as well as urban density. Urban density should not be maximised, but optimised to a level that suits the project's functions in its wider urban context.

Quality of local ecosystems regards the conservation, restoration, creation and compensation of local ecosystems, **biodiversity** and the underground (hydrology and geology, with as a goal minimal disruption by the project).

Effective **green-blue networks** are one way to optimise different parameters of sustainable land and water use at once, and thus to capitalise on several co-benefits like an improved water cycle, more biodiversity and less urban heat island; but also on aspects of well-being like providing recreational green space for the inhabitants of densely populated areas and foreseeing safe and comfortable infrastructures exclusively reserved for active transport (walking and biking).

3.1.5 Sustainable mobility

Additional key concepts: modal shift, physical activity, congestion, air quality, spatial organisation

Mobility induces 'in-between buildings' impact. Because of its current negative environmental impact and the way this impact has been structurally anchored in urban spaces, infrastructures, social habits and economic functions, turning mobility into sustainable modes is a major societal challenge.

Assessing its environmental quality is proposed by evaluating the proximity and accessibility of an urban centre (in order to first reduce the mobility demand following a 'trias' approach), the servicing level by active and public transport, the adopted parking norms in urban environments, and the maturity of mobility as a service (MaaS) and e-mobility infrastructure roll-out (for all e-modes including e.g. shared cars, shuttles, cargo bikes, etc).

Proximity and accessibility of an urban centre/urban services regards the distance to a (local) centre providing (basic) services. This aspect may be instrumentalized through a model like the '15 minute city'.

For the **servicing level by public transport** a distinction can be made between primary, highly efficient public transport connections versus secondary connections, in order to properly value the effectiveness of the public transport functions.

Servicing level by active transport regards the quality and effectiveness of walking and biking infrastructures; convenience, safety, health and comfort are important factors to consider. Servicing levels of both public and active transport are instrumental in drawing people away from individual motorised transport – mostly the car. Even in an electrification scheme, it remains important to reduce car use and facilitate a **modal shift** to the more sustainable transport modes. The **modal split** is an indicator to steer these efforts. However, an appropriate modal split is location and context dependent and shall be carefully researched before implementation.

Parking norms for dwellings and offices are another leveraging instrument to influence the (share of) car use through urban design. Parking norms for cars shall usually define maximum values, while parking norms for sustainable transport modes like bikes shall by contrast define minimum thresholds.

MaaS (Mobility as a Service) and e-mobility level (suggested indicator with regard to the basic indicator set) assesses the provision level of shared, multi-modal mobility solutions, like last-mile services, as well as the charging infrastructure for all types of e-vehicles, including electric cars, (cargo) bikes and others.

3.2 Impact Category 2: Healthy Living

Sustainable living and working environments require a good indoor and outdoor environmental quality. This category could be considered as a hinge between the technical-environmental and the social aspects. It reflects how a physical environment provides the basic quality of life functions for its users and inhabitants.

It includes two subdomains: outdoor and indoor environmental quality.

3.2.1 Outdoor environmental quality

Additional key concepts: Outdoor environmental quality relates to outdoor comfort, health, air quality and safety. The latter includes traffic safety, physical safety, e.g. in terms of assuring physical integrity, risks for children and elderly people or protecting residents from flooding, and crime related safety.

Physical safety including risks related to physical integrity, crime, or risks for children and elderly people. Social control helps to increase physical safety and should be a parameter of good urban design. We may cite Jane Jacobs in her seminal work on *The death and life of great American cities*: *'The first thing to understand is that the public peace - the sidewalk and street peace - of cities is not kept primarily by the police, necessary as police are. It is kept primarily by an intricate, almost unconscious, network of voluntary controls and standards among people themselves, and enforced by the people themselves'* [24]

For **local air quality**, a proxy can be used by assessing local NO2-concentrations and comparing these to established norms or standards. **Noise levels** may for example be addressed through the WHO's L-level standards. One important distinction is between noise levels during the day, versus the night. **Traffic safety** remains a form of physical safety, but given the importance of mobility in realising sustainable and liveable environments a distinct address is recommended.

Outside temperatures can soar in cities during warm weather, creating an **urban heat island (UHI).** Different strategies can be applied to reduce the UHI including providing for more green cover and water parties in the city, choosing building and road surface materials that have higher albedos (i.e., lighter colours), and reducing the cooling load of buildings and vehicles so that less waste heat is ventilated into the urban environment. Passive measures, like insulating and

[24] Jacobs, J. (1961), The death and life of great American cities, Random House, p. 32.

sun-shading buildings or providing car parking space under rows of trees or PV-canopies, greatly help for the latter.

Other nuisance factors that may be considered are excessive wind, traffic congestion, vibrations (e.g. construction sites, industry, tram and bus lines), visual pollution (including unwanted shadow or excessive light, landscape damage), stench, emissions to ground- and surface water, emissions to the soil and building site related nuisances.

3.2.2 Indoor environmental quality

Additional key concepts: This category relates to indoor air quality and hygro-thermal comfort, acceptable noise levels, and the absence of disturbing vibrations.

The main suggested indicators are **temperature and humidity levels, indoor CO_2-concentrations and noise levels.**

Indoor air quality can also be jeopardised by the presence of **hazardous elements like volatile organic compounds (VOCs)** emitted by interior finishing materials and furniture.

Outside air pollution, e.g. from urban highways, may enter indoor spaces and cause similar detrimental conditions for the working and living conditions inside buildings.

3.3 Impact Category 3: Social-Cultural Performance

3.3.1 Effectiveness of services

Additional key concepts: universal design, diversity, green space per capita

This topic addresses the effectiveness of the core social services that are provided in a given urban context. It relates to the **functional mix, diversity and accessibility of services and amenities** for a particular location. Hereby one can refer to the basic functions as the 15-minute city model[25] promotes these - housing, working, commerce, health and childcare, education, and culture and leisure - complemented with access to green and open spaces at short distances, the latter being an important factor of well-being for urban dwellers.

[25] See e.g. C40 Cities: https://www.c40knowledgehub.org/s/article/Why-every-city-can-benefit-from-a-15-minute-city-vision?

Sustainable settings provide for a healthy mix of services and amenities with easy, low-threshold and universal access. This is opposite to monofunctional zoning. Recommended maximum distances to all these types of services exist and can be assessed[26].

As **digitalization** is becoming ever more important, accessibility and quality of digital services needs to be guaranteed, specifically taking into account the accessibility for social groups that have a reduced capacity for using digital information channels and tools.

The range of digital services to consider may be extensive, starting from specific communication strategies towards different target groups up to the use of digital twins for the management of entire cities.

3.3.2 Affordability and inclusivity

Additional key concepts: *social equity, social justice*

Apart from the physical accessibility of services and amenities, their level of **inclusion, affordability and social fairness** (the EU Green Deal pillar 'Leaving no place and no one behind') is a primary social quality.

Affordability implies, for example, that a proper share of social and/or affordable housing is available, while variety in the offer of housing types must also be seen as a factor that increases the level of integration and inclusivity. **Inclusivity**[27] assures that all social or age groups, people with reduced mobility or vulnerable groups have good access to all needed services, and are properly being represented and effectively involved as users or stakeholders in related institutions and processes.

3.3.3 Sociability

Additional key concepts: *social cohesion, adaptive capacity*

Sociability refers to the ability of a place to support and foster healthy, lively social exchanges and social networks; in other words, how the urban fabric supports a prosperous social life. Urban (regeneration) projects should therefore at least aim at minimally disrupting valuable existing social structures and, preferably, leverage on them while realising the urban transformation. To this end

[26] See technical details in Vandevyvere 2010 (op. cit.)

[27] See the CrAFt Inclusiveness and Diversity Management Plan, available at https://craft-cities.eu/results-publications/

project initiators can set up specific stakeholder- and co-creation processes with local actors, building on the existing social capital.

Checking the degree to which an urban environment is child- or elderly-friendly, and/or has universal access (e.g. through universal design) helps to assess additional aspects of sociability.

In a transition context as the one we currently experience, sociability becomes a highly dynamic quality that needs future-proofing. Therefore, the capacity of a place to **adapt to future conditions** in a socially sustainable way is crucial. **Resilience** is a primary aspect to include in this perspective; but also characteristics such as the intrinsic quality of housing, changing demographics, or the design of car-based facilities, may be subject to **future-proofing**[28].

Social innovation supports future-proofing social functions and is an important enabler in the perspective of today's societal challenges.

In this way, a strong **local social capital** can be built, both in terms of social well-being and of education. This is a bridge to indicators describing **education and public health**, which are often included in sets of (urban) indicators.

3.3.4 Cultural sustainability

Additional key concepts: environmental and cultural awareness, self-fulfilment, sense of belonging, appropriation, cultural and creative capital, cultural diversity

Cultural sustainability spans a vast domain of aspects like cultural value and diversity, identity, belonging, history, heritage and traditions, and spatial and aesthetic quality. **Spatial quality** deals with spatial, landscape and architectural quality, including aspects such as:

- **Gradations** of public and private character, transitions between these spheres, buffer areas, and corresponding changes of scale;

[28] A good example of where this can go wrong are the many post-war housing towers built during the 1960's and 1970's throughout Europe, and that provided for a 'modern' and accepted solution regarding the housing needs of that time, but became an obsolete and even problematic asset after a mere 30 years of existence. A similar reflection could be made around car-based shopping areas and malls: apart from their environmental unsustainability, one must question if they provide for a valuable model of social interaction even if today they may be a (commercial) success built on a culture of consumerism. Both examples stand in contrast with numerous historic city centres throughout Europe and beyond that seem to be able to take a new, valuable life over and again, thanks to their inherent functional, social and cultural flexibility.

- **Articulation** of the different programmatic elements with respect to each other; in particular, the relation between buildings and infrastructures and the possible barrier effects of the latter;
- Meaningful **integration of green structures and green-blue networks** into the urban landscape;
- Visual **landscape quality and scenic beauty**;
- **Legibility and permeability** of the urban tissue;
- **Integration of different architectural concepts** in a given setting or master plan; and the articulation and integration of existing patrimony herein; and
- **Authenticity and architectural quality** of individual buildings.

Identity indicates the degree to which the built environment is loaded with **identity, culture and history – or at a higher level of abstraction, meaning**. That quality helps to assure long-term appropriation of the built fabric by its inhabitants and users: it 'has a soul'. This does not only have to be the case for places with a long history. 'Young' environments can quickly and successfully charge with relevant meaning for their inhabitants or users if they have been well designed and created, and subsequently been successfully taken into use. Apart from buildings and other infrastructure, the landscape itself can be a reservoir of identity, culture, history and meaning. Therefore good projects will leverage on that already present ***genius loci***[29].

Spatial quality and identity are different in the sense that some places with much identity may display poor spatial quality and vice versa – the latter situation potentially occurring in 'overdesigned' environments.

Cultural sustainability strongly relates to the role **the arts** can play in enhancing all of this – not only by creating beauty in the narrowest sense of the word, but also by promoting inclusiveness and diversity, mobilising, empowering and emancipating individuals and communities, nurturing local cooperation, and holding a critical mirror to society. In fact, the arts have fulfilled this role throughout history. This holds even more for the highly dynamic transition context that characterises every aspect of life today. By levering on social innovation and increasingly relevant social and cultural capital, NEB solutions can become fully appropriated by their users: they become part of the life people are aspiring.

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[29] Concepts as 'soul' and 'genius loci' may seem very difficult to discuss, let alone measure, yet a reflection around such aspects can be methodologically framed, see e.g. Norberg-Schulz, C. (1980), Genius Loci: Towards a Phenomenology of Architecture, Rizzoli.

Specific approaches to art can contribute to increasing social and cultural sustainability such as relational art, participatory art or community art.

In addition, cultural sustainability is not unrelated to economic and social factors. The arts, culture and creative sectors have the power to infuse life into abandoned urban areas (or buildings) and generate new social and economic dynamics. This is illustrative of the art's and culture's active position in the chain of impacts that projects and interventions can generate.

3.4 Impact Category 4: Economic Performance

3.4.1 Sustainable local embeddedness (including capacity)

Additional key concepts: competences, human and intellectual capital, empowerment, risk control capacity, adaptive capacity

Sustainable local embeddedness assesses the degree to which an investment or project inscribes itself meaningfully in the local economic tissue, with as a boundary condition that it supports sustainable economic activities. **Local temporary and permanent employment** relates to the number of qualitative jobs the project generates in both forms and how well these are anchored in the local labour market. **Educational/capacity building** projects can be linked to such efforts, thus increasing the local **human capital**. This can be complemented by **support to the local green economy**, or how the activity contributes to circular and climate-neutral functioning while reinforcing the local anchoring of such activities (providing, as much as possible, locally closed material and energy loops, locally produced food, nature-based solutions and biodiversity preservation).

Community-supportive business models move from an individual, simple short-term product or service towards more collective, complex and long-term oriented set-ups like micro district heating and cooling networks, shared renewable energy generation installations managed by local energy communities, sustainable collective- or co-housing, shared or collective mobility solutions including mobility-as-a-service (MaaS). Although the underlying composite business model is often more difficult to set up, such enterprises are now much needed (see also Section 4.2: How does the NEB Impact Model help to move beyond *business as usual*?).

Business models based on the cooperative company model can boost community building, help to build local economies, and maintain a for-profit mentality while sharing and reinvesting these profits into the community.

3.4.2 Total societal cost of ownership (TsCO)

Additional key concepts: equitable funding

By valuing investments through a Life Cycle Cost or Total Cost of Ownership approach, sustainable alternatives may win over investment-driven projects that often come with a short-term profit goal. This holds even more if social and environmental externalities are accounted of in the investment equation, a practice that is gaining more and more momentum: (1) accounting of externalities, i.e. all the (hidden) environmental and social costs and subsequently internalising them in the price tag, and reversely (2) including all secondary benefits for society. These benefits reach far beyond the mere financial-economic sphere, but can profit from a monetized pillar to convince decision makers such as politicians and investors.

A TsCO approach should therefore account for the (economic) benefits of:

- Higher energy independence, reduced energy poverty
- Higher materials independence and reduced waste volumes
- Reduced social security expenditure through increased well-being and health
- Less pollution, better and safer living environments and therefore a higher quality of life
- Higher productivity of employees, less absenteeism, better recovery in hospitals, etc. through healthy, comfortable and pleasant buildings
- More local and stable employment in green sectors (energy efficient building renovation, renewable energy production, public transport…)
- Less traffic congestion with related costs
- Higher real estate value of energy-efficient (renovated) residential and non-residential buildings; including future-proofedness with regard to future (energy) requirements.

3.4.3 Legal certainty and future economic value

Additional key concepts: flexible use of assets and multiple use of spaces, legitimacy, civic trust, political and institutional capital

This aspect deals with the **future-proofedness** of economic investments and enterprises, both from the viewpoint of **regulatory stability and foreseeability**, and from a perspective of **future economic value** – how much does the intervention or activity fit within a circular, climate-neutral society?

Many sustainable investments, for example in renewable energy generation capacity, are battered by obsolete legislation, legal uncertainties and changing regulatory frameworks. Lagging or unstable political steering is often an underlying cause hereof. In order to better facilitate the energy, climate and sustainability transition, **predictable, stable and long term (change) policies** are a necessity. Changes in regulatory frameworks should hereby foresee fair transition periods and mechanisms, allowing all concerned stakeholders to duly prepare for the new situations that will come into vigour. Investors that build sustainable assets must be sufficiently assured that their long-term investment horizon and related business case do not come under threat by possible regulatory changes in the future, but will rather be supported by such changes. In this way the related **risk profiles become acceptable for investors**, at least from a legal point of view.

Innovation support can provide for a specific form of legal certainty, and help to limit the risks related to highly innovative projects and developments. This means that the innovation risk is not only taken by the innovator itself, but also by the larger group of societal stakeholders that will co-benefit from the innovation. Innovation support does not only have to come via finance. **Legal sandboxes** can be considered as a non-financial example of innovation support. Their use should be properly set up in order to facilitate real breakthroughs afterwards (i.e. replication/upscaling within newly established regulation, based on the sandbox experiences).

The functional **flexibility and adaptability** of products with a long functional lifetime, like buildings and infrastructures, is another aspect that deserves scrutiny. This not only regards the assets themselves, but also the governance models that manage them. The split incentive problem is an example of a barrier in this regard.

Future economic value assesses **functional flexibility and adaptability**, and thus concerns an economic variant of future-proofedness. Buildings and infrastructures are products with a long to very long service life, and therefore must be designed to adapt, as smoothly as possible, to foreseeable changes in functional requirements. This helps to avoid suboptimal investments and wasted resources: the more functions an asset can dynamically assume over time, the more sustainable it becomes.

3.5 Impact Category 5: Governance

3.5.1 Process quality

Additional key concepts: institutional capital

Especially in a context of societal transitions, good governance processes make the difference. Good governance is needed both in the development phase of a solution, as well as in its operational phase. This is even more stringent in cases where complex (urban) projects are being developed[30] or community supportive business models must be put to work. Appropriately involving all concerned stakeholders in the governance process is a basic requirement, see also the following aspect.

Process quality measures the quality of the integrated process and project management, i.e. the effectiveness with which the project objectives are managed and turned into reality. Because the process quality in the development phase has a permanent effect on the performance of the realised project, this temporary aspect should be included in the assessment of the permanent quality of the project

Sustainable projects will often make use of alternative management concepts, for example for collective energy, mobility, water, green and waste handling infrastructures. These require a well-thought-out operation. Suitable business models, communication structures and related agreements are the basic components for successful exploitation.

When dedicated urban governance processes become well-anchored in the local transition landscape, they gain **legitimacy** and create **institutional capital**. This may further contribute to realising stable, long-term strategies beyond the short-term political cycles.

3.5.2 Participation and co-creation

Additional key concepts: stewardship, agency

Participation and co-creation examine the extent to which the various stakeholders participate in the decision-making process, in which form (e.g. up to co-creation or citizen control) and how this leads to solid support for the project

[30] Cf. 'A Positive Energy District is a process, not a product', Smart Cities Information System (2021), Positive Energy Districts Solution Booklet, p.51, https://smart-cities-marketplace.ec.europa.eu/insights/solutions/solution-booklet-positive-energy-districts

or the development. The participation format must be fit for purpose and can therefore take various forms[31]. As with process quality, participation is partly a 'temporary' indicator, although the participation process will preferably also find an extension in the use phase of the development. The score will therefore be best if the participation functions optimally in both the project and the use phase.

Well-designed participation also supports social fairness, as all involved actors can have their concerns expressed and taken into account. Duly covering the stakeholder field is an important aspect, in particular with regard to onboarding 'silent majorities', marginalised groups and other potentially underrepresented stakeholder groups.

3.5.3 Integrity

Additional key concepts: ethics, burden shifting, greenwashing, reflexive governance

Integrity checks in how far the project or development realises true sustainability, and in how far the share- or stakeholders' agendas, investments and actions support this. Greenwashing is a typical example where integrity is particularly low – sustainability is being claimed but other (unsustainable) goals are being served primarily. Burden shifting (to the environment, to certain social groups, to other locations) is another example where project integrity can be seriously jeopardised. An integrity check is thus instrumental in unearthing hidden agendas, project setup flaws, but also unwanted side effects. This requires, amongst others, the use of well-thought indicator sets for project monitoring.

An integrity check can be (periodically) performed through a process of **reflexive governance**. All stakeholders' interests (including vulnerable groups and even 'nature' or the environment as silent stakeholders) must hereby be considered. An integrity check is also instrumental for identifying clear conditions that must be met at all stages of the process, as well as for building and managing indicator sets for the Impact Model, to ensure aspectual completeness.

[31] Examples of models/methods that can support participation and co-creation are Arnstein's ladder of participation and other models built on the former such as Wilcox's level of participation theory and the framework developed by the Quality of Life Foundation (https://www.qolf.org/framework/).

4. Putting the model to work

4.1 How to plug in your own indicator set(s)?

Many of the above-described indicators will be familiar to potential users of the Impact Model.

The philosophy of the NEB Impact Model is that cities, project actors or other stakeholders can use their own corresponding or additional indicator sets instead, as long as a sound whole systems approach is being applied. The following guiding principles can help to underpin such an approach:

- Check the effectivity and exhaustivity of indicators with regard to assessing the impact category to which they belong. Suggested indicators in the NEB Impact Model are intended as an inspirational set that should cover most of the aspects requiring an address;
- Identify and fill gaps with regard to the entire range of pillars and impact categories. This can, for example, be done by charting and qualifying existing indicators in relation to the Impact Model diagram as shown in Figure 6.
- Set a proper baseline and target value for indicators that can be quantified;
- Reach out to domain specialists (these may also be expert users, citizens, NGO's, …) for additional input;
- Make sure all potential co-benefits are being charted;
- Account of local context parameters to enhance context-sensitivity;
- Assure that all potential stakeholder interests are addressed. This may also unearth additional co-benefits to be realised;
- Create an evidence base to support (political) decision making;
- Provide for coordinated or co-created qualitative assessments where quantitative indicators fall short of doing the job;
- At the same time, avoid over-burdening. If it is effective to use a simple indicator set to discuss and solve the essential questions at hand, then such an approach is preferred over installing a lengthy and burdensome monitoring process in which project actors are eventually inclined to drop out. The story line may be more important than the numbers, certainly at

the early stages of an intervention. Simple indicator sets also better support cross-disciplinary understanding and collaboration, as all participants in the process can get a good hold of what is being assessed.

- Check the integrity of the overall indicator set and make sure that it stands for a balanced approach, where specialist or sector bias is being avoided.

The Impact Model will thus help to identify essential leverage points for systemic change towards integrated sustainability, including climate neutrality and resilience, by addressing all the aspectual layers of sustainability (ecological, infrastructural, social, cultural, economic, aesthetical, legal, etc.) in a balanced way.

The Impact model can also be set to work for focused approaches, like Nature Based Solutions. In a similar vein, it will help to list potential co-benefits (or, reversely, to identify conflicting aspects needing a solution) and thus support an enhanced overall value proposition.

4.2 How does the NEB Impact Model help to move beyond business as usual?

In the present economic context, setting up an intervention that goes beyond established business models, procurement practices or subsidy schemes may prove to be particularly challenging. One way to overcome this hurdle consists of trying to **include (societal) co-benefits into the business case**.

For direct co-benefits like increased comfort or asset value, this may be more easily done than for societal co-benefits like better public health or increased traffic safety. An example of the latter is energy-retrofitted housing where the health and well-being of the inhabitants is drastically improving, resulting in proportional savings in public health expenditures.

From an investment point of view, complex interventions targeting at realising a larger set of co-benefits may require **hybrid financing**, mixing different types of public and private resources.

An experimental strategy for setting up such a scheme at the district scale is provided in the *Green Neighbourhoods as a Service* concept[32] put forward by Bankers without Boundaries[33]: At the investment side, a mix of private and public, repayable versus non-repayable capital is provided to build a project that

[32] https://www.bwb.earth/post/green-neighbourhoods-as-a-service
[33] https://www.bwb.earth/

includes community assets as an extension to the standard private development. This results in, expressed in BwB's terms, a mix of direct financial benefits, specific co-benefits and 'softer' co-benefits like a stronger local community or more well-being.

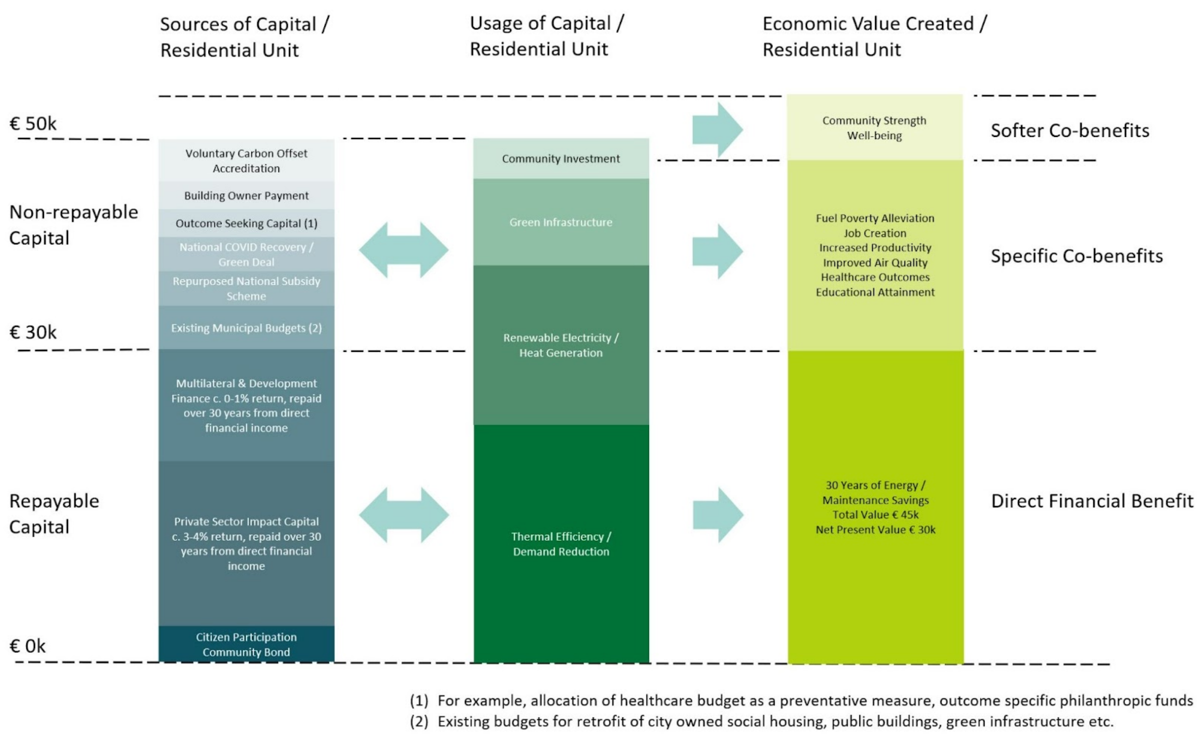

Figure 7: investment concept for 'green neighbourhoods as a service', as proposed by Bankers without Boundaries. Note that the specific co-benefits identified for this model coincide with (societal) co-benefits as they would be charted through the NEB Impact Model. Scheme adapted from BwB[34].

In this way, a corresponding strategy for moving away from the more restrictive business cases of today's established practices could include the following steps:

- Use the NEB Impact Model to identify, quantify and, where possible, **monetise** all the potential benefits and co-benefits of the intervention at stake;
- Identify all corresponding, possible **funding sources** whether they are public or private;
- Proceed to **include** as many as possible of these funding sources into the business case or value proposition;

[34] https://www.bwb.earth/post/green-neighbourhoods-as-a-service

- Get specialist help in **de-risking** the needed investments, especially if these are innovative. For investors, de-risking is a decisive commitment factor;
- Steer towards **T(S)CO-based investing** wherever possible, moving away as much as possible from the short termism of many established economic practices.

Hereby the most challenging step probably consists of drawing in specific funding sources, for example by obtaining a public investment share that accounts for the reduced social expenditures to be expected from the intervention. This is largely uncharted terrain, but a necessary condition to advance with community-based investment models.

4.3 Next Steps

The NEB Impact Model is currently being tested in cities participating in the CrAFt, NEB-STAR[35] and Re-Value[36] projects, and made available to other interested parties. Said projects have iteration loops that will continuously feed back the cities' and project's experiences into a fine-tuned NEB Impact Model. The Impact Model will furthermore be tested in cooperation with CrAFt's Sandbox and Reference Cities as well as with other cities and projects in the NEB Alliance. Assessment models, indicators and documentation methods of these initiatives will also be integrated into the Impact Model to create a common evidence base.

Alignment with the NetZeroCities Impact Framework and its associated Comprehensive Indicator Framework[37] is ongoing. This will assure that cities using NZC's framework have a seamless connection to the Impact Model. Similarly, the Impact Model is aligned with the NEB Compass and potential near-future assessment frameworks, in continuous dialogue with the Joint Research Centre.

The NEB Impact Model is geared at interventions covering a variety of scale levels (intervention, district, city), whereas NZC targets cities as a whole. This implies that the detailed application of the NEB Impact Model in a given smaller scale project may substantially differ from a city-level approach in terms of chosen indicator

[35] NEB-STAR website: https://nebstar.eu/

[36] https://re-value-cities.eu/. For Re-Value, about 600 indicators in use in 9 cities have been inventoried and assessed. This analysis will directly feed back into the further refinement of both the cities' strategies and the NEB Impact Model.

[37] NetZeroCities Deliverable D2.4 Comprehensive indicator framework: https://netzerocities.eu/wp-content/uploads/2023/01/D2.4-Comprehensive-indicator-framework_v3.pdf

sets. However, the whole systems approach with pillars and impact categories remains the same at all scale levels of intervention.

List of Acronyms

CrAFt	Creating Actionable Futures
EU	European Union
KPI	Key performance indicator
(S-)LCA	(Social) Life cycle analysis
LCC	Life cycle cost
NGO	Non-governmental organisation
MaaS	Mobility as as service
MFA	Material/mass flow accounting
MMSA	Multi-modal system analysis
NEB	New European Bauhaus
NZC	Net Zero Cities
T(s)CO	Total (societal) cost of ownership
UHI	Urban heat island
VCO	Volatile organic compound
WHO	World Health Organisation

www.craft-cities.eu

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