syn.ikia

Sustainable
plus energy
neighbourhoods

Multiple benefits of sustainable plus energy neighbourhoods and their potential impact on policy and investment decisions

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BPIE

Glossary of Terms

COMBI	combi-project.eu – Multiple Benefits of Energy Efficiency
CBA	Cost benefit analysis
DEESME	Developing National Schemes For Energy Efficiency in SMEs
EEFIG	Multiple Benefits of Energy Efficiency Investments for Financial Institutions
ESG	Environmental, social and governance
GDP	Gross domestic product
GHG	Greenhouse gas
HIDEEM	Health Impact of Domestic Energy Efficiency Measures
IEA	International Energy Agency
JRC	Joint Research Centre
KPI	Key performance indicator
MBENEFITS	Multiple benefits of energy efficiency
MURE	Mesures d'Utilisation Rationnelle de l'Energie
ODYSSEE	The Odyssee database
PED	Positive energy district
SDGs	Sustainable Development Goals
SPEN	Sustainable plus energy neighbourhood
SRI	Smart readiness indicator
WTP	Willingness to pay

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Executive summary

Sustainable plus energy neighbourhoods (SPENs) offer multiple social, economic and environmental benefits, which consistently overlap with the three pillars of sustainability. These benefits extend beyond individual positive energy buildings and impact both individuals and society as a whole. Some benefits are measurable, while others are not. To fully understand the benefits of a collective group of positive energy buildings or SPENs, it is important to highlight them objectively. Benefits at the neighbourhood level have not yet been fully conceptualised and mapped in detail. These benefits include reduced costs through economies of scale, social cohesion, improved public health and wellbeing, inclusion, and improvements in accessibility, community facilities, safety and public spaces. In addition, socially inclusive transformation depends on community engagement, availability of shared assets, co-design and social support, which could be strengthened through SPENs.

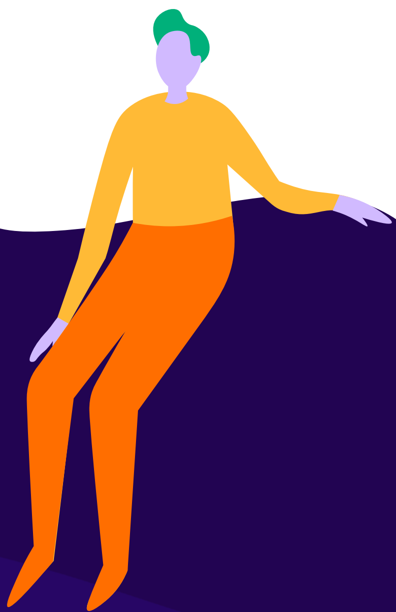
For a comprehensive appraisal of the multiple benefits of SPENs, they should be identified, quantified and monetised. This report reviews various concepts related to the multiple benefits of a group of positive energy buildings on a neighbourhood scale (SPENs). However, the focus of this report is on **identifying multiple benefits** of SPENs that can be quantified and monetised. This can promote policy innovation to support sustainability at the neighbourhood level, including new developments and renovations. It can also aid stakeholder decision-making and stimulate sustainability investment in such projects, e.g. through ESG finance and EU taxonomy.

In this report, we propose a **syn.ikia definition** for **multiple benefits of SPENs** to provide a clarity on the concept and advance the transparent measurement of impacts beyond energy savings and emission reductions:

> Public and private welfare effects (energy and non-energy) that arise throughout the life cycle of investment, development and maintenance of sustainable plus energy neighbourhoods (SPENs). These occur via the interrelationship between human well-being and the physical and social environment at both individual and wider societal level, with a focus on neighbourhoods.

Furthermore, this report develops and presents a **syn.ikia multiple benefits impact pathway – a conceptual framework for SPENs** to clearly identify the multiple benefits that are critical for decision-making. This framework consists of three steps: 1) identifying the key benefits and the stakeholders who will accrue these benefits; 2) quantifying the identified benefits; and 3) translating the quantified benefits into monetary values. Within the scope of this report only the first step is elaborated, i.e. identifying the key benefits by stakeholder, through a conceptual **impact pathway** that explores the **added values** that would arise from SPENs, their resulting **changes** and consequently the arising multiple benefits (i.e., their **end-point impacts**). The forthcoming deliverables ***D5.4 A methodology report on the required calculations for the quantification and monetisation of benefits*** and ***D5.5 A web-based calculation tool to support decision-making and investment*** will cover the next two steps, i.e., quantification and monetisation. Cumulatively, the end-point impacts are identified as SPEN multiple benefits for their inclusion in the tool (D5.5) on the basis of the scale at which they will have an impact, the likelihood of occurrence of their impact and their measurability through reliable and transparent evidence (D5.4).

In chapter 1, we discuss the concept of multiple benefits of energy efficiency through policies and investments for individuals and wider society, especially in the context of urban regeneration though positive energy district and neighbourhoods. Then, we propose a conceptual and working definition of syn.ikia multiple benefits of SPENs, and outline why these multiple benefits are important to various stakeholders. In chapter 2, the syn.ikia conceptual framework for the identification of SPEN multiple benefits is presented and lastly, in chapter 3, a preliminary application of the SPEN multiple benefits impact pathway to identify quantifiable benefits is illustrated.



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1. Introduction to multiple benefits of energy-efficient buildings

The term **'multiple benefits'** usually refers to the many potential intended or unintended benefits to stakeholders of a policy or project that go beyond its primary objectives. In the context of energy efficiency investments, multiple benefits refer to benefits beyond those related to energy, such as savings in energy consumption and costs. These non-energy-related benefits include increased productivity, better health, improved educational outcomes, reduced need for new energy infrastructure, increased property values, employee satisfaction and retention, job creation and economic development. Research and several EU-funded projects [1],[2],[3] have identified, and in some cases quantified and valued (i.e. monetised), several sets of multiple benefits. These projects have consistently shown that the non-energy benefits outweigh the energy benefits.

Multiple benefits of energy-efficient buildings are often identified at two levels: **1) the individual/ private level** and **2) a wider societal level**. The former include reduced energy costs, improved indoor environmental quality and reduced health costs and are usually relevant to value chain actors at the individual building level, such as building owners and tenants. Wider benefits include reduced outdoor air pollution, reduced public health costs and job creation, which are of particular interest to policymakers, public authorities and urban planners. In addition, beyond financial returns, investors find value in some of the multiple benefits at the societal level, which could influence investment decisions in the context of environmental, social and governance (ESG) investments.

The concept of **sustainable plus energy neighbourhoods (SPENs)** presents a new range of benefits, in addition to previous studies on the benefits of individual energy-efficient buildings or positive energy buildings. Many stakeholders in the policy, building and financial sectors recognise that energy-efficient and sustainable buildings can provide additional benefits, add value, and reduce both financial and climate risks. However, incorporating these multiple benefits into decision-making processes can be challenging due to difficulties in tracking, monetising and reporting them. These difficulties arise from the complex nature of SPENs and the lack of associated standardised metrics, reliable data and market transparency. This is also an area that requires further academic research and policy discussions. Furthermore, multiple benefits are often specific to the projects, markets and stakeholders. The potential multiple benefits of SPENs have not yet been fully conceptualised or mapped in detail.

It is therefore crucial to identify and assess these multiple benefits based on reliable data and communicate them through clear key performance indicators (KPIs) in order to transform multiple benefits into actionable and meaningful financial information. Through the SPEN concept, **syn.ikia** contributes to the current discourse on positive energy districts by providing indicators, benchmarks and tools to identify, measure, track and monetise these benefits at the neighbourhood level. This report presents a methodological framework for identifying the added values of SPENs at individual and societal levels, as well as their social, economic and environmental dimensions, the changes they produce and their end-point impacts (multiple benefits) through the syn.ikia SPEN multiple benefits impact pathway conceptual framework.

What are multiple benefits?

A variety of concepts and terms are used in the literature to describe multiple benefits, such as co-benefits, co-impacts and multiple impacts. To establish a precursor knowledge for this report, the following section discusses and elaborates on the definition of multiple benefits and associated terms.

Multiple benefits of a policy intervention

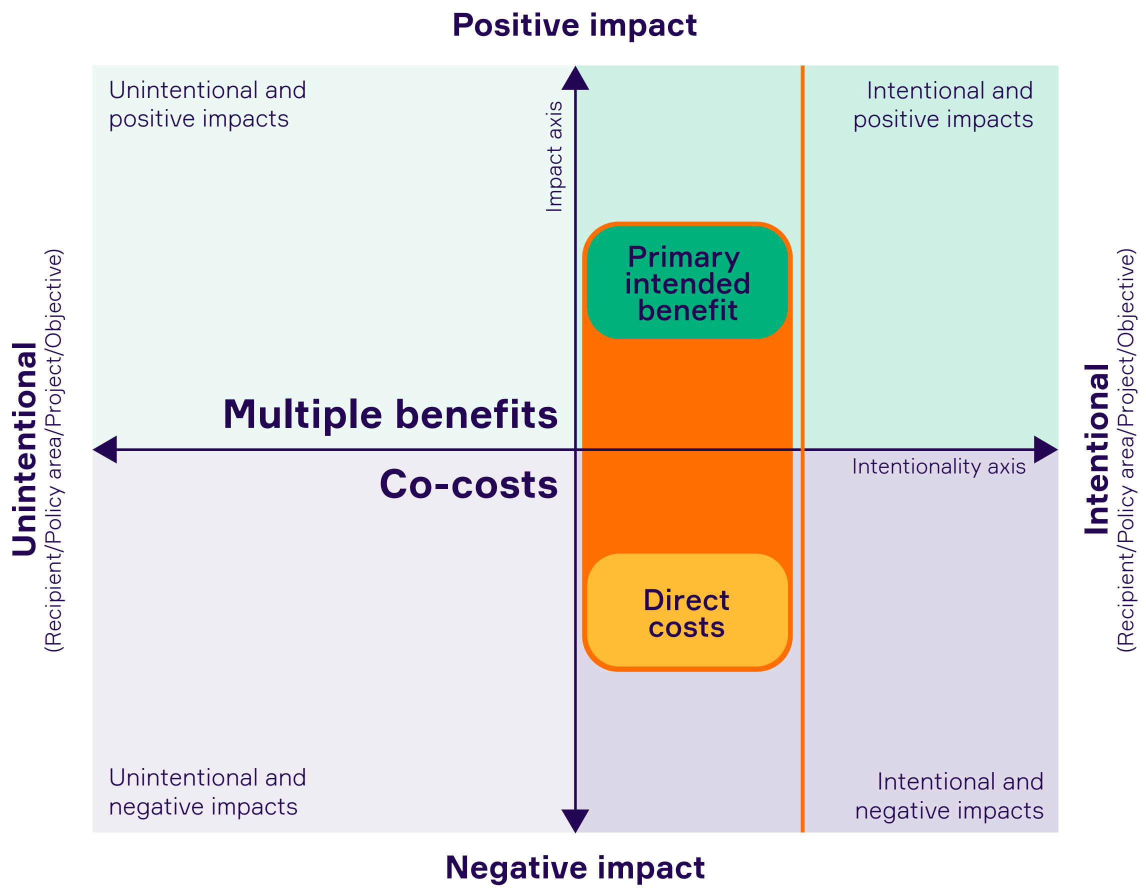
Policy interventions can have intended or unintended benefits, which are explicitly stated or not stated in the policy goals and objectives, respectively. Additionally, policy interventions can have both positive and negative impacts. Figure 1 displays the relationship between the level of intentionality with which multiple benefits are considered in the policy area or project objective or by recipients, and their positive and/or negative impacts [4]. Clockwise from top right, quadrant 1 represents intentional and positive impacts, quadrant 2 represents intentional and negative impacts, quadrant 3 represents unintentional and negative impacts, and quadrant 4 represents unintentional and positive impacts. In policy contexts, a cost-benefit analysis (CBA) is often conducted, which only takes into account direct costs and primary intended benefits (shown in the orange shaded area). However, there may be additional intended and/or unintended costs, transaction costs, hidden costs, policy costs and adverse side-effects that have a negative impact. On the other hand, there may be multiple benefits or co-benefits that have an overall positive impact, i.e. the benefits outweigh the costs. Additionally, there may be ancillary benefits and/or costs that are purely unintentional.

In the context of climate change mitigation policies, the Intergovernmental Panel on Climate Change (IPCC) defines co-benefits and adverse side effects as follows:

"A government policy or a measure intended to achieve one objective often affects other objectives, either positively or negatively...When the effects are positive they are called 'co-benefits', also referred to as 'ancillary benefits'. Negative effects are referred to as 'adverse side effects'.

"The positive effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare. Co-benefits are often subject to uncertainty and depend on, among others, local circumstances and implementation practices." [5]

Figure 1: A map of different terms used that represent overlapping concepts of multiple benefits [4]



In general, multiple benefits or co-benefits can be difficult to quantify and monetise accurately. This difficulty makes it challenging to include their contribution in a conventional cost-benefit analysis for policy measures and investment decisions, particularly in the urban development and building sectors.

This report uses the term 'multiple benefits' instead of 'co-benefits', 'co-impacts' or 'multiple impacts' because it has a broader meaning and encompasses a wider range of benefits with a net positive impact. The term 'multiple benefits' has also become widely adopted after the publication of the International Energy Agency (IEA) report [6] on the multiple benefits of energy efficiency. 'Multiple benefits' include all benefits resulting from energy efficiency measures in buildings and neighbourhoods [6].

Multiple benefits of energy efficiency policies and investments

Two definitions of the multiple benefits of energy-related or energy efficiency policies are given below:

"A broader range of outcomes that contribute to the human ambition to improve welfare and wealth. These benefits include various macroeconomic benefits (e.g. shifts in energy trade balances and employment), increased access to energy and improved affordability of energy services, reduced air pollution, and fiscal improvements for national and sub-national entities." [7][5]

"Multiple benefits is an approach to quantify and communicate the strategic impacts of investments that enhance energy performance." [2]

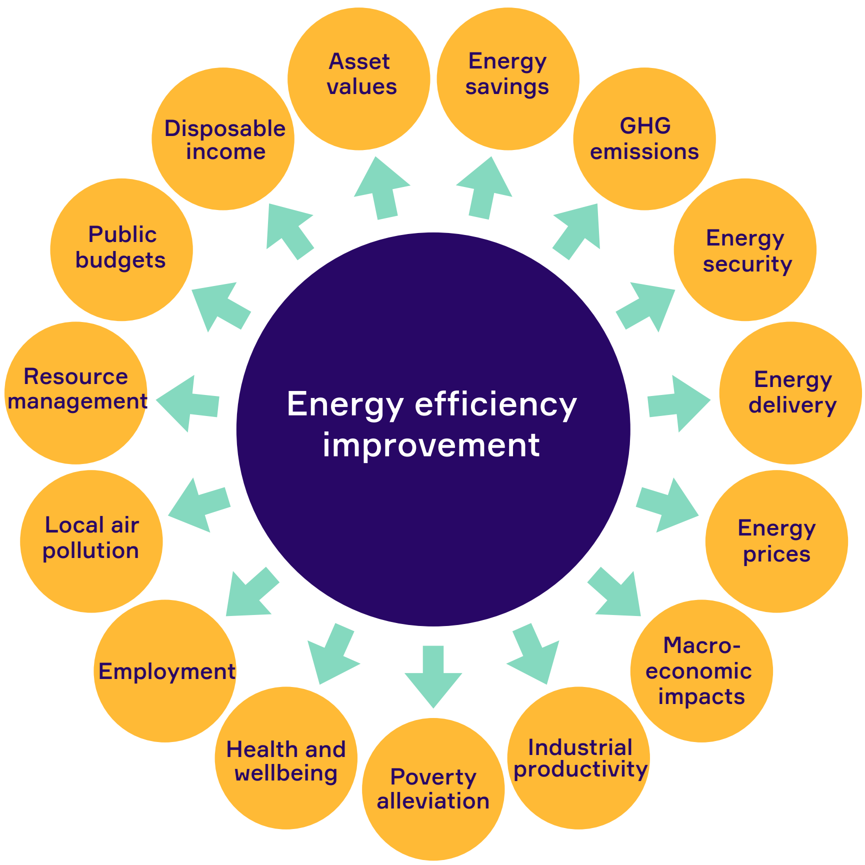
Assessments of energy efficiency-based programmes and policies typically only consider energy savings and, occasionally, greenhouse gas (GHG) emissions reductions. This limited approach underestimates the full range of benefits [6]. In early 2012, Renovate Europe made the first attempt to quantify the multiple benefits of investing in energy-efficient building renovations [8]. The analysis primarily focused on the impact of such investments on public budgets. It presented evidence that improving the energy efficiency of existing buildings has direct benefits (i.e., energy-related benefits), such as reduced energy consumption, and indirect benefits (non-energy related benefits), such as improved health. Since then, several projects have been commissioned and reports published that highlight the multiple benefits in different contexts, including the building sector. Some of these are listed below.

1. Calculating and operationalising the multiple benefits of energy efficiency in Europe (COMBI) [1]
2. Capturing the multiple benefits of energy efficiency (IEA) [7]
3. The macro-level and sectoral impacts of energy efficiency policies (European Commission) [9]
4. Technical study on the possible introduction of optional building renovation passports (EPBD19a Feasibility Study) [10]
5. Cost-effective energy and carbon emissions optimization in building renovation (Annex 56) [11]
6. Untapping multiple benefits: hidden values in environmental and building policies (JRC) [12]
7. Multiple benefits of energy efficiency investments for financial institutions (EEFIG, European Commission) [13]
8. Multiple benefits: Methodology, identification and evaluation tools [14], [15], [16]

Policymakers are increasingly recognising the wider multiple benefits of energy efficiency. The European Commission's 'energy efficiency first' principle prioritises demand- over supply-side resources to the extent that they minimise net costs or maximise social welfare. This means broadening the scope of cost-benefit analysis to include benefits at the societal level, beyond the interests of individual investors [17]. For example, the new Article 3 of the recent Energy Efficiency Directive recast states: "In applying the energy efficiency first principle, Member States shall: (a) promote and, where cost-benefit assessments are required, ensure the application of (...) cost-benefit methodologies that allow proper assessment of **wider benefits of energy efficiency solutions** (...) from the societal (...) perspective."

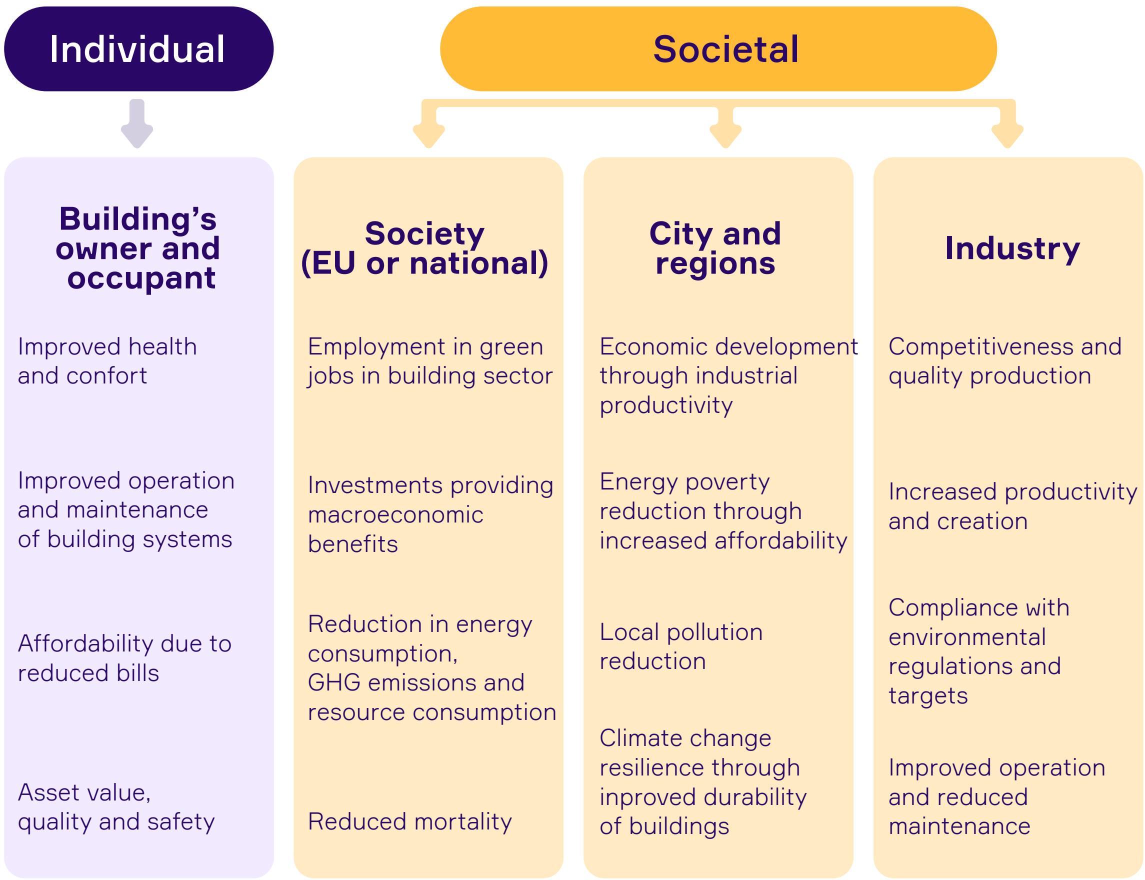
Furthermore, when evaluating projects for public or private investments within ESG investment or the EU Taxonomy frameworks, it is important to consider a wide range of benefits. These may include the environmental impact of reducing GHG emissions, resource efficiency and contribution to the circular economy. By taking into account the impact of these multiple benefits, investments in energy efficiency measures could have a significantly positive impact on the economy, environment and society [18], [19], [20]. Research has demonstrated that the significance of multiple benefits (MB) of energy efficiency compared to the direct benefits (DB) varies between 0.22-3.2 (MB/DB) [21]. This indicates that energy efficiency measures have a substantial impact on multiple benefits. The studies considered various benefits, such as health and comfort benefits, reduced absenteeism from school and work, emission reductions, reduced air pollution and improved employee productivity (see Figure 2).

Figure 2: Multiple benefits of energy efficiency on macroeconomic level. Retrieved from [7]



In relation to energy efficiency improvements, most studies have identified and reported multiple benefits at **individual/private level** (micro level) and at **a wider societal level** (macro level). They are also categorised into (i) social, (ii) economic and (iii) environmental benefits, which are synonymous with the three pillars of sustainability [12][22]. Figure 3 shows an example of some multiple benefits of energy efficiency at both individual and societal levels and categorised as social, economic and environmental benefits.

Figure 3: Multiple benefits of energy efficiency in the building sector (adapted from [6])



Multiple benefits for individuals/homeowners

The multiple benefits relevant for individuals or homeowners are generated with the actual use and operation of the buildings on day-to-day basis. These benefits are linked to enhanced comfort, better health, increased value of assets and reduced energy expenditure. The multiple benefits in terms of user well-being are closely connected to the indoor environmental quality. This includes thermal comfort, lighting (natural or electric) quality, indoor air quality and the acoustic environment. A positive impact from improved indoor environmental quality is the improvement in health which subsequently leads to reduced private and public health costs. Table 1 lists individual-level multiple benefits of energy efficiency identified from the literature [12].

Table 1: Major categories of multiple benefits of energy efficiency for individuals/homeowners (adapted from [12])

Multiple benefits for individuals/homeowners		
User well-being	**Economic**	**Building quality**
• Thermal comfort • Natural lighting and contact with nature • Indoor air quality • Internal and external noise • Pride, prestige, reputation • Reduced health costs • Ease of installation and reduced annoyance	• Reduced exposure to energy price fluctuations • Low operation and maintenance costs	• Building structure and thermophysical behaviour • Ease of use and control by user • Low maintenance • Aesthetics and architectural integration • Useful building areas • Safety (intrusion and accidents)

Wider societal multiple benefits

Multiple benefits at wider societal level include reductions in energy and GHGs, job creation, reduced public health budgets and more (see Table 2 below). Often multiple benefits are quantified and monetised at macro level to inform policies and investments to increase the attractiveness of energy efficiency in the building sector.

Table 2: Major categories of wider societal multiple benefits (adapted from [12][12])

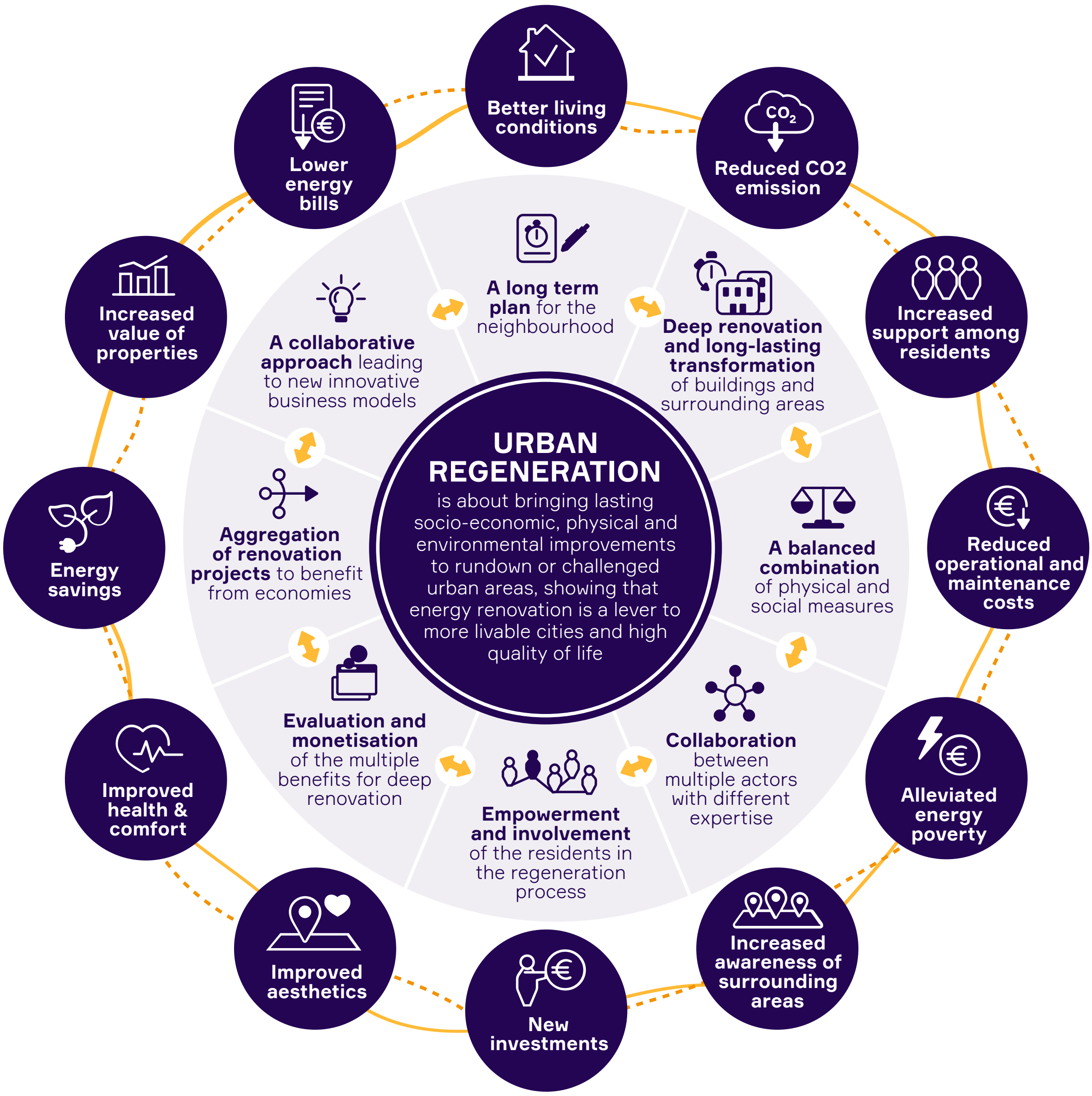
Multiple benefits for individuals/homeowners		
Environment	**Economic**	**Social**
• Reduction of air pollution • Reduction of GHGs • Energy savings • Resource management (whole-life carbon) • Climate change mitigation	• Lower energy prices • Innovation and competitiveness • Employment effects (job creation) • Increase in GDP • Reduced public budget • Energy supply security • Reduced healthcare costs • Reduced investment pressure on renewable energy generation, transmission and distribution	• Reduced mortality • Reduced morbidity • Reduced fuel poverty • Improved productivity

Multiple benefits of urban regeneration through positive energy districts and neighbourhoods

Urban regeneration through positive energy neighbourhoods offers opportunities to accelerate climate change mitigation efforts [23]. The multiple benefits of SPENs extend beyond energy savings in contrast to positive energy districts and include improved indoor air quality, reduced air pollution and improved health, as well as macro-economic benefits from the increased economic activity, including job creation [24]. Additional improvements to the communal private and public spaces are included in the evolving concept of SPENs which are not a part of positive energy district (PED).

Nevertheless, the EU Strategic Energy Technology Plan (SET-Plan) identified 100 positive energy district projects to achieve its goal of planning, deploying and replicating decarbonisation at neighbourhood or district scale by 2025 [25]. This initiative is a work in progress and comprises a combination of projects in both existing neighbourhoods and new developments [26]. However, the majority of new developments have declared a clear commitment to PED objectives, while the vast majority of existing developments do not have a clear commitment within this programme. Renovations at neighbourhood level can lead to significant cost savings through economies of scale and smart logistics. In addition, they can be more attractive to investors and policymakers due to distributed risk and project aggregation aspects. Aggregating the demand for renovation from various individual building owners in a neighbourhood increases the market chances for those involved in selling or supplying new products and services. This aggregation of projects enables industrialised renovation processes at higher quality and lower costs which could become a part of SPENs [27]

Figure 4: The multiple benefits associated with community and urban regeneration [28]



With a strong emphasis on energy savings, building energy efficiency programmes often underestimate their full value to the building occupants and communities in which they are located. This may result in underinvestment in new developments, low renovation rates and sustained (or increased) energy consumption where it should be decreasing. As shown in Figure 4, **urban regeneration initiatives underscore the importance of co-design, social support and community engagement to achieve maximum impact and ensure a socially inclusive transformation**. SPENs share a similar vision of urban transformation by engaging the community when renovating existing buildings or incorporating new developments into existing communities/districts.

Proposing a definition for the multiple benefits of SPENs

Key stakeholders and beneficiaries of SPEN multiple benefits

In order to identify and assess the multiple benefits of SPENs, it is useful to establish a network of stakeholders including policymakers, public administrators, investors, developers and inhabitants [30]. This will enable a continuous and equitable return on investment in the form of monetary, energy-related and non-energy-related benefits for all stakeholders. The issues of 'free riders' and split incentives, where certain stakeholders receive the benefits with minimal or no contribution, must be recognised and addressed in order to maintain the engagement and interest of all stakeholders [31]. Key stakeholder groups include policymakers, investors, industry, neighbourhoods and individuals (see Figure 5). Policymakers at all levels, including the EU, national, regional and local governments, facilitate SPENs by setting policy objectives and regulatory frameworks that enable their development. The suitability of neighbourhoods and the willingness of the inhabitants to participate in SPEN projects then become crucial. Financing these developments requires investment from both financial (e.g., banks, other financial institutions and institutional investors) and non-financial (e.g., building owners, public authorities, municipalities) stakeholders. All of this will provide an enabling environment for real estate and property developers to develop SPENs, either privately or through public-private partnership.

Figure 5: SPEN multiple benefits stakeholder categories categories

Policymakers	Inhabitants
• European Union • National govenments • Regional/state govenments • Local governments/municipalities	• Cities/communities in which SPENs are located • Building owners in SPENs • Tenants in SPENs
Industry	**Investors**
• Residential and commercial real estate developers • SMEs (e.g., tradespeople, manfacturers and other service providers)	• Equity providers • Debt providers • Real estate investment trusts • Public investment and grants

Barriers and enablers to the realisation of SPEN multiple benefits

Barriers

Energy efficiency in buildings offers huge untapped health, social, environmental and economic benefits [32]. Over the past decade, research activities in the building sector have started to recognise these benefits, but their quantification and monetisation have remained a challenge, due to barriers such as uncertainty of the direct impact and diverse outcomes [33]. Some of the key challenges identified in relation to the multiple benefits are [13]:

- Use of different terms for multiple benefits makes it challenging to use uniform benchmarks, set KPIs and identify industry best practices
- Lack of data, standards and measurement practices, inconsistency in analysing the benefits and lack of mechanisms to quantify them.
- Financial institutions find little or no added value in the concept of multiple benefits.
- Limited coordination between building experts and financial institutions or investors, resulting in low awareness and data/information exchange.
- Impact categories and assessments capturing social aspects that not well integrated in multiple benefits evaluation.
- When deciding whether to invest in renovation, homeowners consider the payback period, which can be lengthy, and may not consider the non-monetary benefits.

As this is an evolving concept, accounting for multiple benefits of energy efficiency in the building sector and the advantages it offers to building owners and investors in their decision-making still remains a challenge. While the perceived benefits of some assets may contribute to their market value or investment worth, others may not. Energy efficiency considerations are not adequately incorporated into risk assessment and investment decisions due to a lack of adequate and reliable data, assessment methods and technical skills to assess and monitor building sustainability standards, and a lack of awareness of the multiple benefits concept. Moving from the building to the neighbourhood scale introduces further barriers to comprehending and acknowledging the multiple benefits of SPENs in contrast to business as usual when making investment decisions. The possibility to capture value or monetise multiple benefits varies between at least five market segments [13]:

1. Industry (including SMEs)
2. Commercial real estate
3. Residential owner-occupied buildings
4. Residential rental buildings
5. Public buildings

These market segments have different characteristics that require specific approaches to address the issue of multiple benefits. Stakeholders may choose to focus on micro- or macro-economic benefits, or neighbourhood benefits, depending on their interests. For example, in public buildings, local job creation and urban regeneration can be important benefits; in commercial property, asset value and rental value are important benefits; in sustainable neighbourhoods, social cohesion and energy security are key benefits. Investments in residential development and renovation involve a range of considerations that go beyond purely economic factors such as operational energy cost savings or return on investment. For most owners, the decision to purchase and renovate their properties is influenced by a combination of economic, wellbeing and emotional factors, including comfort, aesthetics, ambience, safety and prestige. These factors pose additional challenges for investors seeking to accurately capture and reflect the value of these 'soft' factors in their property investments.

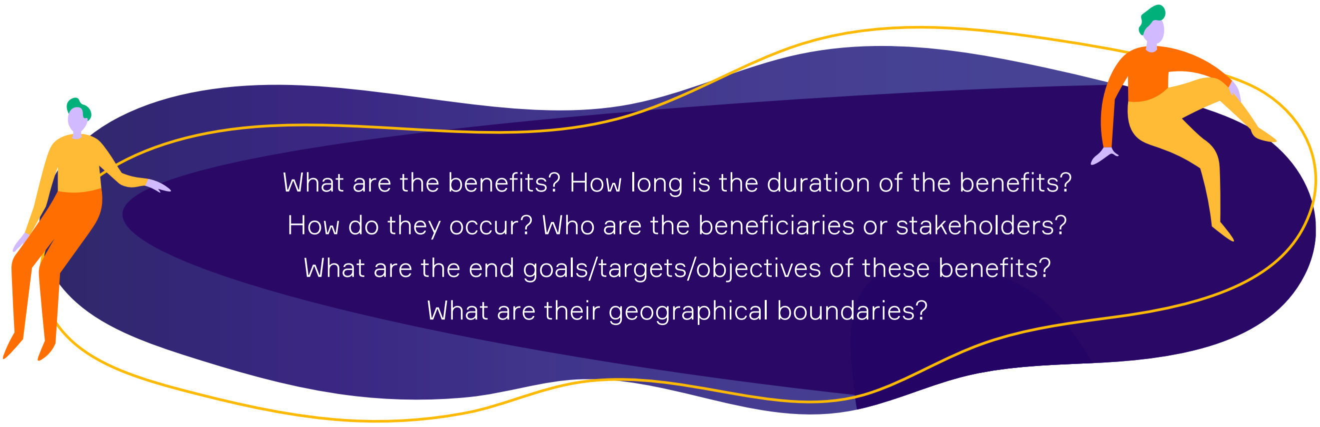
Enablers

Different stakeholders are interested in different benefits. For example, the perceived benefits (and drivers of action) for homeowners may differ from those of the financial institutions rating a property or assessing the risk of investment (see Figure 6) [34]. In both cases, there are wider societal benefits, but these may not figure in their decision-making. ESG finance attempts to incorporate social, environmental or circular economy benefits into investment decisions. This is especially relevant in the context of SPENs, where this added value (i.e., multiple benefits) needs quantification and monetisation to focus beyond energy savings in order to future-proof investments.

Figure 6: Perceived benefits and potential value drivers for building owners and financing institutions, adapted from [34]

syn.ikia definition of SPEN multiple benefits

As the idea of multiple benefits is constantly evolving and covers a wide range of benefits, its adaptation for SPENs could broaden the scope of benefits received by stakeholders and communities. A definition for multiple benefits of SPENs is proposed below to provide clarity on the concept and advance the transparent measurement of impacts beyond energy savings and emission reductions. To define multiple benefits in the context of SPENS, we first asked the following questions, and developed the definition in an attempt to answer them.



Multiple benefits of SPENs are:

> **“Public and private welfare effects (energy and non-energy) that arise throughout the life cycle of investment, development and maintenance of sustainable plus energy neighbourhoods (SPENs). These occur via the interrelationship between human well-being and the physical and social environment at both individual and wider societal level, with a focus on neighbourhoods.”**

Key welfare effects are those direct or indirect contributions that support the targets of the Sustainable Development Goals (SDGs), specifically around eliminating poverty (SDG 1), good health and wellbeing (SDG 2), access to affordable and clean energy (SDG 7), decent work and economic growth (SDG 8), industry, innovation and infrastructure (SDG 9), sustainable cities and communities (SDG 11) and climate action (SDG 13) [29].

Why are SPEN multiple benefits important?

Promoting policy innovation for deep renovation

The multiple benefits of building energy renovation at a neighbourhood scale have not been sufficiently assessed in the literature, mainly because they are difficult to isolate and quantify, complex to understand, and because of a lack of access to practical tools [23]. This creates a real barrier to policy innovation. Policy leaders are powerful change agents if they have the information and tools to promote change; they find it hard to present a case for action if the benefits of policy change are difficult to measure, monitor, verify and communicate [35]. As a result, policies are designed with narrow objectives that overlook a wide range of multiple benefits to individuals and society. The multiple benefits of urban regeneration, including large-scale building energy renovation, should be quantified and monetised by using specific approaches, such as social cost-benefit analysis, integrated assessment modelling, multi-criteria analysis and life-cycle analysis.

Supporting stakeholder decision-making

Objective criteria for quantifying multiple benefits help stakeholders such as policymakers, developers and investors to make informed decisions and broaden their horizons with further insight into benefits and returns. Lack of well-accepted KPIs, common definitions and benchmarks are key barriers to communicating multiple benefits to stakeholders [36]. Existing instruments for measuring building performance, such as energy performance certificates and green building certification systems, may not be fully comprehensive, comparable or linked to the financial performance data of the building [36]. Policymakers or other public actors find it difficult to obtain the data and analysis that are needed to clearly demonstrate multiple benefits. Developers, investors and financial institutions see little value in such data unless it is presented in a way that meets their ESG goals and commitments.

Energy and environmental policy objectives often have multiple dimensions, such as reducing greenhouse gas emissions and air pollution. A multiple benefits approach helps stakeholders visualise and quantify these benefits and contextualise them in relation to other measures. A thorough and integrated approach is therefore needed to fully capture the multiple benefits, going beyond individual buildings as in the case of SPENs, which could provide a better cost-benefit ratio. This should include frameworks, methods and tools for ex ante quantification of multiple benefits that are tailored to suit the needs of different stakeholders [37]. Policymakers and investors can use such tools and the underlying data to enable them to formulate evidence-based policies and make targeted investments.

Certain tools exist for policymakers, such as the Health Impact of Domestic Energy Efficiency Measures (HIDEEM) model which assesses the potential public health impacts of energy efficiency renovation with a focus on building envelope and ventilation (in UK residences) [38].

Previous studies and research have focused generally on economic and environmental impacts [39]. Recently, however, several studies have outlined and quantified social impacts, such as effects on living conditions [40]. The COMBI project studied several interactions and proposed methods to operationalise multiple benefits in energy-efficiency policy and decision-making [41]. The COMBI online tool quantifies multiple non-energy-related impacts of energy efficiency measures in different sectors, including buildings, transport and industry in the EU [41]. In a larger study, Reuter et. al., [42] identified a set of 20 indicators for quantifying the multiple benefits of energy efficiency. These indicators were separated into economic, environmental and social categories ,and the findings are included in the ODYSSEE-MURE database [43]. The DEESME project has developed a tool to implement the multiple benefits approach. This tool helps SMEs and other businesses understand the additional business and non-energy benefits that complement the development of energy audits and energy management systems [44]. The MBenefits project has developed a toolkit for companies to quantify the impact of multiple benefits in terms of value proposition, costs and risks [45]. This toolkit presents a five-step pathway for making investment decisions based on an energy audit. The steps are: 1) analysing the company to understand its business model and investment context, 2) linking key operations and energy services, 3) identifying competitive advantage impacts, 4) evaluating the financial attractiveness of the project, and 5) presenting results and tailored project proposals.

Various tools have been developed to guide investment decisions to support an affordable and equitable transition to sustainability. Although many case studies and research projects have demonstrated the potential for monetising multiple benefits, their application remains a challenge for decision-makers in financial evaluations (e.g. investors, policymakers) in the context of SPENs. Clear methodological frameworks must be developed to strengthen decision-making and demonstrate the added value of SPENs in transforming the built environment and contributing to sustainability goals.

Stimulating sustainability investments through the EU Taxonomy

Investment decisions must consider ESG factors, also known as sustainable finance, to achieve the goals outlined in the European Green Deal, which is driving the EU's ambition for climate neutrality [46]. To this end, the EU Commission has devised a classification system (taxonomy) to identify environmentally sustainable economic activities [47]. This scheme was enacted through legislation, commonly known as the EU Taxonomy, "that defines criteria for economic activities that are aligned with a net zero trajectory by 2050 and the broader environmental goals other than climate" [48]. The EU Taxonomy is primarily technology-neutral and assists investors and businesses in making informed decisions about sustainable investments, assessing their sustainability and increasing transparency through disclosures.

Economic activities can contribute to one of the six climate and environmental objectives set out in the EU Taxonomy: climate change mitigation; climate change adaptation; sustainable use and protection of water and marine resources; transition to circular economy; pollution prevention and control; and protection and restoration of biodiversity and ecosystems.

In addition, they should meet four overarching conditions to qualify as environmentally sustainable: economic activities should make a significant contribution to one of the six climate and environmental objectives, while causing no significant harm to the other five objectives, and comply with the minimum safeguards and the technical screening criteria.

Articles 10 to 15 of the Taxonomy regulation outline the ways in which economic activities can make significant contributions to various climate and environmental objectives. Technical screening criteria for each of these objectives must be established to ensure reliability, consistency and comparability of sustainability-related disclosures. The legislation requires that these criteria should be quantitative and contain thresholds if possible; otherwise, they can be qualitative. It is therefore important to provide clarity on the concept of SPEN multiple benefits to align with the goals of the EU Taxonomy and its technical screening criteria.

2.
syn.ikia conceptual framework for the identification of SPEN multiple benefits

The multiple benefits of energy efficiency in individual buildings have been identified at both individual and societal level, as presented in the previous sections. However, there is no framework for the identification of multiple benefits of SPENs. In addition to the benefits of energy renovation in individual buildings, such as energy savings, improved indoor environmental quality and health, the neighbourhood approach has additional benefits such as reduced renovation costs due to economies of scale, increased social cohesion, improved public health and wellbeing, and availability of shared assets. Additional examples of the multiple benefits of SPENs include the growth of local businesses and the creation of local jobs resulting from urban regeneration, as well as improvements in accessibility, community facilities, safety and public spaces. SPENs can also strengthen community engagement, participatory design (co-design) and social support, contributing to a socially inclusive transformation [27].

A conceptual framework for SPEN multiple benefits would help to advance the transparent measurement of impacts beyond energy savings and emission reductions, which is crucial for decision-making. A consistent methodology for estimating the monetary value of multiple benefits should follow these essential steps:

1. Identify the key benefits and the stakeholders who will receive these benefits
2. Quantify the identified benefits
3. Convert the quantified benefits to monetary values.

There is a wide variety of tools and methods for estimating the macroeconomic and environmental benefits of energy efficiency measures, including the assessment of public and private costs and their impacts. However, estimation of social welfare benefits has been limited. These impacts should therefore be identified, quantified and monetised as part of a cost-benefit analysis (CBA) or included as part of a qualitative analysis where impacts cannot be monetised [6]. This report focuses only on the first step, i.e., the identification of multiple benefits of SPENs that may be quantified and monetised. Deliverables D5.4 A methodology report on the required calculations for the quantification and monetisation of benefits and D5.5 A web-based calculation tool to support decision-making and investment will comprehensively cover the next two steps, i.e., quantification and monetisation.

Development of SPEN multiple benefits impact pathway

To identify the multiple benefits of SPENs, syn.ikia prepared a framework with a conceptual **impact pathway** that explores the **added values** that would arise from SPENs, the resulting **changes** and their multiple benefits (**end-point impacts**).

Figure 7 presents a conceptual impact pathway map to illustrate the wide range of benefits of SPENs. The map illustrates the interrelationships between different KPIs (i.e., welfare effects) and their end-point impacts that contribute to environmental protection, economic prosperity and social wellbeing for various stakeholders. For a comprehensive appraisal of multiple benefits of SPENs, it is crucial to identify the causal relationships and interactions among the **added values** (technological and non-technological), the resulting **changes** and their final **end-point impacts**. However, a more accurate way identify these end-point impacts (which are also the multiple benefits) could be to identify the stakeholders (e.g. homeowners, tenants, developers) who will be affected by an initiative, policy or project. A classification of endpoint impacts has been developed through a review of the literature and expert consultation, although some overlap between the various impacts is inevitable. The interrelationships between various end-point impacts must therefore be studied, and the end-point impacts could be further categorised to social, economic and environmental benefits. Depending on the type of stakeholders, project or policy, there may be several different end-point impacts. These end-point impacts could be better identified in the early stages of decision-making through the recommended impact pathway. syn.ikia provides an example to create an impact pathway for SPENs through the following steps:

1. List the **KPIs** of SPENs [49]
2. Identify the **stakeholders** for which the impact pathways should be constructed and **added values** (technological (e.g., renewable technology, fuel switch) and non-technological (e.g., lifestyle, user behaviour)) created by SPENs for them
3. Identify **changes** (transformation) created by SPENs
4. Identify multiple benefits (**end-point impacts**) occurring from each of the changes
5. Analyse causal relationship between added values, changes and end-point impacts.

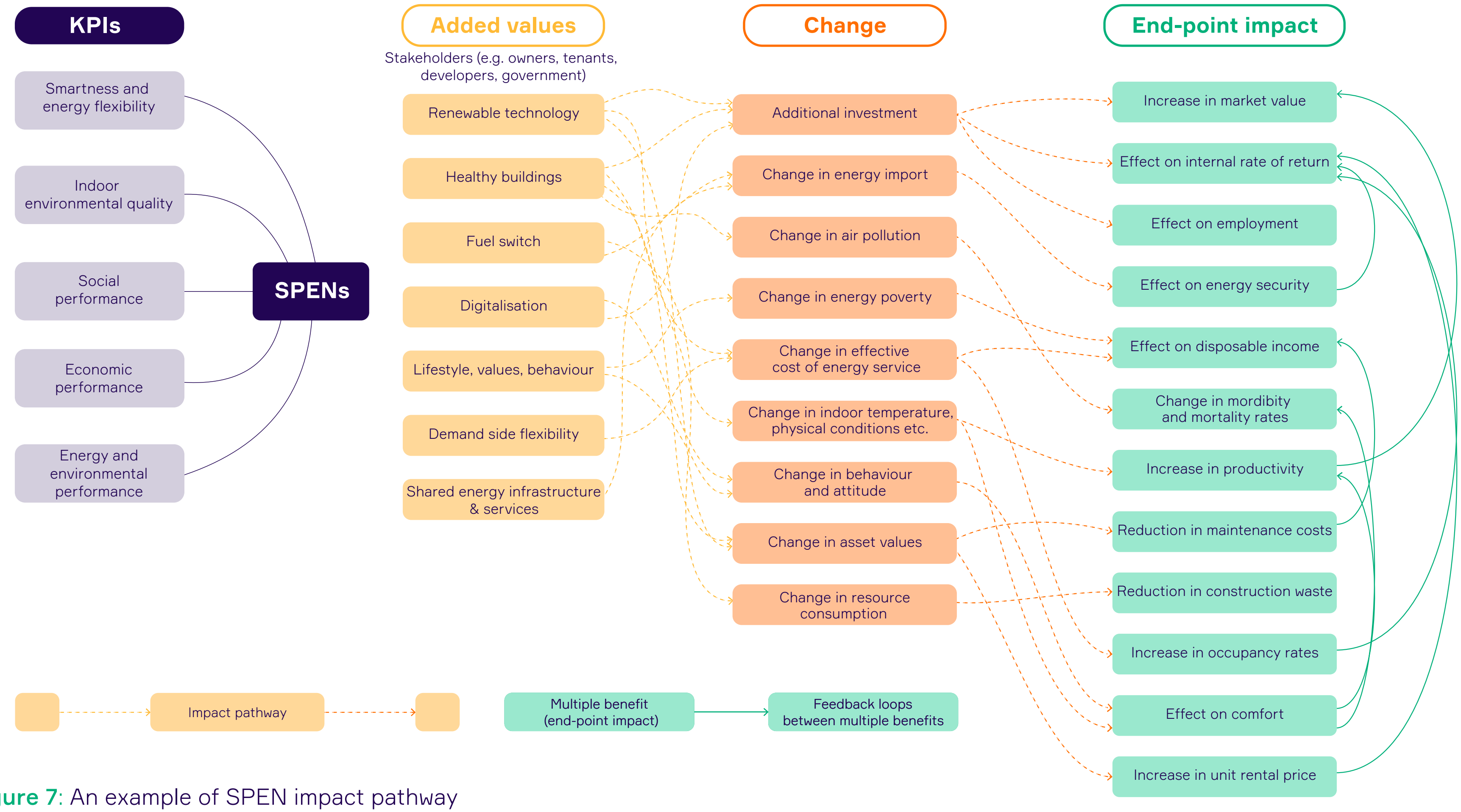


Figure 7: An example of SPEN impact pathway

Key performance indicators (KPIs)

The starting point of the impact pathway is the KPIs specified in the syn.ikia evaluation framework [50], [51]. These KPIs have been defined with the aim of evaluating the building- and neighborhood-level demonstration projects, as part of the syn.ikia project. They are based on a holistic and comprehensive methodology covering multiple dimensions of sustainability in districts. The main categories of KPIs are: 1. Smartness and energy flexibility, 2. Indoor environmental quality, 3. Social performance, 4. Economic performance, 5. Energy and environmental performance. Based on these KPIs, broad categories of benefits are identified.

Added values

SPENs bring many added values (technological and non-technological) over business-as-usual. These added values depend on the type of project, stakeholders, initiative or policy. The ambitions surrounding a SPEN will indicate the added values, which could be identified early in the planning phase (e.g. strategies for demand-side management, introduction of digital monitoring or systems, integration of renewable technology, measures for health and wellbeing etc.).

The synikia project developed the definition of SPENs and specified KPIs in the syn.ikia Evaluation Framework [50]. The KPIs are closely related to the identification of added values and can be linked directly together as described below.

The **smartness and energy flexibility** KPI consists of the flexibility index and smart readiness indicator (SRI). The flexibility index refers to the savings from using energy flexibility for a given price signal. The SRI aims to make the added value of smart buildings more tangible for building users, owners and smart service providers [49]. This KPI is linked to the added value of digitalisation [21] and demand-side flexibility.

The main determinants of syn.ikia's **indoor environmental quality** KPI are indoor air quality, thermal comfort, visual comfort and acoustic comfort. Studies have shown that indoor environmental quality has a significant impact on occupants' health, wellbeing, comfort and productivity, which are directly linked to the added value in SPENs providing healthy homes [52].

The **social performance** KPIs cover three broad areas – equity (fair functioning of the community), community (ability of the community to maintain itself and thrive) and people (human experiences). These KPIs link to added value in terms of lifestyle and human behaviour.

KPIs on **economic performance** include capital (investment) and operational (maintenance, operation etc.) costs and overall performance (net present value, payback period). Added values of these KPIs include added economic value of either the building, neighborhood or other assets within it, and reduced costs associated with either maintenance or operation.

The energy and **environmental performance KPIs** characterise the energy and environmental performance of each building/neighbourhood and its interaction with the energy networks across its system boundaries. The added values directly linked to these KPIs include shared energy infrastructure and services, and reduced greenhouse gas emissions through switching to clean fuels and renewable energy.

Changes

Each added value is a source of social, economic and environmental change that occurs in a neighbourhood. In other words, these are the changes that occur due to SPENs compared to business-as-usual scenarios, such as change in the value of assets, change in environmental pollution or change in behaviour and attitude. These changes are a direct source of one or more end-point impacts that could be quantified or monetised [21].

End-point impacts

End-point impacts are the final positive or negative outcomes of the initiative, project or policy that specify the multiple benefits occurring from SPENs. These end-point impacts may be quantifiable or unquantifiable depending on the existing evidence. For the purpose of understanding the overall multiple benefits, it is necessary to evaluate both positive and negative impacts and comprehensively present them in the analysis of the initiative. Interactions between these impacts may lead to over- or under-counting, so it is essential to check for overlaps using the feedback loops between the end-point impacts.

To quantify multiple benefits at the neighbourhood level, benefits identified at the individual level could be scaled up and benefits identified at the societal level could be scaled down accordingly. These impacts may be relevant to policymakers (e.g. increase in employment, reduction in public health expenditure) or to individuals/society (e.g. health improvement, reduction in health insurance premiums).

In general, the end-point impacts are the effects or consequences that SPENs have on people's lives. These effects could be positive or negative; it is therefore important to identify who is affected and how by an initiative, policy or a project. These could be individuals, families, businesses or the government. **An impact identified is further assessed regarding the size of population it affects (scale), the timeframe during which it is going to occur (likelihood) or the magnitude it will have (measurability)**. These form the next steps to further quantify and monetise the identified multiple benefits; these will be discussed and presented in the forthcoming deliverables D5.4 A methodology report on the required calculations for the quantification and monetization of benefits and D5.5 A web-based calculation tool to support decision-making and investment.

Advantages of using syn.ikia impact pathway approach

There are four key advantages of using an impact pathway approach to evaluate the multiple benefits of SPENs [4] :

1. Impact pathway maps provide a methodological framework for accounting of all the possible impacts (positive or negative), reducing the risk of overlooking any impacts.
2. The detailed identification of the interactions among the end-point impacts enables systematic and precise monetisation.
3. Establishing causal chains and precise identification of the end-point impacts minimises the risk of over- or under-counting.
4. Both positive and negative end-point impacts can be identified for a balanced view of multiple benefits.

3.

Preliminary application of the SPEN multiple benefits impact pathway to identify quantifiable benefits

Some of the benefits (end-point impacts) of SPENs can be measured and monetised, while others are not easily quantifiable. Non-quantifiable benefits are often significant, and many aspects of the quality of the built environment cannot be fully captured or described through quantifiable benefits alone. It is important to acknowledge and raise awareness of these non-quantifiable benefits, even though they may not yet be fully captured in market evidence and KPIs. Stakeholders should be aware of and collect data on non-quantifiable benefits so that evidence can build up over time and the market can properly factor them in. This will help property valuation to price in wider sustainability credentials and identify (long-term) future risks or benefits. However, the syn.ikia project only considers quantifiable benefits for which there is evidence. These are identified through a two-step process:

1. Identify a non-exhaustive list of the added values of SPENs and assess the scale, likelihood and measurability of the changes they bring.
2. Prepare a concise list of quantifiable benefits (end-point impacts)[1] based on the first step.

[2] These will be incorporated into the development of decision-making web-based tool (D5.5)

Most relevant benefits of SPENs and their rating

Table 3 presents a non-exhaustive list of end-point impacts identified for SPENs and the changes they bring based on the impact pathway constructed in this study (section 2). Some of these may or may not be quantifiable. Further selection is therefore required to quantify and monetise the multiple benefits (end-point impacts) for various stakeholders based on the objectives of the initiative, project or policy. To select the multiple benefits for quantification in this study, each added value was rated based on three main criteria as listed below, each on a 1-5 scale (1 being the lowest and 5 being the highest):

1. The scale at which they will have an impact
2. The likelihood of occurrence of that impact
3. The measurability of an impact through an evidence base that is reliable and transparent.

Table 3: Multiple benefits for SPENs (quantifiable/unquantifiable)

Category	End-point impacts	Example of change	Scale (1-5)	Likelihood (1-5)	Measurability (1-5)
Social welfare benefits	Improved thermal comfort	Increased percentage of floor area heated	5	5	4
	Improved indoor air quality	Reduced mortality/ morbidity	5	5	4
	Improved visual comfort	Increased lighting satisfaction	2	3	1
	Improved acoustic comfort	Reduced exposure to external noise	3	3	2
	Reduced operation and maintenance costs	Change in service costs	4	3	3
	Reduced healthcare costs	Reduced insurance premiums	4	4	3
	Reduced absenteeism	Cost gains from reduced sick days	3	4	3
	Reduced overcrowding rates	Reduced mortality/ poor health	3	2	3
	Reduced vacancy rates	Improved financial value of property	3	2	3

Social welfare benefits	Affordable rents	Reduced rents	3	3	3
	Reduced energy poverty	Increased disposable income	3	3	3
	Improved attractiveness to buyers/ tenants	Change in revenue	4	3	3
	Improved durability of buildings	Savings on cleaning/ maintenance costs	3	2	1
	Shared services	Reduced development costs (e.g. car sharing results in reductions in pollution, local congestion and costs)	5	4	2
	Affordable energy services	Decreased energy demand	4	4	3
	Increased safety and security	Discount on insurance premiums	3	4	1
	Increased satisfaction	Increased quality of life	3	3	1
Micro-economic benefits	Job creation	Increased employment	5	4	4
	Reduced energy price fluctuations (reduced risk)	Reduced consumer energy prices	4	3	3
	Self-governance	Reduced supervision costs	3	3	2
	Increased convenience and satisfaction	Reduced maintenance costs	4	4	2
	Low probability to default	Better credit record	3	3	2
	Long-term value preservation	Better present value	4	4	1
	Increased market value	Better return on investment	5	5	3
	Increased unit rental price	Better return on investment	4	5	3

Social welfare benefits	Resident retention	Reduced vacancy costs	3	3	2
	Local business development	Sales, business etc.	2	2	1
	Reduced risk of stranded assets (due to change in cost and regulations)	Value preserved	2	3	1
	Energy system/ security	Less risk of power outages	2	2	3
	Reduced public budget	Additional income tax revenue	3	4	2
	Increased competitiveness	Opportunity costs	2	3	1
Environmental benefits	Energy savings	Increased energy savings	5	5	5
	Reduced local air pollution	Avoided emission of pollutants	5	5	3
	Avoided GHG emissions	Change in GHG emissions	5	5	5
	Reduced whole life carbon (carbon footprint)	Reduced carbon footprint	5	5	4
	Reduced waste heat	Increased energy savings	5	5	4
	Improved space/ land utilisation	Reduction in land used	5	3	2
	Local energy exchange (detach from grid)	Avoided costs for energy infrastructure	4	3	2

Quantifiable benefits of SPENs included in the syn.ikia multiple benefits web tool

After rating endpoint impacts on scale, likelihood and measurability, Table 4 lists some examples of the identified and measurable endpoint impacts of SPENs selected from the previous section for inclusion and development of the multiple benefits assessment tool. It provides specific details and descriptions of how to quantify and further refine the multiple benefits with a more focused impact. The underlying principle for selection is based on the available evidence for quantifying the end-point impacts and the transparency of the assumptions or methodologies[2]. The most relevant multiple benefits identified above for SPENs were therefore further refined based on the level of confidence in the available evidence and the possibility to quantify them through expert review. Where the evidence is very limited, new methods or approaches will be needed to quantify them.

Social welfare benefits

Table 4: Social welfare benefits identified in syn.ikia project

End-point impact category	Specific benefit (end-point impact)	Description
Reduction of healthcare costs	Lower associated cost of asthma: Direct costs	Living in homes with high quality energy efficiency standards, as in SPENs, could reduce the risk of morbidity, resulting in a lower prevalence of respiratory diseases like asthma, chronic obstructive pulmonary disease, hypertension, stroke, heart attack and depression. Reducing the prevalence of such morbidities will result in a decrease in the number of patients requiring care from the healthcare system, leading to a reduction in direct healthcare costs – those associated with medical care such as diagnosis, treatment and rehabilitation.
	Lower associated cost of chronic obstructive pulmonary disease: Direct costs	
	Lower associated cost of hypertension: Direct costs	
	Lower associated cost of stroke: Direct costs	
	Lower associated cost of heart attack (myocardial infarction): Direct costs	
	Lower associated cost of depression: Direct costs	
Improved indoor air quality	Health loss from air emissions (PM10, NOx, CO, hydrocarbons)	Air emission of particles and gases, like particulates (PM10), nitrogen oxides (NOx), carbon monoxide (CO) and hydrocarbons have significant impact on public health. All of these compounds are associated with respiratory problems and some also affect cognitive functions or cause cardiovascular issues. By reducing the negative effects of emissions on health, the ability of individuals to concentrate will be improved and the number of sick days taken can be reduced. In addition, disability-adjusted life years (DALYs) can be increased.

[2] The methodology behind the impact pathway framework is explained in the forthcoming deliverable D5.4 "A methodology report on the required calculations for the quantification and monetisation of benefits" and can be accessed from https://www.synikia.eu/resource-types/technical-reports

Reduced energy poverty	Increase in disposable income due to energy efficiency (reduction in energy poverty)	Energy-efficient homes help reduce annual energy expenditure. Reducing the proportion of household income spent on energy costs increases disposable incomes.
Improved attractiveness to buyers/ tenants	Increased rents (willingness to pay (WTP) for energy efficiency)	SPENs could enhance the quality of buildings and neighbourhoods, while also resulting in higher rental fees for tenants due to their improved energy efficiency. The improved energy efficiency comes at an increased cost (i.e., rent), and the feasibility of renting out such buildings would depend on the WTP approach.
Increase in safety and security	Increased discount on insurance premiums	Property insurance premiums are reduced due to the longevity of the design, products and systems used in SPEN projects and also due to the reduced need for maintenance. For example, average property insurance premiums range around €224 per annum (2022) in Germany. A 10% discount is expected on premiums due to SPENs.

Micro-economic benefits

Table 5: Microeconomic benefits identified in syn.ikia project

End-point impact category	Specific benefit (end-point impact)	Description
Low probability to default	Probability to default reduced (better credit record)	Borrowers who fail to meet contractual payment obligations (or default) risk losing credit worthiness, and face fines and penalties for late or non-payment. Owners and occupiers in SPENs are less likely to default on their payments due to various factors, including lower energy costs, a reduced risk of illness and increased property value.

Self-governance	Supervision costs reduced (cost per m^2)	Requirements on surveillance and inspection in the housing stock are defined in laws, decrees, ordinances, statues and generally accepted technical rules and standards. SPENs, due to their improved design for safety and longevity reduce costs related to supervision.
Increase in market value	Improved asset value (return on investment)	Energy efficiency in buildings has an impact on market values. Buildings with high energy efficiency generate rent about 7% higher and sell for up to 16% more than otherwise identical buildings[3].
	Improved rentability (improved revenue)	SPENs would create better buildings and neighbourhood environments; however, tenants will have to pay increased rents for these buildings as energy efficiency has a price premium. The WTP method would determine the feasibility of such buildings being rented. Some key aspects to consider in evaluating increased rents are: • WTP for renewable technologies is higher than for energy efficiency • WTP differs within a city, so spatial factors must be considered • Increasing rents could be due to dynamic market development and sometimes independent of energy efficiency improvements.
Job creation	Increase in employment (cost per employee)	Construction and renovation of buildings in SPENs will create new jobs in the construction sector. The energy savings generated by SPENs redirects spending away from the energy industry and feeds it back into the local economy.

[3] Asset values – Multiple Benefits of Energy Efficiency – Analysis - IEA

Environmental benefits

Table 6: Environmental benefits identified in syn.ikia project

End-point impact category	Specific benefit (end-point impact)	Description
Energy savings	Energy savings (only renovation)	Higher building standards save energy and tenants/owners have lower energy costs, though this also means lower profits for energy suppliers and reduced tax receipts for the state. But less energy consumption leads to less emissions and costs for society for climate adaption and mitigation measures.
	Energy savings (new renovation)	
	Heat recovery	By using heat recovery measures in ventilation and sewage systems, heat can be "reused" that would otherwise leave the building into the environment or the water infrastructure. This reduces energy use and emissions.
	Wastewater heat reused	
Direct GHG emissions	Direct GHG emissions saved	Saving energy in buildings leads to less energy demand/consumption and therefore less direct emissions into the environment. This reduces the costs associated with these emissions.
Improved space/land utilisation	Increase in access to open space – per person	Open space should be provided until the sum of the marginal willingness to pay of all the inhabitants of a neighbourhood is equal to the market value of residential land in the neighbourhood.

4.
Conclusion and key takeaways

The concept of multiple benefits of SPENs adds a whole new set of benefits to the multiple benefits of individual energy-efficient buildings identified in previous studies. The multiple benefits of an initiative, policy or project differ depending on the stakeholders involved.

This report shows how SPENs differ from business-as-usual scenarios and create greater value through multiple benefits. In doing so, syn.ikia proposes a definition of multiple benefits of SPENs to capture the neighbourhood benefits that lie between the individual and societal levels. Furthermore, it advances the current discourse on the concept of SPENs, providing a framework for identifying, quantifying and monetising the multiple benefits of SPENs. The framework consists of a conceptual **impact pathway** that explores the **added values** that would arise from SPENs, the resulting **changes** and their multiple benefits (**end-point impacts**). It analyses the causal relationship between value added, changes and end-point impacts. It also considers the interaction between different end-point impacts. These end-point impacts are categorised as social, microeconomic and environmental benefits for the purpose of quantification and monetisation. In addition, the impact pathway provides a methodological framework for accounting for all possible impacts (positive or negative), reducing the risk of missing impacts and providing a balanced view of multiple benefits.

A methodology will be developed to identify the various benefits of SPENs based on the conceptual framework presented in this report. The methodology report on the required calculations for the quantification and monetisation of benefits will be included in the forthcoming deliverable D5.4. In addition, a web-based calculator to support decision making and investment will be developed to quantify the multiple benefits of SPENs in the forthcoming deliverable D5.5. The calculator will also include use-case examples to increase user-friendliness.

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Sustainable plus energy neighbourhoods

NTNU
Norwegian University of Science and Technology

DTU Technical University of Denmark

BPIE

SINTEF

HOUSING EUROPE

IREC
Shaping Energy for a Sustainable Future

ARCA NOVA GRUPPEN

area

INCASÒL
Institut Català del Sòl

TNO innovation for life

ENFOR

ABUD
Advanced Building & Urban Design

HEIMAT ÖSTERREICH

SIR
SALZBURGER INSTITUT FÜR RAUMORDNUNG & WOHNEN

ECA ENERGY CONSULTING AUSTRIA

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