FULFILL

Fundamental decarbonisation through sufficiency by lifestyle changes

Reports on beyond GDP analysis

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Project Partners

No	Participant name	Short Name	Country code	Partners' logos
1	**Fraunhofer Institute for Systems and Innovation Research ISI**	FH ISI	DE	
2	**Wuppertal Institut für Klima, Umwelt, Energie GGMBH**	WI	DE	
3	**Accademia Europea di Bolzano**	EURAC	IT	
4	**Notre Europe - Institut Jacques Delors**	JDI	FR	
5	**Association négaWatt**	NW	FR	
6	**Politecnico di Milano**	POLIMI	IT	
7	**International Network for Sustainable Energy-Europe**	INFORSE	DK	
8	**Zala Briviba Biedriba SA**	ZB	LV	

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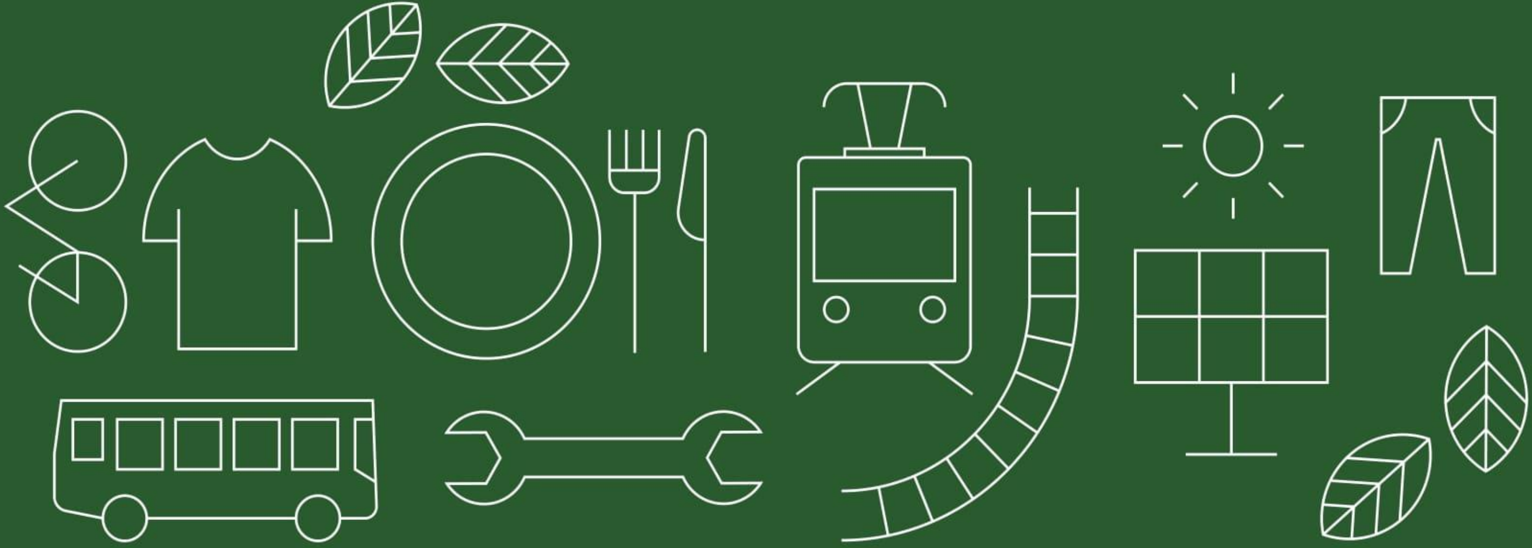

Content

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List of Abbreviations

BLI	Better Life Index
CIW	Canadian Index of Wellbeing
CUSP	Centre for the Understanding of Sustainable Prosperity
DI	Decoupling Index
EBI	Environmental Burden Index
EEA	European Environment Agency
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GPI	Genuine Progress Indicator
HDI	Human Development Index
HPI	Happy Planet Index
IDI	Inclusive Development Index
IPCC	Intergovernmental Panel on Climate Change
ISEW	Index of Sustainable Economic Welfare
MEW	Measured Economic Welfare
MI	Material Intensity
MS	Member State
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plans
NGO	Non-governmental Organization
OECD	Organization for Economic Cooperation and Development
SMs	Sufficiency Measure(s)
SPI	Sustainable Prosperity Index
SSH	Social Sciences and Humanities
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNU-IHDP	United Nations University International Human Dimensions Programme on Global Enivronmental Change
WEF	World Economic Forum
WISE	Wellbeing, Inclusion, and Sustainability & the Economy Horizons
YoY	Year-on-Year

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Abstract / Summary

The reliance on Gross Domestic Product (GDP) as the primary indicator of economic success has prompted widespread criticism for its failure to consider environmental externalities and overall societal well-being. This paper introduces an adapted version of the Sustainable Prosperity Index (SPI), inspired by the innovative work by Jackson and Victor (2020) for Canada. Developed within the FULFILL EU H2020 project, this composite indicator goes beyond GDP by integrating economic, environmental, and social indicators, holistically addressing crucial aspects such as energy sufficiency.

Existing indices, including the Human Development Index (HDI), Genuine Progress Indicator (GPI), Canadian Index of Wellbeing (CIW), Better Life Index (BLI), Happy Planet Index (HPI), Inclusive Development Index (IDI), and Sustainable Development Index (SDI) offer valuable insights but often fall short in adequately considering energy sufficiency. While these indices cover various dimensions of well-being and sustainability, they lack a detailed focus on the potential benefits from energy sufficiency actions. Our SPI stands out by directly integrating the impact of up-scaled energy Sufficiency Measures (SMs) within four high-energy consumption domains: food, transport, housing, and consumer goods.

Recognizing the impact of different weighting approaches for linearly aggregating indicators into a composite weighted index, this paper calculates the SPI using both constant weights and a sensitivity analysis that accounts for the specificities and trends of indicators in each EU country. The SPI, computed for all EU countries, serves as a practical tool for policymakers and researchers. Evaluating the SPI under a *Reference Scenario* and a *Sufficiency Scenario*, we inform the extent to which EU countries could enhance their decarbonization efforts via initiatives that support sustainable energy production and consumption.

Overall, this paper integrates a multi-dimensional understanding of the impact of lifestyle changes on sustainable development and prosperity across the EU, potentially making it a widely spread indicator in the realm of sustainability assessments.

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Introduction and Overview

Purpose of this Document

The purpose of Deliverable 6.4, entitled "*Reports on beyond GDP analysis*" is to develop a comprehensive composite index that goes beyond traditional GDP measures. This index will assess the economic, social, and environmental performance of EU Member States (MS), considering sufficiency principles and lifestyle changes that contribute to decarbonization.
The deliverable aims to:

- Establish a holistic framework: create an index that integrates economic, social, and environmental indicators, drawing inspiration from existing models like the Sustainable Prosperity Index (SPI) developed by Jackson and Victor (2020).
- Incorporate sufficiency principles: quantify and integrate the concept of sufficiency into the index, reflecting the role of lifestyle changes and reduced consumption in achieving decarbonization goals.
- Analyze EU MS performances: apply the composite index to assess the performance of all 27 EU MS, highlighting their progress towards sustainable and equitable growth.
- Analyze the evolution of indicators based on different scenario assumptions: explore the impact on the index outcomes of different scenarios (a *Reference Scenario*, a *Sufficiency Scenario* jointly assessing the impact of assumed sufficiency measures, as well as individual scenarios evaluating the impact of individual sufficiency measures), demonstrating the potential effects of sufficiency-oriented policies and lifestyle changes.
- Provide policy recommendations: increase the availability of tools for drafting data-driven policy recommendations that value and support the transition to sufficient lifestyles and contribute to the EU's decarbonization efforts (see the forthcoming D6.5 of FULFILL for further insights).

By achieving these objectives, Deliverable 6.4 will provide a valuable tool for policymakers, researchers, and stakeholders to understand the complex relationship between sufficiency, lifestyle changes, economic progress and decarbonization. The composite index will serve as a guide for informed decision-making, promoting a more sustainable and equitable future for Europe.

Project Summary

The project FULFILL takes up the concept of sufficiency to study the contribution of lifestyle changes and citizen engagement in decarbonizing Europe and fulfilling the goals of the Paris Agreement. FULFILL understands the sufficiency principle as creating the social, infrastructural, and regulatory conditions for changing individual and collective lifestyles in a way that reduces energy demand and greenhouse gas emissions to an extent that they are within planetary boundaries, and simultaneously contributes to societal well-being. The choice of the sufficiency principle is justified by the increasing discussion around it underlining it as a potentially powerful opportunity to achieve progress in climate change mitigation. Furthermore, it enables us to go beyond strategies that focus on single behaviors or certain domains and instead to look into lifestyles in the socio-technical transition as a whole. The critical and systemic application of the sufficiency principle to lifestyle changes and the assessment of its potential contributions to decarbonization as well as its further intended or unintended consequences are therefore at the heart of this project. The sufficiency principle and sufficient lifestyles lie at the heart of FULFILL, and thus constitute the guiding principle of all work packages and deliverables.

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Project Aim and Objectives

- To achieve this overarching project aim, FULFILL has the following objectives:
- Characterize the concept of lifestyle change based on the current literature and extend this characterization by combining it with the sufficiency concept.
- Develop a measurable and quantifiable definition of sufficiency to make it applicable as a concept to study lifestyle changes in relation to decarbonization strategies.
- Generate a multidisciplinary systemic research approach that integrates micro-, meso-, and macro-level perspectives on lifestyle changes building on latest achievements from research into social science and humanities (SSH), i.e. psychological, sociological, economic, and political sciences, for the empirical work as well as Prospective Studies, i.e. techno-economic energy and climate research.
- Study lifestyle change mechanisms empirically through SSH research methods on the micro- (individual, household) and the meso-level (community, municipal):
    - achieve an in-depth analysis of existing and potential sufficiency lifestyles, their intended and unintended consequences (incl. rebound and spillover effects), enablers and barriers (incl. incentives and existing structures) as well as impacts (incl. on health and gender) on the micro level across diverse cultural, political, and economic conditions in Europe and in comparison to India as a country with a wide range of economic conditions and lifestyles, an history which encompasses simple-living movements, and a large potential growth of emissions.
    - assess the dynamics of lifestyle change mechanisms towards sufficiency on the meso-level by looking into current activities of municipalities, selected intentional communities and initiatives as well as analyzing their level of success and persisting limitations in contributing to decarbonization.
- Integrate the findings from the micro and meso-level into a macro, i.e. national and European, level assessment of the systemic implications of sufficiency lifestyles and explore potential pathways for the further diffusion of promising sufficiency lifestyles.
- Implement a qualitative and quantitative assessment of the systemic impact of sufficiency lifestyles which in addition to a contribution to decarbonization and economic impacts includes the analysis of further intended and unintended consequences (incl. rebound and spillover effects), enablers and barriers (incl. incentives and existing structures) as well as impacts (incl. on health and gender).
- Combine the research findings with citizen science activities to develop sound and valid policy recommendations contributing to the development of promising pathways towards lifestyle
- Generate findings that are relevant to the preparation of countries' and the EU's next NDCs and NDC updates to be submitted in 2025 and validate and disseminate these findings to the relevant stakeholders and institutions for exploitation.
- Consider the relevance and potential impacts of sufficiency lifestyles beyond the EU.

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1. Introduction

Ever since Robert F. Kennedy's landmark speech on the first day of his presidential campaign in March 1968, several efforts have been made to address the limitations of gross domestic product (GDP) as the world's headline indicator of economic success, questioning its over-reliance of governments and international organizations to assess economic welfare of nations.

"GDP does not allow for the health of our children, the quality of their education, or the joy of their play." (Robert F. Kennedy, 1968)

The concept of GDP was originally developed in 1934 by the economist Simon Kuznets, with the main aim of assessing the economic consequences of the Great Depression in the USA. However, he immediately shared a concern, recognizing and warning the US Congress that:

"The welfare of a nation can scarcely be inferred from a measure of national income." (Simon Kuznets, 1934)

Following the Second World War, the indicator was fully integrated into policy making and governmental decisions, although it was well clear to what extent it failed to fully account for the social and environmental consequences of economic growth.

Yet, several researchers and experts have increasingly mined GDP as the appropriate indicator to measure the **relationship between economics and wellbeing**. Indeed, several new ways for measuring human development and wellbeing came up, accounting for environmental sustainability and social indicators of progress.

Furthermore, the paradigm of growth has been largely threatened and rediscussed, amid the distinction between the concepts of "**a-growth**" and "**degrowth**" (Van den Bergh and Kallis, 2012). Whereas the first suggests to completely ignore GDP for measuring economic growth, the latter instead urges for a downscaling of the economy to make it compatible with planetary boundaries. This argument is similar to the discussion put forward by Giannetti et al. (2015), who conducted an extensive literature review suggesting alternative indicators to GDP, overcoming the crude measurement of income and material wealth. Indeed, these alternative approaches can be categorized into two main types, taking inspiration from Sub-section 3.1 of D2.1 of FULFILL (Pagliano and Erba, 2022):

(i) those that originate from GDP, within the efforts to greening and socializing it, then including it in a more comprehensive composite index.

(ii) those that aim at building brand new frameworks and redefining novel indicators, such as environmentally oriented and socially oriented measures, surpassing GDP.[1]

An ongoing topic of discussion among analysts and researchers to reach ambitious climate targets relates to the notion of "*decoupling*", which means ensuring economic growth - as measured by GDP - while decreasing greenhouse gases (GHG) emissions, to combat climate change. Decoupling economic activity from environmental impacts is crucial for guaranteeing a sustainable and equitable societal progress. Metrics such as the *Decoupling Index* (DI), proposed by the United Nations

[1] This report primarily focuses on the latter, identifying an adapted version of the *Sustainable Prosperity Index* (SPI) applied to the case of EU27 countries. We hereby propose a procedure to define and extend the SPI, aiming at underscoring the importance of energy savings and carbon emissions' reductions resulting from the adoption of sufficiency-oriented lifestyle changes.

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Environment Programme (UNEP, 2011), quantify this notion, distinguishing between *"absolute decoupling"* and *"relative decoupling"*.[2]

Kalimeris et al. (2020) observed that welfare, as measured by non-GDP alternative indexes, has increased at a slower rate than suggested by GDP growth. They introduced indexes like the *Material Intensity* (MI) *index* to investigate the nexus between resources and the economy.

Haberl et al. (2020) provided empirical evidence on decoupling trends related to energy consumption, material resource use, and CO2 emissions. Following an investigation of selected 835 peer-reviewed empirical works, they advocated for an integration of **sufficiency-oriented strategies**, while promoting decoupling efforts to achieve reductions in greenhouse gas emissions and resource use.

In a briefing, the European Environment Agency (2021) underlined the importance of developing innovative approaches to promote European growth and long-term sustainability. The study emphasized **lifestyles, communities, and societies that create conditions for consuming less**, an initiative that and can be adopted by all individuals. The shift is challenging, but essential to grow in quality (e.g. purpose, solidarity, empathy) rather than quantity (e.g. material standards of living), ensuring equity among individuals.

The present report is organized as follows. Sub-section 1.1 presents a review of key initiatives that led to innovative ways going beyond GDP metric, while Sub-section 1.2 presents impactful studies and a literature review of main beyond-GDP indicators. Section 2 presents the methodological approach employed in this report for T6.4 of FULFILL project. Section 3 discusses data and information processed in this task. Section 4 presents the main outputs of our research work. Section 5 and 6 conclude with discussion and final remarks, including strengths and weaknesses of the proposed approach.

1.1. Key actions to go beyond GDP

In 2009, the French Presidency Nikolas Sarkozy convened a Commission, the *Commission on the Measurement of Economic Performance and Social Progress* (CMEPSP), led by internationally acclaimed economists like Amartya Sen, Joseph Stiglitz, and Jean-Paul Fitoussi. Their study (Stiglitz et al., 2009) was topical in addressing the limitations of using GDP as the sole measure of a country's economic performance and social progress, opening to a wide range of initiatives by several actors.

> *"There are long recognized problems in GDP as a measure of economic performance, but many of the changes in the structure of our society have made these deficiencies of greater consequence. At the same time, advances both in our conceptual understanding of the issues and data availability mean that it is now possible to construct better indicators. Better indicators might be able to address one of the concerns that motivated this report: a marked distance between standard measures of important socio economic variables like economic growth, inflation, unemployment, etc. and widespread perceptions." (Stiglitz, Sen, Fitoussi, Prolegomena, 2009)*

[2] While *absolute decoupling* is referred to a condition of GDP growth coinciding with absolute declines in emissions/resource use, *relative decoupling* is related to a decline in the resource/energy intensity per unit of economic output.

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Many applications at governmental level followed this first State-led intervention. Here is a brief overview.

Initially, the French example was followed by the 2010 UK prime minister David Cameron, who launched a program to implement Sarkozy's recommendation. This led to outline the concept of "inclusive wealth" in the UK, which aimed at setting up a plan to transform the social setting of the country, creating new opportunities for sustainable prosperity to all Britain's forgotten communities. This concept was adopted in the landmark **UK Levelling Up White Paper** (UK Government, 2022), aiming to induce a 'system change' via the reduction of regional inequalities. This resulted in the outline of 12 quantifiable national missions to be achieved by 2030.

Following this initiative by the UK Government, the Institute for Global Prosperity (IGP) established a novel definition of prosperity, engaging citizen social-scientists and community organizations in a pilot case in east London. Central to this effort is the **Prosperity Index (PI)**[3], an indicator developed by the IGP, which identifies 15 headline factors that local people recognize as priorities to support prosperity and quality of life at the local level.

The **New Zealand's Living Standards Framework** (2021) is the best-known example of a dashboard approach (the LSF Dashboard), a measurement tool which complements the LSF, which in turn represents the main flexible repository to gather all things that matter for the present and future NZ's wellbeing. The LSF acts on three levels: the individual and collective wellbeing (e.g. health, knowledge and skills, housing, environmental amenity, etc.), the Institutional and Governance framework (e.g. central and local government, firms, and markets, etc.) and further complementary aspects of NZ's wellbeing (e.g. natural environment, social cohesion, human capability, financial and physical capital).

The **G15+ collective** has generated a dashboard of 51 indicators to assess the well-being of citizens in Quebec, surpassing GDP-centric evaluations. This initiative aims to steer public policies towards a prosperous, inclusive, and sustainable society by offering a multifaceted perspective on societal progress. Endorsed by experts and supported by key institutions and organizations, this project underscores civil society's dedication to addressing the evolving needs of Quebec's population.

Within the EU, many efforts allowed to foster the discussion on sustainable and equitable growth. The **«Beyond Growth» Conference** (Beyond Growth Conference, 2023) has this main objective of challenging the status-quo of current conventional policies, to generate policy recommendations aimed at establishing sustainable prosperity in Europe, based on a drastic change to the way of approaching economic, social, and environmental sustainability issues.

The European project **WISE Horizons project - Wellbeing, Inclusion, and Sustainability**[4][5] - aims at advancing studies on beyond traditional GDP-centric metrics, paving the way towards a new conceptual foundation. The "WISE triangle" identifies relevant dimensions for evaluating beyond-GDP existing indicators, based on the principles of Wellbeing, Inclusion, and Sustainability (WISE). Wellbeing pertains to the present state of wellbeing, inclusion relates to the distribution of wellbeing, while sustainability points to the wellbeing of future generations. Noteworthily, metrics within the triangle are categorized based on their coverage of such dimensions, illustrating a nuanced understanding of societal progress. The 14 central beyond-GDP indicators are those that distinguish themselves to include all three relevant dimensions.

[3] Institute for Global Prosperity (IGP). The Prosperity Index. https://seriouslydifferent.org/what/prosperity-index

[4] WISE Horizons Database. University of Leiden. 2022 https://www.beyond-gdp.world/wise-database/wise-metrics

[5] This initiative is different from the one by OECD "*Centre on Well-being, Inclusion, Sustainability and Equal Opportunity* (WISE)", working on the Better Life Index.

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The **Doughnut Economics** initiative[6] offers a new way to envision the societal transformation. Central to this initiative is the book (Raworth, 2017), which quickly became an international best-seller due to its profound insights into redesigning economic systems and fostering sustainable growth for the future.

1.2. Review of studies on "beyond-GDP" indicators

The efforts to redefine and innovate the way the progress of a country is measured dates to the previous century.

A systematic review of most impactful studies on the beyond-GDP topic was recently performed by Agrawal and Sharma (2023). By means of a meta-literature analysis, the authors analysed works published between 2012 and 2022, highlighting main articles, publication journals, influential authors, organizations, countries, keywords, and top trend topics.

Nevertheless, we primarily recognize the work by Stiglitz et al. (2009), as well as the one by Corlet Walker and Jackson (2019), as our starting point for our review of prominent beyond-GDP indicators.

Table 1 outlines our major literature review findings, followed by a brief discussion of each documented indicator, organized chronologically for analytical coherence.

Table 1: Review of indicators that go beyond GDP.

Institution	Year	Reference	Indicator	Acronym
-	1972	Nordhaus & Tobin, (1972)	Measured Economic Welfare	MEW
UNDP	1990s	United Nations, (1990)	Human Development Index	HDI
-	1990	Cobb and Daly (1989)	Index of Sustainable Economic Welfare	ISEW
Redefining Progress	1995	Kubiszewski et al. (2013)	Genuine Progress Indicator	GPI
New Economics Foundation	2006	Simms et al. (2006)	Happy Planet Index	HPI
OECD	2011	Boarini and d'Ercole (2013)	Better Life Index	BLI
Canadian Index of Wellbeing Network	2011	Michalos et al. (2011)	Canadian Index of Wellbeing	CIW
UNEP	2012	UNEP& UNU-IHDP (2012)	Inclusive Wealth Index	IWI

[6] Doughnut Economics. 2023 https://doughnuteconomics.org/

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Social Progress Imperative	2013	Stern et al. (2020)	Social Progress Index	SPI
World Economic Forum	2017	World Economic Forum (2017)	Inclusive Development Index	IDI
CUSP	2020	Jackson and Victor (2020)	Environmental Burden Index	EBI
CUSP	2020	Jackson and Victor (2020)	Sustainable Prosperity Index	SPI
SDI Project[7]	2020	Hickel (2020)	Sustainable Development Index	SDI
Legatum Institute	2021	Legatum Institute (2023)	Legatum Prosperity Index	LPI

Initially developed by the Pakistani economist Mahbub ul-Haq in the 1990s, the United Nations Development Programme – UNDP (United Nations 1990) developed the **Human Development Index** (HDI) for an easy-to-use comparison of average human well-being across countries, alongside with the GDP. It measures health (life expectancy at birth), education (mean and expected years of schooling), and per capita income indicators (GNI per capita), and thus, trying to capture the broad dimension of human development. It had the explicit target "*to shift the focus of development economics from national income accounting to people-centered policies*".

Conversely, the **Sustainable Development Index** (SDI) developed by Hickel (2020) aims at overcoming the limitations by the HDI which neglects the fact that "*countries that score highest on the HDI also contribute most, in per capita terms, to climate change and other forms of ecological breakdown*". Thus, the SDI includes the concept of nations' ecological efficiency in delivering human development.

The **Index of Sustainable Economic Welfare** (ISEW) heavily contributed to undermine the concept of conventional GDP. The index was initially developed by the ecological economist Herman Daly and theologian John Cobb in the appendix of their 1990 book "*For the Common Good*" (Daly et al., 1989).

The **Measured Economic Welfare** (MEW) index dates to the work by William Nordhaus and James Tobin in 1972, who undermined the value of GDP as a proper measure of economic welfare (Nordhaus & Tobin, 1972). The MEW took the measure of GDP, adding the value of leisure time and the amount of unpaid work in the economy, while detracting the value of environmental damage, hence accounting for negative externalities generated by increasing economic activity.

The ISEW and the MEW were somehow precursors of the **Genuine Progress Indicator** (GPI), initially developed in 1995 by the U.S. no-profit organization Redefining Progress. The GPI started to be established as an alternative index to GDP, and began to be used both in Canada and the U.S. The GPI is composed by 26 indicators, encompassing the social and environmental dimensions which are not included in the GDP, such as pollution, volunteerism, crime, and climate change. Kubiszewski et al. (2013) use estimates of GPI over the 1950-2003 period for 17 countries, to compare it with GDP. The authors argue that GPI attempts to adjust GDP for a range of factors (environmental, social, and economic) which are not sufficiently reflected in the GDP itself, enabling more effective comparisons between economic growth and well-being. Remarkably, GPI

[7] Sustainable Development Index (SDI) project. 2024 https://www.sustainabledevelopmentindex.org/about

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stems from the concept of sustainable income, which dates to the study by the economist John Hicks (1946), later reviewed by Nordhaus (1995).

The **Happy Planet Index** (HPI), generated in 2006 by the New Economics Foundation, emphasizes the role of life satisfaction, life expectancy, and ecological footprint per capita. The index aims to measure the extent to which countries use natural resources to achieve long and happy lives for their citizens, providing a compass to guide nations towards genuine progress. Remarkably, HPI indirectly incorporates sufficiency, examining how efficiently countries use their natural resources to achieve sustainable well-being, through the inclusion of subjective life expectancy, life expectancy at birth, and ecological footprint per capita.

The **Better Life Index** (BLI) was created by the Organization for Economic Cooperation and Development (OECD) in 2011 and is an interactive tool which consists of *11 topics of wellbeing*, which are initially weighed equally. The rationale behind the Index was introduced by Boarini and d'Ercole (2013), who discussed the shortcomings of GDP from an OECD perspective. The authors present the OECD approach for the BLI, a tool that provides a multi-dimensional assessment which allows for country-comparisons of well-being. The tool is now designed to enable users to prioritize among the 11 topics and monitor the performance of countries of interest. The dimensions include income, jobs, community, education, environment, governance, health, life satisfaction, safety, and work-life balance.

In 2012, UNEP proposed the **Inclusive Wealth Index** (IWI). Index which assesses the change in nations' wealth, by encompassing a comprehensive view of capital assets, including manufactured, human, and natural capital. It is a metric for inclusive wealth within countries, having the main advantage of integrating natural and social capital alongside economic wealth.

The **Canadian Index of Wellbeing** (CIW) was developed by the Canadian Index of Wellbeing Network, with the intention of monitoring the wellbeing of the Canadian population in the area of environmental health to assess well-being and going beyond traditional economic indications of GDP. The CIW is composed of *eight domains (Community Vitality, Democratic Engagement, Education, Environment, Healthy Populations, Leisure and Culture, Living Standards, Time Use)*, where each of them is further disentangled into 8 indicators (). Similar initiatives to CIW have later developed national indexes for wellbeing (e.g. UK, Australia, Norway).

The **Social Progress Index – SPI** (Stern et al. 2020), developed in 2013 by the NGO "*Social Progress Imperative*" – based on the initial inputs of Amartya Sen, Douglass North, and Joseph Stiglitz – assesses social and environmental well-being across three broad dimensions: basic human needs, foundations of well-being, and opportunity.

The **Inclusive Development Index** (IDI) was introduced by the World Economic Forum (2017), as part of the project of the WEF's System Initiative on the Future of Economic Progress. The indicator represents an annual assessment of 103 countries' economic performance, assessing how countries perform on 11 dimensions of economic progress in addition to GDP.

In 2020, Peter Victor and Tim Jackson elaborated two novel indicators going beyond GDP (Jackson and Victor, 2020): the **Environmental Burden Index** (EBI), and the **Sustainable Prosperity Index** (SPI). The EBI describes the environmental impacts of economic activity which are absent from GDP, while SPI incorporates a multi-dimensional framework, integrating economic, environmental, and social dimensions into a unique composite index based on a linear weighed combination of 7 indicators.

In 2021, the Legatum Institute based in UK launched the **Legatum Prosperity Index**. According to the methodology employed (Legatum Institute, 2023), the index is an annual ranking of 167 countries on their levels of prosperity. It is based on multiple factors, including economic quality, business environment, governance, education, health, personal safety, social capital, and natural environment.

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1.3. Inclusion of energy sufficiency in beyond-GDP indicators

The Intergovernmental Panel on Climate Change (IPCC, 2022) underscores the importance of sufficiency as a pivotal element in climate change mitigation. In their Sixth Assessment Report, the IPCC emphasizes that sufficiency strategies can significantly contribute to the reduction of greenhouse gas emissions, particularly in the building sector.
These strategies encompass:

- The design of smaller, compact buildings: This strategy diminishes the requirements for heating, cooling, and lighting.
- The promotion of shared spaces and co-housing: This approach reduces the demand for individual residences and the resources required for their construction and upkeep.
- The encouragement of active transportation and public transit: This strategy lessens the dependence on private vehicles, which are a significant source of emissions.
- The support of sustainable consumption patterns: This involves a transition towards diets with lesser environmental impacts, the reduction of food waste, and the preference for durable, repairable products over disposable ones.

In a recent paper, Bilal and Känzig (2024) estimate that a 1°C increase in global temperature leads to a 12% decline in world GDP. They also estimate that the social cost of carbon is around 1,000 USD per ton of carbon dioxide. The paper concludes that a business-as-usual scenario (comparable to our reference scenario) would result in a 31% present value welfare loss. They also discussed the difference between (single country) domestic cost of carbon (DCC) and the (global) Social Cost of Carbon (SCC): when a government only internalizes domestic benefits, it values mitigation benefits using the DCC, which is always lower than the SCC. This is because damages to a single country are less than to the entire world. For example, under conventional estimates based on local shocks, the DCC of the United States is $30/tCO2, making unilateral emissions reduction prohibitively expensive. However, under their new estimates, the DCC of the United States becomes $211/tCO2, which largely exceeds policy costs. In this case, unilateral decarbonization policy becomes cost-effective for the United States (Bilal and Känzig, 2024). It might be reasonable to assume that the same effects are still valid in the EU.

Bagheri et al. (2018) introduce a novel multi-factor energy input-output (MF-EIO) model to support green growth in Canada by analyzing energy use, CO2 emissions, and economic impacts. They use an MF-EIO model that incorporates eight multipliers and two green growth indices to evaluate the effects of changes in final demand on energy flows, emissions, and job creation. The two new indices developed are:

- *Green Economic Growth Index* (GEGI): this index assesses the extent to which different final non-energy demands threaten the environment through their CO2 emissions due to a unit of economic expansion. It is calculated as the ratio of the CO2 emission multiplier to the total output multiplier, and
- *Green Job Growth Index* (GJGI): this index measures the emissions intensity per energy job created from final non-energy and energy demands. It is calculated as the ratio of the CO2 emission multiplier to the energy job multiplier, indicating the CO2 emissions per energy job created.

As a result, their analysis identifies economic activities that can stimulate green growth with minimal environmental impact, highlighting sectors with high renewable energy use and low CO2 emissions. From this, the study concludes with policy guidelines to help promote green growth through targeted reforms and public expenditure strategies.

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The scientific paper by Millward-Hopkins et al. (2020) presents a model estimating the minimal energy required to provide decent living globally by 2050. It suggests that with advanced technologies and demand-side changes, it's possible to reduce global energy consumption to 1960 levels (which is considered sustainable) despite a larger population. The concept of sufficiency is central to the paper. It involves reducing consumption to levels that meet basic needs without excess ("for decent living, but no more") which is materially more generous than opponents of consumption reduction assume. However, achieving the proposed energy reduction by 2050 requires a massive deployment of advanced technologies across all sectors in addition to Demand-Side Changes: radical changes in consumption patterns are necessary. This means moving away from growth-oriented consumption to sufficiency-oriented consumption, even in high-income countries. The paper thus argues that these changes can provide a high quality of life for all while significantly reducing energy use and ecological impact. It challenges the notion that environmental sustainability requires a return to primitive living, instead proposing a modern, low-energy, and high-living-standard global society (Millward-Hopkins et al., 2020).

> "*highly-efficient facilities for cooking, storing food and washing clothes; low-energy lighting throughout; 50 L of clean water supplied per day per person, with 15 L heated to a comfortable bathing temperature [..] air temperature of around 20 °C throughout the year, irrespective of geography; have a computer with access to global ICT networks; are linked to extensive transport networks providing ~5000–15,000 km of mobility per person each year via various modes [..] universal healthcare is available and [..] education for everyone between 5 and 19 years old.' And at the same time, it is possible that the amount of people's lives that must be spent working would be substantially reduced.*" Millward-Hopkins et al. (2020) p. 8

Of the indices presented in Table 2, none directly and explicitly include energy sufficiency as a component. However, some indirectly touch upon aspects related to energy use or sustainability:

Table 2: inclusion of energy sufficiency by analysed beyond-GDP indicators.

Index	Acronym	Inclusion of energy sufficiency
Happy Planet Index	HPI	It includes ecological footprint, which is related to resource consumption and can be influenced by energy use. A lower ecological footprint often implies more sustainable practices, potentially including energy sufficiency. HPI also includes well-being, through the inclusion of subjective life expectancy, life expectancy at birth, and ecological footprint per capita.
Canadian Index of Wellbeing	CIW	It includes the domain "Environment," which assesses environmental quality and sustainability. While not specifically focused on energy, this domain could indirectly reflect the impacts of energy consumption on the environment. CIW also incorporates sufficiency through leisure and culture, time use, and democratic engagement.
Genuine Progress Indicator	GPI	It adjusts GDP by subtracting the costs of environmental damage, which can be linked to excessive energy consumption. GPI also includes non-market activities like volunteer work and housework. A higher GPI could indicate a more sustainable approach to resource use, including energy.

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Better Life Index	BLI	It indirectly incorporates sufficiency among its 11 dimensions: individuals can prioritize aspects of their lives like health, work-life balance, and life satisfaction.
Social Progress Index	SPI	It includes basic individual well-being, such as health and safety, that indirectly could be associated with energy sufficiency.

The other indices – HDI, IWI, SPI, IDI – primarily focus on economic factors, without directly addressing energy sufficiency. While the Environmental Burden Index (EBI) and Sustainable Prosperity Index (SPI) consider environmental impacts, they don't specifically isolate energy sufficiency as a separate component.

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2. Methodological approach

In this Section, the methodology for the elaboration of the composite beyond-GDP index is presented.
When firstly approaching it, we had to identify an appropriate strategy to **combine environmental, economic, and social impact indicators** in a composite intuitive index going beyond GDP. The main second challenge was to clarify a straightforward approach to directly account for **the impact of sufficiency lifestyle changes** on the developed composite index.

Following our initial literature investigation (see Section 1), our composite beyond-GDP indicator drew inspiration from two indicators developed by Jackson and Victor (2020)[8], in line with specifics of the Grant Agreement (GA) of FULFILL: the Environmental Burden Index (EBI)[9], and the composite **Sustainable Prosperity Index** (SPI). We initially acknowledged that these indicators were developed under a different modelling framework (stock-flow consistent macroeconomic model) and a diverse setting, namely for the case of the Canadian economy. Nevertheless, due to the **flexibility** related to its construction process and the **comprehensive aggregation of relevant economic, social, and environmental indicators**, we welcomed the SPI as our target beyond-GDP index. The challenge was to tailor its computation to the case of the EU continent, adding the complexity of assessing the impact of energy Sufficiency Measures (SMs) under specific scenario assumptions developed in FULFILL.

The process of T6.4 is illustrated in Figure 1, and will be further explored in Section 3.
The procedure entailed a constant processing of information from multiple internal and external sources. We categorized 3 main sources of information:

- **External data collection**. We gathered historical data from international databases (e.g., OECD, Eurostat) to directly acquire information on the variables feeding the SPI. Besides, we collected external data (e.g. population projections from OECD) for processing information resulting from T6.2. This extensive data collection from external sources allowed us to generate the initial database for the computation of our adapted version of the SPI within FULFILL for the 27 EU countries.
- **Data from T6.2 of FULFILL**: We obtained data (GDP, Employment, GHG emissions) for each EU country from output indicators derived from the impact assessment conducted in T6.2 of FULFILL. Additionally, we synthesized these data based on their breakdown into scenario assumptions. This integration was crucial to incorporate the impact of sufficiency lifestyle changes into the formulation of our composite SPI index, specifically through the "*Reference*", the "*Sufficiency, All Measures*", and the set of specific "*Sufficiency Scenarios*".

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[8] The SPI was developed by Peter Victor (Co-investigator at CUSP and Professor Emeritus, York University, Canada) and Tim Jackson (Director of the Centre for the Understanding of Sustainable Prosperity, CUSP). The idea of SPI is included in the book by Victor, P.A.*, Managing without Growth. Slower by Design, not Disaster, 2nd edition. 2019, Edward Elgar Publishing*.
[9] Despite a preliminary attempt to compute an adapted version of EBI for all EU27 countries, we decided to discard the EBI metric, due to risk of including noise especially concerning high complexity regarding the identification of its component weights.

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- **Engagement with external experts**. We engaged with external experts, particularly those from CUSP and researchers from the WISE Horizons project. Our collaboration with CUSP focused on the definition of the mathematical formulation of the index and, importantly, the weighting scheme approach. This collaboration strengthened the robustness of our weighting approach within the linear combination of input indicators. With EU WISE Horizons project, our discussions centered on interpretation, policy implications, validity, and dimensions, ensuring a comprehensive and meaningful assessment.

By following this process based on continuous feedback loops, we ensured the accuracy and relevance of our composite beyond-GDP index, effectively incorporating the impacts of sufficiency lifestyle changes and aligning with best practices and innovative approaches in the field.

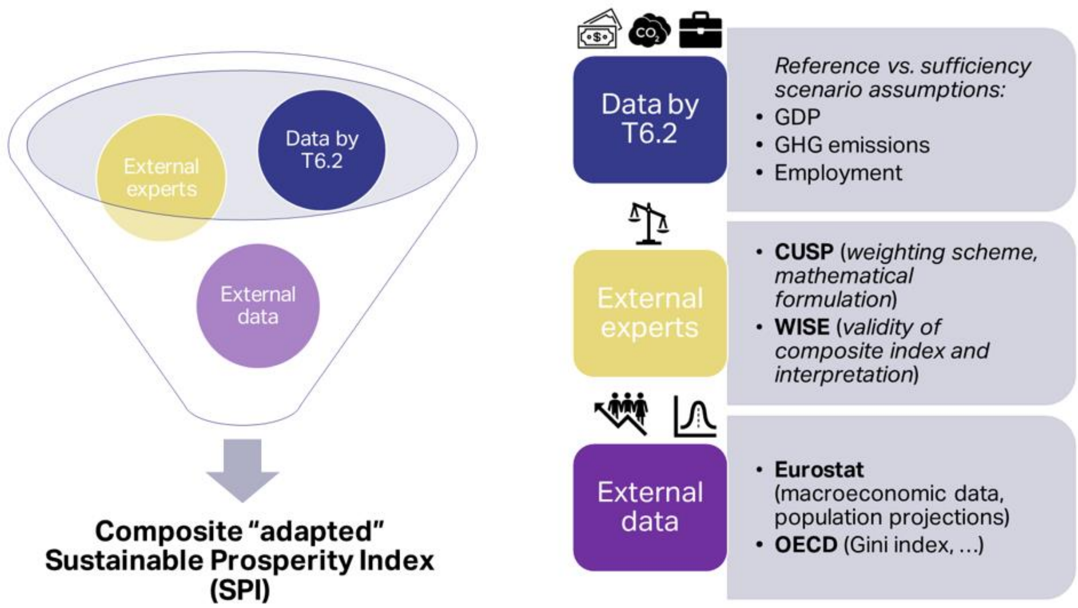

Figure 1 Workflow of T6.4 in FULFILL project to compute the SPI for all EU27 countries, while accounting for the impact of energy SMs.

Throughout the implementation of the process, several critical aspects have emerged in the construction of our composite beyond-GDP index. This mainly revolved around the different setting and objectives in place during the execution of FULFILL. We identified 4 main critical aspects.
The primary concern entailed the **scanning of the pertinent measures and variables** related to economic, environmental, and social dimensions. Secondly, the strategy for **creating uniformity and composedness among input indicators** became significant, to ensure consistency and enable meaningful comparisons among our input variables. Thirdly, the issue related to the **selection criteria for assigning weights** to indicators within the composite index was addressed. Fourth, the **final aggregation of input indicators** and the **construction of our adapted version of SPI** for the case of Europe to account for energy sufficiency was determined.
We investigate each of these critical steps in the following sub-sections.

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2.1. Scanning, comparison, and selection of pertinent indicators

Identification of indicators

Initially, a **scanning, comparison and selection of the pertinent measures and variables related to economic, environmental, and social dimensions** to be selected was undertaken. This process was supported by preliminary data analysis, overlooking the evolution of time series variables between 2000 and 2020, highlighting differences across EU27 countries.

This entailed a comprehensive review of the previous impact assessments conducted under the MARIO framework (T6.2) and the backbone of our literature review. Key indicators were selected based on their relevance, measurability, and ability to reflect changes in the quality of life and sustainability beyond traditional GDP metrics. Given the setting defined in GA of FULFILL, we strongly relied on the process outlined by CUSP for SPI generated by Jackson and Victor (2020).

Regarding the final selection of pertinent input indicators, we opted to execute **three major changes**. Firstly, we excluded the indicator "*unsecured household debt-to-income ratio*", mostly due to data constraints and for its inappropriateness to include the impact of lifestyle changes in terms of energy sufficiency. Secondly, we employed GHG emissions as the comprehensive indicator for representing the environmental dimension of our composite index. Indeed, GHG emissions are a direct outcome of the Input-Output (I/O) modelling framework (T6.2 of FULFILL). Lastly, we constructed the ratio of projected employment over projected population – to substitute *unemployment rate* –, mainly due to data availability on projected values of workforce under the considered scenario assumptions.

The following Table summarizes the selected input indicators for SPI for T6.4 of FULFILL.

Table 3 Selection of indicators for SPI within T6.4 FULFILL.

ID	Indicator	Label	Dimension	Source
1	GDP per capita	$GDP\_pc_{c,y}$	Economic	T6.2 & own processing
2	Employment to population ratio	$Emp/pop_{c,y}$	Economic	T6.2 & own processing
3	Debt to GDP ratio	$Debt/GDP_{c,y}$	Economic	Eurostat
4	Gini coefficient	$Gini_{c,y}$	Societal	OECD
5	Average annual hours worked per worker	$Avg\_hrs_{c,y}$	Societal	OECD
6	GHG emissions	$GHG_{c,y}$	Environmental	T6.2

Integration of Reference and Sufficiency scenarios

The core objective in the elaboration of our modelling framework for our composite beyond-GDP index is the **inclusion of the impact of sufficiency lifestyle changes**, as identified in FULFILL. These changes are essential to capture the behavioural and lifestyle adjustments that might contribute to the road towards sustainable prosperity in each EU country. Indeed, our composite index stands out from the others as it explicitly integrates several assumptions aimed at including the impact of lifestyle changes from the perspective of energy sufficiency.

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The primary distinction lies between a ***Reference* (baseline) *Scenario*** and **a set of sufficiency scenarios**. The main difference boils down to the variations that are hypothesized in final consumption patterns, as specified from the I/O analysis described in T6.2. Specifically, the ***Reference scenario*** outlines a baseline transition process that excludes Sufficiency Measures (SMs) but includes the decarbonization of power and the electrification of certain final uses. A ***Sufficiency Scenario***, instead, was defined as a set of inputs representing at least one sufficiency scenario assumption. Intuitively, the **Sufficiency scenarios** depict the modifications that occur when SMs are applied, in addition to the existing background changes. In contrast, the *Reference Scenario* only captures these baseline changes without the impact of SMs.

Understanding this difference is crucial for gauging the additional impact of SMs on sustainable prosperity. By incorporating these scenarios, our composite index informs on the potential benefits of adopting sufficiency lifestyle changes beyond the improvements already projected in the baseline reference scenario (see Figure 2 for the underlying graphical interpretation).

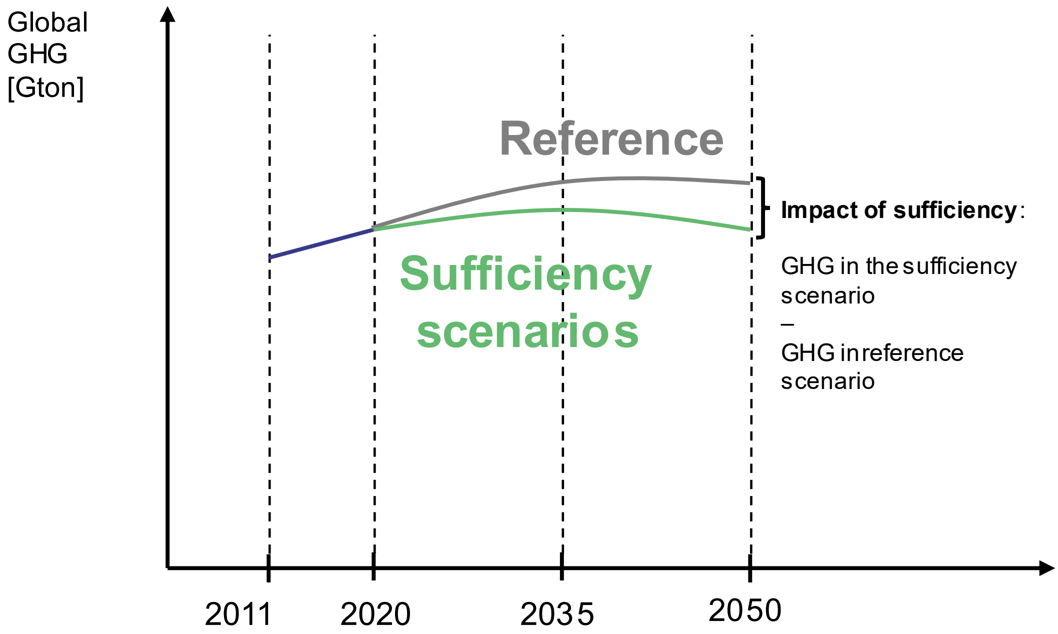

Figure 2 Representation of reference and sufficiency scenarios in T6.4 of FULFILL project, as derived from T6.2. Example applied to the indicator "GHG emissions".

As shown in Figure 2, the set of scenarios where sufficiency scenario assumptions are present (*Sufficiency scenarios*) differ from the one where SMs are absent (*Reference Scenario*). Therefore, the impact of each measure is determined by the net variation in the I/O model's results outlined in T6.2. For example, this was done in T6.4 by collecting output data on emissions of Greenhouse Gases (GHG), GDP, and employment both under the *reference scenario* and the corresponding selected sufficiency scenarios. The difference between the two impacts indicates the effect of the sufficiency scenario assumption over the observed output indicator.

Overall, the inclusion of scenarios for our prospective analysis provides a more comprehensive view of sustainable development, capturing – within our composite index – both the baseline progress and the additional gains from adopting specific SMs, as they were modelled in FULFILL. This approach allows for a more nuanced analysis of policy impacts and supports the formulation of strategies aimed at achieving sustainable prosperity in the EU.

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Dimensions and contributions to SPI

Our approach to determining the direction of correlation for each indicator is based on a combination of our expertise and the methodology established by Jackson and Victor (2020) for the elaboration of the SPI for the case of Canada. The sign in the mathematical formulation (see subsection 2.4) for each indicator's contribution to the composite index is based on our underlying assumption of the expected direction of correlation. Consistent with the assumptions made by the cited authors, positive changes in indicators that contribute to sustainability and prosperity are treated as positive contributions, whereas negative changes in such indicators are treated as negative contributions.

In our adapted version of the SPI, we consider the performance of **economic, social, and environmental dimensions**, which serves as the basis for the assignment of weights (see next subsection). By aligning our methodology with the established expertise of CUSP and incorporating our experience within FULFILL, we ensure that the direction of correlation for each indicator is accurately represented in our composite index.[10]

Figure 3 summarizes the adopted configuration of SPI under T6.4 of FULFILL with the specification of its main components and dimensions.

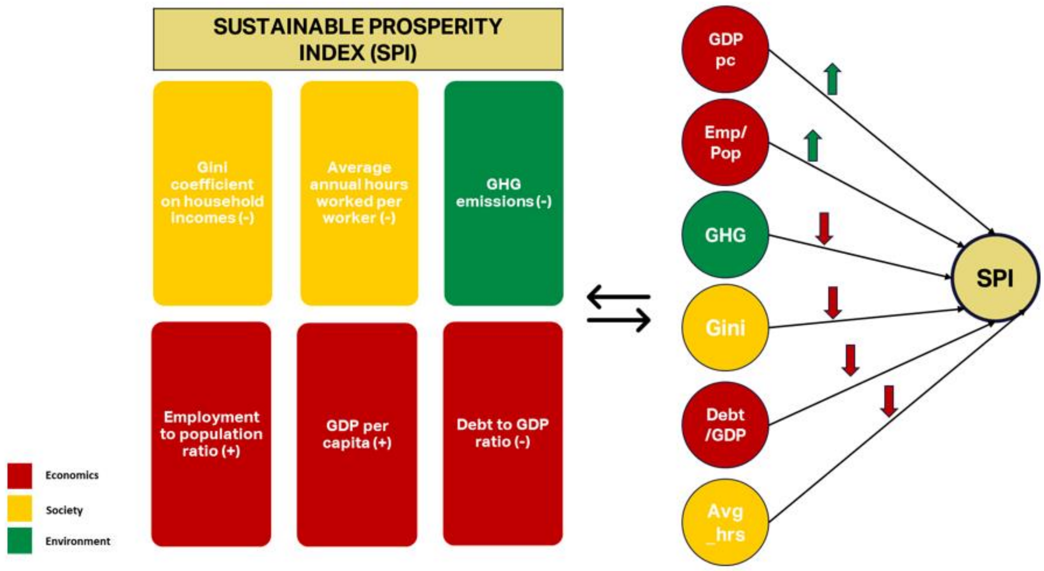

Figure 3 Identification of the three dimensions for sustainable prosperity in T6.4 of FULFILL project (left). On the right, the expected direction of correlation with the composite SPI metric is assumed, in line with Jackson and Victor (2020).

2.2. Normalisation of input variables

Normalization is a critical step to ensure that all indicators are comparable and can be aggregated meaningfully. Instead of converting the indicators to a common scale using min-max scaling or z-score normalization, we retain the variables in their original levels for our main empirical findings. This approach is beneficial for capturing the true dynamics and variations in each indicator.

[10] We assume a positive contribution of GDP per capita to the SPI. For more insights on the relationship between income and happiness, please explore Frey and Stutzer (2002) and Killingsworth et al. (2023).

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To achieve this, we transform the original levels into their **percentage changes (%), i.e. growth rates**.[11] This method allows to compare shocks to input variables based on a common unit of measurement (i.e. rates of growth), to dynamically reflect the **positive and negative contributions of each indicator to the composite index**.
The percentage change of each variable x is calculated as follows:

$$perc\_change_x = \left(\frac{x_t - x_{t-5}}{x_{t-5}} * 100\right)\% \quad (1)$$

Note that, in Equation (1), the percentage change for each indicator in year t is calculated with respect to its previous level observed 5 years before. By using percentage changes for each individual input indicator, we can more accurately capture the dynamic nature of shocks to each indicator, ensuring that our composite index remains responsive to real-world developments and tracks the evolution of the aggregate net effect of percentage shocks.

2.3. Weighting approach

Regarding the selection of weights, we identified in the literature **four primary methods** commonly used to weigh input variables within composite indexes:

1. **Equal weights**: assigning equal relevance to all chosen input variables.
2. **Subjective/flexible weights**: assigning weights based on subjective judgment or adaptable criteria, depending on the goal of the assessment.
3. **Mathematical weights**: employing techniques like Principal Component Analysis (PCA) or factor loadings to compute weights mathematically.
4. **Expert weights**: engaging experts or consultants to determine weights through consultations.

Initially, we tried an equal weighting approach for our proposed SPI index, by assigning the same weight to all indicators. Although convenient for arithmetic purposes, we deemed the approach highly questionable and not robust. Moreover, we acknowledged that applying equal weights to the input indicators to any composite index when the variables are measured as percentage changes would exacerbate even more the results.
To refine our approach, we got in contact with CUSP to access weights used for Canadian SPI. However, these weights were derived from expert judgment and specifically for the Canadian context.
We were advised to select weights in direct alignment with the objectives of FULFILL and the scope of our analysis.[12]
Therefore, we moved to a **subjective/flexible weighting approach**, prioritizing an assignation of weights based on our team's judgement on the contribution of each input variable with respect to sustainable prosperity in the EU. The final chosen approach was to assign the **same weight to each of the three dimensions of sustainable prosperity**. To derive the main results of this deliverable, we assigned uniformly an equal weight across all EU MS to compute results of the adapted version of SPI within FULFILL.
The weighting criterion is shown in Figure 4.[13]

[11] Note that, for the prospective analysis, a 5-year interval dimension was employed to compute percentage changes of the variables.
[12] Eventually, our choice of weights is very different from the approach by Jackson and Victor (2020).
[13] Preferably, the optimal choice would be to consider existing differences across EU countries or groups of them, to attribute weights based on the country's sensitiveness to economic, environmental, and social issues, according to literature. Alternatively, a decision based on experts' feedback could be adopted.

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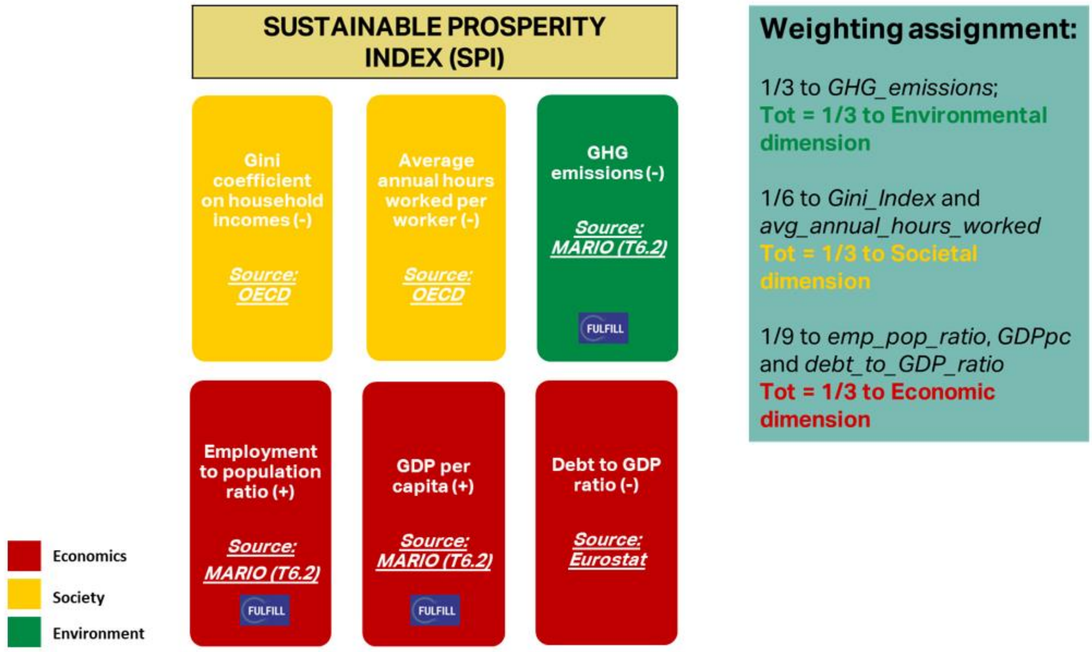

Figure 4 Weighting assignment based on equal-dimension weighting strategy for SPI in T6.4 FULFILL.

2.3.1 *Sensitivity analysis, dynamic attribution of weights*

In addition to the chosen main weighting strategy, we conducted two types of **sensitivity analyses**, to assess the impact of further hypotheses and constraints affecting the SPI**.**

The **first type of sensitivity analysis** is based on an approach that detects country-dependent weights, ensuring that weights reflect the relative importance of the variables across EU27 countries more accurately, reflecting time trends. We followed a methodology that normalizes the variables, allowing for a fair comparison.

We used the following steps for weighting and computing the SPI by means of the dynamic attribution of weights:

1. **Normalization**. For each country, the input variables – taken from 2020 to 2050 either for the *Reference* or the set of *Sufficiency* scenarios – are normalized using **Min-Max normalization**.
2. **Mean Calculation**. The mean value of each normalized variable is calculated for each country.
3. **Weight Calculation**. The mean values are then normalized by dividing each mean by the total sum of all means, ensuring that the weights sum up to 1.

Min-Max normalization was employed to transform the indicators. This step scales the values of each variable to a range between 0 and 1, ensuring that variables are comparable among each other, independently on their unit of measurement. The formula is the following:

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}} \qquad (2)$$

Where x is the original value, x_{min} is the minimum value of the variable, and x_{max} is the maximum value of the variable.

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Secondly, once the data were normalized, the mean value of each normalized variable is calculated for each country. These means represent the relative importance of each variable for that country in the given year.

Thirdly, the mean values are then normalized by dividing each mean by the total sum of all means. This normalization step ensures that the weights sum up to 1. These normalized means are used as weights, reflecting the relative importance of each variable based on the country's specific data. Mathematically, the weight for each variable ω_i is calculated as:

$$\omega_{i,c} = \frac{mean(x_{norm,i,c})}{\sum_i mean(x_{norm,i,c})} \quad (3)$$

Where $x_{norm,i.c}$ is the normalized value of variable *i* for the specific country *c*.

Lastly, the SPI is computed for each country, using these dynamically calculated weights. This approach allows the **SPI to adapt to the varying importance of different variables for each country**, making the index more responsive to specific country contexts.

Therefore, to perform the first type of sensitivity analysis proposed in the report, the SPI is calculated as follows:

$$SPI_{c,t} = \sum_{i,c}(\omega_{i,c} * x_{norm,i,c}) \qquad (4)$$

By incorporating this robust weighting approach, we ensured that our SPI within FULFILL accurately reflects the contributions of different variables to sustainable prosperity within each EU27 country.

2.3.2 Sensitivity analysis, sufficiency threshold on income

The **second type of sensitivity analysis** assumes that while higher income generally correlates with better social and environmental indicators, this relationship may be irrelevant beyond a certain point.

Many countries with moderate income still achieve high levels of life expectancy, education, happiness, employment, sanitation, gender equality, and democracy. Data from O'Neill et al. (2018) indicate that nations with an income range between $7,000 to $12,000 per capita are among the best performers on social and ecological indicators. Research shows that beyond mid-range income levels, further increases can result into net negative social and ecological consequences (Kubiszewski et al., 2013; Lamb et al., 2014; Deaton, 2008).

Given that income is so tightly coupled with ecological and societal impacts, it is worthwhile to study a condition for computing the proposed SPI, assessing performance scores based on the hypothesis that additional increases in income do not convey any additional benefit in terms of sustainable prosperity for a country. Based on this understanding, we set **€20,000 as a sufficiency threshold on GDP per capita** level, at a point above which additional income becomes unnecessary for achieving better performance in SPI.

The sufficiency threshold brings the GDP per capita indicator in line with the other human development indices (education and life expectancy), in terms of what we know of the relationship between income and societal outcomes, while ensuring that countries need not pursue ecologically destructive levels of economic growth to score well. Specifically, the analyzed countries are not punished for exceeding €20,000 but rather, we rely on the assumption that income levels over this threshold do not further boost a country's SPI score.

To guarantee the equilibrium within the weighting system for SPI computation anytime the weight for GDP per capita is set to zero, we re-balance the weights for the other indicators in the following way:

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- Weight for *GDP_pc: 0.*
- Weight for *emp_pop_ratio: 1/6.*
- Weight for *emissions: 1/3.*
- Weight for *Gini_coefficient: 1/6.*
- Weight for *Average_hours_worked: 1/6.*
- Weight for *Government_debt_to_GDP_ratio: 1/6.*

By adopting this **second sensitivity test,** to directly compared the results together with the main findings of this report.

2.4. Aggregation of input variables and computation of SPI

The input indicators were eventually aggregated using a **geometric mean approach**, which helps to balance the contributions of each dimension and prevents compensatory effects where poor performance in one area is offset by high performance in another.
A **weighed linear combination approach** was employed, based on the main weighting approach depicted in the previous sub-section (Figure 4). Eventually, the net aggregate effect of weighed percentage changes of input indicators display the overall net positive or negative contribution towards sustainable prosperity. For reasons of results visualization, the SPI is plotted from a starting value of 100 in the initial year of analysis, to gauge its evolution over time.
The weighed linear combination of chosen input indicators to build the SPI was eventually defined as follows:

$$SPI_{c,t} = 1/9(\Delta\%\, GDPpc_{c,t}) + 1/9\,(\Delta\% \frac{Emp}{pop}_{c,t}) - 1/9\,(\Delta\% \frac{Debt}{GDP}_{c,t}) - 1/6\,(\Delta\%\, Gini_{c,t}) +$$
$$- 1/6\,(\Delta\%\, Avg_{hrs_{c,t}}) - 1/3\,\left(\Delta\%\, GHG_{c,t}\right) \qquad (5)$$

Where: c represents the observed EU country and t the observed year.

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3. Data

The present Section describes the detailed database employed for the empirical analysis. Notably, the proposed composite beyond-GDP index was calculated for the aggregate EU27 group and for each EU individual country. The process is innovative in the sense that it aims at depicting the hypothesized trajectory of our SPI under a reference (baseline) condition, and it adds the direct assessment of a selected number of relevant energy Sufficiency Measures (SMs) and their overall impact on our proposed adapted version of SPI.
As evidenced in the above Figure 1, two primary sources of information were consulted:

- **External sources of information**, mainly concerning the construction of the composite index, as well as for the collection of pertinent indicators and their historical trends.
- **Output information from T6.2 of FULFILL project**, mainly concerning the trajectories of economic and environmental indicators, as well as for the representation of scenarios assumptions.

Specifically, the former set of information includes the data gathered from external international sources and databases, such as the OECD and Eurostat. Additionally, external sources included the access to CUSP's available data on Canadian weights.
Instead, the latter set of information embodies previous outcomes from the I/O analysis performed in T6.2, which provided results in terms of economic, environmental and energy output indicators (see D6.2 by Golinucci et al., 2024 for further information).
We describe each of these primary sources of information in the following sub-sections.

3.1. Data processing from external sources

An initial investigation of historical data of our six selected input indicators was conducted.
The following list details the information accessed through download and processing information from external sources of information, which fed both the initial historical database and – partly – the database for computing the projected values of SPI.

- **Gini coefficient (or Gini index)** measuring income inequality (source: World Bank). The Gini coefficient measures inequality on a scale from 0 to 1, where higher values indicate higher inequality.
- **Average annual hours actually worked per worker** (source: OECD), which are measured in number of hours. They are calculated as the series of annual hours actually worked per person in total employment, in relation to data from mainly National Accounts concepts, and marginally from secretariat estimates from the European Labour Force Survey (LFS).
- **Government debt to GDP ratio** (source: Eurostat). This is defined as the General Government consolidated gross debt, as percentage of GDP.

So far, these data allowed to fulfill two main objectives.
On one hand, (*i*) they fed the initial database for computing historical values (2000-2020) of the SPI. On the other hand, (*ii*) they provided the basis for generating our own hypothesized projections for Gini index, average annual hours worked per worker, and government debt to GDP ratio under the reference and the set of sufficiency scenarios (2020-2050).
To address this latter task, we adopted the following procedure:

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- As for the *Reference Scenario*, we projected the linear trend of the country-specific Gini index, average annual hours worked per worker, and the government to GDP ratio up to 2050.
- As for the *Sufficiency Scenario, all measures* we merged the information on (*i*) the past trend (2000-2020) of the indicator with the (*ii*) assumed contribution of each SM to the SPI, to derive **subjective correction factors**. For instance, if the past trend of the indicator was worsening (e.g. increasing Gini index), we attenuate the values of the indicator only by **1%** under the Sufficiency Scenario (reducing the levels calculated under the Reference Scenario). If, instead, the trend of the indicator was improving (e.g. decreasing Gini index), we attenuate by **5%** the values of the indicator under the Sufficiency Scenario (again by operating a reduction of the levels calculated under the Reference Scenario).
- As for the *Sufficiency Scenario, diets,* and *Sufficiency Scenario, flying less* we repeat the same approach as above, by halving – in both cases – the subjective percentage criteria only to **0.5% and 2.5%**.

Lastly, we collected, aggregated, and processed historical data (2000-2020) for GHG emissions, employment to population ratio and GDP per capita, This last step was fundamental to derive the whole initial database for the calculation of the historical SPI (2000-2020).[14]
Historical data for these three indicators were collected from three main sources of information:

- Historical data on Gross domestic product per capita (USD at 2015 Purchasing Power Parities) were sourced by OECD.
- GHG emissions were directly sourced from Energy Statistics of EU Commission, DG Energy, Unit A4. Data are expressed in CO2 equivalent, including CO2, N2O, CH4, HFC, PFC, SF6, and NF3.
- Employment to population historical data were generated by integrating data for the total number of people employed between 15 and 64 with historical data of population, both from OECD.

3.2. Data processing from T6.2

Output data from the previous T6.2 of FULFILL (including **GDP, employment and GHG emissions**) have fed the database of T6.4 for designing projections of SPI.
The multi-dimensional set of information was generated by the **Multi-Regional Analysis of Regions through Input-Output (MARIO)** of T6.2, producing results on a 5-year stepwise time scale (starting from 2020, up to 2050). The study in T6.2 was grounded on the Exiobase v3.3.18 hybrid-units input-output database, adopted in its supply-use (SUT) version.
The collected output data were disaggregated under different levels of geographical granularity (EU vs. rest-of-the-world, as well as country-by-country dimension[15]) and scenarios (reference condition vs. sufficiency scenarios assumptions).
Several indicators for each dimension (economic, environmental, and societal) were generated. However, for the purpose of tracking the path of EU27 countries towards sustainable prosperity according to the framework proposed by Jackson and Victor (2020), we collected and processed the following data for setting up the database for computing the projections for SPI:

[14] Input data projections (2020-2050) for GHG emissions, employment to population ratio and GDP per capita were collected and processed after receiving output data from T6.2 of FULFILL. See the next subsection for further details.
[15] The initial data for sufficiency measures (SMs) were generated by T6.1 for the 5 FULFILL countries (), and then upscaled at the EU level by means of a *clustering approach* (see D6.2 for further details).

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- Gross Domestic Product (GDP), measured in millions of € in constant values (2011). We transformed this indicator into the **GDP per capita**, by employing data on population projections (sourced by OECD).
- **Greenhouse Gas Emissions (GHG)** in Global Warming Potential at 100 years (GWP100) (measured in tons of CO2eq). This figure includes CO2, NOx, SO2 emissions. This output was generated relying on a production-based approach.
- Employment (measured in thousands of workers). Despite available to the level of skill of workers (low-skilled vs. high-skilled), we relied on aggregate data on number of workers. This set of information was organized and then transformed into the indicator **employment to population ratio**, by using data on population projections (sourced by OECD).[16]

As hinted, the output data were generated under several levels of hypothesized scenarios, with the aim of integrating information of shocks to sufficiency lifestyles and quantify their final effect on the produced composite beyond-GDP index.
The underlying approach to model SMs (T5.3, T6.1 and T6.2) led to the following list of identified scenario assumptions:[17]

(1) *Reference Scenario*. It represents the assumed baseline condition of growth for the EU economy, based on background information on electricity, car, and heating system mixes.

(2) *Sufficiency Scenario, all measures*. In this case, the simultaneous impact of all the following listed sufficiency measures is considered.

(3) *Sufficiency Scenario, diets*. This assumption considers the dietary change by simulating a gradual and country-specific shift from omnivorous diets to vegetarian, vegan, and pescetarian mixes within the EU population.

(4) *Sufficiency Scenario, flying less*. This assumption considers the reduction in fuel consumption and thus, in air transport service, from both households and industrial activities, hence encompassing both leisure and business trips.

(5) *Sufficiency Scenario, moderate car sizing*. This scenario simulates the attention to the purchase of cars by buyers, exemplified by modelling the purchase of different average weights of cars, considering current and projected diffusion of powertrains.

(6) *Sufficiency Scenario, cycling more*. This assumption models the substitution of total kilometers driven by car to the benefit of kilometers cycled by individuals.

(7) *Sufficiency Scenario, sharing products*. This assumption models the use of shared products among multiple residents in the same housing complex, exemplified uniquely by the shared use of washing machines.

(8) *Sufficiency Scenario, sharing living spaces in housing*. This assumption models the reduction of the floor surface per capita in housing.

In this report, only the results for (1)–(4) were selected to be displayed within the Results' Section, for the relevance which was already highlighted in D6.2 (Golinucci et al., 2024).
At this stage, all necessary information from T6.2 of FULFILL was gathered and processed.

[16] To comply with inconsistently high levels of employment projected by MARIO for future years, we executed a *down-scaling of data*. This allowed to align projections with past trends of employment. Thus, we were able to remove the bias introduced by the modelling exercise of MARIO, which omits the potential increase in marginal productivity of labour for future years.
[17] Check D6.1 by Jacob and Taillard (2024) and D6.2 by Golinucci et al. (2024) for further details.

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4. Results

In FULFILL, the proposed composite beyond-GDP index, namely the adapted version of the SPI by Jackson and Victor (2020), was calculated for each European country, providing a full view of the progress towards sustainable prosperity of the EU continent, and tracking the contribution of energy sufficiency in this pathway.
The results are shown by distinguishing among a *Reference Scenario*, a *Sufficiency Scenario* (accounting for the impact of all sufficiency measures), and two further selected scenario assumptions which quantify the impact of two relevant individual sufficiency measures (SMs), namely *Diets* and *Flying less*. The analysis for these two specific SMs is reported in the Annex.

This Section reports the comprehensive main findings.

4.1. Historical SPI

We initially derived calculations of the composite SPI for historical collected data, by applying the methodological framework of Section 2. For this calculation, we relied entirely on external sources of information (integrating data with time range 2000-2020), as described in Section 3.

We display results for FULFILL countries and EU27 only, to simplify visualization of results.

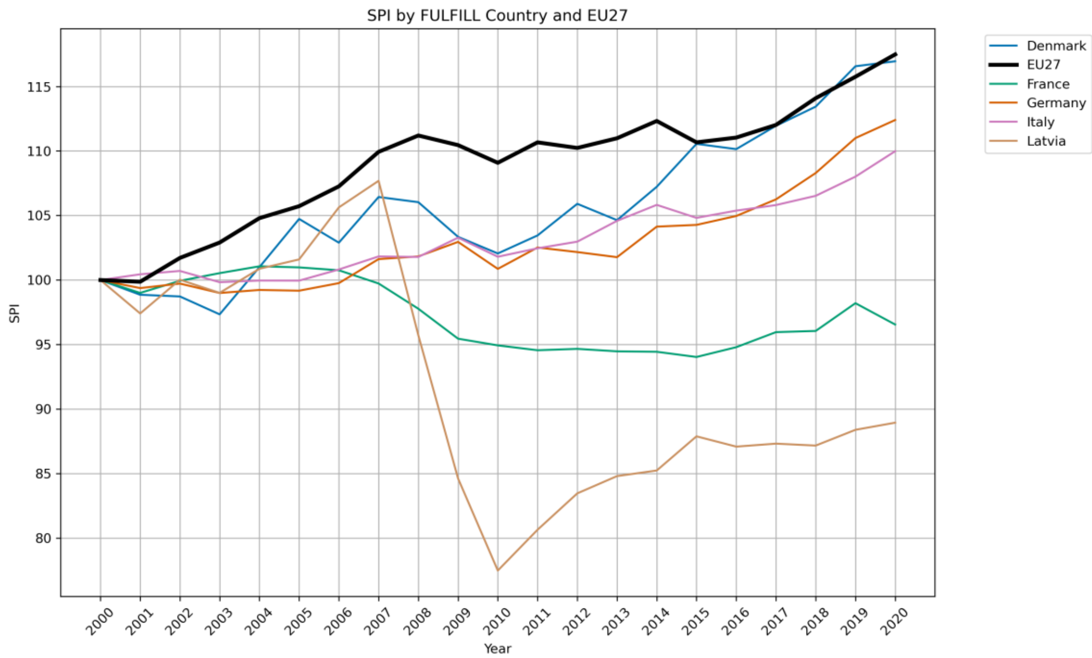

Figure 5 Historical SPI: FULFILL countries and EU27.

The analysis of the SPI for the EU27 group and selected individual FULFILL countries (Denmark, France, Germany, Italy, and Latvia) over the period from 2000 to 2020 highlights significant trends influenced by major economic events, including the global financial crisis (2008), the outbreak of COVID-19 pandemic (2020), and the sovereign debt crisis (2012).

The **EU27 group's SPI** displays a relevant upward trend, with minor slowdowns throughout the period. The global financial crisis had an evident impact (despite minor) on the SPI, which dipped to 109.08 in 2010, largely explained by the drop in GDP per capita and the sharp increase in the debt/GDP ratio in the EU, which outweighed the positive contribution to SPI represented by the decrease in GHG emissions (see Figure 6 for the decomposition of weighed effects). The SPI experienced a slight dip to 110.23 in 2012 during the European sovereign debt crisis, reflecting the macroeconomic challenges faced by many EU countries. The SPI slacked to 110.66 in 2015, mostly driven by a significant fall in GDP per capita (-14.3% year-on-year – YoY). Before the COVID-19

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pandemic, the SPI showed signs of recovery and stability, reaching 115.75 in 2019. In 2020, the SPI peaked to 117.48, showing that while there was a negative economic impact from the pandemic, the EU27 SPI increased mostly due to the strong fall in GHG emissions (-9.78% YoY).

Denmark's SPI showed high variability, remaining below the EU27's SPI until 2015, and then mirroring it from 2015 onwards. Denmark's SPI exhibits significant volatility mostly due to highly variable GHG emissions levels and the contribution of debt/GDP ratio. The SPI fell to 102.05 in 2010, and then recovered to its pre-crisis levels, catching-up with EU27's SPI in 2015. In terms of income inequality, Denmark was the most virtuous among FULFILL countries, marking the lowest level of Gini Index which averaged 26.8 within the observed time frame.

France's SPI showed poor SPI performance throughout the time frame. Following an increase in SPI until 2004, during the following years France experienced a smooth decline in SPI, hitting its lowest value at 94.03 in 2015, mostly driven by a worsening in macroeconomic fundamentals and increasing Gini index. Afterwards, the French SPI recovered (reaching 98.2 in 2019), but then fell to 96.55 in 2020 (the 4th lowest SPI level across EU countries). Indeed, in 2020, the French GDP per capita dropped by 8% YoY, while the French debt/GDP ratio rose by 17.6% YoY.

Germany's SPI remained relatively stable until 2013, showing resilience to economic shocks. Afterwards, its SPI displayed a consistent growth, mostly driven by consistent efforts in abating GHG emissions.

Italy's SPI displays a smooth upward trend, mostly explained by progress in GHG emission reduction, amidst a modest economic growth. The financial and sovereign debt crises led to slight fluctuations, with the SPI at 103.28 in 2009 and 102.97 in 2012. In 2020, despite the worsening in macroeconomic fundamentals (+15.4% YoY in debt/GDP ratio and -8.59% YoY in GDP per capita), the sharp decline in GHG emissions (-10% YoY) and average annual hours worked per worker (-9.76% YoY) outweighed the negative contribution to SPI due to the economic slowdown.

Latvia exhibited more variability compared to the other countries. Its SPI notably dipped to 84.62 in 2009 and 77.48 in 2010, following the global financial crisis. The drop was explained by a sudden hike in the debt/GDP ratio, which climbed from 8.4% in 2007 to 18.5% in 2008 and doubled in 2009 reaching 37%. Additionally, GDP per capita dropped from 23346.9€ in 2008 to 20351€ in 2009. Post-crisis, Latvia's SPI showed signs of recovery, approaching 88.94 in 2020, the 2nd lowest level across EU countries.

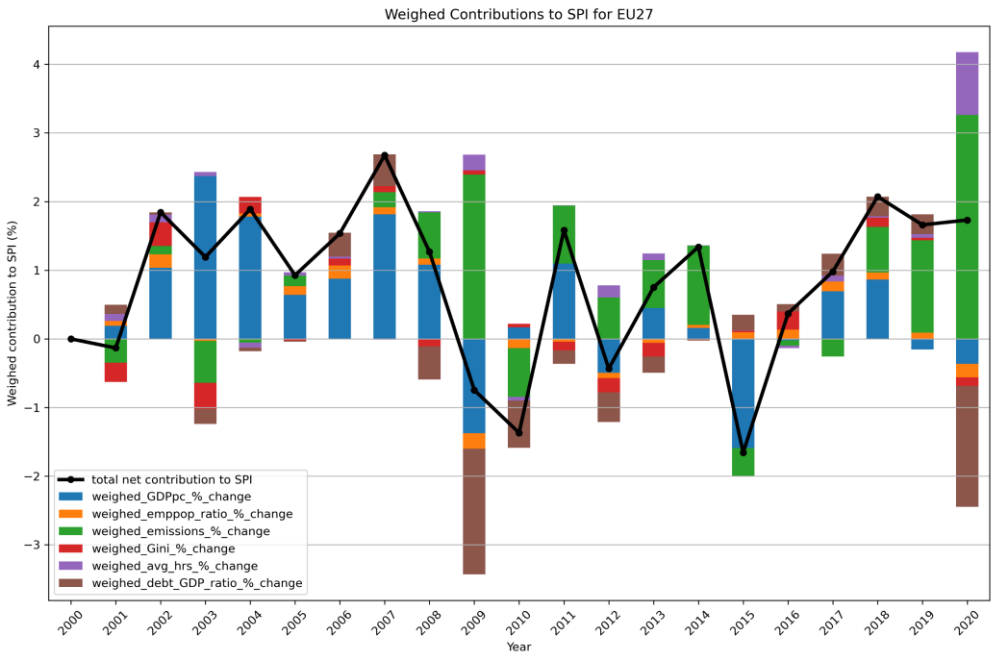

Figure 6 Decomposition of weighed contributions to the historical SPI – EU27 group.

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Variability in sustainable prosperity was notably higher when examining other EU countries, as detailed in the Annex. While Denmark, Germany, and Italy demonstrated increasing SPI values throughout the period under review, other nations experienced more pronounced fluctuations. France and Latvia, for instance, displayed varying levels of resilience in maintaining social well-being amidst economic turbulence.

This variability underscores the diverse impacts of global economic events on sustainable prosperity across EU MS. For a detailed breakdown of effects, please refer to the Annex.

4.2. SPI – Reference Scenario

The analysis of the Sustainable Prosperity Index (SPI) from 2020 to 2050 reveals significant trends influenced by various socio-economic and environmental factors.

The chosen baseline year of 2020 – notably impacted by the COVID-19 pandemic – led to a substantial economic downturn, reduction in GHG emissions, and interruptions in regular activities. This context is crucial for understanding the subsequent growth projected for 2025 and beyond.

Figure 7 provides an overview of the computed SPI for FULFILL countries and the EU27.

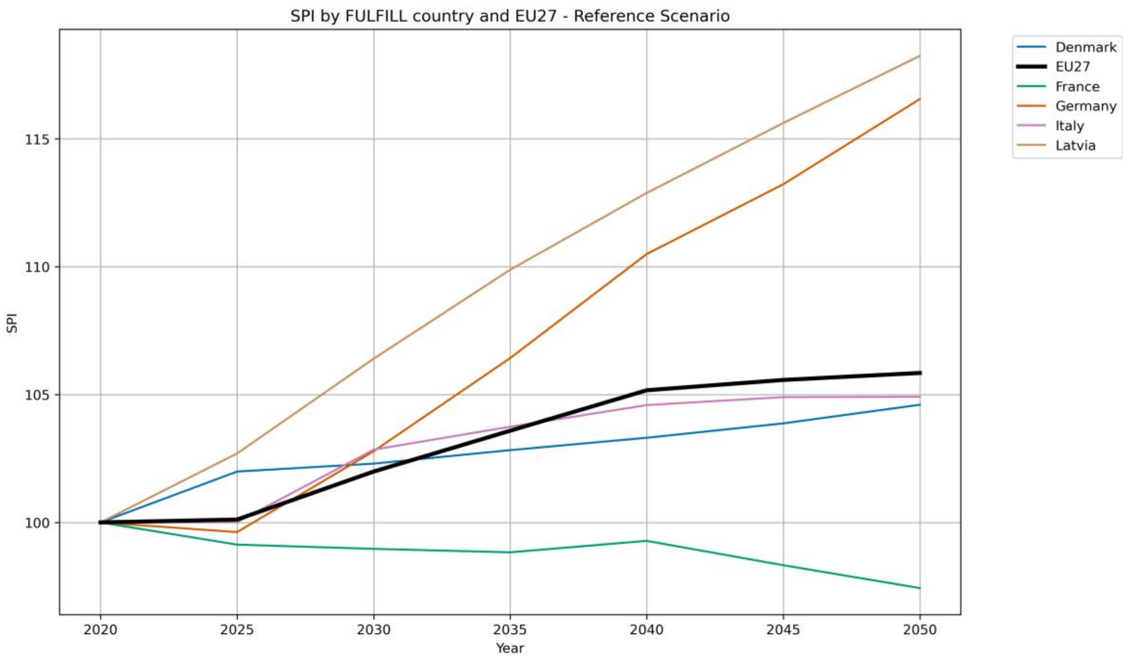

Figure 7 Projected SPI under the Reference Scenario, FULFILL countries and EU27.

EU27

Starting with the **EU27 group**, the SPI rises only slightly to 100.11 by 2025. This can be attributed to recovery efforts post-pandemic, resumption of economic activities, and a correspondent resumption of GHG emissions. The GDP per capita is expected to rise by 8.45% in 2025, the employment/population ratio would increase by 8.22%, while GHG emissions would surge by 4.84% (see Figure 8 to spotlight the negative and positive contributions to SPI change).
The SPI would rise to 101.98 in 2030, driven by a further 7.05% increase in GDP per capita and continued improvements in employment and sustainability measures. By 2040, the index would reach 105.16, mostly driven by economic development, despite slightly increasing GHG emissions. In 2045 and 2050 the EU27's SPI would display a much weaker upward trend, bearing the environmental burden of significantly higher GHG emissions, reaching values of 105.57 and

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105.84, respectively. Overall, the EU27 index remains positive, supported by improvements in economic and employment indicators (with lower average working hours per worker), although softening its growth due to variations in other factors such as emissions and slight increases in Gini index.

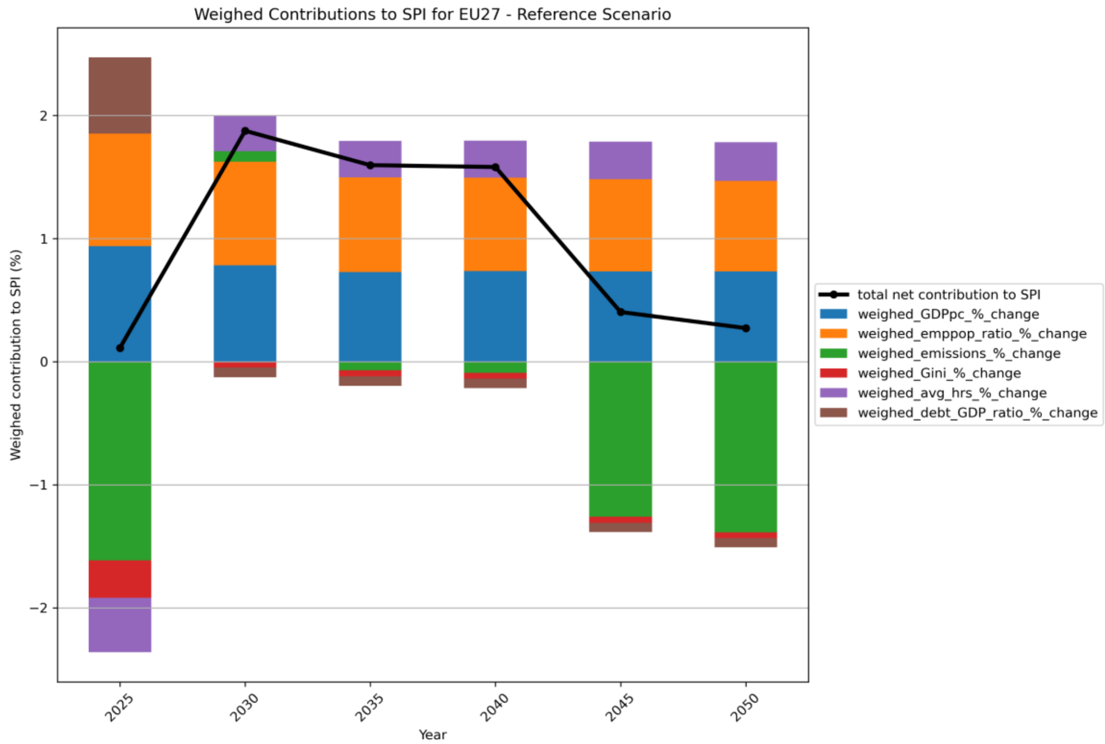

Figure 8 Decomposition of weighed contributions to the Reference Scenario's SPI – EU27 group.

Denmark

Denmark's SPI experiences a soft increase in SPI under the *Reference Scenario*, oscillating above and below the EU27 level. This smooth growth is activated by an 8.82% rebound in GDP per capita in 2025 (compared to 2020), an 8.85% increase in employment-population ratio, and a notable reduction in debt to GDP ratio. By 2030, the SPI slightly rises to 102.29, with a 4.54% rise in GDP per capita and a 4.59% increase in employment-population ratio, indicating a stabilization post initial recovery. Afterwards, the SPI would sustain a smooth rise, with values of 102.82 in 2035 and 103.31 in 2040, reflecting ongoing but more stable improvements in economic and employment indicators, despite slightly increasing GHG emissions and income inequality. By 2050, Denmark's SPI reaches 104.6, indicating consistent progress in sustainable development, driven by sustained improvements in GDP per capita and employment rates, coupled with reductions in debt-to-GDP ratio.

France

France's SPI displays a post-Covid recovery pattern which is significantly weaker compared to the other FULFILL countries. The French SPI falls to 99.13 by 2025, and continues to soften, reaching 98.96 in 2030, driven by a 5.09% rise in GDP per capita and a 5% increase in employment-population ratio, which fall short in outweighing the risks related to surging debt/GDP ratio. By 2040, the SPI would recover at 99.27, still well lower than the other FULFILL countries.

In 2045, the SPI would display a notable dip to 98.32, possibly reflecting economic or policy adjustments, and a correspondent hike in GHG emissions. By 2050, France's SPI would fall further to 97.43, indicating threats to sustainability efforts.

Germany

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Despite an initial worsening in SPI in 2025 – falling to 99.62 mostly due to the post-Covid rebound of GHG emissions–, Germany shows significant improvements in SPI performance. In 2030, the SPI would jump to 102.78, driven by a 5.69% rise in GDP per capita (compared to 2025) and a 5.54% increase in employment/population ratio, coupled with lower debt to GDP ratio. By 2035, the SPI jumps to 106.42, reflecting strong economic performance and sustainable innovations, with a 5.81% rise in GDP per capita and substantial reductions in debt-to-GDP ratio, emissions, and average working hours.

The upward trend continues afterwards, with Germany's SPI reaching 110.49 by 2040, supported by improvements in economic and employment indicators, despite slightly increasing income inequality. By 2050, the SPI stabilizes at 116.55, indicating a robust and sustained commitment to sustainable prosperity, driven by ongoing improvements in economic fundamentals, despite increasing GHG emissions occurring in 2045 and 2050.

Italy

Italy's SPI would rise slightly under the *Reference Scenario*, mostly oscillating around the EU27's level. In 2025, the SPI would reach 100.008, given a positive contribution from GDP per capita (+8.8% compared to 2020) and employment/population ratio (+8.79%), despite higher GHG emissions (+2.35%) and higher Gini coefficient (+1.8%). By 2030, the SPI reaches 102.84, reflecting substantial progress in sustainability, sustained by a notable 7.11% reduction in GHG emissions compared to 2025.

Over the subsequent decades, Italy's SPI growth would soften (mirroring the EU27's SPI), hitting values of 103.74 in 2035 and 104.58 in 2040. By 2050, the SPI reaches 104.91, indicating steady progress despite minor setbacks, supported by sustained improvements in GDP per capita and employment-population ratio, despite higher risks due to increasing GHG emissions, more pressure on the side of debt-to-GDP ratio, and higher income inequality.

Latvia

Among all FULFILL countries, Latvia exhibits the most remarkable hike in its SPI, rising to 102.69 by 2025. This growth is driven by a 14.29% rise in GDP per capita and a 13.62% increase in employment-population ratio, along with societal progress due to decreasing Gini index (-3.72%) and lower average working hours worked in the economy (-2.93%).
By 2030, the SPI reaches 106.4, reflecting continued strong economic recovery and sustainability efforts.

Latvia would keep sustaining its high SPI, soaring to 112.88 in 2040 and 118.24 by 2050. These trends reflect Latvia's strong commitment to sustainable development and economic recovery post-pandemic, supported by sustained improvements in GDP per capita and employment-population ratio, alongside with reductions in income inequality, despite slightly rising GHG emissions.

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SPI, *Reference Scenario* – Key Takeaways, FULFILL countries

- The SPI values in 2025 for FULFILL countries witness different initial patterns of **recovery from the COVID-19 pandemic**.
- The **EU27 group** shows a steady increase in its SPI, peaking in 2040, followed by a smoother upward trend but overall maintaining a positive trajectory. This is driven by improvements in GDP per capita and employment-population ratio, alongside with higher GHG emissions and Gini coefficient.
- **Germany and Latvia** show the most significant improvements, reflecting their strong policies and innovations in sustainable practices, with substantial increases in GDP per capita and employment-population ratio, alongside with lower pressure on debt to GDP ratio. Besides, Latvia will benefit from lower income inequality and reduced average annual working hours, despite higher GHG emissions.
- **Denmark and Italy** also demonstrate positive trends, though with more stability, indicating ongoing challenges and adjustments in their sustainability efforts. Under the *Reference Scenario*, improvements in economic and employment indicators might come at the expense of higher GHG footprint and higher income inequality. For Italy, more pressure on public finances would exacerbate further the debt-to-GDP ratio.
- Under the *Reference Scenario*, the projected trajectory of **France**'s SPI would display several risks related to soaring debt/GDP ratio, higher income inequality, and rising GHG emissions. This evidence indicates the need to adopt more effective sustainability policies for sustainable prosperity in the country.

As shown in Figure 9, by 2050, the *Reference Scenario*'s SPIs reveal significant variations, reflecting the diverse economic, social, and environmental trajectories across the regions.

Latvia, Portugal and Germany would emerge as the **top performers** with the highest SPI scores, hitting 118.24, 117.66, and 116.55, respectively. This suggests strong economic growth and significant improvements in sustainability measures. Over the whole observed period, Latvia's GDP per capita is expected to increase by an impressive 89.08% (behind only Croatia and Lithuania's GDP per capita growths), and its employment-population ratio is expected to rise by 82.37%, while Gini index would drop by 9.2%. Germany also shows robust performance with an overall projected GDP per capita increase of 44.6%.

Countries like **Poland** (SPI: 114.34), **Czechia** (SPI: 113.56), and **Hungary** (SPI: 113.53) show remarkable progress in 2050 under baseline conditions of economic growth. Over the selected time frame, Poland's GDP per capita is projected to grow by 71%, indicating substantial economic advancement, amid lower debt/GDP ratio (-29.7%) and higher employment/population ratio (+58.3%). Polish GHG emissions are expected to increase (+9.73%), whereas income inequality would soften by 9.6%.

Luxembourg (SPI: 85.11), **Estonia** (SPI: 96.8) and **France** (SPI: 97.43) are at the lower end of the SPI spectrum in 2050 under the *Reference Scenario*. Luxembourg would suffer from a surge in GHG emissions (+62%) to support the growth in GDP per capita (+44.49%) and employment-to-population ratio (+40.23%). France would experience a moderate increase in GHG emissions (+9.89%) and a GDP per capita rise of 38.44%, financing growth by a substantial increase in the debt to GDP ratio (+52.1%), with added pressure on income distribution (+9.07% in Gini index).

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Estonia, while having a high increase in its GDP per capita (+71.36%), would struggle with a significant rise in GHG emissions (+40.94%).

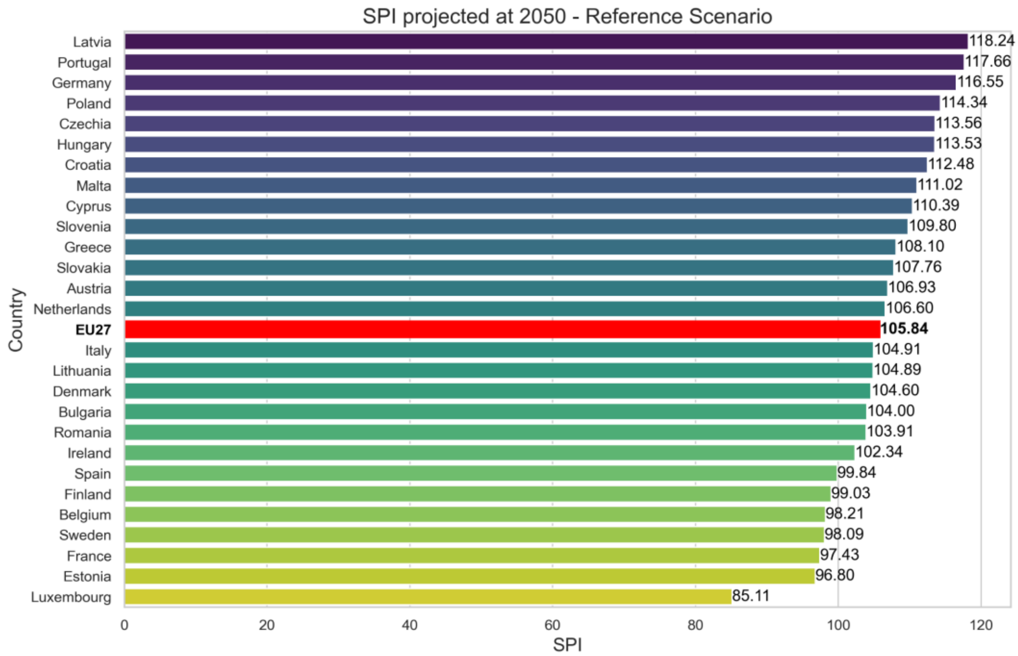

Figure 9 Projected SPI under the Reference Scenario. Ranking of countries in 2050.

4.3. SPI – Sufficiency Scenario, all measures

The application of energy sufficiency measures (SMs) – as modelled within the FULFILL project – has transformative impacts on EU27 countries across four identified domains of sufficiency: diets, mobility, sharing products, and sharing spaces.

Figure 10 shows the evolution of SPI derived from the *Sufficiency Scenario* projections for the period from 2020 to 2050.

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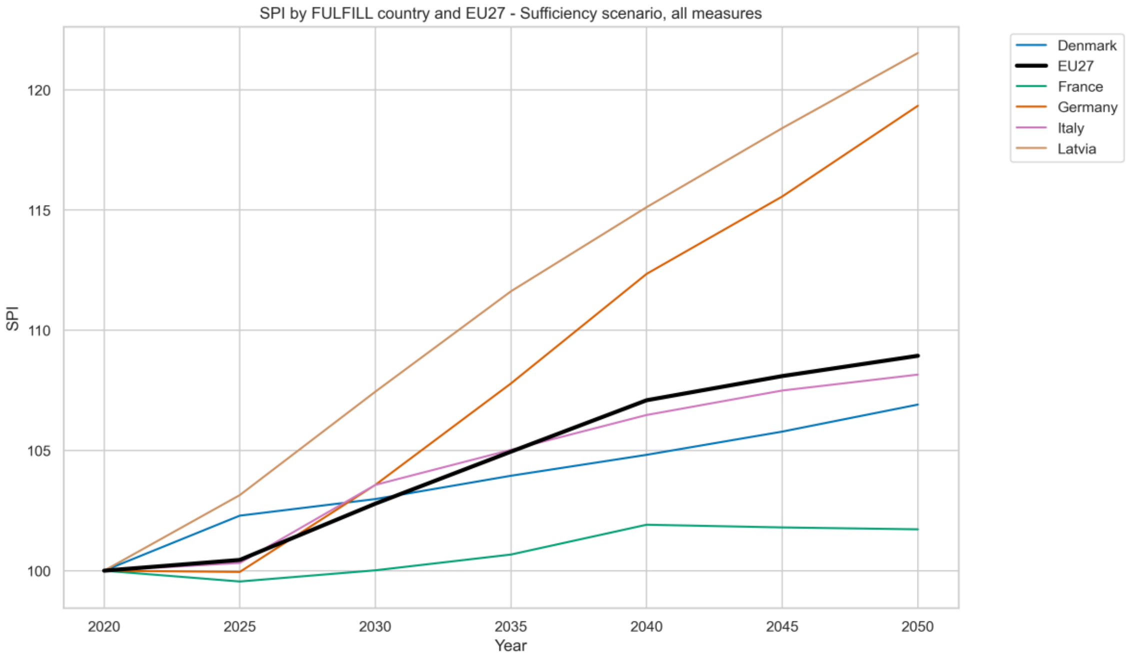

Figure 10 Projected SPI under the Sufficiency Scenario, FULFILL countries and EU27.

EU27

Under the *Sufficiency Scenario*, the SPI for the EU27 would display values that, on average, would be 1.59% higher compared to the *Reference Scenario's* resulting SPI. In 2050, GHG emissions under the *Sufficiency Scenario* would be 11.8% lower compared to the *Reference Scenario*, highlighting a significant improvement under the environmental performance (see Table A.1-A.2 in the Annex). Economic indicators such as GDP per capita and employment-population ratio still grow, but less dramatically, indicating a balanced approach towards sustainability and prosperity.

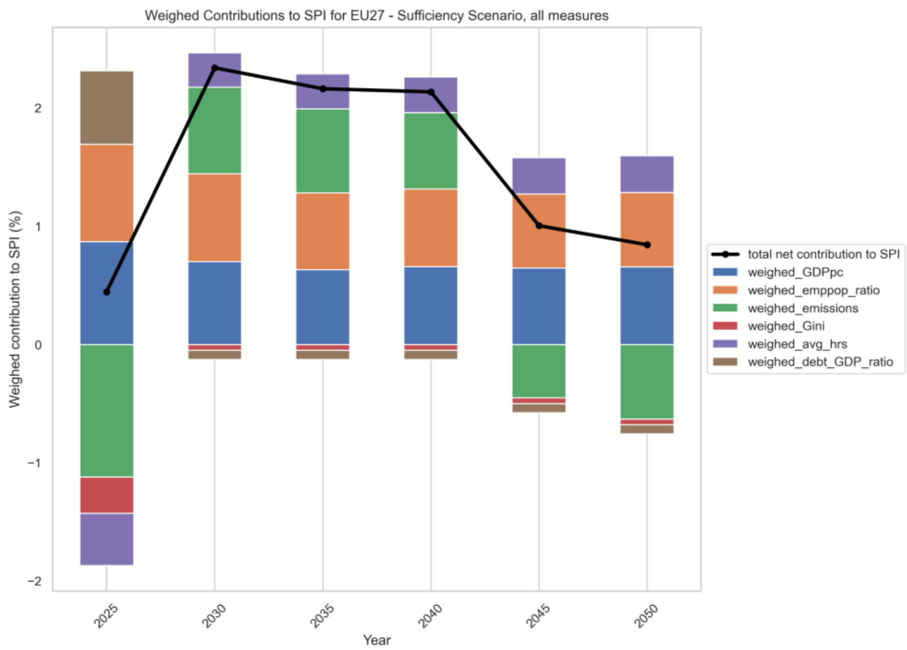

Figure 11 Decomposition of weighed effects for the projected Sufficiency Scenario's SPI – EU27.

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Denmark

For **Denmark**, the computed SPI under the *Sufficiency Scenario* is on average 1.25% higher compared to the *Reference Scenario*. Emissions control is improved, with levels of GHG emissions in 2050 8.28% lower compared to the *Reference Scenario*. The GDP per capita would grow by 37.09%, which is 2.8% lower than in the *Reference Scenario*, but this is balanced by improved socio-economic outcomes, amidst slightly lower GHG emissions.

France

France would significantly benefit from sufficiency measures, compared to a case without such measures (*Reference Scenario)*. In 2050, GHG emissions would be 14.67% lower than the *Reference Scenario*, marking an improvement in the environmental performance especially after 2040. While GDP per capita and employment/population ratio still see positive changes, the emphasis on reducing GHG emissions, improving public finances and equity would lead to a higher SPI, which would peak in 2040 at 101.91. In 2045 and 2050, the French SPI would remain in the positive area, stabilizing nearly at 101.7. Overall, the French SPI would be on average 2.3% higher than the *Reference Scenario*'s values.

Germany

Germany's SPI under the *Sufficiency Scenario* would mark levels which, on average, would be 1.41% higher compared to the *Reference Scenario*. This is due to better management of GHG emissions which, in 2050, would be 10.23% lower compared to the *Reference Scenario*. Despite a lower GDP per capita in 2050 compared to the reference case (-3.68%), most of the factors would contribute positively to the increase in SPI, despite slightly higher levels of income inequality.

Italy

Italy, in 2050, marks a higher SPI under the *Sufficiency Scenario* (SPI: 108.15), with a notable improvement in GHG emissions control (-11.53% compared to the *Reference Scenario*). GDP per capita and employment-population ratio grow healthily, but with a greater emphasis on sustainability and social equity. On average, the SPI would be 1.6% higher than the *Reference Scenario*.

Latvia

Latvia's SPI sees a relevant increase in the *Sufficiency Scenario,* with levels on average 1.7% higher than the reference. Emissions would be better managed in 2050, with an overall reduction of 14.24% compared to the *Reference Scenario*. The decrease in average hours worked is more pronounced (-24.65%), contributing to improved work-life balance and higher overall well-being.

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SPI, *Sufficiency Scenario, all measures* – Key Takeaways, FULFILL countries

- **EU27**: better environmental outcomes with relevant SPI improvement.
- **Denmark**: improved emissions control leads to slightly higher SPI.
- **France**: largest improvement in SPI across FULFILL countries, mostly due to reduced GHG emissions and better social equity.
- **Germany**: improved SPI with better environmental and social indicators.
- **Italy**: higher SPI driven by balanced growth and better emissions control.
- **Latvia**: increase in SPI, mostly due to emissions management and improved work-life balance.

Overall, the *Sufficiency Scenario* generally yields higher SPI values across these countries, driven primarily by better environmental performance and social equity, despite slightly slower economic growth compared to the *Reference Scenario*.

As shown in Figure 12, by 2050, the *Sufficiency Scenario*'s SPI would improve for all EU countries.

Under the *Sufficiency Scenario*, Latvia maintains its top position with a SPI of 121.53, showing a notable increase from the *Reference Scenario* (118.24). This would indicate Latvia's valuable performance on the road to achieve sufficiency goals by 2050. Moreover, Portugal and Germany would both maintain their position in the top 3 countries of the ranking.

Interestingly, France would benefit the most across FULFILL countries from energy sufficiency policies, gaining three positions in the ranking and reaching an SPI of 101.72. Despite an improvement in its SPI, Italy would lose a position in the ranking (still lower than the EU27 average), with an SPI at 108.15 in 2050.

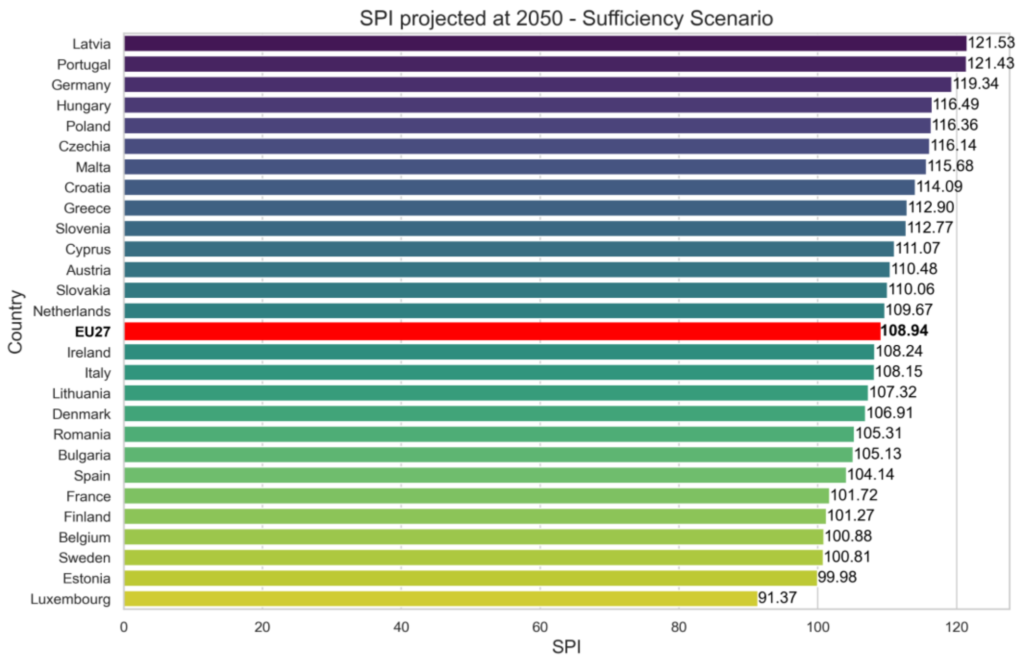

Figure 12 Projected SPI under the Sufficiency Scenario, all measures. Ranking of countries.

Overall, the comparison of results for SPI attributed both to the *Reference* and the *Sufficiency Scenarios* for our observed FULFILL countries is reported in Figure 13.

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Across FULFILL countries, the **relative impact of *Sufficiency Measures (SMs)* on the SPI – compared to the *Reference Scenario* – would range, on average, between 1.25% and 2.3%**. **France would benefit the most** from the implementation of energy SMs, whereas Denmark might benefit the least from the uptake of sufficiency lifestyle changes.

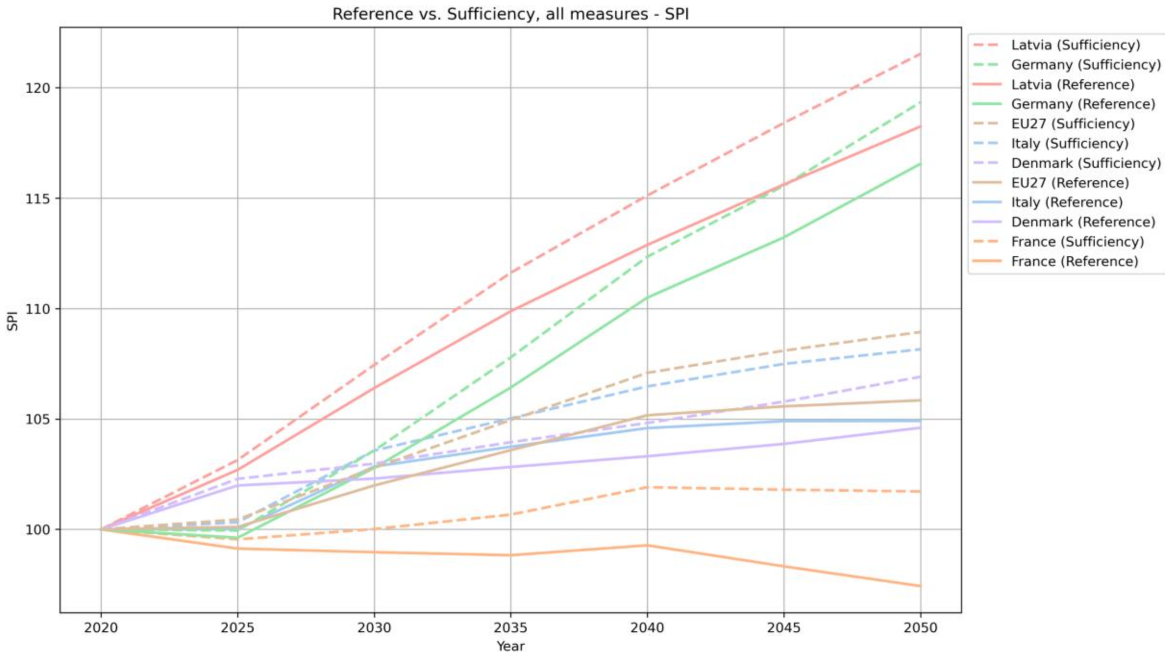

Figure 13 Comparison of SPI under Reference vs. Sufficiency scenarios, FULFILL countries and EU27.

4.4. Sensitivity analysis

Sensitivity analysis, as described in sections 2.3.1 and 2.3.2, was performed to assess:

- The impact on SPI from changes in the hypothesis of the weighting system, to account for EU countries' heterogeneity, deriving country-dependent weights (sensitivity analysis of type 1)
- The impact on SPI from changes in the hypothesis on the GDP per capita scale, introducing a sufficiency threshold on per capita income level of the country (sensitivity analysis of type 2).

The results of these two rounds of sensitivity analysis are here presented.

Sensitivity analysis of type 1 – Dynamic attribution of weights

We proved the robustness of SPI scores by comparing results obtained under (*i*) our main constant weighting system and (*ii*) the usage of **country-dependent weights extracted from a Min-Max normalization of input variables**.

In the case of constant weights, each variable was assigned a predefined equal weight based on the analyzed dimensions, regardless of the specific context of each country. In contrast, the use of dynamic weights entails a **more flexible approach,** where the weights are computed based on the normalized values of the variables for each country, accounting for the heterogeneity of the trends in place at the country-level.

The calculation of SPI using dynamic weights does influence the final SPI scores.

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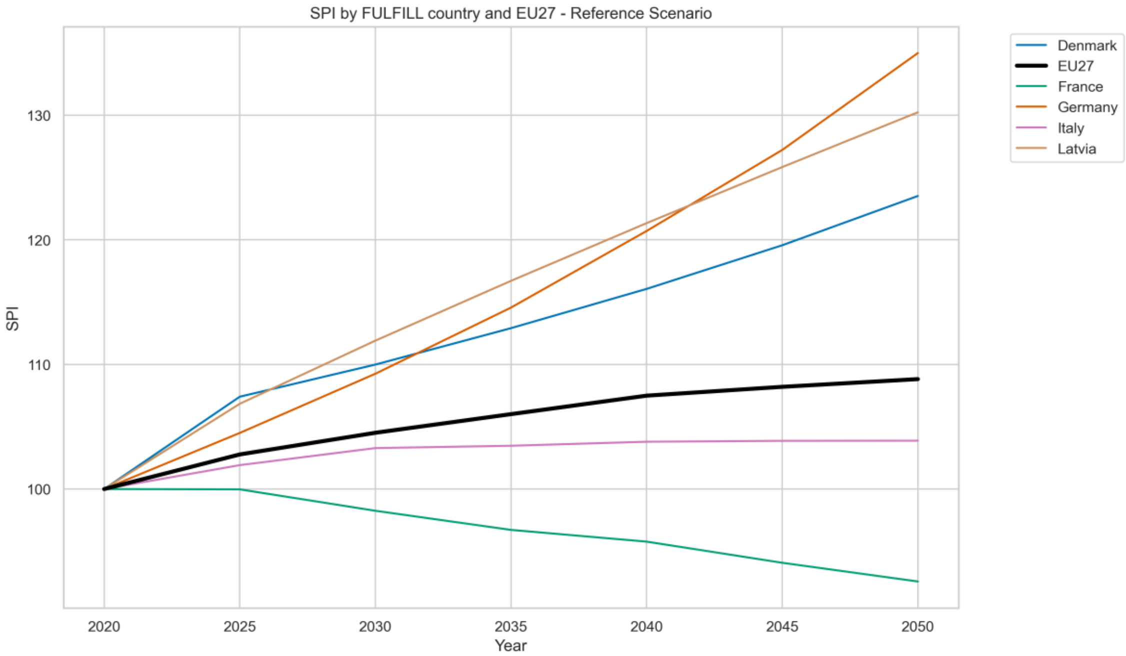

Figure 14 Projected SPI under the Reference Scenario. FULFILL countries and EU27. Sensitivity analysis of type 1.

Figure 14 reports the results of SPI under the *Reference Scenario*, adopting the dynamic attribution of weights. These results can be directly compared with those in Figure 7, reporting the computation of SPI under constant weights.

The **EU27's SPI** shows a slight increase from 102.77 in 2025 to 108.82 in 2050 (vs. 105.84 with constant weights), reflecting adjustments in indicator weights over time.

France's SPI, under the *Reference Scenario*, would decrease more sharply compared to the case of constant weights, declining to 96.72 in 2035, and then to 92.58 in 2050 (vs. 97.43 under constant weights).

The **German SPI** displays the most persistent growth, ranging from 104.5 in 2025 to 134.98 in 2050, indicating sustained improvements in sustainable prosperity metrics. These results significantly outperform the SPI computed under constant weights.

As for the case of SPI at constant weights, the **Italian SPI** closely mirrors the EU27's beyond-GDP metric. It shows minor fluctuations, stabilizing at 103.8 at the end of the observed period.

The **Latvian SPI** would keep showing an upward trend up to 2050, hitting a value of 130.23, slightly behind than the correspondent German SPI level.

Lastly, the **Denmark's SPI** sharply improves its performance compared to the case of constant weights, showing more pronounced growth. The index ranges from 107.4 in 2025 to 123.51 in 2050, strongly outperforming the 104.6 level obtained under the previous weighting system.

Overall, the choice between dynamic and constant attribution of weights significantly affects the interpretation of SPI results for each country, under the *Reference Scenario*. Dynamic weights are more suitable to capture fluctuations and adaptability to changing sustainability priorities, while constant weights provide a stable baseline for assessing sustainable prosperity trends over time. Both approaches offer valuable insights into sustainable development efforts, reflecting either responsiveness to evolving challenges or stability in long-term performance metrics.

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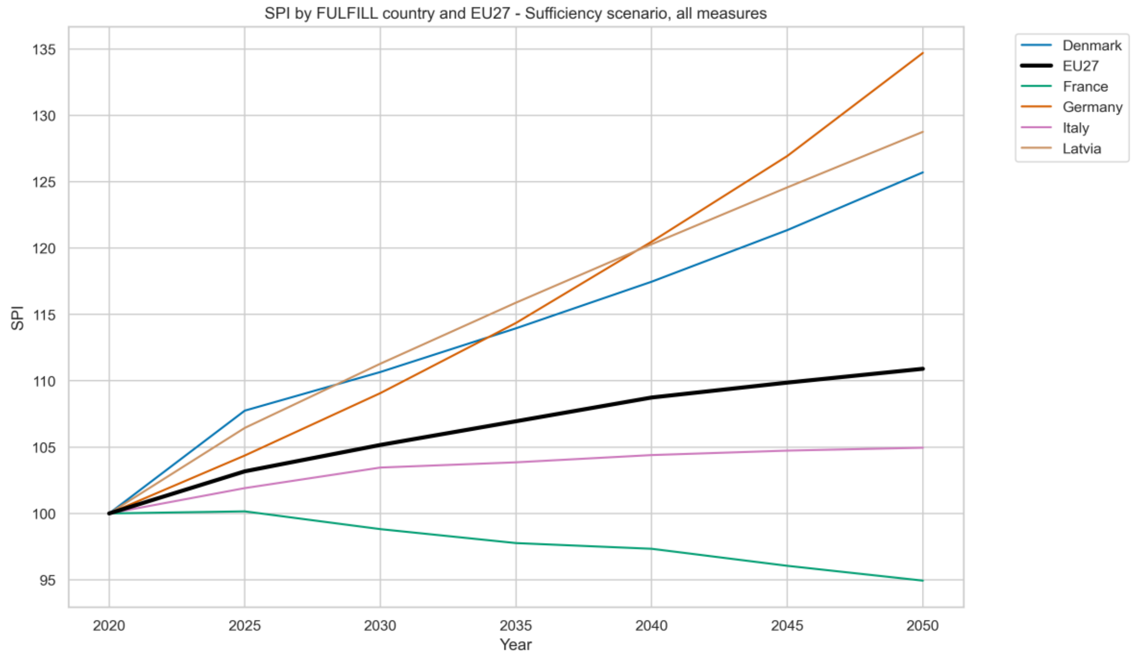

Figure 15 Projected SPI under the Sufficiency Scenario. FULFILL countries and EU27. Sensitivity analysis of type 1.

Figure 15 reports the results of SPI under the *Sufficiency Scenario*, adopting the dynamic attribution of weights. These results can be directly compared with Figure 10, reporting the correspondent computation of SPI under constant weights.

For the **EU27**, the SPI under the *Sufficiency Scenario* generally shows marginally higher SPI values compared to the *Reference Scenario's* SPI with dynamic weights. The SPI ranges from 103.17 in 2025 to 110.9 in 2050, slightly improving the road to sustainable prosperity within the EU.

Under the *Sufficiency Scenario*, **Denmark** would experience an improvement in its SPI with dynamic weights, ranging from 107.74 in 2025 to 125.7 in 2050 (vs. 123.51 under the reference), showing effectiveness induced by SMs over time. This indicates that SMs would have an incremental impact, contributing positively to sustainable prosperity.

For **France, Germany, Italy, and Latvia**, the *Sufficiency Scenario* generally shows slightly higher SPI values compared to the *Reference Scenario* throughout the forecast period. For these countries, both scenarios exhibit similar trends and patterns of fluctuation, suggesting that SMs slightly impact SPI compared to the reference case.

Overall, the SPI computed under the *Sufficiency Scenario* assumption with dynamic weights generally show values that are marginally higher compared to the *Reference Scenario*, depending on the country. This comparison underscores the effectiveness of SMs in enhancing sustainable development across different contexts, highlighting the impacts on sustainable prosperity metrics over the forecast period.

By comparing the approaches used for decisions on the use of weights, this first sensitivity analysis demonstrates the robustness and adaptability of the SPI measurement when dynamic weights are employed, highlighting the importance of considering country-specific contexts in assessments of pathway towards sustainable prosperity.

Sensitivity analysis of type 2 – Sufficiency threshold on income

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We further tested the robustness of our results by imposing a sufficiency threshold of €20,000 on the GDP per capita scale. This threshold is assumed where additional income would turn out to be unnecessary for achieving higher values of SPI.

This threshold has the direct effect of neutralizing the contribution of GDP per capita changes, anytime that the income level surpasses the €20,000 threshold for a country. Thus, any improvement above this level does not further enhance the SPI score of the country. Anytime this condition occurs, the weighting system is reset as specified in subsection 2.3. For ease of visualization, only results for EU27 are here displayed.

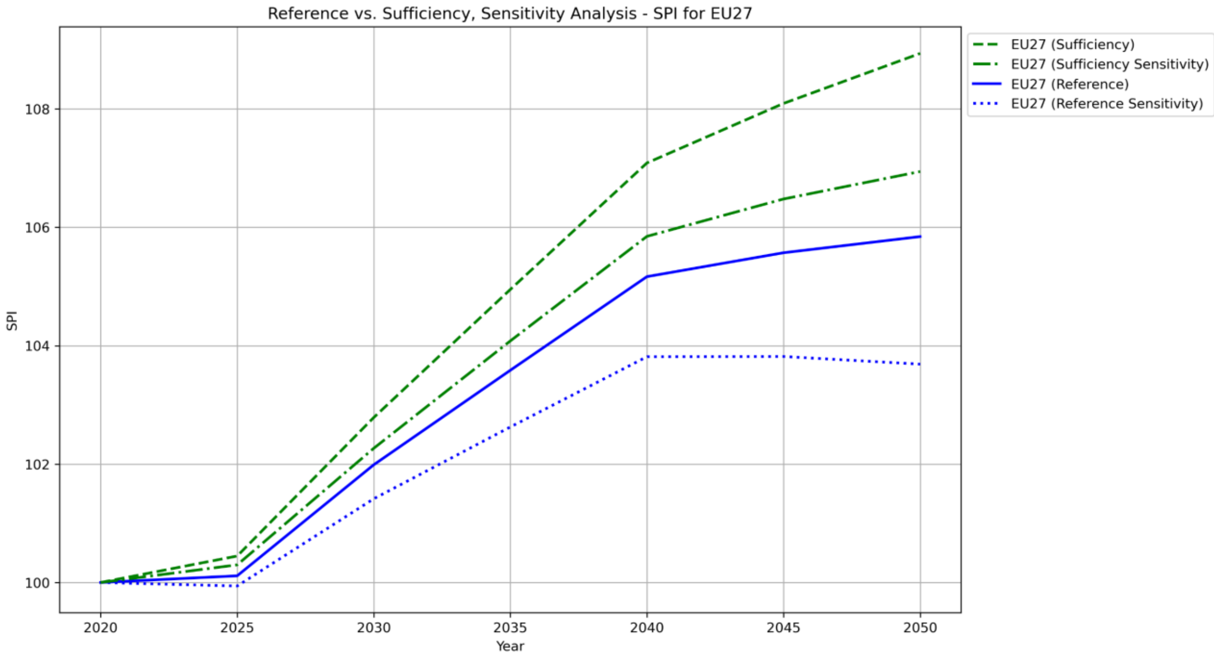

Figure 16 Comparison of scenarios for EU27's SPI under the (i) Reference, (ii) Sufficiency, (iii) Reference with income threshold and (iv) Sufficiency with income threshold. Sensitivity analysis of type 2.

The sensitivity analysis shown in Figure 16 displays variations in SPI scores for the EU27 group.

The SPI in the *Sufficiency Scenario* (without income threshold) displays the highest growth, reaching 108.93 by 2050, performing nearly 2 percentage points higher than the *Sufficiency Scenario* (with income threshold). This result is surprising and somehow unexpected, showing that higher GDP per capita is somehow necessary – together with the adoption of SMs – for achieving higher SPI values. However, this outcome might be strictly related with the reassignment of weights attributed within the SPI computation when the weight of GDP per capita drops to zero.

As expected, both *Reference Scenarios* (with and without income thresholds) display lower SPIs compared to the *Sufficiency Scenarios*, reflecting a **positive impact of sufficiency measures (SMs) both with and without the adoption of the sensitivity analysis**.

Eventually, this second type of sensitivity analysis helps to identify scenarios where countries can perform well socially and environmentally even without high levels of income, guiding energy and environmental policies to achieve sustainable development and prosperity.

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5. Discussion and limitations

This empirical study is clearly not exempt from limitations.

Firstly, our adapted version of SPI does not account for the non-linearity of weights, as specified in the work by Jackson and Victor (2020). The use of equal dimension-based weights does not avoid subjectivity, while the assumption that all indicators contribute equally to the index could lead to misleading results. Besides, applying equal weights to percentage changes of variables disregards the differences in the absolute sizes of their changes.

As a second issue, the choice of indicators in constructing the SPI can significantly affect the results. Different indicators might lead to diverse conclusions about the state and progress of sustainable prosperity. While we selected comprehensive indicators, the exclusion of other relevant socio-economic and environmental variables can bias the results.

Lastly, we believe that the construction of our composite beyond-GDP indicator does not fully integrate all possible domains of energy sufficiency, as our modelling framework adopts a partial view of the effects that energy sufficiency may have on reduced energy consumption and environmental impact. In addition to this, the underlying theoretical framework does not consider the rebound effects from energy sufficiency actions on savings and potential for additional jobs and new value-added creation.

Regarding the economic impact of climate change, the study of Kotz et al. (2024) projects a 19% reduction in global income within the next 26 years due to climate change, highlighting the urgency of individual and collective action. However, there are large regional differences between global regions. Lower latitude regions with lower historical emissions and lower present-day income will suffer the most, emphasizing the need for equitable climate action. Already, the costs of climate damages outweigh the costs of mitigation by sixfold, underscoring the economic benefits of reducing emissions. Kotz et al. (2024) conclude that changes in average temperature, precipitation, and extreme weather events significantly impact economic productivity up to year 2049. Potentially, the significant increase in the risk of damages after the mid-century further underscores the clear economic advantages of mitigation. This has to do with policy and incentives to foster the uptake of sufficiency, designing mechanisms that would spread the benefits generated by energy sufficiency measures. This aspect is often ignored, neglecting the contribution these actions have on reduced GHG emissions and lower energy consumption by individuals.

6. Conclusions

This study aimed to evaluate the impact of different scenarios on the *Sustainable Prosperity Index (SPI)* and other key socio-economic and environmental indicators for the EU27 group and selected European countries belonging to the FULFILL project (Denmark, France, Germany, Italy, and Latvia). The exercise was performed under two primary considered scenario assumptions, i.e. a *Reference* (baseline) *Scenario* and a *Sufficiency Scenario* (assessing the impact of considered sufficiency measures). Here, we summarize the main findings and draw conclusions based on the comparative analysis.

Under the *Reference Scenario*, the SPI for the EU27 increases to 105.84 in 2050. This reflects moderate improvements in socio-economic well-being and is accompanied by a significant increase in GHG emissions (635 Mtons CO_2-equivalent), as well as by an increase in GDP per capita (from €27,609 to €41,386). The Gini index, measuring inequality, also rises from 30.77 to 31.79%, indicating growing economic disparity.
Conversely, the *Sufficiency Scenario* shows a more favourable outcome for sustainable prosperity at the EU27 level. The SPI rises to 108.94 by 2050, reflecting enhanced overall sustainable

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development. Notably, GHG emissions remain nearly stable, increasing minimally, which is a significant improvement over the *Reference Scenario*. GDP per capita increases to €39,736, more slowly than the *Reference Scenario*, while indicating a more sustainable economic growth at a smoother growth rate. The Gini index increases to 31.47%, creating slightly less pressure on income inequality compared to the reference case.

Under the *Sufficiency Scenario*, **all five FULFILL countries – Denmark, France, Germany, Italy, and Latvia – mark an improvement in their SPI scores from 2020 to 2050**, reflecting advancements in sustainable prosperity. Indeed, the *Sufficiency Scenario* generally yields higher SPI improvements and better environmental outcomes compared to the *Reference Scenario*, showcasing the benefits of adopting sufficiency measures (SMs). While witnessing a poor performance under the *Reference Scenario*, France displays the largest benefits from the uptake of SMs, reaching an SPI of 101.72 by 2050. Conversely, Denmark and Italy's SPIs mostly mimic the trend of EU27, while Latvia and Germany would be among the best performing countries.

Across all five countries, **GDP per capita grows from 2020 to 2050 in both scenarios**. However, the increase is slightly lower under the *Sufficiency Scenario*, reflecting a trade-off between economic growth and sustainability measures. For instance, Denmark's GDP per capita in 2050 is €60,416 under the *Sufficiency Scenario* compared to €62,158 in the *Reference Scenario*. This pattern is consistent across the other countries, with France, Germany, Italy, and Latvia all showing lower GDP per capita in the *Sufficiency Scenario* against the reference case.

A **key benefit of the *Sufficiency Scenario* is the reduction in GHG emissions**. In all five countries, the *Sufficiency Scenario* leads to lower emissions compared to the *Reference Scenario*, highlighting the environmental benefits of SMs (for a deeper investigation of which SMs and sectors convey the largest GHG emission reduction, please refer to Golinucci et al., 2024).
Income inequality – as measured by the Gini index – **generally shows a slight reduction under the *Sufficiency Scenario* compared to the *Reference Scenario***. This suggests that SMs may help in achieving a more equitable distribution of income across the population.

To summarise, the *Reference Scenario* shows that while there is economic growth and some improvement in the SPI across the EU27 and the selected countries, this comes at the cost of increased GHG emissions. Economic advancements do not adequately convert into lasting prosperity, considering the environmental and societal aspects. In contrast, the ***Sufficiency Scenario* demonstrates that a balanced approach emphasizing sustainability and equity can lead to better overall outcomes**. The SPI improvements are more significant, with marked reductions in GHG emissions and more equitable income distributions. Although GDP per capita grows more modestly compared to the *Reference Scenario*, the gains in environmental performance and social equity underscore the benefits of SMs.

When looking at selected sufficiency measures (*diets* and *flying less,* in the Annex), SPI results convey positive results. On one hand, **implementing sustainable diets positively impacts SPI** across both the EU27 and individual FULFILL countries, fostering long-term prosperity through environmental and social sustainability measures. Countries like Germany, Latvia, and France show substantial gains in SPI under the *Sufficiency Scenario, diets*, highlighting the effectiveness of sustainable diet initiatives in enhancing overall sustainable prosperity. The *Sufficiency Scenario, flying less* case also shows some promising results in enhancing sustainable prosperity across the EU27 and FULFILL countries. Germany and Latvia are those countries that would benefit the most from these measures, displaying SPI increases especially in the mid-term. Overall, **policymakers should prioritize and incentivize sustainable practices like reducing air travel to foster resilient and prosperous societies, mitigating environmental impacts, and enhancing quality of life**.

Lastly, the sensitivity analysis illustrates how measuring the SPI varies with the use of dynamic or constant weighting. In general, **constant weights offer stability and consistency**, making it easier to track long-term trends. **Dynamic weights**, instead, **provide adaptability and responsiveness**, highlighting the current relevance of each indicator and capturing short-term changes.

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Regarding FULFILL countries, Denmark and Germany show more pronounced differences, indicating greater sensitivity to changing conditions. In contrast, France and Italy exhibit more stable trends under both methods. This is relevant for policymaking, as constant weights may be preferable for assessing long-term sustainability goals, while dynamic weights can inform on the effectiveness of specific policies and the promotion of SMs.

This study acknowledges several limitations. Firstly, the adapted version of the Sustainable Prosperity Index (SPI) does not consider the **non-linearity of weights**, leading to potential subjectivity and misleading results. Secondly, the **choice of indicators** significantly influences the results, and different indicators could yield diverse conclusions about sustainable prosperity. The exclusion of other relevant socio-economic and environmental variables may also introduce bias. Lastly, the construction of the composite indicator does not fully encompass all possible domains of energy sufficiency, as the modelling framework only provides a **partial view of the effects of energy sufficiency** on reduced energy consumption and environmental impact.

The careful reader should then interpret the results bearing in mind these limitations. Future research might better address these issues by incorporating more sophisticated weighting schemes, considering a broader range of indicators, integrating comprehensive SMs, and refining economic models to better capture the complexities of real-world dynamics.

Nonetheless, this analysis underscores the **importance of integrating sufficiency measures into policy frameworks** to foster a holistic approach for tracking sustainable development, while balancing economic, environmental, and societal goals.

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8. Annex

8.1. Summary of results for EU27 and FULFILL countries

Table A.1: Summary of results for EU27 group under the Reference and Sufficiency scenarios in 2020 and 2050.

EU27	2020	2050 *Reference*	2050 *Sufficiency*
SPI	**100**	**105.84**	**108.94**
GDP_pc	27,609.25	41,386.42	39,736.37
GHG	4,741,405,060	5,385,268,477	4,750,550,211
Gini (%)	30.77	31.79	31.47
Emp/pop (%)	31.38	47.48	45.1
Avg_hrs	1505.61	1410.57	1340.04
Debt/GDP (%)	90	87.98	83.58

Table A.2: Percentage changes between 2020 and 2050 under the Reference and Sufficiency Scenarios for the EU27 group.

EU27 (baseline year = 2020)	2050 *Sufficiency vs. Reference Scenario*
SPI	**+2.92%**
GDP_pc	-3.98%
GHG	-11.78%
Gini	-1%
Emp/pop	-0.01%
Avg_hrs	-5%
Debt/GDP	-5%

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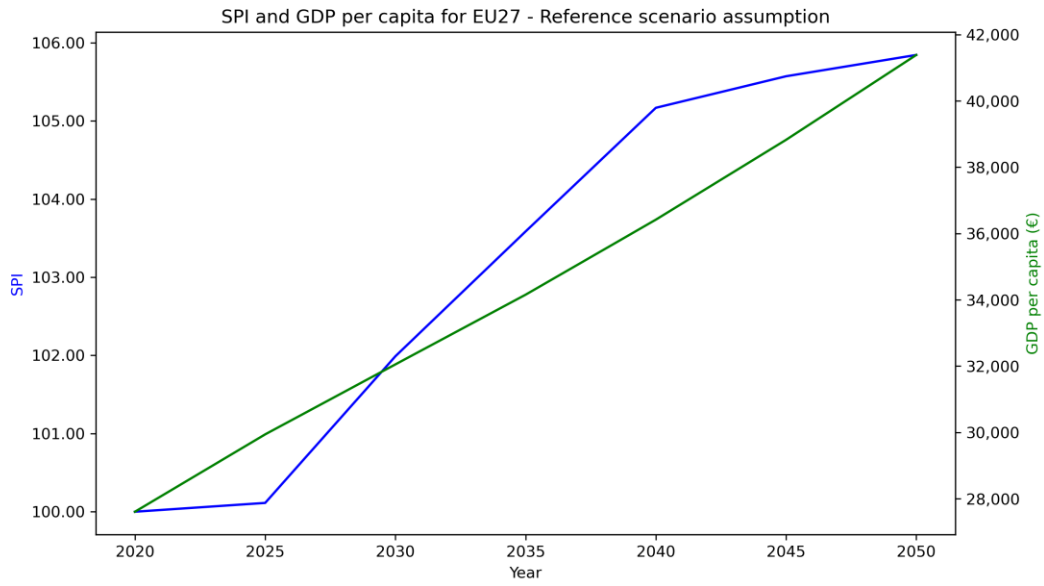

Figure A.1: Comparison between SPI and GDP per capita in the time frame 2020-2050, EU27 – Reference Scenario.

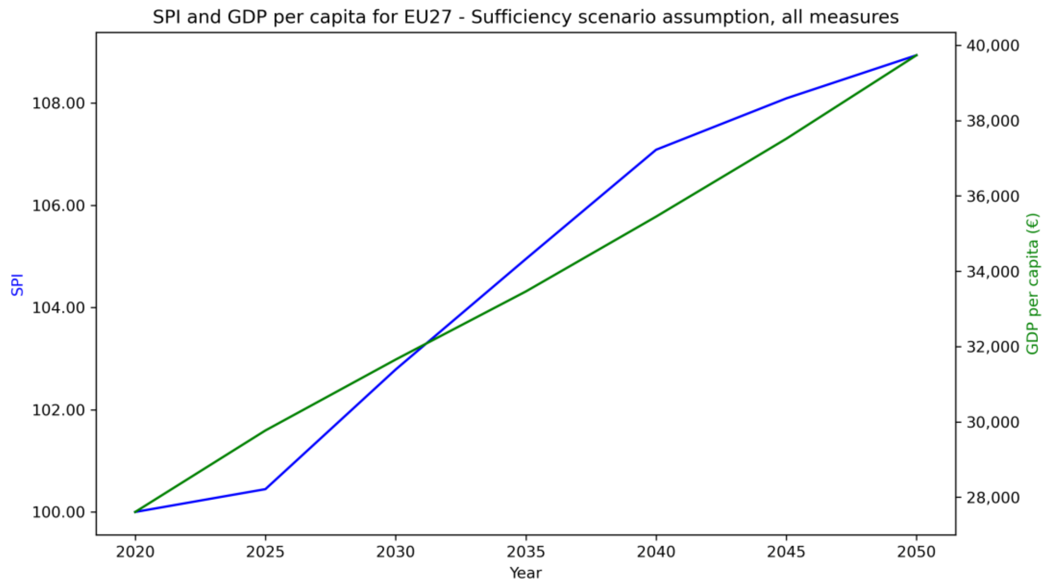

Figure A.2: Comparison between SPI and GDP per capita in the time frame 2020-2050, EU27 – Sufficiency Scenario, all measures.

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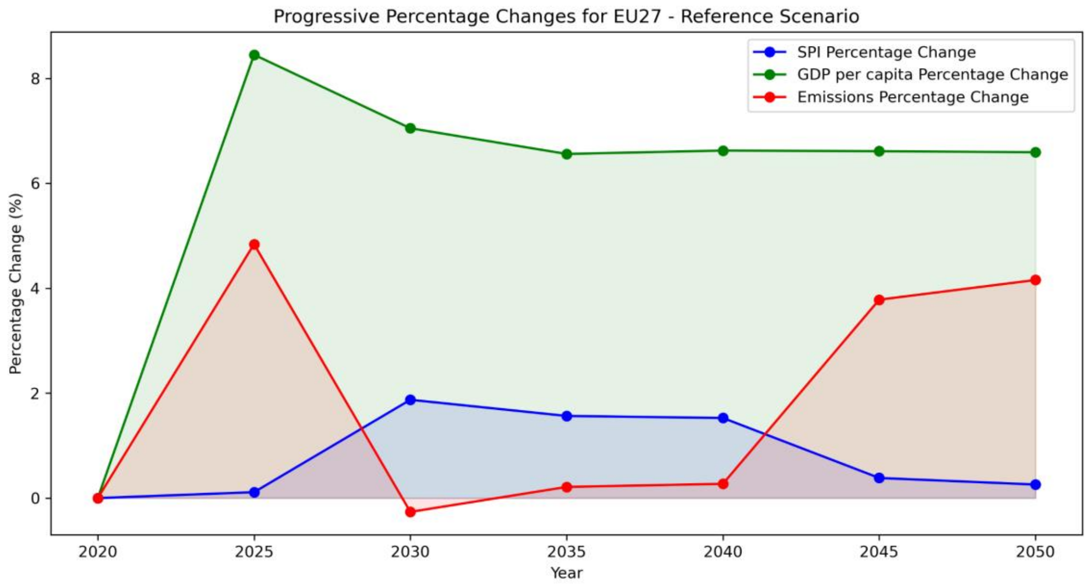

Figure A.3: Evolution of growth rates of projected variables in the time frame 2020-2050: SPI, GDP per capita and GHG emissions, EU27 – Reference Scenario.

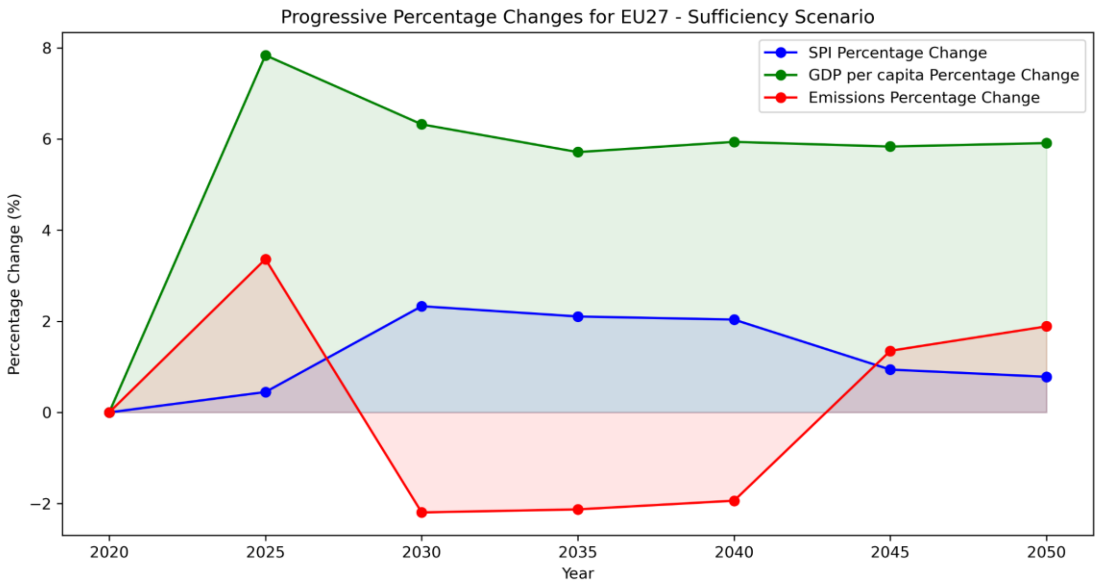

Figure A.4: Evolution of growth rates of projected variables in the time frame 2020-2050: SPI, GDP per capita and GHG emissions, EU27 – Sufficiency Scenario, all measures.

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Table A.3: Summary of results for Denmark.

Denmark	2020	2050 *Reference*	2050 *Sufficiency*
SPI	**100**	**104.6**	**106.91**
GDP_pc	44,067.96	62,157.58	60,415.93
GHG	92,641,137.33	120,114,796.9	110,167,709.5
Gini (%)	27.50	34.83	34.49
Emp/pop (%)	26.98	38.13	36.21
Avg_hrs	1344.85	1227.22	1165.86
Debt/GDP (%)	42.3	19.34	18.37

Table A.4: Summary of results for France.

France	2020	2050 *Reference*	2050 *Sufficiency*
SPI	**100**	**97.43**	**101.72**
GDP_pc	34,574.23	47,865.48	46,029.13
GHG	542,302,438.1	595,929,118.7	508,490,265.8
Gini (%)	30.66	33.44	33.1
Emp/pop (%)	27.34	37.55	35.66
Avg_hrs	1402.64	1432.3	1417.98
Debt/GDP (%)	114.6	174.41	172.66

Table A.5: Summary of results for Germany.

Germany	2020	2050 *Reference*	2050 *Sufficiency*
SPI	**100**	**116.55**	**119.34**
GDP_pc	38,007.45	54,957.94	52,930.33
GHG	1,028,859,367	1,201,815,545	1,078,784,316
Gini (%)	32	34.38	34.03
Emp/pop (%)	42.65	61.26	58.19

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Avg_hrs	1319.13	1192.51	1132.88
Debt/GDP (%)	68.8	18.15	17.24

Table A.6: Summary of results for Italy.

Country: Italy	**2020**	**2050 *Reference***	**2050 *Sufficiency***
SPI	**100**	**104.91**	**108.15**
GDP_pc	29,224.16	42,798.96	41,313.90
GHG	485,013,976.5	489,737,464.3	433,243,708.4
Gini (%)	35.24	38.19	37.81
Emp/pop (%)	23.88	35.1	33.34
Avg_hrs	1543.11	1393.27	1323.6
Debt/GDP (%)	154.9	214.26	212.12

Table A.7: Summary of results for Latvia.

Country: Latvia	**2020**	**2050 *Reference***	**2050 *Sufficiency***
SPI	**100**	**118.24**	**121.53**
GDP_pc	14,588.44	27,584.42	25,866.54
GHG	21,386,599.76	25,832,100.04	22,151,452.55
Gini (%)	35.7	32.41	30.79
Emp/pop (%)	28.65	52.26	49.64
Avg_hrs	1576.93	1188.19	1128.78
Debt/GDP (%)	42.2	29.12	27.67

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8.2. Decomposition analysis of SPI for FULFILL countries

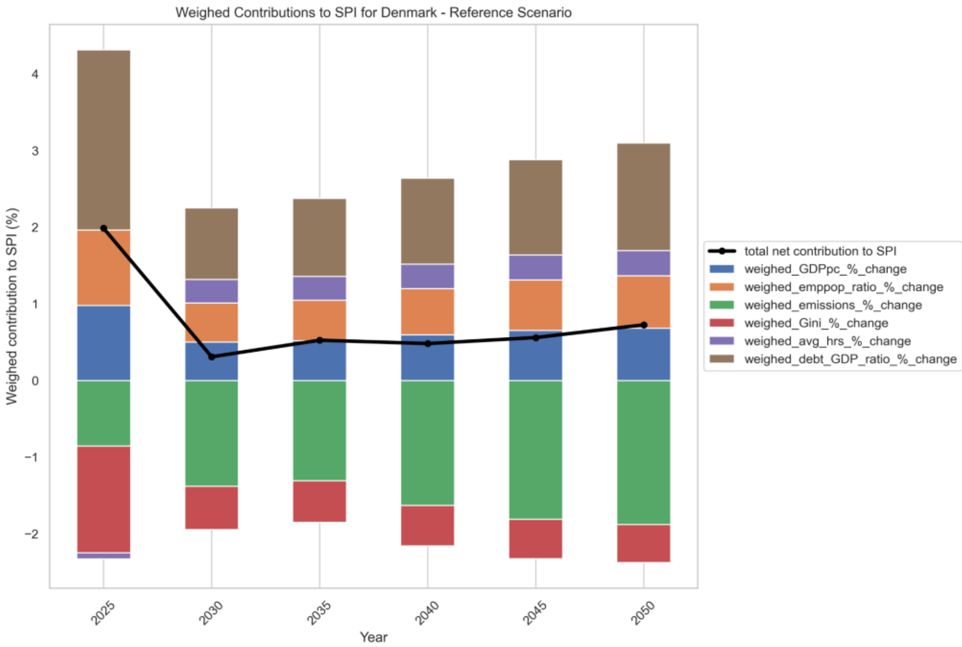

Figure A.5: Decomposition of projected SPI under the Reference Scenario. Denmark.

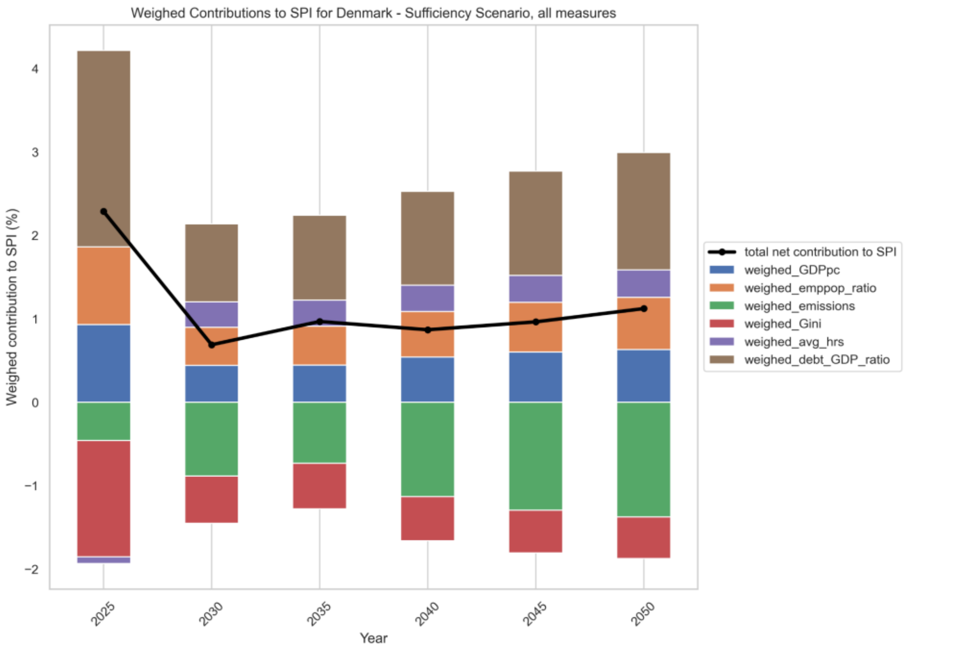

Figure A.6: Decomposition of projected SPI under the Sufficiency Scenario. Denmark.

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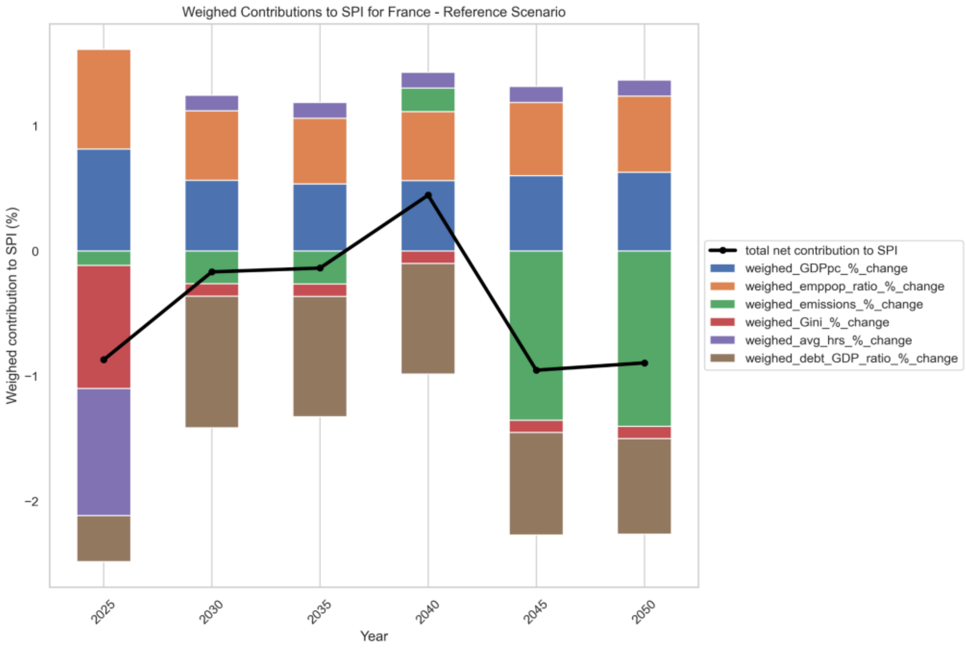

Figure A.7: Decomposition of projected SPI under the Reference Scenario. France.

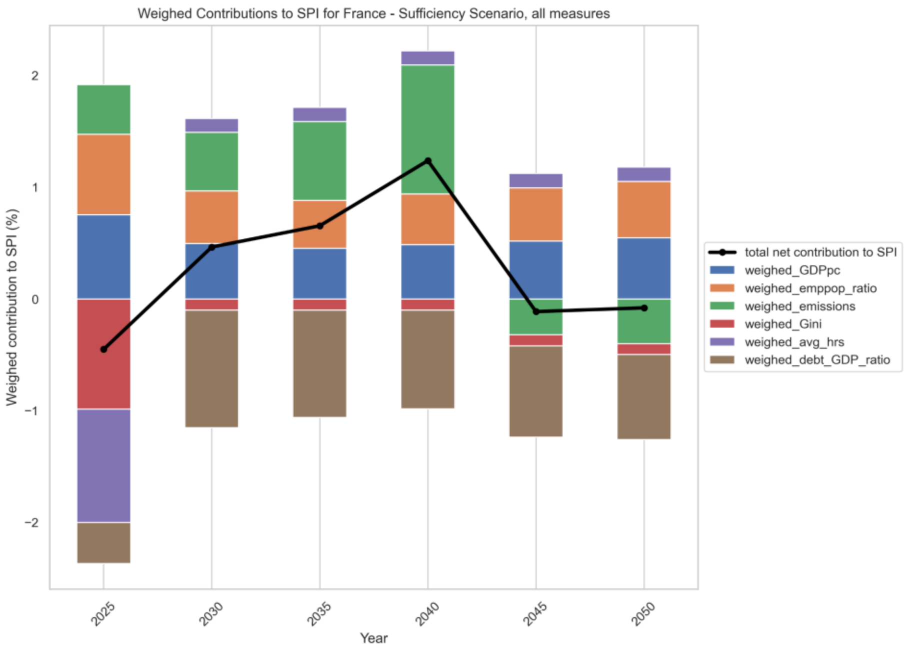

Figure A.8: Decomposition of projected SPI under the Sufficiency Scenario. France.

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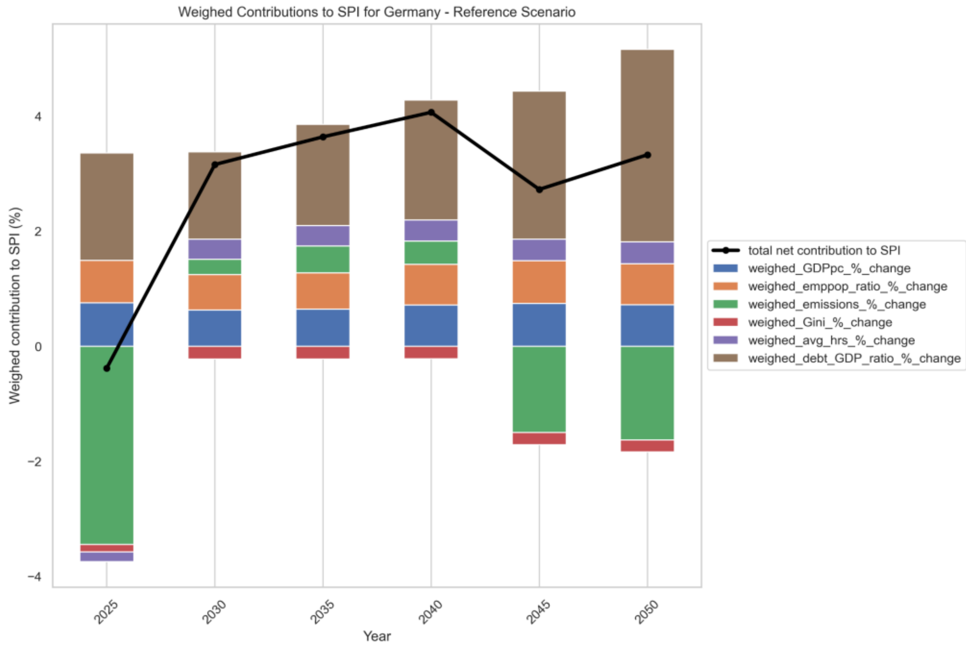

Figure A.9: Decomposition of projected SPI under the Reference Scenario. Germany.

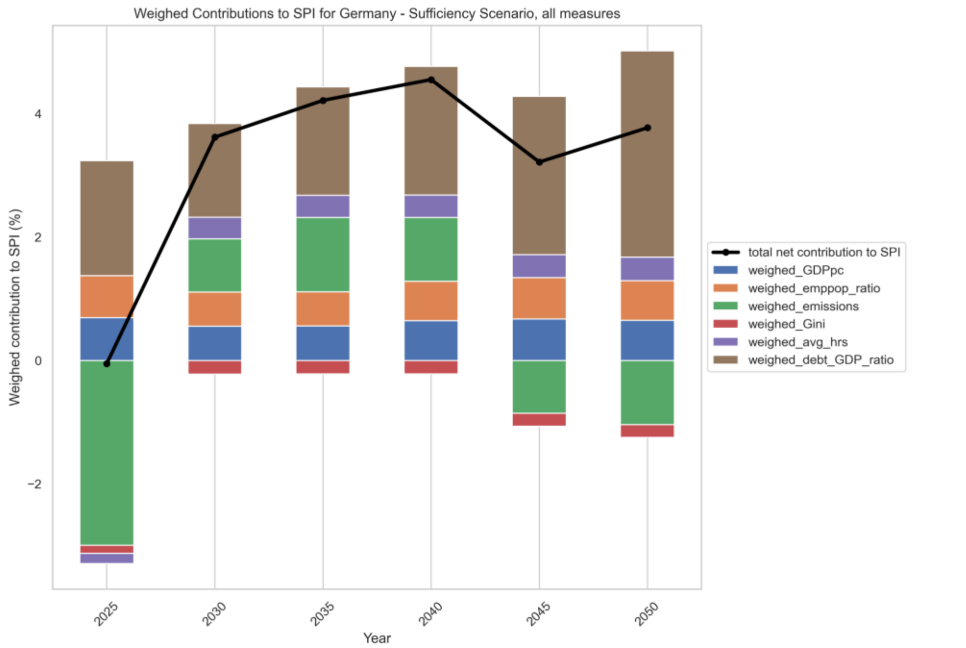

Figure A.10: Decomposition of projected SPI under the Sufficiency Scenario. Germany.

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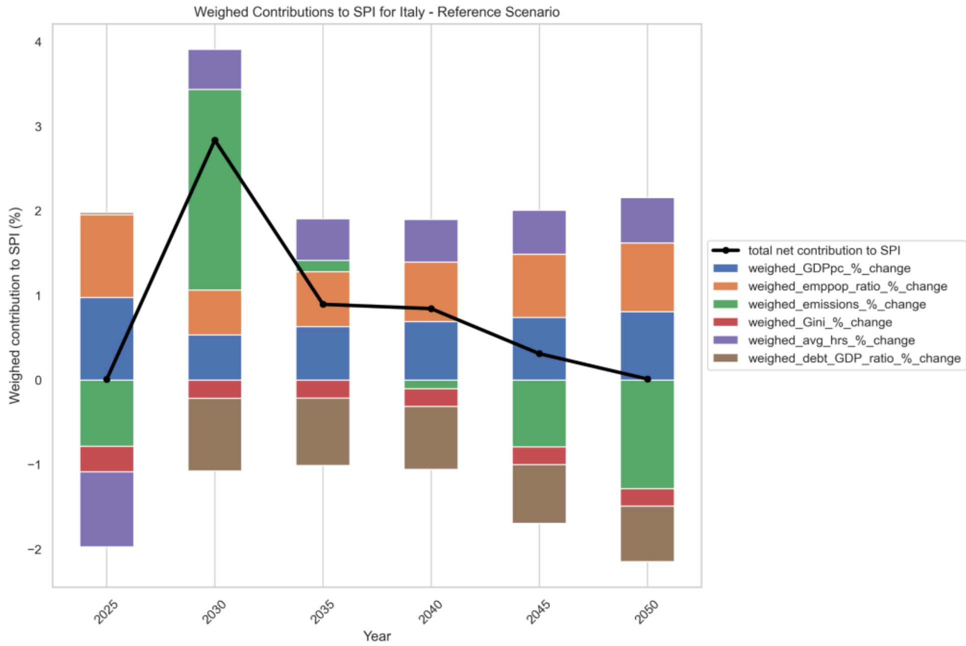

Figure A.11: Decomposition of projected SPI under the Reference Scenario. Italy.

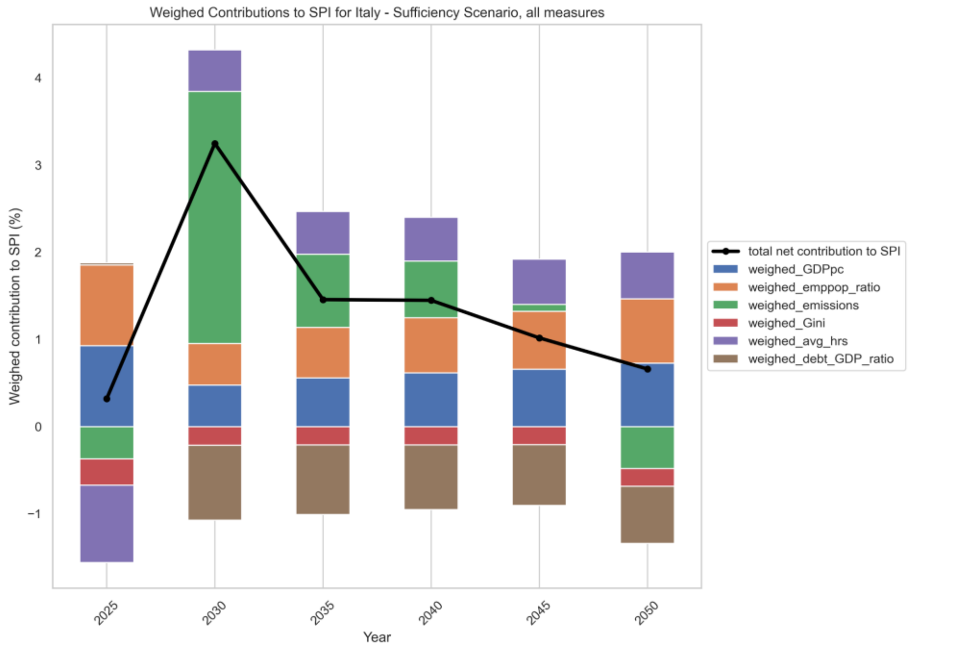

Figure A.12: Decomposition of projected SPI under the Sufficiency Scenario. Italy.

FULFILL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003656.

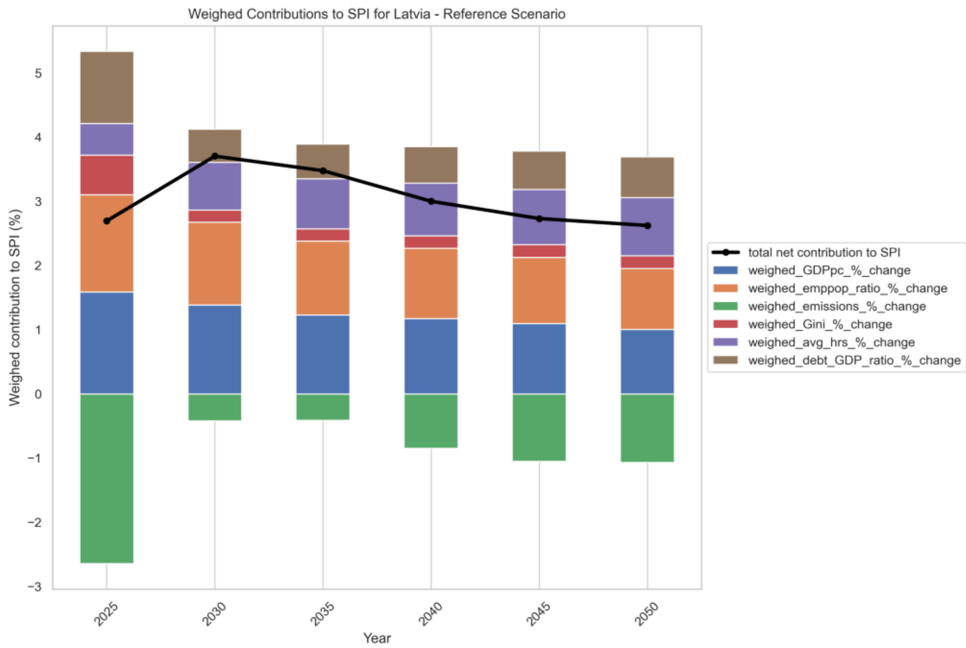

Figure A.13: Decomposition of projected SPI under the Reference Scenario. Latvia.

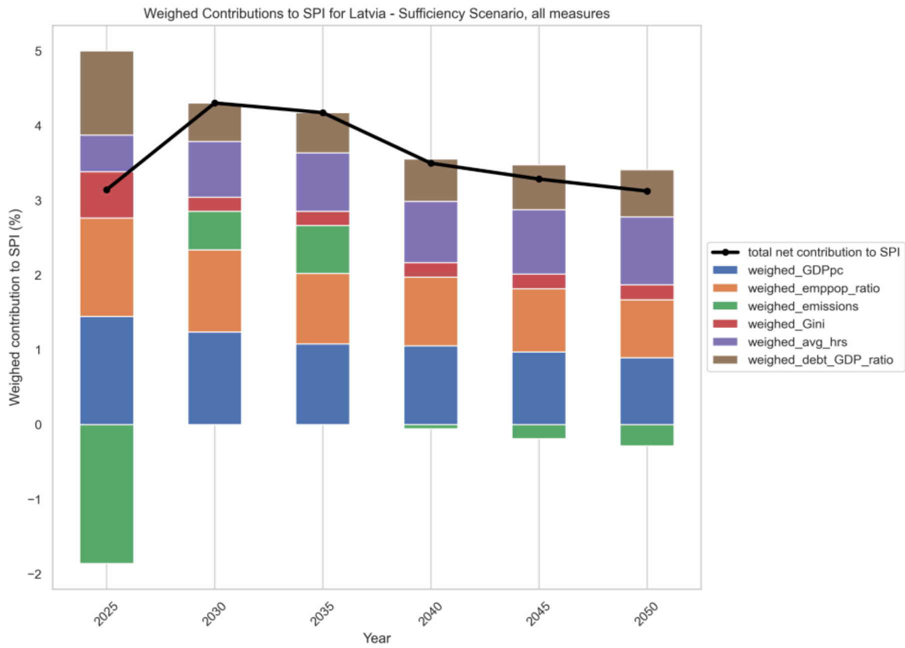

Figure A.14: Decomposition of projected SPI under the Sufficiency Scenario. Latvia.

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8.3. SPI – Sufficiency Scenario, diets

As shown in D6.2 (Golinucci et al., 2024), the larger magnitude for GHG emissions reduction in I/O analysis is mainly driven by two key sufficiency measures (SMs) – i.e. *Diets* and *Flying less* –, significantly outperforming the other measures in terms of contribution to lower GHG emissions.

Thus, the SPI for these two selected sufficiency measures is here reported.

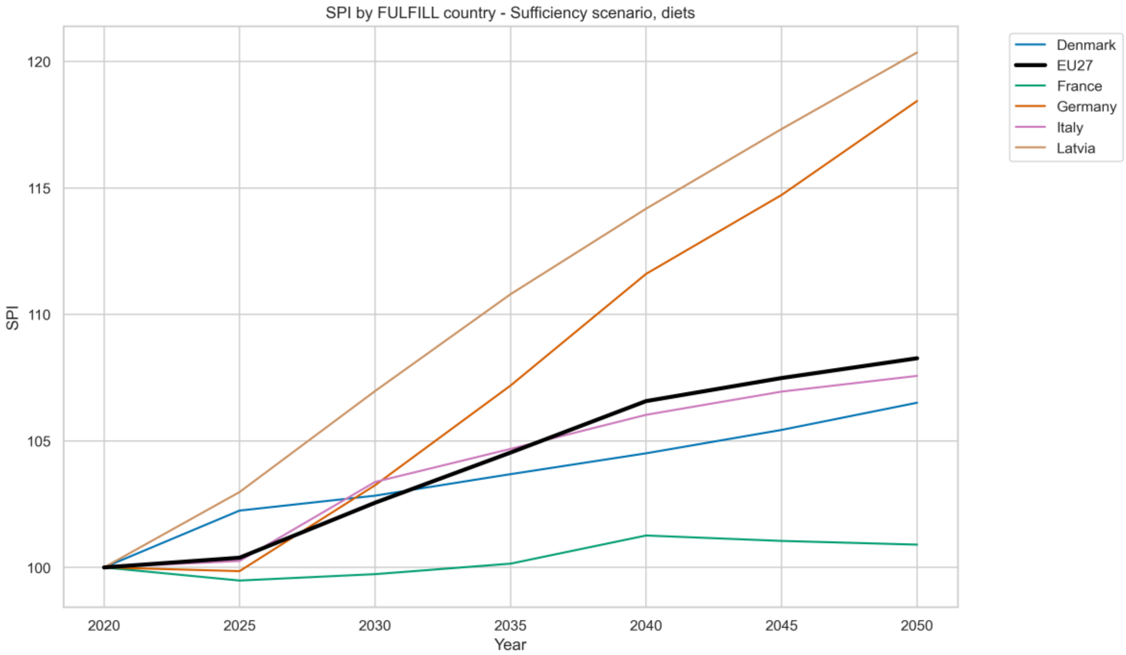

Figure A.15: Projected SPI, Sufficiency Scenario, diets. FULFILL countries and EU27.

Figure A.15 displays the outcomes of SPI for FULFILL countries resulting from the representation of the *Sufficiency Scenario, diets*.

The SPI for the **EU27** shows a steady increase up to 108.26 in 2050 (vs. 105.84 under the *Reference Scenario* and 108.94 under the *Sufficiency Scenario, all measures*). **Denmark** experiences a smooth increase in SPI to 102.24 in 2025, increasing to 106.5 by 2050. **Germany** shows significant increases in SPI, particularly reaching 111.6 in 2040, maintaining high levels through 2050. **France** sees a significant increases in SPI due to changing diets, peaking at 101.2 in 2040 and then softening around 101 by 2050. **Italy** experiences a notable increase in SPI, almost tying EU27 in 2035 and then stabilizing around 107.5 through 2050. **Latvia** experiences the highest SPI, rising to 110.8 in 2030, to then climb up to 120.35 by 2050 under the *Sufficiency Scenario, diets*.

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8.4. SPI – Sufficiency Scenario, flying less

Figure A.16 displays the outcomes of SPI for FULFILL countries resulting from the representation of the *Sufficiency Scenario, flying less*.

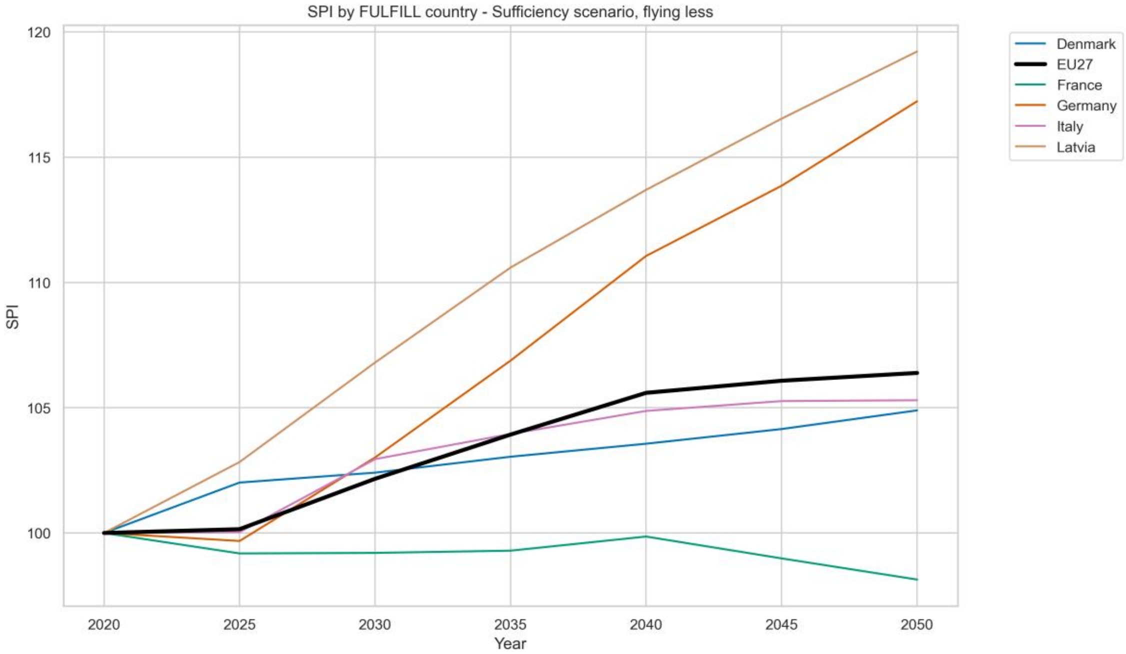

Figure A.16: Projected SPI, Sufficiency Scenario, flying less. FULFILL countries and EU27.

The SPI for **EU27** under the *Sufficiency Scenario, flying less* shows a modest increase, reaching 105.9 in 2040, and then stabilizing around 106.3 towards 2050. In 2050, the index would reach a lower value compared to the case of the SM "diets". Also, for the case of **Latvia, Denmark, Italy, and Germany**, SPI values generally show similar trends but with slightly higher peaks and growth rates compared to the *Reference Scenario*. For the case of France, the SPI under this Scenario (individually taken) would not convey relevant benefits compared to the *Reference Scenario*.

Hence, this "*Sufficiency Scenario, flying less*" emphasizes the reduction of passenger air travel and shows promising results in enhancing sustainable prosperity across the EU27 and all FULFILL countries. Countries like Germany and Latvia benefit significantly from these measures, demonstrating substantial SPI increases in the mid-term. However, the magnitude of the impact remains weaker than the results obtained for the impact of changing diets, which would convey most of the improvement in SPI performances.

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