DEVELOPING NEW PATHWAYS FOR INFRASTRUCTURE DECISION MAKING IN THE CONTEXT OF INCLUSIVE GROWTH

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Executive Summary

- This report has been prepared as part of a collaborative project with EKOS Ltd (EKOS) on behalf of Scottish Futures Trust (SFT).
- The intention of the report is to help develop a more effective understanding of how infrastructure investment supports inclusive growth priorities. The longer-term goal is that the evidence presented will be built upon to inform a new infrastructure prioritisation framework and Scotland's next Infrastructure Investment Plan (IIP).
- The specific framing of our contribution was to provide an international perspective to the research and to offer an element of provocation to the overall project.
- The report is structured around addressing the following six critical questions, split between two themes as follows:

  Illustrating a wide boundary understanding of infrastructure
  - ➢ Q1: If we use the Scottish Government's wider definition of infrastructure (i.e. including natural and social infrastructure investments), are there additional studies or evaluations that could contradict the *Fraser of Allander ("FoA") report*[1]?
  - ➢ Q2: From an international perspective what is the emerging evidence base for the positive and negative impacts of infrastructure on inclusive growth?

  New perspectives for appraisal and evaluation
  - ➢ Q3: What can Scotland learn from 'best practice' infrastructure appraisal frameworks in the UK and internationally?
  - ➢ Q4: How is the way that we understand and measure value in the economy changing and how is that being evidenced in inclusive growth frameworks internationally?
  - ➢ Q5: How can we evaluate the systemic health of the economy (as opposed to individual sectors or policy areas)?
  - ➢ Q6: How can we shift practitioner thinking to consider dynamic rather than utilitarian (allocative) prioritisation frameworks and emerging rather than static systems?

[1] The Fraser of Allander Report was commissioned by the Infrastructure Commission for Scotland in 2019 and its conclusions were a key driver in instigating this current project.

Evidence illustrating a wide boundary understanding of infrastructure

Taking a wider view of infrastructure, the international research has highlighted many interesting relationships between infrastructure as an enabling capability and positive societal outcomes. Some key examples are highlighted below:

- **Social infrastructure**: Institutional infrastructures (including judiciary and law enforcement services) and social capital (such as societal and institutional trust), have been found to be core enabling factors for antifragility and maintaining growth in the face of external shocks. For example, a study investigating the factors driving the adoption of COVID-19 test-and-trace apps found that trust in government was the most important factor, compared to public spending, professionalism of the civil service and levels of physical infrastructural capacity (Cingolani, 2022).
- **Human (core) infrastructure**: Breaking the feedback loop between poverty and mental illness is a crucial leverage point in achieving inclusive growth. For example, a study of 28 European countries found depression alone cost €118bn yearly, of which only 36% related to direct treatment costs, with the other 64% representing lost employment, reduced productivity, and increased insurance and benefit payments. (Funk, Drew, and Knapp, 2012, p. 173).
- **Natural infrastructure**: Studies investigating links between natural capital investments and health outcomes have found evidence for a diverse range of improvements. These include aspects such as cardiovascular health, cortisol levels (indicators of stress) and obstetric outcomes, together with positive impacts on mental health and pro-social behaviours (Suppakittpaisarn et al. 2017).
- **Maintenance**: Achieving a balance between infrastructure maintenance and capital investment has been found to reduce inequality levels whilst also increasing productivity outcomes (Gibson and Rioja, 2017). Furthermore, an interesting crossover consequence of investing in natural infrastructure is that nature-based solutions typically have lower maintenance costs, in addition to more obvious benefits such as maximising limited resources and reducing the ecological footprint.

Considering the unintended consequences of infrastructure investment

If we are working towards societal level prosperity then we must look at investments from a portfolio perspective, thus allowing diverse spillover impacts to be considered and evaluated at all stages of the project cycle. A key challenge is that causality is non-linear and thus when measuring outcomes in aggregate we must consider the distribution of positive and negative impacts across different communities and timeframes. Some specific examples of unintended consequences drawn from our research are as follows:

- **Preventative health**: A report from the World Health Organisation on public health investment emphasised the integrated societal benefits of preventative spending, highlighting a fourfold return to the wider economy for every dollar invested. A wide range of

auxiliary benefits were examined with improvements being evidenced in areas such as violence reduction, road traffic accident rates and unemployment levels (WHO, 2020).

- **Mental Health**: There is strong evidence of links between social determinants (i.e. living conditions, improper heating, employment status, etc.) and health welfare. For example, studies have identified positive correlations between interventions in infrastructure areas such as housing provisions for the homeless and improved levels of mental illnesses, together with urban green spaces reducing depressive symptoms amongst pregnant women. (Alegría et al. 2018; Chrysopoulou, Anielski, and Weatherhead 2021).
- **Childcare**: Delivering early-stage childcare has been shown to have long-term effects both via future workplace opportunities and as a function of reducing failure demand. For example, a recent IFS (Institute for Fiscal Studies) publication found that the UK's Sure Start education initiative (designed to improve early-year care in children under the age of 4) also reduced hospitalisation rates amongst 10-11 year old children by 30% (Rosie Stock Jones 2020).

New perspectives for appraisal and evaluation

Incorporating international best practice

A clear theme that emerged from the international analysis is that it is very difficult to separate the impact of infrastructure investment from other policies. It is evident that the time and spatial horizons of decision making are becoming more fluid and consequently we need to remain flexible and non-prescriptive in our use of frameworks and metrics. Several practical implications for Scotland are outlined below:

- **Applying systems thinking**: Acknowledging complexity (and thus taking a systems-based approach) is central to understanding and addressing evolving risks and opportunities. Trade-offs and emerging complexities are inevitable and it is unrealistic to expect that a single framework (or a specific set of metrics) will provide all the answers. For example, frameworks such as the Canadian Wellbeing Index (CIW), the International Integrated Reporting Framework (IIRF) and New Zealand's Living Standards Framework (NZ LSF) are all centred on taking a systems approach. Conceptually these initiatives are focused on encouraging people to think with an integrated and systemic mindset, rather than relying on specific metrics or rules.
- **A capital / wealth approach**: This framing in relation to wellbeing outcomes is emerging as the gold standard in strong international wellbeing frameworks (NZ LSF, OECD, Australian National Development Index). In our view, linking an inclusive economy to a wealth economy by considering the underpinning Four Capitals is essential, because the capabilities enabled by infrastructure investment (and evidenced by the underlying wealth stocks) provide the means to achieve the target inclusive growth outcomes.
- **Governance and accountability**: Strong framework accountability and governance is critical to connect desired outcomes to the everyday realities of decision making. For example, a recent report published by the Scottish Leaders Forum concluded that the current

status of accountability against the National Performance Framework is '*patchy*' and that it '*is not actively used to shape scrutiny, provide sponsorship, undertake commissioning of work or shape the allocation of funding*'. (Scottish Leaders Forum, 2022). In the context of the rising complexities and challenges being faced, it seems imperative that any emerging infrastructure frameworks are given appropriate agency and resources to transcend governmental departments.

- **Public engagement**: Continuous engagement with the public has been found to be an essential factor in creating an enabling environment for progressive future policy. Strong examples include the interactive format of New Zealand's Living Standards Dashboard and Canada's Wellbeing regional outreach programmes. It is noted that the IIP route map includes a public engagement workstream, as recommended by the Infrastructure Commission for Scotland.

Raising our gaze to achieve transformational effects

The concurrent national strategies of achieving net zero and inclusive growth clearly indicate that infrastructure appraisal techniques must become more holistic and consider a portfolio of impacts. In the UK, the Treasury's Green Book is considered the best-practice standard for public sector investment appraisal. A review of the Green Book in 2020 concluded that '*transformational effects are rare*' in relation to investment and only occur when initiatives are '*part of a coherent strategic portfolio designed to deliver such changes.*' (HM Treasury 2020a). This was a theme that was echoed in our analysis of best-practice prioritisation frameworks, with some key examples being as follows:

- **System level alternatives to GDP**: In recent years there have been numerous criticisms of GDP as a measure of individual wellbeing but less has been voiced about its effectiveness as a measure of the economy's systemic health. Examples include:
    - The Healthy Green Growth Compass (Norway) looks at rates of change in ecological and social (particularly in relation to inequality) indicators as a function of GDP and aligns them with science-based targets (Stoknes and Hawken 2021). The Compass acknowledges the constant fluidity present in natural and social systems and its framing clearly indicates the direction of progress towards informed targets, rather than using fixed or comparative metrics.
    - The SAGE Framework (Global) presents a policy route for recoupling economic and social prosperity and follows a dashboard approach to measurement. The framework consists of four indices (Agency, Solidarity, Environmental Stability & Material Gain) which are represented by a visual matrix designed to identify shifting societal behaviour and norms (De Miranda, K and Snow, D 2020).
- **Applying complexity theory to analytical decision making:** Research drawing on complexity theory has shown that in complex environments there is a need to shift towards dynamic decision making frameworks (as opposed to traditional CBA analysis). The key difference between dynamic and allocative frameworks is that an allocative framework aims to make the optimal use of fixed resources at a single point in time, whereas a dynamic framework seeks to use resources to enact desired changes (Kattel et al. 2018).

In practical terms, this means rejecting the concept of optimality and prioritising adaptable policy choices which can be adjusted as the context evolves.

- **Setting forward facing targets**: Market-shaping (as opposed to market-fixing) policy frameworks require forward facing targets. A successful integrated infrastructure prioritisation framework will need to continuously connect evaluation measurements to evolving appraisal input metrics. If the selected evaluation metrics cannot be readily applied to appraisal targets then there is a danger that the process will remain reliant on traditional economic measures such as GVA (gross value added).

Thought prompts for future policy design

1. **Encourage wide boundary thinking**: By thinking about infrastructure investment as a pathway to creating enabling capabilities and societal resilience, we can transcend the restrictive limitations of ascribing specific asset classes to desired outcome indicators.
2. **Consider the unintended consequences:** If we are working towards societal wide prosperity then we must look at investments from a system-wide portfolio perspective, thus allowing positive and negative spillover impacts to be considered and evaluated at all stages of the project cycle.
3. **Look upstream of the framework**: Well designed frameworks can contribute to the design and implementation of meaningful future policy but are rendered powerless without associated behavioural changes. If we can shift the values behind the decision making, then the frameworks can be repositioned to act as conceptual aids rather than as prescriptive tools.
4. **Contextualise the theory**: The interconnected nature of the investment landscape can be overwhelming and thus to enable practitioners to enact practical change, the theories must be contextualised in both time and place (e.g. using the 4-Capitals model as a proxy for infrastructure investment).
5. **Apply dynamic analysis**: If we accept the fundamental uncertainty of working within emerging contexts then we can become liberated from the concept of optimality. By focusing on adaptable policy choices that can be adjusted as new uncertainties emerge, we can build resilience and reduce fragility.
6. **Commit to a direction of travel**: The non-linearity that defines socio-economic systems means that individual targets can often bring a false sense of security, or worse, can shift behaviours in unintended ways. If we can instead commit to a desired direction of travel for Scotland, then we can remain flexible in our evaluation and decision making pathways.
7. **Acknowledge the reflexivity of targets and indicators:** Indicators which are used as targets can become less meaningful over time because organisations and societies are complex adaptive systems, ever evolving and adapting to their new conditions and incentives.

1. Report context and the six critical questions to be addressed

Report context

This report has been prepared as part of a collaborative project with EKOS Ltd (EKOS) on behalf of Scottish Futures Trust (SFT). Dark Matter Laboratories (DML) were specifically asked by SFT to contribute an international perspective to the research and to provide an element of provocation to the overall project. The standalone outputs from the DML segment of the project are presented in this report, whilst the key ideas, conclusions and recommendations that were drawn from it are included in the full EKOS report (EKOS 2022).

Study background and objectives

In 2021 the Scottish Government (SG) published its latest Infrastructure Investment Plan (IIP) (2021/2-2025/2026) which includes a route map for improvements to the decision-making process for capital investment in Scotland (Scottish Government 2021a). This will inform the development of the next IIP and related capital investments. SFT is assisting the Scottish Government in implementing elements of this route map, including developing a new prioritisation framework that aligns with policy ambitions, such as inclusive growth. However, in order to effectively support the prioritisation framework there is a need to develop a more effective understanding of how infrastructure supports inclusive growth priorities.

The specific objectives of this stage of the project are as follows:

- Establishing if (and thus where) an evidence base currently exists that connects infrastructure investment to inclusive growth.
- Selecting evaluation metrics to be used by SFT in a planned longitudinal study of a portfolio of infrastructure projects across Scotland.

The Dark Matter Labs approach

We have framed our contribution to the research inquiry as a series of questions and responses which are presented below. The queries were designed to provocatively explore existing thinking whilst presenting vanguard and emerging alternatives for the future. Our intention is that these responses will complement the EKOS report and the information flow that is shown below is therefore aligned with (and referenced from) that report.

Six critical questions to be addressed in this report (Q1-Q6)

The following selected themes and questions delineate the report structure:

Illustrating a wide boundary understanding of infrastructure

- Q1: If we use the Scottish Government's wider definition of infrastructure (i.e. including natural and social infrastructure investments), are there additional studies or evaluations that could contradict the *Fraser of Allander ("FoA") report*[2]?
- Q2: From an international perspective what is the emerging evidence base for the positive and negative impacts of infrastructure on inclusive growth?

New perspectives for appraisal and evaluation

- Q3: What can Scotland learn from 'best practice' infrastructure appraisal frameworks in the UK and internationally?
- Q4: How is the way that we understand and measure value in the economy changing and how is that being evidenced in inclusive growth frameworks internationally?
- Q5: How can we evaluate the systemic health of the economy (as opposed to individual sectors or policy areas)?
- Q6: How can we shift practitioner thinking to consider dynamic rather than utilitarian (allocative) prioritisation frameworks and emerging rather than static systems?

[2] The Fraser of Allander Report was commissioned by the Infrastructure Commission for Scotland in 2019 and its conclusions were a key driver in instigating this current project.

2. Illustrating a wide boundary understanding of infrastructure

2.1. Introduction

A key driver and starting point for this project were the conclusions that were drawn from an earlier research study commissioned by the Infrastructure Commission for Scotland ("Infrastructure Commission"). The output from this work was the Fraser of Allander Report (2019) which concluded that it is impossible to draw conclusive causal connections between investment in infrastructure and economic growth (and even less so about inclusive growth). The FoA report predominantly analysed existing literature review studies, which were themselves focused on the causal link between investment in infrastructure and economic growth. In addition, the report began to explore potential inclusive growth indicators and recommended that this work should be expanded upon.

For the purpose of their report, the FoA researchers started with the Scottish Government's simple yet effective definition of inclusive growth, which reads as follows:

> '*Growth that combines increased prosperity with greater equity; that creates opportunities for all and distributes the dividends of increased prosperity fairly*'.

Whilst we accept the robustness and quality of the FoA report, we would stress that in the three years following its publication, there has been a significant shift in the nature of our investment requirements. Furthermore, much work has been done to expand the conceptual boundaries of infrastructure investment, to include categories such as "intangible infrastructure" and "civic infrastructures". In our view, if we wish to establish a link between infrastructure investment and inclusive growth (however defined) in the 21st Century, we first need to carefully consider our understanding of the term 'infrastructure' and thus what may be included within it.

2.2. Q1: If we use the Scottish Government's wider definition of infrastructure (i.e. including natural and social infrastructure investments), are there additional studies or evaluations that could contradict the Fraser of Allander Report?

2.2.1 Notions of infrastructure that may be broader than the FoA Report

To put the FoA conclusions into context, it is interesting to note that all the studies which were included in the evidence review looked at a narrow segment of infrastructure. The categories reviewed were as follows:

- Transport (road and railway networks);
- Energy (electricity networks mostly); and
- Telecommunications and Digital (broadband and cellular network towers).

This approach excluded large swathes of physical infrastructure and the report itself suggested that investigating different types of infrastructure might be required in order to establish a connection to inclusive growth (Fraser of Allander Institute 2019, 28). It is our view that this requirement must include the consideration of intangible infrastructures in addition to broadening the scope of the more traditional categories.

In contrast to the FoA parameters, the Scottish Infrastructure Investment Plan (Scottish Government 2021a, 8) already considers an expanded definition of infrastructure. For example, the IIP accepts the Infrastructure Commission's recommendation to include 'Natural Infrastructure' within its scope. The definition adopted in the IIP echoes that used by the International Institute for Sustainable Development, surmising that:

> *'Natural infrastructure is an area or system that is either naturally occurring or naturalised and then intentionally managed to provide multiple benefits for the environment and human wellbeing.'*

The full definition of infrastructure stated in the IIP is as follows (ibid, 8):

'The physical and technical facilities, natural and other fundamental systems necessary for the economy to function and to enable, sustain or enhance societal living conditions. These include the networks, connections and storage relating to the enabling infrastructure of transport, energy, water, telecoms, digital and internet, to permit the ready movement of people, goods and services. They include the built environment of housing; public infrastructure such as education, health, justice and cultural facilities; safety enhancement such as waste management or flood prevention; natural assets and networks that supply ecosystem services and public services such as emergency services and resilience.'

DML's own understanding of what constitutes infrastructure is evolving and we are currently in the process of creating a more comprehensive taxonomy of infrastructure that we outline below[3]. Our intention is to use this taxonomy (both in this report and in our work more widely) to investigate whether different types of investment are connected to a contextualised understanding of inclusive growth. Our analysis of the different infrastructure asset classes is presented below under the following categories:

A. An overview of the full taxonomy
B. Hard / physical (tangible) infrastructure
C. Core (intangible) infrastructure
D. Social infrastructure
E. Environmental infrastructure

[3] We acknowledge that in delineating any form of taxonomy, judgements and trade-offs are unavoidable. For example, we have included the provision of housing under the category of hard / physical infrastructure, but appreciate that it can also be viewed as a social service under the heading of social infrastructure.

A. A broad overview of DML's infrastructure taxonomy

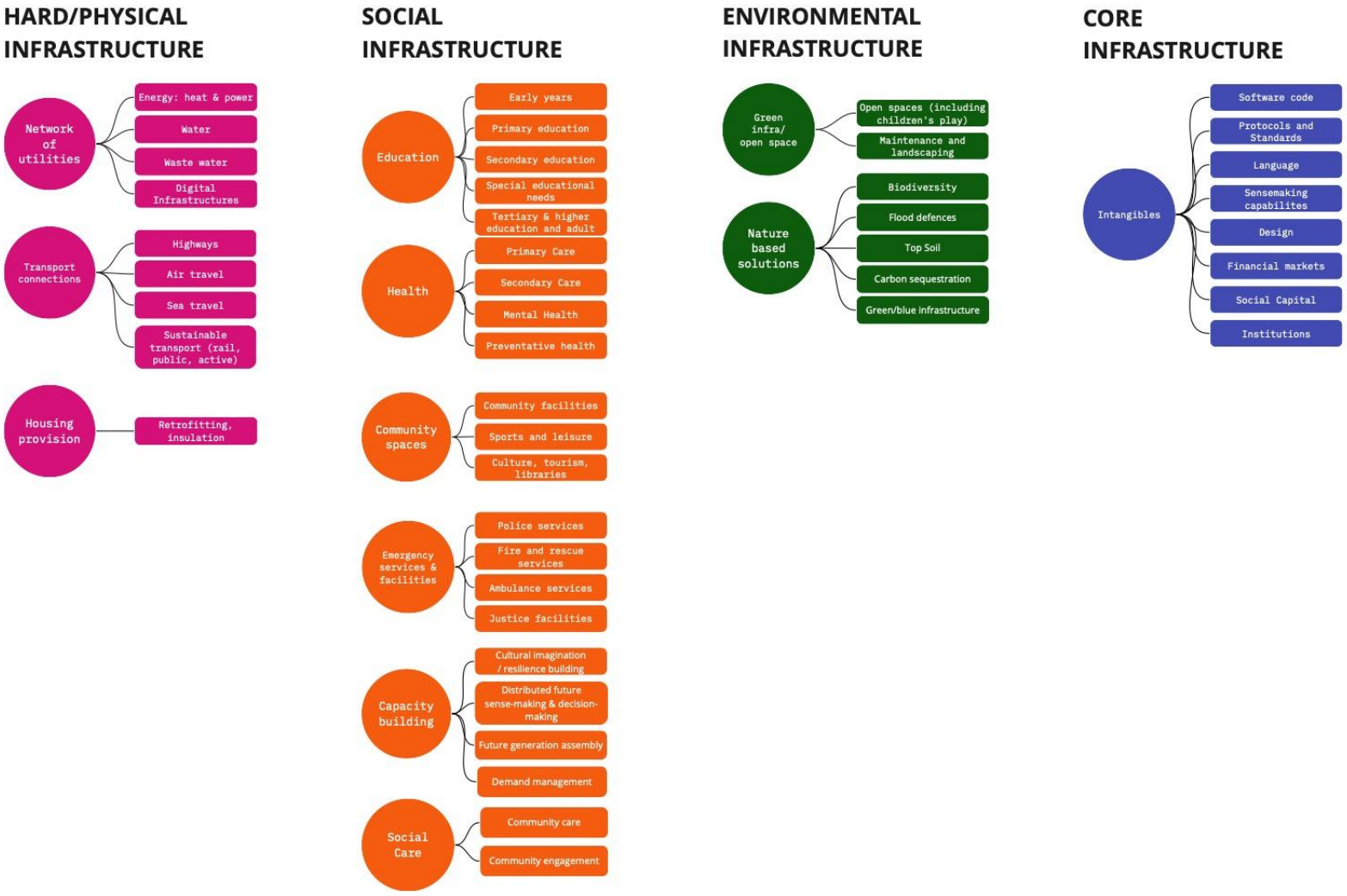


Figure 1. Broad overview of infrastructure taxonomy

B. Hard / physical (tangible) infrastructure

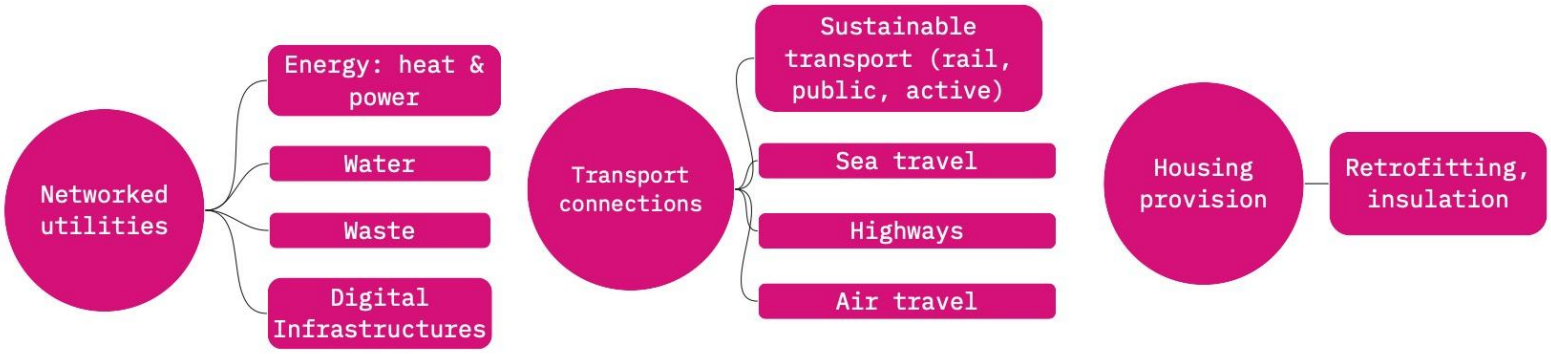


Figure 2. Hard infrastructure taxonomy

The asset classes presented above summarise the more traditional elements of public investment. In our view, whilst these classes remain as key drivers in any investment plan, they must be considered in the context of the wider taxonomy presented above.

C. Core (intangible) infrastructure

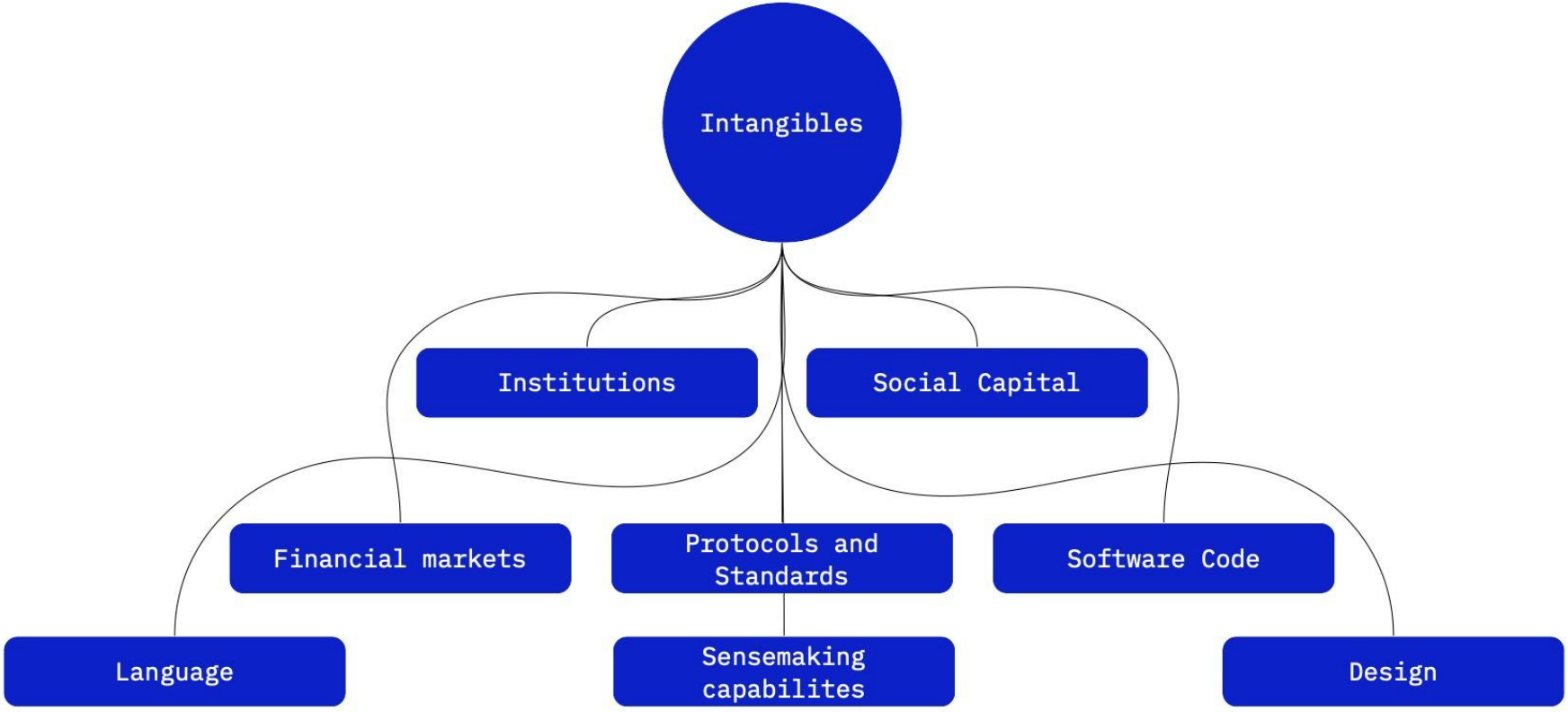


Figure 3. Intangible infrastructure taxonomy

The main addition to the infrastructure categories that are already recognized by the Scottish Government[4] is the core or intangible infrastructure category, which involves broad systems and patterns which are fundamental to modern economic life. Many of these are second-order emergent manifestations of the physical infrastructures that enable them. Our working definition of intangible infrastructures is thus as follows:

> '*Intangible infrastructuring is the shared formulae, relationships, and abilities that underpin society's social, ecological, and economic systems. It refers to the process of using and creating these to scaffold capabilities and values at a societal scale. They emerge through interactive processes between diverse actors and tangible structures in a given context, relative to each actor's conversion factor. Intangibles enable the reduction of fundamental uncertainty and prevention of damage, and most importantly fulfil conditions for societal thriving.*' (Rönnquist, de Dios, Chereji, upcoming)

Considering this broadened definition, the types of investments and spending which could relate to inclusive growth become more diverse. The next subsection therefore aims to explore whether there are existing justifications for this wider definition of infrastructure if we start from the perspective of more traditional economics. The subsequent subsections will investigate connections between three of the sub-categories of intangibles that we have identified above and inclusive growth.

Total factor productivity (TFA)

Our understanding of economic prosperity diverges significantly from neoclassical economic theory. However, even working within that more traditional framework, there are strong arguments for exploring wider definitions of infrastructure when searching for a link to growth (whether inclusive or otherwise).

In neoclassical economics, the Cobb-Douglas production function, which describes the relationship between available input resources and production, has three inputs: capital (K), labour (L) and a residual called Total Factor Productivity (A), which explains the variances in productivity growth that cannot be explained by increases in either labour or capital inputs. In an overview study related to capital

[4] As defined in the *Infrastructure investment: Evidence Summary* document (Scottish Government, 2018) : '*Typically infrastructure refers to economic infrastructure, such as utility networks, transport and digital communications, but the Scottish Government also includes social infrastructure such as schools, universities, hospitals, prisons, community housing and parks*' and taking into account the addition of natural infrastructure to the definition in the IIP (Scottish Government, 2021a).

accumulation and growth, Easterly and Levine (2001) consider that capital accumulation is not the determining factor in differences in growth between countries, but an unexplained 'something else', which is termed total factor productivity. In their view the boundaries of what makes up total factor productivity are not clear and they concluded that: 'These range from changes in technology (the instructions for producing goods and services) to the role of externalities, changes in the sector composition of production, and the adoption of lower-cost production methods. [...] Economists need to provide much more shape and substance to the amorphous term TFP' (Easterly and Levine 2001, 178).

It therefore follows that as capital accumulation refers both to public capital (i.e. public hard infrastructure) and to productive assets (such as private factories and machinery), this broad view regarding the mix of factors is indicative of the contingent nature of economic growth. Some theories on the nature of TFP demonstrate a broad common ground regarding an expanded view on what should be considered as intangible infrastructure. For example:

- Romer's (1986) view on long-run growth includes **knowledge** as an input in production and focuses on **externalities** such as **spillovers**. The social and intangible infrastructures which enable knowledge advancement and diffusion then become critical to growth.
- **Technological adoption** is given as a large factor in TFP by Parente and Prescott (1994). The main barriers of technological adoption vary from institutional setup, industrial relations, culture and of course the skill level of the existing human capital. Technological diffusion then becomes a key factor and the underlying infrastructures that enable this diffusion, both tangible and intangible, can be seen as determinants of growth.
- Rodrik (1998) explores the importance of **social cohesion and conflict resolution institutions** in maintaining growth in the face of external shocks. **Institutional infrastructures (including judiciary and law enforcement)** and **social capital** such as societal and institutional trust then become a core enabler for antifragility and inclusive growth. Moreover, Rodrik's interpretation of social conflict is '*the depth of pre-existing social cleavages in a society, along the lines of wealth, ethnic identity, geographical region or other divisions*.' (Rodrik 1998, 3). This implies that societal inclusivity in itself is a determinant factor of growth and it thus follows that inclusive growth becomes more self-sustainable than unevenly distributed growth.

$$\Delta growth \;=\; -\; external\ shocks \;\times \frac{latent\ social\ conflict}{institutions\ of\ conflict\ management}$$

(Rodrik 1998, 2)

Social capital, cohesion and trust

Social cohesion as an example of infrastructure can be conceptually difficult to visualise. However, an interesting example of how social cohesion and institutional trust can play a critical role in delivering positive outcomes has been evidenced in the adoption of digital infrastructures. A study investigating the factors driving the adoption of COVID-19 test-and-trace apps (Cingolani 2022) found that trust in government was the most important factor in predicting adoption, compared to public spending, professionalism of the civil service and levels of '*physical infrastructural capacity*'.

The studies presented in this section all attempt to show that parameters beyond hard capital are important determinants of economic growth and well-being.

In the final two taxonomy sections, we will therefore look at evidence that links social and natural infrastructure to growth, wellbeing and inclusivity.

D. Social infrastructure (an emerging classification)

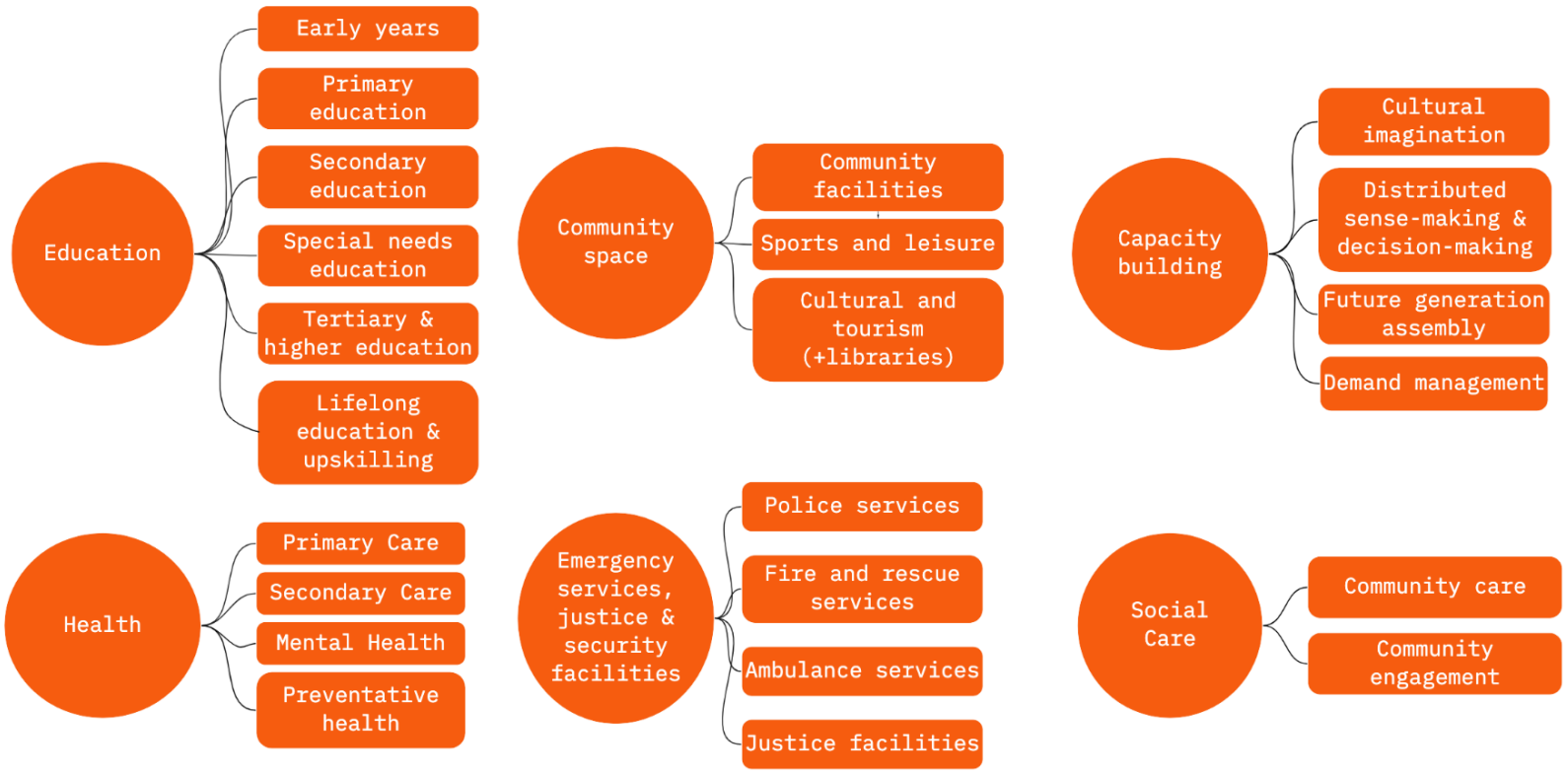


Figure 4. Social infrastructure taxonomy

Social infrastructure itself is a broad term encompassing both the physical and intangible infrastructure that underpins the societal activities that create social cohesion. Examples of this class span diverse aspects of society, including health and social care, education, community building and institutional infrastructure such as justice and policing services. Furthermore, the higher order effects of the investments in the physical infrastructure which enable or hinder cohesion can themselves become infrastructures. Social infrastructure is becoming more

prevalent in economic dialogue but as a concept it remains somewhat opaque. To aid understanding, we have therefore expanded on the evidence base for three of its key underlying components below.

Mental Health

It is generally accepted that a good level of overall mental health across a population is necessary for a well-functioning society. Funk et al. (2012) provide an overview of the evidence linking poor mental health outcomes to poverty directly and to stalled development for lower and middle-income countries (LMICs). While they specifically focus on the impact in LMICs, they do also provide an overview of the economic impacts across the world and evidenced that mental disorders impact people experiencing poverty disproportionately. Firstly they are themselves a high-risk factor for the initial descent into poverty and by reducing people's ability to work they compound their impact on productivity and earning opportunities. Thus on a contextual level untreated mental illnesses can act as a brake on developing human capital more generally (Funk, Drew, and Knapp 2012, 172).

Moreover, on aggregate the costs of poor mental health are significant at a societal level. In a study cited by the abovementioned literature review, Sobocki et al. (2006) estimated that in a study encompassing twenty eight European countries, depression alone cost €118bn yearly, of which only 36% related to direct treatment costs, with the other 64% representing '*lost employment, reduced productivity, and increased insurance and benefit payments*' (Funk, Drew, and Knapp 2012, 173). A similar study conducted by the King's Fund (McCrone 2008) found that the cost of mental health in the UK in 2007 was almost £49bn with £26bn of this relating to lost earnings.

The above analysis indicates that breaking the feedback loop between poverty and mental illness is a crucial leverage point in achieving inclusive growth. Looking firstly at negative impacts, the 'Failure Demand' report recently produced by the Wellbeing Alliance (Chrysopoulou, Anielski, and Weatherhead 2021) found links between inadequate housing conditions, precarious employment (and unemployment) and a degradation of mental health. Another study looking at the association between income levels, social cohesion and mental health found a strong correlation between lower income and degraded mental health in Caerphilly County Borough in Wales (Fone et al. 2007). In contrast, they found that higher levels of social cohesion significantly reduced the correlation between poverty and poor mental health.

Other studies have investigated the links from the perspective of driving improvements in health. For example, a meta-study analysing the social determinants of mental health and the impact of policy interventions to alleviate its associated problems (Alegría et al. 2018) found strong evidence of links between social determinants (i.e. living conditions, improper heating, employment status, etc) and health welfare.

The study also identified positive correlations between interventions in infrastructure areas such as housing provisions for the homeless and improved levels of mental illnesses, together with urban green spaces reducing depressive symptoms amongst pregnant women.

Education

Skill attainment and the overall outcomes of education are difficult to measure and are based on a number of normative assumptions[5]. However, aggregate levels of literacy, numeracy and basic critical thinking have been assessed more robustly. For example, through the OECD's PISA programme where second-order outcomes are usually captured by measuring levels of intellectual outputs, such as patents and trademarks.

A 2005 theoretical modelling study (F. K. Rioja 2005) compared the returns on investment between spending on public capital (i.e. physical infrastructure) or education. The model was calibrated to data corresponding to the economies of seven Latin American countries, which makes the applicability of the results to other countries limited. The study found that increasing spending on education boosted growth rates more than investing in physical infrastructure. Similarly, shifting spending from infrastructure to education (up to 3-4% of GDP) increased the growth rates of those economies. Although we have not found similar models relating to developed economies, evidence from Spain has been collected and analysed which shows that regional variations in both infrastructure stock and educational attainment mean that differentiated levels of investment in the two sectors are required for optimal growth and regional convergence (Esteller and Solé 2005). A similar study found that infrastructure investment had not helped to reduce regional inequalities *because* investment was not prioritised towards the regions most in need of upgraded investment (de la Fuente et al. 1995).

A more recent study analysing Poland (Wójcik 2021) analysed the link between educational attainment and income levels at a local and regional level and found that the patterns of convergence were different. The research highlighted that additional causal mechanisms, such as the migration of more educated workers towards more competitive regions and cities were reinforcing regional inequalities. The study concluded that creating opportunities for success amongst those with a higher level of education in their local regions is an additional requirement for the gains in education to be realised in regional growth outcomes.

[5] The ONS uses measures of educational attainment and more recently has introduced measures of at-school bullying to measure educational quality in its public service productivity measures. (Office for National Statistics 2021a)

Child care

The provision of good quality child care is essential for the solid development of future human capital. This in turn drives future economic growth through increased productivity and innovation. Delivering early stage childcare has been shown to have long-term effects not just via the future workplace, but also as a function of reducing failure demand. For example, a recent IFS study found that the since-discontinued UK's Sure Start education initiative (designed to improve early-year care in children under the age of 4) reduced hospitalisation rates amongst 10-11 year old children by 30% (Rosie Stock Jones 2020).

The issue of providing good quality and accessible child-care infrastructure is a gender inequality issue as well. Even though the U.K. is doing better than most in terms of gender equality, British women spend on average twice as much time doing unpaid child-care work compared to men and three times as much on adult care (OECD 2021a). According to ONS data, unemployed adults who are seeking work respond differently to survey questions depending on their gender with more than 33% of women responding that they cannot find work because of home or family caring duties, compared to only 10% of men (Office for National Statistics 2022). This disparity limits the effective earning potential of women compared to men and this was clearly manifested during the acute stages of the COVID-19 pandemic. For example, a recent IMF blog post (Kristalina Georgieva et al. 2021) highlights that during the lockdown caused by the COVID-19 pandemic, employment amongst mothers of young children fell by over 7%, whereas employment of men in the same situation was reduced by less than 2%.

E. Natural/Environmental Infrastructure

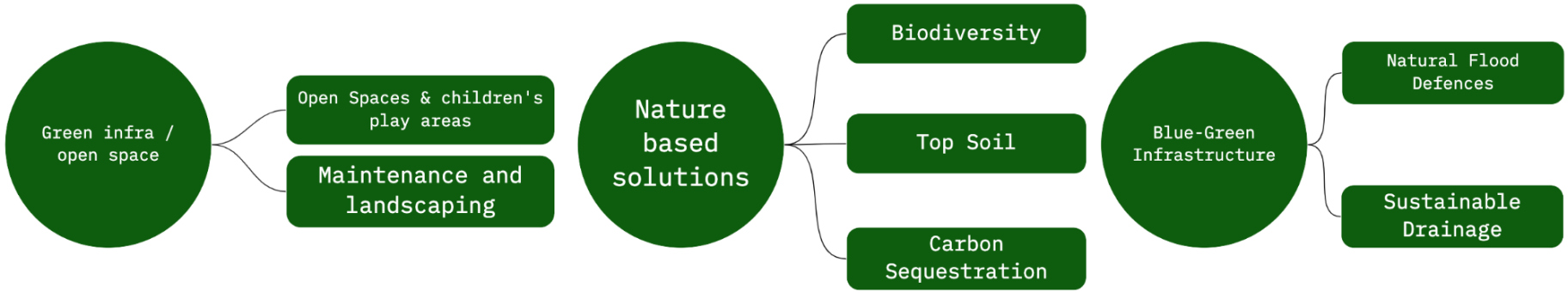


Figure 5. Environmental infrastructure emerging taxonomy

The Scottish Government's recent decision to include natural infrastructure in their definition of infrastructure is progressive and in line with our understanding of an emerging consensus. One of the main criticisms that has been levied against traditional economic measures like GDP (and national accounting more generally) is that they do not account for the benefits of natural capital unless they produce a market transaction or can be viewed as government investment. For example, woodland is economically valuable when it is turned into timber but not as a result of its carbon capture properties[6]. This incumbent reality necessitates a change in focus to look at indirect causal links between natural capital investments and improvements in well-being, as opposed to traditional economic growth. We have therefore selected two examples below (health improvements and energy efficiency) which illustrate how indirect pathways can be linked to achieving inclusive growth goals.

Health improvements

A recent literature review (McKinney and VerBerkmoes 2020) analysed 42 studies searching for links between Natural Green Infrastructure ('*areas of vegetation that are generally unmanaged or, more often, receive some low-cost sporadic management such as debris removal or*

[6] That being said, the ONS and other statistical bodies around the world have started publishing experimental statistical tables describing natural capital which include services such as carbon sequestration and urban cooling (Office for National Statistics 2021b)

invasive plant removal' (McKinney and VerBerkmoes 2020, 36)) and beneficial effects on health. The papers in the review all found beneficial impacts on various aspects of health and social well-being (including mental health, crime reduction, obesity and well-being), either through objective data measurement or self-reported responses.

A related literature review by Suppakittpaisarn et al. (2017) looked both at the links between health outcomes and green infrastructure including the specific asset class of green stormwater infrastructure (GSI), which relates to natural solutions used specifically to store and mitigate stormwater runoff (e.g. bioswales and green roofs). The literature review relating to green infrastructure more generally studied 55 papers and found benefits relating to diverse aspects of health. Improvements were found in mortality rate, cardiovascular health, cortisol levels (indicators of stress), pregnancy and birth outcomes, respiratory diseases and allergies, as well as various aspects of mental health and crime reduction and pro-social behaviours. However, the review did not establish a specific link between GSI and health outcomes.

Energy Efficiency

A 2017 study (Giometto et al. 2017) investigated the effect of urban forests on wind flows and the associated impact on energy usage. The authors found through simulations and collected empirical data that removing all the trees can double the wind speed in an urban setting, leading to increased risks during wind storms. They also found that wind pressure can account for up to a third of a building's energy consumption and that removing trees around a building increased its consumption by 10% in winter and 15% during summer.

An older study (Akbari 2002) similarly estimated the impact that the shade provided by trees has on energy consumption for cooling and heating purposes in various US cities. It estimated that a tree planted in Los Angeles would have the same effect on reducing carbon emissions as 4-5 trees planted in a forest, as a result of avoided emissions made possible by improved energy efficiency and absorbed solar energy. The scale of the savings were estimated to equate to one tree avoiding up to 18kg of carbon annually and producing savings of up to 200$/year. The study's findings were spatially limited to specific US cities and the energy mix and efficiencies of air conditioning and heating systems available at that time. However, a more recent study found that a Plane tree in London can reduce a building's summertime energy use by up to 31% over a hundred years (Donovan and Butry 2009) and there is a growing evidence base of similar findings.

2.2.2 Infrastructure investment versus maintenance

Most of the studies included in the FoA literature review attempted to link capital expenditure to increasing the capital stock of infrastructure, but were not designed to look at the impact of expenditure on **maintaining** the existing public capital stock. In contrast, a study on the value of infrastructure by Rioja (2013) found that '*estimated rates of return for maintenance are high*' and that there is an optimal level of

maintenance expenditure beyond which investment in new infrastructure starts lagging. The importance of maintenance is recognized in the IIP's Annex B (Scottish Government 2021a, 47) and is also reflected in the Scottish Government Investment Hierarchy, which prioritises '*maximising the useful life of existing assets*' as opposed to '*replacing, creating or building new assets*' (2021a, 9).

A study by Gibson and Rioja (2017) simulated the effects of three different models of infrastructure spending in Mexico. The first strategy maximised investment in new infrastructure, the second divided the budget equally between new infrastructure investment and maintenance and the third directed the entire budget to maintenance spend. The study then tracked the effects of these strategies on both productivity outputs and on levels of inequality. The authors found that the '*all maintenance*' strategy was the most effective at reducing inequality, whereas the strategy of spending equal amounts on investment and maintenance optimised productive output. The authors concluded that a strategy that pursues solely new investment fails both at increasing economic growth and reducing inequality. It must be noted however, that these findings were calibrated to Mexico's existing infrastructure stock and have not yet been corroborated more widely.

In addition to the above cited studies, we would emphasise that reducing the maintenance cost of infrastructure must logically be seen as a key enabling factor in terms of maximising limited resources. Furthermore, as one the key benefits of nature-based solutions are their lower maintenance costs. For example, this was illustrated by a study looking at the difference in cost between traditional and sustainable drainage systems which found that the green solutions were more cost efficient (Duffy et al. (2008)). This observation gives further weight to a diverse taxonomy of infrastructure if inclusive growth targets are to be realised.

2.3. Q2: From an international perspective, what is the emerging evidence base for the positive and negative impacts of infrastructure on inclusive growth?

The research outlined in section 2.2 demonstrates that a wider definition of infrastructure is being adopted internationally. Logically, this conceptual expansion also necessitates a wider view to be taken of the scope of potential impacts (both positive and negative) on inclusive growth. For example, both environmental and social infrastructure were shown to have substantiated impacts on health, which itself is a key indicator of both wellbeing and prosperity.

To further illustrate the breadth and diversity of these impacts we have therefore selected a small selection of illustrative examples and case studies which are presented below under the following categories:

1. Place based examples

2. Broad context examples

2.3.1 Placed-based examples

China

Xun and Guanghua (2017) have studied the impact that infrastructure investment in rural China has had on both growth and distributional effects. The study looked at landline telephone and tap water as types of rural infrastructure and found that these types of infrastructure have a strong impact on growth in rural areas, which were severely economically depressed in comparison to urban areas. Additionally they found that these infrastructures had a significant impact in reducing inequality but that individuals with higher levels of education and experience gained more from the presence of rural infrastructure: They concluded that '*from the view of income distribution, infrastructure provides more opportunities for educated and experienced individuals to earn higher incomes*.' (Xun and Guanghua 2017, 107) which highlights the need to complement infrastructural investments with investments in skills.

In an earlier study, Ansar et al. (2016) investigated the economic growth impact of transport infrastructure in aggregate across China, investigating 95 projects, totalling investments of ~$65 bn (2015 equivalent). They found that past the short-term growth caused by the increase in demand that infrastructure construction spurs, an over-investment in infrastructure can '[fuel] *economic growth today by excessive capital accumulation, policy-makers risk suffocating the possibility of steadier and more resilient future economic growth that comes from greater efficiency and productivity of using scarce factors of production*.' (Ansar et al. 2016, 378). The study focuses on the unsustainable amount of both public and private debt that has been accrued in constructing infrastructure (282 % of GDP at the time of the article) as a significant risk factor for future growth. The recent credit crises (Sun Yu and Tom Mitchell 2022) of some of China's largest private or partly state-owned housing companies seems to validate some of the concerns the study brought up. The study also investigates the poor performance (in terms of usage) and cost overruns of projects as further detractors from future growth.

The study acknowledges the risk that future maintenance costs can negatively impact on growth, but did not consider those costs to be the main determinant of future economic performance. More importantly, the authors disregarded the idea that measuring spillover benefits of transport networks would fundamentally change the conclusions of the Benefit-Cost Ratio (BCR) calculations that formed the basis of their findings: 'Benefits, such as value of time savings or increased land values, do not come about unless the forecast traffic volumes materialize. Actual traffic is thus the most concrete and fool-proof gauge of the actual benefits of a transport project. If the basic traffic does not

materialize, the rest of the benefits are also unlikely to emerge' (Ansar et al. 2016, 378). It should also be noted that the study does not take into account distributional effects whatsoever.

South Africa

A Master's Degree thesis (Gnade 2015) from the University of Johannesburg set out to determine the impact of investment in both basic (physical) and social infrastructure in South Africa, differentiating between investments in rural and urban areas. The author concluded that investments in basic and social infrastructure contribute positively both economically (measured by GDP per capita [GDPpc], poverty rates and household income) and developmentally (measured by the Human Development Index and the percentage of people in extreme poverty). The thesis concluded that social infrastructure investments have a stronger economic effect than basic infrastructure investment, and that investments in rural areas tend to yield more significant improvements both in terms of economic growth and social benefits. This research provides evidence that infrastructure investment does play a role in inclusive growth and development in the context of developing countries such as South Africa.

2.3.2. Broad context examples

Preventative health spending

In the UK, preventative health has been treated as a revenue cost rather than as a capital investment but the Health and Care Bill (which will put Integrated Care Systems on a statutory footing from July 2022) is driving a shift in this approach. The arguments for this shift are multifaceted and whilst there is a focus on Return on Investment [ROI] justifications[7] there is also a growing awareness of the reciprocal spillover effects associated with preventative health (WHO 2020). For example, a report from the World Health Organisation on public health investment emphasised the integrated societal benefits of preventative spending highlighting a fourfold return to the wider economy for every dollar invested. A wide range of auxiliary benefits were examined with improvements being evidenced in areas such as violence reduction, road traffic accident rates and unemployment levels. Conversely, looking from the perspective of initiatives outside of the traditional health workflow, there is a growing body of evidence demonstrating positive health effects from investments that do not themselves have preventative healthcare as the primary objective.

[7] The Marmot Review (2010) on health inequality for example leads with figures on lost productivity and taxes due to health inequality and lack of preventative health spending, before describing societal impacts.

An interesting illustration of the concept of positive unintended consequences can be seen in the aforementioned study by the IFS which found that the UK's Sure Start initiative reduced hospitalisation rates amongst 10-11 year old children by 30% (Rosie Stock Jones 2020). Similarly, as previously discussed in the Natural/Environmental Infrastructure section, urban natural resources have a very strong impact on both mental and cardiovascular health. But due to accounting conventions, even when the benefits for health outcomes further down the line of the cohort impacted by an intervention are proven, these investments are not counted towards preventative health spending (as per (OECD, Eurostat, and World Health Organization 2017)). This points to a need to move beyond systems where only primary expected outcomes are used to determine spending (for further context please see New perspectives for appraisal and evaluation section.)

Urban development

In a previous study, DML investigated the impacts of the much applauded public investment into the High Line park in Manhattan[8]. The research highlighted that whilst the initiative had significantly increased the mean property values in the area (the park cost $187m to build and contributed to an additional increase of $3.4bn for nearby properties) the returns to the government in property taxes were limited, with the lion's share of the increase in wealth accruing to private landowners. This outcome, whilst clearly unintentional, epitomises the issue highlighted by Marianna Mazzucato of public investments being hijacked as a mechanism for socialising the risks of innovation whilst privatising the rewards. (Mazzucato 2018) A similar issue was identified by a study that looked at the urban development that occurred in East London as a result of the 2012 Olympic Games being held in the area (Watt 2013). The analysis highlighted that the city's desired outcome of creating improved social and economic conditions in the area did not correspond to the lived experience of those who were displaced by infrastructure development. This is a conclusion echoed by a study undertaken by the *What Works Well Centre for Local Economic Growth* into Estate Regeneration spanning a sample of OECD countries. They found that whilst the economic performance of purposefully regenerated areas improves considerably, this does not apply to all demographics; for example if higher income groups move in as a result of the initiative and lower income groups are forced to move out, then this will indirectly drive up the average area income level. They concluded that *'disentangling these effects on area averages from impacts on particular individuals or groups in an area is a major challenge for evaluation of these projects'* (What Works Well 2015). These studies demonstrate that if the aspiration of an investment programme is to achieve inclusive growth then there is a clear need to consider broader societal impacts, even if the initial links between a given investment and economic growth overall appear attractive.

[8] https://provocations.darkmatterlabs.org/a-smart-commons-528f4e53cec2

2.3.3. Linking a wider understanding of infrastructure to metrics and indicators

Indicators are by their very definition a simplification of the reality that they seek to describe, and are often limited by the level of reliable data that is available. Even then, what can be reliably measured is not always useful, or an accurate representation of reality. This conundrum has plagued studies looking at the economic impact of infrastructure for decades. A review article by Gramlich (1994) acknowledges a broader definition of infrastructure but notes that most studies limit themselves to a simplified metric because of difficulties in measurement (emphasis ours):

> *'There are many possible definitions of infrastructure capital. The definition that makes the most sense from an economics standpoint consists of* ***large capital intensive natural monopolies*** *such as highways, other transportation facilities, water and sewer lines, and communications systems. [...]* ***Broader versions include successively human capital investment and/or research and development capital.*** *Most econometric studies of the infrastructure problem have used the narrow public sector ownership version of infrastructure capital as their independent variable. This is in large part because it is very hard to measure anything else. [...] even if good measures were available, it would be difficult to distinguish private infrastructure capital from other private capital.* ***It is difficult to distinguish human investment spending for health and education from consumption spending.****'* (Gramlich, 1994, p. 1177)

3. New perspectives for appraisal and evaluation

Figure 6. ROAMEF Model Source: (gov.scot 2018)

3.1. Introduction

There are numerous and compelling arguments being made by prominent economists such as Mariana Mazzucato and Mark Carney, formerly Chief Economist at the Bank of England, about the concept of performativity in relation to economic metrics. What we measure clearly matters; both in terms of economic value perception and our prevailing collective societal values. Measurements, however cold and scientific in their construction, are far from neutral in their impact on our values and consequently our behaviour. (Carney 2020; 2021; Mazzucato 2018). If we accept this reciprocal relationship between measurements and behaviour then we must also consider the performative power of frameworks and the outcomes that they aim to achieve.

The diagram below depicts this relationship and illustrates that SFT will need to focus on connecting the two sides of the process for the IIP roadmap to have a tangible impact. In practical terms this means understanding how any chosen evaluation metrics can be clearly linked to appraisal techniques at an early stage in the project.

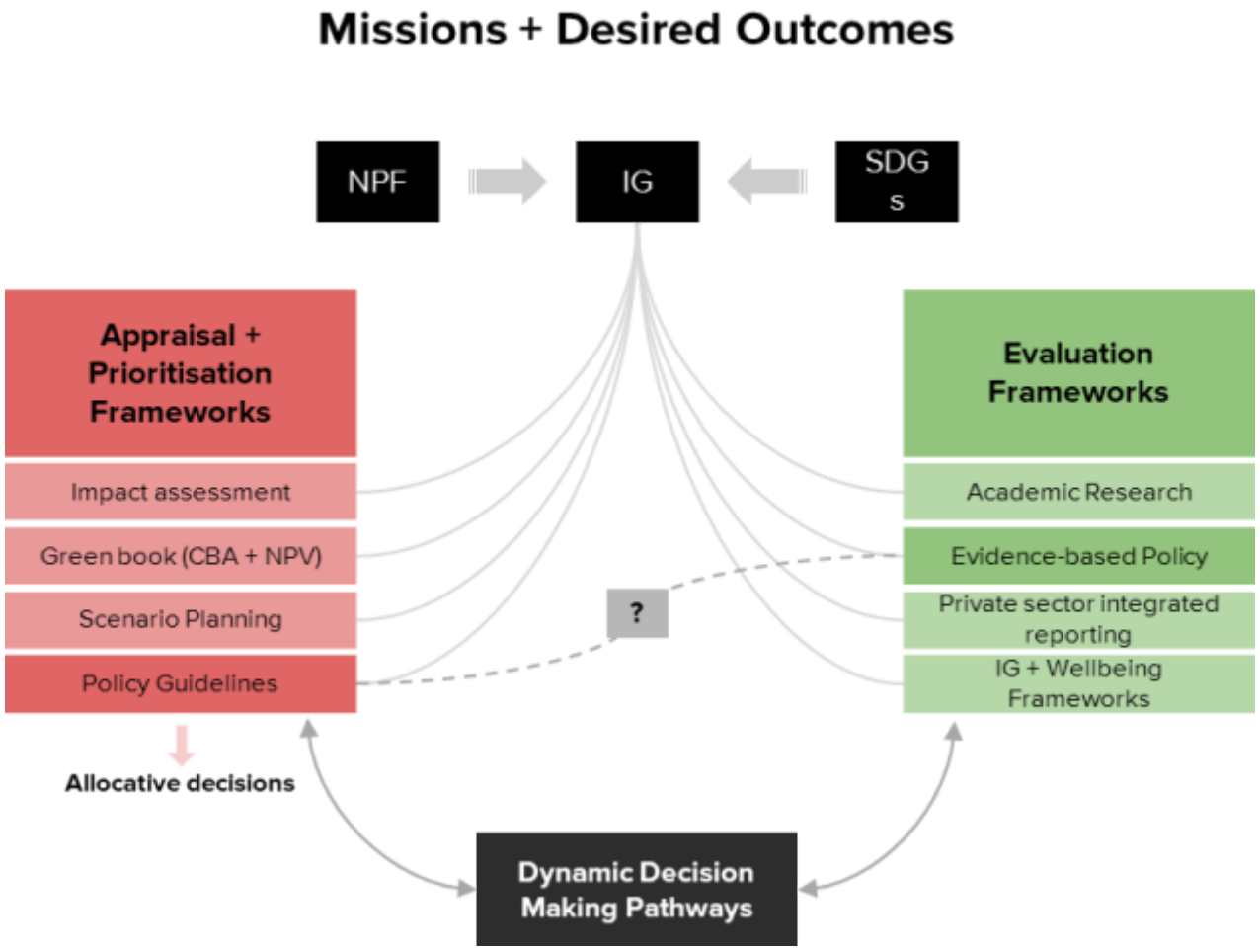


Figure 7. Relationships between evaluation and appraisal frameworks. Source: author elaboration

In order to investigate this relationship in the context of international best practice we can think about the process as being divided into three strands:

1. How are different countries evaluating impacts and outcomes?
2. How are other countries appraising and therefore prioritising projects?
3. How is the evidence base from (1) being meaningfully connected back to the appraisal stage (2)?

To begin exploring these questions (with a specific focus on the practical implications for Scotland's IPP Framework) we have therefore responded to the following four prompts:

1. How is the way that we understand and measure value in the economy changing? How is that being evidenced in IG frameworks internationally?
2. What can Scotland learn from 'best practice' infrastructure appraisal frameworks in the UK and internationally?
3. How can we evaluate the systemic health of the economy (as opposed to individual sectors or policy areas)?
4. How can we shift practitioner thinking to consider dynamic rather than utilitarian (allocative) prioritisation frameworks and emerging rather than static systems?

3.2. Q3: How is the way that we understand and measure value in the economy changing? How is that being evidenced in inclusive growth frameworks internationally?

> *'Without adequate buffer stocks, whether that is proximity to clean air and green space for all, or sufficient investment in skills that people can adapt, or communities where neighbours want to help others, there is no resilience'. Professor Diane Coyle (Bennett Institute for Public Policy 2020)*

In recent years, there has been an explosion in beyond GDP initiatives and the emergence of wellbeing frameworks in geographical regions across the globe. From Estonia's 'Tree of Truth' to the 'WEAll Global Alliance' these frameworks and movements have comprehensively

explored and campaigned for the economy to be more holistically evaluated. Scotland's *National Performance Framework* was one of the first wellbeing frameworks to be given a statutory footing and is rightly held up by others as a robust example of progressive policy making. However, despite this positive and growing impetus, there remains a lack of cohesion and agreement on how to link wellbeing outcomes to decision making in practical terms.

To begin unpicking this relationship at a granular level, we conducted a comparative analysis of a selection of international wellbeing frameworks to examine their selected methodologies, metrics and rationale for inclusion. The following frameworks were selected to reflect a diverse range of audiences, geographies and governance structures:

- New Zealand's living standards framework
- The ANDI (Australian National Development Index)
- Canada's Wellbeing Index.
- The OECD's Wellbeing Framework
- The United Nations SEEA (System of Economic and Environmental Accounting)
- The International Integrated Reporting Framework.

The outcomes from this analysis are presented below in three parts:

1. A brief description of the four frameworks that were judged as having the most practical applications for Scotland.
2. A detailed comparative table drawing out the main themes and areas of contrast.
3. The key identified implications for Scotland, with a focus on applications for infrastructure prioritisation.

3.2.1 Overview of national and international frameworks

There are numerous existing examples of metrics/frameworks both within the UK and in the international context (for example, in the IIP Consultation there were more than fifty frameworks suggested for the SG to look at (APS Group Scotland 2021)). Thus, before we examine some of the positives that can be drawn from these comparatives, it must be emphasised that there remains a substantial gap between framework goals and actual policies on the ground. In our view, the following key questions should therefore be held as open provocations whilst considering the merits of the emerging frameworks:

a) What has prevented a meaningful uptake of existing 'beyond GDP' frameworks? Where is the block in **knowledge mobilisation**?
b) How can we avoid **arbitrariness**? What is the justification and/or rationale for including one metric over another?
c) How can we capture value over different **time frames**?

d) How can we make the link between framework ideas and policy decisions visually coherent and user-pragmatic for a **broad audience**?
e) How do we link this work to **private sector** frameworks and reporting requirements e.g. IFRS Sustainability Standards global baseline?
f) What is an appropriate **narrative** for public engagement? For example, does a 'prosperity compass' signalling direction of travel feel more intuitive than a dashboard of indicators measuring specific metrics?

Australia's National Development Index

The ANDI is still in the process of being implemented and a prototype is currently being tested at the state level. The developers of the ANDI spent two years testing the first two domains (education and heath) to develop a prototype for the wider index. The design is closely aligned with a number of established wellbeing frameworks (e.g. from the OECD and Canada) and is currently being tested in the state of Western Australia. The proposed framework is a combined dashboard and index system which was developed by asking citizens to prioritise the goals and then applying weighting to reflect their perceived importance.

Figure 8. Australia's National Development Index Overview Source: (ANDI 2020)

Although the ANDI's final metrics and indicators have yet to be determined, the framework design has interesting implications for Scotland as its developers have had the benefit of critically analysing existing wellbeing frameworks (including Scotland's NPF) to inform their ideas of best practice. The key elements of best practice that the developers identified are as follows (Stanley and Salvaris 2019):

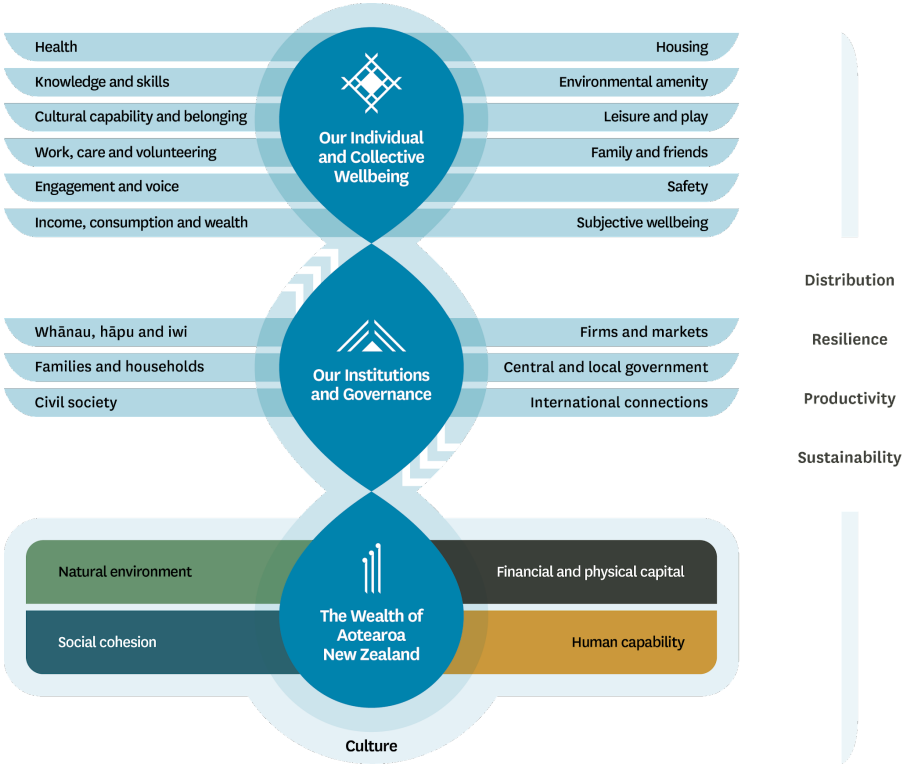
- Includes both current and capital indicators;
- Includes both subjective and objective measurements of wellbeing;
- Measures progress against clear targets rather than using historical or regional comparatives;
- Tracks base qualities such as equity and sustainability across the output domains such as health, housing and safety;
- Presented in a format that is both accessible and attractive to a wide variety of users;
- Suitable for multiple policy uses at both the local and national level;
- Built into and across all areas of Government e.g. planning, budgets, evaluation, community engagement and legislation;
- Used and trusted in the community as a vision for what citizens want.

Key takeaway: The ANDI clearly lays out the international consensus for best practice regarding wellbeing evaluation. Despite this however, Australia is regarded as one of the most extractive and resource intensive countries in the world (OECD 2021b). In our view, strong evaluation frameworks such as the ANDI will remain futile if the metrics that they present are not connected to meaningful decision making at the policy level.

New Zealand's Living Standards Framework

At a nation state level, New Zealand has pioneered the idea of explicitly linking and measuring the intergenerational stocks (capitals) that sustain the surface measures of wellbeing (e.g. health and education). The LSF is a conceptual framework which has been designed by the Treasury of New Zealand to improve the quality of their policy advice, for example in relation to the preparation of the Wellbeing Budget. The framework is supported by an LSF Dashboard but the two elements are viewed as discrete initiatives with different purposes. The LSF Framework is a flexible policy tool designed to provide a broad perspective to decision making, whereas the dashboard is one of many tools that the treasury uses to achieve the framework's aims. The Framework consists of three levels (individual and collective wellbeing, institutions and governance and the wealth of New Zealand) and four cross-level analytical prompts for policy impact evaluation (distribution, resilience, productivity and sustainability). (N. Z. Treasury 2021b; N. Treasury 2021)

The Living Standards Framework (N. Treasury 2021)



Example multidimensional wellbeing indicator from the LSF Dashboard (N. Z. Treasury 2022)

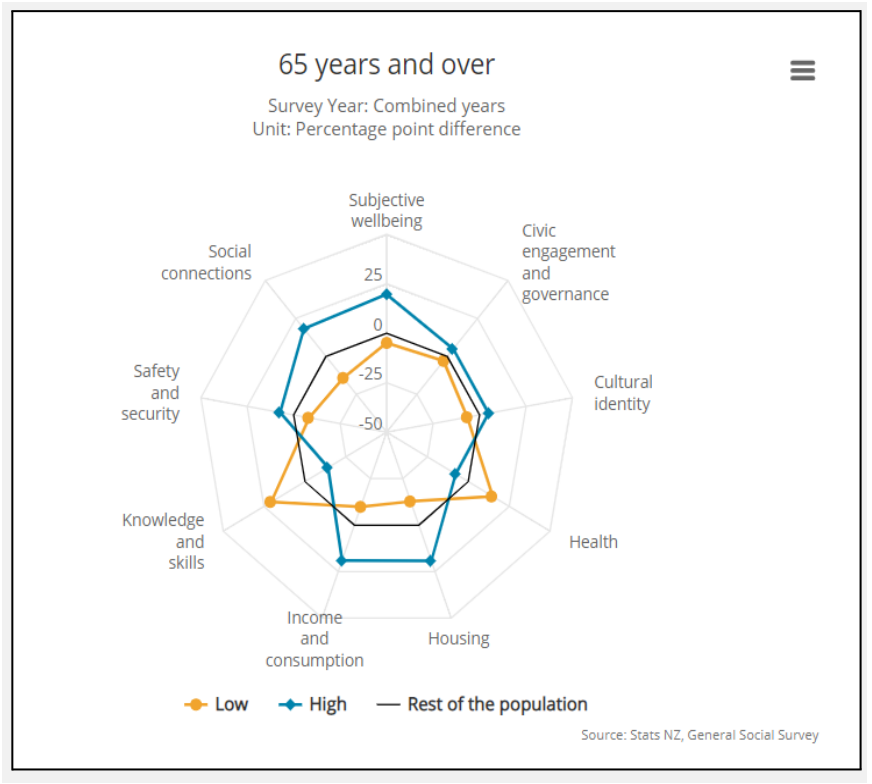


Table 1. New Zealand's Living Standards Framework and example Dashboard

The poster below summarises the key themes from the revised 2021 LSF (N. Z. Treasury 2021a)

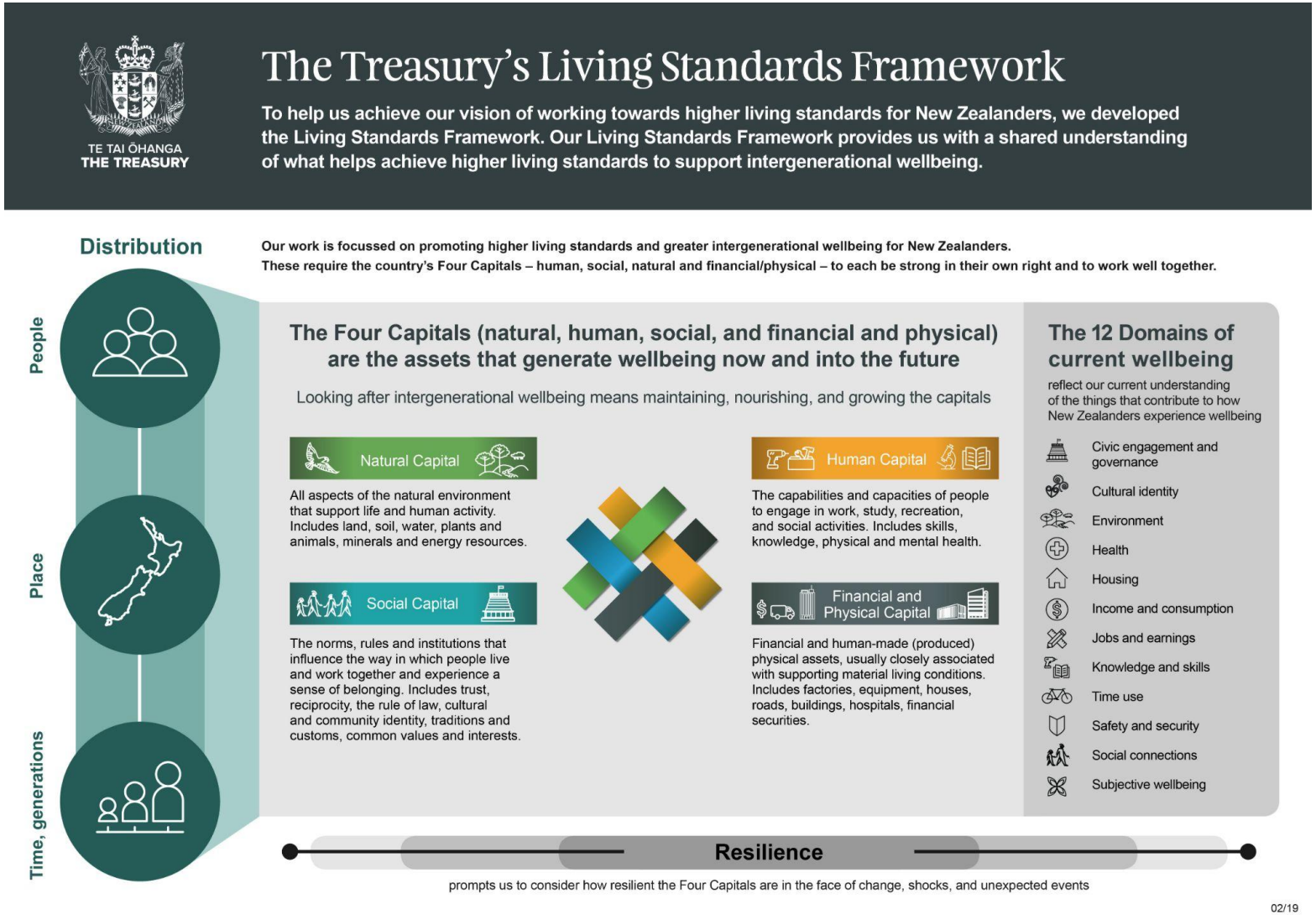
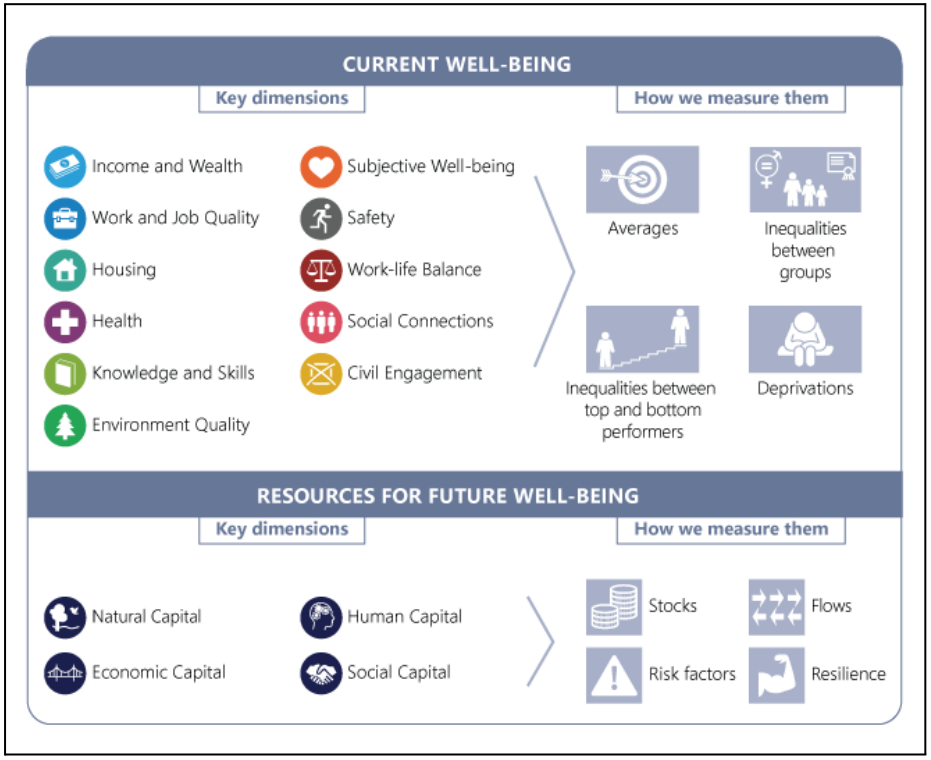


Figure 10. New Zealand's Living Standards Framework

The 2021 version of the LSF has been built conceptually on the OECD Wellbeing Framework, by focusing on the underlying wealth (4 capitals) of a country as being critical indicators for current and future wellbeing. This is illustrated by the inclusion in the updated LSF of new wealth indicators which are shown in the table below.

The OECD Wellbeing Framework ('Measuring Well-Being and Progress: Well-Being Research - OECD' 2021)



New Zealand's proposed wealth indicators (N. Z. Treasury 2021b)	
Resource / capability	Indicators
Natural environment	Biodiversity and genetic resources
	Climate regulation
	Drinking water
	Net greenhouse gas emissions
	Renewable energy
	Sustainable food production
	Waste management
Human capability	Cognitive skills at age 15
	Educational attainment of the adult population (upper secondary)
	Life expectancy at birth
	Non-communicable diseases
Social cohesion	Trust held in others
	Discrimination
Financial / physical capital	Total net fixed and intangible assets
	Gross fixed capital formation
	Net international investment position
	CPI inflation
	Investment in R+D

Table 2. Comparison between the OECD Wellbeing Framework and New Zealand's Wealth Indicators

Key takeaway: The LSF clearly depicts the rationale for focusing on wealth/capability indicators by framing them as the foundations of future prosperity. However, despite this conceptual focus on building deep societal capabilities, New Zealand's Government is still struggling to

deliver in critical areas such as housing inequality. For example, New Zealand's average house price to median income ratio is the sixth highest in the world (*The Economist* 2022) and disabled people have been found to have poorer outcomes across a range of wellbeing indicators (Murray and Loveless 2021). This is a strong reminder that whilst developing theoretically sound and progressive frameworks and evaluation tools is proving eminently possible, connecting them to integrated decision making in a complex environment remains elusive.

The SEEA (System of Environmental Economic Accounting)

> *"The adoption of this economic and environmental framework is a historic step towards transforming the way we view and value nature. No longer will we allow mindless environmental destruction to be considered as economic progress."* - António Guterres, Secretary General of the United Nations

The SEEA is a GDP adjusted framework which is aligned to the System of National Accounts. It was formally adopted by the United Nations Statistical Division in 2021 and has already been implemented in over 90 countries (e.g. the UK's Environmental Accounts, 2021). The framework has been described by its developers as being a story of accounting; a rich narrative that explains the relationship between the economy and the environment that will enable informed decisions about the future to be made. (Natural Capital Ireland 2021)

Although the SEEA might seem slightly abstract and distant from the themes of infrastructure investment and inclusive growth, its design and ongoing global implementation is strongly linked to the concept of economic stocks and flows, so clearly depicted in the OECD and NZ Living Standards Frameworks outlined above. Using wealth-based measures of prosperity to illustrate a nation's socioeconomic health is critical because as summised by the economist Diane Coyle they '*demonstrate that economic progress today is illusory when it comes at the expense of future living standards*'. (Coyle 2021)

The SEEA does not recommend a specific set of indicators and has instead been designed as a flexible framework that organises data relating to economic activity and environmental stocks and flows. One of its overarching goals is to promote a level of conceptual clarity around complex themes to enable salient decision making. The framework is clearly signposted and linked to wider societal goals such as the UN SDGs (supporting 9 goals via 40 indicators) and the Aichi Biodiversity targets. Of particular interest for SFT is that three of the SGD Goals which have been placed in the inclusive growth segment of the IIP indicator dashboard are considered to be of particular relevance to outputs that the SEEA framework can support: SDG 1 - No poverty, SDG 2 - Zero hunger and SGD -9 Industry, Innovation & Infrastructure (with particular reference to targets 9.1 and 9.4: green infrastructure). The following diagram is taken from a SEEA working document analysing the linkages between the SEEA modules and existing global indicators and illustrates the relevance of the SEEA to measuring SDG progress. (SEEA 2019)

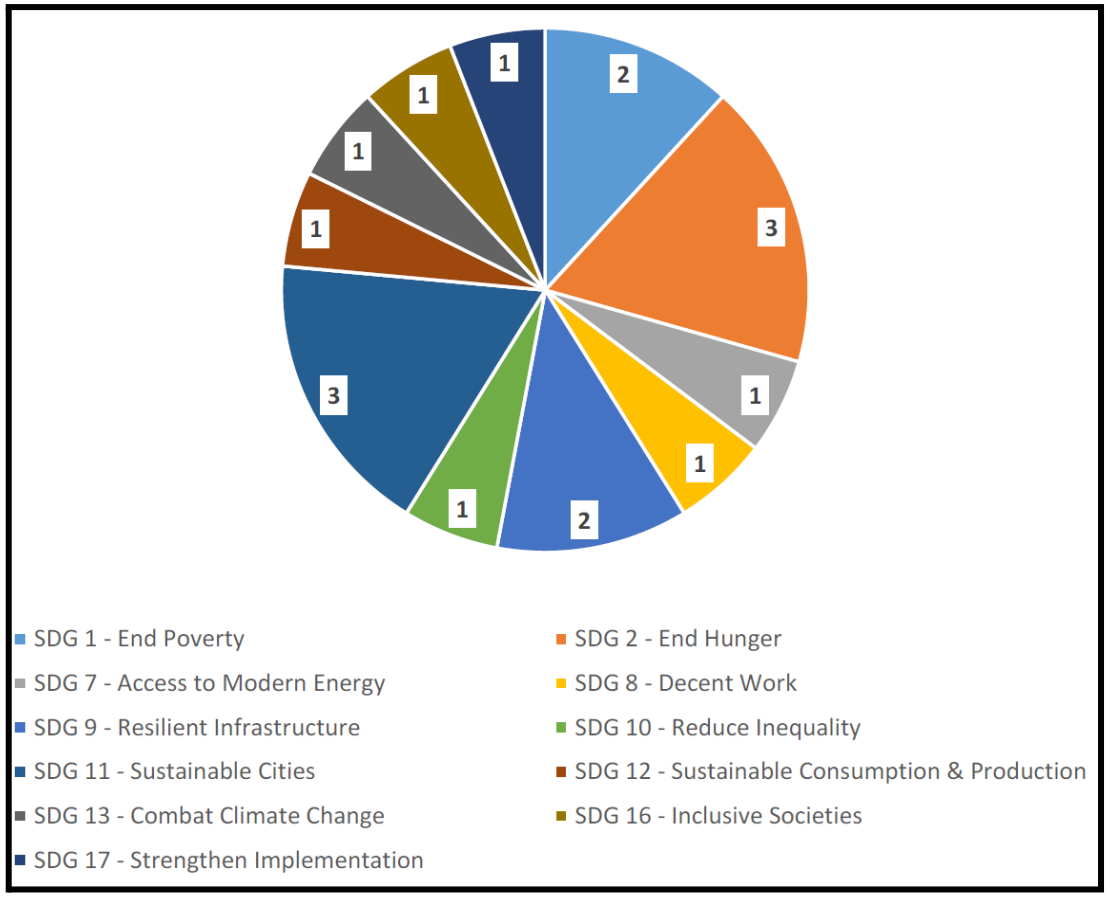


Figure 11. Mainstreaming Opportunities for the SEEA Source: (SEEA 2019)

Key takeaway: The SEEA's conceptual clarity and cross-framework signposting demonstrates that robust and accessible international data is becoming rapidly available for assessing a number of key SDG goals.

International Integrated Reporting Framework

The IIR Framework is a central tool being used to spearhead changes in the international financial reporting sector, as part of a global initiative led by the IFRS (International Financial Reporting Standards) Foundation. The framework is principle-based and helps organisations to both understand and communicate how value is created, eroded and preserved as a result of their decisions.

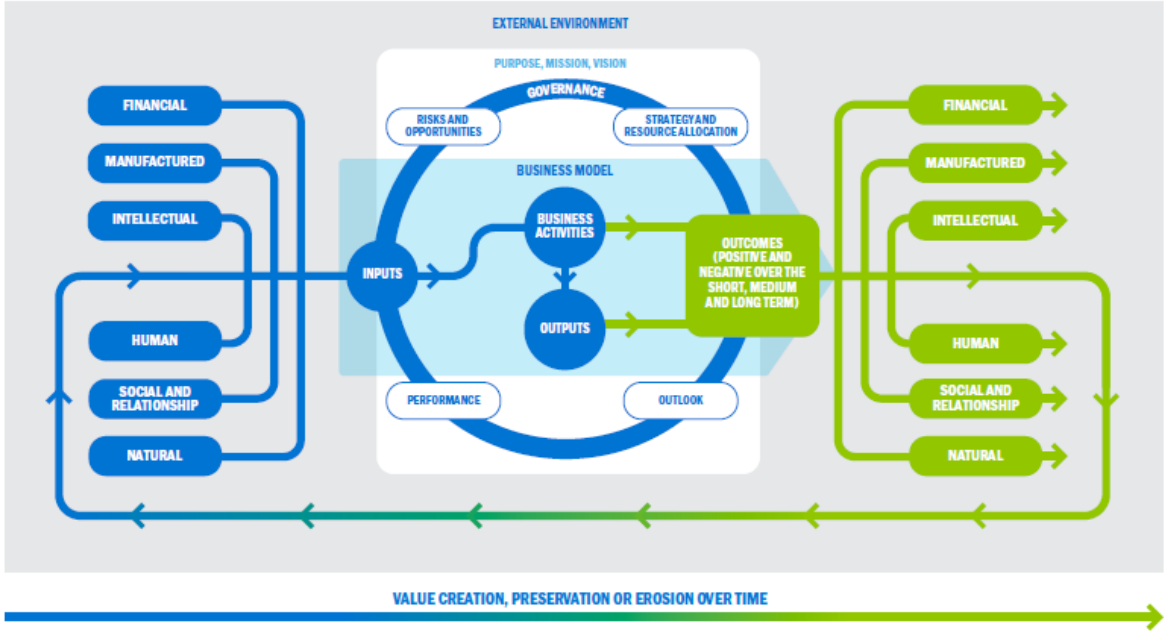


Figure 12. The Integrated Reporting Framework (IIRC 2021)

Whilst transparently promoting an investor (as opposed to wider stakeholder) focus for determining enterprise value, the framework nevertheless provides a valuable visualisation of how decision making in the private sector is evolving. This is important because the Scottish IIP specifically references how critical it is to align their public investment vision with plans to mobilise private investments. (Scottish Government 2021a, 47). There is therefore a strong case for using the developments in the private sector's sustainability and accounting regulations as a benchmark. Evolving the IIP framework in line and at pace with those initiatives has clear advantages in building network resilience and public trust. For example:

- Infrastructure contractors and other supply chain providers will rapidly need to transition towards using the International Sustainability Standards (announced by the IFRS at Cop26). If the Scottish Government's framework for its IIP fundamentally differs from this on a conceptual basis, then it will reduce both comparability and efficiency.
- The Scottish Government has the opportunity to lead by example in terms of behavioural change because what is happening in the public sector, both in terms of impact and accountability is pivotal to what transpires elsewhere. This has been evidenced in countries such as South Africa (via the King Report) who have more advanced public service reporting procedures compared to the UK. (PricewaterhouseCoopers 2022)

This sentiment has also been echoed in Scotland's new National Policy for Economic Transformation, with Kate Forbes stating that: '*ours must be a country in which the public, private and third sectors respect each other's strengths, draw on each other's talents and work together to create and sustain an economy that works for all'.* (Scottish Government 2022)

On a global scale, the private sector has also been rapidly evolving its risk assessment and decision making frameworks and processes. Initially this was predominantly in response to the climate emergency (via the Task Force for Climate Related Disclosures) but the approach is now broadening out to include wider social and environmental factors. An important theme from this work is how the concept of materiality is applied. Double or dynamic materiality assessments have now largely replaced linear financial materiality in terms of organisational decision making. This progression is summarised in the diagram below and provides a clear pathway to the dynamic efficiency of decision making which is discussed in section 3.5.

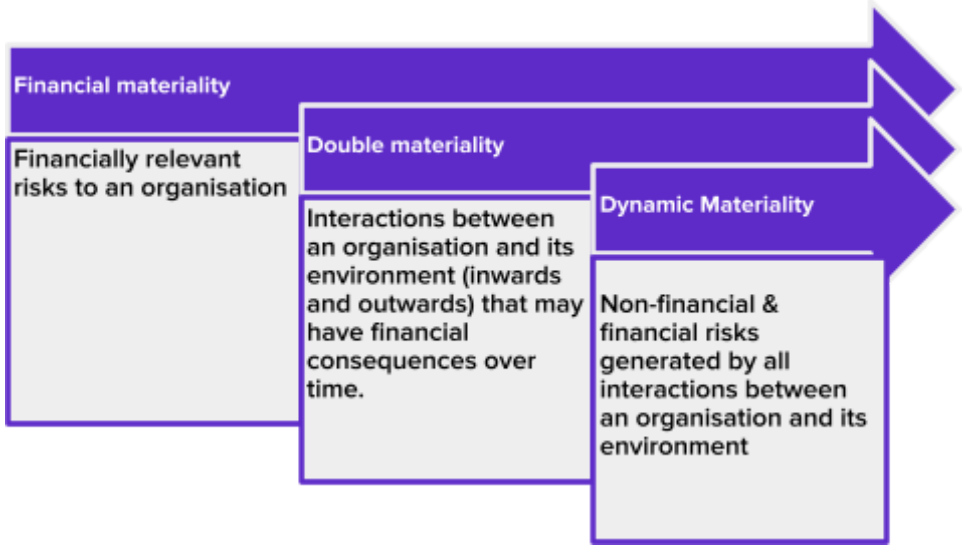


Figure 13. Relationship between Financial, Double and Dynamic Materialities Source: author elaboration

Key takeaway: Investment decision making pathways in the private sector are no longer static and linear. This presents opportunities for the Scottish Government to leverage this emerging knowledge base whilst concurrently building stronger relationships with the private sector.

3.2.2 Comparative analysis of six international wellbeing frameworks

Country	**Australia**[1,2]	**Canada**[3]	**New Zealand**[4]
Framework	ANDI (Australian National Development Index)	Canadian Index of Wellbeing	Living Standard Framework
Governance	Not-for-profit company housed by the University of Melbourne.	University of Waterloo	New Zealand Treasury
Design	12 domains of life which are each represented by 12 goals (144 goals in total). *NB: The framework is still in the prototype testing phase of development.*	8 domains of life are divided into a series of dimensions and sub-dimensions for measurement. Metrics are chosen at the sub-dimension level. For example: ● Domain = Community vitality; ● Dimension = social relationships; ● sub-dimension = social support; ● Indicator = % of population with 5 or more close friends.	LSF framework supported by the LSF dashboard. The framework has 3 levels: (1) Collective and individual wellbeing; (2) Governance and institutions; (3) The wealth of NZ. Dashboard indicators: ● 12 domains of current wellbeing (+ supplementary diversity analysis); ● Wealth stocks are represented by measures of the 4 capitals (human, social, natural, financial/physical).
Methodology	Combined index and dashboard system.	Combined index and dashboard system.	Dashboard

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Country	Australia[1,2]	Canada[3]	New Zealand[4]
Analytics	Assessed against benchmark targets. Citizen engagement to prioritise goals and output metrics weighted to reflect preferences.	Analysed against previous results.	Analyses trends over time with distributional differences (e.g. age, gender) and international comparatives where possible.
Weighting	Weighted	Mixed	Unweighted
Key domains of measurement	Children and youth wellbeing; community and regional life; culture, recreation and leisure; governance and democracy; economic life and prosperity; education, knowledge and creativity; environment and sustainability; justice, fairness and human rights; health; indigenous wellbeing; work and work-life balance; subjective wellbeing and life satisfaction.	Community vitality, democratic engagement, education, environment, healthy populations, leisure and culture, living standards and time use.	**Wellbeing domains**: Housing; health; knowledge and skills; cultural capability and belonging; family and friends; environmental amenity; engagement and voice; income consumption and wealth; work, care and volunteering; leisure and play; safety and subjective wellbeing. **Wealth domains:** natural environment, human capability, social cohesion, financial and physical capital. **Government and institutional domains**: families and households, Whānau, hapū and iwi, central and local government, firms and

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Country	Australia[1,2]	Canada[3]	New Zealand[4]
			markets, civil society, international connections.
Presentation	• Index and status report for overall progress and for individual domains; • A report focused on a single domain will be released each calendar month.	• The 64 indicators are consolidated into a single average result (the CIW composite Index); • More detail is presented in National and regional reports: How are Canadians really doing?	• Interactive online dashboard which analyses and presents data split between the themes of the country's wellbeing, its people and its future; • The LSF will inform the Treasury's new 4-yearly wellbeing report (first publication is due in 2022).
Rationale for inclusion	Community engagement with c.500,000 Australians.	Based on a systems change approach to identify the leverage points which will enable the maximum change.	• Indicators reflect where robust data is currently available with a focus on international comparatives and distributional analysis; • Designed to be a targeted rather than a comprehensive database of wellbeing indicators.
Highlights	• Considers the underlying capitals which sustain wellbeing;	• Seen as a framework to stimulate changes in how people think and act in relation to wellbeing;	• The framework is housed by the Treasury and used in the National budget preparation to assess spending against

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Country	Australia[1,2]	Canada[3]	New Zealand[4]
	• Measures subjective and objective wellbeing; • Community engagement focus.	• Results are reported at the national and regional level; • Strong continuous community engagement e.g. the CIW partnered with the Yukon to produce a profile of wellbeing for the state in 2021.	intergenerational wellbeing; • Acknowledges system complexity and provides an overview to be used in conjunction with other more detailed frameworks.
Key differences to NPF	Clear targets for each output are set illustrating a 'where we want to go' approach (rather than comparing to historical positions).	Released as a single number with strong visuals.	• Accessible interactive format with strong graphical visualisation of data; • The overall goal is sustainable, inclusive **prosperity** rather than growth.

Table 3. Comparative analysis of three national wellbeing frameworks

Organisation	IIRC (International Integrated Reporting Council)[8,9]	OECD[5,6]	United Nations[7]
Framework	Integrated Reporting Framework	OECD Wellbeing Framework	SEEA Framework (System of Environmental Economic Accounting)
Governance	Housed by the IFRS (International Financial Reporting Standards)	Intergovernmental economic organisation	United Nations Statistical Division

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Organisation	IIRC (International Integrated Reporting Council)[8][9]	OECD[5,6]	United Nations[7]
	Foundation		
Design	Reporting framework designed to evaluate an organisation's performance in the context of its commercial, social and environmental impacts.	• 11 dimensions of current wellbeing + 4 dimensions of future wellbeing; • Basis for the OECD Better Life Initiative which itself is an umbrella for a number of other initiatives e.g. the OECD Better Life Index.	• Integrates economic and environmental data to illustrate the interrelationships between the two; • Divided into 8 thematic areas which are used to produce accounts.
Methodology	Conceptual reporting framework based on a 6-Capitals approach.	• Subjective Wellbeing surveys determine the Better Life Index; • Statistical data aggregation of existing country data for other measures.	• GDP adjusted system aligned to the System of National Accounts; • Measured outputs are both physical and monetary in nature.
Analytics	Targeted metrics in a narrative report explaining the organisation's operations and performance in relation to the following capital themes: • Human, social and relationship, intellectual, natural, manufactured and financial	Current wellbeing data analysed by: • Vertical inequalities; • Horizontal inequalities; • Deprivations (people falling below a given standard of living). Future wellbeing data analysed by: • Stocks, flows, risk factors and resilience.	Measurements are analysed across 3 key areas: • Environmental flows; • Stocks of environmental assets; • Economic activity related to the environment.

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Organisation	IIRC (International Integrated Reporting Council)[8][9]	OECD[5,6]	United Nations[7]
Weighting	Unweighted	User preference weighting for the Better Life Index	Unweighted
Key metrics	Metrics are taken from the SASB (Sustainability Accounting Standards Board) and are subdivided by industry. Infrastructure has its own unique set of standards and associated metrics.	**Current wellbeing domains:** Income and wealth, work and job quality, housing, health, knowledge and skills, environment quality, subjective wellbeing, safety, work-life balance, social connections, civil engagement. **Future wellbeing domains:** 4 capitals: natural, social, economic, human	**Thematic areas:** Land accounts; energy; material flow accounts; ecosystem accounts; agriculture, forestry and fisheries, water; environmental activity and air emissions.
Presentation	Integrated Report which sits alongside traditional financial accounts.	• Statistical report released every two years that compiles key statistics across OECD countries; • Better Life Index interactive mapping tool.	• National Accounts and statistics; • Applications and Extensions manual to assist policy makers in achieving the SDGs.
Rationale for selection	Metrics reflect an investor focus for determining enterprise value.	Selected by OECD after consultation with member countries as being essential to material living conditions and quality of life.	Global consultative process led by the UN.
Highlights	• Evaluates value erosion as	• Highlights the importance of	• The SEEA accounts combine

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

Organisation	IIRC (International Integrated Reporting Council)[8][9]	OECD[5,6]	United Nations[7]
	well as creation; • Encapsulates the concept of double materiality (considers the impact of an organisation on its environment in addition to the inward facing single materiality concept); • The integration of the IIRC into the IFRS Foundation announced at COP26 will increase the international prominence of the framework.	looking at future wellbeing indicators in addition to current measures.; • Powerful 'doughnut' style visual used to illustrate the performance of each country.	advanced statistical analysis into a single, comprehensive view that can be used to develop salient indicators for decision making; • 90+ countries have already compiled SEEA accounts providing a readymade evidence base for policy makers.
Key differences to the NPF	Private sector initiative designed to assess how organisations create and erode value through their activities.	Designed to compare data between countries.	The SEEA is not primarily a wellbeing framework. Instead it provides a basis for understanding the relationship between economic decisions and natural infrastructure.

Table 4. Comparative analysis of three international wellbeing frameworks

[1]ANDI Presentation [2]ANDI Website [3]CIW website. [4]NZ Treasury. [5]OECD Better Life Index. [6]OECD How's Life. [7]UN SEEA. [8]IIR Framework. [9]Value Reporting Foundation

3.2.3 Key learnings for Scotland that have specific relevance to infrastructure

The research output from section 2 of this report clearly demonstrates that it is very difficult to separate the impact of infrastructure investment from other policies and we therefore need broad strategies that are integrated across diverse demographics and time horizons. This is a theme that came through clearly in the above analysis with a number of practical implications for Scotland that are outlined below.

A capital / wealth approach

Linking an inclusive economy to a wealth economy by considering the underpinning Four Capitals is essential, because the capabilities evidenced by wealth indicators provide the means to achieve the outcomes measured by IG metrics. This has tangible links to infrastructure prioritisation decisions as long-term investments clearly impact (both positively and negatively) on the different types of capital and the inclusion of wealth indicators is therefore critical. In this context there is a strong argument for establishing an evidence base between infrastructure investment and **deep wellbeing** indicators (capital outcomes), as opposed to surface level wellbeing outcomes. The key difference in this framing is that investment is viewed as providing the foundations for the economy and thus embodying the relationship between the present and the future (Jackson 2017, p. 149). This proposed approach is outlined by the double ended green arrow in the diagram below:

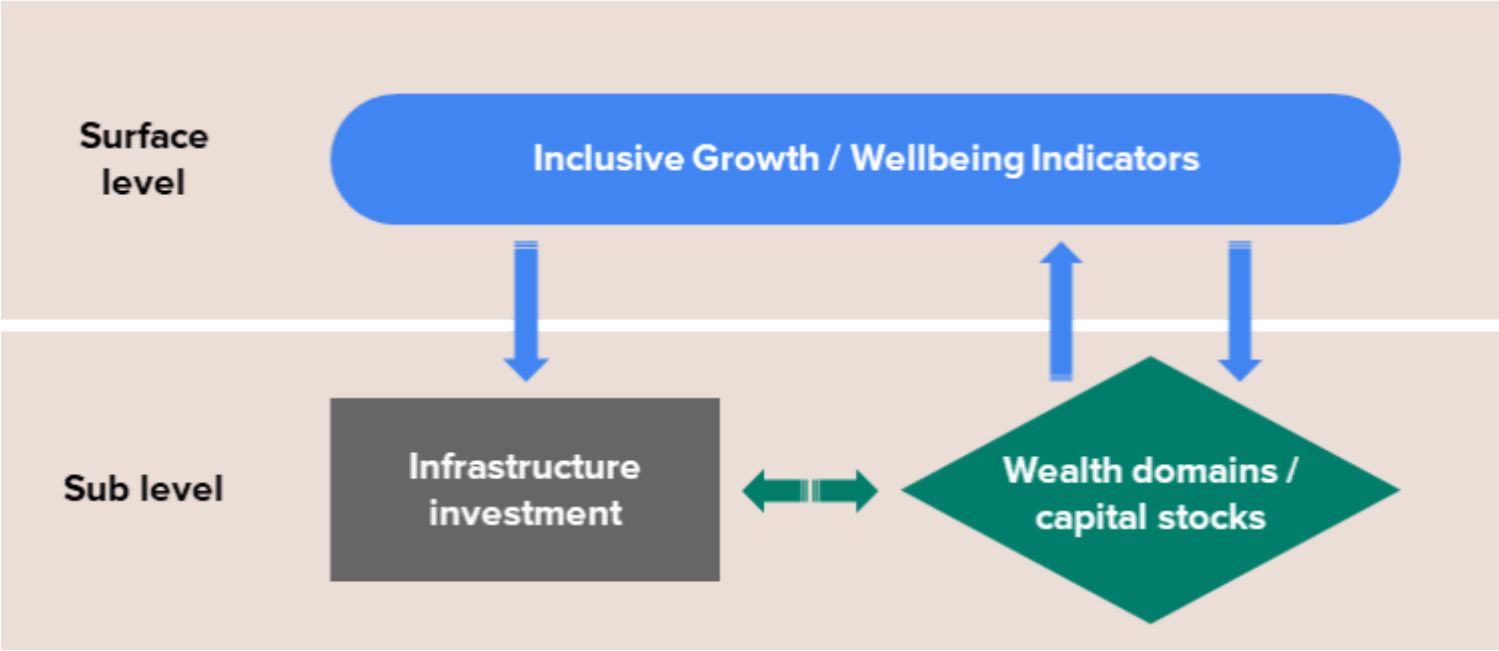


Figure 14. Relationship between deep wellbeing indicators and surface level indicators Source: author elaboration

As an example, if we were considering natural infrastructure evaluation metrics then the following levels could apply:

- Surface indicator: Access to green space;
- Sub-level indicator: Material footprint;
- Investment: Resource efficiency R&D and circular economy skills training.

This approach would prioritise using investment capital to strengthen the circular economy and improve resource efficiency as opposed to establishing a new park or pedestrian walkway. The long term effect would be to preserve and increase natural resources which would consequently increase access to green space, whilst establishing a long term commitment to maintaining natural capital stocks.

Scotland's emerging Wellbeing Indicator Framework (Government 2020)

Linking Scotland's Wellbeing Indicator Framework to emerging international best practice

The table below contains an extract of the provisional indicators that are being considered to measure wealth in New Zealand. Many of the indicators mirror those already included in the NPF; the key difference is the emerging framing of these indicators as measures of long-term capability rather than as wellbeing outcomes. This subtle shift enables a much clearer conceptual link to infrastructure to be visualised and opens a pathway for value alignment in decision making.

New Zealand's proposed wealth indicators (N. Z. Treasury 2021b)

Resource / capability	Indicators
Natural environment	Biodiversity and genetic resources
	Climate regulation
	Drinking water
	Net greenhouse gas emissions
	Renewable energy
	Sustainable food production
	Waste management
Human capability	Cognitive skills at age 15
	Educational attainment of the adult population (upper secondary)
	Life expectancy at birth
	Non-communicable diseases
Social cohesion	Trust held in others
	Discrimination
Financial / physical capital	Total net fixed and intangible assets
	Gross fixed capital formation
	Net international investment position
	CPI inflation
	Investment in R+D

Weighting measurements

Applying weighting to a combined dashboard and index framework can give a clearer visualisation of the status and direction of travel. This is illustrated by the Canadian Index of Wellbeing composite indicator shown in the diagram below:

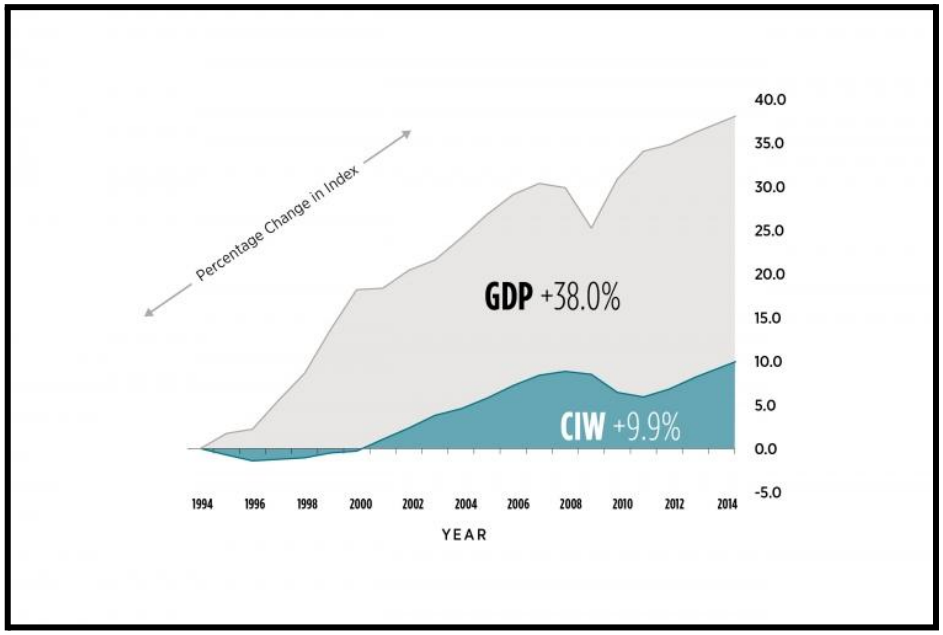


Figure 15. Source: (Waterloo 2012)

There are however limitations to this approach, such as the requirement to make subjective judgements on the relative importance of different indicators and an oversimplification of complex relationships. Whilst such issues must be taken seriously, it is also important to consider the imperative of striking a balance between the integrity of the data presented and its understandability and associated impact. If metrics are amalgamated to provide a more digestible picture, then some of the above risks can be mitigated by ensuring the combined output metrics can be readily disseminated back to a more granular level.

Public engagement

The outcome indicators that are selected by governments impact on future policy decisions which themselves determine the appraisal approaches used for policy prioritisation, thus creating a self-fulfilling cycle. If however, individuals can be empowered to support their elected representatives to achieve different outcomes then there is potential for the traditional cycles to be altered. Ultimately, wellbeing can be understood as a democratic issue because the power of performativity means that what we measure is critical to the institutional and societal norms that we create, which in turn shape our collective future.

Strong public engagement is therefore critical to ensure that there is sufficient support for politicians to enact appropriate wellbeing policies. This is crucial for developing 'future policies' because connecting wellbeing outcomes to tangible actions is both complex and at times frustratingly opaque. As an example, if someone has depression and they are prescribed CBT this would be following evidence-based medical policy, but if they remain living in poor quality housing with no access to green spaces then they are unlikely to get better. Improved mental health is an outcome that few would disagree with but simply increasing the budget for mental healthcare is unlikely to achieve it.

DML is a partner in an emerging project to develop a set of Cornerstone (or core) Indicators which will aim to transcend governmental departments, budgets, targets and ingrained behaviours. The process of choosing and designing the indicators will be shaped to ensure meaningful public engagement and to empower a continuous cycle of learning. Although this project is still in development, there will undoubtedly be important lessons emerging from this work which are closely linked to both the inclusive growth and Infrastructure prioritisation agendas. We will therefore aim to feed this learning back to SFT and to work with interested parties within the Scottish Government to ensure this pivotal work is connected to their emerging priorities.

Acknowledging complexity

New Zealand's LSF and the SEEA stood out in the above analysis for their transparent acknowledgement of the complexity involved. For example, the LSF Framework and dashboard are designed to provide a high level analysis tool that is then supported by in-depth specialist frameworks such as He Ara Waiora for a mātauranga Māori perspective on wellbeing. The SEEA by contrast, has been divided into a number of accessible modules which are then clearly signposted to policy applications via the designated Applications & Associations Manual.

Scotland introduced the NPF in 2007 and after fifteen years there are still many challenges being faced in relation to linking the agreed outcomes to the everyday realities of decision making. Trade-offs and additional emerging complexities are inevitable and it is unrealistic to

expect that a single framework (or a specific set of metrics) will provide all the answers. Establishing a strong conceptual and principles-based framework, supported rather than defined by carefully selected metrics, to guide infrastructure prioritisation therefore seems a logical approach to pursue.

A systems thinking approach

The Canadian Wellbeing Index and Integrated Reporting Framework are both centred on taking on a systems approach. Conceptually these initiatives are focused on encouraging people to think with an integrated and systemic mindset rather than relying on specific metrics or rules.

A possible frame for applying this type of approach to infrastructure is that each appraisal begins by scoping the different types of capital that will be impacted (positively and negatively). In this context capitals can act as a proxy for infrastructure as investing in one type of capital (e.g. manufactured capital such as a road) may impact on another negatively (e.g. natural capital such as air quality) or positively (e.g. social capital – connectivity).

Framework accountability

The status and level of accountability of Scotland's NPF has been highlighted recently as requiring attention. For example, a recent report published by the Scottish Leaders Forum concluded that the current status of accountability against the NPF is '*patchy*' and that it '*is not actively used to shape scrutiny, provide sponsorship, undertake commissioning of work or shape the allocation of funding*'. (Scottish Leaders Forum, 2022).

The international comparatives detailed above can therefore provide some guidance on how these challenges could be addressed. For example:

- New Zealand's NPF sits at the heart of the Government's Treasury Department and it is used to prepare the national budget.
- Australia and Canada have situated their frameworks and ongoing analytical work in world class universities, providing an ongoing link to cutting edge academic research.

In the context of the rising complexities and associated challenges discussed above, it seems imperative that any emerging infrastructure frameworks are adequately resourced and given appropriate agency and voice to transcend governmental departments.

Setting forward facing targets

The ANDI project, whilst not yet fully operational, has a clearly stated intention of setting forward facing targets for each of its indicators. This is very much aligned with Scotland's mission-based approach for its newly created National Investment Bank, together with multiple studies conducted by the UCL Institute for Public Purpose into the need for market-shaping (as opposed to market-fixing) policy frameworks. (Mazzucato, M and Ryan-Collins, J 2019; UCL Institute for Innovation & Public Purpose 2020). The recognition and commitment to a desired direction for the economy is of paramount importance in the selection of evaluation metrics, because an integrated infrastructure prioritisation framework will need to continuously connect evaluation measurements to evolving appraisal input metrics. If the selected evaluation metrics cannot be readily applied to appraisal targets then there is a danger that the process will remain reliant on traditional measures such as GVA. This challenge is discussed further in the following Section (3.3).

3.3 Q4: What can Scotland learn from 'best practice' infrastructure appraisal frameworks in the UK and internationally?

> *'While infrastructure is a necessary condition for economic growth, it is rarely sufficient. Instead, infrastructure should form part of wider economic strategies, alongside other areas like skills and inward investment.'* - National Infrastructure Commission (2021)

The concurrent national strategies of achieving net zero and inclusive growth clearly indicate that infrastructure appraisal techniques must become more holistic and consider a portfolio of impacts. A report from the Bennett Institute for Public Policy concludes that in the future, returns on investment for infrastructure will depend on the complete portfolio of assets that citizens can access. In their view this would include '*different forms of transport, fixed and mobile broadband, roads, bridges and flood defences, housing, social amenities, natural capital, and human and social capital*.' (Bennett Institute for Public Policy 2020) Given the broad factors that will need to be reflected in Scotland's future infrastructure prioritisation decisions, it is helpful to first consider existing best practice approaches, to gain an understanding of the opportunities and limitations that they represent.

In this section we have firstly reviewed recent updates to the UK Treasury's Green Book and secondly provided a brief comparative typology table of three international comparatives.

3.3.1 Her Majesty's Treasury Green Book: UK best practice for business case appraisal

In the UK, the Treasury's Green Book is considered the best-practice standard for public sector investment appraisal. Despite this, there have been many criticisms of its approach and in 2020 the Treasury commissioned a review, which resulted in an updated version of the Green Book being published in December 2020. As a starting point in considering optimal methods for infrastructure appraisal we have therefore summarised the contextually relevant outputs of the review in two parts:

(1) Key changes implemented in the 2020 edition.
(2) Practical considerations for the Scottish IIP.

Green Book 2020 changes

Overall the updates were focused on improving the quality of the submitted proposals with some specific areas of note (HM Treasury 2020a):

- Strategic case

The Green Book guidance now requires projects to present a more robust strategic case before progressing to the (BCR) business case review stage. The intention is to better align project prioritisation decisions to policy objectives and to ensure projects with low BCR results are still considered, if they are the best option available to meet a specific outcome.

- Discount rates for NPV calculations

The recommended discount rate has been reduced from 3.5% to 1.5% for any policies that impact on health or life outcomes and to 1% for environmental projects that will impact future generations. Of particular note is a marked shift in the understanding of social values which has implications for health related appraisals, especially in the context of preventative health infrastructure.

Since the 2020 update there have been a number of supplementary guides (HM Treasury 2021) released with the following being of greatest relevance to infrastructure and inclusive growth:

- Green Book supplementary guidance: wellbeing
- Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal
- Green Book Supplementary Document: Environmental discount rate review, conclusion

Practical considerations for infrastructure appraisal in the context of inclusive growth

Two themes that emerged strongly from the 2020 Green Book review findings are of key importance to this study (HM Treasury 2020a; 2020b):

1. Many business case reviews were found to lack strategic focus and were thus overly reliant on CBA / BCR methodologies that failed to align with policy objectives.

   Cost Benefit Analysis (CBA) and the BCR (benefit cost ratios) remain at the centre of the Green Book methodologies. However, there are some major limitations to this approach with specific implications for infrastructure. For example:
   - The analysis is only relevant at the incremental margins of investment (i.e. comparing one project to another of the same type) and does not take into account the wider implications of any potential investment.
   - Studies have shown that allocative CBA decisions increase regional imbalances. (Coyle and Sensier 2020) This is because CBA methodologies favour investment into areas that are already more productive, due to standard input measures such as GVA being higher in such locations.
   - CBA uses NPV discount rates to calculate a value at a specific point in time. This is a useful but artificial simplification in the context of continually evolving and interdependent systems and results in policy options being viewed in isolation, with no consideration of how they will interact systemically.

2. Section 1.14 of the review concluded that '*transformational effects are rare*' and only occur when initiatives are '*part of a coherent strategic portfolio designed to deliver such changes*' (ibid, p.8).

This second point echoes many of the themes from the international evaluation frameworks review (see section 3.2) and reinforces the need to move to a systems based approach and to reject entrenched siloed departmental targets. From a practical perspective this shift could be initiated by including a set of exploratory prompts at an early stage in the appraisal process. These provocations could include a number of questions designed to broaden the consideration of both benefits and crucially disbenefits that a project could deliver; for example:

- Where does the project sit in the **investment hierarchy**, i.e. replace or repair?
- What is the end goal in respect of the provision of **Assets Vs Services** – will the project create one or both? If it is a service, then the return on the investment will be the level of that service rather than a financial return.
- What kind of **organisations and networks** will be involved? Will this include scope 1,2,3 type assessments to ensure inclusive growth is considered throughout the supply chain?

- What is the **global impact**? Have we considered the risk of ‘green colonisation’ that, for example, sourcing components for electrifying transport will bring?
- What is the **financing** plan? What restraints might this create? Could a fixed percentage be allocated to fund a ‘social premium’ to generate spillover benefits?

Further research suggestions

It is outside of the scope of this study to look at the detail of the Wellbeing Supplement, but its inclusion in such a central HM Treasury decision making tool is testament to the rapid and transformational changes evolving in this policy area. We would suggest that a detailed review of this guidance and the implications for the IIP prioritisation framework is considered in the second stage of the SFT study.

3.3.2 Table of international comparatives

	World Bank Infrastructure Prioritization Framework (Marcelo et al. 2016)	**Infrastructure Australia Assessment Framework** (Infrastructure Australia 2021)	**Global Infrastructure Hub: Inclusive Infrastructure Reference Tool** (Hub 2022)
Organisation type	International development bank.	Independent statutory body.	G20 Initiative
Design	Flexible decision making tool that allows business case analysts to select the most appropriate criteria for the sector in question.	4 stage process where applications must be approved for each stage before progressing to the next: 1. Defining problems and opportunities; 2. Identifying and analysing options; 3. Developing a business case; 4. Post completion review. Sets minimum standards of evidence and analysis to be included and for projects above the threshold the process is mandatory.	Provides practical guidance for maximising the inclusivity and shared prosperity outcomes of infrastructure projects. Based on 6 action areas: 1. Stakeholder engagement, empowerment and capacity building; 2. Governance and capacity building; 3. Policy regulation and standards; 4. Project planning, development and delivery; 5. Private sector roles and participation; 6. Affordability and optimising finance.
Appraisal logic	Pragmatic and allocative	Principles based with 3 overarching	Principles based

	World Bank Infrastructure Prioritization Framework (Marcelo et al. 2016)	**Infrastructure Australia Assessment Framework** (Infrastructure Australia 2021)	**Global Infrastructure Hub: Inclusive Infrastructure Reference Tool** (Hub 2022)
		questions: • Strategic Fit – is there a clear rationale for the proposal? • Societal Impact – what is the value of the proposal to society and the economy? • Deliverability – can the proposal be delivered successfully?	
Methodology	Quantitative, weighted, additive model which uses 2 indices and compares to the public budget (a) Social-environmental (b) Financial-economic	• Rapid CBA and multi-criteria analysis at the earlier stages; • Full CBA (including social CBA) at the business case stage; • Financial appraisal / forecasts.	Based on case studies, live projects, consultative workshops and relevant research.
Criteria type	Multi-criteria	Multi-criteria	Evidence-based
Input criteria examples	**Social-environmental:** Direct Jobs Created, Number of Direct Beneficiaries, People Affected by Repurposing of Land Use, Cultural and Environmental Risks and Pollution. **Financial-economic:** Financial Internal Rate of Return (IRR), Multiplier Effects,	Market capability and capacity analysis, willingness to pay analysis, option value, scenario and sensitivity testing, demand forecasting and strategic planning.	Case studies are selected to illustrate both leading practices and to highlight lessons learned.

	World Bank Infrastructure Prioritization Framework (Marcelo et al. 2016)	**Infrastructure Australia Assessment Framework** (Infrastructure Australia 2021)	**Global Infrastructure Hub: Inclusive Infrastructure Reference Tool** (Hub 2022)
	Implementation Risk, Complementarity/Competition effects.		
Presentation	The indices are mapped onto a 4 quadrant graph Vs the sector budget **(an example is presented below this table).**	Submission templates and checklists for each stage are provided.	Each action area provides a list of recommendations illustrated by real life case studies.
Practical implications	Designed to facilitate active discussion; the process is viewed as being as important as the result.	• Clear expectations and guidelines are provided;; • Methodologies are transparent and clearly defined; • Strong knowledge sharing and technical support.	The diverse range of current, international case studies provides a highly accessible and relatable collection of real-life examples.

Table 5. International Comparison of assessment and prioritisation frameworks

The following graph provides an illustration of the World Bank's Prioritization Matrix (Marcelo et al. 2016)

- The dotted lines represent the budget constraint along each axis. For example, from a financial-economic perspective the budget would only permit funding of projects with an FEI (financial-economic index) score above 72 whilst from an socioeconomic perspective the budget would restrict spending to projects with an SEI (socioeconomic index) score above 48.
- Quadrant A therefore represents the optimal projects and the remaining projects within the budget would then be selected from quadrants B and C.

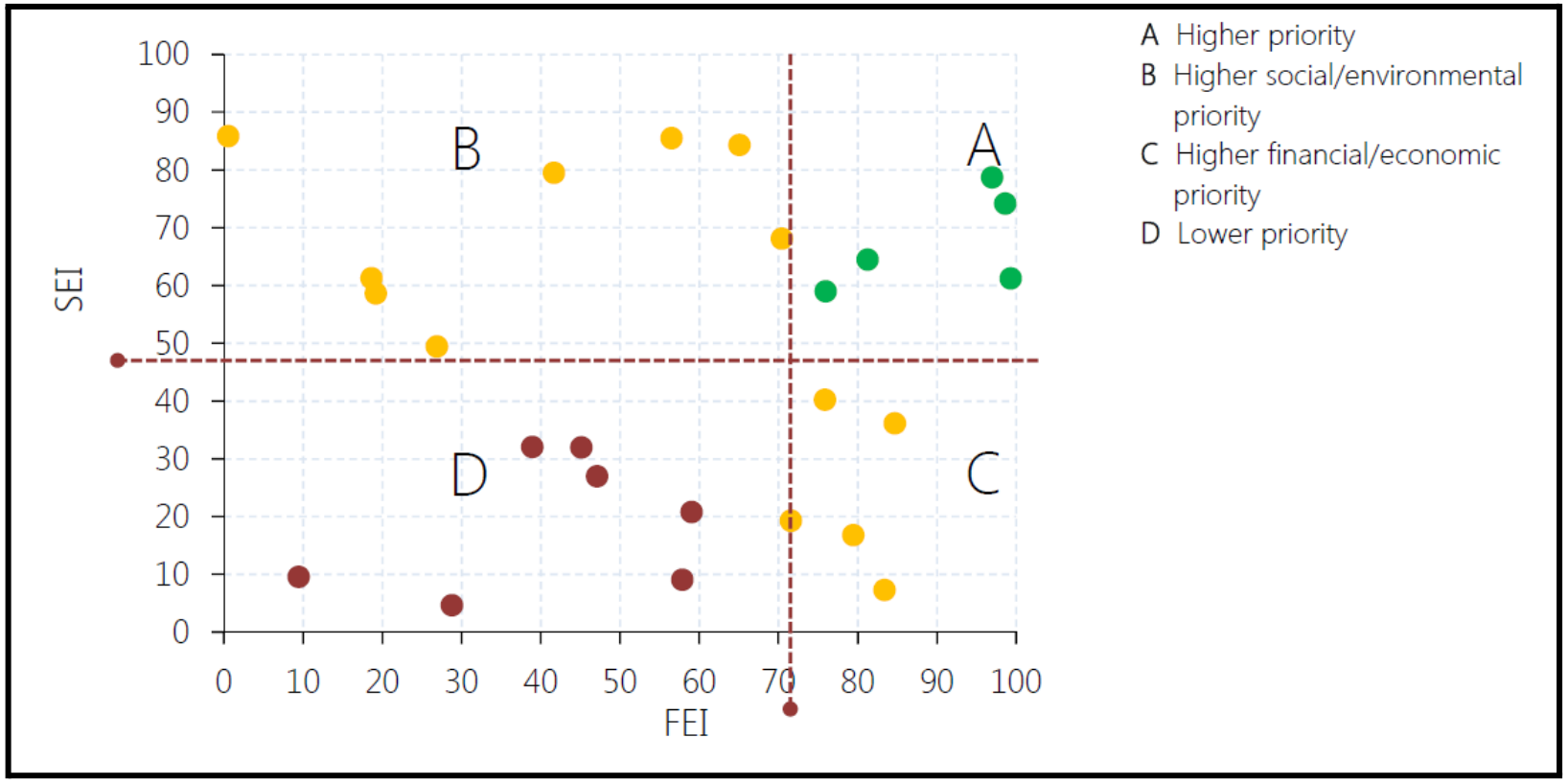


Figure 16. Illustration of World Bank Prioritisation Matrix Source: (Marcelo et al. 2016)

3.4 Q5: How can we evaluate the systemic health of the economy (as opposed to individual sectors or policy areas)?

In recent years there have been numerous critiques of GDP as a measure of individual wellbeing but less has been voiced about its efficacy as a measure of the economy's systemic health. The 'beyond GDP' movement has led to a variety of alternative GDP measures being proposed, which have broadly fallen into three categories:

1. Extending or enhancing GDP (e.g. The United Nation's SEEA).
2. Measuring happiness or wellbeing directly (e.g. the Happy Planet Index).
3. Dashboard approaches (e.g. the Scottish NPF).

The above approaches (and the specific proposals within them) each have their own merits, but a common limitation is their failure to define a desired direction of travel, or tangible system-level goals with which to evaluate progress.

Whilst we appreciate that investigating systemic evaluation frameworks is beyond the scope of SFT's current research project, we think it is important to link detailed infrastructure specific evaluation metrics to the wider superorganism, in terms of social and planetary health. If an investment project scores highly on a focused set of metrics whilst the overall direction and quality of growth in a region is deteriorating, should we still view it as a success? To begin addressing this question we have outlined two examples of emerging approaches that seek to address this issue below: (1) The Healthy Green Growth Compass (2) The SAGE Framework. Both of these initiatives are in the early stages of practical implementation and thus have a limited evidence base to support them. However, we believe that the principles underpinning them will prove useful in future cycles of this inquiry, as complementary cross checks to the more detailed infrastructure specific evaluation metrics that will guide the Scottish IIP.

We have divided the the following overviews into four sections to aid comparison:

1. Concept outline
2. Description of the metrics used
3. The emerging evidence-base
4. Relevance for Scotland

3.4.1. Healthy Green Growth Compass (Stoknes and Hawken 2021)

Concept outline

The HGG Compass was developed by a team of international experts, including the scientists from the Rockholm Institute in Sweden who initially developed the planetary boundaries model that is central to Kate Raworth's Doughnut Economics framework (Raworth 2017). The Compass acknowledges that the constant fluidity and movement of natural and social systems when trying to measure value, within the constraints of a price-based economy, is important. In addition, the framing of a compass is aligned with an outcomes-based focus, as it indicates the direction of progress towards informed targets rather than using fixed or comparative metrics.

Metrics

The HGGC looks at rates of change in ecological and social (esp. inequality) indicators as a function of GDP and aligns them with science-based targets.

For example, the HGGC uses the metric of ecological footprint (EF) to measure resource productivity (Stoknes and Hawken 2021, ch. 5). The logic proposed is that if the change in GDP divided by the change in ecological footprint equals zero then resource productivity also equals zero. Thus, using carbon productivity (CP*) as an indicator of EF, the change in value creation (**Δ**GDP) divided by the change in the ecological footprint (**Δ** CP) must be greater than 5% per year to achieve a 50% reduction in Global emissions by 2050:

$$if\ \Delta\frac{GDP}{EF} = 0 \Rightarrow resource\ productivity\ = 0$$

$$\frac{\Delta GDP}{\Delta CP} > 5\% \Rightarrow green\ growth$$

**NB: Carbon productivity can be calculated by dividing the value added figures (from organisational profit and loss statements or the National Accounts) by the carbon emissions from the CDP (Carbon Disclosure Project) and UN Framework Convention for Climate Change.*

The diagram below (adapted from page 117 of (Stoknes and Hawken 2021) illustrates the four possible directions of growth based on the change in GDP and the change in EF per year. The solid white arrow in the northwest quadrant indicates an improvement in resource productivity i.e. more value created using a smaller environmental footprint.

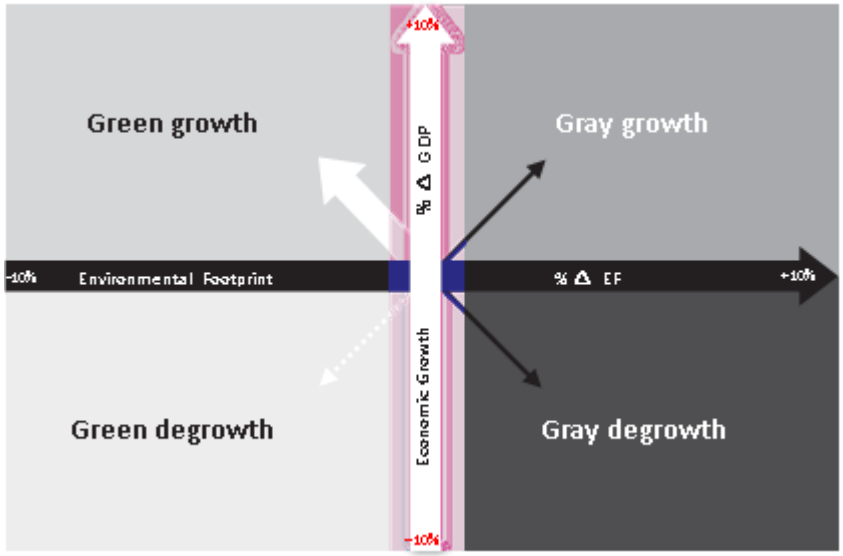


Figure 17. Typologies of growth Source: (Stoknes and Hawken 2021, 117)

The framework recommends that a similar approach can be taken to mapping growth in the context of inequality by looking at the social productivity of growth (SOPRO) (Stoknes and Hawken 2021, chap. 7). In the HGGC framework this is defined as the ratio of value creation (GDP) to inequality (measured by the Palma Ratio). In this case, the annual change in social productivity must be significantly higher than the change in GDP for the growth to be inclusive. Research suggests that countries should be aiming at a Palma Ratio of 1 compared to a current global average of 2 (Alejo Vázquez Pimentel, Macías Aymar, and Lawson 2018). If this is set against a global predicted average annual GDP growth rate of 2.6% over the same time period, then the SOPRO ratio must be greater than 5% to achieve the target improvement of 50%. Thus:

$$if\ \Delta\frac{GDP}{Palma} = 0 \Rightarrow\ social\ productivity\ =\ 0$$

$$\frac{\Delta GDP}{\Delta SOPRO} > 5\% =\ inclusive\ growth$$

Emerging evidence base

The HGGC is being used by Norway in its national statistics to compare different regions. This can be viewed on the Norwegian Country Government website and shows the disparity in progress between, for example Oslo (where green growth is being achieved) and Trondelag (where GDP growth still far outstrips improvements in material efficiency).

Relevance for Scotland

Scotland's 2021-22 Programme for Government was entitled 'A Fairer, Greener Scotland' (Scottish Government 2021b) and set out the Government's commitment to transitioning Scotland towards a sustainable, equitable and green future. The HGG Compass illustrates a pathway for using science-based targets to define and evaluate these exact policy targets. Removing the opacity at the policy level would help to give other stakeholders, for example the private sector, a clearer indication of the direction of travel and thus mitigate concerns such as first mover disadvantage.

3.4.2. The SAGE Framework

Concept outline

The SAGE framework presents a policy route for recoupling economic and social prosperity and follows a dashboard approach to measurement.

A key distinguishing feature of the framework is that it provides a philosophical challenge to our collective cultural definition of success, whereby its indices are not arbitrary and seek to challenge the underlying structures and assumptions of our current economic system. This relationship has been described by the Oxford Economist Eric Beinhocker as a conceptual framework that connects the moral and philosophical foundations of society with the normative structures and metrics at the top. (Beinhocker 2020)

Beinhocker's Ontological Stack*		
Ontological Stack	GDP	SAGE
Metrics	Production, income, consumption	Multi-metric (Solidarity, agency, material prosperity, sustainability)

Normative framework / political ideology	Utilitarian, welfare theorems	Democratic equality, human need
Economy and the environment	Externality	Embedded
Economic systems theory	General equilibrium	Complex, adaptive system
Economic Value theory	Subjective, marginal utility (exchange value dominates)	Value pluralism
Behavioural theory	Self-regarding, utility maximising, rational	Collaborative, relational, heuristic
Psychological concept	Happiness	Prosperity, wellbeing
Philosophical tradition	Hedonic	Eudemonic

Table 6. Comparison between GDP/traditional economic frameworks and SAGE

**adapted from a paper written by the Oxford Economist Eric Beinhocker (Beinhocker 2020)*

Metrics

The framework consists of four indices which are measured as follows (De Miranda, K and Snow, D 2020):

Index	**Theme**	**Metrics**
S: Solidarity	Giving behaviour	Helping a stranger, donating money, volunteering.
	Trust in other people	Analyses responses to the question; generally speaking, would you say that most people can be trusted or that you need to be careful in dealing with people?

Index	Theme	Metrics
	Social support	% of people who think they have friends or family that they can count on in times of trouble.
A: Agency	Labour market insecurity	OECD % effective insurance.
	Vulnerable employment	Contributing family workers and own-account workers as a percentage of total employment.
	Life expectancy	World Bank statistics.
	Years in education	Mean years of schooling post 25 years of age.
	Confidence in empowering institutions	Gallup World Poll: In this country, do you have confidence in the national government?
G: Material Gain	Economic growth	GDP per capita.
E: Environmental sustainability	International comparison of environmental policy targets.	Environmental Performance Index

Table 7. SAGE Framework Metrics

Evidence Base

The Sage Framework was used in a recent study designed to evaluate the societal responses of the G7 countries to the Coronavirus Pandemic (Lima de Miranda and Snower 2021). Unsurprisingly the study found that there was a drop in both GDP and CO_2 emissions in all countries, but

that the impact of the pandemic on societal levels of solidarity and agency was highly variable. The study concluded that these differing societal responses had implications for how well countries will fare in the post-pandemic recovery period and thus highlighted the importance of understanding deeper societal norms in relation to future policy.

The study divided the countries into four groups using the following criteria and the subsequent distribution of the countries shown in the table below:

- Tribalizing: inward solidarity rises while its outward solidarity declines or remains roughly unchanged.
- Cooperating: both inward and outward solidarity rise.
- Empowering: agency rises.
- Not empowering: agency falls or remains roughly constant.

	Empowering	**Not empowering**
Cooperating	Italy	Japan
Tribalizing	Germany, USA, UK	Canada, France

Table 8. Lima de Miranda and Snower country typology

The following diagrams illustrate the interaction between the four indices comparing 2020 to both 2010 and the G7 2020 average for Japan and the UK.

In respect of Japan, the results show much lower levels of both solidarity and agency compared to other G7 countries, with people's perceived levels of empowerment (agency) reducing further in the pandemic. By contrast, the UK showed a marked increase in solidarity in response to the pandemic whereas the impact on societal agency was minimal.

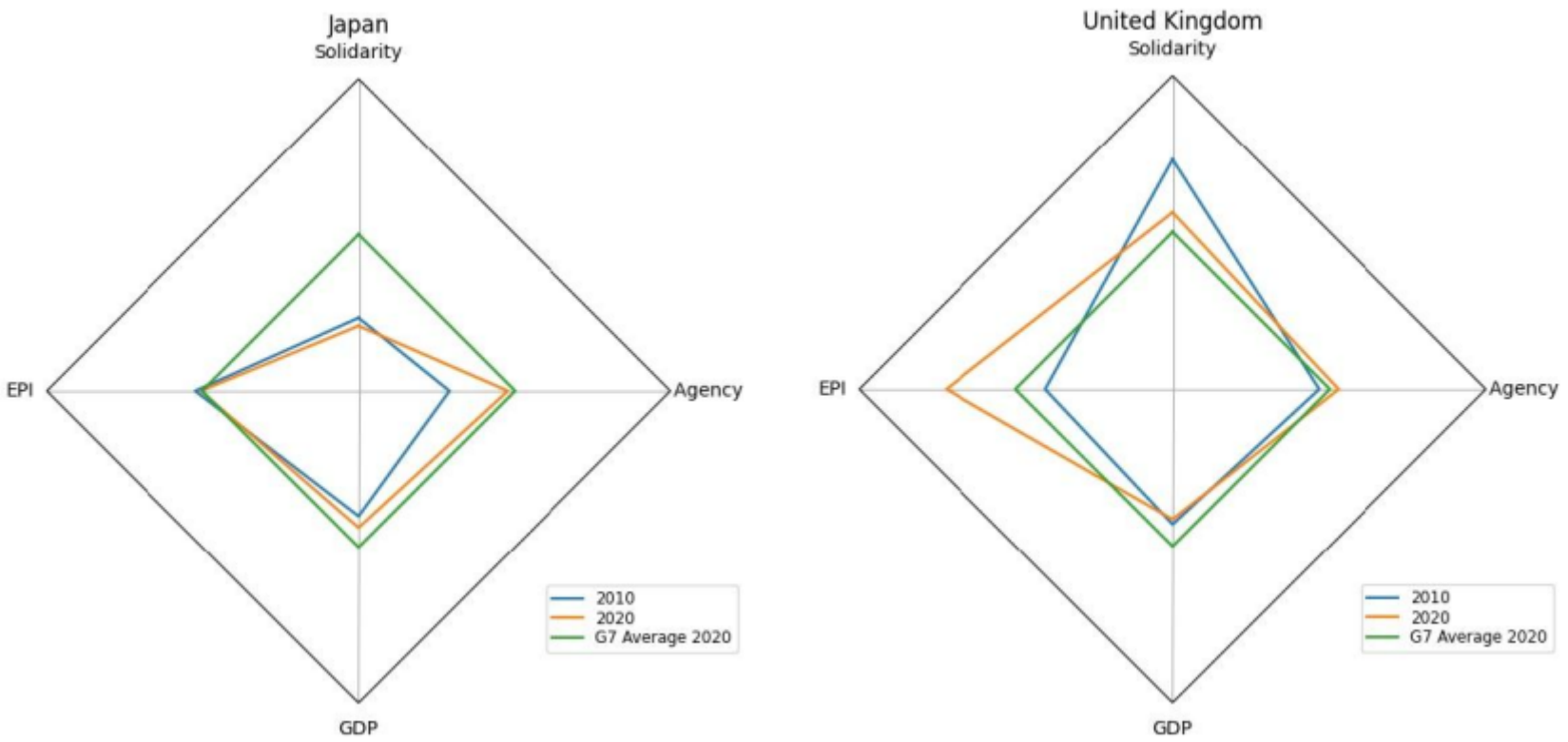


Figure 19. Spiderweb diagram of SAGE metrics between 2010-2020 for Japan and United Kingdom Source: (Lima de Miranda and Snower 2021)

Relevance for Scotland

The framework could provide a high level cross check on the overall success of Scotland's infrastructure investment portfolio. For example, if Scotland's GDP per capita and agency scores are rising whilst its solidarity and/or environmental scores are falling, this would be a warning light that the overall investment profile is not orientated towards inclusive growth.

3.5 Q6: How can we shift practitioner thinking to consider dynamic rather than utilitarian (allocative) prioritisation frameworks and emerging rather than static systems?

'Expect the emergent and the unexpected and treat it as
an opportunity to innovate. Use it to explore the space of possibilities'. (Mitleton-Kelly 2015)

Mark Carney has described the climate crisis as '*the ultimate betrayal of intergenerational equity*' (Carney 2021, 7) caused by our collective failure to take appropriate policy action. In his view, these policy failures are a 'knowledge problem' created by an inability to evaluate outcomes that cannot be readily priced (ibid, p.48). Perhaps a more accurate description however, would be a 'paradigm problem' because we are trying to measure and evaluate complex evolving outcomes from a static utilitarian perspective. If we accept this logic then we are forced into asking a new set of questions; questions that explore ways of facilitating change under conditions of deep uncertainty, questions that acknowledge our humility and the need for constant reflection and adjustment, questions that question the very premise of our incumbent decision-making structures. There is a vibrant and diverse research base emerging in response to such enquiries and in the context of this project we will simply give a brief outline of some helpful themes, which we hope will provoke further discussion.

This section is therefore divided into the following sections:

1. Applying complexity theory to analytical decision making.
2. The relationship between dynamic analytical frameworks and complex systems.
3. The reflexivity of indicators.

3.5.1 Applying complexity theory to analytical decision making

Complexity theory is an interdisciplinary field that draws from both the natural and social sciences and provides a conduit to stimulate new ways of thinking about the systems that we interact with. The theory maintains that the process of identifying and tackling individual discrete issues within a system is based on a false set of assumptions, because issues within social ecosystems can never exist in isolation. Both the challenge being addressed and the solution itself are interdependent and each will act on the other to generate further outcomes; a solution

that proved effective at one in point in time will therefore be unlikely to remain operative as the context changes. Drawn from many years of research, the following properties are considered to be the ten defining principles of complexity theory (Mitleton-Kelly 2015):

• Interconnectivity • Interdependence • Feedback	Social relationships are intertwined, non-linear and intricate.
• Emergence	Outcomes are more than the sum of parts e.g. a creative meeting.
• self-organisation	Spontaneous, decentralised behaviour.
• Exploration of the space of possibilities	Searching for a single, optimal strategy in a volatile environment is neither possible nor desirable.
• Co-evolution	Reciprocal adaptation, e.g. bees and flowers.
• Historicity	The past may influence rather than determine the future.
• Far-from-equilibrium • Creation of New Order	At a critical point the system will either explore its space of possibilities and create a new order or it will cease to exist.

Table 9. Defining principles of Complexity Theory

If we can understand that these properties are playing out in the social systems that we are attempting to change then we can work with them (rather than against them) to (a) understand complex problem spaces and (b) create 'enabling environments' that co-evolve with their contexts.

3.5.2 The relationship between complex systems and dynamic analytical frameworks

Whilst the above commentary may seem somewhat abstract in the context of infrastructure, providing an explanatory theoretical base for complex systems is helpful because, as surmised by the political journalist Paul Mason, '*theories allow us to describe the reality we can't see*' (Mason 2017, 154). Accepting the limitations of our cognitive understanding can help us to develop analytical frameworks that address the reality of the challenges faced, rather than working from a reductionist simplification of a complex problem space.

The key difference between dynamic and allocative frameworks is that an allocative framework aims to make the optimal use of fixed resources at a single point in time, whereas a dynamic framework seeks to use resources to enact desired changes. Such frameworks therefore draw on complexity and systems thinking in their design and purpose (Kattel et al. 2018). For example, by accepting the fundamental uncertainty of working within emerging contexts, dynamic frameworks reject the concept of optimality and instead prioritise adaptable policy choices that can be adjusted as additional uncertainties unfold (Kattel et al. 2018).

The above discussion signals the need for a mission-oriented approach to evaluation and appraisal as opposed to the more traditional Green Book style processes (and the associated limitations) described in section 3.3. The following table is adapted from an IIPP (2020) working paper and brings together the characteristics of complex systems and dynamic frameworks, to delineate these contrasting methodologies:

	Allocative	**Dynamic**
Framework examples	• Green Book (e.g. ex-ante CBA); • Cost efficiency analysis; • General equilibrium modelling; • M&E (monitoring and evaluation) frameworks.	• Social Fabric Matrices* (Hayden 2011); • Public value mapping e.g. Bank of England UK Housing Market Agent based model (Baptista et al. 2016); • Systems thinking e.g. Donella Meadows' Places to intervene in a system (Meadows, D. 1999).
Theoretical base	Market failure, welfare economics;	Complexity and systems theory, Complexity economics, technology transitions

	Allocative	Dynamic
Underlying principles / assumptions	• Optimisation is possible and desirable; • Focus on equilibrium; • Assumes future outcomes can be predicted and measured using discount rates.	• Seeks evidence of adaptability and resilience to shocks; • Focus is on enacting change and finding leverage points; • Accepts fundamental uncertainty; • Experimentation is encouraged and failures are accepted.
Risk tolerance	Low	High
Desired scale of change	Incremental	Transformational
Cause-effect relationships	Proportionate	Disproportionate

Table 10. Comparison of Allocative and Dynamic analytical frameworks

*The SFM is a matrix-based framework that maps out a system's interdependencies from a policy perspective. The framework draws out relationship flows over time between people, technologies and institutions in the context of socio-economic systems. A key feature of the framework is that it can incorporate a diverse set of flows and can include qualitative components such as values and beliefs. (UCL Institute for Innovation & Public Purpose 2020)

3.5.3 The reflexivity and fallibility of indicators

If we acknowledge the complex nature of the social systems that practitioners are attempting to influence through policy, then we must also question the use of indicators to guide such policies. Feedback loops and self-optimisation mean that when a system is given a new goal, which is what happens when an indicator is picked as a target, the system itself adapts to move *towards* the indicator (desired behaviour) but it also moves *around* what the indicator was supposed to measure (undesired behaviour). A classic example of this is *grade inflation*, in which both teachers and educational institutions are incentivised to give better grades to students. Grades then become performance targets to education providers despite their primary intention being to measure the amount of learning and proficiency that a student has attained. In this example and in many other cases the indicator, shaped by what was measurable, has shifted perceptions and priorities in the process.

4. Conclusions and further questions for the future

This report has inevitably drawn on a substantial body of theoretical and empirical detail but we recognise that the next stage of this workflow will need to move into the practical realm. We have therefore summarised some key thought prompts, suggested intentions and questions (together with references to the supporting detail from the report) in the following table, before expanding on a number of the themes more fully in the text below.

THOUGHT PROMPT	INTENTION	QUESTIONS	SECTION
Encourage wide boundary thinking	By thinking about infrastructure investment as a pathway to creating enabling capabilities and societal resilience, we are freed from the restrictive limitations of ascribing specific asset classes to desired outcome indicators.	What would an outcomes-first budget look like?	2.2.1 2.2.2 3.2.3
Consider the unintended consequences	If we are working towards societal wide prosperity then we must look at investments from a system-wide portfolio perspective, thus allowing positive and negative spillover impacts to be considered and evaluated at all stages of the project cycle. Further challenges arise because causality is non-linear and thus when measuring outcomes in the aggregate, we must consider the distribution of positive and negative impacts across different communities.	What sort of weighting should be given to negative spillovers when evaluating the feasibility of a project or an investment portfolio?	2.2.2
Look upstream of the framework	Well designed frameworks can contribute to the design and implementation of meaningful future policy but are rendered powerless without associated behavioural changes. If we can shift the values behind the decision making, then the frameworks can be repositioned to act as conceptual aids rather than as prescriptive tools.	Would we learn more about a programme's success or failure by complementing an indicator framework with methods such as Most Significant Change?	3.2 3.5.1
Contextualise the theory	The interconnected nature of the investment landscape can be overwhelming and thus to enable practitioners to enact practical	Would broader freedom in how different departments and regions	3.2.1 3.2.3

THOUGHT PROMPT	INTENTION	QUESTIONS	SECTION
	change, the theories must be contextualised in both time and place (e.g. using the 4-capitals as a proxy for infrastructure investment).	allocate money between the 4-capitals lead to better local outcomes?	
Apply dynamic analysis	If we accept the fundamental uncertainty of working within emerging contexts then we can become liberated from the concept of optimality. By focusing on adaptable policy choices that can be adjusted as new uncertainties emerge, we can build resilience and reduce fragility.	How does our approach change if we think about using resources to enact change rather than aiming to allocate fixed resources for the maximum benefit?	3.5.2
Commit to a direction of travel	The non-linearity that defines socio-economic systems means that individual targets can often bring a false sense of security, or worse, can shift behaviours in unintended ways (see below). If we can instead commit to a desired direction of travel for Scotland, then we can remain flexible in our evaluation and decision making pathways.	Can we weave broader narrative indicators which are accepted by the Scottish people and provide inspiration for time-frames that stretch beyond electoral cycles? Can these help shift accountability beyond a vision of strict time-bound KPIs which determine a programme's success or failure?	3.4
Acknowledge the reflexivity of targets and indicators	Indicators which are used as targets often become less useful[9] because organisations and societies are complex adaptive systems, ever evolving and adapting to their new conditions and incentives. Whilst pursuing an indicator can push innovation towards improving the associated score, the form that the initiative takes in pursuing the target can disconnect it from its initial intention.	How can we design indicators to capture continually evolving contexts whilst keeping a level of consistency and comparability that is comprehensible to a broad audience?	3.2.3 3.5.3

[9] This is a paraphrasing of Goodhart's Law, which states that "once a measure becomes a target, it ceases to be a good measure".

THOUGHT PROMPT	INTENTION	QUESTIONS	SECTION
	Conversely, the performative nature of indicators can result in a prescriptive framing and thus crowd out other considerations (i.e. "*what we measure is what we value*").		

Table 11. Summarisation of prompts, intentions and open questions

Working with a wider taxonomy of infrastructure

The FoA study that initiated this project journey derived a number of useful conclusions and yet, in our view it also confirmed that what we find (or do not find) in our investigations is partly dependent on what we are looking for. Our worldviews are sculpted by the nature of our attention, with the things that we notice and those aspects that remain obscure existing in the gestalt of our perception. In the same way that Newton interpreted light passing through a prism as being split into different colours and the early astronomers 'viewed' the sun rotating around the earth, our conclusions about the causal links between infrastructure and inclusive growth are coloured by our conceptual framing of the respective terms.

The research detailed in Section 2 has highlighted many interesting causal relationships between infrastructure as an enabling capability and positive societal outcomes. We therefore fully support SFT's intention to further explore this link, rather than limiting any future studies to specific categories of investment or growth-based targets.

Breaking through the glass ceiling of knowledge mobilisation

The international case studies and discussion presented in Section 3 illustrated that the existing impasse between strong frameworks (specifically in reference to Scotland's NPF) and their realisation in practical terms is prevalent across the globe. If Scotland is to overcome this quagmire, then we would suggest that the focus needs to be on unlocking behavioural change. Such an approach would allow government colleagues from diverse departments to capitalise on the existing policy architecture and work together to co-design integrated implementation pathways.

Using complexity theory and systems thinking as a pathway to elicit behaviour change

'Systems-thinking' and 'complexity' are terms that have become ubiquitous in relation to theories of change but less is commonly voiced about the intentions that lie behind the parlance. In our view, theories are useful in helping us to visualise conceptually dense or otherwise

hidden aspects of our environments, but we must retain a sense of humility when considering their practical applications. We have proposed using a 4-Capitals model as a proxy for infrastructure, as a way of assisting people to consider the varying timeframes and contextual spillovers that infrastructure investments demand. However, we would caution this approach being taken too literally (for example if the Capitals become targets in themselves) and would encourage interested parties to first explore how they interact with systems in their own lives as a way of connecting to this logic.

Implications for infrastructure prioritisation

If we are serious about an outcomes-based, mission oriented approach, then we need to think about dynamic rather than utilitarian prioritisation frameworks and emerging rather than static systems. We would therefore suggest reframing infrastructure investment as a complex intergenerational relationship where we are engaged in the collective act of infrastructuring (Penuel 2019) as a pathway to building resilience and reducing fragility. This would have wider associated implications, such as the need to aim for a pre-distribution of wealth (e.g. high-quality jobs) rather than post (e.g. taxes), thus having the potential to stimulate cross-departmental discussion and reflection.

In practical terms, a dynamic framework approach to infrastructure prioritisation could initially be explored (taking this project as a starting point) by using a stepped logic model. For example:

- Step 1: Facilitate systems thinking amongst SFT and SG colleagues to move away from a siloed project mentality (for example by looking at training initiatives such as Nora Bateson's Warm Data Labs.)
- Step 2: Apply landscape mapping to identify the potential impacts (both positive and negative) of projects. For example, the Bristol University Natural Environment online tool which was used by the UK's Infrastructure Commission for its Rail Needs Assessment and the Innopaths policy evaluation tool.
- Step 3: Include multidimensional/multi-capital forecasts as part of the project business case process.
- Step 4: Evaluate the project mix at the landscape / local authority / national level.
- Step 5: Select a portfolio of projects that have the potential to simulate cross-learning and positive additive interactions.
- Step 6: Set collective intermediate milestones.
- Step 7: Continuously evaluate and adjust the direction of travel to orient each and every decision towards inclusive prosperity. Look for signs of significant change (or 'pre-emergence') and investigate their root causes.

Questions for the next phase

- What do we really mean when we talk about systems-thinking and complexity? Is there a shared understanding of these terms (and perhaps more importantly the intention behind them) within the Scottish Government workflows?
- What additional skills and resources will be required amongst the Scottish Government departmental teams to implement the dynamic logic models that this research has indicated are critical?
- Should we be focused on developing evaluation frameworks (that will potentially inform prioritisation frameworks at a later stage), or should we instead be moving towards establishing decision making pathways?
- The longer-term goal of this project is to influence and support the design of an infrastructure prioritisation framework for the IIP. Is this still an optimal outcome or would the creation of a 'systems coordinator network' be a more credible proposition?
- How does this work interlink with the Scottish Government's wider investment approach in terms of fund allocation and decision making methodologies?

It is testament to the progressiveness of the Scottish Government and SFT that this project was even commissioned. Whilst we strongly believe that the changes discussed in this report are both viable and essential, the future of Scotland's infrastructure journey remains very much in the balance. The opportunity to enact positive change in the context of Scotland's IIP is profound. However, without a definitive shift in how public value is perceived, created and maintained, the stated goal of inclusive prosperity for the people of Scotland is unlikely to be fully realised.

'A more positive theory of public value requires beginning with a notion of the public good not as a correction to a failure, but as an objective in itself; an objective that can only come about if linked to a process through which value is created'. (Mazzucato, M and Ryan-Collins, J 2019)

5. References

Akbari, H. 2002. 'Shade Trees Reduce Building Energy Use and CO2 Emissions from Power Plants'. *Environmental Pollution (Barking, Essex: 1987)* 116 Suppl 1: S119-126. https://doi.org/10.1016/s0269-7491(01)00264-0.

Alegría, Margarita, Amanda NeMoyer, Irene Falgàs Bagué, Ye Wang, and Kiara Alvarez. 2018. 'Social Determinants of Mental Health: Where We Are and Where We Need to Go'. *Current Psychiatry Reports* 20 (11): 95. https://doi.org/10.1007/s11920-018-0969-9.

Alejo Vázquez Pimentel, Diego, Iñigo Macías Aymar, and Max Lawson. 2018. 'Reward Work, Not Wealth: To End the Inequality Crisis, We Must Build an Economy for Ordinary Working People, Not the Rich and Powerful'. Oxfam. https://doi.org/10.21201/2017.1350.

Ansar, Atif, Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn. 2016. 'Does Infrastructure Investment Lead to Economic Growth or Economic Fragility? Evidence from China'. *Oxford Review of Economic Policy* 32 (3): 360–90. https://doi.org/10.1093/oxrep/grw022.

APS Group Scotland. 2021. *Analysis of Responses to Consultation on the Draft Infrastructure Investment Plan 2021-22 to 2025-26.*

Baptista, Rafa, Marc Hinterschweiger, Katie Low, and Arzu Uluc. 2016. 'Macroprudential Policy in an Agent-Based Model of the UK Housing Market'. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2850414.

Beinhocker, Eric D. 2020. 'Toward a New Ontological Framework for the Economic Good'. *Global Perspectives* 1 (1): 17578. https://doi.org/10.1525/gp.2020.17578.

Bennett Institute for Public Policy. 2020. 'Building Forward: Investing in a Resilient Economy'. Bennett Institute for Public Policy, University of Cambridge. https://www.bennettinstitute.cam.ac.uk/media/uploads/files/WER_Building_Forward_Investing_in_a_resilient_recovery.pdf.

Carney, Mark. 2020. 'The Reith Lectures'. BBC. 2020. https://www.bbc.co.uk/programmes/m000py8v/episodes/player.

———. 2021. *VALUE(S): Building a Better World for All.* S.l.: WILLIAM COLLINS.

Chrysopoulou, Anna, Mark Anielski, and Michael Weatherhead. 2021. 'Failure Demand - Counting the True Costs of an Unjust and Unsustainable Economic System'. Wellbeing Economy Alliance. https://weall.org/failuredemand.

Cingolani, Luciana. 2022. 'Infrastructural State Capacity in the Digital Age: What Drives the Performance of COVID-19 Tracing Apps?' *Governance* n/a (n/a). https://doi.org/10.1111/gove.12666.

Coyle, Diane. 2021. 'GDP's Days Are Numbered | by Diane Coyle'. Project Syndicate. 16 December 2021. https://www.project-syndicate.org/commentary/replacing-gdp-with-wealth-and-wellbeing-indicators-by-diane-coyle-2021-12.

Coyle, Diane, and Marianne Sensier. 2020. 'The Imperial Treasury: Appraisal Methodology and Regional Economic Performance in the UK'. *Regional Studies* 54 (3): 283–95. https://doi.org/10.1080/00343404.2019.1606419.

De Miranda, K and Snow, D. 2020. 'Recoupling Economic and Social Prosperity'. CESifo working paper. http://hdl.handle.net/10419/216529.

Donovan, Geoffrey H., and David T. Butry. 2009. 'The Value of Shade: Estimating the Effect of Urban Trees on Summertime Electricity Use'. *Energy and Buildings* 41 (6): 662–68. https://doi.org/10.1016/j.enbuild.2009.01.002.

Duffy, A., C. Jefferies, G. Waddell, G. Shanks, D. Blackwood, and A. Watkins. 2008. 'A Cost Comparison of Traditional Drainage and SUDS in

Scotland'. *Water Science and Technology* 57 (9): 1451–59. https://doi.org/10.2166/wst.2008.262.
Easterly, William, and Ross Levine. 2001. 'It's Not Factor Accumulation: Stylized Facts and Growth Models'. *World Bank Review*, 177–219.
EKOS. 2022. 'Measuring and Valuing the Inclusive Growth Impact from Infrastructure Investment'.
Esteller, Alejandro, and Albert Solé. 2005. 'DOES DECENTRALIZATION IMPROVE THE EFFICIENCY IN THE ALLOCATION OF PUBLIC INVESTMENT? EVIDENCE FROM SPAIN a'. Working Paper 2005/5. Institu d'Economia de Barcelona Centre de Recerca en Federalisime Fiscal i Economia Regional. http://ieb.ub.edu/wp-content/uploads/2018/04/2005-IEB-WorkingPaper-05.pdf.
Fone, David, Frank Dunstan, Keith Lloyd, Gareth Williams, John Watkins, and Stephen Palmer. 2007. 'Does Social Cohesion Modify the Association between Area Income Deprivation and Mental Health? A Multilevel Analysis'. *International Journal of Epidemiology* 36 (2): 338–45. https://doi.org/10.1093/ije/dym004.
Fraser of Allander Institute. 2019. 'The Relationship between Infrastructure and Inclusive Growth: Evidence Review'. Review. Fraser of Allander Institute. https://fraserofallander.org/wp-content/uploads/2021/02/2019-10-Inclusive-Growth-and-Infrastructure.pdf.
Fuente, Angel de la, Xavier Vives, Juan J. Dolado, and Riccardo Faini. 1995. 'Infrastructure and Education as Instruments of Regional Policy: Evidence from Spain'. *Economic Policy* 10 (20): 13–51. https://doi.org/10.2307/1344537.
Funk, Michelle, Natalie Drew, and Martin Knapp. 2012. 'Mental Health, Poverty and Development'. *Journal of Public Mental Health* 11 (4): 166–85. https://doi.org/10.1108/17465721211289356.
Gibson, John, and Felix Rioja. 2017. 'Public Infrastructure Maintenance and the Distribution of Wealth'. *Economic Inquiry* 55 (1): 175–86. https://doi.org/10.1111/ecin.12371.
Giometto, M. G., A. Christen, P. E. Egli, M. F. Schmid, R. T. Tooke, N. C. Coops, and M. B. Parlange. 2017. 'Effects of Trees on Mean Wind, Turbulence and Momentum Exchange within and above a Real Urban Environment'. *Advances in Water Resources*, Tribute to Professor Garrison Sposito: An Exceptional Hydrologist and Geochemist, 106 (August): 154–68. https://doi.org/10.1016/j.advwatres.2017.06.018.
Gnade, Johan Hendrik. 2015. 'The Impact of Basic and Social Infrastructure Investment on Inequality in South Africa'. M.Com., South Africa: University of Johannesburg (South Africa). https://www.proquest.com/docview/2566014406/abstract/3CD847ECC0B4CC1PQ/14.
Government, Scottish. 2020. 'Economic Recovery Implementation Plan: Scottish Government Response to the Advisory Group on Economic Recovery'. Gov.Scot. 12 November 2020. http://www.gov.scot/publications/economic-recovery-implementation-plan-scottish-government-response-to-the-advisory-group-on-economic-recovery/pages/3/.
Gramlich, Edward M. 1994. 'Infrastructure Investment: A Review Essay'. *Journal of Economic Literature* 32 (3): 1176–96. https://www.jstor.org/stable/2728606.
Hayden, F. Gregory. 2011. 'Integrating the Social Structure of Accumulation and Social Accounting Matrix with the Social Fabric Matrix: Integration of Socioeconomic Models'. *American Journal of Economics and Sociology* 70 (5): 1208–33. https://doi.org/10.1111/j.1536-7150.2011.00810.x.
HM Treasury. 2020a. 'Green Book Review Final Report'.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/937700/Green_Book_Review_final_report_241120v2.pdf.
———. 2020b. *Green Book Review 2020: Findings and Response*. London. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/937700/Green_Book_Review_final_report_241120v2.pdf.
———. 2021. 'The Green Book and Accompanying Guidance and Documents'. GOV.UK. 2021. https://www.gov.uk/government/collections/the-green-book-and-accompanying-guidance-and-documents.
Hub, Global Infrastructure. 2022. 'Inclusive Infrastructure'. 2022. https://inclusiveinfra.gihub.org/overview/.
Infrastructure Australia. 2021. 'Assessment Framework 2021 Overview.Pdf'. https://www.infrastructureaustralia.gov.au/sites/default/files/2021-07/Assessment%20Framework%202021%20Overview.pdf.
Jackson, T. 2017. Prosperity without growth: Foundations for the economy of tomorrow. [Abingdon], UK: Routledge.
Kattel, R, Mazzucato, M, Ryan-Collins, J, and Sharpe, S. 2018. 'The Economics of Change: Policy and Appraisal for Missions, Market Shaping and Public Purpose'. *UCL Institute for Innovation and Public Purpose*, July. https://www.ucl.ac.uk/bartlett/public-purpose/publications/2018/jul/economics-change-policy-and-appraisal-missions-market-shaping-and-public.
Kristalina Georgieva, Stefania Fabrizio, Diego B. P. Gomes, and Marina M. Tavares. 2021. 'COVID-19: The Moms' Emergency'. *IMF Blog* (blog). 30 April 2021. https://blogs.imf.org/2021/04/30/covid-19-the-moms-emergency-2/.
Lima de Miranda, Katharina, and Dennis Snower. 2021. 'The Societal Responses to COVID-19: Evidence from the G7 Countries'. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3848338.
Marcelo, Darwin, Xavier Cledan Mandri-Perrott, Schuyler House, and Jordan Schwartz. 2016. 'Prioritizing Infrastructure Investment: A Framework for Government Decision-Making'. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2780293.
Mason, Paul. 2017. *Postcapitalism: A Guide to Our Future*.
Mazzucato, M and Ryan-Collins, J. 2019. 'Putting Value Creation Back into "Public Value": From Market Fixing to Market Shaping'. https://www.ucl.ac.uk/bartlett/public-purpose/publications/2019/jun/putting-value-creation-back-public-value-market-fixing-market-shaping.
Mazzucato, Mariana. 2018. *The Value of Everything: Making and Taking in the Global Economy*. [London], UK: Allen Lane, an imprint of Penguin Books.
McCrone, Paul R., ed. 2008. *Paying the Price: The Cost of Mental Health Care in England to 2026*. London: King's Fund.
McKinney, Michael L., and Alexandra VerBerkmoes. 2020. 'Beneficial Health Outcomes of Natural Green Infrastructure in Cities'. *Current Landscape Ecology Reports* 5 (2): 35–44. https://doi.org/10.1007/s40823-020-00051-y.
Meadows, D. 1999. 'Leverage Points: Places to Intervene in a System'. *The Academy for Systems Change* (blog). 1999. https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/.
'Measuring Well-Being and Progress: Well-Being Research - OECD'. 2021. Oecd.Org. 2021.

https://www.oecd.org/wise/measuring-well-being-and-progress.htm.
Michael Marmot, Tony Atkinson, John Bell, Carol Black, Patricia Broadfoot, Julia Cumberlege, Ian Diamond, et al. 2010. 'Fair Society, Healthy Lives: The Marmot Review'. Strategic Review of Health Inequalities 2/2010. London: Institute for Health Inequality. https://www.parliament.uk/globalassets/documents/fair-society-healthy-lives-full-report.pdf.
Mitleton-Kelly, Eve. 2015. 'Effective Policy Making: Addressing Apparently Intractable Problems'. In *Handbook on Complexity and Public Policy*, by Robert Geyer and Paul Cairney, 111–28. Edward Elgar Publishing. https://doi.org/10.4337/9781782549529.00014.
Murray, Sam, and Roger Loveless. 2021. 'Disability: The Living Standards Framework and Wellbeing in New Zealand'. *Policy Quarterly* 17 (1). https://doi.org/10.26686/pq.v17i1.6732.
Natural Capital Ireland. 2021. *Carl Obst of IDEEA Group on Developing the SEEA (System of Environmental Accounting), INCASE 10/2/21*. https://www.youtube.com/watch?v=-0rqdddPHWY.
NIC. 2021. 'Second National Infrastructure Assessment: Baseline Report'. NIC. 2021. https://nic.org.uk/studies-reports/national-infrastructure-assessment/baseline-report/.
OECD. 2021a. 'OECD Social and Welfare Statistics - Time Use'. Statistical Tables. OECD. https://www.oecd-ilibrary.org/social-issues-migration-health/data/oecd-social-and-welfare-statistics/time-use_675ecc4a-en.
———. 2021b. *OECD Environmental Performance Reviews: Australia*. OECD Environmental Performance Reviews. OECD. https://doi.org/10.1787/d73547b7-en.
OECD, Eurostat, and World Health Organization. 2017. *A System of Health Accounts 2011: Revised Edition*. OECD. https://doi.org/10.1787/9789264270985-en.
Office for National Statistics. 2021a. 'Public Service Productivity: Total, UK QMI - Office for National Statistics'. Government Website. Office for National Statistics. 14 April 2021. https://www.ons.gov.uk/economy/economicoutputandproductivity/publicservicesproductivity/methodologies/publicserviceproductivityestimatestotalpublicservicesqmi.
———. 2021b. 'UK Natural Capital Accounts 2021 - Office for National Statistics'. Statistical Tables. UK Natural Capital Accounts. London: Office for National Statistics. https://www.ons.gov.uk/economy/environmentalaccounts/datasets/uknaturalcapitalaccounts2020.
———. 2022. 'INAC01 SA: Economic Inactivity by Reason (Seasonally Adjusted) - Office for National Statistics'. Statistical Tables. Office for National Statistics. https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/economicinactivity/datasets/economicinactivitybyreasonseasonallyadjustedinac01sa.
Parente, Stephen L., and Edward C. Prescott. 1994. 'Barriers to Technology Adoption and Development'. *Journal of Political Economy* 102 (2): 298–321. https://www.jstor.org/stable/2138663.
Penuel, William R. 2019. 'Infrastructuring as a Practice of Design-Based Research for Supporting and Studying Equitable Implementation and Sustainability of Innovations'. *Journal of the Learning Sciences* 28 (4–5): 659–77. https://doi.org/10.1080/10508406.2018.1552151.
PricewaterhouseCoopers. 2022. 'King IV Report - Corporate Governance'. PwC. 2022. https://www.pwc.co.za/en/publications/king4.html.

Raworth, Kate. 2017. *Doughnut Economics: Seven Ways to Think like a 21st Century Economist*. White River Junction, Vermont: Chelsea Green Publishing.
Rioja, Felix. 2013. 'What Is the Value of Infrastructure Maintenance'. In . Cambridge, Massachusets. https://www.lincolninst.edu/publications/conference-papers/what-value-infrastructure-maintenance.
Rioja, Felix K. 2005. 'Roads versus Schooling: Growth Effects of Government Choices'. *Topics in Macroeconomics* 5 (1). https://doi.org/10.2202/1534-5998.1084.
Rodrik, Dani. 1998. 'Where Did All The Growth Go? External Shocks, Social Conflict, and Growth Collapses'. w6350. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w6350.
Romer, Paul M. 1986. 'Increasing Returns and Long-Run Growth'. *Journal of Political Economy* 94 (5): 1002–37. https://www.jstor.org/stable/1833190.
Rosie Stock Jones. 2020. 'Productivity Knocks - Levelling up with Social Infrastructure Investment'. Working Paper 01/2020. Centre for Progressive Policy.
Scottish Government. 2018. *Exploring the economic rationale for infrastructure investment*. https://www.gov.scot/publications/exploring-economic-rationale-infrastructure-investment/
Scottish Government. 2021a. 'A National Mission with Local Impact: Infrastructure Investment Plan for Scotland 2021-22 to 2025-26.'
———. 2021b. *A Fairer, Greener Scotland: Programme for Government 2021-22*. Edinburgh: The Scottish Government. https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2021/09/fairer-greener-scotland-programme-government-2021-22/documents/fairer-greener-scotland-programme-government-2021-22/fairer-greener-scotland-programme-government-2021-22/govscot%3Adocument/fairer-greener-scotland-programme-government-2021-22.pdf?forceDownload=true.
———. 2022. 'Scotland's National Strategy for Economic Transformation'. 2022. http://www.gov.scot/publications/scotlands-national-strategy-economic-transformation/.
Scottish Leaders Forum. 2022. 'Leadership, Collective Responsibility and Delivering the National Outcomes'. https://scottishleadersforum.files.wordpress.com/2022/03/leadership-collective-responsibility-and-delivering-the-national-outcomes.pdf
SEEA. 2019. 'SEEA Global Indicator Review'. Working Paper. https://seea.un.org/sites/seea.un.org/files/seea_global_indicator_review_methodological_note_post_workshop_0.pdf.
Sobocki, Patrik, Bengt Jönsson, Jules Angst, and Clas Rehnberg. 2006. 'Cost of Depression in Europe'. *The Journal of Mental Health Policy and Economics* 9 (2): 87–98.
Stanley, Presented Fiona, and Mike Salvaris. 2019. 'The Case for a Western Australian Development Index', 99.
Stoknes, Per Espen, and Paul Hawken. 2021. *Tomorrow's Economy: A Guide to Creating Healthy Green Growth*. Cambridge, Massachusetts: The MIT Press.
Sun Yu and Tom Mitchell. 2022. 'China's Economy: The Fallout from the Evergrande Crisis'. *Financial Times*, 6 January 2022. https://www.ft.com/content/13476bf7-a519-427c-afd8-06e5579539d8.

Suppakittpaisarn, Pongsakorn, Xiangrong Jiang, and William C. Sullivan. 2017. 'Green Infrastructure, Green Stormwater Infrastructure, and Human Health: A Review'. *Current Landscape Ecology Reports* 2 (4): 96–110. https://doi.org/10.1007/s40823-017-0028-y.

The Economist. 2022. 'New Zealand's Housing Crisis Is Worsening', 12 February 2022. https://www.economist.com/asia/2022/02/12/new-zealands-housing-crisis-is-worsening.

Treasury, New Zealand. 2021a. 'LSF as a Poster'. The Treasury's Living Standards Framework at a Glance. 2021. https://www.treasury.govt.nz/sites/default/files/2019-12/lsf-as-poster.pdf.

———. 2021b. 'Our Living Standards Framework'. Treasury.Gov.Nz. 2021. https://www.treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework.

———. 2022. 'Living Standards Framework - Dashboard'. 2022. https://lsfdashboard.treasury.govt.nz/wellbeing/.

Treasury, NZ. 2021. 'The Living Standards Framework 2021'. ISSN: 2744-6832 (Online). New Zeland Treasury. https://www.treasury.govt.nz/publications/tp/living-standards-framework-2021.

UCL Institute for Innovation & Public Purpose. 2020. 'Alternative Policy Evaluation Frameworks and Tools'. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/926642/alternative-policy-evaluation-frameworks-and-tools.pdf.

Watt, Paul. 2013. '"It's Not for Us": Regeneration, the 2012 Olympics and the Gentrification of East London'. *City* 17 (1): 99–118. https://doi.org/10.1080/13604813.2012.754190.

What Works Well. 2015. 'Estate Renewal Review'. 2015. https://whatworksgrowth.org/public/files/Policy_Reviews/15-01-26-Estate-Renewal-Full-Review.pdf#page=9.

WHO. 2020. 'The Case for Investing in Public Health'. https://www.euro.who.int/__data/assets/pdf_file/0009/278073/Case-Investing-Public-Health.pdf.

Wójcik, Piotr Tadeusz. 2021. 'The Parallel Convergence of Income and Educational Achievements: Joint Distribution Dynamics'. *The Annals of Regional Science*, October. https://doi.org/10.1007/s00168-021-01086-7.

Xun, Zhang, and Wan Guanghua. 2017. 'Rural Infrastructure and China's Inclusive Growth'. *China Economist* 12 (5): 100–108. https://www.proquest.com/docview/1936467893/abstract/3CD847ECC0B4CC1PQ/16.

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