

Toward green and just transitions in city regions

A study of three different approaches to urban sustainability policymaking

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October 2022



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Acknowledgements

This report constitutes a collaborative project between The University of Manchester and the Greater Manchester Combined Authority. The Author would like to thank everyone at the Combined Authority who has provided feedback on the report, and thank the following for their specific inputs into the project:

Rachel Berman	Principal Researcher (Environment)
Katrina Hann	Acting Assistant Director of Research (Programmes)
Lisa Dale-Clough	Head of Industrial Strategy
Prof Elvira Uyarra	Executive Director of the Manchester Institute for Innovation Research, Alliance Manchester Business School, The University of Manchester
Dr Jo Mylan	Sustainable Consumption Institute and Manchester Institute for Innovation Research, Alliance Manchester Business School, The University of Manchester
Dr Imogen Rattle	School of Earth and Environment, University of Leeds
Nathan Feddy	Vector Homes Chief Executive Officer
Liam Britnell	Vector Homes Chief Technology Officer
Jonas Singer	Vector Homes Chief Operations Officer

The author gratefully acknowledges support from Policy@Manchester within The University of Manchester, as part of the QRSPF grant monies allocation from Research England.

Executive summary

The Greater Manchester Local Industrial Strategy (GM LIS) (HM Government et al., 2019), was one of the UK's first modern local industrial strategies. It took a mission-oriented approach, embedding regional economic strategies within a clean growth mission to achieve net zero by 2038. Thinking in a mission-oriented way, according to Mazzucato (2021; p.123) “requires rethinking the role of government in the economy, putting purpose first and solving problems that are important to citizens”. In its foreword, the GM LIS also stated that the “focus on frontier and foundational sectors – and the connections between them – will support the creation of a highly productive, more inclusive and prosperous city-region for all residents” (HM Government et al., 2019: p.5).

The COVID-19 pandemic has heightened the need for such an approach, revealing persistent problems of social polarisation, environmental sustainability and spatial inequality. It has also brought to bear the importance of ‘foundational sectors’ that provide the infrastructure for everyday life and support human needs directly.

In response to this, the new Greater Manchester Strategy 2021-2031 aims to simultaneously pursue carbon neutrality and socio-economic improvements. This can be reinforced as part of the refreshed Greater Manchester Local Industrial Strategy.

This report seeks to understand how to best integrate and mobilise both frontier and foundational sectors to address societal challenges. There is no universal definition regarding which services can be considered foundational. They are, however, understood to include *material infrastructure* – for example, water and electricity – and *providential services* – such as education, food, health and social care. Foundational sectors are important because they are responsible for the provision of essential services, but also because they employ up to 40% of the workforce throughout the UK (Heslop et al., 2019). Improving the working conditions of these sectors is, therefore, critical to raising living standards, social wellbeing, and economic productivity.

An industrial policy focus on foundational as well as frontier sectors requires a broader outlook on policy action, away from narrow targeting of high-tech activities and towards exploiting interconnections between these and more mundane, everyday activities and needs. It requires a shift from adopting a purely supply-side focus to one that considers demand and collective consumption (public, households) as key levers and drivers for innovation, and from a sole focus on economic growth to a focus on supporting multiple value creation (social, economic, environmental) (Flanagan et al., 2022).

The cases analysed in this report provide examples of how some regional and city regional economies have navigated through these challenges in the design of their economic strategies. These insights, based on desk research, centre on the strategic vision of these regions, with less evidence available about the implementation of their strategies. Nevertheless, it is useful to see how different places have framed the challenges and trade-offs they face in their support for economic development, as well as their proposed actions and evaluation frameworks.

Taken together, the case studies and recommendations of this report do not suggest a single course of action for local sustainability policymaking. Rather, they constitute a frame of reference to inform sustainability initiatives, especially for the pursuit of net zero and social equity objectives. However, five key lessons can be extracted from the cases.

1. **Synthesise existing frameworks** (for example, foundational economy and Doughnut Economics) in order to bring different dimensions into conversation to advance policy innovations that better address local challenges. Problem or challenge-oriented industrial and innovation strategies require inputs from a larger and more diverse set of actors, sectors and types of knowledge, and are therefore more likely to contribute to inclusive, sustainable and resilient regional economies.
2. **Expand interactions between frontier and foundational sectors.** Policies to support foundational and frontier sectors should not be seen as dichotomous or competing. Rather, societal challenges are foundational and place-based, and the innovations to solve them will likely require input from both foundational and frontier sectors.
3. **Revise the Mission roadmap to better address current climate and socio-economic challenges.** Multiple policy instruments will be required to support net zero and social objectives and their implementation will need to be closely monitored and coordinated.
4. **Reframe the role of foundational sectors within the context of the local economy.** Mission oriented policies tend to be not only biased towards frontier sectors but also to global problems. Reframing missions to encompass both climate change and socio-economic deficiencies more directly and with reference to local needs, is a first step towards a more socially and spatially inclusive policy.
5. **Conduct longer-term analyses of regions with successful and equitable economic strategies.** Learn from others and form alliances. Collaborating with cities with similar challenges and values can support policy learning and also widen potential markets that help upscale local innovations to new places or fields of application.

Introduction

The Greater Manchester Local Industrial Strategy (GM LIS) (HM Government et al., 2019), was one of the UK's first modern local industrial strategies. It embedded regional economic strategies within a clean growth mission to achieve net zero by 2038. Although the strategy is likely to have an enduring legacy for Greater Manchester's policymaking, new approaches will likely be required to address the various significant environmental, social and economic pressures that have occurred since 2019 (for example, the COVID-19 pandemic, the UK's exit from the European Union, the energy and inflation shock, and increased awareness of the climate emergency). In this context, the Greater Manchester Combined Authority (GMCA) is refreshing its evidence base to inform the refresh of the GM LIS.

This report from the Alliance Manchester Business School (AMBS) is an exploratory paper that aims to contribute to the evidence base refresh for the GM LIS. The report presents three case studies of city regions aiming to deliver sustainability innovations, with the aim of deriving preliminary recommendations for Greater Manchester. The city regions studied are:

1. Amsterdam, the Netherlands;
2. The Basque Country, Spain; and
3. Washington, D.C., USA.

These cases all uphold the pursuit of green and just sustainability transitions, which are priorities that have grown in prominence following the onset of the COVID-19 pandemic (e.g. Hepburn et al., 2020; Shuckburgh et al., 2020; Varenne, 2021; IPCC, 2022). Indeed, the simultaneous pursuit of carbon neutrality and socio-economic improvements is a defining feature of the new Greater Manchester Strategy 2021-2031 (GMCA, 2022). This report offers additional insights into how green and just priorities may be reinforced within the refresh of the GM LIS.

The research for this report was conducted using qualitative techniques, and the case studies were selected following consultations with the GMCA's Research Team and academic experts at AMBS. Three cases were selected with the aim of providing diversity of analysis, while also acknowledging the limited timeframe of five months that inhibited further case selection. The cases of Amsterdam and Washington D.C. were informed by the [C40 Cities network](#), which is an extensive global network of member cities committed to green and just urban transformations.¹ The case of the Basque Country, Spain, was selected following expert academic advice from AMBS. Collectively, these cases were selected for the accessibility and depth of relevant

¹ The C40 network is recognised both as an [information hub](#) and as a mobiliser of climate interventions on the ground. Nguyen et al. (2020) note that the C40 has supported the delivery of about 14,000 pilot projects for climate mitigation in cities since 2011.

source material, and for their engagement with both net zero and socio-economic concerns.

The cases of Amsterdam and the Basque Country focus upon conceptual frameworks to guide sustainability policymaking. The Washington D.C. case study focuses upon action strategies for the delivery of sustainability objectives on the ground. Collectively, the case selection aims to address the challenges of establishing an overarching directionality for sustainability policymaking while also outlining specific actions in support of clear goals.

The cases underscore a key point that emerges from the academic literature on sustainability transitions (e.g. Markard et al., 2012; Geels et al., 2017; Köhler et al., 2019), namely that climate change and socio-economic inequities cannot be resolved through technical fixes alone, but that extensive transformations of societal systems are required. This approach has been adopted in the latest policy recommendation of the United Nations Intergovernmental Panel on Climate Change (IPCC, 2022), among other forums. **Part Two – Preliminary Recommendations** suggests how system-level changes in Greater Manchester can be encouraged on the basis of key considerations from the three case studies.

Moreover, the case analysis and recommendations were formulated within the limitations of a five-month time frame. Further research may yield additional recommendations, add weight to this report, or challenge the current findings. The GMCA's wider strategies and/or resource constraints, of which the specifics may be unknown to the author, can create additional tensions for the delivery of any particular recommendation. The findings of this report, therefore, are presented as exploratory to support the refresh of the GM LIS.

Part One: Case studies of sustainability policymaking in city-regions

Part One presents three case studies of sustainability policymaking in city regions. The regions studied are:

1. Amsterdam, the Netherlands;
2. The Basque Country, Spain; and
3. Washington, D.C., USA.

Each case supports the pursuit of green and just sustainability transitions. The first two cases, of Amsterdam and the Basque Country, represent innovative conceptual frameworks for local sustainability policymaking. The third case of Washington D.C. represents a strategic plan for the implementation of local policy initiatives. **Table 1** presents a high-level summary overview of the cases.

Table 1. High-level overview of the case studies.

City Region	Key Approaches/ Concepts	Relevance for GM LIS
<i>Amsterdam</i>	<ul style="list-style-type: none"> • Doughnut Economics • Planetary boundaries • UN SDGs • Consumption-based emissions • Foundational economy 	<ul style="list-style-type: none"> • GAP-analysis methodology to measure a city's position against a range of sustainability indicators. • Juxtaposition of green and just priorities within single framework. • Juxtaposition of economic and social factors within single framework. • Internationally-acclaimed model for sustainability policymaking.
<i>The Basque Country</i>	<ul style="list-style-type: none"> • Social wellbeing • Planetary wellbeing • Economic performance • UN SDGs • Foundational economy 	<ul style="list-style-type: none"> • Focus on wellbeing / quality of life. • Highlights interrelationships between economic performance and wellbeing. • Examples of data indicators to measure wellbeing. • Alternative conceptualisation of foundational economy's role within wider regional economy.
<i>Washington D.C.</i>	<ul style="list-style-type: none"> • Action strategies for policy implementation • Social inclusivity • Equitable economic growth • Foundational economy 	<ul style="list-style-type: none"> • Sustainability challenges split into Topics, Goals, Targets, & Actions. • Accountability & timeframes defined for each action. • Does not reference mission-led innovation explicitly, but can be mobilised as a complementary approach.

Case Study 1. Amsterdam's adoption of Doughnut Economics²

Introduction

Doughnut Economics (DE) is a term used to describe a particular model of a sustainable economy (see **Figure 1**). It is attributed principally to British economist Kate Raworth (2012; 2017), whose work has received extensive publicity. Raworth's (2018) [TED talk](#) garnered over 4 million views, and the DE model has been presented to the United Nations (Raworth, 2017) and used to engage multinational corporations (such as Unilever) on sustainable business practices (DEAL, 2020a). Key features of the model have also been mirrored in recent policy publications, including those of the European Commission (Pontikakis et al., 2020) and the United Nations Intergovernmental Panel on Climate Change (IPCC, 2022).³

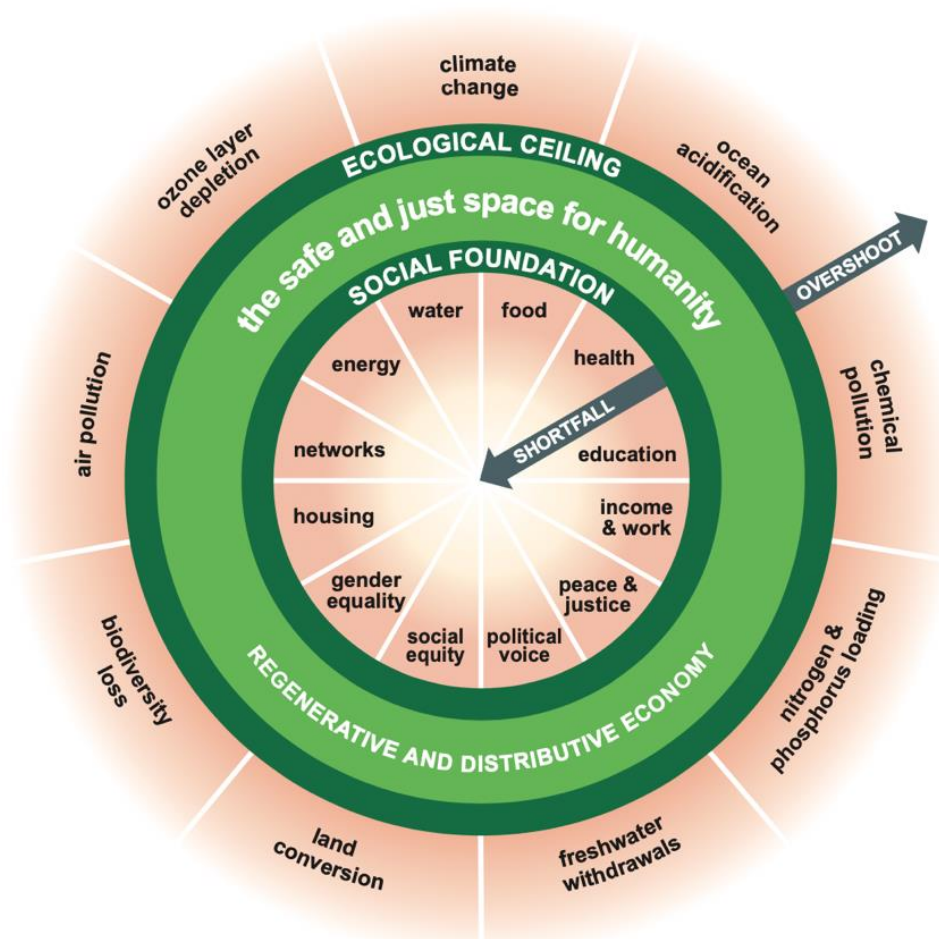


Figure 1. The Doughnut Economics framework. The innermost ring contains economic and social priorities derived from the UN SDGs; the outermost ring contains the nine planetary boundaries. (Source: DEAL et al., 2020a: p.6).

² Full details of the Amsterdam City case study are available in the published [Amsterdam City Doughnut](#) report.

³ The EC's project, *Projecting Opportunities for Industrial Transitions* (POINT), begins with the admission that, "human activity is overstepping *planetary boundaries*" (Pontikakis et al., 2020: p.7, italics added). The IPCC's recent framework for "climate resilient development" has clear similarities to the DE model, placing social priorities at the centre and the Earth's ecosystems at the periphery (see IPCC, 2022: p.4).

The DE model carries multiple antecedents from sustainability scholarship. Principal among this would be Rockström et al.'s (2009) identification of [nine planetary boundaries](#) that delineate “a safe operating space for humanity” (p.472).⁴ Raworth's contribution embeds social and economic priorities, derived from the 2015 United Nations Sustainable Development Goals (UN SDGs), within the planetary boundaries framework (in the centre of the diagram). This prompts questions of how an economy can satisfy core human needs without overburdening the Earth's natural ecosystems.

The [City Portrait methodology](#) (DEAL et al., 2020a) is an approach developed by Raworth and colleagues to “downscale” the Doughnut Economics framework to the city-level. The application of this methodology is most notable in Amsterdam, which in April 2020 became the first city in the world to adopt the DE model formally (C40 Cities, 2020). Accessible and detailed source material exists for Amsterdam's approach, most notably in the publication of [Amsterdam's City Doughnut](#) (DEAL et al., 2020b).

The City Portrait Methodology

The City Portrait methodology begins by presenting urban stakeholders with a single core question:

How can our city be a home to thriving people, in a thriving place, whilst respecting the wellbeing of all people, and the health of the whole planet?
(DEAL et al., 2020a: p.7).

To answer this question, stakeholders are required to articulate their city's desired outcomes according to four “lenses” (or factors): social, ecological, local and global. This process forms a basis for comparing a city's sustainability ambitions against its current position, resulting essentially in a high-level GAP-analysis. This analysis can be informed by both quantitative and qualitative data.⁵ Detailed results from the adoption of this process in Amsterdam can be found in [The Amsterdam City Doughnut report](#). A concise summary is provided below.

Lens 1: Local – Social

The first lens asks policymakers to question what socio-economic outcomes are associated with a thriving local population. Amsterdam's preferred outcomes were defined through a process of collaboration and engagement with local residents

⁴ Continuous evaluation of human activity vis-à-vis the planetary boundaries occurs at the [Stockholm Resilience Centre](#).

⁵ Conducting this exercise requires the identification of data sources that support the evaluation of a city's social and ecological impacts, and conversely, it highlights where limitations in data exist. The [City Portrait methodology](#) (DEAL et al., 2020a: pp. 11, 17, 23, 29) offers decision trees to guide the appropriate selection of data for each factor, with mitigating routes to overcome data limitations.

(DEAL et al., 2020b). A wide range of quantitative data was collated to contrast these preferred outcomes against the city's current position.

Lens 2: Local – Ecological

The second lens queries how a city can fulfil societal needs while protecting biophysical ecosystems. The aim here is to promote “biomimicry”, or innovations inspired by nature, where natural processes are emulated within urban infrastructure and industries. Amsterdam sought to identify specific natural processes from the surrounding ecosystems, and explored how to emulate these within its local economy (more detail on page 9 of [The Amsterdam City Doughnut report](#)).

Lens 3: Global – Ecological

The third lens focuses attention on a city's global environmental impacts, on the basis of local consumption patterns (DEAL et al., 2020b). This encompasses a city's consumption-based carbon emissions (Scope 3),⁶ which refer to the emissions arising from goods and services used within cities, even if a significant proportion of those emissions are produced elsewhere (Wendler & Blakey, 2021).⁷ Through data analysis, one can determine whether a city is overshooting any of the planetary boundaries through its levels of resource consumption.

Lens 4. Global – Social

This lens questions what it would mean for a city to honour the wellbeing of global communities. While Lens 3 focused on global environmental impacts from consumption, Lens 4 explores the global socio-economic repercussions of the city's purchasing and procurement practices. In particular, this means focusing on the labour conditions found in the supply chains that deliver a city's products and services, and how these conditions contrast with the goals of the UN SDGs (DEAL et al., 2020b).

One of Amsterdam's strategies for addressing such concerns is to champion sustainable businesses, registered in the city, which aim to tackle global social injustices. These include [Tony's Chocolonely](#) and [Moyee Coffee](#). Moreover, Amsterdam has formulated responsible procurement guidelines that the Municipal authorities are to adhere to, which focus on labour standards in global supply chains (DEAL et al., 2020b).

⁶ Aziz & Mylan (2021) & Aziz, Mylan et al. (2022). [Incorporating food into Manchester's climate change response: Parts One and Two](#) look further at sources of consumption-based carbon emissions in the context of the foundational economy, specifically the food sector. A wider analysis of consumption-based emissions in Manchester is offered by Wendler & Blakey's (2021) report on [Decarbonising Consumption](#).

⁷ The C40 network's recent guide, [How to cut your city's consumption-based emissions](#), is relevant for further consideration on this issue.

Conclusion

Amsterdam's City Doughnut represents the first attempt by a major city to adopt the Doughnut Economics framework as a centrepiece of sustainability policymaking. The adoption of this framework was facilitated by the City Portrait methodology, which prompts a detailed investigation into a city's environmental and socio-economic impacts through the adoption of four "lenses". The unfolding GAP-analysis can then serve as a foundation for new sustainability strategies.

The case of Amsterdam does not offer a defined path towards sustainability. Rather, it offers a methodology by which cities can explore their range of impacts and generate future visions of a green and just economy and society. The combination in a single framework of several socio-economic priorities and climatic factors is perhaps the greatest attribute of the Doughnut model. **Part Two** of this report will explore how this framework can be expanded further to capture additional considerations that can inform sustainability policymaking.

Case Study 2. The Basque Country's pursuit of competitiveness and wellbeing⁸

Introduction

The Basque Country is an autonomous region of Northern Spain with its own government and a population of over 2 million citizens (Rodríguez, 2015). Following the deployment of regional industrial strategies over several decades, the Basque Country now stands as one of the European regions with the highest GDP per capita and lowest population risk levels of poverty and social exclusion (Álvaro et al., 2021).⁹ This case study explores the leading and most recent economic strategy for the Basque Country – the [2021 Basque Country Competitiveness Report](#) (Álvaro et al., 2021), and its [executive summary](#) (Orkestra BloC, 2021).

A mutual relationship between competitiveness and wellbeing

The *Basque Competitiveness Report* advances a new framework for sustainable economic development (see **Figure 2**), to better address societal and climatic pressures than earlier strategies for the region.¹⁰ In this framework, economic competitiveness is not an end in and of itself, but rather a means for “moving towards inclusive and sustainable wellbeing” (Orkestra BloC, 2021: p.4). Indeed, the *Competitiveness Report* carries the subtitle ‘Constructing Competitiveness for *Wellbeing*’ (Orkestra BloC, 2021, italics added).

The framework builds on earlier iterations developed for regional development in the Basque Country (Álvaro et al., 2021), built around two specific arguments: firstly, to acknowledge the limitations of using GDP to assess regional development and the need to analyse development beyond economic progress; and secondly, the need for governments and the public sector to provide direction to sustainability policy making. The *Basque Competitiveness Report* acknowledges a plethora of academic and grey literature including from the World Economic Forum, the UN SDGs, and Joseph Stiglitz's critiques of GDP measurements (World Economic Forum, 2019; Stiglitz et al., 2018a, 2018b).

This emphasis on “wellbeing” encompasses both human and planetary health. For instance, implicit in the “Environment” dimension of **Figure 2** is an intention to decarbonise all productive sectors in the economy, in pursuit of net zero emissions by 2050 (Álvaro et al., 2021). A positive, circular feedback loop is advanced, where

⁸ Full details of the Basque Country case study are available in the published [2021 Basque Country Competitiveness Report](#).

⁹ International studies, such as those by the OECD (2011), Morgan (2016) and Porter et al. (2016) have identified the Basque region as an example of successful economic development.

¹⁰ The authors stress that the framework in Figure 2 was not designed exclusively for the Basque region, but as a heuristic to guide sustainability policymaking in global cities (Álvaro et al., 2021).

social and planetary wellbeing support economic performance, and vice versa (Álvaro et al., 2021). A key finding from the literature review in the report was that despite the broad range of factors that can be used to denote wellbeing, it is important to limit the number selected in order to promote clarity in future policymaking. The *Basque Competitiveness Report*, therefore, selected seven wellbeing dimensions, which they identify as relating to all 17 UN SDGs (Álvaro et al., 2021, p.15).

The report collates quantitative and/or qualitative data to evidence each of the dimensions listed in the middle of the framework, often using corresponding European Union data as a benchmark to measure progress in the Basque region (Álvaro et al., 2021).¹¹ Pages 15 and 16 of the *Basque Competitive Report* provide the data indicators selected to measure each of the wellbeing and economic dimensions. Furthermore, beyond the detail of **Figure 2**, the Report advocates greater attention towards foundational economy sectors for the facilitation of a sustainability transition (Orkestra BloC, 2021).

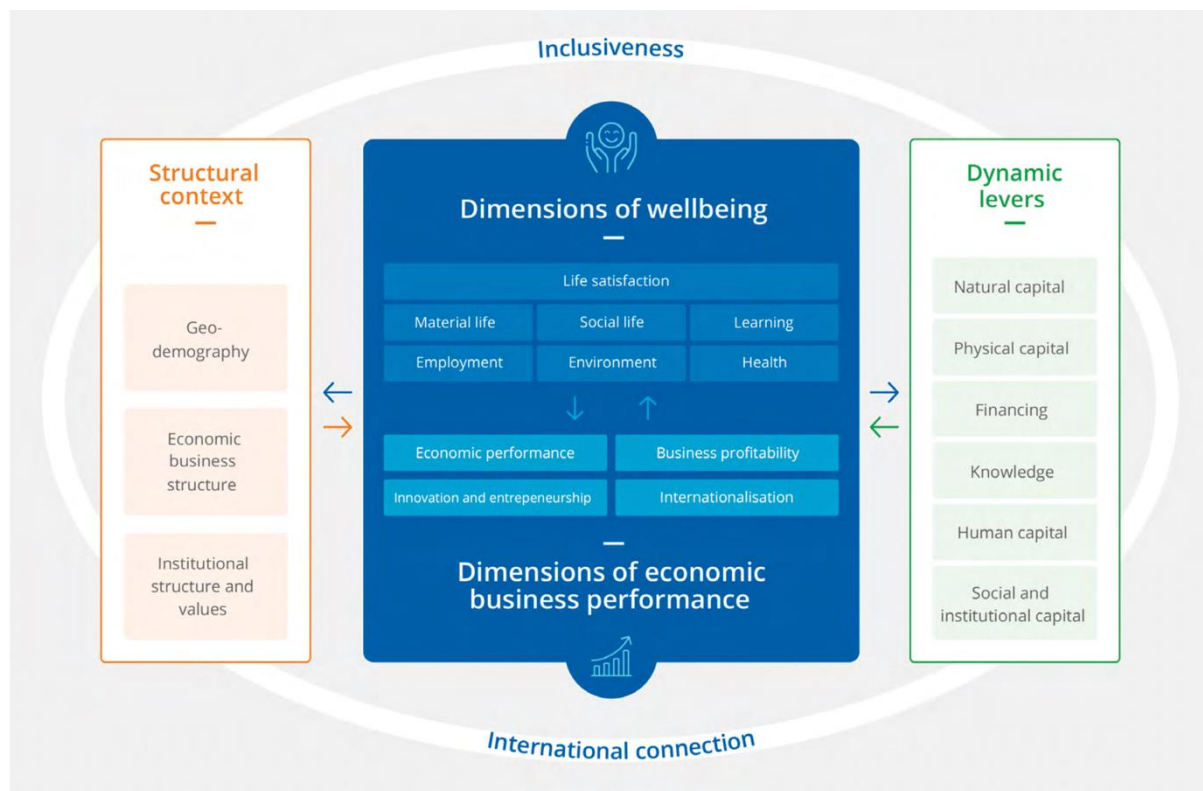


Figure 2. The leading framework from the *Basque Competitiveness Report* to promote economic competitiveness and wellbeing. (Source: Álvaro et al., 2021: p.19).

¹¹ See Álvaro et al. (2021), Chapters 3 & 4 for a full data analysis corresponding to all the dimensions.

The framework references structural context on the left-hand side. This refers to “a number of characteristics of the territory itself which are largely permanent or fairly stable over time... Furthermore, to a large extent, structural characteristics are neither good nor bad in themselves, although public strategies and policies must take them into account” (Álvaro et al., 2021: p.17).

The dynamic levers on the right-hand side of the framework represent actionable factors that can affect both economic performance and social wellbeing. Moreover, these levers can also affect the structural context; for example, by promoting sectoral changes.

Conclusion

The Basque Country has been identified as an example of successful economic development by the OECD, among others (footnote 7 above). The region’s recent policymaking demonstrates innovation through the positioning of planetary and social wellbeing as the principal objective for local economic strategies. As **Figure 2** implies, these outcomes are seen as essential not only for environmental and societal reasons, but as drivers of economic performance. This sentiment is further evoked when the *Basque Report* states, “productivity in all industries... rel[ies] on healthy, qualified and happy people” (Álvaro et al., 2021: p.8). **Part Two** of this report will further explore the interrelationship between economic performance and wellbeing, in particular by focusing upon the potential role of the foundational economy as a driver of both outcomes.

Case Study 3. Washington, D.C.'s action strategies for delivering local sustainability policy¹²

Introduction

Washington D.C., known in full as the District of Columbia, is the USA's capital city with a population of over 700,000 residents (Bowser et al., 2018). The city's leading sustainability plan is [Sustainable DC 2.0](#), (SDC 2.0) authored by the District Government, with a scope extending from 2018 to 2032 (Bowser et al., 2018). SDC 2.0 represents an iteration of an earlier strategy from 2013, and intends to address climate change while giving greater emphasis to local residents' economic and social needs.

The report's structure and methodology

SDC 2.0 adopts a rigorous structure and methodology. At the top sit 13 "topics", which constitute the overarching priority areas for sustainability interventions (Bowser et al., 2018: p.6), such as *climate, economy, energy, nature, and waste*. Each topic is introduced with a data presentation, often in the form of infographics, to demonstrate the city's current situation and/or future forecasts, with each topic then disaggregated into goals, targets and actions to instruct delivery on the ground. For example, for the "Nature" topic, this is:

Goal: "Protect, restore, and expand aquatic ecosystems".

Target: "By 2032, protect, restore, and create 1,000 acres of critical aquatic habitat".

Actions:

- "Develop a Wetland Registry to facilitate restoration or creation of wetland habitat".
- "Plant and maintain an additional 150 acres of wetlands in targeted Conservation Opportunity Areas".
- "Partner with developers to incorporate living shorelines in waterfront developments".
- "Reduce threats to 75 aquatic species of greatest conservation need".

This format is replicated across the report for each topic. Each action is assigned to Lead Agencies and Partner Agencies that are responsible for delivery within a short-, medium-, or long-term duration (Bowser et al., 2018). Lastly, the sustainability interventions advocated for some of the topics are required to yield contributions at the individual, neighbourhood, and/or district level (Bowser et al., 2018: p.110-111).

Underlying the 13 topics are six "Overall Themes", in recognition that "sustainability is crosscutting and interconnected" (Bowser et al., 2018: p.7). These themes are used as guiding principles by the report's working groups, and are summarised

¹² Full details of the Washington D.C case study are available in the published [Sustainable DC 2.0](#) report.

below (see Bowser et al., 2018: p.7 for a full outline). With regards to Point 6, the SDC 2.0 plan offers a table identifying the relationality between itself and the other policies operating in the city, as per Bowser et al., 2018: p.16.

Summary of the *Sustainable DC 2.0* Plan's Overall Themes

1. **Better incorporate accessibility**
“This includes physical accessibility as well as equitable access and treatment by race, age, and gender”.
2. **Think regionally, track locally**
“Sustainability is a regional issue... [but] we need to track our progress at a finer-tuned detail than a citywide level. When the data exists, we need to track progress at both the ward and neighbourhood levels”.
3. **Increase quantitative rigour**
“Sustainable DC 1.0 was released at a time when sustainability planning was relatively new... for sustainability to be taken seriously, targets and actions must be on solid research and analysis”.
4. **Focus on equity**
“Equity – along with environment and economy – is one of the three pillars of sustainability, but often the hardest to address. For that reason, equity must be the leading principle in Sustainable DC 2.0. It should be addressed as its own topic, but also incorporated throughout the plan”.
5. **Use community priorities as foundation**
“The first step in the planning process was to better understand current community priorities... To make sure Sustainable DC 2.0 is relevant to all residents, community priorities must be guiding principles in plan development”.
6. **Align with other District plans**
“We are fortunate to have several robust, detailed plans that address topics within Sustainable DC 2.0... Sustainable DC 2.0 builds on and aligns with these thoughtful documents”.

Given the applicability to Greater Manchester of the ‘Built Environment’ topic within SDC 2.0, this section specifically looks at the example of the Built Environment in more detail.

The Built Environment:

The Challenge

The SDC 2.0 plan highlights that the built environment presents significant environmental and social challenges. It is estimated that 75% of Washington DC’s greenhouse gas emissions result from buildings (Bowser et al., 2018). The city is also one of the most expensive places to live in the USA, and an 11% population increase since 2013 creates additional pressures on housing and social infrastructures (Ibid). The city, therefore, has a need for green and equitable

buildings, which yield a lower environmental income while being affordable and accessible to the city's diverse communities (Ibid). Existing initiatives include the Inclusionary Zoning program, which requires new residential development in mixed income communities to include affordable units (Ibid). Moreover, the SDC 2.0 plan intends to expand the number of initiatives to tackle this challenge.

The Solutions

Solutions to the unsustainability of the city's built environment are grouped under 4 goals. The 4 goals and a sample of their corresponding actions are summarised here (see page 35-41 of the [SDC 2.0](#) for full details).

Goal 1. Sustainably and equitably accommodate future population growth within the District.

Actions towards this goal include (p.35):

- Creating affordable housing with increased energy and water efficiency, particularly because sustainable energy sources (for example, solar) and improved efficiency can reduce household utility bills by 50%. Resource-efficient housing, therefore, yields material advantages particularly for lower income families.
- Expanding brownfield redevelopment initiatives.

Goal 2. Strengthen existing neighbourhoods to be vibrant and walkable while maintaining their historic character.

Actions towards this goal include (pp.36-37):

- Publishing a Walkability assessment map of the city.
- Leveraging local government policy tools to support businesses with occupying and operating in neighbourhood commercial corridors, especially where vacant and underused spaces are found. For example, this can be facilitated by:

streamlining the permanent and temporary permitting processes, providing tax incentives, and creating low-interest financing opportunities. Such programs will help new businesses – including essential services like grocery stores – thrive, particularly in areas that do not have as much commercial development as desired by residents
(Bowser et al., 2018: p.36).

- Supporting the development of affordable “live-work units”. These are spaces that combine living quarters with a workspace, and as such can reduce traffic congestion. The [Brookland Artspace Lofts](#) serve as a current example.
- Strengthen initiatives to finance affordable housing near high capacity transit and commercial zones, to reduce congestion and promote high quality neighbourhoods.

Goal 3. Improve the performance of existing buildings by reducing energy and water use, advancing health, and increasing liveability.

Actions towards this goal include (pp.38-39):

- Continue to retrofit public housing to ensure energy and water efficiency, in addition to improving indoor environmental quality.
- Use the facilities and expertise of District Government and partners to train and develop a “green building workforce”, knowledgeable of best practices and

technological innovations for sustainable buildings, to maximise the benefits of retrofitting and new construction activities. This can be facilitated by an expansion of public-private partnerships. For example, the District Government created a curriculum with the University of the District of Columbia to train public and private building engineers.

- Undertake energy assessments of all District homes and buildings. This involves leveraging smart meter technology to audit more buildings remotely, in order to move towards smart improvements.

Goal 4. Ensure the highest standards of building performance and operation for all new construction, including net zero energy use, while advancing health and overall liveability.

Actions towards this goal include (pp.40-41):

- Ensuring that new public buildings satisfy net zero standards, higher levels of energy efficiency, and renewable energy requirements.
- Incentivise net zero building, through “a coordinated set of incentives (such as accelerated permitting), regulatory improvements, recognition awards, and transparency of energy efficient data to help move the real estate market towards new net zero construction” (p.40).
- Take a holistic approach to neighbourhood planning, addressing walkability, equity, wildlife, and health, among other factors.
- Continuously adopt the latest International Green Construction Code (IgCC), which is updated typically every 3 years.

Conclusion

The principal contribution of the *Sustainable DC 2.0* report is to advance a strategic action and implementation plan, informed by rigorous data analysis, rather than a conceptual framework. Although the report does not reference mission-led innovation directly, the report’s methodology for disaggregating large ambitions into actionable steps (with accountable delivery partners) mirrors key principles of mission-led innovation. The SDC 2.0 report, and the analysis of the Built Environment topic provided here, exemplify the disaggregation process. **Part Two** will argue that this approach can complement the refresh of the GM LIS. **Part Two** will also query how the “Overall Themes” adopted in the SDC 2.0 can complement sustainability policymaking in Greater Manchester.

Part Two: Preliminary recommendations

Part Two offers an analysis of the three case studies covered in **Part One**, in order to present ideas that contribute towards the evidence base for the GM LIS. The analysis is structured as a series of preliminary recommendations, which can be expanded in forthcoming collaborations between the GMCA and AMBS. The analysis is informed by studies in Innovation Management and Entrepreneurship, and Sustainability Transition studies.

Synthesise existing frameworks to promote innovation in local sustainability policymaking

All three case studies have upheld the pursuit of green and just sustainability transformations in city-regions, by focusing upon both economic performance and social justice or equity. While the Washington DC case focused on structuring the implementation of initiatives, the Amsterdam and Basque Country cases presented conceptual frameworks to inform the formulation of policy. While each case study is valuable in and of itself, it is also possible to amalgamate complementary aspects of different approaches to formulate a new strategy. This can help to guide local sustainability policymaking in a more original and impactful manner.

The synthesis of different approaches to sustainability policymaking is being discussed currently in the academic literature. For example, Wahlund & Hansen (2022) point out that the foundational economy and Doughnut Economics have evolved as two separate perspectives on alternative economic development. They recommend leveraging the commonalities between these approaches for a degree of synthesis:

Rather than developing these concepts in isolated silos, we argue that there is *academic and practical merit* in bringing them into conversation... Especially, debates on local responses to failing foundational infrastructure and socioenvironmental systems during the COVID-19 pandemic make it particularly relevant and timely (Wahlund & Hansen, 2022: p.172, italics added).¹³

The forthcoming refresh of the GM LIS constitutes a space where the synthesis of existing frameworks may be attempted, in order to advance policy innovations that better address local challenges.

¹³ This makes particular sense when the social factors found in the inner-ring of the DE model correspond to foundational economy sectors, such as food and water, housing, education and health.

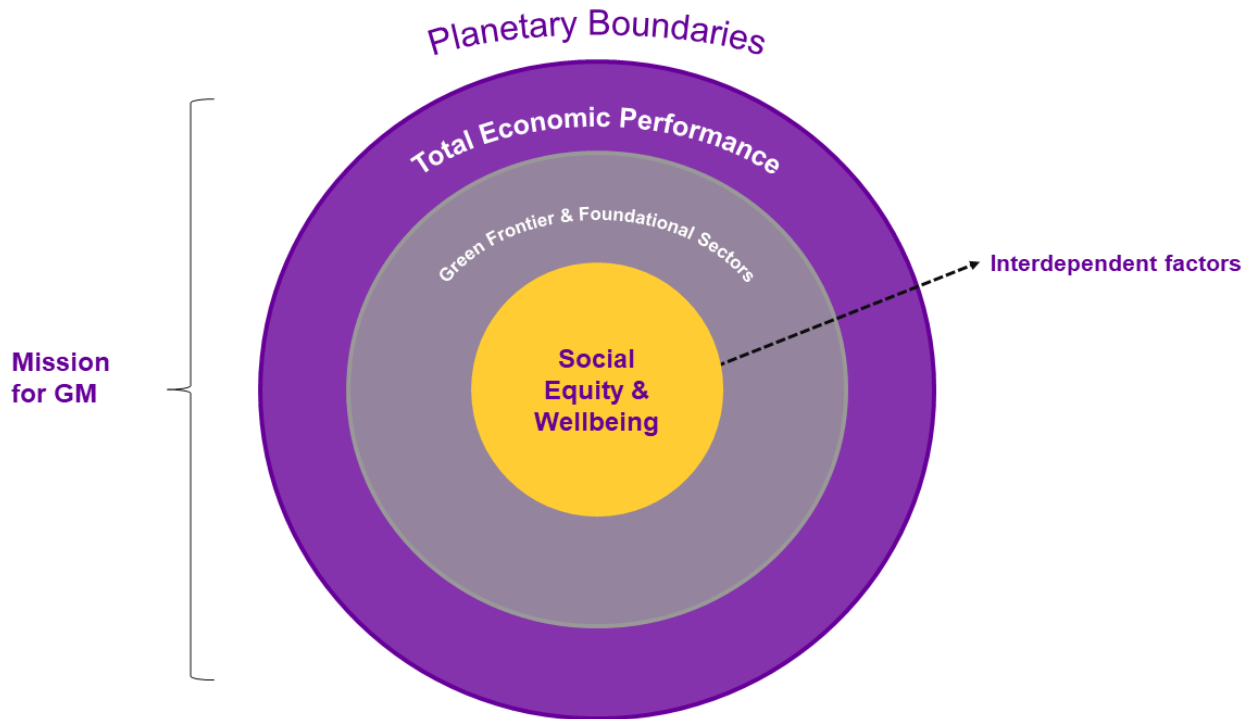


Figure 3. A proposed synthesis of the Doughnut Economics model, the Basque Competitiveness Report's framework for economic competitiveness and wellbeing, and mission-led innovation strategy. (Source: Author based on Álvaro et al., 2021; Bentham et al., 2013; Raworth, 2017; Mazzucato & Dibb, 2019; Wahlund & Hansen, 2022).

Figure 3 represents an initial attempt to synthesise the Doughnut Economics model, the *Basque Report's* framework for economic competitiveness and wellbeing, and mission-led innovation strategy. The key features and implications of this model are discussed as follows:

- At the **core of this framework** are social equity and wellbeing factors (however-so defined).¹⁴
- Surrounding these factors are Greater Manchester's frontier and foundational economy sectors, which are in the process of becoming increasingly sustainable.
- Greater Manchester's frontier and foundational sectors have a **dual purpose**, of upholding social equity while also contributing to the city region's total economic performance.
- At the exterior of the framework are the **planetary boundaries**, as defined by Rockström et al. (2009) and as stated in the DE model. This means that the city region's total economic activity **cannot produce emissions (and other environmental impacts) that exceed the planetary boundaries**.

¹⁴ As discussed in the Basque Country case study, a key finding of the *Basque Report* is that it is advantageous to *limit* the total number of wellbeing indicators selected for inclusion in a particular framework, to ensure clarity in policymaking.

- Borrowing from the *Basque Report's* emphasis on the interdependence of social and economic factors, all of the factors within this new framework are **interdependent**. For example:
 - Strong social equity outcomes will be anticipated to impact total economic output positively (and vice-versa).
 - Exceeding the planetary boundaries and degrading the earth's ecosystems will be anticipated to impact negatively on both social and economic indicators.
 - The frontier and foundational sectors are also interdependent; a consideration that will be discussed further below in **Preliminary Recommendation 2**.
- Encompassing/relating to the framework is Mission-led innovation strategy. This refers to the development of a separate mission diagram for Greater Manchester, which will serve as a companion piece. The mission framework is to draw out the city region's business sectors and action strategies in more detail (see **Preliminary Recommendation 3** below).

Subsequent work between the GMCA and AMBS can further explore the application of this framework to Greater Manchester. In particular, the advantages but also the tensions that may result from the deployment of this framework can be investigated.

Expand interactions between frontier and foundational sectors

The *Foreword* to the GM LIS states that the “focus on frontier and foundational sectors – *and the connections between them* – will support the creation of a highly productive, more inclusive and prosperous city-region for all residents” (HM Government et al., 2019: p.5, italics added). Although mentioned at the outset of the document, the connections between the frontier and foundational sectors were not elaborated upon in the GM LIS. **Consequently, this is a line of enquiry that the forthcoming refresh of the GM LIS can pursue, particularly to demonstrate an evolution in the evidence base for local policymaking over time.**

One way of further exploring the relationality between frontier and foundational sectors is to consider the potential for **innovation diffusion** between the sectors. In brief, this refers to the movement of technologies, products and services across the public, private and third sector, and across different markets. There are a range of methods through which innovations can traverse sectoral or market boundaries. For example, open innovation – a term associated principally with Chesbrough (2003), refers to the role of partnerships and collaborations between actors to catalyse new product/service development. While an actor (such as a university) may design an innovation, its manufacture and commercialisation may be delegated to delivery partners in the private sector. A technology company in the frontier (such as a FoodTech firm), with technical expertise but a lack of proximity to customers, may rely upon a foundational sector firm (such as a supermarket) to sell products to the mass market. In such ways, open innovation creates opportunities for particular institutions to overcome their limitations, by utilising the specialisms of other

institutions, with whom mutual interests can be established. **The key question then is how to harness such dynamics for the purpose of sustainability.**

Sustainable technology ventures can perform a vital role in establishing interrelationships between the frontier and foundational sectors, in order to support green transitions across both domains. While such businesses are situated in the frontier, their target markets can be in the foundational sector. The aim of such businesses, therefore, is to utilise technologies to ‘disrupt’ foundational sectors in order to encourage shifts towards sustainability.

Vector Homes is an early-stage sustainability start-up, registered in Manchester, which is aiming to transition the (foundational) housing market towards carbon neutrality. The start-up’s Co-Founders consented to a series of informal interviews, as part of the primary research undertaken for this report. The outcomes of these interviews, together with additional secondary research, are covered in full in **Appendix 1**. A summary of the findings is offered here.

Vector Homes

[Vector Homes](#) is a clean-technology start-up (“clean-tech”), with four Co-Founders, which was launched in February 2020. The start-up’s aim is to provide sustainable and affordable smart home flat-packs. As such, the start-up is a new entrant to the residential construction market, capable of delivering to both conventional construction companies and the emerging *modular* housing market (VH, 2022a).

Modular homes are made from pre-manufactured sections that are transported to construction sites, where they are combined on-site into complete properties (L&G, 2022a). In general, the modular housing market positions itself as a solution for the problems associated with the mainstream residential market. These problems include housing supply shortages, high house prices, and the environmental unsustainability of either existing homes or new residences constructed using traditional techniques (e.g. VH, 2022a-c; L&G, 2022b).

Vector Homes’ value proposition centres on being **first-to-market** for the introduction of recycled materials that are enhanced with advanced **nanomaterial technologies**, such as graphene, for modular residential construction. These materials carry the potential for re-use at the end of life, supporting circular economy practices (VH, 2022b; 2022c). With nanomaterials being among the strongest known substances, their addition to waste or recycled material can “make them strong, impact resistance, fire resistant, sound proof, and thermally insulating”, and therefore highly relevant for home construction (VH, 2022c). Furthermore, Vector Homes intends to enable product-service systems in their residential builds, for utilities such

as heating and lighting, to create additional sustainability advantages. **Appendix 1** discusses these in further detail.

As an early-stage venture, Vector Homes is currently 18-months from full commercialisation. The company has secured pre-seed funding from a leading early-stage Venture Capital fund, and from a Manchester-based Angel Investor network. In addition, Vector Homes has secured a successful Innovate-UK bid. The start-up is proceeding towards completion of a minimum-viable-product (MVP) by the end of September 2022. The MVP will consist of a demonstration house showcasing exterior and interior design configurations for a modular home. At the time of writing, Vector Homes has secured Letters of Intent from the Wythenshawe Community Housing Group, to utilise a test site in Wythenshawe, and from the Construction Futures Research Centre and the National Brownfield Institute, to utilise a site in Wolverhampton. The start-up has also received a letter of intent from the Platform Housing Group for potential construction in the Midlands.

By leveraging advanced materials and circular economy principles to transform residential housing, the Co-Founders see themselves as crossing the frontier and foundational sector divide. **In doing so, they open consideration of a range of innovation pathways to support the transition towards net zero**, where frontier and foundational sectors are engaged increasingly in collaborative projects. The Vector Homes team stated that housing was selected as the target market for their technology because it serves as an appropriate platform for the application of nanomaterials on a large scale. In other words, the size of the housing market was identified as conducive to innovation diffusion, and therefore to the scalability of the start-up venture. The scale and economic significance of the housing market is reflected in other foundational sectors. For example, the UK's food system generates revenues of about £121 billion per year (Hasnain et al., 2020), and constitutes the UK's largest manufacturing sector (FDF, 2021). **It is precisely the size and scale of foundational sectors, therefore, that can make them attractive target markets for innovation and entrepreneurship originating in the frontier.**

Revise the Mission roadmap to better address current climate and socio-economic challenges

Figure 3 presented an overarching conceptual framework that can guide sustainability policymaking in Greater Manchester. On its own, however, this would be insufficient to coordinate Greater Manchester's diverse stakeholder groups and effect change on the ground. To tackle this, a complementary mission strategy can be mapped onto the conceptual framework, bringing greater attention to the sectors and actions that will drive change across Greater Manchester's economy and society.

A mission roadmap was presented in the GM LIS to progress towards carbon neutrality by 2038 (HM Government et al., 2019: p.58). This mission can be reviewed during the refresh of the GM LIS, to better align to the new conceptual framework, and to better address the current environmental and socio-economic challenges.

Figure 4 offers suggestions of ways in which the mission roadmap can be refreshed. An overview of the suggested changes are discussed below.

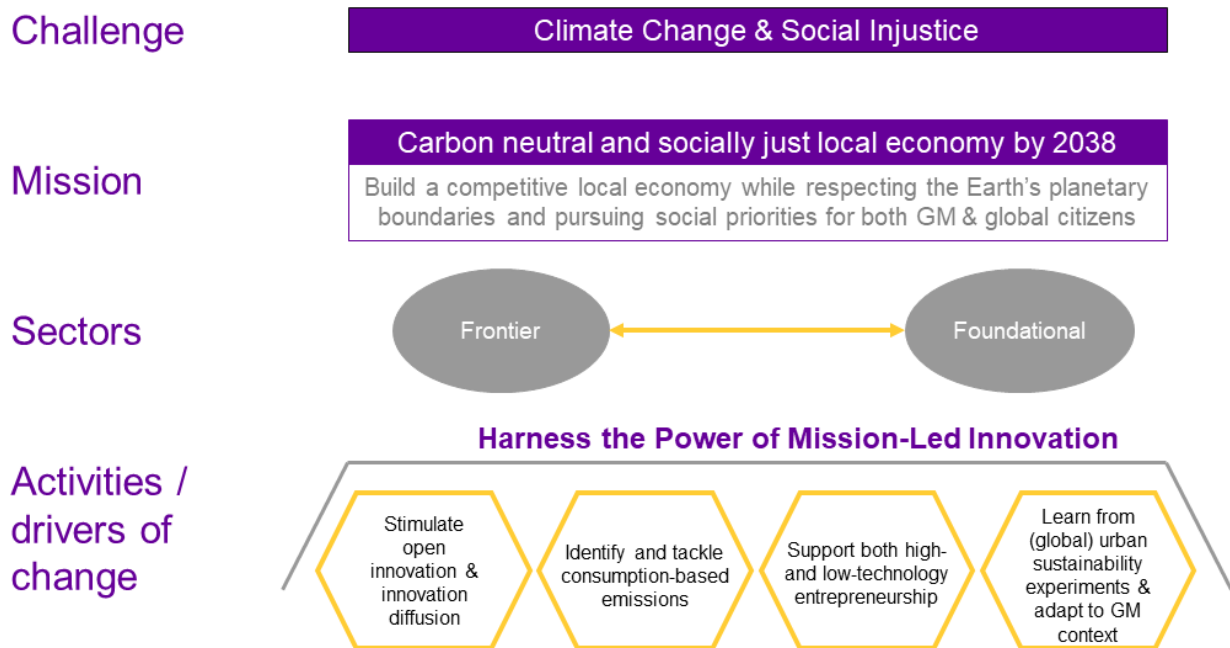


Figure 4. Suggested alterations to the mission roadmap. (Source: Author).

1. The Challenge can be reframed to encompass **both climate change and socio-economic deficiencies** more directly, perhaps with reference to the local economy.
2. The Mission integrates themes of a **just transition** that were missing from the 2019 framework. Net zero is pursued with reference to the earth's planetary boundaries. Social priorities are upheld both locally and globally; the latter encompassing the concept of consumption-based impacts resulting from the city's purchasing and procurement practices.
3. The next step can be to present the Frontier and Foundational economies as the two typologies engaged in this mission. The eight sectors mentioned in the previous roadmap (HM Government et al., 2019: p.58) can then be grouped under the labels of Frontier or Foundational. Alternatively, the specific sectors can be withheld from the mission framework, for the reason that an exhaustive list of all the relevant sectors may not possible or desirable for a high-level diagram.

4. The last element in the previous roadmap is the 'Projects' section. The Project list serves more as desired outcomes (for example, '21st-century energy supply'/'carbon-neutral public realm') than as drivers of change. An alternative approach would be to cite the activities or drivers that can operate within and between the frontier and foundational economies to pursue sustainability transformations. A selection are provided in **Figure 4**.

The aim of a mission is to tackle societal challenges by understanding them in terms of pragmatic steps, around which different organisations and sectors can engage (Mazzucato & Dibb, 2019). The **Sustainable DC 2.0 plan** from the Washington D.C. case study did not utilise the language of mission-led innovation explicitly; however, its methodology evoked the same objective, of disaggregating large challenges into actionable steps. After deciding upon a new mission roadmap for Greater Manchester, an advisable next step may be to borrow from the approach of SDC 2.0, and split the mission into goals, targets, and actions – with clear accountability for delivery – to effect change on the ground. The case study of SDC 2.0 offered the example of the Built Environment topic to demonstrate this disaggregation process.

The development of actionable goals can be supported by rigorous data gathering to understand Greater Manchester's current position, vis-à-vis its desired future. All three case studies in this report offer examples of how data may be gathered and/or presented to facilitate an understanding of the present situation and support policymaking for the future.¹⁵ Moreover, the SDC 2.0 plan's 'Overall Themes' offered additional nuances to augment the data gathering and policymaking process. For instance, the 'Think Regionally, Track Locally' theme emphasised data gathering both at the city-wide level and at ward/neighbourhood levels.

This approach is particularly important with regards to **Scope 3 consumption-based emissions**. A growing evidence based indicates that such emissions result principally from the wealthiest and most privileged in society. For example, in the EU, consumption emissions from the poorest half of citizens declined by nearly 25% between 1990 and 2015, and grew by 3% for the richest 10% (Wendler & Blakey, 2021).¹⁶ By extension, it is likely the consumption-emissions are higher for wealthier localities in city-regions than for income deprived areas. Gathering data on such issues at a micro-level may enable more equitable and nuanced policy responses.

¹⁵ The DE case study adopted a GAP-analysis approach; the *Basque Report* adopted a benchmarking approach vis-à-vis other EU states; and the SDC 2.0 pursued data gathering for each of the 13 topics, presenting the data in the form of infographics.

¹⁶ See Wendler & Blakey (2021: p.18) for more on this issue.

Reframe the role of foundational sectors within the context of the local economy

Sectors associated with the foundational economy are identifiable in all three case studies, yet it is only the *Basque Report* that references the *concept* of the foundational economy directly. The report introduces the foundational economy:

Firstly, as a key vehicle for personal wellbeing through the development of the health care system, education system and food system, *and by extension, productivity in all industries*, which rely on healthy, qualified and happy people. Secondly, through their more direct contribution to the competitiveness of the productive economy through, for example, product innovation or value generation models (Álvaro et al., 2021: p.8, italics added).

This quotation reinforces a central theme of the *Basque Report*, which is the establishment of an explicit and mutual relationship between economic competitiveness and social wellbeing. But this quotation also goes a step further, stating that social wellbeing is a driver of “productivity in all industries, which rely on health, qualified and happy people”. **In this argument, therefore, the foundational economy is a driver of productivity throughout the whole economy, due to its role in upholding personal/social wellbeing.**

This relationship between economic performance and social wellbeing is evocative of a range of suggestions across the natural and social sciences, market research reports, and other policy documentation. Perhaps a weakness of the *Basque Report* was that wider research findings were not integrated to substantiate and add weight to the claims of relationality between social wellbeing and economic performance. An initial attempt is provided here to collate findings that explore such interrelationships further.

There is a growing body of evidence that a lack of social wellbeing, especially in terms of health, may yield extensive negative effects on economies. Taking the chronic disease of obesity as an example, Public Health England (PHE, 2017) state that “obesity has a serious impact on economic development. The overall cost of obesity to wider society is estimated at £27 billion”, a figure estimated to increase to almost £50 billion per year by 2050. McKinsey & Company find that obesity yields a global economic impact of \$2 trillion, resulting from lost productivity, and the direct costs of treatment and mitigation, among other factors (Dobbs et al., 2014). In a study of healthcare in the United States, The Milken Institute think tank found that the annual indirect costs of chronic diseases to the US economy were \$2.6 trillion, resulting particularly from reduced productivity, among other factors (Waters & Graf, 2018). This equates to an average indirect cost of \$7,901 per person (Ibid).

The causes of negative impacts on wellbeing and the economy can relate back to different foundational sectors. The *Basque Report* mentions the food system, but does not emphasise its role as a potential driver of disease incidence. The UK's National Food Strategy, for example, states that one in seven deaths can be attributed to poor diets (Dimbleby et al., 2020). An analysis of The Milken Institute's data on US chronic disease incidence (stated above) by a leading physician at the Cleveland Clinic Centre for Functional Medicine, finds that most of the chronic diseases driving high economic costs relate to poor diet (Hyman, 2021). Such analyses suggest that unsustainable food systems inhibit social wellbeing, and by extension, inhibit economic output and performance. **Further research on the interrelationships between foundational sectors, social wellbeing, and economic performance, may carry significance value for the refreshed GM LIS.**

The direct correlation advanced in the *Basque Report* between foundational economy sectors and economic productivity may have profound consequences for the way that the foundational economy is articulated in the refreshed GM LIS. The GM LIS carries a consistent argument: the foundational economy tends to be characterised by low productivity and low paying jobs. Indeed, the *Foreword* to the GM LIS emphasises the need “to raise productivity and pay in the foundational sectors of the economy - including in large sectors such as retail, hospitality and tourism, and social care” (HM Government, 2019: p.5). This analysis investigates economic dynamics within foundational economy sectors; **what is missing are the ways in which the foundational economy may impact productivity across a whole city region.** The *Basque Report* suggests that the nature and quality of foundational provision will affect social wellbeing, which in turn will affect total regional economic performance. If this is agreed, then the key question for policymaking may be less to do with ‘increasing productivity’ within foundational sectors, **and more to do with investigating what is being provided to society through foundational business models, and how this provision may affect the ability of society to function efficiently, productively, and creatively.**

Conduct longer-term analyses of regions with successful and equitable economic strategies

The antecedents of the *2021 Basque Report* highlight a clear history of regional economic policies. For example, the Report's [website](#) lists previous publications dating back to 2018. But as stated in the introduction to the case study, the Basque region has a longer history of economic development spanning several decades. This has been responsible for GDP per capita increases from 70% of the average in EU-15 countries to 97.5% between 1980 and 2019, among other successes (Álvaro et al., 2021). Due to the time constraints for this research project, a longitudinal analysis of the Basque region's economic history was beyond the scope of this study. Such an exploration, however, could unearth valuable insights into substantial

economic development at the urban level, which in turn could feed into considerations of social wellbeing and economic performance enhancements.

Even for advanced national and local economies, such as those of the UK or Greater Manchester, such insights can still be advantageous due to the persistence of structural inequalities in our regions. For example, according to professional services firm BDO UK (2019), “Manchester is indisputably the UK’s second biggest tech hub after London and the South East”, with the technology sector generating a combined turnover of £3.2 billion; yet, Manchester and Greater Manchester have been recognised nationally as high risk areas for food poverty (MCC & STC, 2020). The Basque Country, on the other hand, now stands as one of the European regions with the lowest population risk levels of poverty and social exclusion (Álvaro et al., 2021). In summary, conducting longer-term analyses of regions with clear histories of equitable economic development may yield valuable insights to support wider social and economic objectives in Greater Manchester.

Conclusion

This report has offered three case studies of sustainability policymaking in city regions. All three cases have emphasised the need for green and just transitions, where economic advances are equitable for society and advantageous for the planet. The **Doughnut Economics** and **Basque Country** case studies offered conceptual frameworks to guide local policymaking. Their high-level focus leans towards the advocacy of system-wide transformations, whereas the case study of **Washington D.C.** can yield a range of nudge-behaviours, in the form of action strategies for societal and economic goals.

This report has offered five preliminary recommendations based on an analysis of the case studies:

1. Synthesise existing frameworks to promote innovation in local sustainability policymaking.
2. Expand interactions between frontier and foundational sectors.
3. Revise the Mission roadmap to better address current climate and socio-economic challenges.
4. Reframe the role of foundational sectors within the context of the local economy.
5. Conduct longer-term analyses of regions with successful and equitable economic strategies.

The most novel insights resulting from the case study analysis may be found within **Preliminary Recommendation 4 – reframing the role of the foundational economy within local sustainability policymaking**. This recommendation evolved principally from the *Basque Report*. It involves identifying the foundational economy as a driver of productivity and economic performance throughout the whole economy, on the basis of the foundational economy's essential role in upholding personal and social wellbeing. This perspective implies that productivity *within* the foundational economy is not necessarily the most important point of analysis, and that more attention should be given to the *nature* of foundational provision. It involves determining whether that provision is likely to uphold wellbeing – and by extension economic performance – or limit it.

Taken together, the case studies and recommendations of this report do not promote a single course of action for local sustainability policymaking. Rather, they constitute a frame of reference to inform sustainability initiatives, especially for the pursuit of net zero and social equity objectives. Moreover, the recommendations offered here were devised on the basis of the three case studies and the secondary literature, which were analysed within the limitations of a five-month time frame. Further research may yield additional recommendations, add weight to this report, or challenge the current findings.

The GMCA's wider strategies and/or resource constraints, the specifics of which may be unknown to the author, can create additional tensions for the delivery of any particular recommendation. The findings of this report, therefore, are presented as exploratory to support the refresh of the GM LIS.

Appendix 1. Vector Homes

N.B. As stated in Part Two, Section 2, this case study was researched through both primary and secondary methods. The primary research consisted of personal communications with Nathan Feddy (CEO); Liam Britnell (CTO); and Jonas Singer (COO). The in-text references below consist only of secondary sources.

Overview

Vector Homes Limited is a Manchester-based entrepreneurial venture launched in February 2020. The company has four Co-Founders: Nathan Feddy (CEO); Liam Britnell (CTO); Jonas Singer (COO); and Sholom Cohen (CCO), in addition to an Advisory Board of industry experts. Vector Homes presents itself as a clean-technology start-up (“clean-tech”) aiming to provide sustainable and affordable smart home flat-packs. As such, the start-up is a new entrant to the residential construction market, capable of delivering to both conventional construction companies and the emerging *modular* housing market (VH, 2022a). The modular housing market carries a global valuation of \$105 billion (Duncan, 2022).

Vector Homes is aiming to disrupt both the wider residential market, and the modular housing niche, through the introduction of recycled materials that are enhanced with advanced nanomaterial technologies. Additionally, Vector Homes will produce the houses from standardised components to enable rapid advanced manufacturing and assembly. This provides the benefit of enabling re-use at the end of life. Taken together, these approaches are also designed to drive down costs, creating affordable homes (VH, 2022b; 2022c). In doing so, Vector Homes will be first-to-market in the UK for the deployment of nanomaterials in modular residential construction.

The Modular Housing Market

Modular homes encompass a series of innovations that differentiate them from traditional builds. Modular homes are made from pre-manufactured sections that are transported to construction sites, where they are combined on-site into complete properties (L&G, 2022a). This market niche is populated by a range of competing firms, from multi-national financial corporations such as Legal & General that have diversified into modular construction (Ibid), to start-up ventures such as Top Hat, located in the East Midlands, which has secured substantial backing from the global investment bank Goldman Sachs (Duncan, 2022).

In general, the modular housing market positions itself as a solution for the problems associated with the mainstream residential market, such as housing supply shortages, high house prices, and the environmental unsustainability of either

existing homes or new residences constructed using traditional techniques. Legal & General (2022b), for example, state:

All of our homes are carefully designed and built to keep energy and water consumption, greenhouse gas emissions and household waste to a minimum, while maximising comfort... We use sustainably-sourced materials during the construction process... Ultimately, we want to help build a fairer housing market by expanding the supply of comfortable, sustainable, affordable houses.

However, such claims, do not always stand up to the facts, with CNBC reporting that modular homes are not necessarily cheaper than traditional homes (Duncan, 2022). Despite such inconsistencies, modular housing is being promoted by notable publications, such as Forbes, as a genuine solution to the above-mentioned problems, and as an attractive outlet for global investors (Suthipongchai, 2021).

Vector Homes' current position

As an early-stage venture, Vector Homes is currently 18-months from full commercialisation. The company has secured pre-seed funding from a leading early-stage Venture Capital fund, and from a Manchester-based Angel Investor network. In addition, Vector Homes has secured a successful Innovate-UK bid, and is currently in an advanced due diligence stage with the GMCA's GMIF. The start-up is proceeding towards completion of a minimum-viable-product (MVP) by the end of September 2022. The MVP will consist of a demonstration house showcasing exterior and interior design configurations for a modular home. At the time of writing, Vector Homes has secured Letters of Intent from the Wythenshawe Community Housing Group, to utilise a test site in Wythenshawe, and from the Construction Futures Research Centre and the National Brownfield Institute, to utilise a site in Wolverhampton. The start-up has also received a letter of intent from the Platform Housing Group for potential construction in the Midlands.

Technology capabilities and market strategy

Vector Homes is entering the modular housing market with the intention of driving technological innovation, through the adoption of advanced nanomaterials such as graphene for residential property construction. The Co-Founders intend to use waste or recycled materials, enhanced with nanomaterials, as a core construction material for residential homes, thereby increasing the homes' sustainability profile (VH, 2022c). With nanomaterials being among the strongest known substances, their addition to waste or recycled material can "make them strong, impact resistance, fire resistant, sound proof, and thermally insulating", and therefore highly relevant for home construction (Ibid).

The deployment of nanomaterials will accompany other sustainability innovations. These include circular economy features and sustainability hierarchy principals

(reduced mass, re-useable components) that will be embedded throughout the homes. This is in addition to the provision of product – service systems for utilities like heating and lighting. Product as a Service (PaaS) business models involve the vendor retaining ownership of products, while providing customers with temporary access to the products and to their performance (Lacy & Rutqvist, 2015). The customers, therefore, act more as temporary “users” than “consumers” (Ibid). Under the Philips Pay-Per-Lux lighting service, for example, clients paid a regular contractual fee to Philips for the light that they consumed, rather than for any lighting products in particular. In return, Philips provided an end-to-end service, covering the design of the lighting arrangements, equipment, deployment, maintenance and subsequent upgrades (Goldapple, 2016). At the end of the contract, the Philips products were returned to the company’s production process so that the raw materials could be re-used, rather than simply disposed of (Philips, 2013). Emulating this business model is another value proposition through which Vector Homes aim to drive sustainability advantages.

Interviews with Vector Homes’ Co-Founders revealed that the start-up aims to be defined primarily as a technology company, and not as a construction firm. This shift in language represents the start-up’s intention to innovate continuously in both the design and the development of residential properties, rather than simply to act as a supplier for blueprints that were conceived elsewhere. In effect, Vector Homes is being established to function as an end-to-end system. This is by: sourcing technologies and concepts from centres of research and development (R&D) and third party property – technology companies; developing strategies for their marketisation; and then manufacturing products for commercialisation. For example, at present Vector Homes is becoming a Tier-2 partner with The University of Manchester and The University of Manchester’s Graphene Engineering and Innovation Centre (GEIC) for the purposes of R&D. This is having already secured a partnership with the Construction Futures Research Centre of the University of Wolverhampton, and while engaging currently with the Sustainable Materials Innovation Hub (Henry Royce Institute) for nanomaterial and demonstration build development. The start-up is also planning for the development of a Manchester-based manufacturing facility, to create a localised supply chain. In this way, Vector Homes is positioning itself as a key network intermediary among Manchester’s nanomaterial and advanced manufacturing ecosystem. The start-up will be able to coordinate a full product development lifecycle, from ideation of technologies in university facilities through to the manufacturing, commercialisation and deployment of products for residential construction.

The Co-Founder Team

The ability of Vector Homes to secure strategic partnerships and develop an ambitious corporate strategy is likely to be influenced by the nature of its Co-Founding team. The team’s strengths have been a consistent feature of the

feedback received from Angel Investors. CTO Dr Liam Britnell, for example, is a PhD Physicist who was supervised by Sir Kostantin Novoselov, the Nobel Laureate involved in the isolation of graphene in 2004 (VH, 2022d). Liam was one of the earliest employees of the GEIC and has held multiple responsibilities since 2017, thereby facilitating Vector Homes' access to one of the world's leading institutions for graphene commercialisation. CEO Nathan Feddy has held a leadership role in the EU's €1 billion Graphene Flagship; COO Jonas Singer is a senior management consultant and agile specialist; and CCO Sholom Cohen is a Chartered Surveyor who sits on the regional policy committee of the British Property Federation, advising the government on advancing the real estate sector (VH, 2022d). The presence of four Co-Founders, each with substantial techno- and/or commercial experience, could be a key reason behind the start-up's achievements in early-stage funding and outreach activities.

Diffusing innovation between frontier and foundational sectors

By leveraging Manchester's advanced material ecosystem to transform the housing market, the Co-Founders see themselves as crossing the frontier and foundational sector divide. In doing so, they open consideration of a range of innovation pathways to support the transition towards net zero, where frontier and foundational sectors are engaged increasingly in collaborative projects. When asked why the Co-Founders wanted to transform housing, Liam Britnell stated that it was both because of the problems associated with this market, such as unaffordability, and because housing was seen as a natural platform for the application of nanomaterials on a wider scale. In other words, the size of the housing market was identified as conducive to the diffusion of nanomaterial technology, and therefore to the scalability and growth of the start-up venture. The scale and economic significance of the housing market is reflected in other foundational sectors. For example, the UK's food system generates revenues of about £121 billion per year (Hasnain et al., 2020), and constitutes the UK's largest manufacturing sector (FDF, 2021). It is precisely the size and scale of foundational sectors, therefore, that can make them attractive target markets for innovation and entrepreneurship originating in the frontier.

Conclusion

Vector Homes is attempting a novel solution for the problems of unsustainability and unaffordability in the residential housing market. The introduction of nanomaterials for modular home construction will represent a first-to-market initiative for UK housing. More broadly, the start-up demonstrates how frontier technologies can be harnessed to promote sustainability transitions in foundational sectors. It appears that the strengths and experience of the Co-Founding team are a leading contributor to the start-up's early-stage successes thus far.

For such endeavours, there may be new opportunities for public bodies such as the GMCA to support sustainable technology start-ups. For example, the scalability of

this venture is contingent upon securing relationships with local councils and housing organisations in order to plan construction. This is an area where the GMCA could act as a network broker, creating introductions to explore the possibilities for commercialisation. The consolidation of public-private partnerships may be key for supporting the development of green entrepreneurial initiatives.

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