CATAPULT
Connected Places

Part of UK-India Innovation for Net Zero Centre

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INNOVATION TWINS

Places driving a Net Zero Future: The Opportunity for Partnerships between the UK and India

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CONTENTS

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This report's content and findings do not imply the endorsement or opinion of the above institutions or representatives therein.

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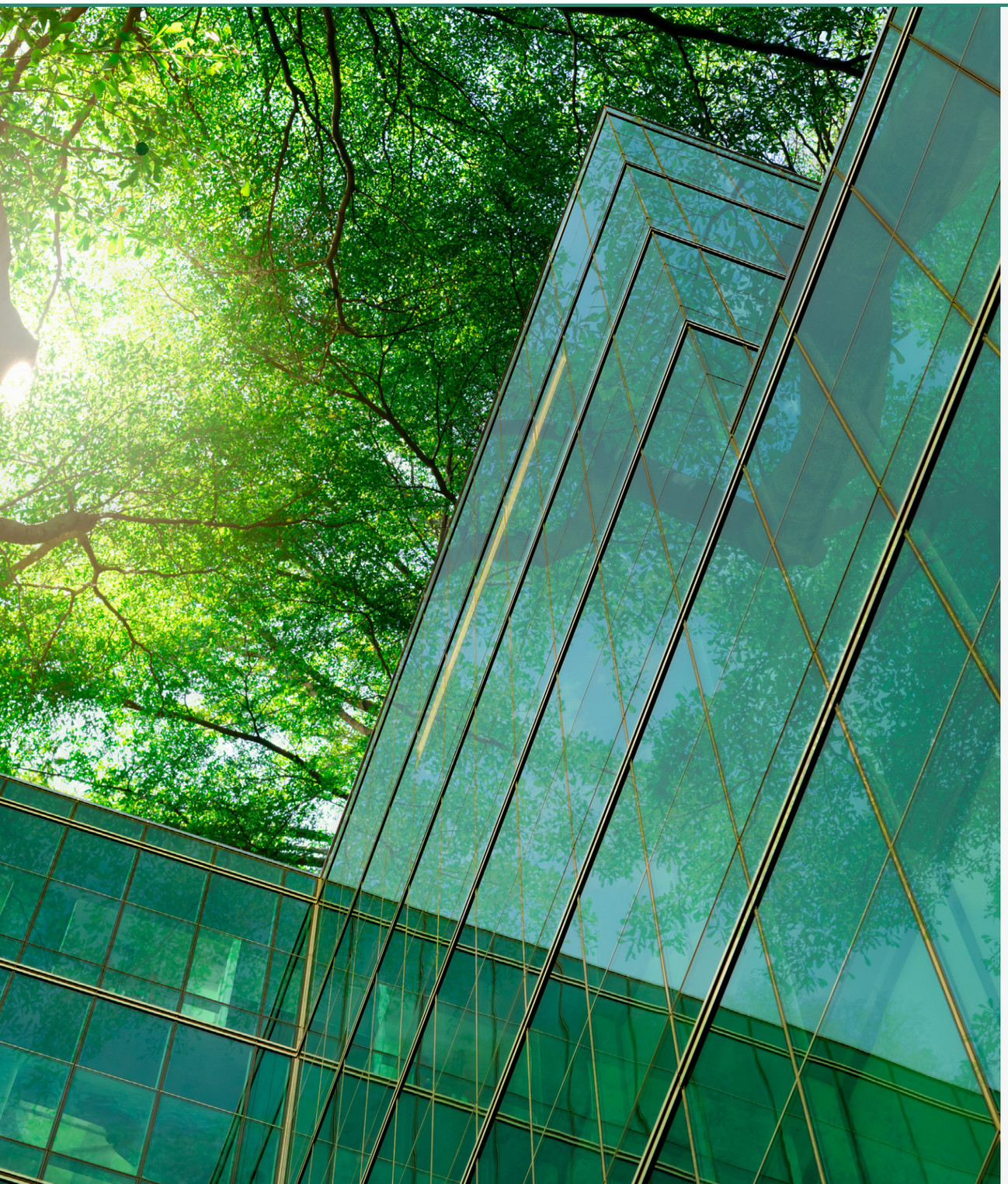
EXECUTIVE SUMMARY



Finding the paths to net zero is becoming ever more urgent. But these paths will not be trodden alone, nation-by-nation, sector-by-sector, city-by-city. They will rely on the power of innovation and scale, and on places – districts, quarters, zones, clusters and others – that galvanise change and share in the quest.

There is now an opportunity for many more of these places to team up internationally with like-minded partners, using their cities as platforms of shared interests and coordination.

Recently the idea of 'Innovation Twins' has been gaining traction, as the Connected Places Catapult develops a structured programme to ensure that international collaboration is place-based and serves the processes of levelling up the UK and India and decarbonising the planet. In this programme, Innovation Twins are being leveraged to connect growth companies to specialist 'hub' locations that concentrate innovation, investment and ideas.[1]

These places are increasingly key for innovation to travel across borders. They link research to settings where they can be applied and tested quickly. They apply promising urban tech to out-of-market locations. They provide a route for infrastructure system owners to share knowledge and introduce improvements. They connect talent in one place to an innovation need in another. They pool skills to solve an intractable challenge. The result is more speed and scale to the two-way flow of investment, learning and impact.

Cities, city-regions and place-based clusters present a strong platform for these Twins to flourish. They are also where most of the UK and India's emissions and climate innovations are generated. Successful Twins have already been established between UK and other nations, for example with South Korea, and between partners in India and other nations globally.

Innovation Twins between India and the United Kingdom therefore have huge promise to accelerate decarbonisation. The careful curation of corridors for trade, technology pilots and commercialisation can provide a shape to the future two-way flow of business, ideas and capital between the two nations.

This report reviews the evidence for which UK and Indian locations host the capacity, propensity and common interests for Innovation Twins to flourish. Both nations are home to world-class innovation economies, scientific expertise, technology businesses, and specialised clusters and districts. Several sustainable technology solutions are already viable to test in both UK and India settings. There is also a large track record of partnerships and collaborations to build off and learn from.

This report starts by mapping which whole-city ecosystems in the UK and India have the most potential to engage in an Innovation Twin. Yet city governments do not always have the capacity to convene and marshal these fast-evolving ecosystems. The expertise and enterprise that resides within them also need specific places to land and partners to work with. So this work also identifies the districts, clusters, programmes and innovation entities through which these pairings can be 'grounded'. Intelligent pairing is essential as purposeful partnership thrives off clearly defined objectives, parity of esteem, and credible champions.

Through careful evidence, local fact-checking and bilateral stakeholder engagement, this paper identifies the Twins that appear to have the most potential for success, and some of the agents of change and leadership. Among many potential Twins we focus on four as case studies. We also explain some of the principles and first steps required – of partners and Governments – to deliver the first Innovation Twins.

The report is delivered by a partnership between the Connected Places Catapult and The Business of Cities and has been peer-reviewed by John Holden at the University of Manchester.

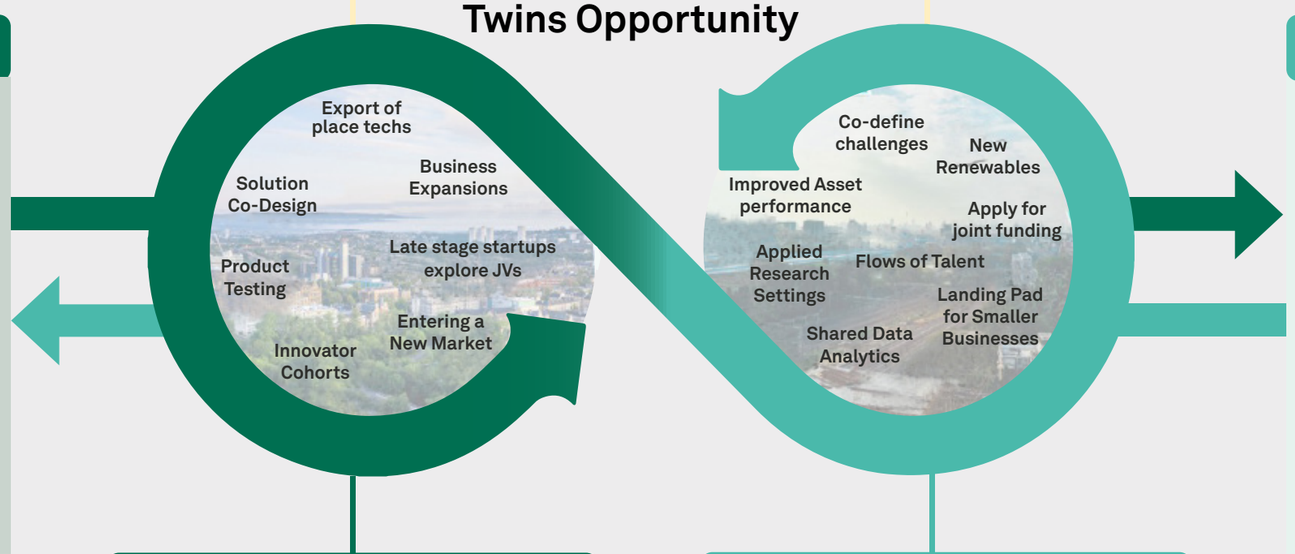
Shared Needs

- Integrated payments and ticketing
- Decarbonisation of food supply
- Re-purposing of legacy carbon infrastructure
- Embedding new sustainable urban technologies
- Innovations for retrofits in housing and legacy infrastructure
- Health effects of pollutants
- Future energy storage solutions
- Improved urban monitoring and management
- Quality of place around key pieces of infrastructure
- A fair transition to new economies and supply chains

The UK-India Innovation Twins Opportunity

The Strengths

1. World-class in Batteries, CAVs and EVs, advanced materials, AI and digital, green construction, blended finance, renewables
2. Places to test and demo
3. Mature place-based networks and alliances to integrate systems
4. Globally relevant green R&D centres and faculty



The Strengths

1. Huge demand for tech and business models for energy storage, smart grids, green steel, hydrogen, batteries, recycling and waste management, digital twins and BIM
2. Superb institutions with desire for research partnerships
3. Internationalising companies in Agritech, EVs, sustainable buildings and coldchain
4. Unmet needs for capacity-building and de-risking for the last-mile, buildings energy, green investment

The Future

- Future proof local infrastructures
- Civic-minded and Place-Conscious Universities
- More curated innovation ecosystems
- More net zero centres that are hosting discovery and spinouts
- Global advantages in hydrogen, zero emissions transport, green finance, digital twins, carbon capture, usage and storage and other energy and infrastructure technologies

The Future

- More cities expanding and amalgamating
- City-wide technology adoption and deployment
- Strong customer-friendly net zero interface with the world
- Many more universities going global and seeding innovation
- City departments with PlanTech, smart apps, and dashboards
- Dynamic and outward-facing local leaders

UK

INDIA

Source: The Business of Cities research. Needs, strengths and future trends based on insights from stakeholder engagement, review of recent national and city-level strategies, and industry-specific commentary about India's specific net zero relevant challenges.

1 INTRODUCTION

Innovation Twins connect carefully selected pairings of places that have the potential and capacity to take part in a curated two-way flow of innovations, investments, business expansions, technology trials, and much more.

Their goal is to innovate in pursuit of decarbonisation and more sustainable cities. The basic premise is that the right international place-to-place partnerships can find new and novel solutions to complex problems.

Innovation Twins are not sister cities 2.0. They do not only link up city governments to other city governments. The most successful Twins – and the ones that drive real place-based impacts – diversify beyond bilateral relationships, trade missions, development partnerships, and research MOUs to build lasting partnerships across science, innovation and technology. They address real needs and opportunities of individual places. They share practical experiences, trial solutions, and share information. Organisations want to be part of them to access a wider innovation market.

Demand for innovative cross-border corridors is growing. City leaders, enterprises, investors, universities and multi-laterals all spot the advantage for agile international collaboration to fuel local innovation economies and solve problems in specific places.

The vast potential for such corridors of initiative between UK and India to address net zero problems is increasingly coming into focus. Both nations are looking to create and embed clean energy in essential systems, establish a position in new value chains, and channel the growth in green sectors for the benefit of both cities and rural areas. This all requires rapid testing and cross-pollinating of new technologies, a surge in the role of private capital, and much more purposeful institutions focused on the tasks of reskilling, resilient communities and consumer choice.

THE SUCCESS OF INNOVATION TWINS SO FAR

Previous innovation twin programmes supported by Connected Places Catapult and its partners have been connecting cities to other cities, in order to accelerate the pace of cross-border innovation and research collaborations, unlock latent potential, and support bilateral trade and investment.

The main programme to date has involved twinning cities in the UK with cities in South Korea, with a SME-minded focus on smart cities, mobility and enabling technologies.

So far as part of this programme, the Connected Places Catapult has been engaging with city governments, ecosystem partners and co-ordinating entities in four high potential city-to-city pairings in order to create a roadmap of projects that can be actively collaborated on in order to drive place-based innovation. One outcome so far has been a shared commitment between the city region of Liverpool and Busan and Korea, including with the state water company K-water to actively explore one of the world's largest tidal power schemes on the River Mersey. It has also led to a range of R&D investments and collaborations in AI and other future technologies.

A NOTE ON TERMINOLOGY

This paper makes important distinctions between cities as functional economies, cities as government jurisdictions, and the locations within cities that host institutions and specialisms.

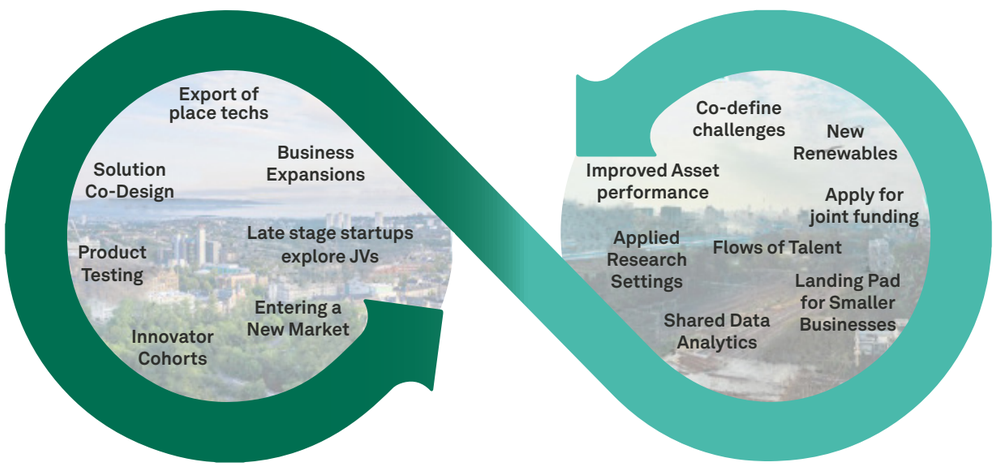
City: this is a shorthand for the whole geography of an urban area – sometimes called a city-region or metropolis. It does not mean city government, unless explicitly referred to as such. Cities act as the platform for innovation Twins. They can do this because the innovation models of many net zero-related industries depend substantially on the proximity between firms and institutions that cities provide, and the specialist talent pool that tends to aggregate in larger urban markets.

Ecosystem: an ecosystem spans all of the actors and relationships whose goal is to enable technology development, enterprise and innovation. It refers especially to the companies, research hubs, investments, technology sites, and convenors. It usually has a geography that operates at a whole city, city-region, or even larger.

Innovation Twin: a structured pairing between two places across borders, that connects partners that are able to purposefully collaborate, innovate and scale for shared benefit.

Innovation district: defined location where corporates, research institutes, SMEs, co-locate in order to enhance agglomeration and speed up the process of converting ideas into commercial applications.

Cluster: a network of companies, institutions, public assets and customers, usually in an industry or set of adjacent industries, that coalesces across a city, region or corridor. A cluster can be quite dispersed but often benefits from some shared infrastructure, promotion and coordination. A cluster is not only a magnet for people and businesses. It may also consist of many converging specialisms, services and markets – whose strength may lie in the propensity to take up innovations from outside established networks and across borders.



TWINNING PLACES WITH SHARED PURPOSE

Cities and city-regions are often effective platforms for twinning, for they are the places where three types of interdependent assets and networks – policy and civic communities, technology, business and enterprise platforms, and academic and research groups – come together. Cities host dense communities of practice, institutions with experience, purposeful multi-disciplinary clusters, and individuals with deep local and global market reach. They are also home to key research hubs, innovation districts, airports, ports, transport agencies, R&D expertise, or multi-city networks.

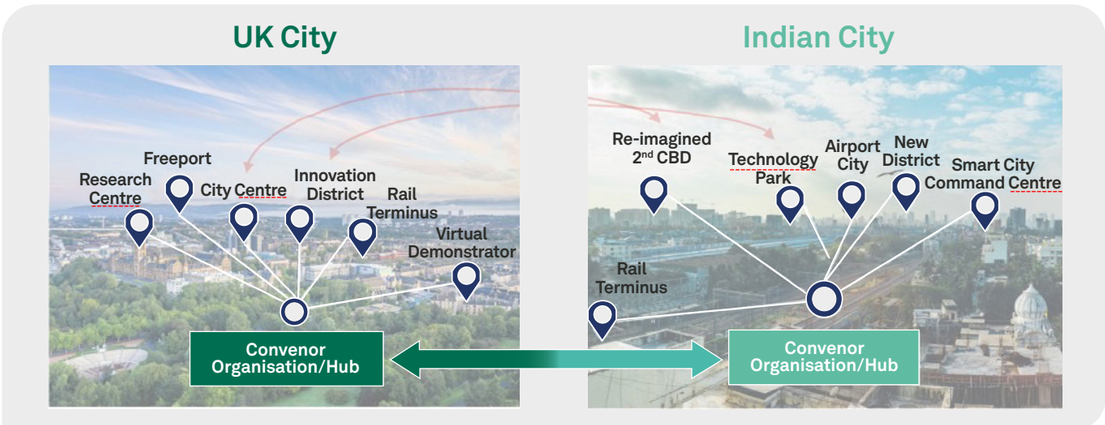
This set of assets and activities cohere in an 'ecosystem'. In many cities, this ecosystem is only loosely joined up, and operates in siloes. It is not tightly co-ordinated or convened. The opportunity of Innovation Twins is to connect whole ecosystems up to one another, to find multiple areas of shared benefit, operating via agreed convenors that can act as a 'front door' for new opportunities and become the partnership organisations through which ideas, projects and joint ventures are mounted and co-ordinated.

In some contexts, for example in South Korea, metropolitan or city governments can play this convening role. This works when city governments have a purview of the whole ecosystem, are closely engaged with large corporates, and have the fiscal, financial and co-ordination powers to convene an ecosystem of districts, places and entities.

But in general Innovation Twins benefit from broader leadership. They do not tend to sit under the auspices of 'City Government'. In India, for example, most city government departments report to State-level governments, and there are other entities that despite having government backing, also have the institutional calibre, dedicated mission and appetite for immediately commercial and practical work that makes them logical partners for growing the whole innovation ecosystem. The most obvious example are the national Science and Technology clusters.

Meanwhile in the UK, the entities that have the convening and connecting power, and the institutional memory to sustain these activities are often the organisations and platforms that are semi-independent or arm's length from government in a city-region. Examples may include new growth companies and investment agencies, chambers of commerce, innovation convenors, and civically minded universities with strong links into the local economy.

The combination of fast-moving innovation ecosystems and limited city capacity in both UK and India, means that it is useful for individual 'hub' locations and assets to ground the initial twinning activities.[2] These may be district-to-district, port-to-port, university-to-university, cluster-to-cluster, and so on. This approach is well suited to cities where there is not yet an obvious convening partner to bring together the different players, or to Twins that aim to convene city ecosystems that are of very different size and scale. In these cases, the aim may be to crowd-in citywide partners over time, to give a more concrete basis for long-term partnership and collaboration.



Note: In the UK and India, the convening organisation or hub is more likely to be a regional cluster, semi-independent investment promotion agency or business chamber/council. The reasons for this are outlined in more detail in Section 4.

TWINS FOR LOW CARBON GROWTH

The climate transition requires the transformation of multiple systems at once. Cities in particular are home to dense concentrations of people, assets and systems where it is possible to enact transformations at scale in ways that can effectively tackle climate change. Speeding up the decarbonisation of cities – which we take here to mean all ways of reducing cities' CO2 emissions – will be essential to the journey to net zero. This imperative applies to cities large and small, and cities in established and emerging economies. All cities will play their part.

There is no one system or catalyst that will decarbonise cities. It will require millions of small and large interventions, not only into buildings, transport, energy, waste and materials, but also more broadly into city systems, assets, services, planning and business models. Digitisation, integration, efficient retrofits, co-ordinated governance, aligned incentives and applied technologies will all be required. These technologies – and creative and innovative approaches more generally – will become especially relevant given the economic and social costs that will arise along the way, and a growing need to ensure that the rights, livelihoods and wellbeing of vulnerable groups are adequately protected from these costs.

Decarbonising cities also promise other core benefits – cleaner air, better mobility, cost savings for citizens and companies, higher liveability, and talent retention. Latest forecasts suggest that the economic benefits of decarbonising cities may amount to £17.5 trillion in Net Present Value by 2050[3].

India, as the second largest urban system in the world, will be at the forefront. Its urban population is rising to 600 million by 2030[4]. For its urbanisation process to succeed will rely on increasing the pace of innovation, improving public health and opportunities for more urban citizens, and improving resilience to climate change.

Many India-wide initiatives have been launched over the last decade by the Ministry of Housing and Urban Affairs to this effect.[5] They include programmatic investments in basic infrastructure (water and sanitation), affordable housing, smart city redevelopment, heritage conservation and improving links between urban and rural areas. India is also home to emerging clusters of applied scientific excellence, and new sources of private sector leadership emerging for places and districts.

The promise of Innovation Twins is to support India's rapid urban transition with corridor partnerships that can tap into more solutions and investments to address and adapt to climate change across all parts of the country, and to unlock a new cycle of catalytic change.

Twinning partnerships also create opportunities for Indian start-ups and companies to access the UK market – the world's sixth largest economy. As one of the first nations globally to experience de-industrialisation, the UK has undergone more than 40 years of innovation and adjustment in delivering urban change - across planning, investment, partnership and leadership. As it now looks to a Net Zero future by 2050, it has developed world-leading sector-specific capability in areas essential for financing and building net zero cities[6], and holds a 'first mover' advantage in niche technologies and place-based innovations that makes it a promising prospect for Innovation Twinning.

Innovation Twins can help accelerate the UK's path to becoming a distinctive net zero market of climate solutions, and can accelerate growth in jobs, skills and investment growth all across the UK. And for India they also offer the opportunity for Indian start-ups and SMEs to validate technologies in a country with more stringent policies and regulations on carbon neutrality before scaling them up.

> **"There is immense potential for collaborations between India and the UK innovation ecosystem for co-development, and validation of, novel technologies."**
>
> **Senior Representative, Pune Knowledge Cluster**

> **"The UK's more stringent policies on carbon neutrality - and its compulsion to use certain technologies - seems like a real opportunity."**
>
> **Science & Technology Cluster Representative in India**

APPROACH AND METHODOLOGY

This report provides an initial approach for assessing and shortlisting high potential places for twinning in UK and India, based on an effective set of criteria that has been developed specifically for the UK-India context.

Taking into account the important differences between the two nations, the aim was **not** to develop a primarily data-led review of which city governments in the UK could twin with which city governments in India. This is partly because:

- City government to city government is not always the most effective approach, especially in contexts where local governments are more 'underpowered' compared to state and national governments and the emergence of whole-city governance systems is ongoing and uneven
- Innovation Twinning potential is not only based on 'hard' data (How big is the ecosystem? How fast is it growing?), but also on 'soft' insight (What is the level of appetite? How does the ecosystem work? Who are the convenors?)

As such, the aim of this report was to observe, through comparative data, insights from interviews and the deep knowledge of The Business of Cities and Connected Places Catapult about the UK and India's priorities, needs and challenges:

1. The districts, places, assets and clusters around which innovation Twins can be galvanised in both nations.
2. The convening and co-ordinating entities operating at the city-region level who can act as platforms for this interaction, through their expertise and experience of working to develop a whole innovation ecosystem.

Three parallel activities were undertaken to generate a framework for developing a qualitatively deep understanding of place-based innovation, the subject of how all types of places (districts, ports, research clusters and whole innovation ecosystems) collaborate, and the synergies that already exist between the UK and India:

1. **Interviews** with stakeholders in the UK and India, to understand existing links and success factors underpinning UK-India collaborations, and in particular, gauge appetite of high potential organisations to participate in Innovation Twins.
2. **Focused research** – to map the universe of all potential place-based entities within both nations, and to clarify the substance and motivation of existing UK-India partnerships and level of alignment within city-regions.
3. **Potential pairings analysis** – to shortlist the city regions that appear to have the most potential for engaging in Innovation Twins in both nations, and then identify the specific places that may be able to 'ground' the activity.

2 THE UK-INDIA OPPORTUNITY

The UK and India are two nations with profound relationships, world-class expertise in science and technology, bold business leadership, and ambitious cities seeking to drive action towards net zero.

The basis for Innovation Twins between India and UK lies in strong existing links whose origins have been decades and centuries in the making**.** In 2023 the flow of businesses, capital, talent and ideas is already great – for example in pharmaceuticals, business services and clean energy – and is set to grow further in line with the India-UK Future Relations Roadmap 2030.[7]

Hundreds of thousands of people travel in both directions to study, undertake research, make new scientific discoveries, and start and grow businesses. Fast growing companies (like India's Ola Electric and the UK's Gravitricity) use the relationship to enter new markets. Indian corporates like Tata Group, Infosys and Essar Oil have all set up in the UK. British companies including Vodafone, GSK and Barclays all have an established presence in India. The NHS India-to-UK programme supports Indian healthtech firms to set up in the UK.

New infrastructure and other systems in both countries' cities are emerging as an attractive asset class for the other's investors.

India and UK also share common national ambitions. In particular, their cities' growth objectives rely heavily on attracting international firms, jobs and capital, and selling goods, services and experiences in international markets. They are also driving growth through fostering larger regional clusters of cities with strong corridors of knowledge, connectivity and digital linkages.[8]

Until recently, both UK and Indian counterparts have had few mechanisms to coordinate growth at the 'whole city' scale. In this context, both UK and Indian cities have learnt to innovate – creating new forms of leadership from development agencies to new towns to PPPs.

In 2023 larger and medium-sized UK and Indian cities tend to share:

International Mindset
Growth objectives rely heavily on attracting international firms, jobs and capital, and selling goods, services and experiences

Problem-solving place mindsets
A high propensity to partner and innovate locally as a result of limited local powers and revenues

Willing higher tiers of government
Who are looking to support more sustainable and productive growth

Enterprising and capable leaders beyond local government
E.g. business coalitions, ports, airports, development partnerships

Green knowledge base
With advanced knowledge clusters in areas that can, or already do, relate to the green economy

Assets to upgrade and modernise
E.g. inherited city centres, established districts, transport interchanges and ports

Creative enterprise
Hubs for smaller but globally minded businesses in digital, design, fashion and tourism

Appetite for PPPs
Significant appetite for governments to work with business to sustainably fund long-term initiatives

These common traits provide a strong basis for exploring areas of shared interest, practice and leadership.

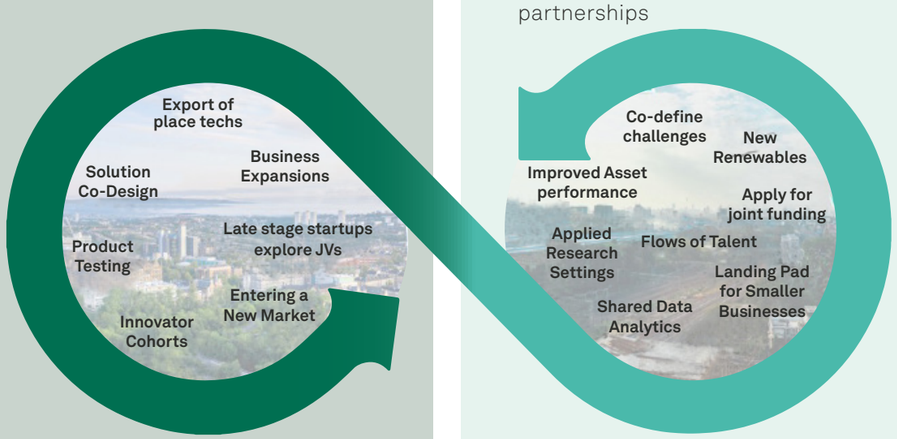
- **There is vast potential to expand the flow of activity.** UK and Indian firms, academic institutions, governments and clusters host compatible expertise – in smart mobility, advanced materials, AI and data-driven approaches to sustainability, green building design and sustainable agriculture, among many others. And the cities and their institutions share priorities. This mainly relates to how to integrate and embed long-term business investment for social, environmental and economic sustainability in co-ordination with the public sector. But it also includes specifics:
- Traffic management and air pollution;
- How to encourage universities to engage more with the city and civic groups;
- Strategy to modernise inherited city centres and established districts with upgraded infrastructure and optimised land use;
- How to scale a robust circular economy;
- And how to drive new approaches to financing catalytic developments.

What UK cities possess

1. World-class exportable green innovation:
   - Batteries, CAVs and EVs
   - Advanced materials
   - Green construction
   - Renewables
2. Recognised places to test and demo innovations and products in fast-growing sectors e.g. e-Mobility
3. Track record of convening place based networks and alliances:
   - Integration of transport, energy and data systems
   - District heating and cooling
   - Green and blended finance
   - Green buildings
4. Critical mass of globally recognised green innovation R&D centres and elite universities

What Indian cities possess

1. Demand for technologies to support broad-based sustainable transition
   - Energy storage, smart grids
   - Advanced materials for green steel
   - Hydrogen fuels
   - Batteries
   - Recycling and waste management tech
   - Digital twins and BIM
2. Fast-growing companies in Agritech, EVs, sustainable buildings and cold-chain, with appetite and potential to establish, grow, test and scale in overseas markets
3. Unmet needs for capacity building, strategy, and platform design, in order to:
   - Integrate last-mile transport
   - Integrate energy and buildings data
   - Develop integrated systems approaches
   - De-risk green investment
4. Superb institutions with desire for research partnerships



Source: The Business of Cities research, based on insights from stakeholder engagement, mapping of the key innovation places and coalitions relating to net zero in the two nations' cities, and review of online databases of innovation and investment activity in specific sector niches (e.g. Crunchbase, Dealroom, etc.).
Note: this infographic is illustrative – there may be other relevant factors that each nation possesses that are not accounted for in this review.

There are also important points of difference and complementarity between UK and India, and their urban economies and platforms.

Of course, the UK and India's respective processes of urbanisation have been very different. Not only has their urbanisation taken place over different time horizons, but they also have quite distinct patterns of industrial and post-industrial development, socio-economic composition, urban form, and (for now) functions of different layers of government and urban authorities. The UK's cities, for instance, follow the unitary system with two tiers of government, while India's cities tend to follow a federal three-tier system. Consequently, UK and Indian cities inherit very different urban systems with different cultural and environmental contexts.

This means that especially where potential pairs of UK and Indian cities are very different, Innovation Twins appear more likely to be successful where they can 'ground' activity in specific districts, places and organisations – including businesses, research clusters, accelerators and incubators.

Yet there are also key complementaries between the two nations.

Among these include:

- **The role of city centres and specialised districts.** UK cities have learned from 25 years of urban regeneration about the physical and economic task of re-equipping their city centres to drive urban productivity. They have also started to curate real specialisation in their city districts – for innovation, retail, life sciences and much more. Indian cities are home to a mosaic of science and technology parks, and are re-focusing on the role of legacy city centre infrastructure.
- **Roles of universities**. UK universities have for many decades and in the past 15 years especially been strengthening civic relationships with their host cities. They are also focused on applying R&D to solve local issues, re-locating strategically and acting as 'anchors'. In India this anchor mindset is now starting to emerge among the IITs and other universities, but is more recent.

2023 Examples of innovation trends and needs in India and UK that provide the impetus for Innovation Twinning

INDIA-RELEVANT INNOVATION TRENDS IN UK

UK universities becoming conscious of and purposeful about their civic roles in their home city, via new directors and teams.

Growing experience connecting net zero research excellence into local infrastructures, industries, investment agencies and networks.

Journey towards more curated innovation ecosystems.

More centres that host discovery research, translation and spinouts.

Evolving advantages in for example hydrogen fuels, zero emissions transport, green finance, digital twins and carbon capture, usage and storage.

UK-RELEVANT INNOVATION TRENDS IN INDIA

India city clusters helping to accelerate city-wide technology adoption and deployment and development of a more credible and customer-friendly personal interface.

Progressive mid-tier universities developing an incubation skillset and seeking to engage internationally.

More cities expanding and amalgamating.

Growing demand in capable city departments for PlanTech, smart cities applications and one-stop dashboard interfaces.

A new generation of dynamic and outward-facing local leaders.

EXAMPLES OF INDIA-RELEVANT INNOVATION NEEDS IN UK

New urban technologies in areas such as clean batteries.

Accelerated development of clusters of expertise in e.g. greentech, cybersecurity, AI, creative industries, food security.

Cost-effective and scalable innovations for national housing retrofits.

Integrated payments and ticketing for city-wide public transport connectivity.

Resilience and decarbonisation of food supply.

Repurposing of legacy fossil fuel infrastructure.

EXAMPLES OF UK-RELEVANT INNOVATION NEEDS IN INDIA

Solutions to mitigate and manage the health and climate effects of pollutants.

Improved quality and regulation of urban development.

Technology-enhanced monitoring and management of water and waste flows.

Energy storage solutions, to help manage the large-scale shift to renewables.

Place activation around the next generation of rail termini, airports and other city-shaping infrastructure (e.g. metro lines).

Source: The Business of Cities research, based on review of recent national and city-level strategies, agenda-setting reports published by academic institutions, large consulting firms and corporates, and global non-profits in the decarbonisation sphere , plus insights from stakeholder engagement.

- **Types of land opportunities.** India's larger cities are tending to focus on new cities, new airports, city centre rail terminuses, riverfront redevelopments and new high-capacity public transport lines. In the UK, there has been at least one cycle of redevelopment in these kinds of sites, and new opportunities centre on ports, innovation districts, green and brownfield housing, and transport and energy testbeds.
- **Public transport**. In the UK, recent cycles of innovation have focused on integrating and improving customer experience to drive uptake. These include integrated payment systems, metropolitan transport authorities delivering transport-oriented development, and improved micro-mobility provision. In India, the task typically centres on reducing congestion and enhancing connectivity within fast-growing cities through large-scale infrastructure projects. New metro lines, airport and rail termini and port developments look to benefit from full design, multi-modal and sustainability criteria from the outset.
- **Brokering partners**. In the UK, the most obvious convening partners or 'front doors' for partnership include the country's more mature city investment and promotion agencies, bilateral trade organisations, globally facing anchors such as research universities, airports and ports, and more established innovation districts. Combined Authorities are also playing more of a convening role, through bringing together partners to participate in joint trade, investment and civic missions. In India, there are important sources of initiative among major Indian corporates, multilateral networks, and cluster champions.
- **Approaches to clusters and convergence.** In India, cross-sector clusters that bring together large firms, city governments, universities, innovation parks and others, are a relatively new concept. The six National Government-funded Science and Technology Clusters stand out as important platforms for innovation. In the UK, clusters are generally more formalised, with more staff holding defined roles and responsibilities. There are opportunities for these activities to partner, combine and become more place-focused, as part of future Innovation Twins.

3 RECIPE FOR SUCCESSFUL INNOVATION TWINS BETWEEN UK AND INDIA

There are already many links between UK and Indian partners – spanning research, innovation, investment and expertise. Several pairs of cities already collaborate in some way on Net Zero and adjacent agendas. This review has identified over 50 different 'pairings' of purposeful collaboration active over the past three years alone[9].

The most common origin-point of existing UK-India endeavour to collaborate tends to be universities. These are founded on shared research projects, MoUs to collaborate, and student exchanges, as well joint ventures around energy and fuels, mobility and transport, circular economy and sustainable buildings.

Many of the more narrowly oriented city government to city government twins between UK and India have so far had relatively limited success. Partly this is because city governments - in both the UK and India - tend to be relatively underpowered. Especially on the Indian side, city governments do not tend to have the budget, capacity or licence for consistent follow up, or to ensure that the agreement remains a priority.

> **"Often [city government to city government partnerships] have resulted in nicely worded MoUs, but nothing much beyond that. There tends not to be much action after the initial fanfare. The risk is that the agreement becomes just a piece of paper."**
>
> **Government planning official, Indian State Govt.**

The opportunity for UK-India is therefore to move beyond city government to city government and instead craft a deeper web of relationships - ecosystem-to-ecosystem – that are grounded in particular places. These require specific ingredients of partnership design. The propensity to galvanise a wider ecosystem also depends on features in the participant cities themselves.

In this section we explore the 10 specific ingredients stakeholders in both nations believe to be required for successful partnerships to be scaled up to Innovation Twins in a UK-India context.

Based on the insights from stakeholder engagement in both the UK and India, there appear to be 10 key features:

1. Clearly defined parameters
2. Concrete opportunities
3. Connective tissue
4. Harnessing existing progress
5. Multiple owners
6. On-the-ground champions
7. Place-based leadership
8. Engaged universities
9. Start with the State
10. Target specific technologies but communicate the wide benefits

1. **A sharply defined account of the ask and the offer**, with a clear up-front assessment on the part of Innovation Twin participants (districts, convenors, ecosystems etc.) of the resources and capacity that they can realistically commit, and what the needs and opportunities are. There is a great deal of interest on both UK and India sides to partner up with like-minded institutions and districts for commercial, R&D, piloting and social innovation purposes. But to do this, partners need confidence in what success can look like. This includes clarity on the 'soft tissue' that will connect the partners, any financial and technical constraints, and what each side of the partnership can offer.
2. **Concrete and differentiated opportunities.** Partners in UK and India both observe the advantage of a fresh mix of partners and collaboration styles in order to avoid stakeholder fatigue among the 'usual suspects'. Demonstrating clear objectives, with a wider suite of allies, and a commitment to on the ground change, is widely sought after.
3. **Personal leadership relationships, alumni and diaspora connections** are critically important to building the soft power behind a place-to-place relationship. Whether in government, business or research, these links broker trust, help to identify potential contacts, and enable a wider set of opportunities to bind to the relationship.

> **"Personal connections, dynamic local leaders, strong local capacity in digital communications - all of these things are extremely important."**
>
> **Science & Technology Cluster Representative in India**

4. **Build on what is already there**. There are already strong academic and business relationships of trust that span many pairs of cities in UK and India. Many are well placed to act as the bedrock of a broader collaboration. Likewise much of the next net zero horizon in Indian cities has to build upon the last 20 years of cumulative work with development banks, philanthropy and other partners (e.g. JICA, KfW, ADB, World Bank, 100RC).[10] Future programmes can be intentional about effectively complementing these activities, and also acknowledging and where possible addressing local issues of staff turnover, single-term finance, and limited capacity.
5. **Careful design and ownership of the Twin**. A very hierarchical and process-led governmental structure is likely to slow down, curtail or constrain the ambitions of Innovation Twins. It will likely also deter many partners in both UK and India. A strong interface with private and civic partners is typically viewed as essential.
6. **Capable convenors and 'champions on the ground'.** Convening bodies that represent a whole ecosystem, cluster or national network, can mobilise interested parties, generate a lot of credibility and argue the benefits for engagement. In the Indian context, these convenors are more likely to be city-wide innovation clusters (e.g. Science and Technology Clusters) than city governments. They enable twinning partnerships to generate multiple types of input further down the line. Experienced intermediaries know how to run, manage and co-ordinate a multi-purpose initiative. They are tuned in to the very different diaries and behaviours across sector groups. They also have reach into the time-scarce and resource-poor SME community, and can align opportunities with the laser market focus these businesses have. They consist of, or enrol, visible 'champions' who possess personality, patience and perseverance in abundance.

> **"It's important to find people - champions and convenors. People that want to see research hit their ground, that want to see something actionable."**
>
> **Senior Representative, Bengaluru Science & Technology Cluster**

> **"It takes a long while to build a presence on the ground. You need a champion who knows how to run and manage the corridor."**
>
> **Senior Representative, Okapi Advisory Services Ltd.**

7. **Harnessing place-based leadership.** The UK has developed a strong place-based innovation approach including more than 20 innovation districts and many place-conscious ports and infrastructures. India does not yet have well-recognised innovation districts or strong multi-partner attempts to innovate in discrete locations. Yet much is changing, and quickly (see Box). There is great potential to ground Innovation Twins in place leadership that has institutional calibre, innovation capability and government backing. The most obvious example are the Science and Technology clusters.
8. **Universities engaged at the right level**. There is clearly a significant mutual desire for UK and India universities to work more strongly with each other. The motives lie in securing industry partnerships, enhancing two-way student flows, solving talent gaps, and diversifying global research networks. India's IITs, formerly seen as 'ivory towers', are starting to become key agents of place change. Several are the HQs of six national science and technology clusters. These are India's most recent and largest attempt to apply multi-stakeholder collaborations and solutions to real place challenges. In India, a number of private universities act as progressive agents of change, for example with the Bhubaneswar City Knowledge Innovation Cluster.
9. **Engage Indian state governments early on in the process.** In India, the states are often the route to working with cities, since many of the key urban systems relating to transport, water, waste and others report directly to the states. Government bodies responsible for energy, industry and planning also tend to operate at the state level. Although each state has its own set of priorities, and the process to engagement can initially seem overwhelming for UK partners, many observers note that once support of the state government is there, the route to market entry, delivering real place-based innovation becomes, and crowding in other civic and business partners, becomes much easier.

> **"In most Indian regions, you cannot go about working with cities without the blessing of the state departments. It's often better to go through them - they oversee the cities."**
>
> **Government Planning Official, Indian State Govt.**

Regional or city-wide governments in the UK (i.e. Combined Authorities) are also useful interlocutors.

10. **Balance a focus on specific technologies and agendas with communication of the wider benefits of the Innovation Twin.** There is a dual risk here. The first is that the Twin should be grounded in specific place innovation needs (e.g. air pollution management) and specific technologies (e.g. micromobility) in order to provide clarity and manage the risk of 'boiling the ocean'. But equally the wider outcomes of the Twin – beyond simply emissions reduction – for example health, poverty reduction, and productivity, also need to be explicit and tangible. Buy-in, especially among larger corporates and government departments, is therefore likely to be stronger when twinning activities focus on specific inputs and challenges, but communicate the wide potential outcomes of the activity.

To read more about specific implications for partnership design, based on the findings from in-depth stakeholder engagement undertaken in Manchester and Bengaluru, please see the other report in this series – "Towards a Service Model for Twinning Places in the UK and India".

☑ Partnerships should look to	☒ Partnerships should avoid
• **Ensure they persuade partners** that the proposition is sufficiently coherent and sizeable enough to be worth the risk and uncertainty of engagement. In particular it has to demonstrate proper buy-in and commitment from both sides, rather than open-ended workshops. • **Encourage (and give confidence to) businesses to lead.** Rather than treat public sector as the customer and arbiter. • **Establish the independent champions** who can act as single-points-of-contact, agile decision-makers and well-connected intermediaries. • **Engage with suitable state government representatives;** those with personal influence with heads of the different departments that matter. • **Establish whether a university, research or knowledge partner can help to ground the partnership in local expertise and discovery** (in general these should be the sweet spot of Indian universities that have either the cutting edge research, clear civic commitment, and/or desire to engage in serious innovation.) • **Focus on city resilience** and the localised benefits of the Innovation Twin.	• **Reliance solely on public sector leadership.** The engaging entity in India should not usually be the City or State government alone. There can be too much process to attract partners in the UK. • **Trying to connect entities who fundamentally do not understand each other and have different kinds of priorities.** • **Stifle potential with excessive rules, procedures and commitments.** • **Engagements with Indian universities or institutes whose motives are primarily research-based as opposed to commercial.** • **Communicating only the direct carbon emissions benefits of Innovation Twin.** Buy- in among larger corporates and government departments in particular may be stronger when twinning activities highlight the indirect benefits, such as health, poverty reduction or productivity benefits, that are likely to be driven by the partnership.

4 CALIBRATING UK-INDIA INNOVATION TWINS

To speed up the flow of net zero innovation and investment between like-minded places and partners first requires an evidence base, in order to effectively matchmake the opportunities and capabilities.

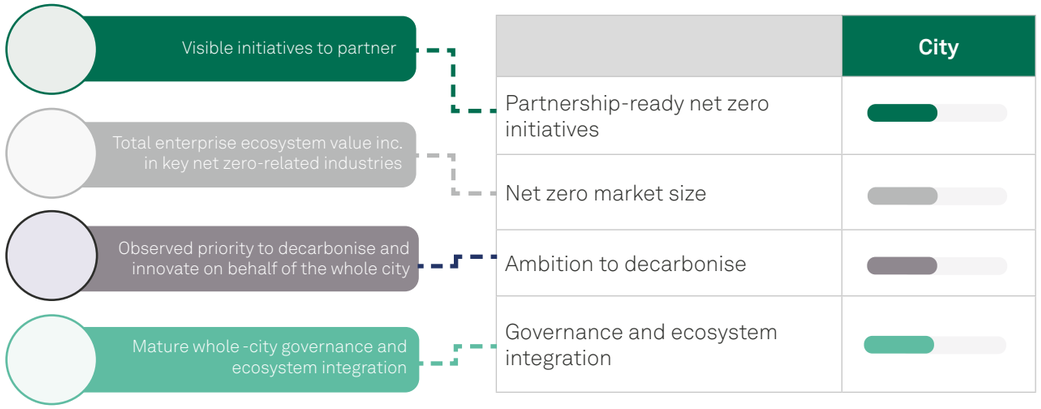
Not all places are equally equipped to participate in Innovation Twins. The value of different twinning relationships will vary depending on the kinds of partners being connected, their short and longer-term goals, and the immediacy of the market opportunities that may arise.

The experience of both UK and Indian practitioners, and of 10 leading examples of city-to-city collaboration internationally, attests that for Innovation Twins to succeed and endure they need some critical mass of shared interest.[11]

This is more likely when there is some commensurability between the places who twin. Large differences in size, capacity and specialism between two places will likely result in reduced engagement between them over time. There also have to be motives for businesses and solutions providers to engage across borders. These arise when a twin presents viable advantages of scale, market entry and innovation partnership.

This review has assessed and shortlisted high potential places for twinning in UK and India, based on an effective set of criteria that has been developed specifically for the UK-India context. The idea is to observe those assets and clusters around which innovation Twins can be galvanised, and the cities and city-regions who can act as platforms for this interaction over the long term.

The criteria for UK and India cities strongly overlap (see below).



See Appendix for explanation of terms and full list of indicators considered.

Where they differ slightly is to reflect the different governance arrangements in each nation (for example two versus three tiers), the different groupings of cities in each nation by size and scale (for example Tier 1 and Tier 2 Indian cities, and Core Cities, Combined Authority Areas, Key Cities etc in UK), plus the different availability and sources of data (see Appendix for detailed explanation of where and why these criteria differ).

The upshot of this analysis is a set of promising pairings from among this group of high potential cities. For each pairing opportunity, we map the possible partnership focus, potential conveners and entry points, and most logical twinning activities. The aim is to inform the next stage of Innovation Twin design.

The pairings analysis is based on three main criteria that consistent feedback from interviewees in both the UK and India indicated are most important for gauging potential:

1. How compatible they are in areas of net zero innovation (energy, technology, pollution, housing, etc).[12]
2. The experience of key institutions, businesses and centres within the cities at partnering on green innovation, and the extent to which there is an active expression of appetite to collaborate internationally. This also includes wider business links, through a review of the size of the Indian corporate presence in UK cities, the number of fastest-growing UK companies in Indian states, and the presence of Indian diaspora in the UK and vice versa[13]
3. The match and 'fit' of the cities themselves (based on their size, scale, global reach and profile).[14]

1. COMPATIBILITY ON NET ZERO INNOVATION

City-to-city collaboration can create 'twinning fatigue'. Working towards concrete outcomes is therefore paramount. A specific challenge to work towards and measure against makes clear the value of engaging, gives participants 'skin in the game', and creates coherence around which to mobilise. The ability to define mutually beneficial challenges is more likely when cities and places share compatible areas of expertise and have parallel ambitions.

> **"When things work, it's because people share risk. Everyone has skin in the game."**
>
> **Senior official, UK regional research & discovery partnership**

> **"There is a need to be able to create coherence and scale that means you can cut through chaos, make it worth the engagement."**
>
> **Senior representative, Energy Research Accelerator**

2. EXPERIENCE, APPETITE AND RELATIONSHIPS

Existing links, no matter how informal, are often the basis for deeper, more meaningful exchanges. Personal relationships and conversations often spark deeper collaboration and are important for building the soft power that can help place-to-place relationships endure over the medium-to-long term.

> **"Lots of the conversations we have been having about the potential for more formalised partnerships have been brokered by personal relationships and links."**
>
> **Senior official, UK city investment attraction agency**

3. CITIES' MATCH AND FIT

Commensurability between the cities themselves (their size, scale and specialisms) helps all kinds of partnerships to flourish – not just city government to city government. When institutions partner up internationally they often have more confidence when the city platforms they connect have some parity of esteem and capability. Even in cases where there are big absolute differences in scale (e.g. in UK-India), a common view is that city twins that bring together places that share similar positions within their national system, or which share clear motives around leveraging new technologies to address place-based challenges for net zero, will be more likely to succeed over the medium-to-long-term.

> **"A 3rd tier city in India, partnering with a 1st tier city in UK (or vice versa), is just not going to work."**
>
> **Senior representative, UK university (India centre)**

What this means is that in a UK-India context, a few select cities (and pairings) are ready to twin up their whole ecosystems – i.e. partners across the whole quadruple helix and beyond.[15] Others are in a better place to start by connecting individual places or assets within a city where there is a strong single motive.

This review has mapped a wide spectrum of places and assets with the capacity and propensity to partner between UK and India around net zero. It has assessed them according to how mature they are, how much capacity they have, and how much scope there is likely to be to partner up (see Appendix).

The review has pointed towards four main types of place-based partnership between UK and India (see below).

1. UK place as producer of green innovation, for India

Places in the UK with significant downstream capability in green innovation niches, looking to export to India and access new high-demand markets

Plus

Indian places and cities that have specific place-based innovation needs in areas where UK firms have expertise

2. UK place as consumer of green innovation, from India

Places in the UK that have capability to host Indian innovators and firms in specific sustainability niches and to enable them to validate their technologies

Plus

Indian places and cities that have exportable expertise in specific sustainability niches and are seeking to access dedicated testing infrastructure or investment

3. Bilateral best practice & insights and research partnerships

Twinning partnerships focused on e.g. ports, airports, districts that enable sharing of best practices in roadmapping the path to net zero, retrofitting assets, etc

Plus

Twinning partnerships that build on existing academic and university links, seeding research and discovery in areas related to green innovation

4. Joint ventures between companies incubated in India & UK

Companies that have been incubated in both Indian and UK places that form joint ventures to deploy in either or both nation

Likely to be facilitated by partnerships between start-up accelerators and incubators and/or 'open calls' in both the UK and India

Places seem to be better set up to engage in direct commercial corridors (e.g. hosting or exporting innovation firms) when there is a broader ecosystem to tap into, that can provide the convening power, coordination mechanisms and existing relationships.

Most individual 'innovation places' – self-organised clusters of innovative firms - do not have the capacity or appetite on their own to properly engage. This means that often, place-based partnerships (e.g. district-to-district, port-to-port, etc.) tend to work best when they can benefit from resource, strategic direction and advice from an ecosystem convenor that has a birds-eye view of other 'live' partnerships. Even direct engagement between individual businesses may be more likely to be successful when businesses can see and learn from other local examples. This is again more likely when a single convening entity has a wide membership and purview over a whole ecosystem.

> **"These partnerships are so time-consuming and resource intensive. Having multiple partners to keep [the partnership] alive [makes it] much easier."**
>
> **Executive Board Member, Queen's University Belfast**

> **"Ecosystem to ecosystem efforts need to be explored. That helps to diversify from just 1 topic to 2-3 topics. And more diversification means more legs [to keep it going]."**
>
> **Senior Representative, Bengaluru Science & Technology Cluster**

University-to-university links are slightly different and do not rely as much on ecosystem-level capacity.

Universities often have their own highly resourced international offices. They also have a direct incentive to work in large emerging student markets such as India as the share of Indian international students grows.

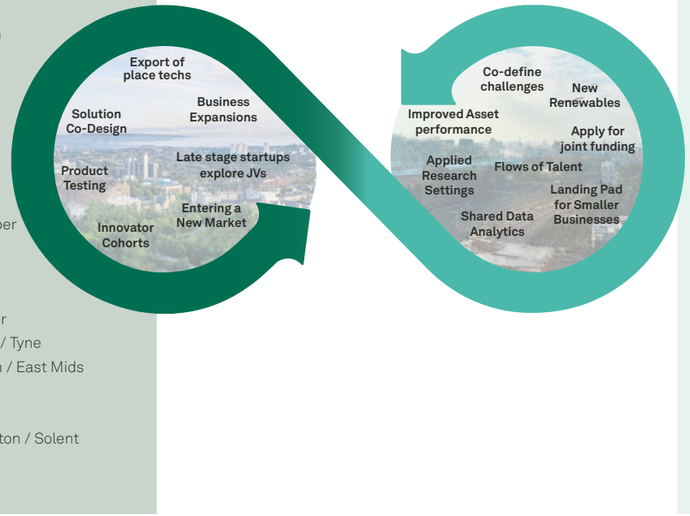
Many universities note that decisions to engage India in research programmes, student exchanges and other initiatives are at least partly driven by recognition of the rapid growth in Indian students seeking to study abroad and India's emergence as a financial and technical powerhouse for the global economy. It also helps to provide a talent pipeline for UK companies that are struggling to access the skills they need to compete.

> **"There is clearly desire for universities to work more strongly with India."**
>
> **Senior official, UK regional research & discovery partnership**

The cities and city-regions assessed

UK Cities

1. Aberdeen
2. Belfast
3. Birmingham
4. Bristol
5. Cambridge
6. Cardiff
7. Dundee
8. Edinburgh
9. Exeter
10. Glasgow
11. Hull / Humber
12. Leeds
13. Leicester
14. Liverpool
15. Manchester
16. Newcastle / Tyne
17. Nottingham / East Mids
18. Oxford
19. Sheffield
20. Southampton / Solent



Indian Cities

1. Agra
2. Ahmedabad
3. Aurangabad
4. Bengaluru
5. Bhopal
6. Bhubaneswar
7. Calicut
8. Chandigarh
9. Chennai
10. Coimbatore
11. Delhi
12. Hyderabad
13. Indore
14. Jaipur
15. Jamshedpur
16. Kannur
17. Kanpur
18. Kochi
19. Kolkata
20. Kollam
21. Lucknow
22. Ludhiana
23. Madurai
24. Malappuram
25. Meerut
26. Mumbai
27. Nagpur
28. Nashik
29. Patna
30. Pune
31. Raipur
32. Rajkot
33. Srinagar
34. Surat
35. Thiruvananthapuram
36. Thrissur
37. Vadodara
38. Vijayawada
39. Varanasi
40. Visakhapatnam

This review maps the opportunities in 20 UK cities and 40 Indian cities. In the UK the focus is especially on Core Cities and other medium-sized cities with strong potential for partnership that can support national levelling up, and as such London was not included in the analysis.

In both the UK and India, the cities reviewed cover:

- Larger, globally connected and consistently innovative urban economies in each nation (based on population size, number of advanced services firms with global reach, and concentration of locally headquartered tech-enabled companies)
- Places that are home to at least one observed initiative with partnership potential through which an innovation twin could be mounted (e.g. a specific net zero project, place, asset, organisation or programme)
- The locations currently with the political momentum to lead and innovate on clean growth

TOWARDS A SHORTLIST OF UK AND INDIAN PLACE TWINS

The experience of cross-border partners indicates that to understand whether and how UK and Indian cities are suited as hosts and platforms for net zero-related Innovation Twins, depends on four key factors.

1. Firstly, city regions need already to be home to centres, programmes and initiatives that are well-established enough to accommodate an international lens.
2. Secondly, they benefit from having a large local market of innovative companies, including in green and low carbon sectors, with capability to test and scale solutions in new markets.
3. Thirdly, the motives to set up and sustain an Innovation Twin tend to be more in place when a city-region is strongly committed and aligned to pursue decarbonisation and/or innovation.
4. And finally, given that Innovation Twins are more likely to succeed where they can connect whole portions of the ecosystem, city regions benefit when there is more coordination and integration at the whole region or where there is a single recognised point of contact that can convene and connect the ecosystem.

Looking at the landscape across many of UK's largest and most globally connected urban economies, there are multiple types of city-region in terms of the kinds of purpose and readiness to participate in place-based Innovation Twins.

The assets and outlook of each type can inform the design, scope and focus of Innovation Twin with India.

	Internationally intentional	Internationally Engaged	Flying Solo	Trading Places	Net Zero specialists
Characteristics	Scale, ambition, and increasingly mature whole-ecosystem approach	Fairly well integrated but smaller scale innovation ecosystems	Ambitious city leadership on net zero, selective partnerships, fast moving green economies	Partnership-hungry districts or gateway infrastructure, some relevant innovation - expertise and early - stage efforts to convene the green ecosystem	Cities with less integrated ecosystems whose net zero and trade pathways are more specific
1. Partnership-ready net zero initiatives	■■■■■	■■■□□	■■■□□	■■■■□	■■□□□
2. Net zero market size	■■■□□	■■□□□	■■■■□	■■□□□	■□□□□
3. Observed ambition to decarbonise	■■■□□	■■■□□	■■■□□	■■□□□	■□□□□
4. Governance and ecosystem integration	■■■□□	■■■□□	■□□□□	■■□□□	■□□□□
Exemplary cities	West Midlands Greater Manchester	Belfast City Region Glasgow City Region	Bristol Edinburgh	Newcastle Leeds Liverpool Sheffield	Southampton Hull Cardiff Dundee Aberdeen
Innovation Twin implications	Ready for ecosystem-to ecosystem partnerships with larger Indian cities	Able to mobilise and pursue partnerships with specialist cities and assets in India	Twins likely to rely on niches in advanced science and technology and demonstrators, rather than grounded in infrastructures or districts	Opportunities for Twins to enlist local place leadership, ports and airports, and advanced net zero production	Twins can engage Indian partners on major renewables, via investment zones, universities and other designated areas

1. Based on total no., maturity and partner-ability of net-zero focused: a) partnerships and coalition b) ports and airports, c) innovation districts, d) city centres, e) research clusters and f) enterprise zones, testbeds and demonstrators
2. Based on total no. of locally HQ'ed firms net zero relevant sectors (see Appendix for list)
3. An all-round measure of cities net zero ambition, the scope and maturity of decarbonisation strategies, the extent of consideration to accountability and responsibility tools for decarbonisation and open data for emissions
4. Maturity of the metropolitan governance system and level of innovation ecosystem coordination and integration

Note: the following seem to have less potential to engage in innovation twinning activities and are therefore not shown: Cambridge, Oxford, Leicester, Exeter, Nottingham

Note: all exemplary cities refer to city regions/metropolitan areas. Sources (from top to bottom):
1) The Business of Cities research, 2) Crunchbase, 3) The Business of Cities research, based on Net Zero Tracker and CDP, 4) The Business of Cities research.

BOX 1: TO TWIN OR NOT TO TWIN: THE ROLE OF CITY GOVERNANCE AND CAPACITY

For UK cities, the character of a prospective Innovation Twin opportunity is strongly shaped by the governance context in city-regions.

Over the last 20 years, UK cities have gone on quite distinct and asymmetric governance paths. A few now have quite mature city-regional governance arrangements, via Combined Authorities and/or metropolitan mayors with strategic ownership over key systems, clear international strategies, and established channels for engaging key local institutions on innovation issues. Others are starting to gain more of these features.

India's city governance models also vary. Much depends on the approaches of state ministers, the presence of federal programmes, the progress at amalgamating local governments, and the existence of metropolitan planning, infrastructure or development agencies.

Innovation Twins have to be customised to this context. In some places, they can be primed to bridge well-organised ecosystems. In others, they are likely to be grounded in particular institutions and leadership teams (see also Appendix).

	1st Cycle	2nd Cycle	3rd Cycle
City context	Limited or fragmented leadership across the city-region. Key knowledge and infrastructure assets operate with high degree of independence. Opportunistic or relationship-led approach to international engagement.	Strong sources of city leadership and/or city regional governance Clear direction in priority sectors. International reach of its leading institutions and assets.	An established city -regional governance. A well-mapped and marshalled innovation ecosystem. Confident leadership from civic institutions and major businesses.
Preconditions for successful Twins	• Strengthening relationships and shared purpose among City Gov, leading institutions and 2-4 largest businesses. • Building the Civic Mission and place consciousness of Key Anchors (especially research universities, ports, airports) • Identifying the place-based innovation opportunity that can amplify the outbound trade and export potential • Supporting the Region to Map the Full Set of Ecosystem Opportunities and viable 'landing pad' locations.	• Supporting the emerging city region trade and investment apparatus to identify and segment Net Zero opportunities. • Helping to select priority Innovation districts and locations with absorptive capacity for SMEs, innovative testing, and outbound engagement. • Liaison with test zones (eg mobility, clean air) to identify innovation gaps and possible third-party sites.	• Grounding an Innovation Twin firmly within the whole city regional innovation governance and the wider strategy. • Ensuring other partners beyond existing core stakeholders can also participate and gain awareness. • Focus on the wider city-to-city relationships including diasporas, sport, real estate, FDI.
Example UK Cities	Dundee Hull Edinburgh Cardiff Southampton	Bristol Aberdeen Sheffield Newcastle Leeds Liverpool	Belfast Glasgow Manchester West Midlands

Twins can be grounded by individual institutions or districts

Twins can bridge whole ecosystems

Source: The Business of Cities qualitative research, based on e.g. maturity of regional governance arrangements, clarity and maturity of international strategies, and extent to which government works jointly with businesses, universities and civic groups to marshall a single unified vision for the innovation ecosystem. Note: this is designed to be an indicative map. It is not designed to be an exhaustive list of all UK city regions. Within each cycle, some regions may be further ahead than others. The ways that regions progress through the cycles also differ according to size, wider devolution context, and innovation specialisms.

Taken together with net zero market size, decarbonisation and innovation ambition, and the presence of partnership-ready net zero initiatives, this means that there are only a small number of city-regions in the UK that appear most ready and joined up to mobilise their whole ecosystems around an Innovation Twin opportunity with India.

These include:

1. Birmingham/West Midlands, where potential convening entities might include e.g. the West Midlands Growth Company and West Midlands-India Partnership
2. Greater Manchester, where potential convening entities might include e.g. MIDAS and the Manchester-India Partnership
3. Belfast City Region, where potential convening entities might include e.g. Innovation City Belfast and Invest Northern Ireland
4. Glasgow City Region, where potential convening entities might include e.g. Glasgow Chamber of Commerce and Scottish Enterprise

Elsewhere there is a lot of potential for individual locations, assets and industries to ground the pairing and partnering activity, potentially crowding in wider partners in a city-region over time. For more detail on these, please see the Appendix.

On the Indian side, 10 of the 40 reviewed cities appear to possess all or most of the four ingredients:

1. Critical mass of innovative tech firms and globally networked advanced urban services firms
2. Recognised entities, organisations and initiatives that have the capacity, appetite and resource to partner up and drive place-based innovation
3. Clear observed support at city or state level for decarbonisation, innovation, or both
4. A potential ecosystem convener or 'front door' for Innovation Twinning activity (especially National Science and Technology clusters – see also Box 2)

This means there are 10 Indian cities that appear to have the most potential for partnership opportunities.

In order, they are:

	Higher weight* ⇦ Enough globally engaged businesses?[1]	Visible initiatives to partner [2]	Proactive on innovation and net zero[3]	⇨ Lower weight* Obvious ecosystem-wide convener?
1. Bengaluru	●	●	●	✓
2. Delhi	●	●	●	✓
3. Mumbai	●	●	●	
4. Pune	●	●	●	✓
5. Hyderabad	●	●	●	✓
6. Kolkata	●	●	●	
7. Chennai	●	●	●	
8. Ahmedabad	●	●	●	
9. Bhubaneswar	○	●	●	✓
10. Kochi	○	●	●	

● High ● Moderate ○ Lower

1. No. of locally HO'd firms with a strong technology and innovation quotient, plus depth of presence of globally networked advanced urban services firms. Sources: Crunchbase, The World According to GaWC
2. Projects through which an innovation twin could be mounted. Examples could include: whole city-innovation clusters and convening organisations, green innovation tech parks. EV testbeds, airport sustainable aviation fuels trials, etc. Source: The Business of Cities Research
3. Average of city/state level net zero ambition, maturity of net zero strategies, extent of accountability, and open data for emissions. Sources: CDP and Net Zero Tracker

*Weights based on feedback from interviewees about the most important factors for determining likelihood of success of international collaboration to date.

BOX 2: INDIA'S SCIENCE AND TECHNOLOGY CLUSTERS

In India, where state governments play a more important role and the track record of metropolitan governance is less well established, the character of a prospective Innovation Twin opportunity is more strongly shaped by the presence of recognised institutions that can play a role in convening, co-ordinating and connecting up the ecosystem.

The S&T clusters emerge as strong potential convening partners for innovation twinning activity because they have mandates to become local solution providers, are actively seeking global industry partners, and are directly addressing net zero.

What are the S&T clusters?

The Science and Technology Clusters have been funded by India's National Government to strengthen whole life-cycle approaches to the innovation ecosystems of six Indian cities (Delhi, Hyderabad, Pune, Bengaluru, Jodhpur, Bhubaneswar).

The six clusters consist of formal umbrella structures that can act as the connective tissue that brings together academic institutions, state governments, research laboratories, incubators, start-ups and others to:

- Foster sharing of resources (labs, researchers, etc.) among members
- Encourage development of solutions to local challenges from the research stage to public procurement
- Promote the international competitiveness of the different cities (e.g. through hosting delegations).

They represent India's most recent and most mature attempt to date to apply multi-stakeholder collaborations and solutions to real place challenges.

Why are they important convening partners for place-based innovation Twins?

The S&T clusters are suitable convening partners because they:

1. **Are place-conscious and problem-solving.** The clusters 'crowd in' the sorts of partners that are needed to solve net zero challenges and have mandates to become local solution providers, catering to science and technology demands. They have an established track record of mounting pilots specifically aimed at solving urban challenges with place-based outcomes, such as air pollution, urban mobility and waste management.
2. **Are actively seeking industry partners.** Their funding structures (seed funded by central government but with the expectation to become independently sustainable after the first three years, and currently transitioning to non-profit companies) means they have significant appetite to partner up and find external projects, sponsors and champions. Many of the clusters are seeking global industry partners to demonstrate impact – academic organisations, government agencies, large corporates (e.g. Google, Tata Power etc.) and international organisations (WEF, UNDP, etc.).
3. **Can work as consortia to mount and sustain projects.** The clusters are able to raise and accept money in several different ways (e.g. via in-kind CSR, research grants, private philanthropy and others). They also have the potential to act as special purpose vehicles to manage projects, money and relationships. Together, these factors enable them to fulfil programme manager functions and provide industry and innovation support as an ongoing service.

The outward-facing and place-aware ethos of India's Science and Technology clusters align well with the premise of Innovation Twins, and can be explored further.

5 TOWARDS THE HIGH POTENTIAL PAIRINGS

The evidence review points to four UK city regions that have the assets and coordination to potentially convene whole ecosystems into Innovation Twins with partners in India.

These city regions in particular possess an abundance of advantages to fuel the success of Innovation Twins. These are explained in detail below and are the focus of the rest of this report.

For the other cities and places where specific knowledge assets or hub organisations that seem well placed to build and expand UK-India partnerships to scale net zero solutions, please see the Appendix.

1. GREATER MANCHESTER REGION

What makes Greater Manchester region a strong Innovation Twin proposition for India?

EXISTING LINKS WITH INDIA

- Capacity dedicated to strengthening trade, investment, cultural and education ties with India, via the Manchester-India Partnership and on-the-ground staff in Bengaluru and Delhi
- Recent history of trade missions and visitors by mayors and other senior officials (Manchester was 1st region to establish MoU with Maharashtra State, home to Mumbai and Pune)
- Significant Indian corporate-led support for Manchester's start-ups - egg Tech Mahindra has grown its Manchester HQ in collaboration with Salford University to create a start-up incubation hub
- Strong track record of academic and university-government collaboration between Greater Manchester and India
- Pre-Covid, the Manchester-Mumbai air route was one of Manchester Airport's most successful direct flights
- Strong cultural and sports ties (e.g. Manchester Museum's recently opened £5m South Asia Gallery)
- University of Manchester has signed a MoU with Digital University of Kerala
- Over 500 Indian students studying at University of Manchester

INNOVATION AND INVESTMENT DYNAMICS

- Largest city region economy in UK (£74.85bn GVA) and top FDI destination outside London
- 200+ year history of innovation, now a Global Top 60 innovation ecosystem
- Mature metropolitan management with international ambition – the city in the UK with the most devolved powers (e.g. over skills, health and local spending) outside of London
- UK leader for city ambition and appetite to reach net zero emissions - e.g. currently transitioning to integrated transport system across whole region
- Export-ready clusters in materials science and fintech

POTENTIAL CONVENING ENTITIES

1. Manchester-India Partnership
2. MIDAS

Sources[16]

Places and leadership in Greater Manchester with potential to ground an Innovation Twin with India

Potential for **high-growth companies** in sectors such as distributed energy (e.g. UrbanChain), energy management (e.g. Qenergy), agritech (e.g. Red Planet Farms) and advanced materials (e.g. Grafine Ltd) to export to India.

Manchester-India Partnership and MIDAS have potential to help strengthen relationships with Indian clusters and create routes for Indian SMEs to bring green innovation and investment to the UK.

Transport for Greater Manchester has potential to share best practices on how to sequence and integrate new infrastructure investment and roadmap integrated transport systems.

NW Hydrogen Alliance has potential to share expertise on how to build a robust hydrogen market across research, production, distribution and storage.

Salford University has potential to build on its MoU with partners like Karnataka State Higher Education Board to drive up R&D, and foster entrepreneurship in e.g. waste management, clean energy, IoT, etc.

University of Manchester has potential to deepen research exchange (e.g. around materials science and urban planning), create new industrial collaborations with Indian firms, and explore with IITs joint research on traffic and transport modelling and relationships between new transport infrastructure and social behaviour.

Manchester Airport has potential to offer expertise in roadmapping to net zero operations.

Cheshire Energy Innovation District has potential to convene pilots looking at feasibility of fuel cells for HGVs.

City-wide institution or organisation | **Research institute or knowledge cluster** | **District or place (port, airport etc.)** | **Accelerator, incubator or start-up**

INDIAN CITIES WITH STRONG POTENTIAL FOR PAIRING WITH GREATER MANCHESTER

	City parity	Net zero links (now and future)	Green economy overlaps	Potential innovation twin partners	Possible partnership focuses	Rationale for Innovation Twins
Bengaluru	✓✓✓	✓✓✓	✓✓	Bengaluru Science and Technology Cluster	Sustainable mobility Green hydrogen Precision agriculture	Both have strong existing university-to-university relationships related to smart cities, energy and waste.[17] Shared track record as capitals of knowledge, education and the digital economy. Both see top-class universities and institutes playing a key role in channelling innovation towards local place needs. Clear synergies in approach to decarbonising mobility and engaging citizens.
Mumbai	✓✓✓	✓✓	✓✓	Maharashtra State Innovation Society Mumbai Circular Economy Park	Circular economy Green finance	Both are national '2nd cities', with shared culture of enterprise, creativity and openness. Shared appetite to bring forward innovative districts, learn from international best practices, and develop effective regional innovation policy.[18] Track record of MoUs, workshops and collaborative initiatives between GM Combined Authority and Maharashtra State bodies.[19]
Pune	✓✓	✓	✓✓✓	Maharashtra State Innovation Society	Advanced materials Renewables Clean mobility	Overlapping specialisms in advanced materials (e.g. graphene), clean mobility, and inducing sustainable behaviour change. Existing relationship between GM Combined Authority and Maharashtra State Innovation Society for partnership between incubators.

2. BIRMINGHAM/WEST MIDLANDS

What makes West Midlands a strong innovation twin proposition for India?

EXISTING LINKS WITH INDIA

- The large Indian diaspora in the region (8% of the regional population is of Indian origin - the 2nd highest share in the UK after Leicester)
- The growing presence of Indian businesses in the region (e.g. Tata Technologies is scaling up its presence through the growing its European Innovation and Development Centre and Jaguar Land Rover)
- Its status as the top destination for inward Indian FDI after London and the South East (more than half of Indian investment into the UK went to West Midlands in 2020)
- Its track record of hosting large delegations of Indian companies in key greentech sectors (e.g. via the Indian Hydrogen Business Opportunity event)

INNOVATION AND INVESTMENT DYNAMICS

- Frequency of collaboration between universities and businesses is a competitive edge (examples include the Energy Research Accelerator, supported by 3 universities to solve the energy industry's most pressing challenges and Jaguar Land Rover, the University of Warwick and Plug and Play UK's mobility programme on advanced propulsion and CAVs)
- One of the UK's most advanced innovation ecosystems in sustainable construction, E-mobility, energy grid retrofits and low carbon utilities
- Home to 10% of UK's high potential investment opportunities (DIT)

POTENTIAL CONVENING ENTITIES

1. West Midlands Growth Company
2. West Midlands-India Partnership

Sources[20]

Places and leadership in West Midlands with potential to ground an Innovation Twin with India

West Midlands Growth Company and West Midlands-India Partnership has potential to help formalise relationships with Indian companies and routes for Indian businesses to bring green investment to the UK.

Energy Research Accelerator and Tyseley Energy Park have potential as platform for firms in fields like hydrogen (e.g. ITM Power) and powertrain systems (e.g. Ballard Motive Solutions) seeking to test and deploy and power and transport solutions in new overseas markets.

UK Battery Industrialisation Centre has potential to help scale-up, commercialise and export new automotive battery tech to Indian cities leading the e-Mobility transition.

Energy Systems Catapult has potential to participate in deepened research partnerships on for example e-Mobility knowledge exchange.

University of Birmingham has potential to share best practice insights about how to implement sustainable cooling technologies.

City-wide institution or organisation | Research institute or knowledge cluster | District or place (port, airport etc.) | Accelerator, incubator or start-up

INDIAN CITIES WITH POTENTIAL FOR PAIRING WITH BIRMINGHAM/WEST MIDLANDS

	City parity	Net zero links (now and future)	Green economy overlaps	Potential innovation twin partners	Possible partnership focuses	Rationale for Innovation Twins
Hyderabad	✓✓✓	✓✓	✓✓✓	Research and Innovation Circle of Hyderabad Telangana State Government	Sustainable mobility Green hydrogen Precision agriculture	Compatible specialisms in electronics, automotives and aerospace, and metallurgy. Both have a track record in sustainable cooling and eMobility - working university-to-university, university-to-government and G2G. Fast-growing software companies that are choosing the other city to expand their operations (e.g. Kagool, Computer Generated Solutions Ltd).[21]
Bengaluru	✓✓✓	✓✓✓	✓✓	Bengaluru Science and Technology Cluster (BeST)	eMobility Hydrogen fuels	Expertise in sustainable mobility, especially EVs, which has driven substantial related FDI.[22] History of university-to-government partnership around energy sustainability in rail systems, and hydrogen re-fuelling systems. Experience harnessing ecosystem champions for sustainable development (e.g. Energy Systems Catapult in Birmingham, Social Alpha in Bengaluru).
Chennai	✓✓	✓✓	✓✓✓	IIT Madras Chennai Smart City Ltd	Electric two-wheelers Energy efficiency and storage	Large FDI around e-Mobility (e.g. £100m recently invested by Chennai-based two-wheeler company TVS in Solihull-based Norton Motorcycles). [23] Future leaders in the areas of future of mobility, energy efficiency and storage, and circular economy. History of research collaboration on cleantech (e.g. recent joint fund and degree accreditation created between UoBirmingham and IIT Madras to support research partnerships in energy systems).[24]

3. GLASGOW CITY REGION

What makes Glasgow City Region a strong innovation twin proposition for India?

EXISTING LINKS WITH INDIA

- Many business-led partnerships between Glasgow and India (e.g. Indian-based Apollo Tyres working with University of Glasgow to use AI and machine learning to improve manufacturing efficiency and tyre quality)
- Track record of engaged academic institutions in Glasgow working to catalyse sustainable urban development with academic, business or government partners in India (e.g. Strathclyde University research for better air quality in Kolkata; Glasgow Caledonian University with Indian Institutes on EV uptake, grid demand management, 3D printing approaches for e-scooters and pollution sensors)
- Experience developing collaborative entrepreneurship initiatives with Indian partners (e.g. Hunter Centre for Entrepreneurship at Strathclyde Business School organised a conference in partnership with IIM Kashipur)
- Appetite for joint incubation and acceleration - e.g. Glasgow HQ'ed accelerator organisation Entrepreneurial Spark chose 4 Indian cities for its first overseas expansion

INNOVATION AND INVESTMENT DYNAMICS

- More purposeful multi-level approach to innovation and place than many city-regions, with clear progression towards a single defined innovation offer
- Globally recognised STEM and R&D strengths, plus progress in cleantech, biotech and deeptech
- Internationally recognised for ambitious approach to reaching net zero
- Plays a strong convening role for sustainability in international networks and partnerships (Glasgow Financial Alliance for Net Zero, COP26, etc.)

POTENTIAL CONVENING ENTITIES

1. University of Strathclyde
2. Scottish Enterprise
3. Glasgow Chamber of Commerce

Places and leadership in Glasgow City Region with potential to ground an Innovation Twin with India

Glasgow Chamber of Commerce has potential to serve as a platform for UK SMEs looking for routes to export greentech, including identifying and liaising with Indian clusters appropriate for local firms.

Glasgow Airport has potential through 'Connected Airport Living Lab' to welcome Indian tech for decarbonisation of ground and air operations and acceleration of sustainable flight.

Glasgow City Innovation District has potential to host Indian cleantech SMEs in sustainable mobility, air quality monitoring, heating tech and energy efficient street tech to become an integrated 'Climate Neutral Innovation District'.

Glasgow Airport has potential to share expertise on improving the ESG performance of key infrastructure systems e.g. eBus fleet, fixed electrical ground power systems, 100% waste diverted from landfill, etc.

Strathclyde University has potential to build on its Institute of Future Cities' agreements with Indian universities, state governments and chambers of commerce for identifying solutions for more sustainable critical urban systems and environmental management.

City-wide institution or organisation | Research institute or knowledge cluster | District or place (port, airport etc.) | Accelerator, incubator or start-up

INDIAN CITIES WITH POTENTIAL FOR PAIRING WITH GLASGOW CITY REGION

	City parity	Net zero links (now and future)	Green economy overlaps	Potential innovation twin partners	Possible partnership focuses	Rationale for Innovation Twins
Kolkata	✓✓	✓✓✓	✓✓	University of Kolkata Bengal Chamber of Commerce and Industry West Bengal State Government	Sustainable water management Housing retrofits Green finance	Existing collaboration between Glasgow universities and Indian IITs and business partners.[25] Shared interests around urban flooding (Kolkata is one of world's cities most at risk of flooding; Glasgow trialling 'smart canal' tech for 'sponge city' surface water drainage over a 100ha redevelopment). [26] Green finance partnership potential (Kolkata needs to leverage new finance sources for sustainability projects; Glasgow is a UK leader in green finance).[27] Desire to grow public transport uptake and modernise rail transport systems (each home to one of the oldest established metro systems in their respective countries).
Hyderabad	✓✓✓	✓✓	✓✓	Research and Innovation Circle of Hyderabad	Energy efficiency Last-mile AR & VR Public realm activation	Smart energy efficiency (Hyderabad had India's highest electricity consumption/capita growth in 2020; Glasgow developed 'smart street' testbed with smart lighting, curb-side EV charging, etc.)[28] Shared interests in how to introduce AR/VR into public realm (Glasgow trialling AR approaches in subway; Hyderabad due to build AR techno park for startups).[29] Potential for knowledge-sharing around creating infrastructure for last mile micromobility (an important identified challenge in Hyderabad and Glasgow has been leader in the UK[30]).

4. BELFAST CITY REGION

What makes Belfast City Region a strong innovation twin proposition for India?

EXISTING LINKS WITH INDIA

- Long-term track record of business-led partnerships promoting student and research exchange (internships, cross-cutting sustainability research, etc.)
- Pioneer in cross-cutting sustainability research (e.g., Queen's University Belfast first ever study into the built environment's impact on physical activity levels in India)
- E.g., recent research project between Queen's IITs in Mumbai and Delhi and Nova Pangea Technologies focused on transforming waste streams into biomass

POTENTIAL CONVENING ENTITIES

1. Invest Northern Ireland
2. Innovation City Belfast*
3. Samart Belfast

INNOVATION AND INVESTMENT DYNAMICS

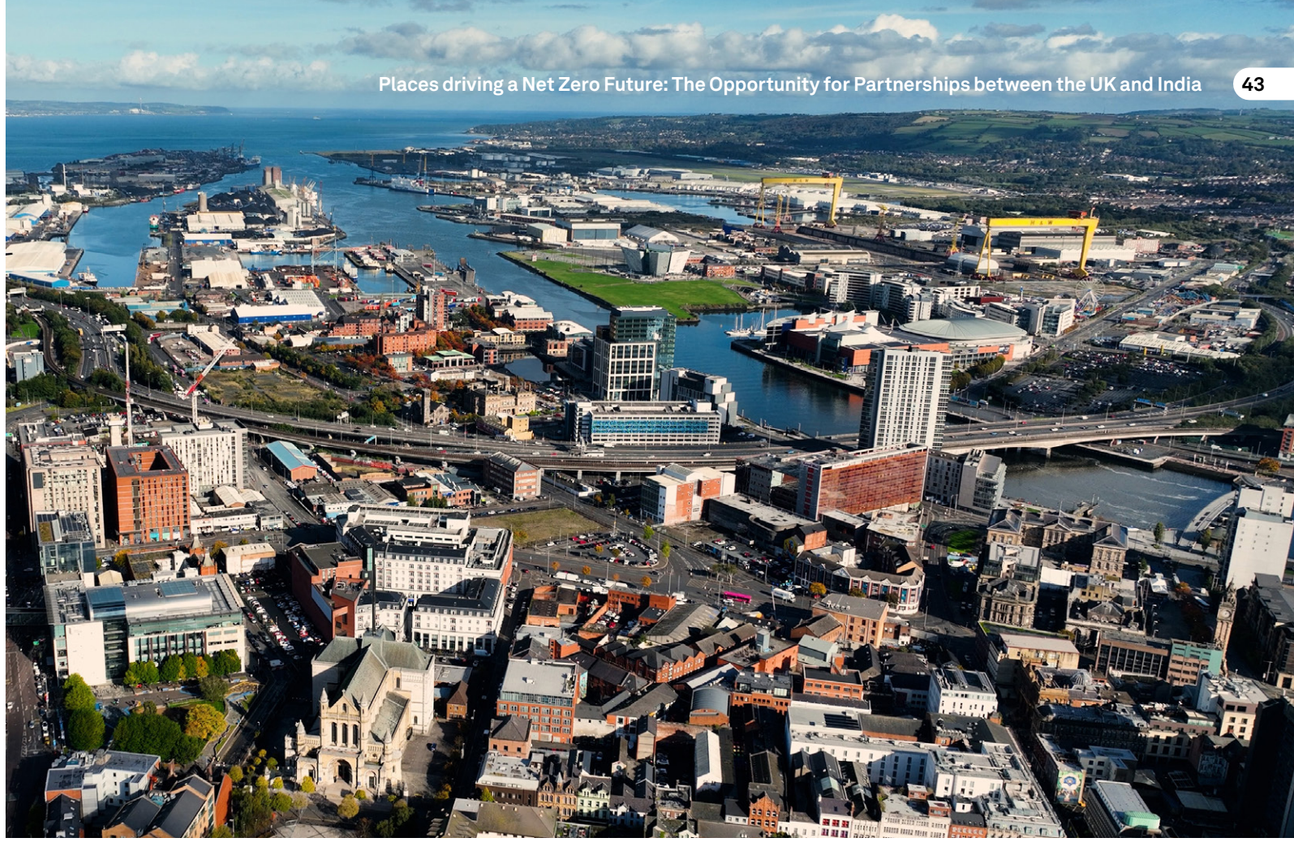
- Home to dynamic and enthusiastic local leaders, who recognise the importance of talking an ecosystem-level approach
- Active participation in UK-South Korea Innovation Twins programme currently
- Strongly pro-innovation business environment thanks to digital competitiveness, policy support for entrepreneurship and inward investment friendliness.
- Important leadership in carbon reduction among UK cities (highest carbon reduction momentum among UK cities since 2014, with emissions reduction of nearly 25%)
- One of the UK's most advanced innovation ecosystems in agritech and digital approaches to sustainability

Sources[31]. *Innovation City Belfast consists of and regularly convenes all of the city's key institutions (Belfast City Council, Belfast Harbour, Belfast Metropolitan College, Catalyst (science park), Queen's University Belfast, Ulster University and Invest Northern Ireland) via steering committee workshops.

Places and leadership in Belfast City Region with potential to ground an Innovation Twin with India

	Queen's University Belfast's digital testbed has potential to host Indian SMEs interested in testing smart factory technologies for improved efficiency and less waste in manufacturing operations.	**Belfast Harbour** has potential to share expertise around trialling biofuels in port fleets	**Belfast Innovation District** has potential to act as a platform to give fast-scaling firms (e.g. EEL Greentech, Catagen, Artemis Technologies) the opportunity to test and deploy products in real-world environments.
	Invest Northern Ireland has potential to establish strong relationships with Indian firms and create a soft landing for Indian SMEs in the wider Northern Ireland regional ecosystem.		**Smart Belfast** has potential to share expertise around developing data and deeptech approaches to sustainable mobility, waste management, port operations, etc.
	Ulster University has potential to deepen research collaboration with central government-owned National Institutes of Technology in India e.g. around sustainable built environment approaches like heat pumps, district heating, distributed energy storage etc.		**Queen's University Belfast** has potential to deepen its agritech-focused research exchanges with IITs in India e.g. around transforming waste streams into biofuels

City-wide institution or organisation | **Research institute or knowledge cluster** | **District or place (port, airport etc.)** | **Accelerator, incubator or start-up**



INDIAN CITIES WITH POTENTIAL FOR PAIRING WITH BELFAST CITY REGION

	City parity	Net zero links (now and future)	Green economy overlaps	Potential innovation twin partners	Possible partnership focuses	Rationale for Innovation Twins
Bhubaneswar	✓✓✓	✓✓	✓✓	Bhubaneswar City Knowledge Innovation Foundation	Data-driven smart cities Agritech Food supply and security Advanced manufacturing	Both seeking to deliver ambitious city centre focused Smart Districts, supported by next generation technologies and advanced fibre optics. Both home to progressive universities that are engaged with the city and civic groups and play key roles in translation and spinouts. Both occupy roles as respective regional innovation hubs.[32] Bhubaneswar has direct experience brokering partnerships with UK entities that are focused on helping Indian start-ups to enter the UK market (e.g. via partnership with the NHS).[33]
Pune	✓✓	✓✓	✓✓	Pune Knowledge Cluster	Energy storage and renewables Agritech Sensing and sensors	Shared expertise in energy storage and renewables and agritech (e.g. Pune-based agritech firm FarmERP was 1st Indian firm to join Global Good Agricultural Practices initiative; Belfast is leading European agritech hub with Institute for Global Food Security). Track record of long-term sustained partnership between both cities (e.g. Infosys and Belfast's CSIT together foster joint research projects, sponsor PhD scholarships, internships and faculty and student exchanges. 35 Electrical Engineering and Computer Science undergaduates from Queen's have completed Infosys internships in Pune and Bengaluru since 2011).[34]

6 TOWARDS A UK-INDIA TWINNING PROGRAMME

To underpin an Innovation Twin requires discrete phases of co-ordination, fostering and market-making

For future phases of development, as and when they are agreed, a number of logical next steps present themselves based on the current window of circumstances and the suggestions and preferences of experienced interviewees. These include:

1. Organise purposeful and focused dialogue with potential convening partners in each of the high potential cities in both the UK and India, in order to scope out the prospect of honing a programme that coincides with those partners' priorities and bandwidth. Establish via these conversations which business, research and innovation partners have strong synergy and appetite, in order to ground the partnership in applied local expertise.
2. Look to engage the relevant India state government departments (planning, IT, urban, environment, finance, industries, ports) once clarity on the preferred scope and mechanics of the twinning opportunity has been established. Meanwhile, develop the 'pitch' for the four UK cities that can be used to recruit and gain interest from the ecosystem co-ordinators, convenors and gatekeepers within the UK.
3. Make an initial approach to the cities that proposes two to three specific areas of overlap and opportunity, and identify the tangible joint ventures that can become a basis for shared partnerships seeking to drive real place-based innovation (e.g. in mobility, air pollution and public health, etc.)
4. Identify and bring together the c. 10 promising and scaling SMEs who are doing the most globally applicable work in these areas, in the UK and also in India.
5. Organise a series of Indian-based workshops, site visits or pitching sessions with a view to organising an 'Innovation Week' – initially in India and then in the UK, focused on:
    - Potential testbed/demonstrator sites
    - SMEs pitching solutions and technologies for solving local place-based challenges
    - Understanding the future of innovation in said cities

APPENDIX

1. Approach and methodology for short-listing UK and Indian cities

The core principles to compare UK and Indian cities as platforms for Innovation Twins are very similar. The differences in criteria and measurement reflect the fact that:

- In India, more consideration is given to how proactive the states are on clean growth, innovation, and sustainability agendas. This is because state governments tend to have more influence and budget in setting the direction of travel, and because urban local bodies have less variety in their explicit commitments and strategies to decarbonise and innovate. The state proactiveness measure is a useful proxy for the overall level of publicly endorsed ambition and progress in innovation.
- The size of the market in the UK is assessed more by considering data on a specific basket of green sectors[35]. In India, data on green innovation specialisms is more nascent, and so the size of the innovation ecosystem is used as an effective indicator of innovation across the suite of sustainable technologies.
- Governance and ecosystem integration is in the UK based on a composite of metropolitan-level co-ordination and how tightly co-ordinated the innovation ecosystem is. In India the track record of metropolitan governance and economic leadership is less commonly established and the State governments play a more important role. So the main criterion is the presence of recognised institutions or organisations that can play a role in convening, co-ordinating and connecting up the ecosystem.

The criteria that are assessed are listed in the table below.

	Visible initiatives to partner	Total enterprise ecosystem value, incl. in key net-zero related industries	Observed priority to decarbonise and/or innovate on behalf of the whole city	Maturity of whole-city governance and ecosystem convenors
UK	Total no., maturity and partner ability of net-zero focused: a) partnerships and coalitions, b) ports and airports, c) innovation districts, d) city centres, e) research clusters and f) enterprise zones, testbeds and demonstrators	• Total no. of locally HQ'ed firms in Net Zero relevant sectors (Crunchbase) • Depth of presence of globally networked advanced urban services firms (The World According to GaWC)	All-round measure of cities' net zero ambition, the scope and maturity of decarbonisation strategies, the extent of consideration to accountability and responsibility,tools for decarbonisation and open data for emissions (NetZero Tracker)	Aggregate score for metropolitan co-ordination (and local government fragmentation), maturity and size of city regional/ combined authority, and shared buy-in across public and private sector to grow specific sectors.
INDIA		• Total no. of locally firms, across all sectors (Crunchbase) • Depth of presence of globally networked advanced urban services firms (The World According to GaWC)	• Average of city/state level net zero ambition, maturity of net zero strategies, extent of accountability, and open data for emissions (NetZero Tracker) • Aggregate score across 10+ benchmarks measuring state proactiveness on innovation agendas (National Institute for Transforming Competitiveness- India Innovation Index 2021)	Presence of recognised convenors and clusters with the mandate and track record to assemble different parts of the business and knowledge ecosystem

2. Additional cities and places that are currently highly engaged in green and net-zero related innovation within the UK

Looking specifically at the locations, initiatives and centres that are currently engaged in green and net zero-related innovation[36], their overall potential is shaped by:

1. How many different types of innovation ready locations, assets and players a city-region currently hosts
2. How well established these activities are, and how engaged and fluent they are in international markets
3. How much likely spare capacity and capability there is to devote to the task of engaging and partnering internationally
4. Level of appetite, confidence and track record in pursuing collaborative programmes outside an immediate orbit

The potential of UK city-regions to act as platforms for place-based partnerships on net zero has been mapped (see below).

Number, maturity and partner ability of...	Ports and Airports[1]	Innovation Places[2]	Universities[3]	Enterprise Zones[4]	Partnerships & Coalitions[5]
Birmingham	Limited	High	High	Moderate	Lower
Manchester	Moderate	Moderate	High	Limited	High
Glasgow	Moderate	Moderate	Moderate	Limited	Moderate
Belfast	High	Lower	Lower	Limited	Moderate
Bristol	High	Limited	Lower	Moderate	Moderate
Edinburgh	High	Limited	Moderate	Moderate	Lower
Newcastle	High	Moderate	High	Moderate	Moderate
Leeds	Limited	Moderate	Moderate	High	Moderate
Sheffield	Limited	High	Moderate	Limited	Moderate
Liverpool	Limited	Limited	Moderate	Limited	High
Cardiff	Limited	Limited	Moderate	Limited	Lower
Dundee	Moderate	Moderate	Lower	Limited	Lower
Aberdeen	Moderate	Lower	Lower	Limited	Limited
Southampton	Moderate	Limited	Moderate	Moderate	Lower
Hull	Moderate	Moderate	Lower	Moderate	High

High **Moderate** **Lower** **Limited**

1. Mobility hubs focused on incubating new approaches to emissions reduction
2. Hubs focused on incubating and accelerating 'clean tech' start-ups (excludes university & research-led locations)
3. Higher-education institutions hosting, leading and commercialising net zero innovation (projects, testbeds, demonstrators, etc.)
4. Growing or established enterprise zones and freeports that are focused on fostering net zero innovation
5. Multi-city/multi-place learning network driving co-ordination, strategy, road-mapping and buy-in for net zero

Based on The Business of Cities research.[37]

These differences mean that cities also vary in terms of their suitability for partnering up as part of the four different types of innovation twinning activity.

WE CAN OBSERVE CITIES THAT:

Appear poised to participate in **many kinds of Net-Zero focused innovation twinning** activities

↳ E.g., Birmingham, Glasgow, Manchester, Belfast

Look to be well suited to twinning activities organised around the **sharing of best practice lessons** around how ports, airports and other mobility hubs decarbonise

↳ E.g., Bristol, Edinburgh, Southampton, Newcastle, Dundee, Aberdeen

Show strong potential for **new or deepened knowledge and university exchanges**

↳ E.g., Southampton, Newcastle, Cardiff, Liverpool

Seem primed for **exporting firms or expertise** from maturing green tech clusters

↳ E.g., Sheffield via the Advanced Manufacturing Innovation District, Hull via Greenport Hull

Are ready to **welcome and host net zero innovation** in enterprise zones, testbeds or demonstrators

↳ E.g., Leeds via the Climate Innovation District, or Hull via the Humber Enterprise Zone

Have vibrant incubation and acceleration ecosystem and critical mass of SMEs seeking to access new markets via **Joint ventures for deployment**

↳ E.g., Edinburgh, Bristol, Aberdeen, Cambridge

3. Additional cities and places within the UK that appear to have potential to build and expand UK-India partnerships to scale net zero solutions

CITIES

Many other cities also present obvious potential, and with follow-on engagement these could be further developed and materialised. For example Leeds, Newcastle, Edinburgh and Bristol all possess distinct combinations of R&D expertise residing in universities and companies, attractive investment environments, and positive examples of city leadership).

Drivers of twinning potential in Edinburgh, Leeds, Newcastle and Bristol

LEEDS

Growing expertise in green finance and fintech.

High level of self-awareness of the innovation ecosystem – its strengths and points of connection.

Leeds University holds roadmapping expertise for net zero.

NEWCASTLE

Major opportunities for low carbon firms to set up a UK HQ presence or specialised innovation teams. These include green hydrogen producers, electric vehicle services, and urban data analytics.

Potential for Newcastle Helix, Newcastle Enterprise Zone and other locations to become homes for net zero firms.

Strong research communities in two leading universities to tackle integrated issues around clean growth, with clear points of contact for international engagement.

BRISTOL

Significant engineering and built environment cluster of expertise with strong focus on lower- and middle-income countries.

Bold city leadership progress towards net zero.

Appetite and aptitude for investment in support of decarbonisation.

EDINBURGH

Edinburgh Climate Change Institute is developing capacity to create investable projects and enhance flow of green finance.

Experience of working within a place-based climate action network.

University's climate impact hub (Edinburgh Centre for Carbon Innovation) has strong track record of working with government, business and the third sector to accelerate climate transition.

PLACES

Other specific pieces of infrastructure, knowledge assets or innovation clusters can also ground an Innovation Twin approach. These include:

IN INDIA

Type	City	Place	Innovation Twin potential	Type(s) of innovation twinning activity	Potential UK partner locations
Innovation district	Bengaluru	Electronic City	Established culture of hosting sustainability-focused innovation competitions and pitch-events for place-based implementation.	Exporter of green innovation	UK clusters home to companies with innovative approaches to urban shading and active travel infrastructure.
Port / airport	Bengaluru	Kempegowda International Airport	Significant UrbanTech testing potential across energy, waste and water. Ambitious sustainable growth plans.	Bilateral best practice, insights and strategy	UK airports driving future of flight through testbed functions
Innovation district	Mumbai	Mumbai Circular Economy Park	Key focus on cleantech development by startups for circular economy, plus R&D, best practice, skills development around sustainable waste management. Very visible State initiative, open to PPP models. Focus on paper, tyres, e-waste and steel.	UK place as consumer of green innovation, from India	UK clusters home to firms with new approaches to tackling paper, tyres, steel and e-waste (e.g. Glasgow, Manchester, WM, Newcastle).
University	Mumbai	Mumbai University – Kalina Campus	Incubation centre at GreenTech building recently established. Large financial backing from State Government for innovation activities, plus strong research and corporate pool.	Exporter of green innovation	UK universities looking to commercialise very India-relevant research on topics like sustainable cooling.
Urban redevelopment	Surat	Tapi Riverfront Redevelopment and Rejuvenation	Large-scale integrated 33km-long public realm improvement project focused on active mobility, sustainable waste management, flood protection. Very clear single 'front door' (is a Surat Municipal Corporation project).	Bilateral best practice, insights and strategy	Urban riverside redevelopment project partners (e.g. in Glasgow Riverside Innovation District)
Port/Airport	Patna	Patna Airport new terminal	Strong emphasis on energy efficient building approaches. Potential to harness learnings from innovation twin partnership to push for more ambitious prospect of net zero operations.	Bilateral best practice, insights and strategy	UK airports driving approaches to net zero operations in 2030s (e.g. Glasgow, Edinburgh, Manchester)
Innovation district	Lucknow	University of Lucknow Precinct	Experience of international twinning relationships (already twinned with Brisbane). Evidence of mature approach to innovation districts, plus focus on sustainable development.	Bilateral best practice, insights and strategy	UK innovation districts in Tier 2 cities featuring civic-minded university anchors who drive greentech spin-outs and place-based sustainable innovation.
Innovation district	Bhubaneswar	Electropreneur Park Bhubaneswar	Experience of business and academic-led partnership and engagement with international organisations (e.g. partnered with American semiconductor firm Texas Instruments, has representative from TAMU on board). Acts as incubator and testbed for energy efficiency and cleantech products.	UK as exporter of green innovation	UK cleantech clusters with companies wanting to adapt their technologies and approaches to the Indian market.
New City	Aurangabad	Aurangabad Industrial City	40km^2 new city being developed near Aurangabad. Considerable international involvement (planning being undertaken by US firm AECOM).	UK as exporter of green innovation	UK cleantech clusters home to firms with integrated approaches to power, water and waste (e.g. Glasgow City Innovation District and its Climate Neutral Innovation District approach)
Port/Airport	Lucknow	Lucknow Airport expansion	Airport expansion includes new multi-modal transport hub with metro integration. Clear ambition to focus on quality of passenger experience.	Bilateral best practice, insights and strategy	UK airports and stations developing new approaches to multi-modal integration , public realm integration etc. (e.g. Manchester Airport City, Bristol Temple Meads' station)
Port/Airport	Kanpur	Kanpur Chakeri Airport new terminal	Special focus on energy efficiency in building (targeting 4-star GRIHA rating). Opportunity to leverage innovation twin partnership for learnings around net zero operations in and beyond terminal.	Bilateral best practice, insights and strategy	UK airports driving approaches to net zero operations in 2030s (e.g. Glasgow, Edinburgh, Manchester)

IN THE UK

Type	City	Place	What makes it a strong innovation twin proposition with India?	Type(s) of innovation twinning activity	Potential Indian partner locations
Port / Airport	Southampton	Port of Southampton	Southampton 1st port in UK to eliminate fossil diesel from operations. Currently working to explore potential use of hydrogen and CCS to reduce emissions across wider port-centred industrial cluster	Bilateral best practice, insights and strategy	Ports looking to decarbonise wider supply chain operations (e.g. Port of Mumbai, Port of Ahmedabad)
Port / Airport	Aberdeen	Port of Aberdeen	Leading UK progress towards creation of a regional Strategic Advisory Group to roadmap the path to net zero port operations and address cross-sector decarbonisation challenges	Bilateral best practice, insights and strategy	Ports looking to decarbonise wider supply chain operations (e.g. Port of Mumbai, Port of Ahmedabad)
Innovation district, testbed	Dundee	Michelin Innovation Parc and LOCATE testbed	Opportunity for long-term co-location and co-production at a 32-hectare campus aimed at commercialising, piloting and testing high potential innovations in sustainable mobility, plus dedicated spaces for firms seeking to test hydrogen and electric fuel cells for zero emissions HGVs	Investment from Indian firms looking to access new markets and test products overseas	Clusters of firms in hydrogen and mobility (e.g. in Bengaluru, Mangalore, Kochi, Chennai), large oil and gas firms e.g. Hindustan Petroleum Corp.
Innovation district	Hull	GreenPort Hull	One of the UK's most rapidly maturing clusters of firms in hydrogen, CCS, biofuels, waste to energy, and solar	Export of firms and expertise from UK to India Investment from Indian firms seeking to access new markets and test products overseas	Indian firms in these sectors seeking to access new markets, and the convening organisations that co-ordinate them
Innovation district	Sheffield	Advanced Manufacturing District	Potential to build long-term partnerships with Indian businesses in advanced manufacturing and engineering, material science and smart manufacturing.	Export of firms and expertise from UK to India Investment from Indian firms seeking to access world-leading R&D	Uttar Pradesh State Govt (Kanpur-Lucknow have ambition to create an advanced manufacturing corridor), IIT Bombay, Pune College of Engineering, Maharashtra Industrial Dev. Corp.
Testbed	Sheffield	Sustainable Aviation Fuels Innovation Centre	First of its kind testing centre for sustainable aviation fuels, based out of University of Sheffield	Academic and research seeding new technologies Investment from Indian firms seeking testing infrastructure	Universities specialising in sustainable aviation, airports seeking to decarbonise aviation operations (e.g. Noida), Indian Ministry of Civil Aviation
Innovation centre	Liverpool	Glass Futures	Focus on whole supply chain approach to materials manufacturing sustainability – a key challenge area for Indian cities. Opportunity to become a member of a non-profit RTO.	Bilateral best practice, insights and strategy	Large corporates (e.g. Tata Steel), advanced materials research centres (e.g. and steelworks
Innovation centre	Cardiff -Swansea	National Steel Innovation Centre, Swansea University	University of Swansea currently working with Warwick Manufacturing Group, University of Sheffield and SUSTAIN Manufacturing Hub to explore feasibility of using waste, renewables and hydrogen as primary energy source for steel industry and steel application in e-Mobility	Academic and research seeding new technologies	Major steelworks in e.g. Jamshedpur, large Indian corporates e.g. Tata Steel

*Does not include university-to-university exchanges unless there is obvious scope or appetite for direct commercially facing work (e.g. by engaging local businesses).

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3 Marion Davis, Shagun Mehrotra et al. (2021) 'Seizing the Urban Opportunity: How national governments can recover from Covid-19, tackle the climate crisis and secure shared prosperity through cities. Insights from six emerging economies'. Coalition for Urban Transitions. Available at: https://urbantransitions.global/wp-content/uploads/2021/03/ Seizing_the_Urban_Opportunity_WEB.pdf

4 https://nudm.mohua.gov.in/about/

5 Examples include the Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation, the Pradhan Mantri Awas Yojana affordable housing programme, the Swachh Bharat Mission, and the Heritage City Development and Augmentation Yojana programme: https://smartcities.gov.in/; http://amrut.gov.in/content/; https://pmaymis.gov.in/; https://swachhbharatmission.gov.in/sbmcms/; smartnet.niua.org/hriday

6 E.g. in ystems integration and the regulatory and policy adjustments required to foster change, plus exportable net zero niches such as smart streetlighting, lithium ion battery storage, electric vehicle charging infrastructure and subscription models

7 https://lordslibrary.parliament.uk/uk-and-india-collaboration-roadmap-to-2030/

8 For examples, see e.g.: https://www.psa.gov.in/st-clusters; https://www2.deloitte.com/uk/en/pages/tax/articles/uk-trade-with-india.html; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1142143/india-trade-and-investment-factsheet-2023-03-17.pdf; https://lordslibrary.parliament.uk/uk-and-india-collaboration-roadmap-to-2030/#:~:text=In%20the%20four%20quarters%20to,of%20the%20UK's%20total%20trade.; https://www.mycii.in/KmResourceApplication/76938.BritainMeetsIndiaTracker.pdf

9 Refers only to collaboration in net zero and green innovation adjacent sectors. There may be other

10 See for example https://www.jica.go.jp/india/english/activities/activity.html; https://www.kfw-entwicklungsbank.de/International-financing/KfW-Development-Bank/Our-results/Results/Ex-Post-Evaluation-Reports-H-I/; https://www.adb.org/countries/india/main; https://www.worldbank.org/en/cpf/india/project

11 https://media.nesta.org.uk/documents/Network_Effects_-_final_draft_2020.09.22.pdf

12 Based on aggregate score calculated according to 1) the share of 7 core net zero sectors where both cities had a presence of innovation firms that was higher than the average in UK or Indian cities – agritech, circular economy, clean mobility, energy efficiency, energy storage, sustainable behaviour and renewables; and 2) the level of overlap in the top 3 specialisms among these 7 sectors between each pair of cities

13 Experience of key institutions, businesses and centres within the cities at partnering on green innovation based on aggregate score calculated according to number of links in sectors adjacent to green innovation, across: business growth and investment links (100% weighting); research and discovery links (50% weighting); roadmapping and best practice knowledge exchanges (50% weighting) and

14 Based on aggregate score of the differences between UK and Indian cities across 4 core factors, where for each factor, every city's score is calculated by its rank relative to the leading city in its nation: population size, innovation ecosystem maturity (no. of local tech-enabled firm HQs), presence of advanced services firms, and level of metropolitan governance maturity (graded according to a 3 point scale of nascent, emerging, established)

15 https://www.sciencedirect.com/science/article/pii/S2405872618301394

16 https://www.investinmanchester.com/manchester-india-partnership/#:~:text=The%20Manchester%20India%20Partnership%20facilitates,knowledge%20exchange%20and%20employment%20opportunities. ; https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/investmanchester/MIP_Strategy_2022_a088d6ef-2188-436a-b5a3-1ebacc74bfb6.pdf ; https://www.businessgrowthhub.com/manufacturing/news/2021/10/greater-manchester-strengthens-links-with-india-s-most-industrial-region ; https://www.deccanherald.com/state/pact-with-salford-varsity-for-research-and-development-767520.html ; https://www.manchester.ac.uk/discover/news/university-of-manchester-and-the-indian-institute-of-science-sign-india-uk-joint-doctoral-programme-and-seed-fund/ ; Aggregate Innovation Performance and appearances across 100+ Global Indicators, 2022, The Business of Cities ; https://www.investinmanchester.com/why-manchester/ ; https://beeactive.tfgm.com/bee-network-vision/

17 Several partnerships already exist between Greater Manchester's universities and Bengaluru's academic institutions and State Government. E.g. the University of Bolton partners with the Karnataka State Higher Education Board and Apollo Hospital, and the University of Salford partners with the Indian Institute of Management Bengaluru

18 E.g. KPMG was a recent government partner mapping new innovation places in Mumbai

19 E.g. Manchester is first city region to establish MoU with Maharashtra State, to enable knowledge exchange between innovation incubators

20 https://www.prnewswire.com/news-releases/mayor-of-west-midlands-andy-street-visits-kagool-in-hyderabad-with-trade-delegation-301673155.html; https://www.investwestmidlands.com/wp-content/uploads/2022/04/WMIP-Strategic-Report.pdf; http://www.ukhfca.co.uk/2022/06/29/uk-hfca-conference-sees-india-joining-forces-with-the-uk-to-realise-global-hydrogen-goals/

21 E.g. the Indian HQ of the US IT and software company Computer Generated Solutions, based in Hyderabad, is expanding in the West Midlands. Kagool, a Coventry-based data analytics and specialist software consulting firm, chose Hyderabad as its Indian HQ, and opened a development centre in the city in 2022)

22 E.g. India's largest eMobility platform, Ola Electric, plans to build £100m global engineering centre in Coventry)

23 https://nortonmotorcycles.com/stories/tvs-announces-100m-investment-in-norton-motorcycles/

24 First such partnership at Masters' level between IIT and Russel Group University) - https://www.birmingham.ac.uk/news/2022/university-of-birmingham-and-iit-madras-launch-joint-masters-programmes

25 (e.g. project by Strathclyde University using satellites to monitor Kolkata's air pollution) https://www.strath.ac.uk/workwithus/centreforsustainabledevelopment/researchadvising/cleanerairforkolkata/

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28 Telengana Today. (2022). Telangana sees rise in power consumption. https://telanganatoday.com/ telangana-sees-rise-in-power-consumption ; Factly. (2020). Data: Hyderabad may emerge as the city with greatest energy consumption outside of NCR. https://factly.in/data-hyderabad-may-emerge-as-the-city-with-greatest-energy-consumption-outside-of-ncr/ ; https://cordis.europa.eu/article/id/415394-glasgow-pushes-on-with-implementation-of-smart-and-sustainable-solutions-in-european-project

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31 (E.g. recent research project between Queen's, IITs in Bombay and Delhi and Nova Pangea Technologies focused on transforming waste streams into biomass. E.g. Belfast is among the top 10 among 2nd tier cities globally based on FDI-led job creation, concentration of knowledge-sector companies and ease of starting a business. https://www.qub.ac.uk/News/Allnews/featured/5mnationalsupercomputeratQueenssettorevolutioniseresearch.html : https://www.manufacturingmanagement.co.uk/content/news/new-digital-testbed-under-construction-in-belfast

32 Bhubaneswar is a recognised launchpad for East and North East India, while Belfast is a key hub in Northern Ireland

33 The Cluster is currently working with the NHS, Yorkshire & The Humber Academic Health Science Network, and the British High Commission to offer a training bootcamp to 6 health-tech start-ups in London. This approach could for example be applied to Indian firms seeking to leverage Queen's University Belfast's smart manufacturing digital testbed.

34 https://www.investegate.co.uk/infosys-limited--infy-/prn/queen-s-university-belfast-partners-with-infosys/20130416070000PF6CD/

35 Sectors included: agritech, circular economy, clean mobility, energy efficiency, energy storage, sustainable behaviour and renewables

36 Beyond just undertaking research (e.g. specialised centres developing new products, track record of testing clean technologies, involvement in externally facing sustainable projects or initiatives, etc.)

37 Based on aggregate score calculated according to number, maturity (year established) and extent to which the place or initiative is either already collaborating with India on green innovation or more generally, has explicit intentions to collaborate with India, has intention to partner internationally, or does not yet have visible ambition to co-ordinate globally (graded on a 5 point scale)

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