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Osborne Clarke

Decarbonising technologies for cities: case studies of Barcelona, Delhi and Paris

Start

WRITTEN BY

ECONOMIST IMPACT

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Foreword

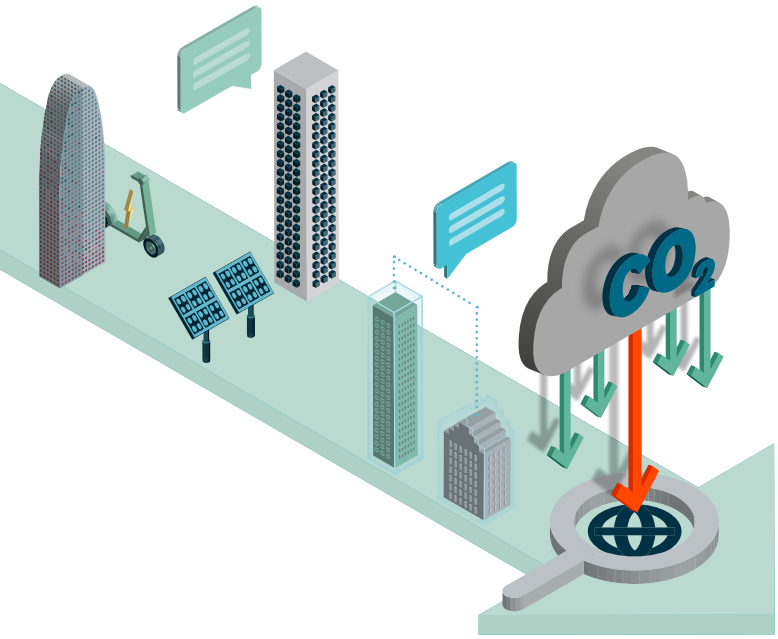
As the world races towards achieving net-zero emissions by 2050, cities are at the forefront of this movement. With over half the world's population living in urban areas, decarbonising cities is crucial to meeting global climate goals. This case study looks at decarbonisation technologies being trialled in Barcelona, Delhi and Paris, highlighting the ground- breaking work done in these cities and the importance of legal insight and legal frameworks in the pursuit of a sustainable future.

The three technologies in focus:

- vehicle-to-grid
- district cooling
- digital twins

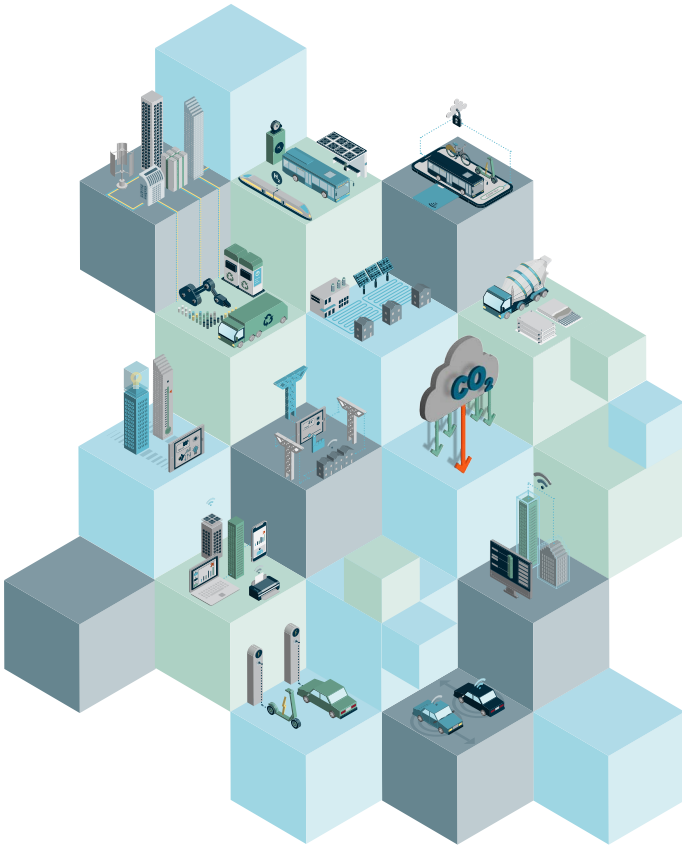
Considering the three technologies in focus: vehicle-to-grid (V2G) technologies can facilitate a cleaner energy system in cities. In order to maximise on the benefits of V2G technologies, an appropriate regulatory framework and business case needs to be explored further. District cooling technologies are important for cities because they provide energy-efficient and environmentally sustainable cooling solutions, but the implementation is complex, with infrastructure requirements and policy complexities to navigate. Digital twin technologies are becoming increasingly important in cities, allowing for real-time monitoring and simulation of urban systems, with the result being more sustainable management of infrastructure.

We are pleased to have commissioned Economist Impact to produce these case studies, which illustrate the opportunities these technologies present for cities around the world and will serve as a resource for cities and businesses as they navigate the complex landscape of sustainable urban development.



James Watson
International Head of Decarbonisation, Osborne Clarke, UK
T +44 20 7105 7254
james.watson@osborneclarke.com

Introduction



For cities looking to decarbonise and achieve their net-zero targets by 2050, green technologies will play a crucial role. In 2021, Economist Impact, supported by Osborne Clarke, embarked on a research project that identified 12 decarbonisation technologies for cities.

Sustainable disruption: 12 decarbonising technologies for cities assessed these technologies based on their potential for impact, scalability and investment. Some of these technologies are already being trialled by cities around the world, each with their own set of regulatory, social, political and economic challenges and opportunities. These first-mover cities – Barcelona, New Delhi and Paris – provide lessons for the applicability, scalability and sustainability of these technologies.

12 impactful, scalable and investable decarbonisation technologies:

Technology and Thematic area	Impact	Scalability	Investment
Buildings and Construction			
Building automation systems	Medium	Medium	Low
Digital twins	Medium	Medium	Medium
High-efficiency heat pumps	High	Very high	Medium
Low-carbon cement & concrete alternatives	High	Very high	Low
City Infrastructure			
District heating & cooling systems	High	Medium	Medium
Smart grids & smart meters	High	High	High
Unified communications (VOIP)	Medium	High	High
Waste robotics	High	Very high	Low
Transportation			
Autonomous vehicles	Medium	Medium	High
Hydrogen transport vehicles	Medium	Medium	Medium
Mobility as a Service	Medium	High	Medium
Vehicle-to-grid technologies (V2G)	High	Medium	Low

For methodology:
Sustainable disruption: 12 decarbonising technologies for cities

Barcelona and vehicle-to-grid

The widespread use of electric vehicles (EVs) is critical to decarbonisation efforts globally. In order to reach net-zero targets by 2050, EVs need to account for around 60% of new passenger sales by 2030.[1]

According to Systemiq's *The Breakthrough Effect* report, moving from niche market to mass market will require investments to increase affordability, but importantly – and echoed in Economist Impact's rEV Index[2], an index assessing the readiness of 40 UK nations and regions for the uptake of EVs – introducing infrastructure interventions to improve charging capabilities and battery storage capacity.

In this context, vehicle-to-grid (V2G) technologies play an important role, as they enable EV batteries to charge and discharge their energy into a power grid, thereby turning car batteries into storage that can be used across the energy network. *"If we want to expand the number of EVs in the market, we need infrastructure. V2G can ease the burden on infrastructure by handling charging at the right time, and helping the grid store energy so we can expand green energy production. This will also enable EVs to provide value even when they are not in use (i.e. parked),"* explains Emanuella Wallin, product owner for charging and product leader for V2G at Polestar.

V2G technologies also form part of the flexibility puzzle. *"For a rapid and safe energy transition, we don't just need renewable energy. We need flexibility. V2G is part of this flexibility ecosystem, as it allows EVs to turn from a mobility to a mobility plus energy tool,"* says Gil Lladó Morales, head of the Energy Transition Department at Area Metropolitana Barcelona (AMB), the public administration in charge of the Barcelona urban area.

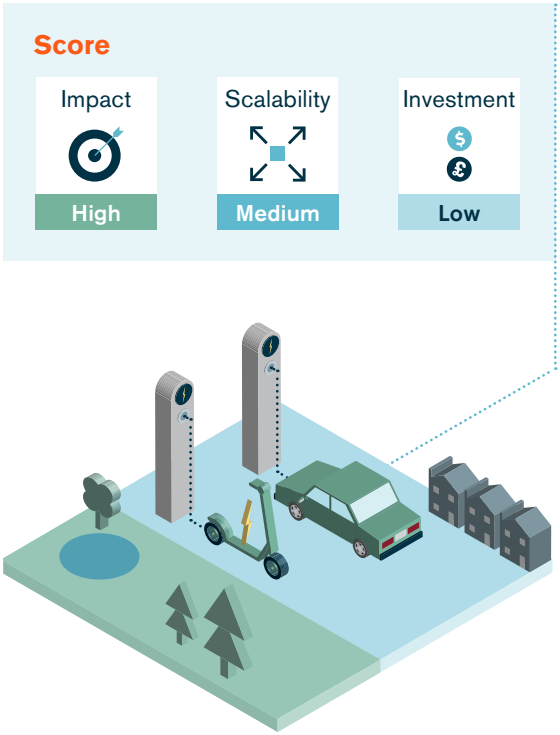
Barcelona, as part of its efforts to reduce pollution and congestion levels,[3] is focusing on electrifying its transport sector through V2G charging infrastructure. In 2019,[4] AMB invested in solar carports for EV charging and connected these to V2G chargers that enable energy to flow back into the buildings that they are plugged into.[5] Currently, the use case for this technology is being piloted among Barcelona's municipality fleets.

"This is just a first market, but looking ahead, we imagine that other municipal fleets like public buses and waste collection vehicles can also start to adopt this technology. There is also a specific use case for vehicle to home, where people can use the battery of their EV to supply their energy needs in their home," explains Mr Lladó.

EV fleets were just one precondition for this pilot. Effective public and private cooperation was also crucial. The AMB had to collaborate with charger suppliers, software developers, installers and investment funds. To realise their vision further, Mr Lladó points to a range of other stakeholders that will need to be properly consulted: car makers will need to develop V2G capabilities across EV standards; utility companies will need to secure feasible commercial offers; and drivers will need to understand the use and benefits of V2G.

Public and private sector familiarity with V2G technologies, however, is still quite limited. A lot of companies installing EV chargers are still not familiar with V2G technology, and currently, the only EVs that support V2G are those using the CHAdeMO standard. Alongside Tesla and the Combo Charging System (CCS), this is one of the three types of DC fast charging systems, with the main differences being in the type of plugs used to connect to charging points. Efforts are underway to standardise these charging systems, which will make infrastructure development for EVs easier. *"As such, as CCS standard becomes more common, particularly in Barcelona, car manufacturers will also need to start adapting their chargers to work with V2G"*, adds Mr Lladó.

"[In this context of standardisation] The ISO 15118-20 standard will help the interoperability between vehicles and chargers, but it is a very new ecosystem, so there are a lot of partners that still need to work together to harmonise their visions – SCALE: the smart charging alignment project co-funded by the new Horizon Europe Programme is one example of these efforts," says Ms Wallin.



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More specifically, Mr Lladó also highlights the need for regulations that create a clear and well defined business model on how the energy will be distributed, the terms of participation and who plays what role. As a result, Barcelona's pilot of V2G is limited to vehicle to buildings for now, as regulations and secondary markets for this technology are still being rolled out.

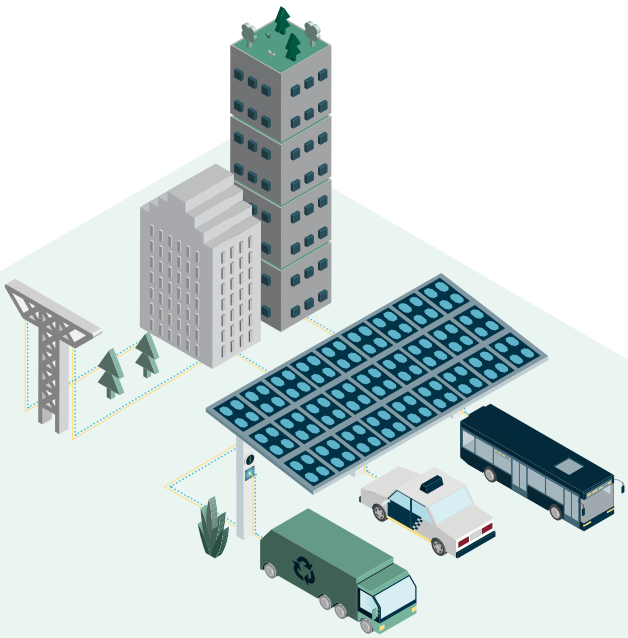
"Without a regulatory framework, you can only exploit half of the V2G capacities, as the main income comes from participating in electricity markets, and making the grid more reliable," he says. As such, the AMB is hoping to push for regulatory sandboxes for their vehicle to market project, which would develop an appropriate business model for V2G across Spain.

Osborne Clarke view

Despite the existing challenges of V2G technology, which is still at an early stage of development, several interesting pilot projects involving bi-directional charging points have already been launched in some areas of Spain, such as the Barcelona metropolitan area and the Balearic Islands. These projects reflect the interest from various sectors in turning electric vehicles into a small but significant source of power storage and providing flexibility in the electricity system (V2G chargers import and store energy in the vehicle battery when there is an excess generation of renewable energy and export it back to the grid, in return for payment, when the system requires it again).

As a result of the technology's potential, we expect that major technical and regulatory advances will gradually take place as the technology matures. This will include improvements to the hardware itself and vehicle compatibility as well as development of a clear regulatory framework so that V2G charging companies wishing to connect chargers to the relevant electricity distribution networks have legal certainty over the permits and legal requirements they need to meet. This legal clarity should in turn help the sector understand any monetisation opportunities and build its investment case. As the number of electric and hybrid vehicles in circulation increases, we expect to see the development of a network of V2G charging points to provide a solid framework for the full development of V2G in the near future.

Blanca Montero
Lawyer, Spain
T +34 91 576 44 76
blanca.montero
@osborneclarke.com

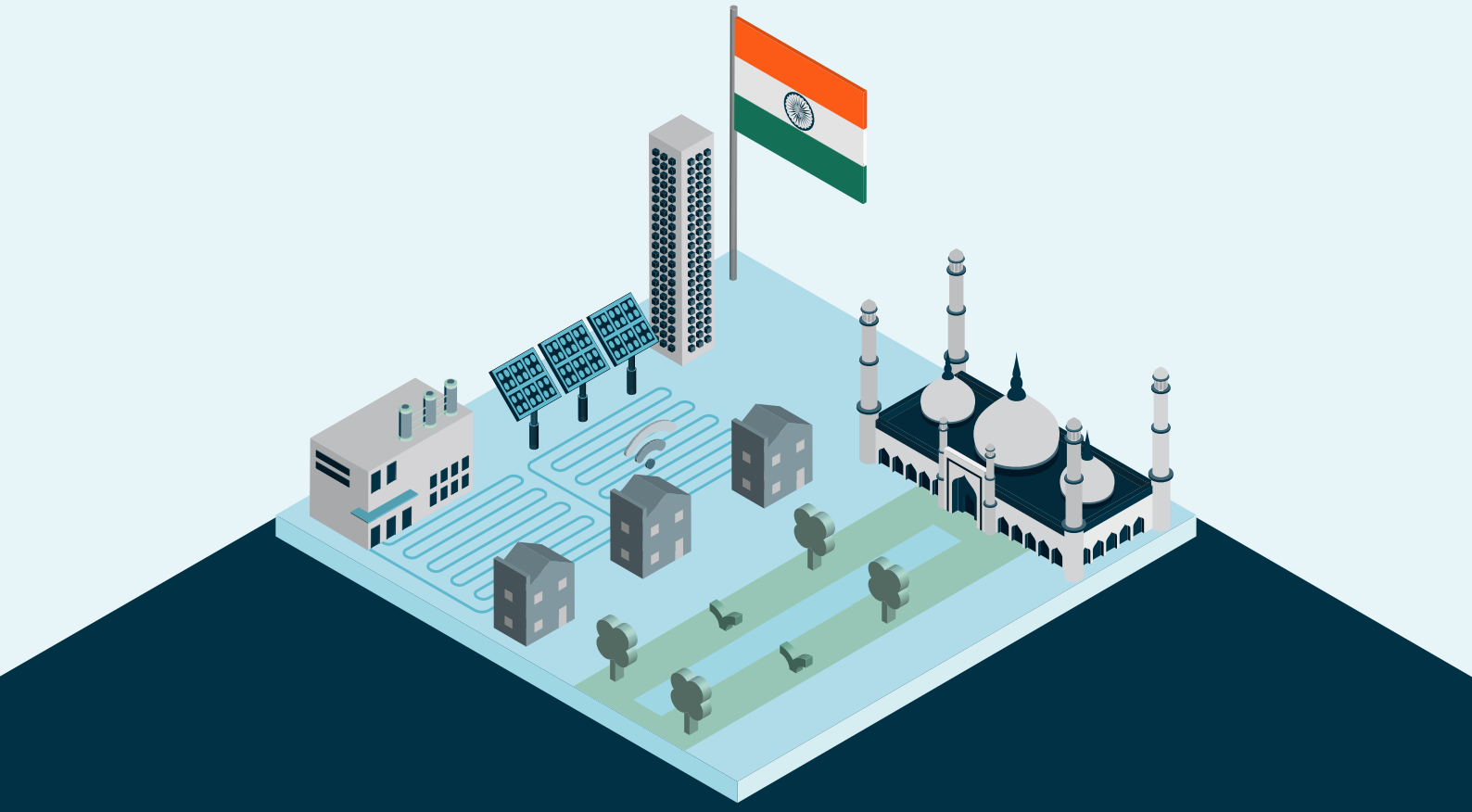


Delhi and district cooling

For cities looking to decarbonise, interventions will also need to focus on infrastructure. Climate change will lead to warmer temperatures globally, and the effects of this will be felt most strongly in countries and cities already struggling with heat.

Demand for cooling is therefore set to surge: by 2050, the International Energy Agency estimates that energy consumption by air conditioning is likely to triple.[6] But cooling, if managed efficiently and sustainably, can also contribute significantly to decarbonisation objectives.[7] Shifting to district cooling systems forms part of this equation.

"District cooling generates cooling – through cold water or cold air – in a single place, and distributes it as a service to consumers. The advantage of this? It reduces the overall size of cooling requirements, thereby reducing energy and water consumption, increasing operational flexibility and emitting less CO_2. It is a simple demand aggregation argument, as producing large quantum of cooling in one place, rather than individually, will increase the efficiency of the entire system," explains Soumya Garnaik, Specialist and Communities of Practice Lead (Green Building & Industry) at the Global Green Growth Institute.



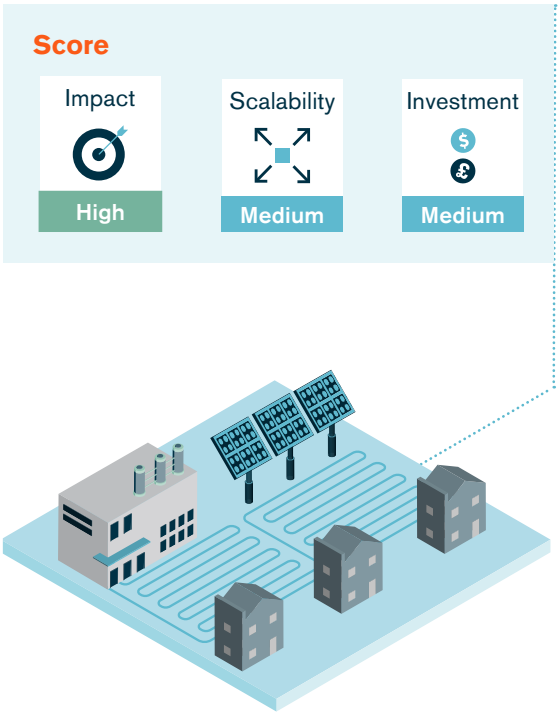
Delhi is a city that is set to see demands for cooling surge. In the summer of 2022, peak demand for electricity already reached 7,695MW,[8] of which approximately half stemmed from the city's cooling needs.[9] Climate change will increase this: by 2037-8, the India Cooling Action Plan (ICAP) estimates that demand for cooling will increase by 15-20% annually.[10]

In response, district cooling systems are being piloted across the city. Cybercity[11] in Gurgaon, India's largest integrated business district, relies on a district cooling system which has helped reduce power demands by around 100 MW and saves approximately 36,000 tonnes of CO_2 per year.[12] Beyond this, there are also efforts by the Delhi airport, the Indian International Convention Centre and the Pragati Maidan exhibition venue.[13] *"Commercial or industry consumer bases are better placed for district cooling compared to domestic consumers (i.e. households), as it is easier to develop service agreements from a business perspective"*, says Mr Garnaik. *"Looking ahead"*, he adds, *"this technology can one day be scaled to domestic consumers living in new-build apartments or buildings. Forward planning, however, is crucial."*

"District cooling systems are much more challenging to implement if you are retrofitting a brownfield site, as these sites will already have their own infrastructure and systems in place. District cooling needs space for the plant, the piping infrastructure, and also needs new metering systems. Greenfield sites, or new projects, are therefore where district cooling systems are the most cost effective, as they can be incorporated into designs from the start," explains Mr Garnaik.

He adds that it is important to have policy and fiscal incentives for developers. It is for this reason that they required district cooling to be included as a key approach when any large construction project seeks approval from their city planners. To complement this, Mr Garnaik also believes that decision-makers need a more standardised toolkit to understand the benefits of this technology, and make decisions accordingly.

District cooling has the potential to provide an estimated 9m tonnes of refrigeration capacity for space cooling in new commercial buildings in 21 cities across India.[14] *"The technology works, but it has not yet reached a mature stage, where consumers and businesses can safely refer to the cost and investment benefits. I have no doubt on the potential to be scaled up, but it needs a bit more time,"* says Mr Garnaik.



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BTG Legal* view

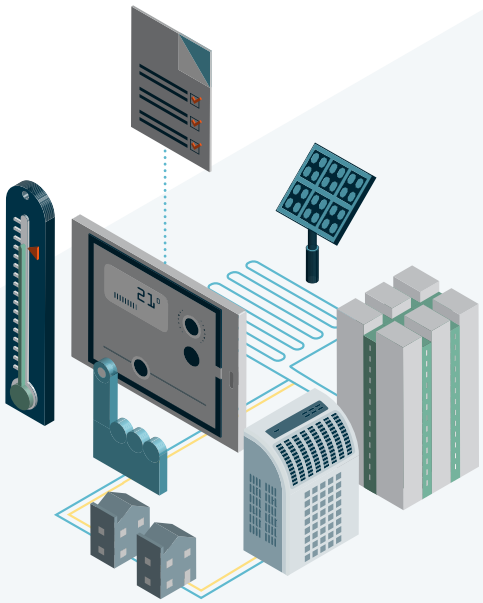
With warnings of record heat waves in the coming years and an ever increasing demand for power and air conditioning being one of the main contributors of CO_2 emissions, Delhi National Capital Region (NCR) will need an effective system of cooling (and heating) which is environment-friendly, cost-effective and reliable. A district cooling system may be an attractive solution, albeit that it is a new technology without significant levels of implementation in India at this time.

An urban metropolis like Delhi NCR consists of a mix of independent houses and high-rise buildings and is governed by various municipal corporations, town and country planning and other regulatory authorities. This mixed use of land and a lack of awareness within government and regulatory organisations may pose a critical challenge for any proponent of a district cooling system to navigate. Receiving the necessary permits and approvals could be a time-consuming process even where officials are aware of the technology and its benefits.

However, if integrated well into the government of India's Smart Cities Mission, with clear and defined incentives for including this technology, urban planners and policy makers will be better placed to recommend its implementation. All municipal authorities will have to come together to issue and implement policies and establish pilot projects to spread awareness and viability. Pilot projects are a useful "sandbox" to test such a system, especially in a city like Delhi which sees weather variations from extreme heat to extreme cold. A district cooling system which can also incorporate heating will be attractive. Other operational and legal aspects such as payment, access, round-the-clock availability etc., will also have to be developed.

Parveen Arora
Partner, BTG Legal, India
T +91-9811297124
parveen.arora
@btglegal.com

**Comment provided by relationship firm BTG Legal*

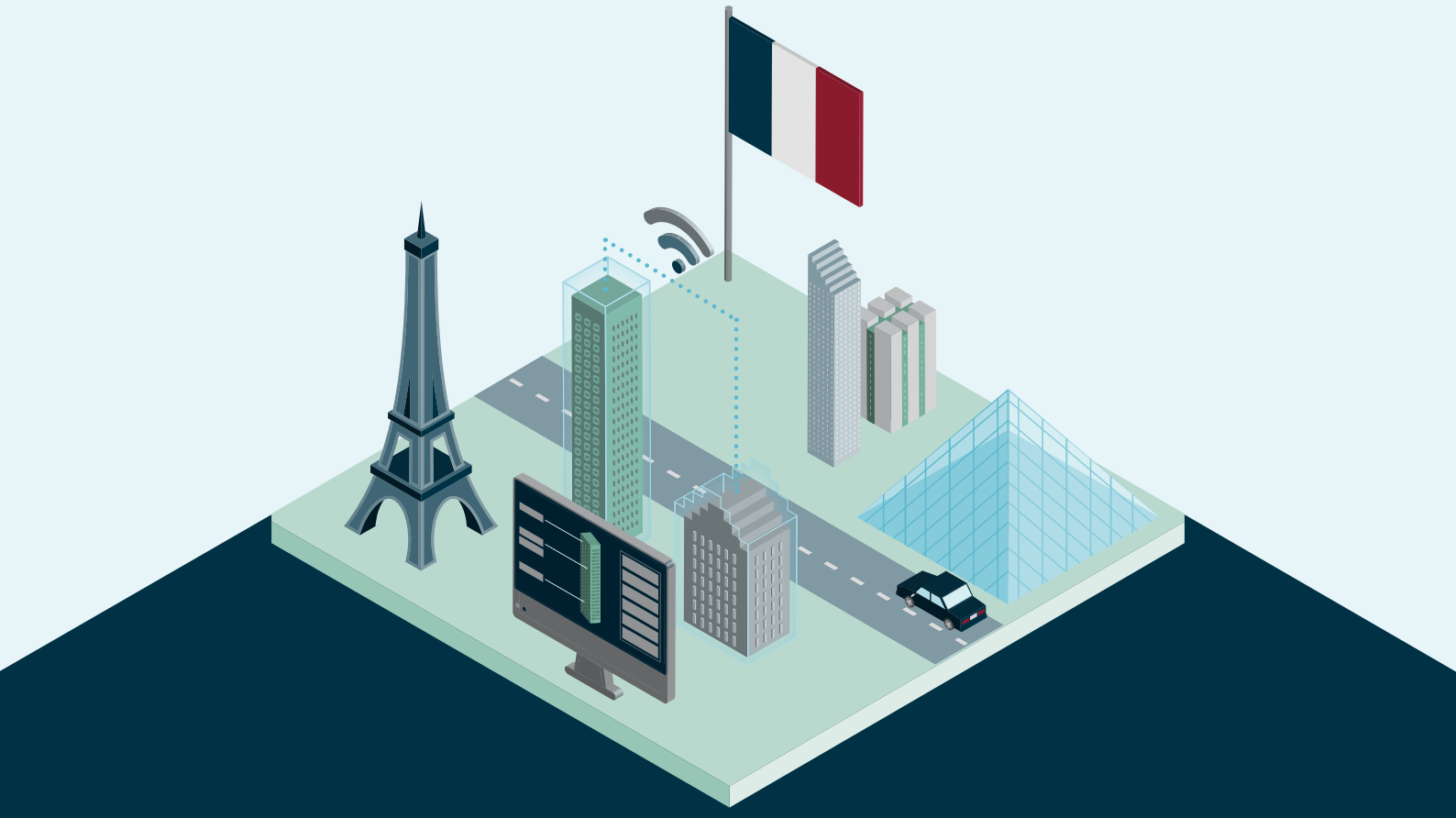


Paris and digital twins

Decarbonisation will be accompanied by digitalisation and the widespread use of data across infrastructure, businesses and operations. This will open up opportunities for new technologies that plan for and monitor developments in a city. A digital twin is one of these.

By creating a replica of a city, or space within a city, it can help city planners monitor performance in real-time and act accordingly, resulting in efficiency and sustainability gains.

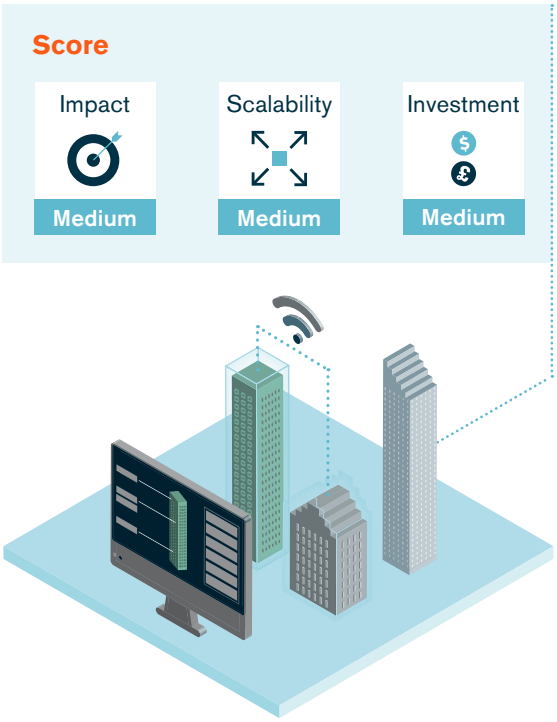
"A digital twin is a virtual copy of something that exists in real life – be it an object, a construction site, or even a city. The twin should capture its 3D geometry, but also its structure, how its different components work together, and what it is made of, its constituent materials. Once you have all this, we can estimate, for instance, how hot a place gets in the summer, how congested, and can plan, monitor and simulate accordingly," explains Professor Vincent Lepetit, researcher at École des Ponts ParisTech.



After a decade of work, a French technology company developed a digital twin of Paris. The 3D model uses geographic information system (GIS) and building information modelling (BIM) data which is collected through terra photography, and stored on a cloud streaming platform.[15] This allows city planners to model the impact of infrastructure changes within the city. It also empowers citizens to become more engaged in urban planning, as it enables them to envision proposed changes and provide informed feedback. Professor Lepetit reminds us, however, that the use of digital twin technology will require a lot of effort and expertise that is specific not just to the technology, but also to the desired objective – be it traffic flows, the build up of heat or the movement of people.

Digital twin solutions are also taking place at a smaller scale in Paris. Organisers of the 2024 Olympic games announced plans to create digital twins of key Olympic venues.[16] This will make the games more energy and cost efficient, and can be used by Paris as part of its broader efforts to attract visitors to the city. *"Olympic games come with a lot of emissions, a lot of this being from site visits: national Olympic committees – and there are many – will come in for site visits to see the venue for themselves. Digital twins can make a dent on the flight and travel-related emissions, as they give these committees a more accurate picture of the venue, as well as a better sense of lighting positions, weather conditions, etc. [without having to fly over],"* says Paul Foster, Founder & CEO of OnePlan, the official digital twin software provider for the 2024 Paris Olympic and Paralympic Games. *"Another benefit of this is of course planning efficiencies: the digital twin will provide everyone with a single source of truth to align plans or simulate safety and security risks, all within the fixed deadline. It is like a Google document for site planning at scale,"* he adds. The use of this technology is the first of its kind in the history of the Olympics – and large scale sporting events more broadly. Initial uptake may require some adjustments, but the hope is for these efforts to be replicated for future events, explained Mr Foster.

To advance the use case for this technology further, Professor Lepetit and his colleagues are looking into the development of digital twins beyond 3D geometry, and develop computer vision algorithms that can capture specific components within a structure. This is particularly helpful, he says, for places like factories or construction sites that need a clearer picture of real-time movements and dynamics within their operations. But this level of granularity is much more difficult to achieve for cities. It takes a lot of effort to capture and eventually process and maintain the data for entire cities. According to Professor Lepetit, *"for it [this higher-level representation of twins] to make sense, you need to capture every street and building, so it is better to capture a smaller area with a lot of detail, than attempt to do all of Paris"*. Beyond this, there are regulatory hurdles that digital twin providers will need to overcome. In particular, Mr Foster pointed to intellectual property laws and image rights concerns, which may complicate efforts to replicate heritage buildings or important landmarks.



> "The digital twin will provide everyone with a single source of truth to align plans or simulate safety and security risks, all within the fixed deadline. It is like a Google document for site planning at scale."

Osborne Clarke view

Digital Twins raise many issues in terms of intellectual property and image rights, especially when it comes to modelling cities or even buildings in 3D. A city includes both public and private properties and the legal regime and its impacts may vary depending on that and, of course, depending on jurisdiction.

For example, in France, owners of private properties do not have exclusive and absolute rights to the image of their properties. However, where the use of the image of their properties causes them damage or an invasion of their privacy, they can object. The damage may be caused when, for example, especially in Paris, the use of the image causes an influx of tourists into the area such that it abnormally disturbs the peace of the owners. This also applies to public property, with the exception that some national estates require prior authorisation from the real estate manager (for example, Le Louvre and Le Palais de l'Elysée).

Besides this, some properties, whether private or public, may also be protected under the architect's copyright. This can include the building itself, models and photographs of the building, and drawings, plans etc. As such, copying the design of a protected building or any accompanying materials will require prior authorisation from the rightsholder, which often includes royalty payments.

In addition to copyright, an architect will also have moral rights with respect to the building and any accompanying documents. These moral rights include the right to be identified as the author and the right to object to derogatory treatment of a building. How these moral rights are to be treated depends on the underlying copyright work. Moral rights will persist even where the copyright has been licensed or assigned and therefore will need to be considered even if an appropriate copyright licence has been obtained.

Moreover, potential copyright and trade mark infringement should be considered with respect to any logos or branding on the building that might be replicated. The shape of the building itself could have been registered as a trade mark so this should also be considered.

Digital twins are, therefore, not without risks – just because a replica is virtual, does not mean that such use will be permitted.

Laurène Zaggia
Counsel, France
T +33 1 84 82 45 98
laurene.zaggia
@osborneclarke.com

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- **Paul Foster**, CEO of OnePlan

About

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