Exploring Two Interpretative Models of Eco-cities in the United Arab Emirates: Masdar City and The Sustainable City Dubai

Marco Carlotti
Laboratoire Médiations, Sorbonne Université
marco.carlotti@etu.sorbonne-universite.fr

Abstract
Since the early 2000s, eco-cities have emerged as a key urban paradigm. As an umbrella concept, the eco-city encompasses diverse models aiming to address urban sustainability through environmental and socio-economic dimensions. However, a lack of consensus and context-sensitive variations has led to multiple "interpretative models." This paper explores two eco-city projects in the United Arab Emirates—Masdar City and The Sustainable City Dubai—revealing contrasting approaches shaped by local challenges such as oil dependency, car-centric urbanism, and extreme climate. Drawing on inductive research, the study highlights how differing visions—technology-driven versus community-centered—embody the flexible nature of the eco-city ideal. It contributes to understanding eco-cities as context-specific laboratories for sustainable urban futures.

Keywords: eco-city ; interpretative models ; UAE ; Masdar City ; The Sustainable City

1.Introduction

Phenomenon

Over the past two decades, we have witnessed a global proliferation of urban initiatives branded as "eco-cities", evolving in parallel with the rise of other future-oriented urban models such as smart cities and knowledge-based cities (Ingallina, 2019). Among these, the eco-city – or ecological city – has emerged as a key manifestation of sustainable urbanism, increasingly promoted by policymakers and planners – making it a new "paradigm" (Nguyen & Vu, 2023) or a "global phenomenon" (Joss, 2010, p. 242). In his global survey made in 2009, Joss (2010) identified 79 eco-city initiatives spanning various continents. This number has since increased to include new and ongoing projects, especially in Global South emerging countries such as Morocco (Zenata Eco-City) or Laos (Amata Smart & Eco City Natuey), to give few examples.

Literature review

The origins of ecological urban development projects can be traced back to the 1970s and 1980s, with the emergence of eco-neighbourhoods in countries of the Global North—particularly in Germany, the United Kingdom, and Scandinavia—largely initiated by grassroots associations. This phenomenon arose in response to global dynamics observed since the 1970s, a period marked by the rise of widespread *environmental consciousness*. This awareness was shaped by the growing visibility of ecological disasters through mass media, alongside the burgeoning body of scientific literature highlighting the human impact on the biosphere. One notable institutional milestone was the launch of UNESCO's *Man and the Biosphere* (MAB) Programme in 1971, aimed at understanding and managing the complex relationships between humans and natural ecosystems on a global scale. This initiative gave rise to one of the earliest known formulations of the eco-city concept, notably articulated by the Soviet sociologist Oleg Yanitsky, who defined it as "a human settlement of the future in which social and ecological processes are harmonized in the best possible way" (1982, p. 470). Over time, a growing number of international initiatives were launched in support of environmental protection, among which the publication of the *Limits to Growth* report in 1972 by the Club of Rome stands out as a major milestone. This report warned against the pursuit of unlimited economic growth in light of the planet's finite resources, thereby reinforcing the urgency of ecological considerations in urban and global policy frameworks.

Gradually, these small-scale European initiatives were paralleled by the emergence of large-scale urban development projects—designed to accommodate several thousand inhabitants—in the Global South. These projects aimed to address the urgent demand for housing while adhering to the principles of sustainable development, which had become a global paradigm following the publication of the Brundtland Report in 1987. Indeed, countries in the Global South are those experiencing the fastest demographic growth and are simultaneously the most exposed to the multifaceted impacts of climate change. These conditions characterise the Anthropocene—a new geological epoch in which human activity has become a dominant force disrupting ecological and planetary systems.

This shift marks a transition from the logic of eco-districts to that of eco-cities, a broader and more encompassing framework used to describe a diverse range of spatial interventions—from compact neighbourhoods to newly built megacities. Despite their differing scales and forms, these projects share a common objective: to ensure socio-ecological balance in an era of increasingly urgent climate warnings (Bibri, 2020; Joss, 2011).

In light of these challenges and the goals it sets out to achieve, the eco-city model is increasingly regarded as a meaningful response to the pressing issues of the 21st century. Urban areas are currently responsible for approximately 70% of global CO emissions associated with energy consumption (Dasgupta, Lall, & Wheeler, 2022), with transport alone accounting for one-fifth of total global emissions (Ritchie, 2020). These figures present a significant challenge for policymakers and urban practitioners, particularly given that the United Nations projects a global population of 9.7 billion by 2050, with two-thirds—over six billion people—expected to live in urban areas, compared to 4.61 billion in 2023 (World Bank, 2018). This demographic trajectory implies an intensification of urbanisation, primarily driven by rural-to-urban migration in developing countries.

To meet international climate mitigation targets—such as those outlined in the Paris Agreement—and to reduce the global carbon footprint, it is essential to address the urbanisation process itself, which has a direct and proven link to global warming (Helbling & Meierrieks, 2023).

Within this context, the development of more ecologically responsible cities—eco-cities—appears to be a relevant and timely strategy for tackling these multidimensional challenges. Such an approach aims to promote socio-ecological sustainability by striving for a balanced coexistence between human and non-human ecosystems. Cities of the future are thus expected to embody greater efficiency, sustainability, and resilience (Kohlhase, 2013).

Theoretical problem

These expectations have fostered a substantial body of literature surrounding the concept of the eco-city, particularly since the early 2000s. However, this literature remains characterised by conceptual ambiguity (Rapoport, 2014). Indeed, the concept is still polysemous, vague, and lacks a shared definition within the scientific corpus. This absence of consensus does not concern the ultimate goal of the eco-city—namely, sustainability in its broadest sense—but rather the means and forms through which it is to be achieved. Beneath the apparent unity of the term "eco-city," which functions as a catch-all expression, lie multiple divergent visions regarding how such projects are conceived and operationalised.

Within this conceptual vagueness, a comparative approach has frequently been favoured by scholars, who endeavour to assess projects against often technical and environmental criteria. Nevertheless, this comparative methodology can prove limiting, particularly in urban planning, given that urban projects are deeply embedded within the contexts in which they emerge—be they geographical, legal, socio-economic, or environmental. Consequently, it is challenging to compare projects located in different geographical settings and responding to diverse socio-political dynamics; moreover, the "urban project" is, by nature, bespoke (Ingallina, 2001).

It is therefore necessary to move beyond this comparative framework and adopt a more interpretative stance aimed at understanding the "meaning" attributed to the urban project. This approach seeks to elucidate the internal logics underpinning these projects and the spatial translations of these logics.

Research question

To better apprehend this diversity, this article proposes to investigate the interpretative frameworks at work within each project through the following question: What interpretative models of the eco-city can be identified through the analysis of eco-city projects? Furthermore, how do these models reveal differentiated visions of eco-sustainability?

Research motivation

This paper seeks to document the multiple interpretations attributed to the concept of the "eco-city," highlighting the intrinsically polysemous nature of the model. Aware of the absence of a single, unified definition, we argue that this lack of consensus should not be regarded as a weakness, but rather as a significant indicator of the plurality of approaches underpinning urban projects labelled as "eco-cities."

Accordingly, rather than aiming to establish a single definition of this urban model, the objective of this paper is to embrace this diversity and examine it through a "project-centred" reading employing an inductive methodology, detailed below.

On this basis, we explore how different eco-sustainable urban projects are shaped by varied project dynamics—ranging from the ideation phase through to operational implementation (Yanitsky, 1982). We thus introduce the notion of "interpretative models," understood as analytical constructs that capture the underlying logics of action, reference frameworks, and socio-spatial translations at work within projects designated as eco-cities. These models are not intended to constitute a fixed typology, but rather to reflect the diversity of visions and practices embedded within projects grouped under the eco-city label. Ultimately, we seek to understand how various actors conceive and operationalise the eco-city—despite their shared commitment to environmental sustainability—thereby revealing the multiplicity of urban projects encompassed by this designation.

Roadmap
The following section outlines the methodology of this research. Subsequently, two eco-cities developed in the United Arab Emirates are presented. The third section presents the conclusive findings emerging from the highlight of these two interpretative models.

Methodology

Research context
This paper presents preliminary findings from an ongoing doctoral thesis in urban planning, initiated in 2022, which investigates the "interpretative models" of eco-sustainable cities, collectively referred to under the umbrella term "eco-city" (Ingallina, 2019 ; Joss, 2010). This doctoral thesis adopts an international perspective, analysing urban projects located in three different countries: France, Morocco, and the United Arab Emirates. Within this framework, the present article focuses on two case studies in the UAE—Masdar City and The Sustainable City Dubai—which constitute the empirical field sites selected for this portion of the research.

Data collection and analysis
Within the framework of this inductive doctoral thesis, we employ the notion of the "urban project" (Ingallina, 2001) as an analytical lens through which to examine the cities under study. This choice is grounded in its capacity to systemically integrate the various constituent elements of the dynamics at play around the project, as well as the project itself. Unlike sectoral or thematic approaches, which are often compartmentalised, the urban project approach enables a comprehensive understanding of the complex relationships between territorial context, political ambitions, the processes of development and implementation, and the evolving trajectories within which these projects are located.

This article draws upon a body of empirical data collected between 2023 and 2025 as part of this research. To ensure a clear and structured analytical reading, we have deliberately chosen to organise the collected data into three categories: (i) the historical context of the project's emergence, (ii) its ambitions, and (iii) its spatial manifestations. These three interpretative keys guide the analysis of the two Emirati cities presented herein. For each category, we detail its scope and the types of data utilised to inform the analysis.

Historical context
Urban projects are embedded within specific historical and political contexts and are developed to provide a bespoke response tailored to the territory in which they are situated: "*The urban project is not simply the application of generic principles devised elsewhere to a particular place. It must emerge from local dynamics*" (Rémy, 1998). The motivations driving an urban project are manifold and stem from diverse political imperatives aimed at linking several themes: socio-economic transition, quality of life, strategic positioning, among others. Understanding this context allows for the identification of the political and strategic conditions underpinning these projects. This first axis employs a genealogical reading (Foucault, 1971) to uncover the processes leading to the formulation of the projects, incorporating planning documents, the strategic agendas of states or metropolitan authorities, and prior territorial transformations. This analysis is based on the examination of official documents, press sources, and interviews with key stakeholders.

Ambitions
Following the analysis of the historical conditions that gave rise to the project, attention is turned to the ambitions and objectives articulated through the urban project. This section draws on official documents (notably planning materials), interviews, and project websites.

Spatial translations
Finally, the stated ambitions and discourses must be confronted with the urban forms produced, the design choices made, and the concrete modes of implementation. This third axis examines the spatial translations of the project—that is, the manner in which the declared objectives are materialised within the urban fabric, infrastructure, morphology, and programming. This analysis relies on site observations, press coverage, official documentation, and interviews.

Case studies
For this article, we have chosen to focus on two urban projects located in the United Arab Emirates (UAE): Masdar City (Abu Dhabi) and The Sustainable City (Dubai). This selection is justified by the UAE's pioneering role in experimenting with so-called sustainable urban models in the Arabian Peninsula. As early as 2008, with the launch of Masdar City in Abu Dhabi, the UAE established itself as a key player in ecological urban transition, both in the Gulf region and globally. Indeed, the project represented the first eco-city to achieve tangible development following the abandonment of the world's first planned eco-city in Dongtan (China). Although still under construction, Masdar stands as the first large-scale attempt to realize an eco-city in a desert environment.

This project aligns with a broader national strategy aimed at supporting the country's energy transition—historically reliant on hydrocarbons—toward diversifying its energy sources by significantly increasing the share of renewables, primarily solar power, in its energy mix. It forms part of ambitious state-driven transformation plans, such as the Energy Strategy 2050 and the UAE Net Zero by 2050 Strategic Initiative, which position sustainability as a key pillar of the Emirates' long-term trajectory (United Arab Emirates, n.d.).

Beyond this pioneering role, the Emirati context also exhibits several characteristics that make it a relevant case study for analyzing eco-cities. The UAE serves as a veritable laboratory, as the country already faces constraints that the rest of the world is striving to mitigate or avoid. These include extreme environmental conditions – particularly its hyper-arid climate (Böer, 1997) – along with automobile dependency (Ochieng & Jama, 2015), urban sprawl (Elessawy, 2021), among other challenges.

Masdar City (Abu Dhabi)

Project's history
Abu Dhabi, the capital of the United Arab Emirates (UAE), has undergone profound urban transformation since the mid-20th century, triggered by the discovery of oil in 1958. In 1939, the settlement was a modest fishing village of approximately 10,000 inhabitants. The city's significant expansion began in the late 1960s under the leadership of Sheikh Zayed bin Sultan Al Nahyan. Upon becoming ruler of Abu Dhabi in 1966, and later founding the UAE in 1971, Sheikh Zayed initiated an ambitious modernization strategy through the creation of the Abu Dhabi Planning Council (Government of Abu Dhabi, n.d.). Breaking away from the austere policies of his predecessor Sheikh Shakhbut—who preferred to conserve oil revenues to maintain a tribal and Bedouin lifestyle—Sheikh Zayed reinvested oil wealth into public infrastructure. This included the rapid development of schools, hospitals, housing, and road networks, aimed at improving the quality of life for Emirati citizens (Davidson, 2010).

This moment marked Abu Dhabi's entry into modernity, characterized by a functionalist approach to urban planning (Bani Hashim, 2019). Under Sheikh Zayed's leadership, Abu Dhabi quickly transformed into a "boomtown", fuelled by successive waves of migrant labour necessary for large-scale construction efforts. These migratory flows were instrumental in the Emirate's rapid demographic growth. The first federal census in 1975 recorded a population of 211,812 across the Emirate, which would continue to expand rapidly in subsequent decades (UAE National Bureau of Statistics, n.d.).

To manage and anticipate this demographic surge, Abu Dhabi commissioned numerous master plans designed by international firms. These plans—closely supervised by Sheikh Zayed—sought to shape Abu Dhabi into a modern,

green city equipped with all essential infrastructures. At this stage, development efforts were overwhelmingly supported by oil revenues, as the emirate had not yet embarked on a transition toward a business-oriented economy.

The death of Sheikh Zayed in 2004 marked a significant turning point in the trajectory of Abu Dhabi. His successor, Sheikh Khalifa bin Zayed Al Nahyan, assumed leadership and ushered in a new development paradigm—one that was distinctly more business-oriented than oil-oriented. This shift in economic strategy, underpinned by efforts to reduce dependence on oil revenues, had far-reaching urban implications (Bani Hashim, 2019). In collaboration with Sheikh Mohammed bin Zayed, Crown Prince of Abu Dhabi from 2004, Sheikh Khalifa promoted economic diversification. This new strategic direction was formalised with the launch of the *Abu Dhabi Policy Agenda 2007–2008*, a foundational roadmap that defined the government's core priorities. The agenda aligned closely with Sheikh Khalifa's entrepreneurial vision to position Abu Dhabi as a robust and globally competitive economy. The ultimate objective was the establishment of a "sustainable knowledge-based economy", which entailed a dual ambition:

"*Sustainable here meant continual economic growth (as distinct from environmental sustainability), which in turn implied profit-making enterprises operating over the medium to long term. The emphasis on knowledge building meant high-skilled, high-wage rather than low-wage, low-productivity areas*" (Rossiter & Yates, 2025).

This vision became the foundational pillar for two subsequent strategic frameworks: the *Abu Dhabi Economic Vision 2030* and the *Abu Dhabi 2030 Urban Structure Framework Plan*. Together, these served as key policy instruments for aligning the Emirate's economic transformation with spatial and infrastructural development. The Urban Structure Framework Plan in particular articulated the principles and spatial strategies needed to position Abu Dhabi as a global economic hub by aligning its urban development with international standards (Samarrai, 2016, p. 112). The plan called for the enhancement of public spaces, improved mobility systems, and the strengthening of the city's global image to secure its success amid intensifying global urban competition.
As part of this broader diversification agenda, the Government of Abu Dhabi, through its majority ownership of Mubadala Development Company, launched the Masdar Initiative. Known as *Masdar* (meaning "source" in Arabic), the project embodied the Emirate's dual objectives: to foster new business ventures and to advance the transition away from oil through investment in clean technologies and alternative energy solutions. This strategic alignment of ecological innovation and economic diversification positioned Masdar as a flagship project in Abu Dhabi's entrepreneurial urban agenda.

The Masdar Initiative was founded with four primary objectives (Embassy of the UAE in Washington, 2009) :

- To help drive the economic diversification of Abu Dhabi;
- To maintain – and expand – Abu Dhabi's position in evolving global energy markets;
- To help Abu Dhabi become a developer of technology;
- To make a meaningful contribution to sustainable human development.

In this context, Masdar City was established as a demonstrator of these ambitions, embodying in its planning and development Abu Dhabi's broader diversification objectives. From 2014 onwards, the city became one of Masdar's four operational units: Masdar Capital, Masdar Clean Energy, Masdar Special Projects, and Masdar City (Griffiths & Sovacool, 2020).

Ambitions

Initial ambitions
Masdar City was conceived as a Special Economic Zone (SEZ), intended to serve as a commercially viable model for sustainable living. From the outset, its design was strategic: by offering the advantages of a free zone, the development aimed to attract international firms to Abu Dhabi. This economic incentive proved effective, drawing major companies such as Siemens and Saint-Gobain to establish a presence in the city. This approach aligned with Abu Dhabi's broader agenda of economic diversification, seeking to reduce reliance on oil revenues by fostering innovation-led sectors.

Beyond its economic ambitions, Masdar was also envisioned as a prototype for sustainable urban life in extreme desert conditions. The project thus combined environmental aspirations with a high-profile development strategy, seeking to demonstrate that sustainability could be both livable and profitable.

A cornerstone of Masdar's early phase was the creation of the Masdar Institute of Science and Technology, a graduate-level research university established in partnership with the Massachusetts Institute of Technology (MIT). The Institute not only brought the city's first residents—students—but also anchored Masdar in a research-driven, innovation-oriented trajectory. These students were envisioned as co-developers of the city's technological infrastructure, actively contributing to the advancement of solutions that would be deployed in Masdar itself.

In its initial configuration, Masdar operated as a Porterian cluster, concentrating government bodies, private enterprises, and academic institutions within a single geographic area to foster innovation and economic development. This strategic co-location laid the groundwork for what would later be conceptualized as a 'green knowledge-based city' (Ingallina, 2019; Carlotti & Alaoui Aziz, 2025), defined by the pursuit and deployment of eco-technological innovations (Ingallina, Park, & Carlotti, 2025).

A hallmark of the project was its bold ambition to become the world's first zero-carbon, zero-waste, and car-free city. This aspiration received widespread media attention, albeit often critical, particularly in light of the paradox that the initiative was spearheaded by a government whose economy remained heavily dependent on oil revenues—accounting for approximately 70% of GDP at the time.

To enhance the project's global visibility and symbolic value, Masdar engaged the renowned architecture firm Foster + Partners. The involvement of a starchitect reinforced the city's image as an iconic, high-tech experiment, positioned to elevate Abu Dhabi's standing on the international stage. This move echoed broader efforts by the emirate to diversify its global identity—not only economically but also culturally, architecturally, and environmentally—as evidenced by parallel initiatives like the Cultural District on Saadiyat Island.

Changing ambitions

Initially scheduled for completion in 2015, the Masdar City project experienced significant delays, particularly following the subprime mortgage crisis, which had substantial repercussions for the United Arab Emirates—Abu Dhabi included—notably in terms of the funding allocated to the project itself. This financial downturn compelled a strategic reorientation of Masdar City, prompting its leadership to broaden its vision beyond purely environmental goals to encompass economic sustainability, with an emphasis on the commercial viability of its operations as a means to ensure continued development. As noted by Masdar City officials:

"Abu Dhabi was not immune to the effect of this crisis. Under such an economic environment, a shift in the direction of Masdar City was about to take place. This shift marked a pivotal moment in Masdar City's evolution. Whereas the earlier focus was solely on environmental sustainability, the new focus was on economic sustainability in the form of commercial viability, but at the same time upholding environmental stewardship" (Masdar City, n.d. a).

The subprime mortgage crisis also had the effect of tempering the project's initial ambitions. Masdar City was compelled to soften its objectives, shifting from a 'zero-carbon' model—where no carbon dioxide emissions occur within the city's boundaries—to a 'net-zero carbon' model. This latter approach permits certain carbon emissions, provided that an equivalent amount is removed or offset, resulting in no net increase in atmospheric COΔ In an interview conducted with a Masdar City official, it was acknowledged that while the goal of achieving zero-carbon was unattainable at the time, it served more as a global message—an aspirational statement of ecological ambition underpinning the entire project:

[...]. *Also, you may have a brand that the big aspirations back then were net zero. This is something that, that most are called out in 2006, much to a lot of criticism and ridicule saying it's impossible and all that. And in many ways, in 2006, that was impossible. But we didn't set out to do what was possible in 2006. The goal was to have this as a kind of a driving factor to aim very high and actually push and develop the technologies within the city to achieve that. (interview, March 2024)*

Today, the project has refocused its efforts around the pursuit of net-zero carbon in alignment with the UAE's Net Zero 2050 Strategy, which targets net-zero emissions by mid-century across six key sectors: energy, industry, transport, buildings, waste, and agriculture. Masdar City now commits itself to the following targets (Masdar City, 2023):

- Reducing the energy use intensity (EUI) of its real estate portfolio by 45% by 2025, relative to the ASHRAE baseline;
- Achieving net-zero carbon emissions by 2050 across Scope 1, 2, and 3 emissions;
- Limiting the embodied carbon of concrete structures to less than 550 kgCOΔe/m² across all new developments;
- Diverting 80% of operational waste from landfills by 2030, across all waste streams.

Spatial translations

Masdar City is a planned urban development situated in the Emirate of Abu Dhabi, encompassing an area of 6 km². Conceived to host approximately 47,500 residents and accommodate 1,500 businesses—with an estimated 50,000 daily commuters—the project represents one of the most ambitious urban sustainability initiatives in the Middle East. According to the development programme, Masdar City will ultimately offer a total gross floor area of 3.7 million square metres, of which 57% is allocated to residential use, 38% to commercial activities, and 10% to community and retail functions. As of today, the city houses over 15,000 residents who both live and work within its limits, and it has established itself as a growing economic hub, hosting more than 1,000 local and international firms registered within the Masdar City Free Zone.

The master plan, designed by the British architectural practice Foster + Partners, is structured around a compact, pedestrian-oriented urban form intended to reduce energy consumption and encourage sustainable modes of mobility. Central to this design philosophy is the principle that all key services and amenities should be accessible within a maximum walking distance of 200 metres (Foster + Partners, n.d.). This contrasts markedly with the car-centric, low-density urbanism that characterises much of the Gulf region, and particularly Abu Dhabi.

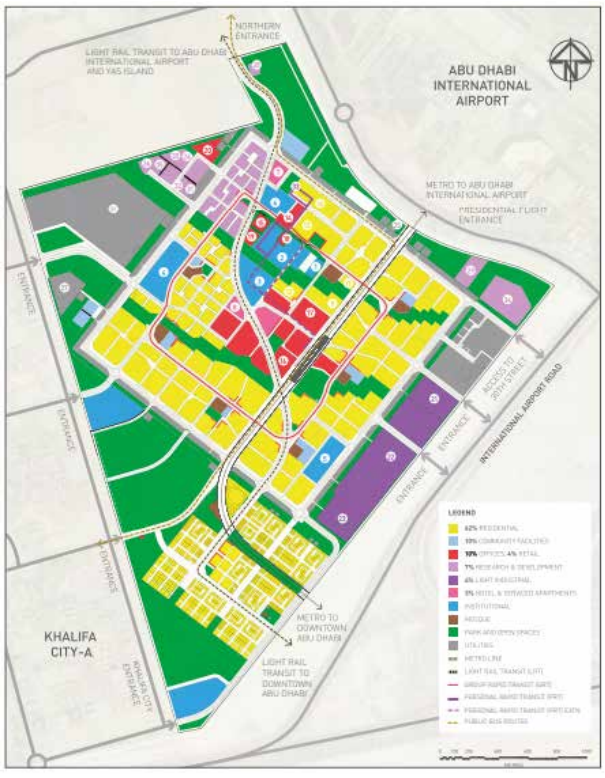

Figure 1. *Masdar City master plan (Masdar City, n.d. c)*

Masdar's spatial logic draws heavily upon the morphological and climatic strategies of traditional Arab cities, particularly those of historic settlements such as medieval Cairo (Hassan, Lee, and Yoo, 2015). These influences are evident in the city's narrow, shaded streets, internal courtyards, and public plazas, all of which are employed to mitigate heat gain and enhance thermal comfort in the public realm. The compact urban fabric and building orientation optimise shading and natural ventilation, aligning with vernacular architectural practices adapted to arid environments.

Figure 2. From left to right: Masdar Park, Masdar Institute, and Masdar City Wind Tower *(personal pictures)*

Furthermore, the city's SE–NW grid alignment is strategically oriented to reduce exposure to the prevailing hot desert winds. This bioclimatic approach reflects a deliberate effort to integrate environmental responsiveness into the physical layout of the city.

Vehicular access to the inner city is strictly limited. Private cars are not permitted within the core of Masdar City, a policy designed to prioritise pedestrian circulation and reduce air and noise pollution. Instead, the city promotes sustainable mobility through a multimodal transport strategy that includes electric shuttles, autonomous vehicles, and extensive cycling and pedestrian infrastructure.

Key examples

Masdar City presents a paradigmatic shift in urban development models within the Gulf region through its explicit integration of cutting-edge technologies, high-performance architecture, and environmental design rooted in local climatic adaptation. Distinguished by a concentration of technologically advanced infrastructure and buildings, the city functions as a demonstrative site for green innovation and experimental sustainable urbanism (Pandita et al., 2024). Numerous scholarly works have analysed the performance metrics of individual buildings within Masdar, demonstrating the extent to which architectural prowess and engineering ingenuity have been mobilised to achieve ambitious energy efficiency goals (AbiSaad et al., 2014; Boyer et al., 2010).

One of the emblematic examples is the Masdar Institute of Science and Technology (now part of Khalifa University), the first completed building in the city, designed by Foster + Partners. The Institute is equipped with smart shading devices, passive design strategies, and a high-performance façade system that collectively reduce cooling loads by up to 70% compared to conventional buildings in the UAE. The integration of photovoltaic panels, wind towers, and optimised building orientation exemplifies the city's ambition to combine architectural excellence with energy consciousness. The Institute thus serves both as a research hub and as a living laboratory for sustainable architecture.

Another flagship development is the Siemens Middle East Headquarters, which achieved LEED Platinum certification and is often cited as one of the most energy-efficient office buildings in the region. The structure features a distinctive façading system that allows for natural daylighting while minimising heat gain, alongside advanced HVAC systems powered in part by renewable energy sources. With an Energy Use Intensity (EUI) far below regional averages, the building symbolises the operational translation of net-zero objectives at the individual parcel scale.

Other large-scale projects have been implemented or are currently planned:

Table 1. *Selected High-Performance Developments in Masdar City (made by the authors, with sources on this table)*

Project	Masdar City Square	The Link	Net-Zero Energy Mosque
Expected Completion	Scheduled for 2025	Scheduled for 2025	Completed (Date not specified)
Primary Function	Cluster of 7 commercial buildings	Mixed-use development (offices, residential areas, co-working spaces, recreational activities, visitor center, multi-use hall)	Religious facility
Sustainability Certifications (targeted)	• Targeting LEED Platinum, WELL Gold • Estidama 4 Pearl PBRS • Zero Energy certification	• LEED Platinum • WELL Gold • Estidama 4 Pearl, • Parksmart Silver for sustainable mobility integration	Targeting Estidama 4 Pearl Rating
Energy Strategies and Technologies	• Extensive photovoltaic panel installations designed to meet 100% of the project's annual energy needs • Shaded walkways to reduce solar gain	• 131% estimated annual savings • 40% light power reduction • Net-zero energy Co-Lab Building powered entirely by renewable sources, incorporating advanced HVAC systems, real-time energy monitoring, and high-efficiency appliances	• 35% reduction in energy consumption relative to conventional mosques • 1,590 m² of photovoltaic panels integrated into the roof system so it can produce 100% of the energy it needs over the course of a year • 55% reduction internal water consumption • 100% of its recycled water used to irrigate outside gardens
Sources	WFES (2025), Masdar City (n.d. b)	WFES (2025), Masdar City (n.d. d)	WFES (2025), ARUP (n.d.)

The Sustainable City (Dubai)

Project's history

Dubai, the largest city in the United Arab Emirates (UAE), has progressively positioned itself as a global city through a rapid and ambitious process of urban transformation. Originally a modest fishing and pearling settlement, Dubai experienced limited economic activity until the decline of the pearl industry in the 1930s. Over the course of the twentieth century, however, the city underwent dramatic changes following the discovery of oil in 1966.

Under the visionary leadership of Sheikh Rashid bin Saeed Al Maktoum, the city invested its initial oil revenues in foundational infrastructure—constructing ports, airports, road networks, and basic utilities to modernise its urban fabric.

Yet it was from the 1990s onward that Dubai's trajectory took a decisive turn, as the Al Maktoum ruling dynasty actively pursued a strategy of economic diversification to reduce dependency on finite hydrocarbon resources. This vision gave rise to a globalised urban identity rooted in leisure, finance, commerce, and large-scale real estate development (Pagès-El Karoui, 2021). Landmark projects such as the Burj Al Arab (1999), the Palm Jumeirah (early 2000s), and the Burj Khalifa (2010) not only redefined the city's skyline, but also projected an image of Dubai as a global city.

As part of this internationalisation and diversification agenda, Dubai enacted *Law No. 7 of 2002* (the Dubai Property Ownership Law), enabling foreign nationals to acquire freehold property in specific areas. Within this regulatory framework, two entrepreneurs founded Diamond Developers in 2003. Between 2004 and 2013, the company engaged in conventional real estate ventures aligned with the prevailing urban logic of the time. These included the Marina Diamond towers, situated near the Palm Jumeirah, and the Diamond Views residential complexes in Jumeirah Village Circle—a popular, family-oriented district that appealed particularly to an international clientele seeking affordable and secure housing within the emirate.

However, the 2008 global financial crisis—driven by the collapse of subprime mortgage markets—prompted a strategic reorientation for the company. In an environment of investor mistrust and depreciating property values, sustainable real estate products were perceived as less volatile and more resilient in times of economic downturn, according to one manager in an interview. It was within this context that the founders of Diamond Developers identified an opportunity to innovate. Moving beyond superficial 'green' add-ons such as photovoltaic panels, they embraced a more holistic understanding of sustainability, one which integrates environmental responsibility, social cohesion, and economic viability. As one of the firm's urban planners explained in an interview, the objective was not simply to construct energy-efficient buildings, but to design entire communities aligned with long-term socio-ecological values.

Ambitions

According to an interview conducted with one of Diamond Developers' urban planners, the company's ambition in the aftermath of the 2008 financial crisis was to demonstrate that an alternative, more resilient model of urban development could indeed be viable. Rather than pursuing high-risk speculative ventures, the objective was to secure a stable return on investment by appealing to prospective homeowners seeking assets perceived as economically low-risk—namely, properties grounded in sustainability principles. Diamond Developers thus adopted a cost-efficiency-driven approach, selecting technologies with a proven track record, such as photovoltaic solar panels. These technologies, while environmentally beneficial, were above all seen as reassuring features for buyers: durable, reliable, and capable of substantially reducing long-term utility costs.

The project's development was therefore underpinned by a strategic philosophy based on six interconnected domains: Food, Energy, Water, Products, Mobilities, and Waste. These six pillars formed the conceptual backbone of the master plan (see after), establishing the foundation for a self-sufficient urban model that contrasted sharply with the typical, resource-intensive developments seen elsewhere in Dubai. By integrating pragmatic solutions into each of these domains, the developers sought to achieve a high degree of sustainability that could respond effectively to the city's harsh climatic and environmental conditions.

Spatial translations

General presentation

TSC Dubai represents the first fully operational sustainable urban community in the Middle East (The Sustainable City Dubai, n.d.). Developed by Diamond Developers, construction began in 2014, with the first residents moving in by 2015. Located on a 46-hectare site (113 acres) and comprising 500 residential villas designed to accommodate approximately 3,000 inhabitants, the project amounted to an investment of USD 354 million.

The master plan is structured around six pillars—Food, Energy, Water, Products, Mobility, and Waste—that articulate the project's holistic approach to sustainability. Central to the design is a "green spine", a linear, pedestrian-friendly corridor running through the development. This spine, accessible to all residents within a five-minute walk, incorporates biodomes, recreational facilities (e.g. swimming pools, sports fields), and community gardens. The biodomes are designed to meet 100% of the residents' caloric needs by supplying free, locally grown fruits and vegetables. The residential clusters—five in total—are oriented northward to maximise thermal massing and reduce heat gain, enhancing passive cooling strategies. Each villa is equipped with rooftop photovoltaic panels, and the cumulative solar infrastructure enables the community to generate 150% of its total energy demand. Internal combustion engine vehicles are banned from the site; mobility within the city is exclusively ensured through electric buggies and soft modes of transport. TSC also adheres to the principles of the "15-minute city", whereby all daily services—including shops, clinics, schools, and a central market square—are within a 15-minute walking radius from any residence.

Figure 3. *The Sustainable City Master Plan (The Sustainable City, n.d.)*

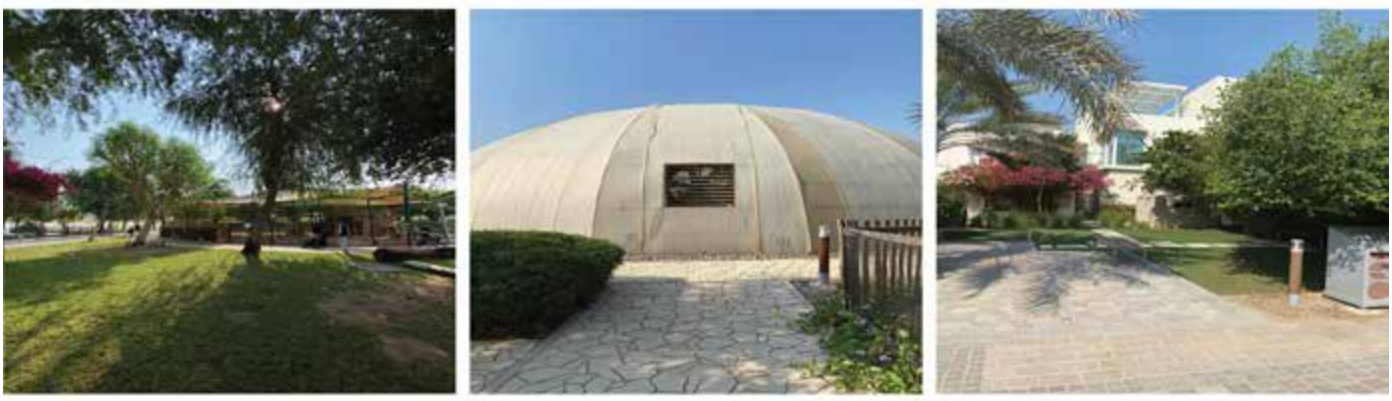

Figure 4. From left to right: the farm ; one biodome ; villa *(personal pictures)*

Key benefits
The developers of TSC Dubai have based the city's development on 6 pillars:

Table 2. *The Six Sustainability Pillars of The Sustainable City Dubai (made by the author)*

Pillars	Implemented Solutions	Expected Benefits
Food	• Biodome greenhouses • Community-based urban agriculture using hydroponics	• Enhanced food security • Reduction in greenhouse gas emissions • Nutritional education
Energy	• Rooftop photovoltaic panels • Passive energy-efficient building design	• 100% renewable energy supply • Reduced utility costs • Lower carbon footprint
Water	• Greywater recycling systems • Measures to reduce water consumption	• Minimised water waste
Products	• Use of sustainable and recycled materials • Low-carbon architecture • Promotion of local supply chains	• Waste reduction • Strengthened local economy • Reduced ecological footprint
Mobility	• Electric vehicles only • Pedestrian and cycling infrastructure (20-minute city model)	• Zero local emissions • Improved public health • Reduced noise and traffic congestion
Waste	• On-site composting systems	• Decreased landfill waste • Organic waste valorisation • Support for circular economy

Findings
Despite being developed within the same national context and underpinned by overarching sustainability goals, Masdar City and TSC Dubai illustrate two markedly different interpretations of the eco-city paradigm, even if they take place in the same Gulf context. Two core findings emerge from this comparative analysis:

(i) Each city articulates a distinct conceptualisation of the eco-city model partly based on governance and actor rationalities;
(ii) And each follows a different operational logic—community-based adaptability in one case, and technological disruption in the other—while both ultimately converge towards similar sustainable development objectives.

Two eco-city types in the UAE
As previously discussed, the eco-city model is inherently protean and subject to diverse interpretations. In the context of the United Arab Emirates, Masdar City and The Sustainable City (TSC) Dubai offer compelling illustrations of this plurality by embodying two contrasting visions of what is often framed as the "city of the future." Like all urban projects, these initiatives are deeply shaped by their historical and geographical contexts—in this case, the unique political economy and developmental trajectory of the UAE. Each project has generated singular responses to the challenges of sustainable urbanism, reflecting the situated nature of their emergence. Their respective trajectories—sometimes diverging, sometimes complementary—can be largely attributed to distinct governance logics and actor rationalities, which significantly influence the projects' underlying philosophies, spatial configurations, and operational frameworks.

Masdar City, for its part, represents a complex and long-term endeavour embedded within a state-led strategic vision. Initiated by Masdar in close partnership with the Government of Abu Dhabi, the city is conceived as the physical manifestation of the Emirate's broader economic diversification agenda, particularly its efforts to pivot away from oil dependence through investments in renewable energy and ecological transition. As previously outlined, this agenda is closely linked to the production of new and bold urban landmarks—such as the Cultural District on Saadiyat Island—designed to brand Abu Dhabi as a global centre for business, leisure, and culture. Within this broader assemblage, Masdar City operates as a new pillar of Abu Dhabi's soft power strategy, projecting an image of environmental consciousness and technological sophistication. This strategy has become particularly visible at the national level, notably during the UAE's hosting of COP28 in Dubai in 2023, where Masdar City was prominently featured and promoted as a national showcase of sustainability.

In this context, Masdar aligns with and extends ambitious national and regional strategic visions. It stands out not only for its philosophical ambition but also for its formal innovation, displaying an architectural futurism emblematic of the UAE's broader approach to urban spectacle, often mobilising renowned starchitects to underscore the project's boldness. As such, Masdar City functions as what Arab (2007) describes as an "operational vector of metropolitan ambitions and urban policies," articulated within larger territorial development frameworks. Its public-private governance configuration further distinguishes it from other eco-city models such as TSC Dubai. Crucially, Masdar's trajectory has been subject to external contingencies—most notably the slowdown following the 2008 global financial crisis—demonstrating the project's need to adopt a more adaptive and phased implementation strategy.

On the other side, The Sustainable City Dubai is a private development by a private developer that took the subprimes crisis as a springboard to promote a more sustainable vision of urban planning in the Dubai context. By being a private-led project, the city is exclusively relying on the developer ambitions which should be market-aligned to sustain a demand. This city fits into what Arab (2007) defines as a Type B project—primarily private-sector-driven, contained within a delimited area, and usually delivered over a relatively short timeframe.

A high-tech disruptive model vs. a modular community-based model

Masdar City: A disruptive high-tech urban model
Masdar City forms an emblematic disruptive urban project—one that seeks to redefine the very boundaries of sustainable design through the integration of cutting-edge technologies, renewable energy systems, and experimental urban form. This ambition is clearly expressed in publications such as *The Future of Energy* (World Future Energy Summit, 2025), where the city is variously marketed and described as a "global model", "greenprint", "sustainable energy-efficient urban space", and "global laboratory" (pp. 14–21). These varied designations reflect the project's experimental and future-oriented character, marking it as a high-tech flagship of eco-urbanism.

The Sustainable City Dubai: A modular, Scalable and replicable model
By contrast, The Sustainable City offers a more grounded and pragmatic model of eco-urbanism—one that prioritises the implementation of proven, low-risk solutions over the development of novel high-tech innovations. Rather than investing in experimental technologies with high costs and uncertain returns, TSC focuses on practices that have already demonstrated effectiveness, thereby fostering buyer confidence and limiting financial and technical risk. Visually and spatially, the development adopts what could be described as a 'conventional' urban morphology, yet it is optimised to deliver tangible socio-ecological benefits.

These benefits manifest, first and foremost, in the creation of a vibrant community, centred around recreational and communal facilities—such as farms, swimming pools, playgrounds, and a local marketplace. This configuration fosters social interaction, especially through the self-sufficient nature of the development, which reduces the need for residents to leave the city for daily necessities. This dynamic was particularly evident during our field observations, where residents' daily routines were interwoven with informal encounters and collective activities. Secondly, TSC's planning principles demonstrate a clear commitment to environmental sustainability—both through the integration of extensive green spaces and the use of photovoltaic solar panels to power the neighbourhood.

What is particularly distinctive about TSC, in contrast to Masdar City, is its character as a replicable urban prototype. It functions as a scalable and modular template for sustainable development, with clear and measurable outcomes that facilitate adaptation across different contexts. Its design logic can be easily transferred to new sites, with flexibility for local adjustments depending on land characteristics, territorial specificities, and regulatory frameworks. Having acquired significant experience and credibility with its first operation in Dubai—which achieved full occupancy—Diamond Developers have been able to replicate and extend the model with greater ease and reduced risk. This modular quality proves to be a strategic asset: as the developers themselves claim, "*The Sustainable City is a resilient, scalable, and replicable working model*" (The Sustainable City, n.d.).

This approach significantly reduces the time required for both conceptualisation and implementation in subsequent projects. It allows for both upscaling and contextual adaptation, enabling each new iteration to refine and build upon the previous version. Such a logic is currently evident in the developer's expansion projects in Sharjah, Abu Dhabi, and particularly Oman, where the core layout—comprising public plazas, leisure centres, and equestrian facilities—is maintained while incorporating substantial improvements. This replicability and modularity stand in marked contrast to a complex urban experiment like Masdar City, which must navigate a distinct set of constraints and respond to broader state-driven strategic imperatives.

References

AbiSaad, M., Nikolopoulou, C., Al Hosany, N., Afshari, A. and Wan, C.C.L. (2014) High performance buildings in hot arid regions – a case study for the Siemens Building in Masdar City. *Journal of Architecture and Planning*, 26(2), pp.105-120.

Arab, N. (2007) Activité de projet et aménagement urbain : les sciences de gestion à l'épreuve de l'urbanisme. *Management & Avenir*, 12(2), pp.147-164. https://doi.org/10.3917/mav.012.0147

ARUP. (n.d.) Designing the world's first net zero energy mosque [online]. Available at: https://www.arup.com/projects/masdar-city-mosque/

Bani Hashim, A.R. (2019) *Planning Abu Dhabi: an urban history*. London: Routledge.

Bibri, S.E. (2020) The eco-city and its core environmental dimension of sustainability: green energy technologies and their integration with data-driven smart solutions. *Energy Informatics*, 3(4). https://doi.org/10.1186/s42162-020-00107-7

Böer, B. (1997) An introduction to the climate of the United Arab Emirates. *Journal of Arid Environments*, 35(1), pp.3-16. https://doi.org/10.1006/jare.1996.0162

Boyer, J.L. et al. (2010) Systems integration for cost effective carbon neutral buildings: a Masdar Headquarters case study. In *ASME 2010 4th International Conference on Energy Sustainability*. https://doi.org/10.1115/ES2010-90335

Carlotti, M. and Alaoui Aziz, B. (in press, 2025) Two Cases of New Knowledge-Based Green Cities in Morocco: The Green City of Benguerir and the Technopole Foum el Oued. In Ingallina, P. (ed.) *The Urban University and the Knowledge Economy : New Spaces of Interaction*. London: Routledge.

Dasgupta, S., Lall, S. and Wheeler, D. (2023) Cutting global carbon emissions: where do cities stand? [blog] *World Bank Blogs*. Available at: https://blogs.worldbank.org/en/sustainablecities/cutting-global-carbon-emissions-where-do-cities-stand#:~:text=Cities%20account%20for%20over%2070,constructed%20with%20carbon%2Dintensive%20materials

Davidson, C.M. (2009) *Abu Dhabi: oil and beyond*. London: Hurst & Company.

Elessawy, F.M. (2021) The abnormal population growth and urban sprawl of an Arabian Gulf city: the case of Abu Dhabi City. *Open Journal of Social Sciences*, 9(2). https://doi.org/10.4236/jss.2021.92017

Embassy of the UAE in Washington, DC (2009) Masdar Initiative supports clean energy [online]. Available at: https://www.uae-embassy.org/news/masdar-initiative-supports-clean-energy

Foster + Partners (n.d.) Masdar City [online]. Available at: https://www.fosterandpartners.com/projects/masdar-city

Government of Abu Dhabi (2008) *The Abu Dhabi Economic Vision 2030* [online]. Available at: https://www.actvet.gov.ae/en/media/lists/elibraryld/economic-vision-2030-full-versionen.pdf

Government of Abu Dhabi (n.d) Sheikh Zayed's legacy [online]. Available at: https://www.abudhabi.gov.ae/en/about-the-government/sheikh-zayeds-legacy

Griffiths, S. and Sovacool, B.K. (2020) Rethinking the future low-carbon city: carbon neutrality, green design, and sustainability tensions in the making of Masdar City. *Energy Research & Social Science*, 62, 101368. https://doi.org/10.1016/j.erss.2019.101368

Hassan, A.M., Lee, H. and Yoo, U. (2016) From medieval Cairo to modern Masdar City: lessons learned through a comparative study. *Architectural Science Review*, 59(1), pp.39-52. https://doi.org/10.1080/00038628.2015.1015947
Helbling, M. and Meierrieks, D. (2023) Global warming and urbanization. *Journal of Population Economics*, 36, pp.1187-1223. https://doi.org/10.1007/s00148-022-00924-y

Ingallina, P. (2001) *Le projet urbain*. Paris: Presses Universitaires de France.

Ingallina, P. (2019) *Eco-city, knowledge city, smart city: vers une ville écosoutenable?* Villeneuve d'Ascq: Presses universitaires du Septentrion.

Ingallina, P., Park, J. and Carlotti, M. (2025) City of challenges: toward eco-technological innovation? Examples from Morocco and South Korea. In Zaidan, E., Ibrahim, I.A. and Azar, E. (eds.) *Smart cities to smart societies: Moving beyond technology*. London: Routledge. https://doi.org/10.4324/9781003439325-10

Joss, S. (2010) Eco-cities: a global survey 2009. *WIT Transactions on Ecology and the Environment*, 129, pp.239-250. https://doi.org/10.2495/SC100211

Joss, S. (2011) Eco-cities: the mainstreaming of urban sustainability – key characteristics and driving factors. *International Journal of Sustainable Development and Planning*, 6(3), pp.268-285. https://doi.org/10.2495/SDP-V6-N3-268-285

Kohlhase, J.E. (2013) The new urban world 2050: perspectives, prospects and problems. *Regional Science Policy & Practice*, 5(2), pp.153-166. https://doi.org/10.1111/rsp3.12001

Masdar City (2023) *ESG Report* [online]. Available at: https://masdarcity.ae/sustainable-urban-development/sustainability-reports

Masdar City (n.d. a) From vision to reality: Masdar City's journey to net-zero [online]. Available at: https://www.worldfutureenergysummit.com/content/dam/sitebuilder/rxae/worldfutureenergysummit/docs/WFES-From-Vision-to-Reality-Masdar-Citys-Journey-to-Net-Zero.pdf.coredownload.398739664.pdf

Masdar City (n.d. b) *Masdar City Square: a gateway for opportunities* [online]. Available at: https://masdarcity.ae/docs/default-source/pdf-to-download/masdar-city-2-brochure-general.pdf?sfvrsn=52c264cf_1

Masdar City. (n.d. c). *Master Plan* [online]. https://masdarcity.ae/docs/default-source/pdf-to-download/masterplan_21-12_english_v2.pdf?sfvrsn=a6dd270e_3

Masdar City (n.d. d) *The Link* [online]. Available at: https://masdarcity.ae/docs/default-source/pdf-to-download/the-link-brochure-2022-general.pdf?sfvrsn=74225601_1

Nguyen, T.H. and Vu, G.H.T. (2023- Eco-city paradigm: urban planning towards sustainable development goals. *E3S Web of Conferences*, 403, 01002. https://doi.org/10.1051/e3sconf/202340301002

Ochieng, M. and Jama, M. (2015) The implications of automobile dependency in Abu Dhabi City. *WIT Transactions on the Built Environment*, 146, pp.143-152. https://doi.org/10.2495/UT150121

Pagès-El Karoui, D (2021) Cosmopolitan Dubai: Consumption and Segregation in a Global City. In Lejeune, E., Pagès-El Karoui, D., Schmoll, C. and Thiollet, H. (eds.) *Migration, Urbanity and Cosmopolitanism in a Globalized World*. IMISCOE Research Series. Springer, Cham. https://doi.org/10.1007/978-3-030-67365-9_6

Pandita, A. et al. (2024) Exploring Masdar City: smart innovations and future eco-city model in urban sustainability. In *2024 Advances in Science and Engineering Technology International Conferences (ASET)*, Abu Dhabi. https://doi.org/10.1109/ASET60340.2024.10708691

Rapoport, E. (2014) Utopian visions and real estate dreams: the eco-city past, present and future. *Geography Compass*, 8(2), pp.137-149. https://doi.org/10.1111/gec3.12113

Rémy, J. (1998) Le projet urbain : sens et signification. In: J.-Y. Toussaint and M. Zimmermann (eds.) *Projet urbain: ménager les gens, aménager la ville*. Sprimont: Mardaga.

Ritchie, H., 2020. Cars, planes, trains: where do CO2 emissions from transport come from? [online] *Our World in Data*. Available at: https://ourworldindata.org/co2-emissions-from-transport

Rossiter, A. and Yated, A. (2025) Abu Dhabi's drive for defence industrialization: paramountcy of the economic diversification agenda. *Defence Studies*, 25, pp.407-424. https://doi.org/10.1080/14702436.2025.2472699

Samarrai, K. (2016) The evolution of Abu Dhabi City's urbanization and the sustainability challenge. In M. Al-Asad and R. Mehrotra (eds.) *Shaping cities: emerging models of planning practice*. Berlin: Hatje Cantz.

The Sustainable City. (n.d). *The Sustainable City* [online]. Available at: https://thesustainablecity.com/

UAE National Bureau of Statistics (n.d.). Methodology of estimating the population in the UAE [online]. Available at: https://web.archive.org/web/20131008044353/http://www.uaestatistics.gov.ae/ReportPDF/Population%20Estimates%202006%20-%202010.pdf

United Arab Emirates (n.d.) The UAE's future roadmap [online]. Available at: https://u.ae/en/about-the-uae/uae-in-the-future/uae-future

World Bank (2018) Urban population [online]. Available at: https://data.worldbank.org/indicator/SP.URB.TOTL

Yanitsky, O. (1982) Towards an eco-city: problems of integrating knowledge with practice. *International Social Science Journal*, 34(3), pp.469-480.