Green Urbanism with Genuine Green Architecture: Toward Net Zero System in New York

Derya Oktay and James Garrison

Introduction

Changes that have taken place in the world over the past 30 years, including ecological disturbances and radical changes in traditional settlements, have produced cities that are not just chaotic and monotonous in appearance but have serious environmental problems threatening their inhabitants. In this context, environmentally sensitive design approaches at the building scale have been understood better comparing to those at the urban scale, and there have been significant developments in the field, although the contemporary architectural practice in the developing countries is still lacking many aspects of sustainable building design. On that ground, sustainable urbanism emerges as a sound framework that draws attention to the immense opportunity to redesign the built environment in a manner that supports a higher quality of life and human health. What is critical here is that a city cannot be green without genuine green buildings.

Today, most architects, unfortunately, continue to see architectural design as the design of an "object," although it is an undeniable reality that building design cannot be isolated from its environment, and an architect while designing a building affects the existing environment positively or negatively. As buildings are one of the principal users of energy and materials and the major causes for damaging nature, new approaches are needed in the conception, theorization, and implementation of architectural practices, which will generate ecologically responsive architectural

D. Oktay (✉)
Maltepe University, Istanbul, Turkey
e-mail: deryaoktay@maltepe.edu.tr

J. Garrison
Pratt Institute, New York, USA
e-mail: jgarrison@pratt.edu; garrison@garrisonarchitects.com

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designs. In this context, "green architecture" emerges as the practice of creating buildings that are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water, and other resources, safeguarding user health, increasing employee productivity, and reducing waste, pollution, and physical deterioration.

However, the concept of green architecture remains poorly defined and inadequately developed as a cultural and technical undertaking. Architecture produced in the context of industrialized, capitalist societies continues to be determined by expedience and profit rather than ecological principles. Even if the most sustainable design and technical solutions are utilized, their effectiveness is dramatically limited by supply chains, work patterns, and materials produced under capitalist priorities. These same priorities in the context of highly competitive and mediated cultures drive claims of sustainability without realizing complete, effective, or holistic solutions. Unsubstantiated or overstated "green washing" prevails across much of the product range and is liberally applied to architecture. Whether resulting from economic limits or partial commitment, we must move beyond such half measures if we are to successfully confront what has become the greatest existential threat of the modern world. It is very rare to see effective architectural examples that safeguard regional populations with locally appropriate sustainable design features that consider climate, health, and renewable energy [8]. The result is a lack of environmental sensitivity and the prevailing sameness in cities worldwide.

Early in the sustainability movement, many rejected the idea of "environmental balance" as an impossible goal that ignored the realities of the Anthropocene. Thirty years hence two questions remain: Can technological means save us from ecological disaster, or will we fail without disruptive cultural, economic, and behavioral change? It is now clear that both are necessary. We can take a lesson from US consumers' response to legislated vehicle mileage improvements; Americans now drive 40% more miles per person than they did 40 years ago.

Based on these shortcomings, this chapter focuses on the concepts of green urbanism and green architecture based on the ideas observed in the development of the ancient settlements and the traditional contexts, introducing the Seventy-Six, the second author's awarded project in Albany, New York, and interrogates the viability of the net zero concept through that exemplary project.

Looking Back for the Idea of Green Settlements

Although sustainability is considered new conceptually, it is not new as a worldview. The adaptation of building to the environment has been a continuous problem throughout the centuries. The use of local data, especially climatic features, in design has been a part of the rational approach of those who have been dealing with buildings since ancient times. In this context, the ancient builders learned to design houses that would benefit from solar energy on cool days and avoid the heat of the sun on hot summer days.

Furthermore, early evidence shows that solar energy and other climatic features were utilized not only on a single house scale but also when designing a group of houses in an urban context. Hippocrates, for example, suggested heading east in living spaces as the healthiest solution, emphasizing that the south direction is also acceptable. Vitruvius, on the other hand, drew attention to the importance of opening wide streets to the wind to clean the air of the city and to avoid the wind so that narrow streets could be used as a living environment [2]. As in Greek cities, streets in ancient Rome were created with walls and arcades that protected from the sun's rays and kept buildings cool, a principle that has become the norm for many urban settlements in the Mediterranean region as an excellent solution to protect pedestrians from climatic elements and enrich the urban space. Vitruvius's recognition of its importance is echoed even by Le Corbusier, who has not been enthusiastic about designing with the environment: "The symphony of climate along the curvature of the meridian, its intensity varies on the crust of the earth according to its incidence… In this play, many conditions are created which await adequate solutions. It is at this point that an authentic regionalism has its rightful place" [9].

In every region, a traditional building style or regional architecture has emerged due to the practical needs of the people living there, topography, and climatic conditions. These anonymous examples are important sources of information that should be considered in the design of new environments in that region, at the settlement and building scale. For instance, traditional Turkish (Ottoman) city is the perfect example of "design with nature." As analyzed by Oktay [6], the preexisting topographic character of the site is apparent at the urban scale even in intense built-up areas. Furthermore, gardens perforate an otherwise dense urban fabric, providing relief to streets and to public and private structures. With its trees, flowers, and small vegetable plot, the courtyard, *avlu*, is the closest relation the house has to nature; thus, it also provides the inhabitant with direct access to nature (Fig. 1). During the hot summer months, the well-defined, open-to-sky courtyard traps the dense, cool air in

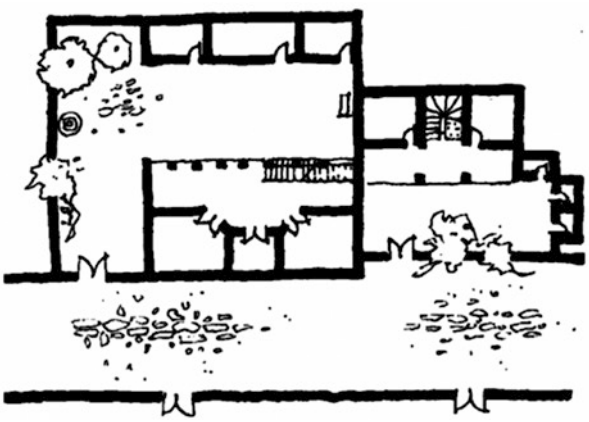

Fig. 1 Traditional courtyard house in the traditional Turkish (Ottoman) house [6]

the center of the house, helping air circulation and bringing down the general temperature inside. Trees, as nature's own evaporative coolers, are the important components of the courtyard; they also filter blowing dust from the air.

The Persian civilization is widely considered to have added windcatchers, the natural ventilation in buildings, to allow for better cooling – such as combining it with its existing irrigation system to help to cool the air down before releasing it throughout the home. As Roaf [10] highlights, in a hot and arid climate, windcatchers can be thought of as a zero-carbon cooling technology (Fig. 2).

Such indigenous environmental creativity was necessarily motivated and limited by available resources. It was, in a sense sustainable by circumstance, as its instigators had no choice but to work from what was at hand. Without glossing over the class and labor exploitation common to such endeavors, we can recognize that limitations are often the most effective way for cultures to work within ecological boundaries. With the arrival of the petroleum age, such boundaries were dissolved by a widely available and abundant source of energy. As is our nature, we have used this resource with abandon inventing means of production, movement, and materiality that sponsored unparalleled population growth and technical advancement without broad recognition of its effect on the world that sustains us.

The search for the cities of the future, against rapid and unbalanced urbanization, how to create the balance between the city and the rural environment, and how to shape ecologically sensitive environments were first brought to the agenda by Ebenezer Howard in 1898. Letchworth (England), designed by Howard as a "garden city" in line with these goals, was a city model with functional diversity and relatively self-sufficiency, surrounded by a production-oriented green belt that minimized dispersed development ([5]/1898). Here, the beauty of nature, easily accessible parks and fields, clean air and water, houses with gardens, high income, and social opportunities were combined with cooperative entrepreneurship (Fig. 3). With its features, Howard's model, unlike other garden city approaches, can be considered as a starting point for planning and design for sustainability.

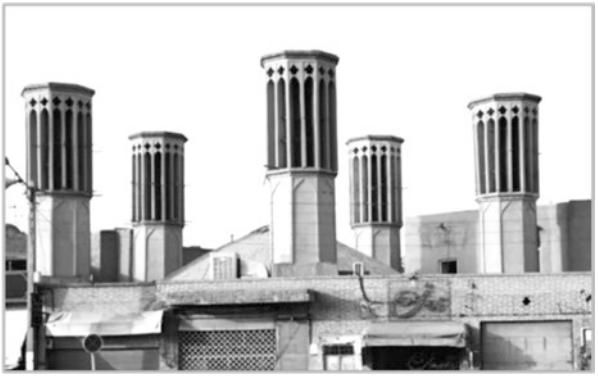

Fig. 2 Traditional windcatchers in Yazd, Iran (https://gate-of-nations.org/wind-towers-or-wind-catchers/ Retrieved: 08.04.2022)

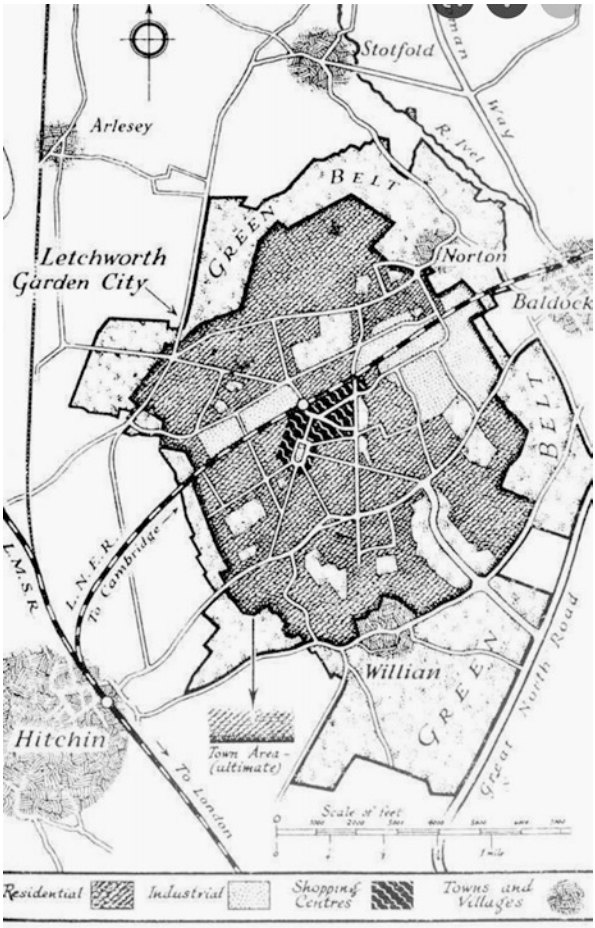

Fig. 3 Letchworth Garden City map [5]/1898

Towards the end of the twentieth century, by redefining urban and nonurban settlements in the United States in the context of sustainability, Peter Calthorpe started the urban and architectural movement that compelled the "New Urbanism" movement. Positioning all functions and services around an advanced and alternative public transportation system and considering pedestrian accessibility, including open spaces in the center that will support social life, creating a distinctive street pattern that does not give priority to vehicles, and designing the buildings in accordance with historical and climatic features constitute the main principles of the New Urbanism movement [3] (Figs. 4 and 5). Although the movement is open to criticism on several fronts, for being focused on better-designed suburban development, often for upper income groups, rather than the creation of truly "urban" places, together with the paradigm of "green architecture" provides the philosophical and practical framework of sustainable urbanism at the city level.

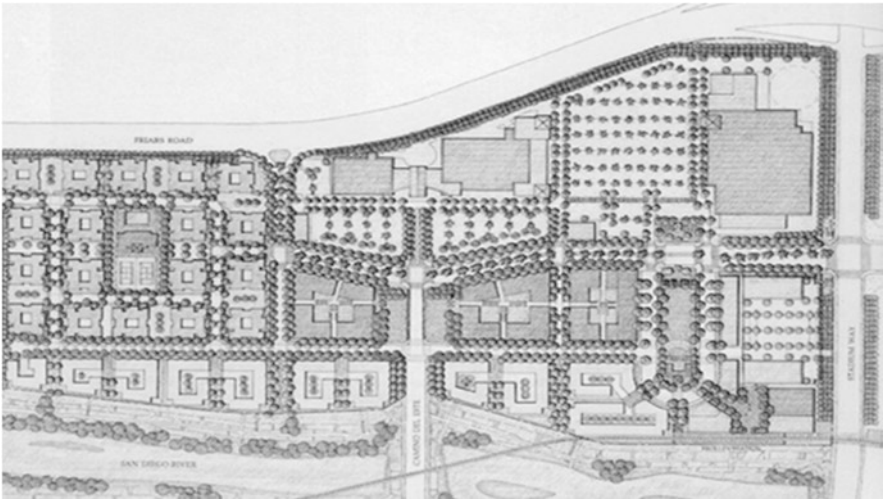

Fig. 4 Rio Vista West (San Diego, California) site plan [3]

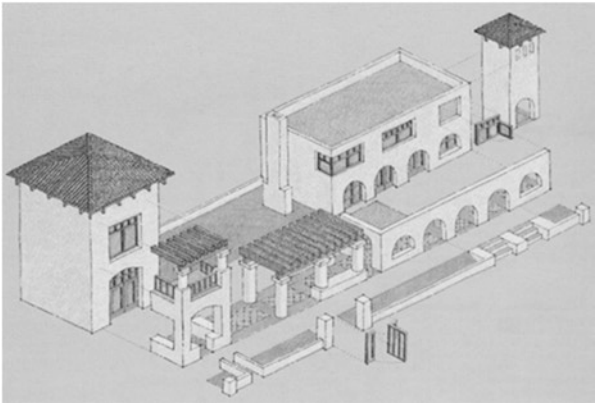

Fig. 5 Architectural language and components in Rio Vista West (San Diego, California) created in harmony with the tradition and climate [3]

Green Urbanism and the Need for "Genuine" Green Architecture in Contemporary Developments

When the theme of sustainability at the urban scale first came to the forefront, all those interested in the subject defined sustainability with great conviction, referring to the Brundlant Report (1987), as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs and expectations." However, it was not very clear how it would be reflected in actual decisions and daily life. In this context, the general objectives were to develop

energy efficiency and minimize air-polluting emissions, to develop mobility without the need for motor vehicles, to reduce the use of private vehicles by improving public transportation in this direction, and to develop new activity centers around the nodal points of public transportation. In this vein, the idea of "green" urbanism focuses on expanding our approach to the phenomenon of urbanism, which covers both urban and architectural scale to include ecological dimensions based on sustainability goals and is now indispensable on the agenda of the world of urban planning/design and architecture and nongovernmental organizations particularly in developed Western countries.

Since the failure of architectural practices to develop attitudes against globalization accelerates the loss of local resources, identities, and social values, what is needed to be emphasized is that the design approaches that take formal aesthetics as the "single and main goal" are extremely dangerous, but what it adds or how it affects the needs is important. In this context, the rapid proliferation of successful examples supporting the idea of "green urbanism," and the intense support and interest in it by being kept on the agenda both at the country and city administration level and through nongovernmental organizations are pleasing developments. One significant contemporary example of housing combining ecological and social principles is Ecolonia in Holland, master-planned by the Belgian architect Lucien Kroll. Ecolonia does demonstrate that significant savings in energy use and environmental impact can be achieved by optimizing the use of the existing methods and building materials. By paying regard to orientation (south, east, and west facing housing, not north), to differential window areas according to aspect, and to increased levels of insulation and efficient boiler systems, Ecolonia has met the target of a 25%

Fig. 6 The settlement layout of "Ecolonia" low-energy housing demonstration project in Alphen aan den Rijn (Netherlands) designed by Lucien Kroll (L. Kroll Archive)

Fig. 7 The sketch view of "Ecolonia" drawn by Lucien Kroll (L. Kroll Archive)

reduction in household energy use in an area with a continental climate ([4], 195) (Figs. 6 and 7).

Our research and investigations reveal that green urbanism based on sustainability should be expected to include the following basic features beyond including "green" in the color palette: locally appropriate density, clear borders, integrated transportation, city and nature unity, climatic design, and energy. It is the "sustainable lifestyle" that we think is necessary for the conservation of these features and the sustainability of these features [7].

To put it simply, it is not possible to create a "green" city with low density and sparse textures dominated by unused spaces. What is important here is an integrated urban fabric with an appropriate density that is harmonious with the local climate and culture. In this way, agricultural areas outside the city will not be damaged, automobile fuel consumption and harmful substance (emissions) will decrease, and the local economy and social life will be strengthened due to the concentration of the people and their activities in the city.

Since ancient times, residential areas have been the basic unit of settlements. The *mahalle*, the traditional neighborhood unit, which determines the structure of the traditional Turkish (Ottoman) city, reflects the features to be learned in the context of sustainability as a social-spatial and recognizable module. It has high ecological efficiency, especially with its strong center and clear borders formed by a mostly production-oriented green belt [7]. Demarcated, recognizable settlements not only support ecological and social life but also encourage citizens to take more responsibility for their care and development.

Positioning the diverse functions and services around a developed and offering public transportation system and considering pedestrian accessibility, including public spaces in the center that will support social life, creating a street pattern with a strong spatial definition, emphasizing the comfortable circulation of people, and attractive pedestrian areas, the city will increase the "walkability" feature, which is important for its ecology, and will keep the city center alive at all hours of the day.

Integration with nature is the most important component of green urbanism. When the history of humanity is examined, it reflects the traces of the perfect harmony of the first examples of collective life with nature. In these examples, nature has been the main determinant of both the identity of the settlements and the physical boundaries of collective life. On the other hand, green spaces in a city contribute to human activities, climate, and ecological diversity without alienating people. Today, many European cities are trying to draw nature into the city and to establish physical and ecological connections between the urban structural areas and the surrounding natural and green spaces. Wetlands, forests, feeding points of underground waters, etc., in the city form the city's green infrastructure and are as important as structural elements because of the many benefits they provide (e.g., flood prevention); to strengthen the city ecologically, it is imperative to protect them.

The practices that will provide ecological benefits within the scope of planning or renewing the city are the use of productive landscape elements such as fruit trees in the arteries in the residential areas and the integration of the shared gardens, where the people of the city can grow their vegetables, with the settlement plan. Local and small-scale food production will not only reduce the environmental pressure caused by industrial agriculture but also form the main source for healthy nutrition.

Towards Net Zero Buildings: The Seventy-Six, New York

The Seventy-Six, the second author's awarded project in Albany, New York, is the brainchild of Corey Jones, a young African American developer, who is looking to create a new community from the ruins of the neighborhood he grew up in. Many environmental, economic, and cultural justice atrocities have confronted the people of Albany's South End where the Seventy-Six is located. Things many of us take for granted – safety, savings, healthy food, available parents, and friends are difficult to find there.

The Seventy-Six intends to be the first triple net zero (energy, water, and waste) multifamily/mixed-use project in the United States and seeks to create a complete transformation of the area, including the creation of economic and environmental equity by integrating scalable ownership models into businesses and homes. A radically sustainable infrastructure with high-quality, affordable, and flexible housing that meets universal design and accessibility requirements that can accommodate aging, changes in family size, and alternative living arrangements. The design team consisted of ME Engineering, The Levy Group (sustainability consultants), Go Energy Link (alternative energy specialists), Steve Ostrowski (an inventor), and the architectural team began with a Skunk Works[1] approach, a project developed by a

[1] A Skunk Works approach is the concept originally developed by Lockheed Martin, to quickly develop solutions by bypassing some of the time-consuming bureaucracy and allowing the team to make ad hoc decisions [1].

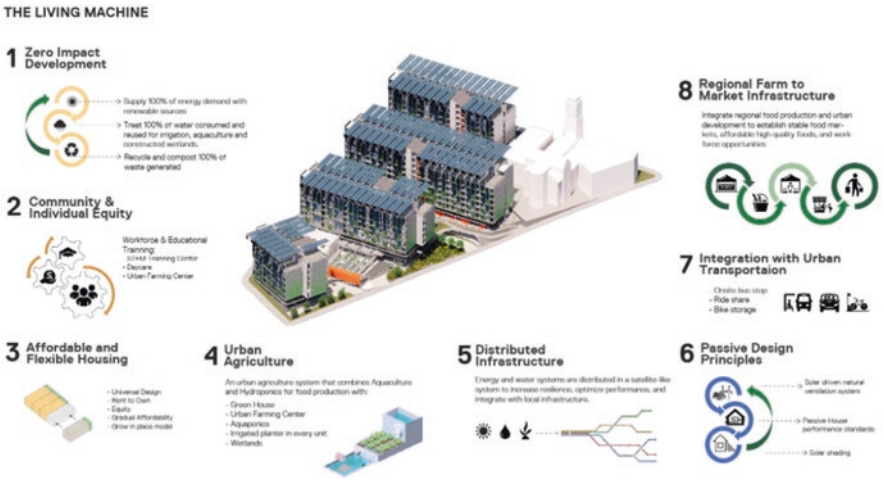

Fig. 8 The rationale of the Seventy-Six, NY. (Source: J. Garrison Archive)

Fig. 9 The general view of the Seventy-Six, NY. (Source: J. Garrison Archive)

relatively small and loosely structured group of people who research and develop a project primarily for the sake of radical innovation.

It always seems as though, by its simple physicality architecture cannot affect meaningful social and environmental change. And although it has real limits, it is a

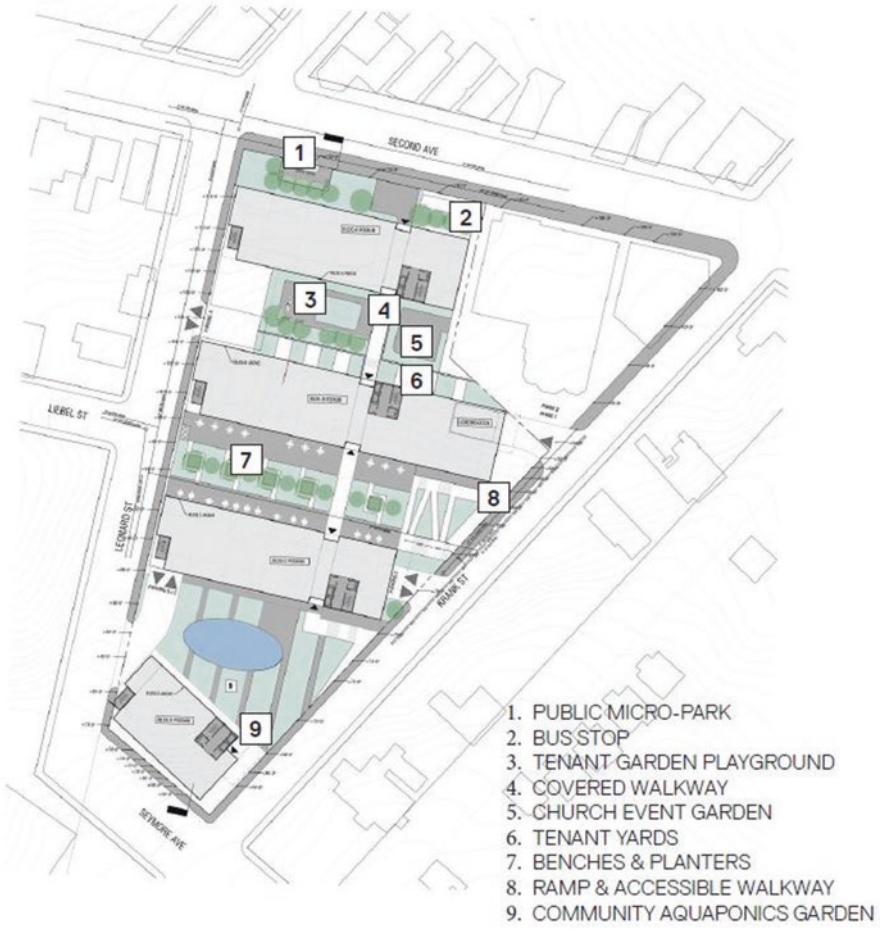

Fig. 10 The general layout of the Seventy-Six, NY. (Source: J. Garrison Archive)

great holistic enterprise that has the potential to create physical and cultural synergies that transcend much more than we may think. The Seventy-Six begins with a recipe for community restoration through effective programming including the creation of affordable housing, coworking, and commercial space, permanent jobs, STEM (science, technology, engineering, and mathematics) learning centers by local institutions, urban gardening resources, aquaculture, daycare, and a novel fresh foods cooperative with surrounding farmsteads. At the same time, these socially motivated programs reduce the need for daily travel while they introduce biodiversity and locally sourced foods. Taken together with the organizational and technical requirements of a triple net zero development, health, equity, affordability, and ecological balance are mutually reinforced (Figs. 8, 9, and 10).

Urban Context

The South End is in many ways typical of historically underprivileged, centrally located communities that exist in mid-sized cities throughout the United States. They are the remains of mid-twentieth-century suburbanization and are impoverished, low density, and bereft of available goods and services. In cities with robust twenty-first-century economies, these communities are often displaced by gentrification. However, this is far from universal in a country with dramatic inequities in wealth and access. Consequently, the Seventy-Six can leverage location, affordable land, and accessibility with the introduction of significant density and programming designed to serve its existing and future population. This opportunity allows us to imagine a new urban reality as we look to create an economically and culturally integrated community without the neighborhood homogeneity of cities like New York.

Equity

The South End will include both rental and ownership housing. Rental programs include market and subsidized rates. Homeownership is promoted and given its tax advantages and potential for personal and family equity generation and preservation. Purchase options include conventional co-op mortgages and limited equity

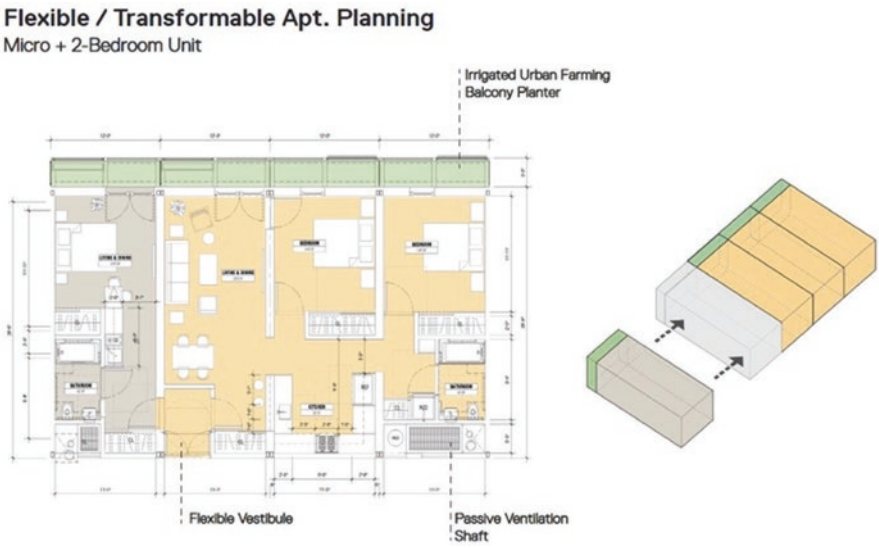

Fig. 11 The adaptability with flexible modules in Seventy-Six, NY. (Source: J. Garrison Archive)

programs for first-time purchasers. The limited equity model is inspired by London's Hackney Council programs[2] with multiple tiers and approaches to purchasing according to income and ability. At the Seventy-Six, affordability extends to retail and coworking spaces in recognition of the difficult economics of business startups.

Adaptability

The Seventy-Six includes a typical mix of urban apartment types with one notable exception; flats can be separated and combined to address growing and shrinking families without requiring residents to leave their neighborhood or building.

The introduction of a micro-studio that can be combined with or used separately from a two-bedroom flat allows several living arrangements; it can expand to serve a growing family, an elderly relative, or a child seeking independence, or it can be separated to provide rental income or a low-cost alternative for a pensioner whose family no longer needs a full-sized apartment (Fig. 11).

Permaculture

From the Permaculture Research Institute: "Permaculture integrates land, resources, people, and the environment through mutually beneficial synergies – imitating the no waste, closed-loop systems seen in diverse natural systems. Permaculture studies and applies holistic solutions that are applicable in rural and urban contexts at any scale. It is a multidisciplinary toolbox including agriculture, water harvesting and hydrology, energy, natural building, forestry, waste management, animal systems, aquaculture, appropriate technology, economics, and community development." Permaculture informs the holistic approach of the Seventy-Six as its more traditional meaning has led to urban forms of regenerative agriculture. As the proliferation of autoimmune diseases in the developed world has been linked to sanitized and hermetic living conditions, we now look to create a complete ecosystem in all architectural settings. To this end, every apartment in the Seventy-Six is outfitted with irrigated planters integrated into continuous terraces. Vertical farming support is provided to residents via an on-site agricultural resource center that advises regarding appropriate plant species and growing conditions as well as providing gardening tools, seeds, and stems.

[2] https://hackney.gov.uk/affordable-home-ownership

Recycling

Recycling programs are often stymied by the limited market for recycled materials, the lack of easy and available receptacles for multiple material streams, and the cooperation of residents. The Seventy-Six addresses these conditions by design, active management, and incentivizing residents to participate. Each flat includes four generous receptacles for composting, metals and plastics, paper, and incinerable waste. Adjacent to each elevator core is generous recycling rooms with multiple receptacles that weigh individual waste contributions. Immediate elevator access and basement collection routes bring recycling to a central hub where it is prepared for pickup. Residents receive a monthly quantity statement via the building operating system and are rewarded with reductions in common charges. Management negotiates contracts with neighborhood community gardens for composting and recycling companies that demonstrate effective sorting and placement.

Waste and Storm Water

While the northeast United States has, at this moment, an overabundance of rainfall that is changing its agricultural practices, its large urban centers require an extensive watershed and statutes to limit surrounding economic development to preserve water quality. This affects the economic growth of hundreds of communities and contributes to economic inequality. While this watershed is currently capable of providing high-quality water without filtration, it has seen steady deterioration due to land development. With filtration comes significant expense and an increasing tax burden for the communities that rely on this water. Subsequently, water, even when abundant, must be treated as the invaluable resource it is.

Like many older cities, Albany possesses a combined sewer system. This means that sewage and stormwater must share the same pipe. As storms and rainfall in the northeastern United States become increasingly intense, such systems are regularly overwhelmed and must release raw sewage into the surrounding water system. This has a direct impact on human health as pharmaceutical waste, viral matter, and microplastics are ingested by marine animals that contribute to the human food chain.

A net zero water program addresses such problems by treating each building and site as a closed loop. Such systems ideally recycle rainfall to supply all a building's water needs. This is, however, impossible for high-density urban development where rainfall can only satisfy a portion of water demand. While supplemental water from the watershed is necessary for the Seventy-Six, all discharged wastewater is retained, treated on-site, and returned to the original water source in a controlled manner.

The elements of this system are water-conserving fixtures, gray water recycling, on-site sewage filtration, stormwater retention, compactly constructed wetlands, and sufficient retention to eliminate storm surge contribution. Each of these

elements requires significant engineering expertise as water treatment is highly regulated, and appropriate systems are chosen based on first and operating cost, flow consistency and quantity, and available technologies. The water system of the Seventy-Six was designed in collaboration with the landscape ecology firm Biohabitats and the engineering firm ME.

Energy Use

Solar radiation in the northeast United States typically generates adequate power through photovoltaic conversion to serve residential buildings up to three stories high when used in combination with significant conservation measures. As a high-density, mixed-use, urban development with seven floors of the residential area, ground floor commercial and community facility uses, and subgrade parking, the Seventy-Six presented what appeared to be an insurmountable challenge.

Recognizing that every available conservation means would be necessary to approach net zero, we began by employing aggressive-passive design strategies to control heat loss and heat gain and take maximum advantage of the northeast United States temperate spring and fall weather. By these means, we sought to increase the time during which apartments could be occupied without active heating or cooling to 4 months per year. Initial energy models revealed that more energy would be required to cool than heat the buildings. In response solar control, exterior envelope tuning and ventilation had to be optimized. Continuous south-facing balconies with integrated vertical farming were designed to completely shade south exposures while allowing low-angle winter sun to pass into apartments.

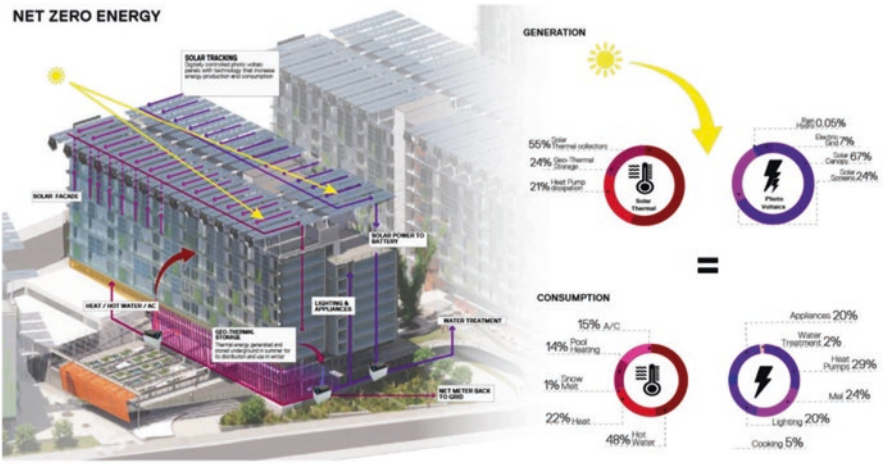

Fig. 12 Analysis of energy use in Seventy-Six, NY. (Source: J. Garrison Archive)

US affordable residential economic models require extreme efficiency and virtually dictate double-loaded corridors. This limits apartments to a single exposure and eliminates the potential for cross ventilation. To create warm-weather comfort without air conditioning, code-mandated ventilation air volume was made controllable and increased 20-fold. Inspired by Persian Wind Towers, large, vertical shafts are accessed from apartment corridors and extended above the roofs to generate air movement through buoyancy and prevailing winds. The shafts were also utilized for the module-to-module connections during erection and integrated with rooftop heat recovery ventilators with separate supply ducts to provide preheated ventilation air during winter months.

As energy consumption models were refined, multiple on-site energy production approaches were tested. Microturbines activated by water retained on roofs were modeled, as were façade-mounted piezoelectric devices activated by wind pressure and various wind turbine products and configurations. In each of these cases, energy output was insufficient to justify the cost of the devices. Single-axis rotating rooftop photovoltaic canopies were modeled and found to result in a 22% increase in electrical output. Façade-mounted panels were distributed where direct low-angle sunlight was available. Ultimately the optimized photovoltaic system was able to meet 50% of the energy needs of the Seventy-Six (Fig. 12).

An analysis of solar thermal energy potential indicated that it could theoretically supply the balance of the project's needs if rooftop space and energy storage were available. A thin, glycol-filled panel manufactured by the Sun Drum company (www.sundrumsolar.com) and designed to be placed directly below photovoltaic panels required no additional space. It also resulted in a 5% increase in photovoltaic efficiency due to the absorption of waste heat and subsequent cooling of the photovoltaics. Taken together the composite photovoltaic and solar thermal array can convert 80% of the sun's energy for direct use.

However, without storage, solar thermal energy is unavailable when it can be most efficiently used. In response, the team identified borehole technology given its ability to store energy in geothermal wells on a seasonal basis. When combined with water-to-water heat pumps, the resulting geothermal energy can provide efficient heating in the winter months and stay within the limits of a net zero system.

Conclusions

Early in the sustainability movement, many rejected the idea of "environmental balance" as an impossible goal that ignored the realities of the Anthropocene. Thirty years hence two questions remain: Can technological means save us from ecological disaster, or will we fail without disruptive cultural, economic, and behavioral change? It is now clear that both are necessary.

Early evidence shows that, in creating urban and architectural settings, the environment should not only be considered as supporting elements but also as essential elements of planning/ design, to reach a long-term and sustainable solution.

"Green urbanism" based on sustainability should be expected to include the following basic features beyond including "green" in the color palette: locally appropriate density, clear borders, integrated transportation, city and nature unity, climatic design, and energy efficiency.

The outcome of the green urbanism debate would be incomplete without people who are aware of the significance of adopting an environmentally responsive living. The ecological citizenship or the ecologically concerned citizens are therefore considered the new dimension of green urbanism, as they can be the civil power making pressure to their local and/or governmental institutions regarding the promotion of environmentally conscious everyday practices such as energy-saving, water conservation, waste management, recycling, green consumption, and sustainable transportation and movement in the city.

"Green architecture" targets to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water, and other resources, safeguarding user health, increasing employee productivity, and reducing waste, pollution, and physical deterioration. In this vein, the concept of the relationship between nature and the architecture as a design philosophy is restored, without resorting to superficial mimicry. The basic principles of green architecture include conformity of the building to its environs and to the climate, the use of renewable energy sources, the use of local and regional materials, the flexibility to adapt to changing conditions over time, and the rich variety of spaces extending from interior spaces to exterior spaces. Design with the climate and with a sense of place is an asset for ecological site design, as perfectly achieved in vernacular examples. In this context, the settlement plan and the block designs must form a cohesive and harmonious whole, in which the dwellers will feel at home in the literal sense of the world.

Over the last two decades, ecologically sensitive design approaches at the building scale have been understood better comparing to those at the urban scale, and there have been significant developments in the field, although the contemporary architectural practice in the developing countries is still lacking many aspects of sustainable building design. However, the absence of the urban or neighborhood scale in most of the environmental literature has been masked by the recent obsession with "green" buildings, most of which look green on their facades but lack energy saving ideas, climate-sensitive design, the use of locally appropriate materials, and so forth.

High-tech innovation and new sustainable technologies undoubtedly have an important role to play, but in an energy-depleted world, cities that can de-link from their dependence on these are likely to be more resilient. The emergence of the net zero buildings concept, taken holistically, anticipates the need to simultaneously disrupt and innovate even if, at this moment, our efforts remain largely technological. Energy and conservation technologies are advancing rapidly though we often cannot take full advantage of them as the necessary cultural and economic commitment remains wanting. Efforts to ascertain the real cost of human activity in environmental terms are also advancing as we develop the tools and concepts necessary to measure environmental impact before we act. Projects such as the Dutch

nonprofit enterprise True Price are developing the means to assess the full environmental impact of goods. The US engineering firm, Thornton Tomasetti, has developed digital tools to analyze the embodied and operational carbon content of buildings. Constraints and opportunities will always coexist though with a committed client and extraordinary architectural and engineering effort we can make significant progress. We look forward to the day that we discuss the cost to build in human and environmental terms and create the buildings and communities we so desperately need.

While the Seventy-Six demonstrates that high-density operational net zero buildings are possible, they do not yet represent complete ecological balance. A true net zero building must also account for the energy required for its construction and physical maintenance. In the future, as we learn to accurately measure and predict the ecological consequences of our actions, we will be able to define just exactly what such a building requires. Human actions at their best are culturally intuitive. We proceed from a deep understanding of the values and priorities that inform our choices. Like the tennis player who overthinks their serve, it's impossible to break down every action and act effectively at the same time. Architecture and construction are inseparable arts, and to employ them in the regeneration of ecological balance, our acts must become second nature.

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