Food Water Energy Nexus in Taipei

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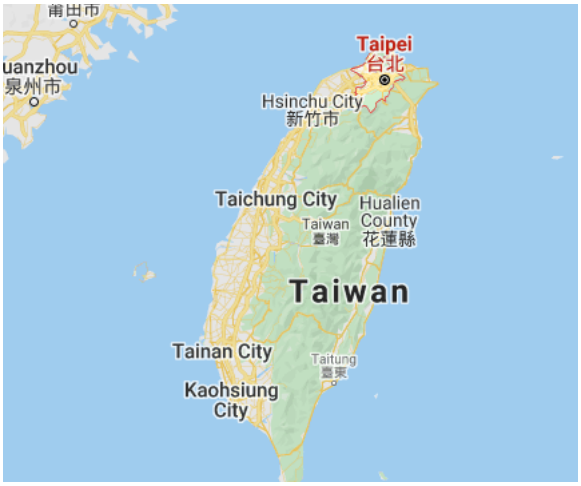
Socio-environmental Backdrop of Taipei City

Taipei City, with a population of 2.6 million, is Taiwan's capital and second largest city. While Taipei City's population has declined in recent years, it sits at the center of an expanding metropolitan region that includes New Taipei City (now Taiwan's largest city with over 4 million people), Taoyuan City (2.2 million), and Keelung City (371,000). This metropolitan area, sometimes referred to as Greater Taipei, sprawls out along the Taipei Basin where three of Taiwan's largest rivers (the Tamsui, Xindian, and Keelung Rivers) converge in the lowlands between the high, steep mountains of the Datun Volcano Group to the north, the Taoyuan Plateau to the west, and the Xueshan Range to the south.

Because of these topographic features, the distribution of development densities vary greatly across Taipei. The city has an average density of 9,540/km^2 but two of its 12 administrative districts have densities of just over 4,000/km^2 while six others have densities of over 21,000. This leads to a highly unequal distribution of access to greenspace. Overall, only 47.6% of Taipei is classified as 'lands for development,' while 52.4% of the city is conservation areas, wetlands, forestry, and agricultural lands. Yet most of these are located in city outskirts, such as Yangmingshan National Park on the mountain region and Guandu Nature Reserve along the rivers. Within 'lands for development,' there are



Facts & Figures

Population
2,592,878

Area
259 km^2

Average Household Income
63,444.69 USD

Population Density
9,732 persons/km^2

only 5.69% of overall areas classified as 'park and greenspace.' The average green resource per-capita in the city, including both accessible and inaccessible natural, semi-natural, and artificial greenspace amounts to an impressive figure of 53.37 m^2. However, in urbanized areas of the basin, the average green spaces per capita (which includes parks and greenspace) marks 6.18 m^2 as of 2020, ranging from 2.05 m^2 in Da-an District at the central area to 11.17 m^2 in District at the outskirt (Figure 1).

Taipei faces similar resource security issues with energy. The city gets all of its electricity from the nationalized Taipower company, which produces most of its energy from fossil fuel thermal plants. Currently, 38.2% of Taipower's energy comes from natural gas, 37.3% from coal, and 13.4% from nuclear power plants. 97% of energy fuels are imported from other countries [1]. This foreign dependence exacerbates the issue of unsustainable energy in Taiwan and has been made potentially more problematic by the Taiwanese government pledging to denuclearize its energy sector (a highly political issue in Taiwan). In fact, this has only increased their reliance on coal. The government has, however, also pledged to increase the proportion of renewable energy to 20% (up from the current figure of 6%) by 2025.

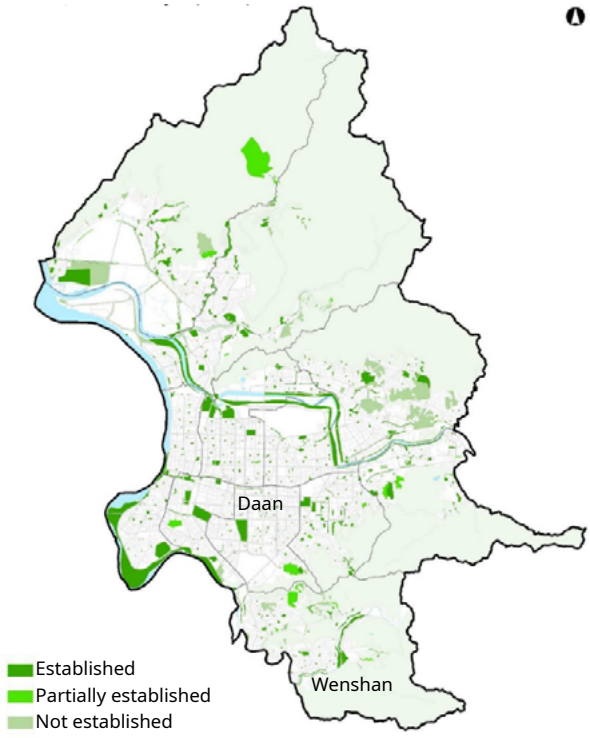


Figure 1 – Greenspace distribution in Taipei

Despite these risks for food, water, and energy security, Taipei's main challenges regarding these resources are typically related to excess and abundance rather than scarcity. For example, food consumption habits have changed significantly as Taiwan developed rapidly in the second half of the twentieth century [2] and diets are now more rich in sweets and meat, while containing less fruits and vegetables [3]. Promoting better food options could help curb rising rates of obesity in Taiwan (which are already amongst the highest in Asia) [4]. In addition, water and electricity consumption patterns could similarly be improved. While Taipei's residential electricity use has decreased in recent years, making the city more efficient overall, energy prices in Taiwan (per kWh) remain much lower than in other developed countries in places like North America and Europe, which can contribute to wasteful behaviors. The same is true for water. As of 2019, Taipei residents consume an average of 329L of water per day [5]. This level of consumption made Taipei the eighth largest per-capita water consumer in 2016 according to an International Water Association study comparing 198 cities in 39 countries [6].

To help abate these issues related to resource security and also help with potential flooding and urban heat island (UHI) problems, the Taipei government has begun to promote greenspace development projects that use urban agriculture schemes to make available a range of FWE benefits for the city and its inhabitants.

Taipei Garden City Program: a Story of FWE Innovation

Taipei Garden City (TGC) is an innovative land use policy launched by the Taipei City Government in 2015. The policy allows for publicly owned land to be adopted by citizen groups and converted into temporary non-profit vegetable and herb gardens. Government, private sector, and non-governmental organizations (NGOs) work together to support the policy's goals, which seek to establish more sustainable FWE practices not only in the gardens themselves, but also in the minds and behaviors of Taipei's citizens more broadly. The policy has three primary goals: creating a green urban landscape, enhancing green education, and building sustainable forms of citizenship.

Creating green landscapes, creating a low-energy 'sponge city'

In five years, the TGC policy has grown to include over 740 urban farms and gardens across Taipei City, accounting for more than 213,000 m^2 of edible forms of green and blue infrastructure (GBI). These gardens are distributed across four categories (school gardens, community gardens, rooftop gardens, and allotment farms) and are located in all 12 of the city's districts. One of the keys to TGC's success is the variety of garden types and locations it includes. In dense city center districts, large allotment farms (large farms sub-divided into rentable plots) are not an option, but the government has large property holdings that can be converted from gray to green and blue infrastructure through school, community, and rooftop gardens, which account for 97% of the total number of gardens and approximately 87% of the total GBI added by the program. Within these, citizens are given a great deal of latitude to generate their own garden plan and structure. Thus, the TGC initiative relies on and encourages innovative, citizen-led methods of re-appropriating underutilized land in more environmentally and socially beneficial ways.

While food production capacity in the Garden City scheme is low (farmers report an average of only a few kilograms of produce each month), the extra greenspace created by the scheme offers a number of ecosystem services beyond food provision. One of the key environmental benefits these gardens can help provide is water retention and flood water control. Working with private sector horticulture specialists and NGOs involved in water regulation, the city government has promoted rainwater harvesting systems in gardens through subsidies and grants, and the policy represents an extension of the government's current 'sponge city' strategy that aims to increase permeable surfaces in the city. Expanded greenspace and green roofs are argued to reduce energy requirements for cooling by reducing the UHI, and in the case of rooftop gardens, offering insulating benefits. Some gardens are also employing solar and wind energy generating systems, although more could be done to encourage these self-sufficient practices. Finally, the government's Environmental Protection Bureau (EPB) supplies gardens with compost-based fertilizer produced from municipal solid waste collection at no cost. Most gardens also have their own composting systems in place, although scale and intensity vary greatly. Gardens are required to be fully organic, meaning energy savings are found (relative to conventional agriculture) by eliminating chemical fertilizers and pesticides.

Enhancing green education, growing a nexus culture

To ensure gardens are innovating to become more environmentally friendly, educating citizens about sustainable food, water, and energy practices is one of TGC's primary objectives. The policy promotes this via multiple channels, both officially and informally. Ten Agricultural Consulting Service Centers have been set up across the city, offering free technical consulting and advice. These are jointly run by various district and city-level Farming Associations (civic organizations for farmers) and members of the national government's Agricultural Improvement Farm. Courses are also offered through the policy, accessible via the Taipei Garden City website, and consist of

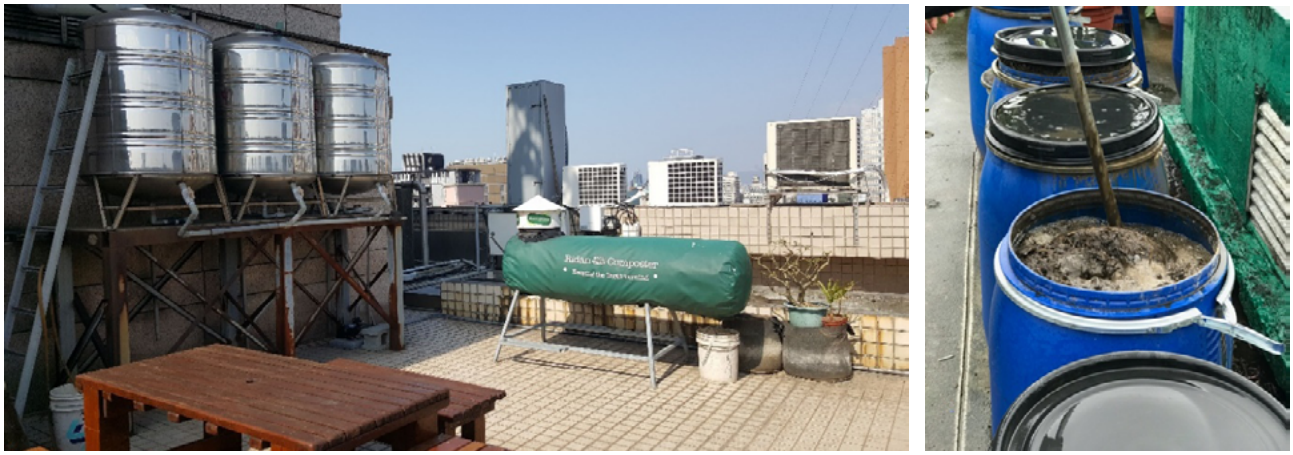


Figure 2 – On-site composting
Photo credit: Author

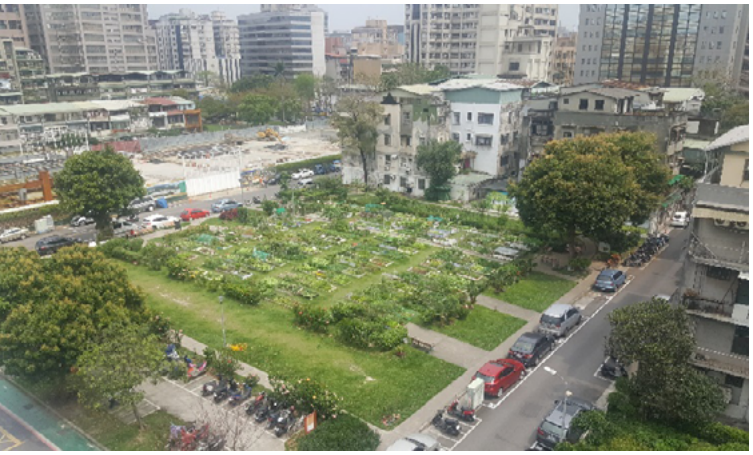


Figure 3 – Fujianli Community Garden
Photo credit: Author

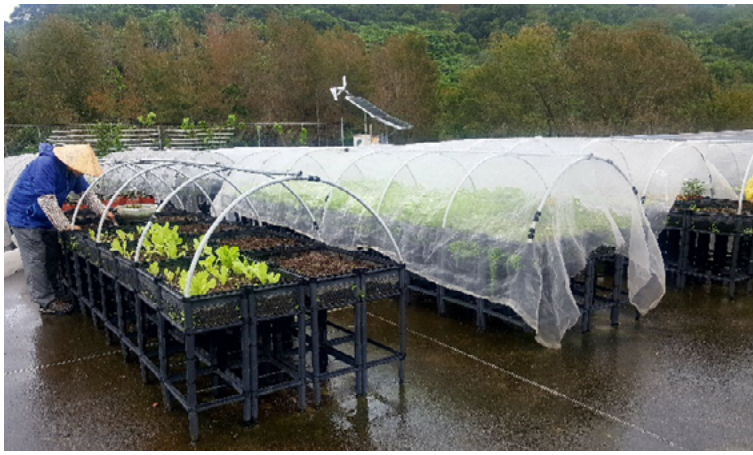


Figure 4 – Da-an Silver-hair rooftop garden rising vegetable beds for the elderly
Photo credit: Author

both in-person, hands-on courses, and online, virtual courses jointly organized by the city government, numerous environmental NGOs and volunteer organizations, local chapters of the National Association for the Promotion of Community Colleges, and academics from local universities. Since the policy's inception, 165 such physical, in-person courses have been offered and 57 virtual courses are available on-demand covering a range of topics focused on gardening techniques and other environmental issues like creating a circular economy. Online courses, which are offered free of charge through the city's Taipei E-University, are designed by both local and international experts. A Community Garden Promotion Center has also been set up as part of the policy, run jointly by the city's Parks and Streetlights Department (the policy's project manager) and a local NGO (the Hsiliu Environmental Foundation). This is a civic space promoting community mutual learning.

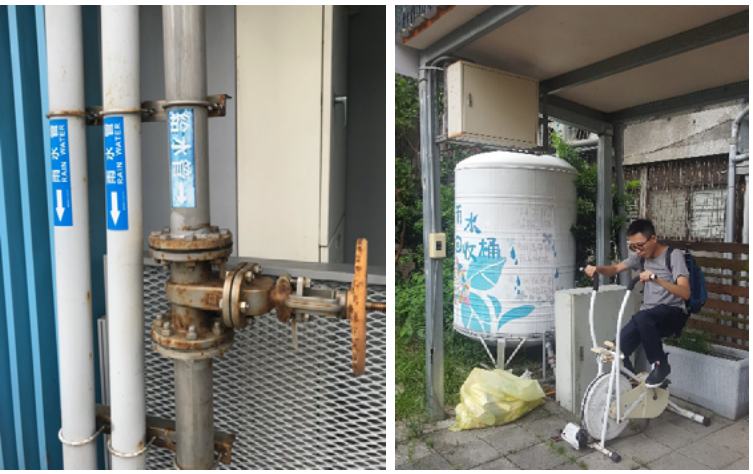


Figure 5 – Rainwater harvesting for garden sites
Photo credit: Author

The large number of school gardens is another key to TGC's educational emphasis. The 537 school gardens in the program account for 73% of the policy's total gardens. The Secretary of Education has actively promoted the expansion of gardens (both rooftop and ground-based) on school properties and created city-wide policies for student participation. Elementary, junior high, and senior high school students are involved not only in the cultivation (education in sustainable food growing practices), but also educated in food production and nutrition as part of this scheme. Subsidies have also been granted to the National Association of Community Colleges, with branches located in each of Taipei's 12 districts, for offering courses and developing gardens. These are non-profit organizations for lifelong learning that offer continued education opportunities for adults in a variety of subjects, and many have been involved in promoting gardening for years.

The expansion of gardens, combined with TGC-sponsored courses, helps promote social forms of nexusing that go beyond improved FWE resource flows. Creating a culture of sustainability and green thinking amongst citizens is key to improving Taipei's resilience, particularly considering the city's high per-capita water usage.

Sustainable citizenship: promoting collaborative governance schemes

TGC's goal of sustainable citizenship promotes innovative forms of integrative management with an emphasis on citizen participation and reflects the policy's grassroots origins. TGC began as a social movement in the 2010s

Figure 6 – Community learning at the Community Garden Promotion Center
Photo credit: Community Garden Promotion Center

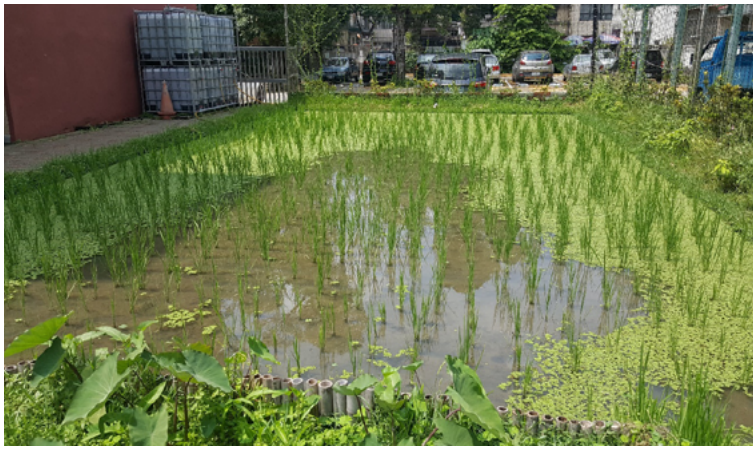


Figure 7 – Paddy field in primary school using harvested rainwater (tanks on the left)
Photo credit: Author

when citizens came together at a regeneration program allowing citizens to transform an empty lot into temporary, informal greenspaces. A handful of individuals got involved and gradually formed the Farming Urbanism Network (FUN), which developed a strong network of support and funding using social media. They developed an online knowledge sharing platform and used crowdfunding to generate income. The FUN used this support network to appeal to candidates of Taipei Mayors for promoting urban farming and expanding green infrastructure, which eventually turned into the Taipei Garden City policy. Its initiators have remained central figures within the policy, having been invited by the city to help design the policy framework, and have three acting members on the advisory board organized to dictate the policy's direction. Furthermore, the organization continues to put pressure on the policy to some extent as a citizen watchdog group. The FUN leaders organize annual reviews of the policy's progress, with workshops facilitating collaboration between members of the government and NGOs to analyze and make recommendations for the policy.

Collaborative decision-making and community relations development are key goals of the policy, and the FUN's continued role in the scheme is just one example of this. Expanding civic involvement is also encouraged via gardens being individually adopted and managed. Any group of citizens can create a garden adoption proposal, but they must be a group and must show a defined group gardening goal. The design of the garden and its control/management are largely left to the group to decide, promoting bottom-up innovation. A wide variety of citizen group types have been involved in adopting and managing gardens so far in TGC. Employees in office buildings, resident groups from apartment buildings, complexes or neighborhoods, cultural and education foundations, environmental groups, hospitals, care homes, and other group types have all adopted gardens. In this way, TGC helps expand participatory citizenship and civic engagement, both of which are important aspects of social sustainability. Additionally, the scheme seems to be reaching a substantial number of citizens. Over 521,000 people have participated in TGC gardens as of May 2021.

Enhanced cooperation between different government sectors is also a key benefit of the Garden City project. Although the Parks and Streetlights Office has been designated as the central project management authority for the

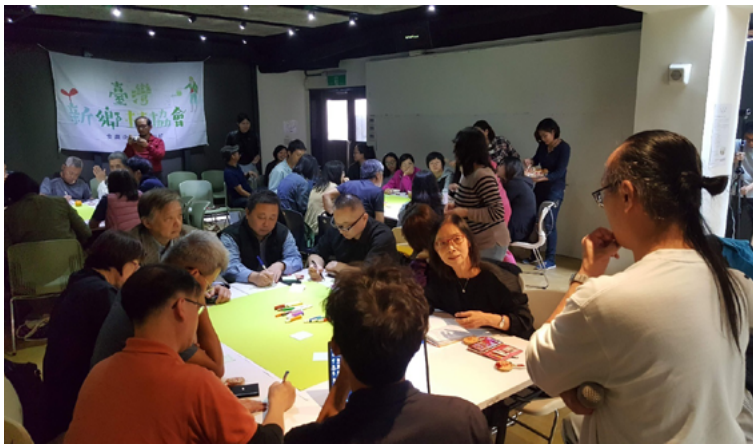


Figure 8 – Farming Urbanism Network Workshop
Photo credit: Author

policy as a whole, when a community garden adoption scheme is issued, the organization in charge of the property on which the garden is being established becomes the managing authority for the project. Regular policy meetings coordinated by the deputy mayor was key to facilitating cross-sectoral collaboration between departments, such as education, economic development, urban development, environmental protection, and health, within Taipei City government. Involved stakeholders have indicated that this structure has streamlined the process and increased inter-departmental cooperation. This is an essential part of enabling a holistic approach for FWE resource management through TGC, which heavily depends on public-private partnership and continuous engagement between various government sectors.

Enabling Environments & Capabilities

The Garden City initiative is notable for its public-private partnership, multi-stakeholder, integrative approach that leverages existing expertise, and infrastructure to create FWE advances in a bottom-up way. The strong involvement of civil society organizations, such as public hospitals, social housing, warden offices, school systems, and social welfare networks, not only helps offset government costs, but also encourages innovative ideas to be developed across gardens.

The empowerment and involvement of multiple NGOs, private citizen groups, academics, and practitioners with knowledge (such as permaculture and landscaping) to train gardeners and inform policy-making has created a foundation underpinning the operation of the program. The establishment of an online platform and social media presence has also successfully facilitated knowledge generation to be shared and undertaken by gardens, while engaging wider communities and individuals to the practice.

Financially, the project requires relatively little funding from the city government but is greatly popular amongst citizens compared to other planning initiatives. The key reason for this was the lift of two land use bans on public-owned lands to allow temporary use for not-for-profit activities. This saves government budgets from land acquisition and facilitates rapid implementation of gardens within most populated districts. However, it is noteworthy that existing champions in the city government who coordinated sectors and evaluated the progress of these implementations has played an important role in creating an enabling environment for TGC.

Synthesis

Taipei Garden City is a notable greenspace policy that offers both direct and indirect FWE benefits. Direct FWE impacts include improved water management across the city due to expanded GBI, a reduced UHI effect, possible scalable energy reductions due to the decreased food mileage, and energy savings from organic fertilizer use. However, these direct FWE benefits are minimal in comparison to the program's indirect impacts.

Indirect impacts include increased citizen participation and collaborative governance between public, private, and non-governmental sectors, and an increased awareness and culture of sustainability enhanced by educational offerings. In addition to expanding GBI in the city and subsequently creating a topographical network of small-scale nexuses with potential large-scale impacts, inclusive and participatory schemes like TGC promote cultural change amongst citizens (greater civic environmentalism) and within the government (enhancing a more cooperative institutional culture).

Table 1 – Enablers for Implementation and Success for Taipei Garden City

Knowledge	Institutional	Social	Ecological	Technological	Economic
The key to Garden City's success has been leveraging various forms of expertise. Gardeners, civic organizers, teachers, academics, politicians and bureaucrats all contributed to developing the initative Knowledge exchange and enhancement are also key components of the scheme, driven by online and in-person learning opportunities for citizens and school children	Impetus for the initiative was jointly driven by citizen activism and city government pushing for greener urban development Gardens are jointly established and managed by private citizen groups, NGOs and various government agencies	Success has been driven by strong civic participation and local community engagement The policy promotes socialization and interaction with neighbors and co-workers	Generating a network of GBI across the city capable of providing a range of ecosystem services including enhanced biodiversity, runoff control, reducing the urban heat island (UHI) effect and reducing building cooling energy with rooftop gardens Classes provide opportunities for enhancing citizens' ecological knowledge	Installation of rainwater harvesting systems, solar and wind power generators, on-site composting and soil nutrient recycling systems Centralized online platform for education opportunities, information sharing, and application for garden adoption	Funds are initially provided by the city, but gardens are designed to become mostly self-sufficient over time Water, compost and energy are provided free to gardens throughout their lifetime City government owns and manages a lot of land in Taipei

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Authors

Erich Hellmer
Wan-Yu Shih
Anina Hartung

Editor

Pourya Salehi

Design

Olga Tokareva

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Contact Us

Kaiser-Friedrich-Str. 7
53113 Bonn | Germany
Tel. +49-228 / 97 62 99-00

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