UNIVERSIDAD POLITÉCNICA DE MADRID
Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas

Effective local adaptation of sustainable city solutions to different contexts around the world

(Adaptación local efectiva de soluciones urbanas sostenibles a diferentes contextos alrededor del mundo)

DOCTORAL THESIS

Submitted for the degree of Doctor by:

Carmen Antuña Rozado
MSc (Arch), EMBA

Madrid, 2023

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Author: Carmen Antuña Rozado

Doctoral Programme: Agro-Engineering

Thesis Supervision:

Dr. Justo García Navarro, Full Professor in Agroforestry Engineering, Universidad Politécnica de Madrid (Supervisor)

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Dedicated to T, N and R.

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Abstract

The starting point of this doctoral thesis is provided by the concept of ecocities developed by VTT Technical Research Centre of Finland Ltd. (VTT), namely "EcoCities, the VTT concept for the regeneration and sustainable development of communities and neighbourhoods", based on evidence collected from numerous European and other international (beyond Europe) research projects, complemented by some implementation examples, and adapted to the needs of developing countries and emerging economies. More specifically, this thesis is linked to Phase III of the evolution of the concept, to which the case studies presented belong and in which the author has participated directly and extensively.

Given the breadth of the concept and the heterogeneity of the projects carried out to date, it seemed necessary to delimit the scope more precisely. Hence the decision to focus on what contributes to making the transfer of knowledge generated in another context more effective, as well as the adaptation of existing technological solutions to different local conditions or the development of new solutions that respond more specifically to them. In turn, this decision led to the present doctoral thesis entitled "Effective local adaptation of sustainable city solutions to different contexts around the world", which constitutes the first attempt at a holistic analysis of the ecocity concept developed by VTT, as well as its components and supporting elements.

Through the description of the application process in different places around the world (illustrative cases), including the interaction with numerous and diverse key actors and local stakeholders, the author sought to extract lessons learned that can be extrapolated to other similar processes, not exclusively related to ecocities, but more broadly with the transfer and adaptation of knowledge and technological solutions to a local context that is sometimes radically different from that in which they originated.

The research presented yields valuable results in relation to the instruments and skills that can support effective knowledge transfer and local adaptation, as well as the description and conceptualization of the process. Finally, some recommendations for the development of new policies as well as some solutions for practitioners are provided, and some lines of future research are suggested.

Resumen

El punto de partida de esta tesis doctoral lo proporciona el concepto de ecociudades desarrollado por el Centro de Investigación Técnica de Finlandia (VTT), a saber, "EcoCities, el concepto VTT para la regeneración y el desarrollo sostenible de comunidades y barrios", basado en la evidencia recopilada por numerosos estudios y proyectos de investigación europeos e internacionales (más allá de Europa), complementado con algunos ejemplos de implementación y adaptado a las necesidades de los países en desarrollo y las economías emergentes. Más concretamente, esta tesis está vinculada a la Fase III de la evolución del concepto, a la que pertenecen los casos de estudio presentados y en la que el autor ha participado directa y ampliamente.

Dada la amplitud del concepto y la heterogeneidad de los proyectos realizados hasta la fecha, parecía necesario delimitar el alcance con mayor precisión. De ahí la decisión de centrarse en aquello que contribuye a hacer más efectiva la transferencia de conocimiento generado en otro contexto, así como la adaptación de las soluciones tecnológicas existentes a las diferentes condiciones locales o el desarrollo de nuevas soluciones que respondan más específicamente a ellas. A su vez, esta decisión dio lugar a la presente tesis doctoral titulada "Adaptación local efectiva de soluciones urbanas sostenibles a diferentes contextos alrededor del mundo", que constituye el primer intento de análisis holístico del concepto de ecociudad desarrollado por VTT, así como de sus componentes. y elementos de apoyo.

A través de la descripción del proceso de aplicación en distintos lugares del mundo (casos ilustrativos), incluyendo la interacción con numerosos y diversos actores clave y partes interesadas locales, el autor buscó extraer lecciones aprendidas que puedan extrapolarse a otros procesos similares, no exclusivamente relacionados con las ecociudades, sino de manera más amplia con la transferencia y adaptación de conocimientos y soluciones tecnológicas a un contexto local en ocasiones radicalmente diferente de aquel en el que se originaron.

La investigación presentada arroja valiosos resultados en relación con los instrumentos y habilidades que pueden apoyar una transferencia de conocimiento y una adaptación local efectivas, así como con la descripción y conceptualización del proceso. Finalmente, se aportan algunas recomendaciones para el desarrollo de nuevas políticas, así como algunas soluciones para profesionales y se sugieren algunas líneas de investigación futuras.

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Abbreviations and acronyms

BAU	Business As Usual
CEA	Cost Effectiveness Analysis
DAC	Development Assistance Committee
DIH	Digital Innovation Hub
DOI	Digital Object Identifier
EC	European Commission
E-JUST	Egypt-Japan University of Sciences and Technology
FI	Frugal Innovation
FIOH	Finnish Institute of Occupational Health
GHG	Greenhouse Gas
HIS	High Investment Scenario
ICI	Institutional Cooperation Instrument
ILO	International Labour Organization
IOP	Institute Of Physics
KFHSD	Khairy Foundation for Human and Social Development
KPI	Key Performance Indicator
LBTC	Lusaka Business and Technical College
LDC	Least Developed Country
LIC	Low Income Country
LIS	Low Investment Scenario
MDPI	Multidisciplinary Digital Publishing Institute
MHU	Ministry of Housing and Utilities of Libya
MIC	Middle Income Country
MO	Main Objective
MUF	Managing Urban Futures
NBC	New Borg El Arab City
NBS	Nature-Based Solutions
NCC	National Council for Construction

NST	Nabta Smart Town
NZED	Nearly Zero Energy District
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OSH	Occupational Safety and Health
PED	Positive Energy District
RES	Renewable Energy Sources
SBC	Sustainable Buildings and Construction
SE	Social Enterprise or Social Entrepreneurship
SD	System Dynamics
SDG	Sustainable Development Goal
SME	Small and Medium-Sized Enterprise
SO	Specific Objective
TPCTC	Thorn Park Construction Training Centre
UN	United Nations
UNEP	United Nations Environment Programme
UN-OHRLLS	United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
UNZA	University of Zambia
VTT	VTT Technical Research Centre of Finland Ltd
WB	World Bank
10YFP	10-Year Framework of Programmes on Sustainable Consumption and Production

Content Map

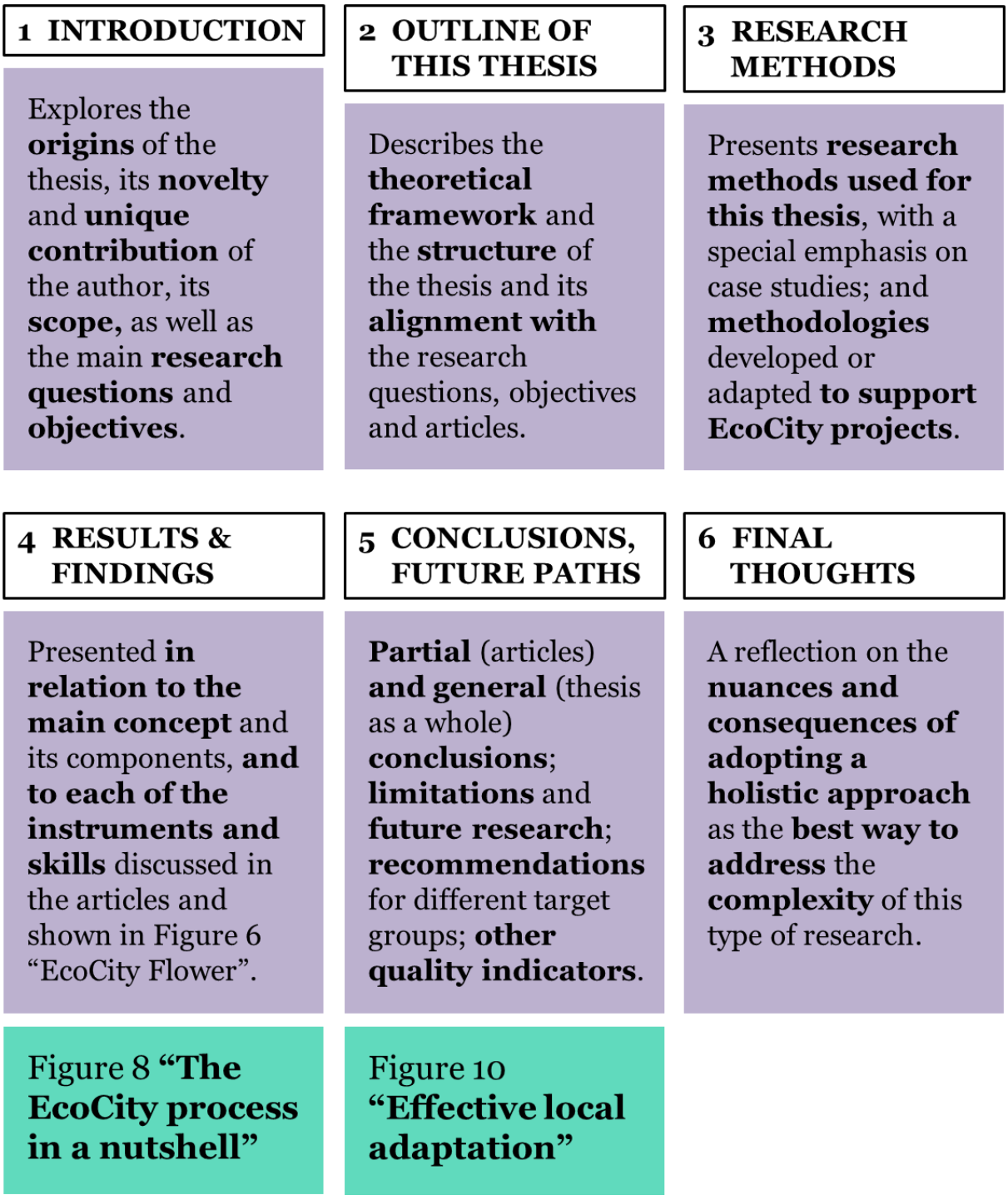


Figure 1: Main blocks of content of this thesis briefly explained for a better overview. (Carmen Antuña Rozado, 2023)

1. Introduction

1.1. Preliminary considerations

According to some, the term "developing countries/world" seems to suggest a certain hierarchy between countries, which has led some international organizations such as the World Bank, for example, to adopt a country classification model based on geographic region, income level, and loan type, thus avoiding the denomination of "developing" and "developed" countries (World Bank, 2023). The OECD uses a similar model for its "DAC List of ODA Recipients" (OECD, 2023), although it includes the category of "Least Developed Countries" (LDCs) as defined by the United Nations (UN-OHRLLS, 2023).

In the same way, a purely geographical designation such as "Global South" can also be misleading because it somehow implies that poor countries are concentrated in the southern hemisphere (Dados & Connell, 2012), when in fact there are rich countries in the south (e.g., Australia, New Zealand) and some poor ones in the north (e.g., Haiti, Honduras). Once again, the definition of rich and poor countries is also debatable. According to what standards? Established by whom? Therefore, it seems necessary to clarify that although the author is aware of the possible controversy regarding the adequacy of these terms, they are kept here in the absence of more precise and neutral ones, and because their use is still very widespread, and they are generally understood. When considering some other alternatives such as "fat and lean" coined by the journalist Dayo Olopade (Olopade, 2014), or LIC (Low Income Country) and MIC (Middle Income Country), lately more favoured by some international organizations, none of them is yet in such frequent use among the public as already noted. To all the above, we must add that it was a commonly used terminology at the time when the specific concept of ecocity on which this thesis is based began to be formalized. In short, the terms "developing country/world" and "Global South" are used for practical communication purposes and do not imply judgment or inferiority in any way. This has also been explained in one of the articles included in this thesis on facilitation processes and skills (see section 2.2 and annexed article for further details).

1.2. Background and origin of this thesis

The starting point of this doctoral thesis is provided by the concept of ecocities developed by VTT Technical Research Centre of Finland Ltd. (hereinafter VTT), namely "EcoCities, the VTT concept for the regeneration and sustainable development of communities and neighbourhoods", based on evidence collected from numerous European and other international (beyond Europe) research projects, complemented by some

implementation examples, and adapted to the needs of developing countries and emerging economies. Before continuing, it seems necessary to clarify that in the context of this thesis and related articles, "ecocity" refers to the generic concept, while "EcoCity" refers to the specific concept developed by VTT as well as related activities and projects. Similarly, it should be explained that the application of the VTT EcoCity concept does not normally imply actual construction of infrastructures or buildings, as will be seen later.

For decades, VTT as an organization has conducted research, both nationally and internationally, on numerous aspects of sustainable buildings and construction, such as sustainability assessment, building performance, indoor climate, energy efficiency, monitoring and KPIs (Key Performance Indicators), renewable energy systems, transport and mobility, eco-materials, product development, or decision support tools. Over the years, the focus has expanded from the building scale to the neighbourhood or district scale, encompassing infrastructure as well as economic and socio-cultural assessment.

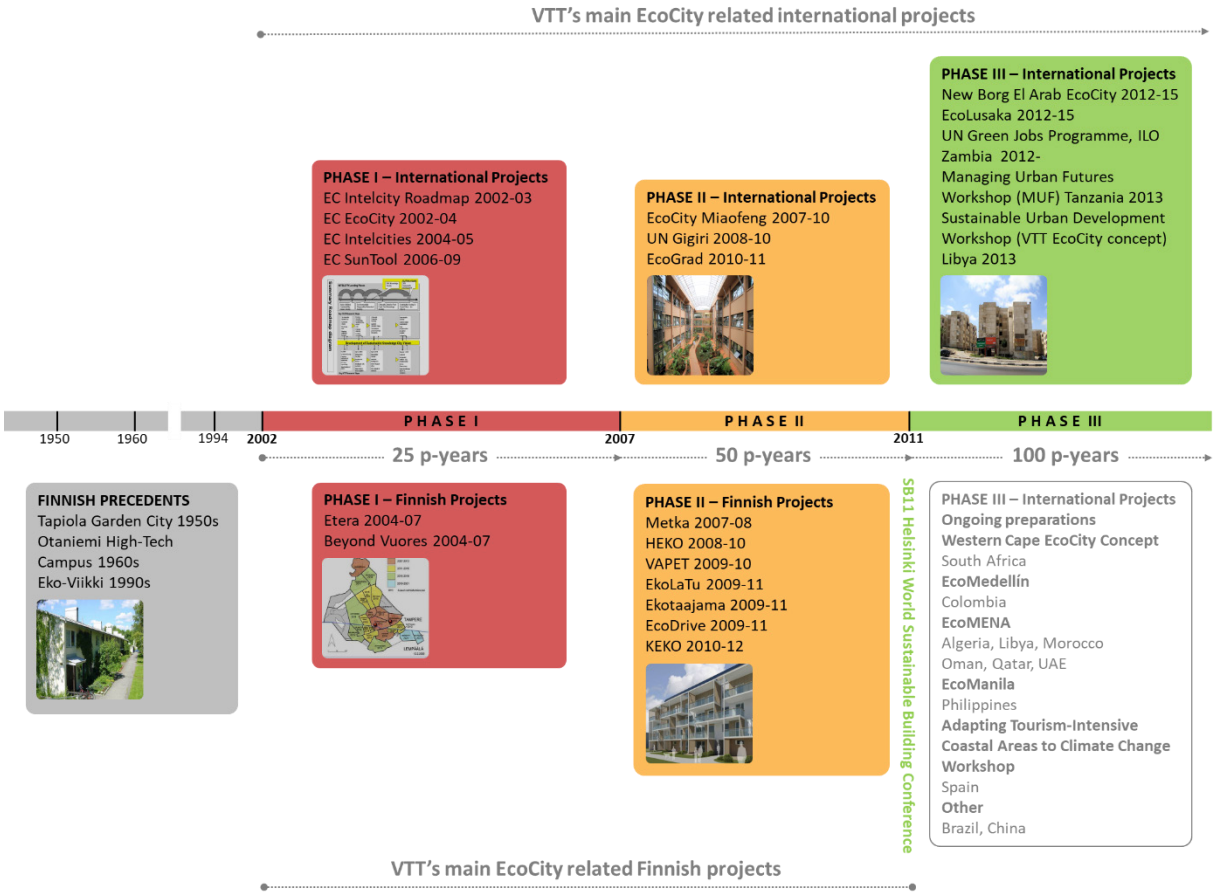


Figure 2: VTT's EcoCity roadmap. (Pekka Huovila & Carmen Antuña Rozado, VTT, 2013)

Figure 2 shows the evolution of the VTT EcoCity concept over time, including the most relevant associated projects, both Finnish and international, and even the approximate estimate of the human resources (expressed in person-months) dedicated to these issues in the indicated periods. It also shows the preceding examples within the Finnish urban planning tradition that, according to the experts involved, may have exerted a greater influence on the development of the new ecocity concept. These notable examples are: Tapiola Garden City (1950s), Otaniemi High-Tech Campus (1960s) and Eco-Viikki (1990s). The first two are located in Espoo, a municipality adjacent to Helsinki, and the third is part of a Helsinki neighbourhood called Viikki. Although the case studies in this thesis deal mainly with Phase III, these "predecessor" examples are presented in Article 1, which explores, among other aspects, the theoretical foundations of the concept and its main influences, to facilitate its understanding and positioning in relationship with other existing ecocity proposals.

During Phase I the concept begins to be developed mainly through two European projects funded under the EC 5th Framework Programme. The experience and knowledge accumulated from these projects and other activities led to Phase II characterized by neighbourhood development projects not only in Finland, but also in Russia, China, and Kenya. For example, in Peltosaari (Finland), at the time a neighbourhood in decline, a study was carried out to see how to increase value through sustainable regeneration, which included a social and economic assessment. In the EcoGrad project, a new model of planning and design of eco-efficient neighbourhoods was developed for St. Petersburg, which encompassed urban density, accessibility and less need to travel, public transport, reduction of energy consumption (Nystedt et al., 2010). In China, a feasibility study was carried out on how to turn 17 villages in the mountainous city of Miaofeng, northwest of Beijing, into socially, ecologically, and economically sustainable settlements where people can live, work, and even thrive in harmony with the surrounding nature (Nieminen et al., 2010). In Kenya, a study was carried out on how the new office building housing UNEP headquarters in Gigiri (Nairobi), could be made energy neutral (Huovila & Antuña, 2012b).

As also shown in Figure 2, Phase III can be considered to start after the 6th World Sustainable Building (SB) Conference which took place in Helsinki from 18-21 October 2011 (SB11 Helsinki). One of the main objectives of the conference was “to expand the international research community’s focus to consider people and their needs, particularly those in the developing world” (Huovila & Antuña, 2012a). Building on the knowledge and contacts gained during the previous two phases and the extensive network of experts from around the world established during the preparation and celebration of SB11 Helsinki, the next version of the VTT EcoCity concept was born. Soon after, feedback from

a couple of workshops involving key local stakeholders in Mwanza (Tanzania), was used to further tailor it to the needs of the Global South. This latest version of the concept has continued to be refined through subsequent projects and activities, as we will see in the following pages. This phase is precisely the focus of this thesis, to which the case studies presented belong. The fact that they cover a period of almost ten years provides a valuable perspective on the evolution not only of the concept itself and the factors that affect it, but more generally, also of urban sustainability. Unfortunately, some of the projects shown in Phase III as ongoing preparations at the time were never implemented due to lack of private funding or a proper open call. However, some did, such as EcoMedellín or EcoMENA/Libya, which are included as case studies in this thesis (see articles 1 and 3). Also, some new proposals were prepared after 2013 (when Figure 2 was created) and some of them obtained funding, such as Nabta Smart Town in Egypt, included as a case study in Article 4, or SHERPA (see section 5.5).

In addition to ecocities, several other models and concepts have been gaining ground around the world in recent years, such as smart cities, circular economy, and Nature-Based Solutions (NBS), to name a few. Most of them entail decision-making processes involving many local actors and stakeholders aimed at formulating strategies and programmes, developing action plans, elaborating proposals, or developing solutions tailored to a specific local context. Given the similarities that all of these processes may have with the ecocity process at the centre of this thesis, lessons learned about what can facilitate knowledge transfer, local adaptation of technological solutions, and legitimate participation may prove to be useful to them too.

Personal contribution and novelty of the work

As far as this thesis is concerned, the VTT EcoCity concept is documented and discussed through several projects and activities belonging to the Phase III in which the author has participated directly, either as a researcher or as a researcher and project manager simultaneously. Therefore, the author has had first-hand access both to the information collected during the preparation stage of the project proposals, as well as to all the documentation generated and solutions developed during their implementation, in addition to the partners, different stakeholders and relevant actors involved. These projects are included in the thesis articles as case studies where they are analysed and explained in detail. Furthermore, most of the graphic and photographic documentation comes from the author herself or from colleagues who were also linked to said projects and who participate as co-authors in the articles. All the co-authors, including the director of this thesis, have outstanding knowledge and experience in relation to the central themes of the articles. Finally, the author participated directly at the time in the

conceptual development of the VTT EcoCity concept and in the creation of the corresponding promotional/dissemination material.

To complement the above, the author's personal research on social entrepreneurship carried out during her Executive MBA studies is behind the content of the fifth article and the scientific paper that preceded it. In short, direct personal experience permeates all the work.

UNIQUE CONTRIBUTION: This thesis constitutes the first attempt at a (holistic) analysis of the VTT EcoCity concept presented and its constitutive and supporting elements, as well as a description of the application process and extraction of lessons learned that can be extrapolated to other similar processes, not exclusively related to planning and implementation of ecocities, but more broadly to those processes that imply the transfer and adaptation of knowledge and technological solutions to a local context that is sometimes radically different from the one in which they originated. (As will be seen, this contribution is closely related to the main objective of the thesis defined in subsection 1.5.)

Obviously, the subject is not exhausted in this thesis because, as has been found, there are many constitutive elements, supporting instruments, as well as related aspects and nuances that additional research would be required to adequately cover them, as will be seen in subsection 5.3.

1.3. The need for ecocities in the Global South

As discussed in most of the articles that make up this thesis, many sources estimate that by 2030 around 60 percent of the world's population is expected to live in cities (Jacobs, 2016), with urban growth primarily concentrated in Africa and Asia. Although generally considered synonymous with modernization and development, the reality is that, particularly in the Global South, urbanization shows its darker side: proliferation of informal settlements, poor sanitation conditions, lack of infrastructure in a broad sense (energy, transportation, communications, etc.), deficient access to basic services, unemployment, environmental degradation... to name some of the most common. Therefore, in response to this situation, the VTT EcoCity concept was proposed to address the following challenges, some of them particularly relevant in the Global South (*):

- Climate mitigation and climate adaptation.
- Sustainable urbanization.
- Affordable housing (*).
- Comprehensive planning and availability of funds.

- Capacity building for local solutions and services (*).
- Empowerment and citizen participation.
- Cross-cutting themes (*): poverty alleviation, gender issues, equality, etc.

Through numerous conversations held with relevant actors as part of dissemination events, but also with local partners and stakeholders during the preparation and development of EcoCity projects and activities, the aspects shown in Figure 3 were identified as main issues of concern in relation to sustainable urbanization. They appear only in alphabetical order and not in order of priority. Furthermore, as explained in article 3 on facilitation processes and skills, these aspects continued to be discussed and enriched with different local perspectives, even incorporating new important aspects such as biodiversity and ecosystem services.



Figure 3: Sustainable urbanization. (Pekka Huovila & Carmen Antuña Rozado, VTT, 2012)

1.4. The need to adapt to different local contexts

The aspects mentioned above are certainly interrelated and have numerous links with other relevant cross-cutting issues such as poverty alleviation, political stability, social cohesion, equality, health, education, awareness, etc. As already noted, they have been systematically chosen as issues of concern in the many workshops with local partners and stakeholders in very diverse contexts around the world. However, in parallel, the need for local adaptation has also been confirmed. Why? Because their manifestation, specific characteristics, degree of importance and the different management options are

particular for each context. This is precisely what constitutes the basis for the local adaptation process.

In one of the first international EcoCity projects included in Phase II, EcoCity Miaofeng in China (2007-2010), the importance of adapting solutions to the corresponding scale as well as to specific local conditions was already realized and highlighted as a notable feature of the VTT approach in the first EcoCity brochure prepared, mainly aimed at the Chinese market, and shown in Figure 4.



Figure 4: First version of the VTT EcoCity brochure developed for the Chinese market. (VTT, 2010)

Over time, this approach was adjusted and refined, so that in the following version of the EcoCity brochure (Figure 5) developed for Phase III it was summed up like this:

- Best combination of technologies and services that form sustainable solutions providing the users and inhabitants a high quality of life and indoor and outdoor comfort.
- Applicable EcoCity solutions depend on local conditions and need to be customized to socio-economic realities.

- There is not one solution that fits all, but a number of possibilities that need to be studied to find the right solution for each case.
- Require knowledge of local traditions, perceptions, available materials, and competent partners.

Here it is necessary to clarify that the brochures shown in figures 4 and 5 have the sole purpose of illustrating the evolution of the promotional/dissemination material produced. The highlights of the content are mentioned in the text of this subsection and therefore the readability of the figures has not been maximized. In response to the challenges in subsection 1.3 and adopting the aforementioned approach of local adaptation in relation to the issues of concern identified in relation to sustainable urbanization (Figure 3), subsequent EcoCity projects were designed around these components:

- Sustainable city planning
- Citizen participation and empowerment
- Sustainable urban infrastructure
- Sustainable housing
- Local businesses and employment around sustainable housing
- Coordination
- Pilot project/Case studies

For each EcoCity project, the most appropriate components will be selected in collaboration with local partners according to local needs and priorities; however, the coordination and designation of the associated pilot project/case study are fixed components. VTT is responsible for coordination, either alone or together with the main local partner.

As will be seen, the case studies described do not correspond to infrastructure or urban construction projects, but rather reflect the previous phases, even very initial ones, of the process that finally (if all goes well) leads to actual execution. In these phases of ideation, deliberation, planning, dialogue between different actors, etc., crucial issues are addressed such as the "landing" of existing policies in said local contexts and their adequacy, the limiting conditions for their implementation, the co-creation of a concrete common vision in accordance with the principles of sustainability, the most appropriate roadmap to follow, various possible scenarios, associated risks, and even potential damage that is not easily foreseeable but may be irreversible. **All this varies from one local context to another.**

It is a complex process of defining a framework of action that will affect the community, enabling and ensuring adequate participation, delimitation of responsibilities and decision-making, financial planning, among other tasks. All of this demands a considerable effort for the correct interpretation of the specific local reality, which in turn requires both knowledge, instruments (in a broad sense), skills (both technical and social; that is, both "hard" and "soft") for its successful achievement.

DEFINITION: Initially, as shown in the promotional/dissemination material discussed above, the VTT EcoCity concept was "explained" through the challenges addressed, the approach adopted and the components to be selected for a potential project, rather than through a strict definition. So, what exactly is the VTT EcoCity concept? In retrospect, the author of this thesis proposes to define it as a "framework to guide the conception, planning, design and implementation of an EcoCity. In addition, it could also be used to monitor and evaluate an EcoCity project or some of its parts."

1.5. Purpose, scope, research questions and objectives

Given the breadth of the concept and the heterogeneity of the projects carried out to date, it seems necessary and appropriate to delimit the scope more precisely. To this end, the focus will be on what contributes to making the transfer of knowledge generated in another context more effective, as well as the adaptation of existing technological solutions to varying local conditions or the development of new solutions that respond more specifically to them. This includes the instruments and skills mentioned above, here more detailed:

- specific methodologies,
- effective facilitation processes and skills,
- participation, communication, and interaction,
- indicators and evaluation tools,
- support for decision making and impact assessment (e.g., machine-assisted, like SD modelling)
- financing and business models,
- other.

The articles that make up this thesis cover all the previous points (i.e., contributors to/enablers of successful knowledge transfer and local adaptation) except the indicators and evaluation tools and the possible decision support methodologies.

VTT's ecocity concept
for sustainable community and neighbourhood regeneration and development

EXPERTISE

VTT has done research on different aspects of sustainable building since decades. There's a continuous stream of international research projects related with sustainability metrics and building performance, indoor climate and energy efficiency, product development, sustainability assessment and decision support tools. The focus is increasingly stretched towards sustainable neighbourhoods covering also infrastructure and economic and social assessment. VTT has 50 to 100 experts doing research on sustainable buildings. The number is bigger if the areas of waste management, transport, energy etc. are also counted.

CHALLENGES

- Climate mitigation and climate adaptation
- Sustainable urbanization
- Affordable housing
- Integrated planning and funding availability
- Capacity building for local solutions and services
- Citizen empowerment and participation
- Cross-cutting themes: gender issues, etc.

OUR APPROACH

- Best combination of technologies and services that form sustainable solutions providing the users and inhabitants a high quality of life and indoor and outdoor comfort
- Applicable EcoCity solutions depend on local conditions and need to be customized to socio-economic realities
- There is not one solution that fits all, but a number of possibilities that need to be studied to find the right solution for each case
- Require knowledge of local traditions, perceptions, available materials and competent partners

ECOCITY CONCEPT MAIN COMPONENTS

1. Sustainable city planning
Sustainable land use, use of geographical information systems, energy efficiency at a neighbourhood scale, developing participatory town planning and sustainability assessment of city plans, management of natural resources

2. Citizen participation and empowerment
Citizen engagement (participatory city planning, awareness raising on sustainable lifestyles, learning & education), sustainable cooking solutions (solar cookers, biogas, sustainable lighting, cultural issues)

3. Sustainable urban infrastructure
Energy systems, waste management, water supply, access roads, public transport solutions, smart traffic management guidelines for sustainable infrastructure, identifying available solutions and gaps => new business opportunities (link to 5)

4. Sustainable housing
Local production, renewables, improving living conditions, regeneration and maintenance of cultural heritage, assessment of existing situation => define targets together with inhabitants => identify development needs... (link to 3, 5)

5. Local businesses and employment around sustainable housing
Services, affordable housing, business opportunities: creating a "support system" for local businesses where locals can get help with developing their business ideas (eco-assesment of the business to be included)

6. Coordination
Planning the pilot(s), e.g. new development, urban regeneration, informal settlement upgrading, assessment and monitoring, management

7. Pilot project
Chosen and implemented according to the local needs and in collaboration with key local partners

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ECOCITY RELATED ACTIVITIES AROUND THE WORLD



ECOCITY REFERENCES

1 EcoCity Miaofeng, China

- Sustainable services, jobs and socio-economic development
- Renewable energy based infrastructure: energy, transport
- EcoCity technologies and building concepts
- Energy demand and carbon footprint
- Investment and life cycle costs

2 EcoGrad, St. Petersburg, Russia

- Ecological city planning
- Heat and power production based on renewable resources
- Highly efficient waste and water management, recycling
- Car free city centre and underground parking
- Building integrated energy production

3 EcoDrive (Riihimäki), Finland

- Value recovery
- Building rights: direct income for the building/apartment owners 20 M€
- Total, eco-effident and high quality renewal including new service structure, work places, shops, etc.
- Value increase over 100 M€
- Reduction of energy costs 1,5-2,0 M€/year

4 UN Gigiri, UNEP Nairobi, Kenya

- 2008 - initial climate neutral building target lowered to energy neutral building
- First estimated energy consumption: 147 kWh/m2/a
- 2009 - VTT's recommendation: objetive 70 kWh/m2/a can be halved
- New UNEP objective: <30 kWh/m2/a (75... 80% saving)
- 2011 - estimated energy consumption: 42,5 kWh/m2/a > energy +

5 New Borg El-Arab EcoCity, Egypt

- Increasing EcoCity knowhow of the local partners
- Capacity building on efficient administration processes
- Raising awareness among local stakeholders about energy efficiency and sustainable lifestyles
- Development of an EcoCity roadmap for Egypt
- Feasibility study for EcoCity development

6 UN ILO Programme, Zambia

- Study of value chain of construction sector in Zambia
- Knowledge transfer to key housing construction stakeholders on sustainable related issues
- Construction of demo houses using local techniques in cost-effective manner
- Productivity improvement programmes for construction SMEs
- Introduction of new efficient technology and innovation in the constitution sector

Figure 5: VTT EcoCity brochure with a special focus on the Global South. (VTT, 2015)

However, these points have been addressed in two research projects, namely SHERPA and Modelling4People, mentioned in subsection 5.5, where the author of this thesis has been a main contributor. Figure 6 below summarizes the above and relates it to the article overview provided in subsection 2.2, which is also shown in Figure 7.

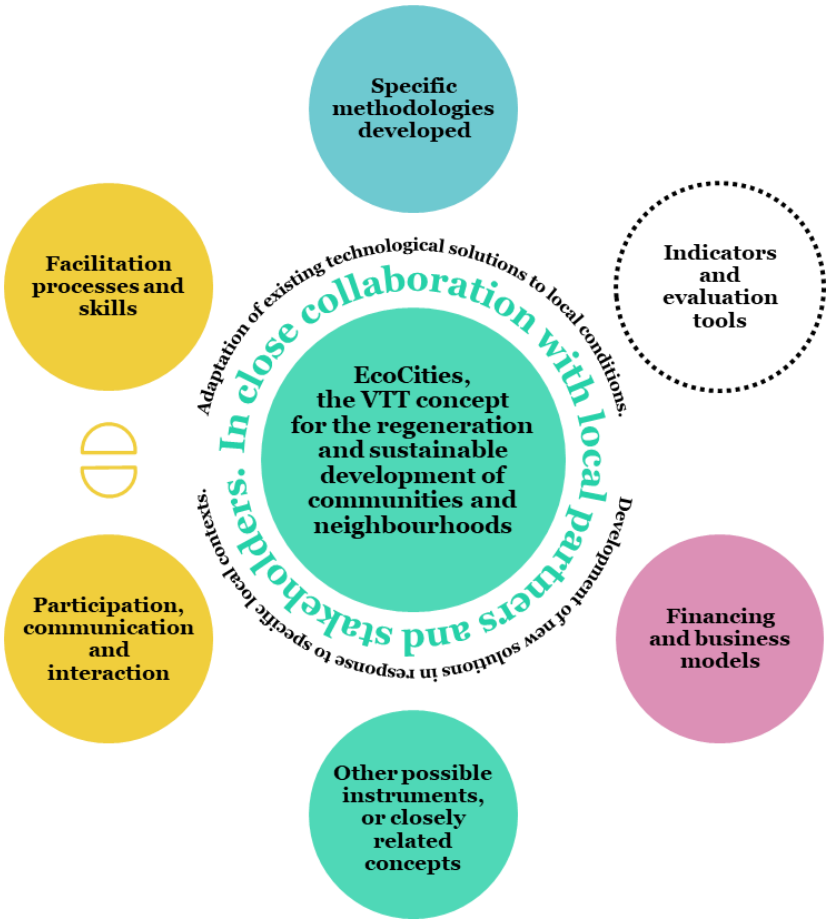


Figure 6: Instruments and skills supporting knowledge transfer and local adaptation. (Carmen Antuña Rozado, 2023)

The colours used for each of the listed instruments and skills match those of the corresponding article/scientific paper. As can be seen, both the VTT EcoCity concept and other concepts relevant to it (green bubbles) are addressed in Article 1. Specific methodologies (blue bubble) are discussed in articles 2 and 4, while facilitation processes and skills, as well as participation, communication, and interaction (yellow bubbles) are addressed in Article 3. Financing and business models (pink bubble) are addressed in Article 5 and the scientific paper that precedes it. In this case, the focus is on the social entrepreneurship model. Whereas, as mentioned, the indicators and evaluation tools fall outside of this thesis, hence the dotted circle without colour. Figure 6 also constitutes the

basis of Figure 9, which relates the aforementioned instruments to the conclusions and recommendations derived from the research behind this thesis and presented in the corresponding articles.

Main research questions

In line with the background information provided so far and the purpose and scope defined, the following research questions (RQs) emerge:

RQ-i. How could the VTT EcoCity concept be effectively defined and what are its main constituent elements?

RQ-ii. What is their specific contribution and how should the practical application of the "instruments" and "skills" identified as key to the implementation of the VTT EcoCity concept be approached?

RQ-iii. What can be learned from the case studies associated with the practical application of the concept?

RQ-iv. What is the potential to replicate and scale both the model and the proposed solutions?

RQ-v. What are the future lines of research that can be suggested to address the gaps and needs identified?

RQ-vi. What policy recommendations and practical solutions can be derived from the findings and gaps identified in order to advance the defined field of study?

Objectives of the thesis

Based on the above reasoning and the proposed research questions, the below main and specific objectives (MO & SOs) were formulated. **As will be seen in Table 1 (subsection 2.1), these objectives can be correlated with the research questions, as well as with the established theoretical framework and the research methods used, and ultimately with the articles and the conference paper that make up this thesis. Therefore, from that moment on, whenever reference is made to the objectives, reference is also made to the corresponding research questions, since they are closely related.**

MAIN OBJECTIVE (MO)
Through a holistic approach to the ecocity concept developed by VTT and associated case studies**, distil, study, and characterize the enabling elements for effective transfer and successful local adaptation** of both knowledge and technological solutions originating in markedly (sometimes radically) different contexts.

SPECIFIC OBJECTIVES (SOs)	
SO-i	**Critically and comparatively analyse the ecocity concept developed by VTT** to define its essence more clearly and identify its main components and characteristics, in order to understand its similarities and differences with other existing ecocity proposals (both in theory and in practice).
SO-ii	**Describe the most relevant instruments and skills** that support successful local adaptation of knowledge and technology solutions generated elsewhere through appropriate involvement of local partners and stakeholders **and discuss the dynamics at play**.
SO-iii	As much as possible, **illustrate the process** of developing a locally adapted EcoCity framework in collaboration with local partners and key stakeholders **through real case studies that facilitate understanding** of how the concept is tuned to different contexts.
SO-iv	**Investigate the possibilities offered by certain business models**, for example social entrepreneurship, not only for the implementation of ecocity projects or ecocity solutions, but in general for the achievement of more sustainable and resilient cities.
SO-v	**Through the detailed description of an example of practical application, delve into the nuances of the process**, from the starting local conditions, the obstacles encountered along the way, the interests at stake, or the assumptions made to the results obtained, affordability and accessibility, etc.
SO-vi	In relation to the implementation of the VTT EcoCity concept, as well as its main constituent elements, **systematically explore its potential for replicability and scalability** both in the initial context of application and in other contexts around the world, especially in the Global South.

SO-vii	Based on the findings of the research, identify the most important existing gaps, and define possible future lines of research aimed at filling those gaps.
SO-viii	**Outline actionable recommendations** for policy makers and **viable solutions** for practitioners, at least on a preliminary basis, in light of the findings made and gaps identified.

2. Outline of this thesis

2.1. Theoretical framework, general structure, and internal alignment

In line with the research questions formulated, as well as with the main and specific objectives described, a theoretical framework was defined to guide the development of this thesis and, in parallel, although intrinsically linked, to structure this summary.

Table 1: Correspondence between the theoretical framework and general structure, and the research questions and objectives, articles and research methods used. (Carmen Antuña, 2023)

	RESEARCH QUESTIONS		
SPECIFIC OBJECTIVES	**THEORETICAL FRAMEWORK / STRUCTURE**	**ARTICLES & PAPER**	**RESEARCH METHODS**
i. Critically and comparatively analyse the ecocity concept developed by VTT	**CONCEPT** Definition and positioning of the VTT EcoCity concept including the description of the instruments and skills developed to support implementation in different local contexts. ***RQ-i, RQ-ii***	**Article 1**	**Non-exhaustive literature review**
ii. Describe the most relevant instruments and skills and discuss the dynamics at play		**Articles 2 and 3**	
iv. Investigate the possibilities of certain business models		**Article 5 and scientific paper**	
v. Through the detailed description of an example of application, delve into the nuances of the process		**Article 4**	
iii. Illustrate the process through real case studies that facilitate understanding	**IMPLEMENTATION** Description of the practical application in various contexts around the world, replicability and scalability, and identification of gaps and needs to be addressed in the future. Formulation of policy recommendations and practical solutions. ***RQ-iii, RQ-iv, RQ-v, RQ-vi***	**All**	**Case study**
vi. Systematically explore its potential for replicability and scalability		**All**	
vii. Identify the most important existing gaps		**All**	
viii. Outline some actionable recommendations and viable solutions		**Done primarily for the thesis as a whole**	
	PRESENTATION OF THE FINDINGS		**Analysis and discussion**
	CONCLUSIONS (AND RECOMMENDATIONS)		
MAIN OBJECTIVE			
Distil, study, and characterize the enabling elements for effective transfer and successful local adaptation			

The theoretical framework in question is closely related to the research methods chosen for their suitability for the purpose and content of the thesis. In addition, all of the above is correlated with the scientific articles (and paper) that make up this thesis. As can be seen in Table 1, the theoretical framework consists mainly of two parts, one that can be called conceptual, related to the definition of the VTT EcoCity concept and its constituent elements, as well as the necessary instruments and skills to support the development of locally adapted models and solutions. The other part has to do with various aspects related to the implementation of the concept or its application in practice, which are illustrated through real case studies. It also covers the potential for replicability and scalability of the locally adapted model and solutions developed, either elsewhere within the same country or in other countries with similar conditions. Perhaps it is worth noting with respect to the correspondence between the theoretical framework/general structure and the defined research questions and objectives, as well as with the thesis articles, that although the conceptual part (RQ-i, RQ-ii; SO-i, SO-ii, SO-iii, SO-iv) is divided between the different articles according to their topic and content, the implementation part is common to all of them (RQ-iii, RQ-iv, RQ-v, RQ-vi; SO-v, SO-vi, SO-vii, SO-viii). All articles (and paper) include at least one case study, as can be seen in Figure 7 and Table 2, and all address replicability and scalability to some degree, as well as discuss identified gaps. However, the implementation part corresponding to SO-viii (i.e., recommendations and viable solutions) is addressed to some extent in the articles and in the scientific paper, but mostly jointly for the thesis as a whole as can be seen in Section 5. Finally, the main objective permeates all the articles and the scientific paper, as is logical.

These two parts are complemented by the presentation of findings followed by conclusions and recommendations, and all of this is reflected in the general structure of this summary, as can be easily seen by comparing Table 1 with the index or table of contents at the beginning of this document. Finally, both the theoretical framework and the summary structure are completed with other more generic sections such as introduction, methodology, and references. The research methods used will be discussed further in section 3 Methodology.

2.2. Article overview (quality indicators)

Figure 7 shows the 5 articles and the paper published, indicating in addition to the order corresponding to the internal logic of the work, the order of publication, not always coinciding. This is due to several reasons, for example, the chronology of the related research projects as well as the readiness of results necessary to document the case studies that illustrate the articles, or the availability of the co-authors to participate in their writing among others. The first three articles form a kind of trilogy that covers the

general concept, as well as the methodologies, skills and facilitation processes developed to support its implementation. Precisely because of the clear link between these first three articles, they were published in the same scientific journal, namely Energies. The fourth article has been published in Habitat International and the fifth article is currently under review (in the same journal). All journals are international and have been chosen considering their alignment with the topics addressed, as well as the geographical areas covered, in order to reach the widest possible audience. The fifth article was preceded by a scientific paper presented at the SBE19 (Sustainable Built Environment) Helsinki Conference and then peer-reviewed and published in IOP Conf. Series: Earth and Environmental Sciences. All articles (and scientific paper) are OPEN ACCESS and available online (see Table 2 where links are provided).

Both in Figure 7 and throughout the text, references are made to the articles that make up this thesis using some KEYWORDS that try to capture their essence (e.g., Article 1 is referred to as "VTT ECOCITY CONCEPT"), instead of their full titles, to simplify and also facilitate their understanding and memorization. Figure 7 also shows the connection between articles 2 and 4. More specifically, the research presented in Article 4 is based on one of the methodologies previously developed by VTT and discussed in Article 2, namely the "Resident Energy Survey and Building Consumption Assessment". From the beginning, one of the additional objectives of the research related to the Nabta Smart Town case study presented in Article 4 was precisely to capitalize on the recommendations of the other project previously coordinated by VTT in Egypt, "EcoNBC, EcoCity Capacity Building in New Borg El Arab City", featured in Article 2. As mentioned in section 1.5, Figure 7 is related to Figure 6, indicating through matching colours the correspondence of the articles with the defined instruments and skills to support the transfer of knowledge and local adaptation.

Energy efficiency and renewable energy in ecocities

In the process of applying the VTT EcoCity concept described in the articles and illustrated through case studies, there is a certain predominance of energy as the focus topic. This is mainly due to the requirements established by the R&D calls through which some of the case studies presented were financed, such as New Borg El Arab (Article 2) and Nabta Smart Town (Article 4), both in Egypt. On the other hand, in the last 2-3 decades there has been a growing interest throughout the world, including the countries of the Global South, towards the promotion of energy efficiency and the use of renewable energies, as well as, in general, towards the adoption of cleaner production processes and more sustainable consumption patterns and even lifestyles.

As is well known that this "energy transition path" has been promoted by international framework agreements, mentioned in the articles, that have subsequently guided the development of specific policies (regional, sectoral, local...) adapted to the particular conditions of each context, which in turn have been translated into laws and regulations for practical implementation. Perhaps the evolution along this path can be summed up as a movement from the more general initial goal of sustainable development to a clear emphasis on climate change and the ensuing measures for its mitigation, which largely involved energy and greenhouse gas (GHG) emissions (International Energy Agency, 2023), to a more recent shift towards adaptation to climate change and climate resilience, concomitant among other aspects, with the conservation of biodiversity and ecosystem services, and the just green transition. Naturally, this evolution is reflected in the content of the articles and is supported by the corresponding bibliographical references.

The lessons learned from the energy research presented in articles 2 and 4 are also included in section 5 “Conclusions” and summarized in Figure 9 (see Energy Highlight in the upper right corner).

Table 2: Relationship between the articles and paper that make up these thesis and the associated case studies. Active links are included. (Carmen Antuña, 2023)

ARTICLE NUMBER > TOPIC YEAR, SCIENTIFIC JOURNAL ACTIVE LINK	**FEATURED CASE STUDY**
Article 1 > VTT ECOCITY CONCEPT 2019, Energies (MDPI) https://www.mdpi.com/1996-1073/12/10/1883	Libya
Article 2 > METHODOLOGIES FOR ECOCITIES 2016, Energies (MDPI) https://www.mdpi.com/1996-1073/9/8/631	New Borg El Arab, Egypt
Article 3 > FACILITATION PROCESSES & SKILLS 2018, Energies (MDPI) https://www.mdpi.com/1996-1073/11/4/777	Dar es Salaam, Tanzania / Medellín, Colombia / Lusaka, Zambia
Article 4 > MORE CONCRETE APPLICATION EXAMPLE 2023, Habitat International (Elsevier) https://doi.org/10.1016/j.habitatint.2023.102782	Nabta Smart Town, Egypt
Article 5 > SOCIAL ENTREPRENEURSHIP FOR SUSTAINABLE CITIES & COMMUNITIES Currently under review Manuscript included in the Annex	Leapfrog Projects / Annansilmät-Aitta / Kanresta / Upcycler Helsinki, ALL from Finland
Paper supporting Article 5 > SBE19 HELSINKI 2022, IOP Conf. Series: Earth and Environmental Science (IOP Publishing) https://doi.org/10.1088/1755-1315/1122/1/012064	Homes For Good, United Kingdom / Nabolagshager, Norway

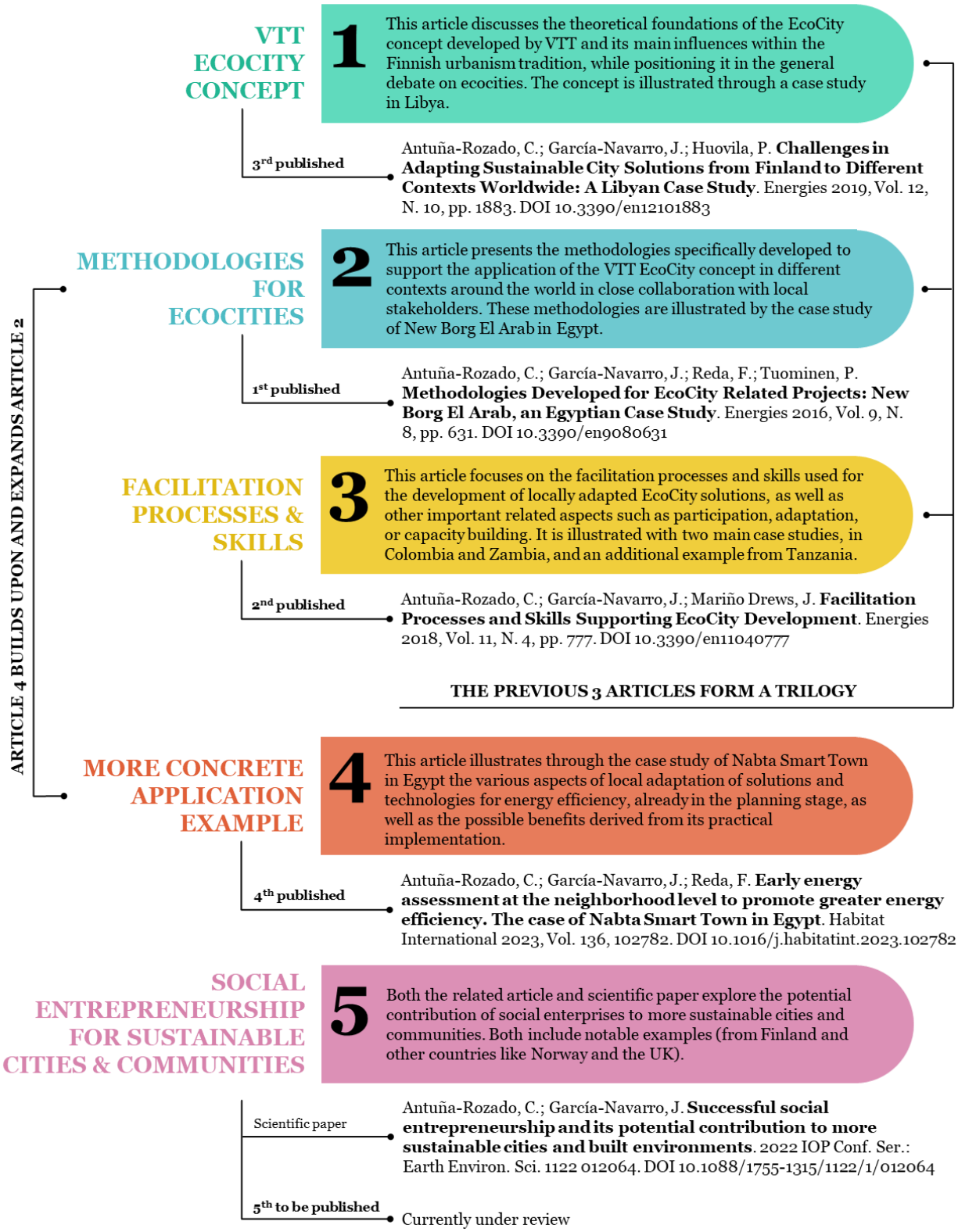


Figure 7: Article overview. (Carmen Antuña Rozado, 2023)

3. Research methods

This section primarily deals with the research methods used strictly for the research behind this thesis as a whole, with a separate subsection for case studies due to their importance in the overall work, but also briefly discusses the methodologies developed to support the development of EcoCity projects throughout the world (see article 2).

3.1. Used in the research behind this thesis

Non-exhaustive literature review. For this thesis, a qualitative approach combining a non-exhaustive, or integrative (Snyder, 2019), literature review, with the study of some relevant examples and direct information from the main stakeholders involved was deemed as the most suitable option. Typically, qualitative methods are used to address research questions related to a social phenomenon or a social context (Ritchie & Lewis, 2003). Given that the topic of this thesis has a marked socio-economic, socio-political, socio-cultural, and socio-environmental character, this approach seems the most appropriate. Furthermore, the research conducted can be loosely categorized as illuminative evaluation. Evaluation because it involves collecting information on the activities, characteristics, and results of a programme (Patton, 1982), in this case with regard to an area of practice (i.e., ecocities, energy efficiency, social entrepreneurship), which will then be analysed with the intention of develop a better discernment to support future decision-making (Chambers, 1999). Illuminative because it is both descriptive and interpretative in order to provide a multi-faceted view on a rather complex subject (Chambers, 2004). This vision seems very suitable for ecocities, and other accompanying concepts discussed in this thesis, where very different aspects interact, and this complexity needs to be unravelled to improve future practice.

Case study method to illustrate through the description of relevant application experiences the process of adapting the VTT EcoCity concept to different local contexts around the world in collaboration with key actors and stakeholders. The case study method is well established to deduce the meaning of qualitative data (Eisenhardt & Graebner, 2007), and is particularly suitable for assessing implementation processes (Yin, 2014).

Analysis and discussion. The objective is to first discuss the main findings resulting from the literature review and case studies in relation to the VTT EcoCity concept and its constituent elements, and then distil that learning into a description of the application process as an articulator of the knowledge transfer and facilitator of local adaptation.

Conclusions and recommendations. From the findings, conclusions will be drawn at two levels, first in relation to the different instruments and skills discussed in the articles,

and second, jointly in relation to the defined objectives and the research questions posed. Possible recommendations and future lines of research will also be formulated.

Case studies included in the thesis

Since case studies, both those associated with specific implementation projects (i.e., EcoCity projects, see articles 1-4) and those that can be considered as desktop research (Article 5 and linked scientific paper), constitute a fundamental part of this thesis, some additional details are provided here.

Table 3: Overview of the case studies included in this thesis. (Carmen Antuña, 2023)

ECOCITY PROJECT / CASE STUDY (DATE)	LOCATION, COUNTRY	MAIN LOCAL PARTNER(S)	FEATURED IN
Sustainable urban development in Libya (2013)	Libya	Ministry of Housing and Utilities of Libya (MHU)	Article 1
EcoNBC (2013-2015)	New Borg El Arab, Egypt	Egypt-Japan University of Science and Technology (E-JUST)	Article 2
Managing Urban Futures, MUF (2013)	Dar es Salaam, Tanzania	Aalto PRO (Finland); Uongozi Institute (Tanzania)	Article 3
EcoMedellín (2012)	Medellín, Colombia	Alexander von Humboldt Biological Resources Research Institute; City of Medellín Environmental Department	
EcoLusaka (2013-2015)	Lusaka, Zambia	University of Zambia (UNZA)	
Nabta Smart Town (2017-2019)	New Borg El Arab, Egypt	Khairy Foundation for Human and Social Development (KFHSD)	Article 4
Homes For Good (2022)	United Kingdom	Strictly speaking, in these cases there are no local partners because this is desk research and not an implementation project in which VTT has collaborated with local partners.	Scientific paper
Nabolagshager (2022)	Norway		
Leapfrog Projects (2023)	Finland		Article 5
Annansilmät-Aitta (2023)			
Kanresta (2023)			
Uncycler Helsinki (2023)			

To begin, the articles describe and analyse the selected cases in terms of their alignment or contribution to the instruments and skills that support knowledge transfer and local adaptation, shown in Figure 6. Additionally, Table 3 provides an overview of the case studies included in this thesis, indicating the EcoCity project they are associated with, the date, the country and specific location within the country (if applicable), the main local partners involved and the article/article in which they appear.

In addition, Table 4 provides more details on those case studies that correspond to implementation projects in which VTT has directly participated (articles 1 to 4), allowing to provide first-hand information on funding sources, as well as the objectives defined together with local partners or clients during the preparation phase. Further reflection on the importance of adequate financing can be found in subsection 5.3. The colour code provides information about the article each case study belongs to as indicated in Figures 6 and 7.

Table 4: Further details on the funding and objectives of the implementation case studies. (Carmen Antuña, 2023)

IMPLEMENTATION CASE STUDIES	FUNDING SOURCE	MAIN OBJECTIVES
Sustainable urban development in Libya (Libya)	Ministry of Housing and Utilities of Libya (MHU)	To find out through presentations and structured discussions with local stakeholders whether the main components of VTT's EcoCity concept are relevant in the Libyan context, and to assess their level of priority. To select a series of possible EcoCity pilot projects in Libya.
EcoNBC (Egypt)	Ministry for Foreign Affairs of Finland (ICI instrument)	To build the capacity of the local partner (E-JUST) on EcoCity development and implementation. To conduct a Feasibility Study for Transforming NBC into an EcoCity. To develop an EcoCity Roadmap for Egypt.
Managing Urban Futures (Tanzania)	Aalto PRO, and Uongozi Institute	To support sustainable urban development in East and Southern Africa with the participation of key stakeholders from Ethiopia, Kenya, Rwanda, South Africa, Tanzania, Uganda, Zambia and invited mentors from the Philippines and Thailand.
EcoMedellín (Colombia)	Jointing funded by Humboldt Institute, City of Medellín, and VTT	To support the environmental management process carried out by the municipal administration of the city in conjunction with local, regional, and national entities. To help identify the area of intervention and define the components and scope of the urban improvement project for the selected area.
EcoLusaka (Zambia)	Ministry for Foreign Affairs of Finland (ICI instrument)	To promote the sustainable education of the construction sector in Zambia, in collaboration with Thorn Park Construction Training Centre (TPCTC) based in Lusaka. Main activities undertaken: capacity building of the local partner; development and implementation of an EcoCurriculum; development of a Strategic Business Plan; upgrade the centre's current structure with the help of ICT; improvement of facilities and equipment.
Nabta Smart Town (Egypt)	10YFP Trust Fund (One Planet Network SBC Programme)	To ensure that the Master Plan and the buildings of Nabta University, as well as the Residential and Commercial facilities of NST comply with the standards of a modern smart EcoCity adapted to the local conditions of Egypt. Additionally, this work should capitalize on the recommendations and findings of "EcoNBC Feasibility Study. Transforming New Borg El Arab into an EcoCity", one of the main outcomes of a previous project in Egypt also coordinated by VTT.

3.2. Methodologies used in EcoCity projects

Much more information about these methodologies can be found in article 2, including bibliographical references, so they are only briefly discussed here to avoid redundancy.

EcoCity Roadmap. The road map method has been widely used since the 1970s both to forecast and guide future developments in order to develop a better understanding and preparation for those potential scenarios. In this case, the road mapping method used derives from a previous version developed by other VTT colleagues and was first applied in the project "EcoNBC. EcoCity Capacity Building in New Borg El Arab City (NBC)" included as a case study in article 2. In this case the purpose was to develop a road map that would guide the urban development of the country (Egypt) as a whole in accordance with the principles of the VTT EcoCity concept.

EcoCity Feasibility Study. This methodology is a derivation of a more generic and quite common methodology that can generally be applied to almost any type of idea or opportunity. In the case of New Borg El Arab (NBC), the objective was to investigate the viability of its potential transformation into an EcoCity according to the concept defined by VTT. Through a series of structured workshops, it began with the definition of a joint vision through collaboration between VTT experts and local partners and stakeholders, to continue with the outlining of several possible scenarios for which different development strategies were formulated. The Feasibility Study was complemented with a techno-economic evaluation and a social impact analysis.

Residents Energy Survey and Building Consumption Assessment. Again, this is a methodology developed by VTT experts and previously used in other contexts that was then adapted to the needs first of the EcoNBC project (article 2) and then the Nabta Smart Town project (article 4) to support the selection process of green or eco-friendly technologies, and evaluate the possible acceptance of the technologies themselves, as well as the probabilities of success of new measures aimed at a more sustainable lifestyle and more efficient energy behaviours.

4. Results and findings

Below is a summary of the main findings in relation to each of the instruments and skills or "bubbles" in Figure 6, which in turn are directly linked to the articles that make up this thesis (see Figure 7).

VTT EcoCity concept. Article 1 discussed the origins and theoretical foundations of the concept, as well as its main defining characteristics. To gain perspective, the VTT EcoCity concept's approach towards the regeneration and sustainable development of communities and neighbourhoods was compared with other approaches, proponents, etc. In this sense, the aspects evaluated were: 1) Whether the concept in question goes beyond the strictly ecological field or not. 2) Local definition (negotiated and agreed) of sustainability. 3) The role of technology. 4) Reliance or lack thereof on physical planning. 5) Emphasis on social aspects. 6) Importance of considering user behaviour and promoting sustainable lifestyles. **Table 5 provides an overview of the findings of this comparative analysis.**

Table 5: Comparison between the VTT EcoCity concept and other approaches (see Article 1).

OTHER ECOCITY APPROACHES	VTT ECOCITY APPROACH
Ecologically centred	Integrated
Rigid models to be replicated worldwide	Locally defined models limited by non-negotiable principles
Technology driven	Technology "conscious"
Prescription based (physical design)	Performance based
Disregard for social aspects	Emphasis on social aspects
Lack of users/community engagement	Promotion of sustainable lifestyles

In the article, this analysis is illustrated with a case study from Libya that shows how these characteristics translate into practice.

Specific methodologies developed. These are generally discussed in Article 2, while Article 4 presents a more concrete application case focusing on energy efficiency at the neighbourhood level. The case studies that illustrate both articles are located in Egypt.

Article 2 covers the methodologies developed by VTT to support the formulation and implementation of the EcoCity concept and its local adaptation to Egypt through a collaborative process involving the local partner and key stakeholders. The methodologies in question were: the EcoCity Roadmap, the EcoCity Feasibility Study and

the Residents Energy Survey and Building Consumption Assessment. The Finnish-Egyptian expert team decided that the scope of the Feasibility Study and Energy Survey would be restricted to NBC (near Alexandria) while the Roadmap would cover all of Egypt. Workshops, training & collaboration with local NGO. The Roadmap and the Feasibility Study were developed through a series of specific workshops with the local partner and stakeholders. While the Energy Survey was carried out with the collaboration of a local NGO previously trained by the project experts so that they could help residents fill out the survey.

For the Roadmap, the main result was a list of implementation actions for the realization of the thematic roadmaps defined for Egypt: water and waste, energy, transport and traffic, and buildings and construction. **As an important finding, investments in human capital, health and education were seen as enabling both growth and sustainability. However, many of the suggested improvements do not necessarily require high investments, such as increasing the use of solar energy for domestic water heating. Likewise, some of the proposed actions have multiple benefits, for example, the preservation of natural greenery obviously contributes both to the well-being of citizens and to the environment.**

For the Feasibility Study, the main result was the three scenarios defined for NBC in line with the previously agreed vision and targets. One of them, Business As Usual (BAU), described the current situation at that time, including demographic and economic growth, and assumed that the pattern of future developments would be the same. BAU was used as a reference for the other two scenarios: Low Investment Scenario (LIS) and High Investment Scenario (HIS). The main difference between LIS and HIS is that HIS considers more advanced technologies and solutions. For instance, in the residential sector, LIS exclusively includes low-cost solutions, while HIS includes technologies for net zero buildings. These scenarios were complemented with a Cost Effectiveness Analysis (CEA) carried out using VTT-CEA tool, and a social impact analysis. **One of the important findings was that, as expected, these additional analyses provided the team of experts with more criteria to evaluate the feasibility of the defined scenarios or of specific solutions associated with them. Continuing with the residential sector, the LIS scenario did not seem to make sense from a purely investment calculation perspective due to the heavy subsidies affecting the price of electricity in Egypt at the time. However, the expected decrease in subsidies could make the investment profitable in the future.**

Locally adapted questions created by social and energy experts for the Energy Survey were posed to residents of different neighbourhoods in NBC with the help of a local NGO.

The responses were evaluated by the Finnish-Egyptian team with the support of other external local experts. **It was found that this locally tuned, multi-step process was found to be critical to accurately understanding the energy behaviour of local residents as well as their needs. This in turn allowed experts to have a better overview of the local market, which is necessary to ensure the penetration of the selected technologies.**

Article 4 describes how the EcoCity methodologies developed by VTT and discussed above were used as a basis for conducting the energy assessment of the NST Master Plan. NST is a new planned neighbourhood located in NBC that combines modern residential and commercial facilities with high-quality "Educational Magnets" and administrative offices. The energy assessment process was designed specifically for the local context and included an in detail assessment of NST Master Plan, training of KFHSD staff (local partner) on specific software, energy categorization of NST building types, and modelling and simulation for energy performance optimization. **This approach was found to have clear potential to achieve the Egypt Vision 2030 and contribute to the SDGs, but only if the solutions are truly inclusive and integrated into the urban fabric of NBC, so that this type of project does not create an "oasis of wealth surrounded by a desert of poverty". Another finding was that the results of our study were aligned with many other similar studies conducted in Egypt but also in many other parts of the world that share similar conditions. Another relevant discovery was the need to investigate synergistic effects combining waste, water, energy, food... solutions to maximize the impact and reduce costs. Ultimately, capacity building proved essential to developing successful locally adapted solutions.**

Facilitation processes and skills, also covering participation, communication, and interaction. Facilitation by VTT experts is aimed at ensuring local adaptation, but as discussed in Article 3, this adaptation occurs at different levels, namely, adaptation of the concept itself, the methodologies to be applied, the process, and necessarily the solutions to be developed. **Furthermore, it was found that the facilitation style must also be adapted to make the most of the input of the local actors involved in the decision making process.**

In addition, facilitation, which inevitably involves communication and interaction with partners and stakeholders, appears to be closely linked not only to adaptation but to participation. Table 6 shows the requirements that both participants and the participatory process must meet to guarantee the validity and governance of the results. Article 3 also analyses the different techniques and dynamics at play in the facilitation processes associated with EcoCity projects. As noted, the main points of

divergence were observed to be related to different mindsets and values (of VTT experts vs. the local actors), and internal differences between local partners and stakeholders due to economic interests, different degrees of formal power, local hierarchy system, political context, background, education, etc.

Table 6: Requirements for participants and the process (see Article 3).

PARTICIPANTS SHOULD BE	THE PROCESS SHOULD BE
Legitimated Informed	Transparent Pertinent Efficient and effective

The case studies that illustrate Article 3 show how the same concept is applied in practice in strikingly different contexts (i.e., Colombia and Zambia), leading to different results even if both processes address the same or a similar topic. **One of the main results was the categorization of local adaptation at a more specific level, as shown in Table 7, in response to the question: What exactly are the local conditions that require adaptation?**

VTT facilitators were also involved as experts in the case studies described, as well as in other similar projects, so it can be said **that our work is similar to what is commonly known as "participant observation"** (Kimber & Maertens, 2023). This is a qualitative data collection method, widely used in the social sciences although challenging to some extent. **The experience of the author and that of her colleagues confirms the appropriateness of this approach, but at the same time it is necessary to be careful to remain neutral and impeccable throughout the facilitation process.**

Social entrepreneurship for sustainable cities and communities. As sustainable initiatives and innovative solutions often struggle to access adequate funding sources or business models suitable for their development or exploitation, Article 5 and its preceding scientific paper investigate the opportunities offered by the social economy, and in particular how social enterprises can successfully contribute to more sustainable cities and communities. **Through some case studies from Finland, Norway, and the UK, selected and described using a simple methodology developed by the author, it was found that social enterprises are flexible and can contribute to different areas of relevance to achieving a more sustainable and fair society: social and health services, wellness services, circular economy, and the environment. Another interesting finding is that they operate at different scales and make relatively little use of storytelling as a tool to gain visibility and legitimacy. Furthermore, even**

successful social enterprises find it difficult to measure and communicate their impact on society, which can be detrimental when trying to attract donors and investors.

Table 7: Overview of the local conditions that require adaptation (see Article 3).

TYPE OF CONDITIONS	MAIN VARIABLE	RELATED VARIABLES	RELATED ASPECTS
Socio-economic	Jobs Income level Quality of life (measured with adequate indicator sets) Education (formal and informal)	Education level Health conditions Skills and capacities Inclusion/Marginality/ Social stratification Vulnerability	Poverty Lifestyle* Employment Health* Food security* Informal settlements*
Socio-political	Policies and regulations Institutional structure and capacities	Legality/Formality of the dwelling Availability of social infrastructure Social welfare Governance	Waste Water & Sanitation Energy Transport Health* Food security* Informal settlements*
Socio-ecological	Location Topography Climate Vegetation Density	Sustainability Risk (threats, vulnerability, resilience)	Pollution Biodiversity Land Food security* Available materials and techniques*
Cultural	Traditions Beliefs Knowledge systems	Openness Receptivity Engagement Relations/Leadership Resilience	Lifestyle* Available materials and techniques*
Degree, legitimacy, and effective participation; decision making and action			

* Indicates those aspects that influence several types of local conditions.

Indicators and evaluation tools. As already clarified, this "instruments" have not been covered as part of this thesis, but this does not mean that they have not been covered at all, because the SHERPA project (2013-2015) mentioned in section 5.5 deals specifically with this. More information can be found in the link provided there.

Finally, as a distillation of the learnings from this study, Figure 8 illustrates the VTT EcoCity process, which is presented as a linear path for a better understanding. However, strictly speaking, the process is not linear, but rather cyclical, as each time the concept is applied to a specific case study, both parties, namely VTT and local partners and stakeholders, collaboratively improve their skills and benefit from lessons learned regarding locally adapted solutions. Therefore, even if the process is repeated, the starting point for the next application is not the same thanks to the new knowledge and experience acquired. Hence, it is an improved process. Additionally, capacity building and local adaptation can potentially occur at each stage of the process, creating multiple feedback loops that iteratively keep improving the concept and its stages. For the last two stages, namely "continuation of local work" and "actual intervention", continuity in contact between VTT experts and local partners and stakeholders is required, which is unfortunately not always guaranteed for various reasons. In Figure 8, this potential that may or may not be realized depending on the conditions in which the collaboration is developed is indicated by dashed lines. To avoid overloading the figure too much, the feedback loops shown refer to the main concept, although as already mentioned, the lessons learned at each stage can improve not only the overall concept but each previous stage individually.

The VTT Ecocity concept stands at the centre of this process, helping to articulate the transition from existing policies of different scales to the formulation of roadmaps or intervention plans and even to the selection, and subsequent drafting, of specific projects for practical application. It also plays a critical role in bringing local stakeholders together, mediating their sometimes conflicting interests and divergent visions, while providing neutral technical advice through expert facilitation and raising awareness of sustainable development. All case studies corroborate the complexity of the aforementioned process, which should not be underestimated and must be adequately recognized and addressed.

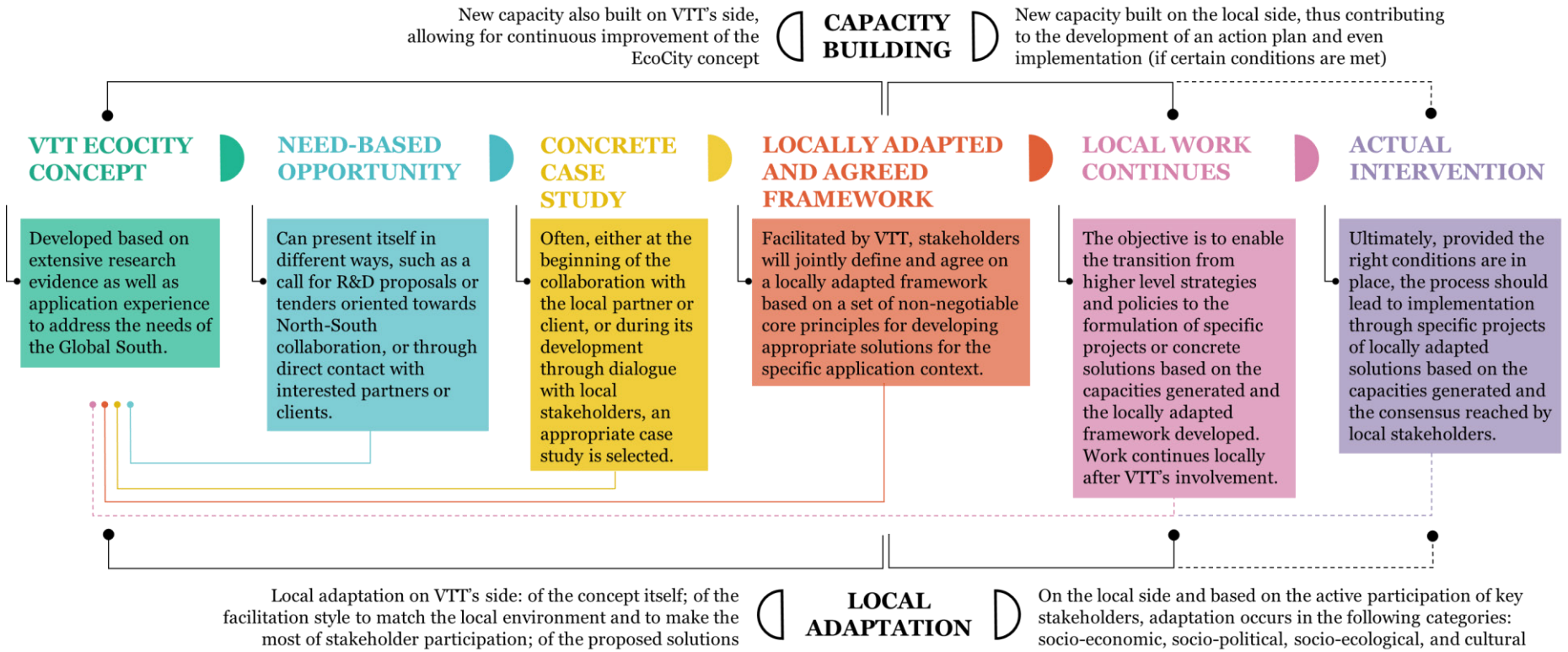


Figure 8. Description of the VTT EcoCity process in a nutshell. (Carmen Antuña Rozado, 2023)

5. Conclusions, recommendations, and future development

5.1. Partial conclusions

For a better understanding, the conclusions of this thesis are first presented in relation to the corresponding article and then summarized in Figure 9 to provide a clear overview. In section 5.2, a joint reading of the conclusions is carried out in relation to the defined objectives (main and specific) to go beyond the partial conclusions of the articles, thus interpreting the results as a whole. Therefore, to begin with, from the research on the **VTT ECOCITY CONCEPT** presented in Article 1, the following can be deduced:

- The VTT EcoCity concept seems to be rooted in the Finnish tradition of urban planning and development, of which Tapiola Garden City, Otaniemi High-Tech Campus and Eco-Viikki are notable and pioneering examples.
- Another key component of the VTT EcoCity concept, i.e., adaptation to the local context, was also of particular importance when selecting the green building criteria for Eco-Viikki to be suitable for Finnish conditions.
- From an even broader perspective, Finland's long-standing commitment to sustainable development is defined by a holistic approach that also permeates the VTT EcoCity concept.
- The favourable environment for the formulation of these concepts found in the Nordic countries carries the risk of taking for granted certain preconditions that are not at all common in other contexts.
- This can be said of the ecocity concept in general, which originated primarily in North America and has largely developed from urban practices carried out in cities in North America, Europe, and Australia, which may limit its applicability in other places.
- Related to the above, collaboration with local partners and stakeholders has been instrumental in making explicit what were originally implicit assumptions derived from the Nordic vision on sustainable development.
- Furthermore, some authors argue that the ecocity concept is based on the "social structures and relationships that already exist in modern and postmodern societies", and therefore may not be able to adequately respond to the challenges faced by cities in the Global South, whose pre-existing conditions are very different.
- However, the author of this thesis and her article co-authors argue that, although this should not be ignored or taken lightly, a flexible and interactive framework capable

of accommodating different local interpretations of an ecocity, all while respecting a number of key principles that cannot be compromised, may be a suitable approach.

- In connection with the above there are several significant aspects: 1) the development of specific methodologies; 2) the definition of a commonly negotiated and agreed local ecocity model, which at the same time respects certain non-negotiable conditions; and 3) expert facilitation to support local stakeholders in the complex decision-making process that, based on available scientific evidence, successfully links the formulated solutions with existing technologies.
- The real and meaningful participation of all key stakeholders is crucial for both top-down and bottom-up initiated and/or developed ecocity projects.
- The experience of the projects carried out and illustrated through case studies seems to indicate that, ultimately, this process generates capacities and adaptation, not only on the local side but also concerning the concept itself and its facilitators, through a dynamic of mutual learning and continuous improvement.
- The complexity of the process leading to the physical realization of an ecocity project (regardless of scale), which typically involves many stakeholders and decision points, is often overlooked, or underestimated.
- The VTT EcoCity concept tries to contribute precisely to the constructive and informed dialogue that should be carried out as part of this process, and that as such has a value in itself regardless of the final result.
- This approach, which goes beyond technology and incorporates many other aspects, is expected to help engage the community and even create a real sense of place and ownership.
- The findings corroborate what other authors have observed regarding the need for a new approach that responds to the very different conditions of the Global South, which, while challenging in many ways, also offers many opportunities for sustainable development and has a huge potential for innovation that remains to some extent untapped.

INSIGHTS FROM CASE STUDIES DESCRIBED IN ARTICLE 1

The Libya case study illustrates how this dialogue takes place. The EcoCity Action Plan for Libya, drafted in collaboration with local stakeholders, tries to build a bridge between the overall vision set out by the "Roadmap on Finnish-Libyan cooperation in the field of housing and public services" and the formulation of specific projects in

selected intervention areas supporting and informing what is always a complex decision-making process. When compared to the Medellin case study (described in Article 3 and discussed a little later), it can be seen how the same EcoCity concept leads to a different "Action Plan" precisely because of its flexibility, allowing adaptation to different local contexts. The pilots identified in both cases are an important aspect in this transition towards concrete intervention projects because they connect the concept (theory) with real examples (practice). However, the highly volatile situation in Libya, and in many other countries of the Global South, constitutes a serious obstacle to the full implementation of such a transformation process, which is complex by nature and takes a long time to complete.

The conclusions of the research carried out on **METHODOLOGIES FOR ECOCITIES**, reflected in Article 2, can be summarized as follows:

- Appropriate methodologies are needed to support EcoCity development in response to the challenges facing communities and neighbourhoods around the world today.
- Their adequacy depends on their ability to provide locally adapted and suitable solutions, and for this collaboration with local stakeholders is of particular importance.
- Successful collaboration with local stakeholders requires strong facilitation skills and understanding of cultural differences.
- Very often, these methodologies require certain data that, although basic, is not available (or will not be disclosed by those who could provide it) or is not reliable. Therefore, a few assumptions may be necessary to overcome this situation.
- The results show that affordable solutions, locally available and relatively easy to implement, can have a very positive impact on the final energy balance.
- The potential to substantially increase energy efficiency, not only in new urban developments but also in existing neighbourhoods, is enormous and offers many opportunities to create employment through green businesses and jobs.

In relation to the **FACILITATION PROCESSES AND SKILLS** that effectively support the development and implementation of solutions for ecocities, discussed in Article 3, the conclusions are:

- Capacity building is so central that it seems that the entire EcoCity concept has been conceived as a process to generate capacities. After all, the participation of VTT is only temporary and mainly oriented to the transfer of knowledge and methodologies, and

to facilitate the process for its effective application according to the characteristics, needs and local possibilities.

- Therefore, facilitation is very often combined with capacity building. VTT experts are not independent facilitators wholly separate from the group they facilitate; they make presentations and are sometimes part of the discussions.
- Facilitation is thus the bridge between the general and the particular. It helps to find a common path transcending management in silos (temporal, spatial, etc.).
- Facilitation also helps to keep the discussion within the jointly defined framework (threshold) of non-negotiables and to prevent participation from becoming an excuse to dilute accountability from those who are held accountable.
- Given the importance of local adaptation, VTT facilitation aims to support the EcoCity process through the development of solutions based on local traditions, specific social and economic realities, local perceptions and identity values, materials available and the skills and competencies of the partners.
- In accordance with this particularized approach for each context, the proposed solutions will be the result of the best possible combination of technologies and services (from a sustainable building perspective) to guarantee a good quality of life for the inhabitants of a specific territory, within and outside of buildings.
- Through its application in diverse contexts around the world, the EcoCity concept itself, along with the facilitation processes and skills that support it, become richer and therefore more useful when applied in new situations.
- In short, capacity building and adaptation occur both on the local side and on the side of the concept and its facilitators.
- The VTT EcoCity concept can be understood as a way of addressing different realities in a complex but effective way and must be supported by adequate facilitation for it to be successful.
- Comparatively speaking, adequate facilitation can substantially contribute to moving from land policies, urban policies, etc., to the definition of specific projects or the formulation of concrete solutions, achieving a high degree of participation and commitment of all the actors and interested parties, thus increasing the probability of appropriation of the project by the community.

INSIGHTS FROM CASE STUDIES DESCRIBED IN ARTICLE 3

VTT's EcoTanzania workshop within MUF2013 (Managing Urban Futures Workshop – Dar es Salaam, Tanzania) served to retrospectively analyse the dynamics at play and the techniques used to facilitate interaction between different actors with sometimes conflicting interests to allow constructive dialogue and true co-creation of locally adapted innovative solutions. An essential part of the facilitation task is the harmonization of the different mindsets and values at play, for example, to begin with, those of Finnish experts versus local partners and stakeholders. It also includes the reconciliation of different circumstances such as the degree of formal power, economic interests, the local hierarchical system, existing dynamics or background and education.

The EcoMedellín project was part of a broader political, administrative and scientific process in which the expert facilitation of VTT contributed to: 1) the articulation of the "grey" technical components of urban development with the "green" components of biodiversity and ecosystem services; 2) the change in scale and perspective from a national and regional public policy project to a local and specific project of direct intervention, supported by the methodologies and instruments provided by the EcoCity concept, which in turn expanded the group of participants, areas coverage themes, and the set of management tools.

In Zambia, by contrast, the process moved from the local to the national scale. VTT's expert facilitation helped the locals create a vision for a sustainable future that covered a number of issues of interest that affect the entire country. The participants were mostly students from different provinces and tribes, which ensured cultural diversity as well as subject areas of coverage since they belonged to different faculties.

The findings and conclusions of the **MORE CONCRETE EXAMPLE OF APPLICATION EXAMPLE** presented in Article 4 can be summarized as follows:

- It is crucial to develop a proper baseline based on the most accurate local data possible, correctly interpret the data collected, and ultimately make the correct assumptions.
- It seems necessary to complete the energy assessment with a cost analysis in order to have a better understanding of the available options in order to help the decision-making process.
- At the end of these "partial" studies (as in this case, main focus on energy, for example) the need for additional studies covering other aspects such as water, waste, material resources, in order to find possible synergistic effects, often becomes evident.

- Cooling demand does not always represent the largest part. For some types of buildings yes, but not for others.
- The heating demand is sensitive to temperature set points, internal gains, and fresh air. Consequently, energy behaviours can contribute significantly to decrease the heating demand.
- Natural ventilation is a good energy saving measure (free cooling) for Residential buildings, unlike for Office and Educational ones, mainly due to too high fresh air volumes.
- Shading has no impact since low-e (tinted) glass is used (infrared wavelength, weak impact on the visible spectrum).
- Replacing the Egyptian stone initially used in the envelope with 5 cm wall insulation, everything else remaining unchanged, slightly improves energy efficiency.
- Unlike cold climates, in this case heat recovery does not have a significant impact.
- Before acting on the system, the energy demand of buildings must be reduced. Different energy savings measures should be adopted for different building types.
- It is highly recommended to optimize on-site consumption to reduce the cost of energy infrastructure.
- NZED (Net Zero Energy District) or PED (Positive Energy District) are possible to achieve with conventional RES (Renewable Energy Sources).
- An early energy assessment that considers local regulations and specific conditions offers great potential for achieving higher energy efficiency and should therefore be preferable to a one-size-fits-all solution directly transplanted from a completely different context.
- There is a clear potential for replicability as long as local conditions are adequately considered, while the potential for scalability also appears to exist but requires further study.
- Overall, these findings should help planners looking for feasible RES solutions for a similar project type and scale, while contributing to achieving SDG 7: Clean and Affordable Energy by 2030 and Egypt Vision 2030.

Below are the conclusions of the research work behind Article 5 and the preceding scientific paper related to the possible contribution of **SOCIAL ENTERPRISES FOR SUSTAINABLE CITIES AND COMMUNITIES**.

From the scientific paper:

- Measuring performance and impact remains one of the main obstacles for social enterprises to demonstrate the benefits they generate for society in a quantitative way, which in turn can discourage potential investors or donors.
- There is potential for certain social enterprises to contribute to the sustainability of cities and the built environment. Therefore, it might be worth conducting more research on both topics and their interrelationships in the coming years.
- The combination, on the one hand, of the business method (they must have a minimum financial sense), the focus on unaddressed or insufficiently attended social and environmental challenges or needs, greater agility and proximity to the target groups, presumably more efficiency... and on the other hand, the possibility of generating a positive impact in areas as important as resilience, adaptation to climate change, social cohesion and integration, food security and/or sovereignty, biodiversity, etc., it can be very beneficial for the sustainability of cities and the built environment.
- In essence, social entrepreneurship tries to address the challenges of society, whatever their nature (environmental, social, or economic), using the entrepreneurial method in the most efficient way possible.
- Plus, combined with carefully selected alliances with strategic partners, it can bring together commonly overlooked aspects for mutual improvement.
- The social needs addressed by the featured enterprises in their domestic contexts can be found in different shades in many other cities around the world. Therefore, they can serve as inspiration both for those who are interested in launching a similar initiative in their city, and for public administrations looking for solutions to efficiently face existing challenges.

From Article 5:

- Social enterprises can address, although not without difficulties, a wide range of needs and gaps in many different sectors of activity and under different market conditions.
- There seems to be considerable potential for social enterprises to contribute to sustainable development and increase the sustainability of cities and communities. However, more research needs to be conducted on this particular topic, including appropriate methodologies.

- Government support seems to be growing in Finland judging by the recently launched new strategy for social enterprises.
- The main objective of the strategy is to provide more and better employment opportunities for people with limited employment capacity, which poses a considerable constraint and leaves much of the potential that social enterprises have still untapped.
- The new strategy does not contemplate a specific legal status for social enterprises that could grant them any benefit, such as tax reduction or any other, although there are support services, tools, and information available.
- Direct access to the knowledge and experience stored in local networks and the possibility of establishing strategic alliances with other partners that share the same values and objectives and that are complementary in some way, is another of the advantages that the Finnish ecosystem provides.
- As part of this ecosystem, the Centres for Economic Development, Transport, and the Environment can play an important role in the replicability and scalability of social innovations throughout the country.
- The social enterprises featured are a clear example of how to fill an existing gap in terms of ignored or insufficiently covered social or environmental challenges and needs using the business method to varying degrees.
- Performance and impact measurement remains one of the main obstacles for social enterprises to demonstrate the benefits they create to society in a quantitative manner, which in turn may discourage potential investors or donors.
- Better reporting, which in turn requires monitoring and continuous data collection and measurement, can be used as a basis for improvement and growth, as well as for comparison.
- The Finnish Social Enterprise Mark can help to increase the visibility and credibility of social enterprises, as well as social awareness about the importance of their goals and mission, but only and to the extent that the companies awarded the Mark are willing to display it and make use of it to mutually benefit from this synergistic effect.
- To encourage reflection on how companies could behave in a more socially and environmentally responsible manner, awareness and understanding of social entrepreneurship could be further promoted not only among the general public, but also in business schools.

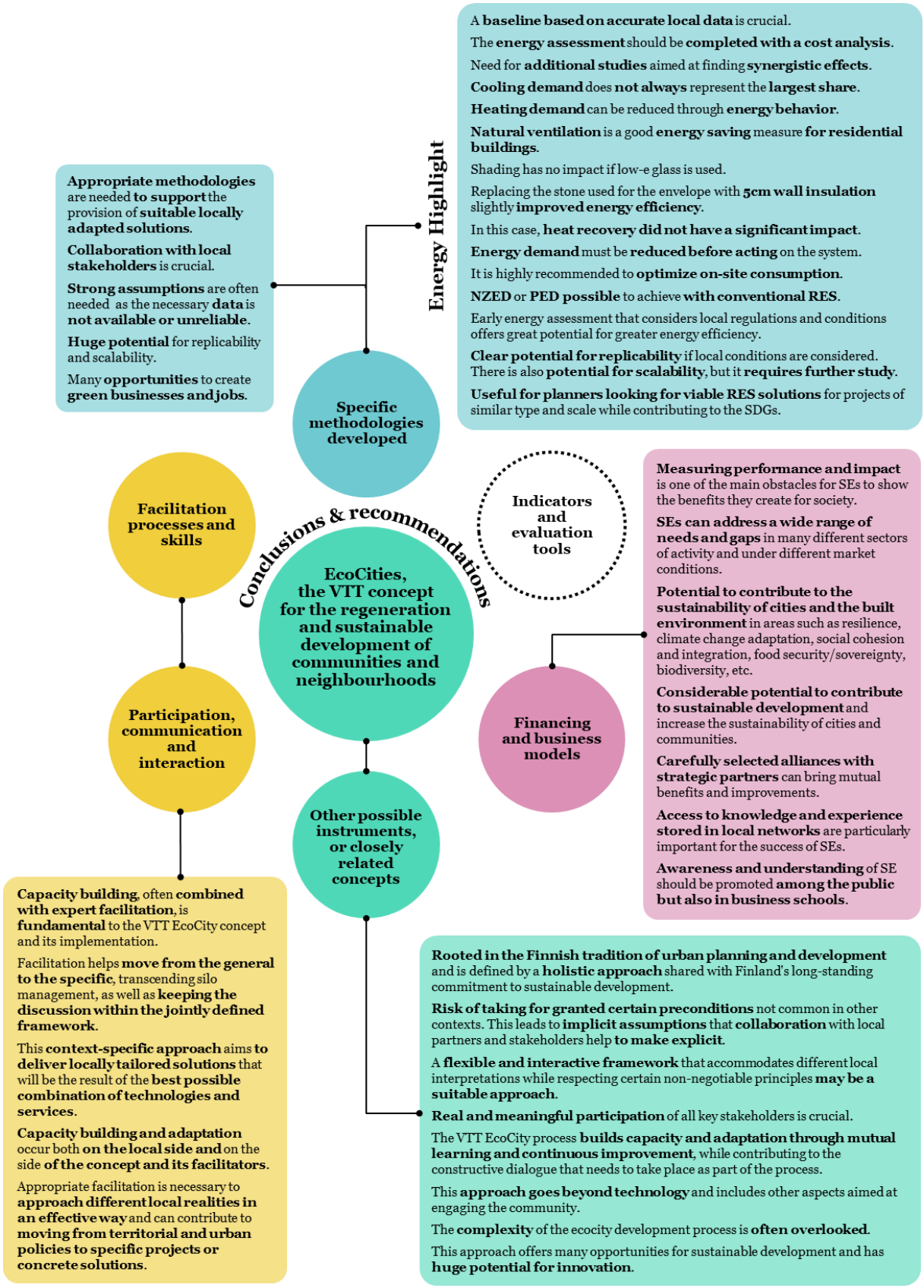


Figure 9: Summary of partial conclusions and recommendations from the papers behind this thesis. (Carmen Antuña Rozado, 2023)

5.2. Conclusions of the thesis

What follows is the result of a joint reading of conclusions and recommendations in relation to the defined objectives, both general and specific, which go beyond the partial conclusions and recommendations of the articles shown above. In turn, as already discussed and shown in Table 1, the objectives are correlated to the research questions.

The **main objective (MO)** established for this thesis was to identify and characterize, using a comprehensive (holistic) approach, those elements that contribute substantially to an effective transfer of both knowledge and technological solutions generated in other places, and to their successful adaptation to local contexts, which can be markedly different from the originals. The reason behind this MO is the verification, through both direct observation and experience shared by local stakeholders around the world, that many similar processes have failed due to the direct transfer not only of knowledge, but above all of "ready-to-use" solutions (from urban planning models to energy efficiency measures) to sometimes radically different contexts. In relation to this MO, Figure 6 shows the instruments and skills recognized as particularly relevant in collaboration with local experts and partners, which in turn have been explored through the articles that make up this thesis. Partial conclusions in relation to each of them have been presented in the previous section 5.1 and summarized in Figure 9. Furthermore, Figure 8 describes, as a distillation of everything elucidated in this thesis, the VTT EcoCity process succinctly, emphasizing the importance of continuous capacity building on both sides and local adaptation. **One of the conclusions that emerges from it is that beyond ecocities, the process itself can be assimilated to many other processes related to urban development or regeneration that involve the transfer of knowledge and the development of solutions that (should) respond to specific local conditions, and that are carried out with the participation of local partners and stakeholders.**

In relation to the **specific objectives (SOs)** defined:

SO-i. The critical-comparative analysis of the VTT EcoCity concept points to its **roots in the best tradition of Finnish urbanism, in turn indebted to Ebenezer Howard's garden cities**, as explained in Article 1.

In addition, some the most relevant examples of this urbanism (i.e., Tapiola Garden City, Otaniemi High-Tech Campus, and Eco-Viikki) are **characterized by a determined desire to adapt to the particular Finnish conditions and show a clear openness to citizen participation perhaps unusual for the time**. Even more unusual in the case of Tapiola Garden City, the oldest example. Concomitant with the above is the **confirmation of the existence of a long-term commitment of Finnish society to sustainable (also urban) development largely common to other Nordic countries as well, and which in**

Finland can be said to employ a holistic approach. As will be seen in the next paragraph, these characteristic features have proven to be fundamental to successfully drive the development/implementation process of EcoCities in the Global South.

In general, it also seems evident that the ecocity model emerges in the Western world conditioned by a specific mentality and enabled by a series of pre-existing structures and relationships, not always explicitly recognized, that are not necessarily in place or can be replicated in other regions of the planet, which logically has often led to failure (total or partial) in its implementation in markedly different contexts. The review of the literature shows that a similar criticism has been raised with respect to other somewhat later urban models, such as smart cities, for example. However, while the VTT EcoCity concept certainly does not ignore the above, the experience on the ground seems to indicate that **close collaboration with local partners and stakeholders makes it possible to identify preconditions that should not be taken for granted in their local context. Likewise, it has been found that a flexible and interactive operating framework that allows a local interpretation of the EcoCity concept while accepting a series of non-negotiable principles, contributes to the success of the process** (see Table 5 in section 4). In Article 1, where the nature of the concept and its defining features are discussed, the Libya case study shows how this dialogue is carried out in practice.

SO-ii. Article 2 discussed the application of some of the methodologies developed to support the implementation of VTT EcoCity concept, namely the EcoCity Roadmap, the EcoCity Feasibility Study, and the Residents Energy Survey and Building Consumption Assessment. The study confirmed **the importance of establishing a baseline (i.e., an initial diagnosis) using local data rather than just global statistical data, which can sometimes be challenging as the necessary data may not be readily available** and must be compiled with the help of local partners. However, it has been found that local data really allows to capture the nuances of particular local contexts. **At other times, data is available, but an expert evaluation determines that it is not reliable, so it is necessary to collect new data or, failing that, make sound assumptions. All the above is part, in our experience, of continuous capacity building and local adaptation** since both are required for the correct development of data collection methods and formulation of assumptions that adjust to the specific context.

Concerning the skills needed, one of the most important conclusions is that both hard and soft skills are equally important. After all, fruitful collaboration with local partners and stakeholders requires not only expert knowledge and preferably also experience, but the ability to build trust and enable meaningful participation, maintain a neutral perspective, create a safe space for debate, reconcile opposing points of view and

conflicting interests... to ensure the achievement of set goals. As discussed in Article 3, the facilitation provided by VTT experts to EcoCity development processes aptly combines multidisciplinary technical expertise (hard skills) with a set of listening and communication techniques (soft skills) cultivated and honed, more unconsciously than consciously, through practical exercise. **The benefits of balancing and perfecting both hard and soft skills can be multifold, but essentially adequate facilitation allows, depending on the starting point, to move from disagreement to fluid discussion and from there to constructive dialogue**. Sometimes it can even lay the groundwork for a conversation between local stakeholders that continues after our intervention. Another important conclusion is that **such facilitation is necessary to address the complexity inherent in these processes effectively and move from territorial and urban strategies, policies, and regulations to the formulation of specific plans or even local projects**. A strong link between capacity development and facilitation has been confirmed.

SO-iii. The research behind this thesis is for the most part closely related to real cases of EcoCity projects and activities in which the author, together with other colleagues who appear as co-authors of the associated articles, have directly participated. Table 4 in section 3 provides more details on what can be called "implementation case studies", which illustrate the process of developing a locally adapted EcoCity framework and solutions in articles 1 to 4. These case studies show the different application contexts and the diversity of scales, priorities, degree of maturity of existing plans, stakeholder groups, power relations between them... not to mention the varying local conditions that require adaptation (see Table 7). **The main conclusion in this regard is that the cases do not have to be the same or exactly comparable, because it is precisely the proper management of this diversity and complexity that most clearly demonstrates how the EcoCity concept described allows for local adjustment, and in some way constitutes a measure of its success.**

There is still a second group made up of those case studies used to illustrate article 5 and its preceding scientific paper (see Table 3). These are examples of social enterprises that the author has studied as part of a wider desktop research linked to her EMBA thesis, sometimes interviewing the entrepreneurs in question and relevant stakeholders, and which have been described and analyzed according to the author's own methodology. The importance of these examples will be seen in connection with the next objective (SO-iv).

SO-iv. The reason for this objective is the verification through experience in numerous R&D projects (also corroborated by the literature) of the difficulty of finding sources of financing and business models suitable for the exploitation of innovative ideas and

solutions that can improve the lives of people in cities and communities around the world. Article 5 and its preceding scientific paper investigated the potential of social enterprises, focused on unresolved or insufficiently addressed social and environmental challenges, to contribute to sustainable development and, more specifically, to more sustainable and resilient cities and communities. **Through a few reasonably successful examples (from Finland, Norway, and the UK), and a brief analysis of others from around the world, the positive contribution that these companies can make to the sustainability of cities and communities seems to be confirmed. And while it is true that more research is needed in this regard, the evidence so far indicates that certain enabling and supportive conditions are needed without which such a contribution is more doubtful or may be seriously compromised.**

SO-v. Article 4 describes in detail an energy efficiency project at neighbourhood level from its most initial stage, starting with the governing international agreements, the national strategies and policies that frame it, the specific location and its characteristics, the urban master plan and the process designed in collaboration with the local partner in response to all the above conditioning factors. **The main conclusion has to do with the possibility of achieving greater energy efficiency through early energy assessment and subsequent design decisions and technological choices, relatively simple and affordable as demonstrated, but requiring local data collection to develop an accurate baseline, training of the local partner, locally adapted methodologies, etc., to ensure its success. As a process it is highly replicable and even scalable.**

SO-vi. All articles (and scientific paper) include a reflection on the potential for replicability and scalability of the concepts, frameworks, methodologies, models, solutions... discussed, not only in similar contexts, but also in others that are not so similar. In the latter case, the caveat is always that **more attention should be paid to avoid literal translation and instead use the examples given and the conclusions drawn as inspiration, as a starting point for a new process of adaptation to the specific local conditions**. To minimize this risk, the case studies have been described so that useful lessons and good practices can be extracted for their application in other contexts. Furthermore, this description is usually completed with a comparative analysis, so that the cases presented are referenced to similar ones in other locations in the Global South.

SO-vii and SO-viii. All articles included recommendations based on the findings and gaps identified. In addition to that, subsection 5.3 provides preliminary general recommendations for policy formulation and viable solutions for practitioners, while subsection 5.4 describes the observed limitations (related to research scope, obstacles to funding, long-term collaboration, impact assessment...) and proposes some suggestions

for improvement and future lines of research. From an even higher point of view, section 6 presents some final reflections that fundamentally refer to the pros and cons of the approach adopted as well as the breadth of the topic undertaken.

Figure 10 shows a kind of "virtuous circle" of aspects to consider not only for the development of ecocities in different local contexts following the VTT EcoCity concept widely discussed here, **but for any other similar process of developing sustainable urban solutions, which is the purpose of this thesis.** The aspects highlighted in the circle are related to the general conclusions of the thesis, which in turn are linked to its objectives (main and specific) as we have already seen, and also to the research questions. **It can be argued that Figure 10 summarizes the key lessons learned and proposes a framework for an effective understanding of the specific context which in turn supports successful local adaptation. These aspects are presented in a circle because, in principle, there is no priority or particular chronological or hierarchical order, which will be determined by the specific case. The author also wishes to emphasize that these aspects influence each other, and therefore reinforce each other when properly developed.**



Figure 10. Virtuous circle of aspects that support effective knowledge transfer and local adaptation of sustainable city solutions. (Carmen Antuña Rozado, 2023)

5.3. Limitations and future lines of research

The fact that the different R&D projects associated with the research of this thesis have been developed over a decade provides a valuable perspective when it comes to evaluating the journey and extracting the lessons learned. Part of this evaluation is the identification of the limitations found along the way, which in turn can serve to formulate future lines of research that compensate them or simply for a better understanding and contextualization of the findings and conclusions presented. Therefore, the most relevant limitations identified are related to the following aspects:

Usually, the scope of the research is limited by the corresponding financing instrument, through the requirements of the call within which the specific R&D project is developed. It also often happens that an instrument that is in principle suitable for the intended R&D project must be discarded because one or more of the key partner organizations in the consortium turn out to be ineligible for it. As an example, the case of Nabta Smart Town (NST) in Egypt, described in detail in Article 4. Originally the intention was to carry out a complete assessment of the sustainability of NST, from which a series of improvement actions would be proposed. However, it was not possible to find adequate funding for this comprehensive study and it became necessary to limit the scope only to the energy field for which funding was most easily available. Similarly, of the two initial partners, VTT and an Egyptian real estate development company, the latter was not eligible for the selected financing instrument and was eventually replaced by a linked local NGO. **In the future, it would be good to consider the possibility of also launching R&D calls with a more holistic approach and a broader scope that can accommodate more comprehensive studies, instead of so narrowly focused on specific topics.**

For various reasons, such as insufficient or no funding, changes in socio-political interests, high turnover among the main actors involved, lack of commitment on the part of local stakeholders… it is practically impossible for foreign experts or consultants (in our case, VTT scientists) to establish a long-term link with the local project beyond our participation in the initial stages until its full achievement and practical application. **Consequently, in the future these processes could be designed in a way that allows for greater interaction with the actors involved in the different phases, or even a final event in which everyone could participate and exchange experiences and learning.**

There is typically no post-completion impact assessment beyond the final report and post-audit, which occurs shortly after the project is completed. Therefore, in order to understand the environmental, economic, and socio-cultural benefit derived from the project in the medium term, it would be necessary to be able to revisit the project, for

example five years after its conclusion. In this way, the impact generated in the local context could be verified and even quantified in relation to the initial defined objectives. However, in some cases, if the project is financed within a sub-programme that is in turn part of a broader programme, it is possible that the organization responsible for it will conduct an evaluation of the programme as a whole, as well as the different sub-programmes that comprise it, sometime after having been completed. But this does not necessarily guarantee that said evaluation is carried out in a way that allows measuring the real impact (understood as positive sectoral, or even social or systemic change, and to a certain extent quantifiable), much less the degree of success in implementation of the EcoCity concept that concerns us here. The fundamental reason is that these evaluation processes are frequently regulated by the programmes and sub-programmes themselves and therefore aligned with their goals and objectives. **Therefore, in the future it would be good if this type of calls could include the possibility of post-project monitoring and evaluation.** Of course, this is not easy to implement this in practice as organizations undergo changes, the experts originally involved may no longer be available, beneficiaries may have moved… but it would still be recommendable to enable mechanisms to evaluate the impact generated with a certain time perspective and neutrality.

5.4. Policy recommendations and solutions for practitioners

What follows is a compilation of recommendations derived from the research behind this thesis and organized according to the main target groups they are addressed to. It provides recommendations to:

- Third parties, more specifically donors and funding bodies, but also policy and decision makers.
- Practicing professionals (consultants, practitioners, researchers, technical experts…). In this case, the recommendations can be interpreted as "practical solutions".

Just to clarify, many of the recommendations given below have a double formulation: as a policy recommendation and as a solution for professionals, since, depending on the target group, the wording should be different. Therefore, in the corresponding cases, the same "recommendation" appears in both subsections but formulated to adapt to the target group.

Policy recommendations

- Design more comprehensive programmes and funding calls but also define policies that address the need to understand beneficial synergistic effects and foster the development of solutions that enable more systemic change.

- When designing programmes and funding calls, include a clear research component of the potential for scalability and replicability of the solutions (methodological, technological, process, etc.) developed and the possible barriers preventing their wider implantation.
- Develop an understanding of the complexity of these processes and the approach they require, as well as the importance of promoting capacity development, true participation, co-creation, expert facilitation, and appropriate mapping of relevant local stakeholders.
- Always keep in mind not only the need for but also the benefit that can be derived from local adaptation, in all contexts, but especially in the Global South where many of the preconditions existing elsewhere cannot be taken for granted.
- Promote the development of adequate financing and business models (including social entrepreneurship) to support the exploitation of innovative sustainable solutions through appropriate policies, programmes, and funding calls.
- Incorporate transparent monitoring systems to evaluate the progress of programs or projects both during their development and even after their completion if possible.

Solutions for practitioners

- When conducting research or consulting services, consider taking a more holistic perspective and exploring, to the extent possible, potential beneficial synergistic effects to maximize impact.
- When conducting research or consulting services, pay attention to the potential to replicate and scale proposed solutions and consider formulating recommendations for other practitioners interested in their adoption.
- Take the time to understand the complexity of the given situation rather than applying an oversimplified view that justifies and leads to an intervention based on generic ready-made solutions.
- Identify the preconditions that must exist for successful implementation, as well as the specific aspects that require local adaptation, and device appropriate strategies to address both.
- Carry out an accurate diagnosis of the current situation as a starting point for the process of developing locally adapted solutions. To this end, develop a baseline, either with available data or with data collected specifically for the project and, if necessary, supplemented with strong assumptions.

- Develop appropriate monitoring KPIs to evaluate progress towards goals throughout the duration of the project, and if possible, also afterwards.

5.5. Other quality indicators

This section brings together all those other scientific publications (papers, articles, reports…) and research projects in which the author of this thesis has directly participated that in some way support or expand the research presented here, thus corroborating its relevance, although they are not formally part of it. They are listed in chronological order. Most of them have been included as part of the bibliography in the articles (and paper) that constitute the thesis and that are shown above in Figure 4. A brief explanation of how they relate to the content of the thesis is also provided.

Publications (and related research)

- Antuña-Rozado, C., Wohlfart, L., Gandikota, V., Åkerman, M., Duderstadt, H. **How Frugal Innovation can empower citizens to make their life simpler and more sustainable. Insights from two ongoing initiatives.** SBEfin2022 Conference - Emerging Concepts for Sustainable Built Environment, 23-25 November 2022, Helsinki, Finland. IOP Conf. Series: Earth and Environmental Science 1122 (2022) 012063. DOI 10.1088/1755-1315/1122/1/012063 (SCIENTIFIC PAPER) https://iopscience.iop.org/article/10.1088/1755-1315/1122/1/012063/pdf

This paper is related to article 5 and the scientific article that precedes it, in the sense that it seeks alternative business models and approaches for the development and implementation/exploitation of innovative solutions that are durable, affordable and, in the case of frugal innovation, with an economy of means and the participation of citizens. In short, harnessing the creative potential of citizens in collaboration with the business sector can help cities and regions that typically struggle with tight budgets to develop better, more sustainable services and products.

- Antuña-Rozado, C., Reda, F., ElMahgary, Y. **Smart and sustainable urban development in Egypt: the case of Nabta Smart Town.** SBE19 Helsinki Conference, 22-24 May 2019, Helsinki, Finland. Awarded Best Paper contributing to a Healthy Built Environment by the Juho Vainio Foundation. IOP Conference Series: Earth and Environmental Science 2019, Vol. 297. DOI 10.1088/1755-1315/297/1/012002 (SCIENTIFIC PAPER) https://iopscience.iop.org/article/10.1088/1755-1315/297/1/012002/pdf

This paper constitutes the seed of Article 4, published later, and mainly analyses in a preliminary way the results obtained in NST using the methodology developed by VTT

and applied in collaboration with local experts. It also opens the discussion, which is then continued in Article 4, on the potential for application at different scales and in different contexts, geographical or otherwise.

- Antuña-Rozado, C., Herzog, C. P., Freitas, T., Cagnin, C., Wiedman, G. **Nature Based Solutions (NBS) for sustainable and resilient cities: experiences from Europe and Brazil.** SBE19 Helsinki Conference, 22-24 May 2019, Helsinki, Finland. IOP Conference Series: Earth and Environmental Science 2019, Vol. 297 (SCIENTIFIC PAPER)
  https://iopscience.iop.org/article/10.1088/1755-1315/297/1/012001/pdf
- Herzog, C. P., Antuña Rozado, C. **The EU-Brazil Sector Dialogue on nature-based solutions. Contribution to a Brazilian roadmap on nature-based solutions for resilient cities.** European Commission, Directorate-General for Research and Innovation. Publications Office of the European Union, September 2019. (REPORT)
  https://oppla.eu/sites/default/files/docs/EU-Brazil-NBS-dialogue-2409-light.pdf

The two previous publications are part of the outputs of the EU-Brazil Sector Dialogue on NBS (EU-Brazil Dialogues, 2019), a learning alliance that seeks to define a cooperation agenda around common topics of interest in relation to NBS. To this end, relevant examples of successful NBS recently implemented or in development/planning in both Europe and Brazil were mapped, with special emphasis on their potential for replicability, scalability, and adaptability to the local context. As has already been discussed, this is a fundamental aspect of the research behind this thesis and therefore, both publications are closely related to it, even when they do not focus specifically on ecocities. On the other hand, the design, financing, and implementation of NBS has many similarities with the process described in the thesis, including the obstacles typically encountered.

- Antuña Rozado, C., Hedman, Å., Tuominen, P., Reda, F., ElMahgary, Y., ElShazly, A., GamalEldin, M., Kamel, A., Negm, A., Tawfik, A. et al. **EcoNBC Feasibility Study. Transforming New Borg El Arab into an EcoCity.** VTT Technology 2015, Vol. 220, 82 p + app. 6 p. VTT, Espoo, Finland (REPORT)
  https://www.vtt.fi/inf/pdf/technology/2015/T220.pdf
- Tuominen, P., AbdelMonteleb, A., Abd Elhafez, S., Balbaa, O., Dawoud, W., Elboshy, B., ElMahgary, Y., Elkafoury, A., Elshafei, G., ElShazly, A., GamalEldin, M., Hedman, Å., Jantunen, J., Kamel, A., Kamel, M., El-Nashar, A., Negm, A., Pajula, T., Antuña Rozado, C., Saeed, H., Salem, B., Samy, A., Shahin, M., Yousry, M. **EcoCity roadmap for Egypt. Actions for eco-efficient urban development.** VTT Technology 2015, Vol. 215, 36 p. VTT, Espoo, Finland (REPORT)
  https://www.vttresearch.com/sites/default/files/pdf/technology/2015/T215.pdf

- Hedman, Å., Antuña-Rozado, C., Jantunen, J., Tuominen, P., Balbaa, O., ElMahgary, Y., ElNashar, A., ElShazly, A., GamalEldin, M., Hamza, A., Kamel, A., Negm, A., Saeed, H., Salem, B., Shahin, M., Tawfik, A., Yousry, A, Youssef, W. **Readiness for EcoCities in Egypt. Insights into the current state of EcoCity systems, technologies, and concepts.** VTT Technology 2014, Vol. 161. VTT, Espoo, Finland (REPORT) https://www.vttresearch.com/sites/default/files/pdf/technology/2014/T161.pdf

The three reports above are mainly related to Article 2 (i.e., METHODOLOGIES FOR ECOCITIES), but also to Article 1, which addresses the VTT EcoCity concept more generally, and to some extent to Article 4 as well. These reports cover in detail some of the most relevant results of the "EcoNBC, EcoCity Capacity Building in New Borg El Arab City" project funded by the Ministry for Foreign Affairs of Finland, such as the feasibility study carried out to evaluate the potential of NBC to transform into an EcoCity, the roadmap towards EcoCities in Egypt, and the state-of-the-art report on what the concept of EcoCity means in the Egyptian context, which provided *an "overview of the current state of urban planning, energy systems, water and waste management, transport planning and general awareness raising".*

- Antuña Rozado, C., Huovila, A., Ahvenniemi, H. **Sustainable education of the construction sector in Zambia.** Smart and Sustainable Built Environments (SASBE) Conference, 9-15 December 2015, Pretoria, South Africa. Published in conference proceedings. (SCIENTIFIC PAPER)
- Antuña, C., Huovila, P., Chitenge, B., Mwansa, J., Mwanza, K. **EcoLusaka project: sustainable education of the construction sector in Lusaka, Zambia.** African Newsletter on Occupational Health and Safety. Finnish Institute of Occupational Health. Vol. 23, No. 68-71, 2013. (ARTICLE)

The two previous publications relate to EcoLusaka project featured as a case study in Article 3. More specifically, each covers an important outcome of the project, namely the development of a new so called "EcoCurriculum" and its position within a broader intervention strategy, and the improvement of health and safety conditions (i.e., Occupational Safety and Health, OSH) both for the local partner, Thorn Park Construction Training Centre (TPCTC) and for the construction sector in Zambia. The latter was possible thanks to close collaboration with key actors in Finland and Zambia, such as the Finnish Institute of Occupational Health (FIOH) and the Zambia Green Jobs Programme (ILO, n.d.) run by the International Labour Organization (ILO) office in Lusaka. This initiative was supported by key local stakeholders such as Lusaka Business and Technical College (LBTC) and the National Council for Construction (NCC).

Research projects

- **FRANCIS_Frugal innovation by citizens for citizens (01/02/2021 – 31/10/2024).** Funded by European Commission under the H2020 Programme, the primary goal of FRANCIS is to harness citizen science for the development of frugal innovations (FIs) that generate high-quality, affordable solutions. To that end, FRANCIS will run open innovation challenges that bridge geographic distances and social backgrounds for the development of FIs with citizens from developed, developing, and emerging countries. Special attention will be paid to the inclusion of marginalized groups such as the elderly, large families, and people with a minimalist lifestyle, all of whom are often neglected by the economy and society. https://www.francis-project.eu/about/

The main components of the FRANCIS project are direct citizen participation, including vulnerable groups, in the innovation process; the exploration of alternative development, financing and exploitation models, in this case through frugal innovation; as well as the need to adapt to different socio-cultural contexts, given that the planned innovation challenges are carried out in different regions of the world. These components, as well as the obstacles derived from their practical implementation, have many points in common with the topic of this thesis.

- **DIGILOGIC_Facilitating and stimulating the unleashing of innovation potential through the first Pan EU-Africa sustainable network of Digital Innovation Hubs (DIHs) focussing on smart logistics (01/01/2021 – 31/12/2023).** Funded by the European Commission under the H2020 Programme, DIGILOGIC aims to unlock the potential of Africa's young engineers and entrepreneurs by forming the first EU–Africa network of Digital Innovation Hubs (DIHs). These DIHs will support growth by allowing startups, SMEs, and innovators to contribute to the development of smart logistics solutions in collaboration with various industries. These solutions could offer significant opportunities for Africa's youth, strengthening EU–Africa cooperation and helping many African nations develop a sustainable and successful economy. https://digilogic.africa/

DIGILOGIC shares with the research behind this thesis a similar approach regarding effective collaboration with local partners, in this case with SMEs and other African organizations in the logistics sector. Accordingly, a support programme that includes knowledge mentoring, go-to-market focused learning, as well as peer-to-peer exchange and networking opportunities has been tailored to the specific needs and context of selected African SMEs.

- **Modelling4People_Smart cities as complex systems (01/2022 – 12/2022).** Smart cities are complex systems. Hence, the aim of this internally funded project was to investigate System Dynamics (SD) models that were simpler and precise enough to allow an agile but precise understanding of the complex phenomena that affect cities and their ecosystems. The potential use of nonlinear dynamic components was placed in a context that could be understood by non-experts, such as stakeholders, business managers, or decision makers.

Modelling4People aimed to develop a simplified approach that can support decision-making processes involving many stakeholders and complex, often rapidly changing situations. Therefore, as an instrument to facilitate sustainable urban and community development, it can be clearly linked to the "specific methodologies" component mentioned throughout the text (for example, see figure 3).

- **SHERPA_Sustainable Housing Design Tool for the Global South Global (2015-2017).** Funded by the 10YFP Trust Fund (One Planet Network SBC Programme), the project consortium was formed by 3 partners from France, Finland and UK coordinated by UN-Habitat; with pilot projects in Burkina Faso, Kenya, and Nepal. The main objective was to develop a hands-on, qualitative, and user-friendly design tool to assess the sustainability of affordable housing projects in the contexts of slum upgrading, social housing, post-crisis reconstruction and large scale affordable housing programmes. The tool should also consider human, social, and cultural factors, and not only “green” technologies.
  https://unhabitat.org/initiative/sherpa-your-guide-to-sustainable-housing

This was a key project in relation to the focus and content of this thesis, as it linked directly to the indicators and evaluation tools mentioned in Figures 6 and 9. Developing an easy-to-use self-assessment tool for the various stakeholders involved in the planning, design, construction, and evaluation of housing projects across the Global South proved to be quite challenging in many ways. Adequately addressing all the pillars of sustainability, maintaining a holistic approach, ensuring that local communities have a say in decisions, covering the entire process from the project inception and site selection to design and construction, and even beyond to the end of the life cycle, thus having to consider the recyclability of construction materials and future deconstruction... everything had to be balanced and combined in a tool that could be accessed both offline and online through a simple but attractive (software) application.

6. Final thoughts

This thesis constitutes the first attempt to address the VTT EcoCity concept in its entirety, thus encompassing both its overall formulation and its defining elements, as well as the interrelationships between them (see Figure 6). In doing so, it recognizes the numerous aspects, for example, technical, human, sociocultural, economic, related to governance and policies, regulatory, among others, which concur in such complex projects. Moreover, this thesis also investigates the corresponding implementation process and the main components around which it revolves, namely capacity building and local adaptation (see Figure 8). To begin to unravel all this complexity, the author argues that a comprehensive or holistic approach is essential, which in turn must be supported by multidisciplinary collaboration between experts in the various disciplines involved, including partners and local stakeholders. Partial visions, from any perspective (energy, housing, transport, waste, water...) are, of course, necessary, but not sufficient. Even if local partners or clients decide to take a narrower approach, either for budgetary or political reasons or due to funding available for certain studies, and focus solely on energy for example, a panoramic view becomes necessary to understand the dynamics at play. As a logical consequence, each aspect mentioned above opens up an entire field of study, which in turn would justify the need to carry out more doctoral theses in the future to address these interesting topics in depth.

On the other hand, this same thesis also constitutes a first attempt to extract valuable knowledge and, to the extent possible, practical lessons that can be extrapolated to other similar processes to promote effective local adaptation. Once again, this decision leads to a vast field of research in which many aspects still remain to be explored and where a holistic vision is also required.

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The following bibliographical references correspond to the content of this summary. The rest of the references of the research that supports this thesis can be consulted in the articles included in the Annex.

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Annex

energies

MDPI

Article

Challenges in Adapting Sustainable City Solutions from Finland to Different Contexts Worldwide: A Libyan Case Study

Carmen Antuña-Rozado [1,2,*], Justo García-Navarro [2] and Pekka Huovila [3]

1 VTT Technical Research Centre of Finland Ltd., PO Box 1000, FI-02044 VTT Espoo, Finland
2 Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIA—Ciudad Universitaria, s/n, 28040 Madrid, Spain; justo.gnavarro@upm.es
3 Sustainability Laboratory Oy, 00640 Helsinki, Finland; pekka.huovila@slab.fi
* Correspondence: carmen.antuna@vtt.fi; Tel.: +358-40-199-3522

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Abstract: The EcoCity concept presented here has been designed in Finland and improved through collaboration with local partners and stakeholders to adapt to varying contexts while trying to provide solutions for the improvement of human settlements around the world, particularly in the Global South. Supported by specific methodologies and effective facilitation processes and skills, also developed by VTT Technical Research Centre of Finland Ltd. (VTT), it provides a structured yet flexible framework for conducting the complex dialogue leading to ecocity implementation, the importance of which is typically overlooked. This article discusses the theoretical underpinnings of the concept in relation to the general ecocity debate, as well as its main historical influences linked to the Finnish urban development tradition. The process thus enabled is illustrated by a Libyan case study.

Keywords: EcoCity; capacity building; Eco-Viikki; local adaptation; New Urban Agenda (NUA); participation; sustainable urban development

1. Introduction

According to the United Nations Population Division, 54.5 per cent of the world's population were living in urban settlements in 2016, whereas by 2030 it is expected that 60 per cent of people globally will live in urban areas with one in every three people living in cities of at least half a million inhabitants [1]. Urbanization poses enormous challenges for cities around the world, particularly in the Global South: adequate infrastructure, affordable housing, public transport, decent employment, access to services, clean energy, water and waste management, food security, environmental quality, etc. To address these challenges, the recently adopted UN-Habitat New Urban Agenda (NUA) [2] has set a new standard for sustainable urban development *"specially committed to*:

- *Provide basic services for all citizens;*
- *Ensure that all citizens have access to equal opportunities and face no discrimination;*
- *Promote measures that support cleaner cities;*
- *Strengthen resilience in cities to reduce the risk and the impact of disasters;*
- *Take action to address climate change by reducing their greenhouse gas emissions;*
- *Fully respect the rights of refugees, migrants and internally displaced persons regardless of their migration status;*
- *Improve connectivity and support innovative and green initiatives;*

- *Promote safe, accessible and green public spaces".*

Now national governments, as well as regional and local authorities, must take their turn in implementing the NUA and to that end, establishing the right technical and financial partnerships across the international community is of great importance. Likewise, national urban policies should be developed to support the implementation of the NUA by means of urban regulations, urban planning and design, and municipal finance. However, in practise, bridging the gap between national and regional policies and local intervention through concrete projects is far from being an easy task.

Ecocity projects can contribute to the achievement of the objectives of the NUA if used, not as rigid "models" of sustainable urbanization (much less as physical "models") to be replicated worldwide as intended by some of them [3,4], but as a transformative force and a laboratory for new ideas as argued by Rapoport [5]. Despite the constant challenge of finding a balance between utopian visions and concrete realizations [6], which has raised considerable criticism, ecocity projects can have a positive impact in terms of increasing environmental awareness, setting examples of good practice that might inspire new ecocity developments, testing innovative solutions, or sparking a public debate on what is a sustainable city. The benefits of demonstration projects is shown by the research on Northern European ecological communities conducted by Saunders [7].

More concretely, the EcoCity concept developed by VTT Technical Research Centre of Finland Ltd. (VTT) for sustainable community and neighbourhood regeneration and development has been designed to make possible the formulation of solutions that can be adapted to different local conditions supported by specific methodologies and effective facilitation processes and skills. As shown by Antuña-Rozado et al. [8], during the EcoMedellín project VTT's EcoCity facilitation enabled on the one hand the articulation of the "grey" and the "green" components, and on the other the change of scale by moving from national and regional policies to a specific local project [8]. Therefore, in this sense the EcoCity concept, methodologies and facilitation can help to bridge the gap identified in the implementation of the NUA. As it will be explained along the article, VTT's EcoCity concept is flexible and constantly evolving to allow the inclusion of other relevant perspectives like those introduced by digitalization (smart solutions), Nature-Based Solutions (NBS) or circular economy, if considered pertinent (and feasible) in the course of the dialogue established with local stakeholders. It seems necessary to clarify that "EcoCity" refers to VTT's own developed concept and related activities, whereas "ecocity" or "ecocities" refer to the generic concept, activities and examples.

Looking at the existing literature, there seems to be a general consensus on the fact that there is not a universally accepted definition of what is an ecocity, as pointed out by a number of authors like Roseland [9] or Joss [10]. This has led to a division in opinion between those that believe that the lack of a clear definition is detrimental to the validity of the concept, and those that consider it positive since it leaves enough margin for the development of locally attuned solutions in a variety of contexts worldwide like Surjan and Shaw [11] or Wong and Yuen [12]. The first ones often insist on the need for assessment frameworks and standards like the Ecocity Framework and Standards developed by Ecocity Builders & the International Ecocity Advisory Committee [13], or indicators as proposed by Kline [14]. VTT's EcoCity concept probably lies somewhere in the middle of these two positions since as corroborated by the authors' experience, considerable flexibility is needed for local adaptation, but at the same time it is necessary to set targets and follow them up, as well as to monitor the performance in specific areas (e.g., air, energy, water).

There seems to be no consensus either regarding the scale of ecocity projects, which in practice can range from relatively small interventions (neighbourhood regeneration and urban retrofits) to whole new towns like those built in Asia and the Middle East. This diversity has led authors like Jabareen to define the ecocity as an *"umbrella metaphor that encompasses a wide range of urban-ecological proposals that aim to achieve urban sustainability"* [15], which matches quite well the authors' observations in all VTT's EcoCity related activities so far.

The in-depth critical analysis of concrete case studies carried out by some authors like e.g., Caprotti or Cugurullo, has contributed to expose the multi-faceted reality of ecocities and the challenges of the

ecocity development process [16,17], both relevant issues not sufficiently covered by the literature. It is for such process, particularly in its early stages that VTT's EcoCity concept provides a structured yet flexible framework for conducting the complex dialogue leading to ecocity implementation, which may be its main differentiating factor. Therefore, this article aims at contributing to the abovementioned debate on the complexities and nuances of the process towards the implementation of ecocities worldwide, as well as on the varying local conditions requiring adaptation. This contribution is half way between theory and practice, inasmuch as VTT's EcoCity concept is placed in the context of the ongoing ecocity debate, thus adding to its intellectual side, but the content and reflections provided originate from practical experience in guiding and supporting the multi-stakeholder dialogue, as the Libyan case study presented illustrates.

2. Research Aim, Methodology and Novelty of the Approach

VTT's EcoCity concept has been designed and improved through collaboration with local partners and stakeholders for the improvement of human settlements around the world, especially in the Global South. The aim of the research shown here is two-folded. On the one hand, to frame the theoretical and historical underpinnings of the concept in relation to the general ecocity debate, thus completing the trilogy including the two previous articles [8,18] focusing on its practical side and covering the methodologies and facilitation processes and skills specifically developed to support the implementation of the concept. On the other hand, to exemplify through a case study how the concept is applied in practice in a specific local context

The methodology followed consists of first explaining why and how the concept developed by VTT emerged, and its links to the Finnish urban development tradition illustrated through relevant examples (Tapiola Garden City, Otaniemi High-Tech Park, and Eco-Viikki) and future opportunities provided by emerging concepts (e.g., Circular Economy and Nature-Based Solutions); then discussing its main components in relation to different approaches, proponents, scope, etc., within the general ecocity panorama; after that showing how the concept and its objectives are communicated and carried forward, briefly illustrated through a case study (Libya); and finally drawing conclusions from the experience in numerous EcoCity activities and projects worldwide.

In short, VTT's EcoCity concept relies upon: (1) the close collaboration with reliable local partners; (2) the adaptation of the solutions proposed to the local conditions; (3) the effective participation of key stakeholders; and (4) the use of specific methodologies and facilitation processes and skills mentioned above. The previous aspects when considered separately do not necessarily constitute a novelty, but their integration into a holistic and flexible framework certainly does. Seen retrospectively, the fact that such framework is used to guide and support the multi-stakeholder dialogue ultimately leading to ecocity implementation, invariably complex and full of challenges, particularly in the first stages, is particularly value-adding. In addition, experience corroborates the importance of adequate assessment tools and indicators in order to set targets and monitor their degree of achievement. Consequently, the concept is enriched and strengthened with each case study, and in turn, the concept thus improved benefits subsequent case studies, resulting in a sort of "continuous improvement feedback loop" which is another novel aspect.

3. Background and Main References

The ecocity concept presented was formulated in Finland, a Nordic country with a long history of promoting sustainable development, both nationally and internationally. The Finnish National Commission on Sustainable Development (FNCSD) was established in 1993, following the repercussion of the Brundtland Commission Report [19], and the 1992 Rio Conference with its subsequent Declaration on Environment and Development [20]. Since its inception the FNCSD has implemented numerous programmes and strategies, the latest of which, "The Finland we want 2050 —Society's Commitment to Sustainable Development" was adopted in 2013 and updated in 2016 in alignment with the UN 2030 Agenda for Sustainable Development [21]. The Finnish approach towards sustainable development is a

holistic one, integrating *"the wellbeing of people and the environment, a healthy and sustainable economy and the promotion of sustainable lifestyles"* [22]. VTT's EcoCity concept stands on the same holistic approach while trying to respond to the needs and challenges typically associated to sustainable community and neighbourhood regeneration in the Global South. To achieve successful results in this regard, close collaboration with reliable local partners and relevant stakeholders has proved to be of crucial importance, as well as adaptation to varying local conditions as discussed by Antuña-Rozado et al. [8]. The references discussed in the next paragraphs should not be considered as a separate set of examples belonging to a specific domain, but as part of a much wider process spanning for decades and involving political commitment, constantly developed technical capacity, adequate legislative framework, and strong citizens' awareness and participation. It is rather this long-term societal quest for sustainable development that should be promoted, instead of a fragmented approach marked by a series of costly flagship ecocity projects, which very often fail in fulfilling the initial expectations. Particularly successful examples of sustainable urbanization in Europe like Freiburg (Germany) or Vitoria-Gasteiz (Spain) to name a couple, corroborate the importance of an integral approach sustained in the long run.

When focusing more specifically on Finland's urban planning and development tradition, the main references of VTT's EcoCity concept are Tapiola Garden City (1950s and 1960s, Espoo), Otaniemi High-Tech Park (1960s, Espoo) and Eco-Viikki (1990s, Helsinki). Based on Ebenezer Howard's Garden City (1898–1902) and its first practical applications in England (Letchworth, Hampstead Garden Suburb and Welwyn Garden City) [23], Tapiola Garden City in Espoo, a municipality next to Helsinki, was built by the Finnish Housing Foundation in response to the great post-war social demand for housing. The project responded mainly to the vision of Heikki von Hertzen, the executive director of the Housing Foundation at the time, who wanted to create *"a modern city that would address the housing shortage in Helsinki and would be both economically viable and beautiful"* [24]. His somehow utopian vision went beyond the dwellings and aimed at building a healthy city that would provide an alternative to what was perceived at the time as an *"oppressive urban environment"*, in the form of a self-sufficient community providing all services and facilities necessary to meet the needs of 30,000 inhabitants including the surrounding districts [25].

The original plans for Tapiola Garden city made by Otto-Iivari Meurman were modified by the Housing Foundation and then handed over to a group of prominent Finnish architects like Alvar Aalto, Aarne Ervi and Kaija Siren who were commissioned to design their own part of the city and its buildings. Other innovative features of Tapiola Garden City, even more considering the period during which it was built, was the multi-disciplinary and participatory approach taken. The city was the result of a successful teamwork that involved architects, civil engineers, sociologists, landscape architects, and experts in domestic science and child welfare. Participation was considered at different stages of its development, and even the name of the city itself ("Tapiola" derives from Tapio, the Finnish forest god mentioned in Kalevala) was chosen through public competition [26]. An adequately validated participation of key stakeholders (see Antuña et al., [8]) is an essential component of VTT's EcoCity concept, which builds on the participatory tradition of Finnish urbanism exemplified by Tapiola Garden City.

The development of Otaniemi High-Tech Campus was initiated in 1946 when it was decided to move the Helsinki University of Technology (TKK, nowadays Aalto University) and the Technical Research Centre of Finland (VTT) from Helsinki city centre to Otaniemi in Espoo. Gradually, different facilities were built and by the beginning of the 70s, most departments of TKK had moved to the new location [27]. The heart of Otaniemi High-Tech Campus consists of the main university buildings like the auditorium, the library, administration offices, a number of faculties and a small shopping centre. Close by there is housing and other facilities such as a convention centre, a sports hall, a chapel and a hotel.

At present, Otaniemi is a technology and innovation hub that brings together academia, research and high-tech companies (also start-ups) in a very stimulating natural environment well accessed by public transport, including the recently inaugurated metro line between Helsinki and Espoo. Very soon

Otaniemi will also host the European Space Agency's (ESA) new arctic space accelerator, and the first European United Nations Technology Innovation Lab (UNTIL) at the recently established A Grid start-up hub [28]. Like Tapiola Garden City and Otaniemi High-Tech Campus, VTT's EcoCity concept promotes an urban model where nature is strongly present, and within walking distance, in the form of forests and wild areas, historic mansion parks, other parks of various sizes, gardens, and lakes for all the citizens to enjoy its biodiversity and benefit from the ecosystem services provided.

Eco-Viikki has attracted a lot of attention both nationally and internationally since it was built in the 1990s, following an architectural competition that specified that proposals had to be ecologically sustainable through the minimization of the use of non-renewable energy sources and rapidly diminishing raw materials, reduction of pollution levels, noise and waste; minimization of the stress on natural resources and local ecosystems; residents empowerment and awareness raising on ecological sustainability [29]. Research programmes for Sustainable Development and Ecological Buildings were initiated to establish what sustainable development in urban planning and building entails. The need to test ecological principles in practice resulted in an invitation to local authorities around the country to work on experimental ecological construction in January 1994 [30]. Figure 1 shows a few images of the main references discussed.



Figure 1. Top row: Tapiola Garden City, the first centre and housing developments from the 1950s. Middle row: Otaniemi High-Tech Campus, Undergraduate Centre (left) designed by Alvar Aalto and nowadays part of Aalto University, and Technopolis Innopoli 1 office park (right). Bottom row: Eco-Viikki. (All photos: Pekka Huovila).

In Helsinki, Viikki was chosen as a test bed because it was sufficiently urban, connected to the existing communal structure and easily accessible by public transport. Already at an early stage, there was an awareness that ecological criteria were required to assess the ecological profile of the neighbourhood. Since no such measures were in use in Finland at the time and it was felt that various

criteria used elsewhere could not be directly applied to Finnish conditions, a group of building consultants defined those specifically for Viikki in 1997. These criteria were used to assess the emissions, resource efficiency, human health, biodiversity and local food production of the projects to be developed [31]. This constitutes a clear example of adaptation to the local context, of the assessment framework in this case, which is a defining characteristic of the EcoCity concept discussed. The winning entry (of 91 proposals submitted) was based on a finger-like structure where the buildings are grouped around residential precincts ("home zones" where pedestrians have the right of way), with "green fingers" penetrating between the built areas, so that every plot is directly linked to the green areas. The major part of the buildings were directed optimally towards the south [29]. Figure 2 shows both the criteria established and the solutions adopted for Eco-Viikki.

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ECOLOGICAL CRITERIA FOR ECO-VIIKKI				
POLLUTION	**NATURAL RESOURCES**	**HEALTH**	**BIODIVERSITY**	**NUTRITION**
Carbon dioxide emissions Clean water consumption Building material waste Household waste Environmental labelling	Primary energy Heating energy Electrical energy Adaptability and multi-use of space	Indoor climate Moisture risks Noise Wind and sun Alternative house plans	Plant selection and habitat types Storm-water management	Cultivation of useful plants

SOLUTIONS ADOPTED FOR ECO-VIIKKI	
"GREEN FINGERS" extending into the block structure	Provide opportunities for farming and composting, as well as for the utilization of rainwater collectors
240 M2 OF SOLAR PANELS	Provide electricity to 39 apartments. (Finland's first apartment building generating solar electricity was built in Viikki in 2003)
VARIOUS SOLAR SYSTEMS TESTED IN DIFFERENT ROOFS	The thermal energy generated is utilized primarily in domestic water heating, and also for floor heating in wet spaces
RESIDENTS' BUILDING (2002)	Common activity facility the cost of which is shared by all housing corporations
DENSE VEGETATION	Planted to attenuate the windiness of the area, improve living comfort and reduce buildings' energy consumption
DITCH REPOSITIONED	Formerly running through the green areas, now separates the housing and the large open recreational area
GOOD QUALITY ARCHITECTURE	Combined with the use of renewable energy sources and local food production
VIIKKI ENVIRONMENT HOUSE (2011)	Finland's most energy-efficient office building was built close to the Eko-Viikki area developed in 1999-2004

Figure 2. Ecological building criteria for Eco-Viikki and main solutions adopted. Own elaboration based on content in [29].

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Beyond the initial ecological requirements, small-scale solar energy production and storm water management solutions, together with other sustainable technologies have been tested and monitored in Viikki. An extensive post-occupancy analysis identified the most successful applications from the residents' perspective. The findings indicated that, despite of real energy and water consumption levels being higher than projected, the strategies implemented still reduced those below standard development [32]. Developing an assessment framework that responds to the local conditions and following it up throughout the ecocity development process, as well as complementing it with monitoring of specific areas of performance (e.g., energy, water, etc.), is also encouraged when conducting a dialogue with stakeholders guided by VTT's EcoCity concept.

Although Eco-Viikki reflects its time, in the mid-1990s ecology was almost a synonym for sustainability, it managed to show how ecological sustainability goals can create not only ecologically-friendly, but also socially-mixed urban living environments with numerous options concerning their financing and forms of ownership. The solutions created originally from an ecological viewpoint gave the area a positive identity, increased residents' initiative and sense of community, added life to the shared yards, and increased the opportunities for inhabitants of all ages to spend time outdoors.

Many relevant initiatives in terms of sustainable urban (and regional) development and regeneration have followed Eco-Viikki, in not only Helsinki, but also all across the country. An exhaustive description of those would make this article too long, therefore, what follows is rather an

Sustainable Urban Development in Finland During Recent Years

Many relevant initiatives in terms of sustainable urban (and regional) development and regeneration have followed Eco-Viikki, in not only Helsinki, but also all across the country. An exhaustive description of those would make this article too long; therefore, what follows is rather an overview of where the process has led focusing on its present highlights. From a wider perspective and with regards to sustainable development, current initiatives in Finland are to be framed within the most important international agreements (already mentioned), and European strategic documents like the White Paper on the Future of Europe [33] or the recently published Towards a Sustainable Europe 2030 [34].

To its long tradition in supporting sustainable development, Finland can also add the accomplishment of having developed the world's first road map to a circular economy, "Leading the cycle—Finnish road map to a circular economy 2016–2025" [35]. Led by the Finnish Innovation Fund, SITRA, the road map outlines the steps towards sustainable success through "*pioneering solutions to ensure that economic growth and increased well-being are no longer based on the wasteful use of natural resources*". With an emphasis on concrete practical actions that can help to accelerate the transition to a circular economy, the road map gathers a collection of best practices and pilots involving all kinds of stakeholders (ministries, regions, cities and municipalities, companies, universities, research organizations, etc.). The focus areas for these actions are Sustainable food system, Forest based loops, Technical loops, Transports and logistics, and Common actions.

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Among the Finnish cities and municipalities committed to the development of innovative circular economy solutions (i.e., Jyväskylä, Kuopio, Lahti, Lappeenranta, Porvoo, Riihimäki, Rovaniemi, Turku and Vantaa), the city of Lahti constitutes a leading example of integrated waste management, not only in households, but also at an industrial level. If everything goes as planned, incineration and landfilling of waste in Lahti will stop by 2050. Moreover, the Päijät-Häme region, to which Lahti belongs, published in 2017 the first regional road map for circular economy. This environment is attracting all kinds of Cleantech companies.

In addition to circular economy, some Finnish cities and municipalities are also pioneering the development and implementation of Nature-Based Solutions (NBS) in response to climate change derived challenges. As an interesting example, Tampere, the third largest city in Finland, is investing in innovative co-created NBS for storm water management and the prevention of flooding since, according to the latest projections, rainfall in Finland will increase significantly in the coming years due to climate change [36]. Other challenges are air and water pollution, and reduced biodiversity. Tampere's main NBS demonstration site is Vuores, a green district to be completed by 2030, providing residence for 13,000 people and 3000 to 5000 jobs (see Figure 3). The NBS demonstrated in Vuores will be scaled up and further developed in Hiedanranta, a former industrial area to be transformed into a residential area for 25,000 inhabitants and more than 10,000 jobs.



Figure 3. View of the storm water retention pond in Vuores Central Park. (Photo: Pekka Huovila).

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In the authors' view, there seems to be potential for "cross-fertilization" between circular economy and NBS, and eco-urbanism. However, since these can be still considered emerging concepts, there are not many examples of such hybridization.

4. Approach towards Sustainable Community and Neighbourhood Regeneration and Development

In this Section, the theoretical support of VTT's EcoCity concept is presented in relation to different approaches, proponents, etc., and in reference to concrete EcoCity activities and projects for better understanding. From the early days of ecocities as envisioned by Richard Register—mainly focusing on ecological aspects; through broader definitions of the term including also economic and socio-cultural aspects, or even localized visions like those proposed in Asia; to the more recent critical evaluation of notorious flagship projects worldwide.

4.1. Beyond the Strictly Ecological

Richard Register coined the term "ecocity" in 1987, when the concept of sustainability also emerged [37]. Back then, ecology and sustainability were considered almost the same, as it has been already pointed out when discussing Eco-Viikki. Along with time, other proponents and practitioners have expanded Register's definition of an ecocity as an *"ecologically healthy city"* to include, in recent years, issues like resilience and climate change as discussed by Newman et al. [38]. Likewise, VTT's EcoCity concept goes also beyond the strictly ecological in favour of a more general approach covering also economic, social and cultural aspects, quite close to Maclaren's vision of *"inter-generational equity, intra-generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual wellbeing, and satisfaction of basic human needs"* [39]. Furthermore, it also goes beyond the narrow focus on GHG emission reduction that dominated ecocity development in the period that followed the adoption of the Kyoto Protocol in 1997, in the implementation of which cities played an important role.

4.2. Local Definition (Negotiated and Agreed) of Sustainability

Experience from a number of EcoCity projects and activities worldwide corroborates the importance of adaptation to the local context due to varying socio-economic, socio-political, socio-ecological and cultural conditions as explained by Antuña-Rozado et al. [8] and illustrated through EcoMedellín and EcoLusaka case studies [8]. Supporting communities to develop and implement their own definition of sustainability is essential to the purpose, very much in line with Roseland [9] for whom there is not one universal definition of the ecocity and perhaps there should not be. Instead, he suggests establishing certain necessary conditions. Similarly, VTT's facilitation for EcoCity development tries to ensure that the framework defined together with local partners and stakeholders stays within the boundaries of the non-negotiable (necessary) conditions previously discussed and agreed upon, while allowing flexibility for locally attuned solutions to emerge.

Furthermore, authors like Wong believe that the particular idiosyncrasy of Chinese cities, as an example, justifies the implementation of their own form of sustainability focusing on a series of priority measures, which may not coincide with those of Western countries where some of them are commonly in use since decades [40]. In a similar manner, history and tradition may offer not only inspiration, but also a solid ground for local adaptation. For instance, in relation to modern Japanese cities, Brown suggests to take a look at the past, particularly that of the Edo period, just before industrialization, when the Japanese lived in harmony with their environment, to see what lessons can be drawn that may help us to achieve sustainability today [41].

4.3. The Role of Technology

Being born in Finland, one of the most technologically advanced countries in the world, technology certainly plays a central role in VTT's EcoCity concept, which is very common in contemporary ecocity initiatives around the world as shown by Joss [42]. Masdar City in Abu Dhabi (initiated in 2006) is a

very well-known example of ecocity featuring a number of clean technologies for the minimization of energy and water consumption, use of renewable energies, waste reduction, water and waste treatment, sustainable and smart transportation, etc. [43]. However, experience from EcoCity projects and activities shows that, as important as it may be, technology alone is not enough to address the complexity of the challenges faced by cities in their transition to sustainability. This is corroborated by a number of authors when critically analysing the results of major ecocity projects with a particular emphasis on technological aspects in China, Japan or South Korea, as an example. In China, the unified top-down approach to ecocity planning and implementation fostered by the central government has failed to take into account the specific local conditions (including local culture and narratives) and to engage the community in a meaningful way along the process [44]. According to Low, Japanese ecocities reflect the tension between tradition and modernity with a strong focus on the revitalization of urban centres by shifting to green technologies and renewable energy sources [45]. Similar in many ways to their Chinese counterparts, ecocity projects in South Korea put an even bigger emphasis on information and communication technology and smart solutions [46]. Songdo, an ambitious "u-eco-city" (ubiquitous-eco-city, a South Korean invention) already in its second phase of development, is an example of some of the intrinsic contradictions shared by many of these technology reliant ecocity projects. Located on the waterfront of Incheon city, its developers have sought to introduce a wide array of sustainable building practices, energy-efficiency measures, construction waste recycling, etc. However, Songdo is a large reclamation project built on former tidal-flats and sea-shallows causing an important loss of valuable biodiversity, e.g., shorebirds and water birds [47].

4.4. No Reliance on Physical Planning

Authors like Sharifi [48] or Holden and Li [49] maintain that, like the preceding urban planning movements, eco-urbanism relies too much on physical design to create social change, often ignoring important drivers and processes (see social aspects ahead) and thus compromising the success of the implementation. In this sense, VTT's EcoCities rather support a performance-based instead of a prescription-based approach to ecocity planning and development, very much in line with the idea of pluralism proposed by Bond et al. as an alternative to physical determinism [50]. The result is a flexible framework that can be applied at different scales, allows the participation of all relevant stakeholders, and takes into consideration the local context. Moreover, participation and capacity building are at the core of VTT's EcoCity concept as explained in previous articles and illustrated here by the Libyan case study. However, to guarantee the validity and governance of the results, certain requirements must be fulfilled in relation to the participants and the process [8]. Additionally, whereas certain local conditions are favourable to bottom-up initiatives and enable active and meaningful participation, others lead almost invariably to the adoption of a top-down approach and deficient stakeholder participation as already mentioned above in the case of Chinese ecocities.

4.5. Emphasis on Social Aspects

As discussed in the previous two articles, the experience and knowledge gained through a number of projects inside and outside Europe were the basis for the formulation of VTT's EcoCity concept. One of those early examples before the concept was formalized was a feasibility study to analyse the possibilities for an EcoCity to be built in Miaofeng Mountain Town in Mentougou District (Beijing, China). The area has high ecological value, which presents some restrictions, and consists of 17 separate villages. The study provided recommendations for the development of a long-term EcoCity model that would, not only address the existing environmental challenges, but also suggest activities (e.g., agriculture, tourism) to improve the economic performance of the whole area, and enhance the local culture and way of life. In addition, a set of guidelines were also developed covering the following categories: natural environment; built environment; urban structure, land demand; land uses, mixed used; public space; landscape and green areas; urban comfort; buildings; transport modes and public transport; individual motorized traffic; transport of goods; energy, water and waste

flows; building materials; socio-economy, social issues; economy; costs. A Sustainable Community Rating System based on indicators (environmental, economic and social) and specially developed for Miaofeng Mountain Town, complemented these guidelines [51].

In contrast with the recurring criticism of eco-urbanism worldwide generally showing an "*asymmetrical implementation of the three dimensions of sustainability*", or even using the environmental and social aspects to mask the real economic concerns driving ecocity projects as maintained by Cugurullo [52], VTT's EcoCity concept tries to balance all dimensions of sustainability through a holistic approach paying particular attention to issues of social and cultural importance. Especially concerning social and cultural issues, it is important to mention that a good number of VTT's EcoCity projects were either funded or somehow supported by the Ministry for Foreign Affairs of Finland. Consequently and to the extent that the nature of each of the projects allowed, they were aligned from the onset with Finland's Development Policy, which guides all those "*activities aiming at reducing poverty, implementing fundamental rights and promoting sustainable development globally*" [53]. Again, Nordic values are very much influencing the Finnish Development Policy, which currently focuses on four priority areas: (1) The rights and status of women and girls; (2) The growth of developing countries' economies to generate more jobs, livelihoods and well-being; (3) Democratic and better-functioning societies; and (4) Food security, access to water and energy, and sustainable use of natural resources [54].

4.6. Importance of Considering User Behaviour and Promoting Sustainable Lifestyles

Project experience shows that in order to achieve long-lasting results and to maximize the impact, it is important to engage the users. For example, as part of a Procurement Handbook for Sustainable Buildings commissioned by the United Nations in 2009, VTT worked on a case study in Kenya provided by the United Nations Environment Programme (formerly UNEP, now UN Environment). UN Gigiri, the new office facility in Nairobi housing the headquarters of both UN Environment and the United Nations Human Settlements Programme (UN-Habitat) aimed at being an environmentally sustainable showcase building for Africa [55]. When considering the possible measures that could be applied to decrease the building's energy consumption, it turned out that changing some of the users' behaviour had a considerable impact. The employees were used to have their own electric coffee makers and individual printers, even compact refrigerators in some cases. Coffee makers and refrigerators were removed and a space was arranged for a common cafeteria where the employees could enjoy their breaks together. Individual printers were replaced by a centralized copy room with multi-function printers. In general, all office equipment was changed to "greener" alternatives.

In all VTT's EcoCity projects and activities, the local partners and stakeholders acknowledged the importance of sustainable lifestyles either implicitly or explicitly. Most workshops, seminars, discussions, etc., highlighted the need to promote sustainable living and its connection with citizens' wellbeing and quality of life in cities. Hence, the efforts dedicated to awareness raising, capacity building and education, or citizens' participation as means to bring about social change if lasting results are to be achieved. Authors like Yu have pointed out that without true community engagement, eco-cities are not much more than a series of green and low carbon technologies often not fully understood by the ordinary residents [56]. Chinese eco-cities, typically developed without real involvement of the different stakeholders, usually miss out the valuable contribution that citizens can provide in terms of energy and resource savings, care for the environment, healthy living, social equality and inclusion. Once again, in the case of the Sino-Singapore Tianjin Eco-City, Flynn et al. have observed that not consulting the citizens about their lifestyles to know whether they are actually using the infrastructures available in the correct way may lead to malfunction or infra-utilization [57].

5. A Libyan Case Study

This section aims at illustrating through a case study how VTT's EcoCity concept is applied in practice to specific contexts worldwide, in collaboration with local partners and with the participation of relevant stakeholders.

In June 2012, the Ministry of Housing and Utilities of Libya (MHU) conducted a study trip to Finland to gather knowledge on Finnish expertise, solutions and technologies for the sustainable built environment. The trip included a number of site visits and meetings with relevant Finnish actors (including VTT), and ended with the drafting of a "Road Map on Finnish-Libyan cooperation in the field of Housing and Utilities" by the Unit for Northern Africa of the Ministry for Foreign Affairs of Finland. The Road Map stated that *"as a follow up, a feasibility study of Libyan ecocities could be made in collaboration with local partners, focusing on aspects of highest priority, e.g., drinking water, wastewater management, housing, etc."* This resulted in a Fact Finding Mission to Libya carried out by VTT in June 2013 and organized by MHU with the overall objective of supporting sustainable community regeneration and development in the country covering a number of aspects like urban planning, water supply, waste management, affordable housing and capacity building on these issues. VTT's EcoCity concept was used as the framework for the definition of the process' phases: Phase I—Fact Finding Mission to understand better local priorities and resources and to prepare the next phase; Phase II—Feasibility Study for development and capacity building for the local stakeholders; and Phase III—Implementation. However, despite the plans for continuation and the efforts made together with the local partners to cover also Phases II and II, due to the circumstances only Phase I illustrated here could be completed. In this context, Phase I—Fact Finding Mission to Libya consisted of the following tasks:

- Understanding local priorities through site visits and meetings with the authorities and other key stakeholders.
- Discussing the components of VTT's EcoCity concept with local decision makers.
- Meeting local business actors and academia to know better local market features, current practices and constraints, and to facilitate access to information.
- Identifying potential funding instruments or bodies that might support the development and implementation of EcoCities in Libya.

Table 1 summarizes the activities arranged during the Mission and the priority topics discussed, whereas Figure 4 shows the challenges, opportunities and risks identified during those discussions for EcoCity development in Libya. However, even though Libyan stakeholders were quite well represented and the agenda was very efficiently organized considering the relatively short time available, unfortunately civil society organizations (CSOs) and citizens associations were not engaged in those activities. This could have been solved in the subsequent phases, but as abovementioned, Phases II and III were never undertaken.

From the meetings with the different Libyan authorities and stakeholders it became clear that all the components defined for VTT's EcoCity concept, namely Energy Efficiency, Food Security, Jobs & Services, Public Transport, Sustainable Housing, Waste Management, and Water Security as shown by Antuña et al. [3], were very relevant in the Libyan context. Regarding the prioritization of those components, it also became evident that the emphasis should be on addressing the housing shortage in the country (around 400,000 housing units needed to be built in the coming years) while providing solutions for the serious environmental threats derived from the deficient management of wastewater and solid waste.

Table 1. Summary of the interview and site visits carried out during the Fact Finding Mission. (Carmen Antuña-Rozado, 2018).

Location	Organizations/Stakeholders	Priority Topics	Site Visits
Tripoli	Ministry of Housing and Utilities Tripoli Local Council Urban Planning Agency (UPA) Libyan National Centre for Standardization and Metrology (LNCSM) Housing and Infrastructure Board (HIB) General Company for Water and Wastewater (GCWW) General Company for Electricity and Renewable Energies Ministry of Transportation Ministry of Labour	• Briefing for the Mission and programme for the week • How does the market work, PPPs, leading actors, incentives for sustainable building • Tripoli Master Plan, environmental concerns, waste management challenges • Urban planning and land use in Libya, land ownership, town planning procedures • Standardization and certification, building product approval, Building Code • Building typologies, density, household size and social structure statistics, revenue collection, sanitation • Current state, objectives and solutions concerning wastewater treatment and drinking water management • Energy plans and tariffs, use of renewable sources • Public transport system, road network, use of private cars • Skills and willingness for job creation around sustainable city development, training courses	Old Town Wastewater outlet New housing developments Dumping site
Green Mountains	Shahat Local Council	• The Shahat Declaration • Developing the tourism industry • Housing plans • Wastewater management and solid waste collection	Visit to the Green Mountains region Ancient Cyrene archaeological site Susa
Benghazi	Benghazi Local Council Libyan Green Building Council (LGBC)	• Benghazi Master Plan, environmental concerns, waste management challenges • Sustainable building and neighbourhood assessment approach, certification plans	

Table 1. Cont.

Location	Organizations/Stakeholders	Priority Topics	Site Visits
Green Mountains	Shahat Local Council	• The Shahat Declaration • Developing the tourism industry • Housing plans • Wastewater management and solid waste collection	Visit to the Green Mountains region Ancient Cyrene archaeological site Susa
Benghazi	Benghazi Local Council Libyan Green Building Council (LGBC)	• Benghazi Master Plan, environmental concerns, waste management challenges • Sustainable building and neighbourhood assessment approach, certification plans	

ECOCITY CHALLENGES IN LIBYA	OPPORTUNITIES
Legal framework • No Building Code • Subsidized pricing (no incentives for saving energy and water) • Illegal housing • Lack of governmental commitment and enforcement	• **Right time for Libyan EcoCity implementation** • **Citizen's willingness for a sustainable built environment** • **Activate existing contracts (currently paralyzed) regarding wastewater treatment and housing** • **Awareness raising for water saving, waste management, energy use, etc.** • **Business from waste (calls for entrepreneurship)** • **Tourism (requires improved quality and service attitude)** • **Readiness of Ministry of Electricity and Renewable Energy for wider exploitation of renewable energy sources, e.g. solar domestic water heating** • **Readiness of Ministry of Labour for training job seekers and unqualified people for sustainable construction**
Environmental threats • Untreated wastewater is already an environmental catastrophe • Solid waste management is also a priority issue	
Housing • Urgent need of housing • Poor quality of existing built stock • Lack of sustainable examples	
MAIN RISK IDENTIFIED: High social and political instability	

Figure 4. Challenges and opportunities for EcoCity development in Libya. (Carmen Antuña-Rozado, 2018).

Figure 4. Challenges and opportunities for EcoCity development in Libya. (Carmen Antuña-Rozado, 2018).

5.1. EcoCity Action Plan for Libya

Based on the understanding of the Libyan context and stakeholders' needs obtained from the above mentioned discussions and targeted visits, an EcoCity Action Plan was proposed to be discussed with and validated by MHU (see Figure 5) including three main components:

All the aims and defined in UN-Habitat's EcoCity Action Plan Energy Efficiency, Food Security, Jobs & Services, Public Transport, Sustainable Housing, Waste Management, and Water Security as shown by Antuña et al. [3], were very relevant in the Libyan context. Regarding the prioritization of those

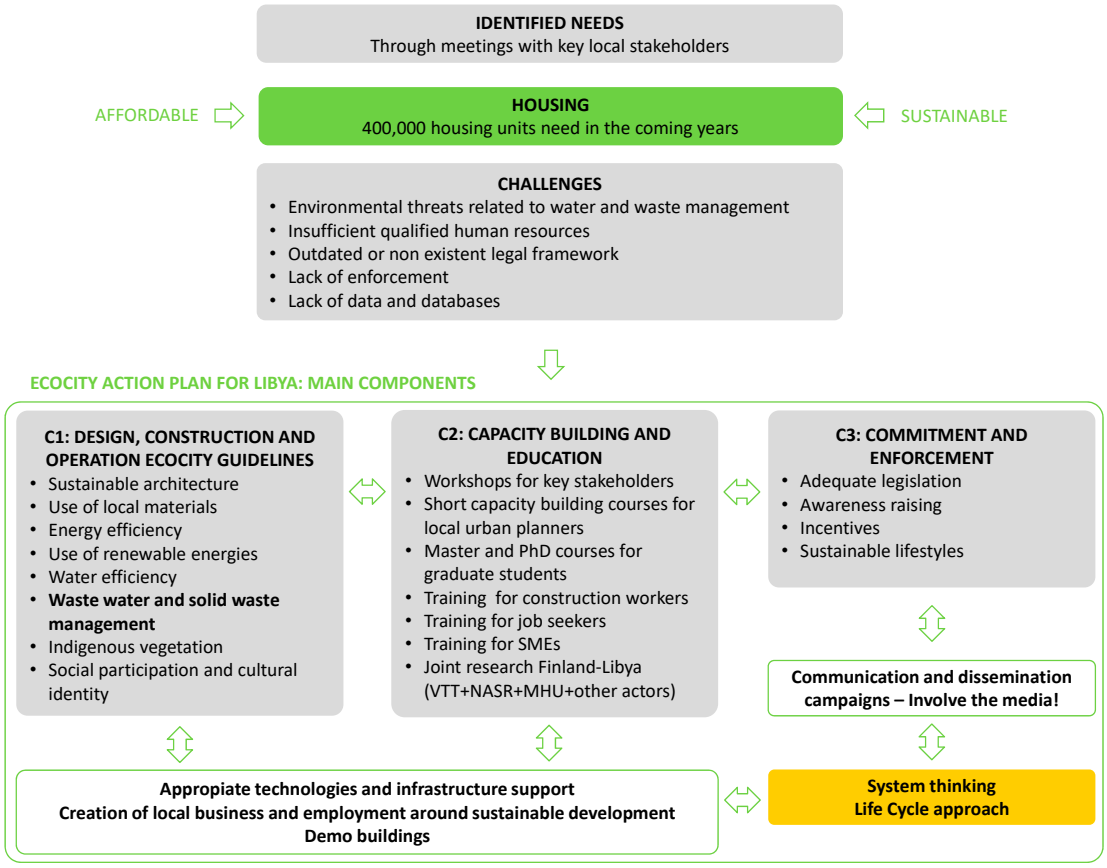


Figure 5. EcoCity Action Plan for Libya (Ministry of Housing and Utilities of Libya, VTT Technical Research Centre of Finland Ltd.).

- *EcoCity Guidelines for the design, construction, operation and maintenance of buildings (C1).*

This component responded to the urgent need of housing and the will of the Libyan authorities to make it sustainable and to initiate a transformation towards the implementation of the EcoCity concept in Libya. In this context, the direct application and demonstration of the EcoCity principles in the Libyan environment through selected pilot projects was deemed essential.

The list included in Figure 5 (Sustainable architecture; Use of local materials; Energy efficiency; Use of renewable energies; Water efficiency; Wastewater and solid waste management; Indigenous vegetation; Social participation and cultural identity) is not comprehensive, but it gives an idea of the principles that can be explored through the pilot projects. Addressing the problem of wastewater and solid waste management is of the utmost importance given the magnitude of the associated environmental (and social) impacts: pollution of the Mediterranean Sea, lagoons and groundwater; health and sanitation threats for the population, etc.

On the other hand, in the absence of proper building regulations and building code, the EcoCity Guidelines could serve as the first draft for the future Building Code for Libya, and as a blueprint for the Libyan administration to aid the design, construction and operation of all public buildings, including public housing. Citizens' participation is necessary to overcome initial opposition to the implementation of EcoCity principles and fundamental if long-term results are to be achieved.

- *Capacity Building and Education (C2).*

To carry out the previous component successfully, it is necessary to build the capacity of all the stakeholders involved through training and education programmes, hence the activities listed in Figure 5. Components C1 and C2 should be supported by the implementation of appropriate design contributes to citizens' wellbeing as argued by authors like Leyden et al. (2011) [58], and fosters economic growth by enabling new business opportunities and even attracting tourism as posited by Shoval (2018) [59].

- Finally, the construction (or renovation) of a few number of demo buildings around the country, in parallel to the real pilot projects, might help to exemplify the EcoCity principles and serve for instance as information points.

This important component relies heavily on the shoulders of the Libyan authorities because it requires high political commitment extended to all Libyan institutions in order to succeed in the implementation of an EcoCity Action Plan for Libya. Likewise, more enforcement is needed to ensure its application. However, this enforcement has to be supported by the development of adequate legislation, and by the raised awareness of the citizenship through education towards more sustainable lifestyles and incentives for the implementation of such sustainability measures.

Developing a dissemination and communication campaign and getting the media involved might be a good way to reach a wider audience throughout the country.

Finally, the whole EcoCity Action Plan should be considered from a lifecycle approach (taking into account the whole cycle of materials and processes) and a system thinking perspective (understanding that most often the problems are interrelated and holistic solutions are needed).

5.2. Potential EcoCity Pilot Projects in Libya

- Libyan authorities were committed to the sustainable reconstruction and development of the country and to the application of EcoCity principles to new urban developments as well as to the deteriorated areas existing in most Libyan cities. It is widely accepted that good urban planning and

technologies customized to suit the Libyan context avoiding a direct application of ready-made solutions that most likely will not work in the local environment.

All along the project, the creation of local businesses and employment around sustainable development should be promoted in order to strengthen the economic tissue of the country and contribute to its growth. This explains the stress on training also Libyan SMEs (Small and Medium Enterprises). To complement this activity, a business incubator could be also considered.

Finally, the construction (or renovation) of a few number of "demo buildings" around the country, in parallel to the real pilot projects, might help to exemplify the EcoCity principles and serve for instance as information points.

- *Commitment and Enforcement (C3)*

This important component relies heavily on the shoulders of the Libyan authorities because it requires high political commitment extended to all Libyan institutions in order to succeed in the implementation of an EcoCity Action Plan for Libya. Likewise, more enforcement is needed to ensure its application. However, this enforcement has to be supported by the development of adequate legislation, and by the raised awareness of the citizenship through education towards more sustainable lifestyles and incentives for the implementation of such sustainability measures.

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The main components included in the Action Plan would be developed through real pilot projects in Tripoli, Benghazi and Shahat/Susa (Figure 6). The proposed projects dealt both with urban development (new housing) and with urban regeneration (refurbishment of existing neighbourhoods), and included different building typologies.

Unfortunately, due to the worsening of the socio-political conditions in Libya (see risk in Figure 4) shortly after Phase I was completed, it was not possible to continue towards Phase II (Feasibility Study) and Phase III (Implementation) and the whole process was left in stand-by to be resumed when the country's situation allows.

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Figure 6. Potential Libyan EcoCity pilot projects in Tripoli, Benghazi and Shahat/Susa. (Ministry of Housing and Utilities of Libya, VTT Technical Research Centre of Finland Ltd. Photos: Pekka Huovila, 2013).

6. Conclusions

When reflecting on the purpose and the content of VTT's EcoCity concept in order to establish more clearly its theoretical and historical underpinnings, it becomes apparent that the concept builds on the Finnish tradition of urban planning and development, of which Tapiola Garden City, Otaniemi High-Tech Campus and Eco-Viikki are remarkable examples, as well as pioneering in many ways. For instance, the multi-disciplinary approach and strong emphasis on participation that characterize VTT's EcoCity concept were already present in the development of Tapiola Garden City as seen in Section 3, which at the time was rather a novelty. Many innovative solutions were successfully implemented in Eco-Viikki, even an ahead of its time introduction of NBS in the form of "green fingers" between blocks that enabled farming and composting, as well as rainwater collection. Another key component of VTT's EcoCity concept, adaptation to the local context, typically pursued in close collaboration with local partners and stakeholders, was also of particular importance when selecting the ecological building criteria for Eco-Viikki so that they would be suitable for the Finnish conditions.

Considered from an even wider perspective, Finland's long-standing commitment to sustainable development is defined by a holistic approach that aims at *"a prosperous Finland with global responsibility for sustainability and the carrying capacity of nature"* [22], and that also permeates VTT's EcoCity concept. However, such supportive environment, although mostly favourable for the formulation of this type of concept, entails the risk of taking for granted certain pre-conditions that pose a great concern for the target countries. In this sense, collaboration with local partners and stakeholders has been instrumental to make explicit what were originally implicit assumptions deriving from the Nordic view on sustainable development. This can be said of the ecocity concept in general. As Lye & Chen point out, the ecocity concept has originated in North America and has developed largely based on urban practices carried out in North American, European and Australian cities, which may limit its

applicability in other regions [60]. Moreover, as Myllylä and Kuvaja argue, the ecocity concept builds on the *"societal structures and relations already in existence (namely, democracy, strong civil society participation, political accountability, etc.) in modern and post-modern societies"*, and consequently it may not be able to provide adequate solutions for the challenges faced by cities in the Global South, which very often lack the pre-existing structures required [61]. For the authors of this article this is certainly an issue not to be taken lightly, but it does not invalidate the applicability of the concept in "Southern" cities. Hence the flexible and interactive framework capable of accommodating different local interpretations of an ecocity, while respecting a series of key principles that cannot be compromised.

The importance of adaptation to the local context, for which specific methodologies have been developed, has been repeatedly stressed by Antuña-Rozado et al. [18]. But equally important is the consensual approach towards a negotiated and agreed local definition of sustainability, and therefore an "own" definition of an EcoCity that, respecting certain non-negotiable conditions, will be ultimately appropriated by the local community as a whole. Hence the relevance of expert facilitation to support the local actors along this complex decision-making process, to help them ground their decisions on the available scientific evidence, and to link the solutions jointly formulated to existing technologies. Moreover, regardless of whether any given EcoCity project is initiated and developed top-down or bottom-up, what really matters is rather ensuring that all key stakeholders are involved through real and meaningful participation.

Somehow it can be argued that the EcoCity concept discussed here combines framework, methodologies and facilitation to support stakeholders in the Global South in the development of locally attuned EcoCity solutions following a jointly defined EcoCity vision. However, experience shows that it ultimately generates capacities and adaptation, not only on the local side but also in relation to the concept itself and its facilitators, through a dynamic of mutual learning and continuous improvement. Hopefully, this approach can help to move away from the "labelling fever" and an overreliance on technology that, according to many critical voices, affects numerous flagship ecocity projects worldwide which unfortunately have failed in engaging the community and even in creating a true sense of place as discussed by Piew & Neo [62]. Although it can be considered that the ultimate goal is the realization of an ecocity project, or in other words, a "built" ecocity, in the authors' view it is necessary to stress the complexity of the process leading to that realization, which very often does not receive the attention it deserves. VTT's EcoCity concept tries to contribute precisely to the dialogue that should be conducted as part of that process, and that as such has a value in itself, which should be separated from the final outcome—the built ecocity. Table 2 summarizes the results of the comparison between VTT's EcoCity concept and different approaches, which was explained more in detail in Section 4.

Table 2. Comparison between VTT's EcoCities and other approaches (Carmen Antuña-Rozado, 2018).

Other Approaches	VTT's EcoCity Approach
Ecologically centered	Integrated
Rigid models to be replicated worldwide	Locally defined models limited by non-negotiable principles
Technology driven	Technology "conscious"
Prescription based (physical design)	Performance based
Disregard for social aspects	Emphasis on social aspects
Lack of users/community engagement	Promotion of sustainable lifestyles

The Libyan case study illustrates how this dialogue is conducted. The EcoCity Action Plan for Libya drafted in collaboration with the local stakeholders attempts to build a bridge between the general vision posited by the "Road Map on Finnish-Libyan cooperation in the field of Housing and Utilities" (see Section 5) and the formulation of specific projects in selected intervention areas by supporting and informing what is always a complex decision-making process. When compared with

the Medellín case study, it can be seen how the same EcoCity concept leads to a different "Action Plan" precisely due to its flexibility, which enables adaptation to varying local contexts. The pilots identified in both cases are an important aspect in this transition towards concrete intervention projects because they connect the concept (theory) with the real examples (practice). However, the highly volatile situation in Libya, and in many other countries of the Global South for that matter, constitutes a serious hindrance for the full implemention of an ecocity transformation process, which is by nature complex and takes rather a long time to realize. The *"global north-based urban knowledge production system"* as Nagendra et al. rightfully call it [63], is supported by consolidated democracies, strong civil society participation (and awareness) and political accountability. The conditions in the Global South are very different from those that have shaped the urban development in the Global North, and therefore a new approach is required that potentiates the local capacities and pays attention to the specificities of the context. In the same paper, Nagendra et al. argue that despite the numerous challenges, cities in the Global South offer many opportunities for sustainability and have unique innovation and experimentation potential. Even though unfinished, the EcoCity path initiated in Libya may be a valid example of how to "downscale" the concept in order to make it applicable in such contexts, by focusing on specific issues according to the priorities of the country and defined case by case.

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Methodologies Developed for EcoCity Related Projects: New Borg El Arab, an Egyptian Case Study

Carmen Antuña-Rozado [1,2,*], Justo García-Navarro [2], Francesco Reda [1] and Pekka Tuominen [1]

[1] VTT Technical Research Centre of Finland Ltd., P.O. Box 1000, FI-02044 VTT, Finland; francesco.reda@vtt.fi (F.R.); pekka.tuominen@vtt.fi (P.T.)

[2] Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIAAB—Ciudad Universitaria, s/n, 28040 Madrid, Spain; justo.gnavarro@upm.es

* Correspondence: carmen.antuna@vtt.fi; Tel.: +358-40-199-3522

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Abstract: The aim of the methodologies described here is to propose measures and procedures for developing concepts and technological solutions, which are adapted to the local conditions, to build sustainable communities in developing countries and emerging economies. These methodologies are linked to the EcoCity framework outlined by VTT Technical Research Centre of Finland Ltd. for sustainable community and neighbourhood regeneration and development. The framework is the result of a long experience in numerous EcoCity related projects, mainly Nordic and European in scope, which has been reformulated in recent years to respond to the local needs in the previously mentioned countries. There is also a particular emphasis on close collaboration with local partners and major stakeholders. In order to illustrate how these methodologies can support EcoCity concept development and implementation, results from a case study in Egypt will be discussed. The referred case study relates to the transformation of New Borg El Arab (NBC), near Alexandria, into an EcoCity. The viability of the idea was explored making use of different methodologies (Roadmap, Feasibility Study, and Residents Energy Survey and Building Consumption Assessment) and considering the Residential, Commercial/Public Facilities, Industrial, Services/Utilities, and Transport sectors.

Keywords: EcoCity; EcoCity methodologies; Egypt; feasibility study; roadmap; energy survey; energy efficiency; sustainability scenarios; CO_2 emissions

1. Introduction

Historically, ecocity planning builds upon multiple traditions in urban planning. Among the early attempts to alleviate the negative effects of cities on the local nature and human wellbeing were the so called garden cities. Largely attributed to Ebenezer Howard and his ground-breaking book "Garden Cities of Tomorrow" [1], the garden city movement called for communities that are planned to be self-contained, limited in population, surrounded by green areas and connected to other similar cities by road and rail.

In the latter half of the 20th century, ideas about green or nature-friendly communities acquired a wider scope as more understanding about the complexities of ecological systems develops. Due to ecosystem effects, pollution and depletion of natural resources, a city's ecological impact need not only to be tempered locally, but also regionally and globally. An early example is Wolman's "urban metabolism" model that created a system of accounting for all material and commodities needed by a city [2]. McHarg, on the other hand, placed emphasis on the need to plan cities in accordance to the ecological and environmental conditions prevalent on the site [3].

The term "ecocity" itself was first coined in the 1980s by Richard Register through his Urban Ecology initiative and the publication of his book "Ecocity Berkeley" [4]. Also during this period the concept of sustainability had grown central in environmental thinking, epitomized by the Brundtland Commission Report [5]. In urban planning literature the key characteristics of sustainability have been summarized by Maclaren [6] as "*inter-generational equity, intra-generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual wellbeing, and satisfaction of basic human needs*".

A new perspective on ecocity planning arose as resilience grew in importance throughout the 2000's. As Newman et al. [7] have pointed out, cities that contain healthy ecosystems and social structures can absorb disturbances and still retain their basic functions and structures. Thus the resilience view points out the benefits of ecological planning in a time when the effects of climate change are a menace to cities.

VTT EcoCity Concept

Based on the experience and knowledge accumulated in numerous EcoCity related projects, mainly Nordic and European in scope, an EcoCity concept for sustainable community and neighbourhood regeneration and development has been developed by VTT Technical Research Centre of Finland Ltd. to respond to local needs in developing countries and emerging economies. EcoCity Miaofeng (China), EcoNBC (Egypt), EcoGrad in St. Petersburg (Russia), UN Gigiri (Kenya) or MUF2013 (Tanzania) are key reference examples.

Among the main challenges faced nowadays by cities are climate change and a number of related social and technological challenges [8,9]). These include climate change mitigation and adaptation, sustainable urbanization and affordable housing, integrated planning and funding availability, access to energy, capacity building for local solutions and services, citizen empowerment and participation, or crucial cross-cutting themes like gender issues and poverty alleviation. To respond to those challenges, the VTT EcoCity concept is built around a strong collaboration with local partners in order to answer to local needs previously identified with them. The flexibility of its approach allows the development and implementation of concepts and technological solutions adapted to the local conditions and customized to varying socio-economic realities worldwide [10]. This approach can be easily linked to Roseland's affirmation that "*it is at present safe to say that there is no (and perhaps should not be any) single accepted definition of ecocities or sustainable communities*" [11]. Moreover, VTT's experience corroborates the need to allow communities around the world to develop and implement a local definition of sustainability, very much in line with Wong and Yuen [12].

Precisely to enable local adaptation, several methodologies have been specifically developed and applied in different case studies. The purpose of this article is to describe those and to illustrate how they can support sustainable community regeneration and development through the results of a particular case study in Egypt related to the transformation of New Borg El Arab (NBC), near Alexandria, into an EcoCity. The importance of this transformation should be understood in the context of the enormous challenges faced by Egypt with regards to human settlements and the living conditions in those. Egyptian cities are increasingly struggling with social, cultural, economic and environmental problems like high unemployment, lack of housing, water scarcity, chaotic traffic, air pollution, noise, deficient infrastructure, etc. These problems cannot be solved with the same policies and strategies that have created the underlying systemic conditions, and therefore a new basic approach is necessary [13]. Hence the need for sustainable development, ecocities and for the methodologies presented here which, as a previous step, can mobilize the Egyptian stakeholders including planners and decision makers, by creating a constructive debate on the viability of the idea (in this case study, turning NBC into an EcoCity) supported by useful facts and figures to aid decision-making, and alternative approaches and solutions for putting the idea into practice. According to Joss' analytical categories for profiling and comparing ecocity initiatives, the case study discussed here can be categorized as follows [14]:

- Type of development: II—expansion of urban area
- Development phase: 1—pilot/planning phase
- Key implementation mode: b (integrated sustainability plan) and c (civic engagement)

Another recent study has explored the possibility of an environmentally-friendly tourist village in the vicinity of Alexandria, finding it to be an optimum location in Egypt when considering the value of greenhouse gas mitigation [15]. However, the approach proposed here is somewhat wider both in scope and methodology. The viability of the EcoCity concept was explored making use of different methodologies: Roadmap, Feasibility Study, Residents Energy Survey and Buildings Consumption Assessment [16]. In this case, "methodology" should be understood as a set of practices, quite established and systematized by now, developed and applied by VTT in order to support the development and implementation of local adaptations (in developing countries) of VTT EcoCity concept.

Finally, even though a large amount of literature exists covering the debate on ecocities, different approaches and proponents, and what are presented as practical realizations of the ecocity concept, etc., there is little relevant literature addressing the methodologies (understood as a set of practices) that can support the development and implementation of ecocities in local contexts worldwide. Therefore by putting the focus on how to achieve ecocities in practice, this article attempts to shed light on the obstacles that can be encountered, but also on the opportunities discovered, hopefully bringing depth to the practical side of the ecocity debate.

2. Methodologies Developed for EcoCity Related Projects

2.1. Ecocity Roadmap

Roadmaps have been used to both forecast and guide future developments. Modern roadmapping approaches have their roots in technological forecasting that was practised in the 1960s and 1970s to foresee the effects of fast-paced technological change on the society [17]. Simultaneously, the RAND Corporation developed the Delphi method of using expert panels for technology and business forecasting [18]. The company to first use a modern business roadmapping method was Motorola in the 1970s [19]. Bob Galvin, the CEO of Motorola at the time, defined a roadmap thus as *"an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field"* [20]. The roadmapping method used here for ecocities is close to this classical definition, but adapted for use in the context of Egypt and local sustainability issues concentrating on the case area.

Figure 1 presents the outline of the roadmapping work, adapted for VTT EcoCity concept from Kazi and Wolf [21], and applied for the first time in the project "EcoNBC, EcoCity Capacity Building in New Borg El Arab City (NBC)", a project funded by the Institutional Cooperation Instrument (ICI) under the Ministry for Foreign Affairs of Finland. The strategic roadmapping and implementation actions method focuses on the achievement of three main goals:

(1) setting key priorities (vision),
(2) developing thematic roadmaps and
(3) identifying implementation actions.

The aim of the roadmap is to match short-term and long-term goals with specific technology solutions to help meet those goals. The development of the EcoCity roadmap has three major uses: it aids in reaching a consensus about a set of needs and the technologies required to satisfy those needs, it provides a mechanism to help forecast technology developments and it functions as a framework to help plan and coordinate future technology developments. The roadmap, while developed with the particular case of NBC in mind, was intended to be applicable for the whole of Egypt. Indeed, many of the changes recommended will have to be applied on a national level.

In this case study the EcoCity roadmap was produced through a series of three consecutive and multidisciplinary workshops that included representatives of the city planning department, traffic

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planners and experts from the Egypt-Japan University of Science & Technology (E-JUST) and VTT Technical Research Centre of Finland Ltd. Other experts from Alexandria University and Cairo University also contributed to the work. The aim was to have a mix of planning practitioners together with experts from various fields working on EcoCity topics.

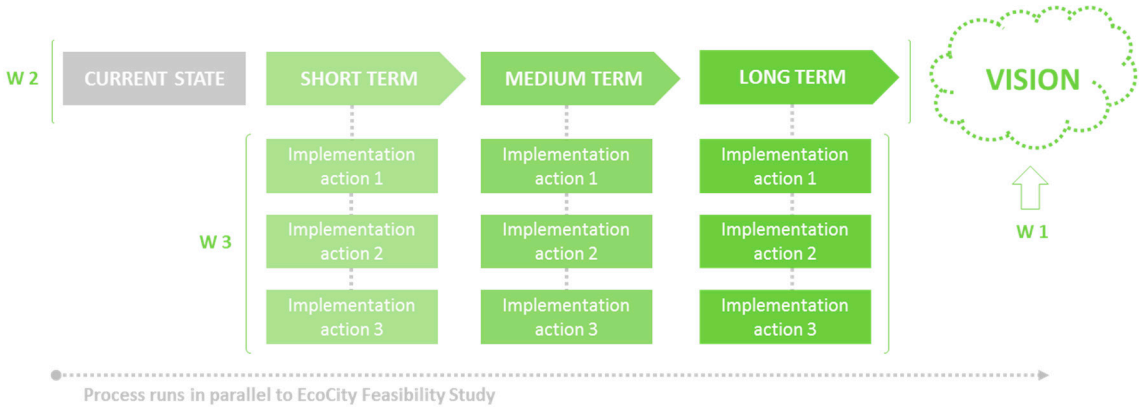


Figure 1. Simplified conceptual outline of a roadmap adapted from [21,22]. The development of the roadmap starts from defining the vision in workshop 1 (W1). Then thematic roadmaps for reaching the vision are crafted in workshop 2 (W2). Finally, detailed implementation actions are outlined in workshop 3 (W3).

The aim of the first workshop was to form a common EcoCity vision. The second workshop produced an outline for the roadmap spanning the short (1–5 years), medium (5–10 years) and long terms (10–20 years). To give an example of how problems can be divided into these timeframes, traffic problems can be alleviated in the short term with changes in ticket prices in public transport, in the medium term with the establishment of new public transport lines and in the long term with city planning. The third workshop resulted in recommendations for implementation actions to realize the envisioned roadmap. The starting point of the roadmap, termed current state in Figure 1 is provided by Hedman et al. [23]. The workshops were held in Egypt in 2013 and 2014, and commenting rounds following those events. Here the methods used in these workshops are described.

2.1.1. Workshop 1: EcoCity Vision

The EcoCity vision for Egypt was produced as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event.
- A workshop for the EcoCity roadmap was held using the roadmapping method described by [21].
- Applicable results from the EcoCity feasibility study workshop were also included in this vision for the EcoCity roadmap.

The vision workshop consisted of three sessions. The first session was a common roundtable discussion aimed at scoping the vision work before separating into smaller groups. The second session was held in two smaller groups, where the participants wrote answers, on sticker notes, to the following questions:

- What do I like of our situation today?
- What do I not like of our situation today?
- **What do I want in the future?**
- What do I not want in the future?

First there were a few minutes for individual work, then writing continued as a group activity. Once the group was satisfied with the amount of answers produced, the answers were prioritized. This was done in two phases. First, voting was conducted, four votes per each participant, by marking with a dot the answers that people saw as the most important ones. Second, deciding as a group, the

This was done in two phases. First, voting was conducted, four votes per each participant, by marking with a dot the answers that people saw as the most important ones. Second, deciding as a group, the participants placed the answer notes on a line of priority ranking them from the less to more important ones. Finally, in the third session, the results of both groups were combined according to four lines of priority that had the following themes: nature, well-being, economy, society.

2.1.2. Workshop 2: EcoCity Roadmap Outline

The EcoCity roadmap outline was produced as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event.
- A workshop for the EcoCity roadmap was held using the roadmapping method described by [21].
- Applicable results from the EcoCity feasibility study workshop were also included in this vision for the EcoCity roadmap.

The work conducted in the workshop was divided into three timeframes: short (2–5 years), medium (5–10 years) and long term (10–20 years). Four small groups were formed around themes decided in the beginning of the workshop: energy; water and waste; transportation and traffic; buildings and construction. For each timeframe the groups completed the following tasks:

(1) Identify key *business drivers* for change and
(2) Define key *actions* and *enablers* needed for the vision to be achieved.

By business drivers it is meant things that spur growth and allow enterprises to reach success. They can mean things that create new demand, create better value to consumers, allow making more competitive products or any other factor that pushes a business forward faster. Key actions mean things that need to be done, and key enablers mean conditions that need to be present to facilitate change.

Templates for writing down the groups' findings were provided. When the groups were ready with their input, they presented them to the whole team. A round of commenting ensued where everybody had the opportunity to include their ideas to the templates with sticky notes. All input, be it from the group work or from the commenting round, are included in the results presented here.

2.1.3. Workshop 3: Implementation Actions

The implementation actions for the EcoCity roadmap were developed as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event.
- A workshop for the EcoCity roadmap was held using the roadmapping method described by [21].

The work conducted in the workshop was divided into three timeframes: short (2–5 years), medium (5–10 years) and long term (10–20 years). Four small groups were formed around themes decided in the beginning of the workshop: energy; water and waste; transportation and traffic; buildings and construction. For each timeframe the groups completed the following tasks:

(1) Development of Implementation Actions (IA) as individual work,
(2) Commenting and further development of IAs as group work,
(3) Implementation plan for IAs as group work, meaning placing them on a timeline and
(4) Presentation, commenting and finalizing the results, all together.

Implementation Actions mean concrete actions to help realize the roadmap. They are related to the thematic outline roadmaps developed in Workshop 2. Each IA includes a listing of the main parties responsible of realizing the action as well as a detailed definition of the action. The IAs were developed using a formalized template that worked as a checklist so that no important aspects are omitted in the description.

2.1.4. EcoCity Feasibility Study

As decision makers usually face the challenge of choosing between a number of projects, they have the problem of making informed decisions between different alternatives. To answer to this need, feasibility studies have become a standard practice in various fields of business since the beginning of 1960s [24] to analyse the viability of an idea or an opportunity. As Justis and Kreigsmann [25] have pointed out, a feasibility study can "*rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success*". However, the activities typically associated to this kind of study are so generic in nature that they can be applied to the analysis of almost any type of idea or opportunity. According to Bryce [26], these are the elements of a good Feasibility Study (FS):

Project scope—used to define, in a concise and clear way, the idea or opportunity to be analysed.

Current analysis—used to define, understand and analyse the current method of implementation.

Requirements—these vary depending on the particular characteristics of the idea or opportunity. For example, the requirements of an EcoCity are entirely different from the requirements of a construction element.

Approach—this refers to the alternatives proposed in response to the requirements previously defined.

Evaluation—used to assess the cost effectiveness of the approach suggested.

Review—the preceding elements are assembled in the form of a FS which should be formally reviewed with all the parties involved in order to make a decision.

The methodology described here has been developed for "EcoNBC Feasibility Study. Transforming New Borg El Arab into an EcoCity", one of the main outcomes of "EcoNBC, EcoCity Capacity Building in New Borg El Arab City (NBC)" [27]. The structure of this FS was agreed in the first of a series of workshops according to the goals of the project and specific needs of NBC. However, a parallelism between the FS presented here and Bryce's FS description shown above has been established only in order to link it with the common understanding of what a FS should be. Therefore, when commented, the links with the elements previously presented will be pointed out.

New Borg El Arab (NBC) was inaugurated in 1988 and is seen as the natural extension of Alexandria, Egypt. It is regarded as the most important industrial zone in Egypt, covering an area of more than 2000 hectares and comprising about 1700 industrial facilities and institutions providing investors and owners with all needed facilities and services. At present, NBC has major development plans underway and the current population of approximately 100,000 inhabitants is expected to grow up to 750,000 inhabitants by 2032. This context offered many opportunities for the sustainable development of the city and the surrounding industry in response to the environmental, social and economic challenges that such expansion plans might arise.

Therefore, to evaluate in as much detail as possible the idea of turning NBC into an EcoCity –*project scope*-, a FS was carried out by a team of experts from VTT Technical Research of Finland Ltd., Egypt-Japan University of Science and Technology (E-JUST), Alexandria University and Cairo University, some of them also practitioners and planners with a vast experience and a deep understanding of the local context and the specific problems to be addressed. Based on the categories established by Abou-Zeid et al. [24] according to the function, this FS can be considered both a Technical and Economic Feasibility Study with some consideration for the social impacts derived from the implementation of the solutions proposed. The FS built on the *current analysis* provided by the state-of-the-art report previously developed under the abovementioned project [23]. This information together with the experience and knowledge gathered within the Finnish-Egyptian team of experts led to the definition of the FS development process shown in Figure 2 with a time horizon of 20 years.

Through a number of structured workshops held in Finland and Egypt, the experts defined a Vision–*requirements*-for turning NBC into an EcoCity that, from the beginning, was intended to remain ambitious but still possible to achieve in practice as long as the necessary political will and

social commitment were in place. Such Vision evolved around three main issues of concern for each of the sectors considered, namely Residential, Commercial/Public Facilities, Industrial, Services/Utilities and Transport. To provide also a summarized view of the Vision across sectors, a "General" sector was also included. Due to their enormous relevance from an environmental point of view combined with their importance in the local context, the issues of concern chosen were Energy, Water and Waste, plus an additional category named "Other independent issues" (e.g., materials, social, etc.). Finally, quantitative and qualitative targets were set for each of the sectors in relation to the issues of concern chosen. An example can be seen in Table 1.

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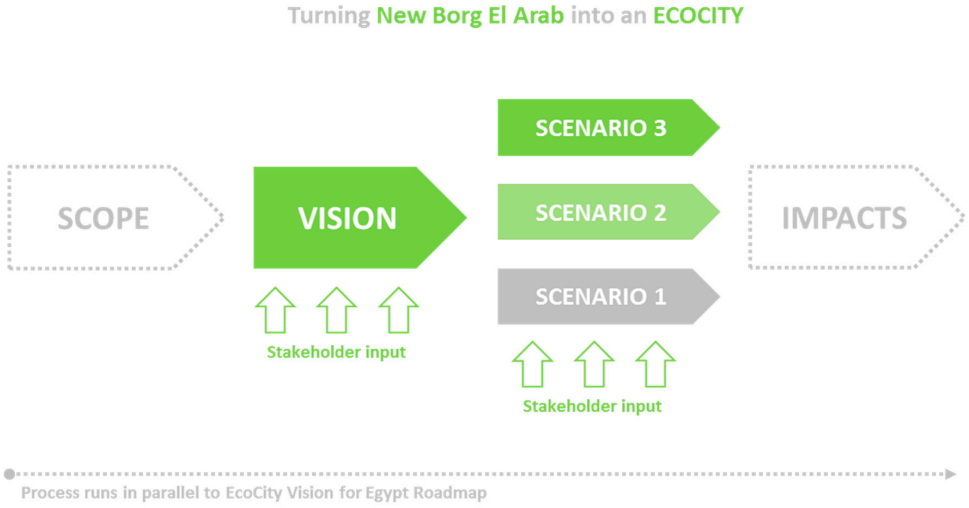


Figure 2. FS development process [27].

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Table 1. Vision and targets defined for the Residential sector [27].

ENERGY
Possibility to sell extra energy to the grid
Local building energy code (including lighting)
Solar water heating
Solar air conditioning
Waste to energy
Increase public awareness
Use of efficient lighting solutions
Smart use of energy (reduce peak consumption, energy storage, load matching, smart control)
Energy efficiency
Use of local materials
Targets:
• *100% net renewable energy in all new buildings*
• *Reduce by 50% in 10 years the total energy consumption compared to business as usual*
WATER
Water conservation
Water quality
Non-conventional water resources (solar desalination…)
Fresh water management
Sufficient water supply
Minimization of water consumption
Recycling and reuse of treated waste water
Provision of fresh drinking water and sanitation
Rain harvesting
Increase public awareness
Targets:
• *30% less water consumption (including water recycling) compared to business as usual*
• *100% pure drinking water for everyone*
• *50% water treated using renewable energy sources in 10 years*
• *100% sanitation for everyone*

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Rain harvesting
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• *50% water treated using renewable energy sources in 10 years*
• *100% sanitation for everyone*

Table 1. *Cont.*

WATER
Targets: • *30% less water consumption (including water recycling) compared to business as usual* • *100% pure drinking water for everyone* • *50% water treated using renewable energy sources in 10 years* • *100% sanitation for everyone* • *Respect carrying capacities in terms of water availability*
WASTE
In situ sorting of waste Increase public awareness Waste minimization **----------** *Targets:* • *Near 100% of the waste (including both solid waste and waste water) is treated, recycled and/or reused* • *100% of hazardous waste is properly treated*

Following the definition of the Vision, and in order to evaluate the future situation of NBC in the year 2035 and its technical, environmental impacts, the scenario technique was adopted. The aim was to consider a range of possible "futures" and to provide various development strategies. The following Scenarios –*approach*- were agreed and developed by the Finnish-Egyptian team of experts also through a number of focused workshops:

- *Business As Usual (BAU)*

Generally speaking, this scenario implies that things will continue in the future as they are now, the evolution pattern will be the same. Therefore BAU is basically the description of the current situation, including population and economic growth, in addition to the results provided by the performance indicators proposed for a basic diagnosis. These are:

Energy consumption (kWh/year) energy source
Water consumption (m^3/year)
Material consumption (kg/year)
Emissions (kg CO_2 equivalent/year)
Wastewater (m^3/year)
Solid waste (tonnes/year) hazardous/non hazardous

To give some more details in relation to specific sectors, for the Residential sector, BAU means no insulation, light weight envelope, single glazing, non-ventilated roofs and poor indoor air quality (low ventilation rate considering that smoking is allowed everywhere). Whereas for the Transport sector, BAU is defined as the continuation in the future of the existing travel behaviour of the year 2013/2014 according to the following assumptions: forecasted population based on the proposed Master Plan and increase rate of population, little change in the modal split to the benefit of the bus mode, and changes in the road infrastructures according to the Master Plan.

- *Low Investment Sustainability (LIS) scenario*

This scenario should contain primary energy efficiency measures along with the introduction of renewable energy sources and improved user behaviour regarding energy efficiency. Minimization of lighting energy consumption, as well as the consistent use of passive solutions in Residential and Commercial sectors, and the general implementation of energy audits for the Industry sector, should also be part of the LIS scenario. In relation to Water, the LIS scenario includes water conservation

measures as well as monitoring energy and water quality inside the buildings. In relation to Waste, this scenario considers separating waste at neighbourhood and district levels.

There are a number of measures specifically related to the Transport sector like the improvement of public transport and traffic control systems, the enforcement of traffic laws, or separate lanes for different means of transportation. Other measures relate to the Industry sector like the development of low cost technologies, the optimization of material and energy flows in industrial processes or improving the skills of the employees.

In addition to this, the LIS scenario also includes other general measures like sustainable planning and design, the creation of databases for different sectors or awareness raising programmes (energy, water, waste, lifestyle . . .).

- *High Investment Sustainability (HIS) scenario*

In relation to Energy, the HIS scenario includes the use of advanced renewable energy technologies and solutions. For Water, this scenario considers upgrading the water distribution network, fresh water management and rain harvesting, as well as increasing the production and use of non-conventional water resources (e.g., desalination). In relation to Waste, the HIS scenario includes hazardous waste dumping sites, classification of the different industries for better common waste management, solid and liquid waste management for the Industry sector, use of non-conventional techniques for improving the added value from materials waste, 100% recycling efficiency especially for water (Zero Liquid Discharge technology).

Additionally, the HIS scenario also includes other social and economic measures with impacts on the main issues of concern selected, like improving sanitation and health, building more schools and hospitals, developing industrial ecoparks, adopting mass transport and Intelligent Traffic Systems, electric vehicles, creation of local SMEs around sustainable technologies, products and systems, etc.

Initially, these Scenarios were first defined in a general way, applicable to all sectors. Afterwards, based on the data and the tools/software available, the same Scenarios were defined more in detail for the Residential and Transport sectors, and then used as basis for energy and CO_2 emissions and cost calculations respectively –*evaluation*-.

Feedback from local stakeholders –*review*- to the Vision and Scenarios thus defined was collected also through a series of workshops, and the content was refined accordingly. Local stakeholders included policy and decision makers at municipal and regional level, and also civil society (NGOs, etc.). In addition, large dissemination events were organized both in NBC and Alexandria. The suggested solutions presented in the FS were expected to assist decision makers and planners, who are concerned with improving the economic, social and environmental conditions. The FS and the alternatives it contains might be also of particular interest to researchers, engineers and scientists who could investigate them thoroughly and pursue the ideas they contain. In addition, the FS should be of considerable importance for the society of NBC as a whole, and even for the Egyptian society, since it is intended to be an example that other cities in the country could follow. On the other hand, this FS is essentially meant for investors, funding organizations and donors, who will be in a position to go through these alternatives and select the solutions which in their opinion are most relevant and applicable, taking also into account social and environmental aspects.

In addition and to complete the FS by illustrating what can be achieved in practice, it seemed necessary to show some pioneering examples from NBC and also from abroad. The examples selected from NBC correspond to some of the main local industries: textile and paper. Their inclusion is meant to highlight the already existing local initiatives towards a more sustainable industry which might hopefully inspire other industries to follow the example.

The content and methodology of the FS was aligned from the beginning, for the sake of consistency, with the EcoCity Roadmap also described here.

2.2. Residents Energy Survey and Building Consumption Assessment

Understanding occupants' energy related behaviour is essential for realizing concrete EcoCity design. It represents the basis of a number of analyses: selecting appropriate novel eco-friendly technologies, assessing people acceptance of such, creating tailored operating guidelines of specific products and enabling behavioural changes towards a low energy lifestyle. All are preliminary ingredients of a successful EcoCity project implementation.

Thus, to investigate and to collect information about occupants' energy related behaviour, in case measurements of direct energy consumption patterns are not available, a suitable instrument to adopt is an energy survey. Within the EcoNBC framework a specific survey, focused on five main aspects has been used: seasonal domestic hot water usage, natural ventilation mechanisms, shading systems, home appliances utilization (including lights), heating and cooling systems and related schedule. The results of the survey served to assess the market potential of energy technologies, ensuring an easy and successful deployment, and to draw events' profiles related to occupants, which generate different energy consumption patterns along the year. Figure 3 shows the implementation process of the survey.

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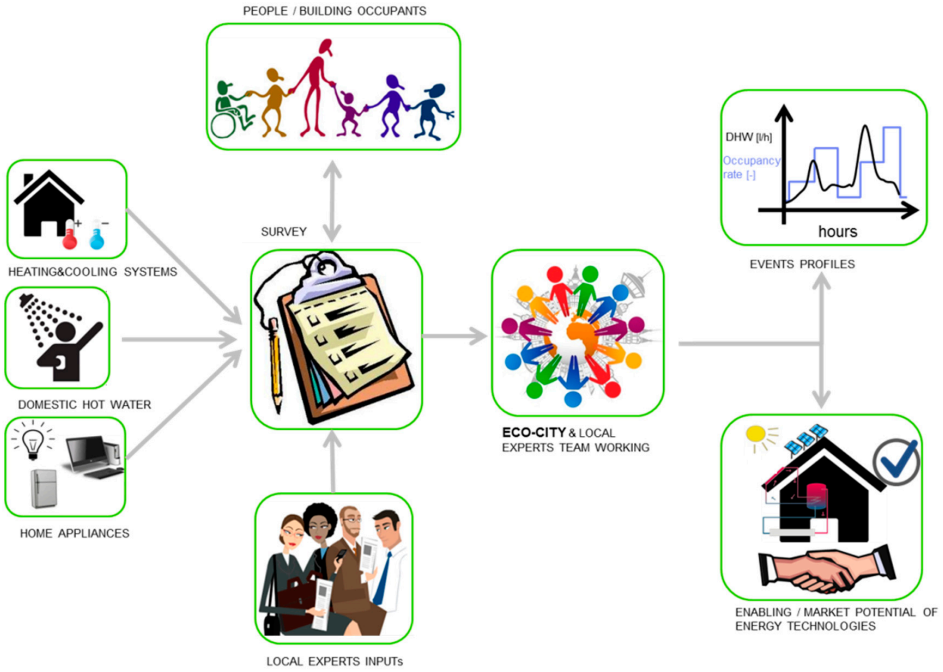


Figure 3. Implementation process of the survey [28].

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The survey consists of tailored questions, created by energy and social experts to dig out fundamental information for understanding residential energy related patterns. Specifically, occupants' behaviour associated to the abovementioned aspects have been generated, evaluating amplitude, frequency and event duration. Before submitting the survey to the building occupants, local experts were involved in localizing and building a solid context around technical and cultural connected questions. Moreover, since the understanding of the survey was not granted especially for uneducated people, local trained people, belonging to NGOs, disseminated it and, in some cases, helped the targeted audience filling the survey.

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VTT EcoCity and local experts (major stakeholders, public authorities and designers) defined market potential of new eco-efficient energy technologies by means of team working. This was done cross-analysing technologies' aims and technical operations with survey results, in terms of occupants' energy related patterns and needs. Involving local experts is important also in this phase for having a close sight on the local market condition and, therefore, ensuring real market penetration of the targeted technologies. Family composition and income level were considered as well

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to keep track of energy related patterns along generations and wealth conditions. This allows generating different offers/scenarios consisting of both passive and active building technologies, based on people expectancy and purchasing power.

Moreover, survey results were further processed by both VTT EcoCity and local experts to generate events' profiles related to different building energy consumption patterns, such as seasonal domestic hot water daily schedule, occupancy rate profiles along the year per each main room of the house and so on. Figure 4 depicts, as an example, the estimated domestic hot water (DHW) daily schedule in winter and summer.

It has to be said that defining a good sample size is a critical issue. In principle, it can be

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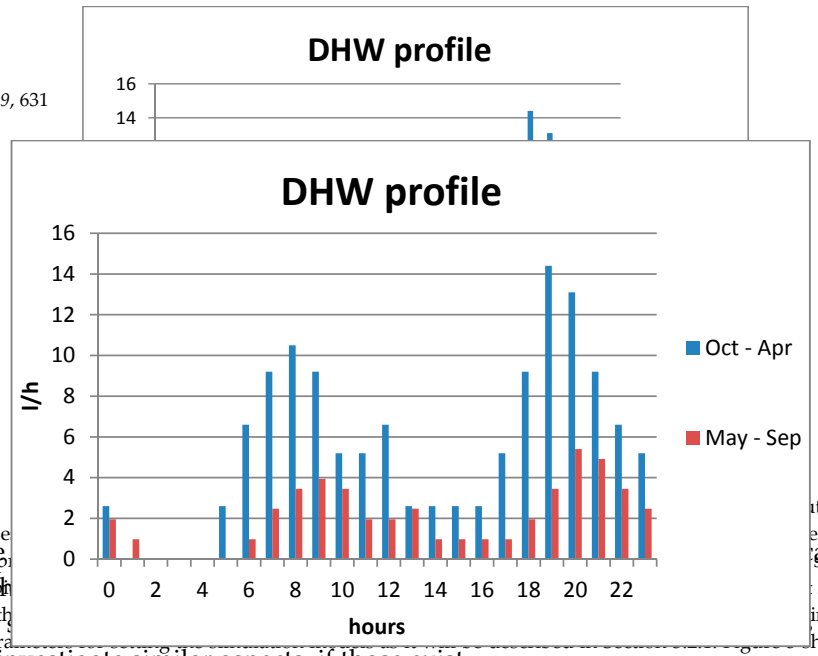


Figure 4. Domestic hot water daily schedule along the year [28].

It has to be [illegible] can be considered enough when [illegible] aim of this work falling into the [illegible] with other local studies which investigate similar aspects, if those exist.

Both survey outcomes, technologies offered and events' profiles, were used as input for assessing building energy consumption associated to each scenario. Dynamic energy modelling approach has been used to carry out the analysis. At this point it should be clarified that, since typically most of energy assessment tools regarding new technologies include software already (at least in the first stage of development), the novelty in this case lies rather the procedure for collecting input parameters for setting the simulation models as it will be described in Section 3.2.1. Figure 5 shows the Building Energy Consumption Assessment Procedure.

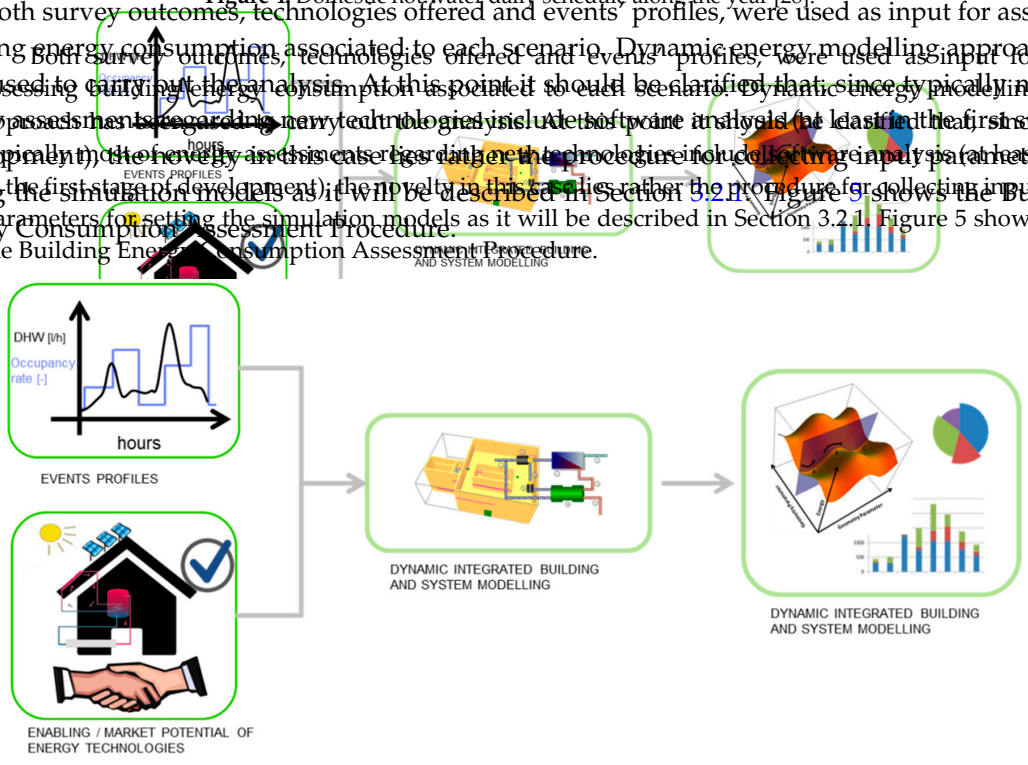


Figure 5. Building energy consumption assessment procedure [28].

3. Results Concerning the Egyptian Case

3.1. Roadmap

An EcoCity roadmap for Egypt was developed using a collaborative work method based on three major workshops and minor revision rounds in between. The first workshop formed a vision

3. Results Concerning the Egyptian Case

3.1. Roadmap

An EcoCity roadmap for Egypt was developed using a collaborative work method based on three major workshops and minor revision rounds in between. The first workshop formed a vision for EcoCities in Egypt, the second outlined thematic roadmaps for the short, medium and long terms, while the third and last workshop defined implementation actions needed to realize the roadmap. Thus the roadmap takes the form presented in Figure 1.

The EcoCity vision included issues such as food and water security, job creation, awareness and habits, sustainable use of resources, biodiversity, protection of cultural heritage, prevention of corruption, mobility, civilian rule, strategic policymaking, enforcement of regulations and policies and inclusion of all members of the society in the process. The importance of investments in human capital, health and education was underscored as an enabler of both growth and sustainability.

To realize the thematic roadmaps concrete implementation actions are recommended. They are listed in Table 2, while a more detailed presentation is given in [22].

Table 2. List of proposed implementation actions for realizing the roadmap [22].

Water and Waste
Water metering and efficient water use campaign
Joint water training programme
Waste-to-energy development programme
Desalination development programme
Campaign to reuse and recycle
Energy
National energy strategy
Energy efficiency improvement programme for businesses
Solar energy expansion programme
Smart grid action plan
Solar cooling development programme
Transportation and traffic
Policy shift to public transport
Multi-modal integrated public transport planning initiative
Privileges for car-pooling and alternative vehicles
Rail traffic development programme
Walking and cycling promotion programme
Buildings and construction
Healthy and safe buildings programme
Energy efficiency improvement programme
Improved building permit process
Quality housing expansion programme

A pressing issue in Egyptian cities is the need for proper housing for a growing population. Many improvements in energy efficiency and energy security do not need high investments, such as increasing the use of solar energy for heating domestic hot water. More technical details are available from [27]. New buildings should have steadily improving indoor conditions as well as well-maintained surroundings with an access to green areas for all. Preservation of natural greenery holds important value for both well-being and ecology.

Industries need to develop towards reduced emissions and energy and resource use. This process can start with energy auditing and efficiency programs for specific industries and move towards continuous improvement goals.

Transport should have less reliance on automobiles to reduce congestion, accidents, pollution and cost to families. Alternative modes of mobility should be promoted in various ways. For short distances

walking should be made more attractive, for longer distances cycling and public transport. Similar policies can be used to promote alternative fuels and electricity in plug-in hybrids and electric vehicles.

Waste should be treated in the order of the waste hierarchy: reduce the generation of waste through more efficient processes and smart consumption choices, reuse products when they are still usable, recycle more materials, and start the use of refuse derived fuels.

In energy policy the phase-out of subsidies for electricity of fuels should be administered so that some of the saved funds are used to reduce the burden of consumers while advancing a smart energy policy that reduces environmental impacts, saves energy resources, promotes local jobs and reduces dependence on imports. In practice this means promoting public transport and making it more affordable as an alternative to cars and supporting energy efficiency and renewable energy investments in homes and businesses.

3.2. Feasibility Study

3.2.1. Residential Sector

Two investment scenarios were considered: LIS and HIS. In the first case, the design includes exclusively low cost solutions, while in the second case technologies commonly associated with Net-zero houses were included. Both cases were compared to a reference case, BAU, which includes the minimum requirements of the Egyptian energy code. In both LIS and HIS scenarios solar technologies were preferred among others because of the high level of solar irradiance in Egypt [28]. All this is shown in Table 3 below.

Table 3. List of technologies selected by local stakeholders, authorities, energy market key player [28].

Technologies	Business As Usual (BAU)	Low Investment Scenario (LIS)	High Investment Scenario (HIS)
System technologies	Incandescent 20% and fluorescent lamp 80%	Fluorescent light bulbs	LEDs
	Free cooling system relying on opening windows when rooms are occupied (natural ventilation only)	Free cooling system using vents (natural ventilation only)	Mixed free cooling ventilation system (through vents + mechanical ventilation)
	-	Unglazed solar thermal collectors	Glazed solar thermal collectors
	-	-	PV
Envelope solutions	-	External reflective paint	External reflective paint
	Double wall of half red-brick with 5 cm air gap in between	Insulation (5 cm on the ground floor and the Roof, 3 cm on the external walls)	Insulation (6 cm on the ground floor and the Roof, 5 cm on the external walls)
	-	Shading system	Shading system
	Double glass window	Double glass window	Double glass low-e (low thermal emissivity) window

The study was carried out in three phases: investigation of the main behaviour patterns of occupants in relation to energy consumption, assessment of relevant technologies and, finally, energy analysis. The impacts of these scenarios were calculated in relation to CO_2 emissions and costs (see Table 4). In addition, a brief expert evaluation of social factors was made.

The impact of energy and CO_2 emissions were calculated by simulating in detail one reference residential building, and more specifically one apartment in the building. The simulations were done with TRNSYS software. The result was multiplied by the total number of apartment units according to the Master Plan.

The final energy consumption of LIS, around 15 KWh/m^2 (half of the BAU), shows that a very energy efficient building can be achieved using simple and affordable envelope and energy system

solutions. HIS scenario was sub-divided into three: HISa, b and c having different PY system configurations. For HISa the final energy consumption, around 5 kWh/m^2, is about 65% less than that of LIS. HISb showed a final energy balance that exceeds slightly zero, around 1 kWh/m^2, while HISc showed a negative final energy balance, around −5 kWh/m^2, meaning that the building produces a surplus of energy over the year.

Table 4. Annual final energy demand of the heating and cooling systems for the residential sector in New Borg El Arab City, PV produced, consumed and exported energies and final energy balance, which includes the appliances' energy consumption of each scenario [28].

Energy & Emissions	BAU	LIS	HISa	HISb	HISc
Final district energy demand (GWh)	619.6	315.5	219.8	219.8	219.8
Districts' produced PV energy (GWh)	-	-	335.5	603.9	763.1
Districts' consumed PV energy (GWh)	-	-	114.7	189.7	205.7
Districts' exported PV energy (GWh)	-	-	116.6	236.2	343.5
Final districts energy balance (GWh)	846.2	542.1	215.1	20.4	−103.0
CO_2 emission (1000 t)	394.3	252.6	100.2	9.5	−48.0

Note: CO_2 emissions are calculated based on the final district energy balance and assuming the average Egyptian emission factor for electricity for all energy use.

A Cost Effectiveness Analysis (CEA) was conducted using VTT-CEA tool on the modelled apartment building [29]. The CEA method selected was Dynamic Generation Cost (DGC), which gives as a result the price of energy saved in USD/kWh. The measures under consideration for LIS would have a cost of 0.21 USD/kWh for energy saved. Since at present electricity price in Egypt is heavily subsidized, it appears that LIS scenario is not economically sensible from a pure investment calculation perspective. However, further cuts in subsidies are expected which might make the investment profitable in the near future [9]. Moreover, the positive effects of reduced pollution, climate change mitigation, and decreased consumption of non-renewable resources may justify the somewhat higher cost. Finally, the results of the social impact analysis conducted are summarized in Figure 6.

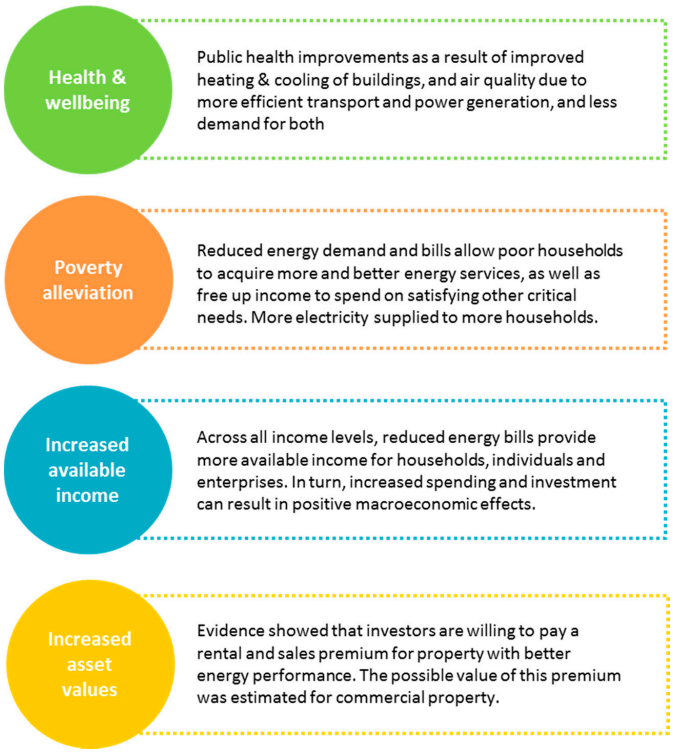


Figure 6. Social impacts derived from the scenarios proposed [27].

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Energies **2016**, *9*, 631 15 of 23

3.2.2. Transport Sector

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Again, BAU scenario was considered the reference scenario for the Transport sector basically implying the continuation of the travel behaviour of year 2014 in the future according to the following assumptions:

- Forecasted population based on the proposed Master Plan and increase rate of population.
- Little change in the modal split to the benefit of the bus mode.
- Change in the road infrastructures based on the Master Plan.

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LIS scenario included measures for saving, shifting and smoothing traffic as can be seen in Figure 7, whereas HIS scenario includes the measures of LIS scenario plus a number of others as can be seen in Figure 8.

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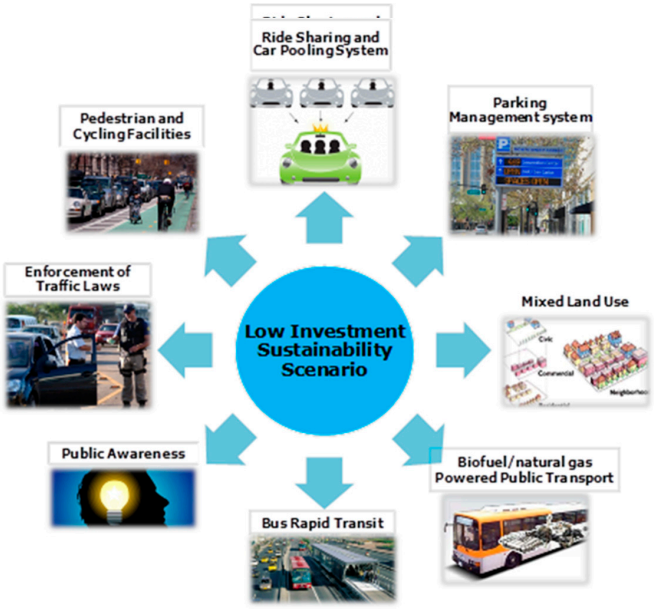


Figure 7. General description of the LIS scenario [27].

Figure 7. General description of the LIS scenario [27].



Figure 8. General description of the HIS scenario [27].

Figure 8. General description of the HIS scenario [27].

In relation to the impacts, the results of the energy calculations showed that the total energy consumption needed for passenger transport in New Borg El Arab under BAU scenario would reach 2.876 PJ in 2035 with an increase rate of about 670% of the consumption in the year 2013. Under LIS and HIS scenarios, significant reductions are expected with about 37% for LIS and 58% for HIS less energy consumption compared to BAU scenario.

The annual CO_2 emissions were calculated using the TraEco programme for different scenarios in the year 2015. The CO_2 emissions for BAU scenario would reach 209 kilo-ton, whereas LIS and HIS scenarios would allow a decrease of respectively 40% and 62% in relation to those emitted in BAU scenario. The main reasons behind these reductions in both energy consumption and CO_2 emissions are the modal shift from road transport to public transport, the improvement of the traffic conditions on the road network, and the switch from fossil fuels to electricity.

The cost analysis for different transit systems included funding agency for acquiring right of way, constructing these systems corridors and stations, procuring vehicles and installing supporting systems like fare collection, security and passenger information systems. Tables 5 and 6 illustrate the capital costs of NBC transport scenarios. There are no costs corresponding to biofuels and electric vehicles since the FS expert team did not include experts able to translate worldwide prices of such technologies to the Egyptian context.

Table 5. Low Investment Sustainability scenario costs [27].

Measures	Description	Consultant's Experience		Worldwide Prices	
		Cost Unit	Total Cost (Million LE)	Cost Unit	Total Cost (Million LE)
BRT Rapid Transit Network on the main roads of NBC	BRT systems, with average route length 99 km covering NBC over 98 stations.	3.2 Million LE Per km	316.8	54 Million LE Per km	5,346
Pedestrian and Cycling Facilities	Pedestrian facilities include paths, sidewalks, crosswalks, walkways, stairs, ramps, and building entranceways. Cycling facilities, all roads should be considered cycling facilities (except where cycling is specifically prohibited). The cycling network should be a network of streets (a grid of 0.5 kilometers or less in urban areas) that ensure safe bicycle access to all popular destinations. Pedestrian and Cycling Facilities will cover NBC over length equal 200 km.	25,000 LE Per km	5.0	25,000 LE Per km *	5.0
Calming Measures in city centers	Traffic calming measures are engineering tools used with the goal of reducing vehicle speed and improving the safety of motorists, pedestrians, and bicyclists. Four types of measures are recommended: Vertical deflections, horizontal shifts, and roadway narrowings are intended to reduce speed and enhance the street environment for non-motorists. Closures (diagonal diverters, half closures, full closures, and median barriers) are intended to reduce cut-through traffic by obstructing traffic movements in one or more directions.		0.5		0.5 *

Table 5. *Cont.*

Measures	Description	Consultant's Experience		Worldwide Prices	
		Cost Unit	Total Cost (Million LE)	Cost Unit	Total Cost (Million LE)
Parking Management system in city centers	Introduce a Parking Management system for access controls and customer management (such as for retail, residents and employees) as well as Park & Ride concepts for commuters turn the city into an inviting space.		1.5		1.5 *
Biofuel/natural gas powered public transport					
Maintenance of vehicles to the manufacturer's specifications and applying for Vehicle Scrapping Programme					
Scenario Cost (Million LE)			**323.8**		**5,353.0**

Note: * Based on the experience of the Egyptian consultant that was part of EcoNBC expert team.

Table 6. High Investment Sustainability scenario costs [27].

Measures	Description	Consultants Experience		Worldwide Prices	
		Cost Unit	Total Cost (Million LE)	Cost Unit	Total Cost (Million LE)
Bus Rapid Transit Network on the main roads of NBC	BRT systems, with average route length 55 km covering NBC over 55 station.	3.2 Million LE Per km	176	54 Million LE Per km	2,970
Light Rail Transit Network on the main roads of NBC	Light Rail Transit, with average route length 102 km covering NBC over 83 station.	7.5 Million LE Per km	765	161.25 Million LE Per km	16,447.5
New Regional Railway connecting with Alexandria City	New Regional Railway with average route length 60 km.	11.0 Million LE Per km	660	11.0 Million LE Per km *	660 *
Implement Intelligent Traffic System	The intelligent traffic system is implemented using road side units (RSU) with friction monitoring, vehicles with environmental sensors and a database for data transfer through different platforms.				
Implement freight transport centers	Implement three Freight transport centers include classification yards and truck terminals where passengers and cargo are exchanged between vehicles or between transport modes.	50.0 Million LE Per Center	150	50.0 Million LE Per Center *	150 *

Table 6. *Cont.*

Measures	Description	Consultants Experience		Worldwide Prices	
		Cost Unit	Total Cost (Million LE)	Cost Unit	Total Cost (Million LE)
Pedestrian and Cycling Facilities	Pedestrian facilities include paths, sidewalks, crosswalks, walkways, stairs, ramps, and building entranceways. Cycling facilities, all roads should be considered cycling facilities (except where cycling is specifically prohibited). The cycling network should be a network of streets (a grid of 0.5 kilometers or less in urban areas) that ensure safe bicycle access to all popular destinations. Pedestrian and Cycling Facilities will cover NBC over length equal 200 km.	25,000 LE Per km	5	25,000 LE Per km *	5 *
Calming Measures in city centers	Traffic calming measures are engineering tools used with the goal of reducing vehicle speed and improving the safety of motorists, pedestrians, and bicyclists. Four types of measures are recommended: Vertical deflections, horizontal shifts, and roadway narrowings are intended to reduce speed and enhance the street environment for non-motorists. Closures (diagonal diverters, half closures, full closures, and median barriers) are intended to reduce cut-through traffic by obstructing traffic movements in one or more directions.		0.5		0.5 *
Parking Management system in city centers	Introduce a Parking Management system for access controls and customer management (such as for retail, residents and employees) as well as Park & Ride concepts for commuters turn the city into an inviting space.		1.5		1.5 *
Biofuel/natural gas powered public transport					
Maintenance of vehicles to the manufacturer's specifications and applying for Vehicle Scrapping Programme					
Scenario Cost (Million LE)			**1,758.0**		**20,234.5**

Note: * Based on the experience of the Egyptian consultant that was part of EcoNBC expert team.

4. Discussion and Conclusions

Egypt faces at present many challenges related to fast growing cities, economic difficulties and sustainable development. EcoCities should be seen as a way to answer all three, rather than pushing to promote one over the others. The proposed implementation actions aim to reduce the

reliance on imported energy, reduce pollution and congestion, conserve resources and valuable nature while promoting local business and jobs, improving mobility, improving the urban environment, increasing the use of renewable resources and promoting the participation of citizens. Following Joss' interpretation of the ecocity evolution, the methodologies developed to assess and support the transformation of New Borg El Arab into an EcoCity present elements of Phase I (1980s to early 1090s: grassroots movement/visions) and Phase III (2000s to present: global expansion/policy mainstreaming). Even though the Egyptian case can be considered an example of Phase III, it begins with the definition of a vision in which local experts and stakeholders had a fundamental role [30]. Perhaps the main difference is that the vision defined had to remain ambitious and yet possible—provided the necessary political and social commitment exists—in order to overcome the existing initial gap between ambition and realization that, according to Barton, characterized Phase I ecocity projects [31].

In general, one of the main obstacles encountered by the experts involved in the application of these methodologies in the case described was the unavailability of the data required or the unreliability of the existing data. As an example, even though the performance indicators listed in Section 3.2 under the BAU scenario should be feasible since they are quite basic, gathering the necessary data proved to be a considerable challenge, particularly in the case of the Industrial sector. Unfortunately, the unavailability of the data or the unreliability of the existing data is the prevalent situation throughout much of the developing world. However, this situation coexists with the demand for EcoCity Feasibility Studies, Roadmaps, etc. that can help to mobilize local stakeholders, among them decision makers and planners who are concerned with improving the environmental, economic and social conditions in their countries. Considering the urgency of these goals, such studies should still be conducted even under the existing conditions of limited availability of data. Above all, to avoid delaying the transformation towards sustainable urban development so urgently needed, particularly when considered from the wider perspective of the rapid urbanization taking place in developing countries and its impacts on climate change. In this context, making assumptions, which of course should have solid grounds and be adequately justified, was found necessary by the experts involved in the FS.

To be more precise, one of the first decisions made by the expert team was to define the Vision (including associated targets) and the three scenarios explained in Section 2.1.4 (BAU, LIS and HIS) for each of the sectors considered (Residential, Commercial/Public facilities, Industrial, Services/Utilities, Transport) plus the "General" sector. However, for the calculation of the impacts in terms of energy, CO_2 emissions and costs, of the defined scenarios, accurate data is needed. In this case, valid and reliable data was only available for the Residential and Transport sectors, therefore it was decided that the impacts mentioned would be calculated only for these two sectors for the sake of consistency. But even if most of the data required was available, still some assumptions had to be made. As an example, for the Residential sector CEA calculation, it was assumed that in LIS scenario on average one workday annually is used by an unskilled worker cleaning the rooftop systems, and one workday by skilled professionals, such as an electrician, on system check-ups, totalling 40 USD/a using typical local costs.

Therefore, one of the main recommendations is to draw the attention of all involved stakeholders towards the importance of making the data available in order to support sustainable development. For example, in the case of NBC Industrial sector, it has been advised to start by collecting basic information in relation to the following key aspects:

- How many plants are there in the city? What is the expected growth of that number?
- How many employees are there? What is the expected growth of that number?
- How developed is the technology used?
- How skilled are the employees? What are the required skills?
- What kinds of energy sources are used? What is the distribution of these?
- Water supply and water treatment.

More specifically about the scenarios proposed and evaluated for the Residential sector, it is evident that the impact would be considerable if these scenarios would be applied to the whole city of New Borg El Arab. Savings up to 605.7 GWh could be achieved and 282.2 K tons of CO_2 emissions could be avoided. This amounts to the total CO_2 emissions of 117,853 Egyptians. This can be considered high impact since the city is planned to host 750,000 inhabitants. Only the savings achieved in the Residential sector would enable 15% of the population to live totally "carbon free", theoretically calculated. The figure becomes even bigger when combined with sustainability actions in other sectors.

In conclusion, very low energy and net zero energy buildings have been designed in line with the local context, using envelope solutions to lower their energy needs and renewable systems to achieve a near zero or a negative final energy balance. It is also important to stress once more that considerable reduction in energy demand can be achieved with relatively low cost solutions, as it has been also corroborated by research in Southern European countries with similar climates. As an example, the correct design of openings can by itself contribute significantly to improve the thermal performance of a building [32]. Ideally, this study along with others should attract the interest of local and central administrations for planning and building new eco-friendly residential districts that include very energy efficient buildings.

In addition to the previous, there is also an enormous potential for developing locally adapted systems and solutions for energy retrofitting and renovation of the existing built stock that would at the same time decrease the energy demand and improve the quality of the indoor living and working environment. Moreover, when applied to buildings with poor accessibility (lack of lifts or ramps), different construction pathologies and service facilities in need of upgrading, substantial improvements in citizens' quality of life and social inclusion of disadvantaged people can be achieved. And as a consequence, the real estate value of those buildings is also increased [33].

As a variety of ecocity initiatives are currently under development worldwide, adequate tools and practices for their implementation are becoming increasingly important. The methodologies presented here, developed in collaboration with local experts and stakeholders, aim at contributing to the practical debate on the mainstreaming of ecocities. They can also complement the definition of ecocity indicators proposed by authors like Joss as a tool to support governance and a necessary step towards establishing common standards for urban sustainability [34].

VTT's experience in different EcoCity projects shows that fruitful collaboration with local actors is the basis for the successful development of locally adapted solutions. It has been also observed that the younger generations in Egypt are increasingly aware of the importance of sustainable development and were eager to take part in a number of activities organized within EcoNBC project. Combined with their fondness for new technologies, ICT and social media, this offers many opportunities for creating employment through green businesses and jobs. This is a crucial issue in countries like Egypt where there is a pressing need to provide employment for the youth. However, tapping into the potential described requires facilitation skills together with an understanding of and a constructive approach to cultural differences.

To finalize, the conclusions that can be drawn from this experience can be summarized as follows:

- Adequate methodologies are needed to support EcoCity development in response to the challenges faced nowadays by communities and neighbourhoods worldwide.
- Their adequateness depends on their capacity to provide suitable locally adapted solutions, and to that end collaboration with local actors is of particular importance.
- Fruitful collaboration with local actors requires strong facilitation skills and understanding of cultural differences.
- Very often these methodologies require certain data that, even if basic, are not available (or will not be released by those that could provide them), or are unreliable. Therefore, a number of assumptions might be necessary to overcome this situation.
- The results show that affordable solutions, locally available and relatively easy to implement, can have a very positive impact in the final energy balance.

- The potential for substantially increasing the energy efficiency, not only in new urban developments but also in existing neighbourhoods is enormous, and offers plenty of opportunities for creating employment through green businesses and jobs.

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Author Contributions: All the authors from VTT conceived and designed the methodologies (or their adaptation), and managed their development process. Carmen Antuña-Rozado managed the Feasibility Study development process; Francesco Reda developed the residents' survey and contributed to the part of the Feasibility Study related to the Residential sector; Pekka Tuominen managed the Roadmap development process and contributed to the Cost Effectiveness Analysis within the Feasibility Study. Justo García-Navarro from UPM has critically reviewed the manuscript and provided useful references linking the methodologies and the Egyptian case study to relevant research conducted in Southern Europe, particularly in Spain, in areas with similar climatic conditions.

Conflicts of Interest: The authors declare no conflict of interest.

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Facilitation Processes and Skills Supporting EcoCity Development

Carmen Antuña-Rozado [1,2,*], Justo García-Navarro [2] and Juana Mariño-Drews [3]

1 VTT Technical Research Centre of Finland Ltd., P.O. Box 1000, FI-02044 VTT Espoo, Finland; carmen.antuna@vtt.fi
2 Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIA–Ciudad Universitaria, s/n, 28040 Madrid, Spain; justo.gnavarro@upm.es
3 Independent Consultant, Bogotá 110221, Colombia; juana@gutsas.com
* Correspondence: carmen.antuna@vtt.fi; Tel.: +358-40-199-3522

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Abstract: Ecocities can provide solutions for the improvement of human settlements around the world and the living conditions therein, but in the authors' experience, only as long as they are able to address the following questions correctly: How to formulate an ecocity concept that, considering issues of general concern, can be at the same time adapted to different local conditions? What are the instruments supporting the development and implementation of ecocity solutions? VTT's EcoCity concept for sustainable community and neighbourhood regeneration and development has been designed in response to the first question. Likewise, specific methodologies and effective facilitation processes and skills have been developed in response to the second question. Since the methodologies have been discussed in a previous scientific article, the present one focuses on the facilitation processes and skills, and also on other related, fundamental aspects like participation, adaptation, capacity building, etc. Facilitation processes supporting EcoCity development require matching "hard" and "soft" skills in a fluid way. The main findings are discussed with the help of two case studies: one in Medellín (Colombia), and the other one in Zambia.

Keywords: EcoCity; EcoCity facilitation; capacity building; local adaptation; participation; sustainable urban development; Medellín; Zambia

1. Introduction

According to the recently adopted New Urban Agenda, the world's urban population is expected to double by 2050 [1] thus increasing even more the pressure on cities in relation to affordable housing, adequate infrastructures, public transport, employment, access to services, food security, environmental quality, etc. This poses enormous challenges for cities around the world, particularly those in developing and emerging countries. To make it even more complex, other equally important issues must be also considered like the rural-urban fringe, disaster risk management, biodiversity and ecosystem services, etc.

Ecocities can provide solutions for the improvement of human settlements around the world and the living conditions in those, but in the authors' experience, only as long as they are able to address the following questions correctly: How to formulate an ecocity concept that, considering issues of general concern, can be at the same time adapted to different local conditions? What are the instruments supporting the development and implementation of ecocity solutions? VTT's EcoCity concept for sustainable community and neighbourhood regeneration and development (discussed more in detail in Section 3) has been designed in response to the first question. Likewise, specific methodologies

and effective facilitation processes and skills have been developed in response to the second question. Since the methodologies have been discussed in a previous scientific article, the present one focuses on the facilitation processes and skills, and also on other related, fundamental aspects like participation, adaptation, capacity building, etc. It can be considered a follow-up article trying to contribute to the practical side of the ecocity debate. Consequently, this article purposely avoids engaging in a lengthy discussion on the theoretical aspects of ecocities (approaches, proponents, scope, etc.) since that would in itself provide material for a separate paper and it can distract from the focus intended. On the other hand, there is a large amount of literature on that topic. The intention in this case is rather to concentrate on aspects contributing to the successful implementation of ecocities in practice that however are typically overlooked, like for example facilitation. Finally, this article purposely tries to inscribe the scientific aspects in the real socio-political context where the urban decisions are being made.

To avoid possible confusion it is necessary to clarify that in this article "EcoCity" refers to VTT's own developed concept and related activities, whereas "ecocity" or "ecocities" are used for the generic concept, activities and examples.

2. Research Aim, Methodology and Novelty of the Approach

The aim of the research presented here is to understand how adequate facilitation processes and skills can positively support EcoCity activities worldwide and thus contribute to sustainable community regeneration and development in varying local contexts. Facilitation is typically discussed alone in the existing literature; therefore the novelty of this approach lies in its evaluation in terms of its importance as a key factor for the success of EcoCity development which in practice has been corroborated by the authors' experience. Likewise, the ecocity debate does not usually focus on the influence of facilitation, so this is another novel aspect.

The methodology followed consists of establishing a link between the consolidated knowledge on facilitation and two cases studies, one in Medellín (Colombia) and the other in Zambia, to illustrate its importance as means of engaging the community with making more sustainable choices at different scales (country, region, municipality, city, neighbourhood, etc). These cases are particularly illustrative not only of the different conditions in which this facilitation takes place but also of the degree of complexity that it must handle. As part of the methodology, facilitation is also linked with other fundamental aspects like capacity building or participation. The evidence presented with the help of these two case studies is also underpinned by similar EcoCity activities carried out in Egypt, Libya and Tanzania omitted here not to make this article too long.

The description of the case studies is preceded by a discussion on EcoCity solutions for developing countries (background) and on the instruments supporting EcoCity development among which is facilitation. This is followed by a more in detail exploration of facilitation processes and skills and then illustrated through the case studies. The results of those are analyzed in order to: (1) establish some categorization; (2) draw conclusions; and (3) monitor next steps. Finally, some general conclusions are formulated.

At this stage, it seems quite difficult to use quantitative indicators for measuring the impacts of facilitation alone in relation to EcoCity development. Perhaps qualitative indicators referred to crucial aspects like articulation, coherence, comprehensive approach to complex decision-making processes, etc., should be considered instead. Ultimately, if the projects and solutions thus developed would lead to practical implementation, then of course quantitative indicators could be used to measure the results in terms of water consumption reduction, CO_2 emissions reduction, etc. However, even though this is obviously a desirable outcome, it was not the main aim of the case studies presented here and its achievement depends on, among other reasons, finding available sources of financing.

3. EcoCity Solutions for Developing Countries

For the sake of clarity and without entering into an ideological debate which would be outside the scope of this article, it should be pointed out that despite the criticism of the appropriateness of the term 'developing country', its use is still very widely spread and that is the main reason for keeping it here in the absence of a more accurate (and neutral) term that could replace it. Therefore, it does not imply the acceptance of any inferiority compared to the so called developed countries, much in the same way that United Nations uses the designations 'developing' and 'developed' for statistical convenience without any intention to make a judgement in relation to the stage of development reached by any particular country or region [2]. Taking a step further, in the 2016 edition of World Development Indicators (WDI), the World Bank [3] is no longer making the distinction between developing and developed countries since these terms have become less relevant, particularly taking into account the global focus of the Sustainable Development Goals (SDGs) [4].

3.1. VTT EcoCity Concept

The EcoCity concept for sustainable community and neighbourhood regeneration and development associated to the case studies discussed in this article has been developed by VTT Technical Research Centre of Finland Ltd. to respond to the needs and challenges of developing countries in close collaboration with local partners and major stakeholders. Originally, VTT EcoCity concept was built on the experience and knowledge gathered through a number of previous projects, mostly Nordic and European in scope, completed with the insights gained more recently in other projects like EcoCity Miaofeng (China) [5], EcoGrad in St. Petersburg (Russia) [6], EcoDrive in Riihimäki (Finland) [7], or UN Gigiri in Nairobi (Kenya) [8]. The ecocity perspective that underlies VTT EcoCity concept goes beyond the strictly ecological associated to the original term coined by Richard Register [9] to include the more general approach provided by sustainable urban planning very much in the way summarized by Maclaren [10] as "*inter-generational equity, intra-generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual wellbeing, and satisfaction of basic human needs*". Even other more recent aspects like resilience and climate change as argued by Newman et al. [11] are considered together with an emphasis on the integration of "green" and "grey" agendas as mentioned throughout the text.

Rapid urbanization is creating enormous challenges particularly for developing countries, like climate change mitigation and adaptation, sustainable urban development, affordable housing, integrated planning and funding availability, capacity building, citizen empowerment and participation, gender issues ... among others. As described by Huovila and Antuña [12], the approach taken by VTT EcoCity concept to address these challenges can be summarized as follows:

- Best combination of technologies and services (understood as "systems" supplying a public need) that form sustainable solutions providing the users and inhabitants a high quality of life and indoor and outdoor comfort.
- Applicable EcoCity solutions depend on local conditions and need to be customized to socioeconomic realities.
- There is not one solution that fits all, but a number of possibilities that need to be studied to find the right solution for each case.
- Requires knowledge of local culture and traditions, available materials and competent partners.

Within this approach, VTT EcoCity concept main components should be customized to meet the local needs and conditions based on:

(1) Sustainable city planning
(2) Citizen participation and empowerment
(3) Sustainable urban infrastructure

(4) Sustainable housing
(5) Local businesses and employment around sustainable housing
(6) Coordination
(7) Pilot project/Case Studies

At this point it seems necessary to stress that there are multiple interpretations for each of these components. Sustainability is understood here not as an absolute, but rather as an agreement resulting from a negotiation process that stands on a series of basic non-negotiable principles which support all that can be negotiated and ultimately agreed.

The last two components, Coordination and Pilot project, are required to achieve its practical realization from an operational perspective. Coordination refers to the role typically played by VTT of gathering local stakeholders and facilitating their participation in the development of sustainable solutions adapted to the local conditions, as well as managing the Pilot project. In turn, a Pilot project is needed to provide the specific context and boundaries for which EcoCity solutions should be proposed.

When moving from the conceptual and operational framework provided by VTT EcoCity concept to its practical application in a number of EcoCity projects and related activities worldwide, including workshops, seminars, trainings, etc., the issues of concern shown in Figure 1 have been consistently and repeatedly chosen by local partners, stakeholders and even citizens as unavoidable aspects to be carefully planned when pursuing sustainable urbanization. As can be seen, most of them can be related to one or several SDGs: SDG-2/Zero hunger, SDG-3/Good health and wellbeing, SDG-6/Clean water and sanitation, SDG-7/Affordable clean energy, SDG-8/Decent work and economic growth, SDG-11/Sustainable cities and communities, SDG-13/Climate action, etc.



Figure 1. Aspects of sustainable urbanization resulting from the discussions held within EcoCity projects and related activities presented simply in alphabetical order from left to right and from top to bottom (Huovila & Antuña, 2012).

Certainly, these aspects are not only inter-related but have, in addition, numerous ramifications and links to other important topics like poverty alleviation, health, social cohesion, equality, awareness, participation, etc. However, while being systematically chosen as key issues of concern regarding sustainable urbanization, a strong need for local adaptation has been identified as absolutely necessary for the success of the EcoCity solutions developed. The reason is mainly that, even though the importance of these aspects has been corroborated in all cases, their manifestation, specific characteristics, degree of importance and, as a consequence, different management options are particular to each case. And this is what constitutes the basis for adaptation to local conditions.

Moreover, this local adaptation is one of the key pillars of a win-win situation where the solutions developed improve the performance of the case studies while the EcoCity concept is enriched and

strengthened, not only in relation to its content and specific methodologies but also in terms of participation and facilitation. As an example, through the Medellín case study (described more in detail ahead) and the collaboration with the local partners and stakeholders, BIODIVERSITY and ECOSYSTEM SERVICES were incorporated to the abovementioned aspects and therefore discussed and applied in subsequent case studies and EcoCity activities. The idea is to engage in a sort of "continuous improvement feedback loop".

3.2. Adaptation to Local Conditions

It seems necessary to stress that the EcoCity concept discussed here was formulated in Finland, a Nordic country that normally scores very high in different international indexes (e.g., Good Country Index, and also with regards to education, wellbeing, equality, good governance and very low corruption, etc.). In addition, Finland has a long tradition of promoting sustainable development both nationally and internationally. The Finnish National Commission on Sustainable Development (FNCSD) was established in 1993, only one year after the 1992 Rio Conference. Since then Finland has implemented various programmes and strategies, the latest of which, "The Finland we want 2050-Society's Commitment to Sustainable Development", was adopted in 2013 and updated in 2016 in line with the UN 2030 Agenda for Sustainable Development [13]. From the beginning, Finland has taken a holistic approach towards sustainable development, aiming at an effective integration of economic, social and environmental aspects. To that end "*sustainable development is perceived in terms of the wellbeing of people and the environment, a healthy and sustainable economy and the promotion of sustainable lifestyles*" [14]. What comes to international development cooperation, Finland's development policy has been outlined in the "Government Report on Development Policy" published in February 2016 and also aligned with the UN 2030 Agenda. Its main goal is to reduce poverty and inequality, with a special emphasis on the rights of women and girls and on promoting employment and wellbeing [15].

Furthermore, Finland has recently published the world's first roadmap to a circular economy, outlining the steps towards sustainable success by decoupling economic growth and increased wellbeing from a wasteful use of natural resources [16]. However, precisely due to Finland's traditional commitment to sustainable development, which constituted the background for the formulation of VTT EcoCity concept, there was certain risk of taking for granted issues of high concern for the target countries that are not explicitly included in the EcoCity's definition of sustainable urbanization, environmental protection, etc. For instance, in most countries in Sub-Saharan Africa, around 80% of the population live in rural areas with no access to electricity [17]. In consequence, priority should be given to ENERGY ACCESS (rather than just ENERGY EFFICIENCY, one of the aspects shown in Figure 1). Therefore, collaboration with local partners and stakeholders, and adaptation to the specific context become crucial to achieve successful results. VTT's experience working with different partners and stakeholders around the world in a number of EcoCity projects and activities clearly corroborates the importance of supporting communities to develop and implement their own definition of sustainability adapted to their local conditions very much in line with Roseland [18], and more recently with Wong & Yuen [19].

But what are those varying local conditions that require adaptation? Based on the experience presented here, they can be mainly categorized as socio-economic, socio-political, socio-ecological and cultural, more detailed ahead in Table 2.

4. Instruments Supporting EcoCity Development

At this point, some clarification regarding the terminology seems necessary to avoid possible confusion and misinterpretation. Instruments should be understood here as all means "used to pursue an aim" [20], the aim being in this case the development of localized EcoCity solutions. In this context, the term "instrument" provides a wider scope than "tool" which is typically used when referring to e.g., sustainability assessment tools, energy rating tools, etc.

As it will be discussed further ahead through the example of two case studies, experience from recent EcoCity projects and related activities, has clearly shown the need for the following instruments to support the development of EcoCity solutions that are adapted to the local conditions:

- specific methodologies,
- participation, communication and interaction,
- effective facilitation processes and skills.

Experience also corroborates the strong interconnection among the three. In addition to the previous, assessment and benchmarking, and consequently adequate indicators, and even tools, are also needed. And all this requires also local adaptation as it is being increasingly recognized [21] in order to respond to those issues that are at the top of the priority list of residents and policy makers in the developing world [22]. However, since indicators are such a broad topic, the discussion on possible EcoCity indicators and how to select, apply and monitor those will not be dealt with here. Likewise, exploring the tools available and their suitability to specific local contexts, particularly in developing countries, exceeds the purpose of this article.

4.1. Methodologies

As presented by Antuña et al. [23], specific methodologies (understood as a set of practices) have been developed in close collaboration with local partners and major stakeholders in order to make sure that the measures, procedures, concepts and technological solutions proposed are adapted to the local conditions and support the generation of sustainable communities in developing and emerging countries. These methodologies have been applied for the first time in "EcoNBC, EcoCity Capacity Building in New Borg El Arab City (NBC)" [24], but since they have already been covered in detail in the abovementioned article, what follows is only a summarized description.

4.1.1. EcoCity Roadmap

Adapted from Kazi and Wolf [25], this methodology for strategic forecasting and planning of future technology developments, comprises the following phases:

(1) setting key priorities (vision),
(2) developing thematic roadmaps and
(3) identifying implementation actions.

In this case, the EcoCity roadmap was intended to be applicable for the whole of Egypt, even though it was developed through a series of multidisciplinary workshops having the particular situation of NBC in mind [26].

4.1.2. EcoCity Feasibility Study (FS)

Through a series of structured workshops held in Finland and Egypt, a FS was carried out to evaluate in as much detail as possible the idea of turning NBC into an EcoCity [27]. And again, the group of participants in the workshops included practitioners and planners with a wide experience and knowledge of the local conditions and needs to be addressed, as well as experts from both countries. From the beginning, and for the sake of consistency, the FS was aligned and carried out in parallel to the EcoCity Roadmap for Egypt described before.

4.1.3. Residents' Energy Survey and Building Consumption Assessment

In order to select appropriate eco-friendly technologies, assessing people's acceptance of those, creating operating manuals for certain products and enabling behavioural changes towards a low energy lifestyle, it is fundamental to understand the occupants' energy behaviour. To that end, energy surveys are suitable means, particularly if direct measurement of energy consumption patterns is not

possible [28]. Since this was precisely the case in NBC, a specific survey was designed focusing on five main aspects:

(1) seasonal domestic hot water usage,
(2) natural ventilation mechanisms,
(3) shading systems,
(4) home appliances utilization (including lights) and
(5) heating and cooling systems and related schedule.

4.2. Participation, Communication and Interaction

As it has been mentioned, the VTT EcoCity concept is structured around the active and decisive participation of key stakeholders involved in the decision-making process related to one or several components of an ecocity. To this end and based on practical experience, both the participants and the participatory process must fulfil a series of requirements to guarantee the validity and governance of the results, especially bearing in mind that the EcoCity concept comprises a wide variety of possible components and, therefore, of potential participants.

In relation to the participants, in addition to their commitment and active participation, it is required that they are:

- Legitimated: they should have the explicitly delegated representation of the institutions or groups in the name of which they will participate and, if needed also make decisions. In the case of representatives of institutions and interested groups, legitimacy refers as well to their participation being representative of the interests and expectations of those and not their own.
- Informed: they should have enough information on the themes to be discussed, on the process itself, and on what is to be expected from it (scope, objectives, results) and from their specific participation. Reciprocally, they should contribute to the process and carry the information thus produced back to their institutions or groups.

With regards to the participatory process, it is required that it is:

- Transparent: the scope, objectives, and results expected should be clearly defined and agreed by the participants in order to avoid false expectations.
- Pertinent: it should allow and facilitate wide discussion on different topics related to ecocities but without losing the focus on the concrete topics included within the scope agreed. This is particularly important when considering the diversity of topics that can come under the umbrella of sustainability and adaptation.
- Efficient and effective: it should adequately manage the time and resources available, as well as generate the expected results as agreed. To allow this, the participatory process should lie on a well prepared programme that enables moving from the initial stages of reflection and discussion to the formulation of conclusions, and ultimately to results, without setting too many constraints.

4.3. Facilitation Processes and Skills

Even though the concrete facilitation processes followed to support the development of locally adapted EcoCity solutions will be described through two case studies, Medellín and Zambia, a more general perspective seems necessary at this point. VTT's experience in different EcoCity projects and activities shows that CAPACITY BUILDING of the local partner (or partners) is a key component to their success. Therefore, there is a strong link between capacity building and effective facilitation processes that can help the local partners and other important stakeholders, firstly in the definition of the problem and the identification of the needs to be prioritized, and secondly in developing solutions that will be accepted and integrated by the community [29].

Furthermore, at the root of these facilitation processes lies PARTICIPATION (see Section 4.2) and, in consequence, they are designed to enable participatory decision-making leading to a proposal for intervention. In turn, participatory decision-making stands on four core values according to Kaner et al.:

(1) Full participation
(2) Mutual understanding
(3) Inclusive solutions
(4) Shared responsibility

Meetings conducted in accordance with these participatory values produce significant results, namely stronger individuals, stronger groups and stronger agreements, along with many other derived benefits. Individuals and groups empowered in such manner will be better equipped to continue developing their own solutions in the future building on the improved skills and supportive atmosphere generated. Similarly, the agreements reached will include more and higher-quality ideas, wiser goals, as well as truly inclusive solutions [30].

From VTT's EcoCity perspective, this is precisely what capacity building is about. To achieve the abovementioned results, a solid expertise is required from the facilitator(s) who should master and integrate a number of listening skills or techniques to ensure participation as shown in Figure 2. In addition to the previous, in the case of EcoCity development, the facilitator(s) must have a strong technical expertise.



Figure 2. Facilitative skills for participatory decision-making. Own image based on content by Kaner et al. [30].

In short, facilitation processes supporting EcoCity development require matching "hard" and "soft" skills in a fluid way. In this case, there has been no conscious adherence to any particular facilitation school, even though some of VTT's experts involved had previous training and experience in group management and group dynamics. The journey has been rather a hands-on learning-by-doing one shared with local partners and stakeholders. Very much in the way Fierro points out, facilitating became a complex endeavour due to the diversity of the participants and the differing views and interests [31]. However, even though not consciously following any facilitation school in particular, when looking back to VTT's EcoCity facilitation experiences trying to draw some sort of parallelism, it seems that a couple of those were particularly close to the World Café process created by Juanita Brown [32]. One of them was VTT's EcoTanzania workshop within MUF2013 (Managing Urban Futures Workshop–Dar es Salaam, Tanzania) shown in Figure 3, and the other was precisely the Zambian case study presented in this article.

In fact, both workshops applied, even though unknowingly, World Café design principles:

(1) Setting the context
(2) Create hospitable space

(3) Explore questions that matter
(4) Encourage everyone's contribution
(5) Connect diverse perspectives
(6) Listen together for patterns and insights
(7) Share collective discoveries

These were particularly important for MUF2013 where participants with different backgrounds from more than ten developing countries gathered to discuss and develop solutions for sustainable communities. Principles (1) and (3) were carefully considered during the preparation of the workshop in order to guarantee the maximum benefits for the participants, while the others were applied during its development.



Figure 3. EcoTanzania workshop within MUF2013 (Photo: Pekka Huovila).

Broadly speaking, in all VTT EcoCity projects the differences observed fall into one of these two categories:

(1) Differences between the mindset and value set of the Finnish expert team as opposed to the mindset and value set of the local partners and stakeholders.
(2) Internal differences among the local partners and stakeholders deriving from a number of circumstances like economic interests, varying degrees of formal power, existing local hierarchy system, political context, background and education, etc.

This in itself called for a special effort to unveil complexity instead of looking for easy ways to simplify the situation as recommended by Holman [33]. In practical terms, managing complexity means understanding the established dynamics according to which local partners and stakeholders usually interact, identifying the perceptions that lie under the reality described by the participants, making space for disruptive views and integrating them into the process . . . And to that end, Fierro's self-reflective practice, as well as joint reflection together with co-facilitators, both from VTT and local, plays a fundamental role. In particular, the joint reflection with local co-facilitators strengthens the win-win situation mentioned in Section 3.1 where VTT experts can help the local counterparts by questioning certain concepts and practices that may have been taken for granted, thus enabling innovative solutions to arise. Likewise, the local co-facilitators and trusted partners, help VTT experts to understand the local context and power relations among the various stakeholders so that in turn they ensure better participation and inclusive solutions.

Medellín and Zambia case studies offer a very good example of all the previous, but also of creative tension and emotional tension as defined by Senge [34]. Both groups of participants strongly experienced the gap between the situation as it was and the situation as they would like it to be—*creative tension*, and in consequence felt the concern and frustration derived from that realization—*emotional tension*.

4.4. Achieving Effective Knowledge Transfer

This is perhaps the ultimate goal, that the methodologies developed together with local actors supported by fluent communication and adequate facilitation processes in order to provide locally adapted EcoCity solutions will also contribute to an effective (and lasting) transfer of the knowledge. The capacity of the local actors thus built will enable them to continue developing EcoCity solutions by themselves. As an example, after the workshops held in Medellín (the results of which are mentioned more in detail ahead), the local stakeholders involved continued the work thus initiated which led to the formulation of a technical and economic proposal for the development phase of EcoMedellín project by Arví Park Corporation and EAFIT University. The EcoMedellín workshops enabled-through participation-the evolution from a public urban biodiversity policy to a specific project proposal that actually built on the conceptual basis established during the workshops. The project would address the urban fringe of Medellín as a social and natural habitat and its main case study would be the micro-watershed of La Honda ravine. However, considering its importance, knowledge transfer should be discussed more in depth in a separate article.

5. Facilitating EcoCity Development. Two Case Studies: Medellín and Zambia

The case studies presented here are different in many ways which helps to illustrate the wide spectrum covered by VTT EcoCities in terms of geographic boundaries, climatic conditions, social and cultural contexts, thematic and methodological outreach, etc. To start with they vary in scale: in Medellín the focus was on the city and the municipality, whereas in Zambia the focus was on the country as a whole. From a thematic point of view, they are also very different since Medellín focused on the rural-urban regeneration of a specific area called La Honda ravine, while Zambia focused on the country's sustainable development.

In relation to the stakeholders, in Medellín those formed a very heterogeneous group, while in Zambia the group was rather homogeneous since most belonged to Academia. Even from the timeline point of view, in Medellín pre- and post-workshop working sessions were carried out, whereas in Zambia none of these took place. There were also differences regarding the cultural background and mentality. The main point is that the case studies are not, and do not have to be, comparable and this is precisely the reason for choosing these particular ones. Therefore, there is a special emphasis on the differences as means to assess the validity of the framework proposed in its practical application to varying local circumstances worldwide. Table 1 summarizes those.

Table 1. Summarized description of Medellín and Zambia case studies. (Carmen Antuña, 2017).

	MEDELLÍN	ZAMBIA
Country	Colombia	Zambia
Scale	Urban, municipal	National
Theme	Urban-rural interface: the urban fringe as social and natural habitat	Sustainable development
Area defined	La Honda ravine	Whole country
Local partner(s)	Alexander von Humboldt Biological Resources Research Institute (National Research & Policy Institution) City of Medellín Environmental Department (Local Authority)	University of Zambia (UNZA)
Participants	Representatives of key agencies in relation to the case study, namely research institutions, regional environmental authorities and social agents (see Section 5.1)	Students from different Schools Faculty members

5.1. Case Study 1: Medellín

5.1.1. Description and Critical Analysis of the Local Conditions

The municipality of Medellín is located in the region known as the Aburrá valley, an interior valley of the central range of the Colombian Andes to the north-west of the country. The Aburrá valley

is an extremely biodiverse territory with great challenges for its conservation and sustainable urban development. In the Andean region urbanization has been an additional engine for the transformation of natural ecosystems, driven by growing industrialization and added to the social and armed conflict of the country, which has established the Colombian Andes and large cities as recipients of displaced population in search of better opportunities, generating unplanned processes of colonization on environmentally and socially fragile territories. 77% of the Colombian population is currently settled in the Andean region, and therefore it is the region of the country with the highest number of hectares transformed by urbanization.

The city of Medellín, located at 1450 MASL, is one of the great urban centres established in the central range of the Andes. It is the capital of the department of Antioquia and the most important city of the Aburrá valley, concentrating nearly 60% of the population of the department. According to Área Metropolitana Valle del Aburrá (AMVA), this results in less than 2% of Antioquia's territory generating an ecological footprint equivalent to 86% of the total area of the department [35].

Currently, Medellín is promoted as a compact city in the middle of the valley, where the river Aburrá is consolidated as a natural structuring axis, and where the management of protection zones and special areas should be strengthened. On the other hand, it is estimated that on the slopes of the Aburrá valley, 284,000 people are at risk of landslides. To the soil instability, the vulnerability of the settlements, mostly in informal and precarious conditions, must be added. Around 8% of the population of the Aburrá valley live in precarious conditions, that is, lacking at least one of the five conditions outlined by UN-Habitat: (1) durable housing of a permanent nature; (2) sufficient living space; (3) easy access to sufficient and good quality water; (4) access to adequate sanitation; and (5) security of tenure that prevents forced evictions.

Under these premises, the ravines (in about 57 micro-watersheds) directly affect the life of the hillside neighbourhoods and are the city's natural urban-rural connectors, offering an opportunity for the construction of a sustainable habitat and the social articulation of those neighbourhoods.

5.1.2. Facilitation Aspects

VTT facilitation process in Medellín was part of an urban environmental management process that was being carried out by the municipal administration of the city with the collaboration of national, regional and local entities.

In 2012, the Municipality of Medellín through its Environmental Department, along with Explora Park Corporation, Medellín Botanical Garden Joaquín Antonio Uribe, the Antioquia Ornithology Society (SAO in Spanish), National Natural Parks and the Institute of Biological Resources Research Alexander von Humboldt (IAVH in Spanish), developed the basis for a policy of integrated management of biodiversity and ecosystem services for the municipality of Medellín. This process is known as "Medellín, a city for biodiversity" and basically defines criteria for biodiversity management to be included as an integral part of urban development strategies and, in general, applied to the spatial planning of Medellín.

In addition to generating the Management Policy, the applied research project led by the IAVH and the administration of Medellín identified needs, opportunities and priorities for intervention in the various landscapes that make up a rural-urban territory. These interventions are related to both biodiversity and ecosystem services—the "green" component, as well as housing and infrastructure—the "grey" component-in each of the landscapes, as summarized in the graph below (Figure 4).

It was concluded that the fringe represents a fundamental territory to regulate the use of biodiversity and ecosystem services as well as a scenario that demands innovation in relation to the regulatory, technological and social framework that traditionally prevails in urban management. Therefore, it was decided to develop a specific intervention project in the urban fringe of Medellín, which would allow incorporating the policy guidelines on biodiversity and ecosystem services in projects oriented to the comprehensive urban improvement of precarious developments.

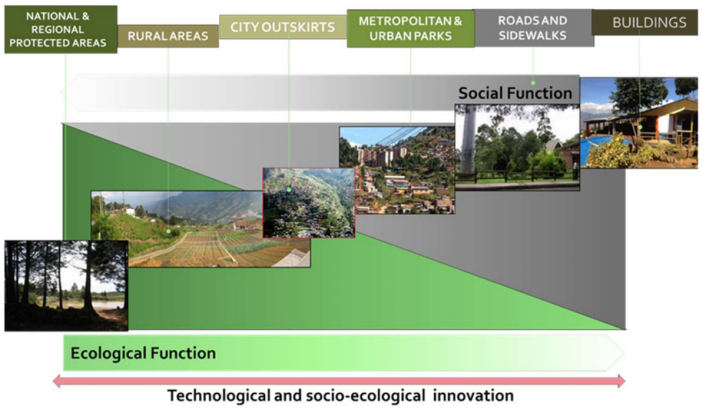


Figure 4. Possible interventions related to both the "green" and the "grey" components (Graph: Juana Mariño).

Given that the framework project was almost exclusively oriented to the "green" component, it required the participation of an institution with wide and recognized experience in supporting and guiding participatory sustainable urban intervention processes. It was found that the EcoCity concept for the regeneration and sustainable development of communities and neighbourhoods developed by VTT comprised the elements required for the comprehensive urban improvement intended (see Section 3.1). The facilitation provided by VTT would complement the thematic components of the original project and strengthen the institutional and social components. The first part of VTT's facilitation process in Medellin aimed at supporting the identification of the area of the urban fringe subject to priority intervention, as well as the definition-together with IAVH representatives and local institutions- of the components and scope of the comprehensive urban improvement project for the selected area (Figure 5).



Figure 5. Various stakeholders select the area of intervention during the workshop in Medellín (Photo: Pekka Huovila).

Identification of the Area of Intervention

A joint analysis of the urban fringe was developed based on the priorities of the local administration materialized in regional projects such as the Central Park of Antioquia; urban-regional projects such as the Metropolitan Green Belt and the Bordes Project; and local ones such as the Proposal for the Integral Management of Biodiversity and Ecosystem Services and the Habitat Strategic Plan. Once La Honda neighbourhood was identified as the potential case study area, a field visit was carried out (Figure 6).

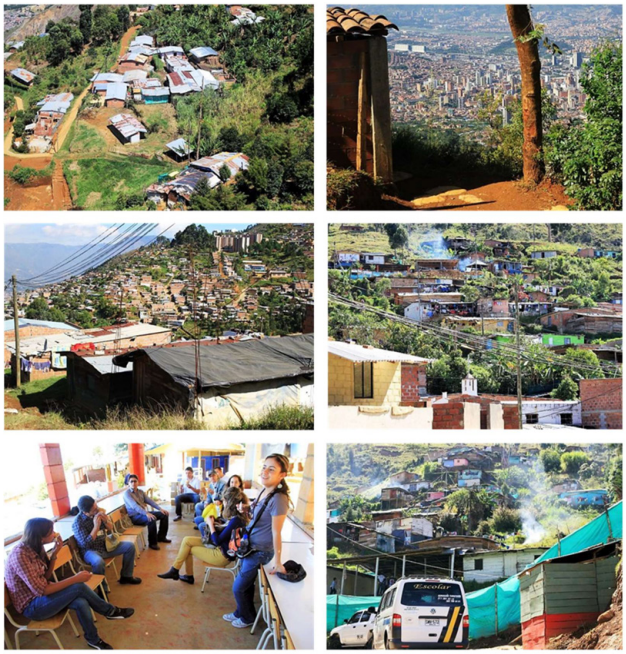


Figure 6. Different views of La Honda neighbourhood taken during the identification trip (Photos: Pekka Huovila).

La Honda neighbourhood is located on the micro-watershed of La Honda ravine (Communes 3 and 4), West of Medellín, with the following general characteristics [36]:

- Social segregration
- Mobility difficulties
- Lack of public space
- High disaster risk
- 5000 dwellings planned for 2030

La Honda ravine starts at the top of the West slopes of Medellín and runs through the diverse urban landscapes of the city, from the Natural Park to the urban centre. The area of intervention covers the upper part of the micro-watershed, on the border between the urban area and the area of natural protection.

Definition of the Scope and Components of the Intervention

Once the area of intervention for the pilot project of integral urban improvement was agreed, VTT supported the process of defining the objectives, contents and scope of the project, as well as the terms of participation of the various stakeholders.

After conducting work meetings in Medellín and Bogota with delegates from local and national institutions, it was concluded that the EcoMedellín project responded to priority action frameworks from the Municipality of Medellín as the Spatial Planning Plan and the Development Plan Medellín a Home for Life 2012–2015 and the country as the National Policy for the Integral Management of Biodiversity and its Ecosystem Services and had a high potential for replicability in other Colombian and Latin American cities that share similar socio-economic circumstances.

Therefore, it was agreed to develop the EcoMedellín initiative with the characteristics shown in Figure 7. As can be seen, the main goal, components to be developed, agents to be involved, processes to be considered and instruments that would constitute the operational policy framework were enunciated and used for the development of a general description of the cooperation project intended according to the following aspects:

- Characterization of La Honda pilot project.
- Characterization of the actors (principal and others).
- Description of reference projects and their links to EcoMedellín initiative.
- Time horizon estimated for the project.

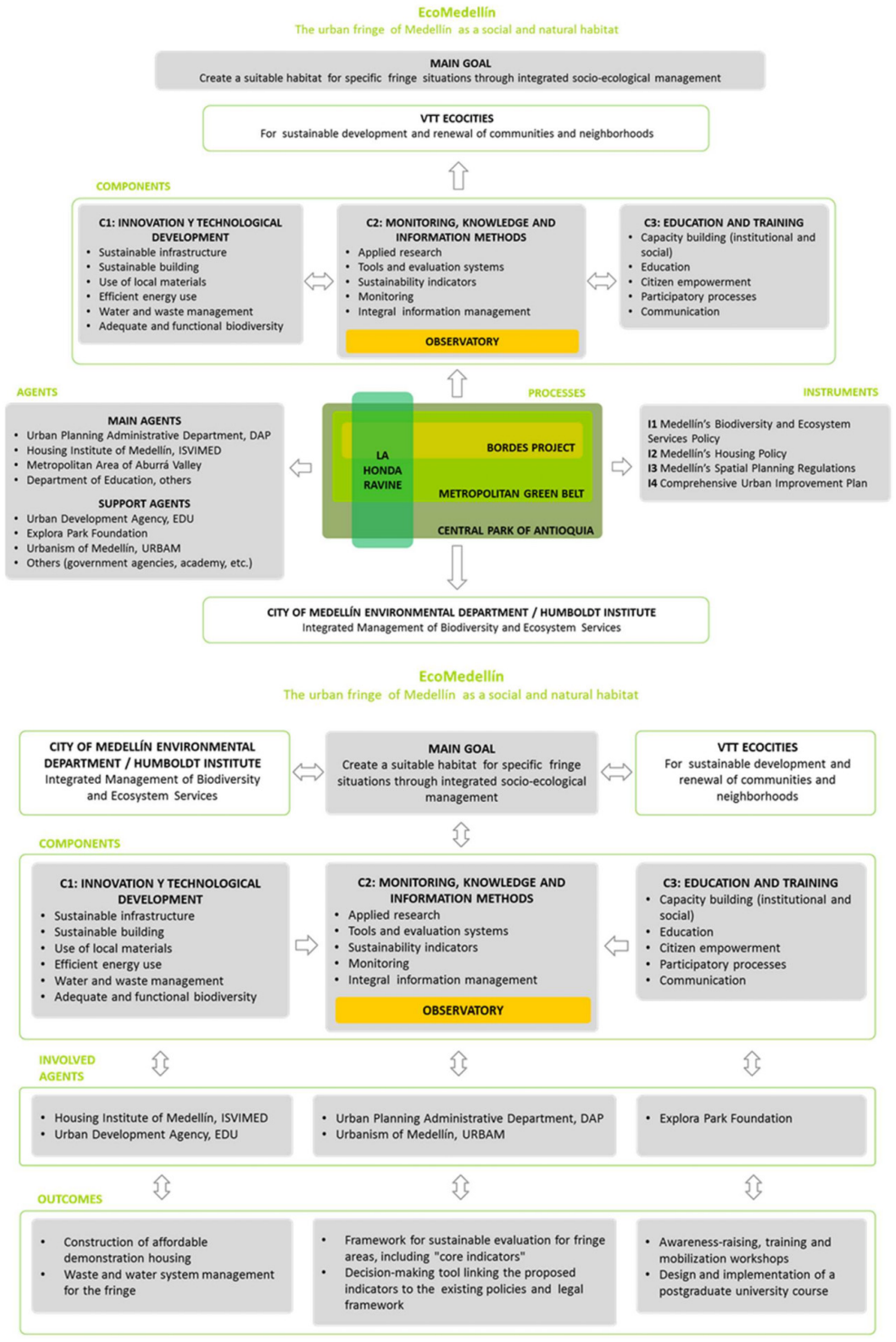


Figure 7. Characteristics of EcoMedellín initiative (City of Medellín Environmental Department, Humboldt Institute, VTT Technical Research Centre of Finland Ltd.).

5.2. Case Study 2: Zambia

5.2.1. Description and Critical Analysis of the Local Conditions

The seminar and workshop "Creating a Sustainable Future for Zambia" was a dissemination action within "EcoLusaka. Sustainable education of the construction sector in Lusaka, Zambia" (2013–2015), a capacity building project funded by the Institutional Cooperation Instrument (ICI) under the Ministry for Foreign Affairs of Finland (MFA). During the project the Finnish partner, VTT, strengthened the capacity of the Zambian partner, Thorn Park Construction Training Centre (TPCTC) based in Lusaka, to provide education on sustainable construction and disseminate the results for wider use in the Zambian construction sector [29]. As a dissemination action, the main purpose of this seminar and workshop was to raise awareness among local stakeholders about the content, aims and results of EcoLusaka, as well as on key sustainability related issues. In addition, dissemination actions sought to enable an impact at a national level that might lead to a change in the Zambian construction regulatory framework towards a more sustainable construction process. In this particular case, it was decided to widen the scope beyond the construction sector and focus on sustainable development in order to engage students from different disciplines at the University of Zambia (UNZA). Therefore, it was organized like a two-day event with the ultimate goal of developing a vision for a sustainable Zambia. The event took place at UNZA on 20–21 May 2015 with thirty-one participants and it was facilitated by four VTT experts (one of them the manager of EcoLusaka project and leading author of this article).

Apart from a couple of faculty members, most of the participants were students from the following schools: Agricultural Sciences, Education, Engineering, Mines and Natural Sciences. This mix brought to the discussion a variety of viewpoints that contributed to enrich the vision developed.

Creating a Sustainable Future for Zambia: the SEMINAR

The seminar was planned as a preparation to achieve the objective of the workshop of developing a vision for a sustainable Zambia. Therefore, after introducing the objectives of the seminar, VTT experts presented VTT's activities, and specially VTT's EcoCity concept and EcoLusaka as an example of EcoCity project. EcoLusaka helped the participants to bridge the gap between the EcoCity concept and its application to a particular context which they could easily relate to, and this led to a very fruitful discussion.

Finally, an introduction to sustainable development was made: definition, pillars, UN indicators, etc. At the end of the seminar, the participants were expected to be ready for addressing in a successful way the tasks of the workshop.

Creating a Sustainable Future for Zambia: the WORKSHOP

As a first step towards a vision for a sustainable Zambia, the participants were asked to define the sustainability framework to be further developed in groups. Based on their own experience and knowledge, and also on the information presented and discussed during the seminar, the participants proposed a matrix formed by a set of key issues of concern and solutions for the problems associated with those as shown in Figure 8. Due to the urgency of the situation, the time horizon established was 5–10 years.

	SOLUTIONS			
ISSUES OF CONCERN	**Policies & other tools**	**Education & Culture**	**Community**	**Technology**
Waste				
Water & Sanitation				
Energy				
Transport				
Poverty				
Employment				
Informal settlements				
Health				
Lifestyle				
Pollution				
Biodiversity				
Land				
Food security				

Figure 8. Matrix representing the sustainability framework proposed by the participants.

The issues of concern selected were the following:

- Waste (solid and liquid, hazardous and non-hazardous)
- Water & Sanitation
- Energy
- Transport
- Poverty
- Employment
- Informal settlements
- Health (specially paying attention to HIV/AIDS, poor nutrition, maternal & infant mortality, poor medical provision, and inadequate health personnel)
- Lifestyle (specially paying attention to prostitution, alcohol/drug abuse, dressing codes, and crime)
- Pollution (considering water, air, noise and land)
- Biodiversity (formulated as "life for all living and support to all life")
- Land
- Food Security

In principle, the methodology followed for the definition of a vision for a sustainable Zambia was the same one presented in detail in [23,27], and developed within the project "EcoNBC, EcoCity Capacity Building in New Borg El Arab City (NBC)" (2013–2015) [24]. However, compared to the issues of concern selected in EcoNBC project when defining an EcoCity vision for NBC, namely Energy, Water and Waste, in the Zambian case the issues of concern were more numerous. In addition to the issues of concern selected in the Egyptian case due to their enormous relevance from an environmental point of view combined with their importance in the local context, the Zambian participants wanted to include also some "social" issues of concern considered crucial for the Zambian context, like Poverty, Employment, Informal settlements, Health, Lifestyle, Land or Food Security. Interestingly, the Zambian participants also selected Biodiversity as a key issue of concern, as in Medellín case study, even though it was covered in a different manner.

To provide solutions for the needs identified in relation to the issues of concern selected, the participants proposed to structure those according to the following categories:

- Policies (strategies, laws, regulations) and other tools (e.g., related to revenue collection)
- Education & Culture (including attitudes, work culture, etc.)
- Community (including individual consumption choices)
- Technology

Again, if compared with the EcoCity vision for NBC, where the issues of concern selected were related to the sectors covered by the project (Residential, Commercial/Public Facilities, Industrial, Services/Utilities and Transport), the approach of the Zambian participants was also different. For example, in the Zambian case Transport was not considered as a sector but as a key issue of concern. This comparison shows clearly how the same methodology is adapted in practice to varying local conditions. From a more general perspective, the framework developed in EcoNBC was very multidisciplinary but less holistic than in Zambia.

5.2.2. Facilitation Aspects

As explained, although the methodology followed was the same one used in the Egyptian case, it had to be adapted to a new environment. Given the number of participants and in order to be more efficient, the facilitators decided to divide them in four working groups and assign each group 3–4 issues of concern for which they had to propose solutions according to the categories listed above. These were the groups:

Group 1—Waste, Water & Sanitation, Energy, Transport
Group 2—Poverty, Employment, Informal settlements
Group 3—Health, Lifestyle, Pollution
Group 4—Biodiversity, Land, Food Security

To assist the work of the groups, a facilitator was always present in the group discussions. The facilitators rotated groups so that all of them could benefit from the different education, background and perspective introduced by the facilitators. The work in groups was preceded and followed by discussions involving the whole group for the purpose of defining the sustainability framework, sharing the results of each group and improving the vision together as shown in Figure 9.



Figure 9. Discussions at UNZA during the seminar and workshop "Creating a Sustainable Future for Zambia" (Photo: Francesco Reda).

On a personal note, the participants in the workshop were so engaged that most of them refused to leave the classroom during the coffee breaks not to interrupt the ongoing discussions. Also, considering the quality of the interaction, it could be said following Bohm [37] that the participants were able to engage in true dialogue instead of discussion, as is common. A final discussion and assessment of the results was held at the end of the workshop with the participation of other professors and heads of several departments. The participants received a certificate of attendance.

6. Analysis of the Results

As already mentioned, the case studies presented here are not, and do not have to be, comparable. This is important since it is precisely through the differences that the validity of the framework proposed in its practical application to varying local circumstances worldwide is assessed. However, despite the many differences, when taking a closer look at the matrix representing the sustainability framework proposed by the participants in the Zambian case as shown in Figure 8 and matching it against the Medellín case, it became clear that most of the issues of concern were also of extreme relevance for Medellín (the only ones that were not covered in Medellín's case were "Health" and "Food security", not because they were not found relevant but because they were not identified as a priority in this context).

Figure 10 partially shows the vision developed for Zambia for the sake of comparison with the Medellín initiative shown in Figure 7. Including the whole vision would make this article too long, therefore only the solutions proposed for Biodiversity, a key aspect incorporated after Medellín to VTT EcoCity concept as explained in Section 3.1, which was also found of great importance in the Zambian case.

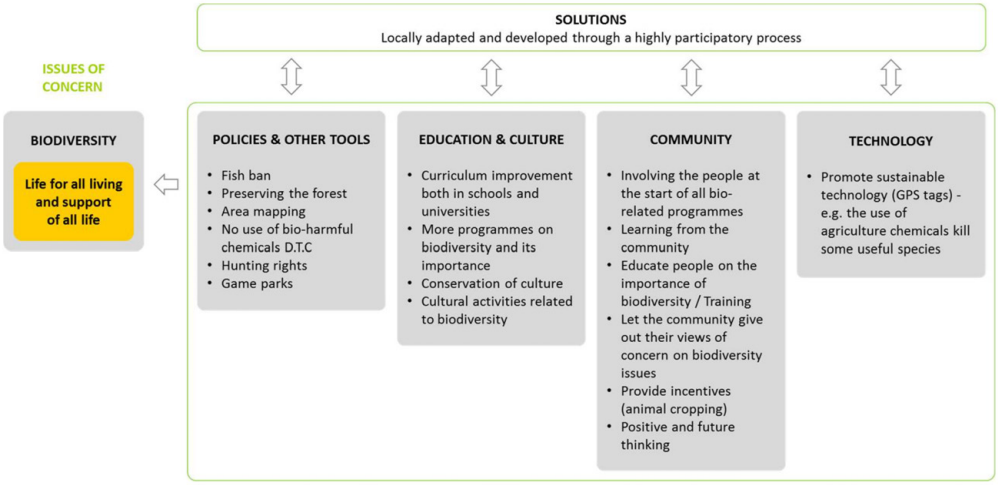


Figure 10. Solutions proposed by the participants in relation to Biodiversity in their own words (Carmen Antuña, 2018).

Taking an even deeper look, it could be observed that those common issues of concern can somehow be considered as important aspects in relation to the variables associated to the varying local conditions that require adaptation. Because local adaptation is precisely what EcoCity facilitation has to ensure. On a general level, the adaptation needed is multiple: of the EcoCity concept itself; of the facilitation "style" so that it matches the local environment and makes the most of stakeholder participation; of the solutions proposed so that they respond adequately to the local conditions and are "owned" by their end-users.

On a more specific level, the adaptation can be categorized according to the following types: socio-economic, socio-political, socio-ecological and cultural as shown in Table 2.

As said, promoting participation is central to VTT's EcoCity concept, but it should be stressed that experience has shown clearly that the local context affects highly the quality, validity and legitimacy of the participatory process. For example, a participatory process involving the inhabitants of La Honda is very different from another one involving the authorities, or from a participatory process involving a diversity of stakeholders, etc. Therefore, as Table 2 shows, participation is strongly influenced by the numerous variables (main and related) linked to the types listed. Finally, in relation to gender, it could be noted that in both cases there was very good balance not only in terms of representativity but also in terms of decision making.

In both cases the visible result, which in the view of the authors can be considered a "success indicator", was the identification and/or formulation of: (1) specific projects (case of Medellín) or (2) concrete solutions (case of Zambia), specially adapted to the local context in a participatory manner thanks to the framework provided by VTT EcoCity concept and facilitation. It could be argued that this is precisely what constitutes the best example of replicability, particularly taking into account the many differences between the two cases.

Table 2. Varying local conditions requiring adaptation (Juana Mariño, 2017).

Type	Main Variable	Related Variables	Related Aspects
Socio-economic	Jobs Income level Quality of life (measured with adequate indicator sets) Education (formal and informal)	Education level Health conditions Skills and capacities Inclusion/Marginality/Social Stratification Vulnerability	Poverty Lifestyle Employment Health Food security Informal settlements
Socio-political	Policies and regulations Institutional structure and capacities	Legality/Formality of the dwelling Availability of social infrastructure Social welfare Governance	Waste Water & Sanitation Energy Transport Health Food security Informal settlements
Socio-ecological	Location Topography Climate Vegetation Density	Sustainability Risk (threats, vulnerability, resilience) Available materials and techniques	Pollution Biodiversity Land Food security Available materials and techniques
Cultural	Traditions Beliefs Knowledge systems	Openess Receptivity Engagement Relations/Leadership Resilience	Lifestyle Available materials and techniques
Degree, legitimacy and effectivity of participation; decision making and action			

Follow up and Further Development

The second phase of VTT facilitation to the Medellín process corresponds to the formalization of the EcoMedellín project for the integral urban improvement of La Honda neighbourhood, within the framework of the previous agreement. In this new phase, the Centre of Urban and Environmental Studies (URBAM in Spanish) of the EAFIT University located in the city of Medellín, was linked to the process. This was done in order to effectively inscribe the socio-ecological and technological components in an integral urban planning project.

For this purpose, a formal association agreement was signed in fulfilment of which the signatories formulated a technical and economic proposal that encourages and shapes the project at an early stage, through the development of a comprehensive intervention model that addresses both biodiversity and technical and social aspects, as well as fundamental components to preserve and recover the ecosystem services associated with La Honda ravine, vital to guarantee adequate living conditions to the community established there.

In the Zambian case, the Head of the Department of Geography and Environment Studies expressed her interest in using the material developed during the workshop part for teaching. Also, based on the positive results achieved, several departments at UNZA indicated their interest in future collaboration with VTT, particularly around the topic of ecocities and sustainable urban planning and design.

7. Conclusions

Considering the purpose, components, methodologies, etc., associated to VTT's EcoCity concept, capacity building is so much at its core that it would appear as if the whole EcoCity concept has

been conceived and designed as a process to generate capacities since VTT's participation is only temporary and oriented to the transfer of the knowledge and the methodologies, and to facilitate the process for their effective application in accordance with local characteristics, needs and possibilities. Therefore, facilitation is very often combined with capacity building. VTT experts are not independent facilitators totally separated from the group they facilitate; they make presentations and are part of the discussions some times. Facilitation is thus the bridge between the general and the particular, it helps to find a common path transcending the management in silos (temporal, spatial, etc.). Facilitation also helps to keep the discussion within the jointly defined framework (threshold) of the non-negotiable and to prevent participation becoming an excuse to dilute the responsibility of those that should be held accountable.

As explained, adaptation is of special importance and VTT facilitation will support the EcoCity process through the development of solutions based on local traditions, specific social and economic realities, local perceptions and identity values, materials available and partners' skills and competences. Likewise, the solutions proposed will be the result of the best possible combination of technologies and services (from a sustainable building perspective) to guarantee a good quality of life for the inhabitants of a specific territory, inside and outside the buildings. Ultimately, through its application in varying contexts worldwide, the EcoCity concept itself together with the facilitation processes and skills that support it become richer and therefore more useful when next applied in new situations. In conclusion, capacity building and adaptation happen both on the local side and on the side of the concept and its facilitators.

EcoMedellín project is part of a broader political, administrative and scientific process, as summarized above. In this process, the main contribution of VTT's EcoCity facilitation was related to two aspects of singular importance. On the one hand, it facilitated the articulation and complementarity between the technical "grey" components of sustainable urban development with the "green" components of biodiversity and ecosystem services-main object of the Framework Project. On the other hand, it facilitated the change of scale and perspective from a national and regional public policy project, to a local and specific project of direct intervention, supported by the methodologies and instruments provided by the EcoCity concept.

In addition, the change of scale and the expansion of themes meant the participation of new social actors, who benefited from the EcoCity experience and in turn generated new contributions "greening" the process of moving from a national project to a local (municipal) one, this being a specific project in which the change of scale widened the group of participants, thematic areas of coverage, and the set of management tools. All this was made possible through VTT's EcoCity facilitation.

In Zambia, on the contrary, the facilitation helped the locals to move from the local to the national scale in order to create a vision for a sustainable future covering a number of issues of concern affecting the whole country. In this case, even though the participants were mostly students, the diversity of thematic areas of coverage was also ensured since they belonged to different faculties. Cultural diversity within the country was secured too since they were coming from different provinces.

In short, this EcoCity concept can be understood as a way to approach different realities in a complex but effective way, and must be supported by adequate facilitation in order to be successful. Comparatively speaking, an adequate facilitation can substantially contribute to move from land policies, urban policies, etc. to the definition of specific projects or the formulation of concrete solutions by achieving a high degree of participation and commitment of all stakeholders and interested parties, thus increasing the probability of appropriation of the project by the community.

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Author Contributions: Carmen Antuña-Rozado has been directly involved in both case studies described in this article. She was one of VTT EcoCity facilitators for EcoMedellín workshops and the manager of EcoLusaka project, of which the seminar and workshop "Creating a Sustainable Future for Zambia" was a dissemination action. Justo García-Navarro has coordinated the comparative study presented here, critically reviewed the manuscript and provided useful recommendations. Juana Mariño acted as the local coordinator and co-facilitator for EcoMedellín workshops.

Conflicts of Interest: The authors declare no conflict of interest.

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Early energy assessment at the neighborhood level to promote greater energy efficiency. The case of Nabta Smart Town in Egypt

Carmen Antuña-Rozado [a,b,*], Justo García-Navarro [b], Francesco Reda [a]

[a] VTT Technical Research Centre of Finland Ltd., PO Box 1000, FI-02044 VTT Espoo, Finland
[b] Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIAAB – Av. Puerta de Hierro, 2-4, 28040 Madrid, Spain

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ABSTRACT

The potential for an early energy assessment to further improve neighborhood/precinct planning and promote greater energy efficiency is considerable, as confirmed by numerous studies around the world and corroborated by the authors' experience. Egypt is certainly no exception and in recent years there is growing research evidence to this effect. However, more knowledge is needed on how to develop affordable and locally viable solutions that are integrated into the urban planning process from the outset. This article discusses the results of the "Energy Efficiency Feasibility Assessment of the Master Plan of Nabta Smart Town (NST)", an "education town" under planning in New Borg el Arab City (NBC), close to Alexandria. The results show how an early energy assessment, carried out as early as the planning stage, which considers local regulations and specific conditions, can help achieve considerable energy efficiency in the future by identifying affordable, evidence-based, and locally feasible solutions that can be further optimized at the design stage. Therefore, the value of this study is not in proposing a new standard solution for everyone, but in showing through an application example how the potential of an early energy assessment at the neighborhood/precinct level can be realized in practice. The immediate benefit is in promoting greater energy efficiency through the design and optimization of renewable energies and passive solutions. This achievement can in turn be used to rethink the planning and decision-making process in the local context. The greatest impact is not only in the selected case study, but in its potential for replicability throughout the Global South.

1. Introduction

The *Sustainable Development Strategy (SDS): Egypt Vision 2030* (Ministry of Planning and Monitoring and Administrative Reform (MPMAR), 2016) represents the aspiration of the Egyptians towards inclusive development and constitutes a strategic roadmap to achieve prosperity and equal opportunities for all through economic and social justice, and to revive the role of Egypt as a regional leader. The SDS is built around 10 pillars organized according to three dimensions, namely, economic, social, and environmental. Energy is the second pillar under the economic dimension. Efficient resource management and the use of renewable energy are promoted as means to achieve economic growth while preserving the environment in compliance with the Sustainable Development Goals (SDGs) (United Nations Sustainable Development Knowledge Platform, 2016).

However, to achieve the global targets of SDG7 - Affordable and clean energy by 2030, it is vital to invest in not only renewable energy and improving energy productivity and infrastructure, but also in better technologies and solutions providing clean and more efficient energy for all. More particularly concerning energy efficiency, the target established by SDG7 is to double the rate of improvement worldwide. This requires a global effort and international cooperation in R&D must be enhanced to facilitate the process. In this sense, the main factors identified affecting the profitability of renewable energy projects for grid-connected electricity generation are technology capacity cost, technology operation and maintenance cost, capacity depending on the renewable potential and effectiveness, project lifetime, feed-in tariff and selling prices, and power purchase agreement (United Nations Economic & Social Commission for Western Asia, 2017). Even though the renewable energy sector is growing globally, and so are the investments, it is still not enough to reach climate and development goals (Carino & Sriskanthan, 2018).

* Corresponding author. Universidad Politécnica de Madrid, ETSIAAB – Av. Puerta de Hierro, 2-4, 28040 Madrid, Spain.
E-mail addresses: carmen.antuna@vtt.fi (C. Antuña-Rozado), justo.gnavarro@upm.es (J. García-Navarro), francesco.reda@vtt.fi (F. Reda).

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With a population of around 95 million according to the last census (Central Agency for Public Mobilization And Statistics (CAPMAS), 2017), Egypt is the third most populous country in Africa after Nigeria and Ethiopia. The demand for energy continues to increase due to population and economic growth and the increase in industrial production, which poses considerable challenges to ensure a continuous and stable energy supply. Power cuts are very frequent. Until very recently, Egypt remained one of the least energy efficient countries in the MENA region despite of its 5-year plan to eliminate electricity subsidies. *Egypt's National Energy Efficiency Action Plan (NEEAP, 2012–2015)* contained a 5% cumulative target, but there was no designated agency and no legal framework for energy efficiency measures (Regional Center for Renewable Energy and Energy Efficiency (RCREEE), 2012). Since then, Egypt has implemented energy efficiency codes for residential (2005), commercial (2009) and governmental buildings (2011). Although some efforts have been made to improve the policy, legal and institutional framework to better support energy efficiency and renewable energy integration, considerable obstacles persist that hamper the scale-up of clean and energy efficient technologies. Lack of adequate information and technical expertise coupled with an inflated risk perception prevent both end-users and investors from making informed investment decisions (Energy Efficiency in the Construction Sector in the Mediterranean (MED-ENEC) Project, 2016).

To address this situation the Egyptian government launched in 2016 the *Integrated Sustainable Energy Strategy 2035 (ISES 2035)*, which aims at having a 42% of renewable energy contribution to the energy mix by 2035 as can be seen in Fig. 1 (Government of Egypt, 2016). The New and Renewable Energy Authority (NREA) under the Ministry of Electricity and Renewable Energy has an instrumental role to play in the implementation of the Strategy. In collaboration with NREA, the International Renewable Energy Agency (IRENA) has prepared the *Renewable Energy Outlook: Egypt* (International Renewable Energy Agency (IRENA). Renewable Energy Outlook: Egypt, 2018), which focuses on the actions of different nature needed to meet the abovementioned targets (e.g., policies and regulations, financial support, capacity building). Furthermore, the report also identifies potential challenges and opportunities for increasing the use of renewable energy in the country. One of the main conclusions is that 53% of power generation from renewable sources can be achieved by 2030 if the right policies are applied and updated regularly to consider new technology developments, cost fluctuation, changes in the energy sector, and regional geopolitics. Apart from diversification through renewables, the Egyptian government is also promoting the introduction of energy efficiency measures, and operation and maintenance programmes. To this end, the report includes a Reference Case based on the energy supply and demand scenario defined by *TARES report* (European Union, 2015), which provides a baseline against which *ISES* energy targets can be quantified. The Reference Case also explores the potential of renewable energy beyond the power sector, namely, in buildings, industry and transport.

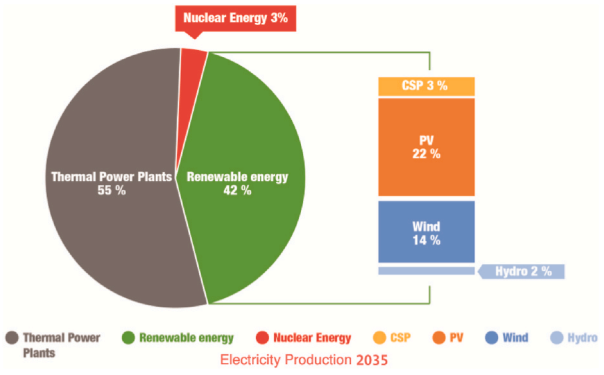


Fig. 1. Egypt's renewable energy targets for 2035. (Source: NREA).

Regarding the building sector in particular, Egypt offers many opportunities for the integration of renewables into different building types, as well as for the implementation of energy efficiency measures. The report *Energy Efficiency and Rooftop Solar* PV *Opportunities in Cairo and Alexandria* (World Bank, 2017), part of an assessment carried out by the World Bank with the support of the Energy Research Centre at Cairo University, presented interesting findings on the potential of rooftop solar PV and EE to contribute to the government's objectives of achieving cost reflective tariffs and address the country's energy challenges. The study analyzes RE and EE potential and measures in relation to public, commercial, and residential buildings, as well as EE potential and measures for potable water, street lighting and transport. Overall, the estimated EE potential for the building types considered is 30–50% for public buildings, 40–60% for commercial buildings, and 30–50% for residential buildings. This study by the World Bank is relevant, but even more in this instance because it involved Alexandria, the second largest city in Egypt with a population of 5.3 million as of January 2019 (Central Agency for Public Mobilization And Statistics (CAPMAS), 2019) and the closest to New Borg El Arab City (NBC) where the case study described in this article is located.

In addition to the abovementioned strategy and assessment studies, which help to define the local context of operation in relation to energy, if returning to the global scale, 68% of the world's population will live in urban areas by 2050 (United Nations Population Division of the Department of Economic and Social Affairs, 2018). This will only increase the already great challenges that rapid urbanization presents for cities worldwide, particularly in the Global South. In African cities, this process has resulted in a particularly intense proliferation of informal settlements where the rapid demographic growth is not adequately supported by the necessary physical and economic infrastructure (United Nations Human Settlements Programme (UN-Habitat), 2014). Urban sprawl, neighborhood fragmentation, and inefficient transport networks often characterize such cities, producing a negative effect on investments, productivity, and access to jobs. It also increases the costs of food, housing, and transport, which in turn leaves cities in Africa *"trapped in the production of nontradable goods and services"* (Lall et al., 2017). The authors conclude that a new urban development path is required to unlock the situation and attract capital investment. Although Egypt is no exception, Cairo ranked first among African cities in attracting foreign direct investment (FDI), due to its proximity and connections to Europe and the Middle East, large internal market, more developed human capital and technology, and strong financial services (United Nations Human Settlements Programme (UN-Habitat), 2018). According to the same report, Alexandria ranked second at country level, but only 23rd in the continent.

This is in short, the global and national context in terms of (unsustainable) urban agglomeration and access to clean and affordable energy for the case study presented here. In response to these challenging conditions, some authors affirm that environmentally conscious architecture can play an important role in development plans as an effective tool to reduce energy and material consumption and to improve quality of life (Ayyad and Gabr, 2013). As a new urban development, Nabta Smart Town (NST) discussed here is an attempt to contribute to the necessary transformation of Egyptian cities towards more sustainable development patterns and better living conditions, which not only requires a new fundamental approach in the form of innovative policies and strategies (Goell et al., 2009), but also concrete examples of good practice. Such examples should be at the same time locally attuned, scalable, and replicable in similar national and international contexts, a balance certainly not easy to strike.

To contribute to this need, several studies have already been carried out in Egypt that highlight the potential of properly optimized hybrid power systems to reduce energy costs, significantly lower CO_2 emissions and secure supply (Elkadeem et al., 2020). Such research covers not only urban communities, like the one just mentioned developed for Safaga, but also isolated rural areas (Abo-elyousr & Elnozahy, 2018). Many of

them focus on micro-grids and propose different approaches and frameworks for the optimization of the multiple combinations possible. Furthermore, the same type of research is taking place in many other regions of the Global South, in both urban and rural contexts. As an example, Almasri et al. have recently analyzed the energy consumption in the residential sector of Qassim region in Saudi Arabia and their findings corroborate the importance of raising awareness (even among school children) on rationalizing energy consumption, supporting the introduction of renewable energy solutions (particularly solar), and improving the efficiency of electrical appliances (especially air conditioning systems) (Almasri et al., 2020). Abdilahi et al. carried out a feasibility study on how to supply electricity to a sample residential area in Hargeisa, the main urban center in Somaliland, through a hybrid micro-grid system supplemented by renewable energy (Abdilahi et al., 2014). Similarly, Masrur et al. found in a recent suitability analysis that a PV/Wind/Diesel/Battery hybrid micro-grid system seems to be the best option to replace the diesel-based system currently in use in St. Martin's, a remote island of Bangladesh (Masrur et al., 2020). In Colombia, Haghighat Mamaghani et al. analyzed the combined use of PV panels, wind turbines and diesel generators in a hybrid system for the electrification of three rural communities with different climatic conditions (Haghighat Mamaghani et al., 2016). All of them acknowledge the opportunities presented by hybrid RE-based systems to secure energy access worldwide while bringing down energy costs and emissions. However, they also point towards the need of incentives and supporting policies, in addition to other measures like tax reductions and exemptions, to make it possible for low-income communities to afford the initial investments as well as the operation and maintenance costs. This is crucial to reach the objectives established by SDG7.

By now, considerable research has also been carried out in the MENA (Middle East and Northern Africa) region to understand how the architectural design, and more specifically the use of passive features and strategies such as orientation, size of openings, shading, insulation, local materials, and natural ventilation can contribute to reduce the net energy demand and to improve the indoor comfort, e.g. (Algendy & Anbar, 2017) (Visser et al., 2017). For instance, in the case of Emirati villas located in a suburban neighborhood in Abu Dhabi (UAE), Birge & Berger found that improved design could potentially reduce CO_2 emissions per household per year as much as 33.7%–49.0% compared to the existing baseline for new construction. This figure could ramp up to 99.4% when combining design and technology (Birge & Berger, 2019). At the urban scale, there is a considerable body of literature on the quality of ecocities built around the world and the extent to which they have achieved their initial goals, particularly in China, e.g., Li & Qiu (Li & Qiu, 2015). There is also increasing knowledge on how to develop sustainable cities in arid regions (Alshuwaikhat & Nkwenti, 2002), as well as how to plan and design energy-efficient neighborhoods (Visser & Yeretzian, 2013). There is also literature on different aspects related to the use of different renewable energies or a combination of them at the urban scale in different countries of the Global South, for example, Razmjoo et al. (Razmjoo et al., 2020). However, few studies have been found related to the benefits of an early energy assessment and the incorporation of energy efficiency measures at the level of planning and design of new neighborhoods and districts, especially in developing countries. Therefore, this paper intends to contribute with a concrete local example to show what can be achieved through early intervention, relatively affordable in the planning stage, and with potential for improvement in the urban design stage (main objective 1).

2. Research objectives and methodology, article structure

2.1. Research objectives and methodology

The main objectives of the research presented in this article were:

1) To show how an early energy assessment, carried out already at planning stage, that considers the local regulations and specific conditions can help to achieve considerable energy efficiency down the line by pointing towards affordable evidence-based solutions that can be optimized even further at design stage.
2) To deepen the understanding of the specific local conditions to ensure a proper adaptation of the solutions proposed for the improvement of NST Master Plan to increase energy efficiency and performance optimization.
3) To develop energy efficient solutions that are viable and affordable in the local context.

Additionally, other objectives were: 4) To capitalize on the recommendations of a project previously coordinated by the Technical Research Centre of Finland Ltd. (VTT) in NBC, "EcoNBC, EcoCity Capacity Building in New Borg El Arab City" funded by the Ministry for Foreign Affairs of Finland. 5) To assess their potential for scalability and replicability. 6) To explore possible beneficial synergistic effects to be covered by future research. Ultimately, this work contributes to the strongly demanded empirical research on the second generation of smart cities, also called smart city 2.0, which unlike the first generation paradigm are characterized by decentralization and people-centricity, and where smart technologies are used to provide solutions to social problems and to address citizen needs (Trencher, 2019). The above objectives are mentioned throughout the text in relation to the findings of the literature review (section 1), the energy assessment designed to adapt to local conditions (section 4), the results (section 5), specific aspects of the project (section 6), as well as in terms of their realization in practice (section 7).

A qualitative research approach was applied using the case study method to deduce meaning from qualitative, complex phenomenological data collected (in this instance) in the form of "inputs bills" that were later reviewed and validated by local experts during several workshops (Eisenhardt & Graebner, 2007) (Yin, 2013). The case study method is particularly adequate when assessing implementation processes (Bryman, 2012). Regarding the materials (or tools) used, based on the data thus gathered and the main building typologies defined in the Master Plan, three building models were generated using Transient System Simulation Tool (TRNSYS) software to calculate the energy demand of NST and to conduct the sensitivity analysis for energy performance optimization.

2.2. Article structure

The structure of this manuscript consists of: **First** framing the case of NST in the global context of the energy targets set by SDG7 - Affordable and clean energy, and the challenges posed, particularly in the Global South, by fast-paced unsustainable urbanization processes. In this instance, the focus of the work was mainly on two targets: 7.2 to increase the share of renewable energy in the energy mix by 2030; and 7.A to enhance international cooperation on clean energy research and technology. Particularly regarding target 7.A, the emphasis is on increasing the share of renewable energy (solar and wind) and improving energy efficiency. Showing the viability of energy efficient solutions and renewable energy (first part of target 7.A) in Egypt is the necessary step before promoting clean energy investments (second part of target 7.A). Incidentally, the solutions developed can also contribute to decrease CO_2 emissions, therefore affecting SDG 13 - Climate action, more specifically in relation to target 13.3 through an improvement of the human and institutional capacity (i.e., training and working with the local partner) on climate change mitigation. **Second**, describing the national context in Egypt concerning the most relevant energy initiatives (strategies, studies, and other relevant documents), as well as pressing urban issues that should be prioritized. The use of this double scale is intended to provide insights into how to develop solutions that can be at the same time adapted to the specific conditions of any given place in a particular

country or region - in this case NBC in Egypt, and yet have the potential to be scaled up in other parts of the country, or even replicated elsewhere. **Third**, narrowing the focus to get a close up of the situation in Alexandria and NBC, the cities that are most directly influencing the planning, design and future implementation of NST. **Fourth**, presenting the case of NST and discussing the results of the work carried out by VTT and the local partner, the Khairy Foundation for Human and Social Development (KFHSD). **Fifth**, drawing conclusions from the previously mentioned results while trying to identify additional components, emerging technologies or concepts that could contribute to the maximization of the expected impacts. **Sixth**, contextualize the results and discuss possible ways ahead to accelerate the implementation of energy efficient measures and the integration of renewable energies.

3. The case of Nabta Smart Town in NBC, Egypt

With a population of 5.3 million as of January 2019 (Central Agency for Public Mobilization And Statistics (CAPMAS), 2019), Alexandria is the second largest city in Egypt after Cairo, the capital, and one of the country's main economic centres. The "Pearl of the Mediterranean" as popularly known, Alexandria enjoys a privileged location between the Mediterranean Sea to the north and Lake Mariout to the south. Despite the beauty of this enclave, its rich history and valuable architectural heritage, Alexandria faces nowadays numerous challenges. Among them, fast population growth; high unemployment, particularly affecting the youth; serious lack of affordable, adequate, and safe housing -e.g., informal settlements keep proliferating, and more than 400 residential buildings collapse every year (Jankowicz, 2017)-; traffic congestion; deficient governance or high environmental pollution in El Mahmoudia Canal and the already mentioned Lake Mariout (Sirry & Woertz, 2018).

NBC, located 60 km to the south-west of Alexandria and 7 km away from the north coast, was established by presidential decree 506/1079 and belongs to the first generation of so-called "Egyptian new towns". The new town policy was launched by the Government of Egypt in 1970 with the intention of alleviating the demographic pressure on the long-inhabited areas along the Nile valley, no longer able to absorb an increasing population. To achieve a more balanced spatial distribution of the population, several new towns were built in desert locations, all with an important industrial base capable of attracting public and private investments (Aafify, 1999). In 1979, the New Urban Communities Authority (NUCA) was created as the body within the Ministry of Housing responsible for establishing new communities. NUCA oversees the whole process from the selection of the sites to the construction of housing and infrastructure. Once the development is completed, NUCA should transfer the jurisdiction to the corresponding governorates for regular municipal administration. The three generations of new towns developed up to date have received considerable criticism from numerous authors due to the many problems identified over the years. Perhaps the main argument against is that they have failed to attract the planned populations, aside of other issues like lack of clarity regarding the criteria followed to select the sites for development, severe environmental problems affecting many new towns, high cost of basic infrastructure, and over-reliance on public investments (Hegazy & Moustafa, 2013).

With a population of around 170,000 people according to 2022 statistics, NBC is an important production centre with 1271 factories (New Urban Communities Authority NUCA, 2015), yet it shows the same flaws and contradictions that afflict most Egyptian new towns. Although most of the workers commute daily from Alexandria, NBC offers several services and facilities (hospitals, schools, mosques, shops, university …) while having to cope with various urban sustainability challenges. A more detailed description of the city's most pressing needs and how to provide locally attuned sustainable solutions can be found in the scientific reports and papers published on the results of the EcoNBC project, like e.g., here (Hedman et al., 2014).

This is the context in which Nabta Smart Town in NBC, emerged as an ambitious project combining modern residential and commercial facilities with high quality "Educational Magnets" and administrative offices, to create a thriving and inclusive community (see Fig. 2). The local promoters of NST envisioned a culture that fosters sustainable water and waste management, recycling, energy efficiency, renewable energy sources, healthy lifestyles, smart mobility, public green areas, increased biodiversity, and citizens' engagement through participatory processes. Moreover, NST has even further reaching goals like contributing to regional development through science, technology, and culture; providing innovative solutions for products and services in response to important human needs; supporting the creation of new businesses; and establishing technical and commercial cooperation with international partners (Antuña-Rozado et al., 2019a). A good example of the latter is precisely the project "Sustainability Assessment of Nabta Smart Town (NST) and Actions for Improvement" carried out by VTT together with KFHSD and funded by the 10YFP Trust Fund (One Planet Network SBC Programme). With the principal objective of ensuring that the Master Plan and the various building types of NST, including those of Nabta University, would follow the standards of *"a modern smart EcoCity adapted to the local conditions of Egypt"* as expressed by KFHSD, it was the first project making direct use of the findings and recommendations of "EcoNBC Feasibility Study. Transforming New Borg El Arab into an EcoCity" (Antuña Rozado et al., 2015), one of the main outcomes of the already mentioned EcoNBC project. The new project was conceived as a general framework for the development of locally viable projects (i.e., based on locally available technologies and existing local capacity) and affordable smart solutions (understood as an optimized set of measures).

From its inception, the Sustainability Assessment of NST tried to establish direct links with the UN Climate Change Conference, 21COP held in Paris in 2015, and the 2030 Agenda for Sustainable Development. The project as initially planned (Sustainability Assessment of NST Master Plan) was expected to contribute significantly to SDG6, 7, 11, 12 and 13. The first phase, the results of which are presented here, focused on the Energy Assessment of NST Master Plan, described in section 4, and therefore the SDGs impacted are mainly 7 and 13. In addition, it provided the opportunity to align the NST energy targets with those of the country from the beginning, capitalizing on previous experience in this area.

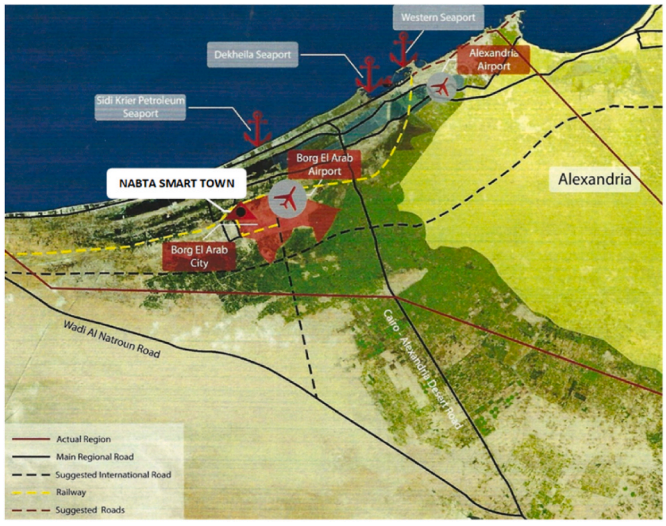


Fig. 2. Map showing the location of Nabta Smart Town. (Source: UPSCALE).

4. Energy assessment of NST Master Plan

This section describes the requirements formulated by the project's initiators based on their goals for the new urban development and the preliminary conditions set by NST Concept Master Plan. It also discusses how the experts involved in the research addressed those requirements in terms of the process followed for the energy assessment of NST Master Plan and the approach taken (software used, data collection, assumptions). Both the process and approach were carefully defined to align with main objective 2 and additional objective 4, and for the results to have a positive impact on additional objectives 5 and 6.

4.1. NST Master Plan

Fig. 3 shows the land use and its distribution, while Tables 1 and 2 provide more details about the projected buildings, their purpose and area, their capacity and even the number of floors, as well as the planned services. Table 1 focuses on the area called Business Bay, while Table 2 focuses on the area known as Knowledge Bay. The information in Tables 1 and 2 is completed with the data collected later in the "inputs bills" to carry out the energy evaluation (see 4.2 and 4.3).

Fig. 4 summarizes the initially proposed construction heights. Subsequently, they selected an Egyptian firm to adapt the design concept developed by Atkins to current local urban planning and construction regulations. It was during this time that the collaboration of KFHSD, one of UPSCALE's trusted partners, and VTT was required to support the sustainable adaptation of the Master Plan to the specific conditions of Egypt and NBC. The results shown in this article correspond to the first phase of the work, which focused on the Energy Assessment of the NST Master Plan.

4.2. Energy assessment process

In recent years, renewable energy sources have gained importance and strategic investments to increase wind, solar and other sources capacity are planned for this decade in Egypt (Salah et al., 2022). As pointed out by Mondal et al. investing in renewable energy represents a necessary step towards a low-carbon society, but also a means to improve Egypt's energy security by diversifying the energy mix and reducing reliance on fossil fuels for power generation (Mondal et al., 2019).

When multiple renewable generation systems have been considered, advanced power design through simulation and optimization is a well-recognized method among the scientific community to properly size power systems, as reflected in the literature (Laitinen et al., 2021; Rehman et al., 2019). Therefore, in this study, the authors have used simulation and optimization to design the district power systems, as photovoltaic and wind generation technologies have been considered. Furthermore, they focused only on energy optimization and not economic optimization, as economic evaluation was not part of the project plan. The economic evaluation should be part of a future study. Building on the methodologies previously developed by VTT (Antuña-Rozado et al., 2016), the Energy Assessment of NST Master Plan was carried out according to the following process:

In detail assessment of NST Master Plan. Since the quality of the data is essential to ensure adequate results, KFHSD experts collected the data needed for the energy assessment (including passive features and user behavior) according to the methodology and instructions provided by VTT experts. The data collection took the form of an "inputs bill" that was also used later for the TRNSYS seminar that followed. As an example, the "inputs bill" for the Residential building type included information on occupancy patterns (e.g., number of people per unit, hours), infiltration rates and domestic hot water (DHW) profile, appliances in use, thermal details of building materials (external wall, roof, ground floor, internal floor, and windows), energy system (air source heat pump, photovoltaic system). The data gathered was jointly reviewed during a workshop facilitated by VTT to remove any possible misunderstandings in relation to its accuracy. For instance, DHW provided for Office and Educational buildings appeared to be rather high, particularly in the case of Office buildings. Upon discussion with the local experts, it seemed that very often this kind of Business and Commercial initiatives have a high DHW consumption due to the availability of multiple amenities, e.g., swimming pool, spa and beauty salons, or sports clubs. Considering this possibility, high DHW was assumed for the Office building model (which in turn was used for both Office & Educational) to be on the safe side of the analysis. Inputs bills are not included here to prevent this article from being too long.

Training of KFHSD staff on specific software. An intensive 4-day course was arranged to provide training on building energy optimization using TRNSYS and GENOPT so that KFHSD experts could help to build the catalogue of NST building types (see next step) supervised by VTT. The course also included nearly and Net Zero Energy Buildings (NZEB).

Energy categorization of NST building types. Different building types included in NST Master Plan (Educational, Residential, Commercial) were categorized in terms of energy consumption (e.g., low/zero energy consumption, energy plus).

Modelling and simulation for energy performance optimization. Modelling and simulation tools available in Finland (particularly those used by VTT, more detailed in Section 4.3) and Egypt were used to

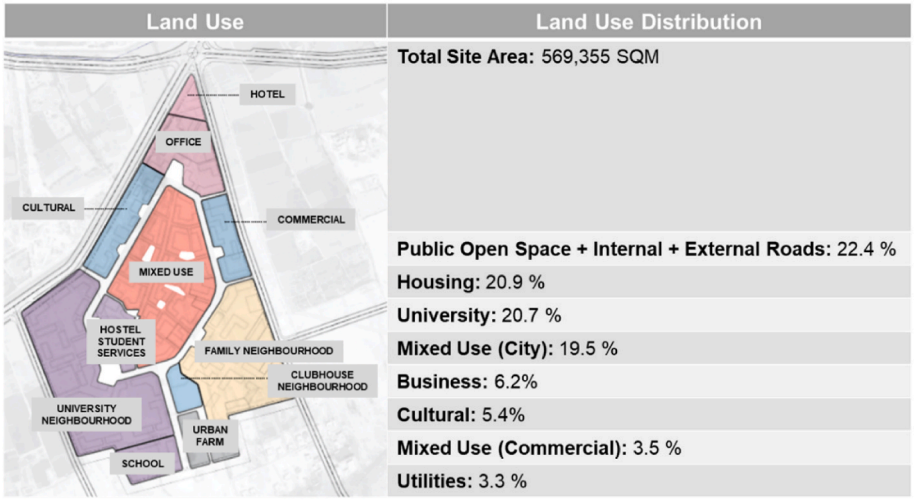


Fig. 3. NST Master Plan: Land use and land use distribution. (Image: UPSCALE/Atkins).

Table 1
Summary description of the Business Bay area.

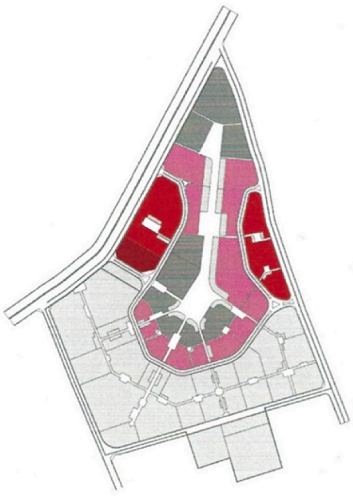
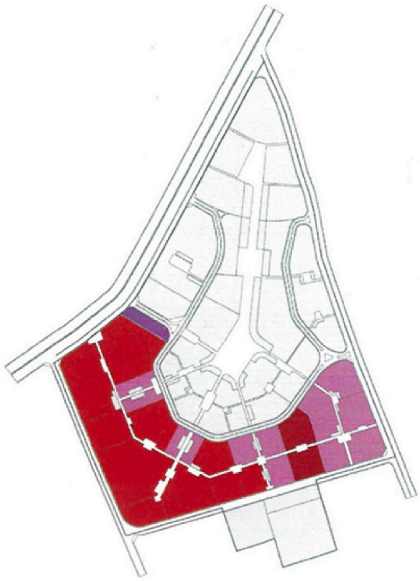
BUSINESS BAY	
Residential and Mixed Use	
Total area: 181,600 m^2 on 4 floors	
Teaching staff hostel	
For Faculty and students, 150 rooms (single and double)	
Residential area planned	
200 single bedrooms	*20 duplex outdoor triple bed.*
1100 double bedrooms	*20 twin houses*
300 triple bedrooms	*15 villas*
100 duplex indoor triple bed.	
Administrative office area	
Total area: 30,800 m^2	
2 data centres	
1 command and control centre	
111 offices including meeting rooms, teleconference, and innovation centres	
Commercial area	**Utilities**
Total area: 28,800 m^2	Total area: 36,830 m^2
48 commercial services (cafes, restaurants, and leisure)	***Telecom utilities***
18 warehouses	*1 satellite facility*
75 commercial shops (boutiques, indoor-outdoor shops)	*19 office facilities including call centres*
Public services (bank, post office, medical facilities)	**Islamic centre**
50 private clinics	*13 waiting areas*	Total area: 3,550 m^2
6 labs for x-rays	*15 offices*	Capacity: minimum 500 simultaneous prayers
6 operation rooms with ICU	*5 storages*	
Social & Sports Club	**Movie theatre**
Total area: 10,850 m^2	Total area: 7,100 m^2

Table 2
Summary description of the Knowledge Bay area.

KNOWLEDGE BAY	
Campus	
Total area: 117,100 m^2	
Planned number of students: 7,800	
Planned buildings: University Main Building +10 Faculties	
Faculties planned	
Engineering & Applied Science (1,500 students in 4 years)	
Biotechnology (500 students in 4 years)	
Dentistry (1,500 students in 5 years)	
Pharmacy (1,500 students in 5 years)	
Physical Therapy (400 students in 4 years)	
Applied Medical Science (400 students in 4 years)	
Entrepreneurship & Economics (800 students in 4 years)	
Mass Media & Communications (400 students in 4 years)	
Foreign Languages & Linguistics (400 students in 4 years)	
Maritime & Logistics Management (400 students in 4 years)	
School area	**Library**
Total area: 12,700 m^2 on 4 floors	Total area: 4,900 m^2 on 4 floors

optimize the building variables like e.g., construction materials, insulation, use of reflective paints, or green roofs. Although the focus was on design principles and construction materials, attention was also paid to the construction process and timetable, local sourcing of materials, and transportation to minimize environmental impacts. Concerning the local climatic conditions, VTT experts have used the information provided for Alexandria by Energy Plus, a widely known and accepted source among professionals in the field.

Finally, the results were presented, discussed, and validated during the project's Final Event for key local stakeholders and a Final Seminar organized for a selected group of students from the University of Alexandria. The results have also been disseminated in several international conferences.

4.3. Approach

As already mentioned, TRNSYS software was used for estimating the energy demand of NST. Three different building models were generated according to the building typologies defined by the Master Plan, namely, commercial, educational, and residential. Fig. 5 shows the layout of a typical residential building in New Borg El Arab based on the findings of the expert team. All information in the tables that follow is partly coming from the specifications in the Master Plan, partly from the "inputs bills" already mentioned, and partly from the workshops held together with the local partner, KFHSD, and the international experts that worked in the project.

Table 3 shows the total area of the different building typologies included in the Master Plan and the paired building model used to simulate the corresponding energy behaviors, as well as the thermal properties of the construction materials used in the models for a typical wall section.

In addition to the previous, VTT experts made the following assumptions:

4.3.1. Buildings

- Low-e windows (tinted double glazed 4/12/4 mm Glass/air/Glass, U = 1.69 $W/m^{2\circ}C$) as provided by the local experts.
- 20 °C and 26 °C as heating and cooling indoor temperature set points respectively.
- Energy efficient practices, such as natural ventilation (free cooling) and external shading devices applied.
- Different internal gains and energy consumption of electrical appliances estimated according to the provided occupancy patterns for each of the abovementioned building models.

Based on these assumptions, eight different building cases were defined as shown in Table 4.

4.3.2. District

- Very efficient buildings, building-to-building transaction.
- Synergies between buildings.



Fig. 4. NST Master Plan: Building heights. (Image: UPSCALE/Atkins).

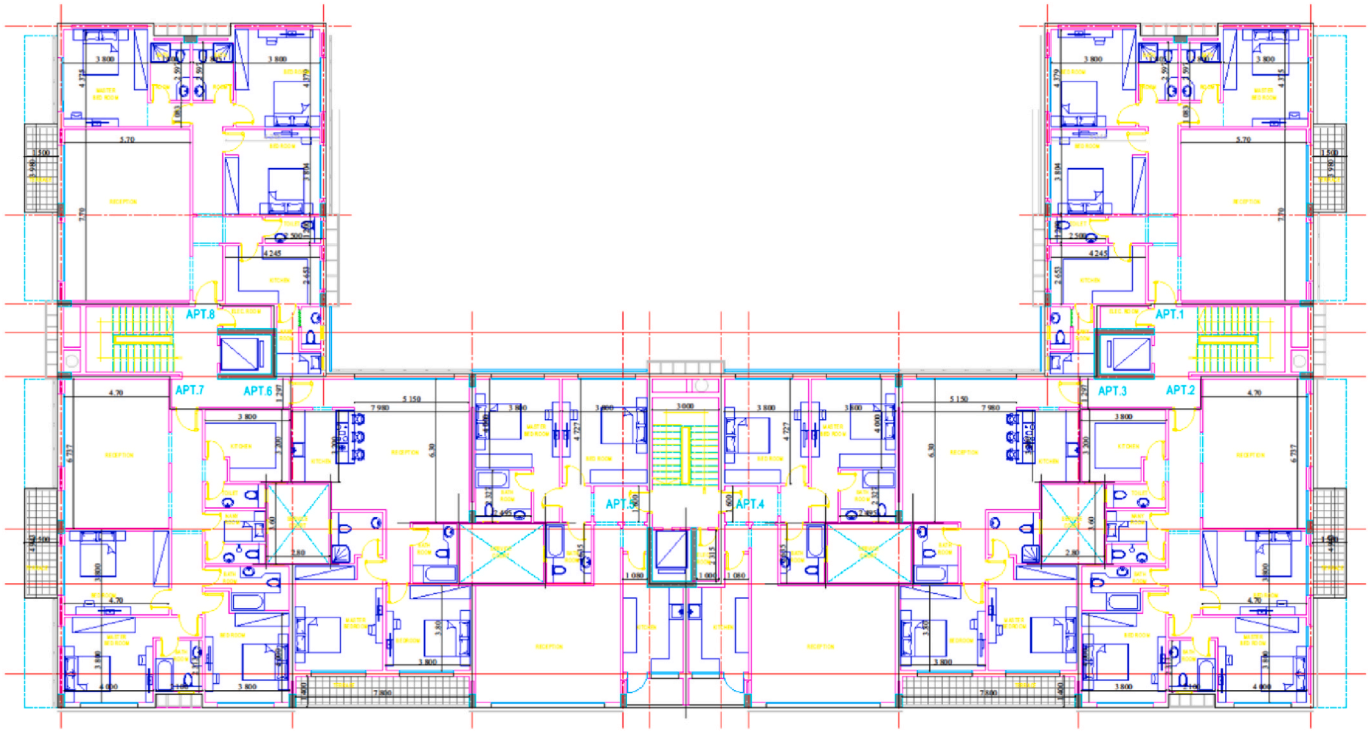


Fig. 5. Residential building floor layout. (Image: Francesco Reda, VTT).

- Different configuration of RES for supplying energy to NST were assessed using a system model and considering both solar PV integrated on building roofs and decentralized ground-mounted wind turbines.
- PV distribution in different buildings optimized to minimize energy export and maximize self-consumption.
- District heat pump in use.

Table 5 shows the cases defined based on the previous assumptions, while Table 6 summarizes the five scenarios considered for the total RES capacity installed. In the light of the results obtained, NST offers a real opportunity for the realization of Egypt's EE potential, even for the residential sector, since NST buildings are not lacking rooftop space, which typically hinders solar PV installation on old and renovated buildings (World Bank, 2017).

Table 3
Total area of building typologies, paired building model and thermal properties of the wall section.

Master Plan		*Paired building model*
Total area (m^2)	**Building typology**	
101 465	University Neighbourhood	*Educational*
51 970	Business	*Office*
46 565	Cultural	*Educational*
180 471	Family	*Residential*
23 490	Hotel	*Residential*
20 223	Commercial	*Office*
16 240	Schools	*Educational*

Material	**Specific Heat [J/kg. °C]**	**Density [kg/m^3]**	**Conductivity [W/m. °C]**	**Width [mm]**
Cement Plaster	1 000	2 000	1.4	25
Red bricks	1 000	1 200	0.5	125
Insulation	900	80	0.04	50
Red bricks	1 000	1 200	0.5	125
Cement Plaster	1 000	2 000	1.4	25
			[W/m^2°C] U (Transmittance)	**0.526**

Table 4
Cases defined for building energy performance simulation.

Reference	Tset, heating-cooling (20–22 °C)
Case 1	Tset, heating-cooling (23 °C)
Case 2	Tset, heating-cooling (20–26 °C)
Case 3	Tset, heating-cooling (20–26 °C), Natural Ventilation
Case 4	Tset, heating-cooling (20–26 °C), Natural Ventilation, Shading
Case 5	Tset, heating-cooling (20–26 °C), Natural Ventilation, Shading, Egyptian Stone
Case 6	Tset, heating-cooling (20–26 °C), Natural Ventilation, Shading, Wall Insulation
Case 7*	Tset, heating-cooling (20–26 °C), Natural Ventilation, Shading, Wall Insulation, HR48%
Case 8*	Tset, heating-cooling (20–26 °C), Natural Ventilation, Shading, Wall Insulation, HR80%

* Only for Educational and Offices.

5. Results

5.1. Buildings

Fig. 6 shows the results corresponding to the Residential, Office and Educational building models defined as described in Section 4.3. For the Residential model, the Reference case is shown at the bottom (BaU: cooling and heating 60 kWh/m^2 and 39.64 kWh/m^2). As could be expected in a country like Egypt, the cooling demand constitutes the biggest share, whereas the heating load appears negligible in all cases, except Case 1 (around 10 kWh/m^2, still a low value). Looking more closely, the temperature set point alone can have a significant effect on the demand. Best case: Cooling 36 kWh/m^2 and 13.59 kWh/m^2 heating (50% reduction).

For the Office and Educational models, again the Reference case appears at the bottom (BaU: 202 kWh/m^2 p.a. as total energy use and 162 kWh/m^2 for HVAC). As it turns out in both cases and unlike the Residential example, here the cooling demand is not always the biggest

Table 6
Scenarios for total RES installed.

S1	25% of the district's power peak	2.40 MW
S2	50% of the district's power peak	4.81 MW
S3	75% of the district's power peak	7.21 MW
S4	100% of the district's power peak	9.61 MW
S5	Enough RES capacity to achieve Net Zero Energy District (NZED) > energy produced = energy consumed	

Table 5
Cases defined for district energy performance simulation.

CASES	Portion of roof covered by PV			[MW]		
	Residential	Educational	Office	PV capacity	Wind capacity	Total RES
Case 1	17%	14%	8%	2.4		2.40
Case 1*	12%	14%	8%	2.02	0.38	2.40
Case 2	34%	27%	16%	4.81		4.81
Case 2*	19%	27%	16%	3.70	1.11	4.81
Case 3	59%	32%	21%	7.21		7.21
Case 3*	25%	41%	24%	5.24	1.96	7.21
Case 4	77%	45%	30%	9.61		9.61
Case 4*	25%	54%	32%	6.43	3.18	9.61
NZED	78%	49%	37%	10.21		10.21
NZED*	25%	58%	34%	6.69	3.57	10.26
NZED**	0%	0%	0%		10.36	10.36
Reference 1	Absorption chiller supplies the 60% of the cooling demand and district heat pump the remaining 40%, heat supplied by gas burner efficiency 70%					
Reference 2	District heat pump					

* PV and Wind combined; ** Only Wind.

share, and the heating load is not negligible. Three best cases: ~67 kWh/m^2 (67% reduction).

The "best cases" highlighted in the previous paragraphs refer to the combination of factors that provides the greatest potential for energy savings based on the simulation results. Specifically in relation to the Office building model, the results obtained are very much in line with the research by Elharidi et al. which indicates that an increased efficiency of the systems installed (HVAC, lighting, equipment, and appliances) combined with a more energy conscious occupant behavior, offer a good potential for energy saving (Elharidi et al., 2018).

5.2. District

Fig. 7 shows an overview of the results obtained at district level indicating the final energy consumption (equal to imported electricity in Fig. 7 for cases from 1 to 4 and NZED), and Onsite Energy Matching (OEM) and Onsite Energy Fraction (OEF) of the different cases (see Table 3). OEM shows the part of the electricity generated onsite used for the onsite demand, rather than exported to the grid, whereas OEF shows the part of the onsite demand covered by onsite electricity generation (Cao et al., 2013). The system performance is better if the values of OEM and OEF are higher (approaching value of 1), resulting in high matching characteristics (Rehman et al., 2019).

The share of the use of Renewable Energy Systems (RES) increases towards Net Zero Energy District (NZED) cases where the OEF reaches the OEM. The objective is to have high RES with low OEF. In an NZED scenario, the amount of energy exported equals the amount of energy imported. However, the optimization goal is to minimize the import-

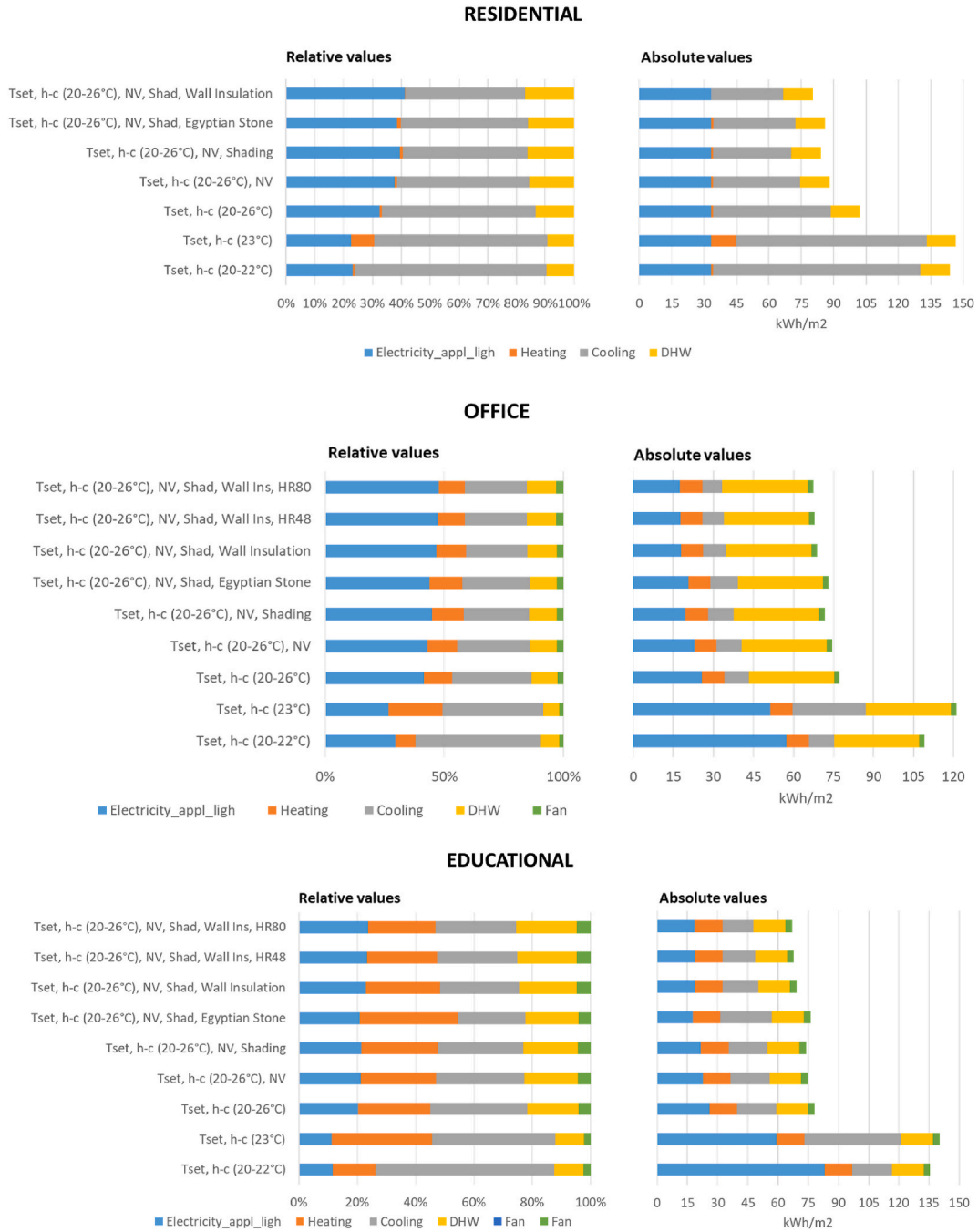


Fig. 6. Energy demand in relative and absolute values obtained for the Residential, Office and Educational building models. (Image: Francesco Reda, VTT)

export, and to provide the energy needed in operation by means of the RES existing in the district.

In Fig. 8, the results shown have a special focus on heat pump and RES. The image on the left depicts the final energy demand showing production shares and import (import = final energy consumption of Fig. 7 for cases 1 to 4 and NZED); while the image on the right shows the common chart for defining NZE target (exported vs. imported energy) (Sartori et al., 2012).

As it can be seen, the mixed use of PV and wind (NZED*) combined with heat pump exports less with almost the same import. Only PV or only wind (NZED**) options import more. NZED cases export more than the other cases. Energy storages are needed to decrease import.

As mentioned, the methodology and approach of the energy assessment work, already discussed in the previous section, were designed to produce results that could contribute to additional objectives 5 (scalability and replicability) and 6 (possible synergistic effects). A more detailed discussion on how to contextualize the results obtained and what next steps to take based on the gaps identified and potential discovered can be found in section 6.

6. Discussion

In the view of the authors of this article, this type of project has a clear potential to add to the realization of the goals of the above-mentioned Egypt Vision 2030 and World Bank report on EE, but only if it can provide truly inclusive solutions and an adequate integration to the existing urban fabric of NBC. Otherwise, there is a risk of deepening the current social divide by creating an island of wealth and technological advancement surrounded by much poorer living conditions. This is in line not only with Graham & Marvin's thesis of "splintering urbanism" (Graham & Marvin, 2001), but also with many other critical voices of certain smart city models over relying on new technologies, networks, and business development to attract global investments, and often leading to "social polarization" and exclusion (Hollands, 2008). Instead, addressing local needs with the help of available technology as means to achieve *"socio-economic stability and urban livability"* should be at the centre of the smart city (or rather citizenship) agenda as formulated by authors such as Sadoway & Shekhar (Sadoway & Shekhar, 2014).

On the other hand, the results presented in section 5 are very much in line with other similar evaluations conducted in Egypt and even in other parts of the world sharing somewhat similar conditions as seen in the Introduction. The case of NST was addressed using VTT's own methodology and previous experience in the country further improved for this application (main objective 1; additional objective 4), as already explained. All these contributions are adding to a growing body of knowledge, which in turn is leading to a deeper understanding of how different energy systems perform in the local conditions of Egypt enabling the development of replicable and scalable solutions (main objectives 2 and 3) that are feasible and affordable in that context.

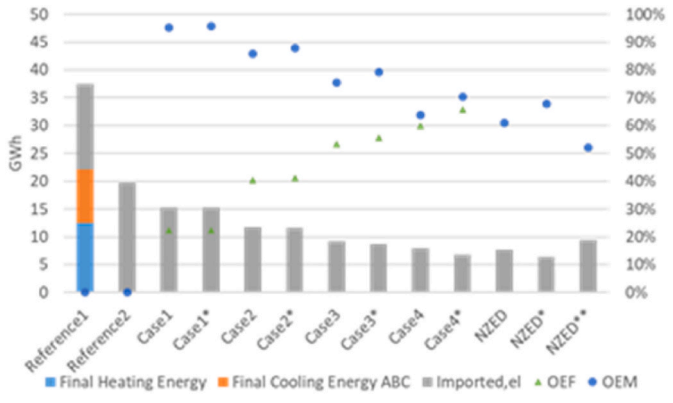


Fig. 7. Results obtained at district level. (Image: Francesco Reda, VTT)

Consequently, the authors believe that the next step is to complement the insight gained so far with good implementation cases that can be monitored and analyzed to advance the body of practice. More pilot projects are needed to test, validate, and further refine the evidence and the solutions resulting from the simulations and calculations carried out within numerous studies concerning the region as seen above. Predictably, these pilots would contribute to inform (and improve) future practice. Additionally, the potential for scalability (additional objective 5) and for increasing the efficiency and decreasing CO_2 emissions when moving from "building" to "district" scale should be further explored, while considering aspects like e.g., the positive effects of green infrastructure (trees, green roofs, façades) to decrease urban heat island (Susca et al., 2011) or more in general, of Nature Based Solutions (NBS). All this contributes to the practical realization of SDG11 - Sustainable Cities and Communities. To this end, the public sector can support the process by e.g., helping to disseminate international, regional, and national best practices, and even more importantly, leading by example. Egypt's New Administrative Capital currently under development east of Cairo (Lewis & Abdellah, 2019) (Midolo, 2019) offers a very good opportunity for scaling up the solutions developed by smaller projects around the country and the findings made by numerous studies, as well as for growing the local expertise. Perhaps a word of caution is due against the proliferation of heavily marketed flagship "ecocity" or "smart city" projects across the Global South that too often focus on the deployment of high-tech solutions and urban practices originating in very different contexts. These are typically supported by pre-existing structures that are not necessarily in place in this part of the world (Myllylä & Kuvaja, 2005). Frequently over relying on technology, they fail to engage the community and to generate a true sense of place (Piew & Neo, 2013). Lack of community engagement can easily lead to these projects not being properly understood by the local citizens and consequently, never fully appropriated (Yu, 2014).

In the authors' view, equally recommendable is to develop deeper understanding in relation to the energy-water-food nexus to discover the potential benefits of multi-level actions (additional objective 6). This is particularly important for Egypt since as Al-Saidi et al. point out, the country faces major security challenges in relation to those three axes, situation that is aggravated by complex regional geopolitics, political instability, and insufficient economic growth (Al-Saidi et al., 2016). Some authors like Fahmi and Sutton warn about the unexpected consequences that the privatization of municipal solid waste (MSW) management can bring for traditional communities of waste collectors, whose livelihood will be threatened by the *"technology-intensive multinational companies"* hired to provide MSW services (Fahmi & Sutton, 2010). However, such situations offer the opportunity to develop innovative business models that will secure the livelihoods of vulnerable communities and yet deliver a sustainable and efficient service. The previously mentioned study of Emirati villas showed that trees would become net carbon sinks if solar-powered reverse osmosis desalination (energy-water nexus in this instance) was to be implemented. Likewise, Egypt should encourage the study of the effects of combined solutions to e.g., reduce water consumption and improve water management, recycle grey and black water for irrigation, introduce aquaponics, increase the efficiency of food production, and strengthen its supply chain. Moreover, considering the gaps identified as well as the need to develop affordable and yet highly functional solutions that can be made available to most of the population, including the poor, Frugal/Grassroots Innovation can "deliver" low-cost robust products and services (Knorringa et al., 2016). Therefore, it may be worth the while to conduct empirical studies on how such innovations can contribute to a more inclusive development in a resource-constrained environment as that of Egypt, and concomitantly, to decrease the risk of splintering urbanism while having a positive impact on several SDGs (Khan, 2016), particularly on SDG10 - Reduced inequalities, by placing citizens at the centre of the process.

Very likely, this discussion would not be complete without

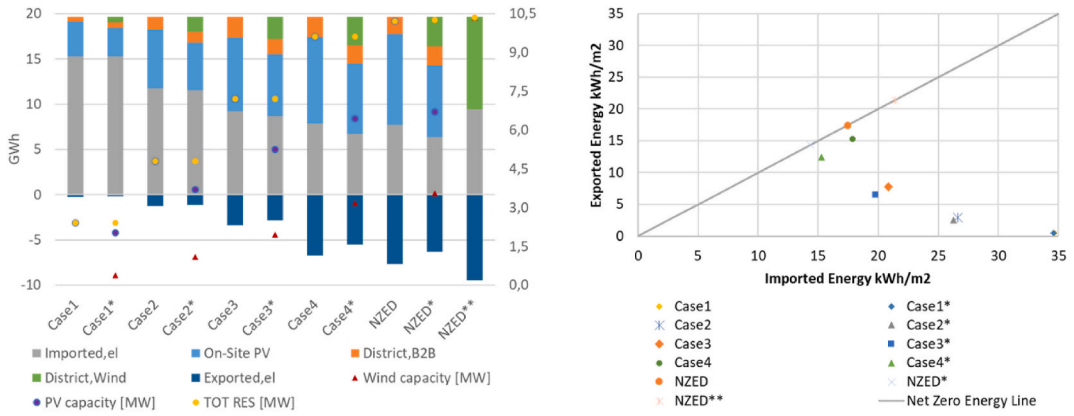


Fig. 8. Results obtained at district level. Focus on heat pump and RES. (Images: Francesco Reda, VTT)

highlighting the importance of capacity building as a fundamental component for the successful development of solutions adapted to local conditions based on the transfer of processes, technology, and good practices. However, in the authors' project experience, capacity is (and probably should be) built on both sides, although it may initially appear that the need for capacity development is only on the local side, in support of the development of better contextualized solutions. More information on this topic can be found in a couple of previous articles by two of the authors of this text (Antuña-Rozado et al., 2018; Antuña-Rozado et al., 2019b).

One of the limitations of this type of research is precisely that it remains at the planning level, which is not necessarily a decision of the researchers but the result of many other circumstances. Therefore, the authors would like to emphasize the importance of monitoring such projects from planning and design to construction, operation, and maintenance to get a more accurate and comprehensive picture.

7. Conclusions

As explained, what has been done in practice is to virtually connect the largest possible number of building models based on the different typologies included in the Master Plan to district energy production. The crucial importance of developing an adequate baseline built on the most accurate possible local data became clear during the assessment process. As equally important is to interpret the data gathered correctly and to make the right assumptions. Another realization was the need to complete the energy assessment with a cost analysis like the one carried out (also by VTT) for EcoNBC project, or the recently concluded study on the feasibility of a hybrid photovoltaic-fuel-cell-battery (PV/FC/B) to supply a small community in the planned city of NEOM in Saudi Arabia (Rezk et al., 2020). Likewise, the need to proceed with the next phases of the study to cover other aspects like water, waste, material resources, taking the same approach and trying to find potential synergistic effects, also became apparent. However, these additional studies have not been carried out yet due to lack of funding.

In the light of the results presented, the findings can be summarized as follows:

- The cooling demand does not always represent the biggest share (it did for the Residential model but not for the Office and Educational ones).
- The heating demand is sensitive to temperature set points, internal gains, and fresh air. Consequently, energy behaviors like setting more "energy-rational" set points, use of more efficient home appliances and saving measures such as intelligent lighting, can contribute significantly to decrease the heating demand.
- Natural ventilation is a good energy saving measure (free cooling) for Residential buildings, unlike for Office and Educational ones, mainly due to too high fresh air volumes. This is consistent with VTT's findings from previous experience in Egypt. A citizens' survey conducted on that occasion in New Borg El Arab showed the users' behavior in relation to natural ventilation, either by opening the windows or through vents (Reda et al., 2015).
- Shading has no impact since low-e (tinted) glass is used (infrared wavelength, weak impact on the visible spectrum).
- Replacing the Egyptian stone initially used in the envelope by 5 cm wall insulation, everything else remaining unchanged, slightly improves energy efficiency.
- Unlike cold climates, in this case heat recovery does not have a significant impact.
- Before acting on the system, the energy demand of buildings must be reduced.
- Different energy savings measures should be adopted for different building types.
- Optimizing on-site consumption is highly recommended to reduce the cost of energy infrastructure.
- NZED or Positive Energy District are possible to achieve with conventional RES.

In the authors' view the main objectives (see section 2) have been achieved to a large extent. This is precisely one of the important lessons learned, that it is relatively easy to realize the potential for greater energy efficiency that an early energy assessment that considers local regulations and specific conditions can offer, instead of providing a universal solution often directly transplanted from a completely different context and developed according to different parameters. In terms of additional objectives (see again section 2), the findings and recommendations of the EcoNBC project have also been capitalized on, and even more so since the NST energy assessment provided an opportunity to further refine the methodology developed by VTT during EcoNBC. The potential for replicability (i.e., at building level) is clearly there, provided that specific local conditions are properly considered. While the potential for scalability (i.e., moving from building to district scale) also appears to exist but requires further exploration. Finally, investigating possible beneficial synergistic effects, for example through the energy-water-food nexus, is something that should be addressed more consistently in the future, as this is one of the limitations of current research (see section 6).

Based on the findings presented, the authors believe that it is reasonable to expect that the results of the analyzes and the conclusions derived from them can serve as valuable recommendations to planners regarding feasible RES solutions and corresponding project size, which in turn can contribute to the achievement of SDG7 - Clean and Affordable Energy by 2030 and Egypt Vision 2030.

Author contributions

C.A.-R. and F.R. have been directly involved in the Egyptian case described in this article. They also worked together, back in the day, on the project "EcoNBC Feasibility Study. Transforming New Borg El Arab into an EcoCity", the results of which were capitalized on by this new research. J.G.-N. has coordinated this study, critically reviewed the manuscript, and provided useful recommendations.

Declaration of competing interest

The authors declare no conflict of interest.

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Abbreviations

B	Battery
CAPMAS	Central Agency for Public Mobilization And Statistics (Egypt)
CO_2	Carbon Dioxide
CSP	Concentrated Solar Power
EE	Energy Efficiency
EU	European Union
FC	Fuel Cell
FDI	Foreign Direct Investment
GENOPT	GENeral OPTimization
HVAC	Heating, Ventilation and Air Conditioning
ISES	Integrated Sustainable Energy Strategy
KFHSD	Khairy Foundation for Human and Social Development
MED-ENEC	Energy Efficiency in the Construction Sector in the Mediterranean
MENA	Middle East and Northern Africa
MPMAR	Ministry of Planning, Monitoring and Administrative Reform (Egypt)
MSW	Municipal Solid Waste
NBC	New Borg El Arab City
NBS	Nature Based Solutions
NEEAP	National Energy Efficiency Action Plan
NREA	New and Renewable Energy Authority
NST	Nabta Smart Town
NUCA	New Urban Communities Authority (Egypt)
NZEB	Net Zero Energy Buildings
NZED	Net Zero Energy Districts
OEF	Onsite Energy Fraction
OEM	Onsite Energy Matching
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Source
SBC	Sustainable Buildings and Construction
SBE	Sustainable Built Environment
SDGs	Sustainable Development Goals
SDS	Sustainable Development Strategy
TARES	Technical Assistance to Support the Reform of the Energy Sector
TRNSYS	Transient System Simulation Tool
UAE	United Arab Emirates
UN ESCWA	United Nations Economic and Social Commission for Western Asia
UN-Habitat	United Nations Human Settlements Programme
VTT	Technical Research Centre of Finland Ltd.

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Successful social entrepreneurship and its potential contribution to more sustainable cities and built environments

C Antuña-Rozado[1,3], **J García-Navarro**[2]

[1] VTT Technical Research Centre of Finland Ltd., PO Box 1000, FI-02044 VTT, Finland
[2] Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIA-Ciudad Universitaria, s/n, 28,040 Madrid, Spain
[3] Author to whom the correspondence should be addressed, carmen.antuna@vtt.fi

Abstract. Globally, social entrepreneurship has caught the attention of academics and researchers, and there is a growing body of knowledge on how it differs from traditional entrepreneurship and where its main challenges lie. In Finland, for example, the number of social enterprises has been growing consistently since 2010. The Finnish case is particularly intriguing because of the country's wide social coverage, which on a first approach, might lead to the assumption that social enterprises are not "so necessary" in Finland. However, the matter is more complex than it initially appears. Moreover, the European commitment to make the transition to a just and green society, in compliance with the ambitious objectives of the European Green Deal, as well as to materialize the so-called economy of wellbeing, exerts pressure on public administrations that perhaps social enterprises can help alleviate.

Despite many open questions, successful social enterprises -that is, those whose mission, strategy, and impact measurement are strongly aligned- can be critical in addressing social or environmental issues that remain largely unaddressed by other actors, whether public or private, in any field, without compromising their growth potential and their ability to attract interested investors.

Considering, on the one hand, the wide range of opportunities offered by the built environment in terms of open challenges; and on the other hand, the fact that in the future there will be more pressure on companies to be more socially responsible, it may be worth looking at how social enterprises can help close these gaps.

To encourage the contribution of social enterprises to more sustainable cities and built environments, this document will discuss what successful social entrepreneurship looks like and show a couple of examples of social enterprises from the UK and Norway, one operating in the affordable housing sector and the other dedicated to sustainable urban development.

1. Introduction

Although social entrepreneurship has been around for decades, it is in years that are more recent that the concept has come under the scrutiny of the academic and research community [1]. Consequently, there is an increasing amount of evidence covering numerous aspects of this "emerging field", including the identification of the obstacles typically faced by social entrepreneurs [2]. Having to report according to the triple bottom line defined by Elkington [3], social enterprises utilize economic metrics to measure the economic value they help to create, and environmental metrics to measure their contribution to a more sustainable environment. However, social metrics are a bit more difficult to

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tackle and social enterprises do not always manage to adequately measure the social impact they seek as a priority.

The use of measures (or the lack of them) that do not reflect the real impact that social entrepreneurship generates often has undesirable consequences that can compromise future growth [4]. In this regard, research has found that aligning Mission, Strategy and Impact Measurement is key to develop meaningful measures that capture the real impact in relation to the objectives pursued [5]. It can also help them gain a deeper insight into their business and operations, thus allowing them to change course, if necessary, in a more planned way.

The number of social enterprises in Finland has been growing consistently since 2010, from 150 then to thousands nowadays. The Finnish case is particularly intriguing because of the country's wide social coverage, which on a first approach, might lead to the assumption that social enterprises are not "so necessary" in Finland. The main questions are why are social enterprises increasing in a country that already has an extensive social protection system? Why does the public administration choose to entrust them with the provision of services that it would otherwise carry out? Perhaps the answer lies in the greater efficiency in service delivery that these companies can provide. This is, of course, simplified thinking, and the reality is somewhat more complex. The legitimacy granted to social enterprises and the potential for fruitful collaboration with government and financial institutions seems to depend both on the degree of market coordination and the state's provision of social welfare, which in turn can vary considerably from one country (and market) to another [6]. Furthermore, Stephan et al. (2015) argue that a strong emphasis on social welfare provision, as in the case of Finland, offers in fact more opportunities for synergistic collaboration between the state and social enterprises, contrary to what it may appear. Therefore, governments should not decrease their support to social enterprises for *"fear that this will reduce privately led initiatives"* [7].

Moreover, the European commitment to make the transition to a just and green society, in compliance with the objectives of the European Green Deal [8], as well as to materialize the so-called economy of wellbeing [9], exerts pressure on public administrations, including cities, that perhaps social enterprises can help alleviate.

Taking all the above into account, it can perhaps be assumed that local administrations and the public system in general can benefit from collaboration with social entrepreneurs. The former, typically quite rigid in their operation, may not be able to see the need to innovate or know how to improve the efficiency of services, in addition to being further removed from the reality of their target social groups. The case studies presented here represent successful examples of social enterprises (according to a set of established criteria that will be explained below) that address important challenges for many cities, both in the developed and developing world. These examples and the discussion around them are intended to initiate a reflection on the potential, not yet fully exploited, of (sound) social enterprises to contribute to improving life in cities and greater urban sustainability.

2. Context, scope, and framework

The results presented in this paper belong to a small study within a larger investigation for an EMBA master's thesis (henceforth, main research) whose purpose was to increase the understanding of social entrepreneurship in Finland and its contribution to Finnish society. More specifically, it explored what kind of value (Mission) social enterprises in Finland help create, how exactly they do it (Strategy), and to what extent they achieve it (Impact Measurement). In the process, an inside view was sought by looking at how those enterprises describe their goals and activities; whereas an outside view was obtained by looking at how others, namely regulators, beneficiaries, and investors, regard their performance. A discrepancy between these views could indicate existing gaps or biases that need to be addressed, while the opposite could reveal valuable lessons learned or good practices with potential for replicability and scalability elsewhere. Following this train of thought, the initial research questions addressed were:

- What kind of value do Finnish social entrepreneurs help to create and for whom?
- To what extent is that value reflected in their Mission and aligned with their Strategy?

- How do they measure the social impact of their activity?
- To what extent are they achieving the objectives pursued?

A framework was defined in two parts, theoretical and practical, both linked in turn to the corresponding methods used as shown in Figure 1. The theoretical part corresponded more clearly to the research questions formulated and focused, on the one hand, on setting the boundaries and, on the other hand, on understanding the value in practice and how to measure the achievement of targets and the generation of impact. It addressed the essential concepts embedded in the research questions, namely social enterprise, value, types of value, social value, value measurement, and social impact. The practical part aimed to illustrate relevant examples of both global and Finnish social enterprises (for comparison) through a short selection of cases to help understand what makes a successful social enterprise, beyond the differences between operating contexts. Cases are defined according to a common template described in section 3.2, which is in turn aligned with the research questions and purpose stated above. The practical framework also includes the collection of qualitative data from key stakeholders through semi-structured interviews.



Figure 1. Defined framework for the principal investigator associated with this study. (Carmen Antuña-Rozado, 2021)

3. Boundary conditions and premises for measurement

Since, as the main research showed, there is a notable lack of agreement regarding many of the concepts involved in social entrepreneurship, starting with the very definition of social enterprise, it may be necessary to talk about the defined boundary conditions, as well as the starting premises to address the measurement of the achievement of the established objectives and the impact generated.

3.1. Social enterprises

Social entrepreneurship has been around for decades, but despite the growing number of publications related to the subject, most of them focus on success stories and the figure of the social entrepreneur as an individual visionary, which undoubtedly attracts the public, but it leaves some important questions open [10]. The Finnish academic interviewed corroborated the lack of consensus regarding the definition of social entrepreneurship by saying, *"it is difficult to say what exactly social entrepreneurship is and how it differs from other closely related concepts like sustainable entrepreneurship or even community entrepreneurship".* In this sense, more and more researchers and academics, both in developing and developed countries, are working to shed light on these more neglected aspects. However, there is still a long way to go to establish the proper connection between social entrepreneurship and general entrepreneurship theory and knowledge [11].

Broadly speaking, when undertaking the task of defining social entrepreneurship, some scholars seem to focus more on the "social" side of the concept, while others prefer the "entrepreneurship" side. None is exempt from complications, even considering them separately since there is no academic consensus around the definition of neither of them. There are fundamentally different notions of the concept of entrepreneur and of the entrepreneurial function [12]. Regarding the social side of the issue, there seems to be agreement that social entrepreneurship is characterized by having social goals at its core. Instead, what the researchers disagree on is whether those social goals are compatible with a for-profit model or not. For some authors, social enterprises should not seek to make profit, purely to create social value [13]. However, there are many prominent examples of profitable social enterprises that show that the two need not be mutually exclusive and that have been noticed by academics [14].

Perhaps a compromise would be more appropriate, that is, combining social objectives with the entrepreneurial method, leaving room for the extent to which social enterprises pursue business benefit and the sectors involved, very much in line with authors such as [15]. Furthermore, for the purpose of the main research behind this study, it seemed necessary to go beyond the predominantly academic debate about whether social enterprises should be profit-seeking. Instead, the emphasis should be on the results obtained by social enterprises in pursuit of their social goals, the impacts they generate, and the alignment between these and the expectations of their beneficiaries and society. This was corroborated by the interviewees; for example, the Finnish academic proposed to focus instead on *"impacts and expectations"*, much in line with the impact investment expert interviewed, who suggested the term *"impact-driven business"* as more appropriate, since what matters is the value created for society.

3.2. Value in social enterprises

As a brief introduction to the topic of value in social enterprises, it would be good to recall the seminal work of Vargo & Lusch (2004), which redefined marketing by proposing a service-dominant (S-D) logic that has since been developed as a collaborative effort by many scholars from different disciplines around the world [16]. They relied on the ideas defended by other authors before them who suggested going beyond the traditional division between goods and services to instead look at offerings rendering services, which in turn create value for the customer [17]. Placing the emphasis on the customer perspective (i.e., on the "receiving end") by focusing on the services provided and ultimately value creation, or rather co-creation, as it involves multiple actors, including the customer, seemed like a fit-for-purpose approach in this case.

Social enterprises are complicated, and one of their complications is that there are multiple stakeholders on the receiving end. For most conventional businesses customers are often, if not the

only ones, at least their main stakeholders; while for social enterprises, depending on their activity, there may be multiple groups of beneficiaries, customers (in the strict sense of the word, that is, people or organizations that pay for services and products and are not necessarily the same as the beneficiaries), and society, for whom they create and deliver value. Each of these groups has its goals and concerns and consequently perceives the same value delivered differently. Therefore, when looking at value in social enterprises, it becomes clear that customer value, understanding "customer" in a broad sense (again, at the receiving end) or as a multiple concept, is of utmost relevance. However, there may be other types of value, also relevant, although they are often overlooked.

Coburn (2018) explains the types of value that characterize social enterprises and compares them with other alternative ways of doing business and addressing social challenges. First, he defines what he calls the Building Blocks of Value for a social enterprise, namely: customer value, financial value, operational value, and social value; and then he goes on to compare different types of organizations (Figure 2). He concludes that, while on one side of the spectrum private business are concerned only with customer value (here also *stricto sensu*), social enterprises, on the opposite side, seem to be concerned with the four categories of value described, albeit to a different extent depending on the degree to which they pursue profit. Of course, always with social value at the centre [18].

Unsurprisingly, a for-profit social enterprise must pay attention to both customer and financial value to survive in the marketplace; but above all, it is expected to create social value. What comes as an additional responsibility is a somewhat "unspoken" obligation to behave in an ethical and environmentally conscious manner. For a non-profit social enterprise, however, concern about customer and financial value may not be a priority, but operational and social value are unavoidable. Coburn's understanding of value in social enterprises based on his long experience fit very well with the main research purpose behind this study. In particular, the explicit mention of operational value was indeed a revelation and was used when evaluating the selected examples in addition to the main method chosen (see the special badge described in section 4.2, Case study method).

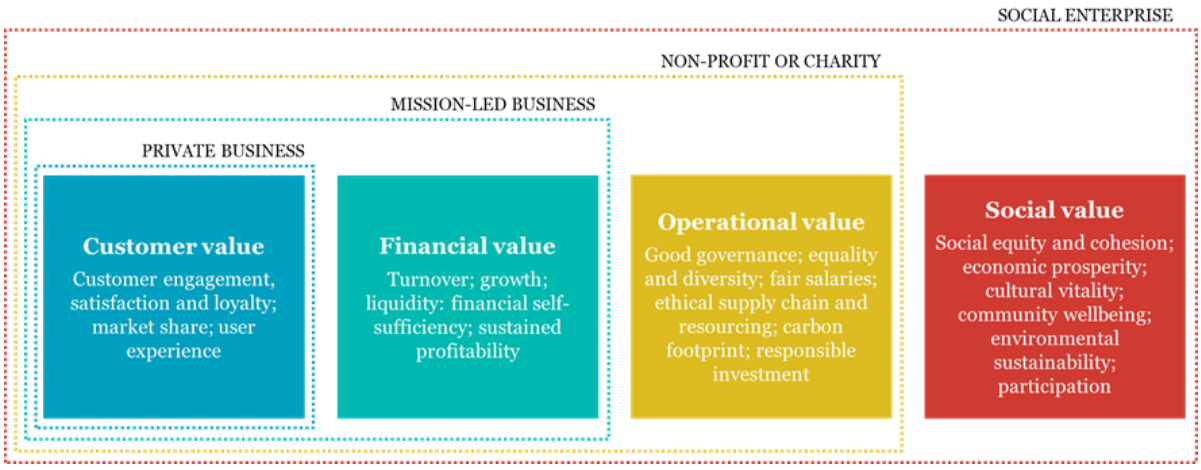


Figure 2. Types of value that concern different organizations. (Own image developed from Coburn's Building Blocks of Value, Carmen Antuña-Rozado, 2021)

3.3. Briefly on social value

Although in social enterprises, social value often appears mixed with other values such as environmental or even cultural, the literature does not make much of a distinction. It mostly focuses on social value understood as that which *"benefits people whose urgent and reasonable needs are not being met by other means"* [19]. Despite its apparent simplicity, this definition captures the essentials for social entrepreneurship, since there is academic consensus on the fact that social enterprises should

prioritize social objectives such as poverty alleviation, access to education or health care, labour integration of the most vulnerable groups, etc.

3.4. Measurement of social value and social impact

While financial profit is widely accepted as a measure of economic value, measuring social value is a more elusive task. Besides, the literature shows a certain confusion between value and impact, or perhaps the problem is that, very often, what appears as a measure of social impact, if examined closely, is in fact a measure of social value. Markless & Streatfield (2006) make it clear when they define impact as *"any effect of the service (or of an event or initiative) on an individual or group"* [20]. Consequently, it can be positive or negative, intentional or unintentional, direct or indirect, etc. The same authors point out that measuring impact requires identifying and evaluating the change elicited, which typically shows as a change of some sort in the quality of life. This is not easy and, to complicate things even more, the impact of a given intervention may depend on other factors, known or unknown. For social enterprises, their social impact may be simultaneously influenced by other circumstances, like policy support (or lack thereof), access to investment, governance practices, etc.

Another source of confusion is the interrelationship between value and impact. While true value does generate impact, impact does not necessarily create value, since it may accidentally occur and have an adverse effect, in which case there is no value. Considering all the difficulties mentioned and the fact that many social enterprises fail to measure value within their activities at all, it is understandable, even if not fully appropriate, that the measurement of value is used in most cases as a proxy for social impact. Further unravelling its meaning, measurement of value closely relates to the measurement of performance or the extent to which the results obtained coincide with the initial objectives. Performance measurement is widely seen as one of the pillars of business excellence, and it is no less relevant for social enterprises since *"what is measured is valued due to the growing demands of stakeholders"* [21].

Fortunately, there are some methods available specially developed to close this gap, two of which appear to be of relevance in this case. One of them is Social Return on Investment (SROI), which in recent years has become very popular among non-profit and charity organizations. SROI is defined as *"a framework for measuring and accounting for (...) value; it seeks to reduce inequality and environmental degradation and improve wellbeing by incorporating social, environmental, and economic costs and benefits"*, and even expressing it in monetary terms [22]. It seems useful, but since it involves quantification, it may not be possible to apply it when studying examples like the ones shown here, for which the information accessed will only be that found on the organizations' official websites, public reports, etc. Therefore, all the data required to calculate SROI might not be available.

Another interesting method is the one proposed by Ormiston & Seymour (2011) to overcome what they call the *"mission measurement paradox"*, which suggests that *"social entrepreneurs are failing to evaluate their social impact with sufficient regard to their social mission"*. According to the authors, very often social entrepreneurs illustrate the impact of their ventures by measuring, for example, growth (as the number of beneficiaries reached), rather than the achievement of their social mission. In practice, this confusion generally manifests as a misalignment between Mission, Strategy, and Impact measurement. Ormiston & Seymour suggest that *"an entrepreneurial understanding of value rather than a managerial"* one may be more fruitful for both academics and practitioners [23]. Unlike the SROI, this approach does not require calculations and can be applied to the selected examples based on publicly available information.

Figure 3 summarizes the boundary conditions and premises, with a particular focus on the concepts that seemed most elusive, namely, social enterprise, social value, and measurement of social value and social impact. A couple of own definitions are proposed that fit better the author's interpretation of social enterprise and social value.

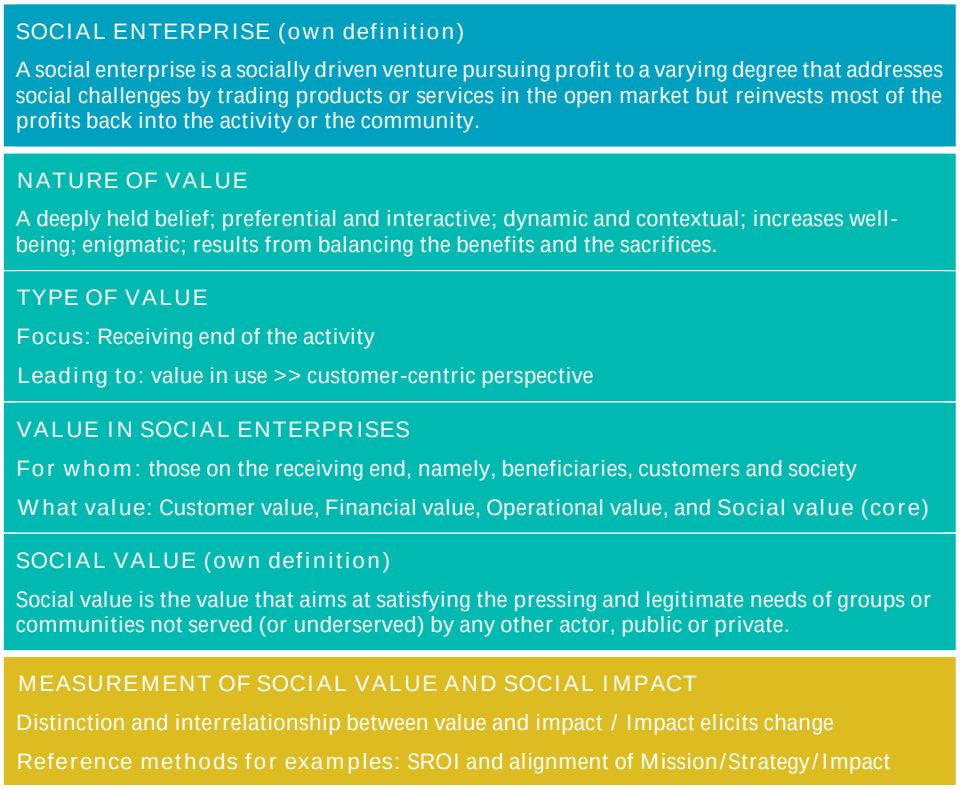


Figure 3. Boundary conditions in a nutshell, including a couple of own definitions. (Carmen Antuña-Rozado, 2021)

4. Methodology

4.1. Research approach

For the main research, a qualitative approach combining a non-exhaustive or integrative literature review [24], with the study of some relevant examples and direct input from the main stakeholders involved, was considered the most appropriate option. Qualitative methods are generally used to address research questions related to a social phenomenon or a social context [25]. Given that social entrepreneurship has a marked socioeconomic or socioenvironmental character, this approach seems the most pertinent.

4.2. Methods used

The methods listed below correspond to the main research. However, since the small study presented here feeds directly into that main research, the same methods apply.

Non-exhaustive literature review. To address the main research questions enunciated in the theoretical framework presented in section 2.

Case study method. Successful cases of social enterprises in Finland and around the world serving different social or environmental needs were collected and described using a common template to enable comparison where possible. The selected examples are analysed in terms of the alignment (or lack thereof) between the value that they help co-create (Mission), the pathways that lead to that value (Strategy), and the way they assess and communicate the social benefits of their activity (Impact Measurement). This is complemented by a special badge used to mark those social enterprises that pay conscious attention to operational value.

Semi-structured interviews with key stakeholders. Commonly used in social research [26], in this case the objective of the interviews was to validate the findings of the literature review; obtain

information from actors whose research or practice is directly related to the topic; discuss the relevant examples collected; and modify, if necessary, the research plan based on the results of the interviews.

Stakeholder profiles initially listed for interviews included: a Finnish social entrepreneur, an academic/researcher doing relevant work in the field of social entrepreneurship, a regulator, an (impact) investor, a representative of an international organization that promotes social entrepreneurship, and a beneficiary. The last two profiles would be interviewed only if possible, given that, in the case of the international organization access may be more difficult, and in the case of the beneficiaries, they may belong to vulnerable or handicapped social groups, which may constitute an obstacle for the interview (as it actually happened, further aggravated by the pandemic situation). Six interviews were conducted in total; all profiles were interviewed except the beneficiary. Some of the opinions expressed by the interviewees are included in sections 3, 6 and 7 to enrich the discussion and corroborate the results of the literature review.

Analysis and discussion. To examine the main findings from the literature review, case studies, and interviews, and point to future research topics on any potential gaps identified.

Conclusions and recommendations. To answer the initial research questions posed and to offer actionable recommendations, based on the information analysed.

5. Inspiring examples: social enterprises successfully contributing to more sustainable cities and built environments

The examples discussed are from two different European cities, namely Glasgow and Oslo. Both were created in response to acute social needs that were not being adequately addressed by the public or private sectors. In the case of Glasgow, the city suffers from a critical lack of decent and affordable housing for social groups with lower economic resources or marginalized, considered by some actors as a real *"housing emergency"*, which unfortunately also affects Scotland in general, and even the UK as a whole [27] [28]. In turn, the Norwegian case focuses on the social side of sustainable urban development, often addressing social and environmental challenges at the same time through mixed projects that include socio-cultural elements such as the integration of vulnerable groups with environmental elements such as sustainable food production or support for biodiversity [29].

5.1. Homes For Good (United Kingdom)

Although based in Glasgow (Scotland), the pioneering model developed by Homes For Good (HFG) is very replicable and could be applied in other local contexts. The HFG group is Scotland's only private sector lettings agency catering for this customer segment. Despite being a relatively young organization (since 2014), it manages over 500 properties and works with 130 property owners and 800 tenants in and around Glasgow and the West of Scotland and has raised around £12 million investment to create its own portfolio of high-quality homes. The latest funds raised from The National Lottery Community Fund have enabled HFG to establish a training programme to share the best practices in the field based on their knowledge and experience. HFG plans to increase its social impact through regular webinars and an online community of practice, possibly adding a few more indicators to those already reported and mentioned in the template (Figure 4), such as stakeholder groups reached, number of people trained, registered members of the online community, etc.

They have recently updated their website and, among other information, show relevant statistics on their activity to date. Behind these data are what can be considered as a new group of indicators added to the existing ones:

- Public and Assisted Housing Units (single family homes, duplexes, apartment buildings).
- Rental Assistance Vouchers.
- Veterans Affairs Supportive Housing Vouchers.
- Shelter Plus Care Vouchers (helps those who need housing that includes daily support).
- Affordable Units designed for people with special needs (managed by specialized local service providers with expertise meeting residents' specialized needs).

- Affordable Units developed and owned in whole or with partners (under the Low Income Housing Tax Credit Program, managed by property management firms).
- Affordable Units funded by Rural Development (managed by property management firms).
- Community Organizations HFG partners with (to provide support for residents living in the public and assisted housing units).
- Million per year to private landlords (through rent assistance payments).

HOMES FOR GOOD, https://homesforgood.org.uk/

Country: United Kingdom

Sector: Rental housing and property management

Beneficiary group(s): Tenants, landlords, housing authorities



Mission (value created): To share the best practice in the Private Rented Sector (PRS) and increase the supply of rental housing.

Strategy (how that value is created): By providing affordable quality homes for people on low incomes or benefits. A very skilled in-house team formed by plumbers, joiners, builders, designers, and tenancy support officers ensures efficient property management.

Impact measurement (how the benefits to society are assessed): Several impact indicators are shown on their website, e.g.,
- investment funds raised to create an own housing portfolio,
- number of homes renovated and made available for the PRS,
- tenants' and landlords' success stories.

Additional comments: Homes For Good operates mainly in Glasgow where there is a considerable shortage of high-quality homes for people in housing need, which constitutes a serious social challenge.

Figure 4. Essential facts of Homes For Good according to template. (Photo: HFG)

5.2. Nabolagshager (Norway)

Nabolagshager is an Oslo-based social enterprise focusing on urban agriculture, eco-innovation, and green community initiatives. Although on its website there is no clear set of impact indicators as such, when delving into its areas of activity, mention is made of the impact generated. These areas are:

Knowledge for resilience. Hundreds of citizens have participated in their public urban food gardens, thousands have received training and tens of thousands of seeds have been exchanged. They also participate in many national and international research projects.

Gardening for urban regeneration and placemaking. Nabolagshager promotes urban farming and communal gardening projects as tools to build social cohesion, a sense of belonging and respect for cultural difference. Over the years, they have successfully involved different social groups like immigrants, the elderly, local businesses, and tourists in many shared experiences.

Growing green employment. By exploring innovative business models, products, and services, Nabolagshager is seeking to provide the skills needed for the creation of green jobs. To that end, they currently focus on building a small team of expert consultants and activists in urban food production, and on piloting aquaponic systems, rooftop farming, vertical food gardens, building of urban furniture, and research collaborations. Figure 5 shows Nabolagshager's essential facts, including the red badge that recognizes its striving for excellence in operational value mentioned in section 3.2.



Figure 5. Essential facts of Nabolagshager according to template. (Photo: Nabolagshager)

6. Findings and analysis

Although both examples presented show a good alignment between their mission (i.e., the value they create) and their strategy (i.e., how they create that value), the link between the previous two and impact measurement (i.e., how to evaluate the benefits they create for society) is better achieved in the case of HFG than in Nabolagshager. According to the main research, without a doubt the greatest difficulty encountered is related to the evaluation of the impact generated and its correspondence with the mission and strategy of the specific social enterprise. One of the various reasons was indicated by one of the social entrepreneurs interviewed who pointed out that *"as entrepreneurs we have a lot to do and very few resources"*. However, the stakeholders interviewed (see section 4.2) agreed that clearly showing the social impact generated, especially in a quantitative way whenever possible, is essential to obtain the support and collaboration of some key partners such as public authorities, donors, or investors. The investment expert interviewed revealed that *"when we were running the impact*

investing programme, we [the organization] did not actually invest in social enterprises because often the value they create is not shown clearly".

Better reporting can not only make the true significance of what social enterprises accomplish accessible to stakeholders, but it can also be used as a basis for improvement and growth, as well as for comparison. In the words of the other social entrepreneur interviewed, *"my conclusion is that measuring and learning should go hand in hand, but it is not easy due to lack of time"*. In turn, reporting requires monitoring and continuous data collection and measurement, which provides social enterprises with a deeper insight into their activity and operations all along the way, and a clearer picture of their weaknesses and potential for improvement, thus allowing them to change course, if necessary, in a more planned and deliberate manner.

It has also become apparent that identifying the correct social goals for the social challenges that social enterprises choose to address, which in turn must derive from a clear understanding of the root causes and how best to benefit society in that context given, in addition to verifying that those social objectives are being achieved, is key to their success.

These findings are independent of the sector in which the social enterprise operates, and therefore also apply to those providing solutions for more sustainable cities and built environments, as both HFG and Nabolagshager illustrate.

7. Conclusions and recommendations

In relation to social entrepreneurship, the findings corroborate that the measurement of performance and impact remains one of the main obstacles for social enterprises to demonstrate the benefits they generate for society in a quantitative way, which in turn can discourage potential investors or donors. Furthermore, in a first approximation, the findings also seem to indicate that there is potential for certain social enterprises to contribute to the sustainability of cities and the built environment. Therefore, it might be worth conducting more research on both topics and their interrelationships in the coming years.

The combination, on the one hand, of the business method (they have to make economic sense, at least minimally), the focus on unaddressed social and environmental challenges or needs not covered or insufficiently attended to, greater agility and closeness to target groups, presumably more efficiency… and on the other hand, the possibility of generating a positive impact in such important areas as resilience, adaptation to climate change, social cohesion and integration, food security and/or sovereignty, biodiversity, etc., can be very beneficial for the sustainability of cities and the built environment. As expressed by the representative of the international organization interviewed, in essence, social entrepreneurship is *"trying to address the social challenges, be it an environmental problem, a social problem, an educational problem… that has been identified and for which an entrepreneurial method is used to solve the problem in the most efficient way"*. Furthermore, combined with carefully selected alliances with strategic partners, it can bring together aspects that are commonly overlooked in ways of mutual improvement.

Finally, the social enterprises discussed focus on providing solutions to two pressing needs in their respective home contexts (Glasgow and Oslo). However, such needs can be found in different shades in many other cities, whether in the developed, developing, or emerging world. Hence, these examples can serve as inspiration both for those who are interested in launching a similar initiative in their city, as well as for public authorities looking for solutions to efficiently face existing challenges. Again, more research would be needed on the scalability and replicability potential of successful examples and the changes needed to ensure adaptation to other local contexts.

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Social entrepreneurship for more sustainable cities and communities. Some examples from Finland

Carmen Antuña-Rozado[1, 2, *], Justo García-Navarro[2]

[1] VTT Technical Research Centre of Finland Ltd., PO Box 1000, FI-02044 VTT Espoo, Finland; Universidad Politécnica de Madrid, ETSIAAB – Av. Puerta de Hierro, 2-4, 28040 Madrid, Spain carmen.antuna@vtt.fi
[2] Research Group on Sustainability in Construction and Industry giSCI-UPM, Universidad Politécnica de Madrid, ETSIAAB – Av. Puerta de Hierro, 2-4, 28040 Madrid, Spain; justo.gnavarro@upm.es
[*] Corresponding author: carmen.antuna@vtt.fi

Abstract:
Social enterprises, characterised by their dedication to unresolved or insufficiently addressed social and environmental challenges, are increasingly numerous around the world. Both due to the nature of their main objectives and values, as well as to the fact that they reinvest their profits in continuous progress towards them, they have great potential to contribute to the sustainability of cities and communities. However, they often have difficulty showing the true impact they generate on society, making it difficult to demonstrate how exactly their activity contributes to sustainable development. More research is needed on this topic, and this article is an attempt to expand that research by exploring the ways in which some reasonably successful Finnish social enterprises help create a better world and what the conditions that support this may be.

Keywords: social economy, social entrepreneurship, sustainable cities and communities, sustainable development, Finnish social enterprises

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1. INTRODUCTION

At a global level, the investigation of possible business models and sources of financing is a recurring aspect of research on sustainable cities, to use a fairly generic term, and of closely associated paradigms and concepts, such as ecocities (Zhan & de Jong, 2017), smart cities (Blanck & Ribeiro, 2021; Mishra, 2019), low carbon cities (Zhan & de Jong, 2018), circular cities (Goovaerts et al., 2018) and nature-based solutions (Droste et al., 2017; Toxopeus & Polzin, 2021), urban biodiversity (Mell & Whitten, 2021), or climate resilience (Panda, 2023). This seeks to close the gap between existing knowledge, scientific evidence, and available technological solutions, and their practical application or implementation in real urban contexts worldwide. Furthermore, appropriate business and financial models can also contribute to the successful exploitation on the market of innovative ideas and solutions that may arise within the framework of the aforementioned research or otherwise. How to overcome this deficiency forms the basis of a growing body of literature covering both developed and less developed countries and emerging economies (Wonglimpiyarat, 2015), seeking to understand the mechanisms that can help the transition towards an innovation-driven economy.

The model proposed by social enterprises can constitute a viable option for the financing and implementation of innovative solutions (Picciotti, 2017), whether products, services, concepts, or processes, in relation to social or environmental needs or gaps not adequately addressed, which in turn can contribute to sustainable development. (Bansal et al., 2019) have studied the role of social entrepreneurship in achieving social change that leads to sustainable development and, in doing so, have highlighted the importance of governments supporting this process through policy formulation, creation of social incubators and promotion of appropriate education and research programmes. Other authors like (Diaz-Sarachaga & Ariza-Montes, 2022) have taken this research even further by focusing on how social enterprises can effectively contribute to achieving the SDGs, for which they even developed an indicator-based assessment tool. Although an increasing amount of evidence is generally being produced in relation to these topics, the majority appears to originate in Western countries, which in turn points to the need to extend this research to other less developed regions of the world (Shah & Saurabh, 2015).

It is estimated that in Europe alone there are currently almost 3 million so-called social economy "entities" that operate in different sectors under different legal forms, from cooperatives to social enterprises, and that provide employment to more than 13 million people, many of them belonging to vulnerable groups. These social economy entities are characterized by prioritizing insufficiently addressed social or environmental challenges and by reinvesting most of their profits in the entity itself to continue advancing their mission. As a continuation of the 2011 Social Business Initiative and the 2016 Start-up and Scale-up Initiative and based on the results obtained (Varga & Hayday, 2016), in 2021, the European Commission launched the Social Economy Action Plan to give more visibility to the economy and support the realization of its potential by creating the conditions for the development of appropriate policies and facilitating access to finance and markets (European Commission. Directorate-General for Employment, 2021).

As in the rest of Europe, in Finland interest in the social economy has also increased steadily over the last two decades and there are currently several mechanisms aimed at supporting social enterprises. For example, as part of the Innovation and Skills in Finland 2021–2027 – EU regional and structural policy programme (Ministry of Economic Affairs and Employment of Finland, 2023), there is a specific coordination project aimed at *"improving the business conditions of social enterprises"* as a way to increase the level of competence and inclusion of the Finnish labor market. In turn, this project is closely linked to the Center of Expertise for Social Enterprises created to facilitate the implementation of the Finnish Strategy for Social Enterprises, as will be seen in more detail in section 3.2.

As seen, there is a growing amount of research and publications worldwide based on the identified need to find adequate funding sources and business models for the implementation of innovative solutions in different areas related to sustainable cities and communities. The social enterprise model could be a viable option, but it is necessary to better understand what its contribution can be to sustainable development and, more specifically, to the sustainability of cities and communities. Therefore, this article aims to explore, through a case study of some Finnish social enterprises that operate in different sectors of the economy, what impact they generate on society and therefore their contribution to the creation of cities and communities more sustainable.

2. RESEARCH OBJECTIVES AND METHODOLOGY

The main objective of the research behind this article was to inspect some reasonably successful examples of social enterprises to discover how exactly they contribute to existing social or environmental needs that are currently not or insufficiently addressed in their context of operation. Additional objectives were to study whether this entrepreneurship model can help improve sustainability in cities and the built environment, and whether there is potential for replicability and scalability. The possible gaps and needs identified along the way are used to formulate recommendations or suggest future lines of research.

This research continues the one presented in a previous paper, which in turn derives from a broader research work carried out for a master's thesis (Antuña-Rozado & García-Navarro, 2022). Consequently, the methodology for the characterization of the selected social enterprises is the same used previously and proposed by the author, as well as the basic definitions and established boundary conditions. The same applies to the methods used. This article is based on the non-exhaustive literature review and the semi-structured interviews with key stakeholders conducted during the research of the aforementioned thesis. In the same way, it is also supported by the defined case studies, expanding them with some new ones. Several cases of Finnish social enterprises addressing relevant social or environmental challenges to achieve more sustainable cities and built environments were collected and analyzed using a pre-created common template as seen above to allow for comparison where possible.

To avoid repetition, the aforementioned methodological approach will not be addressed here, but some more reflection will be shared in relation to the case study method. More specifically, the case study method is well established to deduce the meaning of qualitative data (Eisenhardt & Graebner, 2007), and is particularly suitable for assessing implementation processes (Yin, 2013), as in this instance. Furthermore, since social entrepreneurship focuses on addressing unresolved social and environmental challenges, qualitative research, generally associated with social phenomena (Ritchie & Lewis, 2003), seems most appropriate.

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The structure of this article consists of: 1) introduction to the topic and its contextualization; 2) methodology followed; 3) definition of the operating framework of social enterprises in Finland (typology, national strategy, support instruments); 4) presentation of some outstanding examples of Finnish social enterprises, trying to cover various economic sectors and services, and their contribution to sustainable cities and communities (including barriers and enablers, and potential impacts); 5) discussion of the findings and reflection on the general contribution of social enterprises (those presented and others) to the improvement of urban and social sustainability throughout the world, as well as on the potential for replicability and scalability; 6) conclusions and recommendations that can be deduced from the previous study, as well as identification of possible future lines of research.

3. SOCIAL ENTERPRISES IN FINLAND

According to the Association for Finnish Work the number of social enterprises has steadily increased in Finland from 150 in 2010 to over a thousand today operating in various economic sectors (Suomalaisen Työn Liitto, 2023). More specifically, in 2020 a report commissioned by the Ministry of Economic Affairs and Employment concluded that there were approximately 1,700 social enterprises in Finland providing employment for more than 50,000 people, with a combined turnover of almost €5.8 billion. Most of these companies operate in the following sectors: health and social services, welfare services, circular economy, and environment (Työ- ja elinkeinoministeriö, 2020).

3.1 Types of social enterprises

There are currently three types of social enterprises in Finland:

Type I - Sosiaalinen Yritys (social enterprise in English). Regulated under The Act on Social Enterprises (1351/2003 which entered in force in 2004), this type includes those companies that "employ persons in a poor labour market position" such as the disabled or the long-term unemployed. When this legislative framework was prepared, the purpose outlined for this type of company was to contribute to the labour insertion process, these being the last stage in subsidized employment before finding a job (Wilkinson, 2014). These belong to the category of Work Integration Social Enterprises or WISE (Davister et al., 2004). State support is provided for the establishment of these enterprises and the consolidation of their operations.

Type II - Yhteiskunnallinen Yritys (can be translated into English rather as societal, instead of social, enterprise). According to The Finnish Social Entrepreneurship Mark, these are companies that *"tackle social or environmental problems. They use most of their profits to advance their social goals"*(Suomalaisen Työn Liitto, 2023). They operate in different sectors, and they can be considered more business-oriented or more entrepreneurial so to speak. The Mark primarily serves this type, as it was created for companies to transparently demonstrate their commitment to social goals, to which most of their profits are channeled. It is awarded by an independent committee of experts in the field upon request, usually for three years, sometimes less, for both SMEs and large companies, as long as they meet established qualification criteria and can be used in accordance with the defined Terms of Use. For the social enterprises awarded, it is a powerful tool to communicate their status, thus strengthening their legitimacy and helping to raise the public's general awareness on social enterprises and their role in society. Also, if a company is recruiting people, since the Mark tells how companies use their profits to contribute to social good, this can influence applicants. The more companies use the Mark logo in their marketing materials, websites, etc., the better known it will be, benefiting both the company and the Mark. Unfortunately, not all the awarded companies are equally active in their use, as corroborated by an interviewed Finnish regulator.

Type III - No particular name. This type includes those companies that undertake tasks outsourced by the Finnish state, the municipalities, or the public sector in general. In short, they receive their mandate and funding from the public administration. The fact that social enterprises are on the rise in Finland and that many of them provide services for the public sector is at the center of a debate that has gained momentum in recent years. The main questions are why are social enterprises increasing in a country that already has an extensive social protection system? Why does the public administration choose to entrust them with the provision of services that it would otherwise carry out? Perhaps the answer lies in the greater efficiency in service delivery that these

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companies can provide. This is, of course, simplified thinking, and the reality is somewhat more complex. As (Kibler et al., 2018) found, the legitimacy granted to social enterprises and the potential for fruitful collaboration with government and financial institutions depends both on the degree of market coordination and the state's provision of social welfare, which in turn can vary considerably from one country (and market) to another. Furthermore, based on their research (Stephan et al., 2015) argue that a strong emphasis on social welfare provision, as in the case of Finland, offers in fact more opportunities for synergistic collaboration between the state and social enterprises, contrary to what it may appear. Therefore, governments should not decrease their support to social enterprises for *"fear that this will reduce privately led initiatives"*.

3.2 The Finnish Strategy for Social Enterprises

The Finnish Government's Work Capacity Programme (2019-2023), now concluded, was originally developed to improve the employment of people with reduced work capacity or in a weak position within the labor market (Keyriläinen & Lappalainen, 2023). Closely linked, in 2021, the Finnish government launched a new strategy for social enterprises (TEM, 2021), and to ensure its implementation, the Centre of Expertise for Social Enterprises was created under the Ministry of Economic Affairs and Employment (YYO, 2021). Both were expected to contribute significantly to the successful achievement of the Programme's objectives.

According to the Finnish strategy, a social enterprise is driven by social objectives to which the majority of its profits are directed. Likewise, its activities are expected to be responsible, open, transparent, and led by an inclusive and democratic governance model. Although the strategy promotes the recognition of the way in which social enterprises conduct business as well as the strengthening of the conditions in which they operate, it does not foresee the establishment of a specific legal basis or any special treatment.

The main objective of the Centre of Expertise is to increase the number of social enterprises and the awareness about them, as well as to develop their business skills and competence to improve their performance. To this end, the measures that help to incorporate social innovations will be reinforced. For example, the effectiveness of public procurement will be increased along with the use of social criteria and innovative practices, the systematic production of data and statistics, and research activities. As part of its regular activities, the Centre provides support with the following:

- Guidance and advice to social entrepreneurs and organizations, from any sector, who wish to start a social business.
- Strengthen the operating conditions of social enterprises.
- Increase the employment rate of people with partial work capacity.
- Promote business models based on impact.
- Introduce social innovations, research, data collection and education on different relevant topics.
- Business incubation and acceleration activities.
- Materials and tools for social entrepreneurs.
- Administrative organization.
- Development of new partnerships and cooperation with key stakeholders.

Government funding for the Centre was awarded to a consortium of six national organizations whose capacities complement each other: the Finnish Association of Social Enterprises - Arvo (coordinator of the network), Diaconia University of Applied Sciences, Rehabilitation Foundation, Pellervo Coop Centre, Silta-Coaching Association, and Vates Foundation. The expanded consortium includes educational and research institutions, the Centres for Economic Development, Transport, and the Environment (ELY, n.d.), and other organizations that provide public services. All of them add up to a vast network from whose knowledge, skills, and information the social enterprises that approach the Center can presumably benefit.

3.3 More on the Finnish Social Enterprise Mark

According to the Mark, *"social enterprises are economically viable and sustainable businesses that are strongly committed to upholding certain values"* (Suomalaisen Työn Liitto, 2023). Table 1 summarizes their

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characteristics and the categories of products and services to which they belong. During the process of selecting some social enterprises for a more detailed study of their contribution to under-addressed or neglected social and environmental challenges, the author focused on the categories of products and services that, in principle, may be more strongly linked to cities and built environments. For example, construction and industrial products, foods, home and decoration, information technology, primary production or services were especially investigated in that regard. However, in the end one of the selected companies belongs to the category of clothing and accessories, because it clearly contributes to the Finnish circular economy, something that the author considers especially relevant.

Table 1. Characteristics of social enterprises according to the vision of the Finnish Social Enterprise Mark, and categories of products and services under which they are organized. (Source: Carmen Antuña-Rozado, 2023. Based on information provided by the Mark website)

FINNISH SOCIAL ENTERPRISE MARK	
Characteristics of Social Enterprises	
• Reform service structures. • Produce welfare services in a manner that is sustainable for the economy and the people. • Create jobs and develop services locally and dedicate their profits to improving wellbeing in the local community. • Develop viable solutions for environmental problems.	
Product & Service Categories	
Beauty and wellness	Motor vehicles
Children	Music
Clothes and accessories	Other vehicles
Construction and industrial products	Pets
Electronics	Photography
Foods	Primary production
Home and decoration	Services
Information technology	Sports and leisure

To summarize, the social enterprises awarded with the Mark chosen to be featured here were: Annansilmät-Aitta (Home and decoration), Kanresta (Services), and Upcycler Helsinki (Clothes and accessories – circular economy). They will be discussed in the next sections.

4. SOCIAL ENTERPRISES FOR MORE SUSTAINABLE CITIES AND COMMUNITIES

4.1 Some Finnish examples

In order to have a common frame of reference that favors understanding and comparison between them, the selected examples come from Finland, and all but one have been awarded the Finnish Social Enterprise Mark. In all cases except one the focus is mainly internal, that is, they seek to create social value for Finnish society, while the remaining case operates both internally and externally (especially in Africa). Just to clarify, since there are literally hundreds of innovative and successful social enterprises in Finland, the selection criteria for those included in this study were:

a) Their contribution to the sustainability of cities and the built environment.

b) Diversity of operating sectors and socio-environmental relevance of the challenges addressed.

c) If possible, having obtained the Finnish Social Enterprise Mark as a guarantee of adherence to certain values and practices.

The company fact sheet template used is intended to promote a compact description while highlighting the alignment (or lack thereof) between mission, strategy, and measurement of impact. In most cases, the

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information in the template comes from easily accessible sources, e.g., the company's official website, annual public reports, other references to the company found on the internet, etc. This was a deliberate decision to show what quantity and quality of information is available to anyone interested in these companies. Ultimately, it is about how these companies view themselves and how they want to present themselves to both the public and their stakeholders. However, since one of the Finnish social enterprises featured, namely Leapfrog Projects, agreed to an interview, the publicly obtained information was supplemented by insights from the interview. In the future, it would be advisable to interview all of them, if possible, perhaps as a follow-up to this preliminary study. When some required information is not publicly available, as may occur in relation to impact measurement for instance, this is indicated in the template.

In addition, some of the featured social enterprises (see Figures 2 and 3) display a red badge in the upper right corner in the form of a callout sign, indicating that they excel in managing their operations in an ethical and environmentally responsible manner. In other words, they strive to achieve operational value excellence as defined by (Coburn, 2018).

In general, the examples shown provide solutions to unsatisfied or insufficiently satisfied social and environmental needs. Therefore, if properly and successfully addressed, society as a whole can benefit significantly, not just the direct beneficiaries (Zahra et al., 2008).

LEAPFROG PROJECTS

Leapfrog Projects is a social enterprise driven by a mission based on the research and innovation of the New Global project (Aalto University, n.d.). The knowledge and learning thus accumulated increases Leapfrog Projects' capacity to better serve their clients and partners.

Leapfrog Projects' network of experts includes entrepreneurs, researchers, and designers capable of providing systemic solutions for: urban planning; affordable housing; product, service, and business design; market innovation; digital platforms; innovation and R&D related to energy, water, and environmental engineering. Their approach is challenge based and guided by the planetary boundaries' framework (Stockholm Resilience Centre, n.d.). Therefore, they do not promote any pre-defined technology or solution but rather gather the team of experts and the skills required in each case in order to develop a solution adapted to the specific context. Their core competences are human centered design and systems thinking, inclusion and participation, sustainability and interdisciplinarity and sustainable business model design.

To date their work has been concentrated in different African countries (e.g., Kenya, Tanzania, and Tunisia). Their website does not provide information about the indicators used to measure the social and environmental value created by Leapfrog Projects nor on the impact generated by their activities. However, it is no less true that, in all fairness, one must admit that their holistic approach coupled with their goal of promoting systemic change makes measuring the impact of their activity a difficult task.

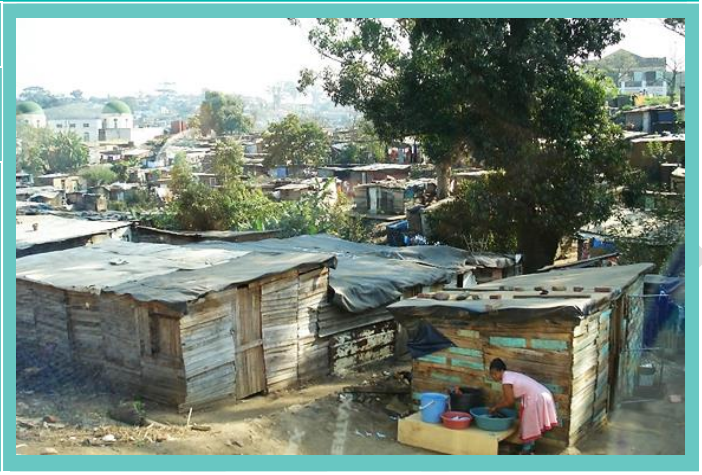
ANNANSILMÄT-AITTA

Owned by The Helsinki and Uusimaa Association for Visually Impaired (HUN), Annansilmät-Aitta has been operating in Helsinki since 1919. HUN is the biggest member association of the Finnish Federation of the Visually Impaired with more than 2200 members and its purpose is to provide services for the visually impaired so they can live more independently (HUN, n.d.). HUN was awarded the Finnish Social Enterprise Mark for their initiatives Annansilmät-Aitta and Iiris (Iiris Centre, n.d.). During the development of this study, and in order to update the information, it was verified that when entering the name of "Annansilmät-Aitta" in the search field of the Mark, no results were obtained, but when entering the name "HUN" a result was obtained. Unfortunately, opening the corresponding link does not show any information, but it can be easily found by accessing the Annansilmät-Aitta website, which has been recently renewed.

Annansilmät-Aitta offers a wide selection of durable, high-quality furniture and home products made by hand from the best raw materials by the visually impaired like rattan furniture, baskets, brushes, and other miscellaneous items. They also sell other quality products from different suppliers including sauna and kitchen products, wooden toys and games, candles and lanterns, textiles, etc., mostly made of wood or other natural material. In addition, they repair rattan furniture, sell rattan tape for self-repair, and upholster rattan furniture using high-quality fabrics. After Sokeva Käsityö ceased operations in 2015, Annansilmät-Aitta continues to

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supply artisan materials and handles sales to their former customers. Unfortunately, their website does not provide concrete information on how they measure the impact of their activity.

LEAPFROG PROJECTS, https://www.leapfrogprojects.com/	
Country: Finland	
Sector: Expert consulting services	
Beneficiary group(s): Organizations and networks in emerging market settings, nature Photo: Pixabay	
Mission (value created): To support the societal transition towards regenerative, socio-ecologic, and socio-economic systems.	
Strategy (how that value is created): Through a network of experts who support organizations and other networks to solve complex sustainability challenges and take a leap to the next level.	
Impact measurement (how the benefits to society are assessed): Information not directly available on their website.	

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Figure 1. Leapfrog Projects fact sheet. (Source: Carmen Antuña Rozado, 2021/2023)



Figure 2. Annansilmät-Aitta fact sheet. (Source: Carmen Antuña Rozado, 2021/2023)

KANRESTA

Owned by The Finnish Public Health Association (SKTY), Kanresta has been awarded the Finnish Social Enterprise Mark. SKTY promotes health and wellbeing in different life situations and supports its affiliate organizations by raising funds for their activities (e.g., pediatric research, mental health promotion, heart disease prevention, welfare of the elderly, etc.) (SKTY, n.d.).

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The leading operator in this particular field of activity in Finland, Kanresta particularly focuses on collaboration with the client for the creation (and efficient operation) of a highly customized concept that will support and further develop their business while enhancing the customer experience. Everything is based on clean and carefully selected raw materials together with the commitment of its professionals. Honoring its socially responsible role, Kanresta makes a special effort to respect the environment in all its operations, the wellbeing of its staff, the selection of good quality local delicacies and its responsible catering. In addition, the profits from the restaurants they operate are dedicated to promoting the health and wellbeing of Finns. Although there are no actual impact indicators on its website, it does provide some financial results for 2019, such as €29.7 million turnover, €34.3 million group turnover, €1.8 million for public health work. No subsequent financial results are available, but it is known that the pandemic had an especially negative effect on Kanresta, causing many layoffs.

KANRESTA, https://www.kanresta.fi/en/

Striving for OV Excellence

Country: Finland

Sector: Restaurant services and catering

Beneficiary group(s): Restaurant owners and their customers



Photo: Kanresta

Mission (value created): To provide individualized and responsible restaurant and catering services to congress, culture and event houses, and experience destinations.

Strategy (how that value is created): By developing unique restaurant concepts in close collaboration with business owners to support their business goals and provide a comprehensive experience to their customers.

Impact measurement (how the benefits to society are assessed): Information not directly available on their website.

Figure 3. Kanresta fact sheet. (Source: Carmen Antuña Rozado, 2021/2023)

Kanresta's affiliate partners also provide meaningful services to vulnerable social groups: MIELI Mental Health, Finnish Heart Association, The Finnish Association for the Welfare of Older People (VTKL), and the Pediatric Research Foundation (Lastentautien tutkimussäätiö).

UPCYCLER HELSINKI

Originally an online store that also included a content production service and a lending company, when the circular economy started to gain ground in Finland, Upcycler became the main reference media platform for the circular economy of Finnish fashion. The online store is currently closed and Upcycler focuses on communicating and training about the circular economy, as well as introducing responsible national entrepreneurs who promote the circular economy through their products and services. More specifically, some of the companies supported by Upcycler offer upcycled fashion products such as clothing, bags, jewelry, and

footwear. While others provide maintenance services such as sewing workshops or supplies to repair and maintain clothing and footwear in good condition, thus considerably lengthening their life cycle.

In order for fashion companies to be featured on the Upcycler site, they must clearly demonstrate that they operate largely in accordance with circular economy principles, plus they are expected to be transparent and have a strong manufacturing ethic. Site members pay an annual fee that gives them access to events and promotions and includes a company introduction page.

UPCYCLER HELSINKI, https://upcyclerhelsinki.com/	
Country: Finland	
Sector: Fashion/Circular economy	
Beneficiary group(s): Companies in the fashion sector committed to sustainability and the circular economy, customers who demand conscious fashion that consumes fewer resources Photo: Markus Winkler from Pixabay	
Mission (value created): To support the transition of the fashion sector towards a more sustainable production and consumption model and a circular economy.	
Strategy (how that value is created): Through an online platform that aims to be the meeting point for circular fashion actors. Among other useful content, it features responsible national companies whose activities have been verified by Upcycler, thus facilitating the work of those looking for reliable operators.	
Impact measurement (how the benefits to society are assessed): Information not directly available on their website.	

Figure 4. Upcycler Helsinki fact sheet. (Source: Carmen Antuña Rozado, 2023)

Upcycler also recommends a selection of second-hand and vintage stores, and provides useful contacts for recycling different materials, such as old silver spoons that are no longer used and can be turned into pieces of jewelry, for example. Other services provided by Upcycler include sustainability communication for small businesses, online courses, content production and sparring (i.e., mentoring and support for small business owners). Lastly, they also have a blog that reports on the circular economy in fashion, as well as other related topics, and reflects on issues of common interest to the sector.

4.2 Contribution to sustainable cities and communities: common barriers, enablers, and impacts

As seen, the social enterprises presented offer expert advice to clients who might not otherwise be able to access such a service to support them in transitioning to cleaner environments (i.e., Leapfrog Projects). Or they provide employment to vulnerable groups while committing to deliver high quality products and services to their customers, partners, and suppliers (i.e., Annansilmät-Aitta). Or they fill an existing gap with a significant new offering that benefits society in general, but also their direct customers and strategic partners in particular (i.e., Kanresta). Or they operate in promising fields of activity that are somehow not yet fully developed but are constantly growing, where setting up a company can be particularly difficult (i.e., circular economy - Upcycler) and yet many opportunities lie ahead.

Barriers and enablers

Frequently, when carrying out their activity, social enterprises encounter a series of barriers that are largely common throughout the world. As is apparent from the research behind this article as well as from the broader study associated with the EMBA master's thesis prior to this article, social enterprises usually struggle with:

- Absence of a specific legal status that defines the limits of their activity, but also that guides their interaction with investors and stakeholders, in addition to enabling certain benefits such as tax exemptions (OECD, 2022).
- Excessive bureaucracy and complicated administrative procedures for its establishment, management and regulation that slow down or hinder their activity, especially in certain countries and regions (Bogacz-Wojtanowska & Jatocha, 2016).
- Difficulties in accessing financial resources, including financing, donations, and also public funds (Davies et al., 2019).
- Difficulties both in attracting highly qualified and motivated workers and in retaining them (Mikołajczak, 2022) (Bhati & Manimala, 2011).
- Challenges in recruiting volunteers, often an essential part of their activities (Doherty et al., 2014).
- Somewhat worrying rate of burnout cases due to work overload and inadequate management of expectations, especially among the most committed and active members, which unfortunately affects all the aforementioned actors (Salemink et al., 2017).
- Lack of alignment between mission, strategy, and impact measurement. Unlike the previous factors, which can be considered to a large extent extrinsic, this one is rather intrinsic (to the social enterprises in question) and does not necessarily depend on external conditions or the ecosystem in which they are inserted. This can be quite limiting considering that scholars like (Austin et al., 2006) have found that tightly aligning these three aspects is paramount to the success of social enterprises.
- Lack of measurement of the impact generated, and even of monitoring and reporting of their performance. This is more common than it seems and is related to what (Ormiston & Seymour, 2011) call the *"mission measurement paradox"*, which suggests that *"social entrepreneurs are failing to assess their social impact with enough consideration its social mission"*. More will be said later on the impact created by the social enterprises selected for this study.

As some authors propose, barriers can become enablers if the appropriate strategies are adopted (Burch, 2010), and those mentioned above are probably no exception. But beyond that, it is worth noting the importance of an "enabling ecosystem" (Biggeri et al., 2017) characterized by the existence of a market with a high degree of coordination, of solvent financial institutions and by a state capable of providing wellbeing services, which together facilitates synergy and collaboration between the different actors and offers more opportunities for social enterprises. In the Finnish case, the current ecosystem is still far from ideal due to a certain lack of understanding and support regarding the characteristics of the social enterprise business model (Kostilainen, 2019). However, on the positive side, there appears to be an increasing number of young entrepreneurs and professionals who are attracted to "values-based" entrepreneurship as an opportunity to fulfill themselves and improve society (Ainonen et al., 2022).

Impacts

As with many other social enterprises, not only in Finland, but around the world, the benefits they create for society are often not sufficiently highlighted on their websites and various promotional materials. Sometimes they do not show up at all. The social enterprises featured here are no exception, so the author of this article has tried to capture the social impacts they generate based on the analysis of various information available about their activities, processes, products and services offered, strategic collaborations, etc. (see Table 2).

Table 2. Potential impacts generated in society outlined as a result of the analysis of the available information. (Source: Carmen Antuña-Rozado, 2023)

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SOCIAL ENTERPRISES	POTENTIAL IMPACTS
Leapfrog Projects	• Accelerate the transition towards regenerative and more resilient socio-ecological and socio-economic systems through a systemic transformation, particularly in the Global South. • Support for the creation and development of new local networks of experts or strengthening of existing ones in the specific contexts of operation. • Better access to expert advice on systemic transformation for local stakeholders and actors, and opportunities for co-creation and learning.
Annansilmät-Aitta	• Higher employment rate, as well as individual and group empowerment and sense of purpose among people with visual disabilities. • Greater social cohesion through better integration of vulnerable groups at risks of exclusion. • Easier access to good quality and affordable products for the home handmade by local artisans. • Increased durability of rattan furniture thanks to its repair and upholstery services, thus contributing to reducing the demand for new products and raw materials.
Kanresta	• Greater health and wellbeing through the quality food and catering services provided by the restaurants and cafeterias with which they collaborate. • More opportunities for certain vulnerable groups in society through direct collaboration with their affiliated partners. • Promotion of local products through their inclusion in the menus they create for their clients, and as a consequence, support for small Finnish producers.
Upcycler Helsinki	• Greater social awareness and information available about the circular economy. • Reduced demand for raw materials. • Reduced waste in the fashion sector. • Greater number of partnerships made around the circular economy in fashion facilitated by the platform. • Easier access to good quality recycled fashion items (clothing, bags, jewelry, and footwear).

Finally, in addition to the mentioned fields, social enterprises can also contribute to many other aspects of sustainable cities, communities, and the built environment. More on this topic in the discussion.

5. DISCUSSION

In general, all the examples above show good alignment between their mission and their strategy. Typically, the social or environmental value they set out to create is clearly stated as well as the specific way they create the desired value. However, filling out the template has required digging up, interpreting, and elaborating the information found on their websites, as it is not necessarily presented in terms of *"our mission is ..." or "our strategy is ..."* at all. Without a doubt, the greatest difficulty encountered is related to the evaluation of the impact generated, especially quantitatively, and its correspondence with the mission and strategy of the social enterprise in question. This can have a negative influence when trying to attract donors or investors (Mair & Martí, 2006).

Comparatively, in terms of impact assessment, the examples described address the measurement of the value (social or environmental) created, and even more so, of the benefits generated for society as a whole, in various ways and, more importantly, to a different extent. Based on the sometimes scant information available, two of

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them (i.e., Annansilmät-Aitta and Kanresta) have earned the badge recognizing their effort towards Excellence in Operational Value.

An interesting finding has to do with the fact that the social enterprises presented hardly use narratives or success stories to show their impact. Many social businesses use the personal stories of their beneficiaries, told by themselves, to grab the attention of their website visitors and invite them to join their improvement journey. Storytelling is a powerful tool that can help give legitimacy to social enterprises (Margiono et al., 2019), particularly at the beginning of their journey when they often face resource acquisition issues (Lounsbury & Glynn, 2001), difficulty in accessing capital (Martens et al., 2007), and the general *"liability of newness"* (Stinchcombe, 1965;Yang & Aldrich, 2017).

In terms of scale of operations, of the Finnish social enterprises analyzed, one of them operates internationally (Leapfrog Projects), another two operate nationally (Annansilmät-Aitta, Kanresta) and another is currently focused on the capital area (Upcycler Helsinki). In addition, all the aforementioned social enterprises have good potential for replicability and scalability, even if certain adjustments to the specific local context were necessary.

It is also worth noting that in Finland, with the exception of WISEs (see Section 3), the rest of the social enterprises do not have a specific legal status and are therefore not entitled to tax benefits. In his country report (Kostilainen, 2019) explains that *"there are no specific support systems or tax relief specifically designed for social enterprises"*, which specially for non-profit social enterprises can be quite cumbersome. Another finding is that strategic alliances with key partners who share the same values and complement each other seem to help increase the positive impact that social enterprises generate in society. As (Weidner et al., 2016) argue, they can also provide them with an external legitimacy that reinforces their social function. Something similar occurs when forming part of support networks that facilitate access to information, knowledge, skills, and best practices (Folmer et al., 2018). This social capital has been found to be an *"impact generation mechanism"* that leads to social value creation in social enterprises through three different main pathways, namely productivity, community resilience and institutional development (Daskalopoulou et al., 2023).

As seen in previous sections, social enterprises in Finland mainly focus on the following areas: social and health services, wellness services, circular economy, and environment. All of these areas can easily be linked to sustainable development and from them it is possible to contribute significantly to the sustainability of cities and communities. However, to establish a broader reference, a quick review has been made of the areas to which social enterprises can contribute globally and the conditions for their success. In the process, it became quite clear that the number of publications, not only on social enterprises in general, but especially on the subdomain of social enterprises for socioeconomic development (SESED), is growing rapidly, as is research exploring the link between the two and therefore the related literature (Ahmad & Bajwa, 2023). This gives an idea of the interest that the topic arouses. So, here are some notable examples presented in chronological order.

After examining several cases of interest in mainland China and Hong Kong, the authors conclude that, rather than opting for one or the other, a mixed form that combines the corporate model and the non-profit model offers the highest potential for finding effective synergies and can benefit from both the business approach and intervention mechanisms (Man & Terence, 2011). In the Netherlands they have recently developed interesting initiatives related to social enterprises working on the provision of fast broadband access in rural areas, thus filling a gap that neither the government nor the market currently serves. A valuable lesson learned is the importance of committing local capital, but also the high risk of burnout among volunteers due to work overload, demonstrating how difficult it is for rural communities to take control of their digital future as a means to support rural development (Salemink et al., 2017). Another study covering 15 island communities in Northwest Scotland struggling with energy poverty and therefore seeking opportunities to develop and implement renewable energy initiatives, showed that these conditions can actually encourage the creation of social enterprises that are able to use resource scarcity to their advantage, thus increasing socioeconomic resilience (Morrison et al., 2017). Other researchers have studied the contribution of social enterprises to transformative community resilience, especially in times of economic crisis, in rural Greece. Although the research concludes that there is great potential for transformation in this sense, it also points out that state

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support is insufficient, and that governance is still predominantly top-down, which makes said potential difficult to achieve. In addition to financial and administrative barriers, the very attitude of social enterprises influences their performance. While some social enterprises appear to have been forced into existence by increasing cuts in available funding, others were motivated by a desire to respond to a market failure (Apostolopoulos et al., 2019).

In Ahmedabad, India, three successful social enterprises appear to play a key role in facilitating the development of social innovations aimed at improving the city's environmental sustainability. The companies in question provide waste management and recycling solutions, as well as decent employment opportunities for those living on the edge of social exclusion such as waste pickers (Ambati, 2019). In Australia, analysis of the transformative potential of social food enterprises using a multidimensional framework yielded interesting results. Despite a clear alignment with the values of sustainability, climate resilience and social justice, as well as an innovative spirit, especially in terms of operating models, some drawbacks were observed. For example, there is still room for improvement when it comes to including farmers in their strategic processes, which in turn could unlock even more innovations. Also, quite often work overload prevents more consistent interaction with government and other authorities to advocate for policy changes. This would help them better achieve their transformative potential by influencing people to move from passive consumers to active citizens, rather than simply providing them with a better food supply option (Vieira et al., 2019).

A study conducted in three Latin American countries, namely, Guatemala, Mexico, and Peru showed how indigenous social enterprises contributed substantially to key SDGs in their local context (SDG 3, 8, 10 and 11). By developing specific empowerment mechanisms and dignity-based innovations, the social enterprises examined were able to improve the health and working conditions of local communities, reduce existing inequalities, and increase their overall sustainability (Vázquez-Maguirre, 2020). Continuing with the Netherlands, recent research has analyzed and categorized the different types of social enterprises involved in bottom-up urban development, a practice that is becoming increasingly common due to disappointment with more conventional approaches. Rather than opposing the establishment, the social enterprises studied seek ways to collaborate with other key actors who share a common vision for sociotechnical innovation and urban sustainability. The authors see this as an opportunity to support the transition towards sustainability of cities around the world (Mens et al., 2021). Another recent study conducted in Surabaya, Indonesia, using a conceptual model proposed by the authors seems to indicate that, contrary to what was initially assumed based on claims from previous research, urban social enterprises can actually contribute to generating environmental innovation and complement the role of the city government (Suprobo et al., 2021). In Lithuania, a recent study focused on how WISEs in the country contributed to relevant SDGs (i.e., SDG 1, 2, 3, 4, 8 and 16) and how their contribution was affected by the pandemic. The findings show that thanks to their flexibility and resilience, most of them were able to quickly adapt to the new challenging conditions and, furthermore, develop new services and products (Urmanavičienė & Butkevičienė, 2023).

All of the above initiatives and many others show the variety and versatility of social enterprises, which in turn points to an only partially realized potential to contribute to the different pillars of sustainability (economic, sociocultural, and environmental). However, it does not seem clear how exactly to measure this contribution nor what are the enabling conditions that allow social entrepreneurship to effectively promote sustainable development and which, therefore, must be ensured. In the authors' opinion, this becomes particularly relevant when evaluating not only an individual social enterprise, or several, but the influence of social entrepreneurship over time in a given geographic area or in a specific community. This was precisely the purpose of a recent study that applied the MLP (multi-level perspective) method to analyze the sustainable transformation of Yiwu, China, through innovation brought about by social entrepreneurship over several decades (Yan et al., 2022).

6. CONCLUSIONS AND FUTURE DEVELOPMENT

As seen, the number of social enterprises in Finland has been growing steadily since 2010, concentrating mainly on the health and wellbeing sector, the provision of social services, as well as the environment and circular economy. However, despite the rapid growth experienced in recent years, the social entrepreneurship model still offers many opportunities to contribute to the improvement of society in general, as well as to the

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sustainability of cities and communities. The examples from different parts of the world reviewed show that social enterprises can address, although not without difficulties, a wide range of needs and gaps in many different sectors of activity and under different market conditions. From rural connectivity to community resilience in remote places; from the improvement of local food systems to waste management and recycling in urban areas, or participatory bottom-up urban development; from social inclusion to the empowerment of indigenous communities. All of the above seems to indicate that there is considerable potential for social enterprises to contribute to sustainable development and increase the sustainability of cities and communities. However, more research needs to be conducted on this particular topic, including appropriate methodologies.

In parallel, government support also seems to be growing in Finland judging by the recently launched new strategy for social enterprises. However, the fact that the main objective of the strategy is to provide more and better employment opportunities for people with limited employment capacity poses a considerable constraint and leaves much of the potential that social enterprises have still untapped. On the other hand, the new strategy does not contemplate a specific legal status for social enterprises that could grant them any benefit, such as tax reduction or any other, although there are support services, tools, and information available through the recently created Centre of Expertise for Social Enterprises, its member organizations and their networks. Ultimately, the current strategy will last until the end of 2023, and since it is not yet clear how exactly it will continue, it would be necessary to follow up on this study in order to monitor the evolution of the existing regulatory framework.

Furthermore, direct access to the knowledge and experience stored in local networks and the possibility of establishing strategic alliances with other partners that share the same values and objectives and that are complementary in some way, is another of the advantages that the Finnish ecosystem provides. The Centres for Economic Development, Transport and the Environment are also part of this ecosystem and can play an important role in the replicability and scalability of social innovations throughout the country.

In short, the social enterprises featured here are a pretty clear example of how to fill an existing gap in terms of ignored or insufficiently covered social or environmental challenges and needs using the business method to varying degrees. In theory, this gives them an agility that the public system often lacks, while collaboration with partners and actors within the network, including the public system itself, creates a multiplier effect. At the same time, the findings corroborate that performance and impact measurement remains one of the main obstacles for social enterprises to demonstrate the benefits they create to society in a quantitative manner, which in turn may discourage potential investors or donors. Better reporting can not only make the true significance of what social enterprises accomplish accessible to stakeholders, but it can also be used as a basis for improvement and growth, as well as for comparison. In turn, reporting requires monitoring and continuous data collection and measurement, which provides social enterprises with a deeper insight into their activity and operations all along the way, and a clearer picture of their weaknesses and potential for improvement, thus allowing them to change course in a more planned and deliberate manner.

The Finnish Social Enterprise Mark can definitely help to increase the visibility and credibility of social enterprises, as well as social awareness about the importance of their goals and mission, but only and to the extent that the companies awarded the Mark are willing to display it and make use of it in order to mutually benefit from this synergistic effect. A greater perceived legitimacy can be instrumental when it comes to attracting young and highly qualified talent, considering that the younger generation seems to be increasingly attracted to professions and jobs that allow them to leave a positive mark on the world.

Despite the observed advances, awareness and understanding of social entrepreneurship could be further promoted not only among the general public, but also in business schools to encourage reflection on how companies could behave in a more socially and environmentally responsible manner.

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Author Contributions

C.A.-R. is responsible for the research behind this article and the scientific paper that preceded it, as well as the original research work associated with her EMBA master's thesis. J.G.-N. has critically reviewed the manuscript and provided useful recommendations.

Conflicts of Interest

The authors declare no conflict of interest.

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