**Digital workflow for regenerative zero carbon urban design in a changing climate: a scalable and robust cross-climatic application**

**1. Strategic relevance and impact**

**> Industrial and societal needs the project address**

The project addresses two current global main challenges: urbanisation and climate change. The rates of global population in cities, and in turn, the cities’ material consumption are rapidly increasing. Already today, the built environment in cities is responsible for the majority of global GHG emissions. Many cities have the ambitious goal to fully decarbonize the global building stock by 2050 at the latest. This new approach requires a comprehensive rethinking of how buildings and cities are designed, in a way that carbon as well as other reliable environmental key performance indicators (KPIs) will inform the design process. However, stakeholders including architects, urban designers, municipalities, and construction companies in both Sweden and Israel lack the methods and tools for holistic environmental design at the urban level. This project will close this gap by offering such workflows which will contribute to achieving carbon neutrally in the built environment.

**> Improvement on current practices**

Current practices are improved in five main aspects: 1) Current environmental evaluation of design proposals is usually carried out for single performance criteria. This project will allow for integrated multi-criteria evaluation over the whole life cycle on the urban neighbourhood level. 2) As LCA at the urban scale has not been explored, our approach will offer new insights on the trade-offs between carbon performance and other environmental KPIs (e.g., daylight, thermal comfort). 3) This project will upscale the analytical boundary from the single building scale, which is the common analytical practice, to the urban block and the district scales. 4) Environmental assessment still involves a lot of manual work by individual expert consultants today. By leveraging the potential of digital workflows, the project increases efficiency and accessibility to the assessments. 5) Current practices rarely account for the future climate. In this project future climate change scenarios and different climatic contexts in both countries will be used to ensure the robustness of the approach.

**> Why has this not been done before?**

Most researchers are specialists in one field, e.g., daylight and focus on improving methods within their specialisation. Researchers like Dr. Natanian who combine several analytical methods and develop them further, are rare. With regards to LCA, the field is mature enough only now to move up to the neighbourhood level. The same holds true for parametric design approaches. Now, the tools are flexible and mature enough to be combined into robust workflows that can be used by a variety of stakeholders, not only experts. The relatively new field of Architectural Design Optimization is rapidly evolving and offers new tools and methods to integrate Artificial Intelligence (AI) into the design process. AI based methods allow to upscale the environmental analytical approach to larger scales and gain new results.

**> Expected users of results or methods**

The results and methods from this project will support designers to apply informed design decisions, working towards zero carbon buildings and healthier environments. Thus, as this work aims to bridge the implementation gap of zero-carbon-driven urban designs in practice, it appeals to the scientific community, urban designers, policymakers, but also construction companies who have to report the GHG emissions and establishes a new link between them. In addition, researchers will benefit from open-source approach of the project, which will allow them to build on the methods and develop them further.

**> The attractiveness of PhDs**

The specialisation of both PhDs - at Chalmers and as the Technion – on urban scale LCA and environmental computational design and optimization, respectively, are currently on very high demand in both countries’ AEC sectors. Especially consulting companies and governmental agencies in the built environment are looking for skilled academics with an analytical environmental focus and the computational knowhow.

**> Other potential applications of the planned research**

Here, the focus lies on multiple environmental aspects, however the developed methods and tools can also be linked and extended to include other criteria. The national competence centre “Digital Twin City Centre” (DTCC) at Chalmers provides an excellent platform with than 30 researchers and 60 industry partners working on social sustainability, mobility, underground infrastructure and many more aspects.

**2. Utilization plan**

**> Means to measure success of the project**

The aim of the project is to contribute to the scientific community which can be measured by the number and quality of journal publications and conference proceedings. Even more important is the contribution to advancing the practice which can be measured by the uptake of the developed workflows within the two case studies. This can provide an indication of the future, long-term uptake of the methods in the whole industry. Therefore, number of publications in both highly ranked scientific and industrial platforms, workshops and participants and number of real-life applications of the workflow will be tracked.

**> Relation to the research groups’ research‐ and innovation strategy**

Both groups work closely with practitioners in Israel, Sweden, and beyond. Furthermore, the PIs have valuable experiences of co-founding two spin-off out of universities and leading an architectural practice. The utilisation of the project results will be supported through the Chalmers Innovation Office, and the Technion’s Research & Development Foundation in Israel.

**> Intellectual property**

This project will share all developments open source under the MIT licence. Other researchers and companies will be free to use the resources and extend existing or develop new business models.

**> Interaction with stakeholders**

On the Swedish side, the project will build on the good relations within the existing network of the DTCC including 60 partners from the different stakeholder groups including architects (e.g., White), contractors (e.g., NCC), consultants (e.g., Sweco) and many municipalities (e.g., Härryda, Helsingborg). On the Israeli side, the project will build on good relations with governmental authorities the Israeli planning administration, Israeli Ministry of Energy, The Israeli Green Building Council, and an array of AEC companies. The stakeholders will be included from the beginning of the project when defining the requirements. The two real case studies will ensure that participating stakeholder and lastly society can directly benefit from the projects’ results. Regular workshops (online and in person) will ensure a continuous knowledge exchange. Furthermore, the professional education activities at Chalmers and Technion will be used as dissemination and exchange platform.

**> Short, medium and long term potential contributions**

The project results will be immediately applied in the case studies within the project and support the stakeholders to save GHG emissions and create sustainable living environment. The collaboration with national institutes such as the Swedish and Israeli Green Building Councils, the Swedish Energy Agency and the Israeli Ministry of Energy will support the dissemination and uptake of the developed methods within 5 years after the project. In the long term, it will contribute to achieving the Paris agreement on an international level and support the transition of the built environment towards net zero GHG emissions until 2045 and beyond.

**3. Dissemination**

The dissemination strategy targets three stakeholder groups: 1) Scientific community, 2) AEC professionals and policy makers, 3) general public:

**1) Scientific community**

Scientific publications: Each researcher will be required to produce at least three conference papers and two articles in high-ranking peer-reviewed journals in the field, published under open access models, to ensure maximum accessibility (e.g. Automation in Construction, Energy, Energy and Buildings).

Bilateral workshops: Each researcher of the project will present his/her research progress as part of the several workshops which will be held in Sweden and Israel, in an open access academic environment.

Urban zero carbon conference: This final event will set the stage for reporting and discussing new and innovative scientific findings and developments. It will ensure a high scientific level through a double-blind peer review process by a scientific committee comprised of experts from both academic partners.

An Online platform will stream updates, events, publications, new tools, and ideas. Tenants of Open Science and in particular Open Access of Publications, Open Access of Data, and Open Access of Source Code will be part of the training and will be effectively used to maximise impact.

**2) AEC professionals and policy makers**

Urban zero carbon conference: The information about this conference will be widely disseminated via both academic and industry outlets to attract policy makers and delegates from the industry. Keynote speakers from academy and industry will be invited to share the latest developments in the field.

Demonstration events will allow local experts in both countries to test the developed workflows. These events will increase the applicability potential of the project’s findings by the local building sectors.

**3) General Public**

Social media will be set up as complements to the more technical internet-based transfer-of-knowledge and communication facilities on the network website.

Popular media: As the challenge the project seeks to address is directly linked to the lifestyle of city dwellers in both countries, the project will seek to be reported in national media channels (e.g., newspapers, magazines, television shows, etc.)