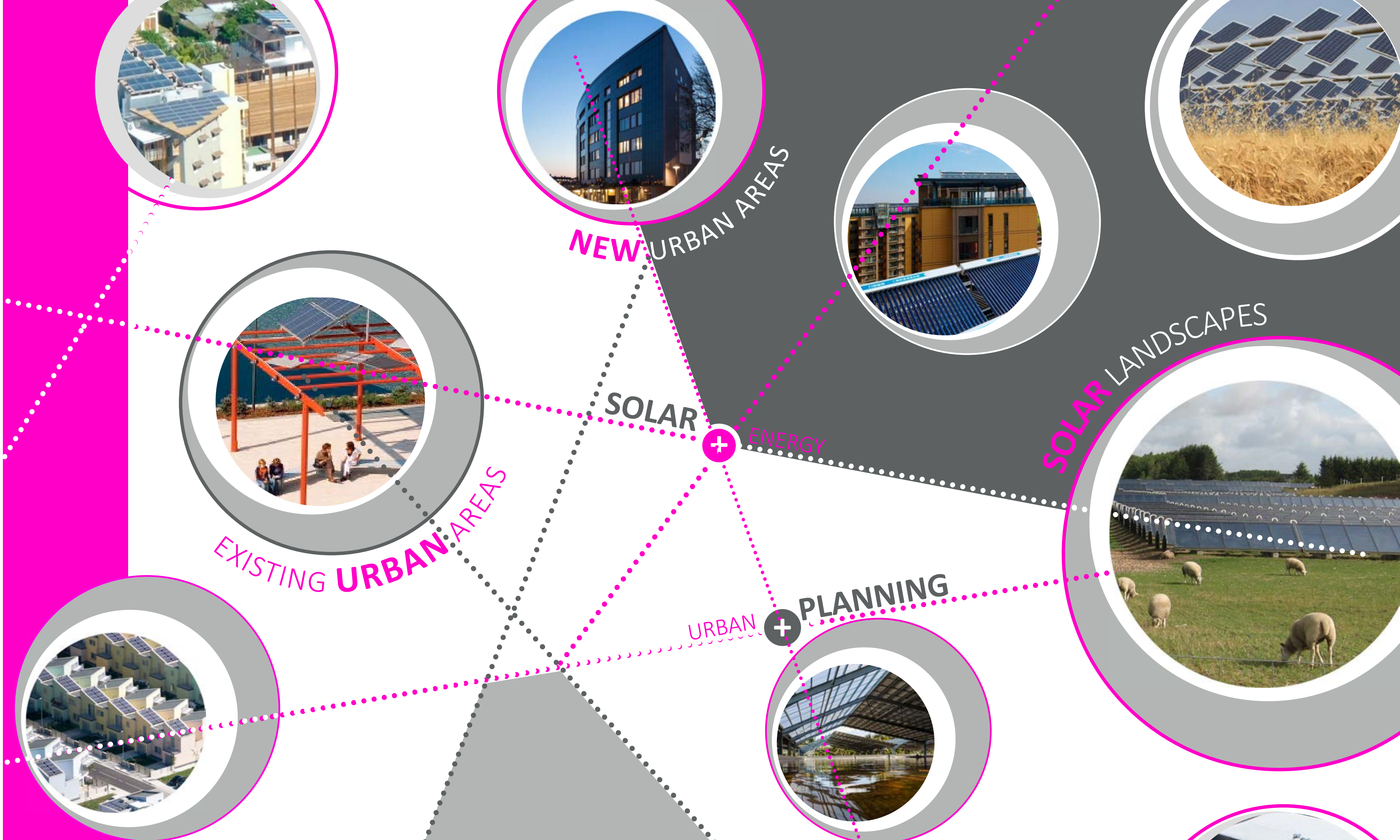


National and International Comparison of Case Studies on Solar Energy in Urban Planning

SHC
IEA SHC TASK 51 SOLAR ENERGY IN URBAN PLANNING | HTTP://TASK51.IEA-SHC.ORG

Solar Heating and Cooling Programme- International Energy Agency
Task 51 "Solar Energy in Urban Planning"

Subtask C – Case Studies and Action Research
Task 51/Report C2 - National and International Comparison of Case Studies on Solar Energy in Urban Planning

DOI: 10.18777/ieashc-task51-2018-0001
Publication Date 02/2018

Title Page:
Gabriele Lobaccaro and Carmel Margaret Lindkvist,
Norwegian University of Science and Technology, Department of Architecture and Planning

Images:
Existing urban areas: © Municipality of Alessandria
New urban areas: © Thomas Zaar, White Arkitekter, 2013
Solar Landscape: © Brædstrup Fjernvarme

Other images:© BAMSphoto- Basilio (Violino District, Italy); © AP Architectures/2APMR (Flores Malacca, France); © www.zhulong.com (Residential Plot B45, China); © REM (Agrovoltaico, Italy); © akuoenergy (Les Cedres, France); © Glen Musk, Adresseavisen (Zero emission office building, Norway)

Gabriele **Lobaccaro**
Researcher - Subtask C (STC)- Leader
Department of Architecture and Planning
Faculty of Architecture and Design
Norwegian University of Science and Technology - NORWAY

Carmel **Lindkvist**
Associate Professor - STC Leader
Department of Architecture and Planning
Faculty of Architecture and Design
Norwegian University of Science and Technology - NORWAY

Maria **Wall**
Associate Professor - Operating Agent of Task 51
Energy and Building Design
Lund University - SWEDEN

EDITORS

AUSTRIA

Daiva **WALANGITANG**
Researcher
Energy Department
Austrian Institute of Technology - AUSTRIA

CANADA

Alexandre **PAVLOVSKI**
Director
Green Power labs Inc. - CANADA

Marlene **MOORE**
VP Marketing
Green Power labs Inc. - CANADA

Miljana **HORVAT**
Associate Professor
Department of Architectural Science
Ryerson University - CANADA

CHINA

Jianqing **HE**
Researcher
China National Engineering Research Centre
for Human Settlements - CHINA

DENMARK

Karin **KAPPEL**
Researcher
Solar City Denmark - DENMARK

Olaf **BRUUN JØRGENSEN**
Senior Researcher
Danish Energy Management & Esbensen - DENMARK

Simon **STENDORF SØRENSEN**
Researcher
PlanEnergi - DENMARK

FRANCE

Anne **MONNIER**
Researcher
Akuo Energy - FRANCE

Aymeric **DELMAS**
PhD Candidate
IMAGEEN/PIMENT/CRENAU
University of Réunion Island- FRANCE

François **GARDE**
Professor
ESIROI/PIMENT
University of Réunion Island - FRANCE

GERMANY

Katharina **SIMON**
Researcher - Subtask D (STD) Leader
Institute for urban design and urban research
University of Wuppertal - GERMANY

AUTHORS

AUTHORS

Margarethe **KOROLKOW**
Researcher
IBUS GmbH
Institut für Bau-, Umwelt- und Solarforschung - GERMANY

Romain **NOUVEL**
Researcher
Research center Zafh.net – Sustainable Energy Technology
Hochschule für Technik Stuttgart - GERMANY

Tanja **SIEMS**
Professor - STD Leader
Institute for urban design and urban research
University of Wuppertal - GERMANY

ITALY

Alessandra **SCOGNAMIGLIO**
Senior Researcher - Subtask B (STB) working group co-leader Landscape Environment
Dipartimento Tecnologie Energetiche | Divisione Fotovoltaico e Smart Networks | Laboratorio sistemi fotovoltaici e smart grids DTE-FSN-FOSG
ENEA Centro Ricerche Portici | largo Enrico Fermi 1 80055 Portici (NA) | Italy

Rossana **PAPARELLA**
Associate Professor
Department of Civil, Environmental and Architectural Engineering
University of Padova - ITALY

Simone **GIOSTRA**
Associate Professor
Politecnico di Milano - ITALY

Silvia **CROCE**
Assistant Researcher
Department of Civil, Environmental and Architectural Engineering
University of Padova - ITALY

Institute for Renewable Energy, EURAC Research - ITALY

Daniele **VETTORATO**
Senior Researcher
Institute for Renewable Energy, EURAC Research - ITALY

NORWAY

Carmel **LINDKVIST**
Associate Professor - STC Leader
Department of Architecture and Planning
Faculty of Architecture and Design
Norwegian University of Science and Technology - NORWAY

Gabriele **LOBACCARO**
Researcher - STC Leader
Department of Architecture and Planning
Faculty of Architecture and Design
Norwegian University of Science and Technology - NORWAY

Annemie **WYCKMANS**
Professor - STC Leader
Department of Architecture and Planning
Faculty of Architecture and Design
Norwegian University of Science and Technology - NORWAY

SWEDEN

Johan **DAHLBERG**
Sustainability Advisor - STB Leader
White Arkitekter AB - SWEDEN

Jouri **KANTERS**

Associate senior lecturer

Energy and Building Design
Lund University - SWEDEN

Marja **LUNDGREN**

Architect - STB Leader

White Arkitekter AB - SWEDEN

Maria **WALL**

Associate Professor - Operating Agent of Task 51

Energy and Building Design
Lund University - SWEDEN

SWITZERLAND

Cristina S. **POLO LÓPEZ**

Researcher

University of Applied Sciences and Arts of Southern Switzerland (SUPSI),
Dept. of Environment Constructions and Design (DACD)
Institute of Applied Sustainability to the Built Environment (ISAAC)
Swiss BiPV Competence Centre - SWITZERLAND

Emilie **NAULT**

Postdoctoral Fellow

Interdisciplinary Laboratory of
Performance-Integrated Design (LIPID)
Ecole Polytechnique Fédérale de Lausanne (EPFL)
SWITZERLAND

Giuseppe **PERONATO**

PhD

Interdisciplinary Laboratory of
Performance-Integrated Design (LIPID)
Ecole Polytechnique Fédérale de Lausanne (EPFL)
SWITZERLAND

Isa **ZANETTI**

Researcher

University of Applied Sciences and Arts of Southern Switzerland (SUPSI),
Dept. of Environment Constructions and Design (DACD)
Institute of Applied Sustainability to the Built Environment (ISAAC)
Swiss BiPV Competence Centre - SWITZERLAND

Within the framework of Solar Heating and Cooling Programme - International Energy Agency Task 51 *“Solar Energy in Urban Planning” in the Subtask C – Case Studies and Action Research, Best Practice Case Studies and Case Stories* across Subtask topics have been set as an objective. The goal is to stimulate successful practice and facilitate the replicability of good practices, by documenting ongoing experiences, exposing potential pitfalls and creating arenas for mutual interaction between researchers and city representatives.

In the Task 51/Report *C2 - National and International Comparison of Case Studies on Solar Energy in Urban Planning,* 14 comparisons among the case studies collected in the Task 51/ Report *C1 - Illustrative Prospective of Solar Energy in Urban Planning: Collection of International Case Studies*, are presented. The analized case studies are from the countries taking part in the IEA SHC Task 51. The case studies are divided into:

1. New urban areas
2. Existing urban areas
3. Landscapes

The case studies are examined primarily through planning, research actions, legislation, simulation, etc. They are divided in two types of comparisons:

1. Collaborative internal country case studies
2. Collaborative cross country case studies

The comparisons were selected according to three main areas of interests

1. Scale and planning process
2. Legislation and technology
3. Targets and goals

Each comparison provides lessons learned and recommendations for the different target groups, such as urban planners, architects, researchers, urban stakeholders involved in the planning process.

SUMMARY

We would like to thank all authors and organisations who contributed to developing case studies for this report – their contribution is stated at the end of each case study text. While all authors gave inputs and comments on the method used to obtain the information for this report, we would particularly like to thank Johan Dahlberg and Marja Lundgren of White Arkitekter AB, Sweden (Subtask leaders in Task 51); Professor Maria Cristina Munari Probst, Professor Christian Roecker and PhD Candidate Pietro Florio of École Polytechnique Fédérale de Lausanne (EPFL), Switzerland and Dr. Alessandra Scognamiglio of Photovoltaic Technologies Unit (UTTP-FOTO ENEA, Italy for their contribution to developing the method.

Finally, we would like to thank all funding bodies without whom this work would not be possible – Austrian Ministry for Transport, Innovation and Technology (bmvit); Natural resources Canada (NRCAN); NSERC Natural Sciences and Engineering Research Council of Canada (NSERC); Green Power Labs; R&D Fundis of China National Engineering Research Centre for Human Settlements (CNERCHS); Energistyrelsen (Danish Energy Agency); AKUO Energy; Bundesministerium für Wirtschaft und Energie (BMWi); Dipartimento Tecnologie Energetiche | Divisione Fotovoltaico e Smart Networks | Laboratorio sistemi fotovoltaici e smart grids DTE-FSN-FOSG - ENEA - Italy; University of Padova; Norwegian University of Science and Technology (NTNU); Norges Forskningråd; The Swedish Energy Agency; Swiss Federal Office for Energy; EuroTech Universities Alliance; Swiss National Science Foundation (SNSF).

The information and images included in this report are the responsibility of authors of the individual case studies. Editors have asked authors to obtain permission to use images and to the best of the knowledge of the editors, this has been done for all case studies.

A special thank to NTNU interns MSc Eng Susanna Salvucci and MSc Eng Giacomo Hinna (Università Politecnica delle Marche (Italy)- Faculty of Engineer- Department of Civil Engineer, Building Engineer and Architecture) who gave a valuable contribution in collecting and systemizing all the information for the case studies comparisons as well as for their support in the conception of the templates.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Objectives

The main objective of this report is to facilitate replicability of successful practice through case studies and stories (Subtask C) across the different Subtask topics of Task 51 Solar Energy in Urban Planning. These Subtask topics are:

1. Legal framework, barriers and opportunities for solar energy implementation
2. Development of processes, methods and tools
3. Education and dissemination

Subtask C creates a state of the art of urban planning case studies as case stories by analyzing the inter-relationship between the variables of the urban surrounding, solar integration technologies, environment, social, aesthetics, methods, approaches and tools. The analysis contributes to lessons learnt and recommendations in order to develop urban planning guidelines for different target groups.

Specifically, in the Task 51/Report C2 similarities and differences from the case studies are examined primarily through cross country comparisons concerning planning, research actions, legislation, simulation, etc. (Link with Subtask B and Subtask D).
The work builds and complements the work of Task 51/Report C1 by developing a deeper understanding of the case studies and highlighting that, while some challenges and opportunities are country specific, there are other challenges and opportunities which cross- borders.

The Task 51/Report C2 - National and International Comparison of Case Studies on Solar Energy in Urban Planning was done through comparison of a minimum of two cases between different countries and/or within countries. Experts were asked to respond to five questions that were believed to be important when conducting the comparative studies:

- What is the background of cases and rationale for comparing?
- What are the similarities between cases?
- What are the differences?
- What are the stakeholders' roles?
- What are the conclusions, lessons learned, recommendation and implications based on the comparison studies?

The experts used various methods to obtain the information for their case for this work, but there was a common approach of how the information was coordinated into this report, which was developed through Task 51 meetings.

In 2015, some experts submitted comparison studies. After the development of Task 51/Report C1, coordinators of Task 51/Report C2 could see common themes which enabled them to identify which countries would complement each other through comparison studies. Experts were then requested to submit their comparative studies for January 2017. These studies went through a review by coordinators and were further developed in February/March 2017. All studies were then compiled into this report.

1.2 Highlights and challenges

Some highlights from the comparative studies regarding solar energy implementation into buildings and urban development are:

- Need for high flexibility in design to allow implementing passive strategies into cases
- Applying active solar solutions to meet energy requirements and demands
- Proposing a structured development plan which provides clear perspectives for future urban planning and energy efficiency strategies
- Performing a solar potential analysis prior to implementation and investigate the shading conditions
- Monitoring the development process and setting up an energy management system to check the efficiency requirements
- Promoting the potential for dual use of land to respect local regulation, to maximize land availability, to protect the ecosystem and to produce energy locally
- Preserving the existing context and neighbourhood and make connections
- Promoting the collaboration between actors (private and public) and key players

Comparing goals, technologies and legislation implemented in each case points out some challenges which can be considered and discussed to move forward in similar future cases/projects:

- Lack of holistic approaches to apply renewable strategies and to exploit infrastructures and public spaces to produce solar energy
- Lack of specific solar energy targets
- Adapting urban planning regulations to new solar energy strategies in buildings and discussing potential proposals for new regulations for solar access within urban context in the future
- Focusing on urban context rather that single buildings
- Lack of follow-up/post-evaluation/ maintenance and residents' and users' awareness
- Promoting and educating stakeholders and target groups on the benefits of technology and design concept

The following sections present the case studies in full detail.

2 METHODOLOGY

2.1 Phases, materials and templates

In the *Task 51/Report C2 - National and International Comparison of Case Studies on Solar Energy in Urban Planning*, 14 comparisons among the case studies collected in the *Task 51/Report C1 - Illustrative Prospective of Solar Energy in Urban Planning: Collection of International Case Studies*, are presented. The analized case studies are from the countries taking part in the IEA SHC Task 51. The case studies are divided into:

1. New urban areas
2. Existing urban areas
3. Landscapes

The case studies are examined primarily through planning, research actions, legislation, simulation, etc. They are divided in two types of comparisons:

1. Collaborative internal country case studies
2. Collaborative cross country case studies

The comparisons were selected according to three main areas of interests

1. Scale and planning process
2. Legislation and technology
3. Targets and goals

Each comparison provides lessons learned and recommendations for the different target groups, such as urban planners, architects, researchers and urban stakeholders involved in the planning process.

2.2 Definition of areas of interests

The guiding topics are clustered as main areas of interest as it follows in below:

1. Scale and planning process

Scale: aims to study and present different topics as listed below for individual case studies:

- Comprehensive/strategic planning
- Urban design and landscape design stages
- Detailed development plan
- Architectural design stages
- Distinction between different types of urban neighbourhoods (renovation of existing neighbourhoods, new buildings in existing and/or new neighbourhoods)
- Relation between solar energy and heritage sites/landscape
- Impact of solar on a district level and diverse timeline for project phases
- Impact of cost when solar is introduced to plans
- Distinction between local projects and EU/international projects

2. Legislation and technology

This part aims to discuss several subjects regarding each individual case study:

- Specifying the solar access rights in terms of new/existing neighbourhoods and building design
- Impact of new policy and new technology on solar energy in urban planning (is it the same thing with new packaging or has there really been a difference made as a result of new developments?)
- Delivering power where new technology is introduced into the city
- Application of tools in design and construction process.

3. Targets and goals

This part aims to discuss several subjects regarding each individual case study:

- Timelines and quantitative\qualitative goals of big district projects that are influenced by solar energy
- Comparing different targets on an international level
- Detecting an universal index/common metrics to classify the energy need in different countries
- Specifying the type and use of tools to achieve targets
- Setting the targets
- Studying the links between solar and other goals
- The percentage of energy need covered by solar energy
- Role of certification scheme such as LEED and BREEAM
- Studying the project in case of no quantitative targets

2.3 Sections of the templates of case studies' comparison

The templates are divided in different sections. Each section is represented by the icons of the following Figure 1 below and Figure 2 in the next page:

SECTIONS

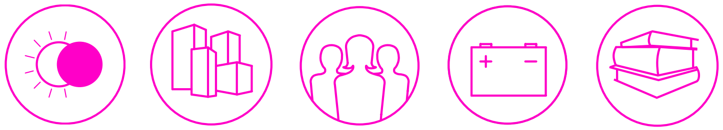


Figure 1 - The sections of the template of the case studies comparison.

The templates have been developed in order to have links with the different Subtasks and other reports of Task 51. Specifically, the sections are illustrated in Figure 1. The section "1 - Background and area of interest" represents the link with Task 51/Report C1 and Subtask A *Legal framework, barriers and opportunities*. In the section "2- Overview of the case studies" the compared case studies are briefly presented, while in the section "3- Stakeholders and Researchers' involvement" the role of the different urban actors are described. This section is linked with Subtask B *Approaches, Methods and Tools*. In the section "4- Similarities and differences" the most relevant aspects of the case studies' comparisons are discussed by underlying the similarities and the differences. Finally in the section "5- Lesson Learned and Recommendations" all the learning outcomes from the case studies' comparisons are presented.

2.3 Sections of the case study templates

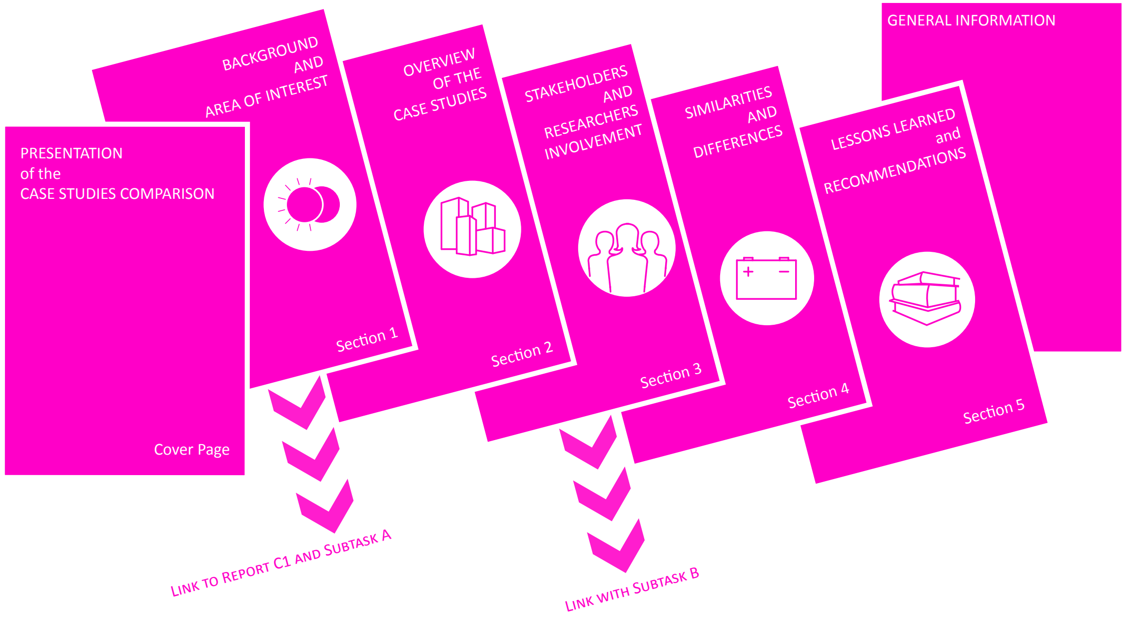


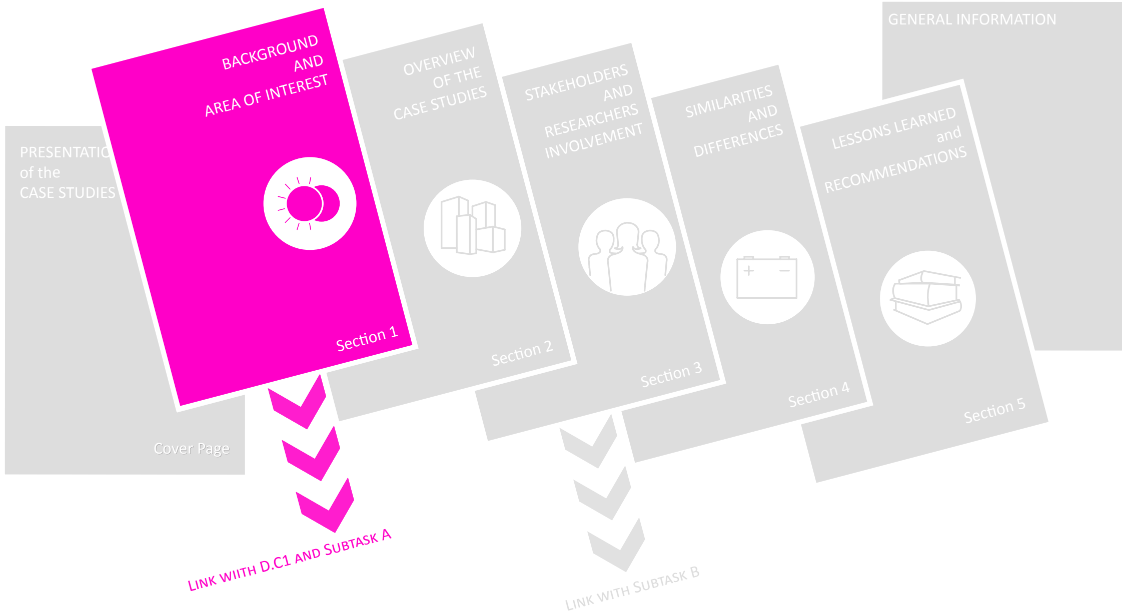
Figure 2 - The sections of the case study templates: the fully coloured pages identified the compulsory sections.

Background of area of interest

Authors of each country filled in the framework template to document the reason of the comparison of the case studies according to the area of interest.

This is the first section that contains a set of pictures to illustrate the case studies and a detailed explanation about the aspects which have been analysed in the comparison.

2.3 Sections of the case study templates



TEMPLATES of CASE STUDIES' COMPARISONS

Overview of the case studies

The second section entitled "Overview of the cases" contains a brief description of the analysed case studies and their features.

It contains highlights, important topics related to the case study and focuses on issues and challenges. In particular, this section underlines relevant features of energy characterization. This section is also relevant to a separate report *A2 - Barriers, challenges and needs of Urban Planning for Solar Energy implementation* (which is part of subtask A).

This section is also strictly linked with the report C1.

2.3 Sections of the case study templates

Stakeholders and researchers involvement

The third section is related to the “Stakeholders and researchers involvement”.

This section describes the involvement and the participation of urban stakeholders and researchers at different phases of the planning process. The effects and impacts of their interventions (i.e. private and public initiatives) are explained in detail and framed in the entire planning process. The section underlines how and when the different stakeholders have been involved during the planning process and which positive and/or negative consequences they have given in the development of the project.

2.3 Sections of the case study templates

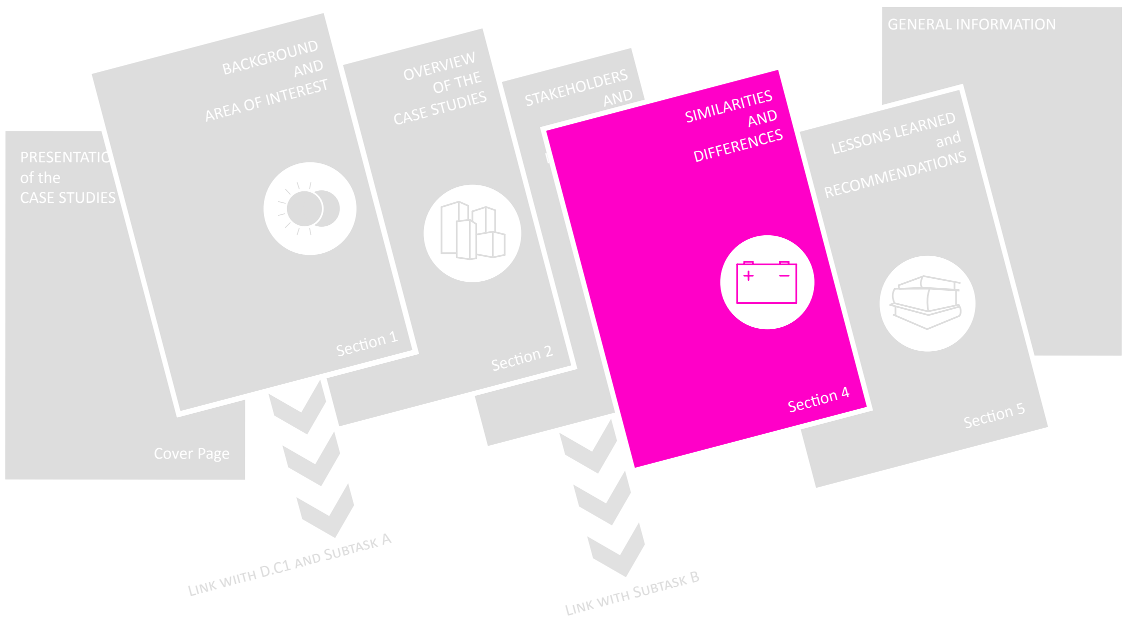
TEMPLATES of CASE STUDIES’ COMPARISONS

Similarities and differences

This section is related to the description of similarities and differences given by the comparison of the analysed case studies.

A description of the most relevant technical and non-technical similar and different aspects have been provided by the experts in order to underline the uniqueness of each case study and the specific relationship among the analysed case studies.

2.3 Sections of the case study templates



TEMPLATES of CASE STUDIES' COMPARISONS

Lessons learned and recommendations

The final section is a summary of the most relevant conclusions, lessons learned, recommendations and implications based on the comparison of the case studies.

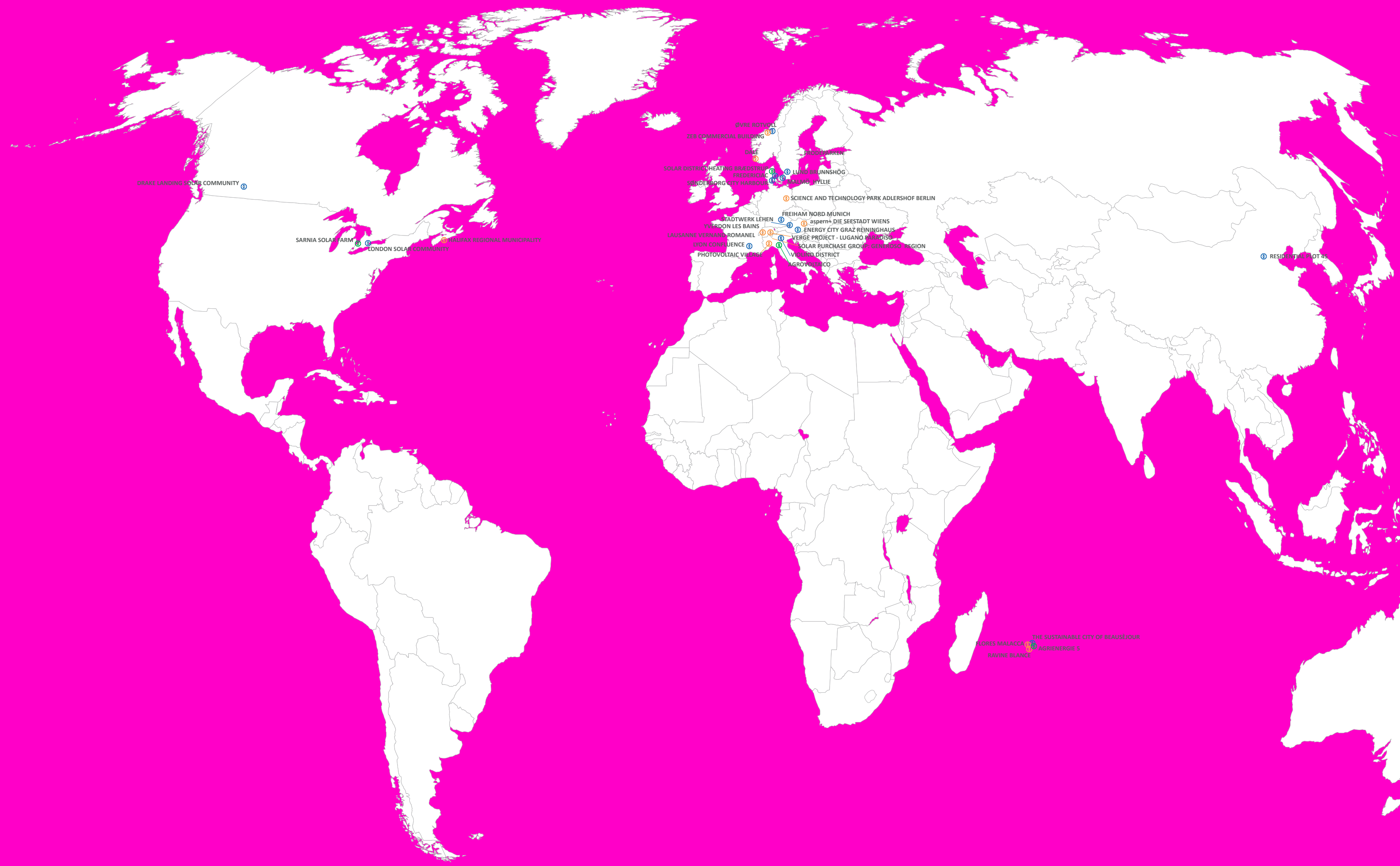
Further work containing lessons learned perspective from all Subtasks of Task 51 will be presented in the report *C3 - Supportive Practice Guidelines for Solar Energy in Urban Planning: Lessons Learned from Case Studies and Case Stories* based on, and referring to, developed processes, methods, tools, strategies and case studies/stories – presented in an “umbrella document” with links to Task results and deliverables.

2.3 Sections of the case study templates

TEMPLATES of CASE STUDIES’ COMPARISONS

3

COLLABORATIVE INTERNAL COUNTRY CASE STUDIES



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

3.1 DENMARK - DENMARK

AUTHORS DANISH CASES

Karin **Kappel**
Solar City Denmark

Simon **Stendorf Sørensen**
PlanEnergi

DENMARK

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

ØRESTAD

DENMARK

Figure 1 - View of Ørestad intervention

In Denmark the municipal urban planners' opportunity to promote solar energy is often limited in practice both by the available relevant legislative framework and by the will of individual developers [1]. These circumstances (among others) constitute a narrow 'space' in which the planner struggles to navigate in different ways to assist and encourage that solar energy is integrated in urban development.

References: [1] Matzen, J. (2015). Solar Energy in Copenhagen Municipality.

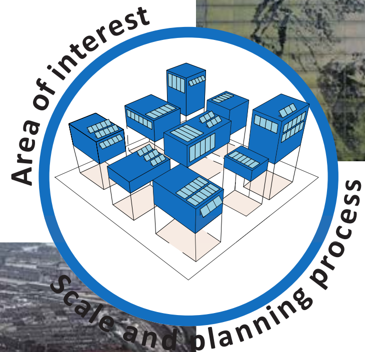


Figure 2 - Top view of the Carlsberg intervention (Source: © Valby)

In recent years, the theoretical notion of 'governance' and 'meta-governance' has increasingly been applied to describe a set of means with the aim to support the planners facilitation of optimal condition for steering [2].

References: [2] Pedersen, A., Sehested, K., & Sørensen, E. (2011, July). Emerging Theoretical Understanding of Pluricentric Coordination in Public Governance. The American Review of Public Administration , pp. 375-394.

CARLSBERG

DENMARK

ØRESTAD, COPENHAGEN, DENMARK

Figure 3 - *Ørestad has four districts that have different layout construction profiles on purpose*

Ørestad is a new urban area in Copenhagen, which, since the 1990s, has been developed primarily from brown fields the development is still ongoing. The municipality itself is directly involved in developing some of the plots in Ørestad as a landowner or as a subsidising body, and several plots have also been developed by private developers. Municipal planners used their mixed role in this development to leverage governance through 'storytelling' [3]. They developed a scheme of guiding principles to ensure an environmental friendly building, which stated that utilising suitable solar energy potentials was obligated in all developments with financial involvement of the municipality.

Municipality planners illustrated a leading role during the development of Ørestad and through engagement with private developers. The municipality used storytelling, constructing interests, images and visions among other stakeholders as argumentation and inspiration to steer private developers towards integration of solar energy. This approach has contributed to a trend in Ørestad where solar energy has been a commonly integrated part of urban planning and development.

Although still in the initial phase of actual building, the integration of solar energy in Carlsberg looks sparser than Ørestad. In 2007, a master plan for the transformation of Carlsberg- an old industrial area in Copenhagen was chosen. The master plan included analysis of optimal ways of integrating solar energy systems in the dense urban area and showed how shadow effects from planned high-rise buildings should be taken into account.

However, recent development plans for plots in the Carlsberg area consider little if any integration of solar energy. Unlike Ørestad the area contains several existing buildings, some of them heritage, which complicates integration of solar energy compared to new buildings. Another difference is that the municipal involvement as plot developer is limited. The plots are developed by private developers.

CARLSBERG, COPENHAGEN, DENMARK

References: [3] Sørensen, E. (2006). Metagovernance The Changing Role of Politicians in Processes of Democratic. The American Review of Public Administration, 98-114.

Figure 4 - *Summer shadow analysis from nine planned high rise buildings in the Carlsberg area. Originally intended as a basis for the integration of solar energy systems (Source: © Esbensen Consult A/S).*

Stakeholders involvement

ØRESTAD, COPENHAGEN, DENMARK

From a planner's perspective it could be seen as if the fate of solar energy lies in the hands of regulators and developers [1]. However, facilitating optimal conditions and necessary knowledge for developers can be an important task of the urban planner, as it can contribute to expose unknown potential to developers or initiate them in the task of integrating solar energy.

Figure 5 - Office building (a), Hotel (b) and school (c) - examples of buildings in Ørestad with photovoltaic

The cases of Ørestad and Carlsberg can be seen as two similar examples of governance processes with a local public authority seeking to promote the integration of solar energy in urban planning but with an apparent difference in regards to the actual outcome of installed solar energy.

CARLSBERG, COPENHAGEN, DENMARK

Figure 6 - Vision of solar architecture in Carlsberg with photovoltaic roofs (a) and residential towers with thin film facades (b).

References: [1] Matzen, J. (2015). Solar Energy in Copenhagen Municipality.

Similarities and Differences

SIMILARITIES

- Ørestad and Carlsberg are large areas set for development with visions to become state of the art neighbourhoods in Copenhagen.
- In both areas, this includes construction of new buildings hosting a variety of functionalities including residential, office and shops.

Figure 7 - Top view of the Ørestad intervention

DIFFERENCES

- Both cases are quite different. Ørestad is an area with new buildings, while Carlsberg is a mix of new and existing buildings.
- In Ørestad, the Municipality of Copenhagen was financially involved as owner or subsidizing body and this was not the case for Carlsberg.
- In Ørestad, the municipality's approach of having financial investment in the development provided them with the opportunity to set up certain obligations for private developers to install solar energy.
- Carlsberg did not have the same leverage over private developer, the municipality was not financially invested in the development.

Figure 8 - View of the Carlsberg station

Lessons learned and recommendations

LESSONS LEARNED

- Public authority who have ambitions to promote and increase implementation of solar energy in development of a large neighbourhood area can do so through strategic financial involvement.
- Ørestad illustrated that there were increased possibilities to assist and encourage the integration of solar energy in urban development which were not available in Carlsberg. Instead, Carlsberg illustrated that without the financial involvement of a municipality, ambitions for solar energy in urban development are more likely to be abandoned.

ØRESTAD, COPENHAGEN, DENMARK

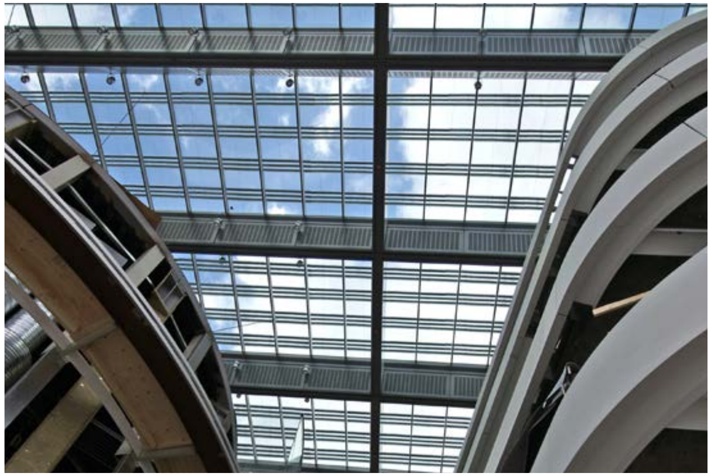
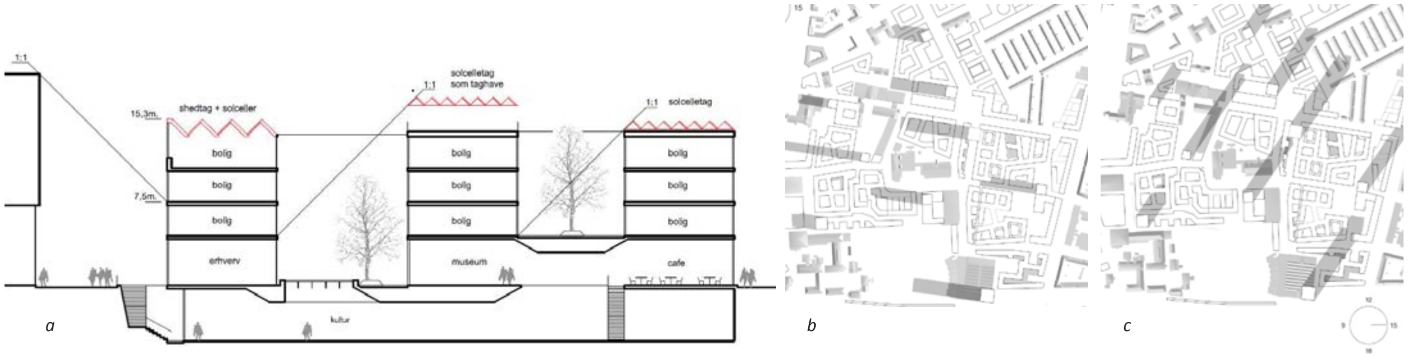


Figure 9 - Danish Televison in Ørestad with photovoltaic on the roof

SOLUTIONS, RECOMMENDATIONS AND SUGGESTIONS

- Development of more ways to inspire developers toward integration of solar energy.
- Consideration of how public funds or ownership of public space can influence developments to include the integration of solar energy.
- Provide municipalities the opportunity to set more ambitious energy requirements than the prescribed regulations.

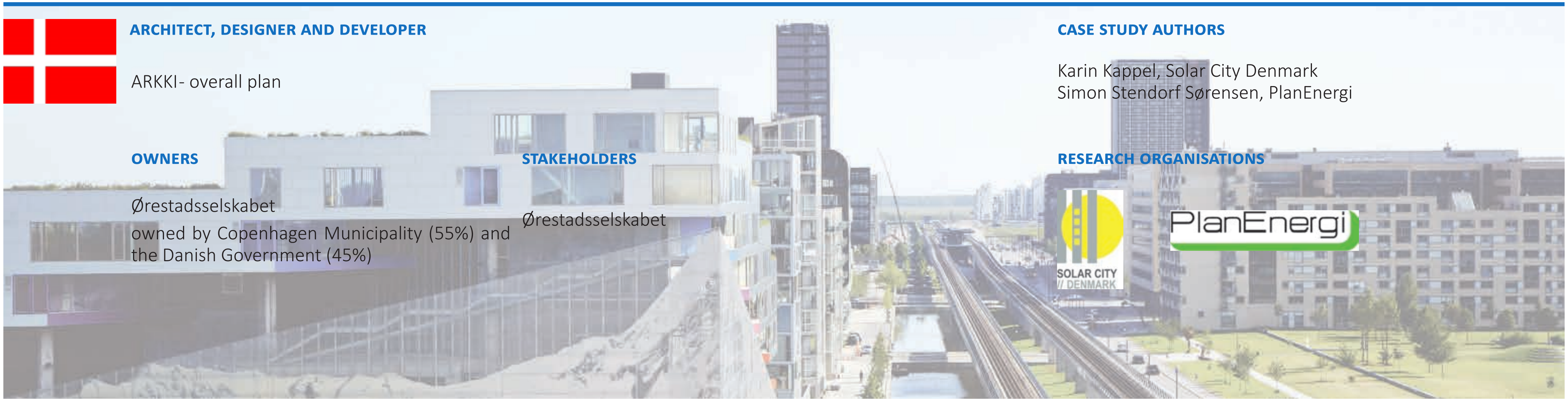
Figure 10 - View of intervention in Carlsberg



CARLSBERG, COPENHAGEN, DENMARK

Figure 11 - (a) Cross section from original masterplan of Carlsberg area with solar panels illustrated (red color) on roof tops (Source: © Entasis) and: Solar diagrams (mid June (b) and mid September (c)) of Carlsberg area with planned new high rise buildings (Source: © Entasis)

Credits



ARCHITECT, DESIGNER AND DEVELOPER

ARKKI- overall plan

OWNERS

Ørestadsselskabet

owned by Copenhagen Municipality (55%) and the Danish Government (45%)

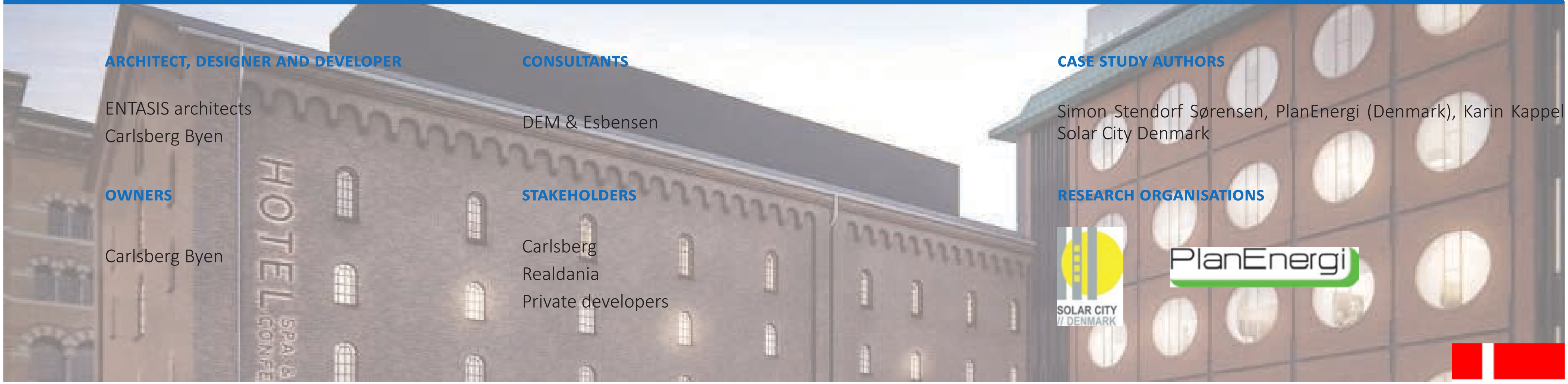
STAKEHOLDERS

Ørestadsselskabet

CASE STUDY AUTHORS

Karin Kappel, Solar City Denmark
Simon Stendorf Sørensen, PlanEnergi

RESEARCH ORGANISATIONS



ARCHITECT, DESIGNER AND DEVELOPER

ENTASIS architects
Carlsberg Byen

OWNERS

Carlsberg Byen

CONSULTANTS

DEM & Esbensen

STAKEHOLDERS

Carlsberg
Realdania
Private developers

CASE STUDY AUTHORS

Simon Stendorf Sørensen, PlanEnergi (Denmark), Karin Kappel Solar City Denmark

RESEARCH ORGANISATIONS

3.2 ITALY - ITALY

AUTHORS ITALIAN CASES

Rossana **Paparella**
Department of Civil, Environmental and Architectural engineering - Padua University

Simone **Giostra**
Politecnico di Milano - Milan (Italy)

03 PHOTOVOLTAIC VILLAGE IN ALESSANDRIA
Existing urban area

04 VIOLINO DISTRICT IN BRESCIA
New urban area

ITALY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

PHOTOVOLTAIC VILLAGE IN ALESSANDRIA

ITALY

Alessandria's photovoltaic village has been redeveloped thanks to a decision of the municipality of Alessandria to propose a new local urban plan in order to realize a public residential urban intervention. It is designed in order to improve sustainability and energy savings, according to the Environmental, Building and Urban Requalification Programme at the Regional level.

Figure 1 - View of the Photovoltaic Village in Alessandria (Photo: © PierFranco Robotti)

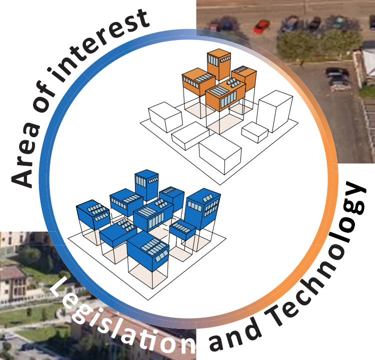


Figure 2 - View of the Violino district in Brescia, Italy. (Photo: © BAMSphoto - Basilio))

Violino District in Brescia has been developed thanks to the decision of the Brescia Municipal Council to develop a new urban local plan for social housing and to organise a competition for realizing a public residential area characterised by energy savings criteria.

In both cases the role of the municipalities has been crucial. Complex operations have been realized through innovative procedures.

VIOLINO DISTRICT IN BRESCIA

ITALY

Figure 3 - Aerial view of the eastern area of the Photovoltaic Village. (Source: © Municipality of Alessandria)

The photovoltaic village in Alessandria represents the final result of a complex course of action that started in 1998 and has led to the realization of a special and highly significant intervention for the city of Alessandria [1]. The total area is around 72 000 m^2. The residential surface area is around 47 000 m^2, while the number of flats are 304 of which 192 subjected to Environmental Requalification, realized with the application of photovoltaic. The intervention finalized in 2005 included the realization of a social center of around 400 m^2 and more than 260 new garages.

The intervention has been developed for plots and altogether 4 cooperatives societies have been developed: 54 flats by 3 private companies operating in convenanted private building; 32 flats by a real estate company that has produced 72 car parks and the A.T.C. (Territorial Agency for the House) public sector with the participation of 96 lodgings.

The Residential Building Operators Council, specifically constituted for this task, had the role of coordination agency. The objective of urban renewal of the district was achieved via the participation of all the actors in the programming and development of the project and rules. The program, in its general intervention description, sets itself the objective of recovering, via reintegration:

- with the surrounding urbanized fabric, a "continuum", to thereby facilitate the recovery of a precise urban identity,
- with a harmonic integration of residency,
- with equipped public green areas,
- and with services and traffic routes.

The complexity of the integrated program was due to the various public and private operators who interacted with each other, and the consequent problems in relation to development. This complexity was dealt via the coordination of the Residential Building Operators Council in the Province of Alessandria, in which all the operators are associate members, through a convention stipulated between the Municipal Town Council and the operators.

References: [1] Comune di Alessandria. Alessandria's Photovoltaic Village. Edited by Comune di Alessandria in collaboration with Consulta per l'Edilizia Residenziale e le Infrastrutture della Provincia di Alessandria, pp 1-48;

Violino District, was presented in spatial planning laid in the General Urban Development Plan of the city of Brescia drafted in 1980. It was finalized in 2002, after the City of Brescia published the public tender competition for the allotment and implementation of building lots for an extension to the south-west. The competition was very innovative: it took concrete form due to the request for compliance of the proposals submitted to requirements that can guide the construction of the district towards measurable quality objectives [2]. The guiding principle was the will to "measure" the quality and the sustainability of the project, but also to compare the costs of such requirements, with those corresponding to standard requirements of economic and council housing. This makes it possible to separate the standard costs from those related to the introduced quality innovations. The project's total area is around 48 500 m^2 and the surface area occupied by residences of around 15000 m^2. The intervention is the construction of 112 terraced housing units and two five-level multifamily houses, (for a total of 143 flats), organised in lots defined by an orthogonal mesh. New buildings take a starting point from the Plan Zone approved by the City Council of Brescia on 28/09/1998 in modification of the 1980 General Urban Development Plan. The theoretical premise, however, is represented by the plan for the economic and council housing that assumes a "house-garden", promoted by the majority of families.

The wide green areas are designed as connecting elements with other built areas; public gardens and squares are thought as elements of neighbourhoods' relationships and qualification. The newly planned square is on the edge of the settlement in direct contact with the existing public garden and recovered, with new paths, to a larger system of green areas, internal and external to the newly constructed area. The building project is part of a sustainable building intervention logic, together with the application of photovoltaic.

References: [2] Palumbo, M, Scognamiglio, A. (2010). Forms of Energy #5- Quartiere Violino, Brescia, Domusweb;

Figure 4 - Aereal view of the context area around the Violino district (Source: © BAMSphoto - Basilio)

Overview of the Cases

PHOTOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 5 - High visibility of the PV panels installed on façade of the row houses of the district (Source: © Google).

The integrated program, includes facilitated and financed public residential buildings, primary urbanization works (equipped green areas, routes etc.) and secondary works (social center). It ensures, as required by Regional Law no.18/96 [1], equipment and standards in compliance with article 21 of L.R. no. 56/77 .

The urbanization works were partly realized with the financial contribution of the operators, and partly with the support of the Municipal Town Council, by means of a detraction of urbanization costs relative to the residential interventions. The national and international success of the Photovoltaic Village lies not in the volumes realized but in the method and in the process experimentation.

Finally, the Photovoltaic Village is included in a project of monitoring planned together with the Municipality of Alessandria and funded by Piemonte Region to support the added experimental expenses.

References: [1] L. R. 9 aprile 1996, n. 18. Programmi integrati di riqualificazione urbanistica, edilizia ed ambientale in attuazione dell'articolo 16 della legge 17 febbraio 1992, n. 179. (B.U. Regione Piemonte 17 aprile 1996, n. 16);

The system of water supply provides both safe drinking water for normal domestic use and non-drinking water for the irrigation of public/private gardens and for toilets of the terraced houses. Another important element that characterises the new quarters is the absence of the gas network for domestic use. For the preparation of food, the use of electrical induction hobs are provided .

The Municipality of Brescia and ASM Brescia S.p.A. (Italian multi-utility, specializing in power generation, gas, electricity and water distribution and district heating) have also organised a monitoring of photovoltaic systems installed [3]. The purpose of the monitoring aimed at: checking the proper functioning of the systems; detecting the amount of energy produced; assessing the share of the produced energy fed into the grid and what is absorbed directly by the user, i.e. the use of the metering service (AEEG -The Italian Regulatory Authority for Electricity Gas- Resolution 28/06).

References: [3] ASM S.p.a. (2007). Attività di monitoraggio: Report 1- PDZ A/19 VIOLINO

The cross-cutting issue considered are: legislation and technology; targets and goals; planning process; stakeholders.

The comparison between the two cases is performed by taking into account the following areas:

- the objective of the intervention;
- the used procedure;
- the role of the municipality and of the operators involved;
- the achievement of an economic-council housing intervention;
- the use of green as an element of qualification and connection with neighboring areas;
- the sustainability of the intervention in all its complexity, not only limited to the application of photovoltaics;
- Quality of design solutions related to the integration of photovoltaics in buildings and outdoor areas;
- the monitoring of interventions.

VIOLINO DISTRICT, BRESCIA, ITALY

Figure 6 - System geometry of PV implementation. (Photo: © Fabio Cattabiani)

Stakeholders involvement

PHOTOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 7 - The iron pylon with the photovoltaic unit. (Source: © Municipality of Alessandria).

Figure 8- System modular pattern [3] The PV panels installed on façade of the row houses of the district (Source: © PierFranco Robotti).

In both of the cases municipality plays a key role because it has defined or activated:

- clear procedures;
- roles for each operator;
- scheduled intervention programs;
- affiliated procedures.

In the case of Alessandria the key role of municipality has been structured in order to give the organisation to a single institutional coordination body.
In the case of Brescia the key role of municipality has been addressed by the energy strategies choices.

Figure 9 - Aereal view of the BiPV system on the roof of the 112 terraced houses (Source: © BAMSphoto - Basilio)

SIMILARITIES

- Complex operations, based on the principle of achieving sustainable interventions, with the use of the photovoltaic;
- The used procedure is innovative in both cases because it implements the planning of urban development models through affiliated procedures;
- The role of the municipalities both of Alessandria and Brescia is that of mentoring, steering and coordination among the institutional authorities or other bodies involved;
- The role of the operators involved is defined from the beginning in the setup procedure for achieving the objective;
- The interventions have also affected the supply of economic-council housing;
- The interventions were conducted with the criterion to make amend the urban fabric between the interest areas and the surrounding ones;
- The interventions were conducted with the criterion to make a mend the urban fabric between the interest areas and the surrounding ones;
- The use of the green as a mending and connecting element between the interest areas and the surrounding ones;
- The case studies have become emblematic and subject of the monitoring campaign.

PHOTOVOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 10 - Internal view of the park in the courtyard of the district. (Photo: © PierFranco Robotti)

VIOLINO DISTRICT, BRESCIA, ITALY

Figure 11 - System modular pattern (Photo: © Fabio Cattabiani)

DIFFERENCES

- In Alessandria, an existing district is upgraded, while in the case of Brescia it is a realization of a new neighbourhood;
- The innovative procedure was implemented in the case of Alessandria, with the identification of a subject, i.e. the Board of Housing Operators of the Province of Alessandria had the task of coordinating all those involved. In Brescia the solution was innovative because in the tender it was required an unique proposed technological solutions of measurable quality without any coordination needed;
- Significant differences are observed from the point of view of quantity with regard to the area occupied by the residences and the number of lodgings;
- The aim of upgrading the existing village in the case of Alessandria has been pursued through the application of photovoltaics on part of the existing buildings while for the Violino District in Brescia the same has been pursued with the use of photovoltaics in new settlement;
- There are different levels of integration; the application of photovoltaics in the case of Alessandria photovoltaic Village was carried out without special attention to the aspects of integration, while more attention has been paid in the case of Violino District in Brescia;
- Quantitative differences are observed with respect to the offer of economic-council housing units in the case of Alessandria photovoltaic village as they relate to the majority of the lodgings while in the case of Violino District in Brescia they are limited to a small part;
- The monitoring campaign in the case of Alessandria has the purpose to replicate the intervention approach while in the case of Brescia it has the purpose of consumption detection and evaluation effectiveness in terms of energy savings.

Lessons learned and recommendations

LESSONS LEARNED

- Both case studies show that the intervention of the City as mentor, coordinator and mediator is critical to the success of the interventions themselves. In fact, the complexity of the realized interventions, would not allow substantial results if not handled by a single leadership.
- The Photovoltaic Village in Alessandria clearly shows the limits of retrofitting an existing building with a photovoltaic system; in absent of an opportunity for deep renovation, including recladding and/or replacing the roof, the designer is confronted with a limited range of design options, severely compromised by the existing building enclosure's geometry and materials;.
- The Violino District in Brescia, on the other hand, makes good use of the opportunities for integration –in terms of both geometry and materials –afforded by a new development; some minor incongruences are still present in the general design strategy, i.e. photovoltaic panels installed at a less than optimal inclination and/or orientation for the majority of buildings.
- The Photovoltaic Village in Alessandria offered great opportunities in terms of available public spaces; however, the designers only made minimal use of outdoor areas for photovoltaic installations; when they did, photovoltaic panels are sparsely installed and the overall effect is rather whimsical.
- The Violino District in Brescia presents a certain monotony in the relentless repetition of two basic building typologies – possibly the result of rigid planning prescription and building codes rather than lack of imagination on the designers' part; perhaps as a counterpoint to that uniformity, two buildings break from the scheme and gain some prominence by an iconic – if slightly inefficient –use of solar collectors.

Figure 12 - Pedestrian public area covered by PV. (Source: © Municipality of Alessandria)

Figure 13 - Southern façade of the terraced houses. (Photo: © Alberto Mucciaccia)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- The criterion of sustainability applied in the broadest possible sense, allows for the upgrading and mending of the urban fabric at the highest level;
- The method used for the construction of the Alessandria photovoltaic village should become a good example because it can carry, through the instrument of the Board of Operators, a coordination among bodies operating in the same area and in the same program;
- The methodology, based on bioclimatic architecture principles for the technological choices and the study of color performed in the Violino District in Brescia should become an handbook for designers.

Credits

ARCHITECT, DESIGNER AND DEVELOPER

A4- Architettura Integrata

OWNERS

A.t.c. Alessandria

CONSULTANTS

Dott. Luigi Tosi, Arch. F. Cuttica, Arch. E. Cima, Arch. E. Pelizzone, Arch. P. Robotti

STAKEHOLDERS

Consulta Operatori Edilizia Residenziale Alessandria
Prof. Roberto Pagani (Politecnico di Torino) (scientific coordinator)

CASE STUDY AUTHORS

Rossana Paparella (University of Padova)
Simone Giostra (Politecnico di Milano)

RESEARCH ORGANISATIONS

Università degli Studi di Padova

ACKNOWLEDGEMENTS

The authors wish to thank the Arch. P. Robotti for the data provided.

DEVELOPERS

Boschi+Serboli Architetti Associati, Studio Associato Cigognetti Piccardi Vitale, Arch. F. Bardelli

OWNERS

Brescia Building Council

CONSULTANTS

Arch. G. Allen and J. Tomquist

STAKEHOLDERS

La Famiglia Monteclarense Seconda soc. cop. a r.l.
La Famiglia rurale di Cadigliano Soc. Cop. a r.l.
La Famiglia Violino Due soc. cop. a r.l.

CASE STUDY AUTHORS

Rossana Paparella (University of Padova).
Simone Giostra (Politecnico di Milano)

RESEARCH ORGANISATIONS

Università degli Studi di Padova

3.3 ITALY - ITALY

AUTHORS ITALIAN CASES

Rossana **Paparella**
Department of Civil, Environmental and Architectural engineering - Padua University

Silvia **Croce**
Department of Civil, Environmental and Architectural engineering - Padua University
Institute for Renewable Energy - EURAC Research, Bolzano, Italy

Daniele **Vettorato**
Senior Researcher
Institute for Renewable Energy, EURAC Research - ITALY

04 **PHOTOVOLTAIC VILLAGE IN ALESSANDRIA**
Existing urban area

05 **SINFONIA, BOLZANO**
Existing urban area

ITALY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

PHOTOVOLTAIC VILLAGE IN ALESSANDRIA

ITALY

Figure 1 - View of the Photovoltaic Village in Alessandria. (Photo: © PierFranco Robotti)

In the Italian case studies of Photovoltaic Village in Alessandria and SINFONIA in Bolzano, interventions of urban regeneration and improvement of energy efficiency have been conducted on existing social housing neighbourhoods.

The Photovoltaic Village in Alessandria is a comprehensive project with the objective of transforming a low-income suburb into an environment-friendly and socially integrated urban area.

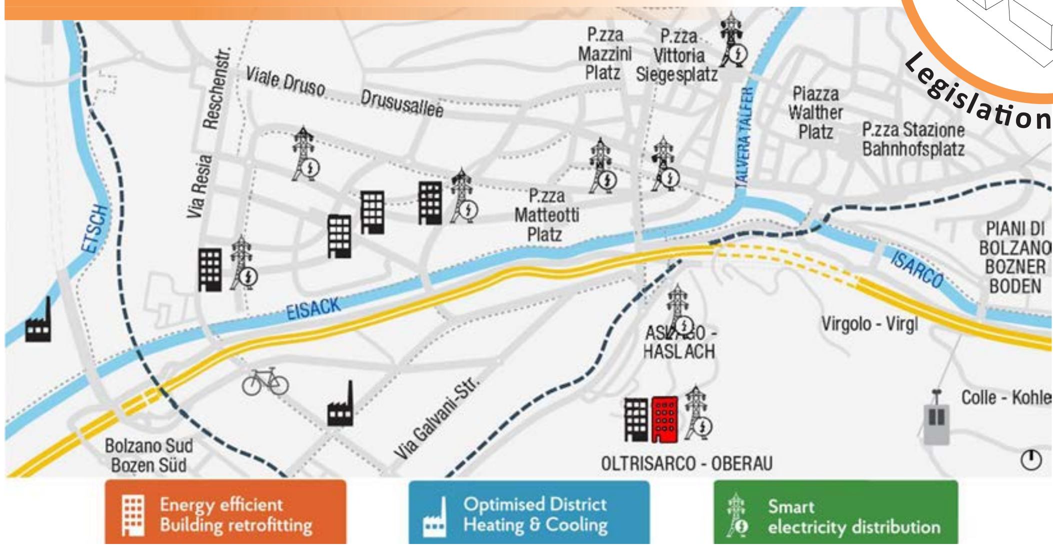


Figure 2 - Map of Bolzano with indication of the different interventions carried out in the context of SINFONIA project. Highlighted in red the complex of Passeggiata dei Castagni. (Source: © SINFONIA)

Within the framework of the European project SINFONIA, building refurbishment interventions to achieve high energy performance and to improve interior comfort have been undertaken for six residential complexes located in the South district of Bolzano. Among those, the apartment complex of Passeggiata dei Castagni.

SINFONIA, BOLZANO

ITALY

Overview of the cases

Figure 3 - Aerial view of the eastern area of the Photovoltaic Village. (Source: © Municipality of Alessandria)

The Photovoltaic Village in Alessandria is the result of a complex urban process aimed at the requalification of an existing urban area in accordance with a sustainable approach. The intervention included the application of photovoltaic systems on existing buildings, the densification of the neighbourhood with the construction of five new residential buildings, and the realization of a public area with sport and recreational facilities and a community centre.

The main driver that led to the realization of the project was the introduction, with a regional law in 1996, of the Integrated Intervention Programme of Environmental, Building and Urban Requalification [1]. The aim of the Programmes was promoting a rational use and reorganisation of the territory, of existing urban areas and of their expansions, as well as energy savings. Within this legislative framework, the Municipality of Alessandria approved the Integrated Programme – Zone 14 [2], a local urban requalification plan finalized to a public residential intervention with the principles of sustainability and energy savings. The programme, integrating energy efficiency with actions at social level, was the first Italian case of Public Residential Building Intervention, where solar energy was applied at urban scale. BAPV, BIPV and "urban integrated" PV systems have been introduced in the project with the objective of supplying 100% of the electricity consumption of the common areas and 70% of the electricity consumption of the apartments. On the buildings, the solar systems have been applied on the roof and on the façades. As the PV technology was introduced at a later stage of the project, it was not possible to merge the construction process with the design of the PV systems, therefore the PV are not fully architecturally integrated. Furthermore, PV panels have been installed on the street furniture of public and green areas.

After the completion of the project, the PV energy production and the energy consumption of the buildings have been monitored for one year [3].

References: [1] Piemonte Region. (1996). Regional Law of 9 April 1996, no. 18. [2] Municipality of Alessandria. (1996). General Local Strategic Plan – Technical Implementation Rules. [3] Municipality of Alessandria. (2006). Alessandria´s Photovoltaic Village, pp 1-48.

The actions undertaken in Bolzano within the SINFONIA project [4] focus on three principal areas:

- Building refurbishment: 37 000 m^2 of social housing buildings retrofitted in order to improve energy performance and interior comfort;
- District heating and cooling: optimisation and extension of the heating and cooling grid to reduce CO_2 equivalent and nitrogen oxides emissions;
- Electricity grid: implementation of an Urban Service-Oriented Sensible Grid (USOS-grid) system for improved energy distribution control.

Beyond technological solutions, SINFONIA addresses districts as living spaces, and therefore integrates air quality and smart mobility measures to improve the citizens' quality of life. Launched in June 2014, the project is set to run until May 2019.

In general, the refurbishment of the residential complexes is following a process constituted by three steps: (i) design phase guided by an interdisciplinary team, (ii) construction phase with lived-in apartments, (iii) monitoring phase lasting for 1 year.

The apartment complex in Passeggiata dei Castagni was built during the 90's without any energy saving criteria. Therefore, the building renovation strategy is based on a comprehensive approach and on the implementation of different interventions. The retrofitting of the building envelope aims to increase the indoor comfort, reduce the energy consumption and rehabilitate both the aesthetic and the functionality of the building. The solution adopted by the design team integrates the use of traditional insulation in the lodges with prefabricated multifunctional façades (MFF) on the other surfaces. Furthermore, renewable energy systems are integrated in the project, including geothermal heat pumps and PV and ST systems. The solar systems are installed on the roofs of the buildings as added elements, hence in a not integrated way.

References: [4] Sinfonia. Low Carbon Cities for Better Living. Avilable at: www.sinfonia-smartcities.eu

Figure 4 - Render of the project of Passeggiata dei Castagni. (Source: © Studio Mellano & ARCH+MORE)

PHOTOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 5 - PV panels installed on façade of the row houses of the district. (Source: © Google)

The integrated project of Photovoltaic Village was developed within the framework of the European programme HIP-HIP (House Integrated PV – Hightech In Public) [5], which had, among its main targets, energy efficiency, project quality, and social dissemination. The general objective of HIP-HIP project was to foster market penetration of grid-connected PV systems in Europe by removing non-technical barriers and developing new PV products for the building industry. The project received funding under the European Union´s Fifth Programme for research, technological development and demonstration on "Energy, environment and sustainable development, 1998-2002".

The project was financed by different financial sources, both public and private. Around 70% of the total cost of the photovoltaic plants, 1.2 million euro, was funded by the national programme "10 000 photovoltaic roofs", curated by the Italian Ministry of Environment [6].

References: [5] European Commission. (2000). HIP-HIP (NNE/430/1999). Available at: http://cordis.europa.eu/project/rcn/57633_en.html
[6] Ministry of Environment. (2001). Ministerial Decree 16 March 2001 – "Programma Tetti Fotovoltaici". (O.J. no. 74 of 29/03/2001).

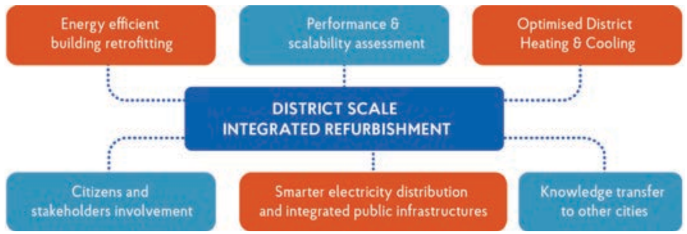
During the design phase of Passeggiata dei Castagni, an Integrated Design Process (IDP) was applied by involving the different stakeholders of the project. With regard to the energy concept, precise targets have been set as constraints, which the final performance of the buildings after the renovation interventions has to comply with. Furthermore, specific analysis has been carried out for optimizing the design of the solar systems and for improving the internal daylight levels of the apartment.

The refurbishment of the residential complexes in Bolzano has been undertaken within the framework of the European project SINFONIA (Smart Initiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy solutions). SINFONIA is a Smart Cities project that aims to demonstrate the deployment of large-scale, integrated and scalable energy solutions in mid-sized European cities in view of fostering the uptake of smart energy efficient solutions Europe-wide and improving citizens' quality of life [4]. The SINFONIA project aims to:

- Achieve 40 to 50% primary energy savings and increase the share of renewables by 20% in pioneer districts in Innsbruck and Bolzano;
- Demonstrate the feasibility of large scale energy measures, combining building retrofitting, electricity grid optimisation, and district heating and cooling systems;
- Define district typologies and refurbishment models to ensure their scalability and transferability to other cities;
- Engage and support other cities in deploying their own smart energy solutions in view of triggering the deployment of smart energy solutions EU-wide.

SINFONIA has received funding from the European Union Seventh Programme for research, technological development and innovation.

References: [4] Sinfonia. Low Carbon Cities for Better Living. Avilable at: www.sinfonia-smartcities.eu



SINFONIA, BOLZANO, ITALY

Figure 6 - Main actions included in the SINFONIA project. (Source: © SINFONIA)

PHOTOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 7 - Public green areas between the buildings and shelters with PV panels. (Source: © Municipality of Alessandria).

Figure 8 - The PV panels installed on façade of the row houses in the district. (Source: © PierFranco Robotti)

Several stakeholders, both public and private, were involved in the project of Photovoltaic Village. Among those the Municipality of Alessandria, the provincial housing agency A.T.C., and different Consortia of private and cooperative builders constituted the Residential Building Operators Council of the Province of Alessandria. The Council had the role of coordinating agency, defining the roles of all the actors and following the development of the Integrated Programme.

The company that realized the photovoltaic systems, A.N.I.T. ("Azienda Nuove Iniziative Tecnologiche"), had also the leading role of the Italian consortia involved in the European project HIP-HIP [5].

Researchers of Politecnico of Torino were involved in the design of PV systems and were responsible for the monitoring activities and the data acquisition and elaboration.

References: [5] European Commission. (2000). HIP-HIP (NNE/430/1999).
Available at: http://cordis.europa.eu/project/rcn/57633_en.html

In the refurbishment project of Passeggiata dei Castagni an Integrated Design Process (IDP), has been applied. It consists in a multidisciplinary collaborative process that analyses and integrates different aspects and knowledge during all phases of a building development. The stakeholders involved in the IDP are the Municipality of Bolzano, the designers of the project, the project partners Eurac and Agenzia CasaClima (i.e. certification body for the energy efficiency of the construction sector in the Province of Bolzano), and the third party TIS innovation park.

The researchers of Eurac, European Academy of Bolzano, are involved in the development of all the phases of the project. They are in charge of guiding the IDP, running solar and daylight analysis. Furthermore, they are involved in designing and testing the MFF and are responsible of the planning and realization of the monitoring phase.

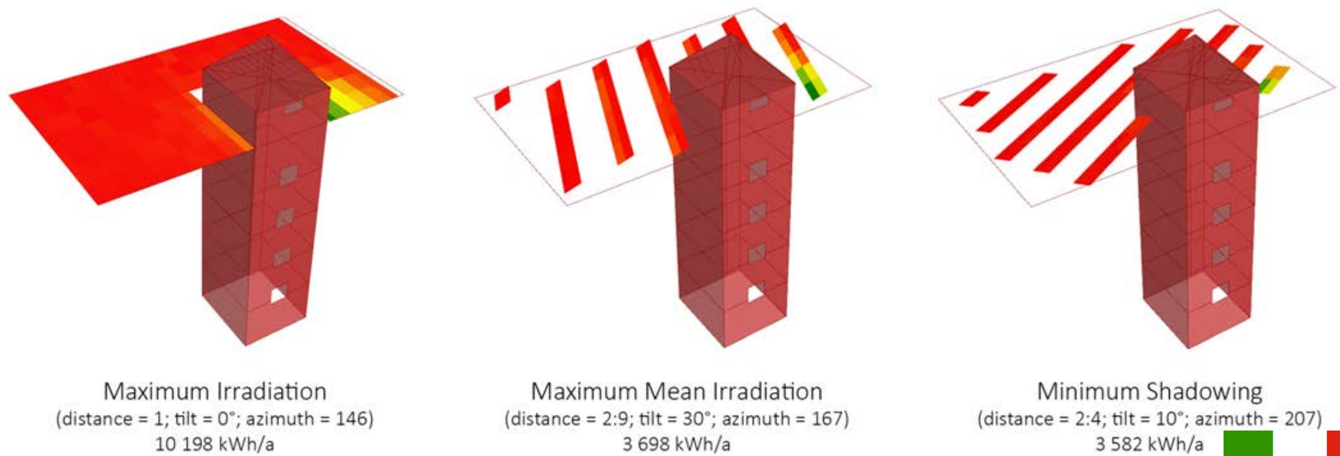


Figure 9 - Results of the solar potential analyses on a portion of the roof: parameters maximizing each configuration and potential energy production. (Source: © Eurac)

SIMILARITIES

- Both case studies are urban requalification interventions focusing on the promotion of energy efficiency and the use of RES in residential areas for social housing, with the main aim of improving sustainability and energy savings. Furthermore, both projects include also further environmental and social measures to improve the quality of life of the citizens.
- The municipality and all the stakeholders, both public and private, have been involved actively in all the phases of the projects. The results obtained prove the importance of a continuous dialogue between public and private stakeholders for the success of the initiatives.
- The two projects have been developed as pilot studies with the aim of proposing replicable solutions for energy efficiency in requalification processes of existing urban areas. Moreover, in both case studies the urban requalification processes happened in the context of European projects, developing international collaborations and receiving funding from the European Union.
- In both the case studies, the PV systems have been installed on existing buildings as overlaid elements and are not fully integrated in the building envelope.
- Researchers were involved and had a key role in both the projects. In Alessandria, researchers of Politecnico of Torino were in charge of the design of the PV systems and, after the completion of the construction, were responsible for the monitoring phase. In SINFONIA project, Eurac researchers guided the IDP and were involved in all the stages of the interventions. Furthermore, they will guide the future monitoring phase.
- Both the case studies took place within the framework of Provincial and Municipal regulations promoting energy efficiency.
- In both cities Bolzano and Alessandria, a monitoring phase of one year has been/will be conducted after the completion of the construction phase.

PHOTOVOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 10 - Internal view of the park in the courtyard of the district. (Photo: © PierFranco Robotti)

SINFONIA, BOLZANO, ITALY

Figure 11 - Render of the project of Passeggiata dei Castagni. (Source: © Studio Mellano & ARCH+MORE)

DIFFERENCES

The construction and monitoring process of Photovoltaic Village in Alessandria ended in 2005, while the SINFONIA project is still ongoing and will be completed in 2019. Therefore, it is possible that the differences between the case studies will continue to evolve together with the different phases of the project in Bolzano.

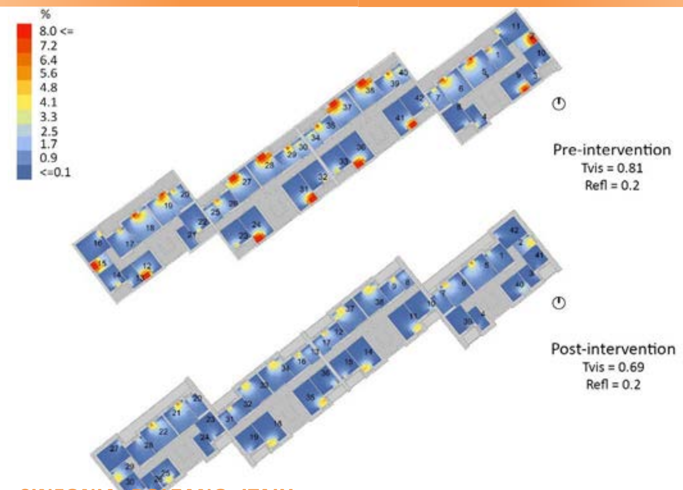
- In SINFONIA, the urban requalification process involves six existing residential complexes. On the other hand, in Alessandria the project included, together with the requalification of existing buildings, the construction of five new apartment buildings together with the realization of an urban area with green and public spaces, sport and recreational facilities, and a community centre.
- The scale of the two case studies is different. In SINFONIA, the residential complexes are located in different parts of the district of Bolzano South. Furthermore, the project includes also the implementation of the district heating and cooling grid and air quality and smart mobility measures at city scale. On the contrary, the intervention in Alessandria were limited to the neighbourhood of Photovoltaic Village and the public areas between the buildings.
- The integration of RES in the projects is different. In Alessandria, PV systems have been used for supplying energy to the common areas and to the apartment buildings. The refurbishment of Passeggiata dei Castagni, in Bolzano, includes the use of both PV and ST systems, together with ground source heat pumps. Furthermore, the solar systems in the SINFONIA project are installed only on the refurbished buildings, while in the Photovoltaic Village are installed not only on the buildings but are also integrated on the street furniture of the public areas.

LESSONS LEARNED

- The collaboration between energy consultants, designers, owners, and researchers is fundamental for the successful development of urban projects focusing on energy efficiency and sustainability.
- The management method of the whole process and the synergy of all the actors involved are essential for the success of pilot projects for urban regeneration.
- Successful urban requalification programmes should include not only interventions at building level, such as energy requalification, but should operate also on the surrounding urban areas by creating public spaces, green areas and community facilities. Furthermore, interventions at social level help attracting the population in the requalified areas and reinforcing their urban role.
- The participation to European programmes represents a favourable opportunity for the successful realization of the projects, offering the possibility of sharing expertise and co-operating with international partners, together with receiving funding for the development of the project.
- Daylight and solar potential analysis play a key role during the design phases of retrofit projects. The former can assist the choice of windows and of the finishing materials of the buildings in order to enhance the level of indoor comfort. The latter can support the integration of solar active systems on the edifices by avoiding overshadowing and enhancing the energy production.

PHOTOLTAIC VILLAGE, ALESSANDRIA, ITALY

Figure 12 - Pedestrian public area covered by PV. (Source: © Municipality of Alessandria)



SINFONIA, BOLZANO, ITALY

Figure 13 - Daylight analysis for the first floor of the building in Passeggiata dei Castagni. (Source: © Eurac Research)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- A comprehensive approach considering the combination of all the different technical and technological aspects of the project is fundamental for the success of urban districts refurbishment initiatives. All the stakeholders should be involved from the early design phases.
- The creation of a coordination council, including participants from both public and private sectors, can be a good method for the development and management of complex projects at urban scale. The council should be responsible of defining the roles of all the actors and following the development of the process.
- With the progress of the technological innovation, the design of solar systems in refurbishment projects should consider their integration on the building envelope, instead of simply overlaying them to the existing structure. Furthermore, the integration of the solar systems in street furniture should become a more diffuse and common practice in both existing and new urban areas.
- The common design process for energy retrofit does usually not consider the buildings occupants' behaviour and their effect on the buildings related energy performance. However, whenever an energy refurbishment of existing buildings is undertaken, the occupants' influences should be examined.

Credits

ARCHITECT, DESIGNER AND DEVELOPER

A4- Architettura Integrata

CONSULTANTS

Dott. Luigi Tosi, Arch. F. Cuttica, Arch. E. Cima, Arch. E. Pelizzone, Arch. P. Robotti

CASE STUDY AUTHORS

Rossana Paparella (University of Padova)
Simone Giostra (Politecnico di Milano)

OWNER

A.t.c. Alessandria

STAKEHOLDERS

Consulta Operatori Edilizia Residenziale Alessandria
Prof. Roberto Pagani (Politecnico di Torino) (scientific coordinator)

RESEARCH ORGANISATIONS

Università degli Studi di Padova

ACKNOWLEDGEMENTS

The authors wish to thank the Arch. P. Robotti for the data provided.

ARCHITECTS, DESIGNERS AND DEVELOPERS

Studio Mellano Associati, Arch+More, Arch. Alberto Sasso, Studio Benedikter, EQ Ingegneria, Studio Tecnico Vettori, Ing. Giuseppe Glionna

STAKEHOLDERS

Municipality of Bolzano, IPES, alperia, SEAB, Agenzia per l'Energia Alto Adige - Casaclima, Eurac Research, ACC, TISS

CASE STUDY AUTHORS

Silvia Croce, Daniele Vettorato, Alyona Zubaryeva, Marco Castagna (Eurac Research)

OWNERS

Municipality of Bolzano

ACKNOWLEDGEMENTS

The authors wish to thank Municipality of Bolzano, Studio Mellano Associati, Arch+More, Arch. Alberto Sasso, Studio Benedikter, EQ Ingegneria, Studio Tecnico Vettori, Ing. Giuseppe Glionna for the information on the project and for the images.

RESEARCH ORGANISATIONS

eurac research

RESEARCH FRAMEWORK

SINFONIA has received funding from the European Union´s Seventh Programme for research, technological development and innovation under grant agreement No 609019.

3.4 NORWAY - NORWAY

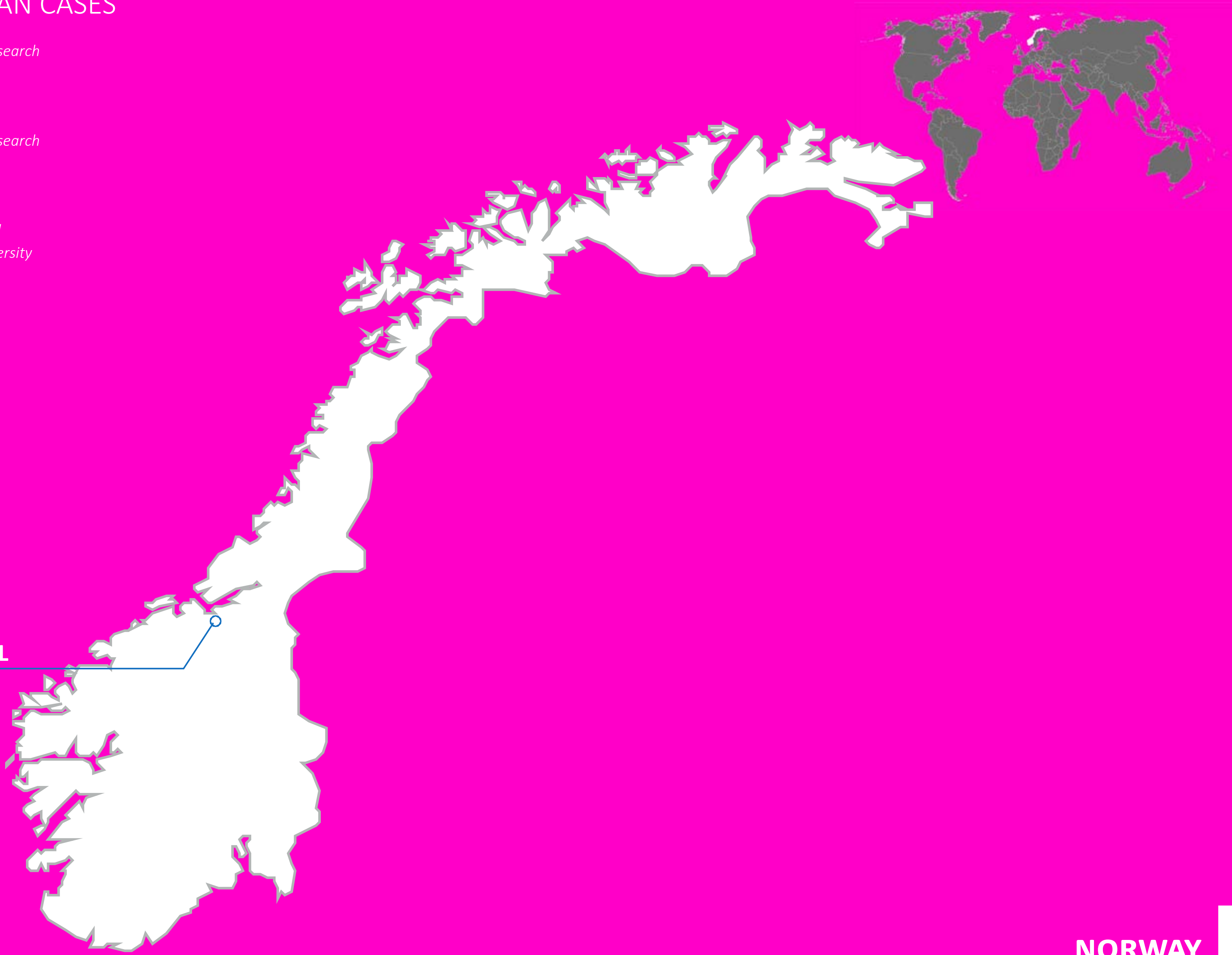
AUTHORS NORWEGIAN CASES

Tanja **Siems**
Institute for urban design and urban research
University of Wuppertal

Katharina **Simon**
Institute for urban design and urban research
University of Wuppertal

Silvia **Croce**
Department of Civil, Environmental and
Architectural engineering - Padua University

Institute for Renewable Energy, EURAC
Research - Italy



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

ØVRE ROTVOL (NTNU/UniPD)

NORWAY

Two approaches adopted in education programs in urban planning with the focus on the optimisation of solar energy potential are presented and compared in this analysis. The studies are based on a new urban development area located in the East part of the city of Trondheim (Norway), Øvre Rotvoll.

Figure 1 - Source: (© Silvia Croce)

Figure 2 - Source: © University of Wuppertal (BUW)

The district aspires to become a new strategic development area according to the energy targets of the net-zero energy neighbourhoods, as well as an important connection between the different parts of the city.

ØVRE ROTVOLL (BUW)

NORWAY

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

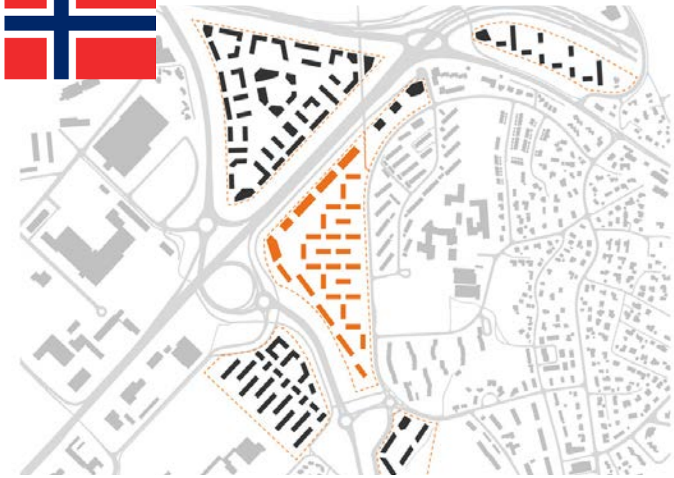


Figure 3 - Masterplan for Øvre Rotvoll. The buildings colored in orange correspond to subarea B1. (Author: © Silvia Croce)

The first example has been developed from a master thesis at the NTNU and UNIPD entitled "Solar potential optimisation in urban planning in extreme cold climate conditions. Design guidelines for solar accessibility and solar design for developing the masterplan of Øvre Rotvoll neighbourhood in Trondheim (Norway)". The methodology adopted for the design of a sustainable masterplan for Øvre Rotvoll will be described in the following chapter.

The thesis explored the potential of implementing the renewable energy production with solar systems from the early design phases. The work was divided into two sections: the first section focused on the development of the solar urban planning recommendations; the second implied the development of the masterplan of Øvre Rotvoll neighbourhood by applying the solar urban planning recommendations previously defined. The study was based by coupling parametric modelling software, such as Rhinoceros [1] and Grasshopper [2] with solar dynamic simulation tools, as DIVA-for-Rhino [3].

In the first part of the study, the simulations and the parametric analyses have been conducted on two typical building typologies in Trondheim in order to:

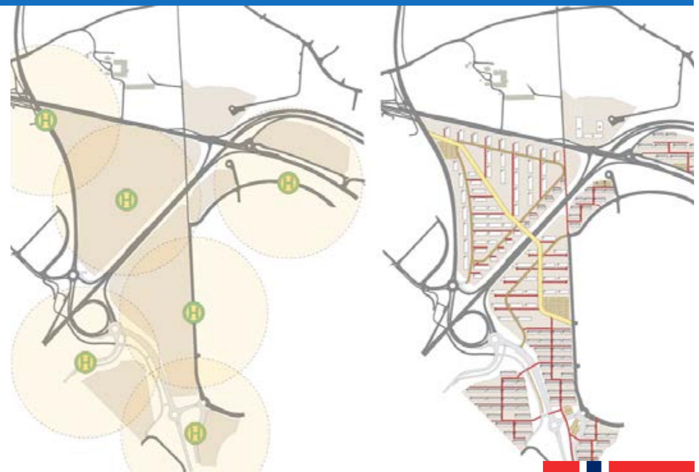
- Optimize the building orientation, both in an isolated scenario and in a district scenario, in order to maximize the global solar radiation that arrives on the building envelope;
- Optimize the distances between buildings in order to maximize solar accessibility;
- Evaluate the solar potential of the buildings, considering the influence of mutual solar reflections from the nearby buildings and from the ground. Different scenarios characterised by various exterior painting colours and finishing materials have been simulated.

References: [1] McNeel Robert and Associates, "Rhino Version 5.0." 2015. [2] S. Davidson, "Grasshopper: Algorithmic Modelling for Rhino." 2014. [3] J. A. Jakubiec and C. F. Reinhart, "DIVA 2.0: Integrating daylight and thermal simulations using rhinoceros 3D, DAYSIM and EnergyPlus," Proc. Build. Simul. 2011

DERIVATION OF THE CRITERIA FOR THE GENERAL DESIGN PROCESS

In general, the aim of the urban design process is to generate a masterplan. This masterplan is developed in three phases. The first phase is the basic phase. Within this phase the task is to secure the defined aims and planning documents. In most cases these are summarised within a competition brief beforehand. Within the second phase, called the preplanning phase, the designer is asked to develop an own understanding of the design brief. The urban situation is primary investigated through analysis that will be afterwards evaluated. Maps demonstrating strength and weaknesses of the area will be produced in the next step. Only in the third phase of the design process, the actual design phase, the work is about to generate a guiding strategy and to translate this step by step into design material.

In general, several decisions have to be made. The following criteria support such a process. The component "space structure" defines the distribution of space within the site. The planner describes where buildings have to be placed, where open areas or public spaces can emerge and how the access of the area will work. The relation of built and public areas must be outlined as well as the selection of possible settlement typologies must be defined.



ØVRE ROTVOLL, NORWAY (BUW)

Figure 4 - Distances to bus stops and bus route, foot and bikepaths. (Source: © BUW Siems/Simon with Master students, 2014/15)

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

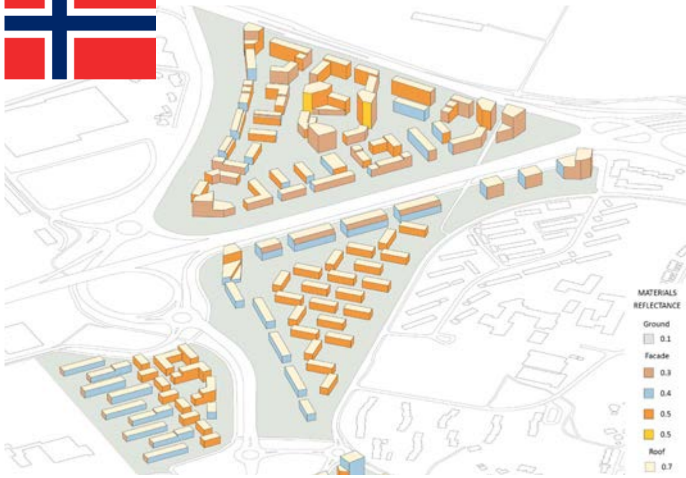


Figure 5 - 3D view of the masterplan. The different colors correspond to different values of reflectance for the surfaces materials. (Author: © Silvia Croce)

THE DEVELOPMENT OF THE ØVRE ROTVOLL

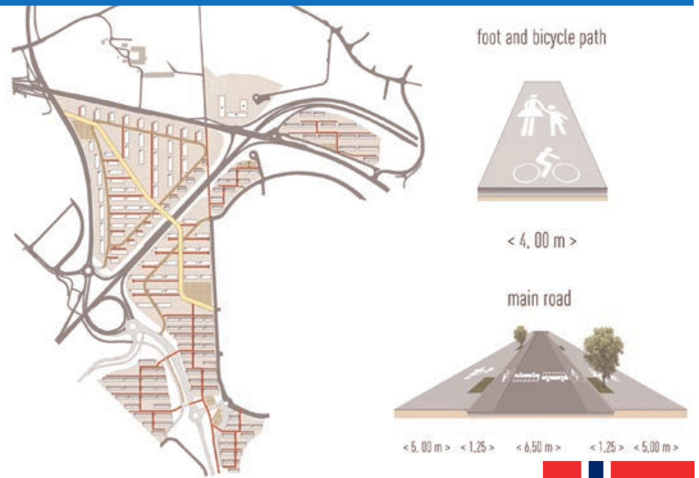
The methodology adopted for the optimisation process was developed in order to maximize the solar potential of each area of the masterplan for Øvre Rotvoll. Firstly, the solar potential of the building's envelope was calculated in the initial configuration without any reflectance contribution (i.e. only direct solar radiation was considered). The results were compared to the values obtained for the same building in an isolated scenario, by individuating the most shaded facades due to the presence of the surrounding buildings. In order to avoid this effect, the exposure of the facades was modified to exploit as much as possible the contribution given by the mutual solar reflections from the urban surrounding. In order to increase the indirect solar radiation reflected by the neighbouring buildings, the choice of the solar reflectance of the facades' materials had a key role.

The masterplan for Øvre Rotvoll represents the first attempt to develop and apply the urban planning recommendations during the early design phase of the urban design process in Trondheim. In order to assess the validity of the recommendations, the solar potential of a selected number of buildings (Figure 5) in the masterplan has firstly been compared with the values calculated in the urban planning recommendations. Secondly, an estimation of the energy production was calculated in order to verify the outcomes derived from the optimisation process of the district.

Structural urban design decision in relation to solar energy and sustainability

As already described the designer makes various decisions during the design process. In most cases these decisions are based on specific criteria and parameter in relation to a specific aim to be reached, such as how to implement solar energy into the urban design process in certain circumstances.

Specific solar criteria do not necessarily harmonise with other relevant criteria of the urban design approach but should nevertheless be addressed in relation to a sustainable urban design. This is because planning cannot be based merely on a singular criterion. Therefore, multi-criteria approach such as social, economic and environmental aspects have equally to be taken into account.



ØVRE ROTVOLL, NORWAY (BUW)

Figure 6 - Distances to bus stops and bus route, foot and bikepaths. (Source: © BUW Siems/Simon with Master students, 14/15)

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

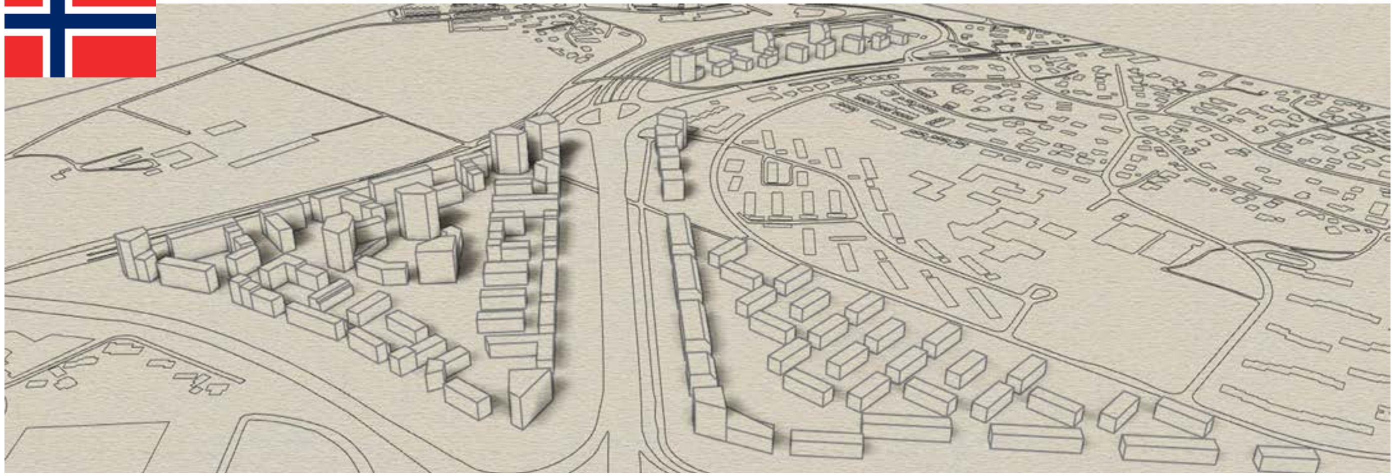


Figure 7 - 3D view of the final masterplan of the entire area of Øvre Rotvoll (Author: © Silvia Croce)

The estimation of the energy production was conducted in two steps. In the first step, the primary energy demand of the district has been calculated, based on the values established by the Energimerking (Norwegian energy labelling system) [4]. In the second step, the energy production of the most suitable surfaces for installing solar systems has been estimated.

References: [4] ENOVA SF, "Energimerking av bygg," 2014. [Online]. Available: http://www.energimerking.no/no/Energimerking-Bygg/.

THE DEVELOPMENT OF THE ØVRE ROTVOLL

The site project is located near Trondheim at the coastal area. The aim of the strategic masterplan for Øvre Rotvoll is to develop a health-promoting, energy-efficient, climate-resilient neighbourhood. To achieve a sustainable settlement, the following criteria should be included: environmental friendly infrastructure, the use of renewable energies, social and economic concerns need to be addressed.In order to apply these sustainable parameters into the design process, all urban layers, such as technical-, traffic-, green- and social layers as well as typology and public spaces were taken into consideration. The starting point of the student's research for producing the sustainable masterplan strategy was to analyse the infrastructural, energetic and social impact to the urban structure by integrating them in an holistic approach. The exploitation of solar potential has been chosen as the main objective of the design process of the urban project; the south orientation of most of the planned typologies facilitates the implementation of PV panels on roofs and on the main façades. The students started with an intense analysis of the existing urban structure and the utilisation of the area to evaluate the strengths and weaknesses of the entire district. In this way, the groups could identify the urban and energy potentials and formulate a strategy plan for the site. Following the analyses they evaluated various strategies and produced different scenarios in relation to the urban functions, utilities and the examination of the volumes' typologies. During the whole creative process, students documented their design decisions in 2D and 3D models, plans, documentation sketches and diagrams. During the evaluation of the urban structure it became clear to the students that especially for residential buildings the pitched roofs reached the best solar irradiation. An optimised distance between the buildings allows the integration of solar thermal systems in the façade. The density of the office building area is higher than of the residential site. The office buildings are planned with flat roofs and more storeys than the residential ones. This aspect has a relevant effect on the urban density and on solar accessibility.

ØVRE ROTVOLL, NORWAY (BUW)

Figure 8 - The steps of the planning process for the case study Øvre Rotvoll (© BUW Siems/Simon with Master students,14/15)

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

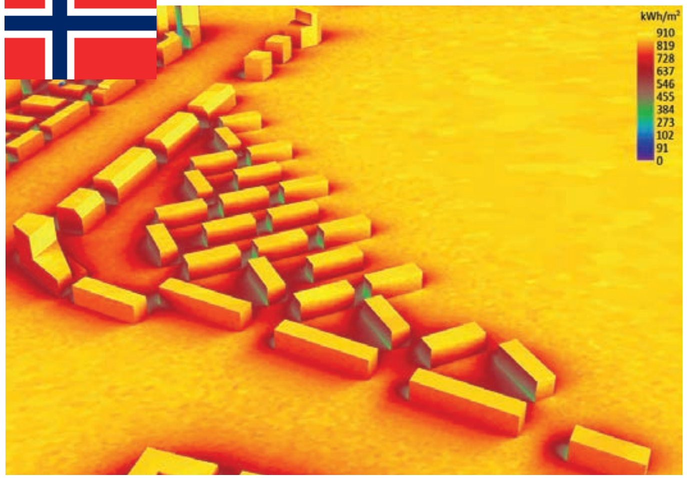


Figure 9 - Solar map of sub-area B1. Solar potential analyses were used for individuating the surfaces suitable for installing solar systems. (Author: © Silvia Croce)

THE DEVELOPMENT OF THE ØVRE ROTVOLL

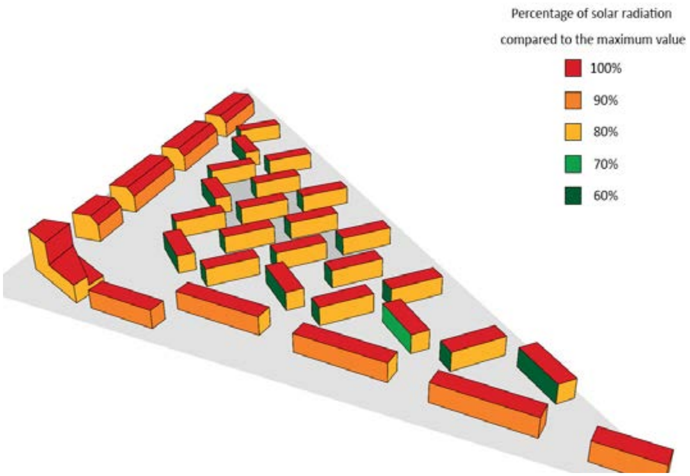


Figure 10 - 3D view of sub-area B1. The roofs and all the colored surfaces of the facades are suitable for installing solar systems. The different colors correspond to different percentages of solar radiation. (Author: © Silvia Croce)

Finally, the total energy production has been compared with the total energy usage of the district. The main aim of this analysis was to assess whether the objective of the energy optimisation of the district has been achieved by evaluating the percentage of the total energy demand of the district that could be covered by the energy production provided by the solar integrated systems.

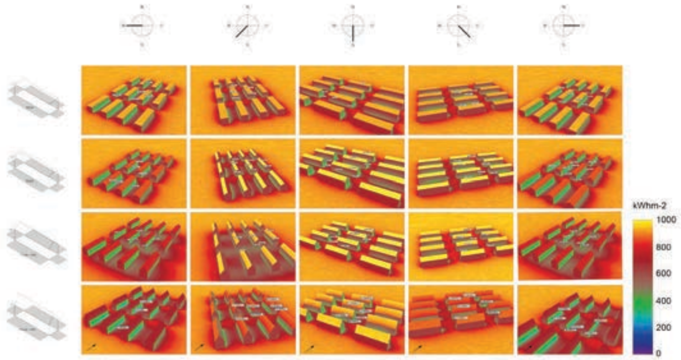
THE DEVELOPMENT OF THE ØVRE ROTVOLL

During the early design phases and even so along the entire process, the students were working with analogue and digital tools in order to support and assess the proposed planning. Especially for developing a sustainable settlement, various aspects should be considered. Analogue tools such as “the irradiation disk for solar energy” and the “typology / density cards” helped to develop optimised urban projects. Furthermore, the artificial sun allowed the analyses of shading in a physical 3D model in order to evaluate solar optimisation from the early stages of the design process. More information about the used analogue and digital tools is fully described in the Report C1.

In that regard, the students have investigated exemplary building shapes with different roof types and different orientations. During the design process physical models have been built to test the students structural design ideas, such as positioning different typologies of settlement as well as technical infrastructural elements and systems.

The students used the software tools District Energy Concept Adviser (DECA) to calculate the energy demand and to evaluate the energy potentials. Simultaneously they used the EnOB-Lernnetz in order to analyse the solar irradiation potential of the surfaces and demonstrate the overshadowing effect on the buildings, which aided in the development of a sustainable energetic concept.

The best solar optimisation was assessed for the south oriented building with a 30-degree pitched roof. The distance between the buildings was set by multiplying the height of the building with a 0.8 factor. The worst solar impact measured by the students was the East or West orientation with a 60-degree pitched roof.



ØVRE ROTVOLL, NORWAY (BUW)

Figure 11 - The steps of the planning process for the case study Øvre Rotvoll (© BUW Siems/Simon with Master students,14/15)

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

This example for developing the masterplan of Øvre Rotvoll neighbourhood in Trondheim (Norway) was developed in a Master Thesis conducted by Silvia Croce.

The research work for the thesis was conducted partly at NTNU and partly at UNIPD, under the supervision of researchers of both the universities.

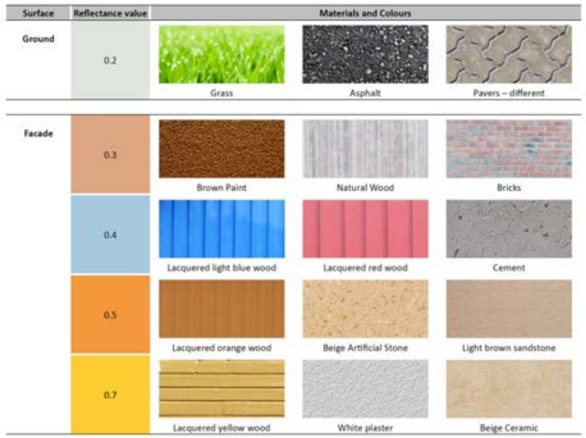


Figure 12 - Some of the materials suggested for the surfaces of the masterplan. The definition of the material had a key rolein increasing the indirect solar radiation. (Author: © Silvia Croce)

Figure 13 - Design tutorial. (Photo: © Julia Siedle)

The case study of Øvre Rotvoll was chosen as a testbed for the master students of the University of Wuppertal (Course Urban Design and Planning leaded by Tanja Siems and Katharina Simon) for the design project seminar “experimental urban research studies” to generate a sustainable masterplan. The main focus of the planning and design process was to optimise solar energy potentials.

ØVRE ROTVOLL, NORWAY (BUW)

Figure 14 - Final site plan of the design project and the used analogue tools. (Photo: © Tanja Siems)

SIMILARITIES

- The main focus of both the approaches was the optimisation of the solar energy potential, implementing the renewable energy production from the early design phases of an urban district.
- Form, dimension of the buildings and distances between them have been studied and optimised in order to increase the solar irradiation on the building envelope and reduce the overshadowing effect.

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD)

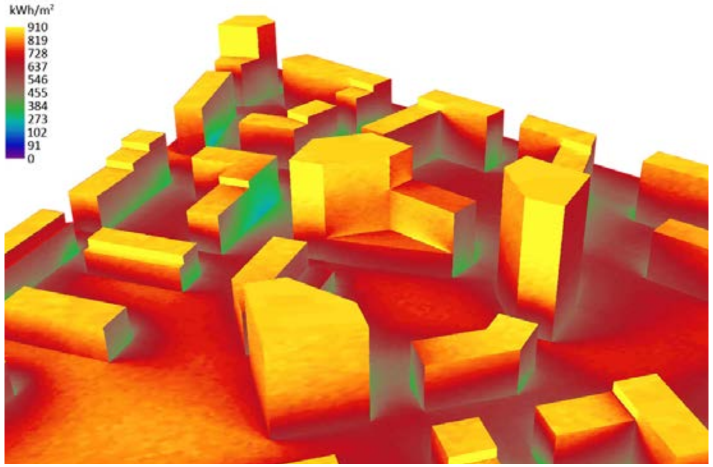
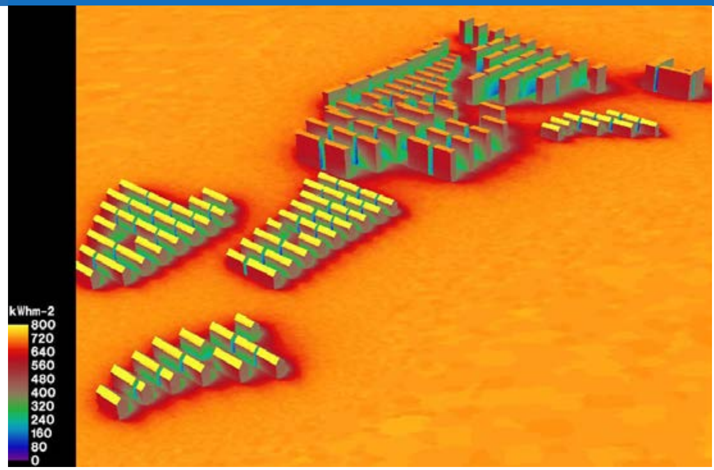


Figure 15 - Central Court in sub-area A: solar map after the optimisation process. (Author: © Silvia Croce)



ØVRE ROTVOLL, NORWAY (BUW)

Figure 16 - Solar irradiation per year (DIVA-for-Rhino). (Source: © Katharina Simon)

DIFFERENCES

- BUW adopted a holistic approach, considering not only the energy sustainability of the district, but also the infrastructure and the social impact of the proposed design, while the process adopted by UNIPD and NTNU was based on a single criteria method. It focused more on the distribution of the building in the district able to maximize the solar irradiation on the building envelope, considering the influence of aspect ratio h/w and orientation, and the positive effect on the solar radiation due to the reflections of the different finishing materials. The design process proposed by BUW focused not only on the solar optimisation but also on the improvement of public transport, by planning the stops in the area, and on the distribution of public facilities and shops.
- The approach adopted in the two case studies for the estimation of the energy consumption is different. While BUW students calculated it by using the tool District Energy Concept Adviser, in the UNIPD/NTNU Master Thesis, the primary energy demand of the district has been estimated, based on the values established by the Energimerking (Norwegian energy labelling system).

LESSONS LEARNED

- Importance of including all the different design parameters in the sustainable design process; solar optimisation could not be the only focus of the design but should be integrated with the other environmental, social and economic criteria.
- Usefulness of analogue and digital dynamic simulation tools for supporting the students in all the phases of the design process.

ØVRE ROTVOLL, NORWAY (NTNU, UNIPD, EURAC)

Figure 17 - Detail of the masterplan of Øvre Rotvoll (Source: © Silvia Croce)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- Transdisciplinary approaches are recommended for a holistic planning process. The knowledge exchange with experts from municipalities and other disciplines stimulates the discussion and offer new approaches in the design process.
- Importance of taking into consideration the integration of solar systems into the building envelope since the early phases of the design process, in order to create energy efficient districts.

ØVRE ROTVOLL, NORWAY (BUW)

Figure 18 - Detail of the masterplan of Øvre Rotvoll (Source: © BUW Siems/Simon with Master students, 2014/15)

Credits

RESEARCH INSTITUTIONS

Norwegian University of Science and Technology (NTNU)

Università degli studi di Padova (UNIPD)

CASE STUDY AUTHORS

Silvia Croce, (UNIPD/EURAC)

COURSE INFORMATION

The result of the research presented in the case study is contained in the author's master thesis for the MSc in Building Engineering and Architecture at University of Padova.

The thesis is titled "Solar potential optimisation in urban planning in extreme cold climate conditions. Design guidelines for solar accessibility and solar design for developing the masterplan of Øvre Rotvoll neighbourhood in Trondheim (Norway)."

RESEARCH ORGANISATIONS

RESEARCH INSTITUTION

University of Wuppertal
(Bergische Universität Wuppertal- BUW)

CASE STUDY AUTHORS

Tanja Siems, BUW; Katharina Simon, BUW.

ACKNOWLEDGEMENTS

University of Wuppertal
(Bergische Universität Wuppertal- BUW)

COURSE INFORMATION

Course name: Urban design and planning seminar "ES1 experimental urban research". Module description: The focus of the urban design seminar lies within identifying the importance of orientation and design systems for a sustainable development of urban projects. Analysis, evaluation and representations of economical, ecological and social interactions between buildings, urban structures, infrastructure and technically related city systems.

RESEARCH ORGANISATIONS

3.5 SWEDEN - SWEDEN

AUTHOR SWEDISH CASES
Jouri **Kanters**
Energy and Building Design
Lund University

07 **LUND BRUNNSHÖG**
New development area

08 **MALMÖ HYLLIE**
New development area

SWEDEN

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

LUND BRUNNSHÖG

SWEDEN

The Swedish case studies Lund Brunnshög and Malmö Hyllie are new urban districts with ambitious environmental goals, where solar energy is expected to play a significant role in producing on-site renewable energy. However, local administrations and urban planning departments face the results of new political decisions resulting in less available legal instruments to set requirements for implementing solar energy in new buildings.

Figure 1 - View of Lund Brunnshög intervention (Source: © White Arkitekter)

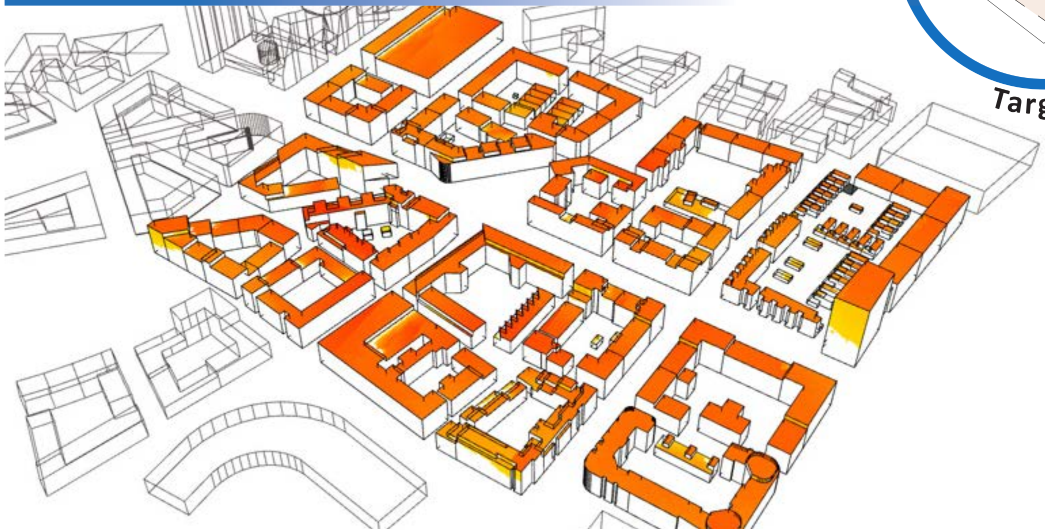


Figure 2 - View of the Malmö Hyllie intervention (Source: © Jouri Kanters)

This development has led to a focus on both voluntary initiatives (like BREEAM which includes solar energy) but also to a search for instruments which fit into the legal framework that local administrations currently have.

MALMÖ HYLLIE

SWEDEN

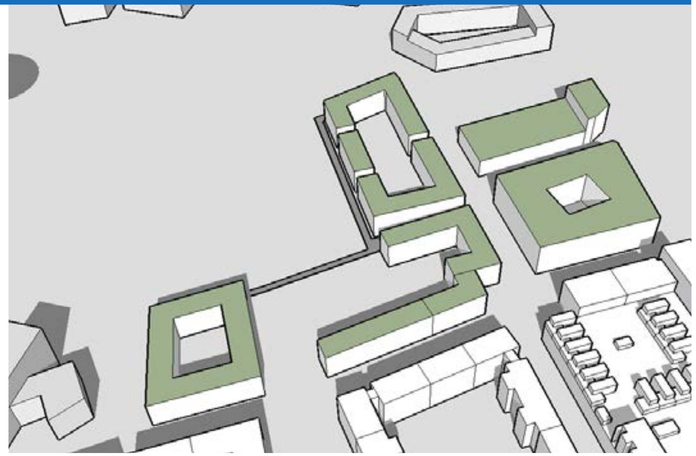
LUND BRUNNSHÖG, SWEDEN

Figure 3 - First stage of development. (Source: © Atkins)

Lund is expanding towards the North East side of the city. In Lund Brunnshög, a mix of research facilities and residential areas are planned. One part of the sustainability goals for Brunnshög is to reduce the energy demand of the districts, while at the same time prioritising the production of on-site renewables. The focus will be mainly on the production of solar electricity, since the research facilities will deliver their excess heat to the surrounding buildings.

The city of Malmö is expanding towards the South West. Malmö Hyllie has been pointed out by the local authorities to be the region's most climate smart urban district. A 'solar neighbourhood' has been assigned to become a testbed for solar energy.

Solar energy is considered to play a significant role as a local, renewable energy source. The production of solar energy has been considered as one of the main elements in the energy / climate strategy in Hyllie.



MALMÖ HYLLIE, SWEDEN

Figure 4 - Top view of the solar neighbourhood. (Source: © Malmö Stad)

References: [3] Sørensen, E. (2006). Metagovernance The Changing Role of Politicians in Processes of Democratic. The American Review of Public Administration, 98-114.

LUND BRUNNSHÖG, SWEDEN

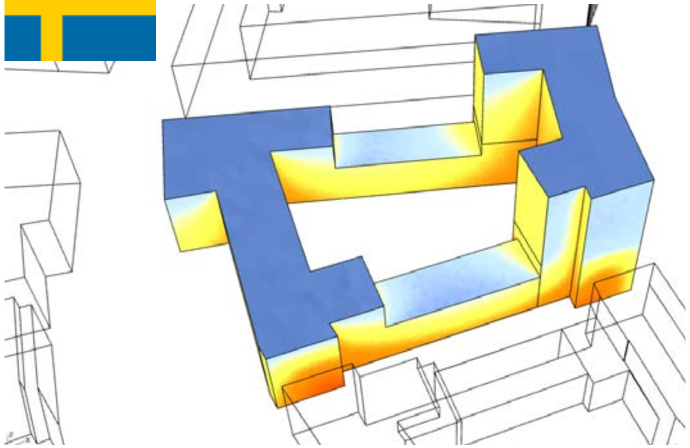


Figure 5 - Annual solar irradiation on the building envelope (Source: © Jouri Kanters)

The involved researchers from Lund University are now proposing the use of a so-called Solar Factor or SAFAR which defines the ratio between the suitable area on a building and the floor area [1]. This solar factor can be used to assess the design of a zoning plan and is obtained by a computer simulation. With this solar factor, it can be calculated how much energy can possibly be produced by means of solar thermal or PV systems and how much of the needed energy in the buildings can be met by the produced solar energy. In the next phase of the research project, it will be tested how the SAFAR can help discussing solar energy in the planning process and weighing it against other design factors in the urban planning process.

References: [1] The impact of urban design decisions on net zero energy solar buildings in Sweden. (2014). Kanters, J & Wall, M. Urban, Planning and Transport Research: An Open Access Journal, (1), 312. doi:10.1080/21650020.2014.893199

The involvement in the urban planning process has made it clear that the real estate developer is one of the key players in the process. Without legal instruments to force the real estate developers, it has become very important to provide useful and quantifiable information which makes it possible to perform feasibility studies.

MALMÖ HYLLIE, SWEDEN

Figure 6 - Simulation of annual solar irradiation. (Source © Jouri Kanters)

Similarities and Differences

SIMILARITIES

- Most of the similarities between the two cases come from the legislative framework. Due to changes in legislation, both cities have, as in other Swedish cities, to find new means for promoting solar energy.
- Since the real estate developers play a significant role in the final decision-making on the implementation of solar energy, it is a key aspect for the municipalities to bring up the issue of solar energy early. However, in the early planning process, the real estate developers are not yet known.

LUND BRUNNSHÖG, SWEDEN

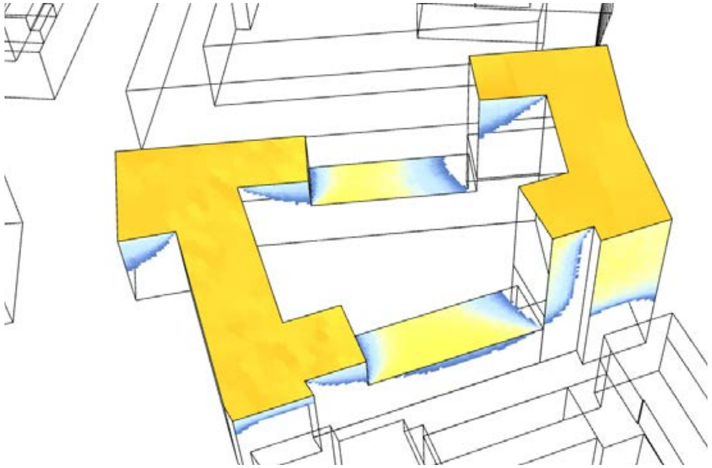
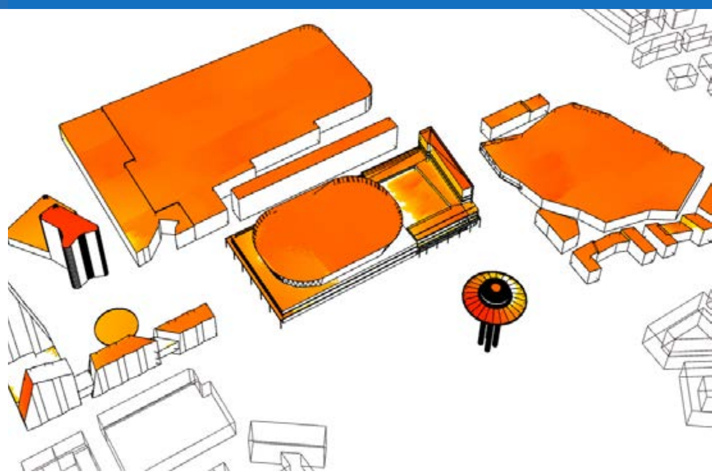


Figure 7 - Masking the areas that receive a higher solar irradiation than a preset threshold. (Source: © Jouri Kanters)



MALMÖ HYLLIE, SWEDEN

Figure 8 - Simulation of annual solar irradiation. (Source: © Jouri Kanters)

DIFFERENCES

- The city of Malmö has started now to 'prepare' one specific sets of buildings to become solar ready. This solar neighbourhood will be a testbed and if it turns out to be successful, the same procedure might be followed in future developments.
- On the other hand, in Brunnshög, the whole development is looked upon at the same time.

Lessons learned and recommendations

LESSONS LEARNED

- The involved researchers will simulate the SAFAR of some key buildings within Lund Brunnshög and Malmö Hyllie to demonstrate how the SAFAR could work as a tool for urban planners.
- This method makes it also possible for real estate developers, architects and other interested players to upload their building model and see how well it performs for solar energy. Furthermore, the involved researchers will look into how the surroundings (buildings, vegetation) will affect the SAFAR of a building.
- The SAFAR will also be used here to inform real estate developers, since it provides how much energy (electricity or heat) can be produced on a building and which parts of the building envelope are suitable to produce this energy. The SAFAR simulation script is developed in such a way that it can export those suitable areas, making it easier for the involved architects to work with the architectural integration of solar energy systems.

LUND BRUNNSHÖG, SWEDEN

Figure 10 - Vision (Source: © Anna Klara Lundberg)

MALMÖ HYLLIE, SWEDEN

Figure 11 - Visualisation of Hyllie. (Source: © Malmö Stad)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- It is planned that in the future, urban planners can upload their own building as a simple Sketchup model on the website www.solarplanning.org and get the results back by email once the simulation is done.
- Another important aspect in the discussion with urban planners is the architectural integration of solar energy systems in buildings. Workshops will be held to discuss this matter.
- Informing key players –urban planners, real estate developers, architects- has become a main task for the involved researchers since the legal possibilities to force solar energy into buildings have diminished.

Credits

DEVELOPER

Urban planning department of the city of Lund

OWNERS

City of Lund

STAKEHOLDERS

City of Malmö, potential real estate developers

ACKNOWLEDGEMENTS

Lund University would like to thank the Swedish Energy Agency for the financial support.

CASE STUDY AUTHORS

Jouri Kanters (Lund University, Sweden)

RESEARCH ORGANISATIONS

Lund University

DEVELOPER

Urban planning department of the city of Malmö

OWNERS

City of Malmö

STAKEHOLDERS

City of Malmö, potential real estate developers

ACKNOWLEDGEMENTS

Lund University would like to thank the Swedish Energy Agency for the financial support.

CASE STUDY AUTHORS

Jouri Kanters (Lund University, Sweden)

RESEARCH ORGANISATIONS

Lund University

3.6 SWITZERLAND - SWITZERLAND

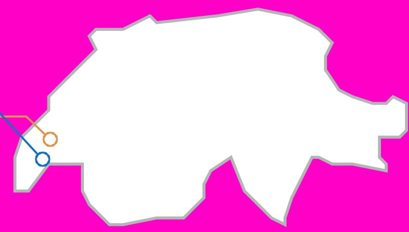
AUTHORS SWISS CASES

Emilie **Nault**
Interdisciplinary Laboratory of Performance-Integrated Design (LIPID)
Ecole Polytechnique Fédérale de Lausanne (EPFL)

Giuseppe **Peronato**
Interdisciplinary Laboratory of Performance-Integrated Design (LIPID)
Ecole Polytechnique Fédérale de Lausanne (EPFL)

09 **ROMANEL-SUR-LAUSANNE, PDLi NORD-LAUSANNOIS**
Existing urban area

10 **YVERDON-LES-BAINS, PDL GARE-LAC**
Existing urban area



SWITZERLAND

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

YVERDON-LES-BAINS, PDL GARE-LAC

SWITZERLAND

This section presents a comparison between two case-studies in Western Switzerland. The PDL Gare-Lac is a masterplan for the re-development of a former industrial area expected to accommodate 3800 new inhabitants and 1200 work places in the city of Yverdon-les-Bains.

Figure 1 - View of the Yverdon-les-Bains (background orthophoto is Google's through © Giueppe Peronato)

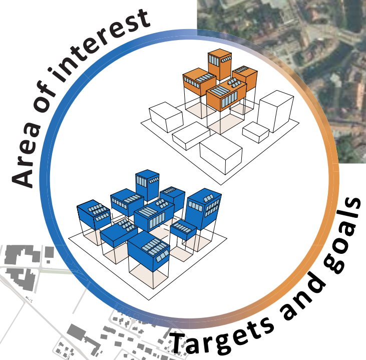


Figure 2 - View of the plan of PDLi Nord-Lausannois, Norway. Source: (© Urbaplan)

The second study concerns the PDLi of Romanel-sur-Lausanne, a masterplan for a new mixed-used area in an open field.

ROMANEL-SUR-LAUSANNE, PDLi NORD-LAUSANNOIS

SWITZERLAND

YVERDON-LES-BAINS, PDL GARE-LAC

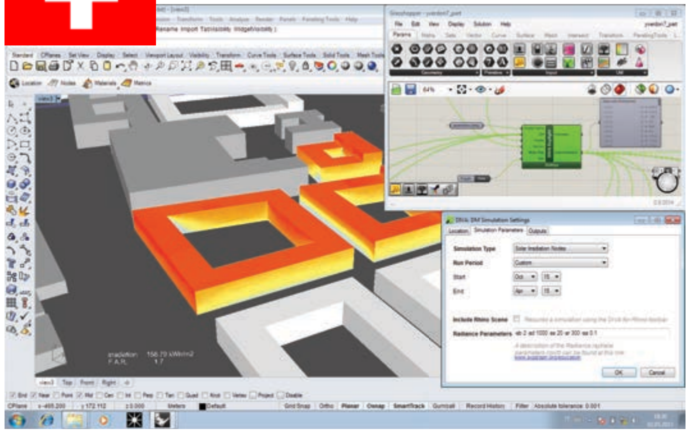


Figure 3 - Simulation interface. (Source: © Giuseppe Peronato)

The case study of Yverdon-les-Bains is based on a research project [2] developed on an actual master plan [3] for the renewal of a brownfield area (Gare-Lac district of Yverdon-les-Bains). This project has studied how the possible variants of building shape influence the building performance (active and passive solar) and the built density.

References: [2] Peronato, G. (2014). Built density, solar potential and daylighting: application of parametric studies and performance simulation tools in urban design. Master's thesis. Venice: Università Iuav di Venezia.
[3] URBAT (2014). Plan Directeur Localisé Gare-Lac. Rapport. Yverdon-les-Bains : Service de l'urbanisme et des bâtiments (URBAT).

The case study of Romanel-sur-Lausanne was conducted in collaboration with a local urban design firm (Urbaplan [1]) in the context of a doctoral research project. The goal was to investigate the passive solar performance – quantified by the daylight autonomy and heating need – of different neighbourhood designs to support the firm in specifying favorable typologies and guidelines during their task of elaborating the structure plan.

ROMANEL-SUR-LAUSANNE, PDLI NORD-LAUSANNOIS

Figure 4 - Schematic master plan of the area. (Source: © Urbaplan)

References: [1] Urbaplan (2014). Plan Directeur Localisé Intercommunal Lausanne-Vernand – Romanel-sur-Lausanne. V.1.3.

YVERDON-LES-BAINS, PDL GARE-LAC

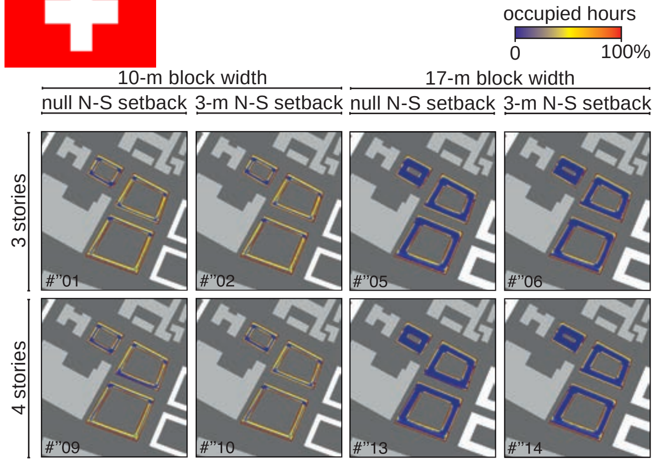


Figure 5 - Spatial Daylight Autonomy of eight notable design variants. (Source: © Giuseppe Peronato)

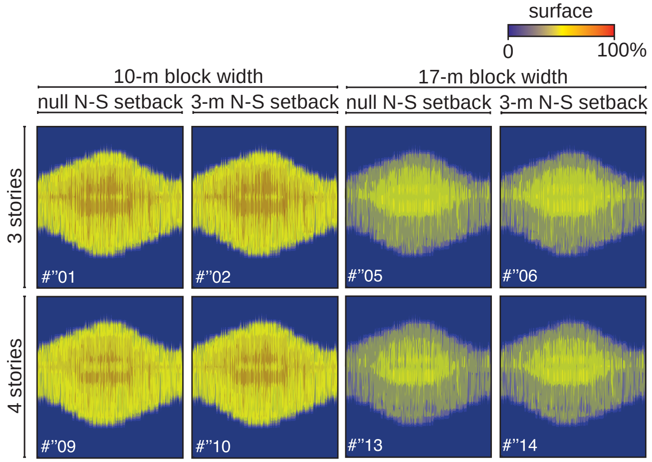
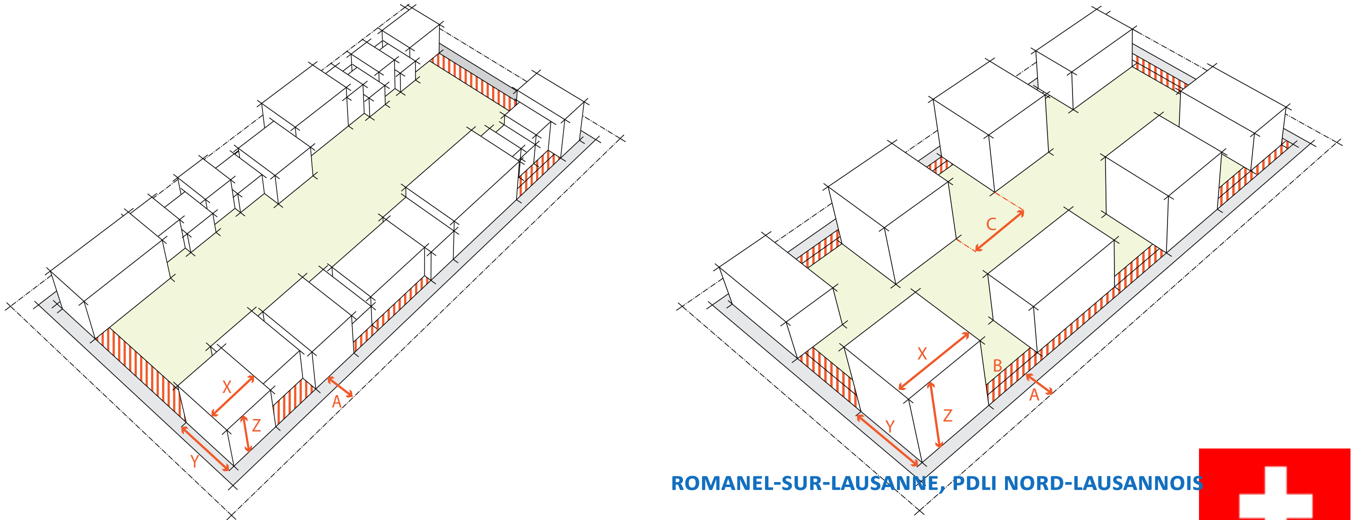


Figure 6 - Temporal Daylight Autonomy of eight notable design variants. (Source: © Giuseppe Peronato)

The Yverdon-les-Bains case study was independently carried out as a research project in the context of a master thesis without the involvement of planners.

In the case study of Romanel-sur-Lausanne, the stakeholders were not directly involved. However, planners in charge of the masterplan proposed this analysis to the research group and provided information on the design variants to be compared. Results were used in a public consultation event and included in a masterplan document.



ROMANEL-SUR-LAUSANNE, PDLI NORD-LAUSANNOIS

Figure 7 - Base case design M1 - Adjacent blocks (left) and M2 - Detached blocks (right). (Source: © Urbaplan).

SIMILARITIES

YVERDON-LES-BAINS, PDL GARE-LAC

DIFFERENCES

- Both case studies refer to the same regional planning document (i.e. Plan Directeur Localisé, the structure plan of the Canton de Vaud). Their general purpose is the early-phase analysis of the solar potential in terms of passive solar (energy need), daylight, and active solar (energy production) in urban design. The methodology based on a series of simulations for various neighbourhood design variants is also similar.

- Challenges were faced in both cases, when applying a performance assessment workflow to early-stage urban designs. In both cases, the simulation-based analysis requires several inputs to be provided, information typically still unknown at the early-design phase. However, given the comparative nature of these studies, this barrier is somewhat overcome by setting the same standard parameters whenever the actual values are unknown. Although setting these simulation assumptions allows these studies to be conducted, further work is required to test whether the assumptions actually influence the outcome of the comparison. Another limitation is related to the computational cost of the simulations, which might limit the transposition of this methodology into the design practice. Such limitations are further discussed in reports from the Task 51 subtask B, when investigating assessment methods and tools.

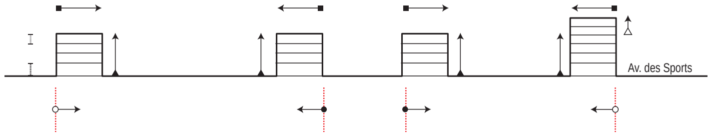
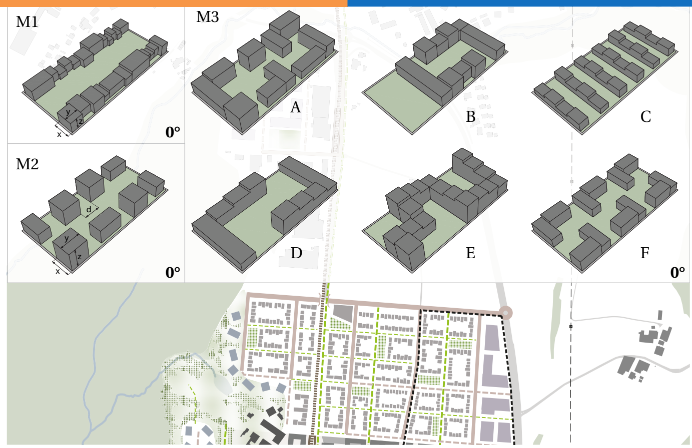


Figure 8 - Schematic of the parametric model. (Source: © Giuseppe Peronato)



ROMANEL-SUR-LAUSANNE, PDLI NORD-LAUSANNOIS

Figure 9 - Example plots (bottom) on which the design variants created from M1 and M2 and the specific M3 designs (top) could be located. (Source: © Emilie Nault)

- Despite similar analysis workflows, the phase at which they are applied differs between the two cases. In Yverdon-les-Bains, the methodology is applied after the definition of the structure plan, based on its content (e.g. guidelines and constraints), while the application for the Romanel-sur-Lausanne case has the purpose of supporting the definition of this structure plan and is therefore conducted earlier in the planning process. As such, in the former case, the degree of freedom in design decisions is dictated by the plan itself, which establishes the building typology and other design requirements. The analysis is then conducted as a fine-tuning of the initial plan within the margins of flexibility allowed by the document. For the latter case, the methodology is applied on a less constrained set of design parameters. Different building typologies proposed by the urban planners are analysed in a comparative way so as to propose some design recommendations.

LESSONS LEARNED

- Both studies highlighted the importance of considering several criteria while analyzing the solar potential of early designs (e.g. daylight, active and passive solar). In particular, it was demonstrated that some criteria are potentially conflicting and therefore require a trade-off to be adopted from the beginning of the planning process.

YVERDON-LES-BAINS, PDL GARE-LAC

Figure 10 - Photo of the areas (Source: © Nicolas Strambini, EPFL ENAC IA LAST)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- Although it is not possible to generalize the results obtained in these two studies, the workflow adopted to conduct them can easily be applied to other projects. The challenges related to the availability of design information should not be underestimated, but dealt with by setting-up a comparative approach using adequate and context-specific assumptions. Results highlight the potential of such studies for supporting urban decision-making as well as easing communication between different actors.

Figure 11 - Photo of the area (Source: © Urbaplan)

Credits

ARCHITECTS*

BAUART Architectes et Urbanistes SA

CONSULTANTS*

Transitec Ingénieurs Conseils, P+ Génie de l'environnement, Radeschallpartner AG Landschaftsarchitekten, Vogt & Partner Lichtgestaltende Ingenieure, ADR Sàrl Architectes, Jaquier & Pointet SA, CSD Ingénieurs SA

CASE STUDY AUTHORS

Giuseppe Peronato and Emilie Nault with Prof. Marilyne Andersen and Prof. Emmanuel Rey (EPFL)

OWNERS*

SBB-CFF-FFS, Société coopérative Fenaco, Sables et graviers La Poissine SA, Travys SA, La société de navigation des lacs de Neuchâtet et Morat *These people/design firms/companies were not involved in the research project, but only in the development of the master plan.

RESEARCH ORGANISATIONS

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

STAKEHOLDERS*

City of Yverdon-les-Bains

ACKNOWLEDGEMENTS

The authors wish to thank Dr. Francesca Cappelletti and Prof. Fabio Peron, advisors of Giuseppe Peronato's master thesis.

DEVELOPER

Urbaplan

CONSULTANTS

BBHN; BG; FRANÇOIS KUONEN; VOGT; bcph

CASE STUDY AUTHORS

Emilie Nault
with Prof. Marilyne Andersen and Prof. Emmanuel Rey (EPFL)

OWNERS

Schéma Directeur du Nord Lausannois (SDNL)
City of Lausanne
City of Romanel-sur-Lausanne

ACKNOWLEDGEMENTS

The authors would like to thank Urbaplan for the opportunity to conduct and publish this study.

RESEARCH ORGANISATIONS

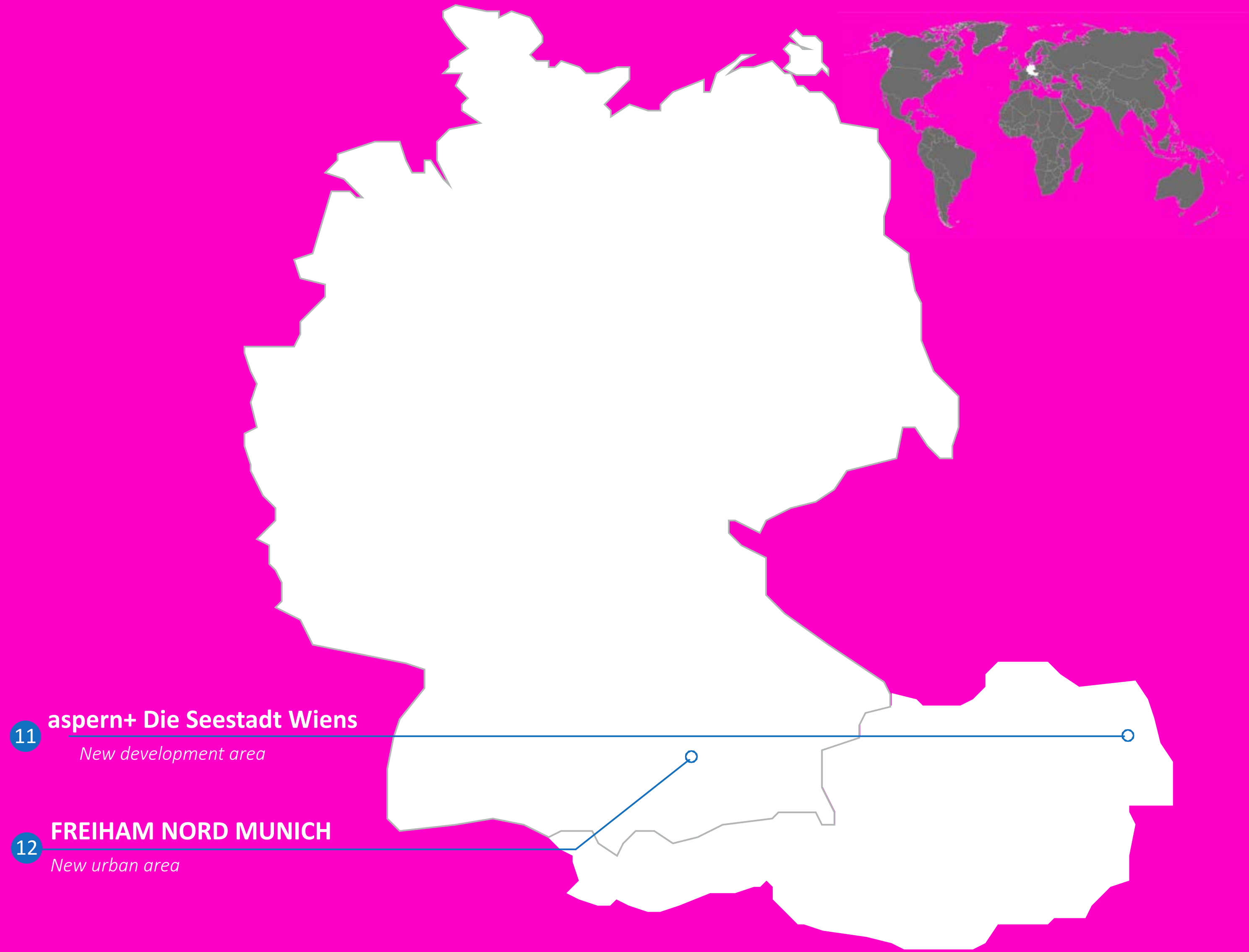
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

4 COLLABORATIVE CROSS COUNTRY CASE STUDIES

4.1 AUSTRIA - GERMANY

AUTHORS GERMAN CASE

Romain **Nouvel**
Research center Zafh.net – Sustainable Energy Technology - Hochschule für Technik Stuttgart



AUTHORS AUSTRIAN CASE

Daiva **Jakutyte-Walangitang**
Energy Department
AIT, Austrian Institute of Technology

AUSTRIA - GERMANY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

FREIHAM NORD MUNICH

GERMANY

Challenges for solar energy integration in new urban disctrict developments: Comparative case of Munchen-Freiham, Germany and Aspern+Vienna’s Urban Lakeside, Austria

Figure 1 - Source: (© City of Munich)

Figure 2 - aspern - die Seestadt Wiens. © Daiva Jakutyte-Walangitang

Facing a high demographic pressure, some cities like Munich or Vienna tends to extend on peripheral green and brown fields, developing new urban districts for tens of thousands inhabitants. This new developments must fit within the ambitious environmental and energy goals of the cities, leading toward climate neutrality and optimizing the utilization of solar energy.

aspern+ Die Seestadt Wiens

AUSTRIA

FREIHAM NORD MUNICH, GERMANY

Figure 3 - Model of the prized project (source: © HFT Stuttgart).

Facing a high demographic pressure, Munich requires increasing its residential park by 30% between 2005 and 2025 according to the forecast of Forschungsinstituts Empirica AG. Having already a densely built city center, Munich is extending to its periphery, in particular to its West City Ring with the development of the new city-district Freiham built on a former 85 hectare agricultural field. In parallel to its extension policy, Munich has set ambitious CO2 reduction goal, which should lead toward climate neutrality by 2050 .

The City of Munich, which owns the site of Freiham, has translated this long-term goal in a catalog of local ecological criteria, including a minimum building energy standard, efficient hvac systems, low energy construction material etc. These criteria have been fixed in agreement with the municipal energy supply company (Stadtwerk München) at the beginning of the project conceptualisation phase in 2007. As a consequence, this company has invested in a new geothermal station and a low-temperature heating district network, to supply the new construction with low-carbon heat energy. The occupancy ratio of the new development and the ban of solar thermal system installation in some parcels have been decided in order to insure an acceptable profitability to the network operator, despite the low specific heating demand of the supplied buildings.

A site plan competition has been organised in 2013, evaluated by city planners of Munich together with a multi-disciplinary expert team. Energy concept and solar planning were two criteria among many others, the architect office West 8 won the competition for Freiham North with the most balanced project.

Vienna is a steadily growing city. According to the most recent statistical forecast it is expected that in the decade between 2014 and 2024 Viennese population will grow by approximately 10%, from almost 1, 8 Million people in 2014 to the anticipated 1,952 Million in 2024 . In line with these demographic dynamics, strong focus of the city's development is set on ensuring sufficient availability of affordable housing and the maintenance and improvement of the quality of life in alignment with sustainability goals that the city is pursuing.

Embracing the Viennese expansion has been translated in adequate planning measures and actions in terms of provision of high quality, well accessible housing in connection with leisure, educational facilities, mobility and jobs. At present Vienna owns three strategic city plans: Climate Protection Programme 2010-2020 [1], STEP 2025 [2] and the overarching 'Umbrella Document'- Smart City Wien Framework Strategy [3]. For the purpose of achieving the goals as delineated in the strategic plans, specific areas within the city have been selected to focus on as the demonstration zones for concrete implementation of specific projects. One of these areas is 'aspern + Vienna's Urban Lakeside', located on the Eastern side of the city. The overall site of this district covers an area of 2.4 million m². The planned and in some areas already under construction as well as partially completed, aspern + Urban Lakeside will supply the city with 2.2 million m² of additional floor space, compiling a healthy mix of residential, commercial, office and in parts industrial uses, offering 20 000 work places and 10 500 apartments, accommodating 20 000 residents. hroughout its historical development the Aspern area was occupied by one of the- at the time most modern- airports in Europe between 1880 and early 1990's.

References: [1] https://www.wien.gv.at/english/environment/klip/ [2] https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008379a.pdf
[3] https://smartcity.wien.gv.at/site/files/2014/09/SmartCityWien_FrameworkStrategy_english_doublepage.pdf

aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 4 - Aspern development and surroundings. (Source: www.aspern-seestadt.at)

FREIHAM NORD MUNICH

Built to provide a dwelling to 20 000 inhabitants, the new district will also comprise a sport park, a school, a campus, and mixed-usage buildings in the district center. 30% of the parcel areas will belong to the public housing company GWG München, while the rest will be sold to private investors. In 2017, the first inhabitants are expected to occupy the new high energy standard buildings.

In public-owned parcels, the City of Munich, through the public housing company, decided concrete energy efficiency measures, like solar-optimised building forms or photovoltaic modules on the roof. The counterpart is to keep investment costs and rents affordable for the inhabitants. In private-owned parcels, the master plan (which fixes floor space ratio, footprint borders and maximal storey number for each parcel) and the ecological criteria catalogue set binding constraints regulating energy-efficiency. Nevertheless, in order to keep attracting private investors, the City of Munich cannot impose more specific measures related to the choice of renewable technologies for instance.

Additionally, other field related issues and goals may conflict sensibly with the use of solar energy. This is the case for instance of the rainwater management in Freiham: due to a local high ground water level, all building roofs must be flat and green, impacting the solar system solutions. Then, the volunteer aim of the City of Munich to build the new district Freiham with high sustainability standard is a series of trade-offs and goal conflict resolving.

Figure 5 - Chimney of the heating plant of Freiham, including PV modules. (Photo: © Stadtwerke München)

It was used for aviation activities until 1970's, before complete closure of the Aspern airport in 1775. In 1982 General Motors opened a manufacturing facility in the area. The first steps on the urban redevelopment started in 1992, going through numerous urban planning phases, till the final urban design competition took place in 2015. From the early stages of the planning, the reduction of the impact of the entire development on the environment was one key area of focus in the process, using planning and monitoring instruments as Environmental Impact Assessment, holistic and integrated energy concept for the entire area, alignment with the criteria for sustainable development, energy efficiency of the built fabric, sustainable mobility, urban design concepts and integration of energy renewable sources. Considering this complexity, a whole range of stakeholders have been included in the planning and implementation process. Different actors are taking part in the planning including municipal departments, energy utility, public transport authorities, research organisations, artists and developers. Participatory events took place in Aspern, exposing the attempts to integrate the ideas coming from the broad set of target groups (i.e. artists, architects, citizens). The agency Wien 3420 Aspern Development AG was set up by the city to which the land ownership of the Aspern area was transferred. It was entrusted with the task of leading the Aspern development, which will take place in three phases: Phase 1: 2010-2017, Phase2: 2017-2022, Phase 3: 2022-2028. Control instruments were applied to ensure the compliance with high environmental, urban planning and construction standards during the development, including the quality building assessment, regular screenings by the Aspern Advisory Board and the Zoning Plans. [1]

References: [1] http://www.aspern-seestadt.at/

aspern + DIE SEESTADT WIENS, AUSTRIA

Figure 6 - Aspern IQ - first building in aspern Seestadt . (Photo: ©Daiva Jakutyte-Walangitang)

FREIHAM NORD MUNICH, GERMANY

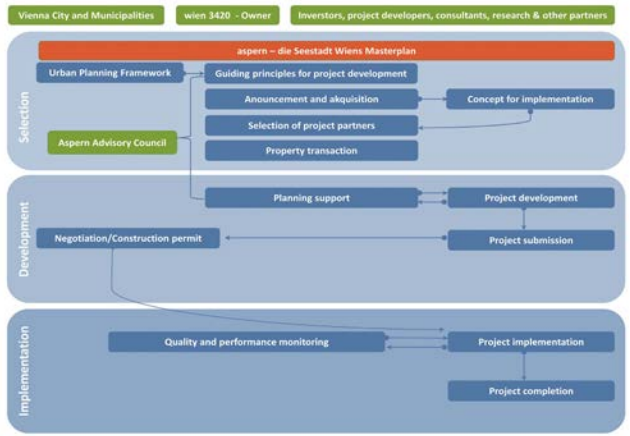
Figure 7 - *Meeting of the multi-disciplinary team of project NSP München. (Source: © HFT Stuttgart)*

For the urban and landscape planning competition, the City of Munich asked HFT Stuttgart to evaluate the solar design of the 14 candidate planning variants.

Because of the non-exploitable input formats and the narrow time frame, this evaluation was only qualitative, by visually determining the main orientations of the façades, the impact of the building height on solar accessibility, and the coherency between building usage and passive solar gains. A subjective score between 1 and 10 has been given to each variant. These scores seemed not having impressed the jury of the competition, since the winner project was placed at the bottom of our ranking. Once the site plan has been decided, a solar and energy optimisation study has been realized on a parcel, calculating precisely the incoming solar energy on every building surface, and the potential photovoltaic production for different variants of building forms and roof configurations. This applied research work gave West8 meaningful inputs for the refinement of their master plan.

The first planning instrument – International Masterplanning Competition was used in order to identify the award winning scheme for aspern Seestadt development. The award winning scheme was presented and reviewed by an international expert panel, following the awarding of the contract. After going through a process of multiple public presentations, discussions and workshops the final Masterplan was adopted by the Vienna City Council in 2007 and subsequently transferred into the urban Zoning Plan . The Zoning Plan (Flächenwidmung) serves as a main urban planning instrument in aspern, which provides mandatory rules for the implementation.

Beyond the formal instruments, a range of informal instruments such as 'City Labs' have been used in different research projects, providing the cross-sectoral collaboration between different stakeholders and enabling innovative impulses: NACHASPERN [1], TRANSFORM [2] and TRANSFORM+ [3] are some of the examples.



aspern + DIE SEESTADT WIENS, AUSTRIA

Figure 8 - *The Process of Aspern Development. (Source: Translation from German in English by Daiva Jakutyte-Walangitang, AIT)*

References: [1] https://nachhaltigwirtschaften.at/resources/edz_pdf/nachaspern_gesamtenergiekonzept.pdf; [2] http://urbantransform.eu/
[3] http://www.transform-plus.at/

Similarities and Differences

SIMILARITIES

- Both projects are new large urban development, expected to accommodate around 20 000 inhabitants. Both projects are located at the outskirts of the city, connected to the central city through a major public transport route. This connection was in both cases implemented before the start of the district construction.

- In both cases, the City is the land owner and the initiator of the project. The city has set ambitious environmental, ecological and energy related goals, although to a varying degree of specificity.

  - A specific number that quantifies solar energy goals has not been fixed in Freiham or Aspern. There are two main reasons for that: legally, German and Austrian cities cannot prioritize a specific renewable energy source over other sources. Economically, the intention and role of cities is to attract a variety of investors, while at the same time promoting affordable housing and ownership costs. Mandatory implementation of solar panels on every building thus forms a controvercial topic in this context.

  - In the case of Freiham as well as of Aspern generous areas are available, occupied by infrastructure, such as rail stations, parking, etc. However, none of these have been considered so far as potential areas for installation of solar panels. At present, the focus has been placed on the PV or solar thermal panel integration in buildings. This fact places additional strain on the financing and affordability of the dwellings.

FREIHAM NORD MUNICH, GERMANY

Figure 7 - Architectural view of the subproject field A from the winner project of the urban and landscape planning competition (source: © West8).

aspern + DIE SEESTADT WIENS, AUSTRIA

Figure 8 - Aspern development around the lake (Photo:©Daiva Jakutyte-Walangitang)

DIFFERENCES

- The planning process and the sequence in which the development of energy concepts has taken place is different in both projects. In Aspern, the urban Master Plan was developed first and then followed by the process of elaboration of different energy concepts. In Freiham, energy related criteria were integrated in the first phases of the district planning process

- In Freiham, the close collaboration between the City of Munich and the municipal energy supply company led to the development of a geothermal-based district heating network, main lever of the low carbon energy strategy, integrated into the city planning process

- The general consensus in the case of Aspern is that urban as well as energy related planning and implementation steps are to be viewed in an integrated manner and one cannot overwrite the other. Thus, the innovative options for integration of energy generation from solar in the district is being revisited at each phase of urban development.

- The planning process as well as the sequence in which specific development steps, including energy concept, have taken place are different in Aspern and in Freiham.

Lessons learned and recommendations

LESSONS LEARNED

- From the two case studies emerges that the driving stakeholders have to be involved and consulted early in the planning and development process: utility companies – energy suppliers, developers, civil engineers, relevant municipal departments, experts, etc.
- Citizens, neighbors and new inhabitants should be included in the planning process as co-developer and not only "consumers", participating in the creation and test of new jointly developed solutions (Urban Lab approach in Vienna).
- The increasing complexity of urban development processes in projects of such magnitude like Aspern and Freiham show the need for new and innovative instruments and methods that are capable to tackle the interdisciplinary aims of these developments.
- In new urban district development whose land is originally owned by the city, the latter can set ambitious environmental, ecological and energy related goals and criterias to reach a nearly zero energy neighbourhood.
- Cities of Germany and Austria don't have legally the right to force installing solar energy systems rather than other renewables energy sources.

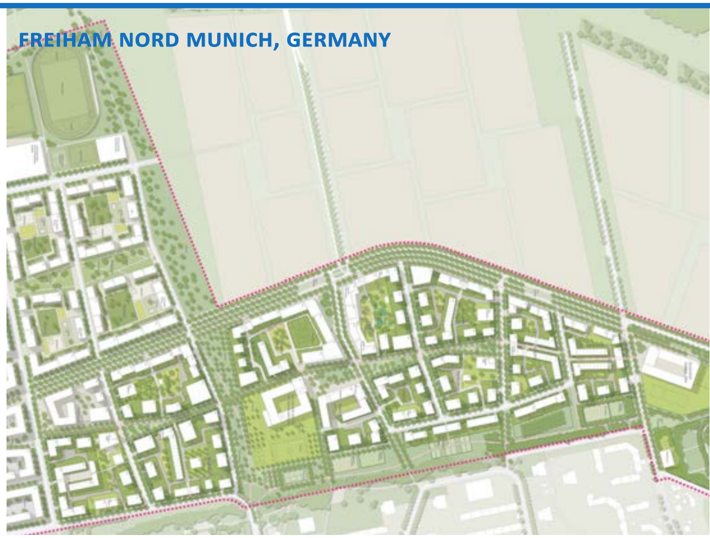


Figure 10 - Masterplan of the entire intervention of Freiham, Munich . (Photo: © West8)

Figure 11 - "Urban gardening" is an essential part of aspern+ development (Photo: ©Daiva Jakutyte-Walangitang)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- Start the development of energy concept in the early stages of the urban planning and involve key local stakeholder from both fields.
- Include an urban form study supported by a solar potential analysis, as a common practice during the drafting of the master plan/framework plan.
- Provide conscious professional education concerning the energy related know-how in urban planning and architectural offices.

Credits

PROJECT INITIATOR

Landeshauptstadt München (City of Munich)

CONSULTANTS

- West8 Urban design and Landscape Architecture
- HFT Stuttgart

CASE STUDY AUTHORS

Romain Nouvel, HFT Stuttgart.

OWNERS

Landeshauptstadt München (City of Munich).

STAKEHOLDERS

Project management team/External consultants/Enterprises.

RESEARCH ORGANISATIONS

Hochschule für Technik Stuttgart

ACKNOWLEDGEMENTS

The authors wish to thanks the City of Munich for the information provided and the long-term collaboration.

DEVELOPMENT AGENCY

Wien 3420 aspern development AG

STAKEHOLDERS

Numerous stakeholders. Vienna City and various Municipal Departments, Wien Stadtwerke- Vienna Utility Companies, ASCR- Aspern Smart City Research and other research organisations, companies, consultants, etc. have been involved in the research, development and implementation activities in aspern+ Vienna's Urban Lakeside.

CASE STUDY AUTHORS

Daiva Jakutyte – Walangitang, Austrian Institute of Technology (AIT)

OWNERS

Wien 3420 aspern development AG, die GELUP GmbH, VIENNA INSURANCE GROUP, Bausparkasse der österreichischen Sparkassen Aktiengesellschaft, Die Bundesimmobiliengesellschaft BIG.

RESEARCH ORGANISATIONS

AIT Austrian Institute of Technology

ACKNOWLEDGEMENTS

The authors wish to thank all the partners in Transform+ and TRANSFORM project and the aspern Energy Group.

FUNDING ORGANISATIONS

bmvit FFG

4.2 ITALY - FRANCE

AUTHORS FRENCH CASE

François **Garde**
ESIROI/PIMENT
University of La Réunion

Anne **Monnier**
Akuo Energy

AUTHOR ITALIAN CASE

Alessandra **Scognamiglio**
Photovoltaic Technologies Unit (UTTP-FOTO)
ENEA

FRANCE - ITALY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

AGRIENERGIE 5

FRANCE

The energy sector affects and limits alternative uses of land; it has been acknowledged that in the future the assimilation, conversion, storage, and transport of renewable energy will be one of the most important land uses of the twenty-first century [1]. Energy generation and food production are often seen in contrast when thinking of land-availability, and this becomes a barrier to the solar energy implementation in the case of large scale photovoltaic systems (social acceptability) [2].

References: [1] Stremke S, van den Dobbelsteen, Sustainable energy landscapes: an introduction. In Stremke S, van den Dobbelsteen, editors. Sustainable energy landscapes. Designing, planning, development, New York: CRC Press; 2013, p. 3 (cit)

[2] ChiabrandoR,FabrizioE,GarneroG.The territorial and landscape impacts of photo voltaic systems: definition of impacts and assessment of the glare risk. Renew Sustain Energy Rev 2009 ; 13 (9) : 2441–51

Figure 1 - Source: © akuoenergy)

Figure 2 - Photo: © Revolution Energy Maker REM

A possible outcome of this condition is represented by restrictive local regulations that do not allow installing photovoltaics on the ground. Recent studies and experiences are exploiting design possibilities for photovoltaics that allow combining food production and energy generation (additional environmental benefits) [3].

References: [3] Scognamiglio A, 'Photovoltaic landscapes': Design and assessment. A critical review for a new trans disciplinary design vision, Renewable and Sustainable Energy Reviews, Volume 55, March 2016, Pages 629-661

AGROVOLTAICO

ITALY

AGRIENERGIE 5, RÉUNION ISLAND, FRANCE

Figure 3 - Agrienergie 5, St Joseph, Reunion Island (FR). Image ©Akuoenergy

Reunion Island is a French overseas department located in the Indian Ocean off the coast of Madagascar (lat.: 21S and long.: 55.5E); the climate is tropical, humid. The building energy demand is mainly electric, and accounts for over 80% of the increasing global demand. Due to its insularity, the CO_2 emission factor per kWh of electricity produced is quite high (0,8 kg of CO_2) if compared with other countries. The source to site factor for grid electricity is above 3. PV fields are a possible answer to the need of reducing the ecological footprint and the CO_2 emissions. Nevertheless, in overseas territories of France, it is prohibited to build anything else than structures or buildings necessary for agriculture in agricultural zones. Moreover, on islands, the local authorities do not allow to install ground mounted PV systems.

As a possible answer to the above expressed consideration, Akuo Energy developed a solution for combining food and PV energy production, and this was named Agrinergie®. Different experimentation was done for growing open field food, and then a special PV greenhouse was developed, named Agrinergie 5. This is a cluster of 13 PV greenhouses (with different sizes), for a total of 1.4 MWp installed (Figure 1 and Figure 3), built in a peri-urban agricultural area in the proximity of the city of St. Joseph in the South of La Reunion. The design of the PV greenhouse takes into account some critical issues:

- The availability of all year crops in La Reunion is a problem due to the cyclones, which periodically destroy the crops.
- Agriculture is often difficult due to the effect of strong rain in mountainous areas (such as the one of the project), and the absence of irrigation systems.

The Agrovoltaico® (AV) is a system developed and patented by REM, Revolution Energy Maker. The land available to grow crops thanks to the use of a double axis tracking system hanging from a structure set above the ground. PV modules are installed on metallic beams placed on 5m high poles. The whole structure is composed of parallel corridors (12 m wide) of 6 x 6 pole modules each. The system implies dynamic shading of about 15-20% of the ground, but adjustments to the tracking system can be done to satisfy the crop radiation requirement. The use of a sun tracking system allows for an increase of the PV production of about 25% to 30%, which is more than a standard array system. This partially compensates for the reduced power of the system per area of land. It should be considered that the ground occupation ration of a typical PV array is in the range of 0.3 - 0.4%, whereas in this case it is about 0.1% (4MWp on 4ha). The structure enables farm machinery to freely access the cropping area (Figure 2 and Figure 4).

Three systems have been installed in Northern Italy, two in Monticelli d’Ongina d’Ongina (45° 5’N) and one in Castelvetro (45° 6’N). Regular agricultural activities have been achieved over the last four years. A monitoring campaign on food production when compared to open field growing of crops showed a slight decrease due to the shadow of the PV system.

AGROVOLTAICO, ITALY

Figure 4 - Agrovoltaico® system, Monticelli d’Ongina (IT) Image ©REM

AGRIENERGIE 5, RÉUNION ISLAND, FRANCE

Figure 5 - Inner view of the farmer working in the greenhouse covered by PV system. (Source: © akuoenergy)

The agricultural partner for this project, Jean-Bernard Gonthier, is the current Chairman of the local Chamber of Agriculture. In the case of Agrinergy, the combination of food production with energy generation has been facilitated by the local authorities. One action to bring solar energy in urban planning to the forefront is to communicate this example to the other agricultural partners in terms of opportunities.

References: [1] Scognamiglio A, Garde F, Monnier A, Ratsimba T, Scotto E, Photovoltaic Greenhouses: A Feasible Solution for Islands? Design, Operation, Monitoring and Lessons Learned from a Real Case Study, Tecnical Digest WCPEC 6, the 6th World Conference on Photovoltaic Energy Conversion,

Agrovoltaico, Italy: the developer, Revolution Energy Makers (REM) involved the Catholic University of Holy Hearth, Agricultural, Food and Environmental Faculty, Sustainable sciences and vegetable productions [1].

AGROVOLTAICO, ITALY

Figure 6 - Tractor in action under the PV track system (Photo: © REM)

References: [1] Scognamiglio A, Garde F, Monnier A, Ratsimba T, Scotto E, Photovoltaic Greenhouses: A Feasible Solution for Islands? Design, Operation, Monitoring and Lessons Learned from a Real Case Study, Tecnical Digest WCPEC 6, the 6th World Conference on Photovoltaic Energy Conversion,

Similarities and Differences

SIMILARITIES

The development of renewable energy sources (RES) is a key priority for the European Union, aiming at the protection of the environment and the security. Due to ambitious energy targets, such as the European Directive 2009/28/EC, the so-called 20-20-20 Directive, or the European Building Performance Directive – EBPD, a massive growth of renewable energy application is necessary. Nevertheless, with the increase of the installation, land use and landscape preservation concerns are growing as well.

- The two cases presented here are a solution found by PV developers for overcoming a barrier set by local governments to the implementation of ground mounted PV.
- Both cases are exemplary of a dual use of land: photovoltaics and agriculture.
- In both cases, a research effort was necessary before implementing the two solutions.
- The developers used alternative design solutions for PV, allowing for a dual use of land. Such a solution and the associated data on the performance of such systems are rare.
- In both cases studies on the efficiency of the crops (photosynthesis effect) in shaded conditions are crucial.

AGRIENERGIE 5, RÉUNION ISLAND, FRANCE

Figure 7 - Detailed view of the PV system integrated in the roof of one greenhouse block. (Source: © akuoenergy)

AGROVOLTAICO, ITALY

Figure 8 - View of the PV track system during the first crop. (Source: © REM)

DIFFERENCES

- The two cases are examples of different technologies: agricultural greenhouse with PV integrated into the rooftop (FR), and suspended double tracking PV (IT).
- Besides the double use of land, the case study in La Reunion adds one more feature to the chosen solution: the greenhouse facilitated the production of vegetables all year round. This is an important benefit in a region where strong winds and hurricanes do not allow vegetable growth all year round, which results in most food being imported from other countries.
- In Agrovoltaico, the sun-tracking PV system implies dynamic shading obstruction of sunlight on the ground. However, adjustments to the tracking system allow to satisfy the crop radiation requirement for plants.

LESSONS LEARNED

- For these two examples, the approach was a bottom-up. The developers had to spend a significant amount of time in order to find an approach with a good balance between landscape preservation issues and energy target. To make the implementation process easier, guidelines and procedures should be developed. Moreover, an appropriate planning phase should identify designated areas suitable for installing PV.

AGRIENERGIE 5, RÉUNION ISLAND, FRANCE

Figure 9 - Aerial view of the PV system integrated in the roof of the greenhouses from the North (Source: © akuoenergy)

AGROVOLTAICO, ITALY

Figure 10 - View of the PV track system during the first crop. (Source: © REM)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- In sensitive landscapes, such as agricultural and heritage ones, the use of renewables should be carefully assessed. In order to meet energy goals, matching quality objectives set by local authorities, the planning and design phases are crucial. Taking the appropriate approach the use of PV, coupled with other functions, can positively impact on the landscape.
- Through multi-criteria decision supporting systems, the right site should be chosen, and guidelines based on landscape quality objectives should be developed.

Credits

SIMILARITIES

Akuo Energy
Austral energy

CONSULTANTS

Engineering company (N/A)

CASE STUDY AUTHORS

François Garde, University of Réunion (France), Anne Monnier, Akuo Energy (France), Alessandra Scognamiglio, ENEA (Italy)

OWNERS

Energy company (N/A)

STAKEHOLDERS

Jean Bernard Gonthier, farmer

RESEARCH ORGANISATIONS

ARCHITECT, DESIGNER AND DEVELOPER

REM Revolution Energy Maker staff

CONSULTANTS

Many industrial and scientific consultants. Among the others, for crops efficiency: Institute of Agronomy, Genetics and Field crops from the Catholic University of Sacred Hearth of Piacenza.

CASE STUDY AUTHORS

Alessandra Scognamiglio, ENEA (Italy)

OWNERS

REM Revolution Energy Maker

STAKEHOLDERS

REM Revolution Energy Maker

RESEARCH ORGANISATIONS

ACKNOWLEDGEMENTS

The authors wish to thank Sergio Praderio: images and general information and Alessandro Reboldi: specific engineering information.

4.3 DENMARK - SWEDEN

AUTHOR SWEDISH TEAM

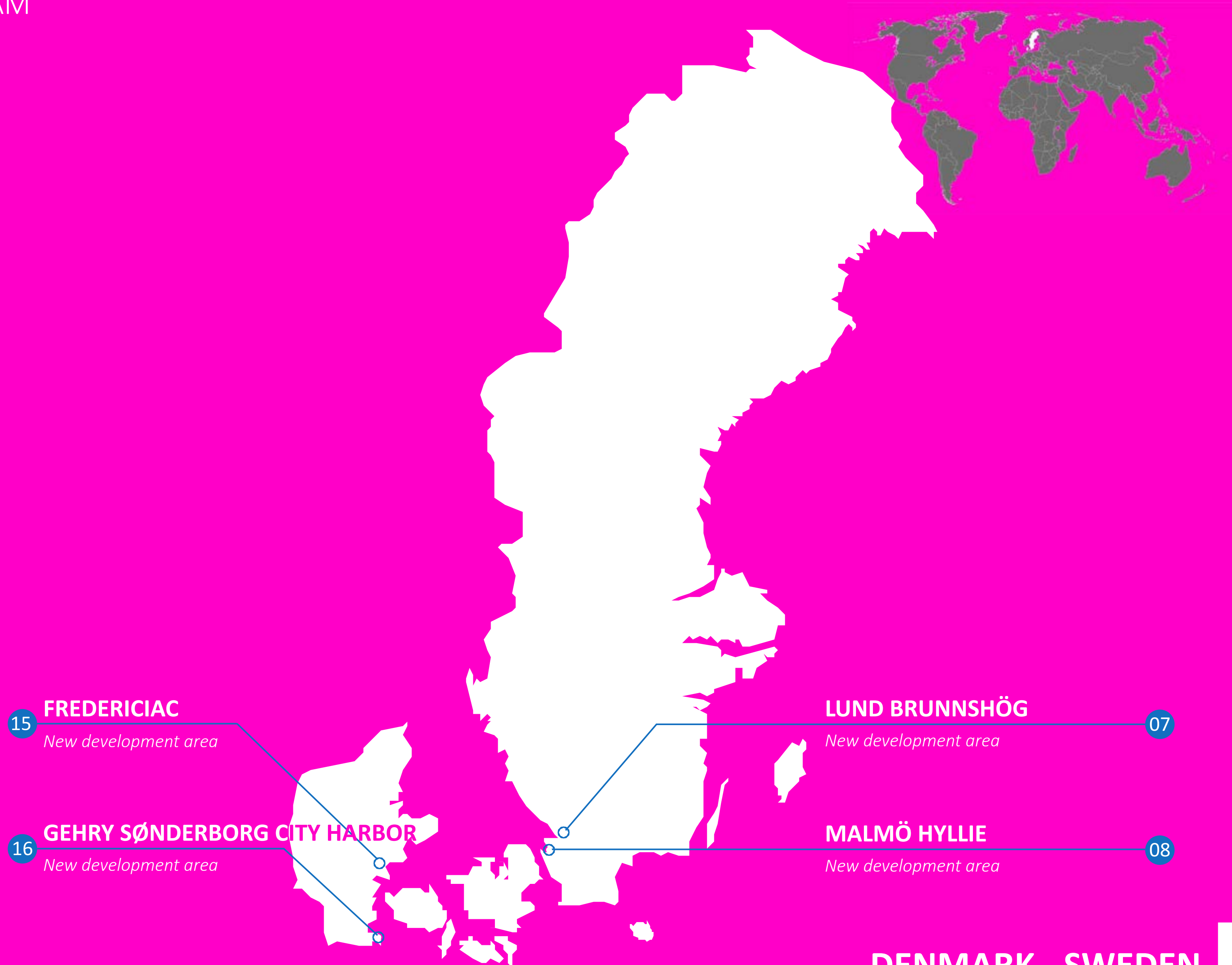
Jouri **Kanters**

Energy and Building Design
Lund University

AUTHOR DANISH CASE

Olaf **Bruun Jørgensen**

Danish Energy Management & Esbensen



DENMARK - SWEDEN

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

LUND BRUNNSHÖG

SWEDEN

MALMÖ HYLLIE

Figure 1 - Lund Brunnshög (Source: © White Arkitekter)

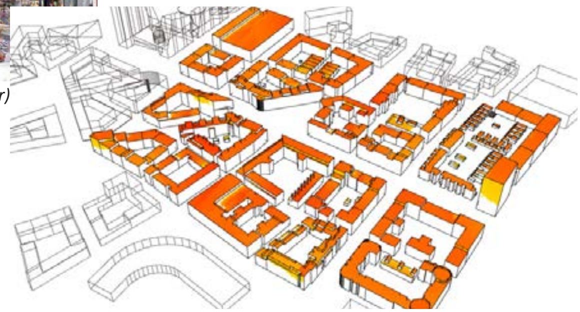


Figure 2 - Malmö Hyllie (Source: © Jouri Kanters)

In these years, several new urban areas are being developed in Denmark and Sweden. Many of these projects have high sustainability goals, which are achieved in different ways.

Figure 3 - FredericiaC (Source: © KCAP)

Figure 4 - Gehry city harbor in Sonderborg (Source: © Gehry Partners, LLP)

Even though the projects are different in scale and are subject to different national legislations, the results and lessons learned from the planning process are valuable for future sustainable urban development in countries dealing with the same challenges regarding minimized energy demands, optimised solar utilization, ensuring attractive outdoor micro climate conditions and good daylight access.

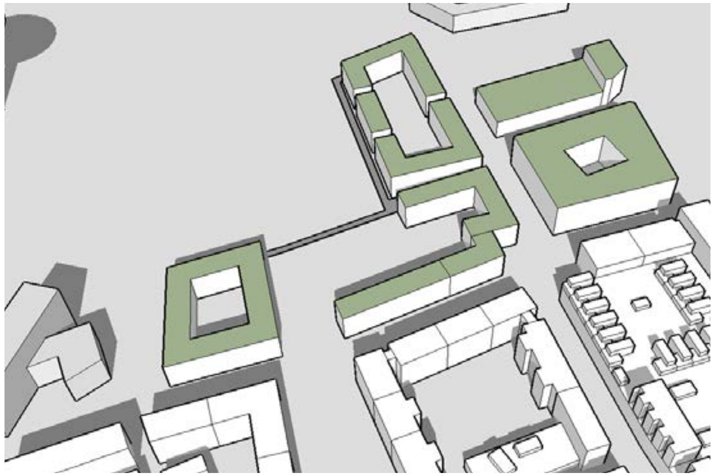
FREDERICIAC

DENMARK

GEHRY CITY HARBOR IN SØNDERBORG

Overview of the cases

LUND BRUNNSHÖG/ MALMÖ HYLLIE, SWEDEN

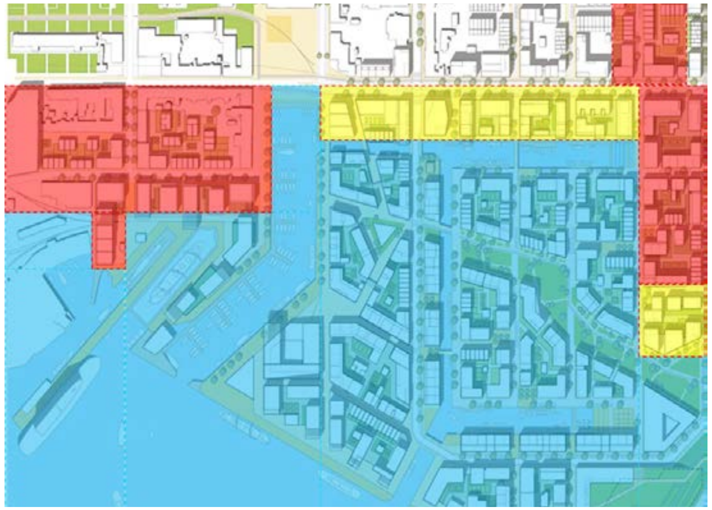


Scale: In the four cases, relative large-scale urban developments are described (Frederica, Denmark 200.000 m^2, Lund, Sweden 2.500.000 m^2, Malmö, Sweden 500.000 m^2 and Sönderborg, Denmark 50.000 m^2). All four cases are within existing cities or at the city boundaries. Large-scale developments require a different approach for implementing solar energy than smaller districts or several blocks of buildings. For large districts, solar energy will often be mentioned as a strategy to produce renewable energy on site, but is seldom specified in quantitative targets, like produced energy. Most planning processes progress from a large scale (zoning plan) towards the building scale. Working down from large scale to smaller scale also means that different aspects of solar energy need to be addressed; for example a first potential study on the urban planning level towards the design of a specific technical layout of a PV system [1].

Figure 5 - (on the left) First stage of development. (Source: © Atkins);
(on the right) Top view of the solar neighbourhood. (Source: © Malmö Stad)

References: [1] Kanters, J. & Wall, M., 2016. A planning process map for solar buildings in urban environments. Renewable and Sustainable Energy Reviews, 57, pp.173–185.

Planning process: In the Swedish planning process, the 'urban designing' is done by the municipal urban planning department. They set building footprints, building heights, roof angles, form of the buildings, range of materials, etc. This is normally also the case in Danish urban planning processes. In the Danish cases selected for IEA SHC Task 51, the urban design is also done by external architects and urban planners. This has lead to a difference in how solar energy is dealt with throughout the whole process and it has also enabled the landowner to set up higher ambitions and demands with respect to energy performance and implementation of solar systems than what is possible for the municipalities within Danish legislation. With the typical Swedish and Danish setup, one advantage is that it might be easier to set up routines for dealing with solar energy. One disadvantage is that due to the fact that many different departments of the city administration are involved, the process might get slowed down.



FREDERICIAC/GEHRY CITY HARBOR IN SØNDERBORG, DENMARK

Figure 6 - (on the left) Proposed heating supply, Blue: Heat pumps, Red: District heating, Yellow: Heat pumps or District heating (Source: © DEM & Esbensen A/S);
(on the right) Plan of the types of buildings of the Gehry city harbor in Sonderborg (Source: © Sønderborg Harbor Company)

LUND BRUNNSHÖG/ MALMÖ HYLLIE, SWEDEN

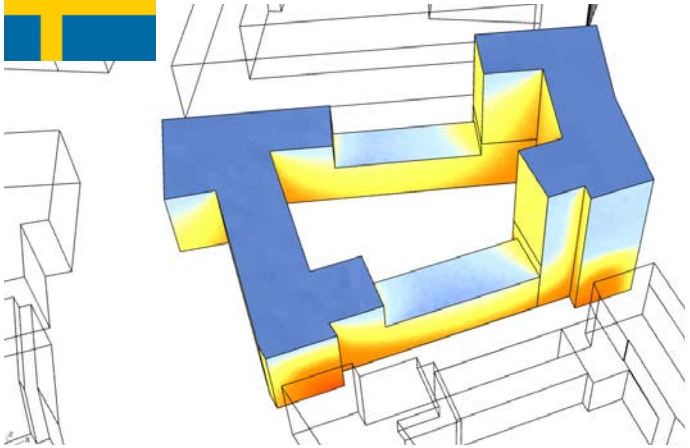


Figure 7 - *Annual solar irradiation on the building envelope (Source: © Jouri Kanters)*

The ownership of the land sets the framework for implementing solar energy in a later stage. In the Danish cases, the role of the stakeholders is clearly the driving force in order to ensure high ambitions with respect to increasing implementation of solar in new urban developments.

FREDERICIAC/GEHRY CITY HARBOR IN SØNDERBORG, DENMARK

Figure 8 - *(on the left) Roof areas suitable for implementation of PV. Green marks roof areas with no shading. Yellow marks roof areas with shading 2 – 3 hours pr. day. 70% of the roof area is suitable for implementation of PV. (Source: © Dansk Energi Management & Esbensen A/S); (on the right) Merged shadows on March/September at 09:00, 12:00 and 15:00 for the final development plan. (Source: © DEM & Esbensen A/S)*

SIMILARITIES

- The Danish and Swedish cases all are large scale developments close to existing cities. In almost all Danish and Swedish cases, first a zoning plan was developed. With the help of a 3D model, the solar potential of that first plan was calculated and served as a base case (Figure 9 and Figure 10).

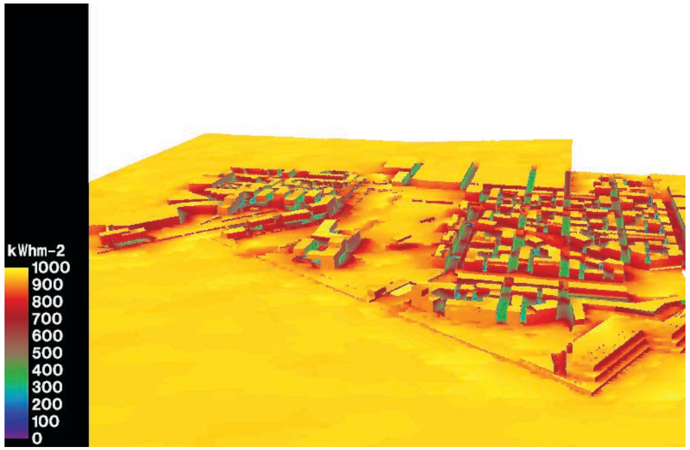
LUND BRUNNSHÖG/ MALMÖ HYLLIE, SWEDEN

Figure 9 - Simulation of annual solar irradiation. (Source: © Jouri Kanters)

DIFFERENCES

Some important differences between the cases could be noted.

- In the Danish cases, land is owned by a (semi) private owner, while in the Swedish cases, the land in these case studies is owned by the municipality. This gives a different framework for the implementation of solar energy. In the Swedish context, the municipality has limited legal instruments to put requirements on future real estate developers. The only instruments are the detailed development plan, where roof angles could be set, as well as a requirement on the materials that should be used in the buildings. If the land would have been owned by a private owner it would have enabled even higher levels for the specific areas.
- Overall energy targets, like CO_2 neutrality, minimized energy demands and maximized implementation of local renewable energy production are clear in the Danish cases but not in the Swedish cases. The goals in the Swedish cases are more of a non-binding (voluntary) character. In the Swedish cases, the existing urban district heating network is almost always extended into the new development. Since prices are low at certain periods of the year, solar thermal is almost never considered in the planning process.
- In the Danish case studies, it is of high importance that the masterplans are designed in a way that ensures sufficient daylight access to the facades of the future buildings. Thus, the proposed masterplans have been carefully analysed and optimised in order to ensure good daylight access to the facades of the individual buildings (Figure 11).



FREDERICIAC/GEHRY CITY HARBOR IN SØNDERBORG, DENMARK

Figure 10 - Solar irradiance on roofs and facades, early stage. (Source: © DEM & Esbensen A/S)

Figure 11 - Illustration of study of facades and the level of daylight incidence on the facades for a future urban development. (Source: © DEM & Esbensen A/S)

Similarities and differences

SIMILARITIES

- In both the Danish and Swedish cases, solar potential studies were performed with a Radiance-tool. In the Swedish cases, the simulations were performed by the involved researchers from Lund University and in the Danish cases the simulations were carried out by the involved consultants (Danish Energy Management & Esbensen A/S).

LUND BRUNNSHÖG/ MALMÖ HYLLIE, SWEDEN

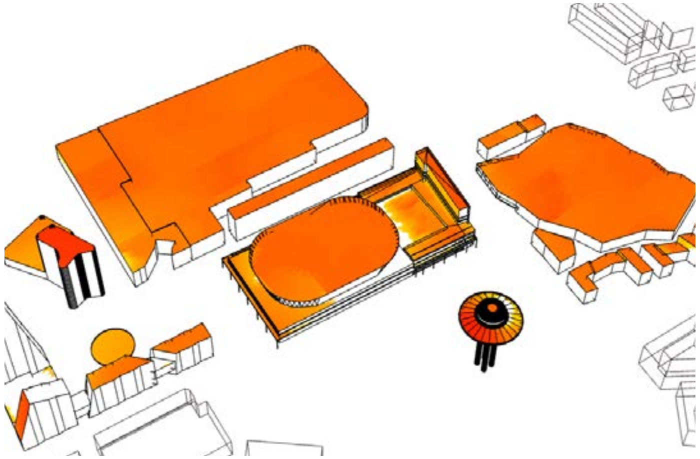


Figure 12 - *Simulation of annual solar irradiation. (Source: © Jouri Kanters)*

DIFFERENCES

- The daylight studies (see figure 11 on page 91) have focused on ensuring that a daylight factor of at least 2% may be achieved in the future buildings in respective areas. This is of key importance as it is impossible to adjust for poor daylight access once the buildings have been placed and constructed in an inappropriate way. Achieving a daylight factor of "2%" in Denmark is typically considered to ensure good daylight conditions according to the Danish building code. These analyses are based on a method developed as part of a business PhD at Esbensen Consulting Engineers [2]. The current Swedish building regulations state that future buildings should have a Daylight Factor of at least 1% [3]. This is however dealt with on the building scale and it is up to the respective owner of the building to reach this goal.

- In the Danish cases it has been important also to analyse and optimize the outdoor micro climate conditions, especially with respect to shading and ensuring a pleasant and varied solar incidence to the open public spaces (Figure 13 and Figure 14). Since the Swedish law does not quantify and / or prescribe a method for ensuring attractive micro-climate conditions, optimisations of the zoning plan are therefore often not carried out in the urban planning phase.

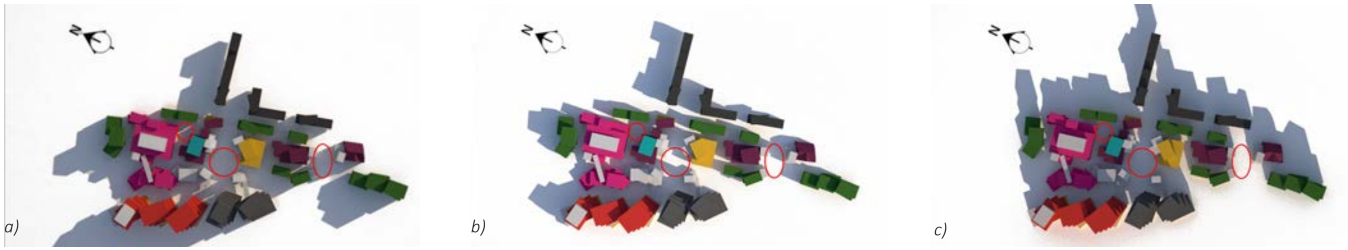


Figure 13 - *Shadows at 9.00 (a), 12:00 (b) and 15:00 (c) on the 21st of September in the first version of the masterplan (Source: © Dansk Energi Management & Esbensen A/S).*

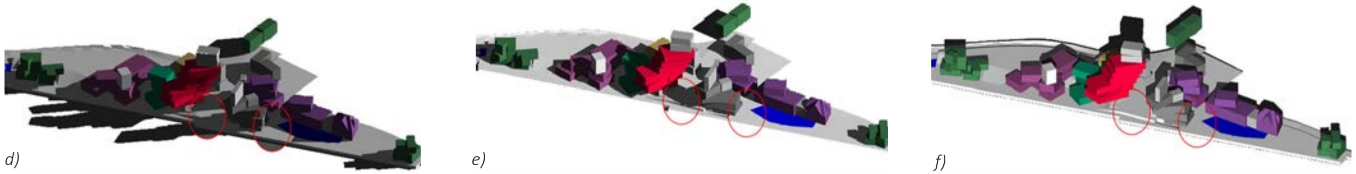


Figure 14- *Shadows at 9.00 (d), 12:00 (e) and 15:00 (f) on the 21st of September after adjusting the masterplan (Source: © Dansk Energi Management & Esbensen A/S).*

References: [2] Iversen, A, 2012. Development of a simple framework to evaluate daylight conditions in urban buildings in the early stages of design. PhD Thesis. Civil Engineering Report R-256 ISBN: 9788778772288. Department of Civil Engineering. Technical University of Denmark

[3] Swedish National Board of Housing Building and Planning, 2016. Swedish building code BBR

FREDERICIAC/GEHRY CITY HARBOR IN SØNDERBORG, DENMARK

LESSONS LEARNED

In general, common conclusions can be drawn for the Danish and the Swedish cases. Setting up specific (and quantitative, measurable) goals would make it easier for all involved actors to work on the integration of more solar energy in future cities. Just looking at the potential is a first step in the process, but then it should be ensured how this first potential study can be transferred into the physical installation of solar energy systems.

LUND BRUNNSHÖG/ MALMÖ HYLLIE, SWEDEN

Figure 14 - Vision (Source: © Anna Klara Lundberg)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

For the Danish as well as the Swedish cases, the whole design team should be more aware of the possibilities and limitations of solar energy. It is also important to understand that different kinds of information and expertise should be available to the design teams at different stages of the design process.

FREDERICIAC/GEHRY CITY HARBOR IN SØNDERBORG, DENMARK

Figure 15 - Green park used for gardening, sports and recreation. (Source: © KCAP)

Credits

DEVELOPER

Urban planning department of the city of Lund
Urban planning department of the city of Malmö

STAKEHOLDERS

City of Lund, potential real estate developers
City of Malmö, potential real estate developers

CASE STUDY AUTHORS

Jouri Kanters (Lund University, Sweden)

OWNERS

City of Lund
City of Malmö

ACKNOWLEDGEMENTS

Lund University would like to thank the Swedish Energy Agency for the financial support.

RESEARCH ORGANISATIONS

Lund University

DEVELOPER

FredericiaC P/S

CONSULTANTS

Dansk Energi Management & Esbensen A/S
KCAP Architects Planners
Vandkunsten

CASE STUDY AUTHORS

Olaf Bruun Jørgensen,
Dansk Energi Management & Esbensen A/S

OWNERS

FredericiaC P/S

STAKEHOLDERS

FredericiaC P/S
The planning department of the Municipality of Fredericia
Private developers

RESEARCH ORGANISATIONS

Dansk Energi Management & Esbensen
En del af Danish Management Group

ACKNOWLEDGEMENTS

The authors wish to thank FredericiaC P/S

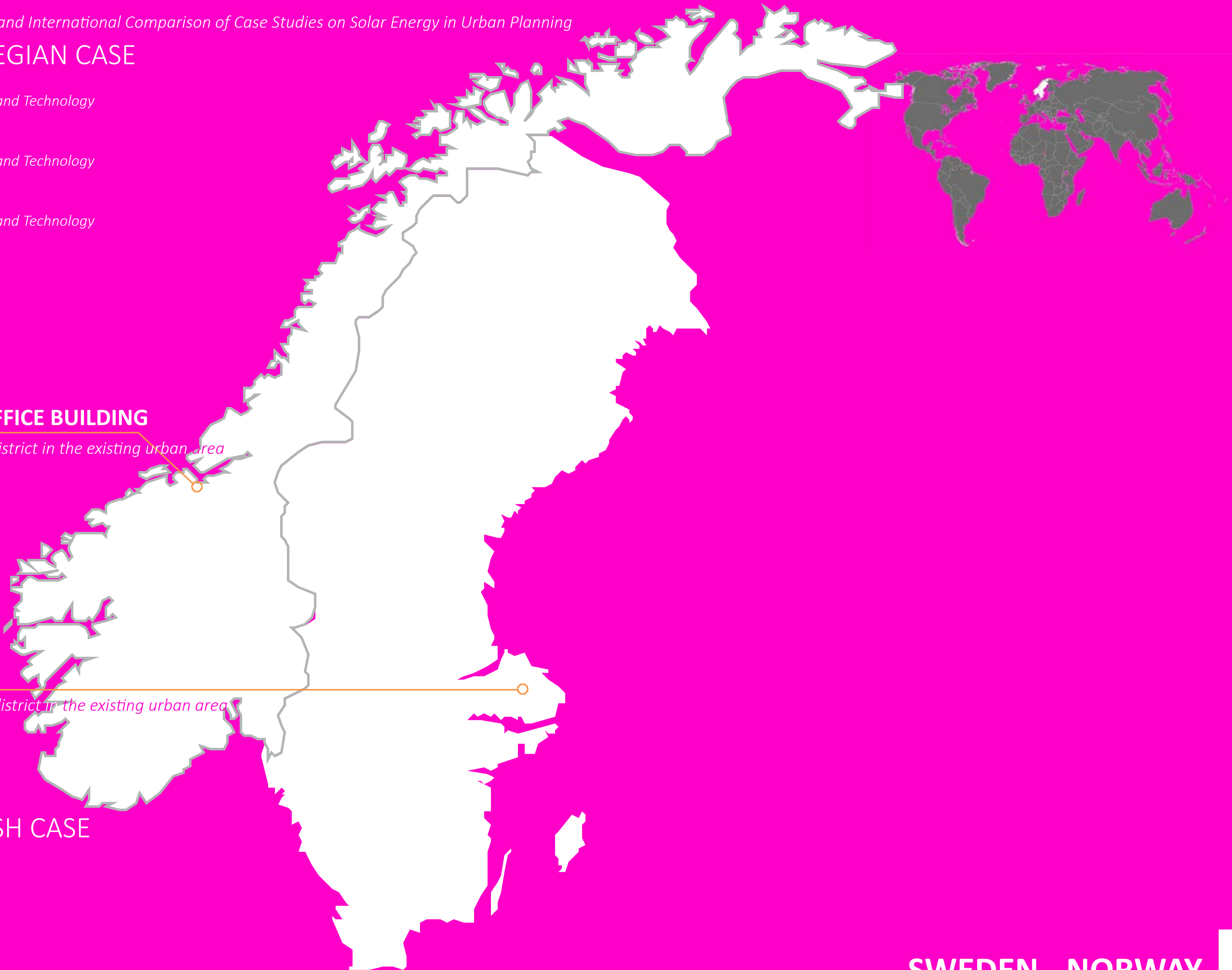
4.4 SWEDEN - NORWAY

AUTHORS NORWEGIAN CASE

Carmel **Lindkvist**
Norwegian University of Scencie and Technology

Gabriele **Lobaccaro**
Norwegian University of Scencie and Technology

Annemie **Wyckmans**
Norwegian University of Scencie and Technology



18 **ZERO EMISSION OFFICE BUILDING**
Fill-ins and densification district in the existing urban area

17 **FRODEPARKEN**
Fill-ins and densification district in the existing urban area

AUTHORS SWEDISH CASE

Johan **Dahlberg**
White Arkitekter AB

Marja **Lundgren**
White Arkitekter AB

SWEDEN - NORWAY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

FRODEPARKEN

SWEDEN

The implementation of solar energy in an urban environment, where the potential of overshadowing is high, is not deeply considered in current planning processes in Sweden and Norway as indicated in the cases of Frodeparken, Uppsala, Sweden and Solar Building (pseudonym), Trondheim, Norway. These cases described here present a relatively common scenario that brings up questions regarding solar rights in urban planning.

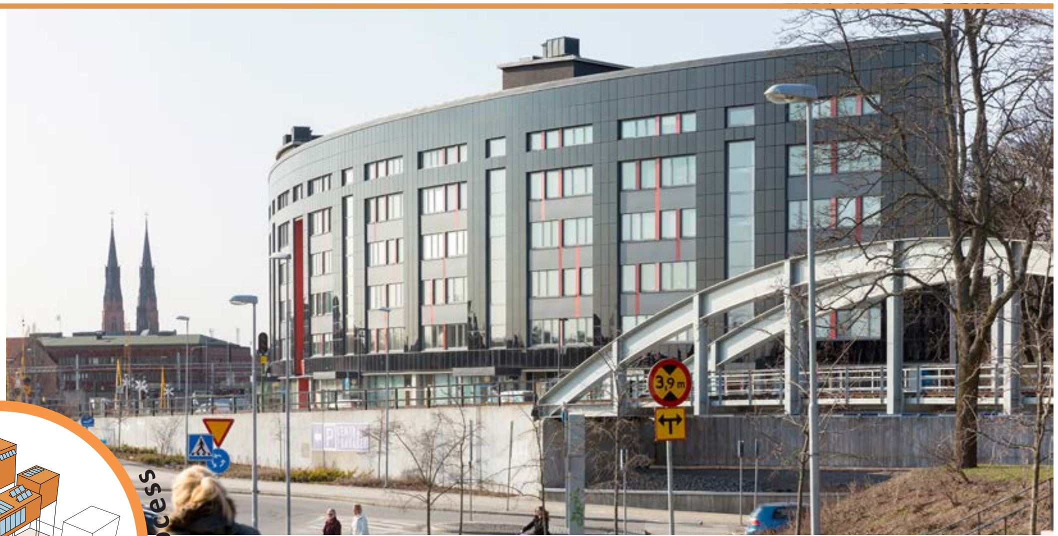


Figure 1 - Frodeparken. (Photo: © Thomas Zaar, White Arkitekter, 2013)

Figure 2 - North view of the office building in Trondheim, Norway. (Photo: © Glen MUsk, Adresseavisen)

We define solar rights as a situation when an existing building with installed solar technology becomes or runs the risk of becoming shaded from a new building. There is a necessity to rethink integrated planning processes and legislation when it comes to installation of solar energy in buildings in an urban scale in order to ensure that ambitious targets can be realized rather than dependent on unknown futures of surrounding areas.

ZERO EMISSION OFFICE BUILDING

NORWAY

FRODEPARKEN, UPPSALA, SWEDEN

Figure 3 - Frodeparken. (Photo: © Thomas Zaar, White Arkitekter, 2013)

Frodeparken is an ambitious project that has the largest solar façade on a residential building in Scandinavia. It was finished in 2013. White architects designed the building for a developer. A separate company was involved in the technical issues relating to the solar façade. The municipality was responsible to design the detailed development plan (detaljplan) for the area which regulates building heights, floor area etc. The detailed development plan was approved in 2009. In 2004 a neighbouring plan was approved by the municipality which allows for a building that could potentially shade the solar façade on Frodeparken. This plan only regulates number of floors and not height of the building. In the design process of Frodeparken a shading study was done with a generic volume but not a solar potential study.

The municipality has since held a competition for the neighbouring plot. According to the developer who won the competition, construction was set to begin in 2015. The competition asked for "the most sustainable building in Scandinavia" which also is promoted by both the developer and the architect firm designing the new building. It is unclear whether this includes consequences on surrounding buildings or not.

A radiation study has been done comparing the situation before and after the new building, based on the design in the submission for the competition. The result shows that the annual radiation differs from 766 kWh/m^2,yr (before new building) to 695 kWh/m^2,yr (after new building). This implies that the new building will cause a reduction of the annual electricity production by nearly 10%. Even though these kinds of radiation studies were not considered in the power output calculations, the estimate was reduced by 10% because it was known that a new building would eventually partly shade the façade. This also correlated to measured power output the first couple of years which were higher than calculated because the shading building had not yet been built.

The "Solar building" in Trondheim is a new commercial building which was complete in 2012. The building has 121 PV modules (200 m2), integrated into the South and West façades, arranged in 9 strings with a total rated power of 27.2 kWp (kilowatt peak). At the time of completion the estimated annual production was approx. 18 000 kWH but actual production in 2013 showed production was 14 400 Kwh. So what changed? This case cannot be understood by examining the building as a singular entity but requires an expanded focus of the surrounding buildings – specifically a student building and a high rise hotel building which were built a year after the Solar Building. The height of these buildings resulted in shading the Solar Building which dramatically impacted on the production of energy. A case study conducted by NTNU on the impact of the urban surrounding area demonstrated, that the complex overshadowing effect, influences the solar radiation on the BiPV South façade, reducing more than 30% of its solar potential [1]. The case questions the robustness of planning processes to protect solar rights as these buildings were built within in a close time period of each other and some planning decisions overlapped. However, the planning process seemingly did not consider the impact of building heights on the Solar Building. Also, there were changes in rules between the time Solar Building was built and the other buildings in terms of where to locate the solar panels. Solar Building was prohibited from putting the solar panels on the roof and so there was a decision to place the panels on the façade which negatively impacted on the amount of solar access of the building. This ruling changed for the hotel building which was allowed to put solar panels on the roof. Also a late change in the student building to increase it by one floor resulted in further limitation to access to solar. The case highlights the need to examine solar rights during planning processes in urban areas in order for buildings to sustain the energy efficient, not just at time of completion but for the long term future.

ZERO EMISSION OFFICE BUILDING, TRONDHEIM, NORWAY

Figure 4 - North view of the office building in Trondheim, Norway. (Photo: © Gabriele Lobaccaro)

References: [1] Good, C. S., Lobaccaro, G., & Hårklau, S. (2014). Optimisation of solar energy potential for buildings in urban areas- a Norwegian case study, Energy Procedia, 166-171.

Stakeholders involvement

FRODEPARKEN, UPPSALA, SWEDEN

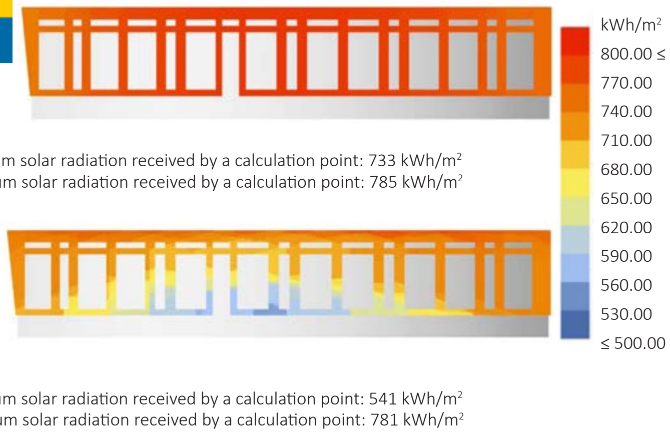


Figure 5 - (on the top) Simulated solar radiation with an unobstructed façade; (on the bottom) Simulated solar radiation considering the effect of Juvelen, on the façade.

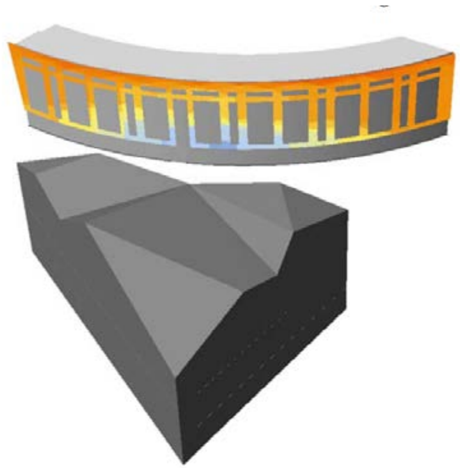


Figure 6 - Screenshot from simulation in Rhino/Grasshopper with context building

The legislation in Sweden does not mention solar energy specifically. According to the national building code (BBR), locally produced energy can be deducted from requirements for energy performance.

In the Planning and Building act (PBL), which regulates the planning process and land use allocation, there are no specific requirements that shading has to be taken into account. When a new site is planned, for PBL, give surrounding land owners and other stakeholders the opportunity to voice their concerns and appeal the plan. There are some cases where an appeal to redesign a plan because of shading issues have been approved. In all cases found it is with regard to daylight though and not active solar installations.

Therefore, it is still unclear how Swedish legislation relates to solar rights. Since it is not mentioned specifically the property owner of the building needs to appeal a land-use plan or a building permit to test the legislation.

There is current legislation in Norway, which does not specifically address solar energy, but where solar energy is a viable solution and applicable referred to in planning and building regulations. These are outlined below.

Plan- og bygningsloven (Planning and building regulation)

This is a general planning and regulation application for both new building and changes to existing building. Applications are managed by municipality. This legislation is relevant on solar energy solutions in new buildings. It is not necessary for existing buildings if the changes are not significant, for example installing solar panels into an existing private home. Significant changes fall under changes to the façade, changes to a protected building (historical or cultural significance) or major changes to the existing structure – then the municipality would have to be notified.

Tek 10 and Tek 17

Tek 10 and the updated version soon to be implemented, Tek 17, applies to new buildings or a very large rehabilitation. There is a lot of regulation when it comes to energy and if a building is considered quite big, you cannot heat it with only oil or electricity and another energy source must be sought. While it does not refer specifically to solar, this is an option. Tek 17 is developed with the building industry to make Tek 10 more precise and transparent.

Legislation which will impact solar energy is under development in Norway on a national level.

Plusskundeordningen (Consumer/Producer of energy)

Plusskundeordningen is under a hearing process and has been developed to include more flexibility in connecting to the grid. For example, if you have a solar plant and you are using electricity- you are allowed to connect to the grid.

Figure 7 - A view of PV system installed on the South façade that results partly covered by the shadowing. (Photo: © Carmel Lindkvist)

Similarities and Differences

SIMILARITIES

- The scale in both cases is similar as they both relate to how one building solar access is effected by its neighbouring buildings.
- Norway and Sweden also have similar planning legislation and from an international perspective the planning process works more or less the same.
- Legislation does not consider the broader aspects of solar energy which is relevant in development of urban areas as illustrated in the Swedish and Norwegian cases.
- There is quite a narrow focus on buildings with no consideration of how surrounding areas can impact on energy efficient targets achieved through the implementation of a solar solution.
- Technology-wise the two cases both have thin-film façade-integrated BiPV

Figure 8 - Night view of the Frodeparken (Photo: © Thomas Zaar, White Arkitekter, 2013)

Figure 9 - South view of the BiPV facade (Photo: © Carmel Margaret Lindkvist)

DIFFERENCES

- Frodeparken is larger than the Norwegian case and the buildings in the Swedish case (both Frodeparken and the new) have higher ambitions regarding solar integration.
- White has also been directly involved and responsible for the design of Frodeparken while NTNU has taken a retrospective examination of a complete building.
- The most significant difference is the fact the calculations for the power output in Frodeparken considered a future shadowing building, something that was not possible in Trondheim since plans changed after the building was completed.

LESSONS LEARNED

- Both cases highlight that planning and building design needs to include solar access rights of individual buildings in order to move toward not just sustainable buildings but sustainable districts.
- The cases question why buildings which have a solar installation are vulnerable to shading from future buildings and that this needs to be considered in planning processes. It is important to understand that this can be an issue when plans for neighbouring plots change such in the Trondheim case, while in a situation where an area is thoroughly planned from the beginning it is easy to account for the impacts of future buildings, such as in Frodeparken.
- The Swedish study particularly indicates that the word “sustainability” can be ambiguous in an urban environment as it is not clear if it is only associated with targeted building or surrounding areas.
- The two cases indicate that urban planners are not prepared to understand how their decisions impact the efficiency in existing solar installations. This correlates to a larger long-term issue that urban planning and energy planning tend to be separate processes.

FRODEPARKEN, UPPSALA, SWEDEN

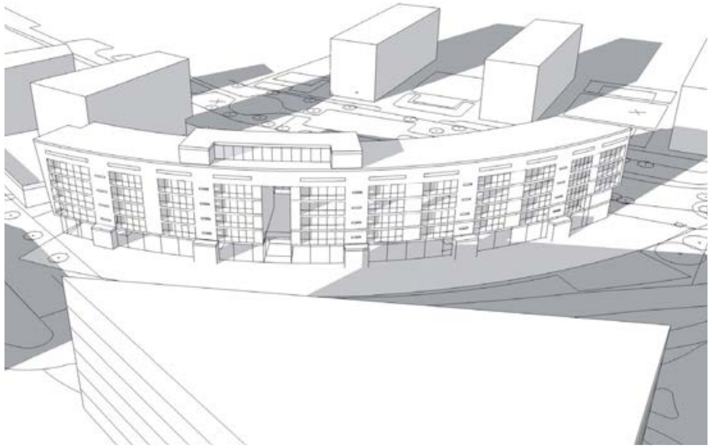


Figure 10 - Part of shading study of Frodeparken with a generic volume on the site of Juvelen (Source: © White Arkitekter, 2010)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- More knowledge is needed around how legislation and planning processes could support the preliminary study at urban scale. As of yet, the impacts of a shadowing building on a solar installation has not been tried in Swedish or Norwegian legislation.
- Conducting solar potential analyses, solar radiation mapping and/or the use of any other method, approach and tool addressing the solar accessibility and solar potential should be included as a common practice in the feasibility study of professionals (i.e. urban planners, architects etc.) as well as in the planning process of urban decision makers and municipalities especially in the early planning phases.

Figure 11 - Top view from the South of Lerkendal district. (Photo: © Fredrik Valde Anthonisen and Edvard Schreiner Sjøblom)

CREDITS

ARCHITECT, DESIGNER AND DEVELOPER

White arkitekter

CONSULTANTS

Direct Energy

CASE STUDY AUTHORS

Johan Dahlberg, Mats Åberg and Marja Lundgren, White arkitekter

OWNERS

Uppsalahem

MUNICIPALITY, PLANNING DEPARTMENT, BUILDING ARCHITECTS

Uppsala municipality Utopia

RESEARCH ORGANISATIONS

white

ARCHITECT, DESIGNER AND DEVELOPER

Tegn 3

CONSULTANTS

Sweco Norway AS; SINTEF/Byggforsk and Enova

CASE STUDY AUTHORS

Carmel Lindkvist, NTNU; Gabriele Lobaccaro, NTNU; Annemie Wyckmans, NTNU.

OWNERS

Skanska Development AS

STAKEHOLDERS

Reinertsen

RESEARCH ORGANISATIONS

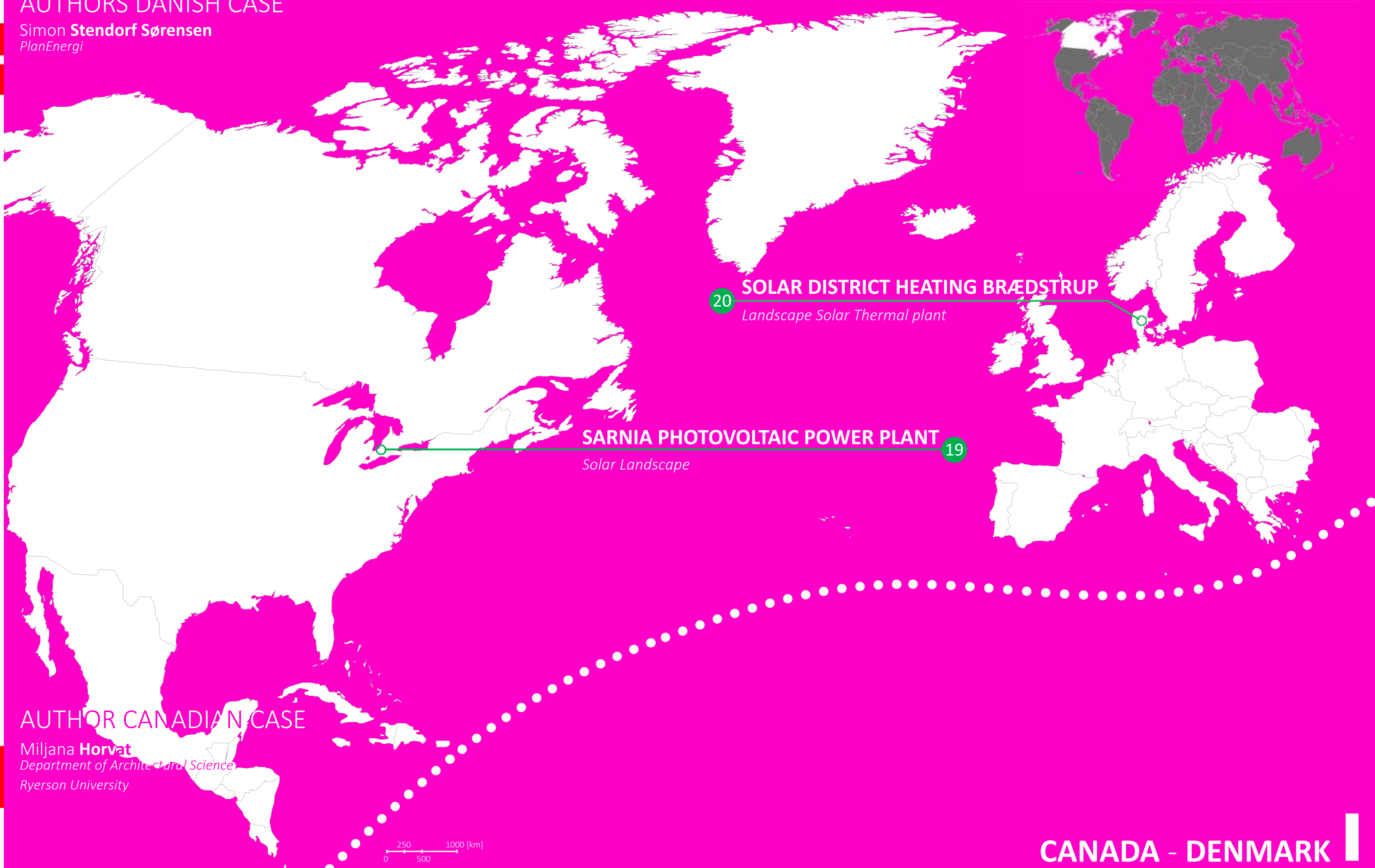
NTNU
Norwegian University of Science and Technology

ACKNOWLEDGEMENTS

The authors wish to thank Clara Good, (NTNU) Siri Hårklau (NTNU), Fredrik Valde Anthonisen (NTNU), Edvard Schreiner Sjøblom (NTNU), Ole Tolstad (NTNU), Ann Iren Bævre (Adresseavisen), Olav Wold (Adresseavisen), Glen Musk (Adresseavisen) for the the data, the materials and the copyright of the picture inserted in the cover.

4.5 CANADA - DENMARK

AUTHORS DANISH CASE
Simon **Stendorf Sørensen**
PlanEnergi



AUTHOR CANADIAN CASE
Miljana **Horvat**
Department of Architectural Science
Ryerson University

CANADA - DENMARK

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

SARNIA PHOTOVOLTAIC POWER PLANT

CANADA

The effect of the solar farms installation on the local landscape and agricultural land can be observed by comparative overview of two projects: Brædstrup (Denmark) and Sarnia (Canada). Even though these projects utilize different technologies (solar thermal in Denmark, and PV in Canada), sufficient commonalities between them present valuable lessons in successfully addressing similar challenges.

Figure 1 - Photo: © Daniel Bellyk

Figure 2 - Photo: © Brædstrup Fjernvarme

SOLAR DISTRICT HEATING BRÆDSTRUP

DENMARK

SARNIA PHOTOVOLTAIC POWER PLANT, CANADA

Figure 3 - Aerial view of the Sarnia Solar Project. (Source: © Enbridge Inc.)

When completed in 2010, Sarnia Photovoltaic Power Plant was the largest in the world and still continues to be the largest in Canada. Located near the city of Sarnia, province of Ontario, Canada, and situated on the 3 850 000 m^2 of land, it generates enough power to serve 12 800 homes. It saves 39 000 tonnes of CO2 (compared if this amount of energy was produced by coal power plant). Originally developed by First Solar Inc., the Sarnia Solar plant was developed under the RESOP (Renewable Energy Standard Offer Program, that later evolved into the Feed-in-tariff - FIT), launched by Ontario Power Authority in order to stimulate smaller distribution connected projects ≤ 10MW. The program was so attractive that the developers were breaking larger scale projects in order to qualify for the lucrative price of $420/MWh for 20 years long contracts. Sarnia was also done in phases, and finally was bought by Enbridge Inc. and upgraded to its final size of 80MW. [2]

Sarnia Photovoltaic Power Plant employs 1.3 million CdTe (cadmium telluride) thin-film fixed-tilt ground-mounted modules. Tilt angle is 25° and modules are 0.6 x 1.2 m in dimensions, elevated 1 meter above the ground. The land under the solar modules, which was once used for agriculture, does not have any alternative use. From above, the solar module layout (uniform, parallel rows, straight borders) fits within the grid of the surrounding farmland. [3]

References: [2] Enbridge completes Sarnia solar farm, CBS news October 4th, 2010; [3] A. Obin, Enbridge Inc., personal communication with K. Saunders, March 11th, 2016

Solar District Heating Brædstrup is a solar thermal plant of 18 600 m^2 ground mounted solar thermal collectors (using 70 000 m^2 land area) installed and run by Danish district heating company Brædstrup Fjernvarme. The solar collectors were installed in two stages, starting in 2007 and expanded in 2012. When the second stage was finished, it was the largest solar thermal plant in Europe. It is a goal to expand the solar thermal plant further, potentially reaching 60 000 m^2 solar collectors using a land area of 150 000 m^2.

The plant is located in landscape close to the town Brædstrup (around 3 500 inhabitants) where the heat is used. It is integrated in the natural landscape levels, and sheep are grazing on the areas beneath and between the solar collectors. The heat production from the solar thermal collectors is substituting heat production previously based on natural gas, generating an annual CO_2 reduction around 3 700 tonnes.

The plant is a typical example of landscape solar thermal plants in Denmark, with a heat production covering around 20% of the annual heat demand in a related local district heating system. During the last 10 years installation of large-scale ground mounted solar thermal plants have increased strongly in Denmark to a total installed capacity of 550 MW in 2015 equivalent to twenty times the installed capacity in 2005 [1].

SOLAR DISTRICT HEATING BRÆDSTRUP, DENMARK

Figure 4 - Aerial view of the solar plant in landscape next to the town of Brædstrup.(Photo: © Brædstrup Fjernvarme)

References: [1] PlanEnergi (2016): List of Danish Solar District Heating Plants – January 2016

Overview of the cases

SARNIA PHOTOVOLTAIC POWER PLANT, CANADA

Figure 5 - The view of the system (Photo: © Daniel J Bellyk)

Several issues have been noted in relation to the design and building of the Sarnia Photovoltaic Solar Plant. Namely:

- The nature of the ground-mounted installation renders the land useless for any purpose aside from energy generation;
- The system is located close to a town of Sarnia and within a sprawling and flat agricultural landscape, which can impede future expansion of the city as the other side is limited by the lake;
- Although the land was previously farm land, which is usually protected from being developed on, it was re-zoned as industrial land prior to this installation; [4]
- Neighbours were concerned about drainage, lighting in the plant at night, and vegetation management.

References: [4] P. Carrie, Enbridge Inc., personal communication with M. Horvat, July 15th, 2016

The project has shown that it can be economically feasible for district heating companies with natural gas based heat production to invest in large-scale solar thermal plants, to cover part of their heat production. This could also be applicable for district heating companies that have heat production at similar cost level as natural gas.

A large-scale solar thermal plant requires a large area. Using land areas (often agricultural) near towns or cities is in many cases economically optimal. However, the solar collectors is a technical system that largely occupy this land area for a single functionality of energy production. In urban areas with limited access to such land areas, this could be a barrier, as integration of other functions (e.g. recreational values) – without increasing costs to an unfeasible level – remains a challenge.

SOLAR DISTRICT HEATING BRÆDSTRUP, DENMARK

Figure 6 - The view of the system of solar district heating

Stakeholders involvement

SARNIA PHOTOVOLTAIC POWER PLANT, CANADA

Figure 7 - *Official opening of Sarnia Solar Farm. (Source: © Postmedia Network)*

Sarnia project had two main stakeholders. The developer is First Solar, Inc., one of the largest solar module manufacturers in the world at the time. First Solar, Inc. is also under a long term contract to operate the facility. The owner and financer of the project is Enbridge, Inc., a Canadian energy supply company. Phase 1, consisting of 20 MW of PV modules, was completed in 2009 for $100-million CAD. The second phase, an additional 60 MW, was completed in 2010 and cost approximately $300-million CAD [5]. Design team consisted of engineers from Enbridge and First Solar, and no researchers / academics were involved during the planning process.

References: [5] Enbridge completes Sarnia solar farm, CBS news October 4th, 2010

In Brædstrup there have also been two main stakeholders: Brædstrup District Heating Company who is the owner and the operator of the district heating plant and initiator of the solar thermal project, and Horsens Municipality, who is the local authority on the district heating supply system and the overall planning of the area where the plant is located. PlanEnergi (researcher) has been involved as consultant in the project

SOLAR DISTRICT HEATING BRÆDSTRUP, DENMARK

Figure 8 - *View of the actual visual impact of the first stage in the project including integration of a wooden pavilion built to invite local citizens to visit the area. (Source: © Brædstrup Fjernvarme)*

SIMILARITIES AND DIFFERENCES

SIMILARITIES

Even though these two case studies describe two different technologies (solar thermal in case of Brædstrup, and PV thin film in Sarnia), there are obvious similarities between the two projects: both are utilizing ground-mounted modules, installed in large-scale arrays, integrated into existing energy systems: district heating in one case, and electricity grid in another. Both projects are using agricultural land in close proximity of urban settlements. Moreover, both locations are on relatively flat terrain, with modules organised in parallel uniform rows with more or less straight borders. Both projects also faced similar challenges, which include preserving landscape values and bio-diversity for local flora and fauna. Finally, in both projects, the land is used only for energy generation and no additional agricultural production (except for the occasional sheep-grazing of the grassland in Brædstrup).

In summary, however, the following valuable conclusions can be drawn :

- Installing large-scale solar energy plants as ground-mounted systems in agricultural areas is often the most economically optimal solution;
- Large-scale energy production from solar thermal and photovoltaic solar plants is in both cases feasible to integrate in the existing energy systems, replacing fossil fuels and reducing CO2 emissions while increasing self-sufficiency in the systems;
- Large-scale solar energy plants require large areas, and these areas are to a great extent occupied by this single functionality of energy production, with little possibility of multifunctional purposes.

SARNIA PHOTOVOLTAIC POWER PLANT, CANADA

Figure 9 - The photovoltaic space (Source: © Enbridge Inc.)

SOLAR DISTRICT HEATING BRÆDSTRUP, DENMARK

Figure 10 - View of solar collectors in the first stage of the project. (Photo: © Brædstrup Fjernvarme)

DIFFERENCES

The main differences between these two solar energy projects is that they consist of two different technologies, producing energy for different segments of energy systems: PV for electricity generation to the (inter)national electricity grid in Sarnia, and solar thermal collectors generating heat for the local district heating system in Brædstrup. In addition, the projects are quite different in size: 3 800 000 m^2 of land in Sarnia versus 70 000 m^2 in Brædstrup.

LESSONS LEARNED

Lessons learned from Sarnia Photovoltaic Solar Plant is that large-scale solar photovoltaic installations are feasible in Ontario when connected to the Ontario grids Feed-In-Tariff program.

In addition, power plants such as this can help to offset peak cooling electricity demands in summer with peak electricity generation occurring simultaneously. Finally, the biggest lesson learned from the construction of the site was around grading and drainage. Most solar farms now are doing minimal grading and try and keep the natural drainage previously available to them. Sarnia did a lot of soil moving to provide a leveled surface for solar arrays and ensure proper draining; this project emphasized the importance of installation of the drainage tiles during the construction, as it is a challenge to do after the fact [4].

In addition, legislation in Ontario needs to investigate improved options to better control the siting of large-scale PV projects in the future for development of more appropriate sites such as brownfields. Future installations should also consider the potential for multi-functional land use.

SARNIA PHOTOVOLTAIC POWER PLANT, CANADA

Figure 11 - Solar Panels. (Source: © Postmedia Network)

SOLAR DISTRICT HEATING BRÆDSTRUP, DENMARK

Figure 12 - Illustration from the local plan of the visual impact of the first stage in the project. (Source: © Municipality of Horsens)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- The Brædstrup project showed that large-scale solar thermal plants can be an economically feasible technology to cover a considerable part of local district heating production, replacing e.g. natural gas as fuel.
- In similarity to the project in Sarnia, the project in Brædstrup also showed that a large-scale solar thermal plant will occupy the dedicated land area, with little or no possibility for other functionalities.

Credits

ARCHITECT, DESIGNER AND DEVELOPER

Enbridge Inc.
First Solar, Inc.

CONSULTANTS

First Solar, Inc.

CASE STUDY AUTHORS

Miljana Horvat, Ryerson University (Canada)

OWNERS

Enbridge Inc.

STAKEHOLDERS

Enbridge Inc., First Solar, Inc.,
Ontario Power Authority (OPA) since 2014 known as Independent Electricity System Operator (IESO).

RESEARCH ORGANISATIONS

Ryerson University Faculty of Engineering & Architectural Science

ACKNOWLEDGEMENTS

The authors wish to thank Peter Carrie, First Solar Development Canada Inc. (Kitchener, Ontario), Aja Obin, Enbridge Inc. (Calgary, Alberta)

ARCHITECT, DESIGNER AND DEVELOPER

Brædstrup Fjernvarme

CONSULTANTS

PlanEnergi

CASE STUDY AUTHORS

Simon Stendorf Sørensen, PlanEnergi (Denmark)

OWNERS

Municipality of Horsens

STAKEHOLDERS

Municipality of Horsens

RESEARCH ORGANISATIONS

Brædstrup Fjernvarme
PlanEnergi

ACKNOWLEDGEMENTS

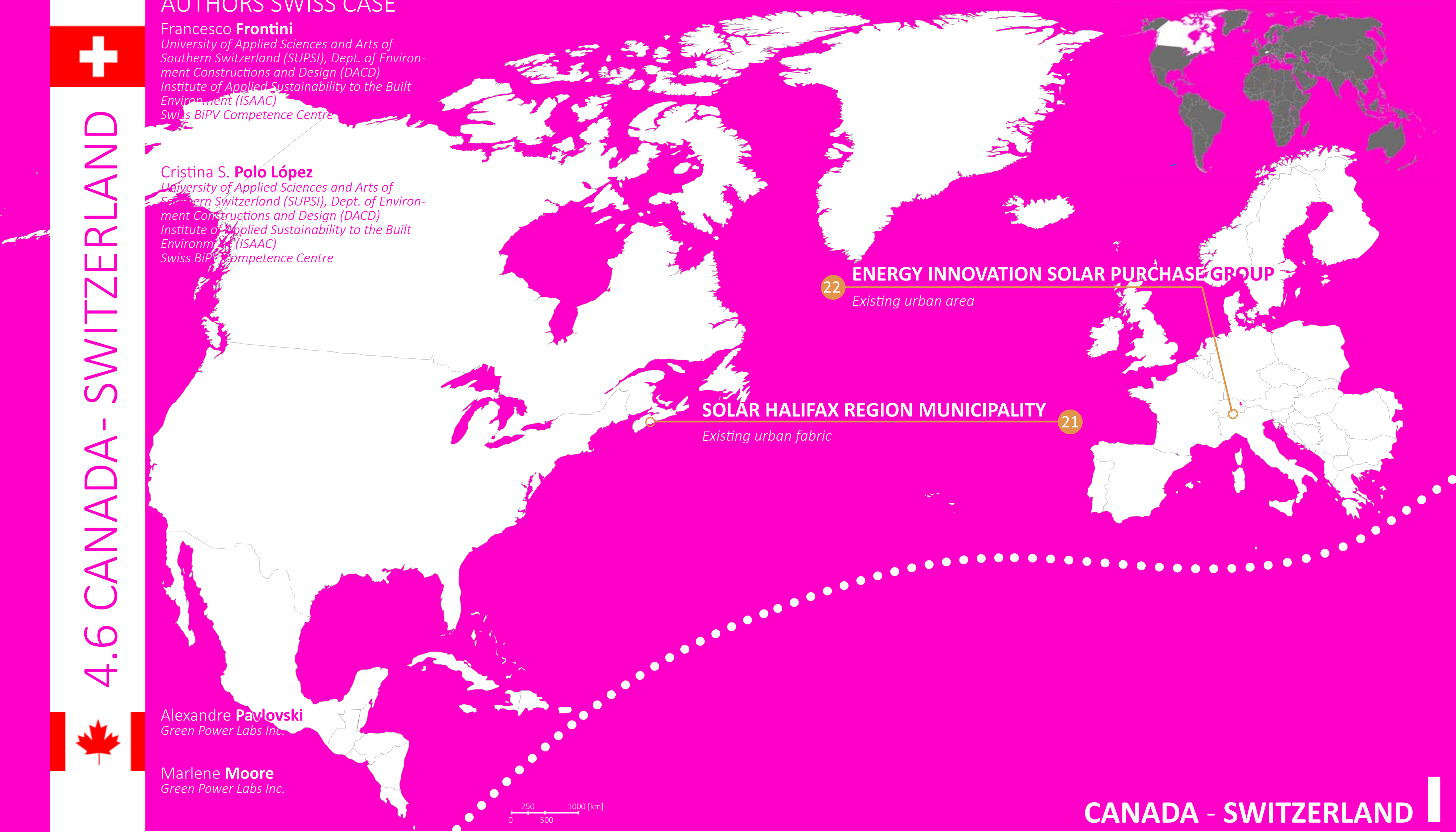
The authors wish to thank the Municipality of Horsens.

4.6 CANADA - SWITZERLAND

AUTHORS SWISS CASE

Francesco **Frontini**
University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Dept. of Environment Constructions and Design (DACD)
Institute of Applied Sustainability to the Built Environment (ISAAC)
Swiss BiPV Competence Centre

Cristina S. **Polo López**
University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Dept. of Environment Constructions and Design (DACD)
Institute of Applied Sustainability to the Built Environment (ISAAC)
Swiss BiPV Competence Centre



Alexandre **Pavlovski**
Green Power Labs Inc.

Marlene **Moore**
Green Power Labs Inc.

CANADA - SWITZERLAND

SOLAR IN HALIFAX REGIONAL MUNICIPALITY

CANADA

Figure 1 - *Photo: © Halifax Regional Municipality*

Figure 2 - *(Source: © SUPSI)*

SOLAR PURCHASE GROUP GENEROSO REGION

SWITZERLAND

SOLAR HALIFAX REGION MUNICIPALITY, CANADA

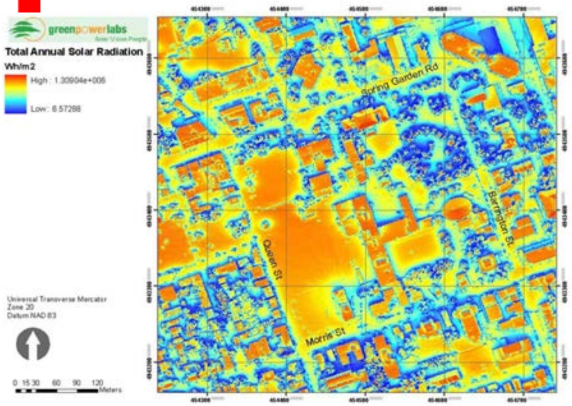


Figure 3 - High resolution mapping of solar irradiation and solar suitable commercial and residential buildings in Halifax urban environment (Source: © Green Power Labs Inc.)

Halifax Regional Municipality (HRM) is Canada's fourth largest municipality by geographic size, and it is ranked as the 14th largest by population. In 2013 HRM developed a growth scenario strategy to minimize its service costs and environmental footprint. While municipalities in Atlantic Canada see themselves as national leaders in areas of sustainability, climate change initiatives, energy security, and greening their communities, complex regulatory and legislative relationships between municipalities and provincial governments limit the municipal regulatory capacity. There is no existing municipal legislation in Atlantic Canada's coastal cities that requires consideration of planning for passive or active solar energy generation/use as a function of urban planning. However, a number of leading national initiatives in urban solar energy use such as HRM Solar City program have been deployed in HRM at municipal and district level.

The case study provides information on three projects in the Halifax Regional Municipality: Solar Energy in Municipally-Owned Buildings, Solar Energy in Residential Houses (HRM Solar City Program) and Solar Energy at Dalhousie University Campus (Dalhousie University Renewable Energy Planning and Project Implementation).

ENERGY INNOVATION SOLAR PURCHASE GROUP, SWITZERLAND

Since the 2011, Switzerland decided to withdraw from the use of nuclear energy. As result a new "Swiss energy strategy 2050" was defined emphasizing the importance to increase the energy supply from renewables while reducing the energy demand in consumption sectors, with specific focus on the construction sector [1]. In 2014 the new "Model for energy requirements at Swiss Cantonal level" was approved [2]. It introduced obligation to install at least 10 Watt/m^2 of PV in new buildings. This requirement has not yet been applied by the Swiss cantons. In the Canton Ticino, new buildings have to be built so that renewable energy will cover at least 20% of the energy needed for heating and hot water production.

Four towns located on the slopes of Monte Generoso (Breggia, Castel San Pietro, Morbio Inferiore and Vacallo) launched, in collaboration with SUPSI, two "solar" purchase groups (purchasing goods collectively). These municipalities are located near the south border of Switzerland in a region called "Generoso" with a high solar potential. In 2012, a solar thermal purchase group was created, and in 2014, a photovoltaic purchase group was set up to promote photovoltaic installations. This initiative can greatly reduce the costs of installing solar panels by leveraging the collective purchasing power of individuals, businesses, or municipal agencies to secure discounted pricing by buying in bulk.

In these cases professionals active in the energy field and researchers from SUPSI worked directly with local communities to facilitate solar group purchases and providing support through the procurement process. This initiative has allowed to motivate many small property owners to realize their own installation, while reducing the investment costs.

Figure 4 - View of the PV panels installed on the roof of one of the houses in the Castel San Pietro (Photo: © SUPSI)

References: [1]Energy Strategy 2050. Swiss Federal Office of Energy SFOE, [2] Conférence des directeurs cantonaux de l'énergie (EnDK). Modèle de prescriptions énergétiques des cantons (MoPEC), edition 2014.

SOLAR HALIFAX REGION MUNICIPALITY, CANADA

Solar Energy in Municipally-Owned Buildings: Halifax Regional Municipality (HRM) is committed to energy efficient and clean energy solutions at municipally owned buildings. In its solar energy deployment program, the municipality focused on applying solar water heating (SWH) technology at the two major categories of buildings that could most benefit from its use: sport facilities and fire stations. The major sport facilities utilizing SWH technologies are Centennial Pool and Halifax Canada Games Centre; examples of fire stations utilizing various SWH technologies: Central, Sackville and Mainland North. HRM implemented SWH systems on these municipally owned buildings to demonstrate net benefits, including GHG emissions reductions that could be deployed on a larger scale throughout the entire municipality [6].

Solar Energy in Residential Houses (HRM Solar City Program [7]): The Solar City program offers homeowners in Halifax innovative solar energy options, which can be financed through a solar collector account with the Halifax Regional Municipality. On March 31, 2015, after a successful two year pilot projects, Halifax Regional Council approved the continuation of the Solar City Program for another three years. The new Solar City program aims to: complete 450 installations of a variety of solar technologies annually; increase the opportunities for residents and businesses to save money and reduce their environmental footprint, and continue to administer the program on a cost neutral basis for the municipality. The new program will offer property owners the three solar technology options: Solar Photovoltaic, Solar Air and Solar Water Heating.

Solar Energy at Dalhousie University Campus: Dalhousie University is a public research university in Nova Scotia, Canada, with three campuses in Halifax and an agricultural campus (AC) in Bible Hill. Founded in 1818, Dalhousie is one of Canada's oldest universities. Dalhousie University [8] is actively involved in sustainability issues and has received a number of sustainability awards for academic programs, university operations, and research. In the 2010, Dalhousie developed its new Campus Master Plan, including a comprehensive solar suitability assessment of the campus. A campus utility master plan released in 2012 includes energy and water audits of buildings on campus, and a renewable energy plan. In 2014, the university released a renewable energy plan for the AC.

References: [6] Solar City Pilot Program: Green Municipal Fund. Pilot Program- Project Review. Green Power Labs Report to Halifax Regional Municipality, October 2015, [7] Solar City Halifax https://www.halifax.ca/solarcity/
[8] Dalhousie University Campus Mater Plan, Dalhousie University, September 2010,

Each participant was thus able to individually define the installation details along with the selected solar installer while being supported by impartial professionals during all the purchase phases. This project was initially aimed at promoting the spread of photovoltaic systems in the municipal territory of Castel San Pietro. Then, thanks to the cross-border cooperation program Italy- Switzerland 2007/2013 "Energy Innovation" [3] it was extended to promote other purchasing groups in the Generoso region (Breggia, Castel San Pietro, Morbio Inferiore and Vacallo) and to consider also solar thermal system. Solar systems were integrated in the roof of small buildings, usually single family detached homes or small apartment blocks, carried out in not densely built urban areas or areas outside the city center.

This initiative was undoubtedly a success. In 2013, 35 thermal plants and at least 50 photovoltaic installations with a total output of 350 kWp were implemented [4]. This project was awarded the Swiss Solar Prize 2014, as best practice, not only in the optic of an excellent collaboration between different local authorities, but also for the involvement of property owners in the area [5].

ENERGY INNOVATION SOLAR PURCHASE GROUP, SWITZERLAND

Figure 5 - Brusadelli family, 3.5 kW, Castel San Pietro. (Photo: © SUPSI)

References: [3] Interreg Programma di Cooperazione trasfrontaliera Italia Svizzera 2007-2013. Progetto Innovazione Energetica,
[4] Cereghetti, N. (2013) Castel San Pietro e il suo "Gruppo di acquisto solare". Castel San Pietro, primo comune in Ticino a promuovere attivamente e localmente l'energia rinnovabile attraverso un Gruppo di acquisto solare. Ecoenergie magazine, management and public services topic- September 2013, pp 11-13,
[5] Solar Agentur. Publikation 24. Schweizer Solarpreis 2014, pp 26-27.

Stakeholders involvement

SOLAR HALIFAX REGION MUNICIPALITY, CANADA

Figure 6 - Facilities Management's Max Zhao (left) leads a tour of Dal's new Solar PV/solar wall installation on the room of the Goldberg Computer Science Building. (Photo: © Bruce Bottomley)

GAPS WHICH NEED TO BRING SOLAR ENERGY IN URBAN PLANNING TO THE FOREFRONT OF STAKEHOLDERS

The promotion of a participatory approach allows for greater involvement of property owners. With their support and their trust it is actually possible to intervene convincingly on the energy market and eventually overcome the old perceptions regarding to solar energy.

This initiative has motivated many small property owners to realize their own installation, while reducing the investment costs.

As stated before, in this kind of regional programs for small and medium-sized property owners, the main goals and priorities would include setting specific planned capital investments and short-term return on investment (ROI). Stakeholder and researcher involvement has been fundamental to provide expert support on technical and legal assistance throughout the program and to promote and support these initiatives in the territory.

GAPS WHICH NEED TO BRING SOLAR ENERGY IN URBAN PLANNING TO THE FOREFRONT OF STAKEHOLDERS

ENERGY INNOVATION SOLAR PURCHASE GROUP, SWITZERLAND

Figure 7 - First informative meeting of the photovoltaic purchase group held in Ticino, Switzerland. (Photo/Source: © SUPSI)

SIMILARITIES

Common elements (similarities) that led to success of the initiatives:

- A community based effort was started by representatives from different non-profit organisations that involved residents of different regional areas and helped them understand the process of going solar.
- The working group organised a comprehensive outreach campaign to identify building owners and advertise the program in order to increase participation. Experts provide technical and legal assistance throughout the program, including free solar site assessments and analyses.
- The collective approach has multiple benefits for both the citizens who adhered to the program and the local authority, respectively the region, which promotes it.

SOLAR HALIFAX REGION MUNICIPALITY, CANADA

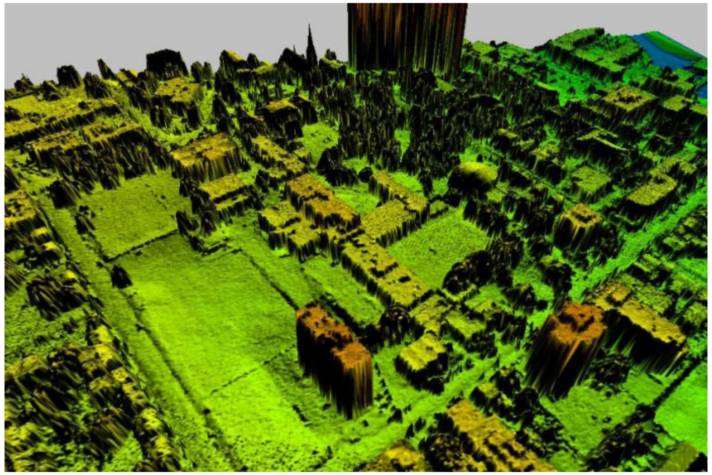


Figure 8 - LIDAR-based Urban Digital Elevation Modeling (Source: © Green Power Labs Inc.)

Figure 9 - HRM Solar City Program: Call for Action. (Photo: © H. Douris)

DIFFERENCES

Halifax

- Halifax regional municipality (HRM) is committed to solutions at municipally owned buildings while Solar City program offers home owners in Halifax different innovative solar energy financial options through municipal rate adjustments for up to ten years. The Dalhousie University Campus is focused in a vast scale planning project considering an energy mix development.
- The Solar City Pilot was managed to be cost-neutral to HRM and to non-participating tax-payers, and to have economic value to its participants.
- A screening process, including site assessment and measurement, was followed for each residence to determine the suitability of the proposed location of the equipment, the installation cost, the expected energy cost savings, and the projected return on investment. HRM offered financing arrangements for projects which met a threshold value of 2% estimated return on investment.
- Citizens of HRM are actively engaged in the city's Community Energy Planning; the subsequent Solar City Program have engaged citizens across all districts of the city, and diverse socio-economic groups.
- HRM hosted eleven 'open house' information sessions throughout the community, which described the SWH technology, how it works, how the economic and environmental benefits and costs are assessed, and the process for implementing a system at a home through the program.
- The Solar City Program attracted extraordinary amount of media attention and public interest due to its vision, sign-up system and simplicity.

Similarities and Differences

SIMILARITIES

Common elements (similarities) that led to success of the initiatives:

- A community based effort was started by representatives from different non-profit organisations that involved residents of different regional areas and helped them understand the process of going solar.
- The working group organised a comprehensive outreach campaign to identify building owners and advertise the program in order to increase participation. Experts provide technical and legal assistance throughout the program, including free solar site assessments and analyses.
- The collective approach has multiple benefits for both the citizens who adhered to the program and the local authority, respectively the region, which promotes it.

ENERGY INNOVATION SOLAR PURCHASE GROUP, SWITZERLAND

Figure 10 - New solar photovoltaic installation. (Photo/source: SUPSI)

Energia solare **Acquisto di gruppo**

Iniziativa di quattro Comuni per la promozione di impianti fotovoltaici

I cittadini di Vacallo, Breggia, Castel San Pietro e Morbio Inferiore avranno la possibilità di usufruire di un piano energetico intercomunale, grazie al quale potranno realizzare un impianto fotovoltaico sul proprio tetto. Si tratta di un progetto Intereg denominato «Innovazione energetica» ed è promosso dall'istituto di sostenibilità applicata costituito in seno alla SUPSI. Progetto al quale i quattro Comuni – rappresentati mercoledì a Vacallo durante la presentazione dai relativi capidicastero Andrea Rigamonti (Vacallo), Giorgio Cereghetti (Castel San Pietro), Giovanni Ambrogini (Breggia) e Ermanno Canova (Morbio Inferiore) – nel 2012 hanno deciso di aderire, e che, nella pratica, si propone di sensibilizzare, informare e coordinare la popolazione, permettendole di formare un unico gruppo di interessati domiciliati che, alla fine del processo, sarà in grado di acquistare gli impianti fotovoltaici da una ditta specializzata della regione. Durante tutto l'iter, il gruppo usufruirà di una consulenza «neutrale, affidabile e professionale» – e gratuita – da parte di una società attiva nell'ambito delle energie rinnovabili, scelta su indicazione della SUPSI.

La procedura

I cittadini nei prossimi giorni riceveranno un volantino e un formulario che, una volta completato, permetterà di partecipare alla prima serata informativa, che si terrà venerdì 15 gennaio alle 20 nell'aula magna della scuola elementare di Vacallo, dove si presenterà il progetto e il procedimento. Saranno inoltre nominati dei volontari tra i membri del gruppo che dovranno valuterà le offerte con l'aiuto della società di consulenza. Toccherà a quest'ultima, quindi, stilare il capitolato tecnico che i Comuni poi invieranno agli installatori. Questi ritorneranno delle offerte che, come detto, saranno valutate dal gruppo di volontari che elaboreranno un preavviso. Gli aderenti si esprimeranno quindi sull'offerta migliore tramite votazione. Durante l'ultima serata informativa, l'azienda vincitrice inviterà i privati a contattarla per un'offerta personalizzata basata sulla stesura del capitolato. Solo a questo punto, con la firma del contratto, l'offerta del proprietario diventerà vincolante. A.B.

FINANZIAMENTI Il progetto è finanziato dai fondi Interreg, alimentati dalla Confederazione e dall'UE. *(Foto Crinari)*

November 22, 2013 Powered by TECNAVIA

Copyright © 22/11/2013 Corriere del Ticino 7:56 am

Figure 11 - Call of Action to promote Generoso regional program in Ticino, Switzerland. (Photo/source: Corriere del Ticino 22.11.2013)

DIFFERENCES

Generoso Region

- Generoso solar purchase group program were initiated to provide cost-effective options for the traditional solar market for small and medium residential properties. Most of the solar installations that were realized thanks to Generoso solar purchase project are "domestic-sized".
- Another important component of the Generoso program was the ability to streamline financing decreasing costs due to a single power purchase agreement (PPA contract) was signed with each property owner.
- Small and medium-sized property owners have specific priorities, including current operational issues and needs, planned capital investments, and short-term return on investment (ROI) goals.
- Municipal technical offices have organised workshops and meetings where citizen volunteers have participated actively, in collaboration with the neutral consultants, to select the local certified solar installers and European solar panel manufacturers. This approach resulted in a more neighbourly image to join the campaign.
- As a customer, the "purchase group" allows each person to strengthen the position themselves on the building and/or energy market. By acting as a collective and not individually, and with the support of competent and neutral experts in the specific field, enables to acquire a greater negotiation power.

Lessons learned and recommendations

LESSONS LEARNED

- The program's participants were able to achieve more favourable contract terms than they would have otherwise. Acting as a collective and not individually, and with the support of competent and neutral experts in the specific field, enables to acquire a greater negotiation power.
- Although property owners are key players of the energy policies is not easy to reach and motivate them. Moreover between local and regional authorities administrative and logistic coordination is often challenging. Technical and economic aspects are also source of confusion and frustration for the property owner considering how difficult it is to get clear and objective information about technical aspects linked to the solar technology (performances, prices and services), as well as legal, economic feasibility and regulatory aspects.
- The programs engaged municipalities and regions in an activity which is consistent with the interests of their residents in a manner which is understood to be: innovative on the part of municipality/region, enabling residents to act on their environmental and financial objectives, and without penalty to non-participating tax-payers.
- The programs increased awareness of a major social issue (environmental stewardship) in terms of municipalities and regions ability to act as a community.
- The programs contributed to the community's understanding of practical, economic and environmental considerations related to implementing renewable energy technologies. The programs prepared the way for future technology applications of renewable energy, demonstrated the process and provided insight into what changes may be advised.

SOLAR HALIFAX REGION MUNICIPALITY, CANADA

Figure 12 - (Source: © Renewable Energy Storage Laboratory (RESL) Dalhousie University)

ENERGY INNOVATION SOLAR PURCHASE GROUP, SWITZERLAND

Figure 13 - New solar thermal installation. (Source: © SUPSI)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- The PPA financial system (power purchase agreement) is the only financing option used by customers. The Halifax model demonstrates that other financial models are possible but for small and medium size property owners it was found that the multitude of financing options made the program more complicated for potential participants.
- Solar campaigns were always a limited-time offer, which pushed potential customers to participate while they could. The regional programs used a competitive process to select contractors. Installers compete against each other for bids.
- In the comprehensive outreach campaign to promote and to advertise this kind of regional programs it is important to focus the marketable priorities of specific potential customers.
- City residents might include the financing for all expenses associated with solar project, also for retrofitting intervention in existing buildings by considering BIPV or BIST systems.
- The solar purchase group for solar systems aims to promote local installations, concrete contributions to an increased use of renewable energies.
- Increasing the opportunities for residents to save money and reduce their environmental footprint through a variety of solar technologies (i.e. PV, solar air heating and solar water heating) should be consistent with municipal/regional community energy plans and economic strategies.
- In financial systems, specifically with upfront capital investments, municipal/regional programs are focused on a cost-neutral basis for municipalities and/or regions.
- For municipal/regional programs, it is critical to monitor factors influencing potential participation such as evaluation of future participation, pre-screening of potential sites, detailed evaluation of the return on investment of solar technology applications, and evaluation of installation cost options and financing options available to home-owners.

Credits

ARCHITECT, DESIGNER AND DEVELOPER

Thermo Dynamics Ltd

OWNERS

Halifax Regional Municipality
Dalhousie University

CONSULTANTS

WHW Architects

STAKEHOLDERS

Halifax Regional Municipality

CASE STUDY AUTHORS

Dr. A. Pavlovski. P. Eng. (Green Power Labs Inc.)
M. Moore (Green Power Labs Inc.)

RESEARCH ORGANISATIONS

greenpowerlabs

CONSULTANTS

Kim Bernasconi, Greenkey Sagl, ing. HES
Michela Sormani, Enermi Sagl, MSc. Umnw. ETHZ

OWNERS

Private owners.

STAKEHOLDERS

Comune di Breggia
Comune di Castel San Pietro
Comune di Morbio Inferiore
Comune di Vacallo

ACKNOWLEDGEMENTS

The authors wish to thank Ing. Nerio Cereghetti, ISAAC-SUPSI.

CASE STUDY AUTHORS

Dr. Arch. Cristina S. Polo López, ISAAC-SUPSI
Arch. Isa Zanetti, ISAAC-SUPSI

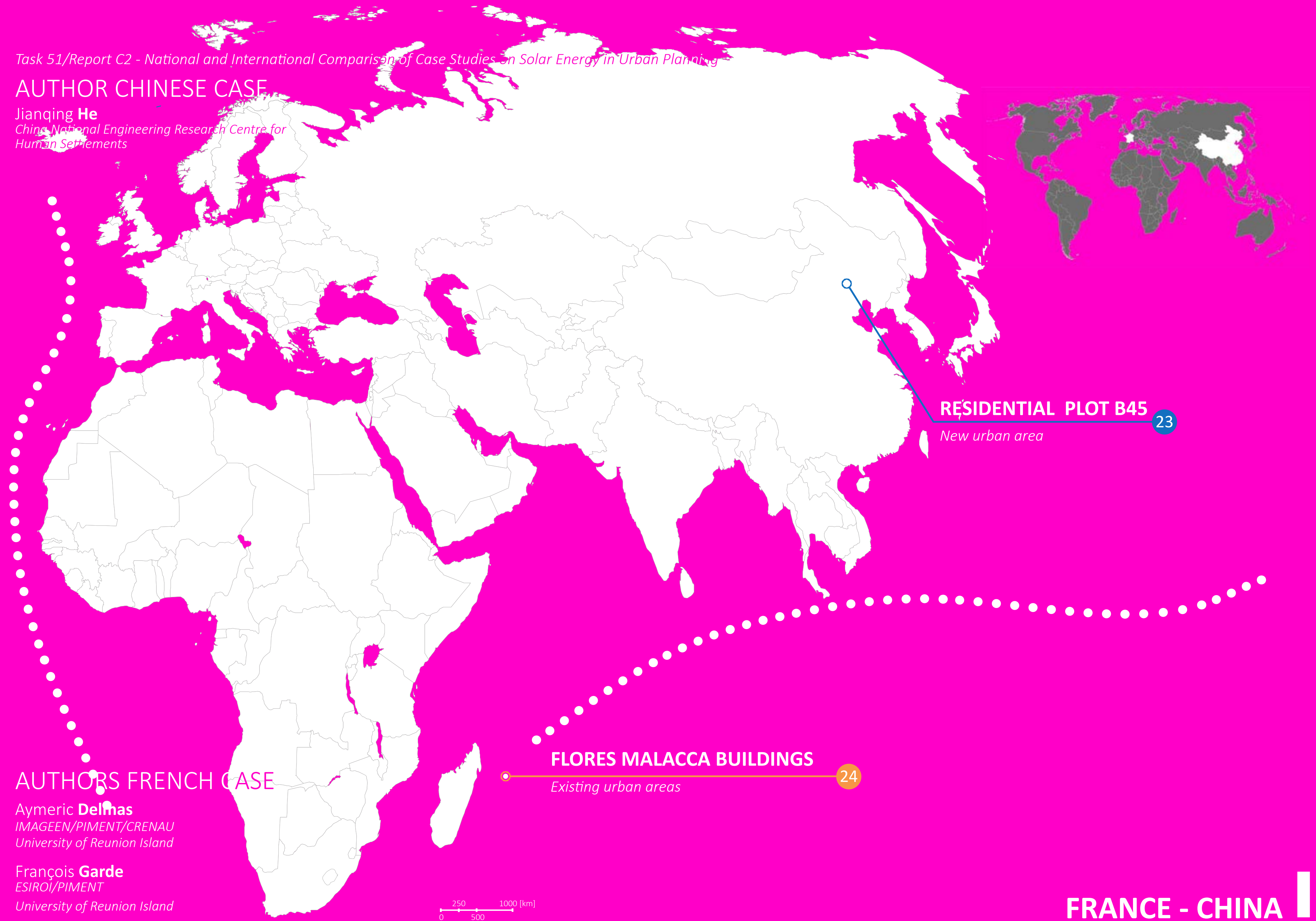
RESEARCH ORGANISATIONS

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

4.7 FRANCE - CHINA

AUTHOR CHINESE CASE

Jianqing **He**
China National Engineering Research Centre for Human Settlements



AUTHORS FRENCH CASE

Aymeric **Delmas**
IMAGEEN/PIMENT/CRENAU
University of Reunion Island

François **Garde**
ESIROI/PIMENT
University of Reunion Island

FRANCE - CHINA

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

FLORES MALACCA BUILDINGS

FRANCE

In extreme environments like in the hot and humid tropical climate of Reunion Island or in the high urban density areas of Beijing, solar energy in urban planning does not only have to deal with the integration of renewable energy production systems, but must also be part of a holistic approach with much concern on renewable energy, microclimate, carbon fixation and sustainability.

Figure 1 - View of the Flores Malacca (Source: © H. Douris)

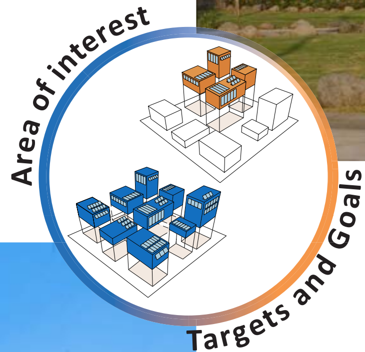


Figure 2 - Viev of the intervention of Residential Plot B45 (Source: © zhulong.com)

Hence, the definition of ambitious targets and goals is one of the key roles that local authorities should play to support urban sustainability in these continuously evolving and sensitive environments (Plan for Climate, Air & Energy of La Reunion [1]; Chinese National Standard for Green Building Evaluation [2]).

References: [1] La Reunion County Council. (2012) Plan for Climate, Air & Energy of La Reunion,
[2] MoHURD. (2006). Standard for Green Building Evaluation, GB/T50378-2006 (updated to GB/T50378-2014).

RESIDENTIAL PLOT B45

CHINA

FLORES MALACCA BUILDINGS, FRANCE

Figure 3 - *The urban development project of "Le Mail de l'Ocean" (Source: © AP Architectures/2APMR).*

The Flores and Malacca buildings are two triangular islets that belong to a large urban development project initiated by the city of Le Port in Reunion Island for the requalification and the densification of its city centre. The five premises of the operation are designed according to passive and bioclimatic principles to provide 138 comfortable and energy efficient subsidized housing units (including 53 student apartments).

Targets and goals: For Flores Malacca, the municipality of Le Port asked the developer to integrate an Environmental Approach to Urban Planning at all stages of the urban development project. This resulted in a comprehensive master plan that ensures the efficiency of the bioclimatic design of the new buildings [3]. Microclimate considerations from the early design stages facilitated the creation of favourable conditions on site which impact the performance of the nearby buildings. In Réunion Island and more especially in the city of Le Port which owns the record of highest solar irradiation and temperatures of the island, the design goals were: (i) to improve the living environment of residents with comfortable housing, (ii) to reduce the environmental impact of urban development with low energy consumption and carbon emissions and (iii) to support the ambitious national and regional environmental policy with a high level of renewable energy integration [4].

References: [3] EnviroBAT Réunion. (2013). Opération «FLORES MALACCA», ZAC Mail de l'Océan, Le Port, Logements sociaux et locaux d'activités. Retour d'expérience, [4] AFC. (2014). Sustainable Cities and Territories, Diversified financing tailored to territorial conditions.

Residential Plot B45 is one block of the eco-community built in the Changxindian eco-city. It is a remarkable project which benefits from eco-city and green building development. These tower buildings integrate solar water heating systems and aim to contribute to scaling-up solar energy use in urban planning and design.

Targets and goals: For Residential Plot B45, the new town to which it belongs has been selected as a national pilot project for ecological development by benchmarking eco-city criteria to regulate zoning, urban design, site planning and building design indicators . The eco-city criteria implemented in this project include renewable energy use, building energy efficiency and emission reduction indicators and are all higher than the national and local levels [5]. In combination with the eco-city criteria, the Residential Plot B45 buildings comply also with the 3-star Design and 2-star Operation Label of the Green Building Program criteria of Beijing [6]. In terms of energy goals, the building energy consumption is regulated by the eco-city criteria and should be 21% less than the current national level for the same building type. Residential Plot 45 is thus designed with an energy conservation rate of 72%.

RESIDENTIAL PLOT B45, CHINA

Figure 4 - *Layout of roofing system for solar collector arrangement (Source: © Beijing Institute of Residential Building Design & Research Co., Ltd, 2011.)*

References: [5] MoHURD. (2006). Standard for Green Building Evaluation, GB/T50378-2006 (updated to GB/T50378-2014).
[6] Beijing Muncipality. (2014). Beijing Green Building Action Implementation Plan.

FLORES MALACCA BUILDINGS, FRANCE

Figure 5 - Overview of the combined PV and solar thermal panels roof plant. (Surce: © AP Architectures/2APMR)

Commissioned by the Municipality of Le Port, the Flores Malacca social housing buildings are part of a wider urban development, "Le Mail de l'Océan" (36.5 ha). The planning process of this urban development comprised a preoperational participatory approach, in which residents, private and public stakeholders had been consulted. In addition to the selected elements from this participatory approach which favoured the feeling of ownership of the occupants, the municipality, the social housing and development operator and the private investors worked together, with support from the French Environment and Energy Management Agency) on the city's integrated sustainable development plan (transport, public spaces, services, facilities). The French Development Agency also financially supported this project in particular by financing additional environmental costs.

Residential Plot B45 is part of a large urban development, in this case the Changxindian Eco-city. Similarly to Flores Malacca, stakeholders (Beijing Vanion Investment Group Co., Ltd., Beijing Institute of Urban Planning and Beijing Institute of Urban Infrastructure) worked conjointly to define the master planning of this new city, regulating zoning in accordance with ecological criteria. This collaborative process has been later followed on during the design process, when urban planners, architects, engineers, consultants, solar products, constructions and supervision companies, all worked simultaneously to optimise the SWH system layout of the buildings without compromising on aesthetics, textures and perspectives. This cooperation among the stakeholders favoured the integration of bioclimatic and solar energy strategies to ensure urban architectural quality, people's comfort and liability and limited environmental impact and was hence a key feature of the planning process in both cases.

RESIDENTIAL PLOT B45, CHINA

Figure 6 - Integration layout of solar modules and green roof (Source: © www.zhulong.com)

Similarities and Differences

SIMILARITIES

- A roof-top solution with enlarged platforms for solar modules has been utilised by both projects. These structures are used for shading the roofs of the buildings and for limiting the adverse thermal gains through material conduction. This feature allows also cooling the panels and avoiding potential overheating which affects their efficiency. This solution creates new possibilities to scale up the use of solar energy generation systems for residential use. With these installations, Residential Plot B45 reaches 21% energy consumption coverage (combining SWH systems to cover 9% and geothermal to cover 12%). In the Flores Malacca buildings, all the hot water needs are covered by the 220 m² of solar thermal collectors installed on the over-roofs, while the 420 m² of PV panels (88kW power, grid connected) produce 10 000 kWh monthly.
- Microclimatic considerations and more especially wind and light environments were taken into account for designing the layout of the buildings in the two cases. The arrangement of buildings in the case of Flores Malacca facilitates the air flow at the scale of the building block and all housing units are hence cross naturally ventilated through louvered windows. Similarly in the case of Residential Plot B45, the different orientations of the buildings were selected to form wide ventilation corridor for summer. The distances between the towers were also optimised to control illuminated hours under the major cold days.
- The integration of planted surfaces is also part of the common features of the two projects. On Residential Plot B45, green roofs use the solar collectors as shadings in summer. In combination with the solar roofs, they allow to reduce the heat island effect by cooling the outdoor air by about 3-5°C. On Flores Malacca, vegetated spaces are connected to rain water and grey water management systems. The vegetated surroundings also contribute to cool the air which is used to ensure the occupants' thermal comfort thanks to natural ventilation.

FLORES MALACCA BUILDINGS, FRANCE

Figure 7 - Flores Malacca and the newly created axis towards the sea. (Source: © H. Douris)

RESIDENTIAL PLOT B45, CHINA

Figure 8 - View of the intervention of Residential Plot B45 (Source: © zhulong.com))

DIFFERENCES

- Massing of the Flores Malacca buildings was defined to make them harmoniously integrated in their environment. Their progressive and limited building heights (with maximum 5 storeys) with recessed pent-houses respect the existing scale of the district which mainly comprises low-rise residential buildings. The context sensitivity of the site is as much respected as the view of the pedestrians. The installed solar systems are in fact hardly visible from the public space since installed on the high over-roofs. Conversely, the architectural integration strategy for Residential Plot B45, which is the first block being developed in the new urban environment of the Changxindian Eco-city, is different. The building towers were designed as real landmarks. The roof-top solar collectors' platforms can be closely or remotely seen from the underground station, Park Expo, river front and new town centre. These very characteristic and innovative supportive enlarged steel platforms allow, in conjunction with the up to 15 storey slim shape and recognizable facades of the towers, to easily identify Residential Plot B45's architecture in its environment.
- Whereas Residential Plot B45 focuses its solar energy production on hot water generation thanks to solar thermal collectors only, Flores Malacca integrate both PV and ST systems on its over-roofs. Even though, a particular work has been in order to integrate both systems on the same plans. Their different sizes, materials and in between spaces make them not coherently integrated with the roof of the Flores Malacca buildings.

LESSONS LEARNED

The presented two cases demonstrate that even in extreme climates and urban environment where population growth leads to increasing the density (mostly vertically), solar energy integration is made possible thanks to ambitious targets and goals. In both cases, urban planning and building design are appropriately constrained by environmental and sustainable frameworks supported by the different stakeholders from early design stages.

FLORES MALACCA BUILDINGS, FRANCE

Figure 9 - Solar protection optimised solar shading devices, over-roofs and external passageways are architecturally integrated. (Source: © H. Douris)

RESIDENTIAL PLOT B45, CHINA

Figure 10 - Modular pattern. (Source: © www.zhulong.com)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

- The importance of studying solar systems and microclimate strategies from the early design phases is highlighted in both cases. This allows to better integrate solar technologies through the design of innovative features like the solar over-roofs of these cases that simultaneously work as passive and active strategies (shading the building roofs, while producing electricity and hot water). Either designed as actual landmarks or more visually integrated in the case of existing environment, the planning, massing and zoning of these two urban development projects were designed according to their context sensitivity and expected sight link with public spaces.
- The collaboration between stakeholders from the early design phases allowed in both cases to meet a large range of design goals keeping in mind both the impact on the environment and on the occupants' comfort. This is key to ensure living quality, comfort, energy efficiency and limited environmental impact in such highly densifying urban areas with specific microclimatic conditions.

Credits

ARCHITECT, DESIGNER AND DEVELOPER

AP Architectures
2APMR
SIDR

OWNERS

SIDR
Municipality of Le Port

CONSULTANTS

LEU Reunion
GECP
SOCETEM
TOP BIS

STAKEHOLDERS

ADEME
AFD

RESEARCH ORGANISATIONS

CASE STUDY AUTHORS

François Garde and Aymeric Delmas, PIMENT, University of Reunion Island (France).

ARCHITECT, DESIGNER

Beijing Institute of Residential Building Design and Research Co.,Ltd.

OWNERS AND CLIENTS

Beijing Vanion Investment Group Co., Ltd.
Individual homeowners; Beijing Vanion Real Estate Development Company

CONSULTANTS

Beijing Zhongchengshenke Ecological Science Co., Ltd.

DEVELOPER

Beijing Vanion Real Estate Development Company

STAKEHOLDERS

China Railway Electrification Bureau (Group) Co., Ltd
Beijing Jianyuanjinsha Project Management Co., Ltd.
Shandong Linuo Paradigma Co., Ltd
Beijing Xingbang Property Management Co., Ltd.

CASE STUDY AUTHORS

Jianqing He, Xiaoxuan Zhang, China National Engineering Research Center for Human Settlements.

RESEARCH ORGANISATIONS

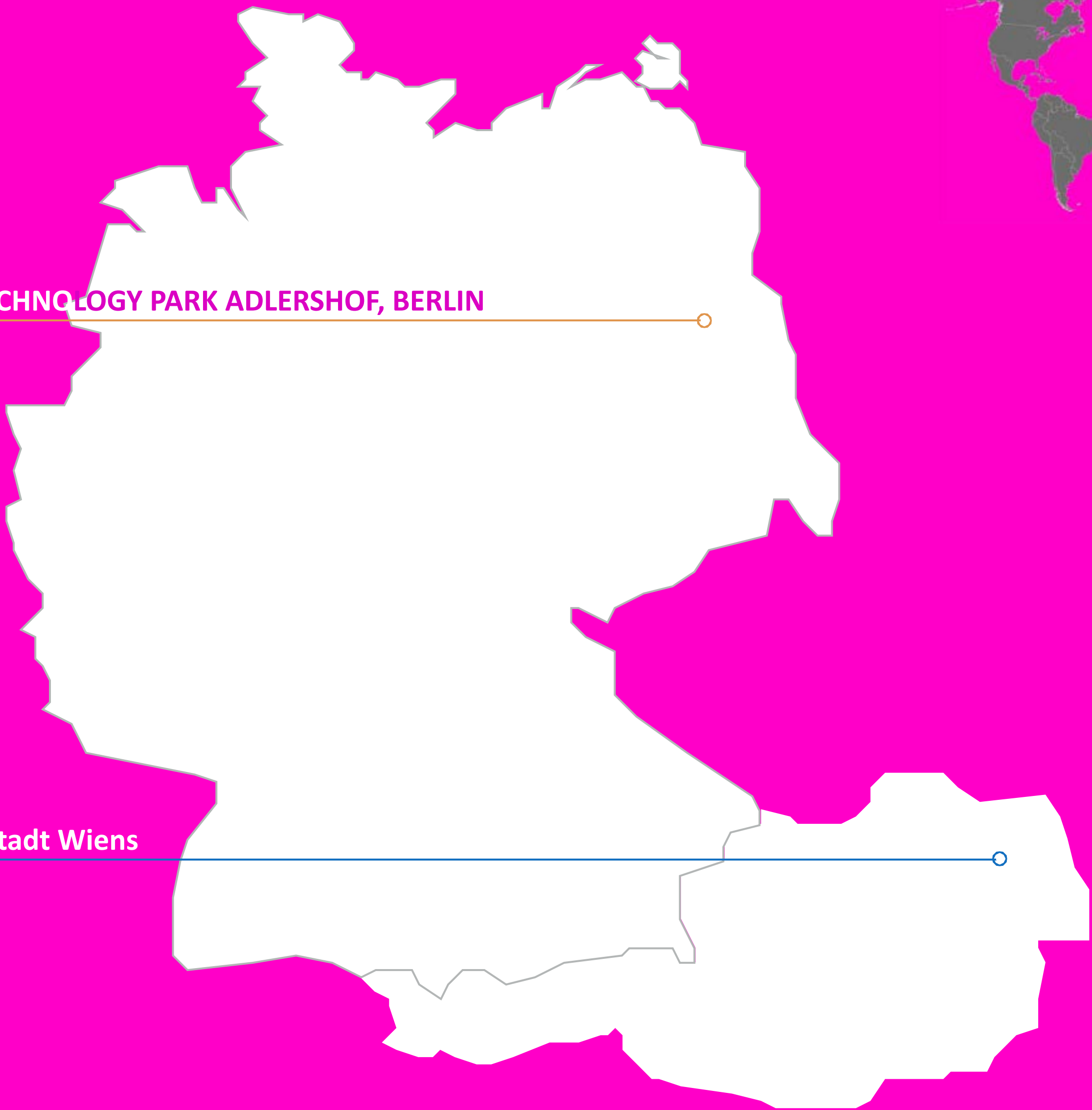
ACKNOWLEDGEMENTS

The Authors would like to thank: Liu Jianfeng, Beijing University of Civil Engineering & Architecture, for proof reading; Beijing Housing and Urban-Rural Development Science and Technology Promotion Center, for data and information sharing.

4.8 AUSTRIA - GERMANY

AUTHOR GERMAN CASE

Margarethe **Korolkow**
IBUS GmbH – Institut für Bau-, Umwelt- und Solarforschung



25 **SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN**
Existing urban area

11 **aspern+ Die Seestadt Wiens**
New development area

AUTHOR AUSTRIAN CASE

Daiva **Jakutyte-Walangitang**
Energy Department
AIT, Austrian Institute of Technology

AUSTRIA - GERMANY

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

GERMANY

Figure 1 - © Senatsverwaltung für Stadtentwicklung und Umwelt, Berlin

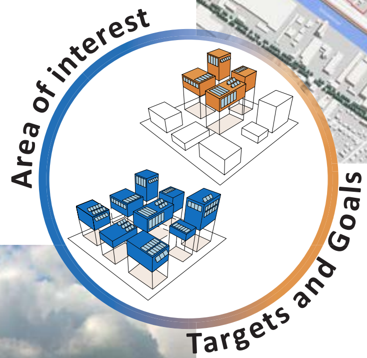


Figure 2 - aspern - die Seestadt Wiens. © Daiva Jakutyte-Walangitang

aspern+ Die Seestadt Wiens

AUSTRIA

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 3 - Welcome sign near the train station. (Photo: © Margarethe Korolkow)

The development area Adlershof is located in the Adlershof district and is a part of the Treptow-Köpenick municipality, still within the administrative boundaries of the City of Berlin. The total development area adds up to 4 200 000 m². First original buildings of Adlershof date back to the start of the 20th century. The resent development of Adlershof as a Science and Technology Park was started in 1994 when Adlershof was defined as urban development area. The development entails a mix of urban functions, including residential, office, commercial uses as well as a university campus, research institutes and industrial areas. It is an ongoing development, expected to be completed in the year 2030.

aspern Seestadt [1] is located on the South Eastern outskirts of Vienna occupying the grounds of the former Aspern airfield. Most of the built environment in Aspern will consist of newly constructed urban fabric.

The strategic debates considering different options for the development of Aspern area started in 1995, leading to an urban design competition in 2003. Based on the winning Master Planning scheme (designed by the Tovatt Architects & Planners from Stockholm) for Aspern Seestadt, the final Masterplan was negotiated and approved by the Vienna City Council in the year 2007.

The gross site area of aspern Seestadt amounts 2 400 000 m². At the time of the planned completion in the year 2029, aspern Seestadt development is planned to house 20 000 residents and to provide working places for 20 000 people.

aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 4 - Aspern development and surroundings. (Source: www.aspern-seestadt.at)

References: [1] http://www.aspern-seestadt.at/en

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 5 - Listed "buildings": The Egg and the wind tunnel. (Photo: © Margarethe Korolkow)

Berlin has the goal to become CO_2-neutral in 2050. Therefore the Energy Transition Law and the Berlin Energy and Climate Protection Programme were enacted. Adlershof is aiming to reduce its primary energy use by 30% until 2020 [2]. The urban area serves as a model for an energy efficient high tech science and technology park. In order to reach this goal, different approaches are used: high buildings' standards for new buildings and refurbishment, optimisation via multi-media energy planning, smart grids and e.g. aquifer storage to reduce energy loads. Adlershof is one of the biggest Technology Parks in Germany. It stands for research, education, jobs, inventions, start-ups, and international connections. Beyond the primary energy reduction goal, the urban area has decentralized rain water management system. Implementation of green roofs is obligatory in the entire area in order to retain rainwater and reduce the local heat island effect. The district heating network includes partly renewable energy sources. PV systems are connected to the grid. An increasing number of systems are being installed, focusing on the internal consumption of the generated electricity. However, such harvesting of energy from renewable sources is not integrated in the development plan to date. Current contributions in this area amount from voluntary contributions of the building owners, since building sustainability provides advantages in marketing. In the process of land purchase from the City of Berlin, usually the candidates "apply" for the land purchase by providing different development concepts. Thus, the award of the purchase- contract goes to the best concept, not the highest monetary offer.

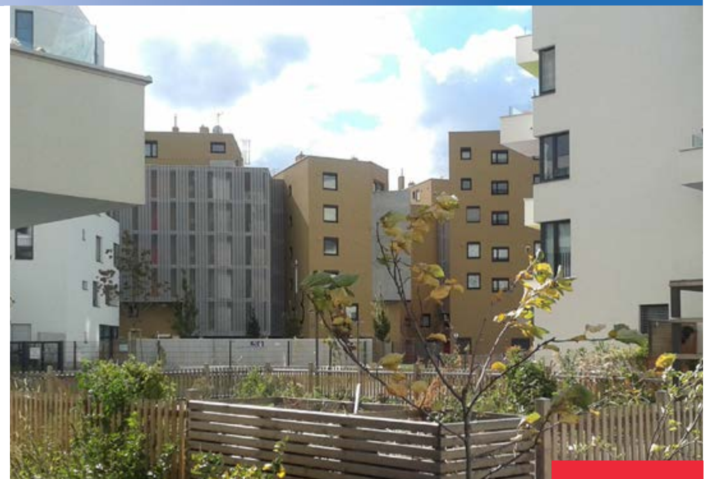
References: [2] http://www.stadtentwicklung.berlin.de/umwelt/klimaschutz/bek_berlin/ (access: june 2016)

Vienna aims to reach the following environmental goals:

- 35% per capita CO_2 reduction by 2030 (in comparison to 1990)
- 80% per capita CO_2 reduction by 2050 (in comparison to 1990).

Increased energy generation from renewable sources plays an essential role in this context. By the year 2030 more than 20% of gross energy consumption in Vienna is targeted to be supplied from renewable sources, amounting to 50% by 2050 [3].

At the same time, Vienna is a growing city, exposing a pressing demand for new housing, accompanied by the need for new local employment opportunities. Given these framework conditions, Vienna pursues the goal to contain and increase the quality of life, while accommodating the growing population, while limiting the consumption of resources. In alignment with the overall urban strategy of the city of Vienna, aspern Seestadt development serves as a demonstration area, which sets new innovative impulses and trends, showcasing the implementation of a lively, high urban quality district that uses least amount of resources. These goals are presently being achieved primarily through application of additional district management and collaboration models, ensuring high building standards, provision of multi modal transportation ('short distance' urban concept) and a close bottom collaboration with the developers and residents.



aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 6 - "Urban gardening" is an essential part of aspern+ developmen (Photo: ©Daiva Jakutyte-Walangitang)

References: [3] https://smartcity.wien.gv.at/site/files/2014/09/SmartCityWien_FrameworkStrategy_english_onepage.pdf, p.32-47

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

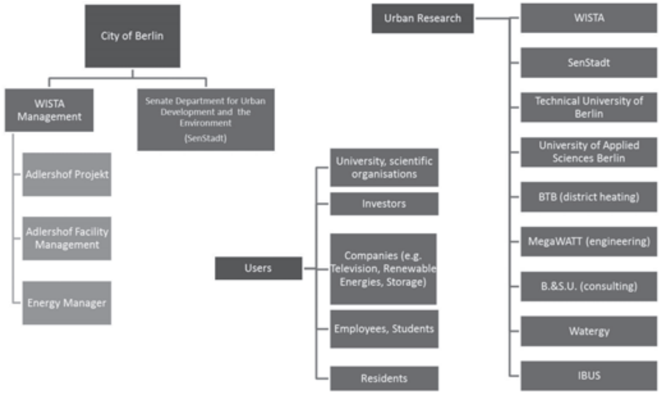


Figure 7 - Overview (no claim to completeness) of involved stakeholders in Adlershof (© IBUS GmbH)

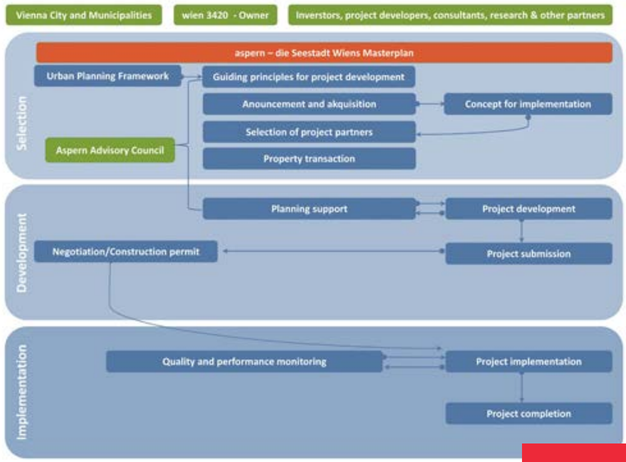
An Urban Development Measure allows a fast and target-oriented development of an urban area. Both community and owners have to support the development. The community buys, prepares and sells building plots. The selling process does not only consider monetary benefits but also the building and utilization concept. On sold plots the new owners are bound to build. If owners want to develop their plots during a reasonable timeframe, they can do so. Owners, that do not want to or cannot develop their land, can request that the community buys their property. If they want to sell it to others, they need the permission of the community [4].

There were/are several research projects dealing with the energy efficiency of the Adlershof. One project led to an integrated energy concept that shows ways of reaching a reduction of the primary energy use of the whole area by 30% until 2020 [5]. One ongoing research project is dealing with energy planning guidelines where a multi-media energy planning map for the area is realized. The goal is to provide a future-compliant and flexible infrastructure and its optimisation through foresighted and sustainable planning. Therefore, a pre-planning of the grids and the corresponding infrastructure was carried out as well as the development of an energy utilization plan for existing areas, fill-ins and undeveloped areas based on four different utilization scenarios. Other research projects are dealing with the topics "Smart Grids" or "Networking of Energy Flows".

References: [4] Senatsverwaltung für Stadtentwicklung. (2007). Städtebaulicher Entwicklungsbereich Johannisthal/Adlershof – Bilanz der Entwicklung.
[5] http://www.eneff-stadt.info/en/pilot-projects/project/details/energy-grid-berlin-adlershof/ (access: May 2016)

The first planning instrument – International Masterplanning Competition was used in order to identify the award winning scheme for aspern Seestadt development. The award winning scheme was presented and reviewed by an international expert panel, following the awarding of the contract. After going through a process of multiple public presentations, discussions and workshops the final Masterplan was adopted by the Vienna City Council in 2007 and subsequently transferred into the urban Zoning Plan. The Zoning Plan (Flächenwidmung) serves as a main urban planning instrument in aspern, which provides mandatory rules for the implementation.

Beyond the formal instruments, a range of informal instruments such as 'City Labs' have been used in different research projects, providing the cross-sectoral collaboration between different stakeholders and enabling innovative impulses: NACHASPERN [6], TRANSFORM [7] and TRANSFORM+ [8] are some of the examples.



aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 8 - The Process of Aspern Development. (Source: Translation from German in English by Daiva Jakutyte-Walangitang, AIT)

References: [6] https://nachhaltigwirtschaften.at/resources/edz_pdf/nachaspern_gesamtenergiekonzept.pdf; [7] http://urbantransform.eu/
[8] http://www.transform-plus.at/

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 9 - Ferdinand Braun Institute. (Photo: © Margarethe Korolkow)

City of Berlin mainly owned the land and put a developer in charge. Therefore the companies WISTA MANANGEMENT GmbH & Adlershof Projekt GmbH were established. WISTA MANAGEMENT GmbH manages the public relations for the entire development district. It realizes the marketing and sales (together with Adlershof Projekt GmbH), and establishes and manages local technology centres. Adlershof Projekt GmbH is an urban development agency and trustee of the Federal State of Berlin. It is responsible for development, urban planning, building plan and infrastructure project management, trust fund administration, sale of plots, and marketing. The Senate Department for Urban Development and the Environment is also involved in the development of the district.

As a Science and Technology Park, Adlershof tries to attract companies or research institutes dealing with high technologies. It also tries to be attractive to employees, students and their families and businesses that cover every day needs.

The Senate Department for Urban Development and the Environment commissioned the masterplan. In a first stage seven urban planning offices proposed developments for Adlershof. In a second stage, four offices detailed the masterplan, each focusing on a part of the development area.

The success of an urban development project of this size depends on the involvement and collaboration between diverse public and private stakeholders. In the case of aspern Seestadt, an agency - Wien 3420 – aspern development AG - has been established and commissioned by the city of Vienna with the management of the development and implementation of aspern Seestadt development. The Corporation is responsible for the definition of planning guidelines, property provision and consultancy services for the individual project development.

Different Magistrate departments of Vienna are involved in the development process as well. Ombudsmann aspern Seestadt serves as a first contact point for Aspern residents. A variety of research projects have supported and continue to provide innovative impulses to the development of aspern Seestadt. Furthermore, a research institution has been set up on the grounds of aspern Seestadt- Aspern Smart City Research GmbH & Co KG (ASCR) . ASCR examines buildings along their technological, environmental and energy related aspects. A large variety of infrastructure service providers, such as Wien Energie – Energy Service Company and Wiener Netze – Energy Infrastructure Utility as well as Wiener Linien- public transport supply utility- are key stakeholders involved in Aspern development.

aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 10 - Aspern IQ - first building in aspern Seestadt . (Photo: ©Daiva Jakutyte-Walangitang)

SIMILARITIES

aspern Seestadt as well as Adlershof development occupied former industrial-airfield sites, both located on the urban fringe of the respective city. Loss and/or relocation of the initial urban functions in aspern and in Adlershof have prompted the re-development of aspern Seestadt as well as Adlershof. In addition, the present and projected urban growth of Vienna as well as Berlin causes an increased demand for housing and jobs and serve as one of the core motivators for the development of aspern Seestadt and Adlershof.

Both developments aim to accommodate diverse urban functions, including (but not limited to) the residential, commercial, educational, etc. uses. Typically, urban undertakings of such size and significance like aspern Seestadt and Adlershof are long term developments. Both are planned to reach the state of completion in the year 2030. Further main attributes, common for both areas, are the accommodation of educational campuses on site as well as landscape elements central to the development: urban lake in aspern and urban park in Adlershof.

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 11 - ZPV (Photo: © Margarethe Korolkow)

aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 12 - Aspern development around the lake (Photo:©Daiva Jakutyte-Walangitang)

DIFFERENCES

The comparison between Adlershof and aspern Seestadt also exposes some differences. First of all, the size of Adlershof area is almost twice the size of aspern Seestadt development. Secondly, the building stock of Adlershof is more diverse and contains constructions from different time periods of the 20th century. aspern Seestadt on the other hand, is a new development altogether.

Lastly, the distribution of urban functions in aspern Seestadt and Adlershof differs significantly. While the goal of aspern Seestadt development is to reach a 1:1 proportion of residential accommodation versus provision of local working places, the focus of Adlershof development lies predominantly on the provision of working places, only a minor area of the overall site being allocated for residential use.

SIMILARITIES

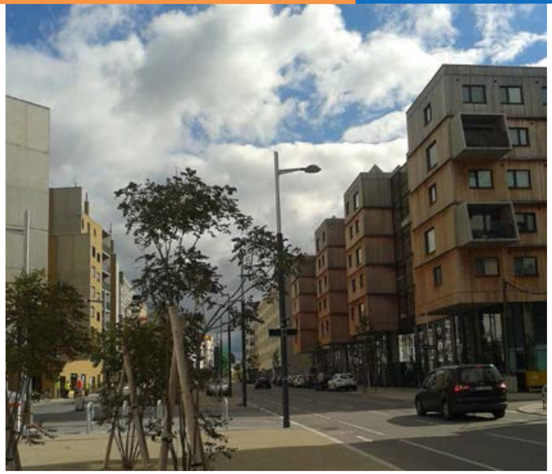
aspern Seestadt differs from Adlershof when considering local historical heritage. Adlershof site contains numerous protected and listed buildings, while aspern Seestadt accommodates entirely new buildings.

Both developments play a key role in the overall urban strategy of the city and serve as trendsetters and demonstrators of sustainability principles, conveying the image of innovative districts. Locally set goals embrace a broad range of environmental aspects, including the aim to increase the proportion of energy generated from renewable sources.

Both developments expose a complex set up of relevant stakeholders, demanding good coordination, communication and management of a large variety of actors and activities. The overall success of aspern Seestadt as well as Adlershof development depends on the cooperation between numerous public and private actors and skilled negotiation of conflicting interests, including the integration and on-site tapping of solar energy. Such stakeholder configurations are inherently typical for European urban developments of such size and complexity.

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 13 - Soltecture Headquarters (Photo: © Margarethe Korolkow)



aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 14 - One of the main streets in aspern+ development (Photo: ©Daiva Jakutyte-Walangitang)

DIFFERENCES

An overall energy concept for Adlershof was developed fairly recently, in the year 2012. The focus on energy efficiency related considerations was absent in the starting phases of the development. In the recent years, the developments, which include energy efficiency as an asset, have obtained an increasingly well received marketing image and thus often serve as a useful “tool” for attracting innovative companies active in the field of energy.

The situation in aspern Seestadt is similar. Even though, the initial master planning considered different environmental aspects, specific need for an overall energy concept was recognized fairly recently an is still in the process of development.

In aspern Seestadt as well as in Adlershof a range of formal and informal planning and development instruments were applied and continue to be applied in order to meet the complex needs, dynamics and aims of such undertakings. Within these processes significant attention has been placed on collaboration between different sectors and disciplines, contributing to the overall innovative character of both areas. A variety of instruments, methods and approaches were applied in order to include citizens and relevant actors in the development and co-creation processes of both areas: urban labs being one example. Beyond analytical methodologies and tools, such as simulation of solar potentials, modeling of energy demand, etc., different synthesis methodologies have been applied in order to create synergetic value that integration between spatial and energy planning can generate. In this context, research projects have played a significant role in shaping aspern as well as in Adlershof developments and demonstrating new processes, tools and types of collaboration.

LESSONS LEARNED

The two given case studies, one in Berlin and one in Vienna, serve as good examples that represent typical spatial typologies and developments in most European cities. The challenge as well as potential that many cities in Europe face is due to the fact that numerous urban areas formerly accommodated uses, which are no longer relevant in the face of contemporary economic, demographic and social urban dynamics. The regeneration and redevelopment of these areas present good opportunities for a 'remake' of the existing urban fabric in a more sustainable manner. In order for this to happen however, a few key conditions have to be in place. The urban districts, being targeted for redevelopment have to be equipped with a clear vision and identity within the overall city strategy. Furthermore, an involvement of diverse key stakeholder setting in the process of co-creation of the district is essential.

In Adlershof, the establishment of a local development company is working well for the development. The buildings as well as solar panels are in great demand and Adlershof continues to grow steadily. It seems that companies do not only want a good location for their offices in terms of infrastructure, moreover also the requirements and goals concerning energy efficiency, increase the attractiveness of the area. Having a cluster of like-minded companies enables cooperation and the nearby campus helps to get in contact with young researchers.

SCIENCE AND TECHNOLOGY PARK ADLERSHOF, BERLIN

Figure 15 - Centre of Biotechnology and the Environment. (Photo: © Margarethe Korolkow)

aspern+ DIE SEESTADT WIENS, AUSTRIA

Figure 16 - Public space in Aspern (Photo: ©Daiva Jakutyte-Walangitang)

SOLUTIONS, RECOMMENDATIONS AND SUGGESTION

The approach of encouraging building owners to voluntarily set energy efficiency goals can be recommended. During the concept phase the collaboration with local universities and residents can give valuable input for development options of an urban area.

The application of the Environmental Impact Assessment in the case of aspern Seestadt has proven successful. It allowed aspern Seestadt Development Agency to install requirements concerning building standards as well as other mandatory pre-conditions ensuring the implementation of the development would follow the principles of sustainability. This approach can be recommended for other developments. Furthermore, involving research institutions throughout different development stages has shown to be of a great benefit, providing innovating impulses to the entire development.

Credits

DEVELOPER

WISTA MANAGEMENT GmbH
Adlershof Projekt GmbH

OWNERS

City of Berlin
WISTA MANAGEMENT GmbH
Private and Public Owners

CONSULTANTS

Senate Department for Urban Development and the Environment (SenStadt), WISTA MANAGEMENT GmbH, Adlershof Projekt GmbH, BTB (district heating provider) and more.

CASE STUDY AUTHORS

Margarethe Korolkow, IBUS GmbH, Berlin, Germany

RESEARCH ORGANISATIONS

ACKNOWLEDGEMENTS

Thanks to WISTA MANAGEMENT, SenStadt, Technical University and HTW Berlin for the information provided and the collaboration.

DEVELOPMENT AGENCY

Wien 3420 aspern development AG

OWNERS

Wien 3420 aspern development AG, die GELUP GmbH, VIENNA INSURANCE GROUP, Bausparkasse der österreichischen Sparkassen Aktiengesellschaft, Die Bundesimmobiliengesellschaft BIG.

STAKEHOLDERS

Numerous stakeholders. Vienna City and various Municipal Departments, Wien Stadtwerke- Vienna Utility Companies, ASCR- Aspern Smart City Research and other research organisations, companies, consultants, etc. have been involved in the research, development and implementation activities in aspern+ Vienna's Urban Lakeside.

CASE STUDY AUTHORS

Daiva Jakutyte – Walangitang, Austrian Institute of Technology (AIT)

RESEARCH ORGANISATIONS

FUNDING ORGANISATIONS

ACKNOWLEDGEMENTS

The authors wish to thank all the partners in Transform+ and TRANSFORM project and the aspern Energy Group.

SHC CHAPTER 5

5.1 IEA Solar Heating and Cooling Programme

The Solar Heating and Cooling Technology Collaboration Programme was founded in 1977 as one of the first multilateral technology initiatives ("Implementing Agreements") of the International Energy Agency. Its mission is "to enhance collective knowledge and application of solar heating and cooling through international collaboration to reach the goal set in the vision of solar thermal energy meeting 50% of low temperature heating and cooling demand by 2050.

The members of the IEA SHC collaborate on projects (referred to as "Tasks") in the field of research, development, demonstration (RD&D), and test methods for solar thermal energy and solar buildings.

A total of 59 projects have been initiated, 51 of which have been completed. Research topics include:

- Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44, 54)
- Solar Cooling (Tasks 25, 38, 48, 53)
- Solar Heat or Industrial or Agricultural Processes (Tasks 29, 33, 49)
- Solar District Heating (Tasks 7, 45, 55)
- Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52, 56, 59)
- Solar Thermal & PV (Tasks 16, 35, 60)
- Daylighting/Lighting (Tasks 21, 31, 50, 61)
- Materials/Components for Solar Heating and Cooling (Tasks 2, 3, 6, 10, 18, 27, 39)
- Standards, Certification, and Test Methods (Tasks 14, 24, 34, 43, 57)
- Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- Storage of Solar Heat (Tasks 7, 32, 42, 58)

In addition to the project work, there are special activities:

- SHC International Conference on Solar Heating and Cooling for Buildings and Industry
- Solar Heat Worldwide – annual statistics publication
- Memorandum of Understanding – working agreement with solar thermal trade organisations
- Workshops and seminars

5.2 Country members

Australia	France	South Africa
Austria	Germany	Spain
Belgium	Italy	Sweden
Canada	Mexico	Switzerland
China	Netherlands	Turkey
Denmark	Norway	Portugal
European Commission	Slovakia	United Kingdom

5.3 Sponsor Members

European Copper Institute
ECREEE
Gulf Organisation for Research and Development
International Solar Energy Society
RCREEE

For more information on the IEA SHC work, including many free publications, please visit www.iea-shc.org