City-zen: New Urban Energy

Dubrovnik 'City-zen Roadshow' REPORT

Martin, C.L.; van den Dobbelsteen, A.A.J.F.; Pulselli, Riccardo; Stevens, Tine; Vandevyvere, Han; Keeffe, Greg

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NEW URBAN ENERGY

Dubrovnik (Gruž) Roadshow REPORT

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MAIN COORDINATOR

Name	Sarah Bogaert
Organization	VITO
Address	Boeretang 200, 2400 Mol (Belgium)
Phone	+32 14 33 58 14
E-mail	sarah.bogaert@vito.be

CONSORTIUM PARTNERS

N° DoW	Organization	Acronym	Country
1	Vlaamse instelling voor technologisch onderzoek	VITO	BE
2	Stichting Amsterdamse Economic Board	AIM	NL
3	Universiteit van Amsterdam	UVA	NL
4	Westpoort Warmte B.V.	WPW	NL
5	Alliander	LIAN	NL
6	HESPUL Association	HESP	FR
7	The Queens University of Belfast	QUB	UK
8	Th!nk E	THNK	BE
9	KEMA Nederland BV	KEMA	NL
10	Technische Universiteit Delft	TUD	NL
11	Stichting Waternet	WAT	NL
12	Greenspread Projects BV (subject to reservation, provided acceptance by EU)	GREE	NL
13	Sanquin (subject to reservation, provided acceptance by EU)	SANQ	NL
14	AEB Exploitatie BV	AEBE	NL
15	Daikin Airconditioning Netherlands B.V.	DAIK	NL
16	Siemens Nederland NV	SIEM	NL
17	Universita'degli Studi di Siena	UNIS	IT
18	Ville de Grenoble	MUNG	FR
19	Commissariat a l'Energie Atomique et aux Energies Alternatives	CEA	FR
20	Compagnie de Chauffage Intercommunale de l' Agglomeration Grenobloise	CCIA	FR
21	Gaz Electricite de Grenoble	GEG	FR
22	SAS ATOS Worldgrid	ATOS	FR
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The Dubrovnik Roadshow would not have been possible without the commitment and energy of two individuals. Those persons being Andrea Novaković (Director - City of Dubrovnik Development Agency DURA) and Goran Krajacic (Assistant Professor, University of Zagreb). Both Andrea's and Goran's unwavering support during the preparations for the SWAT Studio and later Roadshow were pivotal in their joint success. The Roadshow team would also like to take this opportunity to thank all of Andrea's colleagues at DURA. Marko Cosmai, Ana Marija Pilato and Tomislav Matković, all three major factors in the success of the event. We wish them every success in taking the zero energy outcomes of the Dubrovnik (Gruž) Roadshow to the next level of realization.

The DURA offices on 15 Branitelja Dubrovnika would be the base of the Roadshow during its co-creative efforts to develop a sustainable city vision for Dubrovnik. Their staff worked tirelessly to ensure that the objectives of the Roadshow were met. A special mention must also go to Viktorija Dobravec (PhD candidate - University of Zagreb) whose daily support during the 2-week intensive SWAT Studio was highly appreciated by both TU Delft staff and students. Finally, a mention for Dr Siir Kilkis (The Scientific and Technological Research Council of Turkey) who originally nominated the City of Dubrovnik to be a Roadshow city.

ABSTRACT

The City-zen Roadshow travels with a team of internationally recognized experts, in the field of energy planning and design to help develop a sustainable agenda for cities and their neighbourhoods. It will visit 10 cities in total over a 4-year period that are seeking expert guidance on how to become more sustainable and wish to move towards energy neutrality. The overall aim of the Roadshow team, known as 'Roadies', is to work closely with people from the hosting city, whether they be city leaders, entrepreneurs, energy planners, local architect, professionals, academics, students and of course the citizens themselves. The Roadshow devotes 5 days in each hosting city to deliver energy and urban design workshops in which all local stakeholders are welcome and encouraged to join and to take ownership of the final outcomes. Outcomes that will allow the cities recourses, both people and energy, to be directed effectively, by highlighting the energy challenges and potentials to be found in their neighbourhoods, and to finally present a sustainable 'City Vision'.

The following report will describe the activities and outcomes of the Roadshow that took place at the DURA offices in Dubrovnik, Croatia, between the 31th Oct & 4th Nov 2016.

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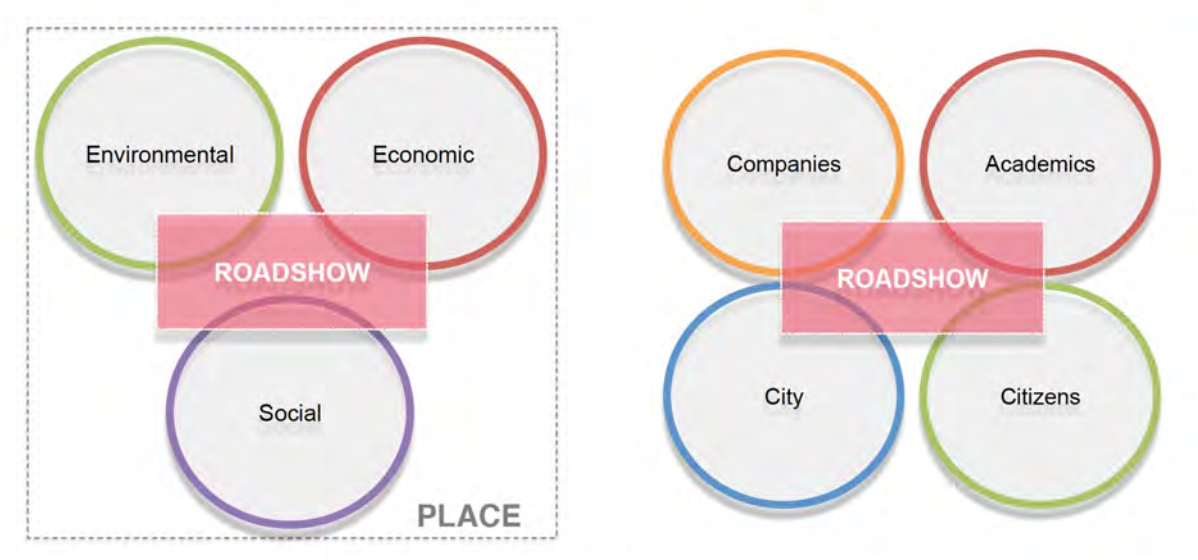
CHAPTER 1 – Introduction

The Roadshow travels with a team of internationally recognized experts in the field of architectural design and energy planning to co-create a sustainable 'City Vision' with city stakeholders. It will visit 10 cities that are seeking expert guidance on how to become zero energy and carbon neutral over a 4-year period. The project has already successfully collaborated with 2 cities, those being Belfast and Izmir. The overall aim of the project team, is to work closely with people from each hosting city, whether they be city leaders, neighbourhood associations, energy planners, architects, academics, students and of course most significantly the citizens themselves. The project consists of a 5-Day event model, a culmination of a 3-month preparation/promotion period that includes a 2-week Masters level onsite intensive studio workshop. Local stakeholders are welcomed and encouraged to join and to take ownership of the process and the final outcomes. Outcomes that will allow the cities resources, people, knowledge and renewable energy potential to be directed effectively over a realisable timescale that will meet their energy transition.

The process starts by identifying a neighbourhood's urban lifestyle and energy challenges. Then, on the final day of the event model, a definitive sustainable 'City Vision' is presented to a public audience and high-ranking city leaders. This presentation shows design and strategic proposals that respond to all scales of their built and natural environment.



(a) *(b)*

Fig. 1. (a) The Roadshow investigates Environmental, Economic and Social aspects of each Roadshow city to develop a 'City Vision' that is specifically tailored to respond to place. (b) The Roadshow team brings together all stakeholders, it facilitates this 5-Day event to propose a sustainable 'City Vision' that is 'owned' by the City itself.

City engagement is an exciting and thought-provoking prospect. Many questions arise at the beginning the journey. Making first contact with a prospective project location, conducting preparations, explanations and agreements is far from an exact science. The method of achieving this successfully has evolved city-by-city and is arguably as valuable than the sustainable solutions that are produced at the end. There are potentially many political, cultural and language obstacles to overcome. The outcomes must have the power to inspire and potentially be realised post-project. The first questions are who is 'the City'? What are the city's sustainable expectations, aspirations and current agenda, if they indeed have one at all? What is the current and future calculated energy demand? Where are the urban challenges, are they purely energetic, spatial & social, administrative or a combination of all? Does the 'City' even realize or accept they have challenges, despite its desire to be sustainable?

To answer these questions and many others, the project team began the process of identifying the cities that need and want our collaboration. First contact begins with an educational architecture workshop studio (Known as the SWAT Studio), which occurs in the months leading up to the project. This student-focussed workshop facilitates an extended and detail discussion with city stakeholders. The event model lasts for 5 days and is based on 'themes' that guides the evolution of the vision in which expert input would be delivered at key points throughout. Each event is constructed to relate to individual citizen experiences and knowledge, this giving them confidence in the processes that are them extended later to relate to their street, neighbourhood, district, city and island. The project is not intended to be a one-way stream of information and ideas, instead the process aims to activate, convince, openly invite and encourage 'the City' to be part of the process at any level that they feel comfortable with. The method includes going out of the studio and into the community to engage with various initiatives and to meet and talk with their members no matter what age or background. The project leader selects cities that have diverse climates, urban typologies, economies, cultural backgrounds, this ensures that the project the highly mobile and compact method is fully tested and evolved by different contexts and challenges.

1.1. AIMS

The aim is to develop an event model capable of implementation in all cities to co-create a city's sustainable vision with citizens from all backgrounds. Proposals developed exclusively by the project team, and not by the multidisciplinary city stakeholders, would physically and metaphorically leave with the project, hence a homegrown solution is key. A legacy must remain in which all participatory groups continue to exchange knowledge and speak with a common voice, making any future research bids, beyond the scope of the project more coherent and effective. The project wishes to extend its agenda by strengthening connections and bringing together a global family of project cities, where experiences can be shared together with collaborative research bid proposals across the wider community of Europe.

The most important target group are inhabitants of the neighbourhood, city and wider hinterland of the hosting city. Companies and start-ups in the field of technology and sustainability are encouraged to be active participants during the project. A key objective is to reach 600 students across the EU by visiting local universities, colleges and secondary schools. Students are the future. It has been mutually beneficial idea to combine the energy and enthusiasm of architecture, urban planning and building technology 'SWAT Studio' Master's students with that of the stakeholders and students of each hosting city. The student projects, and more significantly the close relationships that were forged whilst conducting them, lay the foundation on which later to build the later intensive 5-Day

project. Promotion, full participation and dissemination contribute significantly to overall success, as a consequence the project and student workshop leader encourages any and all interested groups such as municipalities, neighbourhood associations and universities to grasp the opportunity to do so. Taking the time to discuss what is expected allaying any reservations or doubts they may have. It is not the intention of the event to criticize a cities perceived lack of sustainability, project team specialists are aware of many complex global and local level obstacles toward the energy transition.

1.2. OBJECTIVES

1.2.1 Student Engagement

A Masters level Building Technology student workshop (known as the SWAT Studio), with identical project aims, develop and propose innovative, sustainable, contextually sensitive urban design interventions. A key ambition of the workshop being to demonstrate that, through building interventions at all scales ranging from façade, building, street, neighbourhood and district, that sustainable lifestyles are possible within existing cities. This student-orientated programme is a precursory educational event to the later specialist project. In Dubrovnik, at the studio venue kindly donated by the University of Dubrovnik the studio leader (Dr Craig Lee Martin) and student's forged pre-Roadshow relationships with key city stakeholders, allowing project sites to be evaluated and selected. The outputs of each sustainable workshop would be presented on the first onsite day of the project, the workshop making positive connections with academic and municipality leaders and sustainable energy and smart city entrepreneurs.

Fig. 2. The Dubrovnik 'SWAT Studio'. A MSc's Building Technology 'Onsite' studio (TU Delft, The Netherlands), an educational precursory event that took place 2 months prior to the start of the Dubrovnik Roadshow. SWAT Studio aims and objectives are identical to that of the Roadshow. The dissemination activities and relationships made during the preparation and completion of this 2-week intensive student workshop build a firm foundation on which to build the later expert Roadshow. The photographs here show activities on day one of the studio. These include presentations by Marko Cosmai (DURA), Goran Krajacic (Univ of Zagreb) and Željko Raguž (Deputy Mayor of Dubrovnik). The remaining images show the site investigation of the Gruž area by the SWAT students.

Fig. 3. The Dubrovnik 'SWAT Studio'. The studio is an intensive workshop that develops sustainable social and technological urban design interventions. The photographs show the students group working in the studio kindly donated by The University of Dubrovnik. The two lower images show the final presentation that took place on Friday 30th September 2106. In attendance were members of the Dubrovnik Municipality Environment department and Andrea Novaković, Director of the City of Dubrovnik Development Agency.

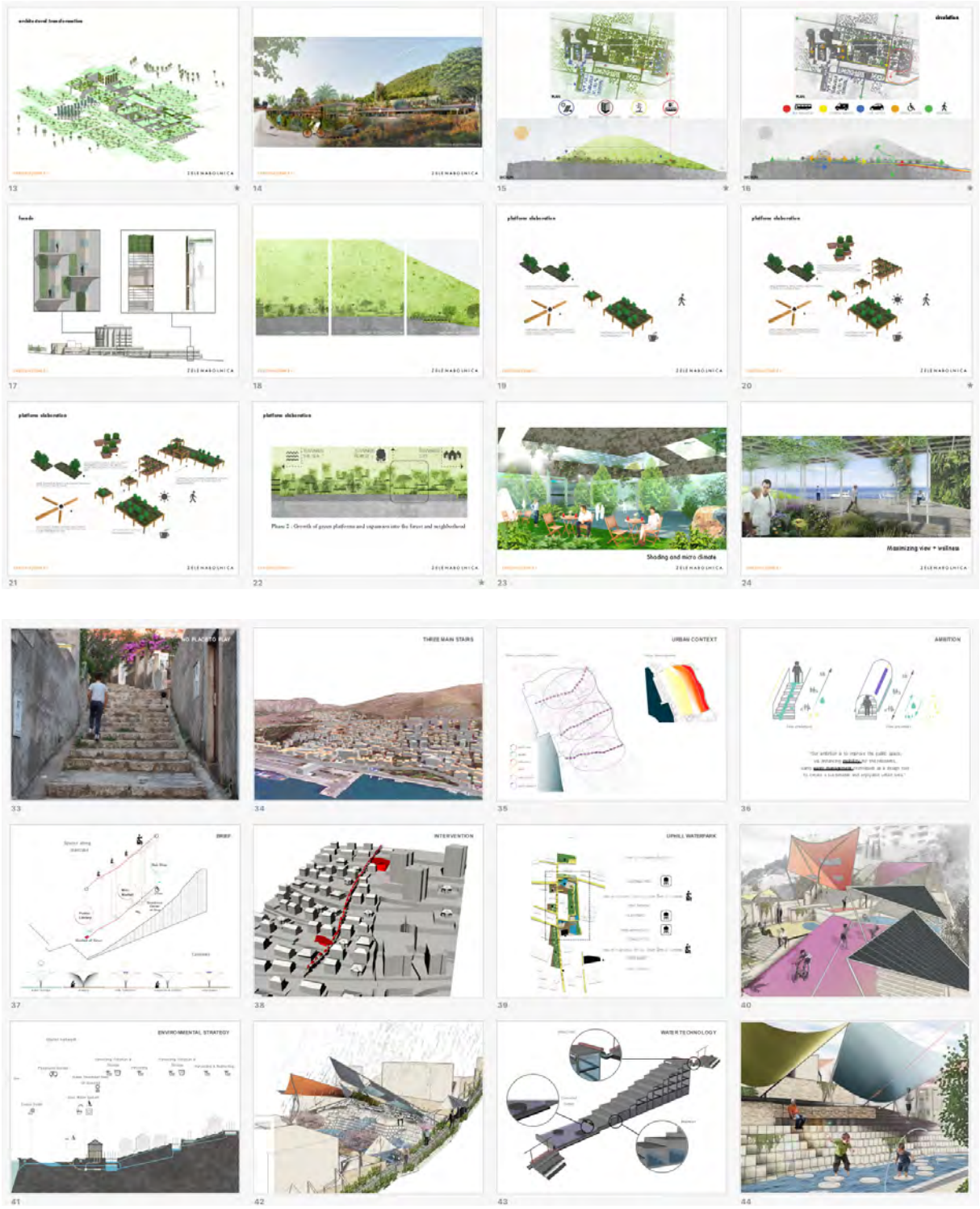


Fig. 4. A small selection of 'SWAT Studio' sustainable design interventions presented on the final day. Slides 33 to 44 show the Gruž project site, one of 5 sites under SWAT investigation around the Dubrovnik area. The Gruž site was later to be the neighbourhood project site for the Dubrovnik Roadshow.

1.2.2 Process

As described above, the process in Dubrovnik began with a Masters level Building Technology and architecture student workshop 2/3 months prior to the project start (19th Sept to 30th Sept 2016). Both the workshop and the later Roadshow were developed to be intensive by optimizing time, simplifying communication & explanation, and maximising participation. Components such as Pecha Kucha presentations (quick fire 20 minute lectures) site excursions, design workshops and Mini-masterclasses were strategically timed and citizen focussed at key points during the 5-Day period to push forward sustainable propositions, and to later evaluate and expand upon them. The outputs, synchronised with specific project team specialisms in energy and urban design, were qualitatively spatial and quantitatively energy focused, and combined to form a sustainable 'City Vision' on the final day of the Roadshow (Friday 4th November 2016).

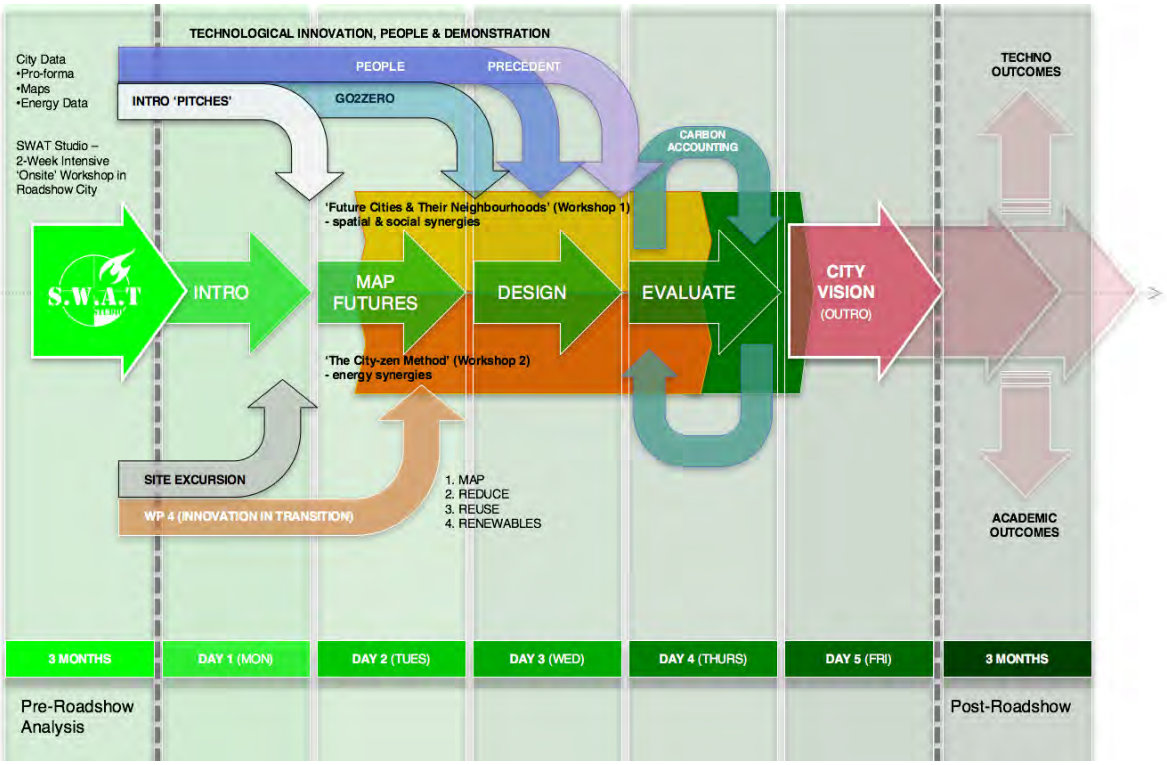


Fig. 5. Dubrovnik Roadshow 5-Day schematic. The outcomes of the MSc Building Technology student 'onsite' workshop (SWAT Studio) being the starting point of the later 5-Day Roadshow.

DAY	Morning/ Afternoon	Time	ACTIVITIES
DAY 1 31/10/16 (Mon) Theme: 'INTRO'	AM	10:00 - 10:30	MEET & GREET (Venue: DURA **Branitelja Dubrovnika 15, 20,000**)
		10:30 - 12:00	**'MINI-BUS' EXCURSION AROUND DUBROVNIK SITE**
	PM		LUNCH
		12:30 - 12:45	**'Welcome to the Dubrovnik Roadshow'** by Andrea Novaković (Director, City of Dubrovnik Development Agency – DURA) & Dr Goran Krajacic (University of Zagreb)
		12:45 - 13:00	**'The Roadshow Methodology' (5-Day Timetable)** by Dr. Craig L. Martin, Delft University of Technology (TUD)
		13:00 - 13:15	**'Future Cities & Their Neighbourhoods' (Workshop 1)** by Prof. Greg Keeffe (QUB)
		13:15 - 13:30	**'The City-zen Method' (Workshop 2)** by Prof. Andy van den Dobbelsteen (TUD)
		13:30 - 13:45	**'Dubrovnik Roadshow' ANY QUESTIONS?** by Roadshow Team + BREAK
		14:00 - 14:15	**'The Best of Dubrovnik SWAT Studio 2016'** by Dr Craig L. Martin (TUD)
		14:15 - 14:20	**WELCOME & INTRODUCTION DUBROVNIK 'Pitches'**
		14:20 - 17:30	**Dubrovnik Project Presentations by 'The City'** with Marko Cosmai (DURA) & Dr Goran Krajacic (University of Zagreb)
		17:30 - 18:00 +	End of DAY 1 SUMMARY: INFORMAL DRINKS & DISCUSSION
		20:00	**EVENING DINNER**
DAY 2 01/11/16 (Tues) Theme: 'MAP FUTURES'	AM	09:15 - 09:30	COFFEE & MEET UP POINT
		09:30 - 12:00	**'Future Cities & Their Neighbourhoods' (Workshop 1)** PERIOD 1 / **'The City-zen Method' (Workshop 2)** PERIOD 1
		12:30 - 14:00	LUNCH — PERIOD 2 / PERIOD 2
	PM		BREAK
		14:15 - 15:45	PERIOD 3 / PERIOD 3
			BREAK
		16:00 - 17:00	PERIOD 4 / PERIOD 4
			BREAK
		17:00 - 17:30	DAY 2 'MAP FUTURES' SUMMARY + WORKSHOP 1 & 2 'CATCH-UP' — ALL WELCOME!

Fig. 6a. Dubrovnik Roadshow Timetable (Days 1 to 2).

DAY 3 02/11/16 (Wed) Theme: 'DESIGN'	AM	08:15 - 08:30	COFFEE
		08:30 - 12:00	**'SERIOUS GAME Go2Zero'** by Ewoud Vos (KEMA Nederland B.V.) & Ivo Wenzler (AccentureStrategy / TU Delft)
	PM		LUNCH
		12:30 - 14:00	**'FUTURE TECHNOLOGIES' by Ceco Gakovic (CityOS)** Seminar discussion on sustainable technologies in Dubrovnik & Croatia
			BREAK
		14:15 - 16:30	PERIOD 5 / PERIOD 5
			BREAK
		16:45 - 17:30	**Mini-Masterclass 1 - 'THE LINK BETWEEN PEOPLE & TECHNOLOGY'** by Dr Han Vandevyvere (VITO)
		17:30 - 18:00	DAY 3 'DESIGN' SUMMARY + WORKSHOP 1 & 2 'CATCH-UP' — ALL WELCOME!
DAY 4 03/11/16 (Thurs) Theme: 'EVALUATE'	AM	09:15 - 09:30	COFFEE
		09:30 - 10:30	**Mini-Masterclass 2 'CARBON ACCOUNTING EXPLAINED'** By Riccardo Pulselli (University of Sienna)
			BREAK
		10:40 - 12:00	PERIOD 6 / PERIOD 6
	PM		LUNCH
		12:30 - 13:30	FINAL AGREEMENT & DISCUSSION of CITY VISION — ALL WELCOME!
			BREAK
		13:40 - 14:20	FINAL AGREEMENT & DISCUSSION of CITY VISION (Cont...) — ALL WELCOME!
			BREAK
		14:30 - 15:00	DAY 4 'EVALUATION' SUMMARY + WORKSHOP 1 & 2 'CATCH-UP' — ALL WELCOME!
DAY 5 04/11/16 (Fri) Theme: 'OUTRO'	AM	09:30 - 10:00	WELCOME COFFEE
		10:00 - 10:15	**'WELCOME TO THE DUBROVNIK ROADSHOW'** by Dr Craig L. Martin
		10:15 - 11:15	**'THE CITY VISION'** Presented by 'The City' & 'The Roadies'
		11:15 +	ROADSHOW DISCUSSION DRINKS & CLOSURE
	PM +		FINISH

Fig. 6b. Dubrovnik Roadshow Timetable (Days 3 to 5).

1.2.3 Daily Activities

In Dubrovnik, daily activities would involve citizens, members of the City of Dubrovnik Development Agency (DURA), smart technology entrepreneurs, architects, municipality staff, PhD students and academics visiting the Roadshow studio base at the DURA offices. A location ideally situated in the centre of city, immediately adjacent to the old town. 5-Day programme was devised in such a way to encourage participants to 'drop-in' and 'drop-out' so that the project workshop activities and Mini-masterclasses could fit into their professional and domestic schedules, a strategy that would increase city involvement. Following a site investigation around the Gruž project site in the morning, PechaKucha style presentations on Roadshow Day 1 ('PechaKucha' meaning 'chit-chat' in Japanese, is a format that keeps presentations concise and fast-paced, facilitating multiple-speaker events) informed the participants of what to expect. Dubrovnik's stakeholders also contributed on the day with presentations that outlined past, present and future aspirations for their city. Presentations by Marko Cosmai (Head of Office - DURA) and Goran Krajacic (Assistant Prof – Univ of Zagreb) began the session with critical input that helped identify the environmental, social, tourism and energy challenges.

Fig. 7. Dubrovnik Roadshow Day 1. Images of the site investigation to the Gruž neighbourhood by the Roadshow team, including student facilitators from Queens University Belfast and local stakeholders. The area is immediately adjacent to the Port of Gruž, the only port in Dubrovnik that at the height of the tourist season can accommodate up to 9 cruise liners containing around 12,000 passengers who currently visit the old town by coach. This situation that has isolated the residential Gruž area economically and environmentally. The steep topography of the area has hindered past attempts to link the area with public transport, the commercial portside market area and the tourist centre in the old town.

Fig. 8. Dubrovnik Roadshow Day 1. Introductory Pitches by the Roadshow leader (Dr Craig Lee Martin TUD) and Workshop coordinators (Prof. Andy van den Dobbelsteen & Prof. Greg Keeffe) communicate to the participants what to expect in the upcoming 5 days. The lower two photographs show accompanying 'Pitches' from local stakeholders outlining the current context and the latest city proposals.

The project method aims to foster an intensive working environment, yet one, which allows adequate flexibility to ensure maximum participation of stakeholders. It must be respected and appreciated that all stakeholders are likely to have full time jobs and a family life beyond any project, they are not financially supported to attend. Therefore it is one of the roles of the project leader to strike a balance during discussions between conveying the urgency of being part of the process but not to an extent that it distances prospective attendees. Whilst the student workshop is underway on location many preparations and negotiations take place with stakeholders, here various visual descriptors are used to communicate what is expected during the project.

Photographs of co-creative and intensive scenarios from previous projects in Belfast and Izmir were incredibly effective in translating what was to come. Coloured marker pens, rolls of tracing paper, laptops and notebooks are the tools of choice for Roadshow participants. Activities have the same aim - energy neutrality. However each component is enjoyably diverse and offers new perspectives and skills on how to attain it. Whilst two parallel workshops run continually over the week (See sections 2.1, 2.2) participants sign up to play a Serious Game entitled 'Go2Zero' (See section 2.3), stakeholders have the opportunity to 'Role' play, whilst having group fun experiencing the cause and effect of energy strategy decisions they each made at the regional, neighbourhood and family household level.

1.3. ROADSHOW AT A GLANCE

The following points list 18 keywords that best describe the story and ambitions of the City-zen Roadshow:

1. **ZERO ENERGY** Aims to develop and demonstrate Zero Energy Cities with a central role for citizens.
2. **MOTIVATE & EMPOWER** End-users to a long-term energy saving attitude.
3. **CITIZENS** Placed in the heart of a creative process that develops designs, strategies, guidelines and timelines at all scales of their own cities built environment.
4. **NUMBERS** 4 Cities completed - 3 months prep / city - 5 days onsite / city - All Citizens - 7 International sustainability experts - 6 Cities next.
5. **IMPACT** Healthy lifestyles, environmental comfort, building efficiency, independence from fossil fuel uncertainty. But most of all confidence that sustainability is for all who want it.
6. **TRUST** Citizen's need belief in the process, objectives and solutions, no matter how radical or unfamiliar. Students open the door!
7. **OWNERSHIP** Citizen's take ownership of their built environment without fear of hidden agendas, affiliations or political constraint.
8. **HOMEGROWN** The solutions stay with the people.
9. **WHO IS THE CITY?** Doesn't matter where the ideas come from, as long as they come and begin to be realized.
10. **DISRUPT** Project rocks the status quo to reach zero energy.
11. **GLOCAL** Specialist global expertise combined with local stakeholder energy and knowledge of context and lifestyle.
12. **GRAPHICAL** Use graphical descriptions to get your messages across.
13. **SACRIFICE?** Its not about losing, its about what you gain. Replacing it with something better for your children and community.
14. **TIMETABLE TO SUIT** Schedule to fit stakeholders, not the other way round. Remember, stakeholders are not on the payroll, they have other daily priorities.
15. **INDIVIDUAL PERSPECTIVE** Make sure activities relate to the people and their experiences. These can be expanded later to other scales.
16. **COMPARISONS** To design what is possible is one thing, to show what has been realized or what can occur under the right circumstances is even better.
17. **HIGHLY VISUAL** Outcomes to be colourful representations of the future, before/after scenarios.
18. **BE INSPIRATIONAL** Encourage 'City Vision' participants to take the lead in the next step!

CHAPTER 2 – ROADSHOW COMPONENTS

The following content and photographs best describe the underlying approach undertaken in Dubrovnik and specifically in the residential neighbourhood of Gruž located adjacent to the Port of Gruž. This section will include a brief explanation of the 'City Vision' that resulted. The main content of the 'City Vision' will be in the form of the final presentation delivered on the final day, this is included in the final chapter.

Beginning on Day 2 Two parallel workshops continued throughout the project week, on arrival stakeholders were guided to select one workshop depending on their interests or specialisms, however migration to each was recommended in order for stakeholders to get a full overview of energy and urban strategies and their implementation. At the end of each day the workshops met to summarise their findings and to agree on that evenings, and the following days, objectives.

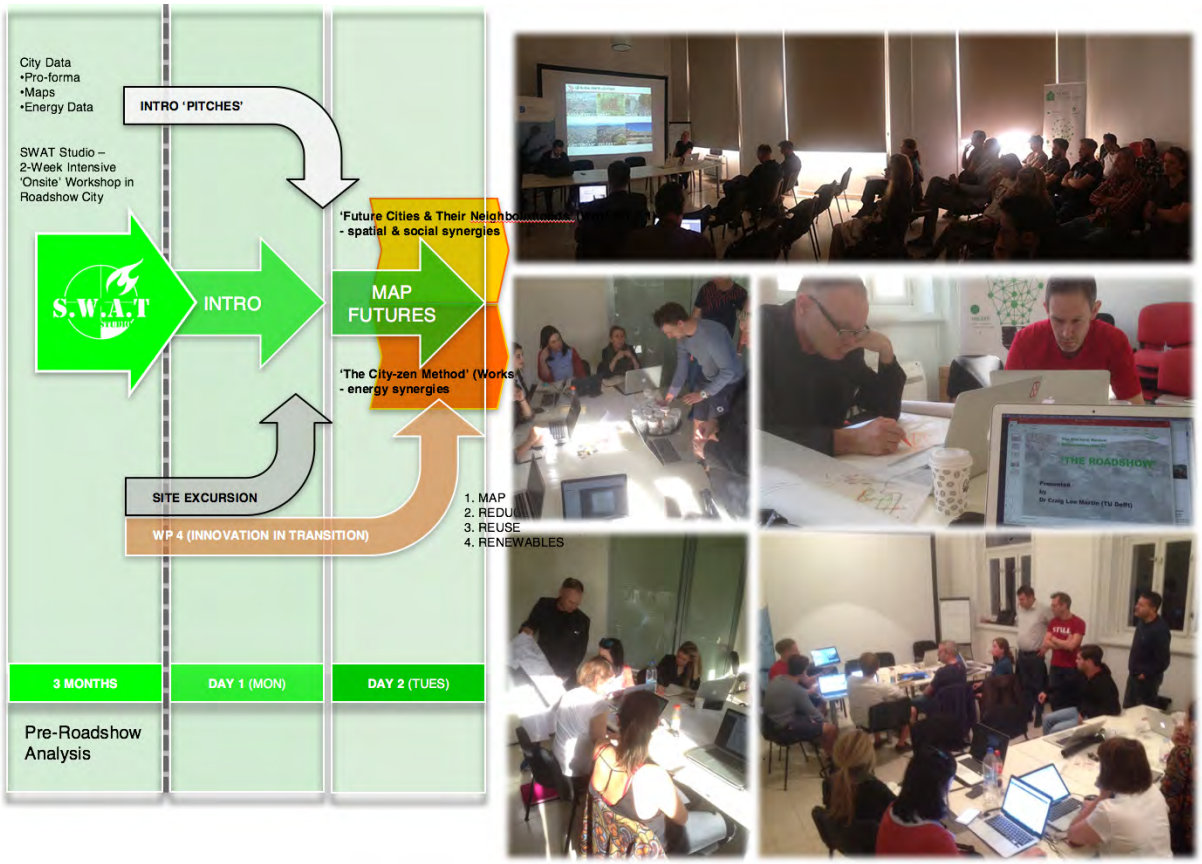


Fig. 9. Parallel Workshops (Days 2 to 5). 'Future Cities & Their Neighbourhoods' (Coordinator - Prof. Greg Keeffe, Queens University Belfast) and 'The City-zen Method' (Coordinator - Prof. Andy van den Dobbelsteen, Delft University of Technology) co-creatively begin work inside the DURA Building. One focussing on social and spatial urban sustainability, the other more focussed on energy demand, potentials and measures. Students from Queens University Belfast took the role of workshop 'facilitators' for the full 5-Day programme.

2.1. FUTURE CITIES & THEIR NEIGHBOURHOODS (WORKSHOP 1 – DAY 2 TO 5)

2.1.1 Background

The aim of 'Future Neighbourhoods' is to inspire people to imagine a more sustainable future, one that embraces the best of new technology in a way that is life enhancing. The workshop encourages freethinking and open-ended discussions about how things should be. It asks stakeholders to imagine new life-styles and then to develop strategies to achieve them. In Dubrovnik the workshop began with an envisioning session about the future, and quickly moved onto designing the infrastructure necessary to achieve these visions. Once the infrastructure was developed a phased strategy would be proposed to achieve these goals. The design element has clear objectives in that it aims to kick-start carbon descent through the development of a series of options for the neighbourhood. The scope was holistic and arguably over challenging for a typical consultancy team to resolve, however this along with all elements of the project offers a service that is currently unmatched.

Zero energy neighbourhoods are places where people live and dwell, it is important to remember this, as it is the actions of people that use energy, thus the environment created not only is a conglomeration of technologies, but also a landscape that encourages behaviours. Behaviour change is crucial for carbon descent and the new neighbourhoods we create will create lifestyles that are sustainable, healthy and happy. It is also important to see the neighbourhood as part of a nested series of environments, each sitting within another, with others within, in turn.

2.1.2 Aim & Objectives

The aim of the Dubrovnik project workshop specifically was to develop strategies at a range of scales that allow a process-based adaptation of the city to carbon neutrality. The scales utilised were: the city, the neighbourhood, and the building. The city scale is important because city form is the basis for the behaviours engendered in the city. Here urban grain can encourage or discourage car usage, can allow safe routes for schoolchildren, and connect the inner city with the countryside. The neighbourhood scale allows us to visualise the commons i.e. the things we share. This may be things such as smart grids, or other networks, but may also be spaces for meeting, playing or growing. Energy storage is most cost-effective at this scale too, as is car share. In addition, density is one of the key factors in making neighbourhoods function, and many behaviours are linked to this such as car usage, local economy etc… The house or building scale is crucial, because here we see many of the technologies for neutrality being employed. Technologies such as PV cells, heat-pumps, shading devices, DHW production all have been developed to work at this scale.

2.1.3 Methodology

The workshop starts with an understanding of city form, historic and future growth, urban grain, climate, eco-system services and density. From these initial studies, an understanding of the city as a holistic super-organism is developed. This bio-climatic understanding allows new insights into current trajectories. Urban design is based on understanding urban trajectories and deflecting or manipulating them, to create new futures in a seamless way. Once a sustainable urban design strategy for the city is developed, we change to the neighbourhood and building scales to look at the issues this strategy creates at the smaller scales. More detail can be developed here, and the solutions become more technological.

We then visualise the impact these technological insertions have on the built environment and the lifestyles of the residents.

2.1.4 Outcomes

The outcomes of the workshop would be multi-scaled in form in that responded to façade, building, neighbourhood and the city as a whole. Mobilities and connections to the port of Gruž and the Old town, as well at the circular transformation energy/fuel demand and waste production of the cruise ships that birth at the Port Gruž would be a major driver for the urban intervention proposals and circular economic strategy for the neighbourhood and city. A full description of the City Vision is included in section 3.2 'The Presentation'.

2.2. 'THE CITY-ZEN METHOD' (WORKSHOP 2 – DAYS 2 TO 5)

As with the two previous project cities in Belfast and Izmir the aim of this workshop was to make an Energy Master Plan. For the neighbourhood in Gruž the first steps would be to identify existing and implementable sustainable interventions together with the actions that would lead to a zero energy neighbourhood. The objectives were to map the areas energy demand and potentials. This also involved a social, political, economic and climatical analyse of the region.

The workshop representing the energetic-technical part of the energy transition during the Dubrovnik project. To achieve this various methodological steps were taken:

- Step 1: Energy Analysis (Mapping the technical geographical present)
- Step 2: Present planning and trend (Mapping the near future for energy plans)
- Step 3: Society & stakeholder analysis (Mapping the political-legal-social-economic climate)
- Step 4: Scenario for the future (Mapping external influencing variables)
- Step 5: Energy vision with targets and guiding principles
- Step 6: Roadmap with energy interventions and actions

Any energy transition of a neighbourhood is always intertwined with its surrounding city and region. The goal was to define in a first step the real demand in terms of heat, cold, electricity, energy for transport and processes for the residential, non-residential, industrial functions and for transport. And in the next step the sustainable potentials of the city. A full description of the City Vision is included in section 3.2 'The Presentation'.

2.3. SERIOUS GAME 'GO2ZERO' (DAY 2 – MORNING)

In Dubrovnik, the serious game session took place in the meeting room of the DURA building. 15 stakeholders took part in the session simultaneously. Communication was recognised as a potential issue at early stage in Roadshow preparations. However, in the Dubrovnik case translation would be facilitated by Ivo Wenzler ('Go2Zero' coordinator – TU Delft/Accenture), who originates from Croatia and is a fluent in the language. The game session itself took about 3.5 hours.

The goal of the interactive game session is to not only allow citizens to get involved by also those in government and the energy sector to experience their role within a local energy transition. However, the objective of the game is to reduce the amount of CO2 consumed within a residential area. The participants will have to balance this overall objective with achieving their own individual goals. It present's them with realistic obstacles based on realistic limitations and constraints, and the challenges to make decisions and try to overcome obstacles through cooperation with other stakeholders. Through playing the game, the participants will:

- Create insight in the energy demand of residential buildings
- Create insight in a variety of state-of-the-art technologies
- Get to know the roles of key stakeholders in the transition process
- Get to know how to individually reach the role-related, individual objectives
- Recognize and understand the actions of other stakeholders
- Learn how their actions influence other stakeholders
- Learn how to work together to reach collective and individual objectives

The methodology is a tabletop role-playing game, where the participants take on different roles within the energy supply chain. The game revolves around the electricity and heat consumption in a residential area, as well as the CO2 emissions resulting from the consumption. The area is represented through a game board representing the different residences and the network connecting them. Different coloured chips on the board represent consumption and emissions. The following roles are taken within the game:

- Consumers
- Housing corporation
- Technology companies
- Local energy company
- Network operator
- Municipality

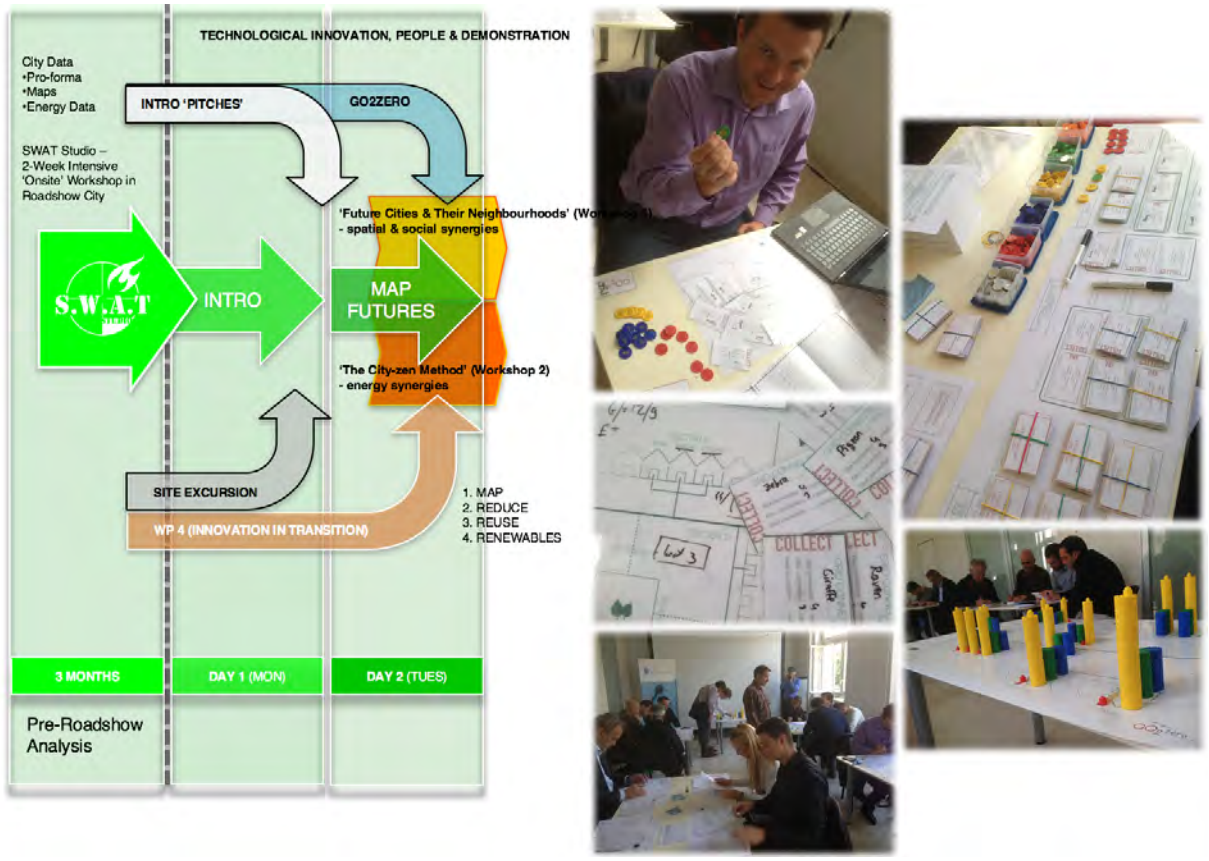


Fig 10. The Serious Game 'Go2Zero'. Photographs show the game underway at the DURA Offices on Day 2 of the Dubrovnik Roadshow.

Each group of stakeholders had their own set of goals to achieve, and means through which they could achieve them. These ranged from ensuring grid stability to increasing revenues. Participants are challenged to formulate a strategy beforehand, which would influence their decision-making process throughout the game.

The game takes place in a number of rounds. At the start of the round, all financial transactions are handled: everyone pays for their taxes, energy bill and a contribution to the network operator. Following this the negotiation phase starts. Here the different stakeholders engage in discussions and make decisions to achieve their own objectives. Consumers and the housing corporation can buy more sustainable technologies to upgrade their houses, or move from grey to green energy contracts. The municipality could decide to increase taxes and give out subsidies. The local energy company had the option to buy large-scale renewables in order to avoid having to buy green energy elsewhere for their green energy contracts etc.…

Following the negotiation phase decisions taken by the stakeholders are presented and the results are calculated. Any reductions in electricity or heat use, and the resulting CO_2 reductions, are visualized by removing chips from the game board. In the game, a total of six playable rounds are possible. After each round, new technologies are introduced to represent development. As a result of the round system, players were confronted with the effect of their decisions and strategies on both the short and long-term. During the game the participants were very enthusiastic and motivated.

2.4. ‘MINI-MASTERCLASSES’

(a) *(b)* *(c)*

Fig 11. Dubrovnik Roadshow ‘Mini-masterclasses’.

Strategically scheduled and content diverse sustainable Mini-masterclasses took place on Day’s 3 and 4 to support the two parallel workshops that run throughout the week. On Day 3 the ‘Future Technologies’ Mini-masterclass was to be delivered by Ceco Gakovic (CityOS), a Dubrovnik stakeholder and well-known Croatian entrepreneur who described the many Smart Cities and technology projects that are currently being developed in Croatia. This locally based and inspirational Masterclass would be immediately followed by the ‘People & Technology’ Mini-masterclass delivered by Han Vandevyvere (VITO).

On Day 4 carbon accounting expert Riccardo Pulselli (Univ of Siena) ran a ‘Carbon Accounting Explained’ workshop with stakeholders. Here Riccardo explained the theory and math behind the concept of reaching carbon neutrality. Illustrative geographical graphics show how areas of forestland can capture or sequester carbon. The exercise then going onto visually describe how variously scaled renewable interventions can lower the area of carbon capture step by step to reach the carbon neutrality of Dubrovnik. These carbon facts, calculations, approximations and equivalences are of course complex and at times seemingly impenetrable, even to specialists who work with them on a daily basis, ‘Carbon Accounting Explained’ takes great care in ensuring that the carbon story is interactively told in first principles and tuned to each participating citizens perspective and carbon usage.

CHAPTER 3 – SUSTAINABLE CITY VISION

3.1. FINAL DAY (THE CITY OF DUBROVNIK DEVELOPMENT AGENCY)

The final day of the Dubrovnik Roadshow took place at the City of Dubrovnik Development Agency (DURA) on the 4th November 2016. The final 'City Vision' was presented to an audience comprising Dubrovnik's Municipality leaders, members of the Smart City start-up initiative, members of the City of Dubrovnik Development Agency, professionals, architects, students and citizens from the City of Dubrovnik. Mr. Željko Raguž, Deputy Mayor of Dubrovnik and Andrea Novaković, Director of DURA initiated the proceedings by introducing the Roadshow team and welcoming the many participants.

Fig 12. The culmination of the 5-Day Roadshow - The final 'City Vision' presentation hosted by the City of Dubrovnik Development Agency. In attendance Mr. Željko Raguž the Deputy Mayor of Dubrovnik and Andrea Novaković, the Director of DURA.

The Dubrovnik 'City Vision' took the form of four integrated presentations. The first, briefly outlining the overall objectives, and specifically the ambitions, format and activities completed during the Roadshow. The second and third, formed the major content body including spatial, social and energy measures / guidelines at all city scales (façade, building, street, neighbourhood and city). The fourth, a comprehensive overview of energy strategies, scenarios and carbon offsetting measures at overlapping scales.

The project has successfully reached out to, collaborated with, and made meaningful relationships and networks with city stakeholders across Dubrovnik. The methods implemented in Belfast and Izmir, and now in Dubrovnik gaining an internationally wide reputation as an innovative and societally impactful event model. Building upon these experiences, and looking forward to Roadshows in Menorca (Balearic Islands), Sevilla (Spain), Roeselare (Belgium), Klaipeda (Lithuania) and Catania (Sicily). The key to success has been to identify, reach and gain the trust of city inhabitants and 'decision makers'. To achieve this, an exchange of knowledge, experience and commitment continues to be crucial. As part of the on-going evolution of the project, it is the intention to extend the Roadshow method with 'Revisits' in order to guide Dubrovnik and forthcoming Roadshow cities on specific detailed aspects of their city vision, as well as how best to realise them.

3.2. THE PRESENTATION

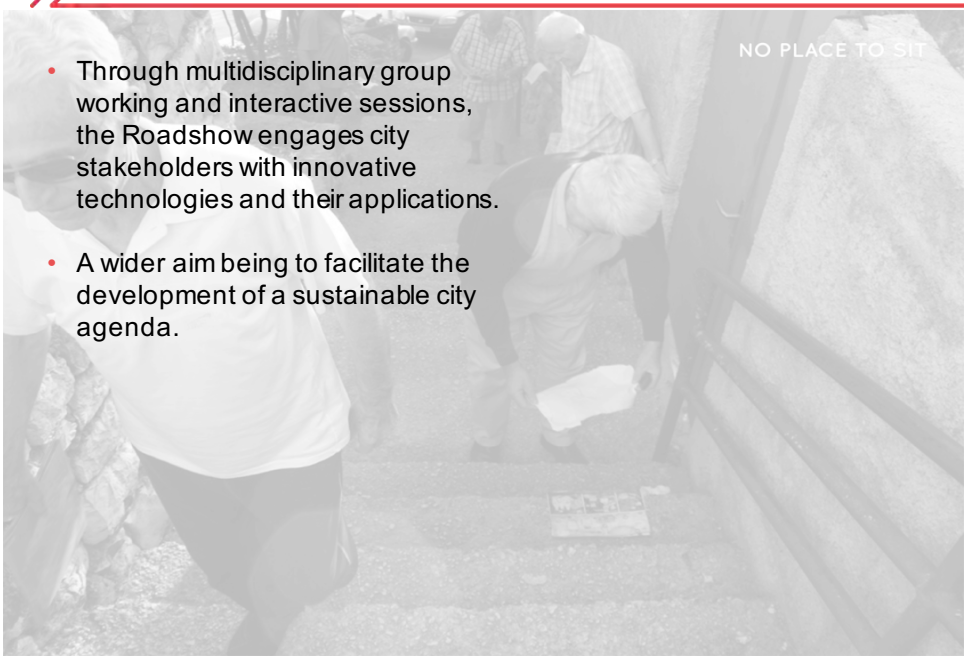
The following 'City Vision' presentation (Roadshow findings) was delivered at The City of Dubrovnik Development Agency on Friday 4th November 2016:

‘The CITY-zen Dubrovnik (Gruž) Roadshow’

THE CITY VISION

Monday 31st Oct to Friday 4th Nov 2016
Hosted by DURA – The City of Dubrovnik Development Agency

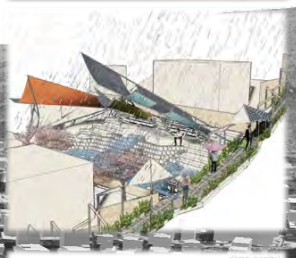
AIMS & AMBITION

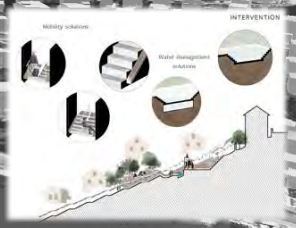


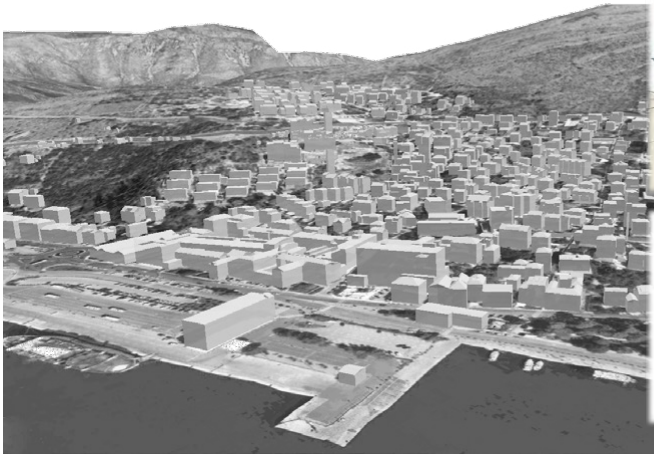
- Through multidisciplinary group working and interactive sessions, the Roadshow engages city stakeholders with innovative technologies and their applications.
- A wider aim being to facilitate the development of a sustainable city agenda.

SWAT STUDIO

- A 2-Week Intensive Student Sustainable Urban Intervention workshop, will visit each hosting city within 2 months before the start of each Roadshow.





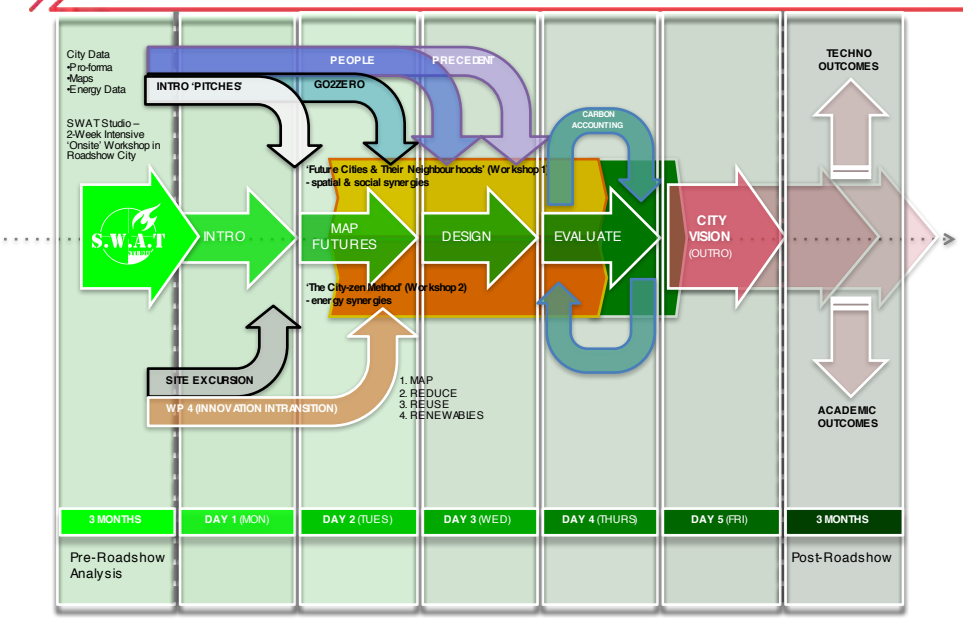


DAILY ACTIVITIES

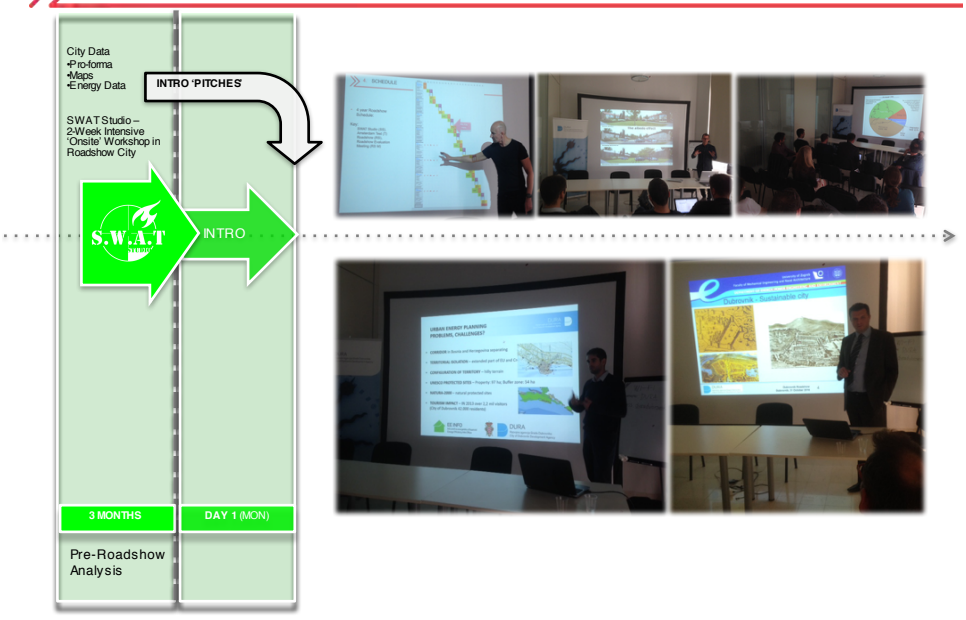
Activities & events that have taken place so far over the 5 Day programme include:

- Energy Potential Mapping
- Design workshops
- Serious Gaming
- Mini-Masterclasses (Social & Technical)
- Future Innovation Technology lecture/seminar
- Carbon Accounting

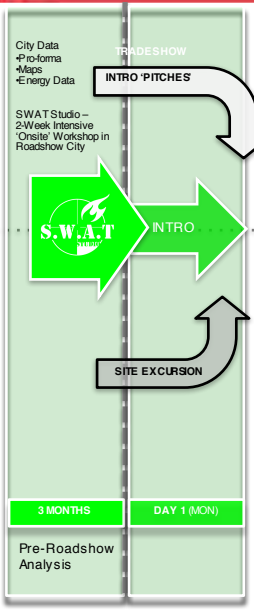
DAILY ACTIVITIES (5-DAY SCHEMATIC)



DAY 1 - 'PITCHES' BY ROADIES & THE CITY

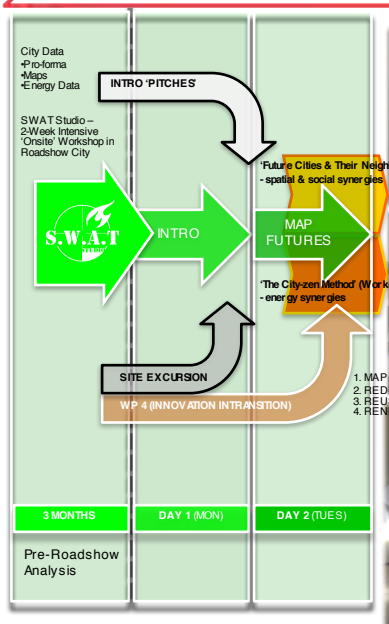


DAY 1 - SITE EXCURSION

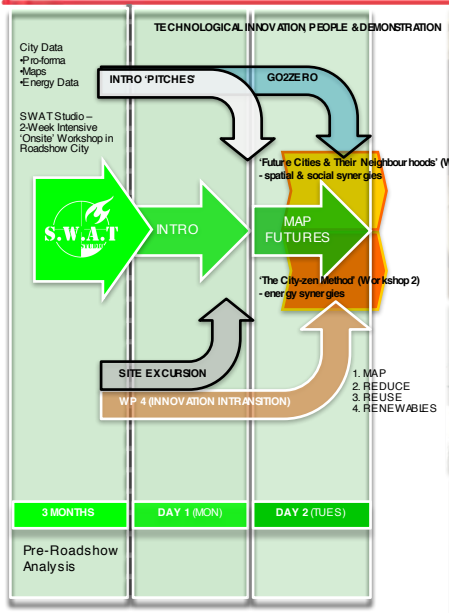


Gruz, Dubrovnik (Croatia).

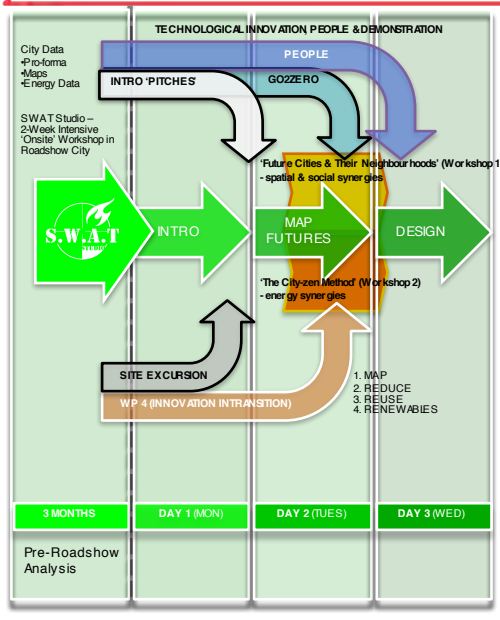
DAY 2 - WORKSHOP BEGINS

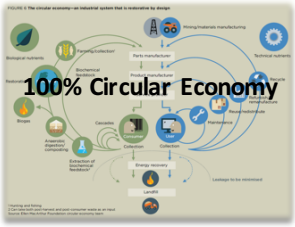


DAY 2 - GO2ZERO (SERIOUS GAME)

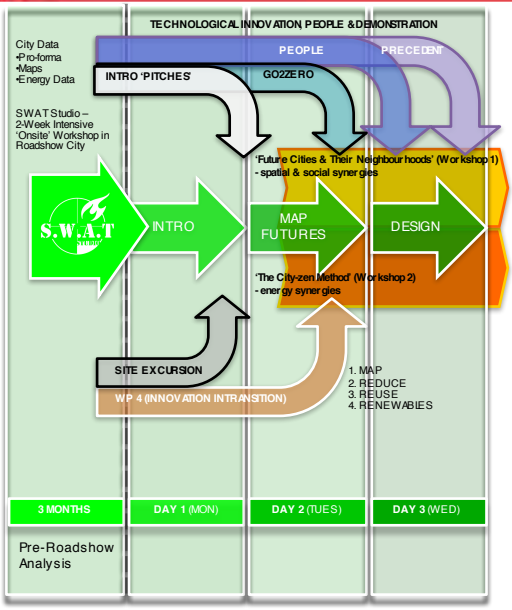


DAY 3 - MINI-MASTERCLASS 1 (PEOPLE & TECHNOLOGY)



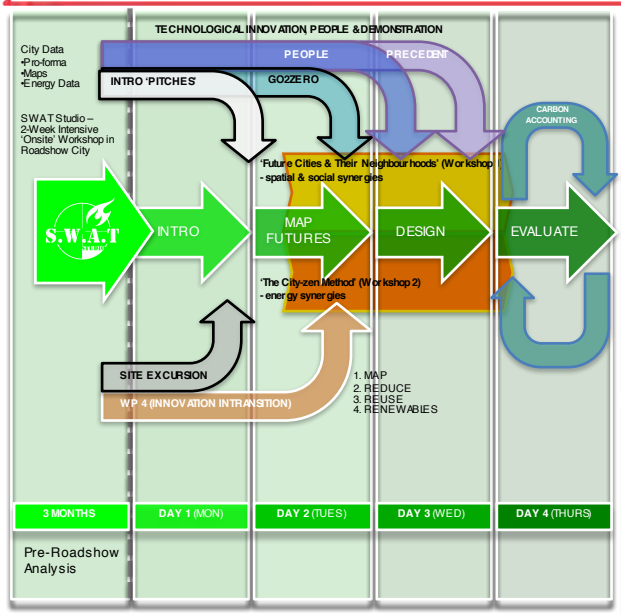


DAY 3 - FUTURE TECHNOLOGIES (SMART CITIES)

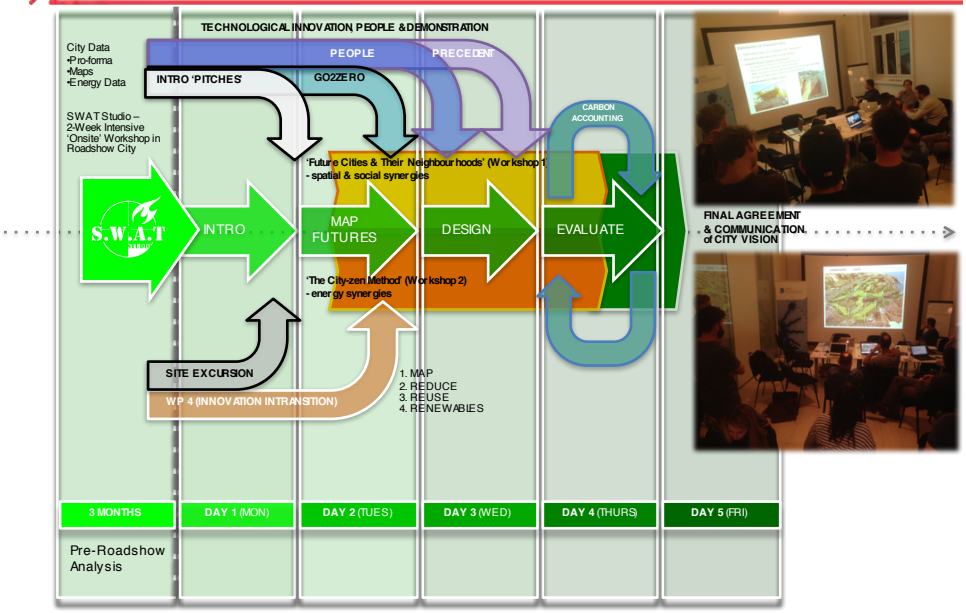


At the Dubrovnik Roadshow **Ceco Gakovic** (CityOS) gave a seminar on Smart Cities and technologies in Dubrovnik, Sarajevo & Croatia generally.

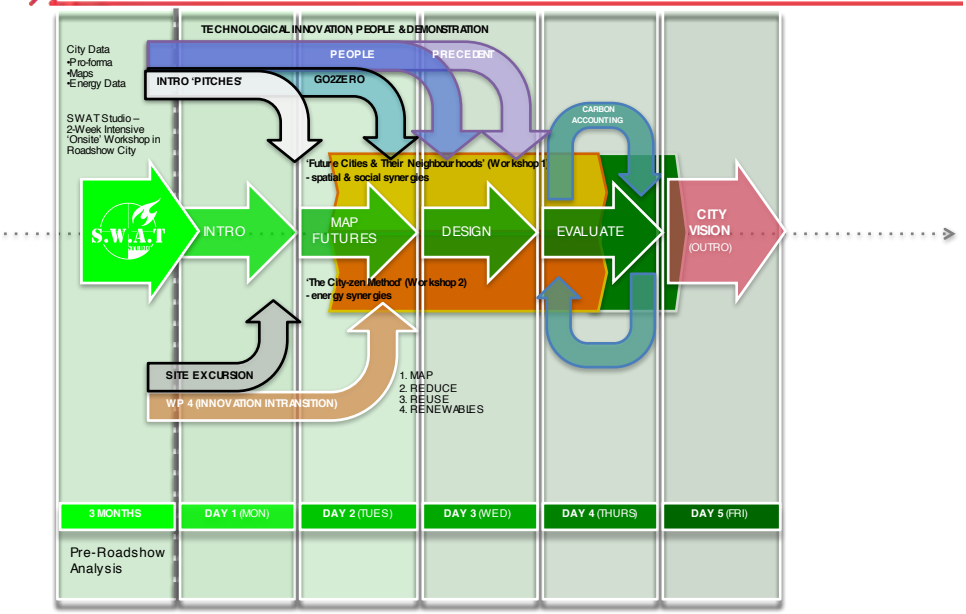
DAY 4 - MINI-MASTERCLASS 2 (CARBON ACCOUNTING)



DAY 4 - FINAL AGREEMENT & COMMUNICATION



DAY 5 - 'THE CITY VISION'



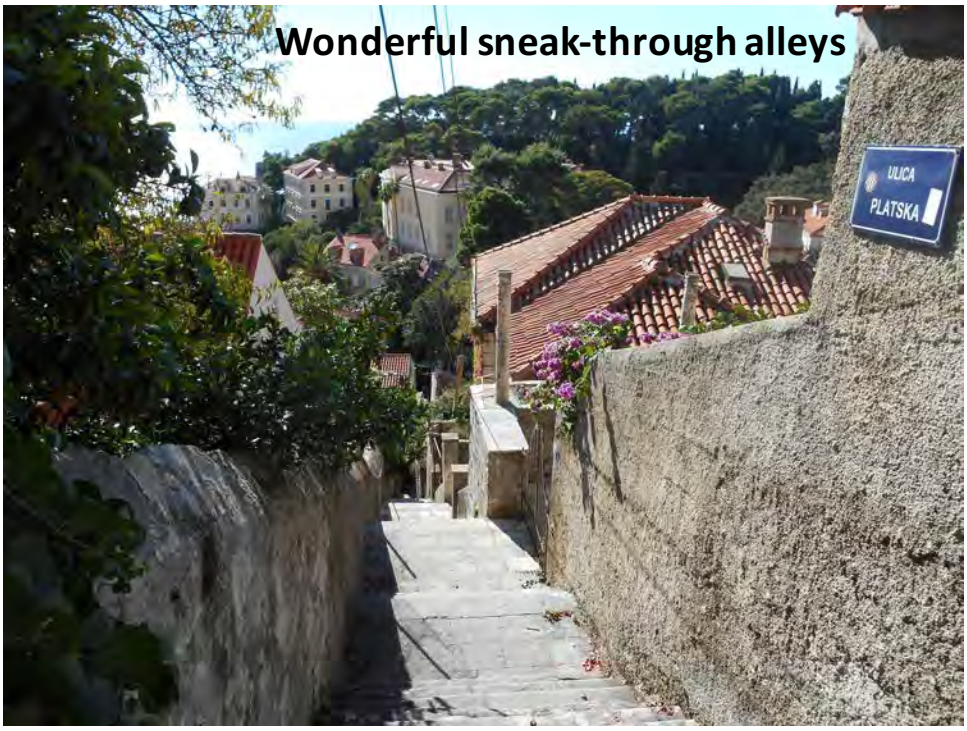
Gruž energy transition plan

Final presentation – DURA, Dubrovnik, 4 November 2016

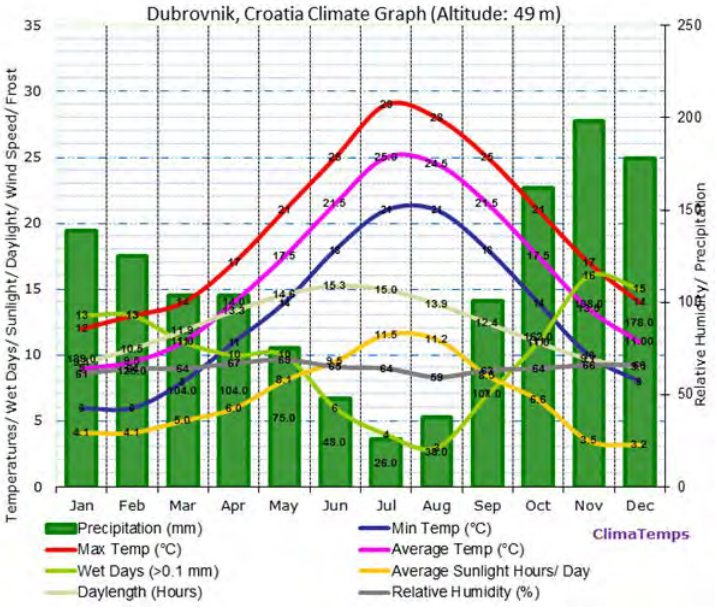
The site


Gruž houses and apartment blocks


Beautiful palaces, some poorly maintained



Climate chart Dubrovnik



Mean temperature: 16.4ºC

Temperature of soil and deep open water is nearly stable around this value.

→ Close to perfect for pre-heating and for pre-cooling buildings

Annual rainfall: 1304 mm

= nearly 1 mln m^3/yr for Gruž, excl. run-off from mountains.

There are 2900 households in Gruž.

These households use 280 m^3/yr

→ There is more than enough rain for domestic water use

Renewable energy potential: sun

Renewable energy potential: wind & reforestation


Renewable energy potential: water


In short,
WELCOME TO


But also this

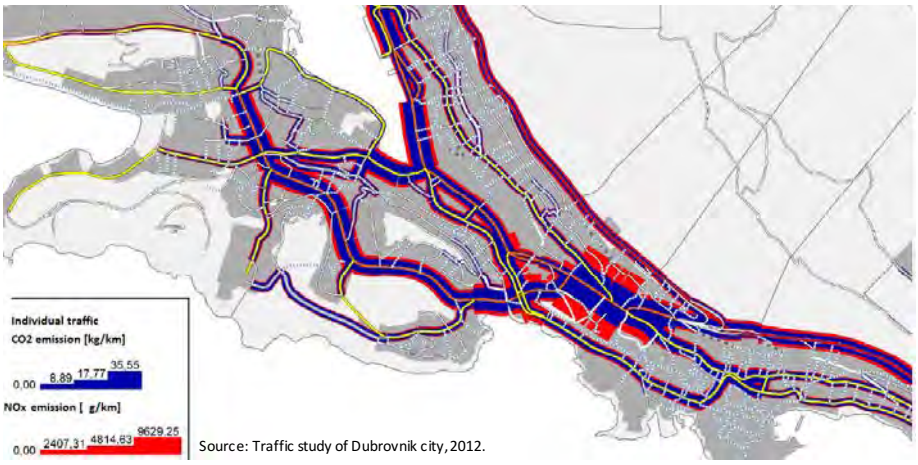

…and this
MSC ARMONIA

…and this

… and this.

CO_2 and NO_x emission of urban traffic

- Not enough parking space
- Bicycle transportation difficult
- Public transportation system in need of improvement
- Pedestrian traffic problem during touristic season



Source: Traffic study of Dubrovnik city, 2012.

Conclusion on characteristics

- **Croatia already largely runs on renewables (57%), Dubrovnik less so**
- **Dubrovnik has a favourable climate for energy efficiency**
- **Dubrovnik has great renewable energy potential**
  - Sun: passive solar energy, solar thermal, photovoltaic, PVT
  - Wind: passive drafts up and down the hills, wind power
  - Water: sea mass for heat exchange, hydro-electric from run-off water, blue energy
  - Biomass: bio-organic waste, material from forest maintenance
- **Dubrovnik people have adaptive capacity**

Challenges

- **Tourism** → great numbers of people in summer
  → energy consumption of boats, pollution
  → secondary traffic → see traffic…
- **Traffic** → fuel consumption of cars & buses, pollution, traffic jams, safety issues
- **Energy**
  - Reliance on fossil fuels
  - Unused renewable potential
  - Unused potential from waste (water)

Opportunities

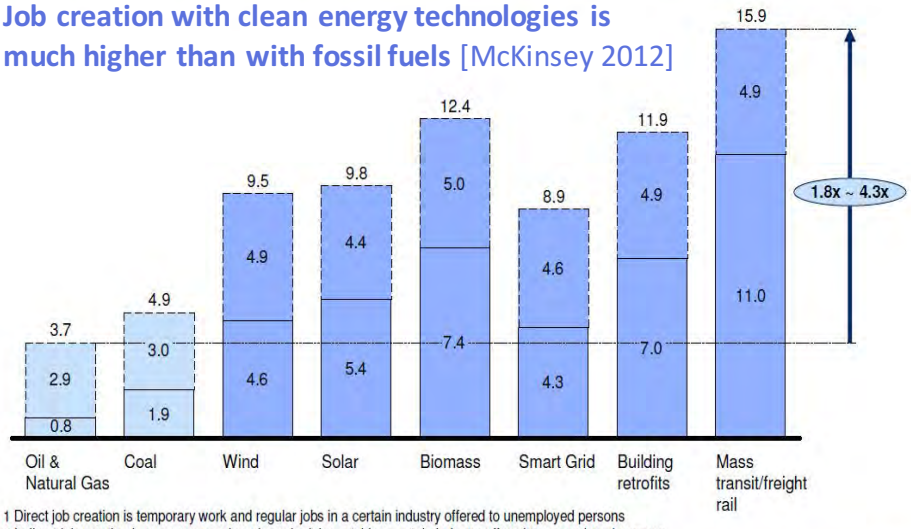
- **Saving energy in existing neighbourhoods**
- **(Micro) Grids for smart use of heat, cold and electricity**
- **Use of local renewables**
- **Making better use of cruise ship tourism**
  - Increase tax on cruise tourists
  - Waste water to bio-energy
  - Become a green fuel port

Bornholm: 'We want to be part of the future, not of the past'

Employment impacts by energy source
Number of job creation per $1 million of investment

Fossil-based jobs
Green jobs
Direct job creation[1]
Indirect job creation[2]

Job creation with clean energy technologies is much higher than with fossil fuels [McKinsey 2012]

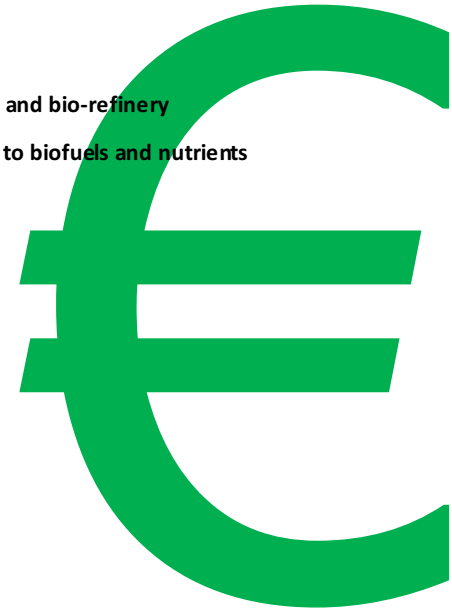


1 Direct job creation is temporary work and regular jobs in a certain industry offered to unemployed persons
2 Indirect job creation is temporary work and regular jobs outside a certain industry offered to unemployed persons

SOURCE: PERI; Center for American Progress; SRP analysis: Yu Yang & Jessica Stuart 6

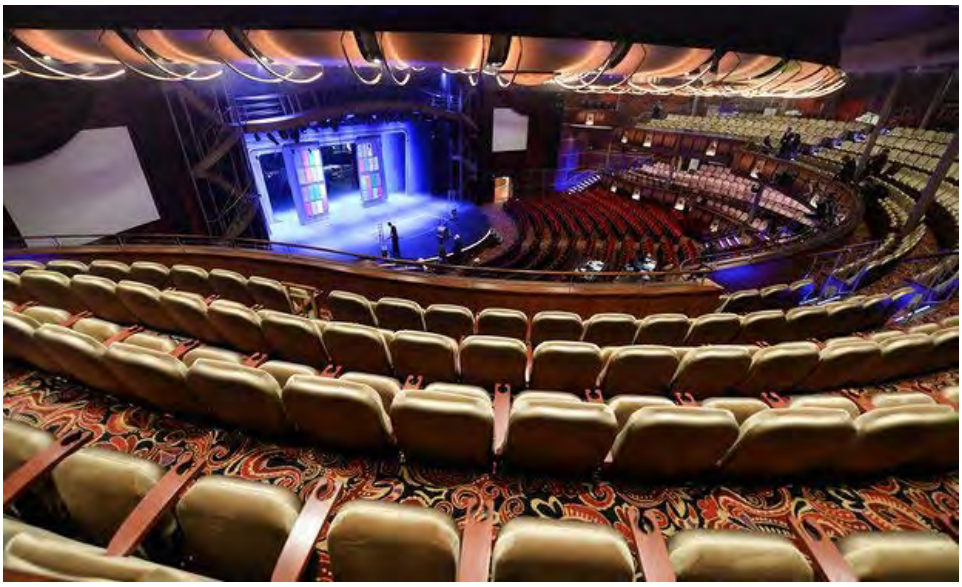
Triple win objective

- **Increase taxes on cruise ship tourism**
- **Invest in green bio-digester, algae farm and bio-refinery**
- **Process waste water from cruise ships to biofuels and nutrients**
- **Create employment for Gruž**
- **Sell back biofuel and food**
- **Create a cleaner city**



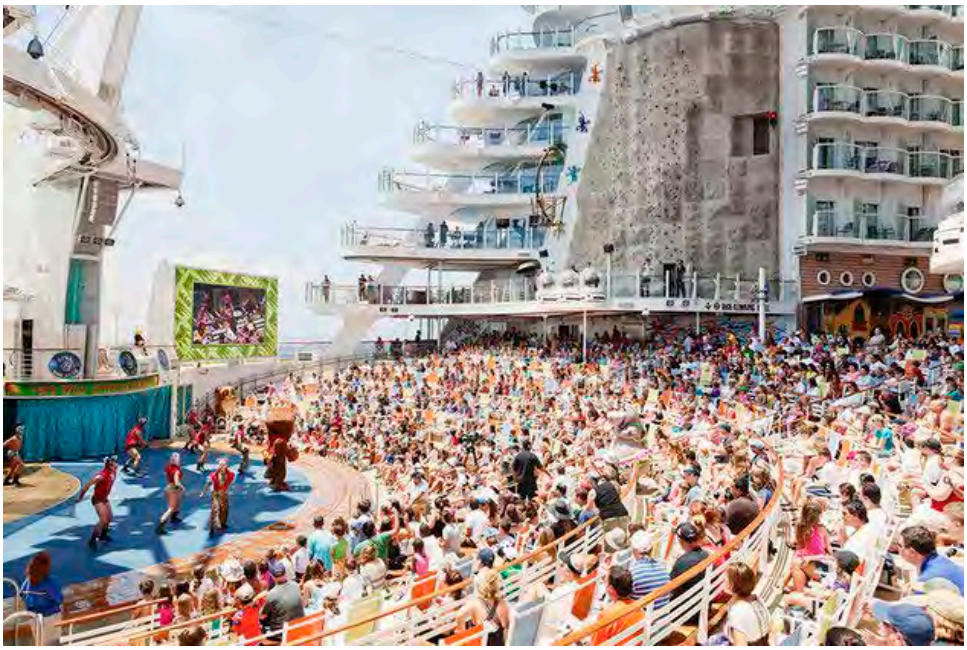
Can your city be sustainable, without a sustainable economy?

Four heated swimming pools, etc

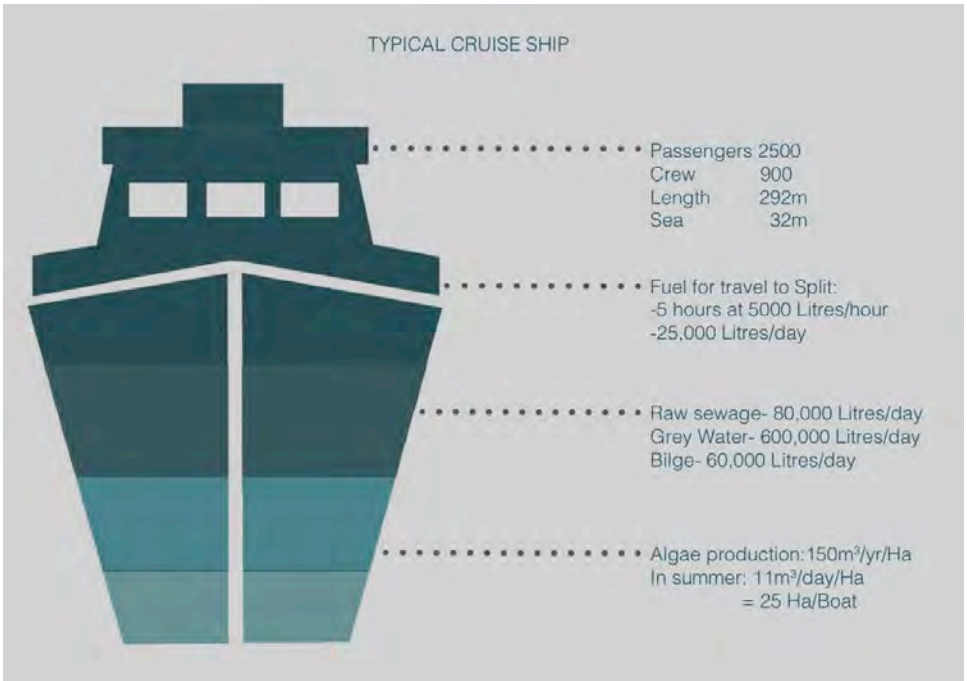


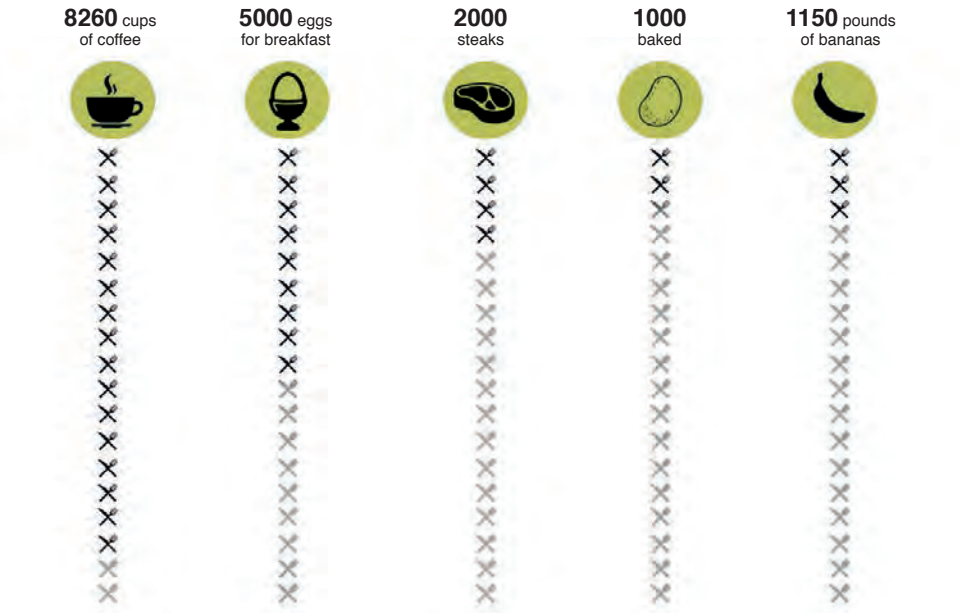
The cruise ship is a city – that moves!

Fully air-conditioned American lifestyle has 4 x the impact of a typical European

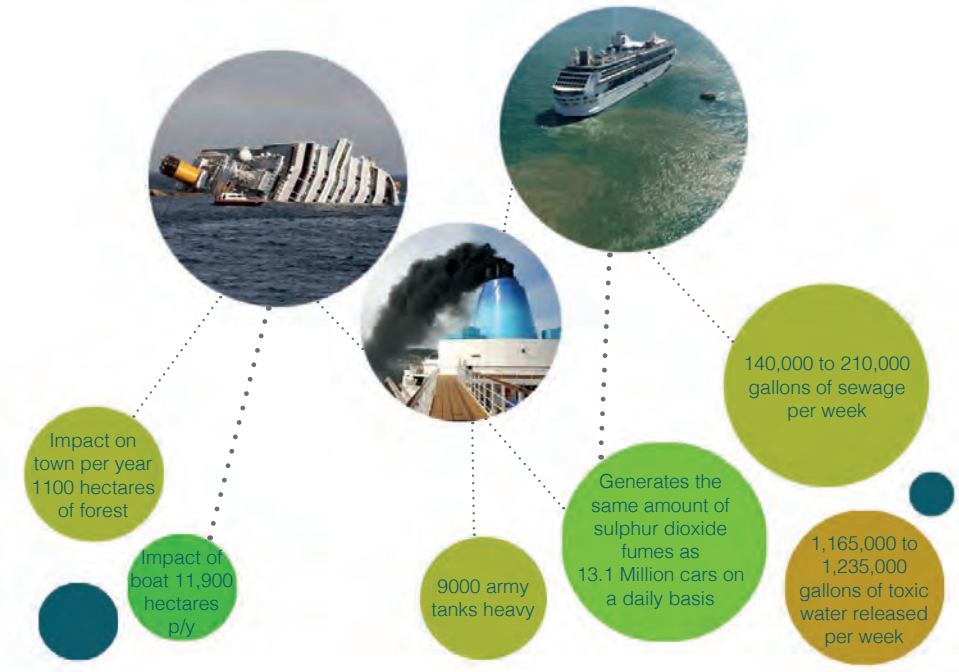


Density = 5,000 people per hectare Gruz= 60 people per hectare



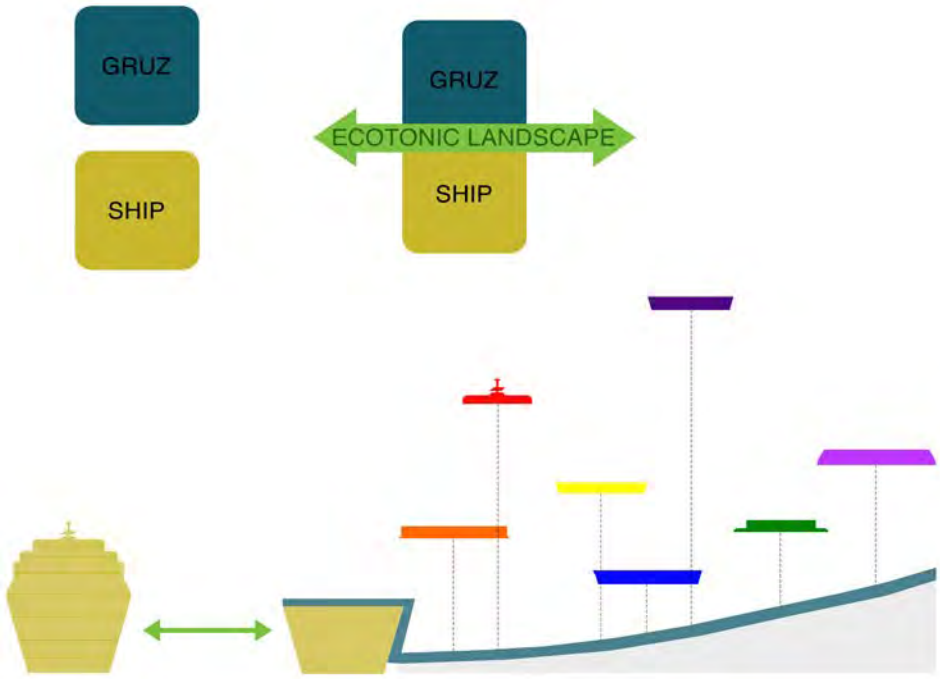


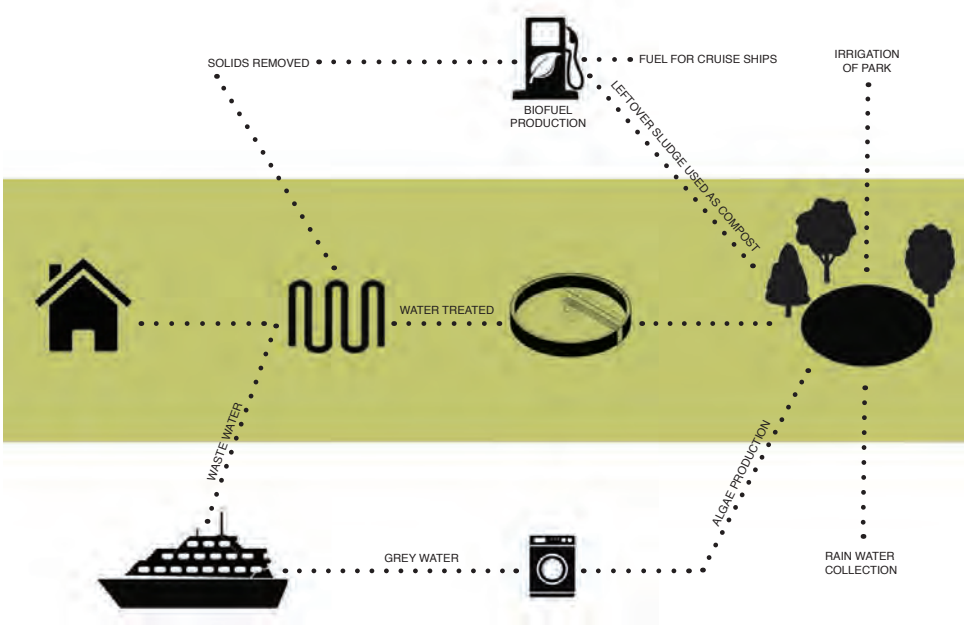
Food and drink consumed daily on cruise ships (Based on Disney Cruise Line statistics)

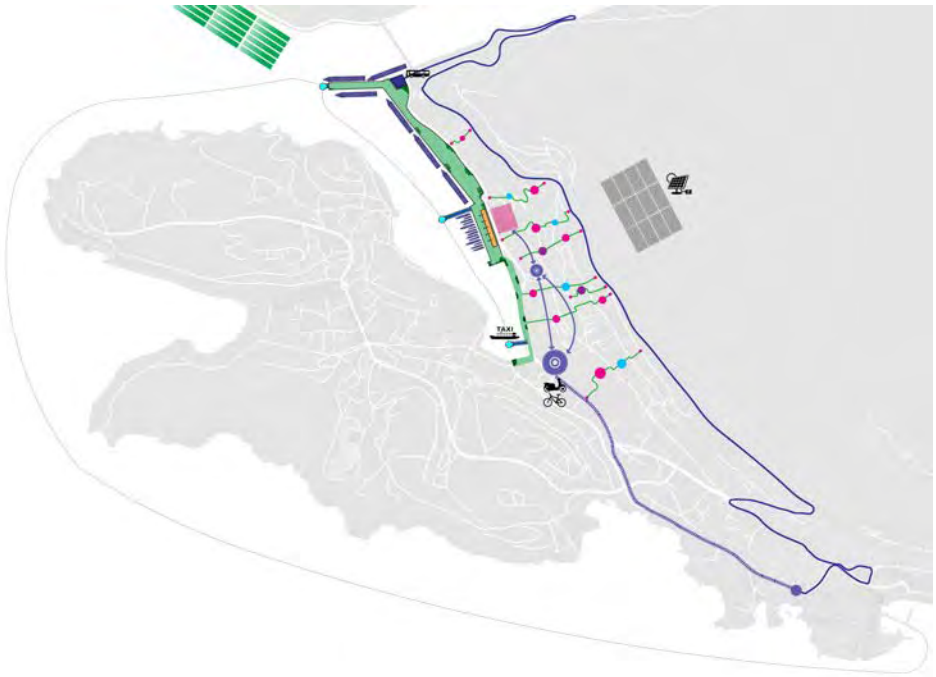


CARBON FOOTPRINT OF CRUISESHIPS							1 day		Season	**Tourist Season x 8**
item	value	unit	EF	unit	CF: t CO2eq/day	note	ha forest/day		ha/yr	**x8 ships**
people	3400	n								
passengers	2500	n								
crew	900	n								
fuel oil	25000	L/day	3.14	kg CO2eq/kg	78.40		5.81		1,045.29	**8,362.31**
mooring	5000	L/5hrs	3.14	kg CO2eq/kg	15.68	Period of mooring	1.16		209.06	**1,672.46**
solid waste	1200	kg/day	1.16	kg CO2eq/kg	1.39		0.10		18.56	**148.48**
water supply & grey water manag	600	m3/day	0.585	kg CO2eq/m3	0.35	assumed 200L/day per capita	0.03		4.68	**37.45**
sewage	80000	L/day	0.115	kg CO2eq/L	9.20		0.68		122.64	**981.12**
bilge	60000	L/day	0.115	kg CO2eq/L	6.90		0.51		91.98	**735.84**
TOTAL GHG EMISSION					112	**TOTAL IMPACT OF N1 CRUISESHIP / day**	8.29		1,492.21	**11,937.66**
						Total Impact of Gruz neighbourhood				**1,100.00**

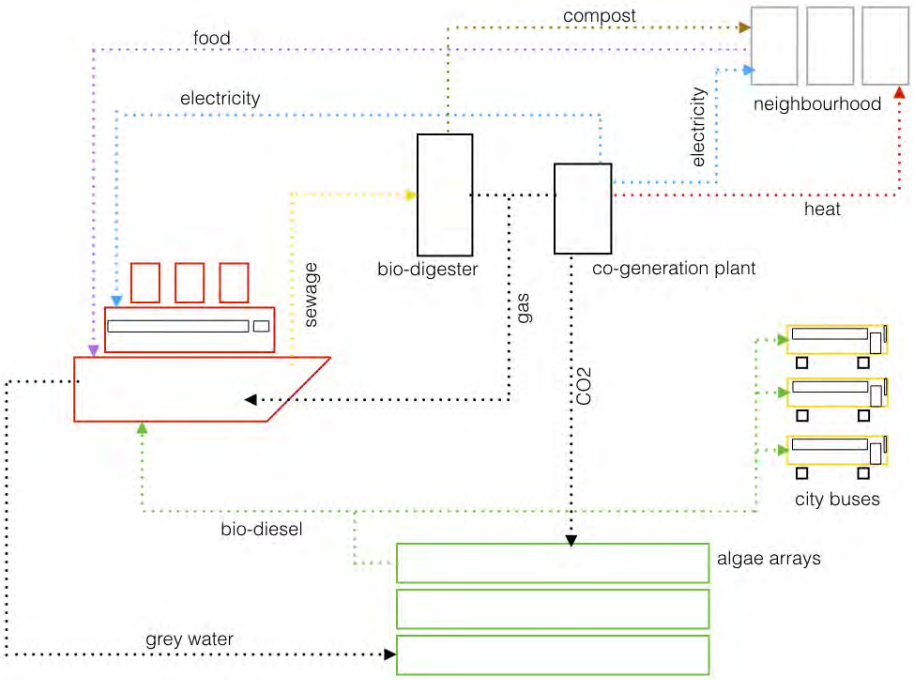
AVOIDED CARBON EMISSION										Possible income
item	value	unit	EF	unit	CF: t CO2eq/day	note	eq. ha forest over season			
BIOGAS production from sewage	3200	m3	1.31	kg CO2eq/m3	4.19	potential biogas production assumed to replace an equivalent quantity of natural gas (EF natural gas to assess avoided emission)	55.89			
BIOFUEL production from algae 50ha array	200000	kg	3.24	kg CO2eq/kg	648.00	potential biofuel production assumed to replace an equivalent quantity of diesel (EF diesel to assess avoided emission)	8,640.00		Fuel value /annum =	**€ 38,000,000.00**
HEAT production from sewage	200	kWh	0.136	kg CO2eq/kWh	0.03	potential heat production assumed to replace an equivalent quantity of heat from natural gas combustion (EF natural gas to assess avoided emission)	0.36			
Electricity for mooring from renewable source	32	MWh/day							cost	**€ 518,400.00**
TOTAL AVOIDED EMISSION					**652.22**		**8,705.74**			

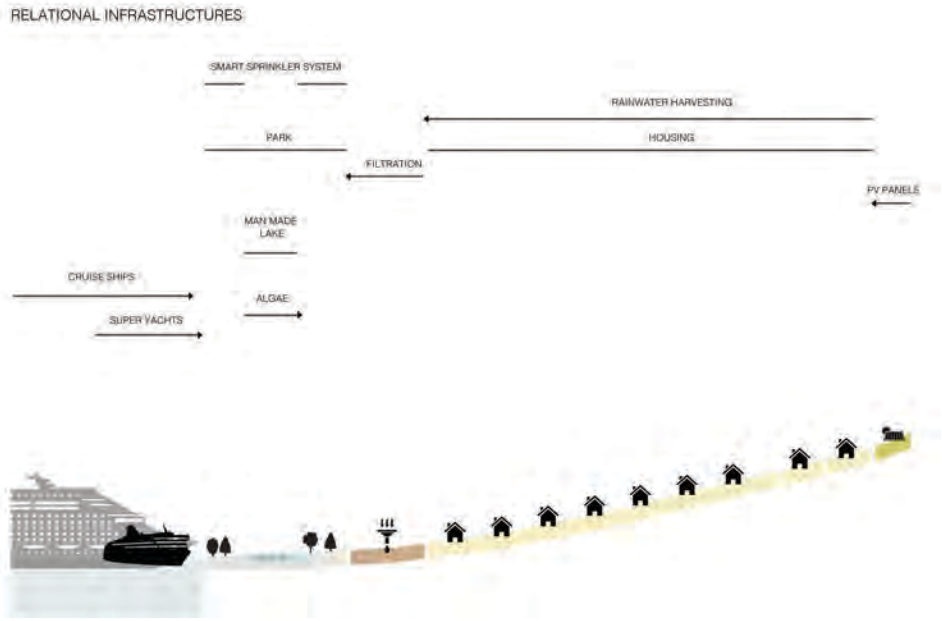

GRUZ
SHIP
GRUZ
ECOTONIC LANDSCAPE
SHIP


SOLIDS REMOVED
BIOFUEL PRODUCTION
FUEL FOR CRUISE SHIPS
IRRIGATION OF PARK
LEFTOVER SLUDGE USED AS COMPOST
WATER TREATED
WASTE WATER
ALGAE PRODUCTION
GREY WATER
RAIN WATER COLLECTION

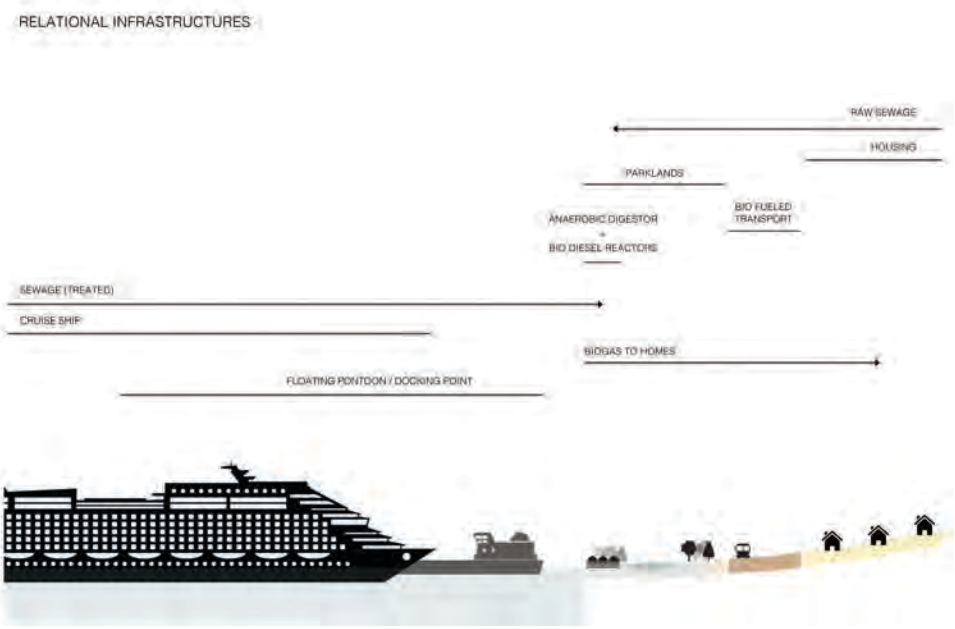


Attenuated tourist experience

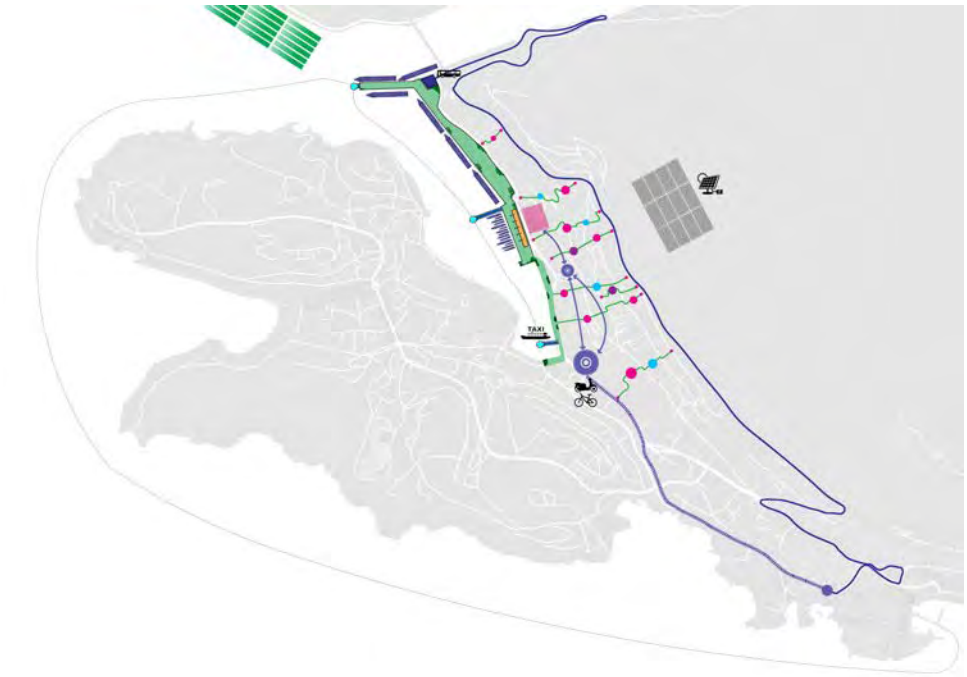




Attenuated landscape



Attenuated landscape



Attenuated Landscape

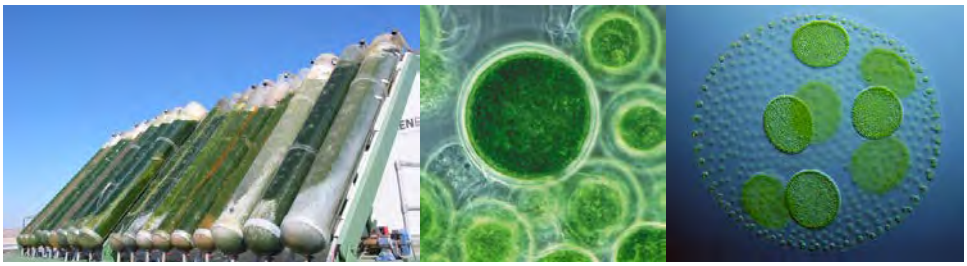
Algaculture

Most productive strains are Spirulina and Botryococcus Braunii

Natural oil content 45 % dry weight – low in sulphur – biodegradable – in fact edible!

Grown in bio-reactors – translucent cultivation tanks

Can utilise waste Carbon Dioxide from power plants



Algae - biofuel

100,000 strains

Exceptionally rich in natural hydrocarbons.

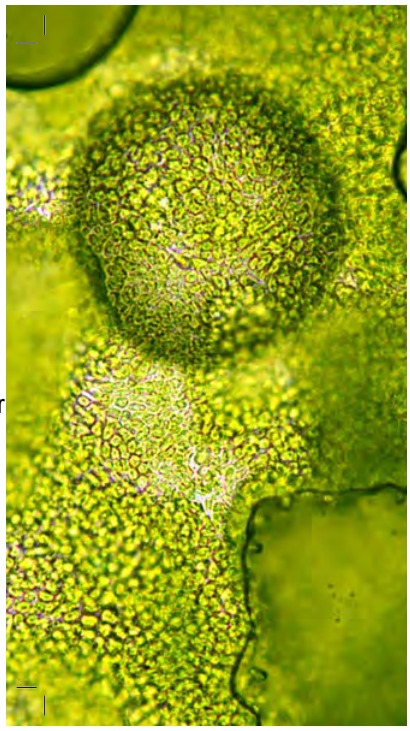
100x yield of rape

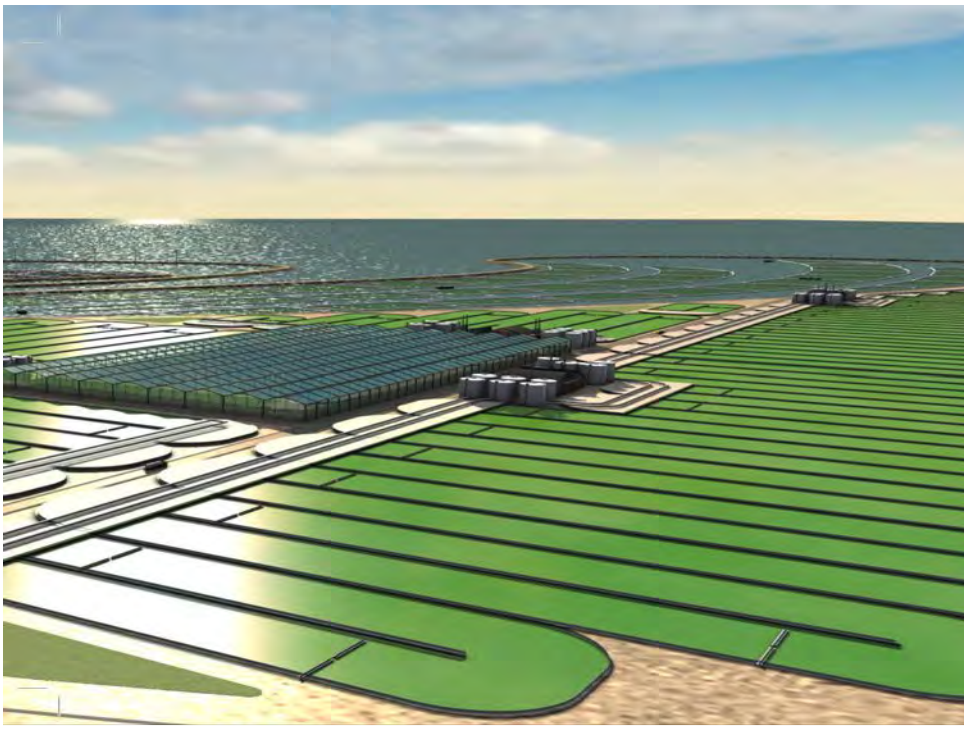
Produce up to 150,000 litres of bio-diesel per hectare/yr

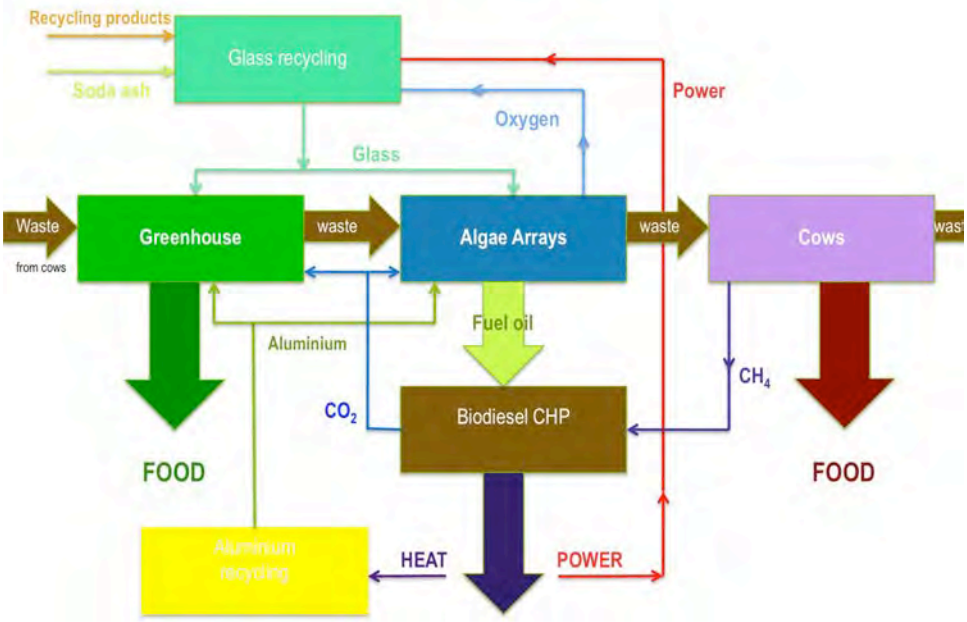
New technologies could increase this to 3,000,000 l/ha
Using lit technology.

Continuous production cycle, unlike land crops

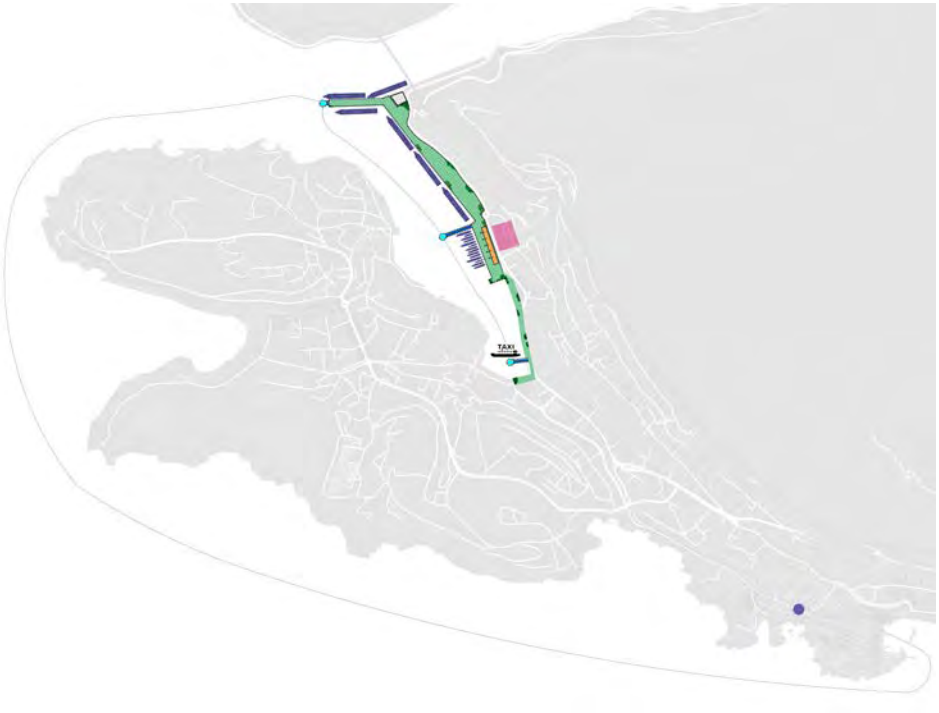
Carbon neutral

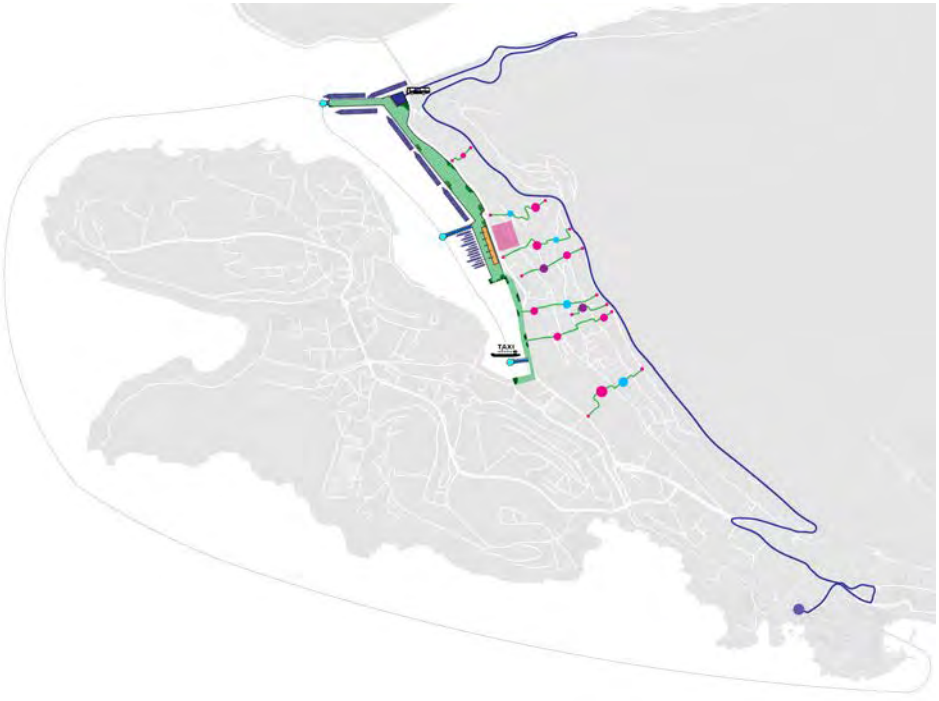


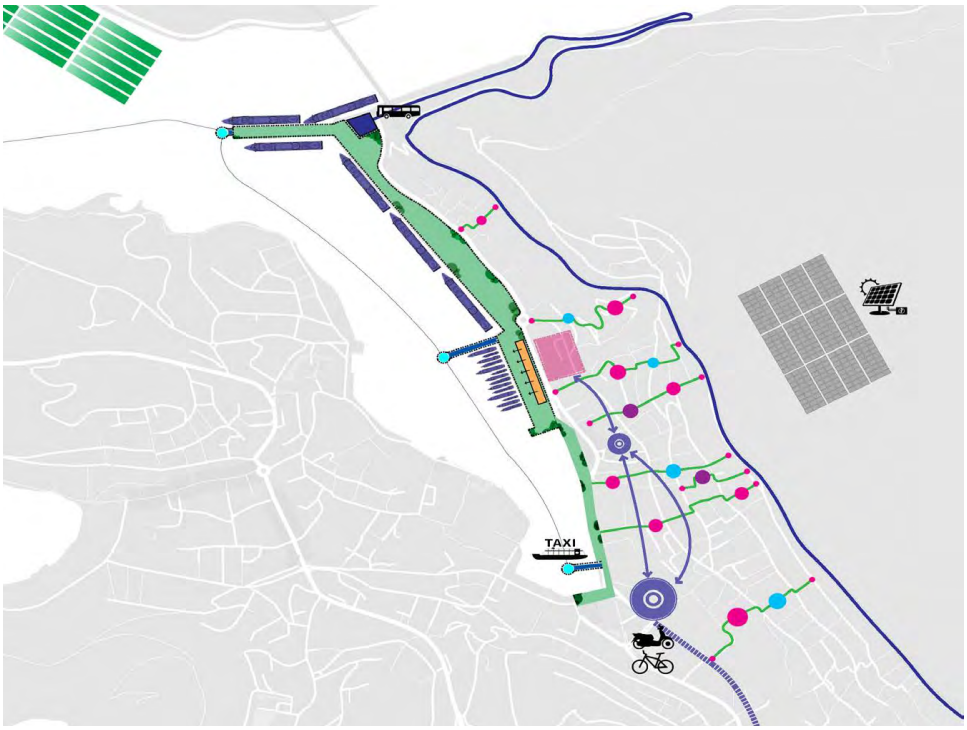


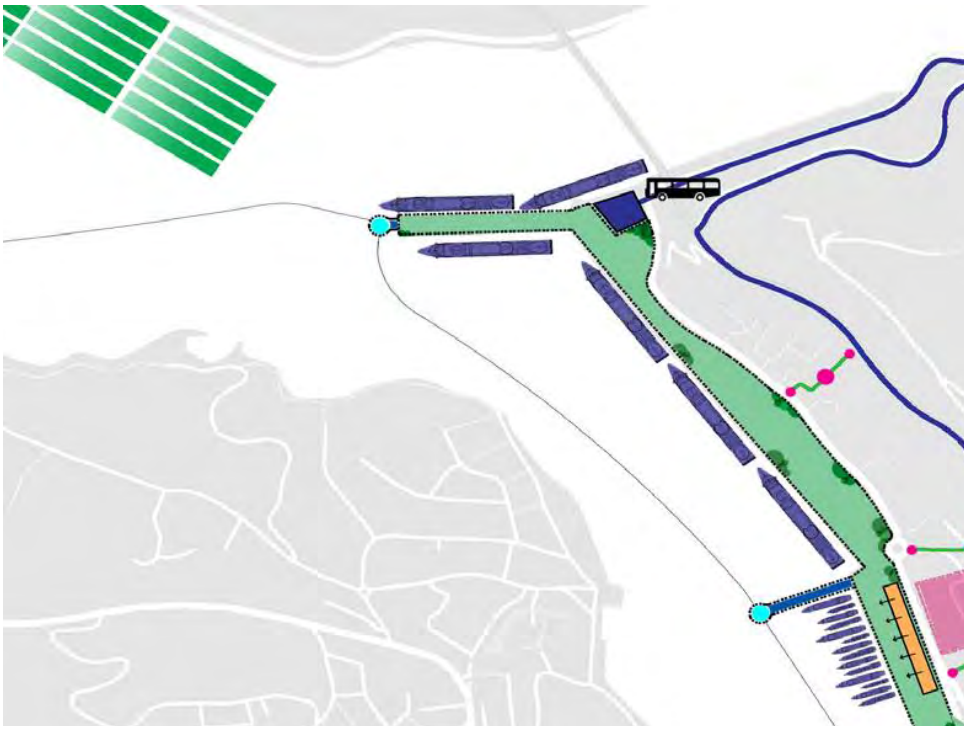


Generate €38,000,000 fuel oil in tourist season and bio-diesel for transport

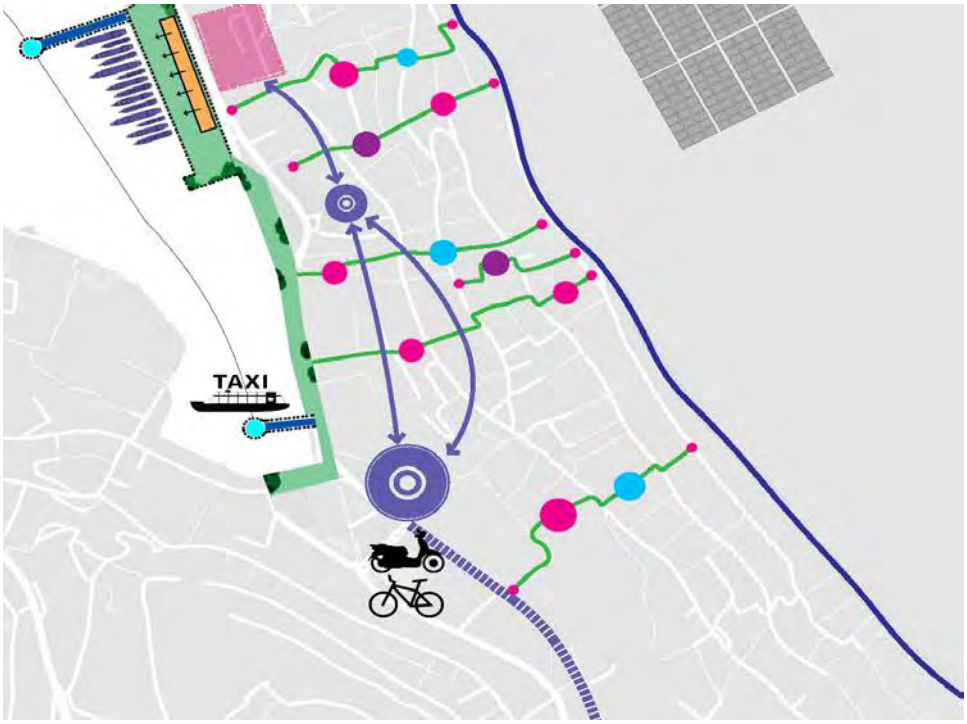




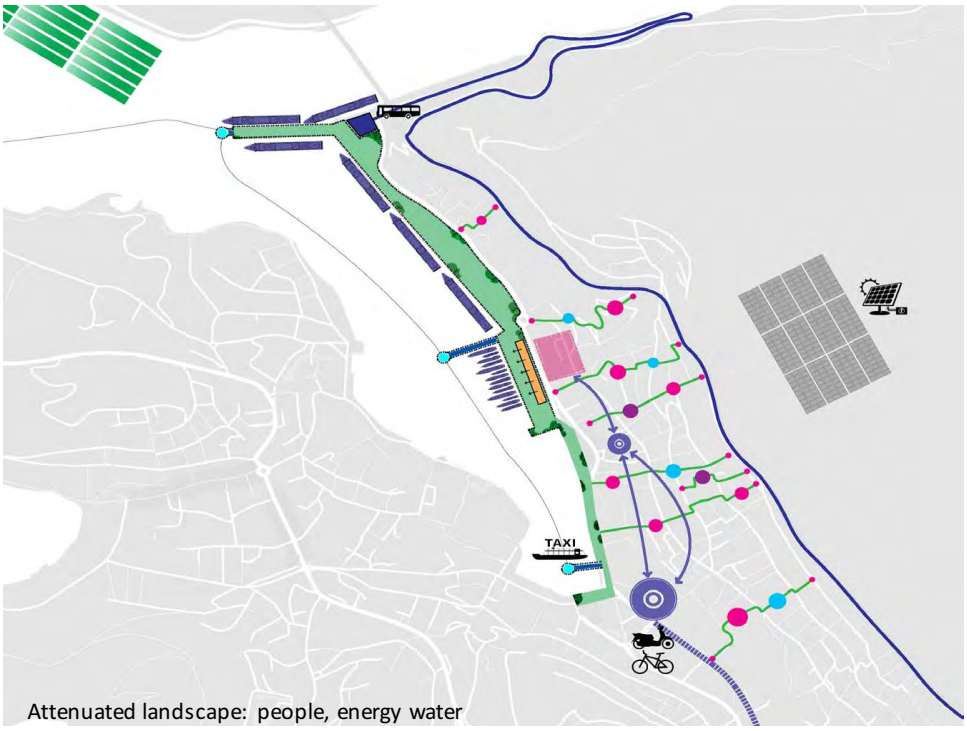

TAXI




140m
140m
280m
140m
140m

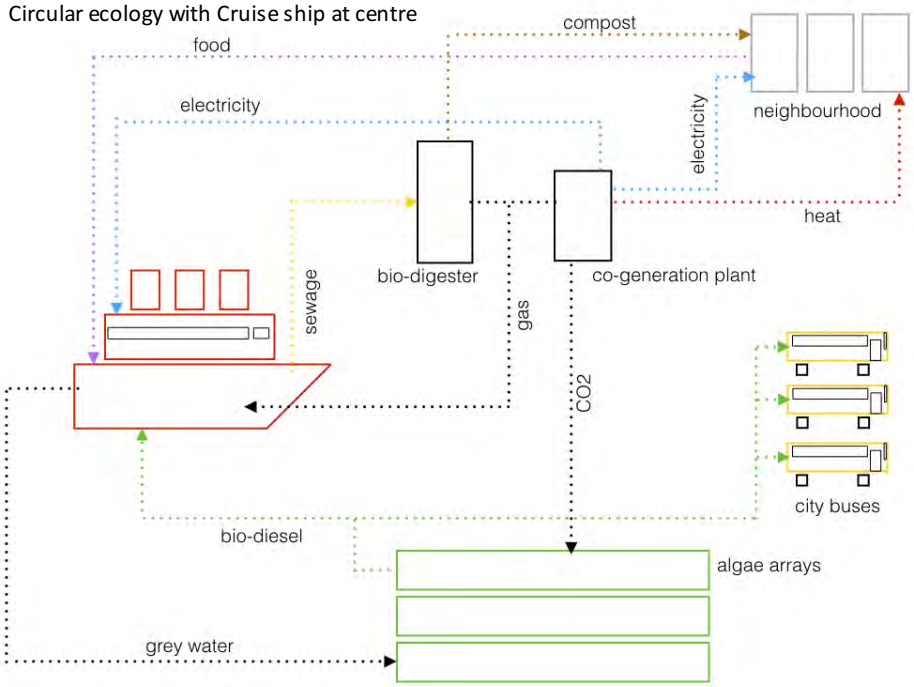

TAXI

FLOW OF PEOPLE
Water taxi - foot - electric bike - bus



Attenuated landscape: people, energy water

Circular ecology with Cruise ship at centre



TECHNICAL MEASURES

Our New Stepped Strategy (for different scale levels)

1. **Reduce** the energy demand

- Urban planning & design
- Architectural design
- Passive, smart & bioclimatic design
- Using local characteristics, vernacularity

2. **Reuse** waste energy

- Attune supply and demand
- Exchange surpluses with shortages
- Cascade heat
- Store energy

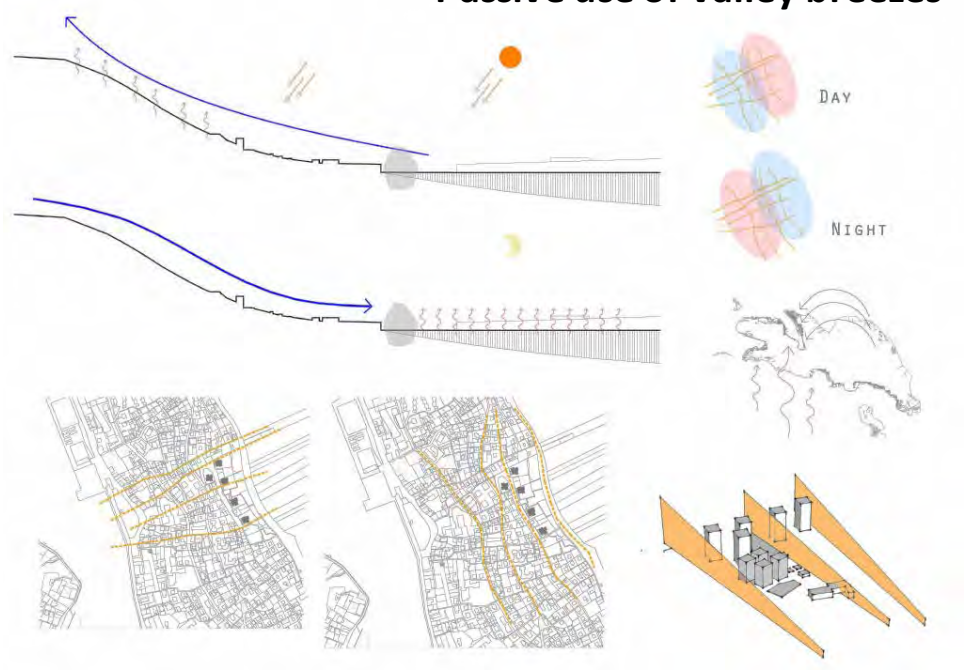
3. **Produce** renewable energy

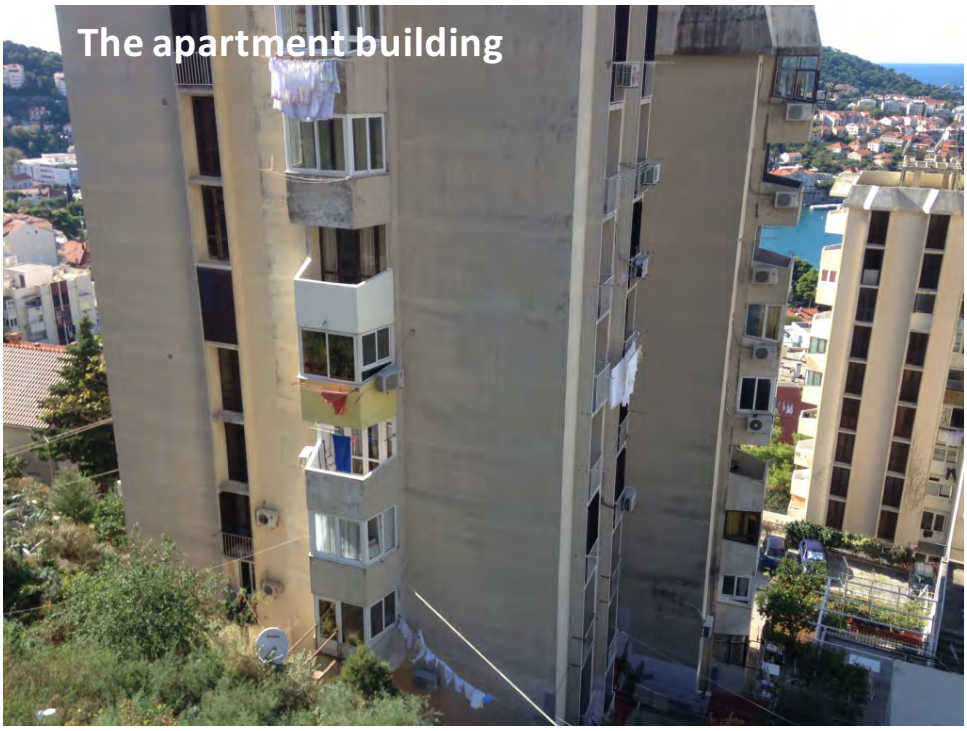
- Sun
- Wind
- Water
- Air
- Soil
- Biomass

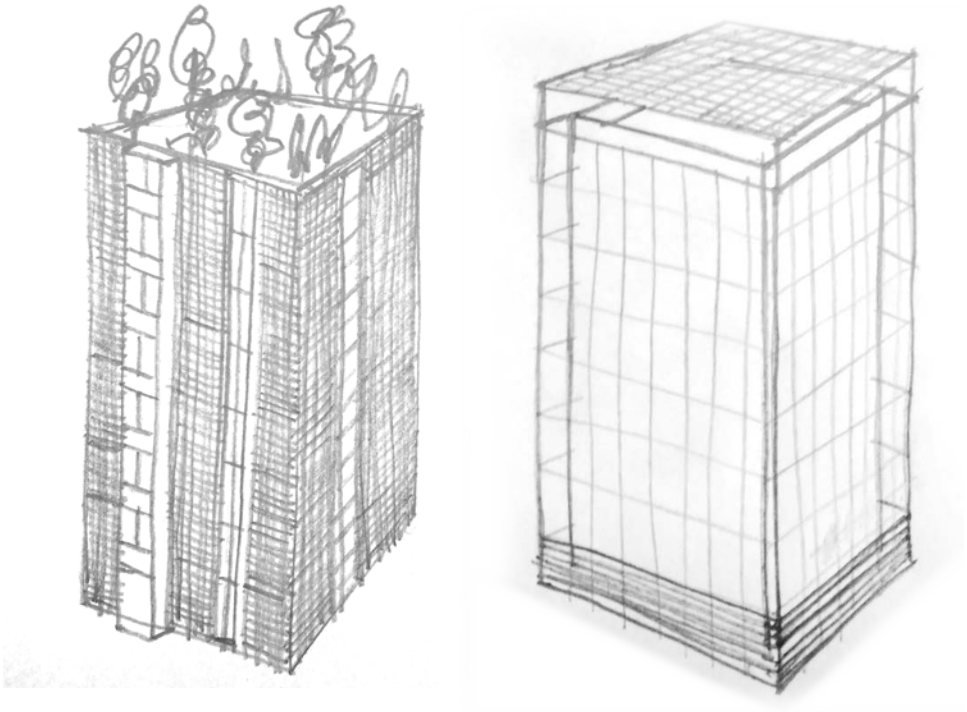
STEP		SCALE individual house	apartment block	neighbourhood	district (Graz)	city (Dubrovnik)
reduce energydemand	avoidheating	postinsulation on wall	postinsulation on wall			
	+cooling	postinsulation on roof	postinsulation on roof			
		cavity wallinsulation	cavity wallinsulation			
		replacecomplete window-frames	replacecomplete window-frames			
		replacewindow-glazing	replacewindow-glazing			
				clustering ofbuildings	clustering ofbuildings	densify
	avoidheating	passivesolar heat	passivesolar heat			
		individual conservatory	conservatory-atrium-gallery	glass-coveredspaces		
	avoidcooling	tropical roofsystem	tropical roofsystem	coveringpublic spaces		
		sunshading	sunshading	heat collecting surfaces	heat collecting surfaces	heat collecting mast roads
		greenshading	greenshading	greenlines	greenlines	greenmast roads
				greenpergolas	greenparks	greensurroundings
				cross-ventilation roof-slit	cross-ventilation roof-slit	
				cross-ventilationduct	cross-ventilationduct	planning cooldpools
				wind channelsthroughstreets	wind channelsthroughstreets	planning sweetwaterfront channels
	avoidelectricity	optimized daylight access	optimized daylight access			
		LED lighting		LED streetlights	LED streetlights	LED streetlights domain roads
		domotics	building management system			
reuse waste energy	heat +cool			heat exchangebetweenbuildings	heat exchangebetweenbuildings	
			cistern rel cellar (8/17 deg/rain)water	cistern rel cellar (8/17 deg/rain)water		
			LTheat andHT collectorpipe(cellar)	collective LT heatand HTcold storage	collective LT heatand HTcold storage	
				aquifer thermal energystorage(ATES)	aquifer thermal energystorage(ATES)	
	heat	heat recovery ventilated (air-air)	heat recovery ventilated (air-air)			
		heat recovery(air-water)+heatpump	heat recovery(air-water)+heatpump			
		heat recovery pithowerwater	heat recovery pithowerwater	heat recovery onsewage(water-water)	heat recovery onsewage(water-water)	heat recovery onsewage(WWTP)
		water storage(55-deg)forhotwater	water storage(55-deg)forhotwater	collective water storage(55-deg)forhot water		
	electricity	battery system	battery system	collective battery system	battery system	battery system
		electric carseatelectricity storage	electric carseatelectricity storage	electric carparkseatelectricity storage	electric carparkseatelectricity storage	electric carparkseatelectricity storage
		individual peak-shaving	ptot peak-shaving	collective peak-shaving	peak-shaving	peak-shaving
	biol			organicwaste (water)tobiogas	organicwaste (water)tobiogas	organicwaste (water)tobiogas (WWTP)
			waste waterto algae	waste waterto algae	waste waterto biodiesel (algae)	waste waterto biodiesel (algae, WWTP)
						biodigestion and biomethanplant
produce renewableenergy	heat +cool	groundducts(for ventilated air)	groundducts(for ventilated air)	heat exchanger centrosolar run-offwater		
		soil collector: verticaltubes	soil collector: verticaltubes	collective soil collector: verticaltubes		
		soil collector: horizontaltubes	soil collector: horizontaltubes	collective soil collector: horizontaltubes		
		heat pumpon: openwater	heat pumpon: openwater	collective heat pump: openwater	collective heat pump: openwater	collective heat pump: onriverlake or sea
		heat pumpon: air	heat pumpon: air			
	heat	solar collector: onthe roof	solar collectors: onthe roof	solar collectors: underground	solar collectors: underground	
		solar collector: onthe façade	solar collectors: onthe façade	solar collectors: inparks	solar collectors: inparks	solar collectors: inparks
		heat collecting: walls	heat collecting: walls	heat collecting: urbansurfaces	heat collecting: urbansurfaces	
					geothermal heat plant	geothermal heat plants
	electricity + heat	PVT: underground	PVT: onthe roof	PVT: underground	PVT: underground	
		PVT: onthe façade	PVT: onthe façade	PVT: aboveparkinglots	PVT: aboveparkinglots	
					PVT: inparks	PVT: inparksorsurroundings
			micro CHP(smallgas)	collective CHP (smallgas)	collective CHP (smallgas)	hot rockbedheatand power
	electricity	PV: onthe roof	PV: onthe roof	PV: underground	PV: underground	
		PV: onthe façade	PV: onthe façade	PV: aboveparkinglots	PV: aboveparkinglots	
				PV: inparks	PV: inparks	PV: inparksorsurroundings
		small wind turbine	micro vertical bikes	small wind turbine	small wind turbine park	largewind turbine parks
						bike energyplant
						wavesenergyplant
						tidal plant

The Gruž lagoon

Passive use of valley breezes




The apartment building



Starting-point

Starting-point **+ post-insulation**

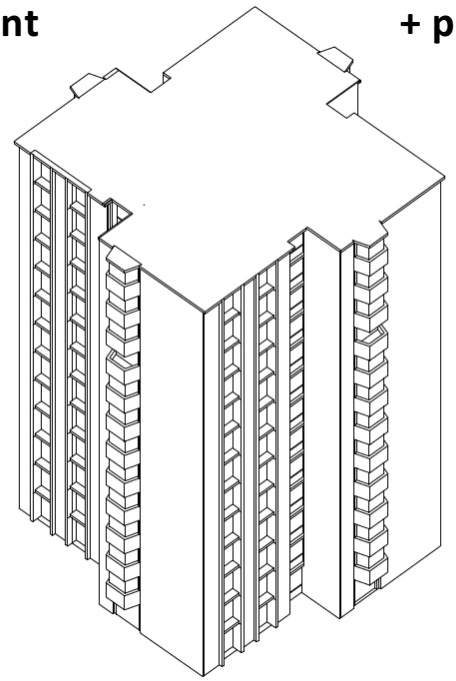
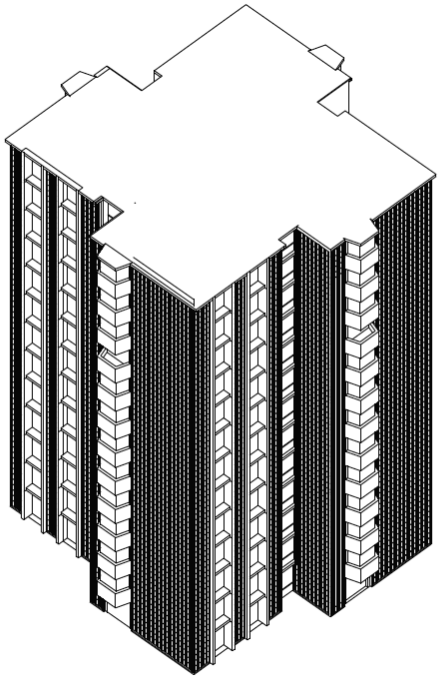


Image after post-insulation (and plaster finish)

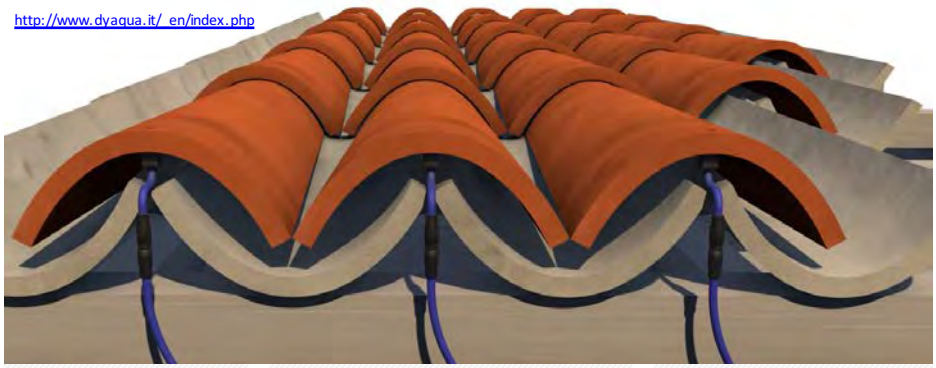


PV façade cladding

Image with PV façade cladding

Integrated PV for single houses

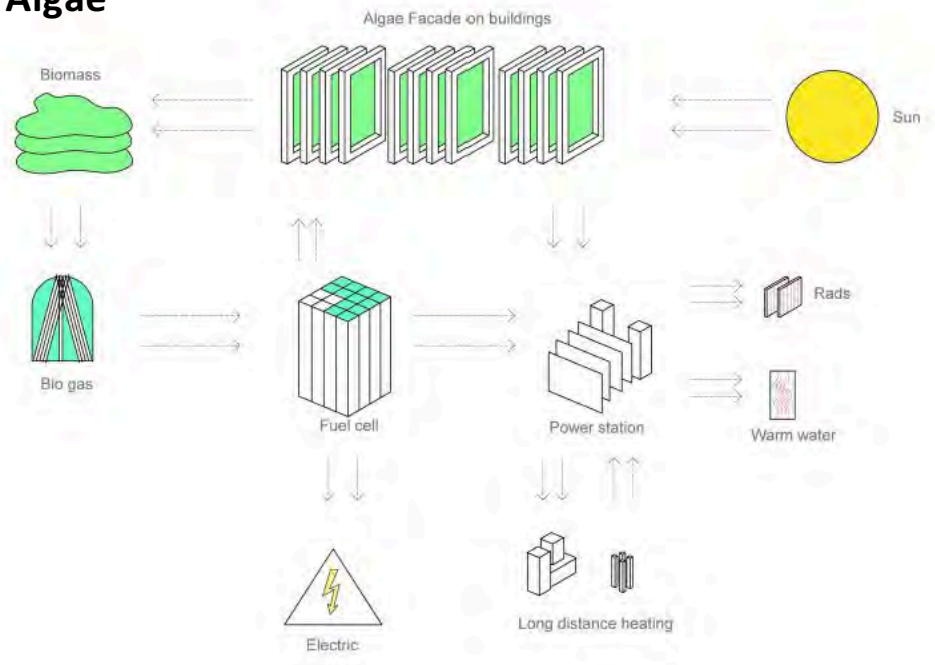
http://www.dyaqua.it/_en/index.php



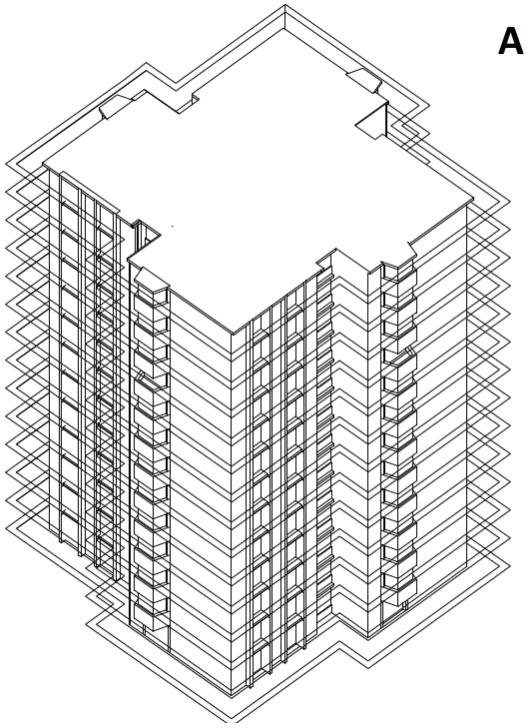
4,5 Wp	15 m2	223 Rooftiles
Peak power	Required area for 1 kWp	To generate 1 kWp

PV-covered parking lots

Algae



Algae façade elements



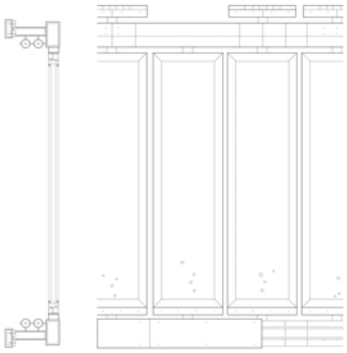


Image with algae façades

Algae façade

Solar glasshouse façade

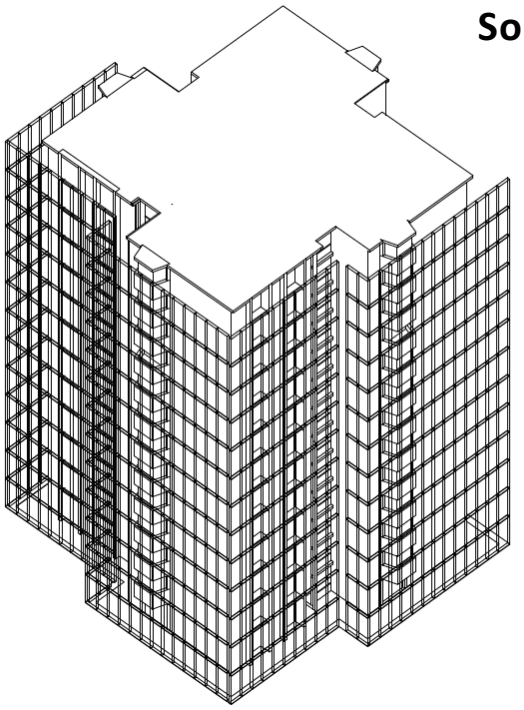
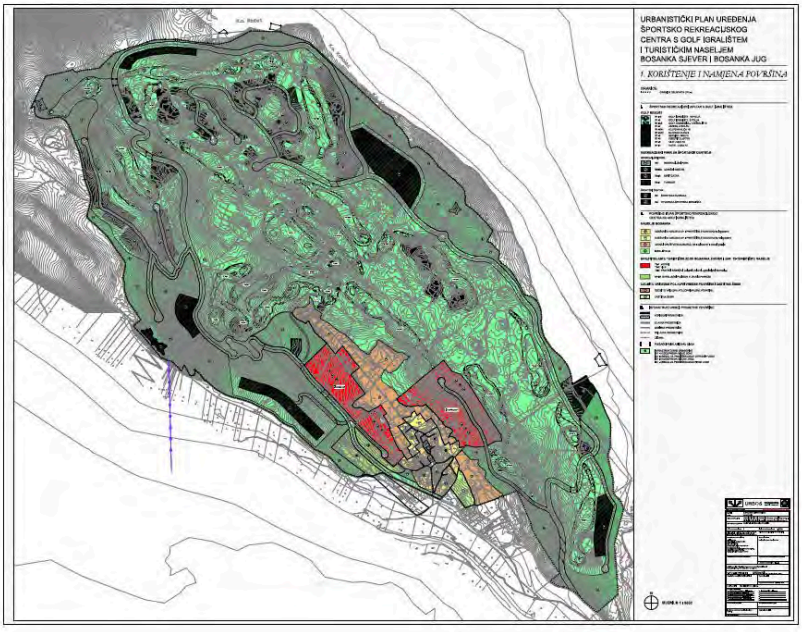


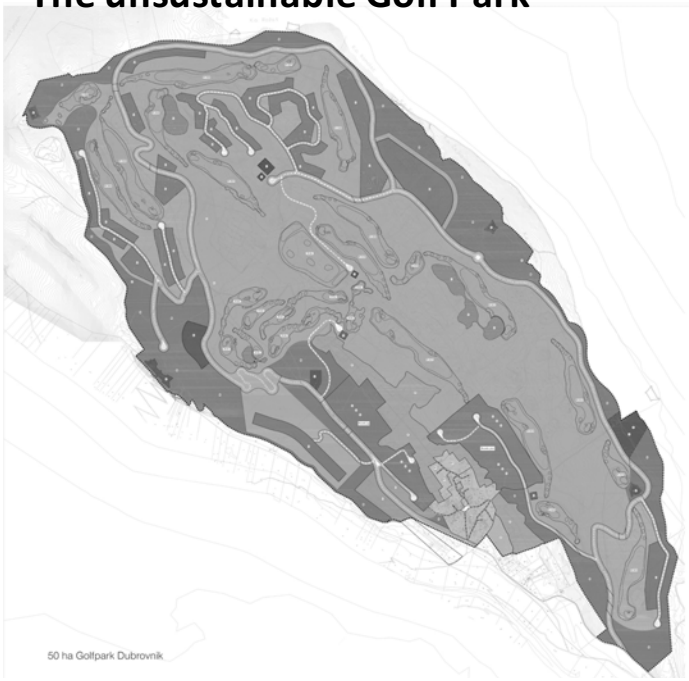
Image with solar glasshouse façade

Example for a terraced house

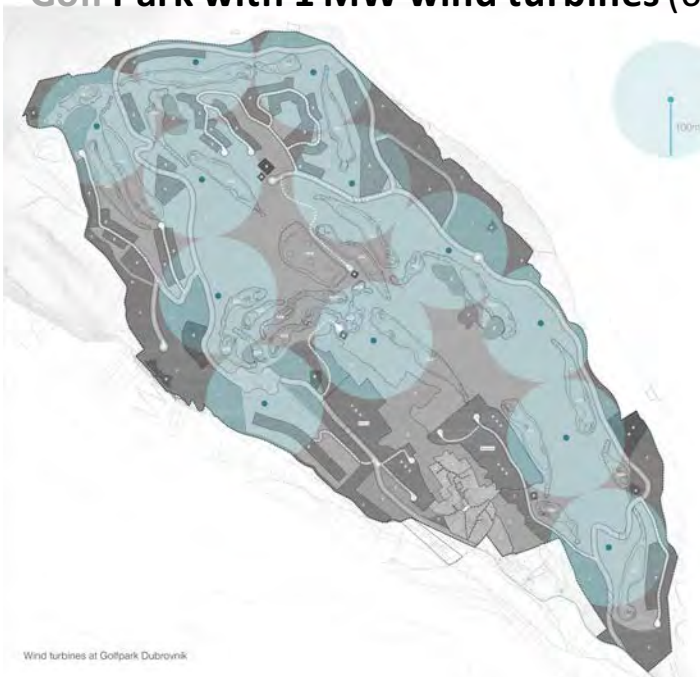
Talking about green: the Golf Park plan…



The unsustainable Golf Park



Golf **Park with 1 MW wind turbines** (60 m tall)

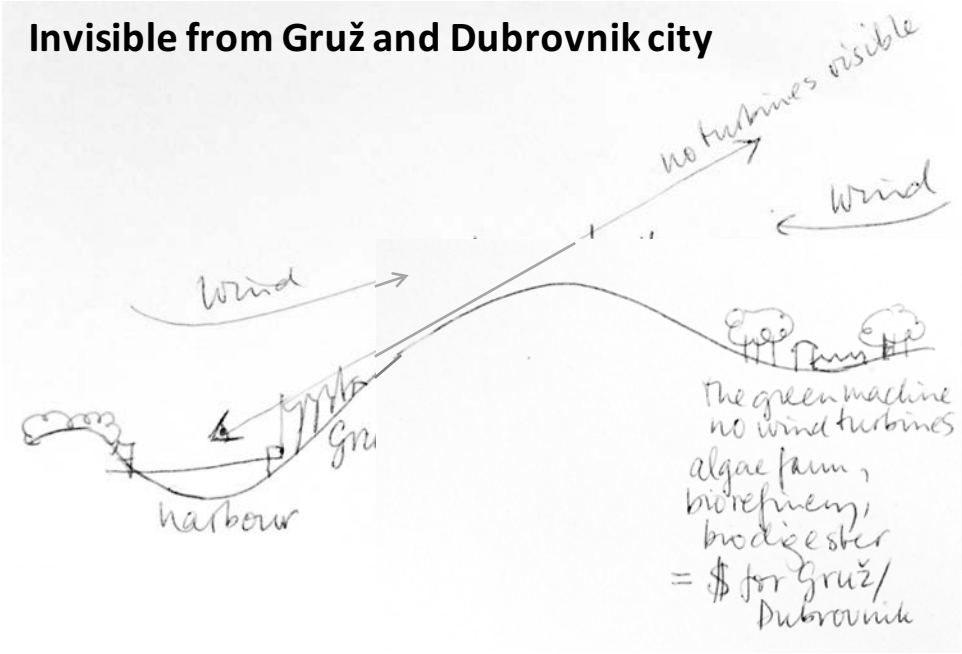


Golf **Park with 5 MW wind turbines** (100 m tall)

Unsustainable Golf Park

sustainable Golf Park → 16 GWh/yr Gruž power

Invisible from Gruž and Dubrovnik city



Golf courts can be sustainable


Samsø golf club

Wind power, PV golf carts, PV mowing machines, sheep, micro-clover, turkey manure on green

Wind turbines with hydro-power station

Wind turbines connected to a hydro-electric power plant by a channel to the valley [Max Boegl Wind]

Wind-powered water towers [GE]

Mobility: bottlenecks from Gruž to the Old Town

Mobility: bottlenecks from Gruž to the Old Town

Mobility: bottlenecks from Gruž to the Old Town

92% not satisfied with pedestrian infrastructure
100% not satisfied with biking infrastructure

[Dubrovnik energy study]

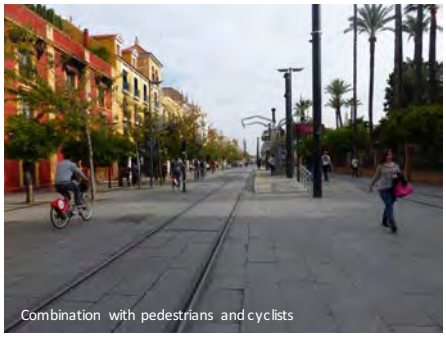
'A developed country is not a place where the poor have cars. It's where the rich use public transportation.'

Petro Gustavo, Mayor of Bogotá

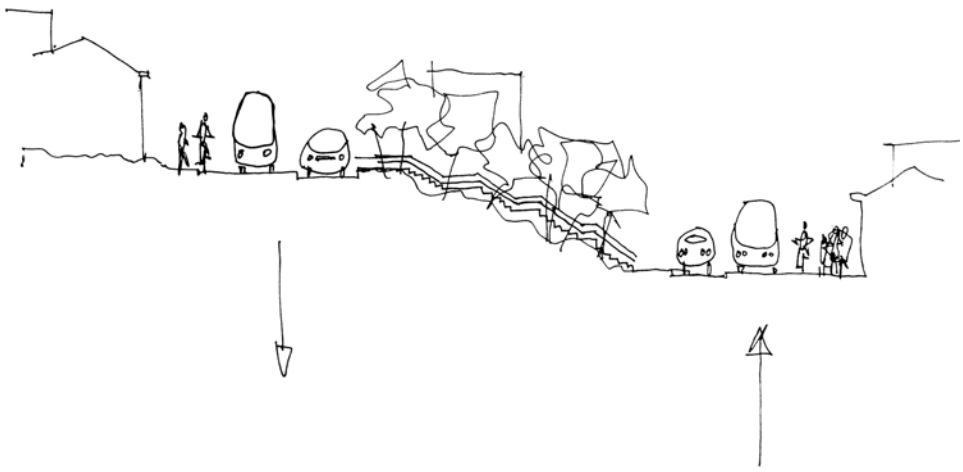

Game of Roads: carbon-free healthy travel
Motorway
Main access roads
(E-)Bike lanes
New tramway
kiss & ride
Google


Proposal: tram - e-bike - pedestrian in shared space
Nice, France


Bruges, Belgium

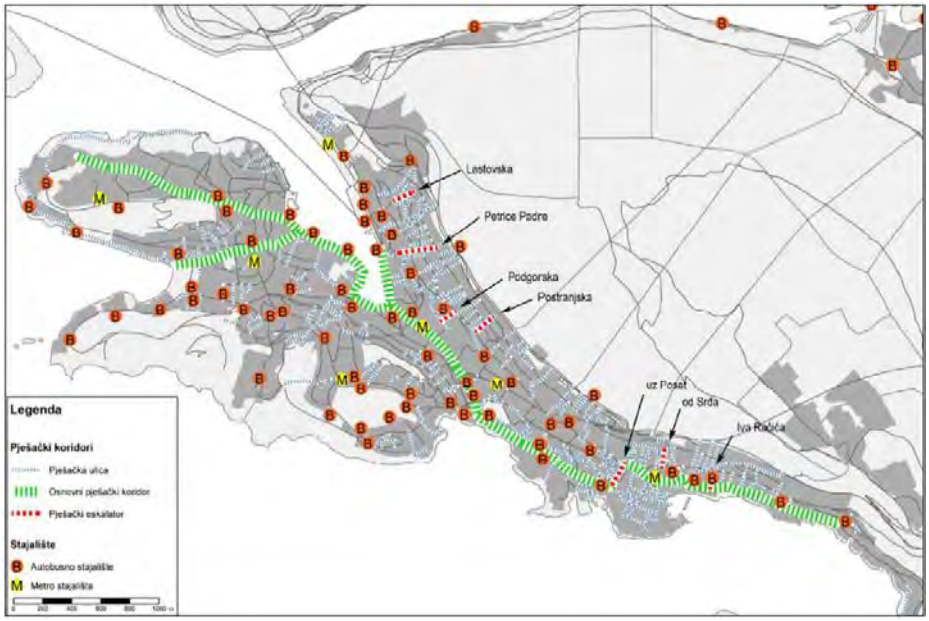

Combination with pedestrians and cyclists

BROAD PROFILE DOUBLE ONE WAY ROADS
ONE CAR LANE PER DIRECTION

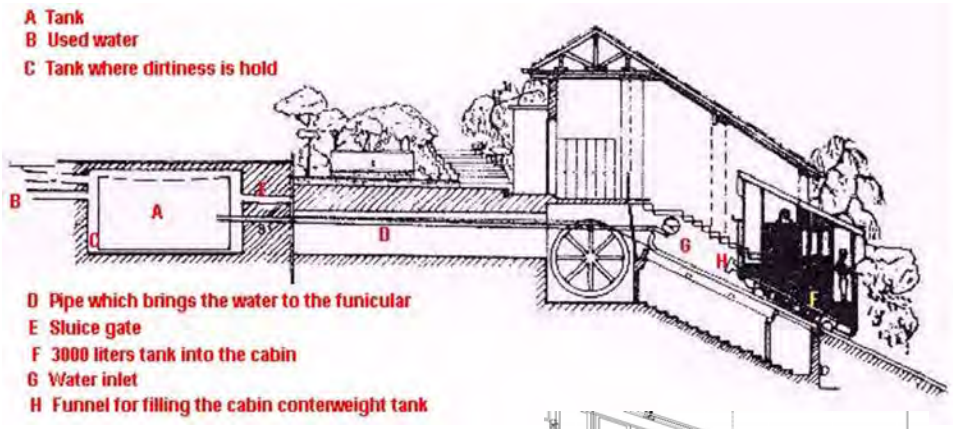


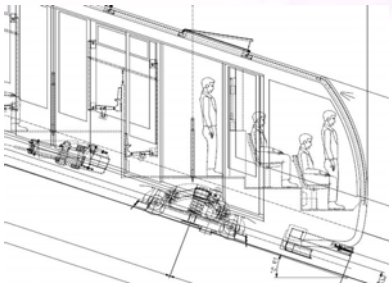
Similar proposals were formulated already before

[Traffic study of Dubrovnik city, 2012]



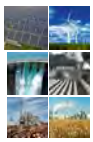
New cable cars?





Water-powered escalator

ELECTRICITY EMISSION FACTOR FOR CROATIA



CROATIA

	annual values
Electricity demand	**17.5 TWh**
Electricity production	**13.6 TWh**
NET IMPORT (22.6%)	**3.95 TWh**
THERMO-ELECTRICITY (20%)	**3.50 TWh**
natural gas (5.7%)	**1.00 TWh**
oil (0.7%)	**0.13 TWh**
coal (13.5%)	**2.37 TWh**
RENEWABLE (57%)	**10.1 TWh**
PV (0.2%)	**0.035 TWh**
hydro (52.1%)	**9.12 TWh**
wind (4.2%)	**0.73 TWh**
geothermal	-
biomass (0.9%)	**165 MWh**
biofuel	-
NUCLEAR	
nuclear	-

ELECTRICITY EMISSION FACTOR

0.341 kg CO_2eq/kWh

CARBON FOOTPRINT PER HOUSEHOLD IN GRUŽ

GRUŽ (DUBROVNIK) HOUSEHOLD

Average inhabitants	2.75		
Gross floor area	100	m^2	
ENERGY DEMAND	**2704**	**kg CO_2eq**	**47%**
Cooling electricity	1850	kWh_e/yr	
Lighting & appliances	2450	kWh_e/yr	
Heating energy	900	kWh_e/yr	7930 kWh/yr
Water heating	2210	kWh_e/yr	
Cooking	520	kWh_e/yr	
MOBILITY	**1110**	**kg CO_2eq**	**20%**
km by 1 car (80% work day)	15.3	km/day	
WASTE MANAGEMENT	**1726**	**kg CO_2eq**	**30%**
Waste per household	1,67	t/yr	
Waste to energy	0	%	
Waste to landfill	89	%	
Organic waste	1	%	
WATER MANAGEMENT	**164**	**kg CO_2eq**	**3%**
Water use per household	280	m^3/yr	

5.92 t CO_2eq/yr

5.04 t CO_2eq/yr

CARBON FOOTPRINT

5.70 t CO_2eq/yr

*5.16 t CO_2eq per 80 m^2 household

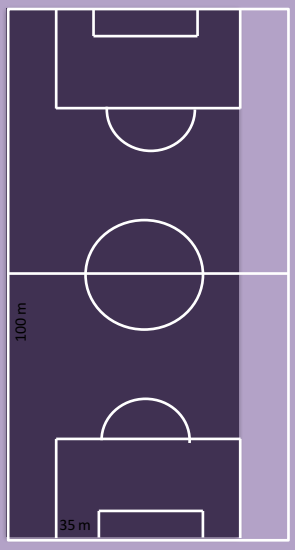
CARBON FOOTPRINT PER HOUSEHOLD IN GRUŽ

CARBON FOOTPRINT OFFSET
carbon uptake by urban forestry (i.e. 1.35 kg CO_2/m^2)

The carbon footprint of one household is equivalent to **14,300 km driven by car**

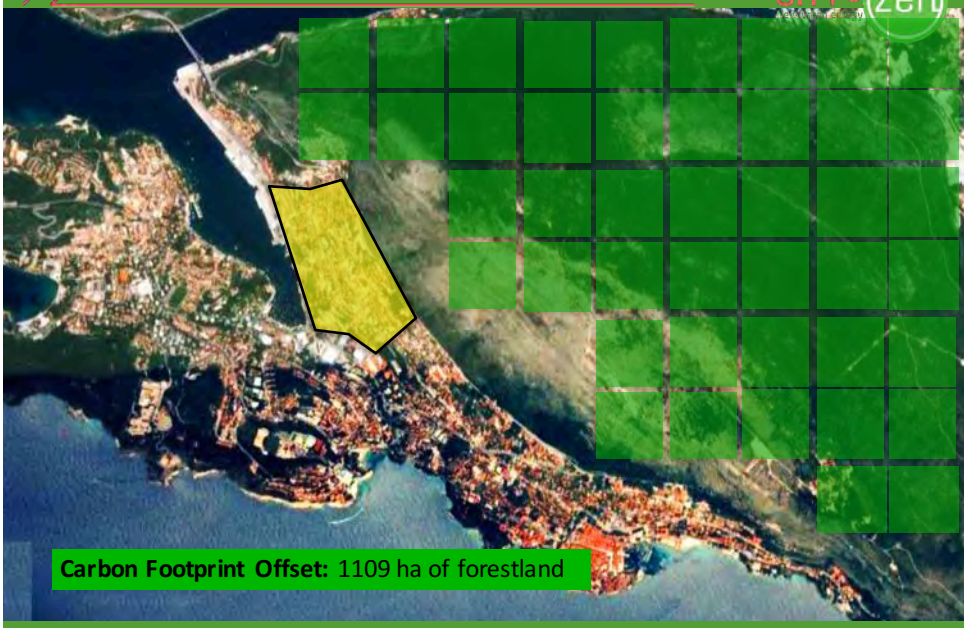
The carbon footprint offset of one household is equivalent to **0.42 ha forestland**

*0.38 ha per 80 m^2 household



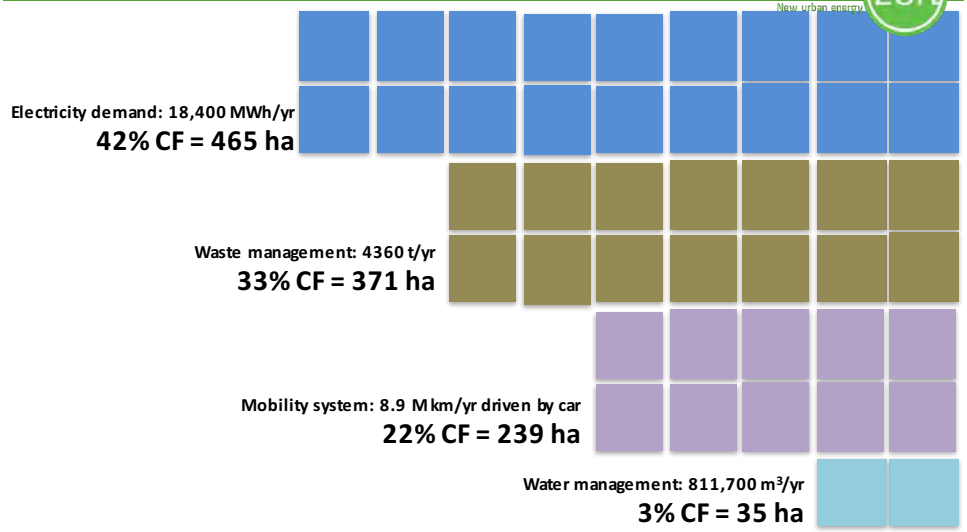
CARBON FOOTPRINT OF GRUŽ

CARBON FOOTPRINT OFFSET OF GRUŽ



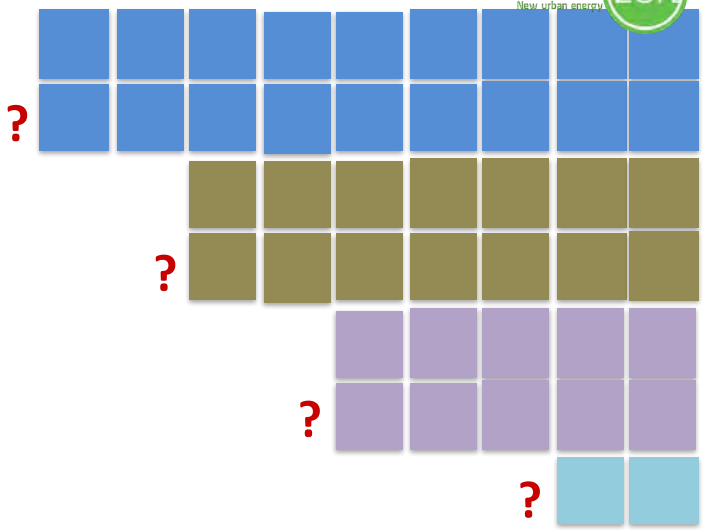
Carbon Footprint Offset: 1109 ha of forestland

CARBON FOOTPRINT OFFSET OF GRUŽ



Carbon Footprint Offset: 1109 ha of forestland

CARBON FOOTPRINT OFFSET OF GRUŽ



Carbon Footprint Offset: 1109 ha of forestland

ENERGY MEASURES

Energy efficiency assessment

- **Roof and façade shading**
  - Reduction of cooling demand: 10%
  - For 50% of households
- **Greening the building**
  - Reduction of cooling demand: 10%
  - For 60% of households
- **Insulation of roofs/walls/glazing**
  - Reduction of heating demand: 35%
  - Reduction of cooling demand: 5%
  - For 80% of households
- **Greening the street block**
  - Reduction of cooling demand: 5%
  - For all buildings

ENERGY MEASURES

Solar energy production assessment

- **Big potential for solar energy production**
  - 2480 hours of sunshine per year
  - Average solar irradiation: 1810 kWh/m² (SW orientation)
  - Good orientation of buildings (mainly parallel to coast)
    - 73% pitched roofs (35°) → 6% South-East (SE) ; 6% South (S); 61% South-West (SW)
    - 27% flat surfaces → free choice
    - Big apartment blocks → wall surfaces available
- **Proposed solution for Gruž area**
  - ± 750 roofs available
  - Average roof area: 80 m² (useful: 24 m² for PV, 2 m² for solar panels)
  - Orientation of panels on roofs: 20% SE; 20% S ; 60% SW
  - 285 m² of apartment walls SE and SW orientated
- **Total production for Gruž area**
  - 3616 MWh electricity
  - 685 MWh hot water

ENERGY MEASURES

Assessment for heat pumps

- **Big potential for heat pumps**
  - Suitable for space heating, district heating and cooling
  - More efficient than conventional electric heating
- **Proposed solution for Gruz area**
  - Ground- or water-source heat pump for 50% of households
  - COP heating season: 3
  - COP cooling season: 4
- **Total energy savings: 26%**

ENERGY MEASURES

Wind energy production assessment

- **Small wind turbines**
  - Limited potential
  - Quite expensive
  - Proposed for Gruž: 50 x 5 kW wind turbines
  - 1300 full load hours (wind velocity 5 m/s)
  - **Total renewable energy production: 325 MWh**
- **Big wind turbines**
  - Great technical potential behind the hills
  - Building permit might be problem
  - Proposed for Gruž: 12 x 1 MW wind turbines
  - 1300 full load hours (wind velocity 5 m/s)
  - **Total renewable energy production: 15,600 MWh**

CARBON FOOTPRINT OFFSET OF GRUŽ

Integrated energy measures

9,000 MWh = - 235 ha

1
Roof and facade shading
Applied to 50% households
- Cooling energy -10%

CF 98.8%

2
Building greening up
Applied to 60% households
- Cooling energy -10%

CF 97.5%

3
Building envelope insulation
Applied to 80% households
- Heating energy - 35%
- Cooling energy – 5%

CF 93.5%

4
Solar PV & thermo-panels
Applied to all feasible surfaces
- Water heating -13%
- Electricity (appliances) -52%

CF 70.1%

5
Greening street blocks
Applied to street blocks
- Cooling demand -5%

CF 69.1%

6
Heat pump system
Applied to 50% households
- Total energy -26%

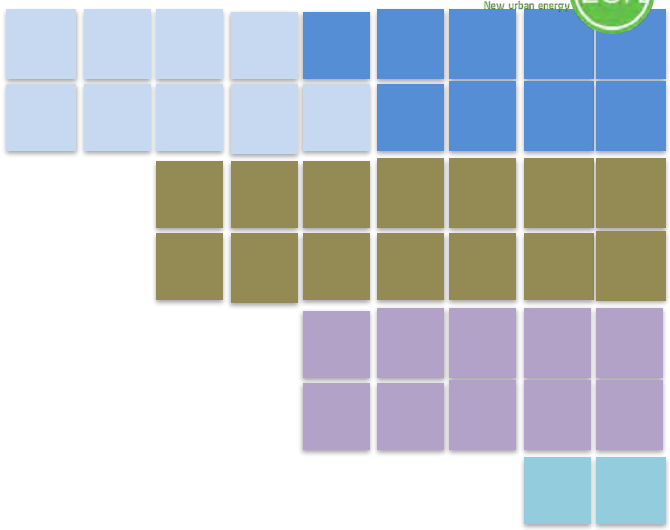
CF 51.1%

7
Mini-wind turbine
50 installed
- Total energy -4%

CF 49.4%

CARBON FOOTPRINT OFFSET OF GRUŽ

Integrated energy measures
9,000 MWh = - 235 ha

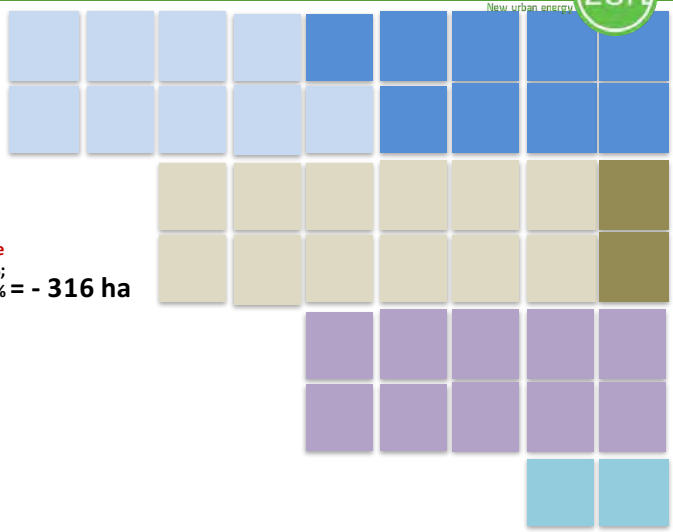


CARBON ACCOUNTING EXPLAINED

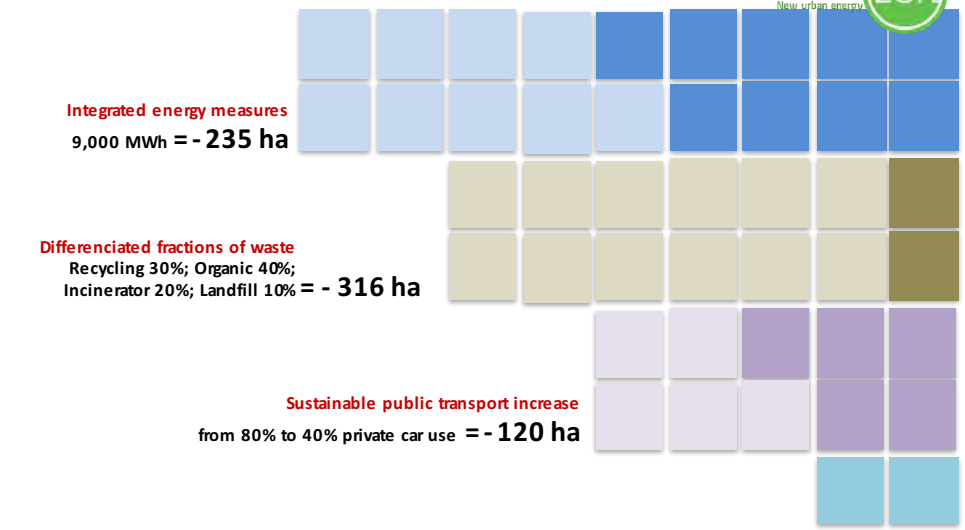
CARBON FOOTPRINT OFFSET OF GRUZ (DUBROVNIK)

Integrated energy measures
9,000 MWh = - 235 ha

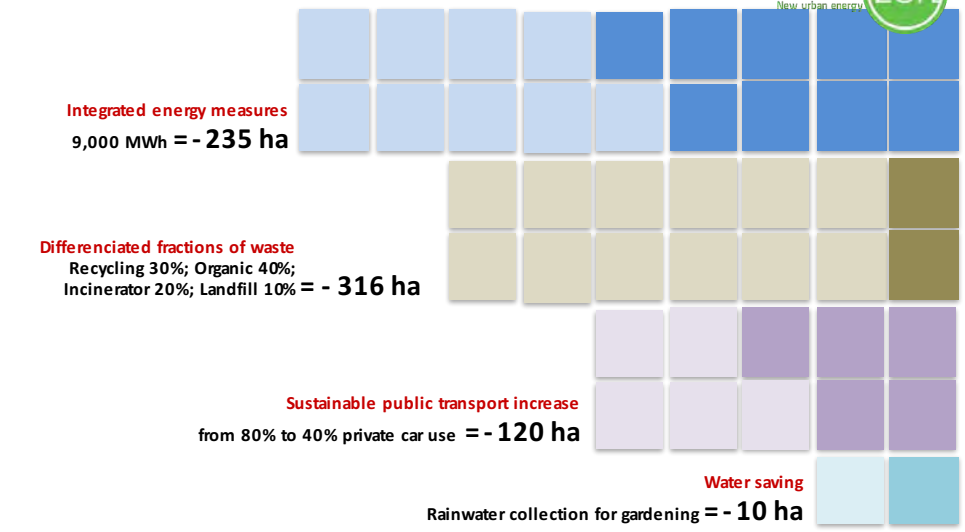
Differenciated fractions of waste
Recycling 30%; Organic 40%;
Incinerator 20%; Landfill 10% = - 316 ha

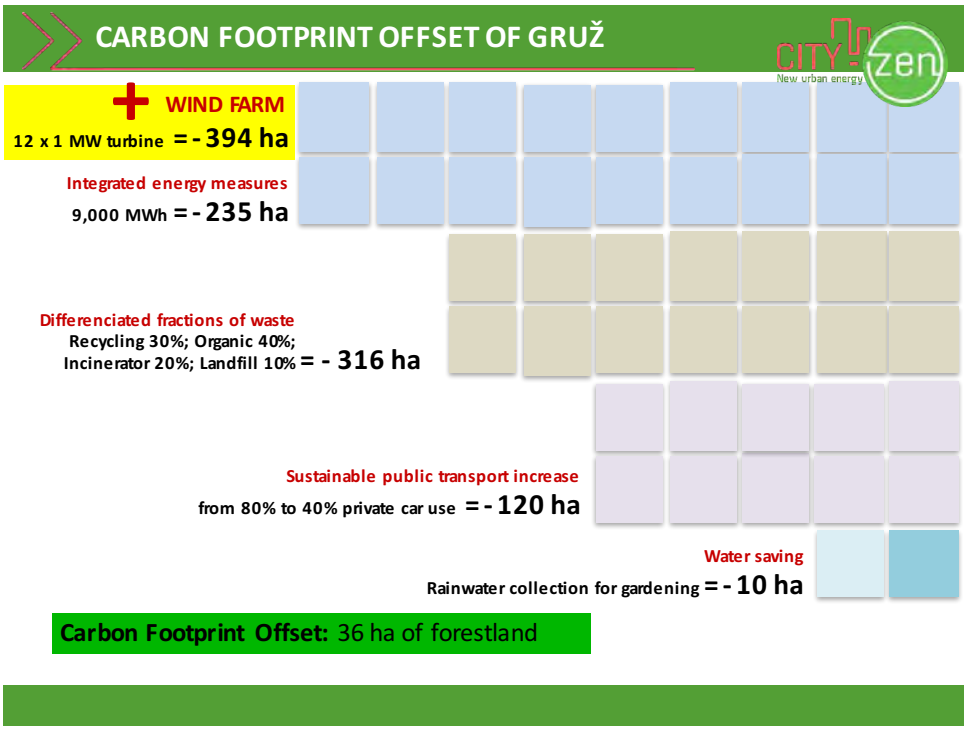


CARBON FOOTPRINT OFFSET OF GRUŽ



CARBON FOOTPRINT OFFSET OF GRUŽ





Conclusion

- **With a realistic set of measures and some reforestation, Gruž …**
  - can be made energy neutral and carbon neutral
  - will have its own energy cooperation
  - will become resilient, healthier and much more liveable
- **There are great potentials in a large green energy plant, for …**
  - waste water processing of cruise ships (cleaner ocean)
  - production of biogas, biodiesel, fibres and nutrients
  - food and bio-based material production
  - job creation
  - money making, for Dubrovnik and the local population of Gruž
  - health and safety

Thank you, Dank u wel, Grazie mille, Go raibh maith agat!
Hvala!

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