1. CITTÀ, AMBIENTE URBANO E SVILUPPO SOSTENIBILE

1

Energia e città da sempre vivono un rapporto di intensa interdipendenza: la nascita, la crescita e l'estinzione delle esperienze urbane ha, infatti, sempre coinciso con il rapporto delle stesse con le fonti di approvvigionamento energetico.
Ma cosa intendiamo per città e a cosa ci riferiamo quando parliamo di energia?
La città, dal latino civitas, rappresenta il luogo di un insediamento umano stabile dove sono concentrate funzioni atte alla crescita e allo sviluppo della civiltà. L'energia consiste, invece, nella "capacità di agire" aristotelica che nella meccanica classica diventa la capacità di un sistema fisico di sviluppare una forza attraverso un lavoro.
Il nodo stretto che lega i due termini si trova, quindi, nei concetti di sviluppo e crescita, ma è altresì interessante sottolineare come sia nel termine "insediamento" che in "sistema" siano insiti concetti di misurabilità e finitezza.
Dalle costruzioni all'agricoltura, dall'artigianato all'industria, tutti i possibili modi di implementazione e modificazione della realtà necessitano di lavoro e quindi di energia.
Per una città antica la sua energia consisteva nei suoi uomini e nei suoi animali e la loro capacità di compiere lavoro in un sistema di dipendenza con le risorse naturali, unico carburante per entrambi. Per secoli è stato così, fino a quando non sono stati individuati nuovi sistemi che, attraverso l'utilizzo di risorse fossili facilmente reperibili, fossero capaci di sollevare dalla fatica uomini e bestie. Da questo momento in poi le città hanno subito una forte accelerazione nel loro sviluppo e a una conseguente e spesso apparentemente inesorabile crescita demografica, economica e sociale ha coinciso l'emergere delle prime preoccupazioni in materia di organizzazione urbana. L'escalation iniziata con la seconda rivoluzione industriale non si è ancora arrestata.
In questo capitolo sono trattati il tema dei modelli di città e dei modelli di sviluppo: l'hardware e il software di un dispositivo che deve essere colto nella sua integrità. La città è descritta secondo quelle che risultano le sue principali caratteristiche fenotipiche, i modelli di sviluppo seguendo le fasi che hanno portato l'attuale agenda politica internazionale a porre il contrasto al cambiamento climatico, la riconversione del modello energetico e lo sviluppo sostenibile in cima alle priorità per affrontare il futuro della nostra civiltà.
Il breve *excursus* storico, limitato agli ultimi cinquant'anni di politiche urbane, serve a fornire un quadro di riferimento dal quale emerge la sempre più pressante esigenza di una revisione epistemologica per l'urbanistica e del ruolo dei suoi interpreti.

Previous page:
Las Vegas, United States of America (photo @Mauro Filippi)

1.2 Urban environmentalism

«Any intelligent fool can invent further complications, but it takes a genius to retain, or recapture, simplicity»
E.F. Schumacher, *Small is Beautiful*

There are three significant dates that can be distinguished concerning the so-called "environmental theme". The first date is 1972, year in which the civil society submitted a report to the press of the Massachusetts Institute of Technology (MIT) in Boston; the renown The Limits to Growth recognizes the depletion of resources and the limits to the growth system proposed by the UN at the Stockholm Conference which argued theories on smart use of resources. Whereas, the second date coincides with 1987, year in which the Brundtland Commission Report "Our Common Future" was published, which identifies the limits of growth not in the scarcity of resources, but in the ability of the planet (biosphere) the very effects of human activity. The last one is 2016, when almost 180 countries adopted the UN New Urban Agenda to guide the future development of cities and make them inclusive, safe, resilient and sustainable.

1.2.1. The origin of the environmental issue: its literary account

Between the 1960's and the 1970's intense debates on the relationship between man and environment, causing vast literary productions. In fact, a new (scientific and social) self-consciousness emerges, which does not consider man as a ruler of nature, but as an integrating part of it: man's world domination does not any longer appear to be a realistic hypothesis.
How does this change occur? In the fifties and sixties the industrialized countries underwent a considerable expansion, which corresponded to a considerable increase

in income per capita of the population. The technological development and the distribution of produced wealth created the illusion of "unlimited growth", which would have maintained its unaltered rate through time. At the time, the unequal growth rate between industrialized countries and did not appear to be a problem, because it was thought that the non-industrialized would eventually catch up.
Towards the end of the sixties the first effects of the unlimited growth model were observed, at which point they become relevant and no longer avoidable. The effects become apparent in one way with the exploitation of resources, in another with pollution and environmental decay. Furthermore, the increasing levels of well-being favor an exponential growth of the population, allowing a vicious spiral to take place: increase in food production and resource consumption, increase in pollution and so on.
Therefore, the economic model is faced with a new issue: attribute a market value to the natural resources, the so-called social and environmental costs.
One of the first texts that expose the effects of new technologies on the environment is *Silent Spring* by Rachel Carson [Carson, 1962], which describes drastic changes tied to pollution produced by chemical agriculture to land and wells in the United States territory.
In 1971 the book *The Closing Circle* [Commoner, 1971] is released, which fiercely contests the dominating economic model on which the so-called "consumer society" is based on, and focuses on the apparent irresolvable conflict between economic growth and maintaining an environmental balance.
As far as the theme of energy consumption, 1973 is a historic date because it marks the division between two eras: in connection with the Kippur war (between Israel and Arab states), the illusion of being able to use an infinite amount of energy (oil) at a low cost ends. For this reason, starting with the date previously mentioned, a debate starts on a global scale on the use of energy sources and on humanity's fate facing problems connected to intense exploitation of resources.
In this debate it is important to discuss the role that the engineer Adriano Olivetti and the leading class assumed during the Olivetti industries experience in Ivrea. The holistic model connecting cities, society, labor, energy and growth suggested through texts, projects and solutions represented an extraordinary Italian experience, between the forties and fifties, which became an international benchmark for the application of a sustainable approach in an economy of capitals.
In fact, it was not a coincidence that *"Club di Roma"* of Aurelio Peccei, former director of Olivetti industries, commissioned the Report.
A premonition to the importance of the energy subject was the Report of the Massachusetts Institute of Technology (MIT) in 1972, *The Limits of Growth* [Meadows et Al., 1972], which alerts politicians and scientists on the dangers tied to the, at the current time, production methods, along with forecasting the planet's collapse.
Therefore, from this period on the central theme became the problem of non-renewable energy and its conservation, given the fact that they are not reproducible once

used, in which case no longer available. The environmental issue, the protection and development of nature clash with the dominant economic interests and rules. Schumacher, in line with Olivetti's vision of economy's role and the concept of scale, anticipates the main knot of the environmental issue comprised in what will sub sequentially will become concept of sustainable energy, which is the problem of energy consumption tied to the use of fossil fuels.
Schumacher is not the only economist that discussed the matter. In fact, in 1980 Jeremy Rifkin publishes *Entropy. Into the Greenhouse World* [Rifkin, 1980], where the history of urban development coincides with the history of the development of the rising energy consumption.
However, not until 1983 when Eugene P. Odum definitely lays the scientific basis of ecology with his renown text *Basic Ecology* [Odum, 1983], which systematically illustrates the concepts of ecosystem, environmental systems, metabolism, complexity, resilience, predation, co evolution etc.

1.2.2. The MIT Report and the debate on expandable resources

At the time of the MIT report, the concept began to spread of the coming of a technological era would have modified the collective and individual behaviors of society, that is, the dominance of the economic and technological development could have implicated the loss of environmental values and society's ideals. Therefore, the focus of the debate is the issue of the limits of environmental growth and the potential role of technological innovation in removing such limits.

> «For many […] the new frontier is called science and technology, to which has the role to move the limits of the possible. However, for others the known and unknown resources that Earth has, are not sufficient for a long period to allow the actual and potential rates of usage: it is therefore necessary to confront as of now the problem of a more national resource exploitation, in order to avoid catastrophic consequences in the near future.» [Bresso, 1982]

The report had the objective to define the limits that Earth places on human activity: which is the degree of compatibility between human activity and limited dimensions of the planet in terms of space and resources, through the determination and study of the *main factors* that cause the dynamic behavior of such system. For such purposes, a mathematical model *(World3)* has been devised, which describes the trending lines of the system, the way in which they interact between each other and the eventual consequences of these trends.
The model elaborated by J.W. Forrester tended to highlight in a finite way the exponential growth of any subsystem, which would clash with the limits of availability of base resources. This model identifies five synthetic variables considered fundamental to represent the system made of a combination of over 150 simple variables.

The synthetic variables are:
– Population;
– Agriculture (food production, ground fertility, expansion, loss of land);
– Economy (industrial production, service production, job positions);
– Natural non renewable resources;
– Pollution.

The most relevant part of the report leads to the conclusion that the actual growth trends of population and industrialization are in conflict with the material factors, the resources, which constitutes the base for every growth process.
The resources are identified as:
– Food (farmable land);
– Raw materials;
– Fossil fuels;
– Nuclear fuels.

If only agricultural production would double or quadruple (as indicated in the curve in the figure), the effects would consist in pushing back a few decades the "crisis point". Analogous considerations can be made for raw materials, the withdrawal of which grows more rapidly than the population.
The availability of resources is not the only issue engaged in the report; higher limits are imposed by the planetary ecosystem. The latter mentioned, is capable of absorbing human waste products and converts them, through a series of cycles, into new resources. However, once the saturation level is passed the waste products start to accumulate in a toxic and excessive way with no possibilities of disposal.

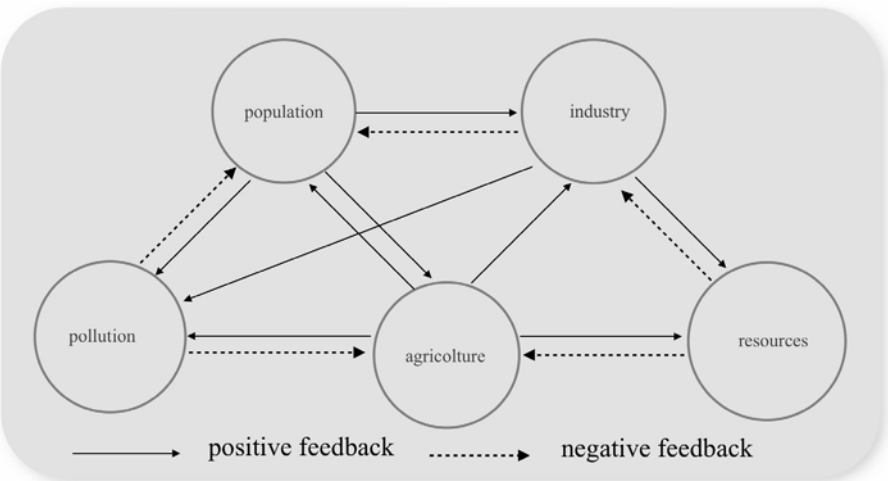


Figure 1. MIT model's main elements

1.4. Urban design and the other disciplines: an epistemological review

«The urbanist's intelligence and passion dig deep in the most complex and delicate subject; he wants to intervene where life is an undividable unit of its processes, his work and his reality have slowly and laboriously developed a kind of balance»

Renato Zweteremich*, 1948, Zoning Plan of Val d'Aosta*

The complexity that dictates the urban systems and the new development models, the present uncertainty in the environmental phenomena and the lack of linearity of the processes that highlight the necessity for interdisciplinary relationships, specifically the ones concerning natural sciences. There is a demand, most of all, by the urbanist community [Cheshmehzangi and Butters, 2016].

Society	Ecology	Economy
1. Aesthetics	1. Land Use	1. Flexibility
2. Sociability	2. Biodiversity	2. Management
3. Involvement	3. Bioclimatic	3. Communication
4. Variety	4. Energy	4. Services
5. Security	5. Water cycles	5. Financial
6. Identity	6. Materia cycles	6. Activity
7. Accessibility	7. Transport	7. Functionality
8. Socio-diversity	8. Health	8. Cost

Figure 2 - Sustainable value map (Chris Butters holistic framework)

Urbanism is developed as a group of hygienic and building guidelines in response to the industrial revolution, which poses the problem for a new form of settlement, meaning the city, where thousands and then millions of people begin to concentrate due to the industries new forms of production. Therefore, this discipline is devel-

oped around the technical knowledge based on functional zoning, which is land organization and management. This conceptual and technical system is proven to be ineffective to confront raising problems, which were the relationship between social projects and urban-architectural projects, the renewed relationship between man and nature and the dismissal of the anthropocentric vision and the new limits imposed by the environmental problem [Ratti and Claudel, 2016].
At this point, it is fundamental to define in which the direction to look and to begin a new path in the discipline. The conceptual frame is clear; it is necessary to find the courage to overcome the disciplinary barriers to redefine the role of who develops urban projects [Carta, 2013].
However, transferring concepts from one discipline to another is not always legitimate: it could be a phenomenon caused by trends, or result unproductive and inefficient. Urbanism has a past that is characterized by various aborted transitions, which produced ambiguity and false scientific results, but on the other hand it developed disciplinary diversifications, such as modelist, designers and analysts. Obviously, not all of the transitions failed. Some were successful, such as the transition from economy, and others like the transitions from ecology are still undergoing experimentation.
According to Isabelle Stengers, the adaptation of concepts to a discipline become legitimate, productive and fertile when it allows progress for the disciplinary knowledge regarding the concept [Stengers, 1997]. This means that the adaptation of a given concept is meaningful when it gives adequate instruments to confront the new problems rising from the scientific community of the given discipline. Therefore, it is necessary to verify is such adaptation is pertinent, and also if it is fertile; two aspects that are often dependent on each other.

Cities are becoming always more and more important for the future of life on earth, and their complexity is becoming overwhelming for those who are in charge for making decisions [Ratti and Claudel, 2016].
This brought this research to investigate innovation in management processes and the attempt to build a bridge between urban design and lean thinking.

2. POLITICHE PER L'EFFICIENZA, ASPETTATIVE PRESENTI E FUTURE

2

Come abbiamo evidenziato nel capitolo precedente, quelle risorse che in un primo tempo sembravano infinitamente disponibili, negli ultimi anni hanno iniziato a scarseggiare e a mostrare le conseguenze del loro sfruttamento scriteriato. In quest'ottica, quello della sostenibilità energetica in ambito urbano è diventato, un tema sempre più attuale e in cima a molte agende politiche: consumare meno e consumare meglio. Come si è già verificato storicamente con le rivoluzioni industriali, si è iniziato a progettare il futuro del mondo attorno a un nuovo vettore energetico, quello delle energie rinnovabili. Il modello prevede un'architettura distribuita, l'utilizzo di tecnologie più efficienti e rispettose dei cicli naturali dell'ambiente, oltre all'impiego di nuovi sistemi ICT per elaborare e condividere a grande velocità le complesse informazioni. Le città sono affrontate quindi come veri e propri esseri metabolici intelligenti, in uno slogan: *Smart Cities*.

Anche se i risultati di alcune politiche e soluzioni tecnologiche sono molto incoraggianti tuttavia, ad oggi, sembra molto lontana la possibilità di applicazione di questo approccio in contesti rimasti ai margini dei processi di globalizzazione e nei paesi in via di sviluppo. Per cercare di far fronte ai limiti di un approccio squisitamente top-down di tali politiche, è sempre più frequente il tentativo di innescare processi condivisi con il sistema nervoso del tessuto urbano: i suoi cittadini.

Il concetto di "innovazione sociale", oggi talvolta utilizzato per sintetizzare un approccio "dal basso", ha in realtà confini molto labili e spesso mostra dei caratteri in comune con quello di *"Smart City"*. Entrambi, in effetti, condividono gli stessi obiettivi e gli stessi attori, non il punto di partenza: L'innovazione sociale non parte dagli oggetti materiali, dalle infrastrutture, dalle procedure, ma parte dalle persone, dalle interfacce, dalle relazioni.

Negli ultimi 15 anni la svolta digitale di internet legata alla democratizzazione della rete ha accelerato molti processi dal basso, cambiando profondamente il nostro modo di vivere le nostre città. Attraverso computer, smartphone e wearable oggi viviamo una vera e propria realtà aumentata: l'essere costantemente connessi influenza abitudini, generando nuovi comportamenti. Questo luogo di frontiera della percezione appare a molti il terreno più fertile e ricettivo in cui progettare esperienze e dinamiche nuove di relazione con la realtà. Qui sembra possibile innescare nuovi processi di consumo e rendere i cittadini protagonisti di ambiziosi progetti di rigenerazione ambientale, energetica e sociale.

In questo capitolo sono quindi trattati i principali strumenti a disposizione di progettisti, pianificatori e *policy makers* per trasformare le città, e innovare il modo in cui i cittadini stabiliscono relazioni tra loro e con l'ambiente urbano.

Previous page:
"Borgo Vecchio", Palermo, Italy
(photo @Mauro Filippi)

3. PROGETTI DI RICERCA-AZIONE

3

Come abbiamo visto nel capitolo precedente, gli strumenti per affrontare le politiche di sviluppo urbano sostenibile possono essere formali *(top-down)* e informali *(bottom-up)*.
Ma esistono valori comuni e dipendenze fra questi strumenti?
Come è possibile progettare strategie *top-down* e *bottom-up* interconnesse?
Per cercare di rispondere a queste domande, come anticipato nell'introduzione, si è scelto l'approccio *"action research"* per affrontare direttamente e sul campo tutte le questioni connesse alla progettazione sostenibile del territorio.
Il "campo" di queste ricerche è l'ambiente costruito di due aree urbane complesse nella regione del Mediterraneo: Lampedusa e Palermo.
In questi specifici ambiti, infatti, a causa di questioni sociali, tessuti urbani fortemente storicizzati e soprattutto a causa della quasi totale assenza di politiche di sviluppo indirizzate alla sostenibilità ambientale, il bisogno di nuovi modi per progettare l'ambiente urbano sembra essere ancora più urgente.
In questo capitolo sono riportati i risultati della simulazione di un SEAP per l'isola di Lampedusa e quelli di un progetto di innovazione sociale per potenziare la mobilità sostenibile a Palermo.
Il primo progetto di ricerca applicata è piano d'azione multi-obiettivo per rendere le isole di Lampedusa e Linosa indipendenti da risorse fossili entro il 2030. Nel simulare tale strategia, oltre al tipico approccio top-down, il progetto prova anche ad innescare un approccio dal basso per incoraggiare buoni comportamenti all'interno della comunità. Un filone della ricerca, l'applicazione per smartphone *"The Social Market"*, è stata ispiratrice di parte del progetto *"Sharing Cities"* promosso dai Comuni di Milano, Londra e Lisbona e poi vincitore del bando *"Lighthouse"* del programma *Horizon 2020*.
Il secondo, *TrafficO_2*, è un progetto di ricerca applicata con l'obiettivo limitare l'impatto dei trasporti individuali sull'ambiente e sulla vivibilità urbana a Palermo senza l'utilizzo di alcun approccio top-down. Per far questo è stata progettata, sviluppata e testata con la comunità di studenti dell'università degli studi di Palermo un'applicazione per smartphone. I partecipanti al test hanno migliorato le proprie abitudini del 54%. Co-finanziato nel 2012 attraverso il bando *"Smart Cities and Communities and Social Innovation"* dal Ministero dell'Istruzione dell'Università e della Ricerca, i risultati della ricerca sono stati alla base del progetto *"MUV – Mobility Urban Values"* selezionato nel 2016 dall'acceleratore d'impresa *"Google 30 Weeks"* e nel 2017 divenuto una *Research and Innovation Action* finanziata sotto il bando Horizon 2020 *"Mobility for Growth"*.

Previous page:
"TrafficO_2" comunication campaign (photo @Mauro Filippi)

3.1. Lampedusa Revolution

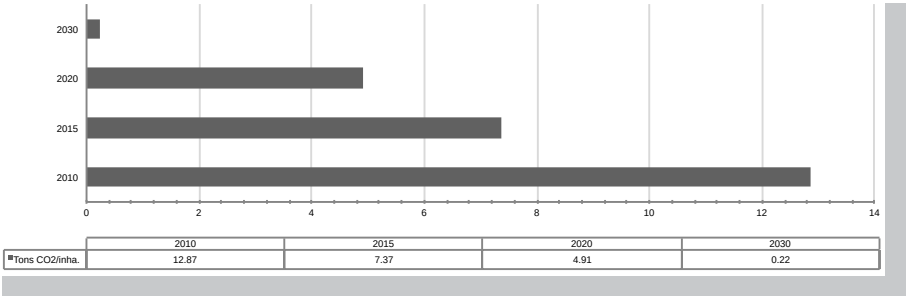
«The term utopia is the most comfortable way to avoid what one has no will, ability, or courage to do. A dream seems to be a dream until one does not start somewhere, only then it becomes a goal, meaning something infinitely bigger.»

Adriano Olivetti, 1960. *La città dell'uomo*, Edizioni comunità, Milan

The following action-research study aims at measuring the potential effectiveness of the Sustainable Energy Action Plans in deprived areas. The objective was to demonstrate how certain action-design strategies are perfectly adaptable in such communities where there are not existing urban planning instruments. Where classical policies strategies have failed for many years, this tools, always in a top-down manner but starting from different planning scale and goals, could give reinforcements (political and economic) to the territory crating more complex processes of urban renewal. Having a holistic approach, in fact, they can aspire to be strategical for many different urban policies and, most of all, be effective and build a change.

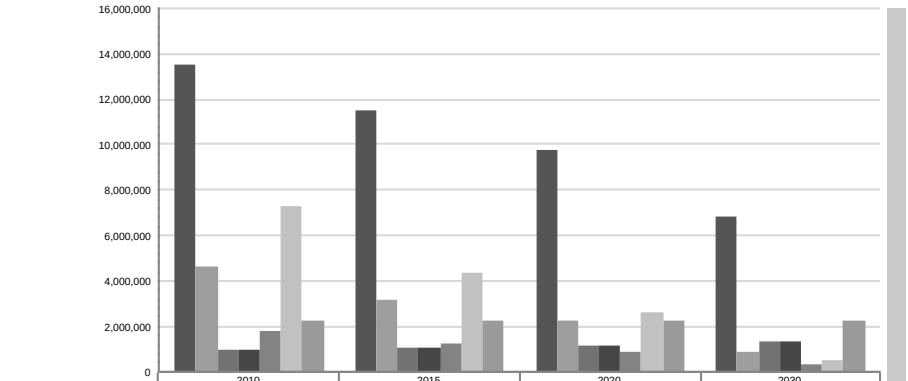
The following paragraphs are a synthesis of the most extensive work presented as a final thesis in 2010 for the master *CasaClima* (thesis supervisor arch. Stefano Fattor, assistant prof. engineer Giuseppe Trombino, engineer Corrado Giacomelli) published as contribute in the 2011 "Cities with no oil" book edited by the Italian Institute of Urbanism.

The Social Market" mobile app, in 2013 won the first prize of the national competition *"AAA Architetti cercasi"* and it has also been selected as one of the 20 best ideas worldwide (among more than 700 proposals) for the FI-WARE Smart Cities Challenge 2014 contest. In 2015 "Digital Social Market" approach was inspiring for the project "Sharing Cities", promoted by the Municipality of Milan, London and Lisbon, and then winner of the call "Lighthouse" of the Horizon 2020 program.



	2010	2015	2020	2030
Tons CO2/inha.	12.87	7.37	4.91	0.22

Figure 2 – The CO_2 goals



	2010	2015	2020	2030
first households (kWh/a)	13,560,000	11,526,000	9,797,100	6,857,970
second households (kWh/a)	4,599,000	3,219,300	2,253,510	901,404
touristic structures (kWh/a)	945,000	1,050,000	1,155,000	1,365,000
new urban areas (kWh/a)	945,000	1,050,000	1,155,000	1,365,000
municipality (kWh/a)	1,777,143	1,244,000	870,800	348,320
electricity distribution (kWh/a)	7,295,864	4,377,518	2,626,511	525,302
other (kWh/a)	2,246,513	2,245,390	2,244,267	2,242,023

Figure 3 – Energy demand simulation

Actions for the Municipality of Lampedusa and Linosa

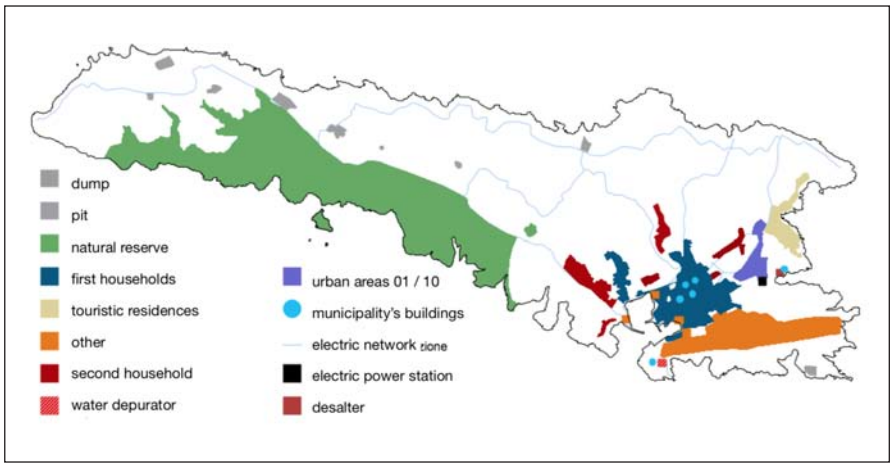
Preliminary phase:

The municipal administration will set the bases by creating a public-private energy agency (a E.S.Co with the current energy provider on the Island and an accredited energy certification institute such as *CasaClima* or others).

Design phase:

The Agency will take care of the first phase for co-drafting the APSE. This instrument will provide the guidelines for the PGR, for a detailed plan for the infrastructures on the Island and an integrated plan for waste management.

Figure 4 – Lampedusa current use of soil



Executive Phase:

This phase will be dedicated to the requalification of the municipal building heritage, will draft an energy land registry and will manage the renewable energy structures distributed throughout the island.

Actions for energy

- Creating an underground electric grid will decrease energy loss for distribution.
- Creating an underground electric grid will allow the use of the pole for small wind powered generators.
- The photovoltaic structures will be distributed in the degraded areas, to reduce their visual impact.
- Hotels will receive incentives to adopt geothermic climate systems using the seawater.
- By analyzing the current state, it is deduced that 90% of the buildings have flat rooftops. To give incentives to adopt photovoltaic systems, the municipality could offer a volume increase in relations to the covered surface (light structure). The renovation and extension of the property must include a greater overall efficiency, and the new roof surface must be predisposed for a solar thermal and photovoltaic system. The provision aims to increase the square footage of the Island for the housing supply, sparing the territory.
- Every household will receive incentives, in any case, by equipping solar thermal systems for health and hygienic consumptions.
- The power plant will slowly be reconverted into a hydrogen stock station and reconversion through combustion cells.

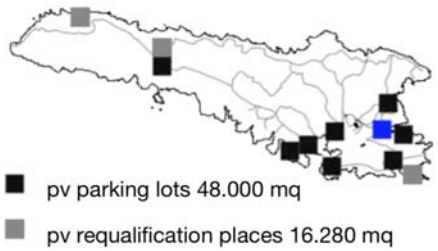


Figure 5 – Distributed Alternative Energy solutions: photovoltaic parking lots

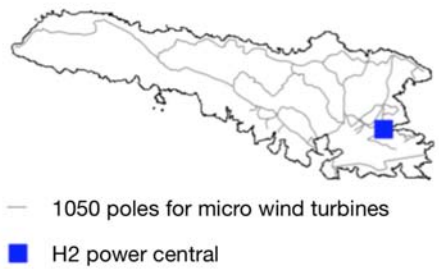
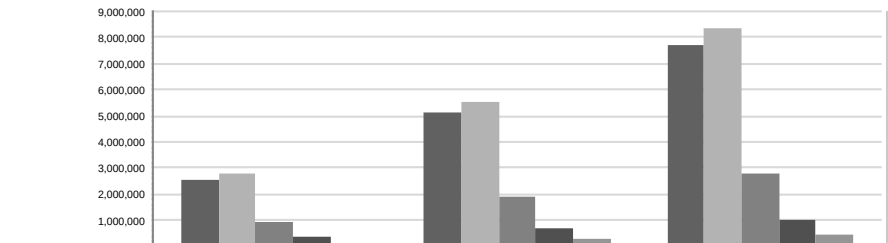


Figure 6 – Distributed Alternative Energy solutions: micro wind turbines



	2015	2020	2030
pv roofs (kWh/a)	2,566,181	5,132,363	7,706,250
pv parking lots (kWh/a)	2,783,121	5,566,241	8,357,719
pv requalification (kWh/a)	937,690	1,875,381	2,815,887
waste digester (kWh/a)	334,600	669,200	1,004,804
micro wind turbines (kWh/a)	159,440	318,881	478,800

Figure 7 – Distributed Alternative Energy production

Actions for waste management

A provision for all goods entering the Island will reduce the production of undifferentiated waste.
A fee for packaging will facilitate recycling PET, aluminum, steel, etc.

An integrated door to door waste pick up will allow for using the fraction of wet waste to power the waste digester (5.000 ton capacity) that will produce electric and thermal energy (usable to power absorption refrigerators for storing groceries or to depurate for domestic usage the sea water).
The organic waste can be used to fertilize vast areas of the territory (today of uncultivable Mediterranean garrigue).
The residents will be able to pay their waste management tax based on the effective quantity produced, through a magnetic ID card. On the other hand, tourist can charge a credit on a magnetic card attached to the travel ID. The credits can be spent on the island on tourism services.

Figure 8 – Waste digester

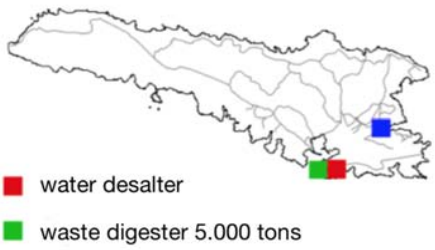
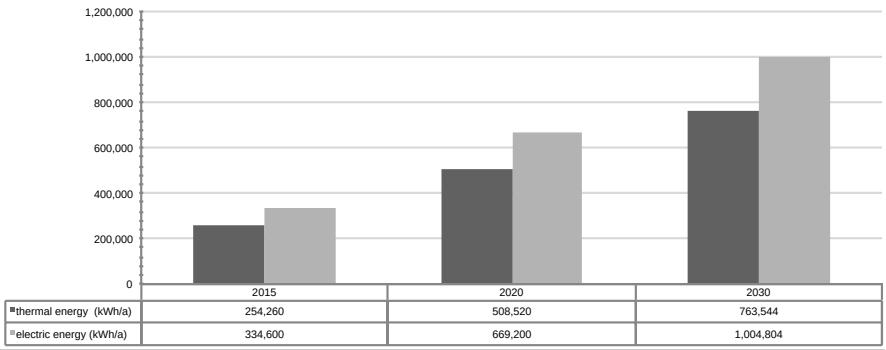


Figure 9 – Waste digester energy production



	2015	2020	2030
thermal energy (kWh/a)	254,260	508,520	763,544
electric energy (kWh/a)	334,600	669,200	1,004,804

Actions for territorial design

The expansion areas will be located upon completion of the current urban fabric.
The new green areas will act as a filter between the existing real estate and the future development.
The water network will be renovated to reduce its leakages (currently 35%).

3.2. TrafficO_2 – social network for communities' sustainable mobility

Play is older than culture.
JOHAN HUIZINGA, 1949. *Homo Ludens*, Routledge, London.

The following action-research study started with the ambition of being a real effective bottom-up solution for the urban mobility issues.
Without touching neither a bus lane journey or digging the historic city's tissue for a metro lane, in fact, we thought possible to change urban traffic dynamics just by talking to the people, giving them the right motivations at the right time to do the "right thing" regarding their urban mobility behaviors.
This bottom-up proposal is far to be a formal Sustainable Urban Mobility Plan but, regarding the final results, it shares the same ambitions.
It, actually, applies to the "Gamification" approach to investigates the connections between energy and behaviours (briefly described in the previous chapter) and it uses all the habits change techniques know in literature.
The following paragraphs are a short overview of the work that won the 2012 Italian Challenge co-funded by the Italian Ministry of University and Research "Smart Cities and Communities and Social Innovation" done by "Push – design lab" organization.

In 2013 TrafficO_2 was included in the campaign for sustainable mobility "Do the right mix" by the European Union, and in 2014 it was the only italian project selected for the international conference Behavior Energy and Climate Change. During the same year it won the first edition of the Social Innovation AROUND Award and in 2015 it won the first edition of the Smart City Innovation Awards promoted by MIT Enterprise Forum and BNL/BNP Paribas. The project was also mentioned in the Legambiente report "Best Practices – Ecosistema Urbano XXII". In 2016 the results

of the research project were the basis for the MUV project during the business accelerator program "Google 30 weeks".
In 2017 MUV won the call "Mobility for Growth" funded by the European Commission through the Horizon 2020 program and it is part of CIVITAS.

3.2.1. Introduction

As many thinkers on cities and citizens' behaviors, from Kevin Lynch [Lynch, 1960] to Peter Calthorpe [Calthorpe, 2011], have stated, cities are communities made of people, and if we aim to effectively change the urban conditions, we have to change how people perceive cities, how they interact with them, how they act upon them. All over the world designers are dealing with studies that aim to define new tools to face urban traffic issues in the old and consolidated cities. Many believe that we need to change citizens' views towards mobility systems, simply focusing on and improving "human transit".
The social sciences have already crossed into the urbanism field, but today new information technologies are making this communication faster and more productive. American private enterprises such as *Nuride* (http://nuride.com), *Zimride* (http://www.zimride.com/) and *LYFT* (https://www.lyft.com/), and European enterprises like *moovel* (https://www.moovel.com/en/US/), *Mo-bility* (http://www.mo-bility.com/mo/home.html) and *Covivo* (http://www.covivoturage-dynamiq.eu/) are quickly moving the debate on changing cities by switching their attention from the necessary modifications of the urban structure (the hardware) to the changes that can be induced by working on citizen behavior and the urban communities' habits (the software).
All of these initiatives try to stimulate the community to change its bad habits, fostering more responsible behavior through the use of smartphone apps. Essentially, the idea is to trigger a social and cultural change with the "dialog" tool provided by social media technology and, possibly, create a new service and, therefore, a new market. In fact, the majority of the above-mentioned projects were all developed by start-ups. This area of computer science is called "Social Computing". The idea behind it is: deep impact on global economy and on social organization can be obtained by fast connections (with low cost devices), modular contents and shared computing resources.

The planning process for the city of Palermo is stimulated over time along the same lines of the other well-known experiments implemented at international level, by a series of bottom-up initiatives. The Italian Ministry of University and Research is funding the three most relevant ongoing projects that are being implemented in Palermo with 4 million euro. These applied research projects aim to stimulate local communities to promote more responsible behavior in the field of urban mobility through the aid of smartphone applications [Kamal et Al., 2014]. The three teams of researchers that won the fellowship grant are multidisciplinary groups with a "social entrepreneur" approach: Muovity, CityFree and TrafficO_2. Each of them concen-

trates their efforts towards the large urban community of the University of Palermo. This choice was made based on the selected target to test their products: young and curious students are probably the best social community on which to experiment projects that, driven by new technologies and social media, aim to changing their mobility behavior [Di Dio and Vinci, 2014].

3.2.2. The mobility system of Palermo

Many researchers and designers are attempting to create "tailor-made" solutions for behavior-changing projects that are able to improve energy efficiency policies. Following this main research approach, the city of Palermo was chosen because of the interesting situation the city has been facing for the past few years.

Palermo is an important Italian city, ranking the fifth place in population (about 1.200.000 in the large metropolitan area), with a density of 4.270 inh./km^2 in its territory of 159 km^2. Despite these figures that certainly depict a relevant urban context, Palermo, as many cities in Italy, struggles every day with traffic issues. If we look to the 2015 ISTAT (Italian Institute of Statistics) data about car and local public transport average speed in urban areas, it's evident how the city is one of the slowest in the whole Italian peninsula as reported in Table 1.

Palermo has the third vehicle density in Italy and referring to the vehicular fleet of Palermo, it must be noted that it includes mainly old vehicles (see Table 1). These data are probably enough to draw a first sketch of the complex scenario we are dealing with. The city is covered by a 254 km bus network and is served by one of the oldest bus fleets in Italy. More than 50% of the fleet, in fact, belongs to the class Euro 0 (busses built from 1992) and class Euro 1 (busses built from the 1995). The city has a good distribution of bus stations (14,2 stations/km^2 – above the 15 Italian biggest cities average) but the offer (2.034 seating capacity per km per inhabitants) is broadly under the Italian average (about 2.700). According to official AMAT's data, the bus fleet actually on duty is only the 51% of the whole stock (in the 2010 only 287 busses circulated among 560 available), despite the number of passengers in the 2010 increased by +18% compared with the previous year.

Table 1 – Public Transport average speed and private vehicle density [ISTAT 2015]

	ROME	MILAN	NAPLES	TURIN	PALERMO	GENOVA
Public Transport average speed (km/h)	15,1	16,8	12,4	16,8	13	17
Cars per 1000 inhabitants	613	510	544	619	567	460
Euro 6 cars	2,60%	3,30%	1,15%	8,30%	1,90%	2,80%
Euro 5 cars	23,40%	26,80%	10,30%	24,70%	15,20%	24%
Less than euro 4 cars	74%	70%	88,50%	67%	83%	76%

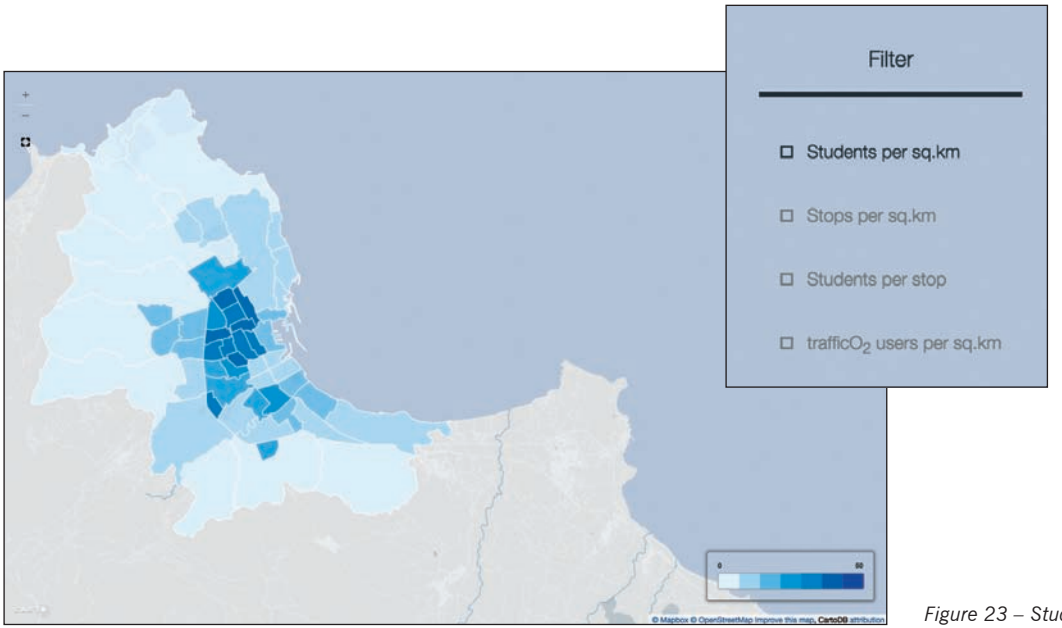


Figure 23 – Students distribution

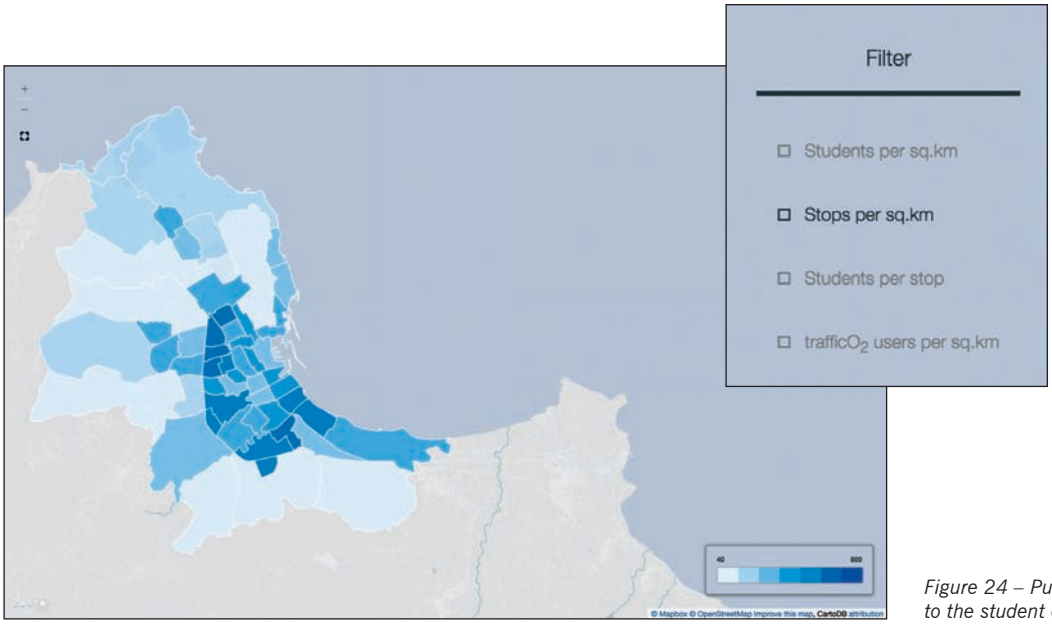


Figure 24 – Public transport offer to the student community

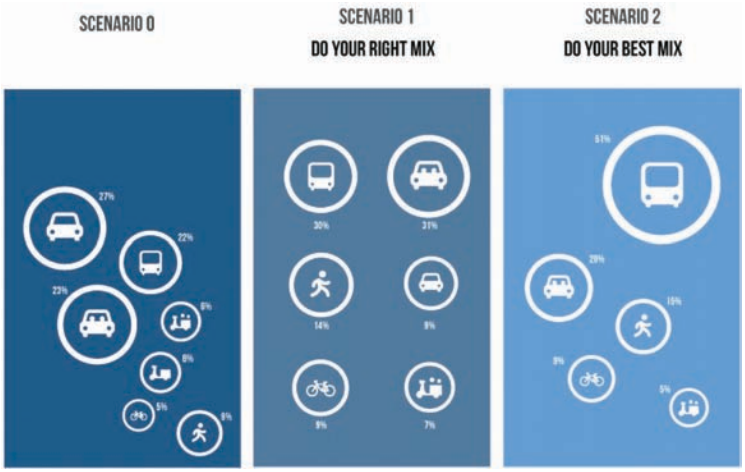


Figure 26 – University community's modal split improvement simulations

These two different scenarios, in fact, can help us to qualitatively measure the effectiveness of the whole system in terms of mobility behavioural changes.

3.2.5. Field Tests

To test the assumptions TrafficO2 application was tested four times in the city of Palermo with the participation of the students from the University in what was called "SUV Challenges", where the acronym stands for Sustainable Urban Values.
The selected sample, although it is not representative if related to the total number of students of the University residing in the urban area (about 25,000), still displays some interesting features allowing us to detect specific habits and behaviors connected to urban mobility.
The sample was divided into five categories, depending on the daily one-way length for getting to the University sites. These distances were obtained by means of a simple © Google map analysis.
The first test, from May to June 2014, was conducted mainly for the definition and validation of the analysis model, the second one, from November to December 2014, for the implementation of new features in response to the first testers' feedback.
In the third test, from April to May 2015, the app had all the features and it represents the most relevant application of the game.
Once the game was completely tested, it was possible to test the real value of the incentives and the gifts provided to the users by removing them. During the last test, from June to July 2015, moreover it was possible to highlight the role played by communication activities on social networks and on field to better understand the "cost" of user acquisition.

Figure 27 – S.U.V. Challenge badge for the students' community testers

To obtain a result not contaminated from previous activities, the experimentation was also extended to the city of Milan, keeping university students as main target of the social communication campaign.

First Test

Although the first version of the app provided only two systems of mobility (on foot and by bike), thanks to game dynamics and to the fact that real prizes could be won, the first test yielded encouraging results. As shown in Table 3, starting from a sample of 77 testers almost a third of them were active users (they used the app at least 4 times for Home-to-Work trips during the test). As it is possible to see from Figure 28 students living in 10 km radius from the university departments mainly made the sample.

Table 3 – Results of first test of the service (from May to June 2013)

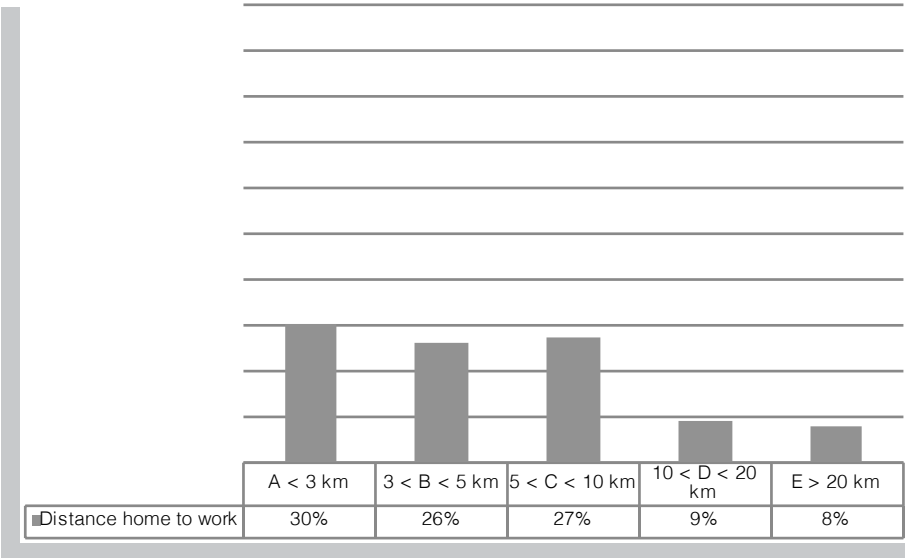
▪ Sample	77
▪ Active users	22
▪ Local Business	12
▪ Rewards (value in euro)	450
▪ Tracks	306
▪ Tracks Home to Work and vice versa	32,35%
▪ Total km	678
▪ Time spent on the app (in minutes)	7.326
▪ Active user redemption	28,57%
▪ Avarage routes per active user	13,91
▪ Avarage km per active user	30,82

In terms of CO_2 emissions, the game active users' performances reached an improvement of almost the 70% for the group of user subdivided in the B class, (Figure 26). The desirable change seems indeed to be possible.

Second Test

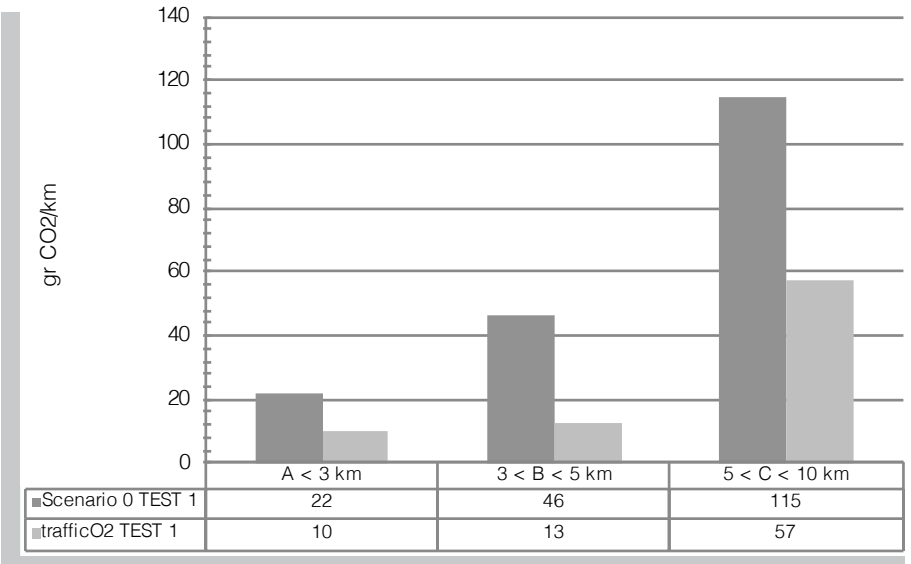
The second round of tests was performed on a larger number of testers, 128 active users with more than 400 trips home-to-work (Table 4), and vehicle pooling was introduced as additional system of mobility. Also, data shows that the app is especially used in the user's spare time, in so highlighting that the users' appreciation for this new experience, for the gaming dynamics, and for the engagement with the companies. As shown in figure 30 the large part of the sample still lived in the urban area very closed to the university departments.In comparison with the previous test, this second SUV Challenge provided to the sample incentives and rewards for about 4.500 €.

Figure 28. –First test sample's distribution



	A < 3 km	3 < B < 5 km	5 < C < 10 km	10 < D < 20 km	E > 20 km
Distance home to work	30%	26%	27%	9%	8%

Figure 29 – University community's CO_2 reduction during the first TrafficO_2 test



	A < 3 km	3 < B < 5 km	5 < C < 10 km
Scenario 0 TEST 1	22	46	115
trafficO2 TEST 1	10	13	57

▪ Sample	245
▪ Active users	128
▪ Local Business	78
▪ Rewards (value in euro)	4500
▪ Tracks	3988
▪ Tracks Home to Work and vice versa	11,13%
▪ Total km	7473
▪ Time spent on the app (in minutes)	80.728
▪ Active user redemption	52,24%
▪ Avarage routes per active user	31,16
▪ Avarage km per active user	58,38

Table 4 – Second test of the service (from November to December 2014)

The performance results of the sample taken for this test are in line with the previous results obtained as it's shown in Figure 32. Referencing to the route home-to-university the data analyzed shows that the sustainable mobility performance of the active users' sample has improved of the 30% reducing CO_2 emissions in the atmosphere of about 30 kg.

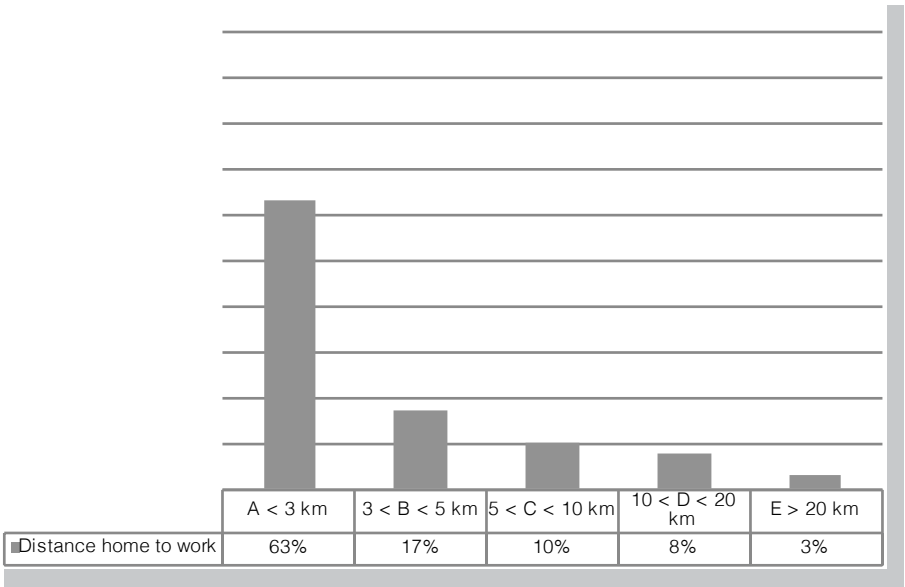


Figure 30 – Second test sample's distribution

Figure 31 – Tracks per day during the second test

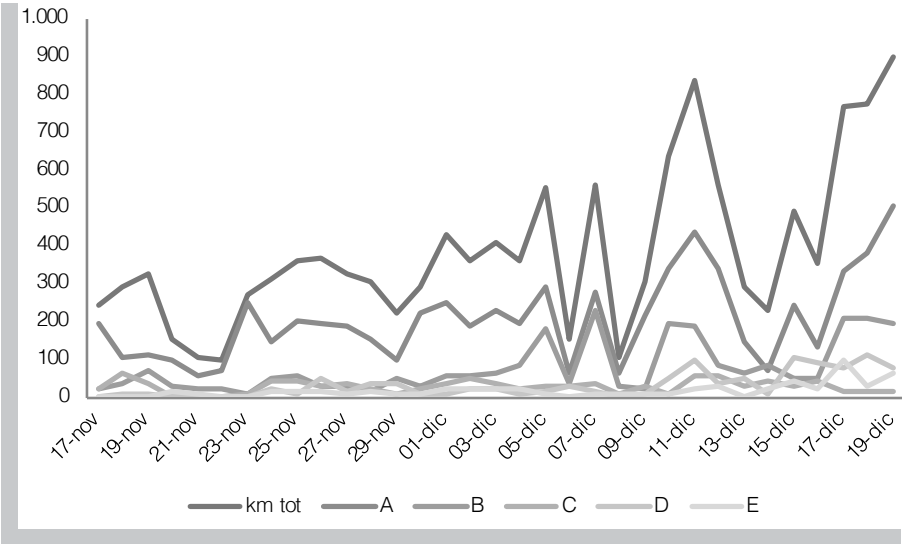
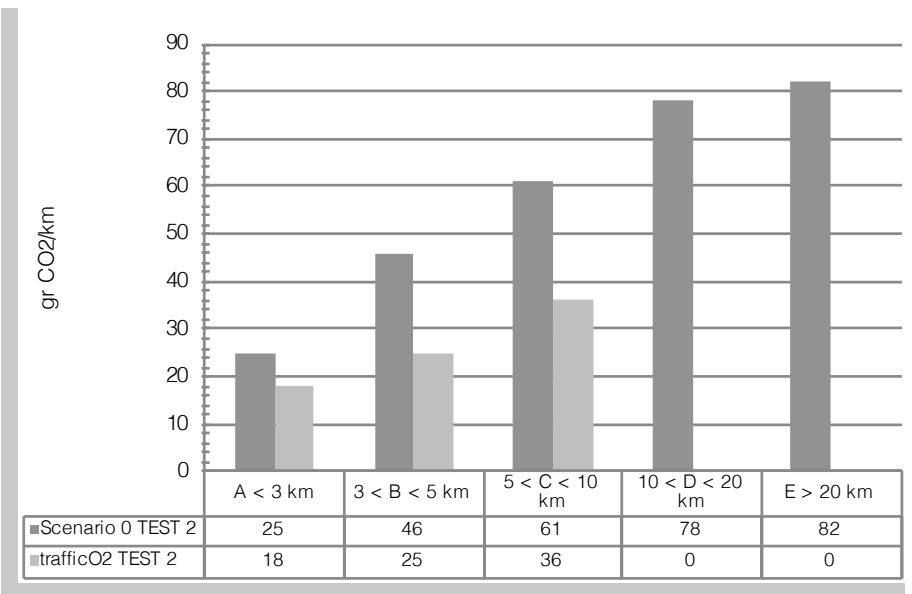


Figure 32. University community's CO_2 reduction during the second TrafficO_2 test



	A < 3 km	3 < B < 5 km	5 < C < 10 km	10 < D < 20 km	E > 20 km
Scenario 0 TEST 2	25	46	61	78	82
trafficO2 TEST 2	18	25	36	0	0

4. L'APPROCCIO 'LEGGERO' NEL PROGETTO DELLE POLITICHE URBANE

4

I due progetti trattati nel capitolo precedente mostrano dinamiche differenti ma, ex-post, sembrano condividere qualcosa in comune.
Obiettivo di questo ultimo capitolo è di associare al dominio della pianificazione urbana sostenibile le proprietà e i metodi propri del *"lean thinking"*.
La connessione fondamentale rintracciata tra questi differenti quadri concettuali è essenzialmente legata alla caratteristica di urgenza, efficacia e qualità: un approccio per creare valore ed eliminare gli sprechi in contesti estremamente complessi.
La teoria *"lean"* nata in ambito industriale manifatturiero *(lean manifacturing)*, è stata poi adattata alla gestione di imprese *(lean management)* e nel campo dell'innovazione tecnologica e dei servizi digitali *(lean startup)*.
Sono già diversi i tentativi di applicare il *Lean Thinking* al dominio della pianificazione urbana, partendo dal disegno alla scala urbana (Paolo Soleri – *Lean Linear City*), ai più ambiziosi spunti per connetterlo alle dinamiche dei processi urbani (Andres Duany – *Lean Urbanism*) per arrivare alle applicazioni che più condensano i suoi principi, più simili queste a *"performance"* urbane che a strategie *(Tactical Urbanism)*.
Di seguito è presentata la teoria generale del *Lean Thinking*, le sue applicazioni nei diversi domini e il ruolo che sta giocando nel dibattito sulle politiche urbane.
A seguire, attraverso l'esplorazione delle due ricerche applicate, lo studio mostra le caratteristiche generali dei due progetti in relazione con i "princìpi *lean*" e offre un'astrazione capace di adattare l'approccio lean alla progettazione di politiche urbane sostenibili.
Le "logiche *lean*" rispondono in modo chiaro al bisogno di "circolarità" per le politiche urbane e i processi di innovazione sociale e inoltre aggiornano il ruolo di progettisti, urbanisti e *policy makers* a manager dell'habitat umano.
Inoltre, le nuove tecnologie dell'informazione oggi consentono di comprendere meglio le istanze delle comunità e contestualmente offrono la possibilità di attivare con esse un dialogo più inclusivo e costruttivo.
Questa nuova opportunità spinge i progettisti di soluzioni per la sostenibilità urbana a diventare veri e propri esperti di *'citizen-experience'* (CX – prendendo in prestito dal mondo della progettazione digitale *user-experience* UX). Il progetto di una esperienza "aumentata" della città, infatti, non richiede grossi investimenti e può consentire di raggiungere due obiettivi: innescare processi per valorizzare la vita delle comunità e, contemporaneamente, ridurre l'impatto dell'organismo urbano sull'ambiente.

Previous page:
"TrafficO_2" co-design workshop (photo @Luca Savettiere)

4.1. Lean Thinking

«How can performance be improved? Sweat and longer hours are not the answer but will be employed if no one knows how to work smarter.»

James P. Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Productivity Press, Portland

The term was first coined by John Krafcik in his 1988 article [Krafcik, 1988] based on his master's thesis at the MIT Sloan School of Management. The concept of 'lean' became worldwide known because of the work of Womack, Jones and Roos [Womack, 1990] where they describe the working philosophy and practices of the Japanese vehicle manufacturers and the Toyota Production System (TPS). More specifically, it was observed that the overall philosophy provided a focused approach for continuous process improvement and the targeting of a variety of tools and methods to bring about such improvements. Effectively, the philosophy involves eliminating waste and unnecessary actions and linking all the steps that create value.

4.1.1. Five key principles

In 1996 the initial concept of lean was more extensively defined and described by five key principles [Womack and Jones, 1996]:

1. ***Specify value*** – Define value precisely from the perspective of the end customer in terms of the specific product with specific capabilities offered at a specific time.
2. ***Identify value streams*** – Identify the entire value stream for each product or product family and eliminate waste.
3. ***Make value flow*** – Make the remaining value creating steps flow.
4. ***Let the customer pull value*** – Design and provide what the customer wants only when the customer wants it.
5. ***Pursue perfection*** – Strive for perfection by continually removing successive layers of waste as they are uncovered.

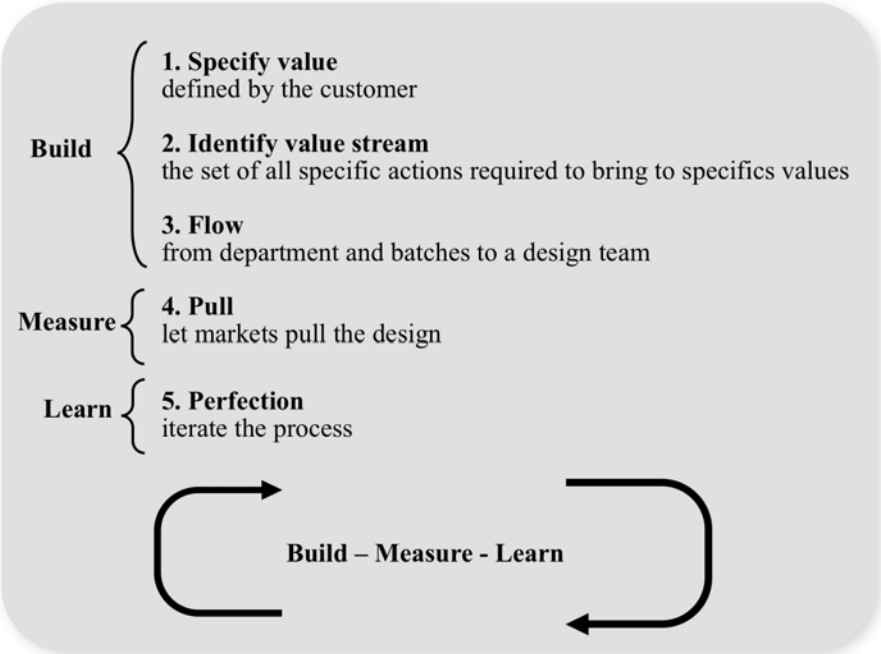


Figure 1 – Lean thinking approach

In order to introduce lean thinking within manufacturing environments the philosophy relies on the identification and elimination of waste and it is this fundamental aspect, which must first be understood, in order to effectively target and apply the various lean tools. In general lean transformations employ techniques such as Kaizen [Imai, 1986], SMED [Shingo, 1996], Six Sigma [Pyzdek, 2003], value stream mapping [Hines and Rich, 1997] and the five 'S's [Warwood and Knowles, 2004] in order to remove waste and deliver improvements in specific areas. However, it is the fundamental understanding of waste that is critical to successful lean transformation.

4.1.2. Seven wastes

Within the context of manufacturing systems there exist seven types of waste. These were first identified by Ohno of Toyota and reported by Womack and Jones. The seven wastes include:

1. ***Overproduction*** – Occurs when operations continue after they should have ceased. This results in an excess of products, products being made too early and increased inventory.

2. ***Waiting*** – Sometimes referred to as queuing and occurs when there are periods of inactivity in a downstream process because an upstream activity has not delivered on time. Sometimes idle downstream processes are used for activities that either do not add value or result in overproduction.

3. ***Transport*** – Unnecessary motion or movement of materials, such as work in progress (WIP) being transported from one operation to another. In general transport should be minimised as it adds time to the process during which no value is added and handling damage can occur.

4. ***Extra processing*** – Extra operations such as rework, reprocessing, handling or storage that occur because of defects, overproduction or excess inventory.

5. ***Inventory*** – All inventory that is not directly required to fulfil current customer orders. Inventory includes raw materials, work-in-progress and finished goods. Inventory all requires additional handling and space. Its presence can also significantly increase extra processing.

6. ***Motion*** – Refers to the extra steps taken by employees and equipment to accommodate inefficient layout, defects, reprocessing, overproduction or excess inventory. Motion takes time and adds no value to the product or service.

7. ***Defects*** – Finished goods or services that do not conform to the specification or customer's expectation, thus causing customer dissatisfaction.

In addition to these seven deadly wastes, Womack and Jones identified an eighth category. This relates to the underutilisation of people and in particular their ideas and creative input for improving the processes and practices.

4.1.3. The application of lean thinking

Over the last decade the principles of lean have been extensively applied to manufacturing operations and production environments in not only the automotive [Kochan, 1998] and aerospace industries [Brown et Al., 2003] but increasingly many small to medium-sized manufacturing organisations [Achanga et Al., 2004] and the construction industry [Pheng and Fang, 2005]. The relative success and commercial benefits of lean thinking include a focused enterprise-wide approach to continuous improvement, increased productivity, improved quality and improved management. As a consequence, both academia and industry are beginning to investigate the application of the lean philosophy beyond the primary manufacturing system. This includes what can be thought of as secondary and supportive processes for manufacturing, production processes beyond the traditional manufacturing and physical products, and also other aspects of the business, such as administrative processes. Hicks [Hicks, 2007] describes the application of lean to the software development

process in order to improve quality and build in a continuous improvement cycle. The study defines waste, the principal contributors to value, the process for allowing customers to pull demand and product optimisation. Eric Ries investigate the application of lean to the product introduction process and propose the key activities, tools and techniques that constitute the lean startup processes [Ries, 2011].

4.1.4. The Minimum Viable Product

During the last years another concept was added to the Lean Thinking theory. It is called MVP and means Minimum Viable Product.
It has just those core features that allow the product to be deployed, and no more. The product is typically deployed to a subset of possible customers, such as early adopters that are thought to be more forgiving, more likely to give feedback, and able to grasp a product vision from an early prototype or marketing information. It is a strategy targeted at avoiding building products that customers do not want, that seeks to maximize the information learned about the customer per dollar spent. «The minimum viable product is that version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort.» The definition's use of the words maximum and minimum means it is decidedly not formulaic. It requires judgment to figure out, for any given context, what MVP makes sense. An MVP is not a minimal product, it is a strategy and process directed toward making and selling a product to customers. It is an iterative process of idea generation, prototyping, presentation, data collection, analysis and learning. One seeks to minimize the total time spent on an iteration. The process is iterated until a desirable product/market fit is obtained, or until the product is deemed to be non-viable. The purposes to build a MVP is:

- Be able to test a product hypothesis with minimal resources
- Accelerate learning
- Reduce wasted engineering hours
- Get the product to early customers as soon as possible

Steve Blank, a silicon valley serial entrepreneur and consulting associate professor of entrepreneurship at Stanford, typically refers to minimum viable product as minimum feature set. He said: «You're selling the vision and delivering the minimum feature set to visionaries, not everyone.»

4.1.5. The Lean Startup

Lean startup is a method for developing businesses and products first proposed in 2011 by Eric Ries. Based on his previous experience working in several U.S. startups, Ries claims that startups can shorten their product development cycles by adopting a combination of business-hypothesis-driven experimentation, iterative product releases, and what he calls "validated learning".

4.3.3. The principles of Lean Urban Policies Design

1. Specify value

The starting point is to recognize that only a small fraction of the total time and effort in urban policies design actually adds value for the citizen. By clearly defining Value for a specific product or service from the citizen's perspective, all the non value activities – or waste – can be targeted for removal.

Of course "values" changes from place to place and they depend on what objectives politicians want to address for their citizens.

The definition of the value is a strategic choice.

2. Identify value stream

The Value Stream is the entire set of activities across all the stakeholders (private and public) involved in jointly delivering the product or the service. This represents the end-to-end process that delivers the value to the citizens and in this crucial step the energy efficiency of the system and the environmental sustainability must be considered.

The need here is to find the best stream of value to make the citizen happy and the city better. This step needs a special effort because it asks to rethink the tools that are generally used to accomplish the planning goal.

3. Flow

Typically after the Value Stream is mapped it takes out that really few activities add real value to the citizens. Eliminating this waste ensures that the product or service "flows" to the customer without any interruption, detour or waiting. Typically most of the waste is eliminated after a deep rethinking of the internal processes, transforming the urban design structure from department and batches to a design team. This is, actually, the point where the research of Andres Duany defined new possible strategy to make "change and development in our cities" happen in a sustainable and viable way.

4. Pull

This is about understanding the citizen demand and then creating a process to respond to this.

In the market domain the MVP (Minimum Viable Product) comes for help. Its very lean structure, in fact, guarantees a small investment and a immediate feedback from the target.

Tactical Urbanism strategies represent a very effective way to "test" the cities' dynamics and understand if the city really need those services or urban transformations. Empirically, it would be a right way to face the city's issue if the city "pulls" the design.

5. Perfection
Build-Measure-Learn is a core part of the Lean Urban Design methodology. It is a loop process of turning ideas into urban policies proposals, measuring citizens reactions and behaviors, and then learn whether to persevere or pivot the idea; this process repeats over and over again.
The Build-Measure-Learn loop emphasizes speed as a critical ingredient to urban development.
This is a key point for our domain: each urban design project is a never ending process that planners have to follow and improve constantly.

4.3.4. Lean Urban Policies' Design research

To define the assumption in a simple phrase: Lean Urban Policies' Design is a values-centered way to design citizens-centered policies environmentally focused.
According to this study, in order to apply more sustainable policies in such contexts as marginal or even disadvantage areas, it results necessary to operate on every single urban process where energy and resources are involved, minimising the wastes and maximising the values to the citizens.
To build up effective proposals to face the urban issues, in fact, we designers, planners and policy makers should be ready to design urban solutions with both top-down and bottom-up approaches.
These two way of acting and transforming the city are apparently different but, as we tried to demonstrate, complementary to whole task of the planner [Ratti and Claudel, 2015].
In such complex domain each intervention, on each resources-values process, in fact, could trigger virtuous dynamics able to improve the whole strategic vision of the city future.
This planning path define a "circular" way of thinking, a never ending process to test, learn and than improve the urban conditions [Carta et Al., 2017].
This sort of "quality process" to improve a complex system is the reason why we believe that Lean Thinking methodology could be a useful tool able to face urban issues, at different scale and in different contexts, by creating tailored made effective and sustainable solutions.

Future research will explore how to integrate and eventually modify the different design instruments commonly used in *business-driven* lean projects, into a specific framework for *people&environment-driven* solutions.