

BDC

Università degli Studi di Napoli Federico II

18

numero 1 anno 2018



BDC

Università degli Studi di Napoli Federico II

18

numero 1 anno 2018

**Approaches and Tools
for Implementing
the Circular City Model**



BDC

Università degli Studi di Napoli Federico II

Via Toledo, 402
80134 Napoli
tel. + 39 081 2538659
fax + 39 081 2538649
e-mail info.bdc@unina.it
www.bdc.unina.it

Direttore responsabile: Luigi Fusco Girard
BDC - Bollettino del Centro Calza Bini - Università degli Studi di Napoli Federico II
Registrazione: Cancelleria del Tribunale di Napoli, n. 5144, 06.09.2000
BDC è pubblicato da FedOAPress (Federico II Open Access Press) e realizzato con Open Journal System

Print ISSN 1121-2918, electronic ISSN 2284-4732

Editor in chief

Luigi Fusco Girard, Department of Architecture,
University of Naples Federico II, Naples, Italy

Co-editors in chief

Maria Cerreta, Department of Architecture,
University of Naples Federico II, Naples, Italy
Pasquale De Toro, Department of Architecture,
University of Naples Federico II, Naples, Italy

Associate editor

Francesca Ferretti, Department of Architecture,
University of Naples Federico II, Naples, Italy

Editorial board

Antonio Acierno, Department of Architecture,
University of Naples Federico II, Naples, Italy
Luigi Biggiero, Department of Civil, Architectural
and Environmental Engineering, University of Naples
Federico II, Naples, Italy
Francesco Bruno, Department of Architecture,
University of Naples Federico II, Naples, Italy
Vito Cappiello, Department of Architecture,
University of Naples Federico II, Naples, Italy
Mario Coletta, Department of Architecture,
University of Naples Federico II, Naples, Italy
Teresa Colletta, Department of Architecture,
University of Naples Federico II, Naples, Italy
Ileana Corbi, Department of Structures for Engineering
and Architecture, University of Naples Federico II,
Naples, Italy
Livia D'Apuzzo, Department of Architecture,
University of Naples Federico II, Naples, Italy
Gianluigi de Martino, Department of Architecture,
University of Naples Federico II, Naples, Italy
Stefania De Medici, Department of Civil Engineering
and Architecture, University of Catania, Catania, Italy
Francesco Forte, Department of Architecture,
University of Naples Federico II, Naples, Italy
Rosa Anna Genovese, Department of Architecture,
University of Naples Federico II, Naples, Italy
Fabrizio Mangoni di Santo Stefano,
Department of Architecture, University of Naples
Federico II, Naples, Italy
Luca Pagano, Department of Civil, Architectural
and Environmental Engineering, University of Naples
Federico II, Naples, Italy
Stefania Palmentieri, Department of Political Sciences,
University of Naples Federico II, Naples, Italy
Luigi Picone, Department of Architecture, University
of Naples Federico II, Naples, Italy
Michelangelo Russo, Department of Architecture,
University of Naples Federico II, Naples, Italy
Salvatore Sessa, Department of Architecture,
University of Naples Federico II, Naples, Italy

Editorial staff

Mariarosaria Angrisano, **Martina Bosone**,
Antonia Gravagnuolo, **Silvia Iodice**,
Francesca Nocca, **Stefania Regalbuto**,
Interdepartmental Research Center in Urban Plannig
Alberto Calza Bini, University of Naples Federico II,
Naples, Italy

Scientific committee

Roberto Banchini, Ministry of Cultural Heritage
and Activities (MiBACT), Rome, Italy
Alfonso Barbarisi, School of Medicine, Second
University of Naples (SUN), Naples, Italy
Eugenie L. Birch, School of Design, University
of Pennsylvania, Philadelphia, United States of America
Roberto Camagni, Department of Building
Environment Science and Technology (BEST),
Polytechnic of Milan, Milan, Italy
Leonardo Casini, Research Centre for Appraisal
and Land Economics (Ce.S.E.T.), Florence, Italy
Rocco Curto, Department of Architecture and Design,
Polytechnic of Turin, Turin, Italy
Sasa Dobricic, University of Nova Gorica,
Nova Gorica, Slovenia
Maja Fredotovic, Faculty of Economics,
University of Split, Split, Croatia
Adriano Giannola, Department of Economics,
Management and Institutions, University of Naples
Federico II, Naples, Italy
Christer Gustafsson, Department of Art History,
Conservation, Uppsala University, Visby, Sweden
Emiko Kakiuchi, National Graduate Institute
for Policy Studies, Tokyo, Japan
Karima Kourtit, Department of Spatial Economics,
Free University, Amsterdam, The Netherlands
Mario Losasso, Department of Architecture,
University of Naples Federico II, Naples, Italy
Jean-Louis Luxen, Catholic University of Louvain,
Belgium
Andrea Masullo, Greenaccord Onlus, Rome, Italy
Alfonso Morvillo, Institute for Service Industry
Research (IRAT) - National Research Council of Italy
(CNR), Naples, Italy
Giuseppe Munda, Department of Economics and
Economic History, Universitat Autònoma de Barcelona,
Barcelona, Spain
Peter Nijkamp, Department of Spatial Economics,
Free University, Amsterdam, The Netherlands
Christian Ost, ICHEC Brussels Management School,
Ecaussinnes, Belgium
Donovan Rypkema, Heritage Strategies International,
Washington D.C., United States of America
Ana Pereira Roders, Department of the Built
Environment, Eindhoven University of Technology,
Eindhoven, The Netherlands
Joe Ravetz, School of Environment, Education
and Development, University of Manchester,
Manchester, United Kingdom
Paolo Stampacchia, Department of Economics,
Management, Institutions, University of Naples
Federico II, Naples, Italy
David Throsby, Department of Economics, Macquarie
University, Sydney, Australia



Indice/Index

- 7 Editorial
Luigi Fusco Girard
- 11 Circular city model and its implementation:
towards an integrated evaluation tool
Francesca Nocca, Luigi Fusco Girard
- 33 The implementation of circular economy model
for the Torre Annunziata waterfront
regeneration
*Mariarosaria Angrisano, Martina Bosone,
Sara Ravezzi, Valentina Ascione*
- 49 La pianificazione “antifragile” per il sistema
dei trasporti: l’applicazione del geodesign
come strumento operativo
Antonio Acierno, Gianluca Lanzi
- 71 La ricerca di un linguaggio per il piano
urbanistico comunale: il caso della Regione
Campania
Francesco Varone
- 91 Planning a Nation: the Jewish land from the
Sharon plan to Israel 2020
Gianluigi Freda
- 105 Resilienza e rigenerazione: l’approccio *water
sensitive urban planning* come strategia di
sostenibilità urbana
Alessandro Sgobbo
- 127 PLUS hub: a cultural process for Pisticci
regeneration (Matera, Italy)
Gaia Daldanise, Maria Cerreta

THE IMPLEMENTATION OF CIRCULAR ECONOMY MODEL FOR THE TORRE ANNUNZIATA WATERFRONT REGENERATION

Mariarosaria Angrisano, Martina Bosone, Sara Ravezzi, Valentina Ascione

Abstract

The aim of this paper is to study the “circular economy approach” to understand how to apply it for the regeneration of port areas.

The circular economy has the potential to help us make better decision about resource use, design out waste, provide benefit for business, and proceed along a secure route to society-wide prosperity and environmental sustainability for future regeneration (Ellen MacArthur Foundation, 2015).

Through the analysis of the some best practices, in this paper, a design exercise has been proposed for the Torre Annunziata port area regeneration, with the aim to activate new symbioses between the urbanized city and the waterfront.

Keywords: circular economy, waterfront regeneration

L'APPLICAZIONE DI UN MODELLO DI ECONOMIA CIRCOLARE PER LA RIGENERAZIONE DEL WATERFRONT DI TORRE ANNUNZIATA

Sommario

Lo scopo del presente contributo è analizzare l'approccio dell'economia circolare applicato alla pianificazione urbana, al fine di individuare strategie circolari per la rigenerazione delle aree portuali. Il modello di economia circolare permette di eliminare gli sprechi di risorse, di ridurre i rifiuti, di dare valore aggiunto al business, e di garantire sostenibilità ambientale e prosperità per le generazioni future (Ellen MacArthur Foundation, 2015).

Attraverso l'analisi di alcune buone pratiche, in questo paper è proposto un nuovo progetto per la rigenerazione dell'area portuale di Torre Annunziata, con l'obiettivo di attivare nuove simbiosi tra la città e il waterfront.

Parole chiave: economia circolare, rigenerazione del waterfront

1. Introduction

According to the Ellen MacArthur Foundation, the circular economy is a restorative and regenerative model, relying on system wide innovation. It aims to redefine products and services to design out waste, while minimising negative impacts. The circular model builds economic, natural and social capital (Ellen MacArthur Foundation, 2015).

Pearce and Turner first raised the concept of a circular economy (CE) (Pearce and Turner, 1990). They asserted that the traditional economy was not opened to recycle, so the environment was considered as a waste reservoir.

The concept of “circular economy” has its roots in the industrial environment (Rizos *et al.*, 2015). The circular economy model can be defined as “restructuring the industrial systems to support ecosystems through the adoption of methods to maximize the efficient use of resources by recycling and minimizing emissions and waste” (Preston, 2012).

But a circular economy model is capable to go beyond waste prevention and waste reduction to inspire technological, organizational, and social innovation throughout the value chain in order to “design out” waste from the beginning, rather than relying solely on waste recycling at the end of the chain (Ellen MacArthur Foundation, 2015; Rizos *et al.*, 2015).

This new economy has the aim to redefine growth, design out waste and pollution, keep products and materials in use and regenerate the natural systems (www.ellenmacarthurfoundation.org).

It is also possible to say that circularization processes and synergies, which promote resilience and creativity and then sustainability (Fusco Girard, 2010) should be transferred from a sectoral approach (waste management, etc.) to the whole organization of the city, its economy, its social system, its governance (Fusco Girard *et al.*, 2014) to improve the urban productivity (Fusco Girard, 2013).

Analysing literature, there are four main principles of the circular economy model that we could summarize:

1. considering the reuse from the design stage to minimize waste;
2. using renewable sources of energy and materials;
3. studying feedback loops within the system to optimize the production system as a whole;
4. maximizing the usage value of products through sharing them among users and prolonging their life through the reuse, maintenance and repair (Ellen MacArthur Foundation, 2015; Rizos *et al.*, 2015; Stegeman, 2015).

In the “New Urban Agenda”, the circular economy model is considered a fundamental strategy to manage the resources like land, water, energy, materials and food. It can be useful to solve the problems tied to the emission of greenhouse gases and air pollutants. It is very important to evaluate the environmental impact and the sustainability of the new project and that strives to transition to a circular economy while facilitating ecosystem conservation, regeneration, restoration and resilience in the face of new and emerging challenges (United Nations, 2016).

In this paper, we have focused our attention on the regeneration of the port cities, trying to understand how circular economy principles are applied.

Ports are the nodal points connecting Europe, Asia, Australia and America in a mutual cooperative and competitive process, aimed at improving the benefits of their strategic

localization. In fact, ports are a driving force of economic wealth, since in ports are localized commercial, industrial, logistic, tourist and fishing activities (Fusco Girard, 2013).

As seaport areas and coastal cities have significant potential for industrial projects, they have a particular development potential. At the same time, they should pay attention to pollution prevention, resources and waste management, and minimizing environmental costs in order to enhance seaport sustainable development and competitiveness (Ezzat, 2016).

Nowadays port areas are the places where different problems develop; one of the most relevant is related to pollution. Around 90% of world trade in terms of volume is transported by sea, which is why port cities can be considered the gateway to globalisation (Jung, 2011). On the other side, port areas contribute to climate change and chemical pollution. Furthermore, a big quantity of waste and biomass resources is produced in port areas. Industrial activities, present in the ports, they are producers of different materials, like metals, sewage, sludge, building materials, biofuels, fertilizers, food waste and many others. Therefore, the recovery of raw materials through recycling, the recourse of new renewable sources, the production of biofuels and biochemical represent the new economy of the ports. In this new economy, products are considered services.

Seaports throughout Europe are realising their potential and several have set out visions for their transition to the circular economy. The bio-based economy is already emerging in a number of ports, and the many initiatives to support this development include the introduction of wind and solar power and the production of biomass and waste-based energy production (ESPO, 2016). Several European ports have already engaged in the circular economy process through regional initiatives and strategies.

There are many port cities in the world that invested in the circular economy for the reorganization of their port areas.

About this, in this paper we have focused our attention on the case studies of Amsterdam, Rotterdam and Copenhagen.

The aim of this paper is to report a practice design exercise, developed as Master's thesis (Master in sustainable planning and design of port areas). We have tried to apply the principles of the circular economy for the regeneration of Torre Annunziata port area.

Through the analysis of the circular economy literature and the analysis of the most recent applications in some cities, we propose new functions for the waterfront.

2. Circular port cities

The approach of the circular economy in Amsterdam is based on some different principles: all the materials enter into an infinite technical or biological cycle; energy comes from renewable sources; resources are used to generate value (financial or other kind of value); modular and flexible design of products and production chains increase adaptability of systems (Klaske, 2015). New business models for production, distribution and consumption enable the shift from possession of goods to (use of) services (Klaske, 2015). The logistics systems shift to more region oriented services with reverse-logistics capabilities, and human activities positively contribute to ecosystems, ecosystem services and the reconstruction of "natural capital" (Klaske, 2015).

Moreover, the port of Amsterdam represents an important port cluster in Europe. All the docks are equipped for sustainable energy supply. For the future, the aims are to make the

port always smarter, faster and cleaner.

About the energy sector, the use of LED lighting in the port of Amsterdam is a good innovation for giving shape to sustainability targets, for the port and its customers. Energy savings are around 60% vis-à-vis existing lighting solutions, also thanks to the dimmable light fixtures. Moreover, the white light increases safety, which in turn improves working conditions. There is an environmental benefit too, as the light is less diffused (Port of Amsterdam, 2017).

The port of Rotterdam has proposed the Port Vision 2030 according to the circular economy principles. The port invests in some priority sectors: buildings and urban development, cleantech maritime cluster, feeding, medical cluster. They represent the economic pillars on which Rotterdam intends to develop the circular economy. Within these clusters, priority material flows and partners were analysed to identify opportunities for a city's circular economy (Gemeente Rotterdam, 2016).

The symbioses between the industries are relevant thanks to district heating using the residual heat produced by the industrial complex reducing the greenhouse gas emission.

There are two heating networks in the city that conduct heat in the urban area thanks to two incineration plants near Rotterdam that give heats at 160,000 homes, hospitals, swimming pools and offices. Furthermore this incineration plant converts 1,7 million tons of residual urban waste from industries and urban activities.

The recourse at the green roofs and the rain way is a good example in Rotterdam. Nowadays in this city, there are 100,000 square meters of green roofs in the urban area (Gemeente Rotterdam, 2016). The Port Authority invests also in the use of photovoltaic panels for all the activities present within the port. This also happens for electrical mobility, to reduce the CO₂ emissions in the port area.

The port of Copenhagen invests in the circular economy to reduce the environmental impacts generated by the cruise ships. The port authority has recognized four elements in which investing to safeguard the environment: the ship-waste, port waste management, biogas plant. Ship power supply is used to set up the model in a closed loop (Karimpour, 2017). Based on the model, the port authority will take care of waste management from cruise ships to use the waste in a port-owned biogas plant. The port-owned biogas plant produces clean electricity from ship waste while to some extent contributes to port energy security (Karimpour, 2017).

Finally, the produced clean electricity within this model will be consumed in port for shore supply to ships or for other purposes like port buildings. Through this model, the ship-generated waste will gain benefit and given back in terms of energy, to close the loop based on the circular economy approach (Karimpour, 2017).

From this analysis, it is clear that the smart sustainable development of port areas/cities should be shaped on the basis of three principles for the regeneration of city wealth:

- the synergy principle (between different actors/institutions and systems like the socio-cultural and economic system etc.);
- the circularization principle (re-use, recycle, regenerate, in analogy to a natural system organization);
- the creativity principle (introducing novel changes) (Fusco Girard, 2013).

Therefore, a port would be a good location for value added activities (Kuipers *et al.*, 2015). An important factor to eventually reach the point of a complete circular economy is innovative solutions for new product design. Therefore a lot of research and development

must be done. A port authority could stimulate promising start-ups to trigger innovation. In the long term, the global closed loops could be more regional and then ports should search for new solutions for continuation (Kuipers *et al.*, 2015).

After the analysis of literature, the design exercise for the regeneration of Torre Annunziata waterfront starts with the identification of the present businesses along the port area/waterfront that contribute to the city economy. At the same time we analysed cultural and landscape/environmental resources of the area. Through this investigation, we identified new functions to re-design the port area towards circularity.

3. The knowledge of the territory

Torre Annunziata is a municipality of 42,406 inhabitants, which is geographically situated in the metropolitan area of Naples on the Vesuvius coast, in equidistant position among Naples and Sorrento (Tutta Italia, 2018).

The Port of Torre Annunziata is one of the most important harbours of the Campania Region, the fourth after the ports of Naples, Salerno and Castellammare di Stabia and the third one for manipulations after Naples and Salerno (Porti d'Italia, 2018). In Roman epoch the city was called "Oplontis", a suburb of Pompeii considered a summer residence of the Roman patricians, an ideal stay for thermal cares. Around the year 1000, some populations settled near the mouth of the Sarno River engaged in the fishing and in the trade of wheat. The period of maximum expansion for the port coincides with the end of the second World War, when in Italy began an intense industrialization of the port areas (Angrisano and Fusco Girard, 2017). In the 70s it increased the traffic of cereals, bitumen, wood trunks (coming from Africa, Indonesia and American forests) and iron. An important activity developed in the past, still today present, is the "wheat industry", whose establishments were installed along the port (Gravagnuolo and Angrisano, 2013).

In the XIX century iron, metal complexes and chemical industries were located in the port area.

The 80s see the definitive closing of the industries located on the waterfront of Torre Annunziata, leaving the area under conditions of notable degradation. This situation through the years has favoured illegality and transformed the port in a zone of illegal activities (Angrisano and Fusco Girard, 2017).

In the past years, the port was served from a maritime station of the State Railroads, made up by nine platforms and a storage area. There were besides two platforms that continued over the station up to the east dock to directly allow the transport of the commodities from ships to trains.

Today the traffic is limited to ships that transport wheat to the silos of Solacem Company. The waterfront is perceived by now as a space without identity, in which there are abandoned areas, stores, neglected factories, mixed productive activities and residential units. Today the Port has a commercial vocation, like shipbuilding industry, fishing and recreational activities.

Along the waterfront there are economic/productive, cultural and environmental resources (Tab. 1).

About the companies of relief inside the Port of Torre Annunziata, there are the Solacem and the Isecold of the Rocco group, working in the international commerce of agri-food products. The wheat storage company extends on a surface of 20,000 sqm with a dock 260 m long and 40 m wide with a draught of 8.60 m. The annual movement of commodities

passed through the fittings and the deposits of the Solacem have touched points of over 500,000 t, firmly attesting around 450,000 t/year (SRM, 2015).

Tab. 1 – The territorial resources of Torre Annunziata

Economic/productive resources	Cultural resources	Landscape/ Environmental Resources
Fish market	Villa of Oplonti (Unesco site)	Sorrento peninsula
Storage of oil tankers ships	Thermal establishment	Capri Island
Nautical club	Historic villas	National Park of the
Berths	The Bourbon bridge	Vesuvius
Silos for storage of cereals	Ancient churches	
Petrochemical industry	Royal weapons factory	
Maritime district offices		
Shipyards		
Pasta factories		

Behind the silos there are three sheds composed by seven metallic compartments completely refrigerated, for a total surface of 6,500 sqm, equal to 65,000 cbm, for the deposit of particular types of commodity such as feed food, sugar, cellulose, fruit and perishable products.

Isecold (Industry Services Commerce Liquid and Derived Oils) is a society of “Services to the Oil and Petrochemical industry”. It occupies 15,000 sqm in the port area, actives in the sector of the unloading movements of oil and petrochemical products and concessionaire of a coastal deposit. The area is directly connected to the West dock through a submarine pipe, employed to the movement of the petrochemical goods that now involves the transit of over 350,000 tons of gas-oil in one year on behalf of the Spanish oil society Repsol. The deposit is used for the storage and the movement of gas-oils of the Italian Branch of the Spanish multinational “Repsol YPF” (Isecold, 2018).

The port area is 3.5 km distant from the Pompeii archaeological area, and 800 m from the roman “Villa Oplontis”. However, the connecting itinerary with this cultural heritage is in conditions of abandonment and degradation.

4. The definition of strategies and planning choices

After the analysis of the port area context, of its cultural, landscape and economic resources, many positive characteristic of the territory emerged, but also some critical issues. Among these, the fragmentation of the industrial activities is a serious problem, because there is a physical barrier among the port and the historic centre. Moreover, the presence of the railway that divides a part of the waterfront from the city. Wheat silos, illegal buildings, small size of urban green areas, make the area scarcely comfortable and liveable.

Therefore, key aims of the planning project have been defined:

- to valorise the cultural and the natural capital;
- to recover the abandoned areas;

- to enhance the economic activities (§2);
- to encourage the new productive activities;
- to connect the sea with the archaeological areas.

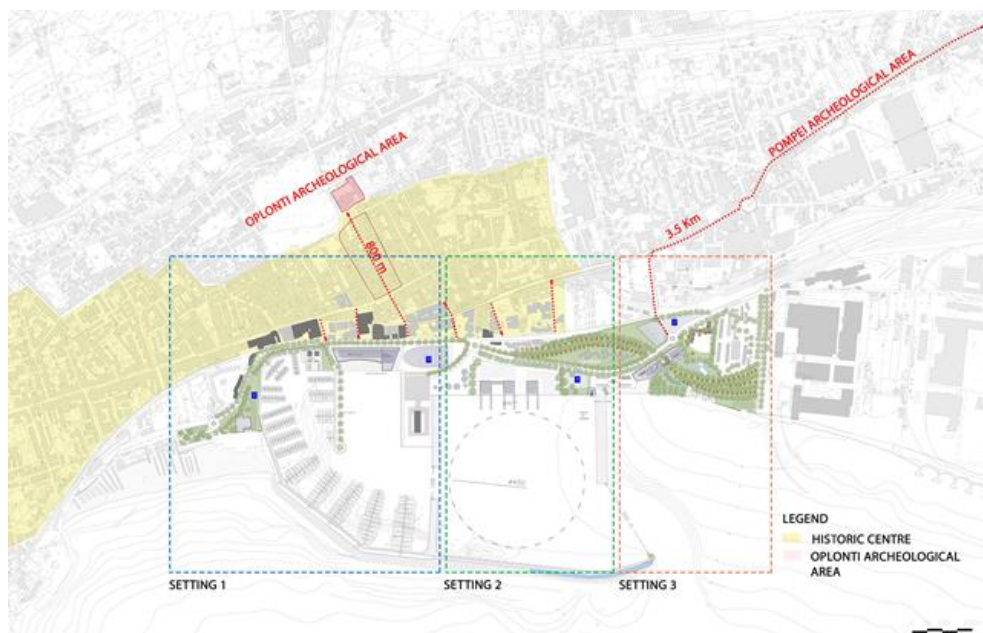
In this perspective, the presence of 19,049 sqm of disposed areas inside the port could represent a great opportunity to maximize these objectives.

The actions to realize this project are also studied through the analysis of urban planning tools prepared by the municipality. Therefore, it seems necessary to proceed with:

1. the reorganization of space and relocation of functions;
2. the improvement of port area accessibility and permeability, by replacing the small sidewalks with a big pedestrian-cycle;
3. the organisation of new services connected with port facilities;
4. the redesign of waterfront provision of urban services;
5. the implementation and connection of the public green with urban elements;
6. the reclamation of affected areas;
7. the reduction of the energy consumption;
8. the reuse of the urban waste and the reshaping the breakwater.

According to these actions, the new functions for the port areas have been inserted in different “setting areas”, according to the features of the existing industrial activities and the morphology of the docks (Fig. 1).

Fig. 1 – The Torre Annunziata waterfront project



Setting One is “the tourist port”, where we designed: 1,119 boat spaces, a slipway, some services for boaters, an area for the port authority and the executive offices, a parking for boaters, a fishing area with 25 fishing boat, a fish market with cargo storage area and auctioning, a wholesale and retail sale and dining area, with parking for suppliers and buyers, a sailing school for sailing sports and rowing activities (Angrisano and Fusco Girard, 2017).

Setting Two is the “Commercial port”, with an area dedicated to the Silos for the storage of grain of Solacem, another area for the storage and handling of diesel oil for Isecold, an area for shipyards with warehouses and wharves and a dock for bunkering (Angrisano and Fusco Girard, 2017).

Setting Three is the “Cruise Port”, divided into different functions as a dock for the cruise ships, the cruise terminal, an area for widespread receptivity, a food and wine pole, a wharf, a composting centre, a logistic hub, an uncovered parking space, trails and green areas, a new road.

5. The circular economy in the project

During the definition of the new master plan functions, some strategies have been defined to make the new project “sustainable”, according to the principles of the circular economy and through the best practices analysed previously (§2).

The idea is to planning an “ecosystem port”, where all the new activities collaborate with each other and share resources.

Assumption that the “circular processes” should be characterized by the reinforcement of the relationships among the single forms of capital (water, land, energy, man-made capital, financial capital, etc.), we have hypothesized a set of solutions to make the project sustainable, according to the best practices analysed in the previous chapter:

1. the use of sustainable lighting for the whole port area (Amsterdam best practice);
2. the electric mobility (Rotterdam best practice);
3. the electrification of the docks/ the use of cold ironing (Copenhagen best practice);
4. the greening of surfaces and roofs (Rotterdam best practice);
5. the use of photovoltaic panels (Rotterdam best practice);
6. the recovery and reuse of rainwater (Rotterdam best practice);
7. the management and recycling of waste, through the design of a composting plant (Copenhagen best practice);

Therefore, in the sector of “efficiency of public lightning”, we proposed the use of LED technology, in particular the use of 1,130 light points for the port area and the ways that drive to the archaeological sites, with a total saving of 135,374 €/year.

Considering the useful life of the two typologies of lamps and the necessity to reduce the maintenance of the LED lamps (a fifth or a sixth of the maintenance of the sodium), this data would be already enough to prefer the choice of LED solution. If we consider energy savings (761 kWh/year for each light) or the economic one (€ 119.8 for each light), the differences become remarkable.

As regards the “electric mobility”, both inside the port area and inside the area of the archaeological sites of Pompeii and Oplonti, an endowment of 20 electric shuttles of the type Piaggio Porter, glazed van Electric Power 1.8 t, has been hypothesized. Such electric traction vehicles in course of use have low consumption, in fact the electric traction has an efficiency 3-4 times superior to that of the thermal motor. The advantage is such to

compensate largely the losses that happen in phase of production and distribution of the electric energy. These losses are obviously much greater than the ones we have in the refinement and distribution of the liquid and gas fuels, but that are many redoubts, in the last decade, for the best efficiency of the national electric system.

The Association for Defended Orientation Consumers (ADOC) has calculated that using an electric car we can spend only alone € 3 to cover 160 km, that are around the maximum autonomy of a good electric vehicle (Idee Green, 2014).

To verify this data we have to consider the cost of electricity and the autonomy of the battery of the electric cars.

A car is able to accumulate 24 kWh to give an autonomy of 160 km, the cost/km will be of: $24:160 = 0.15 \text{ kWh/km}$, $3:24 = 0.125 \text{ €/kWh}$.

The unitary cost for one kilometre is: $0.125 \text{ €/kWh} \times 0.15 \text{ kWh/km} = 0.019 \text{ €/km}$. Some electric cars for example recover energy from brakes and this increases their autonomy diminishing the cost €/km (Gemelli, 2018).

Regarding the problem of power supply of the ships from the dock, in the project of Torre Annunziata Port, in particular of the cruise terminal, we have proposed to adopt the “cold ironing solution”, according to other positive experiences in this sector (Copenhagen). The Cold Ironing brings in the port the necessary electric power to guarantee the correct operation of the shipboard services maintaining the motors of the ship and so limiting the pollution that these produce.

The Cold Ironing answers therefore to the concrete necessity of safeguarding the environment. The cruise ships have important energetic demands, that can vary from 10 up to 20 MW of electric power disbursed to 11,000 Volts. A great cruise ship, in the Port for 10 hours, burns up to 20 tons of berthed fuel and it introduces 60 tons of carbonic anhydride in the atmosphere (Roncarolo, 2010).

About The Cold Ironing for the Torre Annunziata port, it is estimated that a hour of mooring of a cruise turned on ship dumps a quantity of CO₂ and heavy metals in the air equal to 50,000 cars to 130 km/h in highway. To solve this problem, the project foresees the electrification of the dock of the terminal cruise. A system of electric cables connected to cabins to earth and to a photovoltaic plant would allow a complete autonomy of the ship with auxiliary motors out. The photovoltaic plant, with an extension of 18,900 mq will guarantee 43% of the necessary energy compared with the energy required by a cruise that is berthed in the port (8,640,000 kWh/year) (Tab. 2).

A new method to capture the “sea energy” is proposed for the port. The project foresees the building of a port dike for the production of electric energy from the sea waves (Black, 2006). The wavy motion in front of the dock wall generates a fluctuation of pressure on the external superior mouth of the duct that causes in alternate phases the entrance and the exit of the water from the plant. The fluctuation brings to compress (crest of wave) and to decompress (cable of wave) the lung of air in the room of absorption and the flow of air produced makes to operate the turbine generator positioned in the superior part of the room, producing electric energy. This trial besides introduces clean water inside the port basin, strengthening the recycling of the water (Tab. 3).

For the use of “photovoltaic panels” in the port area, we studied a system able to give energy for 2,119 families, according to the energy requirement of a family per year: 3,300 kWh/year (Tab. 4). The use of clean energy source would allow a production of energy able to cover the 35% of the monthly energetic requirements, able to stoke the movement of

cruise ships of 300 meters with auxiliary motors out (1 ship/week in a time of berth equal to 1 day/ship) (Tab. 4)

Tab. 2 – The electrification of the cruise dock

Electrification of cruise dock	
Required energy by cruise ship during the mooring (1,300 m) for 4 days/month	8,640,000 (kWh/year)
Percentage of energy satisfied by renewable sources	43%
Cruise ship in mooring	8,640,000
Unload electric pumps (WC)	23,652
Lighting System	162,900
Lighthouse	24,273
Total required energy	8,850,825

Tab. 3 – The renewable energy project

Sources of renewable energy	Energy produced (kWh/year)
Energy required by cruise ship during the morning (length equal to 300 m) for 4 days/month	8,640,000
Unload electric pump (WC)	23,652
Lighting system	162,900
Lighthouse	24,273
Total required energy	8,850,825
Percentage of energy satisfied by sources of renewable energy	47 %

Tab. 4 – The photovoltaic plants

Buildings/areas used	Surface (sqm)	Number of panels	Energy produced (kWh)
Shipyards	4,700	2,765	395,616.2
Yacht club	2,300	1,353	193,587.24
Parking	501	294	42,065.52
Silos	8,000	4,706	454,489
Fish market	9,981	5,871	840,022.68
Food and wine polo	6,550	3,853	551,287.24
Terminal cruise	4,580	2,694	405,371.92
Logistic Hub	2,200	1,294	185,145.52
Total energy produced			3,067,585.32

We proposed a SEU system to produce electric energy, with power altogether not superior to 20 MW. With this system, it is possible to constitute a Society of Purpose that will be the responsible/titular subject of the plant of production. The investor can sell the energy produced to different clients, at a smaller price compared to market prices.

A rationalization in the use of the unreproducible resources is ensured, as well as the energetic provisioning drawn by renewable sources.

Another important action is the management of the water cycles. The separation of black waters (containing the unloading of the WC) and grey waters allows to recover these last ones. In this way, it is possible to treat with systems adoptable to the domestic restrooms and reuse them for the irrigation or for other purposes (WC, washing, etc.). Grey waters are purified much more easily than the black ones and they contain only 1/10 of the total nitrogen and less than half of the organic load in comparison with the black waters.

In our project, we have planned that the consumption of the water resource will be rationalized through the collection of meteoric water in 5 reserves (that allow to collect 27,970,652 litres/year of meteoric water). The water will be reused for the irrigation (water demand for irrigation equal to 27,562,200 litres/year) of the 110,000 sqm of planned green areas and for the unloading of the 225 toilets that will endow the area (water demand for toilets equal to 5,854,200 litres/year) (Tab. 5).

Tab. 5 – Water intercept

Meteoric water intercept					
Number of reservoirs	Annual precipitation (mm)	Collection area (sqm)	Out flow coefficient	Filter efficiency	Water meteorological intercept liters/year
1-2-4	875	36,031	0.7	0,9	19,862,089.3
3-5	875	15,990	0.5	0,9	8,108,562.5
Water requirement for unloadings of hygienic services					
Unload point		liters/day		liters/year	
225		17,740		5,854,200	
Water requirement for irrigation					
Annual requirement (l/sqm)		Surface (sqm)		liters/year	
200		108,540		21,708	

Another strategy to use for the project is the use of “green roofs” for a total of 110,000 sqm. This technology is able to sensitively act on the improvement of the environmental components (air, ground and microclimate), according to the following data (Tab. 6).

A “Plant of aerobic composting” was designed for the port area with the aim to transform wastes into goods of consumption (compost of quality and organic mulches). Usable materials are wastes from alimentary discards of cruise ships, fish discards of the market, discards of the food and wine pole as well as domestic organic waste from the

municipalities of Torre Annunziata, Torre del Greco and Castellammare of Stabia. This strategy would start a symbiotic process between the city and the port. All waste materials produced in these areas would be used to make quality compost as a fertilizer for Vesuvius agricultural area and for the mountains of Sorrento and the Amalfi Coast. The output has positive effects on the environment (domestic organic wastes return to the earth enriching it and preventing the desertification) (Tab. 7).

Tab. 6 – Air, ground and microclimate

CO₂ Absorption		
Green type	Units	CO₂ Absorption (Kg/year)
Trees of I e II size	n. 620	5,580
Trees of III size	n. 650	2,925
Lawn/shrubs	108,540 sqm	651,240
Total CO ₂ absorbed		658,395

Oxygen production		
Green type	Units	O₂ Production (cbm/year)
Trees of I e II size	n. 620	777,001 (correspondent to the annual requirement of oxygen of 4,257 people)
Trees of III size	n. 650	407,290 (correspondent to the annual requirement of oxygen of 2,230 people)
Lawn/shrubs	sqm 108,540	6,602,850 (correspondent to the annual requirement of oxygen of 36,180 people)
Total O ₂ produced		7,379,851 cbm/year (correspondent to the annual requirement of oxygen of 42,667 people)

Tab. 7 – The quality compost

Compost						
Good quality compost			5.000 t/year			
Organic mulches			3.000 t/year			
Total treated waste produced			8.000 t/year			

Organic fraction of the urban solid refusal (FORSU)						
Waste of fish market	Hay meadows tree trimming	Cruise ship (48 days/year)	Torre Annunziata (0,1 tons x 42,406 inhabitants)	Castellammare di Stabia (0,1 tons x 66,466 inhabitants)	Torre Annunziata (0,1 tons x 86,275 inhabitants)	Total treated waste (tons/year)
33,2	374,8	40	4,240.6	6.646,6	8.627,5	20,000

6. Conclusions

In the last part of the exercise, we hypothesized, through a cost-benefit analysis, the possible positive impacts we could record. The reuse of 55,021 square meters of rainwater per year is an important action, because it will be used for the water demand of 225 toilets and for irrigation of 55,021 waterfront urban park.

Another green strategy is the built of 108,540 square meters of green areas along the waterfront that is currently very empty.

The installation of 38,812 square meters of photovoltaic panels on the new buildings (shipyards, yacht clubs, parks, grain silos, fish market, food and wine pole, Terminal Cruise, logistics hub) will allow the production of 3,067,585.32 Kw/year of energy. In this way it is possible to satisfy the required quantity from the port of Pompeii for the docking of four ships per month for the entire year.

The circularization of the industrial process would be guaranteed by the creation of the composting centre realized near the waterfront. It will pick the organic waste both coming from the activities present in port Area, and those coming from the organic domestic wastes of the municipalities of Torre Annunziata (4,278.9 kg/inhabitant), Torre del Greco (8,627.5 kg/inhabitant) and Castellammare di Stabia (6,646.6 kg/inhabitant).

From the processing of 19,592.9 tons/year of organic waste of 195,530 kg approximately for the total population, it would be able to produce 8,000 Tons/year of resold quality compost for agricultural use.

According to these strategies also social impacts could be registered, in fact 884 new jobs could be created on an area of 22,986 square meters, such as to reduce by 2.1% the unemployment rate of the city of Torre Annunziata today equal to 26.5%.

Moreover, the street that connects the port and the Pompeii excavation would be redeveloped (3.5 km). The existing factories present in the port area would be redeveloped, enhancing their technological performances.

A significant indicator is the number of beds for tourists, which will be equal to 1,200 compared to the total absence referred to the waterfront.

In this way, the tourism economy could increase (increase of business licenses, increase in employment). For example, it would increase the employment rate in restaurants, cafés and shops.

However, investments should not have as main goal the increase of tourism, but the improvement of residents living conditions that, in turn, in a circular vision, are a source of tourist attraction: life quality and tourist attractiveness are, therefore, in a symbiotic and circular relationship. «If you do it for the locals, the tourist will come; if you do it for the tourist, only the tourists will come» (Rypkema *et al.*, 2011).

References

- Angrisano M., Fusco Girard L. (2017), "The circular economy approach for the regeneration of Torre Annunziata port area". *BDC-Bollettino del Dipartimento di Conservazione dei Beni Architettonici e Ambientali*, vol. 17, n. 1, pp. 11-21.
- Black R. (2006), *Sea energy "could help power UK"*, www.news.bbc.co.uk
- Ellen MacArthur Foundation (2015), *Growth within: a circular economy vision for a competitive Europe*, www.ellenmacarthurfoundation.org.
- ESPO (2016), *Trends in EU Ports Governance 2016*, www.espo.be
- Ezzat A. M. (2016), "Sustainable Development of Seaport Cities through Circular

- Economy: a comparative Study with implications to Suez Canal Corridor Project". *European Journal of Sustainable Development*, vol. 5, n.4, pp. 509-522.
- Fusco Girard L. (2010), "Sustainability, creativity, resilience: toward new development strategies of port areas through evaluation processes". *International Journal of Sustainable Development*, vol. 13, n. 1-2, pp. 161-184.
- Fusco Girard, L. (2013), "Toward a smart sustainable development of port cities/areas: The role of the "Historic Urban Landscape approach". *Sustainability*, vol. 5, n. 10, pp. 4329-4348.
- Fusco Girard L. (2014), "The role of cultural urban landscape towards a new urban economics: new structural assets for increasing economic productivity through hybrid processes". *HoPUE*, vol. 1 n.1, pp. 3-27.
- Fusco Girard L., De Rosa F., Nocca F. (2014), "Verso il Piano Strategico di una città storica". *BDC-Bollettino del Centro Calza Bini*, vol. 14, n. 1, pp. 11-37.
- Gemeente Rotterdam (2016), *Roadmap Circular Economy Rotterdam*, www.rotterdamclimateinitiative.nl
- Gemelli F. (2018), *Auto elettrica, il prezzo di un pieno in Italia e in Europa*, www.it.motor1.com/news/248336/auto-elettrica-prezzo-ricarica-italia-europa
- Gravagnuolo A., Angrisano M. (2013), "Assessment of Urban Attractiveness of Port Cities in Southern Italy - A Case Study of Torre Annunziata". *Sustainability*, n. 5, pp. 3906-3925.
- Idee Green (2014), *Auto elettrica: consumi e costi*, www.ideegreen.it
- Isecold (2018), *I servizi del deposito costiero di idrocarburi di Torre Annunziata*, www.isecold.it
- Jung B. (2011), "Economic Contribution of Ports to the Local Economies in Korea". *The Asian Journal of Shipping and Logistics*, vol. 27, n. 1, pp. 1-30.
- Karimpour R. (2017), "Circular economy modelling to accelerate the transition of ports into self-sustainable ports: a case study in Copenhagen-Malmö Port (CMP)". *World Maritime University Dissertations*, n. 591.
- Klaske K. (2015), "The Practical Implementation of the Circle Economy", Track of Springtij Forum Circle Economy, Masterclass 3 on the Local Circular Economy of the Resources 2015. Springtij, Nederland, September 24-26, 2015.
- Pearce D., Turner R. K. (1990), *Economics of natural resources and the environment*. Johns Hopkins University Press, Baltimore, Maryland, Stati Uniti.
- Port of Amsterdam (2017), *Port of Amsterdam. Result of 2017. Annual Report*, www.portofamsterdam.com
- Porti d'Italia (2018), *Porto di Torre Annunziata*, www.portiditalia.it
- Preston F. (2012), "A Global Redesign? Shaping the Circular Economy". Chatam House Briefing paper, n. 2, pp. 1-20.
- Rizos V., Behrens A., Kafyeke T., Hirschnitz-Garbers M., Ioannou A. (2015), "The Circular Economy: Barriers and Opportunities for SMEs". *CEPS Working Document*, n. 412, pp. 1-22.
- Roncarolo I. (2010), *La Spezia, Porto Verde*, www.shippingtech.it
- Rypkema D., Cheong C., Mason R. (2011), "Measuring economic impacts of historic preservation". A Report to the Advisory Council on Historic Preservation. Washington, D.C.
- SRM (2015), *Il Porto di Torre Annunziata. Intervista con il Direttore Generale di Solacem, Giuseppe Rocco*, www.srm-maritimeconomy.com
- Stegeman H. (2015), *The potential of the circular economy*, www.economics.rabobank.com

Tutta Italia (2018), *Il comune di Torre Annunziata*, www.tuttitalia.it/campania
United Nations (2016), *HABITAT III. Draft New Urban Agenda*, www.habitat3.org

Mariarosaria Angrisano

Dipartimento di Ingegneria, Università Telematica Pegaso
Piazza Trieste e Trento, 48 – Napoli (Italy)
Tel.: +39-3883415319; email: mariarosaria.angrisano@unipegaso.it

Martina Bosone

Dipartimento di Architettura, Università di Napoli Federico II
Via Toledo, 402 – Napoli (Italy)
Tel.: +39-3687675982; martina.bosone@unina.it

Sara Ravezzi

Arch. Indè Progetto e Restauro Srl
Via Duomo, 133 – Napoli (Italy)
Tel.: +39-3663006769; s.ravezzi@indeprogetto.com

Valentina Ascione

Arch. Responsabile Sportello Unico Edilizia Privata Abitativa
Palazzo Di Citta' – Corso Resina, 39 – Ercolano (NA, Italy)
Tel.: +39-3450921586; v.ascione@comune.ercolano.na.it

