

# A Community-based Waste Management System for the Historic Centre of Naples

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## Abstract

The municipal area of Naples produces 1600 tons of garbage every day, only 9% of which is recycled. While many cities in Europe have made remarkable progress in managing urban waste meaningfully, it remains a major concern for Naples. As the centralized system appears incompetent, on-site waste management seems a solution. The Infra-Free (IF) system is the inspiration behind an alternative model. It reduces burden on the urban infrastructure for both; waste management and energy as the later is produced in the process of the first. Every house does not have adequate space and this leads to a solution based on the community. The proposed system will manage waste and generate energy not only for the community but also for the urban spaces around. It is economically beneficial and helps to accumulate social capital, which is a vital asset for any city. The authors worked on a block located in the historical center of Naples and found that the network of courtyards provided an ideal setup for a community based waste management system. Thus, urban waste no longer remains a problem but becomes an economically rewarding opportunity for generating social energy and revitalizing the community.

**Keywords:** Naples; waste management; Infra-Free; energy; community

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## 1. Waste Management in Naples: An Introduction

Naples, the capital of the Campania region is the most important city in Southern Italy. The Metropolitan Area with 3.5 million inhabitants is the second largest in Italy in terms of population; the city proper has a population of approximately one million. In the recent past, Naples has been in the world media for a wrong reason: Urban Waste.

Naples produces 604 kg of waste/person/year which is not significantly high in comparison with the Italian average: 560 kg/person/year. But, Naples lags far behind the Italian standard of recycling. The Italian decree no. 22/1997 required each territory (Ambito Territoriale Ottimale) to recycle 40% of its waste by 2004. The modification of this decree i.e. 4/2008 has set a target for territories to recycle 45% of their waste by December 2008, which will have to be increased up to 65% by December 2012. While many cities have

already accomplished the first target of 40% recycling, Naples has managed to achieve only 8.9% as yet; the region of Campania recycles 11.6%. Interestingly, most cities and territories that have managed to reach the 40% mark are from Northern Italy, more specifically from the regions of Lombardia, Piemonte and Veneto. Turin recycles 41.1% of its waste while Milan recycles 44.6%. Most of the territories from Southern Italy and the centre have failed to reach the target of 40%. Florence recycles 33.4% of its waste while for Rome; the figure is only 12.1% (Waste Report, 2007).

Presently, in most developed countries, incinerators play a vital role in waste management and in the process also generate energy in various forms. The high number of incinerators is a testimony of North Italy's industrial culture while the absence of any in the Campania region is a result of the absence of an industrial culture combined with political stagnation and criminal involvement. Lombardia has as many as 13 incinerators, while even eight years after the commencement of building its first incinerator in Acerra, Campania has none.

With the low rate of recycling, most of the urban waste is used as landfill. 50.3% of the total waste in Italy ends up as landfill; it is even more in Campania: 66.7% (Waste Report, 2007). In the recent past, the Municipality of Naples failed to find new sites for

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landfill because regions around Naples refused to allow them in their areas; they had bitter experiences regarding disposal of garbage, especially hazardous garbage in the past. Presently, the problem of garbage in Naples is being considered as an emergency situation and the central government has come forward to help in finding new landfill sites. But, this is not going to solve the problem for long. It is important to develop an ethics and practice of recycling.

With the lack of proper infrastructure and management, decentralization of waste management can be seen not only as a solution but also as an economically rewarding opportunity to produce energy at local levels.

## 2. The Infra-Free System

The idea of waste management and energy generation at the local level is inspired by the Infra-Free (IF) system. Today, we primarily rely on centralized infrastructure that provides basic facilities and services needed for the daily functioning of our communities. IF is the concept of not having to depend on centralized infrastructures. It also embodies a new way of thinking about existing objects and technologies to enable us to become more self-reliant. It is a bottom-up, small scale and integrated approach; local but integrated in the larger context. IF (Anilir *et al.*, 2006) may be pertinent to the following scenarios:

1. NO infra (structure): Areas without or with inadequate amounts of infrastructure.
2. TEMPORARY infra (structure): Urban areas, where the infrastructure is lost because of natural disasters or other reasons.
3. SELF infra (structure): Areas, where the maintenance of infrastructure becomes a technological/economical problem.

The concept of making urban waste management IF is based on the realization that in Naples, there is a technological and management problem regarding it. So, a solution to the waste management problem in Naples might be making it SELF infra. This paper investigates the possibility of making urban waste management in Naples SELF infra by taking a block in the historic centre of the city as a case study.

### 3.1 The Historic Centre of Naples

Sitting in the centre of the Tyrrhenian coast, Naples is located between two volcanic areas, the Volcano



Fig.1. Gulf of Naples and the City

Vesuvius and the Phlegraean fields. The two thousand five hundred years old city was founded by the Greeks and later, was a part of the Roman Republic. The historic centre bearing the legacy of the Greco-Roman origin largely shaped the urban structure of Naples (Pane, 1971). It is still the functional heart of the city.

The historic centre is located close to the central administrative district and showcases masterpieces of religious and secular architecture. Intensive economic activity of small enterprises, handicrafts and specialized vocations takes place in this area. It comprises an extraordinary mix of social classes, roles, incomes and aspirations. Since 1995, Naples's historic centre has become a part of the UNESCO World Heritage Sites (Fig.3.).

The original nucleus of the historic centre still represents a strong identity: a gridiron plan with rectangular blocks.



Fig.2. The Gridiron Plan with the Study Block hatched

The blocks are the results of incremental growth and they possess an organic character; each block is an accumulation of smaller building interventions around courtyards over different time periods. As population and the demand for built area grew in the past, the free spaces around the blocks were gradually filled in. The buildings in some places encroached upon public spaces and have distorted the original gridiron layout. The only real spaces that exist within the blocks for interaction are the courtyards. The internal courtyard remains the most identifiable common element in the buildings of the historic centre.

### 3.2 The Block

The block (No. 27, surrounded by Via Atri, Largo Regina Coeli, Vico Purgatorio Ad Arco and Via dei Tribunali) was selected for this study because it comprises courtyards of different size, shape and

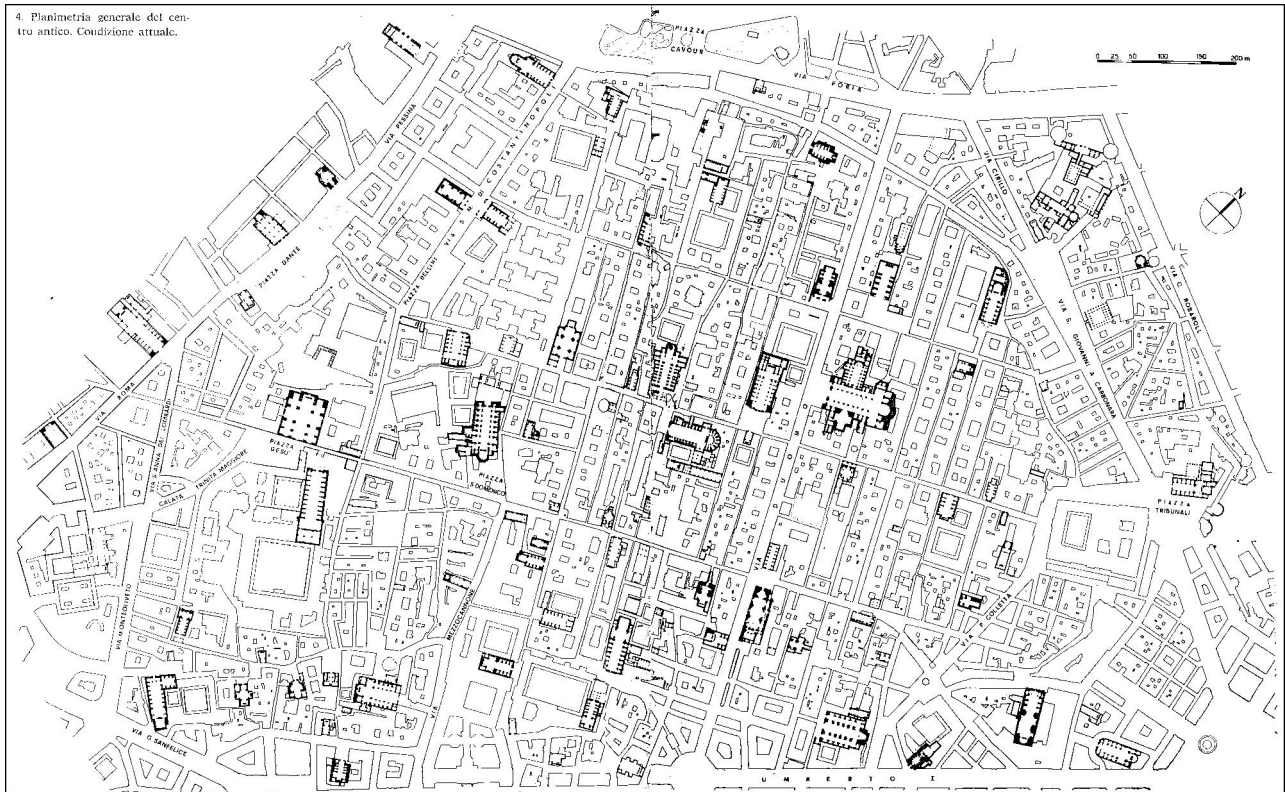


Fig.3. Historic Centre of Naples (Source: Pane, 1971)

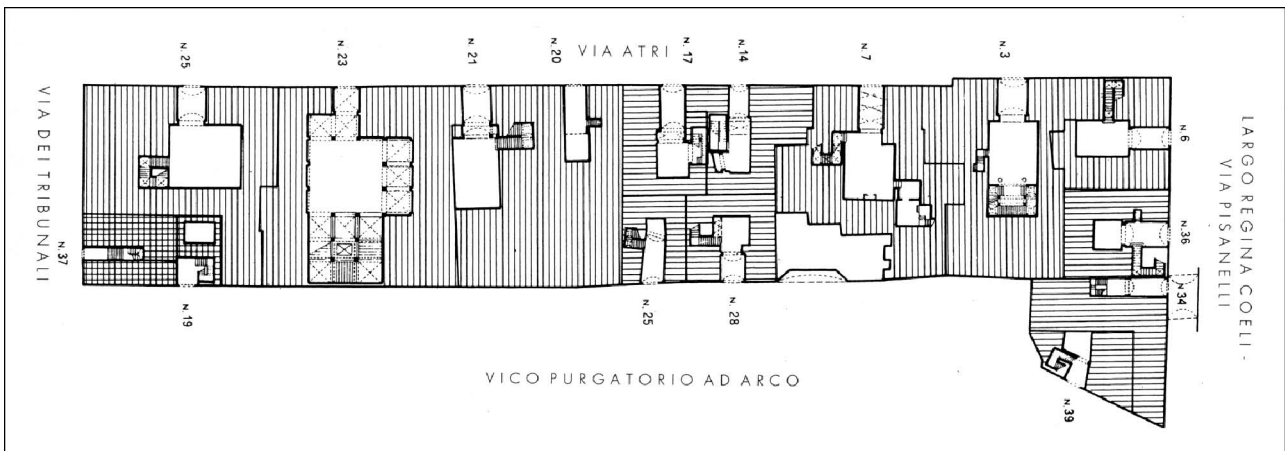


Fig.4. The Block and Network of Courtyards (Source: Savarese, 1991)

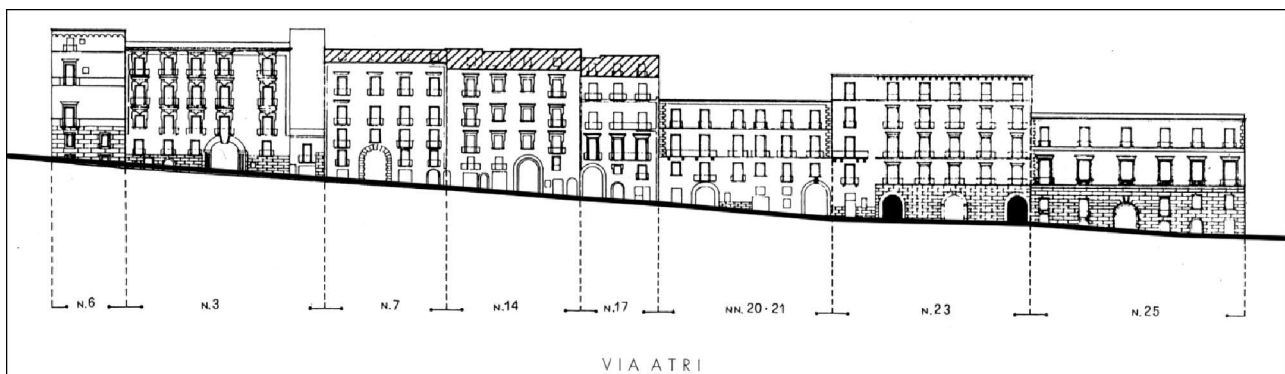


Fig.5. Longitudinal Elevation of the Block from Via Atri (Source: Savarese, 1991)



Fig.6. View from Vico Purgatorio Ad Arco



Fig.7. Entrance to the Main Courtyard

importance; it is archetypal and the results obtained here may later be easily applied in other blocks. Generally, the blocks in the historic centre are in dilapidated conditions; the block under study is no exception.

The central courtyard of the block, accessible from Via Atri has been designated as of historical value and should be conserved. The part on Largo Regina Coeli is mixed-use in character and houses some small workshops besides residences. Shops of different types occupy the ground floor on Via Dei Tribunali.

Given below is some basic information regarding the block<sup>1</sup>:

Table 1. Block Data

Area	7981 m <sup>2</sup>
Built-up area	6500 m <sup>2</sup>
Total floor area	11710 m <sup>2</sup>
No. of units	186
No. of families	161
Total Population	436



Fig.8. Typical Courtyard in the Block



Fig.9. Typical Courtyard in the Block

#### 4. Urban Waste: An Opportunity

The objective of the study was to find a pragmatic solution for decentralization of urban waste management that is compatible with the tangible and

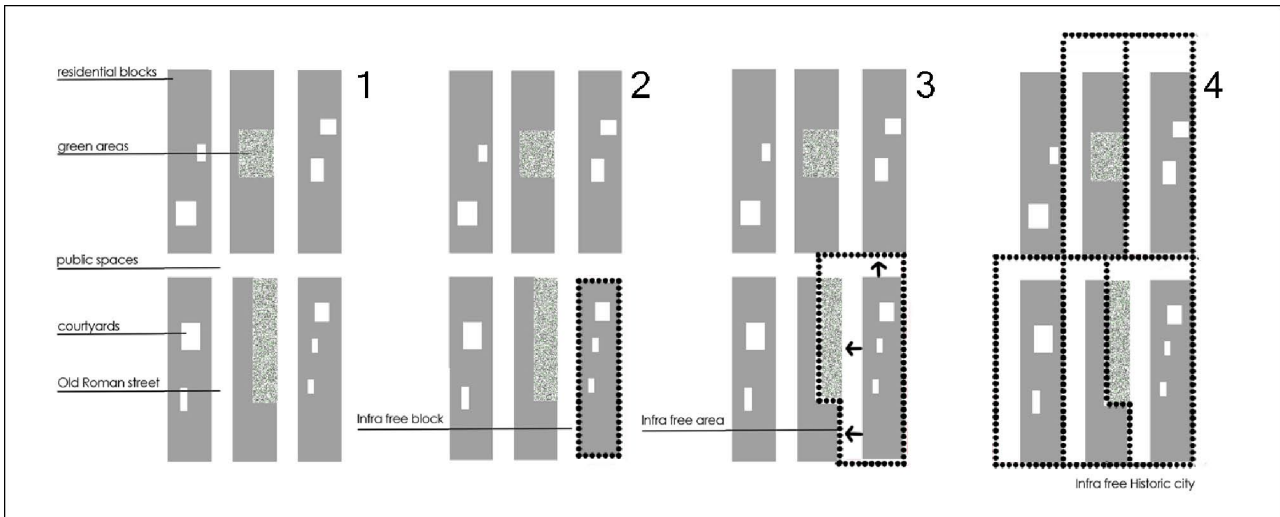


Fig.10. IF Historic City

the intangible context. Thus, the urban morphology and social capital i.e. community are the key elements of the project; urban waste becomes a source of energy. In this perspective, the grim situation of social and ecological threat can be converted into an opportunity for sustainable development.

The block under study is to become the first "autopoietic" and propulsive cell of energetic transformation of the whole urban tissue through the delimitation of an own public space connected to other cells. In this way the historical block, historically closed, opens energetically into the surrounding urban spaces represented by streets, small empty spaces and green areas. This new urban concept proceeds step by step from block to neighbourhood scale with the prospect of energetic and social interaction among the blocks (Fig.10.).

The antiquity of the blocks demands adaptation of the technological advancements to the urban reality of the historic city. So, the machineries will be distributed beneath the courtyards and on the terraces (in a solar sensitive way) to avoid negative impacts on the building systems.

The programme is based on a reinterpretation of the typical residential courtyards; from collective and social spaces they are to become also technological spaces, precursory of new scenarios. An important intervention required is the emptying of the spaces beneath the courtyards for installing small waste incinerators: a system for the production of thermal energy from the combustion of household waste produced by the residents of each block. The unit below the courtyard consists of the incinerator and other ancillary installations: a space for waste storage, an adiabatic chamber that works like a thermal exchanger to warm water for domestic uses, a container for receiving grey water to be reused etc. In some cases, these units could be placed in natural cavities and existing underground cellars in the historic centre

of Naples. The exhaust fumes of incinerators, through a chimney will be conveyed beyond the residential units while a turbine with a vertical axis placed on top of the chimney has the dual task of exhausting fumes from incinerators and to produce through wind movement, a small rate of electricity. A substantial amount of energy can be obtained from solar panels located on the terraces, thanks to sunny sky typical of Naples in summer and also in winter (Fig.11.).

#### 4.1 Energy, Environment and Cost

The waste management system can be conceived in two different perspectives leading towards two different scenarios and are analyzed below.

Table 2. Composition of Waste in Campania

Description	Proportion	Management
Glass	7%	Reusable/recyclable
Metal	4%	Reusable/recyclable
Wood	2%	Recyclable/incinerable
Plastic	12%	Recyclable/incinerable
Paper and packaging	21%	Recyclable/incinerable
Textile	6%	Recyclable/incinerable
Electronics	1.5%	Partially recyclable
Bulky Goods	2%	Not recyclable/partially incinerable
Dust and Pebbles	1%	Reusable
Domestic organic waste	32%	Recyclable/incinerable
Other non-recyclable wastes	11.5%	Not recyclable/incinerable

*The Energy Perspective:* The finite reserve of fossil fuel and its high price warrants a search for alternative energy sources. This perspective drives towards the generation of as much energy as possible from the combustible waste. The maximum amount of energy producible depends on the amount of waste generated and the proportion of the waste that may be incinerated.

From Table 2. (Waste Report, 2007), it can be

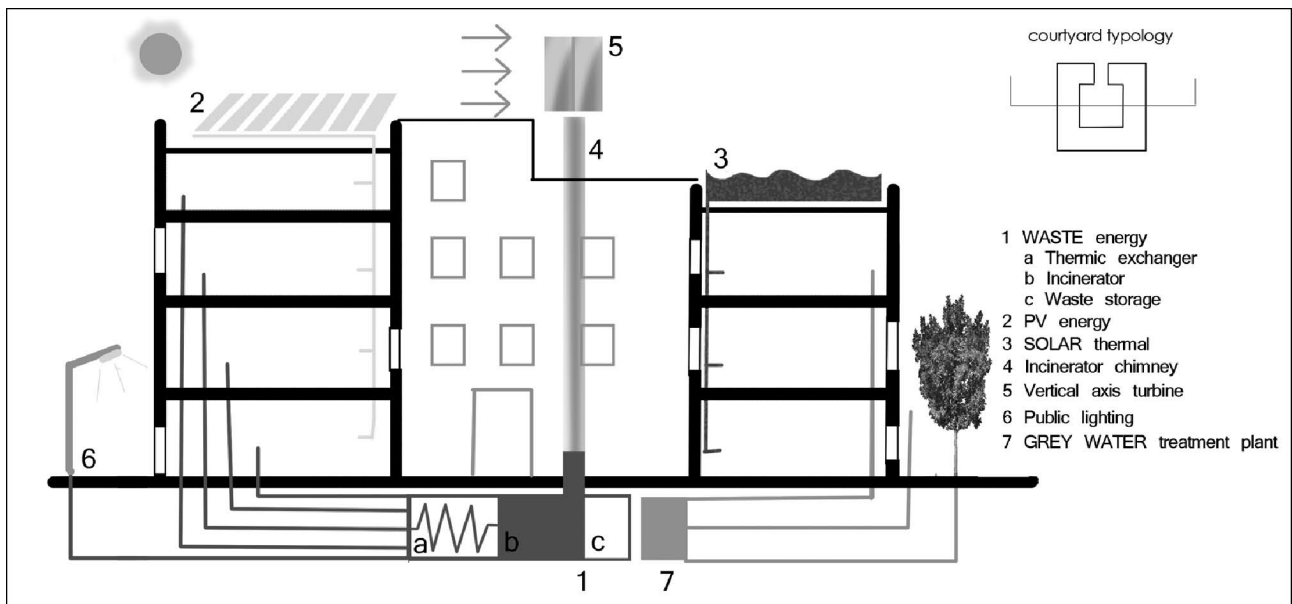


Fig.11. Proposed Section for the Block

Table 3. Household Energy Consumption in Naples<sup>2</sup>

Type of energy	Daily/family	Daily/block
Electricity	7.1 KWh	1143 KWh
Gas (cooking)	0.7 m <sup>3</sup> (16.8MJ)	113 m <sup>3</sup> (2712MJ)
Gas (heating, winter)	3.78 m <sup>3</sup> (91 MJ)	609 m <sup>3</sup> (14616 MJ)
Gas (heating, non-winter)	1.04 m <sup>3</sup> (25 MJ)	167 m <sup>3</sup> (4008 MJ)

One m<sup>3</sup> of gas produces 24 MJ of thermal energy (Anilir, 2008).

assumed that 85.5% (glass, metal, electronic items, dust and pebbles and half of the bulky goods cannot be incinerated) of the total waste can be incinerated. Based on 604 kg waste generated every year by each person, the block generates 721 kg of waste every day. So, the daily available waste for incineration is 616 kg. It is possible to generate 10.5 MJ of thermal energy from the incineration of one kg of waste (Anilir, 2008). Thus, 6,468 MJ of thermal energy can be produced from the waste generated by the block every day.

By comparing the amount of thermal energy that can be generated from the incinerator to the actual consumption, we can derive that 44% of the heating need in winter months and full heating (mainly hot water) demand in non-winter months can be satisfied. In fact, during the non-winter months, there will be a surplus of 2,460 MJ of thermal energy that can be used directly or converted into electricity for other uses.

The thermal energy generated from the incinerator is equal to which can be produced from 269 m<sup>3</sup> of gas. The present cost of one m<sup>3</sup> of gas in Italy is €0.65. So, the cost saved from gas purchase/daily is €175; 63,875 Euros/year.

Total cost saved/year is: cost saved from gas purchase/year + cost saved from waste collection/year i.e. €63,875 + €29,302 = €93,177. The cost of an

Table 4. Household Expenditure on Services<sup>3</sup>

Type of Service	Year/Family	Year/Block
Electricity	€ 518	€ 83398
Gas	€ 573	€ 92253
Water	€ 263	€ 42343
Waste Collection	€ 182	€ 29302

incinerator capable of handling 616 kg of waste/daily including other ancillary installations is approximately 20,000 Euros. The incinerator will operate at 1,100 degrees C to eliminate dioxins and will be equipped with an auxiliary heater to ensure this. The auxiliary heater will be fuelled by natural gas. The incinerator in consideration requires 4.1 m<sup>3</sup> of natural gas/hour. The incinerator will be in operation for 20 hours/day and 53.30 Euros will be spent daily for this purpose i.e. €19,455/year. So, in the first year approximately 39,455 (20,000 + 19,455) Euros will be required for the installation and operation of the system and 53,722 (93,177 - 39,455) Euros will be saved. In the following years, 73,722 (93,177-19,455) Euros/year will be saved. Even after providing for occasional repair and maintenance, a substantial amount of money will be saved each year which may be utilized for the betterment of the living environment of the block and gradual enrichment of the IF system with the introduction of new components.

*The Comprehensive Perspective:* The comprehensive perspective takes into account the reuse and recycling potential of urban waste. So, the first objective is to reduce the amount of waste produced. The second objective is to reuse and recycle as much waste as possible while the rest of the garbage should be disposed off in an environmentally safe way; incineration is an option for this. We may refer again to Table 2 to determine the best possible way to manage each type of urban waste. Considering

reuse/recycle potential and health hazards associated with the incineration of certain types of waste, we may incinerate wood, domestic organic waste, half of the bulky goods and other non-recyclable wastes i.e. 46.5% of the total waste. If we use the residual ash for fertilizer production, we expect to attain the Italian government's target of 65% recycling by 2012. 46.5% of total waste implies that 335 kg waste is available for incineration in the block everyday, which is capable of generating 3,517 MJ of thermal energy. Thus, the system may provide 24% of energy in the winter months and 87% of that in non-winter months required for heating; 95 Euros will be saved daily from gas purchase i.e. 34,675 Euros/year.

If we consider that a portion of the recycling and reuse will be administered onsite, approximately 50% of the money paid for garbage collection will be saved. Thus, every house will save 91 Euros/year i.e. 14,651 Euros/year/block. The block will save 49,326 (34,675 + 14,651) Euros every year. In the first year, the cost incurred from the installation and operation is approximately 29,727 Euros (considering the same incinerator is used as in the energy perspective but for 10 hours of operation/day) and in the later years the operational cost is 9,727 Euros. Thus, in the first year, 19,599 (49,326 – 29,727) Euros and in each of the consecutive years, 39,599 (49,326 – 9,727) Euros will be saved. The scenarios have been summarized in Table 5.

In addition to these, there are economic benefits also from generation of solar energy and reuse of grey water that are included in the IF system.

In both cases, more specifically in the first perspective, we almost eliminate the transportation cost and in the second perspective we save at least 50% of the transportation cost for urban waste. If the scenarios are perceived keeping the whole of Naples in mind, in the energy perspective, the need for waste transportation is reduced by 1400 tons/day, which is 800 tons/day in case of the comprehensive perspective. If a truck carries 4 tons/trip, 200-350 round trips/day and the associated carbon footprints can be averted.

#### 4.2 The Incinerator

The incinerator in consideration has a capacity of 35kgs/hour and operates at over 1100 degrees C to ensure complete combustion, and conforms to the European Union directive to keep the incineration or co-incineration gases at a temperature of at least 850 degrees C for at least two seconds and 1100 degrees C for at least two seconds if hazardous waste with a content of more than 1% of halogenated organic substances, expressed as chlorine, is incinerated (EU, 2000).

The proposed incinerator is one meter long and 0.7 meters wide; and weighs 950 kg when fully loaded. So, it does not require heavy infrastructure for installation. It may be in operation for 24 hours/day but eight hours stoppage time is preferred in every 48 hours for

maintenance and cleaning. Therefore, the operational hours for the incinerator have been calculated as 20 hours/day. The incinerator has a timer, does not require constant observation and may be operated and maintained easily by the block porters who are very common in Naples, together with some voluntary assistance from the community. The incinerator has an expected operational life ranging between 12 to 15 years (INCINER8, 2008). The community will have enough financial resources to replace the incinerator every 12 years with the economic benefit that it offers.

Table 5. Block 27, Historic Centre of Naples Waste Management Scenarios

S1. no.	Description	Energy perspective	Comprehensive perspective
1	Waste/block/day	721 kg	721 kg
2	Waste incinerated/day	616 kg (85.5%)	335 kg (46.5%)
3	Energy producible/day	6,468 MJ	3,517 MJ
4	Meets heating needs in winter months	44%	24%
5	Meets heating needs in non-winter months	100% (2460 MJ surplus)	87%
6	Savings from gas purchase/year	€63,875	€34,675
7	Savings from waste collection/year	€29,302	€14,651
8	Total savings/year (6 + 7)	€93,177	€49,326
9	Price of combined incinerator and hot water system	€14,000	€14,000
10	Ancillary installations	€6,000	€6,000
11	Running cost/year	€19,455	€9,727
12	Net savings/ first year {8- (9 + 10 + 11)}	€53,722	€19,599
13	Net savings/ later years (8-11)	€73,722	€39,599

#### 4.3 The Social Dimension

The social response depends on a complex matrix that encompasses the technological soundness of incinerators, social mobilization, governance and also the law and order situation. People are afraid of the health and environmental hazards that were associated with the first generation of incinerators and are sceptical concerning its benefits. Most pronounced are the problems regarding fine particles, dioxins and furan produced from the incinerators. Today, however, due to advances in emission control designs, incinerators emit virtually no dioxins. Particulates can be collected by particle filtration, most often electrostatic precipitators (ESP) and/or bag-house filters are used.

Another apprehension related to incineration is the CO<sub>2</sub> emission. If the waste were used as landfill, one ton of waste would produce approximately 62

m<sup>3</sup> of methane in the anaerobic decomposition of the biodegradable part of the waste. This amount of methane has more than twice the global warming potential of the CO<sub>2</sub>, which would be produced by incineration (Carnevale, 2005).

In Campania, and especially in Naples, people were very afraid of these hazards, and the absence of any incinerator in Campania is evidence of this. The NIMBY syndrome in Naples has deep roots, directly linked with the distrust in the local political class who were chronically incapable of finding a solution to the waste problem and the criminal cartel making the most out of the sufferings of common people. The criminal organizations have made more than six billion Euros from activities linked to the disposal of hazardous waste in these years of emergency (Saviano, 2006). Thus, it is very difficult to recover the trust of citizens and start new large projects regarding urban waste management.

A more realistic solution is to inform, involve and give responsibility to each city dweller. The IF waste management system is capable of coping with this challenge because it directly involves the inhabitants of the block in recycling and reducing the environmental risk. The citizens can ensure that only non-hazardous domestic waste is incinerated, which is difficult to monitor and check in case of the large incinerators; large incinerators are usually apprehended to be controlled by the corrupt politico-criminal racket.

One of the main concepts of the IF system is to make the installation and maintenance user friendly (do by yourself) i.e. to impart more autonomy and self reliance in the community. It is also a process where more facilities can later be plugged in according to the actual need of the users. So, it is not a closed end project but, an upgradable process which further strengthens its autonomous character that other blocks will also like to emulate. The eternal desire of human beings to become autonomous and the economic benefit associated with this system will gradually lead the historic city toward adopting the decentralized waste management system.

Adaptation of IF technology is also an opening for economic revitalization of the historic centre of Naples because, it does not accept the mummified vision (museum city) for this area. This is a new vision: from preservation to innovation, based on the realization that the historical centre is still a resource to bring about vibrancy in the city; not only to be preserved like a museum. The economic benefits that the IF waste management system offers can be invested to transform the historic centre gradually into an IF city and may be emulated by other parts of Naples. The IF system is a self-help bottom up approach and helps to involve the local population, civic organizations, government and economical actors in the process of revitalization.

## 5. Concluding Remarks

Waste management, not only in Naples but all over the world should be conceived of as a policy of creating less waste, recycling more and disposing the remainder in a safe and environmentally friendly way.

There is also the issue of energy, which is becoming more and more critical day by day. This study has investigated the possibility of a decentralized waste management system in the Historic City of Naples from both points of view. But, the liberty to make a choice should be left with the inhabitants because; they are the main resource for a community-based system where urban waste may be transformed into social energy.

The historically sensitive context and restrictive laws for new projects in the historic centre represents another great challenge. However, it does not involve architectural alterations of the historic site, but is an innovative technology capable of reducing the load on the current infrastructural network and bringing in economic vitality; thus, counteracting the current Italian phenomenon of historic centre isolation. It refers to the capability that architecture and technology possess to develop new habits, redefine social roles, and to generate direct economic benefits. In the end, waste, from being a cause of conflict and concern becomes an element of social bonding and new hope.

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## Notes

- <sup>1</sup> Data and information regarding the block were collected from the Statistical Office of the Municipality of Naples. For more information, please visit [www.comune.napoli.it](http://www.comune.napoli.it) ;
- <sup>2</sup> Data and information regarding Energy consumption in the city of Naples were collected from the National Office for Statistical Study of Italy. For more information, please visit [www.istat.it](http://www.istat.it) ;
- <sup>3</sup> All the calculations were based on data collected from the Italian Authority of electricity and Gas ([www.autorita.energia.it](http://www.autorita.energia.it)), Water Resources Company of Naples ([www.arin.na.it](http://www.arin.na.it)) and the Environmental Services and Hygiene Company of Naples ([www.asianapoli.it](http://www.asianapoli.it)).