Urban Waste As Resource For Sustainable Environment

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Abstract: The emerging model of waste disposal, develops an integrated approach based on waste reduction, selection, recycling, energy recovery and residual use of landfill. Here we discuss the fundamentals of a proper planning of waste disposal system, specially the thermal recovery, the integration and the methodological approach, either from the environmental and economic point of view.

The growing demand for energy, the resulting environmental problems due to satisfy the demand for energy and the complex-economic system, necessitate the study of new technologies such as energy from municipal solid waste (MSW) obtaining as a result of decrease huge mass of solid waste to sanitary landifill and emissions of landifill gas as (CH^4 and CO^2).

Therefore, we propose to validate a technical, economical and environmental analysis of waste-treatment systems with enphasis on generation of energy.

The recovery of heat from a waste-to-energy plant, can make a useful contribution to the city energy needs. Whilst we have been slow to exploit fully this resource in Sicily, economically in urban areas.

Introduction

The production of waste in recent years has assumed ever increase proportions. This increase can be attributed to the improvement of living conditions and the progress of industrial development, which led to significant increase in consumption and the product life cycle are often shorter. This large production of waste, represent a great loss of resources and pressure on the environment, which is extended on the all environmental components: air, water and soil.

Sustainable waste management implies reducing dependence on landfills and increasing recycling and reuse. Planning urban waste management in this framework, bring up a number of issues like public health and the people's livelihood, considering how changing lifestyles, introduction of new technologies and advances in science have taken advantage of the environment. Sustainable waste management, must therefore adopt techniques that are cost effective and efficient.

Waste as resource for sustainable development

One of the critical issues in smart cities, is waste management that can be defined as the " Collection- Transportation- Processing- Treatment- Recycling or Disposal " of waste materials to reduce their adverse effects on human health or amenities. In sustainable development, economic progress must be in tandem with preserving the environment. Smart cities use technology to optimise the allocation of resources, drive efficiency and support sustainable living.

Wastes need to be seen not as a problem to be disposed, but as a resource for sustainable development. Disposing solid waste is a common problem and efforts are being made to create affordable alternatives for sustainable waste management with methods that are cost-effective and technically feasible.

This involve:

- using materials resources efficiently to reduce the amount of waste produced;
- deal with the waste generated in a way that it aligns with economic, social and environmental goals;

A vision of metropolitan area in evolving from primarily “ open loop systems “ with one-ways flows of resources (in) and wastes (out), to primarily “ closed loop systems “ where the definition of wastes and resources become blurred. In other words, cities can become more resourceful.

Urban infrastructures in the smart cities [1]

Everybody wants benefit from efficient urban infrastructure (such as waste water treatment, waste treatment and Combined heat and power production (CHP), but nobody want to see and definitely must be located in on’s own backyard.

According to EU directive for Renewable Energy Sources (RES), the proposals for Energy Efficiency (EE) and according to the EU Energy Efficiency Plan 2011, Smart Cities are how have supposed to develop cost-effective smart grid infrastructure for electricity, heating and cooling. Moreover CHP plants are supposed to be located near or in the cities, in order to transfer renewable energy and surplus heat to the buildings. The solution is an urban and architectural design to form a more socially sustainable city design. By 2050 more than 6 billion people, will live in urban areas, most of them in developing and less-developed countries. The number of megacities (with more than 10 million people) is expected to increase from three in 1975 to 29 by 2025. These cities contribute to climate change and in turn are affected by its consequences.

Energy saving is considered an important goal in order to minimize the problems by the increase in energy consumption and the relevant effects on the environment. The recovery of heat from a waste to energy plant, can make a usefull contribution to the city energy needs. The current best technology for the low pollution disposal of municipal solid waste (MSW) is burning as fuel, with production of electricity, and heat for district heating and cooling. [2 - 3]

The fig. 1 and the next table 1 shows a flow diagram of energy recovery system from waste for district heating plant and the performance of engines gas and gas turbines. [4]

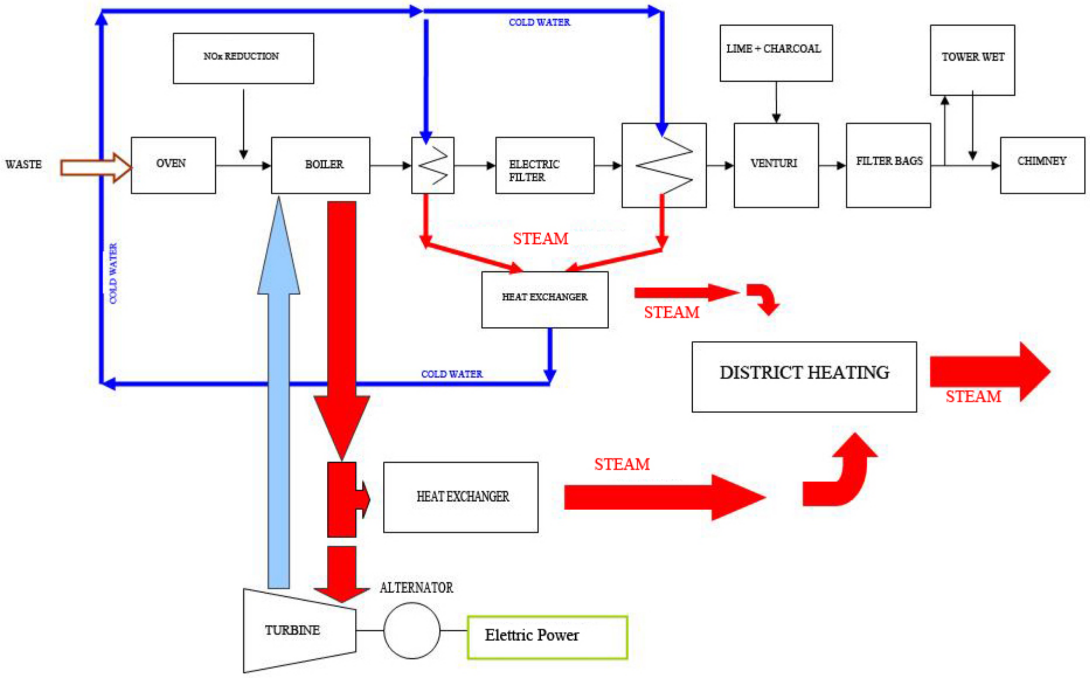

Fig 1 Flow diagram of energy recovery system from waste for district heating plant

Tab. 1. Performance of engines gas and gas turbines

Types cogeneration plants				
	Gas turbine	Alternative engines	Steam turbines	Combined cycle gas-steam
Power Range Standard	1 MW - 250 MW	0,1 MW - 5 MW	0,5MW-200MW	5 MW - 350 MW
Elettrical Performance	30% - 35%	30% - 42%	25% - 35%	40% - 60%
Total return system	75% - 85%	75% - 85%	75% - 85%	75% - 85%
Combustible	Methane or gas fuel	Methane or gas fuel	Any fuel, heat recovery	How to gas turbine + steam turbine
Benefits	Thermal recovery at high temperature	High flexibility, possibility of stopping daily	Allows recovery of waste heat from industrial processes for electricity generation	High electrical efficiency

Recovery energy from MSW

The potential of recovery of energy from MSW through different methods, can be made from knowledge of its calorific value and organic fraction, as under. [5]

The most used technologies for energy recovery are distinguished in thermo-chemical in which both the organic component biodegradable non-biodegradable, contribute to the production of energy in output, and in bio-chemistry where only the biodegradable component of the organic substance, can contribute the production of energy.

The Tables 2 and 3 outlines the performance obtained for the two different technological solutions.

Table 2. Thermo-Chemical conversion

Total waste quantity:	Q	T (Tonnes)	
Net Calorific Value:	NCV	kWh	
Energy recovery potential: (KW/h)		kWh	NCV*Q
Power generation potential:			NCV*Q/24
Conversion efficiency:		kW	0,25
Net power generation potential:		kW	0,25*NCV*Q/24

When NCV= 4,07 kWh the net power generation is 0,042* Q

In bio-chemical conversion, only the biodegradable fraction of the organic matter can contribute to the energy output:

Table 3. Bio-Chemical conversion

Total Waste Quantity	Q	T (tonnes)	
Total Organic/Volatile Solids	VS		0,5*Q
Say Organic Bio-degradable Fraction			0,66*VS=0,33*Q
Typical Digestion Efficiency			60%
Calorific Value of Biogas	CVB	kWh/mc	5,81 kWh/mc
Energy Recovery Potential		kW/h	V*5,81
Power generation		kW	V*5,81/24
Typical conversion efficiency			0,30

When CVB= 5,81 kW/mc the net power generation is 11,5* Q

In order to prove the validity of the system technology described, are summarized in table 4 the estimations of the consumption of fossil fuels for heating a 100 m_2 household

Table 4. Fossil fuel and biofuel cost management

Fossil fuels and biofuels						
Fuel	U.M	Cost (€)	U.M.	Lower Calorific	Performance	Price (€)
Wet Wood	€/kg	0,13	kWh/kg	4,00	85%	0,038
Pellets	€/kg	0,29	kWh/kg	5,00	85%	0,068
Natural Gas	€/mc	0,76	kWh/mc	9,50	85%	0,094
Diesel Fuel	€/l	1,20	kWh/l	10,00	85%	0,141
LPG	€/l	0,90	kWh/l	7,00	85%	0,151

Table 5. Cost for 100 m^2 household

Fuel	G (days)	H (hours)	Consume (kW)	Cost (€)
Wet Wood	120	10	8	364,8
Pellets	120	10	8	652,8
Natural Gas	120	10	8	902,4
Diesel Fuel	120	10	8	1353,6
LPG	120	10	8	1449,6

The next table 6 shows the example of a smart city of 100.000 inhabitants and the amount of energy obtainable from MSW respectively as power and thermal energy

Table 6. Perfomance of power and thermal energy recovery for three technical solutions

Production of MSW for 100,000 Inhabitants 150 T/ day	U.M	Steam Turbine	Thermal engine	Gas Turbine
Waste feed- in flow, per hour	kg/h	6250	6250	6250
Waste low heating value	kjkg	14651	14651	14651
Thermal energy	kWt	25436	25436	25436
Primary source energy conversion efficiency steam generator / pyro-gasifier	-	0,78	0,60	0,70
Thermodynamic cycle global efficiency	-	0,22	0,37	0,30
Global net efficiency	-	0,19	0,22	0,21
Electric power	kWe	4816	5596	5342

Conclusions

Smart Cities technologies can provide an important contribution to the sustainable development and energy saving. The District Heating ,Cooling and trigeneration system, aims to support communities in their effort to use energy more efficiently.

In Sicily, the consumption of electricity for domestic use (year 2010) was 5.848,3 GWh/year, compared to the total consumption of 18.949,5 GWh,and the consumption of electricity inhabitant/ year is 3.783 KWh/ year * inhabitant.

Most of the consumptions are to be attributed to the consumption of power for heat pumps for air conditioning in summer. The total production of solid waste in Sicily in 2009 was 2.408.127 Tonns/year. In this context, the use of the potential of energy from solid waste, can help to reduce Global Warming and Greenhouse Gases Emissions due to increasing demand for fossil fuels for heating, cooling, hot water and electric power in urban areas. [6 - 7]

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