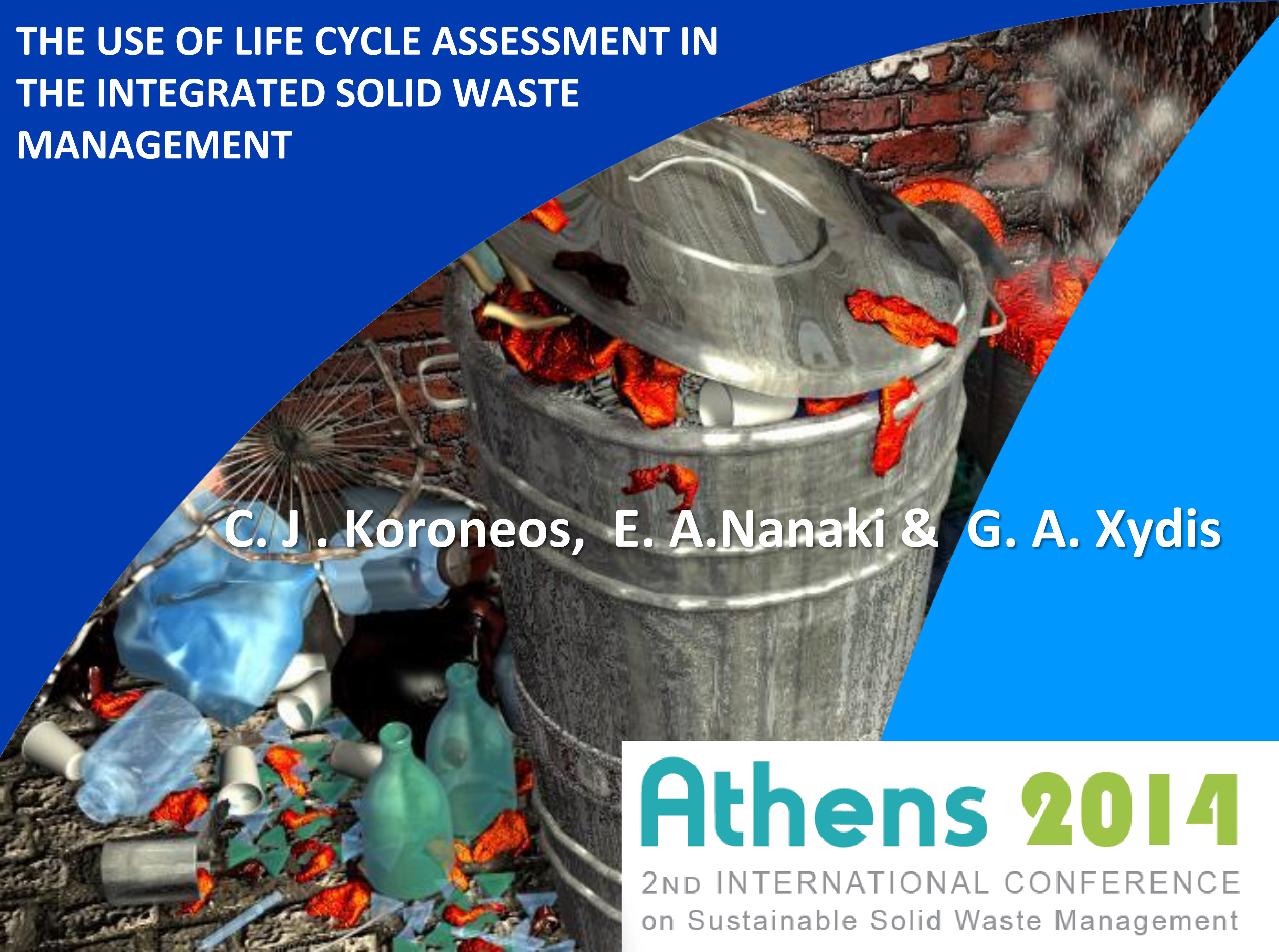
THE USE OF LIFE CYCLE ASSESSMENT IN THE INTEGRATED SOLID WASTE MANAGEMENT



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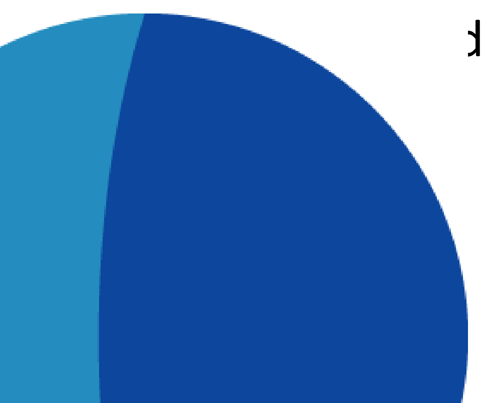
on Sustainable Solid Waste Management

Perspective: European Commission`s “Thematic Strategy on Avoidance & Recycling of Waste”

- Promotes Sustainable Waste Management
- Considers ***Life Cycle Analysis*** to implement Sustainable Waste Management
- Accepts that there is a lack of data on waste generation and treatment in Member States
- Broadens ECs view from Municipal Solid Waste towards other hazardous and high volume waste streams (e.g.
  demolition, agriculture)



Sustainability is :

a balance between the needs of the Environment, the Economy and Society

Sustainable Waste Management needs to be :

- Environmentally effective
- Economically affordable
- Socially acceptable

Sustainable solid waste management systems can be engineered by:

- Accepting the concept of an integrated approach to solid waste management
- Using a Life Cycle Assessment tool to optimise the integrated waste management system

Life Cycle Assessment

Definition:

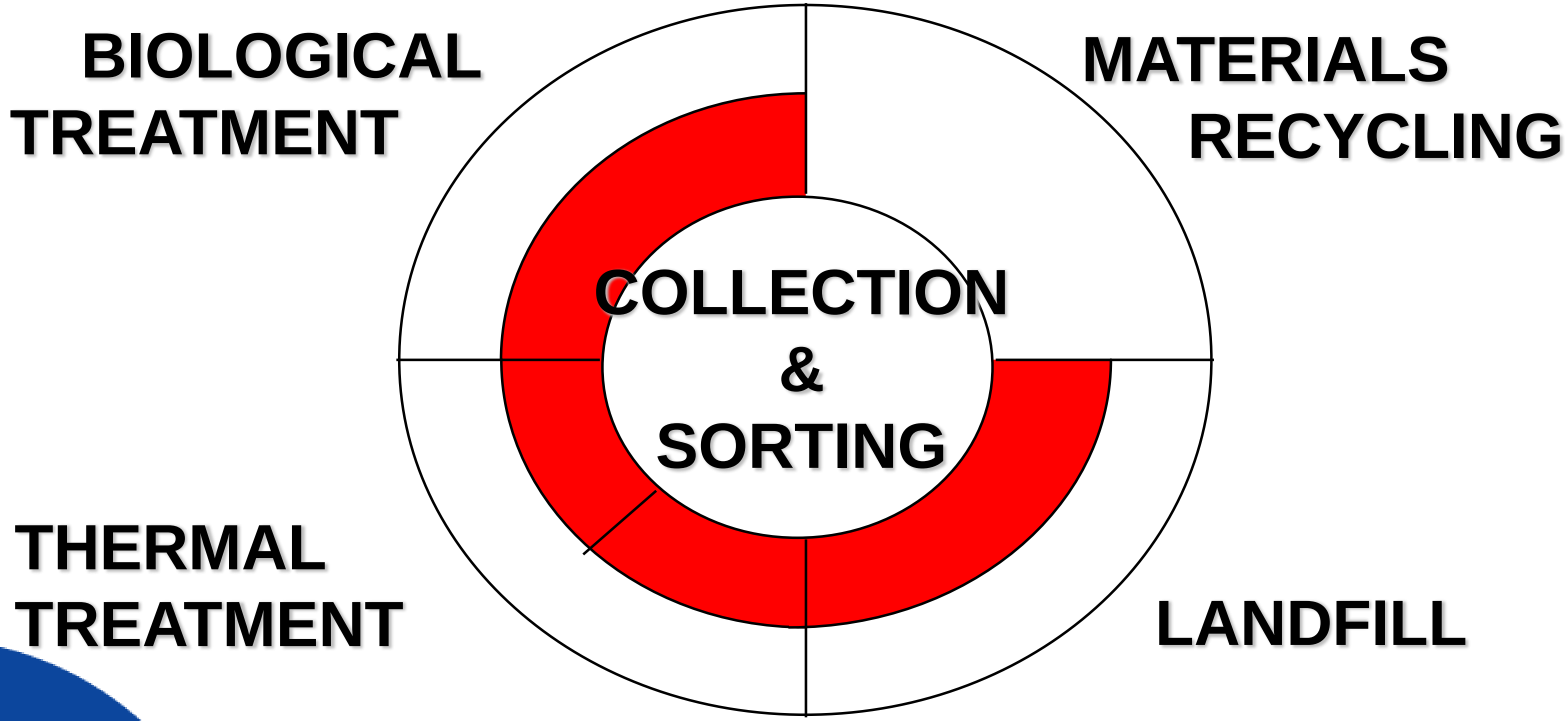
- "Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle"
- This establishes an environmental profile of the system!

ISO = International Organization for Standardization
Ensures that an LCA is completed in a certain way.

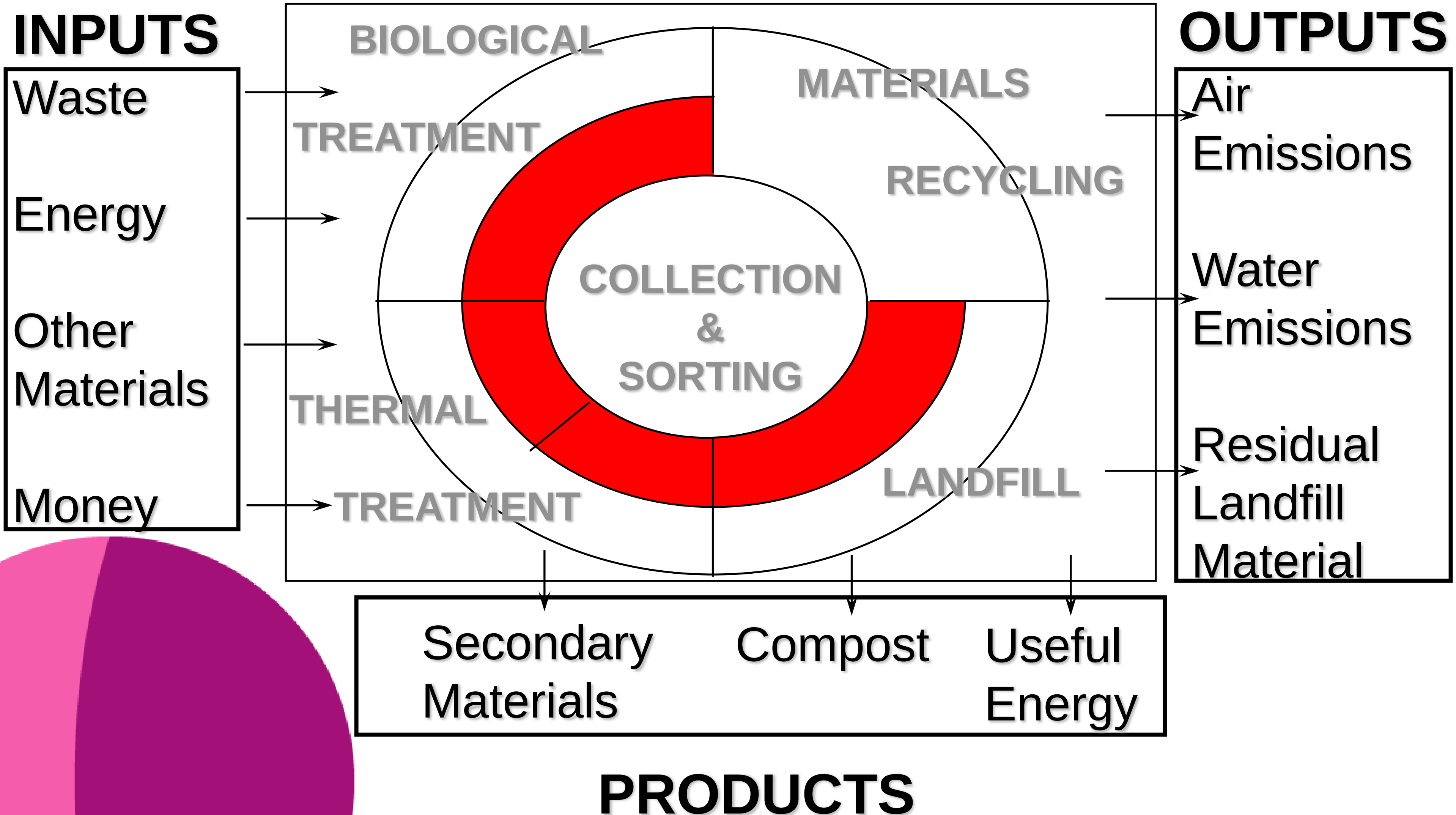
The concept of Integrated Waste Management

- IWM takes an overall approach and manages waste in an environmentally effective and economically affordable way.
- IWM involves the use of a range of different treatment options at a local level.
- IWM considers the entire solid waste stream.

Integrated Waste Management includes:

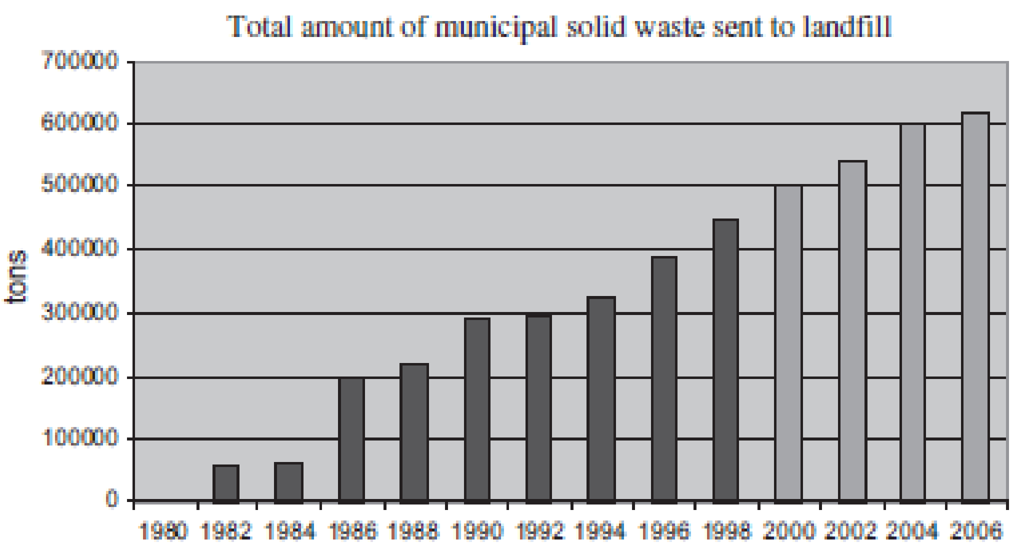


Integrated waste management: a Life Cycle Assessment



Implementation: The city of Thessaloniki

- Thessaloniki is the second largest city in Greece located in the northern part of the country. The whole area is served by a sanitary landfill operated by the Association of Local Authorities of Greater Thessaloniki for the last 14 years.
- The functional unit used in this treatment of municipal solid waste which is collected during one year in Thesssaloniki.
- The fractions of municipal solid waste included in the study are the total amount of food waste, paper and plastic collected during the period of one year. The amounts of these waste fractions are based on 2004 data, whereas their average composition is based on 1998 data, since the change in time is insignificant. These three waste fractions account for 74% of the total waste produced in Thessaloniki and due to their physical and chemical properties, various treatment methods could be utilized to avoid the hazards they create



Identification of Municipal Solid Waste Treatment Strategies

Waste treatment strategies	Landfill	Recycling	Anaerobic digestion in a plant
System 1	100% for all waste fractions	-	-
System 2	50%for food waste, 100% for plastic and paper	-	50% for food waste
System 3	70%for paper, 100% for plastics and food waste	30% for paper	-
System 4	50%for food waste, 70%for paper, 100% for plastics	30% paper	50% for food waste

Description of Municipal Solid Waste Treatment Strategies

	Scenario A	Scenario B	Scenario C	Scenario “land use”	Basic scenario	Scenario “natural gas”	Scenario “biocells”
Biogas collection from landfill site:	0%	50%	50%	50%	50%	50%	65%
Biogas from landfill site utilized as electricity:	0%	0%	30% of collected	30% of collected	30% of collected	30% of collected	30% of collected
Leachate collection from landfill site	0%	80%	80%	80%	80%	80%	90%
Heat recovery from landfill biogas replaces:	No heat recovery	No heat recovery	No heat recovery	Heat from oil	Heat from oil	Heat from natural gas	Heat from oil
Land use at landfill site impact category:	No	No	No	Yes	No	No	No
Biogas from anaerobic digestion plant utilized as electricity	30%	30%	30%	30%	30%	30%	30%
Heat recovery from anaerobic digestion plant replaces:	Heat from oil	Heat from oil	No heat recovery	Heat from oil	Heat from oil	Heat from natural gas	Heat from oil
Biogas utilized as heat: (both landfill site and plant)	60%	60%	No heat recovery	60%	60%	60%	60%

Environmental Impact Assessment -Results

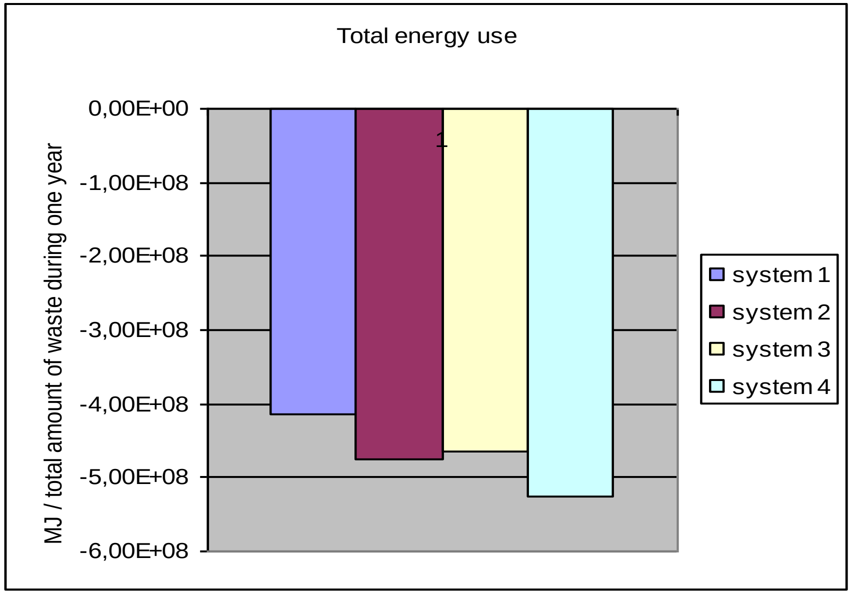


Figure 1: Total energy use for each one of the four systems. The bars represent the average value of the sensitivity analysis scenarios of each system

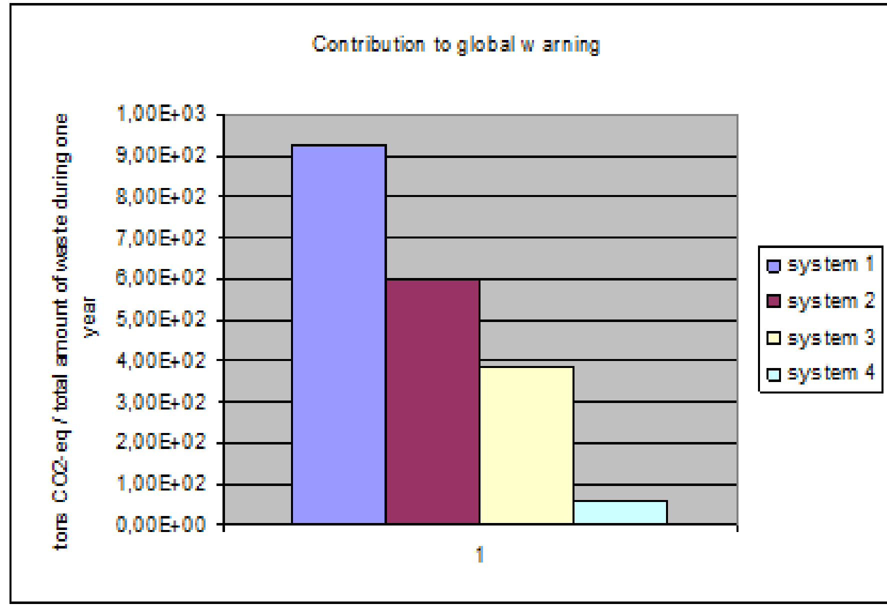


Figure 2: Contribution to global warning for each one of the four systems. The bars represent the average value of the sensitivity analysis scenarios of each system

Environmental Impact Assessment -Results

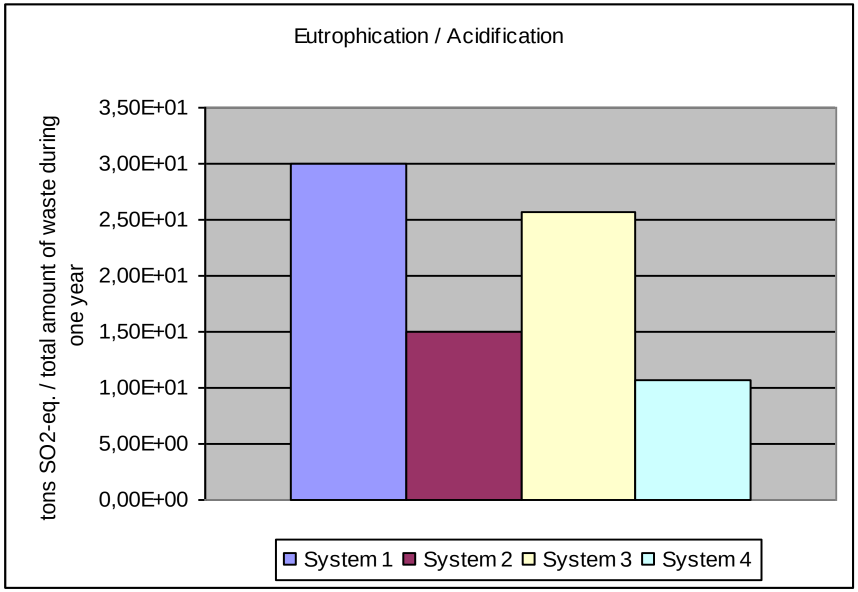


Figure 3: Contribution to the combined eutrophication/acidification impact category for each one of the four systems. The bars represent the average value of the sensitivity analysis scenarios of each system.

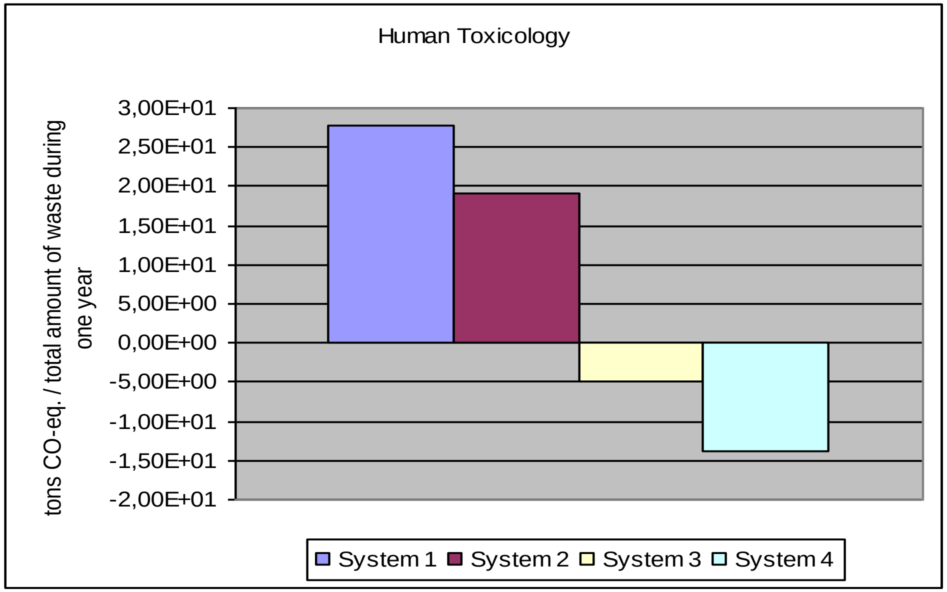


Figure 4: Contribution to the human toxicology impact category for each one of the four systems. The bars represent the average value of the sensitivity analysis scenarios of each system.

Environmental Impact Assessment - Results

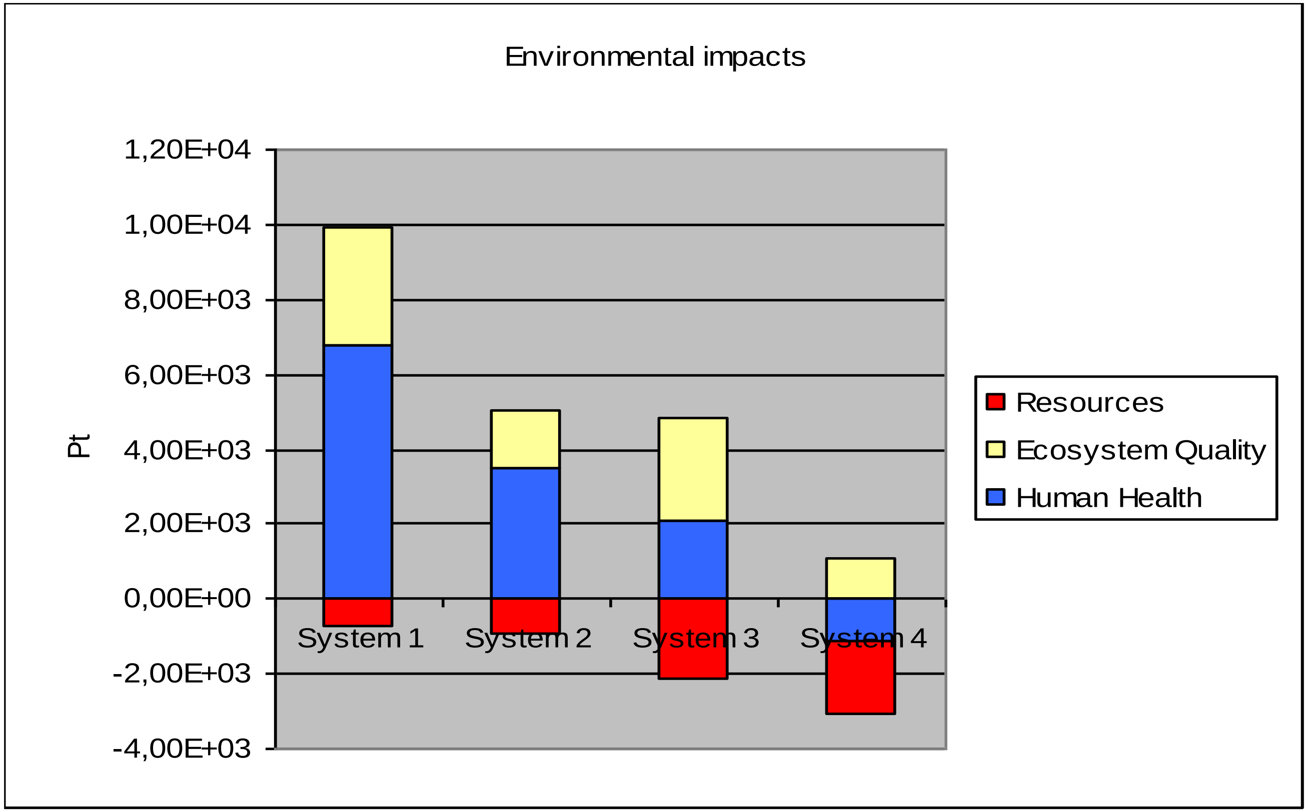


Figure 5: Total Environmental Impacts for each one of the four systems. The bars represent the average value of the sensitivity analysis scenarios of each system. (Method eco-indicator 99, total weighted results, single score)

Conclusions

- According to the main assumptions made in this work, electricity production is based on lignite and this remains constant in all scenarios since lignite is the primary energy carrier in Greece. For this reason, electricity production from biogas (that accounts for the 30% of energy recovery from biogas) is assumed to replace part of the electricity based on lignite. On the other hand, heat production from biogas (60% of the total amount of energy recovery from biogas) in scenarios A, B, “biocells” and “basic”, replaces thermal energy from oil. In the scenario of “natural gas” it replaces thermal energy from natural gas and in scenario C it replaces no thermal energy at all.

- When heat from natural gas (instead heat from oil) is replaced by heat coming from biogas, a small increase in the impact categories of human health and ecosystem quality is noticed, while the impact category of non renewable resources is positively influenced. In scenario C where no heat from biogas is utilized, it does not seem to effect significantly the results except for systems 2 and 4 where an anaerobic digestion plant is present leading to increased heat energy recovery (even though the difference is too small).

Conclusions

- Parameters regarding the landfill site seem to have a significant effect on the overall results. Another very important issue is the fact that the environmental impacts of all systems under study are maximized in the case of uncontrolled waste disposal site (no biogas and leachate control). There is no point (at least though an environmental perspective) in investing money on recycling programs and anaerobic digestion plants while large amounts of waste are disposed at uncontrolled landfill sites.

- Although parameters regarding biogas and leachate treatment have a considerable effect on the results, the inclusion of land use as an impact category only gave an insignificant increase of 6-16% (depending on the system) on ecosystem quality impact category.

- When discussing solid waste management strategies it would be interesting to see how the inclusion of other electricity sources (e.g. from renewable sources instead of lignite based power plants) would affect the results. Additionally, a more detailed study could contain some other relevant waste treatment methods like incineration, composting, recycling of plastic and aluminum and of course the process of waste collection and transfer. That would give a holistic approach to the problem of municipal solid waste management.

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