



**Waste-To-Energy Research
and Technology Council**



WTERT 2006 Annual Meeting at Columbia University

NYC, October 19-20

**Location: Davis Auditorium, Schapiro Center for Engineering and Physical Science
Research, Fu Foundation School of Engineering and Applied Science**

*530 West 120th St. (between Broadway and Amsterdam Avenue), New York City (take
elevator to 4th floor)*

Thursday, October 19, 2006

8:00 AM Registration and continental breakfast in lobby of Davis Auditorium

**9:00 AM Welcome and introduction: Prof. Nickolas J. Themelis, WTERT Chair,
Director, Earth Engineering Center, Columbia University**

**9:15 AM Keynote presentation: Thermal Treatment –An essential element of
Sustainable Waste Treatment**

Prof. Paul H. Brunner, Vienna University of Technology, Recipient of
the WTERT 2006 Education Award. (paul.h.brunner@iwa.tuwien.ac.at)

In the past century, material turnover in all sectors (residential, commercial, industry, trade, agriculture) has increased tremendously and there are no signs yet that this trend will change in the near future. Recycling can divert an important fraction of the total waste stream back to consumption. However, due to energetic and economic reasons, the total recycling of wastes is not feasible. Thus, means to dispose of large amounts of wastes in a safe and goal oriented way is necessary. Goals of waste management comprise protection of man and the environment, the conservation of resources such as energy, materials and land, and after-care-free landfills (precautionary principle). Since

wastes are important carriers of hazardous as well as valuable materials, waste management plays a major role in environmental protection and resource conservation.

In service oriented economies, non-hazardous wastes are larger carriers of hazardous substances than hazardous wastes. Hence, if risks from hazardous substances are to be minimized, the environmentally safe management of non-hazardous wastes, in particular municipal solid wastes, is crucial. State of the art thermal treatment is a feasible way to process many hazardous and non-hazardous wastes. There are different thermal processes available to treat waste materials; each has its specific advantages and disadvantages. Investigations into mass balances of modern thermal processes show that incinerator emissions can be much smaller than the most advanced standards. If state of the art air pollution control technology is applied, flows of heavy metals and organic substances from incinerators are insignificant in comparison to other emission sources. The new question is what to do with the resulting incineration and filter residues. Results from material flow analysis point to the large potential for future reuse. If long term scenarios are investigated, it seems feasible that certain materials such as volatile metals can be efficiently recycled by thermal processes. It is necessary to develop new strategies in waste management such as combining energy recovery with materials recovery. If introduced on a large scale, such reuse strategies could successfully compete with present waste management trends, which are often based on dilution strategies.

10:00 AM Session 1 (Chair: Mr. Ted Michaels, President IWSA)

■ **Release of Trace Organic Compounds During MSW Decomposition and Environmental Implications of Waste Management Using Landfills and Waste-to Energy**

Prof. Morton A. Barlaz, North Carolina State University.
(barlaz@eos.ncsu.edu)

Landfill gas contains numerous speciated organic compounds (SOCs) including alkanes, aromatics, chlorinated aliphatic hydrocarbons, alcohols, ketones, terpenes, chlorofluoro compounds and siloxanes at ppm to ppt levels. The source, and rate and extent of release of these compounds are poorly understood. The objective of this study was to characterize the release of SOC and of the regulated non-methane organic compounds (NMOCs), during the decomposition of residential refuse and its major biodegradable components (paper, yard waste, food waste). Tests were carried out under anaerobic and also aerobic conditions in laboratory 8-liter reactors operated to maximize decomposition and the rates of NMOC and also CH₄ release were measured for refuse, paper, yard waste and food wastes. NMOC release was faster than CH₄ production in all treatments. Terpenes and ketones accounted for 32 to 96% of SOC release in each treatment, while volatile fatty acids were not a significant contributor. Release in aerobic systems points to the potential importance of composting plants as an emissions source.

Life-cycle assessment (LCA) provides an analytical framework for an objective comparison of alternative processes. The results of two LCA case studies will be presented. The first is a hypothetical comparison of landfill disposal and mass burn combustion. The second analyzes alternatives for solid waste management in the State of Delaware using an optimization model. The results of both studies illustrate the benefits of combustion with respect to energy recovery and mitigation of greenhouse gas emissions.

10:30 AM Coffee Break (15 minutes)

10:45 AM Session 1 (continued)**■ Recent Developments in WTE Grate Combustion (“Mass Burn”): Technology and Implementation**

Dr. Edmund Fleck, Managing Director, Martin GmbH für Umwelt- und Energietechnik; Chairman, European Suppliers of Waste to Energy Technology (ESWET). (*Edmund.Fleck@martingmbh.de*)

Waste incineration plants were built as early as the 1850s. However, it took another century for waste incineration to really start playing a role in treatment of municipal solid waste (MSW). Landfill space became scarce in some countries while the standard of living and, thus, the awareness of environmental quality increased. Legislation was put in place in many countries, paving the way for substantial improvements in incineration technology. Steam boilers recovered the energy contained in the MSW and Flue gas treatment started with the removal of particulate matter. Removal of acid gas components and heavy metals was made mandatory, followed by the requirements to reduce emissions of NO_x and organic compounds, most notably dioxins and furans. With the adoption of EU Directive 2000/76, all EU member states have been required to meet emission limits that are the most stringent for any industrial process by the end of 2005. Today, waste-to-energy is accepted in many countries as an important step in the overall sustainable waste management scheme. The priority of waste reduction and recycling is recognized as are the drawbacks of landfilling, mainly in terms of greenhouse gas emissions, and long-term liability with risks of soil and groundwater pollution. In addition, MSW is more and more recognized as a resource - of both energy and materials, many efforts are under way to improve recovery efficiency, and some countries (e.g., Italy, Netherlands etc) are granting financial incentives for higher energy recovery.

Martin GmbH has concentrated very successfully on the combustion of MSW, first on the Martin reverse-acting grate and, in 2002, by acquiring the forward pushing horizontal grate of Alstom. Since 1955, over 660 WTE lines have been installed using the Martin technologies. Technology improvements have included adaptation to varying calorific value of the MSW, reduction of combustion related emissions, reduction of fly ash, reducing boiler corrosion, and use of the combustion residues. This paper will describe highlights in the development history of Waste-to-Energy and its current role in general. It will then present important key facts of the Martin experience and ongoing development effects to advance this important technology.

■ Industrial Installation and Testing of an Innovative Catalyst System for NO_x Removal in WTE Units

Dr. Antonio Bonomo, Director, Energy Division, ASM, Brescia, Italy; Chair, Technical-scientific Committee, FEDERAMBIENTE, Rome; President, Euroheat & Power (European Association of District Heating and Cooling), Brussel. (The ASM Brescia WTE is the recipient of the WTERT 2006 Industry Award) (*abonomo@asm.it*)

In 1997, in the construction phase of Brescia WTE plant (in operation since 1998 with 2 x 88.3 MWth units and since 2004 with the 3rd 100 MWth unit), a modification was introduced to the project, with \$ 5 million additional investment, in order to leave the provision for possible future installation of a “High Dust” catalyst, integrated in the boilers.

All three units have been equipped with Selective Non-Catalytic Reduction (SNCR) system, still in operation with rather good results (80 mg/Nm³ NO_x). Even better results

can be obtained with a catalyst, but the conventional solution requires reheating the gases and, therefore, considerable energy losses.

For these reasons ASM, in line with the “continuous improvement” stated the ISO 14000 certification of the Brescia WTE, decided to test an innovative “High Dust” Selective Catalytic Reduction (SCR) that is integrated in the boiler. The main disadvantage of this process is that the catalyst is poisoned by the particles in the flue gas. Therefore this technology has not yet implemented industrially.

After an extensive investigation, ASM decided to test a full scale application of High Dust SCR to #2 unit of the WTE plant. This research project has been approved and partly financed by the E. U Commission, within the program “NextGenBioWaste” (Innovative Demonstration for the Next Generation of Biomass and Waste combustion plants for energy recovery and renewable electricity production). In 2005, the SCR equipment installation was completed and in March 2006 operation was started. The test project will last four years, in several steps. The first five months of operation are very promising. If this test is proved successful, it could change the state of the art of NO_x control in WTE plants.

■ **Maximum Recycling of Materials and Energy, Minimum Landfilling**

Mr. Hakan Rylander, CEO SYSAV, Malmo, Sweden; and Chair, ISWA Working Group on Thermal Treatment of Waste; Past President ISWA (1996-98). (The SYSAV Malmo WTE was one of the top finalists in the WTERT 2006 Industry Award)
(Hakan.Rylander@sysav.se)

Nine municipalities in southwest Sweden formed SYSAV in 1974. On January 1, 2004, the company’s area of operation increased when a further five municipalities became part-owners. The SYSAV operations are based on a joint business agreement among the part-owners. The eco-cycle approach is the very foundation of the SYSAV operations and the guiding strategy is to invest in a combination of methods to achieve the most recycling possible. Our aim is to continuously improve and through regional cooperation fulfill the increasingly high environmental requirements, improve the cost-effectiveness of the operation and offer the best possible service to the participating communities.

By using a combination of processing methods, SYSAV ensures that as much waste as possible is reused or recycled either as material or energy. Combustible waste is recovered in a WTE facility, as heat to the district heating system and as electricity. SYSAV supplies the district heating system of the City of Malmö with 40% of its demand and by 2008 it will increase to 60%. Garden and park waste are converted to nutrient-rich compost and prepacked soil. Construction and demolition materials are sorted and resold. Wood is shredded into chips and sold as fuel. SYSAV deals with hazardous waste and receives and dismantles electrical and electronic scrap. Waste collection and transport is handled by the municipality’s themselves and by contractors engaged by municipalities and companies. In 2005, the SYSAV Group received a total of 871,000 tonnes of waste. Over 91 % was recycled as energy or materials and less than 9% was landfilled.

12:15 PM **Lunch (to be served in Faculty Room of Low Memorial Library, please see directions at the last page)**

The sponsorship of this luncheon by Integrated Waste Services Association is gratefully acknowledged



2:00 PM **Session 2 (Chair: Prof. Marco Castaldi, Columbia University)**

■ **WTE Carbon Emission Credits: Now and Opportunities for the Future**

Dr. Frank Zeman, Lenfest Sustainable Energy Center, Earth Institute at Columbia University.

The biomass fraction of MSW is considered in the E.U. and in several states as “carbon-free” renewable energy. Also, additional carbon savings are obtained by avoiding the emission of non-captured methane at landfills. In the foreseeable future, the carbon credits of WTE can be increased by a) the use of “waste” steam for District Heating and b) the capture of carbon dioxide in the WTE exhaust gas. (Note: WTERT is collaborating with Beta Analytic of Florida and Wheelabrator Technologies in carbon dating tests that will show the ratio of biomass- to fossil fuel-derived fuel in MSW combusted in a WTE over a period of time.)

■ **Comprehensive Comparison of Energy Recovery from MSW in “Dedicated” WTEs and RDF in “Non-Dedicated” Cement Kilns and Power Plants**

Prof. Stefano Consonni^a, Mario Grosso^b, Michele Giugliano^b, and Ms. L. Rigamonti^{b,c}, ^aDep’t of Energy Engineering and ^bDIIAR – Environmental Section of Politecnico di Milano; ^ccurrently WTERT intern. (stefano.consonni@polimi.it)

Following the study presented at the 2005 WTERT Meeting on the assessment of strategies for energy recovery from Municipal Solid Waste in “dedicated” WTE plants, this work extends the scope of the analysis to strategies based on the co-combustion of Refuse Derived Fuel in existing “non dedicated” industrial plants such as coal-fired power plants and cement kilns. Both studies have been supported by Federambiente, the federation of Italian public utilities operating in the environmental sector.

Consistently with the previous evaluation, the assessment proceeds from the unsorted, “Residual” Waste left downstream of Material Recovery and follows its fate along a number of alternative routes according to an LCA approach. In this presentation the focus is on the routes going through “non-dedicated” plants, for which we develop mass, energy, environmental and economic balances that specifically account for two recent Italian experiences.

The overall energy balance is based on the performance estimate of the waste-to-energy plant and of the co-combustion unit by means of a dedicated design and simulation tool developed at Politecnico di Milano. Results have been validated with actual data registered at state-of-the-art plants currently operating in Italy. Energy consumption of the RDF production plant and of the handling of all the materials (waste, RDF, solid residues) were also included in the energy balance.

The overall environmental balance takes into account all the fluxes of pollutants released in the environment by each process, including both direct (those released from the waste treatment plants and from the transport of the materials) and indirect emissions (those related to the production of the reactants and to the construction of the plants). The positive emissions are compared with the avoided emissions, that are those released from fossil fuel-fired power production plants which produce the same amount of energy in the case of dedicated incinerators, or those released from the amount of fossil fuel displaced by the waste in the case of co-combustion.

Results are discussed in terms of specific energy production, of emission inventories and of the principal impact indicators. For dedicated plants, energy recovery (electric and thermal) plays a basic role in the environmental balance; if this is combined with the very stringent air emission limits currently in force for WTE plants, a positive net result is obtained (i.e. most of the emissions from the WTE plant are lower than those from the power plants producing the same amount of energy). Co-combustion of RDF in industrial plants shows interesting results, too, especially in terms of reduction of greenhouse gas emissions; concerns related to the possible long-term effects of the operation in co-combustion mode call for careful monitoring of the operational history.

Dedicated WTE plants fed directly with Residual Waste appear most suited to large scale waste management systems with a highly concentrated waste production, even more if the WTE cogenerates heat and power. The production of RDF and its co-combustion in industrial plants might be preferable for small scale waste management systems where a facility that can be adapted to co-combustion is available.

The potential of co-combustion on the national scale is finally assessed by referring to the sites and the capacity for cement production now installed in Italy, as well as to the coal-fired electric capacity envisaged for the near future.

■ **Innovative Concepts for Combining WTE and Natural Gas Turbine Power Plants - An Economically Feasible Solution for Rio de Janeiro**

Dr. Sergio Guerreiro, University of Brazil and Petrobras Distribuidora.
(sergiog@rjnet.com.br)

The waste situation in Rio de Janeiro has reached a point that parallels what happened in NYC: Gramacho, the last and largest landfill (8,000 tonnes/day) has reached capacity and should be closed soon. There was a bid to build a new landfill, 40 miles away from downtown Rio, but was cancelled due to lack of environmental permit and strong opposition from the surrounding community. The only certainty is that the price of waste disposal may open the door for a large WTE. The objective of this work is to make WTE more economic by simplifying the design of WTE plants and also increase the amount of electricity generated per ton of MSW. A huge step toward this goal seems to be the combination of NG and MSW as was done at the Zabalgardi, Spain, WTE. However, the cost of the boiler and the high price of NG, a non-renewable fuel, requires further improvement in the design. This can be done by removing the boiler from within the furnace and mixing the hot gases from the incinerator with the exhaust of a natural gas turbine to generate steam in a conventional Heat Recovery Steam Generator.

Currently, a small non-commercial WTE plant in Rio, burning 30 ton/day of RDF and producing 440 KW of power is being revamped to demonstrate the above concept. The objective is to supply 4 MWe to the adjacent University of Brazil campus, 3 MWe from NG and 1 MWe from MSW, i.e. 830 kWh per tonne.

3:30 PM Coffee Break (15 minutes)

3:45 PM Session 3 (Chair: Mr. Steve Goff, Director, Process Engineering, Covanta Energy Corp.)

■ **WTERT Project for Increasing WTE Metal Recovery**

Mr. Werner Sunk, WTER/Earth Eng. Center. (ws2172@columbia.edu)

Part of the WTER effort to increase the amount of metals recovered in the U.S. WTE industry was a survey to determine a) the equipment used for metal recovery at the front- and back-end of U.S. WTE facilities, b) the correct amounts of metals recovered, and c) the distribution in percent between front- and back-end recovered metals. Therefore, a questionnaire was developed and sent to the headquarters of the major WTE companies. Fifty three WTE plants all over the U.S. participated in our survey and provided data for the year 2004.

By comparing the data provided by the responding WTEs with the estimated amounts of ferrous (5%) and non-ferrous (0.7%) metals generated in U.S. MSW, we calculated that 48% of ferrous and 9% of non-ferrous metal input are recovered at these 53 WTE facilities every year. The remainder is landfilled and represents a total revenue loss that could add up to \$162 millions per year.

Mass burn plants recover an average of 43% of the ferrous and 5% of the non-ferrous metals; RDF plants recover an average of 71% of ferrous and 30% of non-ferrous metals, i.e. significant more metals from the MSW input.

Analysis of the front- and back-end recovery at mass burn and RDF plants shows that at mass burn plants only 1% of the ferrous metal is recovered at the front-end and 99% from the ash. In comparison, RDF plants recover 88% of the ferrous metal at the front-end and only 12% after combustion. The breakdown for non-ferrous metals shows that for mass-burn plants 6% of the assumed non-ferrous input is recovered at the front end and 94% are recovered at the back-end of mass burn plants. At RDF plants, only 2% of the total non-ferrous input are recovered at the front-end and 98% on the back-end.

Our analysis shows that there is room for increasing metal recovery of both ferrous and non-ferrous metals at several mass burn facilities, since some WTE plants recover less than 10% of the input ferrous metals. The overall non-ferrous recovery is very low for mass-burn plants and low for RDF facilities. Since the value of WTE metals has increased appreciably recently, due to increased consumption in China, it is a good time to consider plant modifications that will help increase metal recovery.

■ **Reforming Landfill Gas to Syngas** (research by Tracy Jackson, Noah Whitmore, and M.J. Castaldi)

Prof. Marco Castaldi, Columbia University. (mc2352@columbia.edu)

According to the EPA Landfill Methane Outreach Program (WMW Review Issue 2006) landfills generate about 26% of the U.S. methane emissions. Methane is the second most important greenhouse gas (GHG) and globally it accounts for about 18% of the total climate radiative forcing. Since landfilling will continue to be used in the foreseeable future, it makes sense to design landfills that capture the maximum possible amount of methane. However, the use of LFG is plagued by low and fluctuating calorific value resulting in flame instability, higher undesirable emissions and compromised fuel efficiency, due to the periodic need for supplemental fuel. Also, because of the low heating value of LFG, most engines need to be modified considerably and, once modified, they require a consistent composition of the fuel (e.g. 50% CH₄ and 50% CO₂). When the methane content drops, secondary fuel has to be added to ensure stable combustion of the engine. This variation leads to higher pollutant emissions, such as NO_x, CO and unburned hydrocarbons (UHC) and emissions waiver are often required before LFG thermal energy projects are permitted. The cost of fuel upgrading, need to use specialized

power generators, and permitting costs have prevented widespread use of LFG so that much of the LFG captured is flared off.

This WTERT project is an in-depth study of the potential for partially reforming LFG gas and the effects of the participatory mechanism of H₂ in emissions reduction, subjects that have not been examined much in the scientific literature. The presence of CO₂, N₂, H₂O and some O₂ in the fuel stream makes this system unique with regards to previously examined high energy gaseous fuels such as natural gas, propane, etc. An investigation into the catalytic reforming of landfill and anaerobic digestion biogas (LFG) to synthesis gas has begun. Thermogravimetric analysis work was performed over 0.5% Pt/ γ -Al₂O₃ and Au/ γ -Al₂O₃ catalysts. Variables such as reforming temperature, CO₂ concentration, and effect of pre-reduction have been studied. EDX analysis was used to confirm the deposition of carbon on the catalyst surface.

■ A Frank Appraisal of the Future of Using U.S. WTE Ash Outside Landfills

Prof. Frank Roethel, SUNY at Stony Brook and WTERT Research Associate and **Prof. Nickolas Themelis**, Columbia University.
(froethel@notes.cc.sunysb.edu, njt1@columbia.edu)

Mass burn WTE facilities generate bottom ash, from the combustion grate, and “fly” ash, from the Air Pollution Control system. Roughly, six million tons of bottom ash and one million tons of APC ash are generated nationally. The volatile metals and the minute amount of organic compounds that are captured in the APC system end up in the fly ash. In most cases, the two ash streams are mixed with water to form what is called “combined ash”. While combined ash typically is determined non-hazardous in accordance with the TCLP protocol, is it the best way in the long run? Beneficial utilization has been studied to exhaustion in the US and, unlike Europe, has not progressed. The barriers to ash utilization are varied but opportunities for ash reuse are not one of the obstacles. Markets for the processed ash and financial limitations limit the areas where ash utilization can be successful, but there would be many more opportunities if the ash streams were kept separate.

WTERT has equipped a TCLP lab at Columbia and looked into several beneficial uses of WTE ash outside landfills, such as formation of large concrete blocks in Bermuda and remediation of old strip mines in Pennsylvania. We have concluded that by not mixing APC ash with bottom ash, and controlling combustion so as to obtain a low-carbon bottom ash, the chances of using the bottom ash beneficially will increase appreciably. Separating the two streams of ash requires equipment modifications at existing WTEs and also a simple method for processing the APC ash within an existing WTE facility so that it becomes inert, can pass the TCLP test, and be disposed at MSW landfills. With respect to new WTEs or WTE expansions, WTERT definitely recommends that the plant design include separate handling of the two ash streams.

It is believed that readily available and inexpensive technologies to render the APC ash inert are currently available. Removal of the APC ash component will enhance opportunities for large volume applications of bottom ash, reduce significantly the regulatory barriers associated with ash utilization, and move the U.S. closer to the strategies that have been employed in Europe for several years.

5:15 ~ 6:30 PM Poster Session (Foyer in front of Davis Auditorium)

- **Federico Barrai: Trace Contaminant Removal Via Enhanced Mass Transfer Selective Catalytic Reaction**
- **Maxime du Bois and Alexandra Bowen: Waste Management and WTE in France**
- **Heidi Buttermann: Biomass Gasification**
- **Georgia Columbus: Technical Economics Study of the First WTE in Greece (Attica)**
- **Paula Estevez: Technical Economics Study of the First WTE in Chile (Santiago)**
- **Eilhann Kwon: Combustion Reactions of Rubber**
- **Shang-Hsiu Lee: Study of Corrosion of Superheater Tubes Under Controlled Gas-Metal Temperature Gradients**
- **Masato Nakamura: Physical and Stochastic Modeling of Transport Phenomena of Municipal Solid Waste (MSW) Particles on a Traveling Grate**
- **Lucia Rigamonti: Municipal Solid Waste Management in Italy**
- **Priscilla Ulloa: Combined Heat and Power from Waste-to-Energy Plants**
- **Noah Whitmore: Greenhouse Gas Reforming to Produce Syngas**
- **Yue Zhou: Downhole Combustion Method for Methane Gas Production from Methane Hydrate**

6:45 PM WTERT Awards Dinner (Presidents' Room of Faculty House, please see directions at the last page)

The sponsorship of the WTERT 2006 Awards Dinner by the Solid Waste Processing Division of ASME International is gratefully acknowledged



- **Presentation by Prof. M.J. Castaldi of the WTERT 2006 Education Award to Prof. Paul H. Brunner, Vienna University of Technology**
- **Presentation by Prof. N.J. Themelis of the WTERT 2006 Industry Award to the ASM Brescia (Brescia, Italy)**

Friday, October 20, 2006***The Friday session is open to the public*****8:30 AM Registration and breakfast in lobby of Davis Auditorium****9:00 AM Session 4: Waste Management in Large Cities (Session Chair: Prof. N.J. Themelis)****■ The State of WTE in Europe**

Mr. Ferdinand Kleppmann, President, and **Dr. Ella Stengler**, Managing Director, Confederation of European Waste-to-Energy Plants (CEWEP).
(ella.stengler@cewep.com)

CEWEP was founded in 2002 and represents 330 Waste-to-Energy Plants from across Europe: Austria, Belgium, Denmark, Czech Republic, France, Germany, Hungary, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and Switzerland. Its goals are to promote WTE as a renewable source of energy, highlight the fact that recycling and energy recovery are complementary and both divert waste from landfilling, in accordance to the EU landfill ban of combustible waste, and ensure that EU waste policy moved towards a level playing field so that there is no “eco-dumping” from one country of the union to another. CEWEP represents European WTE facilities at the EU level, through analysis of legislation on the environment and by providing information on the Waste-to-Energy sector to the Commission, Council and European Parliament. CEWEP also serves as a platform for the exchange of experience between members and advances scientific, technical and practical aspects of WTE.

■ Discussion of Policies Related to WTE Industry in the E.U. and the U.S.**■ An American in European WTE**

Mr. Jeffrey Harnly, Xcel Energy Company, Red Wing, Minnesota.
(jeffrey.l.harnly@xcelenergy.com)

In coordination with WTERT, Mr. Harnly visited this year several WTEs in Europe. EU continues to be on the cutting edge of WTE technology. More lines are being constructed and existing facilities are retrofit for improved performance and higher capacity. WTE is the most resourceful alternative as compared to Mechanical-Biological Treatment (MBT) and composting. Examples of WTE by-product advances are: Fly ash mixed with asphalt for roads, bottom ash as aggregate, de-icing salt for roads, and refined HCL from the flue gas. A large number of WTEs in the northern nations, such as Denmark, Sweden, and the Netherlands derive revenues from both district heating and electrical generation. Another advantage is the formation of large consortiums of municipalities that have long term contracts with the haulers (10-25 years). Refuse in some states is becoming a competitive commodity, causing new contracts to be agreed to with lower tipping fees. Judicious land usage, reduction in resources required for long distance hauling of waste to landfills, and avoidance of the long term liabilities that are associated with landfills are some other factors to be considered when deciding on methods for the disposal of waste. On the basis of this survey of several EU WTEs*, it was concluded that NYC and other large American cities have the opportunity to develop

a comprehensive waste disposal program, based on recycling whatever can be recycled and combusting the rest in WTEs.

Facilities visited by Mr. Harnly (Jan.-May 2006):

Spittelau – Wien, Austria – Fernwärme Wien GmbH; Arnoldstein, Austria – Karntner Restmüllverwertungs GmbH; Sotec – Freiburg-im-Breisgau, Germany; MVR Müllverwertung Rugenberger Damm – Hamburg, Germany; I/S Reno-Nord – Aalborg, Denmark; SYSAV – Malmö, Sweden; Kristinehedverket – Halmstad, Sweden; Vattenfall Varmer Uppsala AB – Uppsala, Sweden; Clergy-Pontoise – Clergy-Pontoise, Onyx, France; Afval Energie Bedrijf – Amsterdam, Netherlands; Vestforbrænding – Glostrup/Copenhagen, Denmark; Afvalverbrænding Zuid Nederland (AZN) – Moerdijk, Netherlands.

■ **More energy from WTE: District Heating in Denmark and Potential for the U.S.**

Ms. Bettina Kamuk, Ramboll, Denmark and **Ms. Priscilla Ulloa**, WTER. (BKC@ramboll.dk; pau2102@columbia.edu)

This paper will present an overview of the development of District Heating in Denmark and in the United States using Waste-to-Energy (WTE). Currently, all WTE plants in Denmark provide heat for District Heating in Denmark. In fact, 18 % of the national district heating is provided by WTE. In contrast, there are few WTE plants in the U.S. that supply steam for District Heating, most of them only generate power to the grid. As fossil fuel prices increase and new WTEs are located closer to communities so to decrease truck transport, it is expected that DH will be examined for new WTE installations in the U.S. Contrary to intuition heat can be transported, either as hot water or steam over long distances with very low heat losses. The factors that need to be considered in designing WTEs that provide both electricity and heat will be discussed.

10:45 AM Coffee Break (15 minutes)

11:00 AM Session 4 (continued)

■ **Waste Fired Power Plant, City of Amsterdam: Designed for Output of Energy and Materials**

Mr. Hendrikus de Waart, consultant to AEB, presenting on behalf of **Mr. Daan van der Linde**, Managing Director, Afval Energie Bedrijf, Amsterdam, Netherlands. (Note: The AEB Amsterdam WTE was one of the three top finalists in the WTER 2006 Industry Award) (linde@afvalenergiebedrijf.nl)

The City of Amsterdam started the process of waste management some 125 years ago and the combustion of waste in 1919. Over the years, the Waste and Energy Company of the City of Amsterdam (Afval Energie Bedrijf or AEB) has improved the thermal efficiency, increased the quality of the by-products and reduced the environmental impact to negligible levels.

With the start-up of the two high efficiency lines of the WFPP next year, Amsterdam shall be processing 1.5 million tons of solid municipal waste annually, making it the largest facility in the world. Our new WFPP incorporates some 30 or so innovative and unique technologies (10 of which patented). It will produce power with a net electric energy efficiency to the grid of 30%, which we believe is also a world's first.

In addition we incinerate sewage sludge, produce steam, provide district heating and produce and recover valuable materials, all contributing to the operating results.

Even more importantly than economics, is the much reduced environmental impact. Our air emissions are less than 20% of the very stringent limits set by the EU and Dutch regulators. Emissions to surface water are zero and presently less than 1% of the total throughput ends up as an inert landfill. We have designs presently being tested, to make this zero.

WFPP has acquired the “Green Status” which signifies minimal environmental impact. This is also the reason why AEB has sailed through the permitting for the expansion, without a single protest from the community or the NGO’s.

■ **Advancing U.S. Recycling by Means of Improved Data Collection and Analysis**

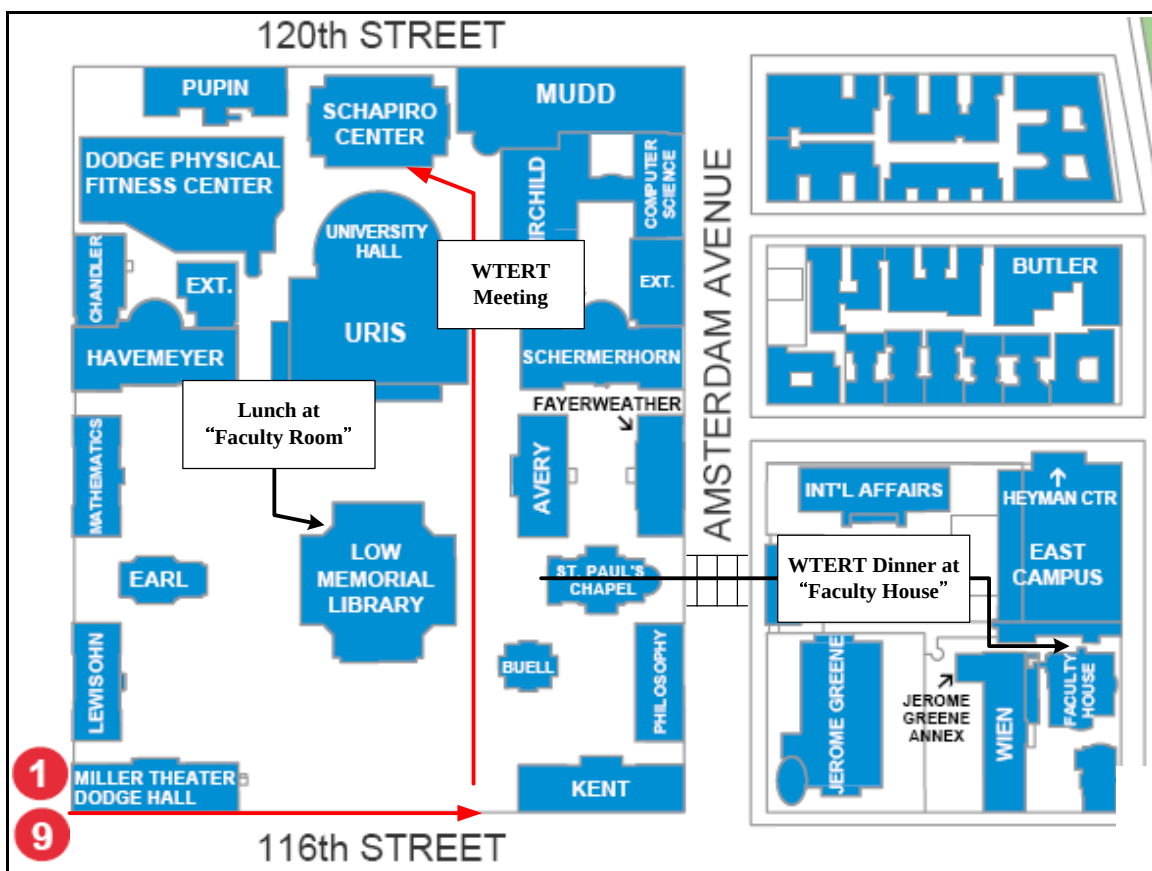
Mr. Scott Kaufman, Manager, EEC Recycling Project and **Prof. N.J. Themelis**, Director EEC, Columbia University.(smk2108@columbia.edu)

The two major sources of US MSW generation and disposition data – the EPA/Franklin Report and the Earth Engineering Center’s (EEC)/BioCycle “State of Garbage” Survey – vary greatly in their reported tonnages. Indeed, for the year 2003, the EPA reported that there were 236.2 million tons of MSW generated. For 2004 (the closest available year to 2003), the EEC/BioCycle survey, based on data provided by the waste management departments of the fifty states, reported 388 million tons of MSW, a difference of nearly 151 million tons, or more than 50 percent. A discrepancy this large cannot be ignored and was discussed this fall with senior officers of the USEPA Office of Solid Wastes (EPA/OSWER). Without accurate measurement of materials flows through the solid waste management infrastructure, it is very difficult to adequately plan the technological, economic, and policy measures necessary to optimize the system. This presentation will highlight EEC’s efforts to improve the accuracy, reliability, and general availability of MSW data. It will also describe the ongoing effort, supported by EPA Regions 3 and 9 and by Aluminum Association Inc., to create at Columbia University a national database of reliable recycling data. The objective is to collect and analyze data from a multiplicity of sources and provide reliable information that will be used to increase collection and processing efficiencies and advance recycling technologies.

- **Panel Discussion:** “Challenges and opportunities for waste management in large urban centers”.

12:30 PM End of Meeting

Directions



Lunch at "FACULTY ROOM" (Low Memorial Library)

