GLOBAL WTERT COUNCIL

Research, education, and information for sustainable waste management

Summary Report of 2018 Activities of WtERT Partner Organizations

(January 20, 2019)

This Report is a summary of the research and other activities of the partner WtERT organizations around the world. The Report shows the breadth and depth of the research, education, and information dissemination activities of the national organizations affiliated with the Global WtERT Council. We thank all who have submitted or contributed to these research activities. The order of presentation is shown below:

National Organizations Activities

WtERT-Brasil Activities in 2018

By Dr. Sergio Guerreiro Ribeiro, Presidente,
WTERT-Brazil (sergiog@wtert.com.br)

1. WTERT Brazil – 1st International Seminar in WM - Brasília

The President of WTERT Brazil ("WtERT_Brasil") made a 90 minute presentation on Global Waste Management at the 1st International Seminar in WM in the Capital of Brazil, Brasília. The event was sponsored by the "Ordem dos Advogados do Brasil – OAB" (Brazilian Bar Association) (https://www.youtube.com/watch?v=JuZidlsH--4&feature=youtu.be); senior authorities were present including the Governor and several officials in charge of the WM policy in the country.

In Brazil, there is a strong lobby against WTE and most waste management companies that own landfills influence the environmental agencies using false arguments to prevent energy recovery from post-recycling materials.

WtERT-Brazil has contributed to public discussion of the European Directives, as well as the current China effort to reduce the number of landfills, emphasizing the need to reduce the organic waste fraction and the limits of recycling using the city of Vienna as good example of how MSW management should be done.

The new elected President, Mr. Jair Bolsonaro, has signalled the current view about MSW and that landfills should change toward a more realist and environmentally sound direction.

2. WTERT Brasil - Forum Internacional de Gestão Integrada de Resíduos Sólidos e Limpeza Pública – Waste Expo – IFAT 2018

WTERT Brasil 20 minutes presentation at Waste Expo/IFAT – BAT for Energy Recovery from MSW (link http://www.wasteexpo.com.br/) . This event is one of the best in the country and after the presentations there was an open discussion panel with the participation of members of the Environmental Ministry of Brazil as well as the director of FOXX company, owner of the first WTE project in Barueri, São Paulo.

3. Partnership with Pontificia Universidade Catolica – Rio De Janeiro

A Master Thesis by Mr. Leandro Andrade Furtado was presented and accepted titled **Hybrid Thermodynamic Cycles for High Efficiency Biomass / Natural Gas Power**

Plants. Dr. Sergio Guerreiro of WTERT Brasil was the advisor on this study and Mr. Furtado has been accepted as candidate for the PhD degree on the same subject. WTE will be included in his PhD dissertation in conjunction with use of landfill biogas, as a total or partial replacement for natural gas.

PUC-RJ and WTERT Brasil completed a detailed study, sponsored by GasBrasiliano, about the increase in GHG emissions when natural gas is introduced in sugar cane mills producing ethanol, sugar and electric energy. The results showed that the overall CO2eq/MWh is reduced when natural gas is introduced, because of the efficiency increase in the electricity generation. This is only true when the natural gas share is small as compared to the biomass share burned in the boiler; which is the case when natural gas is only used to externally reheat the low-pressure steam. A similar conclusion will be achieved for WTE plants using this external reheat scheme.

4. Hybrid Cycles (Biomass/MSW/Natural Gas) Applications -GasBrasilano/ WTERT Project

This research partnership with GasBrasiliano, the natural gas distributor in West São Paulo State, started in 2015 **http://www.gasbrasiliano.com.br/noticias/saiu-na-midia/gasbrasiliano/** and has been recently renewed. So far 10 major ethanol mills were studied and the results indicate a small amount of natural gas can double the net energy export by the cogeneration plant. Two of them are starting phase 2 where more detailed studies will be conducted aiming the construction of the power plants as well as the gas pipeline to bring natural gas to the site. Part of the natural gas can be replaced by the anaerobic digestion of vinasse a byproduct resulting from ethanol production which is very polluting when discarded without treatment.

WtERT-Chile Activities in 2018

By Profs. Rodrigo Navia (Universidad de la Frontera), Luis A. Diaz-Robles (University of Santiago) and Alex Godoy (Universidad del Desarollo).

2018 activities: In the framework of the waste management and research- activities we organized the workshop. **Waste to energy: Energetic valorization of municipal solid wastes** in November 2018 in Universidad de La Frontera, Temuco, Chile, with the presence of Dr. Thanos Bourtsalas (U. Columbia, New York), Dr. Edmundo Muñoz (UNAB, Santiago, Chile), Prof. Francisco Cereceda (CETAM, UTFSM, Valparaíso, Chile), M.Sc. Priscilla Ulloa (Ministry of the Environment, Chile) and Mr. José Marpia Menendez (Ategrus, Spain). In this workshop, state of the art technologies were discusse, also focusing on the projected WTE in the Araucanía Region of Chile. In the workshop around 100 persons participated, representing the public and private sectors as well as academia.

With Dr. Edmundo Muñoz, we have published an editorial in Waste Management & Research (the scientific Journal off ISWA) describing how urban metabolism can be used as a method for assessing the sustainability of cities.

(Muñoz E. & Navia R. (2018) Urban metabolism as a key method to assess sustainability of cities. Waste Management & Research 36, 661-662).

With two colleagues from Pontificia Universidad Católica del Perú, we have completed a project assessing, using the life cycle methodology, the potential benefits of using rice husk as an energy source in Perú.

(Quispe I., Navia R., Kahhat R. (2019) Life cycle assessment of rice husk as an energy source. A Peruvian case study. Journal of Cleaner Production 209, 1235-1244).

The University of Santiago de Chile, committed to the vision of resource recovery from organic waste by means of Waste to Energy technologies, has been developing projects linked to Hydrothermal Carbonization (HTC) since 2015 with the Universidad Tecnica Federico Santa María (UTFSM). Within the framework of a 2015 FONDEF IDeA Project, and with the support of the US DRI, the main Chilean biomasses were clearly identified, analyzing as relevant factors their abundance and seasonal availability: pine sawdust, oats, raps, among others have been treated through HTC. In a first phase of experimentation, mixtures of biomass were carbonized at 220 º C and 1 h, of 14 mixtures

studied 7 showed an increase in calorific value, with respect to crude biomass, greater than 30%, and a considerable decrease in Ash content of up to 80%. In some specific cases, such as pressing of grape-sawdust (85-15% w / w) 96% of energy efficiency was reported, and in two other mixtures: raps-sawdust 70-30% and sawdust 100% higher values were obtained 70% on this parameter. These results can be described as positive, since the solid obtained not only presents an increase in its calorific value, but also emits less contaminants and particulate matter, a fact that was verified by a comparison between pellets obtained from the HTC product (hydrochar) and commercial pellets. The latter emit 9 times more particulate material, the difference can be explained by the hydrophobic properties of the hydrochar and by the migration of chemical components from the original biomass to the liquid by-product of the process, thereby concentrating the carbon and improving combustion.

The next stage, addressed by the BMBF-CONICYT Project, that is carried out jointly with German Institutions (University of Rottenburg and the company GRENOL), evaluated the influence of additives in biomass mixtures, the results indicated that the additives do not increase in form significant energy yield, although they produce more ash. In addition to this, the BMBF-CONICYT Project studied the application of the HTC to the organic fraction of municipal waste (OFUSW), determining a percentage of the organic part close to 52%. The optimum working temperature is 200 ºC with a time of 90 min. The results obtained were a hydrochar of 28 MJ / kg with less than 1% ash. Today this team of researchers is training 4 new doctors in this line, and has been awarded 2 new FONDEF projects from Waste to Energy with EMERES Ltda. And with Celulosa Arauco (HTC from OFUSW and organic sludge from urban wastewater treatment plants). industrial).

A major event was the First International Seminar "Sustainable Waste to Energy", held on January 17, 2018 at the University of Santiago de Chile.

WtERT-China Activities in 2018

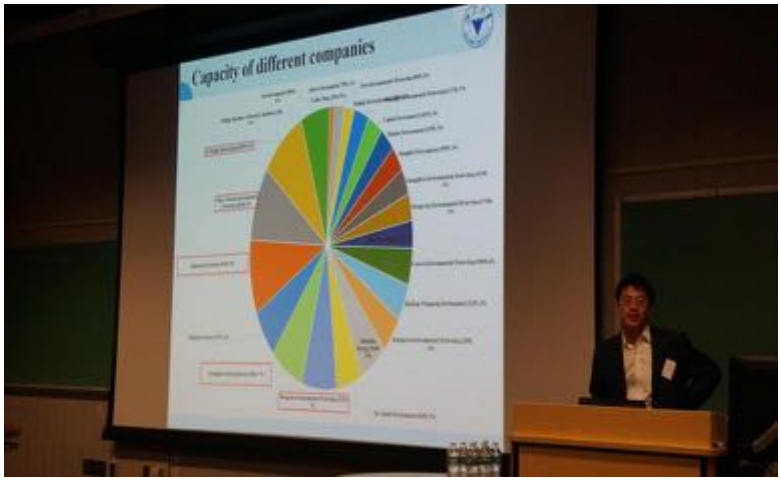
By Prof. Qunxing Huang, Vice Director,
Institute for Thermal Power Engineering (ITPE),
State Key Laboratory of Clean Energy Utilization, Zhejiang University

1. National Key Research Program on waste-to-energy technologies

In Dec. 2018, the proposal of WTERT-China hosted by Institute of Thermal Power Engineering (ITPE) of Zhejiang University on clean waste-to-energy was approved by the National Key Research and Development Program. The total project budget is over US $8.0 million, of which US$3.0 million will be supported by the MOST organization of China. This project is aimed to developing ultra-clean waste to energy technologies and extra high heat recovery efficiencies. Prof. Qunxing Huang is the principal investigator. The top three Chinese waste-to-energy companies, China Everbright International, Jinjiang Group and China National Environmental Protection group have joined in this project. They will be responsible for building new demonstration plants using advanced-design moving grate and Circulating Fluid Bed combustion systems. This project will end in 2022.

2. Participation in the Bi-annual WTERT meeting in New York City

In October, WTERT-China attended the bi-annual meeting at NYC and made a presentation of “WTE progress in China”.



WTERT-China organized the 2018 WTE training workshop for developing countries

ITPE of Zhejiang University representing WTERT-China has organized the second international training workshop of waste-to-energy. Over 23 government officers and engineers respectively from Vietnam, Thailand, Pakistan, Malaysia, Indonesia et.al. have attended this workshop.

3. Publications

Ya-fei Wang, Qun-xing Huang, Fei Wang, Yong Chi, Jian-hua Yan. “Effects of morphology and wavelength on the measurement accuracy of soot volume fraction by laser extinction”, *Measurements in Science and Technology*, 29(2018) 015202.

Ya-fei Wang, Qun-xing Huang, Fei Wang, Yong Chi, Jian-hua Yan. “Brownian dynamics simulation of soot primary particle aggregation in laminar ethylene diffusion flames”, *Physica* A 514(2019) 936-947.

Ya-fei Wang, Qun-xing Huang, Fei Wang, Yong Chi, Jian-hua Yan. “Method for calculating the radiative properties of soot particle ensembles in flames”, *Journal of Quantitative Spectroscopy & Radiative Transfer* 224(2019) 222-232.

Peng Lu, Qunxing Huang, Yong Chi, Fei Wang, Jianhua Yan. Catalytic cracking of tar derived from the pyrolysis of municipal solid waste fractions over biochar. *Proceedings of the Combustion Institute*, 2019, 37(3), 2673-2680.

Peng Lu, Qunxing Huang, A. C. Bourtsalas, Yong Chi, Jianhua Yan. Synergistic effects on char and oil produced by the co-pyrolysis of pine wood, polyethylene and polyvinyl chloride. Fuel, 2018, 230, 359-367.

Peng Lu, Qunxing Huang, A.C. Bourtsalas, Nickolas J. Themelis, Yong Chi, Jianhua Yan. “Review on fate of chlorine during thermal processing of solid wastes”. Journal of Environmental Sciences, 2018.

Bingcheng Lin, Qunxing Huang, Mujahid Ali, et al. “Continuous catalytic pyrolysis of oily sludge using U-shape reactor for producing saturates-enriched light oil”. Proceedings of Combustion Institute [J]. 2018. https://doi.org/10.1016/j.proci.2018.05.143.

Bingcheng Lin, Qunxing Huang, Yong Chi. “Co-pyrolysis of oily sludge and rice husk for improving pyrolysis oil quality”. *Fuel Processing Technology* [J]. 2018, 177: 275-282.

Meng, X., Huang, Q., Gao, H., Tay, K., Yan, J., 2018. “Improved utilization of phosphorous from sewage sludge (as Fertilizer) after treatment by Low-Temperature combustion. *Waste Management* 80, 349-358.

Kai Sun, Qunxing Huang, Ali Mujahid, Yong Chi, Jianhua Yan. Producing Aromatic-Enriched Oil from Mixed Plastics Using Activated Biochar as Catalyst. *Energy & Fuels* [J]. 2018, 32(4), 5471-5479.
Kai Sun, Qunxing Huang, Xiangdong Meng, Yong Chi, Jianhua Yan. Catalytic Pyrolysis of Waste Polyethylene into Aromatics by H3PO4-Activated Carbon. *Energy & Fuels* [J]. 2018, 32(9), 9772-9781.
Kai Sun, Qunxing Huang, Yong Chi, Jianhua Yan. Effect of ZnCl2-activated Biochar on Catalytic Pyrolysis of Mixed Waste Plastics for Producing Aromatic-enriched Oil. *Waste Management [*J]. 2018, 81, 128-137.
Guoshun Zhou, Qunxing Huang, Ben Yu, Hui Tong, Yong Chi, Jianhua Yan, Effect of industrial microwave irradiation on the physicochemical properties and pyrolysis characteristics of lignite, *Chinese Journal of Chemical Engineering*, doi:10.1016/j.cjche. 2017.11.00.
Jun Wang, Chen Sun, Bing-Cheng Lin, Qun-Xing Huang*, Zeng-Yi Ma, Yong Chi, Jian-Hua Yan, Micro- and mesoporous-enriched carbon materials prepared from a mixture of petroleum-derived oily sludge and biomass, *Fuel Processing Technology* 171 (2018) 140–147.
Yijing Tang, Qunxing Huang*, Kai Sun, Yong Chi, Jianhua Yan Co-pyrolysis characteristics and kinetic analysis of organic food waste and plastic, *Bioresource Technology* 249 (2018) 16-23.
Jun Wang, Xu Han, Qunxing Huang, Zengyi Ma, Yong Chi, Jianhua Yan. Characterization and migration of oil and solids in oily sludge during centrifugation. Environ. Technol., 2017:.1-9. *Environmental Technology*, 2018, VOL. 39, NO. 10, 1350–1358.

WtERT-Colombia Activities in 2018

By Sr. Enrique Posada, Presidente, WtERT-Colombia and Ms.Catalina Jaramillo
(catalinajara107@gmail.com}

Waste to Energy Research and Technology Council (WTERT) – Colombia was established as the result of the efforts of the Colombian Association of Engineers (ACIEM) and its chapter of Antioquia and the Earth Engineering Centre (EEC) of Columbia University, New York, with the goal of proposing and fostering solutions and understanding of the current challenges in sustainable waste management, with emphasis in the energy valorization of waste.

WTERT-Colombia was established in 2016, conformed with representatives from University, Society, State and Productive Sectors. It seeks to stimulate research, to contribute to identify and divulge different methods and technologies for energy use and waste management, especially for Urban Solid Waste, actively seeking the participation of industrial and governmental organizations interested in promoting sustainable waste management. The following is the list of current members and their associations:

Name	Email	Sector	Organization
Enrique Posada	enrique.posada@hatch.com	Productive	HATCH-Colombia
Gabriel Naranjo	ganapiz@une.net.co	Society	ACIEM
Hugo Ospina	hugo.ospina@yahoo.com	Society	ACIEM
Walter Ospina	icatersas@gmail.com	Productive	ICATER S.A.S.
Juan Daniel Martinez	juand.martinez@upb.edu.co	University	Universidad Pontificia Bolivariana (UPB)
Farid Chejne	fchejne@unal.edu.co	University	Universidad Nacional Sede Medellín
Javier Hurtado	javierignaciohurtadohurtado@gmail.com	Productive	ALICO (advisor)
Nicolas Alveiro Echeverry	diputadonicolas@hotmail.com	State	National Congress of Colombia
Alejandro Hincapié	alejandro.hincapie@rutan.co	State	Ruta N
Hernán Giraldo	hdgiraldo@ces.edu.co	Univsersity	Universidad CES

In general, WTERT Colombia holds meetings every three weeks, to discuss current actions and plans, to propose and plan activities, suggest contacts and projects to be executed, among other topics.

In every meeting, Waste to Energy topics are presented and discussed among the members, with one of them being in charge of presenting the technical subject in the subject matter of their knowledge.

Acts are kept for all the meetings.

The following slides show the members.

WTERT Colombia seeks also to be present in the different events in the country related to waste management. For this, it establishes and maintains relationships and conducts technical visits. Also, looks for the creation of a database of people and companies, experts and interested in the subject, in order to participate in projects, proposals, review of works, or activities related to the subject. One of the important objectives is to seek funds and financial resources to support its activities in association with ACIEM.

Another activity is the management of social networks, with the generation of content for divulgation purposes, the promotion of events, courses, and the dissemination of technical and institutional information.

REPORT OF ACTIVITIES IN 2018

Meetings and activities related to the WTERT council

In the first semester of 2018, the council dedicated a good part of its meetings to organize the second Panamerican Conference in waste to energy which was held in Medellin from June 6 to 8. Many subjects were considered, among them:

- Contacts with companies and experts from several countries and with embassies seeking support. In this way it was attained to count with an important group of international presenters.

- Contacts with universities and research groups and definition of procedures to attract papers and presentations at the conference.
- Discussion of activities to invite people, define the site and all the related logistics. In this sense. very important relationships were established with Politécnico Colombiano and Universidad CES, two universities that supported all the logistics of the conference.
- Discussions related to the financial and economic aspects of the conference.
- Organization of WtERT-Colombia meetings.

Other activities related to the Council Meetings

Technical presentations of the members in the reunions. Related to several themes:

- Research on pyrolysis at UPB
- Research on gasification and waste combustion at Universidad Nacional
- Studies of cost and benefit in gasification of biosolids at Hatch Colombia
- Organic waste treatment
- Basic technologies for waste to energy mass burning.

Preparation of chapter on waste to energy regulations and possibilities in Colombia, prepared as a chapter for an Elsevier publication being prepared by experts in Argentina and Brazil. The material was prepared by some of the members of the council and discussed in some of the meetings.

Other activities

- Meetings with Tapio Antilla consul of Finland and Jarmo Kuuttila Finland Embassy; with delegates of the France Embassy and the South of Korea Embassy in Bogotá to present WTERT Colombia and seek opportunities.
- Coordination of a visit to the existing WtE Plant In the San Andres Island in Colombia, which is not working, after seven years of its inauguration. Interview with personnel at SOPESA, the plant operator.
- Discussions and preparation of report on the San Andres Plant.

Presence and talks in events throughout the year

During this year, WTERT was part of some important events and fairs in the country, as illustrated as follows:

- Exposolar Fair, Plaza Mayor. May 31, june 1st y 2nd of 2018.

Talks: June 1st. Presentation WtERT Council by: Mr. Gabriel Naranjo and Walter Ospina WtERT Council Members.

- "2do encuentro Internacional de movilidad eléctrica", Centro de eventos El tesoro. 26th y 27th of september of 2018.

- Expo- Ingenieria Fair, Plaza Mayor 16th to 19th of October of 2018.

Talks: October 16th "Waste to Energy". By: Professor Farid Chejne, WtERT Council Member.

- Semana de la Ingeniería ITM, Centro Cultural ITM Fraternidad, 6th to 9th of November.

- Exporesiduos Fair, Jardín Botánico de Medellín. 14th to 16th of 2018.

Talks: November 15th and 16th of 2018. "Beneficios Económicos y Estratégicos de la generación de energía a partir de RSU", aplicación del caso en Colombia. By: Enrique Posada, President WtERT Council

“Viabilidad de una planta de biógas en un botadero o relleno sanitario. Caso de estudio botadero Marmolejo de Quibdo". By: Walter Ospina WtERT Council Member.

“Pirólisis de llantas en un sistema continuo”. By Juan Daniel Martínez

Conference Organized:
Second Panamerican Conference on Waste to Energy

This important event, which was the highlight of the WTERT Colombia activities in this year, took place on June 6th to 8th, 2018 at the CES University, Poblado Medellín. There were 8 keynote lectures and 21 oral presentations, given by national and international participants, focused on the main topics of the event. Additionally, there was a closing forum with the participation of Jaime Slomianski from CDMX (City of Mexico), Prof. Federico Casares from Veolia France and engineer Mauricio Giraldo from Argos (a cement making conglomerate from Colombia), who presented their conclusions of the event together with engineers Gabriel Naranjo and Walter Ospina.

The event included Commercial exhibitions, where companies of the sector exposed their products, services and experiences with the assistants.

Some of the main results of this event were the following ones:

There was a interesting set of technical presentations and papers presented by different researchers from universities and companies in Colombia and abroad. It is evident that the valorization of waste is a theme that concerns the local university teachers, which includes the study of WTE technologies, in the presenting countries. This shows that there are opportunities to apply this and explore and assess the potential of MSW, in some of the municipalities Latin American, for example, studies conducted by universities to characterize and estimate the calorific value of MSW and studies to determine the prefeasibility of WTE technologies in small, medium and large municipalities of Latin American countries.

Companies in the industrial sector, cement, steel and agricultural, showed, through the exhibition of ongoing projects, that they are already applying WTE technologies to enhance certain types of waste. For example, the cement companies that use the tires of the vehicles and the african palm crops that use the waste to produce biogas. In these

cases, it is necessary to put the industrialists and public officials in contact, so that they bring experiences and encourage the municipalities to undertake this type of project.

The experiences shared by public officials and the City of Mexico and the State of Mexico, as city and state, pioneers in Latin America in the management and approval of two WTE projects that apply the incineration of MSW, shows that if it is possible to convince to the environmental authorities and the community in general to accept this type of technology.

The work of WTE plant suppliers, such as Babcock and Wilcox, and Veolia, to financially structure WTE projects, together with municipal and departmental governments, to make the projects viable, is a lesson for project engineers and public officials who must promote this type of projects.

There were also very good presentation on the treatment of organic waste, based on the experiences in Europe. Also prof Bourtsalas from WTERT USA presented the main aspects of the WTE technology. ETERT Colombia took him also to meetings and talks with the AMVA (Environmental Authority for the Aburrá Valley region), EMVARIAS - EPM (the local utility in charge of handling waste and of the landfill site) and with one of the local universities.

Among some of important people from around the world with knowledge about waste to energy that presented lectures, we had two special guests related to WTERT.

Right: Athanasios Bourtsalas WTERT USA - Earth Engineering Center, Columbia University, New York, USA.

Talk: “Developing waste management systems that recover materials and energy in Colombia”
Left: Arun. D Sawant WTERT INDIA Council.
Talk: “Equipment manufactures for Waste to Energy technology in India”

First Panamerican meeting of WTERT Councils Meeting:

WTERT COLOMBIA was able to organize this meeting in parallel with the Second conference. There was a wide exchange of experiences among the attendees. It is highlighted:

- The experience we have in WTERT United States and the interest in supporting developments in Latin America based on all the knowledge developed, the availability of experts to help develop local projects and train people.
- The complexities of Colombia for the development of WTERT projects related to the size of the necessary investments and the orientation that the country has had towards landfills.

Entities such as EMVARIAS-EPM are examining various possibilities for the use of waste. Comments were made on the options of promoting own technology, including through joint work and support with foreign suppliers.

Technical visits: La Pradera Landfill

On June 4, a technical visit was made to the "La Pradera" Landfill with Prof. Athanasios Bourtsalas - WTERT USA Council and Eng. Bruno Mathews from Belgium, the WTERT Colombia director, Mr. Gabriel Naranjo and the WTERT Council president. Colombia Mr. Enrique Posada. The photographs illustrate the visit, which was very important, because it allowed the experts to have first-hand information about what is a local sanitary landfill, which is modern in many aspects, well managed and equipped with a sophisticated wastewater treatment plant (for leachates), which was visited in detail with the kind collaboration of the company VALREX TEPSA, designer, supplier and operator of such plant and the intervening company (TICSA) and the ONDINA operator.

The entire visit was possible thanks to the collaboration of EMVARIAS - EPM and its officials, which allowed visiting all the facilities in detail and answering the questions of the experts. The visit was accompanied by Adriana Aguirre, responsible for the operation of the leachate plant (ONDINA), Mariluz Durango and Victor Cervantes of the intervener of the leachate plant (TICSA) and Santiago Gonzáles of EPM-EMVARIAS.

Central Sopesa- San Andrés (WTE plant)

On October 30th, a technical visit was made to the "WTE Plant in San Andres Islas" by engineer Walter Ospina, WtERT Council member.

This plant, situated in an island and built with government support (with an investment of around US 17 million) based on a mix of local and Indian technology, should have been a timely model to demonstrate that the technology of the incineration of MSW is more friendly to the environment and to humans, than landfills, which are often not filled or sanitary, as is the case with the one at the island. Unfortunately, it has not worked properly since it was commissioned some six years ago, and it is not functioning. A major problem is that it was designed with two locally made and designed rotary furnaces which apparently require a previous separation of the MSW bay means of some system which is not installed yet. All this has caused red tape, bureaucratic and legal situations that have not been resolved yet.

WTERT is trying to help with this and a proposal (a conceptual study) will be presented to the responsible actors (The local state government, SOPESA the operator and the environmental authorities) to seek a friendly and conciliatory approach, based on a technical study of the plant and its real capacities to process incoming waste and to process of the accumulated waste in the land fill site. (In principle the plant is able to receive 120 tons/day of waste while the island generates about 40 per day). So far, the Comptroller's Office, the Attorney General's Office, etc.), Council of State, Court of San Andrés, have entered into the picture but it is not clear how it is going to be resolved.

That, which should have been the star project in the waste sector, to show how these types of plants help to conserve maritime and river waters, and to keep them away from the leachates produced by landfills on the shores of the sea and rivers, does not operate because of the problems and misunderstandings among the different institutional actors.

This allows us to see the inabilities, and lack of wisdom of the public sector to do proper Project Management, as indicated by the Project Management Institute (PMI) and common practice engineering procedures. WTERT Colombia sees clearly that good engineering practices are fundamental in this sense and it is trying to divulgate these principles.

The WTERT-Colombia Council hopes, for the good of the Colombian waste sector in its final disposal component, that the WTE plant will start operating as soon as possible, to continue with its work to promote thermoelectric plants that use RSM, counting on a project that can be shown to the mayors and governors of Colombia, to motivate them to apply this technology.

Some aspects of the WTE plant in San Andres

Presence at UPME meeting at Bogotá

UPME the unit of Energy Planning for the Ministry of Energy and Mining is doing a project on the application of waste to energy to municipal towns and cities in the country. WTERT was invited to a meeting in Bogotá where several technologies on WTE and organic digestion were presented, including several projects that are currently being proposed on some cities. There we explained our goals and fields of work.

While this project is a very welcome initiative, we saw that there is a tendency to give preference to zero waste or 100 % recycling on the part of many of the attendants to the meeting, which were mostly government environmental oriented officers and experts. The alternatives presented include some non-tested options and also the well known WTE ones.

International events and talks:

2018 EEC/WtERT BI-Annual Conference New York, USA.

On October 3rd of 2018, at the University of Columbia, New York, United States, there was a meeting of attendants form several countries with Wtert Global in the Columbia University and at Prof. Themelis house. Colombian WTERT president engineer Enrique Posada, met with them accompanied by publicist Catalina Jaramillo from the communications area of ACIEM Antioquia and the Wtert Colombia Council.

There were conversations regarding the working methodology of the WTERT Colombia Council and the possibilities of doing a WTE project in Colombia.

On October 4th and 5th, 2018, the Earth Engineering Center of Columbia University organized at the City College (EEC | CCNY) 2018 EEC / WTERT Bi-Annual Conference.

It included speakers from around the world who represent the global image on best waste management practices.

The conference presented the bases to generate a broad perspective regarding the sustainable management of waste and how to convey the correct messages regarding the generation of waste, recycling, recovery of materials and energy. As also some of them had

presentations and discussions on aspects and technical processes, perspectives of local municipalities, industry, people and regulations. The main message of the conference was that the circular economy is coming. Good engineering practices can be achieved there, but efforts to manage the increase in waste streams must be strengthened in an appropriate way.

There was a talk on October 5th, at the meeting City College of New York on the subject ”Need for Sustainable Waste Management in Colombia” given by Enrique Posada, President WTERT Colombia Council.

In it, it was shown that in Colombia, a country located in South America, with special historical, geographical, demographic and cultural antecedents that play an important role in the genesis of many problems, including waste management there is a clear need for sustainable waste management, but also there are important barriers. Some of them were considered and discussed in relationship to options for developing WTE projects. The Colombian electricity companies seem to consider WTE projects that produce electricity only from the point of view of comparing investment cost per kilowatt installed and the cost of generation per kilowatt-hour, to hydroelectric, wind or solar projects.

This in general leads to conclude that the generation of electricity from MSW is neither profitable, nor viable. This conclusion is also felt in the companies and entities of the waste sector. Of course, in this way, the integral, comprehensive picture is not included. So, the waste sector and the communities must consider a more sustainable and broader perspective and see electricity generation as one aspect of WTE and not the only goal. The interests of the electricity sector and the waste management sector, apparently, are not the same and do not seem to coincide. But there is a common ground to consider,

which is sustainability and the need to integrate solutions looking for the real (evident and hidden) cost and benefits to society.

To help provide some perspective on this matter, the authors present also a model of application of WTE to solid waste in Colombia.

Plans for 2019

Preparation and developing of a 100-hour course on WTE, in alliance with local university institutions.

In this sense, The Wtert Colombia Council, the Colombian Association of Engineers ACIEM, Antioquia Chapter, together with the Remington University Institution, present the first Diploma course in Energy Recovery of Solid Waste, which is aimed at engineers, officials and managers of environmental authorities in the region and personnel of technological vocation with interest in the valuation and rational use of solid waste.

By March 2019 this innovative, accessible and high-level academic proposal will be made to train those interested in this subject so close to everyone's daily life.

It has a duration of 100 hours, it will be held twice a week, for 4 hours at UNIREMIGTON University at Medellin, presenting the basis for the energy recovery of waste. There will be a team of expert teachers in the subject. This diploma will serve and will allow us to continue advancing and have more knowledge about Waste to Energy waste energy recovery.

Preparation of documents on cost/benefit analysis of WTE

WTERT will prepare talks and documents in this area

Establishing demonstrative projects with our university associates

WTERT will seek to establish a working base with students belonging to the research groups of the participating universities, to propose and develop projects

VISITS

WTERT is planning to organize several visits either to China, Ciudad de México o Plam Beach to visit projects there and establish links and get experience applicable in Colombia.

PREPARATION OF PROJECT OF LEGISLATION FOR WTE IN COLOMBIA

WTERT will prepared a draft of a possible law to impulse WTE to be presented and discussed with the support of our WTERT council member Congress man Nicolás Albeiro Echeverri

WtERT- France Activities in 2018

By Prof. Ange Nzihou, (Chair) Ecole des Mines Albi

AWARDS

Professor Ange Nzihou was awarded the Grand Prix 2018 of the French Academy of Sciences in collaboration with the Institut Mines Telecom. This prestigious distinction is intended to reward a scientist who has made an outstanding contribution and through a recognized body of work in the fields of sciences and technologies of the digital transformation in industry; sciences and technologies of energy transition; or environmental engineering. Prof. Nzihou was recognized for his contribution on sciences and technologies of energy transition.

This Prize is awarded without any requirements regarding nationality, to a scientist working in France, or elsewhere in Europe, and whose research has led to the emergence of innovations and disruptive approaches, and contributed to partner-based research with companies.

The Prize was given among the Academician during 2 official ceremonies in Paris at the Academy of Sciences on November 20 followed by lectures of the laureates on November 22.

INTERNATIONAL NETWORKING AND CONFERENCE

WasteEng conference Series in collaboration WTERT France and WTERT Global Council has organized the WasteEng2018 conference in Prague (Czech Republic) from July 2 to 5, 2018. WasteEng Conference Series has reached an outstanding international recognition with participants from over 50 Countries for each issue during the last 10 years. Following the event WasteEng2014 held in Rio de Janeiro (Brazil) in August 2014, WasteEng2016 in Albi (France) in May 2016, the WasteEng2018 Conference was held successfully from July 2 to 5, 2018 in Prague (Czech Republic). 525 abstracts from 61 countries were presented at this 7th issue of the WasteEng Conference Series that features cutting-edge R&D and address barriers related to the Conversion of Biomass and Waste to Energy to Added-Value Materials. The conference also emphasizes life cycle assessment and technologies/processes/practices that reduce emissions.

WASTE AND BIOMASS VALORIZATION JOURNAL

Worldwide and renowned research teams in the field of Waste to Energy and Added Value Materials in *Waste and biomass Valorization* (http://www.springer.com/engineering/journal/12649).
This journal is gaining an outstanding reputation. The 2017 Impact Factor is 1.874. Each year 1 Volume with 12 issues is published.

PUBLICATIONS IN PEER REVIEWED INTERNATIONAL JOURNALS

WTERT France researchers at IMT-Mines Albi published papers in renowned peer reviewed journal. A selection of papers for 2018 is given below:

1) NZIHOU A., B. Stanmore, N. Lyczko, D. Pham Minh. The Catalytic Effect of Inherent and Adsorbed Metals on the Fast/Flash Pyrolysis of Biomass: A Review. Acceted in Energy, December 2018

2) O. W. Awe, J. Lu, S. Wu, Y. Zhao, NZIHOU A., N. Lyczko, D. Pham Minh, Effect of Oil Content on Biogas Production, Process Performance and Stability of Food Waste Anaerobic Digestion. *Waste and Biomass Valorization*, 9(12): 2295-2306, 2018
3) R. Munirathinam, D. Pham Minh, NZIHOU A., Effect of the Support and Its Surface Modifications in Cobalt-Based Fischer–Tropsch Synthesis. *Industrial & Engineering Chemistry Research*, 57(48): 16137-16161, 2018
4) D. Pham Minh, T. J. Siang, D. N. Vo, T. S. Phan, C. Ridart, NZIHOU A., D. Grouset, Chapter 4 - Hydrogen Production From Biogas Reforming: An Overview of Steam Reforming, Dry Reforming, Dual Reforming, and Tri-Reforming of Methane. *Hydrogen Supply Chains Design, Deployment and Operation*, 111-166, 2018
5) J. Dong, Y. Tang, NZIHOU A., Y. Chi, E. Weiss-Hortala, M. Ni, Z. Zhou, Comparison of Waste-to-Energy technologies of gasification and incineration using life cycle assessment: case studies in Finland, France and China. *Journal of Cleaner Production*, 203: 287-300, 2018
6) M. Hervy, A. Villot, C. Gerente, D. Pham Minh, L. Le Coq, E. Weiss-Hortala, NZIHOU A., Catalytic cracking of ethylbenzene as tar surrogate using pyrolysis chars from wastes. *Biomass and Bioenergy*, 117: 86-95, 2018
7) L. M. Romero Millan; F. E. Sierra Vargas; NZIHOU A., Steam gasification behaviour of tropical agrowastes: A new modeling approach based on the inorganic composition. Accepted in Fuel, 2018.
8) P. M. Nigay, NZIHOU A., C. E. White, W. O. Soboyejo, Removal Mechanisms of Contaminants in Ceramic Water Filters. Accepted in Journal of Environmental Engineering, 2018
9) P. M. Nigay, NZIHOU A., C. E. White, W. O. Soboyejo, Accumulators for the Capture of Heavy Metals in Thermal Conversion Systems. *Journal of Environmental Engineering*, 144(12): 04018118, 2018
10) A. Ephraim, D. Pham Minh, D. Lebonnois, C. Peregrina, P. Sharrock, NZIHOU A., Co-pyrolysis of wood and plastics: Influence of plastic type and content on product yield, gas composition and quality. *Fuel*, 231: 110-117, 2018
11) D. Pham Minh, T.J. Siang, D.-V. N. Vo, T.S. Phan, C. Ridart, NZIHOU A., D. Grouset., Hydrogen production from biogas reforming: an overview on steam reforming, dry reforming, dual reforming and tri-reforming of methane. In: *Design, deployment and operation of a hydrogen supply chain*. Editor: C. Azzaro-Pantel. Publisher : Elsevier, Chapter 16, Published in June 2018
12) B. Rego de Vasconcelos, D. Pham Minh, N. Lyczko, T. S. Phan, P. Sharrock, NZIHOU A., Upgrading greenhouse gases (methane and carbon dioxide) into syngas using nickel-based catalysts. *Fuel*, 226: 195-203, 2018
13) T. S. Phan, D. Pham Minh, D. Grouset, NZIHOU A., Thermodynamic Equilibrium Study of Methane Reforming with Carbon Dioxide, Water and Oxygen. *Journal of Clean Energy Technologies*, Accepted April 2018

14) E. Daouk, R. Sani, D. Pham Minh., NZIHOU A., Thermo-conversion of solid recovered fuels under inert and oxidative atmospheres: gas composition and chlorine distribution. *Fuel*, 225: 54-61, 2018
15) Said M., Cassayre L., Dirion J.L, NZIHOU A., Joulia X., Influence of nickel on biomass pyro-gasification: coupled thermodynamic and experimental investigations. *Industrial & Engineering Chemistry Research* Manuscript ID: ie-2017-05201s.R2, Accepted in February 2018
16) S. Berhanu, M. Hervy, E. Weiss-Hortala, H. Proudhon, M-H. Berger, A. Chesnaud, M. Faessel, A. King, D. Pham Minh, A. Villot, C. Gérente, A. Thorel, L. Le Coq, NZIHOU A., Advanced characterization unravels the structure and reactivity of wood-based chars. *Journal of Analytical and Applied Pyrolysis*, 130: 79-89, 2018
17) J. Dong, Y. Tang, NZIHOU A., Y. Chi, E. Weiss-Hortala, M. Ni, Life cycle assessment of pyrolysis, gasification and incineration waste-to-energy technologies: theoretical analysis and case study of commercial plants, *Science of the Total Environment*, 626: 744-753, 2018
18) M. Hervy, D. Pham Minh, C. Gerente, E. Weiss, NZIHOU A., A. Villot, L. Le Coq, H2S removal from syngas using wastes pyrolysis chars. *Chemical Engineering Journal*, 334: 2179-2189, 2018
19) T. S. PHAN, A. R. SANE, B. RÊGO de VASCONCELOS, D. PHAM MINH, P. Sharrock, D. GROUSET, NZIHOU A., Hydroxyapatite supported bimetallic cobalt and nickel catalysts for syngas production from dry reforming of methane. *Applied Catalysis B: Environmental*, 224: 310-321, 2018

PLENARY AND KEYNOTE LECTURES AT INTERNATIONAL CONFERENCES

Prof. Ange Nzihou has been invited to deliver plenary lectures and keynotes in international conferences on the field of interest for WTERT.

1) Nzihou A., “Syngas cleaning and characterization», 13th International Congress on Biofuels and Bioenergy”, Ottawa, Ontario, Canada, 19th October, **2018**
2) Nzihou A., “Role of inorganics in the thermochemical conversion of biomass and waste to energy and added value materials”, Académie des Sciences, Institut de France, Paris, 16 October, **2018**
3) Nzihou A., “French perspective on waste management and valorization”, WTERT Bi-Annual Conference, CCNY, New York, USA, 4th October, **2018**
4) Nzihou A., “Unravel the structure and reactivity of wood and biowaste biochars”, 6th International Conference on Sustainable Solid Waste Management, Naxos Island, Greece, 13-16 June, **2018**

5) Nzihou A., “Advanced in Clean Gas Cleaning” 5th International Conference on Renewable Energy Gas Technology, REGATEC 2018, Toulouse, France,3-4 May, **2018**
6) Nzihou A., “Nanostructured Carbon and Phosphate based Materials for Energy production”, International Conference on Advanced Nanostructures, Plenary Lecture, Pattanamthitta, Kerala, India, 13th March, **2018**
7) Nzihou A., “Biochars: Production, Characteristics and Applications”, Plenary Lecture, 4th International Conference on Recycling and Reuse of Materials (ICRM), Kerala, India, March 9-11, **2018**
8) Nzihou A., “Versatile transition Metal-Phosphate catalysts and applications”, 2nd International Conference on Catalysis and Chemical Engineering, Paris, France, February 19-21, **2018**

WTERT FRANCE – NEW WEBSITE

The activities in France in the field of WTE will be available at: https://wtertfrance.wixsite.com/wtert-france. The French version of this website towards Francophone countries will be available soon!

WtERT- Germany Activities in 2018

By Hedwig Vielreicher, Director of WtERT-Germany vielreicher@wtert.net,

Werner Bauer, Managing Director, WtERT Germany, bauer@wtert.net

WtERT-Germany was founded in 2008 and is hosted by the company ia GmbH since 2013. In January 2017, WtERT Germany was assigned by the Global WtERT Council (GWC) to collect and showcase data from all WtERT organizations. The new communications infrastructure was implemented by www.wtert.net in August 2017. Since then, news, technical papers and case studies are being added continuously and more and more experts, business partners and waste management organizations have joined the WtERT network.

In addition to our day to day upkeep of www.wtert.net in 2018, we provided consulting services in Tunisia and Croatia, started discussions with organizations from Czech Republic, Ghana, Croatia and Tunisia on their starting future WtERT organizations, supported delegations from Romania, Kazakhstan, Ghana, Singapore and met with visitors from Chile and Bosnia-Herzegovina.

www.wtert.net

Following many discussions on the subject of WtE being an essential part of sustainable waste management, we developed the vision to succeed by not only compiling the knowledge of our WtERT partner organizations but also combining this activity with the experience of multiple partners in research organizations, industry and municipalities. To reach a high credibility of the whole "WtE System" we believe it is essential to present existing solutions (case studies) and share personal recommendations of international WtE experts.

www.wtert.net provides a platform to stakeholders from all over the world to

- get informed and inform others about state of the art methods and technologies for sustainable waste management,
- inform about the status of waste management in their country and learn about solutions in neighboring and other countries toward approaching sustainable waste management,
- to provide a database of realized solutions by means of case studies from all over the world,
- to get in contact with scientists, local decision makers, associations and companies who may assist with implementation of the needed technology.

www.wtert.net provides information classified by

- countries

- technical terms, subdivided into *Recycling*, *Incineration*, *Landfill* as well as *Strategies and Complementary*. Each term is followed by a brief recommendation, which has been provided by one or more of the WtERT experts.

Consultancy Projects

- **Sustainable Waste Management for Slavonia/Eastern Croatia**

On behalf of the German-Croatian Foreign Chamber of Commerce, Werner Bauer, CEO of WtERT Germany and of ia GmbH, and Dr. Ulrich Wild, em&S, rendered their services to support the region of Slavonia in Eastern Croatia in further developing their waste management system in a sustainable way. A focus has been laid on the management of biowaste. Further information can be found at https://www.wtert.net/Croatia.html

- **Sustainable Waste Management for Tunisia**

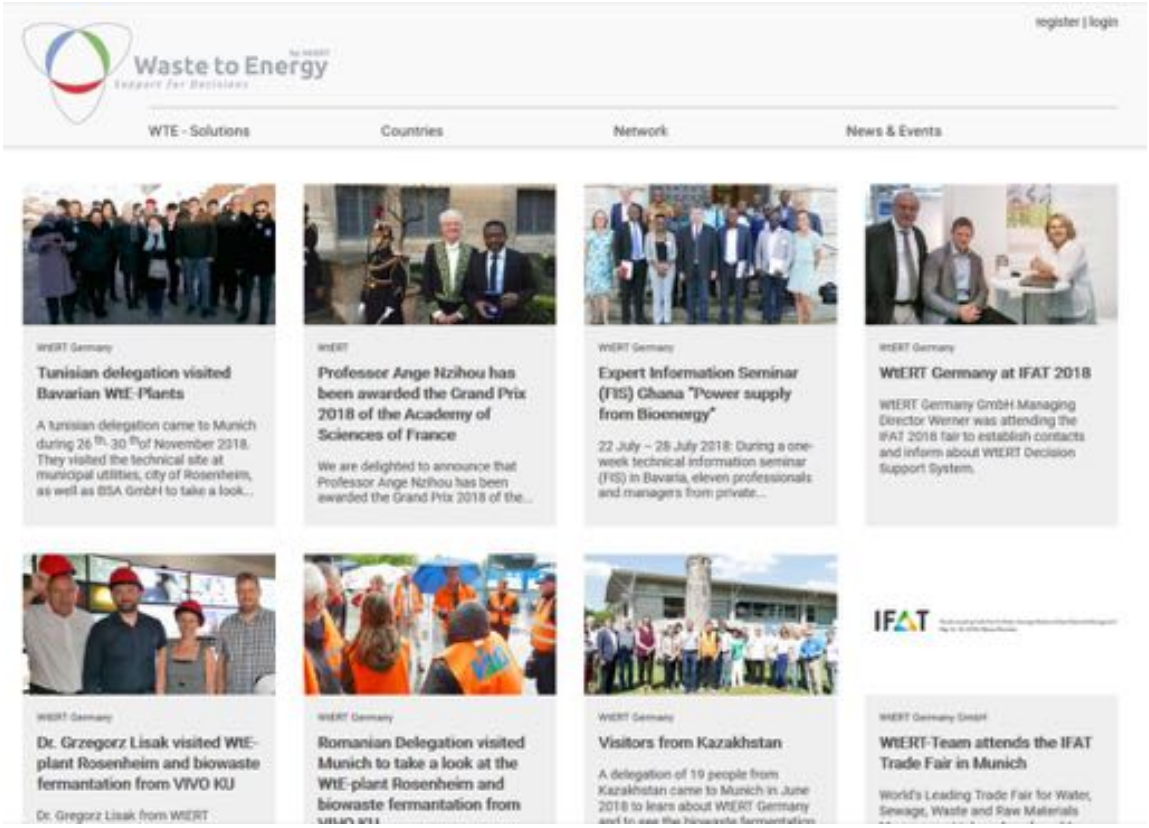
On behalf of the Bavarian State Ministry of the Environment and Consumer Protection, a consortium of Fraunhofer Umsicht, WtERT Germany GmbH, em&S and the Bavarian State Office of Environment visited Tunisia in October 2018 to identify pilot projects for further cooperation. Fourteen delegates from ministries and governmental organizations from three regions in Tunisia visited Germany in December 2018, as part of this collaboration. The consultancy services were completed at the end of this year by recommending specific solutions.

A financing request for implementation has been submitted for 2019.

Further information can be found at https://www.wtert.net/Tunisia.html

Hosting of Delegations and Guests

In 2018 we hosted delegations from Tunisia, Ghana, Singapore, Romania, Kazakhstan and guests from Chile as well as Bosnia and Herzegovina. Further information can be found at https://www.wtert.net/WTERT_News.html



For the new year of 2019 we plan to successfully continue our projects in Tunisia and Croatia, extend the WtERT network into Czech Republic, Ghana, Tunisia and Croatia and serve as many stakeholders as possible worldwide.

Please become an active part of the Waste to Energy - Decision Support System, by sharing your knowledge, enhancing the web-reputation of WtE Technologies and contributing your data to wtert.net by e-mailing to Hedwig Vielreicher, vielreicher@wtert.net.

WtERT- Greece Activities in 2018

By Prof. K. Aravossis (Chair, arvis@mail.ntua.gr)

WTERT Greece researchers published, made presentations and participated in several National and International meetings and conferences and organized or participated in various events in areas concerning WTE, Waste and Energy Management and Circular Economy.

1. Activities and Publications by Prof. K. Aravossis, Chair WTERT Greece

Zamparas M., Kapsalis V., Aravossis K., Kanteraki A., Kalavrouziotis I.K.

"Medical waste management and environmental assessment in Rio University Hospital, Greece", Fifth International Symposium on Green Chemistry, Sustainable Development and Circular Economy, Skiathos, Greece, September 30 – October 3, 2018

Kapsalis V., Aravossis K., Zamparas M., Kanteraki A., Kalavrouziotis I.K.

"Hospital waste management in Greece: Current situation, perspectives and proposals", fifth International Symposium on Green Chemistry, Sustainable Development and Circular Economy, Skiathos, Greece, September 30 – October 3, 2018

Strantzali E., Aravossis K., Livanos G. A., Chrysanthopoulos N.

"A Novel Multicriteria Evaluation of Small-Scale LNG Supply Alternatives: The Case of Greece"

MDPI "Energies" — Open Access Journal of Energy Research, Engineering and Policy

11(4), 903; doi:10.3390/en11040903

Aravossis K., Kapsalis V.

"Thermal Energy Storage Technologies", Power Engineering: Advances and Challenges Part A, Ch.13, CRC Press, Taylor and Francis Group, pp. 383-420, 2018

Presenttions by K. Aravossis

“Resource and Energy Saving – -WtE- Circular Economy - The Solution to the Waste Problem”.

Conference of the Central Union of Municipalities of Greece – KEDE, presentation in the plenary session on the Thematic Environment-Spatial Planning-Waste, Athens, 04/12/2018.

“Resource and Energy Planning – WtE, key parameters of a Circular Economy Model”, Environmental Conference co-organized by the Central Union of Municipalities-KEDE, the Union of Regions of Greece-ENPE and the Pan-Hellenic Network of Ecological Organizations – PANDOIKO, Athens, 10/11/2018.

“Plastics management towards sustainable development – Circular economy principles application”, International Conference "Circular Economy and Plastics", Association of Plastic Industries of Greece, Athens, 12/10/2018.

"Energy recovery of waste within the framework of the Circular Economy", Scientific Panel Coordinator and Chair, International ECOCITY FORUM 2018 on “Circular Economy in Smart Cities”, Thessaloniki, 3-5/10/2018.
"Waste to Energy as part of an Efficient Integrated Waste Management System", 6th International Conference on Sustainable Solid Waste Management, NAXOS 2018.

(Also Member of the Scientific Committee of the Conference, Co-Chairman, and Coordinator of the WtE Panel as Chair of WTERT Greece, Naxos island, 13-16/06/2018).

"Waste and Waste Management Policies", Meeting Circle: "Climate Change and Water Saving - Impact on Crete, Impact on Water Supply - In Heraklion", Heraklion, 27/04/2018.

"Circular Economy and Sustainable Development" Conference: "Law, Environment, Energy & Investments: Problems and Prospects of the Future", Athens, 22/03/2018.

Konstantinos Aravossis, Vasilios C. Kapsalis (Guest Editors)

Special Issue "Selected Papers from ERSCP 2017: 18th European Roundtable for Sustainable Consumption and Production", A special issue of *Energies* (ISSN 1996-1073)

Konstantinos Aravossis, Jaco Quist, Vasilis Kapsalis, Annelise De Jong (Guest Editors)

Special Issue of the Journal of Cleaner Production (Last update: 1st December 2018) Sustainable Production and Consumption within the Circular Economy

Prof. Aravossis published regularly articles on the Greek Press.Indicative titles: “Goals and Prospects for National Energy Planning”, “Environmental protection as a tool for economic growth”, “Waste management in Greece: the role of the economic crisis”, Circular Economy and its Impact on Investments etc.

2. Activities by Prof. M. Loizidou, Member of the Scientific Committee WTERT Greece

The National Technical University of Athens (NTUA) headed by Prof. Maria Loizidou organized the NAXOS 2018 6th International Conference on Sustainable Solid Waste Management in Naxos Island, Greece from 13th to 16th June 2018 (www.naxos2018.uest.gr) with about 600 participants. The conference included an extensive Session (Session XVII on Friday 15th June 2018 from 9.15 until 14.00 available at: http://uest.ntua.gr/naxos2018/proceedings/proceedings.html#friday) on Waste-to-Energy. The Session included 16 oral presentations in the main conference room and was chaired by Prof. K. Aravossis (NTUA), Prof. M. Loizidou (NTUA) and Prof. Stephen Smith (Imperial College, UK). Prof. K. Aravossis also made the first of the 16 presentations with title: "Waste to Energy as part of an efficient integrated Waste Management System".

It is also noted that the Summer School of the NAXOS 2018 Conference (1st Executive training on solid waste management) that took place on 11th and 12th June 2018 also included extensive presentation on Waste-to-Energy.

In the well-attended two-day event with title "Regional Solid Waste Management Plan & Circular Economy", which was organized in Heraklion, Crete on 29th March 2018 by the Region of Crete, Prof. Maria Loizidou made the oral presentation "Waste-to-Energy opportunities and new technologies".

Dr. Konstantinos Moustakas made the presentation "Waste-to-Energy and new technologies" by M. Loizidou, K. Moustakas in Mistras, Sparta on 24th October 2018 in a two-day event organized by the Association of Greek Municipalities about the national plan for waste management and the implementation of the regional management plans with emphasis on the case of Peloponnese Region, attended by a large number of representatives of Municipalities.

3. Activities and Publications by Prof. C Psomopoulos, Member of the Scientific Committee WTERT Greece

1. Journal Papers

1.1. C.S. Psomopoulos, D. Barkas, G.C. Ioannidis, "Recycling Potential of Submersible Sewage Pumps in the EU". ***Recycling 2018, 3(14)*****;** **https://doi.org/10.3390/recycling3020014**

Abstract: Sewage pumps have been among the main electromechanical equipment of the sewage and wastewater management facilities around Europe for over 30 years. Their operational life ranges between 15 and 20 years. Therefore, a significant proportion of that equipment is currently non-operational, and many of them must be disposed of in the forthcoming years. Although the “Waste electrical and electronic equipment” Directive (2012/19/EU) is the main related legislation, sewage pumps are not directly addressed. EcoDesign Legislation is the main legislation applicable on such cases. This work investigates the possibilities of recycling sewage pumps used in wastewater management facilities after their renovation or upgrade. Evaluation results indicate that there is high potential for material recovery and for significant economic benefit. Therefore, the recovery of materials and safe handling of non-operating industrial and possibly hazardous electrical equipment waste, could contribute to the minimization of their impact on the environment.

1.2. E. Kyriakis, C.S. Psomopoulos, P. Kokkotis, A. Bourtsalas, N.J. Themelis, “Selection of location and capacity of a waste-to-energy facility on basis of maximum output energy and minimum gate fee”, *Environ Sci Pollut Res, 2018, 25(27),* pp 26715–26724, https://doi.org/10.1007/s11356-017-9488-1

Abstract: This study attempts the development of an algorithm in order to present a step by step selection method for the location and the size of a waste-to-energy facility targeting the maximum output energy, also considering the basic obstacle which is in many cases, the gate fee. Various parameters identified and evaluated in order to formulate the proposed decision making method in the form of an algorithm. The principle simulation input is the amount of municipal solid wastes (MSW) available for incineration and along with its net calorific value are the most important factors for the feasibility of the plant. Moreover, the research is focused both on the parameters that could increase the energy production and those that affect the R1 energy efficiency factor. Estimation of the final gate fee is achieved through the economic analysis of the entire project by investigating both expenses and revenues which are expected according to the selected site and outputs of the facility. In this point, a number of commonly revenue methods were included in the algorithm. The developed algorithm has been validated using three case studies in Greece—Athens, Thessaloniki, and Central Greece, where the cities of Larisa and Volos have been selected for the application of the proposed decision making tool. These case studies were selected based on a previous publication made by two of the authors, in which these areas where examined. Results reveal that the development of a «solid» methodological approach in selecting the site and the size of waste-to-energy (WtE) facility can be feasible. However, the maximization of the energy efficiency factor R1 requires high utilization factors while the minimization of the final gate fee requires high R1 and high metals recovery from the bottom ash as well as economic exploitation of recovered raw materials if any.

2. Conferences Papers

2.1 Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES18, 19–21 September 2018, Athens, Greece.

K. Kalkanis, C.S. Psomopoulos, S. Kaminaris, G. Ioannidis, P. Pachos, "Wind turbine blade composite materials – End of life treatment methods", *Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES18,* 19–21 September 2018, Athens, Greece, paper No 190

2.2 2nd International conference on Bioresources, Energy, Environment, and Materials Technology (BEEM 2018): Technology nexus for the resonance of nature and humans. Hongcheon, South Korea.

Nikkhah, A., Bagheri, I., Zareiforoush, H., Psomopoulos, C., Hossein Payman, S., Bakhshipour, A., & Ghnimi, S. (2018). Renewable energy generation potential from biomass resources in Guilan Province. *2nd International conference on Bioresources, Energy, Environment, and Materials Technology (BEEM 2018): Technology nexus for the resonance of nature and humans.* Hongcheon, South Korea

3. Research studies supervised (Advisor or co-Advisor: Prof. C.S. Psomopoulos)

3.1. On-going PhD study: Stathis Kyriakis: Developing models for optimizing the transition pathways to zero waste economy

3.2. On-going M.S. studies

Maria Papakonstantinou: Review of the Ecodesign Legislation in EU since 2007

4. Other Activities

Prof. Psomopoulos is the Guest Editor of the Special Issue "Social and Economic Aspects of Waste Management" A special issue of *Social Sciences* (ISSN 2076-0760). This special issue is part of the section "Social Economics".

WtERT- India Activities in 2018

Waste to Energy Research & Technology Council
(WTERT-India) (info@wtert.in)

WtERT-India was founded by the National Energy and Environment Research Institute (NEERI) in Mumbai and as of 2017 is also hosted at the Ramaiah University of Applied Science. WtERT-India is organizing a major international conference in Bangalore on sustainable waste management , as described fully in the following link:
www.2exhibitions.com › Environment and Waste Management

Prof. A. D. Sawant (arun50@wtert.in), Director of WtERT-India has invited heads of other WtERT natonal organizations to attend this meeting. Dr. A. .C. (Thanos) Bourtsalas has been invited and will represent the Global WtERT Council at this important meeting.

WtERT-India, Ramaiah University of Applied Science

Report submitted by Dr. Dayananda of RUAS

(bsdayananda.aae.et@msruas.ac.in)

1. International Convention on Waste Management

WtERT-India at RUAS, in association with the Sanitation Waste Management and Environmental Engineering Research Centre, organized a two-day international convention on “Environment Protection through Sustainable Waste Management” on August 3-4, 2018. The inaugural ceremony was held on 3rd August at Ramaiah University of Applied Sciences, Peenya Campus. Prof. Govind R Kadamabi, Acting Vice Chancellor welcomed the participants and an inaugural address was delivered by Shri Sarfaraz Khan Sardar, Joint Commissioner, Health and Solid Waste Management, BBMP, Bengaluru. Mr. Khan emphasized the importance of the role of civic society in joining hands with the Government in bringing an effective solid waste management system. He noted that Bangalore has the best such system in the country and that many of the problems associated with solid waste management has been addressed meticulously. An inaugural address was also delivered by Shri M.R. Sreenivasa Murthy, Retired IAS officer and presently Chief Executive of Gokula Education Foundation – Medical. Prof. Arun Sawant, Director of WtERT-India focused on the research that has been undertaken on the technological aspects of solid waste management. Dr. B.S. Dayananda, Head of SWMEE Research Centre proposed a Vote of Thanks to organizers. More than one hundred delegates participated, including students from

diverse backgrounds, industry and NGO representatives. More than ten expert speakers presented the latest developments and research directions of various waste management technologies; and available practices for protecting the environment.

2. Doctoral Studies

2.1 Study on "Situation analysis of infection control and prevention and hospital waste management practices to evolve implementation strategies for sound management among dental health care establishments in Bengaluru city" – Doctoral thesis by **Dr Pushpanjali K**

2.2 Study on "Field Investigations and modelling of flow in Vadose zone in forested watershed"–Doctoral thesis by **Dr Harshad Rameshwar Parate**

3. Research studies supervised by WTERT-RUAS (INDIA) (Advisor or co-Advisor Dr.B.S.Dayananda, Dr.Harshad R Parate, Dr. Jyotsna Kumar)

3.1. On-going PhD study

Ms Pirathiba: Study of synthesized gold and silver nanoparticles with vegetable peel waste as reducing agents for the treatment of textile effluent

3.3. Completed P.G. Studies

Arpana: Design and development of air purifier for traffic pollution

Pooja N: Performance evaluation of diesel engine using the bio-diesel produced from Grease Trap Extracted at Municipal Sewage Treatment Plants

Sri Sanjith A: Design of an aerobic composter for garden waste with enzymatic treatment

Vishwanath G.R: Design and Development of Micro Scale Anaerobic Digester

Arpana A M, Sri Sanjith A, Vishwanath G R: Purification of Kitchen Waste Water By Using Natural Coagulants

Mohammed Umraz: Design and Analysis of Effluent Treatment Plant for Pharmaceutical Effluents to Achieve Zero Liquid

Mohammed Umraz, Pooja N, Prashanth James: Development of a Cost Effective Purification Device for Bathroom Wastewater Reuse

MatER (WtERT- Italy) Activities in 2018

By Prof. Stefano Consonni (Chair of MatER) and
Prof. Mario Grosso, (mater@polimi.it)

Materia & Energia da Rifiuti
Materials & Energy from Refuse

The MatER Study Center, sister organization of the Global WTERT Council, wishes you a Happy and Successful 2019. 2018 has been the eighth year of MatER activity, since its foundation in 2011.

We are very glad to confirm that 2018 the seven waste management companies (A2A, Brianza Energia e Ambiente, HERA Ambiente, IREN Ambiente, Linea Group Holding, Hest Ambiente, SILEA Spa), members of the MatER Coordinating Committee, continued to support our work guaranteeing the necessary funding for further investigation activities.

In 2018 our research activity addressed issues raised by either private companies or public authorities. Here is a short list of the main areas of investigation covered:

- Assessment of WtE plants performances, with particular attention to the calculation of the R1 Index, the design of Advanced Waste-to-Energy plants and the combustion modelling of solid waste mixes;
- Experimental High-Temperature measurements in WtE plants;
- Measurement of Ultrafine and Nanoparticles Emissions;
- Technical and economic assessment of novel technologies for the thermal treatment of waste;
- Technical-economic evaluation of the overall urban waste management system in the Puglia region (South of Italy), with a focus on the quantitative streams, on the different technologies currently used for the MSW disposal and on the critical aspects of the current planning, including some suggestions on how to improve it.

In accordance with the aim of the Study Center, the communicative aspect continued to be essential in our daily work. With the aim to reach a closer connection with the civil society, in 2018 we participated to a “work-school alternation” project with local high school students in Piacenza. The project, called “REPACK”, focused on the theme of packaging and the purpose of the MatER team was to get the students closer to the complex world of packaging waste recovery. Three students were hosted at LEAP for a period of 1 month during the summer, carrying on an evaluation of possible solutions for the recovery of material and energy from polylaminated composite packaging waste.

This experience resulted very productive on both sides. We were able to get a deeper insight on this problematic packaging material, that still doesn't have a proper destination for its disposal, offering at the same time the opportunity to the high school students to analyze the problem with an academic and critical approach.

As a result of this investigation we are now completing the final report that will be published soon on our website. Furthermore, the local newspaper of Piacenza recently dedicated us an article over this activity and it's our intention to pursue in the future more collaborations with schools and public institutions over similar topics.

Another initiative has been the cooperation with "Amici della terra", an environmental association whose headquarter is set in Rome, for the development of a website to share best practices over the circular economy, funded by the Italian Ministry of the Environment. The MatER activity mainly consisted in the review of the contents of the web pages, as well as the support to the dissemination from a technical-scientific point of view. At this link it is possible to see some pages of the website, that contains interesting best practices and myth busters around the world of waste recovery and circular economy.

In addition, 2018 has been the first year of full activity of our new website that we completely renovated and activated in 2017, with the aim of improving our communication strategy. For this reason, we carefully monitored the accesses to our website: in 2018, we received globally 50.493 visits from users of 134 different countries, with Italy of course leading the way, followed by USA, Denmark, Switzerland and Germany.

We are very glad to announce that the number of users who visited our site in 2018 increased with respect to previous years. In particular, in November 2018 we recorded a peak of 45.499 users. However, this special interest was purely Italian: in that period the Italian political scene recalled the attention of all the national media around the world of Waste to Energy after that an Italian minister in one of his interviews mentioned the novel WtE facility of Copenhagen. Since in 2017 we published a detailed description in Italian of the functioning of the Danish plant, many people visited this specific page on our website and started to share it impressively on social networks as well. The media attention also led to some brief interviews of prof. Consonni and prof. Giugliano, directors of the Study Center, in national newspapers and at a night TV talk.

During this year, we continued to monitor and analyze the most important Italian and international updates on waste management, such as the new European Circular Economy Package, the Italian legislation over the classification of Incineration Bottom Ash and the recent final draft (FD) of the Waste Incineration BREF (Best Available Techniques REFerence document).

Our MatER researchers and collaborators published and presented contributions about waste management, residues recovery and LCA activities: a list of them can be found in the *"Our Study"* section of our website.

On the academic side, in the second half of 2018 we also had the possibility to enhance our collaboration inside the Global WTERT Network by hosting Maria Luisa Carneiro from the Catholic University Rio de Janeiro, Brazil, as a visiting researcher. She will stay until summer 2019 for the conclusion of her PhD thesis over the *"Thermo-economic environmental assessment and optimization of Hybrid Waste-to-Energy plants"*.

In compliance with its communication objectives, during 2018, the MatER Study Center organized and took part to some meetings and workshops on waste management for local public administrations. On April 2018 we presented at the premises of the Lombardy Region headquarters in Milan the work "*Evaluation with a LCA methodology of the flows and the destiny of Construction & Demolition waste in the Lombardy Region",* coordinated by Lucia Rigamonti.

Moreover, our MatER researchers constantly took part all over the year to many national and international meetings, with oral presentations, posters and related full paper available in the meeting records. Here below is a short list of the most significant ones with the name of the speakers and title of the work:

- *PREWIN R&D Workshop at VTT: participation F. Viganò and F.Poretti, Espoo-Finland March 22nd-23rd.*
- *6th International Conference on Sustainable Solid Waste Management*: *"Advanced Waste-to-Energy plant design for the enhanced production of electricity", F. Viganò,* June 2018 - Naxos Island, Greece.
- 9th CEWEP Waste-to-Energy Congress 2018, *"Waste-to-Energy Making Circular Economy Happen"*, 20th-21st September, Bilbao, Spain, with Mario Grosso chair of the technical session of the first day.
- *VENICE 2018 – 7th International Symposium on Energy from Biomass and Waste: "Modelling the combustion of any solid waste mix", F. Viganò, Venice-Italy, 15-18 October 2018.*
- *ECOMONDO 2018 (November 2018- Rimini, Italy):*
  - *"Critical analysis and future perspectives for the urban waste management system of the Puglia Region" (MatER Team)*
  - *"Alternative thermal treatments and the innovation in waste to energy processes" (F. Viganò).*
  -

Last but not least, during the year the MatER team has set up the organization of the 4th MatER Meeting on *"Innovations & Technologies in Waste Recovery"*, to be held on May 27th-28th 2019 at the Piacenza Campus of the Politecnico di Milano. The Meeting

aims at being an update on latest trends in Sustainable Waste Management, dealing with regulatory, strategic and technical-scientific aspects in accordance with the previous editions.

A dedicated page in our website has been developed to collect the works of the authors and to manage all the applications through an on-line registration form. With the 4th edition of the conference it is also our ambition to strengthen the connection between the applied research and the industry. For this reason, we decided to set 2 twin calls, that will be equally evaluated but addressed to two different bodies:

1. **"scientific contributions"** dedicated to Universities, Academic Institutes, Research Centers, R&D Units, Control Authorities;
2. **"technical contributions"** dedicated to Industries, Consulting & Engineering Companies, Plant Operators, Technology Suppliers.

The 2-days Meeting will comprise oral and poster presentations over these indicative subjects: innovative Municipal Solid Waste treatment technologies, material and energy recovery from waste, bio-based industry and residual valorization, environmental sustainability and circular economy, normative and economic framework, waste management and its sociological issues. An optional technical visit to an Italian important waste treatment facility will be also organized on May 29th, in collaboration with a MatER partner. The **CALL FOR ABSTRACTS** is still open and we look forward to your participation!

With the aim and the hope to reach further achievements in 2019 together, our best wishes for a Joyful and Fruitful New Year to all WTERT sister organizations!

WtERT-Republic of Korea Activities in 2018

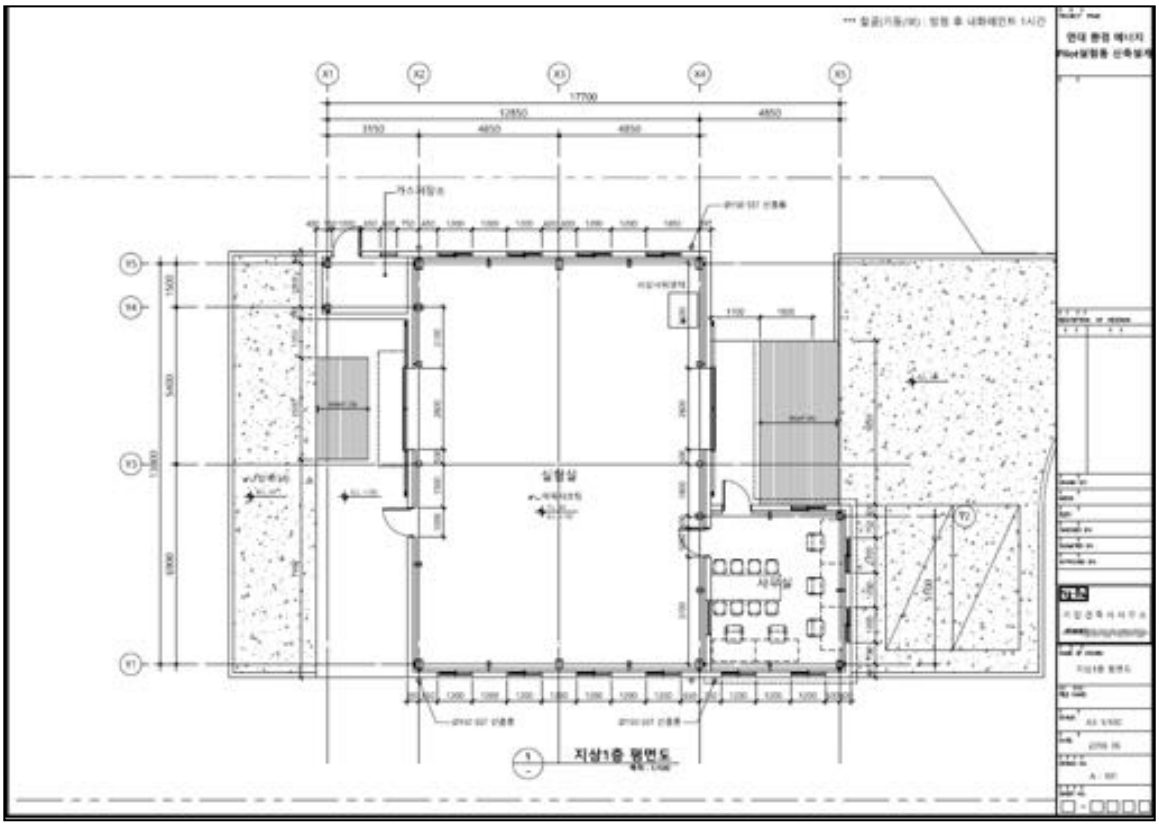
By Prof. Yong-Chil Seo, Director of WtERT-Korea and BK+21 Program,
Prof. Hang-Seok Choi, Head of Dept. of Environmental Eng., Yonsei University.

1. Contract `1` for constructing a laboratory building for WTE to conduct various experiments related to Waste to Energy R&D

Through some R&D projects, we contracted to install a laboratory building in Yonsei University. Main projects will include the BK 21+ project and the Human Resources Development program of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) on WtE R&D. Most of experiments are related with thermal conversion technologies such as torrefaction, pyrolysis, and gasification of waste and biomass.

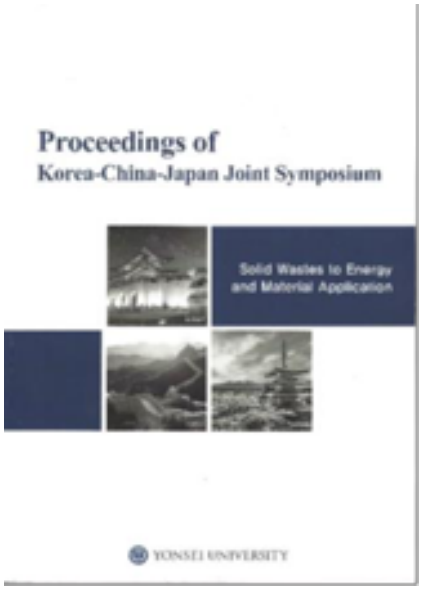
The main experimental apparatus in the building will be

1. Fixed bed gasifier
2. Fluidized bed gasifier/pyrolyzer
3. Torrefactor (screw type)
4. Micro-GC and Real-time analyzers



2. Hosting of 2018 Korea-China-Japan Symposium, Asan city, Korea – Title: Solid Waste to Energy and Materials Applications

The Korea-China-Japan symposium was held in the Asan Hot-Spring resort and the participation institutions were Yonsei University in Korea, Tokyo Institute of Technology in Japan, and Dalian University of Technology in China. The symposium was co-sponsored by the BK+ and KETEP projects at Yonsei and by the ILEERT(International Laboratory on Energy and Environment Research and Technology) of Green Environment Corp., which has established a research lab for collaborating on WtE R&D by the three institutions. There were 35 oral presentations and 21 poster presentations divided in six sessions. This symposium was attended by about 75 persons in this symposium. The symposium of next year will be held in Japan and the topic will also be related to WtE technology.



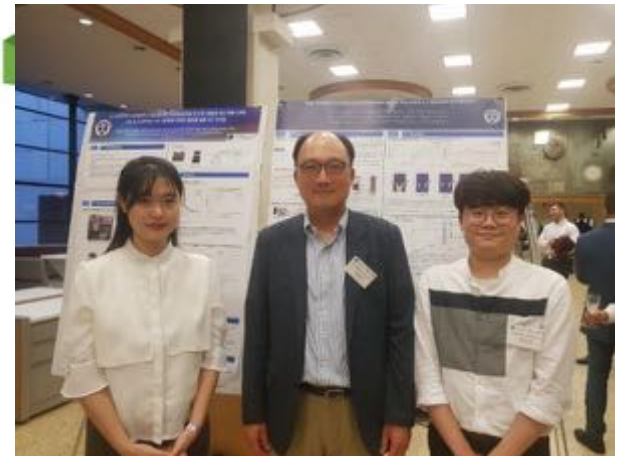
Education and information dissemination activities

Prof. Seo, head of WtERT-Korea participated and presented on the WtE technology at the 2018 Energy, Utility & Environment Conference (EUEC, San Diego, March 2018). Also, he attended and presented various topics in WtE and environment; “Status of E-waste Recycling and Recent Technological Interventions in South Korea: Polyurethane to Energy, Refrigerant Recycling, and Small Size E-waste Handlings” at 3R Forum in Asia and the Pacific (New Delhi, India, April 2018). He also presented “Status and Technological Issue of Combustible Waste to Energy in Korea” of TPM 15 International Workshop between 3 countries national environment research centers of Korea, Japan, and China (Pusan, Korea, October 2018), and “Operational Characteristics of Pilot-Scale Gasification Process for Solid Refuse Fuel Generated from Municipal Waste” of Ascon-IEEChE conference (Taipei, Taiwan, November 2018). Recently, he attended as plenary

lecture and presented “Technological Status and Issues on Waste to Energy in Korea and Asian Countries” in I-cipec conference (Bangkok, Thailand, December 2018).

Participation in 2018 EEC/WTERT Bi-Annual conference

The 2018 EEC/WTERT Bi-Annual conference was held at City College of New York (Oct. 4-5). Prof. Choi and students participated and presented two research studies: “Gasification characteristics of bio-crude oil in a conical spouted bed reactor” and “Heat transfer-hydrodynamic characteristics on gas-solid in a spouted bed”. Through the conference, the recent policy trends related to the management and utilization of waste including biomass in advanced countries were identified and valuable information on thermal conversion was collected.



“Optimization of Scale-up of Fast Pyrolysis Process for Polymer Waste Based on AI (Artificial Intelligence)” Research

One of the most important design processes is scale-up with high fidelity for the commercialization of fast pyrolysis reactor. In general, the scale-up effect appears when designing a large scale commercial plant by use of small pilot scale test results. Therefore, accurate prediction of scale-up effect is crucial to design a commercial scale for a wide range of operating conditions. In addition, physical complexity of the fast pyrolysis process makes it hard to obtain accurate numerical models, where the difficulties come from the complex multiphase multispecies flow, accompanying multi-physical transport phenomena, the chemical kinetics of fast pyrolysis of solid fuels, and etc. Even with these difficulties, experimental facilities or pilot plants are developed first for the scale-up design in general, which requires considerable cost and time. Instead of pilot plant test, CFD (computational fluid dynamics) can be utilized.

Even though CFD reduces the time and cost significantly compared to pilot plant test, it requires considerable efforts in computational modeling and optimization not only for pilot, but also for commercial plant. Due to these complexity, artificial neural networks (ANNs), one of artificial intelligence techniques, is a promising alternative solution. ANN is a mathematical model adopting the brain's problem solving approach. In the proposed research, first, for the fast pyrolyzer, the numerical process model of pilot-scale will be setup. Second, a detailed CFD model including hydrodynamics, transport phenomena and the associated chemical reactions will be developed for simulating the fast pyrolyzers of real demonstration scale. Third, ANN models will be trained by using CFD data and apply the results to the pilot-scale process model. Finally, ANN combined pilot-scale process model will be developed for accurate prediction of the scale-up effects. Prof. Choi will conduct the above research from Sep. 2018 to Aug. 2019 at Purdue University in USA, while on sabbatical leave from Yonsei University.

R&D Projects granted in 2018

1. Technology of thermal energy of thermal energy production and solid refuse fuel usin g mixing waste of low calorific value, KETEP (2015-2018)
2. Development of high quality syngas production technology for MSW fluff SRF by mixe d oxidants gasification, KEITI (2013-2018)
3. Commercialization of 0.5 TPD-class process for mercury harmless and recovery from mercury wastes, KEITI (2016-2018)
4. Estimation on natural emission of long range transported mercury and assessment of contributions by anthropogenic emission between surrounding nations, KEITI (2015-2018)
5. Development of integrated electro-mechanical actuator (300g weight class) for aircraf t of operational ceiling height 60,000ft (18.3km), KEIT (2017-2020)
6. Advanced Graduate Program in Process System Technology of Combustible/Organic Waste to Energy, KETEP (2017-2021)
7. Production of high-grade biofuel from by-products of domestic timber industry and ev aluation its practical use as heating fuel, KFS (2017-2019)
8. Development of integrated production process and scale-up optimum design technolo gy of high-calorific fuel and hydrocarbon material based on polymer waste, NRF (201 7-2020)
9. Knowledge-based Environmental Service Human Resource Development Project, KE ITI (2015-2018)
10. Development of 20T/D pyrolysis oil production demonstration and utilization technol

ogy, KETEP (2017-2021)

11. National mercury integrated evaluation report, NIER (2018)
12. Studies on Management of BAT and BEP for Reducing Mercury Release from Wast e, NIER (2018)
13. Study on the Standards of Mercury Interim and Long-Term Storage Facilities in Kore a, NIER (2018)
14. Experimental Study on the Optimization of Treatment of Mercury Containing Waste Products, NIER (2018)

PhD and MS dissertations supervised by WtERT-Korea (2018)

1. **Heung-Min Yoo**: Ph D, Applicability Assessment of Gasification and Pyrolysis to Em pty Fruit Bunches from Palm Oil Mills with Enhancement of Feedstock Qualities
2. **Jin-Ho Sung**: Ph D, The Development of a Best Available Technology to Control Mer cury Emission from Flue Gas using a Hybrid Filter
3. **Se-Won Park**: Ph D, Studies on Gasification of Biomass and Solid Waste in Various Conditions to Enhance Syngas Qualities
4. **Eun-Song Lee**: MS, Development of Thermal Processing and Stabilization Technolo gy for Mercury Contaminated Waste
5. **Yean-Ouk Jeong**: MS, A Study on Characteristics of Hydrothermal Carbonization an d Gasification of Sewage Sludge for Efficient Energy Conversion
6. **Joo-Chan Lee**: MS, Study on the oxidation enhancement of gaseous elemental merc ury using steel slag
7. **Jeong-Hun Kim**: MS, Experimental study on the thermal treatment and reduction of mercury waste including mercury containing lamps
8. **Hoon-Chae Park**: Ph D, Advanced Process Analysis on Spouted Bed Fast pyrolysis System of Biomass using CFD Library
9. **Hyo-Sung Kim**: MS, Study on Multi-phase Flow and Heat Transfer Characteristics in a Conical Spouted Bed Reactor

Publications (2018)

1. Back, S. K., Bhatta, D., Kim, S. H., Jang, H. N., Kim, J. H., Kim, K. H., Kim, Y. R., & S eo, Y. C. (2018). **Thermal decomposition characteristics of mercury compounds in industrial sludge with high sulfur content**. Journal of Material Cycles and Wast

e Management, 20(1), 622-631.

2. Yoo, H. M., Lee, J. S., Yang, W. S., Choi, H. S., Jang, H. N., & Seo, Y. C. (2018). **Co-gasification characteristics of palm oil by-products and coals for syngas production**. Korean Journal of Chemical Engineering, 35(3), 654-661.

3. Yoo, H. M., Seo, Y. C., Park, S. W., Kang, J. J., Choi, H. S., & Oh, C. H. (2018). **Removal Effect of Ash and Metallic Species by Washing from Empty Fruit Bunch By products in Palm Mills on Pyrolytic Characteristics to Produce Bio-Crude Oil**. Waste and Biomass Valorization, 9(3), 491-502.

4. Sung, J. H., Back, S. K., Jeong, B. M., Kim, J. H., Choi, H. S., Jang, H. N., & Seo, Y. C. (2018). **Oxy-fuel co-combustion of sewage sludge and wood pellets with flue gas recirculation in a circulating fluidized bed**. Fuel Processing Technology, 172, 79-85.

5. Park, S. W., Lee, J. S., Yang, W. S., Alam, M. T., Seo, Y. C., & Lee, S. Y. (2018). **Gasification characteristics of biomass for tar removal by secondary oxidant injection**. Journal of Material Cycles and Waste Management, 20(2), 823-831.

6. Kim, J. H., Sung, J. H., Back, S. K., Lee, E. S., Lee, J. C., Park, Y. J, Moon, K. L., & Seo, Y. C. (2018). **Adsorption Capacity Regeneration of Waste Activated Carbon from Mercury Adsorption Process using Thermal Treatment**. Journal of Korea Society of Waste Management, 35(3), 243-249.

7. Sung, J. H., Roy, D., Oh, J. S., Back, S. K., Jang, H. N., Kim, S. H., Seo, Y. C., Kim, J. H., Lee, C. B., & Han, Y. J. (2018). **Trans-boundary movement of mercury in the Northeast Asian region predicted by CAMQ-Hg from distribution of anthropogenic emissions**. Atmospheric Research, 203, 197-206.

8. Sung, J. H., Oh, J. S., AHM, M., Back, S. K., Lee, E. S., Kim, S. H., & Seo, Y. C. (2018). **Estimation and Future Prediction of Mercury Emissions from Anthropogenic Sources in South Korea**. Journal of Chemical Engineering of Japan, 51(9), 800-808.

9. Jang, H. N., Back, S. K., Sung, J. H., Kang, Y. S., Jurng, J., & Seo, Y. C. (2018). **The simultaneous capture of mercury and fine particles by hybrid filter with powder activated carbon injection**. Environmental Pollution, 237, 531-540.

10. Park, S. W., Lee, J. S., Yang, W. S., Alam, M. T., & Seo, Y. C. (2018). **A Comparative Study of the Gasification of Solid Refuse Fuel in Downdraft Fixed Bed and Bubbling Fluidized Bed Reactors**. Waste and Biomass Valorization, 1-12.

11. Jeong, Y. O., Park, S. W., Lee, S. Y., Han, G. H., Yang, W. S., & Seo, Y. C. (2018). **Assessment of Gasification Applicability in a Downdraft Fixed Bed Reactor to**

Coffee Residues. Journal of Korea Society of Waste Management, 35(6), 515-524.

12. Lee, S. Y., Park, S. W., Han, G. H., Jeong, Y. O., Yang, W. S., Park, Y. S., & Seo, Y . C. (2018**). Manufacturing Characteristics of Concrete Brick using Bottom Ash Generated from Combustion After Upgrading Treatment of Solid Refuse Fuel Residues**. Journal of Korea Society of Waste Management, 35(6), 553-560.
13. Park, S. W., Lee, S. Y., Jeong, Y. O., Han, G. H., & Seo, Y. C. (2018). **Effects of Ox ygen Enrichment in Air Oxidants on Biomass Gasification Efficiency and the R eduction of Tar Emissions**. Energies, 11(10), 2664.
14. Yoon, Y. S., Park, D. K., Gu, J. H., Park, Y. S., & Seo, Y. C. (2018). **A Study on the Formation and Reduction of NOx in 5TPD SRF Boiler**. Journal of Korea Society of Waste Management, 35(7), 647-652.
15. Park, H. C., & Choi. H. S. (2018). **Visualization of flow structures inside a conica l spouted bed by electrical capacitance volume tomography.** Journal of Particuo logy. In press
16. Upadhyay, M., Park, H. C., & Choi, H. S. (2018). **Multiphase fluid dyanmics coupl ed fast pyrolysis of biomass in a rectangular bubbling fluidized bed reactor: P rocess intensification.** Journal of Chemical Engineering and Processing – Process Intensification, 128, 180-187.
17. Choi, M. K., Park, H. C., & Choi. H. S. (2018). **Comprehensive evaluation of vario us pyrolysis reaction mechanisms for pyrolysis process simulation.** Journal of Chemical Engineering and Processing – Process Intensification, 130, 19-35.

WtERT- U.K. Activities in 2018

By Dr. Costas Velis, University of Leeds, Prof. Chris Cheeseman, Imperial College London

We are delighted to report that we have had another successful year in the UK and would like to share with you a few selected updates. **Prof. Cheeseman** of Imperial College London (Chair) and **Dr. Velis** of University of Leeds (Vice Chair) discuss developments in the UK sector, which include an exciting brand new policy of the Environment Agency of U.K.: The **"Resources and waste strategy"** was released in December 2018, covering many emerging challenges for mature solid waste management and resource recovery systems, such as tackling littering, marine litter, reducing food waste and delivering a more curricular economy for plastics. https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england/resources-and-waste-strategy-at-a-glance

Prof Cheeseman remained very busy as **Director** of the **EPSRC Centre for Doctoral Training (CDT) in Sustainable Civil Engineering** http://www.imperial.ac.uk/sustainable-civil-engineering, and also kept his public involvement and education on the real reasons behind the plastics pollution global challenge, as in this article of **Financial Times**: https://www.ft.com/content/13523546-4496-11e8-803a-295c97e6fd0b and an indicative **blog**: http://blogs.bath.ac.uk/iprblog/2018/03/08/dont-blame-plastic-blame-poor-waste-management/

Dr Velis had a very busy year with his role as **Leader of the ISWA Task Force on Marine Litter** http://marinelitter.iswa.org/, his research team modelling the flows of plastics waste from land sources to the water; and leading the campus wide activities of the **Circular Economy and Resource Recovery network** at the **University of Leeds: CERRY:** https://cerry.leeds.ac.uk/

With the China imports ban in place, the interest on the 2014 report on plastics global flows is constant https://www.iswa.org/fileadmin/galleries/Task_Forces/TFGWM_Report_GRM_Plastic_China_LR.pdf and regularly get invitations to global media, such as recently in the **BBC World Service**:

https://www.bbc.co.uk/programmes/w3csy1sh and a German documentary film on plastics by SPIEGEL TV GmbH/ ARTE/ RILANA directed by Albert Ketchel https://www.arte.tv/de/videos/RC-015976/plastik/ and webinar for **Be Waste Wise**: https://wastewise.be/2018/10/costas-velis/ **Dr Velis** represented WtERT-UK at the Bi-annual Meeting of WtERT, held at City College of New York, in October 2018.

International research collaboration between WtERT-UK and various WtERT national members

- A BBSRC/ Newton Fund (UK) and India DBT call "UK-India Industrial Waste Challenge 2017" resulted in a jointly funded project on ***'Economic non-food sugar from variable mixed solid waste for high value chemical products'*** **an international collaboration led by the University of Leeds with India Universities/ Research Institutes (ICT Mumbai, VIT, NEERI), University of Manchester and UK Companies.** The WtERT link between UoL and NEERI and previous visit (2016) at the NEERI's institute enabled this collaboration.
- The paper that has emerged from the UK visit at NEERI, led by **Prof Cheeseman**, [Kumar S., Smith S.R., Fowler G., Velis C., Kumar S.J., Arya S., Rena, Kumar R. and Cheeseman C. (2017). **Challenges and opportunities associated with waste management in India**. *Royal Society Open Science* 4. https://royalsocietypublishing.org/doi/10.1098/rsos.160764 Features in the 'Most Read' of the journal for many consecutive months now: https://royalsocietypublishing.org/action/doSearch?SeriesKey=rsos&sortBy=downloaded
- **Ms Loula Gerasimidou** at University of Leeds is lead author to a manuscript a systematic review of the literature on the role of chlorides in solid recovered fuels used in cement kilns to be submitted to leading Journal, and in collaboration with **Prof Castaldi (co-author)**.
- **Dr Costas Velis** is assisting a part of the Scientific Committee the next biannual conference, organised by our by Prof Consonni and the Italian counterpart organisation Mater at LEAP, Politecnico di Milano.

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WtERT- U.S.A. Activities in 2018

U.S.A. Part 1) WtERT-related activities at Earth Engineering Center (EEC) of City College of New York (CCNY-CUNY)

By Marco J. Castaldi (mcastaldi@che.ccny.cuny.edu) (Chair) and

Demetra Tsiamis (dtsiamis@ccny.cuny.edu), Associate Director EEC|CCNY

The WTERT-CCNY of the Earth Engineering Center|CCNY had a very productive 2018 toward research, education and dissemination of thermal conversion and sustainable management of waste with interactions ranging from high school student officials of several municipalities. Professor Zhixiao Zhang of Hanzhou Danzi University spent a one-year sabbatical collaborating on Chinese developments of WTE and how they could impact the U.S. market and Zhouchao Weng was a visiting student from Zhejiang University studying ash from WTE facilities.

Overall there were six (6) peer-reviewed publications completed, eight (8) presentations at domestic and international conferences, several reports, a Professional Seminar course, a visit from the Chinese EPA Delegation coordinated by the US Department of State, national and international media coverage and the 2018 EEC-WTERT Bi-Annual Conference held at CCNY. Two EEC Resident Research Engineers have moved on toward a PhD program, one at the University of Perugia, Italy and one at University of Sherbrooke, Canada and four others have accepted full-time positions at Golden Renewable Energy, Corning and Lockheed Martin. Finally, as announced in September 2018, Professor Castaldi has become the Head of WTERT-USA.

Listed below is a summary of the activities of 2018 with more detail available at www.CCNYEEC.org. In 2019 it is anticipated that the momentum will continue beginning with a visiting student from University of Bolzano who will be exploring the use of char from MSW gasification facilities.

Peer-Reviewed Publications

1. MA Barlaz, CH Benson, M Castaldi, S Luettich, Spatial and temporal characteristics of elevated temperatures in municipal solid waste landfills, Navid H. Jafari, Timothy D. Stark, and Todd Thalhamer, *Waste Management*, 201, 71, 244-245.
2. M Webster, HY Lee, K Pepa, N Winkler, I Kretzschmar, MJ Castaldi Investigation on electrical surface modification of waste to energy ash for possible use as an electrode material in microbial fuel cells *Waste Management & Research* 36 (3), 259-268.
3. ACT Bourtsalas, J Zhang, MJ Castaldi, NJ Themelis, Use of non-recycled plastics and paper as alternative fuel in cement production, *Journal of Cleaner Production* 181, 8-16.

4. DA Tsiamis, M Torres, MJ Castaldi, Role of plastics in decoupling municipal solid waste and economic growth in the US *Waste Management* 77, 147-155
5. S Ciuta, F Patuzzi, M Baratieri, MJ Castaldi, Enthalpy changes during pyrolysis of biomass: Interpretation of intraparticle gas sampling, *Applied energy* 228, 1985-1993.
6. LM Fortuna, MJ Castaldi, New York City's Reuse Impact Calculator: Quantifying the zero waste impact of materials reuse, *Waste Management & Research* 36 (12), 1190-1200

Reports/Theses

1. DA Tsiamis, MJ Castaldi, The Effects Of Non-Recycled Plastic (Nrp) On Gasification: A Quantitative Assessment, report submitted to the American Chemistry Council, Plastics Industry Association (PLASTICS) and the Canadian Plastics Industry Association (CPIA).
2. L Fortuna, MJ Castaldi, E Andujar, M Lugo, Facilitating Food Donations in New York City Background Research in fulfillment of Local Law 176 directed by DSNY
3. DA Tsiamis, ACT Bourtsalas, L Arsova, S Simmons, MJ Castaldi, NJ Themelis, Conceptual Study for a Waste-to-Energy Facility - Mesa Grande Band of Mission Indians submitted to Gershman, Brickner & Bratton, Inc. McLean VA.
4. DA Tsiamis, A Fenichell, Global Assessment of Secondary Salvage Markets for New York City Used Textile Waste – report submitted to DSNY
5. DA Tsiamis, Analysis Of Plastics Pyrolysis Systems; Technical Due Diligence – submitted to Golden Renewable Energy, Yonkers, NY
6. A Licata, M Sankey, MJ Castaldi, RE Sommerlad, Analysis of Heat Rate Impacts from the Proposed ACE Rule report submitted to ASME's Subcommittee on Heat Rate, of ASME Research Committee Energy, Environment & Waste.
7. Isamar Garrido Rodriguez, Luz Maria Valdiviezo, Tiffany Harden, Xing Huang, Transforming Non-Recyclable Plastics to Fuel Oil Using Thermal Pyrolysis – Senior Design Feasibility Study, submitted to Golden Renewable Energy, Yonkers, NY

Presentations

1. MJ Castaldi, Pyrolytic reactions in municipal solid waste landfills: Theory, Experiment and Connection to Field Observations – Global Waste Management Symposium, Indian Wells, CA, February 2018
2. MJ Castaldi, Plastic Impacts on Gasification Technologies and Waste Generation Rates – Presentation at University of Bolzano, Italy, April 2018
3. MJ Castaldi, Combustion and Catalysis of Carbon Based Waste for Energy and Environmental Applications – Presentation at University of Sherbrooke, Canada, May 2018

4. MJ Castaldi, Waste-to-Energy; The Future of Waste Disposal? – presented at 43rd International Technical Conference on Clean Energy (Clearwater Clean Energy Conference), Clearwater, Florida, June 2018
5. MJ Castaldi, Global Status and Future Prospects of WTE – Plenary Lecture at 2nd International Conference on Bioresources, Energy, Environment, and Materials Technology (BEEM2018), Korea, June 2018
6. DA Tsiamis, A Comparison of Waste Management, Statistics and Methodologies in the,United States and the European Union – Presented at NAWTEC 26, Lancaster, PA, May 2018
7. Z Zhang, Status of Chinese WTE Facilities since 2015 - Presented at NAWTEC 26, Lancaster, PA, May 2018
8. G Correa, Plenary Flash Presentation Session, Emissions of Fuel-oil from Plastic Pyrolysis Systems – - Presented at NAWTEC 26, Lancaster, PA, May 2018
9. Four Posters presented at NAWTEC by; Tasnuva Moutushi, Grace Correa, Joseph Figueroa, Riliwan Sanni

Media

1. EEC|CCNY featured on CUNY TV's "Study with the Best" March 22, 2018 (https://www.dropbox.com/s/y3h2h7przeiy42s/Waste%20management.mov?dl=0)
2. EEC|CCNY Report on Impact of Non-Recyclable Plastics on the Enerkem Gasification-to-Biofuels Process is Published by the American Chemistry Council. (https://www.youtube.com/watch?v=sRNtgHPXqRg&feature=youtu.be&_cldee=Y3JhaWdfY29va3NvbkBhbWVyaWNhbmNoZW1pc3RyeS5jb20%3D&recipientid=contact-5797f9ae644be41199400050568134c0-e5f7f91cd3ce4513a05afb8c04afaa95&esid=6a3b32f9-8b4c-e811-99a5-0050568134c0&urlid=2)
3. Castaldi and Tsiamis Featured on CCNY Website for Work on Gasification of Non-Recycled Plastics (https://www.ccny.cuny.edu/news/ccny-study-shows-plastic-waste-can-be-converted-energy-and-fuels)
4. EEC|CCNY Paper Featured on Sustainable Brands® Website (https://www.sustainablebrands.com/news_and_views/waste_not/tony_kingsbury/plastics%E2%80%99_effect_waste_answer_might_surprise_you)
5. Tsiamis Writes Waste Dive Op-Ed on MSW Decoupling Research (https://www.wastedive.com/news/plastic-society-waste-problem-earth-engineering-center-city-college-new-york/531532/)
6. Castaldi Interviewed by ACS's Chemical & Engineering News (https://cen.acs.org/environment/sustainability/Should-plastics-source-energy/96/i38?utm_source=Twitter&utm_medium=Social&utm_campaign=CEN&hootPostID=fa06b41eb62b9b3c49b380f9a8dface8)

U.S.A. Part 2: 2018 WtERT Activities at EEC-Columbia University

By: A.C. (Thanos) Bourtsalas (ab3129@columbia.edu), Associate Research Scientist and N.J. Themelis (njt1@columbia.edu), Director, Earth Engineering Center, Columbia University

1. Study of mercury emissions from the US WTE facilities

Published Paper: Major sources of mercury emissions to the atmosphere: The U.S. case, A.C. (Thanos) Bourtsalas, Nickolas J. Themelis, *Waste Management* 85 (2019) 90–94.

The authors obtained mercury emission data from operators of most of the waste-to-energy (WTE) power plants in the US. The results showed that in 2014 the 77 U.S.WTE plants in total emitted 0.35 tons of mercury, corresponding to 0.73% of the U.S. total. This number was one half of that reported by the National Emissions Inventory (NEI) for ‘‘municipal waste combustion’’ (0.64 t) due to the fact that the NEI survey included incinerators without energy recovery. A 2002 Earth Engineering Center study had shown that the mercury emissions of the U.S. WTE industry decreased from 81.8 t in 1989 to 2.2 t in 2001. This study showed that between 2001 and 2014 the U.S. WTE industry mercury emissions were reduced further, by a factor of seven.

2. Participation in waste management meetings and conferences

In 2018 WTERT-Columbia participated at the following events:

March 2018: Surabaya, Indonesia: Presented at International Conference on Sustainable Waste Management Jakarta, Indonesia: visit of 30-acres open dump and a plant that processes wood chips for the production of pellets. Participated at a conference on waste management and guest lecture at the University of Airlaanga (Jakarta), where about 100 students participated. Meeting and guest lecture at the Universitas Prasetiya Mulya, where a pilot scale multiple-stage combustion plant is constructed with the aid of Prof. Huang and WTERT-China (Zhejiang University).

May 2018: NAWTEC, Lancaster: Presentation on the activities of the EEC-Columbia

June 2018: Medellin, Colombia: Meeting with Medellin utilities; keynote lecture at the International Conference on Waste Management organized by ACIEM (National Association of Engineers), and WTERT-Colombia. Hosting a meeting of the heads of the WTERT organizations attending: WTERT India, WTERT Colombia, WTERT Cuba, and WTERT US.

July 2018: Prague, WasteEng Bi-annual Meeting: Presentation on advancements of waste management in developing nations by facilities that recover energy and materials

July 2018: Xi'an, China: Participated at the UNECE meeting on the development of Guidelines for PPP in WTE; Singapore: Invited participant at the CleanEnviro Summit 2018

October 2018: Shanghai, China: 10th year Anniversary of SUS Environment company

November 2018: Temuco, Chile: Keynote lecture at the International Conference on Waste to Energy

3. Research studies supervised by WtERT-Columbia (Advisor or co-Advisor: Prof. Nickolas Themelis and Dr. Thanos Bourtsalas)

3.1. Studies completed by May 2018

Yiran Song: Optimization of integrated waste management systems in China

Yixi Tian: Laboratory production and testing of concrete blocks using WTE bottom ash residues

Jane Wu: Analysis of capital costs of waste-to-energy (WTE) plants built in recent years in China and in the U.S.

3.2. On-going PhD study

Yixi Tian: Development of processes for the beneficial use of WTE residues

3.3. M.S. studies completed by January 1, 2019

Yibo Yang: Assessment of the 'wasteaware' indicator for selected cities in the US and China

Lianna Aharon: Acid Neutralization Capacity during the processing of WTE bottom ash for the production of concrete blocks

Haokai Zhao: Estimation of methane generation in landfills (thesis to be issued in April 2019

Ruixin Mao: Application of Wasteaway performance indicator to selected companies

Yuji Lin: Industrial scale processes in China for pyrolysis of mixed plastic wastes to oil

Jun Dong: Application of Circulating Fluidized Bed (CFB) plant in Hong Kong

Yang Rui: Evaluation of waste management in New York

Zhixuan Wu: Life Cycle Environmental and Cost Analysis of systems for the destruction of Nitrogen Oxides in Waste to Energy plants

Jianrui Ma and Qibi Zhong: Comparison of four Chinese pyrolysis processes

Jane Wu: Analysis of capital costs of waste-to-energy (WTE) plants built in recent years in China and in the U.S.

Yiran Song: Application of MBT technology in China: The case of Shenzhen

4. Other publications

'Encyclopedia of Sustainability Science and Technology: Volume on Materials and Energy Recovery from Urban Wastes.' Springer. Editors: N. J. Themelis, A.C. Bourtsalas (in press)**.**

'Status of Waste Management and Waste to Energy for district heating in South Korea, A.C. (Thanos) Bourtsalas1, Yoonjung Seo1, Md Tanvir Alam, Yong-Chil Seo, accepted with minor revision, *Waste Management* journal

It was found that about 8% of the district heating demand in S. Korea is provided by the low-pressure steam of the 35 operating WTE plants. Also, all WTE plants operate with significantly lower emissions than the national established limits.

'Use of non-recycled plastics and paper (NRPP) as alternative fuel in cement production', A.C. Bourtsalas, J. Zhang, M. J. Castaldi, N.J. Themelis. *Journal of Cleaner Production*

It was found that the use of NRPP in the cement industry reduces greenhouse gas emission by up to 3 tonnes of CO2 per tonne of EF used in place of a high-quality coal.

'Comparison of the waste-to-energy (WTE) moving grate and circulating fluidized bed technologies, as applied in China', A.C. Bourtsalas, Q. Huang, H. Zhang, N. Themelis, submitted to *Journal of Cleaner Production*

The feedstock to MG is as-received MSW while the MSW to CFB reactors is pre-shredded using high torque-low speed shredders. The availability of MG plants, over a one-year period, is 90%+ while that of CFB facilities is 80%+. The CFB combustion chamber is more compact with a heat flux of about 1.7 MW/m2 of furnace cross section, while that of MG furnace ranges from 0.5-0.6 MW/m2 of grate surface area.

'Synergistic effects on char and oil produced by the co-pyrolysis of pine wood, polyethylene and polyvinyl chloride', P Lu, Q Huang, ACT Bourtsalas, Y Chi, J Yan

Fuel 230, 359-367.

'Review on fate of chlorine during thermal processing of solid wastes', P Lu, Q Huang, ACT Bourtsalas, NJ Themelis, Y Chi, J Yan, Journal of Environmental Sciences.

5. Visiting Scholars

Mr. Peng Liu, Zhejiang University, WTERT-China: Sep. 2017- April 2018.

Prof. Wenchao Ma, Tianjin University, China: Nov. 2018-October 2019.

6. Doctoral thesis under way

Yixi Tian: Laboratory production of concrete using WTE bottom ash and assessment of heavy metals leaching behavior

7. Awards: Floyd Hasselriis Awards of Materials and Energy Recovery Division of American Society of Mechanical Engineers to EEC MS students, Ms. Yixi Tian and Mr. Haokai Zhao.

8. Education and information dissemination activities

A.C. (Thanos) Bourtsalas represented WtERT/EEC-Columbia at the following events:

-Singapore (March): Meeting at the National Environmental Agency (NEA) for the development of a legislative framework for the use of WTE bottom ash for land reclamation;

-Delhi, India (April): Presentation at roundtable of IIT Delhi, where the major stakeholders of waste management in India participated;

-Mumbai, India (April): Invited lecture at Columbia Global Center of Mumbai;

-NAWTEC conference (Minneapolis, April): Presentation on Thermal Spray Coatings in WTE boilers;

-Hong Kong (May): Meeting of UNECE for the development of Public and Private Partnerships (PPP) in waste management. Dr. Bourtsalas was appointed as an expert of UNECE with regard to WTE PPPs;

-Astana, Kazakhstan (June): Presentation at the Ministerial conference of UNECE;

-Santiago, Chile (August): Invited lecture at Columbia Global Center of Santiago.

9. Publications

'Materials and Energy Recovery from Urban Wastes': Prof. N.J. Themelis and Dr. A.C. (Thanos) Bourtsalas are the **e**ditors of a new volume combining invited essays on "Materials and energy recovery from urban wastes" (2nd edition of Encyclopedia of Sustainable Science and Technology; Springer, pub.).

'Comparative Study of European Mechanical Biological Treatment Plants'. To be presented at the Global Waste Symposium, February 2018, California, USA

'Experimental research of basic properties and reactivity of waste derived chars', Peng Lu, Qunxing Huang, A.C. (Thanos) Bourtsalas, Yong Chi, Jianhua Yan, *Applied Thermal Engineering*

'Effect of chlorine on the structure and reactivity of char derived from solid waste', Binhang Hu, Qunxing Huang, A.C. (Thanos) Bourtsalas, Mujahid Ali, Yong Chi, Jianhua Yan, *Energy & Fuels.*

'Effect of Operating Conditions on Coke Formation and Nickel Catalyst Performance During Cracking of Tar', Peng Lu, Qunxing Huang, A.C. Bourtsalas, Yong Chi, Jianhua Yan, *Waste and Biomass Valorization.*

'Initial studies on the cytotoxicity of ceramics prepared from dry discharge incinerator bottom ash dust', A.C. (Thanos) Bourtsalas, Rainer Detsch, Aldo R Boccaccini, Christopher Cheeseman, *Ceramics International.*

***'Carbon Mitigation Cost of WTE and Comparison with Other Waste Management Methods* ', presented at Athens International Conference, June 2017; to be submitted at Waste Management& Research**

Five scenarios were investigated: Sanitary landfilling without and with landfill gas recovery and utilization, waste to energy (WTE), and mechanical and biological treatment (MBT) combined with WTE. The GHG reductions, net present costs and carbon mitigation cost were calculated. The carbon mitigation cost followed the same ranking as implied in the waste management hierarchy. Among the five target scenarios, MBT plus WTE indicated the lowest carbon mitigation cost. WTE ranked the second but had the highest GHG reductions. The introduction of carbon credit schemes was beneficial for decreasing carbon mitigation cost.

'Life Cycle Assessment of processes for resource recovery from waste-to-energy bottom ash', submitted to Environmental Impact Assessment Review

Six processing scenarios, corresponding to innovative IBA recycling schemes in EU, were subjected to Life Cycle Analysis (LCA) and Material and Substance Flow Analysis. Inventory data was obtained from industry and literature. The results showed that dry discharge is more efficient than wet discharge for resource recovery and energy use. Ferrous and non-ferrous metal extraction and use of the IBA mineral fraction increases resource efficiency. The alternative of landfilling involves significantly higher energy consumption and relatively high eutrophication and abiotic depletion.

'The Status of Waste Management and Waste to Energy Facilities in South Korea', submitted to *Waste Management* journal

It was found that about 8% of the district heating demand in Republic of Korea is provided by the low-pressure steam of the 35 operating WTE plants. Also, all WTE plants operate with significantly lower emissions than the national established limits.

'Use of non-recycled plastics and paper (NRPP) as alternative fuel in cement production', submitted to *Journal of Cleaner Production*

It was found that the use of NRPP in the cement industry reduces greenhouse gas emission by up to 3 tonnes of CO2 per tonne of NRPP used in place of a high-quality coal.

“Be Waste Wise” website co-sponsored by GWC

Be Waste Wise is a knowledge dissemination platform co-founded by EEC - Columbia University alumnus Ranjith Annepu and Global WTERT Council. *be Waste Wise*‘s programs started in 2018 made it the largest and most consistent source of webinars to provide easily understandable and first-hand information in the waste management sector. *be Waste Wise*’s programs include a) the Global Dialogue on Waste, where experts around the world join in an online conference for three days every year, and b) the *be Waste Wise* Collective, where organizations like Asian Development Bank, ISWA and WasteAid UK leveraged *be Waste Wise* platform to showcase their expertise through webinars.

In 2019, we are starting a new Interview Series with nearly 30 webinars which will be moderated by six experts from around the world with diverse backgrounds. This provides a broader audience for *be Waste Wise*, a platform for the moderators to gain visibility, and more importantly a richer discussion around solutions to and through waste.

In 2019, *be Waste Wise* will conclude a grant it has been managing since 2016 for waste management organizations in India. This grant was awarded to Thanal, a non-profit organization based in Trivandum, India. Thanal is working with a start-up called Haritha Gramam to improve waste management services through a decentralized model of on-site composting and monthly recycling. It is also working with schools and the city administration to simultaneously raise awareness about the need to subscribe to waste management services.

Be Waste Wise continues to be one of the most effective ways to disseminate knowledge with minimal effort. It continues to be a rich space for discussion for both experts and the general public, something that’s completely missing in our rapidly evolving culture and discourse.

WtERT National Organizations Under Development:

WtERT-Czech Republic 2018

By: Prof. Dagmar Juchelkova, Technicak University of Ostrava (VSB-TUO)
Dagmar.juchelkova@vsb.cz.
Note: The Global WtERT Council greatly appreciates WtERT-Germany for connecting us with WtERT-Czech

We are proud to announce start of preparation of the WtERT- Czech web page. It will contain important information from Czech Republic in the field of waste management and also technical information from abroad (preferably from other WtERT group members). The Czech Republic needs to advance sustainable waste management, especially in the area of thermal conversion of wastes and energy utilization.

The WtERT web page will be hosted by presently the most widely used web page for the issue of waste handling, **Tretiruka** – https://www.tretiruka.cz/ (now available only in Czech language), where one can also find information as to what other countries are doing on the subject of "waste management".

Specific information about research and applied results can be find at the section – Waste Forum https://www.tretiruka.cz/waste-forum/. This is an electronic and peer-reviewed journal on industrial and municipal ecology. WASTE FORUM is an electronic peer-reviewed journal that primarily publishes original scientific papers concerning all topics of industrial and municipal ecology. WASTE FORUM is on the List of Reviewed Periodicals published in the Czech Republic and is included in the international database of scientific journals of EBSCO Publishing and in the SCOPUS database. The organizers of WtERT-Czech also have strong collaboration with the IRRC Conference in Wien (http://www.vivis.de/veranstaltungen/irrc)

Presently the activities of the WtERT Czech group are focused on the NEXUS approach to sustainable waste management. The main "problem" in this field has been identified as the low acceptance by the public of thermal processes that use waste as the fuel for heat and electricity generation. In the near future, there will be an initiative by WtERT-Czech

To involve WtERT partners and also other international organizations, such as Erasmus+ - Strategic partnership, H2020. etc. on raw materials innovations

for the circular economy: sustainable processing, reuse, materials and energy recovery schemes, etc.

WtERT-Czech will also be concerned applications in rural villages and small towns, including RES utilization, biomass and waste “handling”.

Last but not least it is necessary the active work within the education system, e.g. at universities.

WtERT-Serbia, one of the newest GWC members, is headed by Nebojsa Vranes of the organization Zero Waste Serbia and its web page is www.wtert.rs. The management team includes Prof. Goran Vujic of the University of Novi Sad (goranvujic@uns.ac.rs) and Prof. Aleksandar Jovovic (ajovovic@mas.bg.ac.rs) of the University of Belgrade.

In 2017, WtERT-Serbia reviewed the present state of waste management across the country (MSW generated, disposition) and initiated contacts with the cement industry regarding the use of refuse derived fuel (RDF) in cement production. At this time, the cement industry (a total of three factories) is the only one licensed to use waste materials in place of fossil fuels. However, there have not been any concrete agreements and the cement industry expects WtERT-Serbia to facilitate this process, using the research studies already carried out at WtERT-Columbia and other research institutes.

WtERT-Serbia also had contacts and meetings with the city of Belgrade regarding the first incinerator in Belgrade (340,000 tons/year, projected cost of 340 million euro) to be located at the Vinca landfill. This project may have been already awarded to the Japanese-French consortium Suez-CNIM. If not, WtERT-Serbia and GWC may be able to assist with realization of such a project.

WtERT-Serbia has requested the assistance of the Global WtERT Council in suggesting waste management projects that are suitable for Serbia and which would be presented by WtERT-Serbia to the Ministry of the Environment or an international organization. GWC has suggested that a less costly WTE plant could be built in Belgrade and not only generate electricity but also provide heat for the existing district heating system of Belgrade. This would improve the air quality in the city in the cold season by shutting down thousands of residential boilers, as was the case in the city of Brescia, Italy.

WtERT-Cuba, 2018 Activities

By: Prof. Maritza C. Marino, Universidad del Oriente (Santiago, Cuba)

Participation in:

• First meeting of Latin American Waste to Energy Councils. Medellin, Colombia.
• Second Pan-American Conference Waste to Energy, Medellín, Colombia.
• International Workshop on Renewable Energy carried out by the Universidad de Oriente, in Cuba, as part of the Inter-institutional Collaboration Program (part of the university project "EU quality standards aligned modernization of renewable energy engineering curriculum ...")
• National workshop of Recycling. Recovering Company of Raw Material. Santiago de Cuba. November 2nd, 2018
• 19 Scientific Convention on Engineering and Architecture, Palace of Conventions, Havana. November 26 - 30, 2018

Publications:

1. Community project: Waste: throw away or reuse?, A contribution to local development.
2. Determination of the physical and chemical composition of urban solid waste in the municipality of Santiago de Cuba.
3. Procedure to determine the lower caloric power and the generation potential of urban solid waste in the municipality of Santiago de Cuba. Published in the Proceedings of the Second Pan American Conference Waste to Energy, Medellín, Colombia. ISBN 978-3-319-39368-1.
Available in
https://www.dropbox.com/sh/chb845xh7qlo2v5/AADTxTY6B5PqBLVdb4D2_b31a?dl=0
4. Development of a laminated carbon steel reinforced with glass fibers from recycled materials. 5. Development of a composite material reinforced with ceramic particles from alternative materials.
6. Characterization of urban solid waste in the municipality of Santiago de Cuba. Published in the Proceedings of the 19 Scientific Convention on Engineering and Architecture, Palace of Conventions, Havana. November 26 - 30, 2018. ISBN 978-959-261-585-4.

Currently Projects:

- Community project: waste: throw away or reuse? Project developed with the students of the school "Rubén Bravo Álvarez" for environmental education from the point of view of proper management of urban solid waste (see photos and Annex 1).
- Presentation of an institutional project for local development and environmental education from the point of view of the adequate management of urban solid waste of great utility for the country and the community.

- Presentation of the Project "Energetic use of solid urban waste in the municipality of Santiago de Cuba", it will be presented as a business project together with the Provincial Commodities Company.

Theses in Mechanical Engineering

- Characterization of urban solid waste from the municipality of Santiago de Cuba.
- Presented successfully on June, 2018.

Current Work: Study of the production and recovery of biogas in landfills of the city of Santiago de Cuba (thesis in Mechanical Engineer. To be presented on June, 2019. Task to be develop: - Carry out an inventory and monitor the waste generated in the Municipality. - Complete the characterization of solid waste in the city to establish the appropriate management plan. - Carry out the measurements of the moisture component of the solid waste. - Estimation of emissions that will be produced in the landfill. Master thesis in “Energy efficiency” Title: Efficient use of sugarcane bagasse and agricultural residues. To be presented in May, 2019. Title: Characterization of different agroforestry biomass, Marabú (Dichrostachys cinérea) To be presented on May, 2019. Title: Construction of a pelletizer for the use of solid waste product of wood To be presented on May, 2019.

Brief Report by Mr. Nebojsa Vranes, head of WtERT-Serbia

Our organization is very slow progressing even though at the end of 2017 we thought that the takeover of the Belgrade landfill by the company Suez and and th projected construction of the first waste to energy plant in Serbia would accelerate our work. Unfortunately it did notBut unfortunately, it is not.
We are trying to obtain funding from the City of Belgrade for dissemination of information and public education but the city did not approve our request, although we were the only organization for such activities who submitted a proposal.

Of course, we will continue to work in anticipation of better days. We attended a reception at the French Embassy reception on the occasion of climate change and we met with Suez senior management. We hope that we will be able to cooperate.
Of course, we have many individual goals but not direct contact with WtERT.
Regards,
Nebojša Vraneš
Asocijacija za Upravljanje Otpadom
Zero Waste Serbia
www.wtert.rs

WtERT- Philippines 2018 Activities

Messrs. Mark Bergman and Nelson Remulla of WtERT-Philippines submitted the Special Issue of Cosmopolitan Humanist on thie WtERT-Philippines 2018 activities

WTERT Asia

WTERT-Asia 2018 Activities (by: Hanwei Zhang)

WTERT-Asia, as a sister organization of WTERT focusing on the advocacy of sustainable solid waste management, aims to bridge the gap between academia and industry in the field of sustainable waste management and in particular waste-to-energy (WTE) in the Asia-Pacific region.

1. **Official Website has been Launched**
   The bilingual web page has been officially launched. We have been working continuously on updating the newest information on waste management in Asia. Please visit our new website at www.wtertasia.org.

2. **Waste Utilization & Management Journal**

   The official publication of WTERT-Asia, *Waste Utilization & Management* will become an important communication platform that strengthens communication and connections within the industry. The magazine will absorb the essence of all parties with an inclusive mindset and seize industry opportunities with forward-facing vision to explore and promote the best solutions for solid waste management, specifically in Asia Pacific region.
   The first issue of the journal will be published in English and Chinese and will be available both in hard copy and digital copy. The International Standard Serial Number ("ISSN") of the journal has been applied.

3. ***Sustainable Waste Management Guidebook***

Sustainable Waste Management Guidebook, co-authored by Zhejiang University, Columbia University and China Everbright International, is a reference book applied to all of the activities, especially waste-to-energy (WTE), related with the management of society's waste. The guidebook puts the engineering details of waste treatment into the framework of sustainable municipal solid waste management. The comprehensive operation and construction details of WTE plants are the highlights of this guidebook. Currently, the first rough draft in Chinese has been finished and it will be revised by Zhejiang University.

The GWC 2018 Report was compiled by Prof. Nickolas J. Themelis, Chair, Global WtERT Council (GWC)