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**Workshop: Green Energy and Municipal Solid Waste Solutions**

# Title: Combustion Characterization of Refused Derived Fuel from Municipal Solid Waste



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# ORAU-PROJECT PIs:

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## INTERNATIONAL COLLABORATION:

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Mr. Christos Venetis, ICP Germany

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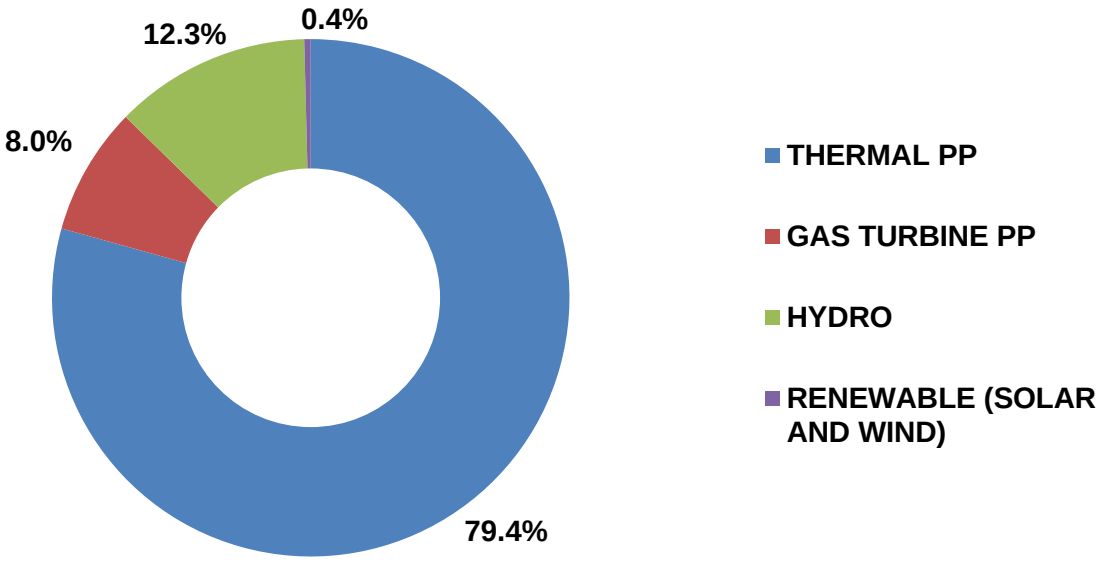
# Energy Balance of Kazakhstan

Electricity production in Kazakhstan are shared by thermal power plants -79,4%; gas turbine power plants - 8%, hydro power plants -12,3% and 0.4% from solar and wind power plants;




Energy Balance of Kazakhstan, 2016

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# Overview of Energy System

**In total 128 power plants:**

- Total installed capacity by 2017 - 21.7 GWt (19.44 GW in 2010)
- Available capacity by 2017 - 18.79 GWt (15.29 GW in 2010)

**The plants are classified according to their property:**

- Public (82% of the total stock)
- Industrial (18%)
- Regional CHP plants

**3 hydro-plants: Buhtarminslaya, Ust-Kamenogorskaya and Shulbinskaya**

The electric system (transmission) of the country is divided by three zones:

*I.* *South zone:* Almatinskaya, Zhambylskaya, Kzul-Ordinskaya and south Kazakhstan;

*II.* *North zone:* Akmolinskaya, Pavlodarskaya, Karaginskaya, Kustanayskaya, Aktiybinskaya;

*III.* *West zone:* Atyrauskaya, Mangistayskaya and west Kazakhstan region;

Ref: National Grid Operator JSC KEGOK. Available: www.kegoc.kz

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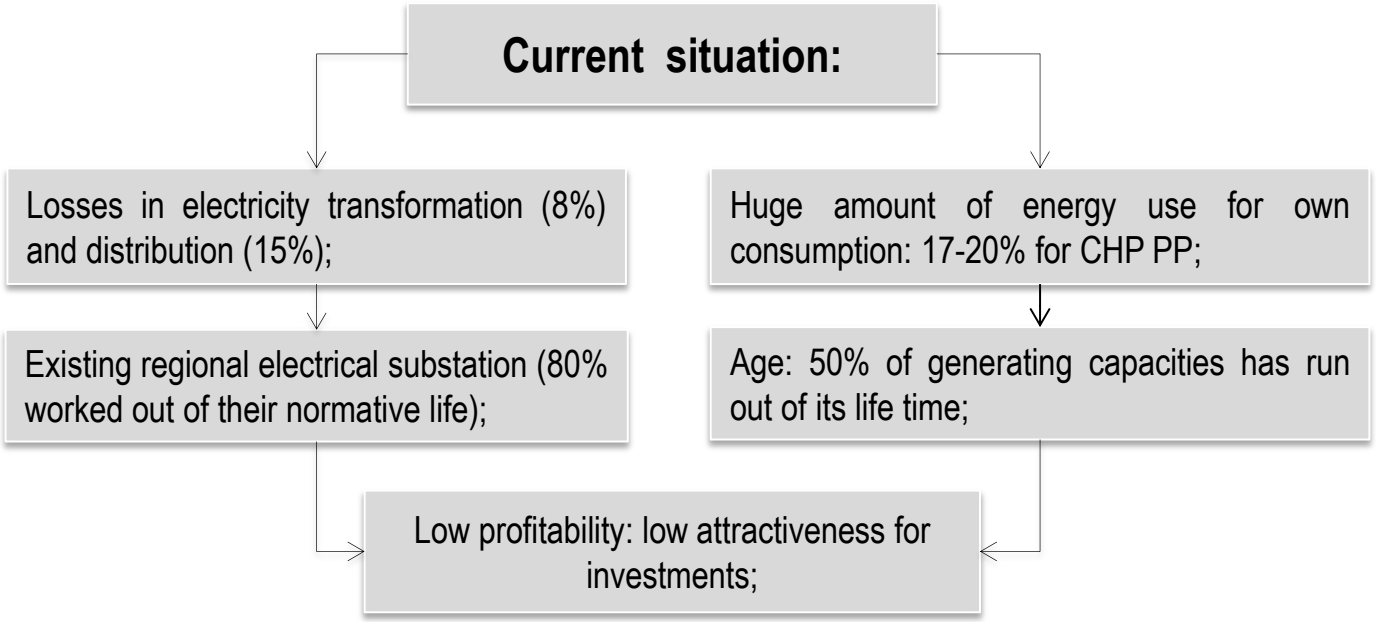


## Areas need to be addressed:

- Public awareness campaigns for efficient energy, water and waste savings;
  - Energy efficiency in buildings
  - Smart grids system/smart distribution
  - Micro/mini CHP systems in rural areas
- Municipal solid waste (MSW)/biomass utilisation and incineration technologies

## New solution/an alternative fuel for energy use:

Clean coal, co-firing and waste-to-energy incineration technologies could be an attractive option?

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# Municipal solid waste (MSW) in Astana city

- Landfilling of MSW is well practised in Kazakhstan;
- Municipal solid waste of Astana city **1200-1300** tons/day
- Average value - **1.39** kg per person per day;
- Generation rate per capita **526 kg/capita in** 2015;
- Recycling rate of MSW **7-10%** and the rest being disposed at the landfill;
- Population of city: **1 036 thousand** in 2018;

Residents by ages 2016 (source: www.stat.gov.kz): **28%** in the age of 0-15 years old;
**66%** in the age of 16-62 years old;
**7%** in the age of 58-63 and higher;

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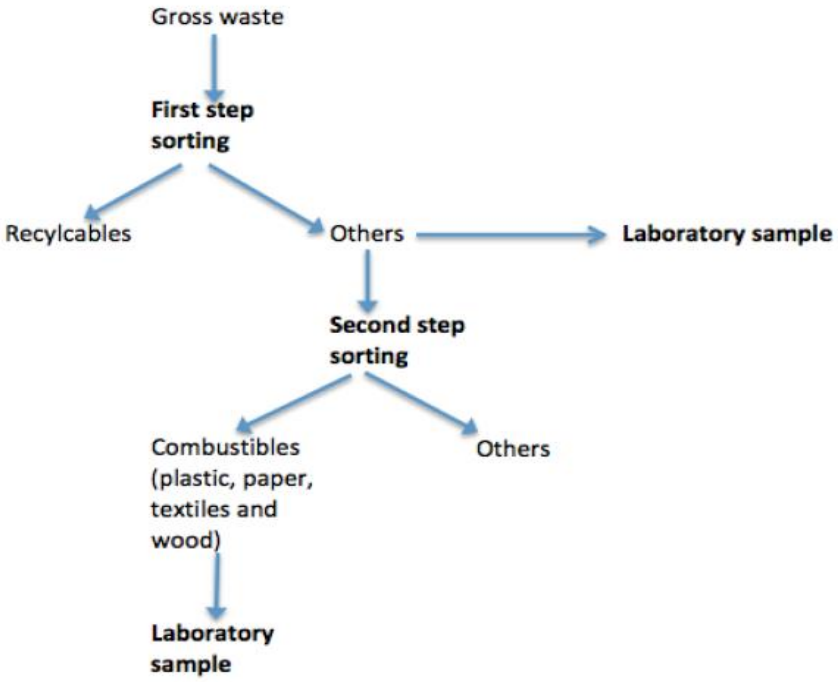
# Sampling of MSW

## SAMPLING PROCEDURE




## SEASONAL INVESTIGATION OF MSW MORPHOLOGY

*First sampling: 25-29 September 2017*

*Second sampling, 06-10 November 2017*

*Third sampling, 22-29 February 2018*

*Fourth sampling, June 2018*

- ***Moisture content;***
- ***Heating value;***
- ***Thermal properties of samples;***

**First step sorting (recyclables):**
Plastic (PET), plastic (PE), other plastic, paper (books, newspaper, cardboard and tetrapack), metals (Fe & non Fe), glass, textile, wood, electronic waste and others

**Second step sorting (RDF):**
Mixed plastic (PET), mixed paper, textile and wood;

**Third step sorting:**
Fine sizes, Organic fraction

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# SITE PREPARATION/PICTURES

## Site area/mixing and loading/collection




## Waste after 1st step sorting

## Waste after 2nd step sorting

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# MSW SAMPLING CATEGORIES:

| | | |
|---|---|---|
| **Plastic (PET)** | Plastic bottles for water<br>Plastic bottles for soft drinks |  |
| **Plastic (LDPE)** | Bags from stores |  |
| **Plastic (HDPE)** | Bottles for household cleaners<br>Bottles for shampoo |  |
| **Other plastic** | Plastic boxes, toys, buckets etc |  |
| **Paper** | Printed paper, books, newspapers |  |
| **Cardboard** | Cardboard boxes (all types) |  |

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# MSW SAMPLING CATEGORIES:

| | | |
|---|---|---|
| **Cardboard** | Cardboard boxes (all types) |  |
| **Metals** | Fe metals (canned food, tools), tools<br>Non Fe metals |   |
| **Glass/Wood** | Bottles/Furniture, Wood boxes |   |
| **Textile/WEEE** | Clothes, handbags/All types of electronic equipment |   |
| **Food/Green waste** | Food waste: leftovers, uncooked meat, vegetables |  |
| **Green waste** | Flowers, leaves, branches etc |  |

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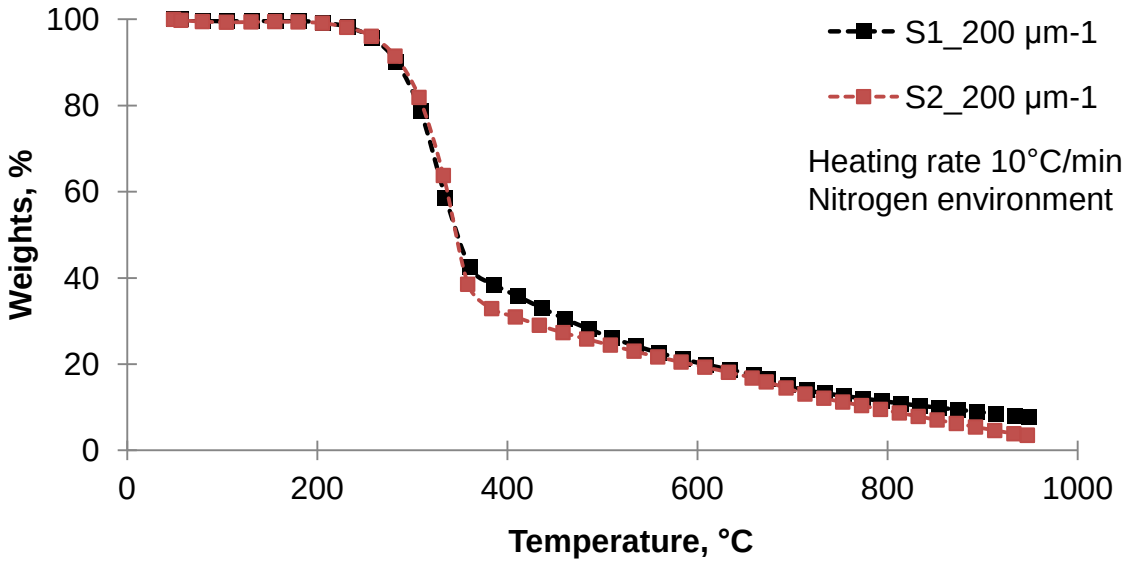
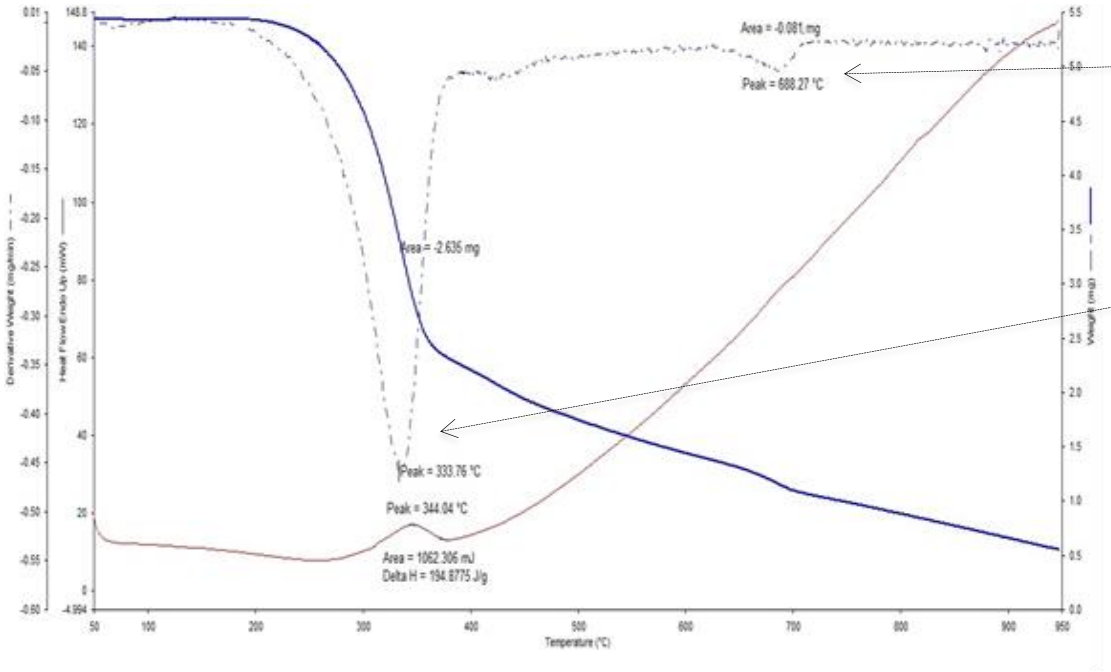
# Effect of season on the mass loss rate




Peak2 at 688°C

Peak1 at 333°C

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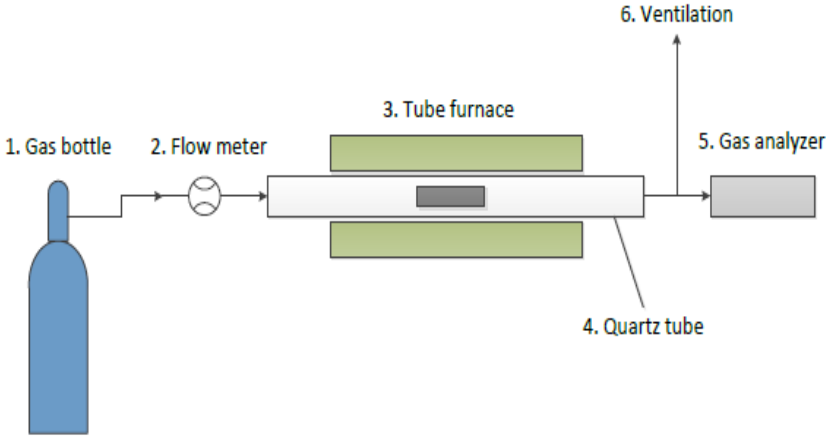
# HORIZONTAL TUBE FURNACE TESTS





**Sketch of the horizontal tube furnace setup**
**(**Quartz tube: Internal diameter – 54 mm; Length – 1000 mm**)**

**Operating conditions:**

| | |
|---|---|
| Weight of RDF sample, g | 20 (±0.3) |
| Furnace temperature, °C | 600, 800 |
| Flow rate of air, L/min | 3.4 (at 600°C), 2.9 (at 800°C) |
| Heating rate, °C/min | 20 |

Residence time of gas in a heated zone kept at 5 sec

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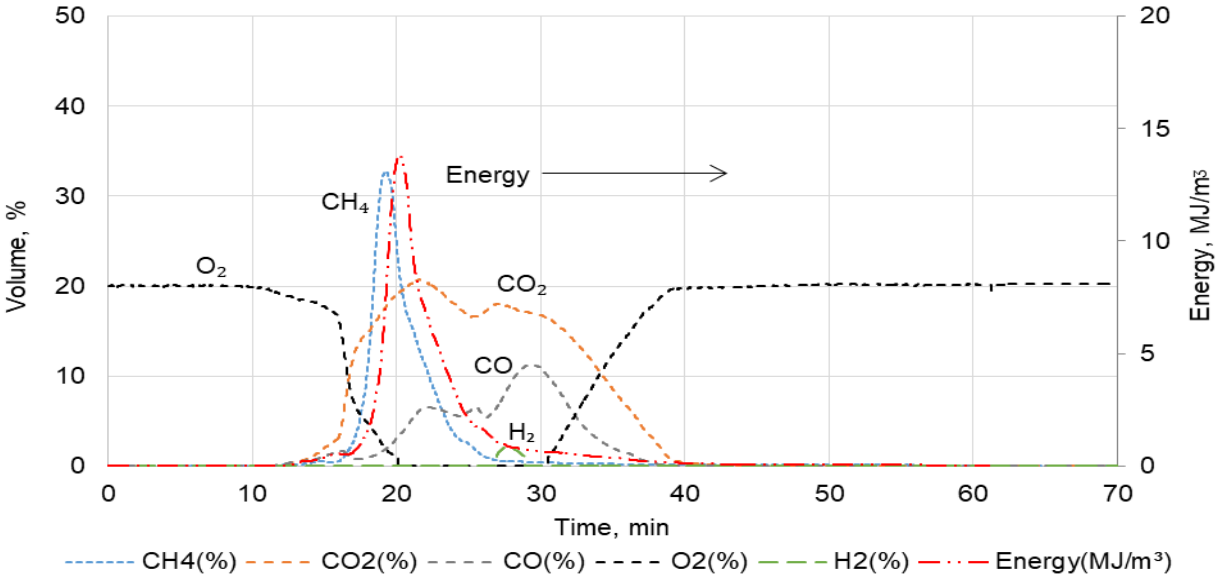
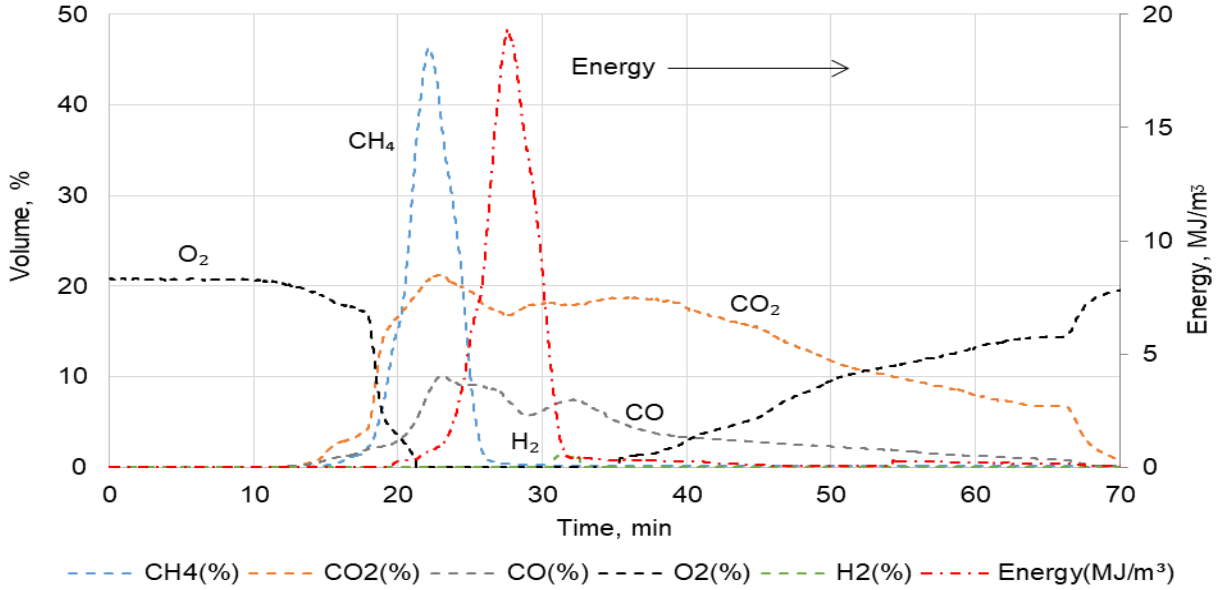
# Flue gas measurements

Test at 600°C, heating rate 20°C/min, hold time 40-min




Test at 800°C, heating rate 20°C/min, hold time 40-min



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# Facilities:

1. Fluidized bed rig;
2. Bomb calorimeter;
2. Heavy metal analysis (ICP-MS);
3. Flue gas measurements (FTIR);
4. NDIR gas analyzer

Gasmet Dx4000

Rapidox 5100

Inficon micro gas chromatograph 3000

Bomb calorimeter

Fluidized bed furnace

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# Thank you for your attention!

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  Christos Venetis,
  Dr Vassilis Inglezakis,
  Dr Edward J Anthony;