Circular Economy: Heating the heart of Paris with Energy-from-Residual Waste

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Many useful Materials may run in a quasi-circle. But both users and consumers generate residues.

Something is going wrong in this drawing.

Can you find it?
Circular Economy according to European Commission

Extracting raw materials is needed, and some residual waste is unavoidable

Again something is missing in this drawing

Can you find it?
Once upon a time...

Just arrived in France with her ‘father’ Leonardo, the most famous Italian lady in France was worried.
Paris’ District Heating Network
CPCU (Compagnie Parisienne de Chauffage Urbain)

12 municipalities served
470 km heating network
16 hot water loops
11 generation sites (among which 5 CHP) including
- 3 Waste-to-Energy plants (SYCTOM)
Saint-Ouen W-t-E plant
- started in 1990
- 600,000 tpa residual municipal waste
- bottom ashes removed by boat along the Seine river
1.1 TWh_{th}/y \rightarrow 104,000 home eq.
http://www.syctom-paris.fr/edi/comm/comm/stouen/presentation.htm

Issy-les-Moulineaux W-t-E
- started in 2007
- 460,000 tpa residual municipal waste
0.5 TWh_{th}/y \rightarrow 66,000 home eq.

Ivry-Paris XIII W-t-E plant
- started in 1969 (running since 45 years)
- 700,000 tpa residual municipal waste
- World record in capacity per line: 2 x 50 t/h
0.8 TWh_{th}/y \rightarrow 75,000 home eq.
What is in a Waste-to-Energy Plant?

- Waste bunker: storage without pre-treatment
- Hopper and Feed-Chute
- Control room & crane driver
- Traveling crane and grab
- Recovery Boiler
- Flue Gas Cleaning system
- Turbine-generator set
- Waste Feeder
- Combustion Grate
- Bottom ash discharge

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Paris W-t-E*: Energy from waste in CHP** mode

- Waste: 1,750,000 tpa of municipal waste not suitable for recycling
  - From some 5.7 million inhabitants of the Paris Metropolitan area
  - From 84 municipalities (SYCTOM)

- Steam produced in the 3 W-t-E * plant is used in CHP** mode:
  1) To generate ELECTRICITY 200,000 MWh per year
     - A small part is used by the plants,
     - The majority being sold to the electricity grid (EDF)

  2) To feed the DISTRICT HEATING network (CPCU)
     - 2,400,000 MWh of heat
     - This is 50% of the DH demand (ca. 5 TWh in total)

* W-t-E: Waste-to-Energy
** CHP: Combined Heat & Power

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Paris W-t-E*: Environmentally friendly

- The energy produced by the 3 W-t-E* plants prevents:
  - The consumption of 300,000 tonnes of oil equivalent each year
  - The release of some 800,000 tonnes of CO₂ into the atmosphere each year

NB: 50% of the energy from residual municipal waste is recognized as renewable energy

The energy produced by the 3 W-t-E* plants is sold to CPCU:
- 16.3 €/MWh of steam

- It is economically profitable
  - Natural gas EU average: 41.7 €/MWh (to which must be added the heat production cost)
  - NB: The price of steam from waste is a political decision
    - In Tallinn it is 30 €/t of steam
    - The profit must be shared between
      - The Tax payer (for waste treatment)
      - The heat user
The Paris District Heating network:

- Provides heat to 1/3 of Paris buildings
- 490,000 home-equivalent, i.e. around 1.5 million inhabitants

50% comes from the 3 W-t-E plants

245,000 home-equivalent heated by the 3 W-t-E plants

The CPCU dispatching centre was entirely re-engineered in 2010. It is a world first for such a large network.

http://www.cpcu.fr/La-chaleur-urbaine/SUPERVISION-ET-CONDUITE
The 21 Parisian hospitals are heated by Waste-to-Energy

- **100%** of Parisian hospitals
- Most Parisian monuments and museums
  - including the Louvre museum
Happily ever after...

... Mona Lisa keeps on smiling, thanks to Waste-to-Energy!
Where do cities find a benefit in using their waste for heating?

Why should W-t-E strive to export heat?

- Synergy
- Clean and environmentally friendly
- Cheaper and more efficient
- Protective
Waste: an energetic source of energy

- Oil shale. Net Calorific Value: 8 – 9 MJ/kg
- Lignite. NCV*: 6 – 11 MJ/kg
- Waste. NCV: 7 – 12 MJ/kg
- Biomass. NCV: 7 – 12 MJ/kg
- Peat. NCV: 7 – 14 MJ/kg

* NCV: Net Calorific Value

- The energy embodied in a tonne of waste is the same as in a tonne of many common fuels
- The more is recycled, the higher is the NCV of the residual fraction

Photos from Connaisancedesenergies.org, pixshark, lenergeek.com, Firepower

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The more is recycled, the higher is the NCV of the residual fraction.

If

1 tonne of Municipal waste

= =

Fuel oil : 200 l

1 tonne of sorting residue

= +

Fuel oil : 220 l
Waste-to-Heat: a cheap source of energy

**UNEP* report, published on 26/2/2015 on**

"District Energy in cities - Unlocking the Potential of Energy Efficiency and Renewable Energy"

- Modern district heating:
  - The most effective approach for many cities to:
    - Transition to **sustainable** heating and cooling,
    - By improving **energy efficiency** and enabling **higher shares of renewables**.

- Energy from waste
  - “Waste incinerators produce very low-cost heat and often initiate development of a city’s district heating network.” (page 25)
  - “District energy is a core strategy in putting **Paris** on the pathway to a **75 per cent reduction in CO₂ emissions by 2050**; the city’s waste-to-energy plants alone avoid the emission of **800,000 tons of CO₂ annually**.” (page12)

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Waste-to-Heat: a cheap source of energy

The cheapest heat is from W-t-E

Note: Centralized plant costs are estimates based on available data and will vary significantly by country. Such variance is caused by (but is not limited to): load factor; local fuel prices currently and in the future; fuel prices at point of consumption (i.e., electricity consumed may have higher price than average annual electricity price); installation and labour costs; capacity of installation; land prices; cost of finance; development costs; any subsidies and tax incentives. UNEP has calculated CHP and waste-to-energy heat prices based on the lowest heat price possible based on fuel prices and electricity price received (prices detailed below) as well as on GAPEX and OPEX payments. Waste cost: – US$26/ton (negative). Wood chips: US$169/ton. Gas: US$38/MWh. Electricity price received for CHP/Incinerators: US$102/MWh. Electricity price for cooling: US$127–US$165/MWh. Steam price for absorption chillers: US$19–US$38/MWh. Discount rate: 10 per cent. Waste incinerator load factor: 80 per cent. All CHP plants load factor: 40 per cent. District heat gas/electric boiler load factor: 10 per cent. District heat wood chip boiler load factor: 40 per cent. Geothermal load factor: 80 per cent Free cooling load factor: 62 per cent. Electric chiller load factor: 30 per cent. Absorption chiller load factor: 30 per cent.

W-t-E: an environmentally friendly source of energy

- Synergy
  - Solves both waste treatment and heating problems at a time
  - Reduces the cost of both

- Clean
  - By far, W-t-E* have the most stringent requirements of all industries in respect of emissions and monitoring and comply with them

- Renewable energy
  - Biodegradable part of waste is recognised renewable (typically 50%)

- Recoverable energy
  - The other part of residual waste would be lost if not sent to W-t-E*

- Low carbon emissions
  - Avoids fossil fuel consumption
  - Avoids methane emissions from landfill

- Complement recycling and biological recovery
  - W-t-E* is very flexible: It can process the residues of material recycling whatever they left over
  - And so comply with the waste management hierarchy
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supplying 14 million inhabitants

79 million tonnes of remaining waste in Europe

32 billion kWh electricity

thermally treated in Waste-to-Energy Plants

Metals from bottom ash

8 – 44 million tonnes of fossil fuels Year 2012
Waste-to-heat: a protective source of energy

- Reliable
  - Not dependant on weather conditions
  - Operating 7/7 days and 24/24 hours
- Available
  - E.g. 13,000 tonnes of waste/day in the Paris Metropolitan area

- Local
  - No dependence on import of fuel
Circular Economy according to Ellen MacArthur Foundation

So, what was wrong with this drawing?

How do we run/drive/propel such an economy?

Energy is needed!

Fortunately the leftovers of recycling contain energy which can be recovered by W-t-E
Circular Economy according to European Commission

So, what was missing here?

Again, though, it’s what keeps this circle spinning

Fortunately the residual waste contains energy
Waste Hierarchy encompasses both Material AND Energy

Many materials can run in a quasi-circular economy

But there is always a residue, and there is always a need for energy

Most cities export residual waste to landfills and import fuels for heating

Some cities do it differently, by converting their residual waste into local energy... How?
Yes, CNIM can assist

- **Project developer**
  - In-house Project Finance team
    - to develop **innovative financing** solutions for private and public clients
  - Proprietary technical, operating and financial model
    - to structure **bankable financings**

- **Designer**
  - Proprietary performing Technologies
    - Combustion
    - Heat recovery
    - Energy conversion
    - Flue Gas Cleaning

- **EPC contractor (> 160 plants supplied)**
  - **Turnkey** delivery

- **Operator**
  - **Wide range** of capacities
    - 25,000 – 500,000 tpa
  - In several countries

- **All the expertise needed in one hand**
  - **50 year experience**
    - 1st plant started in 1964
  - **Proven** technologies
    - Paris-Ivry plant (700,000 tpa) started in 1969, still running
  - **Wide variety** of techniques and **know-how**
    - Each ideally suited to the local conditions
  - Experience as JV or Consortium leader, worldwide
Further information?

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Don’t waste your waste: Use Energy-from-Waste