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Bioeconomy & Cleantech Opportunities

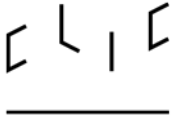


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Material Value Chains

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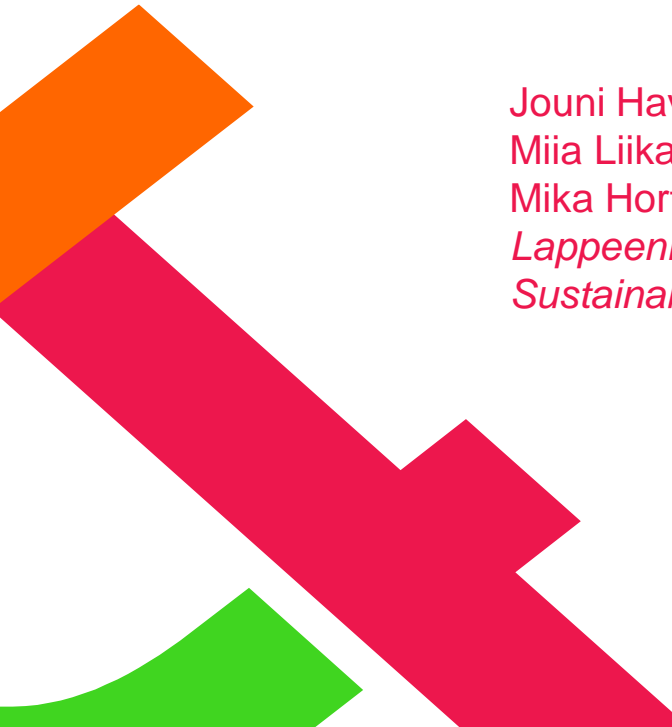
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technology

# Systemisellä ymmärryksellä kestävyyttä ja liiketoimintaa yhdyskuntajätteiden käsittelyyn Kiinassa ja Brasiliassa



# Objectives and Implementation

- The overall objective of the MSW theme was
  - to increase understanding of the municipal solid waste management systems (and nitrogen recovery from sludge),
  - thus increasing the value of the recovery and
  - facilitating sustainability
  - in different business environments.
- Implementation
  - Systems analysis in different operation environments
    - South Karelia, Hangzhou, Sao Paulo
  - Environmental LCA as the main method
  - Organization of MSW management and money flows
  - Co-operation with business analysis



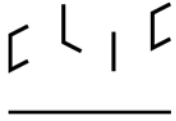
# Systems analysis for MSW management of Hangzhou city in China

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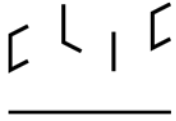
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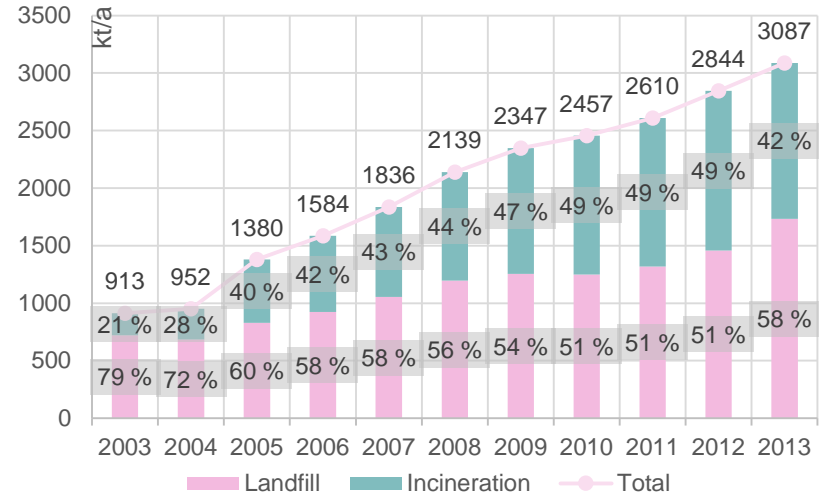
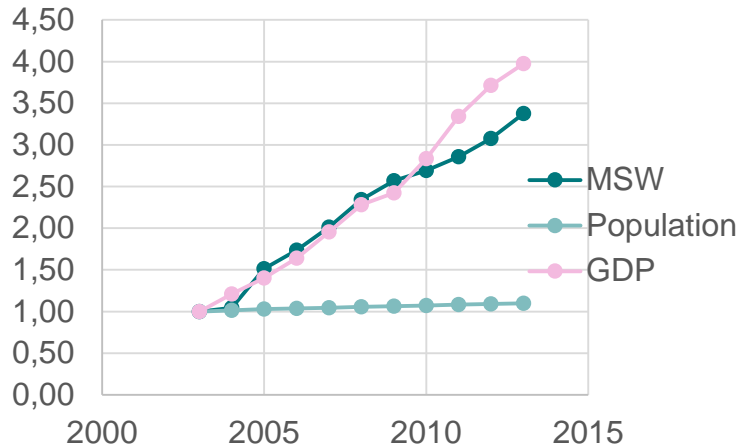
# Systems analysis for MSW management of Hangzhou city in China

- Objectives
  - Analyzing the current MSW management system of Hangzhou city
  - Analyzing the possibilities to improve environmental sustainability with WtE solutions including Finnish technology
    - SRF production – *Avoiding coal use*
- Environmental impact analysis with LCA method
  - Producing SRF from mixed MSW
  - GHG emissions and emissions causing acidification and eutrophication
  - Comparing to current mixed MSW co-combustion with coal



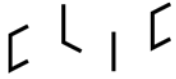
# Study region: Hangzhou city

- Inhabitants: 7 million
- Capital city of Zhejiang province
- Stark increase in MSW generation

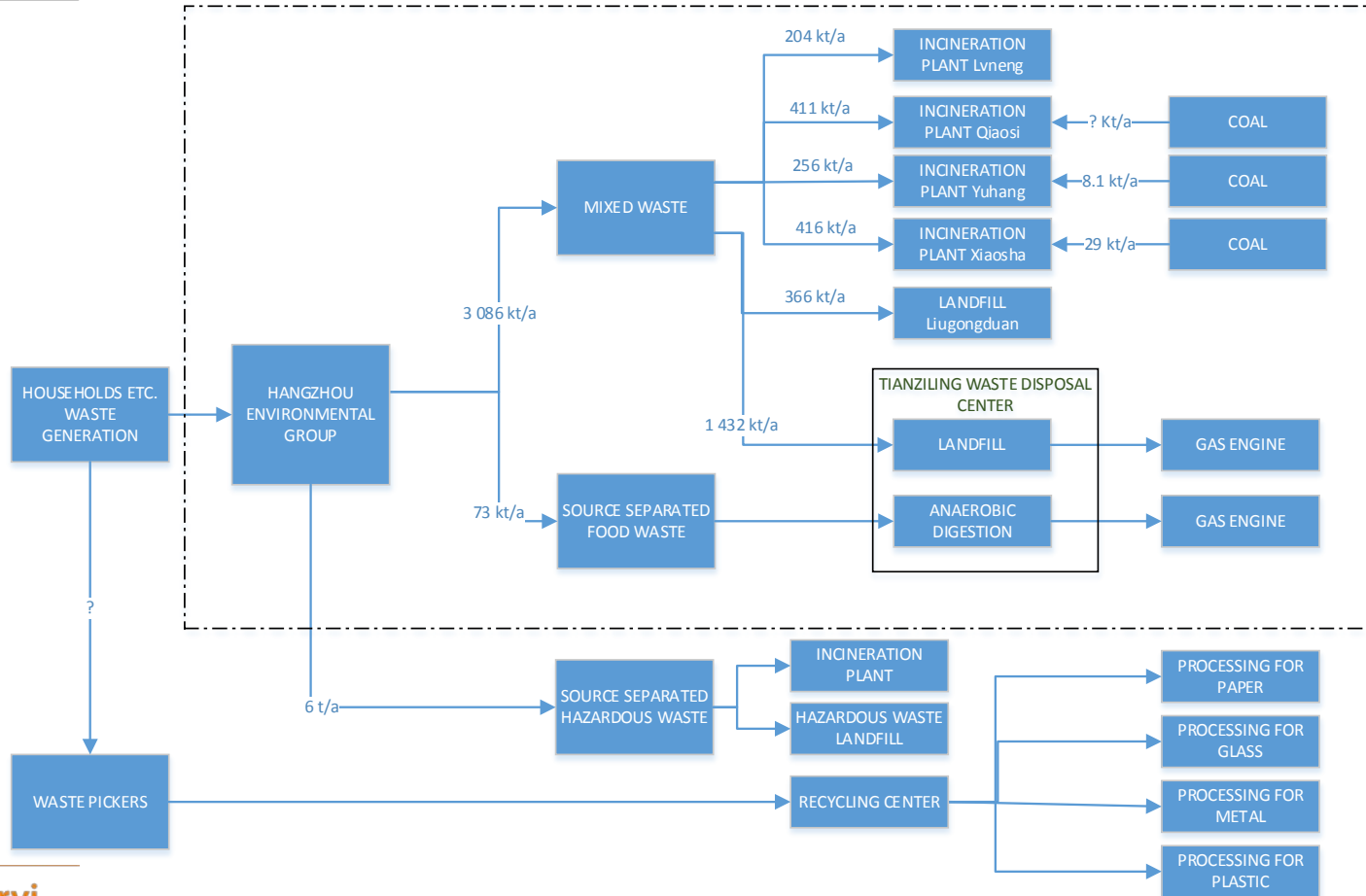


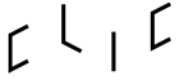
## MSW per person

- 2003: 142 kg/inhab./a
- 2013: 432 kg/inhab./a

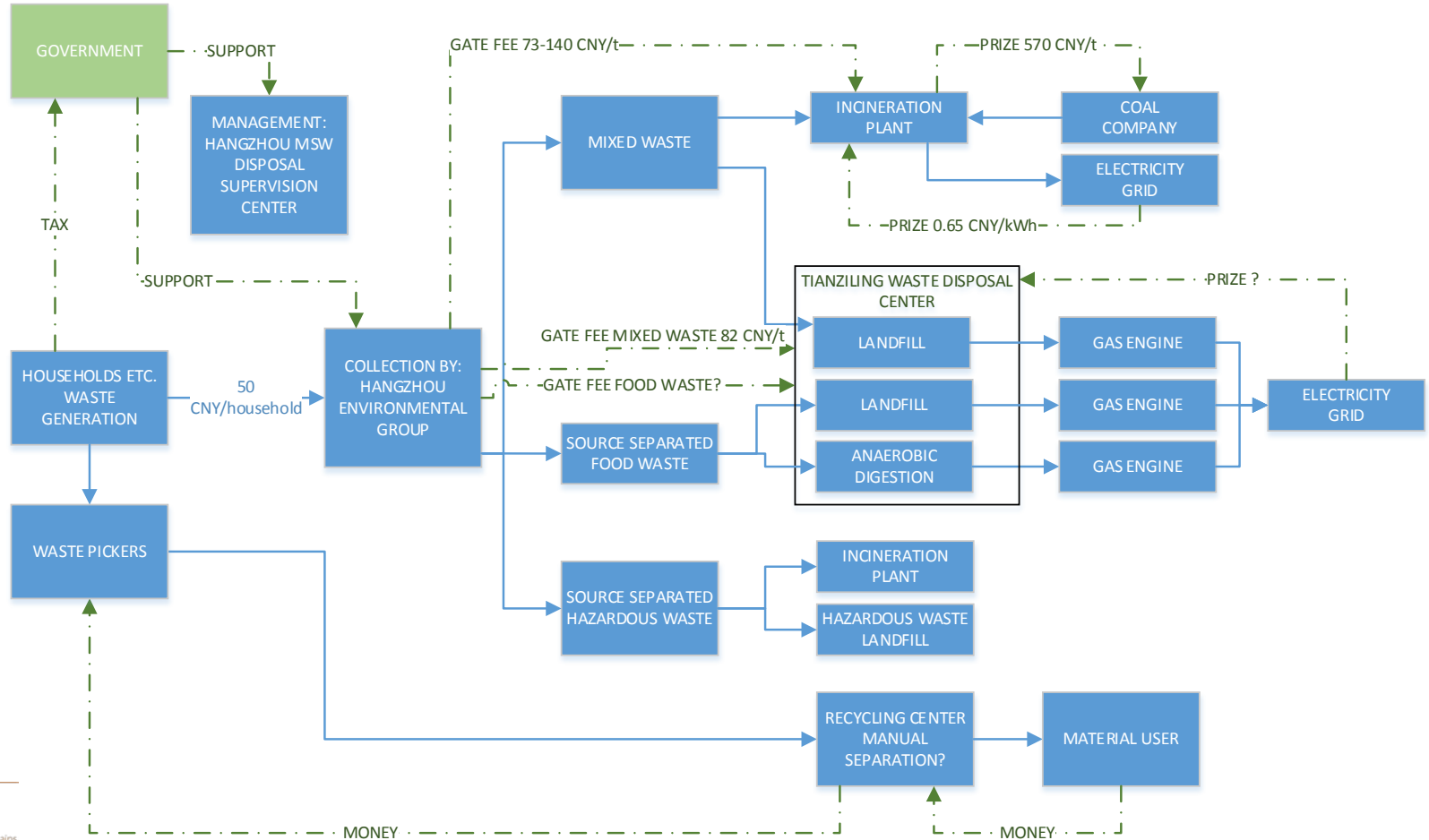


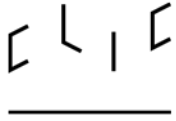
# MSW management system: **Mass flows**



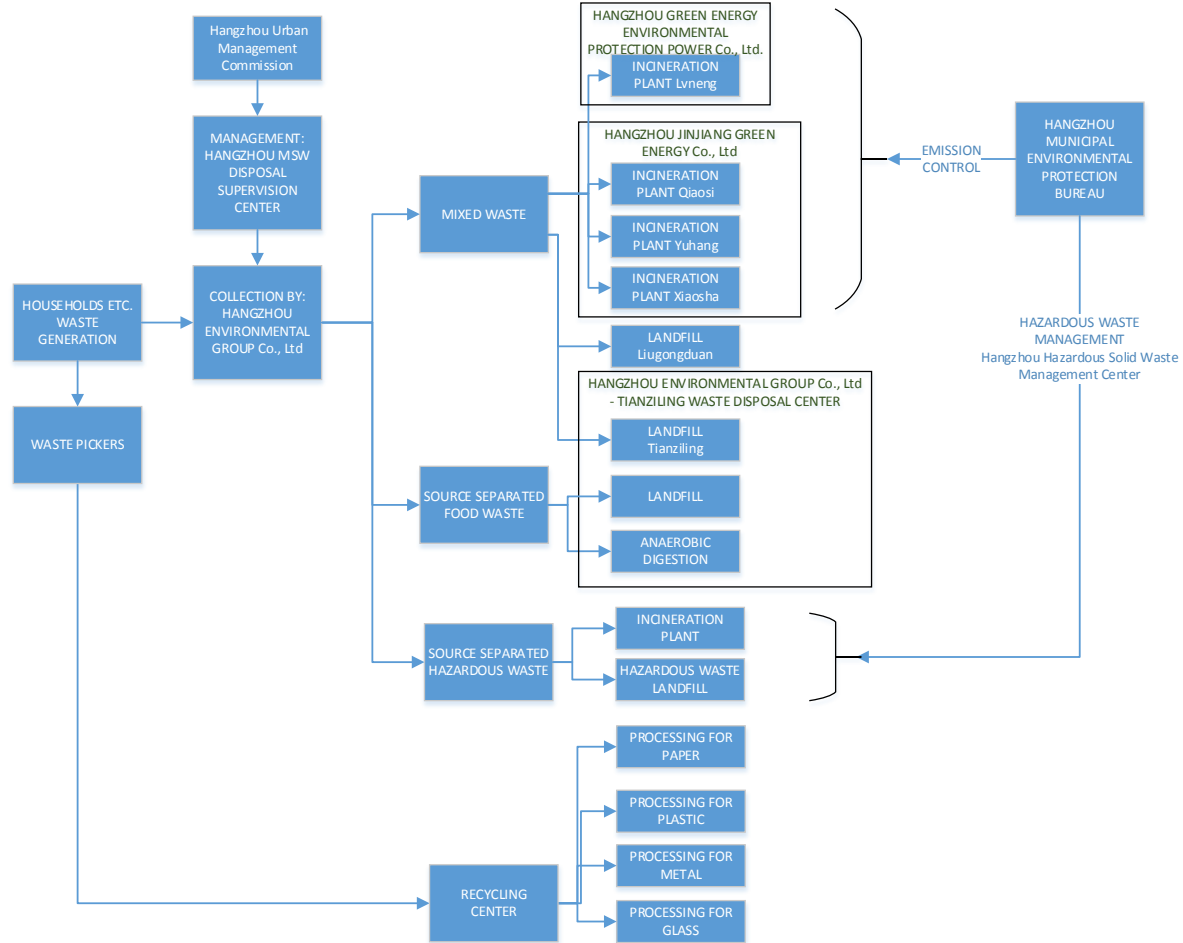


# MSW management: Money flows

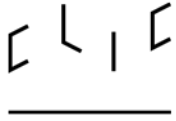




# MSW management: Organizing



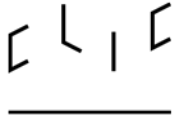




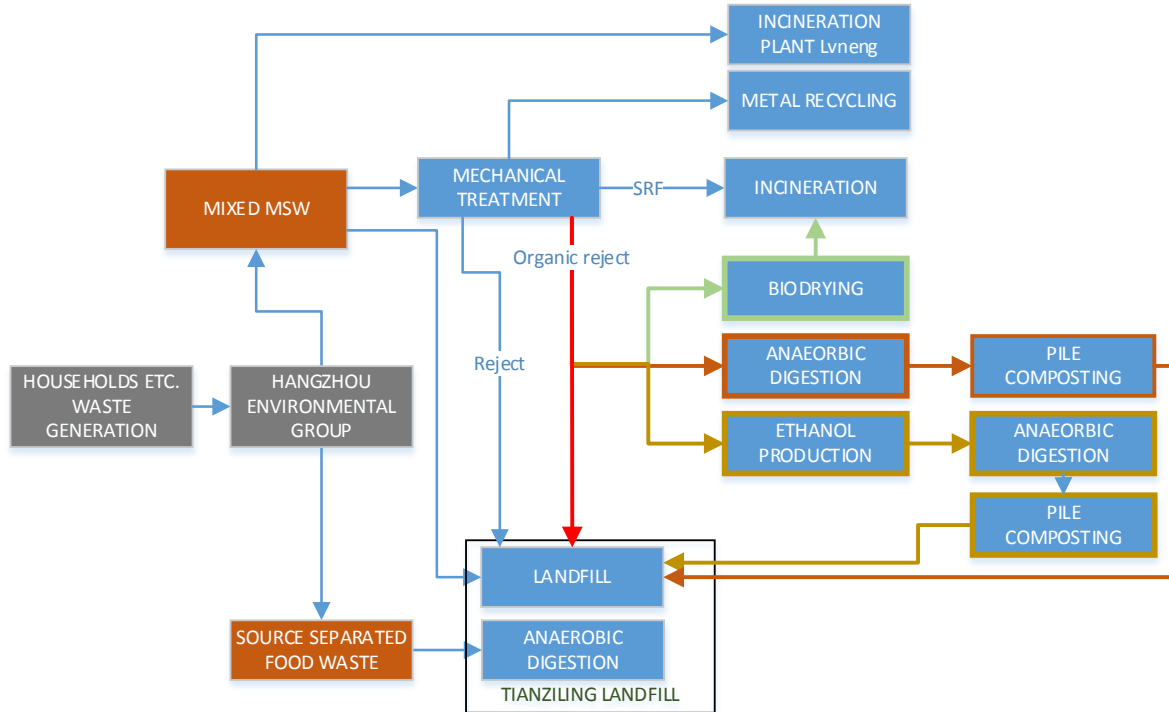
# Life cycle assessment

## Hangzhou city MSW management system

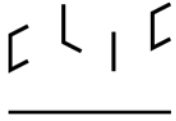
- Functional unit is the MSW mass produced in 2013, i.e. **3 100 kt**.
  
- Compared scenarios
  - **Scenario 0**
    - Present incineration and landfilling
  - **Scenario 1**
    - SRF production and incineration in existing incineration plants
  - **Scenario 2**
    - SRF production and incineration in new CFB plants
  
- Scenarios 1 and 2 include **sub-scenarios with different biodegradable reject treatment**
  1. Landfilling
  2. Biodrying and incineration
  3. Anaerobic digestion, composting of digestate
  4. Ethanol production, anaerobic digestion of stillage, composting of digestate



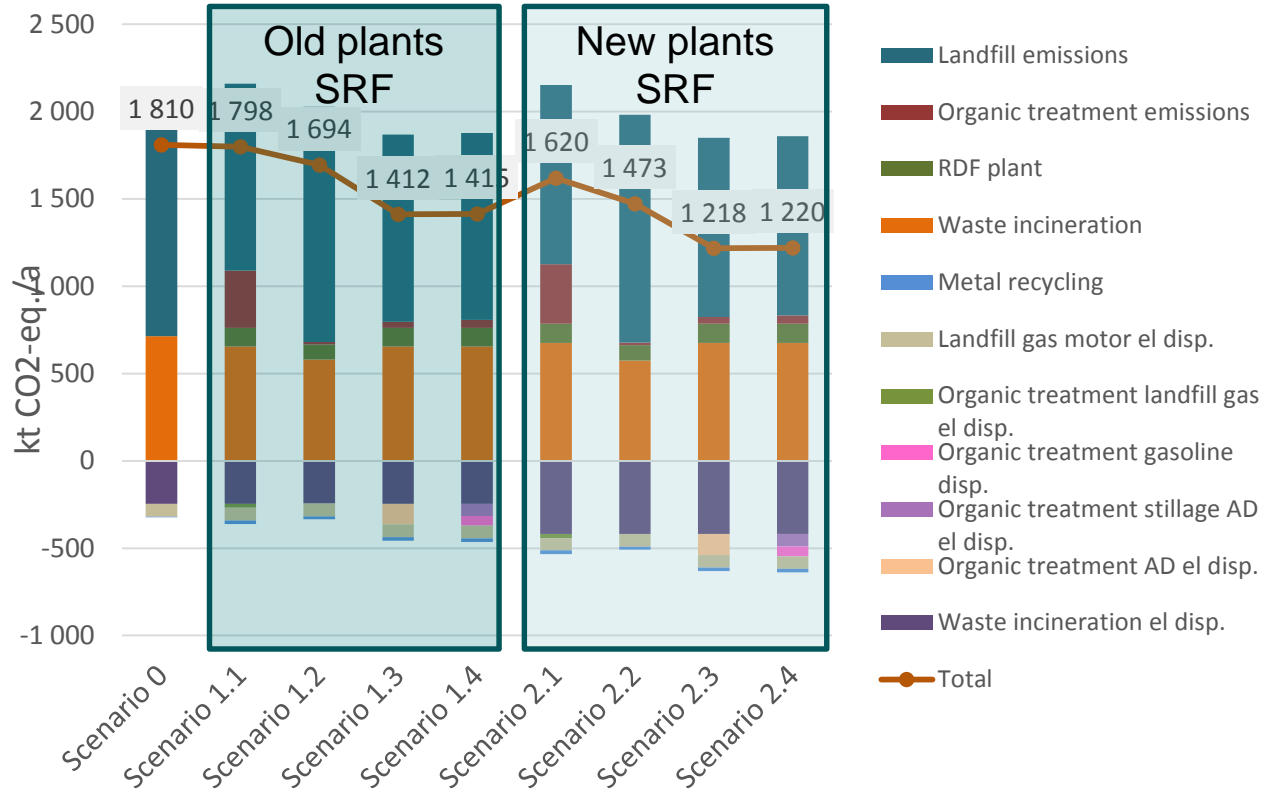
# Hangzhou city MSW management LCA

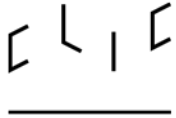


- Options for biodegradable waste treatment
- Option 1 —
  - Option 2 —
  - Option 3 —
  - Option 4 —

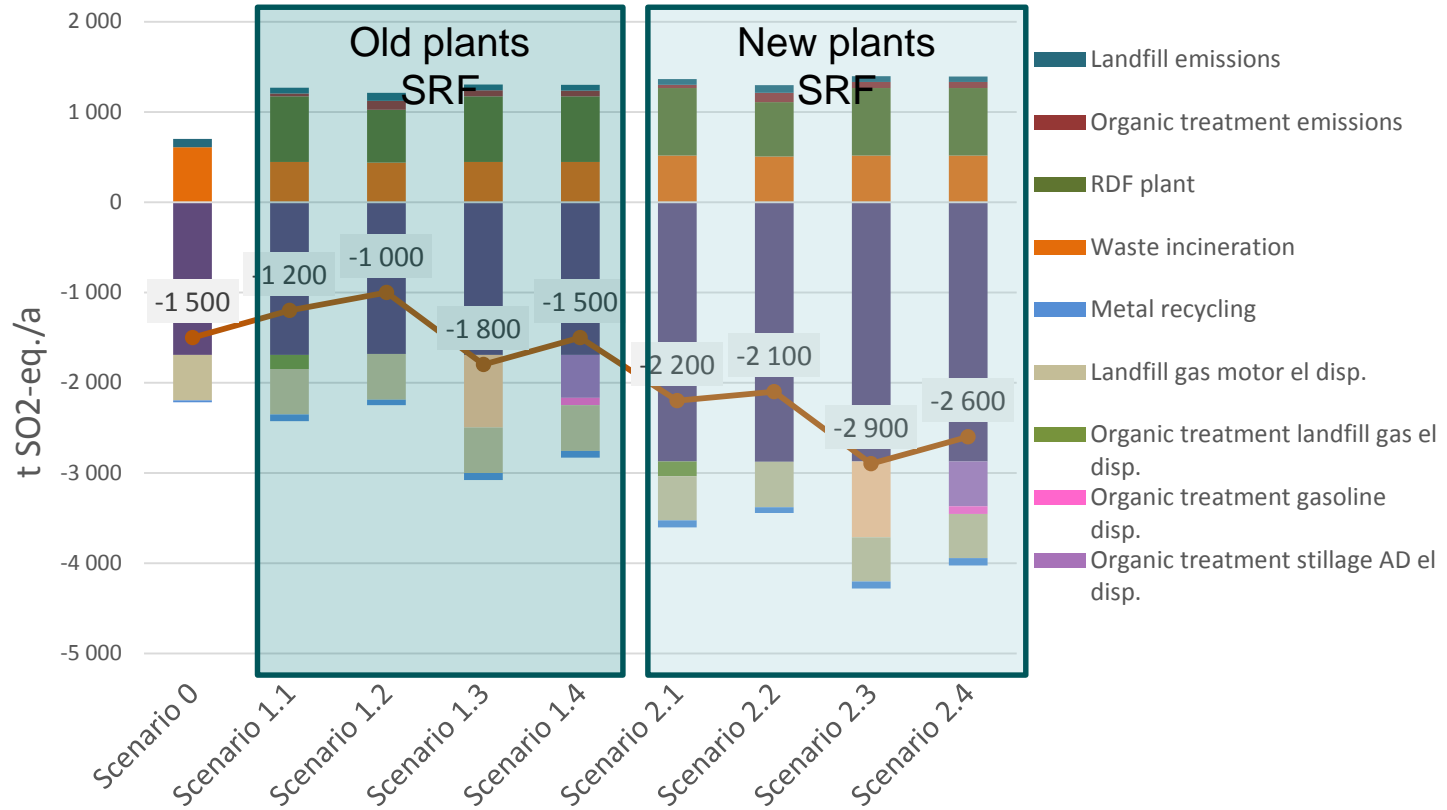


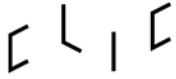
# Results: Global warming potential (GWP)



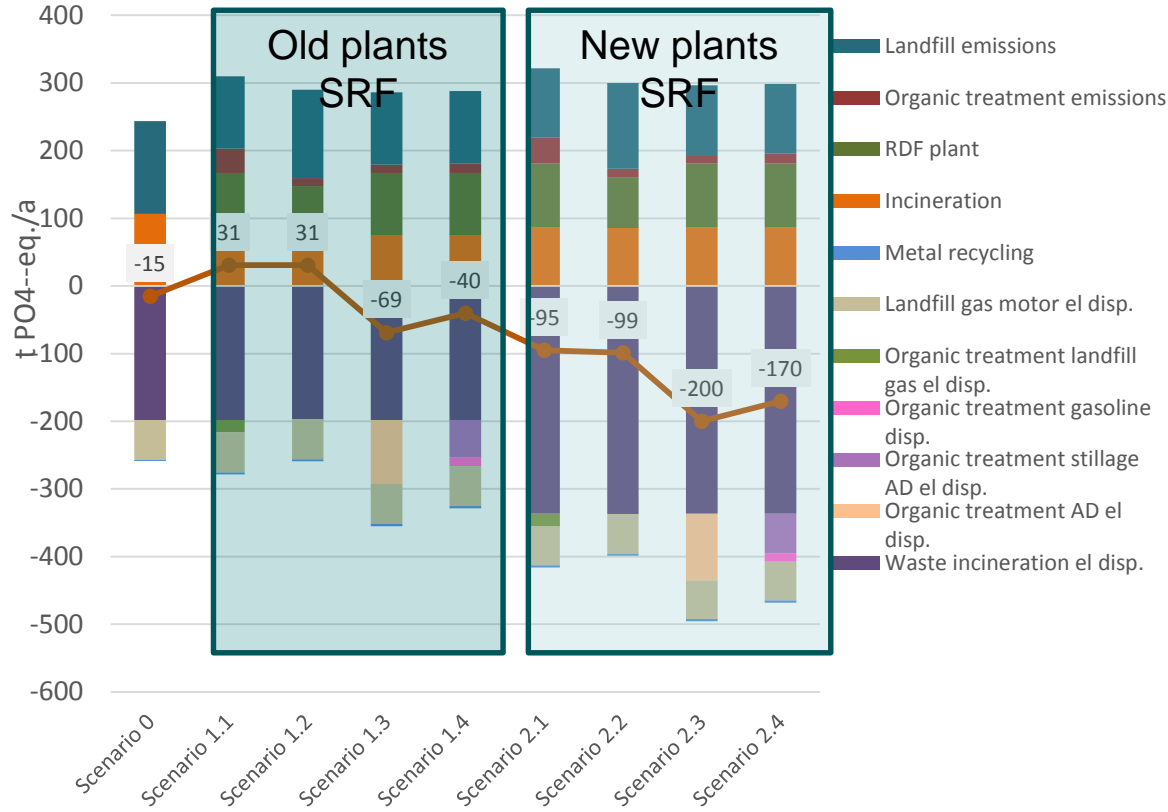


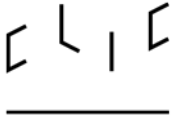
# Results: Eutrophication potential (EP)





# Results: Acidification potential (AP)





# Conclusions

- Main problem: lack of source separation
  - High food waste share → High moisture content → low LHV
    - Mechanical separation of recyclables difficult
  - Educating citizens is necessary
  
- The environmental performance would be improved a lot if the incineration plants could recover also heat
  - Placing near the industry which uses steam
  
- SRF production could improve significantly the environmental performance of Chinese energy recovery of MSW
- *Recovery of the reject* from SRF production is important



# Steps towards sustainable municipal solid waste management in São Paulo, Brazil

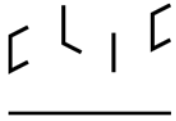
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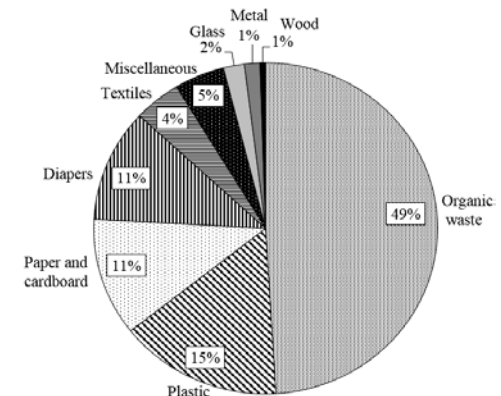
# MSW management in São Paulo

- Brazil is the fourth largest MSW producer in the world
- São Paulo is the largest city in Brazil
- No proper source separation of MSW
- Landfilling is predominant treatment method for MSW
- 2 sanitary landfills, 3 waste transfer stations and 2 mechanical sorting plants in the city
- MSW management is contracted out to two companies, Ecourbis and Loga
  - 20-year contracts
- São Paulo plans to develop MSW management system
  - Need to diminish the volume of MSW landfilled
  - Separate collection for organic waste in future
  - *Incineration opposed*



São Paulo City

- Population: 11-12 million, depending on the source
- Surface area: ~1500 km<sup>2</sup>
- MSW generation: ~400 kg/capita/year



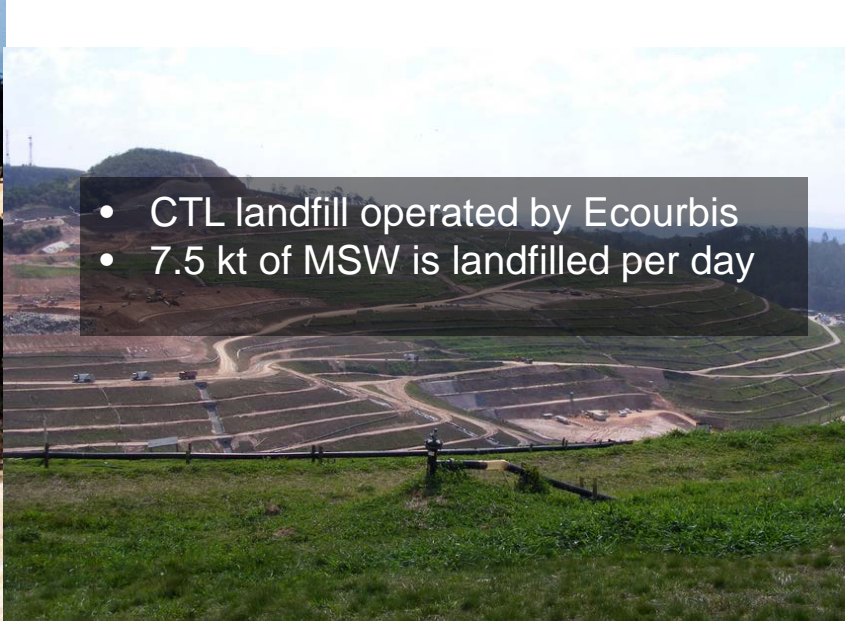


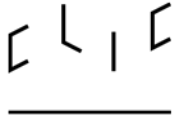


- Essencis landfill operated by Loga
- 8-9 kt of MSW is landfilled per day



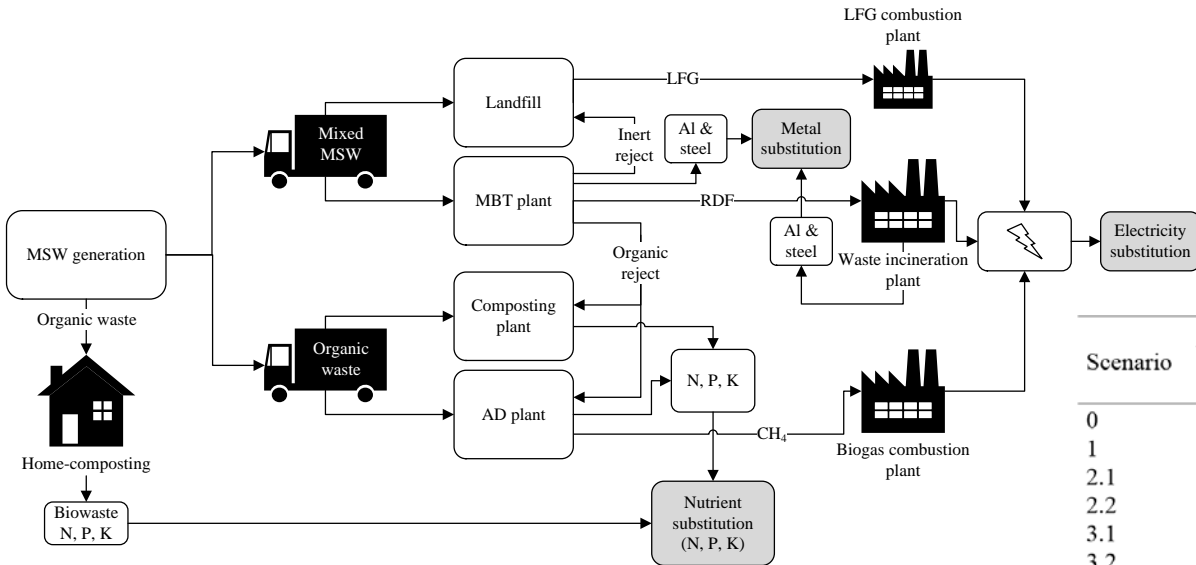
- CTL landfill operated by Ecourbis
- 7.5 kt of MSW is landfilled per day





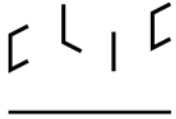
# LCA of MSW management in São Paulo

- Functional unit: the treatment of domestic MSW generated in the city in 2015, i.e. 3.8 million tonnes
- Impact categories: global warming potential (GWP), acidification potential (AP) and eutrophication potential (EP)

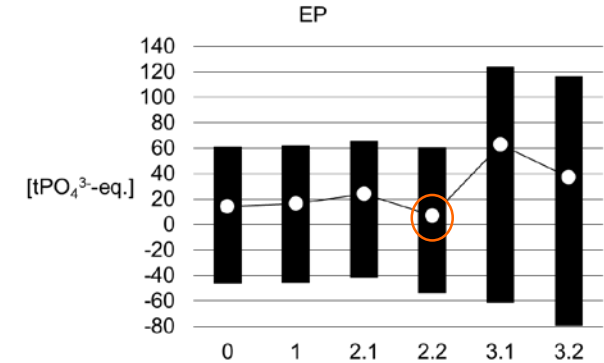
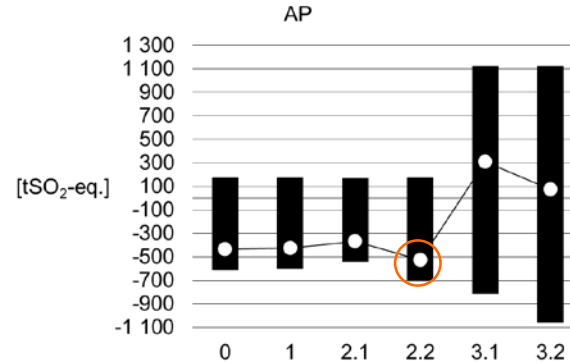
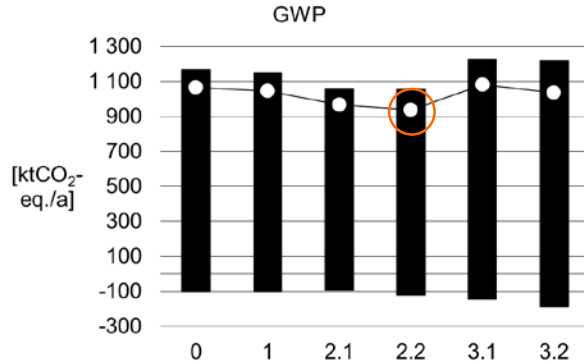


*Assessed treatment methods for MSW*

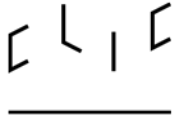
Scenario	Mixed MSW [kt]		Organic waste [kt]			Σ [kt]
	Landfill	MBT	Home-composting	Composting plant	AD	
0	3 800	0	0	0	0	3 800
1	3 707	0	93	0	0	3 800
2.1	3 335	0	93	372	0	3 800
2.2	3 335	0	93	0	372	3 800
3.1	2 668	667	93	372	0	3 800
3.2	2 668	667	93	0	372	3 800



# Results



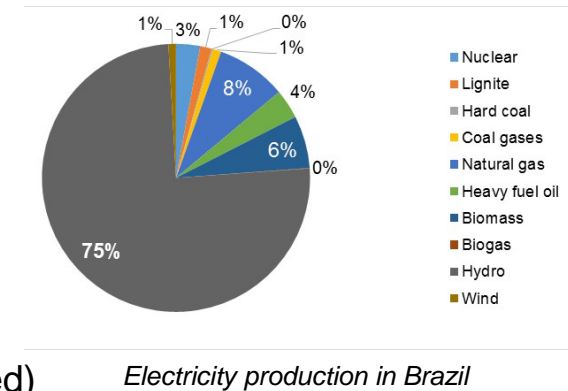
- Scenario 2.2 (i.e. home-composting + separate collection of organic waste (AD)) had the lowest environmental impact in all impact categories
- MBT and incineration of mixed MSW did not decrease the environmental impacts of MSW management
  - In AP and EP impact categories, they even increased the emissions notably
  - However, it should be noticed that MBT and incineration decreases significantly the volume of MSW landfilled, i.e. they have other environmental benefits

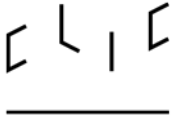


# LCA of MSW management in São Paulo

## Conclusions

- Home-composting and Separate collection of organic waste beneficial from these impact categories point of view
- Electricity substitution is very important factor
  - Most of the electricity in Brazil produced with Hydropower
  - LFG collected and utilized for electricity production
  - Electricity generation from incineration not effective for environmental impact reduction (if average grid mix substituted)
- Waste to energy could be used for other purpose
  - Cement kiln fuel
  - Replacing coal





# Conclusions from different operation environments

- General MSW management situation important
  - Incineration increase + coal co-incineration in China
  - No proper source separation in most of the developing countries
- Political decisions important
  - Almost categorical incineration ban in Brazil
  - SRF/RDF proposed for emission reduction in Chinese standardization
- Scenario selection for the local needs
- Energy infrastructure important
  - Substituted energy
  - Possibility to recover heat (integration with process industry)
- Scenarios can be re-formulated after first results and conclusions
- Selling arguments for a MSW technology or service can be very different
- Correct system knowledge and sustainability knowledge is valuable



# Thank you for attention!

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