XV. LCA KONFERENCIA

SZENT ISTVÁN UNIVERSITY
FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES, GÖDÖLLŐ

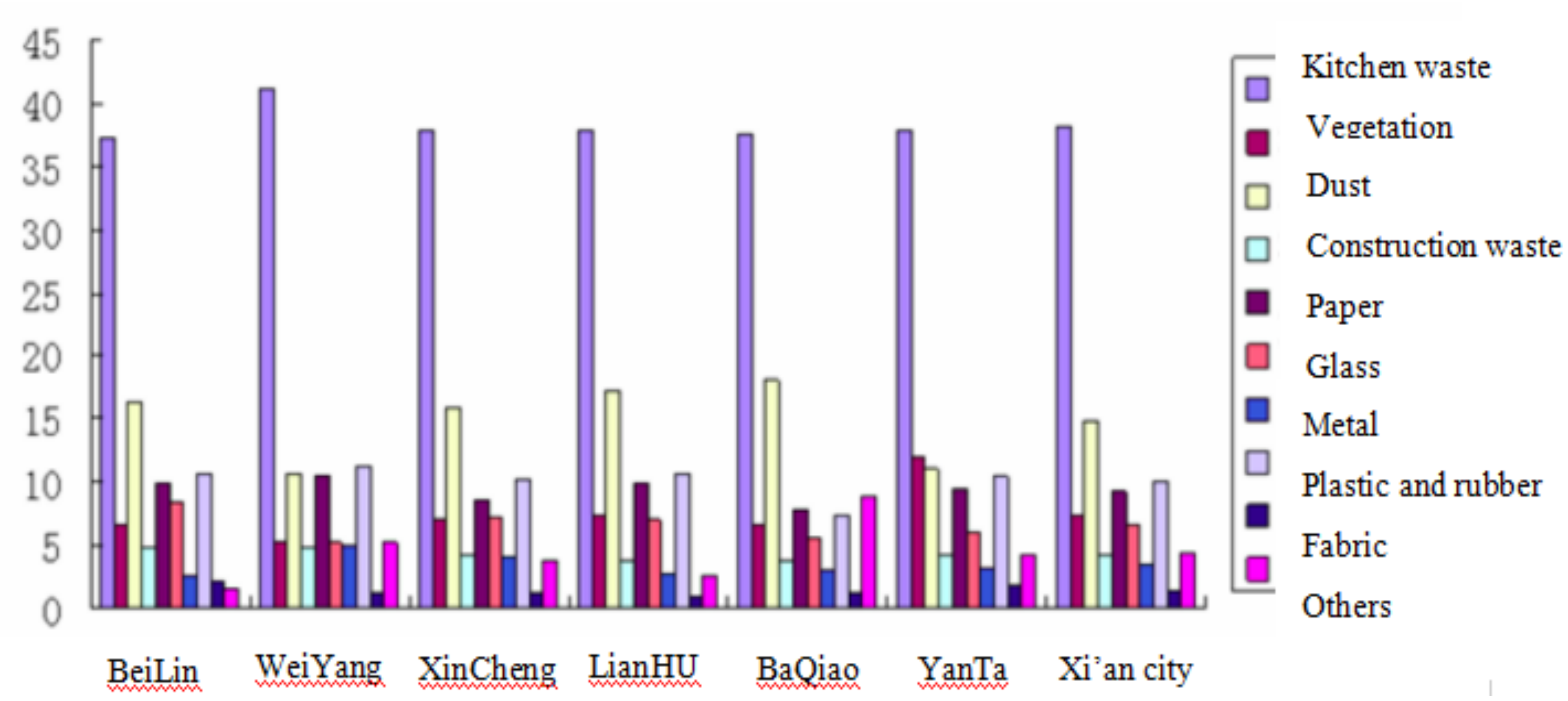
Life Cycle Assessment as a decision tool for food waste Management----A Xi'an Case Study

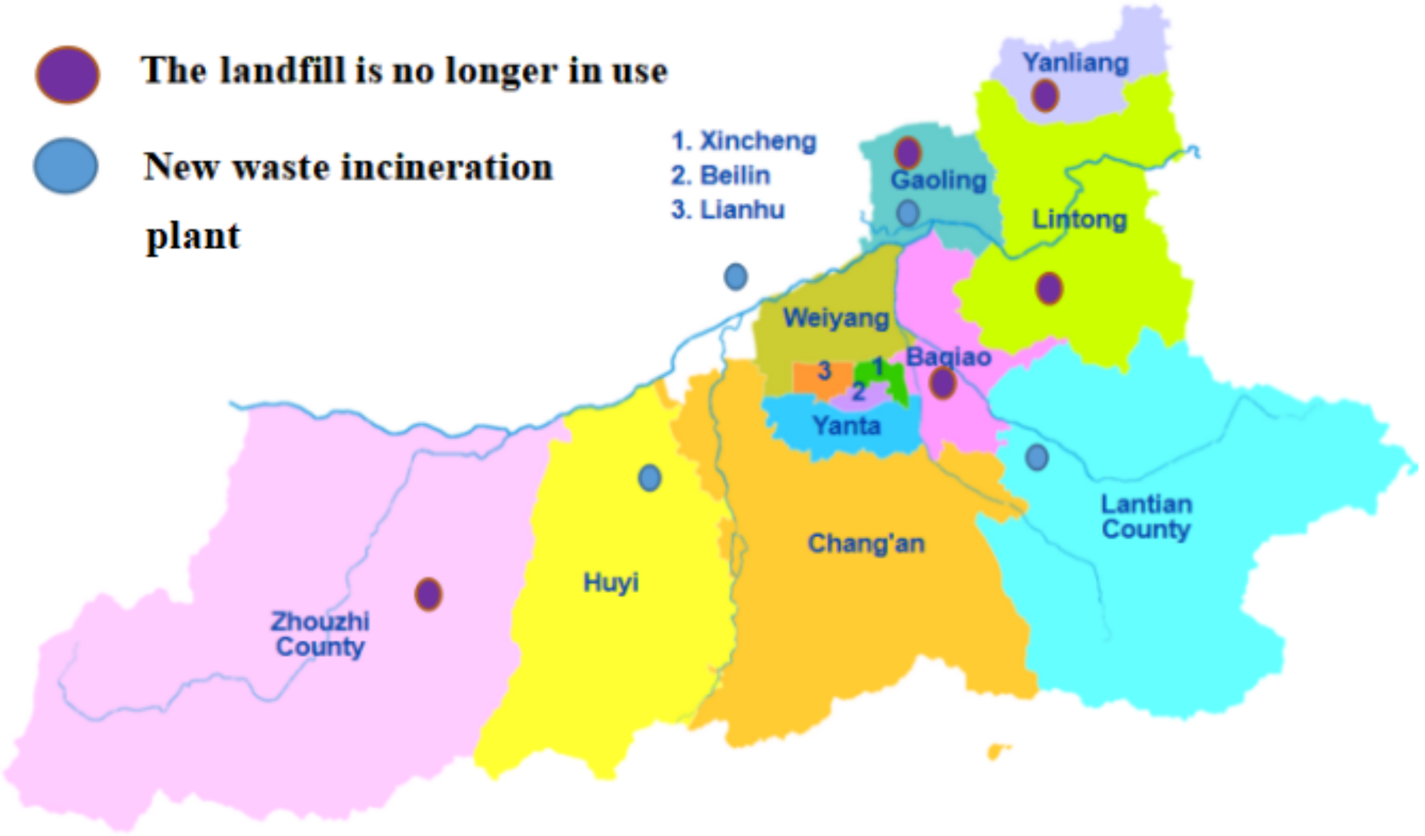
Presentor/Előadó: Liang Zhiwei

Supervisors/Témavezető: Mérőné Dr.Nótás Erika

Date/Dátum: 2020/11/30

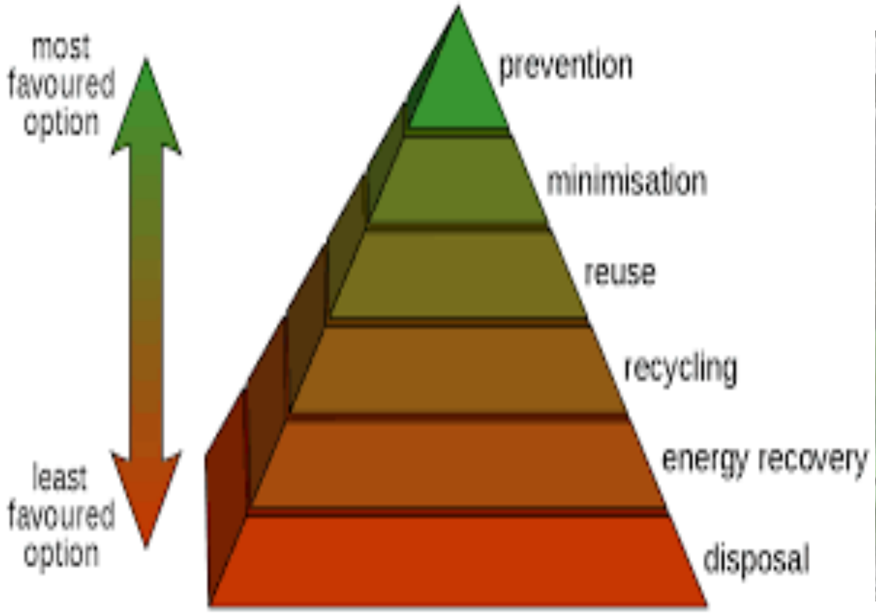
Problem and purpose





- The domestic waste in Xi'an has been treated as mixed landfill, which has caused serious leachate pollution and affected the surrounding land and people's lives.
- As the landfill is filled, Xi'an urgently needs a A sustainable way to dispose of domestic waste.
- I compared the six ways of treating kitchen waste with LCA.
- I calculated the environmental impact potential value and energy consumption of each scenario.
- It can provide a basis for decision-making of relevant departments of the city.

LCA of kitchen waste



Extraction: Separate collection or mixed collection

Transformation: Fermentation(Aerobic&Anaerobic) ,& Composting, Incineration, Shredding etc.

Use: Biogas, Organic fertilizer ,Electric energy, Livestock feed etc.

End of life: Landfill, Ash from incineration Organic fertilizer etc.

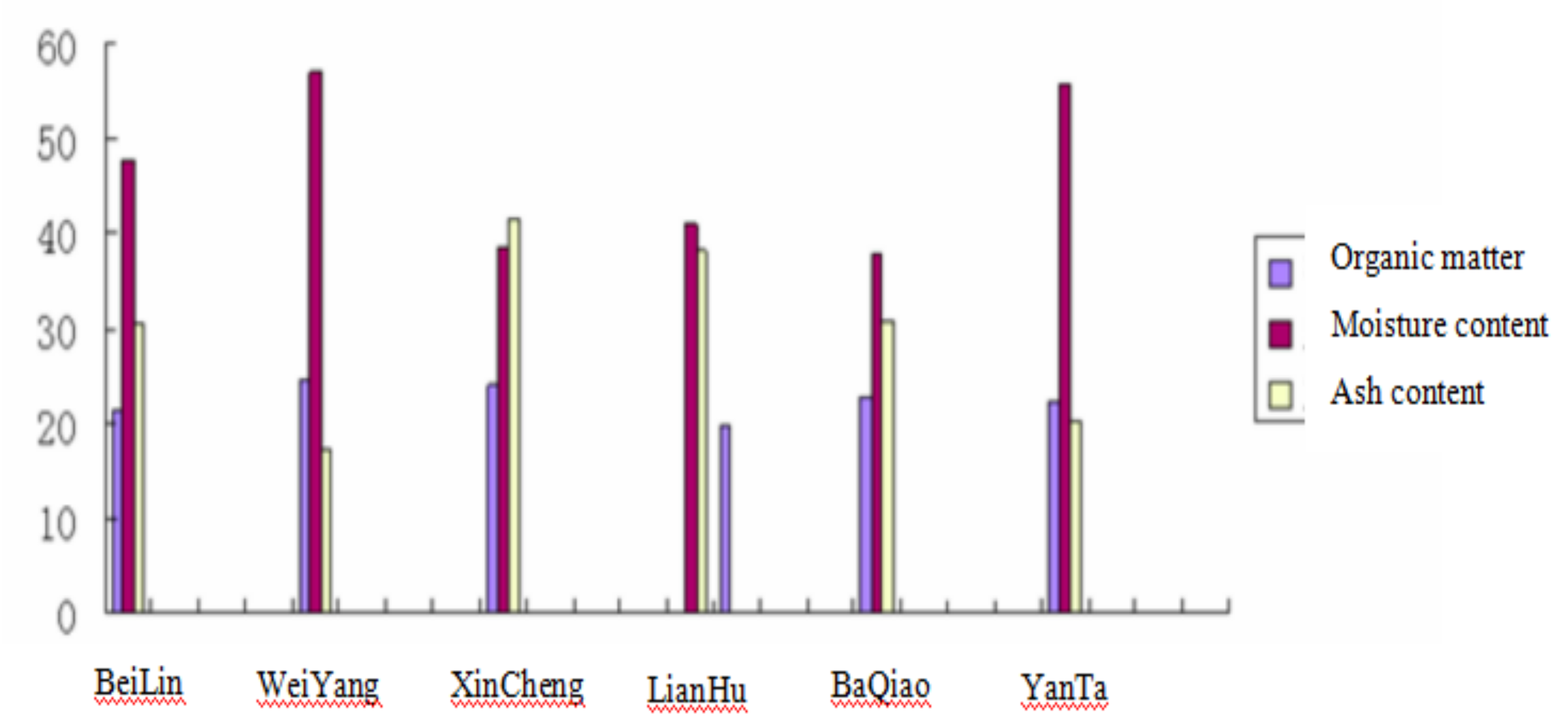
Material and Methods

Data collection:

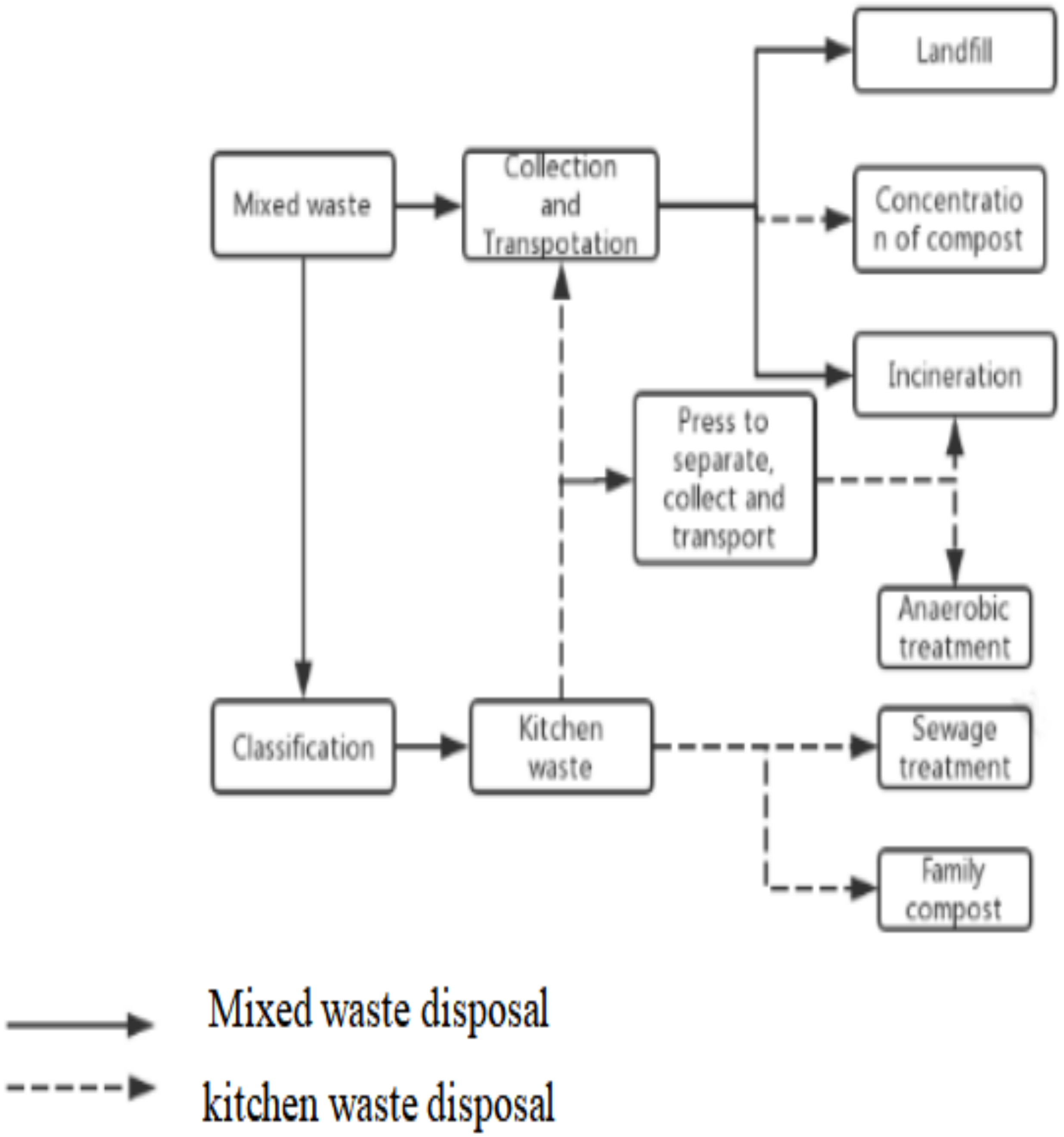
Self-collection

Life cycle assessment database

Literature data



The chemical composition of living garbage composition in Xi’an (%)



Scenarios and scoping

Scenario 1：Collect transport mixed + sanitary landfill

Scenario 2：Collect transport + mixed incineration

Scenario 3 ： Classification collection and transportation + kitchen waste press dehydration + anaerobic digestion and incineration treatment

Scenario 4：Classified collection with transportation + centralized composting

Scenario 5：Classified collection + composting at home

Scenario 6：Classification collection + kitchen waste disposal with breaking machine + sewage treatment + sludge disposal

Functional unit

I selected **500** waste classification pilots in xi 'an city as the research objects. There are average **3,000 people** in each pilot project and the per capita waste output is 1.5kg/d, so the total waste output is **2250t/d**. The content of kitchen waste in household waste is **40%** according to the survey of household waste data of xi 'an city, that is, the per capita output of kitchen waste is **0.6kg/d**.

ISO14040
ISO14044

Inventory analysis of kitchen waste

		Scenario1		Scenario2	
		Life cycle stage of landfill		Life cycle stage of incineration	
		Transportation	Landfill	Transportation	Incineration
Material	Input				
	Output				
Energy	Input	Fuel	Electricity	Fuel	
	Output				Electricity, thermal energy
Pollutant discharge		Automobile exhaust, leachate	Exhaust gas, leachate	Automobile exhaust,	Exhaust gas

Inventory analysis of kitchen waste

		Scenario3			
		Life cycle stage of Press anaerobic digestion integrated treatment			
		Transportation	Squeeze	Incineration	Anaerobic digestion
Material	Input				
	Output				
Energy	Input	Fuel	Electricity		
	Output			Electricity, thermal energy	Electricity, thermal energy
Pollutant discharge		Automobile exhaust,	Leachate	Exhaust gas	Exhaust gas, waste residue, waste water

Inventory analysis of kitchen waste

		Scenario4		Scenario5	
		Life cycle stage of Centralized composting		Life cycle stage of compost at home	
		Transportation	Compost	Compost at home	Transportation
Material	Input		Ingredients		
	Output		Composting product	Composting product	
Energy	Input	Fuel			
	Output				
Pollutant discharge		Automobile exhaust	Exhaust gas, Leachate	Exhaust gas, Leachate	

Inventory analysis of kitchen waste

		Scenario6	
		Life cycle stage of kitchen waste processor	
		Crushing	Sewage treatment
Material	Input	Water	Chemicals, water, etc
	Output		
Energy	Input	Electricity	
	Output		
Pollutant discharge			Waste gas, sludge

Results of energy consumption or release

Scenarios	Energy consumption or release	MJ/Functional unit
1	377.01MJ/t waste	206.35
2	-718.17MJ/t waste	-393.07
3	-649.58MJ/t kitchen waste	-134,8
4	478.48 MJ/t kitchen waste	104.92
5	211MJ/t kitchen waste	46.21
6	700MJ/t kitchen waste	153.30

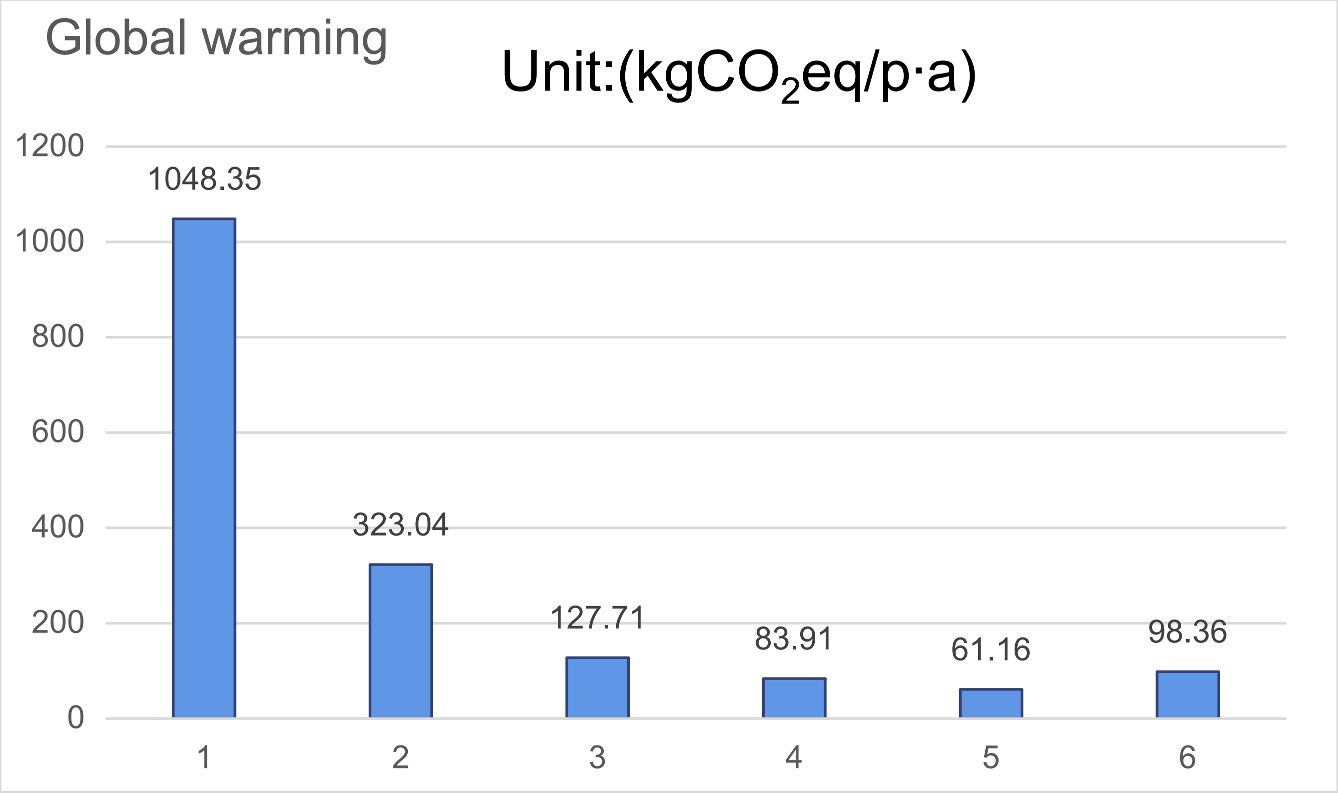
Functional unit:(kg/p.a)

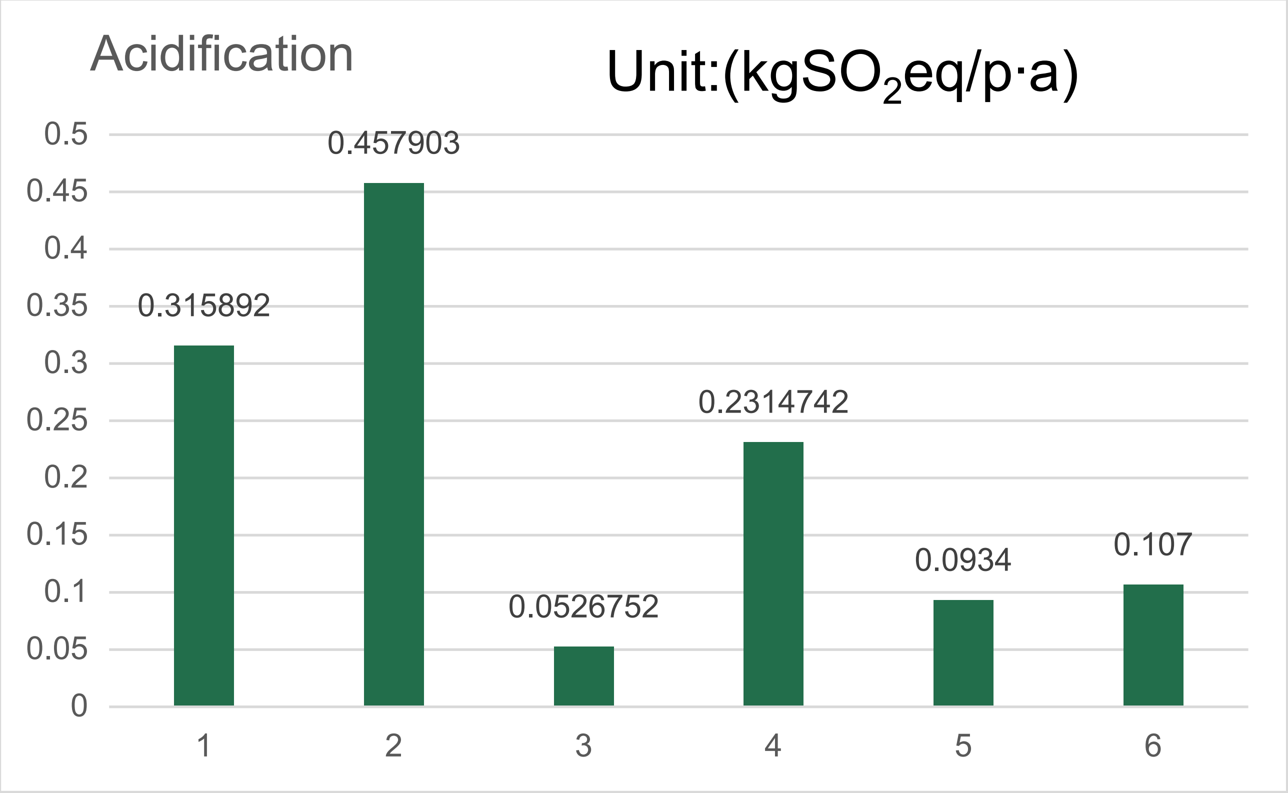
Evaluation: +1 or -1 point/ 100 MJ/ Functional unit

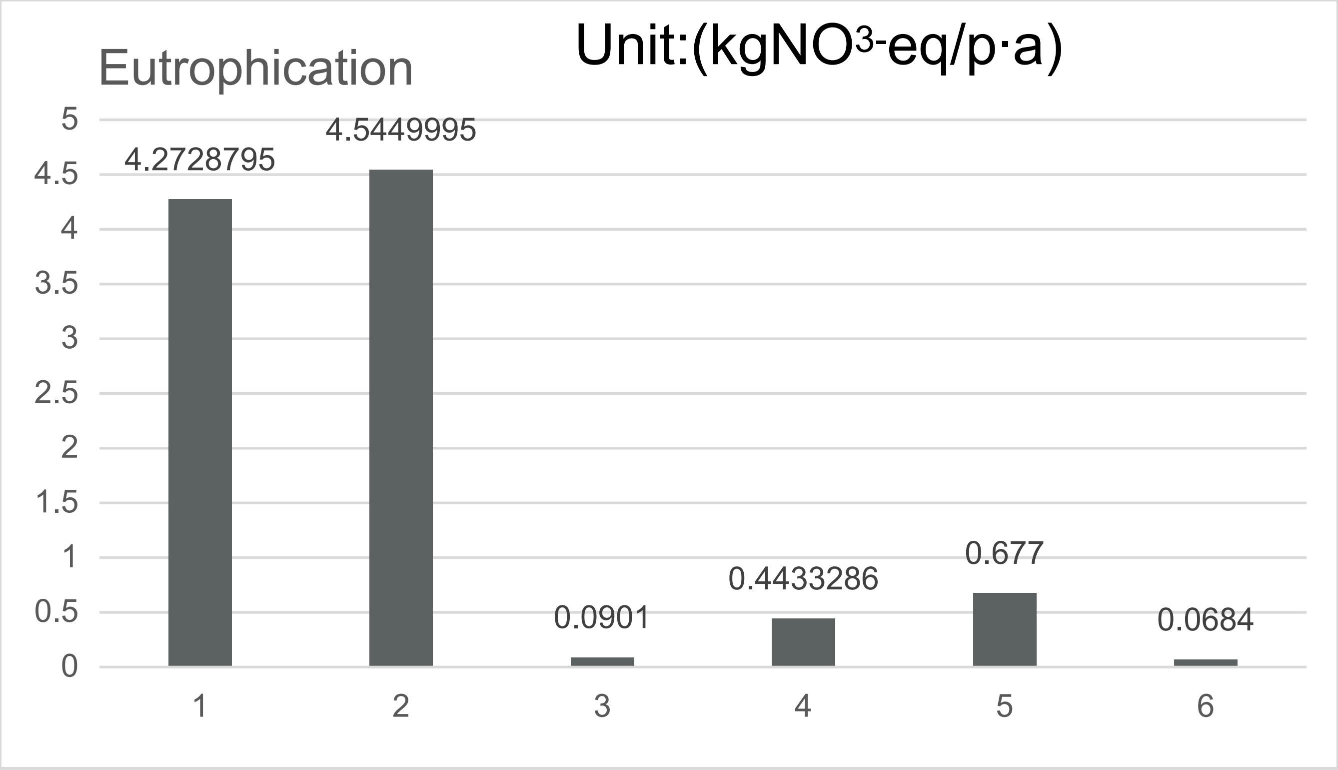
SCENARIOS	POINT
1	+2
2	-4
3	-2
4	+1
5	+1
6	+2

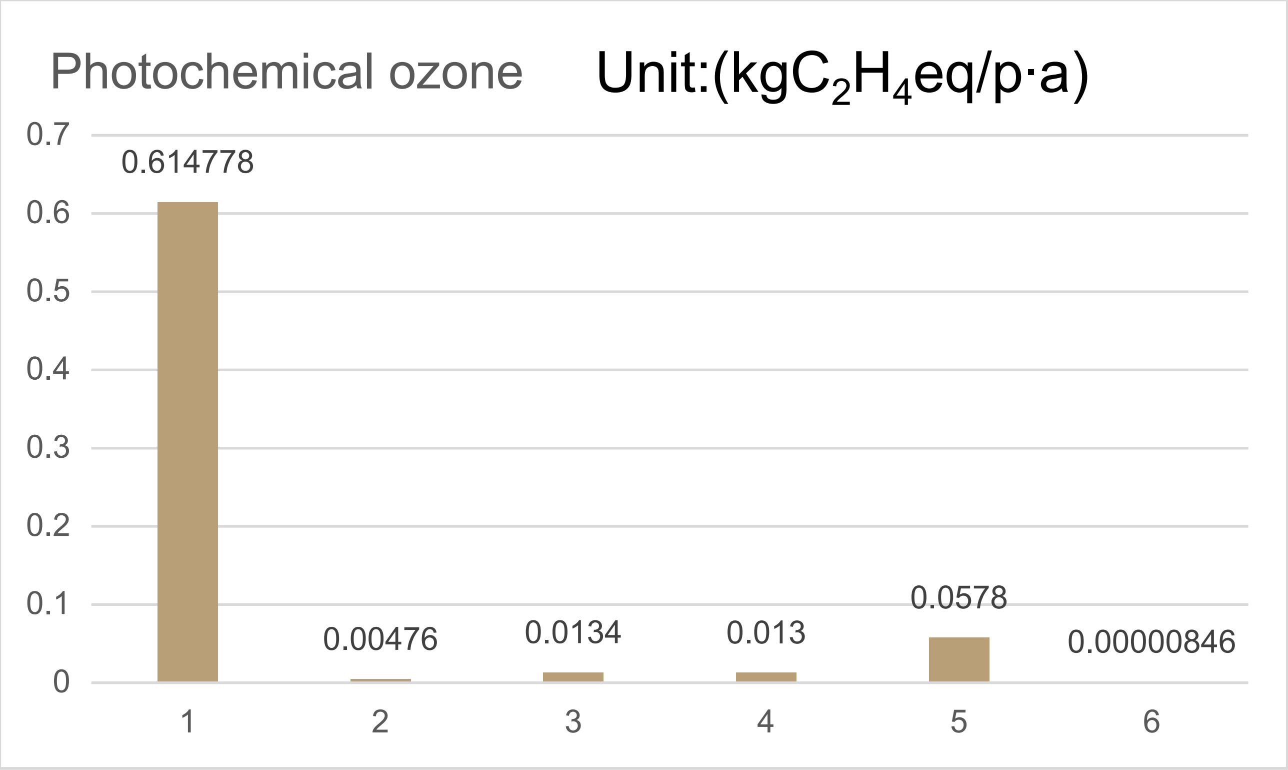
The released energy is used for production of eletricities

Results without standardization and weighting







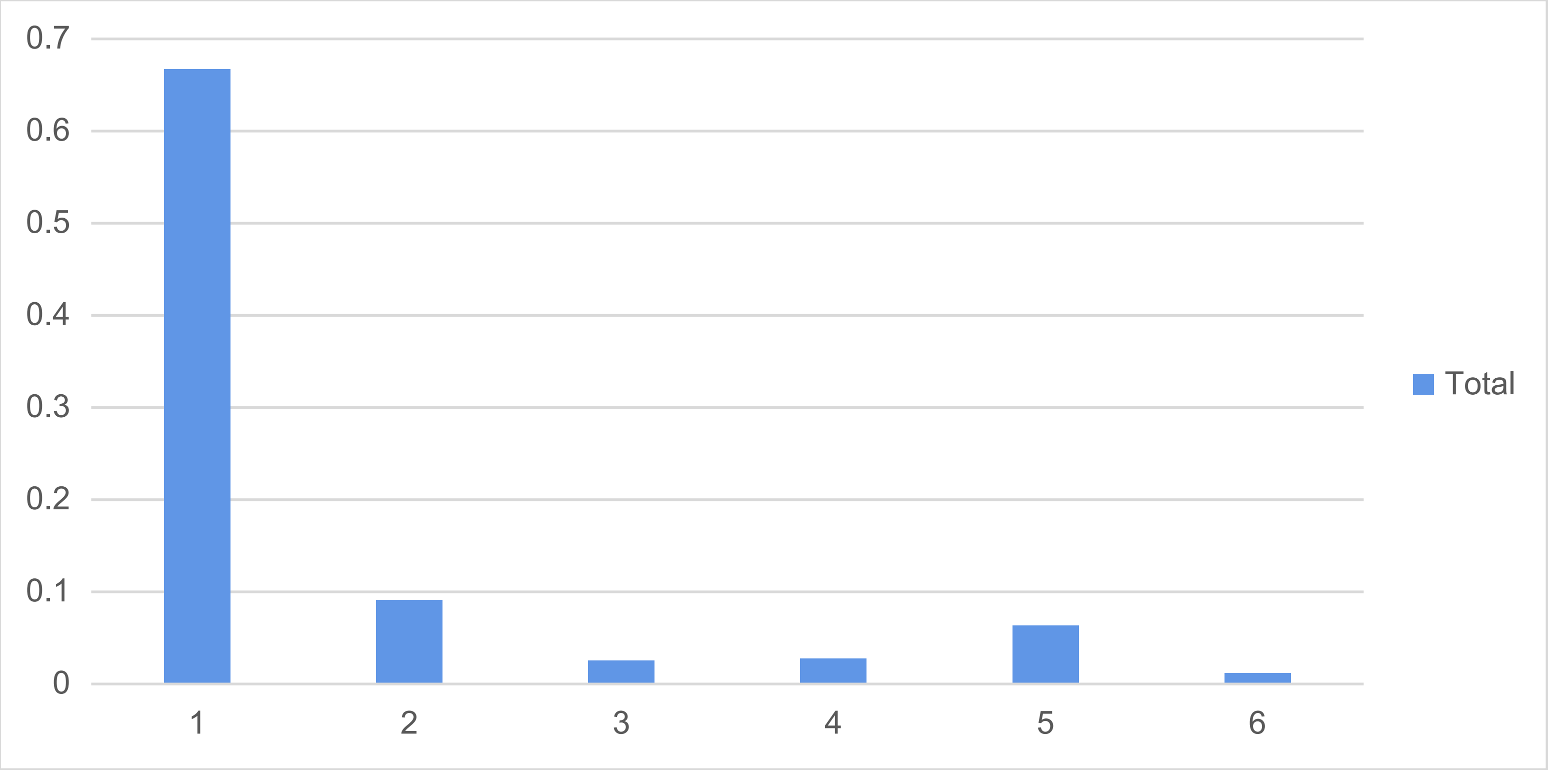


Results(without standardization and weighting) The environmental impact of the scenarios based on the ranking order

Scenario	1	2	3	4	5	6
GWP	6	5	4	2	1	3
AP	5	6	1	4	2	3
EP	5	6	2	3	4	1
POCP	6	2	4	3	5	1
Point	**22**	**19**	**11**	**12**	**12**	**8**
Energy point	**+2**	**-4**	**-2**	**+1**	**+1**	**+2**
SUM POINT	**24**	**15**	**9**	**13**	**13**	**10**

Total environment impact potential of scenarios(with standardization and weighting) without energy consumption and release

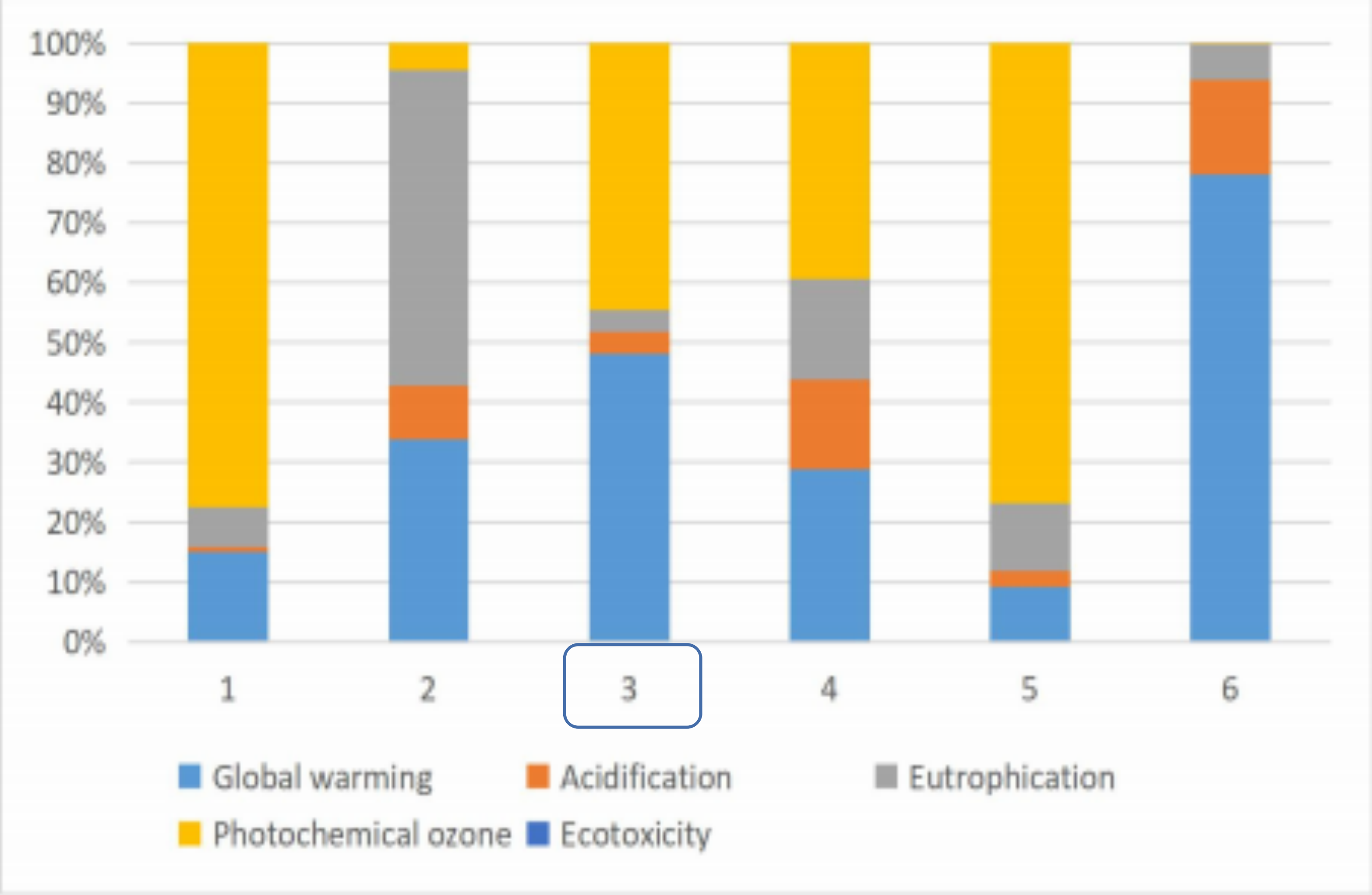
	1	2	3	4	5	6
Total	0.667	0.0911	0.0254	0.0277	0.0634	0.012



The sixth scenario is most suitable waste disposal without energy consumption

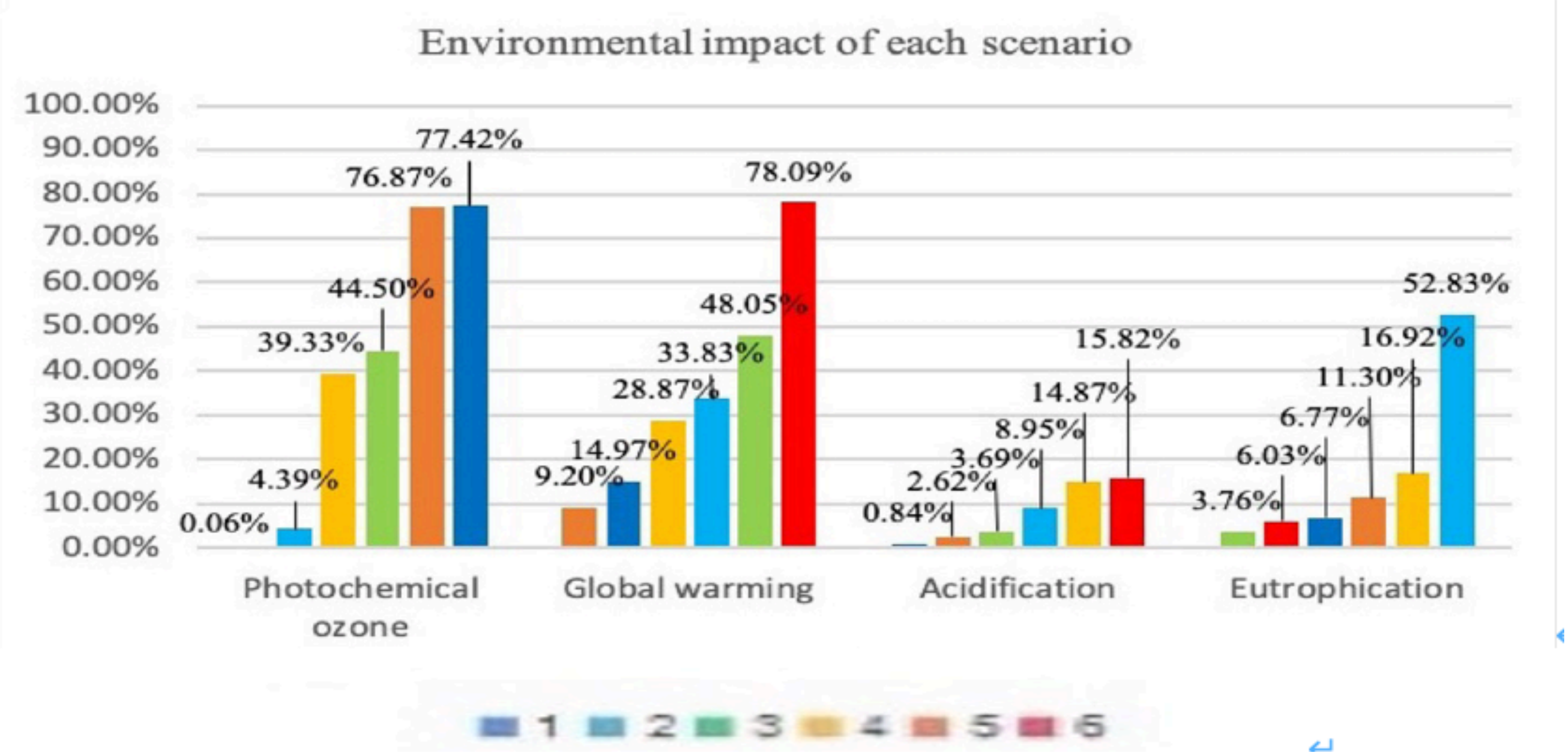
Results(with standardization and weighting)
Environmental impact of each scenario

Impact type	1	2	3	4	5	6
Global warming	14.97%	33.83%	48.05%	28.87%	9.20%	78.09%
Acidification	0.84%	8.95%	3.69%	14.87%	2.62%	15.82%
Eutrophication	6.77%	52.83%	3.76%	16.92%	11.30%	6.03%
Photochemical ozone	77.42%	4.39%	44.5%	39.33%	76.87%	0.06%
Ecotoxicity	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



Mix waste problem:Mixed waste has a great negative effect in various treatment methods, and its physical and chemical properties are complex. For example, in the incineration process, the burning of plastics will produce toxic gases, and in the composting process, indegradable substances will hinder fermentation

Results(with standardization and weighting)
The order of the scenarios in each impact category



Results(with standardization and weighting)
The environmental impact of the scenarios based on the ranking order

Scenario	1	2	3	4	5	6
GWP	2	4	5	3	1	6
AP	1	4	3	5	2	6
EP	3	6	1	5	4	2
POCP	6	2	4	3	5	1
Point	**12**	**16**	**13**	**16**	**12**	**15**
Energy point	**+2**	**-4**	**-2**	**+1**	**+1**	**+2**
SUM POINT	**14**	**12**	**11**	**17**	**13**	**17**

- Data standardization

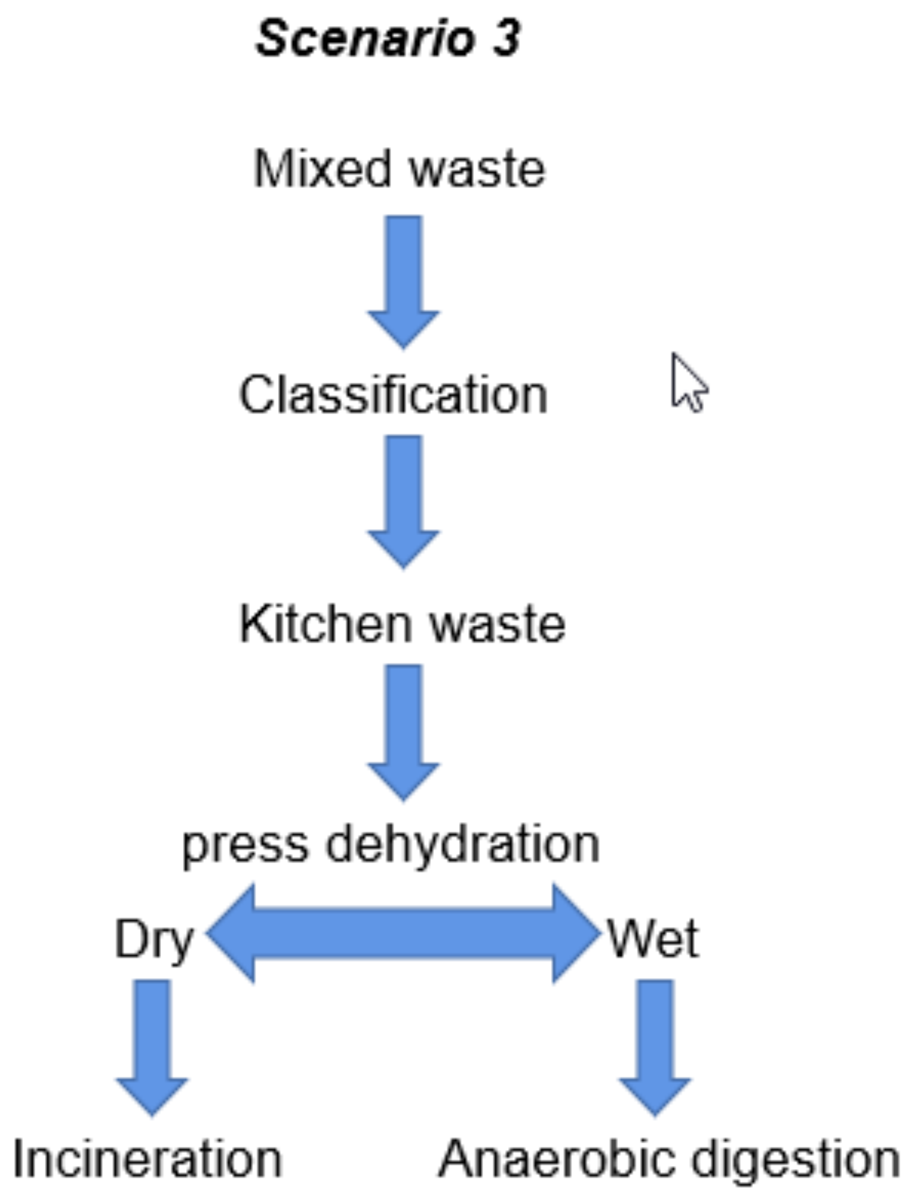
Data standardization has **two purposes:**

1.Provide comparable criteria by comparing the relative size of the contribution to the various types of impact。

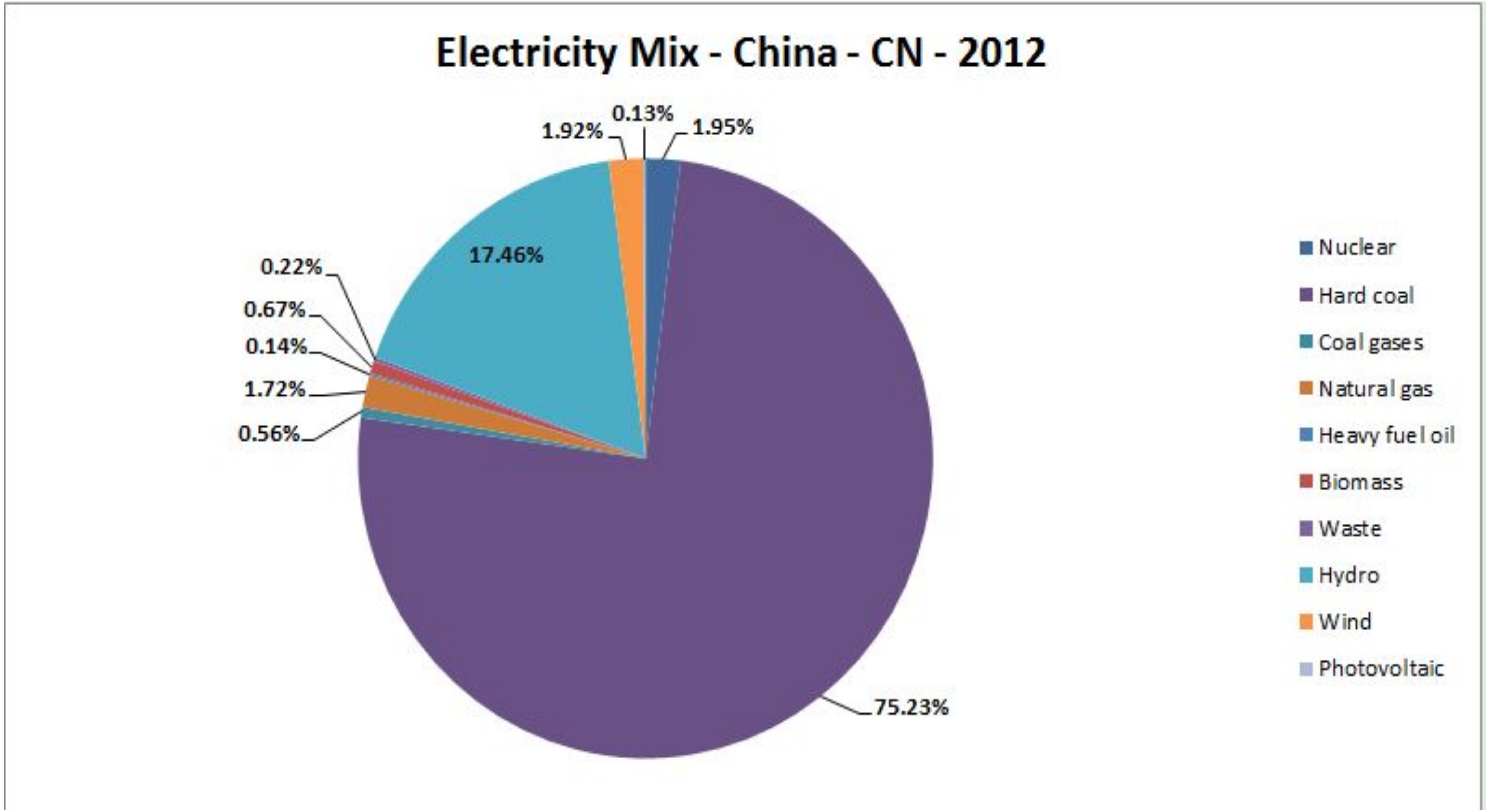
2. Based on the annual total potential environment influence in the whole society should be taken as the basis of standardization.

Conclusion and recommendation

- The third scenario is the most suitable waste disposal method with and without standardization+ weighting in Xi'an.
- However, due to economic , household disposal is not ideal.
- Due to the lack of awareness of waste classification, mixed incineration of waste is the current disposal mode.
- We can only expect on the manual discard of plastic and the sorting of hazard waste.
- The best way to reduce environmental impact is to sort from the raw material resource.
- In situation of not weighting and standardization. Scenario third get the lowest score.



Thanks for your attention!
Köszönöm a figyelmet!


Electricity Mix - China - CN - 2012
0.13%
1.92%
1.95%
17.46%
0.22%
0.67%
0.14%
1.72%
0.56%
75.23%
Nuclear
Hard coal
Coal gases
Natural gas
Heavy fuel oil
Biomass
Waste
Hydro
Wind
Photovoltaic

Impact assessment model

- The potential value of environmental impact *Yang J. X. et al.(2001)*

$$EP(j)=\sum EP(j)_i=\sum[Q_i\times PF(j)_i]$$

Q_i ---- The yield of the i type of pollutant

$PF(j)_i$ ----The equivalent factor for the potential environmental impact of the i type pollutant on the j type pollutant.

$EP(j)$ ----System contribution to the j potential environmental impact.

$EP(j)_i$ ----The i emission contributes to the third potential environmental impact.

- Data standardization

Data standardization has **two purposes:**

1.Provide comparable criteria by comparing the relative size of the contribution to the various types of impact。

2. Based on the annual total potential environment influence in the whole society should be taken as the basis of standardization.

$$NR(j)_{10}=\frac{EP(j)_{2010}}{POP_{2010}}$$

The formula:

$NR(j)_{10}$ ----2010 global (or regional) per capita environmental impact potential.

$EP(j)_{2010}$ ----Global (or regional) total environmental impact potential for 2010.

POP_{2010} ----2010 global (or regional) population.

$$NEP(j)=\frac{EP(j)}{NR(j)_{2010}}$$

Impact assessment model

- Weighted assessment *Yang J. X. et al.(2001)*

$$WP(j) = WF(j) \cdot NEP(j) = WF(j) \cdot \frac{1}{T \cdot R(j)} \cdot P(j)$$

WF(j) ----The weight factor of the j type of environmental impact

NEP(j) ----The environmental impact potential after standardization.

The weight factor can be determined by the following formula：

$$WF(j) = \frac{EP(j)_{2010}}{ER(j)_{T2020}}$$

EP(j)2010 ----Sum of global (or regional) environmental impact potentials in 2010

ER(j)T 2020 ----Sum of global (or regional) environmental impact potential values in 2020.

The weighted environmental impact potential value is:

$$EIL = WF(j) \times \frac{EP(j)_{product}}{NR(j)_{2010}}$$