School of Civil Engineering
Institute for Resilient Infrastructure (iRI)
Institute for Public Health & Environmental Engineering (iPHEE)

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Solid waste management systems:
from local to global

Συστήματα διαχείρισης αστικών στερεών απορριμάτων: απο το τοπικό στο πακγόσμιο
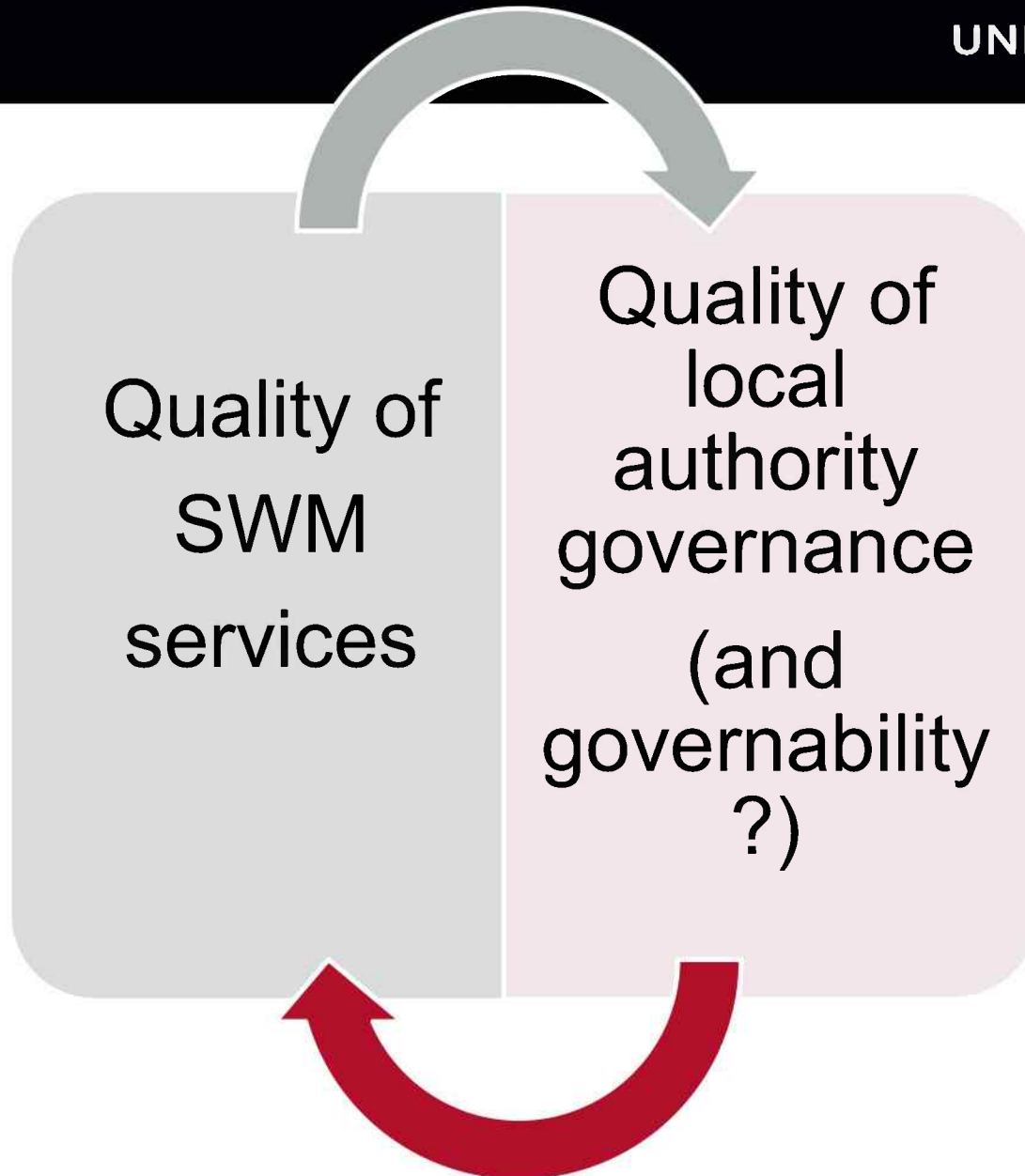
Dr Costas Velis

Energy Leeds

RESILIENT SUSTAINABLE SOCIETIES & INFRASTRUCTURE Cities

ΑΣΤΙΚΑ ΣΤΕΡΕΑ ΑΠΟΒΛΗΤΑ
ΜΟΝΤΕΛΑ ΔΙΑΧΕΙΡΙΣΗΣ ΚΑΙ Ο ΡΟΛΟΣ ΤΩΝ Ο.Τ.Α.
Εκτίμηση χωρικών, πληθυσμιακών
και οικονομικών παραμέτρων

15-16 ΙΑΝΟΥΑΡΙΟΥ 2016
Thraki Palace, Αλεξανδρούπολη

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CERRY

Circular Economy & Resource RecoverY

Cities, Sustainable Societies and Infrastructure

Waste and governance…

Quality of SWM services

Quality of local authority governance (and governability?)

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SWM and resource recovery system in Bishkek, Kyrgyzstan
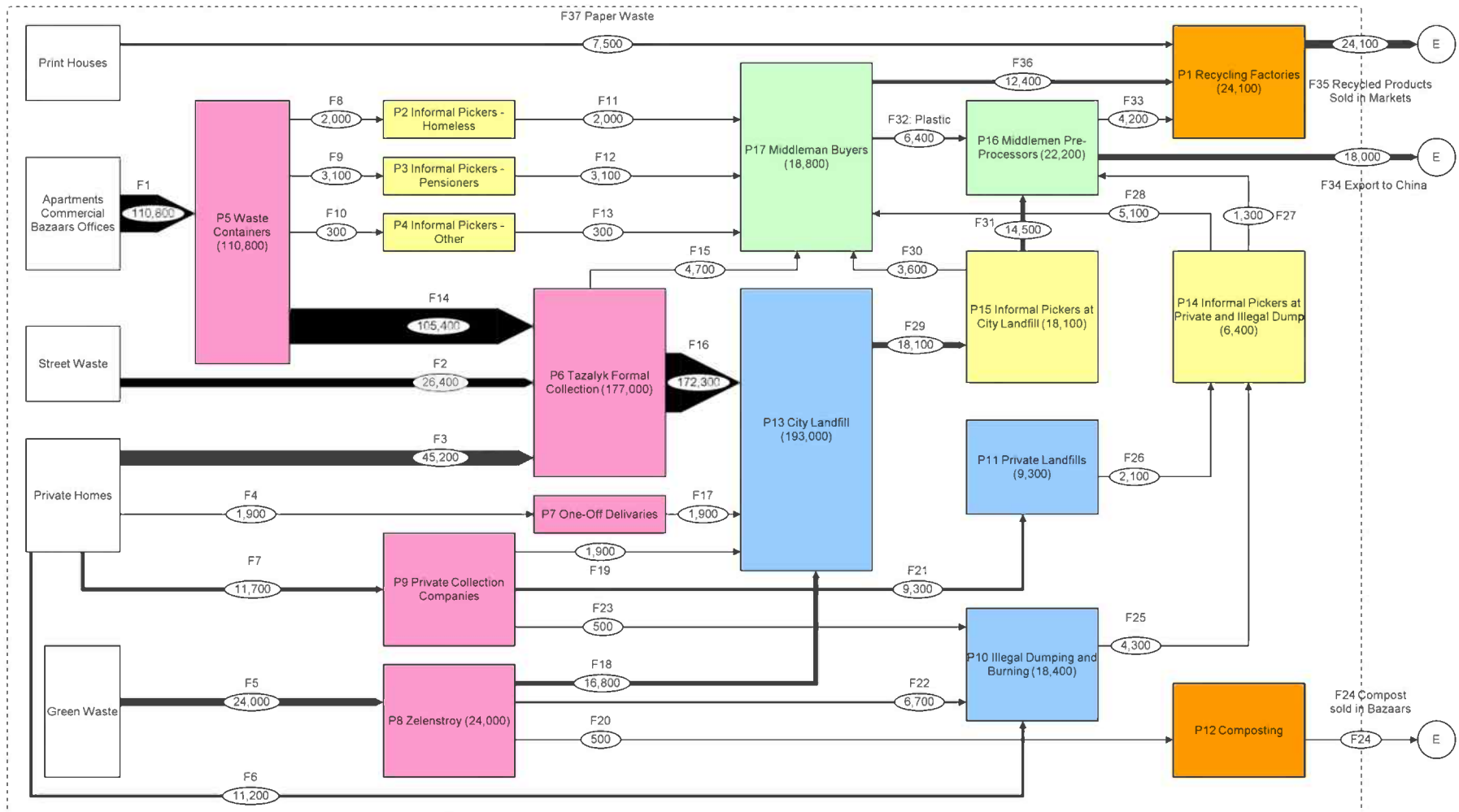
Source: Sim et al., 2013
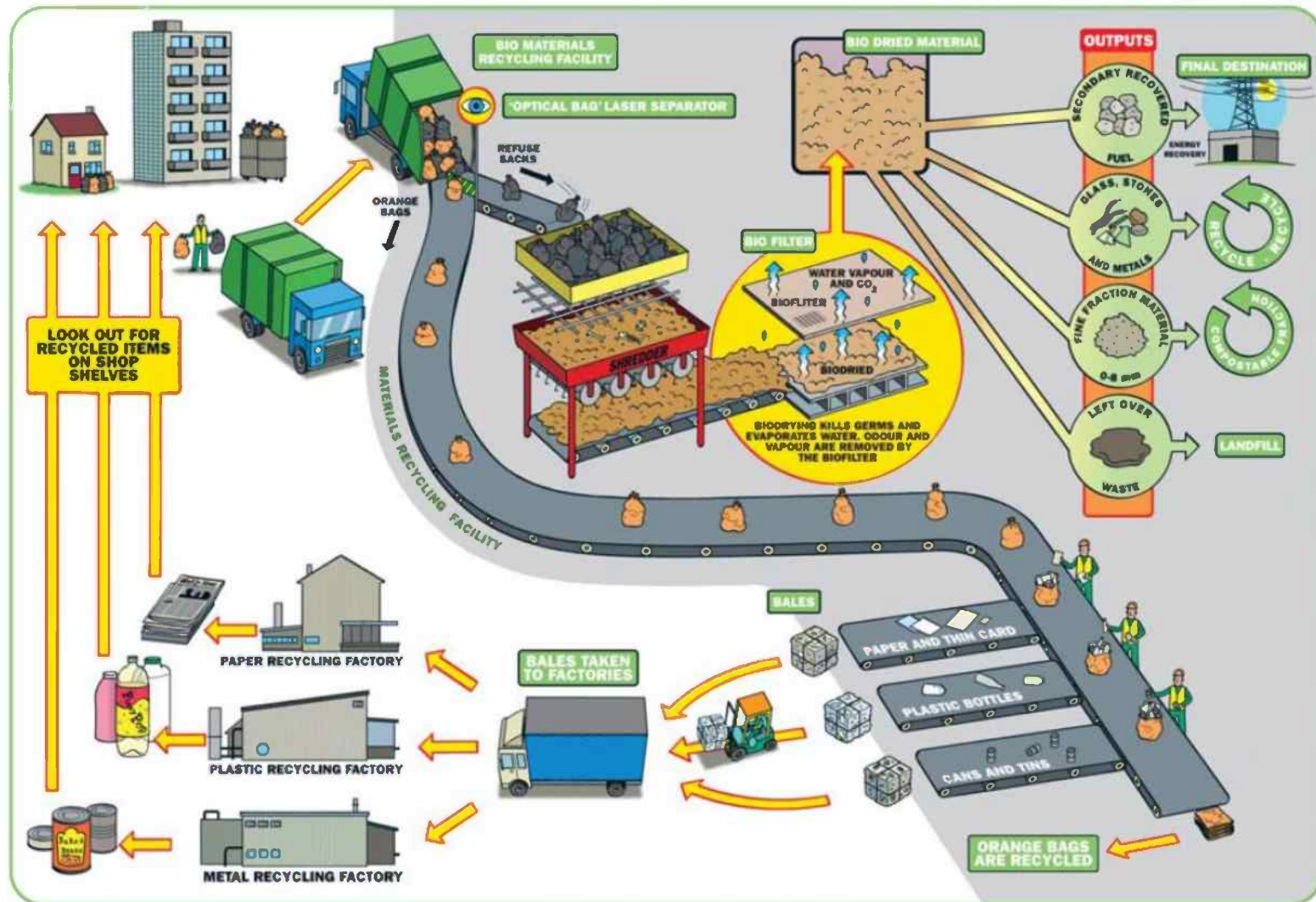
Graph source: ELWA

New EfW Veolia plant in Leeds / Cross Green

- *ca.* 300 temporary jobs during plant construction

- 45 permanent jobs during operation

- Processing 214,000 tonnes of Leeds' household waste

- Generating enough electricity to power up to 20,000 homes

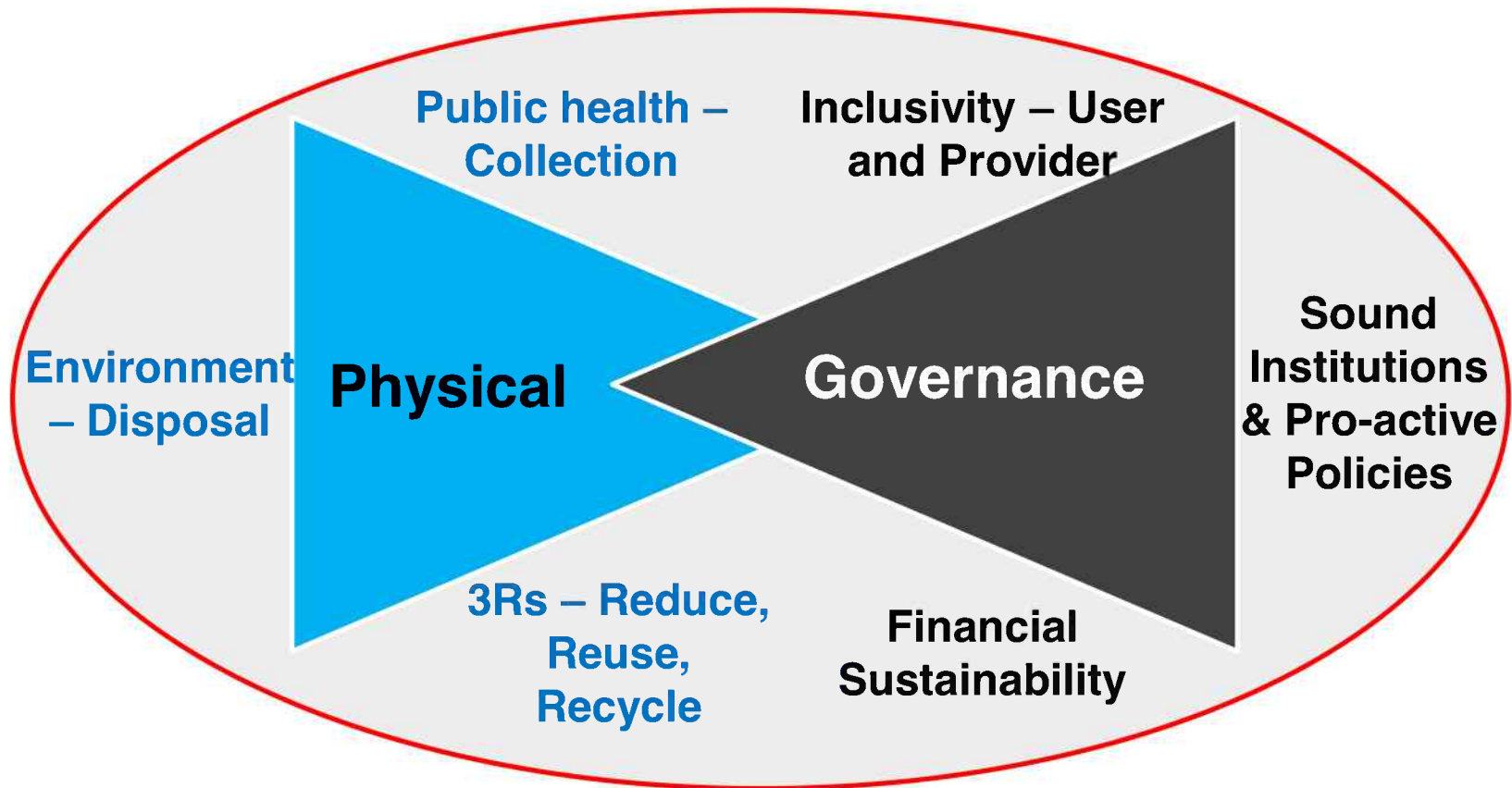- **£460 million** private finance initiative (PFI) contract

Letsrecycle: http://www.letsrecycle.com/news/latest-news/councils/leeds-signs-ps460m-incinerator-contract-with-veolia
BBC News: http://www.bbc.co.uk/news/uk-england-leeds-22048022

Integrated Sustainable Waste Management Framework

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Public health – Collection

Inclusivity – User and Provider

Environment – Disposal

Physical

Governance

Sound Institutions & Pro-active Policies

3Rs – Reduce, Reuse, Recycle

Financial Sustainability

Source: Wilson et al., 2012

Coverage:

- Both physical and governance aspects

Indicators comprise:

- 4 quantitative + 8 composite qualitative
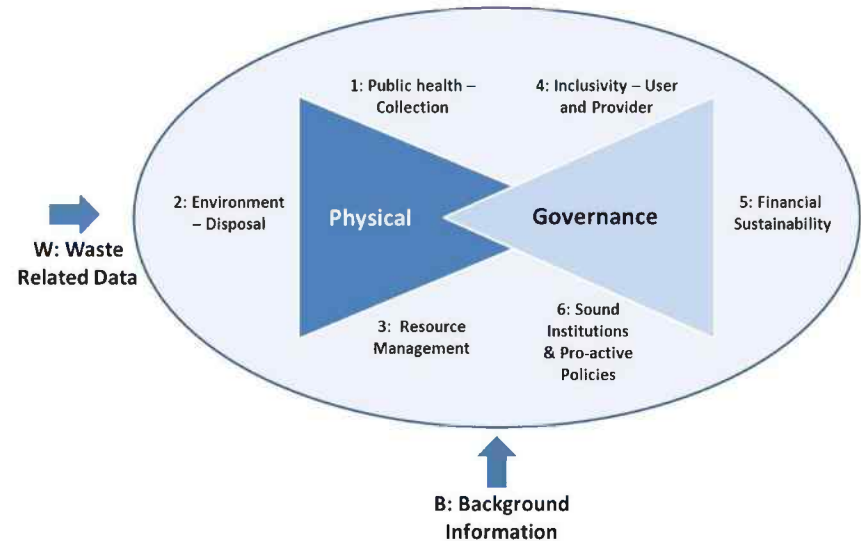
Global applicability:

- Both 'South' & 'North'

Visualise relative performance:

- Using 'Traffic lights' system

Ready to use:

- Tested in 39 cities in all 6 inhabited continents

Background R&D

- Based on ISWM

- Many person-years of development since 2009

- Builds on work for UN-Habitat and GIZ
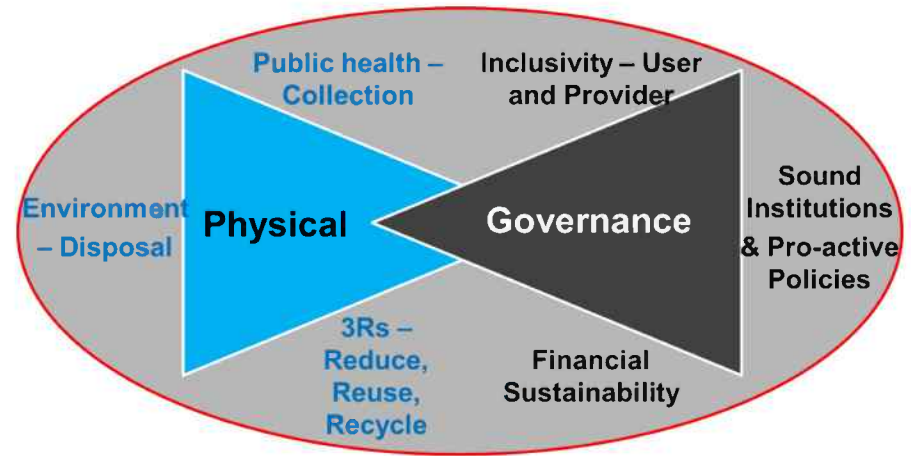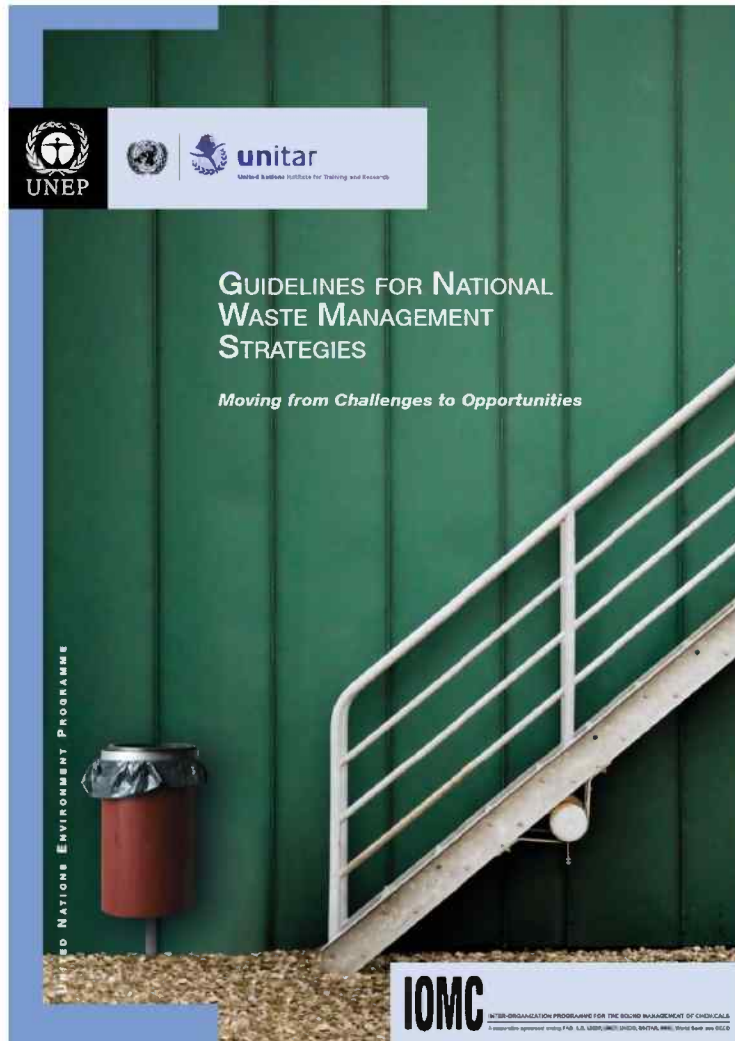
'Wasteaware' city indicators: state of the art

Belfast, UK
Rotterdam, NL
Vitoria-Gasteiz, SP
Sofia, BG
Varna, BG
Bishkek, KG
San Francisco, US
Tompkins County, US
Sousse, TU
Athens, GR
Lahore, PK
Ghorahi, NP
Qena, EG
Delhi, IN
Kunming, CH
Guadalajara, MX
Bahrain, BH
Surat, IN
Dhaka, BN
Bamako, ML
Warangal, IN
Managua, NC
Castries, LC
Bengalore, IN
Quezon City, PH
Monrovia, LR
Kampala, UG
Nairobi, KE
Singapore, SG
Moshi, TZ
Dar-es-Salaam, TZ
Jakarta, ID
Canete, PR
Lusaka, ZM
Belo Horizonte, BR
Curepipe, MU
CIGRES, BR
Maputo, MZ
Buenos Aires, AR
Adelaide, AU

Original 20 cities **Expansion to 40 cities**

GUIDELINES FOR NATIONAL WASTE MANAGEMENT STRATEGIES

Moving from Challenges to Opportunities

Public health – Collection

Inclusivity – User and Provider

Environment – Disposal

Physical

Governance

Sound Institutions & Pro-active Policies

3Rs – Reduce, Reuse, Recycle

Financial Sustainability

Global waste management outlook – Editorial Team
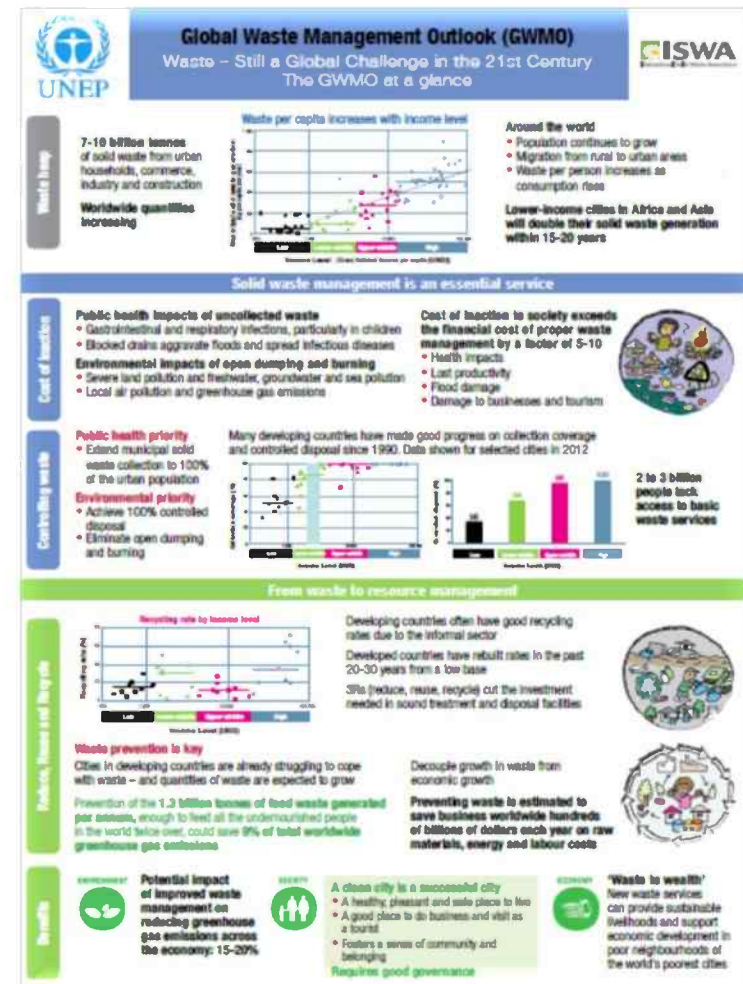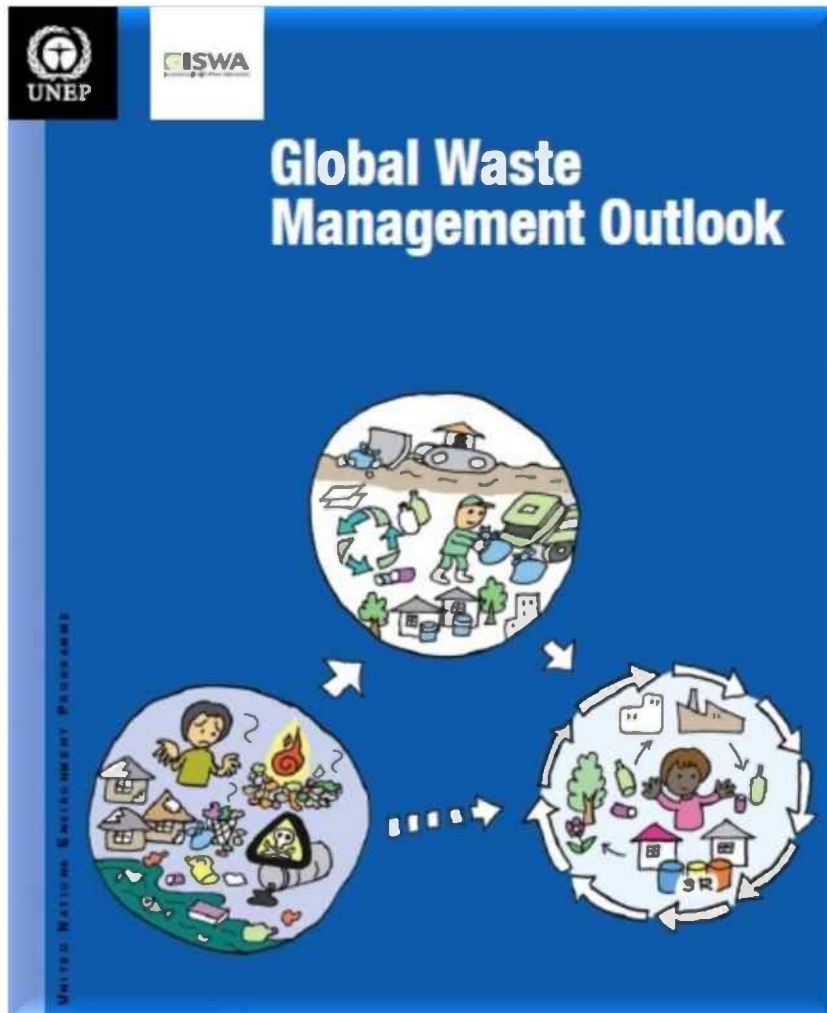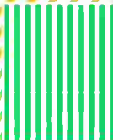
Physical indicators: an example

No.	Category	Indicator	Results	
1	Public health – Waste collection	Collection coverage	82%	
1Q		Quality of waste collection service	M/H	
2	Environmental control – waste treatment and disposal	Controlled disposal	0%	
2Q		Environmental quality of waste treatment and disposal	L/M	
3	3Rs – reduce, reuse and recycling	Recycling rate	< 5%	
3Q		Quality of 3Rs provision	L/M	

Governance indicators: an example

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No.	Category	Indicator	Results	
4U	User inclusivity	Degree of user inclusivity	M	
4P	Provider inclusivity	Degree of provider inclusivity	M/H	
5F	Financial sustainability	Financial sustainability	M/H	
6N	Sound institutions, proactive policies	Adequacy of national SWM framework	L/M	
6L		Degree of institutional coherence	M	

Spider diagrams benchmarking – e.g. Belfast
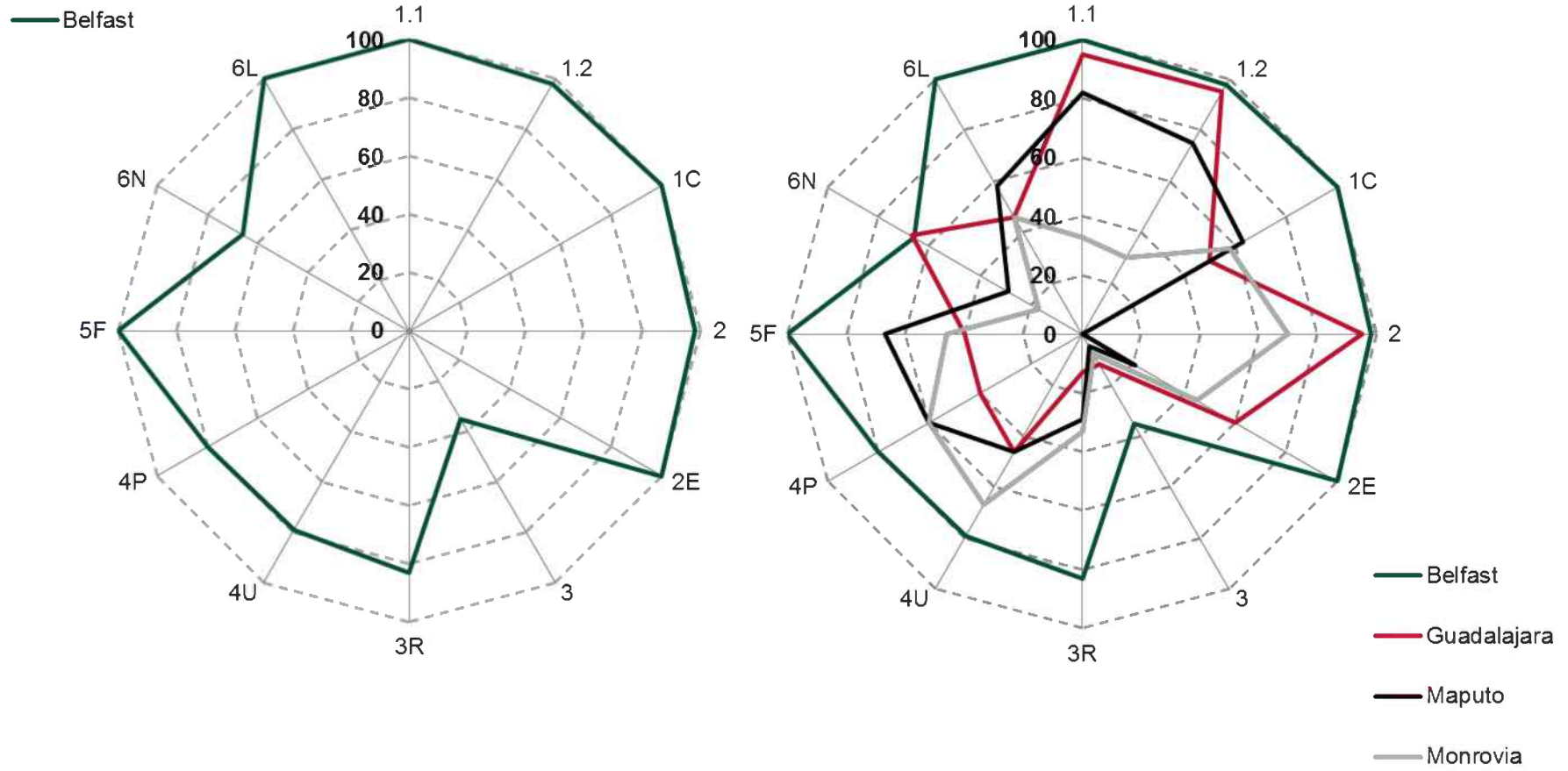
Wasteaware: collection%
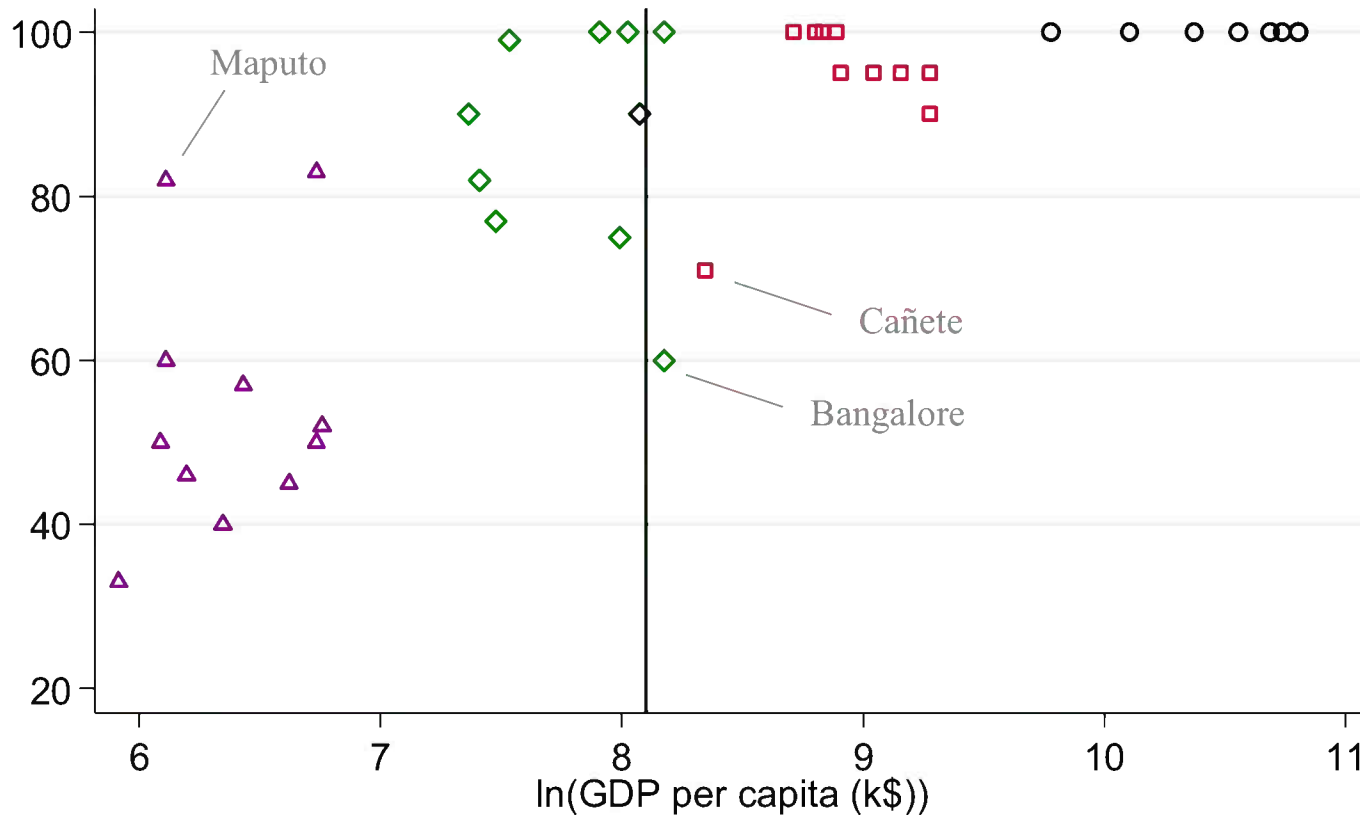
Source: Fargier et al., Unpublished

Wasteaware: quality of collection and gross domestic product per capita

Source: Fargier et al., Unpublished

GWMO:
Typical net cost for key systems parts

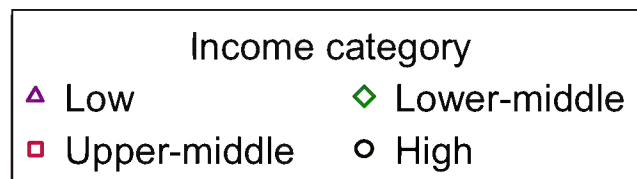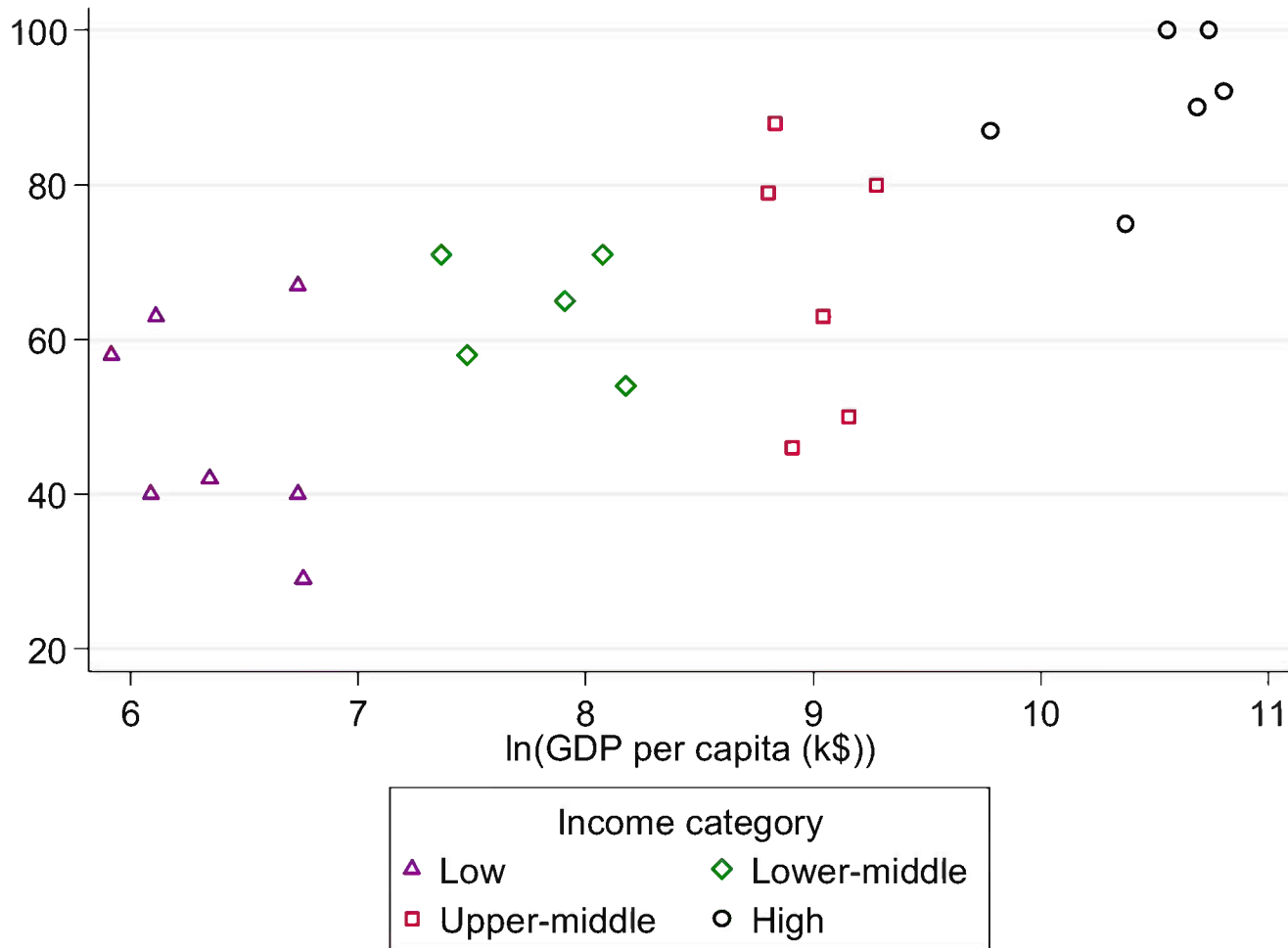| PART A: WORLD BANK PROJECT DATA (NOMINAL DATE 2006)[11]	LOW INCOME COUNTRIES	LOWER MIDDLE INCOME	UPPER MIDDLE INCOME	HIGH INCOME COUNTRIES
Income (GNI/capita) 2006	< 876 USD	876-3 465 USD	3 466-10 725 USD	> 10 725 USD
Waste generation (kg/cap/yr)	220	290	420	780
Collection coverage[12] (percent of households served)	43%	68%	85%	98%
	Cost of Collection and Disposal (USD/tonne)			
Collection	20-50	30-75	40-90	85-250
Sanitary landfill	10-30	15-40	25-65	40-100
Open dumping	2-8	3-10	NA	NA
Composting	5-30	10-40	20-75	35-90
Waste-to-energy incineration	NA	40-100	60-150	70-200
Anaerobic digestion	NA	20-80	50-100	65-150

Collection: **Up to 30% of total net costs** for high income –
BUT: assuming high level of treatment and disposal

GWMO: SWM: Affordability

- **Combined net costs for unit operations**: icl. investment and operating costs, minus: resource recovery revenues
- **Unit costs increase with income level** (higher costs of personnel and compliance + more stringent environmental regulations)
- **As income levels rise, more sophisticated technologies generally become more affordable**
- **Upper limit on affordability of 1% of the GDP/GNI per capita**

PART B: RESEARCH STUDY COMPARING ALTERNATIVE TECHNOLOGIES (2012 DATA)[13]	LOW INCOME COUNTRIES	LOWER MIDDLE INCOME	UPPER MIDDLE INCOME	HIGH INCOME COUNTRIES
GDP [USD/capita/year]	< 2 700	2 700-5 400	5 400-8 100	34 000-41 000

PART C: CALCULATED FOR GWMO[16]	UPPER LIMIT ON AFFORDABILITY CALCULATED AT 1% OF GNI[17] (USD/TONNE)			
Affordability limit for total cost of solid waste management	< 40	40-120	120-255	> 255

Someone has to pay!

Money matters

Global Waste Management Outlook
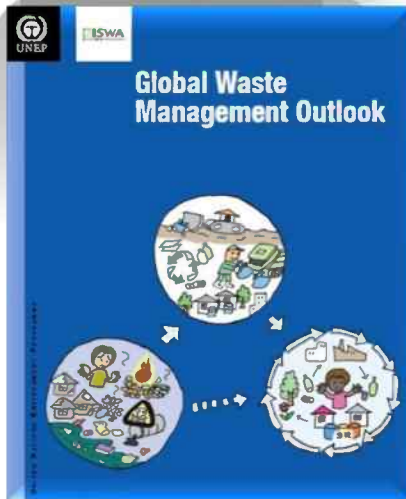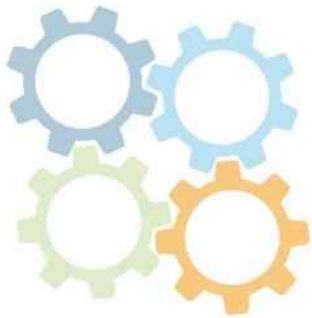
- **Know your costs** and the revenues available
- Someone has to pay. Find the appropriate financing model and sources of funding for investment. There is **no 'right' or 'wrong' answer** – each local situation is different
- **Larger waste generators should pay** the economic cost of sound management of their own waste
- **Ensure disposal is priced**: provides an incentive for the 3Rs
- Aim to **increase cost recovery gradually** – support those who cannot afford to pay
- Consider **transferring (some) costs of managing end-of-life products** from the municipality to the 'producer'

Meaning / role of "recycling": Recycling *vs.* primary raw material substtuton

Goal

Basis - NOT Goal

Substitution of primary raw material – equivalent functionality

Specialised reprocessing (mechanical – thermal – chemical)

Separation
(At source – MRFs – post EfW)
(Manual vs. mechanised)

Collection for recycling = "recycling"

Least consid ered

Focus to date
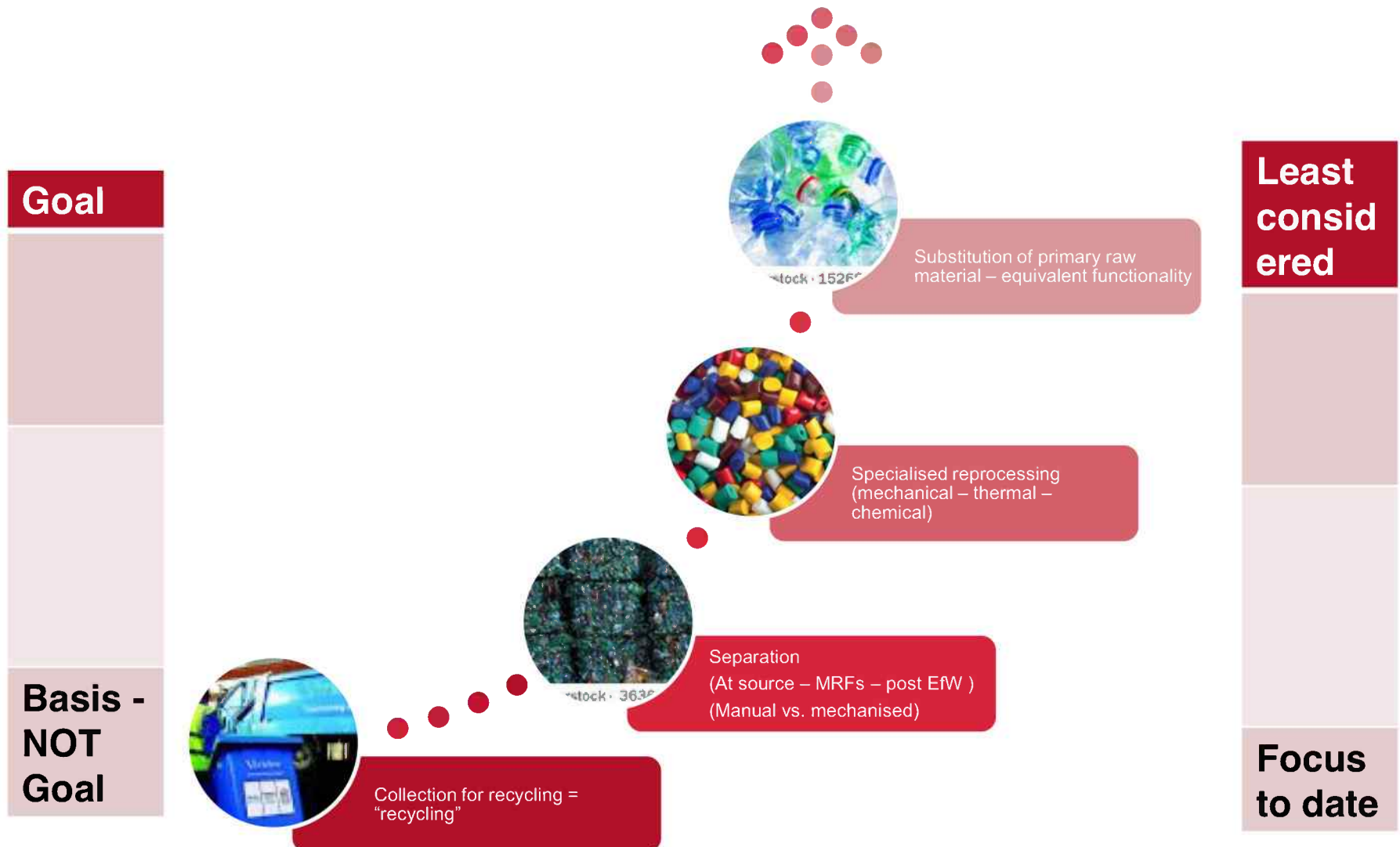
SWM only one part of a circular economy...

- De-pollute material flows
- Meet needs and quality standards

New Materials Products

Manufacture

Needs Wants Rules

Two Way

Retail Consume Use

Re-process

Collect Sort
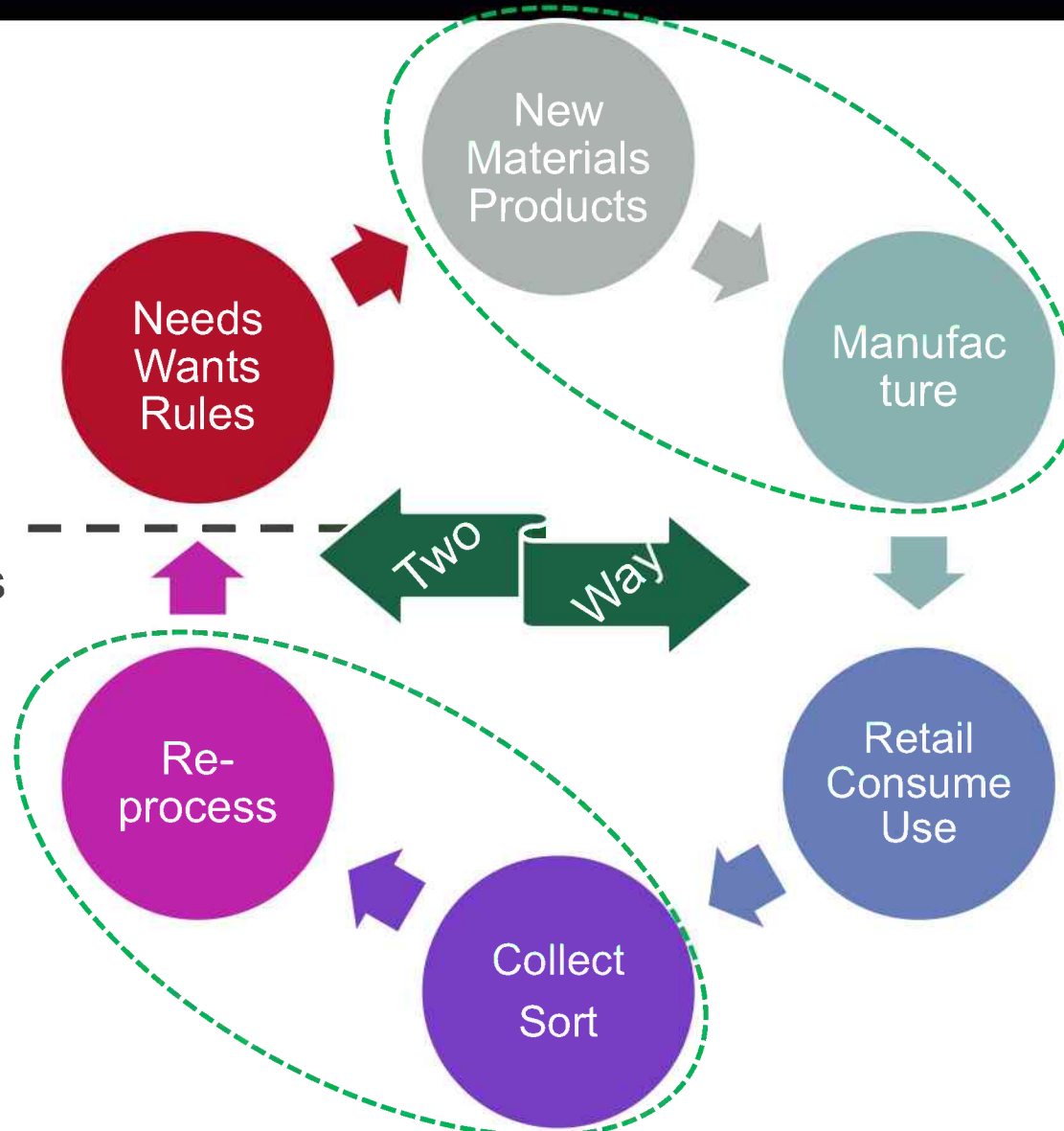
CIRCULAR ECONOMY: CLOSING THE LOOPS

Costas Velis
Maria Coronado
David Lerpiniere

ISWA
International Solid Waste Association

Paper

PP

Resources efficiency

ISWA TASK FORCE
on Resource Management
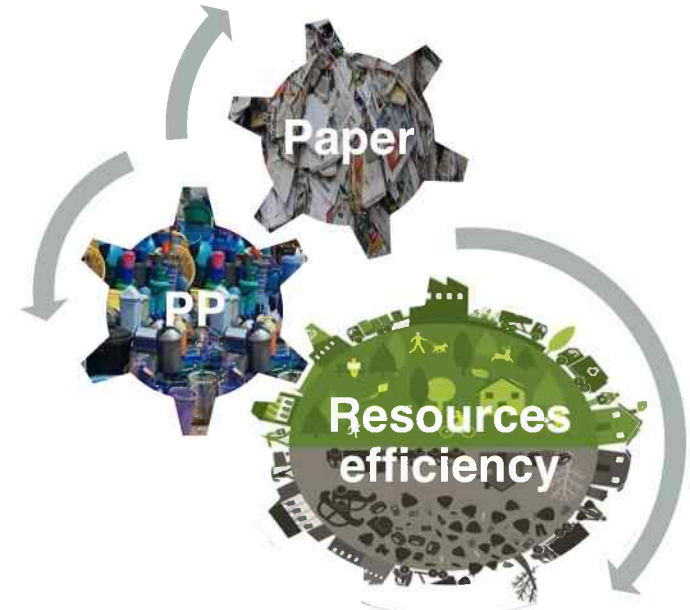
25% of global plastics production is polypropylene (PP)

Why PP is one of
the least recycled polymers?

Technical challenges for closing the PP loops

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Variability: materials – products – sectors

Ineffective collection for recycling

Material and Mechanical recycling limitations

Sorting out pure PP + grades + miscibility

Processing output / rPP standards

Global supply chains – Outlets / prices?

Environmental performance – Inputs & losses

Global recycling markets: plastic waste

A story for one player – China

A report from the ISWA Task Force on Globalisation and Waste Management

Author : Costas Velis

ISWA
International Solid Waste Association

Prepared by:
fUELogy
UNIVERSITY OF LEEDS

ISWA TASK FORCE
on Globalisation and Waste Management
PUBLICATIONS

Sources of Waste Plastics Imported in China in 2010

	kt	%
Hong Kong SAR	1984	24.7
Thailand	802	10.0
Japan	737	9.2
Germany	669	8.3
The Philippines	455	5.7
USA	426	5.3
Others	2972	36.9
	8042	100

Hong Kong SAR: serves as an entry point to China, re-exporting to China almost all the imported quantities

China is the dominant global player (importer)

Along with Hong Kong SAR this activity accounts for the
49% of the global financial activity in plastic scrap imports

Others / China **56%** wt. of the global market

China is the largest importing country for waste plastics

China receives most material from the
USA 21%
followed by
Japan 18%
Germany 12%
UK 9%

Global demand for plastic scrap was recently predicted by Pöyry to reach
85Mt
by 2020, fueled also by continued growth in China

EU-27 produces 25.2M tonnes of post-consumer waste plastics

26%
6.5 M tonnes collected for recycling
46% exports
3.0M tonnes
87% China and Hong Kong
2.6 M tonnes

Europe (EU-27) exports 46% of all the post-consumer plastics collected for recycling; 87% wt. exported to China + Hong Kong SAR

2006 ➤ 2012
Between 2006 and 2012 plastic waste imports in China increased from 5.9Mt to 8.9Mt

Copyright: ISWA Background research: Fuelogy Infographic: D.Waste

20 Globalisation and Waste Management

Complex and volatile globalised markets

National collection capacity

Reproceccing capabilities and material needs

Global supply netwroks

Oil and primary resins cost

Export / import laws and enforcement

Assumentry of information for players

Technlogical innovation

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Technical challenges – standards for quality?

household plastic packaging

Contamination limit: 0% to 5%

Plastic Pots, Tubs & Trays: This is a very young market, so specifications are only just being developed. Markets are growing by polymer type at present, so (for example) the polypropylene and polyethylene markets have a good demand, while others are still developing.

At the moment this material is sold 're-processors want zero contamination of their 1% residual food waste on packaging by weight is the overall maximum level of contamination, of which can be Small WEEE & Plastic Bags; < 2% Steel Cans; < 3% News & PARS; < 5% Aluminium Cans; and < 5% Plastic Bottles. Food Waste must not exceed 1% by Weight. Suppliers must speak to their re-processors directly to obtain their very latest specification.

Sold 'as seen'?

plastic bags and film

Contamination limit: 0% to 5%

Plastic Film/Bags: UK Re-Processors tamination. The majority of material currently recycled RF. The contaminants are typically paper & cardbo bottles and plastic foil (e.g. crisp packets, biscuit have put in a plastic bag. The re-processors with mo accept up to 8% contamination, of which a maximum as glass or residual food.

Majority handpicked at MFRs?

Source: http://www.resourceassociation.com/recycling-quality-specifications/#plasticbottles
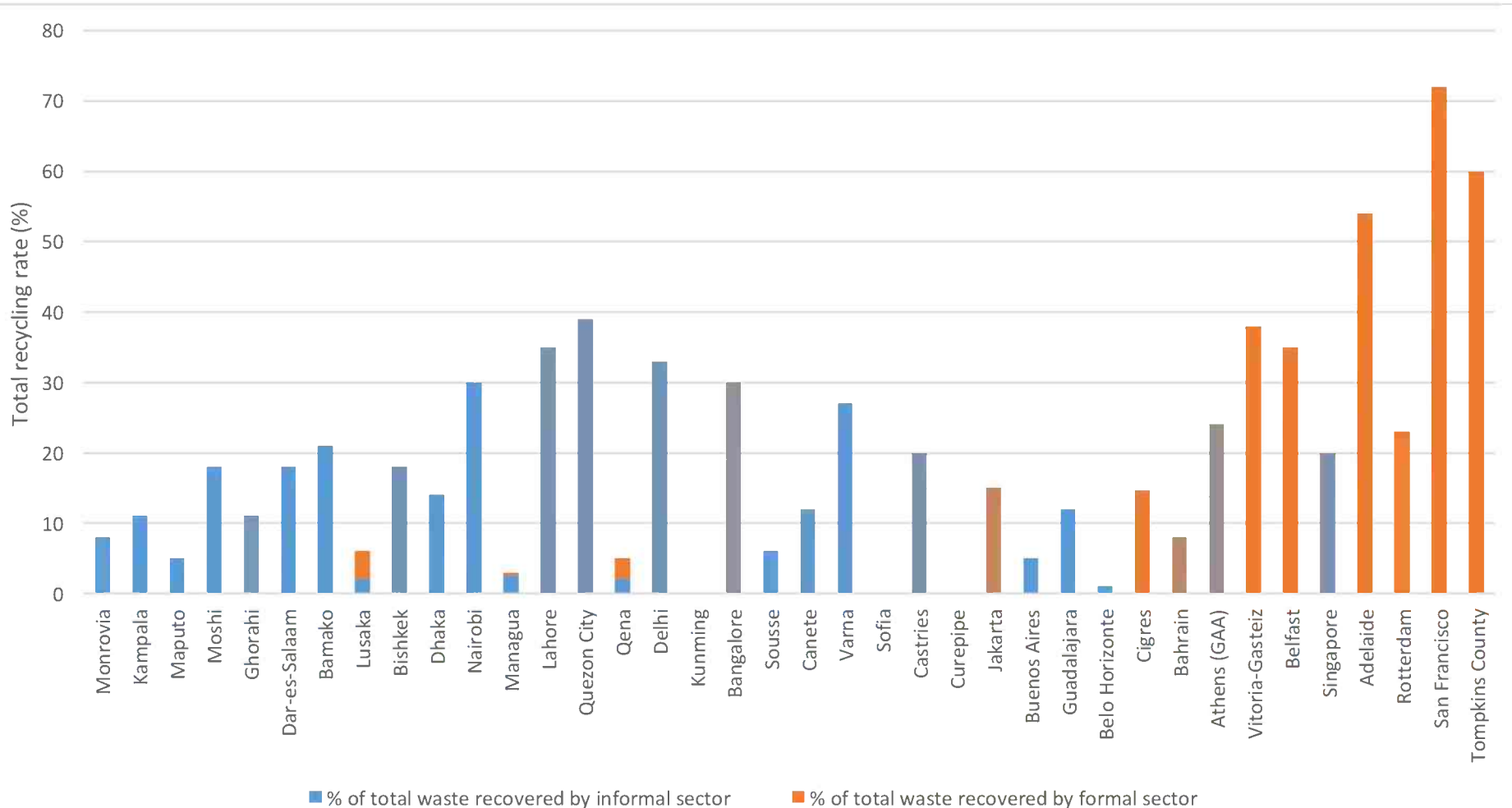
Wasteaware: Recycling – Cultural clusters
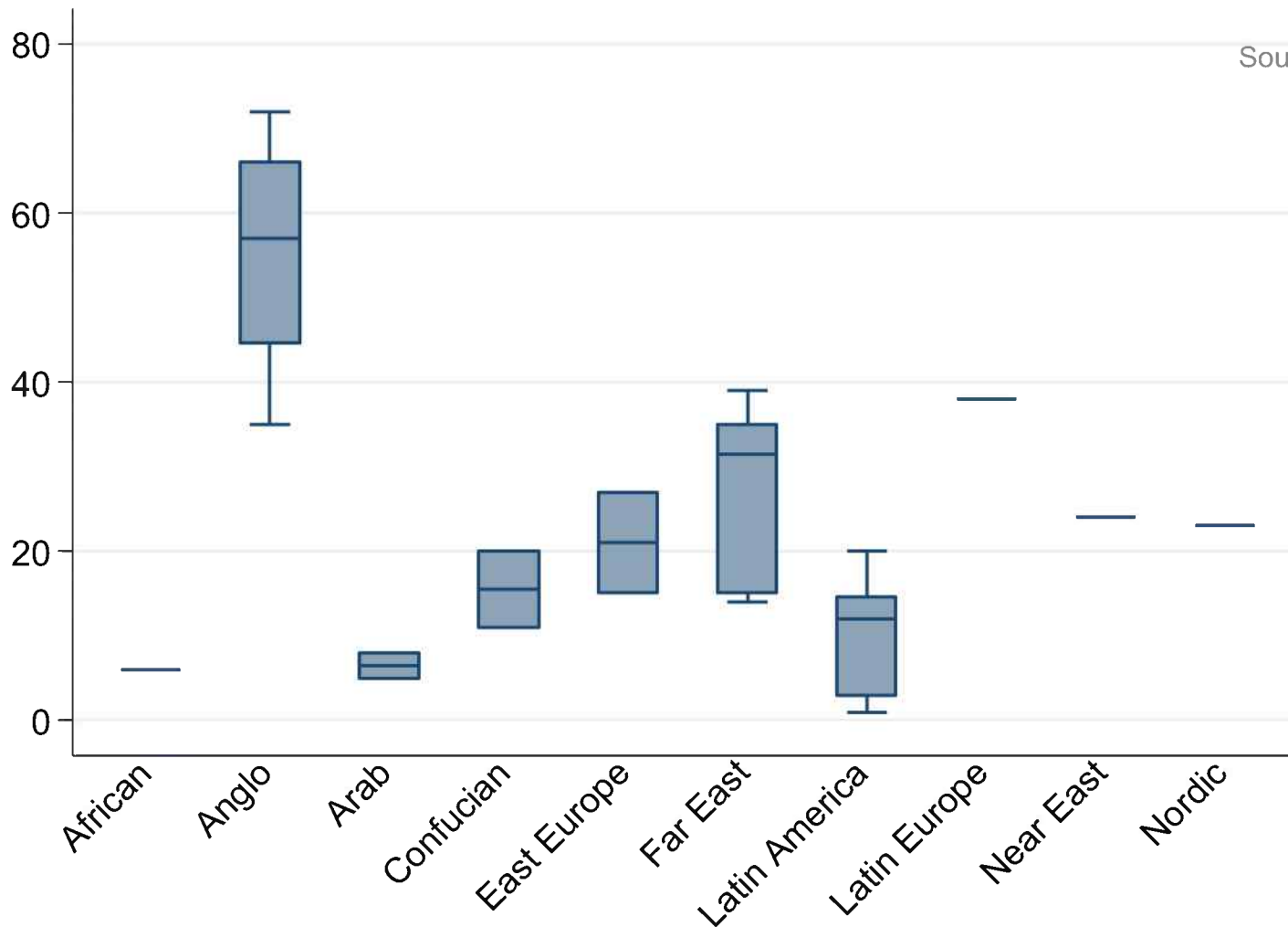
Source: Fargier et al., Unpublished

Wasteaware: informal recycling dominates around the world…

Source: Fargier et al., Unpublished
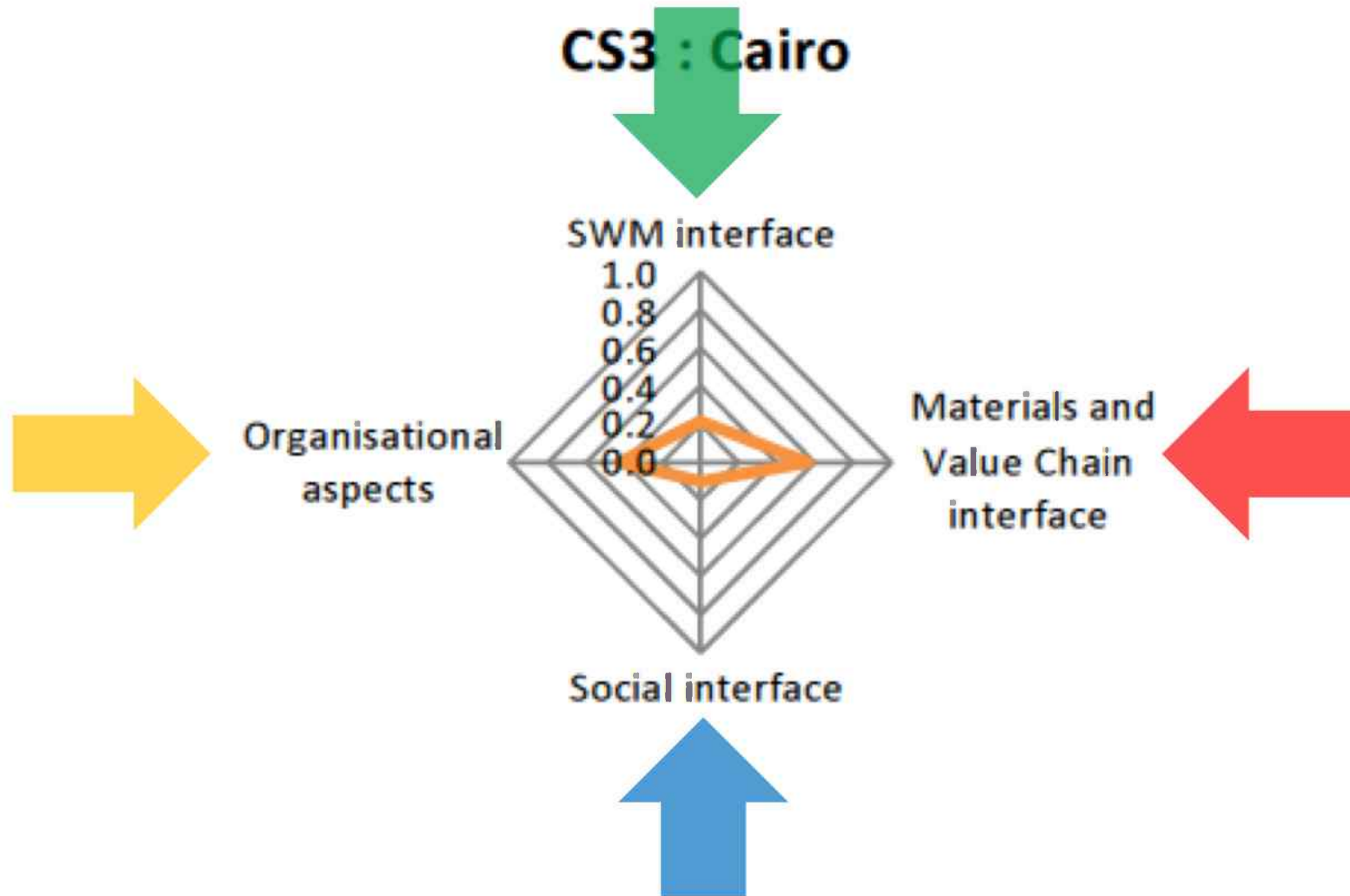
Integration Radar (*InteRa*): A visualisation tool revealing the focus of interventions

CS3 : Cairo

Source: Velis et al, 2012

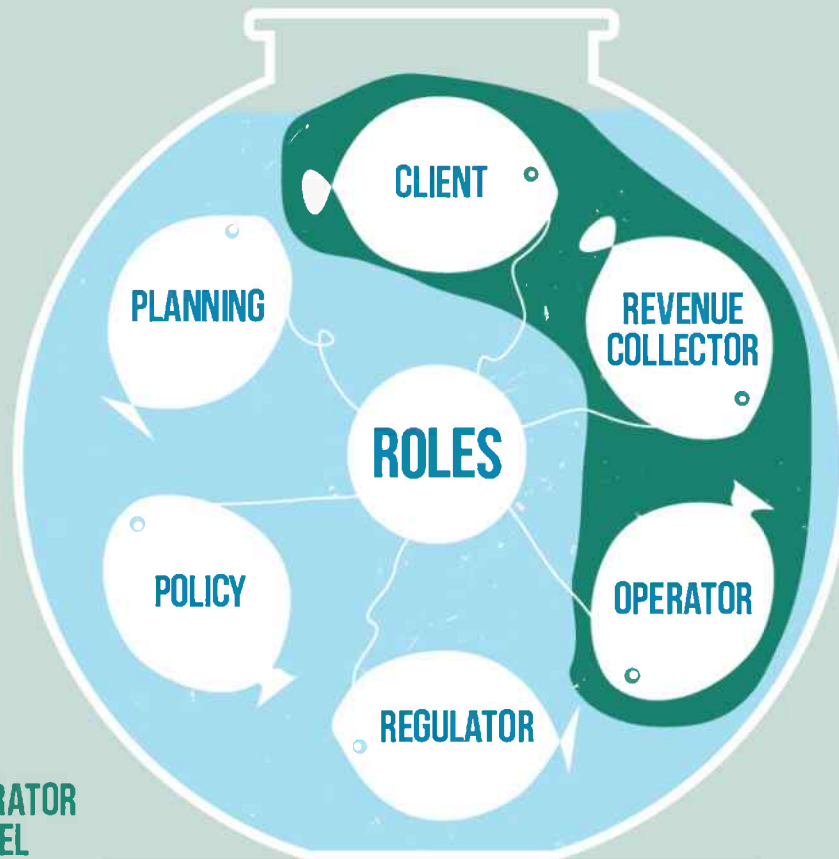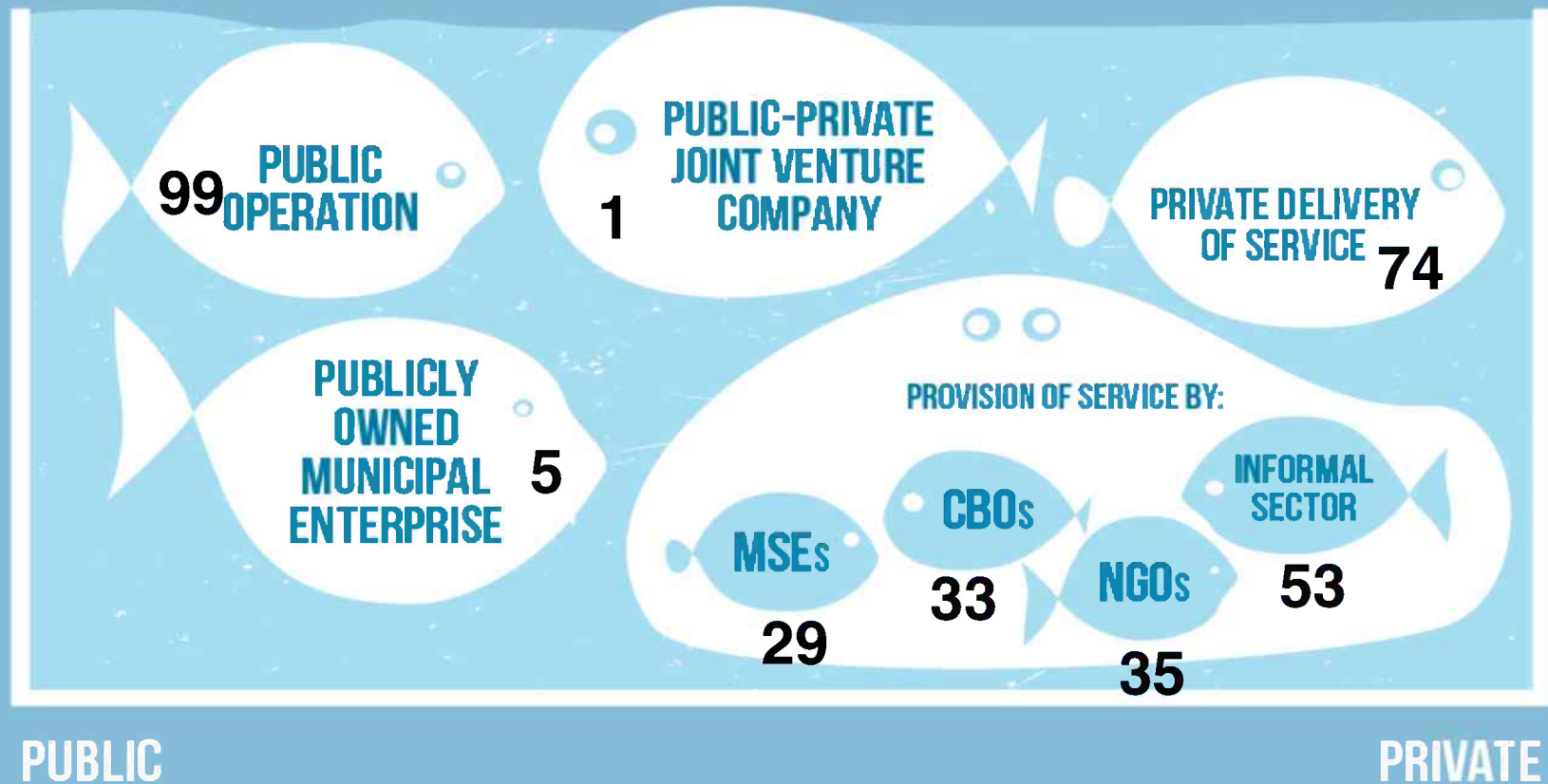Beware: NOT a sustainability / viability evaluation tool

Figure © GIZ - RWA - ERM

Concept: Wilson, D., Whiteman, A. & Tormin, A. (2001) Strategic Planning Guide for Municipal SWM. Washington D.C.: World Bank, www.worldbank.org/urban/solid _wm/erm/start_up.pdf

Provider inclusivity: Categorisation of service providers across 134 case studies analysed for GIZ

Average of 2.5 different operator models per city

PUBLIC OPERATION 99
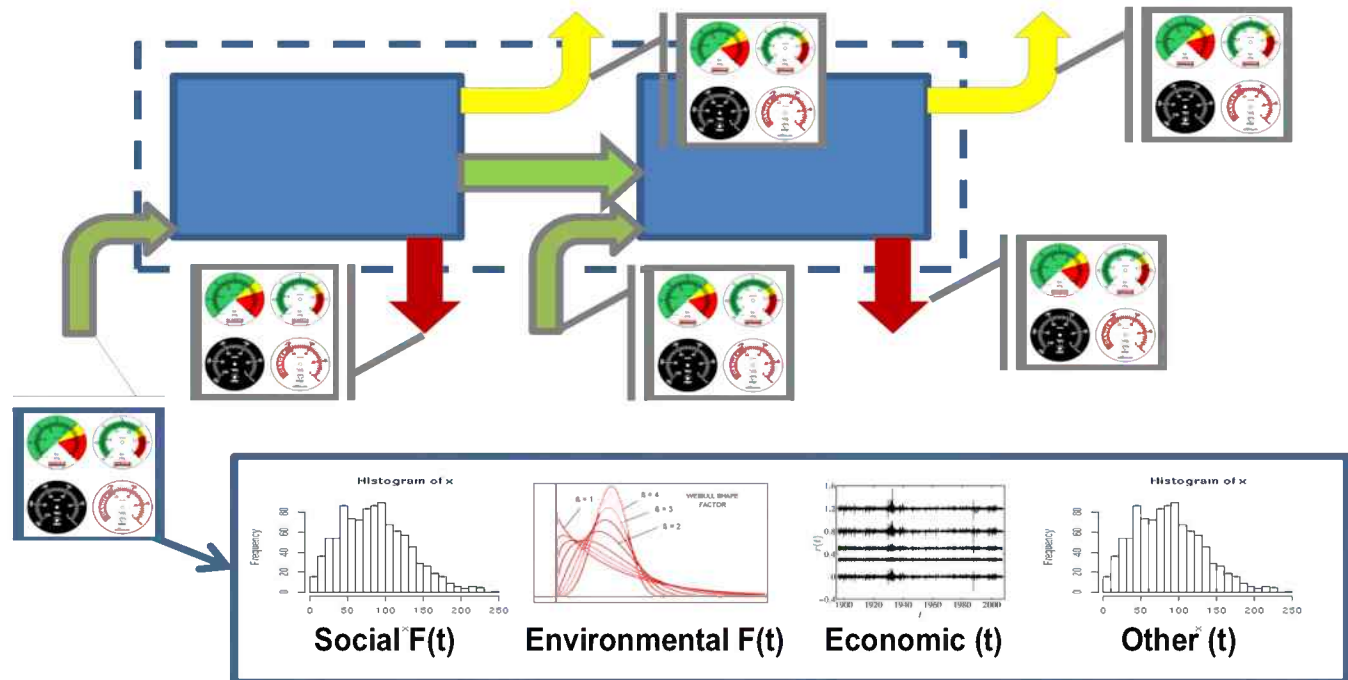
PUBLIC-PRIVATE JOINT VENTURE COMPANY 1

PRIVATE DELIVERY OF SERVICE 74

PUBLICLY OWNED MUNICIPAL ENTERPRISE 5

PROVISION OF SERVICE BY:

MSEs 29

CBOs 33

NGOs 35

INFORMAL SECTOR 53

PUBLIC

PRIVATE

C-VORR: multiple-value dimensions systems and concurrent approach
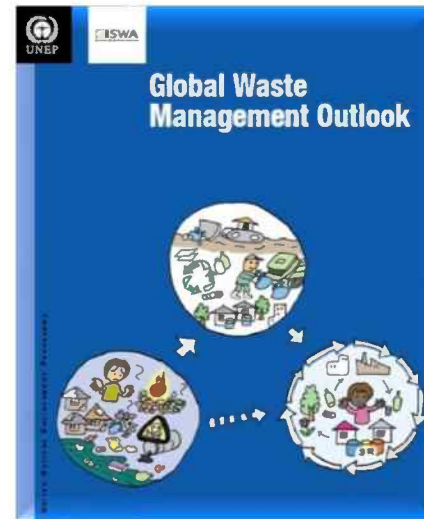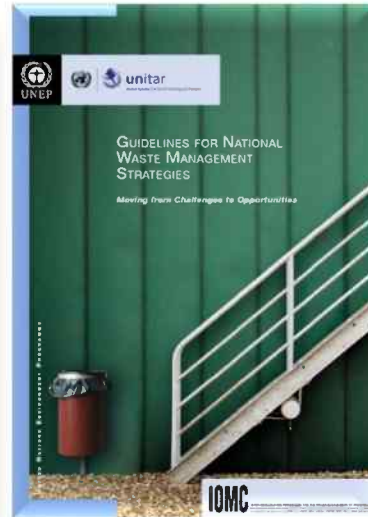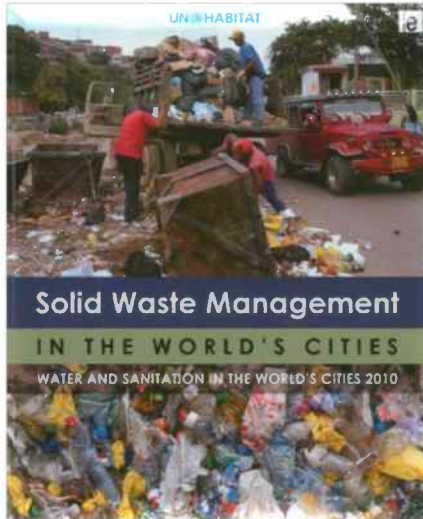

Complex
Value
Optimisation for
Resource
Recovery

No need to reinvent the wheel…
Info and tools for SWM systems

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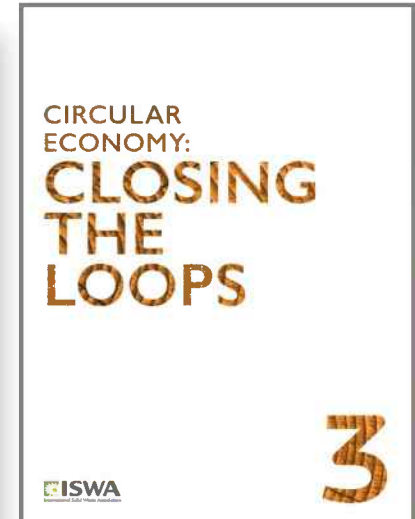
Wasteaware — • Available on-line

InteRa — • Available on-line

CVORR — • Under development…

Cites and waste systems: Your governance matters!

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All is already said…but not listened to

Waste in cities are part of complex systems – often global, always interdependent

Informal recycling is here

Recycling rates will not be just "collection for recycling"

Affordability is relevant – but what we pay for?

Measure it so that you can manage it

If you run out of red – use blue!

Waiting already means defeat

Develop socioeconomically for higher recycling rates

School of Civil Engineering
Institute for Resilient Infrastructure (iRI)
Institute for Public Health & Environmental Engineering (iPHEE)

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Thank you for listening!!

Ευχαριστώ για την προσοχή σας!!

Costas Velis

c.velis@leeds.ac.uk