United Nations Centre for Regional Development
UNCRD

E-waste management in Asia: Challenges and Opportunities - Human health and resource efficiency perspectives

Greater Mekong Sub-region (GMS) training workshop on building capacity to deal with the illegal shipments of e-waste and near-end-of-life electronics
Ha Noi, Viet Nam, 10-13 July 2012

CRC Mohanty,
Environment Programme Coordinator, UNCRD

Purpose of the Workshop

- **Enhance understanding** on the significance of controlling transboundary movement of e-waste and near-end-of-life electronics, and of proper recycling of e-wastes, taking into consideration the impact of e-waste on environment, occupational health and safety, and resource efficiency.

- **Build local capacity** of the **Customs Department** ***and*** **Ministry of Environment** in effectively controlling transboundary movement of e-waste and near-end-of-life electronics.

- Improve **interagency coordination** towards effectively addressing the issue of transboundary movement of e-waste and near-end-of-life electronics.
- Reinforce the **recommendation of GMS Workshop on National 3R Strategies**, Do Son, Viet Nam, 28-29 July 2010.
- Reinforce the **recommendation of the Singapore 3R Forum**, 5-7 Oct 2011
- Contribute towards the **Rio+20 outcome – The Future We Want**

Both ministries need to be on board to deal with this highly complex issue:
◆ **Customs Department** to address the governing environmental laws and regulations on illegal movements of e-waste; and
◆ **MOE** to work with the Customs Department towards better compliance and implementation of these environmental laws and regulations on the ground.

Composition of waste becomes more complicated as the economically & industrially grow…

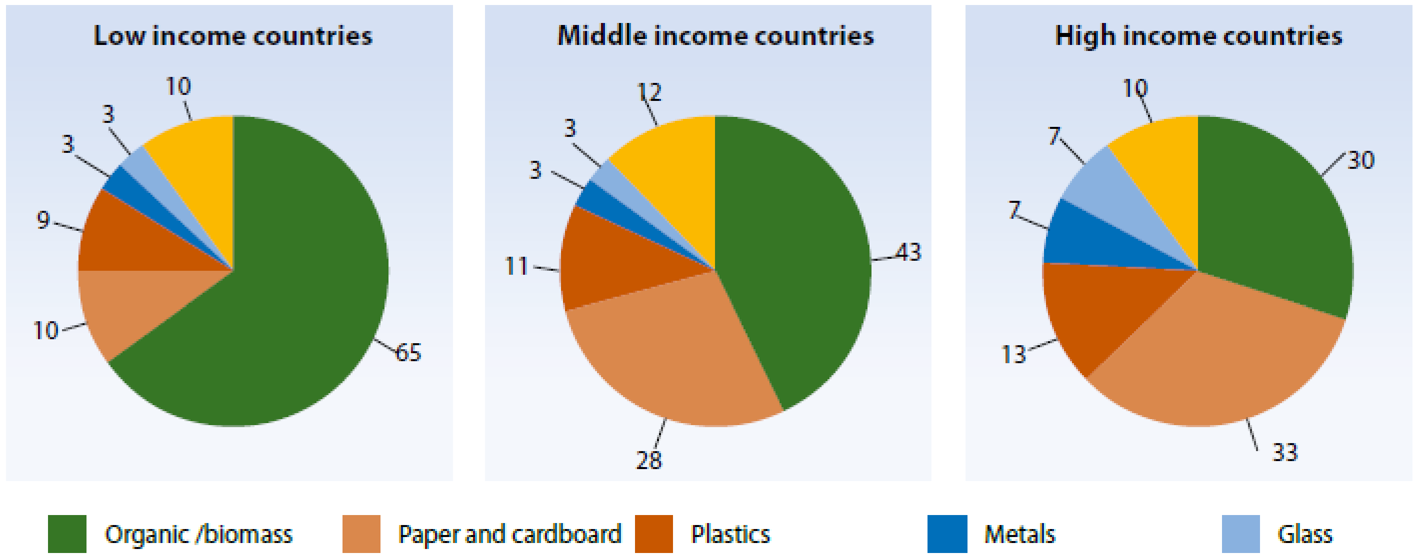


Figure 2: Composition of MSW by national income

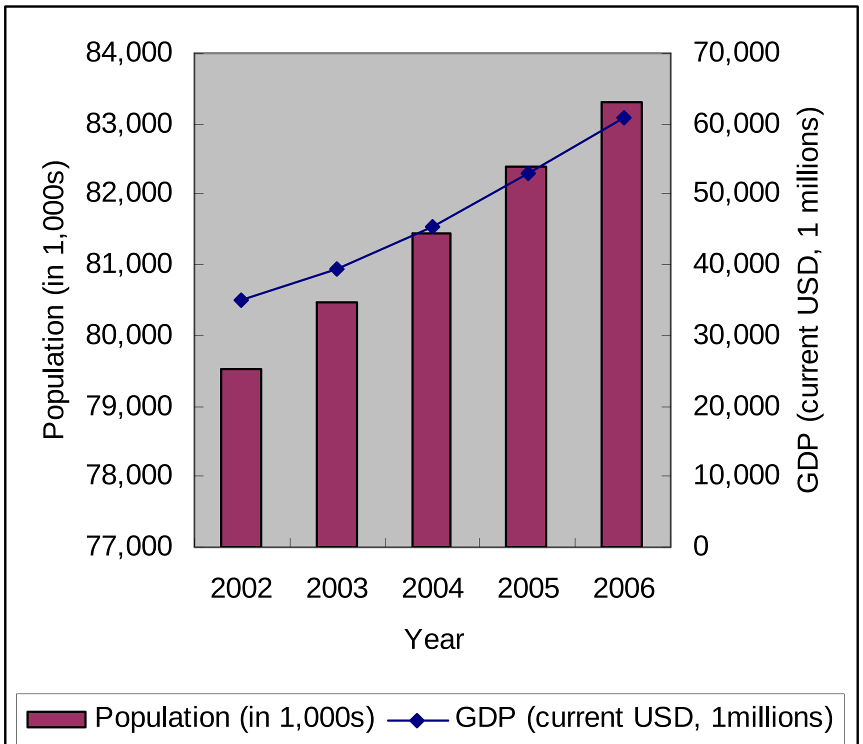
Source: Chalmin and Gaillochet (2009) and averaged

Source: UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.

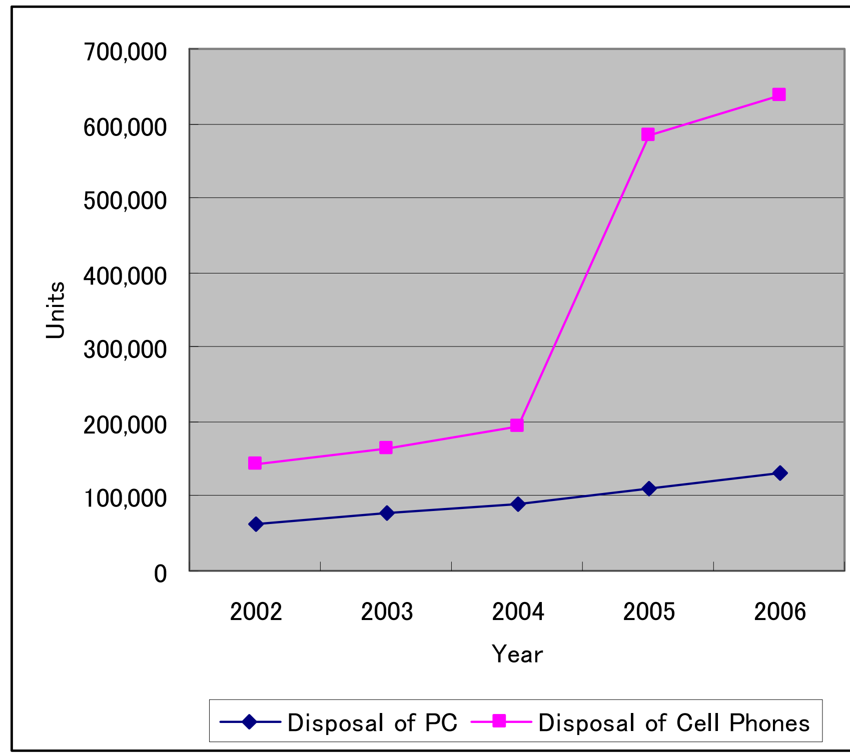
- New emerging waste streams such as **e-waste, and industrial wastes (including hazardous waste construction and demolition waste, end-of-life vehicles, healthcare waste, etc.)** further compound the pressure to the local environment

Population growth, economic growth, and the increase of e-waste in Asia

- Example in Viet Nam



Growth of Population and GDP (2002-2006)

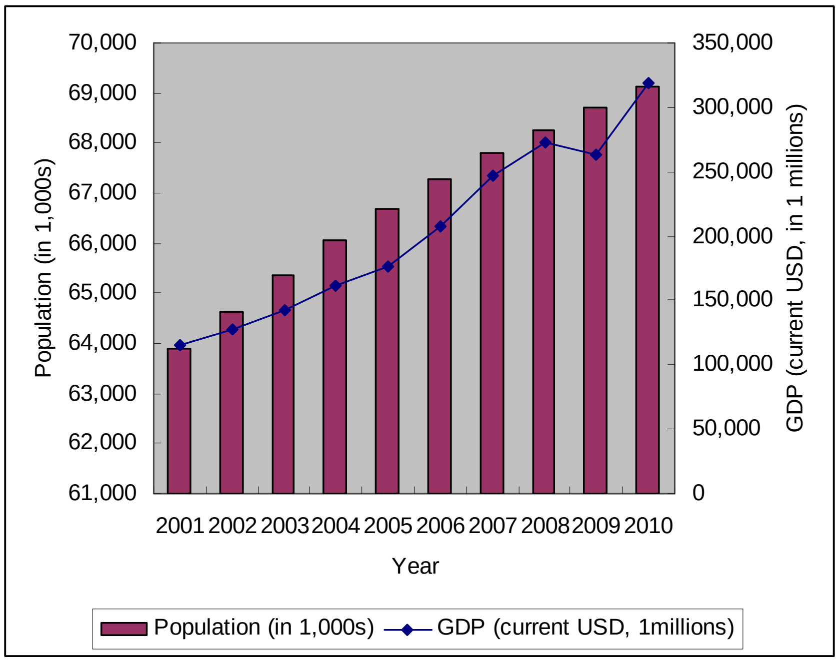


Disposal of PCs and Cell Phones (2002-2006)

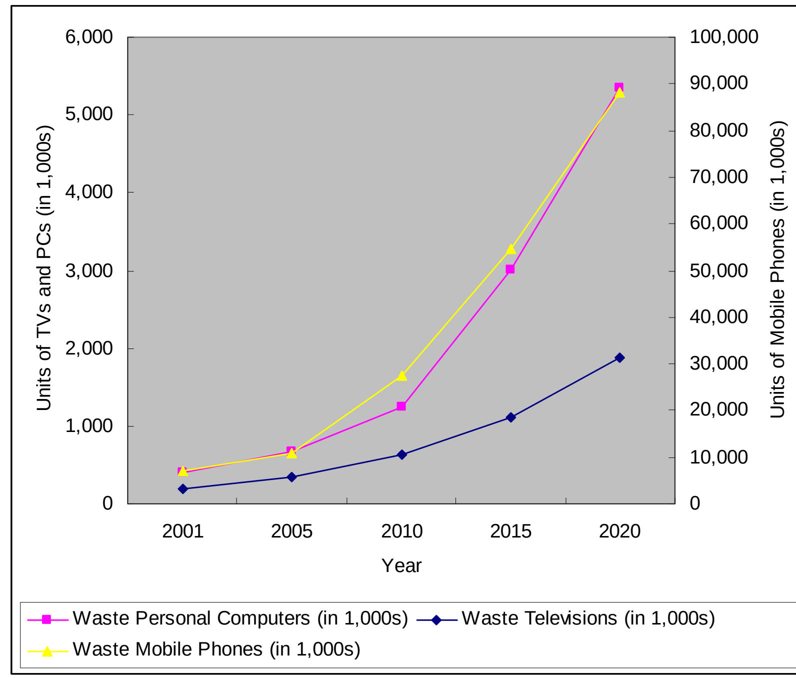
Source: URENCO Viet Nam, 2007 and http://databank.worldbank.org/

Population growth, economic growth, and the increase of e-waste in Asia

- Example in Thailand



Growth of Population and GDP(2001-2020)



Estimated generation of E-waste (2001-2020)
(Note: Years after 2006 are projected figures)

Source: Adapted from Electrical and Electronics Institute, Thailand, 2007, and http://databank.worldbank.org/

In advancing 3Rs/Resource Efficiency, what should be the priority for government authorities?

UPSTREAM MEASURES

Source reduction, Extended use, re-use

(Product policy towards resource efficiency)

versus

DOWNSTREAM FOCUS

An expanded recycling industry

(Resource intensive and hazardous production of expanding markets)

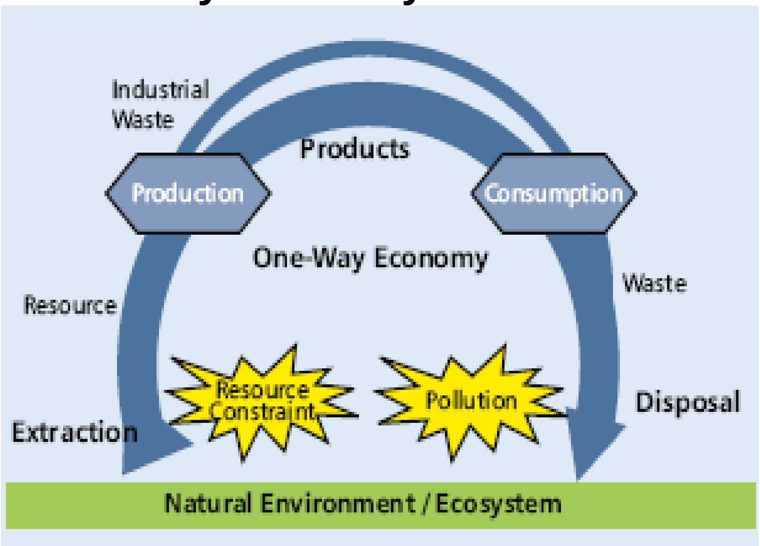
Many government policies and programs tend to focus on conventional waste management solutions such as sanitary land filling or incineration – mainly downstream disposal, which is expensive, while failing to pursue upstream measures to reduce the actual waste load

Waste disposal is expensive – financially and in lost resources

- Requires substantial inputs of labour (for collection/processing)
- Substantial materials input (construction of facilities for wastewater treatment, landfilling, incineration)
- Energy input (collection, treatment, incineration)
- Land resources (land-filling, incineration, treatment facilities)

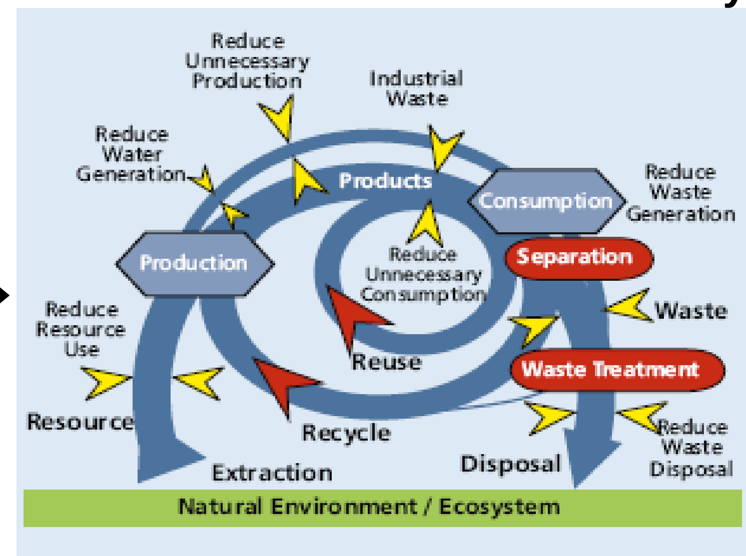
Where should the governments be heading?

1. One-way Economy



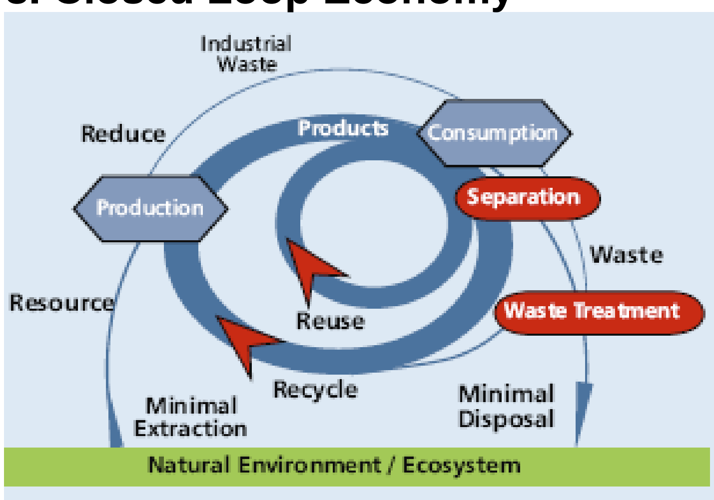
Source: ADB.

2. More resource efficient economy



Source: ADB.

3. Closed Loop Economy

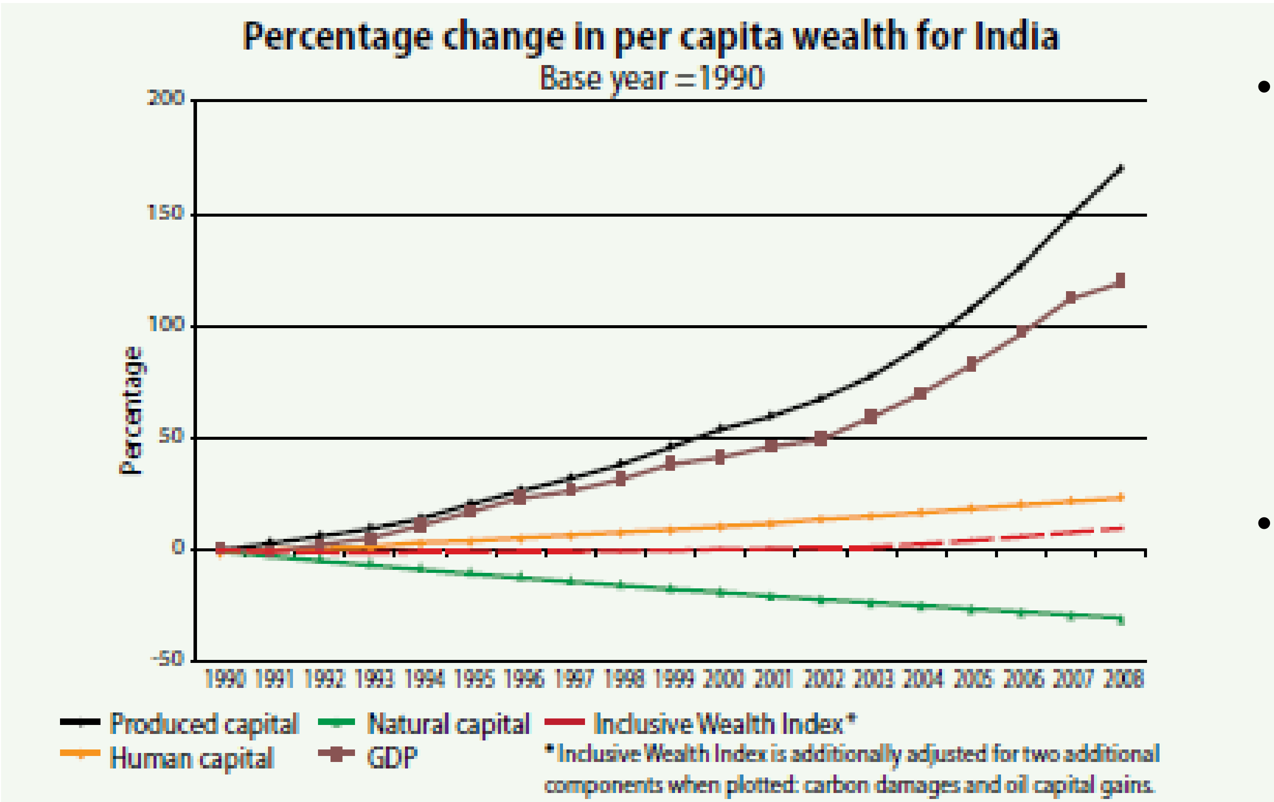


Source: ADB.

Resource efficiency => minimize per unit product or services

- Raw material input ⇩
- Water input ⇩
- Energy input ⇩
- Emission, pollution, waste generation ⇩

Economic growth in India 1990-2008 … at the sacrifice of natural capital



- GDP per capita grew by 120% between 1990 and 2008 in India, while the Inclusive Wealth Index increased by mere 9%.
- Natural capital (i.e., ecological assets) declined by 31% during the same period.

Note: Inclusive wealth consists of three main components: human, manufactured, and natural capital.

Source: http://www.planetunderpressure2012.net/pdf/policy_green_economy.pdf

Risks associated with end-of-life treatment of e-waste

Table 6. Risks associated with end-of-life treatment of electronic waste (e-waste).

End-of-life process	Occupational risks	Environmental risks
Traditional waste handling		
Landfilling		Leakage of metals (e.g. Pb, Cu, Ni, Sb, Cd, Zn) and organic compounds (e.g. BFRs, plastizicers). Evaporation of Hg and MeHg.
Incineration		Emission of various metals and organic compounds via exhaust gases (e.g. dioxins, BFRs, PAHs, Cu, Pb, Sb). Leakage of various compounds from ashes (e.g. dioxins, Cu, Pb, Sn)
Controlled recycling		
Collection and dismantling	Dust containing various compounds during dismantling activities. Dust containing Pb and Ba-oxide from broken CRTs. Cuts from CRT glass in case of implosion. Volatile compounds (e.g. Hg) from broken components.	Emissions of volatile compounds (e.g. Hg) from broken components.
Shredding	Dust containing various compounds (e.g. BFRs, TPP, phthalates, Cd, etc.).	
Pyrometallurgical processes	Dust and fumes of the shredded material and the melting process, containing various compounds (e.g. Pb, Cd, Hg, Be, BFRs, dioxins, TPP, phthalates).	Emissions of various metals (e.g. Pb, Cd, Hg, Be) and organic compounds from the melting process (e.g. BFRs and dioxins).
Hydrometallurgical process	Acid fumes containing various hazardous compounds	
Plastic recycling	Dust and fumes of various chlorinated and brominated compounds (e.g. BFRs and dioxins), and some metal additives (e.g. Cd)	Emissions of various chlorinated and brominated compounds (e.g. dioxins) from the thermal processes used.

Source: Swedish Environmental Protection Agency, 2011

Risks associated with end-of-life treatment of e-waste

Uncontrolled recycling		
Collection and dismantling	Dust containing various compounds during dismantling activities, e.g. Pb and Ba-oxide from broken CRTs. Cuts from CRT glass in case of implosion. Volatile compounds (incl. Hg) from broken components.	Emission of dust and fumes containing various metals (e.g. Pb, Zn, Cu, Sn, Sb, Cd, Ni, Hg) and organic compounds (e.g. BFRs) to the local environment.
PC-board heating	Exposure to fumes of various compounds from solder and PC-board components (e.g. Pb, Sn, BFRs and dioxins)	Leakage of various compounds (e.g Cu….) from dumped PC-board residues.
Toner sweeping	Exposure to toner dust including carbon black.	Leakage of various compounds from emptied and dumped toner cartridges.
Acid extraction	Exposure to acidic fumes containing various hazardous compounds.	Leakage of various metals (e.g. Pb, Sn, Cu, Sb, Ni, Hg, Ba, Cd) and organic compounds (BFRs, phthalates, TPP, dioxins) from dumped residues of the extraction process.
Shredding	Dust and fumes of various metals and organic compounds present in the plastics (e.g. BFRs, phthalates, TPP, Cd, etc.)	Emissions of dust containing various plastics components to the local environment.
Plastics and waste burning	Exposure to a wide range of metals (incl. Cd, Cu, Pb, Zn, Sb) and organic compounds (incl. PBDEs, PAHs, PCBs, dioxins) via the smoke.	Emissions of a wide range of metals (incl. Cd, Cu, Pb, Zn, Sb) and organic compounds (incl. PBDEs, PAHs, PCBs, dioxins) to the local, regional and global environment.
Dumping of residual materials	Exposure to dust and fumes, containing various compounds, from dumped materials. Secondary exposure via contaminated drinking water and food.	Leakage of various metals and organic compounds to the ground and water reservoirs in the surroundings

Source: Swedish Environmental Protection Agency, 2011

E-waste in Asia – Examples of human health impacts

The contaminant levels found in the bodies of people living and working in the recycling areas:

- Elevated levels of blood metal level found in children living in recycling areas (Studies in Guiyu, China).
- High blood metal levels measured were found to correlate with their parent's engagement in e-waste recycling business.
- Other negative health effects observed include respiratory diseases, skin infections, stomach problems, and leukaemia.

Swedish Environmental Protection Agency, 2011.

http://amicor.blogspot.jp/2010_02_01_archive.html Photograph: Jim Puckett/AP

A study comparing the population involved in informal e-waste recycling in Guiyu, China vs. control population:

- Guiyu had about four times higher risk of stillbirth compared with Xiamen.
- The median level of core blood lead (CBPb) was much higher in neonates of Guiyu than those in the control group (10.78 μg/dL *vs.* 2.25 μg/dL).
- Prenatal exposure to informal e-waste recycling related to high rate of adverse birth outcomes, lower Apgar scores and unsafe lead level in cord blood.

Xijin Xu et al, 2011.

http://english.vietnamnet.vn/en/environment/3077/toxic-waste-poses-environmental-threat.html

Business opportunities on e-waste

- Global e-waste recovery market holds enormous revenue potential and is expected to reach $21 billion by 2020, growing from $6.9 billion in 2009. In China alone, the volume of e-waste is expected to reach 5.1 million metric tons in 2020, an increase of more than 150% from 2005. (GBI Research, 2010)

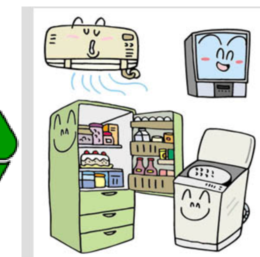
- The revenue generated from the e-waste management market is expected to grow from $9.15 billion in 2011 to $20.25 billion in 2016 at a compound annual growth rate (CAGR) of 17.22% from 2011 to 2016. (marketsandmarkets.com, 2011)

Pictures: (Top) http://environmentalgeography.wordpress.com/2012/02/
(Bottom) http://www.wastemanagementrecycling.net/e-waste.html

E-waste management and job creation

- In the US, for every 1,000 tons of electronics:
  - **Landfilled** - less than 1 job is created
  - **Recycled** - 15 jobs are created
  - **Repaired** - 200 jobs are created

- In Japan, it is estimated that the introduction of the Home Appliances Recycling Act contributed to creating 2,000 new jobs.



☆ Caution ☆

- E-waste management provides lots of jobs, but needs to be practiced in such a way that the environment and human health are protected through appropriate practices.
  - Even in developed countries, there has been a reported incidence in which workers at a electrical waste recycling facility suffered from mercury poisoning, generated by recycling of eco-light bulbs containing mercury, due to poor work practices (ILO, 2012).

Source: http://www.illinoisbiz.biz/NR/rdonlyres/8DD41FE3-A7ED-4447-87C0-DD05815F2747/0/EwasteFactSheet.pdf, http://www.pwmi.or.jp/public/news200909.html,
Picture and Photos: http://www.pref.yamaguchi.lg.jp/cms/a15700/25recycle/kaden-recycle.html, http://www.epa.gov/ozone/title6/608/disposal/household.html, http://allabout.co.jp/gm/gl/4159/

“Waste as resources” in the context of e-waste

How much are there inside?

a) Mobile phones:
1200 Million units
x 250 mg Ag ≈ 300 t Ag
x 24 mg Au ≈ 29 t Au
x 9 mg Pd ≈ 11 t Pd
x 9 g Cu ≈ 11,000 t Cu
1200 M x 20 g/battery*
x 3.8 g Co ≈ 4500 t Co
* Li-Ion type

b) PC & laptops:
255 Million units
x 1000 mg Ag ≈ 255 t Ag
x 220 mg Au ≈ 56 t Au
x 80 mg Pd ≈ 20 t Pd
x ≈ 500 g Cu ≈ 128,000 t Cu
≈100 M laptop batteries*
x 65 g Co ≈ 6500 t Co
* Li-Ion type is > 90% used in modern laptops

World Mine Production		a+b share
Ag: 20,000	t/y ►	3%
Au: 2,500	t/y ►	3%
Pd: 230	t/y ►	13%
Cu: 16	Mt/y ►	1%
Co: 60,000	t/y ►	15%

- Combined unit sales of mobile phones and personal computers in 2007 add up to 3% of world mine supply of gold (Au) and silver (Ag), 10 13% of palladium (Pd) and to 15% of cobalt (Co).

Source: UNEP and UNU, 2009.

... and how much are recycled?

	Electronics	Industrial applications
Palladium (Pd)	5-10%	80-90%
Silver (Ag)	10-15%	40-60%
Gold (Au)	10-15%	70-90%

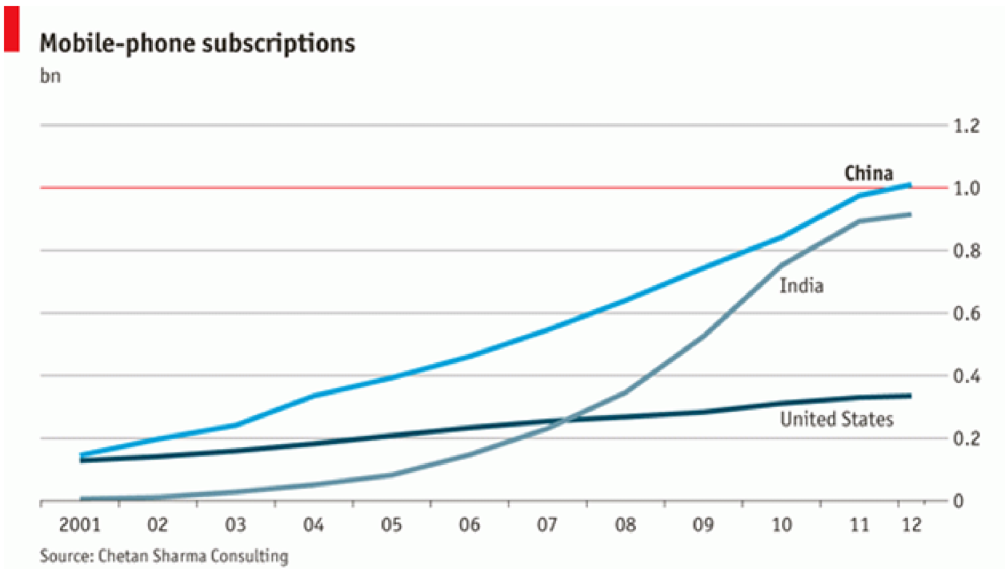
Estimated end-of-life recycling rates for precious metals from the electronics are very low.

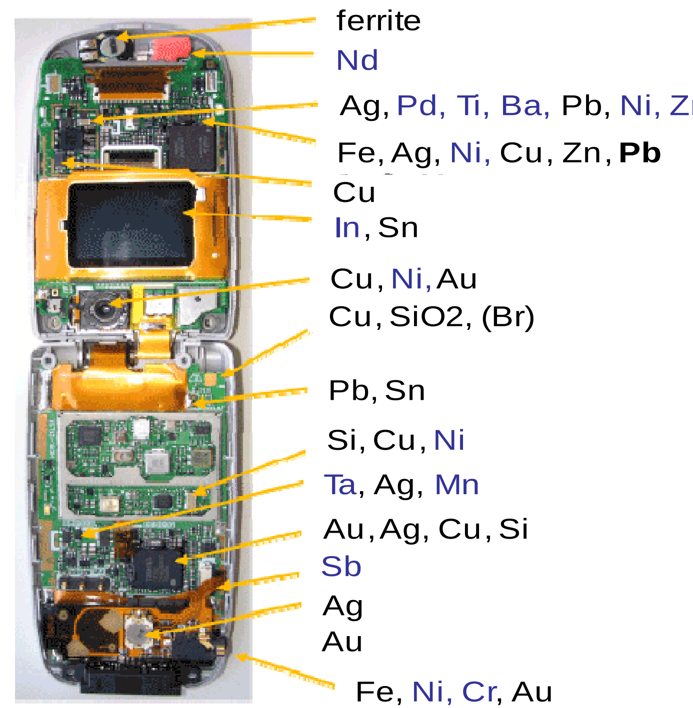
Source: UNEP, 2011.

Precious metals left unutilized – mobile phones

Nokia Global Consumer Survey on Recycling (2008)*

- Overall, **74%** said they do not think about recycling their mobile phones.
- Half of those surveyed didn't know phones could be recycled.





Source: http://www.coden.jp/rare-metal/use.html

For every 1 million cell phones recycled, we can recover 75 pounds (34kg) of gold, 772 pounds (350kg)of silver, 33 pounds (15kg) of palladium, and 35,274 pounds (16 ton) of copper.

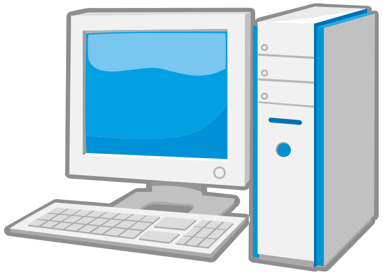
http://www.epa.gov/agingepa/press/epanews/2010/2010_0401_3.htm

Source: http://www.slideshare.net/nokiaconversations/nokia-recycling-survey-results-presentation, http://press.nokia.com/2008/07/08/global-consumer-survey-reveals-that-majority-of-old-mobile-phones-are-lying-in-drawers-at-home-and-not-being-recycled/

Resource efficiency of electronic appliances – a lifecycle perspective

- **Case for Computers:**
  - The average 24 kg desktop computer with monitor requires at least 10 times its weight in fossil fuels and chemicals to manufacture, much more materials intensive than an automobile or refrigerator, which only require 1-2 times their weight in fossil fuels.
  - **Manufacturing one desktop computer and 17-inch CRT monitor uses** at least 240 kg of fossil fuels, 22 kg of chemicals and 1,500 kg of water - **a total of 1.8 tonnes of materials.**
  - While the technology is advancing to improve energy efficiency, the growth rate of the industry (i.e., the quantity of outputs produced) is much faster thus the **net consumption of natural resource is increasing.**

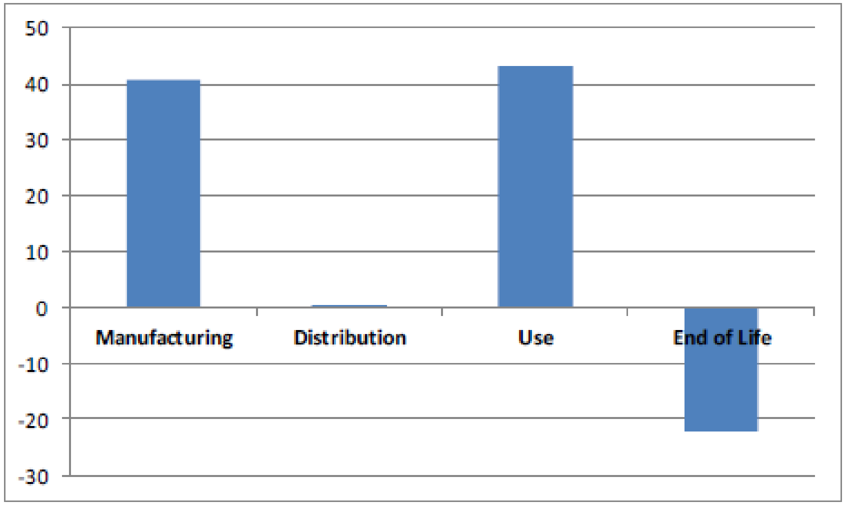
(based on a 2004 study)



Source: http://archive.unu.edu/update/archive/issue31_5.htm; http://www.e-squareinc.com/reports/pub_pdf/EcoBusiness.pdf

Resource efficiency of electronic appliances – a lifecycle perspective

Case: Aggregate environmental impacts of a PC manufactured in China, used over a period of six years and disposed of using mandatory procedures for treating waste from electric and electronic equipment (WEEE) in the European Union.



Note: the vertical axis displays eco-indicator points. Positive numbers represent aggregate negative environmental impact during the life-cycle phase. Negative numbers represent positive environmental impact.

- During production most impacts result from energy use, manufacturing-related extraction of raw materials and use of other natural resources.
- Environmental impacts during the use phase result solely from the use of electricity by the PC and peripheral devices.
- Under *optimal conditions* (*i.e.* following WEEE-mandated shares of recycling), the end-of-life phase has positive environmental impacts owing to the recovery of materials and adequate treatment of hazardous substances.

Source: OECD, 2010

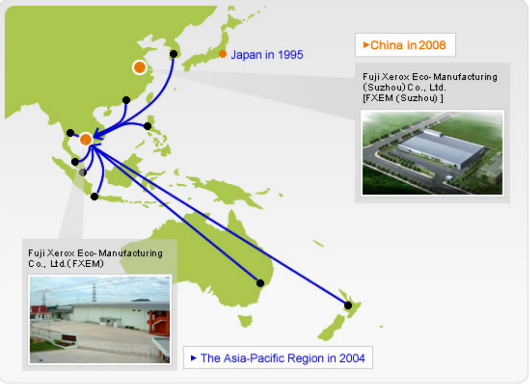
Resource efficiency of electronic appliances – Up-stream (Production)

Efforts to improve resource efficiency at the up-stream

- Resource-saving design: Reduced size, thinning of parts, use of recycled material
- Long-life design: Adopting durable materials and structures, up-gradable design
- Resource-saving production system: Reduce byproducts and losses, promote reduce and reuse
- Total elimination of specific hazardous chemicals used in the products (e.g., Pb, Cd, Cr6+, Hg, PBB, PBDE)

Establishment of regional recycling systems:

- Case of Fuji Xerox
  - Launched the Integrated Recycling System covering the Asia-Pacific region in 2004, with a recycling center based in Thailand.
    - By 2007, approx. 9,000 tons of resources were recycled from 55,000 recovered used products. Recycling rate was 99.2%.
  - Inaugurated the Integrated Recycling System in China, where used office equipments and cartridges collected from throughout China are recycled, aiming to achieve "zero landfill" , "no pollution" , and "no illegal disposal."



http://www.fujixerox.com/eng/company/ecology/cycle/newstyle/international/

Source: http://www.fujixerox.co.jp/eng/company/headline/2007/0822_circulate.html; http://news.fujixerox.com/news/2008/0115_recycle/

Resource efficiency of electronic appliances – Down-stream (e-waste management)

The Reality:

- Most e-waste in developing countries are improperly handled through practices that release toxic pollution harming the people and environment, and yield very low metal recovery rates compared to advanced industrial facilities.

• Negative impact on the environment and human health

• Loss of economic opportunity (e.g., precious metals)

• Materials wasted, which could have been used as input in place of newly extracted natural resource.

What can be done?

Key Factors for environmentally sustainable management of e-waste

- **Appropriate policies, regulations and guidelines**
  - WEEE Directive (2002/96/EC) in EU
  - Home Appliances Recycling Law (2001) in Japan
- **Enforcement of the laws**
- **Appropriate E-waste management infrastructure**
- **Multi-stakeholder participation, backed by clear roles and responsibilities and awareness**
  - For example, under the Home Appliances Recycling Law in Japan, the specific responsibilities are given to the stakeholders.

    End users: Payment of recycling fee

    Retailers: Collection of used home appliances

    Manufacturers: Recycling of collected home appliances

More to be discussed during the workshop

Rio+20 Outcome – The Future We Want

Green economy in the context of sustainable development and poverty eradication (para. 56-74)

RIO+20
United Nations Conference on Sustainable Development

Among others, the States ..

- emphasize that ***green economy*** should contribute to eradicating poverty as well as sustained economic growth, enhancing social inclusion, improving human welfare and creating opportunities for employment and decent work for all, while maintaining the healthy functioning of the Earth's ecosystems.
- acknowledge ***increasing resource efficiency and reduction of waste*** and achieving green economy in the context of sustainable development and poverty eradication are complementary to each other in enhancing the ability to manage natural resources sustainably and with lower negative environmental impacts
- recognize urgent action on ***unsustainable patterns of production and consumption*** where they occur remains fundamental in addressing environmental sustainability and promoting conservation and sustainable use of biodiversity and ecosystems, regeneration of natural resources and the promotion of sustained, inclusive and equitable global growth

Rio+20 Outcome – The Future We Want

Chemicals and waste (para. 213-223)

RIO+20
United Nations Conference
on Sustainable Development

Among others, the States call for:

- *Sound management of chemicals and waste* which is crucial for the protection of human heath and the environment.
- ***development and implementation of policies for resource efficiency*** and environmentally sound waste management, including commitment to further ***3Rs*** as well as to increase energy recovery from waste with a view to managing the majority of global waste in an environmentally sound manner
- development and enforcement of comprehensive ***national and local waste management policies, strategies, laws and regulations*****.**
- continued, new and innovative *public-private partnerships* among industry, governments, academia and other non-governmental stakeholders aiming to enhance *capacity and technology* for environmentally sound chemicals and waste management, including for ***waste prevention***

Rio+20 Outcome – The Future We Want

Sustainable cities and human settlements

(para. 134-137)

RIO+20
United Nations Conference
on Sustainable Development

Among others, the States ….

- recognize that, if they are well planned and developed, including through **integrated planning and management approaches**, cities can promote economically, socially and environmentally sustainable societies.
- commit to promote sustainable development policies that support a **safe and healthy living environment for all**, safe and clean drinking water and sanitation; healthy air quality; generation of decent jobs; and improved urban planning and slum upgrading.
- support sustainable management of waste through the application of the **3Rs**.
- emphasize the importance of increasing the number of metropolitan regions, cities and towns that are implementing **policies for sustainable urban planning and design** in order to respond effectively to the **expected growth of urban populations in the coming decades**.

Rio+20 Outcome – The Future We Want

Other thematic areas and cross-sectoral issues..

Ocean and seas/coastal ecosystem:

•commit to protect, and restore, the health, productivity and resilience of oceans and marine ecosystems, and to maintain their biodiversity, enabling their conservation and sustainable use for present and future generations..(para 158)

•commit to take action to reduce the incidence and impacts of various marine pollution such as debris, especially **plastic**, persistent organic pollutants, heavy metals and nitrogen-based compounds, from a number of marine and land-based sources, including shipping and land run-off (para 163).

Sustainable production and consumption:

•recognize that fundamental changes in the way societies consume and produce are indispensable for achieving global sustainable development (para 224).

Rio+20 Outcome – The Future We Want

Other thematic areas and cross-sectoral issues..

RIO+20
United Nations Conference
on Sustainable Development

Water and sanitation

- underline the critical importance of water and sanitation within three dimensions (social, economic, environmental) of sustainable development (para 119)
- reaffirm commitments under **MDG on access to safe drinking water and basic sanitation** (para 120)
- reaffirm commitment to 2005-2015 International Decade for Action, Water for Life
- protect freshwater ecosystem in maintaining quantity and quality

Promoting full and productive employment, decent work for all and social protection

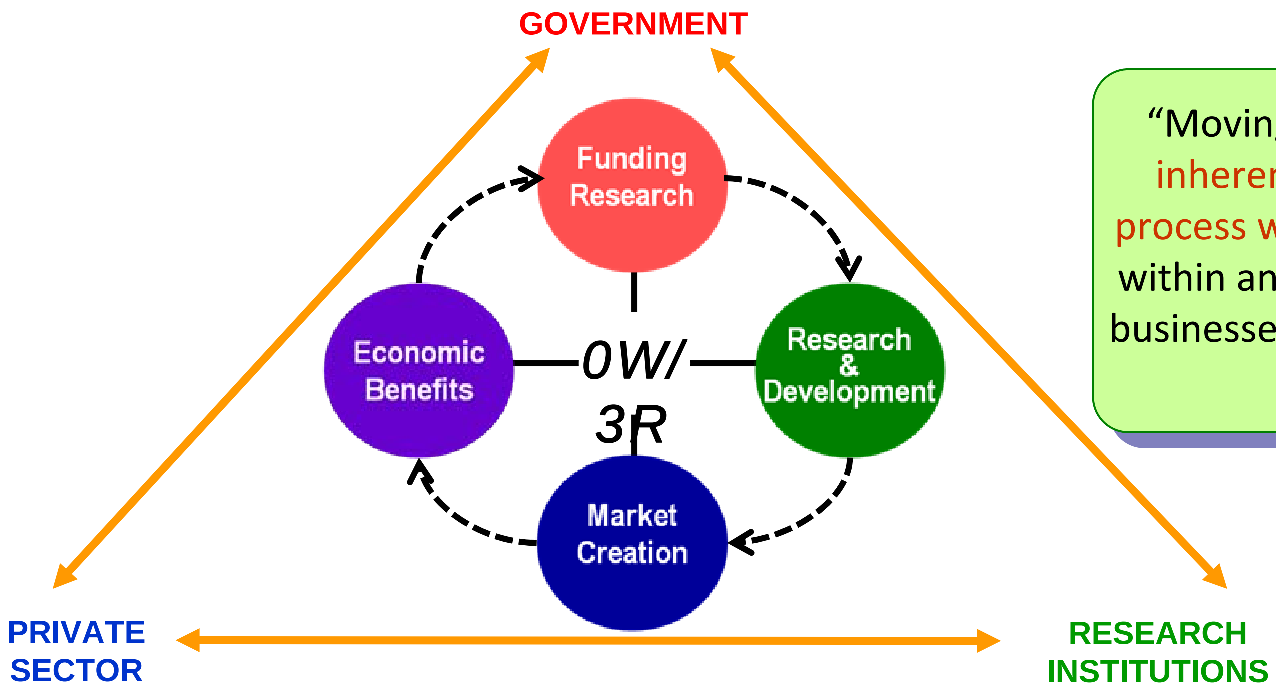
- recognize that workers should have access to education, skills, health care, social security, fundamental rights at work, social and legal protections, including **occupational safety and health, and decent work opportunities** (para 152).
- acknowledge the importance of efforts to promote the exchange of information and knowledge on decent work for all and job creation, including **green jobs** initiatives and related skills…(para 154)

There are many other key stakeholders who can play very important role in promoting resource efficiency/3Rs

National Government	Develop policies, programs, and institutions, innovative financing for resource efficiency / 3R infrastructures (eco-towns, eco-industrial parks, R&D facilities (Environment, 3Rs, Nano-Technology, IT, Biotechnology) etc.), create conducive policy framework to encourage PPPs, capacity building programs/facilities for SMEs, awareness programme for citizens, green procurement, develop and institute EPR system, foster triangular cooperation (government-private/industry-R&D/Universities) for , circular economic approach, green growth, technology transfer, information clearing house, etc.
Local Government	Integrate resource efficiency in urban development policy and strategy (energy, transport, water, industry), innovative financing for resource efficient infrastructure (eco-towns, eco-industrial parks, R&D facilities, etc.), realize PPPs, awareness programs for citizens, green procurement
Private / Industry Sector	Develop strategies to commercialize 3Rs, Environmental performance reporting, R&D (3R technologies, green products, waste recycling, waste exchange, green purchasing, PPP, in-house capacity building programs, CSR,
Banks / Financial institutions	Investment/loan schemes for eco-town projects and green industries
Scientific and Research Institutions / Universities	Provide back up for science based policy making at government level, develop dedicated R&D projects on resource efficiency/3Rs in collaboration with government and business/industry sector, create human resources and experts in the field of resource efficiency/3Rs, look for international collaboration (University-University, University-Multi-national corporation), catalyst for decision makers, technology evaluation.
Citizens / NGOs	Promote green consumerism, community awareness raising on house-hold waste segregation and its contribution to resource efficiency/3Rs, knowledge dissemination (Source: C.R.C. Mohanty, 2012)

Triangular cooperation between Government – Private – scientific/R&D institutions

- Promote recycling of waste from one industry as a resource for another (industrial symbiosis), through, for example, supporting the establishment of eco-industrial parks, science parks, and research/university networks.
- Encourage joint R&D, knowledge sharing, technology transfer among various actors (e.g., between private sector and universities).



"Moving towards zero waste is inherently a multi-stakeholder process which calls for partnerships within and between communities, businesses, industries, and all levels of government."

Conclusion: (1) Pursuing resource efficiency will help countries..

•**Tackling local environmental problems** –> in efficient use of resources lead to environmental burdens;

•**Addressing climate change** –> resource efficiency is key strategy for low carbon path by reducing GHG emissions from energy generation and use, material extraction, processing, transportation, and waste disposal;

•**Ensuring energy security** –> through energy efficiency measures, WtE;

•**Preserving natural capital and avoiding resource conflicts**

•**Improving economic competitiveness of firms and nations** –> better respond to volatility of oil prices, metal prices, etc; improvement of production process brings financial benefits to the producer as well as improvement of product quality;

•**Minimizing disposal costs by minimizing wastes** -> land fills and incinerators are very expensive methods; end-of-pipe disposal is a sunk cost with no financial return;

•**Developing new business opportunities** -> resource recovery, recycling, WtE schemes can create green jobs; biotechnology, nanotechnology, renewable energy;

•**Pursuing social benefits** ->environment industry as potential source of employment and long term natural asset protection; reducing environmental impacts from harmful wastes;

Conclusion: (2)Partnership is key to expand waste management services of local authorities that lack resources, institutional capacity, and technological know-how…

- **Partnerships** offer alternatives in which governments and private companies assume co-responsibility and co-ownership for the delivery of solid waste management services.

- **Partnerships** combine the advantages of the private sector (dynamism, access to financial resources and latest technologies, managerial efficiency, and entrepreneurial spirit, etc.) with social concerns and responsibility of the public sector (public health and better life, environmental awareness, local knowledge and job creation, etc.)

- **Partnerships** provides win-win solutions both for the public utilities and private sector—if duly supported by appropriate policy frameworks. Such partnerships could lead to savings in municipal budgets where waste management usually consumes a large portion. The private sector, on the other hand, may use this opportunity to convert waste into environmentally friendly products and energy that could also serve as income generating opportunities.

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