Reducing UPOPs and Mercury Releases from The Health Sector in Africa

Modules 24 and 25

Treatment of healthcare waste, incineration and the Stockholm Convention

UNDP

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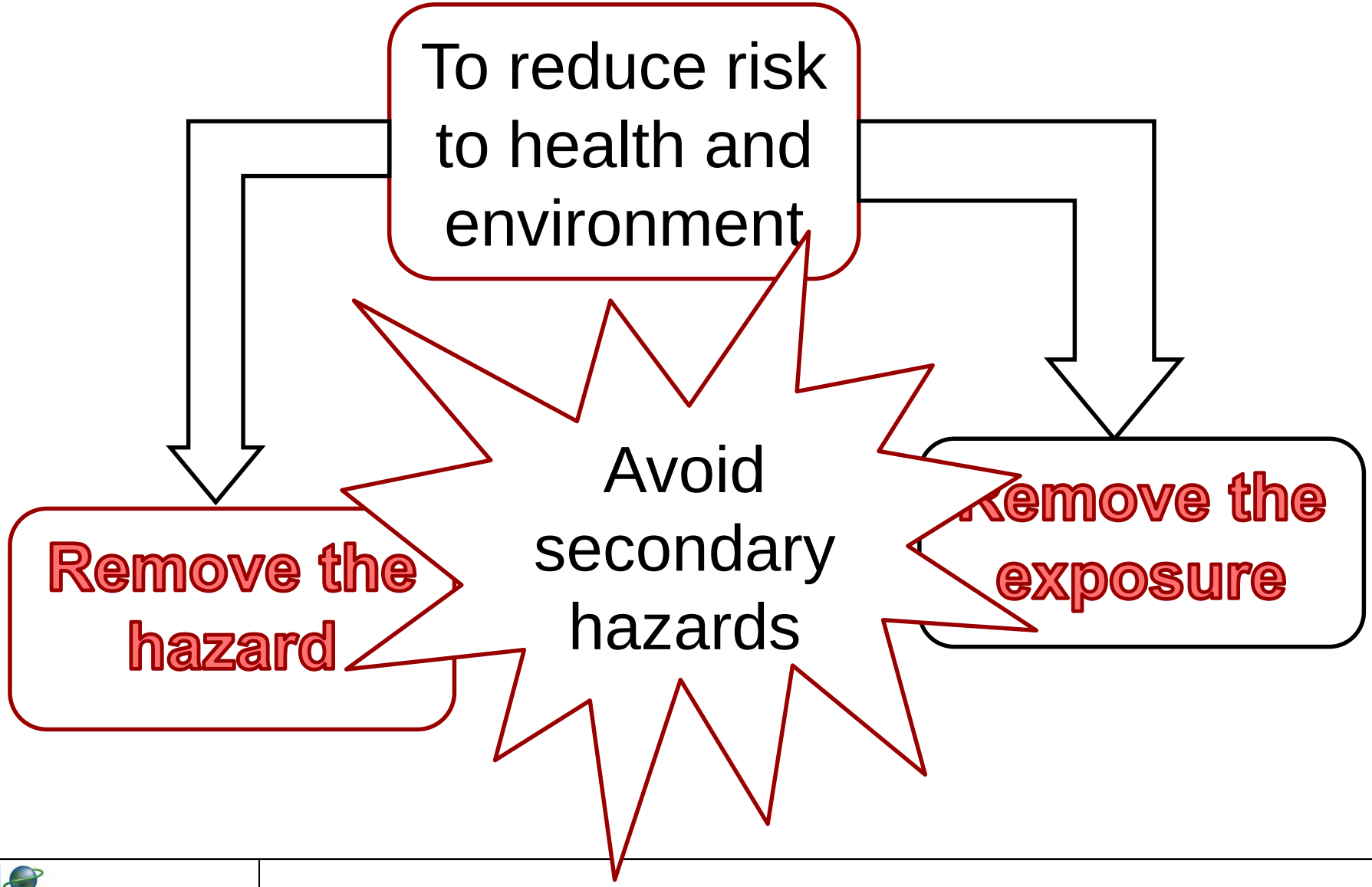
Learning objectives

- Discuss why waste is treated
- Consider the different organisational options
- Understand the Stockholm Convention guidance on healthcare waste incineration
- Compare incineration with autoclaving as the most common alternative treatment technology

Why treat waste?



Risk reduction and hurdles

Remove the hazard

- Steam treatment
- Incineration
- Needle destruction
- Chemical treatment

Remove the exposure

- Burial/landfilling
- Encapsulation/stabilisation
- Long term storage

Secondary hazards

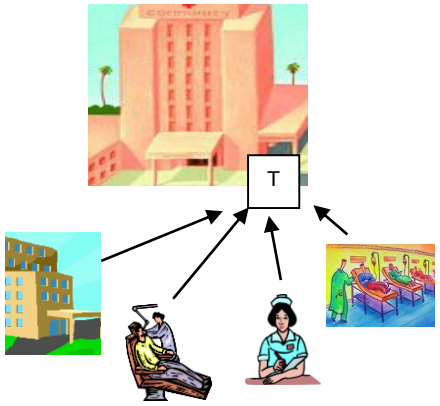
- Failure to remove hazard
- Physical hazards
- Toxic emissions
- Toxic byproducts/transformation products
- Excavation
- Spillage
- Greenhouse gases

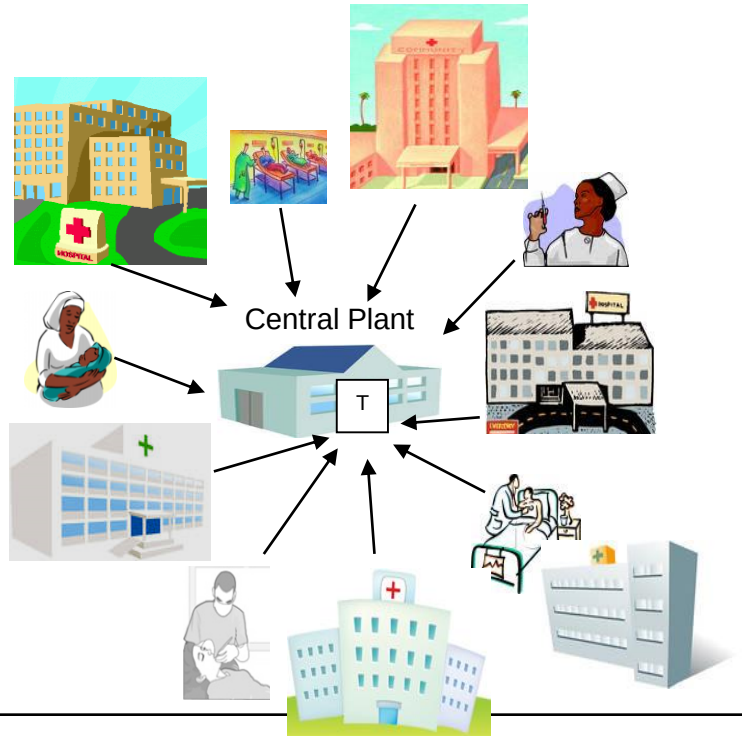
Treatment Approaches

- **On-site** - hospital treats its own waste
- **Cluster treatment** – hospital treats waste from health facilities in a small area
- **Central treatment** – dedicated facility collects and treats wastes from many health facilities in an urban center or region

On-Site Treatment

Hospital as Cluster Hub





Technology selection factors

- Regulatory acceptance
- Throughput capacity
- Types of waste treated
- Microbial inactivation efficacy
- Environmental emissions and waste residues
- Space requirements
- Utility and other installation requirements
- Waste reduction
- Occupational safety and health
- Noise
- Odour
- Automation
- Reliability
- Level of commercialisation
- Background of the technology manufacturer or vendor
- Community and staff acceptance
- Cost

Stockholm Convention and other legal instruments

Stockholm Convention:

- waste incinerators are specifically identified as potential sources of highly toxic dioxins and furans.
- guidelines on medical waste states that “priority consideration should be given to alternative processes” that do not generate dioxins and furans

World Health Organisation

- 2004 policy: scale up steam-based treatment
- Blue Book Second edition, 2014: priority for non-incineration

Basel Convention:

- 2003 Guidance: prefer steam based treatment

Human Rights Council 2011

- Substitution of incineration with alternatives wherever practicable

European definition of incineration

‘**incineration plant**’ means any stationary or mobile technical unit and equipment dedicated to the thermal treatment of wastes with or without recovery of the combustion heat generated.

This **includes the incineration by oxidation of waste as well as other thermal treatment processes such as pyrolysis, gasification or plasma processes** in so far as the substances resulting from the treatment are subsequently incinerated.

DIRECTIVE 2000/76/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 December 2000 on the incineration of waste (updated and consolidated 2008)

Stockholm Convention on Persistent Organic Pollutants

- Entered into force in 2001; ratified by 180 parties
- Is an international legally binding agreement on persistent organic pollutants (POPs):
  - “chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment”.
- Requires Parties to take measures to eliminate or reduce the release of POPs into the environment.

- Website www.pops.int

The First 12 Stockholm POPs

- **Pesticides**:
  - aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene;
- **Industrial chemicals**:
  - hexachlorobenzene, polychlorinated biphenyls (PCBs); and
- **By-products**: ”U-POPs”
  - hexachlorobenzene; polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.

New Stockholm POPs

Alpha hexachlorocyclohexane

Beta hexachlorocyclohexane

Chlordecone

Hexabromobiphenyl

Hexabromocyclododecane

Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether)

Hexachlorobutadiene

Lindane

Pentachlorobenzene

Pentachlorophenol and its salts and esters

Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride

Polychlorinated naphthalenes

Technical endosulfan and its related isomers

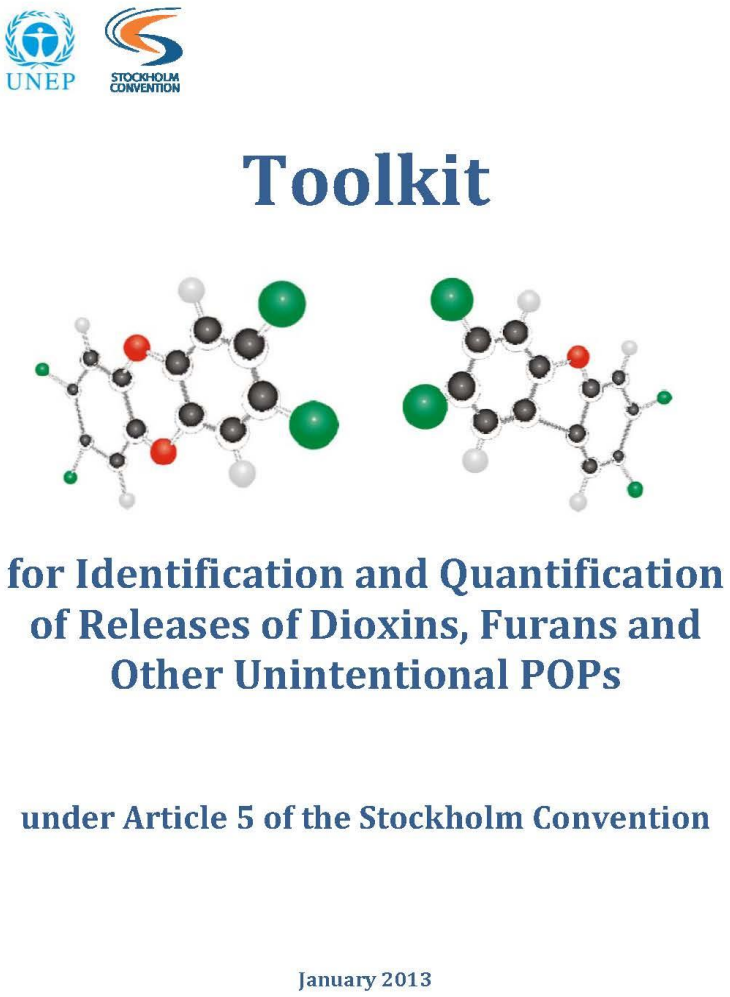
Tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial pentabromodiphenyl ether)

Implementation

Each Party is required to develop a plan for the implementation of its obligations under the Convention

Parties are required to identify, characterize, quantify and prioritize sources of releases of unintentional POPs, and develop strategies with concrete measures, timelines and goals to minimize or eliminate these releases.

http://chm.pops.int/Implementation/UnintentionalPOPs/ToolkitforUPOPs/Overview/tabid/372/Default.aspx



Stockholm BAT/BEP and incineration

- Best available techniques, including primary and secondary measures, lead to PCDD/PCDF emission levels in air no higher than 0.1 ng I-TEQ/Nm3 (at 11% O2).

- For small medical waste incinerators, application of best available techniques is often difficult, given the high costs associated with building, operating, maintaining and monitoring such facilities.

Incinerator operating and management practices

- Site selection
- Ensuring good combustion
- Regular facility inspections and maintenance
- Monitoring
- Handling of residues
- Operator training

BAT BEP

- **Best environmental practices for waste incineration**
- *Open burning of health-care wastes should not be carried out.*
- Well-maintained facilities, well-trained operators, a well-informed public, and constant attention to the process
- Effective waste management strategies (for example, waste minimization, source separation and recycling), by altering the volume and character of the incoming waste, can also significantly impact releases.

Best available techniques for incineration

- **Waste input and control**
- **Combustion**
  - Over 850ºC in general; over 1100ºC for waste containing over 1% chlorine; residence time over 2 seconds at 6% oxygen.
- **Avoiding cold starts, upsets and shutdowns**

Pollution control

Secondary measures are essential to meet Stockholm emissions guidelines

- Air pollution control devices
  - Dust removal eg electrostatic precipitator
  - Acid gas removal
  - Flue gas polishing and NOx removal

- Residue treatment and disposal
  - Bottom ash, fly ash
  - Semisolid residues
  - Effluents

Emissions estimates for small-scale incinerators

- Best practice 10 ng TEQ/Nm3
- Expected practice (improperly designed, constructed, operated or maintained units that feature afterburners): 500- 600 ng TEQ/Nm3
- Worst-case. Incinerators without an afterburner. 4000 ng TEQ/Nm3 for this simple technology.

Stockholm Convention

0.1ng I-TEQ/Nm3

Autoclaving delivers cleaner air

Pollutant	Reductions achieved through meeting MACT# (lb/yr)*	Reductions achieved through alternative disposal (lb/yr)*	Advantage alternatives- how many times more effective they are at reducing pollution**
HCl	168,000	198,000	1.18
CO	1,140	20,200	17.7
Pb	313	420	1.34
Cd	15.6	35.1	2.25
Hg	605	682	1.13
PM	3,170	89,900	28.4
CDD/CDF, total	0.0678	0.0985	1.45
CDD/CDF, TEQ	0.00145	0.00183	1.26
NOX	146,000	1,080,000	7.40
SO2	73,700	126,000	1.71
Total	**393,000**	**1,520,000**	

*USEPA Standards of Performance for New Stationary Sources and Emissions Guidelines for Existing Sources: Hospital/Medical/Infectious Waste Incinerators; Final Rule. Federal Register Vol. 74, No. 192, October 6, 2009 , Rules and Regulations, pp 51368 – 51415 - **Calculated from data in previous columns, # MACT= maximum achievable control technology

Incineration is too expensive for the USA

Based on the stringency of the HMIWI standards promulgated on October 6, 2009, sources would likely respond to the HMIWI rule by choosing not to construct new HMIWI and **would use alternative waste disposal options rather than incur the costs of compliance**.

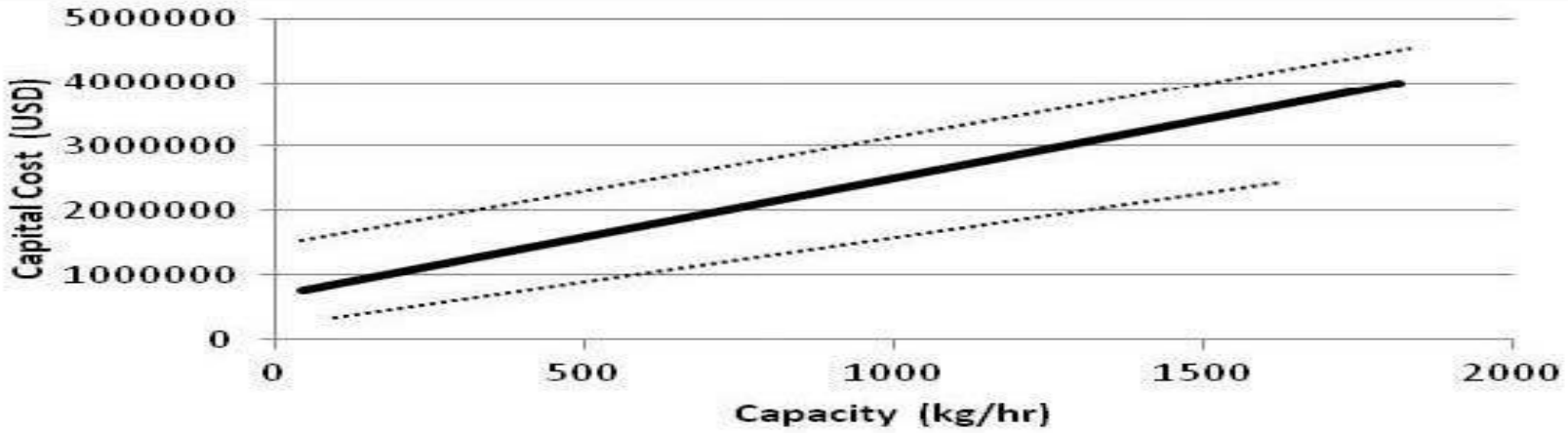
US Environmental Protection Agency Standards of Performance for

New Stationary Sources and Emissions Guidelines for Existing Sources: Hospital/Medical/Infectious Waste Incinerators. Federal Register

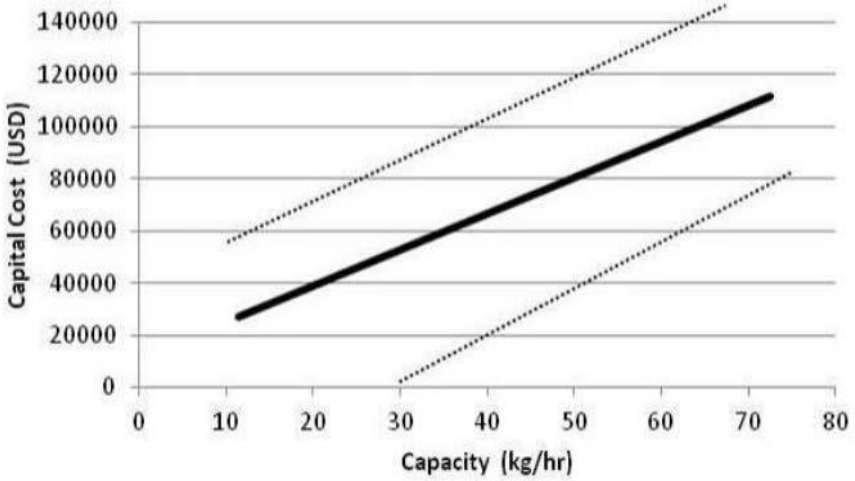
Vol. 76, No. 64 April 4, 2011, Rules and Regulations, pp 18407-18415

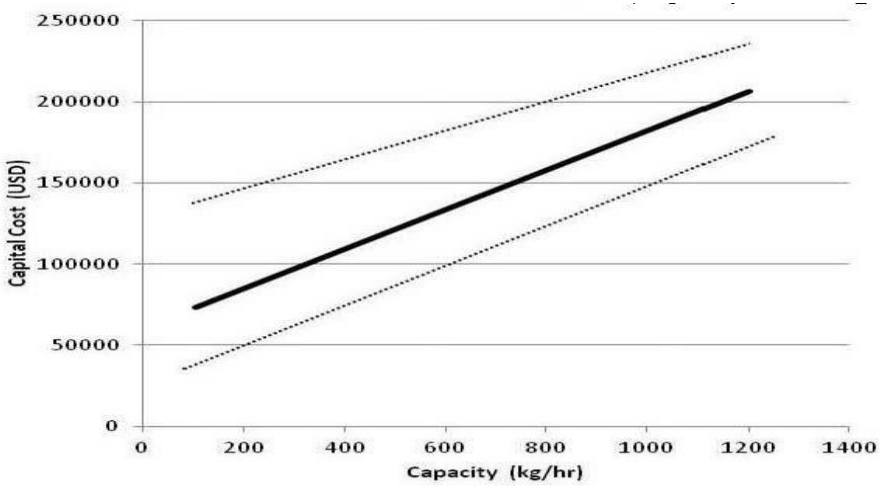
Investment costs of incineration and autoclaving

Cost of incinerator with air pollution control meeting Stockholm Convention



Cost of a waste treatment autoclave
below 100kg/hr (left hand chart) and above 100kg/hr (right hand chart)



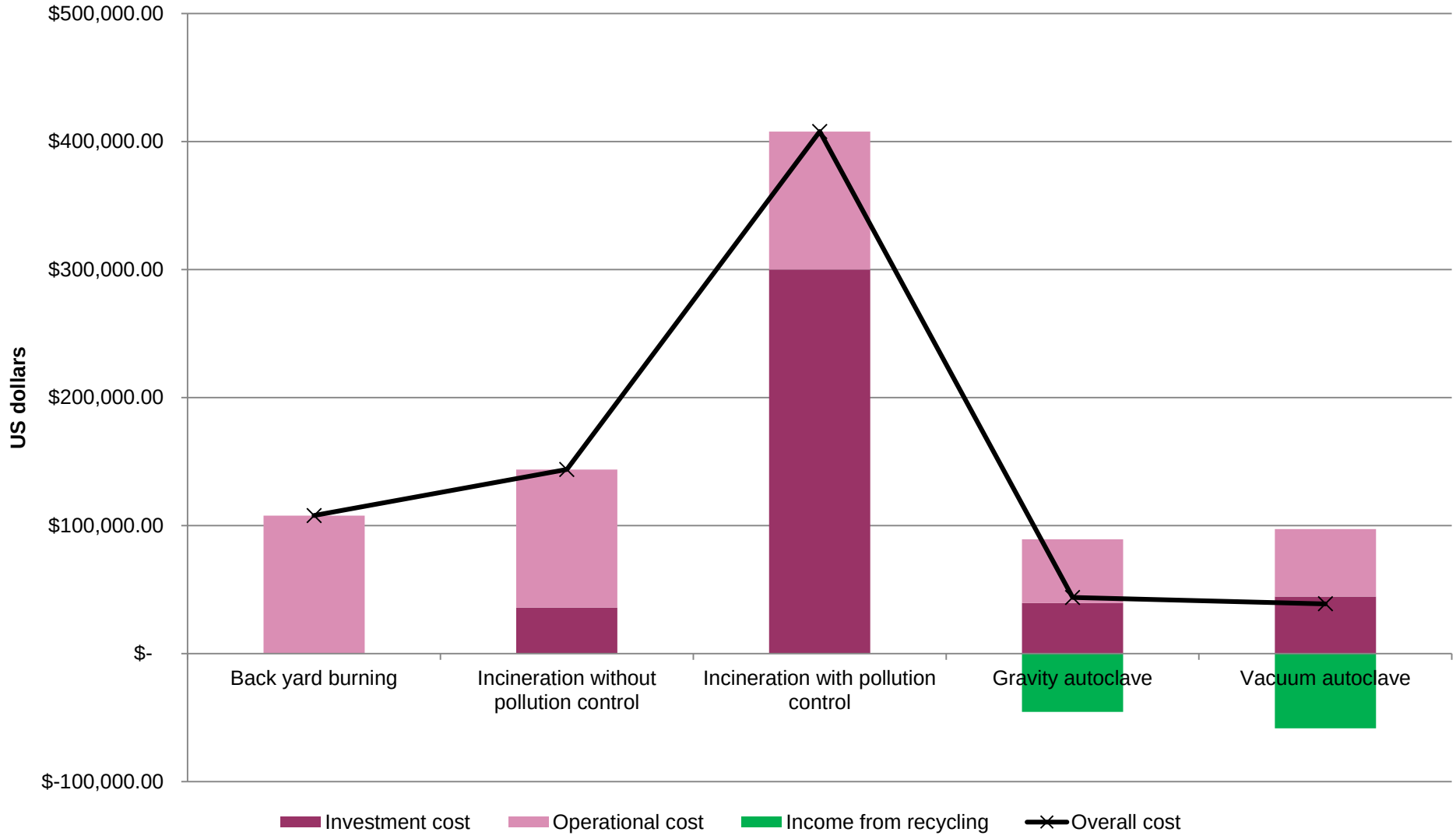


Technology operating costs

Technology	Range of Capacities (kg/hr)	Range of Operating Costs (USD/kg)
Autoclave	2 to 3600	0.14 to 0.33
Hybrid autoclave	18 to 2200	0.05 to 0.12
Continuous steam treatment	100 to 1800	about 0.15
Batch microwave unit	1.5 to 31	about 0.13
Continuous microwave unit	100 to 810	0.07 to 0.11
Frictional heating	10 to 1500	>0.13
Incinerator with air pollution control	5 to 3500	0.27 to 1.66
Alkaline hydrolysis	7 to 4500 kg per cycle	0.10 – 0.19
Chemical treatment	23 to 410	0.12 to 0.52

UNEP (2012) Compendium of Technologies for Treatment/Destruction of Healthcare Waste

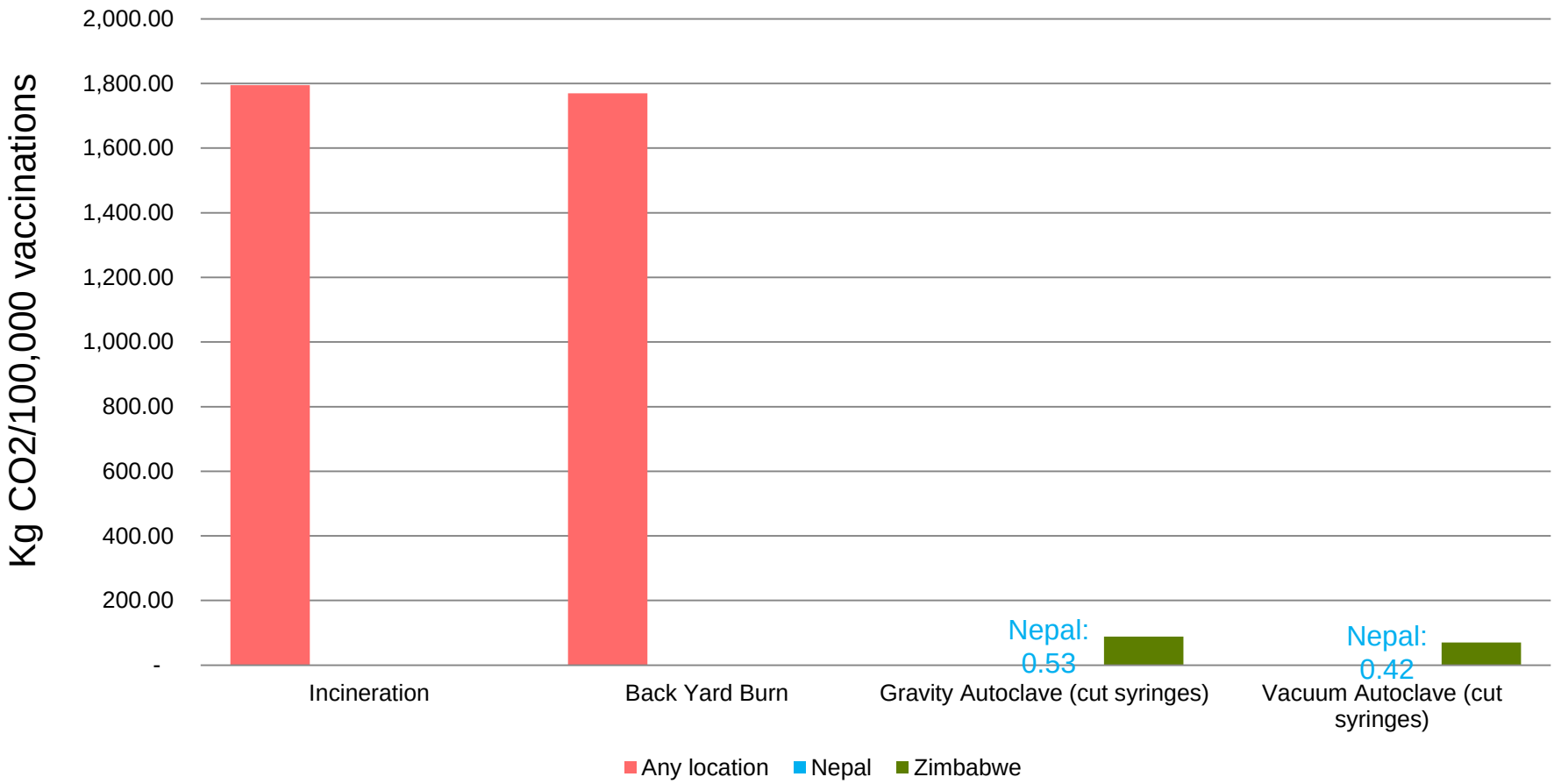
Autoclaving is cheaper than incineration



Incineration undermines recycling

- A lot of infectious waste – pathological waste, used bandages etc- is hard to burn
- A lot of recyclable materials- esp paper, cardboard and plastics burn well
- So waste is burned that should be recycled
  - Waste of resources
  - Release of carbon dioxide

Carbon footprint- burn vs autoclaving

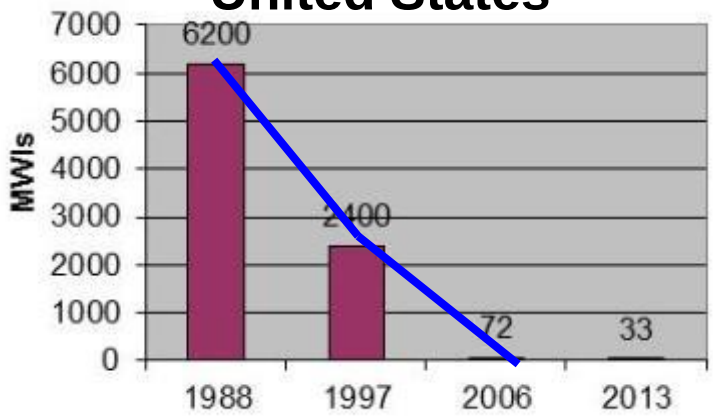


Note- Nepal mostly generates its power from hydroelectric sources, so the carbon footprint of grid electricity is very low in comparison to most countries. Zimbabwe is more typical for a low income country

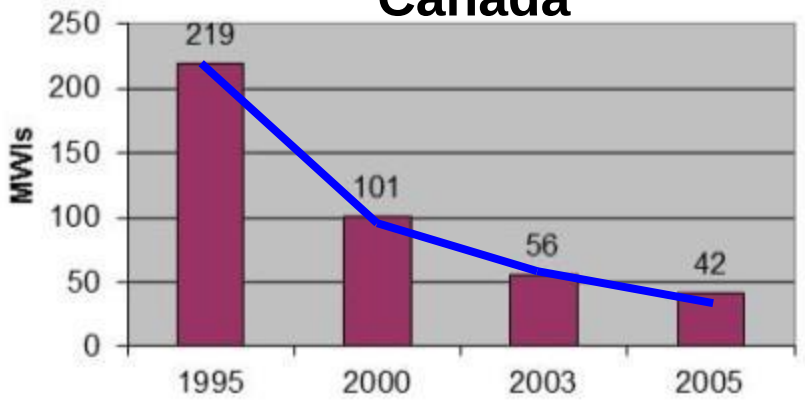
Funded by a grant from the Bill and Melinda Gates Foundation through the Grand Challenges Initiative

Closure of Medical Waste Incinerators in Developed Countries

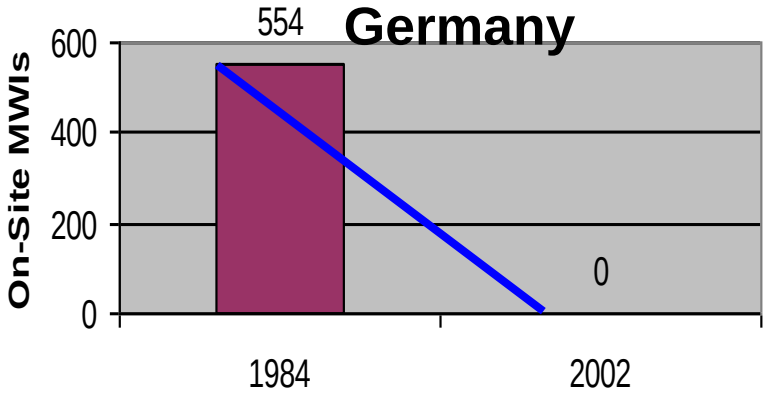
United States



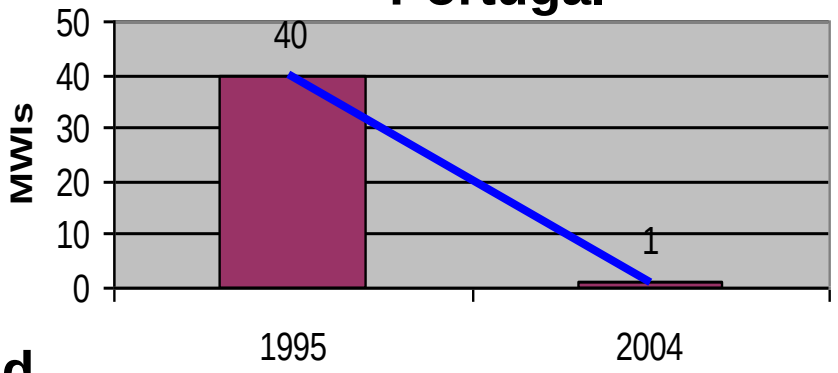
Canada



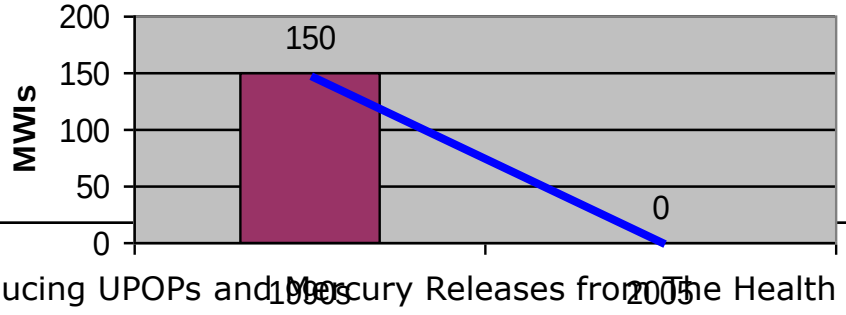
Germany



Portugal



Ireland



Conclusions

- Waste treatment aims to eliminate hazard and/or exposure
- The Stockholm Convention and other international legislation call for reduction/elimination of incineration to reduce unintentional persistent organic pollutants
- Small scale incineration is the most polluting
- Autoclaving is cleaner and cheaper
- The number of medical waste incinerators in developed countries has dropped dramatically in the last 20-30 years