



IAEA

International Atomic Energy Agency

Small Inventories – Pre-disposal Considerations

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Waste Technology Section

Background

- Many MSs have small volumes of waste generated from medical, research and industrial applications of nuclear energy
 - Often referred to as ‘institutional waste’
- However, many of these MSs do not have the established radioactive waste management capabilities to **characterize, process, store and dispose** of these small inventories

What is considered a small inventory?

Waste Generation Country Case



Types

Case	Typical Nuclear Activities
A	Radioactive waste is generated from nuclear power plants, front end and back end fuel cycle facilities, wide use of nuclear R&D facilities, and extensive nuclear applications in industry and medicine.
B	Radioactive waste is generated from nuclear power plants, wide use of nuclear R&D facilities, and extensive nuclear applications in industry and medicine. No fuel cycle facilities.
C	Radioactive waste is generated from limited use of nuclear R&D facilities, research reactor, limited use of nuclear applications in industry and medicine. No nuclear power plants, no fuel cycle facilities.
D	Radioactive waste is generated from limited use of nuclear applications in industry and medicine. No reactors, no fuel cycle facilities, no nuclear R&D.
E	Only NORM waste is generated from limited industrial applications, such as mineral extraction or oil and gas drilling. Ref: NW

Waste Generation Country Case



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IAEA perspective: Typical Scenario 1

- Current annual arisings
 - 10s DSRs (cat 3-5)
 - Cat 1-2 sources recycled/returned
- Larger stored inventory of conditioned and non-conditioned DSRs
 - Category 1-5 (usually in their original shielding)
 - Partial/full inventory (some key parameters may be missing)
 - Conditioned packages which may or may not meet current safety standards

IAEA perspective: Typical Scenario 2

- Current annual arisings
 - 10s DSRs (cat 3-5)
 - Cat 1-2 sources recycled/returned
 - 1-2 drums of institutional type (compactable) waste
 - A few litres of liquids
- Legacy trench-type storage facility
 - Incomplete inventory
 - Mix of conditioned and non-conditioned DSRs and waste

Other Typical Small Inventories



NORM

NORM residues from processing groundwater
Contaminated pipes and vessels
Mining and mineral processing waste



Facility Decommissioning

Surface contaminated metal and concrete
Relatively small volumes of aqueous and organic radioactively contaminated waste
Contaminated soil and/or land



Reactor Decommissioning

Ion exchange resins
Spent fuel pond water
Sludges
Large components
Activated components
Surface contaminated metal and concrete
Contaminated soil and/or land

Small Inventory Challenges

-  No plan to implement policy*
-  No defined end-goals*
-  Lack of human resources
-  Insufficient financial resources
-  Access to technologies*
-  No disposal concept
-  No waste acceptance criteria*

*Ongoing IAEA activity

Small Inventory Challenges cont.



No single responsible waste management organization



Incomplete inventory*



No waste processing and storage facility



Multiple sites with small volumes



Lack of know how to source 'fit-for-purpose' cost effective waste management solutions



Low volume annual waste arisings with one/two challenging legacy waste inventories/facilities^{TC}



Reactor or facility decommissioning*



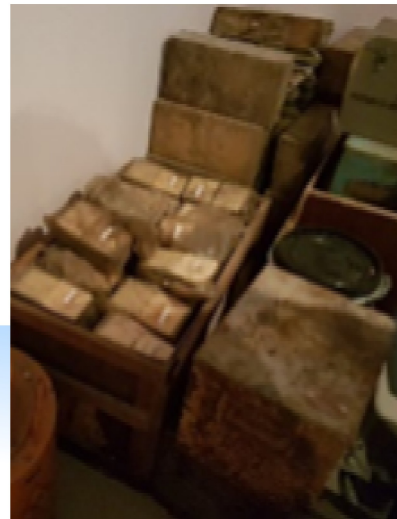
"Legacy" and "one-of-a-kind" waste inventories*

*Ongoing IAEA activity^{TC}
IAEA TC projects

'Legacy Waste'*

Waste from past activities includes:

- Waste that does not have an identified route for disposal
- Waste that does not have a predisposal concept and/or defined waste acceptance criteria
- Waste that is conditioned, stored or disposed of in a form that does not comply with the current regulatory requirements



RWM in the Future.....



- **Life-cycle radioactive waste management planning begins before any waste is generated**
- **Waste hierarchy principles** are adopted (avoid, minimize, recycle, reuse, dispose) to **minimize waste** going to disposal
- **End-of-life plans** are in place for all new sealed sources (i.e. **recycle, return, disposal**)
- All waste is **characterized** at the **point of generation**

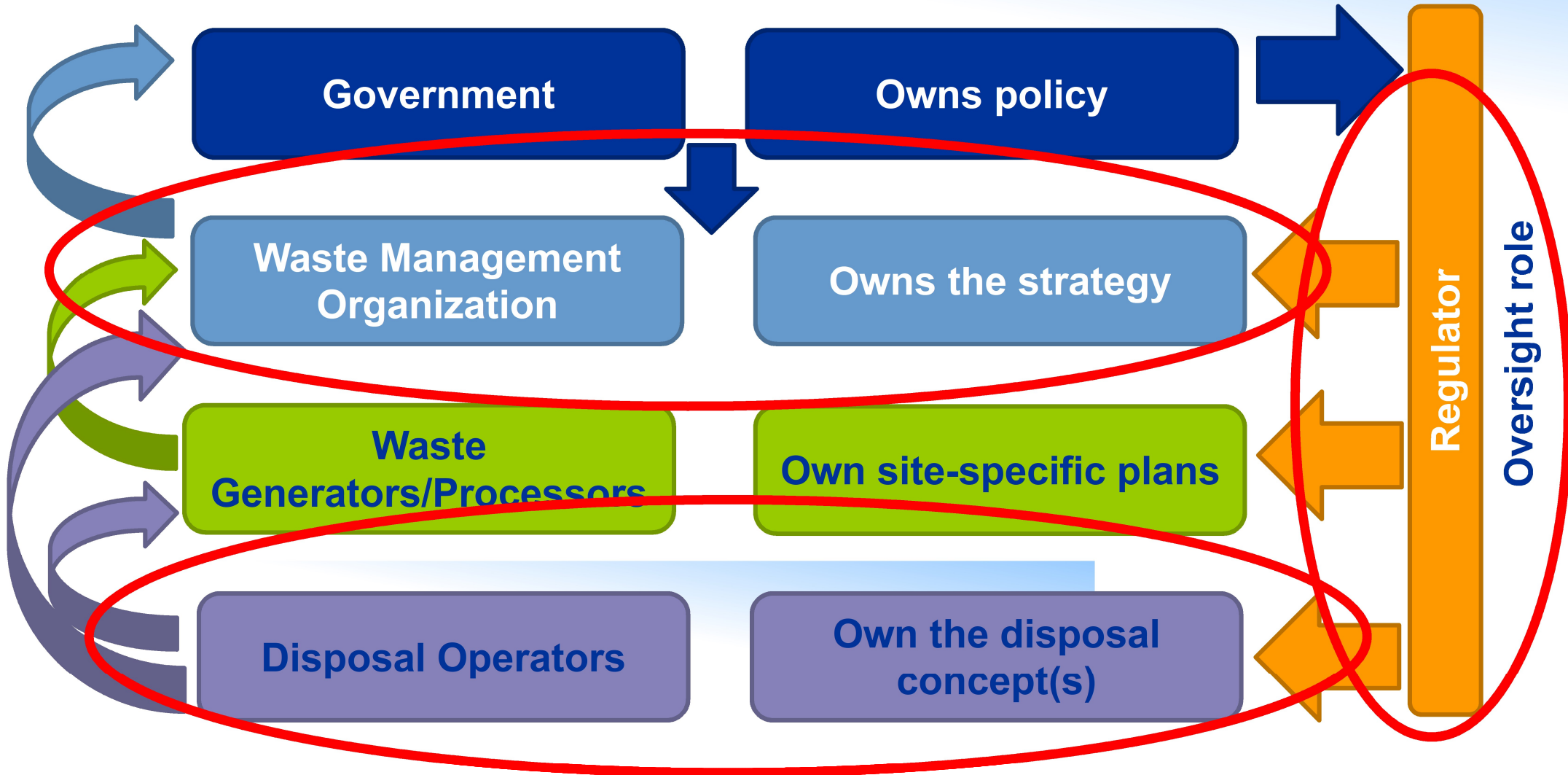
*Ongoing IAEA activity – Integrated Waste Management Plans

IAEA Predisposal Vision

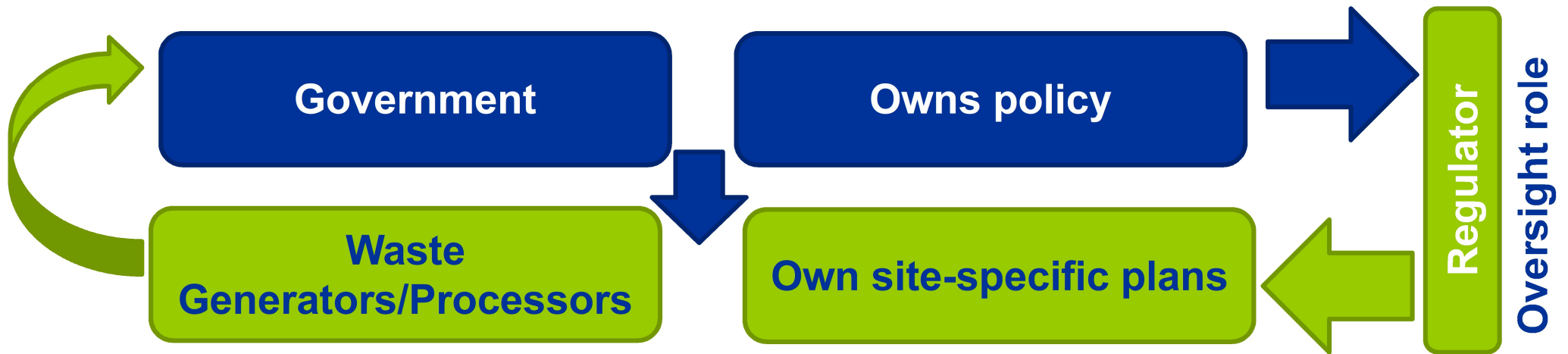


- Key is **identifying viable pathways** to move all waste towards disposal while maintaining **flexibility** for future decisions regarding the end-point – disposal is preferred but if not feasible at this time, **storage of well characterized, stable waste packages in a way that maintains flexibility** to comply with **future disposal concepts**

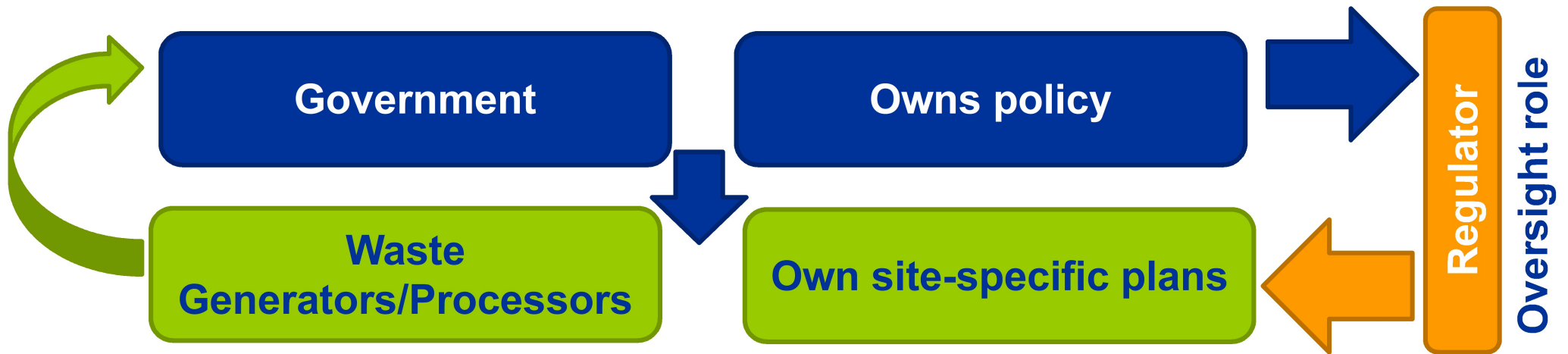
Policy, Strategy & Planning



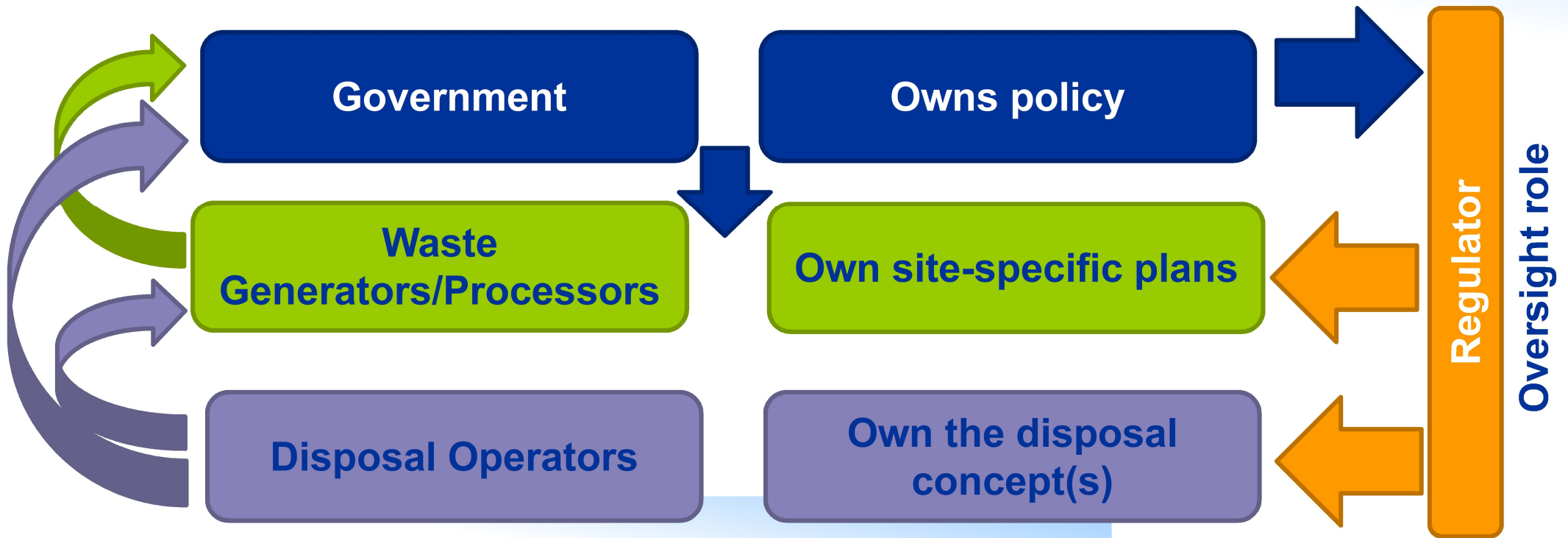
Small Inventory Member States (1)



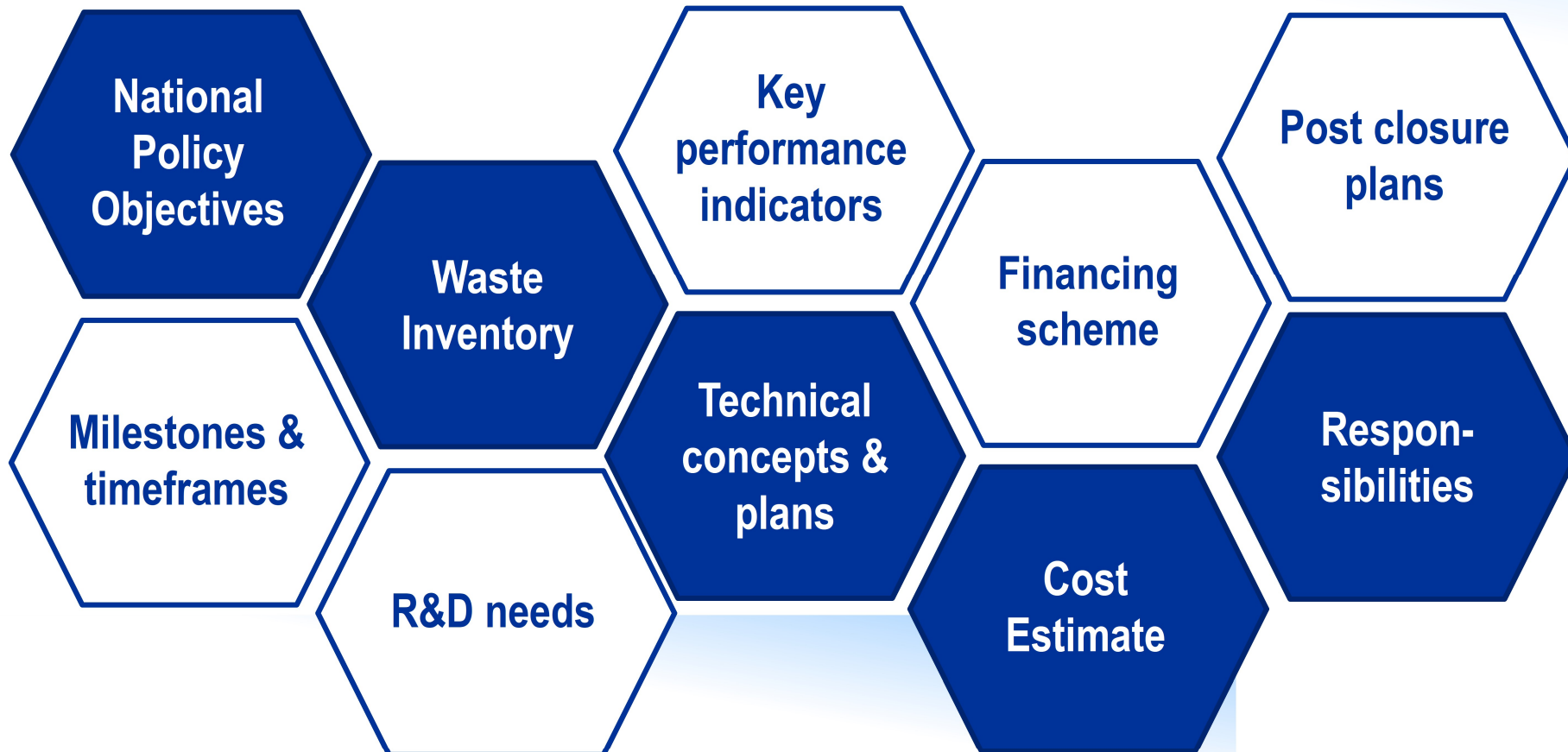
Small Inventory Member States (2)



Policy, Strategy & Planning (3)



Elements of an Integrated RWM Plan



Radioactive Waste Management Plan



*Ongoing IAEA activity – publication Establishment of Waste Inventory

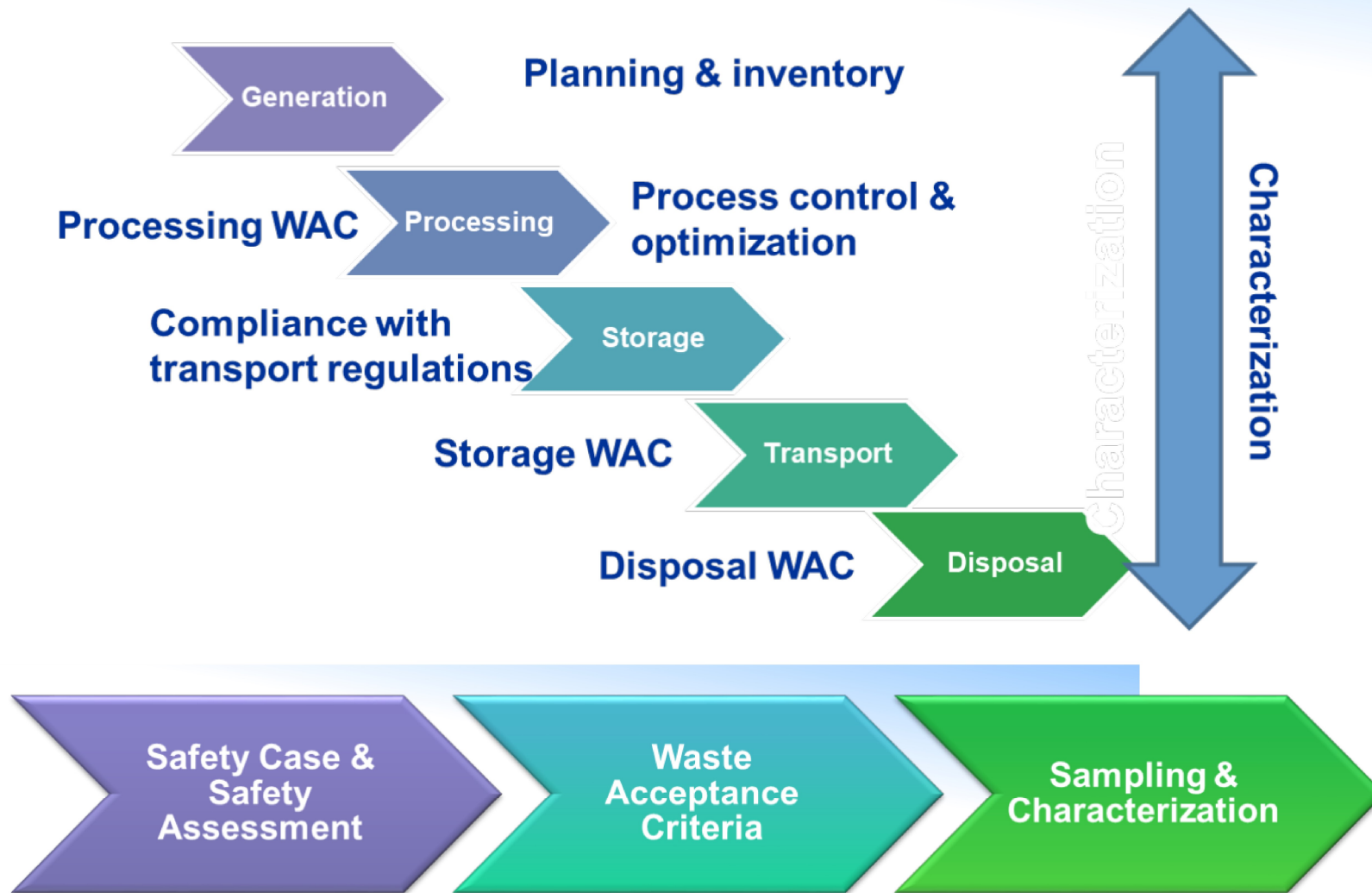
Cradle to Grave RWM



Waste Optimization*

*Ongoing IAEA activity – Waste Optimization during NPP operations

Role of Characterization in RWM



Opportunities for Cooperation: Waste Acceptance Criteria



Comparison and benchmarking of existing waste acceptance criteria



Disposability assessment and analysis of approaches to moving to storage in the absence of WAC*



Good practices/lessons learned inventory/waste acceptance criteria

Prohibited constituents, minimization toxic components (steel vs. lead), organic materials, liquids etc.

*Ongoing IAEA activity – publication on Waste Acceptance Criteria

Opportunities for Cooperation: Implementation



- Training, mentoring, secondment^{TC}
- Ageing management strategies and practices for stored waste
 - Including strategies for maintaining trained human resources during long-term storage
- What services do you ‘buy in’ vs. maintain ‘in house’
- Sharing of predisposal good practices*
 - at least to the level of an ‘intelligent customer’
- ^{TC} IAEA Technical Cooperation projects
* IAEA predisposal Handbook series
Information/knowledge management over long periods of time

Opportunities for Cooperation: Characterization



**Characterization
methods and
techniques to
establish inventory**



**Characterization
methods and
technologies for
clearance and
exemption**



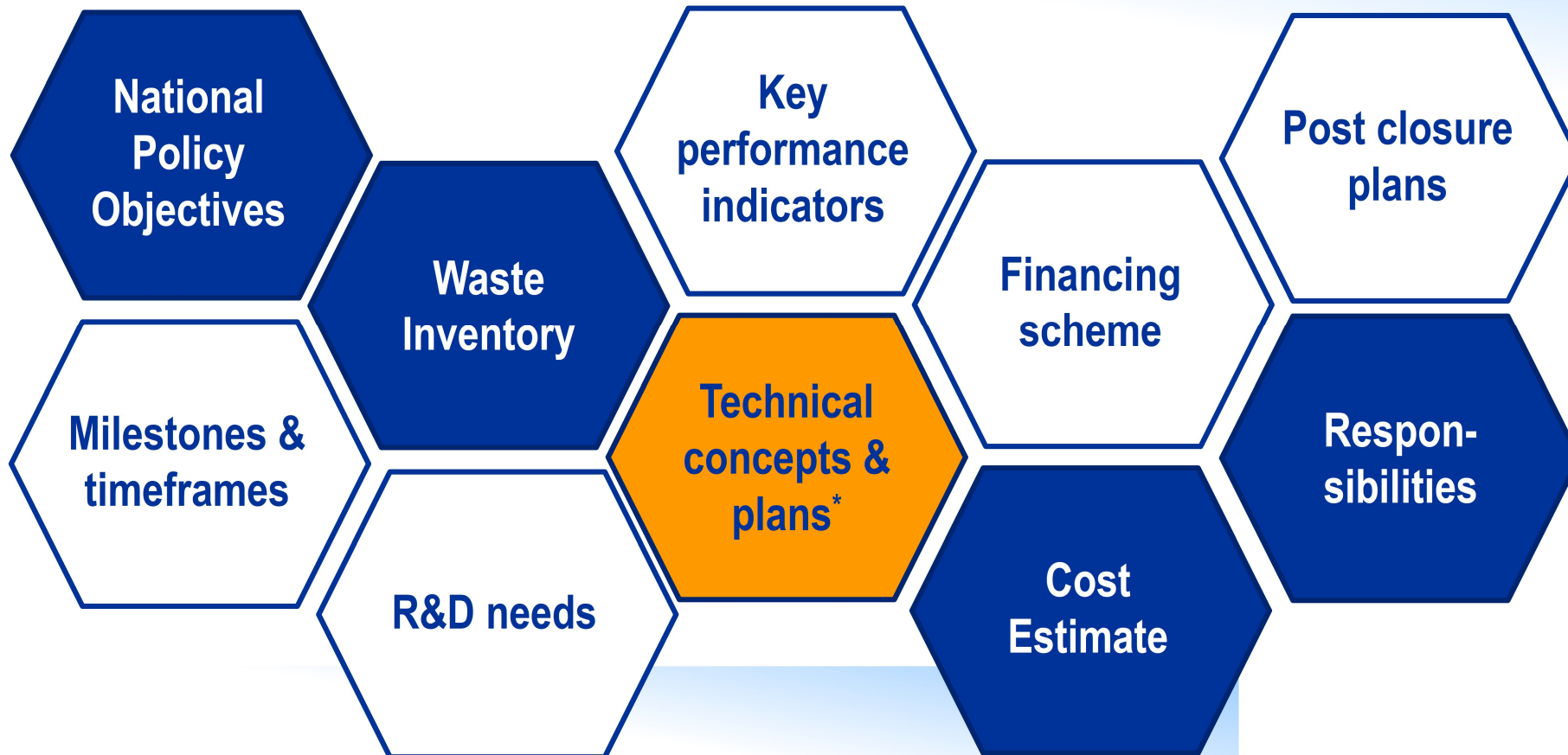
**Characterization
methodologies and
approaches to meet
WAC (radionuclides
& hazardous
components)***



**Compilation of
characterization
services**

*Ongoing IAEA activities – “Characterization Handbook”, LABONET network and RWM wiki articles on characterization methods, technologies and sampling

Elements of an integrated waste strategy



*Ongoing IAEA activities – publications – Predisposal Handbook series, Integrated Waste Management Planning

Waste Processing/Storage Options

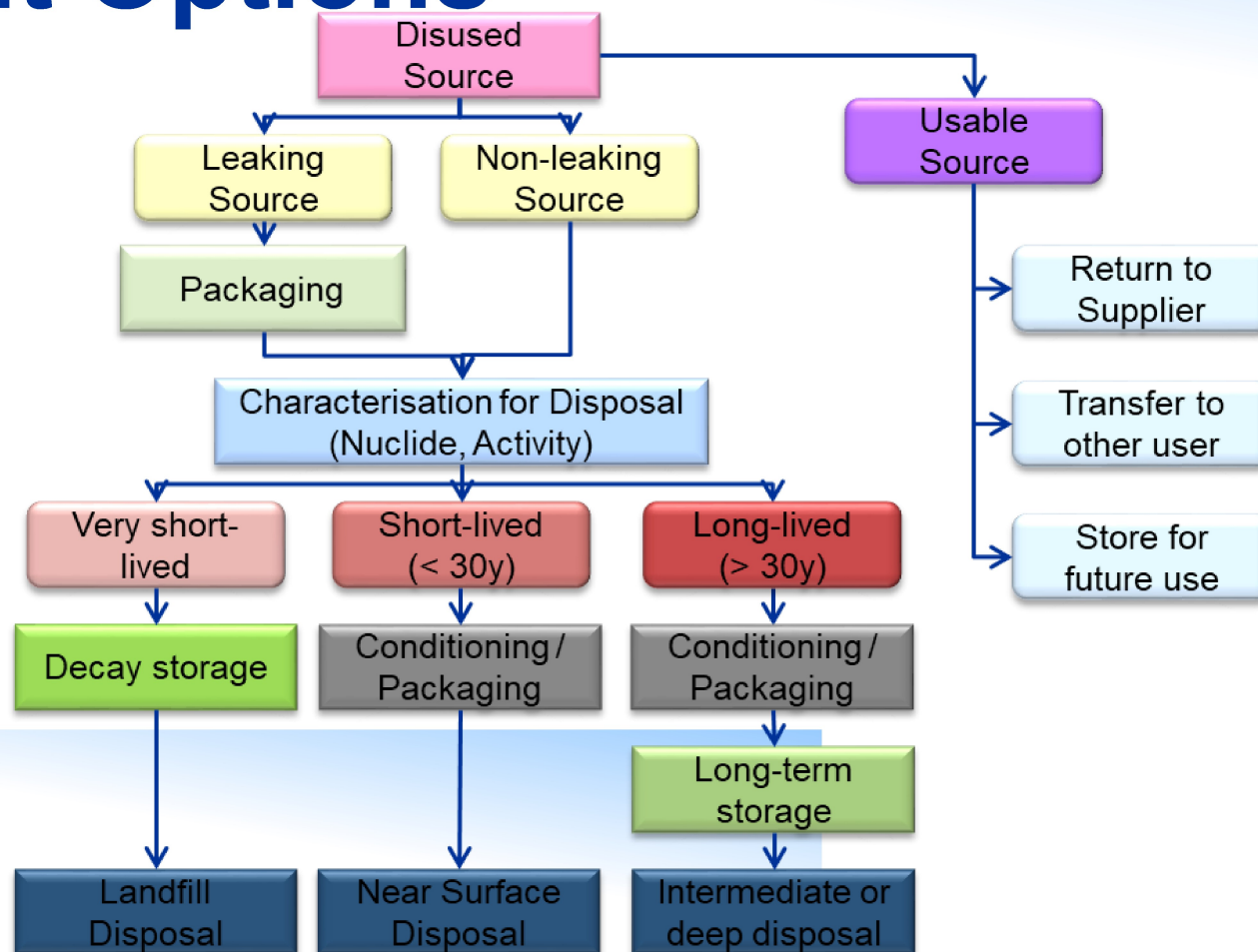


- On-site facilities – situated at the location where the waste is generated
- Centralized facilities
 - Involves transportation of waste
 - Benefits from economies of scale
- Modular facilities*
 - Processing/storage modules developed off-site
 - Alternative to centralized facilities
- Mobile units*
- Turn-key solutions^{TC}
- International waste processing

*Existing IAEA guidance

^{TC} IAEA Technical Cooperation Projects

Disused Sealed Radioactive Sources Management Options



Waste Processing Options



- Solid Treatment Technologies**
- Low force compaction
 - Supercompaction
 - Incineration
 - Metal melting
 - Pyrolysis

- Liquid Treatment Technologies**
- Ion exchange
 - Filtration
 - Precipitation
 - Evaporation

- Immobilization**
- Cement
 - Geopolymer
 - Polymer
 - Ceramic
 - Vitrification

Packaging

Overpack



Centralized Processing & Storage Facilities

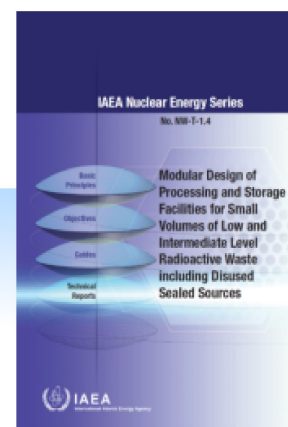
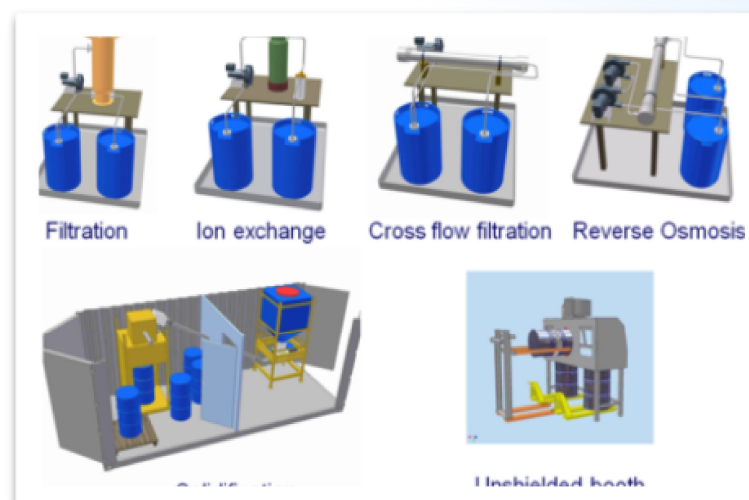
Nuclear Engineering Siebersdorf



Photos courtesy of NES, Austria

Modular Designs for Small Volumes

- Ideal for small waste quantities
- Flexible size & configuration
- 11 pre-designed modules that can be assembled & factory-tested off-site before being transported to waste processing/storage site
- **Processing modules** available for:
 - High & low volumes of liquid waste
 - All types of solid waste:
 - compactable & non-compactable
 - Sludges, ion-exchange resins, DSRS
- Can be **combined** to form an integrated process scheme
- **Storage modules** are available for all types of LLW packages/DSRS and sizes of inventory



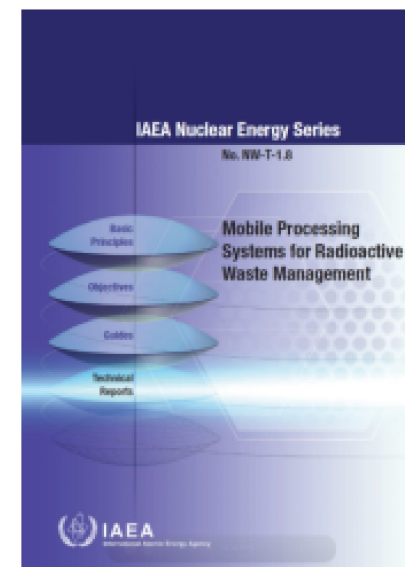
Mobile Processing Systems

Key benefits:

- Lower capital cost
- Alternative to centralized facilities
- Easy replacement
- Shared use
- Useful for small volume streams
- Potential to cross borders
- Disposability
- Ability to schedule processing campaigns

Common uses:

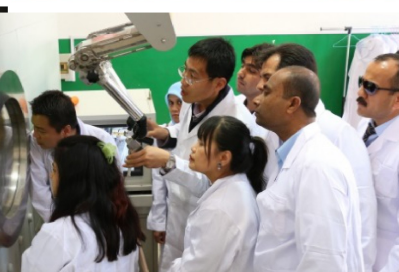
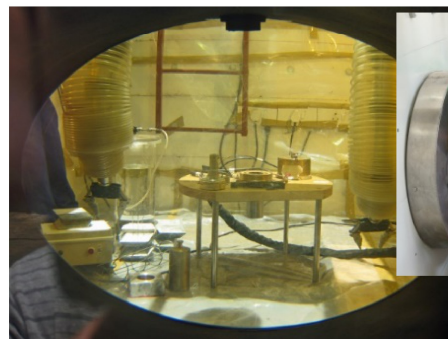
- Smaller volume, problematic waste streams
- Accident/urgent response situations
- Decommissioning & remediation



Cat I-II DSRS conditioning

Mobile Hot Cell (MHC) – used to remove and condition high activity sources in devices

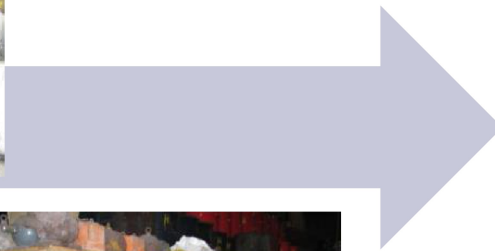
- Used in all TC regions, nationally, and regionally
- Sources from both medical and industrial applications
- Following MS request
 - MHC shipped to location where disused sources have been assembled
 - Trained operators use remote manipulators to repackage sources into long term storage capsules
 - Capsules placed in shielded long term storage containers
- Training courses provided for operations and management of sources



Design/build contract with on-the-job training



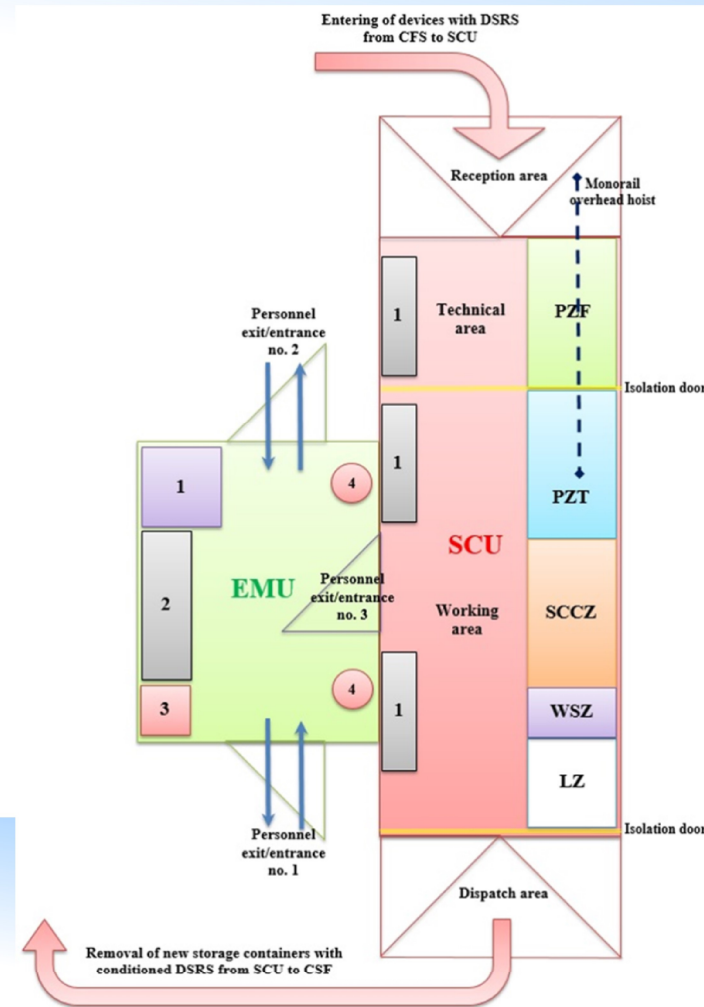
Through the IAEA Department of Technical Cooperation, the Agency facilitated a multimillion dollar project between the Agency, the European Union, the United States, the Serbian government and a radioactive waste management contractor to design a retrieval & processing facility. The stored waste will be processed & moved to the new storage facility by the contractor working alongside the licensed site operator.



Turn-key Contract^{TC}

- Contract let for design/build of predisposal facilities at counterpart's site
- Waste and DSRS processing performed by local resources

^{TC} Ongoing TC national projects



International Waste Processing



Opportunities for Cooperation

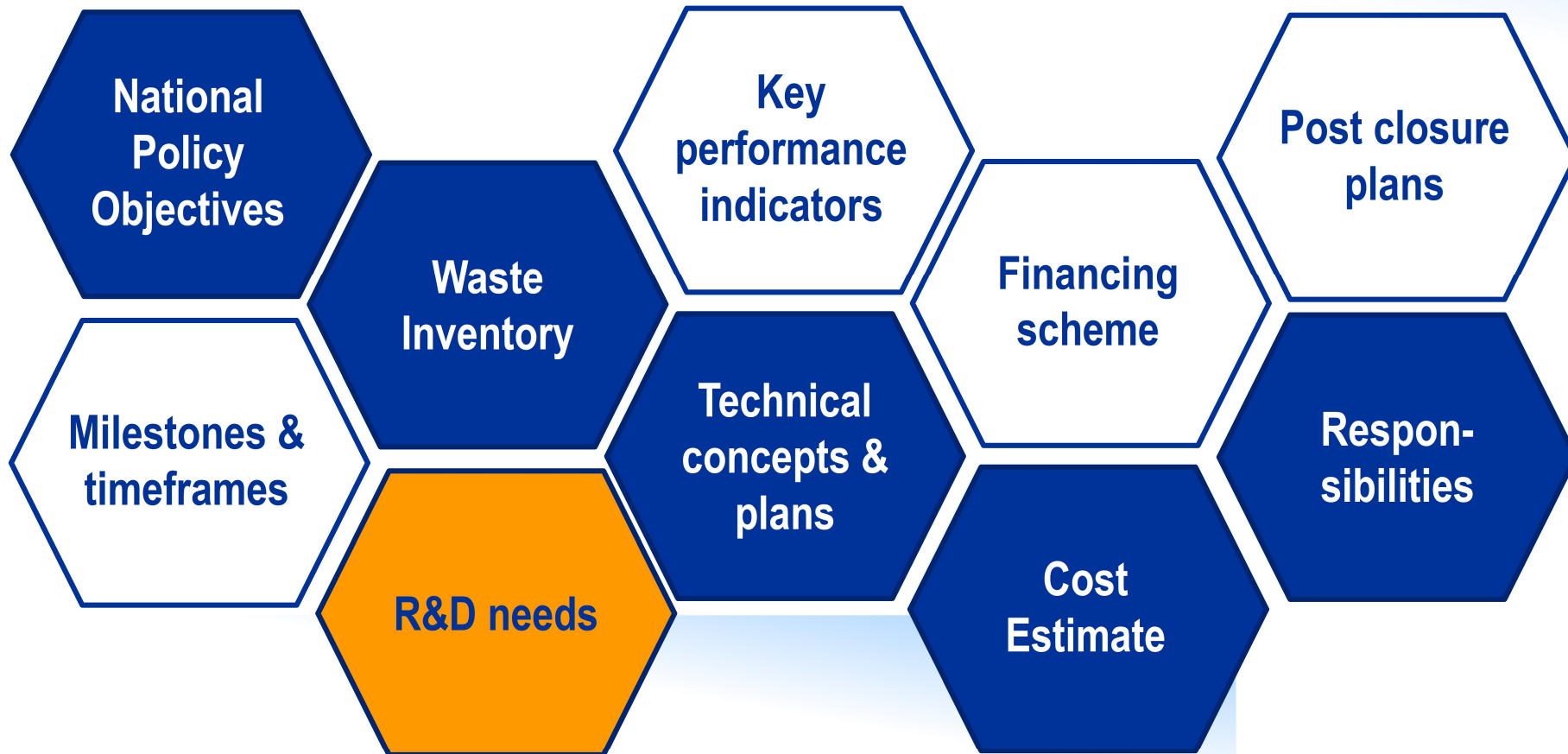


- Mapping available waste processing services within Europe
 - What is available
 - What organizations are willing to share service
 - Gaps – opportunities for ‘new company’
 - People
 - Technologies
 - Services
- How to manage peaks and troughs in resource needs

Opportunities for Cooperation

- Regional ‘processing hubs’
 - DSRS: dismantlement & conditioning*
- Catalogue of qualified available services
 - Mobile services
 - Characterization
 - Processing
 - Design engineers – small companies
 - E.g. shielding calculations, safety case, safety activity assessment, pre-feasibility studies
- Reference designs

Elements of an integrated waste strategy



Small Inventory Challenging Waste Types



- Radioactively contaminated organic liquids
- Previously conditioned waste
 - Cemented waste and DSRSs
- Decommissioning
 - Be reflectors, activated aluminum, irradiated graphite
- Ion exchange resins
- Cellulosic and organic material (e.g.PCBs)
- HEPA filters NORM contaminated pipes and

Conclusions

- Principle steps of pre-disposal management are independent of the size of the waste inventory
 - Scalable technical solutions exist
 - Options for **accessing technologies/solutions** are becoming more established
- Strong driver for national and international cooperation & sharing in the area of pre-disposal
- IAEA continues to provide guidance targeted



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Thank you!

