Studsvik

Comments on Blending of Low-Level Radioactive Waste (NRC-2009-0520)

December 14, 2009

Studsvik Pedigree

- Studsvik founded in 1949
  - Began as a branch of the Swedish government to develop, build and operate nuclear power plants in Sweden
  - Early years, specialized in nuclear research, specifically uranium production and fuels and materials technology
- Since those formative years
  - Has diversified its international holdings to become a full-service nuclear company with over 1,200 employees and a presence in the US, UK, Germany, Sweden, France, and Japan
  - Is the world leader in minimizing through processing technologies the amount of waste presented for disposal

Studsvik Commitment to Sustainability

- Basic tenets of a sound environmental policy and the cornerstone of Studsvik's business
  - Reduce
  - Reuse
  - Recycle

Studsvik's Position on Large Scale Downblending

- Just as Depleted Uranium & the importation of Foreign Waste, Large Scale Downblending is one of the most significant policy issues facing the Nuclear Industry today.
- We believe the NRC should set forth clear guidance that
  - Is consistent with stakeholder expectations
  - Ensures the safety of the public
  - Is protective of the environment
  - Is consistent with NRC policy on volume reduction
- "NRC considers it desirable that licensees reduce the volume of low-level radioactive waste generated and **shipped** to commercial waste disposal sites. Such action would:...1/ Extend the operational lifetime of the existing commercial low-level disposal sites; 2/ alleviate concern for adequate storage capacity if there are delays in establishing additional regional sites; 3/ reduce the number of waste shipments."*

*NRC Policy Statement on Low-Level Waste Volume Reduction - 16 October 1981

Clarifications to November 30, 2009 Federal Register Notice

- Generators do not have to store waste onsite
- Many generators have elected to send their waste to Studsvik where it is volume reduced and subsequently sent to WCS for interim storage

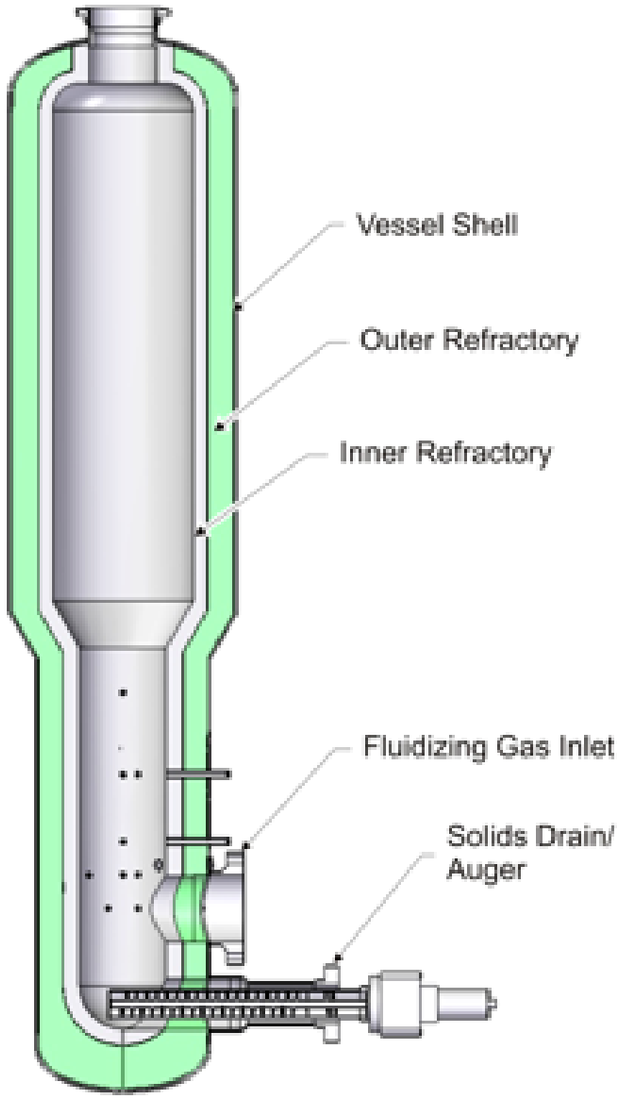
Steam Reforming Technology

- Common industrial process
- Gas passes through a bed of granular solids at sufficient velocities to suspend the solid bed media and cause it to behave as though it were a fluid
- Used for more than 50 years in a variety of industries
  - Biomass gasification
  - Syngas production (coal gasification)
  - Metal reduction
  - Pharmaceutical industry
  - Petroleum refineries (catalytic cracking to produce gasoline/petrol)
  - Chemical industry (rubber, vinyl chloride, styrene)
  - Pulp and paper industry

PCLA #1
1st catalytic cracking fluid bed in USA (1942)

Steam Reforming Technology

- Uniform reactions and consistent product due to:
  - Homogeneous waste form
  - Better gas-solid contact than other processes
  - Uniform temperature gradients
- Very high heat transfer coefficients, so more efficiency
- High efficiency due to continuous operation
- Highly predictable
- Highly reliable
- High degree of control



THOR® Steam Reformer
for DOE Savannah River Site
Tank 48H Treatment

THOR® Steam Reforming: Process Applications

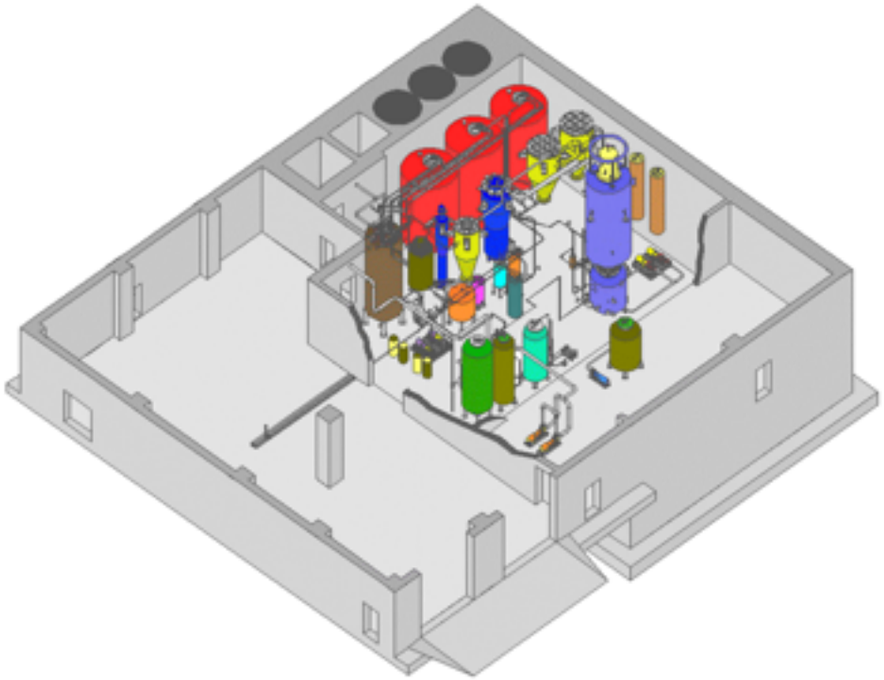
- Studsvik Processing Facility:
  - 10 years of LLRW operations
  - Ion Exchange Resins, Paper, Plastic, Oil, Filters
- DOE-Idaho: Integrated Waste Treatment Facility
  - Under construction
  - Nitrate Slurry: RH-TRU
- DOE-Savannah River SC: Tank 48H Treatment Facility
  - Design underway
  - Nitrate Waste: High Level Waste

Studsvik's THOR® facility in Erwin, Tennessee

Studsvik's THOR® facility meets all air permit and emissions limits

Studsvik's Fluidized Bed Treatment: THOR® Process – Resin Treatment Using Steam

- Extremely high radionuclide retention
  - ^{137}Cs >99.99% retained in product
  - ^{60}Co >99.99% retained in product
- >9600 m^3 (~350,000 ft^3) processed
- ~81,000 ft^3 disposed (VR=~5)
  - Saved 319,000 ft^3 disposal
- >3,000 incoming LLW shipments
- >4.7 x 10^9 MBq (126,000 Ci) processed
- Incoming LLW resin contact dose rates up to 10 Sv (1,000 R/hr)
- Over 10 years of operation



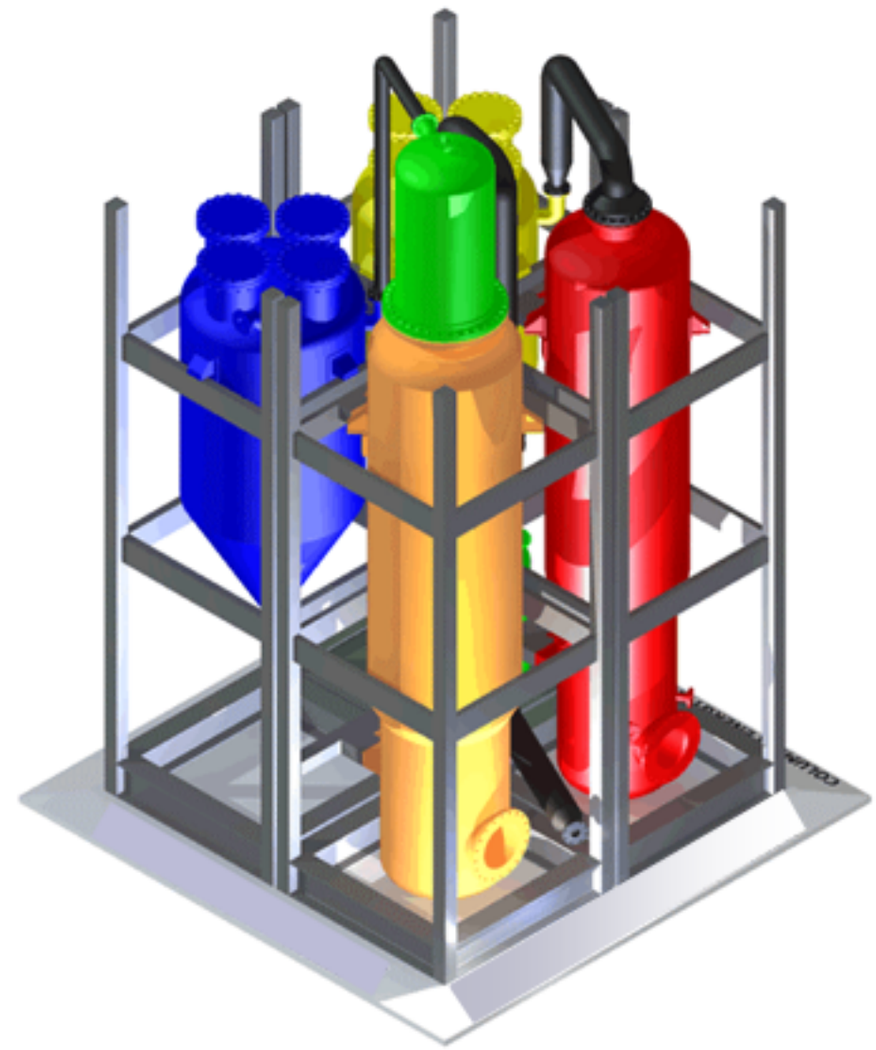
DOE Idaho Cleanup Project
THOR® Integrated Waste Treatment Unit

- THOR® treatment of ~3.8 million liters of Sodium Bearing Waste (SBW: sodium nitrates, RH-TRU, ~100 R/hr)
- SBW generated from spent nuclear fuel solvent extraction process systems
- THOR® plant construction underway
- Treatment to start 2011-2012

Integrated Waste Treatment Unit Construction
at DOE's Idaho Site

DOE Savannah River Remediation Tank 48H - THOR® Process

- THOR® treatment of ~1 million liters radioactive high-level liquid waste in Tank 48H (sodium nitrate, >100 R/hr)
- Complex nitrate mixture with ~21,800 kg organic tetraphenylborate
- Two separate independent technical review teams selected THOR®
- Integrated pilot plant tests complete
- Detailed design for full-scale plant underway



Design of Treatment Module for Tank 48 Waste

THOR® Process - Resin Waste Form

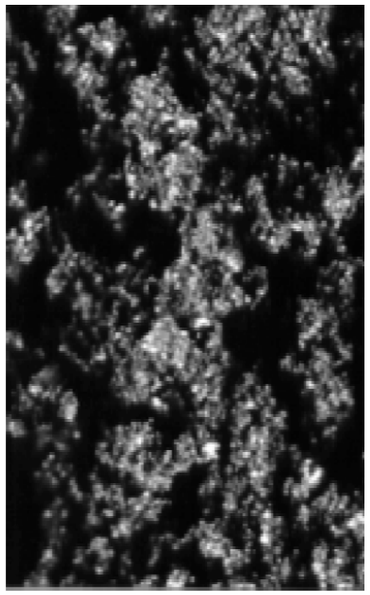
Organic Resin

Powdered and Bead Ion Exchange Resins

- Organics
- Metals
- Water
- Salts

Heat + Aluminum Additive →

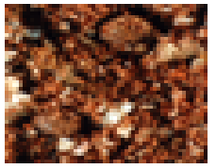
Pyrolyzed Resin



- Fixed Carbon
- Aluminum Salts
- Metal Oxides
- Metal Spinels

Heat + Oxygen from Superheated Steam →

Reformed Resin Residues

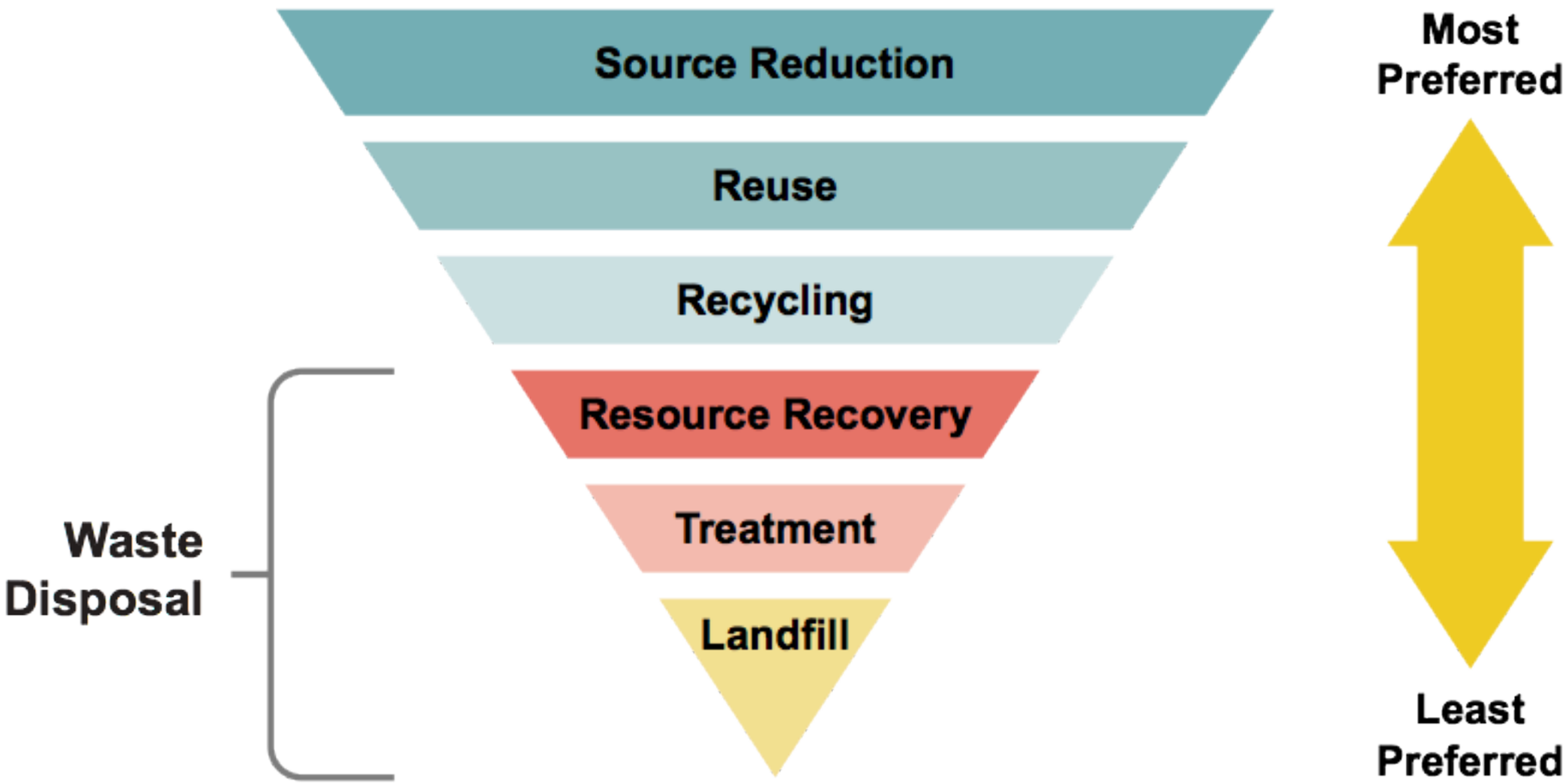


- Metal Oxides
- Metal Spinels
- Aluminate Salts
- Residual Fixed Carbon

THOR® Treated Class B and C Resin Waste Form: Comparison with Direct Burial of Downblended Waste

Waste Characteristic	THOR® Waste Form	Burial of Downblended Waste
Volume Reduction	VR of 5 to 6	None
Organics in Waste	No	Yes
Waste Stabilized	Yes	No
Radiolysis Risk	Minimal, inert with no organics	Yes, high organics
Package Type	High Integrity Container	Strong Tight Container

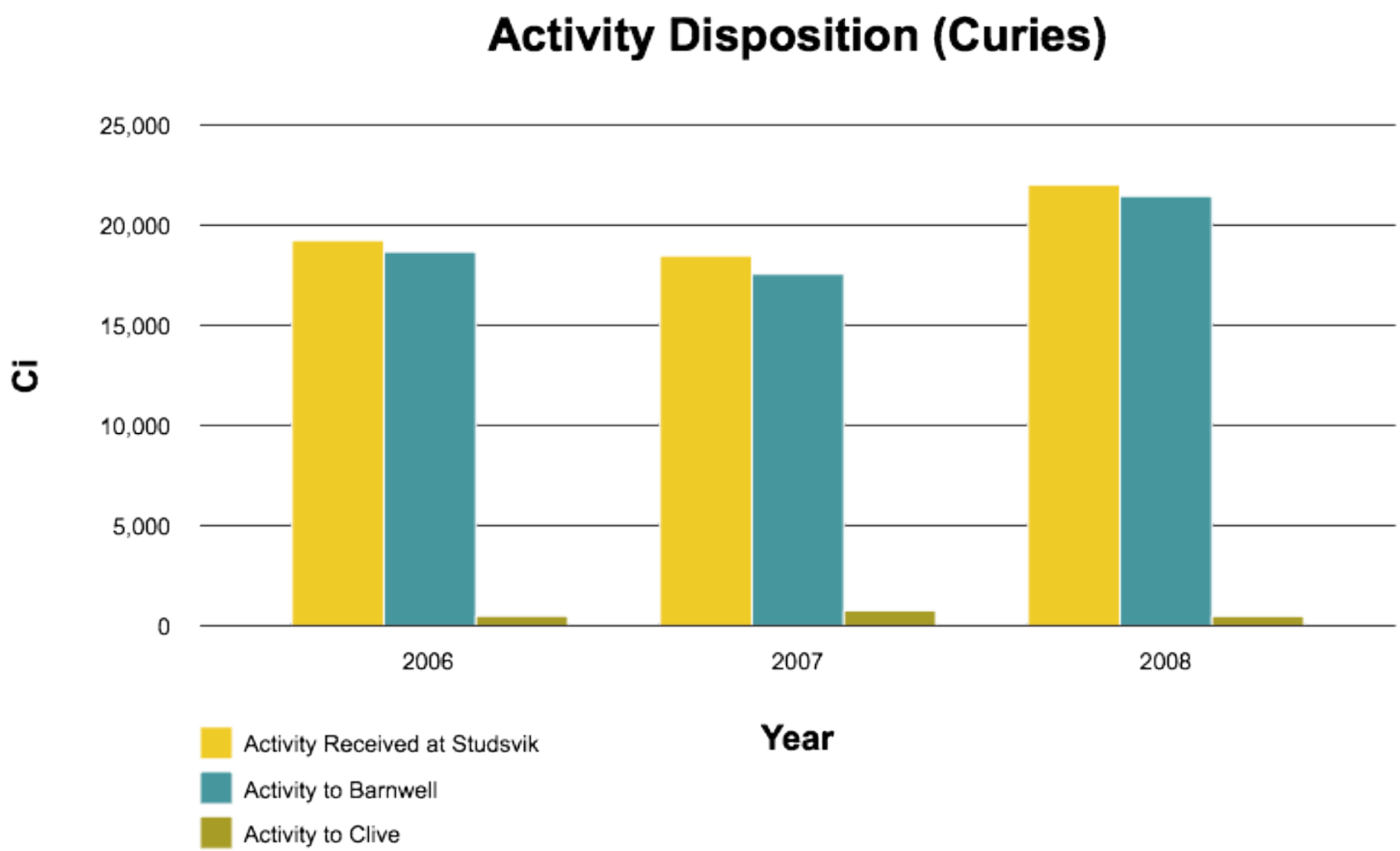
Best Practices - NDA Waste Hierarchy



THOR® Steam Reforming Process Considered Best Practice

- DOE-SR selected THOR® steam reforming for treatment of Tank 48H nitrate HLW Waste (2009)
- DNFSB recommended that DOE-HQ proceed with steam reforming of Tank 48H nitrate HLW waste (2009)
  - Letter dated March 5, 2009: "…appropriate to safely treat the Tank 48 waste."
- DOE-ID selected THOR® steam reforming for treatment of RH-TRU Sodium Bearing Waste (2005)
- Only commercial thermal treatment process for volume reduction of Class B and C organic waste in US (1999 through 2009)
  - Long-term (>10 years), reliable treatment of higher activity ion exchange resins
  - Treated and volume reduced more higher activity wastes than all other commercial processes in the world combined.

Operations History



Policy Considerations

- Large scale downblending does not promote sustainability
  - There is not enough Class A resin generated to use as down blending material for all Class B & C resins to become Class A wastes Tab 9
  - Not all generators/stakeholders are in a position to "down blend" Tab 10
  - Disposal costs will increase dramatically for B/C waste that cannot be blended
  - Acute public awareness of radioactive waste issues

Large scale downblending does not solve the problem

Policy Considerations

- Large scale downblending is inconsistent with global philosophies for handling other types of hazardous waste

- RCRA/CERCLA

- IAEA Principals of Radioactive Waste Management – "...preferred

Large scale downblending does not solve the problem

Policy Considerations

- Large scale downblending more rapidly consumes a critical national resource
- Agreement states have not endorsed large scale downblending
  - Downblended waste can be disposed of in Texas but must be classified at the highest level of the waste before blending Tab 21
  - Proposed rule in Utah would effectively prohibit disposal of downblended waste at Clive Tabs 22, 23
    - Similar to Texas rule, requiring waste to be classified at the highest level of the waste before downblending
    - Utah law prohibits acceptance of B/C waste for disposal or processing

Large scale downblending does not solve the problem

Animations

CWF_AerialAnimation.mov

CWF_CurrentPath.mov

CWF_Downblending.mov

CWF_VR.mov

Technical Considerations

- No operational efficiencies
- To be successful, blending requires precise isotopic mix
  - Input must be carefully controlled resulting in precise scheduling and ordering of input into blending tank
  - Requires use of all US commercial Class A resin to be successful Tab 9
    - The less Class A available for blending, the more B/C that cannot be blended
  - Resins (including what is Class A LLW before blending) will need to be stored either at generator or at blending location until they are right for the mix
    - Without blending, Class A LLW can go directly to disposal or for processing and then directly to disposal without the need to manage waste into a mix that will meet Clive disposal acceptance criteria
  - High risk that bead resins and powdered resins including sludges will not stay uniformly mixed in the final container

Technical Considerations

- No ALARA benefits

- Large scale blending increases dose

  - To workers through operations

  - To general public through additional transportation requirement, fenceline

Technical Considerations

- Safety and environmental issues

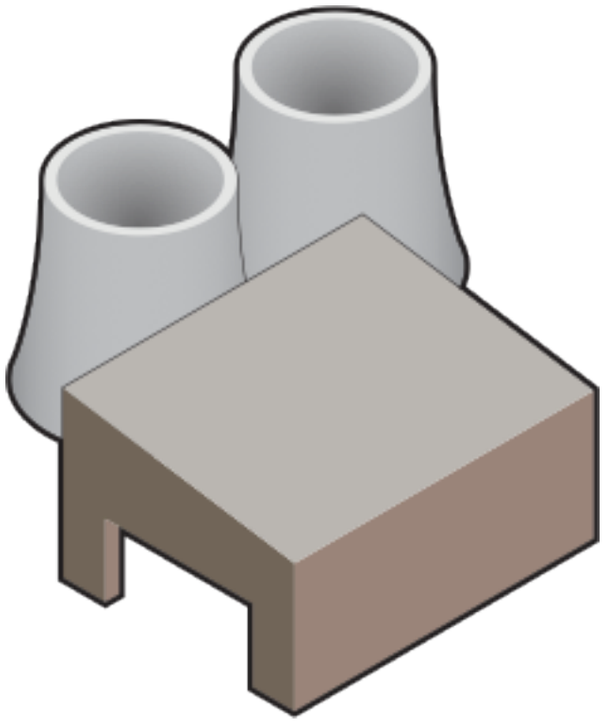
- Blending does not reduce the activity of individual resin beads

- Blending will not provide uniformity of activity through the blended waste

- Because of the known presence of B/C LLW in blended waste, Class A LLW disposal criteria do not provide sufficient safeguards for the blended LLW Tab 7

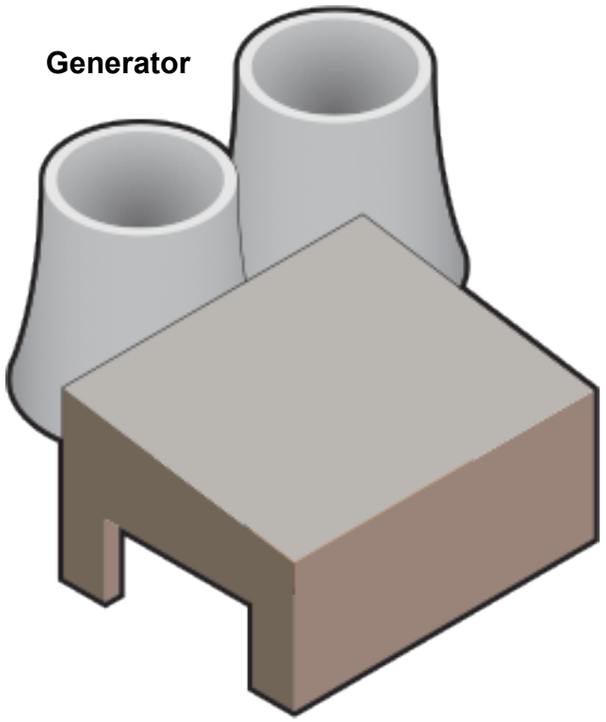
Direct to Disposal

Number of Shipments



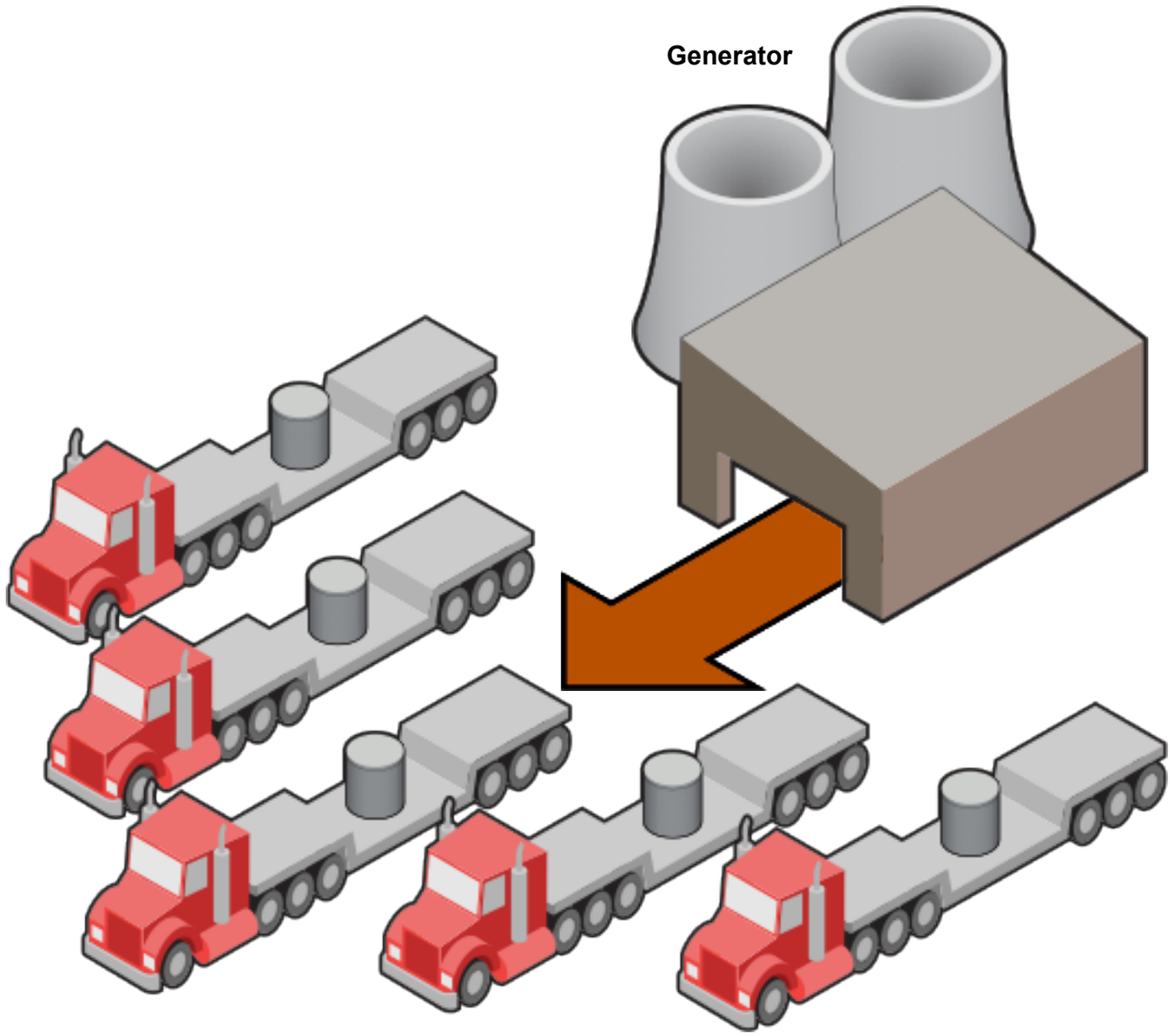
Direct to Disposal

Number of Shipments



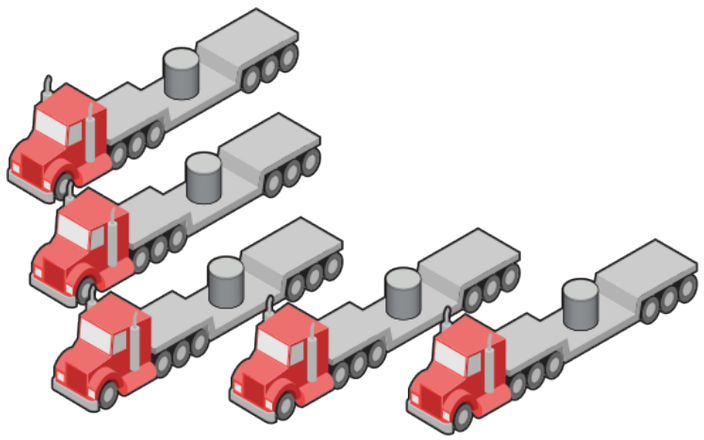
Direct to Disposal

Number of Shipments



Direct to Disposal

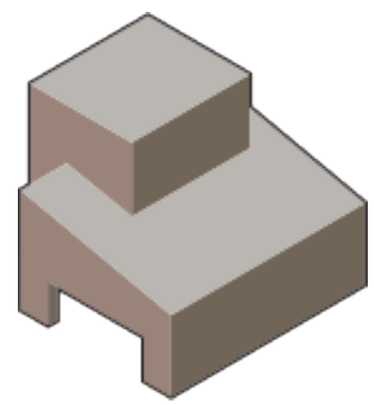
Number of Shipments



Downblending

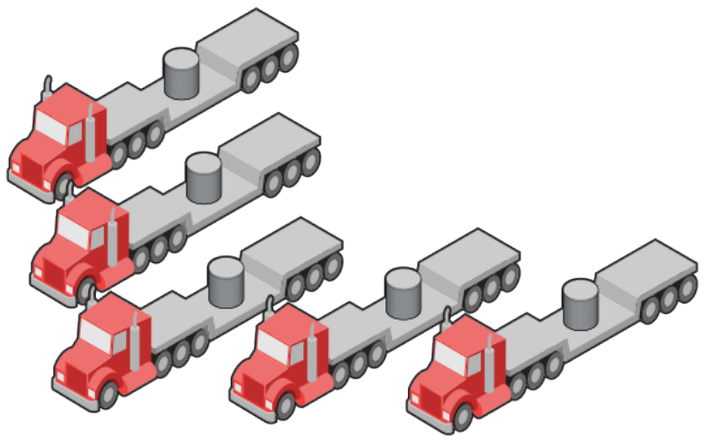
Number of Shipments

Oak Ridge, TN
Facility



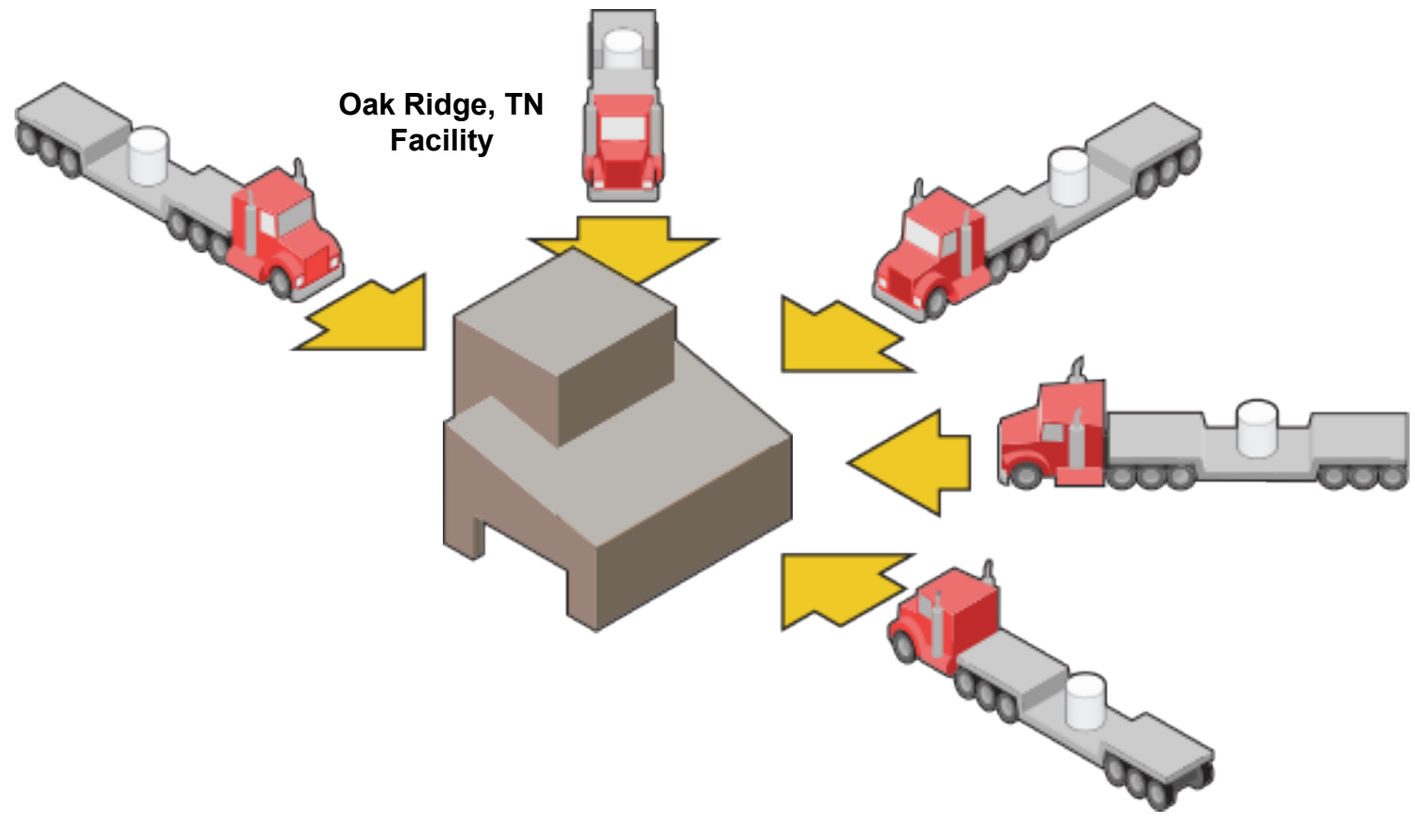
Direct to Disposal

Number of Shipments



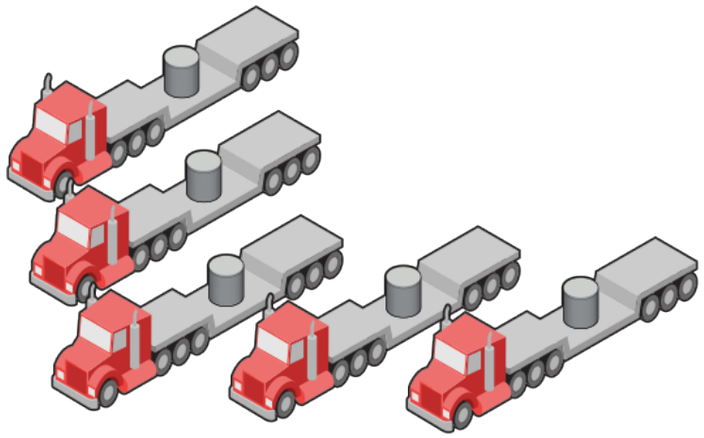
Downblending

Number of Shipments



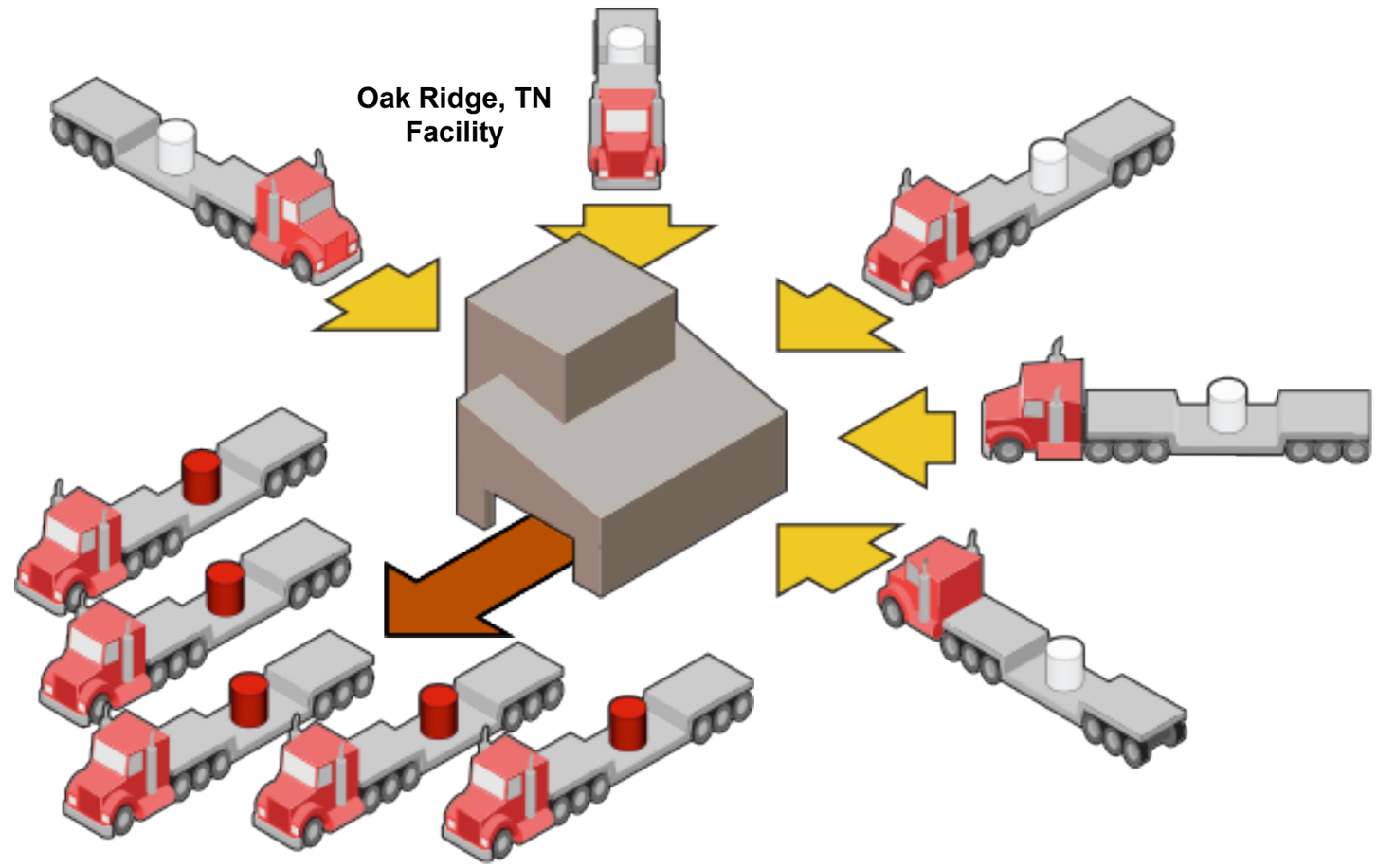
Direct to Disposal

Number of Shipments



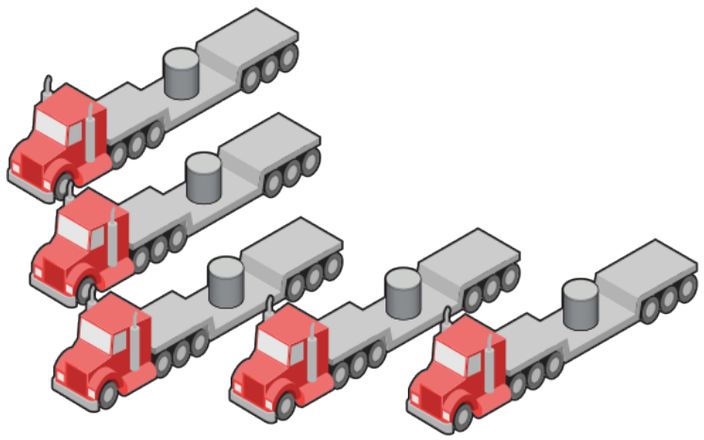
Downblending

Number of Shipments



Direct to Disposal

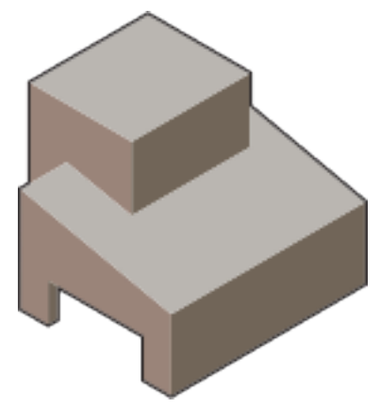
Number of Shipments



Volume Reduction

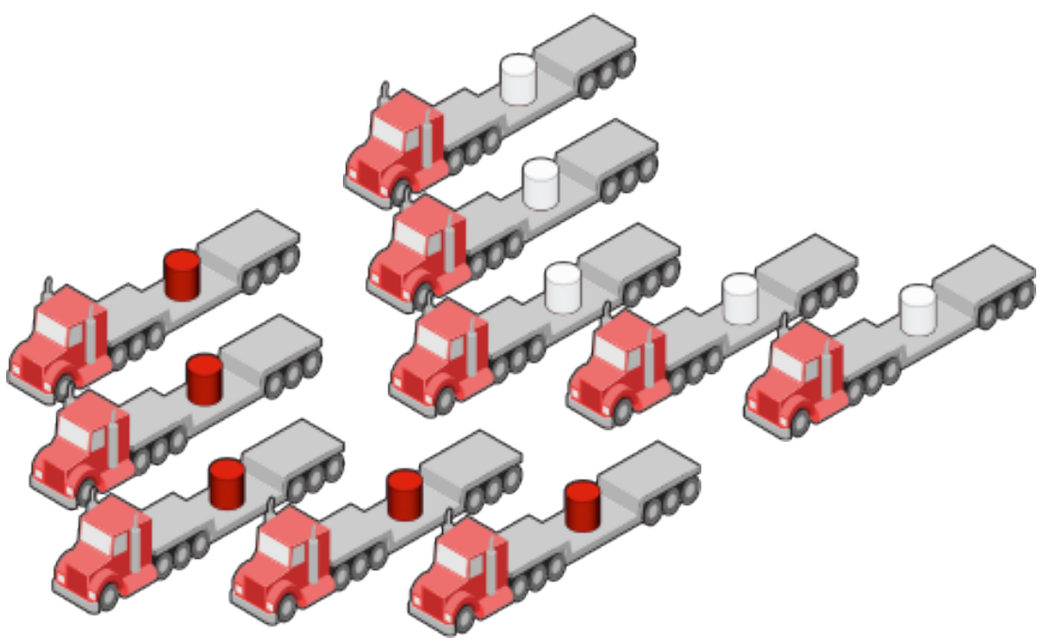
Number of Shipments

THOR Facility
Erwin, TN



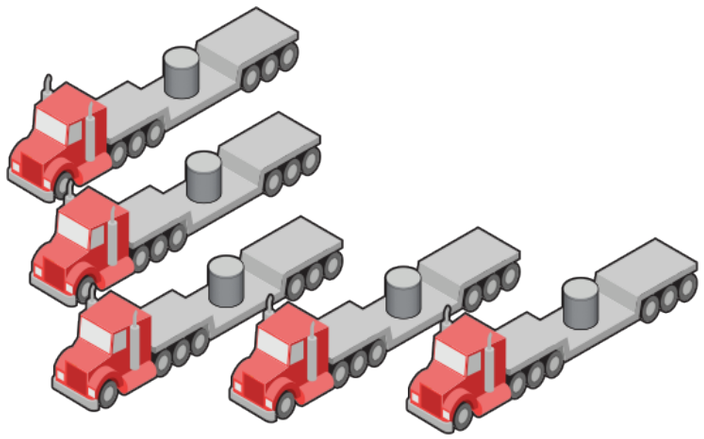
Downblending

Number of Shipments



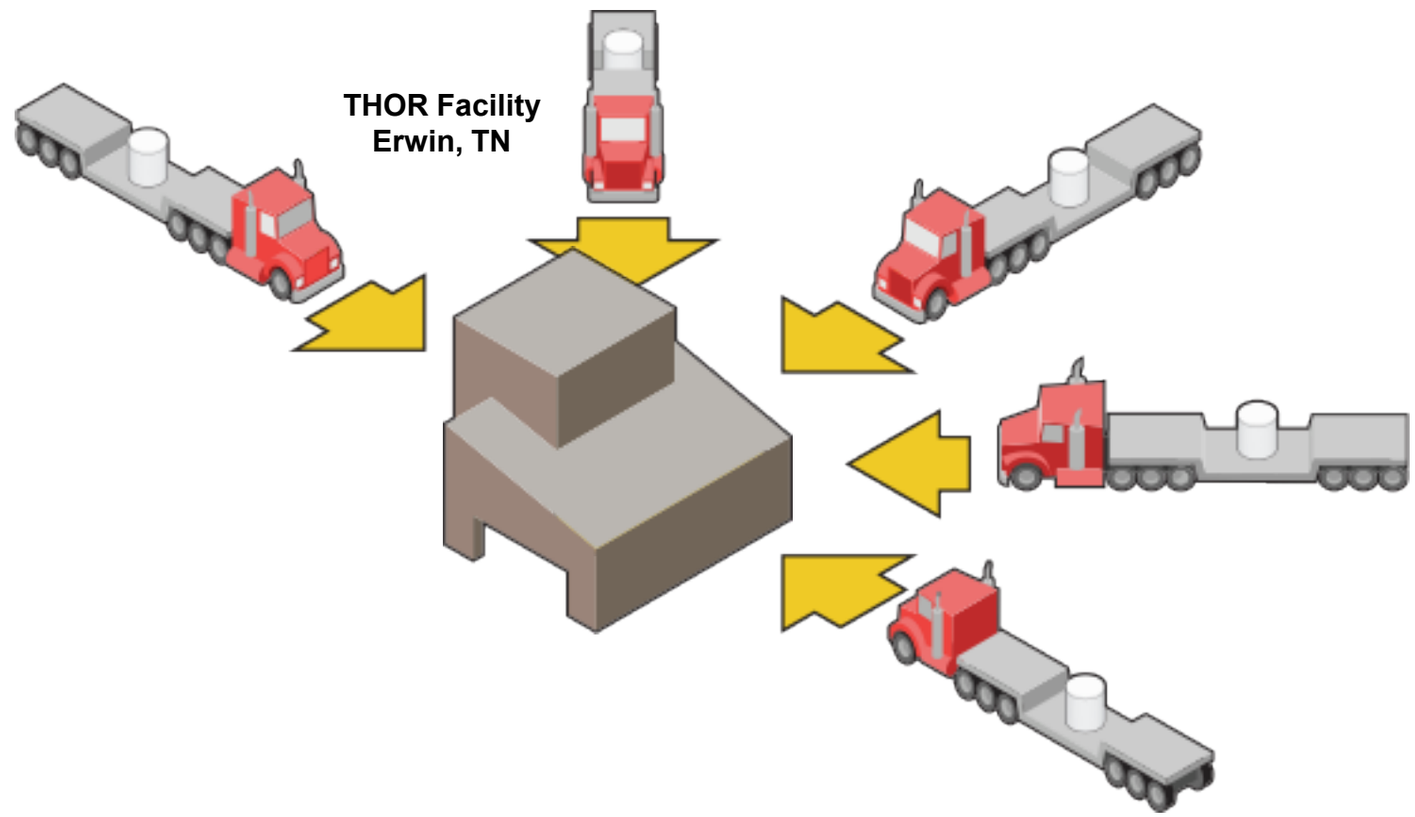
Direct to Disposal

Number of Shipments



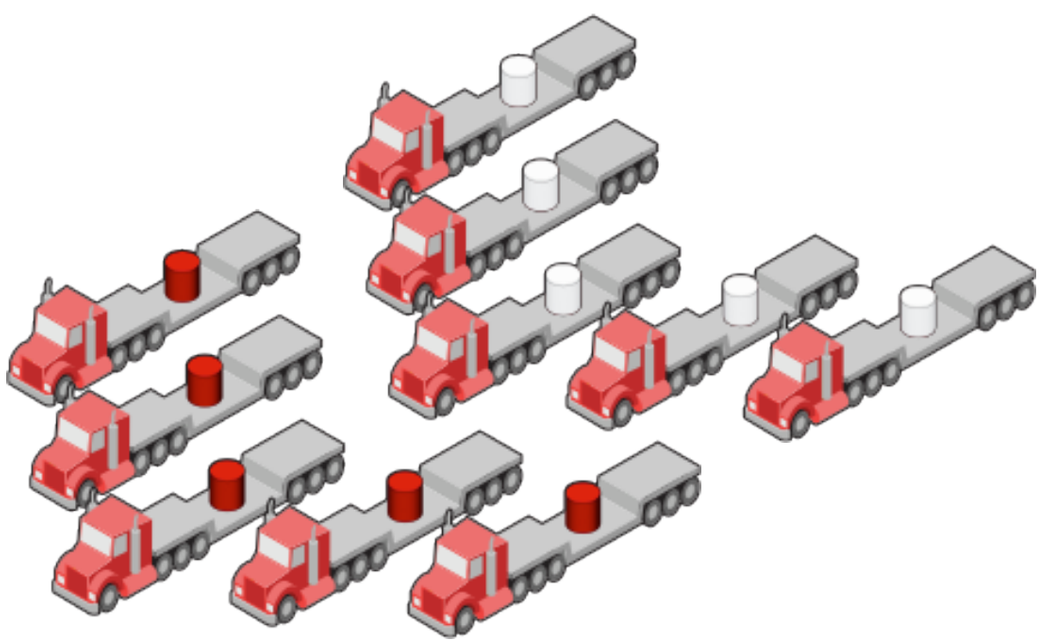
Volume Reduction

Number of Shipments



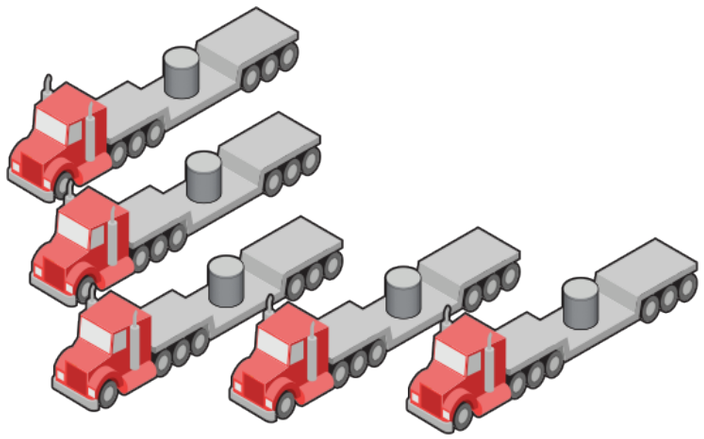
Downblending

Number of Shipments



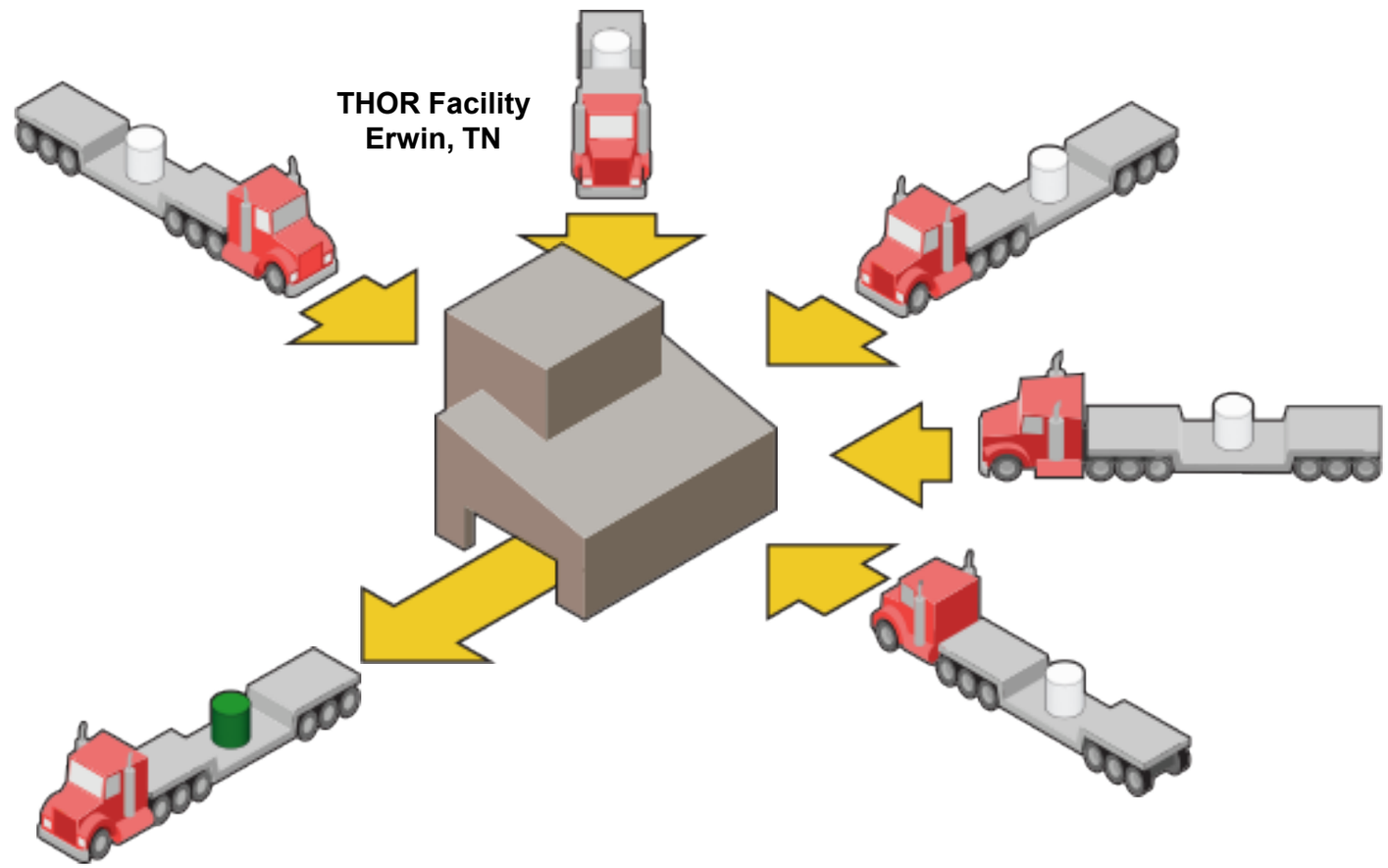
Direct to Disposal

Number of Shipments



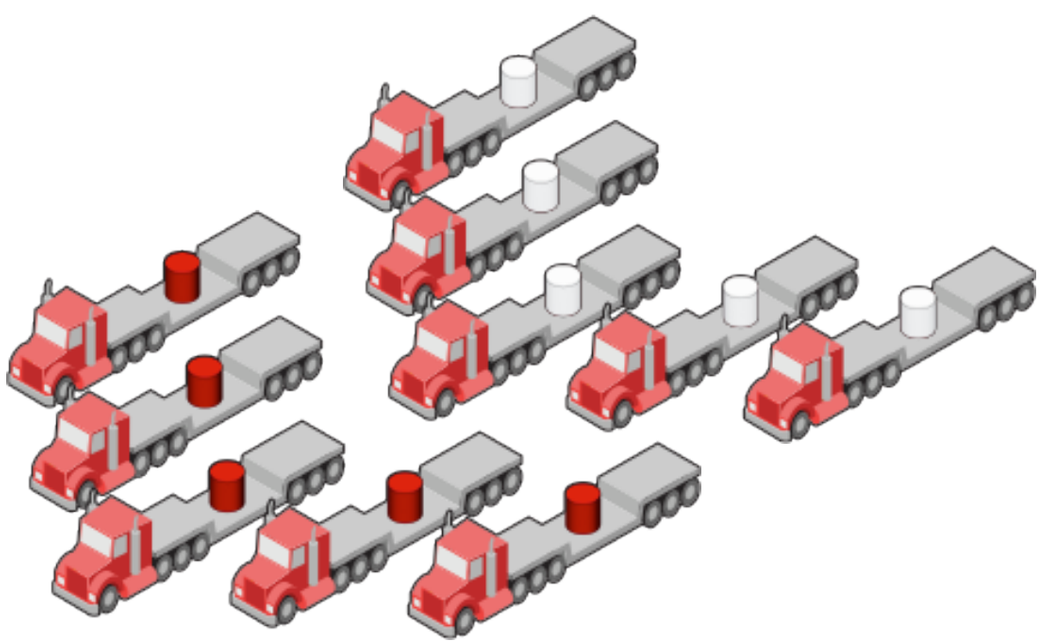
Volume Reduction

Number of Shipments



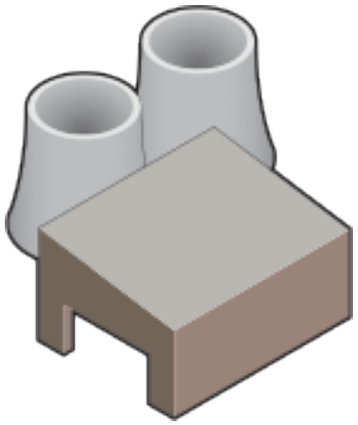
Downblending

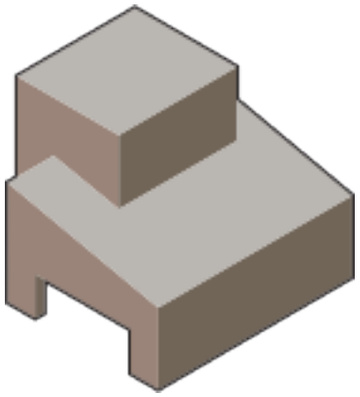
Number of Shipments



Studsvik Volume Reduction

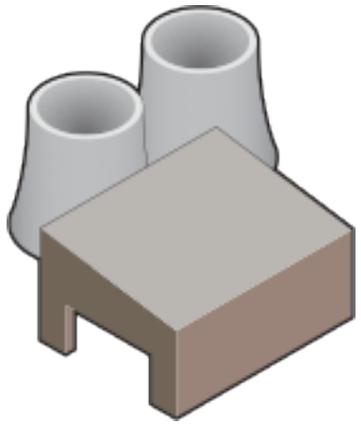
Annual

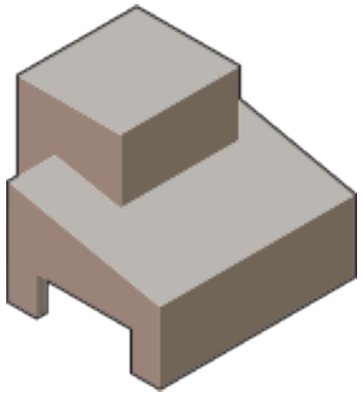




Downblending

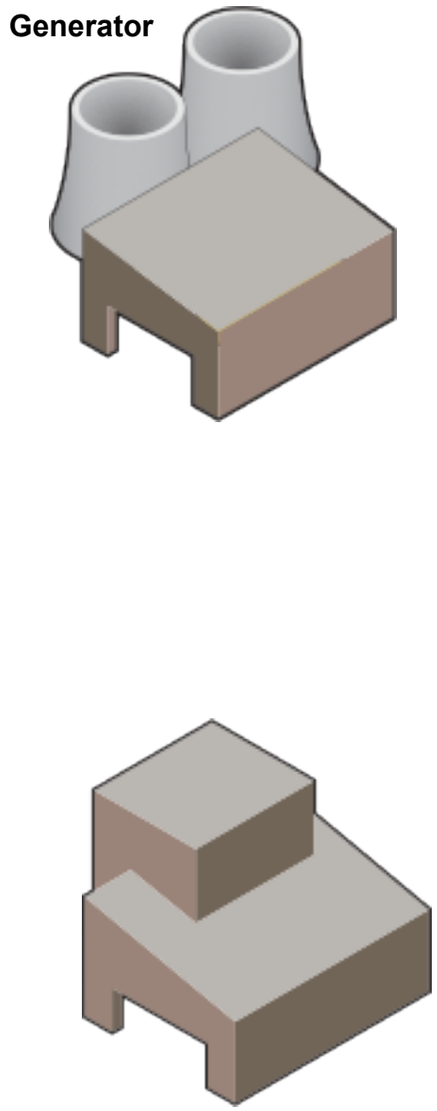
Annual





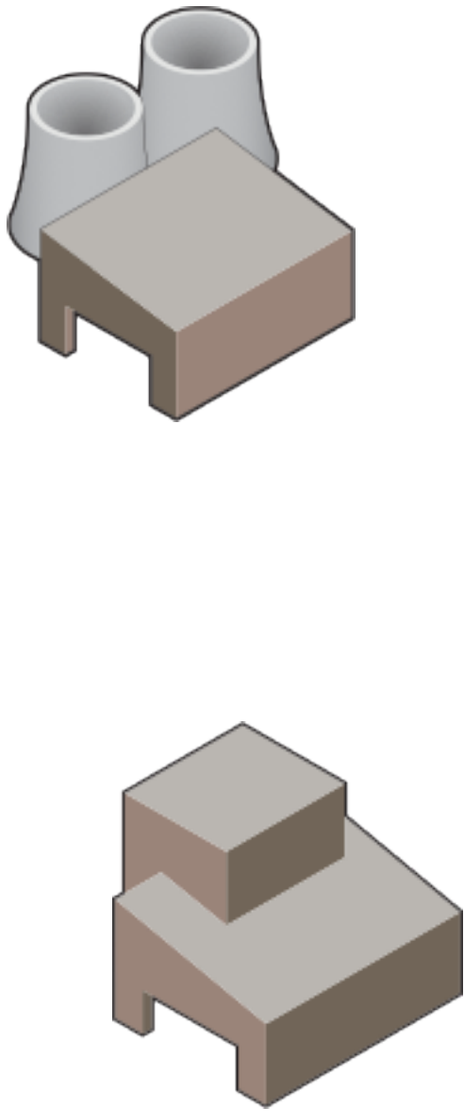
Studsvik Volume Reduction

Annual



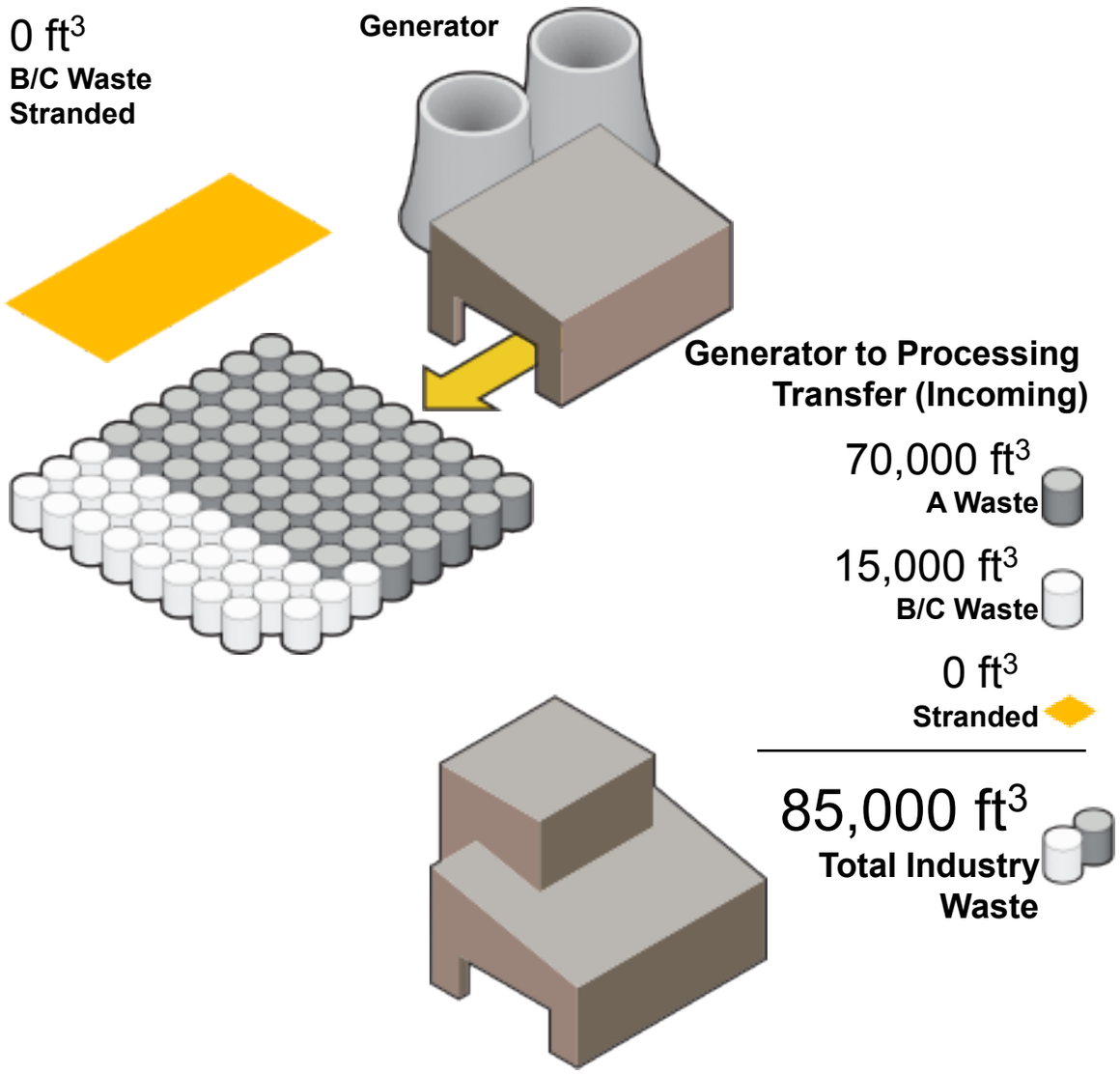
Downblending

Annual



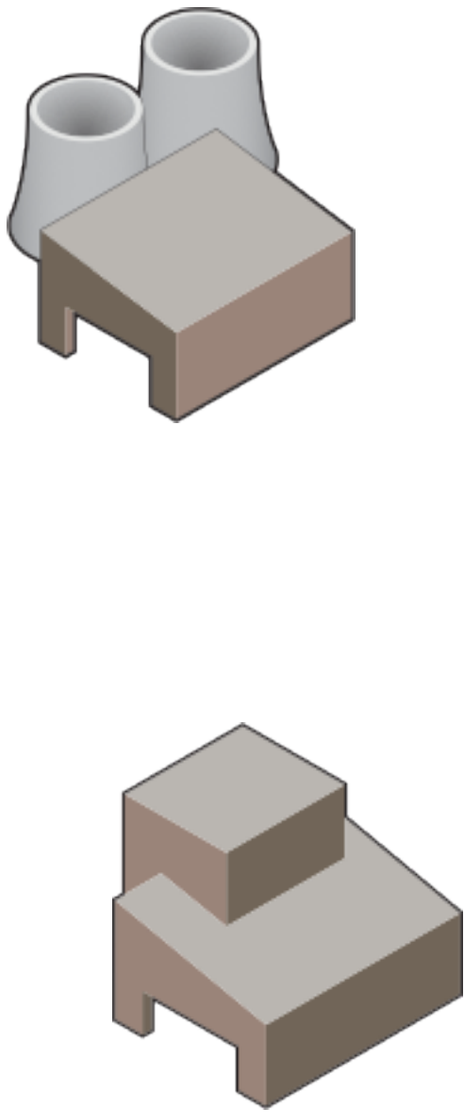
Studsvik Volume Reduction

Annual



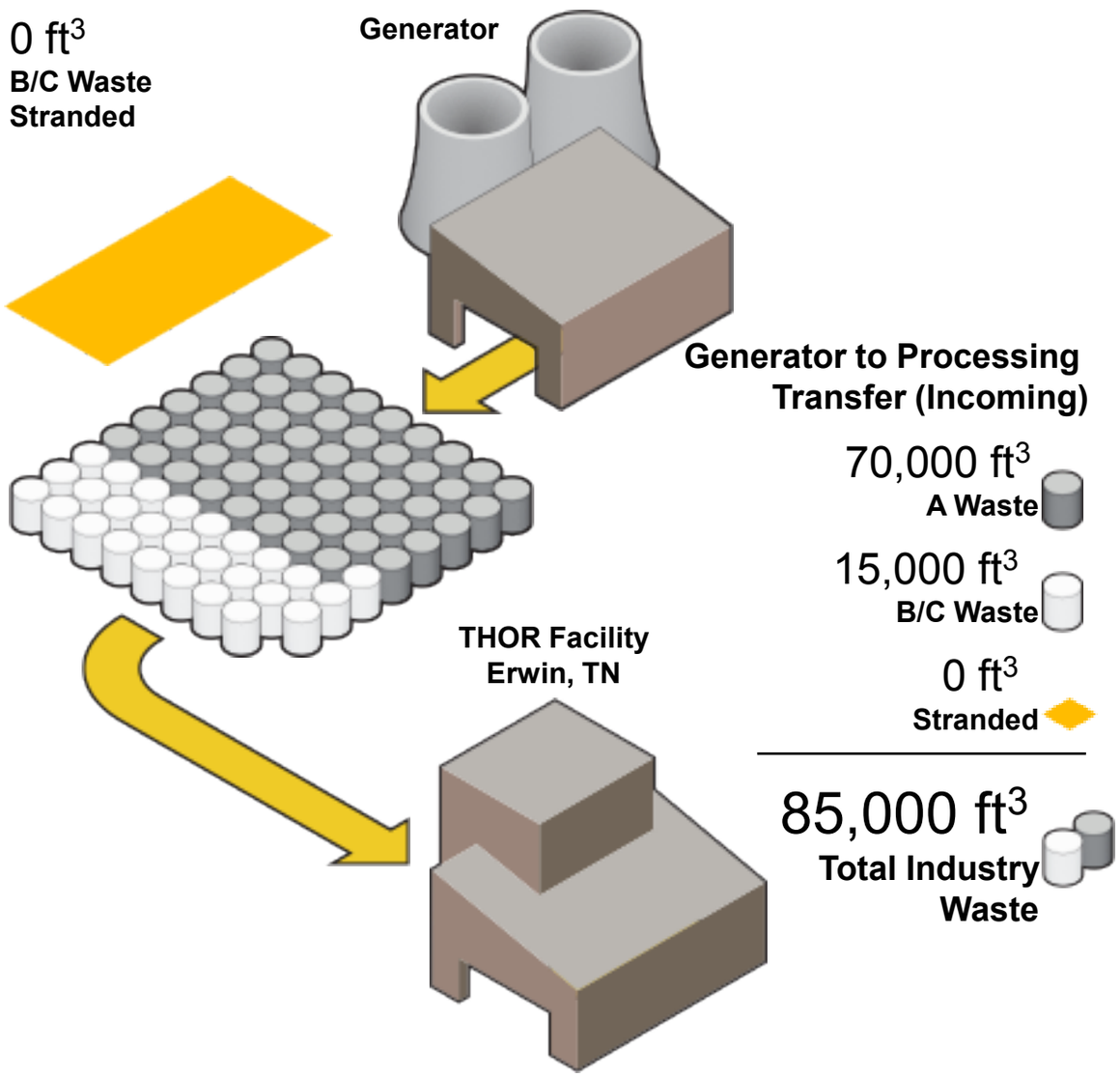
Downblending

Annual



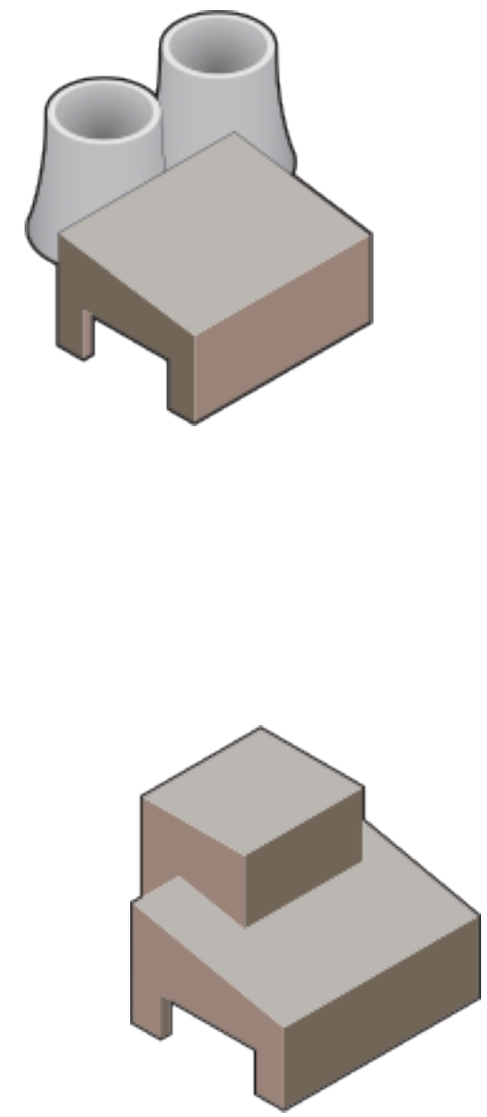
Studsvik Volume Reduction

Annual



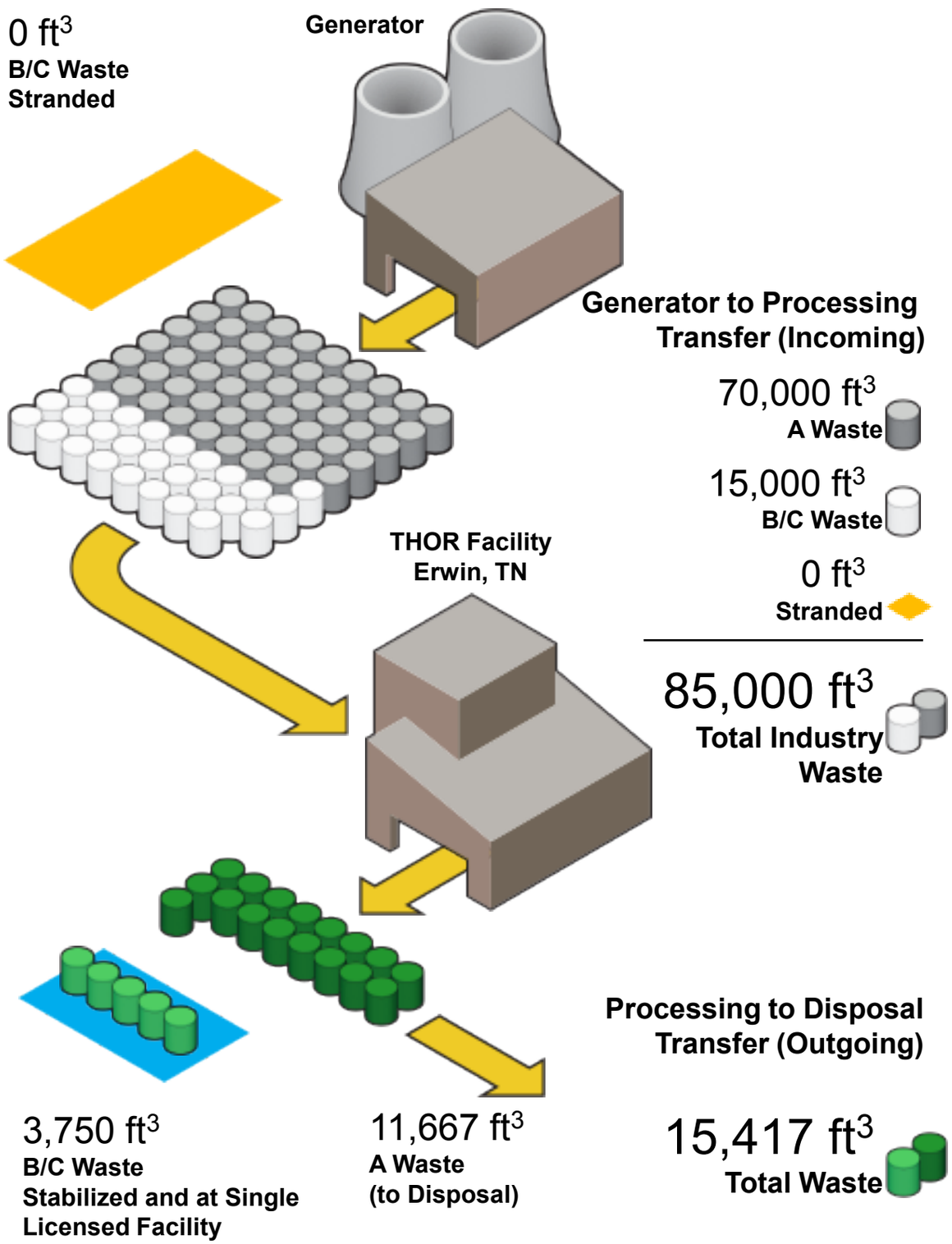
Downblending

Annual



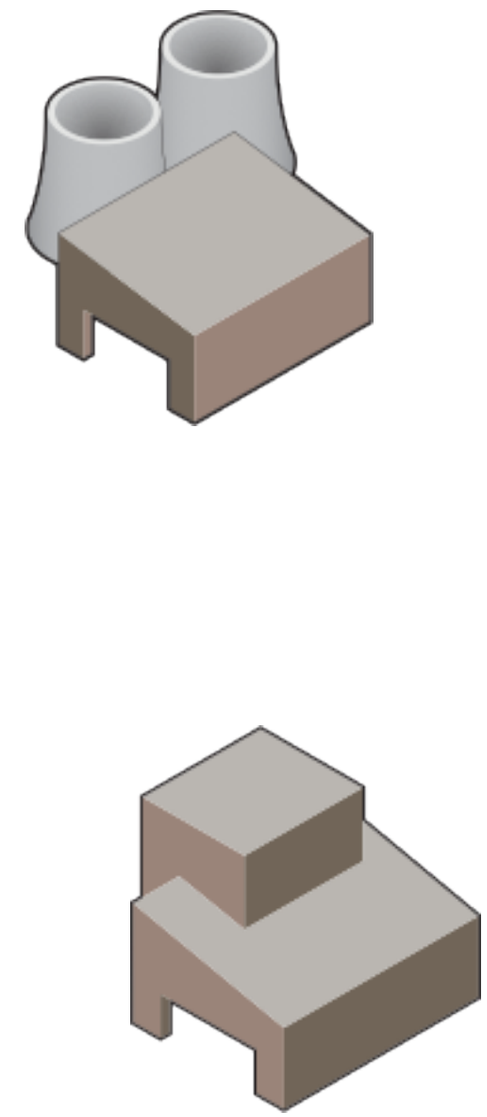
Studsvik Volume Reduction

Annual



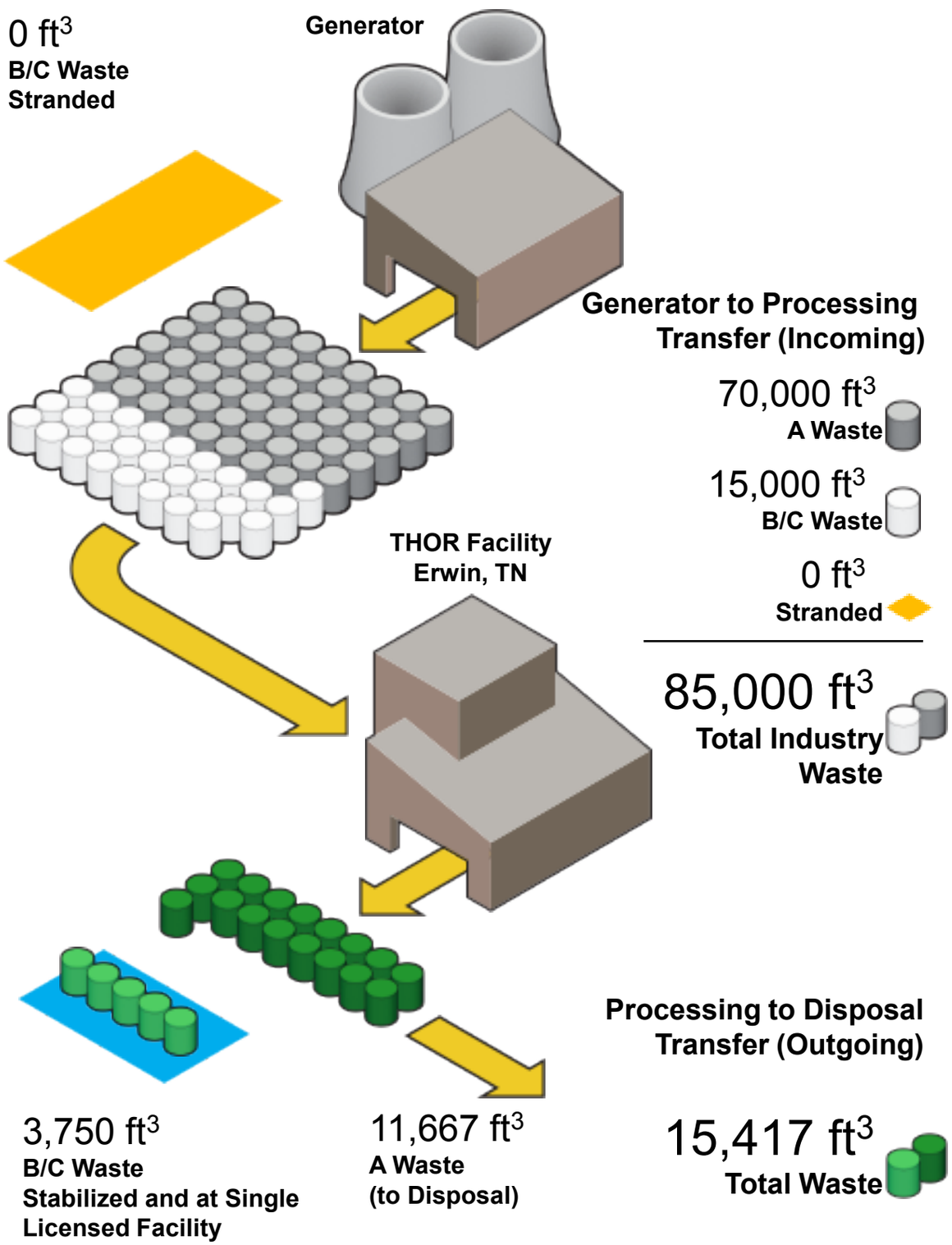
Downblending

Annual



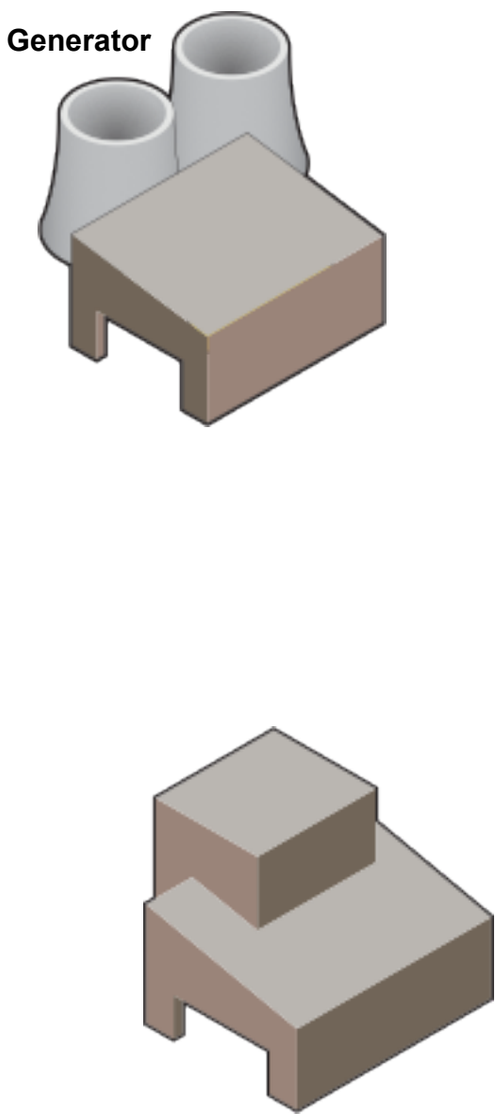
Studsvik Volume Reduction

Annual



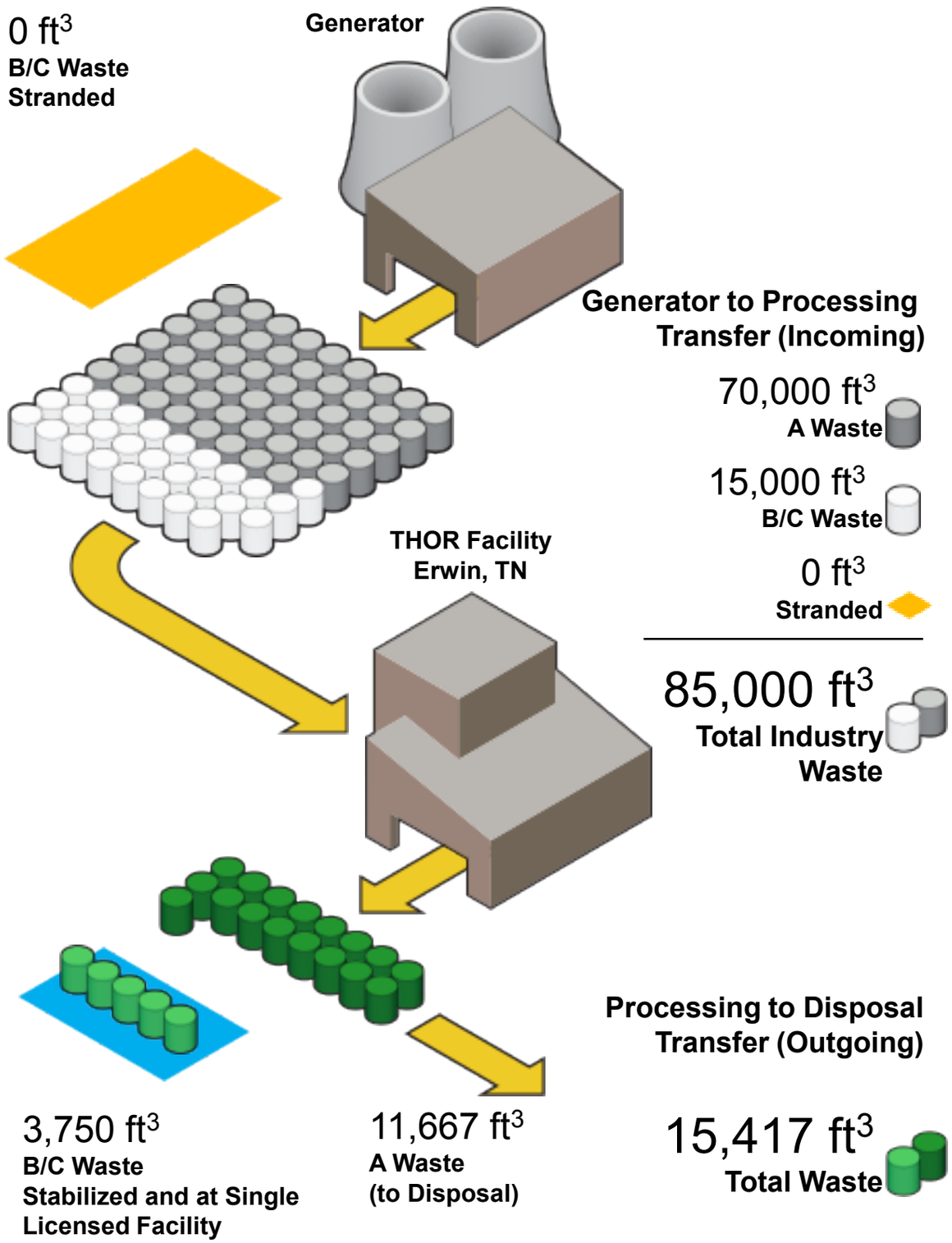
Downblending

Annual



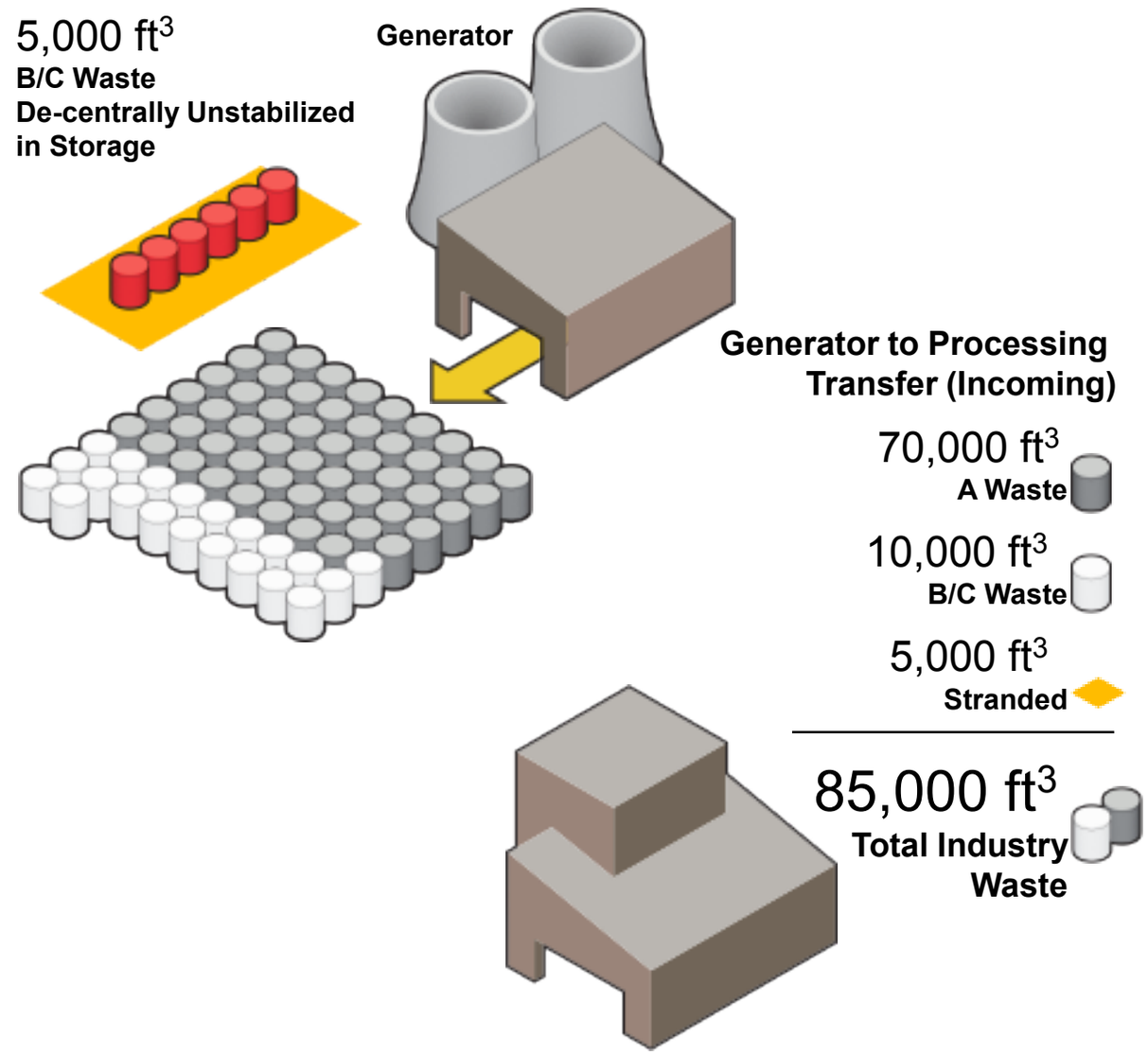
Studsvik Volume Reduction

Annual



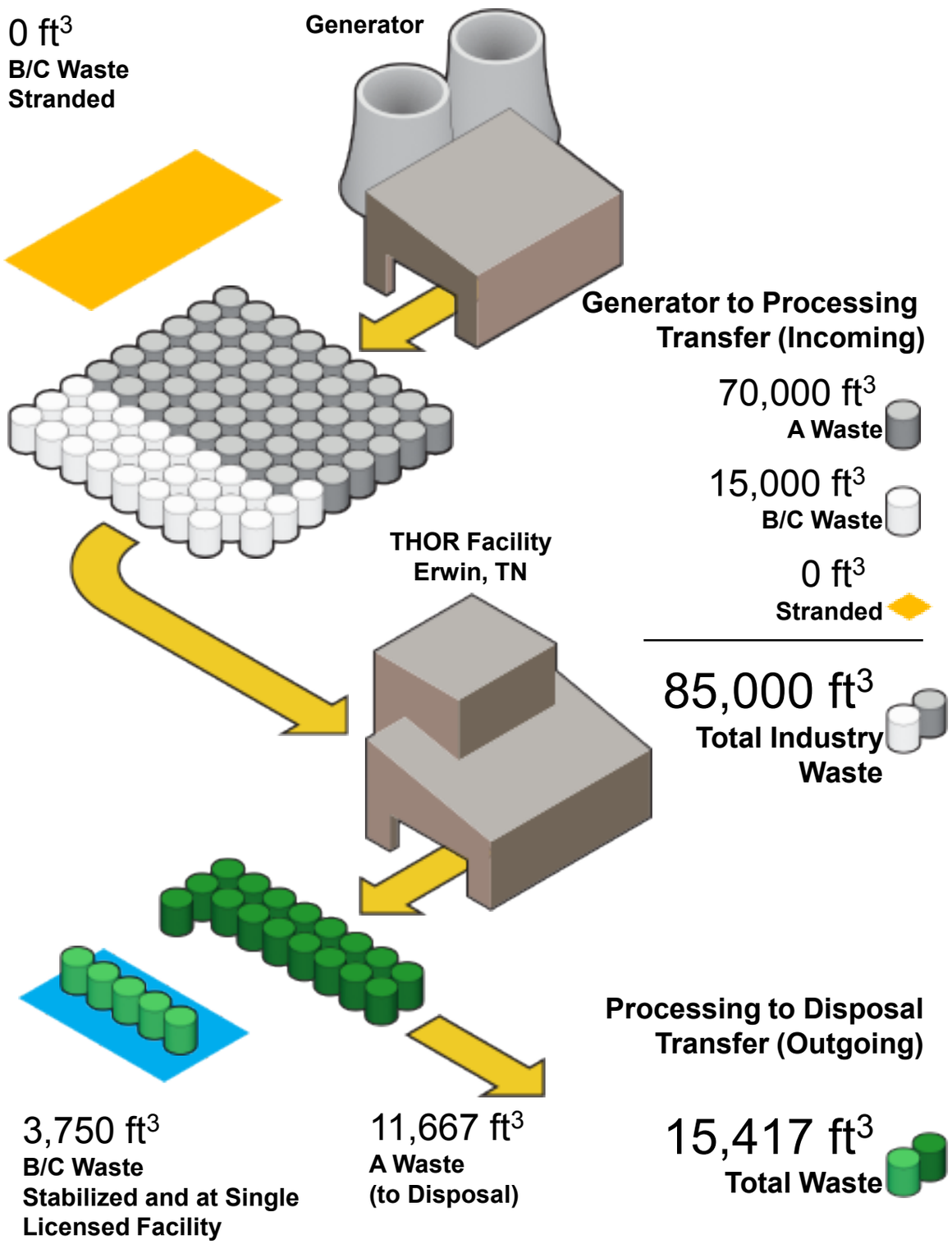
Downblending

Annual



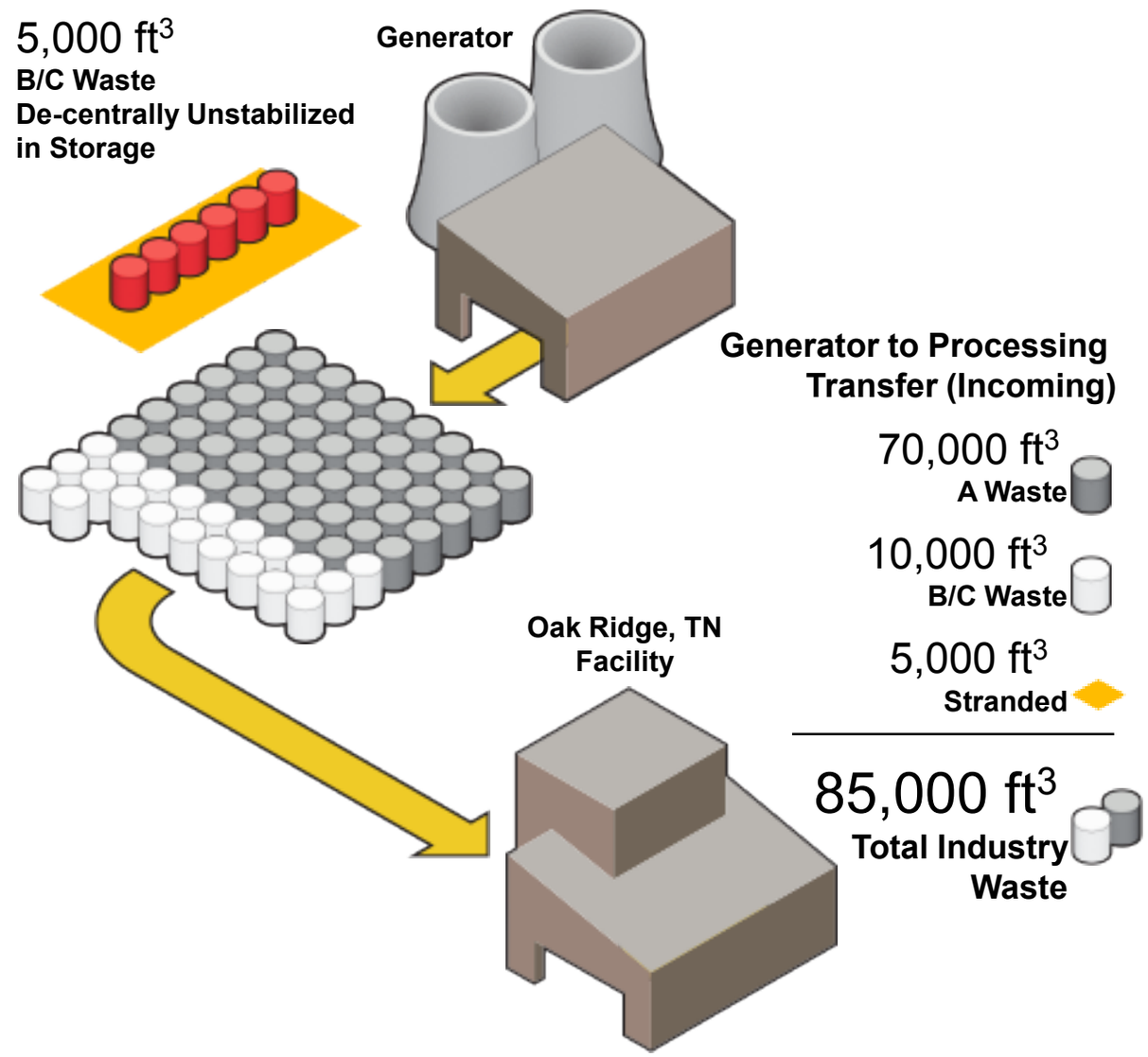
Studsvik Volume Reduction

Annual



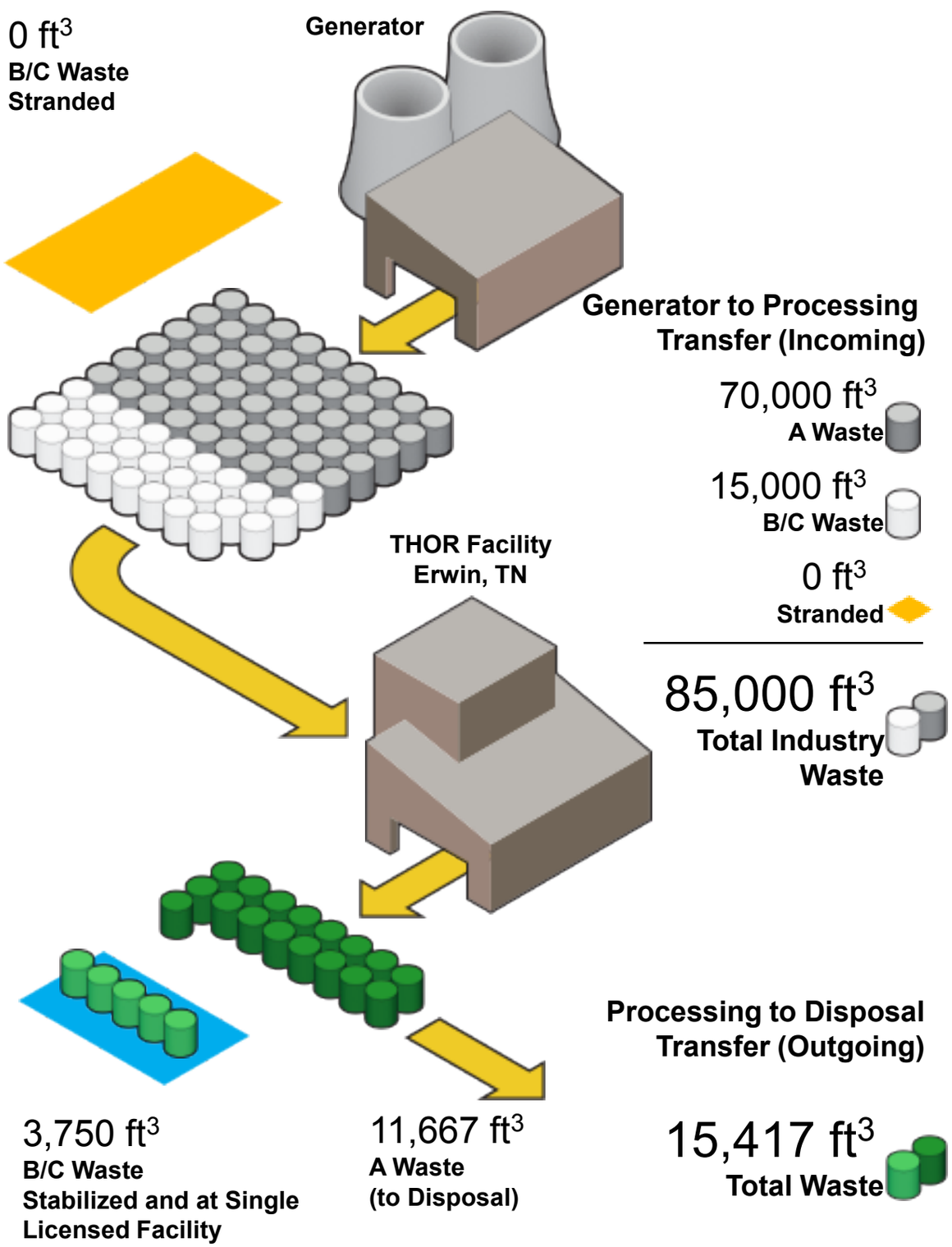
Downblending

Annual



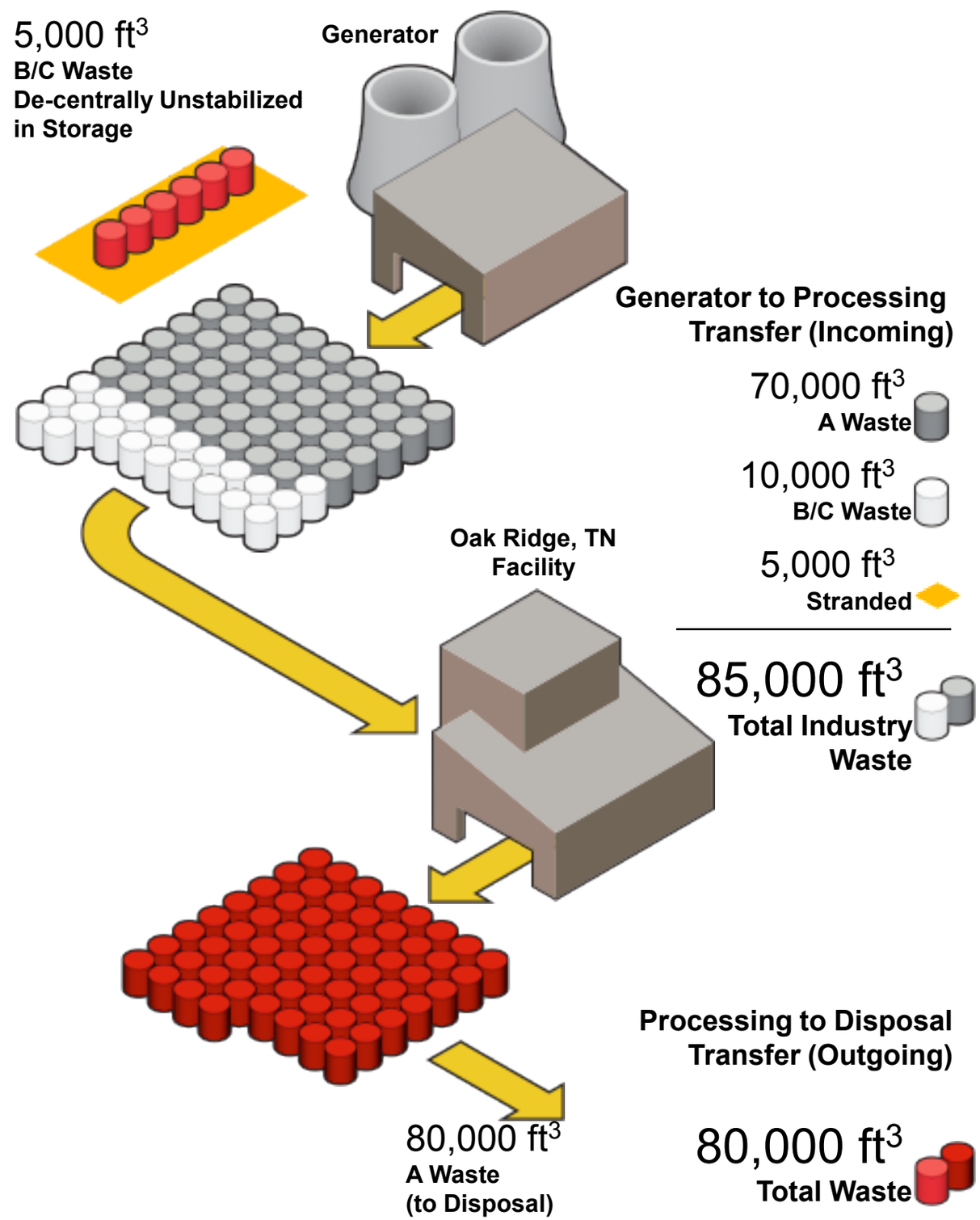
Studsvik Volume Reduction

Annual



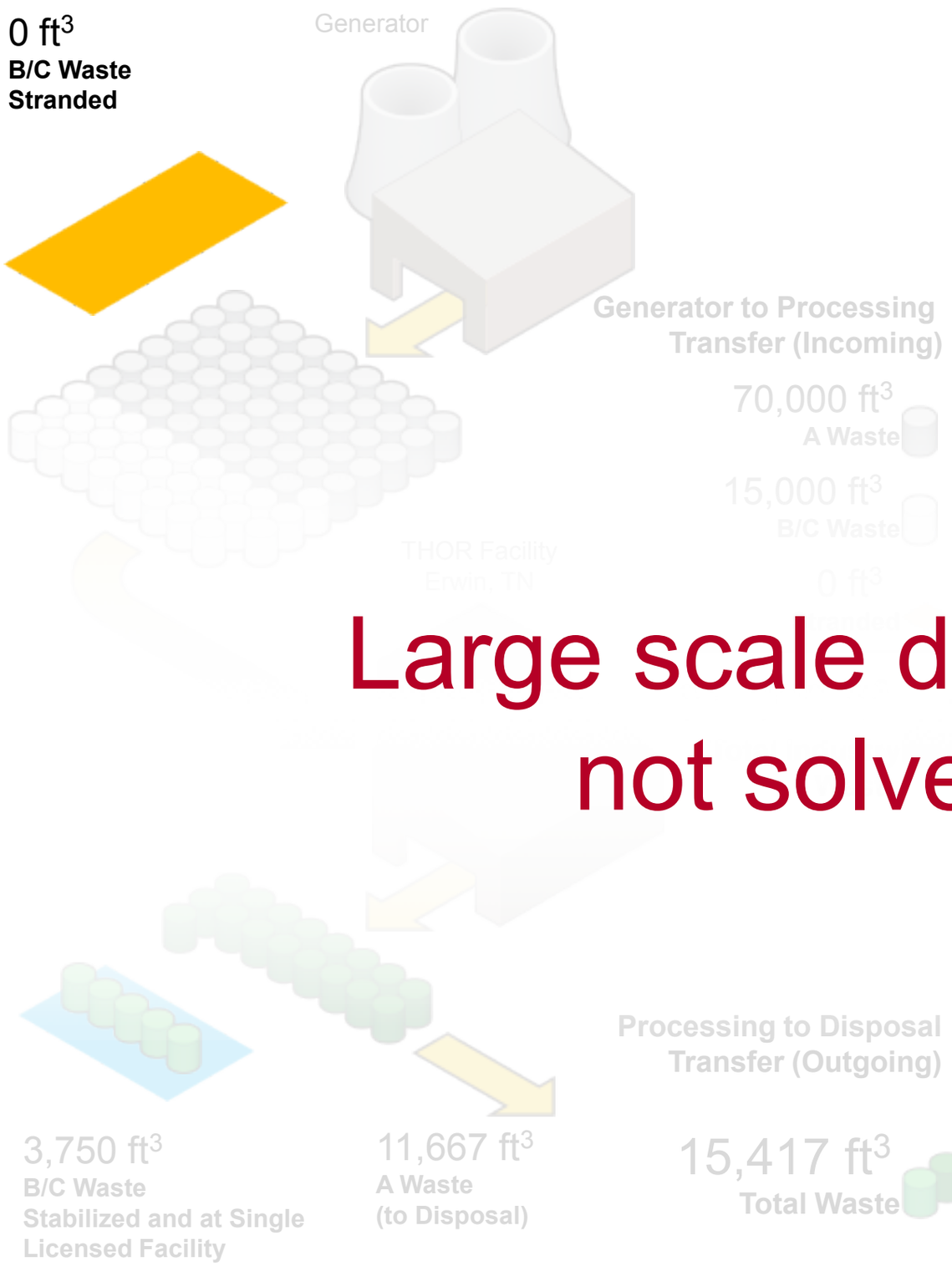
Downblending

Annual



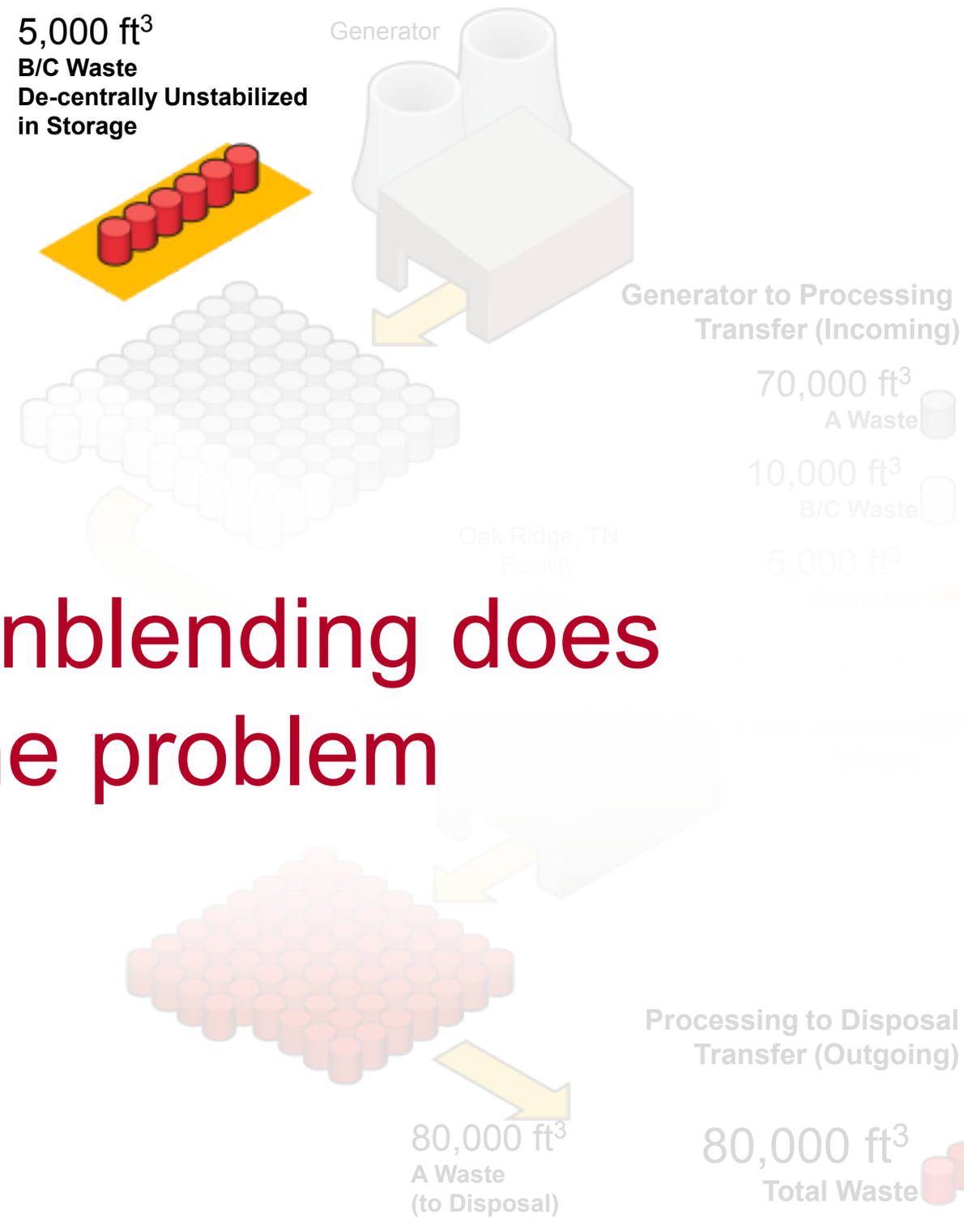
Studsvik Volume Reduction

Annual



Downblending

Annual



Large scale downblending does not solve the problem

Studsvik