An Introduction to Product Takeback

- Overview
  - Driving forces behind product takeback
  - Product takeback legislation
  - Product end-of-life options
  - Reverse logistics
  - Case study

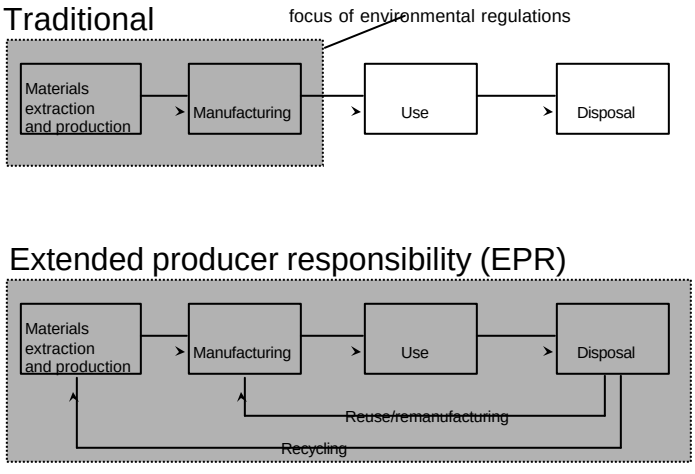
Motivation for Product Takeback

- Producers were traditionally responsible for environmental impacts from production facilities
  - pollution prevention expenditures are reflected in product prices
  - downstream environmental impacts were largely ignored
- Negative externalities associated with use and end-of-life stages
  - tailpipe emissions from automobiles
  - toxic waste at end of life

Concept of Extended Producer Responsibility (EPR)

- EPR emerged as a concept to incorporate negative externalities from product use and end-of-life in product prices
- Producers are made responsible for environmental effects over entire product life cycle
  - cost of compliance cannot be shifted to a third party and must thus be incorporated in product prices
- Examples of EPR regulations:
  - emission and fuel economy standards (use stage)
  - product takeback requirements (end of life)

Concept of Extended Producer Responsibility (cont.)



Product Takeback Legislation

- Producers are made responsible to collect and recycle end-of-life products
- Waste-management costs are shifted to those most capable of reducing EOL costs by changing designs for recyclability, longevity, reduced toxicity, and limited volume of waste generated
- EOL costs reflected in product prices -- consumers can make more informed decisions

Goals of Product Takeback Legislation

- shift waste management costs to producers
- reduce volume of waste generated
- increase use of recycled materials

Implementation of Product Takeback Legislation

- Main characteristics:
  - numerical targets for collection, product recovery and incineration, and
  - time frames for implementation (i.e., dates by which the collection and recycling targets must be achieved)
- Landfilling often less expensive than recycling --> diverting waste from landfills requires recycling targets!
- No incentives for going beyond the set standards

Products Targeted by Product Takeback Regulations

- Characteristics:
  - products that create a serious disposal problem in terms of volume, hazardous and toxic content
  - no functioning secondary markets
  - hazardous products for which the producer does not retain ownership through leasing contracts or other arrangements
- European Union regulations on electronics, automobiles, batteries, tires

Alternatives to Product Takeback

- unit-based pricing for household municipal solid waste (MSW) generation
- raw material taxes
- landfill bans
- purchase policies requiring a certain percentage of recycled content
- leasing

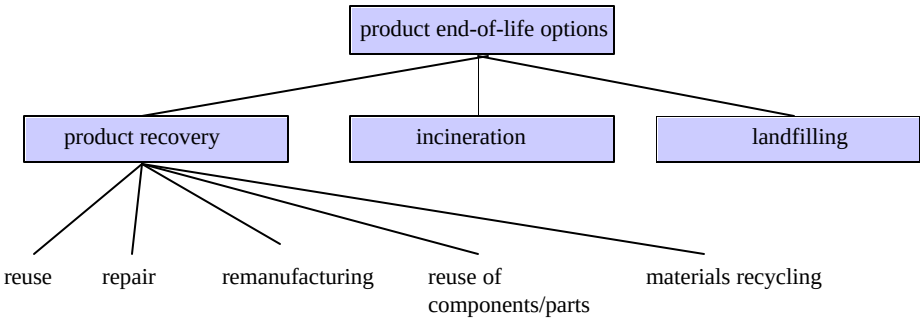
Allocation of PTB Responsibility Along the Supply Chain

- Who should be targeted: OEM, materials supplier, retailer/dealer?
- PTB goals can be achieved if OEM is held responsible
  - Market forces would resolve the allocation problem in the supply chain. Component and material prices would reflect end-of-life costs.
  - Cost of enforcement would be minimized as a limited number of solvent principals able to control other parties would be liable.

Voluntary Takeback Programs

- Motivations for manufacturers
  - reclaim value from end-of-life products (e.g., computers, copiers)
  - avoidance of regulation (e.g., power tools)
  - control fate of end-of-life products (OEM wants to avoid resale on secondary markets)
  - marketing considerations
    - demonstration of environmental awareness
    - buying argument for green consumers

Product End-of-Life Options



Materials recycling

- Majority of returned consumer products recycled for materials
- Metals recycling in place for a long time
  e.g., steel, aluminum, copper
- Plastics recycling is getting more mature
  - e.g., Ford recently approved 100% recycled ABS for use in new cars
  - Bosch is reusing high-grade polymers from power tool housings

Materials Recycling (cont.)

- Product design accounts for recyclability at end of life
  - choice of joining and fastening methods
  - choice of materials and material combinations
- Economics of materials recycling depend on product and legal environment
  - aluminum can (++) vs. power tool (--)
  - unregulated vs. regulated auto recycling

Remanufacturing

- Remake or rebuild used products to a condition as good as new
  - extensive quality control ensures that quality of remanufactured products is equivalent to quality of new products
  - remanufacturing processes very similar to manufacturing processes
- Typical applications
  - jet and car engines, military equipment, copiers, auto parts
  - *consumer products?*

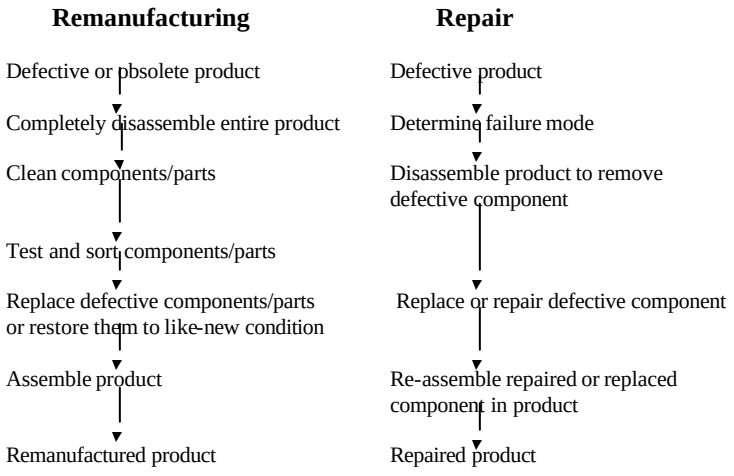
Criteria for Remanufacturability

- The product fails functionally rather than by dissolution or dissipation. There must be a "core" - a discarded, malfunctioning, or used product that becomes the remanufactured product.
- The technology exists that can restore the product to its original shape, condition and function.
- The product is factory-built, is standardized, and is made with interchangeable parts.
- The recoverable value added in the product is a high percentage of the product's original market price.

Criteria for Remanufacturability (cont.)

- The cost of obtaining a core is low relative to its true economic value.
- Product technology is relatively stable. Rapid technological obsolescence dooms otherwise remanufacturable products.
- The remanufactured product can be priced at 60% or less of the new product price, while still obtaining a profit.
- The remanufactured product can be sold to "knowledgeable buyers" who can appreciate the worth of a remanufactured product.

Remanufacturing vs. Repair



Reuse of Components/Parts

- Recover high-value parts from end-of-life products
  - no technological obsolescence or technology suitable for other applications
  - remaining lifetime enough for second use cycle
- Examples of reusable components
  - microprocessors
  - electric motors (copiers, power tools, etc.)
  - power supplies

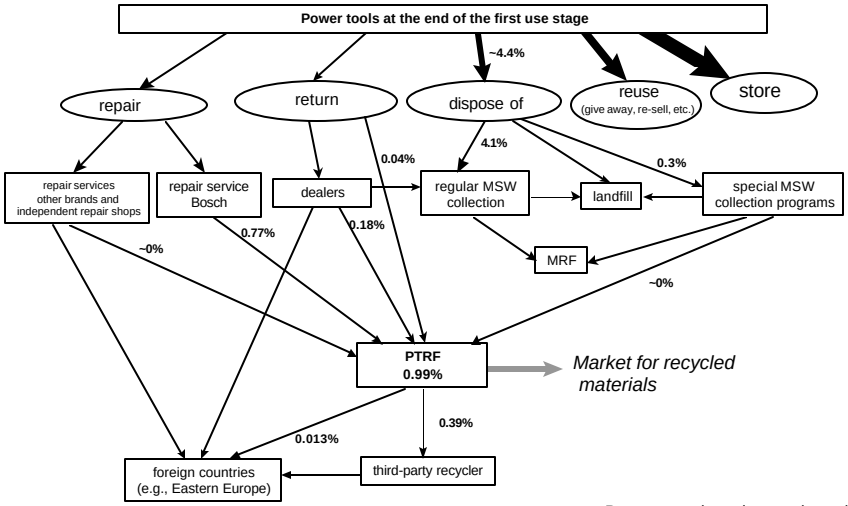
Reverse Logistics

- Return end-of-life products to point of product recovery
- Return volume depends on existence of alternative legal disposal options
- Collection mode determines reverse logistics cost
- Reverse logistics system design determined by product recovery

Power Tool Takeback Case Study

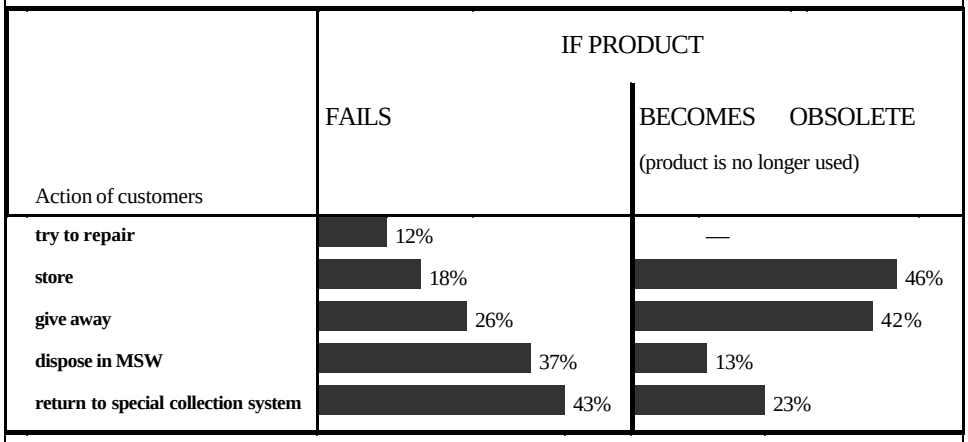
- Voluntary takeback program for power tools in Germany since 1993
  - takeback initiative of all major manufacturers
  - customers can return end-of-life power tools free of charge to dealers/retailers
  - power tools recycled at dedicated Bosch recycling facility
  - Bosch reuses high-grade polymers for accessories
- Only 0.22% of market volume is returned

End-of-Life Fate of Power Tools in Germany in 1996



Percentages based on market volume 1996

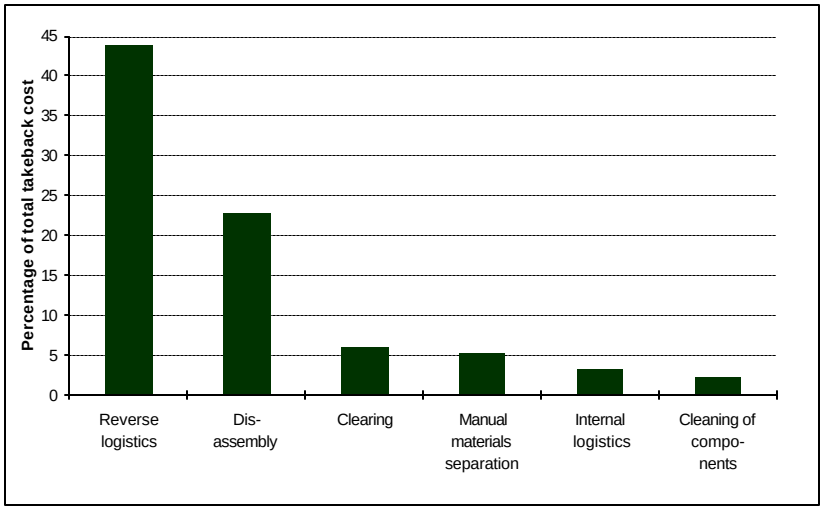
Market Study: What would you do with an obsolete or defective small electric or electronic device…?



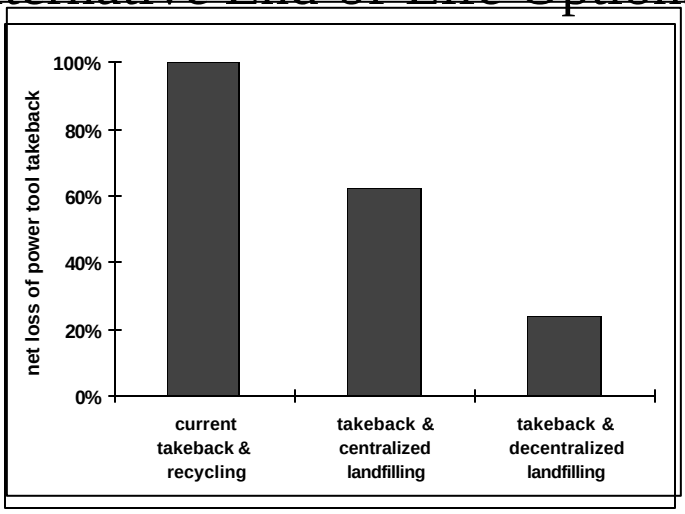
Economics of Power Tool Recycling (1996)

Cost of materials recycling	DM 5.49 ($3.05)
Cost of reverse logistics	DM 4.29 ($2.39)
Takeback cost	DM 9.78 ($5.44)
Takeback cost in % of revenue per new power tool	7.2%
Revenues of materials recycling	DM 0.91..1.83 ($0.51..1.02)
Net revenue	DM -7.95..-8.87 ($-4.42..-4.93)

Cost Drivers in Power Tool Recycling



Costs Associated With Alternative End-of-Life Options



Environmental Effects -- Conventional Pollutants

Pollutants	(1) Emissions for producing aluminum, steel and copper from virgin materials (obtained from EIO-LCA)	(2) Emissions for producing PA6 (obtained from GaBi)	(3) Total emissions associated with producing the four materials from virgin materials (1)+(2)	(4) Transportation-related emissions obtained from GaBi	(5) Energy-generation-related emissions obtained from GaBi	(6) Total emission reduction (3)-(4)-(5)
SO_2	24	3	27	0.05	6	**21**
NO_x	1	2	3	0.4	3	**0**
CO	6	0.3	7	0.1	0.3	**7**
VOC	1	7	8	0.06	3	**5**
CO_2	*4,450*	1,390	5,840	38	1,210	**4,590**

Assessment of Power Tool Takeback Program

	Positive	**Negative**
Manufacturer (Bosch)	• "green image" • avoid more onerous regulation • materials cost savings due to recycled polymers (accessories, etc.) • sound recovery concept for rejected repairs	• negative net revenue • low return rate • no control of return flow • no incentives for DFE • no closed-loop recycling • negative impact on competition when return rate increases and not all power tool manufacturers participate (free-rider problem)
Society	• 18% of power tools intended to be disposed of were prevented from being landfilled • high level of recycling for returned power tools • NiCd battery recycling • reduction in discharges of conventional pollutants • lower costs of MSW treatment	• low return rate
Individual Customer	• offer to "green consumers"	• no better alternative to existing legal disposal options
Third Parties	• no significant impact on recyclers • chance of new sales for dealers	• additional (indirect) cost to dealers