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End-of-Life Management of Cell Phones in the United States

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Introduction

End-of-Life Cell Phone Challenges
- Waste and Toxicity
- Material and Energy Recovery Opportunities
- Residual Economic Value
- High Replacement Rate (130 million units retired/yr)
- Design Trends

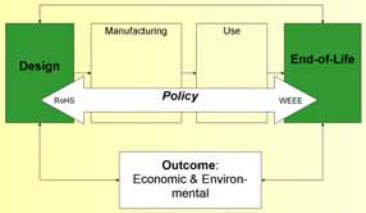
Policy Options
- Mandatory Take-back
- Voluntary Programs

End-of-Life Management Options
- Reuse of Product
- Reuse of Components
- Recycling of Materials

Objectives

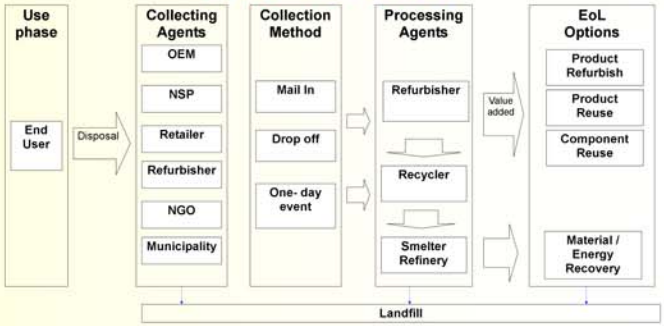
- Recommend optimal management for the end-of-life fate of cell phones in the United States
- Combine design, policy and end-of-life considerations to optimize market outcome
- Maximize net economic outcome and minimize environmental impact

Project Scope & Approach



- Multi-source research: literature review, web search, interview with industry stakeholders, phone collection campaign, and recycling process conducted by third party recycler.
- Multi-factor analysis: market, technology, environment, ethics, economics, and politics.

Process Overview



Collection & Recycling Process

Collection & Sorting

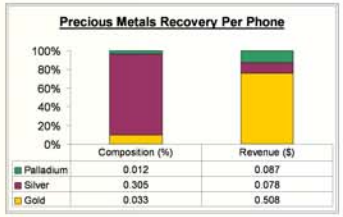
Shredding

Smelting & Pouring

Slag & Metal Bars

Project Recycling Results

- Average age of recycled phones in the market is ~ 6 years.
- Recycling process yielded 0.35% of precious metals and ~7% of copper per cell phone. Composition depends on sample age and design trends.
- Precious metals rendered < $1 per cell phone. Gold represented 80% of the revenue.
- Profit margin rendered < $0.10 per cell phone emphasizing the importance of economy of scale in this business.
- Process profitability is highly sensitive to metal market volatility.
- Recyclers cannot afford to bear collection cost.



	Composition (%)	Revenue ($)
Palladium	0.012	0.087
Silver	0.305	0.078
Gold	0.033	0.508

Findings

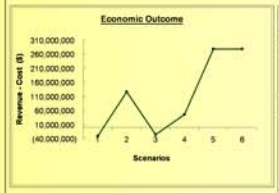
Policy & Design
- There is no national legislation regarding e-waste in the United States. However, there are various initiatives at the state level
- Previous legislation mechanisms focused on process (WEEE) and product (RoHS)
- Design trends show miniaturization, a decrease in precious metals, and a variation in toxicity
- Current design trends will affect EoL operation in the upcoming years

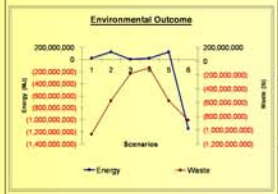
End of Life Options

Economic performance
- Collection and pre-processing account for 80% of entire EoL cost
- Current market (65% reuse) is profitable: 95% comes from second-hand market, the rest from recycling
- Different collection methods yield different quality of phones affecting their EoL fate and residual value accordingly

Environmental performance
- Assuming no displacement of new phone production, all processes are energy consuming. The larger the market operation becomes, the higher the energy consumption
- There is an aggregate amount of waste displaced in the market when recycling results in the reduction of ore mining
- Material recovery increases with recycling

Sensitivity and Scenario Analysis





Economic outcome
- Minimum reuse rate is required to sustain a positive economic outcome
- Collection rate enhances the economic outcome
- Second-hand phone value plays an important role in the market profitability

Environmental outcome
- High collection rate results in high amount of avoided waste and material recovered; this also results in increased energy consumption
- High recycling rate is preferred as long as there is zero displacement of new cell phone production
- If displacement is assumed, reuse is preferred since the environmental performance aligns positively with the economic outcome

Conclusions & Recommendations

Results highlight the importance of the reuse rate, the economy of scale, and the value of second-hand phones.

- Set a minimum reuse target to all stakeholders involved in the processing stage. This will ensure a positive economic market outcome.
- Foster high collection rates to create economy of scale and decrease associated waste. policy makers should set a minimum collection target for OEMs and NSPs and consider incentives for end-users (i.e., tax credits, deposit mechanisms).
- Use existing infrastructure of retailers and network service providers to interact with end-users in order to minimize capital investment and shipping transactions
- Share reverse logistics efforts between supply chain agents in order to improve efficiency
- Focus on capturing high-end cell phones to maximize profits
- Develop a sound displacement strategy
- Ban cell phones from landfills
- Promote design for disassembly and recyclability by providing guidelines and tax credits for advanced DfE R&D efforts
- Create flexible mechanisms to allow OEMs take-back their own products to incentivize DfE