Promoting Cleaner Technology in Mining: Andean Region Case Study

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Sustainable Development Context

- Agenda 21 – Rio 1992: "promote, facilitate and finance as appropriate, the access to and transfer of environmentally sustainable technology and corresponding know-how, in particular to developing countries"

- Rio + 10 – Johannesburg 2002 Plan of Implementation priorities:
  - ✓ poverty eradication
  - ✓ sustainable production and consumption
  - ✓ sustainable management of natural resources

Sustainable Development

Classic Definition:

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

United Kingdom Definition: "Sustainable development is about ensuring a better quality of life for everyone, now and for generations to come."

Pollution Response Options

1. Do Nothing
2. Discharge to Environment
3. Treat at End-of-Pipe
4. Prevention

Why Pollution Prevention is More Viable than End-Of-Pipe Systems

Traditional "End-of-Pipe"	Paradigm Shift	Appropriate Pollution Prevention (PP)
Cost effective control of waste **after** generation.	**Goal**	Cost effective reduction of waste **before** generation.
Address pollution after the fact. Manage to reduce impacts on the environment after generation.	**Focus**	Prevent the release of waste to the environment before the waste is ever produced or generated.
Arbitrary delineation of hazardous and non-hazardous waste. Management methods vary by type of waste (e.g., hazardous vs. Non-hazardous)	**Wastes of Concern**	All releases to the environment are treated equally.
Approaches are defined separately for each environmental medium.	**Media**	Multimedia - Approach is integrated and addresses all releases to all media.
Increases operating costs. (True for over 25 years in U.S.)	**Costs**	No automatic increase in operating costs, and most costs can be recovered within a few years.

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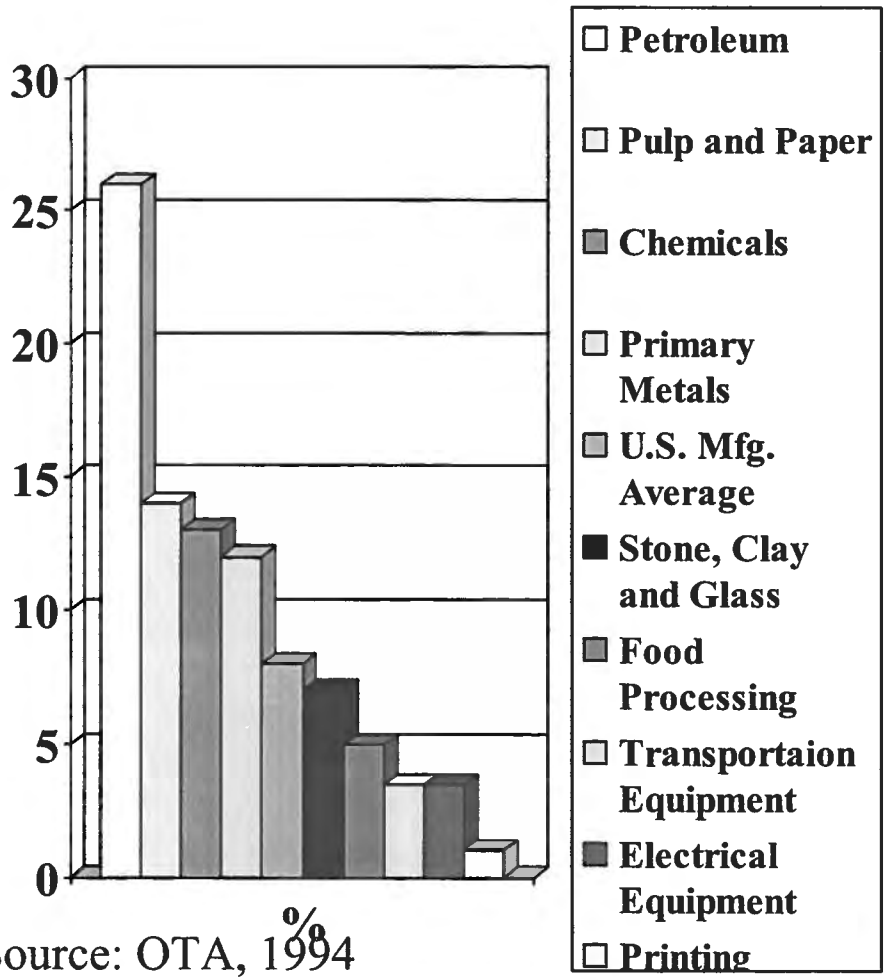
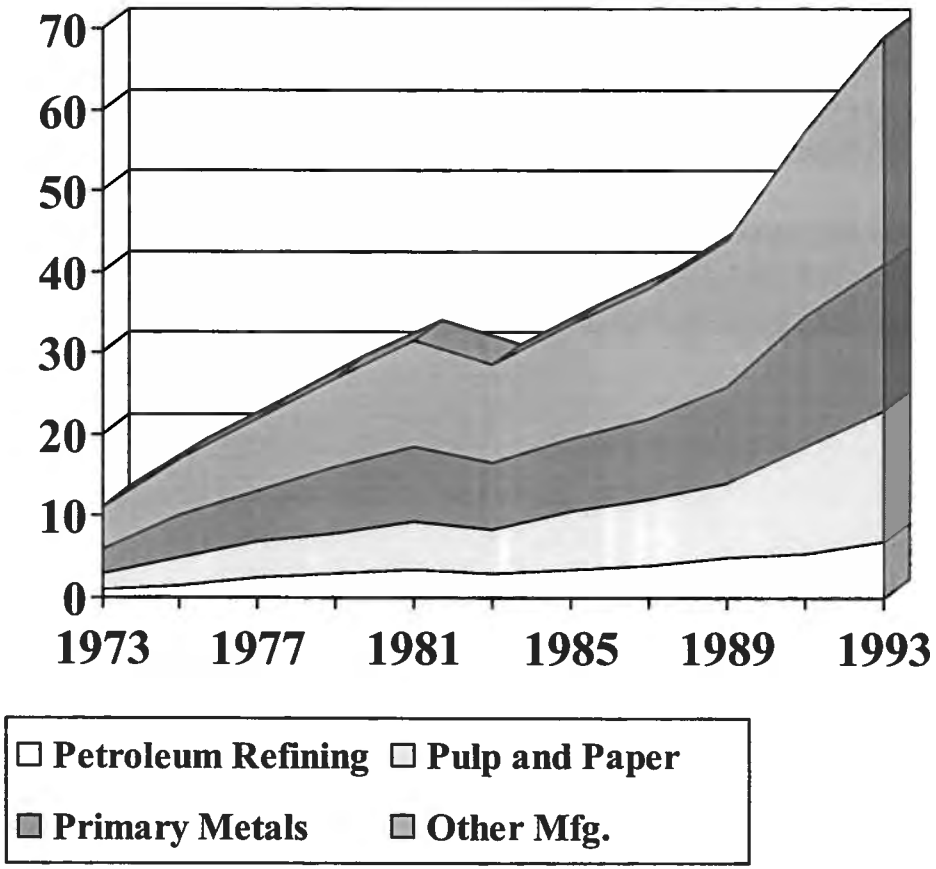
U.S. Industrial Experience: Cost of End-of-Pipe Control Technology

Percent of Capital Expenditures (1993)



Source: OTA, 1994

Treatment Costs and Expenditures (1973 - 1992) in US$ billion



The Waste Management Hierarchy

Reduction at the Source

↓

Recycle within the process

↓

Recycle within the Plant

↓

Recycle Outside the Plant

↓

Waste Treatment

↓

Landfill Disposal

Growth with a Small Footprint: Environmental Management Example

Reduction at the Source

Change Product

- Design for reduced environmental impact
- Increase life of product

Change Process

Improve Operations

- O&M processes
- Administrative practices
- Segregate Effluents
- Improve management of materials
- Organization of production
- Inventory control
- Training
- Segregate wastes

Change Technology

- Know-how
- Increase automation
- Improve operations
- Improve equipment
- New technology
- Greening supply chain

Raw Material Changes

- Purify materials
- Substitute materials for less toxic alternatives

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Waste Minimization Returns

STEP 1: GOOD HOUSEKEEPING

Most cost efficient, easiest, and most effective method of achieving waste minimization

STEP 2: RECYCLING & REUSE

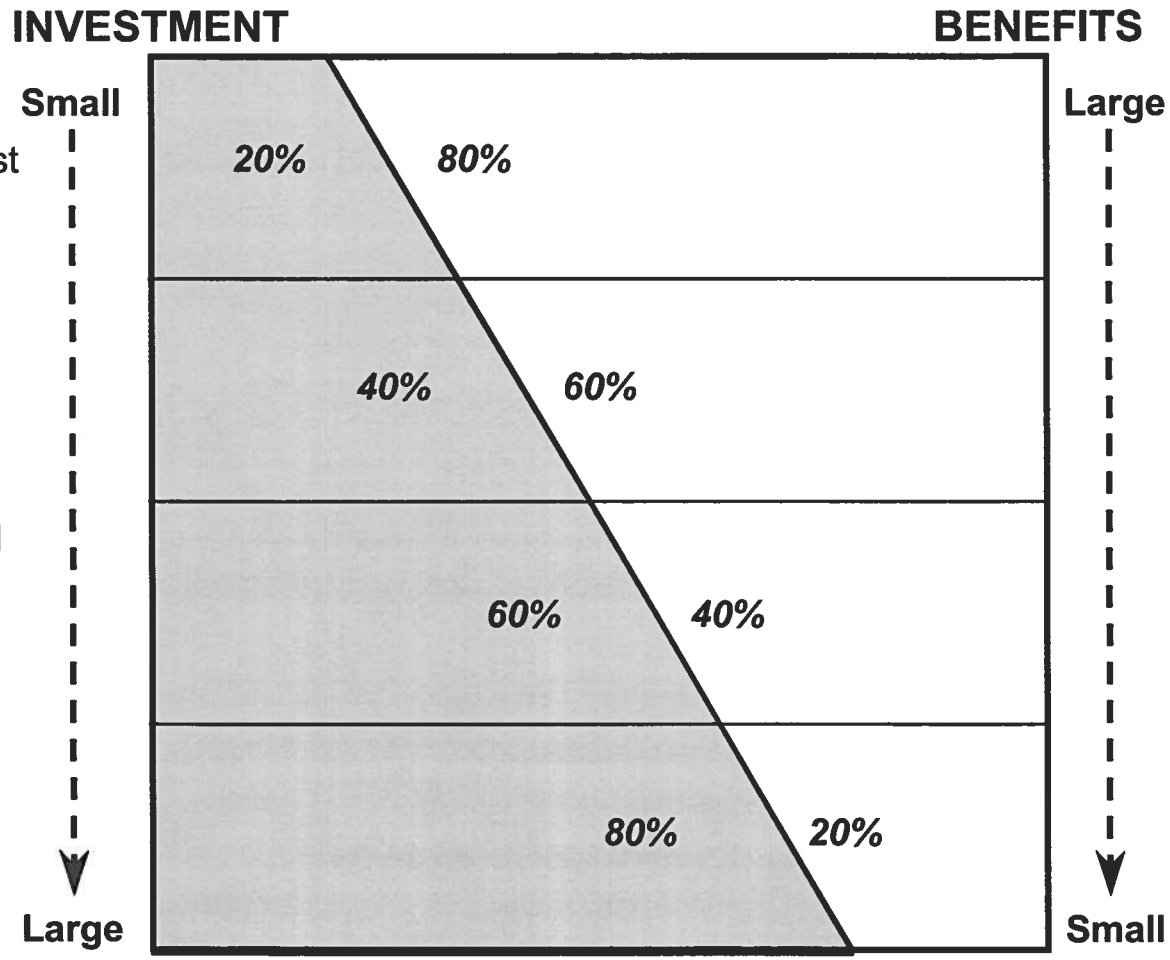
Cost effecient, easy, and effective method of achieving waste minimization

STEP 3: MATERIALS SUBSTITUTION

Practices are costly, but effective in achieving waste minimization

STEP 4: PROCESS MODIFICATION

Practices are the most expensive, but also the most efficient and most effective waste minimization



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Growth with a Small Footprint: Technology Transfer for Sustainability

Technology Transfer is integral to the solution:

USAID promotes innovative technology solutions in energy, environment, and information technology that enable SMEs and municipalities in emerging and underdeveloped markets to increase efficiency and competitiveness and solve development problems leading to a more robust foundation for economic growth.

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USAID's Role: Catalyst for Competitiveness

Traditional Federal Role →

1. Federal Investment
2. R&D
3. Intellectual Property

Traditional Private Sector Role →

4. Private Investment
5. Prototyping
6. Product Development
7. Commercialization

USAID's Role Today →

7. Catalyst:
   - market framework
   - technology demonstrations
   - training / TA

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USAID's Role
Technology Transfer

Approach:

- **Identify innovators/pioneers in developing countries to adopt technology and demonstrate applications to other early adopters.**
- **Assist U.S. technology providers to identify potential markets and partners, including investors.**
- **Increase drivers of demand: support for FTA's, certifications, policy, regulatory compliance, etc.**

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USAID's Role
Technology Transfer

Tools:

- Technical assistance, training, institutional strengthening
- Professional exchanges
- Demonstration projects
- Case study dissemination
- Publications, conferences, workshops
- Partnerships with U.S. and local entrepreneurs, Missions, businesses, investors, other donors, NGOs, technology centers, and universities.

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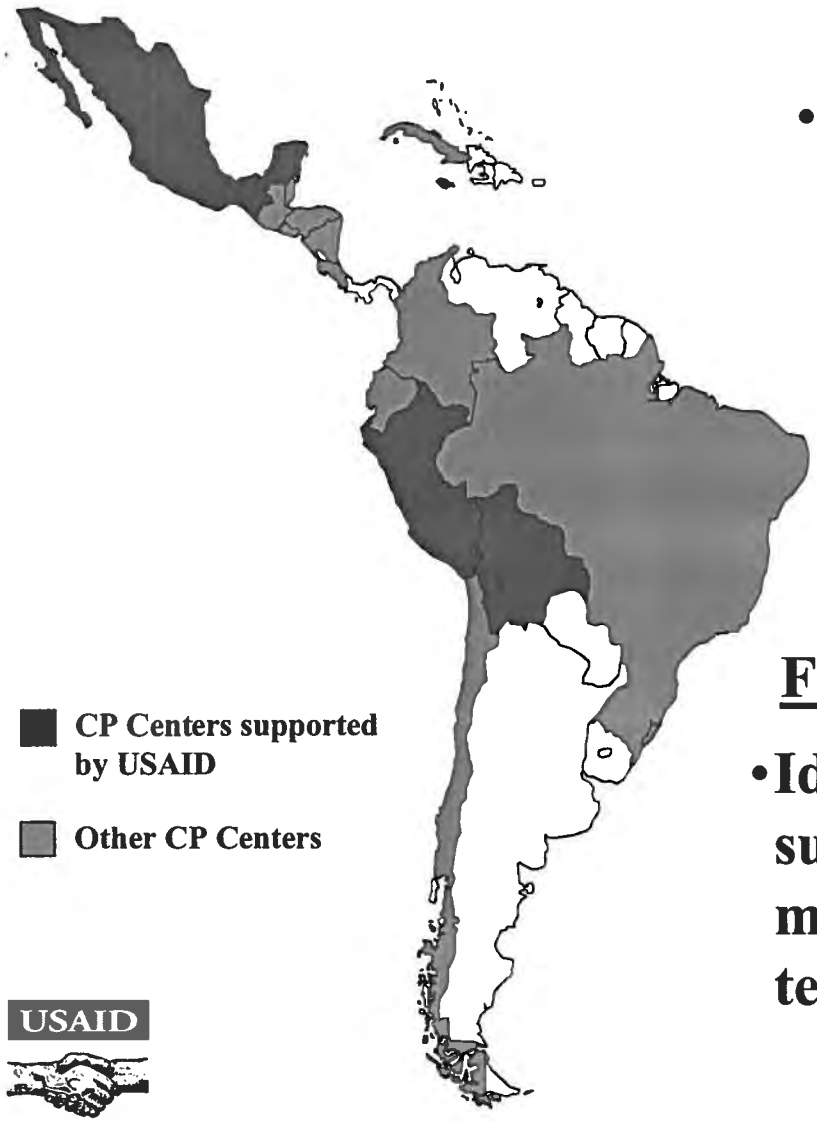
Results in LAC: A Case Study



Policy Support:

- Enhanced regulatory and institutional capacity of relevant government agencies and municipalities

Financing Support:

- Identified and supported financing mechanisms for technology transfer

Industrial Sectors:

- Cement
- Chemicals
- Electroplating
- Fish meal
- Food & beverage
- Hospitals
- Leather tanning
- Metal finishing
- Mining
- Paper and wood
- Textiles
- Tourism

Production of Selected Nonferrous Metals in South America, 1996

Country	Cu	Pb	Zn	Au	Ag	Sn	Al
Bolivia	0.1	16.5	145.1	12.6	0.4	14.8	
Brazil	46.2	6.0	167.4	76.8	0.1	20.3	10.0
Chile	3,052.4	1.1	35.6	51.8	1.0	0	
Peru	479.4	248.6	758.4	66.1	1.9	26.7	
Subtotal	3,578.1	272.2	1,106.5	207.3	3.4	61.8	10.0
Total L.A.	3,905.9	452.2	1,524.0	238.0	4.7	61.8	33.21
% of total L.A.	91.6	60.1	72.6	87.1	72.3	100	30.1

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(thousands MT except Au, MT)
Source: World Bureau of Mining Statistics (1997)

Mineral Production in Selected Latin American Countries

Country	Production Value 1994 (US$ M)	Share in the GDP (%)	Share in Exports (%)
Bolivia	450	5-10	25-50
Brazil	6,000	1-5	5-10
Chile	5,600	10-25	25-50
Colombia	1,500	1-5	10-25
Ecuador	120	<1	1-5
Peru	2,120	11(*)	46(*)
Venezuela	800	1-5	1-5

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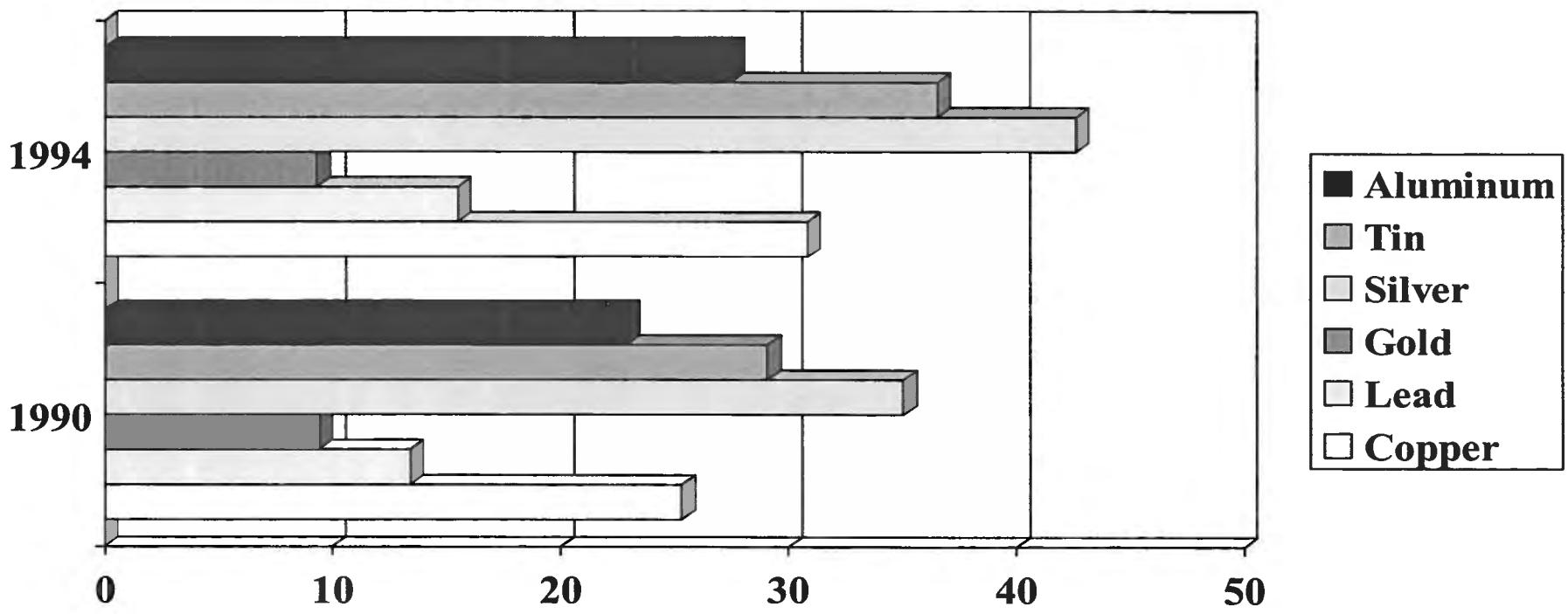
Sources: World Bank, 1996; (*) MEM, 1998

Share of Latin America in the World's Production of Selected Nonferrous Metals, %



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Source: World Bureau of Mining Statistics, 1996
World Resources Institute, 1997

Principal Waste Streams from Metals Mining and Processing

- Principal Waste Streams
  - Mining
    - Waste rock
    - Overburden
    - Mine water
    - Acid drainage
    - Dust
  - Ore processing
    - Tailings
    - Process water
    - Acid drainage
    - Dust
  - Metals processing and refining
    - Emissions
      - SO2
      - Particulates
      - Volatile compunds
    - Wastewater - heavy metals
    - Solid waste - slag

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"Best Management Practices in Nonferrous Mining and Processing" -- A Practical Manual

- Objective of the manual – to describe the technologies and environmental management practices that offer:
  - greatest opportunity for environmental protection, and
  - cost savings through pollution prevention and control
- The manual discusses typical wastes and clean mitigation measures in:
  - Mining and Extraction
  - Ore Processing
  - Metals Processing and Refining
- The manual includes guidance in establishing an Environmental Management System at the company level.

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Mining Waste Mitigation Measures

Process	*Mitigation Measures*
Mining and Extraction	• Backfilling of waste rock into dry mine workings • Maximizing the use of waste rock of overburden in reclamation • Selective placement/covering of acid generating materials • Separation of wastewater flows according to water quality and final treatment and disposal methods • Wastewater evaporation and reuse in processing operations • Proper design of ventilation systems • Use of dust suppressants
Ore Processing	• Separation of wastewater flows according to water quality and final treatment and disposal methods • Wastewater evaporation and reuse in processing operations • Maximizing the reclaim/reuse of tailings water • Collecting and treating runoff/seepage from tailings
Metal Processing & Refining	• Process water reuse • Slag reprocessing if metal content is high enough • Using baghouses to capture and reuse particulate losses • Using dry air pollution control methods such as sulfur fixation equipment • Using improved techniques during ore processing to prevent toxic contaminants from accompanying the metal concentrate to the furnace

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Pollution Prevention Options - Metal Finishing Plant in Ecuador

Recommendation	Capital Costs	Savings/yr	Environmental Benefits
1. Switch to Counter-Current and Still Rinsing	$5,000	$55,000	Reduction in water use
2. Extend lifetime of caustic etch through selective removal of aluminum	$300,000	$77,000	Reduction in etchant disposal and chemical use
3. Extend lifetime of anodizing baths through selective removal of aluminum	$40,000	$98,000/yr	Reduction in anodizing bath disposal and chemical use
4. Recovery of sodium hydroxide from caustic etch rinse bath	$5,000	$4,600/yr	Reduction in chemical consumption
5. Install additional drain boards to reduce chemical losses	$90	$500/yr	Reduction in chemical losses
6. Control toxic fumes and heat losses from process baths	$11,000	$29,000/yr	Reduction in energy costs & improved worker safety
7. Recovery of sodium hydroxide from die cleaning operation	paid in option 2	$12,300/yr	Increase in etchant life

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Average payback period = 14 months

Future Objectives for LAC Mining

- Develop trained manpower to incorporate clean technology (CT) and complete audits
- Provide access to technical assistance and information for up-to-date "know-how"
- Corporate Social Responsibility
- Financial assistance to understand short pay-back periods for CT
- Fiscal incentives to tilt towards CT adoption

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Future Objectives… (cont.)

- Create proper water/energy pricing policies to encourage true cost accounting
- Reduce emphasis on EOP to a minimum by using principles of CT
- Establish long-term industrial policy for sustainable development
- Institutional support from both public and private sector

"The difficulty lies, not in the new ideas, but in escaping the old ones"

- John Maynard Keynes

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