# Material and Process Selection Methodology: A Data Cable Case Study

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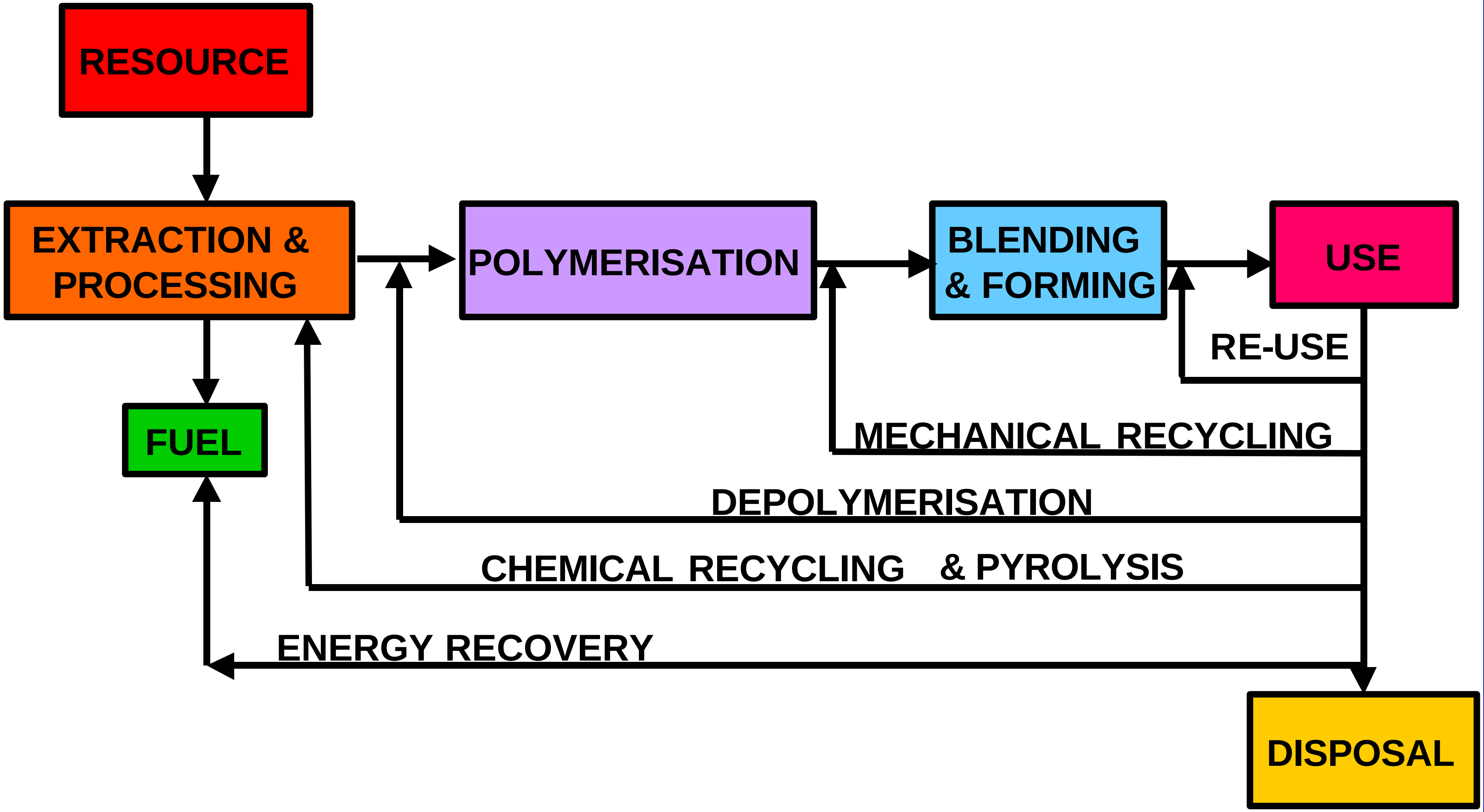
# Background

- Category 5 cables have become the standard for LANs with 80% market share.
- Increasing pressures from Producer Responsibility to take back used product in addition to environmental procurement.
- These pressures are driving the research to look at alternative cable designs in addition to various methods of waste disposal.
- Decisions must be based on technical and economic grounds as well as environmental considerations.
- This highlights a need for a multi-attribute decision making tool

# Methodology

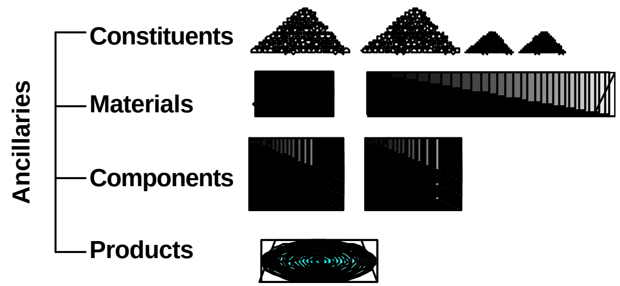
- The methodology has been developed under a UK EPSRC DTI-LINK Project
- The methodology will deliver a decision tool called CHAMP
- Prime objective is to identify optimum re-use and recycling routes for polymer materials
- Based on Life Cycle thinking but also addresses technical and economic criteria.
- This has been developed another stage further and focuses on Life Cycle Product Design (LCPD) and cascaded use of materials.
- Also offers the ability to optimise the available options.

# Industrial Ecology of Polymers



# Methodology

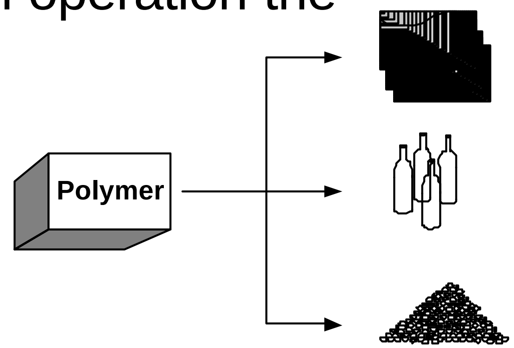
- **Approach:**
  - Model the flow of materials through a series of operations and processes throughout the life cycle of the material.
  - The methodology allows the existing process to be modelled explicitly and full logistics to be included.
- **Mass flows considered in this framework**
  - polymer
  - non-polymer



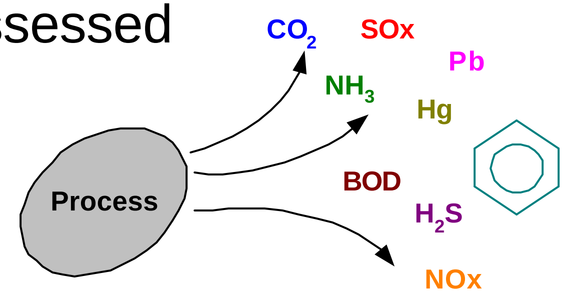

- **Cascaded Materials**
  - Opportunities for re-use and recycling can be identified
  - Suitable options are identified using several criteria
  - These options can be optimised

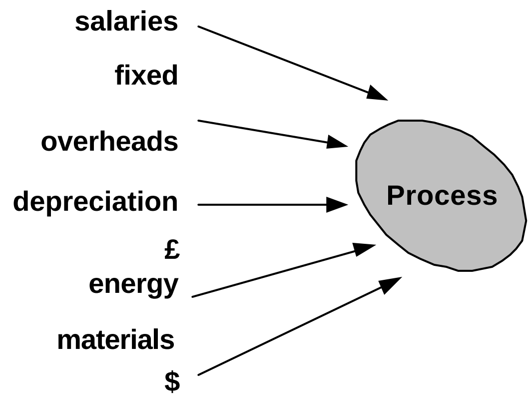
# Methodology Overview

- **Utilities**
  - *u=(thickness, colour, impact strength, melting point, …, $u_n$)*
- **Operations & Processes**
  - As a mass flow member passes through an operation the utilities will be changed.
  - operation functions can be modelled and used to predict optimal cascade options.




- **Environmental & Economic**
  - both criteria assessed



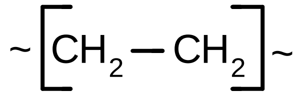



# The Case Study

- **Purpose: To develop and improve the CHAMP methodology**
- **Examined the existing cable manufacturing process and waste disposal methods**
- **Considered in detail two different jacket materials and compared any changes in environmental, technical and economic performance in the first life cycle**
- **The study has moved on to focus on cascaded use.**
- **First case study of a series of six which will be used to refine and develop the methodology. Other case studies include:**
  - Fibre optic cable design / Bottles & packaging waste
  - Electronic equipment and components / Car windshields
  - Logistical collection schemes

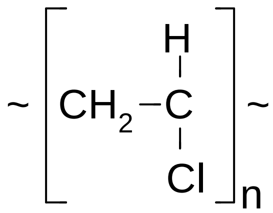
# Polymers Under Analysis

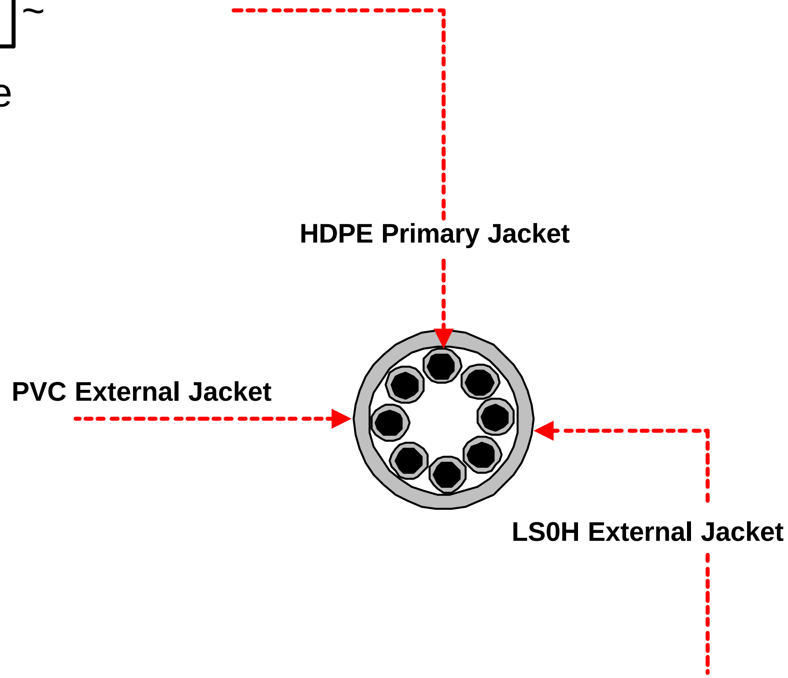
- HDPE



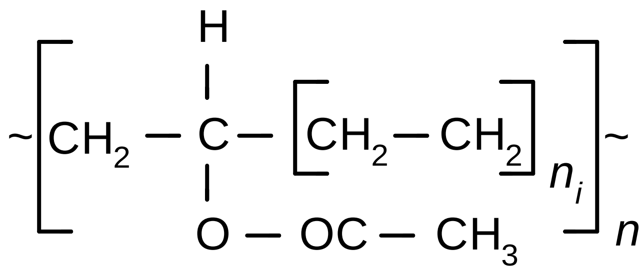
Polyethylene

- PVC





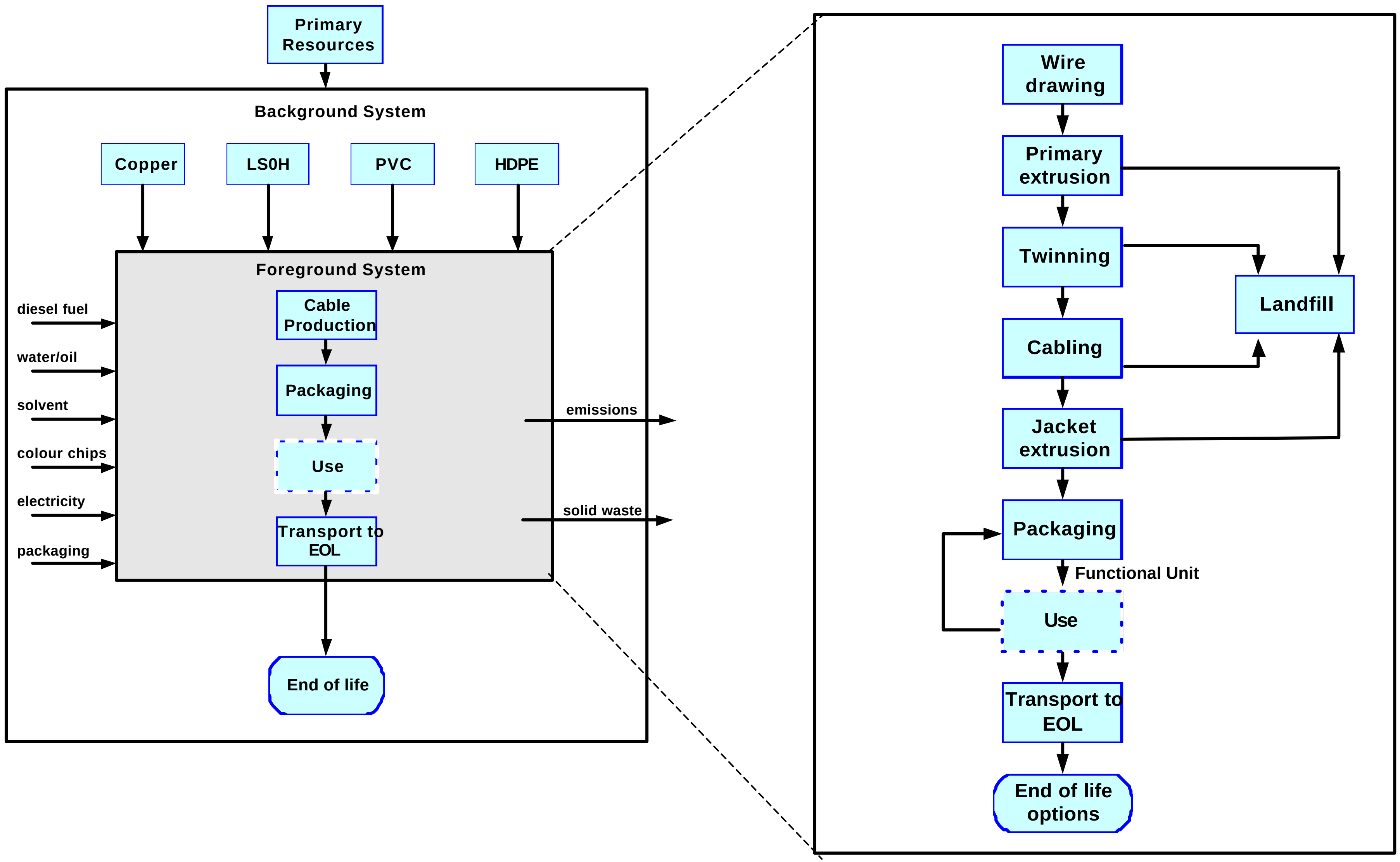

- LS0H Composition
  - 50-67% Aluminium Trihydrate ( FR)
  - 30-35% EVA
  - 1% Antioxidant



Ethylene Vinyl Acetate

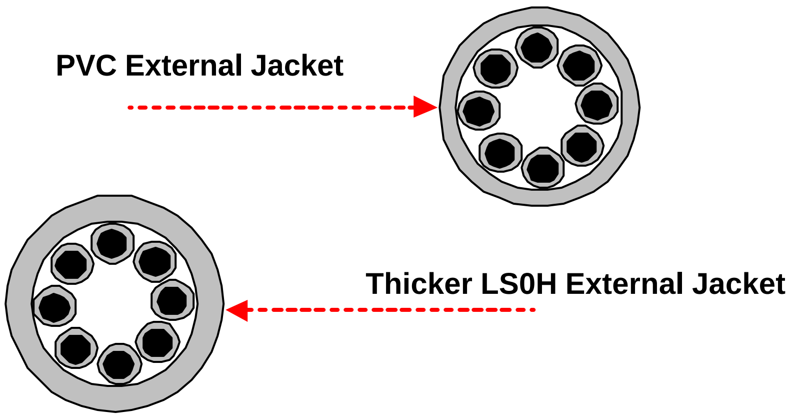
where $n_i$ = approx 140

# Background & Foreground



# Technical Analysis

- **Utilities and Key Utilities**
- **Utilities which the polymer needs to possess:**
  - Shore Hardness
  - Tensile Strength
  - Elongation
  - Shrinkage
- **Both polymers meet these requirements**
- **Differences - mass**



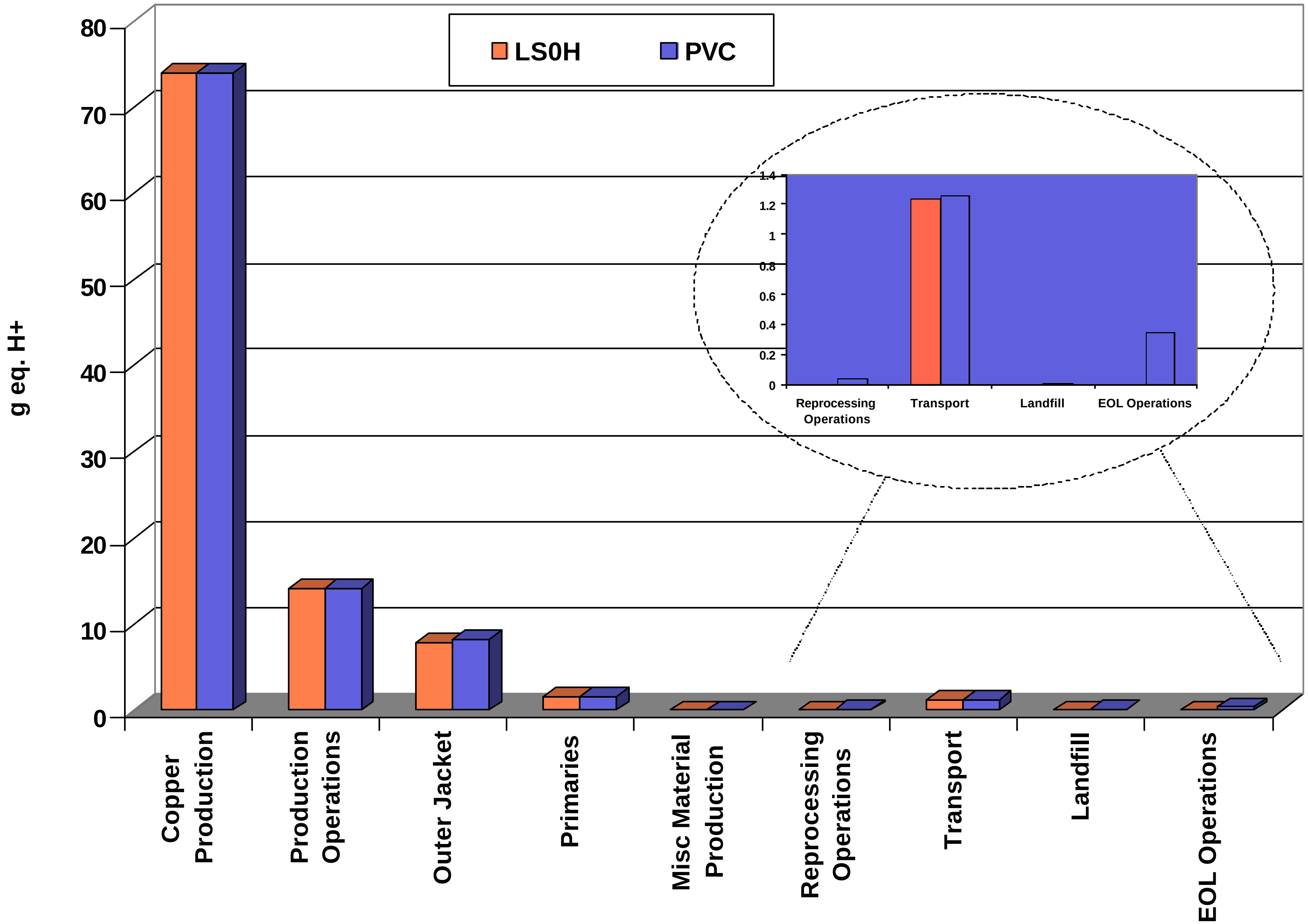
# Life Cycle & Impact Assessment

- **Carried out a LCA from Cradle to Grave on all the components of both cables within the existing system.**

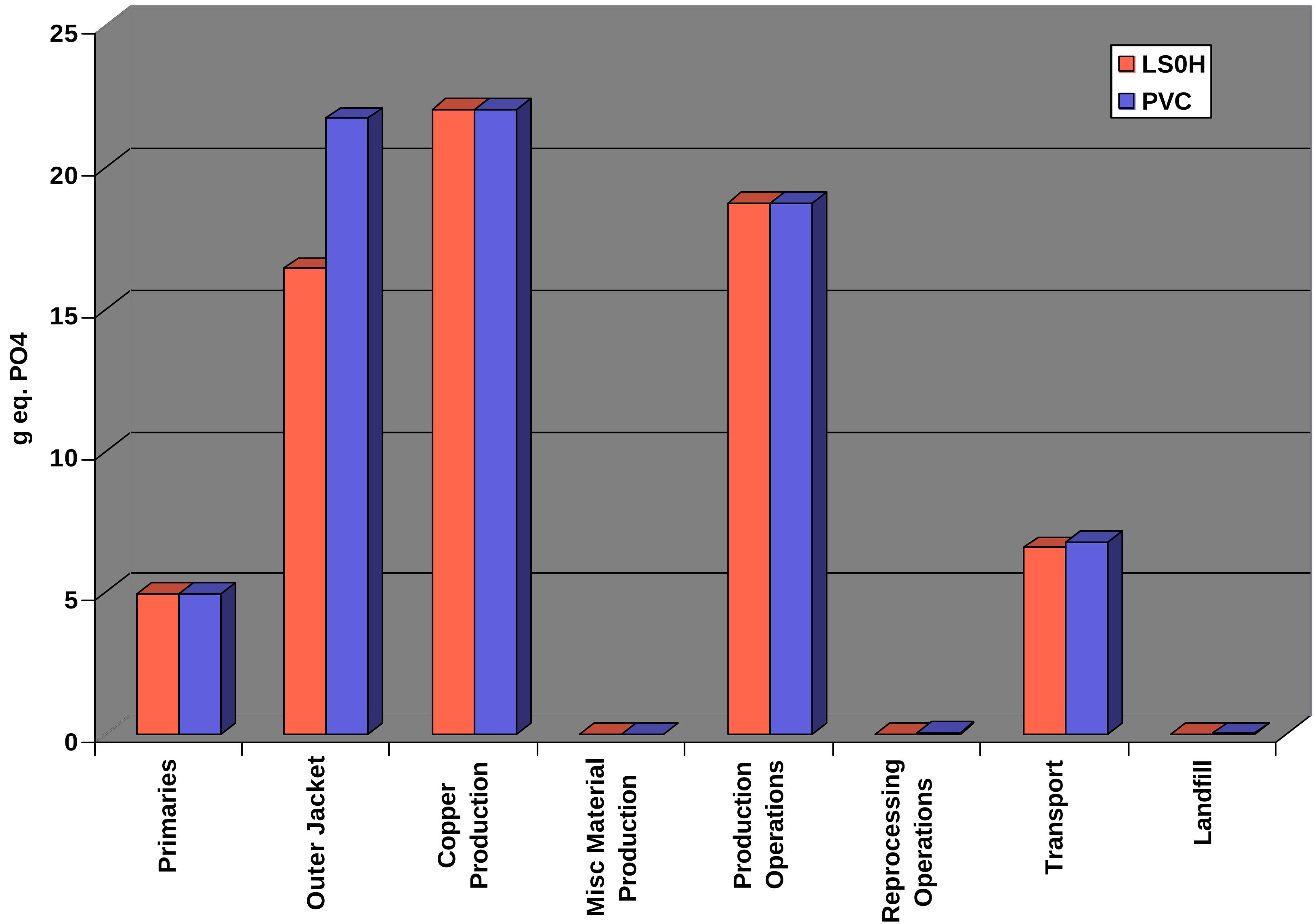
- **Assumptions**
  - EVA – 97% LDPE and 3% Vinyl acetate and LS0H – 35% EVA and 65% $Al(OH)_3$
  - The PVC used was assumed 100% pure
  - Transport type used was a 16 tonne truck
  - All operations are run for 24 hours each day and 5 days a week.
  - Both a twinning and cabling operation is used not one “Quadding” operation
  - transport costs for EOL options are included in cost of reprocessing.

- **Concentrated on the following indexes**
  - Air Acidification
  - Eutrophication - Total and Water
  - HumanToxicity
  - Aquatic Toxicity
  - Terrestrial Toxicity

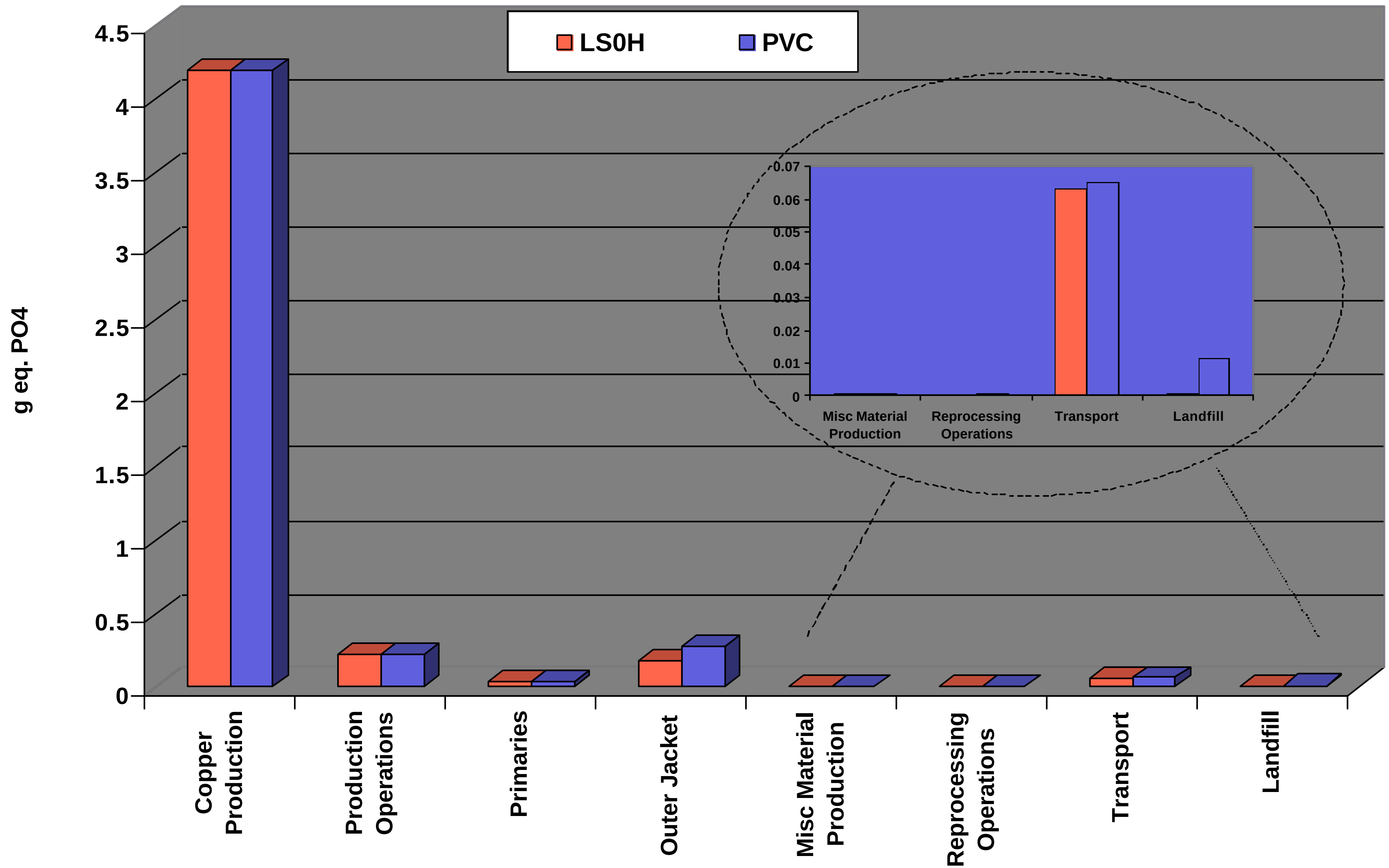
# Air Acidification



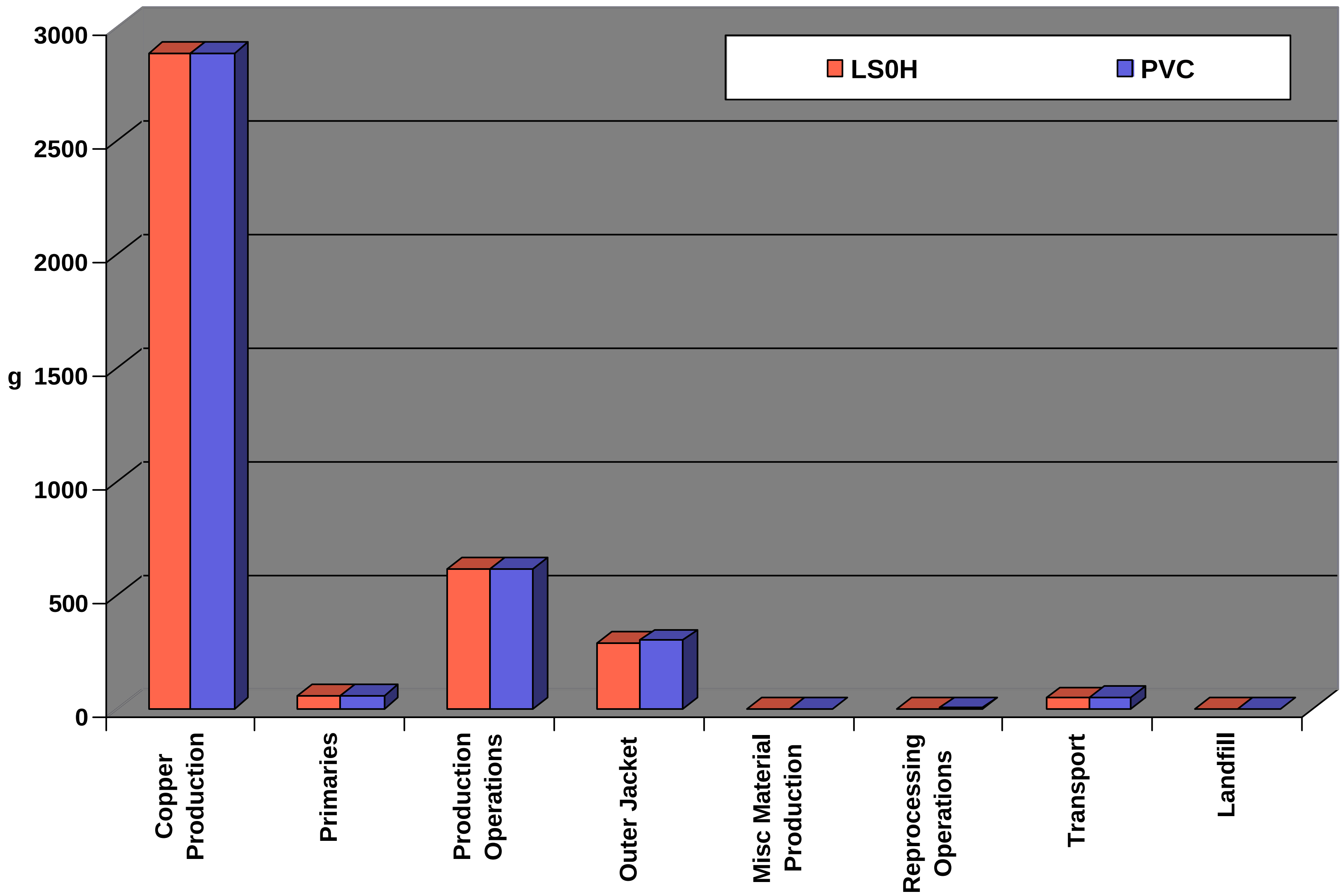
# Eutrophication



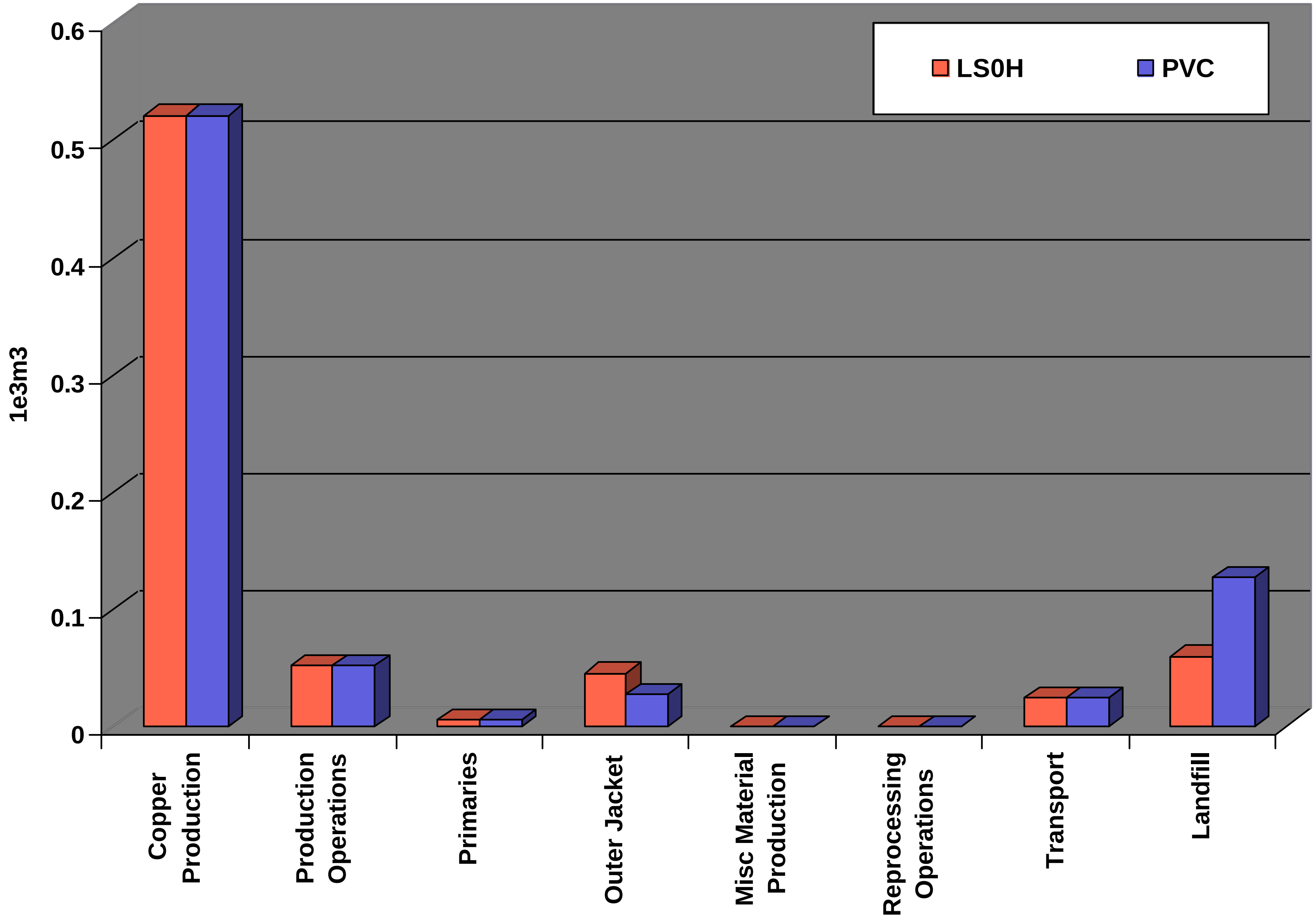
# Eutrophication (Water)



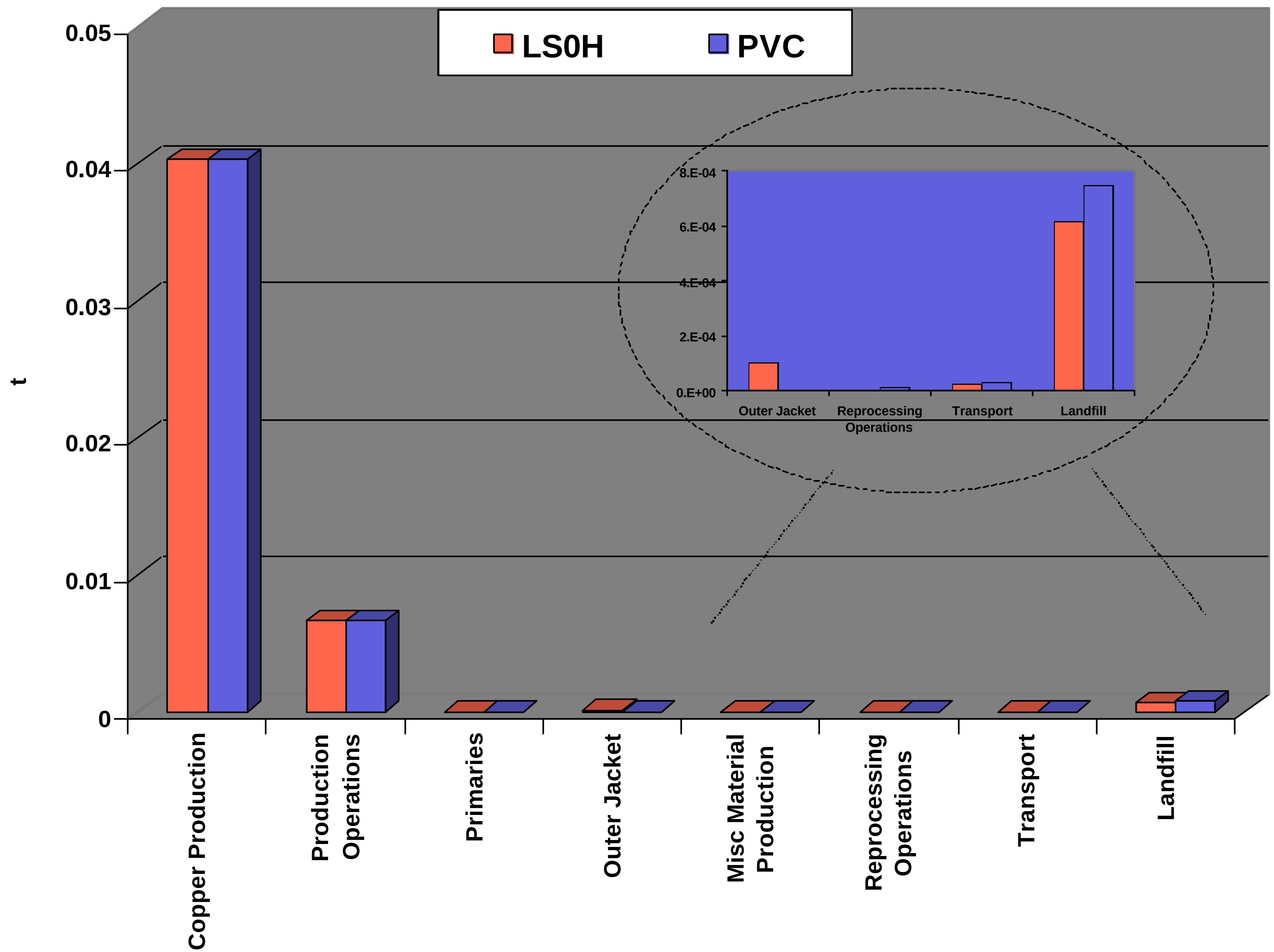
# Human Toxicity



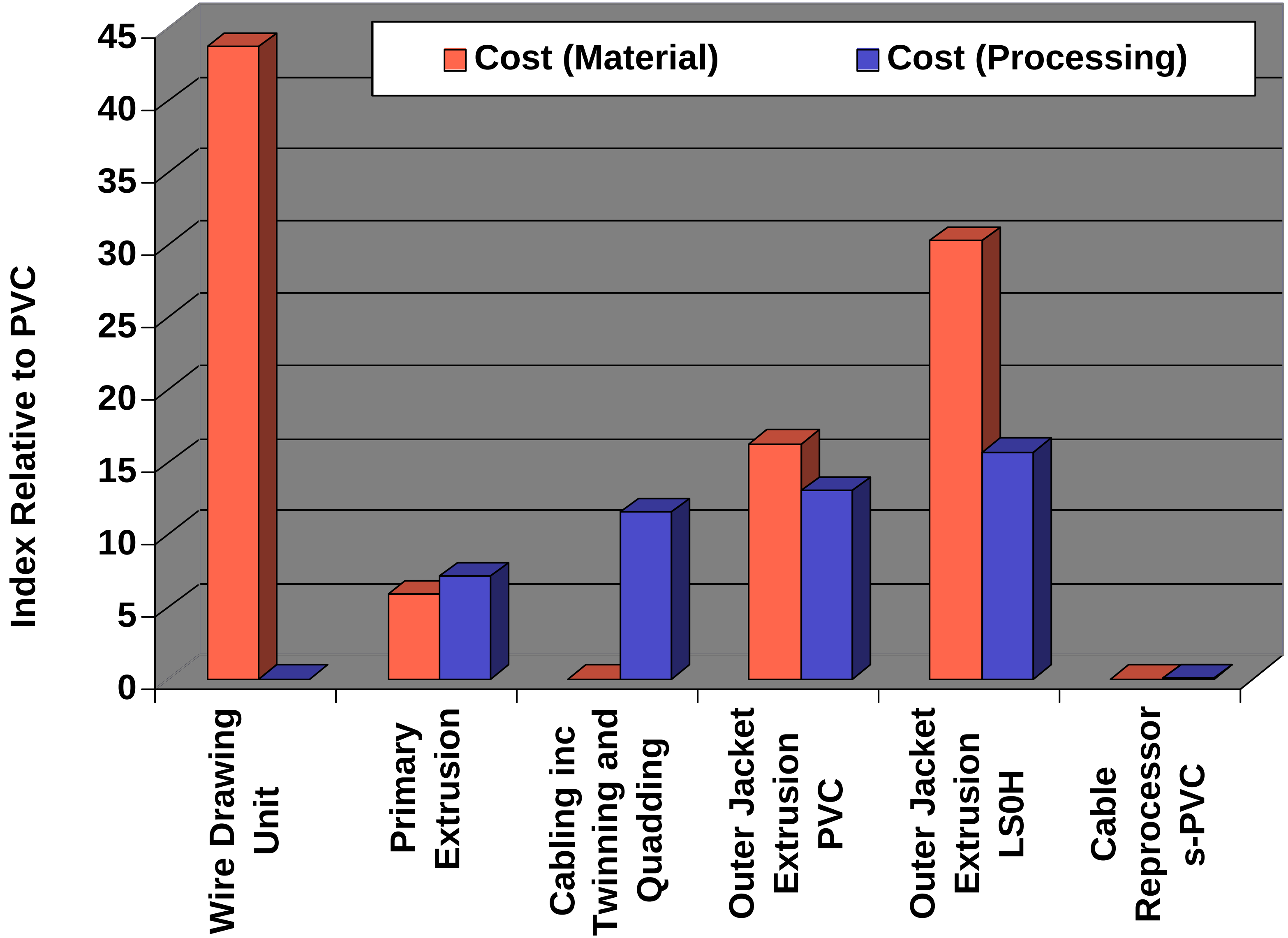
# Aquatic Eco-toxicity



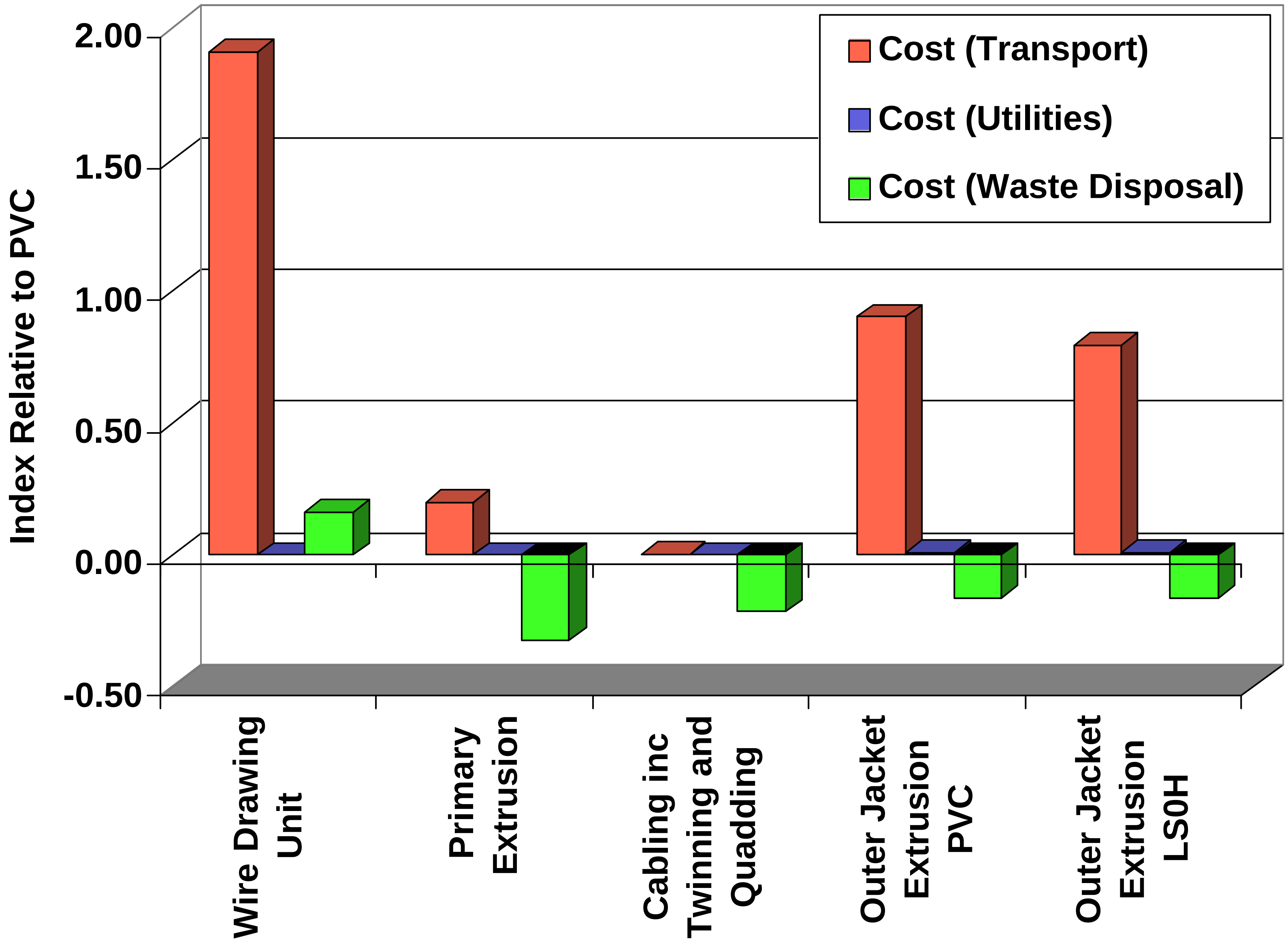
# Terrestrial Eco-toxicity



# Material and Processing Costs

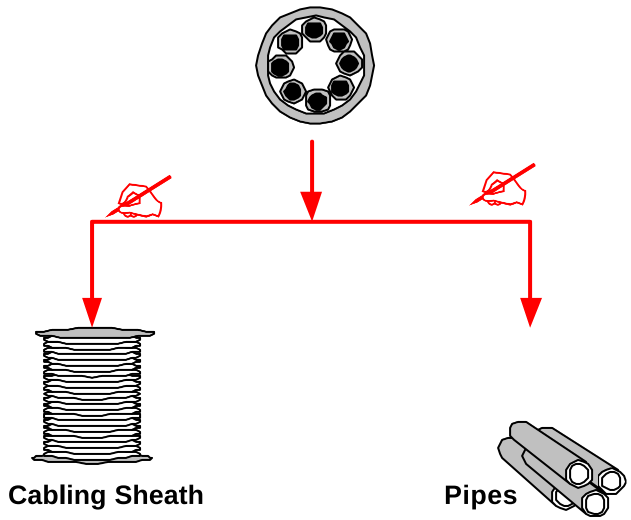


# Transport and Waste Disposal Costs



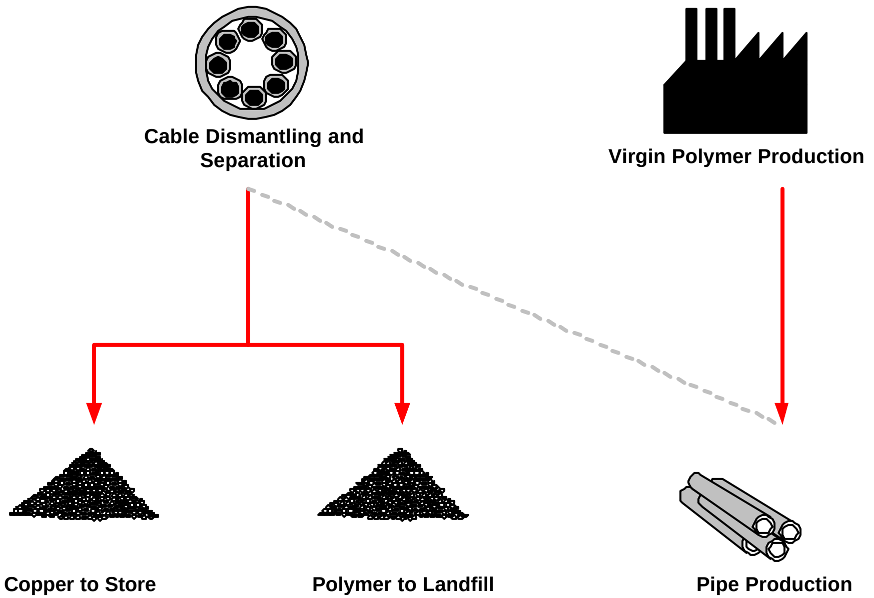
# Cascaded Systems

- **Specification from cable dismantlers**
  - energy requirements to dismantle, shred and separate
  - % purity & utilities
- **Compare these with specifications for other applications**

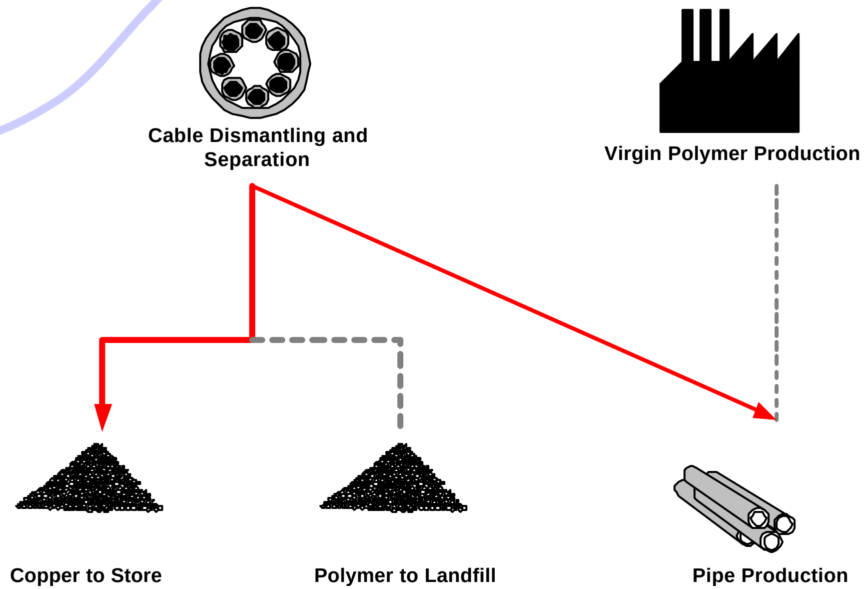



- **Re-run LCA and economic analysis comparing cascaded use vs. virgin polymer**

# Cascaded System Assessed

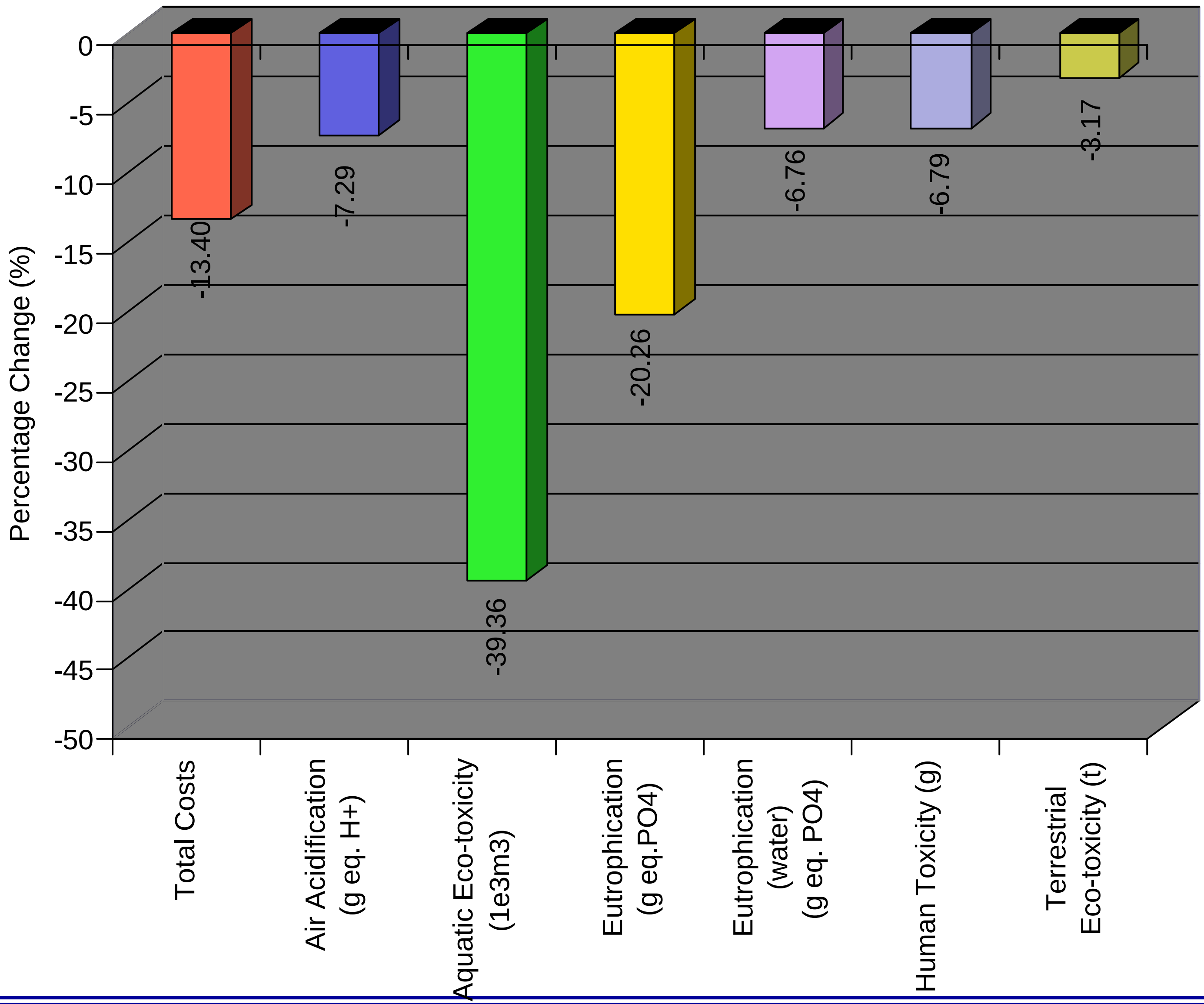



The EOL polymer is disposed of via landfill and virgin polymer is used for pipe production




The PVC from the end of life cable is mechanically recycled for use in pipe production.

# Impacts of Cascaded Use - PVC



# Overall Conclusions

- Both polymers have an almost equal impact on the environment in each category.
- Copper dominates the environmental impacts.
- PVC shows less economic impact than LS0H with the assumptions used.
- PVC shows a greater potential for recycling within the first cascade.
- Expect differences in multiple recycles - future work will focus on the maximum achievable cycle number.
- Optimisation of all materials and technical and impact criteria will increase decision making ability
- Case study illustrates the potential of the methodology to assess technical, economic and environmental impacts together.

# Contact Details

- **For further information look at our web site:**

**www.surrey.ac.uk/CHAMP/**

- **Or contact us by email:**

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