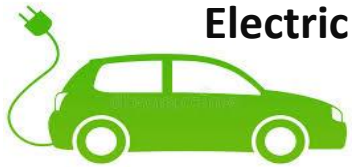
Life Cycle Assessment

Systems Thinking: Electric Cars Example

Petrol Car

115 g CO_2 emissions / km

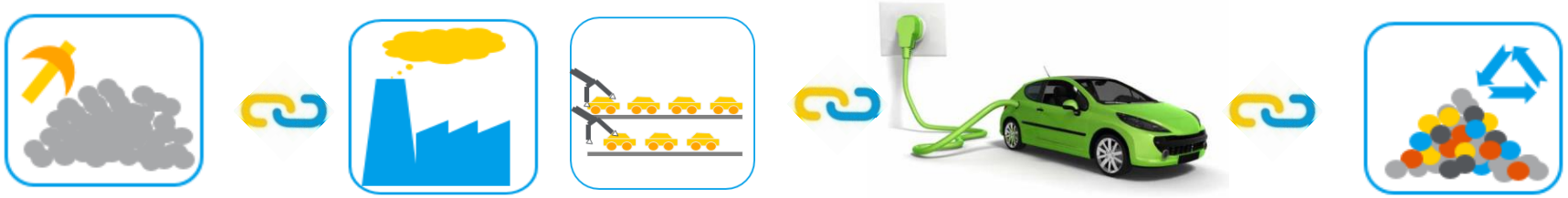
Electric Car



0 g CO_2 emissions / km

Coal Source

Electricity



Raw Materials

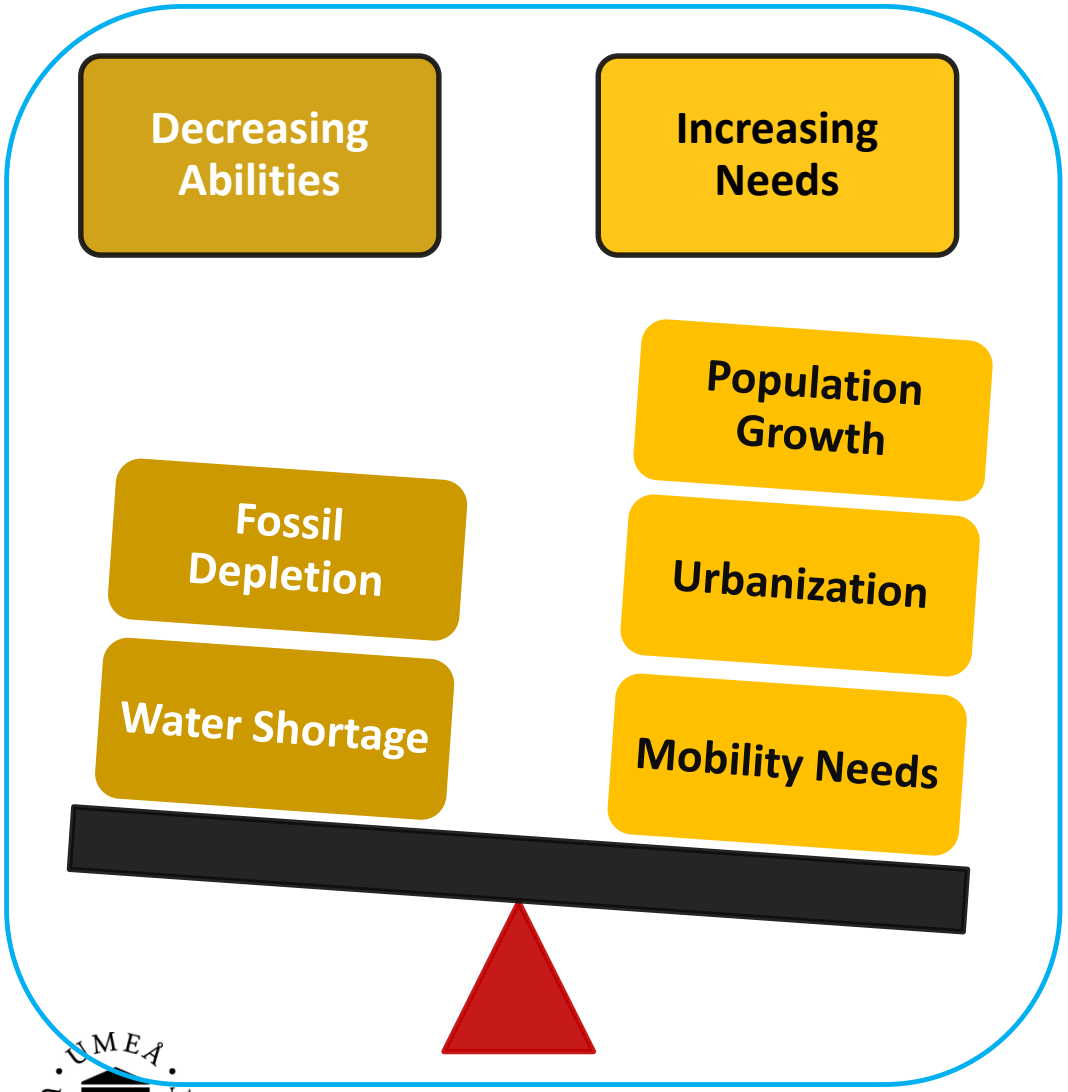
Manufacturing

Car Operation

Disposal

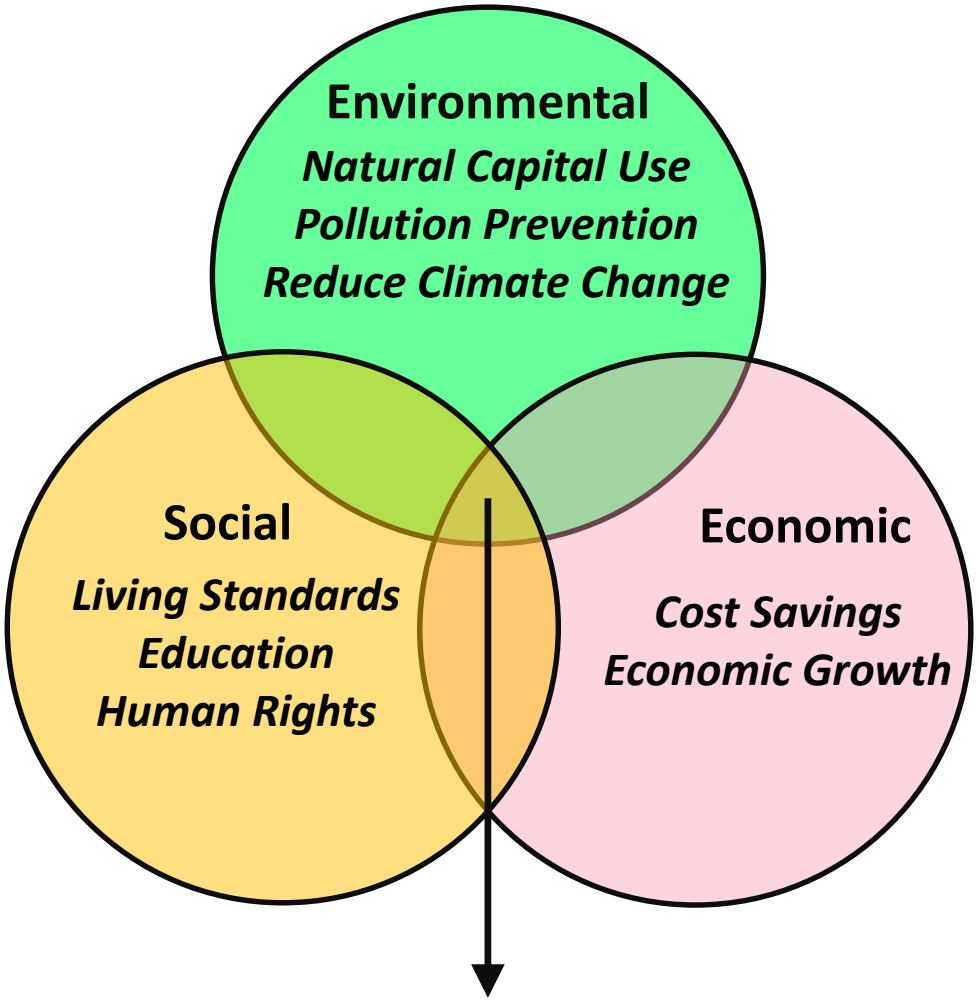
282 gCO_2 emissions / km

Imbalance Results in Multiple Sustainability Challenges



UMEÅ UNIVERSITET

Sustainable Development & Three Pillars



Sustainable Development

Development that meets present *needs* without compromising *ability* of future generations to meet their own *needs*

Tools for Measurement of Sustainability

Measurement of Effective Utilization of Natural Resources

Life Cycle Assessment (LCA)

Material Flow Analysis (MFA)

Ecosystem Services

Energy and Carbon Footprints

Measurement of Effective Utilization of Economic Resources

Life Cycle Costs

Techno-Economic Analysis

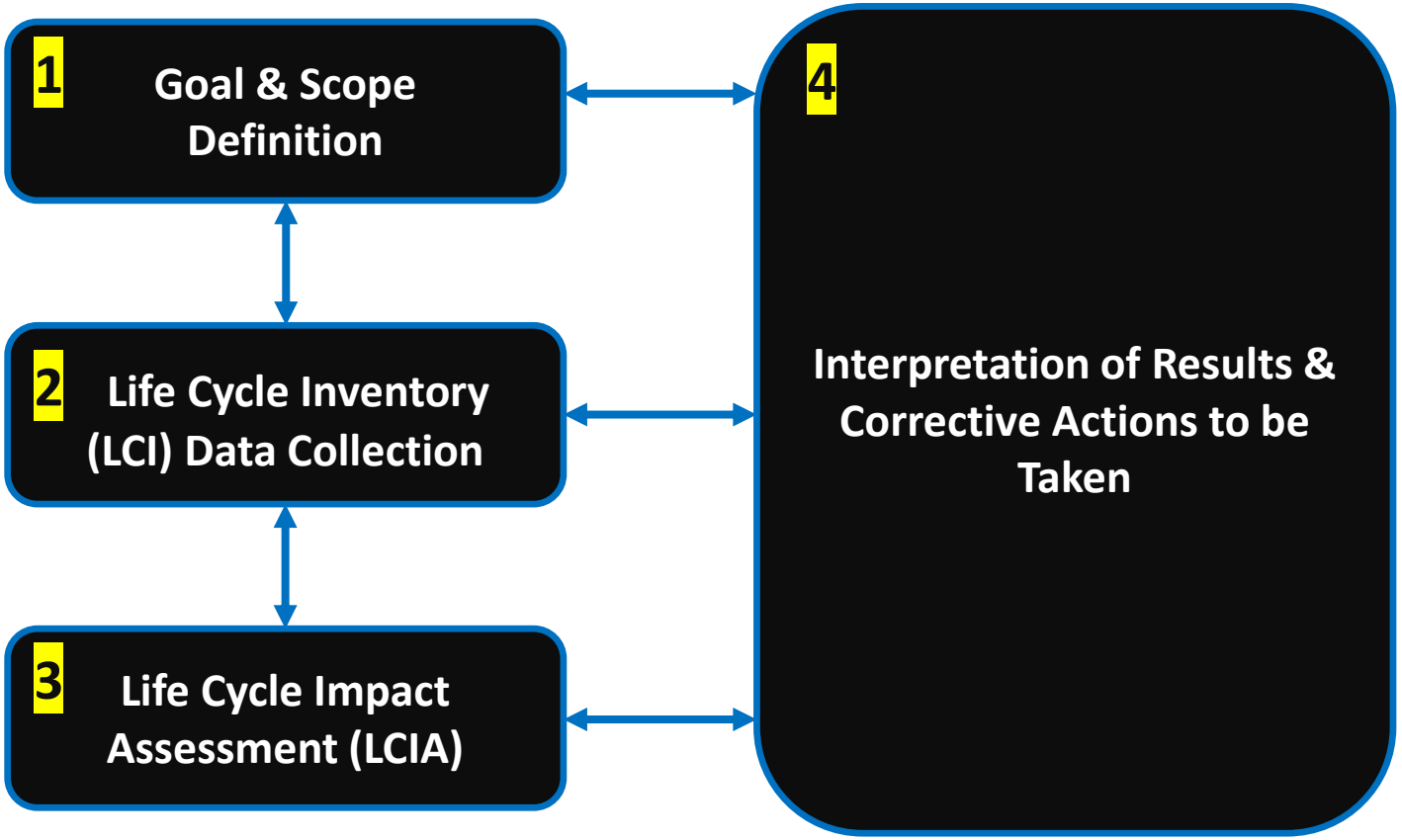
Measurement of Effective Utilization of Social Resources

Social LCA

Customer Surveys

What is Life Cycle Assessment (LCA) & Its Steps

LCA is a Tool to Measure and Quantify Environmental Impacts of a Product, Process or a Service



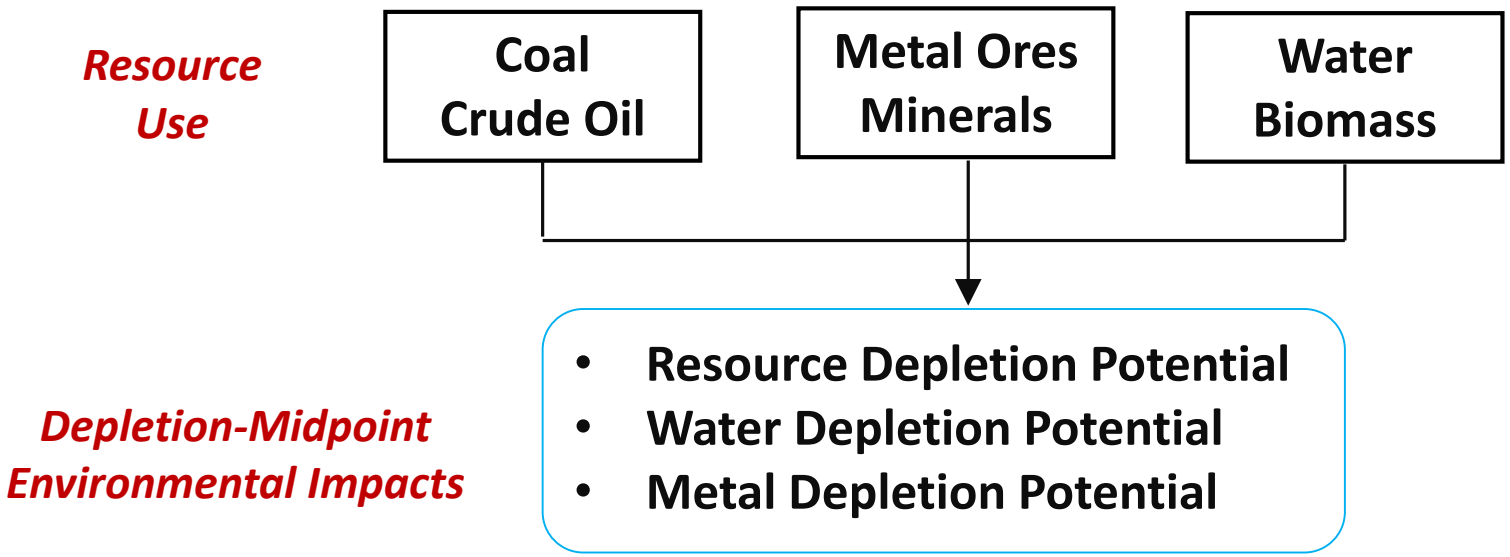
LCA Steps According to International Standards Organization (ISO) 14040 Standard

Sources of Life Cycle Inventory (LCI) Data Collection

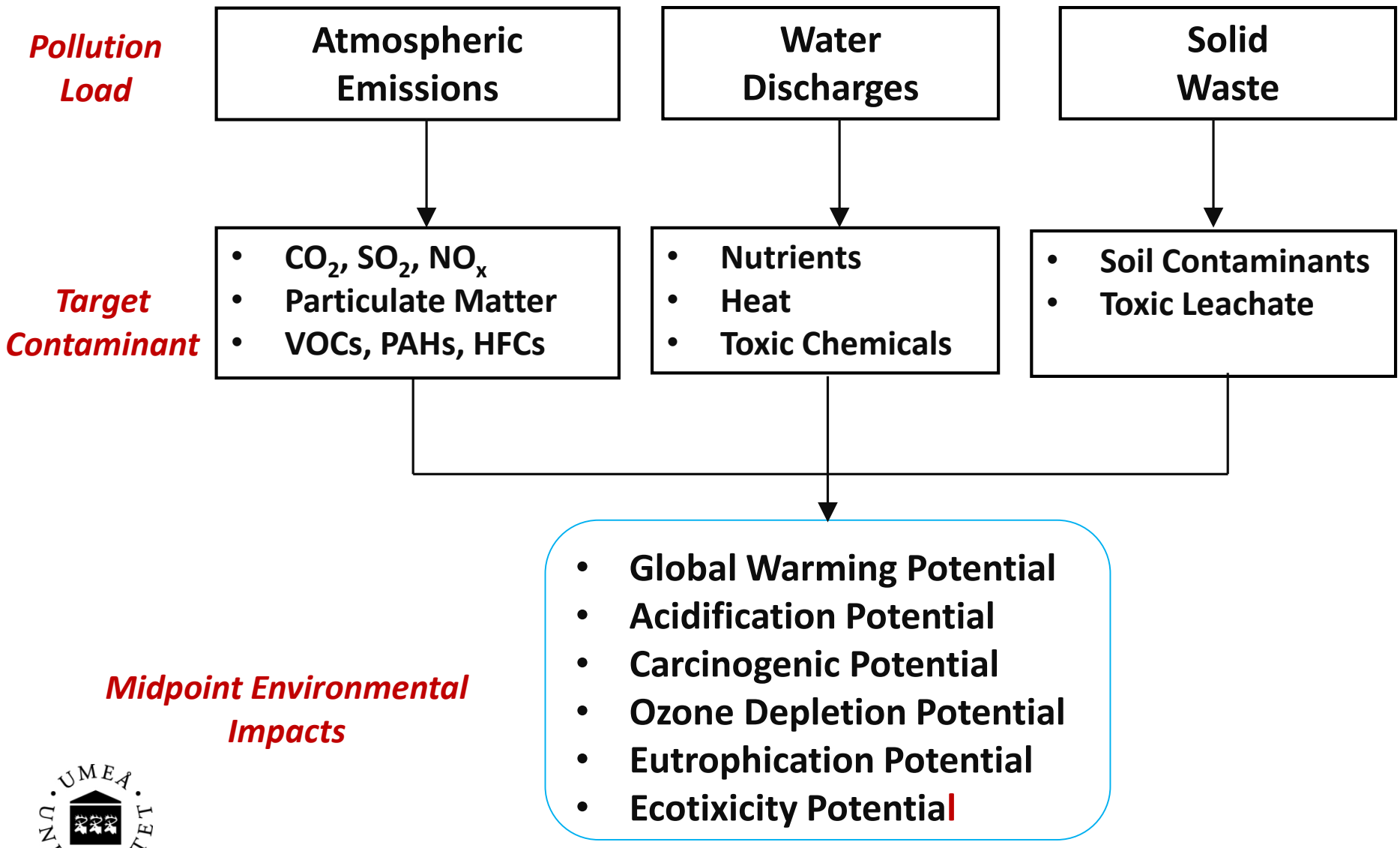
- **Primary Data (You Collect from Onsite)**
  - **High Quality Data but skewed when larger industry perspective need to be understood**
- **Secondary Databases**
  - **Ecoinvent**
  - **USLCI**
  - **ILCD**
- **Industry Consortium and Industry Association**
  - **World Steel Association for Steel Data**
  - **Aluminum Association for Aluminum Data**
- **Patents and Academic Literature**

UMEÅ UNIVERSITET

Inputs Related Environmental Impacts



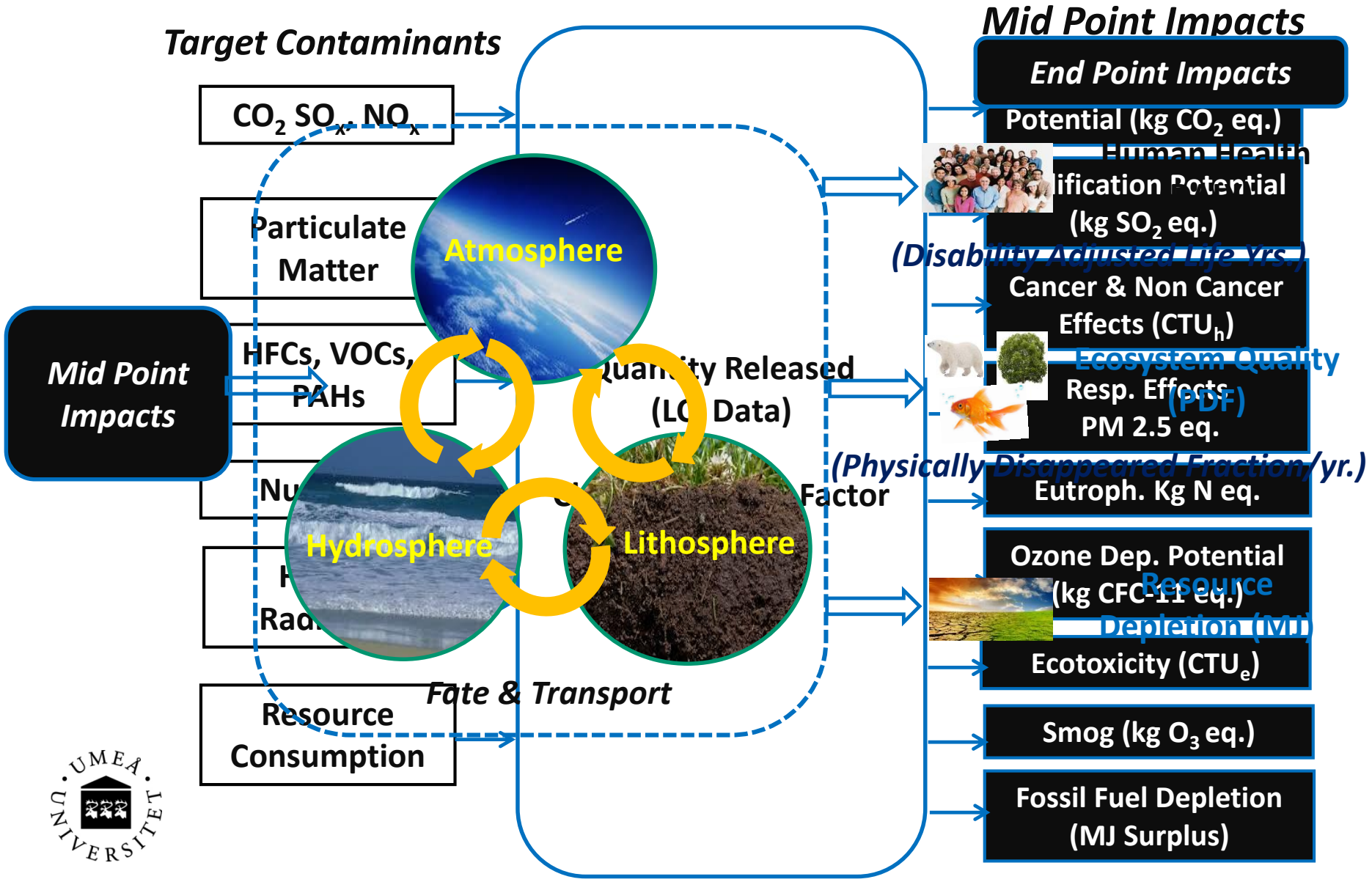
Outputs Related Environmental Impacts



UMEÅ UNIVERSITET

Midpoint Is a Potential for Environmental Damage But not Actual Damage

Step 3: Translating LCI Data to Environmental Impacts



Life Cycle Impact Assessment Methods

- **Midpoint Impact Assessment Methods**
  - ReCiPe (Europe and World)
  - CML2000
  - ILCD 2011
  - Ecoindcator-99
  - TRACI (Americas)
- **Endpoint Impact Assessment Methods**
  - ReCiPe (Endpoint)
  - Ecoindicator-99
- **Single Issue Methods**
  - IPCC Method for Global Warming potential
  - Cumulative Energy Demand Method

UMEÅ UNIVERSITET

Interpretation- Where LCA Results Are Used

How Can I Apply LCA Results

Manufacturing

Identify Potential Hospots (Env. Impacts of Using Metal Catalyst is High. Can I Change to Enzyme Catalyst?)

Government

Promoting Sustainable Transportation (e.g. Biofuels for Transport)

UMEÅ UNIVERSITET

Interpretation- Where LCA Results Are Used

How Can I Apply LCA Results

Innovation

Early Stage Decision Making (Impacts of Nanoproducts)

Supply Chain

Optimization of Supply Chain (Deliver Product to Customers the Most Effcient & Environmentally Friendly Way)

UMEÅ UNIVERSITET

Most Common Software Used for Conducting LCAs

SimaPro

openLCA

GaBi
Product Sustainability
Performance

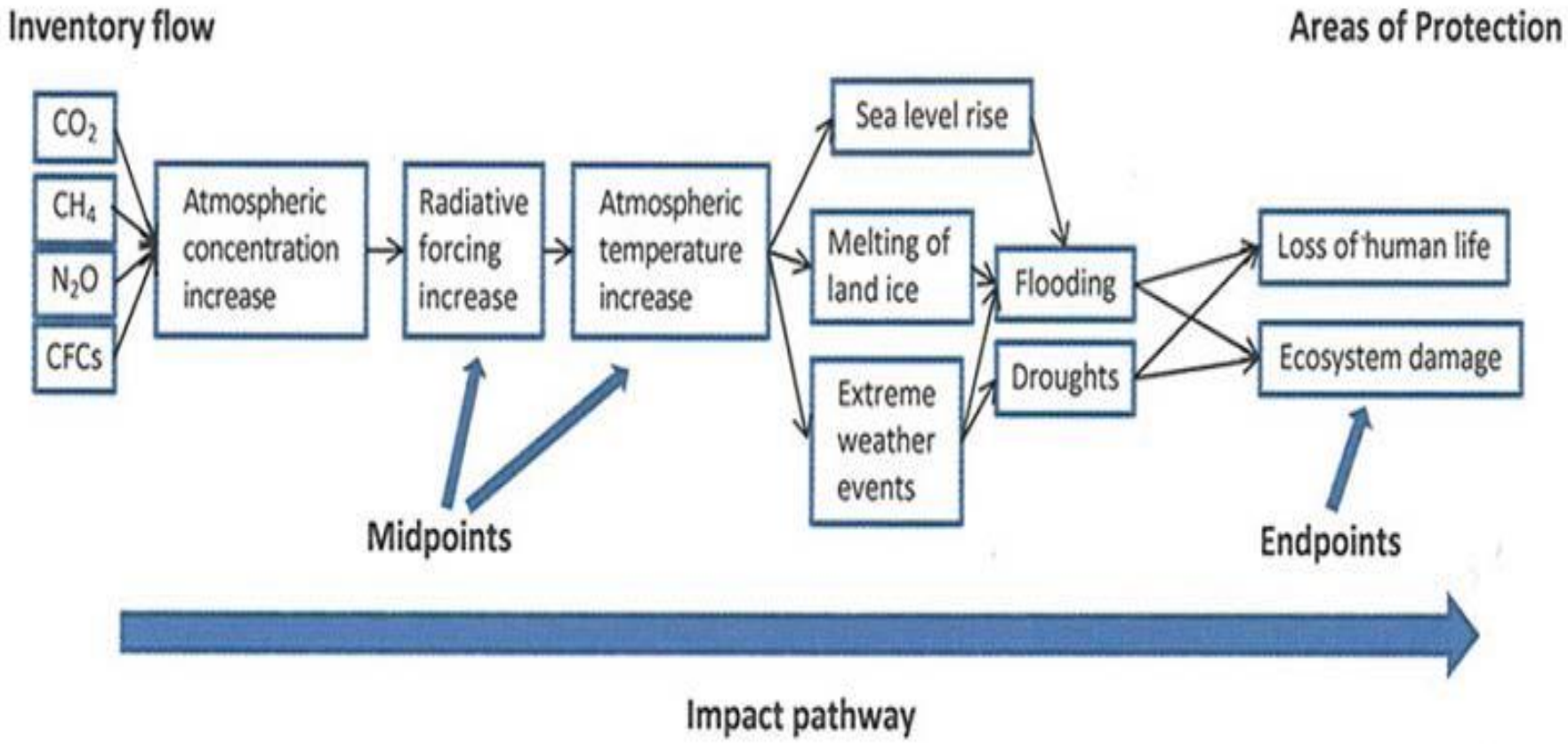
LCA Analytics

- **Baseline: Results of System Modeled**
- **Uncertainty Analysis: Variation with Data Changes**
- **Contribution Analysis: How much each lifecycle stage contributes**
- **Sensitivity Analysis: Validating the sensitivity of Data & Assumptions**

UMEÅ UNIVERSITET

Global Warming Potential (GWP) Impact Pathway

Ecotec Report, Brussels, 2016



Global Warming Potentials (GWP) of Greenhouse Gases

CO2 = 1 kg CO2 eq.

CH_4 = 21 times higher than CO_2 (1 kg CH_4 = 21 kg CO_2 eq.)

N_2O = 310 times higher than CO_2 (1kg N_2O = 310 kg CO_2 eq.)

SF_6 = 23,900 times higher than CO_2 (1 kg SF_6 = 23900 CO_2 eq.)

Thankyou!!