The Forum on Environmental Efficiency for Artificial Intelligence and other Emerging Technologies

Session 2: Accessing the environmental benefits of emerging technologies

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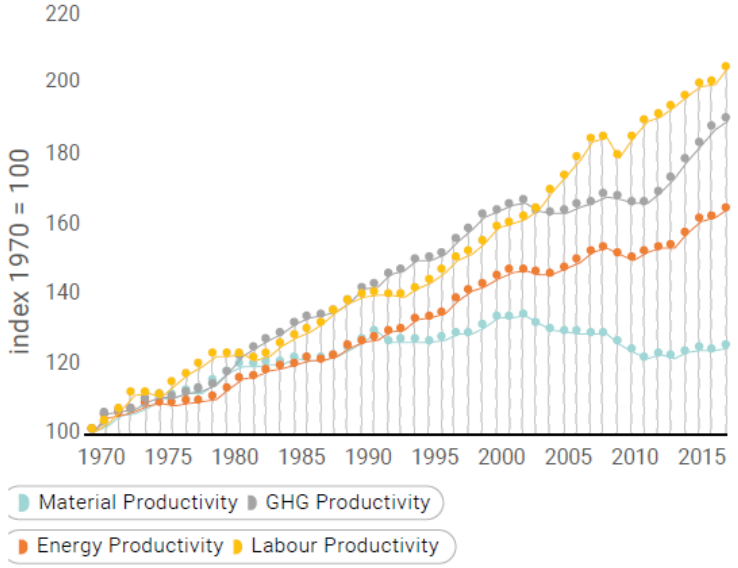
Investing in material productivity as crucial area for improving environmental objectives

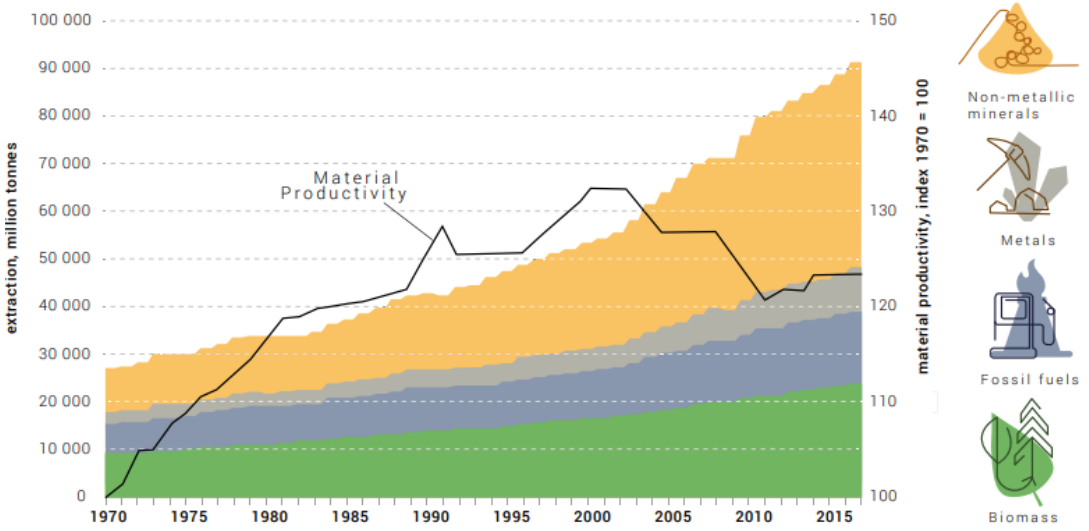
→global material productivity has grown substantially slower than labor and energy productivity and has not improved in the last 20 years

Figure 4 Global resource productivity (material, energy and CO2 emissions) & labour productivity



Source: United Nations Environment Programme, 2019

Figure 5 Global material extraction 1970 – 2017, million tons



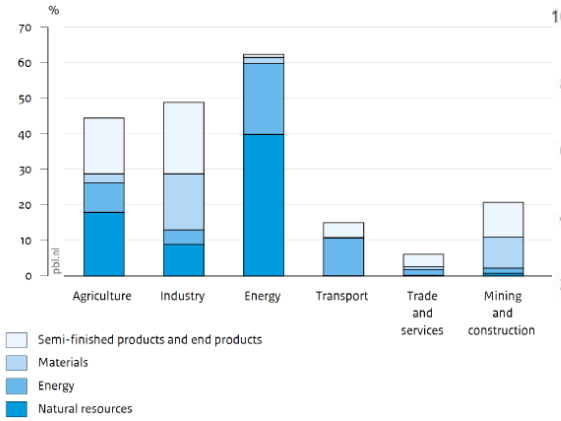
Source: United Nations Environment Programme, 2019

Raw material costs as an indicator for resource use within an economy

→ Investment in technologies for more efficient use of resources → economically & ecological beneficial

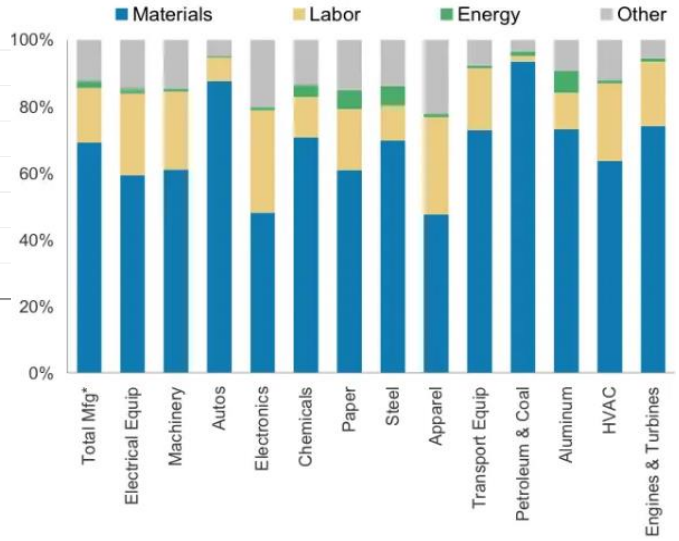
→ Federal Statistical Office of Germany estimates material costs at 40% in the manufacturing industry

Figure 6 Share of energy & material costs in total costs, the Netherlands, 2010



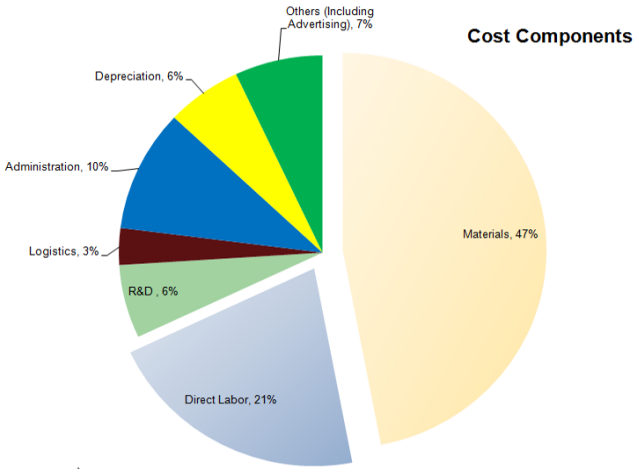
Source: PBL Netherlands Environmental Assessment Agency, 2014

Figure 7 Components of US Manufacturing Costs



Source: Morgan Stanley Research, 2013

Figure 8 Cost structure of entire added value in automotive industry



Source: Automobile Engineering Partners 2014
Note: Labor costs defines as gross income of employees (incl. social security costs)

How to access environmental benefits of AI

1. Enhanced operational efficiency

→ **Labour efficiency ↑**

- Lean Management
- Digital Kaizen

2. AI for greater environmental efficiency

→ **Material efficiency ↑**

- Carbon intensity tracing
- New materials
- Circular Economy:

Linkages between material intensity and AI

→ AI for more sustainable & efficient industrial production

1. Optimization of material use through AI-enhanced decision-making

- Identification of exact raw material needs
- Best operating parameters to cut down energy use, optimization of logistical routes
- Detecting hidden product defects early, save on excessive processing

2. Connection of AI and material sciences

- AI-based tools for discovering and designing innovative new materials
- Advances in scientific theory, modeling, simulation, high performance computing, algorithms, software, data analysis, and experimental techniques
- Digital transformation in materials science requires application of algorithms of AI
- Researchers produced computational tools for design of new materials useful for a range of applications; from energy, electronics to aeronautics & civil engineering

→ **Crucial for development of environmentally sustainable technologies & products**

Example: Steel Making Industry

Implementation of AI enables reduction of production costs, improve in product quality

- 5% of ferroalloy costs reduction
- Over $4m in yearly savings

→ More certainty in steel making industry through AI
→ More efficient production
→ Less raw material use

Example: Mining Sector – Ore Beneficiation

Cyanide is used to enrich ores such as gold or copper, if they are not rich enough during the beneficiation process

- Cyanide is very poisonous & expensive and can account for up to 40% of the process costs

AI predictive models can save companies anything from 3-5% at the beginning, and as AI continues to obtain more data, even 10% as predictions are becoming better

→ Less cyanide
→ Less toxic waste

Source: Zavalishina, 2017

Example: Clean Energy Materials

- Opportunity to apply AI to clean energy value chain: materials
- Existing materials are often toxic, non-earth abundant and require carbon-intensive processing
- New materials compatible with 3D printing can;

→ Reduce embedded emission, toxicity and costs

Example: Machine Learning & AI in mining

AI within the domain of smarter planning and operations, advanced master data management, workflow management and predictive analytics

Digital mines:

→ high-speed Ethernet networks and fibre optic cables enable tracking and monitoring of processes & avoiding mistakes

→ Tracking generates data about mine's operations → used by analytical programs & AI to pinpoint ways of process optimization

Example: Gas fractionation optimization

AI is used to improve efficiency, reduce costs and minimize downtime upstream performance

→ by using AI to 'virtually' detect changes in the incoming gas stream and recommend optimal parameters for a fractionation unit, to decrease energy use by 5-7%

→ increased throughput

→ less energy and water consumed

Source: Zavalishina, 2017

Example: Better control energy consumption of data centres

- Global data centre electricity demand in 2018 was an estimated 198 TWh
- Almost 1% of global final demand for electricity

→ Applying artificial intelligence in data centres to reduce energy consumption

Source: IEA, 2019

The Role of AI and frontier technologies in achieving the Sustainable Development Goals

- **Nature-like & convergent technologies** enabling genetically modified cereals and forest cultures for increased food production and resistance to agricultural pests, allowing reduced use of pesticides.
- **AI** used in agriculture to forecast and analyse changes in ecosystems

- **Nano-filters, catalyst technology** and other equipment and materials for water purification
- **AI** for management of water-related hazards

- **Nano-materials** for new electrodes for hydrogen production & storage
- Cheap autonomous buildings with **self-sufficient energy systems**
- **Hybrid cars** with combined engines, saving non-renewable energy sources

The Role of AI and frontier technologies in achieving the Sustainable Development Goals

- **Smart technologies, smart factories, cloud-based services, 3D-printing, industrial Internet** enable growth in industry, infrastructure & innovation
- **Sensors** for real-time monitoring boosting industrial safety at industrial sites

- **Biomimicry** saves materials & energy in industry and urban infrastructure planning, design and management

- **IoT** and **cloud computing** for more customized products
- **IoT** for a safe disposal of products
- **AI** for more efficient use of materials

The Role of AI and frontier technologies in achieving the Sustainable Development Goals

- **Nature-like & Convergent technologies** promising for circular economy goals, effective use of materials, elimination of waste and use of toxic materials
- Drones equipped with **AI** can combat deforestation and poaching

- **AI** for environmental management and disaster risk reduction
- Competition for natural resources → critical issue in economics & politics
- **Big data, cloud computing and AI** for better understanding and predicting climate change and geohazards

- Collective actions are needed to embrace the benefits **AI and emerging technologies** can offer
- Interdisciplinary approach is needed; combination of nano-technological approaches with achievements in molecular biology, bioengineering, genetic engineering

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17 PARTNERSHIPS FOR THE GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Thank you

AI for more effective Environmental Management

- Combination of AI, Geographical Information Systems, Modelling and Simulation, User Interfaces etc. for a better integration of data, information and knowledge from various sources in the environmental sector
- Examples:
  - → Natural environmental modelling; such as contamination of soil, groundwater, atmosphere
  - → Industrial Safety: dealing with the increasing complexity of industrial accidents due to human–machine interactions is difficult to monitor without installation of cyber-technologies such as sensors and AI
  - → Cloud-based AI decision support systems for water quality monitoring
  - → Circular Economy: digitized product development for enhanced 'design for circularity'
- AI techniques applied in three broad categories
  1. Data interpretation & mining techniques → identification of potential problems and opportunities
  2. Problem Diagnosis techniques → recognition of characteristic symptoms do develop and confirm hypotheses about possible causes, expert systems play an important role
  3. Decision Support techniques → evaluation of alternatives, exploration of their possible consequences