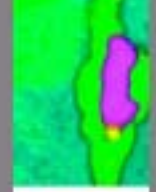
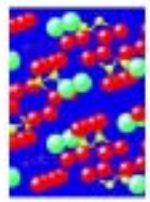
Sustainable Development and the Information Society

Prof. Dr. Lorenz Hilty, EMPA

EMPA

The Materials Science and Technology Institution in the ETH Domain






- Internationally competitive research
- Innovative development
- Pretentious services
- Knowledge transfer, teaching

to meet society's needs for sustainable materials and system technology for

- Mobility
- Construction and Engineering
- Communication
- Health
- Energy
- Safety and Reliability

EMPA Today

3 Sites

Dübendorf, St. Gallen, Thun

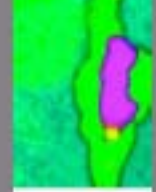
820 Employees

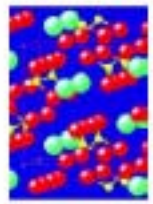
310	University graduates including 170 PhDs
60	PhD candidates
5	Professors
100	Graduates of universities of applied science

Budget

80 mill. CHF ETH-Board
20 mill. CHF Third party means
15 mill. CHF Services

EMPA's Research Programs






- Nanotechnology
- Adaptive materials and systems
- Technosphere – Atmosphere
- Materials and systems for the protection, comfort, health and wellbeing of humans
- Materials for energy technology
- Sustainability in the information society (2000 – 2005)

Technology and Society Lab @ EMPA

- We analyse the impacts of technological developments on society and the environment.
- Focus on technologies in the areas of information and communication, mobility, materials, and energy.
- Research units:
  - Innovation and Technology Analysis (ITA)
  - Life Cycle Assessment (LCA)
  - Information Systems and Modelling (ISM)
  - Technology Cooperation North-South (SusTeC)

Technology and Society Lab @ EMPA

- Permanent activities:
  - the R&D program **Sustainability in the Information Society (SIS)**, an innovation and cooperation project funded by the ETH Council (2000-2005)
  - the operations of the **Swiss Center for Life-cycle Inventories, ecoinvent**, www.ecoinvent.ch
  - **Monitoring the Recycling of Electrical and Electronic Equipment** in Switzerland

www.empa.ch/**tsl**

Projects on Impacts of ICT

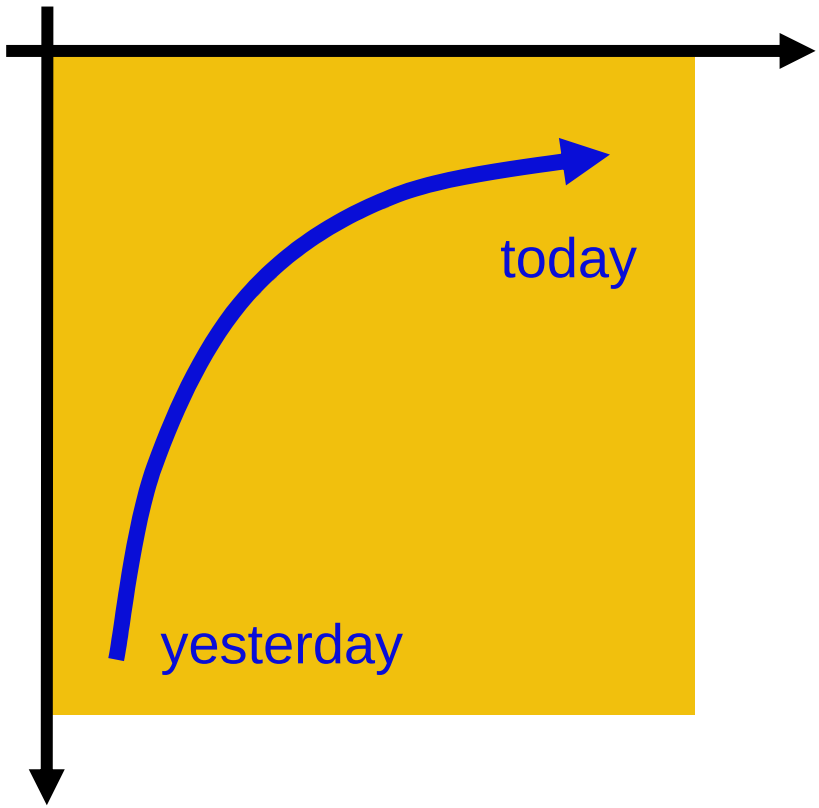
- Impacts of pervasive computing on health and the environment (for TA-SWISS)
- The future impact of ICT on environmental sustainability (for EU-IPTS)
- The impact of Moore‘s Law on the productivity of computer workplaces (with KTH Stockholm)
- Knowledge partnerships in electronic waste recycling (for seco)

Contents

Dematerialization due to ICT

Will the „information revolution“ lead to decreasing mass and energy flows?

Natural Resource Intensity



Labour Intensity

Information Intensity

tomorrow

today

?

yesterday

Labour Intensity

Resource Intensity

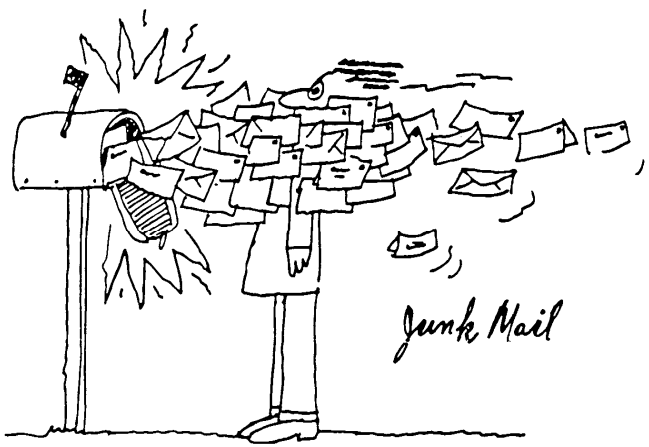
The Role of Information in Dematerialization

- Vision of a knowledge-based economy:
  Information and knowledge as resources that could partially replace material resources
- Emergence of a global information society:
  Milestone WSIS, Geneva 2003
- Sceptical voices:
  Limits to dematerialization?
  Rebound effects?

Rebound Effect Example 1: Paper Consumption

ICT was expected to reduce paper use in the 80ies

Per-capita paper consumption in Switzerland



1970	**156 kg**
1990	**214 kg**
2000	**246 kg**

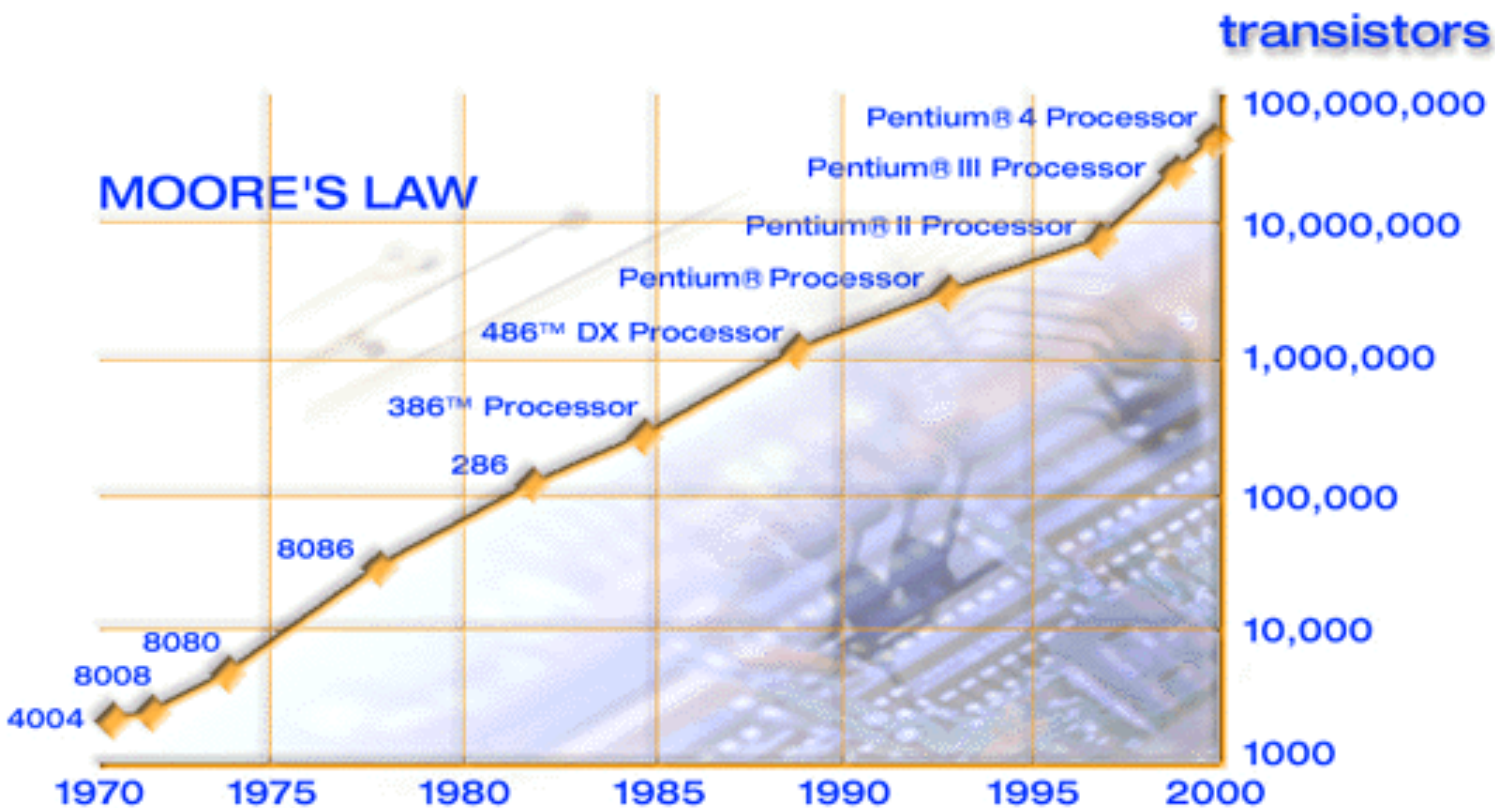
Rebound Effect Example 1: Paper Consumption

Where does the paperless office exist?

Per-capita paper consumption in 1999:

- North America **337 kg**
- Switzerland **240 kg**
- EU **196 kg**
- Africa **6 kg**
- Ethiopia **300 g**

Rebound Effect Example 2: ICT Miniaturization



Rebound Effect Example 2: ICT Miniaturization

Electronic waste: a creeping problem

© BAN

Rebound Effect Example 2: ICT Miniaturization

Electronic waste: a creeping problem

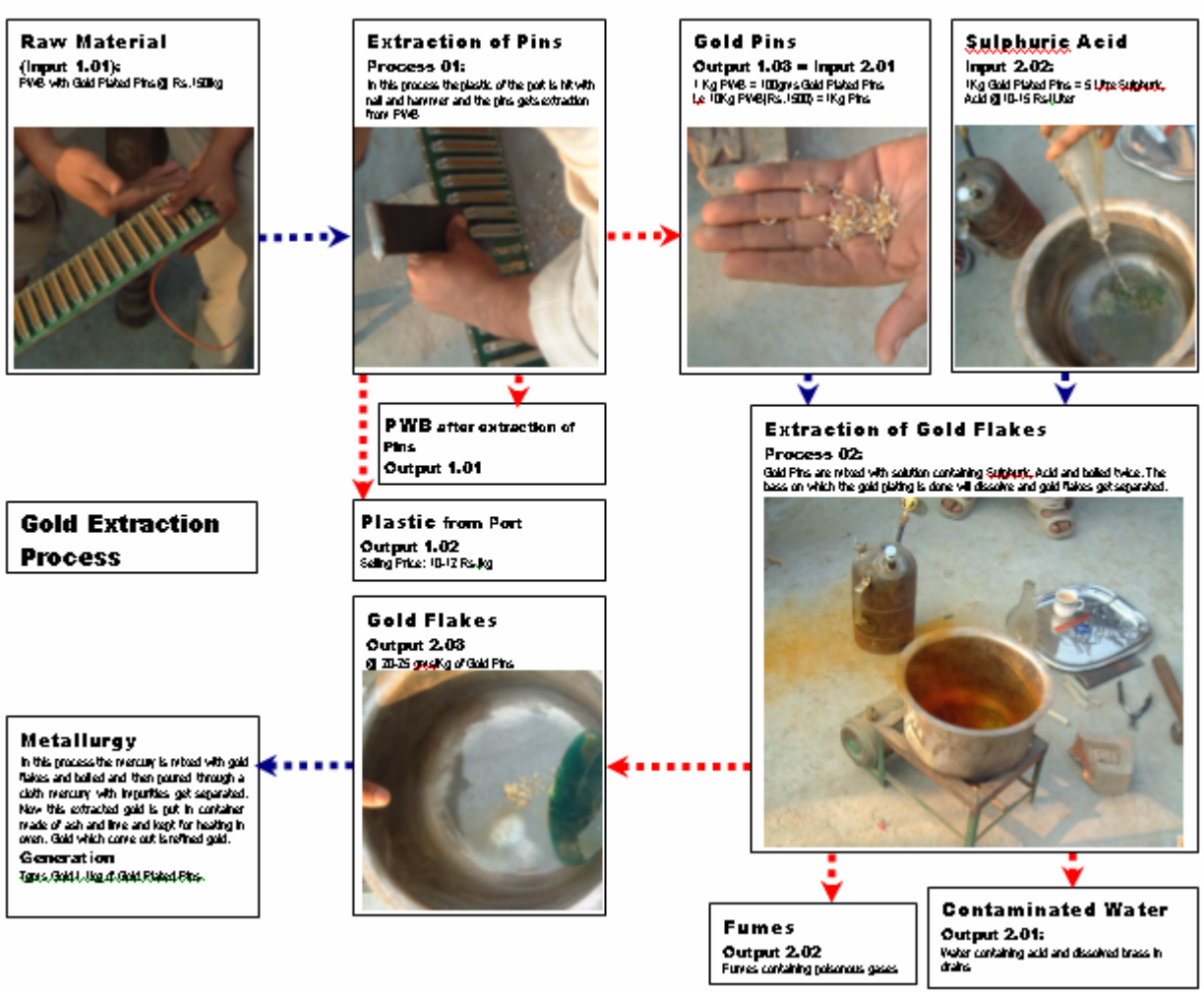
- Worldwide arisings of **20 Megatons per year** are estimated for the near future.
- **315 Million PCs** will become obsolete in 2004.
- **130 Million mobile phones** are expected to be disposed of in 2005.

Similar waste flows are expected for all kinds of portable electronic devices, such as PDAs, MP3 players, computer game equipment.

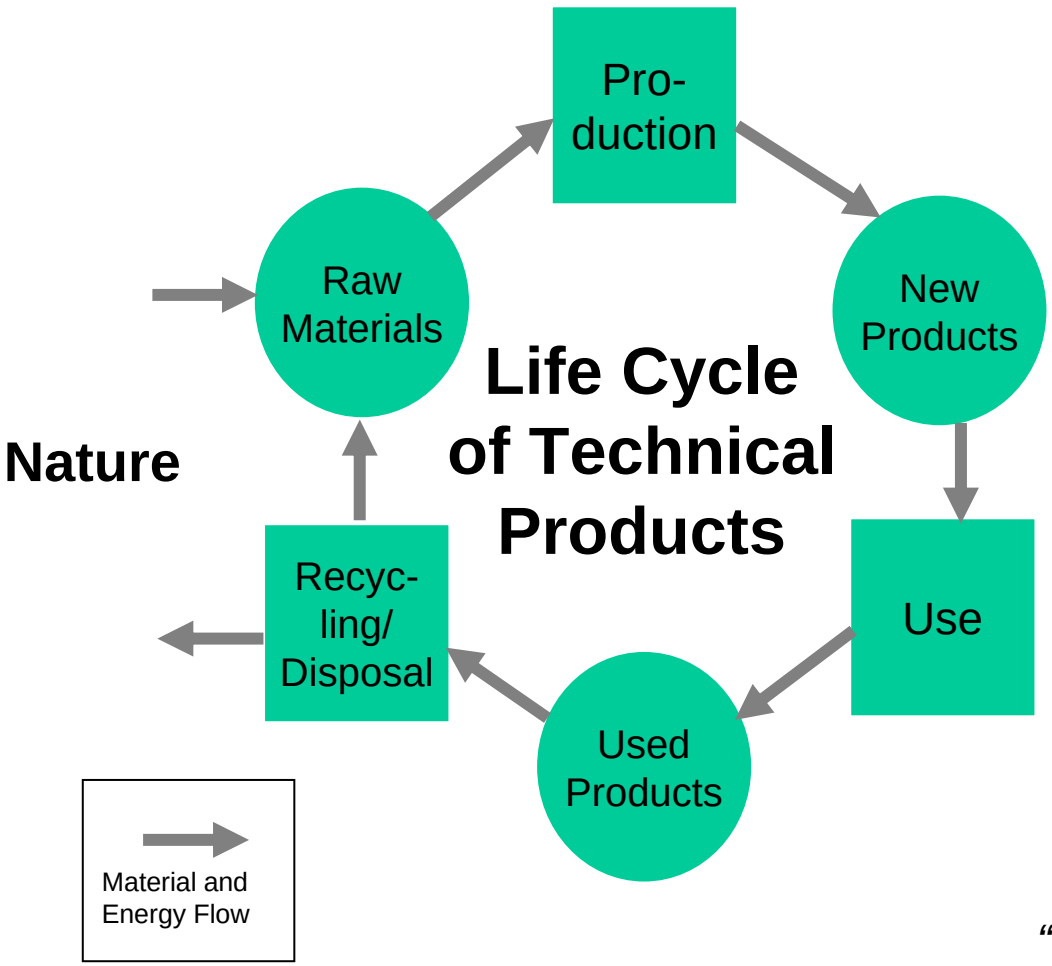
A guide to the world of e-waste

www.ewaste.ch

Quantitative Analysis of Gold Extraction



Systematic approach to impacts of ICT



Opportunities

Risks

Society

“beyond functional units”

Classification of ICT Effects

- First-order effects:
  Effects of the physical existence of ICT, from cradle to grave
- Second-order effects:
  Effects of the application of ICT
- Third-order effects:
  Medium and long-term effects of the availability of ICT and the services it provides to a large number of people

Examples

- First-order:
  Producing a 23 kg desktop PC with CRT monitor requires **500-1500 kg raw materials**
- Second-order:
  Intelligent heating systems could save **3 - 6 % of total energy** consumed in 2020
- Third-order:
  Intelligent transport systems will induce **10-30 % of total freight transport** in 2020

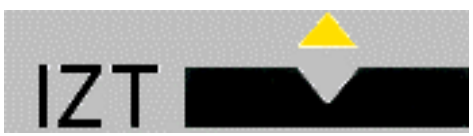
Contents

The Impacts of Pervasive Computing on Health and the Environment“

2002-2003

Commissioned/ supported by:

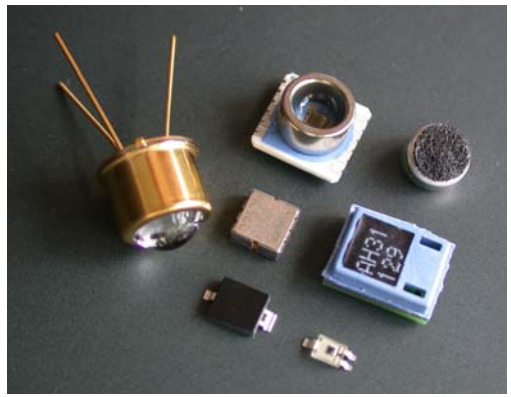
Project team:



Communication
in Science

Five Properties of Pervasive Computing

- Miniaturization
- Embedding
- Ubiquity
- Wireless networking
- Context sensitivity



~ ubiquitous computing
~ ambient intelligence

Sample applications

- “smart” home, “smart” car
- “smart” objects (with sensors, memory, transponders) for identification and localization
- location-based services
- body area network
- personal health monitoring

Objectives of the study

- Assessment of health and environmental risks of pervasive computing
- Interpretation of the precautionary principle in the context of the information society

Time horizon: 2010

How did we proceed?

Phase I:

- Scenarios of technological and market development for selected application fields: housing, traffic, work, health
- Health and social impact assessment (qualitative)
- Environmental impact assessment (qualitative)
- Assessment of the impacts of higher efficiency (rebound effects)

Identified Opportunities (Examples)

- Health:
  - More safety and autonomy for patients due to personal health monitoring
- Environment:
  - Pervasive Computing is an enabling technology for a product-to-service shift
- Social Aspects:
  - More flexibility in combining family and professional activities

Identified Risks (Examples)

- Health:
  - Non-ionizing radiation (NIR): Biological effects are uncertain, fears and conflicts are certain
- Environment:
  - Increasing power consumption of ICT infrastructure
  - E-Waste: Higher number of devices compensates for miniaturization
- Social Aspects:
  - Threats to privacy – the possibility of ubiquitous surveillance

How did we proceed?

Phase II:

- Qualitative assessment of the risks identified in **Phase I** by applying a risk filter, yielding risk clusters
- Formulation of recommendations to political, economic and educational actors (not reported in this presentation)

The Risk Filter:
A Set of Qualitative Risk Assessment Criteria

- Socio-economic irreversibility
- Delay effect
- Conflict potential
  - Involuntary exposure
  - Unfairness
- Burden on posterity

Result:
The Five Most Relevant Risk Clusters

- Conflict potential of non-ionising radiation
- Stress caused by unreliable technology, threats to privacy and high-tech crime can affect the quality of life
- Consumers and patients may have to pay for things they don‘t want to use
- Backlashes for ecological sustainability (electricity consumption of networks, diffusion of e-waste)
- Causation principle as a basis of our legal system is increasingly difficult to implement

Results regarding dematerialization, first-order effects

- Despite miniaturization, mass flows caused by ICT will not decrease, because of
  - the larger number of devices (IBM: 1000 / person)
  - the trend to shorter useful lives of the devices
- Total power consumption of ICT networks will increase, because
  - machine-to-machine communication will dominate
  - increasing dependence on ICT infrastructures requires uninterrupted operation

Specific results for dematerialization, first-order effects

- E-waste streams tend to cross-contaminate other waste streams (e.g. paper, glass, plastics), because
  - pervasive computing components are embedded in other objects („smart objects“) or packaging („smart labels“)
  - it is increasingly difficult for the consumer to separate electronics from non-electronics

Specific results for dematerialization, second- and third-order effects

- The effects of pervasive computing on **transport** are ambivalent
  - optimization effects
  - substitution effects
  - shift effects (modal split)
  - time rebound effects, price rebound effects
- Pervasive computing can act as an enabler for a **product-to-service shift** („virtual goods“)

More results

Full study (TA 46A/2003) and short versions available free of charge at:

ta@swtr.admin.ch (print)

www.ta-swiss.ch (download)

The Future Impact of ICT on Environmental Sustainability

2002-2004

Commissioned by the European Commission

Institute for Prospective Technological Studies

IZT

Institute for Futures Studies and Technology Assessment Berlin

EMPA

Swiss Federal Laboratories for Materials Testing and Research

Forum for the Future

Forum for the Future London

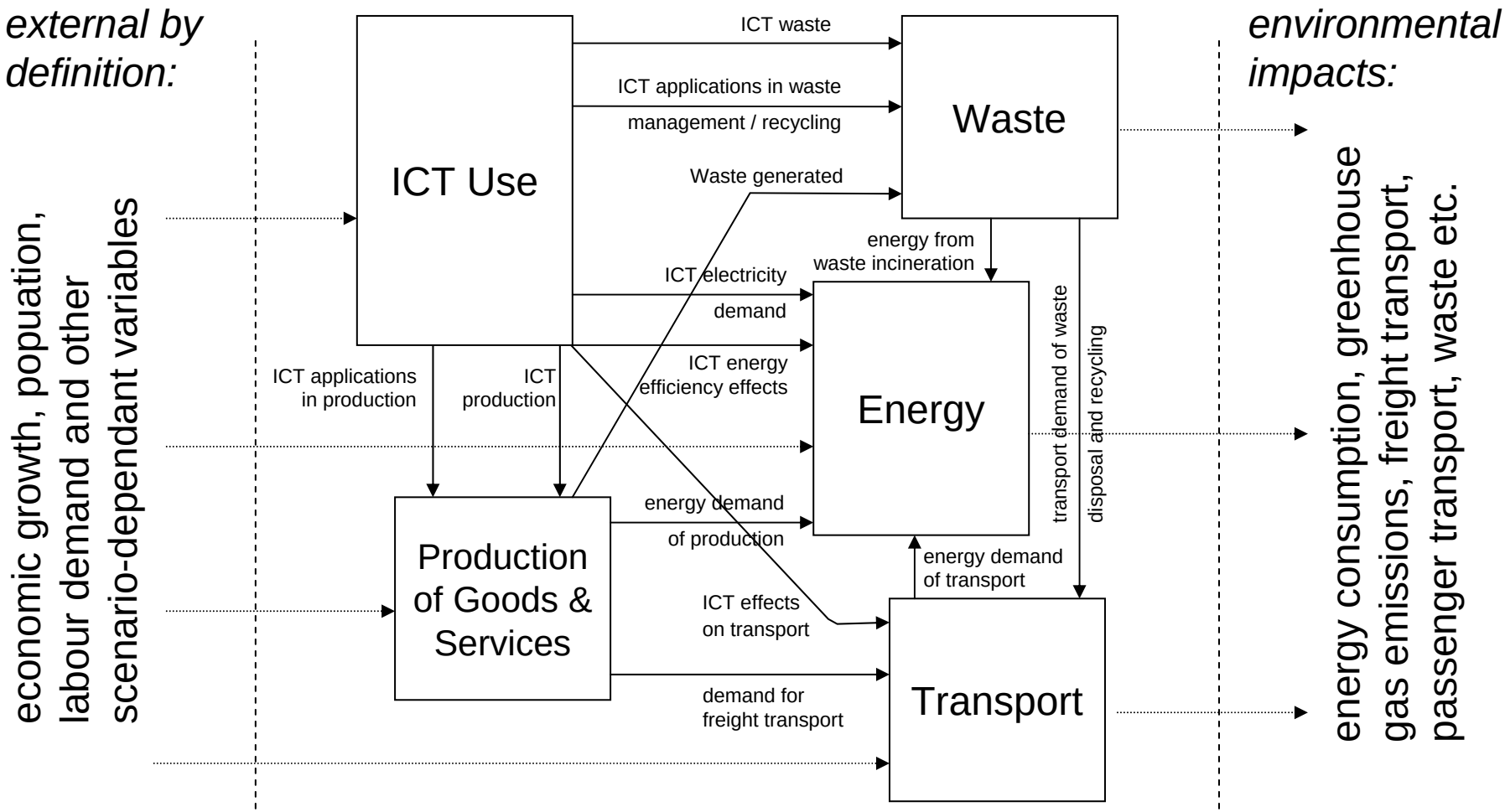
iiiee

International Institute for Industrial Environmental Economics
University of Lund

Methods

- Literature reviews, trend extrapolation
  ➔ „script“ organized in fact sheets
- Scenario development with expert groups
  ➔ three scenario narratives
- Causal modelling (System Dynamics)
  ➔ five sub-models, > 2000 equations
- Sensitivity analysis, best-case / worst-case optimization

Model structure



Scenarios (possible futures)

Scenario Frameworks	**A** **"Technocracy"**	**B** **"Government first"**	**C** **"Stakeholder Democracy"**
Technology Regulation	Incentives for innovation	Government intervention	Stakeholder approach
Attitudes to ICT	Moderate, conservative	Open and accepting	Highly accepting
ICT in business	High level of cooperation	High level of competition	Between A and B
Attitudes to the environment	Moderate / controversial	High awareness and interest	High awareness and interest

➔ detect ICT impacts that are invariant over all scenarios

Survey of “scenario-invariant” results

	Total freight transport	**Total passenger transport**	**Private car transport**	**Total energy consumption**	**Share of renew-able electricity**	**Greenhouse gas emissions**	**Municipal solid waste not recycled**
Potential impact to:	reduce tkm	reduce pkm	reduce %	reduce TWh	increase %	reduce CO_2-eq. Mt	reduce Mt
First order effects of ICT	-	-	-	☹	-	☹	☹
ICT in supply chain management	☺	-	-	☺	-	☺	☺
Teleshopping	☹	☺	😐	😐	-	☺	😐
Telework & virtual meetings	-	☺	☺	☺	-	☺	-
Virtual goods	☺	-	-	☺	-	☺	☺
ICT in waste management	-	-	-	-	-	-	☺
Intelligent transport systems	☹	☹	☺	☹	-	☹	-
ICT in energy supply	-	-	-	😐	☺	☺	-
ICT in facility mgmt.	-	-	-	☺	-	☺	-
ICT in production process mgmt.	☺	-	-	☺	-	☺	☺
Mobile ICT time utilisation effect	-	☹	☺	😐	-	😐	-

More Information

The details behind the presented results are documented in six interim reports and a synthesis report, available by June 2004 at:

www.jrc.es

You may also send me an e-mail, and
I will provide you with the reports when published:
lorenz.hilty@empa.ch