



Universität
Zürich^{UZH}

Institut für Informatik



Materials Science & Technology

Nachhaltigkeit in der Informatik und durch die Informatik

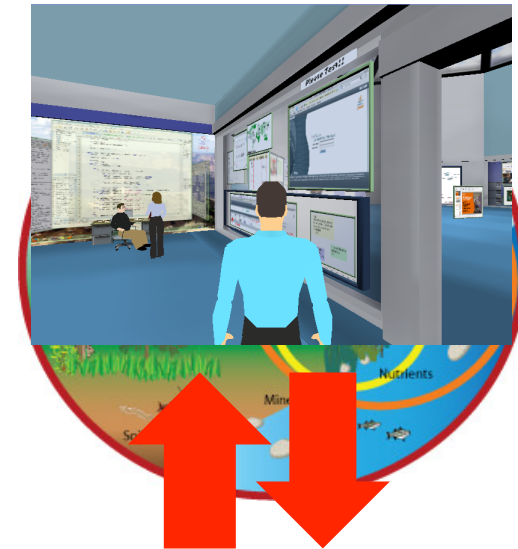
Prof. Dr. Lorenz Hilty

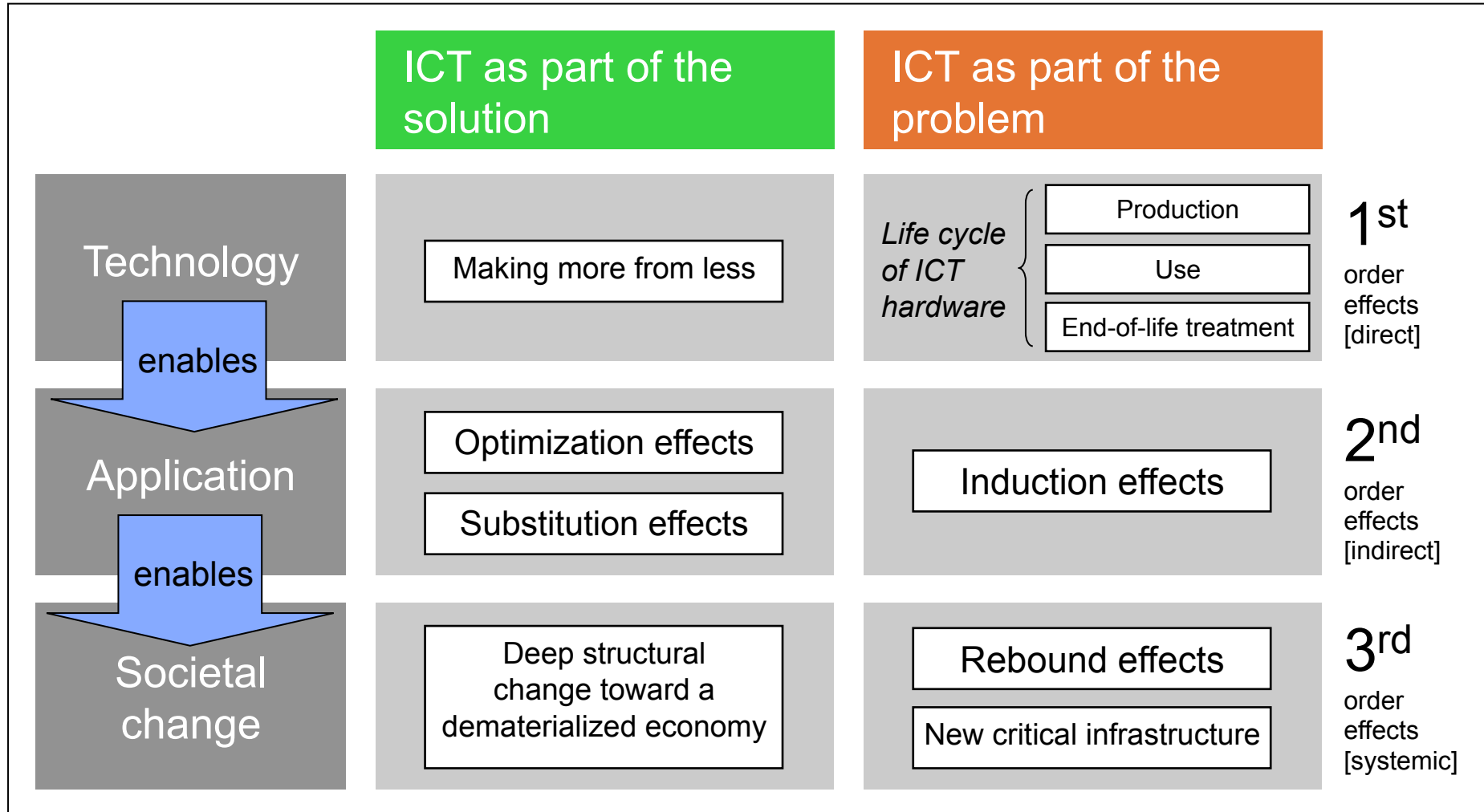
Forschungsgruppe Informatik und Nachhaltigkeit
Institut für Informatik
Universität Zürich

Abteilung Technologie und Gesellschaft
Empa, Eidgenössische Materialprüfungs- und Forschungsanstalt
St.Gallen, Schweiz

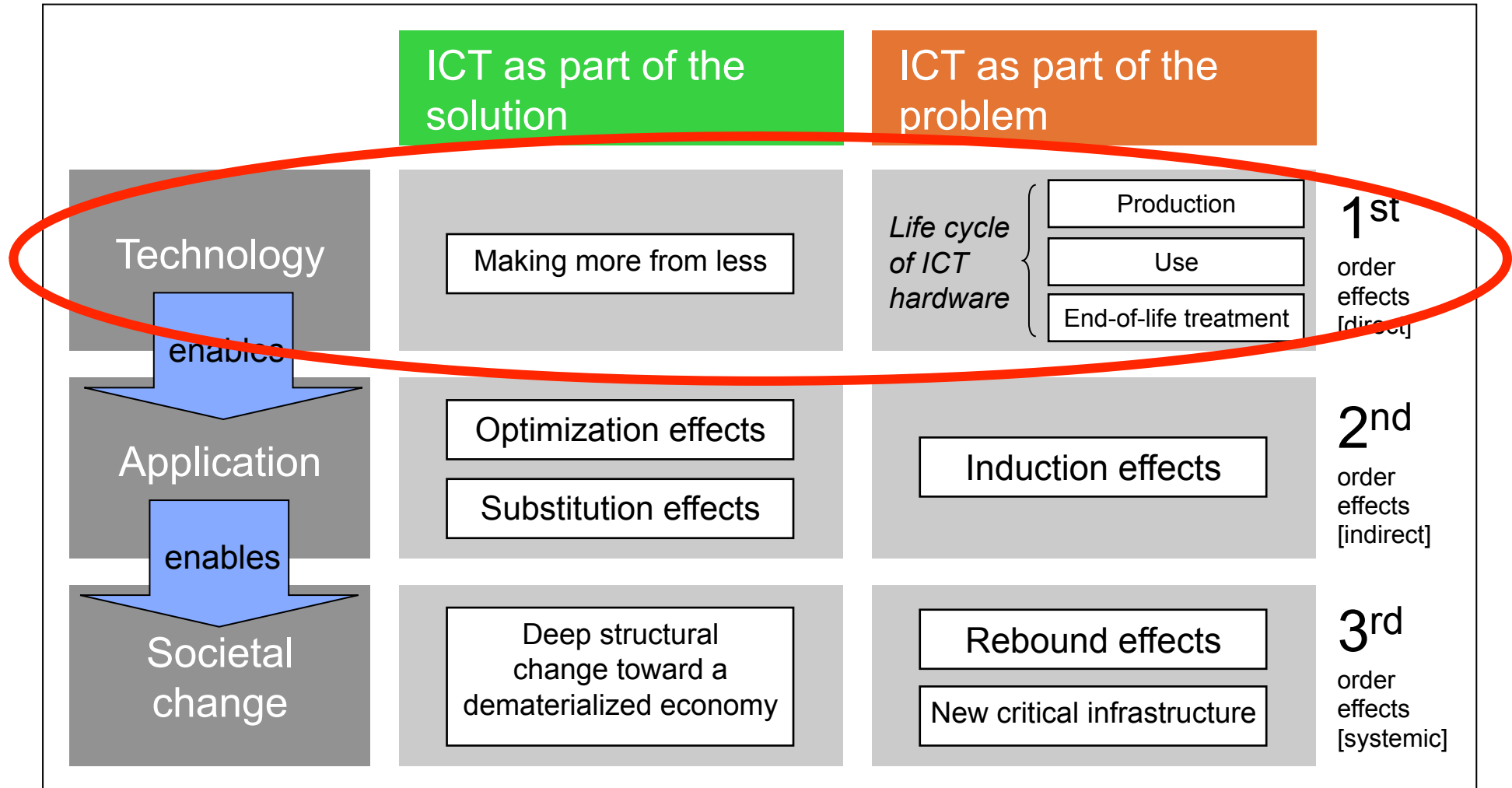


"Ein System nachhaltig nutzen" bedeutet,
das System so zu nutzen, dass es in seinen
wesentlichen Funktionen langfristig erhalten
bleibt.

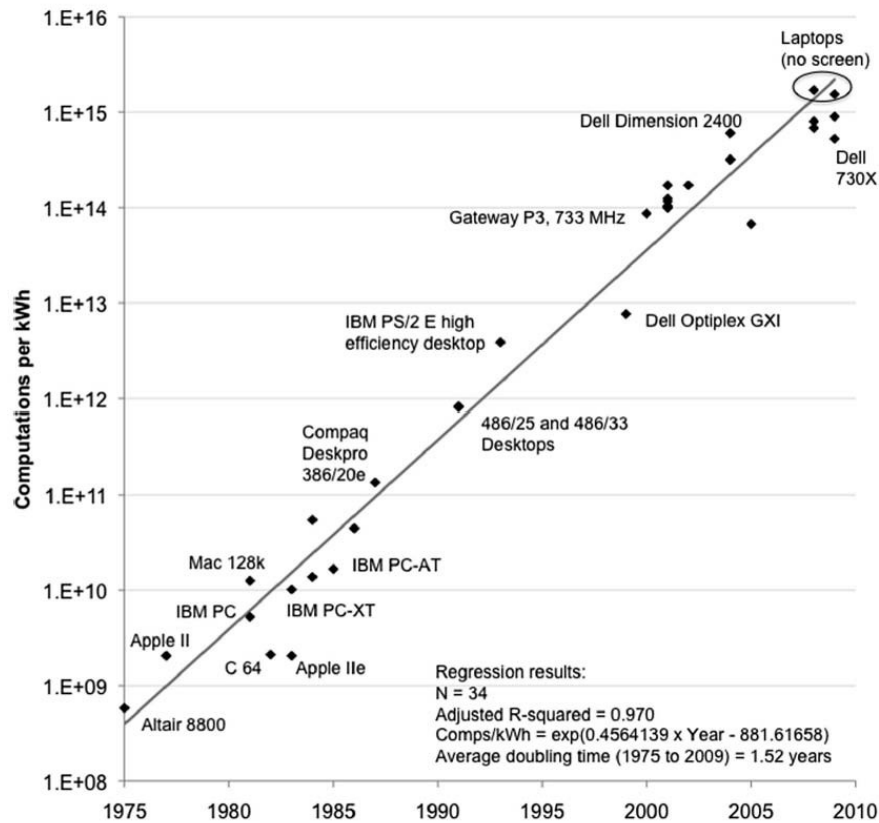




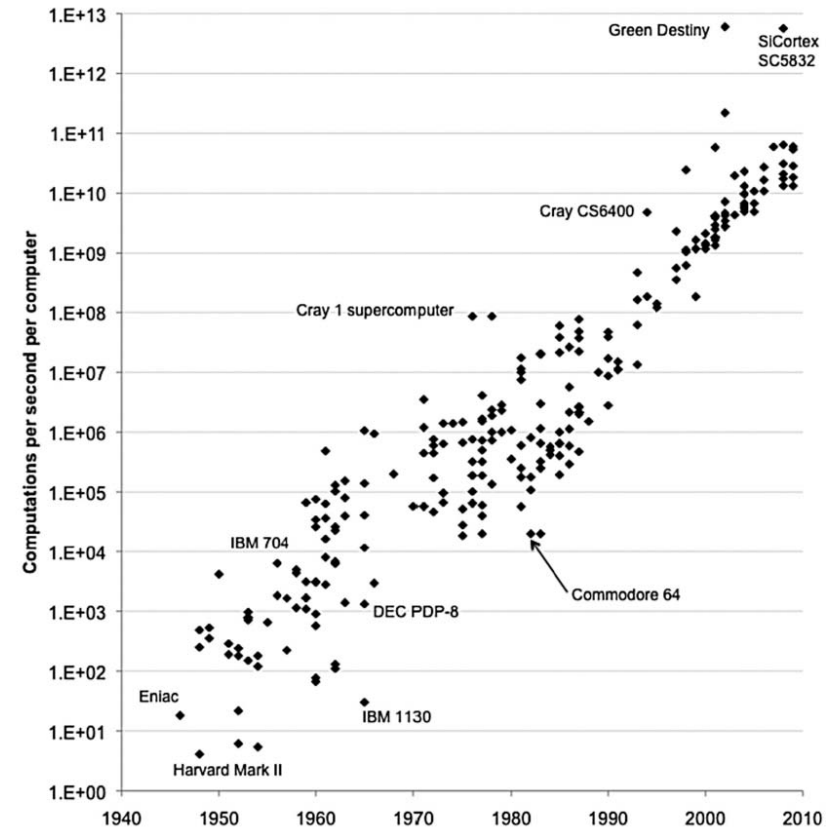
Source: Hilty, L. M.: Information Technology and Sustainability. Essays on the Relationship between ICT and Sustainable Development. Books on Demand, Norderstedt 2008, ISBN: 9783837019704



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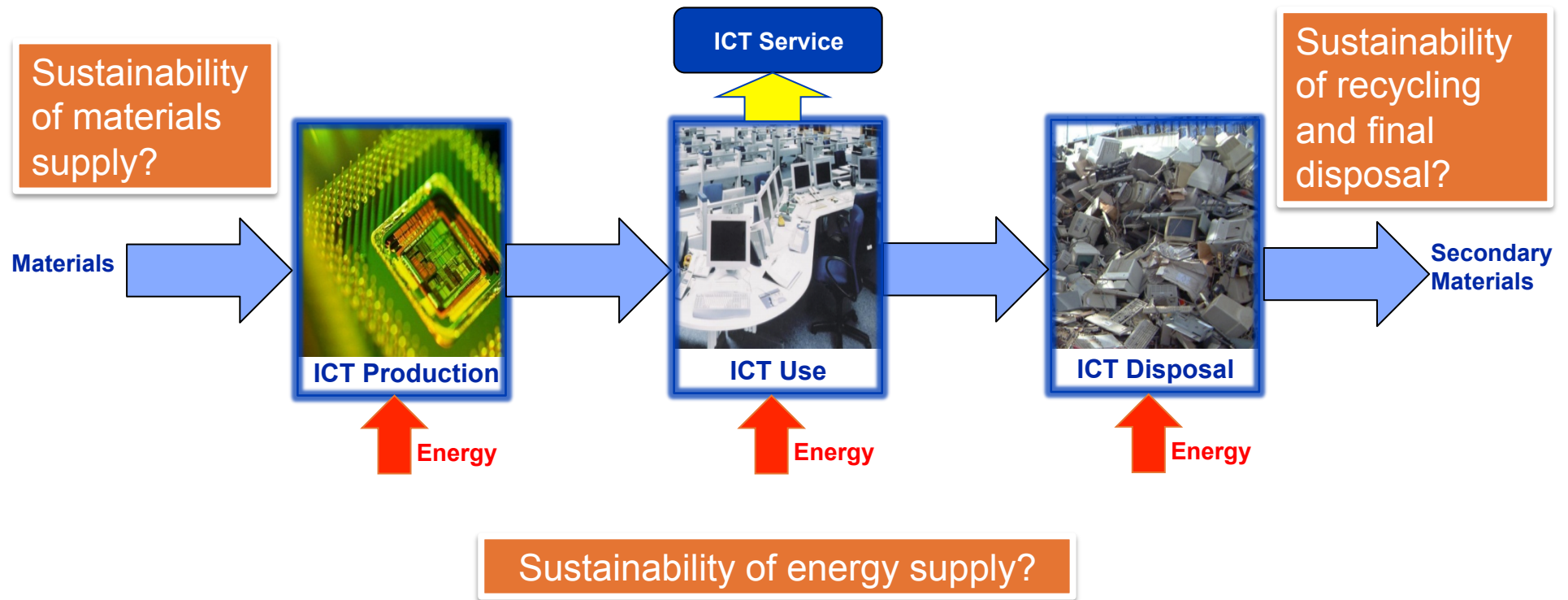
Computations per kilowatt-hour.
 Doubling time is **1.57** years (1946-2009)
 (Koomey et al., 2011).



Computations/second per computer.
 Doubling time is **1.5** years for personal
 computers (1975-2009) (Koomey et al. 2011).



ICT Life Cycle





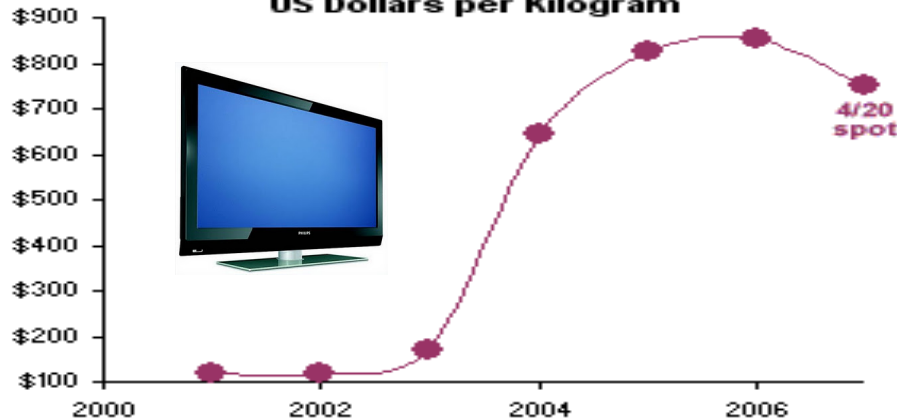
In the 1980ies, a PC micro-processor contained only **12 elements**.

25 years later, **57 elements** were used to build a PC microprocessor.

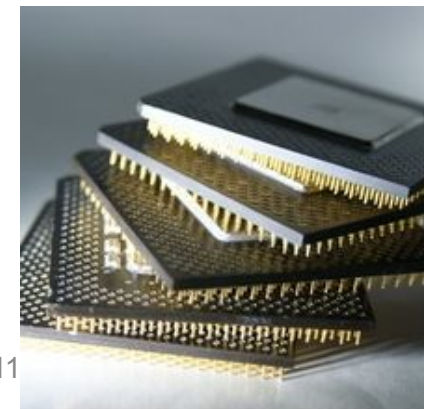
Source: National Research Council 2008

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1	2																2
H	He																He
1.008	4.003																4.003
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
6.941	9.012											10.81	12.01	14.01	16.00	18.99	20.18
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
22.99	24.30											26.98	28.09	30.97	32.07	35.45	39.95
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.1	40.08	44.96	47.87	50.94	52.00	54.94	55.84	58.93	58.93	63.55	65.39	69.72	73.61	74.92	78.96	79.90	83.8
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
85.47	87.62	88.91	91.22	92.91	95.94	98.91	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
132.9	137.3	138.9	138.9	181.0	183.8	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	209	210	222
87	88	89	104	105	106	107	108	109	110	111	112						
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt									
223	226	227	261	262	263	262	265	266									
58	59	60	61	62	63	64	65	66	67	68	69	70	71				
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
140	141	144	145	150	152.0	157	159	163	165	167	169	173.0	175.0				
90	91	92	93	94	95	96	97	98	99	100	101	102	103				
Th	Pa	U	Np	Pu	Am	Cu	Bk	Cf	Es	Fm	Md	No	Lr				
232	231.0	238.0	237	244	243	247	247	251	252	257	258	259	262				

Annual Average Indium Price
US Dollars per Kilogram

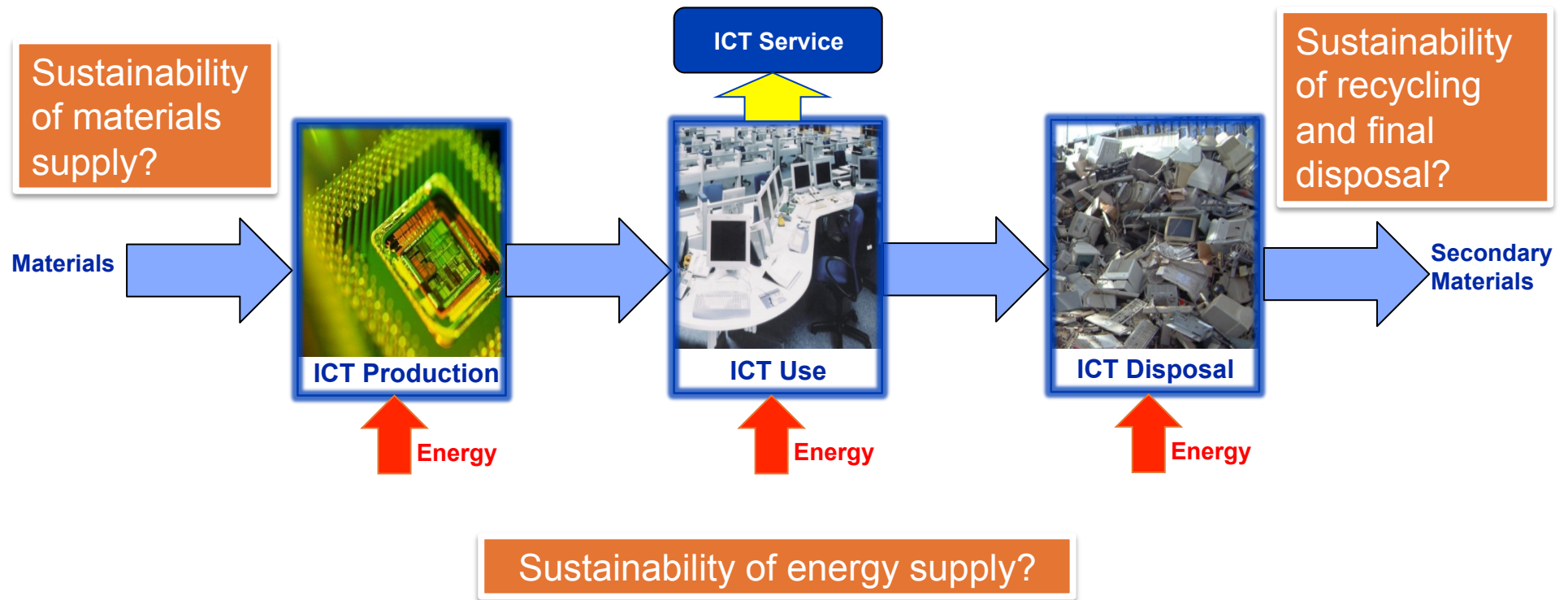


Source: Behrendt et al. 2007





ICT Life Cycle



E-waste Recycling in Cape Town, South Africa



Source: Empa

E-waste Recycling in Guiyu, China

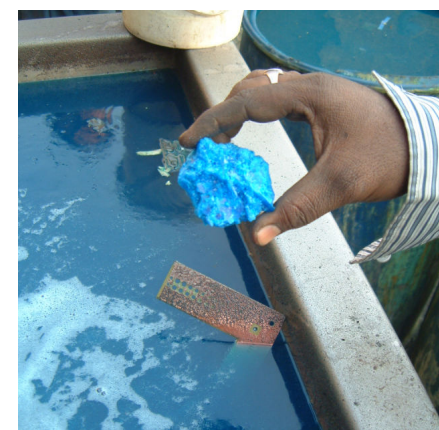


E-waste Recycling in Delhi, India





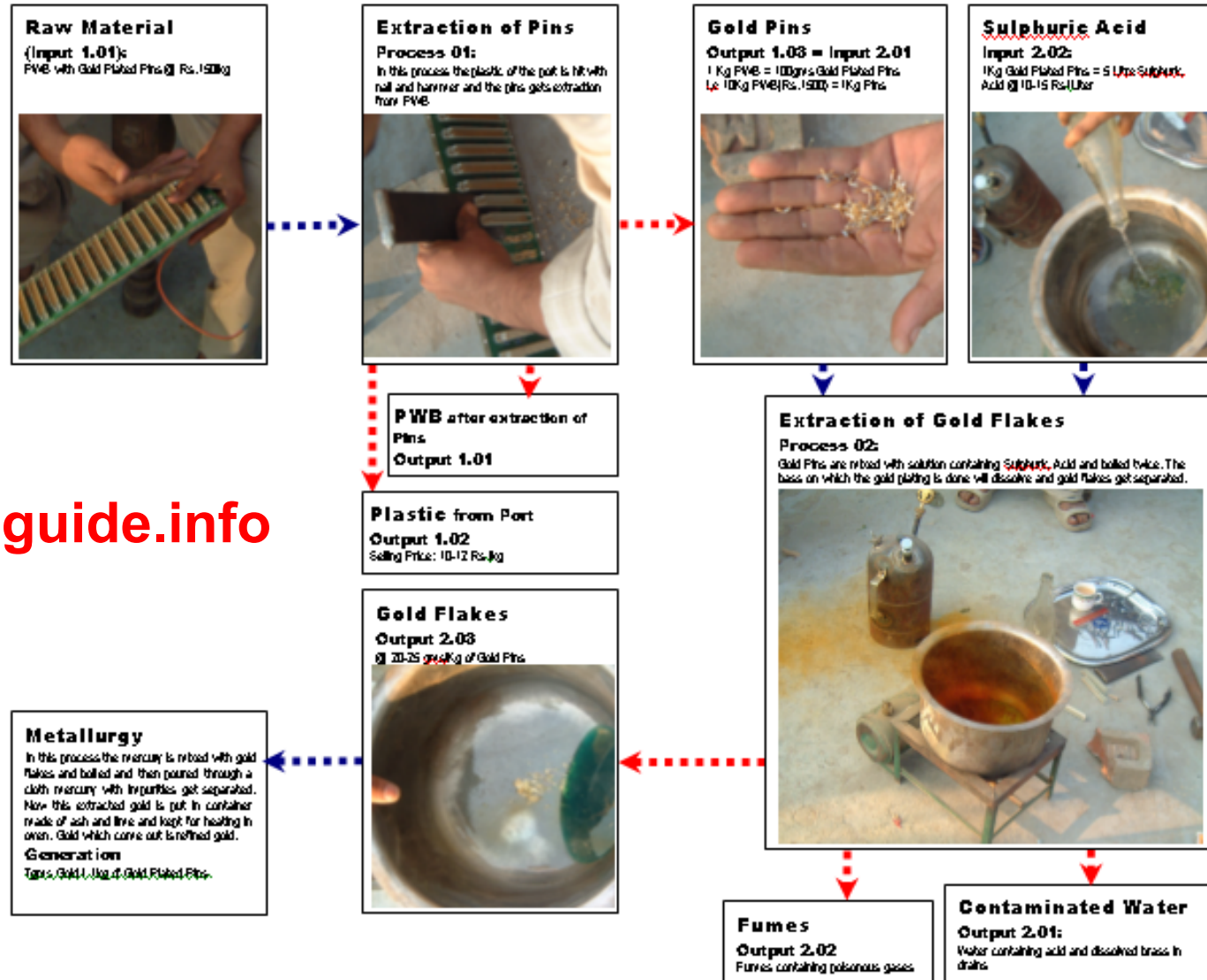
Copper Extraction Process



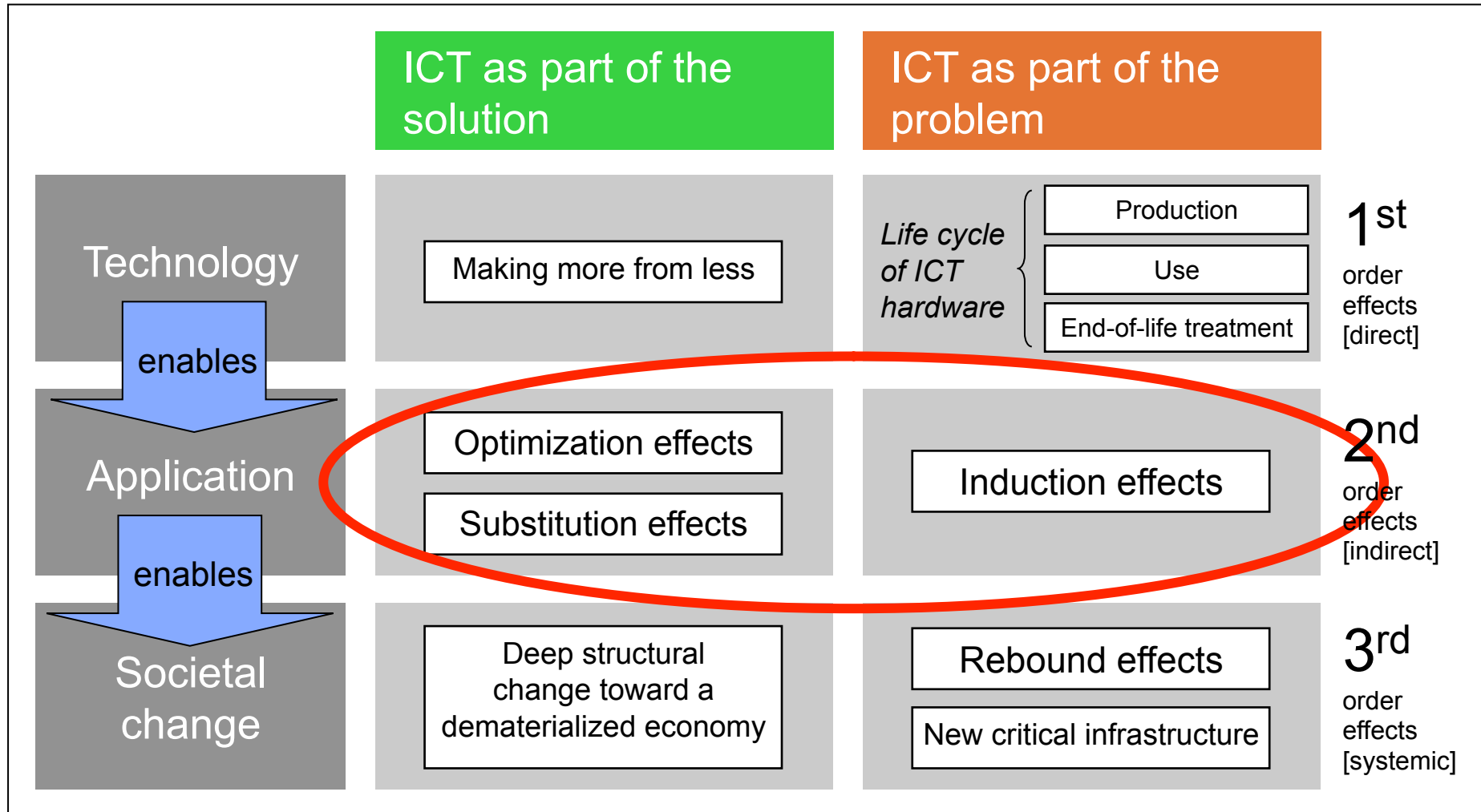
Source: Empa

Manual extraction of copper from printed wiring boards in Delhi, India.
Typical backyard company with 12 workers. Yield: 1-2 tons/month

Gold Extraction Process



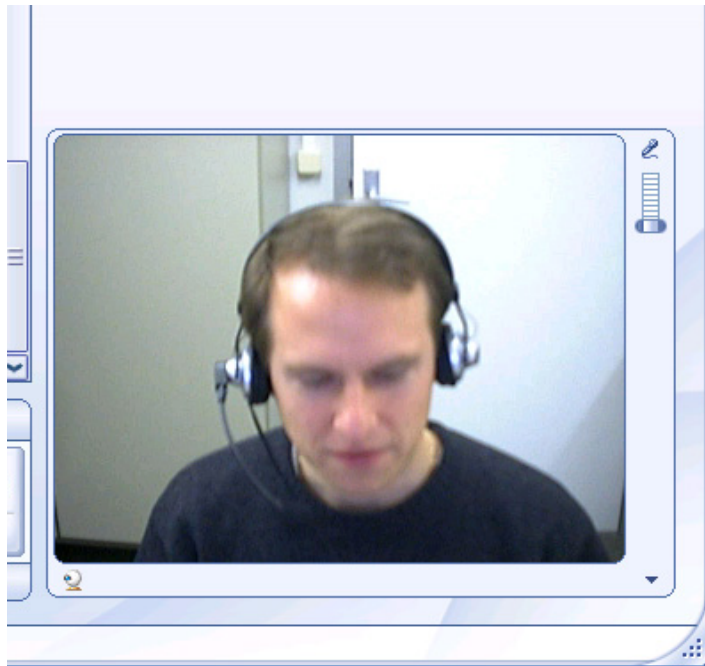
<http://ewasteguide.info>



Source: Hilty, L. M.: Information Technology and Sustainability. Essays on the Relationship between ICT and Sustainable Development. Books on Demand, Norderstedt 2008, ISBN: 9783837019704



Virtuelle Meetings?





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Substitution Example: One conference on two continents



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Source: Empa

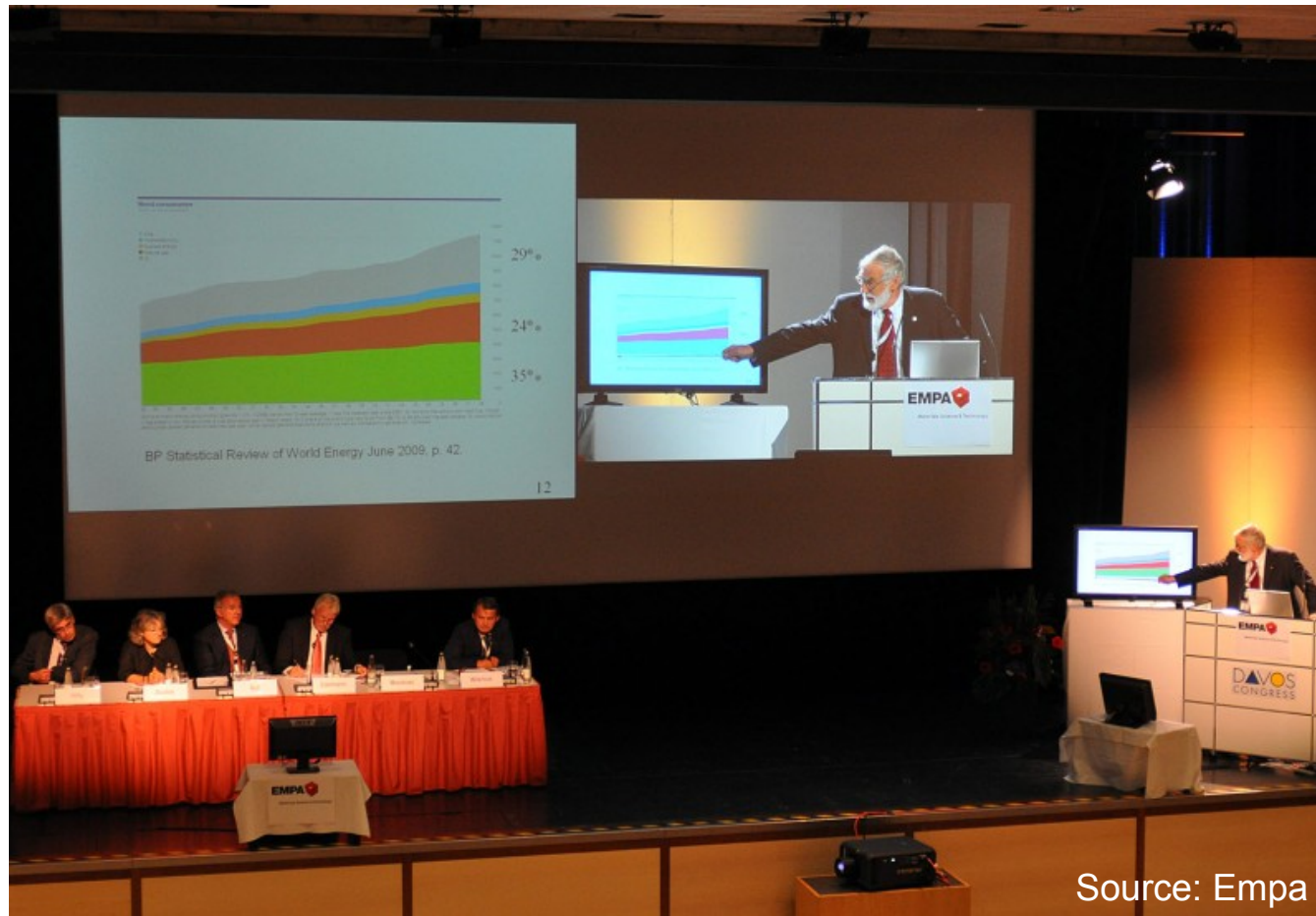


SWITCH
Serving Swiss Universities

Herzlichen Glückwunsch zum 40. Geburtstag der Informatik an der Uni Hamburg! 18.11.11, Lorenz Hilty



Substitution Example: One conference on two continents



Source: Empa

Full HD picture of the presentation and of the presenter pointing on content





Substitution Example: One conference on two continents



Institut für Informatik



Source: Empa

Speaker Has Eye Contact to Remote Audience

Herzlichen Glückwunsch zum 40. Geburtstag der Informatik an der Uni Hamburg! 18.11.11, Lorenz Hilty



Substitution Example: One conference on two continents



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Source: Empa



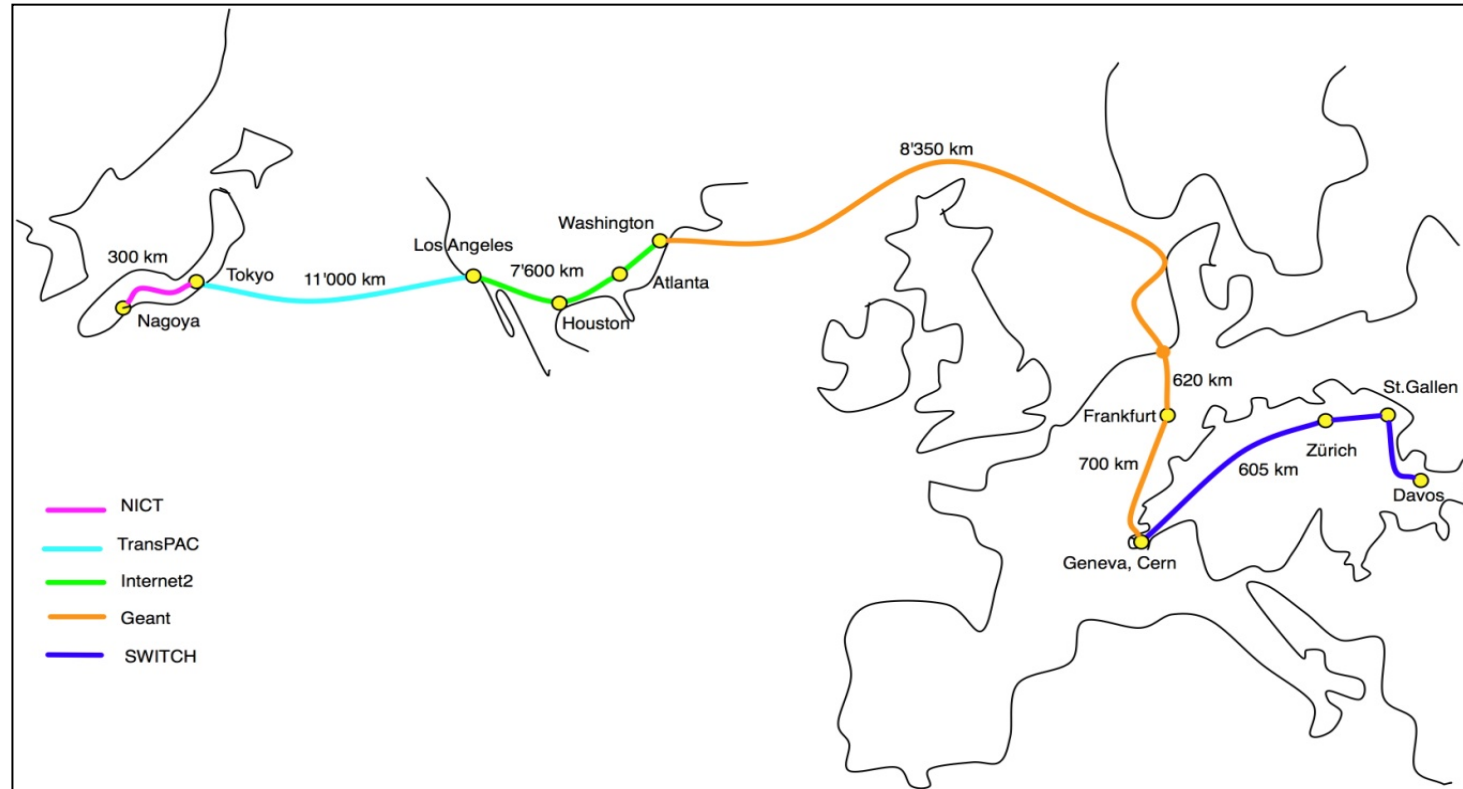
Source: Empa



Source: Empa

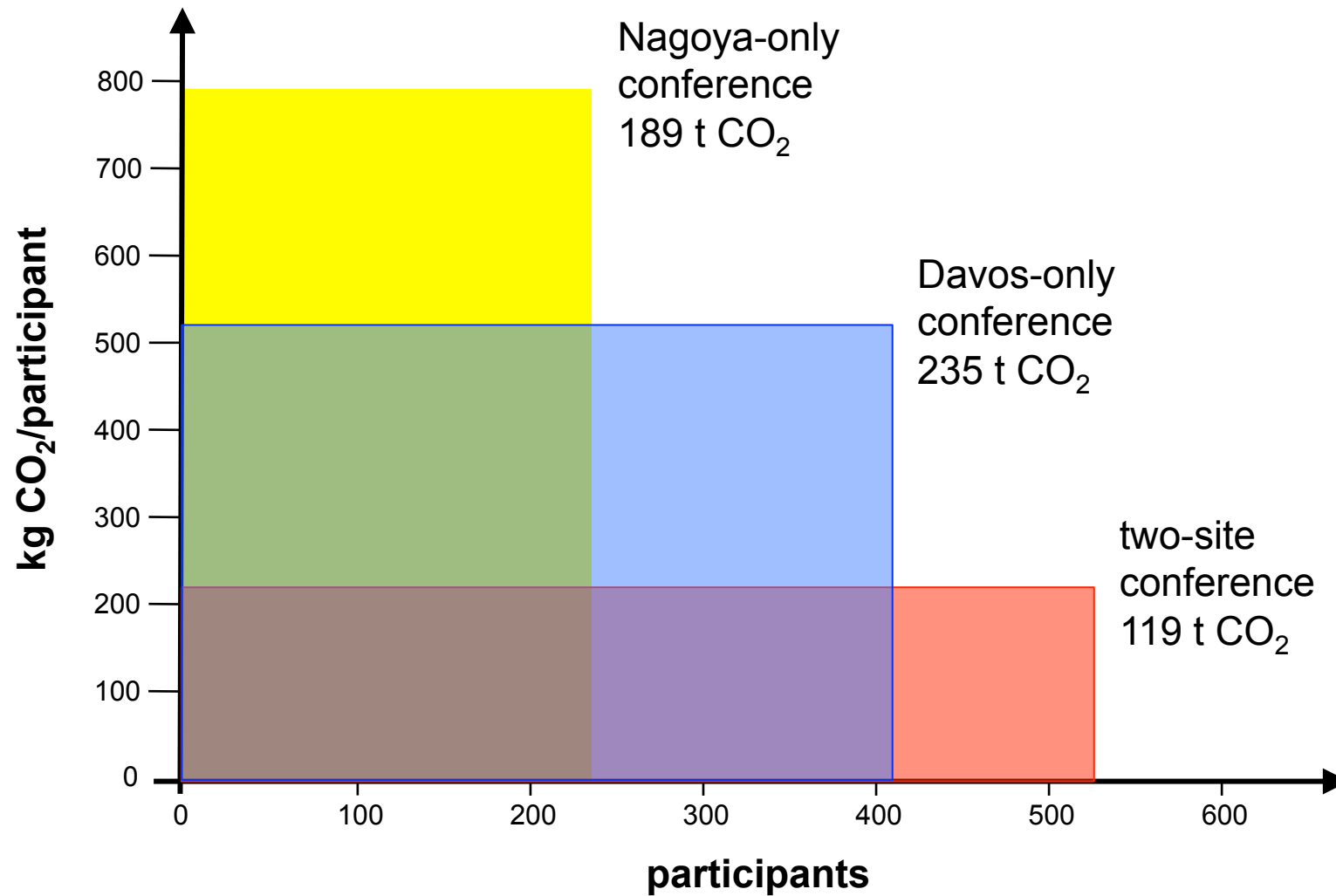


Source: Empa



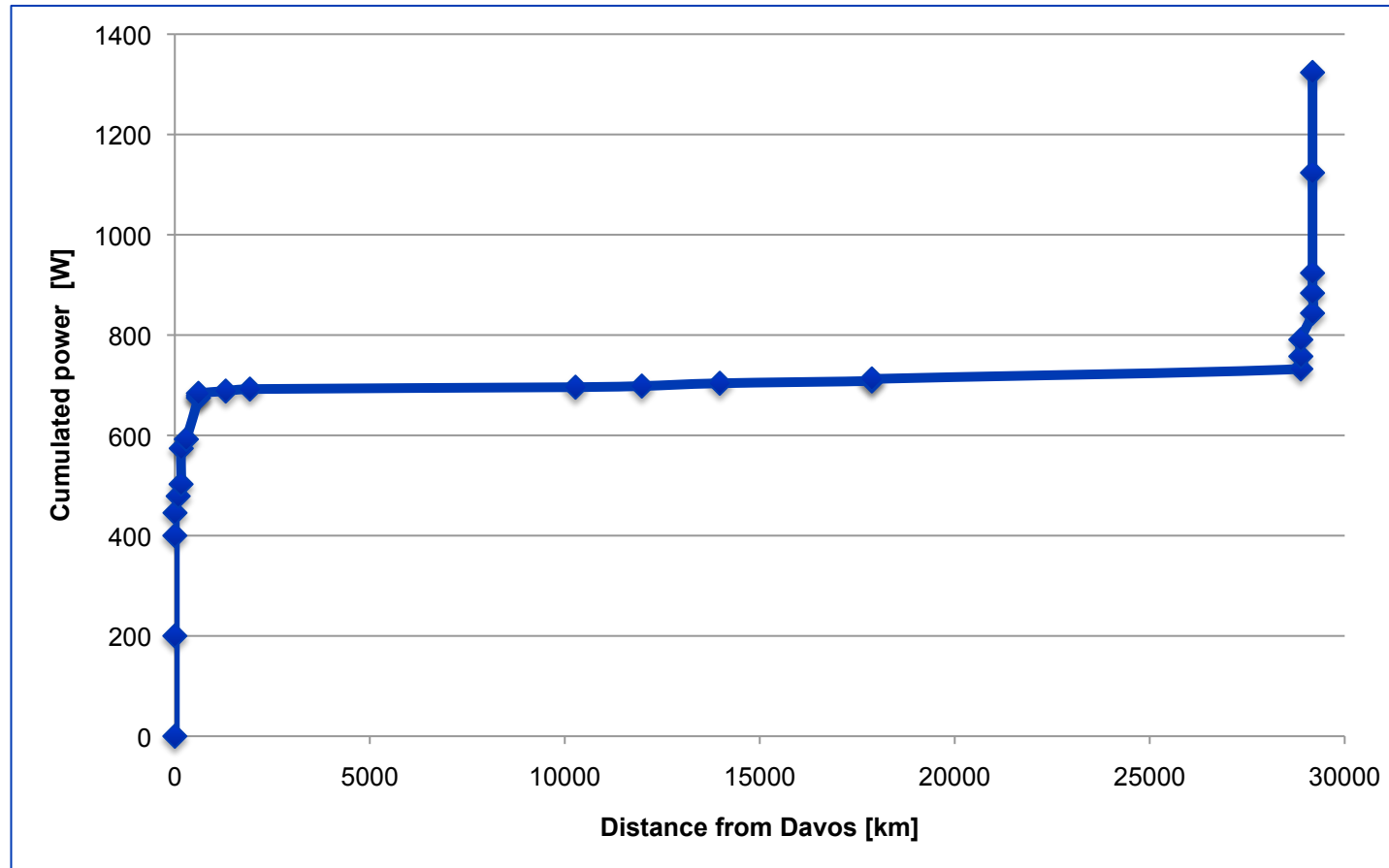
The route from Switzerland to Japan, over the Atlantic, continental US, and the Pacific, with a total fiber optic length of 29,175km.

Source: Coroama, Hilty et al. 2012





Energy demand of Internet Transmission



Cumulated power demand for a 20 Mbit Internet connection Davos-Nagoya.



Estimates of energy per data transmitted

136 kWh/GByte

derived from Koomey et al. 2004

8.8 - 24.3 kWh/GByte

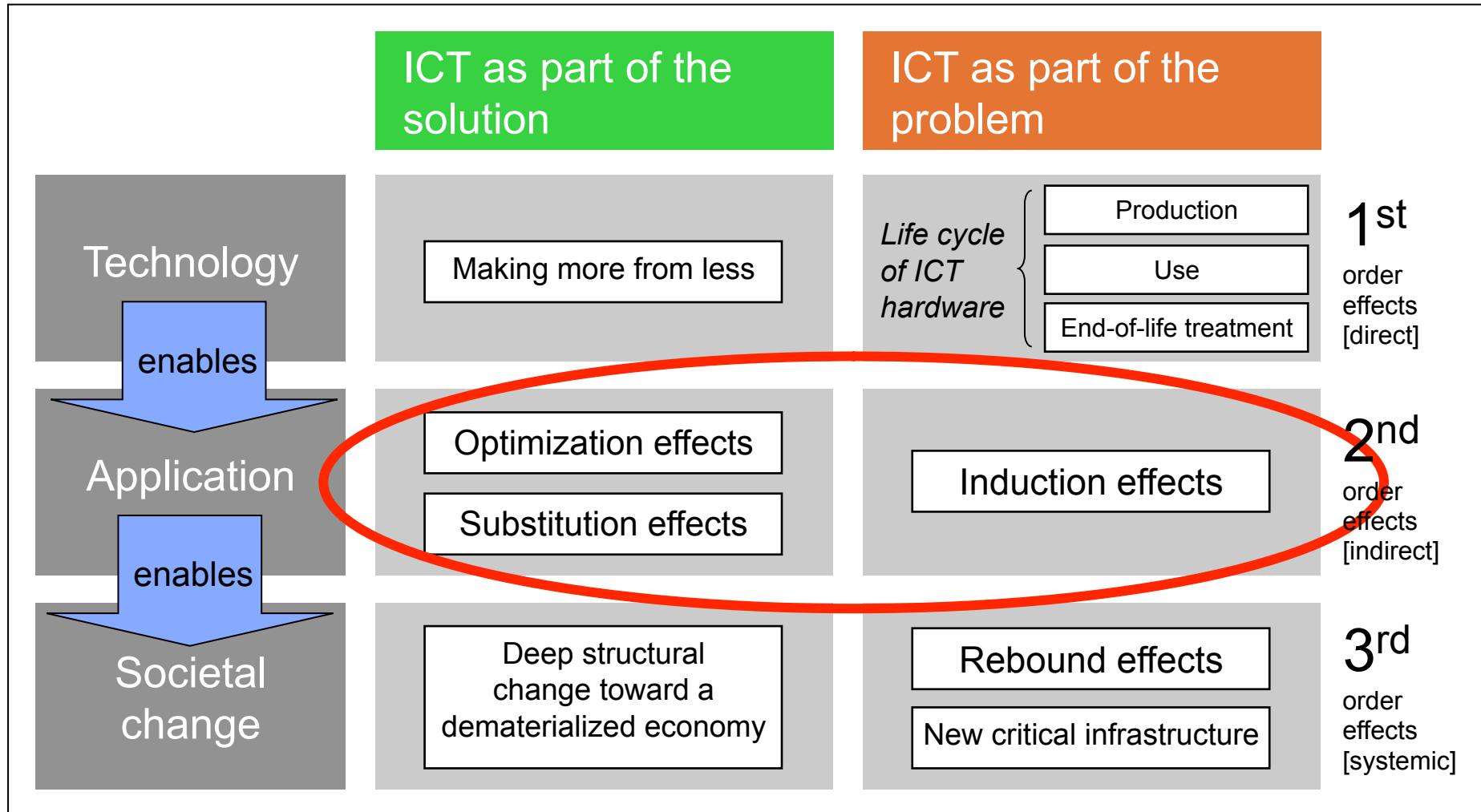
derived from Taylor and Koomey 2008

1.8 kWh/GByte

derived from Pickavet et al. 2008

0.15 kWh/GByte

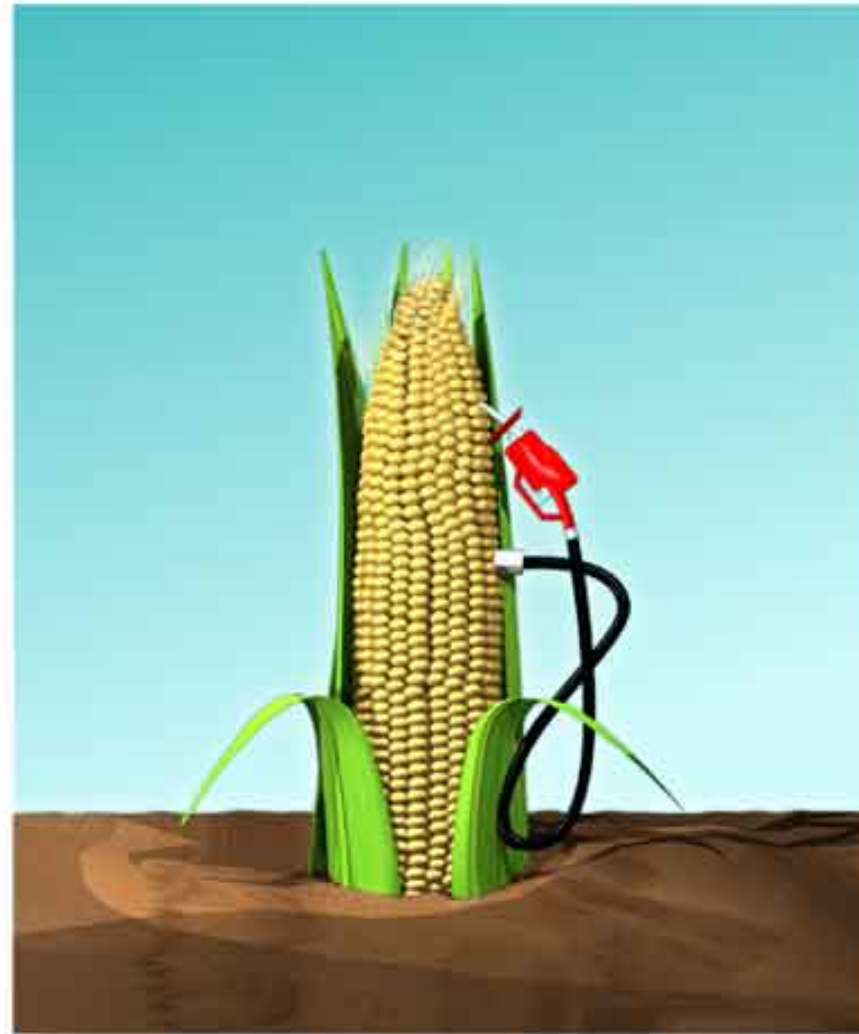
Coroama, Hilty et al. 2012



Source: Hilty, L. M.: Information Technology and Sustainability. Essays on the Relationship between ICT and Sustainable Development. Books on Demand, Norderstedt 2008, ISBN: 9783837019704



Wie kann Informatik
den Vollzug von
Umwelt- und Klimapolitik
optimieren?

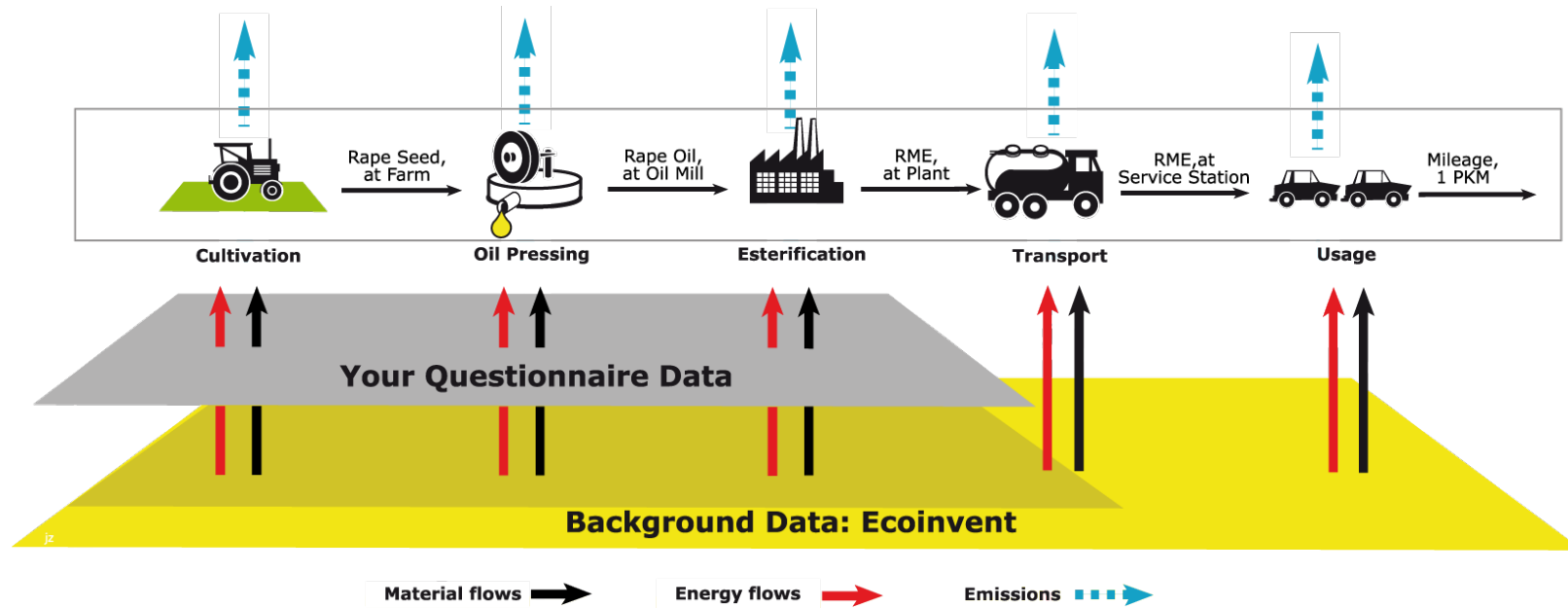





Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Volkswirtschaftsdepartement EVD
Staatssekretariat für Wirtschaft SECO





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Staatssekretariat für Wirtschaft SECO





Basic Data

Cultivation

Processing

Social Criteria

Validation Calculation

Results

Overview

UBP06

GWP

MAKE PDF

Basic Data



Cultivation Data

Provider1

Processing Data



Social Criteria



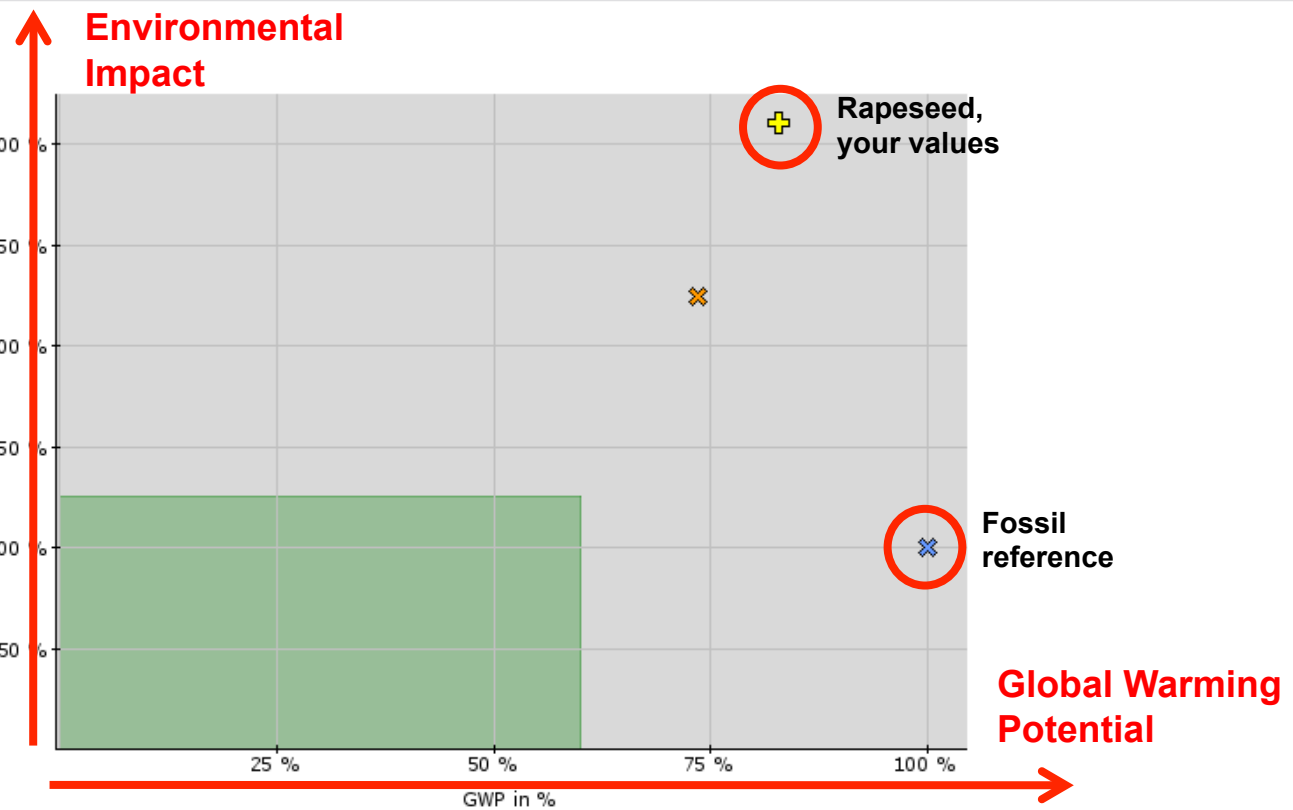
Validation/
Calculation

Results

Reset entered data



show help boxes?





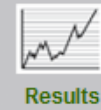
Basic Data

Cultivation

Processing

Social Criteria

Validation Calculation



Results

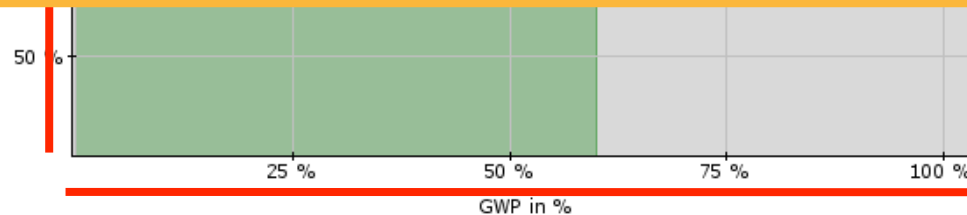
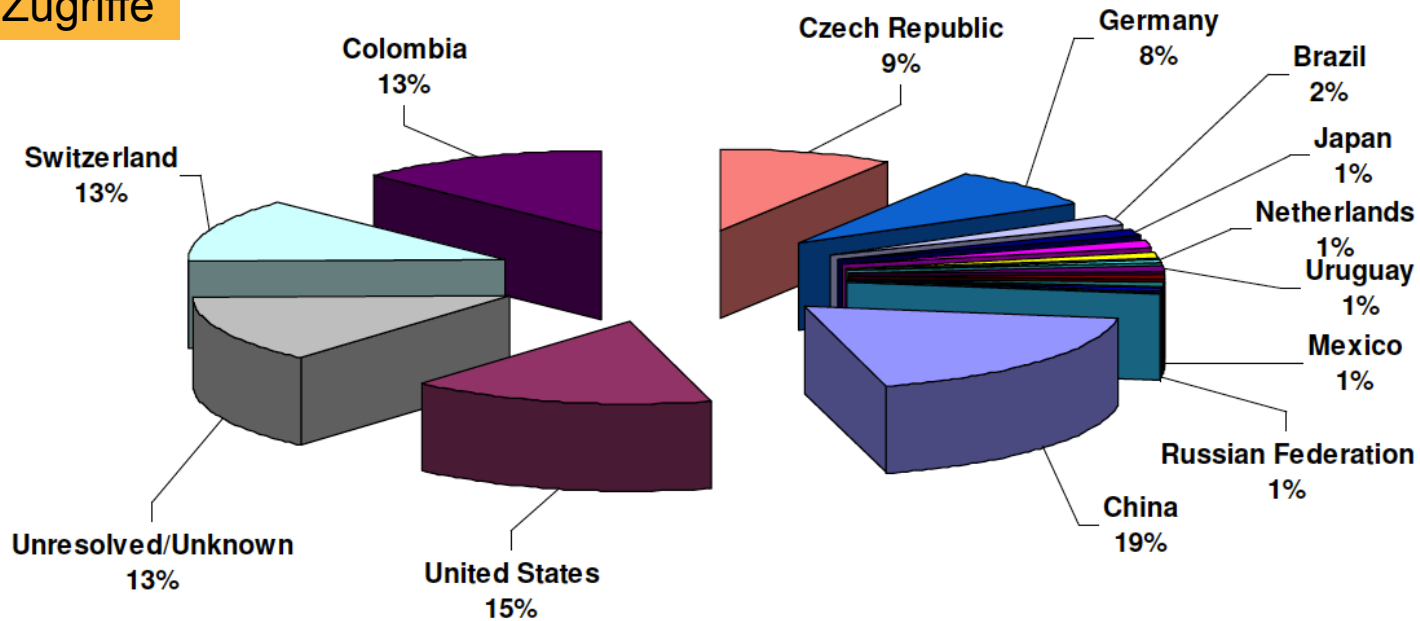
Overview

UBP06

GWP

MAKE PDF

Zugriffe



Global Warming Potential



- **Greening through IT?** "...how the tools and techniques of information technology (IT) can help us tackle environmental problems" (Bill Tomlinson, UCI, 2010)
- **Sustainable HCI?** "...how sustainability can be taken into account when designing technology, and how novel technology can be used to support and encourage sustainable behaviors on the part of users" (Elaine Huang, 2011)
- **Integrated Sustainable Development – Requirements Engineering for Sustainable Systems:** "Software can play a major role in enabling and optimizing sustainability... for example, for optimizing energy and resource efficiency" (Masdar Institute, 2011)
- **Computational Sustainability?:** "...an interdisciplinary field that aims to apply techniques from computer science, information science, operations research, applied mathematics, and statistics for balancing environmental, economic, and societal needs for sustainable development. (ICS, 2008)

Handbuch der Informatik

B. Page/L. M. Hilty (Hrsg.)

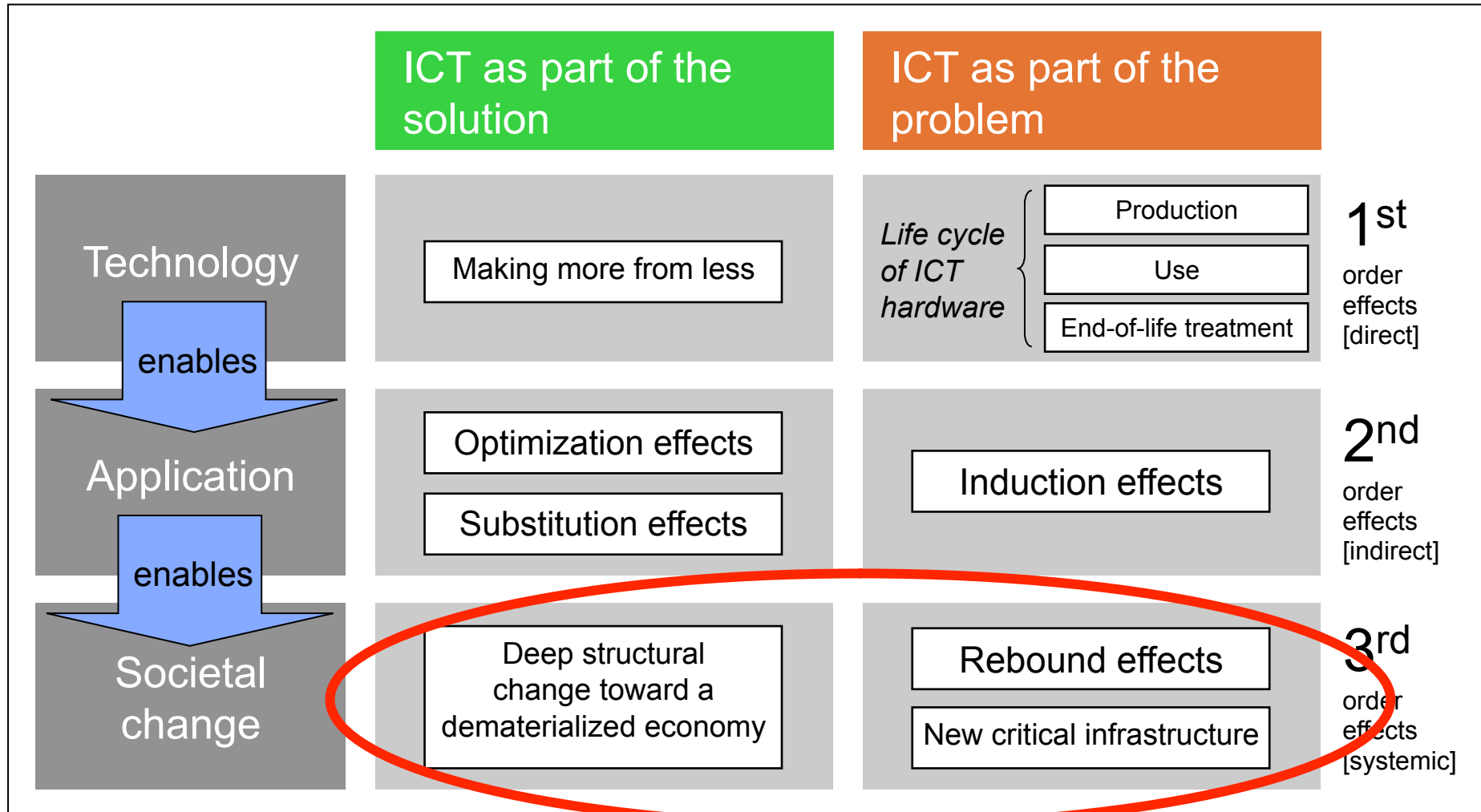
Umwelt- informatik

Informatikmethoden für
Umweltschutz und Umweltforschung

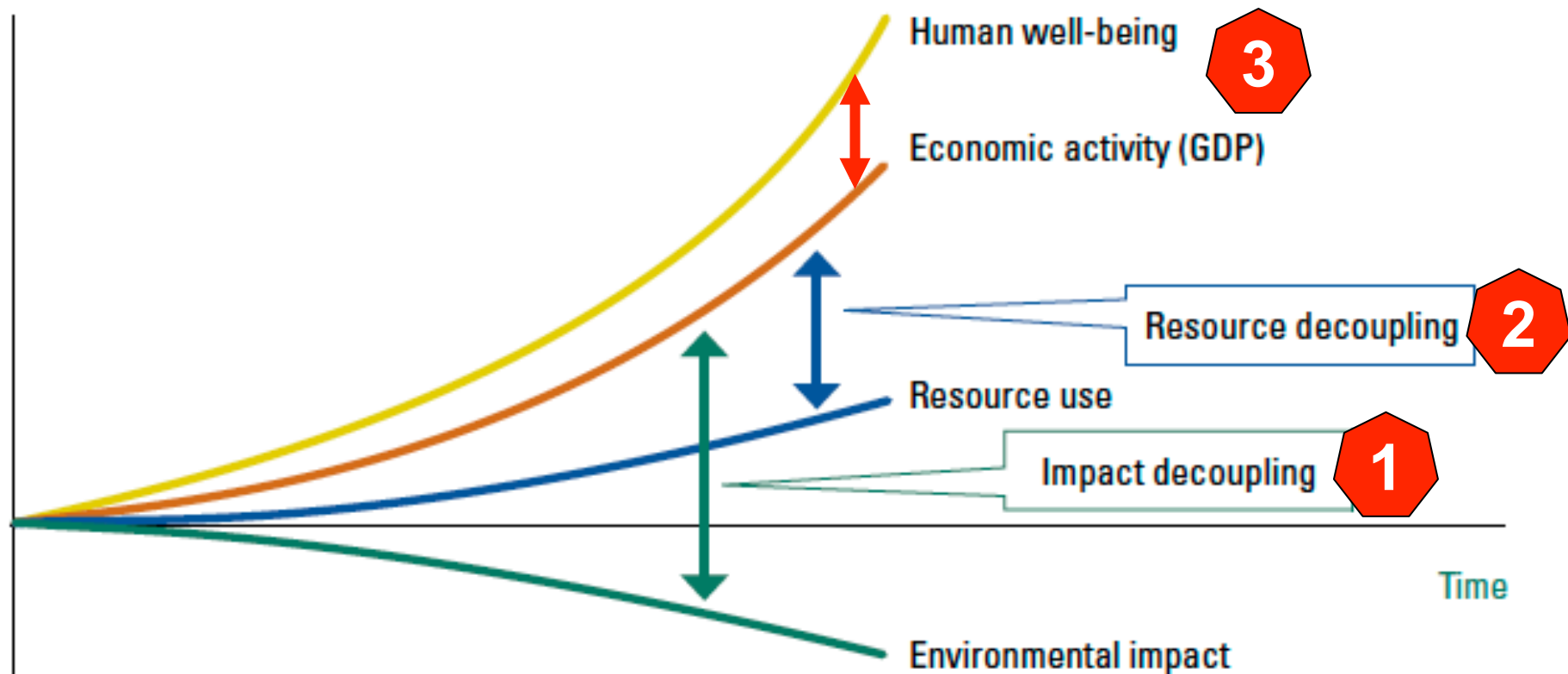
2. Auflage

Oldenbourg

13.3



Source: Hilty, L. M.: Information Technology and Sustainability. Essays on the Relationship between ICT and Sustainable Development. Books on Demand, Norderstedt 2008, ISBN: 9783837019704



Source: Decoupling Natural Resource Use and Environmental Impacts from Economic Growth. UNEP 2011



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Danke für Ihre Aufmerksamkeit!

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www.ifi.uzh.ch/isr



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ICT for Sustainability
14.-16.02.2013, Zürich
www.ict4s.org

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



University of
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