Water use and management
–
Cleaner production

Full version

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Lecture 7 part 1 in the Master Course
Sustainable Development and Sustainability Science,
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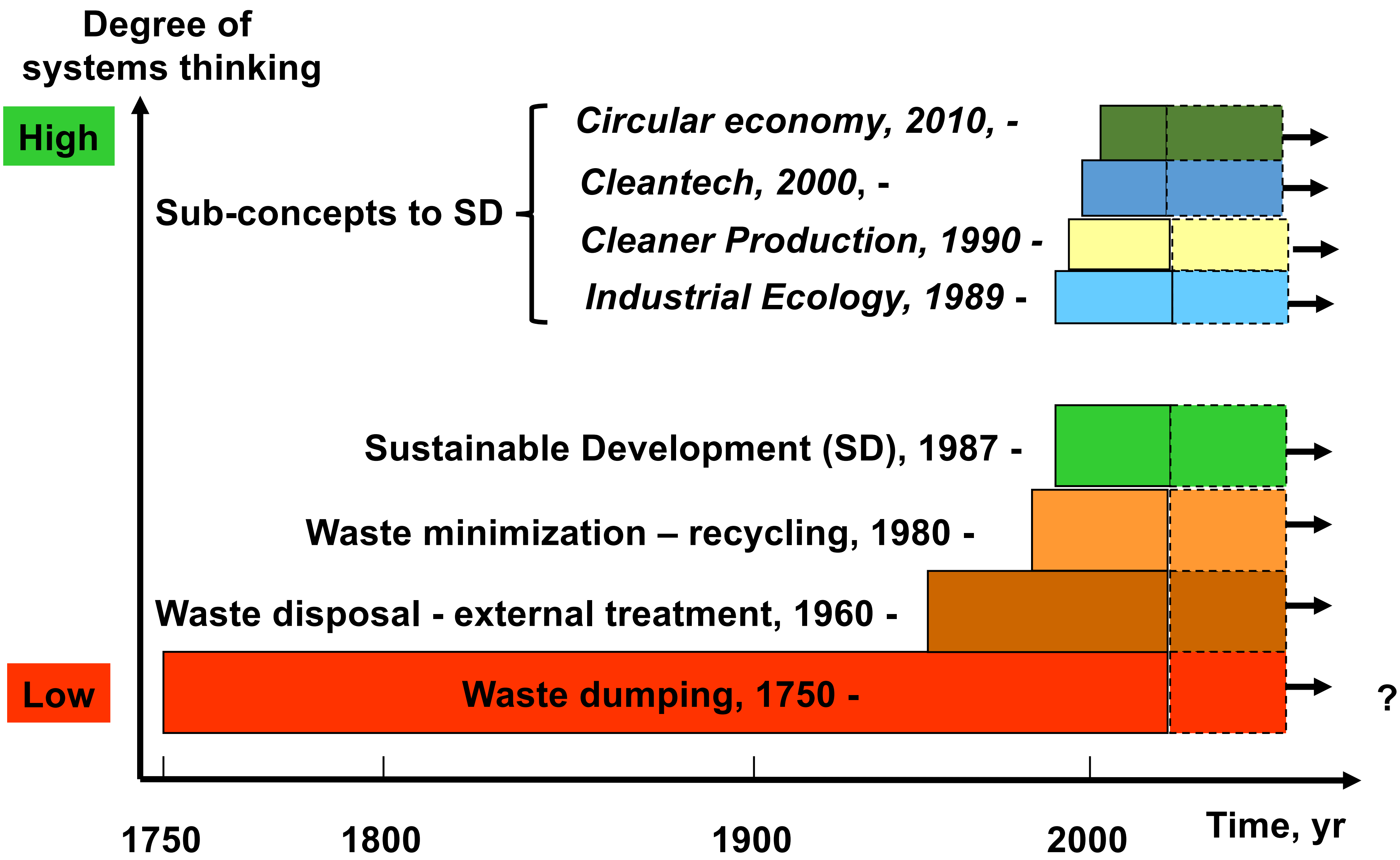
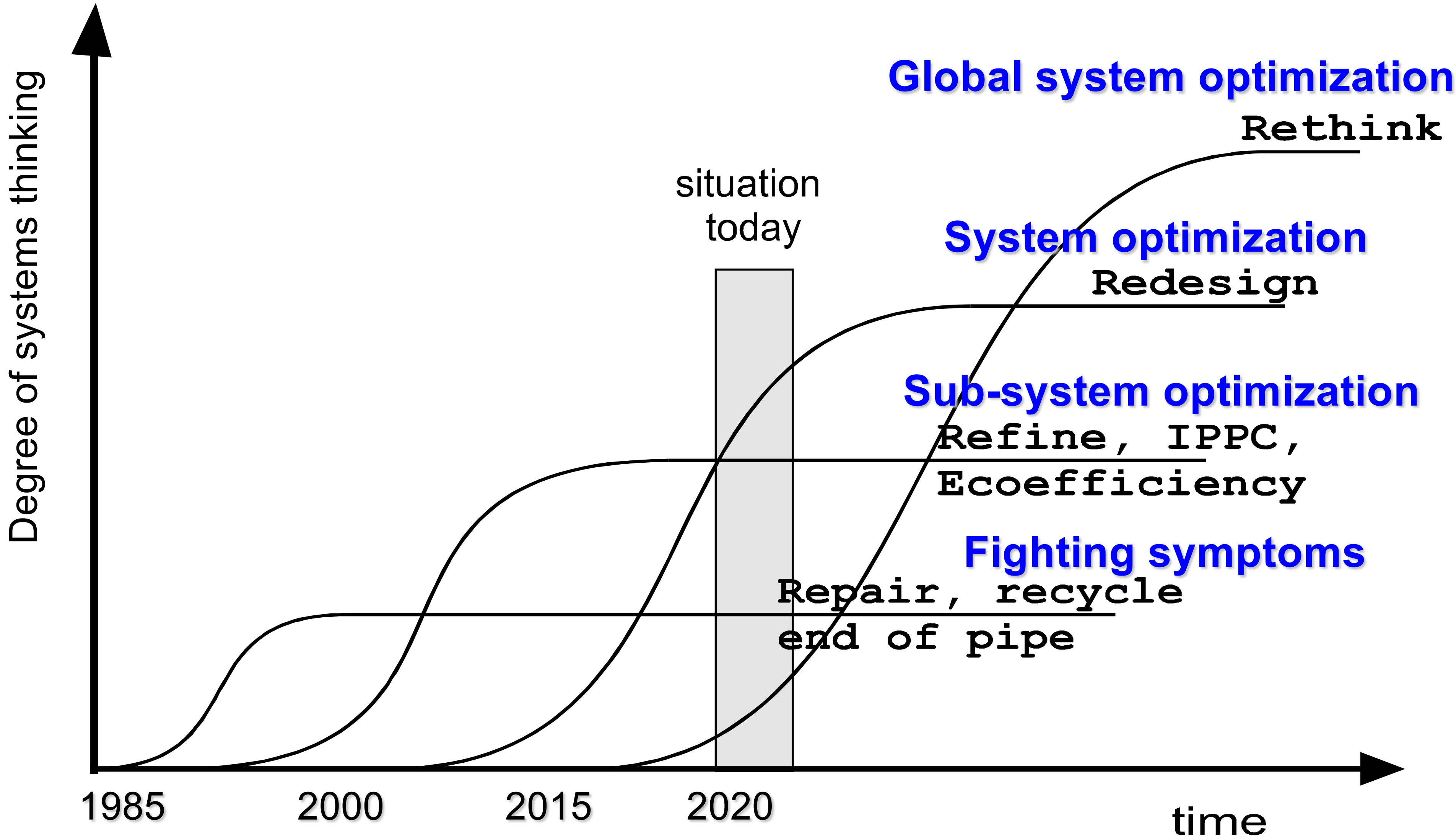
between the universities and the Swedish Aral Sea Society

Part 1
Water use and management

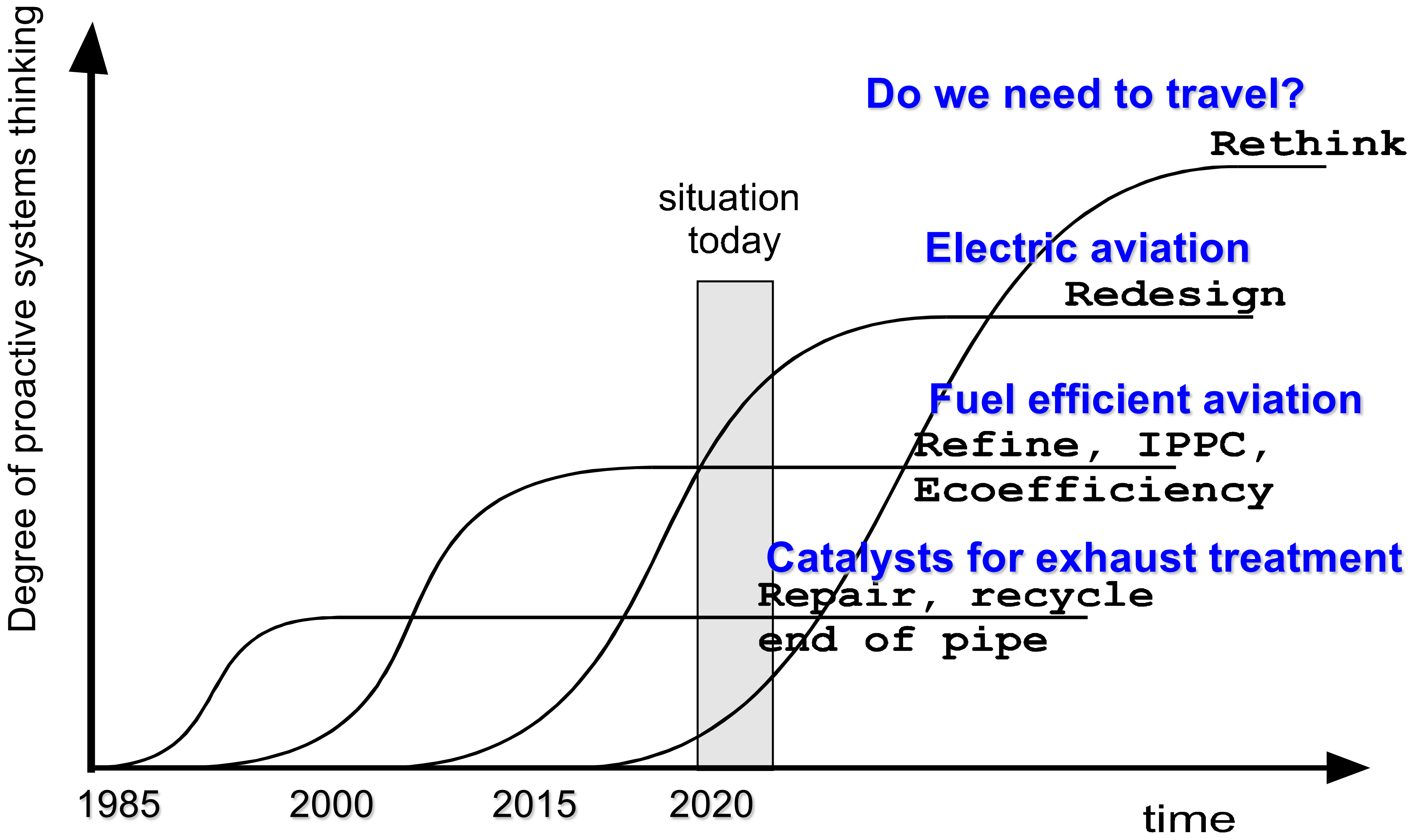
Development of the industrial approach to environmental management 1750 - 2020



The paradigm shift in ecologic thinking



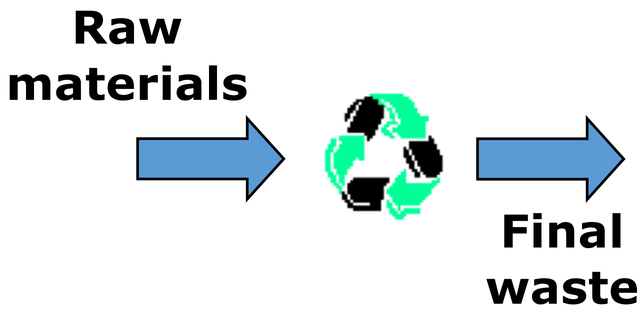
The paradigm shift applied for international cooperation travel



Material flows and ecocycles – now and in the future

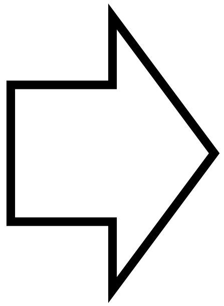
Now

Society



High raw material use

Low degree of recycling



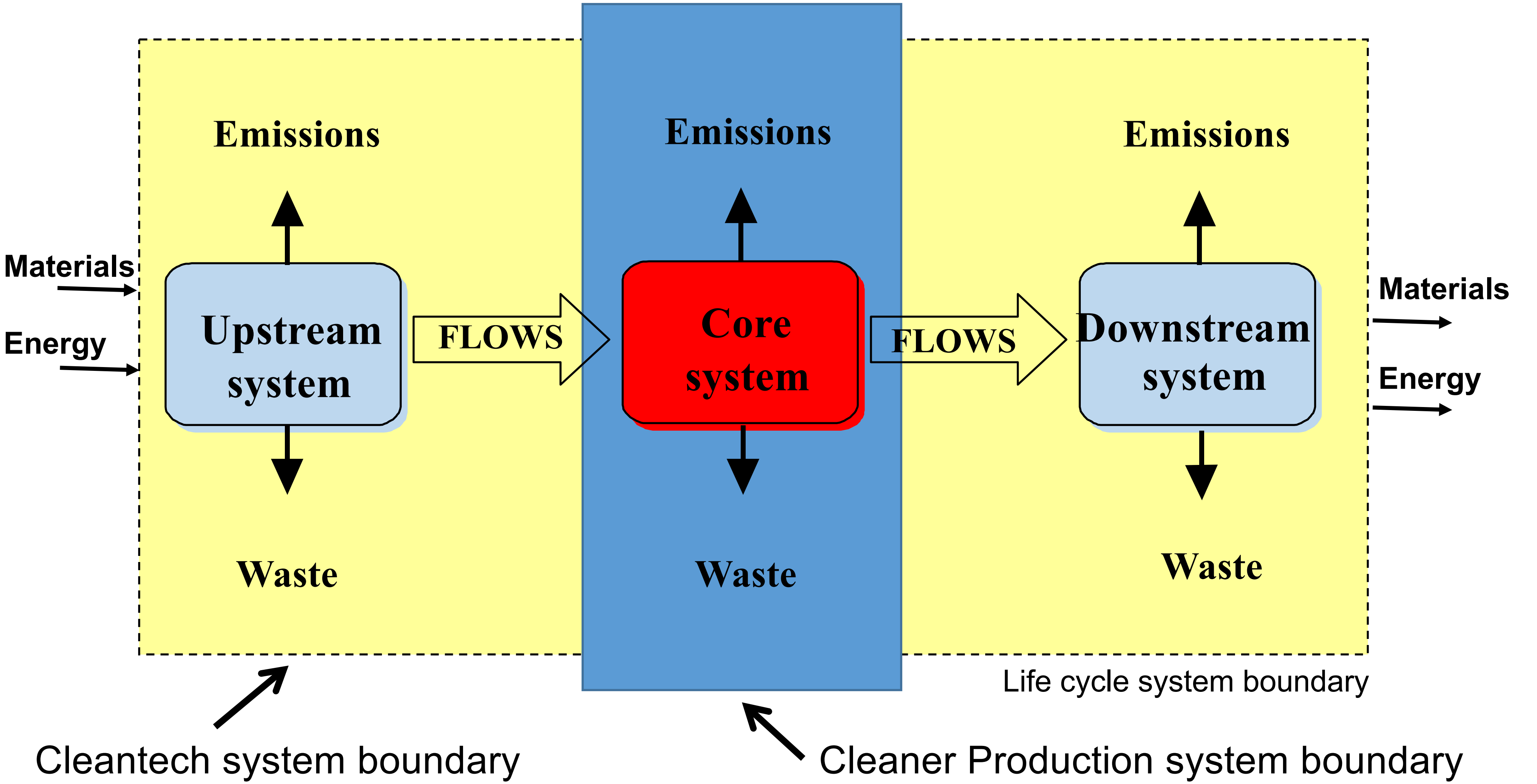
Future

Society

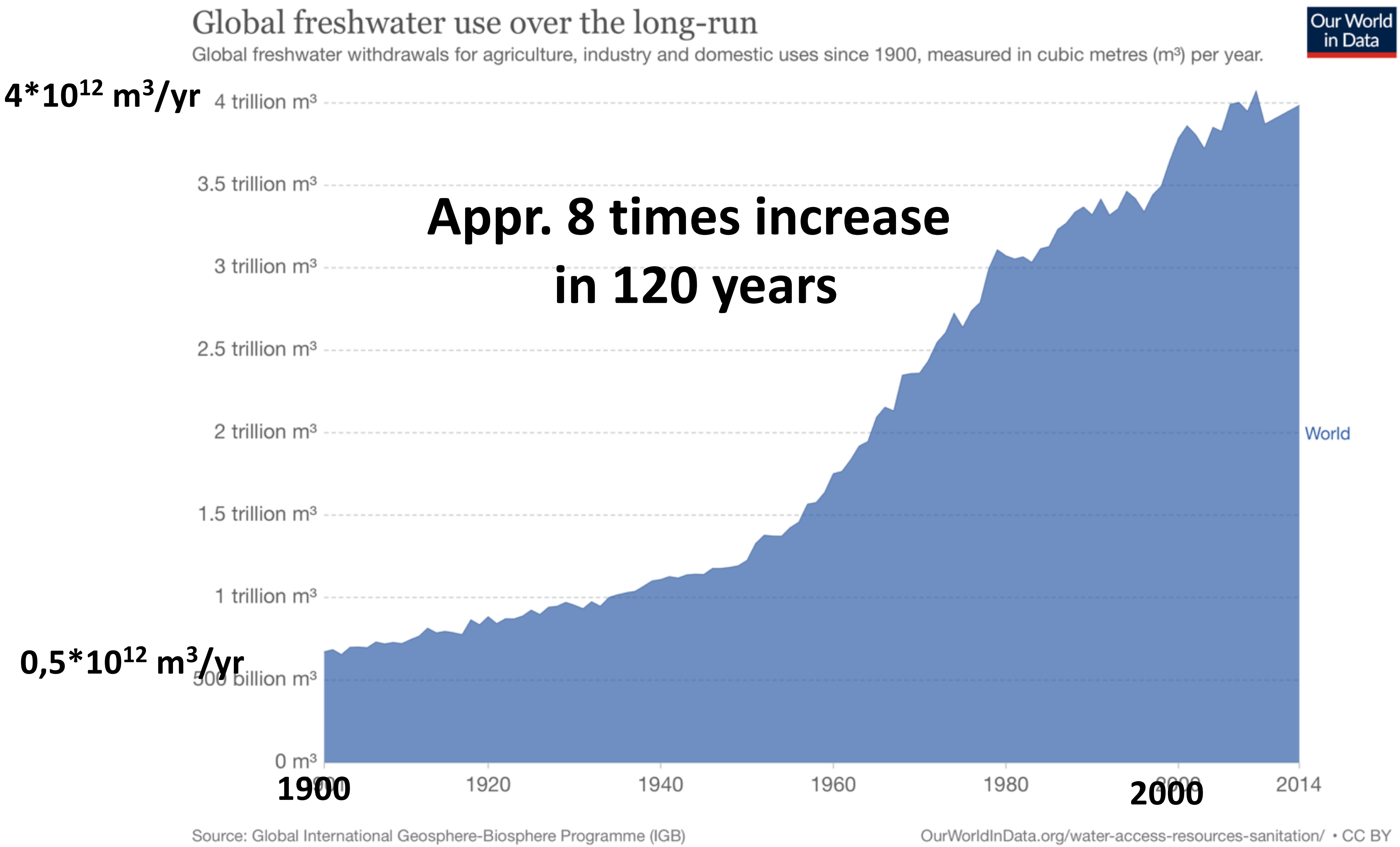
Low raw material use

High degree of recycling

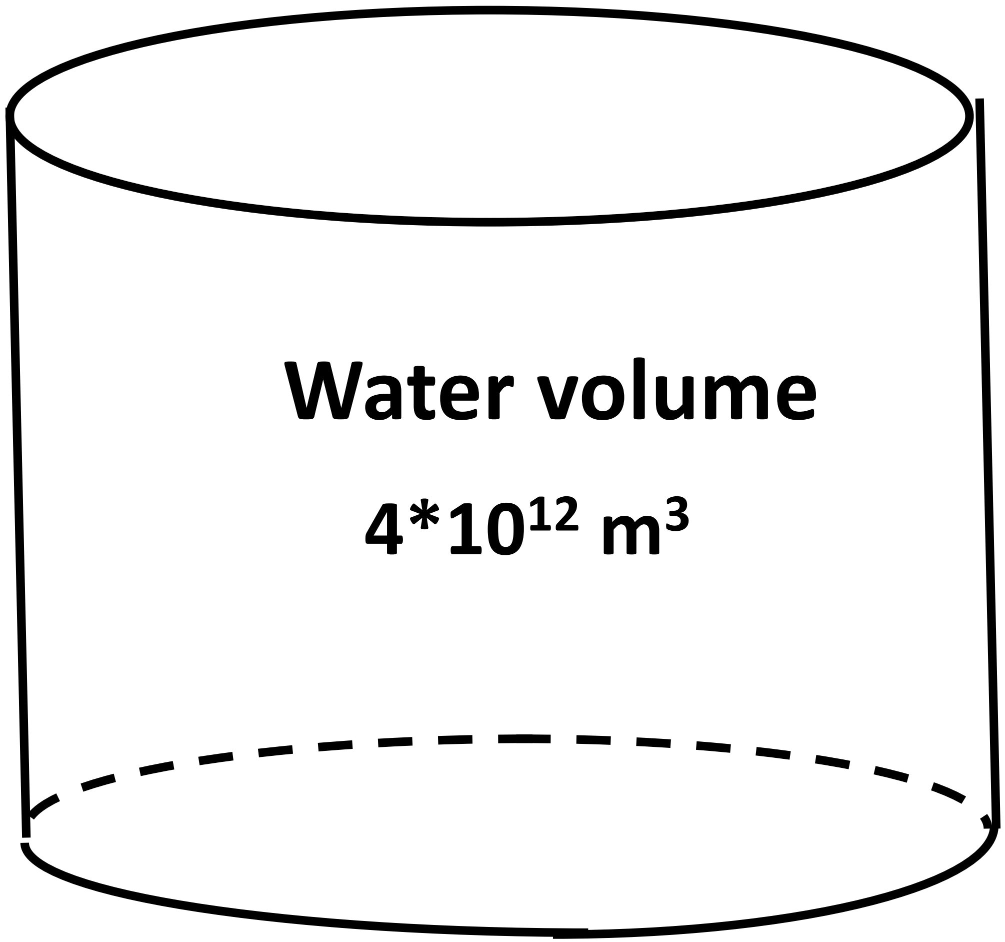
The Life Cycle Perspective
Cleantech and Cleaner Production



Global freshwater use 1900-2014



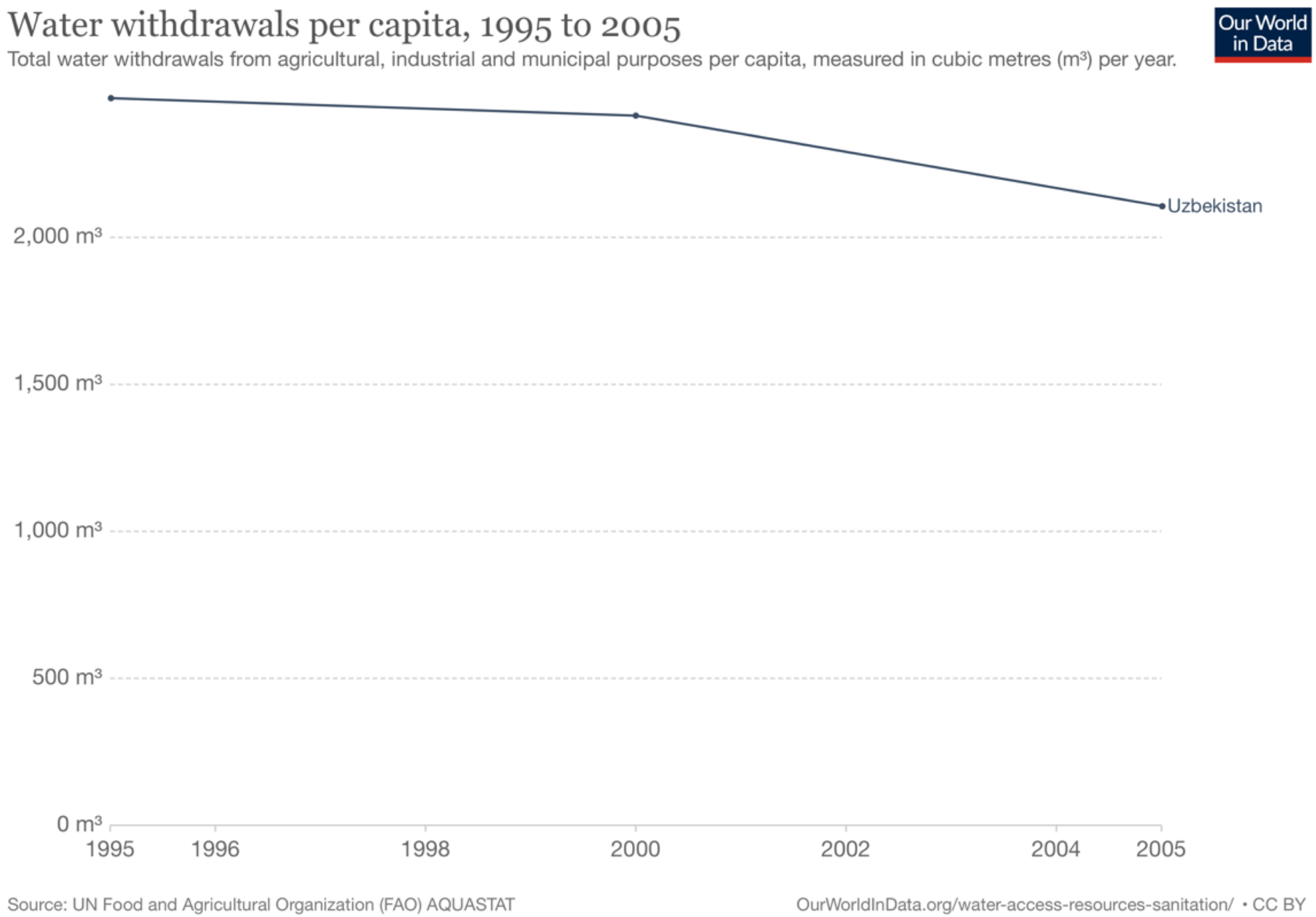
How much is 4 trillion m^3 water per year



Height = 17,2 km

Tank diameter = 17,2 km

Water withdrawal in Uzbekistan 1995 – 2005 m^3/capita*yr



2000

500

0

1995 **2005**

Water use in three countries 2002 and 2017

Water withdrawal in Uzbekistan, USA and Sweden 2002 and 2017							
Parameter type	**Parameter**	**Uzbekistan 2002**	**USA 2002**	**Sweden 2002**	**Uzbekistan 2017**	**USA 2017**	**Sweden 2017**
Absolute	Agricultural water, 10^9 m^3/yr	53,7	195	0,135	54,4	176	0,075
Absolute	Industrial water, 10^9 m^3/yr	2,14	301	1,50	2,13	210	1,35
Absolute	Municipal water, 10^9 m^3/yr	3,61	64,6	1,04	2,41	58,4	0,96
Absolute	Total withdrawal, 10^9 m^3/yr	59,4	561	2,68	58,9	444	2,38
Relative	Agricultural water, m^3/cap*yr	2123	677	15,2	1679	542	7,5
Relative	Industrial water, m^3/cap*yr	85	1045	168	66	646	135
Relative	Municipal water, m^3/cap*yr	143	224	117	74	180	96
Relative	Total withdrawal, m^3/cap*yr	2348	1948	301	1818	1366	238
Population, millions		25,3	288	8,91	32,4	325	10,0

Conclusion: Water use in agriculture = of key importance for Uzbekistan

Examples of water saving measures

1. Start to monitor water use carefully
2. Install valves to close water when not used
3. Fix “low hanging fruits” (leaks etc)
4. Reuse of wastewater (down-classing of water)
5. Recirculate cooling water after cooling (closed cooling water system)
6. Install recirculation of process water (after specific purification)
7. Redesign processes (e.g install counter current rinsing)

A Paper Mill –
a major water user that emits a lot of water as steam

Field irrigation system in Uzbekistan

Lecture break discussion questions

Why is it so important to adopt av Life Cycle Perspective on the physical resource metabolism of human activities? Compare with the two pictures on water metabolism from a Swedish paper mill and an Uzbek field

What main conclusions can be drawn from the water withdrawal numbers presented for Uzbekistan, USA and Sweden?

Part 2
Cleaner Production

Cleaner Production

UNEP (United Nations Environmental Program) definition of Cleaner Production

“C***leaner production means the continuous application of an integrated, preventative environmental strategy to processes, products and services to increase eco-efficiency and reduce risks to humans and the environment***"

Cleaner Production may be regarded not only as a goal but rather as a journey towards shaping a more efficient physical resource metabolism in industrial activities

Cleaner Production – priorities

In the work towards Cleaner Production – especially when considering processes that are open and discontinuous – it is important to establish a list of priorities between different potential and desirable measures. Such a priority list would normally consider health and process accident risks before environmental risks according to the following:

Priority 1:	**Health aspects for the workers**
Priority 2:	**Process accident risks**
Priority 3:	**Risks for local environmental impact**
Priority 4:	**Risks for regional environmental impact**
Priority 5:	**Risks for global environmental impact**

The Cleaner Production Project

1. Issue raised
2. Management decision
3. Cleaner production group assigned
4. Mass and energy balances established
5. Improvement alternatives selected
6. Feasibility of alternatives assessed
7. Selection of preferred alternative
8. Project implementation
9. Project evaluation

Cleaner Production in practice – the necessity to integrate auditing, monitoring and practical measures

In practice, it is absolutely necessary to integrate the work with monitoring, evaluation and auditing in Cleaner Production. Without this integration, there will be a suboptimisation of the work with Cleaner Production. Two important Initial considerations are:

1. **With primitive processes – (i) open and/or (ii) non-continuous it will be necessary to reconsider the design of the processes themselves**

2. **With advanced processes (closed and/or continuous the work with Cleaner Production can be based on the establishment of mass- and energy balances**

Basic Approaches to Cleaner Production

In order of complexity, time and investment

1. Good Housekeeping (actions without investment)
2. Improved process monitoring and control
3. Input-Substitution (less polluting/toxic raw materials)
4. In-situ recycling (e.g. water and chemicals)
5. Technological optimisation (Process modification)
6. Redesign of product, by-products and or packaging
7. Off-site recycling (e.g. aluminium or paper)

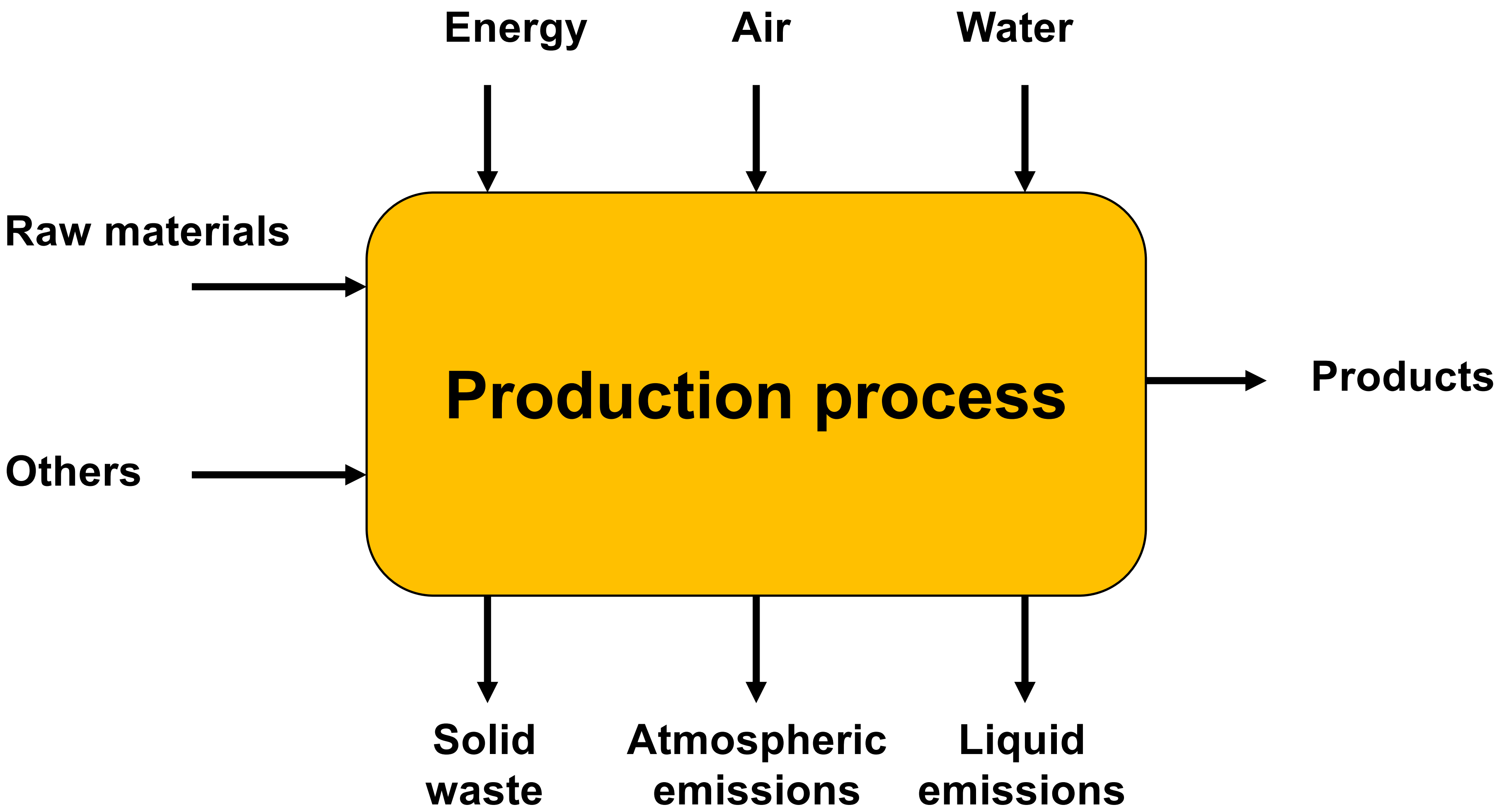
Mass and energy balances as a basis for Cleaner Production measures

It is necessary to establish mass and energy balances in order to set up appropriate priorities for Cleaner Production measures. It is very important to consider this in the planning of both initial and permanent monitoring programs for the activity in focus. At least two levels of balances will have to be established:

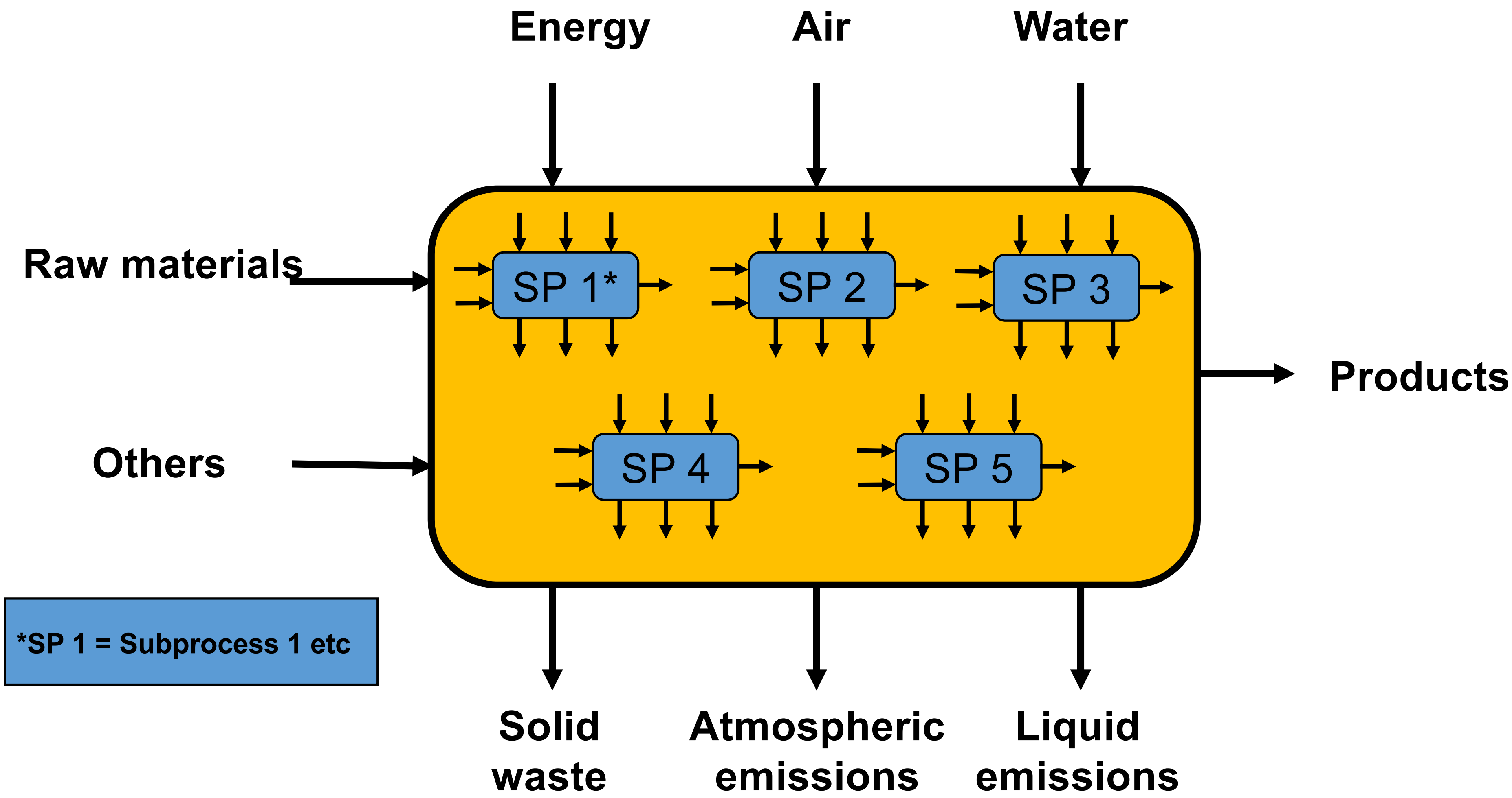
First step: Balances for the entire process the factory

Second step: Balances for the most important sub processes

Mass and energy balances – fundamental approach 1



Mass and energy balances – fundamental approach 2



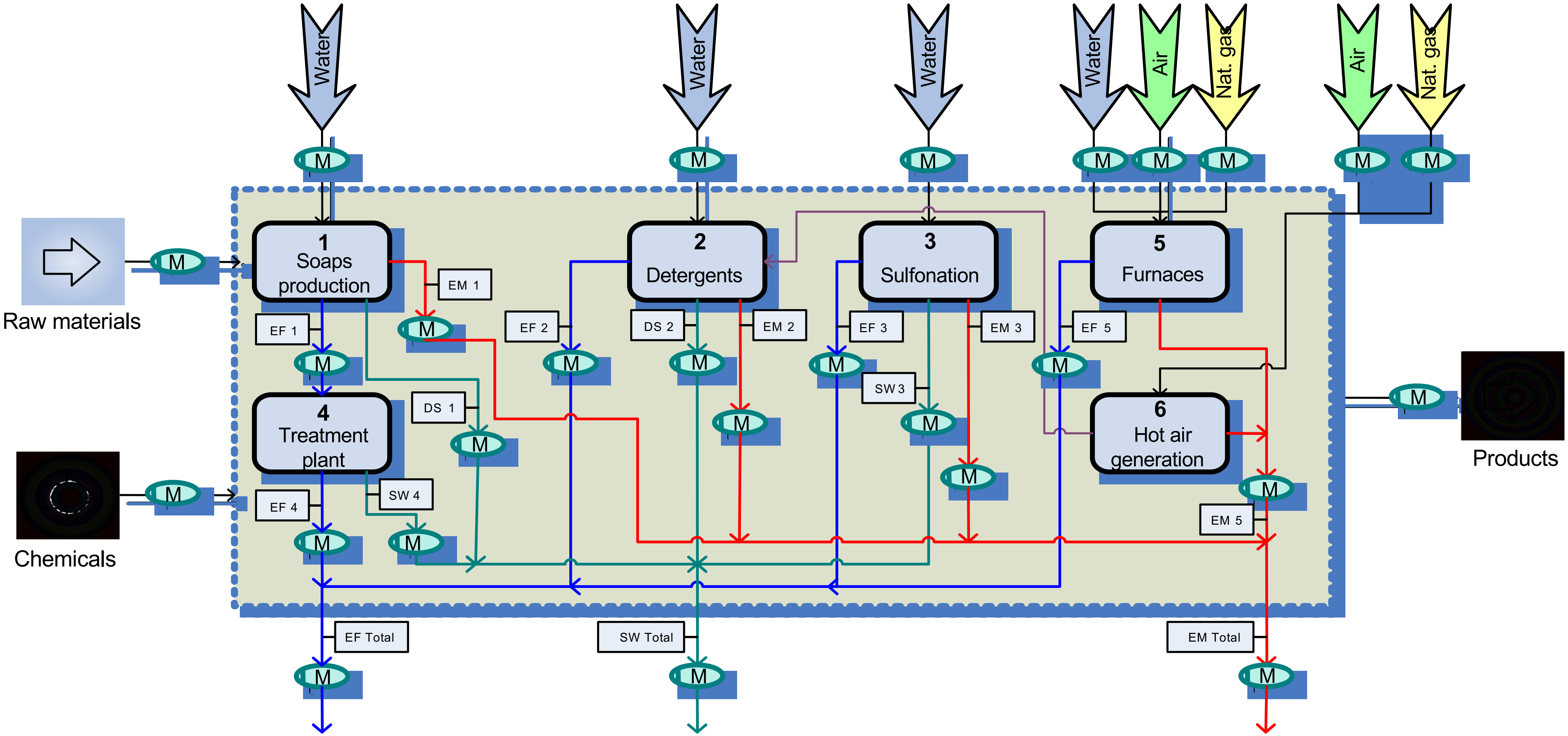
*SP 1 = Subprocess 1 etc

Cleaner Production Mass and Energy Balances Methodology

1. Aim of the study
2. System boundaries
3. Materials considered
4. Processes/subsystems included
5. Time span
6. Quantification of flows and stocks
7. Presentation of results
8. Conclusions from results

Example – Detergent factory

Code Description
EF = Effluents
SW= Solid wastes
EM = Atmospheric Emissions
M = Monitoring point



Examples of results from Cleaner Production Projects

Contribution from different measures and payback period

Product area	Metal working	Dairy products	Car components	Beverages	Paints	Fine Chemicals	Average, %
Good housekeeping, %	42	53	44	55	48	15	**43**
Source reduction, %	0	0	0	0	0	45	**8**
Process modification, %	0	26	36	13	30	0	**18**
Materials substitution, %	12	5	4	0	3	0	**4**
In-situ recycling, %	0	16	12	13	16	35	**15**
Off-site recycling, %	4	0	4	11	3	5	**5**
Product Modification, %	42	0	0	8	0	0	**8**
Payback time, yrs*	**1,0**	**0,3**	**3,2**	**6,2**	**0,43**	**8,0**	**3**

* Without interest

Source: https://www.un.org/esa/sustdev/sdissues/technology/cleanerproduction.pdf

Lead battery recycling in Cochabamba, Bolivia 2004

Cleaner Production?

Other recent concepts

- Industrial Ecology
- Circular Economy

Industrial Ecology

Definition 1

the study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory and social factors on the flow, use and transformation of resources (White 1994)

Definition 2

…is the study of the **technological organisms**, their use of **resources**, their potential **environmental impact** and the way in which their **interactions** with the natural world could be restructured to enable global **sustainability** **(**Graedel & Allenby 2010)

Circular Economy

The circular economy is based on three principles, driven by design:

- **Eliminate waste and pollution**
- **Circulate products and materials (at their highest value)**
- **Regenarate nature**

It is underpinned by a transition to renewable energy and materials. A circular economy decouples economic activity from the consumption of finite resources. It is a resilient system that is good for business, people and the environment.

Source: Ellen MacArthur Foundation
(https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview)

Suggested readings

This list comprises both PPTs, scientific articles and books. May be used by
By the interested student fort further exploration of the themes. They are
available on the Internet

Cleaner Production

Kaunas University An Introduction to Cleaner Production
https://www.un.org/esa/sustdev/sdissues/technology/cleanerproduction.pdf

Industrial Ecology

Ayres, R,U., Ayres, L.W. (Eds; 2002) A Handbook of Industrial Ecology, Edward Elgar Publishing Limited.

http://pustaka.unp.ac.id/file/abstrak_kki/EBOOKS/A%20Handbook%20of%20Industrial%20Ecology.pdf

Circular Economy

Geissdoerfer, M. and Savaget, P. and Bocken, N.M.P. and Hultink, E.J. (2017) The circular economy. a new sustainability paradigm?', Journal of cleaner production., 143 . pp. 757-768.
https://dro.dur.ac.uk/29108/1/29108.pdf

Laurenti, R., Singh, J., Frostell, B., Sinha, R., Binder, C. (2019) The Socio-Economic Embeddedness of the Circular Economy: An Integrative Framework, *Sustainability* **2018**, *10*, 2129; doi:10.3390/su10072129.
(Available on the course homepage)

Thank you!

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