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How does a whole Swiss Canton manage to go for maximal phosphorus recycling from sewage?

Dr. Leo S. Morf

Baudirektion Kanton Zürich

Amt für Abfall, Wasser, Luft und Energie (AWEL), Kanton Zürich, Schweiz
Office for Waste, Water, Energy and Air, Canton Zurich, Switzerland

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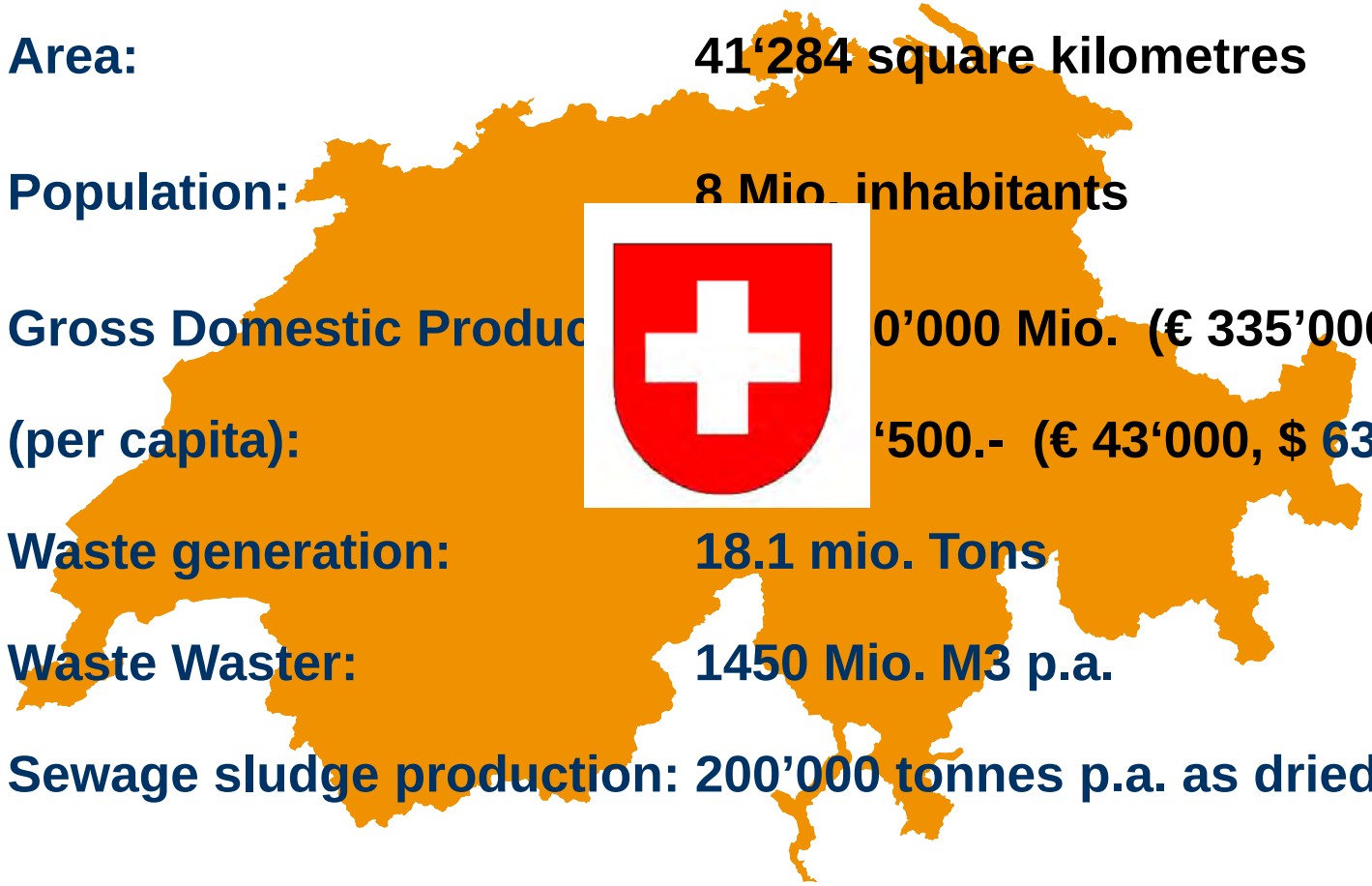
1. Some important facts about Switzerland

Basic Figures of Switzerland



- **Area:** 41‘284 square kilometres
- **Population:** 8 Mio. inhabitants
- **Gross Domestic Produc** 0’000 Mio. (€ 335’000 Millions)
  (per capita): ‘500.- (€ 43‘000, $ 63’000)
- **Waste generation:** 18.1 mio. Tons
- **Waste Waster:** 1450 Mio. M3 p.a.
- **Sewage sludge production:** 200’000 tonnes p.a. as dried matter

The role and principles of Environment protection and resource management

Characteristic:

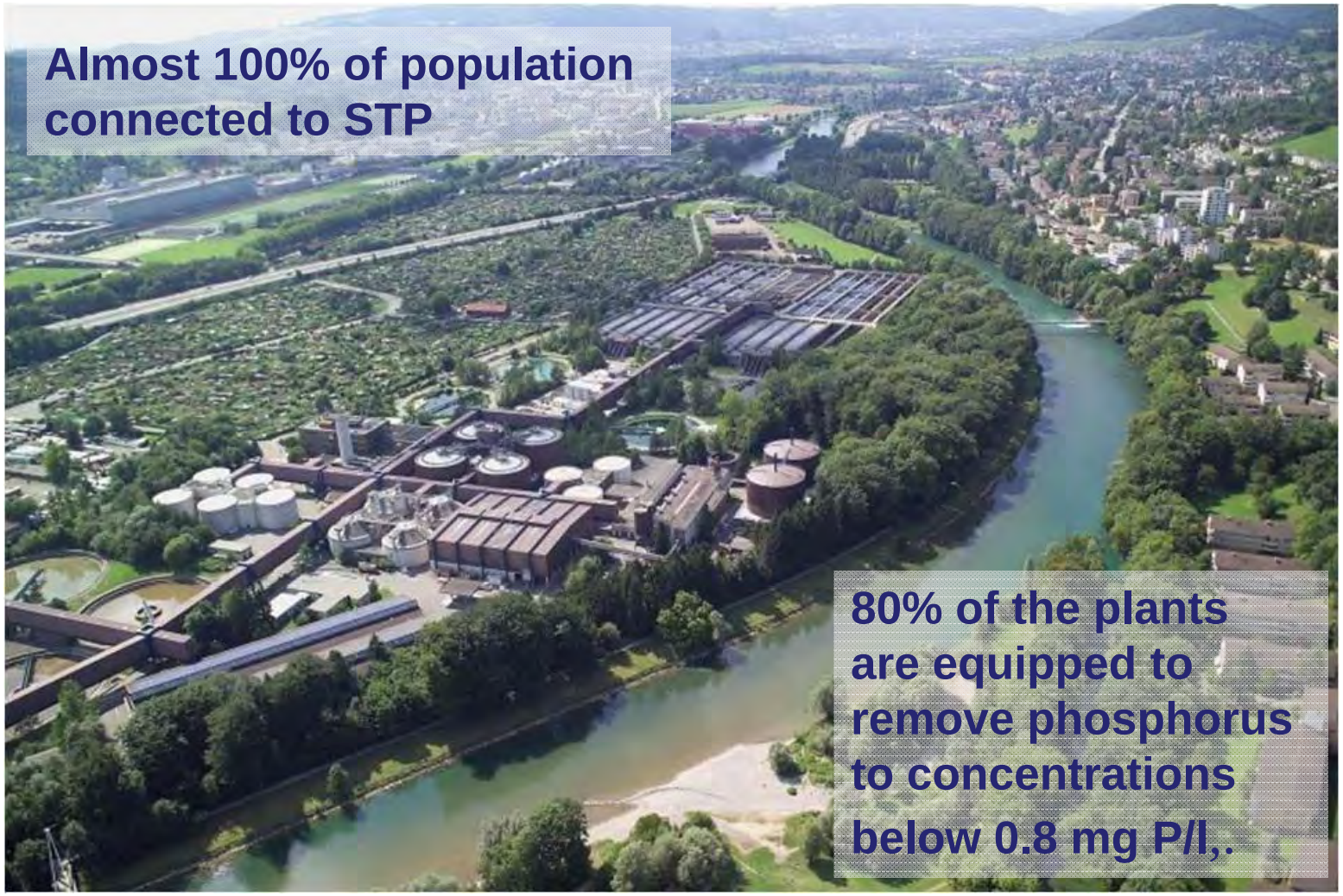
- Very vulnerable environmental resources (air, water, soil)
- High living standard, resource consumption and waste production rate
- High dependency on imports (resource and consumer products)
- Liberal, well educated and innovative society
- Low waste management cost compared to income (*low cost hypothesis*)

Results in motivations for:

- high environmental awareness
- socially and environmentally compatible economic growth
- high priority of the precautionary and polluter-pays principle
- Innovative, goal oriented resource and waste management based on closed cycles (Urban Mining concepts)

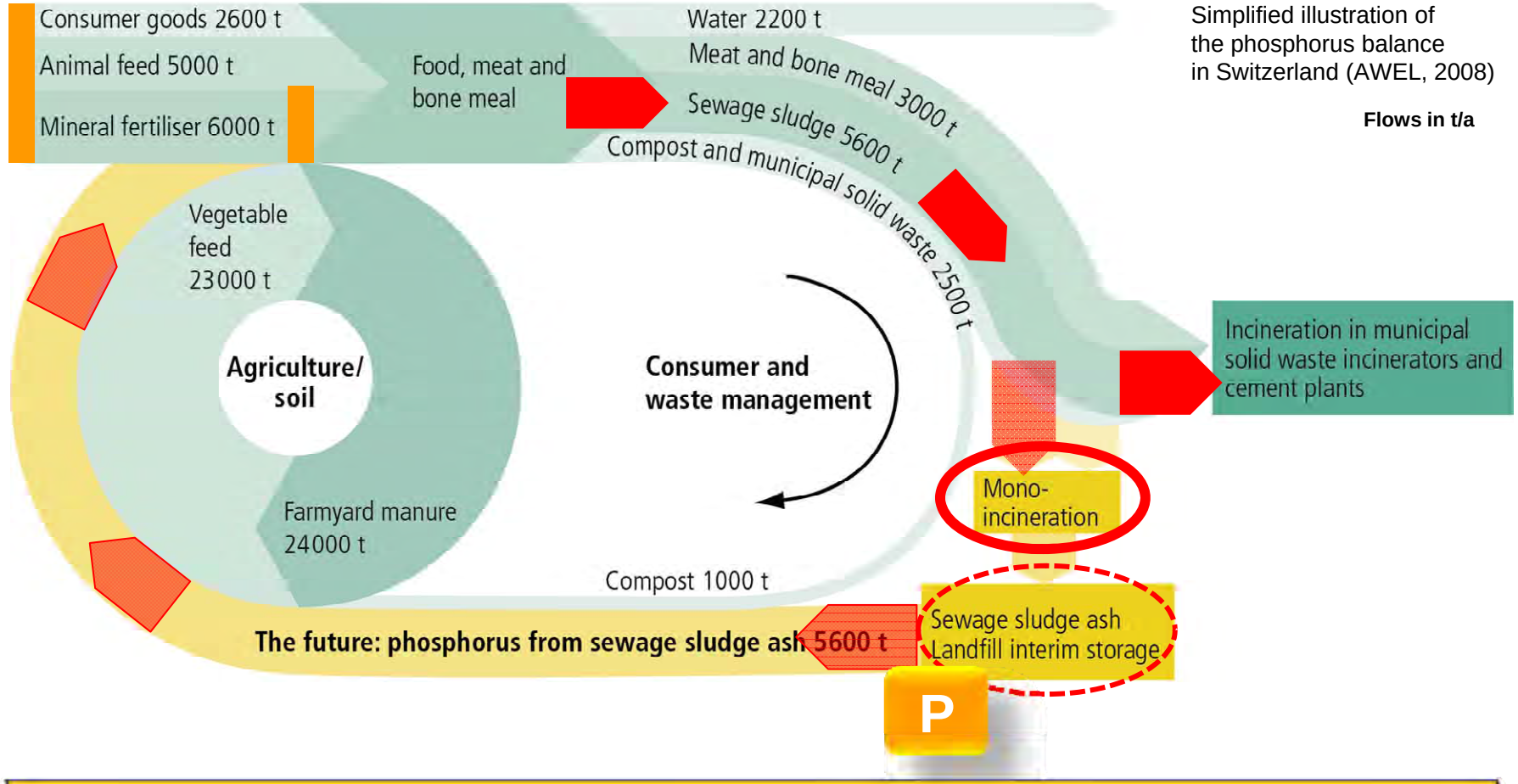
We have beautiful lakes to protect

We had to build sewage treatment plants (STP)



sewage treatment plants (STP), Werdhölzli, City of Zurich

Large P-Potential in Waste; e.g. Sewage sludge



Simplified illustration of the phosphorus balance in Switzerland (AWEL, 2008)

Flows in t/a

Conclusion for Switzerland: Efficient P-recovery in Sewage sludge can substitute almost the total mineral fertilizer import

2.Sewage sludge management in Switzerland

5 Mile-Stones towards the total ban for direct use of sewage sludge in farming since 2008 because of BSE and contamination with organic pollutants.

70/80 -ties:	**Heavy metal soil pollution caused by sewage sludge directly applied to agriculture.**
80-ties:	**Loss of trust and the problem with the monopoly for disposal (Disposal safety).**
90-ties:	**New perceptions (micro pollutants)**
00-ties:	**Falling acceptance for direct use in agriculture, (due to increasing organic farming, „no risk“ strategy, problem awareness of consumer and wholesaler)**

… and finally the mad cow disease (BSE-crises)

In 2008 Switzerland had enforced maximum protection of human and environmental according the precaution principle but not jet the resource conservation regarding phosphorous

3. Canton Zurich: The change towards P-Mining

General Waste and Resource Management Plan: Overall goals and strategies;Goal regarding phosphorus (2007)

Goals

Goal 1	Goal 2	Goal 3	Goal 4
Conserve and use resources	**Ecological and energy efficiency**	**Optimised disposal safety**	**Protection of the environment and population**

Sewage sludge

Treatment only in a way to ensure max. P-recovery

Strategies

Element A	Element B	Element C	Element D
Defined under-standing of roles	**Active information and communication**	**Cost transparency**	**Cooperation**

Situation for sewage sludge in the Canton Zurich in 2006

- **Inhabitants: 1.4 Mio.**
- **72 public sewage treatment plants (STP, 230 Mio. m3 waste water p.a.)**
- **550‘000 m3 digested sewage sludge = 100‘000 t dehydrated sewage sludge p.a. (30% dry matter)**

- **Disposal paths:**
  - **Municipal solid waste Incinerators: 65%**
  - **Cement plants: 10%**
  - **Sewage sludge incinerators (mono) 25%**
    (with no separate storage for later P-recovery)

- **Realizing capacity bottlenecks for actual disposal concept in 2015**
- **Arising awareness of scarcity and value of phosphorus**

4. Political order: Goal and Solution

New strategy for sewage sludge management in 2007:

The governing council of the Canton of Zurich adopted a resolution 572/2007 with clear general conditions in the year 2007:

Future disposal methods are to be planned, in particular when building new plants so that

- **the (later) retrieval of phosphorus is possible and**
- **the renewable energy in sludge is used regardless of the place it is treated in the optimum economic manner.**

Evaluation Process

1. **Environmental monitoring for the choice of procedure:** Apply a holistic system approach to clarifying whether there are better alternative methods of sewage sludge disposal than the preferred mono-incineration with (later) P-recovery from ash (2007-2009)

2. **Selection of location and allocation decision for the sludge treatment (incinerator) plant** (2009-2012)

3. **Feasibility study of phosphorus retrieval procedures from incinerator ash** (2012-)

Evaluation criterion:
-Possible P-Recoveryrate
-Cost
-Use of Energy
-CO_2-Balance
-Transport logistics
-Reserve space

Technical Solution

1. P-Recovery in mono-incineration ash: An effective and clever concept!

- Well established mineralization-technique combined with direct recovery or after intermediate storage (future urban mine)
- High P-recovery yield for overall waste water treatment system (>75% P)

Ash

indirect

direct

Intermediate storage

P-Product

2. One new central mono-Incinerator plant sited at the largest STP (City of Zurich) ecologically and economically most effective solution.

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Quelle: ERZ

Change from inefficient decentralized to efficient centralized system: A challenging undertaking!

174 Communities

72 sewage treatment plants

Co-determination
Regulation

Disposal
Emergency
Concept

Closing of
existing plants

Phosphorus recovery technique or intermediate storage capacity

Regional dewatering stations

Transport cost compensation/ Optimized logistic concept

Import/Export/ Exclusions

MSI=Mono-Sludge-incinerator

Technical Solution

3. Evaluation of direct P-Recovery from mono-incineration ash

- **Focus on wet-chemical extraction similar to primary phosphate production (Leachphos®-Process)**
  - Technical evaluation (full scale test)
  - Product quality/Product management (Fertilizer/P-Product)
  - Market/ Costs/ Economical aspects

- **Comparison with 2 alternatives**
  - Thermo-chemical process (ASHDEC)®
  - Phosphoric acid treatment (RECOPHOS®)

5. Conclusion (Reflection)

Positive and critical Aspects

1. **Canton Zurich will manage to change from a decentralized resource-inefficient to a very efficient centralized system in an democratic/interactive multi-stakeholder planning process in less than 8 years.**
2. **The selected P-recovery concept applying sewage sludge mono-incineration is relevant, effective and clever. If in operation, it avoids further phosphorus dissipation and secures this scarce resource starting in 2015.**
3. **This solution also guarantees the compliance with the precautionary principle regarding hazardous substances.**
4. **An open challenge is the evaluation and early implementation of a reliable, ecological and economical feasible P-Recovery process to avoid intermediate storage costs.**

Deficits- Uncertainties and incomplete knowledge

1. **Future market price of raw phosphate**
2. **Final product quality (final agricultural investigations)**
3. **Reliability of industrial partners for long term perspective (➔ robust product management strategy)**
4. **Further optimization potential of P-recovery processes (Refining➔ Increased added value)**
5. **Complex and small scale organizational structure of waste management system prevents from implementing a large scale business competitive to primary phosphorus products.**

Prospect / Vision

- Regarding phosphorus-recovery the Canton Zurich is willing to act as a front runner to enable successful direct P-recovery from incinerator ash soon, in order to avoid intermediate storage costs.

- The Canton Zurich as well as Switzerland will strengthen its leading position regarding environmental protection and support the competitiveness for innovative environmental technology by applying urban mining concepts such as P-Mining early (pioneering task).

Thank you for your attention and interest

For more information:

Leo S. Morf (2012) Phosphorus from sewage sludge – The strategy of the Canton of Zurich and Switzerland, 45. Essner Tagung Wasser- und Abfallwirtschaft, 14.-16. März 2012 in Essen (english version).

Dr. Leo S. Morf
Zurich, Switzerland
2013

leo.morf(at)bd.zh.ch
www.klaerschlamm.zh.ch