Ecological scarcity 2013:
Overview and main elements of the update and its implications

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treeze Ltd., Uster
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Eco-factor Carbon dioxide (CO$_2$):

460 UBP/kg
Contents

- Project outline
- Methodology and main elements of the update
- Focus: greenhouse gases, nuclear wastes
- Eco-factor time series
- Synthesis
Project goal

- Update of Swiss eco-factors 2006
- Track
  - Swiss environmental legislation
  - Swiss emission situation
- Expand to new/emerging environmental impacts
- Provide
  - ready to use eco-factors Switzerland 2013
  - method applicable in other countries/regions
Project organisation

**Commissioner**
- FOEN, P. Gerber

**Steering group**
- P. Gerber (Lead), FOEN
- N. Egli, FOEN
- G. Hildesheimer, Öbu
- A. Braunschweig, E2

**Advisory group**
- G. Hildesheimer (Lead)
- various companies
- P. Gerber
- A. Braunschweig
- R. Frischknecht

**Discussion group Methodology**
- R. Frischknecht (Lead)
- A. Braunschweig, E2
- P. Gerber, FOEN
- E. Egli, FOEN
- E. Franov, carbotecch
- M. Scheringer, ETHZ

**Contractors**
- R. Frischknecht, treeze,
  Main Contractor, (Lead)
- staff at treeze
- ideja communication
- ETHZ, ICB
Advisory group

- Christian Brütsch, RePower AG
- Patrik Burri, Credit Suisse
- Roland Högger, Geberit International AG
- Elisabeth Huber, Geberit International AG (until 12. 2012)
- Martin Kilga, Sinum AG
- Peter Müller, Knecht und Müller AG
- Paul Schnabl, Die Schweizerische Post
- Jörg Schwille, Schweizer Metallbau AG
- Marcel Sutter, BWK-FMB AG
- Patrik Walser, Migros Genossenschaft
- Anne Wolf, Die Schweizerisch Post
**Project phases**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Topics discussed</th>
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</thead>
<tbody>
<tr>
<td>10.10</td>
<td>Additional ecofactors and adaptation of methodology</td>
<td></td>
</tr>
<tr>
<td>06.11</td>
<td>Feedback on proposed new elements</td>
<td>normalisation</td>
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<tr>
<td>07.11</td>
<td>Background investigations for Eco-factors 2013 and determination of</td>
<td>multiple impact assessment</td>
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<td></td>
<td>draft Eco-factors 2013</td>
<td>rounding</td>
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<tr>
<td>04.12</td>
<td>1st test phase</td>
<td>POPs and bioaccumulating substances</td>
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<td>05.12</td>
<td>Revision of draft Eco-factors Switzerland 2013</td>
<td>land use in different biomes</td>
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<tr>
<td>09.12</td>
<td>2nd test phase</td>
<td>abiotic resources</td>
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<tr>
<td>11.12</td>
<td>Final set of Eco-factors Switzerland 2013</td>
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</tbody>
</table>

**Contractors**
- Discussion group methodology
- Advisory group
The ecological scarcity formula

\[
\text{Eco-factor} = \frac{K}{\text{Characterization (if applicable)}} \cdot \frac{1 \cdot UBP}{F_n} \cdot \left(\frac{F}{F_k}\right)^2 \cdot c
\]

- **K**: Characterization factor of a pollutant or a resource
- **Flow**: Load of a pollutant, quantity of a resource consumed or level of a characterized environmental pressure
- **\( F_n \)**: Normalization flow: Current annual flow with Switzerland as the system boundary
- **\( F \)**: Current flow: Current annual flow in the reference area
- **\( F_k \)**: Critical flow: Critical annual flow in the reference area
- **c**: Constant \((10^{12}/a)\)
- **UBP**: Eco-point: the unit of the assessed result
The regionalised ecological scarcity formula

\[ \text{Eco-factor}_{\text{Region 1}} = K \cdot \frac{1 \cdot \text{UBP}}{F_{n}^{\text{CH}}} \cdot \left( \frac{F_{\text{Region 1}}}{F_{k}^{\text{Region 1}}} \right)^2 \cdot c \]

- **K** = Characterization factor of a pollutant or a resource
- **Flow** = Load of a pollutant, quantity of a resource consumed or level of a characterized environmental pressure
- **\( F_{n}^{\text{CH}} \)** = Normalization flow: current annual flow with Switzerland as the system boundary
- **\( F_{\text{Region 1}} \)** = Current flow: current annual flow within Region 1
- **\( F_{k}^{\text{Region 1}} \)** = Critical flow: critical annual flow within Region 1
- **c** = Constant \((10^{12}/a)\)
- **UBP** = Eco-point: the unit of the assessed result
Final report: Structure and new elements

- **Part I: Life cycle assessment in short**
  - Basic information for decision makers
  - Questions and answers concerning Life Cycle Assessment (FAQ)

- **Part II: Method fundamentals**
  - The ecological scarcity method
  - Derivation principles
  - Application principles
  - Characterisation and grouping by environmental issues

- **Part III: Eco-factors for Switzerland**
<table>
<thead>
<tr>
<th>Environmental topic</th>
<th>1 tier grouping</th>
<th>2 tier grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water resources</td>
<td>Water resources</td>
<td>Water resources</td>
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<tr>
<td>Energy resources</td>
<td>Energy resources</td>
<td>Abiotic resources</td>
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<td>Mineral primary resources</td>
<td>Mineral resources</td>
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<td>Land use</td>
<td>Land use</td>
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<td>Non radioactive waste to deposit</td>
<td>Non radioactive waste</td>
<td>Soil</td>
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<tr>
<td>Radioactive waste to deposit</td>
<td>Radioactive waste</td>
<td></td>
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<tr>
<td>Climate change</td>
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<td>Climate change</td>
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<td>Ozone layer depletion</td>
<td>Ozone depletion</td>
<td>Ozone depletion</td>
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<td>Main pollutants and PM</td>
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<td>Carcinogenic substances into air</td>
<td>Air quality</td>
<td>Air quality</td>
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<tr>
<td>Heavy metals into air</td>
<td></td>
<td></td>
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<tr>
<td>Radioactive substances into air</td>
<td></td>
<td></td>
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<tr>
<td>Water pollutants</td>
<td></td>
<td></td>
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<tr>
<td>Heavy metals into water</td>
<td>Water quality</td>
<td>Water quality</td>
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<tr>
<td>POP into water</td>
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<tr>
<td>Radioactive substances into water</td>
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<tr>
<td>Pesticides into soil</td>
<td>Soil quality</td>
<td>Soil quality</td>
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<tr>
<td>Heavy metals into soil</td>
<td></td>
<td></td>
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<tr>
<td>Noise</td>
<td>Noise</td>
<td>Noise</td>
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</table>
Climate change: Target and characterisation

- **Two targets**
  - Act on the reduction of CO$_2$-Emissions (CO$_2$-Gesetz): minus 20 % (relative to 1990) by 2020
  - Sustainable Development Strategy 2012-2015: minus 50 to 85 % reduction by 2050

- **Target (agreed by FOEN):** minus 80 %

- **Characterisation:**
  - GWP of 4$^{th}$ IPCC assessment report 2007
  - No adjustments for emissions of greenhouse gases in lower stratosphere (by airplanes)
### Greenhouse Gases, Ecofactors

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2006</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Normalisation Flow</td>
<td>53’040</td>
<td>53’034</td>
<td>emissions 2009</td>
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<tr>
<td>Actual Flow</td>
<td>53’040</td>
<td>45’436</td>
<td></td>
</tr>
<tr>
<td>Critical Flow</td>
<td>10’766</td>
<td>11’183</td>
<td>80 % reduction relative to 1990</td>
</tr>
<tr>
<td>Weighting Factor</td>
<td>24.3</td>
<td>16.5</td>
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<tr>
<td>Ecofactor</td>
<td>460</td>
<td>310</td>
<td></td>
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</table>

- Increase of CO₂ ecofactor by 50 % compared to 2006
Radioactive wastes, new concept

- damage potential instead of «(political) acceptance»
- Radiotoxicity Index (RTI), dependent on
  - activity of radionuclide
  - dose factor of radionuclide
  - limit value of dose
- international measure used by NAGRA (National Cooperative for the Disposal of Radioactive Waste)
radioactive wastes, actual and critical flow

- actual flow (Data source: NAGRA): Maximum value RTI inventory Switzerland
- critical flow (Data source: NAGRA): RTI at time of final closure of deposit: presumably 2115
- Ordinance of Closedown and Waste disposal funds for nuclear installations (Stilllegungs- und Entsorgungsfondsverordnung)
- Nuclear Energy Act (Kernenergiegesetz (KEG)), § 39, cypher 2: «... the Federal Council shall order the closure of the repository, if the permanent protection of humans and the environment is ensured.”
Radiotoxicity inventory -2050 of radioactive wastes in Switzerland
Radiotoxicity inventory 2050+ of radioactive wastes in Switzerland

Time of final closure = permanent protection of humans and the environment is ensured

c. 2115  Years since 2050 (logarithmic)
radioactive wastes, characterisation

- Basis: Radiotoxicity index (RTI)
- Reference «substance»: high active waste (HAA)
- Characterisation factors \( \text{cm}^3 \ HAA\text{-eq/cm}^3 \)
  - low and medium active wastes: 0.000045
  - alpha toxic wastes: 0.0015
  - high active wastes (incl. spent fuel): 1
- High active wastes are important
- Low active wastes from hospitals etc. are marginal
## Radioactive Wastes, Ecofactors

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>2013</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low and medium active wastes</td>
<td>2.1 UBP/cm³</td>
<td>3’300</td>
</tr>
<tr>
<td>Spent fuels, high active wastes, alpha toxic wastes</td>
<td>35’000 UBP/cm³</td>
<td>18’000</td>
</tr>
<tr>
<td>High active wastes (including spent fuel)</td>
<td>46’000 UBP/cm³</td>
<td></td>
</tr>
<tr>
<td>Alphatoxic wastes</td>
<td>69 UBP/cm³</td>
<td></td>
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</tbody>
</table>

- EF low and medium active wastes much lower
- EF high active waste approx. doubled
- In total, very similar assessment like in 2006
Evolution of ecofactors of selected pollutants/resources
Evolution of the shares of Swiss environmental impacts (UBP)
Evolution of Switzerland’s ecopoints (UBP)
## Actual impacts Switzerland: Relative importance and change

<table>
<thead>
<tr>
<th>Importance</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>higher</td>
<td>high</td>
</tr>
<tr>
<td>lower</td>
<td>low</td>
</tr>
</tbody>
</table>

- Climate change: high
- Energy resources: low
- Abiotic resources: low
- Noise: low
- Ozone depletion: low
- Water use: low
- Non radioactive waste: low
- Radioactive waste: low
- Soil quality: low
- Water quality: low
- Air quality: low
Actual situation and environmental target (in UBP’13)
Synthesis: «UBP-view» on Swiss environmental situation

- Climate change: more and more important
- Air and water quality: slightly less important
- Ozone depletion and non radioactive wastes significantly less important
- Overall reduction of environmental impacts (in UBP) by about 50% to reach Swiss environmental targets
4th generation ecofactors
Switzerland brings you

● up to date Swiss ecofactors
● approach ready to be implemented in other countries/regions
● ecofactors covering new impacts such as resource dispersion, noise and persistent organic pollutants
● broadened regionalised ecofactors for land use and water use
● no revolution but evolution
Thank you very much for your attention!

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Appendix
Electricity supply systems
Electricity supply systems
Transport services
Transport services
construction materials
construction materials
Environmental impacts in Switzerland (UBP’13)

Frischknecht et al. forthcoming