How to derive a consequential national electricity mix: The case of a Swiss municipality

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62nd LCA Forum,
ETH Zürich, Switzerland, 9 September, 2016
Municipality with 2000-Watt-society goals

- Municipality wants to achieve
  - 2000 Watt continuous power (primary energy) per person
  - 1 Ton CO₂ emissions per person and year
- Different strategies
  - Efficiency
doi the same with less consumption
  - Substitution / Consistency
doi the same but differently (with renewable energies)
  - Sufficiency
use less («less is more»)
2000-Watt-society goals: Large reduction is required
Motivation of a municipality to use a consequential LCA approach

- Longterm investment decisions in real estates

Requirements
- Comply with the goals of the 2000-Watt-society
- Real estate strategy independent of shortterm energy-related changes

Environmental impacts of buildings are determined by:
- longterm: energy efficiency level (construction/retrofit)
- shortterm: electricity product, fuel
Longterm perspective

- Energy-related investments today have an impact on the future energy demand
  - Savings due to effective efficiency measures
  - Increase in electricity demand due to substitution of fossil fuels (fuel oil, natural gas) with electric heat pumps

Marginal electricity approach

- enables longterm perspective by modelling the future consequences of decisions
Marginal electricity mixes: Derivation

- No general or partial equilibrium model but coarse sectoral consideration
- Which technologies likely produce more/less electricity in the future?
- If electricity is used more efficiently:
  - Non renewable power plants don’t need to be expanded or can be shut down
  - Import of non renewable electricity can be reduced
  - Export of excess renewable electricity
Marginal electricity mixes: Two main thinking models

- Swiss consequential electricity mix
- European residual electricity mix
Switzerland: Energy strategy 2050
Development in electricity demand

3 scenario

Households
Service sector
Industry
Mobility

Prognos (2012)
How would additional demand in electricity be covered?

Consequential electricity demand

- Business as usual
- Political measures
- New energy policy

Prognos (2012)
The future of electricity according to the Energy strategy 2050

Scenario New Energy Policy (NEP)
Consequential electricity mix Switzerland

- Energy strategy 2050, 3 scenarios: BAU, NEP, POM
- Additional electricity demand of the BAU scenario is covered to 99 % with Swiss natural gas power plants (mostly combined cycle plants).
- Consequential electricity mix Switzerland = 100 % electricity from gas combined cycle plants
Residual electricity mix Europe

- Power plant portfolio of the utility of the municipality: hydro, wind parks, photovoltaics
- Decrease in electricity demand in the municipality → more export of renewable electricity
- Substitute fossil and nuclear electricity and help shutting down its power plants
- Residual electricity mix based on today's operated fossil and nuclear power plant park
Two Scenario: What happens if ...?

Consequential mix Switzerland
- Potential of new renewables is limited
- Efficient use of electricity requires less fossil fuelled power plants in Switzerland

Residual mix Europe («bad mix»)
- Export of electricity from renewable sources which is no longer needed in Switzerland
- Opportunity for the EU to reach their reduction targets regarding climate protection and nuclear phase out
Case study retirement home «Tilia»: Retrofit yes or no?

- Retirement apartments, shops, café and car park
- Built in the 70ies
- Key parameters:

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<tr>
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The easy way:
Heat pump and green electricity

Greenhouse gas emissions

Environmental impacts
Case study retirement home «Tilia»: Retrofit measures

- new windows (triple glazing)
- Insulation façade
- Insulation rooftop and ground floor (car park ceiling)
- Ventilation equipment

<table>
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Tilia: Total environmental impacts
Current state and retrofit

District heat | Green el. | Consequential mix Switzerland | Residual mix Europe

Current state | Current state, heat pump | Current state, heat pump | Retrofit, district heating | Retrofit, heat pump | Current state, heat pump | Retrofit, district heating | Retrofit, heat pump

1'000 UBPI3/m²

Materials | Space heating | Hot water | Ventilation
Discussion

- Applying consequential mixes in investment situations:
  - Retrofit is the preferred option
  - A switch from district heating to heat pump without any energy saving measures leads to an increase in environmental burdens

- Applying attributional electricity mix (ecopower):
  - current state with heat pump is preferred
    - low incentive to invest in efficiency measures
    - contradicts longterm perspective
Conclusions

- Consequential mix Switzerland and residual mix Europe are likewise recommended to support investment decisions to support the 2000-Watt-society goals
  - Operation phase becomes more important
  - Structural measures reducing the energy demand in the operation phase pay-off sooner

- Similar considerations required for district heating networks and traditional fuels (fuel oil, natural gas, wood)
Thank you very much for your attention!

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Acknowledgement (funding):
Swiss municipality