

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

Rolf Frischknecht, treeze Ltd.

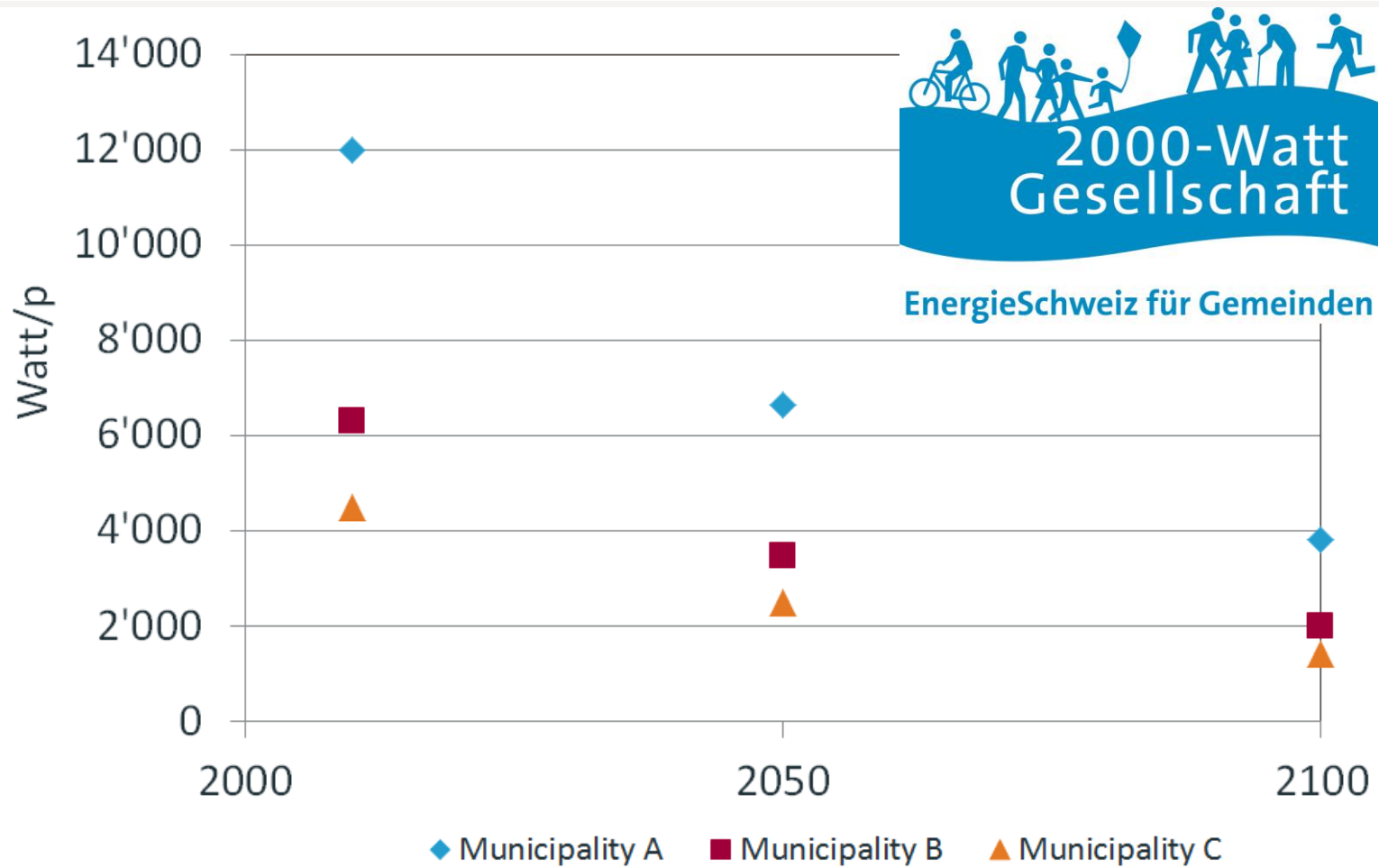
62nd LCA Forum,
ETH Zürich, Switzerland, 9 September, 2016

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**
do the same with less consumption
 - **Substitution / Consistency**
do 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

- 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

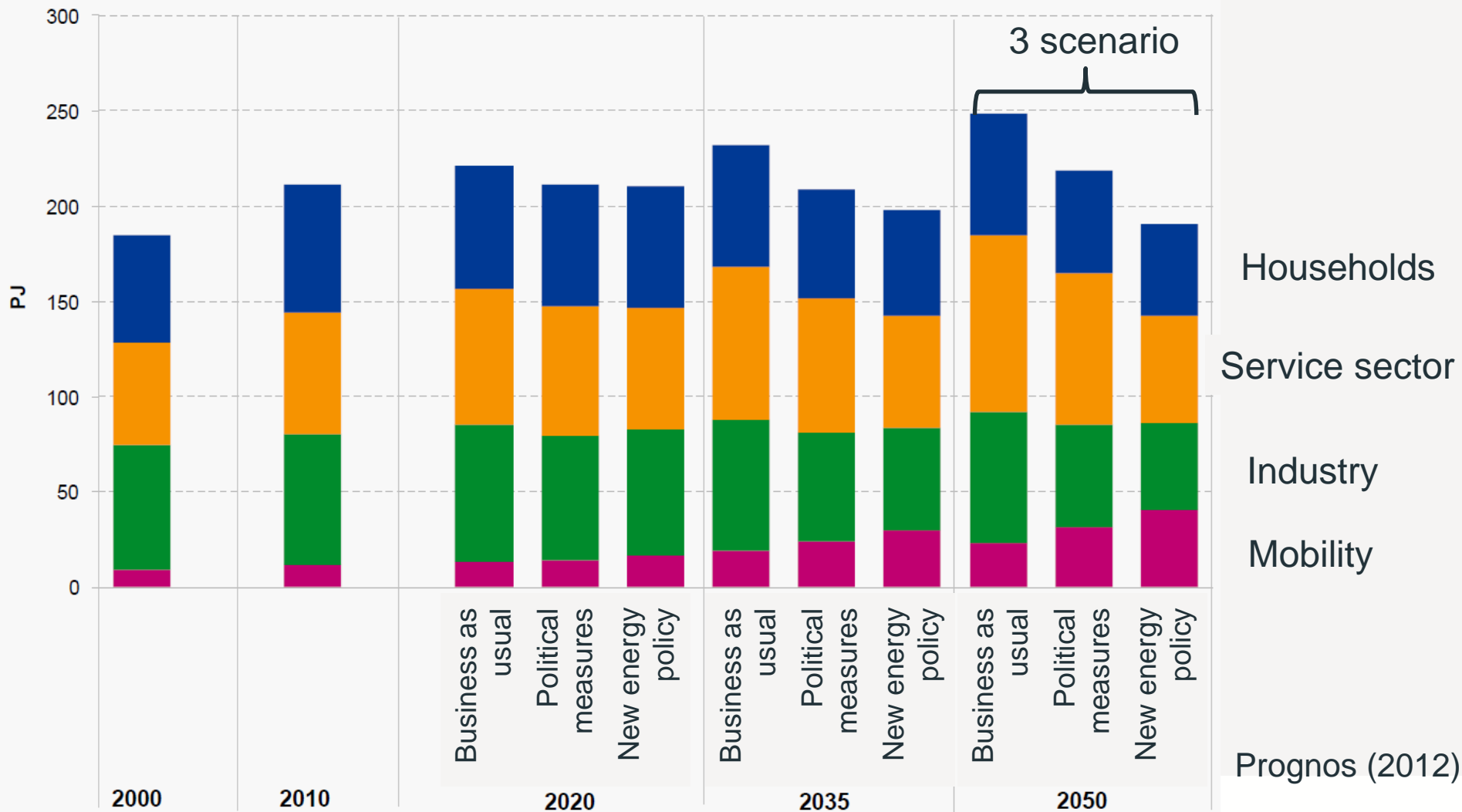
- No general or partial equilibrium model but coarse sectoral consideration
- Which technologies likely produce more/less electricity in the future?
- If electricity is used more efficiently:
 - Non renewable power plants don't need to be expanded or can be shut down
 - Import of non renewable electricity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

Marginal electricity mixes: Two main thinking models

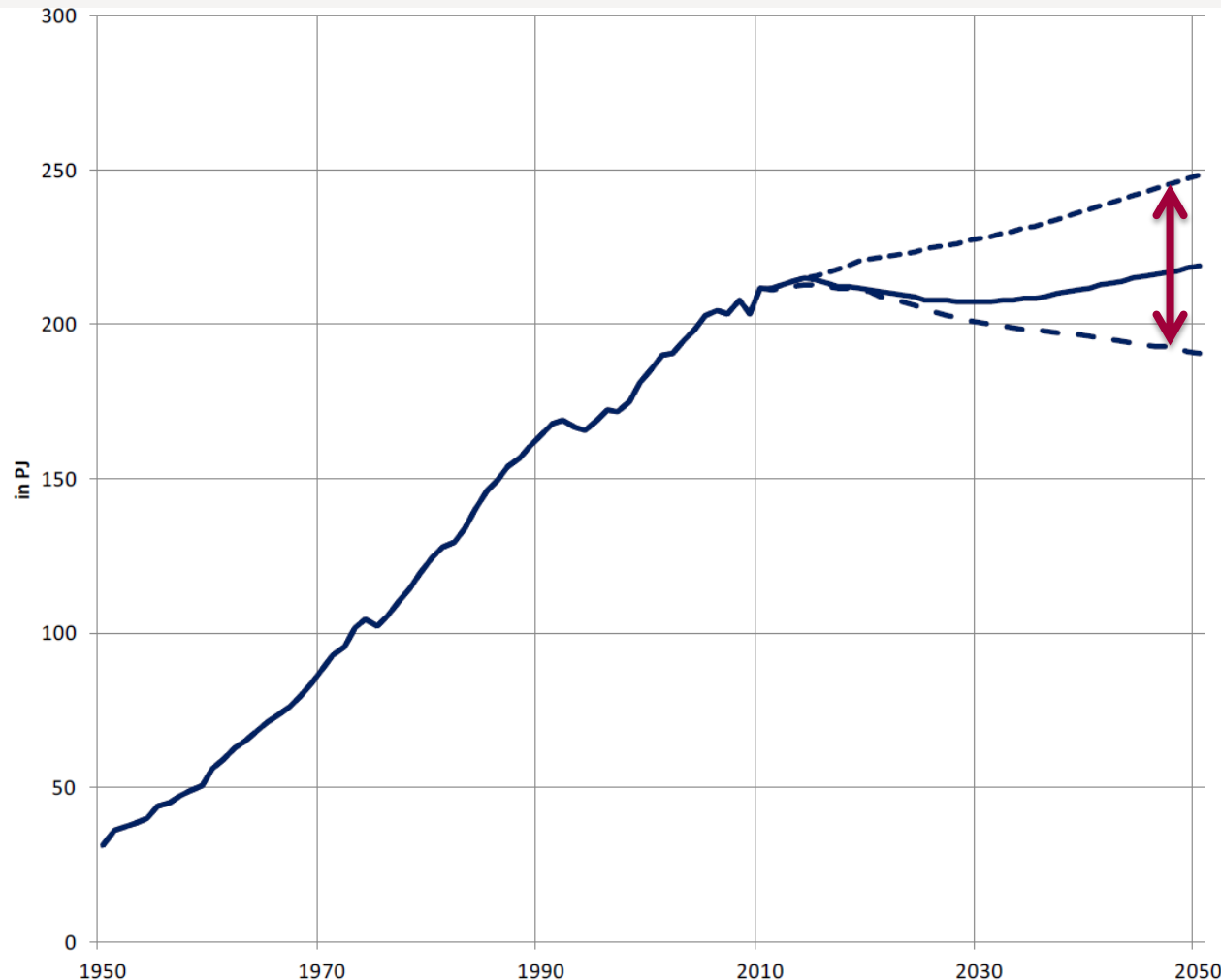
- Swiss consequential electricity mix
- European residual electricity mix

Switzerland: Energy strategy 2050

Development in electricity demand



How would additional demand in electricity be covered?

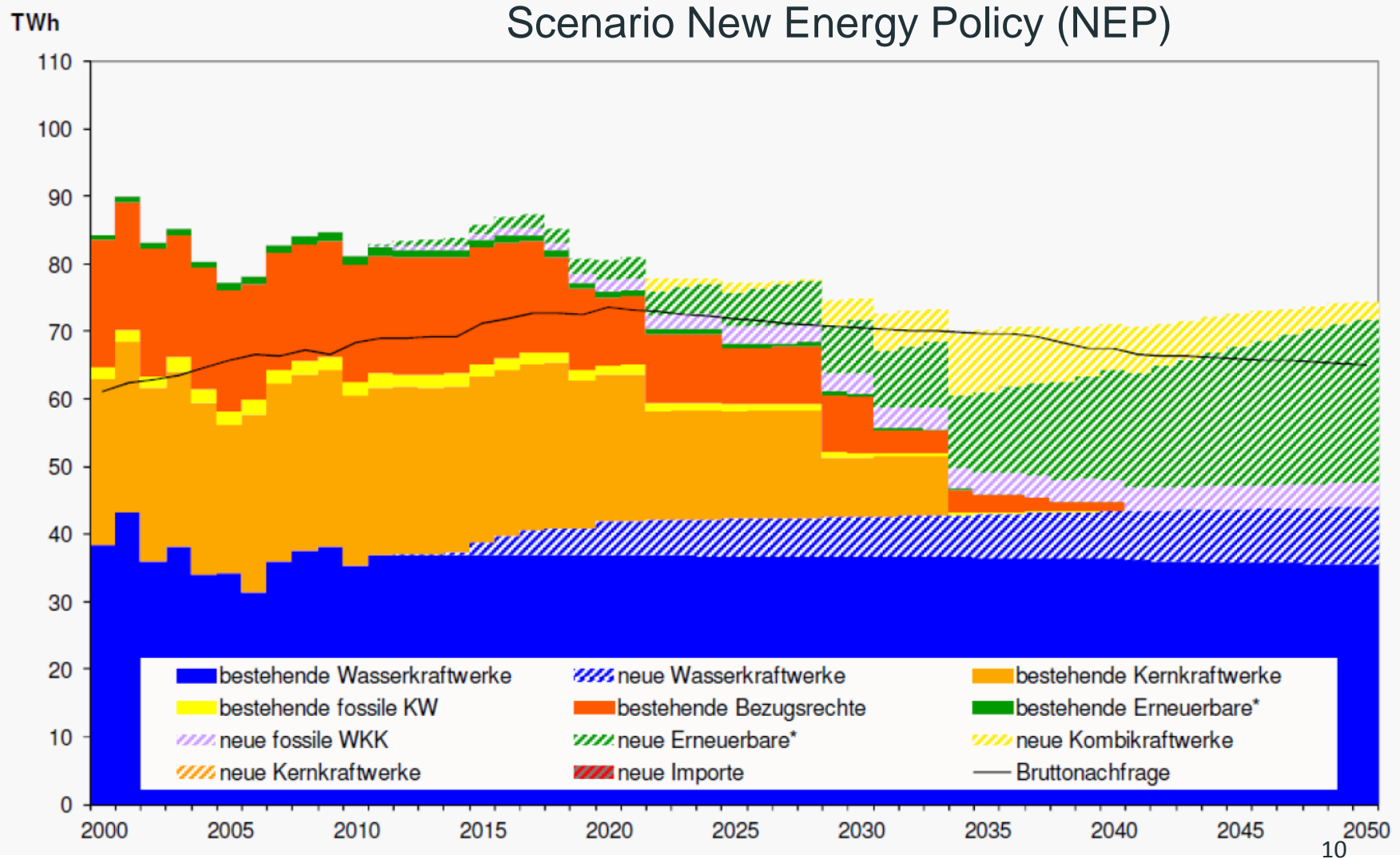


**Consequential
electricity demand**

- Business as usual
- Political measures
- - - New energy policy

Prognos (2012)

The future of electricity according to the Energy strategy 2050



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

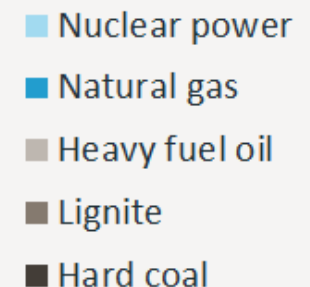
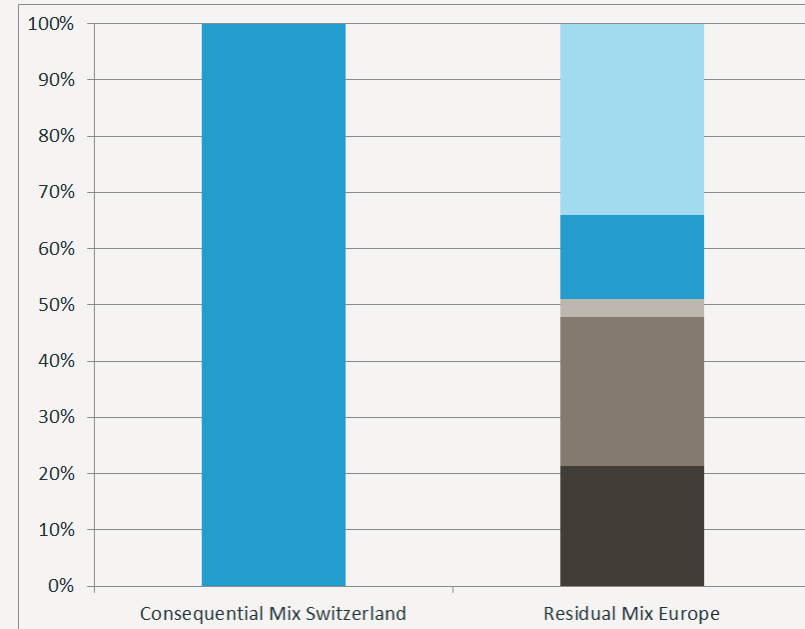
Two Scenario: What happens if ...?

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?

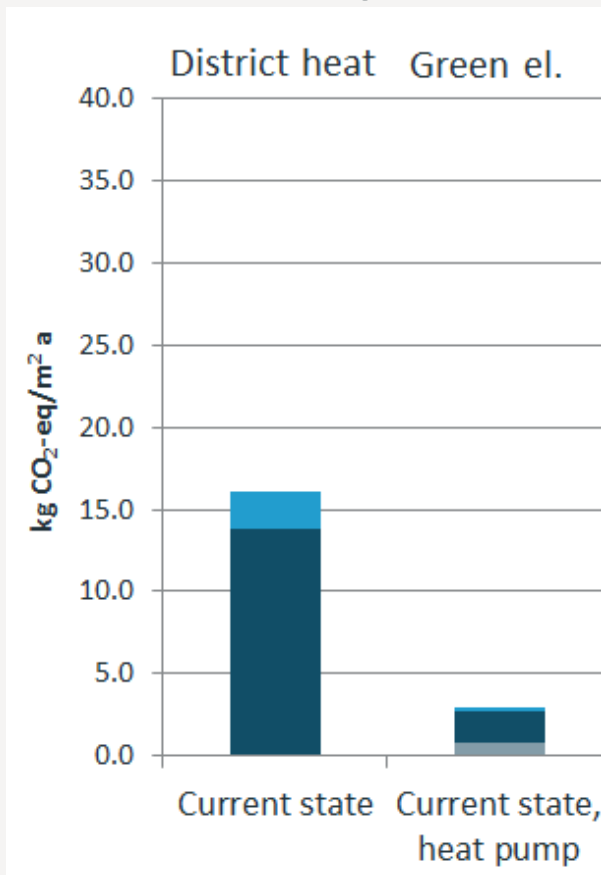
- Retirement apartments, shops, café and car park
- Built in the 70ies
- Key parameters:

| Parameter | Unit | Ist |
|-----------------------|---------------------|--------|
| Gross area | m ² | 10'000 |
| Energy reference area | m ² | 10'000 |
| Energy demand | | |
| Space heating | MJ/m ² a | 435 |
| Hot water | MJ/m ² a | 50 |
| Ventilation | MJ/m ² a | - |

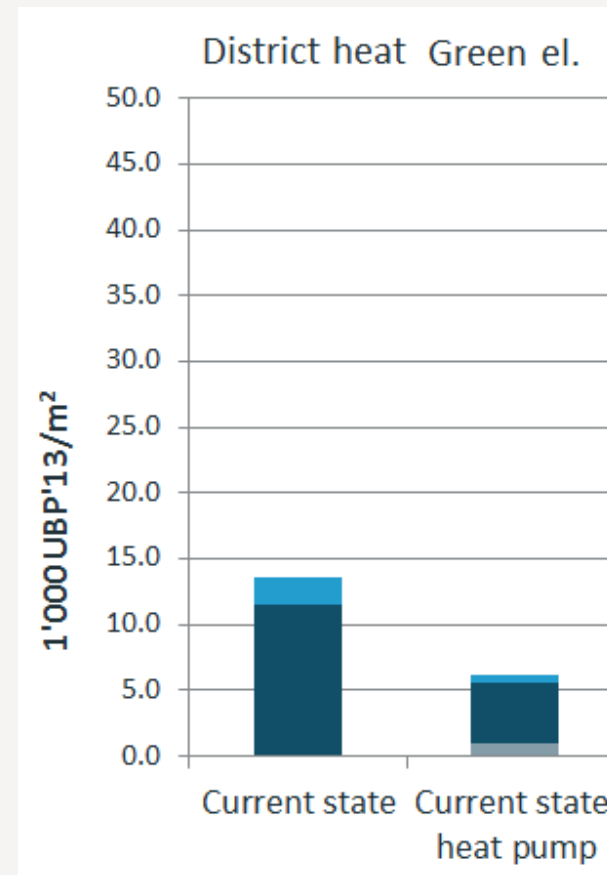


The easy way: Heat pump and green electricity

Greenhouse gas emissions



Environmental impacts



■ Materials

■ Space heating

■ Hot water

■ Ventilation

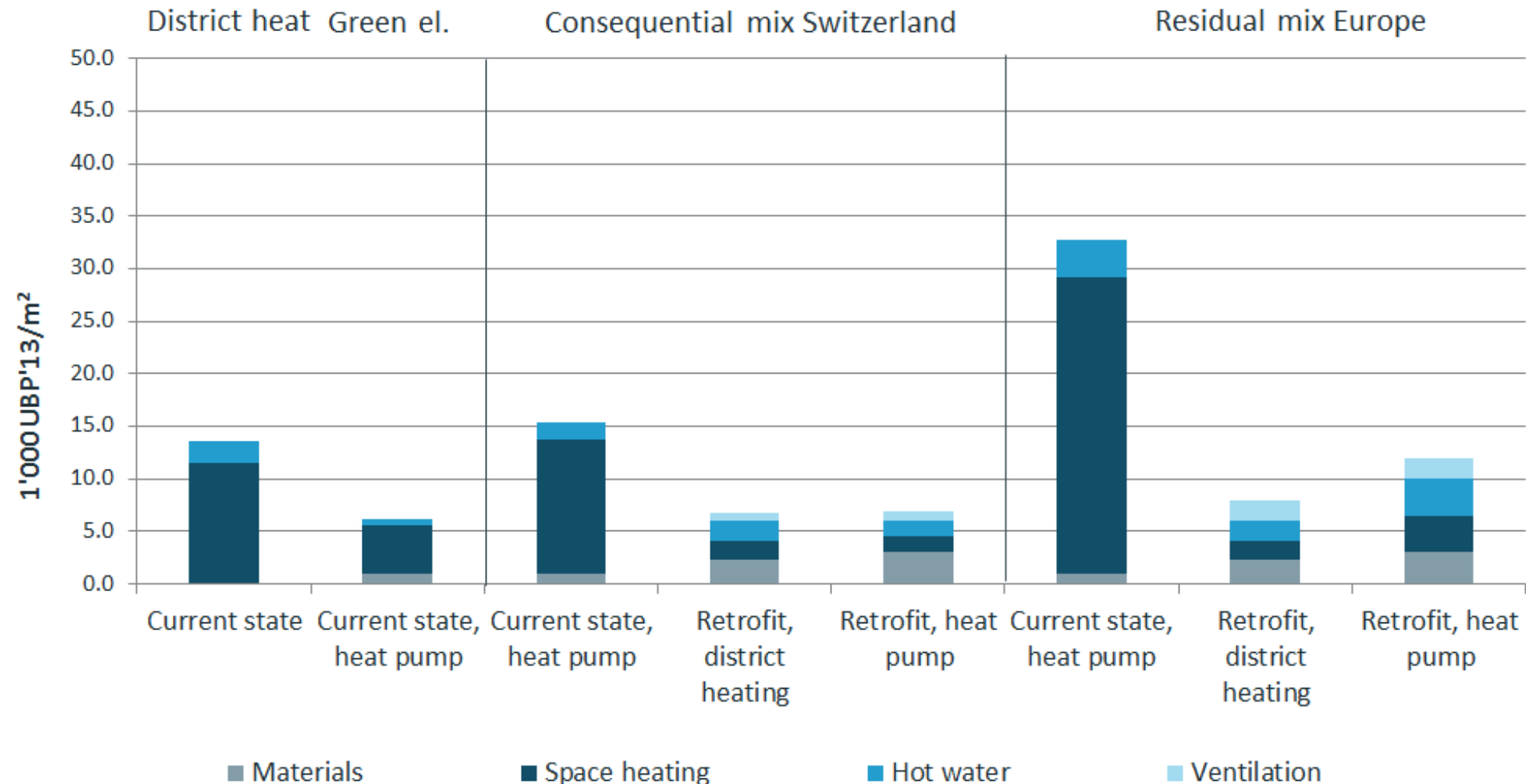
Case study retirement home «Tilia»: Retrofit measures

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

| Energy demand | unit | today | retrofit |
|---------------|---------------------|-------|----------|
| Space heating | MJ/m ² a | 435 | 68 |
| Hot water | MJ/m ² a | 50 | 50 |
| Ventilation | MJ/m ² a | - | 10 |

Tilia: Total environmental impacts

Current state and retrofit



- 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!

Contact:

frischknecht@treeze.ch

Website:

www.treeze.ch

Acknowledgement (funding):

Swiss municipality