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ENERGY PERSPECTIVES 2050+

NET ZERO EMISSIONS BY 2050

ENERGY PERSPECTIVES 2050+ CONTENTS

Most important findings from the Energy Perspectives 2050+:

How do we get to an energy system by 2050 that is compatible with the net zero target and at the same time, ensure a secure energy supply?

ENERGY PERSPECTIVES 2050+ ISSUES

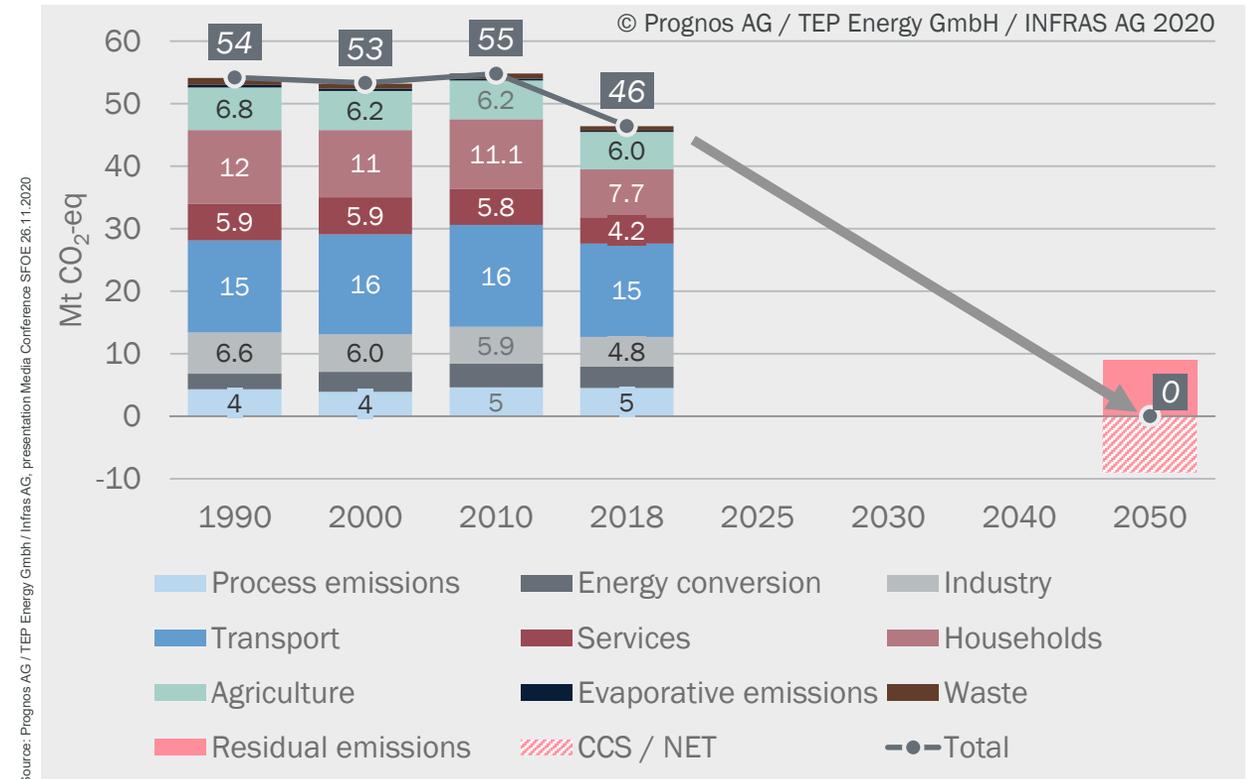
Climate neutral Switzerland by 2050

- Net zero emissions by 2050:
 - Unavoidable residual emissions to be offset by natural or technical sinks
- Which paths enable achievement of target?
 - Working with scenarios

Delimitation

- CO₂, CH₄, N₂O, fluorinated gases
- Alongside the energy system, process emissions plus non-energy-related emissions from agriculture and waste treatment to be taken into account

Greenhouse gas emissions & CCS/NET





SCENARIOS AND VARIANTS

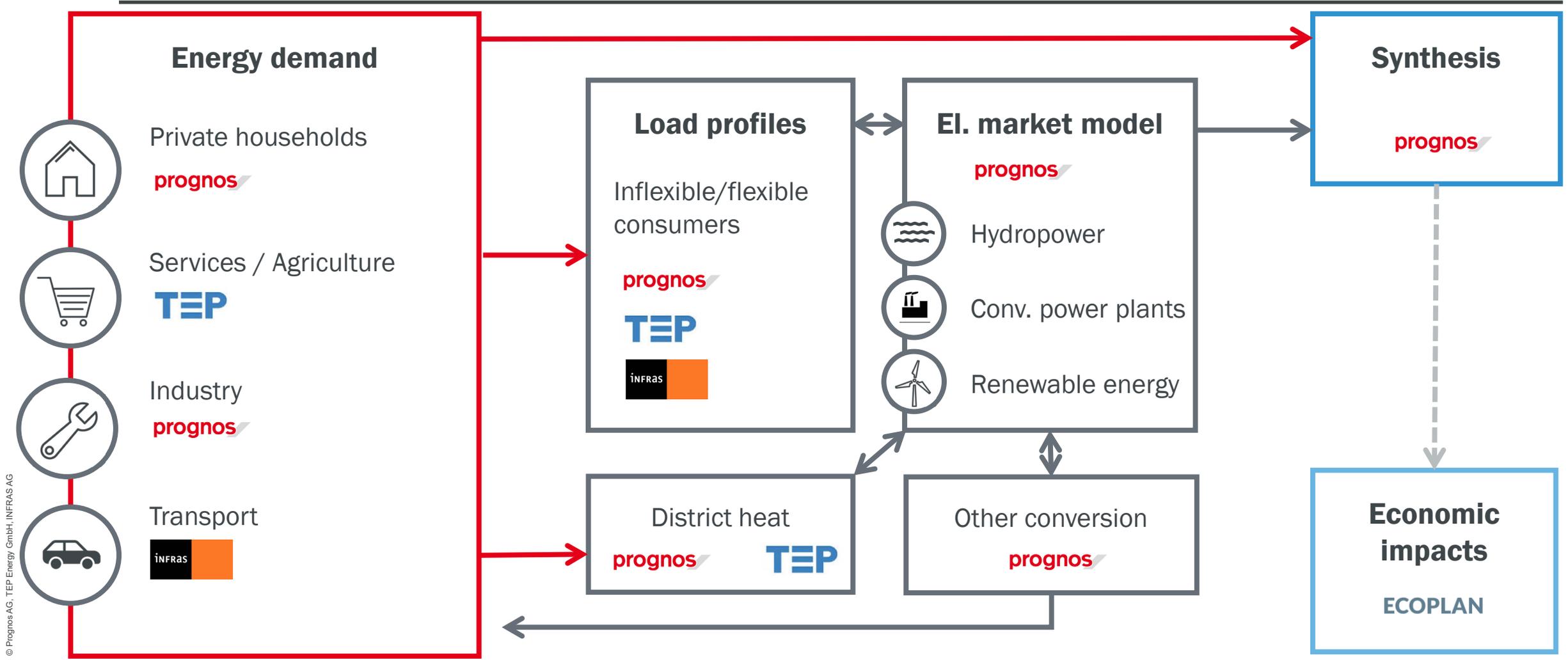
VARIOUS PATHS LEADING TO THE TARGET

| Scenario | Variant | Strategic electricity production variants |
|----------------------------------|---|--|
| Net zero scenario (ZERO) | Basis variant (ZERO Basis) | Even annual import-export balance 2050 Guidelines / expansion targets Current framework conditions |
| | Variant A (ZERO A) <i>extensive electrification</i> | Even annual import-export balance 2050 Guidelines / expansion targets Current framework conditions |
| | Variant B (ZERO B) <i>stronger focus on gas</i> | Even annual import-export balance 2050 Guidelines / expansion targets Current framework conditions |
| | Variant C (ZERO C) <i>stronger focus on heat networks and liquid fuels</i> | Even annual import-export balance 2050 Guidelines / expansion targets Current framework conditions |
| Business as Usual scenario (BAU) | Current energy and climate policy measures | Existing legal and framework conditions |



MODELLING OVERVIEW

CONSORTIUM OF 4 PROJECT PARTNERS

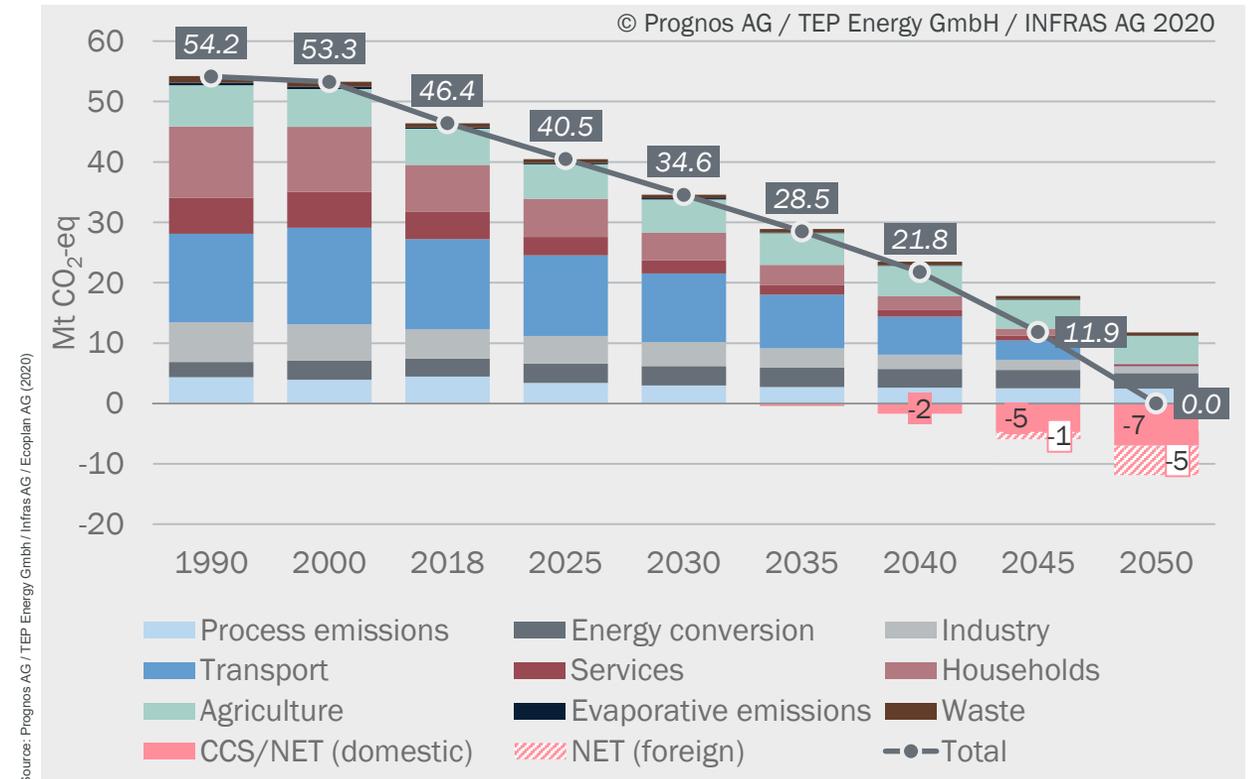


ENERGY PERSPECTIVES 2050+ GREENHOUSE GAS EMISSIONS

Net zero greenhouse gas emissions 2050:

- Net zero target is achievable
- In 2050, around 12 million tonnes of unavoidable residual CO₂-equivalent emissions
- Mainly in the following areas:
 - Agriculture
 - Industrial Processes (including cement)
 - Waste treatment (incineration plants)
- Application of CCS/NET necessary so that balanced zero can be achieved

Greenhouse gas emissions & CCS/NET



Scenario ZERO Basis

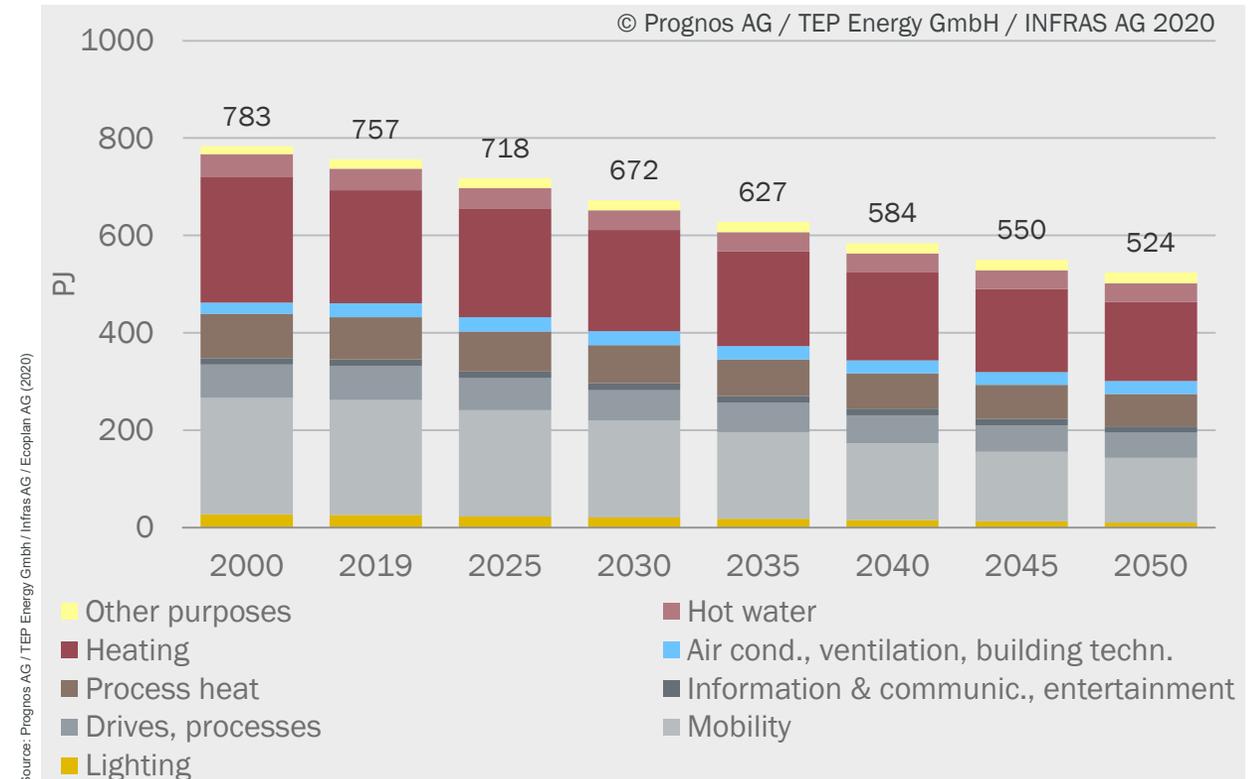
Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years

ENERGY PERSPECTIVES 2050+ FINAL ENERGY CONSUMPTION

Development 2019 to 2050:

- Total: -31% (BAU -19%), additional saving versus BAU 91 PJ
- Strong reductions in:
 - Lighting -60%, BAU -51%
 - Heating -30%, BAU -22%
 - Mobility -44%, BAU -32%
- Heating and mobility remain the segments with the highest consumption
- Consumption in all segments decreasing, except “other uses” (collective group with electrical applications)

Final energy consumption by purposes

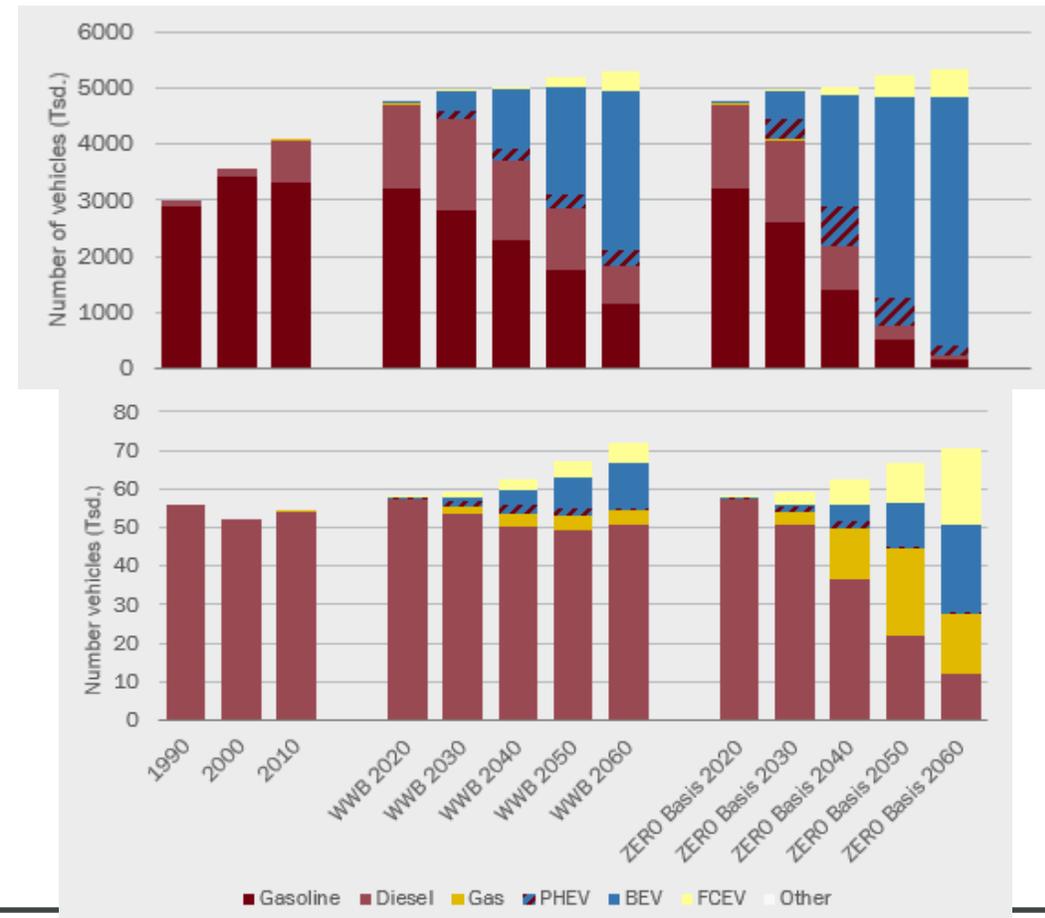


Scenario ZERO Basis

ENERGY PERSPECTIVES 2050+ **TRANSPORT SECTOR**

- The share of (battery) electric increases rapidly in all categories. In 2050, the fleet of battery-electric cars will be around 3.6 million vehicles.
- Heavy goods vehicles segment: biofuels and hydrogen play a significant role alongside battery operated vehicles.
- Electricity-based fuels will also be required in order to cut greenhouse gas emissions to zero.

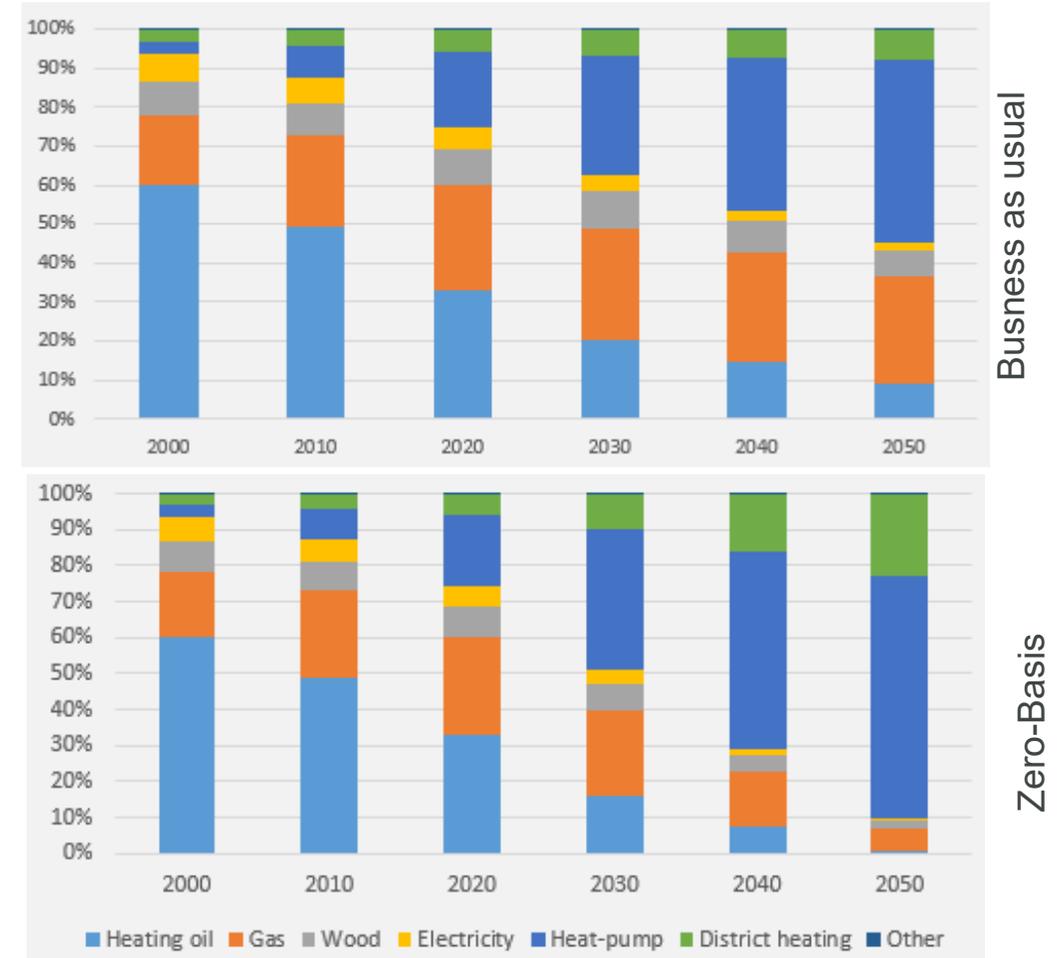
Number vehicles PV (above) and HCV (below)



ENERGY PERSPECTIVES 2050+ HEATING SEGMENT

- The share of heat pump increases rapidly in all type of buildings. In 2050, the number of heat pumps will be in the private household and service sector around 1.5 million.
- Heat pumps are complemented by local and district heating networks

Development of the heating structure in private households



Above: Scenario Business as Usual

Below: Scenario ZERO Basis

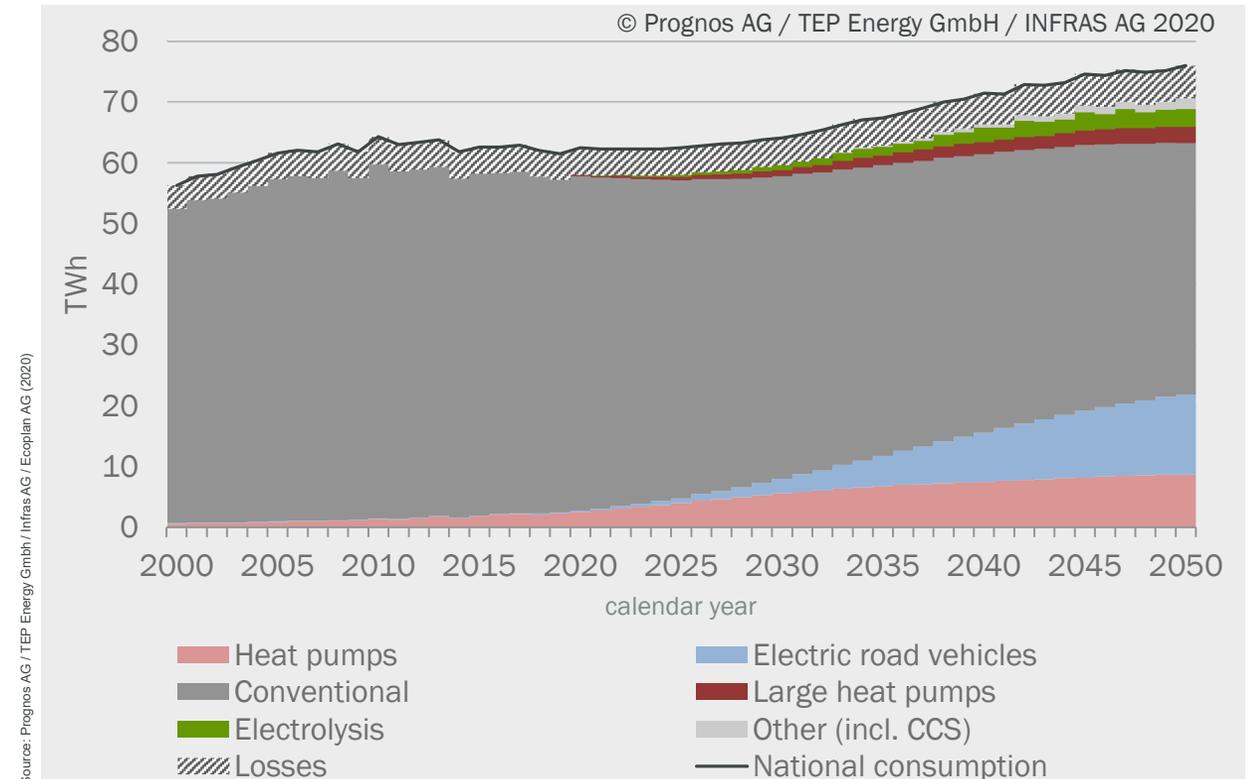
Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years

ENERGY PERSPECTIVES 2050+ ELECTRICITY CONSUMPTION

National electricity consumption:

- Increase in national consumption by around 24 % by 2050
- Main drivers:
 - Electric vehicles (road transport) (13 TWh)
 - Heat pumps (9 TWh)
 - H₂ electrolysis (3 TWh)
 - CCS / NET (2 TWh)
- The increase is damped by efficiency: decrease in conventional electricity consumption

National consumption by application



Scenario ZERO Basis

Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years

ENERGY PERSPECTIVES 2050+

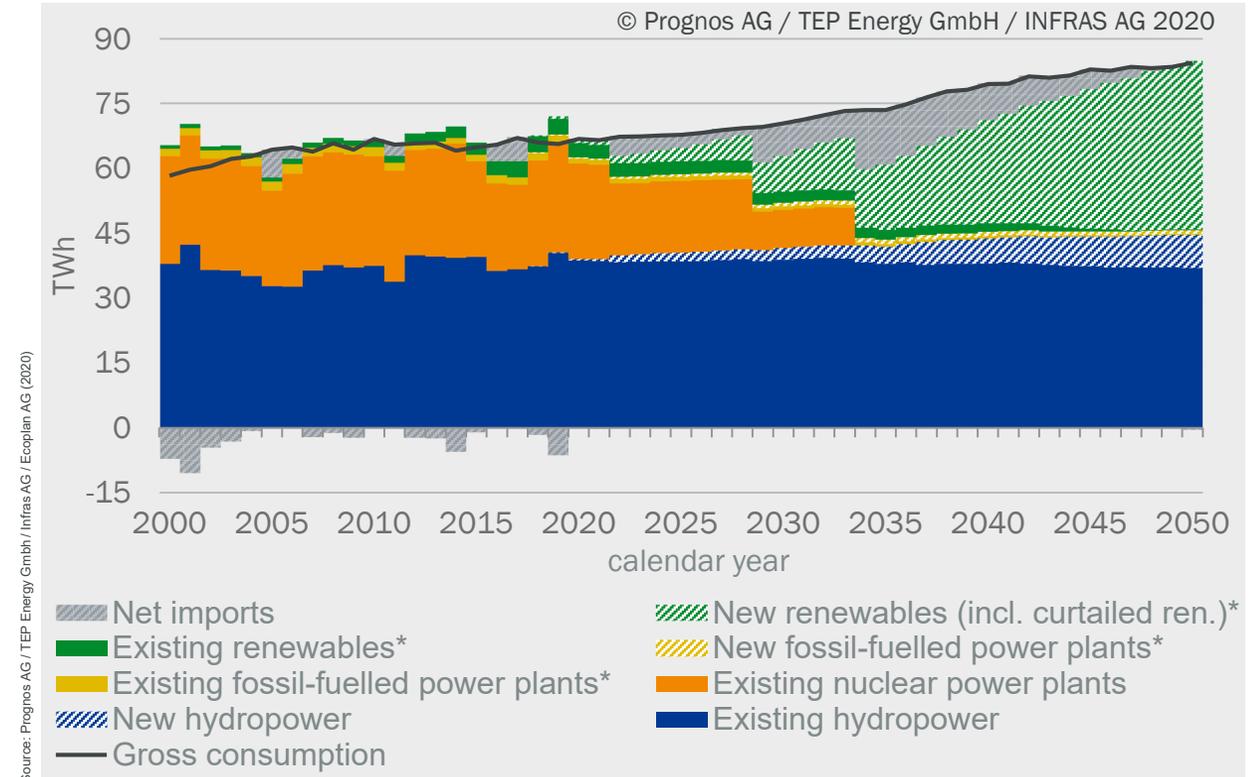
ELECTRICITY SUPPLY

Electricity supply system:

Up to 2050, Swiss electricity supply sourced by hydropower and renewable energy, temporarily supplemented by electricity imports.

- Increase in total consumption (including storage pumps) to 84 TWh in 2050.
- Sharp increase in domestic electricity generation through renewable energy and hydropower.
- Net imports balanced by 2050 after withdrawal from nuclear energy.

Annual electricity generation by technology



Scenario ZERO Basis

Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years

(* coupled and uncoupled)

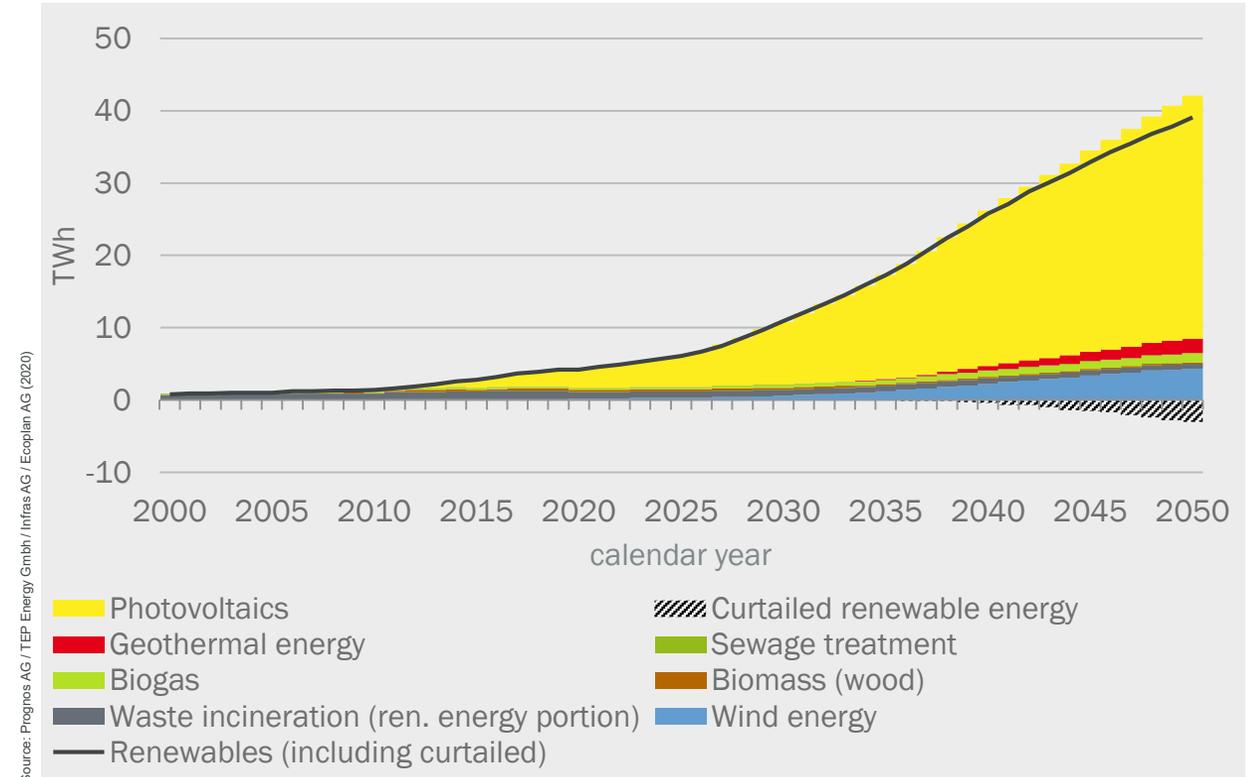
ENERGY PERSPECTIVES 2050+ ELECTRICITY SUPPLY

Renewable energy:

Sharp increase in electricity generation from renewable energy by 2050 to 39 TWh (4 TWh today).

- High share of photovoltaics due to falling costs and high potentials in Switzerland: 34 TWh in 2050.
- Wind power with low costs at good locations, but challenges regarding acceptance.
- Biomass and geothermal energy supplement the electricity mix and provide CO₂-free heat.
- Flexibility in generation and consumption is essential for integration.

Annual electricity generation new renewables



Scenario ZERO Basis

Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years



EP 2050+ COSTS

Accumulated figures 2020 to 2050:

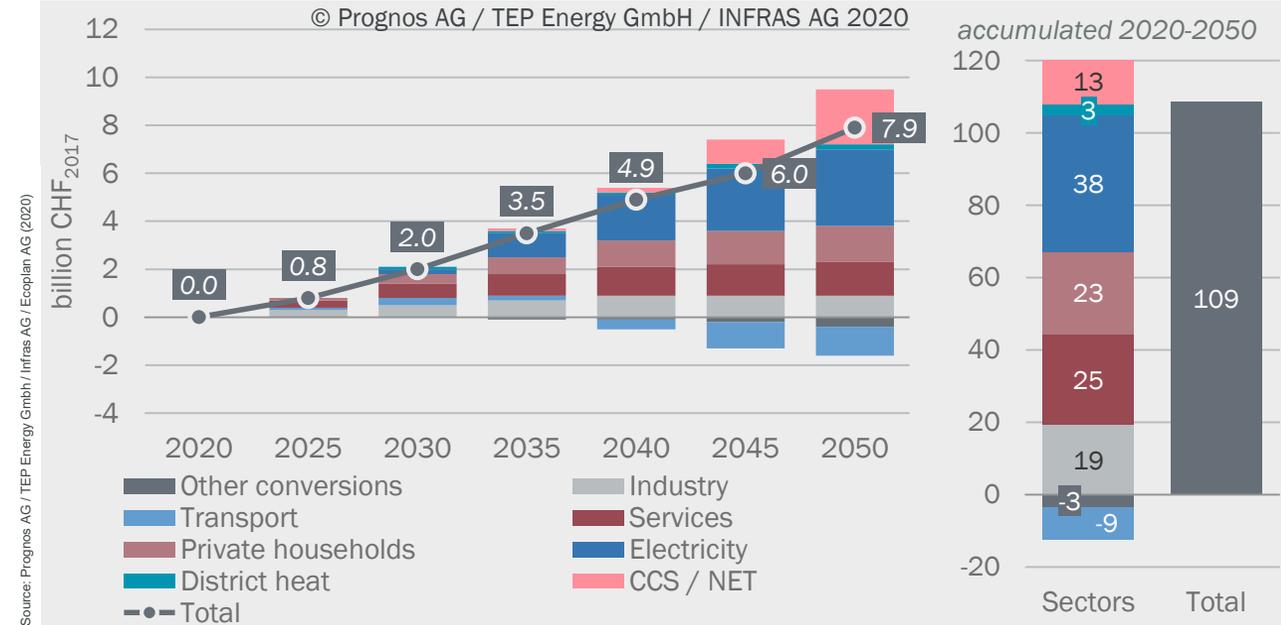
- Total additional costs of 73 billion CHF* compared to BAU, of which
 - annualised investments: 109 billion CHF
 - maintenance costs: 14 billion CHF
 - saved energy costs: -50 billion CHF
- Additional investments of 109 billion CHF means an increase of 8% compared to the existing investments in the energy system of 1'400 billion CHF
- Average annual additional costs (2020 to 2050): 2.4 billion CHF/yr

* CHF in real terms at 2017 prices

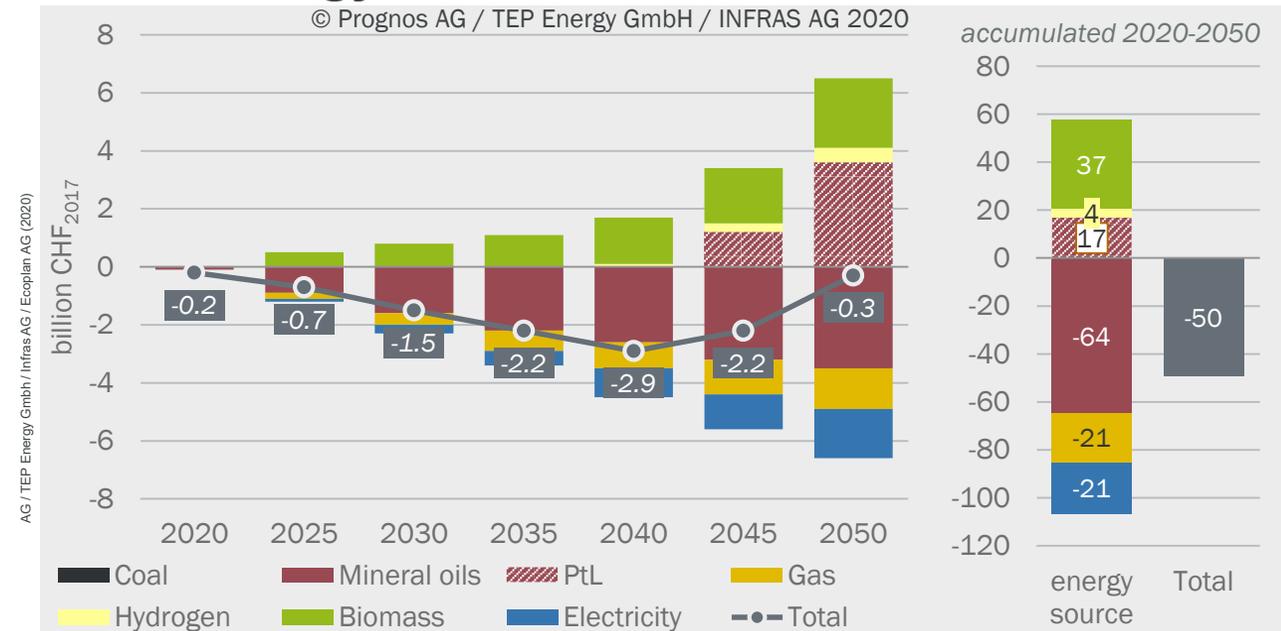
Scenario ZERO Basis

Strategic variant «even annual import-export balance 2050», lifetime NPP 50 years

annualised difference investments



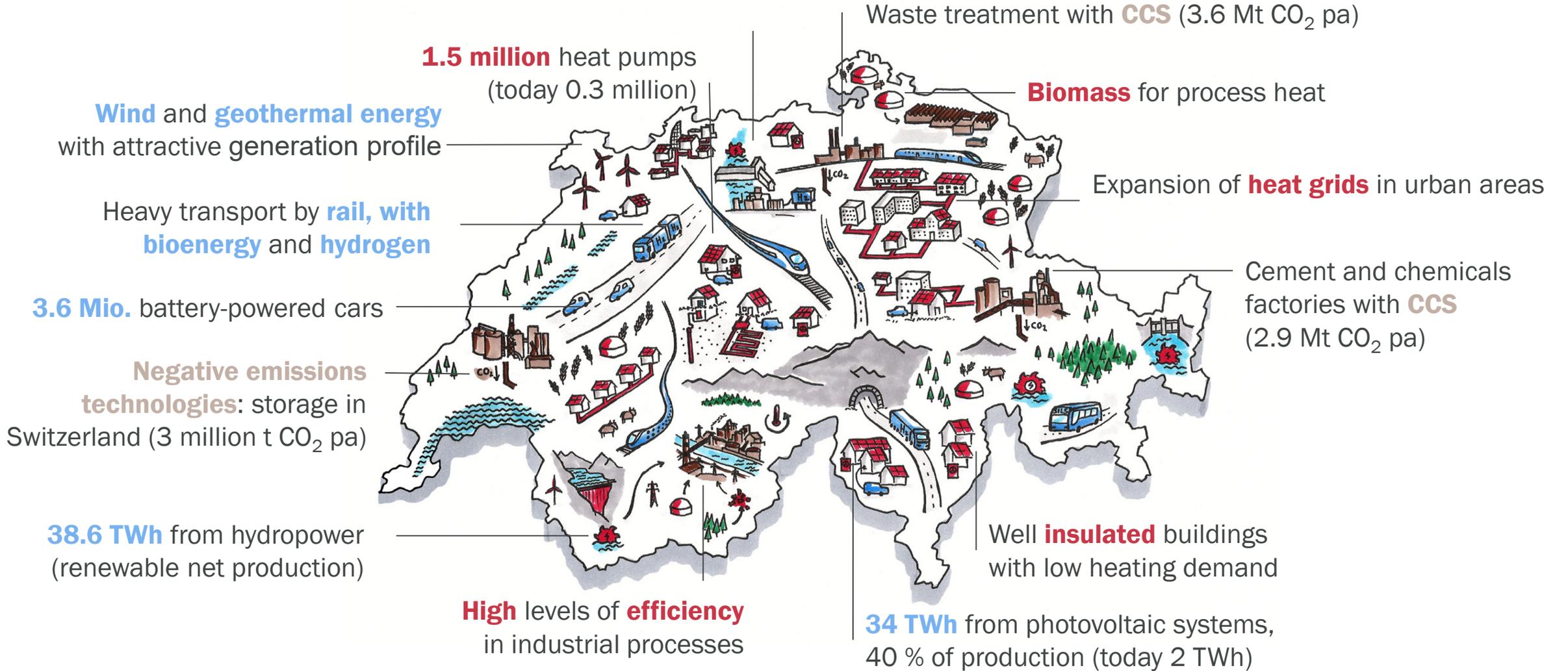
saved energy costs





CLIMATE-NEUTRAL SWITZERLAND IN 2050

Hydrogen production at run-of-river sites (7 PJ)



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