Power Station Switzerland

A Plea for an Energy Paradigm Shift With a Real Future

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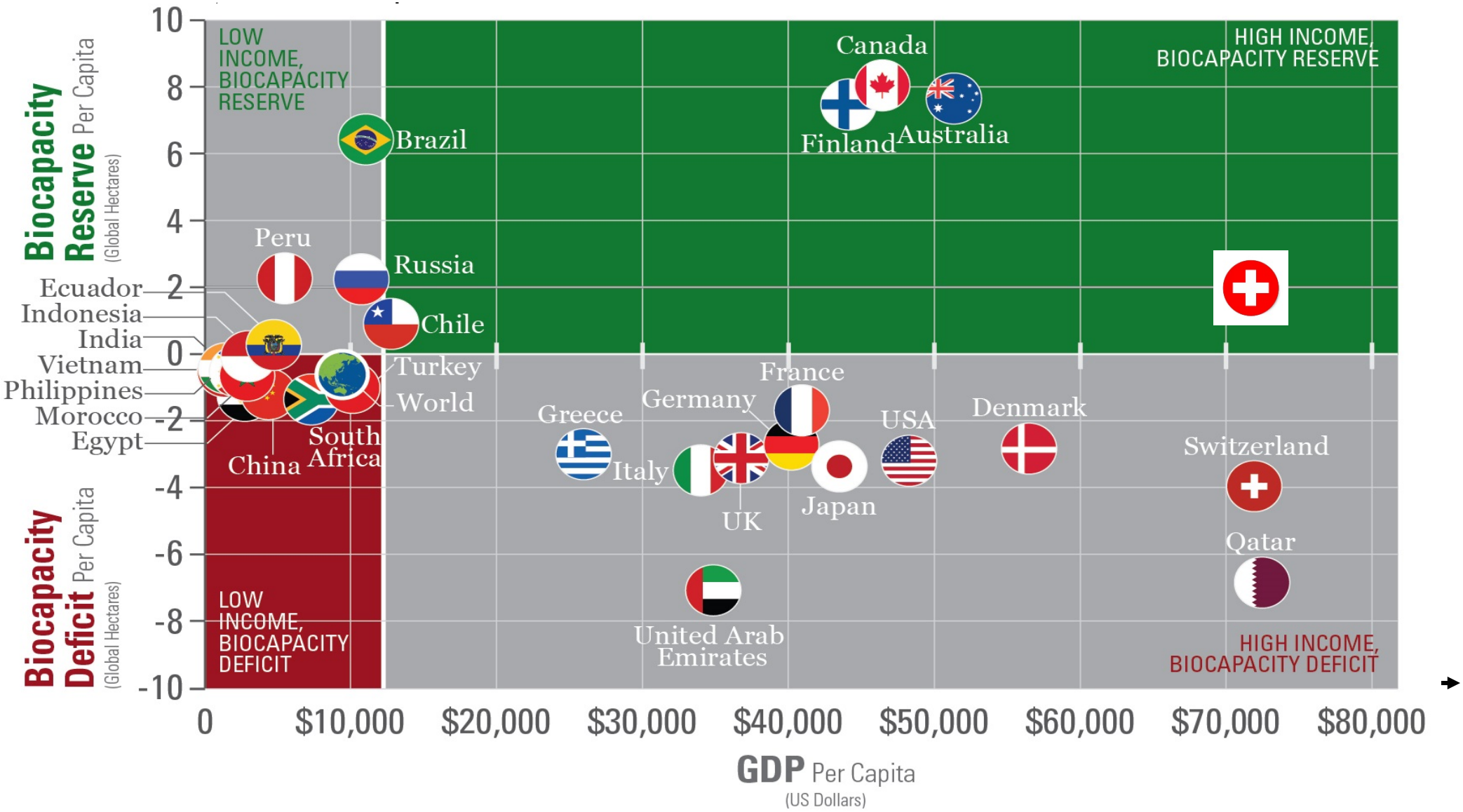
What Is It All About? Footprint and Economic Strength



Source: Global Footprint Network

Design Principle

- time horizon: > 1 generation (> 25 years)

- technically feasible
- similar economic wealth
- low economic costs

- ~~politically feasible~~
- ~~low commercial costs~~

Power Station Switzerland
The Important Questions:

1. How do we heat in the future?
2. What does our mobility look like in the future?
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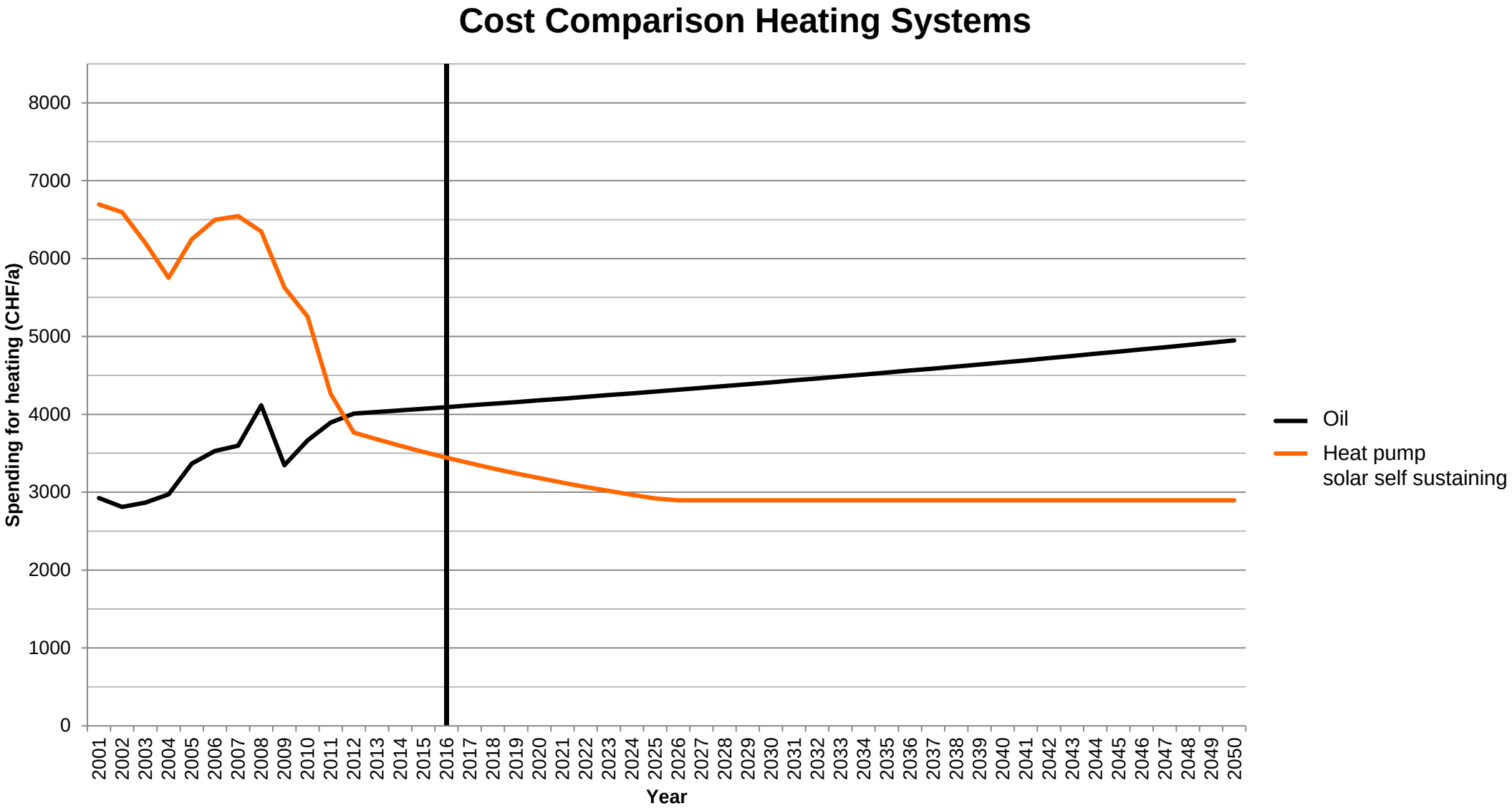
Heat

- The improvement of insulations led from 22 l (1970) to 3.6 l of oil per square meter & year (2010); (Factor 6)
- Reduction of the energy power consumption using heat pumps by a factor of 3 – 6
- Switzerland is doing a good job

- Remaining houses requiring a renovation (78%):
  - Renovation rate today: 1.1% p.a. → 70 years
  - Renovation rate Swiss State: 2% p.a. → 35 years
  - Renovation rate Gunzinger: 4% p.a. → 20 years

Heating Costs (Full Cost Calculation) for a Typically Swiss Detached House



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Base: Fair TCO (Total Cost of Ownership)

- **Electric Grid:**
  Value as new: ~ 60 billions CHF
  Yearly Costs: ~ 4.5 billions CHF

- **Road Network: (> 80'000 km)**
  Value as new: ~ 600 billions CHF
  Yearly Costs: ~ 45 billions CHF
- **Official Calculation of Yearly Costs: 8.7 billions CHF per year**

- **Adequate costs: Gasoline should be 4 – 5 x more expensive**
- **Rather high taxes than high fuel prices**
- **Land use for automobiles: 1200km^2, only in use by 2.7% of time.**
- **Land use rest: 400 km^2**

Mobility: Behavior Change in the Past

- **1960:**
  700 kg
  2.4 Passengers

Today we move 4 x more mass, which equals to a 4 x higher energy consumption

- **2015:**
  1.4 t
  1.3 Passengers

Mobility: Behavior Change (Sufficiency)

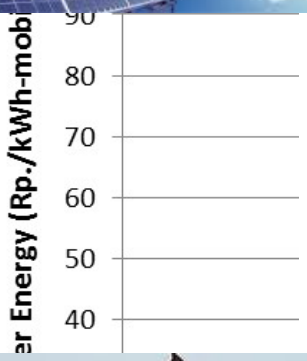
- **Distances < 500 m: walking (~ 30% of all car trips)**

- **Distances < 5 km: (E-) Bike (~ 30% of all car trips)**

- **Rest: Multiple Passengers in (light) Electric Vehicles**

Energy Savings: Factor 2 – 4

Energy Costs: Oil vs. Electric/Solar

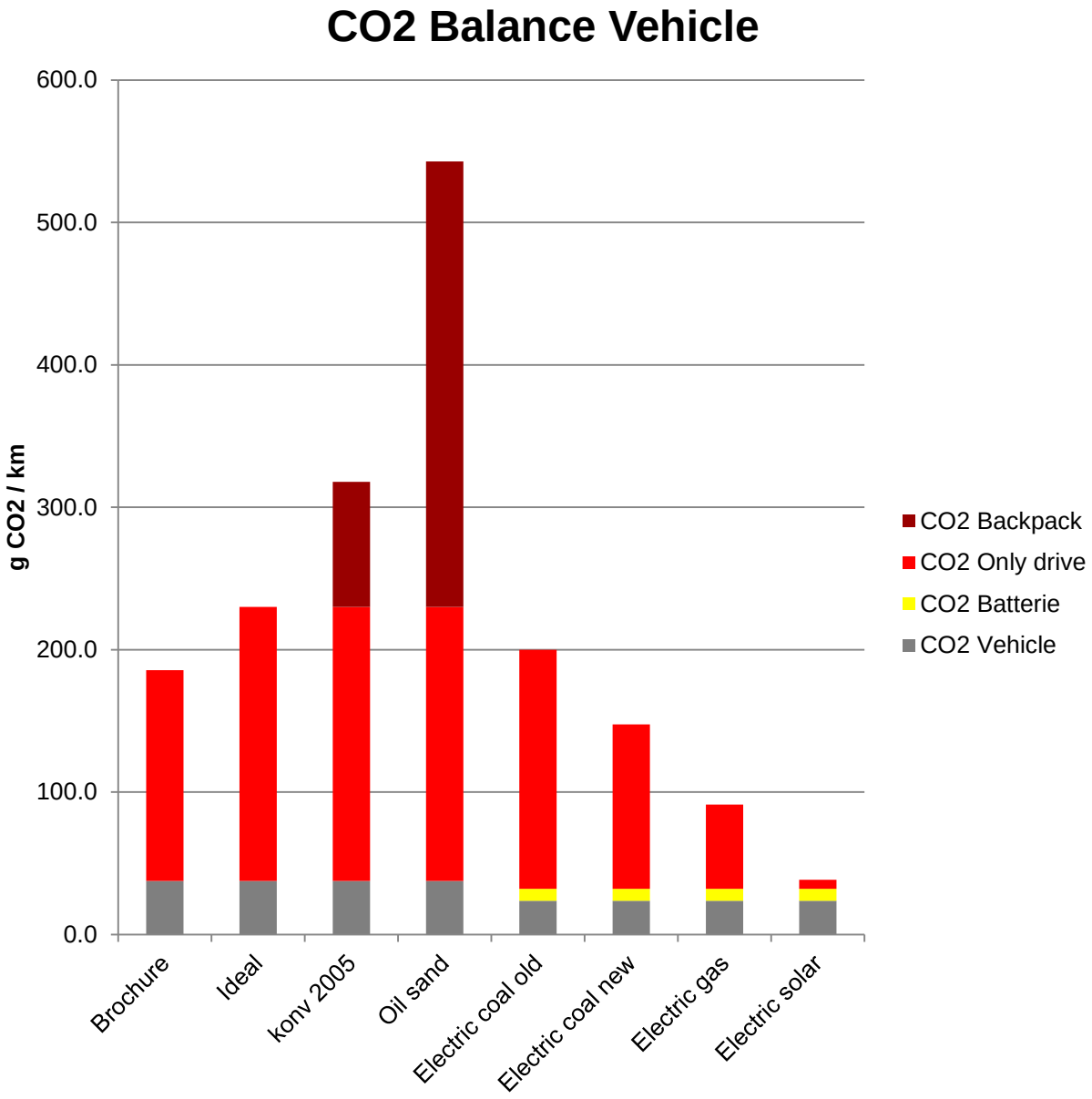


CO_2 Emissions [g/km]
Brochure: 148
Reality: 280
Fracking: 309

Petrol
Diesel
Electricity (PV)

CO_2 Emissions [g/km]
Reality: 6

CO_2 Emissions of an Average Car (1400 kg)



driving electric cars produces 10 x less CO_2.

Infrastructure:
45 gCO_2/km

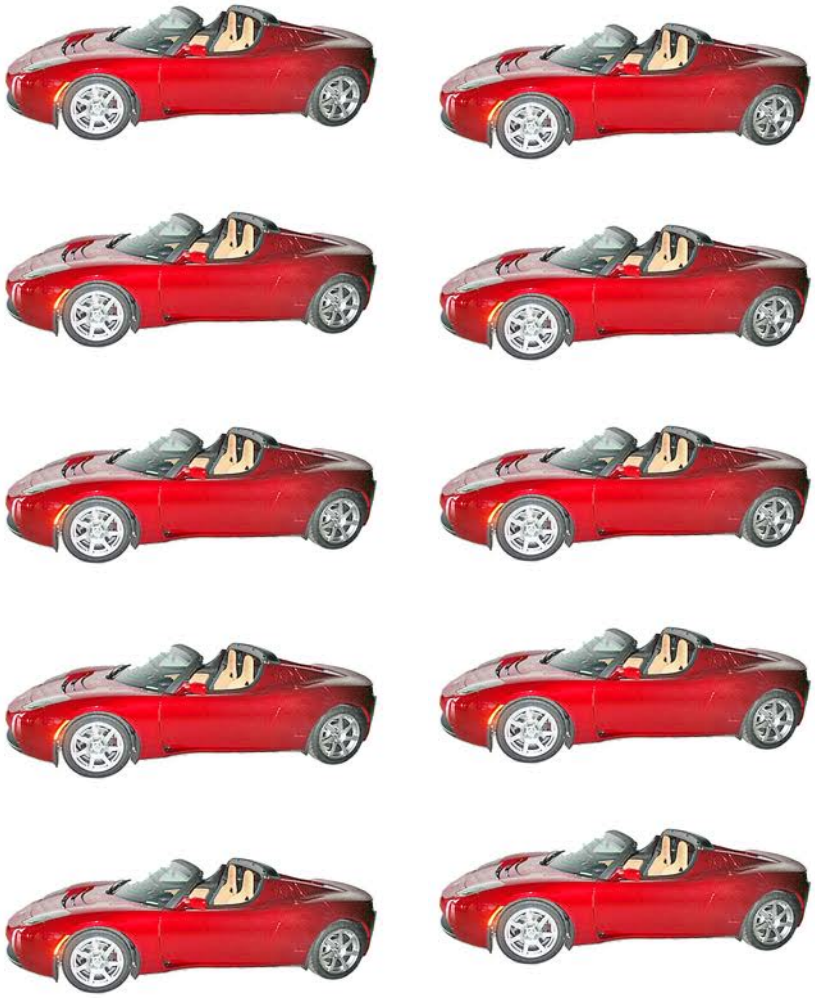
Infrastructure construction:
270 gCO_2/km

Electric Driving is Highly Efficient

		Tesla	Porsche
Type		Roadster Sport	911 Carrera S
Power	[HP] [kW]	300 225	350 260
Acceleration 0-100 km/h	[s]	3.7	4.8
Consumption	[kWh/100 km] [l/100km]	14 1.6	110 12

electric driving requires
6 – 8 x less energy

Where does the Electricity for Electric Driving Come From?



- 133 m^2, 21 kWp
- 1100 h sun/year
- 23’100 kWh/a
- **How many electric vehicles can be powered by that?**

The Battery, the Great Challenge

- **2012: TESLA Roadster 1000 CHF/kWh**
- **2014: TESLA Modell S 500 CHF/kWh**
- **2017: Renault elektro 200 CHF/kWh**
- **2019: 100 CHF/kWh**

- **2022: Gunzinger 300 CHF/kWh**

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Power Consumption 2035

	Consumption [TWh/a]
Consumption today	**60**
Savings potential (25%)	**-15**
Additional consumption heat	**+6**
Additional consumption mobility	**+4**
TOTAL	**55**
Population Growth Today: 8.5 millions inhabitants; Tomorrow: 10.0 millions inhabitants	**65**

Production today: ~ 40% nuclear power stations (~ 24 TWh/a)
Production tomorrow?

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Renewable Energy Sources

Solar:

- Initial costs 60 ct./kWh;
  Today EU 7 ct./kWh
- Marginal costs: 1 ct./kWh
- Production fluctuating
- Potential CH: ~ 30 TWh p.a.

Wind:

- Costs: around 50% of Solar
- Today 2 – 4 MW/Windmill
- Production fluctuating
- Potential CH: ~ 10 TWh p.a.

Biomass

- Wood, sludge, organic waste
- Potential CH: 6 - 10 TWh p.a.

Cost of Nuclear Energy

Production:

- **Used to be 2 Rp./kWh, today 15 Rp./kWh**

Waste Disposal Switzerland:

- **Cash on hand (2016) 6 billions CHF**
- **Waste disposal (BFE, 2006) 18 billions**
- **Waste disposal (BFE, 2014) 25 billions**
- **Waste disposal (BFE, 2016) 27 billions**
- **Waste disposal Gunzinger 50 billions**

- **Largest financial disaster in Switzerland's history**
- **Pool all nuclear power companies (power stations, Zwilag, nagra) in swiss nuclear joint stock company («Bad Bank»), otherwise, the electric companies go bankrupt. Finally, tax payers end up paying.**

Switzerland and the World

World

- World wide expansion of renewable energies in 2016:
  ~ 250 TWh (30 large nuclear power stations); growth 30 % p.a.

Switzerland

- Solar Electricity 2015: ~ 167 kWh (~2%) per inhabitant
- EU Rank 25 of 27 countries
- 35’000 pending applications for solar panels
- Expansion of renewable energy target: ~2.5 TWh p.a. (1% of the World GDP)
  2.5 TWh p.a. equals the energy of the nuclear power station Mühleberg / Beznau;
- Actual: ~0.3 TWh p.a.
- At a rate of 2.5 TWh p.a.: in 10 years all nuclear power stations are compensated for

Is it possible to replace nuclear power by solar energy, wind, and biomass?

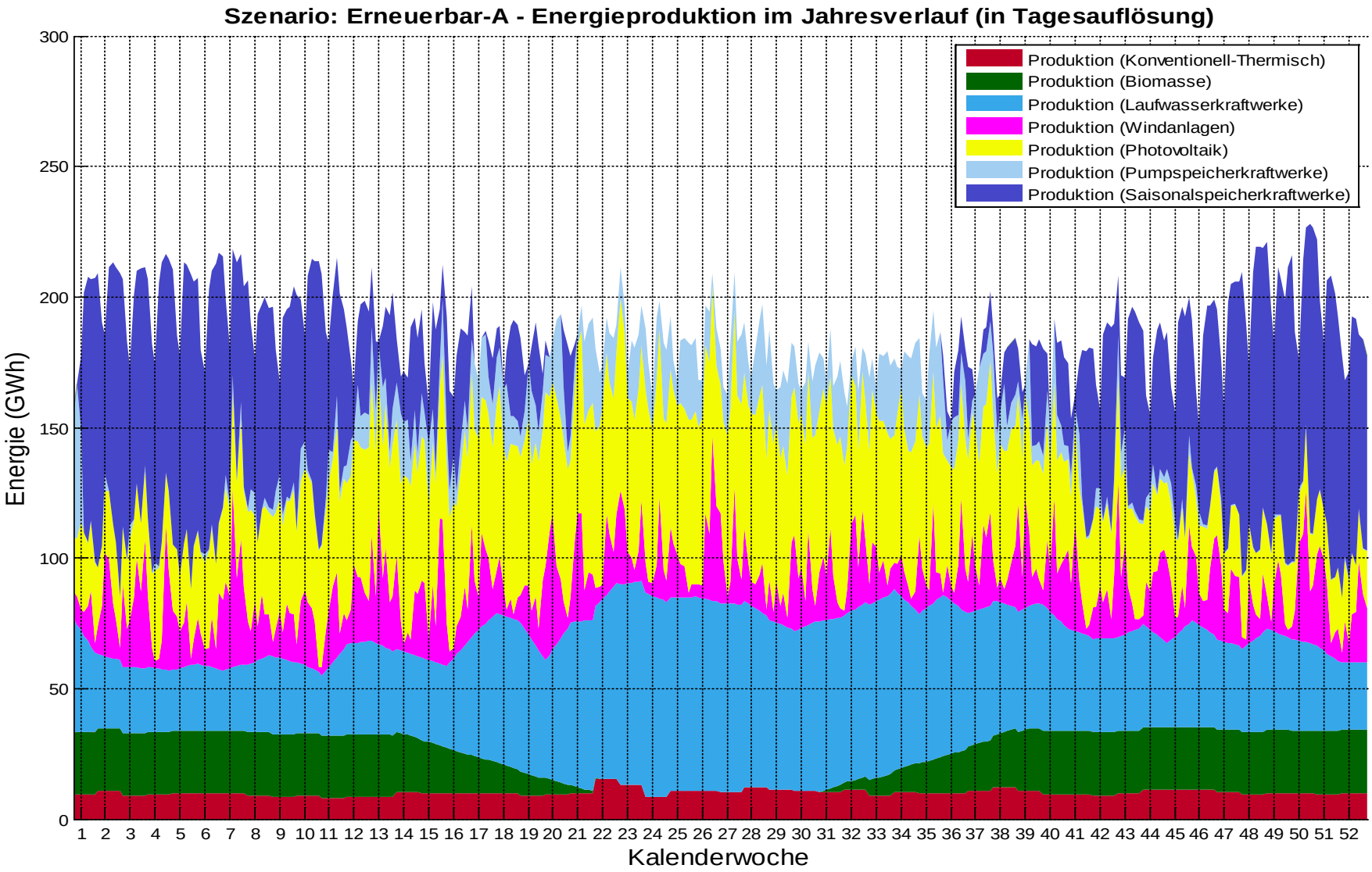
“It is not possible for solar energy and wind to replace nuclear power. We proclaim and proof it over and over again. Both of them produce unreliable fluctuating power, that is especially available, when it is not needed”

Source: http://kaltduschenmitdoris.ch/
Dr. Irene Aegerter; erm. Prof. Dr. Silvio Borner,Volkswirtschaftslehre UNI Basel; erm. Prof. Franz-Karl Reinhart, EPFL; erm. Prof. Dr. Bernd Schips, KOF ETHZ

“Our calculations conclude that it is possible to achieve a 100% electricity provision for Switzerland with renewable energy at low costs, if a correct dimensioning is being applied”.

Source: «Kraftwerk Schweiz – Plädoyer für eine Energiewende mit Zukunft»

Solar, Wind and Biomass: Yearly Course of Energy



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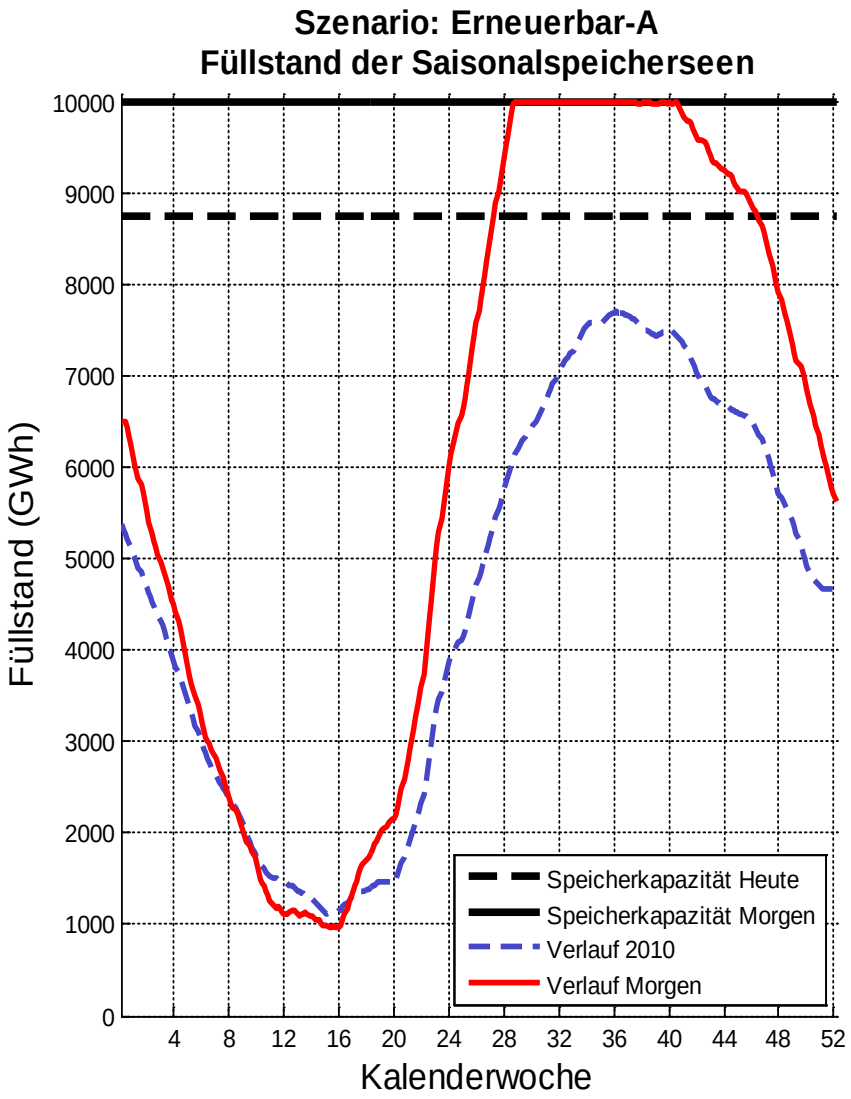
The Reservoir Questions: Level of the Reservoir Dams (Solar, Wind And Biomass)



Waste incinerator	3.7 TWh
Rivers:	16.6 TWh
Reservoir Lakes:	19.8 TWh
Nuclear Power:	0.0 TWh
Solar:	16.4 TWh
Wind:	7.0 TWh
Biomass:	5.9 TWh
Total:	69.4 TWh
Usable Energy:	60.0 TWh
Deficit:	0.3 TWh
Costs:	16.8 Rp. / kWh (cheaper than new nuclear power stations)

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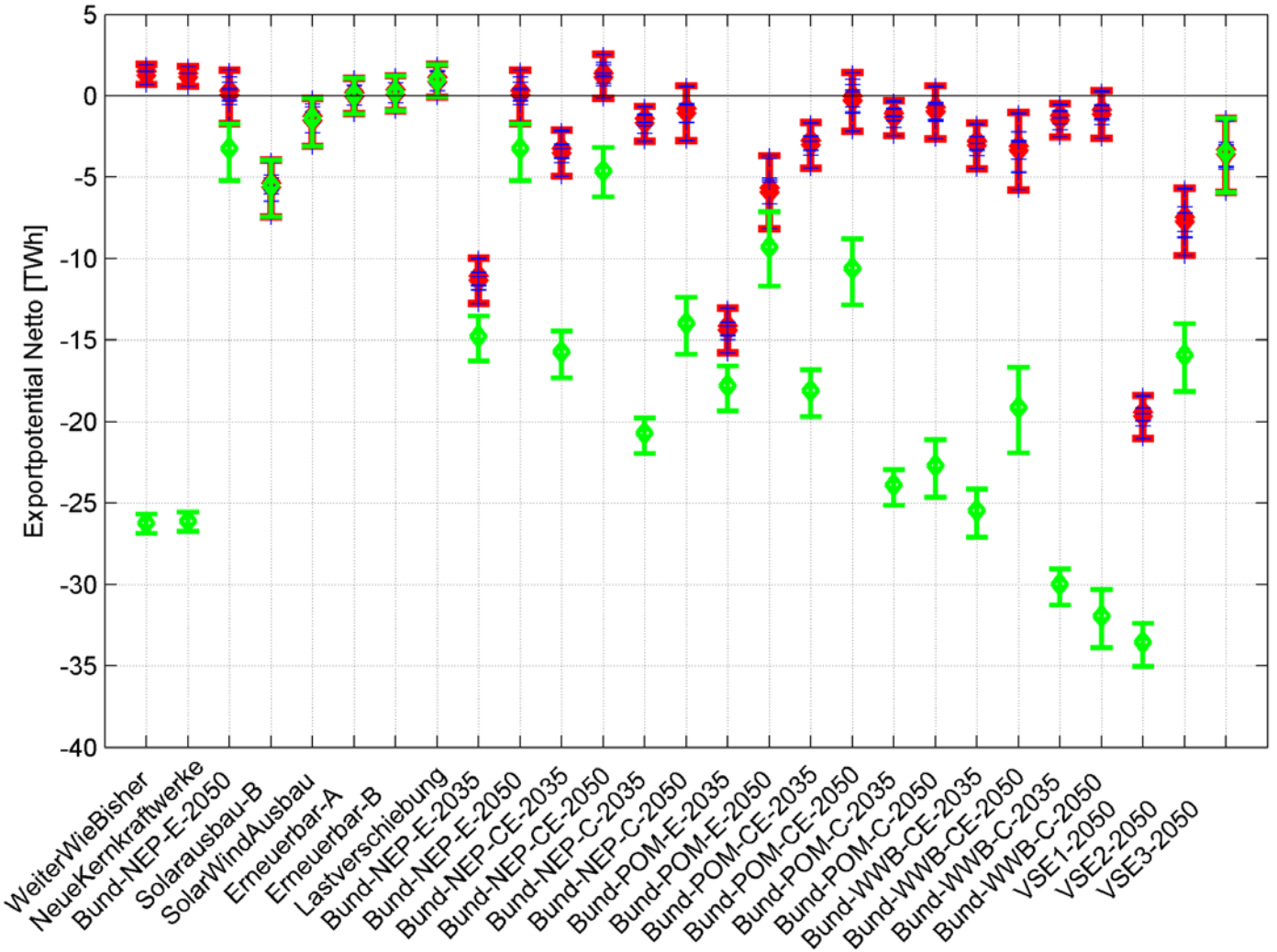
CH Energy-Autonomy: Water Years 2003 - 2012



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Energy Costs Switzerland From 2016 To 2050 (excluding taxes and fees)

	WWB
Domestic Costs [billions CHF]	490
Foreign Costs [billions CHF]	1610
Total Costs [billions CHF]	2100

Energy Costs Switzerland From 2016 To 2050 (excluding taxes and fees)

	WWB	ES2050	Gunzinger
Domestic Costs [billions CHF]	490	590	690
Foreign Costs [billions CHF]	1610	1350	420
Total Costs [billions CHF]	2100	1940	1110
Workforce [thousands]	140	169	196
CO_2-Production (2035) [Mt]	5.2	5.1	0.9

Thank you for your attention

Vision meets reality.