Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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**Bundesamt für Energie BFE**
**Office fédéral de l'énergie OFEN**
**Ufficio federale dell'energia UFE**
**Swiss Federal Office of Energy SFOE**

# Challenges of the Nuclear Power Phase-out in Switzerland

NCCR-MUST/SLN Workshop, 13th June 2012, EPFL

Tony Kaiser

# Content

- Energy demand and supply up to 2050
- Key challenges
- How to get there – key measures
- Discussion
- Conclusions

# Federal Council's approach to future energy supply – Decision from 25th May, 2011

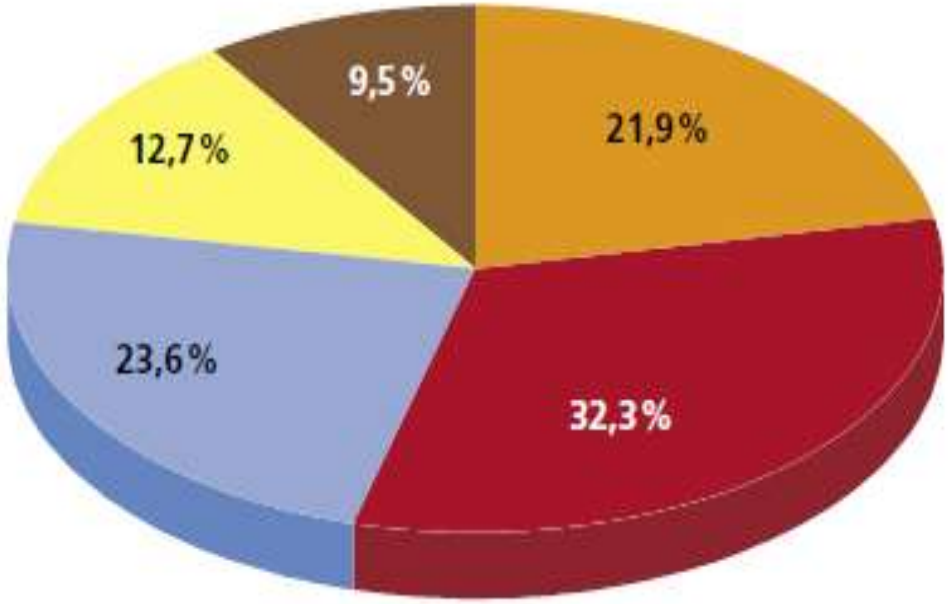
- The Federal Council would like the energy supply to be clean, secure, largely autonomous and economical
- Existing nuclear power plants to be disconnected from the grid when they can no longer be operated safely
- No new nuclear power plants to be built
- Energy strategy to take new direction, New Energy Policy
- Current climate goals will be pursued. Any additional energy production from fossil sources must be reduced to a minimum.

Federal Council decision
25 May 2011

# Final Energy Consumption in Switzerland 2010

(Source OFEN)

- Domestic fuel oil
- Gasoline, Diesel
- Electricity
- Gas
- Biomass, Biogas etc.



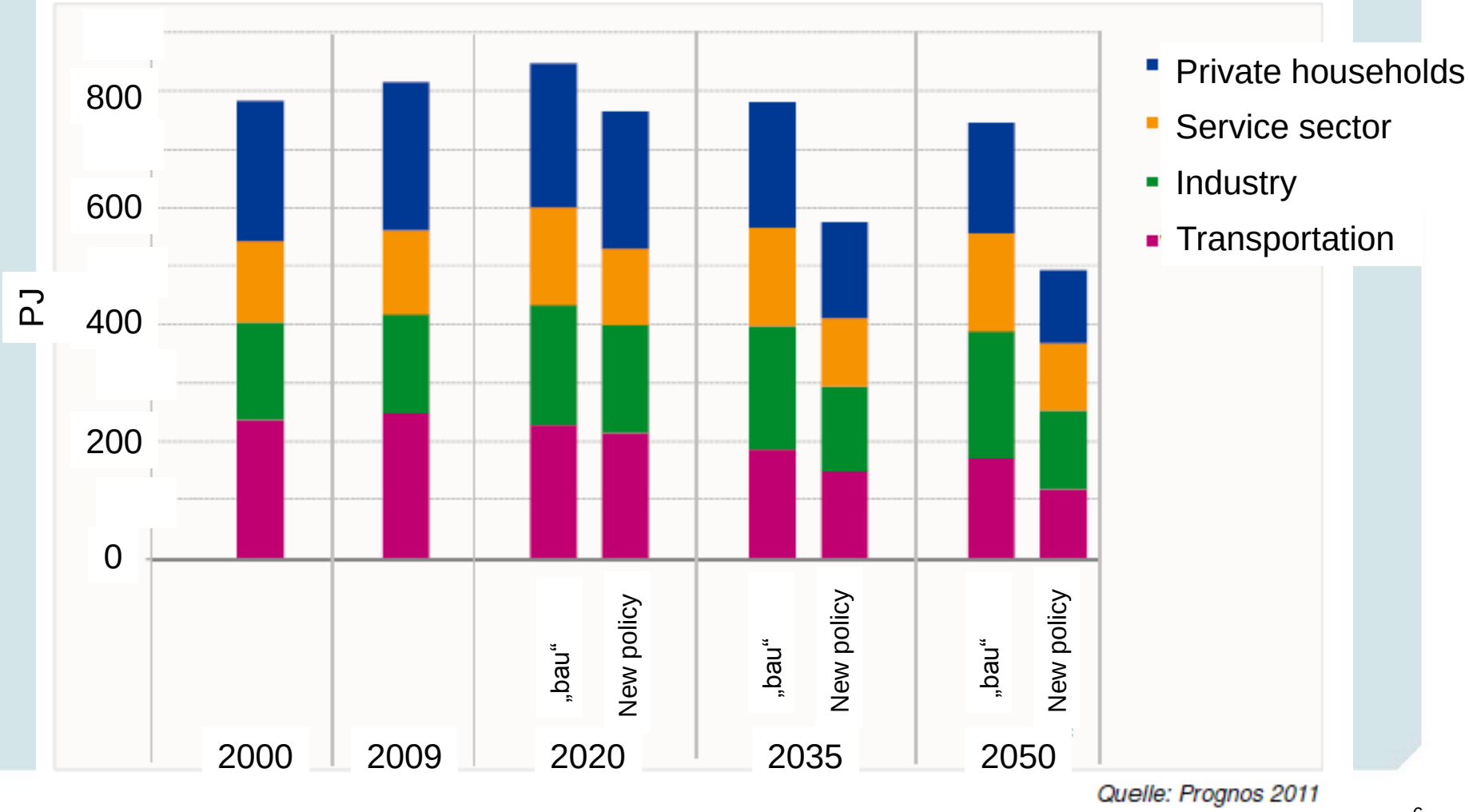

Total ca. 900 PJ or 250 TWh

# Energy strategy sets following (initial) priorities:

- To improve energy efficiency
- Expand hydroelectric power (Objective: 10 TWh by 2050; without additional pumped storage plants approx. 4 TWh by 2050)
- Increase proportion of renewable energies (Objective: 22.6 TWh electricity and double share in heating/cooling by 2050)
- Meet remaining demand with fossil fuels – primarily CoGen (CHP, Objective: 8.2 TWh by 2050), secondarily with gas-fired combined cycle – and imports

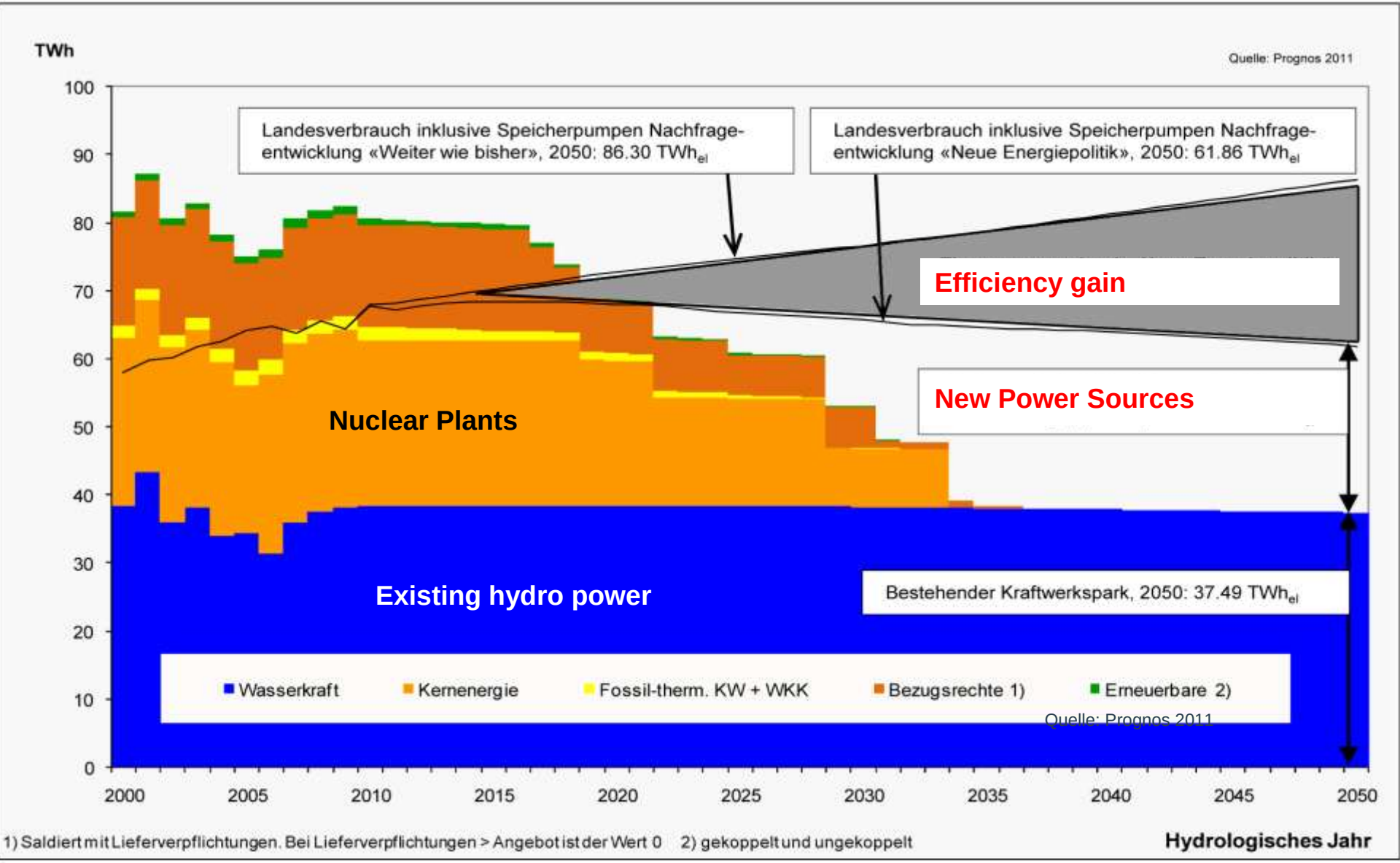
Federal Council decision
25 May 2011

# Final energy demand by sector – „business as usual“ and „New Energy Policy“ (May 2011)




*Quelle: Prognos 2011*

# Electricity supply, efficiency gains – the need for substituting 25 TWh of Nuclear Power



# Key challenges of the New Swiss Energy Policy in numbers (May 2011)

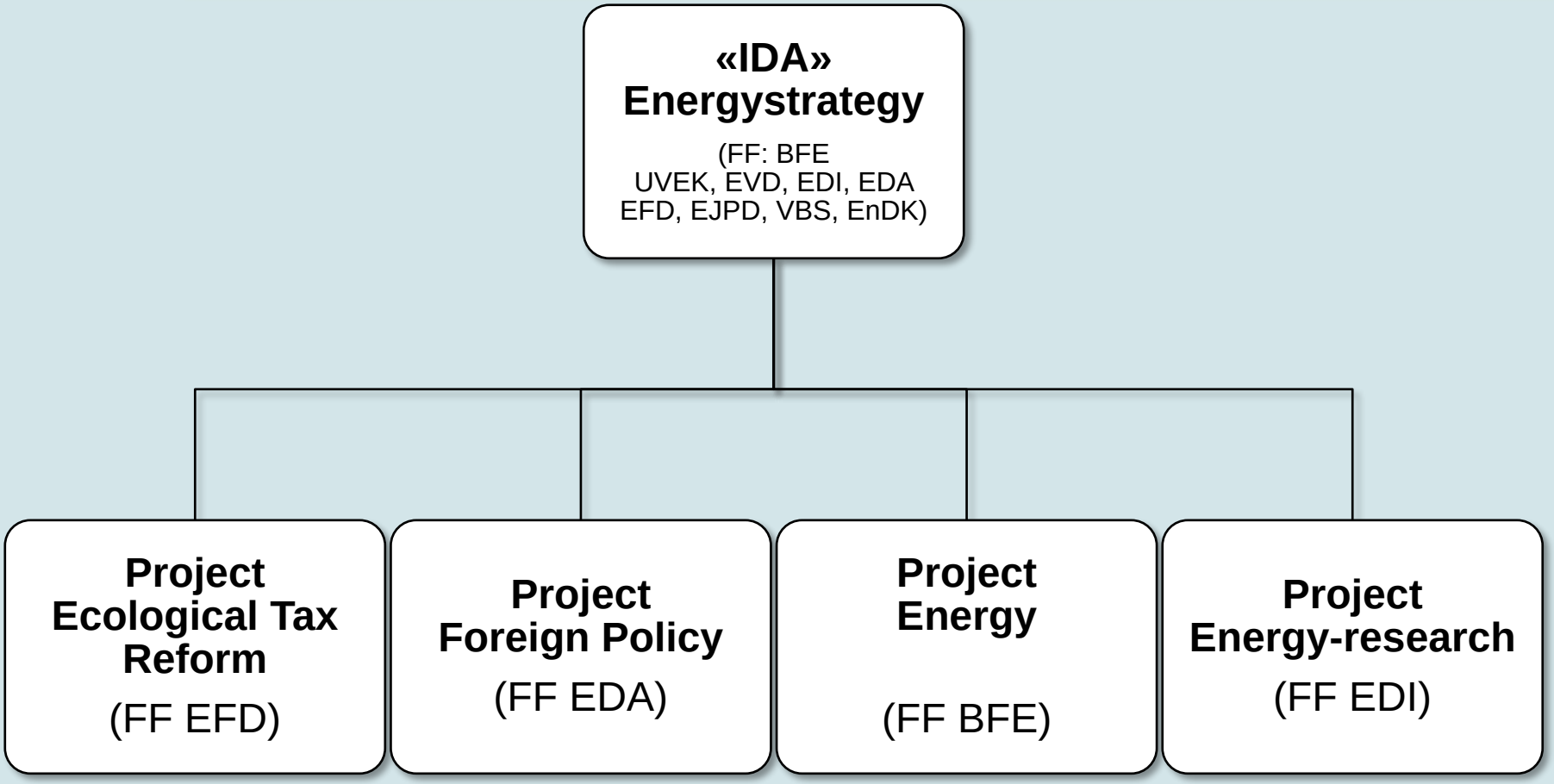
| | 2009 | 2050 | „Challenge“ |
|---|---|---|---|
| Final energy demand (PJ) | 813 | 493 | -39% |
| Final energy supply* „new renewables“(PJ) | 52 | 96 | +84% |
| Savings potential of private households (PJ) | 240 | 127 | -49% |
| Savings potential of fossil fuels in transportation (PJ) | 238 | 117 | -53% |
| Electricity demand (TWh) | 58 | 56.5 | -2% |
| Renewable power supply** (TWh) | <1 | 22.6 | >2000% |

* without electricity

** without hydro power

Expected growth until 2050:
Economy: +40%
Population: 9 Mio. up from 8 in 2011

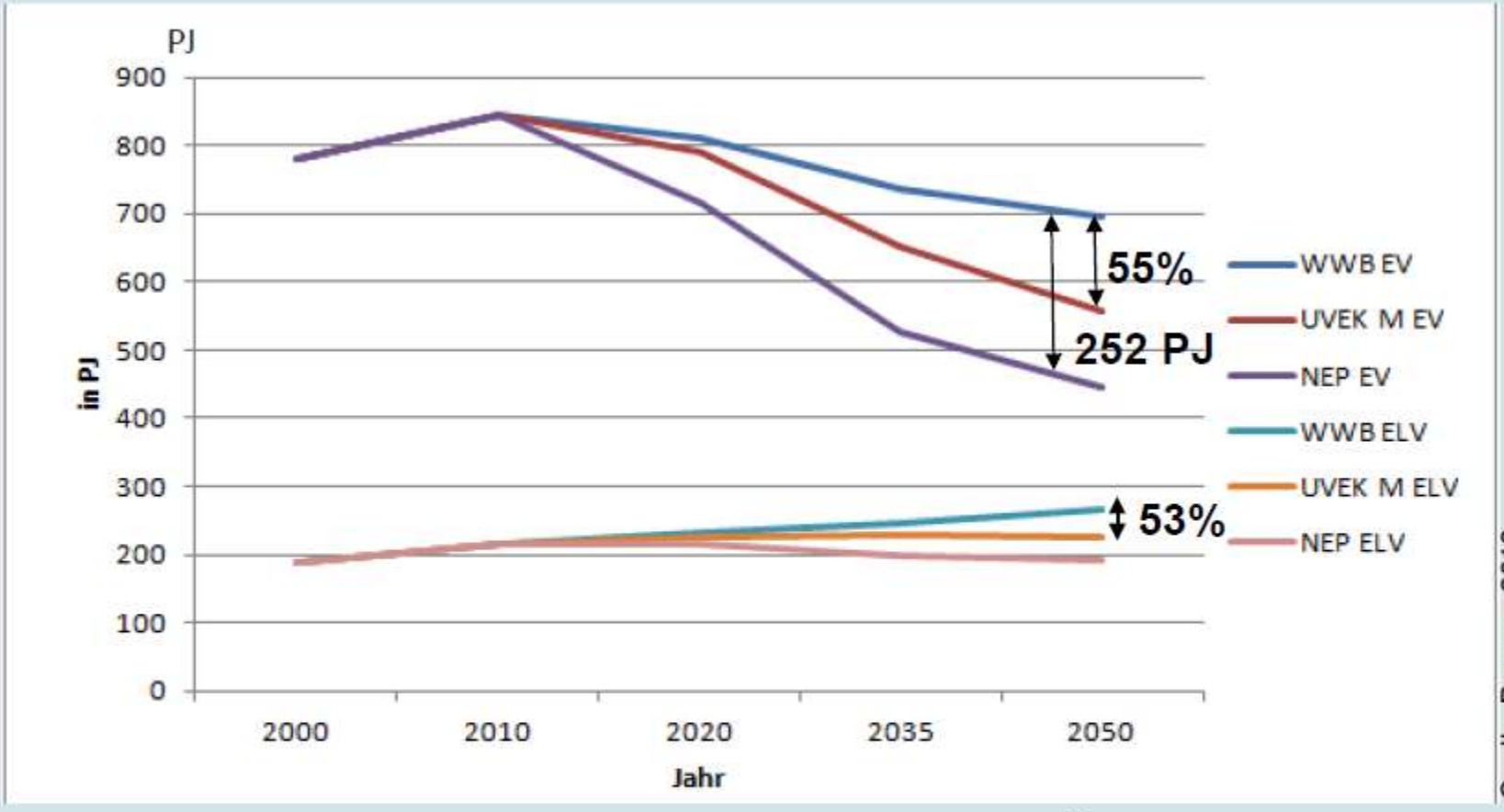
# «Interdepartementale Arbeitsgruppe Energiestrategie»



# Key Measures (April 2012)

| until 2020 | 2020 – 2035 | past 2035 |
|---|---|---|
| 1. Massnahmenpaket<br>• RES<br>• Efficiency<br>• Fossile / Imports<br>• Electrical Grids<br>• R&D, Demo projects<br>• … | New «energy tax» and time-limited feed-in tariffs or similar<br><br>(from feed-in tariff to steering/incentive tax) | |

# Endenergy and Electricity Demand (revised) – New Energy Policy Scenario – May 2012




**Szenarien:**

WWB = Weiter wie bisher

UVEK M = Massnahmen UVEK

NEP = Neue Energiepolitik

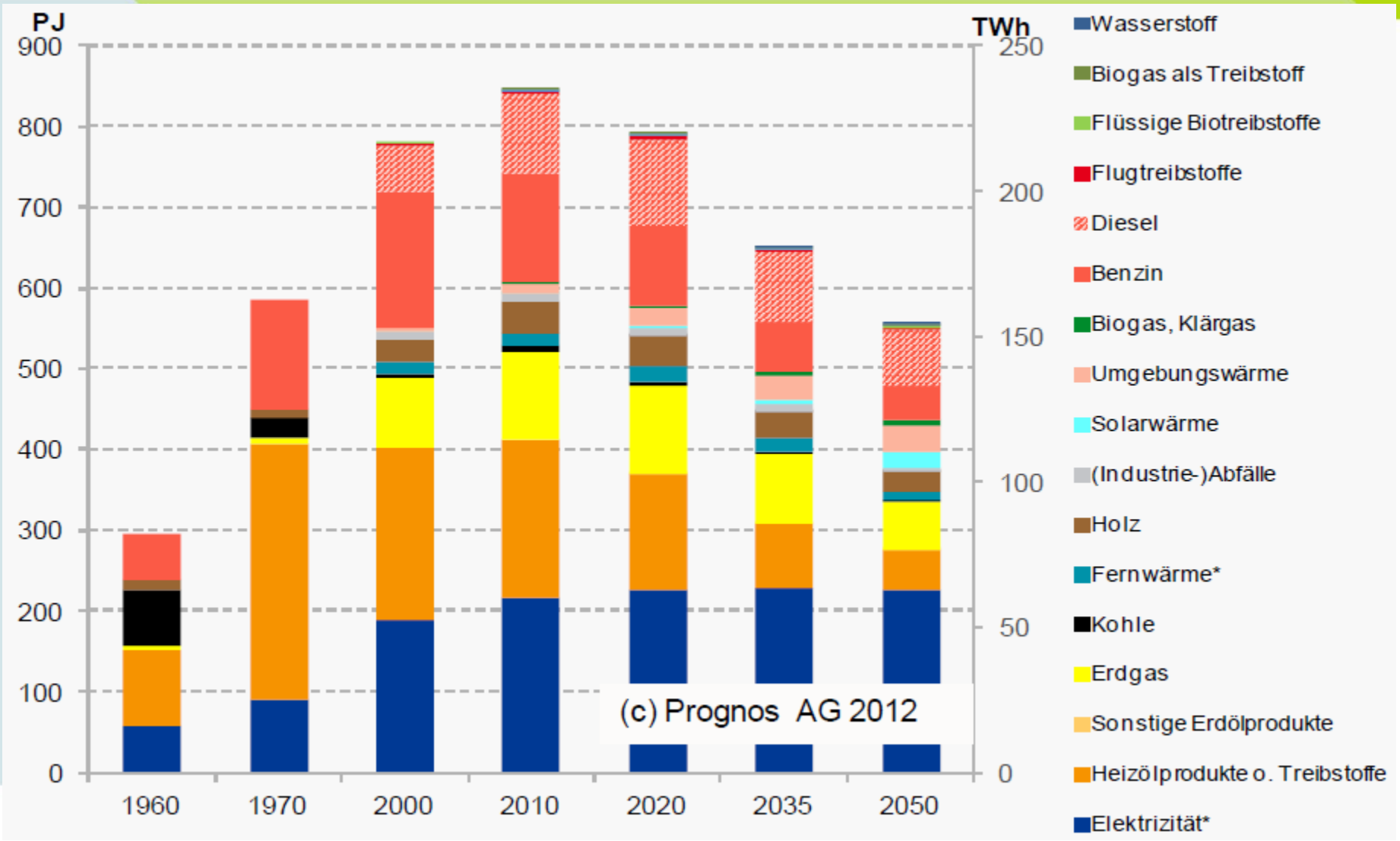
**Weitere Abkürzungen:**

EV = Endenergieverbrauch

ELV = Elektrizitätsverbrauch

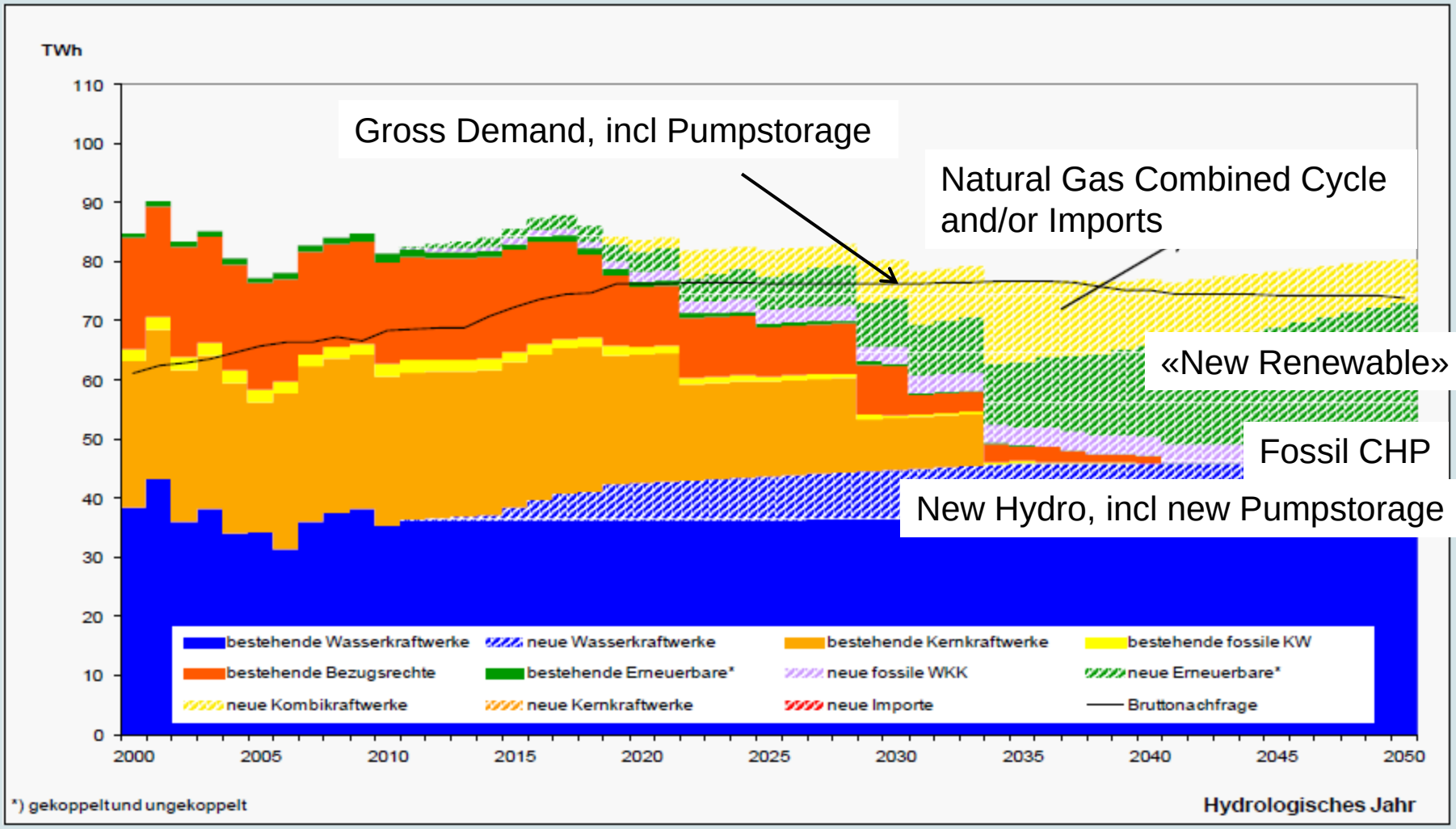
Source: Prognos/BFE 2012

# Future Energy Consumption (revised) – New Energy Policy Szenario – May 2012




Source: Prognos/BFE 2012

# Electricity Supply (revised) – New Energy Policy – May 2012




Source: Prognos/BFE 2012

# Planned Addition of Renewable Power and CHP until 2050 – Revised Potentials (May 2012)

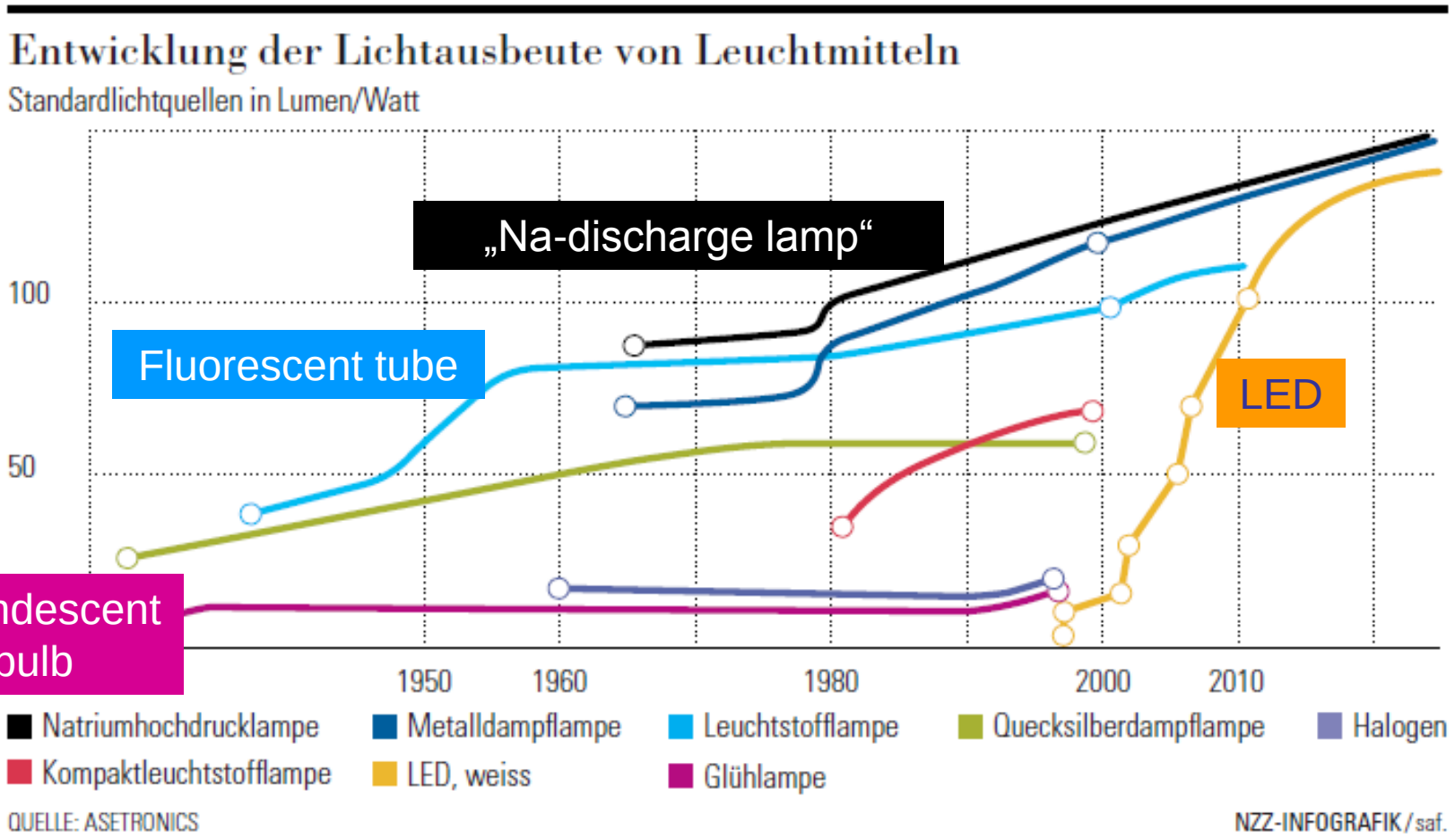
| Renewable Energy | TWh |
|---|---|
| PV | 10.4 |
| Wind | 4 |
| Geothermal | 4.4 |
| Biomasse | 1.1 |
| Biogas | 1.4 |
| Waste incin/waste water | 1.3 |
| total | 22.6 |
| | |
| CHP | 2 |

| Hydro Power | TWh |
|---|---|
| New large plants | 1.5 |
| New small plants | 1.5 |
| Repowering | 1.5 |
| New Regulations | -1.5 |
| Climate change impact | 0 |
| total | 3.2 |
| | |
| Pumpstorage (new) | 7.5 |

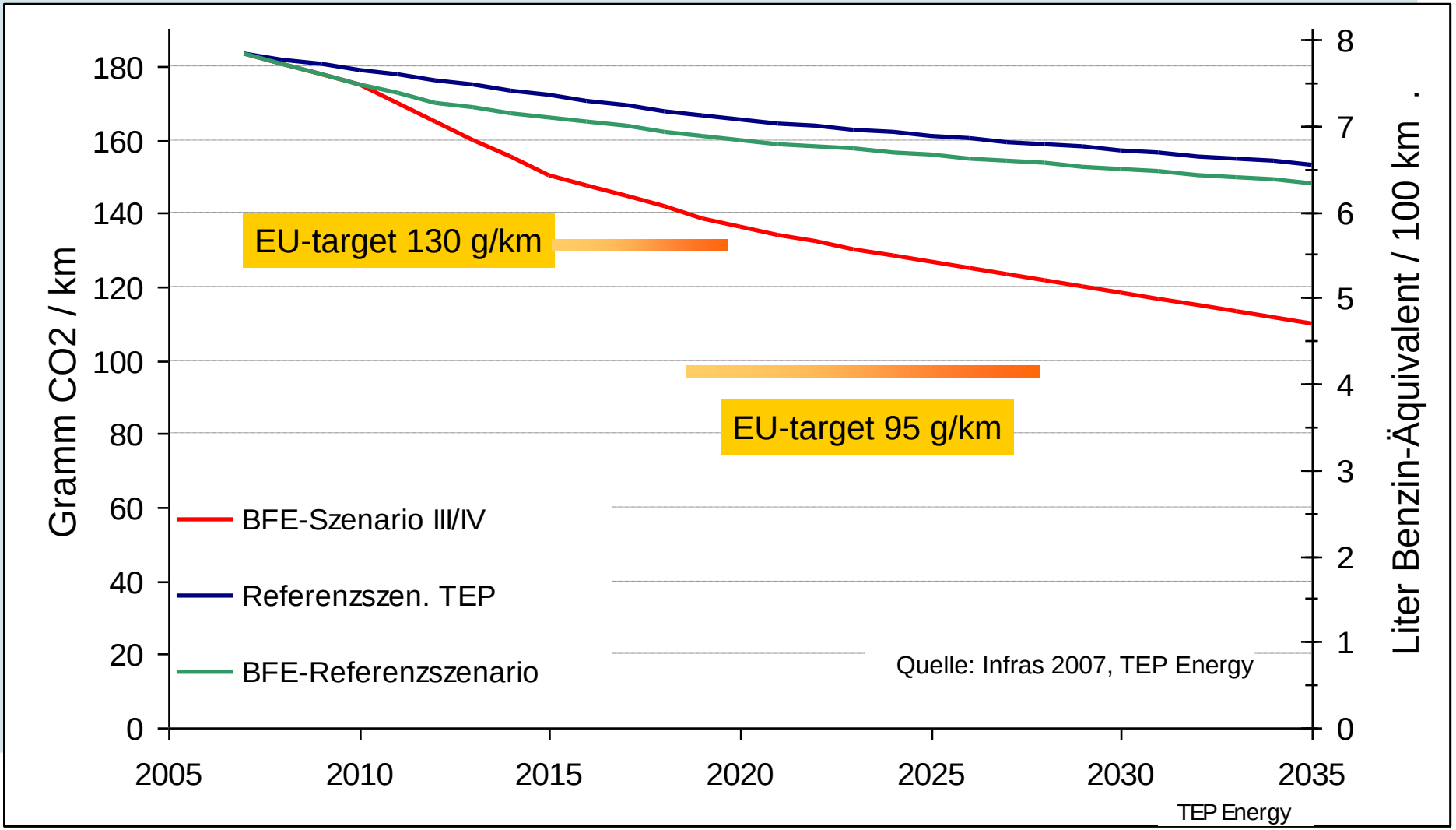
# Replacement capacity for 1 GW Nuclear Plant or 7.5 TWh yearly production of electricity

| Type | Unit size (el.) [MW] | Electr. Effic. | Energy / install. Power [TWh/GW] | Number of units | Remarks, Sources |
|---|---|---|---|---|---|
| Nuclear | 1000 | 33% | 7.5 | 1 | reference case |
| Hydro | 1kW-1000MW | >95% | | | variable |
| Gas (CC) | 400 MW | 58-60% | 7.5 | 2.5 | Base load operation |
| PV small (CH) | 10kW | | ≈1.0 | 750’000 | 70km$^2$ |
| Wind (CH) | 2,5MW | | 2.0 | 1500 | suisse eole |
| Biomasse | 20MW | 25% | 7.0 | 54 | Typical size |
| Geothermal | 10MW | 15% | 7.0 | 110 | Typical size |

# Efficiency developments of various illumination technolgies

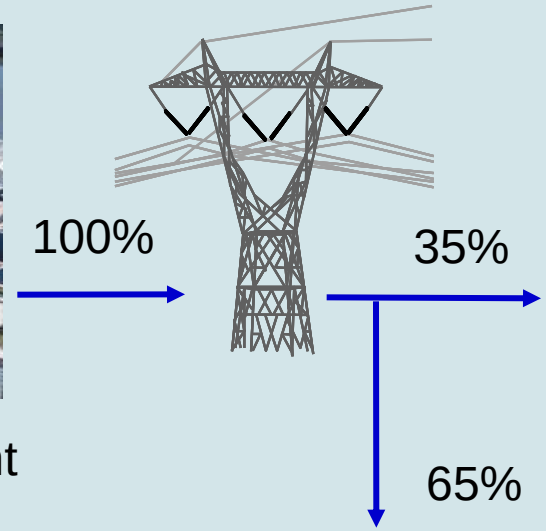


# Privat cars:
# CO2-Emissions and gasoline consumption



# Indirect CHP –
# Gaspower to replace domestic fuel oil – system approach

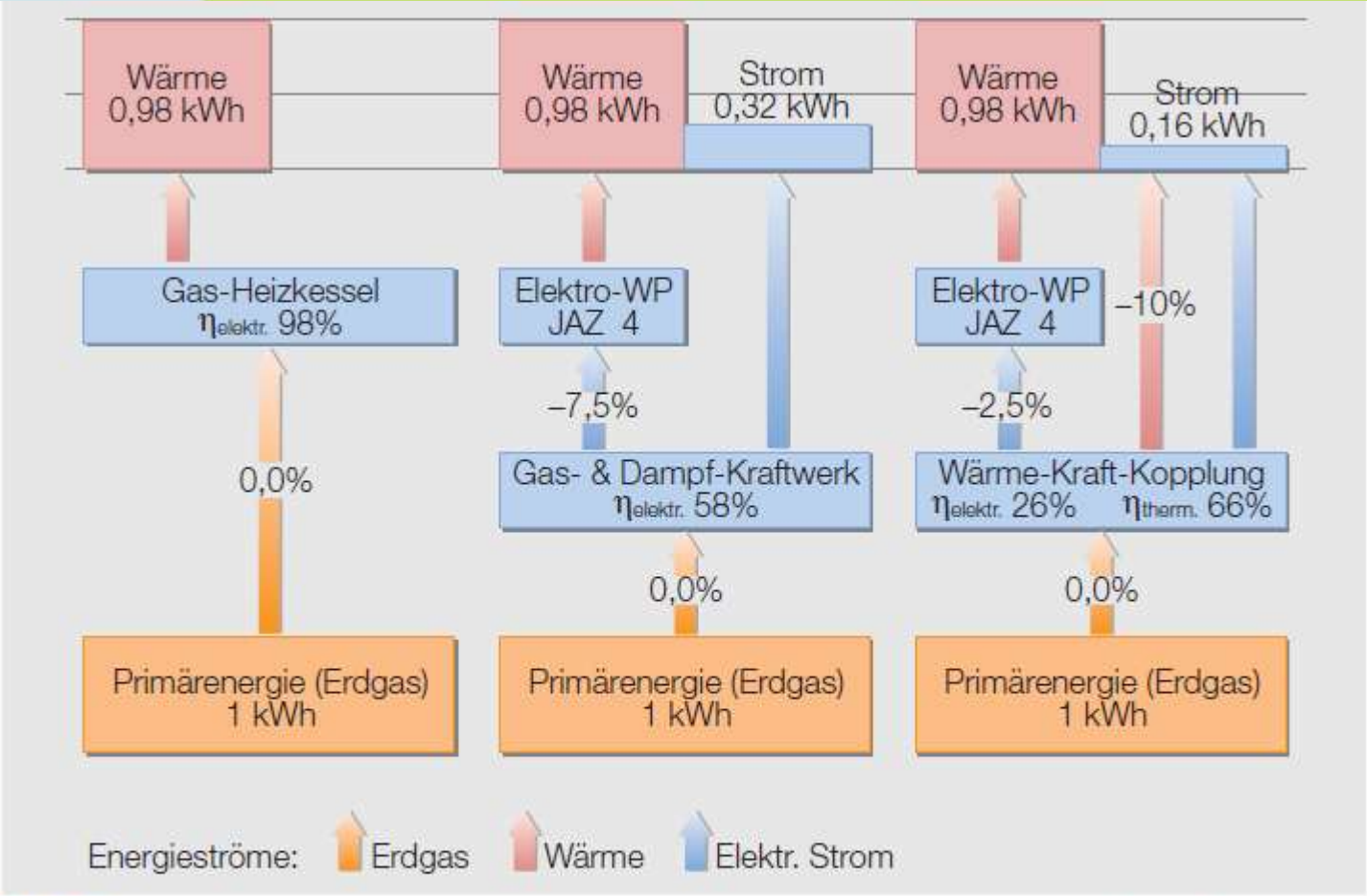
Combined Cycle Power Plant




Substition of domestic fuel oil by heat pumps

Power

# Gaspower (Combined Cycle) vs small CHP (I) – comparison of surplus electricity production




(Source: VSE/electrosuisse, May 2012)

Comparison of overall efficiency for using gas to produce electricity and domestic heat with a) Gas combined cycle plant plus heat pump, c) small CHP with heat pump

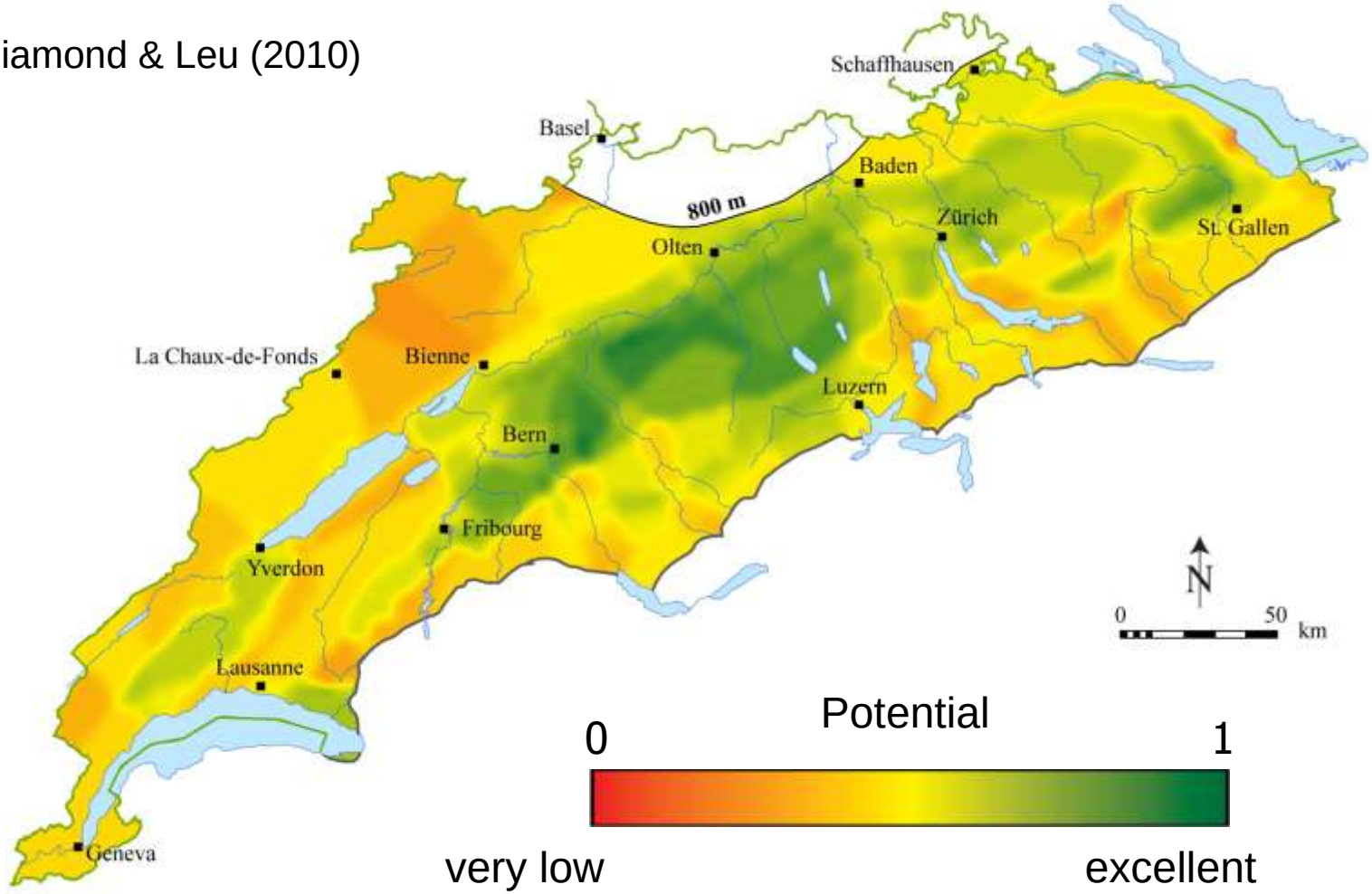
# Potential of a «CO2-neutral» use of domestic heating oil and gas in Switzerland – Combined Cycle Strategy

| Current energy consumption, source | Heat supply [TWh] | Surplus electricity supply [TWh] |
|---|---|---|
| Gas | 32 | 0 |
| Heating oil | 55 | 0 |
| total | 87 | 0 |
| | | |
| Combined Cycle and Heat Pumps | 87 | **33** |
| Future loss of electricity from Nuclear Plants | | **25-26** |

(Source: VSE/electrosuisse, May 2012)

# Preliminary findings on potential $CO_2$ storage in Switzerland

Chevalier, Diamond & Leu (2010)



# The challenges of the New Swiss Energy Policy in numbers – how easy will it be?

| | 2009 | 2050 | „Challenge“ | |
|---|---|---|---|---|
| Final energy demand (PJ) | 813 | 493 | ≈ -1/3 | ≈ |
| Final energy supply* „new renewables“(PJ) | 52 | 96 | ≈ +85% | √ |
| Savings potential of private households (PJ) | 240 | 127 | ≈ -50% | √ |
| Savings potential of fossil fuels in transportation (PJ) | 238 | 117 | ≈ -50% | √ |
| Electricity demand (TWh) | 58 | 56.5 | ≈ stabilization | ? |
| Renewable power supply** (TWh) | <1 | 22.6 | > +2000% | ≈ |

* Without electricity

** Without hydro power

Expected growth until 2050:
Economy: +40%
Population: from 8 to 9 Mio.

# Accelerating Efficiency Development in Endenergy Use – New Energy Policy (May 2012)

- Increase efficiency improvement rate of Switzerland to 2%/a
  - up by a factor of ca. 3 as compared to the past.
  - i.e. further weakening of coupling between energy and economic growth
  - i.e. doubling energy productivity by 2050
- Stabiliziation of electricity consumption after 2020 means
  - Reducing growth of electricity demand
    - below economic growth and
    - after 2020 revert trend
  - Past growth: ca. 1.3% (past 20 year average) i.e. equal or bigger than economic growth.
  - Target: after 2020 efficiency gains must compensate for increase in demand by economic and population growth.

# Energy Research – «Coordinated Action Plan» (BFE. June 11, 2012)

- **Ausbau der Forschungskapazitäten im Bereich Energieforschung**
- ETH-Bereich, Universitäten, Fachhochschulen

- **Aufbau von Kompetenzzentren**
- Priorität 1– Effizienztechnologien
- – Netze und ihre Komponenten, Energiesysteme
- – Strom- und Wärmespeicherung
- – Strombereitstellung (PV plus ein weiteres Kompetenzzentrum)
- – Ökonomie, Recht, Verhalten
- Priorität 2– Effiziente Konzepte, Prozesse, Komponenten in Mobilität und Industrie
- – Biomasse
- Priorität 3– Chemische Energiespeicher
- – Effiziente industrielle Prozesse

- **Kompetitive Fördermittel für Forschungsprojekte** (KTI)

- **Nutzung der Förderaktivitäten des SNF** (NFP, NCCR, Förderprof.)

# Next steps

- Workgroup results from Swiss Administration (for all modules) are becoming available stepwise
  - revised CHP potential, revised hydro power potential. Studies on electrical grid and refurbishment/extension needs etc.)
- Sept. 14, 2012: New energy policy (and corresponding new legislation) submitted for public consultation
- Winter 2012/2013: Discussion and decisions in Parliament
- In addition: numerous studies by trade associations, NGOs etc.

# Thank you for your attention!