SCCER SoE

Energiewende
Nationales Forschungsprogramm NFP 70

# Annual Conference 2015

## Challenges and prospects of HydroPower and Deep Geothermal electricity production in Switzerland

Neuchâtel, September 10-11, 2015

Prof. Domenico Giardini
Head, SCCER-SoE

In cooperation with the CTI

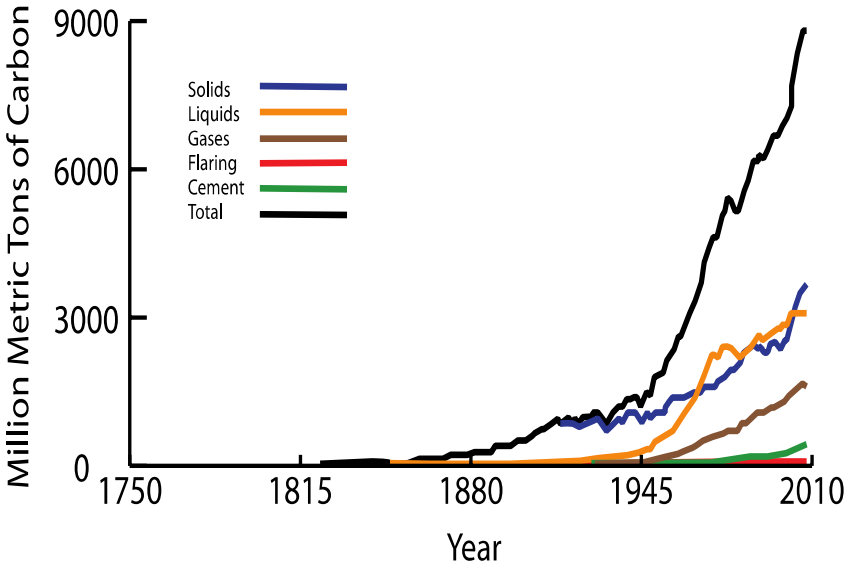
Energy
Swiss Competence Centers for Energy Research

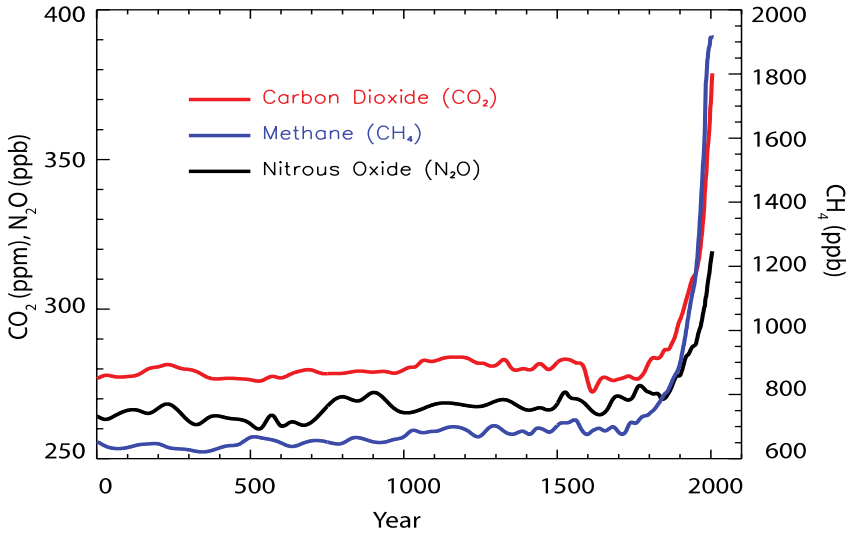
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

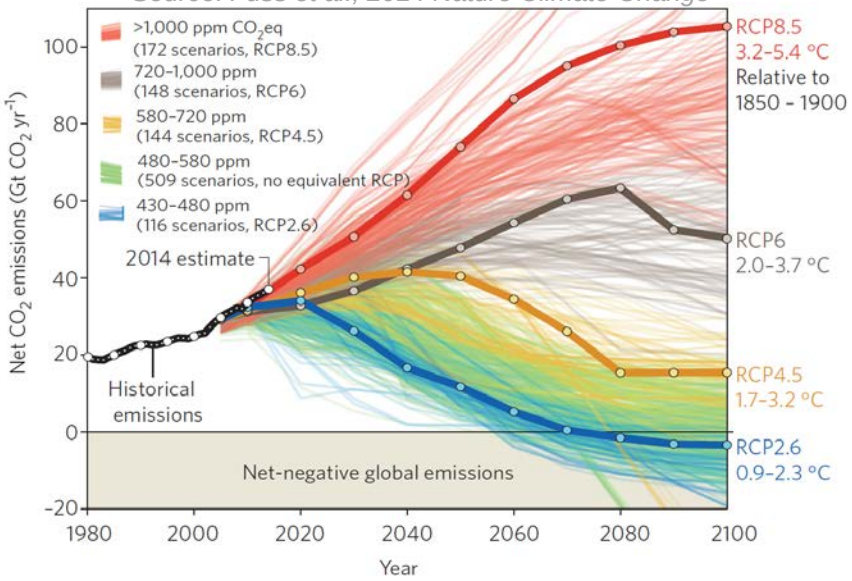
Commission for Technology and Innovation CTI

# $CO_2$ emissions and GHG atmospheric concentrations …



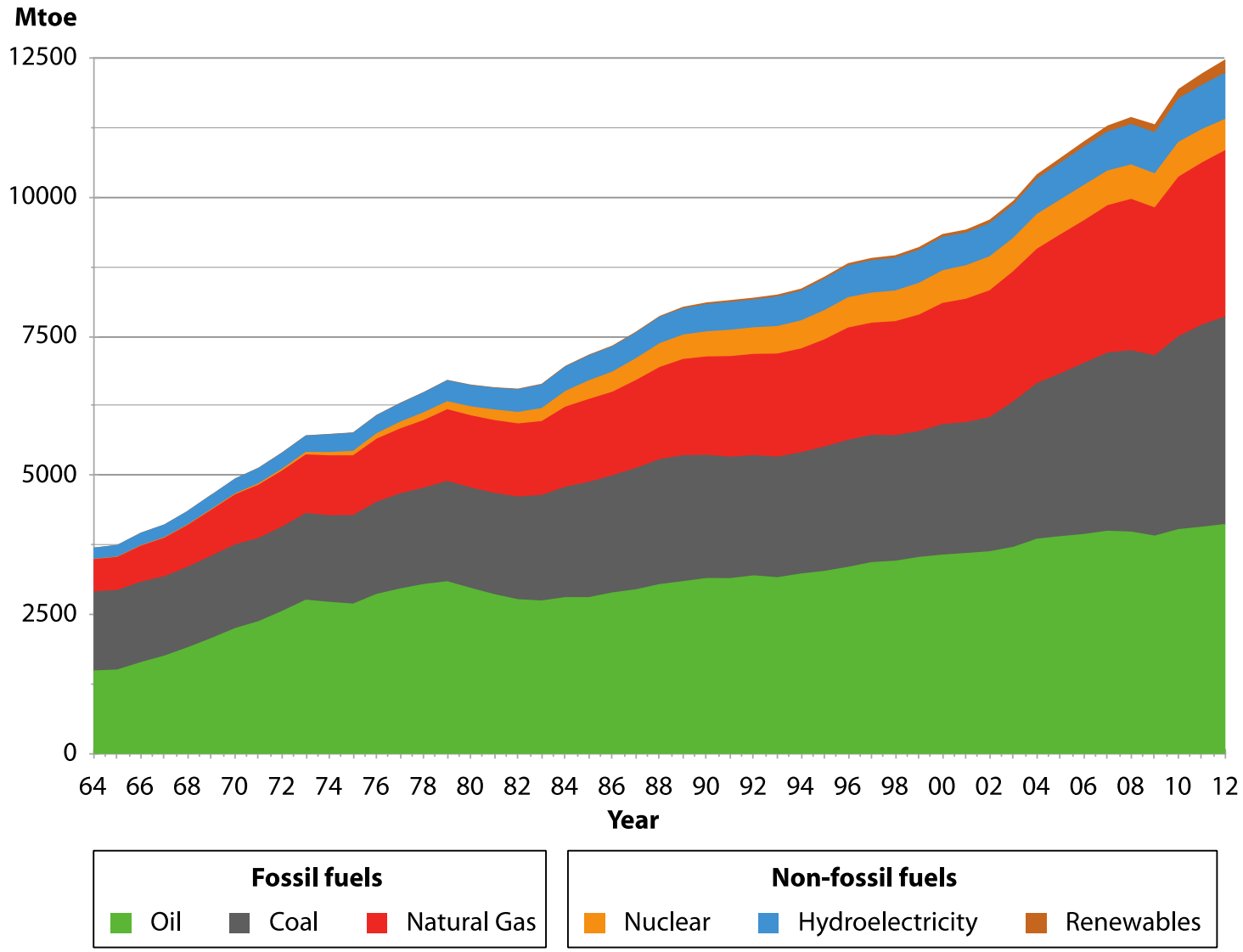




Source: Fuss et al., 2014 Nature Climate Change




… and projected temperature increase

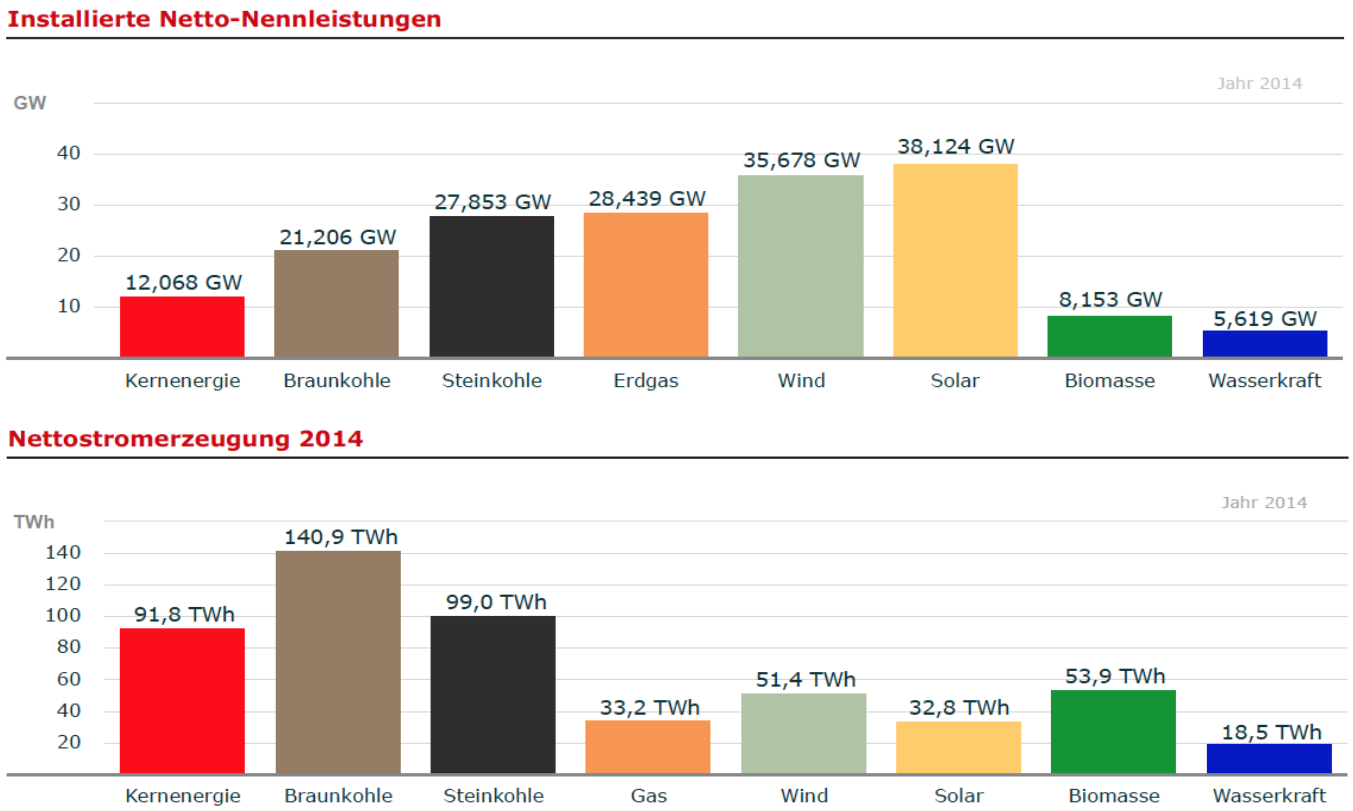
# World Energy Consumption



# The new renewables' challenge

- ✓ Low efficiency → 10-20%
- ✓ Still more expensive than fossils (4-20 times)
- ✓ Stochastic: Solar-Power, Wind-Power
  - Intermittent
  - Every MW installed must be matched by storage (i.e. hydro), other technologies (i.e. gas), or trade
- ✓ Band-electricity:
  - Geothermal: so far successful only in volcanic areas
  - Biomass/biofuels: higher efficiency, but so far successful mostly with primary agricultural production

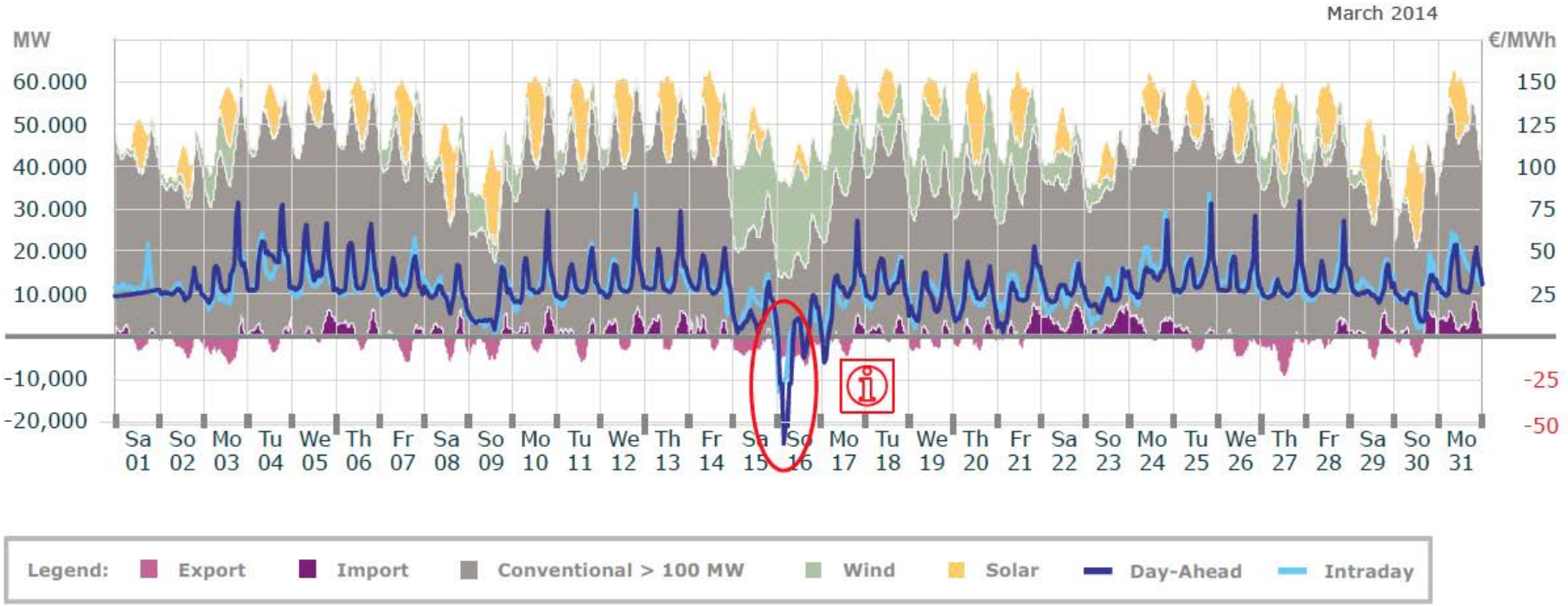
# Germany: electricity production 2014




- ✓ Production: 18% nuclear, 52% fossils, 30% renewables
- ✓ Utilization/efficiency: nuclear and biomass high, wind and solar low (17%, 11%)
- ✓ Export: 38 TWh/yr and growing

*Source: Fraunhofer ISE, Germany, 2014*

# Germany: electricity production 2014



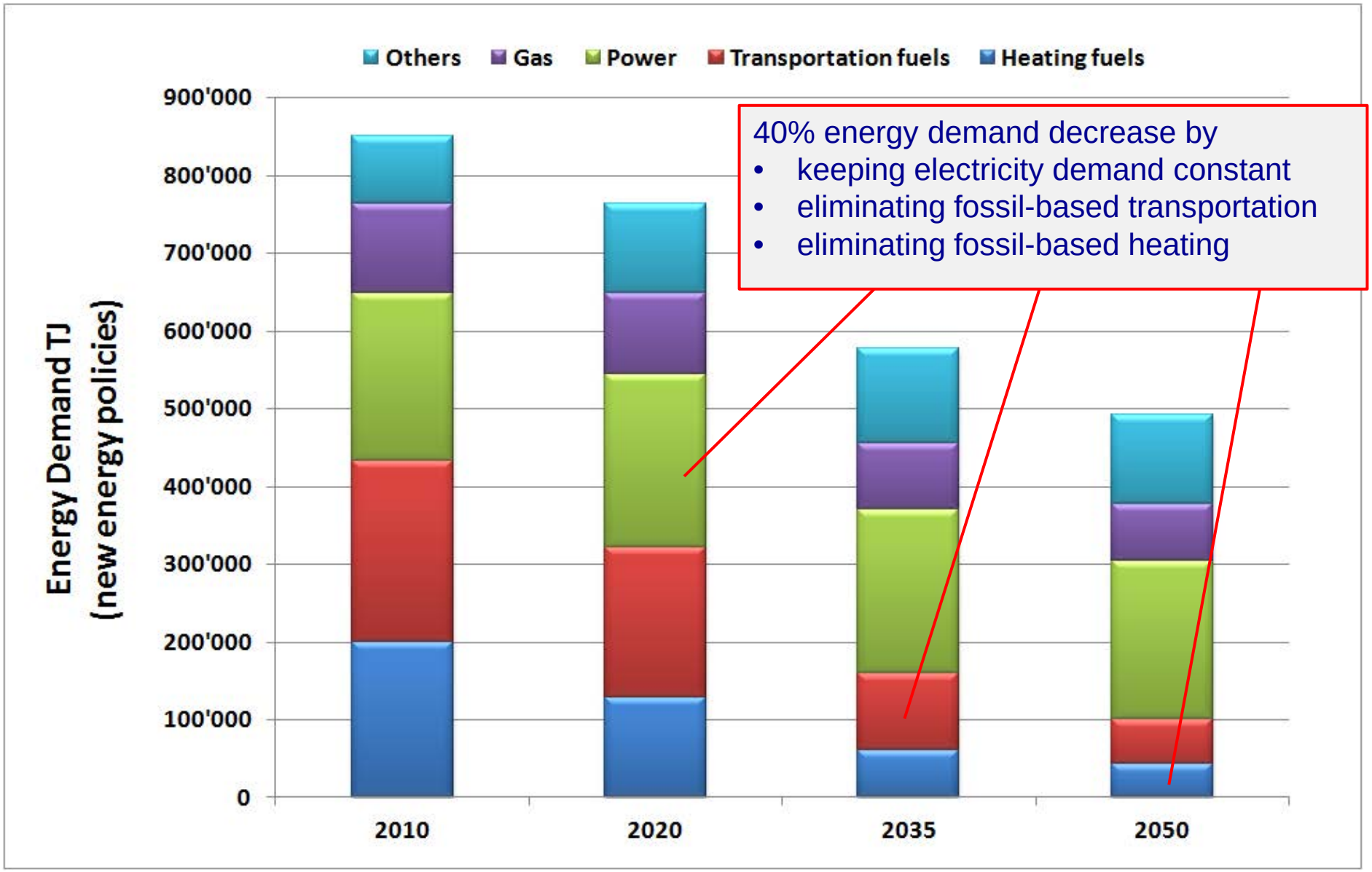

- ✓ Daily and weekly cycles
- ✓ Increasing role of intermittent SP and WP
- ✓ Spot-prices: day-ahead and intraday (15 min updates)
- ✓ Increasing and longer episodes of over-production and negative electricity spot-prices (over 4 combined days in 2014)

*Source: Fraunhofer ISE, Germany, 2014*

# Decreasing push for new renewable energy

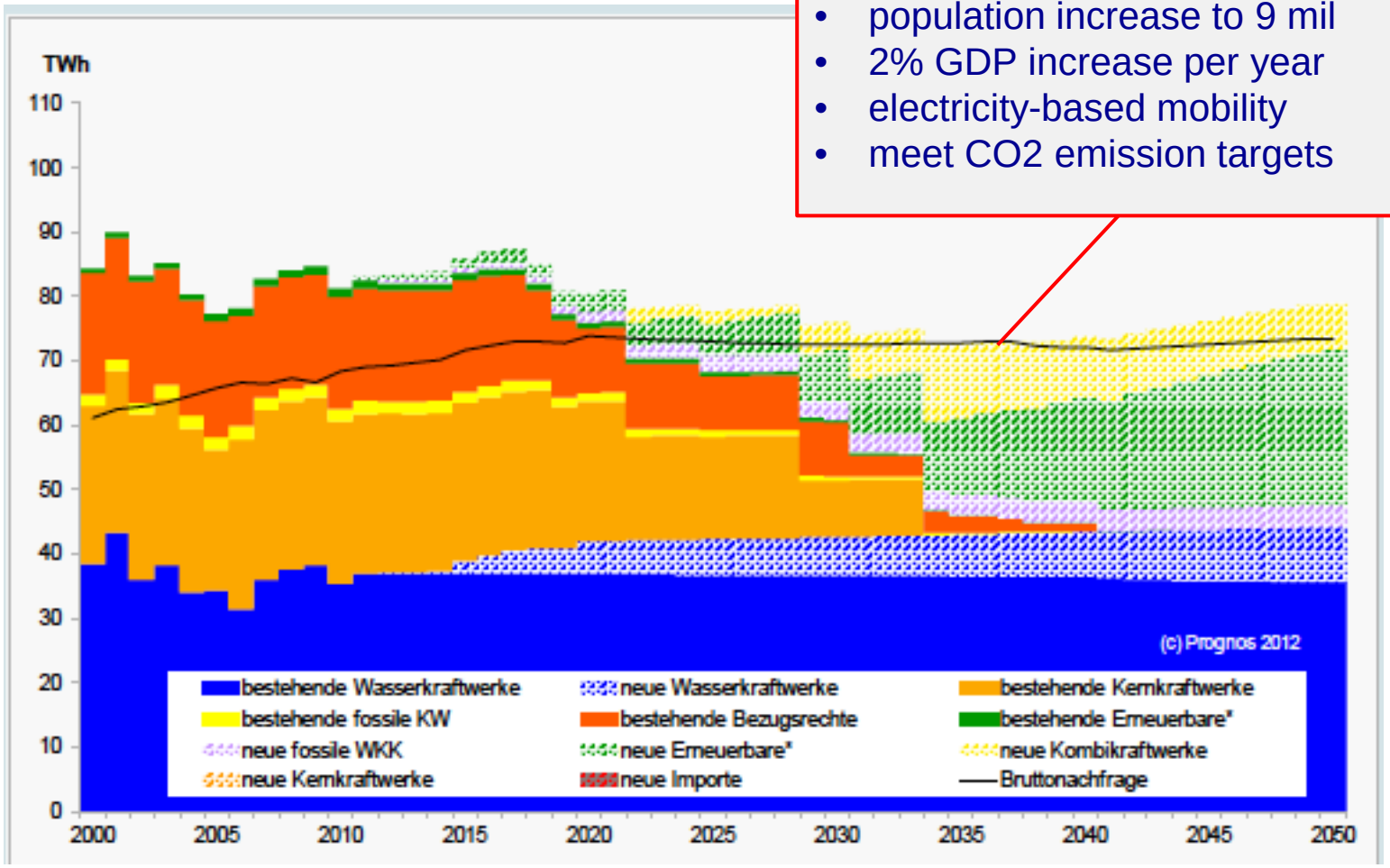
- ✓ According to the IEA, the world is falling behind in every indicator and technology required to keep atmosphere warming within 2° C
- ✓ Solar-Power currently supplies less than 1% of global electricity; in Germany, the largest SP producer in the world, PV installation decreased for the 4th year and half of the PV workers have been laid off
- ✓ The only commercial-scale coal-fired power plant equipped with CO2 capture opened in 2014 in Canada
- ✓ The increase in global energy demand will not stop → 20% of households in India do not have yet electricity
- ✓ Global oil consumption stands at 90 million barrels per day; oil price is now below 40 US$ per barrel and still decreasing
- ✓ In 2014, global investments declined for the 4th year, to 250 B$, and venture capital investments were only 25% of the 2011 level, at 1 B$
- ✓ The US/DOE budget for energy research is 2% of the federal R&D budget

# Swiss ES2050: energy demand

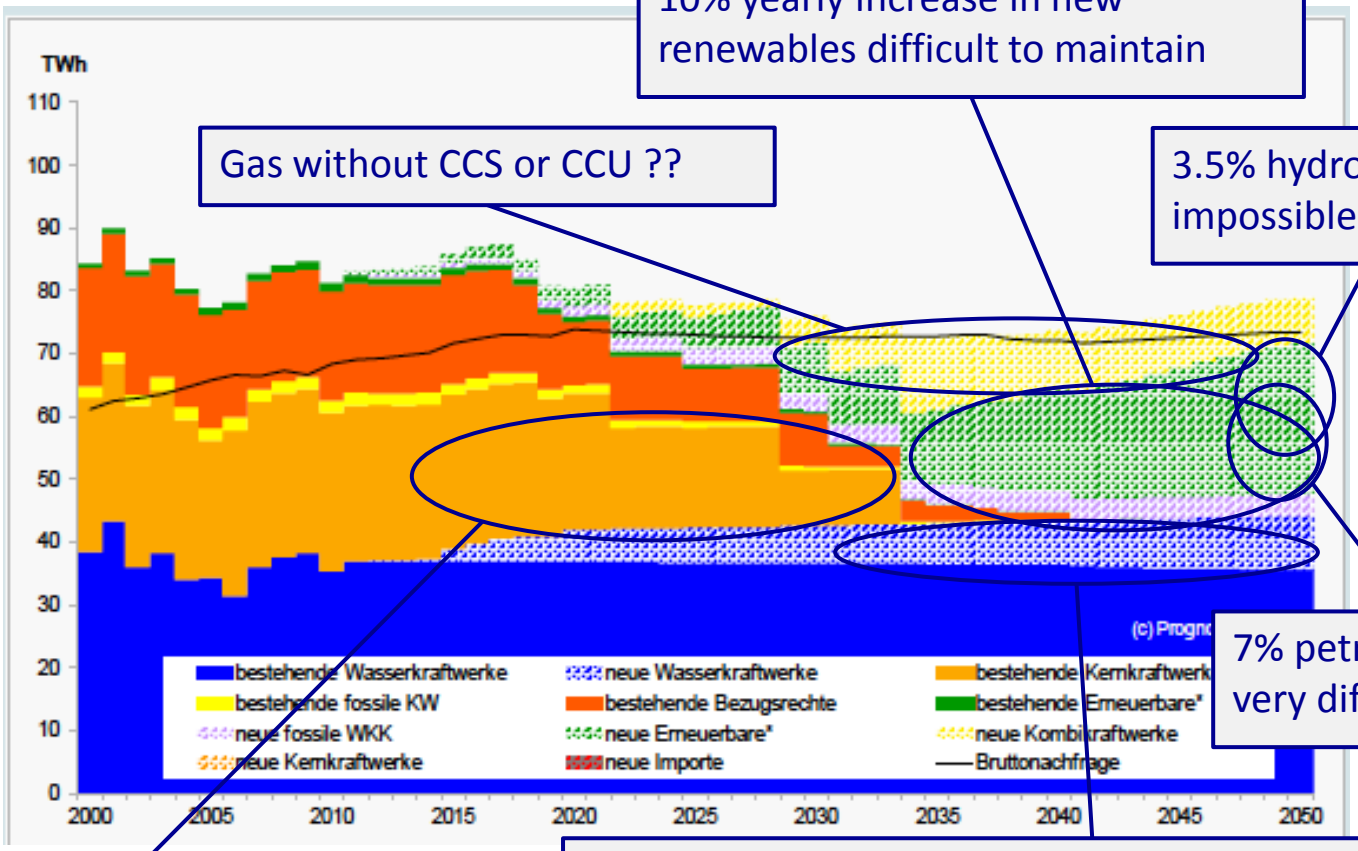


# Swiss ES2050: electricity demand

Constant electricity demand with
- population increase to 9 mil
- 2% GDP increase per year
- electricity-based mobility
- meet CO2 emission targets



# Swiss ES2050: supply of electricity




10% yearly increase in new renewables difficult to maintain

Gas without CCS or CCU ??

3.5% hydrothermal impossible

7% petrothermal very difficult

Global nuclear industry is very vulnerable and would not survive another Fukushima

- We don't know what water we will have in 2050
- Market conditions are very unpredictable and industry today is unable/unwilling to invest for long-term M&O and new large/small HPP

# Electricity supply

The SCCER-SoE was initiated on November 1, 2013, to respond to three questions posed by the Bundesrat and Parliament for the supply of band electricity:

1) can we extract safely the deep geothermal heat and produce at competitive costs a substantial portion of the national electricity supply, covering up to 5-10% of the national baseload supply ?

2) is the geological capture of CO2 a viable measure to enable carbon-free generation of electricity from hydrocarbon resources ?

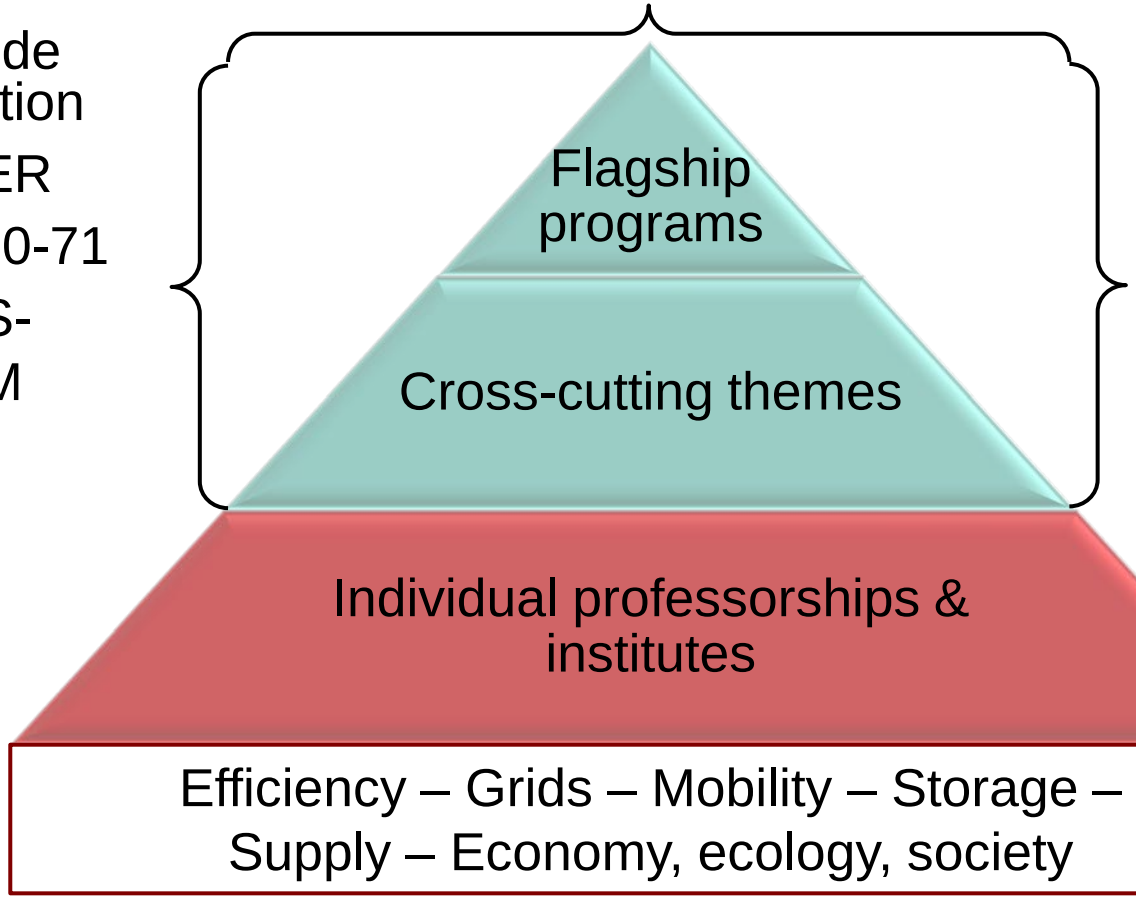
3) can we increase (i.e. by 10%) the present hydropower electricity production under changing demand, climate and operating conditions ?

# Energy Research in Switzerland

EU and global coordination:
H2020, IEA, EERA, ERA-Net, US/DOE …

Swiss-wide coordination

- ✓ SCCER
- ✓ NFP70-71
- ✓ CCES-CCEM




School-wide coordination

Energy Science Center

EPFL CEN

PAUL SCHERRER INSTITUT PSI

# Structure

- ✓ Phase I: 1.11.2013-31.12.2016
- ✓ CTI budget: 12 mln Fr
- ✓ 2 thematic WorkPackages and 3 transversal activities

**Deep Geothermal Energy & CO2 Sequestration**

WP1 Geo-energies

T1.1 Resource exploration, assessment and characterization
T1.2 Reservoir modeling and validation
T1.3 P&D for reservoir creation
T1.4 Geo-data infrastructure

**HydroPower: usage & infrastructure**

WP2 Hydropower

T2.1 Morphoclimatic controls of future HP production
T2.2 Socio-economic drivers of future HP production
T2.3 HP infrastructure adaptation
T2.4 Environmental impacts of future HP operating conditions
T2.5 Integrated simulation of HP systems operation

WP3 Innovative technologies

T3.1 Geo-energy technologies
T3.2 Hydraulic machines

WP4 Integrative activities

T4.1 Risk, safety and societal acceptance
T4.2 Global observatory of electricity resources
T4.3 SCCER-SoE modeling facility

Capacity building, Technology Transfer, Outreach

SCCER SoE

# Facts and Figures

- ✓ 13 academic and 10 cooperation partners
- ✓ Capacity building (CTI) completed by Nov 2014:
  - 42 new researchers supported by CTI, as many in-kind
  - 7 new professorships in geo-energies (ETHZ, EPFL, UniGe, UniNe)
  - Matching funds on target
  - Over 50 PhDs already funded
  - Overall, about 200 new researchers/PhD/professors
- ✓ Innovation roadmaps for DGE, HP, CCS
- ✓ A new R&D mechanism, for true swiss-wide cooperation, national coordination and integration
- ✓ Strong alignment with SFOE (P&D)
- ✓ A shift towards “big science”: NRP, KTI clusters, H2020
- ✓ Evaluation 2014 positive, funding 2015 confirmed
- ✓ Strong EU presence (Hyperbole, Strest, Consent, EPOS-IP, NERA-2, ...)

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich
eawag aquatic research
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
unine UNIVERSITÉ DE NEUCHÂTEL
Hes·so
PAUL SCHERRER INSTITUT PSI
Lucerne University of Applied Sciences and Arts HOCHSCHULE LUZERN
UNIVERSITÉ DE GENÈVE
HSR HOCHSCHULE FÜR TECHNIK RAPPERSWIL FHO Fachhochschule Ostschweiz
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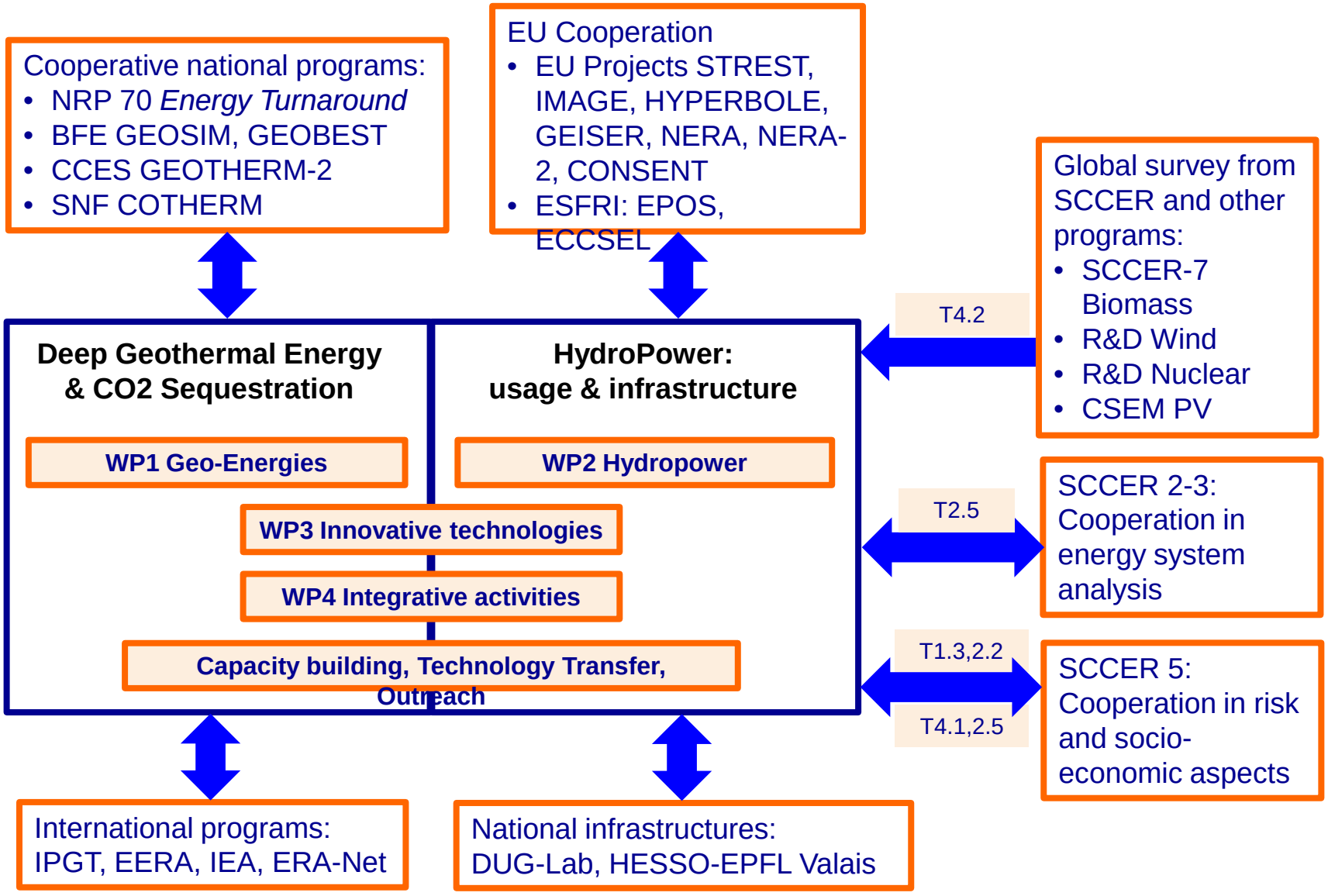
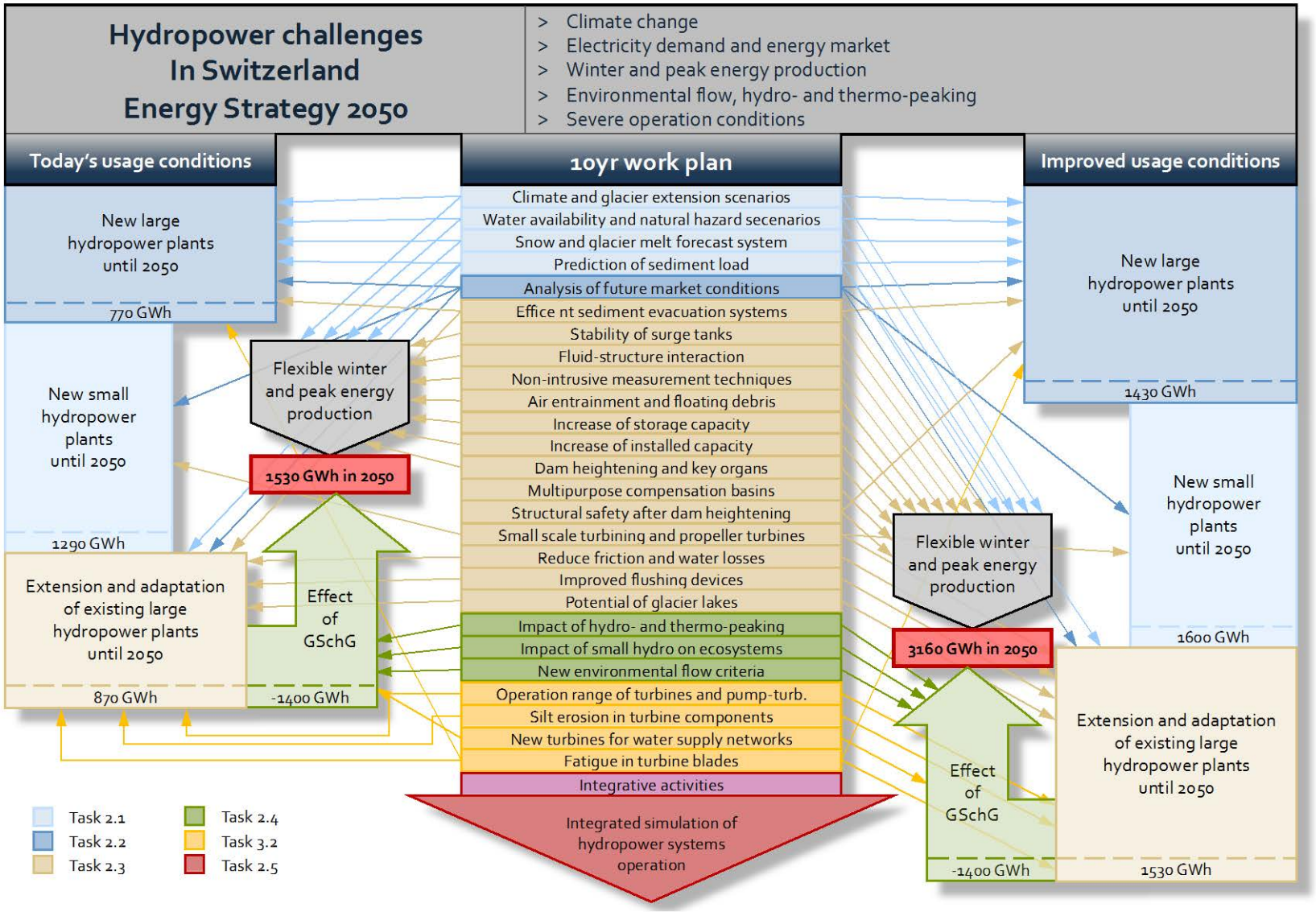
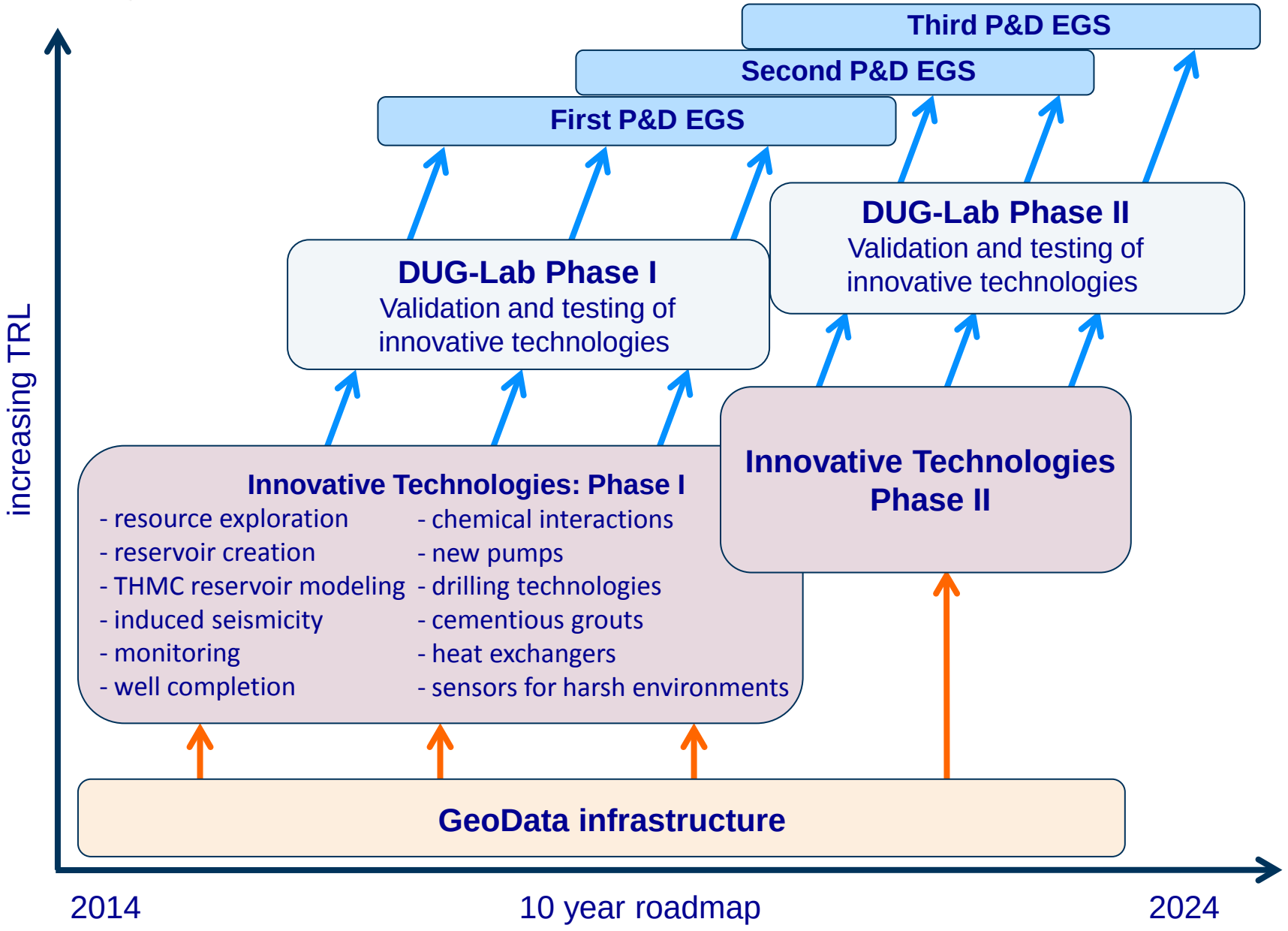
# Integration across programs



# Roadmap Hydropower 2014



# Roadmap DGE 2014



# Goal of the Annual Conference 2015

- ✓ Review R&D progress
- ✓ Integrate energy research across Switzerland
- ✓ Build common identity
- ✓ Increase drive towards solution-oriented breakthrough
- ✓ Involve and exchange with stakeholders
- ✓ Identify challenges and prospects
- ✓ Confirm our roadmaps
- ✓ Prepare 2015 evaluation
- ✓ Plan 2017-2020 phase