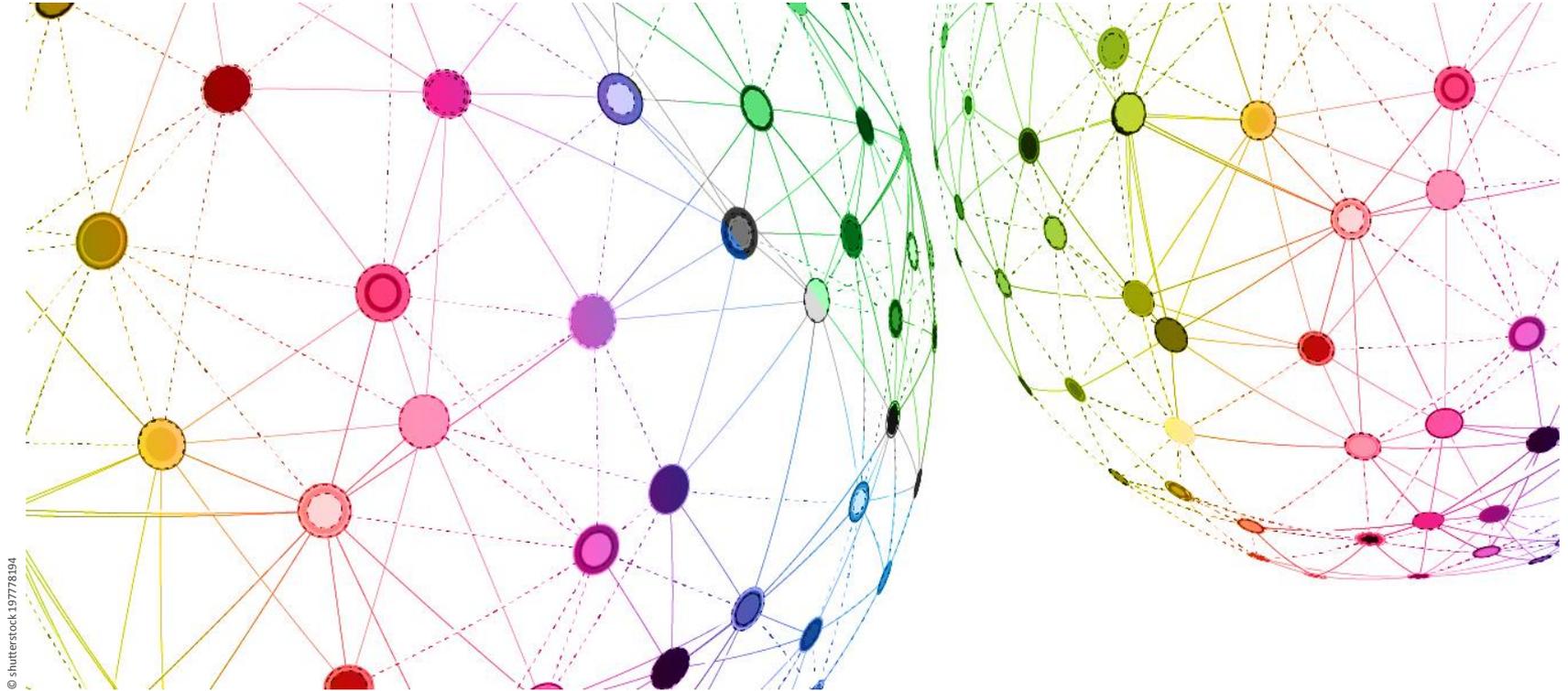




Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Office fédéral de l'énergie OFEN
Ufficio federale dell'energia UFE
Swiss Federal Office of Energy SFOE



Geothermal Energy in Switzerland – Recent policy developments



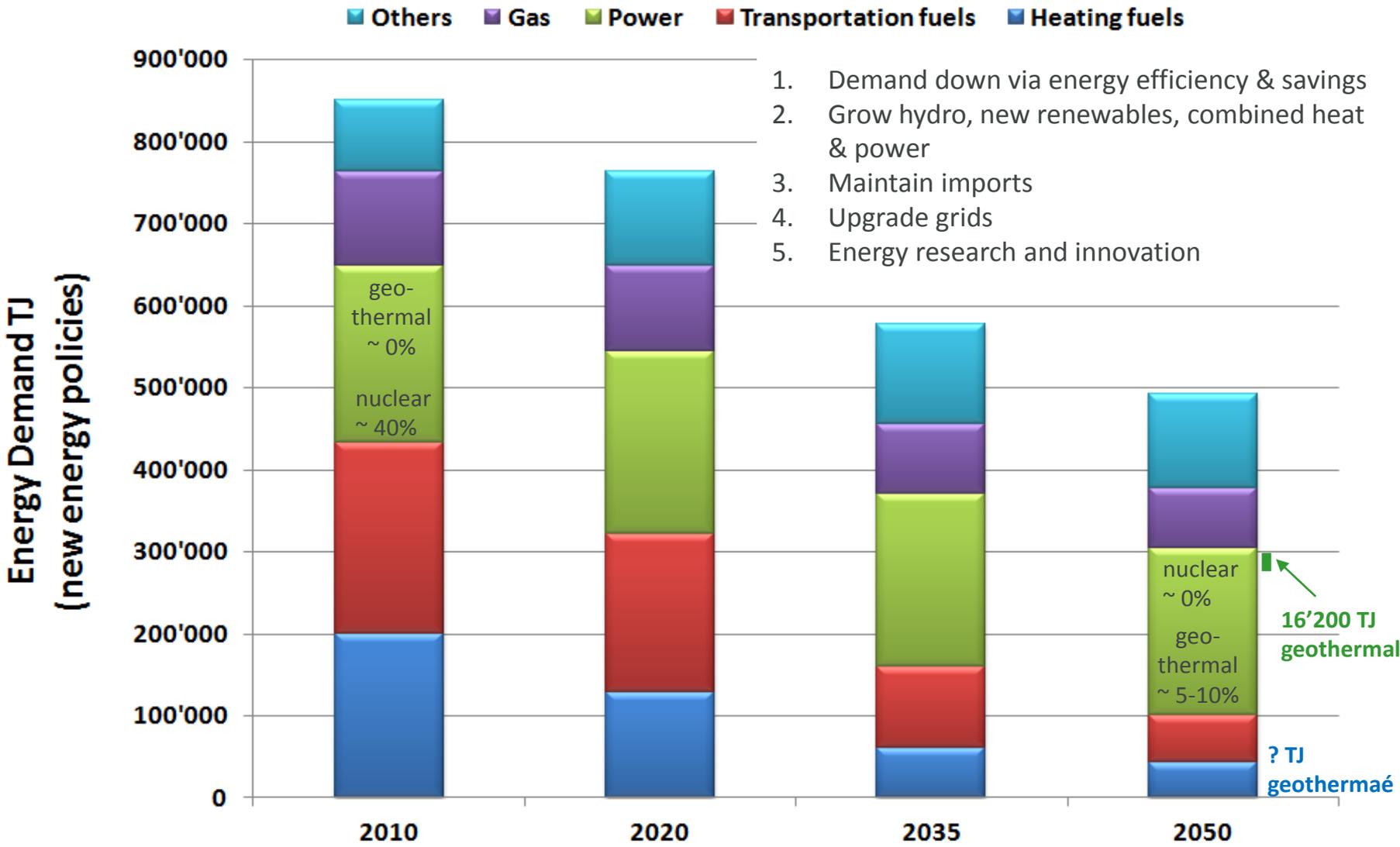
KEY FOR SUPPORT FOR GEOTHERMAL: REVISIONS OF A NUMBER OF ACTS (ENERGY, CO₂, NUCLEAR ENERGY,)

- June 2011: Federal Council (government) with approval of parliament decides to develop a new energy strategy
 - Trigger: Fukushima plus convergent trends (cost reduction renewables, climate change, political instability in Middle East and North Africa...)
 - Sept 2013: Gov't sends bills to parliament
 - Features: exit nuclear when no longer technically safe, up efficiency & savings, decrease fossils, increase renewables
 - 30. Sep 2016: both chambers approve the Acts (optional referendum if 50'000 signatures are collected within 3 months against the Acts)
 - Nationalist conservatives successfully launched collection of 68'000 signatures
- > 21 May 2017 Swiss population will vote

- In parallel, a people's initiative (100'000 signatures) called for the shut-down of nuclear after 45 years of operation
- 45 years means that 3 of 5 plants to be shut in by the end of 2017
- But, Swiss voters rejected «accelerated» phase-out vs. «orderly» phase-out on 27 November 2016 with a solid majority of 54%.

- In parallel, 1 February 2017: Federal Administration launches the consultation process of ordinances (implementation rules of policy support measures)
- Subject to 21 May 2017 results: all will enter into force on 1 January 2018

SWITZERLAND'S ENERGY STRATEGY 2050: DEEP GEOTHERMAL ENERGY HAS A ROLE TO PLAY



1. Demand down via energy efficiency & savings
2. Grow hydro, new renewables, combined heat & power
3. Maintain imports
4. Upgrade grids
5. Energy research and innovation

Note: kerosene excluded

Source: Prognos, 2011 and Swiss Federal Office of Energy



HEADLINES: 1ST SET OF MEASURES TO IMPLEMENT SWITZERLAND'S ENERGY STRATEGY 2050

No new nuclear (ea. of the 5 existing ones [24 TWh in 2015] retire at end of their technical/safe lifetime)

New renewables (excl. hydro) targets for electricity production:

2015: 2.8 TWh; 2020: 4.4 TWh
2035: 11.4 TWh

Energy consumption relative to the year 2000:

2000: 854 970 TJ, 2015: 838 360 TJ
2020: -16% and 2035: -43% (rel. 2000)

Of which electricity consumption:

2000: 52.4 TWh, 2015: 58.2 TWh
2020: -3% and 2035: -13% (rel. 2000)

CO₂ targets remain unchanged:

-20% by 2020 rel. to 1990

Revision of CO₂-Act has been initiated
New target: -50% by 2030 rel. to 1990
-30% domestic and -20% foreign

Geothermal energy policy measures (target enforcement date: 1.1.2018)

Geothermal guarantee scheme (until 2031)

Increase coverage to 60% of total sunk subsurface development cost, if the subsurface does not live up to expectations

Exploration support scheme (until 2031)

Max. 60% towards pre-spud exploration activity and first well to confirm the presence of a reservoir

Feed-in tariffs (15 years) for projects with first power before 2024

Support for direct use geothermal energy (to 2025)

CHF 30 mln p.a. for upstream exploration and development activities that lead to uptake of geothermal energy for direct heating

Geothermal in the “national interest”

Cantons should accelerate planning and permitting



FINANCING POLICY MEASURES

Energy Act Art. 33 Contributions to exploration and Geothermal guarantees

- Program financed by a max. CHF 1 per MWh of electricity transmitted via the national high voltage grid (~ 60 TWh) -> at most CHF 60 mln per year

Energy Act Art. 19 Feed-in tariffs for geothermal energy

Installed Capacity	Hydrothermal (CHF / MWh)	Enhanced/Engineered Geothermal Systems (CHF / MWh)
≤5 MW	400.0	475.0
≤10 MW	360.0	435.0
≤20 MW	280.0	355.0
>20 MW	227.0	302.0

Average retail / consumer end price (generation + transmission + policy support): CHF 200 / MWh
Average annual consumption 4 person single family home: ~ 5 MWh
Cap of all grid surcharge available for all RES programs: CHF 23 / MWh



SWISS FEDERAL DISPATCH ON RESEARCH AND INNOVATION (PERIOD 2017-2021)

- Dispatch: policy instrument that governs funding of federally sponsored research and innovation
- Energy research is a pillar in Switzerland's Energy Strategy 2050 (from fundamental to pilot+demonstration) & ~CHF 300 mln p.a.:
 - 2013: Geothermal CHF 9.4 mln.
 - 2014: Geothermal CHF 11.5 mln.
 - 2015 and later: no statistics available, but strong upward trend
 - Swiss Federal Office of Energy is sole programmatic funding agent, with applied research funding levels decreasing < CHF 1 mln but piloting and demonstration up (~ 3 mln)
- Key for geothermal energy research and development:
Swiss Competence Center for Energy Research – Supply of Electricity (SCCER-SoE) operative since 2013



TOPICS COVERED BY THE SCCER-SOE

WP1 Geo-energies: Deep Geothermal Energy

T1.1 Resource exploration and characterization

T1.2 Reservoir stimulation and engineering

T1.3 Hydrothermal resources and geofluids: exploitation and storage

T1.4 Geo-data infrastructure and analysis

WP3 Innovation agenda

T3.1 Innovative technologies

T3.2 Computational energy innovation

WP4 Future supply of electricity

T4.1 Risk, safety and societal acceptance

T4.2 Global observatory of electricity resources

T4.3 Socio-economic-political drivers

T4.4 Joint SCCER Scenario & Modeling Initiative

WP2 deals
with
hydropower

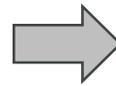


CHALLENGES OF STIMULATION

BENOIT VALLEY (UNI NEUCHÂTEL) & BRICE LECAMPION (ÉCOLE POLYTECHNIQUE DE LAUSANNE)

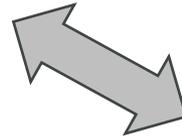
From science to engineering

What processes are activated during stimulation ?

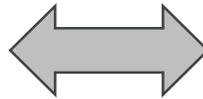


How to **control** what processes are activated during stimulation ?

Which processes are most efficient for reservoir creation ?

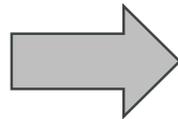


How to measure reservoir parameters at depth ?



What parameter is **required** to make engineering decisions ?
To what precision ?

New modeling tools and techniques



We need to develop stimulation **design workflow** for deep geothermal reservoirs, applicable at the different **project stage** and including **uncertainty / risk analyses framework**.



POLICY RELEVANT OUTCOMES RELATED TO INDUCED SEISMICITY FROM:



Government Treaty of USA, Iceland, Switzerland, Australia and New Zealand: Government-Industry Platform to coordinate and pursue joint research and innovation via Working Groups
Stefan Wieder (CH) is lead of the WG Induced Seismicity



Under the auspices of the International Energy Agency IEA: Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Korea, Switzerland, UK and USA; European Commission; Spanish Geothermal Technology Platform (Geoplat) and ORMAT Technologies, Inc
Topic lead: Induced Seismicity (Chris Bromley, New Zealand)



IEA: Australia, USA, Norway, the Netherlands, the European Commission, Switzerland
Workstream on unconventional resources (fracking, imaging, modeling, understanding the subsurface)



Europe (sponsored by the European Commission): 16 geothermal energy research and innovation program owners and managers from 13 countries and their regions work on coordinating research and innovation – and also on induced seismicity



THANK YOU FOR LISTENING

After 3 years of focused research and innovation activities, first results show promise: field pilots will be the next step! Watch this space!

