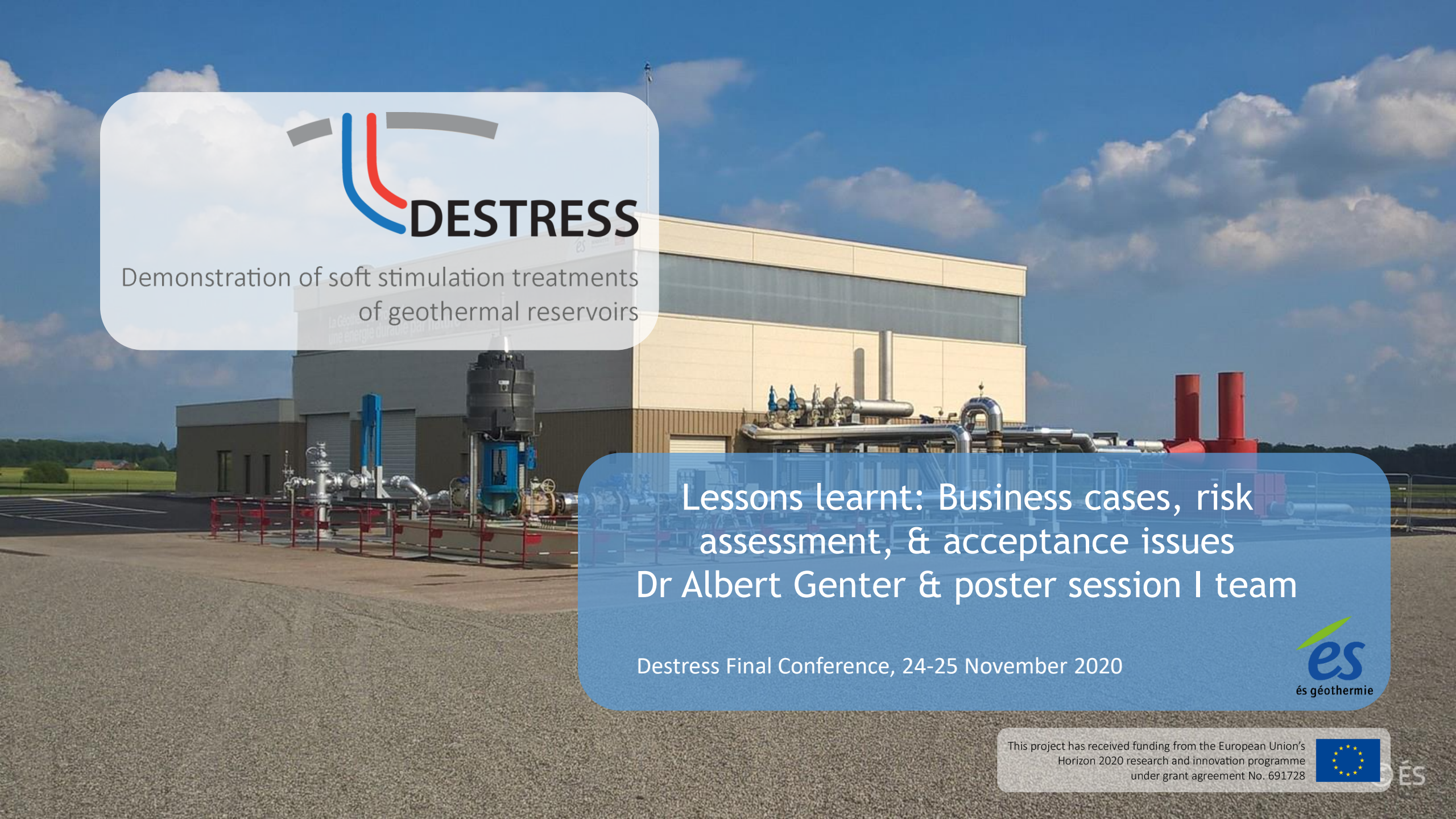


DESTRESS

Demonstration of soft stimulation treatments of geothermal reservoirs

Lessons learnt: Business cases, risk assessment, & acceptance issues
Dr Albert Genter & poster session I team

Destress Final Conference, 24-25 November 2020

és géothermie

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 691728

Overview poster presentations

- **Elif Kaymakci**: "Cost accounting and business case calculation model"
- **Elif Kaymakci**: "Risk Mitigation Assessment"
- **Jan Henninges:** "Technical performance monitoring for validation and control"
- **Albert Genter**: "Regulatory framework for geothermal seismicity monitoring and insurance scheme in stimulation and operation phases"
- **Vincent Maurer**: "Synergies and standardisation: O&G / Geothermal"
- **Christofer Friberg**: "4th leg generation geothermal for smart viable cities"

Session 1

- Albert Genter
- Ernst Huenges
- Vincent Maurer
- Jan Henninges
- Christofer Friberg
- Elif Kaymakci
- Laurie-Anne Michnick
- Jerome Caudroit
- Rodrigo del Potro
- Jan-Diederik van Wees

DESTRESS presentations, the posters as well as the Final DESTRESS Report 2020:
Key messages and lessons learnt

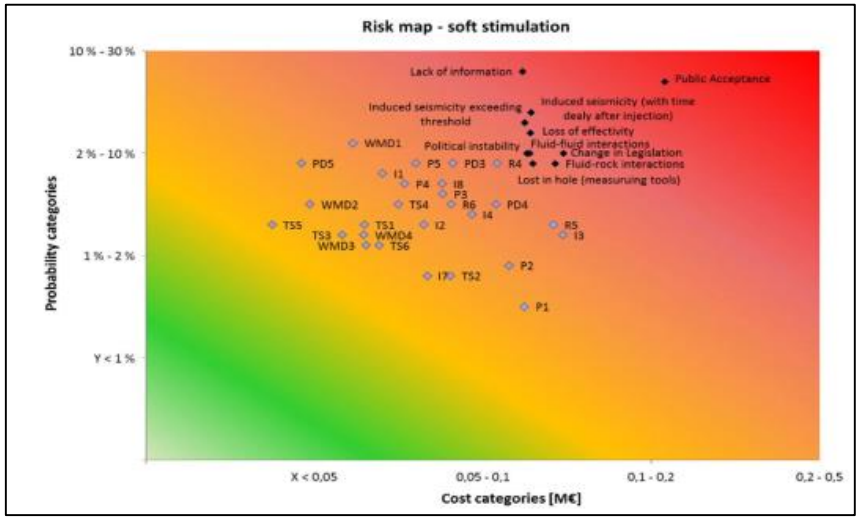
Business cases: risk maps

Key points
Integrating uncertainty information is beneficial for decision-makers
Identifying risk mitigation measures helps project developers and authorities
Publishing data of operational power plants enables further development of other techno-economic models

Final DESTRESS Report, 2020

Risk Maps

- Experiences from exploration and production sector within oil and gas industry used for cost calculation model (Monte Carlo) and for integrating uncertainty to the techno-economic evaluation
- Techno-economic evaluation is subject to biases (knowledge, experience)
- About 40 risk factors were identify and top ten risk factors were prioritized based on expert knowledge
- Public acceptance, lack of information & induced seismicity: main risk factors
- About 30 risk factors identified for the chemical stimulation planned at Mezöberény
- Need for quantitative approach not only expert



Kaymakci et al., 2020
Welter et al., 2020

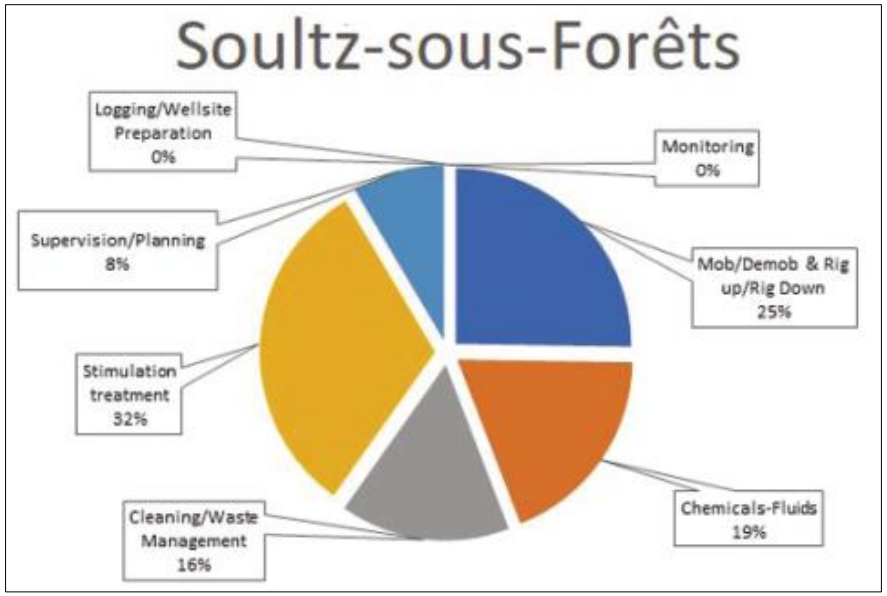
Business cases: integrated techno-economic model

Real datasets

- Stimulation costs
- Cost analysis of Rittershoffen thermal-chemical and hydraulic stimulations
- Cost analysis of Soultz GPK4 chemical stimulation during exploitation
- Pohang and Geldinganes sites have been analysed in terms of stimulation investment costs
- 30 risk factors identified for the chemical stimulation planned at Mezöberény

Challenges

- Improve the robustness of the risk factors
- Lack of relevant data from real projects
- Risk factors with high probability and high risk associated costs are prioritized



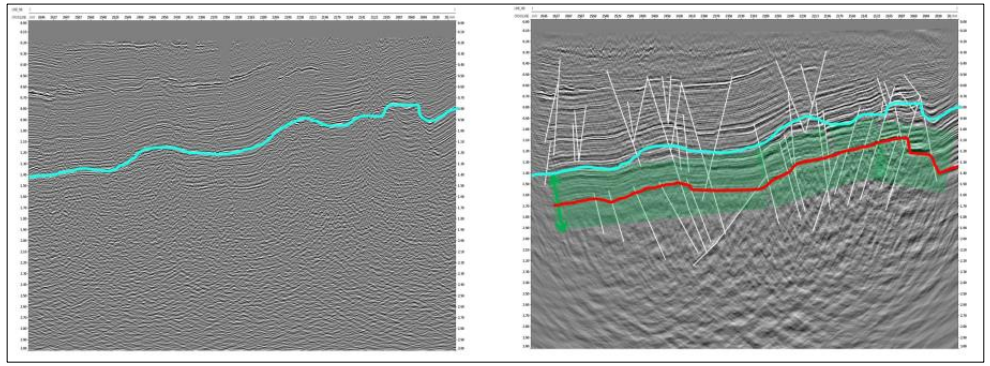
Final DESTRESS Report, 2020

Kaymakci et al., 2020
Welter et al., 2020

Business cases: innovative technologies

Reduce uncertainty and geological risk

- Synergies and transfer from oil & gas sector
- Vintage 2D versus modern 3D seismic reflection in the Upper Rhine Graben

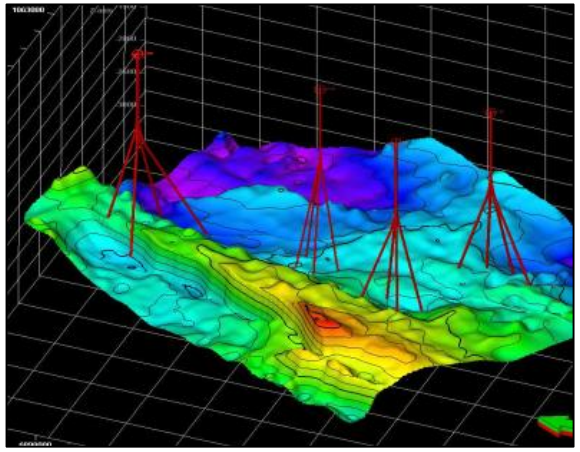


2D vintage *3D recent dataset*

Blue: Muschelkalk & Red top granite basement

Environmental monitoring with optic fiber sensing technology

- Passive monitoring to test the seismic noise correlation
- Monitor well integrity behind the casing (shallow aquifer)
- Improve velocity model of the subsurface (improve IS events location)
- High quality VSP (Vertical Seismic Profile) products at reduced cost
- Detection of induced micro-seismic events used as an antenna

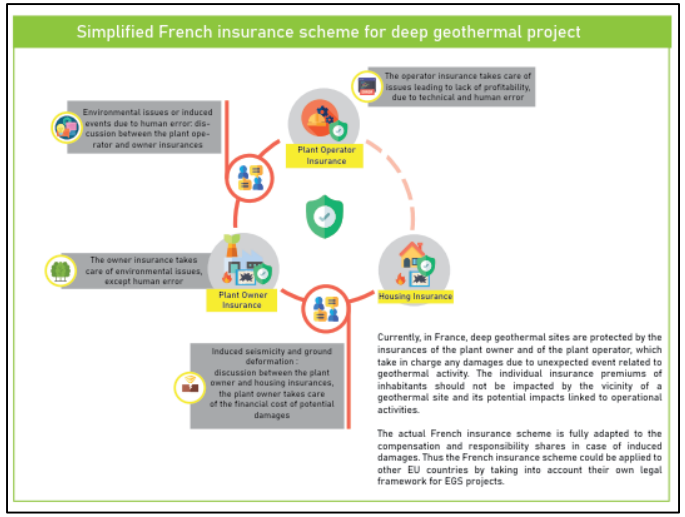


Map of the top basement in the URG

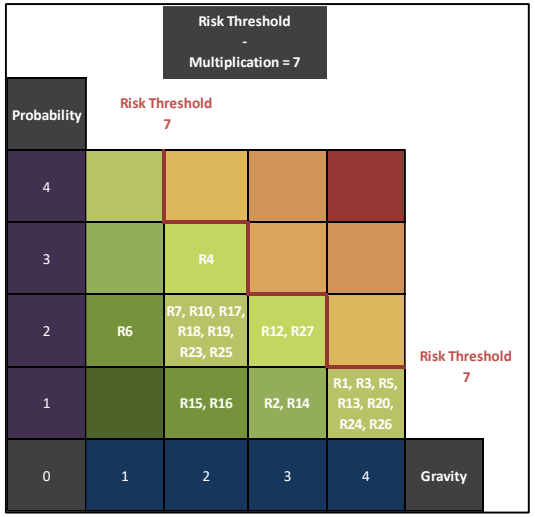
Henninges et al., 2020
Richard et al., 2020

Risk assessment: improvement of practices

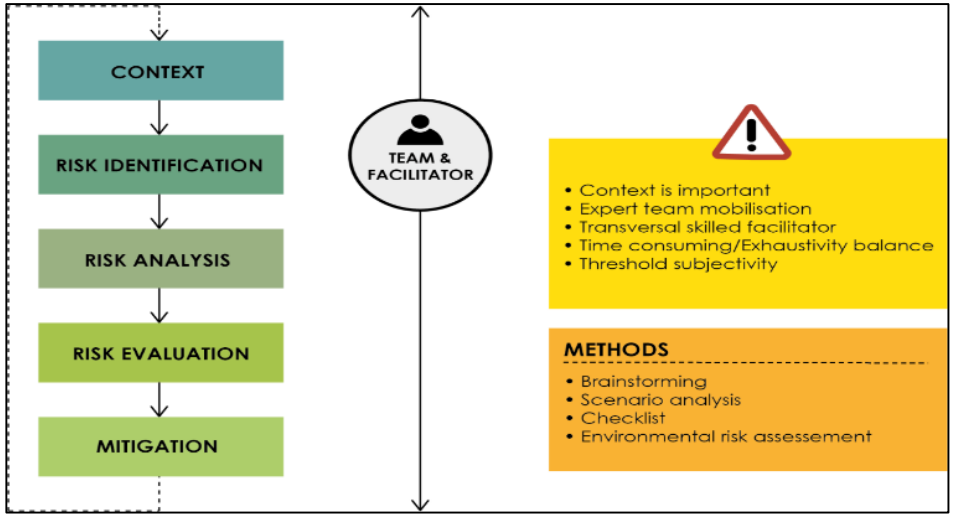
- No environmental risk analysis, no stimulation operations
- Operators must conduct more systematically risk analysis: not only technical and financial but also environmental
- Clear insurance scheme covering site operator responsibility, site owner responsibility and insurance of inhabitants living close the geothermal site



Peterschmitt et al., 2020



Hehn et al., 2020



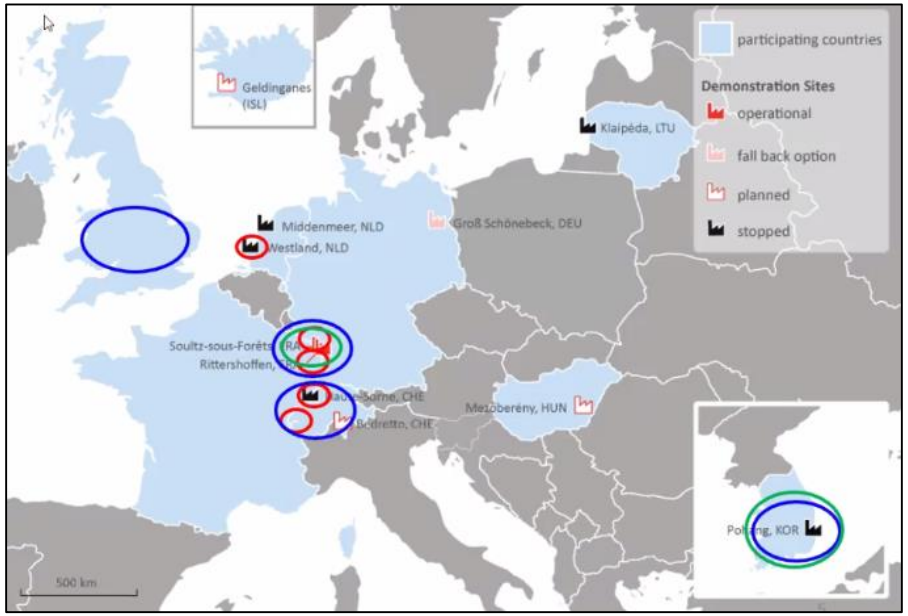
Peterschmitt et al., 2018

Risk assessment: focus on induced seismicity

- New developments of deep geothermal projects must be framed by appropriate regulatory frameworks
- Legislative framework status about deep geothermal energy is heterogeneous in Europe but seismic network and Traffic Light System are implemented
- There is a need of harmonized best practices about induced seismicity monitoring
- Dense seismic network around a geothermal site is unquestionable necessity to monitor in real time hydromechanical processes
- Most advanced regulation for Germany and France for induced seismicity monitoring.
- Clear mining rules with appropriate protocols before, during and post-drilling (e.g. 5 permanent seismological stations around the drilling site for seismic monitoring)
- Clear mining rules with appropriate protocols like PGV (Peak Ground Velocity) scale, GPS, adaptative TLS, maximum well-head pressure, reinforced seismic network during punctual stimulation (< one week) or continuous exploitation (< 3 decades), interference study between neighbouring geothermal sites, …

Acceptance 1/2

- Societal aspects is a non-technical barriers
- Several “demonstration sites” on the social item: France (Northern Alsace), Switzerland (Geneva, Haute Sorne, St Gallen), UK, Korea (Pohang)
- Various methodologies: surveys, questionnaires, focused groups, media analyses
- The results indicate that the perception of stimulated geothermal energy projects is influenced by a variety of factors:
  - **Cultural factors**: rural/urban, innovative region, the tradition of mining activities, social identity
  - **Political factors**: Interrelations between institutional politics and geothermal projects
  - **Informational factors**: how project developers interact with the public (public engagement, eco-participation, consultations)

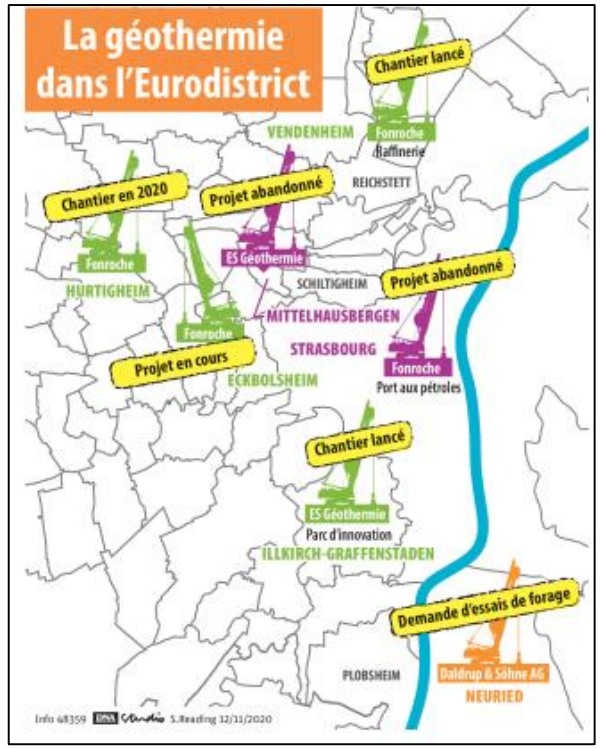


Ejderyan, 2020
Chavot et al., 2020
Serrano et al., 2020
Suheun et al., 2020
Willems et al., 2020
Final DESTRESS Report, 2020

A geothermal project must be rooted (or not) in a territory! *(Ejderyan, 2020)*
Not only technically (with MWe) but socially (discourses, practices)

Acceptance 2/2

- Mainly positive coverage in the studied areas
- Negative arguments are related to specific projects
- Reporting is driven by events
- Polarizing effects: voice form both parties with statements emphasizing risk and statements relativizing risk (e.g. on seismic risk)
- Heat and local use are crucial: we need to show the local benefit!
- Trust is very important, and thus local public utility is more trusted (Alsace)
- Bad perception and thus potential project rejection if risks seem unaddressed
- Operators and institutions must consider the project through the eyes of the local population
- Public engagement is necessary
- Co-participation or co-development is recommended
- Use social science for bringing the knowledge and communication experts for implementation



Serrano et al., 2020

Rooting a project is the key of success!

Ejderyan, 2020

Conclusions and perspectives 1/2

- The main risk factors are public acceptance, lack of information, & Induced seismicity
- Need of best practices applicable on future geothermal stimulations and exploitation on EGS reservoirs
- Need of harmonized practices not only for induced seismicity but other items like environmental monitoring (water, gas emission, ….)
- Need for innovative monitoring tools and artificial intelligence for optic fiber sensing application : physical and environmental monitoring of stimulation and exploitation (Which physical sensor is missing?)
- Risk assessment and cost evaluation. Need more quantitative approach and thus we need relevant databases for reducing uncertainty
- Need to develop new concepts for low geothermal gradient areas like the Nordic bedrock for modern smart cities: district heating and cooling from crystalline rock at 3-4 km
- Risk is a real issue in EGS and projects developers are aware that danger and lost are possible
- Real need to perform quantitative risk analysis instead of qualitative analysis based on experts and in house knowledge only

Conclusions and perspectives 2/2

- Risk map is a relevant tool for cost evaluation for decision-makers
- Use of probability methods like Monte Carlo for reducing uncertainty
- Problem of lack of economic database available for cost evaluation of stimulation treatment
- Need of more demonstration sites with relevant technic-economic datasets available
- Risk assessment must take into account not only punctual stimulation treatments (several days) but also operational exploitation phase (several decades)
- Technologies like optic fibre are relevant for environmental monitoring (induced seismicity, deformation) but there is a need for optimizing the size of the dataset
- Use new methodologies like artificial intelligence or neuronal network for environmental monitoring (ATLS – alert system)
- Development of heat projects in crystalline rocks for Scandinavian countries

Thank you very much for your attention!

Liability claim

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