

# Reservoir Sustainability ReSus Joint Activity

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*ReSus JA, Moravske Toplice, 13<sup>th</sup> October 2016*

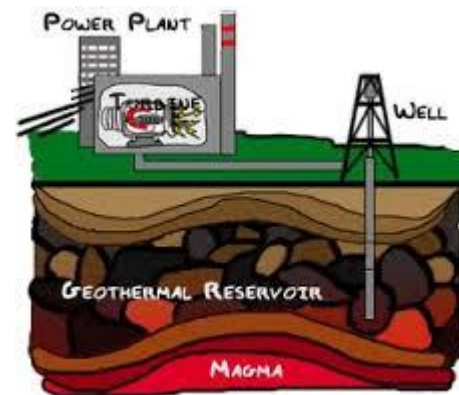


# Background

The energy production from geothermal system is mainly related to the specific reservoir **properties**.

**Key factors** allowing a sustainable use of the resource balancing **commercial viability**, **environmental impact** and **impact on people**:

1. reliable reservoir **models**
2. **operation and maintenance** schemes
3. specific **arrangement of surface**
4. installations, careful selection of system **components**



Different geological conditions, pressure, temperature and chemical properties makes reservoirs different.

# Target Group



☐ Research, Industry, Project developer

## Aims

- ☐ **Encourage** collaboration and knowledge exchange between existing studies on "Geothermal Reservoirs"
- ☐ **Encourage** collaboration and knowledge exchange between operators
- ☐ **Evaluation** of possible topics for a joint call



*ReSus JA, Moravske Toplice, 13<sup>th</sup> October 2016*



# JA Participants:



**National Research Council of ITALY**



**Bureau de Recherches Géologiques et Minières - FRANCE**



**Julich - Germany**



**OS Orkustofnun – ICELAND**



**Swiss Federal Office of Energy (with Swiss Geological Survey)**



**Magyar Foldtani és Geofizikai Intézet – HUNGARY**



**Tubitak - Turkey**

**Classification of Joint Activity: JA1** (can be proposed as topic for a call)

**Start date:** 15/03/2015 **Kick-off:** 15/04/2015 **End:** 09/2016

**Duration:** 18 months



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# National investigation Genesis



- To **highlight** the **objectives** of the stakeholders regarding reservoir sustainability
- To **collect** their **practices** to achieve these objectives
- To **gather** the **remaining gaps**
- Web questionnaire **open** 10-25/09/2015 and 01-31/03/2016
- 2 sections: institution typology + reservoir sustainability concept



*ReSus JA, Moravske Toplice, 13<sup>th</sup> October 2016*



# Section 1 - Institution typology



- Administrative details
- Aspects of geothermal energy : **potential assessment**, **regulatory**, power generation, etc.
- **Types** of geothermal energy
- Horizontal scale: from one drilling to regional scale
- Vertical scale : from shallow to deep

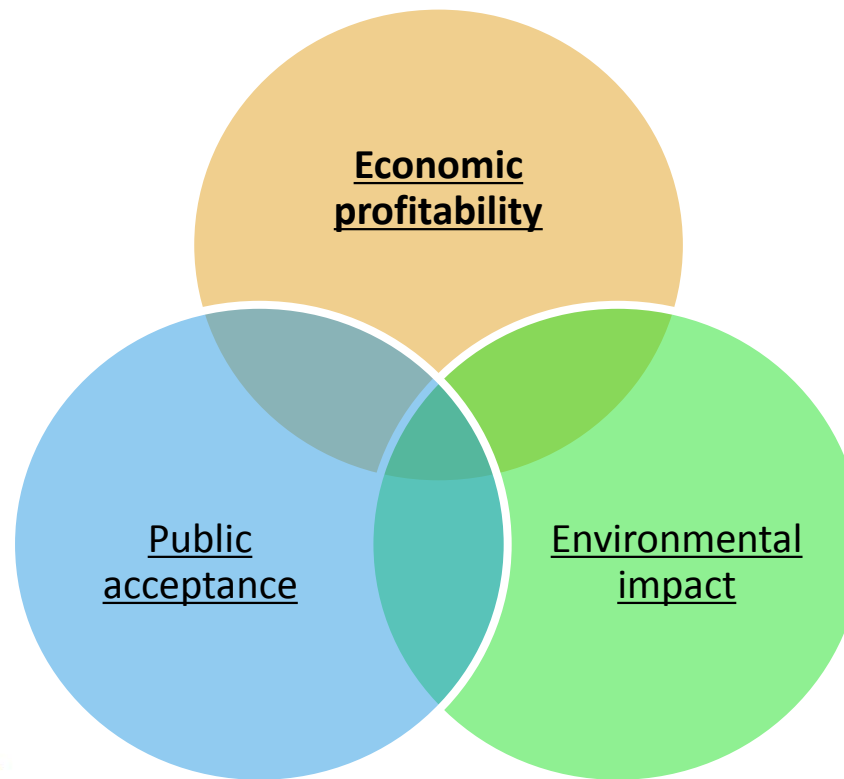


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# Section 2 - Reservoir sustainability concepts

Based on the 3 classical realms



# Pillar contents

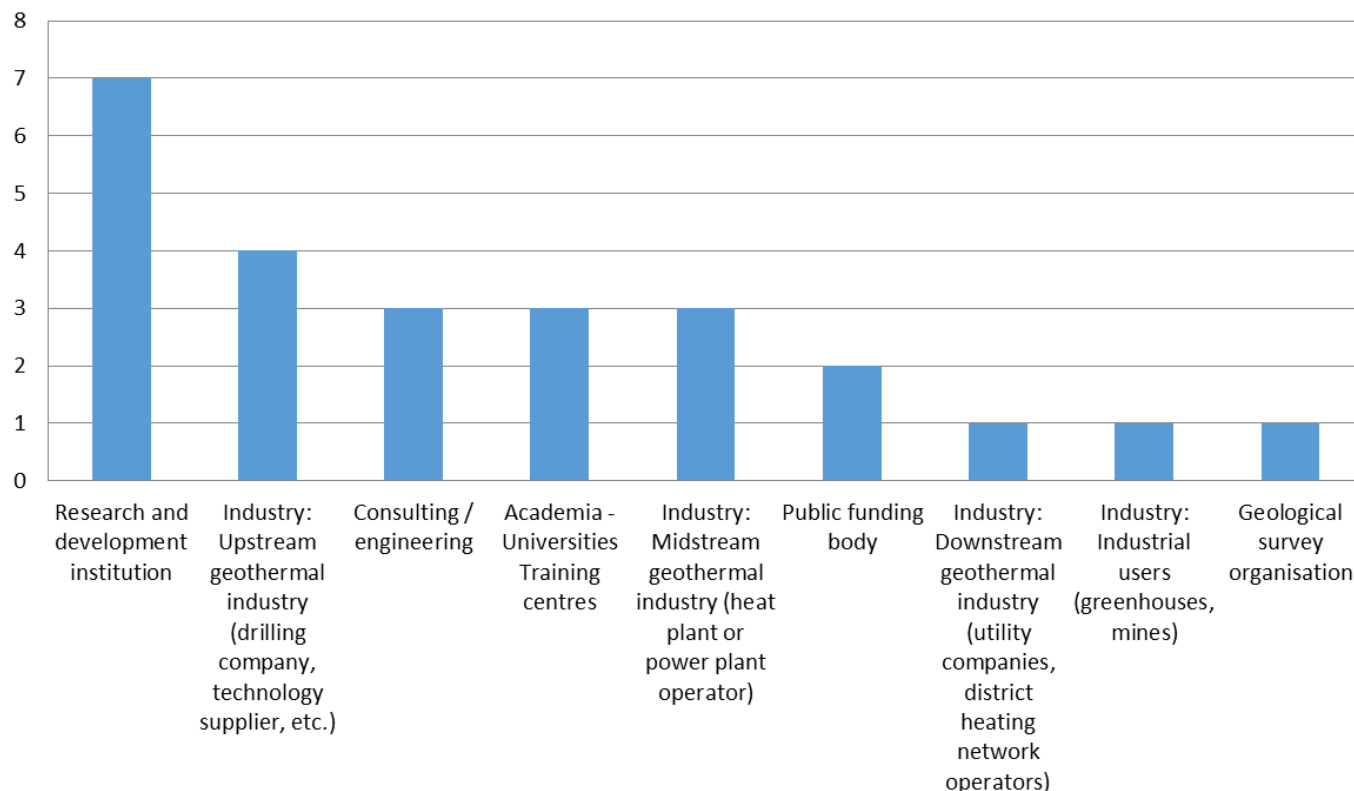
Each pillar is investigated in the same way:

- **Rank** a dozen of predefined criteria + 3 (max) *open criteria*
- Indicate how the top 3 criteria are **tackled**
- **Point out** the main gaps (3 max) that hamper reservoir sustainability regarding the pillar



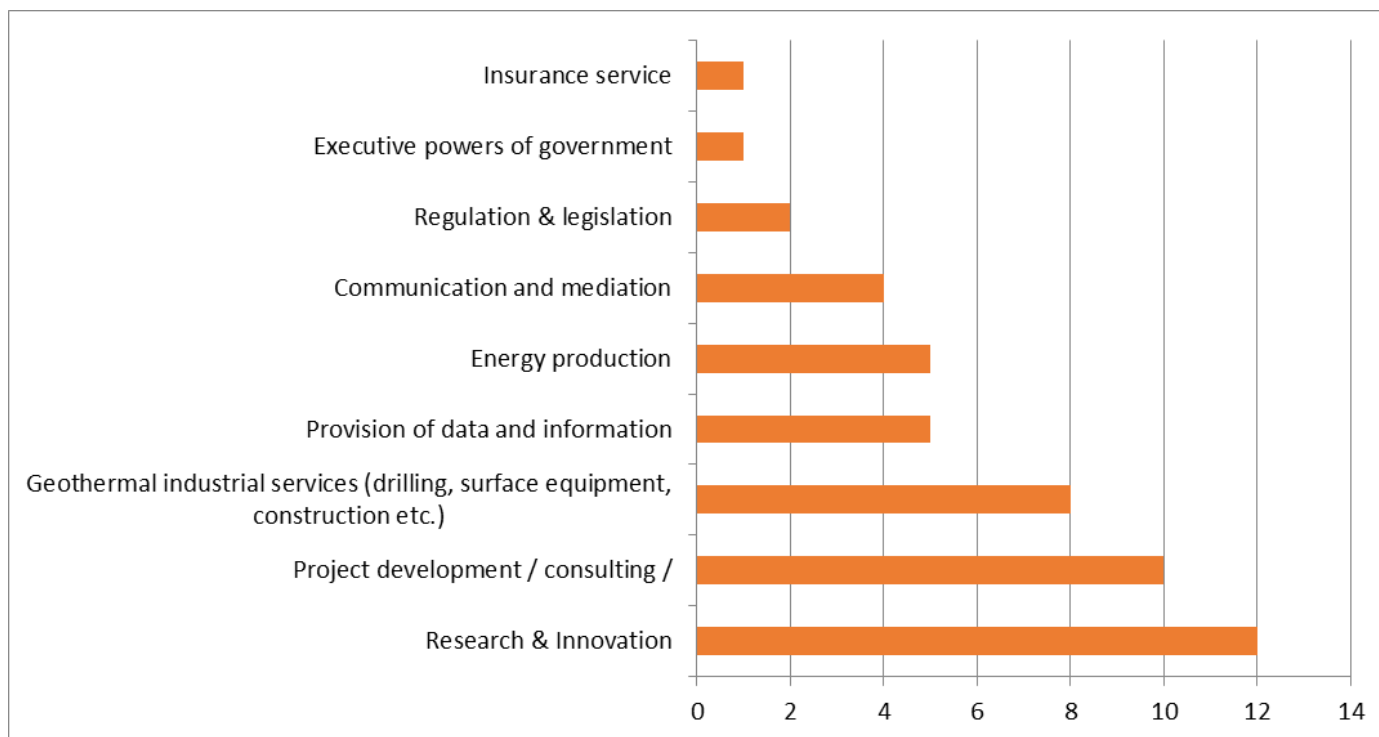
# ReSus Survey results

**Institution tipology**



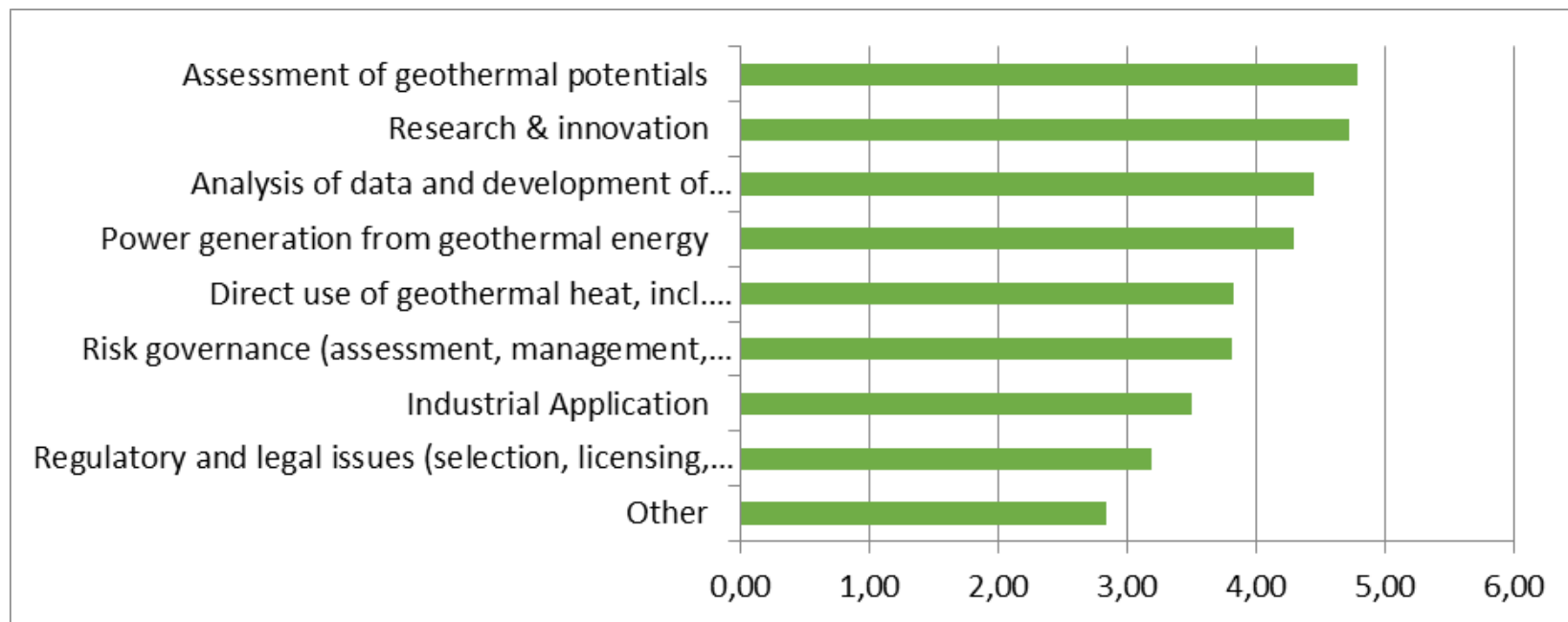
# ReSus Survey results

Your institution is active in the following domain:



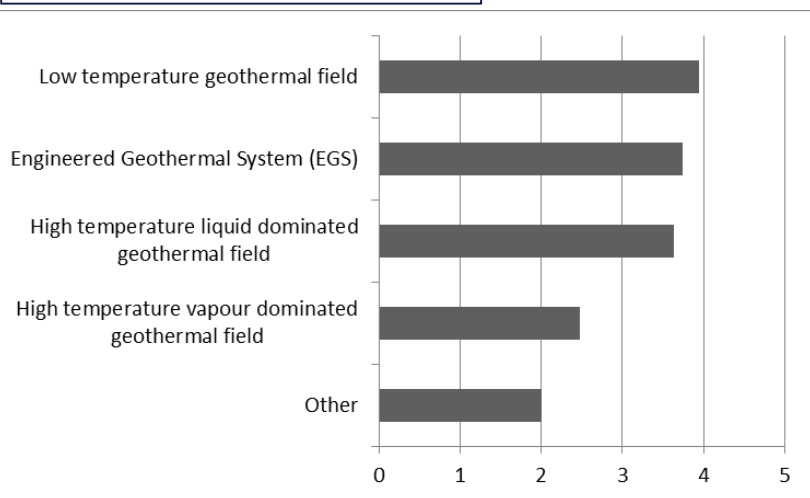
# ReSus Survey results

What aspect of geothermal energy : is your institution interested in?

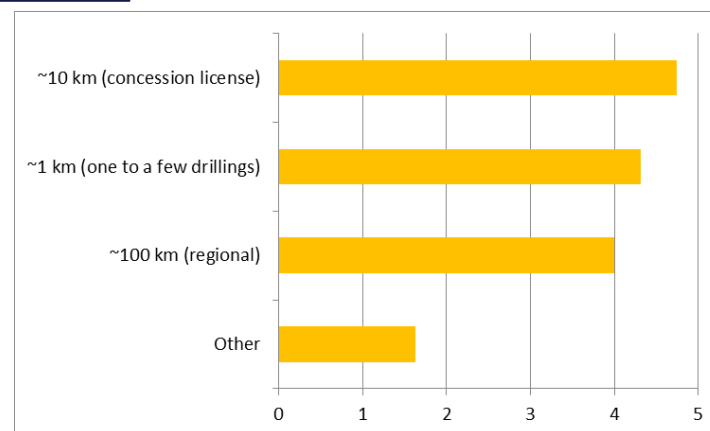


# ReSus Survey results

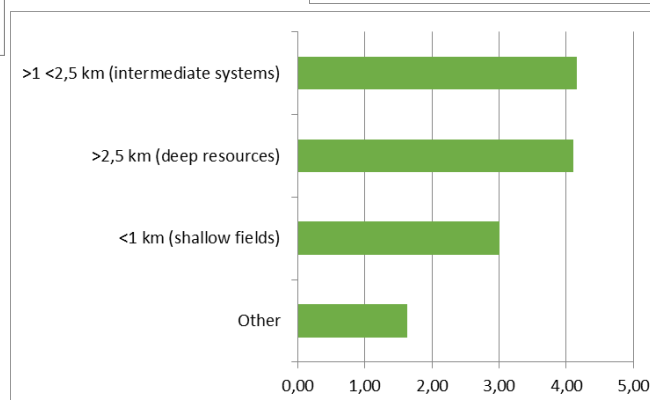
What type of geothermal system is your institution interested in?



What scale is your institution interested in?



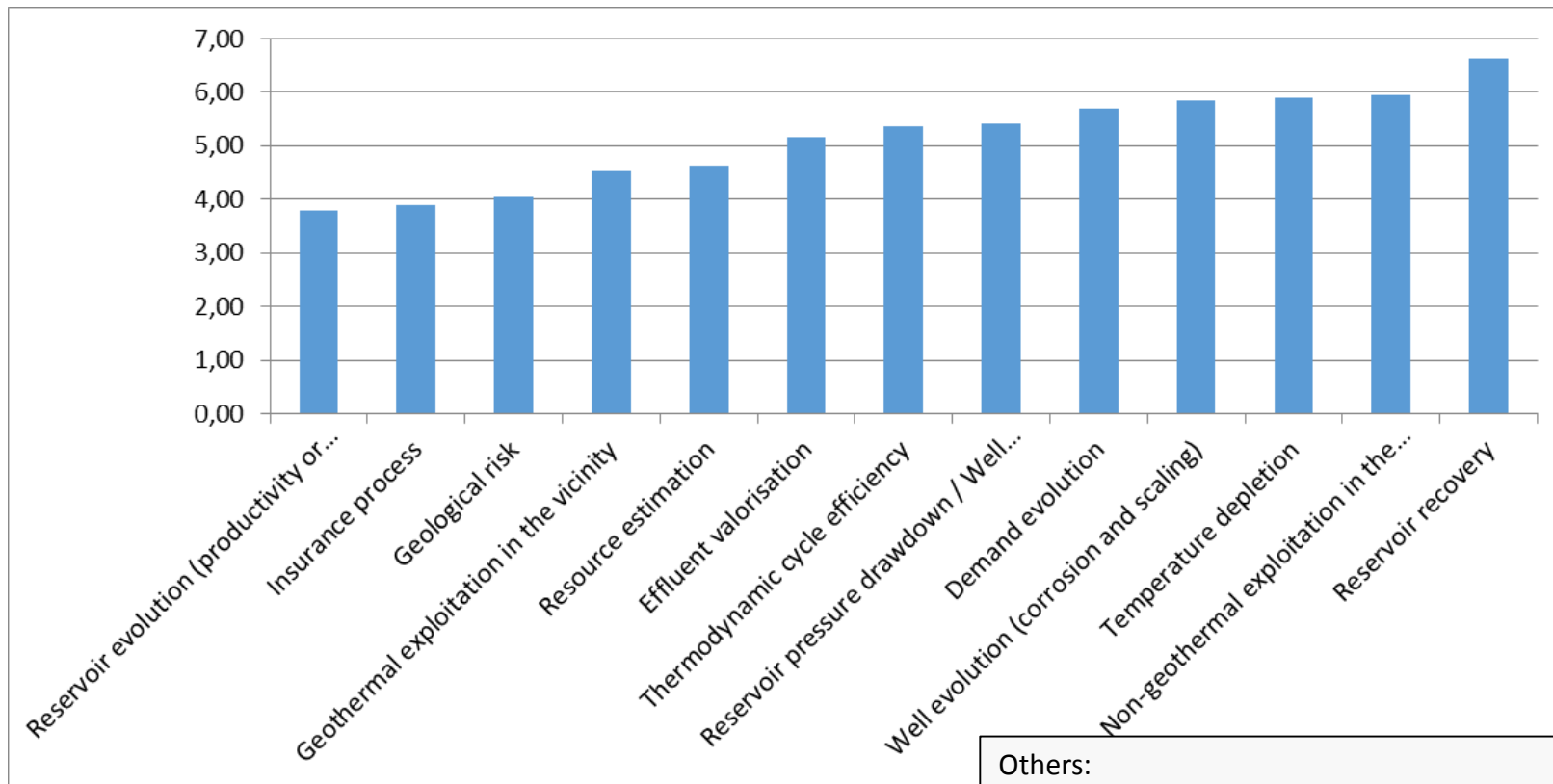
What scale in depth is your institution interested in?



# ReSus Survey Result

Rank the aspects that affect the: **Economic profitability**

On y axis the average of the  
obtained rank



Others:

- taxes and depreciation, royalties, fees
- Government subsidies (feed-in tariffs or premiums)

# ReSus Survey Result

## Economic profitability: Top Criteria and how to tackle

#	Top criteria	How to tackle criteria
1	Reservoir evolution (productivity or injectivity losses)	<ul style="list-style-type: none"><li>Careful reservoir management</li></ul>
2	Insurance process	<ul style="list-style-type: none"><li></li></ul>
3	Geological risk:	<ul style="list-style-type: none"><li>Process identification – Monitoring - data evaluation</li><li>The pressure drawdown during well testing and also later, during operation provides exact data for profitability calculations</li></ul>
4	Geothermal exploitation in the vicinity	<ul style="list-style-type: none"><li></li></ul>
5	Resource estimation	<ul style="list-style-type: none"><li>Data assessment -regional / conceptual modelling – monitoring - numerical evaluation</li><li>Calibrated numerical modelling</li><li>3D static and dynamic modelling, will be the base of resources estimation and economic assessments</li></ul>

# ReSus Survey Result

**Economic profitability:** the main gap(s) that hamper reservoir sustainability

Most important gaps
<ul style="list-style-type: none"><li>• Missing transparency of operators / field developer</li><li>• Demand evolution</li><li>• Assessment of the reservoir recharge/depletion and need of re-injection</li><li>• The exploration cost should be partly supported by public funds</li><li>• Subsurface uncertainties (reservoir imaging and prediction)</li><li>• Pressure drawdown</li></ul>

Medium important gaps
<ul style="list-style-type: none"><li>• Establishing academic partnership on sustainability issues</li><li>• Well evolution. Well costs strongly influence the investment and operation costs</li><li>• Problematic re-injection scheme</li><li>• Reservoir continuity, connectivity and 3D permeability</li></ul>

Other gaps
<ul style="list-style-type: none"><li>• Geothermal exploitation in the vicinity. Receiving permissions can be more difficult</li><li>• possible negative impact of induced seismicity may hamper public support if not well managed</li></ul>



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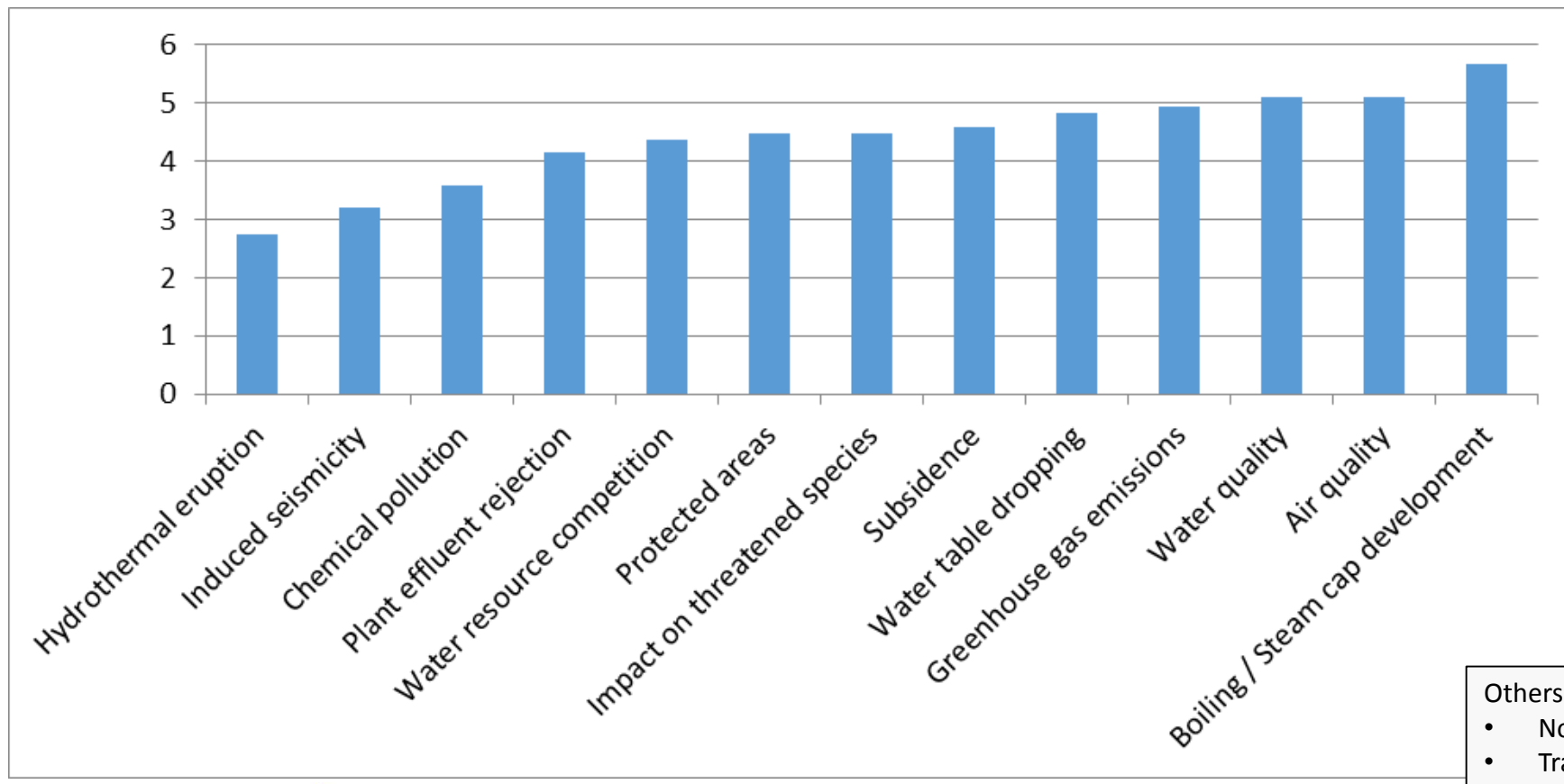
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# ReSus Survey Result

Rank the aspects that affect the: **Environmental impact**

On y axis the average of the  
obtained rank





# ReSus Survey Result

## Environmental impact: Top Criteria and how to tackle

#	Top criteria	How to tackle criteria
1	Hydrothermal eruption	<ul style="list-style-type: none"><li></li></ul>
2	Induced seismicity	<ul style="list-style-type: none"><li>Appropriate operational controls to minimize risks</li><li>Definition of active monitoring station network (local and national) coupled with theoretical modelling of subsurface stress realise following water circulation and well stimulation</li></ul>
3	Chemical pollution	<ul style="list-style-type: none"><li></li></ul>
4	Plant effluent rejection	<ul style="list-style-type: none"><li>Measuring pressure gradients and water interfaces behind casings right after drilling and during the lifecycle of the wells. Classic pressure gauges and nuclear tools methods are used</li></ul>
5	Water resource competition	<ul style="list-style-type: none"><li>Geochemical characterisation of key aquifers and sealing stratigraphic units</li></ul>

# ReSus Survey Result

**Environmental impact:** the main gap(s) that hamper reservoir sustainability

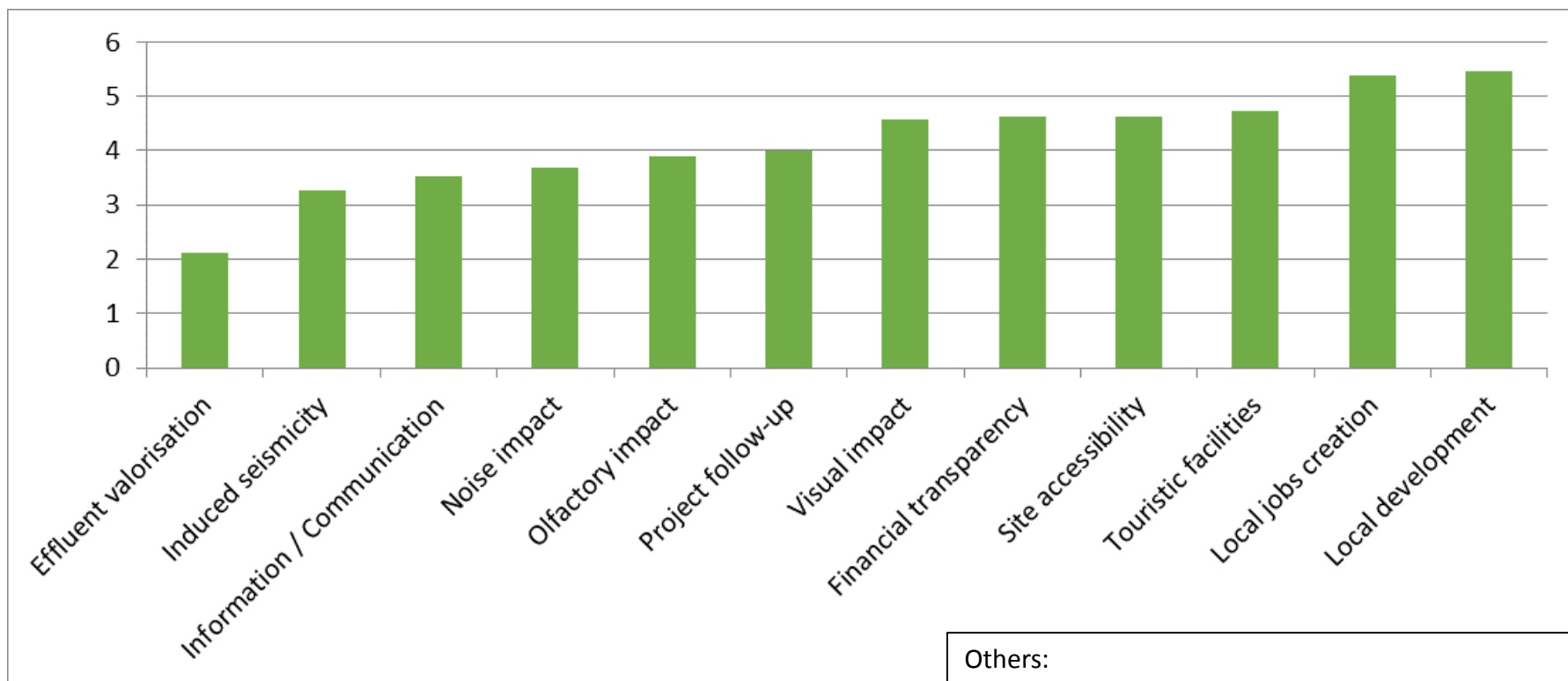
## Main gaps

- Water resource competition
- Water table drop if reinjection is missing
- Chemical pollution if the system is not closed
- Optimization of the plant operation and management
- Long term monitoring of the potential impacts
- Enhanced communication of the low environmental impact

# ReSus Survey Result

Rank the aspects that affect the: **Public acceptance**

On y axis the average of the  
obtained rank



Others:

- taxes and depreciation, royalties, fees
- government subsidies (feed-in tariffs or premiums)

# ReSus Survey Result

## Public Acceptance: Top Criteria and how to tackle

#	Top criteria	How to tackle criteria
1	Effluent valorisation	<ul style="list-style-type: none"> <li>Financial support to local community to compensate the annoyance</li> </ul>
2	Induced seismicity	<ul style="list-style-type: none"> <li>Operational controls to minimize risk of felt induced seismicity</li> <li>See above plus installation of ad hoc seismometers station network to establish baseline prior geothermal exploration and exploitation</li> </ul>
3	Information / communication	<ul style="list-style-type: none"> <li>Make projects "owned" by the local community</li> <li>Coordinated effort between Academia and local Industry and Canton to organise communication and demonstration events (e.g. vibroseism) at different scale for different communities (city, village etc)</li> </ul>
4	Noise impact	<ul style="list-style-type: none"> <li></li> </ul>
5	Olfactory impact	<ul style="list-style-type: none"> <li></li> </ul>

# ReSus Survey Result

**Public Acceptance:** the main gap(s) that hamper reservoir sustainability

## Main gaps

- Information/communication
- Induced seismicity
- Local development
- the benefit should be directly delivered to local community without intermediate steps
- direct link between operators and administrators

# ReSus outcomes



- Respondents SHs seem to be interested mainly in: **research and innovation, assessment of geothermal potential, analysis of data and development of process/workflow**
- Principal respondents belonging group are: **research and innovation, project development / consulting engineering, geothermal industrial service**
- **Low temperature** and **EGS** resulted the most interesting geothermal systems
- High interest on **all** scale of geothermal system
- High interest in **intermediate** and **deep** system in term of depth
- For economic profitability, **geologic risk** and **resource estimation** got high rank
- **Induced seismicity** is the principal aspect that affect environmental impact
- On public acceptance pillars the most ranked criteria resulted **induced seismicity, information/communication** and **local development** and **job creation**



*ReSus JA, Moravske Toplice, 13<sup>th</sup> October 2016*



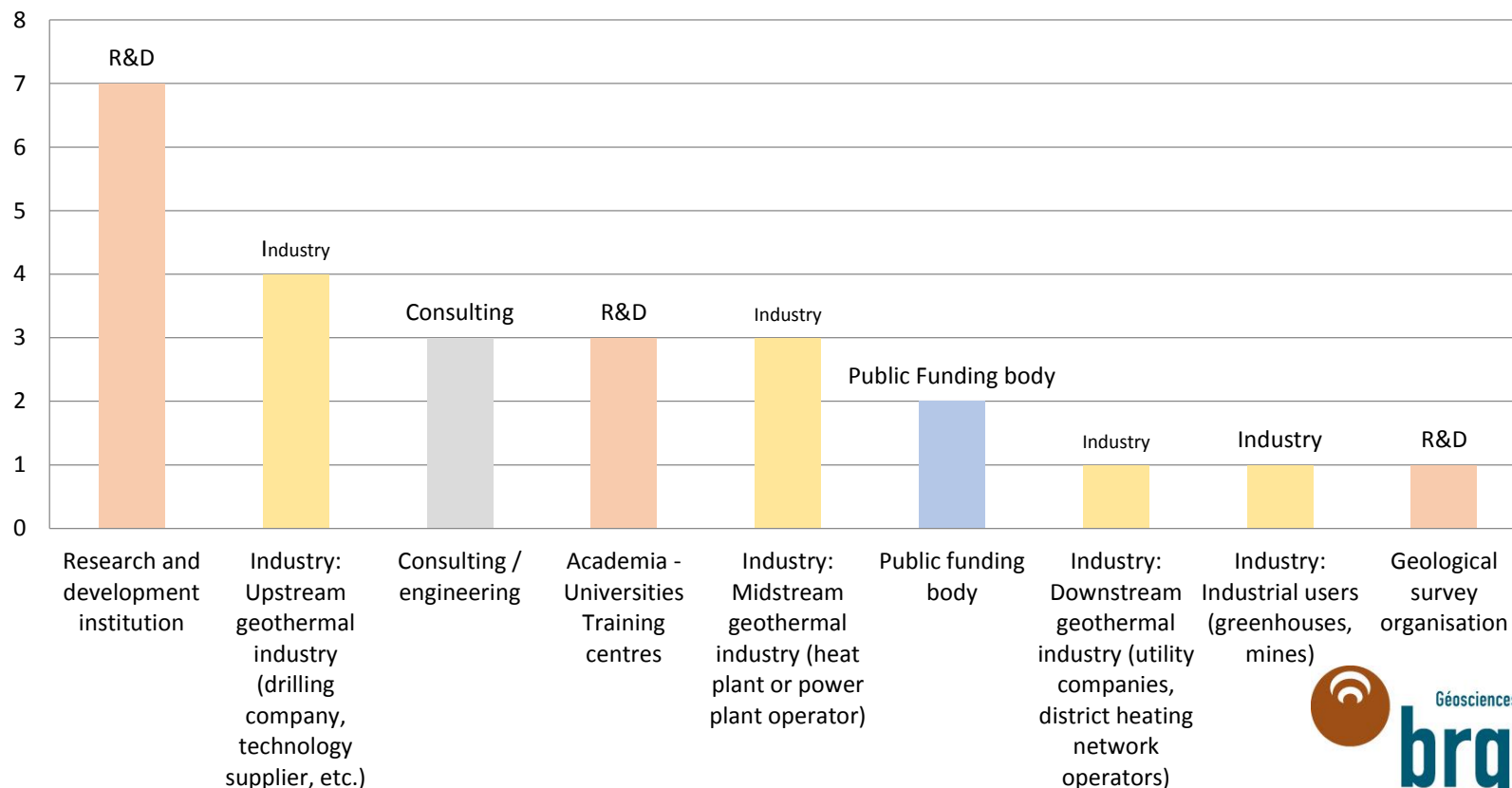
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# ReSus Survey results

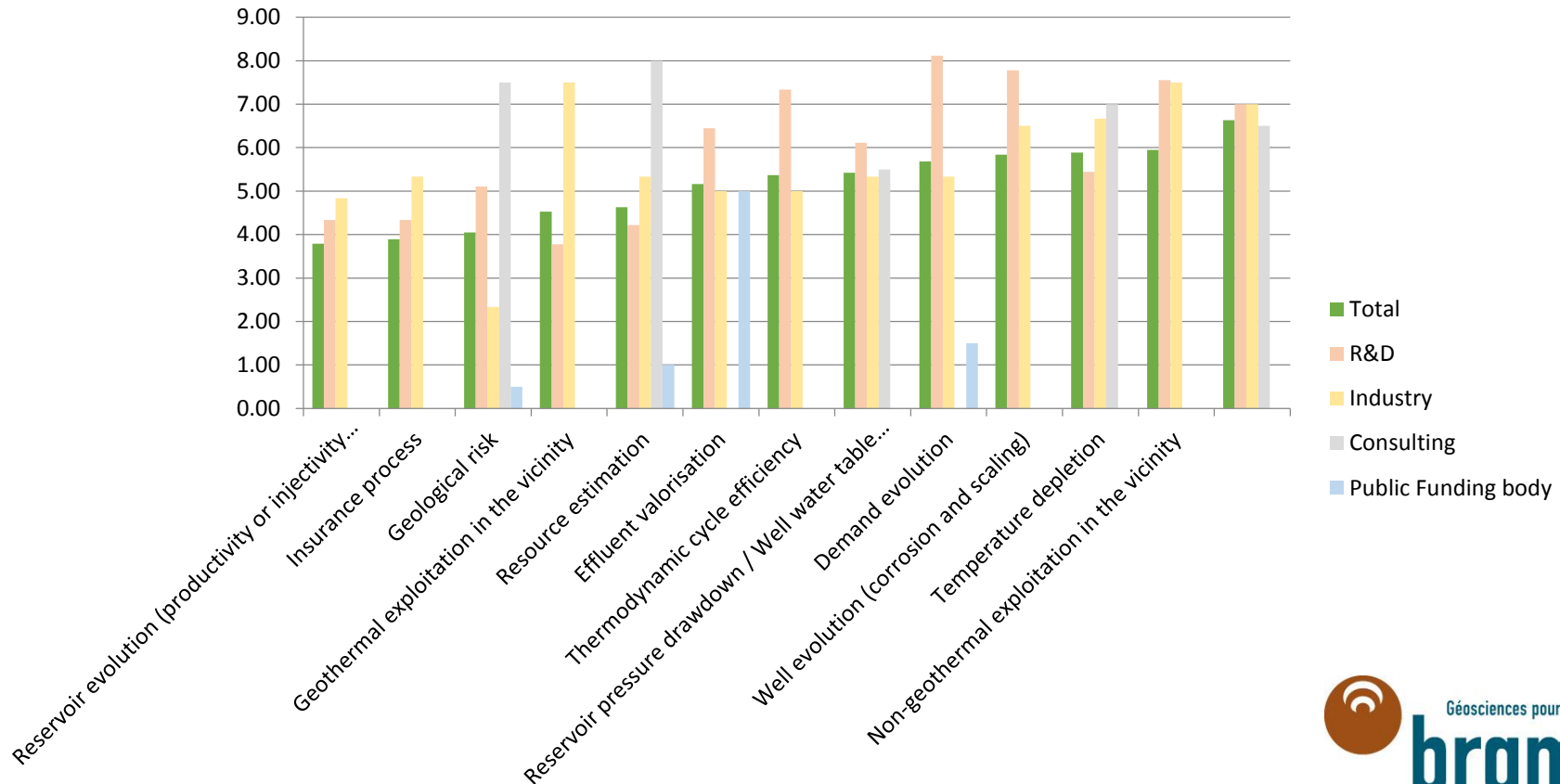
## Institution tipology



# ReSus Survey Result

Rank the aspects that affect the: **Economic profitability**

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# ReSus Survey Result

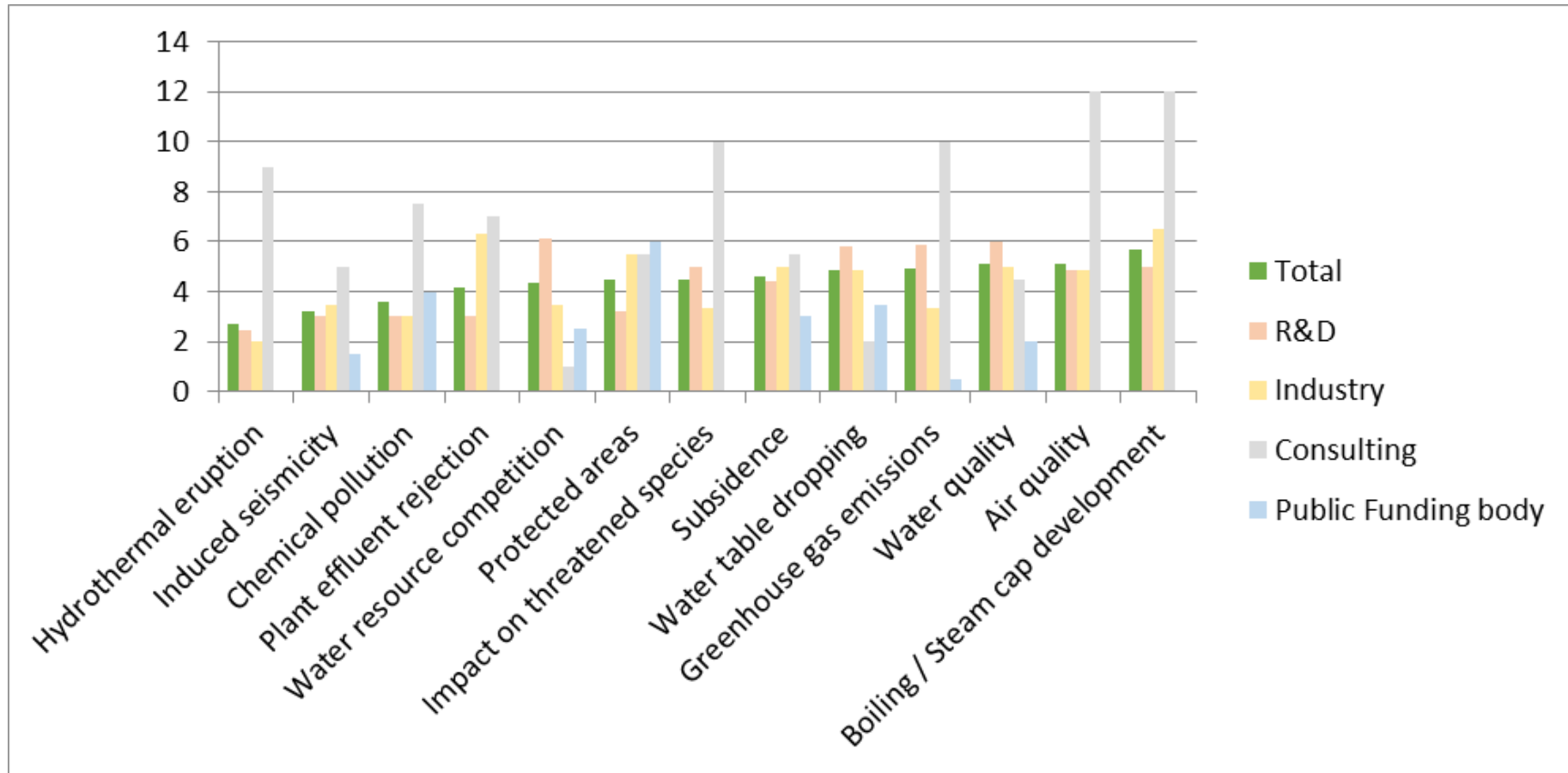
Rank the aspects that affect the: **Economic profitability**

R&D	Industry	Consulting	Public Funding body
<ul style="list-style-type: none"> <li>• Geothermal exploitation in the vicinity</li> <li>• Resource estimation</li> <li>• Insurance process and Reservoir evolution</li> <li>• Geological risk</li> <li>• Temperature depletion</li> <li>• Reservoir pressure drawdown / Well water table dropping</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Geological risk</li> <li>• Reservoir evolution</li> <li>• Thermodynamic cycle efficiency</li> <li>• Insurance process, Resource estimation, Demand evolution, Reservoir pressure drawdown / Well water table dropping</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Reservoir pressure drawdown / Well water table dropping</li> <li>• Reservoir recovery</li> <li>• Temperature depletion</li> <li>• Geological risk</li> <li>• Resource estimation</li> </ul>	<ul style="list-style-type: none"> <li>• Geological risk</li> <li>• Resource estimation</li> <li>• Demand evolution</li> <li>• Effluent valorisation</li> </ul>

# ReSus Survey Result

Rank the aspects that affect the: **Environmental impact**

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# ReSus Survey Result

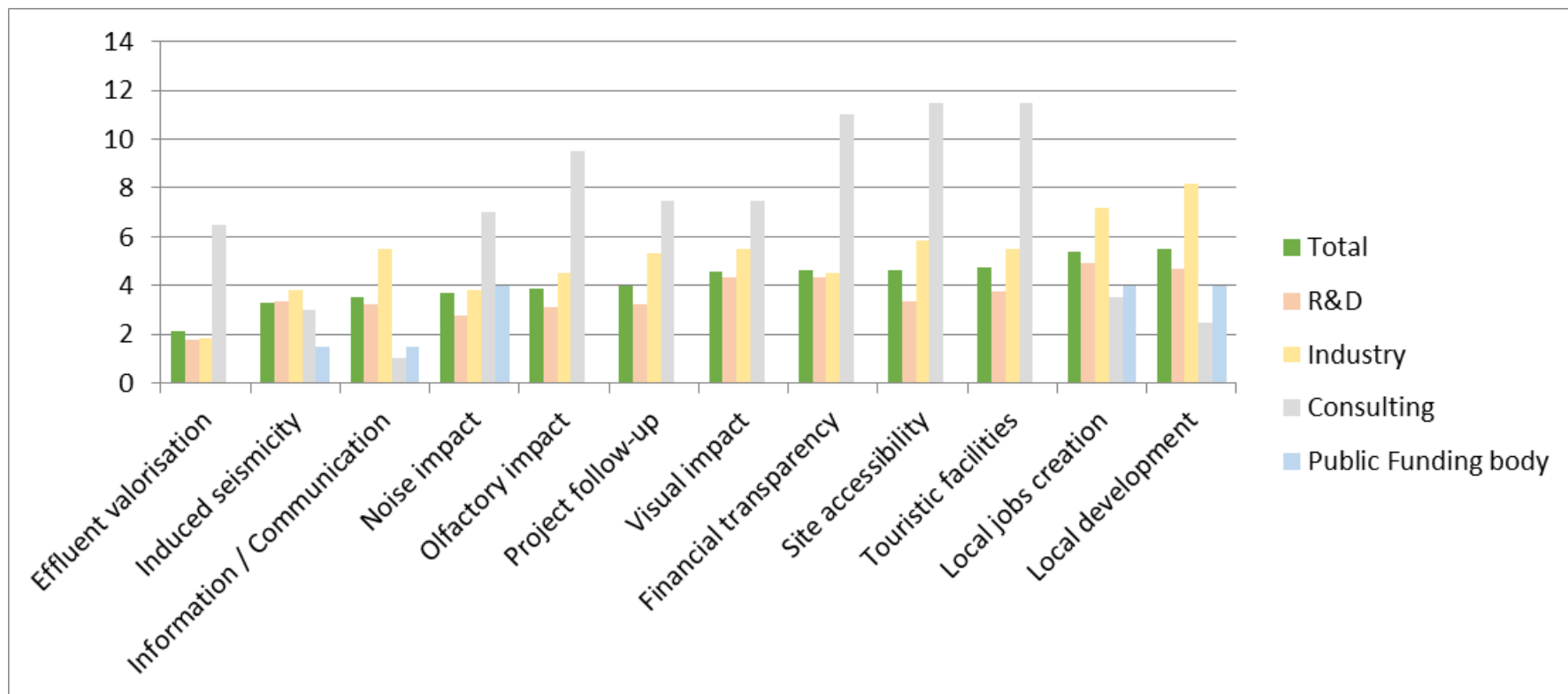
Rank the aspects that affect the: **Environmental impact**

R&D	Industry	Consulting	Public Funding body
<ul style="list-style-type: none"><li>• Hydrothermal eruption</li><li>• Induced seismicity, Chemical pollution, Plant effluent rejection</li><li>• Protected areas</li><li>• Subsidence</li><li>• Air quality</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Hydrothermal eruption</li><li>• Chemical pollution</li><li>• Impact on threatened species, Greenhouse gas emissions</li><li>• Water resource competition</li><li>• Water table dropping, Air quality</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Water resource competition</li><li>• Water table dropping</li><li>• Water quality</li><li>• Induced seismicity</li><li>• Protected areas</li><li>• Subsidence</li><li>• Plant effluent rejection</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Greenhouse gas emissions</li><li>• Induced seismicity</li><li>• Water quality</li><li>• Water resource competition</li><li>• Subsidence</li><li>• Water table dropping</li><li>• Chemical pollution</li><li>• ...</li></ul>

# ReSus Survey Result

Rank the aspects that affect the: **Public acceptance**

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# ReSus Survey Result

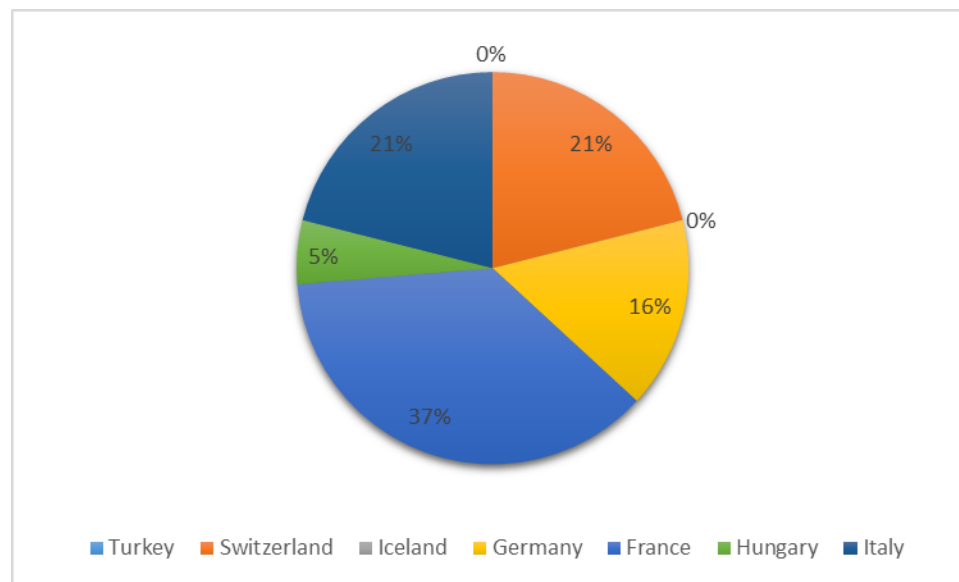
Rank the aspects that affect the: **Public acceptance**

R&D	Industry	Consulting	Public Funding body
<ul style="list-style-type: none"><li>• Effluent valorisation</li><li>• Noise impact</li><li>• Olfactory impact</li><li>• Project follow-up, Information / Communication</li><li>• Induced seismicity, Site accessibility</li><li>• Touristic facilities</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Effluent valorisation</li><li>• Induced seismicity, Noise impact</li><li>• Olfactory impact, Financial transparency</li><li>• Information / Communication, Visual impact, Touristic facilities</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Information / Communication</li><li>• Local development</li><li>• Induced seismicity</li><li>• Local jobs creation</li><li>• Effluent valorisation</li><li>• Noise impact</li><li>• ...</li></ul>	<ul style="list-style-type: none"><li>• Information / Communication, Induced seismicity</li><li>• Noise impact, Local jobs creation, Local development</li><li>• ...</li></ul>

# ReSus Survey results

## Survey participation:

	Submitted	Completed Survey	Feedback %
<u>Turkey</u>	?	0	
<u>Switzerland</u>	?	4	
<u>Iceland</u>	?	0	
<u>Germany</u>	15	3	20
<u>France</u>	119	7	6
<u>Hungary</u>	5	1	20
<u>Italy</u>	22	4	18
<b>TOTAL</b>	<b>161</b>	<b>19</b>	<b>11.8</b>



The reopening provided 32% more

# ReSus Completion



- Report on the 'ReSus survey results and next steps' delivered in September 2016

## Next step

- Promotion this topic in the frame of GEOTHERMICA Co-fund action



*ReSus JA, Moravske Toplice, 13<sup>th</sup> October 2016*



**Thank you for your attention  
and  
to all you who participated and  
supported  
ReSus JA**