

Report on the Inventory of National and European Public RD&I actions

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Author(s): Holger Ihssen, Olga Suminska-
Ebersoldt
Author'(s)' affiliation: KIT

Deep GEOTHERMAL IWG
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1. Introduction

IMPLEMENTATION PLAN R&I ACTIONS

The **Strategic Energy Technology Plan (SET-Plan)** has been the research and innovation pillar of the EU's energy and climate policy since 2007. It was revised in 2015 to effectively line up with the EU's "**Energy Union research and innovation priorities**". On 24 December 2018 the Regulation on the governance of the energy union and climate action ((EU)2018/1999) entered into force.

The Energy Union research and innovation priorities contain a dedicated vision for each technology area and sets ambitious targets. For each of these technology areas, Implementation Plans have been developed.

Within the SET-Plan the member states and the EU Commission agreed on an ambitious set of **research and innovation (R&I)** priorities for deep geothermal energy actions. In order to achieve these, a specific geothermal **Implementation Plan (IP)** was developed and is currently under execution. It identifies eight priorities for R&I actions, two non-technical barriers and two cross-cutting issues.

The eight R&I priorities for the deep geothermal sector are:

1. Geothermal heat in urban areas (TRL 7-9);
2. Materials, methods and equipment to improve operational availability
 - a. improve operational availability (TRL: Equipment 5-9) and
 - b. high temp., corrosion, scaling (TRL: Materials 4-6);
3. Enhancement of reservoir (conventional and unconventional (TRL 4-8),
4. Improvement of performance (TRL 5-8),
5. Exploration techniques (TRL 5-8),
6. Drilling techniques (TRL 3-7),
7. Flexibility from geothermal CHP plants (TRL 4-9) and
8. Zero emissions power plant (TRL 5-7).

Non-technical barriers (NTBE) are:

- Community and stakeholder acceptance of geothermal projects and
- Risk mitigation.

And the two cross-cutting issues (CCI) are:

- Knowledge transfer + training and
- Recommendation of an open-access policy to geothermal information

To define resources needed for the deep geothermal research in fulfilling the R&I actions and the non-technical aims, an inventory of the available public national and European resources available for researchers was generated. The data were gathered in the EERA Geothermal community and by non-EERA members. In order to collect the data, three surveys were distributed in the research community.

The Project Inventory

The inventory bases on the table published by (Siddigi & Breembroek, 2019) and was completed at the end of 2019 by the EERA members and updated in early 2020. The project list includes 78 large projects with a budget of about €1 million or more.

The Institutional Funding Inventory

The main aim of the survey was investigating the funding not covered by the European and national projects. 23 EERA GE members provided the data for 2018 and 2019.

The Geothermal Institution Inventory

The Survey gives an overview of the research interests, scientific infrastructure and spatial distribution of geothermal research in Europe.

2. Resources on the European geothermal research

EU FUNDING

In 2014, the European Commission launched the eighth Framework Programme for Research and Technological Development for the years 2014-2020, known as Horizon 2020 (H2020).

The Horizon 2020 energy Work Programme for 2018-2020 (European Commission, 2017) included R&D topics specifically targeting or mentioning geothermal energy, covering the range of technology development, from TRL (Technology Readiness Level) 3 (experimental proof of concept) to TRL 8 (system complete and qualified):

LC-SC3-RES-1-2019-2020 - Developing the next generation of renewable energy technologies

LC-SC3-RES-11-2018: Developing solutions to reduce the cost and increase performance of renewable technologies

LC-SC3-RES-12-2018: Demonstrate highly performant renewable technologies for combined heat and power (CHP) generation and their integration in the EU's energy system

LC-SC3-RES-13-2018: Demonstrate solutions that significantly reduce the cost of renewable power generation

LC-SC3-RES-14-2019: Optimising manufacturing and system operation

LC-SC3-RES-18-2020: Advanced drilling and well completion techniques for cost reduction in geothermal energy

According to the CORDIS (<https://cordis.europa.eu/en>) data, in years 2018 and 2019 the geothermal research was co-funded by Horizon 2020 with 58m€ and 37m€ respectively. In 2021, H2020 will be succeeded by a new seven-year R&D funding programme, named Horizon Europe.

NATIONAL FUNDING

The national funding of geothermal projects is covered by the GEOTHERMICA and national calls.

GEOTHERMICA's objective is to combine the financial resources and know-how of geothermal energy research and innovation programme owners and managers from 16 countries and their regions. Together with financial support from the European Commission GEOTHERMICA launches joint projects that demonstrate and validate novel concepts of geothermal energy deployment within the energy system, and that identify paths to commercial large-scale implementation.

Table 1 provides information on the national funding sources in the EU. The data are taken from (Siddigi & Breembroek, 2019).

Call name	Funding agency	Short description and web link if available	Start year	End year	Budget (EUR million)	Relevant targets or activities addressed
GEOHERMICA II	ADEME; FZJ-PtJ, Rannis; GSI; RVO; RCN; DGEG, UEFISCDI ; AEI; DETEC; TÜBITAK and DoE	http://www.geothermica.eu/call-to-action/	2020	2023	18	All R&Is
Innovation Fund	EC	https://ec.europa.eu/clima/policies/innovation-fund_en	2020	2030	Around 10'000	All
National calls						
Germany	BMWi, BMBF,	7 th National Energy Research Program: Ongoing national research Program for Energy topics	2018	ongoing	1'300 million €/year	Complete Energy sector
Netherlands	RVO	"Hernieuwbare Energie" (broader than geothermal only) https://www.rvo.nl/subsidies-regelingen/hernieuwbare-energie	Annual publication		2019: M€ 50	All R&Is except R&I 8
Netherlands	RVO	"Demonstration Energy Innovation" (broader than geothermal only) https://www.rvo.nl/subsidies-regelingen/demonstratie-energie-en-klimaatinnovatie/energie-innovatie-dei	Annual publication		2019: M€ 35	All R&Is except R&I 8

France	SGPI/ADE ME	Programme des Investissements d’Avenir 3 (PIA3 ¹) Once a year / regular	2019	2021	N/A	All R&Is
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Table 1 National funding

INSTITUTIONAL FUNDING

The data considering the institutional funding was provided by 23 EERA Geothermal members including 10 universities and 13 research organizations. The EERA GE members were asked to estimate the personal months and the financial support not covered by national or EU projects.

Member State	2018		2019 (estimated)		Number of institutions	
	Person months	Funding in €	Person months	Funding in €	in EERA Ge	participating in the survey
Italy	148,5	608.000	146,8	605.000	11	7
Germany	1188,00	4.044.000	1164,00	4.542.000	7	5
Norway	50,20	490.000	74,80	715.000	4	3
France	509	2.492.200	516	1.808.200	3	3
Netherlands	15	150.000	15	150.000	3	1
Switzerland	0	0	0	0	3	0
Belgium	87	1.019.105	118	1.396.469	1	1
Greece	20	100.000	20	100.000	1	1
Portugal	4,6	0	4,2	0	1	1
UK	0	0	20,2	154.000	1	1
Iceland	0	0	0	0	1	0
total	2022,3	8.903.305	2079	9.470.669	36	23

Table 2 Institutional funding at EERA Geothermal

Based on the delivered information we can make a projection, that all the EERA members had an overall institutional funding of ~15M€ supporting ~3250 pm in 2019. The average costs per person year is about 55k€. This is an indication, that a larger fraction of this resource was used for non-academic staff.

For now data for non-eera organisations are not available.

¹ <https://www.ademe.fr/sites/default/files/assets/documents/presentation-aap-pia-ademe.pdf>

REMARKS

The national authorities of the Deep Geothermal IWG decided to use their databases for extracting the national project budget in this field. It is expected that this information is available in autumn 2020 and will be used to replace table 1.

Furthermore the number of non-EERA members delivering information on research activities and available resources is still very small. This needs a much more active role from the secretariat and support from the national authorities of the Deep Geothermal IWG.

3. Geothermal research institutions in Europe

EERA MEMBERS

The European Energy Research Alliance (EERA) was founded in 2008 by leading European research organizations with the goal to coordinate the research in the energy field across Europe and to accelerate the development of new energy technologies, combining national and European sources of funding and maximizing complementarities and synergies. Nowadays more than 250 organisations and around 50,000 researchers from 30 countries in the EU and associated member countries are working together in 17 Joint Programmes² (JPs), which are aligned with the priorities of the [SET-Plan](#) (specific information is available at the website www.eera-set.eu). The EERA JPs constitute strategic permanent collaborations between major research organizations and institutes forming a virtual centre of excellence. The JPs implement the need for better coordination among research organizations from different European member states, maximizing synergies and identifying research priorities.

The EERA Joint Programme Geothermal (EERA GE) was officially launched in 2010 and is coordinated by University of Bergen in Norway. This JP is the first pan-European programme to bring together all major fields of geothermal research and therefore represents a unique opportunity to align research and development activities in the field.

EERA Geothermal is a key stakeholder of the European Technology & Innovation Platform Deep Geothermal ([ETIP-DG](#)) as well as the SET-Plan Implementation Working Group Deep Geothermal (Deep Geothermal IWG).

² AMPEA, Bioenergy, Carbon Capture and Storage, Concentrated Solar Power (CSP), Economic, environmental and social impacts (JP e3s), Energy Efficiency in Industrial Processes, Energy Storage, Energy Systems Integration, Fuel Cells and Hydrogen, Geothermal, Nuclear Materials, Ocean Energy, Photovoltaic Solar Energy, Shale Gas, Smart Cities, Smart Grids, Wind Energy

EERA GE members are listed in the table below.

Member State	Research institution
Italy	Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) Italian Institute for Geophysics and Volcanology (INGV) Italian National Agency for New Technologies, Energy, and Sustainable Economic Development (ENEA) Italian National Research Council (CNR) Politecnico di Milano (POLIMI) Politecnico di Torino (POLITO) Sapienza University of Rome (SAPIENZA) Sant'Anna School of Advanced Studies (SSSUP/SSSA) University of Bari Aldo Moro (UNIBA) University of Florence (UNIFI) University of Turin (UNITO)
Germany	Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences (GFZ) International Geothermal Centre (GZB) Helmholtz Zentrum für Umweltforschung (UFZ) Karlsruhe Institute of Technology (KIT) RWTH Aachen University (RWTH) Technische Universität Darmstadt, Department of Geothermal Science and Technology (TUDA) University of Bayreuth (UBT)
Norway	Institute for Energy Technology (IFE) NORCE-Norwegian Research Centre (NORCE) SINTEF University of Bergen (UiB)
France	French Geological Survey (BRGM) University of Strasbourg (UNISTRA) Lorraine University (UL)
Netherlands	Netherlands Energy Research Alliance (NERA/TUD) The Netherlands Organisation for applied scientific research (TNO) Utrecht University (UU)
Switzerland	Ecole Polytechnique Fédérale de Lausanne (EPFL) Swiss Federal Institute of Technology in Zürich (ETH Zürich) University of Geneva (UNIGE)
Belgium	The Belgian Research Alliance (BERA/VITO)
Greece	Centre for Renewable Energy Sources and Saving (CRESS)
Portugal	National Laboratory for Energy and Geology (LNEG)
UK	Natural Environmental Research Council/British Geological Survey (NERC/BGS)
Iceland	Iceland GeoSurvey (ISOR)

Table 3 EERA GE members

4. Project inventory

The inventory presented below bases on the data published by (Siddigi & Breembroek, 2019) and was completed with the data provided by the EERA GE members and updated in early 2020. The table includes 8 GEOTHERMICA projects, 26 HORIZON 2020 projects, 3 projects funded with multilateral funding opportunities and 42 large national (NL, NO, FR, DE, CH) projects.

Most of the projects are devoted to one or more R&I actions. The number of projects focusing on the eight R&I actions is shown in Figure 1. The non-technical barriers are covered by 8 projects, the cross-cutting issues by 2.

Project name	Website or short description	Start year	End year	Budget / Funding (EUR million)	Relevant activities addressed/ targets achieved	Results open to SET Plan community
GEOTHERMICA						
CAGE	http://www.geothermica.eu/projects/cage/	2018	2021	13.5 / 5.8	R&I 6	Y
COSEISMIQ	http://www.geothermica.eu/projects/coseismiq/	2018	2021	2.5 / 1.1	R&I 3, NTBE A	Y
GeConnect	https://www.geothermalresearch.eu/geconnect/	2018	2021	1.2 / 0.9	R&I 3, 6	Y
GEOFOOD	https://geofoodproject.eu/	2018	2021	1.7 / 1.2	R&I 7, NTBE A	Y
GEO-URBAN	http://www.geothermica.eu/projects/geo-urban/	2018	2021	0.7 / 0.5	R&I 1	Y
HEATSTOR E	https://www.heatstore.eu/project.html	2018	2021	16.3 / 8.3	R&I 1, 7	Y
PERFORM	http://www.geothermica.eu/projects/perform/	2018	2021	3.0 / 2.2	R&I 2, 4	Y
ZoDrEx	http://www.geothermica.eu/projects/zodrex/	2018	2021	4.9 / 2.9	R&I 6, 3	Y
Horizon 2020						
CARBFIX2	https://www.carbfix.com/	2017	2021	2.2 / 2.2	R&I 8	Y
CHPM2030	https://www.chpm2030.eu/	2016	2019	4.2 / 4.2	R&I 3	Y
CoolHeating	https://www.coolheating.eu/en/	2016	2018	1.6 / 1.6	R&I 1, 7	Y

CROWDTHE RMAL	https://cordis.europa.eu/project/rcn/224316/factsheet/en	2019	2022	2.3	NTBE A & B	Y
DEEPEGS	https://deepegs.eu/	2015	2019	42 / 19	R&I 3, 6	Y
DESCRAMBLE	http://www.descramble-h2020.eu/	2015	2018	15.7 / 6.8	R&I 6, 3	Y
DESTRESS	http://www.destress-h2020.eu/en/home/	2016	2020	24.7 / 10.7	R&I 3, 6	Y
EoCoE-II	www.eocoe.eu	2019	2021	8.6 / 8.3	R&I 5	Y
GECO	https://geco-h2020.eu/	2018	2022	18.2 / 15.6	R&I 8	Y
GeMex	http://www.gemex-h2020.eu/index.php?lang=en	2016	2020	10 / 10	R&I 3, 5	Y
Geo-Coat	http://www.geo-coat.eu/	2018	2021	4.7 / 4.7	R&I 2	Y
Geo-Drill	https://cordis.europa.eu/project/id/815319	2019	2022	5.0 / 5.0	R&I 2, 6	Y
GEOENVI	https://www.geoenvi.eu/	2018	2021	2.5 / 2.5	R&I 8, NTBE A	Y
GeoFit	https://cordis.europa.eu/project/id/792210/en	2018	2021	7.9 / 9.9	R&I 6	Y
GeoHex	https://cordis.europa.eu/project/id/851917	2019	2022	5.0 / 5.0	R&I 2,4	Y
GEOPRO	https://cordis.europa.eu/project/id/851816	2019	2021	5.0 / 5.0	R&I 5	Y
GEORISK	https://www.egec.org/georisk-project/	2018	2021	2.2 / 2.2	NTBE B	Y
GeoSmart	https://www.geosmartproject.eu/	2019	2023	19.7 / 17.4	R&I 7, 4, 2	Y
GEoUs	https://cordis.europa.eu/project/id/856670	2020	2022	0.7 / 0.7	NTBE A	Y
GeoWell	http://geowell-h2020.eu/	2016	2019	4.7 / 4.7	R&I 2, 6	Y
MEET	https://www.meet-h2020.com/	2018	2021	11.7 / 10.0	R&I 3,4	Y
REFLECT	https://cordis.europa.eu/project/id/850626	2020	2022	5.0 / 5.0	R&I 2,5	
S4CE Science for Clean Energy	http://science4cleanenergy.eu/	2017	2020	9.8 / 9.8	R&I 8	Y
SU-DG-IWG	https://cordis.europa.eu/project/id/838814/en	2019	2022	1.0 / 1.0	CC A, B	Y
SURE	http://www.sure-h2020.eu/	2016	2019	6.1 / 5.9	R&I 6, 3	Y
THERMODRILL	http://www.thermodrill-h2020.org/	2015	2019	5.8 / 5.4	R&I 6	Y
Multilateral funding opportunities						

SYSEXPL-REX (D, CH)	SYSEXPL - Systematic Geothermal Exploration via (geo)magnetic Potential Field Methods; REX-Quantitative exploration risk analysis	2019	2023	3.2 / 2.4	R&I 5	Y
IDDP (IS, NO)	http://iddp.is/					
DGE Rollout (D, NL, B, F)	https://www.nweurope.eu/projects/project-search/dge-rollout-roll-out-of-deep-geothermal-energy-in-nwe/	2018	2022	18.7 / 11.1	R&I 1, 5	Y
Large national/regional projects						
SCAN (NL)	https://scanaardwarmte.nl/english/ Seismic campaign, novel data reprocessing and exploration wells to facilitate future geothermal development	2019	2021	15.0 / 15.0	R&I 5	Y
HIPE (NL)	https://www.rvo.nl/subsidies-regelingen/projecten/high-performance-geothermal-well	2017	2021	6.0 / 3.8	R&I 6	Y (partially)
CRECCIT (NL)	https://www.rvo.nl/subsidies-regelingen/projecten/cost-reducing-enhanced-composite-casing-installation-technology	2016	2021	10.0 / 5.2	R&I 2, 6	Y (partially)
LEAN (NL)	http://europeangeothermalcongress.eu/wp-content/uploads/2019/07/346.pdf	2018	2021	13.5 / 6.0	R&I 1, 5, 6	Y (partially)
EPOS – NL (NL)	https://www.uu.nl/en/research/departement-of-earth-sciences/collaboration/epos-nl	2019	2024	12,5	R&I 5	Y
Geothermal Directional Drilling (NL)	https://www.rvo.nl/subsidies-regelingen/projecten/geothermal-directional-drilling	2014	2019	8.9 / 4.0	R&I 1, 6	Y (partially)
G2G (NL)	https://www.rvo.nl/subsidies-regelingen/projecten/geothermal-directional-drilling	2014	2020	8.0 / 1.4	R&I 6	Y (partially)

	regelingen/projecten/g2g-van-gas-naar-geothermie					
ANIGMA (NO)	https://www.uib.no/fg/brs/118027/characterising-modeling-geothermal-reservoirs-anigma#project-coordinator-s-	2015	2019	1.2	R&I 5	?
INNO-Drill (NO)	https://www.sintef.no/en/projects/inno-drill-technology-platform-for-research-based-/	2016	2019	3.5	R&I 5	?
ERIS (NO)	https://pmg.w.uib.no/eris/	2017	2020	1.3	R&I 4	Y
RockStore (NO)	RockStore's objective is to evaluate, develop and demonstrate the design and operation of borehole thermal energy storage systems for buildings, district heating and neighbourhoods.	2018	2022	1.3	R&I 1, 7	Y
TheMSES (NO)	https://themses.w.uib.no/	2016	2022	2.4	R&I 5	Y
DONUTS (FR)	Development of Digital Interpretation and Processing Tools for Geophysical Signals for unconventional reservoirs.	2019	2020	1.4 / 0.9	R&I 5	Y
EGS Alsace (FR)	geothermie.es.fr	2015	2019	4.7	R&I 3	
GEFISS (FR)	http://www.geodenergies.com/sites/default/files/upload/documents/fichesprojet/fiche_synthetique_gefiss_en.pdf	2018	2022	3.5 / 1	NTBE A	
GEOFAST (FR)	Drilling tools for hard rocks	2017	2020	1.7 / 0.8	R&I 2	Y (partially)
GEOPUMP (FR)	Pumps for geothermal resources	2018	2020	1.7 / 0.9	R&I 2	Y (partially)
GEOTREF (FR)	https://geotref.com/fr/page-daccueil/	2015	2023	43 / 30	R&I 5	Y (partially)
Injection CO2	Coupled geothermal exploitation and COP2 injection	2018	2020	2.0 / 0.7	R&I 8	Y (partially)

LabEx G-eau-thermie Profonde (FR)	http://labex-geothermie.unistra.fr/en/labex-g-eau-thermie-profonde/	2012	2020	6.3	R&I 3, 5	Y (partially)
Pilot CO2 dis (FR)	http://co2-dissolved.brgm.fr/	2016	2018	2.3 / 0.9	R&I 8	Y (partially)
Ouroboros (FR)	Optic fibres to monitor deep reservoirs	2018	2021	1.2/0.6	R&I 6	Y partly
Pertherm (FR)	Monitoring the cold bubble	2018	2020	0.7/0.2	R&I 4	Y partly
Refllet (FR)	Methodology for the construction of a conceptual model of a Fault type geothermal reservoir in a graben context (France)	2015	2020	8.3/4.9	R&I 5	Y partly
Temperer (FR)	induced microseismicity	2016	2020	3.0/1.4	R&I 3	Y partly
Therma'li (FR)	li' extraction from geothermal brines	2019	2023	1.6/0.6	R&I 5	Y partly
FaMeK (DE)	Fiber-optic acoustic measuring system for more accurate and cost-effective exploration of deep geothermal wells	2018	2020	2.6 / 1.3	R&I 6	Y
Drill:BOGS (DE)	Acquisition, implementation and first operation of a fully automatic, large-scale drill rig for the development of next generation drilling technologies for the exploration of deep geothermal systems	2018	2020	0.52	R&I 6	Y
EffGeo (DE)	Specific and general improvements in efficiency of geothermal power plants	2018	2021	0.83 / 0.4	R&I 4	Y
ReSalt (DE)	Reactive Reservoir systems - Scaling and Erosion and its Impact on Hydraulic and Mechanic Reservoir properties	2018	2020	2.0 /1.9	R&I 2 & 3	Y

GeoMo (DE)	Geothermal monitoring for the installation and operation of probes with integrated monitoring of the consumption for individual optimization of the heat pump	2019	2021	1.9 / 1.5	R&I 1	Y
INSIDE (DE)	Handling induced seismicity and ground displacements as interference aspects during the operation of geothermal projects in the South German Molasse basin.	2019	2022	4.7 / 3.1	R&I 1 & CC A	Y
GeoFern (DE)	Geothermal District Heat Supply in Berlin	2019	2022	1.8	R&I 1	Y
GeoMare (DE)	Optimized control and operation technology with sustainable reservoir management for the deep geothermal heat projects in the Munich area	2018	2021	5.3 /3.1	R&I 1	Y
Geothermal Alliance Bavaria	https://www.mse.tum.de/en/geothermal-alliance-bavaria/	2016	2020	11.5	R&I 1, 2, 5, 6	Y
Hessen §D 2.0	https://www.geo.tu-darmstadt.de/fg/angeotherm/geotherm_projekte/hessen_3d.de.jsp	2016	2020	0.95	R&I 1, 2, 6	Y
OBE (DE)	Optimization of drilling operations for geothermal projects through realistic real-time simulation	2019	2022	1.3	R&I 6	Y
Optimog	https://www.geo.tu-darmstadt.de/fg/angeotherm/geotherm_projekte/optimog.de.jsp	2017	2020	0.9	R&I 4, 5, 6	Y
Roll-out of Deep Geothermal Energy in NWE – Germany (DE)	Roll-out of Deep Geothermal Energy in NWE – Germany; a project portfolio that aims to substitute coal-fired energy supply into district	2019	2022	6.2 (2.35 German Funding, 3.85 NER 300 for German Part)	R&I 1	Y

	heating schemes with geothermal energy supply					
SEIGER (DE)	Seismic monitoring of deep geothermal power plants and possible seismic impact	2019	2022	3.3 / 2.8	NBTE-A	Y
VALTRE (CH)	Validating technologies for EGS development	2017	2020	12.4 / 2.3	R&I 3	Y

Table 4 Geothermal project list

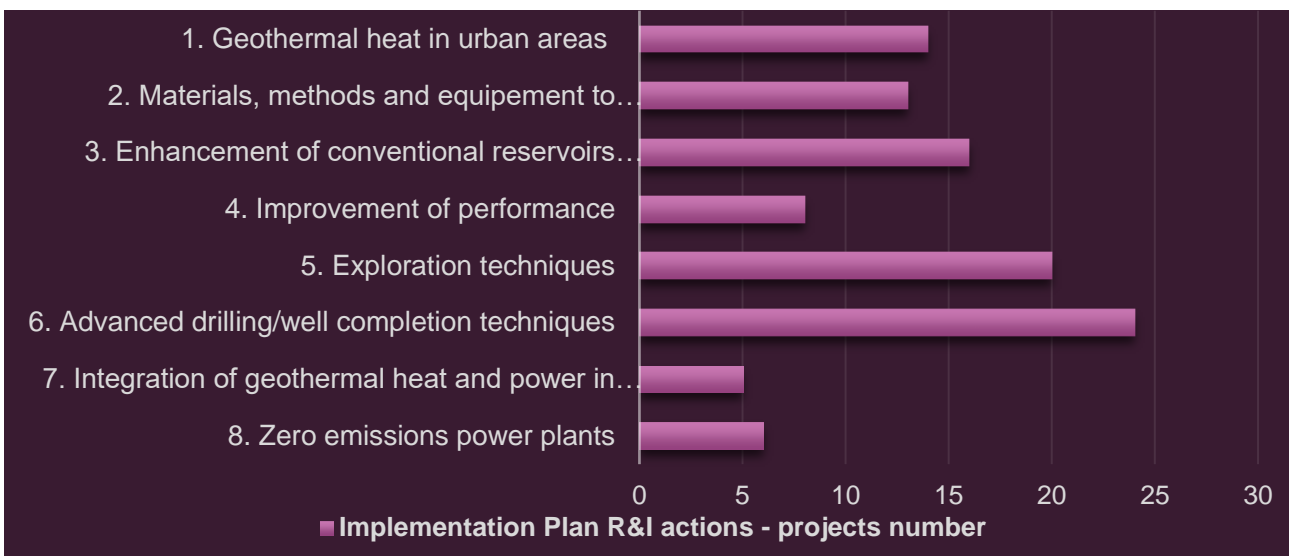


Figure 1 Number of projects corresponding to the Implementation Plan R&I Actions (described in Implementation Plan R&I Actions)

5. Conclusion

The first data on national and European public R&D actions are available. Contributions from non-ERA members are still missing, and information on national public R&D activities needs to be completed in the next forthcoming report.

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