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LEAP-RE
Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Report about the outcome on scientific collaboration and potential for training

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Summary

The report outlines the significant outcomes and capacity-building efforts resulting from the LEAP-RE WP9-Geothermal Atlas for Africa project's scientific collaborations between Europe and Africa. The key actions involved focused training, research mobility and the promotion of scientific exchange, contributing to the advancement of geothermal knowledge, sustainable energy transitions, and the development of future energy systems in AU countries, including energy system integration. Key Achievements: 1. Research Mobility and Networking Facilitated knowledge exchange and research mobility between AU-EU countries. Enabled the creation of collaborative links between African and European geothermal institutions, encouraging knowledge-sharing and long-term cooperation. 2. Capacity Building Developed and implemented specialized geothermal training courses targeting scientists, and stakeholders in Africa. Promoted knowledge transfer between Europe and Africa and among African countries, focusing on geoscientific, technical, economic and social dimensions of geothermal energy. 3. Scientific Dissemination and communication on geothermal energy and related topics through conferences, webinars and scientific publications.

Approval

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LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Research & Innovation Action

09/2025

Report about the outcome on scientific collaboration and training

Capacity Building Actions Performed

Version N°3

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This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

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Abbreviations and Acronyms

Acronym	Description
WP	Work Package
GAA	Geothermal Atlas for Africa
CB	Capacity Building

Summary

The report outlines the significant outcomes and capacity-building efforts resulting from the LEAP-RE WP9 – Geothermal Atlas for Africa project's scientific collaborations between Europe and Africa. The key actions involved focused training, research mobility and the promotion of scientific exchange, contributing to the advancement of geothermal knowledge, sustainable energy transitions, and the development of future energy systems in AU countries, including energy system integration.

Key Achievements:

1. Research Mobility and Networking

Facilitated knowledge exchange and research mobility between AU-EU countries.

Enabled the creation of collaborative links between African and European geothermal institutions, encouraging knowledge-sharing and long-term cooperation.

2. Capacity Building

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Developed and implemented specialized geothermal training courses targeting scientists, and stakeholders in Africa.

Promoted knowledge transfer between Europe and Africa and among African countries, focusing on geoscientific, technical, economic and social dimensions of geothermal energy.

3. Scientific Dissemination and communication on geothermal energy and related topics through conferences, webinars and scientific publications.

Keywords

Capacity building, transfer knowledge, international conferences, scientific publications, research mobility, training, young researchers, renewable energy, geothermal.

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1. Schools and Training

An assessment of capacity training needs was developed, based on knowledge gap identified during the creation of the Geothermal Atlas coupled with the mapping of existing training addressed to different stakeholders (i.e. academia, research, industry, vocational). Courses were developed in collaboration with existing geothermal training programs. This allowed the identification of knowledge gap to be filled and specific needs to based on regional specificities (both from geological, infrastructure, and social gaps). The creation of a network for geothermal resources assessment also guaranteed that the Geothermal Atlas for Africa remained alive with newly information made available a-posteriori as it may was implemented further into a GIS form in relation with existing platform. The structure of research mobility and capacity building actions realized within GAA can be summarized in the following points:

- Organization of research mobility
- Development of courses on geothermal energy and transfer of knowledge and experience from Europe to Africa
- Capacity building for African partners.

A series of high-impact training events were conducted, targeting both early career researchers and students, with a focus on geothermal energy systems.

1. RESchool – Renewable Energy Schools for PhD students to early career researchers and innovators were held during the three LEAP-RE Stakeholder Forum in Pretoria (South Africa, 2022), in Kigali (Rwanda, 2023) and in Milan (Italy, 2024).

The aim of the schools was to support the development of early career researchers and innovators or entrepreneurs who are part of the LEAP-RE community. Format: hybrid (in presence and online). WP9 – GAA partners were actively involved for the preparation and for lectures/training of the RESchools.

1st RESchool held in Pretoria, Title: Energy modelling in Geothermal

2nd RESchool held in Kigali, Titles:

- Geothermal energy: fundamentals, technologies, examples.
- Life Cycle Assessment: Environmental analysis of geothermal system

2. Short geothermal course of the GRÓ-GTP, GDC, KenGen in Naivasha, Kenya (30/11/2021); More than 50 participants from different African countries (Algeria, Burundi, Comoros, Djibouti, DRC, Ethiopia, Malawi, Morocco, Nigeria, Rwanda, Tanzania, Uganda, Zambia, Kenya)

3. Short training: introduction to the GAA project by UNIFI as GAA coordinator; An overview of geothermal energy, Utilization of geothermal resources, Introduction to thermodynamic modeling and its applications in geothermal systems and Socioeconomic assessment of geothermal systems by SU and LCA of geothermal energy systems by the Geothermal Development Company (GDC). The 30 attendees were from: the UNESCO Chair for Climate Change, Resilience and Sustainability team (SU), the data science team from iLab Africa (SU), UNIFI, Strathmore Business School (SBS), TNO, GIZ Kenya, Strathmore Energy Research Centre (SERC), GDC, Kenya Electricity Generating Company (KenGen), Technical University of Kenya (TUK) and students from the Master of Science in

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Sustainable Energy Transitions program (MSc. SET) (SU). Kickoff GA Meeting in SA, 7th - 9th June 2023

4. An online training course for 60 engineering students on power generation, geothermal systems covering power generation using electrical generators, alternative prime movers for electricity generation, steam turbines and their use in power generation. This was to prepare them ahead of the Olkaria visit. 19 October 2023

5. SCES students visit Olkaria. A visit to KenGen's power plant by the project team and 90 undergraduate engineering students from the School of Computing and Engineering Sciences (SCES) at SU. The team and students got an opportunity to interact and be trained on geothermal systems, 24 October 2023.

6. BSc. Electrical and Electronics Engineering on geothermal power production through training and site visit

7. A visit to Or Power plant, a binary plant, in the Olkaria region by the project team. This involved a guided tour around the facility where the team got a chance to interact with binary geothermal technology, 22nd May 2024.

8. Free access, training and/or use of geo-scientific laboratories in Europe. Opportunities for African researchers and students to get free training in advanced analytical methods (experimental rock deformation; analogue modelling; multi-scale X-ray and electron microscope structural and chemical imaging). Two calls:

•EXCITE network call (open from June 15 until August 31, 2023);

•EPOS-NL call (open from July 3 until August 31, 2023)

9. Online lecture for undergraduate engineering students on GAA and geothermal systems

10. Lecture carried out at Strathmore University on GEOTHERMAL ATLAS FOR AFRICA AND INTERNATIONAL PtX TRAINING. Main focus on geothermal energy and applications for the exploitation of the resource, social and environmental analysis, and development of the decision-making tool (UNIFI).

11. Enhanced capacity of young professionals to carry out Thermodynamic modeling and LCA analysis on available software (UNESCO Chair for Climate Change Resilience and Sustainability & Data science team-iLab Africa teams)

12. Training on Introduction to Geothermal Science, Technology and Social Sciences to Homa Hills Geothermal Community-Based Organisation and relevant government officials (15th and 16th November, 2023).

2. Research/Career

1. PhD thesis: Development of a decision-making tool for the sustainable exploitation of geothermal resources in Africa, Doctoral thesis, University of Florence, Italy, [DOI], Claudio Zuffi, 2025

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2. Joint UU-UDSM PhD: Lithospheric Structure and Thermal Characterization of Southwest Tanzania: Implications for Geothermal Resource Exploration. Doctoral thesis, Utrecht University, The Netherlands. [doi], Mtabazi EG, 2025.

3. Three BSc Thesis on: Geothermal power plants and resources in Africa, current status and possible future developments; Assessment of Geothermal and power plant potential in Sub-Saharan Africa: Current Status and Possible Developments

4. Thesis geochemical supervision: Etude de la dynamique d'écoulement dans le système hydrothermal du rift d'Asal, République de Djibouti of the Abdek Hassan Aden's (from Ministry of Energy and Natural Resources of the Republic of Djibouti) thesis. This thesis was funded by the Islamic Development Bank, begun in 2019 and finished in July 2022.

5. The Project sponsored two DeKUT students to Nairobi to the 3-day Kenya Geothermal Conference in July 2022.

6. Internship 1st year Master on Bugarama data.

7. Three final year students for internship at TGDC-Tanzania Geothermal Development Company, USDM.

8. EU-AU joint research: Joint UU-TNO MSc intership and MSc thesis research projects.

9. Cooperation with Strathmore University staff in the framework of hiring African researchers by UNIFI, GFZ, TNO.

10. Questionnaire, giving a good overview of the data needed/required for the Geothermal Atlas for Africa (English/French version), circulating via Jean-Claude Guillaneau (BRGM General Direction and manager of the PanafGeo training and AfricaMaVal EU-AU projects) in order to increase the contacts with all the African Geological Surveys and get relevant data from North and West Africa partners.

It opened the door towards further reseach specilization, developing skills and capacity of young researchers. 2 young researchers at NARSS are currently focusing on geothermal energy.

3. Dissemination and Communication

3.1 Conferences (Proceeding/Oral Presentation)

1. Characterization of the geothermal resource in Africa: maps of engineering applications for sustainable use with focus on low to medium temperatures. Claudio Zuffi, Jan Diederick van Wees, Isabella Nardini, Daniele Fiaschi. 18th Conference on Sustainable Development of Energy, Water, and Environmental Systems (SDEWES), Saidia, Morocco, from June 2-6, 2025.

2. Sustainability assessment of geothermal energy systems: an example from REShcool within LEAP-RE GAA Project, D. Fiaschi, C. Zuffi, I. Nardini, AFRICAN ENGINEERING EDUCATION FORUM, Morocco, 2025.

3. Maestrelli, D. and Sánchez Á., C. P.: A dynamic study of caldera collapse: Insights from analogue models and geophysical data, EGU General Assembly 2025, Vienna,

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Austria, 27 Apr–2 May 2025, EGU25-9714, https://doi.org/10.5194/egusphere-egu25-9714, 2025.

4. 26th World Energy Congress, the LEAP-RE Project with focus on geothermal energy potential and applications, 22 – 25 April 2024, Rotterdam, NL.

5. Zuffi, C., Ramundi, F., & Fiaschi, D. (2024). HIGH-TEMPERATURE HEAT PUMPS FOR GEOTHERMAL APPLICATIONS IN AFRICA: THERMODYNAMIC, ECONOMIC AND ENVIRONMENTAL EVALUATION. In 37th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, ECOS 2024 (pp. 1-12). ECOS 2024.

6. Characterisation of the geothermal resource in Africa and maps for sustainable exploitation. C. Zuffi, J. D. van Wees, H. Veldkamp, M. van Unen, J. Mos, J. Hofstra, J.F. Hesselman, Fred Beekman, I. Nardini, D. Fiaschi. Proceedings, 10th African Rift Geothermal Conference Dar es Salaam, Tanzania, 23-25 October 2024.

7. Maestrelli, D., Corti, G, Bonini, M, Keir, D., Facincani, P., Vannucci, P., Del Ventisette, C., Montanari, D., Sani, F. Fault reactivation and growth at rift-related calderas. 6° Conferenza Rittmann, 18-20 September 2024, Catania, Italy.

8. Corti G., Muluneh A., Keir D, Isola, I., Mazzarini F. Control of gravitational potential energy on the distribution of off-axis volcanic activity in the Turkana Depression, East African Rift. 6° Conferenza Rittmann, 18-20 September 2024, Catania, Italy.

9. Miranda, R., & Sanchez, M. (Eds.). (2024). The silent revolution: Can Sub-Saharan Africa lead the future of renewable energy? Opportunities and challenges in one of the world's most dynamic continents [Dossier Harambee]. ROMA 2024 IscomMaryvelma Nafula attended the conference and had opportunity to present on GAA and discuss how standardization aligns closely with geothermal systems with fellow young professionals. International Electrotechnical Commission (IEC) Young Professionals Conference, 21-24 October 2024.

10. The Kenya Geothermal Congress' (2024): Discussions on scientific cooperation and proposal preparation on focused on geothermal in Kenya.

11. 18th Conference on Sustainable Development of Energy, Water, and Environmental Systems (SDEWES), 2023.

12. Zuffi, C., Socci, L., Rocchetti, A., Manfrida, G., & Fiaschi, D. (2023). Evaluation and possible direct utilization of low-to medium-enthalpy geothermal resources for the sustainable development of the african continent. In 36th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, ECOS 2023 (pp. 1631-1642). International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems.

13. Renewable energy communities in Africa: Evidence from a systematic literature review. Conference paper presented at the SIMA Conference 2023, 29-30 June 2023, Bari, Italy. Iannone F., Annunziata E., Rizzi F., Frey M. Proceedings: ISBN 978-88-94-7136-3-3.

14. 9th African Rift Geothermal Conference' (ARGeo-C9), Exploration of the deep geothermal potential of Petite-Terre Island in Mayotte, Chrystel Dezayes, Alexandre Stopin, Pierre Wawrzyniak, Frederick Gal, Thomas Farlotti, Philippe Calcagno, Antoine Armandine Les Landes, https://brgm.hal.science/hal-03799757; Djibouti 1-6 November, 2022.

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15. 9th African Rift Geothermal Conference' (ARGeo-C9), Auxiliary chemical geothermometers applied to waters from some East African Rift geothermal areas (Djibouti, Ethiopia and Kenya) for geothermal exploration" by Bernard Sanjuan (2022), Djibouti 1-6 November, 2022. [DOI]

16. 9th African Rift Geothermal Conference' (ARGeo-C9), Steps to Outline the Maps of Engineering and Social Sustainability of Geothermal Resources. J. Onjala, W. Mitullah, E. Annunziata, F. Iannone, M. Frey, I.A. El-Magd, N. Soliman, S. Magdy, C. Rochelle, D. Jones, L. Talluri, C. Zuffi, D. Fiaschi, Djibouti 1-6 November, 2022.

17. Bonechi, N., Fiaschi, D., Manfrida, G., Talluri, L., & Zuffi, C. (2021). Exploitation assessment of geothermal energy from African great rift valley. In E3S Web of Conferences (Vol. 312, pp. 1-7). EDP Sciences.

18. C. Zuffi, J. D. van Wees, H. Veldkamp, M. van Unen, J. MMos, J. Hofstra, J.F. Hesselman, Fred Beekman, I. Nardini, D. Fiaschi. 2024. Characterisation of the geothermal resource in Africa and maps for sustainable exploitation.

19. D. Fiaschi, Geothermal Atlas for Africa at Macerata Humanities Festival, September 2022, Macerata (Italy)

20. Maestrelli D., "Evolution of rift calderas and faults and implications for geothermal systems". TALENTS The rift science network for energy transition - Marie Skłodowska-Curie Actions, 2 Workshop, 11-17 May 2025 Florence, Italy.

21. Zuffi C.-Ungar P.-Agostini F.-Bigi T.-Cappello I.-Linari A.-Manfrida G., Talluri L., Fiaschi D.,Proceedings of ECOS 2022 - 35th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems

3.2 Journal Articles/Books/GIS Dataset/Reports

1. Geothermal Atlas for Africa, LEAP-RE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530

2. Zuffi C., & Fiaschi D. (2025). High-temperature heat pumps for geothermal applications in Africa: thermodynamic, economic and environmental evaluation. Applied Thermal Engineering, 127302. [doi]

3. Corti, G., Maestrelli, D., Bonini, M., & Sani, F. (2025). Off-rift volcanism during continental rifting: Observations and models with a focus on the Main Ethiopian Rift, East Africa. Journal of African Earth Sciences, 105590.

4. Corti, G. et al., (2025). Control of gravitational potential energy on the distribution of off-rift volcanic activity in the Turkana depression, East African rift. Geophysical Research Letters, 52(12), e2024GL114277.

5. Zuffi, Claudio and Fiaschi, Daniele and Musonye, Xavier and Mukhongo, Harness and Nafula, Maryvelma and Da Silva, Izael, Predictive Model for Sustainable Exploitation of Geothermal Resources in Africa: The Case of Olkaria Geothermal Field.SSRN: https://ssrn.com/abstract=5334709

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6. Sanjuan B. (2024). Auxiliary chemical geothermometers applied to waters from some East African Rift geothermal areas (Djibouti, Ethiopia and Kenya) for geothermal exploration. Journal of Petroleum and Chemical Industry International, Vol. 7, Issue 4, 12 p.

7. Van Wees JD, Hofstra J, Veldkamp H, Van Unen M, Beekman F, Mos J, 2024. Geothermal Atlas for Africa: From resource mapping to performance indicators. EU H2020 LEAP-RE project, WP9 Geothermal Atlas for Africa. [doi]

8. Hofstra J, Beekman F, Van Wees JD, 2024. On the structure and geothermal energy potential of the sedimentary basins of Africa. EU H2020 LEAP-RE project, WP9 Geothermal Atlas for Africa. [doi]

9. Book Chapter: Geothermal Power Generation, Isabella Nardini, The Palgrave Handbook of International Energy Economics Book, Springer International Publishing, 2022 Book, DOI:10.1007/978-3-030-86884-0, ISBN:9783030868833, Open Access, p. 183-194. The Palgrave Handbook of International Energy Economics | SpringerLink

10. Hofstra J, Van Wees JD, Beekman F, 2022. On the geothermal potential of African's sedimentary basins. EU H2020 LEAP-RE project, WP9 Geothermal Atlas for Africa. [doi]

11. Finger NP, Kaban MK, Tesauro M, Mooney WD, Thomas M, 2022. A thermo-compositional model of the African cratonic lithosphere. Geochemistry, Geophysics, Geosystems, 23, e2021GC010296. [doi]

12. New Insights into Hydrothermal Fluid Circulation Affected by Regional Groundwater Flow in the Asal Rift, Republic of Djibouti" , Abdek Hassan Aden, Jasmin Raymond, Bernard Giroux and Bernard Sanjuan, 2021, Energy Journal, vol. 14, 25 p.[doi]

13. Delvaux D, Maddaloni F, Tesauro M, Braitenberg C, 2021. The Congo Basin: stratigraphy and subsurface structure defined by seismic reflection, refraction and well data. Global and Planetary Change 198. [doi]

14. Maddaloni F, Braitenberg C, Kaban MK, Tesauro M, Delvaux D, 2020. The Congo Basin: subsurface structure interpreted using potential field data and constrained by seismic data. Global and Planetary Change 205. [doi]

15. Jones, D. (2022). 'TARGET' GIS dataset: A GIS containing geo-data for the energy transition across continental Africa created by extracting data from open sources into a series of shapefiles and rasters containing information on culture, geology, geothermal and geophysical data.[doi]

16. Jones, D. (2020). A summary of the East Africa Rift Temperature and Heat Flow Model (EARTH). British Geological Survey Open Report for the Overseas Development Assistance Programme, OR/20/006, 24pp.

17. Mtabazi EG, Beekman F, De Bresser JHP, Van Wees JD, Boniface N, 2025. Integrated 3D geological model of the upper crust and East African Rift basins in SW Tanzania – Implications for geothermal resources. Global and Planetary Change (in revision).

18. Mtabazi EG, Van Wees JD, Beekman F, De Bresser JHP, Boniface N, 2025. Geothermal energy resource assessment of the East African Rift basins in SW Tanzania. Energies Geothermal (in preparation)

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19. Geothermal Potential Maps of African continent (in preparation)

3.3 Webinars and Science Days

1. LEAP-RE Webinar 29th Jan 2025 - Bridging Data and Action: Leveraging Greenhouse Gas Research to Drive Policies and Renewable Energy in Africa.

2. LEAP-RE Webinar, 22 April 2025, LEAP-RE: The Role of Geothermal Technology in Africa's Just Energy Transiton

3. Presentation at the Gender, Local Communities, and Capacity Building session, Milan Stakeholder Forum 2024.

4. Webinar on Gender-Energy Nexus, 3 June, 2024

5. Peer-2-Peer session for the Green Energy Transition in Africa, 7 May 2024

6. Sustainability Science Days 2023, University of Helsinki (Finland), 25 May 2023

7. ESEW2023 European Sustainable Energy Week. Stand representing EU-AU project (LEAP-RE), Bruxelles.

4. Other activities

1. Mapping on existing training programs and schools in AU countries in the RES sector with special attention to geothermal energy to identify gaps and needs.

2. Identification of training programs proposed by Kenya National Research Fund (NRF), and US embassy in Nairobi and others to empower women and youth through training.

3. Organization and dissemination/communication activities (i.e. webinars reported in WP4) of the Geothermal and Capacity Building Clusters within the LEAP RE Clustering activities.

4. Proposal of a round table organized by LEAP RE at COP28 in Dubai, 30/11-12/12-2023

5. Presentation to 50 Geothermal Association members online and 100 students of SEKU and DeKUT universities (DEKUT)

6. Submission of proposal to VolkswagenStiftung (26/11/2021): Pan-African Workshop on Geothermal Energy - "Knowledge for Tomorrow - Cooperative Research Projects in Sub-Saharan Africa

7. Preliminary work on the possible exploitation of geothermal resources in the African rift valley, with participation in the 76th ATI national congress "Ecological and digital transition, the role of energy".

8. Surveys of Dutch funding organizations to check for calls/opportunities to stimulate research mobility and/or to support capacity building projects.

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9. Cooperation with Strathmore University staff in the framework of hiring African researchers by UNIFI, GFZ, TNO

10. Questionnaire, giving a good overview of the data needed/wanted for the Geothermal Atlas for Africa (English/French version), circulating via Jean-Claude Guillaneau (BRGM General Direction and manager of the PanafGeo training and AfricaMaVal EU-AU projects) in order to increase the contacts will all the African Geological Surveys and get relevant data from North and West Africa partners.

11. It opened the door towards further research specialization, developing skills and capacity of young researchers. Two young researchers at NARSS are currently focusing on geothermal energy

12. EU-AU joint organization and moderation at the Gender, Local Communities, and Capacity Building session, Milan Stakeholder Forum 2024.

13. AU-EU organization and moderation of the Teaming and Twinning Session, Milan Stakeholder Forum 2024

Conclusion

The LEAP-RE WP9 – Geothermal Atlas for Africa project has contributed to the development of geothermal energy across the African continent through robust Europe-Africa scientific collaboration. By combining targeted capacity-building initiatives, research mobility, and high-level knowledge exchange, the project has strengthened both academic and technical competencies within African institutions. Furthermore, the project has laid the groundwork for long-term cooperation between African and European institutions, promoting sustainable energy transitions aligned with Africa's development priorities.

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