



PUSH-IT

Piloting **Underground **S**easonal **H**eat **S**torage **I**n geothermal reservoirs**

D5.4 Lecture about Open Science principles and practice



Funded by
the European Union

Grant agreement number	101096566		
Project title	Piloting Underground Storage of Heat In geoThermal reservoirs		
Project acronym	PUSH-IT		
Start date	01-01-2023	DURATION	48 months
End date	31-12-2026		
Work Package No. and Title	WP5 Project coordination		
Deliverable number	D5.4		
Deliverable title	Lecture about Open Science principles and practice		
Actual date of delivery	27-06-2023		
Nature	OTHERS	DISSEMINATION LEVEL	Sensitive
Deliverable Leader	Technische Universiteit Delft		
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Document history

Version	Description (Section, page number)	Author	Role (Organisation short name)
V0.1	First draft	Danitsja van Heusden & Diana Keijzer	TUD
V0.1a	Review	Consortium partners	Consortium partners
V0.2	Second draft Processed of feedback received from reviewers / partners	Danitsja van Heusden	TUD
V0.2a	Review	Consortium partners	Consortium partners
V1.0	Final version	Danitsja van Heusden	TUD

Quality control

Author	Organisation short name	Role	Date
Danitsja van Heusden	TUD	Work Package Leader & Deliverable Leader	16-05-2023
Consortium partners	Consortium partners	Reviewers	26-05-2023
Martin Bloemendal	TUD	Scientific Project Coordinator	26-06-2023
Danitsja van Heusden	TUD	Project Coordinator	26-06-2023

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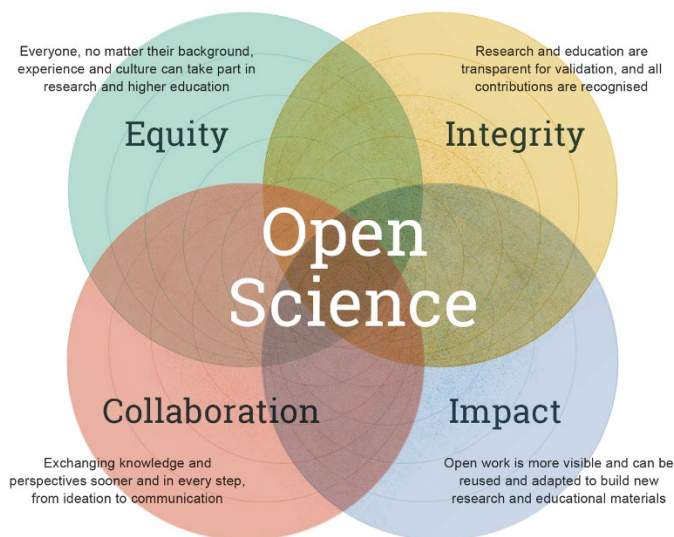
1. Introduction

The PUSH-IT project is focussing on extending storage temperature ranges to high temperatures with a consortium of eighteen partners across Europe. The use and the development of open standards and also practicing open science is important to maximize the use of the results during and after the project lifespan. Open Science assures that the (intermediate) results of the project are findable, accessible, interoperable and reusable by others. This is important for the scalability of the project results, the uptake of the results by a wide range of stakeholders and the maximization of the project's impact.

This deliverable documents the presentation on Open Science given by Dr. ir. Bastiaan van Loenen and Tanya Yankelevich, both from Delft University of Technology. In the presentation, the open science principles are explained. The recorded lecture has been shared with the PUSH-IT consortium members via the PUSH-IT MS Teams Channel. All consortium members were invited to view the lecture and it has been discussed during a Steering Committee meeting on 23 May 2023. This enables all members of the PUSH-IT consortium to optimally adhere to these principles and apply the open science within the PUSH-IT project.

Practicing Open Science is an important principle in the PUSH-IT project in order to make best use of the project results during and after the project. At the next General Assembly in November 2023 in Litomerice, Czech Republic, we will also reserve some time in the program on this topic to discuss in person some relevant aspects on this matter.

The Open Science Lecture is based on the EU document '*Providing researchers with the skills and competencies they need to practice Open Science*¹.' The open science practices of PUSH-IT are in line with Section 1.2.13 of the Grant Agreement.



¹ European Commission, Directorate-General for Research and Innovation, O'Carroll, C., Hyllseth, B., Berg, R., et al., Providing researchers with the skills and competencies they need to practise Open Science, Publications Office, 2017, <https://data.europa.eu/doi/10.2777/121253>

2. Lecture

The lecture was given by Dr. Bastiaan van Loenen and Tanya Yankelevich. **Dr. ir. Bastiaan van Loenen** (associate professor) holds a PhD from Delft University of Technology, and a M.Sc. from The University of Maine (Spatial Information Science and Engineering) and Delft University of Technology (Geodetic Engineering). He is chairing the [Knowledge Center Open Data](#) at the Faculty of Architecture and The Built Environment. **Ms. Tanya Yankelevich** (M.Sc MRes) is Delft University of Technology Open Science programme community engagement manager.

The main topics of the lecture were:

- An introduction to Open Science and its (cultural) history
- Definitions of Open Data and their usage and relevance
- The European Union's Open Science Policy and the EU's Open Science Ambition for 2020-2024
- The FAIR principles
- Open Data: interfering interests
- The European Union's Open Data Directive
- Definitions and conditions of Research Data
- High Value Datasets and the special regime they require
- Open Licences
- Further reading

3. Conclusion

The main message of the lecture to publish data and software that will be delivered by the project is “As open as possible; as closed as necessary”. The lecture was well received by the project beneficiaries and proved very useful to translate knowledge into the practice of the PUSH-IT project. Moreover, since at Delft University of Technology each faculty has a Data Steward to accompany individual researchers and consortium projects in their handling of Open Science principles, remaining or upcoming questions about open science principles can be asked to experts to be able to optimally implement them in PUSH-IT.

Annex 1: Presentation slides of the Lectures Open Science

Open data: What is it and what does it really mean?

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<https://www.kc.opendata.eu>



ODECO

Towards a sustainable Open Data ECOSystem
<https://www.odeco-research.eu>

Open data

1. Data Must Be Complete
2. Data Must Be Primary
3. Data Must Be Timely
4. Data Must Be Accessible
5. Data Must Be Machine processable
6. Access Must Be Non-Discriminatory
7. Data Formats Must Be Non-Proprietary
8. Data Must Be License-free
9. Compliance must be reviewable
10. The work shall be available as a whole and at no more than a reasonable reproduction cost

<http://opendefinition.org/okd>

Updating the Open Definition to meet the challenges of today

Home / Featured / Updating the Open Definition to meet the challenges of today

March 16, 2023, by [Renata Ávila](#)



About Renata Ávila

CEO at Open Knowledge Foundation.

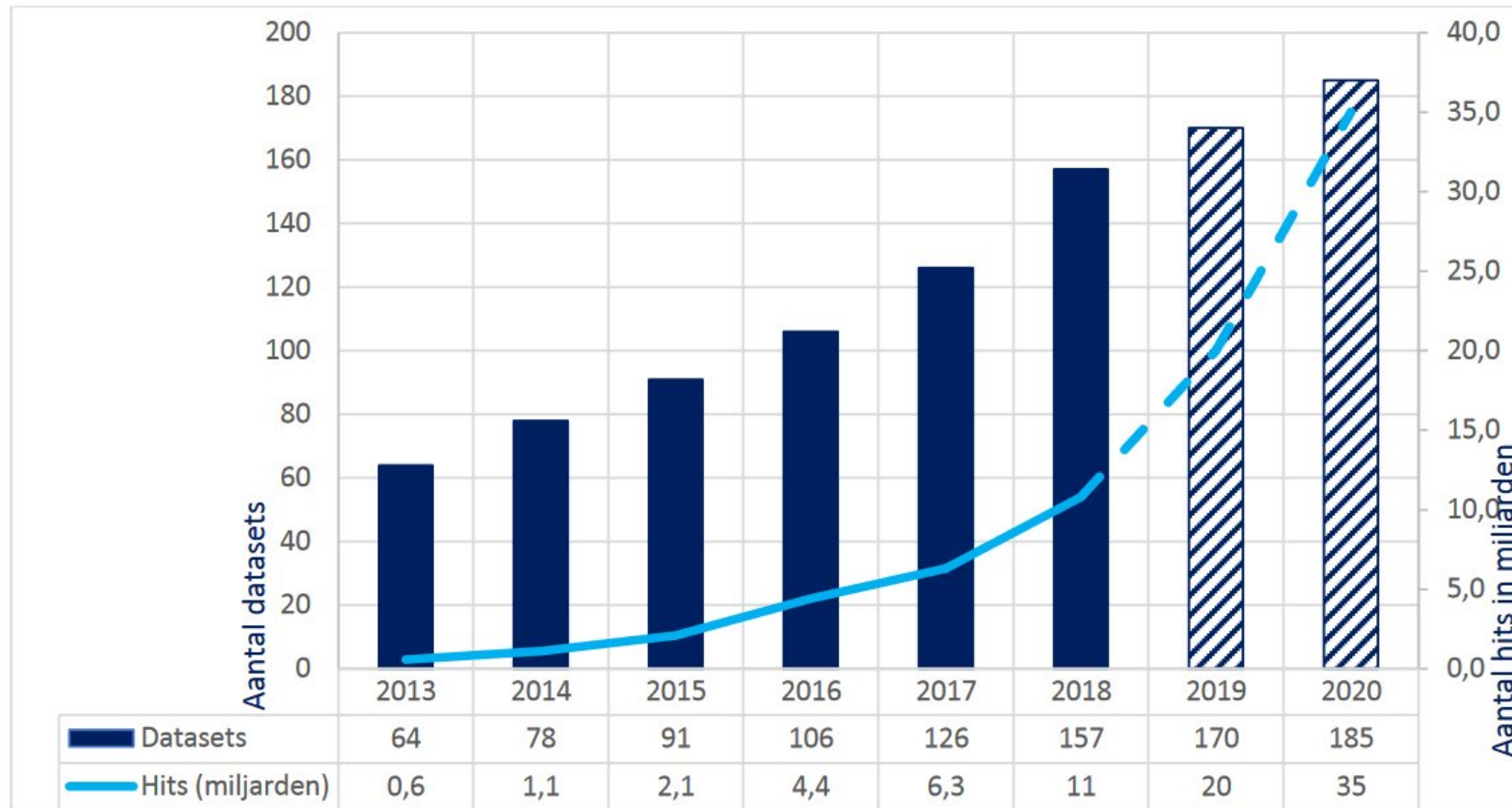
Check:

<https://blog.okfn.org/2023/03/16/updating-the-open-definition-to-meet-the-challenges-of-today/>

Open data

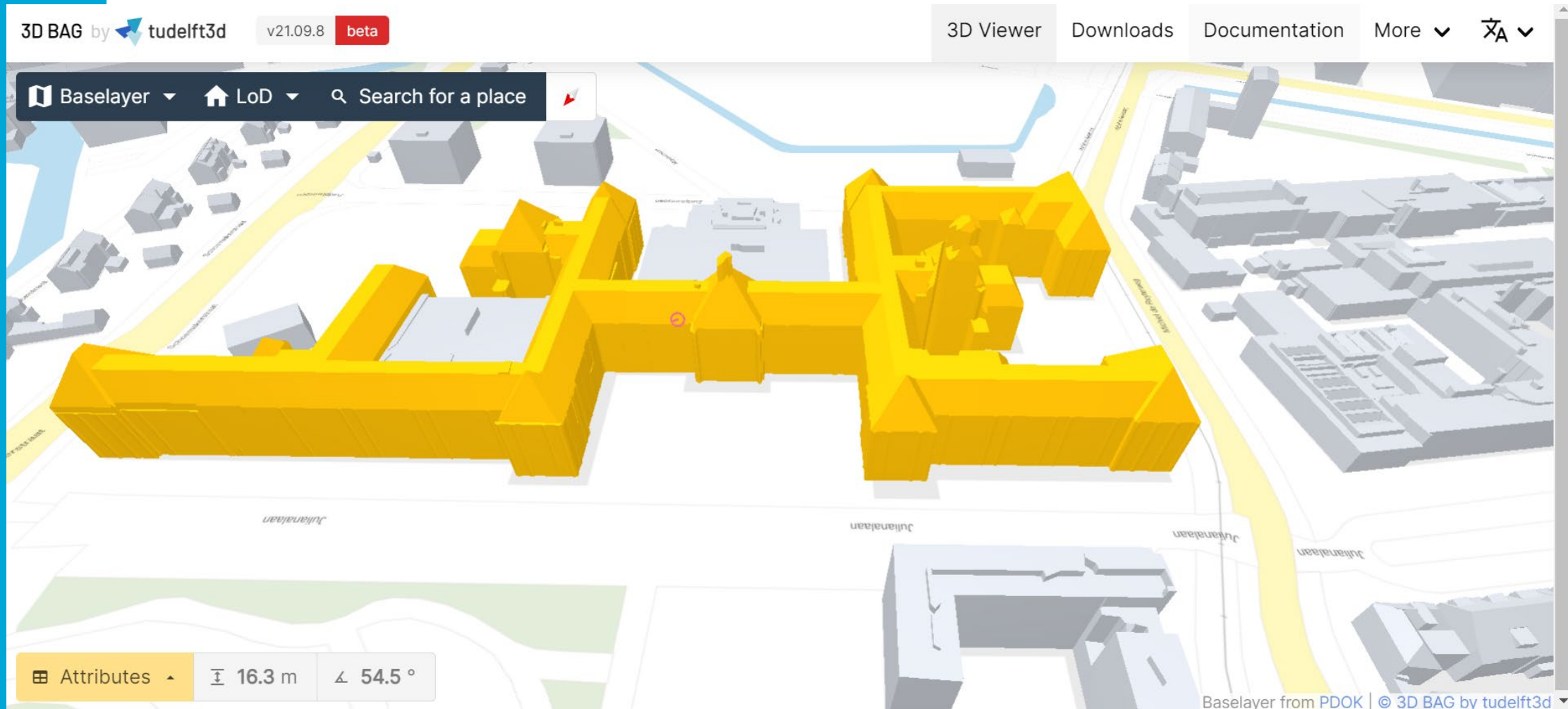
- Data without any restrictions in the (re-) use and provided free of charge

Spectacular increase in data use



Source: <https://www.pdok.nl/rapportages>

Open science: 3dbag.nl





Be careful. Your data may interfere with other interests:

- the confidentiality of the proceedings of public authorities, [..];
- the confidentiality of commercial or industrial information, [..];
- intellectual property rights;
- the confidentiality of personal data [..];
- the protection of the environment to which such information relates, such as the location of rare species,
-

The EU Open Data Directive

Stimulating the economy ...

Provides procedures for *reusing* **public sector** information including **publicly funded research data**

Research data (Art. 2(9))

‘research data’ means documents in a digital form, **other than scientific publications**, which are collected or produced in the course of scientific research activities and are used as evidence in the research process, or are commonly accepted in the research community as necessary to validate research findings and results;

Publicly funded research data:

- Reusable
- Free of charge
- following the principle of 'open by default' and compatible with the **FAIR principles**
- 'as open as possible, as closed as necessary'.

Those *national* open access policies shall be addressed to research performing organisations and research funding organisations.

FAIR?

Box 2 | The FAIR Guiding Principles

To be Findable:

- F1. (meta)data are assigned a globally unique and persistent identifier
- F2. data are described with rich metadata (defined by R1 below)
- F3. metadata clearly and explicitly include the identifier of the data it describes
- F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:

- A1. (meta)data are retrievable by their identifier using a standardized communications protocol
 - A1.1 the protocol is open, free, and universally implementable
 - A1.2 the protocol allows for an authentication and authorization procedure, where necessary
- A2. metadata are accessible, even when the data are no longer available

To be Interoperable:

- I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- I2. (meta)data use vocabularies that follow FAIR principles
- I3. (meta)data include qualified references to other (meta)data

To be Reusable:

- R1. meta(data) are richly described with a plurality of accurate and relevant attributes
 - R1.1. (meta)data are released with a clear and accessible data usage license
 - R1.2. (meta)data are associated with detailed provenance
 - R1.3. (meta)data meet domain-relevant community standards

Your research data

Try this at home

- Is your research data:
 - Findable?
 - Accessible?
 - Interoperable?
 - Reusable?
 - Free of charge?

To whom is it FAIR, and/or should it be FAIR?

The Open Data Directive relevant to you as a data user?

- If public sector information is publicly accessible: reuse should be required
- Conditions for reuse
 - in **formats** that are **open, machine-readable, accessible, findable and re-usable**, together with their metadata.
 - **no legal restrictions**, but if, those conditions shall not unnecessarily restrict possibilities for re-use and shall not be used to restrict competition
 - charges shall be **free of charge**, unless public sector bodies are required to generate revenue to cover a substantial part of their costs relating to the performance of their public tasks

Special regime for high value datasets

‘high-value datasets’ (HVD) means documents the re-use of which is associated with important benefits for society, the environment and the economy, in particular because of their suitability for the creation of value-added services, applications and new, high-quality and decent jobs, and of the number of potential beneficiaries of the value-added services and applications based on those datasets;

Six thematic categories of HVD

1. Geospatial
2. Earth observation and environment
3. Meteorological
4. Statistics
5. Companies and company ownership
6. Mobility

See [Commission Implementing Regulation \(EU\) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use](#)

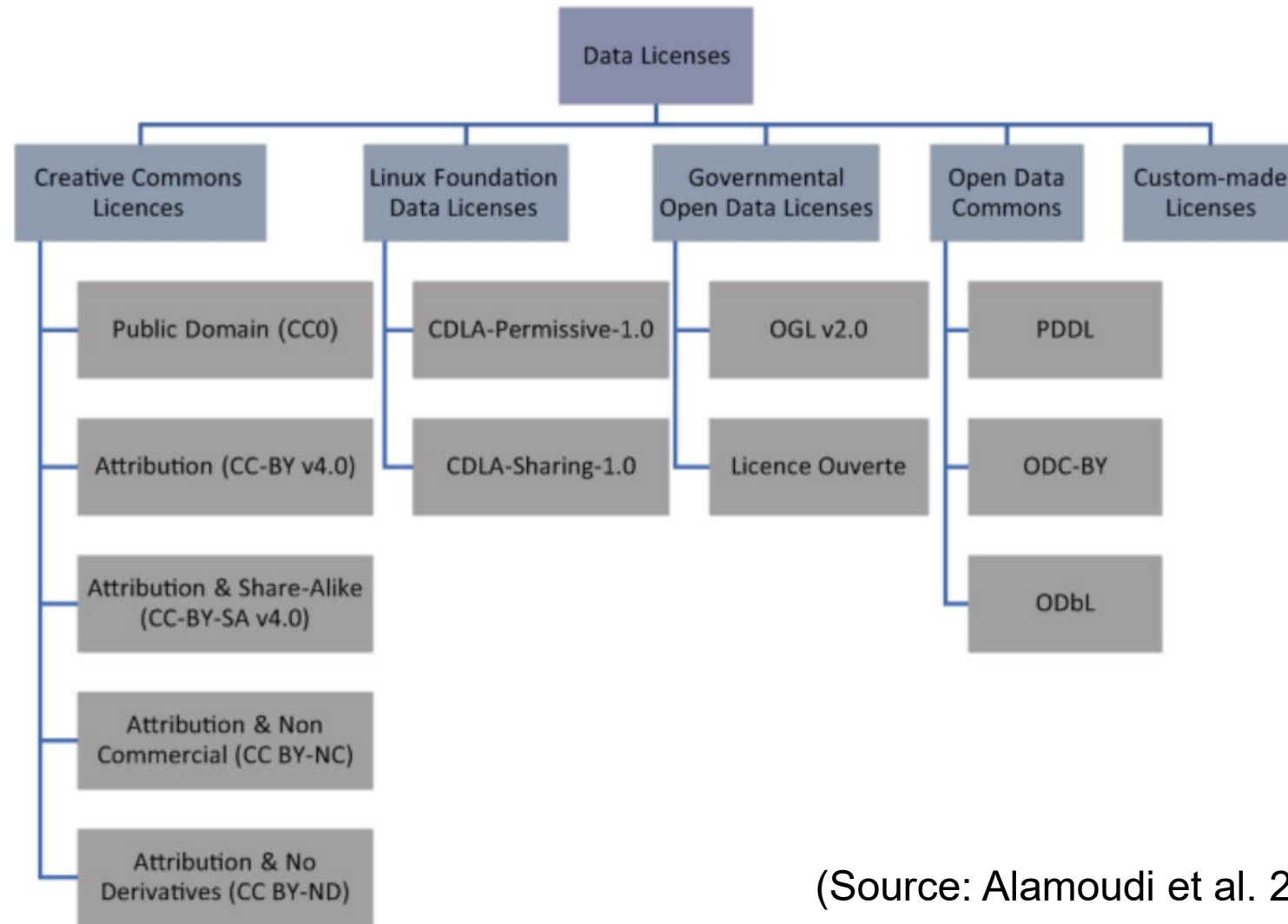
HVD (2)

- shall be made available for re-use in machine- readable format, via suitable APIs and, where relevant, as a bulk download.
- available free of charge, [..]

HVD Act (art. 4(3))

“High-value datasets shall be made available for re-use under the conditions of the **Creative Commons Public Domain Dedication (CC0)** or, alternatively, the **Creative Commons BY 4.0 licence**, or any equivalent or less restrictive open licence, as set out in the Annex, allowing for unrestricted re-use.”

Open licences



(Source: Alamoudi et al. 2020)

For CHEK

- Be transparent and consistent in your interpretation and implementation of open data/ open science in all facets of the project

Literature

- Alamoudi, E., Mahmood, DR., Al Judaibi, W., Albeshri, A. and Hasan, S. H. (2020) 'Open Source and Open Data Licenses in the Smart Infrastructure Era: Review and License Selection Frameworks', in Mehmood, R., See, S., Katib, I. and Chlamtac, I. (eds.) Smart Infrastructure and Applications: Foundations for Smarter Cities and Societies. Cham: Springer International Publishing, pp. 537-559.
- Open Data Directive, DIRECTIVE (EU) 2019/1024 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on open data and the re-use of public sector information. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019L1024&from=EN>
- HVD Act, European Commission (2023). Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R0138&qid=1677593287379>
- Open Knowledge Foundation, Open Definition 2.1, <http://opendefinition.org/okd>
- PDOK rapportage, <https://www.pdok.nl/rapportages>
- Van Loenen, B., 2021, Open data history, definition, and impact, <https://www.youtube.com/watch?v=KPwrbsnPhPI>
- Wilkinson, M.D., Dumontier, M., Aalbersberg, IJ.J., G. Appleton, M. Axton, A. Baak, N. Blomberg, J.-W. Boiten, L. Bonino da Silva Santos, P.E. Bourne, et al.: The FAIR Guiding Principles for scientific data management and stewardship. Scientific data, 3(1), 1–9, 2016.

Questions?

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Thanks for your attention!

Bastiaan van Loenen

**OPEN SCIENCE:
JUST
SCIENCE
DONE RIGHT**

Open Science*

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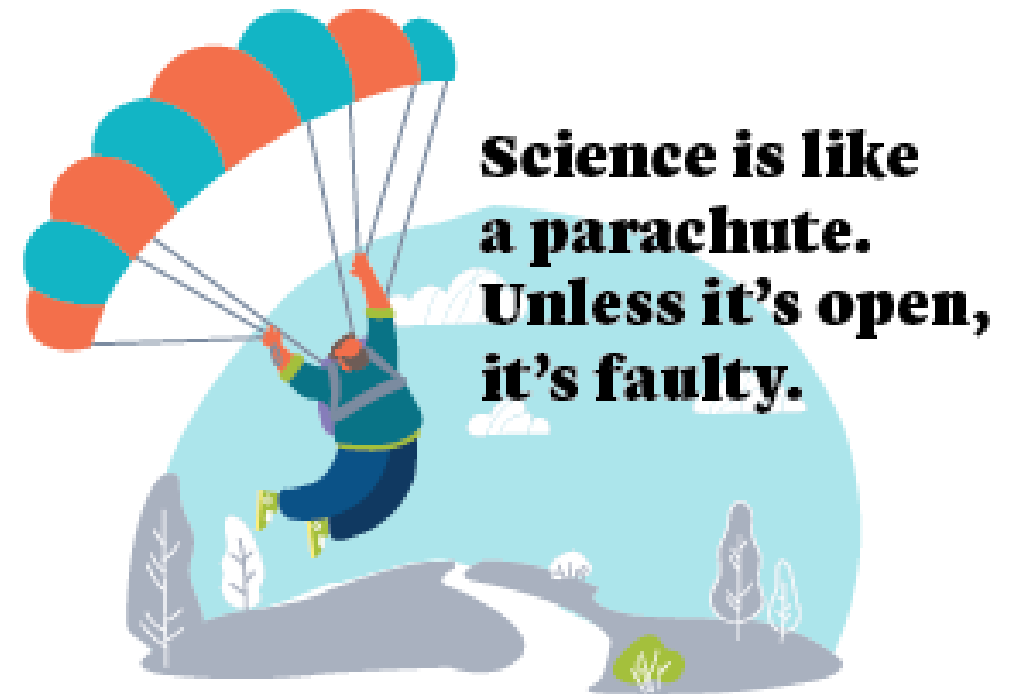
*This presentation is based on the original
presentation by Nicolas Dintzner



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Today:

- Why Open Science?
 - Open Access to Publications
 - Reproducibility Crisis
- What is Open Science?
 - Culture change
 - Definitions
- How to Open Science (data)



Open Access to Publications



1991

arXiv

arXiv is a free distribution service and an open-access archive for 2,218,718 scholarly articles in the fields of physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics. Materials on this site are not peer-reviewed by arXiv.

2003

Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities

The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities of 22 October 2003 was written in English. It is one of the milestones of the Open Access movement. The wording of the English version shall prevail.

2011-2013

The United States Vs. Aaron Swartz

“Information was the most valuable of currencies, a form of wealth no one should be deprived of”



RollingStones, [The Brilliant Life and Tragic Death of Aaron Swartz](#) by David Amsden



Open Access to Publications: Dutch approach



Science without
open is just
anecdote



Reproducibility crisis

Google scholar results: “reproducibility clinical trials”

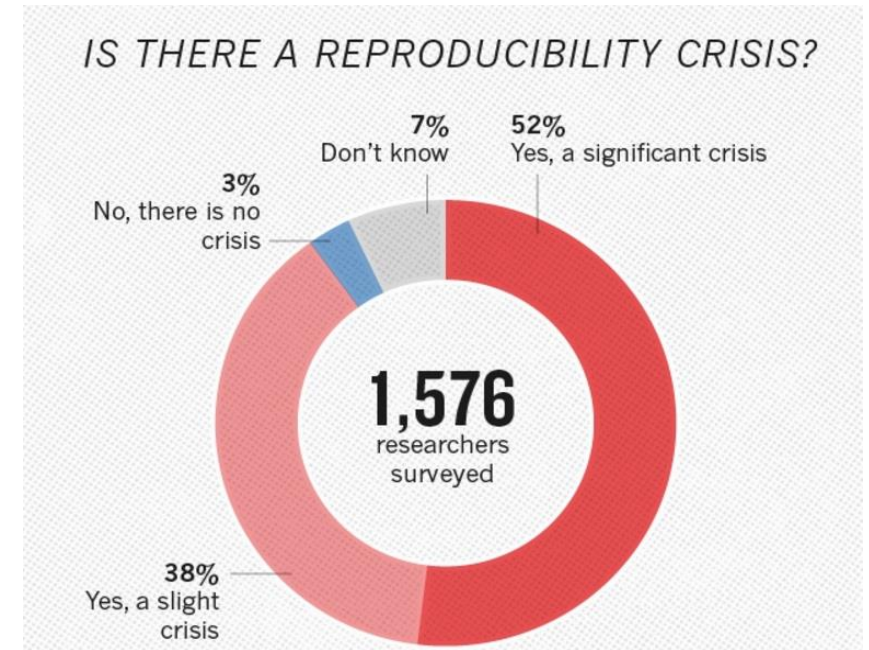
2000-2011:	18k results
2012-2013:	56k results
2015	
2016	

RESEARCH ARTICLE

Estimating the reproducibility of psychological science

OPEN SCIENCE COLLABORATION Authors Info & Affiliations

<https://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970>



Reproducibility crisis: data



2011

2020

Report finds massive fraud at Dutch universities

Investigation claims dozens of social-psychology papers contain faked data.

Ewen Callaway

When colleagues called the work of Dutch psychologist Diederik Stapel too good to be true, they meant it as a compliment. But a preliminary investigative report (go.nature.com/tqmp5c) released on 31 October gives literal meaning to the phrase, detailing years of data manipulation and blatant fabrication by the prominent Tilburg University researcher.



<https://op.europa.eu/en/publication-detail/-/publication/6bc538ad-344f-11eb-b27b-01aa75ed71a1>

Culture change: International Cooperation



- 2012 DORA agreement “*San Francisco Declaration on Research Assessment*” – funders and publishers
 - eliminate the use of journal-based metrics, such as Journal Impact Factors, in funding, appointment, and promotion considerations;
 - assess research on its own merits rather than on the basis of the journal in which the research is published; and
 - capitalize on the opportunities provided by online publication (such as relaxing unnecessary limits on the number of words, figures, and references in articles, and exploring new indicators of significance and impact).

- 2022 CoARA agreement “*Coalition for Advancing Research Assessment*” – research institutions
 - Supported by the European Commission
 - Agreement open for signature mid-2022, finalized by Dec 2022

Culture change: Global move towards OS



“Making science more accessible, inclusive and equitable for the benefit of all”

- 2017 UNESCO Recommendation on Science and Scientific Researchers
- 2019 UNESCO Recommendation on Open Educational Resources (OER)
- 2021 UNESCO Recommendation on Open Science

Culture change: EU Strategy



2020
2024

EU Research and innovation strategy 2020-2024:
The EU's Open Science Policy

“Open science is a policy priority for the European Commission and the standard method of working under its research and innovation funding programmes as it improves the quality, efficiency and responsiveness of research.”

A definition: Open Science as a goal (UNESCO)

Open science increases scientific collaborations and sharing of information for the benefits of science and society

makes multilingual scientific knowledge openly available, accessible and reusable for everyone

opens the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community.





A definition: Open Science as a goal and a method (European Research Council)

Open Science

The mission of the ERC is to support excellent research in all fields of science and scholarship. The main outputs of this research are new knowledge, ideas and understanding, which the ERC expects its grantees to publish in peer-reviewed articles and monographs. The ERC considers that providing free online access to these materials is the most effective way of ensuring that the fruits of the research it funds can be accessed, read, and used as the basis for further research.

WHICH MEANS:

- Open Science is
- by researchers
 - through “free access”
 - for more research
 - to maximize usefulness

Other definitions: OS as a practice



Open Science is **the practice of science** in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods ([FOSTER Open Science Definition](#)).

KEY POINTS

- 1) Other can collaborate and contribute
- 2) Data, notes, and processes are available
- 3) Under specific terms

Goal: re-use, reproduction, distribution

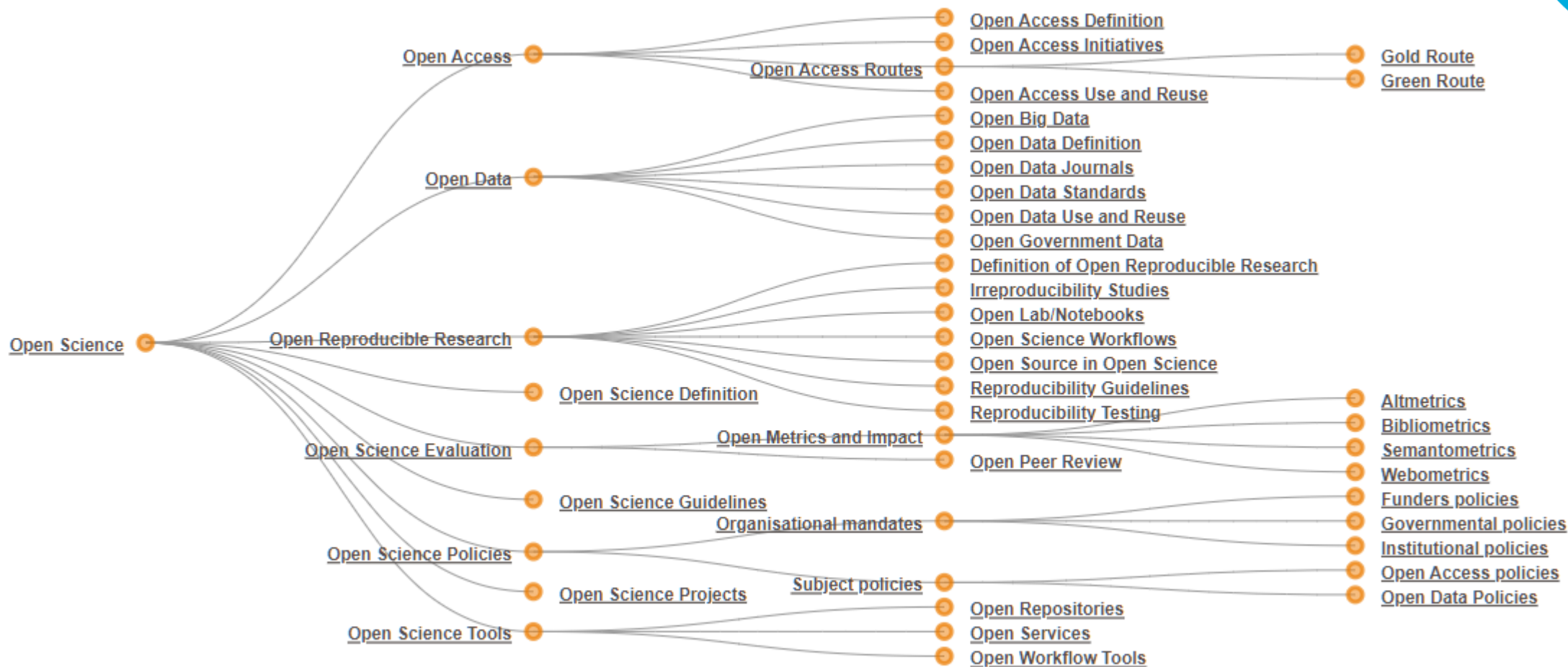
Open Science is transparent and accessible **knowledge** that is shared and developed through collaborative networks ([Vicente-Sáez & Martínez-Fuentes 2018, Open Science Training Handbook](#)).

Other definitions: OS as a movement



Open science is the **movement** to make scientific research, data and dissemination accessible to all levels of an inquiring society ([source](#)).

What is Open Science: the full view



EU Open Science Ambitions 2020-2024



- Open Data
- European Open Science Cloud (EOSC)
- New generation metrics
- Future of scholarly communication
- Rewards
- Research integrity & reproducibility of scientific results
- Education and skills
- Citizen science

Open/FAIR X



- **Open Access:** articles are freely available on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts.
- **Open Hardware:** Physical objects that are licenced in such a way that said object can be studied, modified, created, and distributed by anyone.
- **Open Methods:** Open methods are available details of the research methods, such as procedures, protocols, plans, notes and interpretations.

Open/FAIR X (cont.)



- **Open Education:** collective term that encompasses educational resources, tools and practices that can be freely used in the digital environment without legal, financial or technical barriers
- **FAIR Data:** the data is accessible, and I can see it, (re)use it and redistribute it (under conditions)
- **FAIR Software:** Open-source can be viewed, used, modified, and distributed for any purpose
- **Citizen Science:** The inclusion of members of the public in scientific research, to include citizens and communities in setting research priorities, and to engage them with the research process.

Open/FAIR X (finally)



Ideally:

- Open/FAIR **X**: I can see, (re)use, and redistribute **X**, and I know how **X** came to be (process that was followed)

**OPEN SCIENCE:
JUST
SCIENCE
DONE RIGHT**

Thanks for your attention!

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The EU aims to have a net-zero greenhouse gas (GHG) economy by 2050, with 55% reduction on 1990 levels by 2030. At present, heating and cooling represent around 50% of the final energy demand in Europe and are mainly supplied by fossil fuel derived energy. It is therefore essential for heating and cooling to decarbonise to achieve EU ambitions.

A challenge for decarbonizing heat systems is the size of the seasonal mismatch between demand for heat and heat generation from sustainable sources – this mismatch is much larger than the equivalent intermittency in electricity supply and demand. The two main solutions to address this mismatch are: (i) to install a large capacity, so that peak demands can be met even at low production levels; or (ii) to store energy for later use if it is not needed at time of conversion. Many sustainable heat supply systems are characterised by high capital expenditure and low operational costs. Therefore, an installed capacity tailored at peak demand is not cost effective, while extending the annual operation period is advantageous for meeting energy needs, reducing levelised cost of energy (LCOE) and decarbonisation. Optimal utilisation of sustainable heat requires storing large amounts of heat to account for seasonal supply and demand fluctuations. Various technologies have been proposed for large-scale heat storage in geothermal reservoirs and low temperature storage is routinely applied. PUSH-IT focuses on extending storage temperature ranges to high temperatures. We will tackle remaining barriers, demonstrate applicability, increase public engagement, and optimise and de-risk operations. We will showcase three technology options that are fit for a wide variety of geological conditions covering most locations in Europe.



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