EINSTEIN CENTER Digital Future

Technische Universität Berlin

Obstacles to open source in building energy technology: An analysis of the German research landscape - FOSDEM 2023

04.02.2023

Federal Ministry for Economic Affairs and Climate Action

Why do we need open source software for buildings and energy?

- How do buildings impact climate?
- How can open source reduce that impact?

What is the state of open source software?

- A review of funded projects
- Major obstacles identified

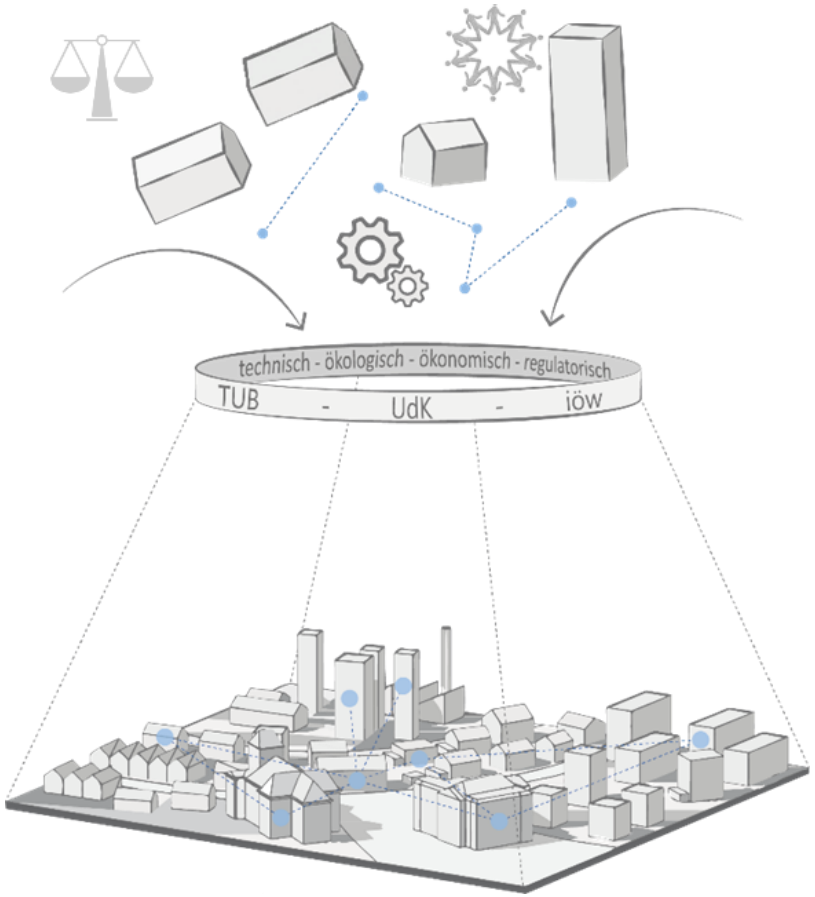
Where will we be in five years?

Our Job

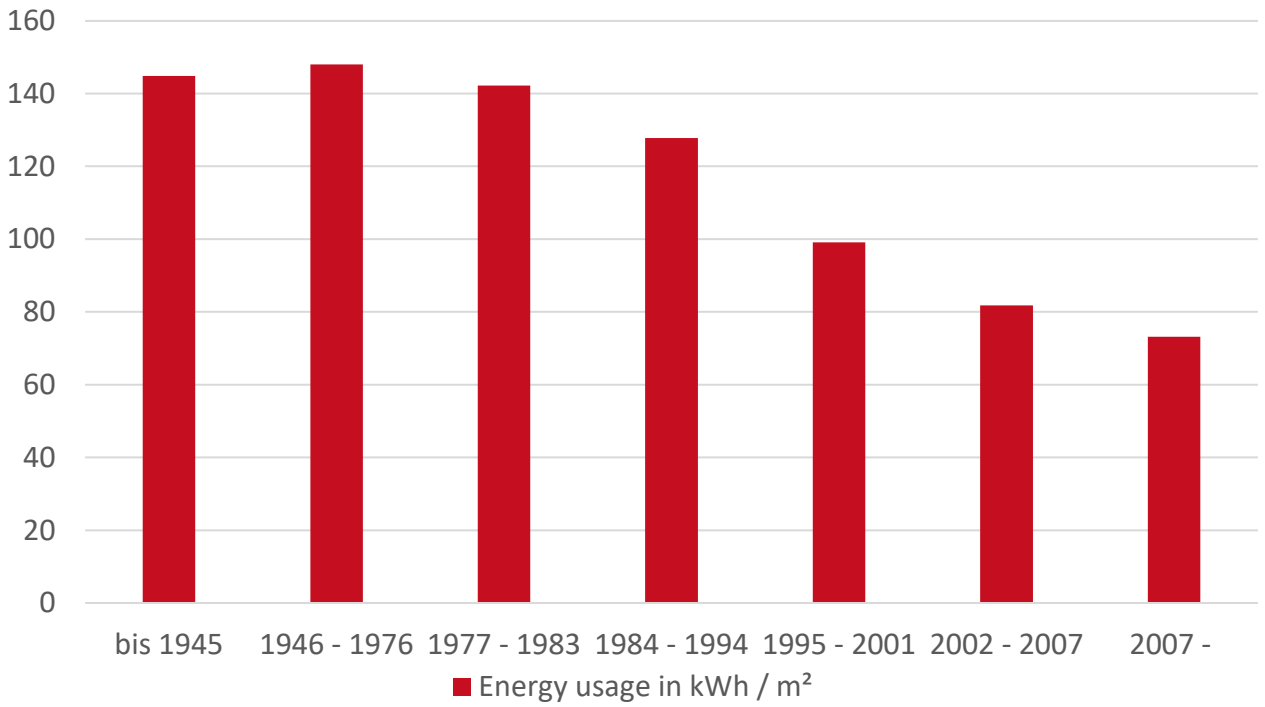
- Survey and support of more than 300 research projects
- Focus on aspects of digitalization

Our Goal

- Supporting standardization and integration of standards and software
- At FOSDEM we would like to foster the exchange between the (international) open source community and the national research community



Energy usage of residential buildings



[1] S. Metzger, N. Walkewitz, K. Jahnke, M. Otto, und S. Fritz, „Wohnen und Sanieren - Empirische Wohngebäudedaten seit 2002“. Umweltbundesamt, Januar 2019. [Online]. Verfügbar unter: https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-06-03-barrierefrei-broschuere_wohnenundsanieren.pdf

The energy demand of buildings is too high:

The energy demand of buildings is a major contribution to the global greenhouse gas emissions.

Tomorrow’s buildings are being built today:

The long lifespan of buildings (30+ years), creates a strong need for high building standards today.

Strategies to reduce energy consumption

Reduction of demand:

The installation of insulation can help reduce the energy demand of buildings.

Improvement or replacement of technology:

The improvement or replacement of technology can ensure a more effective usage of technology.

Improved control strategies:

The change of control strategies can ensure a demand- and grid-oriented supplying approach.

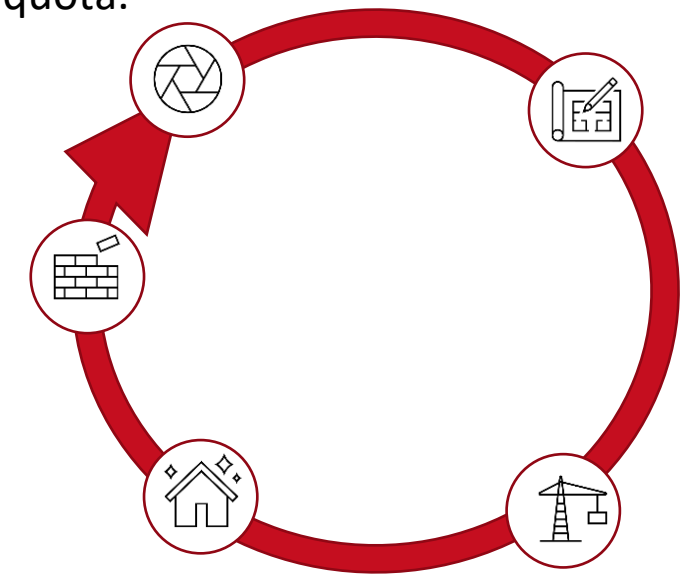
Digital Technologies are essential for climate friendly buildings. Software can help to plan and effectively manage buildings. Open-source software in science can make the transformation, faster, cheaper and more transparent.

[2] C. Ceccolini und R. Sangi, „Benchmarking Approaches for Assessing the Performance of Building Control Strategies: A Review“, *Energies*, Bd. 15, Nr. 4, S. 1270, Feb. 2022, doi: 10.3390/en15041270.

How can open-source help with that?

Recycle:

Material Databases can improve the recycling quota.



Plan:

Open CAD can help improve building energy demand through smart design (e.g. orientation).

Renovate:

Simulation tools can help chose the right option between technology and insulation.

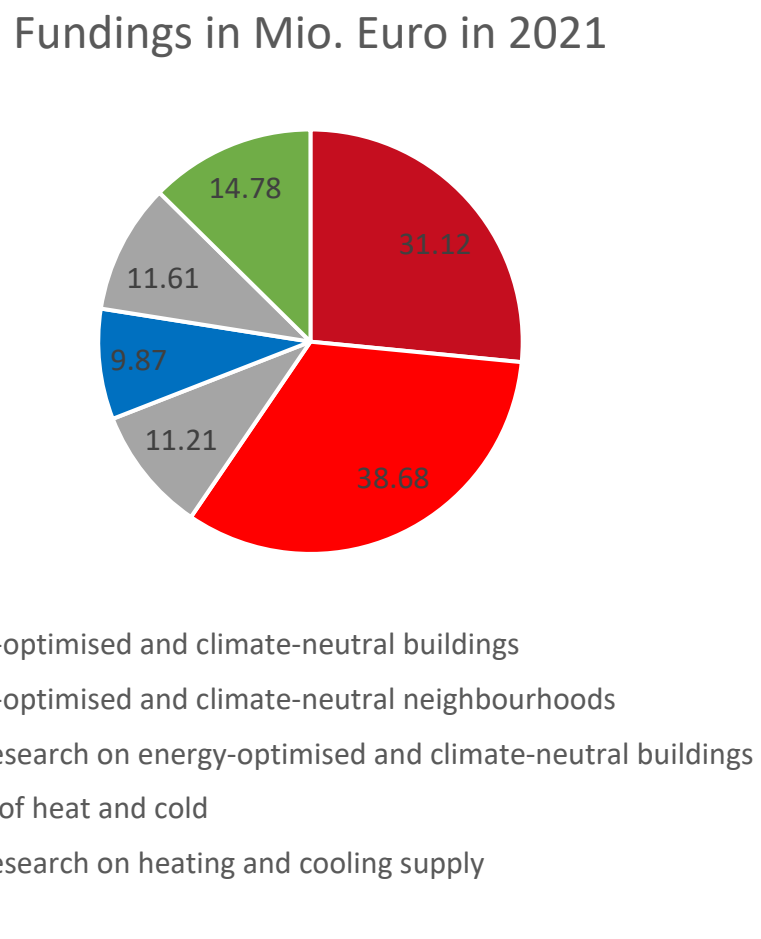
Use:

Monitoring can be used to deploy building control strategies.

Build:

Open AR-Apps can help with as-Built classification and support optimization.

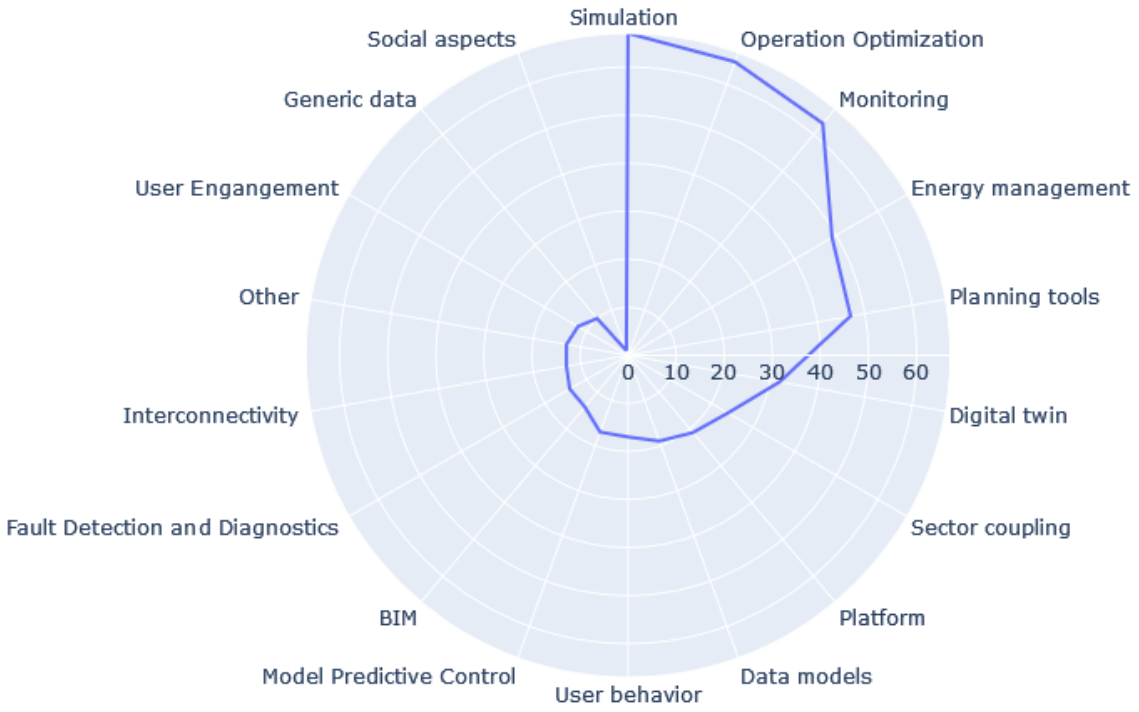
Public fundings by German Federal Ministry for Economic Affairs and Climate Action



Integration and linkage of different technologies are becoming more important. Hence the funding for neighborhoods has been growing.

[3] „Bundesbericht Energieforschung 2022 - Forschungsförderung für die Energiewende“, Bundesministerium für Wirtschaft und Klimaschutz (BMWK), Apr. 2022. [Online]. Verfügbar unter: https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/bundesbericht-energieforschung-2022.pdf?__blob=publicationFile&v=28

What topics are developed?



Tags, the projects self-stated to describe their digital applications in a survey in 2021.

179 projects surveyed:

Of the surveyed projects, **128 were developing** or using digital applications and provided a description of it.

Simulation as the focus:

Research projects are focusing on simulation, operation optimization, and monitoring. The projects were asked to describe their applications using previously defined tags.

The state of open source in 2018

A minority of software was planned for open-source release in 2018:

Only 3 % of surveyed projects planned for a full open source release of developed tools and software.

Most of the software uses at least one proprietary tool:

On average, a research project uses between 4-5 other digital tools. A majority (~ 70%) of these tools are not open source.

[4] L. Kirnats, J.-N. Joost, S. Berg, J. Frisch, und C. Van Treeck, *Tiefenbohrung - Digitale Werkzeuge und softwarebasierte Lösungsansätze*. 2018. [Online]. Verfügbar unter: https://www.forschungsnetzwerke-energie.de/lw_resource/datapool/systemfiles/agent/fnepublications/95162103DAA31D19E0539A695E862DF6/live/document/Tiefenbohrung_Digitale_Werkzeuge_und_softwarebasierte_L%C3%B6sungsans%C3%A4tze.pdf

Why software and data are not open:

Ethical and security concerns

Sensitive and personal information might be included in data.

Unwanted exposure

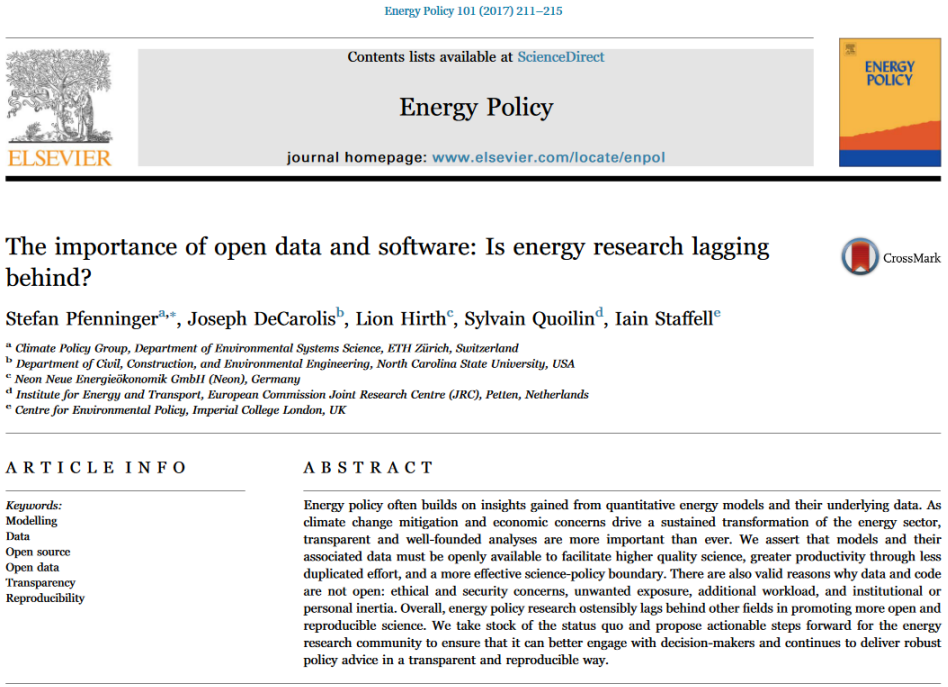
Openly sharing can lead to unwanted exposure.

Protection of intellectual property

Expertise can be a business Model.

Institutional and personal inertia

Long Running practices are hard to overcome.



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The importance of open data and software: Is energy research lagging behind?

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ABSTRACT

Energy policy often builds on insights gained from quantitative energy models and their underlying data. As climate change mitigation and economic concerns drive a sustained transformation of the energy sector, transparent and well-founded analyses are more important than ever. We assert that models and their associated data must be openly available to facilitate higher quality science, greater productivity through less duplicated effort, and a more effective science-policy boundary. There are also valid reasons why data and code are not open: ethical and security concerns, unwanted exposure, additional workload, and institutional or personal inertia. Overall, energy policy research ostensibly lags behind other fields in promoting more open and reproducible science. We take stock of the status quo and propose actionable steps forward for the energy research community to ensure that it can better engage with decision-makers and continues to deliver robust policy advice in a transparent and reproducible way.

[4] S. Pfenninger, J. DeCarolis, L. Hirth, S. Quoilin, und I. Staffell, „The importance of open data and software: Is energy research lagging behind?“, Energy Policy, Bd. 101, S. 211–215, Feb. 2017, doi: 10.1016/j.enpol.2016.11.046.

Technical obstacles

Heterogeneity in data:

Buildings and technology are very different and lack common standards. On the one hand, some may think it is not worth publishing the software anyway, on the other hand, some software may not be applicable.

Tool chains:

Need to be carefully documented, open data, open source, and open science. This applies to the individual components as well as to the entire chain.

Missing open software:

In some areas, there is a lack of OSS, especially in CAD and solvers. Therefore, there may be restrictions in some fields of research, e.g. closed and open BIM.

In the future, it will become more important to automatically optimize the overall system in coordination with subsystems. It needs ways to change the level of abstraction. Simple models must be able to be derived automatically from complex models. The basic prerequisite for this is that the interfaces fit.

Response of a project manager to the question: "What are the most important topics in the future"?

Cultural obstacles

Lack of development skill:

Software development is often underrepresented in engineering education. There is no common understanding of software quality. A catalog of criteria for minimum quality is needed.

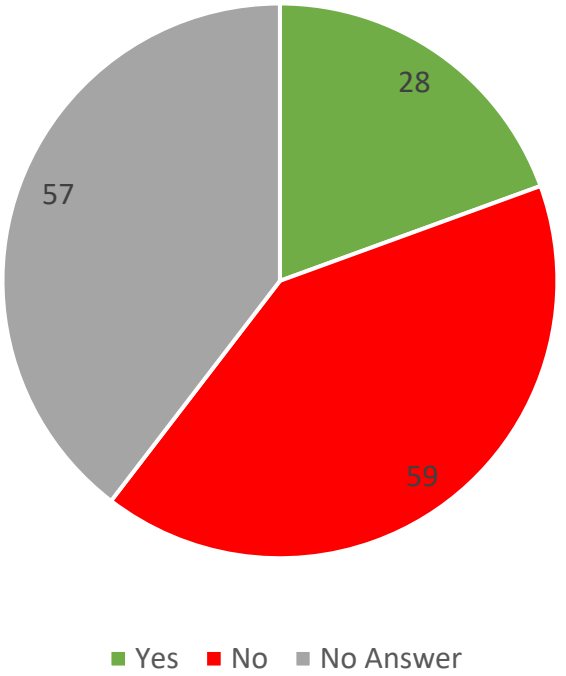
Software as a tool:

In research, software is often seen as a tool in research rather than an output. Accordingly, research projects often focus on publishing.

Missing user focus:

Software lacks usability. Out of 144 interviewed surveyed, only 28 said they evaluate the usage of the target group's use. This reduces applicability.

If you develop an applications for users, do you also evaluate how the target group uses the digital offer?



Out of 170 surveyed Projects in 2021. 37 Projects skipped the question.

Financial obstacles

End of funding:

Software is often achieved, as the project or PhD is finished. As the focus shifts, time spent on opening internally developed software lacks. Additionally, no further support can be guaranteed. Funding needs to be adjusted to accommodate for this.

Business interest:

Research is also a business, developing open source can hurt that interest.

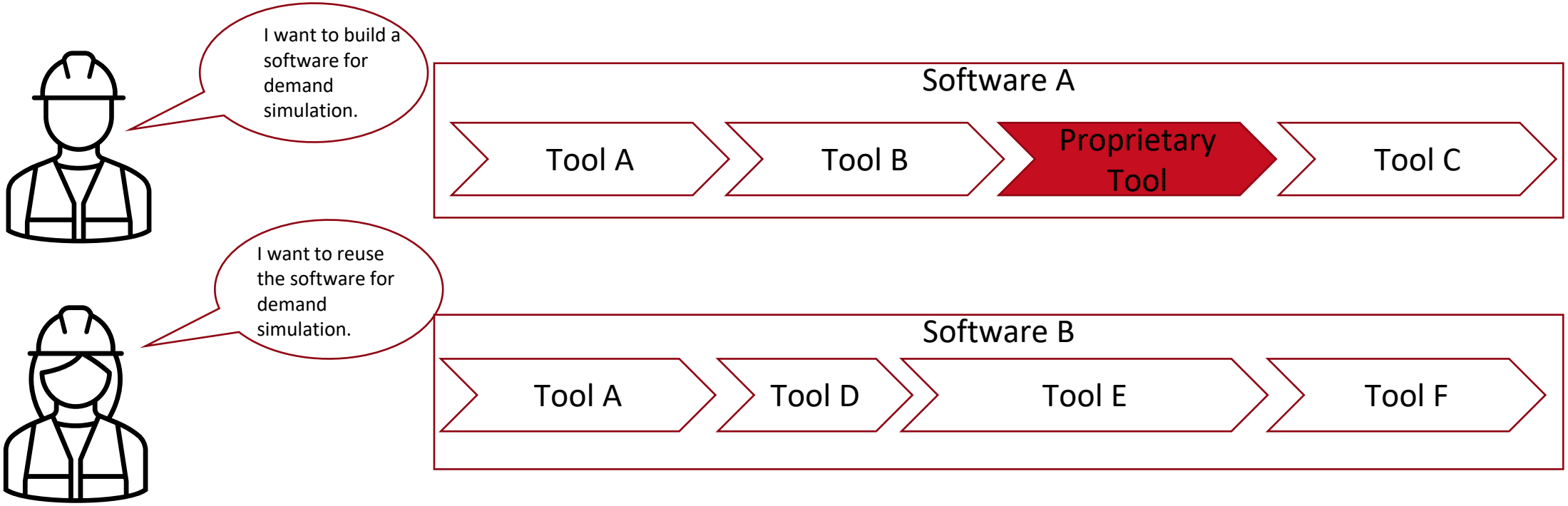
Commercial alternatives:

Project partners want commercial alternatives, as they can provide a long-term service agreement.

Currently, the maintenance, the development and the use of the software often ends with the end of the project. There is a need to create a structure for the long-term development of software, so that programs developed continue to add value to practice beyond the end of the project.

A Participant during a workshop on software quality, about obstacles on software developed in research projects.

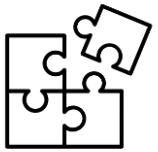
Lacking tool chains as obstacle



Partial open source is not enough:

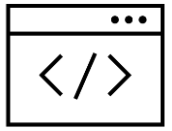
Usage of a single proprietary tool usually leads to rebuilding the whole tool chain, as interconnections no longer work. This leads to inefficiencies, especially in standard tools.

Recommendations



Modularized development:

Modular development of software and hardware enables maintenance and reusability.

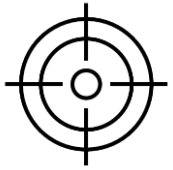


Publishing the status quo:

Publicly publish and collect existing software, data, documentation and related papers.

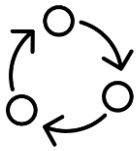
User Focus:

Software should be focused on the users.



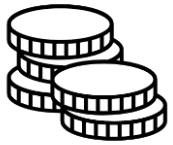
Focusing on essentials:

Crucial software (e.g. monitoring) should be focused on.



Using standardized Interfaces:

Using open and standardized APIs increases reusability.



Adapted funding:

Funding structures need to be adopted to changing needs.

But what is the state of open source?

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Variety of listed open source projects

EnArgus - a database for publicly funded research projects lists 446 projects as relevant to open-source

Increase in recent years

In recent years there has been an increase, with only 16 projects being dated before 2010.

Unclear degree of openness

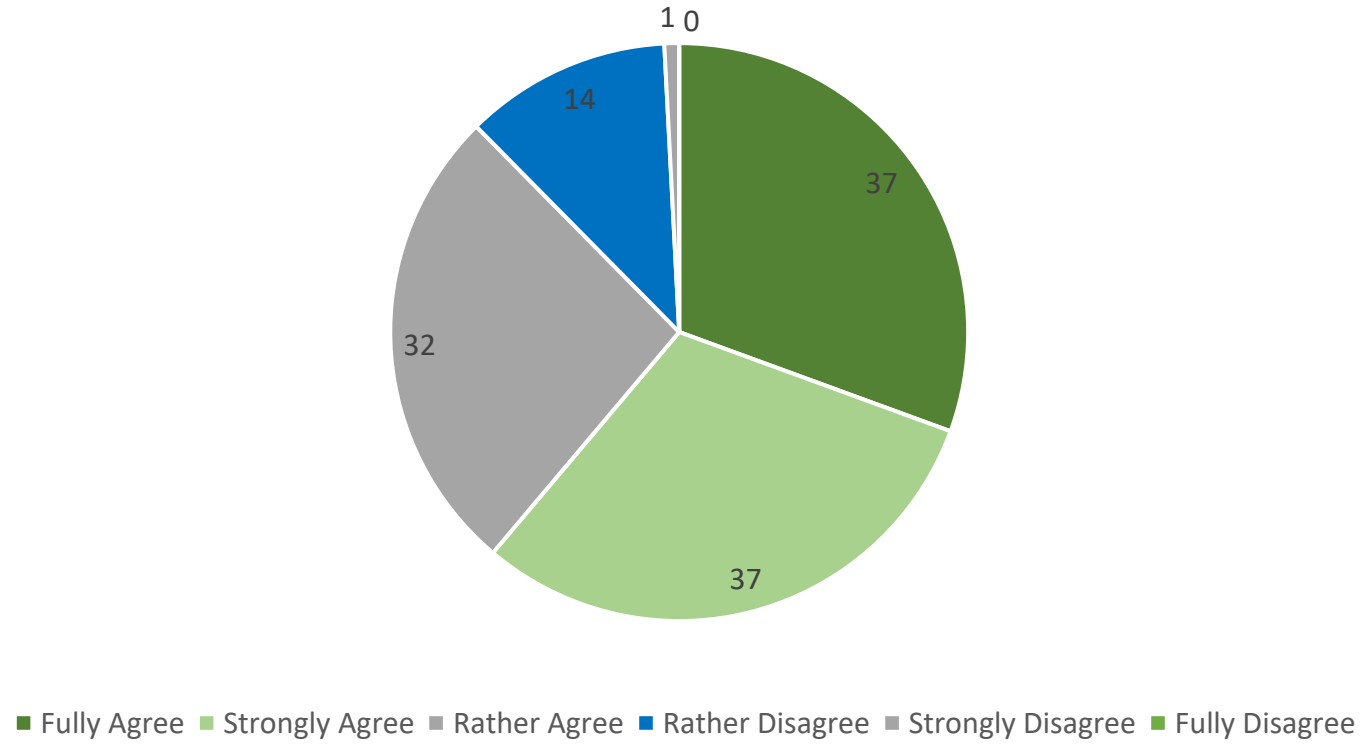
However, often it is intransparent why a project is considered Open Source.

What about the next years?

Easy access to methods (e.g., parameterized models), infrastructures (e.g., public data centers for energy technology) and high-quality data (e.g., for the development of solutions that use artificial intelligence), the involvement of people in digital systems (e.g., through research on front-end developments) can be central building blocks of the digitization of the energy system.

Response of a professor to the question: "What are the most important topics in the future"?

It needs the promotion of open standard tools like in the USA (e.g., EnergyPlus) and corresponding libraries.



Survey of 150 researchers that work in funded projects in November 2022.

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