## Annual Report Oeko-Institut 2023





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# EXTREME!

### Pushing the boundaries – reaching the limits

We have witnessed violent conflicts, a further upsurge in extreme political positions, and the world's hottest year on record, with extreme weather – from droughts to floods.

2023 was a year of multiple extreme events – both here in Germany and especially beyond our borders.

## Conflicts

- Russia's war of aggression against Ukraine enters its third year. Thousands of Ukrainian civilians die in 2023.
- Some 1200 Israelis lose their lives in Hamas' brutal terrorist attack on 7 October.
- 85% of Gaza's population is displaced after Israel begins its counter-attacks. More than 10,000 people lose their lives.
- In Iran, at least 94 people are executed in 2023.
- There is ongoing civil war in Syria. More than half the Syrian population is displaced.
- The military seizes power in coups in Gabon and Niger.

## Politics and society

- More than 8% of Germans have a far-right worldview.
- The Netherlands sees a shift to the right in its parliamentary elections.
- The far-right candidate Javier Milei comes to power in Argentina.
- Inflation in Germany climbs to its second-highest level since reunification, averaging 5.9%.

## Environment and climate

- The global average temperature is almost 1.5 °C above the pre-industrial baseline.
- Canada experiences the most destructive wildfires on record.
- Countless people die or are displaced in floods in Myanmar, Kenya, Somalia, Uganda, Rwanda and the Republic of the Congo. In March and April alone, cyclones strike East Africa, the west coast of Australia and Myanmar.
- Worldwide, some 74,000 people die following natural disasters, with damage totalling 250 billion US dollars.

### Don't incite – inform!

In this tense and challenging situation, we need people who can keep calm. We need people who are guided by the facts and provide mediation, rather than allowing the hotheads to take the stage. We need people who seek to unite society so that it is not torn apart by extremist positions.

The fact is that we can only respond to the extreme challenges facing us in future if we work together.

## Conflicts

- 90,000 peacekeepers are currently deployed by the United Nations (UN) in 14 operations worldwide.
- In the conflict in the Caucasus, there are signs of a cautious rapprochement between Armenia and Azerbaijan.

## Politics and society

- 2023 sees the end of the remaining coronavirus restrictions.
- The number of vegetarians in Germany reaches a record high: more than eight million people now eat little or no meat.
- In Poland, the Civic Coalition wins the election, defeating the right-wing nationalist PiS.
- 72% of EU citizens believe that EU membership is good for their country. There is growing interest in the European elections.

### Environment and climate

- The ozone layer is recovering following the ban on ozone-depleting substances. The hole in the ozone layer is on track to close by 2066.
- Germany shuts down its last nuclear power plants in April 2023.
- Global renewable power generation capacity additions increase by almost 50% compared to the previous year the fastest expansion in two decades.
- Here in Germany, the renewables share in electricity consumption rises above 50% for the first time.
- In November 2023, some 97,000 people attend the UN Climate Change Conference in the United Arab Emirates.
- The international community reaches agreement on a marine conservation treaty.

### Our year 2023 Dear readers,

2023 was, in many ways, a year of extremes. The climate is an example: **2023 was the warmest year on record;** the global average temperature was 1.46 °C above the pre-industrial baseline and extreme weather is gradually becoming the new normal.

Devastating wildfires in Hawaii, Canada and Greece, severe drought in the Amazon, heavy rainfall and floods in Greece, Libya, Pakistan and Japan, and a hurricane that wreaked havoc in the Mexican resort of Acapulco are just a few examples of **extreme weather** around the globe. And we are experiencing numerous **political and social extremes** at the same time. Russia's war of aggression against Ukraine is entering its third year. Hamas' brutal attacks on Israel have sparked a new war in Gaza. In Iran, anti-government protests were crushed by force. Extreme events, violence and conflicts appear to be steadily increasing, adding to those which have existed for some time and have not been resolved.

Many people viewed the actions of the Last Generation as extreme – and their own reactions to these activists were also extreme in some cases. The abiding impression is that the climate movement has lost a good deal of support and that society is increasingly divided over the climate issue. It's an impression which is not shared by sociologist Steffen Mau, for example. His book Triggerpunkte (Trigger Points), co-authored with colleagues, shows that a very large section of society still supports action to mitigate climate change and regards it as a matter of urgency. It also reveals that there is a basic social consensus on the issues of welfare, tolerance and, indeed, immigration.

The supposed polarisation is mainly occurring on the extreme margins – and they are often far more vocal than mainstream society. Sadly, climate action tends

to be a highly emotive topic, partly because it raises issues of justice – such as the question whether people on lower incomes are disproportionately affected by measures to protect the climate – or because it requires behavioural changes from many people who have no wish to give up their cherished habits. Above all, conflicts arise over the practical action that must be taken to protect the climate and the question of how it can be reconciled with social justice.

Extremes – if they persist – can tear a society apart. They impede a joint response to the (equally extreme) challenges that will face us in future – and the sense of common purpose which we urgently need at national and international level. However, cooperation appears to be decreasing rather than gaining ground. This was apparent at the international climate negotiations in Dubai in December 2023. They were dominated by tough wrangling between those who champion the continued use of fossil fuels and those who are striving for a renewable future. But the Climate Change Conference also brought together tens of thousands of people who are initiating and implementing the necessary changes for climate change mitigation and adaptation all over the world. And with considerable success: in 2023, globally installed renewable generation capacity surged, with an increase almost 50% higher than in the previous year – the largest growth rate in two decades. Particularly high levels of growth were seen in Europe, Germany, the United States and Brazil, but nowhere was the increase as large as in China: here, the growth in photovoltaic capacity in 2023 was equivalent to the entire world's additions in 2022. China's wind power capacity also rose by 66%.

Last year, the renewables share in electricity consumption passed the 50% mark in Germany for the first time. According to the International Energy Agency (IEA), the costs of generating electricity in new solar PV and wind energy plants are now lower than those of existing coal- and gas-fired power plants. Renewables are therefore expected to replace coal as the largest global energy source in 2025. So there were some positive extremes. What's more, last year, substantial elements of the EU's "Fit for 55" package were taken forward – a major advance given the diversity of voices in Europe. The effective measures defined in the package include a higher level of ambition for the EU's emissions trading systems, revised CO<sub>2</sub> emissions standards for cars, a ban on combustion engine vehicles from 2035 and more ambitious targets for renewable energies, accompanied by many more individual items of legislation. It is a major political success, achieved in a short timeframe, which means that legislation is now in place to deliver Europe's climate goals.

To conclude, let me also give you an encouraging insight into the Oeko-Institut. In 2023, we conducted a staff survey which, in its own way, was also extreme – extremely positive, for it showed that most of our staff support the Oeko-Institut's values, feel connected to the Institute, consider the workplace to be highly respectful, and feel comfortable in this environment. And last year, we appointed more new staff than ever before – including two new members of the Executive Board: André Nelius and Christof Timpe. Together, we will continue to provide reliable and future-focused management for the Oeko-Institut.

In 2023, we all worked to temper extreme positions by providing factual information and ensuring that our research establishes a shared and objective basis for dialogue. We will undoubtedly continue along this path until we reach that goal.



Warmest wishes, Yours, Anke Herold

Scientific Director of the Oeko-Institut

## Selected data on diversity at the Oeko-Institut (2023)

Staff, project numbers, turnover – we saw growth across the board in 2023. We are working continuously, but not to extremes, in order to increase the store of knowledge and information to support the transition to sustainability.

In 2023, **210** staff in Freiburg, Darmstadt and Berlin contributed to the Oeko-Institut's success. Of this figure, 149 were engaged in research and 61 staff working for Central Services ensured that all the Institute's internal procedures ran smoothly.

In all, our staff worked on almost 500 projects – one of the most "extreme" numbers in the Oeko-Institut's history. In total, the Oeko-Institut achieved a turnover of around 22.5 million euros (forecast) – another record for the Institute.



## Respect, appreciation, responsibility

## The Oeko-Institut's Code of Conduct

After we published our <u>Diversity Strategy and</u> <u>Gender Equality Plan</u> in early 2023, we went a step further in November: we developed a Code of Conduct in which we define the bases for our interaction at the Oeko-Institut. Our collaboration within the Institute and in our external relations is governed by the following principles:

### **Respectful and appreciative**

Our interaction at the Oeko-Institut is characterised by mutual respect and appreciation. The Institute is notable for its highly motivated and competent staff, with a diversity of viewpoints and personalities. We offer an attractive workplace with opportunities for professional development in a respectful working environment. We are committed to gender equality and a work/life balance.

#### **Diverse and non-discriminatory**

The Oeko-Institut is committed to a fair and respectful work environment. It does not tolerate discrimination or harassment in any form and actively promotes diversity and equal opportunities through its Diversity Strategy and Gender Equality Plan. The Code of Conduct includes a separate Code of Conduct to Avoid Sexual Harassment and Discrimination. It also defines the basis for a complaints office in order to guarantee a respectful working environment that is free from prejudice.

### Participatory and responsible

In order to meet the demands of a dynamic research and consultancy landscape, our Institute is continuously developing its internal structures in line with the principles of decentralised responsibility, participatory decision-making, individual autonomy and transparent processes. The staff and extended management elect representatives to the Committee. In addition, the Institute attaches great importance to protecting the health and safety of all employees and therefore complies with guidelines, carries out risk assessments and takes protective measures.

In our cooperation with our partners, we undertake to respect human rights and avoid conflicts of interest. We are committed to integrity and transparency and do not tolerate any form of corruption or bribery. The Code of Conduct includes provisions on dealing with environmental and sustainability goals and sets out the principles governing our non-profit status. Lastly, it describes our quality standards in relation to good research practice.

Compliance with these principles is mandatory for all employees. Regular communication and training on sensitive, high-risk issues and business processes support compliance with and implementation of these internal guidelines.

#### The Oeko-Institut's Code of Conduct



### Continuity and change Management at the Oeko-Institut

The Oeko-Institut is notable for the trustful and efficient cooperation between the Executive Board, Central Services and the research divisions, which produce high-quality research to support the transition towards sustainability.



On 1 January 2024, Christof Timpe became the Oeko-Institut's new Chief Executive Officer. He takes over from Jan Peter Schemmel, who left the Institute at the end of November 2023. Christof Timpe has more than 30 years' experience as a researcher at the Oeko-Institut, working on energy policy and climate change mitigation strategies and heading its Energy & Climate Division in Freiburg from 1996 to 2023.

The Executive Board



**Jan Peter Schemmel** Chief Executive Officer (Until November 2023)



**Christof Timpe** Chief Executive Officer (From January 2024)

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**Anke Herold** Scientific Director



Executive Director Susanne Froeschl left the Oeko-

by André Nelius, who headed the Oeko-Institut's

Institut at the end of February 2023. She is succeeded

Finance & Accounting Department from 2019 until early 2023 and is now responsible for Institute Management.

> André Nelius Executive Director Institute Management

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Despite further personnel changes in the management of the Energy & Climate Division, the Environmental Law & Governance Division and the Finance & Accounting Department, stable leadership was maintained in 2023, enabling the Institute to respond appropriately to internal and external challenges. The members of the Committee, with new additions, were confirmed in office by the Members' Meeting, underscoring the Institute's continuity and success.

### THE COMMITTEE

### External members of the Committee Internal members of the Committee

Dorothea Michaelsen-Friedlieb First Chair of the Committee

Ulrike Schell Second Chair of the Committee

Sebastian Backhaus Helmfried Meinel Wolfgang Renneberg **Prof Dr Thomas Schomerus** Prof Dr Volrad Wollny

Dr Johannes Klinge (formerly Betz) Carl-Otto Gensch Dr Roman Mendelevitch Christof Timpe **Gudrun Wursthorn** 

### **Research Divisions**

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### Selected projects in 2023 Lowering the volume

When opinions are expressed at full volume on the left and right, it is not always easy for those in the centre to keep calm. This is where sound knowledge, transparent data and verifiable facts – such as those provided, once again, by the Oeko-Institut in 2023 – are helpful. These facts debunk the arguments put forward by climate deniers, disempower the nuclear energy enthusiasts and signpost viable pathways towards a sustainable future. In the following pages, we showcase 10 projects as examples of our researchers' work. They also demonstrate that a clear position can lower the volume at the extremes.

Our short quiz in the following pages may encourage you to give some thought to other kinds of extremes that relate to each topic. Try it out!



This Division examined new reactor concepts, with a focus on their technological development status, their safety and the risk of nuclear proliferation.

The Resources & Transport Division considered how Germany can secure its supply of the raw materials that will play a vital role in mitigating climate change. It also examined the potential for the electrification of road freight transport.

The environmental and climate impacts of artificial intelligence (AI) were the focus of a project conducted by the Environmental Law & Governance Division. Experts from this Division also explored the risks and opportunities of digitalisation for nature conservation.

And lastly, researchers in the Sustainable Products & Material Flows Division examined the sustainability potential of digital technologies. They also showed how to make a success of the circular economy in Germany as a way to protect the environment, climate and diversity, save resources and reduce our dependence on imports.

### A circular future A model for the circular economy

Germany consumes far too many resources -30 per cent more than the global average. This resource consumption is associated with numerous environmental, social and human rights problems. A circular economy, by contrast, has the potential to respond effectively to a multitude of challenges: it protects the environment and biodiversity, mitigates climate change and reduces our dependence on resource imports. On behalf of WWF, the Oeko-Institut assessed the environmental and economic impacts of a circular economy in Germany and defined a policy blueprint and binding targets for consistent action by decisionmakers, also as part of the National Circular Economy Strategy (NCES).

The researchers developed five strategies for action, including longer product use, closing resource loops, and material substitution. They defined a total of 63 measures across nine sectors, such as minimum service life requirements for electrical and electronic equipment and a recyclable design for packaging materials. The study revealed that there is potential for Germany to cut its greenhouse gas emissions by around 26 per cent and reduce its resource consumption by as much as 27 per cent by 2045.

The project team argues that absolute raw material consumption (RMC) needs to be reduced by more than 60 per cent to around seven tonnes per capita

per year, while the circular material use rate (CMU) – i.e. the ratio of secondary raw materials to overall material use – must be raised to 25 per cent by 2030. Ten guiding principles support the implementation of circular economy measures; they include the formation of social alliances and the adoption of binding resource targets. Framework-setting instruments, such as environmental taxes and extended producer responsibility (EPR), are also required, along with a resource conservation law and specific targets for the various ministries. Acceptance by society also has a key role to play; this can be achieved by educating consumers and creating incentives for industry, for example.

PROJECT TITLE Model Germany Circular Economy (MDCE) CLIENT WWF Germany TIMESCALE May 2022 – June 2023 www.oeko.de/jb2023-circular-economy-en "When it comes to reducing resource consumption, the market and strategies which rely on voluntary commitments and incentives have clearly failed. It is often assumed – incorrectly – that a circular economy will lead to high socio-economic costs. However, we have demonstrated that its overall benefits to society far outweigh the costs." – C. Loew



### Clara Loew

Researcher Sustainable Products & Material Flows Division





### Siddharth Prakash

Senior Researcher Sustainable Products & Material Flows Division / Head of the Circular Economy & Global Value Chains Subdivision

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## Which country has the world's highest per capita resource consumption?



### Smart and sustainable? The environmental and climate impacts of Al

Artificial intelligence (AI) impacts the environment and climate in a multitude of ways. Al applications require vast amounts of energy for training and operation, and substantial resource inputs are needed to manufacture AI hardware. In addition, the new AI capabilities are often utilised for purposes that run counter to environmental goals, such as supporting more intensive agriculture, leveraging potential for economic efficiency, or facilitating resource extraction. In other words, these innovations have indirect effects which take the form of adverse environmental impacts. By contrast, much of these technologies' potential to support the transition to sustainability is not being utilised. In its amendments to the much-discussed AI Regulation, the European Parliament put forward a series of proposals aimed at addressing these impacts. The proposals were analysed by the Oeko-Institut and its project partners.

The environmental and climate-related provisions in the European Parliament's proposed amendments constituted a clear socio-ecological turnaround compared to the European Commission's existing draft. Under Parliament's proposals, energy and resource consumption would have to be measured and logged, for example, and other foreseeable environmental risks assessed and mitigated.

In the view of the authors – including experts from the Society for Institutional Analysis (sofia) – these were workable provisions. Another plus point, according to the researchers, was that the parliamentary draft offered great flexibility for development. However, the parliamentary proposal did not fully address the gaps in the Commission's draft. For example, its determination of which systems would fall within the scope of the Regulation did not take environmental risks into account. In the project team's view, with this approach, systems that are especially environmentally sensitive may remain outside the scope of application.

The European Parliament adopted the AI Regulation in March 2024. Regrettably, some of the key measures set forth in the proposals were deleted in the preceding EU trilogue. The experts are therefore hoping that these measures will be included in future regulatory provisions.

PROJECT TITLE Regulatory concept for algorithmic decision-making systems under environmental law

CLIENT German Environment Agency (UBA)

PROJECT PARTNERS Society for Institutional Analysis (sofia), Frederic Theodor Stahl (German Research Center for Artificial Intelligence), Lars Nolle (Jade University)

TIMESCALE May 2022 – June 2023 PUBLICATION OF POLICY PAPER September 2023 www.oeko.de/jb2023-ai-ecological "Al systems can help us to achieve sustainability objectives – fully in line with the twin (digital and green) transition that the EU is seeking to implement. Whether this actually works will depend on a multitude of conditions. That being the case, smart regulation is needed, particularly for the sake of the environment and climate change mitigation." – Dr P. Gailhofer



**Dr Peter Gailhofer** Senior Researcher Environmental Law & Governance Division

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### How much energy does ChatGPT consume every day?



### Electric trucks Electrifying road freight transport

Is a 100 per cent battery-powered truck fleet feasible? Yes – but only with a broad-scale and well-performing charging network! If this is in place from 2035, a successful market rollout of zero-emission drive technologies can be achieved within a short timeframe – and climate-neutral road freight transport would be within reach by 2045. In a project funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK), the Oeko-Institut evaluates various electric drive technologies to identify their technical and economic potential and models their impacts on energy demand.



In order to achieve a successful rollout of e-trucks on German roads, a substantial expansion of the charging infrastructure for heavy-duty commercial vehicles is required; this applies particularly to charging hubs along motorways for overnight and rapid charging.

The experts carried out a comprehensive appraisal which shows that 80 per cent of a truck's total energy demand can be charged in the depot or overnight using public night charging systems (NCS) on multi-day journeys. For high power charging requirements, Megawatt Charging Systems (MCS) are needed so that batteries can be charged within the legally prescribed rest period.

#### PROJECT TITLE StratES – Scenarios for the electrification of road freight transport

FUNDED BY Federal Ministry for Economic Affairs and Climate Action (BMWK) through the Renewable Mobile programme TIMESCALE November 2019 – March 2023

www.erneuerbar-mobil.de/projekte/strates (in German)

"As Megawatt Charging Stations rely on a connection to the high-voltage grid to provide high power charging at locations with heavy traffic, planning for the rollout of a charging infrastructure needs to start right away. A network of around 2000 MCS and roughly 40,000 NCS charging points is required along Germany's motorway network." – Dr K. Goeckler



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What is the maximum range that a battery electric truck already in everyday use can drive without recharging?





For those of us who are unable or unwilling to avoid emissions completely but still aim to achieve climate neutrality, carbon credits are often a good option. This is a growing market that generates funding for climate projects – but some of these carbon credit schemes fall short of the required quality standards. The Carbon Credit Quality Initiative (CCQI), founded and managed by Environmental Defense Fund (EDF), WWF-US and the Oeko-Institut, aims to change this situation and enable the general public and market players to spot differences in quality and make informed decisions when purchasing carbon credits. To support this process, an interactive scoring tool to assess the quality of carbon credits was developed within the CCQI framework. The CCQI has also prepared a set of factsheets on various project types for the Foundation **Development and Climate Alliance.** 

The CCQI scoring tool can be used to rate carbon credits against various quality objectives, including permanence of carbon storage and avoidance of double counting.

The CCQI also takes account of the major carbon crediting programmes, including the Clean Development Mechanism and the Verified Carbon Standard (VCS). It examines various project types, such as solar PV and wind power, commercial afforestation and household biodigesters. Other project types will be covered in future. The CCQI assessments already show that in many of the carbon credit schemes, there is a considerable risk that emission reductions will be overestimated.

The experts have also produced six factsheets in which they summarise their research results for the various project types in clear and comprehensible language. They present their results on the basis of the defined quality objectives and thus help to make the CCQI assessments easily accessible. Those assessments provide detailed, publicly available information, enabling users to ascertain whether carbon credit schemes genuinely deliver environmental benefits.

PROJECT TITLE Carbon Credit Quality Initiative (CCQI)

CLIENT Environmental Defense Fund (EDF), Foundation Development and Climate Alliance (factsheets) PROJECT PARTNERS Environmental Defense Fund, World Wildlife Fund (WWF-US), Carbon Limits,

Greenhouse Gas Management Institute (GHGMI), INFRAS, Stockholm Environment Institute (SEI) TIMESCALE Ongoing since 2021

https://carboncreditquality.org

"The rules on the issuing of carbon credits require considerable improvement. Some good-quality and innovative schemes already exist, so it is now up to the carbon crediting programmes to identify and implement the best approaches and thus safeguard environmental integrity in the voluntary carbon market across the board." – F. Fallasch



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## What is the most potent known greenhouse gas?



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## The basic premise: sustainability

## A framework for living labs

Living labs – also known as real-world laboratories – are incubators of change and are used to develop, test and research new social practices and innovative ideas. The purpose of the Real-World Laboratory Act, now being developed by the German Federal Ministry for Economic Affairs and Climate Action (BMWK), is to establish a suitable framework for their activities. The Real-World Labs for Sustainability Network – a coalition of 50 organisations, including the Oeko-Institut – welcomes this initiative but is also calling for a clear focus on sustainability as the basic premise for the testing of social and technical innovations.



In a statement, the Network makes the following points: A Real-World Laboratory Act must be more strongly aligned with sustainability criteria than currently envisaged. In addition, harmonised minimum standards for living labs are required, along with extensive civil society engagement. On topics such as artificial intelligence or the accelerated expansion of wind power, it is essential to involve the full range of stakeholders in order to build broad-based social coalitions with the capability to respond effectively to future challenges. The experts conducted a detailed analysis of the BMWK's Green Paper on Real-World Laboratories, which will form the basis for the future legislation. They are calling for amendments to the general standards described in the Green Paper, notably as regards the focus of research, with the inclusion of new knowledge generation as a further objective, and education, reflecting the fact that living labs play a key role as transdisciplinary learning spaces. Their essential nature as laboratories is also important: they serve as spaces for open-ended social experiments and offer scope for reflection on the results and lessons learned.

#### PROJECT TITLE Living Labs for Sustainability

PROJECT PARTNERS A network of 50 organisations and more than 80 active and completed real-world laboratories TIMESCALE April 2023 – September 2023

www.oeko.de/jb2023-reallabore (in German) www.reallabor-netzwerk.de (in German)

"A major benefit of transdisciplinary living labs is that they involve stakeholders from a range of disciplines, sectors and industries. It is important to strengthen the role of civil society here, not only by engaging in appropriate outreach but also by providing more financial support." – Dr R. Rhodius



**Dr Regina Rhodius** Senior Researcher Nuclear Engineering & Facility Safety Division





**Professor Dierk Bauknecht** Senior Researcher Energy & Climate Division

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## What is the world's longest-running laboratory experiment?



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### Avoiding dependencies Resilient raw material supply chains

Without critical raw materials, climate neutrality is out of reach. Solar PV modules and lithium-ion batteries cannot function without them. Due to surging global demand, however, supply bottlenecks and dependencies may impact key resources such as graphite, cobalt, manganese, iridium and rare earths. Many stages of the supply chain are currently concentrated in China. So how can dependencies be avoided? Which steps can Germany and Europe take to secure a supply of raw materials? These questions are addressed in a study on behalf of the Climate Neutrality Foundation.



Experts from the Oeko-Institut, the Wuppertal Institute and Prognos analysed resource demand and supply chains for technologies of strategic importance for the energy and mobility transition, including photovoltaics, wind power, electrolysers for power-to-hydrogen production, and heat pumps. Based on a scenario of climate neutrality by 2045, they identified Germany's demand for strategic raw materials for the various technologies. On this basis, they then assessed the availability of these raw materials and possible vulnerabilities in the supply chains to 2030 and 2035, by which time key roadmaps must be in place for the development of low-carbon technologies. The researchers also ranked the strategic raw materials in priority categories and developed targeted measures with potential to increase resilience in the German economy.

The study reveals that resolute policy action is required. This includes locating highly critical elements of the supply chain in the EU, expanding new and more differentiated trade relations with further partner countries and investing in recycling capacities in Germany and Europe. Furthermore, according to the project team, efforts must be made in the context of research and development (R&D) to identify alternatives and reduce demand.

PROJECT TITLE Securing Germany's Sovereignty: Resilient supply chains for the transformation to climate neutrality by 2045
 CLIENT Climate Neutrality Foundation / Stiftung Klimaneutralität
 PROJECT PARTNERS Prognos, Wuppertal Institute
 TIMESCALE October 2022 – September 2023
 www.oeko.de/jb2023-resilient-supply-chains

"Due to the expansion of electromobility, demand for lithium, for example, will increase substantially in Germany – we're expecting it to peak at around 20,000 tonnes per year between 2030 and 2035. So it's important to expand lithium production and initiate new projects in Europe, potentially in combination with geothermal schemes. Diversifying the range of partner countries is also important." – Dr J. Klinge



**Dr Johannes Klinge (formerly Betz)** Senior Researcher Resources & Transport Division





**Dr Matthias Buchert** Head of the Resources & Transport Division

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## What is Germany's top import (by value)?



### Where to land? A PtX tool for supply countries

Power-to-X (PtX) and PtX products – in other words, hydrogen based on renewable electricity and other energy carriers produced from it, such as synthetic fuels – are a pillar of the energy transition. But what kind of opportunities do they offer to supply countries? These countries can now answer that question by using the PTX Business Opportunity Analyser, an interactive tool developed by the Oeko-Institut on behalf of Agora Energiewende and Agora Industry. It differs significantly from other tools that focus on importing countries as it is designed for use by stakeholders in exporting countries. The PtX tool enables exporting countries to assess their PtX value chain opportunities, evaluate their products and make comparisons with other countries. They can also calculate landed costs of various PtX products. The tool utilises publicly available global datasets, thus facilitating informed and unbiased comparison with other supply countries.

It is also possible to change the input data based on local knowledge and specific expertise and trace the amended results that this produces. In addition, the PtX tool places a clear emphasis on sustainability: for example, it characterises and defines sustainability aspects for

PROJECT TITLE PTX Business Opportunity Analyser CLIENT Agora Energiewende and Agora Industry TIMESCALE June 2023 – July 2023 www.oeko.de/jb2023-ptx-boa electricity use and other inputs such as water. Moreover, the tool assists decision-makers to identify promising regions and business opportunities within the PtX value chain.

As part of the project, the researchers held three country dialogues to facilitate discussion and validation of country-specific data. This enabled potential supply countries' standpoints and perspectives to be taken into account. Stakeholders from Argentina, Morocco and South Africa were involved in this process. "The PtX tool includes information on the hydrogen strategies of demand countries, as well as on existing regulatory and certification systems. This shows users which sustainability aspects are covered and which are missing." – C. Heinemann



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In which year was water electrolysis first performed to produce hydrogen from water using electricity?



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## An algorithm for species conservation

# Digitalisation and nature conservation

Digitalisation offers numerous opportunities for nature conservation. For example, it enables planners to give more consideration to conservation issues by using geodata and makes it easier for researchers to collect, analyse and share data. However, digitalisation also poses risks to the natural environment: the required hardware's energy and resource consumption is just one example. On behalf of the German Federal Agency for Nature Conservation (BfN), the Oeko-Institut organised a series of conferences in order to explore these opportunities and risks. The key findings on a range of topics, including biodiversity monitoring and conservation management, are documented in a conference report.

One of the major benefits of digital applications is that they offer opportunities for citizen engagement. Improved access to data makes it easier to involve citizens in science-based nature conservation projects, such as wildlife monitoring or invasive species surveillance. Linking the various databases remains a challenge, however.

Apps are also available to aid the identification of flora and fauna or support digital planning of hikes and cycle tours. From the researchers' perspectives, one of the risks here is that commercial app developers often fail to consider the nature conservation dimension; as a consequence, recommended routes may cut across nesting sites, for example. In agriculture, digital methods are already being applied in precision farming in order to manage yields or support more targeted use of fertilisers and pesticides. According to the experts, however, more research is needed to ascertain whether these methods genuinely support nature conservation.

In reality, the benefits are highly dependent on the quality of the collected data and how it is used. Another important factor is how the algorithm is programmed – in other words, whether its aim is to maximise yields or support nature conservation.

PROJECT TITLE NaturschutzDigital – Digital Nature Protection: Opportunities and risks of digitalisation for nature conservation
 CLIENT German Federal Agency for Nature Conservation (BfN)
 TIMESCALE March 2020 – December 2022
 www.oeko.de/jb2023-naturschutz-digital (in German)

"Government regulation of algorithms and artificial intelligence requires a holistic approach. For us, this means that it must also take conservation aspects into account. This is particularly important at the intersection between economic interests and nature conservation – in agriculture and forestry, for example, and also in the fisheries sector." – Dr N. Kampffmeyer



#### Dr Nele Kampffm<u>eyer</u>

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## Which native tree species stores most carbon during its lifetime?



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### Not a viable alternative Novel reactor concepts

Opponents of the exit from nuclear power often make claims about so-called novel reactor concepts (SNRs). According to their developers, these "fourth-generation" technologies offer advantages in terms of criteria such as safety, fuel utilisation, economic efficiency and reduced production of waste. However, none of these reactor concepts has reached technological maturity or is commercially competitive at present. So what do SNRs have to offer? In a study for the German Federal Office for the Safety of Nuclear Waste Management (BASE), the Oeko-Institut and TU Berlin provide comprehensive answers to this question. The researchers investigated six different technology lines – including sodium-cooled fast reactors (SFRs), lead-cooled fast reactors (LFRs) and molten salt reactors – against criteria such as technical development status, safety and proliferation risks.

They also reviewed research activities in six countries, including the US, Russia and China. This revealed that SNRs are not novel technologies – yet they have never become established despite decades of research. It is therefore inaccurate to describe them as a "new generation" of reactors.

The analysis of the individual technology lines shows that SNRs may have potential advantages over today's light water reactors – but only in relation to specific criteria. None of the technology lines can be expected to have an overall advantage. On the contrary, improvements in safety may create disadvantages in terms of additional costs, while advances in the area of waste disposal may lead to new risks relating to safety or nuclear proliferation.

The project team therefore concludes that based on their current development status, SNR concepts cannot solve today's problems in nuclear technology.

PROJECT TITLE Analysis and evaluation of the development status, safety and regulatory framework for so-called novel reactor concepts
CLIENT Federal Office for the Safety of Nuclear Waste Management (BASE)
PROJECT PARTNER TU Berlin
TIMESCALE January 2022 – March 2024
www.oeko.de/jb2023-snr (in German)

"Developers of novel reactors repeatedly refer to intrinsic properties – such as higher efficiency of electricity production through utilisation of process heat – to indicate advantages of these technology lines over light water reactors. However, these advantages typically lead to challenges or disadvantages in other areas, such as safety." – Dr C. Pistner



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## What is the world's largest nuclear power plant?



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### **Burden or relief?**

### The sustainability potential of digital technologies

Digital technologies require large amounts of raw materials and energy. Yet there are hopes that they will increase the efficiency of technical processes. So when it comes to the environment and sustainability, do the benefits of digital technologies outweigh the disadvantages? Detailed observations and analyses will be required in future in order to draw firm conclusions here. On behalf of the German Informatics Society, the Oeko-Institut therefore analysed the sustainability potential of various research projects in the field of digital technologies, with a focus on applications for forestry, the circular economy and water resources management. The researchers looked at potential reductions in environmental impacts – such as efficiency gains in industrial processes – and environmental burdens. For this purpose, they supported the research projects' own efforts to carry out sustainability analyses, e.g. by providing suitable evaluation tools. Three of the projects were then subjected to an in-depth sustainability analysis by the Oeko-Institut and the results were scaled up to Germany as a whole.

The study showed that in almost all cases, the projects can be expected to reduce greenhouse gas emissions. However, the magnitude of this potential varies considerably. Digital technologies that support the substitution of CO<sub>2</sub>-intensive materials such as concrete can have very positive environmental impacts. Greenhouse gas reductions of several thousands of tonnes of CO<sub>2</sub> equivalents per year are possible if the new developments are successfully scaled up to Germany as a whole. However, this is merely a fraction of the reductions, amounting to 23 million tonnes of CO<sub>2</sub> equivalents annually in the period up to 2025, required to achieve Germany's climate targets. Even so, every contribution to climate change mitigation is important. The development of digital technologies can also generate further sustainability gains. For example, they can help to reduce insecticide use in forest areas and thus conserve biodiversity.

PROJECT TITLE Development-accompanying sustainability analyses in the cross-sectional project for the "Digital GreenTech" funding measure CLIENT German Informatics Society / Gesellschaft für Informatik e.V.

FUNDED BY Federal Ministry of Education and Research as part of the Network Digital GreenTech (NetDGT) project

TIMESCALE May 2021 – December 2023

www.oeko.de/jb2023-digital-greentech

"Our analysis shows that if players in the research projects conduct a self-evaluation, they will systematically engage with the issue of sustainability at an early stage. This can generate momentum for further research and development by facilitating capacity-building in the modelling and evaluation of key issues." – Dr M. Moeller



### Dr Martin Moeller

Senior Researcher Sustainable Products and Material Flows Division

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### What is the world's most powerful/ fastest computer?



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### Funders and clients in 2023 1/2

### 1. Politics & government

- Austrian Ministry for Climate Action (BMK)
- Baden-Württemberg Media and Film Society (MFG)
- Baden-Württemberg Ministry of the Environment, Climate Protection and the Energy Sector
- Brandenburg Ministry of Agriculture, Environment and Climate Protection
- Bundesgesellschaft für Endlagerung (BGE, Germany's federal company for radioactive waste disposal)
- Bundesnetzagentur (Germany's main federal authority for infrastructure and networks)
- Bundesstelle für Energieeffizienz (BfEE, Germany's federal centre of competence for energy efficiency)
- Bundestechnologiezentrum für Elektround Informationstechnik (BfE)
- City of Hamburg
- City of Munich and Munich municipal utilities

- Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)
- District authorities of Alzey, Cuxhaven, Osnabrück
- European Commission
- European Education and Culture Executive Agency (EACEA)
- European Environment Agency (EEA)
- European Parlament
- European Union
- Food and Agriculture Organization of the United Nations (FAO)
- German Federal Agency for Nature Conservation (BfN)
- German Federal Environment Agency (UBA)
- German Federal Foreign Office
- German Federal Highway Research Institute
   (BASt)
- German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)
- German Federal Ministry for Economic Affairs and Climate Action (BMWK)

- German Federal Ministry for Economic Cooperation and Development (BMZ)
- German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)
- German Federal Ministry of Education and Research (BMBF)
- German Federal Ministry of Food and Agriculture (BMEL)
- German Federal Office for Radiation
   Protection (BfS)
- German Federal Office for the Safety of Nuclear Waste Management (BASE)
- German Federal Office of Administration (BVA)
- Gesellschaft für Anlagen- und Reaktorsicherheit gGmbH (GRS)
- Karlsruhe district authority
- Lübeck City Waste Management Enterprise
- Ministry of Economic Affairs, Industry, Climate Action and Energy of the State of North Rhine-Westphalia
- Organisation for Economic Co-operation and Development (OECD)

- Oesterreichische Agentur für Gesundheit und Ernährungssicherheit GmbH (AGES)
- State of Baden-Württemberg
- Statistical Office of the European Union (Eurostat)
- Swiss Federal Office of Justice (FOJ)
- United Nations Environment Programme
   (UNEP)
- United Nations Office for Project Services
   (UNOPS)
- Zukunft Umwelt Gesellschaft gGmbH (ZUG, Germany's federally owned project management agency)

#### 2. Private sector

- 50Hertz Transmission GmbH
- ACLARIS Water Innovations GmbH
- Andritz Fabrics and Rolls GmbH
- Apple Inc.
- Badenova AG & Co.KG
- Carbon Limits AS

### Funders and clients in 2023 2/2

- Constructor University Bremen gGmbH
- Currenta GmbH & Co. KG
- Deutsche Energie-Agentur GmbH (dena)
- Deutsche Telekom AG
- Deutsche Sportmarketing GmbH
- Doerner GmbH & Co KG
- Duesenfeld GmbH
- E.ON Energie Deutschland GmbH
- Honda R&D Europe (Deutschland) GmbH
- Jokey Holding GmbH & Co. KG
- MEIKO Maschinenbau GmbH & Co. KG
- Physikerbüro Bremen
- Ramboll Deutschland GmbH
- Ricardo Energy & Environment
- Vaillant GmbH
- Werner & Mertz GmbH
- Würth Elektronik GmbH & Co. KG

### 3. Academia, stakeholder groups and civil society

- adelphi research gGmbH
- Agora Energiewende
- Carbon Market Watch (CMW)
- Children's Investment Fund Foundation (CIFF)
- Climate Action Network (CAN) Europe
- Deutscher Mieterbund e.V.
- Deutsches Tiefkühlinstitut e.V.
- Eberswalde University for Sustainable Development
- EnergieVision e.V.
- Environmental Coalition on Standards (ECOS)
- Environmental Defense Fund (EDF)
- European Climate Foundation (ECF)
- Exit Plastik
- Federation of German Consumer Organisations (vzbv)
- Foundation Development and Climate Alliance

- Fraunhofer-Gesellschaft
- Freiburg Archdiocese
- Friends of the Earth Baden-Württemberg
- German Federal Environment Foundation (DBU)
- German Informatics Society (GI)
- German Newspaper Publishers and Digitalpublishers Association (BDZV)
- German Olympic Sports Confederation (DOSB)
- Greenpeace Germany
- Hans Boeckler Foundation
- Institute for Resource Efficiency and Energy Strategies (IREES)
- Integrity Council for the Voluntary Carbon Market (ICVCM)
- Mountain Research Institute
- Nürtingen-Geislingen University (NGU)
- Oeko-Recherche GmbH
- Perspectives Climate Group GmbH
- Sustainable Digital Infrastructure Alliance e.V.
- Swiss Federal Laboratories for Materials
   Science and Technology (Empa)

- Swisscontact
- TA-SWISS, the Foundation for Technology Assessment
- The Nature and Biodiversity Conservation Union (NABU)
- Transport & Environment
- Umwelthaus gGmbH
- University of Freiburg
- University of Stuttgart
- Utopia GmbH
- VDI Technologiezentrum
- Werkstatt Zukunftsfragen e.V.
- WWF Germany

These are some of our funding providers and clients. A full list of references is available (in German) on our website: www.oeko.de/referenzen2023

# The Oeko-Institut in the media

From traditional media relations to our website, social media and podcasts: we use various methods to share our research findings with the public. We aim to use language that is as clear and accessible as possible in order to foster a broad consensus on the need for a just and sustainable transition.

### In 2023, the Public Relations & Communications Department ...

- ... produced 34 press releases and 27 news articles > Find out more
- ... published 50 blog articles Find out more
- ... posted 453 tweets to 19,236 followers Find out more
- ... created 390 Instagram posts and stories for 3427 subscribers Find out more
- ... sent 206 updates via the LinkedIn profile to 7789 followers Find out more
- ... recorded 9 episodes of the "All change please!" podcast > Find out more
- ... sent out 12 issues of the EcoMail Newsletter > Find out more
- ... published 4 issues of the eco@work online magazine > Find out more



### A new design for our website

Our redesigned website offers users even more opportunities to access a full range of information on a given topic from one page. Whether you're interested in the just transition, digitalisation or the heat transition, the website's new theme-based structure guides you to our publications, projects, press releases and other communication products. With its new format and streamlined modern design, our website showcases our research findings and offers easy access to our topics.

### Independent research

Last year, the Oeko-Institut came in for criticism in connection with staffing policy at the Federal Ministry for Economic Affairs and Climate Action (BMWK). We were accused of using unfair practices. We vigorously refuted these claims and were able to produce factual evidence showing how we secure our contracts and conduct our scientific research.

We would therefore like to take this opportunity to reiterate that we present our ideas and insights independently of the positions of political and social organisations and avoid potential conflicts of interest. Maintaining our independence is part of our statutes and institutional strategy.

Since its establishment, the Oeko-Institut has worked on an inter- and transdisciplinary basis with partners from industry, academia and civil society. With more than 150 commissioning parties, its main clients include the German ministries at the federal and regional (Land) level, local authorities, businesses and the European Union. The Institute also takes on commissions from NGOs and environmental organisations. To ensure that the Oeko-Institut is equipped to deal with baseless allegations of this nature in future, we have agreed a Code of Conduct for the Institute. The **Code of Conduct** not only includes provisions on gender equality and diversity but also enshrines our commitment to good research practice. We are actively engaged in open science practices and share our findings with the public.

A works agreement is in place in order to ensure that potential conflicts of interest are avoided. We also uphold fundamental scientific standards and disclose our contacts in the EU Transparency Register and the German Lobbying Register.

### Helpful in the extreme! The Oeko-Institut's members

The Oeko-Institut is a non-profit association with around 2000 members and finances its work mainly through projects funded by third parties. Members' subscriptions and donations enable the Institute to conduct independent research aside from its clients' commissions and address topics that we believe are relevant for the future.

## Donation-funded projects for the future

Thanks to our many donors and our members' subscriptions, we are able to realise research ideas and projects for which no external funding is forthcoming. Our annual donation-funded projects and our own-initiative projects enable us to conduct independent research that addresses the major challenges facing humankind today.

#### **Donation-funded project 1:**

### Al-generated content – opportunities and risks

In our latest donation-funded project "Al-generated Content – Fact or Fiction?", we aim to conduct an early-stage investigation of the specific risks and opportunities associated with the new Al-based large language models (LLMs) and find out to what extent Al-generated content provides users with easy access to reliable information on environmental and climate-related issues.

Large language models based on artificial intelligence (Al) interact with users in the form of dialogue and provide seemingly trustworthy responses. But how accurate is the information in these responses? The factual accuracy of Al-generated content is a frequent topic of public debate at present – and social media-based disinformation campaigns on environmental issues are nothing new. In order to provide an active policy steer for the rollout of AI-based large language models, it is important to identify their opportunities and risks.

In our donation-funded project, we are therefore developing a methodology for reviewing answers generated by AI-based large language models on key environmental topics and assessing whether the factual accuracy of the answers evolves over a given period of time. We also aim to find out whether access to environmentally relevant information is improved through the use of AI-based large language models. The Institute's experts will then devise a set of policy recommendations as a basis for a regulatory framework.

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Or use our online form here: www.oeko.de/spenden



### The circular economy – reducing resource consumption

In order to generate new impetus for a circular economy in Germany, a paradigm shift is required. In a circular economy, the value of products and materials is maintained for as long as possible.

A circular economy means minimising resource consumption and waste. It means reusing end-of-life products, with high-quality recycling of products that are not suitable for reuse. A circular economy aims to make sparing and efficient use of resources.

As part of its donation-funded Circular Economy – An Appeal and Proposals for Closing the Loop project, the Institute has developed recommendations showing how to achieve this paradigm shift.

Find out more

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Quiz answers

#### <sup>1)</sup> p. 14, B: Qatar

According to the Global Footprint Network, Qatar is the country with the highest per capita resource consumption worldwide. If everyone in the world lived like residents of Qatar, 8.7 Earths would be needed to satisfy global resource demand. Source: Statista, 5.6.2023

<sup>2)</sup> p. 16, C: 510,000 kW

Data scientist Alex de Vries at the Dutch central bank (DNB) has calculated that ChatGPT consumes an estimated 510,000 kilowatt-hours of electricity per day – equivalent to the energy consumption of around 17,000 US households.

Source: Der Standard, 13.3.2024

#### <sup>3)</sup> p. 18, C: More than 1000 km

The maximum distance that an e-truck in everyday use has driven without recharging is more than 1000 km – 1099 km, to be precise. A battery-powe-red truck operated by DPD Switzerland travelled this distance in 23 hours in 2021, setting a Guinness World Record. Source: Continental, 31.8.2021

#### <sup>4)</sup> p. 20, A: Sulphur hexafluoride (SF6)

According to the IPCC's Sixth Assessment Report, the global warming potential (GWP) of sulphur hexafluoride (SF6) is 25,200 times that of carbon dioxide, making it the most potent known greenhouse gas. Despite its great potency and long atmospheric lifetime of 3200 years, it exists in relatively low concentrations in the atmosphere and therefore has a minimal effect on global warming.

Source: Dossier produced by the German Bundestag, 17.10.2022

#### <sup>5)</sup> p. 22, C: Pitch drop experiment

Thomas Parnell started his experiment in 1927 by pouring a sample of liquid pitch into a funnel, which he then sealed. The funnel was opened three years later and the falling pitch drops have been recorded ever since. The ninth – and latest – drop fell in 2014. Source: Wikipedia, 16.4.2024

#### <sup>6)</sup> p. 24, B: Natural gas

Natural gas is Germany's top import by value. Due to its limited natural resources, Germany is reliant on energy imports, spending 68.1 billion euros on natural gas imports in 2022. Petroleum oil and oil obtained from bituminous minerals were Germany's top imports by weight. Source: Statista, 2.4.2024

#### <sup>7)</sup> p. 26, A: 1800

In 1799, the Italian physicist Alessandro Volta developed the first battery capable of providing a continuous electric current. Having learned of Volta's invention, the Scottish chemist William Cruickshank performed the first experiments involving electrolysis in 1800. Source: Forschungsstelle für Energiewirtschaft e. V., 2021

#### <sup>8)</sup> p. 28, C: Beech

Studies by the University of Zurich found that compared with other native tree species, beech has very high carbon uptake potential. For example, a beech tree that is 120 years old and 35 metres high with a diameter of 50 cm (measured at 1.3 metres) has a dry weight of 1.9 tonnes, around 0.95 tonnes of which consists of carbon. This is equivalent to approximately 3.5 tonnes of  $CO_2$  – around one tonne more than a spruce, for example. Source: Nature First, 19.10.2019

#### <sup>9)</sup> p. 30, B: Kashiwazaki-Kariwa, Japan

Kashiwazaki-Kariwa in Japan is the world's largest nuclear power plant. It consists of seven reactor blocks with total installed capacity of 7965 MW. Due to safety breaches, an operating ban was imposed and the power plant – which is run by the same company as the Fukushima nuclear plant – was taken offline in 2012. The ban was recently lifted, however. Source: Statista, 10.1.2024

#### <sup>10)</sup> p. 32, A: Frontier, USA

The Frontier system, developed in Tennessee in the US, ranks first on the TOP500 list of the world's most powerful computers. This exascale machine is a supercomputer capable of performing a trillion calculations per second. Source: TOP500, 14.11.2023