eco@work

April 2025

Sustainable reading
from the Oeko-Institut

Artificial, but climate-conscious

AI and sustainability

Another car? Traffic tracking

AI and safety Interview with Dr Heidy Khlaaf

Without artificial assistance

Anke Herold
Acting CEO of the Oeko-Institut
a.herold@oeko.de

When we started working on this issue of eco@work, one question came up repeatedly: should we use artificial intelligence to support the process? Should we feed in a study to see if it came up with anything useful? Or perhaps even conduct an interview with ChatGPT et al. and find out how AI rates its own performance on environmental and climate issues?

As you may have noticed already, a decision was taken to include an interview with Dr Heidy Khlaaf instead – and most of the rest of this issue was also produced without artificial assistance. That's not to say that we don't use AI from time to time – even in our research. Our colleagues from the Energy and Climate Division used ChatGPT in one of their projects in order to produce a summary of research papers, for example. I am convinced that we will increasingly outsource this type of task to AI in future. After all, it can make our work easier in many areas – for example, when searches, summaries or translations are required.

But away from the scientific field as well, artificial intelligence can make our lives easier and more enjoyable. I'm thinking, for example, of smart houses or apartments that control the heating, lighting and many other devices intelligently so that the occupants enjoy home comforts while also benefiting from efficiency. On matters of efficiency in particular, AI offers great potential – within our own four walls, but also in the operation of the power grids. As we show in this issue of eco@work, this technology creates countless opportunities – but also a multitude of risks, relating to social welfare, basic and human rights and the protection of the environment and climate. In the following pages, we look at why this is the case and how we can respond to these challenges.

With considerable misgivings here at the Oeko-Institut, we are seeing the major Internet companies now bringing nuclear power generation options back into play in response to AI's vast energy demand. And yet with smarter AI programming, there are many opportunities to drastically reduce this energy hunger. That's where the European AI development pathway should be heading.

Yours,
Anke Herold

CONTENTS

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

eco@work – April 2025 (date of publication of German edition: March 2025)– ISSN 1863-2025
Published by: Öko-Institut e.V.
Edited by: Mandy Schoßig (mas), Christiane Weihe (cw)
Responsible editor: Anke Herold
Translated by: Christopher Hay
Design/Layout: Hans Löbermann – Technical implementation: Markus Werz
Address of editorial office: Borkumstraße 2, 13189 Berlin, Germany
Phone: +49 (0) 30/4050 850, redaktion@oeko.de, www.oeko.de

Account Details for Donations:
GLS Bank, Bank Code No.: 430 609 67, Account No.: 792 200 990 0,
IBAN: DE50 4306 0967 7922 0099 00, BIC: GENODEM1GLS
Donations are taxdeductible for German income tax purposes.

Picture Credits:
Title: Just_Super @ istock.com; p. 4 olaser @ istock.com;
p. 6 - 9: Lidiia Moor @ istock.com; p. 10 melissagiss @ istock.com;
other © private or © Öko-Institut

"AI algorithms are unsuitable for safety-critical applications"

Whether in autonomous vehicles or nuclear power plants - artificial intelligence plays a role in many technical applications or is expected to do so in the future. However, we are not adequately considering the safety of its use, says Dr Heidy Khlaaf. The Chief AI Scientist at The AI Now Institute is an expert in safety-critical applications. In an interview with eco@work, she explains why the use of nuclear energy is problematic for AI's growing hunger for energy and which safety gaps the EU AI Act leaves.

Dr Khlaaf, why aren't the risks of AI better taken into account?
There is an overall lack of understanding of the nature of AI systems themselves and how unreliable they are, which causes policymakers to disregard the risks intrinsic to them. These challenges have often stemmed from unsubstantiated claims and the AI hype. When in reality, the nature of AI systems is to provide outcomes based on statistical and probabilistic inferences and not any type of reasoning or factual evidence. This means that AI algorithms have persistent accuracy issues, making them unsuitable for applications that require precision and safety-criticality.

The big tech companies are bringing nuclear power in play to provide for the rising energy consumption of data centres. Does that make sense?
The matter of fact is, nuclear power requires significantly longer timescales to build that are incompatible with the pace at which tech companies are building data centres and deploying AI. The average time to build nuclear power plants has ranged from 10 to 20 years. So any immediate investment in nuclear energy will not satisfy or meet energy demands now, or in 10 years' time, needed to alleviate pressure from AI usage.

Google, Amazon and Oracle are heading to SMRs. How safe is this technology and which risks does this have?
SMRs by design are actually safer than larger nuclear plants, but there are several obstacles we still face with their potential. First, SMRs are still under development, with over 80 designs in progress, but only a handful in operation or testing. Any successful designs would then be required to undergo licensing, permitting, construction and regulatory activities. Second, SMRs will also lead to an increase of nuclear waste. Some studies have found that SMRs may in fact create greater and more complex nuclear waste per unit of energy produced than large power plants.

Microsoft wants to reactivate a reactor in Three Mile Island. How safe is that?
Three Mile Island is due to re-open in 2028, pending regulatory approval. However, it's also due to undergo a relicensing process in 2034. There is a concern here that the urgency for immediate energy needed for AI may put unprecedented pressure on regulators to meet demands and potentially disregard any risks uncovered. The irony in this is that the Three Mile Island accident in 1979 showed that its root cause was primarily a lack of safety culture.

Microsoft is already training LLMs to fast-track the process of nuclear approval in the US. What do you think of this?
Producing highly structured documents for safety-critical systems is a safety process in itself. Nuclear power plants are highly complex systems. Even the most minute of failures can cascade into a catastrophic or high-risk event. To view these regulatory processes as merely burdensome paperwork speaks volumes about their understanding, or lack thereof, of nuclear safety.

Is the EU AI Act sufficient with regard to safety issues?
From the perspective of safety engineering, a key challenge is that the AI Act's definition of "systemic risk" is exceptionally inconsistent and broad. It lumps together concepts like system safety with broader societal, financial and economic risks. As these risks require very different mitigation strategies, the fuzzy definition renders measures listed in obligations fractured and often inconsequential.

Thank you for talking to eco@work.
The interviewer was Christiane Weihe.

Talking to eco@work: Dr Heidy Khlaaf, Chief AI Scientist at The AI Now Institute hello@heidyk.com

Look what's passing by

The Telraam traffic counter

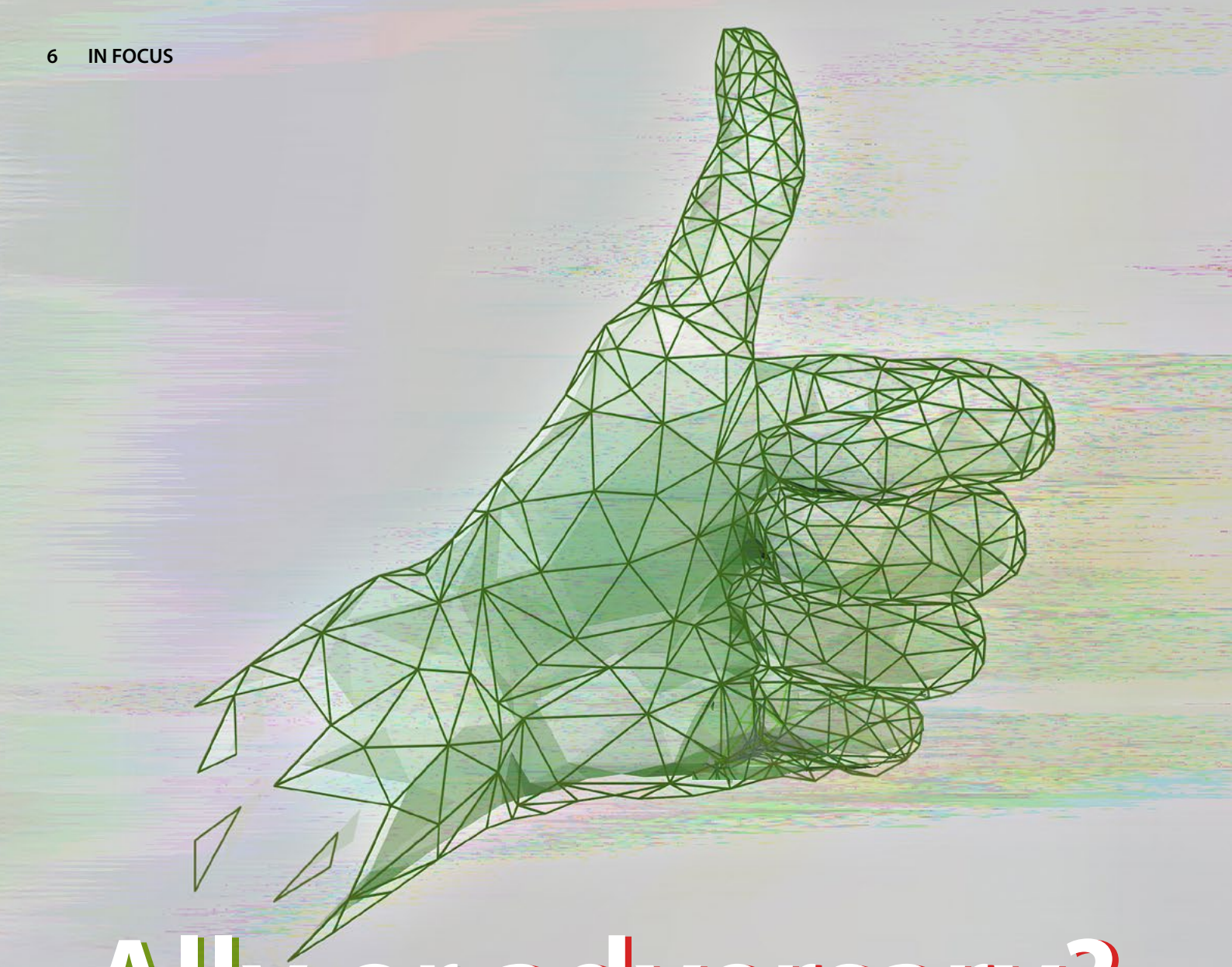
Is it a bike or a bus? A pedestrian or a truck? For anyone living in a street with heavy traffic, the answer to these questions is critical. But urban planners also benefit from traffic counts – they can use them to assess the impact of traffic management measures, for example. "Traffic counting is often very costly and complex, however," says Kris Vanherle, co-founder and CEO of the Belgian company Rear Window. "We want to make it simple and affordable while simultaneously involving the public based on citizen science." That's why the company, a subsidiary of Transport & Mobility Leuven (TML), developed Telraam, a small-scale device that anyone can place inside a window at home in order to count road users. The new version – the S2 – uses artificial intelligence (AI) technology. "This helps us to differentiate between road users with greater accuracy. For example, Telraam can now tell us whether what's coming past is a bike or a moped, a truck or a bus. That wasn't possible before," says Kris Vanherle. "The device's installation and use have also been simplified and made more intuitive."

Telraam devices have already been installed in windows in Germany as well. In Berlin, for example, they are used by citizens' action groups that are campaigning for the establishment of neighbourhoods where through traffic is banned – known as superblocks – and need traffic data to make their case. Telraam devices have also been placed in windows by safer street campaigns. "In Belgium, for example, local authorities have used Telraam to set up school streets; this means that roads are temporarily closed to traffic before the start and end of the school day, mainly to improve safety. Telraam can provide valuable data on where there is spillover traffic during these periods and whether pupils are changing how they travel to school. This also helps to defuse conflicts with local residents."

For the next version, Kris Vanherle would like to see even more citizen engagement – in the interpretation of gathered traffic data, for example. In that case, Telraam would no longer just be a "counting window" – ik tel and raam mean "I count" and "window" in Dutch, and telraam is also the word for "abacus" – but one which provides further information. Telraam poses no risk to data protection or privacy, incidentally. "The device does not save or transfer images; all it does is count – and thanks to AI, it now does so more accurately than before."

Christiane Weihe

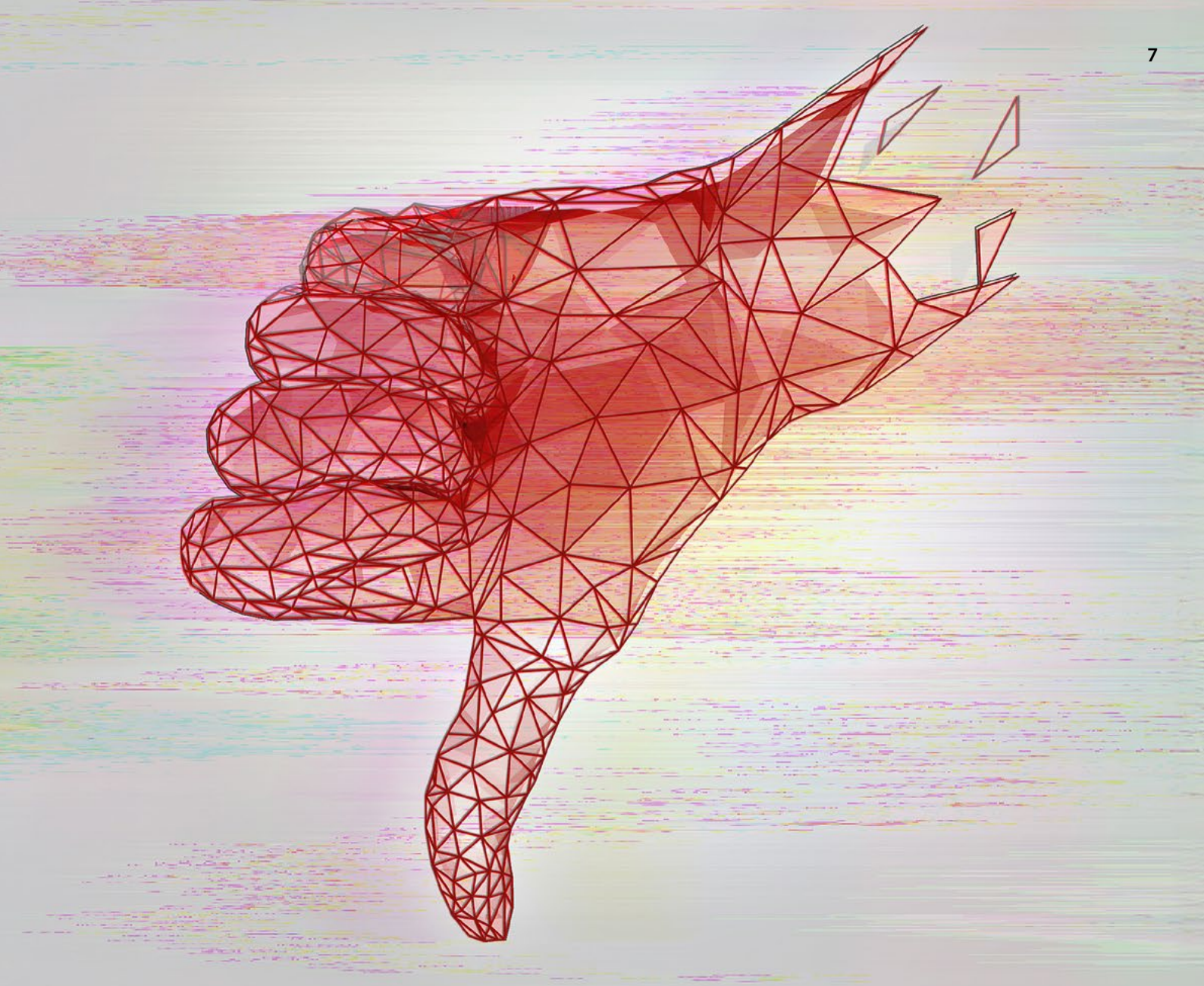
kris.vanherle@telraam.net
www.telraam.net



Ally or adversary?

Regulating artificial intelligence

Artificial intelligence is transforming our world – and has been doing so for years. We use it to translate texts and are increasingly accepting AI-based systems' recommendations of films or music that we might like. This development has its upsides, for it promises to deliver more efficiency and introduces entirely new functions and improvements in key areas of life – in medical diagnostics, for example. But it also poses various risks: discrimination against certain demographic groups, job losses, disinformation, or even risks to our survival from the deployment of AI in weapons systems are just a few examples that come to mind. The profound changes within society resulting from AI also have implications for the environment and climate. AI could help to protect them, but right now, all too often, it does them more harm than good.



AI-based systems are taking over a multitude of functions and are increasingly operating autonomously – driving trains in metro rail networks, for example. Many systems are designed to continuously adapt to a changing environment; in other words, they are continually learning. An AI-based system that suggests products for consumers aligns itself with its users' preferences, thus ensuring that its suggestions are always improving. "A key basis for AI systems' 'behaviour' is provided by the data on which they are trained and optimised. If these data are biased, incomplete or inaccurate in any way, this is reflected in the systems' output," says Dr Peter Gailhofer, a lawyer at the Oeko-Institut. "But that's just one reason why we cannot simply allow AI and its providers to do whatever they want – and why clear rules are required."

A FIRST REGULATION

In May 2024, the EU adopted the world's first law aimed at uniform regulation of AI. "The legislation is primarily intended to protect important basic rights, prevent misuse of AI and mitigate safety risks. It follows a risk-based approach: its provisions mainly concern systems and models that are associated with a particular risk – for example, if they are deployed in critical infrastructure like power grids or are used in decision-making that has a major impact on people's lives, such as access to public services," Peter Gailhofer explains. "Indeed, the use of AI systems is prohibited if they threaten personal autonomy. This includes applications that manipulate people or classify them on the basis of personal characteristics, for example."

Scientists at the Oeko-Institut continuously monitored the development of the AI Regulation, including as part of a joint project with researchers at the Society for Institutional Analysis (sofia), the Independent Institute for Environmental Issues (UfU), Jade University of Applied Sciences and the German Research Center for Artificial Intelligence. Among other things, they analysed the European Parliament's proposal in their Policy Brief "The European Parliament's Amendments to the AI Act", with a particular focus on environmental and climate issues. "One of the strengths of the parliamentary draft was that unlike the Commission's proposal, it also looked at environmental risks and thus broadened the focus beyond the specific hu-

man interests that dominated many of the debates," says Peter Gailhofer. After all, artificial intelligence has a colossal impact on the environment and climate. "For example, there is now more discussion of the resource demand for hardware and the environmental problems that may be associated with its disposal, or of water usage in data centres' cooling systems." ChatGPT uses half a litre of water for a conversation with up to 50 prompts and answers. High and ever-increasing energy demand in data centres is also a major problem and could even put the energy transition at risk *(for more detailed insights on this topic, see "Infinite growth" on p. 10)*.

The use of AI-based systems also poses indirect risks to the environment and climate, although they are even less a focus of debate. "Ultimately, the risks depend on which goals the systems are geared towards. This can be illustrated by examples from logistics: if the intention is to make supply chains as cost-effective as possible, their carbon emissions can increase dramatically unless there are clear environmental rules in place." Similar risks are identified for agriculture as well. "If the aim here is to achieve a high yield, AI is likely to opt in favour of excessive use of fertilisers and won't conserve soil and water resources." Indirect effects can also arise in relation to individual consumption if AI persuades users to engage in more – or more harmful – consumerism.

"The European Parliament's draft included some sensible approaches to protect the environment and the climate that were missing from the Commission's proposal," says Dr Peter Gailhofer. "One example is the requirement to assess and mitigate foreseeable environmental risks. Sadly, most of these proposals were then deleted from the Regulation in the trilogue. The version that was adopted contains barely any binding provisions of relevance to the environment." It does include a requirement for AI providers to state the known or estimated energy and water consumption of so-called large language models like ChatGPT. "But there is still no uniform methodology or limit values here. It is also unclear what the consequences would be if this consumption is too high. In sum, a major opportunity for broad-based embedding of environmental and climate aspects has been missed."

Even so, from the Oeko-Institut's perspective, the Regulation makes an important contribution to protecting human rights and safety interests. What's also encouraging, in the experts' view, is that the AI Regulation is seen as a flexible set of rules that is intended to respond dynamically to practical lessons learned. "Mechanisms like these should be used to close the gaps in environmental sustainability as swiftly as possible."

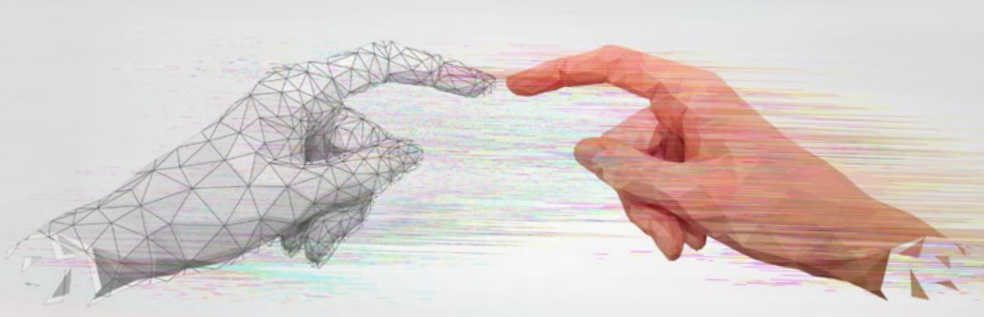
CRITICAL KNOWLEDGE

As Dr Peter Gailhofer also emphasises, we know that there are major gaps in our knowledge. "We still have much to learn about the complex interactions between AI and society and what its use will mean from an environmental and climate perspective. This is critical knowledge when it comes to regulation." However, these knowledge gaps can be closed, he says. "But for that, far more transparency is required around issues such as training data. Open access and open source rules and comprehensive research data access would also make sense. Researchers would then be able to identify problems and risks and generate information about policy options."

RISKY DEPENDENCIES

In light of the above, it is already clear that the AI Regulation does not go far enough in responding to all the risks associated with this technology and leveraging its environmental potential, says Dr Peter Gailhofer. "The most realistic solution, from my perspective, lies in sector-specific rules which are able to respond much more effectively to the challenges in the individual fields of application and which would help to bring together the environment agencies' specialist knowledge and AI-specific expertise."

In a project titled "Regulatory Concept for Algorithmic Decision-making Systems under Environmental Law" on behalf of the German Environment Agency (UBA), the researchers – together with UfU and sofia – have looked at this form of sector-specific regulation. "Wherever AI is used, it can worsen environmental problems, but it can also contribute to their solution. It's essential to address this issue. This can be done with an overarching regulation, but it may work better with one that focuses on specific issues." The Oeko-Institut has therefore developed a form of regulatory toolbox that is intended to help decision-makers from various environmental policy fields regulate AI applications effectively in future. Sector-specific rules with this type of focus can feasibly exist alongside the AI Regulation, in the team's view.



54 % of Germans expect AI to significantly change their lives.

The project team has examined a multitude of questions, some relating to matters of principle. For example, the team began by identifying the subject-matter for regulation and developing strategies for evaluating risks of relevance to environmental law, as well as instruments to regulate AI applications. "The aim is to use the law to help identify and mitigate environmental risks. From our perspective, incidentally, a failure to leverage the potential of these technologies in mitigating environmental impacts should also be classed as a risk." Due to the high complexity of risk assessment and the fact that AI is continually evolving, an institutional framework is required that enables the dynamic expansion of the knowledge base in order to improve decision-making. "Environmental law, but also some individual instruments provided for in the AI Regulation, offer various models via which our practical knowledge of risks and potentialities can be broadened and appropriate responses developed," says Peter Gailhofer. With that aim in mind, the project proposes numerous instruments that may help to avoid negative environmental impacts and improve the prospects for environmentally meaningful applications to be developed and achieve commercial success.

TAKE A CLOSER LOOK!

Dr Peter Gailhofer laments the fact that policy-makers are not looking more closely at AI –especially in the light of previous experience. "We still don't fully understand how to get to grips with the major impacts of Web 2.0 and social media on democracy and society. And now we have another, perhaps even bigger upheaval on our doorstep." Timely regulation is also important, he says, because the possible consequences for our society are so profound and far-reaching. "Artificial intelligence is permeating all sectors of society and thus creating dependencies. That's not something that can easily be reversed later on."

Christiane Weihe

Dr Peter Gailhofer laments the fact that policy-makers are not looking more closely at AI – especially in the light of previous experience. "We still don't fully understand how to get to grips with the major impacts of Web 2.0 and social media on democracy and society. And now we have another, perhaps even bigger upheaval on our doorstep." Timely regulation is also important, he says, because the possible consequences for our society are so profound and far-reaching. "Artificial intelligence is permeating all sectors of society and thus creating dependencies. That's not something that can easily be reversed later on."
p.gailhofer@oeko.de

Can AI language models be trusted?

Submitting a query to an AI language model is how people often access information these days. But these models don't always provide correct answers. At a time when disinformation campaigns around sustainability issues are gaining ground, this may prove to be a problem. The Oeko-Institut therefore conducted a donation-funded project to determine the factual accuracy of answers generated by various large language models on key environmental and climate topics. The researchers looked at a range of topics: renewable energies and power grids, new nuclear reactor concepts, dietary habits, and carbon capture and storage (CCS). With ChatGPT, for example, they found that there are differences between topics. On questions relating to established fields of knowledge, such as dietary habits, AI provided more accurate answers, but in newer subject areas like CCS, the answers were more likely to be incomplete or incorrect. The project looks at another challenge as well: how to create a framework that facilitates access to reliable environmental and sustainability-related information and minimises the risk of disinformation.

Infinite growth

AI and power consumption

Artificial intelligence has immense capabilities – but it also poses significant demands. The large amounts of data and multiple computing processes associated with AI require substantial energy inputs. For example, when ChatGPT answers a query, the AI consumes between three and 10 times as much electricity as a traditional search engine. And the development phase of this popular large language model has a large environmental footprint – the training of ChatGPT in Version 3 alone is estimated to have produced 500 tonnes of CO_2. Due to the immense popularity of these systems, their power consumption will increase significantly in the coming years. What can be done to address this issue, not least for the sake of the energy transition? The Oeko-Institut is working to answer that question in many of its projects.

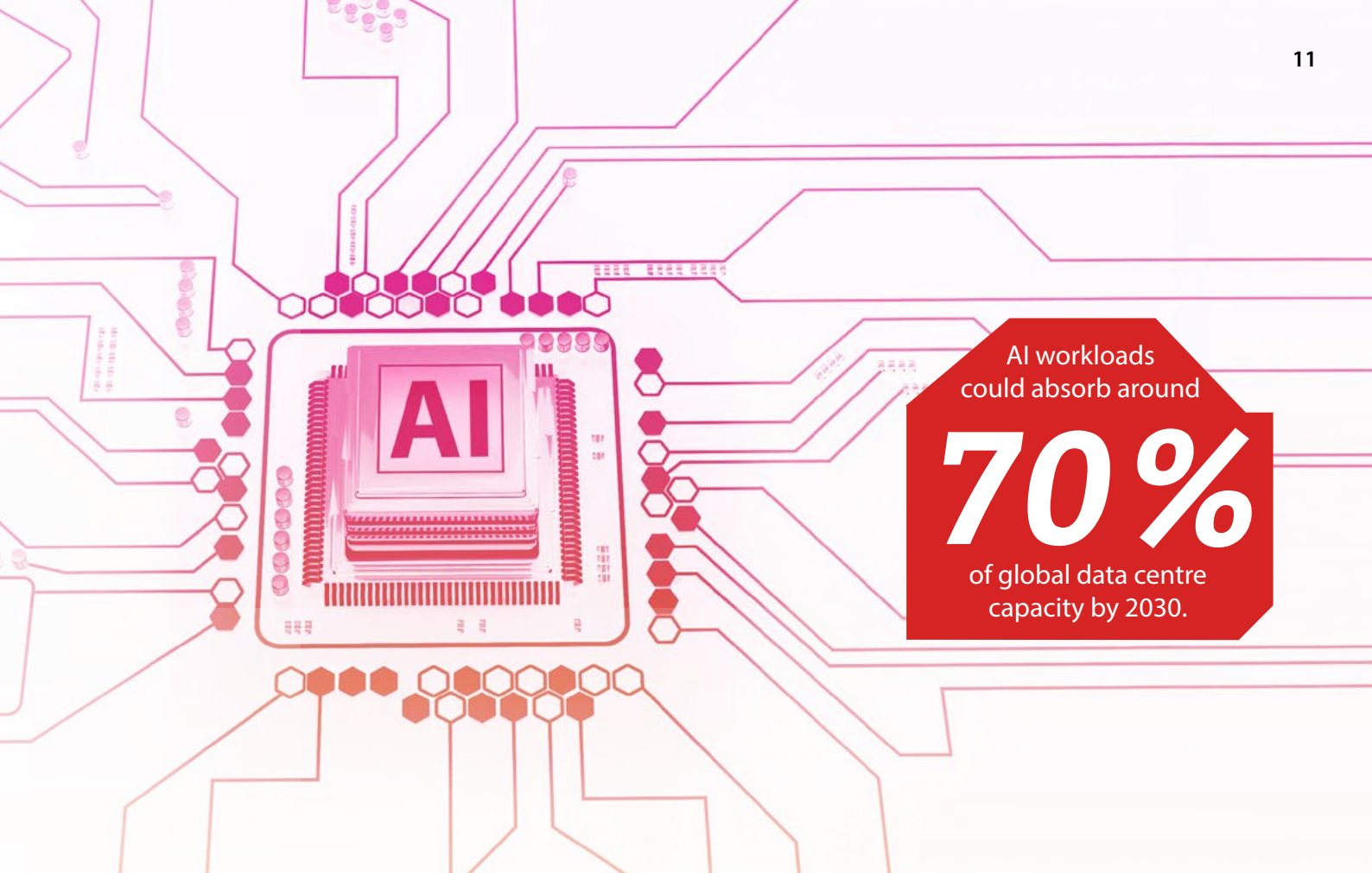
According to a forecast by the International Energy Agency (IEA), data centres' global energy consumption will double to more than 1,000 terawatt-hours annually between 2022 and 2026 due to the AI trend – equivalent to an increase of 21% per year. An end to the trend is not in sight. It is mainly driven by so-called "hyperscalers" – vast data centres operated by corporations like Google, Microsoft and Amazon. "This growth is highly problematical, as the example of Ireland clearly shows. Data centres already account for a fifth of Ireland's power consumption. This is putting national climate targets at risk and driving up electricity prices for consumers. That's why Ireland now has an emerging citizens' movement that wants to prevent the establishment of more data centres," says Jens Gröger from the Oeko-Institut. In Germany, the share of data centres' consumption in total electricity demand is currently around 3.5% – on a clear upward trajectory. "We are seeing this development in Frankfurt, for example. It has one of Europe's largest Internet exchanges, and 20% of the city's electricity is channelled into data centres."

All this is happening against the backdrop of a society that is becoming increasingly reliant on electricity. Heat pumps, e-mobility, a hydrogen economy: they need large amounts of electricity as well. "However, in contrast to these examples, where a shift from fossil fuels to renewable energies is under way, we are seeing artificial intelligence generating additional energy demand linked to new types of services. This growth is jeopardising the energy transition," says Jens Gröger, Research Coordinator for Sustainable Digital Infrastructures at the Oeko-Institut.

The success of their business models is creating a dilemma for the major tech companies as well: they have pledged to be carbon-neutral by 2030. "But it's increasingly clear that they can't meet their electricity demand from renewables. That's why they are bringing nuclear energy into play – an act of megalomania, in my view." Microsoft, for example, has initiated plans to restart the nuclear power plant at Three Mile Island in Pennsylvania, which was shuttered after a partial core meltdown in 1979. Google and Amazon are turning to small-scale reactors, known as Small Modular Reactors. "But these supposed solutions come with the risks that we're already familiar with from our use of nuclear power, such as unresolved safety and disposal issues," says Jens Gröger. "It was at that point, in my view, that digitalisation shed any pretence of innocence. So the question we should be asking ourselves right now, and no later, is this: are we genuinely willing to accept nuclear risks simply to generate a few humorous memes?"

THE EFFICIENCY OPTION

There are ways to reduce digital infrastructures' electricity demand through efficiency measures, however. With the Blue Angel for Data Centres ecolabel, researchers at the Oeko-Institut, on behalf of the German Environment Agency (UBA), have identified key areas where leverage can be applied. And with the Blue Angel for Software Products, they have ensured that the energy consumption of digital services can be measured and optimised. In practice, however, voluntary instruments such as these are rarely used. So it's good news that Germany's Energy Efficiency Act has established the basis for a national energy efficiency register for data centres. "At present, there's a lot we don't know about the actual energy and resource consumption of data centres. We are hoping that mandatory publication of key environmental data will spark a competition for efficiency within the industry." In the Public En-



AI workloads could absorb around

70 %

of global data centre capacity by 2030.

ergy Efficiency Register of Data Centres (Peer-DC) project on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK), the Institute's experts collaborated with the University of Stuttgart (IER) and other project partners on laying the foundations for the register. "We have developed an evaluation system and evaluation software that take various criteria into account, including the efficiency of building technology and the performance of the information technology," Jens Gröger explains. "We have also analysed whether and how an energy efficiency label for data centres could be rolled out Europe-wide." In future, this would enable customers to identify which data centre scores best for environmental performance.

THE ENVIRONMENTAL FOOTPRINT

Making an informed choice: this should also be possible for anyone who uses a computer or a smartphone. In the eco:digit – Enabling Green Computing and Digital Transformation project, the Oeko-Institut is working with the Open Source Business Alliance (OSBA) and software developer Adesso, among others, to develop a methodology for determining the key environmental impacts of digital services. The project is coordinated by the German Informatics Society and funded by the BMWK. "The aim is to calculate an environmental footprint for specific software applications that includes not only greenhouse gas emissions but also resource and water consumption and other environmental impacts." The project team is therefore creating a simulation environment, known as a "test bench", which is able to evaluate mobile apps and desktop and cloud-native applications. "The Oeko-Institut has developed a methodology for this purpose, which covers the manufacturing, operation and disposal of the hardware and links it to the related software." A further objective is to introduce the methodology into the international standardisation process with a view to its broad-scale rollout.

SAVING THE BEST FOR LAST

When it comes to efficiency, too, artificial intelligence has its upsides: it can optimise technical processes by making the best possible use of renewable energies, for example. "At present, however, there is a complete lack of clarity around the scale of these positive effects and whether they can balance out the increased electricity demand," says Jens Gröger. "A technology impact assessment is essential to ensure that AI does us more good than harm. Had this been done for nuclear power, for example, we might have dispensed with nuclear altogether because of the associated risks. And that might make sense with some AI applications as well."

Christiane Weihe

Sustainable information and communication technology is the main focus of Jens Gröger's work. A graduate in energy, chemical and process engineering and the Oeko-Institut's Research Coordinator for Sustainable Digital Infrastructures, he investigates energy-efficient data centres and IT infrastructures and the environmental impacts of software and cloud services.
j.groeger@oeko.de