FONDAZIONE BRUNO KESSLER
MAGAZINE

AI & Energy: Challenges and Opportunities for a Sustainable Future

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A workshop organized by Fondazione Bruno Kessler to reflect on the intersection of artificial intelligence and energy transition.

Artificial Intelligence is today a driver of transformation in many domains, including industry, healthcare and energy. For this reason, too, its environmental impact is increasingly in the spotlight. On the one hand, AI models require huge amounts of data and computing power, with a significant environmental impact; on the other, the same algorithms can be used to optimize energy use, predict consumption peaks, and facilitate the transition to a sustainable system.

“The workshop on Energy and Artificial Intelligence (AI) is part of a series of events dedicated to strategic topics for our research and innovation at FBK.” **Paolo Traverso, Director of Strategic Planning at Fondazione Bruno Kessler** commented, *“The first event explored alternative AI technologies to training huge systems with large amounts of data, the second focused on AI at the Edge and sensors that require low-energy models: topics that explicitly introduced the subject of this workshop, which allows us to delve deeper into the topic with data, numbers and examples, highlighting both the risks and the possibility of sustainable and environmentally friendly AI.”*

The current energy landscape

We are in the midst of ecological transition, with horizons not yet fully defined. **Nicola Armaroli, Research Director at ISOF – Institute for Organic Synthesis and Photoreactivity (Bologna),** highlighted the challenges and opportunities of these major changes. On the one hand, we see that global energy needs are still highly dependent on fossil fuels, and CO? emissions do not seem likely to go down in the short term. However, there are positive signs: by the end of 2023, combined wind and photovoltaic power generation had grown a lot, competing with nuclear power and highlighting the central role of renewables.

But who can emerge in such a complex landscape? According to **Armaroli,** PV is the real winner in the energy transition because of its modularity, scalability and accessibility. In fact, solar panels can be installed anywhere, without complex permits and with low maintenance costs. However, two

factors must be taken into account: to date, photovoltaic module production is dominated by China, posing strategic questions about the global production chain, compounded by the critical issue surrounding energy storage.

New global challenges in the energy industry

The goal set by the European Union is to achieve climate neutrality by 2050, but – according to **Luigi Crema, director of Fondazione Bruno Kessler's Center for Sustainable Energy –** this cannot be achieved with a single technology.

"What is needed is an integrated energy model," Luigi Crema said in his talk, "capable of balancing production and consumption, reducing waste and ensuring stability of the power grid. *Hydrogen represents a strategic opportunity and requires the construction of a new market for this technology. This challenge is similar to what was done for the advent of the Internet, in terms of complexity, but also in terms of future positive impact. Building the entire hydrogen supply chain will require many years of investment and a robust regulatory framework."*

The solutions will therefore inevitably be multiple: renewables, hydrogen, digitization, and electricity system reform. Artificial Intelligence can also play a key role in grid optimization, energy storage management, and renewable integration, but it must be used responsively because its own energy impact is a variable to be considered.

The energy impact of AI: a balance to be found

While AI can optimize energy use, its increasing use means significant demand and consumption. **Patricia Lago, director of the Center for Digital Sustainability at the University of Amsterdam,** pointed out that data centers, which are essential for AI processing, are consuming more and more energy, growing by 20 percent annually while, currently, less than 1 percent of computing resources are being used efficiently. Therefore, it is important to optimize energy use.

The problem also extends to AI-specific applications: tools such as recommendation models on the large platforms we all frequent consume huge resources, posing doubts about the sustainability of these systems. There is a need to rethink algorithms from a *sustainability-aware AI* perspective, balancing computational efficiency and environmental impact: research is moving in this direction.

An integrated and intelligent energy model

The workshop highlighted the need for an **integrated energy model**, where AI, renewables, hydrogen and advanced infrastructures operate in synergy. The time available for the transition is limited, and collaboration between institutions, research, and industry will be crucial to accelerate the change.

Artificial Intelligence cannot be the sole solution, but a strategic ally in the management of energy resources. For this reason, it is essential to develop a sustainable approach *by design*, minimizing the environmental impact of AI and ensuring that its use generates real value for society.

Sustainability is not just a technology issue, but also an economic, social, and political one. A system-wide rethinking is needed to ensure a fair, efficient, and low-carbon energy future.

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