Supercharging decarbonization through intelligent technologies

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Digital technologies provide the possibility of decarbonising industry through big data, machine learning and the Internet of Things. Credit: Cambridge CARES

Integrating digital tools into the world's energy systems could reduce carbon emissions by more than 50%, a new review has found.

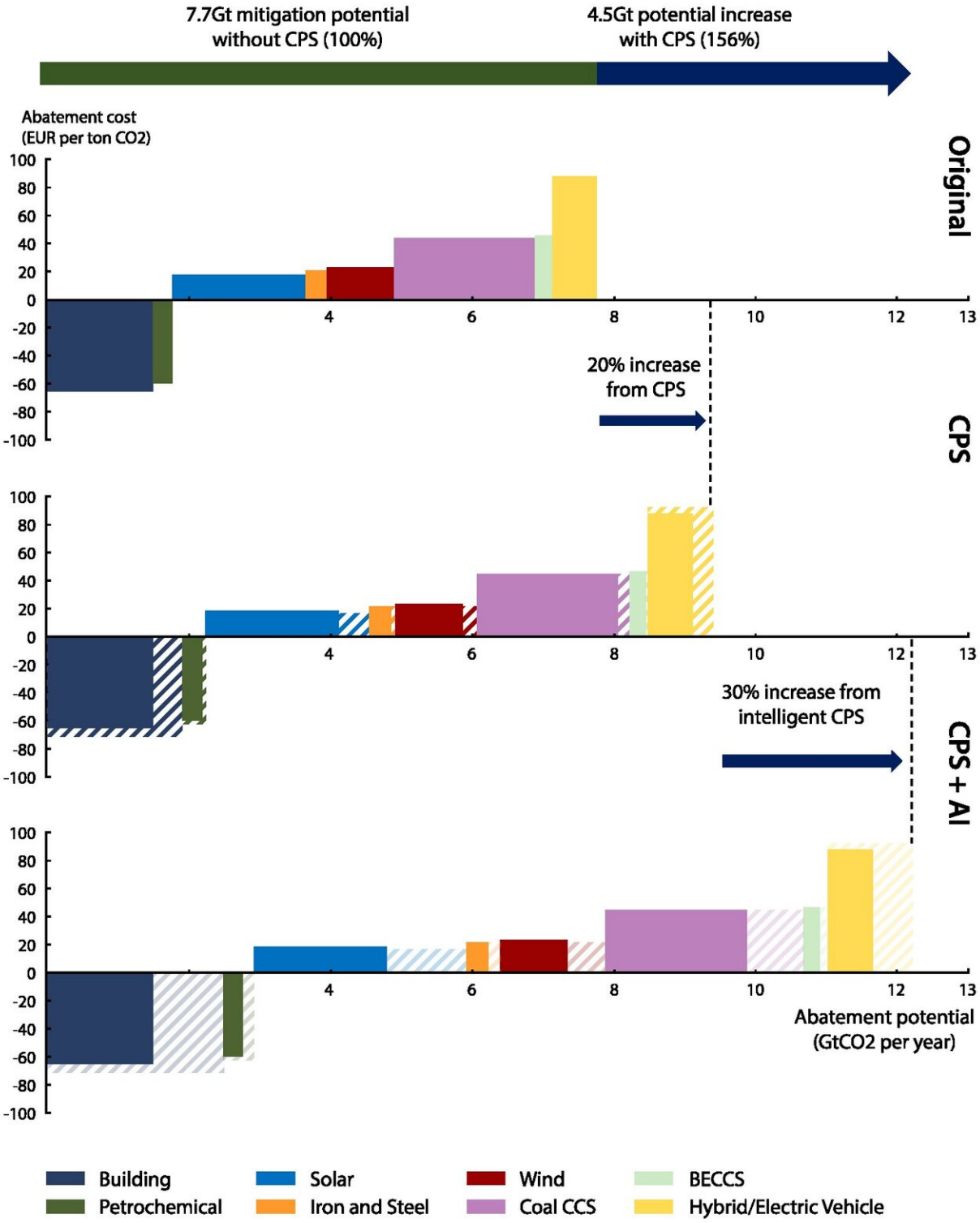
The review reassesses the marginal abatement cost curve (MACC) popularized by McKinsey and finds that digitalization of energy systems completely alters the curve, thanks to the creation of novel pathways for the transition to low-carbon energy. If cyber-physical systems are integrated into our energy systems, carbon abatement potential can be

expected to increase by 20%, rising to 30% when artificial intelligence (AI) is included.

MACCs illustrate both the cost and potential of various carbon dioxide reduction strategies and are used by policy makers to assess which paths to pursue. The addition of cyber-physical systems –digital technologies that interact with the physical world – is a substantial update to the MACC and further establishes it as an indispensable tool for those working on decarbonization.

Decarbonising the world's energy systems is a crucial part of mitigating climate change through the reduction of greenhouse gas emissions. While decarbonization is non-negotiable if climate breakdown is to be halted, it must be balanced with ensuring economic stability and a smooth transition to sustainable energy.

Digital technologies such as big data, machine learning and the Internet of Things hold immense potential to help us meet this challenge. Their applications range from helping to reduce our power bills by employing smart meters in the home, to assisting with peer-to-peer energy trading between power stations via blockchain.



The impact of cyber-physical system technologies on the marginal abatement

cost of selected decarbonisation technologies in energy transition. Credit: Cambridge CARES

An international team of researchers from Singapore, Switzerland, the U.K. and the U.S. found that while existing digital technologies have numerous and effective applications when considered individually, the potential reduction of carbon emissions is multiplied when they are combined. Such combinations are called cyber-physical systems – interacting networks of physical infrastructure and computers that allow for smarter analysis, decision-making and optimization of energy systems.

Introducing AI into these cyber-physical systems can lead to further carbon savings; up to 30% more than without AI. This combination of technologies creates what is dubbed "intelligent cyber-physical systems". Benefits include more resilient infrastructure and operational flexibility, among others.

Enhanced renewable energy forecasting is one good example of how an intelligent cyber-physical system can be applied. The wind and solar energy sectors have seen much growth and while the price of these technologies has come down, the intermittent nature of this type of power has limited its application. The integration of backup energy systems (natural gas plants, for example) or energy storage technologies is required. Intelligent cyber-physical technologies, in particular machine learning, could help with this integration through improved forecasting of solar and wind variability.

Other large energy systems such as power plants can also benefit. When applied to carbon capture and storage plants, for example, these technologies can convert operational data into actionable intelligence,

thereby reducing costs and improving energy efficiency through improved processes.

Cyber-physical systems, especially those combined with AI, provide the much-needed boost required for countries to meet their decarbonization and emissions targets. It is now up to policy makers to take this forward by incentivizing the deployment of these technologies to combat climate change.

More information: The impact of intelligent cyber-physical systems on the decarbonization of energy. Oliver Inderwildi, Chuan Zhang, Xiaonan Wang and Markus Kraft, *Energy Environ. Sci.*, (2020), DOI: 10.1039/c9ee01919g

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