We must accelerate transitions for sustainability and climate change, experts say

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We must move faster towards a low-carbon world if we are to limit global warming to 2°C this century, experts have warned.

Changes in electricity, heat, buildings, industry and transport are needed rapidly and must happen all together, according to researchers at the universities of Sussex, Manchester and Oxford in a new study published in the journal *Science*.

To provide a reasonable (66%) chance of limiting global temperature increases to below 2°C, the International Energy Agency and International Renewable Energy Agency suggest that global energy-related carbon emissions must peak by 2020 and fall by more than 70% in the next 35 years. This implies a tripling of the annual rate of energy efficiency improvement, retrofitting the entire building stock, generating 95% of electricity from low-carbon sources by 2050 and shifting almost entirely towards electric cars.

This elemental challenge necessitates "deep decarbonisation" of electricity, transport, heat, industrial, forestry and agricultural systems across the world. But despite the recent rapid growth in renewable electricity generation, the rate of progress towards this wider goal remains slow.

Moreover, many energy and climate researchers remain wedded to disciplinary approaches that focus on a single piece of the low-carbon transition puzzle. A case in point is a recent Science Policy Forum proposing a 'carbon law' that will guarantee that zero-emissions are reached. This model-based prescription emphasizes a single policy instrument, but neglects the wider political, cultural, business, and social drivers of low carbon transitions.

A new, interdisciplinary study published in *Science* presents a 'sociotechnical' framework that explains how these different drivers can interlink and mutually reinforce one another and how the pace of the low carbon transition can be accelerated.

Professor Frank Geels from the University of Manchester, lead author of the study, explains: "Our 'big picture' socio-technical framework shows how interactions between various social groups can increase the momentum of low-carbon transitions."

Professor Nick Eyre from the University of Oxford, End Use Energy Demand Champion for the UK Research Councils' Energy Programme, adds: "Accelerating transitions is critical if we are to achieve the goals of decarbonizing and saving energy faster, further, and more flexibly. This international quality study shows the importance of whole systems thinking in energy demand research."

Professor Benjamin K. Sovacool from the University of Sussex, a co-author on the study, says: "Current rates of change are simply not enough. We need to accelerate transitions, deepen their speed and broaden their reach. Otherwise there can be no hope of reaching a 2 degree target, let alone 1.5 degrees. This piece reveals that the acceleration of transitions across the sociotechnical systems of electricity, heat, buildings, manufacturing, and transport requires new conceptual approaches, analytical foci, and research methods."

The Policy Forum provides four key lessons for how to accelerate sustainability transitions.

Lesson 1: Focus on socio-technical systems rather than individual elements

Rapid and deep decarbonization requires a transformation of 'sociotechnical systems' - the interlinked mix of technologies, infrastructures, organizations, markets, regulations and user practices that together deliver societal functions such as personal mobility. Previous systems have developed over many decades, and the alignment

and co-evolution of their elements makes them resistant to change.

Accelerated low-carbon transitions therefore depend on both techno-economic improvements, and social, political and cultural processes, including the development of positive or negative discourses. Professor Steve Sorrell from the University of Sussex, a coauthor of the study, states: "In this policy forum we describe how transformational changes in energy and transport systems occur, and how they may be accelerated. Traditional policy approaches emphasizing a single technology will not be enough."

Lesson 2: Align multiple innovations and systems

Socio-technical transitions gain momentum when multiple innovations are linked together, improving the functionality of each and acting in combination to reconfigure systems. The shale gas revolution, for instance, accelerated when seismic imaging, horizontal drilling, and hydraulic fracturing were combined. Likewise, accelerated low-carbon transitions in electricity depend not only on the momentum of renewable energy innovations like wind, solar-PV and bio-energy, but also on complementary innovations including energy storage and demand response. These need aligned and then linked so that innovations are harmonized.

Prof. Paul Ekins, Director of the UCL Institute for Sustainable Resources, University College London, and project leader to the EU INNOPATHS consortium researching low-carbon transitions for Europe, comments: "One of the great strengths of this study is the equal emphasis it accords to technological, social, business and policy innovation, in all of which governments as well as the private sector have a key role to play.

"European countries will become low-carbon societies not only when the

required low-carbon technologies have been developed but when new business models and more sustainable consumer aspirations are driving their deployment at scale. Public policy has an enormous role to play at every step in the creation of these changed conditions."

Lesson 3: Offer societal and business support

Public support is crucial for effective transition policies. Low-carbon transitions in mobility, agro-food, heat and buildings will also involve millions of citizens who need to modify their purchase decisions, user practices, beliefs, cultural conventions and skills. To motivate citizens, financial incentives and information about climate change threats need to be complemented by positive discourses about the economic, social and cultural benefits of low-carbon innovations.

Furthermore, business support is essential because the development and deployment of low-carbon innovations depends upon the technical skills, organizational capabilities and financial resources of the private sector. Green industries and supply chains can solidify political coalitions supporting ambitious climate policies and provide a counterweight to incumbents. Technological progress can drive climate policy by providing solutions or altering economic interests. Shale gas and solar-PV developments, for instance, altered the US and Chinese positions in the international climate negotiations.

Lesson 4: Phase out existing systems

Socio-technical transitions can be accelerated by actively phasing out existing technologies, supply chains, and systems that lock-in emissions for decades. Professor Sovacool comments that: "All too often, analysists and even policymakers focus on new incentives, on the phasing in of low-carbon technologies. This study reminds us that

phasing out existing systems can be just as important as stimulating novel innovations."

For instance, the UK transition to smokeless solid fuels and gas was accelerated by the 1956 Clean Air Act, which allowed cities to create smokeless zones where coal use was banned. Another example is the 2009 European Commission decision to phase-out incandescent light bulbs, which accelerated the shift to compact fluorescents and LEDs. French and UK governments have announced plans to phase-out petrol and diesel cars by 2040. Moreover, the UK intends to phase out unabated coal-fired power generation by 2025 (if feasible alternatives are available).

Phasing out existing systems accelerates transitions by creating space for niche-innovations and removing barriers to their diffusion. The phase-out of carbon-intensive systems is also essential to prevent the bulk of fossil fuel reserves from being burned, which would obliterate the 2^{o}C target. This phase-out will be challenging since it threatens the largest and most powerful global industries (e.g. oil, automobiles, electric utilities, agro-food, steel), which will fight to protect their vested economic and political interests.

Conclusion

Deep decarbonization requires complementing model-based analysis with socio-technical research. While the former analyzes technically feasible least-cost pathways, the latter addresses innovation processes, business strategies, social acceptance, cultural discourses and political struggles, which are difficult to model but crucial in real-world transitions. As Professor Geels notes, an enduring lesson is that "to accelerate low-carbon transitions, policymakers should not only stimulate techno-economic developments, but also build political coalitions, enhance business involvement, and engage civil society."

Additionally, the research underscores the non-technical, or social, elements of transitions. Dr. Tim Schwanen from the University of Oxford, a coauthor, states that "the approach described in this Policy Forum demonstrates the importance of heeding insights from across the social sciences in thinking about low-carbon transitions."

While full integration of both approaches is not possible, productive bridging strategies may enable policy strategies that are both cost-effective and socio-politically feasible.

More information: F.W. Geels at University of Manchester in Manchester, UK el al., "Sociotechnical transitions for deep decarbonization," *Science* (2017). science.sciencemag.org/cgi/doi … 1126/science.aao3760

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