Varun Sivaram (ed) (2018) Digital Decarbonization: Promoting Digital Innovations to Advance Clean Energy Systems. New York: Council on Foreign Relations. 146 pages. ISBN: 9780876097489

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In but a few decades the face of the world's most highly valued public companies changed remarkably. During the latter part of the 20th century, with few exceptions, the highest-grossing corporations were in the energy sector. Today, things look different with digital technologies specialists forming the world's five most valuable businesses. This indisputable fact forms the linchpin of Varun Sivaram's introduction to his essay collation, *Digital Decarbonization: Promoting Digital Innovations to Advance Clean Energy Systems*. The volume is a compilation, edited by Sivaram, of submissions from various parties who attended a 2018 conference convened by the Council on Foreign Relations, a New York-based think tank. Participants traveled to discuss the risks posed by the rapid digitization of the global economy as well as the areas in which digital technologies can enable the adoption and development of clean energy systems. Conference attendees and authors contributing to this volume include researchers such as Dr. Kyle Bradbury, a fellow of Duke University and machine learning expert alongside representatives of private-sector businesses like John O'Leary, a director of Strategic Marketing at Boston-based AlphaStruxure. Sivaram himself is a previous Rhode's scholar, CTO of ReNew Power, India's largest renewable energy company, and author of well-received 2018 title, *Innovations to Harness Solar Energy and Power the Planet*.

The point that economic digitization offers the potential for decarbonization and is one of the main drivers of change for global power infrastructure is already a topic of vigorous debate as discussed in Maria Luisa Di Silvestre's (2018) oft-cited work, *How Decarbonization, Digitalization and Decentralization are changing key power infrastructures*. It is not surprising, however, given the complexity of the world's economy and the inherent uncertainty of new energy technologies that no firm consensus exists on what the overall impact of new clean energy technologies will be. To this end, the multi-author format Digital Decarbonization is a great asset. The book is able to encapsulate usually mutually exclusive perspectives. For example, Jesse Scott's piece on the economic and privacy risks derived from energy sector digital innovation emphasizes the need for caution and well-designed policies to manage change. Conversely, Lidija Sekaric's survey of digital decentralized power system innovation offers a more straightforward and hopeful look at potentially transformative technologies.

The structure of Digital Decarbonization makes this a good source of information for those familiar with energy sector digital innovation and newcomers to the topic alike. Digital Decarbonization's first section provides background for the discussion followed by essays on potential digital innovation opportunities. Later follows a discussion of risk analyses and, finally, a compilation of

policy recommendations is presented. Despite the number of contributors involved in creating this work, the common-sense nature of this construction ensures that consecutive articles appear to build on one another's findings such that the reader feels they are experiencing a cohesive narrative.

Following Sivaram's introduction, Part I of Digital Decarbonization consists of two essays dealing with the background of digital clean energy innovation. Anyone reading about clean energy innovation trends for the first time will be particularly grateful for the accessibility and level of detail here. In his piece on early-stage financing trends, Stephen Comello provides convincing numbers that suggest corporations investing in digital energy startups are making more savvy choices than they did between 2008 and 2011, a period in which large sums were sunk into the industry, bearing little fruit.

Sivaram elects to turn Part II of this work into three subsections that respectively discuss the digital energy opportunities associated with electric power, transportation, and big data. The sheer volume of articles in this section leads to slightly repetitive content, but there are still some strong pieces here such as Ben Hertz-Shargel's chapter How Distribution Energy Markets Could Enable a Lean and Reliable Power System. Here, Hertz-Shargel describes how advanced monitoring infrastructure may relieve the world's outdated grid systems which, with their costly and slow-to-implement infrastructure upgrades, are increasingly struggling to cope with modern energy demands. As a solution, Hertz-Shargel puts forward a compelling argument for a quick-to-react decentralized blockchain-powered energy market that would eradicate supply-side and consumer behavior inefficiencies. Sunil Garg also makes a welcome addition to this part of the book with Applying Data Science to Promote Renewable Energy, a chapter that convincingly demonstrates the cost of renewable energy generation can be reduced by data science through better prediction of equipment failure and accurate output projections. Although Garg is an executive of a data-science business providing such services to energy corporations, he only spends a few paragraphs discussing his

affiliated-company. One does not get the impression that he is being unfairly optimistic about the potential impact of big data. Garg's piece goes a long way toward explaining why digitization may contribute to decarbonization, a connection often made by the general press but one for which a confidence-inducing mechanism is rarely put forward.

At no point does Shivaram claim that this work is intended to form a comprehensive treatise on digital energy innovation, but one sour note is that Digital Decarbonisation's Part III, a summary of risks associated with innovations, fails to mention the existential crises predicted by some for much of the last century that would stem from the development of a sufficiently advanced Artifical Intelligence (AI) system. Few contemporary thinkers warn of a doomsday-like consequence of AI development, but several such as Markoff (2015) argue that even with a carefully defined goal, a super-intelligent AI system could easily develop unintended and potentially dangerous sub-goals.

The omitted mention of AI-risks aside, the contributions of Erfan Ibrahim and Jesse Scott on innovation risks do a good job of summarizing the short-term problems associated with economic, privacy, and cybersecurity issues. This section transitions neatly into the closing chapter of Digital Decarbonization which offers policy recommendations that take into account digital risks and opportunities already discussed.

In the first part of this final chapter, Richard Kauffman and John O'Leary consider generic state-level reforms and policies that can enable next-generation digital grids. Meanwhile, Hiang Kwee Ho provides an analysis of Singapore's transition into clean energy. The connection between the two is obvious and satisfying: Only by exploring the specific circumstances of an economy with a unique set of dependencies on fossil fuels can we understand how Kauffman and O'Leary's policy recommendations would be practically implemented.

It would be hard for any reader to walk away from this book without a deep interest in what the onward march of digitization holds for the future of energy generation, transport, and the global economy. Although there are some inevitable weak links, the work from contributing authors can

generally be characterized as thought-provoking and successful when it comes to highlighting and contrasting the major trends and risks associated with digital innovation.

Overall, Sivaram and the Council on Foreign Relations have successfully compiled an informative volume that is sure to spark further debate on decarbonization and economic digitization. Digital Decarbonization does the unenviable job of tying together a disparate collection of opinions on a complex topic and does so with a good deal of finesse.

References

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