

The Energy Revolution

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Summary

The last two centuries of unprecedented development in the world have improved human condition enormously. The gross world product now stands at almost ten thousand dollars per capita, which is sufficient to provide for a good average quality of life. However, at the same time, inequities are increasing and the "bottom billion" has to live on barely a dollar a day. A predominant social issue that is increasingly becoming a major preoccupation for world leaders is addressing social inequality and poverty, especially in the developing world. These contrasting developmental patterns have not only resulted in increasing gaps between the poor and the rich but also in adverse environmental impacts on all scales, from indoor air pollution to climate change and biodiversity loss.

Fundamental, game-changing transformations are needed for a shift toward more sustainable development paths. By significant investment in new technologies and decarbonization multiple co-benefits can be achieved – from provision of affordable access to modern energy and creation of new business and economic opportunities to addressing the threat of climate change. Global energy perspectives will be presented that addresses these paradigm-changing, multiple energy challenges toward more sustainable futures.

Decarbonization of the global economy toward a carbon-free future is such a paradigm-changing transformation. In the energy area, this implies a shift from traditional energy sources, in the case of those who are excluded from access, to clean fossils and modern renewable energy, and in the more developed parts of the world a shift from fossil energy sources to carbon-free and carbon neutral energy services. In all cases this means a vigorous improvement of energy efficiencies, from supply to end use, expanding shares of renewables, more natural gas and less coal, vigorous deployment of carbon capture and storage, and in some cases (where it is socially acceptable and economically viable) also nuclear energy.

All of these energy supply technologies need to mesh with emerging innovations in energy networks and end use in direction of smart integration. This would occur at a number of levels, from local and distributed to centralized generation. The very nature of energy end use is undergoing fundamental transformation as well toward more self-organization and internet-like structures and integration.

The emerging new energy systems require two complementary co-evolutions – one is technological and the other institutional. With new technologies and systems, new business models and institutional arrangements will emerge. All of these complementary and co-evolving transformations will require market, regulatory and behavioral changes.

The cumulative nature of technological and associated institutional changes, all compounded by deep uncertainties, require innovations to be adopted as early as possible in order to lead through experimentation and evolutionary changes to lower costs and wider diffusion in the following decades. The longer we wait to introduce these advanced technologies, the higher the required costs and emissions reduction will be as well as the "lock-in" into the old structures. The transformational change toward more sustainable futures requires enhanced research, development and deployment (public and private) efforts as well as early investments to achieve accelerated diffusion and adoption of advanced energy technologies and systems.

The ever more evident crisis of the "old" development patterns is an opportunity for the "new" ones to emerge.