THE GEOPOLITICS OF THE ENERGY TRANSFORMATION*

INTRODUCTION

The centre of the global energy outlook has been influenced by renewables. Technological advances and decreasing costs have made renewables grow more rapidly in contrast to other energy sources. While the increase in wind, solar and other renewables has mostly occurred in the electricity sector, new technologies enable this change in other sectors.

Renewable energy deployment in transport, industry and buildings sectors has been increasing due to electric vehicles and heat pumps. Digitalisation and energy storage innovations also improve the potential for renewables to progress.

The accelerated deployment of renewables has initiated a global energy transformation with great geopolitical consequences. The global distribution of power, relations between states, the risk of conflict, and social, economic and environmental drivers of geopolitical instability will be affected by this transformation.

THE GLOBAL ENERGY TRANSFORMATION

- Renewable energy sources especially wind and solar energy have grown at an unprecedented rate over the last decade and continually exceeded expectations.
- Renewables are now the leading edge of a far-reaching global energy transition, combined with energy efficiency.[1]
- This ongoing transition to renewables is not just a shift from one set of fuels to another. The term 'energy transformation' that will have major social, economic and political implications obtains broader implications.[2]
- Renewables will also be a powerful vehicle for democratization. Energy supplies will be decentralized, also citizens, local communities and towns will be emancipated.

[1] IRENA, OECD/IEA and REN21, Renewable Energy Policies in a Time of Transition, International Renewable Energy Agency, Organization for Economic Co-operation and Development, International Energy Agency, Renewable Energy Policy Network for the 21st Century, 2018.

[2] We use the term 'energy transition' to refer to the shift from fossil fuels to renewable energy sources. We use the term 'energy transformation' to refer to the broader implications of this shift.

ENERGY TRANSFORMATION

The transition is based on 3 primary aspects: 1. Energy Efficiency, 2. Growth of Renewables, 3. Electrification

1. Energy efficiency enables low energy inputs to grow economically. In the 20th century, the average energy demand growth rate was 3%, about the same as the global GDP growth rate. In recent decades, the primary energy demand is projected to increase by 1% per year by 2040.[3]

2. Growth of renewables: Renewables have become the fastest growing energy source.[4] Bioenergy, geothermal, hydropower, ocean, solar and wind are the main renewable energy sources.

- Solar and wind energy are growing very rapidly while the rest are growing more slowly.
- Solar and wind share a common feature: the amount of power they generate varies with weather and daytime. Therefore, they are called variable sources of renewable energy.
- The influence of the remarkable renewable energy growth was mainly felt in the electricity industry. Since 2012, renewables have increased their capacity to generate more energy than conventional energy sources.[5]
- In 2017, solar power added more new capacity than combined coal, gas and nuclear power plants.[6]
- Wind and solar generation now account for 6% of the world's electricity generation, up from 0.2% in 2000. In total, renewables account for about one quarter of the global generation of electricity.[7]
- The power systems in Germany, Portugal and Denmark have been able to run entirely on renewables in the last year.

3. Electrification: Electricity has been the fastest growing final energy demand segment and has grown two-thirds faster than the total energy consumption since 2000. Since 2016, the electricity sector has attracted more investment than the upstream oil and gas sectors, a further reflection of the world economy's ongoing electrification.[8]

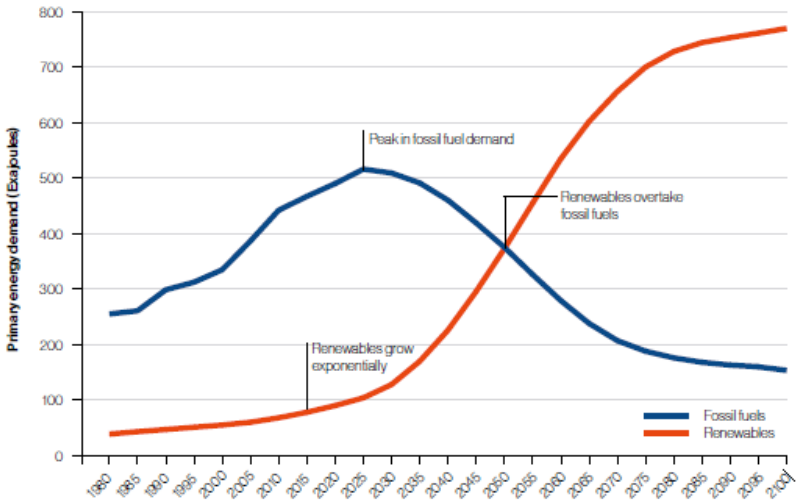
- Scenarios that model a future energy compatible with the objectives of the Paris Agreement have a similar structure: a short-term peak in demand for fossil fuels,

[3] IEA, World Energy Outlook 2018, New Policies Scenario, International Energy Agency, 2018. Global GDP growth in the same period is now forecast to grow at 3.4 % per year.
[4] IEA, Global Energy and CO2 Status Report, International Energy Agency, March 2018.
[5] IRENA, Renewable Energy Statistics 2018, International Renewable Energy Agency, 2018.
[6] IRENA, Renewable Energy Statistics 2018, International Renewable Energy Agency, 2018; UNEP and BNEF, Global Trends in Renewable Energy Investment 2018, UN Environment Programme and Bloomberg New Energy Finance, 2018.
[7] IRENA, Renewable Energy Statistics 2018, International Renewable Energy Agency, 2018.
[8] IEA, World Energy Investment 2018, International Energy Agency, 2018.

a rapid recovery of renewables and a long decline in demand for fossil fuels.[9] Figure 1 illustrates these dynamics.

As a whole, the sudden growth of renewables, especially solar and wind can mainly describe the global transformation of energy. The energy transition will affect oil, gas and coal differently, as they have different characteristics and are used in a variety of sectors.

Figure 1. The energy transition framework



THE FORCES OF CHANGE

1. DECLINING COST

There is a considerable shift towards renewable energy since the cost of the technologies have fallen sharply. The costs of renewable energy have declined especially in solar PV and wind by 73% and 22%, respectively.[10] Also, the cost of lithium-ion batteries has fallen by 80% since 2010.[11] It is suggested that by 2020, there will be considerable cost declines in solar and wind sources thus, resulting in more investments in renewable technologies.[12] IRENA suggests that by 2025, the global weighted average cost of electricity may fall by 26% from onshore wind, by 35% from offshore wind, by

[9] See, for example, Shell Global, Sky Scenario 2018 – Meeting the goals of the Paris Agreement, Shell Global, 2018; IEA, Sustainable Development Scenario, International Energy Agency, 2018; Equinor (2018), Energy Perspectives 2018; IRENA, REmap – Renewable Energy Roadmaps, International Renewable Energy Agency, 2018; DNV-GL, Energy Transition Outlook 2018, DNV-GL, 2018; and "Mitigation pathways compatible with 1.5°C in the context of sustainable development", Chapter 2 of IPCC, Special Report: Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above preindustrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, Intergovernmental Panel on Climate Change, 2018.

[10] IRENA, Renewable power generation costs in 2017, International Renewable Energy Agency, 2017.

[11] BNEF, New Energy Outlook 2018, Bloomberg New Energy Finance, 2018.

[12] IRENA, Renewable power generation costs in 2017, International Renewable Energy Agency, 2017.

at least 37% from concentrated solar power (CSP) technologies, and by 59% from solar photovoltaics (PV).[13]

2. POLLUTION AND CLIMATE CHANGE

Fossil fuel use causes severe problems such as air pollution and climate change, increasing investor and public awareness on reducing fossil fuel use. Unless urgent measures are taken to reduce pollution and combat climate change, the world will not achieve the Paris Agreement goal. IRENA's analysis shows that the growth of renewable energy together with energy efficiency is the most effective way to reach the goal of Paris Agreement.[14]

3. RENEWABLE ENERGY TARGETS

Many countries have ambitions to increase their deployment of renewable energy. 57 countries have developed plans to decarbonize the electricity sector and 179 countries for renewable energy.[15] Many countries are shifting towards renewables because they lack reserves of oil and gas, they want to rely less on imported energy sources. Even oil-producing countries such as The United Arab Emirates have plans to increase their renewable energy share in the energy mix.

4. TECHNOLOGICAL INNOVATION

Accelerating the deployment of renewable energy also includes the role of technological innovations. Digitalisation and energy storage innovations also opened new borders. New digital technologies, such as smart grids, the internet of things, big data and artificial intelligence are being used in the energy industry to increase efficiency and usage of renewable energy.

5. CORPORATE AND INVESTOR ACTIONS

Corporate and investor actions are also important as possible drivers of this change. Investor groups force companies to reduce their carbon footprints. In addition, some of the world's leading companies are moving towards the same direction.

6. PUBLIC OPINION

Public ad civil society movements want carbon footprint to decrease. They push their government to have plans in order to reduce air pollution and carbon emissions.

WHY RENEWABLES WILL TRANSFORM GEOPOLITICS

There are differences between renewables and fossil fuels in many ways and these differences will have geopolitical outcomes.

[13] IRENA, The power to change: solar and wind cost reduction potential to 2025, International Renewable Energy Agency, 2016.
[14] IRENA, Global Energy Transformation: A Roadmap to 2050, International Renewable Energy Agency, 2018.
[15] REN21, Renewables 2018 – Global Status Report, Renewable Energy Policy Network for the 21st Century, 2018.

- In most countries, even though fossil fuels that are concentrated on particular geographical locations, renewable energy resources can be found in one form or another.
- The majority of renewables take the form of flows while fossil fuels are in stocks. Energy stocks can be stored; they can only be used once. In contrast, the flow of energy does not exhaust itself and is more difficult to disrupt.
- Renewable sources of energy can be deployed at almost any scale and are better suited for decentralized forms of energy production and use.
- Renewable energy sources don't have any significant costs. Solar and wind benefit from cost reductions of almost 20% for each capacity duplication.[16]

ENERGY SECURITY FOR FOSSIL FUEL IMPORTERS

- At least 80% of the world's population lives in countries which are net fossil fuel importers.[17]
- In an economy driven by renewable energy, most countries will be able to achieve energy independence and therefore, they will have greater energy security. Countries that currently rely mainly on imports will be able to gain strategic and economic benefits.
- Countries that can develop their own renewable energy sources are better positioned in terms of energy security.
- Economically, a high degree of dependence on imports also creates costs and risks.
- Increasing the proportion of renewables in the energy mix can diminish these risks and give new potential to economic development.
- Countries that switch from imported fossil fuels to renewable energy will fundamentally enhance their balance of trade.
- Energy independence does not mean complete self-sufficiency or self-determination.[18] Even if a country can generate renewable energy, it does not necessarily choose to do so due to its comparative advantages. Even if the energy needs of a country are supplied entirely from domestic sources, international value chains and the trade in technology, goods and services will continue to benefit.
- Increasing energy security through the deployment of renewable energy can change the dynamics between exporters and importers of energy. In international politics, it will also reduce the role of oil and gas. Ensuring energy security is more a matter of domestic governance than of international security.

HOW RENEWABLES CREATE NEW TRADE PATTERNS

While trade in fossil fuels will decline, trade in at least 3 other areas will grow:

[16] DNV-GL, Energy Transition Outlook 2018, DNV-GL, 2018.
[17] Authors' calculations based on data from the World Bank.
[18] Autarchy implies a complete absence of foreign trade.

1. Trade of goods and technologies related to renewable energy will increase. There are large amounts of goods and technologies, from solar PV panels to smart meters and batteries, as well as their components, parts and related services.
2. Additional interconnections make grids more stable and resilient and they provide to increase trade. Renewables require flexible and interrelated power systems that can balance supply and demand.
3. Trade in renewable energy fuels may also grow significantly.[19] Such fuels like hydrogen allow seasonal storage of renewable electricity using existing infrastructure. They also have the potential to reduce emissions in hard-to-electrify sectors such as aviation and some industrial processes.[20]

CONCLUSION

- The global transformation of energy driven by renewables will have considerable geopolitical consequences. It will reconfigure relations among states and bring fundamental structural changes in economies and societies.
- Power is getting increasingly decentralized and diffused.
- China continues to grow because it has invested excessively in renewable technologies.
- In contrast, states that depend heavily on fossil fuel exports and do not adjust to the energy transition will confront risks of losing influence.
- The energy supply will no longer be controlled by a small number of states, as most countries will have the potential to attain energy independence and thus, improve their energy security.
- The transition brings considerable advantages. The energy security and independence of most countries; contribution to prosperity and job creation; enhancing food and water security; and developing sustainability and equity will be in a better situation thanks to the transition.
- Fossil fuel exporting countries may face problems unless they reinvent themselves for a new energy age; a rapid shift away from fossil fuels could create a financial shock with significant consequences for the global economy; workers and communities who depend on fossil fuels may be affected negatively.
- The energy transformation will achieve important actions like tackling climate change, combating air pollution, and promoting prosperity and sustainable growth.

[19] In general, these green fuels are often referred to as 'power-to-X', where 'X' stands for any fuel or feedstock from renewable power via electrolysis.

[20] The World Energy Council Germany estimates that a mature global market for synthetic fuels can supply between 10,000 and 20,000 TWh per year by 2050. This corresponds to about half today's global demand for crude oil. Frontier Economics, International aspects of a power-to-X roadmap, World Energy Council Germany, October 2018.