RESOURCES FOR THE FUTURE

The New Climate Math: Energy Addition, Subtraction, and Transition

Issue Brief 18-09 by **Richard G. Newell** and **Daniel Raimi** — October 2018

A deluge of recent data heralds the rise of renewable energy. Since 2010, the costs of producing electricity from solar photovoltaic systems have decreased by **more than 80%**. Wind and solar now vie with natural gas to provide new electricity **generating capacity**. Asset managers like BlackRock have asked major energy and utility companies to pay attention to the "**material climate risk inherent in their business operations**".

To some, these trends signal the world's latest energy transition: away from fossil fuels and toward a renewable future. But a close look at history teaches a different lesson—with stark implications for climate policy.

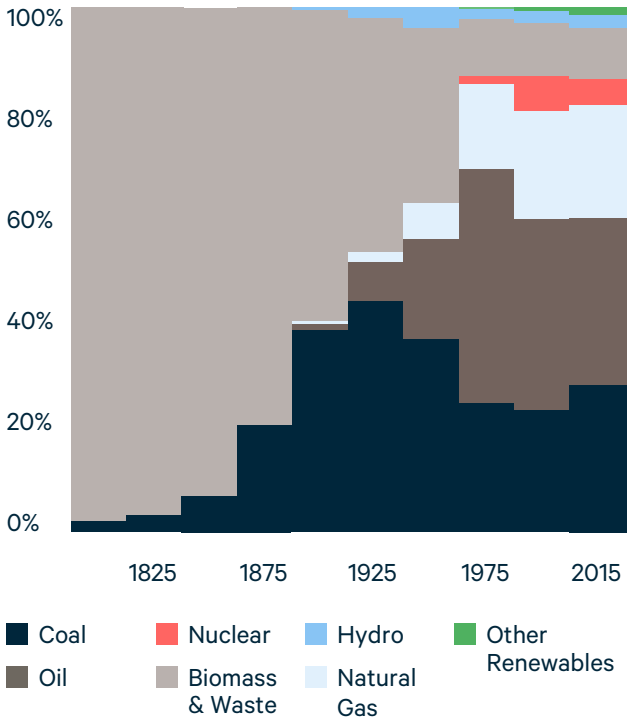
The lesson? The world has never truly undergone an energy transition, and the challenge of climate change will—for the first time—require one. Instead, the world has experienced a series of energy additions, where new fuels build atop the old, rising like a skyscraper under construction for more than 200 years.

Consider four fuels: biomass (mostly wood), coal, oil, and natural gas. In 1800, biomass provided almost 100% of the world's energy—now it's just 10%. Coal, the driving force behind the industrial revolution, rose to 44% of global energy in 1925—now it's down to 28%. Oil and natural gas came on strong in the post-WWII era, together rising as high as 62% in 1973—before falling to 53% today. This is the narrative of global energy transition, where the world moves away from one fuel and toward the next on a decadal time scale.

But look closer. The world never transitioned away from biomass or coal. Since 1800, biomass consumption has increased by about 275% and is still the principal source of energy for billions of people. Since 1900, coal use has increased more than eightfold; since 2000, by more than 60%. Rather than displacing older fuels, oil and natural gas, then nuclear, and most recently wind and solar, have added new stories atop the ever-growing energy skyscraper.

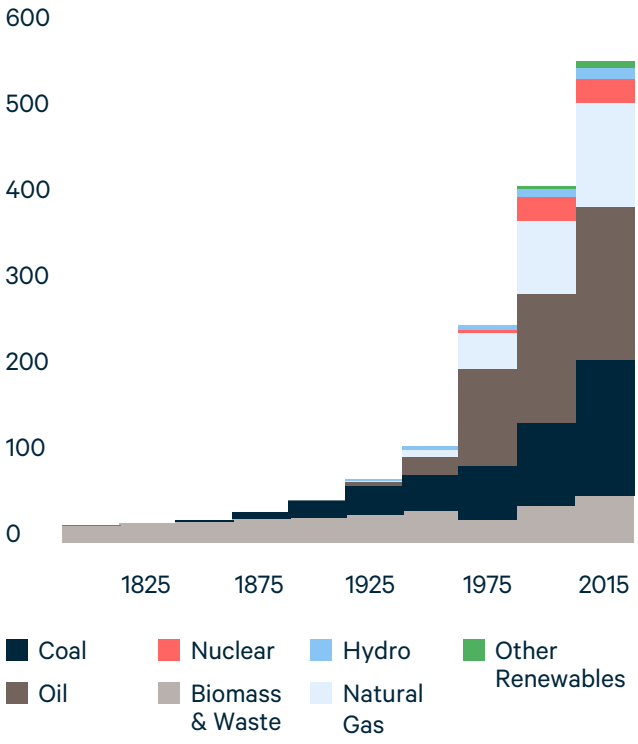
To put it simply, changes in the energy system have been about addition, not transition.

Figure 1: Global Shares of Primary Energy
(Data for Every 25th Year, 1800-2015)



Sources: Arnulf Grubler (2008), International Energy Agency (2017)

Figure 2: Global Levels of Primary Energy Consumption
(Quadrillion British thermal units)



Sources: Arnulf Grubler (2008), International Energy Agency (2017)

The implications are startling. While renewable energy enthusiasts rightly rejoice about the rapidly falling costs and growing investments in wind and solar, these new energy sources—like the ones that came before them—are simply stacking on top of the old ones.

In 2017, **investments** in renewable electricity generation totaled $298 billion. That's a large sum, but relatively small in comparison with global investment of oil and natural gas supply of $716 billion. Investment in new coal supplies totaled a substantial $79 billion, while new fossil fuel-fired electricity generation saw an inflow of $132 billion.

To meet climate change goals like those laid out in agreements including the 2015 Paris Accord, renewables and other zero-carbon technologies such as nuclear energy and carbon capture will need to do more than build atop the CO_2-intensive fuels of the past.

A true energy transition will be a story of addition but also one of subtraction—in particular, reducing carbon emissions. By 2040, the International Energy Agency **projects** that to reach the climate targets laid out in Paris, global coal consumption would need to decline by more than half while oil consumption falls by almost 25%. Natural gas continues to grow under this scenario, but more slowly than it otherwise would—and its continued growth is coupled with reduced methane emissions across the global supply chain. Renewables, led by wind and solar, grow the fastest, increasing roughly tenfold from today's levels. In 2040, renewables and nuclear would provide more than 25% of global energy, then grow even faster in the following decades.

But the world is not on track to achieve this true energy transition. The "best guess" projections from every major government, nongovernment, and industry source show that renewables largely follow in the tradition of the fuels that came before, adding to—rather than displacing—today's energy incumbents.

To avoid the worst impacts of climate change, the story of energy requires a new script. Rather than following the historical path of addition, tomorrow's energy technologies will need to both add and subtract from today's energy mix—increasing access to energy globally while reducing the system's environmental footprint.

This energy transition is achievable. With the right mix of policies in sync with the marketplace, and an open approach toward technological options, it can work hand-in-glove with a thriving economy. Yet the challenge is substantial.

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