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It's that time of year again. Last month, the International Energy Agency (IEA) released its annual [World Energy Investment Report](#), providing a survey of investment trends in the global energy sector. If you want get a sense of where capital is going in the world energy system, this is one of the best sources out there.

Not much has changed since last year (summarized in a previous [blog post](#)), which is bad news for the climate. As IEA Executive Director Fatih Birol states in the Foreword to the report: "Current market and policy signals are not incentivizing the major reallocation of capital to low-carbon power and efficiency that would align with a sustainable energy future." Put a bit more directly, we are not anywhere close to where we need to be in terms capital investment trends in the energy sector if we want to have a chance of meeting climate targets.

A few numbers—all taken from the report—to illustrate: In 2018, total investment in the world energy system was around \$1.8 trillion (the previous year's total was around \$1.7 trillion). Of that total, investment in what the report refers to as "low-carbon energy"—including both supply- and demand-side investments—was flat at around \$620 billion or about 35%. As the report notes, that share will need to grow substantially over the next decade—by a factor of 2.5 or more—if we want to have a chance of hitting long-term climate and sustainability goals.

Looked at from the other direction, that means that in 2018 around 65% of total investment in the world energy system (more than \$1.1 trillion) was dedicated to conventional fossil fuel-based energy systems—upstream oil, gas, and coal supply, downstream refining

operations, and infrastructure and power generation facilities devoted to transporting and burning fossil fuels. While spending on fossil-fuel based power generation declined slightly, this was offset by increased spending on upstream oil and gas development and coal supply. Taken as a whole, all of that new investment just makes things that much harder going forward. The roughly \$1 trillion invested in fossil fuel related assets is going to new infrastructure and machines with long lives (20-30 years (or more) in the case of new power plants and refineries; more in the case of pipelines and other infrastructure; less in the case of upstream oil and gas production) that reinforces the existing momentum in a global energy system that is already dominated by the extraction, processing, transport, and conversion of fossil hydrocarbons. The more fossil fuel assets we add to the system today, the harder it will be to decarbonize tomorrow.

Although renewables continue to make up the largest share of power generation investments, global investment in renewable electricity generation actually *declined* slightly for the second year in a row, to around \$300 billion. Investment in energy efficiency also stalled in 2018 at roughly \$240 billion.

And for those who think we need to find ways to maintain or even increase nuclear power's share of power generation, given its important contribution to zero emissions electricity, the news was better than last year, with several new plants coming on line (mainly in China). This modest growth, though, needs to be viewed in the context of ongoing declines of nuclear power's share of total generation in the U.S., Europe, and Japan. A new assessment of [nuclear power](#) in these and other "advanced economies" (also from the IEA) concludes that nuclear operating capacity will decline by more than two-thirds by 2045 without substantial new investment. Needless to say, this will put considerable additional pressure on renewables to make up the difference.

The global picture for coal remains mixed. Responding to a more than doubling of thermal coal prices since early 2016, investment in coal supply actually increased by 2% in 2018, the first increase since 2012 (virtually all of which was directed at sustaining production levels at existing mines rather than opening new mines). China continues to drive global coal production, accounting for 45% of total investment. In 2018, coal supply investment increased in China for the first time in 5 years. Coal supply investment in India also grew by 5% in 2018. At the same time, however, investment in coal-fired power plants declined by nearly 3% to its lowest level since 2004, mainly as a result of reduced spending in China and India. Retirements of existing coal-fired power plants also continued at near record levels. But the global fleet of coal-fired power plants continued to grow due to net additions in developing economies in Asia. We are still building more coal plants (globally) than we are retiring.

The news was much better on the transportation side, with global electric passenger car sales reaching almost 2 million vehicles in 2018, a 70% increase over 2017 as a result of a more than doubling of EV car sales in China. Investments in battery storage also rose by 45% to more than \$4 billion, driven by large increases in both grid scale and behind-the-meter batteries.

As in years past, government R&D spending in the energy sector around the world continues to languish at absurdly low levels. Despite an increase of 5% in 2018, it was still a paltry \$26 billion. The one bright spot here is that most of the growth in government R&D spending last year was dedicated to low-carbon technologies. But this is still an incredibly small number given the need to rapidly decarbonize our economy. For comparison, the [US National Institutes of Health spent more than \\$37 billion on R&D last year](#). Global private sector investment in biotechnology R&D was more than [\\$45 billion in 2016](#). This is not a new problem ([commentators have long pointed to limited government investment in energy R&D](#)), but it is an increasingly urgent problem if we want to build and maintain a robust technology pipeline for clean energy. And the shortfall is not being compensated for by private sector investment: venture capital investment in emerging energy companies, to take one indicator, reached an estimated \$6.9 billion in 2018 according to the IEA. While this is a high point for VC deals in energy and although most of that total was focused on clean energy technologies (with the lion's share dedicated to clean transportation investments), it is still far below what is needed.

One last interesting fact: according to the report, the vast majority of investment in the power sector (more than 95%) was made by companies whose revenues are fully regulated or tied to out-of-market mechanisms intended to manage the risks associated with price variability in competitive electricity markets (i.e., long-term power purchase agreements). That means that government policies and regulation together with long-term contracts continue to drive the lion's share of investment in the power sector—suggesting that shifting those policy levers and using existing regulatory models to channel investment is where we should be focusing much of our attention if we want to accelerate the move to a low carbon electricity system.

Climate change is – among other things – an investment challenge; perhaps the mother of all investment challenges. [A 2014 study by the International Energy Agency](#) estimated that close to \$50 trillion will be invested in the global energy system between now and 2035. There are multiple scenarios for how such investment will proceed under different policy regimes and based on various assumptions about technology and economics. But one thing we know right now is that far too much capital investment is continuing to flow into fossil fuel related assets, adding to the problem of [committed emissions and carbon lock-](#)

[in](#) associated with the existing energy system. One recent [study](#) found that the committed emissions, that is, the emissions already embedded in the existing capital stock making up the global power sector (assuming those assets live out their expected useful lives) is already more than the remaining carbon budget needed to stay below 2 degrees. To be sure, devaluation and early retirement of existing assets is always a possibility. It may be that some (or even most) of the investments in fossil fuel related assets will be stranded by future government policies or by new technologies and continued price declines. As the authors of the [previously mentioned study](#) observed: “Even if all currently planned projects [for fossil-fuel generation in the power sector] are immediately suspended, up to 20% of global fossil-fuel generation capacity would still have to be stranded (that is, prematurely decommissioned, underutilized, or subject to costly retrofitting) if humanity is to meet the climate goals set out in the Paris Agreement.” Such an undertaking would entail a painful and highly contested set of choices that will mean taking on some very powerful interests. Follow the money.