Not that money. Not the hush money, the payoffs, the tax and banking fraud. And not the dark money seeking to influence our environmental, climate, and clean energy policies. Nope, I am talking about the actual money invested in the world energy system last year. Granted, this may not be as interesting to many readers as all the scandals currently swirling around Washington. But if you care about the fate of the planet, these facts matter.

Earlier this summer the International Energy Agency (IEA) released its third annual World Energy Investment Report, providing a survey of investment trends in the global energy sector over the last year. While there are some bright spots identified in the report, the big picture is sobering. As IEA Director Fatih Birol states in the Forward to the report: “the overall trend of energy investment remains insufficient for meeting energy security, climate and air quality goals, and is not spurring acceleration in technologies needed for the clean energy transition.”

A few numbers—all taken from the report—to illustrate: Last year, total investment in the world energy system was around $1.7 trillion. Of this, slightly less than 60% (close to $1 trillion) was dedicated to fossil hydrocarbons–upstream oil and gas development, downstream refining and petrochemical operations, and infrastructure and power generation facilities devoted to transporting and burning fossil fuels. That proportion is down from 2014 (when it was closer to 70%), so the trend is going in the right direction. But not nearly fast enough. And all that new investment just makes things that much harder going forward. Put another way, much of the close to $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.

Ah, but look at the growth in spending for renewables the optimist might say. What growth? Although global investment in renewable electricity generation accounted for 16% of total world energy investment in 2017– around $300 billion–that actually represented a *decline* of 7% from the previous year. At least for the time being, global spending on renewable electricity has stalled. Investment in energy efficiency did increase 3% to $236 billion and purchases of electric vehicles increased to $43 billion—a quarter of which was attributed to government purchase

incentives. One does not have to be good at math to see the huge mismatch in global spending on fossil fuel assets versus that dedicated to clean energy, efficiency, and electric vehicles.

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 is dismal. Global investment in nuclear power saw another sharp decline last year (45%), though there was an increase in spending for operating license extensions at existing nuclear power plants. This, too, puts an added burden on renewables in the effort to decarbonize the power sector. To take one example, in Europe, the decline in nuclear power generation since 2010 has offset more than 40% of the growth in solar PV and wind-generated electricity.

Still another sobering number from the report is the one for government R&D spending in the energy sector around the world. Despite an increase of 8% in 2017, it was still a paltry $27 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 $32 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 low-carbon energy, to take one indicator, fell last year to $2.1 billion. That is about 1.3% of total global VC investment of more than $164 billion last year.

Not all the news was bad. China continues to shift its investment away from coal and toward renewables and efficiency. Investment in new coal plants in China declined by 55% in 2017. And in India, investment in renewable energy for power generation actually exceeded the investment in fossil-fuel based power generation for the first time in 2017. Those are important and positive trends given the large contributions of China and India to global GHG emissions.

Last year also saw record spending for solar photovoltaics, 45% of which was in China. Investment in battery storage continues to increase, but there remain big questions about overall costs and how fast the technology can scale. Still, since 2012, investment in lithium mining has increased 10-fold while investment in

battery manufacturing capacity has increased 5-fold.

Notwithstanding the Trump administration's efforts to prop up coal in the United States, which several of my Legal Planet colleagues have commented upon, the global picture for coal is mixed. Despite a more than doubling of thermal coal prices since early 2016, investment in coal supply in 2017 declined by 13%. And retirements of coal fired power plants continued at roughly the same pace as in 2016 (about 24 GW of capacity retired in 2017). But retirements of existing coal-fired power plants (mainly older, inefficient, heavily polluting subcritical plants in Europe and the US) only offset about half of the new additions to the global fleet of coal-fired power plants. We are still building more coal plants (globally) than we are retiring.

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.