RAYMOND JAMES

The newest innovations in energy transition

As we always point out when writing about energy transition, it is vital to have a full-spectrum, all-of-the-above approach – it will take some of everything to bring down CO^2 emissions. Solar, wind, electric vehicles – these are the technologies that have successfully scaled up around the world. Beyond that, there are plenty of newer technologies that are still in the R&D or early commercialization stages. Here is a sneak preview vis-à-vis five of the intriguing innovations that we will be watching over the next several years.

DIRECT AIR CAPTURE

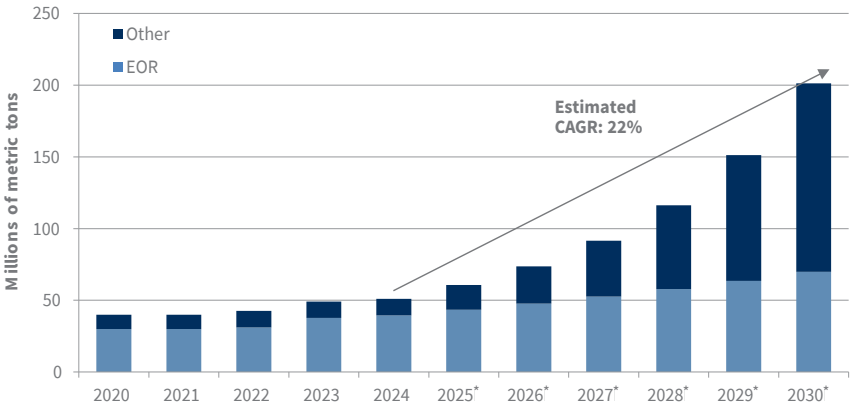
Carbon capture, which is typically found at fossil fuel power plants and large industrial sites, involves specialized equipment that prevents CO2 emissions at these facilities from entering the atmosphere. A fraction of one percent of the world's CO2 emissions are currently being captured, though as shown below we anticipate solid growth through 2030. The newest variety of carbon capture – direct air capture – involves removing CO2 that has already entered the atmosphere. The CO2 being removed may have been emitted at any point in history, and anywhere on the planet – it makes no difference. The machines doing the removal look a bit like giant air conditioning units. Once the CO2 is removed, it can be injected for permanent storage in depleted oilfields or underground caverns. Carbon capture overall tends to be an expensive proposition, and direct air capture is especially pricey – economies of scale have yet to be achieved. The world's largest plant (albeit still modest in scale) opened in Iceland in 2024, and a plant that is roughly 10x larger is set to open in Texas later this year.

KEY TAKEAWAYS

In the electric power industry, there are opportunities for small modular reactors, virtual power plants, and concentrating solar power.

Electrofuels and direct air capture are other case studies of energy transition innovations that are just starting to scale up.

Global Carbon Capture and Sequestration Capacity in Operation



Source: Global CCS Institute, Raymond James research

*Estimated

SMALL MODULAR REACTORS

All of the nuclear power plants that are currently operating around the world use a traditional, large-scale reactor design, 500 to 1,000 megawatts in size. What's getting a lot more attention these days is small modular reactor (SMR) technology, which ranges from 5 to 300 megawatts. SMRs are especially high-profile in the context of the relentless conversations around AI data centers and their insatiable need for power. An SMR offers the same ultra-reliable power generation as a traditional reactor, but with a compact form factor and a quicker time to market. However, "quicker" is not the same thing as "quick". Although less than the 10 to 15 years that are typically required for a traditional reactor, SMR projects are still lengthy, bearing in mind that everything nuclear-related involves thorough permitting, followed by a complex construction process. Only two SMRs are currently being built – one in China, one in Argentina – which means that all of the U.S. and European projects that you may have heard about, including the ones with Big Tech customers, are still in the pre-construction stage.

ELECTROFUELS

You have probably read about buses and trucks that run on hydrogen. Instead of an internal combustion engine, or an electric battery, they have a hydrogen fuel cell. Well, what if hydrogen could be used in an ordinary engine, just like gasoline or diesel? The appeal of this approach is that there would be no need to replace existing buses and trucks with fuel cell models, thereby saving money while also making it faster to achieve lower emissions. This can be done, but additional processing is required: hydrogen is combined with CO2 into a synthetic liquid hydrocarbon. In contrast to hydrocarbons that are derived from oil or gas fields, this new category – called electrofuels, or e-fuels – is more climate-friendly. The drawback is that the additional processing is costly, above and beyond producing the hydrogen itself. The world's first commercial-scale electrofuels plant opened in Texas in 2024. Various other projects are underway, but volumes are unlikely to become needle-moving until 2030 at the earliest.

VIRTUAL POWER PLANTS

Imagine an intensely hot summer day, with the electric grid overloaded. This often leads to rolling outages, which no one likes. In the best-case scenario, the outages are managed via interruptible supply agreements. The good news is that there is a way to avoid anyone losing power: it is called virtual power plants.

Here is how it works: a software platform aggregates thousands of distributed (small-scale) energy resources, such as rooftop solar or battery storage. When the utility urgently needs more power to balance supply and demand, the software instructs these assets to push all available electricity into the grid. Interestingly, electric vehicle batteries can also be used to feed the grid – this is called bidirectional charging. The asset owners, which are either households or commercial customers, are paid by the utility in two ways: 1) a fixed fee for being "on call" to provide power; and 2) a variable amount when the assets actually get used. The utility avoids the unpleasant PR (and regulatory issues) of outages, while end users earn an extra return on their investments. The software company that manages the platform links the two sides and naturally takes a share of the economics. While there is no clear-cut data, we have come across sizable virtual power plants in places such as Germany and California.

CONCENTRATING SOLAR POWER

When you think of solar, what comes to mind has the technical term of photovoltaics, or PV – panels, usually made from polysilicon, that convert sunlight directly into electricity. Close to 99% of the world's solar installations use PV technology. The other 1% is called concentrating solar power, or CSP, which involves a two-step process: 1) the solar energy is used to produce heat; and 2) the heat powers a turbine, generating electricity. The main reason why CSP has only 1% share is that it requires very high amounts of sunlight, found in places such as the U.S. Southwest, the Persian Gulf region, and Australia. In other words, CSP simply cannot work across large swaths of the world. But in places where CSP is viable, the economics can be competitive with traditional energy sources. Plus, CSP can be a good solution for industrial customers that need heat rather than electricity.

Concentrating Solar Power Projects , 200+ MW, as of 2024

Project	Country	Capacity (MW)	Startup Year
In Operation			
Mohammed Al Maktoum Solar Park	UAE	700	2023
Moor-Ouarzazte	Morocco	510	2015
Ivanpah Solar	U.S.	377	2014
Solar Electric Generating Station	U.S.	310	1985
Mojave Solar Project	U.S.	280	2014
Solana Generating Station	U.S.	250	2013
Genesis Solar Energy Project	U.S.	250	2014
Solaben	Spain	200	2012
Under Construction			
Golmund	China	300	2025

Source: NREL, Raymond James research

PAVEL MOLCHANOV
Investment Strategy Analyst
pavel.molchanov@raymondjames.com

SUSTAINABLE INVESTING
sustainableinvesting@raymondjames.com

RAYMOND JAMES®

INTERNATIONAL HEADQUARTERS: THE RAYMOND JAMES FINANCIAL CENTER
880 CARILLON PARKWAY // ST. PETERSBURG, FL 33716 // 800.248.8863 // RAYMONDJAMES.COM

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