Growing Pains - Renewable Transition in Adolescence

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Growing Pains: Renewable Transition in Adolescence

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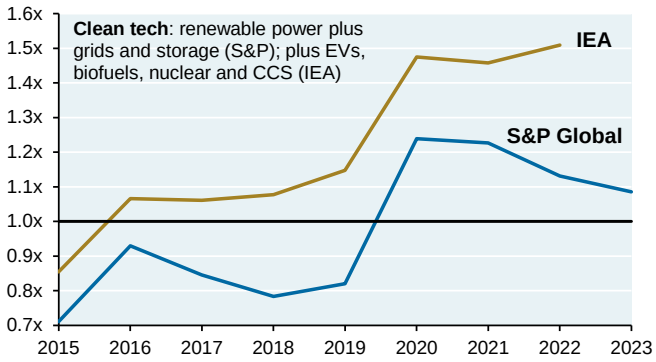
MR. MICHAEL CEMBALEST: Good morning, welcome to the Eye on the Market 2023 Energy Paper podcast. This year's paper is called Growing Pains: The Renewable Transition in Adolescence. Every year when I write this paper, it's kind of an amazing experience. I share it, I screen it with some clients and some friends, some academics in advance. And every year, including this year, there are people that respond by saying, well, this is really well researched, it's fascinating, I learned so much, but it really bummed me out. I was kind of hoping to read something different.

And happens all the time, and I'm kind of amazed that I got that feedback this year because we start the paper with a lot of good news. I mean, there are certain things about the transition that are accelerating, and we haven't even kicked in the US and the European energy bills yet. So there's a lot of good news here, but it shows you as a Rorschach test, people still somehow believe that this transition can be accomplished in a few years, whereas it takes decades for energy transitions to take place, and some of the things that are keeping the transition from happening more quickly, most people either don't know about or when they find out about them, don't do anything about them and don't lobby to change them and don't vote accordingly. So anyway, this podcast is not meant as a substitute for reading the piece. It's 50 pages with a gazillion charts on it. But I want to give you a sense for what we worked on this year.

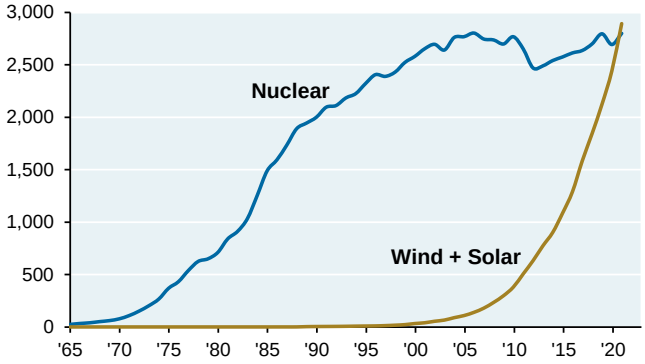
So there's lots of good news to share, clean tech, investment is soaring. As I mentioned even before the energy bills, wind and solar generation globally exceeded nuclear for the first time last year.

Clean tech spending outpacing fossil fuels
Ratio, clean tech / fossil fuel capital spending by year



Source: S&P Global, IEA, JPMAM. 2023.

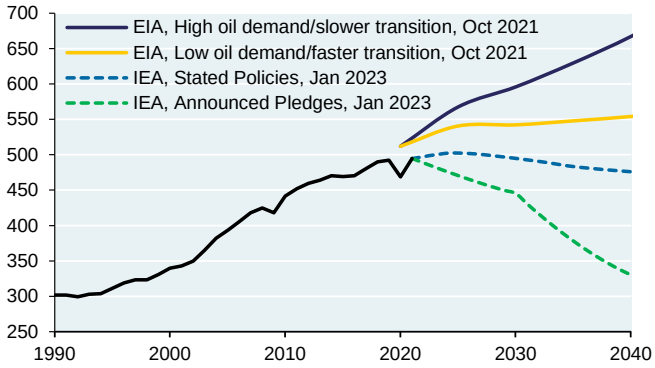
Global nuclear vs solar+wind electricity generation
Terawatt-hours



Source: BP Statistical Review of World Energy, JPMAM. 2022.

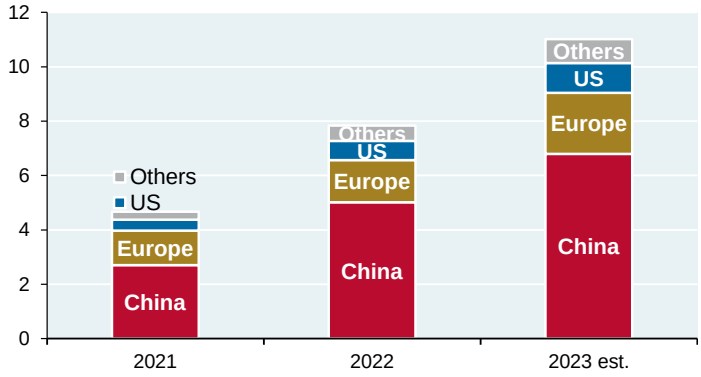
The IEA projects this year if you make it to the end of this decade, you will probably see peak global fossil fuel demand. At least that's what the IEA is projecting even in their slower transition case. Over the next five years, there may be as much renewable capacity added as over the prior 20 years. EV sales are picking up globally.

Future global fossil fuel demand: depends who you ask
Exajoules



Source: Energy Information Admin., Int'l Energy Agency, JPMAM. 2022

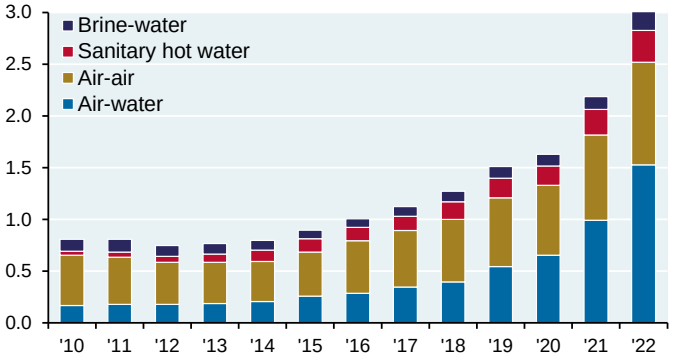
Global sales of battery electric vehicles
Number of vehicles, millions



Source: WSJ, LMC Auto, EV Volumes. January 16, 2023.

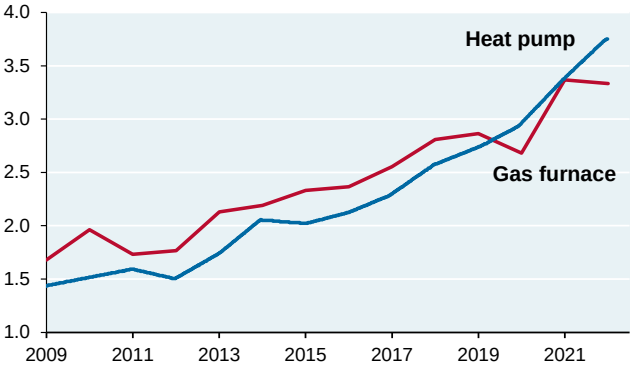
Residential heat pump adoption is rising rapidly in the US and Europe in response to rising energy prices. Battery plant buildout in the United States is really picking up speed. The cost of storage has declined, energy storage, to the point where combining it with a utility-scale solar facility in some locations is now competitive with gas peaker plants.

European heat pump sales reach 3 million units
Annual sales, millions



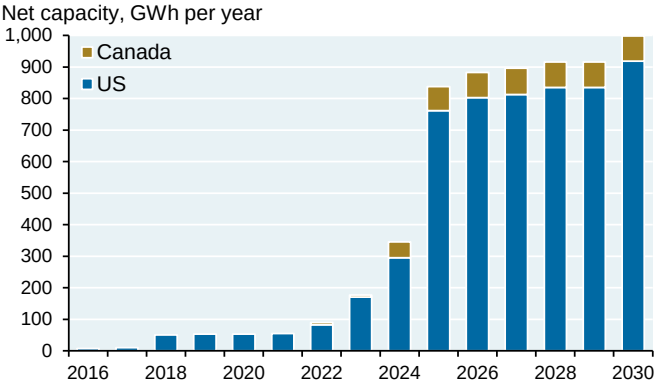
Source: European Heat Pump Association. February 2023.

US heat pump sales exceed gas furnace sales
Annual sales, millions



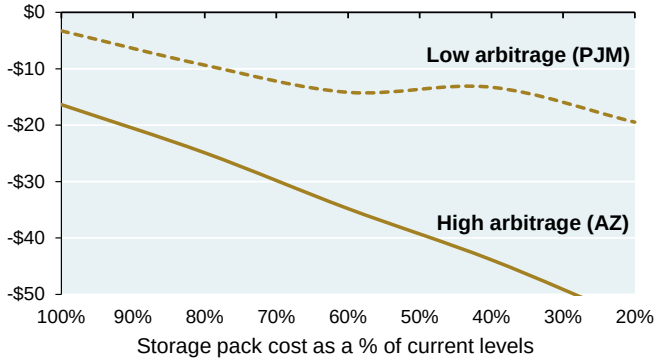
Source: Air Conditioning, Heating and Refrigeration Institute. 2023.

Announced battery plant capacity
Net capacity, GWh per year



Source: Argonne National Laboratory. November 2022.

Solar + storage: payments not required in either location
Revenue requirement, US$ per kW-year



Source: Decision Solve LLC, JPMAM. 2023.

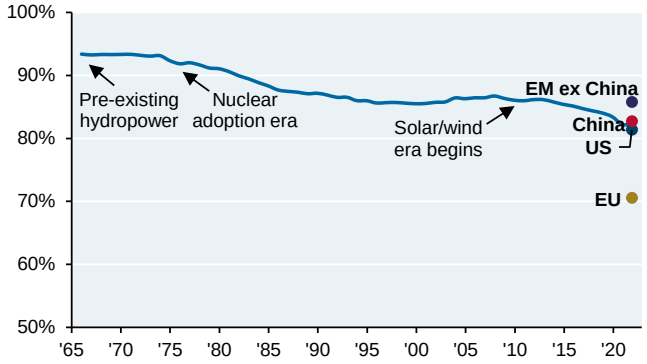
Last year China added more renewable capacity than the US, Europe, India, Asia, and Latin America combined. And so there's a lot of good news about how the transition is picking up speed. And this was all listed on the first page, and some of the feedback I got was that people were still a little disappointed.

And look, despite all those good news, the decarbonization of energy use is going to be a gradual process. There's been about $6 trillion spent on renewable energy since 2005, another $3 trillion spent on electricity networks, and the world is still about 80% reliant on fossil fuels, down from 85% in 2005. It's hard to electrify certain forms of industrial, commercial, residential, and transport energy use. So this paper gets into what's going on here.

For the most part, renewable energy today is displacing the fossil fuels that power your HVAC systems in homes and buildings. That is overwhelmingly what renewable energy does today. It also decarbonizes a little bit of industrial energy use, and global oil consumption would be 2% higher without all the electric cars and vans

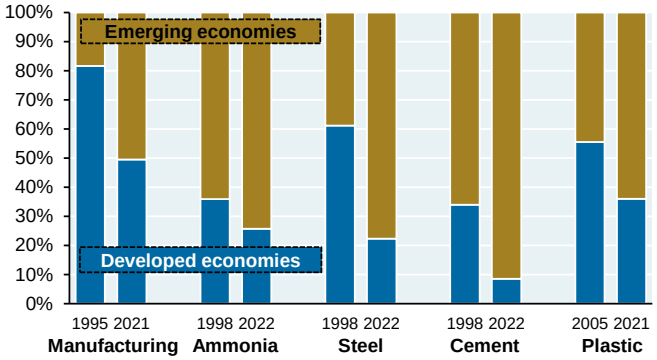
and trucks and buses in the world. But the pillars of modern society, steel, cement, ammonia, fertilizer, plastics, glass, rubber cement are still made using fossil fuels, particularly in the developing countries to whom the West outsourced all of that stuff in the first place.

Fossil fuel share of primary energy since 1965
% of global primary energy consumption from coal, oil and nat gas



Source: BP Statistical Review of World Energy, JPMAM. 2022.

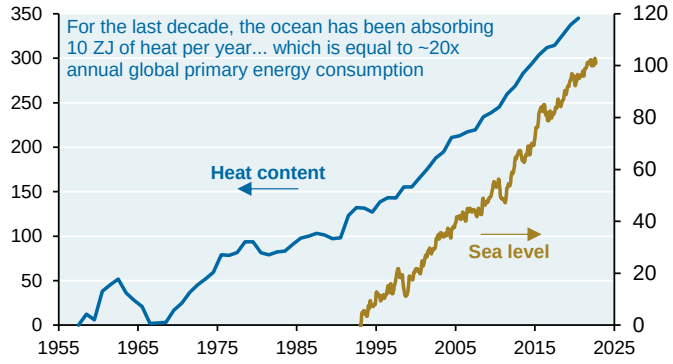
A shift in energy intensive manufacturing to the emerging world, % of global production



Source: UN DESA, Worldsteel, Plastics*Europe*, USGS, JPMAM. 2022.

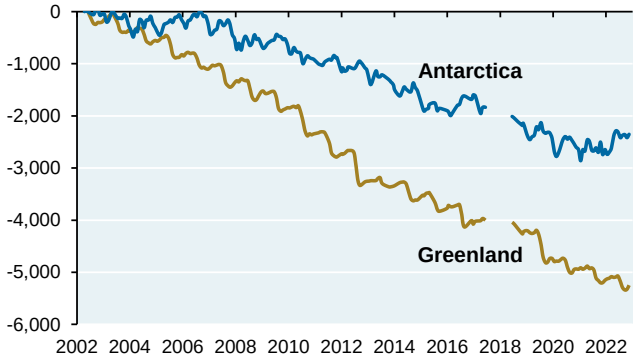
We do discuss up front, there is evidence pointing to the need for more rapid transition, and none of this is new information, but we've correlated some of it, rising open ocean temperatures, rising sea levels, the falling ice sheet mass and things like that.

Ocean heat content and sea level
Zettajoules, vs 1957 baseline — Millimeters, vs 1993 baseline



Source: NASA/NOAA. 2022. 1 ZJ = 10^{21} joules.

Antarctica and Greenland ice sheet mass
Mass variation, gigatonnes



Source: NASA. November 2022.

But if that's the case, this paper discusses some of the transitions' primary obstacles, permitting delays for generation and transmission, a lack of eminent domain in the West, resource nationalism, and the availability of critical minerals to support the transition, the very high cost needed to decarbonize industrial heat, the backup thermal power and storage costs and logistics to accompany intermittent wind and solar power, probably the topic that's been misreported on most over the last 15 years. Challenges for grid managers, integrating

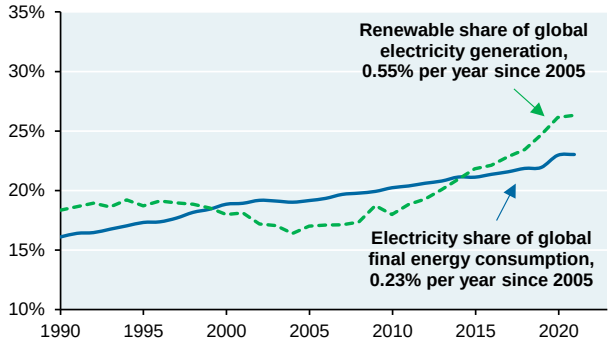
thousands of new wind and solar projects, and then the long useful lives of existing machines, vehicles, and furnaces, and the time it takes for societies to build new ones to utilize new forms of energy.

And if that's what's constraining the pace of change, I'm unconvinced that starving the oil and gas industry of capital is going to make the transition go any faster, particularly since new pools of capital will just step in as long as demand for fossil fuels exist. And Europe is Exhibit A for what happens when you mismanage your access to thermal energy while the renewable transition is ongoing. So I think the handful of countries in the world that have oil and gas reserves, even though the renewable transition is picking up speed, don't quit your day job. You're going to need those oil and gas reserves for many years to come.

The paper starts out with an executive summary that takes a detailed look at the goals and the realities of the energy transition. In this section, we look at the efforts behind electrification and grid decarbonization. And it's important to understand that there's two different transitions going on. One is can we make the grid greener by adding wind and solar, and the second is can we electrify other forms of energy use so that we can then decarbonize it?

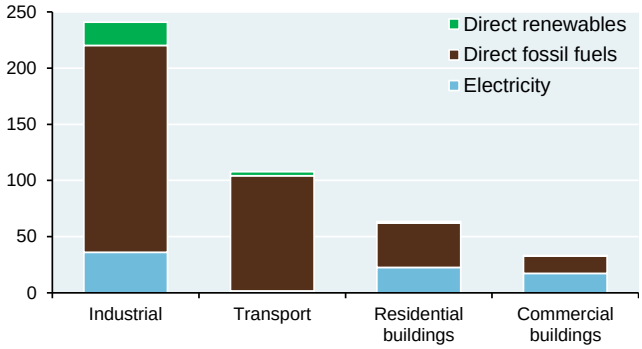
And one of them is easier to do than the other one. The greenification of the grid, there's a chart on page six, is happening about twice the speed as the electrification of overall energy use. And that's important to understand. Electricity use is only 20 or 30% in most countries, particularly the larger ones, of overall energy consumption. So even if you decarbonize substantial portions of the grid, you're not really doing as much as you think unless you can start electrifying other kinds of energy use.

Grid decarbonization outpaces electrification of energy use
Percent



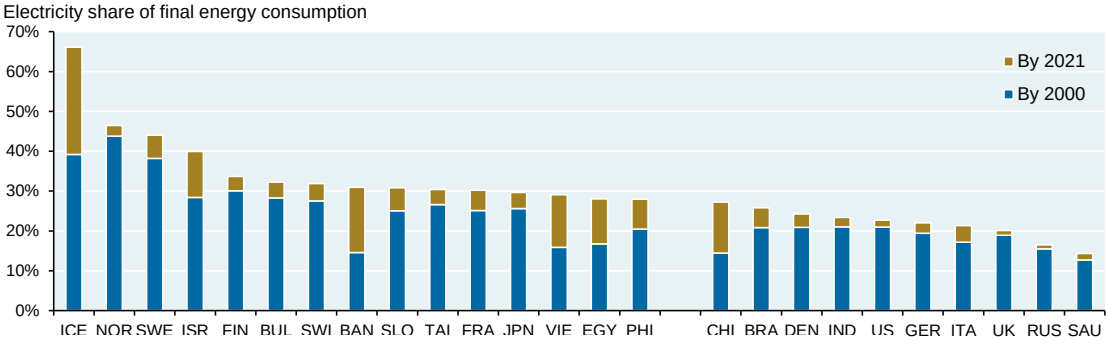
Source: BP Statistical Review of World Energy, JPMAM. 2022.

Global final energy consumption by sector and fuel
Quadrillion BTUs of final energy consumed by sector



Source: Energy Information Administration, JPMAM. 2021.

The gradual advance of electrification, 2000 to 2021
Electricity share of final energy consumption

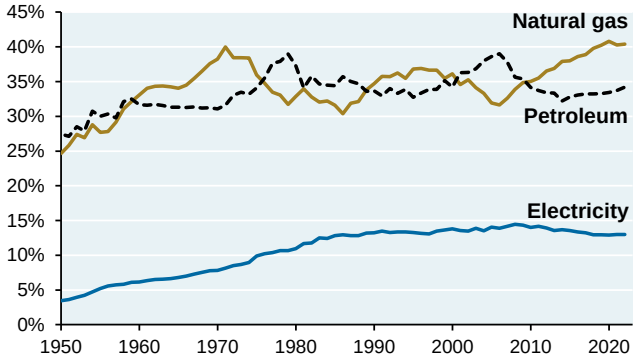


Source: BP Statistical Review of World Energy, JPMAM. 2022.

And so the industrial sector, for example, is the biggest consumer globally of fossil fuels. So the executive summary discusses the four sections in order: the industrial sector, then transport, then residential buildings, and then commercial buildings in terms of for the prospects of electrifying and otherwise decarbonizing them. And the short answer is electrification in industrial energy use is a really hard thing to do, and you don't have to look any further than the United States, where the electricity share of industrial energy consumption has been unchanged for 40 years.

So you're going to read tons of articles on decarbonization of steel and cement and concrete and glass and fertilizer and ammonia and other chemicals. All of those are interesting pilot projects, they deserve the support they get. But the electrification of industrial energy use in the US has been unchanged for four decades, at about a 15, 14% share. It's a very hard thing to do.

Electricity share of US industrial energy use unchanged for decades, Share of industrial energy use

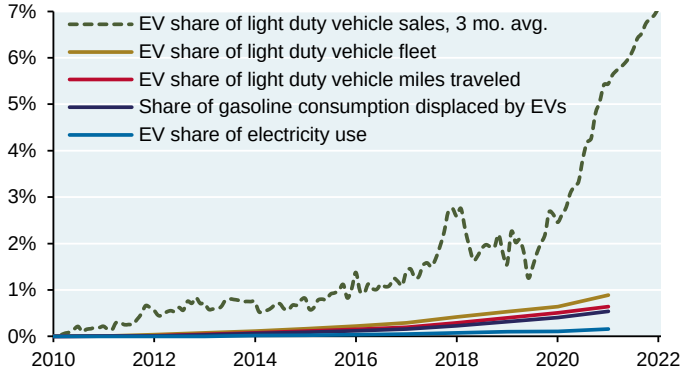


Source: EIA, JPMAM. January 2023.

As it relates to transportation, there's some great news on battery-electric vehicles. They were 10% of global passenger cars last year. They rose almost 70%, another 40% gain projected for 2023. All of that is good news. Two issues to think about. One is it takes time for the percentage of EV sales to impact the fleet. We have a chart in here on the US showing the EV share of light-duty vehicle sales soaring, whereas the overall EV share of the light-duty fleet itself and miles traveled and gasoline consumption is much, much smaller. Cars last 12 to 15 years now. You know, every time we run out of one, we give one to one of my wife's friends and they keep driving it for several years. So that's part of the issue here, which is the long useful life of the existing internal combustion engines.

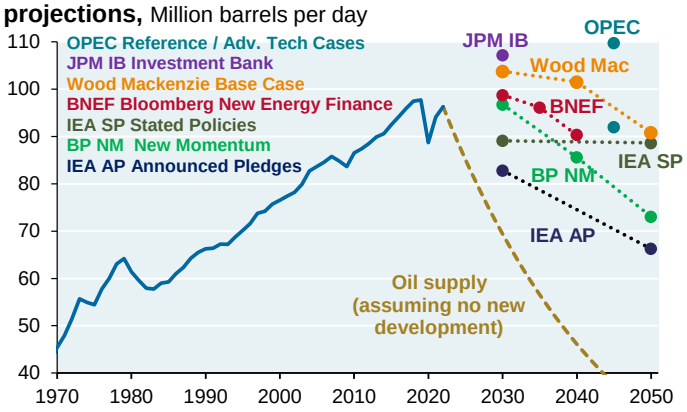
The other thing to think about, passenger cars only represent globally about a quarter of oil consumption, so the progress that you make decarbonizing passenger cars will have to be accompanied by progress on decarbonizing the oil that gets used in other road freight, aviation and shipping, and in the production of chemicals and other kinds of industrial energy use. So it does look like over the next 10 to 20 years, global oil consumption will stop accelerating at the same pace it did historically. It just may take quite a while for oil consumption to consistently register below let's say 100 million barrels a day.

It takes time for EV sales to impact entire fleet
Percent



Source: ANL, JPMAM. 2023.

Oil demand, supply from existing fields and demand projections, Million barrels per day

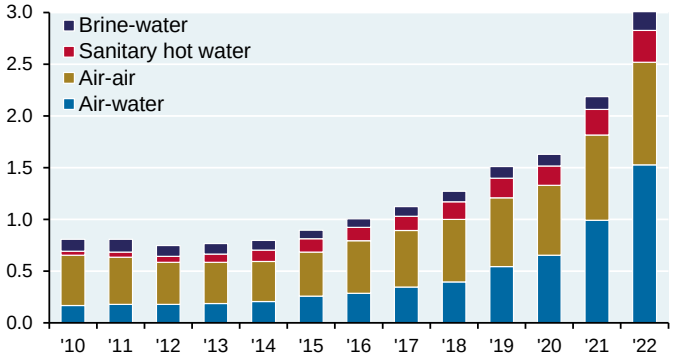


Source: BP, EIA, IEA, OPEC, Wood Mac, BNEF, JP Morgan IB, JPMAM. 2023.

And the best news probably is on the commercial and residential building heat. They are smaller categories, but they still use a lot of fossil fuels, and here the development of really efficient heat pumps over the last decade is very good news, 'cause not only does that electrify the use, electrify heat, but it does so in a very efficient way, which results in less overall energy consumption as well. And we have some information here on how Europe and the US,

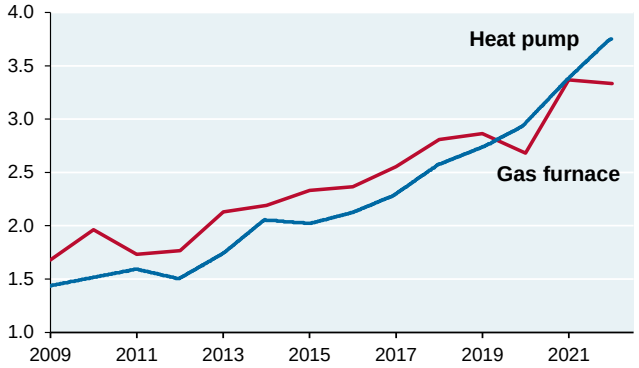
you're finally starting to see heat pump sales displace gas furnaces and other boilers.

European heat pump sales reach 3 million units
Annual sales, millions



Source: European Heat Pump Association. February 2023.

US heat pump sales exceed gas furnace sales
Annual sales, millions



Source: Air Conditioning, Heating and Refrigeration Institute. 2023.

So the executive summary walks through the major uses of fossil fuels and the prospects behind decarbonizing them. And that's the section that I think is the most important to read.

We also have some individual sections on topics that we think are important. One of them is this whole issue of levelized cost of energy for wind and solar power, which we think is kind of an irrelevant calculation because it's only looking at the cost of a marginal megawatt hour and not looking at all of the other costs necessary in terms of storage or backup power that you need to build systems with lots of wind and solar power. So there's a numbers in, garbage out problem with levelized cost of energy.

We look at issues around grid expansion and renewable interconnection in the US and Europe. The grid is being expanded at a fraction of the pace that's necessary for deep decarbonization plans.

We look in detail, there's a long section on the issue of critical minerals. And what's important to understand about critical minerals is that they are not really scarce. All these transition minerals are not very scarce. There's at least 40 years of supply based on production relative to global reserves and relative to global resources, which as a broader category there's even more. The question is who has them and will they sell them, and at what price, and how much would it cost for countries that don't currently process them or produce them to start doing so and how long that would take. So it's really a question of resource availability rather than scarcity on critical minerals.

We talk about the rise of projects with co-located storage and solar power now that storage costs have declined, municipal solid waste as a source of energy, and the dispute over forest biomass in Europe. There's a section on carbon capture. I've been known to say, I've written in the past that the single highest ratio in the history of science is the ratio of academic papers written on carbon sequestration divided by actual carbon sequestration. So the hit rate of these CCS projects has been historically very low. That may change a little with some new incentives and economies of scale, but I still think the math argues against a large contribution here over the next 10 to 15 years.

And then we have a section called California Dreaming, which is on some futuristic ideas that I don't think are going to be making any contribution, meaningful contribution at all over the next 10 to 15 years so you can just ignore them. Electric planes, nuclear fusion, solar power based in space, outer space, direct air carbon capture, and fully autonomous car networks.

And then we end with an epilogue on how Europe survived the winter, what they're facing going forward, and the risks of deindustrialization, and then what comes next in the Russia/China energy partnership. And then there's an appendix at the end, an important one, with a methane update, because some aerial and drone studies are showing leakage rates of methane in the US that are much higher than the methane data that the oil and gas industry reports to the EPA.

So here are some concluding thoughts for this year. I see a lot of energy papers where the authors are projecting seismic changes in the energy landscape by 2050, and where some of the transitions involved kick in in 2035 or 2040. I have no idea how they have visibility that far out or claim to. Decarbonization of electricity, passenger cars, and winter heating in homes and buildings is definitely advancing in many parts of the world. We can see that. And in the developed world, fossil fuel use and emissions are almost certainly starting to plateau. That much we can see. But that's about all we can see here. The future is a lot less clear than what a lot of these reports are projecting.

And as an example of that, one of the think tanks that we've spoken to that modeled the energy bill on behalf of the Senate and for Schumer and Manchin made these projections of massive solar and wind expansion, GHG declines, and other major transitions in vehicles and truck, 90% of long-haul trucks decarbonized by 2030 in terms of

percentage of sales. And we were struck by how aggressive and optimistic the forecast was.

And then we saw it in kind of a small font the following caveat, if you were able to spot it in this report. Several constraints that are difficult to model may limit these growth rates in practice, including the ability to site and permit projects at the requisite pace and scale to expand electricity transmission, to expand the transport of Co2, and to expand storage to accommodate the new generation capacity and to hire and train the expanded energy workforce needed to build them.

So in other words, as long as the reality of the world in which we live doesn't get in the way, all of the goals are achievable rapidly. That's how I think you should interpret a lot of these long-dated energy projections from Wall Street firms and think tanks and governments. They're assuming that the only important driver here are the subsidies and an optimized world in which people take advantage of them, whereas in reality it's a lot more complicated than that. And we talk about the technology and policy and chemistry and physics and nationalism issues that get in the way each year.

And my view is that the fossil fuel demand is going to evolve closer to the slower of one of the IEA scenarios. And if that's the case, it would be premature to rely on renewable energy for more than it is organically capable of providing, in which case the countries that constrain access to fossil fuels prematurely like Europe did are going to end up regretting it.

So that's the end of this year's podcast. Thank you very much for listening, and I'll be back to you shortly with another Eye on the Market podcast on the banking deposit situation in both the US and Europe. Thanks for listening, bye.

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