# Energy Musings

Insights into the Energy Industry



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***Energy Musings*** *contains articles and analyses dealing with important issues and developments within the energy industry, including historical perspective, with potentially significant implications for executives planning their companies' future.*

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## Should We Stop Building New Homes?

Real estate creates 30% of our carbon emissions and uses 40% of our energy, so it has become an important target of climate activists. An important ingredient in the emissions is concrete because of the coal burned to heat the limestone that forms the basis for Portland cement and the energy needed to turn it into concrete. Because cement accounts for between 4-8% of global emissions. Startup companies are working to find fewer polluting ways of making cement and concrete. One approach is to switch to building using 'mass timber'. Wood can be a great way to reduce carbon emissions in building conventional buildings. And now there is a move to encourage remodeling that releases much less carbon than building new with significant embedded carbon in the construction materials. Look for a housing transition.

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# Should We Stop Building New Homes?

Investors and economists focus on the latest housing data – new home starts, building permits, used and new home sales, and housing vacancy rates – for indications of the health of the real estate sector. Real estate represents 17% of the nation's GDP, but importantly is the foundation of wealth building for the middle class and provides insight into the health of the flow of goods, services, and income for millions of Americans.

According to the United Nations Environmental Program, the real estate sector produces around 30% of the world's annual greenhouse gas emissions and consumes nearly 40% of the world's energy. Ten percent of those emissions come from cement, a key building material for world economies. Concrete is the second most used material in the world after water and it is the most used construction material. It is estimated we produce around four tons, or just under 60 cubic feet (a cube measuring four feet on each side), for each person in the world annually. It represents between 4-8% of global emissions. If cement were a country, it would rank fourth in annual carbon emissions.

As the world focuses on decarbonization in addressing climate change, cement and real estate are moving into the target zone, after aviation and shipping (industries we addressed in Energy Musings, July 19, 2023). Eliminating carbon emissions from cement is hard. That's because manufacturing it is highly energy- and emissions-intensive since extreme heat is needed to produce it. Emissions come directly from the heating of the limestone that releases $CO_2$. The burning of fossil fuels to heat the kiln indirectly results in the release of $CO_2$.

Producing a ton of cement requires about 4.7 million BTU of energy because the kilns must be heated to 2700$^o$ F to break down the limestone which is then mixed with gypsum to make clinkers that are ground up to make cement. The energy needed to heat the kilns is the equivalent of burning 400 pounds of coal, which releases nearly a ton of $CO_2$. One way to cut emissions is to switch the kiln's fuel source from fossil fuels to renewable electricity, but that can be a challenge because of the energy density of coal that allows it to burn extremely hot and the level of heat needed.

In Greece, according to a European energy podcast, the government is working on a plan to switch kilns from coal to renewable electricity. The problem, according to the owner of the nation's largest cement manufacturer, is that amount of renewable energy currently available is insufficient to power all his kilns, let alone any of those of his competitors. Therefore, the government is trying to ramp up investment in new renewable energy plants. However, because renewable energy is part-time, the grid is susceptible to brownouts and blackouts. The cement company's CEO said the loss of power for four hours will destroy a kiln. To protect his kilns, he is contracting backup power to the supply he receives from the electric company because he expects more outages. This becomes expensive insurance which will force him to raise the price of his cement.

Cement companies worried about the destruction of their kilns from blackouts have few alternatives other than independently securing backup power or praying a lot. Could there be other solutions to cement's emissions problem? Are there ways to make the process more efficient, such as improving how kilns work? Maybe cement can be made from lower-carbon raw

materials, or produced differently, such that when blended with the other necessary materials it will still make a product equal to traditional concrete.

Major cement companies are experimenting with different mixtures of limestone and gypsum to reduce the energy needed to turn it into a cement-like product. Start-up companies, often founded by material sciences professors at major research universities, are testing many of these solutions. Some of these companies are also exploring other solutions.

Sublime Systems claims it has found a way to make cement using cheap renewable electricity. That avoids the traditional energy needed to heat limestone in a kiln, thereby reducing carbon emissions. How they overcome the part-time performance of renewable energy needs to be demonstrated.

C-Crete Technologies says it has invented a new process that does away with cement entirely in making concrete. The product utilizes a mixture of natural minerals and industrial by-products. In its manufacture, it produces almost no $CO_2$. It also absorbs $CO_2$ from the air over time. Will it stand up to the long-term performance of traditional concrete?

The company says that each ton of C-Crete binder replacing Portland cement prevents approximately one ton of $CO_2$ emissions. In a recent press release, C-Crete said the product was used for the first time in a foundation and sheer walls of a commercial building being built in Seattle, Washington.

Another startup, Chement, based in Illinois, has invented a way to make cement at room temperature. Although the process still produces $CO_2$, it avoids using kilns heated by burning coal and powers its process with renewable energy. The emissions released are in the form of a pure gas that can be captured. The cost of carbon capture in such a plant is estimated to be a small fraction of trapping those emissions from existing kilns.

While these startups offer promising ways to reduce cement emissions, they are in their infancy. Therefore, we do not know their economics at scale or the long-term performance of their output. But they are promising.

When we turn to the issue of emissions from the real estate sector, two interesting trends are emerging. The first, which we wrote about in our Energy Musings of May 17, 2022, is the return of wood as a construction material, even for high-rise hotels, apartments, and office buildings. Known as *"mass timber"* construction, it utilizes trees selectively cut rather than clear-cut. Therefore, building with mass timber creates less waste, can be quicker, and can be quieter than using conventional construction materials. At the time of our article, the tallest mass timber building was the 280-foot tall, 18-story Mjøstårnet tower in Brumunddal, Norway. It has been surpassed by the 25-story Ascent MKE apartment building in Milwaukee, Wisconsin that stands 284 feet tall. It features 259 luxury apartments, retail space, an elevated pool with operable window walls, and a sky deck.

**Exhibit 1. Ascent MKE Is Tallest Mass Timber Building**

**Source: Ascent MKE**

We wrote in the Energy Musings:

*"These are not log cabins or even stick-built homes, these high-rise buildings use cross-laminated timber. That is essentially large-scale plywood, made by gluing two-by-fours together into a sheet, then flipping the sheet 90-degrees and gluing more two-by-fours on top. This produces a sheet of wood that is much like a slab of concrete but weighs 80% less. The wood is kiln-dried, a process that can take weeks, but the manufacturing process enables computer imaging to cut pieces precisely to size before they are transported to the building site reducing construction time."*

*"To replace steel, glue-laminated timber can be made to resemble beams rather than sheets. These beams can support buildings, and they can be bent allowing design options such as domes."*

Challenges in building with mass timber are moisture content and building strength. The timber must be dried to the normal moisture environment at the building's location. If it is too dry, then the structure will absorb moisture and swell. Likewise, if there is too much moisture, it can dry out

and crack. In either case, there would be structural issues. Since mass timber is manufactured in a plant, its moisture content should be able to be managed sufficiently to avoid these structural issues.

Wood does have a strength problem. It is lighter than steel and concrete, which means fewer piles are needed to support a foundation, or the concrete slab it is built on can be thinner, but the challenge becomes as the structure gets taller. Steel with concrete coatings adds strength to the structure, which does not happen with wood. Since tall buildings must be able to sway to compensate for wind and earth movements, a building that sways too much or too fast will make its residents or office workers seasick from the motion. Therefore, wooden structures must take stiffening measures to reduce the potential swaying from the lighter material. This is more of an engineering issue and not a safety issue.

Another drawback to wood construction is that it is a resonant material. This requires adding sound-deadening material to the walls to dampen the sound-transmission quality of wood. Again, an easily addressed issue, but the additional cost will offset some of the savings from the speed of wood construction compared to building with steel and concrete.

While key construction materials are changing to adjust to a decarbonized world, there are other interesting emissions reduction trends emerging in residential and commercial construction markets. The trends were described as “the carbon conundrum” in a recent Financial Times article, which discussed new home construction versus renovation from the viewpoint of climate change. The debate centers on the focus of most home buyers interested only in the operational carbon emissions of their new home rather than the embodied carbon in the materials used for its construction. This can make renovating an older home that uses fewer new materials the more environmentally friendly choice.

The FT article detailed the purchase and renovation of a home rather than the expected teardown and rebuild. Catherine Ramsden, who runs an architecture and design practice, purchased a “well-appointed 1960s family home in the countryside near Surrey’s Box Hill,” that she then preceded to renovate as opposed to the widely expected tear down and rebuild. By converting the garage into living space, she expanded the livable area by a third to 294 square meters (3,165 square feet). She estimates the $CO_2$ savings compared to building a new home of that size was 86 tons or 21 years’ worth of emissions from running the average U.K. home based on data from the government’s Climate Change Committee (CCC).

According to architects, engineers, and sustainability consultants the FT talked with, customers are fixated on the carbon emissions generated by operating their homes while ignoring those created by construction. Cador Pricejones of Byggmeister, a Boston-based design and building company that specializes in remodeling and retrofitting existing homes, told the FT, *“I would love to say that embedded carbon is why people are coming through our door, but I can’t. What is motivating most of them is to get off natural gas and electrify their homes.”* The problem, as the FT article pointed out, is that *“the emissions generated by construction materials are already released into the atmosphere, whereas those saved incrementally by using a heat pump of by improving insulation take decades to accrue.”* That is like the emissions generated from building an electric vehicle versus driving it carbon-free. It takes years of driving to offset the legacy emissions.

The FT wrote:

*"Surveys in the US and Europe indicate that construct-ing a new home pro-duces about 400kg [882 pounds] of $CO_2$ emissions for every square meter. In the UK, the average detached home would create about 60 tons of $CO_2$. That equates to about 15 years' worth of emissions from the average home, using the CCC data, which was calculated in 2014. (With homes' emissions fall-ing since then, however, the length of time at today's levels is likely to be significantly longer.)"*

As often happens with government policies and subsidies, they can be misfocused and thus create disincentives for acting in ways that would have a more positive impact on curbing $CO_2$ emissions. In the U.K., building new earns an exemption from the Value Added Tax (VAT) paid on building materials and services, but not on those materials used for remodeling. Last year, the tax was revamped to allow VAT exemptions on certain energy-saving home improvements.

In the U.K., the City of London and the City of Westminster require an embodied carbon assessment for all major developments. But the announcement by retailer Marks and Spencer of plans to demolish and rebuild its flagship store on Oxford Street has created an outburst over the decision. The controversy is both about the embodied carbon but also the destruction of the classical architectural features of the existing building. The governments are being pressured to create binding standards for embodied emissions to help guide the renovation versus new construction decision.

We found a comment attributed to an engineer about energy efficiency in the FT article interesting. *"'When it comes to energy efficiency [on appliances], everything is labelled,'* says Jesus Menendez, an engineer working in Manchester and Spain. *'Why not put a label on [showing] the carbon that was used to make it? I just don't think people are aware of what is available.'"*

Since we believe education is the best way to motivate the public to change their consumption patterns, why not label appliances and even electric vehicles with the data about the carbon emissions generated when they are being made? The labels could show both the emissions created and those avoided by their use. If we are so concerned about stopping putting more carbon emissions into the atmosphere, we suspect people would be surprised to see how much is released when products are made versus how long it may take in using them to offset those legacy emissions. People will likely be quite surprised by what they learn. Maybe consumption patterns will change, but maybe they will change in the wrong direction as consumers weigh the cost/benefit of purchase and construction decisions.

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