Chapter 21 – Energy in Commercial Buildings

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The Commons, The Worst of the Worst, Wouldn't it Be Nice? And Then There's the Water, How Much Should I Eat? References

The Commons

The next biggest consumer of energy in the U.S., after residential energy and transportation, is commercial building energy use. Commercial buildings are basically every type of building that isn't a residence or factory. Anything from a store to a school to a hospital to a restaurant to a grocery store to a football stadium to office buildings to government and municipal buildings to data centers falls into this hugely varied and widespread category. This category, unlike food, residential energy and transportation, isn't directly driven by personal decisions, but rather by owners and managers of commercial buildings. Table 1 shows the same general breakdown for commercial buildings from Table 5 in Chapter 16. The quantities of CO_2 emissions from this building category is similar to residential, just a little lower, and the principles of reducing emissions through reducing energy are similar. The main difference is that each of us can make a difference in the residential emissions with our daily choices of how we use energy, while commercial buildings are largely dependent on decisions that each of us may have little direct control over. However, with commercial facilities, there are ways that individual choices, community action and government regulations can help.

Table 1 - Breakdown of U.S. Commercial Energy - 2020

Priority	Description	CO_2e, million metric tonnes/year (mmt/year) - 2020							Percent of Gross*
		Non-Combustion Emissions	Electricity	Stationary Combustion	Transportation, Non-Freight	Land	Transportation to Point of Use or Sale	Total	
5	Commercial Facilities	129	485	326	10	43	0.01	992	13.6
9	Water and Wastewater Treatment	60	33	5.7	1.9	2.2	0.96	103	1.4
Total		189	518	332	11.9	45	0.97	1,095	15.0

**Gross CO_2e emissions in the U.S. in 2020 was 7286 mmt.*

Residential buildings use more electricity and less natural gas, propane and other combustion fuels compared to commercial buildings, and non-combustion emissions from the commercial sector is significantly higher than for residential buildings. The difference in non-combustion emissions is due to the commercial refrigeration, as well as the wastewater treatment plants and landfills that emit methane, which fall under the commercial sector.[1]

Water and wastewater treatment plants are technically part of the commercial building sector, making up about 10% of it. I have broken it out from the general commercial sector in Table 1, because

they are significantly different from typical buildings, although it can easily be argued that there really is no "typical" commercial building, since they all have widely varying functions. By breaking out the water facilities, we can see the contribution of our water usage in terms of CO_2e emissions, in addition to the issues concerning water treatment and quality and its importance to the environment, humans and wildlife, as discussed in Chapters 13 and 14. All-in, water treatment facilities account for 1.4% of our carbon emissions in the U.S., and, is one type of commercial facility that we can impact with our personal daily choices, because we can choose how much water we use, as one example.

A breakdown in commercial facility emissions is shown in Table 2, with total carbon followed by percent of gross emissions in parentheses. The carbon emissions are shown as total carbon emitted in the U.S., rather than carbon footprint per capita, since these are all common facilities that are used by everyone, and the percentages are the same either way.

Table 2 – Commercial Facilities - Carbon Emissions, CO_2e, mmt/year, (% of Gross), U.S., 2020*

Category	Non-Combustion Emissions	Electricity	Combustion	Transp. On-Site	Land	Transp. Off Site	Total
Electricity	15.0	485	10.5	9.65	7.22	0.0084	528 (7.2%)
Natural Gas	0	0	315	0	0.067	0	315 (4.3%)
Leaks, Non-Combusted CO2, Land	114	0	0	0	35.3	0	149 (2.0%)
Total	129	485	326	9.65	42.6	0.0084	992 (13.6%)

** Gross Emissions in U.S. in 2020 was 7286 mmt of CO_2*

The electricity for commercial facilities is the same mix of fossil fuels and renewables from the grid that is shown in Figure 1 of Chapter 19 for residential buildings.

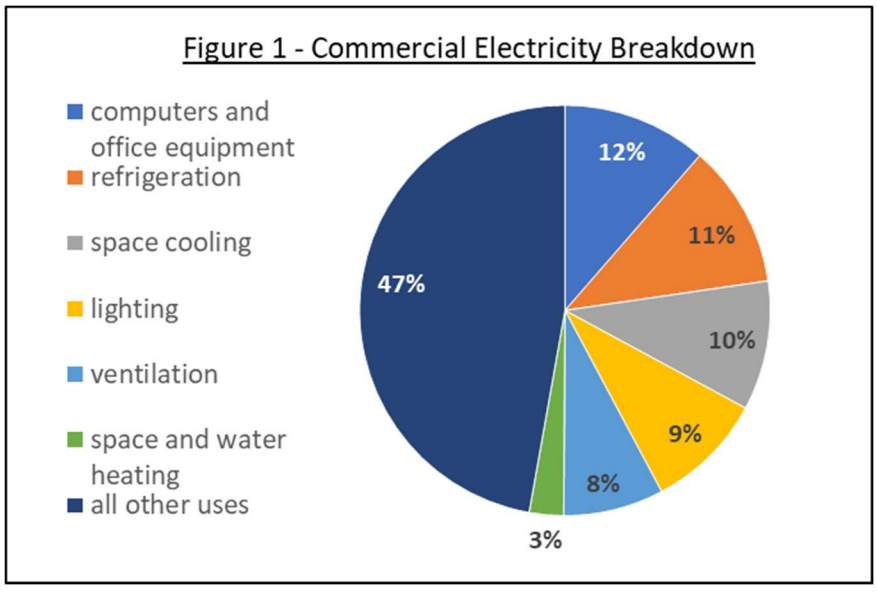

Figure 1 in this chapter shows a breakdown of electricity usage for commercial buildings. The largest piece of the pie is the "all other uses", which reflect the variety of electrical equipment that can be found in different facility types, such as hospitals, with diagnostic equipment like X-Ray machines, Ultra-sound and CAT scanners, or airports with extensive conveyance systems. Warehouses, which also fall within the commercial sector, are likely to have conveyance equipment as well as forklifts. Restaurants will use electricity for cooking, big office buildings and hotels will have transformers, elevators, escalators, laundry machines, computers and coffee brewers. You get the idea.

Similar to residential buildings, commercial buildings use natural gas mainly to heat buildings and water, and restaurants use it for cooking.

When it comes to personal choices, many commercial facilities, such as stores, hotels and restaurants, have standards for environmental responsibility, and consumers can choose more responsible venues over less responsible ones. We can choose stores, restaurants and hotels that donate leftover food to local food banks. We can choose hotels with transparent sustainability standards that are proudly displayed on their website, and restaurants that serve food on washable dishes and cloth napkins, and no Styrofoam for take-out or single-use packets for condiments. Venues with LED lighting that uses motion sensors in the halls, and hotels with key cards that turn off all the lights, air conditioner and heater when the guest leaves the room. Low-flow shower heads are another energy and water-saving alternative for responsible hotels. Many hotels have switched to dispensers for soap and shampoo in the bathrooms. Other responsible policies can include native landscaping, paperless registration and check-out, use of recycled paper with double-sided copying, and signs encouraging guests to re-use their sheets and towels. A strong recycling program that includes everything that can't be avoided, including printer cartridges, is yet another thing to look for.

The Worst of the Worst

Data centers are a steadily increasing demand on electricity and water, and are an example of emissions that individuals impact daily, similar to water, that doesn't show up on residential metrics directly. When we use the internet, it may feel like magic, but it's not. There's a file server in a data center cranking away somewhere every time we query, stream, game or send an e-mail. And it's not trivial. In 2020, data centers in the U.S. consumed 73 billion kWh of electricity, emitting 29 mmt of CO_2e,[2] which works out to about 0.4% of our gross emissions. The data centers also consumed 136 billion gallons of water.

Naturally, big corp is never satisfied, so now they're constantly throwing things at us in order to increase our usage of the cloud, basically to continue growing profits, driven by greed. On my own laptop, I'm constantly beating back offers for apps that I want no part of, games (even though I don't game) and they even had the balls to send me a review form for a local restaurant that I happened to walk past as I was hiking up the Clear Creek bike path. And I didn't even go in there. So now big brother is watching my every move, hoping to somehow squeeze money from me and profit from my actions while spewing unnecessary carbon emissions stalking and pestering me and haranguing me simply because I exist. That happened twice, and I was about ready to completely turn my phone off, which I may yet do.

And, when I buy something I need off the internet (remember I won't take the easy road to Home Depot because they sell poisons that are used to kill wildlife) the vender somehow thinks that means I want everything else they sell too. I just replaced a cover for an outdoor grill that finally completely fell into pieces after about 20 years of weathering Colorado winter storms, from an online source that WASN'T Home Depot, from "Covers and All", and they immediately started flinging marketing e-mails at me. Like I want many more covers now that I finally found THEM. I

mean, WTF? No, in 20 years I might need a new one. I just have the one grill. And every other vender with similar product thinks I'm suddenly a great candidate too. Throwing stuff at me by email that I don't need or want and never will. All the while churning away on those file servers. It's absurd. So then I have to churn right back at them by unsubscribing to make it stop, yet another waste of my time, just because I bought a stupid grill cover.

By the way, every single time I buy something, there's always a check box at the bottom of the shopping cart that gives them permission to pester me at every turn for the rest of my life, and I always uncheck it. And, as often as not, it gets ignored and I get pestered anyway. And it's on me to make it stop. Now how much hogwash is that? Sadly, going through the unsubscribe process is the most responsible thing to do, because if you just push the "junk" button to spam it out, the e-mail still comes in, but it goes to your junk mail box, so no energy is saved unless you actually stop it from being mailed by unsubscribing.

It turns out that when we query on Google, which is how I researched a lot of this book, matters. And even though a file server is cranking away somewhere, pulling the carbon emissions information from the EPA website, for example, is much better than the way I would have done it 20 years ago, which would have been by ordering a copy of the 800 page annual report. The comparison below shows that Chat searches consume about 10 times the energy of a plain old Google search, and AI consumes 30 times as much.

- Google Search: 0.3 – 0.5 Wh (watt-hour)
- Chat GPT: 3 Wh
- Artificial Intelligence (AI): 9 Wh

And now, even with this reality, big corp has taken it to a whole new level, adding AI to all my programs, including Word, where it offers to write for me, as though I can't do that for myself, sitting in the way of my work on Xcel, offering to do my graphs for me, as though I can't do them myself, and on Power Point, offering to design my slides. It's even offering to summarize pdf documents, as though I'm not capable of reading and understanding a document. And, worst of all, it shoved AI in my face as the default search platform in a recent upgrade of my laptop, even though I was perfectly happy with Google. Since I know that AI uses 30 times as much energy as a basic query, I was furious when that happened, and immediately tried to get rid of it, but the "help" (that didn't help at all) said that it was not possible to turn it off. I finally read in a news article that I can stop it by following my query with "-ai". I wonder how many users will somehow find out about that little secret tip, and then actually bother to do it every time? Does it feel like they're trying to dumb us down on purpose? It does to me. And, I shudder as I wonder what they'll think of next. All this pressure on the consumer to satisfy the endless greed of the data center owners while increasing energy consumption unnecessarily.

Wouldn't It Be Nice?

The utility that supplies our electricity in the Colorado front range is trying to figure out how to get funding to provide for a growth of 20% of electricity in the next few years, mainly driven by data centers. You have to be kidding me. Data centers? At a time when we should be reducing our electricity? My input on that particular issue is similar to many other renewable energy activists. New construction of that magnitude should be required to provide their own power, and it should be required to be renewable. Simple end of story. It will be interesting to see what happens with that. Given the general history of greedy rich corporations driving important political decisions that are currently trashing our planet, the rate payers will probably eat the costs through their electricity bills as our electricity emissions from fossil fuels continues to increase. Which I guess isn't too unfair, if they're spending copious amounts of time on the internet, and using AI.

The idea of incorporating renewable energy into all new construction isn't really new. The National Renewable Energy Laboratory (NREL) here in Golden estimates that rooftop siting of solar panels could provide about 40% of current electrical demand. This would be even higher if solar panels were also installed over parking lots that are already occupied, and the cost wouldn't be more than 5 – 10% of the building cost for new construction. Obviously, once installed, the building would be energy-independent, with no utility bills, so the added cost would pay out fairly quickly, in just 5 – 10 years for commercial buildings.[3]

Given that commercial facilities are about half of our electricity, this direction would reduce U.S. electricity by 50% by definition in the next 30 years, assuming the number of facility square footage doesn't change, and new buildings replace obsolete ones. Obviously, this is only possible if we stop growing our population. The energy is more efficient when it's generated locally, because there are no transmission lines, and the building is less likely to lose power in a storm. As individual citizens, our role is to insist on these kinds of actions for commercial and industrial facilities going forward. As discussed in Chapter 19, numerous cities and towns are pushing for change in this very positive direction. For my part, I'm fighting against additional data centers in Colorado that draw from the grid. They should be required to be powered with their own renewables. And, in a dry state like ours, they should also be required to figure out their water without demanding any more, because we don't have enough as it is.

And Then There's the Water

It was already shown in Chapter 16 that water and wastewater treatment plants comprise 1.4% of gross carbon emissions in this country. Table 3 shows a detailed breakdown of these emissions.

Table 3 - Carbon Emissions of Water and Wastewater Treatment Plants, mmt CO_2e/year (% of Gross), U.S., 2020*

Category	Non-Combustion Emissions	Electricity	Combustion	Transp. On-Site	Land	Transp. Off Site	Total
Electricity	0.78	23.8	0.54	0.50	0.37	0	26 (0.36%)
Natural Gas	0	0	0.93	0	0.0002	0	0.93 (0.01%

Land and Treatment Plant	47.7				0.24	0.43	48 (0.66%)
Treatment Chemicals	11.0	8.79	4.21	1.41	1.58	0.52	27.5 (0.38%)
Total	60	33	5.7	1.9	2.2	0.96	103 (1.4%)

** Gross Emissions in U.S. in 2020 was 7286 mmt of CO_2*

As with the other deep dives in this book, the emissions include all components of each category. The electricity includes all the raw fuels to generate it, as well as mining energy, transportation and transmission, as well as manufacturing of renewable energy equipment and components. The natural gas includes the energy for pipeline transmission as well as the energy to produce the gas. The land includes the actual land that the treatment plants require, as well as the estimated 1.5% of landfill space for sludge,[4] its anaerobic decomposition in landfills, and the transportation of dewatered sludge to either landfills or composting facilities, as well as the aerobic decomposition of the sludge in composting facilities.

Since my core discipline is chemistry and chemical engineering, I had a blast diving into all the chemicals that are used in water and wastewater treatment facilities. I probably missed a few, but included all the ones I could think of, including the ferric chloride and the caustic soda and the methanol and the potassium permanganate and the aluminum sulfate and the polymer and the magnesium hydroxide and the lime and the calcium hydroxide and of course don't forget the chlorine.

Construction of the treatment plants themselves aren't included, since I chose to leave all construction under the same category, along with power plants, roads, residences, commercial buildings and factories, basically to make the point of how massive our construction really is. However, in the case of wastewater plants with tertiary treatment systems designed to remove all the super nasty non-traditional pollutants and petrochemical dyes and fragrances and silicones and such, additional replaceable filtrations units for microfiltration systems and reverse osmosis, are probably involved. Also, both water and wastewater treatment plants use massive amounts of sand, gravel, carbon and other filtration media that regularly gets replaced or at least supplemented after the original construction. In a word, the total carbon emissions for water plants in Table 3 is likely a tad on the low side, but not by much.

How Much Should I Eat?

At the end of the day, commercial energy is something that hits everybody's carbon footprint in the U.S., sort of like construction. So, do all of us eat our share on our CO_2e emissions metrics? It's a valid point, because even though as individuals we don't have much say in how energy is used in commercial buildings, whether it's used responsibly, whether the building is a Leadership in Energy and Environmental Design (LEEDS)[5] compliant building or a drafty old building owned by a slum lord with no insulation in the walls. As consumers, we can at least pick and choose who to do business with, and stay away from obvious losers, hoping that by not giving them our dollars, if enough of us say away they'll

eventually go out of business and somebody more responsible will take over. And, as mentioned earlier, each of us can insist that new construction, including commercial facilities, meet sustainable building standards and provide their own power supply as part of the construction. That should be a no-brainer that would certainly turn things around on our planet if it takes hold.

Still. For my part, I'm going to take a few reductions in commercial energy. For one thing, at our house we use about a third of the average water per consumer in our home, because of our minimal water usage practices, described in Chapter 13. Since water and wastewater are 1.4% of our gross emissions, I'm comfortable accepting responsibility for 0.4% of that, for a reduction of 1%. Also, as in construction, we only replaced ourselves and haven't contributed to the population growth that has led to the number of commercial buildings that we have now. In the past 40 years, since we had our kids, population has increased by 41.9%, while commercial building carbon emissions has increased by 16.6%, presumably due to more efficient energy usage in commercial buildings. I think it's fair to reduce our emissions per capita in the commercial sector by 16%, which works out to 2.2% of gross emissions. Honestly, I could probably be comfortable reducing my part of this by even more, because if our population hadn't grown by 41.9% in the past 40 years, with the improvement in building energy efficiency, the commercial sector would be emitting about 25% less CO_2e instead of 16.6% more. This is an example of how our population growth is washing out our efficiency increases. Think about that.

Basically, I think it's fair to reduce our CO_2e emissions for commercial buildings by 1% for water and wastewater treatment, and 3% to account for population increase that we have chosen not to be a part of. This is a total of 4% reduction in carbon emissions per capita for commercial facilities, which increases our reductions up through residential energy and personal transportation emissions in Chapters 19 and 20 from 47.9% to 51.9% against that looming goal of 80% reduction by 2050. Wow! Look at us breaking 50%! Is this goal seeming more doable as we go along? I'm beginning to think so. As long as enough of us do it.