Carbon Drawdown Now! Building to Combat the Climate Crisis

Supplemental Q&A

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Top 5:

1. Do you have any recommendations on the best way to educate the construction industry and building officials about the importance and practice of carbon-storage building?

   A: This will require a multi-faceted approach depending on the individuals we need to educate. It requires us to understand what are the primary motivations and concerns of those we are engaging, and trying to address those concerns in our approach. For example, building code officials care greatly about safety, so taking an angle that material changes are safe, predictable, and fit comfortably within governing codes will go a long ways. Energy code officials and policy-makers, however, may care much more about environmental/climate impact, in which case explaining the importance of considering material climate impact will align with the goals already established for energy codes. Many industry groups are very concerned about first-cost and economic impacts; accordingly, arguments there should be centered around feasibility of integrating more standard materials, simpler steps that make larger impacts, and the potential for market value in "greener" products for those who have a niche there. An associated angle is for those who respond more to healthy homes and owner exposure to toxicity; arguments towards low-carbon materials can be focused on low-toxic materials that also have low embodied carbon emissions, and leverage those stacked benefits (a similar angle can be leveraged for clients with a preference for a "natural" aesthetic or design motif). Further, showing the volume of data and research out there, available in places such as the Carbon Leadership Forum (http://www.carbonleadershipforum.org/) and Architecture 2030 (https://architecture2030.org/), will greatly legitimize the rigor and authenticity behind the argument.

2. Are there any disadvantages to using these alternative low-carbon materials, (i.e. cost, structural integrity, longevity)? Specifically, can larger buildings with loads of cement, steel, and concrete replace these materials with cleaner materials without compromising structural integrity? Are there case studies showing this?

   A: It really depends on the material. Wood is a low-carbon material, especially in comparison to steel, for example; heavy timber can perform better than steel in fire exposure in many cases, and can be finished with lower toxicity finishes which is relevant for both worker health and occupant health when exposed. Concrete formulated with lower Portland cement content can be as strong or stronger, at cost,

using a variety of techniques. I strongly encourage conversations comparing "cost" to also compare "value", not just in ecological impact, but also potential benefits in toxicity, durability, etc. I believe bio-based materials can be more durable than petro-chemical-based materials in many scenarios (e.g. above-grade insulation with appropriate moisture management strategies), and worse in others (e.g. below-grade). We can install cellulose insulation less expensively than spray foam, in many cases. There are just so many different materials in so many categories that qualify as low-carbon that we can't generalize their advantages or disadvantages beyond their qualifications as being better for the climate. Carbon Leadership Forum (http://www.carbonleadershipforum.org/) is a great resource for case studies and published resources, as well as a resource directory for other organizations with published case studies.

3. What is the best way to calculate CO_2e in a project? And then put this in context with operational emissions?

   A: There's no one best way to calculate embodied carbon (eCO2e), it really depends on what question you are trying to answer. If you are in design and you want know how your design choices are impacting the building's eCO2e, you'd want to use a Life Cycle Assessment (LCA) design tool, such as Athena Impact Estimator (https://calculatelca.com/software/impact-estimator/), Tally (https://choosetally.com/), or One Click (https://www.oneclicklca.com/), among others. These tools will give you industry-average information. If you are trying to select the lowest carbon product during procurement or get very specific about the impact based on actual products you've used, a tool like EC3 (https://www.buildingtransparency.org/en/) is the right one to use; it is built off of Environmental Product Declaration (EPD) publications (https://www.environdec.com/) that can get very product-specific. Builders for Climate Action (https://www.buildersforclimateaction.org/) will be releasing a simplified tool that is industry-average in scope but also built off of EPDs, if a simpler and easier tool is what's appropriate for your practice; look for the release of this in May. There are also LCA databases, such as the Inventory of Carbon and Energy (https://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html) amongst others, that can be a good resource, however it will require more effort on your part to convert these values to the material quantities in your project, and the data sets may not be as relevant to your circumstances (ICE is a UK-based database, for example). You can also do direct material comparison using product EPDs as more manufacturers are releasing EPDs, however this can also be challenging to get the units correct for comparison, and avoid "apples-to-oranges" comparisons across products in different categories that may not be directly comparable. There are also calculators specifically designed for engineers (Beacon - https://core-studio.gitbook.io/beacon/), for concrete (Climate Earth - https://www.climateearth.com/), and other more focused scopes and audiences.

4. Are low-carbon materials, like cellulose for insulation, all byproducts or are some being grown for use as building materials specifically? If it's the latter, what is the impact of using land to grow these materials?

A: To our knowledge, at this point no one is growing agricultural or forest products with a primary use for insulation. Cellulose is almost entirely post-industrial or post-consumer recycled paper (and in some cases, cardboard), and is providing a market for the recycling industry. All ag-fiber materials (primarily straw or hemp) are by-products or waste products from primary food or fiber crops. Wood fiber (board or loose fill) are similar by-products from the timber industry. Cork insulation mostly piggybacks off primary markets for bottles or industrial processes. To incorporate bio-based materials successfully into our building product supply chain, we must ensure that we attend to impacts of land use as we work to meet market demand; our goal is that this market demand can support regenerative agricultural and silvicultural practices, and this is why material substitutions cannot simply replace one extractive model without managing the relationships all the way back to the soil.

5. How can students and non-professionals get involved in the carbon drawdown movement?

   A: Follow your interest! If you are a student, seek out educational opportunities that include climate impact as part of their scope within the curriculum, there are many fantastic sustainability-focused programs in nearly every sector of professional education. If you are a consumer, highlight climate impact as an important decision-making criteria, and reward professionals, vendors, and manufacturers who share your values with your business. If you are a concerned citizen, get involved with the myriad citizens action efforts available to you, from your town or city's Energy Committee, to following and engaging in policies relating to climate impact, to joining non-profit efforts led by groups such as 350.org (https://350.org/) or your regional PIRG (https://uspirg.org/). And of course, Project Drawdown (https://drawdown.org/) will point you towards the dozens of different critical impact categories and provide resources for how to get engaged.

Clarifications:

1. Who was the person who initiated the study on high UEC, typical, best conventional, best? Is there a report or summary of this research that we can look at?

   A: This analysis was the basis of Chris Magwood's recent Master's thesis, "Opportunities for Carbon Dioxide Removal and Storage in Building Materials" (https://www.chrismagwood.ca/uploads/1/5/9/3/15931000/magwood_opportunities_for_co2_capture_and_storage_in_building_materials_copy.pdf). A white paper was published by Magwood through his organization Builders for Climate Action, which is a great visualized summary of this work (https://www.buildersforclimateaction.org/whitepaper1.html).

2. Does embodied carbon include the full life cycle (use, end-of-life)?

   A: There are different definitions of embodied carbon. The most comprehensive definition does include the full life cycle, through end-of-life; this is what is

reported through Life Cycle Assessment (LCA) tools. We use the term “Up-front Embodied Carbon” (UEC) to distinguish our focus on the pre-operational phase of the life cycle – cradle-to-gate or cradle-to-site – that we use for our analysis when looking at carbon impact within a shorter time frame.

3. Is the process referred to “Carbon Capture Storage (CCS)”?

   A: CCS (http://www.ccsassociation.org/what-is-ccs/) traditionally refers to the capture of carbon from industrial processes (specifically fossil fuel combustion for electricity or industry) and storage in stable environments, most frequently underground but occasionally in other forms such as injection into concrete or other materials. There may be some cross-over with our approach, which is to support photosynthetic capture of CO2 from the atmosphere into biomass for incorporation into building materials while supporting manufacturing practices that preserve soil and ecosystem vitality, but the fields are generally separate.

4. For building materials categorized as negative carbon, is that gauged only over now thru 2050? I.e., organic materials with stored carbon would presumably be less negative the longer they are in use, if they do not mitigate carbon use completely. Insulation that may not be as high in R value would be a good example.

   A: The stored carbon value of the material does not change over time. The beauty of focusing on biogenic materials is all of the carbon in those materials has already been pulled from the atmosphere by the time we use them (as opposed to “offset” strategies that rely on planting trees and a decades-long growth timeframe to balance out the emissions). That carbon stays in place fixed in the material until/unless that material is burned or decomposed at the end of the building’s lifespan. We have chosen 2050 as the boundary of our analysis, because of the IPCC’s mandate that we must completely decarbonize our industry by that time. We are shifting that timeframe to 2030 now as we learn more about how quickly we must act. The stored carbon does not change over time, it is fixed at the pre-occupation phase of the life cycle. The operational emissions, however, do accumulate over time as the building continues to consume energy for its operations; insulation is related to this as its use influences energy consumption and related emissions, but those are two different categories of emissions, distinct in their relationship to time.

5. Why do you assume natural gas heating on the Boston, MA table?

   A: Many – perhaps most? – buildings in our study’s building typology in Boston are on the natural gas pipeline. This heating fuel seemed more relevant than coal, electricity, or #2 fuel oil when generalizing for our study. In a more rural region, propane or #2 fuel oil may be more appropriate.

6. 36 million tons = number of coal plants, is that annual emissions from those plants or lifetime emissions of those plants?

A: Annual emissions. For every year's worth of new construction, that same number of coal plants' annual emissions would be added or replaced, depending on the material choices.

7. The slide that shows 28% of a building's atmospheric CO2 emissions is from operation, is that lifetime, and what is the EUI and life?

   A: As this chart is looking at global emissions on an annual basis, my understanding is that the operational emissions are on an annual basis as well. The source of this graph is the "2018 Global Status Report" by the Global Alliance for Buildings and Construction, as referenced from Architecture 2030 (https://architecture2030.org/buildings_problem_why/), for more information.

8. What is the methodology behind the carbon scores assigned to materials?

   A: The primary data source is from EPDs (https://www.environdec.com/) released by North American industry averages. Where these were not available, we averaged North American products to ascertain an average for the product category. Where North American data wasn't available, we used European data. Where formal EPDs were not available, we used published LCA reports, or LCA databases such as the Inventory for Carbon and Energy (https://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html). We followed industry best practices for EPD analysis, as referenced by Carbon Leadership Forum (http://www.carbonleadershipforum.org/) and others.

9. Please provide the name or web site of the builders' collaborative that Jacob mentioned at the end.

   A: Builders for Climate Action (https://www.buildersforclimateaction.org).

Materials

10. Is there a website or other source that provides a comprehensive list of low-carbon/carbon-storing materials, information about these materials, where we can source them, and which organizations are already building with them?

    A: Unfortunately, no. We recommend referencing the white paper released by Builders for Climate Action (https://www.buildersforclimateaction.org/whitepaper1.html) and note the materials used in each of the building material scenarios for a quick reference. Architecture 2030 has published a Carbon Smart Materials Palette (https://materialspalette.org/) that gives some general guidelines on favored materials. The Renewable Materials Focus Group in the Embodied Carbon Network (http://embodiedcarbonnetwork.org/) is actively working on compiling a materials list that will be available soon. There are healthy materials databases, such as the Pharos Project (https://pharosproject.net/) that have a lot of cross-

over, but are more focused on toxicity and are not specifically a low-carbon material database.

a. Specifically, is there a list of simple substitutions that the mainstream building industry won't even notice (shh! Don't tell them it stores carbon)?

   A: Not a formal list, but some common rules of thumb can help you select. Use plant-based materials whenever possible. Reduce the use of metals and Portland cement. Cellulose insulation is preferable above-grade than spray foam. Wood fiber board is preferable above-grade than mineral or foam board. Wood siding is preferable to cement-composite. We look forward to seeing more comprehensive resources available as the industry continues to embrace this approach to material selection.

b. Can you give us concrete (pun intended) examples of "invisible" changes we can make in building specifications to improve building carbon storage?

   A: In addition to those mentioned above, concrete provides lots of opportunities for reducing carbon emissions through better specification development; check out the first low-carbon code in the U.S., specific to concrete carbon emissions, published by Marin County, CA: https://www.marincounty.org/depts/cd/divisions/sustainability/low-carbon-concrete-project

11. Is there a list of high carbon materials (similar to the red list) that we can target for immediate elimination in our projects? What are the top-5 worst products to use?

    A: Check out the slides in our presentation and BCA's white paper (https://www.buildersforclimateaction.org/whitepaper1.html), and reference the building case representing the highest-emission materials. I'm reluctant to prescribe a simplified list of what to avoid – it really depends on the product category, the type of building, and the part of the building. In low-rise construction with minimal concrete/structural materials and lots of above-grade insulation, closed-cell HFC-based spray foam is likely to be a big offender in the building, however that material may be a critical tool in a retrofit. In a big building, structural materials as a category are likely to be much more of an impact, and the strategy may be to avoid the use of steel (especially 100% virgin steel produced in coal-fired plants), or reduce the concrete emissions through design reductions or re-formulation.

12. Is there a .org resource with impartial information regarding the environmental impact (toxicity, impact of production, resource extraction, etc.) of a given material?

    A: EPDs (and accordingly, the design tools and databases that reference them) are great resources, as they are completed and/or reviewed by third-party organizations to ISO (internationally-recognized) standards. This applies to any

Life Cycle Assessment (LCA) process that follows ISO standards, so accordingly LCA tools will also provide this information.

13. Let's get on the concrete already! Can we make a network/list to identify what concrete is better, what to ask for and who provides it now?

    A: There is a lot being done already; I'd start with the National Ready Mixed Concrete Association's Sustainability program (https://www.nrmca.org/sustainability/index.asp) to see what's being done on an industry level. Companies such as CarbonCure (https://www.carboncure.com/) are examples of other approaches towards pre-cast and ready-mix low-carbon concrete solutions. Also, check out the first low-carbon code in the U.S., specific to concrete carbon emissions, published by Marin County, CA: https://www.marincounty.org/depts/cd/divisions/sustainability/low-carbon-concrete-project

14. Are there any North East manufacturers of wood product insulation?

    A: Yes; MSL (http://www.mslfibre.com/) is a Canadian company manufacturing wood fiberboard products. GO Lab (https://golab.us/) is a manufacturer in Maine that is under development now and will soon have product available to market (we hope!).

15. How does wood fiber board compare to Gutex? Or is it virtually the same?

    A: Gutex is one of a number of different wood fiberboard manufacturers; Steico (https://www.steico.com/en/products/wood-fibre-insulation/) is another, as well as others mentioned above. Wood fiberboard is a broad product category with multiple different types of products that are manufactured in a couple of different ways.

Making the Argument

16. Are there additional costs associated with carbon-storing materials versus the more commonly used insulation materials during the construction phase? Is lowering embodied carbon in buildings a significant investment? Is there a way to estimate the financial costs (by region) of building with low-carbon materials?

    A: There is a wide variation in cost based on different materials in different markets. For us, it's cheaper to blow cellulose than spray foam; for others, quite the opposite. In many ways, it can be cheaper (e.g. not over engineering foundations and reducing concrete consumption), or costs can be negligible (e.g. wood fiberboard replacement for foam board where insulation is a relatively small part of the overall costs, or replacing cement cladding with cedar). The challenge – and the beauty – is that low-carbon building is a constellation of strategies that include not just material substitutions, but design techniques and engineering strategies; therefore, project cost and embodied carbon emissions do not track directly, and vary as widely as the materials and strategies employed in the design and construction of the building. We strongly encourage a systems-based

approach to the climate impact of buildings to optimize both emissions reduction, carbon storage, building performance, and cost alignment.

17. The biggest issue we run into is having to justify these fundamental changes in our construction approach. This probably leads right back to the discussion of the need for culture change. Aside from doing a full-blown embodied carbon study (we are actually doing a hotspot embodied carbon analysis as a start), **how do we go about creating a cogent, easy-to-digest argument for our colleagues?**

    A: Yes, it is cultural change. And yes, we have to start somewhere. For those willing to learn and read, BCA's white paper (https://www.buildersforclimateaction.org/whitepaper1.html) is a great resource targeting builders. For those who will never care about carbon, pivot to what motivates them. Healthy homes are a big motivator for builders whose clientele really care about health and safety of their homes; dovetail that with material choices that are also low-carbon (the weatherization industry has been doing that as a strategy to encourage building performance for decades). For those who really don't care and will not be motivated by anything other than ease or first-cost and are not responding to any market demand or pressure, that's where you may want to focus on industry trade groups or regional regulatory authorities to move the industry that way – peer influence or regulatory mandate. It comes down to understanding what is going to motivate decision-making for that builder, and find the argument that aligns with that motivation.

18. Is there a collection of case studies (including costs) of buildings that use low-carbon materials?

    A: The Carbon Leadership Forum (http://www.carbonleadershipforum.org/) is the best information resource portal for research and studies, as well as links to other resources.