United States House of Representatives
Select Committee on the Climate Crisis

Hearing on October 17, 2019
"Solving the Climate Crisis: Cleaner, Stronger Buildings"

Questions for the Record

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<u>The Honorable Kathy Castor</u>

1. **Why are some of your clients, like hospitals, airports, and universities, opting for electric space and water heating? What are some of the benefits they have experienced? What policies do we need to support building electrification?**

Energy efficiency and renewable energy are critical first steps to achieving a low carbon built environment. Another critical element is the **electrification of buildings**. While Renewable Portfolio Standards (RPS) are addressing the combustion of fossil fuels at the utility level, it is important to also address the consumption of fossil fuels on site at the building and central plant. This means replacing fossil fuel-based cooking, water heating, space heating and cooling equipment and co-generation equipment with electric equipment.

In many cases natural gas or coal is used in large central plant facilities serving multiple buildings, particularly at hospitals, airports, universities and other campuses or networks that serve our communities. Eliminating onsite combustion of fossil fuels can have co-benefits such as improved safety, indoor air quality and grid flexibility. When these facilities and campuses convert to all-electric systems, they are more grid flexible (energy can run both ways, depending on time of day pricing), renewable-ready and zero energy-ready. This flexibility and adaptability to alternative energy sources helps them to be more resilient, capable of safely storing energy for emergency scenarios, and better prepared for the future.

Congress can offer incentives, such as tax deductions where applicable, for the replacement of fossil fuel-based equipment in existing facilities, particularly water heaters, furnaces, boilers and space heating/cooling equipment (i.e. heat pumps), or rebates (for non-profit institutions) to buy down the cost premium for first-time installation of electric equipment. Studies indicate regional state-led incentive programs[1] have been successful to date.

Congress can also revisit a Federal law[2] which often precludes state action on efficiency and emissions. In 1975 Congress enacted the National Appliance Energy Conservation Act (NAECA) to set national standards for equipment like heaters, boilers and rooftop air conditioners, but this legislation also disallows states and other jurisdictions from setting more stringent local standards on these products. The

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[1] http://www.aceee.org/sites/default/files/publications/researchreports/a1803.pdf

[2] Federal Preemption as a Barrier to Cost Savings and High-Performance in Local Codes (NBI, 2017)

International Code Council (ICC), the states, and or cities that adopt stretch energy codes, are still strictly limited in how much efficiency they can achieve in the products covered by NAECA. Innovative U.S.-based manufacturing companies could be created by demand for high performance heating and cooling equipment should more stringent state and local requirements be permitted. The performance cap or ceiling created by NAECA suppresses such innovation.

2. **How could all-electric buildings save consumers money upfront and over the lifetime of the buildings? What barriers prevent developers and owners from building electric-only buildings?**

When the local energy grid can support the entirety of building loads (i.e. both heat and power demands), an all-electric building can save the consumer money upfront, offsetting the cost of an electric heat pump by eliminating the costs of gas boilers and natural gas connections. In some cases, the length of connection to a natural gas line is quite long and therefore the savings by eliminating the gas connection are substantial.

In other cases, if there is insufficient capacity in the local grid to handle both power and heating needs, and if the utility forces the developer or consumer to bear the cost of adding an additional transformer, substation or other electric infrastructure, then that cost could pose a barrier to all-electric construction. Other barriers may include cultural or social preferences for cooking with natural gas. If any natural gas infrastructure is provided, even for nominal uses, then the savings for eliminating natural gas aren't realized.

Over the lifespan of the building, an all-electric system has greater capacity for grid flexibility (energy can run both ways, depending on time of day pricing), is renewable-ready and zero energy-ready, is capable of safely storing energy for grid harmonization or emergency scenarios. This can substantially lower a home or building owner's costs to operate over the lifespan of the building.

Natural gas is a finite resource that already utilizes environmentally harmful extraction methods such as fracking. As resources become scarcer the cost for this resource will rise. An all-electric building can be completely powered with renewable energy, which already outpaces coal in states like Texas[3] and the "cost of renewable energy is now falling so fast that it should be a consistently cheaper source of electricity generation than traditional fossil fuels" as early as 2020 according to International Renewable Energy Agency's (IRENA) *Renewable Power Generation Costs in 2017* report. Renewable energy at utility scale already costs less to build and these savings can be passed on to consumers: "Costs for most coal plants ranged between $33–111/MWh. Costs in 2018 for solar were between $28-52/MWh. Wind power costs varied more widely, based on location, coming in at $13-88/MWh, said the coal-cost report."[4]

3. **In your testimony, you mentioned that several cities and states are adopting net zero energy and net zero carbon building codes and goals. You also referenced the Zero Code appendix to the 2021 model energy code currently being developed. What can the Federal government do to incentivize the adoption of net zero building codes and goals?**

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[3] https://www.cnn.com/2019/07/25/us/texas-wind-energy-trnd/index.html
http://www.ercot.com/content/wcm/lists/172485/DemandandEnergy2019.xlsx

[4] https://energyinnovation.org/wp-content/uploads/2019/04/Coal-Cost-Crossover_Energy-Innovation_VCE_FINAL2.pdf

Congress can incentivize states and cities to be early adopters of **Zero Energy** and **Zero Carbon codes** by supporting the staff and permitting infrastructure, public education and engagement programs, annual benchmarking and reporting infrastructure and the development of shared tools and lessons learned.

There are existing models and vehicles for this kind of support. For example, the **American Recovery and Reinvestment Act (Recovery Act) of 2009** provided the State Energy Program (SEP) with $3.1 billion of resources, requiring required states to develop a plan for achieving compliance with codes equal to or greater than the 2009 IECC and ASHRAE Standard 90.1-2007 in at least 90% of new and renovated residential and commercial buildings within eight years (by 2017). The U.S. Department of Energy provided workforce training, code manuals and other tools. While the Recovery Act SEP funding represents an unprecedented level of federal support for energy code implementation, the requirements also called for an extraordinary level of commitment and planning from participating state and local entities. This incentive program is likely a major factor leading 88% of the U.S. to *at least* be on the 2009 energy code or a later edition now. This is a model for a program that could be developed around zero energy or zero carbon codes, providing workforce training, code manuals and other tools to states and local jurisdictions willing to accelerate the adoption of these advanced building standards.

Congress can also direct federal spending through existing programs to focus on zero energy and zero carbon goals, such as the **Building Technologies Office** (BTO), the development and maintenance of free/open source energy modeling tools such as **EnergyPlus** and renewable energy sizing tools such as **PVWatts**, and most importantly, **the Building Energy Codes Program**, which can provide training and technical assistance, assess savings impacts, and administer a help desk specific to model zero energy codes.

Congress can maintain and increase Federal tax incentives for Renewable Energy technologies, including **energy storage**. As more production comes online, the ability to store energy and control how and when it flows onto the grid will be critical to maintaining our infrastructure and energy autonomy.

Congress can also link existing **Federal tax incentives** (or restore lapsed tax incentives) to Zero Energy and Zero Carbon goals. By leveraging existing financial incentives but tying them to Zero Energy or Zero Carbon, Congress not only uses its buying power to reduce carbon emissions in the built environment but also creates a replicable framework that smaller jurisdictions can emulate and normalizes the expectation of performance outcomes.

Examples of existing or recently lapsed tax incentives include:

> The **Low-Income Housing Tax Credit** (LIHTC) gives incentives for the utilization of private equity in the development of affordable housing aimed at low-income Americans. LIHTC accounts for 90% of all affordable rental housing created in the United States today. Congress can incentive zero energy or zero carbon low income housing.
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> The **Federal Historic Preservation Tax Incentives Program** (HTC) provides a 20% Federal tax credit to property owners who undertake a substantial rehabilitation of a historic building in a business or income-producing use while maintaining its historic character. HTC is designed to not only preserve and rehabilitate historic buildings, but to also promote the economic revitalization of older communities in the nation’s cities and towns, along Main Streets, and in rural areas. HTC has leveraged over $162 billion in private investment in historic rehabilitation and generating almost 2.7 million jobs. Congress can incentivize zero energy or zero carbon historic

restoration and preservation projects. In addition to the 20% Historic Preservation credit, Congress can resurrect a lapsed 10% tax credit for the restoration of non-historic buildings. This tax credit should be linked to zero energy and zero carbon renovation projects.

The tax deductions for **commercial buildings** have expired, effective December 31, 2017. The tax deduction of up to $1.80 per square foot was previously available to owners or designers of commercial buildings or systems that saved at least 50% of the heating and cooling energy as compared to ASHRAE Standard 90.1-2007 (or 90.1-2001 for buildings or systems placed in service before January 1, 2018). Partial deductions of up to $.60 per square foot could be taken for measures affecting any one of three building systems: the building envelope, lighting, or heating and cooling systems. Congress could reinstate a commercial building tax deduction for zero-ready, zero energy or zero carbon buildings.

The Federal Energy Policy Act of 2005 established tax credits of up to $2,000 for builders of new energy-efficient **homes**. This tax credit has also expired[5], effective December 31, 2017. Congress could reinstate the tax credit for zero-ready, zero energy or zero carbon homes.

4. **Can you discuss the potential scale of embodied carbon emissions in new construction? What are the emissions and climate benefits of low embodied carbon building materials, such as cross-laminated timber? How can the Federal government help incentivize the use of low carbon materials and encourage other ways to reduce embodied emissions?**

Globally we must phase out fossil fuel CO2 emissions in the built environment by 2050 in order to stay "well below 2 °C – preferably 1.5 °C – warming above pre-industrial levels", but new research from the IPCC, the UN, and the scientific community stresses the critical importance of a 2030 milestone: if we do not achieve a 45-55% reduction in total global emissions by 2030 we will have lost the opportunity to meet the 1.5/2 °C warming threshold and climate change will become irreversible. The immediate focus for embodied carbon reductions must therefore be on the next decade.

Annually, the **embodied carbon of building structure, substructure, and enclosures are responsible for 11% of global GHG emissions** and 28% of global building sector emissions. Eliminating these emissions is key to addressing climate change and meeting Paris Climate Agreement targets.

Under a business as usual scenario, embodied carbon in buildings constructed globally between 2020 and 2050 could exceed 250 gigatons ($GtCO_2$). This is half of the 500 $GtCO_2$ global carbon budget we must stay within to stay within a 2^0 C temperature rise and nearly three quarters of the 340 $GtCO_2$ global carbon budget we must stay within to stay within a 1.5^0 C temperature rise.

Of the 173 billion square meters (1.86 trillion square feet) of new buildings we will construct between 2020 and 2050, approximately 52% of associated carbon emissions (130 $GtCO_2$) in that time frame will be derived from embodied carbon, and 48% of associated carbon emissions (120 $GtCO_2$) will be derived from operating carbon.

Looking more narrowly at the critical window between 2020 and 2030, under a business as usual scenario, approximately 72% of associated carbon emissions in that time frame will be derived from embodied carbon, and 28% of associated carbon emissions will be derived from operating carbon. This is because embodied carbon emissions are 'front loaded' and although they average out over the life span of a building, we are concerned with the 'time value of carbon' when it is particularly critical that we stay under a total 500 $GtCO_2$ carbon limit

[5] https://www.energystar.gov/about/federal_tax_credits/federal_tax_credit_archives/tax_credits_home_builders

Buildings are complex systems. There is no such thing as a wholly concrete building; it requires steel reinforcement. There is no such thing as a wholly steel building; it requires concrete footings and foundations. and there is no such thing as a wholly mass timber building; it requires steel fasteners and concrete footings and foundations. We need all materials in our palette, and we need to decarbonize them all. There are ways to decarbonize concrete, by replacing cement with fly ash or blast furnace slag, or using a carbon sequestration technology such as **Carbon Cure**[6], or using a cement manufactured with a coal replacement product[7] that is processed in an aerobic digestor and that reduces landfill waste. The are ways to select steel products with lower embodied carbon, based on manufacturing location, methods and fuel sources. And there are an increasingly wide variety of mass timber products, such as **cross laminated timber** that are inherently a lower embodied carbon material.

Perhaps even more importantly, over one third of the solutions described in the Paris Accord are described as 'natural climate solutions'. If the construction industry specifies significantly more timber products, it could lead to increased land use for forestry. Much of the cement and steel used in the U.S. is manufactured and milled overseas. But wood products actually are a robust domestic industry and have the potential to grow should the market signal increasing demand.

Historically code barriers, cost premiums and a lack of workforce familiarity or experience with mass timber construction have been barriers to increase specification. Fortunately the 2021 International Building Code (IBC) has removed barriers to 12- and 18- story tall wood buildings (exposed structure, and concealed behind fire proofing, respectively).

Congress can incentivize states and cities to adopt IBC 2021 by supporting the staff and permitting infrastructure, public education and engagement programs, and the development of shared tools and lessons learned.

There are existing models and vehicles for this kind of support. For example, the **American Recovery and Reinvestment Act (Recovery Act) of 2009** provided the State Energy Program (SEP) with $3.1 billion of resources for workforce training, code manuals and other tools. This could be replicated around IBC 2021 with particular emphasis on **Mass Timber** construction.

Congress can also direct federal spending through existing programs to focus on low embodied carbon goals, such as the **Building Technologies Office** (BTO), the development or expansion of free/open source embodied carbon modeling tools, and **the Building Energy Codes Program**, which could partner with industry leaders to develop a framework for an embodied carbon model code, or an integrated operating and embodied carbon code.

Congress can also link existing **Federal tax incentives** (or restore lapsed tax incentives) to low embodied carbon goals. By leveraging existing financial incentives but tying them low embodied carbon, Congress not only uses its buying power to reduce carbon emissions in the built environment but also creates a replicable framework that smaller jurisdictions can emulate and normalizes the expectation of performance outcomes.

Examples of existing or recently lapsed tax incentives include:

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[6] https://www.carboncure.com/

[7] https://biohitech.com/renewables/

The **Low-Income Housing Tax Credit** (LIHTC) gives incentives for the utilization of private equity in the development of affordable housing aimed at low-income Americans. LIHTC accounts for 90% of all affordable rental housing created in the United States today. Congress can incentive the use of **Mass Timber** or other low embodied carbon materials for low income housing.

The tax deductions for **commercial buildings** have expired, effective December 31, 2017. The tax deduction of up to $1.80 per square foot was previously available to owners or designers of commercial buildings or systems that saved at least 50% of the heating and cooling energy as compared to ASHRAE Standard 90.1-2007 (or 90.1-2001 for buildings or systems placed in service before January 1, 2018). Partial deductions of up to $.60 per square foot could be taken for measures affecting any one of three building systems: the building envelope, lighting, or heating and cooling systems. Congress could reinstate a commercial building tax deduction for **Mass Timber** or other low embodied carbon building materials for commercial buildings.

5. **In your testimony, you outlined several policies that could reduce emissions in the building sector. In your opinion, which policies would be most impactful and should be prioritized?**

Policy Priority 1: address existing buildings through transparency and benchmarking

The model energy code addresses new construction and planned alterations projects that require a permit. Planned construction activity triggers the code. Buildings with no planned construction activity are not typically addressed by energy codes.

In most established U.S. cities, 80-90% of the buildings that will be consuming energy in 2050 already exist. U.S. cities only see 1-2% turnover (renovation or replacement) of building stock every year on average. And yet, in cities, buildings represent on average 50-75% of GHG emissions inventory. Buildings are the single largest opportunity to meet climate goals. Therefore, building codes alone won't address the issue of emissions in the built environment. Other complementary policy solutions, such as energy transparency and benchmarking, as well as building performance standards are required.

Energy benchmarking and transparency ordinances have been adopted by over two dozen jurisdictions across the country, making publicly and privately-owned building annual performance data available to jurisdictions and the public. These policies currently encompass nearly 92,000 properties[8] at 11 billion square feet of floor area[9] reported every year. Through transparency alone these cities are seeing an average of 4-13% energy improvement in their existing building stock. Just starting to use the benchmarking and reporting tools, such as EnergyStar Portfolio Manager, shining a light on building performance, and introducing a comparative metric has already inspired improved operations and maintenance as well as investment in energy efficiency.

Congress can incentivize states and cities to adopt transparency and benchmarking policies, by co-funding staff or providing resources and tools, particularly when policies are linked to a national benchmarking platform such as the U.S. Environmental Protection Agency (EPA) **EnergyStar Portfolio Manager** tool. Congress can also incentivize building owners by providing financial incentives (tax incentives or rebates) for energy audits, retro-commissioning, deep green retrofits, systems or component replacement, and building operator training programs.

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[8] https://www.buildingrating.org/graphic/us-number-properties-covered-annually
[9] https://www.buildingrating.org/graphic/us-building-area-covered-annually

Investment in Energy Efficiency is investment in local jobs and the local economy. Building improvements focused on improved energy efficiency in existing building stock cannot be shipped overseas. They are labor intensive and site-specific projects, driving the creation of local jobs in construction, renovation, installation, operations and maintenance[10]. According to the *2019 U.S. Energy and Employment Report,* Energy Efficiency produced more new jobs in the United States in 2018 than any other energy sector, and accounted for more than **2.3 million jobs** overall, as compared with about 534,000 in renewable energy and about 200,000 in coal.

Policy 2: address existing buildings through building performance standards

Once jurisdictions have established transparency and benchmarking infrastructure with its annual communication channels between building owners and a building performance oversight agency, it is easier to put a building performance standard into place. Cities may want to require building owners to take additional steps beyond just reporting performance such as improving buildings that exceed carbon intensity, energy- or water-consumption thresholds or fall below peer building EnergyStar scores.

There are a small number of jurisdictions that have already passed building performance standards, but many more are looking at similar policies to address their existing building stock. The next most likely jurisdictions to pass similar policies will be those with existing transparency and benchmarking policies already in effect.

Congress can incentivize states and cities to adopt Building Performance Standards, particularly when policies are linked to a national benchmarking platform such as the U.S. Environmental Protection Agency (EPA) **EnergyStar Portfolio Manager** tool. Support may include co-funding staff or providing resources, tools and training for jurisdictions.

Congress can continue to support the development and improvement of energy simulation tools that aid building owners in making financial investment decisions, as well as EPA EnergyStar Portfolio Manager platform, and ensure it remains relevant by maintaining funding for the **Commercial Building Energy Consumption Survey** which populates the database on the backend.

Congress can leverage the National Laboratories and the U.S. Department of Energy Building Technologies Office (BTO) to provide demonstration and field validation of advanced technologies so that American businesses may foster innovative solutions to our building energy challenges, these technologies may become shelf-ready and cost-competitive, and building owners may confidently employ these technologies in existing buildings to improve their performance.

Congress can also incentivize building owners by providing financial incentives (tax incentives or rebates) for energy audits, retro-commissioning, deep green retrofits, systems or component replacement, and building operator training programs.

Policy Priority 3: modernize code enforcement

The International Energy Conservation Code (IECC) is in use or adopted in 48 states, the District of Columbia, Puerto Rico and the U.S. Virgin Islands. The model code is updated in three-year cycles, supported by research and analysis conducted by industry stakeholders and U.S. Department of Energy (PNNL). The model building code is a powerful and far reaching tool, however many jurisdictions do not

[10] Energy Efficiency in Buildings: the key to Effective and Equitable Clean Energy Action for Cities (IMT)

have the personnel or fiscal resources to adequately ensure compliance with energy requirements. Codes are only as good as they can be and are enforced, which is why the next policy priority focuses on enforcement.

Congress can provide resources to state and local governments in many ways. Congress can provide assistance to jurisdictions who wish to convert to an **e-plan review** process or to leverage **integrated technology solutions** that work with Building Information Modeling (BIM) design tools to facilitate virtual inspections through Augmented Reality (AR), Virtual Reality (VR) or drone site visits, all of which can streamline the permitting and inspection process and creates more efficient use of staff resources, enabling better code enforcement procedures and more consistent code updates.[11]

Congress can also incentivize jurisdictions to adopt the latest codes by offering to co-fund staff or provide training for code officials using the existing U.S. Department of Energy (DOE) energy code training modules. There was a highly successful Federal program in the wake of the last recession with the **2009 American Recovery and Reinvestment Act** that provided free training and 2009 IECC code books and workbooks along with strong incentives for all jurisdictions to adopt the 2009 IECC[12].

Policy Priority 4: incentivize outcome-based codes

Congress can incentivize states and cities to be early adopters of **outcome-based codes** by supporting the transition of staff and permitting infrastructure, public education and engagement programs, annual benchmarking and reporting infrastructure and the development of shared tools and lessons learned. Outcome-based codes establish a target energy use level or energy allowance, then require measured and reported actual energy use in relation to that target once the building is completed and occupied. At a minimum, an outcome-based energy code requires 12 consecutive months of post-occupancy performance within the allowed energy or carbon budget, typically within the first 18-36 months of use to normalize for weather and allow for commissioning. If the building doesn't meet performance requirements, the builder or owner forfeits a financial penalty.

By focusing on the outcome, code officials and communities can be assured that requirements are being met while not incurring additional enforcement burdens. Outcome-based codes mean that there would be less reliance on design documentation to obtain a permit, alleviating the pressure on a diminishing code enforcement workforce and freeing that workforce up to focus on building lifecycle performance policies such as transparency (annual benchmarking) and building performance standards. Typically, communities that are prepared for an outcome-based code already have adopted public and commercial building benchmarking policies, thus establishing an annual communication channel between building owner and building performance oversight agency[13].

This simplification of the energy code would allow for more rapid escalation of performance expectations without the burden of retraining the entire code enforcement workforce every code cycle. It will also link escalation design expectations to more rigorous oversight of **construction quality** and **ongoing performance optimization** as an integral part of operations and maintenance activities. The National Institute of Building Sciences (NIBS) and New Building Institute NBI) have provided energy code appendix language in the guide *Implementing an Outcome-Based Compliance Path in Energy Codes* to help jurisdictions interested in moving towards an outcome-based code.

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[11] Disruption, Evolution, and Change: AIA's vision for the future of design and construction (AIA, 2019)
[12] http://bcapcodes.org/topics/federal-funding/
[13] Implementing an Outcome-Based Compliance Path in Energy Codes (NIBS, NBI; 2017)

Policy Priority 5: incentivize zero carbon buildings

The 2021 model energy code includes a **Zero Code appendix**, a platform that jurisdictions can opt into to incentivize or make mandatory for certain building types or sizes to help them meet their climate goals. As an appendix it is built into the code enforcement framework of the IECC but is voluntarily adopted by jurisdictions and could be adjusted locally to align with a step code or other local programs. The provisions contained in this appendix will become mandatory when specified as such in the jurisdiction's adopting ordinance.

The Zero Code appendix to the 2021 IECC is constructed to require that new commercial, institutional, and mid- to high-rise residential buildings install or procure enough renewable energy to achieve zero net carbon annually[14]. The appendix encourages on-site renewable energy systems when feasible but also supports off-site procurement of renewable energy through a variety of methods. This appendix does not allow renewable energy to be traded off against the energy efficiency required by the 2021 IECC. Buildings are required to comply with the 2021 IECC using either the prescriptive or performance approach. When the prescriptive approach is used, the renewable energy that must be installed or procured is specified based on building type and climate zone.

Once the IECC 2021 model code is published Congress can offer incentives to state and local governments to increase speed of adoption and encourage use of the **Zero Code appendix[15].** Congress can incentivize states and cities to be early adopters of **Zero Energy** and **Zero Carbon codes** by supporting the staff and permitting infrastructure, public education and engagement programs, annual benchmarking and reporting infrastructure and the development of shared tools and lessons learned.

Congress can also link existing **Federal tax incentives** to Zero Energy and Zero Carbon goals. By leveraging existing financial incentives but tying them to Zero Energy or Zero Carbon, Congress not only uses its buying power to reduce carbon emissions in the built environment but also creates a replicable framework that smaller jurisdictions can emulate and normalizes the expectation of performance outcomes.

Congress can maintain and increase Federal tax incentives for Renewable Energy technologies, including storage. As more production comes online, the ability to store energy and control how and when it flows onto the grid will be critical to maintaining our infrastructure and energy autonomy.

6. **Recent reporting has revealed that the National Association of Home Builders has the ability to select 4 out of the 11 members of the residential code committee, based on a formal quid pro quo agreement with the International Code Council. How has this 4-vote block affected the code development process and the energy efficiency and resilience outcomes of the codes adopted? What reforms to the code development process would you recommend, if any?**

The code update process typically involves a Code Development Committee (CDC) that is formed by qualified applicants representing a broad range of stakeholders. These stakeholders may include code officials, members of the building product or material manufacturing community (or representative

[14] Understanding Code Change Proposal CE264-19 Zero Code Renewable Energy Appendix (AIA, 2019)
[15] https://architecture2030.org/wp-content/uploads/ZERO-Code-RE-Appendix-Fact-Sheet.pdf

associations), members of the architecture or engineering community, code consultants, and in the case of the residential code, home builders. The residential code is unique in this, as commercial developers and contractors are not typically engaged in the code development process. Anyone can propose code amendments, however the bulk are proposed by Code Action Committees (CACs) who have a vested interest in improving the code. Individual stakeholders who have identified unclear language, unintended barriers to good design or construction, inherent conflicts or other challenges within the code also propose amendments. There are some proposed amendments in every code cycle that attempt to 'roll back' the requirements or stringency of the code. It is the Code Development Committee's role to protect the intent and integrity of the code.

While it has been evident that the residential energy code committee has had disproportionate representation by the National Association of Home Builders (NAHB), it was not evident until recently that this was a formal agreement. The agreement with the International Codes Council (ICC) was that having this significant representation or voting block on the committee would be in exchange for promoting the adoption of the i-codes, including the energy conservation code, with states and local jurisdictions.

The NAHB has leveraged this voting block to attempt to roll back much of the progress made in the residential energy code over the last couple of cycles, and other stakeholders have had to work in earnest merely to try to keep the code holding steady. For example, the update from the 2015 to 2018 residential energy conservation code only saw a nominal improvement:

- 1.97 percent energy cost savings
- 1.91 percent source energy savings
- 1.68 percent site energy savings

At the same time the commercial energy conservation code was advancing at four times the pace of the residential energy code. This is similar to the trajectory of the 2012 to 2015 energy code update and the 2018 to 2021 energy code update (in the 2021 code cycle the residential energy code improved by about 3% while the commercial energy code improved by about 12%). For three cycles in a row the commercial energy code has progressed at four times the rate of residential code because of the stranglehold NAHB has on the code development committee.

Ultimately it is the consumers who pay the price for inefficient homes, not only in energy bills but in thermal discomfort and poor indoor air quality and health impacts as well.

A better thermal envelope allows for passive survivability, or habitable human conditions with the loss of power. Increased r-values, lower u-values, and improved air tightness retain heat in the winter (when winter storms may knock out power) or prevent heat gain in the summer (when tropical storms, hurricanes or drought-driven fires may knock out power). Residents can stay in their homes without power for many more when their homes are built to more efficient standards.

Despite this quid pro quo, allowing the NAHB to maintain a significant voting block on the residential energy code development committee, thereby holding back code progress, in exchange for its support, the NAHB and its membership have *not* worked with jurisdictions advocating for the adoption of the latest energy codes. NAHB and its membership have actively lobbied against adoption of the latest codes, decrying them as too stringent, too difficult, too much of a cost burden, despite the fact that NAHB has barely allowed the residential energy code to make any changes at all in nearly a decade.

No single organization or entity should be able to have such a large influence on the code development process. Nor should there be any quid pro quo arrangements that trade votes for influence or support. This has clearly been an ineffective arrangement with the energy code AND consumers losing on both sides of the deal.

Although the code hearings and public comment process are public, the final votes are only open to ICC members, primarily comprised of code officials. Even code development committee members cannot vote if they are not code officials. It seems that both the development committee and the final vote are lacking in representation from the most important constituencies: the people who actually must live in these homes. If not actual home buyers or home owners, then associations that represent them (REALTORs, etc.) who can advocate for that stakeholder population. Other advocates from the community may also be able to represent these concerns and issues on the committee as well as in the final vote.

The Honorable Garret Graves

1. **Your testimony highlighted the role that buildings play in global emissions—40 percent. Could you elaborate on the role that the Department of Energy's Building Technology Office plays in finding new construction techniques that may make a difference not just for Californians, but also residents of developing nations?**

The Building Technologies Office (BTO) supports the development and implementation of residential and commercial building energy codes by engaging with government and industry stakeholders, and by providing technical assistance for code development, adoption, and compliance. Through advancing building codes, we aim to improve building energy efficiency, and to help states achieve maximum savings. Through the Building Energy Codes Program, BTO:

- Assesses the savings impacts of model energy codes, calculating energy, cost and carbon savings to inform jurisdictions and the public
- Coordinates with key stakeholders to improve model energy codes, including architects, engineers, builders, code officials, and a variety of other energy professionals
- Reviews published codes to ensure increased energy savings, such as the International Energy Conservation Code (IECC) and ASHRAE 90.1
- Tracks the status of energy code adoption across the U.S. and provides technical assistance to states implementing updated codes
- Provides a variety of educational and training resources and assists states working to measure and improve code compliance
- Administers a Help Desk to assist individual code users with questions about energy codes

BTO also sponsors an Emerging Technologies (ET) Program that fosters the development of cost-effective, energy-efficient technologies and helps introduce those technologies into the marketplace. ET funds and directs applied research and development (R&D) for technologies and tools that support building energy efficiency. The BTO provides demonstration and field validation of advanced technologies so that American businesses may foster innovative solutions to our building energy challenges, these technologies may become shelf-ready and cost-competitive, and building owners may confidently employ these technologies in new and existing buildings to improve their performance.

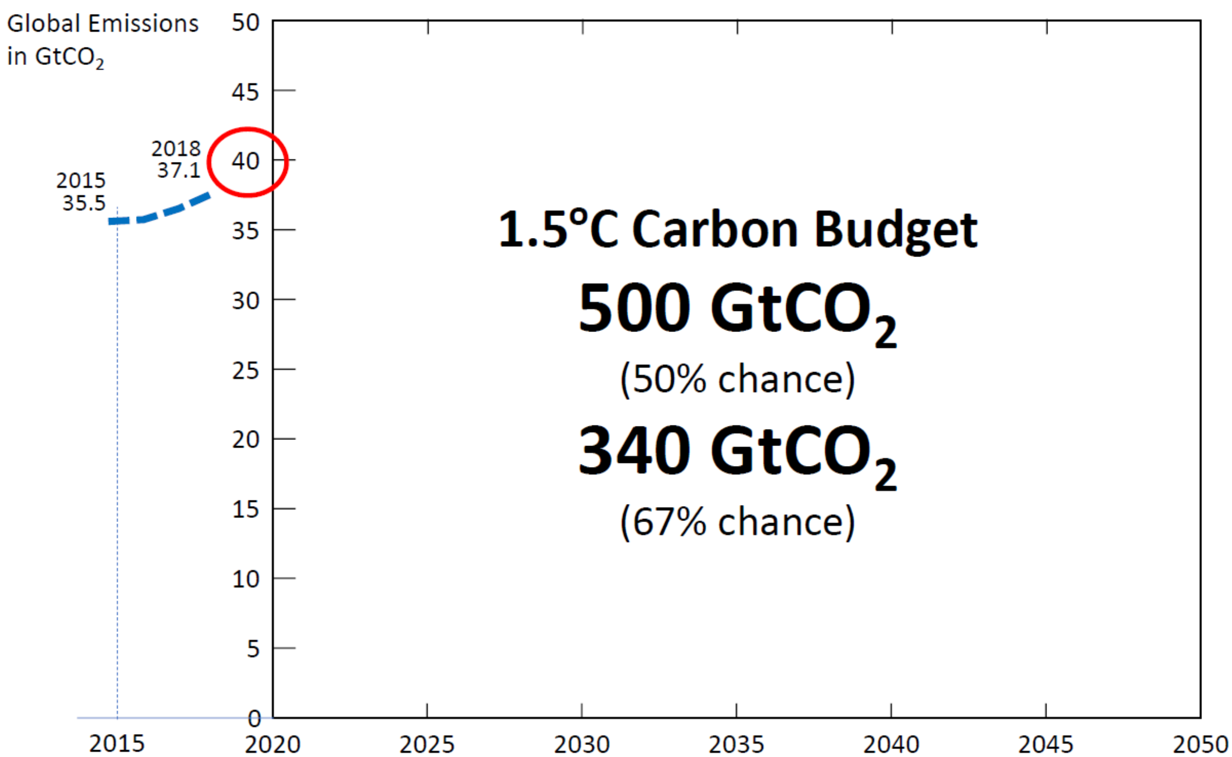
BTO develops and maintains open source Whole-Building Energy Modeling (BEM) tools such as EnergyPlus and Open Studio. These are versatile, multipurpose tools that are used in new building and retrofit designs, code compliance, green certification, qualification for tax credits and utility incentives, and real-time building control. BEM is also used in large-scale analyses to develop building energy-efficiency codes and inform policy decisions. These energy simulation tools are vital support to aid building owners in making financial investment decisions. They provide timely feedback on first cost, energy cost savings and simple payback analysis, as well as load reduction and first cost tradeoffs for cost neutral high-performance construction.

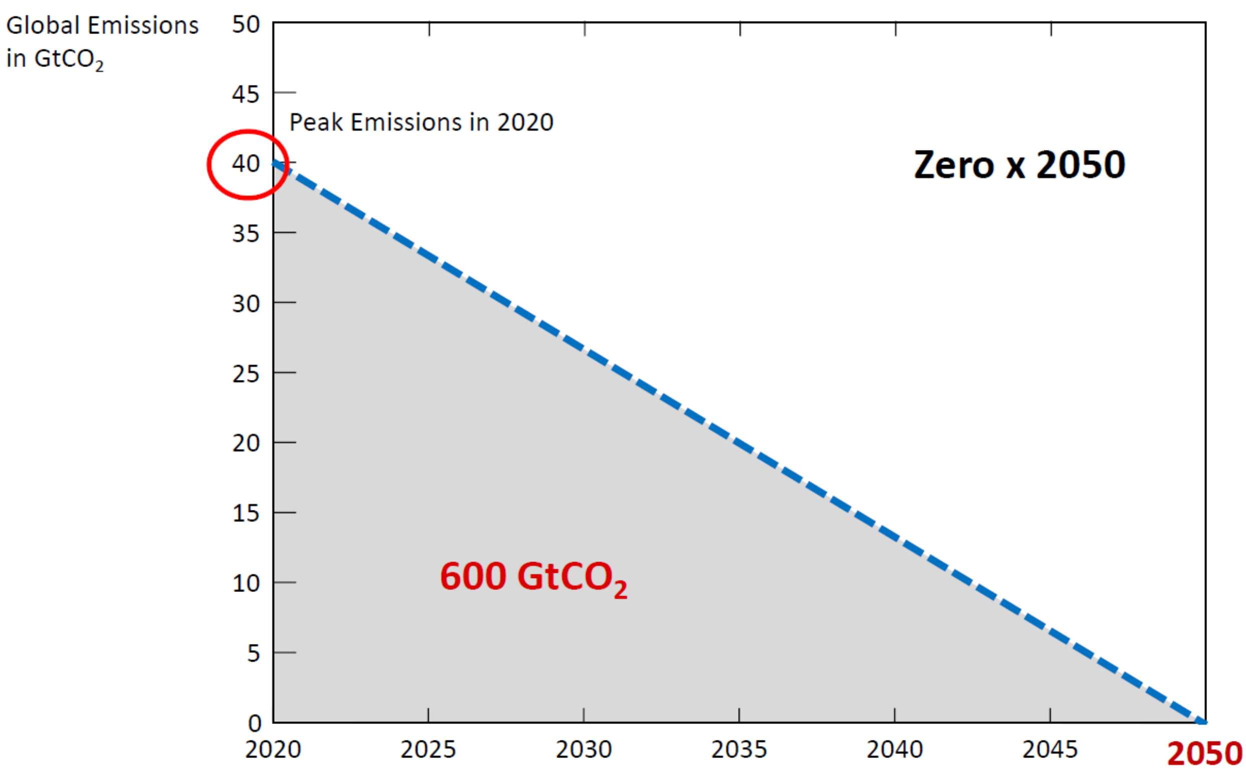
By providing model code assistance, tools and resources are made available including cost effectiveness studies, technical training and implementation guides that many developing nations would not be able to produce on their own. These tools and resources enable developing nations, many of whom are constructing billions of square feet of new buildings over the next few decades, to adopt and enforce a higher caliber of building and energy code. This results in safer, more resilient buildings, as well as lower global carbon emissions, which makes us all safer.

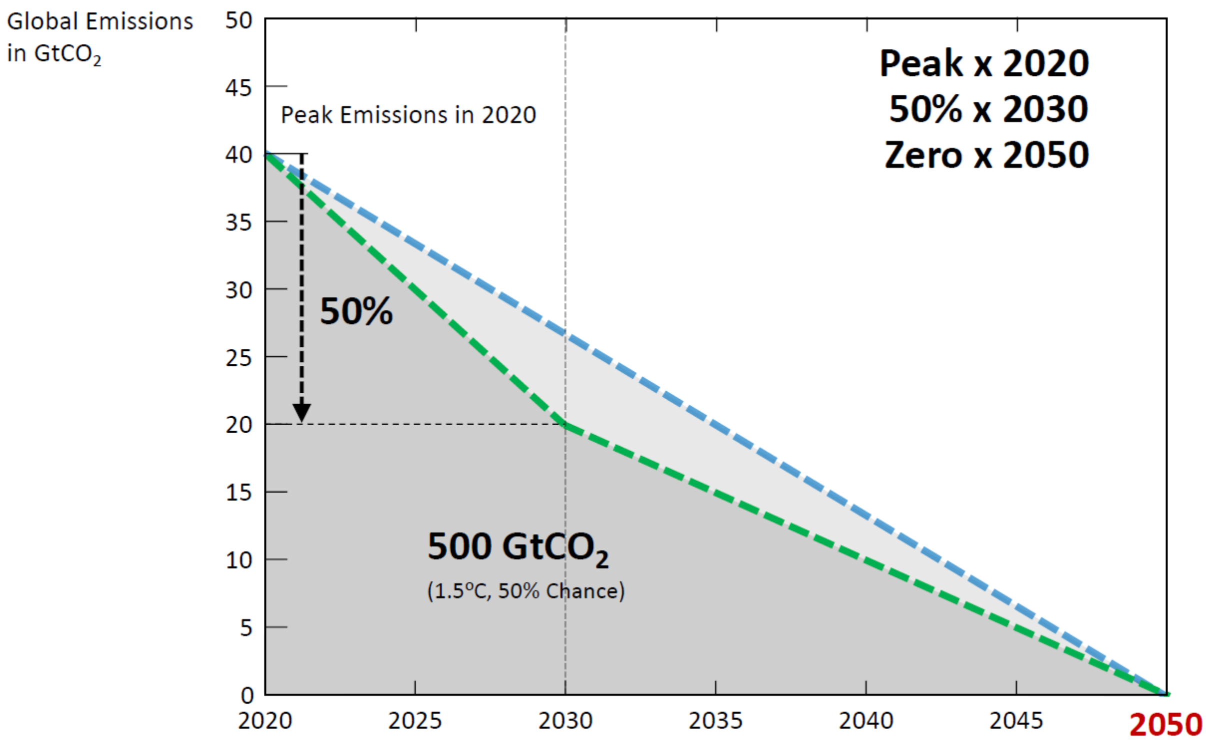
By fostering emerging technologies and proving their effectiveness, BTO is able to introduce technologies that ultimately become shelf-ready and cost-competitive, not just in the U.S. but in developing nations. By providing access to open source Whole-Building Energy Modeling (BEM) tools such as EnergyPlus and Open Studio, BTO enables designers and building owners to make construction decisions informed by first cost, energy cost savings and simple payback analysis, as well as load reduction and first cost tradeoffs for cost neutral high-performance construction. Simulation in concert with lower energy, lower carbon technologies contribute to lower carbon construction in developing nations. They result in safer, more resilient buildings, as well as lower global carbon emissions, which makes us all safer.

References Page

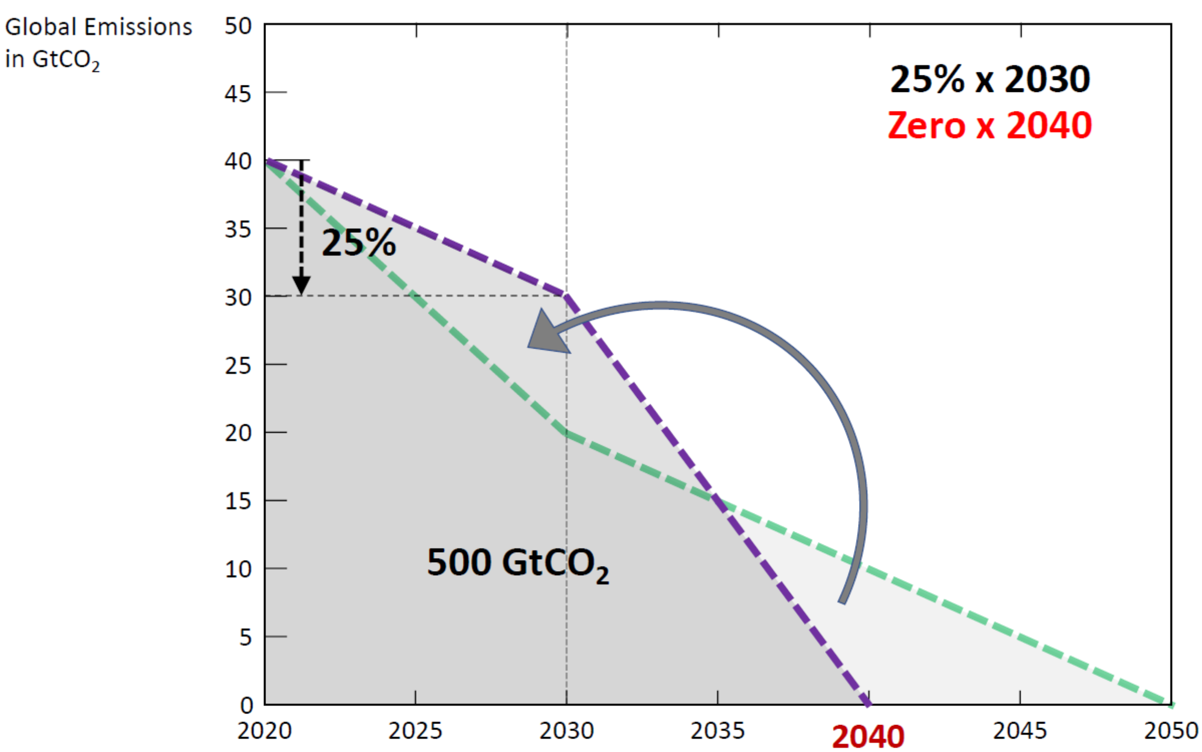
Graphs, charts, diagrams courtesy of Architecture 2030, except where noted.



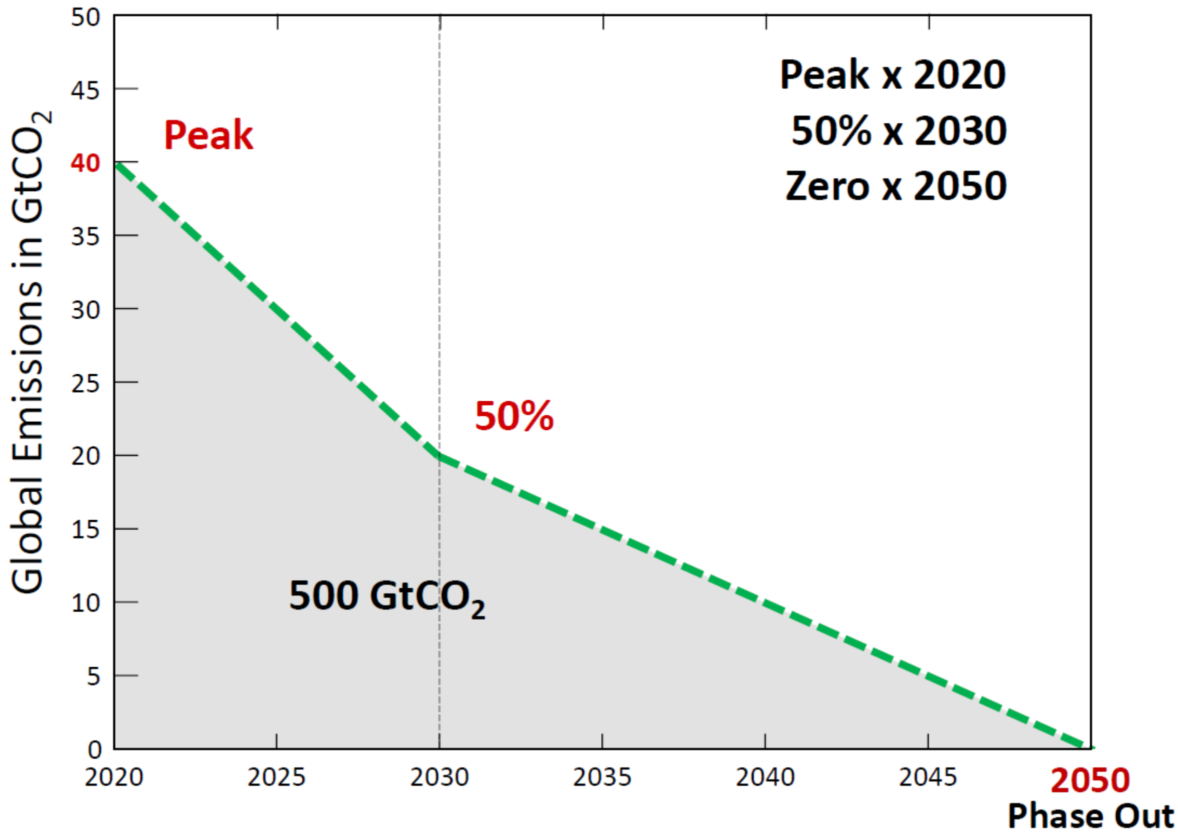




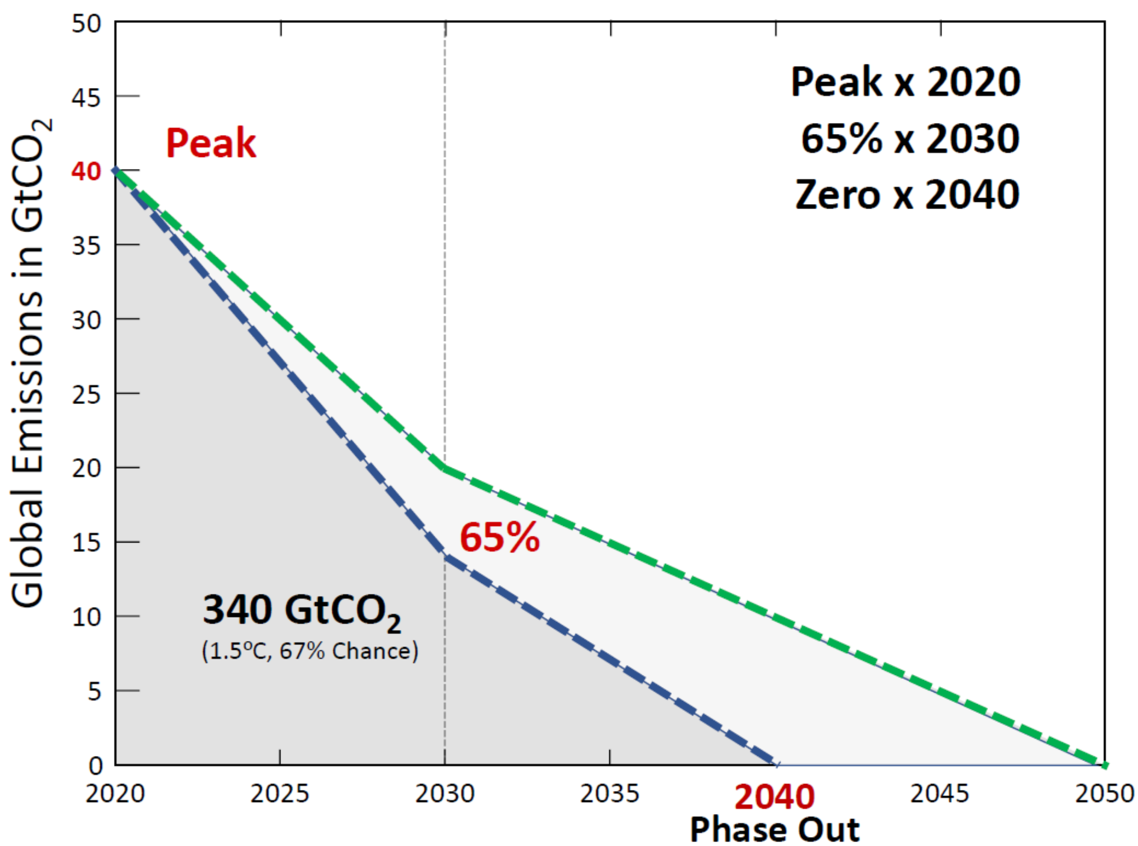
Source: Architecture 2030; Adapted from RealClimate.org "How much CO2 your country can still emit, in three simple steps"; and IPCC SR15, Table 2.2



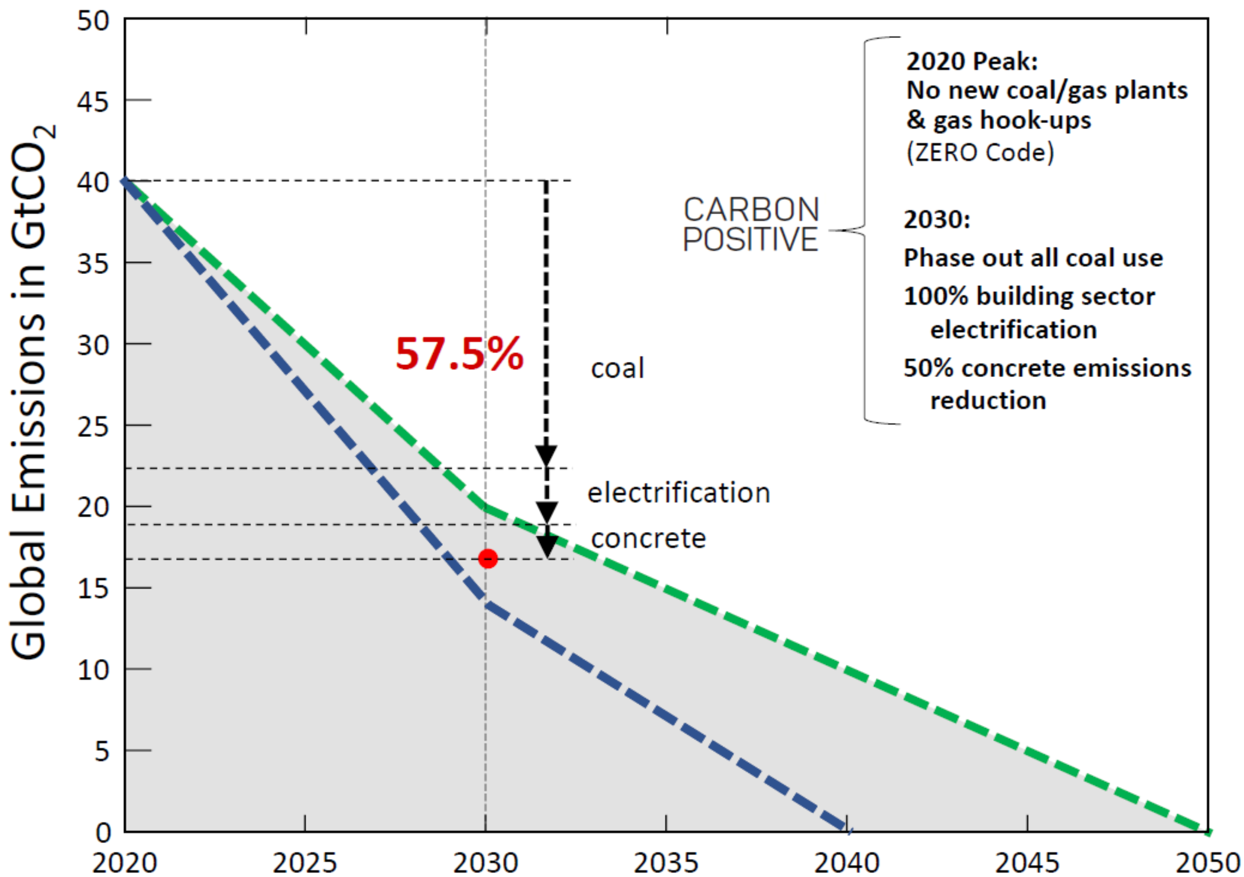
Source: Architecture 2030; Adapted from RealClimate.org "How much CO2 your country can still emit, in three simple steps"; and IPCC SR15, Table 2.2



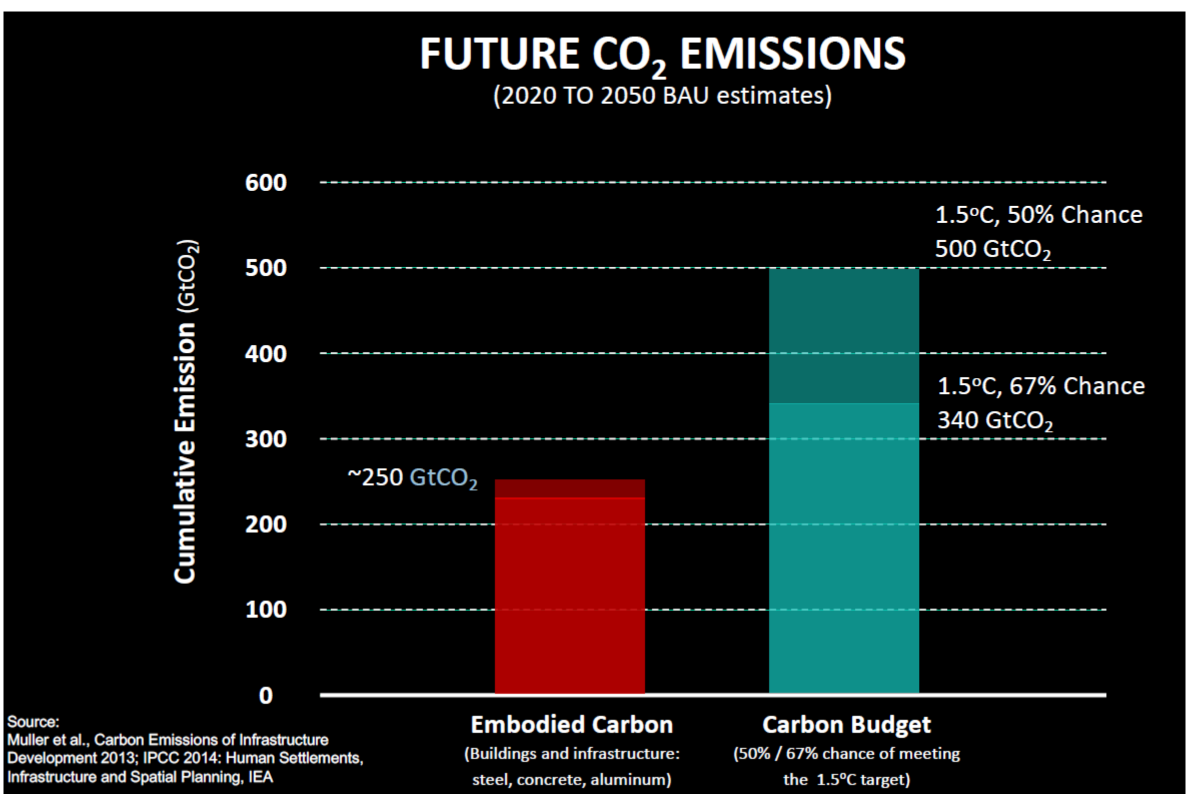
Global Emissions in $GtCO_2$
50
45
40
35
30
25
20
15
10
5
0
2020
2025
2030
2035
2040
2045
2050
Phase Out
Peak
50%
500 $GtCO_2$
Peak x 2020
50% x 2030
Zero x 2050



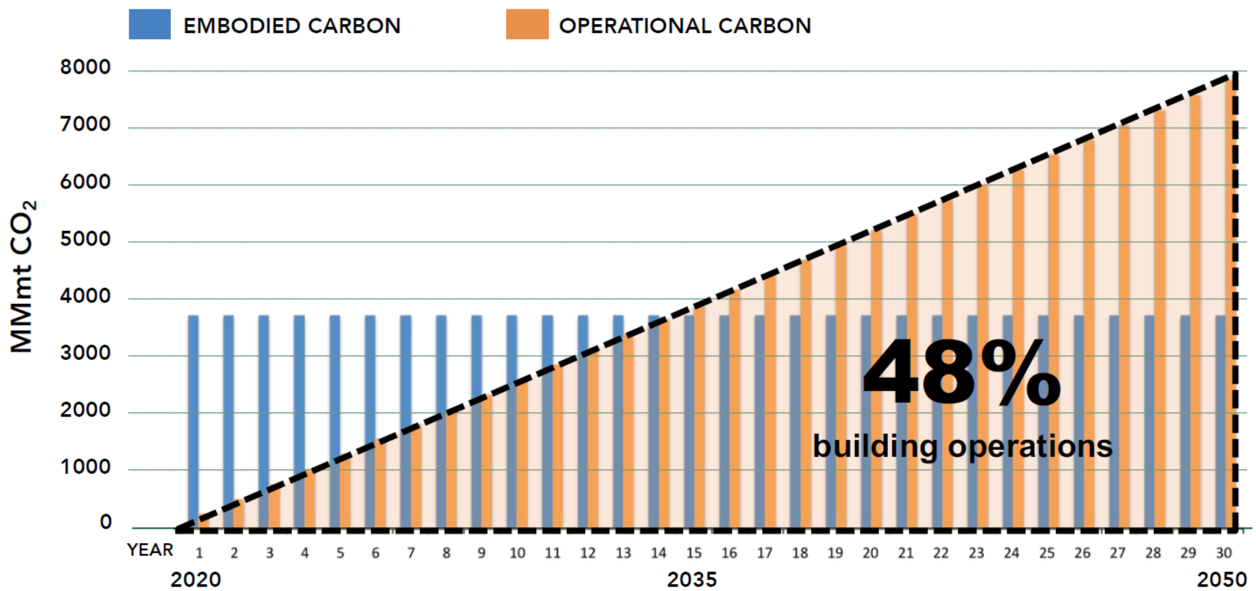
Global Emissions in $GtCO_2$
50
45
40
35
30
25
20
15
10
5
0
2020
2025
2030
2035
2040
Phase Out
2045
2050
Peak
65%
340 $GtCO_2$
(1.5°C, 67% Chance)
Peak x 2020
65% x 2030
Zero x 2040



Global Emissions in $GtCO_2$
50
45
40
35
30
25
20
15
10
5
0
2020
2025
2030
2035
2040
2045
2050
57.5%
coal
electrification
concrete
CARBON POSITIVE
2020 Peak:
No new coal/gas plants & gas hook-ups
(ZERO Code)
2030:
Phase out all coal use
100% building sector electrification
50% concrete emissions reduction

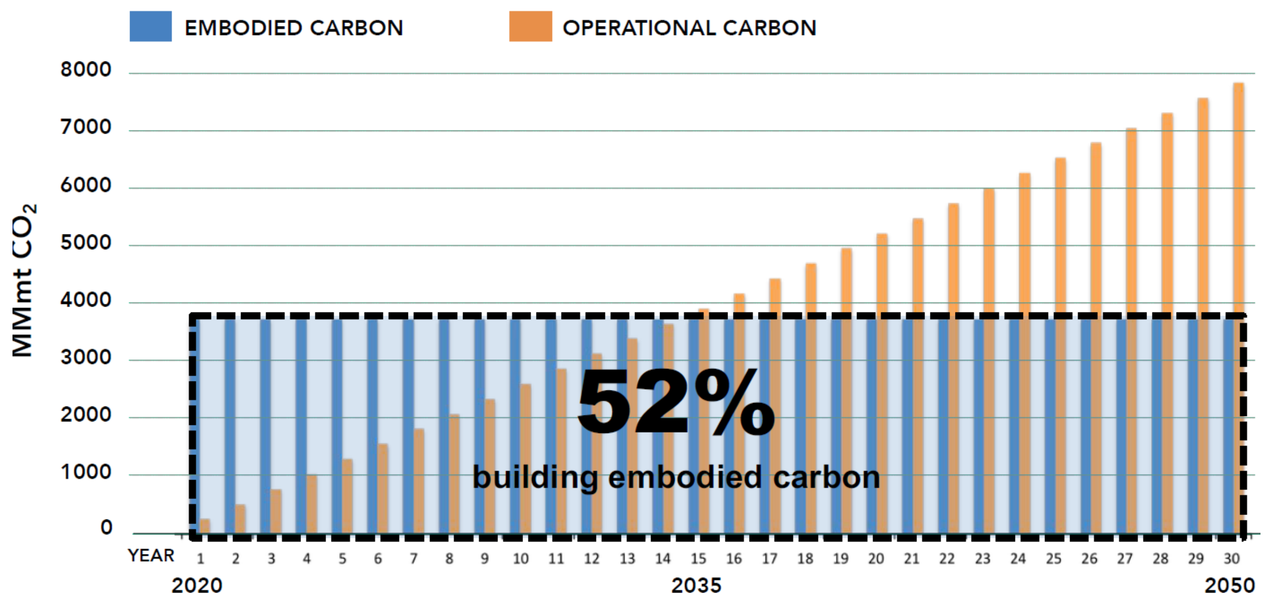


FUTURE CO_2 EMISSIONS
(2020 TO 2050 BAU estimates)
Cumulative Emission ($GtCO_2$)
600
500
400
300
200
100
0
1.5°C, 50% Chance
500 $GtCO_2$
1.5°C, 67% Chance
340 $GtCO_2$
~250 $GtCO_2$
Embodied Carbon
(Buildings and infrastructure: steel, concrete, aluminum)
Carbon Budget
(50% / 67% chance of meeting the 1.5°C target)
Source:
Muller et al., Carbon Emissions of Infrastructure Development 2013; IPCC 2014: Human Settlements, Infrastructure and Spatial Planning, IEA



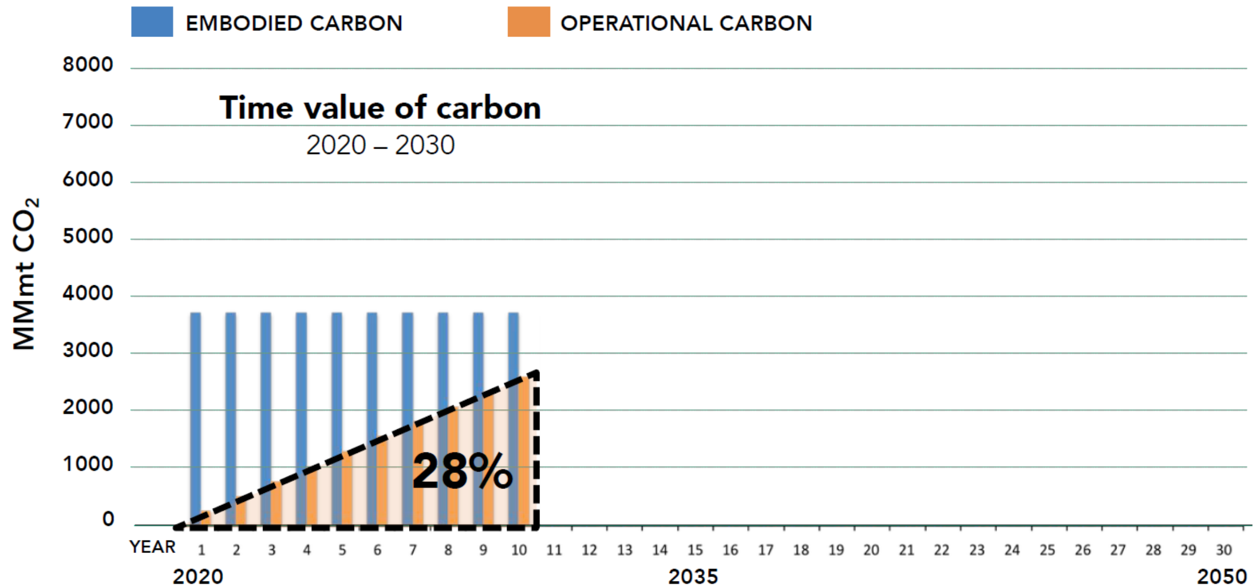
TOTAL EMISSIONS OF GLOBAL NEW CONSTRUCTION
2020 to 2050 (business as usual)

Source: Architecture 2030, Adapted from EIA AEO 2017 and Global ABC, Global Status Report 2017



TOTAL EMISSIONS OF GLOBAL NEW CONSTRUCTION
2020 to 2050 (business as usual)

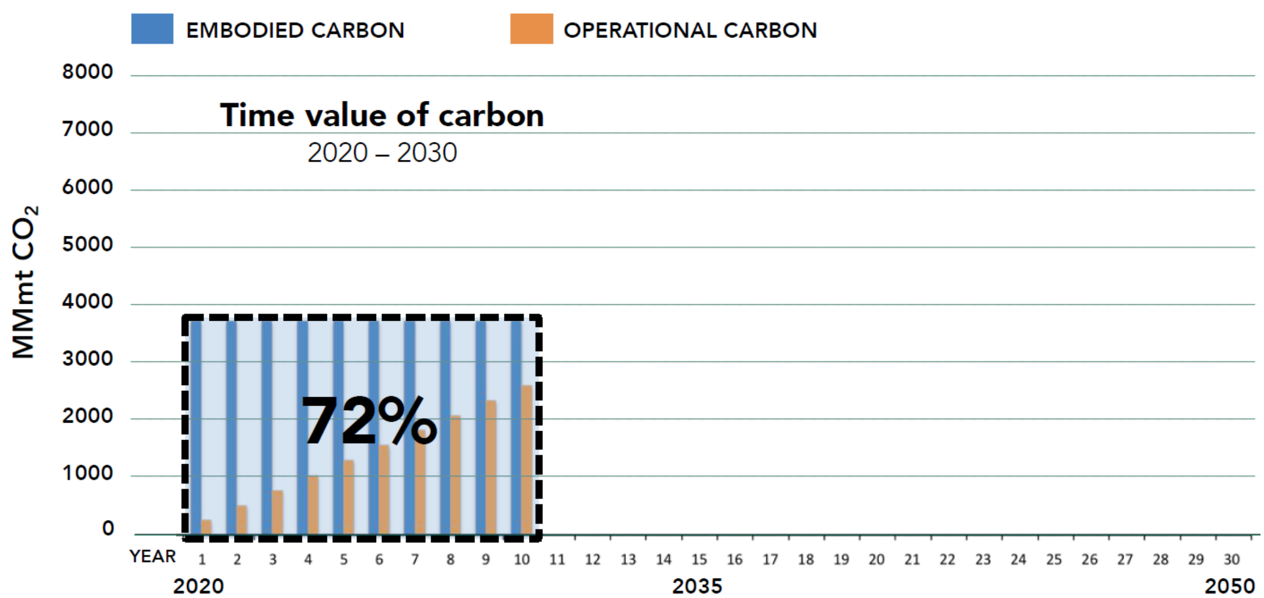
Source: Architecture 2030, Adapted from EIA AEO 2017 and Global ABC, Global Status Report 2017



TOTAL EMISSIONS OF GLOBAL NEW CONSTRUCTION

2020 to 2030 (business as usual)

Source: Architecture 2030, Adapted from EIA AEO 2017 and Global ABC, Global Status Report 2017



TOTAL EMISSIONS OF GLOBAL NEW CONSTRUCTION

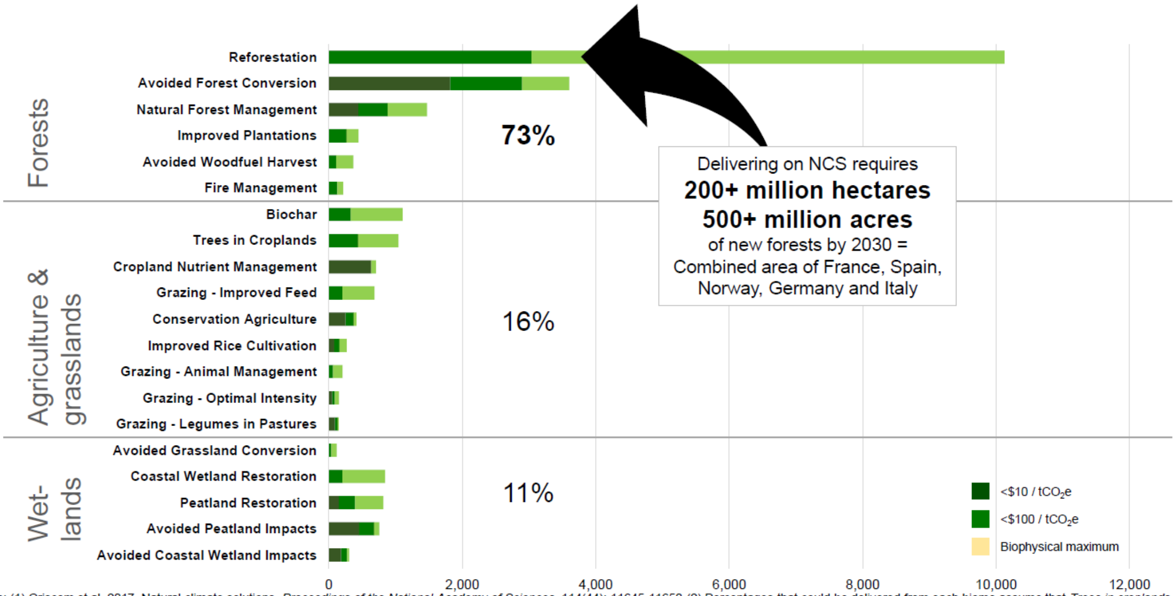
2020 to 2030 (business as usual)

Source: Architecture 2030, Adapted from EIA AEO 2017 and Global ABC, Global Status Report 2017

Image/graph courtesy of The Nature Conservancy

NATURAL CLIMATE SOLUTIONS

NCS can provide 37% of mitigation through 2030



Notes: (1) Griscom et al. 2017. Natural climate solutions. *Proceedings of the National Academy of Sciences.* 114(44): 11645-11650 (2) Percentages that could be delivered from each biome assume that *Trees in croplands* is included in Forests.