

# **BUILDING AMERICA HOMES: A BLUEPRINT FOR THE 2030 CHALLENGE**

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## **ABSTRACT**

Architecture 2030 is a non-profit organization aimed at reducing global greenhouse gas (GHG) emissions by transforming the building sector into a carbon neutral industry. Individuals, firms, and all levels of government are beginning to adopt this 2030 Challenge. With this commitment comes the responsibility of meeting the challenge with cost-effective solutions that benefit not only the planet, but also the stakeholders involved in bringing this goal to fruition.

Meanwhile, the U.S. Department of Energy's Building America Program goal of cost-effective, marketable net-zero Energy Homes by 2020 is within sight. Building America teams work with progressive builders, product manufacturers, and other building industry stakeholders across the country to design communities of homes that incorporate tried and true energy efficiency measures and on-site renewable energy. The successes and resources of Building America can act as a blueprint to achieve the lofty goals of The 2030 Challenge.

## **1. GREENHOUSE GASES: THE MESS WE'RE IN**

There is a general, but not universal, consensus that greenhouse gas (GHG) emissions from human activities are having, and will increasingly have, a negative impact on the planet. Before one can begin attempting to address the problem, however, it needs to be quantified in some useful manner.

The first valuable number that needs quantifying is the amount of GHG emissions per year generated by the United States. According to the U.S. Energy Information

Administration (EIA), in 2006 U.S. carbon dioxide (CO<sub>2</sub>) emissions were almost 6 Billion Metric Tons (BMT). When including other GHG emissions, the total jumps to over 7 BMT CO<sub>2</sub> equivalent (BMTCO<sub>2</sub>e). This number has been holding steady around 7 BMTCO<sub>2</sub>e since 2000. So each year, the U.S. alone emits the equivalent of about 7,000,000,000 metric tons of CO<sub>2</sub> into the atmosphere.

It is common knowledge that the U.S. generates its fair share of waste, but how exactly does it stack up to the rest of the world? According to EIA, U.S. CO<sub>2</sub> emissions account for over 20% of the world's 26 BMT per year.

While this can sound like a massive amount of GHG emissions, this number alone doesn't tell the whole story. To look at the significance of these emissions, the other side of the equation needs to be analyzed. The Earth also has a (finite) capacity to absorb, fix, and/or capture these emissions. The world's forests, soils, and oceans are all hard at work pulling as much carbon out of the air as they can. So who's winning, the emitters or the collectors? While reports vary as to the exact size of the Earth's natural carbon "sinks," all of them agree that we are already well outstripping the Earth's natural ability to offset our emissions. The remainder stays in the atmosphere, increasing the overall concentration of GHG, bringing the threat of global warming ever closer to the present.

While the majority of people would agree that the GHG mess that we find ourselves in is a looming worldwide disaster, there is much less of a consensus on how exactly emissions should be curtailed. An organization called Architecture 2030 has stepped up and provided what it calls The 2030 Challenge: a series of goals with the objective of transitioning the building sector into a carbon-neutral industry by 2030.

## 2. THE 2030 CHALLENGE: VISION FOR THE FUTURE

In order to keep up with the times, most buildings will eventually need some significant overhauls beyond the usual retrofits and upgrades they have been receiving over the years. In a similar manner, we are rapidly approaching a point where the building industry will need more than a fresh coat of paint in order to sustain itself. Architecture 2030 has offered up The 2030 Challenge as a conceptual drawing of what the building industry should look like in order to address the GHG concerns.

In 2002, Edward Mazria founded Architecture 2030 with the desire to produce significant reductions in GHG emissions. This independent, non-profit organization issued a challenge for the building industry – The 2030 Challenge, to be specific – and many significant entities (including builders, local jurisdictions, manufacturers, and individuals) have picked up the gauntlet.

But why target the building industry? Energy consumption data is typically split between four primary market sectors: industrial, residential, commercial, and transportation. However, using data from the EIA, Architecture 2030 pulled out the energy consumption information for building operation, building construction, and building material embodied energy in order to get a better picture of the building industry's impact. This new calculation showed that buildings account for 48%, or almost half, of all energy consumption nationwide; the majority of this coming from building operation, which accounts for 76% of all electricity generated by power plants in the U.S. By comparison the transportation sector, which for years has been receiving significant, industry-wide attention with regards to reducing GHG emissions, accounts for 27% of energy consumption (see Figure 1). Clearly the buildings sector represents a large target in need of a similar concerted efficiency movement.

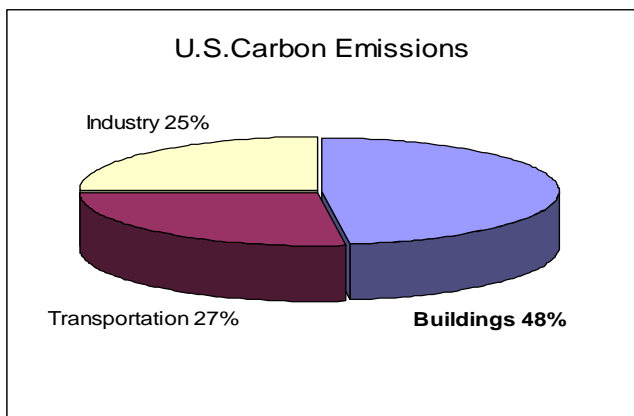


Fig. 1: U.S. carbon emissions distribution.

The ultimate goal of The 2030 Challenge is that by the year 2030 all new buildings will be carbon neutral. To gradually meet this ambitious objective, they set interim goals starting at 50% energy savings for all current new buildings and increasing by 10% every five years (i.e. 60% in 2010, 70% in 2015, 80% in 2020 and 90% in 2025). In addition to new construction, they state that each year an amount of existing building area at least equal to that of new construction shall be renovated to achieve 50% energy savings. In order to quantify these savings, they have also established a list of benchmark energy consumption levels for a wide variety of building types.

As a voluntary goal, The 2030 Challenge requires widespread support and commitments in order to have any hopes of being a success. So far they have received pledges from architecture, consulting, and design firms; local governments; individuals; organizations; and many other concerned entities. There are also many international groups on the list. Amongst the supporters are the U.S. Green Building Council (USGBC), the Environmental Protection Agency (EPA), the U.S. Conference of Mayors (USCM), and, of course, the American Solar Energy Society (ASES). As part of the 2007 Energy Independence and Security Act signed by President Bush on December 19<sup>th</sup>, 2007, all new federal buildings are now required to meet the energy performance standards of The 2030 Challenge.

The 2030 Challenge is beginning to mobilize some major players to action, and with support increasing there are immediate needs to determine and demonstrate how these goals will be met: an image of the final overhauled structure will not alone achieve the goals; blueprints are needed.

## 3. BUILDING AMERICA: MEETING THE CHALLENGE

The Building America Program (BAP) was established by the U.S. Department of Energy (DOE) as a ground-up, market-driven approach to producing net-Zero Energy Homes (ZEH) by 2020. BAP is forward-looking in its scope, but also identifies solutions that work today. In this way, BAP is building homes that are incrementally moving towards the net-zero goal; these homes can lead the way for the residential market in The 2030 Challenge.

There are three integral facets of the program that are responsible for its demonstrated effectiveness: the homes have to be sustainable and cost effective; the solutions have to work on a production scale; and methods and models have to be developed for all major climate zones. BAP understands that while it is already possible to make a Zero Energy Home today, in order to make substantial industry-

wide impact the solutions have to be able to generate affordable, marketable ZEH communities across the U.S.

### 3.1 The Building America Method: Grassroots Partnership

The program consists of five Building America (BA) teams across the U.S. Each team has its own specific targets and goals in the residential new construction (RNC) market, though there is also collaboration between the teams. The teams are working to produce homes that are more efficient than an established national benchmark, which represents a typical code-compliant home built in the 1990s; all projects are therefore evaluated on a similar scale. The Building Industry Research Alliance (BIRA) team, for example, has produced 10,000 homes between 30% and 80% above the BA Benchmark.

Each team establishes partnerships with builders in order to find effective ways to reach the BA goals. ConSol, the team lead for BIRA, is not only an energy consulting firm, but also a builder advocate. The company works with its local, statewide, and national builder partners to find the most cost-effective, builder-approved solutions that will meet the needs of each project. All angles of the project – including project location, building style preferences, project goals, available incentives, local codes and standards, and industry partnerships – are assessed in order to find the best option(s) for the builder. Realizing that production builders do not typically do research and development of current and emerging technologies, BAP has stepped up to provide those resources in order to facilitate market change.

While BIRA's core partners are builders, working with builders alone would never have achieved the successes that the program has had so far. Other industry partners include manufacturers, local governments and organizations, utilities, building associations, research groups, and more. All of these parties are brought to the table to produce communities of sustainable, highly efficient homes. Working together, many more opportunities are uncovered and possible roadblocks avoided. Beyond energy efficiency, the teams also work to improve home comfort, reliability and quality: it doesn't matter how efficient a home is if no one will want to live in it. Additionally, finding ways to improve productivity and reduce construction time and waste can provide savings to offset non-cost neutral measures that are otherwise very effective. In this way BIRA and the BA program are in a unique position to bridge the gap between where the builders are and where the builders will need to be; they do so by providing practical solutions for today in order to meet the energy requirements of tomorrow.

### 3.2 The Building America Method: The Research Cycle

There are three primary stages to the BA research cycle. Interesting measures aren't simply selected and installed in an entire housing development to see if they work. Before a new design or technology gets to the community scale, it must prove its merits. At each stage of the cycle, the feature must also satisfy a series of "must meet" and "should meet" criteria. These factors help to determine whether or not a feature is ready for further analysis.

The first stage in the research cycle is systems testing and evaluation. This is where many of the basic questions are answered about the system: Does it cost effectively provide energy savings? Does it provide these savings cheaper than other measures? Is it readily available and marketable? Which climate types is it intended for? Are there any building code conflicts with this measure? If strong, negative answers come up for any of these questions, it would be a imprudent to proceed further with the analysis of this feature. On the other hand, unforeseen benefits might be identified that help push the feature to the next stage. Moving air ducts into conditioned space was introduced for its significant energy savings, however a previously unidentified value was quickly uncovered: in some circumstances builders found it much cheaper to install the ducts in this way, the energy savings were an afterthought.

If the feature satisfies the systems evaluation, indicating that it looks good on paper, the feature will be installed in a prototype home with monitoring equipment to track its performance in the real world. Once again the feature will be evaluated to see if there are any reasons why it wouldn't be effective in the production market: Were there significant installation problems that are unlikely to be remedied? Did it not perform as expected? Were there unforeseen costs that made this feature less cost effective? If problems are identified at this stage, the feature may be scrapped altogether or recycled for later research. Failures at this stage are expected and are much less of a setback than if they came up in an entire community of homes.

The use of Dow's T-MASS wall system in a prototype home in Borrego Springs, California provides one example of a feature that failed the prototype stage while at the same time provided important research conclusions. Research showed, when managed correctly, introducing mass into a home provides significant peak electricity reductions in desert homes when pre-cooled. However, the builder cited numerous problems in the design, manufacturing, and installation of the T-MASS panels that would make them extremely difficult to implement cost effectively into production building. Building on Borrego Springs, BIRA is currently performing research on Concrete Structural Insulated Panels (C-SIPs) as an alternative method of implementing mass.

After successfully completing the prototype stage, the feature moves up to the production market. At this point there is every indication that this feature should be ready to be integrated into sustainable, high-efficiency neighborhoods. The feature is installed in a test community and evaluated by a final set of criteria to ensure that it is a true success: Were there any installation delays or issues on a production scale? Is the feature marketable to various stakeholders, including the homebuyer? Would the builder and relevant subcontractors be strongly committed to utilizing this feature in the future?

Once a feature has been successfully demonstrated in a production market, it goes into the BA database of effective ZEH features. It may also go through further research cycles under different climate regions or building types. The point of the research cycle is to continue to expand the spectrum of features that can be combined to get closer and closer to the goal of a net-Zero Energy Home.

### 3.3 The Building America Method: Program Results

Just as The 2030 Challenge has set out a series of stepping stones in order to achieve the final goal of net-zero buildings, so has Building America been stepping up the performance requirements as the program progresses. Each climate region has its own series of intermediate goals in order to reach the net-zero target by 2020. Each year or two the homes must perform at least 10% better as compared to the BA Benchmark. Currently, most program homes are being built 30-40% more efficient than the Benchmark, or 50-60% more efficient when you include renewable sources, typically solar electric. To date there have been over 40,000 homes built in BA research projects.

As BA projects progress, lessons continue to be learned and applied in future research cycles. Best Practices Guides are developed and revised (see Figure 2). New building methods and practices are constantly being evaluated. This iterative process continues to produce better performing, higher quality homes.

BAP is developing an ever-evolving body of technical resources, case studies, and Best Practices Guides in order to enrich the knowledge base of the entire industry. Builders looking to construct homes to meet The 2030 Challenge don't have to develop their own technology pathways through trial-and-error; they can now look at BAP for practical solutions. The core tenant of all of this research is not to simply show that cost-effective, net-zero communities *can* be built; the purpose of the research is to provide an open-source blueprint for exactly *how* to build these communities across the U.S.

### 3.4 The Building America Method: Beyond RNC

BAP can readily serve as the guidepost in order to achieve the goals of The 2030 Challenge for residential new construction. However, the contributions don't have to end there.

Other market sectors within The 2030 Challenge may take up many of the BAP methodologies in order to develop similar market-wide systematic approaches to tackling the challenges set forth by Architecture 2030.

Together, Architecture 2030 and Building America can make great strides towards transforming the building sector into a sustainable, efficient industry.

## 4. REFERENCES

- (1) Architecture 2030
- (2) Building America
- (3) The US Energy Information Administration

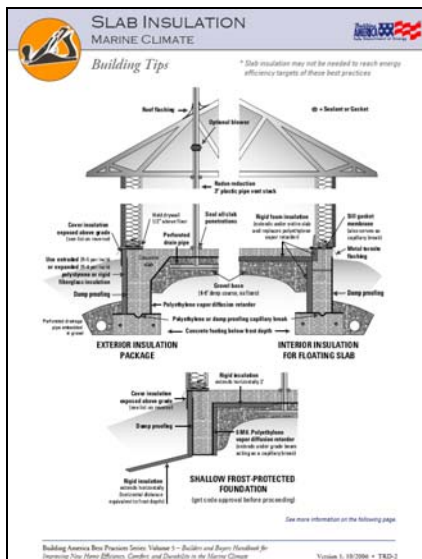


Fig. 2: Building America Best Practices Guide sample page.