How to Protect Ourselves from Climate Change While Saving Money: Use Building Techniques from Europe

Ephram Glass
Smart Grid Consulting

Victor Glass
Rutgers University

Abstract

The recent Camp Fire in California demonstrates that aside from being energy inefficient, homes in the United States are particularly vulnerable to wildfires. While energy efficiency may slow the increase in destructive fires, it's clear we must improve wildfire building survivability. Few Americans realize that Europeans have been using materials in their buildings that make them both more energy efficient and significantly better protected against fires than standard American buildings. On top of this, European construction methods produce buildings that cost significantly less over their lifetimes than buildings in the U.S. It's time the United States embraced these modern building materials and techniques by changing building codes to jumpstart their use in this country, especially in areas where wildfires often occur.

A Missing Element in the Green New Deal: New Building Codes to Mitigate Wildfire Damage

The Green New Deal, sponsored by Representatives Alexandria Ocasio-Cortez and Ed Markey was defeated in the Senate 57-0 with 43 democrats voting present.[1] Besides the effect of no-compromise politics, the bill's defeat was not surprising because it was an idealistic and very expensive fourteen-page resolution aimed at setting an eco-friendly agenda. One of the Green New Deal's most expensive proposals called for "upgrading all existing buildings in the United States and building new buildings to achieve maximum energy efficiency, water efficiency, safety, affordability, comfort,

and durability, including through electrification." [2] In fact, residential and commercial buildings do consume nearly 40% of all the energy used in the United States.[3] Drastically reducing their energy usage would cut greenhouse gas emissions significantly – the primary goal of the Green New Deal.[4] However, even if everyone on the planet stopped burning fossil fuels tomorrow, temperatures would likely continue to increase for a few decades before leveling off because of the greenhouse gases already added to the atmosphere.[5] This indicates we will still need a strategy to live with the effects of climate change.

While the goal of reducing emissions provides some justification to upgrade building codes, a more immediate need is to address one of the most pressing effects of climate change: increasingly destructive wildfires.

The recent Camp Fire in California burned more than 13,000 homes.[6] It is yet another demonstration that fire codes in the United States are not sufficient to protect against wildfires. While energy efficiency may slow the increase in destructive fires, it's clear we must improve wildfire building survivability. Realistically, both of these goals can be achieved simultaneously and without unrealistically large outlays.

Few Americans realize that Europeans have been using materials in their buildings that make them both more energy efficient and significantly better protected against fires than standard American buildings. On top of this, European construction methods produce buildings that cost significantly less over their lifetimes than buildings in the U.S. It's time the United States embraced these modern building materials and techniques by changing building codes to jumpstart their use in this country, especially in areas where wildfires often occur.

A Brief History of Wildfires and Fire Suppression in the United States

The United States has a long and controversial history of wildfire suppression. For nearly a century, the U.S. government sought to eliminate all fires.[7] This program of complete suppression ended up causing significant harm to ecosystems and species that relied on periodic fires. It's been long known that before European colonization, the ecosystems we recognize as native were already shaped by humans through use of fire.[8] Native Americans routinely set fires for a variety of reasons including as a means of increasing forage for large game animals. Today we are still burning the landscape but at a much higher frequency than in the past. Approximately 90% of fires today are not natural; they are caused by sparks from power lines, burning waste, discarded cigarettes, and vandalism.[9] Lately, fires have become more severe in part because of a dryer landscape today than just a few decades

ago.[10] Property destroyed by fires has increased dramatically because of a large increase in the number of buildings and homes built in fire-prone areas. Regardless of the causes of climate change, the fact is that more homes and businesses are at risk from larger and larger fires as suburbs continue to expand into undeveloped, fire-prone areas.

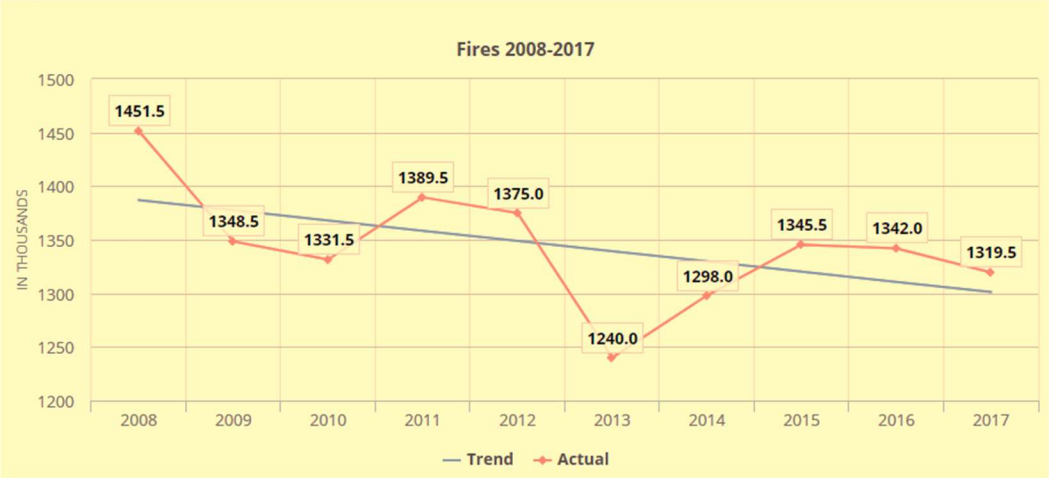
Many local and state governments enacted fire codes in reaction to fires that shocked the nation such as the Great Chicago and Triangle Shirtwaist Factory fires that killed hundreds of people.[11] These fires started inside buildings located in large cities. The resulting fire codes were designed to address these kinds of fires by ensuring that occupants could safely exit the building on fire and that the fire would not spread to adjacent buildings. These codes included prohibitions on the use of combustible materials such as wood to construct large buildings. But, smaller buildings, such as two-story homes, were exempt.[12]

Fire codes across most of the country still permit wood construction for homes and smaller buildings even in areas prone to wildfires because most codes are designed to provide occupants the opportunity to escape from fires inside the building, not from fires outside the building or home. In today's landscape where wildfires are larger and more intense, they can quickly encircle homes and businesses built in fire-prone areas cutting off any chance of escape. This was particularly evident in California's recent Camp Fire that killed 86 people.[13] Because buildings there had almost no resistance to fire, some victims who fled their homes found themselves trapped with no safe place to wait out the fire and died as the wildfire closed in around them.[14] In fact, the highly-flammable buildings made the fire much more destructive and deadly because the fire primarily spread from structure to structure rather than creeping along the ground like a normal forest fire.[15] Fires fueled by structures often leave houses in piles of ash while nearby trees remain alive and standing. The photo at the beginning of this article showing a development in Paradise, California in the aftermath of the Camp Fire is typical of that increasingly more common type of wildfire.

The Growing Cost of Wildfires

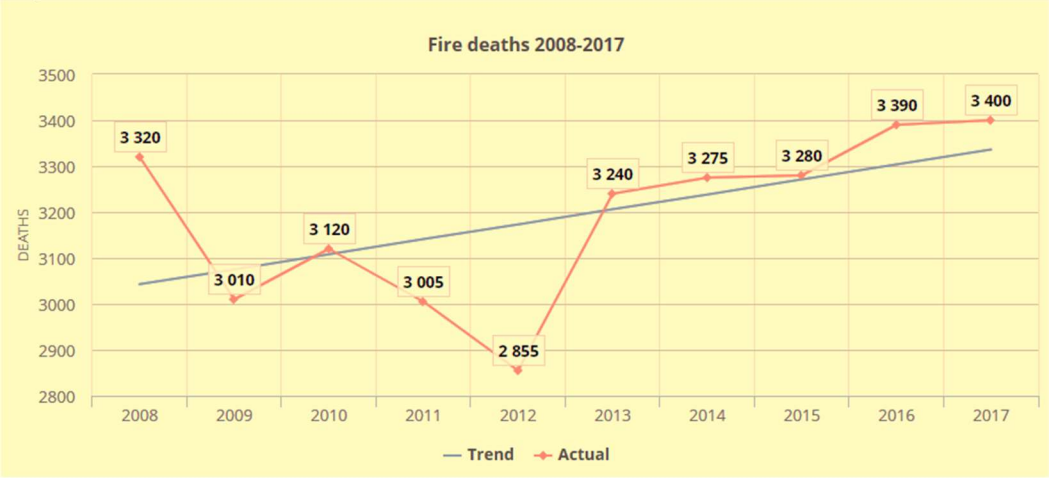
While the number of fires has been steadily decreasing in the United States, the number of deaths has not decreased and loss of property has been increasing (see Figures 1-3).[16] Between 2007 and 2017, 3,000 to 4,000 people have died each year as a result of fires (Figure 2).[17] Direct property loss ranged from $10 billion and $23 billion per year (Figure 3).[18] Indirect losses include lost economic productivity, environmental pollution, especially when hazardous materials are burned, and health care costs associated with air pollution.

Figure 1. Wildfires in the United States



Source: U.S. Fire Administration

Figure 2. Fire Deaths in the United States



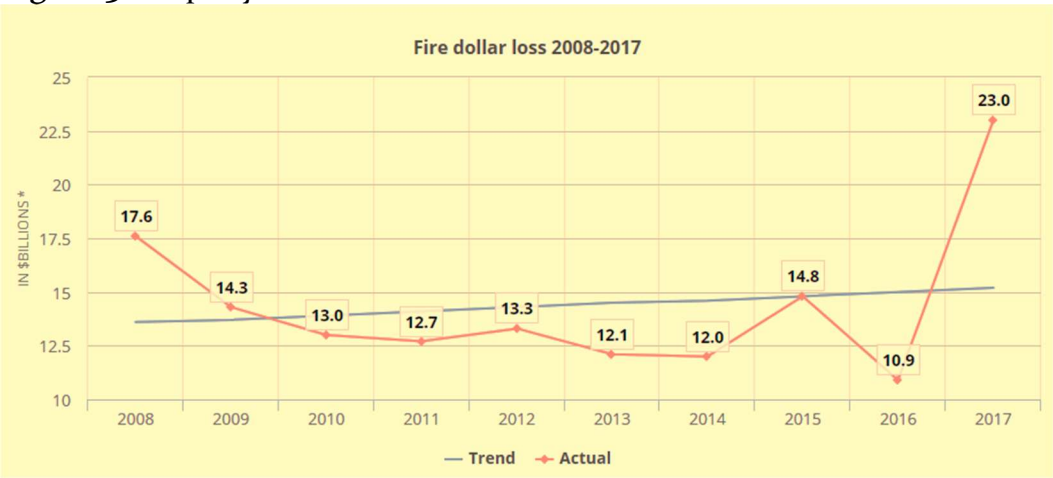
Source: U.S. Fire Administration

Large losses from wildfires occur because it is difficult to protect homes or developments surrounded by highly-flammable brushland or forests. Fire prevention efforts are stymied by these developments because typical management techniques such as controlled burns cannot be used because they run the risk of damaging nearby buildings. On top of this, few localities have zoning ordinances that factor in fire prevention.

None of these issues are new. They were presented to Congress in 2002, but little has been done to address them in the following 16 years.[19] One roadblock is jurisdictional. Unlike most European countries that have national building standards, the U.S. federal government does not have that authority.[20] The responsibility for building codes is vested in local

governments. The federal government can only provide them with suggested guidelines. Local control of building standards continues despite state and federal governments often paying to fight out-of-control wildfires and for the subsequent disaster relief and reconstruction. This typically occurs when the state or federal government declares a state of emergency to contain the fire.

Figure 3. Property loss due to fire in the United States



Source: U.S. Fire Administration

Broadening the coverage of building codes makes sense because if a local government fails to implement effective fire prevention measures, when a wildfire does occur, its failure puts adjacent areas at risk. Besides direct fire damage, the pollution fires create spreads far and impairs air quality well beyond local and state borders. Because the fire damage and pollution costs of wildfires are not limited to local or state boundaries, it makes sense for the federal and state governments to start regulating fire codes and imposing fire mitigation techniques. They would have the broader perspective of ensuring that one locality or state doesn't put another one at risk.

European Construction Techniques Are Green, Fire Resistant, and Cost Competitive

While future housing development design could benefit from better planning to mitigate the danger from wildfires, ultimately it's the building construction that is critical. Even with firebreaks, such as roads, sparks from a wildfire can easily float over them and ignite brush or other flammable materials next to or on houses quite a distance away.[21] Despite using some mildly fire-resistant materials, the exterior of homes in the U.S. will readily catch fire when flammable materials next to or on top of a building ignite.[22] The standard homes built in the U.S. are constructed with 2x4 lumber and

asphalt shingle roofs and are commonly called stick-built homes. Once the roofs or walls catch fire, they will burn down in a matter of minutes. In contrast, Europeans build their homes out of non-flammable materials that will not ignite from a wildfire. When Americans think of buildings built out of non-flammable materials, they usually think of brick, cinderblock, or poured concrete. However, Europeans have been using "modern" materials such as Autoclaved Aerated Concrete (AAC) and Poroton blocks (typically called Thermoplan or Ziegel blocks outside of Germany) for decades.[23]

Both AAC and Poroton blocks are produced using environmentally friendly manufacturing methods and are resistant to termites, mold, mildew, and fire.[24,25] AAC is a precast concrete building material, used widely in construction around the world, that is light weight and highly insulating due to a manufacturing process that aerates the concrete. It comes in a large variety of shapes and sizes from block shaped to large panels. In contrast, Poroton blocks are made of fired clay, like bricks, and are larger than cinder blocks but weigh less due to multiple hollow channels throughout the block that give it a honeycombed look. Similar to AAC, its manufacturing process produces air bubbles making the blocks pumice-like and yields a much higher insulation value than traditional non-porous bricks. The Poroton blocks typically have an interlocking design that allows for quick construction without a need for mortar between adjacent blocks.[26] Both Poroton blocks and AAC use very similar construction methods that require very little skill or labor: they both only need thin-set mortar, can be cut using standard saws at the construction site, use U-shaped blocks filled with reinforced concrete at the top of each exterior wall, and can be routed for cables and plumbing.

Besides using Poroton or AAC for walls, interior floor construction in Europe uses reinforced concrete and nearly all roofs are covered in ceramic or concrete tiles.[27] In effect, virtually all structural materials used to construct a European house are non-combustible with the exception of roofing beams, which continue to typically be made from wood. If American homes and buildings were constructed using European construction methods, there would be significantly less property damage and probably fewer casualties as a result of fires or other natural disasters. As one fire research scientist stated in the aftermath of the Camp Fire, "A house that doesn't burn is the best place to be during a wildfire." [28]

If American homes started using European building materials and methods, one of the top concerns would be price. Comparing European costs to those in the U.S. can be difficult given that American homes are bigger on average and Europe has higher taxes, specifically the value added tax that applies to both materials and services.[29,30] Using Germany as an example, the

average cost to build the exterior of a home, including foundation and roof but excluding windows and doors, is approximately $50 per square foot.[31] The exterior shell of an average home in the U.S., using stick-build construction, costs slightly more at $53 per square foot.[32] Given the number of differences between Germany and the U.S., it would be hard to say home construction costs would definitely go down if homes started using AAC or Poroton blocks, but it should be safe to say the costs wouldn't change much. When just looking at the costs of using fire-resistant concrete or clay tile roofs instead of the standard asphalt shingles, the costs are not that much higher. Within the U.S., asphalt shingles cost between $0.70 and $1.60 a square foot compared to $1.50 to $2.50 for concrete tile and $3.00 to $6.00 for clay tile.[33] Factoring in that concrete tiles last twice as long as asphalt shingles and clay tiles last many times that, the overall lifetime cost differences are rather small.

The Barriers for Adopting European Construction Techniques

So, the question is: why don't American's use European materials and construction methods? Many blogs debate this question.[34] One primary reason is simply a lack of familiarity in America with European building methods and materials, especially among architects and contractors.[35] Even when introduced to European building materials like AAC, most contractors are unwilling to work with it because using completely different building methods puts them too far out of their comfort zone.[36] A few manufacturers have attempted to bring AAC to the U.S. with very limited success in the South. Because AAC use is rare in the U.S., the material costs and labor costs associated with it are higher here than in Europe – so much higher that the costs of building with AAC makes their use unaffordable at the lower end of the housing market despite the lower long-term costs associated with lower maintenance. Often, Americans that have seen European construction and materials and want to replicate a European home in the U.S. usually find out they can't get the materials because there are few or no manufacturers and they can't find contractors who are familiar with the building methods or are willing to learn to use them.[37]

A second reason for not adopting European building technology is that its long-term benefits are not easily marketable in the current U.S. environment. There is a disconnect between the people who fund the upfront capital costs and the people who pay for the maintenance and energy costs. Developers have little incentive to build homes that have higher upfront costs since maintenance and energy costs aren't typically provided to prospective buyers or factored into the overall cost of the home. Mortgage lenders also rarely figure in lower maintenance and energy costs into their

lending calculations.[38] In many ways, it's ultimately a cultural issue. Europeans tend not to move often or far from where they were born and therefore are interested in the long-term cost of their homes.[39] In contrast, Americans move more frequently and are typically only interested in the short-term costs. This has led to a prevalence of cheap, inefficient houses which now dominate the U.S.

The Benefits of Adopting European Construction Techniques

Germany, which usually tops the list of most efficient countries, is at the forefront in its use of modern materials in its buildings.[40] Their construction methods produce buildings and homes that are more durable, require less maintenance, are more energy efficient, and cost significantly less over their lifetimes than stick-built construction. Due to their higher insulation values than AAC, Poroton blocks are now used by Germans on the majority of new homes.[41] Poroton blocks used on the exterior of the home have rock wool or other insulation added to its honeycombed cavities that, depending on the type and size of the block, have an insulation rating that's 20% to 120% higher than a typical 2x4 wall in an American home.[42,43] Even so, many Germans opt to add another layer of insulation to further increase the efficiency of their homes. Additionally, Germans and other Europeans typically use high-efficiency windows that have insulation values 40% to over 200% better than Energy Star guidelines.[44,45] Though European countries don't suffer from hurricanes, Germany and other European countries frequently install rolling hurricane shutters over their windows, mostly for temperature control, privacy, and security.[46] Because their homes are highly insulated, most new German houses include a heat or energy recovery ventilator that brings fresh air into the house and minimizes heat gain or loss by exchanging heat between the exhausted air and the incoming fresh air. This contrasts with homes in the U.S. that leak so much conditioned air that there's no need for active ventilation.[47] Lastly, German roof tiles, which are typically concrete or ceramic, have lifetimes of 60 to 80 years and often come with 30 to 50 year warranties.[48] While there are further efficiencies in German construction on the interior, the sturdy and efficient construction of the exterior goes a long way in explaining why Germans on average spend 82% less on home insurance and use over 65% less energy compared to the average home in the U.S.[49-54]

The Way Forward

There are three major first mover obstacles manufacturers need to overcome to introduce products like AAC and Poroton blocks to the U.S.: (1) most Americans have no idea the materials exist; (2) very few contractors are

willing to learn an entirely new way of construction; and (3) because of high transport and import costs, manufacturers must build manufacturing plants in the U.S. to be cost competitive relative to stick-built construction. Given that AAC and Poroton blocks have been around for over 50 years and neither has gained ground in the U.S., it's likely that without some help from the government, manufacturers will continue to be unable to get a foothold in America.

A change in building policy requires a change in public focus on wildfires. The news media mainly investigate who caused the wildfires. It's rarely mentioned, as in the recent Camp Fire in California, that when highly flammable homes are built in fire-prone areas, the risk of property damage and loss of life increases dramatically. While utilities like PG&E aren't blameless for starting wildfires like the Camp Fire, they aren't entirely to blame for the damage or deaths caused by them. Ultimately, all three levels of government need to acknowledge that they are primarily to blame for the damage and casualties fires cause due to inadequate building standards. If governments continue to allow people to build flammable houses and buildings in fire-prone areas, then they should expect the cost of fires to continue to increase. If governments change course and impose strict building standards that mandate that houses and buildings be built from non-combustible materials, then the damage and loss of life, like that caused by the Camp Fire, would be much more limited.

Proposals like the Green New Deal are correct when they state we could do a lot better when it comes to constructing more energy efficient homes and buildings. However, the Green New Deal does not recognize that using modern materials could increase energy efficiency while simultaneously mitigating the effects of climate change by making homes and businesses highly resistant to fires and other natural disasters. It makes sense to impose higher standards for both energy efficiency and resistance to fires because homes and buildings typically last for 100 years or more. Looking long-term, low-maintenance, highly efficient, and durable homes and buildings save money and the environment. Because the effects of climate change and wildfires are not limited to local boundaries, states and federal governments should consider setting minimum standards for energy efficiency and fire, wind, and hail resistances. The federal government should consider providing incentives to manufacturers of AAC and Poroton blocks to build plants in the U.S. and should provide training programs to teach contractors European construction techniques. The increase in standards coupled with the introduction of modern, European materials will save Americans money, protect the environment, and save lives.

Authors

Ephram Glass is an independent utility consultant specializing in smart grid services and enterprise asset management. In his thirteen years in the industry, he has worked on load growth planning, renewable energy and demand response regulatory affairs, generator interconnections, compliance, cyber security, transmission and distribution automation, reliability, analytics, asset accounting, resource management, and project management. He earned a Bachelor of Science degree in Electrical Engineering from Princeton University.
email: ephramglass@gmail.com

Victor Glass is Director, CRRI Scholar, and Professor of Professional Practice - Finance and Economics, Rutgers Business School - Newark and New Brunswick, Rutgers University. Prior to joining Rutgers, Dr. Glass was Director of Demand Forecasting and Rate Development at the National Exchange Carrier Association. For almost thirty years, he was responsible for forecasting demand and setting switched and special rates for more than 1100 telephone companies. He was heavily involved in access restructure, universal service reform, and new access services. He is the lead author of many business and academic studies. Dr. Glass earned his MBA in marketing and finance, and Ph.D. in economics from Columbia University.
email: vglass@business.rutgers.edu

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