NET ZERO EVERYTHING

The world is moving toward a zero sum game of resource production, use and reclamation.

Here's a primer on the strategies and products that can help us get there faster.

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EMBRACING A FLEXIBLE FUTURE

BY SARA GUTTERMAN

The world is undeniably changing. The trifecta of enhanced consumer awareness, bold corporate commitments, and ratcheted regulations are quickly shifting our economy to net zero energy, water, and carbon. How can you stay abreast of the rapidly evolving market? Consumer demand for climate positive products, homes, and policies is transforming the rules of engagement across all sectors of our economy.

Within the building sector, the vernacular is moving from net zero energy, which focuses on operational efficiency, to full-scale decarbonization, addressing embodied carbon, or the total amount of emissions generated during the manufacturing, transportation, construction, operation, and end-of-life phases of the building process.

Reaching net zero carbon will not only require us to rethink how we design and build structures, but also how we draft land-use policies, codes, and regulations. This is a colossal task, no doubt, but one that is arguably essential for our very survival. Here's a primer.

NET ZERO AT HOME

ZERO SUM GAME. *This net-zero home in Driftwood, Texas won a Green Builder Meda Green Home of the Year Award for 2022.*
PHOTO: MARK ADAMS

The built environment is one of the most conspicuously consumptive industries and has a tremendous impact on carbon and other greenhouse gas emissions. The sourcing and manufacturing of materials, construction process, and ongoing operations of homes and buildings require an immense amount of energy and emit a substantial amount of pollution.

The Department of Energy (DOE) estimates that homes and buildings in the U.S. account for 40 percent of our nation's total energy use, 70 percent of electricity use, and 40 percent of total emissions.

On a global scale, it's expected that 2 trillion square feet (equal to the built environment in New York City) will be constructed every 35 days for the next 35 years, which makes getting to zero an absolute imperative.

Fortunately, the transition to net zero energy in the built environment is underway, irrespective of location, climate and political jurisdiction.

The ROI of net zero energy homes is penciling out in markets throughout the nation, yielding quick payback periods for efficiency upgrades, as well as enhanced experiences for occupants, lower ongoing operations and maintenance costs and higher resale values.

For building professionals who are looking for a roadmap to zero, the DOE's Zero Energy Ready Program offers a cost-effective way to get a building envelope to a HERS 40 score. Then, by specifying energy efficient HVAC systems, water heaters, appliances, and lighting and sizing the best, most durable solar array to close the gap, you have a ready-to-go, performance-based, net zero solution.

EFFICIENCY FIRST

Any conversation about getting to net zero must begin with energy efficiency. Net zero energy "must-haves" include:

- **High-performance, well-insulated, air-tight envelope on all 6 sides of the structure**
- **Super-efficient, right-sized HVAC system**
- **Good windows, with less than .25U and .25 solar heat gain**
- **Cost-effective, energy efficient appliances and lighting**
- **Heat pump technologies for air and water heating**
- **Access to renewable energy (rooftop or community solar array or a grid-tied system)**

RAISING THE STRUCTURAL BAR

The first line of defense in any energy strategy, advanced structural systems have come on stronger than ever due to market changes and climate concerns.

The construction industry (and the entire economy) has been impacted by soaring material costs, labor shortages and material shortfalls. These challenges have driven up the cost of a typical American home by up to $50,000 in some markets. Nimble builders, however, have reduced this inflationary factor, at the same time improving their homes' performance. How? By switching to alternative structural systems, such as Insulated Concrete Forms, which have not been affected as dramatically by market pressures.

Building professionals have also taken a second look at Structural Insulated Panels (SIPs), panelized wall systems, and prefab construction.

Each of these systems has perks over traditional stick framing, be it in superior energy efficiency, consistency, resiliency, quality control or waste reduction.

As one example, Nudura's Plus Series ICFs can offer R values as high as R-48. Lightweight forms can be shipped at reasonable cost, and are easier to deal with on site than heavy dimensional lumber. The forms include snap-together hardware and can be assembled quickly by crews that can be brought up to speed with less time in the field. Resulting walls are extremely hurricane resistant and super-efficient in hot or cold climates.

With R-values as high as R-48, Nudura Plus+ Forms can be assembled quickly and easily onsite, for optimal energy performance.

FACTS ABOUT NUDURA'S INSULATED CONCRETE FORMS

For the general contractor new to Nudura ICFs, how does the labor process work? Will he/she need to give employees formal training in ICF install?

Yes, Nudura offers learning opportunities (both in-person and online) for architects, builders, engineers, contractors, homeowners, design professionals and other industry members who are interested in learning more about building with Insulated Concrete Forms. The Nudura Basic Installation Training Program is the first step in learning key installation skills required, for building homes and light commercial structures with Nudura ICFs.

Does Nudura provide video training etc?

Yes, Nudura offers an extensive library of online training resources. From a self-paced online Basic Installation Training Program, to numerous YouTube videos, and several registered AIA courses, Nudura has the online resources to support the learning process from start to finish.

For coastal building and rebuilding, how is a Nudura ICF structure more resilient in the face of hurricanes and flooding?

Nudura provides a poured-in-place, fully reinforced monolithic concrete structure that has proven to withstand some of the worst extreme weather events. Nudura ICF walls can be designed to withstand winds up to 250 mph (402 kph), equivalent to an F4 tornado, and provide fire protection for up to 4 hours.

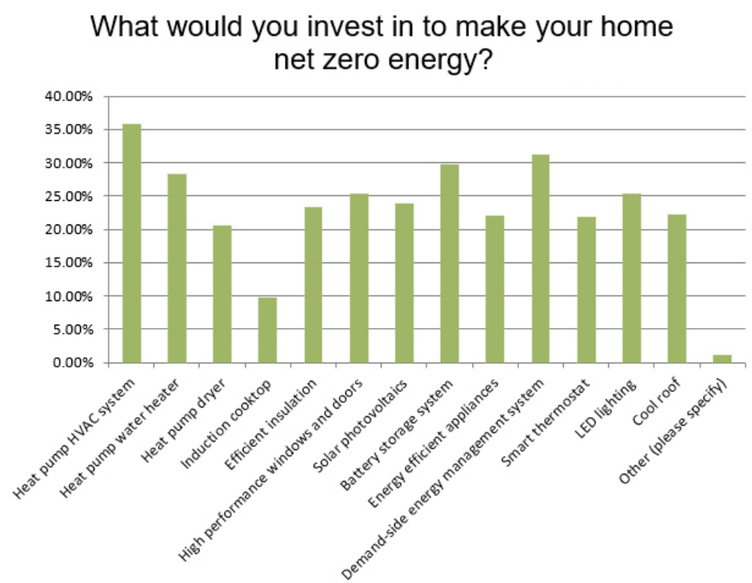
3. Do ICFs offer advantages in climates with extreme heat days on the rise?

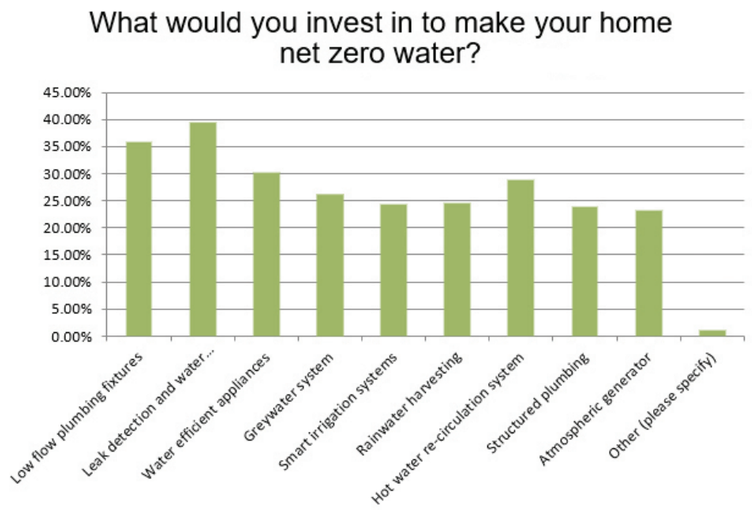
Absolutely, the ICF walls substantially reduce peak loads on the building's mechanical equipment. The monolithic concrete is layered between two continuous panels of EPS foam, which isolates the concrete, and significantly reduces the flow of heat through the wall. The Nudura ICF walls have a high storage capacity with low thermal conductivity, providing the most useful Thermal Mass level. This helps to stabilize the internal temperature of the building from day to night temperature fluctuations and provides a largely self-regulating environment.

WHAT WILL BUYERS PAY FOR?

HOMEBUYERS SAY THEY'RE WILLING TO EMBRACE BUILDING TECHNOLOGIES THAT GET THEM CLOSER TO NET ZERO LIFESTYLES.

A recent COGNITION Smart Data survey indicates that consumers are willing to pay for heat pump HVAC systems, demand side energy management systems, battery storage systems, and heat pump water heaters to make their homes net zero energy.





ADVANCES IN BUILDING TECH

Beyond the building envelope, advances in HVAC systems, windows, solar, cavity insulation and smart controls are further facilitating the transition to zero.

Heating & cooling systems account for approximately 55% of household energy use, so it makes sense to invest in high performance technology, such as variable speed heat pumps.

While heat pumps have existed in the global market for almost 30 years, they are now reaching a tipping point in the U.S. due to a blend of technology advancements, enhanced codes, incentives, consumer awareness, and builder/contractor education.

Today's advanced heat pumps use approximately one-third of the energy for heating and cooling as conventional technologies, and newer heat pumps can operate in extreme temperatures. Furthermore, developments in variable speed motors means that heat pumps can run quietly and ramp up or down more quietly and efficiently, making them more flexible and viable for integration with renewable power sources.

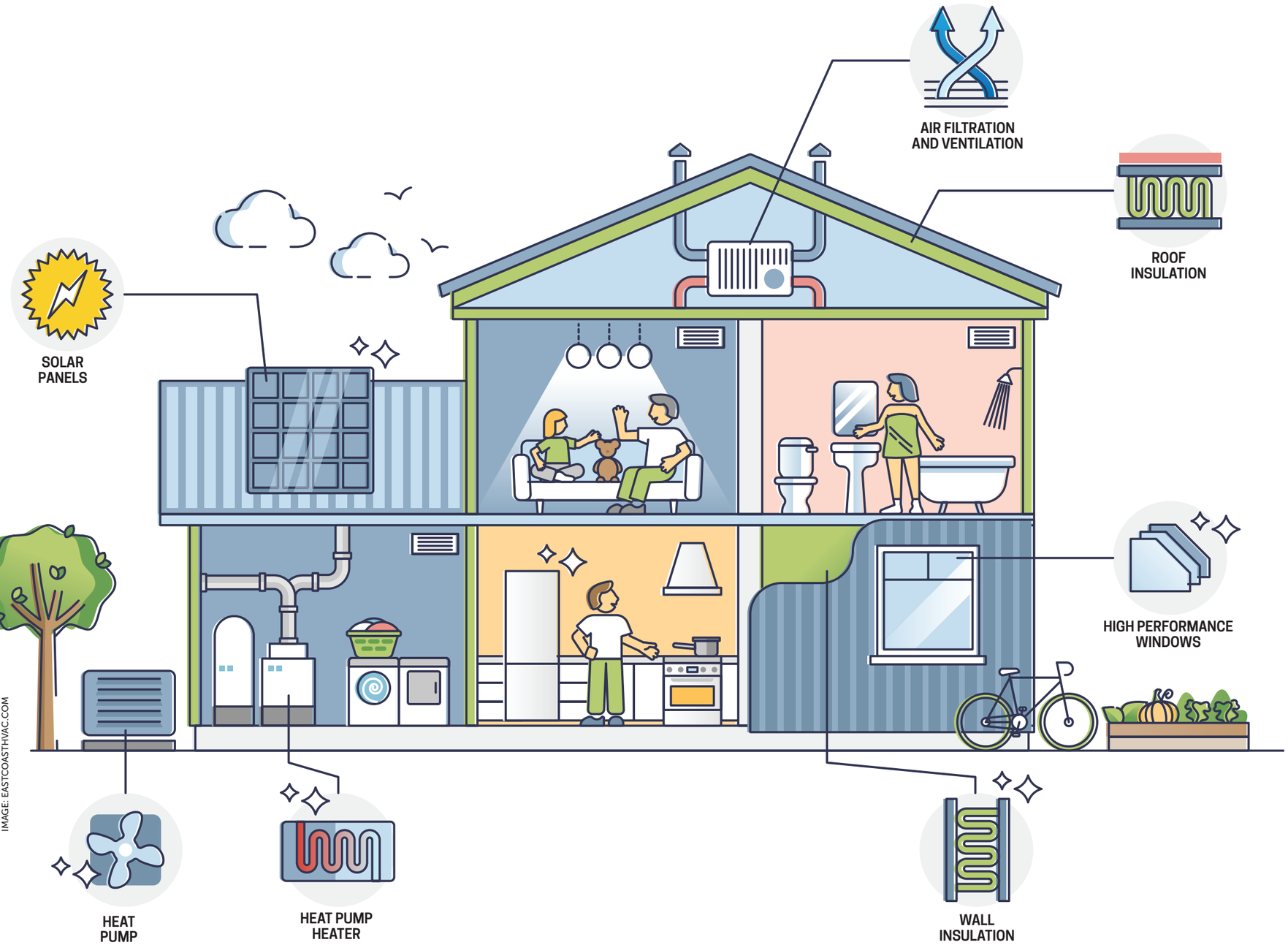
HVAC manufacturers are not only making systems more energy efficient but, they're also creating solutions that safeguard indoor air quality, which can reportedly remove up to 99.9 percent of harmful airborne particles, such as bacteria, pollen, and even COVID, in 30 minutes.

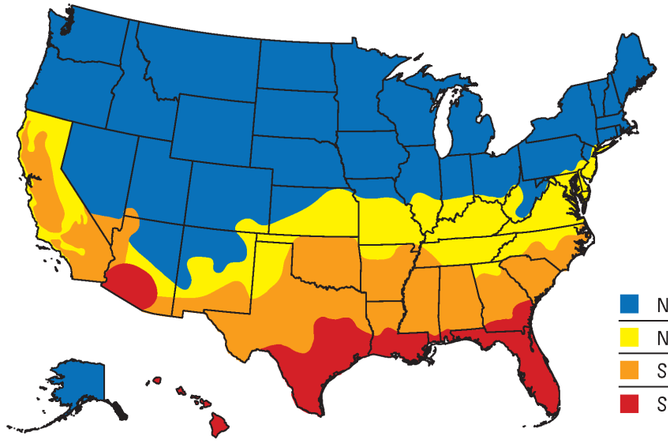
IMAGE: EASTCOASTHVAC.COM

HEAT PUMPS. *Electric heating technology cuts air conditioning cost-per-btu by up to 70 percent, and can also be used for heating.*

Windows and doors. Fenestrations generally constitute the weakest link in a building envelope. Improving their performance thus plays a major role in getting to zero. Up to 30 percent of a typical American home's energy can escape out of the windows and doors, representing an estimated $50 billion dollars in annual energy leakage in the U.S.

Standard windows used today have an R-Value between R-3 and R-5. According to the Department of Energy, increasing from





COST SAVINGS. *Upgrading windows from single pane to double pane results in significant energy savings. Adding low-E glazings raises the bar even more.*

	AVERAGE ANNUAL HEATING AND COOLING SAVINGS WHEN REPLACING	
	Single-pane windows	Double-pane windows
Northern Zone	**$366 (22%)**	**$134 (9%)**
North-Central Zone	**$236 (20%)**	**$87 (8%)**
South-Central Zone	**$319 (31%)**	**$108 (14%)**
Southern Zone	**$280 (31%)**	**$126 (17%)**

Source 2015: D+R International in support of ENERGY STAR®. Savings estimates are based RESFEN 6.0 modeling of 8 home profiles across 93 U.S. cities. Home profiles include new construction or existing construction, single-story (1,700 square feet) or two-story (2,600 square feet), and natural gas or electric heating. Savings estimates for each city represent the average of the 8 home profiles in that city. Climate zone savings estimates represent the average savings among the cities in each climate zone. Cost savings calculations used 2013-2014 average natural gas prices and 2012-2013 average electricity prices for each state from the Energy Information Administration (EIA). Actual savings will vary by local climatic conditions, utility rates, and individual home characteristics. Hawaii was excluded from this analysis, as the assumptions in RESFEN 6.0 diverge significantly from the norm in Hawaii. Savings for all climate zones are for whole-home replacements with ENERGY STAR Version 6.0 windows.

R-3 to R-5 will reduce the average heat loss in a home by 30 to 40 percent (depending on the climate zone).

While high-efficiency windows can cost anywhere between $70 and $150 per square foot (compared to basic vinyl framed windows, which cost between $25 and $70 per square foot,) the upfront investment yields a relatively quick payback period and then nets positive for a homeowner for the lifetime of the windows.

Solar plus Storage. New rules under California's Model Energy Code will require all new homes to include both photovoltaics and home battery storage. This trend is likely to spread across the United States. The impetus behind the rule change is two-fold. First, demand for electricity is about to rise dramatically as we shift from combustion to electric vehicles, and second, due to this shift, utilities don't want to build new fossil fuel plants, but need extra energy supply. When combined with demand side energy management (described at right), renewable power offers a decentralized source of energy that can prevent blackouts and result in much less CO_2 entering the atmospere.

IMAGE: PANASONIC SOLAR

UNDERSTANDING DEMAND SIDE ENERGY MANAGEMENT

This term, abbreviated as DSEM, describes smart home systems that automatically adjust power use in the home based on real-time local utility demand.

This shift has become essential in the quest for zero. Smart devices enable load shifting (the ability to draw less energy from the grid during peak demand when energy costs are at their highest) to reduce grid stress and increase cost savings. Utilities, municipalities, and cities across the country are implementing DSEM programs, with the highest adoption in states like California, New York, Vermont, Washington, Oregon, Colorado, Minnesota and Utah.

Advanced energy monitoring devices, such as Schneider Electric's Wiser smart home power monitor, allow homes and buildings to have a sophisticated 2-way dialogue with the grid for optimized load shifting.

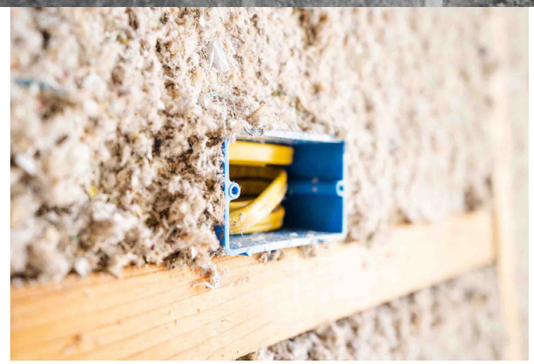
And breakthrough technology, such as solid state power management systems, can digitally control the electricity use of every device and endpoint in a structure, enabling any home or building to seamlessly add IoT functionality to outlets, security systems, circuit breakers, lighting fixtures, appliances, and dimmer switches.

Insulation. Upgraded insulation and air sealing can save an average of 15% on heating and cooling costs. Whatever type of insulation you choose, the key is to be certain all gaps are filled completely, and any cracks or gaps in walls are filled with a suitable caulking or otherwise taped or sealed.

Along with R-value, insulation differs in terms of what it's made from and what applications it is best suited for. Cellulose insulation, for example, is popular among green builders, because it's made from 85 percent post-consumer recycled paper products, and, when used to fill wall cavities or blown into attics, has exceptional sound deadening qualities. Greenfiber (shown) also has a new product spec that will create a two-hour firewall between townhouses. This could be a game changer for quality of life for those buyers, because it not only quiets sound, but it also reduces the transfer of cooking smells through the wall.

One common practice now is to create a "hybrid" wall envelope by combining caulking with loose fill insulation and sealing small leaks inside the wall with caulking before filling the cavity. This results in a super-efficient wall with minimal leakage.

It's not always necessary, however, to add additional caulkings and sealants to achieve good air tightness. For example, the Building Performance Institute issued performance standards in 2010 suggesting that if you apply packed cellulose to a density of at least 3.5 lbs. per cubic feet in wall cavities, you achieve a very tight wall. What's considered "tight?" Limit airflow that corresponds to an air permeance value of ≤ 3.5 cfm/sq ft at 50 Pascals. You may be able to achieve this with other insulating materials as well, if you can pack them tightly enough.



NATURAL FIBERS. *Greenfiber's All-Borate treated Stabilized Spray Insulation resists pest, fire and settling, and can be sprayed directly into wall cavities. Builders and Architects can get more information on their WEBSITE.*

A RENEWABLE ENERGY REVOLUTION

TO GET TO ZERO, WE NEED A FULL-SCALE ADOPTION OF RENEWABLE ENERGY, AS WELL AS THE ADAPTATION OF INFRASTRUCTURE, REGULATIONS, AND FINANCING TO SUPPORT THE TRANSITION.
BUT HOME TECHNOLOGY ALSO MATTERS.

Fortunately, the clean energy future is already here. Wind and solar energy are now cost-competitive in most parts of the world, and clean energy technologies can now harvest more power using less space and fewer resources than ever before.

In fact, studies by Environment America show that solar panels and wind turbines are approximately 40 percent more efficient than those produced a decade ago. In the same timeframe, the cost of wind power has dropped by 71 percent and utility-scale solar by 90 percent.

To complement advances in solar and wind technology, the battery storage market is evolving at breakneck speed. The cost per watt-hour of utility-scale battery storage has fallen dramatically, down 70 percent since 2015.

ELECTRIC ALL THE WAY. *Transitioning away from gas heating and cooking has become a municipal norm already in certain cities.*

All Electric Living

As we transition to net zero energy, we're also shifting to full electrification in the built environment.

Electric homes are not a new concept in the U.S. In fact, according to the U.S. Energy Information Administration, nearly 40 percent of all homes nationwide are all-electric, most of which are located in the South.

Jurisdictions across the country are requiring new homes and commercial buildings to electrify. 51 municipalities in California (including Berkley, San Luis Obispo, Mountainview, Sunnyvale, Santa Monica, and Oakland) have created codes that ban natural gas hookups and have added incentives, like density bonuses, for builders/developers who choose to go all-electric. Cities in New York, Massachusetts, Oregon, Texas, New Mexico, Washington and Louisiana are following suit.

The electrification of homes is expected to increase worldwide over the next decade, with a projected market growth from $2.4 billion in 2020 to $12.9 billion in 2029 for electrified home technologies such as air-source heat pumps, heat pump water heaters, and induction cooking technologies.

According to the EPA, the switch to an all-electric built environment will reduce our national emissions by approximately 560 million tons of CO_2 each year.

Codes in Play

While increased consumer demand for climate solutions and bold corporate environmental, social, and governance (ESG) commitments are accelerating the transition to zero, ratcheted codes are the true keystone.

California, the harbinger of all things sustainable, is marrying its energy code with decarbonization targets. According to Andrew McCalister, Commissioner at the California Energy Commission, the State has adopted a strict version of the 2022 energy code (set to be implemented in January 2023) and has set its sights on decarbonizing its electric grid by 2040.

To further align the energy code with decarbonization, California has adopted a new way to value energy costs—rather than just deploying a use-cost metric (which is a time-dependent valuation to measure the average cost of energy over time), the State is now incorporating a second metric that tracks source energy (tracing power back to its source), which provides a more accurate assessment of carbon emissions.

"We can no longer separate net zero energy from net zero carbon," insists McCalister.

And his words couldn't be more accurate—while getting to net zero energy is paramount if we're going to reach our climate goals, the cold, hard truth is that net zero energy isn't enough.

To even have a remote chance at remaining under a 2-degree Celsius temperature increase, we must eliminate carbon emissions from the entire building lifecycle, from product sourcing to construction, operations and end-of-life uses.

SOLAR MANDATES. *New rules for California taking effect in January require both solar panels and battery storage on every new home.*
PHOTO: PANASONIC SOLAR'S EVERVOLT SYSTEM.

WILL BUYERS DO THEIR PART?

Our survey data shows that consumers are willing to pay for leak detection and water management systems, low flow plumbing fixtures and water efficient appliances to make their homes net zero water.

Net Zero Water

Water is humanity's most vital natural resource. The perilous threats to global water availability and quality pose alarming sustainable development challenges.

Water and climate are inextricably linked—climate impacts often manifest as water problems. Warmer temperatures and changing weather patterns affect water sources, placing tremendous stress on water reliability, accessibility, and quality.

Increased precipitation in areas like the Midwest, Northeast, and Southeast has led to excessive flooding, erosion, pollution runoff, and damage to surface water and drinking water sources.

Extensive drought in the American West has depleted regional water sources and threatened waterways and reservoirs.

Rising sea levels and superstorms along the seaboards have compromised coastal aquifers and wetlands.

And that's just a short list of early climate change impacts.

Precious Resource Under Threat. According to the World Resources Institute, two-thirds of the global population will live in water-stressed areas by 2025 as a result of climate change, population growth, rising water consumption rates, unsustainable water withdrawals, poor infrastructure, and weak local governance.

Humans consume about 9,087 billion cubic meters of water per year, a number that is increasing by nearly 2 percent annually. The leading offenders are China, India and the U.S. consuming 1,207 billion, 1,182 billion and 1,053 billion cubic meters respectively, followed by Brazil at 482 billion.

In the U.S., skyrocketing population growth in dry regions is intensifying water demand beyond current capacity limits. In the water-parched West, experts predict 100 percent growth in Nevada and Arizona by 2030, 60 percent in Texas, and upwards of 30 percent in California and Colorado.

Already experiencing dramatic water shortages, some of these high-growth areas are implementing stringent water policies, regulations, pricing structures, reporting and drought contingency plans to manage water availability.

As need to solve for water availability becomes increasingly dire, so too is the urgency to address water quality: Our dilapidated infrastructure and high levels of water pollution place the U.S. at a shocking 64th position in the World Health Organization's drinking water quality assessment.

Water and the Built Environment. While power production and agriculture account for the majority of water use in the U.S., managing water in homes and buildings is paramount.

And make no mistake, anyone and everyone in the building industry, or in business for that matter, should be paying attention to water, as it is the number one prohibiting factor to growth: If there is no water, there will be no permits.

Unfortunately, archaic water laws sometimes stand in the way of common-sense solutions. Nonetheless, net zero water is now an attainable goal through the deployment of technologies and strategies that address water conservation, monitoring, recycling, and environmentally appropriate discharging practices.

States and cities from coast to coast are tackling clean water scarcity through the implementation of stringent water policies and pricing mechanisms. Santa Fe, NM, for example, has the most rigorous water regulations and highest water prices in the country, and correspondingly, the lowest per capita water usage (87 gallons per person day.)

California has set an aggressive goal to limit water use to 55 gallons per person per day by 2050 (indoor use only).

Other municipalities, like Westminster, CO, are integrating water data into planning processes, using sophisticated GIS software to overlay water resources and infrastructure to measure total water impact before issuing building permits.

Water offset programs are proliferating as well, requiring that builders and developers submit net zero water plans to get proj-

ROCK BOTTOM? *Persistent drought has lowered water level in Lake Mead to historic levels.*

ect approvals.

Exploding water tap fees have contributed to surging home prices and development delays in markets like Fort Collins, CO, where hookup costs have increased by up to 400 percent.

Bainbridge Island, WA, and Osceola, FL, are examples of cities that have placed temporary moratoriums on building due to depleted water sources.

As the stress on our water resources continues to increase, comprehensive net zero water strategies are becoming essential—and cost-effective.

The formula for developing a successful water management strategy isn't complicated, but it does take forethought.

• *Take stock.* The first step is to develop situational awareness and an accurate water assessment, keeping local water risks, regulations, pricing, climate impacts, and solutions in mind.

• *Plan.* Then, determine appropriate water objectives and risk mitigation strategies, and finally,

• *Apply tools.* Identify innovative water technologies that can conserve water and safeguard quality. Implement sensors and monitors to offer real-time data, and create an ongoing monitoring and management plan.

Water Innovations

Fortunately, the water sector is experiencing substantial innovation and technological advances that provide solutions for any water management plan.

Low flow faucets, showerheads, toilets and appliances are a must-have the net zero water equation.

According to the EPA, modern low-flow faucets reduce water flow by 30 percent, saving approximately 700 gallons of water a year (the equivalent of 40 showers' worth of water.) Low flow toilets now use 1.28 gallons or less per flush, reducing water use by 54 percent and saving homeowners as much as $110 per year.

When it comes to homes, more than 50 percent of water is used in bathrooms—showers and baths account for approximately 25-30 percent, and toilets make up about 20-25 percent. Greywater systems, like Greyter, capture and reuse shower and bath water so that it can be used again for flushing, reducing interior household water use by as much as 25 percent.

Leak detection and water monitoring systems, like Phyn, also play a pivotal role, automatically shutting off water when leaks are detected to save water and protect homes, and also offering homeowners insights into how they're using water and where savings can be achieved.

Outdoors, smart irrigation systems, like Rachio, can create tailored schedules that meet a yard or garden's specific watering needs (based on climate, seasonality, weather, and other factors), dramatically reducing water use and saving up to 50 percent on water bills. Organic lawn care strategies and xeriscaping (planting native and drought-resistant vegetation) can also save water, time and money.

Other important water innovations include:

• On-demand hot water recirculation systems that can be turned on with a switch so that they don't run continuously, using more energy than needed

• Rain/roof water harvesting systems with holding tanks and filtration systems so that water can be reused for indoor or outdoor applications

• Atmospheric generators that pull water out of the air for fresh water supply

• New water meters with auto/remote shut off

• Groundwater recharge products such as permeable pavers

In combination with water innovations, water programs are starting to gain traction, such as the Water Efficiency Rating Score, or WERS, a performance-based rating for residential water efficiency.

Certainly, there is no one-size-fits-all approach for reaching net zero water, but codes and regulations will play an important big role.

And, of course, increased consumer awareness will be paramount, requiring a combination of education and incentives to facilitate a behavioral paradigm shift.

powershift by NVEnergy

Business Energy Services

Reduce Your Business's Energy Expenses and Boost Your Bottom Line

PowerShift Business Energy Services provides cash incentives for existing facility improvements, major renovations and new construction. We have helped Nevada customers save more than 2.4 billion kWh, which equals $182 million in savings.

Energy management is one of the most promising profit improvement and cost reduction strategies available for businesses.

Customer Benefits

- **Annual Long-Term Cash Savings**
- **Reduced Operating Costs**
- **Improved Employee & Customer Comfort**
- **Reduced Carbon Footprint**

Why Work with a Contractor

- **Trained on Program Offerings**
- **Verified References**
- **Completes Paperwork**
- **Ensures Highest Savings**

LIGHTING

Lighting is estimated to offer the largest and most cost-effective potential for energy savings of any commercial building end use.

HVAC

Commercial buildings spend approximately 40% of their electricity usage operating HVAC (heating, ventilating and air conditioning) systems.

COMMERCIAL KITCHEN

Cooking appliances account for about 12% of the electricity bill in a typical restaurant.

REFRIGERATION

Refrigeration equipment in grocery stores, convenience stores and restaurants typically accounts for 25%-60% of total electricity consumption.

COMPRESSED AIR

Compressed air accounts for approximately 10% of a typical facility's electrical use.

Earn a 20% Bonus on Retrofit Projects

Early retrofit applications for NV Energy business customers can qualify for an extra 20% cash incentive bonus. Conditions apply.

Follow These 3 Easy Steps to Apply

STEP 01 — SUBMIT PRE-APPLICATION

STEP 02 — RESERVE INCENTIVE FUNDS

STEP 03 — COMPLETE PROJECT, SUBMIT FINAL APPLICATION

Save **Energy** & **Money,** Year After Year

PowerShift Incentives Available

Building Retrofits

Take advantage of incentives for energy efficiency equipment upgrades and improvements including lighting, cooling, commercial kitchens and more.

New Construction

New buildings that exceed energy code requirements by 5% or more may be eligible for incentives. Prescriptive, performance- or whole building-based measures are available.

Small Business

Save money on energy efficiency projects with lighting and equipment incentives and technical support tailored to your small business.

Nonprofit Agency Grants

Nevada's 501(c)(3) nonprofit organizations save money and energy with grants from NV Energy.

Get our free interactive Business Energy Savings Guide to learn more and discover what projects qualify for cash incentives.

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CAN WE REACH NET ZERO CARBON?

The quickening pace of our climate emergency has made our collective global goal crystal clear: reaching full scale elimination of carbon emissions.

The transition to a Decarbonized Economy will effectively require a complete overhaul of our socio-economic system. We won't be able to shoehorn sustainability into old systems, meaning that we have the rare and thrilling opportunity to redesign our economy at a scale and scope that equals the transformation brought about by the Industrial Revolution.

While recent climate reports issued by the United Nations and scientists across the globe are soberingly dire, many of the world's best minds are focused on mitigation and adaptation solutions.

The transformation will be scary for some—namely, those who cling to antiquated business models, obsolete energy sources, and outdated technologies. They will fight, attack, and fashion every conceivable obstacle possible to impede progress.

But just as earlier naysayers couldn't suppress the adoption of breakthrough innovations like indoor plumbing, incandescent lights, or the combustion engine, efforts to hinder progress will ultimately be futile.

Our world is evolving into a cleaner, greener, and better ver-

sion of itself, and the good news is that all of us, even those that launch the most vigorous assaults on advancement, will reap dramatic rewards.

We will all enjoy clean air, fresh water, fertile soil, protected species, vibrant ecosystems, social justice, and a flourishing economy that is not only free of carbon emissions, but offers opportunity for incredible capital gains for those with just a little ambition and imagination.

A Roadmap to Decarbonization

Getting to net zero carbon will require an inspired, novel, multi-pronged approach, with strategies ranging from simple, nature-based solutions like planting trees to deep energy retrofits to the deployment of complex enabling technologies.

Essential tactics include:

- Sequestering existing emissions in the atmosphere through the protection of forests, oceans, and other critical habitats.
- Driving renewable energy adoption; investing in super-efficient solar, wind, and battery storage technology; and implementing a national clean energy standard that requires utilities to derive increasing amounts of electricity from carbon-free sources.
- Transitioning the entire built environment to net zero and all-electric by implementing energy efficiency retrofit programs and ratcheted codes, mandates, and incentives.
- Electrifying transportation, requiring that all new vehicle sales are electric and implementing a "cash for clunkers" trade-in program to incentivize the transition to clean vehicles.
- Reimagining industry and manufacturing, primarily in highly resource intensive and polluting categories like cement, steel, chemical and paper.
- Transforming agricultural practices to reduce the impact of food production and preserving more land that can be used for carbon sinks.

To give you an idea of the scale of the financial opportunity, Moody's estimates that G20 financial institutions have nearly $22 trillion tied to carbon-intensive industries, representing nearly 20% of their portfolios. With the net zero commitments that these institutions have recently established, those dollars are now being shifted into the burgeoning areas of carbon tech, climate tech, renewable energy systems, battery storage, and the electrification of homes and buildings.

Decarbonizing the Built Environment

It is estimated that if all buildings were net zero embodied carbon (including the manufacturing, transportation, construction, operation, and end-of life-phases), then the United States could reduce its greenhouse gas emissions by more than 50 percent.

On a global scale, the UN says that emissions from buildings must be reduced by 50 percent by 2030, and 100 percent by 2050, if we stand a chance at staying under a 1.5-degree temperature rise.

Lamentably, we have a long road to travel—not even 1 percent of existing buildings are considered net-zero carbon today.

Emerging technologies. Fortunately, pioneering materials and technologies are being developed that will expedite the transition to net zero carbon in buildings, offering sustainable solutions in high intensity categories like concrete and steel.

For example, 3D Graphene is a 3D-printed lightweight porous foam made of carbon that is reported to be 5 percent of steel's density and 10 times its strength, making it an excellent, sustainable replacement for steel in skyscrapers and tall buildings, and Self-Healing Concrete has a water-activated bacteria that reacts with starch to produce calcite to repair cracks, increasing the estimated lifespan of concrete by over 200 years.

A PUBLIC THAT'S "TUNED IN"

Data from our COGNITION Smart Data research shows that consumers consider net zero energy, water, and carbon to be very important when making purchasing decisions about products for their homes.

Clean and Electric

To get to net zero, we need a full-scale adoption of renewable energy, as well as the adaptation of infrastructure, regulations, and financing to support this transition.

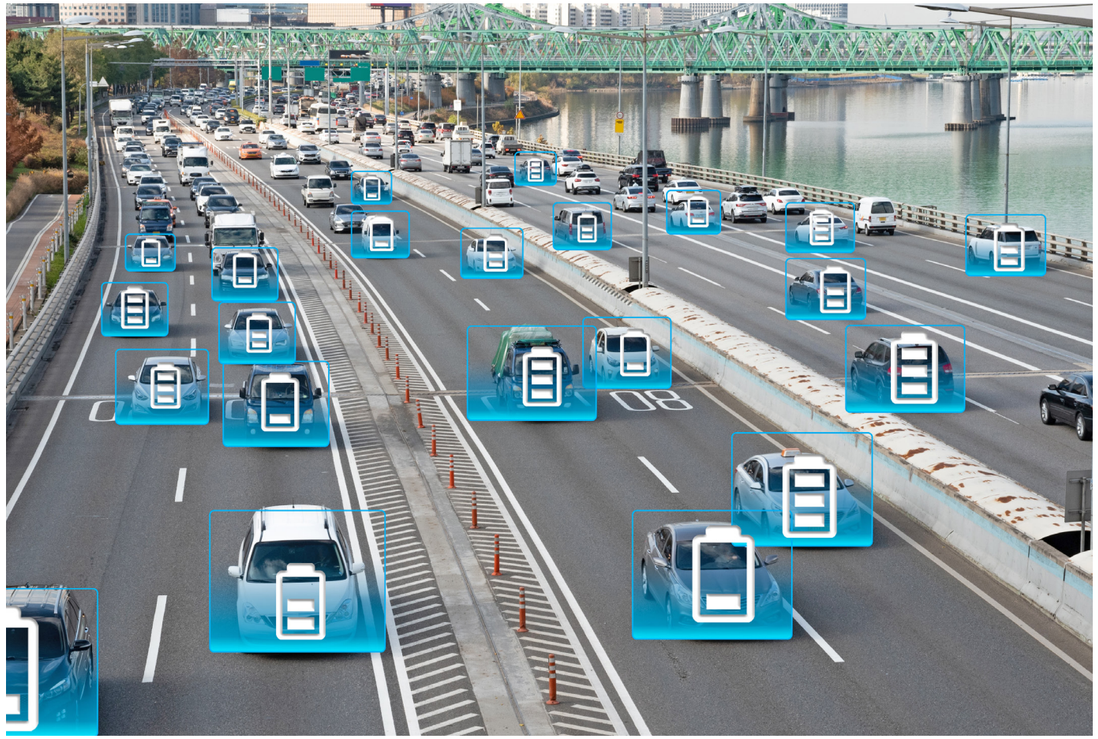
Power sourced from wind and solar is now less expensive than power produced by fossil fuels on a national scale, and it is now less expensive to build new onshore wind and utility-scale solar power generation facilities than it is to operate existing fossil fuel facilities in many markets.

The adoption of clean energy technology is leading to the transformation of grid architecture. Power generation is becoming more distributed and localized, with enhanced load management and optimized demand-side energy management.

The Internet of Things (IoT) is enabling intelligent devices to remotely manage everything, from manufacturing to building operations to vehicle fleets to power grids, with the goal of optimizing efficiency, while Artificial Intelligence (AI) technology is monitoring cybercrime to enhancing digital security across grid networks.

Advances in battery storage are also enabling the transformation of our power systems, further facilitating peak load shifting and enhancing the resiliency of the built environment.

The cost per watt-hour of battery storage has decreased by approximately 70 percent since 2015, which is not only helping to fulfill the promise of distributed energy generation, but is also spurring a revolution in vehicle electrification.



EVS RISING. *California is phasing out gas vehicles, and other states could follow, as efforts to accelerate the exit from fossil fuels take shape.*

Some experts predict that economies of scale will bring down the cost of batteries to allow electric vehicles (EVs) to reach price parity with gas-powered vehicles by as soon as 2024, increasing the number of EVs on the road to 550 million globally by 2040—up from 13 million vehicles today.

Vehicle-to-grid technology, or the ability to store power in EVs and feed it back to the electrical grid when demand is high, is also evolving, taking its rightful place as an essential tool for optimized demand-side energy management. Smart charging software and bidirectional chargers not only allow EVs to draw power from or feed power back to the grid, depending on demand, they also enable EVs to serve as a backup power source for homes and buildings during emergencies and blackouts.

Carbon Tech

Another emerging industry that is facilitating the transition to net zero is CarbonTech, technology capable of capturing and embedding large amounts of carbon into products and materials.

Companies throughout the economy are getting creative about keeping greenhouse gas emissions out of the air from industrial and manufacturing activities, as well as capturing existing CO_2 particles and repurposing them into a useful input material. While it's not clear whether these technologies can achieve the sheer scale necessary to make a global impact, the technology is promising.

Companies such as Carbon Engineering and Climeworks are removing CO_2 from air, using massive fans and storing the gas permanently underground in a process called Direct Air Capture.

CarbonCure is injecting CO_2 from factory exhaust into a cement mix so that it can mineralize in concrete—an essential innovation given that concrete production is one of the most intensive processes in our entire economy, accounting for approximately 7 percent of annual global CO_2 emissions. Not only does this process reduce emissions, the addition of the CO_2 yields a stronger concrete material.

By putting carbon to work and removing it from the atmosphere, these companies are turning a harmful greenhouse gas into a valuable raw material, offering utilities, manufacturers, and other carbon emitters a much-needed economic incentive to capture carbon particles rather than release them into the atmosphere.

ALL HANDS ON DECK

Imbued with an inherent ethic of sustainability,
Millennials and Gen Zs are pushing green values, and corporations are beginning to listen.

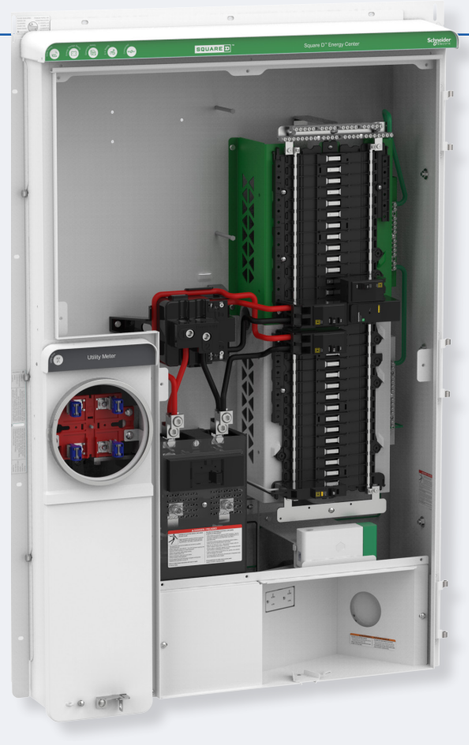
In a recent COGNITION Smart Data survey of this influential audience segment, 86% of females and 81% of males responded that they prefer to buy products from companies that demonstrate a strong commitment to sustainability. 77% of Millennials are willing to pay more for sustainable products, and 79% of Millennials are concerned about the environmental impact of products they buy.

Corporate mobilization

In response to mounting public pressure, multinational corporations have entered a fierce competition to become the sustainability leaders in their sectors, pledging to become net neutral with respect to energy, water, materials, emissions, waste, operations, packaging, and mobility within the next decade. Sustainability is now a moral imperative, driving business strategy, innovation, and sales.

Companies large and small are finding ways to solve for mounting environmental challenges. Behemoths Amazon, Best Buy, IBM, Philips, Schneider Electric, Unilever, and Verizon have all pledged to reach zero carbon by 2040.

Companies including Whirlpool and Facebook also have made global commitments to reach net zero emissions in plants and operations and convert to 100 percent renewable energy by 2030.



SMART PANEL. *Schneider Electric's Square D Energy Center gives the homeowner instant feedback on energy use and can be used to fine tune solar production and storage*

Automotive companies like Volvo and GM have pledged to electrify their entire product portfolios by 2040, while simultaneously eliminating carbon from their manufacturing, operations, and supply chain, sourcing renewable energy, and purchasing carbon offsets.

Microsoft has not only committed to becoming carbon negative by 2030, it has also pledged to remove all of the carbon the company has emitted since its inception

Governmental support

Of course, the private sector can't go it alone—governments will play a pivotal role in the shift to net zero carbon through programs and policies that bolster green infrastructure, research, and innovation; establish national mandates for renewable energy and electrification; incentivize energy efficiency upgrades; reduce emissions from agriculture; and address toxic emissions from industrial process and manufacturing (including CO_2, methane, hydrofluorocarbons and other potent climate pollutants.)

The U.S. has recently set aggressive targets to become net zero carbon by 2050. China has pledged to cut carbon emissions by over 65% by 2030 and become carbon-neutral by 2060. India has committed to reaching net zero emissions by 2070.

France, the UK, China, and India have all announced intentions to phase out combustion engine vehicles as early as 2035.

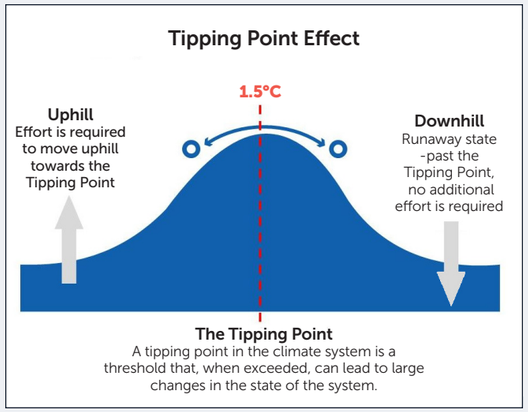
Germany, has shifted to primarily renewable energy and decreased its emissions by 23% since 1990.

Britain has dropped its emissions by an impressive 43% since 1990, including a 65% decrease in its power sector emissions resulting from the phase out of coal and super pollutants like methane and hydroflourocarbons.

Reality Check. Time is Short.

While these commitments are certainly encouraging, the reality is that they're not enough to keep us below a 1.5 degree temperature increase.

According to the UN, current climate commitments would only cut global greenhouse gas emissions by approximately 1 percent by 2030—a frighteningly far cry from the 45 percent cut needed to limit global warming to 1.5 degrees.



RAZOR'S EDGE. *Even in the best scenario, the world is already at or just past several major climate "tipping points" likely to raise havoc with global weather and temperatures, not to mention sea level.*
SOURCE: THE HEARTLAND INSTITUTE

In fact, at our current trajectory, we're expected to surpass 2 degrees Celsius within a shockingly short 5 years.

With climate change wreaking havoc across the globe, reaching net zero has become an absolute imperative, and the window for action to safeguard our planet is closing fast.

As we race against the clock and more people wake up to the reality of our climate emergency, expect the pace of change to accelerate.

Make no mistake, the revolution has begun.

Green Builder Media is North America's leading media company focused on green building and sustainable living, affecting positive change by providing inspirational information to over 200,000 progressive building professionals and millions of early adopter and first mover consumers who are interested in sustainable living.

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