

2020: A Year of Global Impact

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SECTION 01

Introduction

Letter from Armond

Success Prepares Us for the Challenges of the Next Twenty-Five Years



In 1996, Clean Air Task Force was a band of seven staffers formed to achieve a specific goal: reducing carbon emissions from United States power plants. We did this by pushing new federal air quality regulations that would cut power plant air pollution and carbon. At the time, our methods and scope were traditional. We created and funded ground campaigns in 20 key states, built a formidable litigation machine, and commissioned bookshelves of analyses from some of the nation's leading universities and research consultancies. And we worked to put in place regulations that are saving tens of thousands of lives, while helping to retire a third of the nation's coal plants.

Nearly 25 years on, CATF has become an international organization of 40 experts with offices in the US and Europe, and activities in Canada, China, the Mid-East and North Africa, Sub Saharan Africa, and Latin America as well as other countries and regions. We collaborate with a wide range of global think tanks and researchers, as well as governments, technology companies, and investors. Our scope now extends to nearly everything related to climate and energy. Some of our key initiatives: displacing carbon-emitting fuels by spurring international markets to create low-cost hydrogen; controlling natural gas emissions from production sites across the globefrom Texas to Russia to the Mideast; pushing the new Biden Administration to better regulate fossil-fuel power plants and methane sources in the oil and gas industry; pressing to convert global marine shipping from diesel to carbon- free ammonia; demonstrating and deploying advanced carbon capture for heavy industry and electricity generation; and commercializing advanced nuclear power and fusion.

But in many ways, CATF's DNA is the same as when we started. We define climate and air pollution problems at their root cause. We look for the biggest levers of change. We stay grounded in facts. We look for realistic, scalable solutions. We build coalitions not just with like-minded advocates but also explore cooperative pathways with industries that are willing to change. We are not afraid to challenge conventional wisdom about technologies or policies. And we are relentless.

We know that reshaping the \$25 trillion global energy system to eliminate carbon and methaneat the same time it doubles in size is a huge lift that will take decades. The new political alignment in Washington will help, but we don't take anything for granted. We need durable policies that will withstand inevitable political cycles—and then there is the rest of the world, much of it energy starved and 80% dependent on fossil fuel.

Our progress has been achieved in collaboration and with the support of thousands of colleagues in the US and around the world, as well as major investment from committed funders and donors who recognize that big change can't happen overnight.

To manage our planet's climate, we must effectively eliminate greenhouse emissions. Climate models suggest that we have, at most, three decades to do so about the same number of years since CATF's founding.

That's not impossible. But it will take everything we've got today, and more. CATF looks forward to keeping you informed on the journey to zero.

Armond Cohen Executive Director

01 - INTRODUCTION

Our Global Footprint

Clean Air Task Force works across the globe, focusing on regions and countries in which we can most effectively promote critical path advances in technologies, programs, and policies that address climate destabilization, as well as on areas that pose the greatest threat to climate stability.

In 2020, CATF's work and partnerships spanned across every continent and show that our focused efforts, unique approach, and expanded network of experts can lead to a broader impact in the quest for sustainable solutions.

CATF Areas of Focus

CATF Staff and Experts



I've worked for over 40 years in all facets of the energy industry—in all sectors: for profit, non-profit and as a government official, as well as in all sorts of roles: CEO, board member. management consultant, and exploration geologist. In all my work I have come to appreciate that getting the facts, understanding their implications and appreciating what has and has not worked makes all the difference in achieving great outcomes. CATF is and has been an unparalleled font of facts, insights and understanding about our global energy and climate challenges. I am honored to serve along with my board colleagues in CATF's important work-especially now, when our progress for creating a better global energy and climate future has never been more crucial for ourselves and the generations to come.

> Phil Giudice CATF Board of Directors



SECTION 02

Overview

02 - OVERVIEW

The Push and Pull of Climate Transformation...

CATF works at the frontier of change—the event horizon, if you will-crafting strategies that advance the boundaries of what is possible. And we move quickly—there is no time to spare. One of our strengths is that CATF puts into practice an important insight: given the need to cut projected worldwide greenhouse gas emissions to net zero by mid-century to protect our climate, we must push into the commercial marketplace innovative technologies capable of achieving a zero-carbon future. At the same time, we must pull hard right now on all available regulatory policies and instruments. Only then can we hope to arrive at our destination. This is the essential push and pull that will maneuver into place a long-term, deep-rooted, and successful climate policy.



Where We Push

- Advanced Nuclear Energy: CATF aims to make nuclear energy a viable option for decarbonizing the global energy system at needed scale and speed. We catalyze private sector and government activity to lower the cost and deployment timeline of both advanced fission energy and, potentially, commercial fusion.
- Decarbonized Fossil Energy: CATF's efforts here focus on carbon capture and storage, the process of collecting waste CO₂ from power plants, refineries, factories, and even directly from the air—then injecting it deep into the earth for safe, permanent sequestration. We are developing and advocating for policies that will make carbon capture globally cost competitive, particularly in the massive coal-fired infrastructure of India, China, and Southeast Asia.
- Zero-Carbon Fuels: Recognizing that a large segment of world energy demand comes from mobile or hard-to-electrify devices—cars, trucks, ships, trains, airplanes, and certain industrial operations—we are rapidly expanding our research into two non-electric, zero-carbon energy sources that hold great promise hydrogen and ammonia. At the same time, we are examining ways that zero-carbon energy technologies like advanced nuclear energy and carbon capture can create a platform for the massive fabrication of these versatile fuels. And we are catalyzing the growth of commercial networks to move them from production sites to distribution points. To accelerate the process, we promote policy change and support commercial coalitions.
- Advanced Energy Technologies: We delve deeply into the science and the industrial alignments needed to demonstrate and bring to commercial fruition energy sources that, while now in nascent stages, could, if successful, play a major role in eliminating carbon fuel by the 2050s. These include superhot rock geothermal, which would tap into the endless heat of the earth's upper crust, and nuclear fusion, a technology that has just started to attract major private investment.

Where We Pull

- Zero Emissions for the Power Sector: CATF works to ensure the adoption of federal emission standards on all US fossil power plants that will, through legislation and regulation, zero out power sector carbon emissions by 2050. A major focus here is our groundbreaking work on federal and state Clean Energy Standards, which we've added to our traditional administrative advocacy and high-impact litigation aimed at achieving enduring climate benefits.
- Federal and State Climate Policy: The main focus here is to push states and, ultimately, the federal government to adopt coherent, far-reaching, and effective climate policies. These include federal economy-wide and sector-specific policies (such as a Clean Energy Standard for the power sector or a Zero-Carbon Fuel Standard for transportation), federal clean energy technology incentives (tax and direct subsidies), as well as broadened state efforts to enact or enable clean energy policies open to all technologies that provide zero-carbon power including advanced nuclear, carbon capture and sequestration, and advanced geothermal.
- Super Pollutants: In the US and internationally, CATF advocates for major reductions in so-called super pollutants, particularly methane and black carbon, which possess inordinate capacity to sabotage our climate. We support scientific research, promote policy initiatives, encourage the development of financial incentives, and champion and defend programs that can dramatically reduce emissions of these "super spreaders" of climate disruption. Our work takes us to Latin America, Africa, the European Union, and China.
- **Bioenergy:** Identifying and promoting measures to maximize the climate benefits arising from thoughtful land use practices—from carefully targeted rollout of bioenergy, to smarter and more comprehensive forest management. Right now, our efforts center on convincing the US to relinquish the view that progress requires support for the corn and soy plantations of international agribusiness.

Where We Apply the Secret Sauce

- Energy Systems Analysis: To plan for a global low-carbon future, it is essential to apply analytic tools to understand what's needed for an affordable zero-carbon energy system—including the risks and opportunities associated with promising pathways, and their management during transitional periods. This big-picture task, conducted with the help of academic and industry experts, as well as a network of civil society analysts, informs all of CATF's initiatives. It tells us what policies can work and where we should apply our resources—where to push, and where to pull.
- Legal Evaluation and Intervention: Our team of six attorneys provides advice—strategic and tactical, legal and regulatory—across the organization. In addition, we litigate clean power cases in US courts on behalf of other non-profits, from national groups like the American Lung Association, to regional and local organizations. The legal team works on statutory language and comments on proposed regulations. We analyze the legal landscape for everything from methane regulation, to the licensing of fusion generators and the operation of a tax credit to stimulate the commercialization of carbon-capture technologies.
- Communications and Education: CATF's advocates and consultants frequently publish reports and peer-reviewed articles of significant depth on key aspects of our work, and participate each year, often as organizers, in hundreds of bilateral briefings, symposiums, technical seminars, workshops, and expert roundtables in the US and across the globe. We also create and host a number of interactive websites allowing users to see the local impacts of air pollution in their communities.

We have been consistently impressed by the quality of the research that Clean Air Task Force produces, finding it to be well-reasoned and even-handed. Their team is widely respected among the various climate experts, academics and activists that we have spoken to.

Founders Pledge: Charity Reports

02 - OVERVIEW

CATF: Designed to Confront the Climate Challenge Head On

The graphics on this page and the next tell the story and it's not a pleasant one: we live in a world almost totally dependent on unscrubbed fossil fuels—on carbon—and that world is approaching thresholds of such potentially profound climate disruption that political, economic, and social catastrophe is all but certain.

Indeed, 2020 looks as though it was just about the hottest year on record. The one remaining way to blunt the consequence of this is rapid and drastic reduction of our carbon diet. And we will need to do that over the next three to four decades—a short window no wider than the period that started with the fall of the Soviet Union and ends today.

Projected Global Greenhouse Gas Emissions

Source: UNEP, Emissions Gap Report (2019), p. 26



In its 25 years, Clean Air Task Force has increasingly become focused on climate destabilization and what must happen now to avoid this slow-motion menace. Our strategy is unusual, sometimes contrarian, and always focused on the element we have in shortest supply: time. So put, our strategy depends on detailed, fact-based analysis—about technologies, about economics, and about the political state of play. **Put simply, we focus on what will work.**

A decade of expert analysis as well as direct involvement in the venues where ideas germinate and decisions get made has fully convinced us that, in addition to deployment of renewable forms of energy that have reached cost competitiveness, we can control carbon and reduce the risk of failure only by developing a robust suite of zero-carbon options. These include advanced iterations of large-scale, existing technologies (nuclear fission, for example), continued pressure to eliminate the most virulent pollution (e.g., from dirty coal plants, and oil and gas operations), and the capture and permanent sequestration of CO₂. We also need to plan for mid-century and beyond. That's why we're also generating interest and momentum in developing nuclear fusion and deep hotrock geothermal—either of which could address the planet's entire energy needs on its own (although, if proven, would likely be part of a portfolio of options). And, in addition to driving carbon from the power grid, we need to facilitate transition to zero-carbon fuels, the energy-dense gases and liquids capable of propelling much of our massive and growing transportation system.

That is the story we tell on the pages that follow. It's a story of a "venture capital" approach to advocacy (making multiple bets on potential big payoffs) and it's the story of how we build durable coalitions of advocates, innovators, and technicians who remain rooted to a solid groundwork of fact—but still dream big.

Because big challenges demand big solutions.



World Energy Consumption

Source: BP Statistical Review of World Energy (2018), p. 10

SECTION 03

Our Work & Focus



03 - OUR WORK & FOCUS

Energy Systems Modeling

Finding Resilient Pathways to a Clean Energy World

Every part of the Clean Air Task Force advocacy program—whether fission, superhot geothermal, bioenergy, carbon capture, hydrogen and ammonia fuels, legal tools, or the advanced policy initiatives that will make them happen—is bound together by a single vision: to remove all carbon, methane, and other greenhouse gas emissions from the global energy system by mid-century.

All of our work in pursuit of this vision begins with research and analysis. With models and other analytic techniques, we draw on the power of logical inquiry, scenario development, and quantitative stress testing to examine this challenge in a manner precise enough to guide key objectives, actions, and results over the arc of the next half century. To ask what's needed to totally decarbonize the entire world energy system, all of it, by mid-century is highly ambitious. Luckily, we've made a strong head start, continue to gather and analyze powerful data, and have teamed up with some of the planet's best thinkers and analysts.

This work has proceeded in four overlapping phases.

In the first phase, we focused on the question of what combination of zero-carbon energy sources would give us the greatest chance of achieving an affordable zero-carbon power grid. With dropping prices of wind and solar energy and, more recently, of energy storage, some argue that a 100% renewable energy power grid could achieve a zero-carbon goal quickly. In 2012, we tested this hypothesis by gathering meteorological and renewable energy performance data from Germany, the nation thought to be the most advanced in making the transition to a low-carbon system. What we found surprised us.

Considering the Cost of Power Failure

Though wind and solar could in theory provide nearly all of Germany's electric power, that nation, like the rest of the Northern Hemisphere, experiences intervals of little wind and sun ("dunkelflaute" or the dark doldrums), often lasting weeks or months. To compensate for this seasonal variation, you would need wind and solar capacity double or triple the size of peak electricity demand, or you'd be forced to install massive but littleused storage equal to the size of the generation system itself (or perhaps a combination of these). For Germany, a nation already facing some of the world's highest electric rates, this strategy would double or triple the price of electric power. In contrast, a more balanced combination of renewable energy and zero-carbon, always-available generation-such as gas with carbon capture and storage, or nuclear (even at relatively high cost)-would deliver a zero-carbon power grid at far lower cost.

To further test this conclusion, in 2015 CATF brought together international researchers for a two-day workshop in Cambridge, Massachusetts to compare our conclusions with other teams' findings. One of the key insights of that workshop was that it is risky to build fourfifths of a system out of variable energy sources, while assuming that the last 20% "can be figured out later." By then, we found, no cost-effective solution to plug seasonal gaps would exist; all options would entail high capital cost, while operating only seasonally. The likely result: a decarbonization "dead end."

Adding depth to this core insight, CATF's workshop spawned dozens of subsequent studies by academic and industrial experts. We also commissioned analyses looking at the power systems in the Midwest, New York, Arizona, Pennsylvania, and many other US states (as well as India) and found similar results. We presented these widely, which helped lead to the enactment of clean energy standards in seven states friendly to a broad range of zero-carbon technologies, as well as similar pledges from utilities that together cover roughly half of US electric sales. (Here, you can learn more about our state and regional decarbonization commitments.) Then, with colleagues at the Environmental Defense Fund, CATF commissioned teams at Stanford, Princeton, and the respected consulting firm E3 to model California clean energy pathways. That 18-month study confirmed the wisdom of keeping all zero-carbon options on the table.



California: CATF Analysis Shows the Need for Always-Available, Zero-Carbon Power

This "heat map" produced by CATF illustrates why zero-carbon, always-available power sources are helpful. Here, average hourly electric demand in California (thick black line) is mapped against supply from a 100% renewable grid consisting of wind and solar energy (dotted line). Although the state has surplus power in summer, it faces shortages in fall and winter (the red and orange hours). Filling these gaps requires an electric system massive enough to meet more than double existing peak demand, backed by expensive storage. Having always-on, zero-carbon power would reduce costs, as well as the space required for generation.

Looking at the Landscape

More recently, our analysis has moved into a second phase. There, we will examine the physical requirements of various zero-carbon options, including an all-renewables strategy. We are engaging sophisticated GIS tools to examine siting and build-out of a variety of zero-carbon grid systems, looking at a number of US states and non-US regions. Our analysis will help inform system resource choices and examine the sophisticated contingency planning required to anticipate real-world obstacles.

A third, more recent phase of CATF's analytic work examines the additional cost and resource requirements of expanding infrastructure to provide zero-carbon fuels such as hydrogen and ammonia. Only a quarter of all global energy is used as electricity-the other 75% is consumed through the direct combustion of coal, oil, and gas in buildings, industrial furnaces, and truck, plane, and ship engines. We may be able to electrify much of this demand-but likely not all. That means we will need to ramp up the production of the two leading zero-carbon fuels, hydrogen and ammonia, as well as associated infrastructure. These can be manufactured through electrolysis (splitting water), via renewables or nuclear energy, or by reforming natural gas and capturing the carbon outflow. Our preliminary analysis suggests that, as with power grids, a mix of approaches is likely to produce zero-carbon fuels at lowest cost and with the least impact on land use.

Energy Modeling 2.0

A fourth phase, meta-analysis, gets to the core of the energy transition puzzle. Here, we will provide a dispassionate overview using analytic tools and frameworks that identify both common and differential risks associated with each zero-carbon pathway e.g., cost, land use, materials availability, and political acceptance. By using simple "game" models as well as potentially more sophisticated mathematical simulations, we hope to uncover principles that transcend both linear and "black box" deterministic thinking.

CATF's work, while academically rigorous, has been far from academic in its impact. As noted, it already has helped shape dozens of state and utility pledges to be technology inclusive. In addition, our efforts have influenced the leading federal climate change proposals—including a national clean energy standard, an idea that is gaining traction among policy makers.

Indeed, we have changed the way people think about the path to zero.

Deep decarbonization is politically and economically very challenging, which is why CATF's focus on the facts and analysis is so refreshing and so vitally important.

> Professor David G. Victor School of Global Policy and Strategy, UCSD



03 - OUR WORK & FOCUS

Policy Advocacy

Keeping on Track by Transforming Policy into Action

Federal Policy

With a clear focus on the development and deployment of the new technologies that will be required for decarbonization of the economy, CATF is attentive to opportunities to press for supportive government policy—both in the US and abroad. In the US, that means working at the highest levels of government on an array of federal legislation that advances climate repair—through emissions limits, policies that require an increasing percentage of clean energy deployment, incentives, funding, realignments, and programs—and moving matters towards a single end goal: innovation that achieves a zero-carbon world by mid-century.

CATF's Federal Policy Program is where we translate the work of CATF's subject matter experts on energy,

technology, and policy design into federal action. Culminating a multi-year effort to generate energy innovation policies for a whole suite of zero-carbon technologies, we helped push across the finish line a major legislative package that will provide billions of dollars to advance the design and realization of a zerocarbon economy. And it wasn't easy.

A Race to the Finish—and a \$100B Bill

The challenge started with the need to blend literally dozens of individual, bipartisan bills we'd backed promoting an array of clean energy technologies. Led by Advocacy Director Conrad Schneider and newly hired Federal Policy Director Lindsey Griffith, CATF's Federal Policy team deployed project staff to help shape and support major provisions of this initiative. And our new 501(c)(4) entity, CATF Action, founded this year to enhance our lobbying capability—along with assistance from lobbyist consultants at AJW, Inc. and Waxman Strategies—focused on the carbon capture, nuclear, geothermal, long-term storage, and industrial decarbonization elements of what turned into a twochamber effort. The Senate's offering, the American Energy Innovation Act, had been under debate on the Senate floor when the COVID-19 crisis struck back in March 2020. Meanwhile, the House version, the Clean Economy Jobs and Innovation Act, was passed later, just in October.

With time running out, CATF worked the endgame, ensuring that lawmakers heard from all quarters that comprehensive energy legislation was of prime importance. The result: Congress gift-wrapped key climate provisions into a year-end omnibus spending package covering, among other things, a much-needed COVID-19 relief measure—all in all, a medley impossible for legislators to resist. With passage comes some \$125 billion in new spending authorizations over a fiveyear period to support research, development, and deployment incentives covering renewables, energy storage, advanced nuclear, carbon capture, geothermal, building efficiency, and more. It also unlocks \$40 billion in clean energy funding at the Department of Energy's Loan Program Office, extends key tax credits for renewable energy, and continues the 45Q credit for carbon capture and storage that CATF helped to revamp three years ago.

Part of the Package: Major Climate Legislation

Almost unnoticed in the fog of the US election and post-election controversies, the year-end omnibus also contained the most significant climate legislation ever passed by Congress-legislation that will allow the US to comply with the Montreal Protocol. This international treaty will avoid up to a half-degree Celsius of global warming by reducing the emissions of hydrofluorocarbons (HFCs)—a potent super pollutant. CATF staff and consultants worked hard to ensure the measure was included in the final package, a key to winning Democratic support. The legislation also reauthorizes the Diesel Emissions Reduction Act, which CATF helped to design, and it includes the Utilizing Significant Emissions with Innovative Technologies (USE-It) Act, which supports federal, state, and NGO collaboration in the construction and development of carbon capture, utilization, and storage facilities, as well as carbon dioxide pipelines.

The environmental and energy elements of the omnibus bill will be key in developing the scaled-up clean energy technologies required by mid-century, if we are to attain our deep decarbonization goals. They will also create thousands of good paying jobs across the clean economy. Plus, because they were enacted with bipartisan support in both the House and Senate, they validate CATF's theory of change: that durable climate solutions arise from cross-aisle cooperation, which itself is sustained by the understanding that people in all regions of the nation can be winners in the clean energy economy. During a year of record-setting divisiveness, this legislation is an encouraging harbinger of future bipartisan progress on clean energy. And it stands as a capstone to literally years of work by CATF's technology and policy teams. But we are not finished. Already CATF's policy advocates are mapping out ways to turn the new spending authorizations into real-world appropriations, while our technology teams are planning further energy innovation advancement via the new Congress.

Still, while necessary, innovation or "push" policies will not be sufficient to solve the climate crisis. So, inspired by our axiom that "the best climate policy is the one that can be enacted," CATF's Federal Policy team is working on climate "pull" policies that set limits on greenhouse gas emissions and "pull" clean energy technologies into the market. Our work in 2020 began with the release by the leadership of the House Energy and Commerce Committee of the CLEAN Future Act, comprehensive, economy-wide climate legislation containing decarbonization policies for the power, transportation, and industrial sectors of the US economy. With its goal a zero-carbon economy by 2050, the CLEAN Future legislation includes a broad range of climate-friendly features, among them a clean power standard for the electricity sector, tighter controls on methane emissions from the oil and gas industry, enhanced energy efficiency, and a more serious commitment to environmental justice. At the request of the legislative drafters, CATF provided extensive technical assistance on a range of provisionsin particular, those relating to clean energy standards (power sector), zero-emissions vehicles (transportation), low-carbon fuel standards (transportation and industry), innovation (especially, nuclear energy and carbon capture and storage), industrial decarbonization, state climate policy, and super pollutants.

CATF Executive Director Armond Cohen testified at the kickoff hearing for the CLEAN Future Act and returned a year later to the House Energy and Commerce Committee to testify on the importance of retaining nuclear power as a viable decarbonization option. Later in 2020, Cohen testified (virtually) before the Senate Environment and Public Works Committee in favor of the American Nuclear Infrastructure Act (ANIA).

Turning Clean Energy Policy into Clean Energy Standards

Beyond work on the comprehensive CLEAN Future Act, our efforts on climate legislation focused on promoting discrete bills containing clean energy standards (CES) for the power sector. A CES policy requires that an increasing percentage of clean energy be sold into power markets each year until retail electricity is entirely carbon free. (Our state advocacy also is engaged with CES-see below.) Right now, eight states accounting for more than 20% of the nation's generation have adopted climatefriendly policies requiring fully decarbonized electricity by mid-century. When we add to that the commitments by dozens of electric utility companies to deep carbon removal in the same timeframe, we see a clear trend that is now embodied in President Biden's endorsement of CES, via his Clean Energy Plan, as the preferred policy path for the power sector.

We worked with the Biden transition team to help actualize the campaign's promise to draw on the power of \$500 billion in annual federal procurement spending to propel the government towards zero-carbon energy and, in the process, to leverage the decarbonization of supply chains serving the private sector.

From a broader perspective, as Advocacy Director Schneider points out, CATF's climate strategy is "multidecadal." Our goal is to create a durable legislative platform in the US (and elsewhere) able to support permanent climate vigilance. The coming year will see us continue to apply our detailed, nuts-and-bolts knowledge of the legislative process to better identify the right moments to advance climate priorities. Top of the list: passing climate legislation (including clean energy provisions) in an economic stimulus or infrastructure bill, and working with the new federal climate leadership on everything from replacing the past administration's regulatory rollbacks with an aggressive climate program, to renewing our international engagement, having just rejoined the Paris Climate Accord. With 74% of all Americans of every political stripe seeking greater investment in clean energy, "there will be a lot of action in the next year," says CATF's Lindsey Griffith. "We know it's a popular issue."

State Policy

Clean energy doesn't just happen. From experience, CATF has learned that enacting clean energy policies at the state level is an essential catalyst to more comprehensive action. In addition, state policies often produce more immediate results, and myriad efforts can "seed the policy space"—foreshadowing, facilitating, and, potentially, elevating later, all-inclusive federal programs.

That's where Andrew Place comes in. One of CATF's newest advocates and a former commissioner of the Pennsylvania Public Utility Commission, Place brings the detailed knowledge and experience needed to press for clean energy standards.

Zero-carbon programs, ideally in all 50 states, must meet several criteria. They need to be sufficiently stringent, diverse in approach, effective in prompting serious federal action, and, importantly, open to a full range of zero-carbon energy sources. These include nuclear, truly green bioenergy, superhot geothermal, and carbon capture and sequestration, as well as advanced clean fuels like hydrogen and ammonia—themselves produced by zero-carbon sources.

As Justice Brandeis famously remarked, individual states serve as laboratories for policy creativity. Because programs in different states come in different flavors-in politics, energy mix, resource endowment, and in electric industry structure, among other thingsit's important that we have an expert on the ground who is well-versed in playing the "three-dimensional chess" involved in working with multiple, and sometimes overlapping, jurisdictions. The one constant is that we are pressing for state and regional clean energy standards that are agnostic and, consequently, facilitate a significantly broad set of generation technologies to provide the greatest potential for achieving decarbonization by mid-century-a critical criterion if the economy is to develop sufficient decarbonized energy capacity and baseload (always-available) power to supply growing electricity demand.

Decarbonization, from Maine to California

Seven states have now embraced clean energy standard legislation that includes a full range of zerocarbon generation. Additionally, Maine has enacted a 100% decarbonization statute through its renewable portfolio standard. Many other states have set clean energy objectives through other non-binding actions, such as executive orders and policy proposals. Place is assisting states and their utilities as they move towards this goal. Right now, they include Arizona, Illinois, Virginia, Pennsylvania, and the Carolinas. Some have strong statutes or executive orders on the books, while others, like Arizona, pose the challenge of working with a vertically integrated electricity sector at a politically divided moment.

But to transit from what, in most states, are very general goals to workable clean energy standards demands some "serious heavy lifting," Place notes. With a Biden Administration, it will be easier to advance federal action; but, with polarized politics, it won't be a walk in the industrial park. Hence, individual states will continue to be critical. Some, like California, New York, and Massachusetts, are "head and shoulders" above the rest, he says. The real challenge will be to convince others—particularly populous, economically struggling jurisdictions with long fossil fuel histories—to choose a new path.

From CATF's vantage point, this calls for both deep analytic skill around issues such as permitting, land impact, transmission needs, local ordinances, technical risk and long-term cost, and for broad experience in connecting the silos—regulatory, legislative, executive, utility, generator, and public interest groups ("a cast of thousands"). In short, the ability to navigate highly complex environments. And that, says Place, "is what gets me up in the morning."



US Decarbonization Commitments Map



03 - OUR WORK & FOCUS

Power Plants

The Legal Team—Shaping Strategy, Batting Cleanup, Taking a Victory Lap

After spending the better part of four years managing a rear-guard action to delay the prior administration's broad-spectrum campaign to undermine environmental protection (and particularly its effort to help outdated coal plants limp along), CATF is now well-situated to play a far more proactive role. In anticipation, in fact, we'd devoted time since mid-2020 to plan for a potential Biden Administration.

Perhaps our crowning achievement was the recent win in the US Court of Appeals for the District of Columbia, where a three-judge panel rejected an attempt by the Trump EPA to undermine the Obama Administration's Clean Power Plan. The CPP was an innovative multiyear program projected to dramatically cut climate pollution, including carbon dioxide, with the additional benefit of reducing conventional air pollutants and air toxics. In mid-2019, however, Trump's climate deniers revoked the Clean Power Plan and replaced it with their so-called Affordable Clean Energy (ACE) Rule. Contrary to its name, the new rule barely touched greenhouse emissions; indeed, in some scenarios it would have increased them—along with other air pollutants.

The DC Circuit's verdict in *ALA v. EPA* was damning. The court held that EPA's ACE Rule "hinged on a fundamental misconstruction" of a key provision of the Clean Air Act—and that the agency's insistence that the only way to reduce power plant greenhouse emissions would be to "bolt on" specific hardware at each individual plant was "arbitrary and capricious" (which is the judiciary's way of saying that EPA didn't have a leg to stand on). The prospect going forward is far more promising. With the Biden Administration in place, CATF is in position to advance a new version of the Clean Power Plan, one that is far more protective than the ACE Rule and better suited to the realities of our chaotically changing climate. In practice, this means initiatives to ensure that existing coal and natural gas power plants stay the course by continuing to cut their emissions, while new and modified sources—particularly gas plants—are outfitted to accommodate carbon capture and storage technologies (see below) and, potentially, to directly burn hydrogen.

But looking back at 2020, there's little doubt that our defense of the Obama Clean Power Plan delayed the Trump EPA's final ACE Rule for the crucial period of a year or more. That enables the new administration to avoid further litigation and simply revoke ACE, focusing instead on issuing new, aggressive carbon regulations. In fact, we immediately engaged the Biden transition team on this and other priorities—for Day 1, for the First 100 Days, and for the First Year. Power plants and methane regulations top the list.

Our successful litigation to stop the ACE Rule shows the CATF legal team at its best. We represented the lead plaintiff, along with six other public health and environmental organizations, while working with a coalition of states and organizations. Our own Jay Duffy was among the attorneys appearing before the threejudge panel (via Zoom) during more than nine hours of oral argument.



Protecting Scientific Integrity

A second priority in 2020 centered on Trump EPA efforts to undermine both the empirical science and commonsense economics of air pollution management—a transparent (but well-camouflaged) attempt to slow down or block the incoming administration from quickly adopting new, more protective rules. We will now work with the Biden Administration to "roll back the rollback"—and, if possible, do so on an expedited basis.

Still, the Trump EPA's activities are worth taking a close look at. For example, last year the administration declared that EPA's 2012 Mercury and Air Toxics Standards (MATS) cost too much. Ironically, the utility industry had been in full compliance with MATS since 2016, resulting in a 96% reduction in coal plant pollution. The reduction includes mercury, arsenic, cadmium, and dozens of other toxic metals and acid gases. It also includes the huge co-benefit accruing from the ongoing move away from coal: a massive decrease in greenhouse gas emissions. (CATF Senior Counsel and Legal Director Ann Weeks characterizes the work she's done on this issue over the past 15 years as among the major achievements of her career as an advocate.)

Yet, despite full industry compliance with MATS, the Trump EPA decided to play games with the economics. It did so to undermine an earlier finding that the benefits of the mercury rule outweighed-by a factor of ten-its costs. But the agency's new math came straight from the world of Orwell: EPA decided simply to ignore the co-benefits. And it chose to restrict its calculation of the remaining benefits only to those it could "monetize" (that is, reduce to hard currency). Thus, it ignored a constellation of social welfare resources that are unpriced, but priceless-improved health in environmental justice communities, for instance. In June 2020, representing five environmental and health organizations, CATF brought suit in the D.C. Circuit to further defend MATS. The case will not be taken up until 2021, if at all-meanwhile, we will press the Biden Administration to excise this very odd application of cost/benefit analysis.

CATF lawyers also played a significant role last year in pushing back against the Trump EPA's broader antiscience efforts, as well as its beneath-the-radar bid to completely redo how costs and benefits inform all rulemaking decisions. These midnight rules attempted to take the bizarre anti-science, anti-benefit valuation twists of the MATS proceeding and stretch them over all future Clean Air Act regulations. We have already asked the Biden Administration to remove them. Going forward, we will ask the new team to prioritize the further strengthening of MATS—for example, by addressing localized and residual risks.

Cleaning the Air While Cutting Carbon

CATF attorneys also are an integral part of the national environmental and public health alliance working on national ambient air quality standards that govern particulate matter and ground-level ozone. For our legal team, working to tighten these standards affords a way to support key public health allies under our broad advocacy tent, to assist environmental justice communities, and to realize a co-benefit that advances our chief mission—the dramatic curtailment of greenhouse gas emissions.

This bread-and-butter work involves periodic review to ensure that the standards reflect the best current scientific and public health data. Last spring, during the height of the COVID respiratory pandemic, the Trump EPA rejected the science entirely—including its own staff's recommendation that the two standards be significantly tightened. Particulates and ozone, which are emitted or created by cars, trucks, power plants, and industry, significantly damage respiratory health. In the face of this, the Trump EPA chose to do nothing.

Last year we also emerged victorious in forcing EPA to reduce the interstate transport of ozone and to properly implement 2015's tighter ozone standards. All of this supports our broader goal—a transition to cleaner fuels and sources, and the elimination of greenhouse gas emissions. This year, we intend to ask the new administration to prioritize upgrading the Cross-State Air Pollution Rule to ensure that it evolves in step with tightening health protections of the national air quality standards.

Tracking the Impact

Meanwhile, now that the clock has expired on our successful efforts to delay and deflect four years of climate obstructionism, we can assess the impact of CATF's work by looking to our <u>health impact tracker</u>. This online resource calculates that, from 2014 to November 3, 2020, election day, the Obama Administration's coal plant regulations—MATS, the Cross-State Air Pollution Rule, and the 2008-2012 national ambient air quality standards—saved nearly 175,000 American lives, while compelling an industry shift that reduces carbon dioxide.

As of year's end, the number of lives saved had increased to 181,000. But, as you can observe on CATF's interactive <u>Toll from Coal</u> website, coal plant pollution still severely harms human health and causes tens of thousands of premature deaths.

Playing a Dual Role

The six attorneys on CATF's legal team hold down dual positions. They provide legal advice and strategic thinking for all CATF initiatives, and, as noted above, play a leading role in our long-standing effort to reduce emissions from major sources of air and climate pollution. Here we've focused on fossil-fueled electric power plants. These facilities are major air polluters (notably, of environmental justice communities) and they also are the largest single source of atmospheric carbon dioxide in the US. In fact, cleaning them up has been a core CATF concern since our founding in 1996.

Clearly, CATF has had good reason to focus on fossil power plant emissions. As Legal Director Weeks points out, by monitoring and improving clean air programs, our attorneys are able to achieve CATF's broader strategic goals. "We tend to get involved in cases where we will really make a difference," she notes. This can mean burrowing into the complex machinery of the Clean Air Act to zero in on pollution that, when reduced, yields public health benefits, while also addressing climate destabilization.

Given its broad scope and record of success, the Clean Air Act offers opportunities to achieve both climate and public health wins. As Weeks puts it: "We focus both on carbon dioxide and its companion pollutants: mercury and dozens of other toxics, ultrafine particulates, ground-level ozone, and oxides of sulfur and nitrogen knowing that reducing such 'conventional' air pollution yields climate benefits as well."

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IN THE MEDIA:

Science Magazine – April 14, 2020 EPA scientists said U.S. should tighten key air pollution limit. The agency's head just said no \rightarrow



03 - OUR WORK & FOCUS

Super Pollutants

Constructing Decarbonization, Continent by Continent

Wicked problems—climate chaos is one—are woefully difficult to wrap your mind around. So it is useful to identify a strategy that is relatively straightforward, one that is both technologically simple and politically attractive, particularly on the international front. It also helps if your approach can produce fast results.

A prime example is CATF's Super Pollutants Program, which focuses on two major greenhouse gases that, until recently, were largely downplayed or ignored. That was so even though one of them, methane, in the short term is a climate destabilizer more than 80 times as potent as carbon dioxide, while the other, black carbon, is of crucial concern in polar regions drifting towards the tipping point of catastrophic meltdown.

Our super pollutant work, on the radar for nearly two decades, made particular strides in 2020, as we extended success in the US, Canada, and Mexico to South America and Europe. New support has allowed us to add four staffers, including a methane scientist, an oil and gas campaign manager, a technical and policy analyst, and a communications officer—all of whom are based in Europe.

A Focus on Methane

Much of CATF's recent work on this project has focused on methane, CH_4 —and for good reason. Methane is a powerful greenhouse gas that in the short-term accounts for about a quarter of all global climate destabilization. Recently that rationale was further fortified when the Biden Administration and its Clean Energy Plan declared methane control to be a number-one priority and ordered the new EPA to come up with a reduction plan no later than September. That in turn provides us with a solid platform for seeking a significant (and defensible) 65% decrease in CH_4 emissions by 2025. And this volatile molecule poses exactly the type of challenge that CATF thrives on. The oil and gas sector, a major methane emitter worldwide and the largest industrial source of CH_4 in the US, offers a rich lode of low-cost, simple fixes that depend less on complex technical interventions than on industrial re-education and policy commitment.

Our methane expertise, in the words of Super Pollutant Director Sarah Smith, makes CATF a central player: we serve as a clearinghouse of accumulated knowledge (that is, we "have the right legal, technical, and policy information that our partners need at the right time"), and we provide the "glue" that draws advocates and their allies into a coherent, tight coalition—for instance, our Methane Partners Campaign.



Tracking methane in Argentina with our partner Earthworks

One important element of our success in 2020 has been the purchase of a sophisticated optical gas imaging camera. The new OGI camera will serve a key educational role—transforming imperceptible but widespread methane leaks from oil and gas equipment into vibrant video. And, as we have found, showing policymakers, politicians, and the media the torrent of global warming gases that gush forth from wells, tanks, compressors, dehydrators, and other extraction equipment is a persuasive way to move things from advocacy to action.

Exporting CATF's Expertise

Another major achievement this year—and a blueprint for next—has grown out of the successful transplantation of major methane initiatives from North America where top regulators have committed to reducing oil and gas methane emissions by 75% in five years. More recently, we've been working on similar programs in Colombia and Argentina, while broadening our outreach to other Southern Hemisphere nations. In Lima, for example, we co-hosted a regional conference on methane capture, which attracted government officials from Ecuador, Peru, Argentina, and Bolivia, as well as representatives from each country's state-owned oil company.

In Colombia, we've continued to make substantial progress. This includes crafting a technical paper on global best practices for methane reduction, providing detailed guidance on how to set a methane emissions baseline and maintain an accurate emissions inventory, and a week-long survey of more than three dozen oil and gas operations. Accompanying the survey team was an OGI camera that graphically illustrated the extent of the challenge—and led to widespread media attention across the nation.



Estimated Abatement Potential – A Global Reduction of 75%

Source: IEA (2020)

Following political upheaval there, we're back on track in Argentina, after the new energy minister signed a joint cooperation agreement with the Inter-American Development Bank, allowing our Global Methane Coalition to resume capacity-building exercises. By the end of 2021, we're hoping to see final methane rules in place in Colombia, followed two years later by proposals in Argentina, Peru, and Ecuador.

In achieving these successes, we've relied on the expertise and enthusiasm of Mexican energy regulators to inspire others with the story of how their nation is implementing the strongest methane controls on the planet. We also drew on Mexican expertise to transport our program across the Atlantic-first to Nigeria, where we hosted a popular workshop, and then to the EU.

Advocating in the EU for Cleaner Gas Imports

Growing emphasis over the coming years will be placed squarely on Europe, where much of our new staff is located and where, emerging from years of neglect, interest in methane control is finally gaining traction. This is a promising turn, as the EU is the second-largest global consumer of natural gas (which is, essentially, methane) and the largest (by far) gas importer. Our goal is not just to help EU nations put the stopper on domestic methane leaks, but also to achieve what would

be a first: legislation requiring supplier nations to control CH, leaks before selling their product to the 27 member nations of the political and economic alliance. The number one supplier is Norway, where our recently hired technical and policy specialist-and a former Mexican oil regulator-is stationed. Strict but achievable standards to reduce methane discharge from outside the EU (which accounts for about 94% of total EU-related releases) would be an immediate plus, equal to the elimination of 120 coal plants by 2030.

Our big challenge in the EU, apart from working on ways to reduce emissions from gas imported from places like Russia, Algeria, and Qatar, will be to encourage EU officials to follow through with strong legislation minimizing methane emissions and flaring inside Europe.

A third accomplishment over the past year has been launching the Country Methane Abatement Tool-CoMAT. This electronic instrument, fully open-source and totally customizable, allows policymakers, industry representatives, and academics to explore methane reduction options for their oil and gas systemsbased both on a default case and on up-to-date, countryspecific data. Going forward, CoMAT will become ever more detailed and accurate, drawing in more users and helping to spread the word that major greenhouse gas reductions can be identified and addressed right now.



Estimated and Projected Global Anthropogenic Methane Emissions by Source, 2020 and 2030

Finally, CATF is preparing to work with the Biden Administration to achieve rapid progress on our domestic methane agenda. This has included crafting a detailed white paper explaining how the US oil and gas industry, one of the world's largest, can implement a suite of welltested, bolt-on measures that have the aggregate capacity to cut methane emissions levels by two-thirds within five years. These include more frequent leak detection and repair (critically important for halting super-emitters in their tracks), pneumatic pump upgrades that don't rely on (or release) natural gas, the elimination of emissions from well completions, the reduction of regulatory exemptions for compressors and dehydrators, and the prohibition of routine venting and flaring. CATF has found working examples of each of these measures in established regulatory programs in individual US states and Canadian provinces. At the national level, our goals are embodied in the CLEAN Future Act, released in the US House, and in the June 2020 Action Plan issued by majority members of the House Select Committee on the Climate Crisis. With the new Biden Administration, those goals point to a stronger methane regulatory proposal from EPA by the end of 2021, final rules the following year, and on-theground reductions soon thereafter.

Defending US Methane Regulation

This year, not surprisingly, we were called on once again to play defense. This meant guarding the major regulatory advances of the Obama years from total demolition by the Trump Administration. First, there was the attempted unravelling of the federal Bureau of Land Management's methane waste rule, which limits new and existing wells from needlessly squandering natural gas on federal lands. Prospecting there poses a growing problem, because these sources (like others) also emit hazardous air pollutants and fine particulate matter, both of which are major human health hazards. Next, there was the threat, ultimately realized, to do the same to EPA's methane rules, which extend nationwide, although they apply only to new or modified equipment.

So, CATF was forced to deploy another of its wellfashioned tools, litigation. Though always best used as a last resort, this past year such last resorts have not been all that rare. After CATF and allies challenged the BLM rescission in federal District Court, we secured a ruling that halted the dismemberment of the BLM program. In response to EPA's parallel attack on its own methane program, we once again deployed our legal team. Fortunately, the change in administration will simplify the challenge considerably and allow us to go on the offense, pressing for strong new rules.

One of the great collateral benefits of our Super Pollutant Program has been its tendency to break down silos, both external and internal to CATF. For methane, we've made new connections with the litigation team (of course), as well as with our carbon capture and sequestration advocates, who like us are focusing on the oil and gas sector and the fuels it extracts. For black carbon, CATF's other major super pollutant, synergies center on our broader campaign for zero-carbon fuels (here, we're advising American and European governments on relevant policy opportunities to reduce black carbon), on protecting earth's ice cap, and on securing reauthorization of the Diesel Emission Reduction Act, a federal grant-and-loan program targeting black carbon emissions from the existing fleet of on- and off-road vehicles. One near-term candidate for an energy source based on hydrogen or ammonia-neither of which contains a carbon molecule-is international shipping, particularly in the polar regions.

All of which provides real-world proof of the first law of ecology: everything is connected to everything else.

Projected Impact of Super Pollutant Reductions

Source: adapted from UNEP 2011, p. 255





IN THE MEDIA:

Washington Post – October 14, 2020 The number of global methane hot spots has soared this year despite the economic slowdown →



03 - OUR WORK & FOCUS

Carbon Capture and Storage

A Critical Option for Climate Success

Carbon capture and sequestration (or storage) (CCS) is a critical tool for taking on the climate challenge—and a key one. Beyond providing an option for firm electricity generation in the power sector, CCS will most likely be needed for heavy industry, where fossil fuel substitutes are hard to find or where process chemistry inherently emits carbon. It's also a potential aid in reforming methane into hydrogen and thus producing zero-carbon fuels. In the future, CCS may be called on to supplement "direct air capture," just now being demonstrated, in which carbon is extracted straight from the atmosphere and injected underground. To jump start the process, today we are pushing for innovation policies and engaging in support of pioneer CCS projects.

The solidly pragmatic objective here is to propel carbon-capture technology from early commercial and demonstration projects to fully commercialized components of a coordinated global climate response. Right now, much of the action is in the US, with interest brewing (and funds flowing) in another favorable venue, the EU. But, to meet global decarbonization goals, CCS must take root beyond the highly developed nations of the West. Coal and natural gas plants have been erected at a rapid rate, particularly in Asia, and those new, young plants are likely to be in full operation for many years. In fact, the number of coal-fired generators in China, India, and Southeast Asia built less than a decade ago exceeds by a factor of 30 the number of coal plants in the US built over the same period. The total annual power generation from just Asia Pacific coal plants (45% of which are less than a decade old) generates nearly twice as much electricity as all US power sources (coal, gas nuclear, and renewables combined). This foreshadows a long trail of intractable carbon. CCS can provide a way forward.

Growing Government Support

"In the past year," says Deepika Nagabhushan, director of our CCS initiative, "we've upped the momentum that's freeing carbon capture and storage from its 'very neglected space'—and ushering it into the realm of policy formulation." With CCUS Policy Innovation Director Lee Beck joining the staff last June, CATF successfully fought to include CCS-friendly provisions in several major federal bills and reports, including the action plan issued by the Democratic staff of the House Select Committee on the Climate Crisis, key sections of the bipartisan Clean Economy Jobs and Innovation Act adopted by the US House of Representatives, and even emergency economic legislation responding to the COVID pandemic.

In December 2020, CATF's efforts culminated with several CCS provisions making it into the bipartisan Energy Act of 2020, passed as part of a \$1.4 trillion omnibus spending bill. Importantly, the Energy Act authorizes Department of Energy aid of more than \$6 billion to help develop CO_2 storage sites, commercialization of carbon-capture technologies, and at-scale demonstrations of direct air capture technologies.

At a broader level, CATF Technology and Markets Director John Thompson is working on an "innovation agenda" articulating the strategic steps needed to transform carbon capture and storage from a solidly demonstrated technology to one that promises broadscale commercial viability. As part of this effort, we're examining several policies that support carbon sequestration infrastructure and markets. They include policy proposals to drive new technology development, shepherd technologies across the so-called "valley of death" to commercial demonstration, propel early deployment, and create an ecosystem nurturing favorable infrastructure and regulations. All of these pieces will be necessary to ensure that CCS is a scalable and affordable technology option for the world.

One innovative concept we're looking at is a geologic storage organization. This entity would be responsible for all aspects of storing captured carbon within a given geologic basin—including site selection, transportation, underground injection, monitoring, and long-term liability. In doing so, geologic storage potential could be optimized across entire basins. It would also offer regulators a single point of accountability for resource management, accelerate CCS adoption by providing to multiple carbon capture projects in a given region a centralized source of storage services, and develop CO₂ supply pipeline networks.

Opportunities Across the US

In addition to work at the federal level, we've expanded our carbon-capture efforts in specific states, particularly Pennsylvania, historically reliant on fossil fuel extraction, and California, the birthplace of so much modern clean energy policy and innovation. In Pennsylvania, we're pressing to advance into law a specific incentive for carbon dioxide storage—especially fitting for a state with significant carbon emissions (95% of all greenhouse



US Early-Stage CCS Project Map

gases from coal-fired power in the entire New England and Mid-Atlantic combined, and the eighth-highest in the nation) and, given its geology and history of coal mining, potentially significant underground storage. In California, we're deeply involved in analyzing the state's plans to achieve carbon neutrality by 2045, particularly ways in which CCS can become an important zero-carbon technology player across the power, transportation, and industrial sectors.

Our national work has been facilitated by our taking what we've uncovered from real-world research and putting it into an online map and data tracker. Here, the nearly three dozen carbon capture and sequestration projects now underway in the US can be parsed by location, type, stage, and a host of other features. Tools like this have increased transparency into the emerging state of the industry. Moreover, they contribute to growing the diverse coalition that is bringing to market a technology which, by mid-century, may be called on to remove from the air and forever sequester hundreds of billions of tons of CO₂. With our CCS data tracker up and running and continually updated, "now project developers want to be seen on it, they want to come back to CATF and give us updates," notes Nagabhushan. But, she adds, it also means that action must start immediately-"if we want to be ready with the technology when we need it."

Expanding into New Issues and Regions

One key aspect of any advanced green technology is its potential to deliver what are known as "co-benefits" that is, additional value beyond carbon reduction. Co-benefits can be especially significant when looking at social equity. Working with advocates in Texas and California, for example, we're undertaking a study to examine the impacts of CCS on particulates and other airborne health hazards emitted by refineries and cement plants, which are commonly located in or near environmental justice communities. This research has the potential to better inform all stakeholders, and especially front line communities, of the potential public health co-benefits, risks, and risk management strategies associated with CCS.

Internationally, we recently expanded our work in Europe, a major focus of which will be increasing our impact in the mature climate policy environment of the EU. Related to this, we are aggressively commenting on key CCS components of proposed EU climate strategies, laws, and regulations, while also organizing an effective stakeholder network. And we recently published a white paper on the very extensive European CCS efforts. On the other side of the globe, we're continuing to work in China. This fall, our Chief Geoscientist L. Bruce Hill, Ph.D. and colleagues from the Chinese Academy of Sciences published in the peer-reviewed <u>International</u> <u>Journal of Greenhouse Gas Control</u> an extensive review of Chinese geologic storage sites related to enhanced oil recovery, which is the Chinese government's first focus area for geologic storage.

The prospects look even brighter for 2021. With the arrival of the Biden Administration, we hope to accelerate implementation of our innovation agenda. That means pressing even harder for federal energy and climate legislation, while helping to clear a pathway for carbon capture and storage to move into commercial demonstration and broad deployment. Immeasurably helpful here will be the innovative CCS tax credit expansion (45Q), which CATF helped escort through the legislative process two years ago and that this past May was further advanced with the issuance of final IRS regulations. The 45Q credit provides an important incentive for CCS development, as evidenced by the fact that, since its passage, initial real-world projects have increased from only a handful to, at last count, nearly 35 in a dozen states across the US.

All of that portends a broader push for clean energy legislation in additional jurisdictions, particularly those open to a full range of strategies for a zero-carbon future. In California, seen by many as the primary incubator for that future, we plan to press for a governmentbacked carbon capture and storage task force that will streamline agency review, initiate a regulatory approval process for geologic storage utilities, move to include carbon capture in the state's cap-and-trade program, and examine how CCS can address carbon emissions from California's hulking cement plants and oil refineries. As is often the case, a non-governmental alliance is accelerating this effort. Here, it is called the California Decarbonization Partnership, a coalition of universities (Stanford, for one), federal research labs (e.g., Lawrence Berkeley), labor organizations (the United Steelworkers), potential CCS developers (Shell, Chevron, and Calpine), and NGOs—including, of course, Clean Air Task Force.



IN THE MEDIA:

Reuters – September 17, 2020 ANALYSIS-All must come aboard for a smooth ride to carbon-neutral future →



03 - OUR WORK & FOCUS

Advanced Nuclear Energy

Building a Viable Nuclear Energy Option

Our analysis and research on the climate crisis and the timely availability of the proper tools to fix it have convinced us—again and again—that a strategy encompassing nuclear energy can significantly enhance our chances of success.

What nuclear fission has going for it is scale. (Today's conventional nuclear plants typically are one gigawatt (GW) in size, and each can power about 1.4 million homes, providing the same output as 400 wind turbines or 3 million solar panels). Scale is what enabled France to use nuclear energy to decarbonize its electric grid in a mere two decades, which is about the time we have to do that for the planet today.

But the nuclear pathway that CATF seeks to promote is a new one. Although it builds on decades of experience with a keystone source of power across much of the

earth (fission provides 20% of America's electricity today), the hundreds of yearly gigawatts of needed nuclear first must deploy technologies that have been demonstrated, but for the most part not yet developed at commercial scale. And we must deliver these new technologies in a new way. This means both large and small configurations of traditional light water reactors, as well as full-size and modular versions of potentially a host of more efficient and less costly options: hightemperature gas reactors, reactors cooled with lowpressure molten salt, or with liquid lead or sodium, as well as pebble-bed designs. Importantly, we see nuclear not just as a clean source of consumer electricity, but also potentially as clean feedstock power for manufacturing zero-carbon fuels-essential if we are serious about managing climate.

Changing the Delivery Model

Perhaps even more important than new technology itself is a profound change in the business, delivery, and regulatory model used to deploy it. Today's nuclear power industry builds its huge plants craft-style, in small numbers, customized for sites, often taking more than a decade to finish. This outdated approach will never move the climate dial. We need an industry that delivers a global, factory-built, standardized product, much like natural gas turbines today, which can be licensed and overseen by regulators in multiple nations on a cooperative basis—thus reducing costs through economies of scale and compressing delivery times to a few years, rather than a decade.

On technology choice, CATF is not playing favorites at this early stage. We instead develop new laws, regulations, and policies that can support any technology and shepherd it through the complex process of acceptance, action, and adoption. In the past two years, for example, CATF played a key role in developing and supporting two important bills that will help to modernize the nuclear power industry—particularly in the US, where a variety of innovative advanced reactor designs are under development. Passed by overwhelming bipartisan majorities in late 2018 and early 2019, these are the Nuclear Energy Innovation Capabilities Act and the Nuclear Energy Innovation and Modernization Act. They provide funding for demonstration of advanced designs and encourage US nuclear power regulators to modernize the licensing process to account for these new technologies.

In 2020, we advocated for a number of additional pieces of legislation-among them, the Nuclear Energy Leadership Act (NELA) and the American Nuclear Infrastructure Act (ANIA). As a part of a larger coalition, CATF worked with Capitol Hill staff and partners to see that NELA was included in the House energy bill and in the Senate's National Defense Authorization legislation. Later, most of NELA became law as part of the Energy Act of 2020, which itself was an element of a much larger omnibus package. CATF is optimistic that the remaining provisions, which relate to Power Purchase Agreements (PPAs), will be enacted by the new 117th Congress. NELA focuses DOE on advancing concepts for the demonstration of advanced reactors, improving options for fueling advanced reactors, and helping to grow the nuclear energy workforce. CATF testified on the draft version of ANIA in August and has been engaged with Hill staff and partners to further refine it prior to introduction. ANIA awards monetary prizes for

French Electricity Sources 1960-2015

Source: CATF based on World Bank Development Indicators

The most dramatic example of scaling is France, which nearly completely decarbonized its electric grid in 15 years through the deployment of nuclear energy, shown below:



certain advanced reactors, supports existing reactors, and funds the cleanup of hard rock mining on Native American lands.

Together, these strikingly bipartisan legislative initiatives (they drew support from progressive climate hawks like Senator Sheldon Whitehouse, as well as climate skeptics like Senator James Inhofe) will ease the domestic nuclear industry's entry into the 21st century, while helping to harmonize essential federal support with growing interest and commitment from private investors.

Also over the past year, we've been working on a change framework to help a modernizing nuclear industry advance from the current average of 10 large reactors a year to planning for the deployment of 10 times that number. Much of the technology development can occur in the US, while we create a sophisticated and integrated international licensing system to expedite the marketing of new, safe designs—particularly modular designs with major components produced in bulk off-site—all across the globe. Potential customers include 30 to 40 nations in Southeast Asia, sub-Saharan Africa, Eastern Europe, Indonesia, and the Middle East. Today, more than two dozen US companies are vying to satisfy this huge global demand by creating reactor designs of this type.

Reshaping Discourse, Crafting Partnerships

Our initial work over the past year has been less than flashy, perhaps, but essential to reshaping the conversation—making it clear that, to meet the global climate challenge, we must think big about global nuclear expansion. That means being able to replicate the capacity of the entire existing system—more than 400 reactors—every few years.

To that end, we commissioned and are helping to fund several studies looking at the key elements of a nuclear industry harnessed to protect climate. The studies are examining strategies for international licensing, safety regulation, and reactor fabrication; early US development of advanced reactors; and the use of nuclear energy to produce hydrogen and ammonia, key zero-carbon fuels. And we are already taking this knowledge and turning it into policy proposals at the national and international level.

The New Face of Fission



Artist's rendering of the Natrium reactor, which was developed by TerraPower and General Electric-Hitachi, and recently awarded demonstration funding by US DOE. This highly compact reactor uses 80% less concrete than traditional units and contains on-site energy storage, which allows power to respond to grid demand, complementing natural fluctuations in wind and solar output. From its compact footprint, this plant's annual output would equal that of the world's largest offshore wind farms, which occupy 40 mi.², or four of the largest solar farms—a total of 5 million solar panels. (Credit: TerraPower)

Other recent activities:

- Filing an amicus brief in New Jersey backing state laws that provide financial support for existing nuclear units and helping to craft Illinois policy that would preserve existing nuclear plants;
- With MIT, co-developing and offering a three-day educational workshop ("Nuclear Energy 101") for federal and state policy staff, environmental NGOs, academics, and philanthropists;
- Devising and helping to enact funding for a revised federal research program on the health effects of lowdose radiation, the better to shape future regulation of nuclear energy; and
- Designing policies in Pennsylvania and Virginia that would include nuclear energy in future decarbonized power portfolios.

A More Receptive Political Environment

With the Biden Administration, we expect a broadened, more serious discussion about climate and greater opportunity to more deeply engage the federal government in our long-term nuclear strategy.

Top goals are to:

- Further develop and publish our vision to greatly expand reactor deployment, and carry its message to a broad worldwide audience of political leaders, regulators, climate advocates, nuclear vendors, investors, large industrial customers, and allied industries;
- Work to establish an entity to provide technical assistance for improving and harmonizing international licensing and oversight of nuclear energy;
- Foster the enactment of provisions of nuclear bills we are supporting and providing input on, such as the PPA provisions of NELA and ANIA; and
- Be able to look back on 2021 as the year in which nuclear was understood to be not only a major building block for generating electricity, but also for producing zero-carbon hydrogen.

Ultimately, explains Executive Director Armond Cohen, CATF's goal is to see that nuclear power "is transformed into a mass commodity industry like aviation or marine shipping—where we're churning out hundreds of units a year, rather than just a few. That's how solar and wind became cheap, and gas and coal power plants became the first choice for developing countries seeking big blocks of energy. We need to replicate that success, but with a power-dense, carbon-free source."

CATF is the bridge to the future. We bridge both aisles of Congress and both sides of industry. I see CATF as a stepping stone to bringing people together.

Brett Rampal Director of Nuclear Innovation



03 - OUR WORK & FOCUS

Bioenergy

Separating the Chaff from the Wheat and Husks from Kernels

Bioenergy—this term used to be virtually a synonym for a green future. But after several decades under the illusion that if it grows it glows, CATF has had to take the axe to a forest of confused and contradictory policy tendrils surrounding this particular outgrowth of the word "sustainability."

At root, the problem is simple, says Senior Counsel Jonathan Lewis, head of our bioenergy initiative. It's about holding the line on an energy resource that's become increasingly political—and one that, over time, has developed a distinctly unsustainable footprint. But finding a workable way forward—for example, building legislative guardrails to keep bioenergy focused on actual, real-time carbon removal—is anything but simple. And this is one of the paramount lessons that CATF has learned: that it takes careful study and sustained ingenuity to shed off slogans in favor of science, and to shift a conversation that, as Lewis puts it, "doesn't break down along party lines." Though still an uphill battle, our goal is to describe the current impacts and future potential of energy from plant material in a way that gets understood by lawmakers and agency staff, and then gets acted on. Congress has sent conflicting signals over the years, as it has tried to mollify two key political interests: Big Agriculture, with its fleet of ethanol refineries dotting the Farm Belt, and, to their south, the American petroleum patch, which generally has remained unexcited about replacing fossil fuel with corn ethanol, soy biodiesel, and the like.

The Downward Spiral

Fortunately, the past few years of confusion have helped us cement relations with allies and sympathetic policymakers to ensure that the primary driver of biofuels, the federal Renewable Fuel Standard, doesn't develop any more traction going forward. The empirical issue, we've found, is that, because most US biofuels are created by harvesting corn and soybeans on real estate previously used to grow food, landowners frequently respond to the unmet demand by clearing more land so they can plant more corn and soybeans. The result: existing carbon sinks in the form of uncultivated land are destroyed, and more carbon ends up in the atmosphere.

A second challenge exists, too, and that is biomass power. Bioenergy not only encompasses feedstocks for liquid fuels, it also includes wood products and woody waste burned in electric generators. There, the prime issue is time-without careful accounting to ensure that incoming fuel consists only of waste wood that already has ended its life as a long-term carbon storage vessel, the feedstock will include a heavy dose of wood that was still absorbing carbon when harvested. Although it's true that the forest may regrow (assuming that it isn't turned to some other use, like a cornfield or a subdivision), such a system ensures that feedstock carbon goes directly into the air, while the replacement forest-the sequestered carbon (aka, the carbon sink)-develops only inch by inch, typically over a period of decades. In other words, the current approach to biomass power ensures that we are living on borrowed time.

This past year, one of CATF's consultants ran a decarbonization model exploring the potential climate impact of a US bioenergy system relying solely on plant

waste or on high-yield energy crops harvested only from areas currently planted for corn-based ethanol. Analyzed as part of a year 2050 decarbonization pathway, this more selective approach could avoid new rounds of land clearing. A first cut suggests that bioenergy generated this way— good bioenergy, if you will—could help satisfy a modest portion of future US demand for liquid transportation fuels.

Resetting the Narrative

At the same time, CATF and a cadre of NGOs such as the National Wildlife Federation and Earthjustice are looking at ways to totally change up the conversation. Regular meetings among environmental allies consider new forms of bioenergy—including hydrogen made from gasified biomass, the refiring of fossil energy plants with biofuel (while sequestering related carbon emissions underground), and attempts to crack the hardest nut of all: how to transform the current bioenergy landscape into an advanced biofuels industry that is carbon neutral.

In 2021, with the new administration, CATF hopes to accelerate thinking about and planning for what we see as the required transition from the existing US Renewables Fuel Standard—too weak and fundamentally misdirected towards mega-farms that turn food crops into biofuel—to a zero-carbon fuel standard. Of necessity, that will include a more honest discussion about the inadequacy of the current bioenergy regime.

When it comes to bioenergy, CATF is exercising a core strength—exposing what has morphed into an ecological impostor, and then working with our allies to transform the entire conversation.

CATF never settles. We're always looking for new ideas, new opportunities, and new challenges.

Jonathan Lewis Senior Counsel



03 - OUR WORK & FOCUS

Zero-Carbon Fuels

The Prize—Zero-Carbon Fuels for a Zero-Carbon World

At the central point around which so much of CATF's work revolves sits our core mid-century objective: to achieve a world that emits into the atmosphere absolutely no carbon dioxide or other greenhouse gases. This is the zero-carbon future that animates everything we do.

But, realistically, such a future will not be reached unless societies can bring carbon-free fuels into the mix. On a global basis, 85% of total end-use energy consumption is delivered by hydrocarbon molecules and, of that, nearly two-thirds arrives as oil or gas. Much of this is used in activities and processes (shipping, trucking, chemical manufacturing, for instance) that do not lend themselves to the usual substitute, electricity. Thus, the need for carbonless liquid energy. Even some requirements of the electric grid—e.g., dealing with the significant variability of renewables—can be satisfied with this new generation of fuels. Hydrogen is likely to be the zero-carbon fuel of choice for many applications. It carries more energy by weight than any other molecule, and when bundled up as ammonia, NH₃, it has physical properties similar to propane. In fact, notes Mike Fowler, director of Advanced Energy Technology Research, "hydrogen could be used all across the economy." It's versatile, portable in a variety of ways, and, when burned, decomposes into water."

Focusing on Where Hydrogen Makes Sense

At this early point, CATF's primary challenge is to "focus the field," says Fowler. That means identifying uses where hydrogen makes the most sense. Serendipitously, in the past few years, interest in hydrogen as a clean fuel has gained narrative momentum, while at the same time our own involvement has blossomed. Fowler rejoined CATF after a stint working on carbon capture and advanced batteries; a few months earlier, his colleague Jonathan Lewis, senior counsel and lead of our new zero-carbon transportation initiative, had elevated the discussion by issuing *Fuels Without Carbon*, a CATF report outlining the way forward—and describing (in Lewis' words) "a landscape of opportunity."

As with any new idea, particularly one calling for major change that promises long-term benefits, our work this past year on zero-carbon fuels has involved extensive engagement with energy companies and thought leaders in the US and, particularly, in Europe and Asia—regions further along in the process of understanding. Until the pandemic, this included travel to what is perhaps the leading clean fuel nation in Asia—Japan. Fowler and Lewis visited several times in late 2019 and early 2020, meeting with staff at the hydrogen ministry, presenting to the green ammonia consortium (first in person, then by video), and checking out new demonstration projects that co-fire NH₃ to generate power.

"Among NGOs," says Lewis, "we're a leading voice and thinker on zero-carbon fuels." But, because the US is far behind in this area, most of the work is overseas. Fowler is helping to set up CATF's office in Europe. "Europe is moving aggressively on hydrogen use to decarbonize buildings and heavy transport," he notes, "while blazing a trail of global significance."

Our intensifying examination of clean fuels this year looked at how to best manufacture hydrogen and ammonia, as well as how to most effectively use it. On the production side, we are eyeing the development of regional hubs, where hydrogen can be manufactured cheaply and then distributed for use. One candidate is Southern California, whose enormous solar resource could generate hydrogen through the electrolytic partition of ordinary water. Alternatively, along Houston's Gulf Coast, natural gas (as noted, mostly CH_4) could be tapped, with its waste carbon captured and sequestered underground—yielding so-called blue hydrogen, which also is climate compatible so long as upstream methane emissions are eliminated.

Emphasizing Heavy-Duty Applications

This year, we put particular emphasis on several highenergy uses that would be especially hard to electrify and could accommodate hydrogen.

Key areas include:

- Heavy-duty commercial trucking (Lewis helped organize a November conference on transportation decarbonization);
- High-temperature process heat in the petro-chemical industry, which is a major user of petroleum-based fuels, as well as in advanced ironmaking;
- The electricity sector, with hydrogen stored essentially as a chemical "battery"—and then burned when the system's renewable resources (wind and sun) are not available—an application likely to be far less costly than a massive renewable system able to operate 100% of the time; and
- International marine shipping.

The latter area has been a focal point of Lewis's work this year. In addition to extensive interaction with the major shipping companies and regulators, this has included testifying in September before the US Senate Committee on Energy and Natural Resources regarding zero-carbon fuels for marine shipping, and working with a team from Columbia University's School of International and Public Affairs on an extensive study of the capacity of major global port systems to supply zero-carbon fuel—most likely, ammonia—to large ocean vessels. The report, <u>Zero-Carbon Fuels for Marine</u> <u>Shipping</u>, was released in May.

With a new administration in Washington, the feeling is that climate change will receive renewed emphasis. In the near term, that is likely to mean more funding for green infrastructure, some of which Fowler and Lewis hope can be directed to zero-carbon fuels. But, regardless of when funding arrives, CATF will continue to press full speed ahead with its fundamental strategy, one that does not hinge on immediate attention from the political powers of the moment: to work with industry, NGOs, and other non-government players to advance the hydrogen fuel future towards demonstration projects and early-stage deployment—or, as Fowler puts it, "so that the technology and infrastructure are ready when the political climate allows greater decarbonization efforts."



03 - OUR WORK & FOCUS

Advanced Energy Technology

Tapping into Next-Generation Technologies—Today

The scientists, policy pros, and advocates at Clean Air Task Force often take the long view—not just in estimating the impacts of climate disruption, but also of the future technologies that can be brought to bear to address it. To us, these are not moonshots; rather, they comprise a very calculated strategy to take existing research programs to the next level—and to do so over what is necessarily a broad arc of time.

One of these efforts, so-called superhot rock geothermal, will build on long-established drilling techniques (read: oil and gas) to reach down to and harvest the limitless energy of the earth's crust. The other, nuclear fusion, would help direct seasoned research programs toward a clear mission—seed power to propel a zero-carbon energy system by mid-century. The first, deep geothermal, looks inward; the second, fusion, looks for inspiration to the sun. Each could cleanly power entire sectors or turn basic feedstock into pollution-free fuel. Each, in other words, would be a game-changer.

Interrogating the Inferno

To the uninitiated, geothermal tends to be viewed as a niche resource, pumped from volcanic rock that lurks just below the surface of some of the planet's more farflung landscapes: Iceland, Italy, California, Mexico, and New Zealand. But superhot geothermal is different—at depth, it is available everywhere on earth. And, if tapped, it becomes a highly scalable energy resource that would provide essential, always-on power from a tiny surface footprint in virtually limitless quantities—forever.

But CATF doesn't waste time chasing flashy promises; rather, it invests in promising climate solutions anchored in existing technology and know-how. In the case of energy from hot rocks—known formally as engineered (or enhanced) geothermal systems (EGS)—that technology and know-how grounds the very approach that made the US a top global oil producer: innovative drilling. And it builds on a technology that is well understood by an international industry increasingly interested in locating sustainable opportunities that tightly fit its deep experience. Like hot rocks.

The challenge is that rocks sufficiently thermal to do the job-a toasty 400° C or more-generally lie in the upper layer of the lithosphere, 5 to 20 kilometers below the earth's surface. That means abandoning rotary metal bits in favor of direct energy drilling-that is, melting open subterranean shafts with the help of plasma torches, lasers, or extremely high-frequency millimeter waves. When injected into deep crevices, water instantly assembles itself into a superhot, superfluid hybrid of liquid and steam, then shoots up through a production well to drive a high pressure turbine. After cooling, it heads back underground, endlessly recycled. Because it delivers ten times the energy of a conventional well, superhot geothermal can radically upgrade the economics of this long-overlooked source of superclean power.

A Revolutionary New Energy Source

Right now, however, deep hot rock technology is confined to the laboratory bench. CATF aims to coax it out. We're using our long experience in bringing together scientists, technicians, knowledgeable industry leaders, and climate advocates to spread the news that EGS is not your grandparent's geothermal. We're working to transform it into a major long-term strategy for constraining climate chaos.

The start-up challenges, though significant, are not overwhelming. We estimate that an initial federal program funded at less than 10% of the nation's current investment in other renewables would inject the needed momentum. Although CATF's geothermal initiative, one of our newest, is just getting underway, the prospects are promising—and the potential payoff is more than profound. Not a bad forecast for a first-ever advocacy effort to develop and commercialize advanced baseload renewables.



Perspectives on the Geothermal Sweet Spot

Key

- 1. Deepwater Horizon oil well (Gulf of Mexico)
- 2. Current geothermal (Nesjavellir, Iceland)
- 3. Kola borehole, Russia (world's deepest)
- 4. Ground-source heat pump

In the coming year, CATF will build on this groundwork by:

- Reaching out to the oil and gas, utility, mining, and industrial sectors to educate and win support for superhot rock demonstration projects;
- With colleague and former Obama Administration Deputy Assistant Secretary for Fossil Energy at US DOE, David Mohler, developing a bridge strategy to advance demonstration projects to the early commercialization phase;
- Building an international advisory board and hosting an expert workshop to galvanize research and demonstration projects;
- Connecting with US Congress and DOE to advance geothermal innovation recommendations developed through an ongoing process that's brought together federal decision makers, key advocates like CATF, and the Edison Electric Institute, which is the trade association for investor-owned utilities; and

 With partners Seattle-based HERO (Hot Rock Research Organization) and Lucid Catalyst, issuing a report and roadmap focusing on superhot geothermal's technical readiness and need for additional innovation, and undertaking an updated modeling assessment of the expected levelized cost of energy from superhot rock projects.

Nudging Nuclei into Line

Another potential game-changing option is fusion energy, long known by its ironic tagline: the limitless energy source that's always three decades away. Only, again, that's becoming more myth than reality. In fact, at a time of technical progress as well as a growing perception by private capital that fusion presents an attractive opportunity for competitive investment, the pathway from idea to commercialization is shrinking. As a result, focus is shifting away from massive and long-term government endeavors, like the International Thermonuclear Experimental Reactor (ITER)

Funding to Fusion Energy Companies by Year

Source: www.fusionenergybase.com



program, towards nearer-term deployment of fusion technology at the commercial scale. Within the fusion space, CATF has few peers among advocates.

Although fully commercial fusion is not likely to arrive before the mid-2030s, we're increasingly optimistic that the energy source that powers the stars can play a potentially significant role in decarbonizing earth's air before mid-century—an essential period of catch-up if global temperature escalation is to be held to 2° C or less. Recent technical breakthroughs—in computing power, super-conducting magnets, control of hot plasmas, and materials science—have led to improved understanding of the forces that hold nuclei together and the prospects for harnessing their massive energies.

In the past decade, reported private investment in fusion research has grown from virtually zero to more than \$1.5 billion, eclipsing the parallel funding of fission. It is now attracting such VIP investors and high-tech visionaries as Bill Gates, Jeff Bezos, Reid Hoffman, Michael Bloomberg, Richard Branson, Ray Dalio, Dustin Moskovitz, and Sam Altman. Even major investors in the oil industry recently placed a big bet on fusion.

This indeed portends a paradigm shift, with most of the action happening in the United States. CATF's role is to seize the moment, helping weave together players, conversations, and concepts so that in the near term these key areas can be optimally aligned:

- Research and development priorities;
- Assessment of commercial viability and timeline;
- Market analysis of opportunities for and barriers to commercialization; and
- Sound approaches to regulation, safety, and the potential for proliferation.

Cultivating the Landscape of New Fusion

In the fusion space, CATF plays to its strengths, serving as an experienced matchmaker. For example, we are nurturing and attempting to expand private investors' gathering interest in fusion, evidenced by recent fusion start-ups and high-powered alliances like Breakthrough Energy. As Director of Nuclear Innovation Brett Rampal explains, "The growth of private fusion developers and investment could offer the world transformative change in the form of clean and abundant energy in a fundamentally different timeline than public endeavors have previously considered."

Although fusion today is definitely on the hot, rather than cold, side—with researchers seeking commercial viability via such futuristic-sounding technologies as high-temperature, super-conducting magnets and high-velocity projectile gas guns—it offers positives that parallel superhot rock geothermal: plenty of fuel (hydrogen isotopes), a small footprint, always-available power, absence of very long-lived radioactive waste, and, of course, zero greenhouse gas emissions.

CATF's focus over the past two years, and its continuing focus for the next two, is to help bring fusion from the lab to the beginnings of advanced design and future commercial development—initially, by designing a reactor able to produce more energy than it consumes.

To do this, we're:

- Convening monthly with interested NGOs, while continuing to host workshops, connect with multiple developers, and meet with key government officials, including fusion research directors at national labs;
- With several NGOs and utility partners as well as the fusion industry, developing a federal policy roadmap to grow fusion as a green energy source;
- Carefully assessing potential institutional and supply chain constraints to identify public policy actions that will remove these hurdles and expedite future commercial fusion deployment;
- Broadening target audience awareness of fusion's increasing significance, particularly its long-term climate benefits; and
- Advocating for more public support directed to commercial development of fusion power.

SECTION 04

At a Glance

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04 - AT A GLANCE

Fundraising

CATF's Big Vision Propelled by New Donors

CATF's mission has long been advanced by our generous donors, including foundations and family funds. In 2020 some of our biggest heroes were the individuals whose enhanced giving at all levels helped drive CATF's unprecedented growth and create bold opportunity. We added 15 new staff, enhanced our development and communications capacity, and launched a major presence in Europe, while elevating our voice on a global stage. We're grateful, encouraged, and ambitious about what's to come.

Thanks to *all* our supporters, CATF is closing in on our most ambitious goal—to decarbonize the global energy system and permanently stabilize our climate.



2020 surge in contributions from individual donors



We have been consistently impressed by CATF's transparency and honesty in our dealings with them.

Founders Pledge: Charity Reports

04 - AT A GLANCE

Endorsements and Partners

Endorsements

CATF has received the highest possible rating from <u>Charity Navigator</u> and a **2020 Gold Seal of Transparency** from <u>Guidestar</u>, and has been endorsed as a highly effective organization by <u>Founders Pledge</u> and <u>Giving Green</u>.



Fundraising Partners

Centre for Effective Altruism - US, UK, Netherlands

The Crowd – United Kingdom

Double Up Drive

Effective Altruism Foundation – Switzerland

Effektiv Spenden – Germany

Founders Pledge

Giving What We Can GivingMultiplier High Impact Athletes legacies.now – Germany Rethink Charity Forward – Canada

04 - AT A GLANCE

CATF in the News

CATF continues to be lauded for our work across the globe and is seen as a highly effective organization and leader in the climate change solution space. We are proud of the many articles written about our work in the past year. A few examples:



The Atlantic – December 1, 2020 <u>The Weekly Planet: The Best Way to Donate to</u> Fight Climate Change (Probably) →



Vox – September 17, 2020 Want to fight climate change effectively? Here's where to donate your money \rightarrow



New York Times – January 29, 2020 One Thing You Can Do: Make Smart Donations →



Rolling Stone – October 27, 2020 Another Reason We Can't Breathe \rightarrow



New York Times – June 24, 2020 Projects to Stash Carbon Dioxide Underground Get a Boost →

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NPR – March 6, 2020 Resources On Climate Change \rightarrow

 CATF's deep technology and policy expertise makes them a great partner for advancing climate change solutions in our region.

> John Nielsen Energy Program Director, Western Resource Advocates

Board of Directors



Armond Cohen Executive Director, Clean Air Task Force, Boston, MA



Phil Giudice Board Member, Ambri, Marlborough, MA



Jane C.S. Long

Fellow, Center for Global Security Research Principal Associate Director at Large Lawrence Livermore National Laboratory, Livermore, CA



Seema Paul

Managing Director, The Nature Conservancy, Washington, DC



Bruce Phillips

Director and Co-Founder, The Northbridge Group, Concord, MA



Sue Sheridan

President and Chief Counsel, Coalition for Fair Transmission Policy, Washington, DC



In Memoriam – CATF Board Chair

Wendy Jacobs

On February 1, 2021, Wendy Jacobs, the Chair of CATF's Board of Directors, died after a valiant struggle with an illness. Wendy joined CATF's Board in 2016, and become our board Chair in 2018. Wendy first became associated with CATF through her position as the Emmett Clinical Professor of Environmental Law and Harvard Law School and Director of the school's <u>Emmett Environmental Law & Policy Clinic</u>, where she had a long and fruitful relationship with CATF. She will be sorely missed.

CATF Experts

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Jonathan Banks International Director, Super Pollutants, Brunswick, ME

Lee Beck CCUS Policy Innovation Director, Washington, DC

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