From the bestselling author
of *Measure What Matters*
John Doerr

speed & scale

A Global Action Plan for Solving Our Climate Crisis Now

Featuring interviews with Bill Gates, Christiana Figueres, Jeff Bezos and Al Gore

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For Ann, Mary,
and Esther, and the
wonder of their
unconditional love.

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ABOUT THE AUTHOR

John Doerr is an engineer, venture capitalist, the chair of Kleiner Perkins and the author of the *New York Times* number-one bestseller *Measure What Matters*. For over forty years, John has served entrepreneurs with ingenuity and optimism, helping them build bold teams and disruptive companies. He was an original investor and board member at Google and Amazon, helping to create more than a million jobs. A pioneer of Silicon Valley's cleantech movement, Doerr has invested in zero-emissions technologies since 2006. Outside Kleiner Perkins, Doerr works with social entrepreneurs who are tackling systemic issues across climate, public health and education.

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Prologue

"I'm scared, and I'm angry."

In 2006, I hosted a dinner after a screening of *An Inconvenient Truth*, former vice president Al Gore's seminal documentary on the climate crisis. We went around the table for everyone's reaction to the film's urgent message. When it came to my fifteen-year-old daughter, Mary, she declared with her typical candor: "I'm scared, and I'm angry." Then she added, **"Dad, your generation created this problem. You better fix it."**

The conversation stopped cold. All eyes turned to me. I didn't know what to say.

As a venture capitalist, my job is to find big opportunities, target big challenges, and invest in big solutions. I was best known for backing companies like Google and Amazon early on. But the environmental crisis dwarfed any challenge I'd ever seen. Eugene Kleiner, the late cofounder of Kleiner Perkins, the Silicon Valley firm I've been with for forty years, left behind a set of twelve laws that have stood the test of time. The first goes as follows: *No matter how groundbreaking a new technology may seem, make sure customers actually want it*. But this problem led me to invoke a lesser-known Kleiner law: *There is a time when panic is the appropriate response.*

That time had come. We could no longer afford to underestimate our climate emergency. To avert irreversible, catastrophic consequences, we needed to act urgently and decisively. For me, that evening changed everything.

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My partners and I made climate a top priority. We got serious about investing in clean and sustainable technologies—or "cleantech," as they're known in Silicon Valley. We even brought in Al Gore as the firm's newest partner. But despite Al's excellent company, my journey into the world of zero-emissions investing was pretty lonely at first. After the iPhone debuted in 2007, Steve Jobs invited us to launch our iFund for mobile apps from Apple's headquarters. We were hearing great pitches from mobile app startups; I could see opportunities left and right.

So why commit a chunk of capital to the uncharted territory of solar panels, electric car batteries, and meatless proteins? Because it seemed like the right thing to do, for the firm and for the planet. I thought the cleantech market was a monster in the making. I believed we could do well by doing good.

We pursued mobile apps and climate ventures at the same time, despite doubters on both fronts. Our mobile app investments gave us a burst of quick wins. Our climate investments were slower out of the gate, and many of them failed. It's hard to build a durable company under any circumstances, and doubly hard to build one to take on the climate crisis.

Kleiner Perkins got beaten up in the press. But with patience and persistence, we stood by our founders. By 2019, our surviving cleantech investments began to hit one home run after the next. Our $1 billion in green venture investments is now worth $3 billion.

But we have no time for a victory lap. As the years roll by, the climate clock keeps ticking. Atmospheric carbon already exceeds the upper limit for climate stability. At our current pace, we will blow past 1.5 degrees Celsius (or 2.7 degrees Fahrenheit) over the Earth's preindustrial mean temperatures—the threshold, scientists say, for severe planetary damage. The effects of runaway global warming are already plain to see: devastating hurricanes, biblical flooding, uncontrollable wildfires, killer heat waves, and extreme droughts.

I must warn you up front: we're not cutting our emissions fast enough to outrun the damage on our doorstep. I said this in 2007, and I say it today: **what we're doing is not nearly enough.** Unless we course correct with urgent speed and at massive scale, we'll be staring at a doomsday scenario. The melting polar ice caps will drown coastal cities. Failed crops will lead to widespread famine. By midcentury, a billion souls worldwide could be climate refugees.

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Fortunately, we have a powerful ally in this fight: innovation. Over the past fifteen years, prices for solar and wind power have plunged 90 percent. Clean energy sources are growing faster than anyone expected. Batteries are expanding the range of electrified vehicles at an ever lower cost. Greater energy efficiency has sharply reduced greenhouse gas emissions.

While a good many solutions are in hand, their deployment is nowhere near where it needs to be. We'll need massive investment and robust policy to make these innovations more affordable. We need to scale the ones we have—immediately—and invent the ones we still need. In short, **we need both the now and the new.**

So where's the plan for getting the job done? Frankly, that's what's been missing: *an actionable plan*. Sure, there are lots of ways on paper to get to net-zero carbon emissions, the point where we add no more greenhouse gas into the atmosphere than we can remove. But lists of goals are not plans. A long menu of options, however excellent they might be, is not a plan. Anger and despair aren't plans; neither are hopes and dreams.

More than anything, we need a clear course of action. That's why I've written this book. With help from some of the world's foremost experts in climate and cleantech, I created *Speed & Scale* to show precisely how we can drive greenhouse emissions to net zero by 2050. My hope is to build on the hard-earned triumphs and lessons of our climate pioneers and heroes, many of them hailed in these pages. They're the ones who blaze new trails by executing better and smarter.

A plan is only as good as its implementation. To achieve this monumental mission, we'll need to hold ourselves accountable every step of the way. That's the great lesson I learned from my mentor, Andy Grove, the legendary CEO of Intel. It's a mantra I've seen proven over and again: *Ideas are easy. Execution is everything.*

To execute a plan, we need the right tools. In my previous book, *Measure What Matters*, I outlined a simple but powerful goal-setting protocol that Andy Grove invented at Intel. Known as OKRs, or Objectives and Key Results, they guide organizations to focus on a few essential targets, to align at every level, to stretch for ambitious results, and to track their progress as they go—to measure what matters.

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Now I'm proposing we apply OKRs to solve the climate crisis, the greatest challenge of our lifetimes. But before going all in (and this is an all-or-nothing proposition), we must answer three basic questions.

Do we have enough time?

We hope so, but we're fast running out of it.

Do we have much margin for error?

No, we don't. Not anymore.

Do we have enough money?

Not yet. Investors and governments are stepping up. But we'll need a lot more funding, from both public and private sectors, to develop and scale technologies for a clean economy. Most of all, we'll need to divert the trillions spent on dirty energy over to clean energy options, and use that energy more efficiently.

The data is clear. The moment is now. I am committed to using my time, my resources, and whatever knowledge I have to work with you to build a net-zero future. I invite you to join our effort at speedandscale.com. To put our plan into action, we need all hands on deck. Above all, we'll need to execute our plan with unprecedented speed and unprecedented scale. That's what matters most.

I've written this book for leaders of all kinds, for anyone anywhere who can move others to act with them. It's for entrepreneurs and business leaders who can mobilize the power of markets. For political and policy leaders willing to fight for our planet. For citizens and community leaders who can press their elected officials. And, not least, for leaders from the rising generation, like Greta Thunberg and Varshini Prakash, who will be showing the way to 2050 and beyond.

Speed & Scale is written for the leader inside you. I'm not here to prod consumers to change their behavior. Individual actions are both needed and expected, but they won't be nearly enough to reach this huge goal. Only concerted, collective, *global* action can get us past the finish line in time.

I might seem an unlikely advocate for this call to action. I'm an American, a citizen of the biggest historic polluter on Earth. I am an affluent white man, born in St. Louis, Missouri, from a generation whose negligence helped create this problem in the first place.

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Yet from the home office where I wrote this book, not far from San Francisco, I've looked out over the hills and seen the bright orange skies of the wildfires, the signposts of drought and devastation. They've devoured millions of acres of forests each year in California alone, spitting back more carbon dioxide into the atmosphere than all the state's emissions from fossil fuels. It is the most vicious of circles, and I cannot stand idly by. Whatever my flaws as a messenger, I am impelled to act.

In my fifteen years on this path, I've collected my share of scar tissue. Cleantech ventures demand more money, more guts, more time, and more perseverance than just about anything else. Their horizons stretch longer than most investors can stomach. The washouts are acutely painful. But the success stories—however few and far between—are worth all the setbacks and then some. These companies are more than turning a profit. They are helping to heal the Earth.

In large part, this book is a collection of stories from my own trek through these minefields and those of dozens of other climate leaders, many of whom I've been proud to back as an investor. Their behind-the-scenes narratives illustrate the potential of our plan to reach net zero by 2050, and the hurdles we'll need to overcome. My hope is that they'll offer the reader some respite from the more technical, data-drenched sections. In making this journey, I've been inspired by both the problem and the people. I hope you will be, too.

Entrepreneurs are those hardy individuals who do more with less than anyone thinks possible—and do it faster than anyone thinks possible. Today, bold risk-takers are innovating like mad as they rewrite the rules to avert a climate apocalypse. We need to bottle their entrepreneurial energy and distribute it as widely as we can—to governments, companies, and communities worldwide.

A plan is not a guarantee. A timely transition to a net-zero future is no sure thing. But though I may be less optimistic than some, **consider me hopeful—and impatient.** With the right tools and technology, with precision-honed policies, and most of all with science on our side, we still have a fighting chance.

But the time is *now*.

—John Doerr
July 2021

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What's the Plan?

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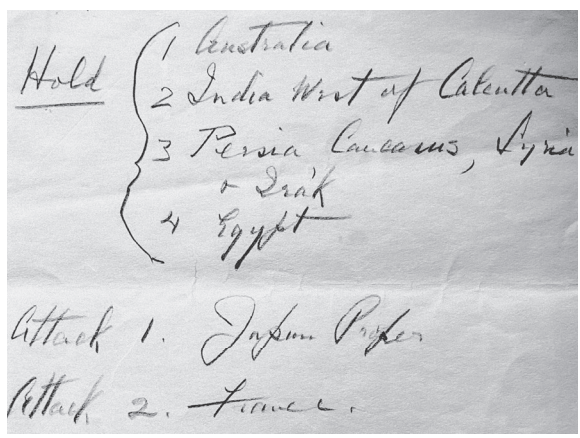
Introduction

What's the Plan?

On a chilly day in March 1942, three months after the attack on Pearl Harbor, President Franklin D. Roosevelt met at the White House with Henry "Hap" Arnold, commanding general of the U.S. Army Air Forces. The agenda had one item: Roosevelt's plan to win World War II. It was a challenge of historic proportions—especially at that moment, when things looked especially grim. FDR might have expounded upon geopolitics or cataloged every conceivable battlefront. He might have plunged into complexity and intricate detail. Instead, the president grabbed a cocktail napkin and sketched a three-point plan stripped to its bare bones:



In March 1942, FDR outlined his plan for winning World War II on this cocktail napkin.

1. Hold four key territories
2. Attack Japan
3. Defeat the Nazis in occupied France

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The points were focused, action-oriented, and definitive. Roosevelt's napkin provided what the nation's military leadership desperately needed: clarity.

Not coincidentally, the plan wound up succeeding. After the meeting ended, General Arnold took FDR's napkin with him back to the Pentagon. It was kept top secret through D-Day and remained classified for decades. In 2000, the entrepreneur and book collector Jay Walker bought it at auction for display in his library.

"Whenever anyone tells me a problem is too complex to solve with a clear, simple plan," Walker says, "I show them the napkin. Is the problem you are trying to solve really more complicated than World War II?"

What are greenhouse gases?

They're the gases in our atmosphere that absorb heat. The sun radiates energy; you can feel it when you step out of the shade. Some of it is absorbed by the Earth and is radiated back into the air. Nitrogen and oxygen, the predominant gases in the atmosphere, allow this thermal energy to pass freely into space. But greenhouse gases are more loosely bound, complex molecules that trap a portion of the energy and radiate it back again to the Earth's surface. Hence the "greenhouse effect," the extra warming that adds to direct heating from the sun.

We need greenhouse gases, in moderation; warmth is vital to life. But too much of them is a problem. Carbon dioxide, the most abundant, is odorless, invisible, and stubbornly enduring. Once released from a tailpipe or a chimney, it stays in the atmosphere for centuries.

Methane is a different beast. The primary ingredient in natural gas, it heats our homes and lights our stoves. Cows release it in abundance. Though methane endures in the atmosphere far more briefly than CO_2, it is many times more potent for the short-term trapping of heat.

Other gases heat the planet too. They include nitrous oxide, a by-product of fertilizers, as well as some common refrigerants. All these greenhouse gases can be calibrated by a single measure: carbon dioxide equivalents, or CO_2e. This umbrella metric accounts for the gases' uneven warming impacts and makes for more meaningful comparisons.

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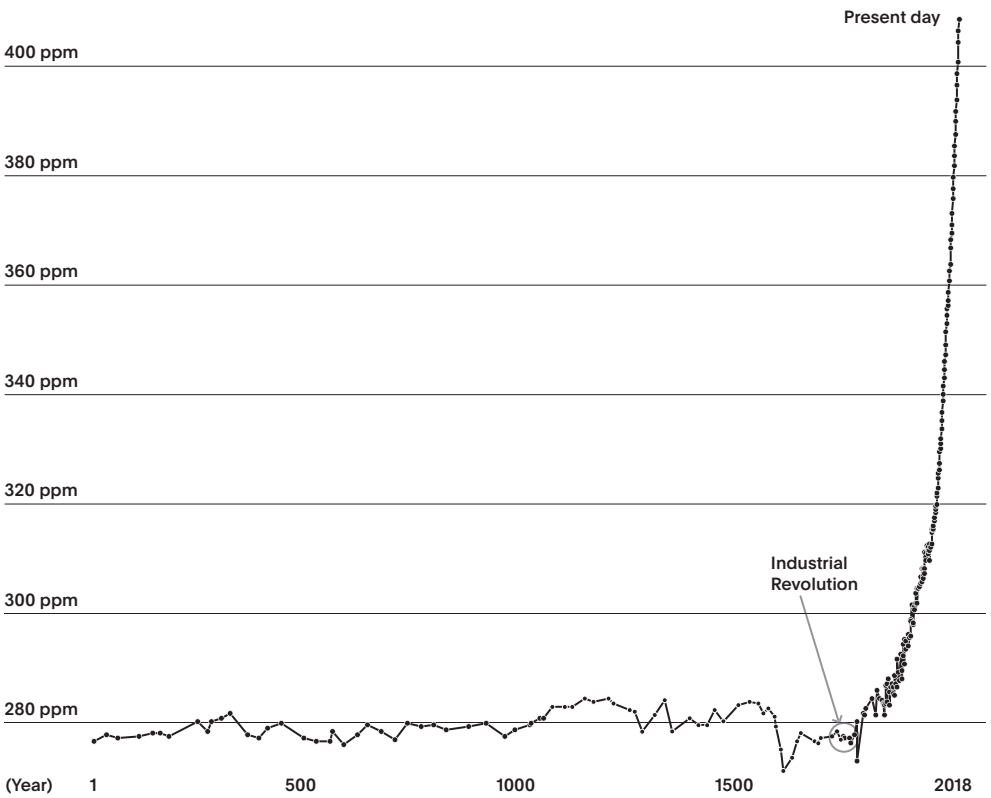
How much greenhouse gas is in our atmosphere?

In the preindustrial era, every million molecules of air contained around 283 molecules of CO_2e. In 2018, the Intergovernmental Panel on Climate Change warned that we needed to keep CO_2e below 485 parts per million. The problem is that we've already crossed that threshold and are now at more than 500 parts per million. (This data comes from eighty collection sites around the world and is rigorously measured by the National Oceanic and Atmospheric Administration.)

To stave off a climate catastrophe, our goal must be to prevent any additional greenhouse gas accumulation, drive CO_2e back under 430 parts per million, and keep it there.

Carbon dioxide in the atmosphere has risen dramatically over the last 200 years

Annual concentration of carbon dioxide (CO_2) measured in parts per million (ppm).



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When assessed on a planetary scale, CO_2e is typically measured by the gigaton, or one billion metric tons—the weight of 10,000 fully loaded aircraft carriers. In terms of emissions, burning 110 gallons of gasoline emits one ton of CO_2e. Powering 12,000 homes with fossil fuels for one year emits 100,000 tons of CO_2e. Driving 200,000 gasoline-fueled cars an average of 12,000 miles apiece emits 1 million tons of CO_2e. Operating 220 coal-fired power plants for one year emits a gigaton of CO_2e. The annual sum of all human-caused emissions is 59 gigatons of CO_2e.

Why do these numbers matter?

Unabated greenhouse gas emissions have created runaway warming on Earth. All told, the average global temperature has risen by about 1 degree Celsius—or almost 2 degrees Fahrenheit—since 1880. Though they may not sound like a whole lot, these small numbers have a massive impact.

Our climate crisis has been a long time coming. Since the dawn of the Industrial Revolution, the burning of fossil fuels and other human activities have emitted more than 1.6 trillion tons of greenhouse gases into the atmosphere—more than half of those emissions since 1990. Many of us are part of the problem—anyone who's ever traveled by car or by plane, had a cheeseburger for lunch, or enjoyed the comforts of a well-heated home.

Only drastic cuts to emissions—*before* they enter the atmosphere—can begin to prevent ecosystem collapse and an uninhabitable Earth. Consider these dire projections for the year 2100:

We will far exceed our 1.5°C limit.

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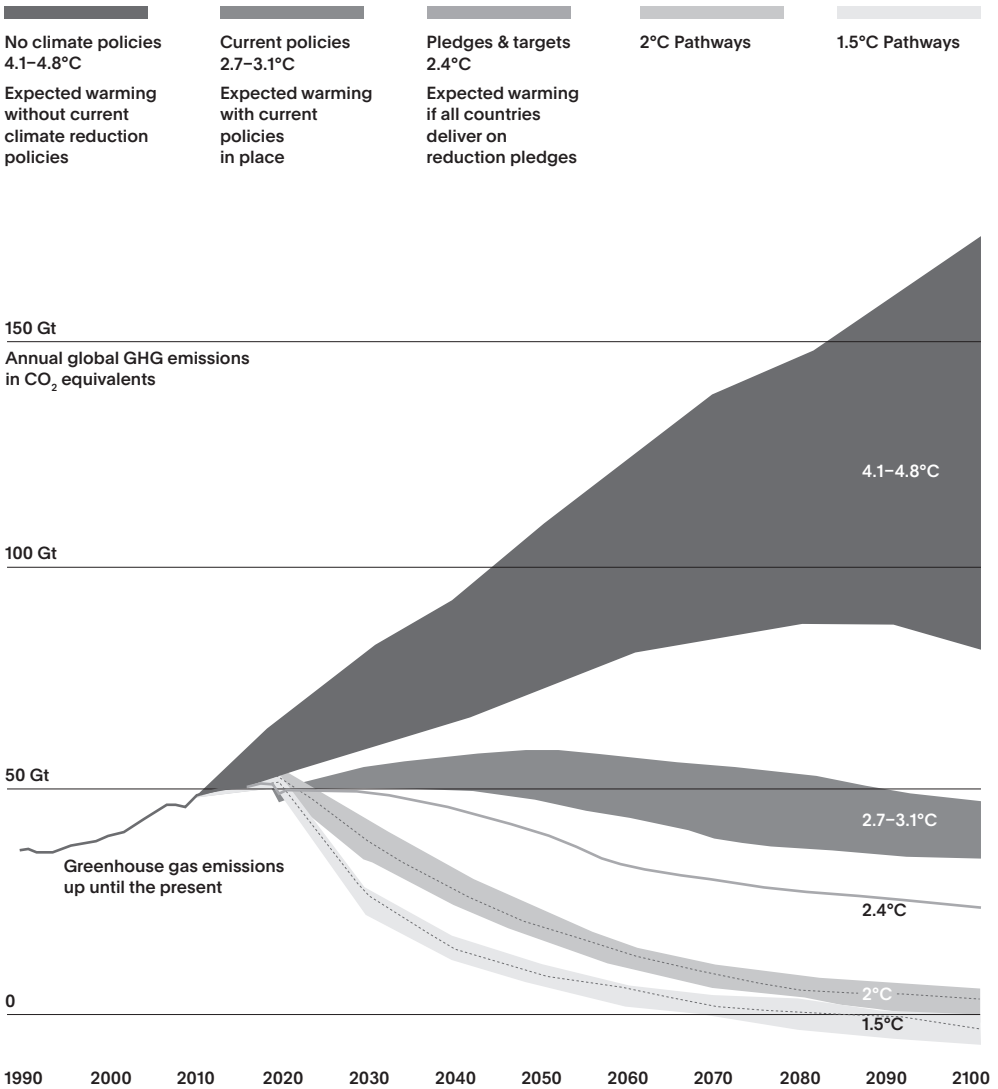
Policy scenarios, emissions and temperature range projections



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Based on numerous studies, 4 degrees Celsius of warming would devastate the global economy, especially in the Southern Hemisphere. The scale of the disaster would far surpass the 2008 financial crisis, and it would come to stay. We would enter a permanent climate depression.

But frankly, warnings of this sort aren't likely to move us onto a planet-saving path. Eighty-year projections are too remote for the human brain. A few degrees of warming sound too innocuous to be ominous. Here's the biggest obstacle: without a road map, people are slow to commit to change. Real change requires a clear and achievable plan.

Can you show me the plan? That's the question I began asking after investing hundreds of millions of dollars of venture capital into all kinds of climate solutions. As you and I know by now, a portfolio of solutions isn't a plan. The Beatles noted the difference in "Revolution": "You say you got a real solution," they sang. "We'd all love to see the plan."

And so: Just how do we keep the climate crisis from becoming a climate catastrophe? **What's the focused, actionable, measurable plan that can actually stave off this looming disaster?** Where's our cocktail napkin when we need it?

I've been troubled by these questions for some time now. Over the last fifteen years, I've read everything I can on this endlessly complex subject. I've consulted with world-class authorities on the theory and practice of fighting climate change. The more I learned, the more I worried. In 2009, I shared my concern with a U.S. Senate committee. The energy tech revolution, I said, was being hamstrung by bad federal policy and insufficient funding for research and development.

The following year, to build a cleantech innovation network, my partners and I organized a workshop on the climate crisis. We brought together Nobel Prize–winner and then Secretary of Energy Steven Chu and some of the world's top climate and economic thinkers, including Al Gore, Sally Benson, Abby Cohen, Tom Friedman, Hal Harvey, and Amory Lovins.

As we began to grasp the scale of the problem, Kleiner Perkins expanded our investments in cleantech from about 10 percent to nearly half our portfolio. At the same time, I began to advocate in Sacramento for vanguard climate and energy policies in California. I gave an emotional TED talk on climate change and investing, urging others to join the crusade.

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As a founding member of the American Energy Innovation Council, I worked to urge the U.S. government to increase its funding for climate research and development. With some like-minded advocates, I visited labs and factories in Brazil to see how sugarcane became biofuel. We journeyed to solar thermal farms in the Mojave Desert. We hiked through Amazon rainforests and climbed up California wind turbines. We met with President Obama in the White House. Our doggedness paid off with some initial federal funding for a new federal agency called ARPA-E, the Advanced Research Projects Agency for Energy, and a basket of loan guarantees for early-stage companies.

Internationally, the Paris Agreement of 2015 rallied the global community to declare their own emissions reduction targets—a historic advance. But as John Kerry, the United States' climate envoy, has observed, these commitments are not adequate to the task. Even if the pledges made in Paris were met in full, they would result in a much warmer world—by 3 degrees Celsius or more by 2100, well past the tipping point for global catastrophe.

In my hunt for a comprehensive plan, I've pored over more analyses of our options than I can count, from the rigorously scientific to the heartily optimistic to the deeply bleak and gloomy. It's not hard to get confused or overwhelmed. But here is what I've learned from helping generations of new companies succeed: **to execute a big plan, you need clear and measurable goals.** My first book showed how OKRs, Objectives and Key Results, can drive success for all sorts of organizations, from Google to the Bill and Melinda Gates Foundation, from modest startups to titans of the Fortune 500. I believe they can work for global emergencies too.

To learn more about OKRs, see resources at whatmatters.com.

OKRs stand for Objectives and Key Results. They address the two critical facets of any goal worth achieving: the "what" and the "how." Objectives (Os) are simply *what* you aim to accomplish. Key Results (KRs) tell us *how* we'll get the objectives done; typically they cascade down to more granular goals.

A well-formed objective is significant, action-oriented, durable, and inspirational. Each objective is supported by carefully chosen and crafted key results. Strong key results are specific, timebound, aggressive (yet realistic), and most of all, measurable and verifiable.

OKRs are not meant to be the sum of all tasks. Rather, they focus on what's most important, the handful of essential action steps for a given pursuit. They enable us to track our progress as we go. And they're designed to aim high—to stretch for ambitious but still reachable goals.

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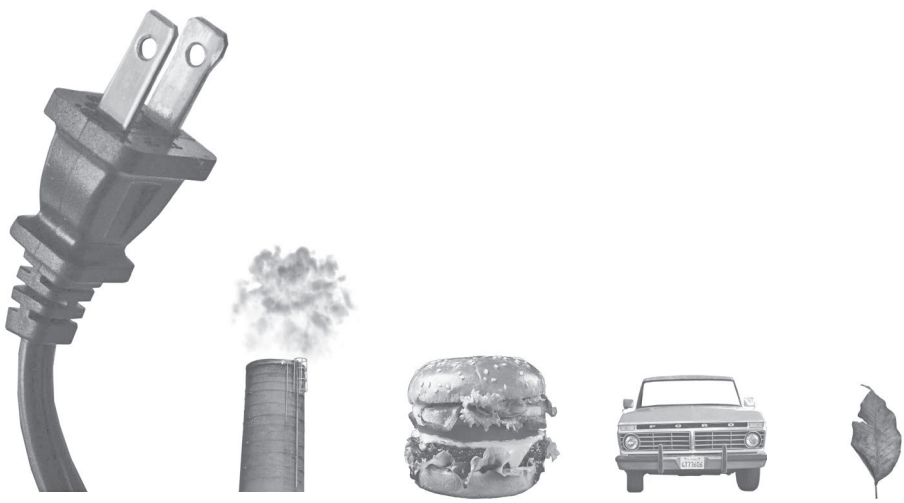
Net zero is our goal line. The "net" signifies that there's no plausible route to zero through emissions reductions alone. We'll also need to lean on nature and technology to remove and store emissions from hard-to-abate sources. But to be clear, we cannot fall back on future atmospheric cleansing as an excuse to keep on burning fossil fuels today. The primary work ahead of us is to cut emissions.

Speed & Scale's top-line OKR is to reach net-zero emissions by 2050—and to get halfway there by 2030, a critical milestone. In the face of such an enormous challenge, Objectives and Key Results will keep us clear-eyed and practical. They'll prevent us from promising pie in the sky. They'll save us from distractions by bright and shiny objects, the seemingly brilliant innovations that can't yet compete on cost or work at scale. By holding us accountable to our own quantitative targets, they make us less tempted to rely on the slender reed of hope. We'll focus ruthlessly on the biggest, most fruitful opportunities, the ones that will get us to net zero on time.

How our greenhouse gas emissions add up



24 Gt	12 Gt	9 Gt	8 Gt	6 Gt
Energy	Industry	Agriculture	Transportation	Nature
41%	20%	15%	14%	10%

59 Gt
Total
100%

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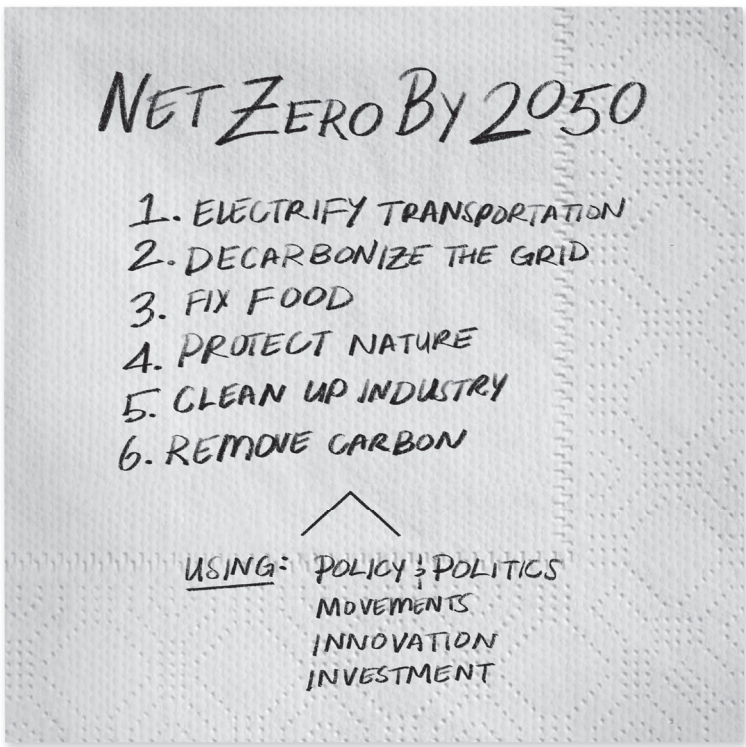
As I've noted, the world's greenhouse gas emissions amount to 59 gigatons of CO_2e per year. Business as usual will take us north of that figure, somewhere between 65 and 90 gigatons every year. (But if it's business as usual, we'll all be going out of business.) By standards of both logic and fairness, the nations responsible for the lion's share of the planet's emissions should be the first to cut them aggressively. As the developed world leads by example, it will drive down the costs of clean energy for the developing world as well.

Many lower "business-as-usual" projections assume that current policies are maintained. But as we've seen in the United States, there's no guarantee policies will stay intact.

Our targets conform with calculations by the Intergovernmental Panel on Climate Change, the United Nations Environment Programme, and the delegates who negotiated the Paris Agreement. All three bodies computed emissions levels that correlate with scenarios for warming of 1.5 degrees, 1.8 degrees, and 2 degrees Celsius over preindustrial levels. To simplify our objective, **Speed & Scale has aligned its key results with the most ambitious target, a warming of no more than 1.5 degrees Celsius.** That's our best chance to avert climate calamity—though scientists agree it is no sure thing. Which is all the more reason to move quickly.

So here is our plan: the Speed & Scale Plan to solve the climate crisis. Like FDR's pencil sketch, it contains but a handful of words. It barely hints at how hard our objectives will be to achieve. It truly could fit on a cocktail napkin:



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The first six items support our top-line objective: to solve the climate crisis by getting to net zero no later than 2050. All six are intricate worlds unto themselves, and each has its own chapter. They compose Part I of the book, "Zero Out Emissions." Beneath them you'll find a set of "accelerants" to speed the pace of climate action. That's Part II, "Accelerate the Transition." It contains four chapters, one for each accelerant.

To shape our key results, we've enlisted a team of policy experts, entrepreneurs, scientists, and other climate leaders who have given generously of their time and thoughtfulness. We've been inspired by the solutions and pathways recommended by the authorities at Project Drawdown, the Environmental Defense Fund, Energy Innovation, World Resources Institute, RMI (formerly Rocky Mountain Institute), and Breakthrough Energy.

In the spirit of FDR, we aim to be clear and concise:

By "electrify transportation," we mean switching from gasoline and diesel engines to fleets of plug-in electric bikes, cars, trucks, and buses (chapter 1)

By "decarbonize the grid," we mean replacing fossil fuels with solar, wind, and other zero-emissions sources (chapter 2)

By "fix food," we mean restoring our carbon-rich topsoil, adopting better fertilization practices, motivating consumers to eat more lower-emissions proteins and less beef, and reducing food waste (chapter 3)

By "protect nature," we're referring to interventions and protections for forests, soil, and oceans (chapter 4)

By "clean up industry," we mean that all manufacturing—particularly cement and steel—must sharply lower their carbon emissions (chapter 5)

By "remove carbon," we're saying we must remove carbon dioxide from the atmosphere and store it for the long term, using both natural and engineered solutions (chapter 6)

As for our four accelerants, we'll expedite these solutions by doing the following:

- → **Implementing vital public policies (chapter 7)**
- → **Turning movements into meaningful climate action (chapter 8)**
- → **Inventing and scaling powerful technologies (chapter 9)**
- → **Deploying capital at scale (chapter 10)**

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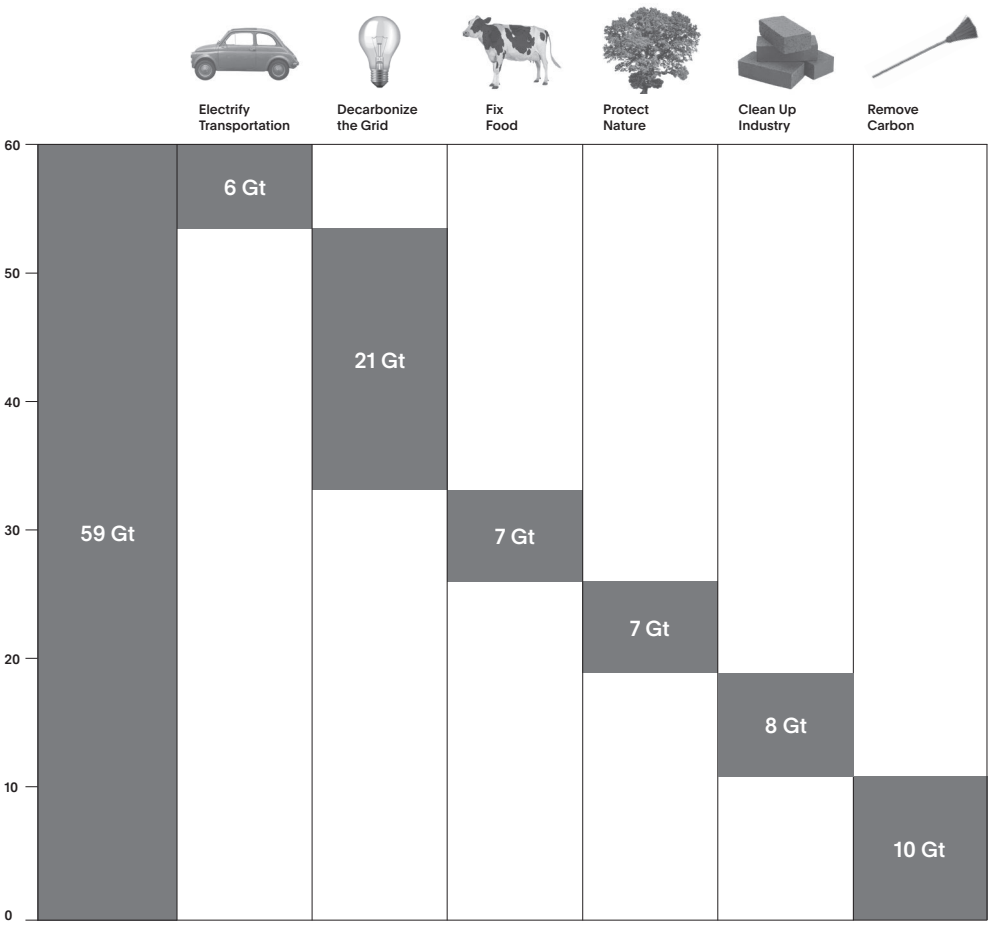
Since we cannot afford to fail, each of these goals comes with its own set of measurable key results. We'll track our progress toward these milestones to show how we're doing and whether we need to pick up our pace or course correct.

Though I believe all of our goals are achievable, none are sure things. We may overachieve on some of our key results and fall short on others. And that's all right—as long as we land at net zero by 2050. That is our debt to future generations; it must be paid in full.

Our targets are informed by the work of a worldwide network of valiant climate researchers. For too long they have been voices crying in the wilderness; only in this eleventh hour have those with power, influence, and money begun to listen. Their work guides our estimates of the sources of carbon emissions, as of where and how the needed cuts might be made.

Speed & Scale: Countdown to net zero



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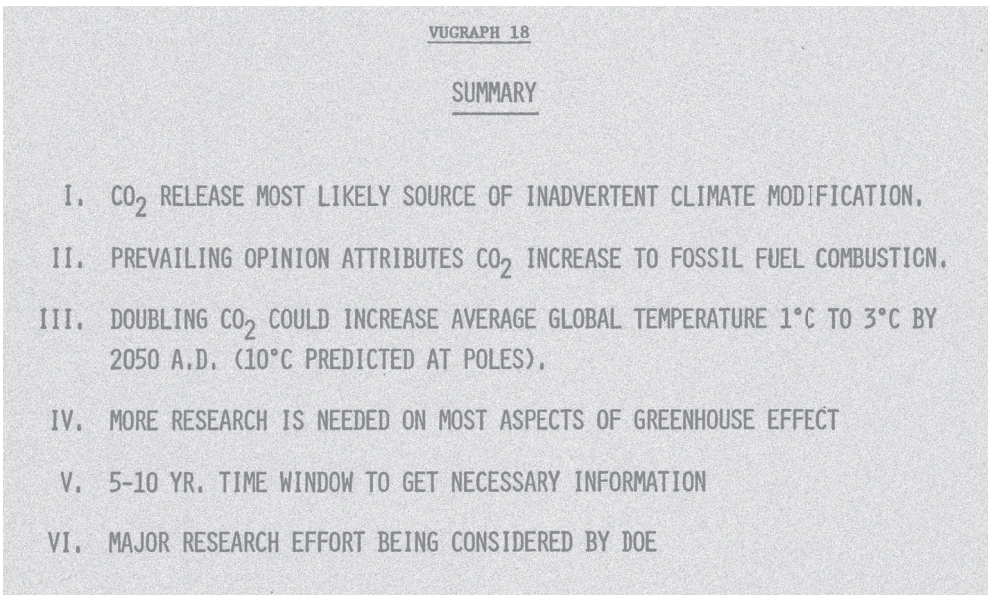
In fairness, we must add a caveat. Though we know to a high degree of accuracy how much greenhouse gas is in the atmosphere, our calculations of present-day emissions—by country and by industry—involve margins of uncertainty. Our targets for cutting those emissions represent one earnest view of how to tackle the crisis before us, no more and no less.

In business, as I've learned, there are often several right answers. The same holds true for public policy and climate solutions. The Speed & Scale Plan isn't the only "right" plan for this emergency, but we believe it strikes a practical balance. It is wildly ambitious yet rooted in hard realities. In many ways, it's the ultimate application of Objectives and Key Results. I've yet to see a bolder goal than getting to net zero.

We're in peril, to say the least, and what's infuriating is that it didn't have to be this way. Forty years ago, an Exxon scientist named James Black connected the dots between fossil fuels, rising carbon levels, and global warming.



VUGRAPH 18

SUMMARY

I. CO_2 RELEASE MOST LIKELY SOURCE OF INADVERTENT CLIMATE MODIFICATION.

II. PREVAILING OPINION ATTRIBUTES CO_2 INCREASE TO FOSSIL FUEL COMBUSTION.

III. DOUBLING CO_2 COULD INCREASE AVERAGE GLOBAL TEMPERATURE 1°C TO 3°C BY 2050 A.D. (10°C PREDICTED AT POLES).

IV. MORE RESEARCH IS NEEDED ON MOST ASPECTS OF GREENHOUSE EFFECT

V. 5-10 YR. TIME WINDOW TO GET NECESSARY INFORMATION

VI. MAJOR RESEARCH EFFORT BEING CONSIDERED BY DOE

Excerpt from internal Exxon presentation, 1978.

At the time, we might have gotten out of this jam with incremental changes—say, emissions cuts of 10 percent or so per decade. But the scientist's analysis was ignored and further research suppressed, as Exxon (and later ExxonMobil, after a merger) went on to lead the

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charge of climate change denial. Twenty-odd years ago, when Al Gore conceded and George W. Bush became president, we might have gotten away with aggressive actions to cut around 25 percent per decade.

But now we are out of time, and half measures will not suffice. To beat the odds and limit warming to 1.5 degrees, according to the IPCC, we cannot emit more than 400 gigatons. That's our carbon budget—and we are on pace to spend it within this decade. **Nothing less than drastic, immediate action will do.** We need to cut 50 percent of our emissions by 2030, and the rest by 2050. Because whether we're ready or not, irreversible climate damage is brewing.

President Obama framed the challenge before us with his customary eloquence: "We are the first generation to feel the effect of climate change and the last generation who can do something about it."

Let's consider the strategies that can unlock a net-zero future. In order of climate impact, they are:

1. **CUT (slash emissions)**
2. **CONSERVE (get more efficient)**
3. **REMOVE (clean up what's left)**

Avoiding greenhouse gas emissions in the first place—say, by electrifying transportation or decarbonizing the grid—remains our primary course of action. It's both the fastest and most reliable way to cut gigatons of greenhouse gases today. Next comes energy efficiency, which gets us more output per energy input.

The third strategy is the natural or technological removal and long-term storage of carbon. It addresses hard-to-avoid emissions, especially in transportation, industry, and agriculture. Even with the globe's best and most focused efforts, these emissions will be with us for the foreseeable future. We must add, however, that carbon dioxide removal is no substitute for avoidance or efficiency, but rather a critical complement. We'll need to pursue all three paths simultaneously.

The Speed & Scale Plan challenges leaders everywhere, in both government and business, to be guided by a deep sense of climate justice and equity. To ensure a just transition, we must acknowledge the differences between developing and developed countries. There are vast disparities in their economic ability to move away from fossil fuels and in how fast they can go. We must be mindful of the millions of everyday workers whose livelihoods are tied to fossil fuels. They deserve retraining and quality job opportunities in our green future.

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Finally, we must recognize climate-related inequities within countries as well. Fossil fuel pollution has a disproportionate impact on poor communities and communities of color. They're the least responsible for the crisis and least able to guard against its ravages. Those who are most damaged by carbon-intensive industries must receive their share of the benefits of the energy transition already under way.

Clean technologies can contribute to a fresh start. As coal-burning power plants close, we should seize the opportunity to revive downwind communities and transition workers to clean energy jobs. We must stop dumping carbon, methane, and other greenhouse gases into our precious atmosphere as though it were a free and open sewer.

Keep in mind that our plan is designed to cut emissions to the bone. It is not intended to help us adapt to an ever-warmer world. Yes, climate change is already well under way. And yes, we do need to invest in securing our cities and farmlands against more ferocious hurricanes, cyclones, wildfires, floods, and droughts. But the more we do today to limit global warming, the less drastic our adaptations will need to be.

When asked why he robbed banks, Willie Sutton supposedly said, "Because that's where the money is." We need to go where the emissions are. **We must go for the gigatons.** That means tracking the twenty top emitters, the ones responsible for 80 percent of the world's greenhouse gases. It means targeting in particular the top five, which account for nearly two thirds: China, the United States, the European Union (plus the United Kingdom), India, and Russia.

As of June 2021, at least fourteen countries—including Germany, Canada, the United Kingdom, and France—had a law or had proposed legislation to ratchet down their carbon emissions to net zero by 2050. The problem is that all of these countries combined account for only about 17 percent of total global emissions.

Only recently have the very largest emitters begun to signal their ambitions. The Biden administration's plan for climate action calls for net zero by 2050, an impressive leap beyond previous U.S. policy. The European Union has committed to do the same. China has declared a national commitment to get there by 2060—ten years too late, in our view, but at least a basis for negotiation. India and Russia have yet to make any firm net-zero pledge. Still, there is finally some grounds for hope on the international front. What remains is the all-important question of follow-through.

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Mitigating decades of reckless carbon emissions won't come cheap. But we know it will be vastly more expensive to defer aggressive action than to start today. In the eloquent words of the internationally recognized climate policy expert Hal Harvey: **It is now cheaper to save the Earth than to ruin it.** While betting on clean technology was once seen as risky or rash, it's beginning to be seen as the express route to economic growth.

As I write this, the coronavirus crisis is still with us, with horrific, unacceptable death tolls in many parts of the world. The pandemic reminds us how vital it is to act *before* disaster strikes. The same goes for our climate crisis, where every ounce of prevention will save us unimaginable pain.

In 2020, in the midst of a pandemic, life as we know it virtually ground to a halt. Yet all the restrictions forced by COVID took just 2.3 gigatons of carbon emissions off the top, around 6 percent of the world's annual greenhouse gas emissions. Soon enough, even that small reduction was gone; carbon pollution came roaring back. Short-term deprivation may help slow the spread of a plague, but it won't solve the climate crisis.

The task before us is clear. The need to act has never been more urgent. If we reach net zero in time, we can be justly proud of the planet we pass on to our children and future generations.

So let's do this, with speed and scale.

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Electrify Transportation

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Chapter 1

Electrify Transportation

There's an old venture capital axiom: *Never invest in anything with wheels*. In 2007, not long after committing to cleantech investing, Kleiner Perkins considered breaking that rule. Should we back an electric car company? Smart people warned me away. In a little more than a century, more than a thousand car companies have been launched, and nearly all are gone. Many failed spectacularly. Do you remember the DeLorean?

Kleiner was deep in discussions with a brilliant designer who'd made his mark at Aston Martin and BMW. Henrik Fisker hailed from Denmark but lived in Los Angeles. In our first meeting, he sketched a strategic plan to produce an electric car for luxury buyers, then to move down the price curve toward the middle of the market, where the real money is. Fisker Automotive would make only the car's frame, minimizing its risk. For the battery, the most expensive part, they'd contracted with the well-funded A123 Systems, with technology created by the highly regarded Yet-Ming Chiang at MIT.

Just around that same time, we were approached by a pair of engineers who'd named their startup after Nikola Tesla, the legendary inventor. They'd partnered with a wildly successful PayPal entrepreneur who'd put in so much of his own money that he was now chairman of the board. That is how Elon Musk came to us to pitch his idea.

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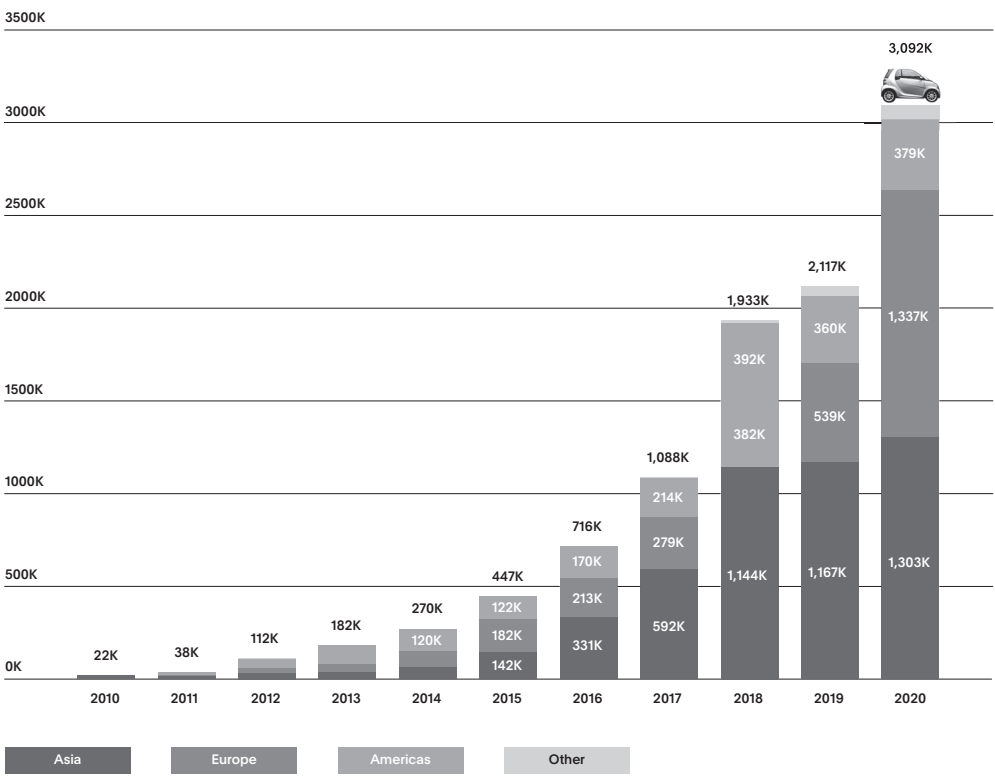
We liked Elon's three-step business plan. Tesla would begin with a high-end sports car, the Roadster, to show that electric vehicles (also called EVs) were feasible *and* cool. The company was ready to enter production as soon as it raised the cash. Next up would be a luxury sedan, the Model S, to compete with BMW and Mercedes. Finally, ten years or so down the road, Tesla would launch a lower-cost EV for the mass market.

The protracted time frame didn't bother me. In fact, nothing about Tesla's plan bothered me—it was strategically sound and beautifully structured. But even if Kleiner could have afforded to invest in both Fisker and Tesla, it wouldn't have been right. As competitors, they'd put us squarely in a conflict of interest. We'd have to choose one or the other.

We got the decision wrong—really wrong. By opting for Fisker, we lost out on one of the top-returning investments of all time. It still stings; Tesla would have been quite the ride. But even though we didn't get to take it, I'm thrilled with the outcome for the world. Elon steered the company through some of the tightest spots ever faced by a startup.

A seed-level investment of $1M in Tesla in 2007 would today be worth more than $1B.

Electric vehicles are growing in popularity



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Tesla thrived while pushing the car industry forward. To help boost the electric vehicle market, the company freely shared its patents with its competition.

By 2019, Tesla was selling one of every five electric vehicles worldwide. In 2020, it sold half a million. It boasts a stock market value of around $600 billion, more than its four closest rivals combined. Best of all, in a classic knock-on effect, Elon spurred global auto leaders to rev up their EV production. Every one of those sales is good news for our climate plan.

As for Kleiner's pick? The Fisker Karma made a magnificent debut for the 2012 model year. The car was sleek and gorgeous. But for reasons ranging from price ($100,000-plus) to performance, it didn't sell. Before Fisker's market could even materialize, A123 Systems, the sure-thing battery maker, folded. A pair of sedan fires triggered a recall. Any lingering hopes were washed away on a soggy day in October 2012 at the Port of Newark in New Jersey, when Hurricane Sandy flooded a $30 million shipment of Karma plug-in hybrids inbound from Europe. More than three hundred cars were totaled; sixteen of them blew up. Fisker was finished before it ever really started.

Counting Down in the Transportation Sector

Our global countdown from 59 gigatons to net zero covers five broad sources of emissions: transportation, energy, agriculture, nature, and industry. Our first objective, to electrify transportation, targets the 8 gigatons of emissions that come mostly from tailpipes. To achieve this goal, the world must replace all gasoline- and diesel-powered vehicles with a fleet of zero-emissions cars, trucks, and buses by 2050.

The electrification of transportation is already under way; as of January 2021, nearly 10 million EVs were on the road worldwide. But the technology we need to scale is behind schedule, and **progress is frustratingly slow. We must accelerate.** The world drives more miles each year. Over the next two decades, despite the growing popularity of EVs, the number of miles driven with combustion vehicles are projected to remain at their current level. We're not moving fast enough because EVs can't yet compete on convenience and cost with gasoline and diesel cars. With the average new car's life span of up to twelve years, the global fleet's turnover has slowed to a crawl. Combustion vehicles will keep spewing their carbon for a long time to come.

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The impact of complete electrification cannot be overstated, and it goes beyond climate change. Each year, tiny particles from tailpipes and power plants cause 350,000 premature deaths in the United States alone and one of five worldwide. According to the Environmental Protection Agency, this pollution is linked to heart disease and lung cancer. Electrifying transportation is more than a cornerstone of our net-zero plan. It's essential to curbing deadly diseases that disproportionately plague poorer countries and communities of color. It is a matter of life and death.

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Nine of ten cars on the road today are powered by fossil fuels.

In our effort to cleanse transportation of greenhouse gas emissions, we've framed a handful of key results. A good KR can be measured and verified against publicly available data. If we achieve all our key results, we'll be sure to meet our objective—in this case, cutting emissions from the sector to 2 gigatons per year.

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Objective 1

Electrify Transportation

Reduce 8 gigatons of transportation emissions to 2 gigatons by 2050.

KR 1.1 Price

EVs achieve price-performance parity with new combustion-engine vehicles in the U.S. by 2024 ($35K), and in India and China by 2030 ($11K).

KR 1.2 Cars

One of two new personal vehicles purchased worldwide are EVs by 2030, 95% by 2040.

KR 1.3 Buses and Trucks

All new buses are electric by 2025 and 30% of medium and heavy trucks purchased are zero-emission vehicles by 2030, 95% of trucks by 2045.

KR 1.4 Miles

50% of the miles driven (2-wheelers, 3-wheelers, cars, buses, and trucks) on the world's roads are electric by 2040, 95% by 2050.

↓ 5 Gt

KR 1.5 Planes

20% of miles flown use low-carbon fuel by 2025; 40% of miles flown are carbon-neutral by 2040.

↓ 0.3 Gt

KR 1.6 Maritime

Shift all new construction to "zero-ready" ships by 2030.

↓ 0.6 Gt

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← For designated key results, the emissions cut is quantified in gigatons, e.g., KR 1.4 yields a 5 gigaton reduction.

Our Price KR (1.1) breaks a stubborn barrier for electric vehicles: parity on price and performance with combustion engines. If EVs are to capture the bulk of the passenger car market, they must be broadly affordable. When people spend more to buy a "green" product over one that emits more carbon, they're paying what's known as a "green premium," a term I first heard from Bill Gates. Markets have proven that when given a choice, most people won't pay or can't afford a premium for energy. "People are going to adopt the low-cost solution," says Eric Toone, technical lead at the Breakthrough Energy fund. "If it costs a penny a gallon more for cleaner fuel, versus petroleum from the world's dirtiest tar sands, many people won't pay for it." And even those willing to pay more will expect superior performance.

The green premium varies widely across sectors

	"Green" (no- or low-carbon) price	Traditional product price	Green premium
Electricity	$0.15 / kWh*	$0.13 / kWh**	$0.02 / kWh (15%)
Passenger EVs (U.S. prices)	$36,500 (Chevy Bolt)	$25,045 (Toyota Camry)	$11,455*** (46%)
Long-haul trucking/shipping transportation fuel	$3.18 / gallon (B99 biodiesel)	$2.64 / gallon (diesel)	$0.54 / gallon (20%)
Cement	$224 / ton	$128 / ton	$96 / ton (75%)
Aviation fuel	$9.21 / gallon	$1.84 / gallon	$7.37 / gallon (400%)
Round trip (economy) SFO to Hawaii	$1069 / ticket	$327 / ticket	$742 / ticket (227%)
Ground beef hamburger meat	$8.29 / pound	$4.46 / pound	$3.83 / pound (86%)

*Residential solar contract.

**Global average consumer price including distribution.

***Before incentives.

Source: Multiple sources. See endnotes.

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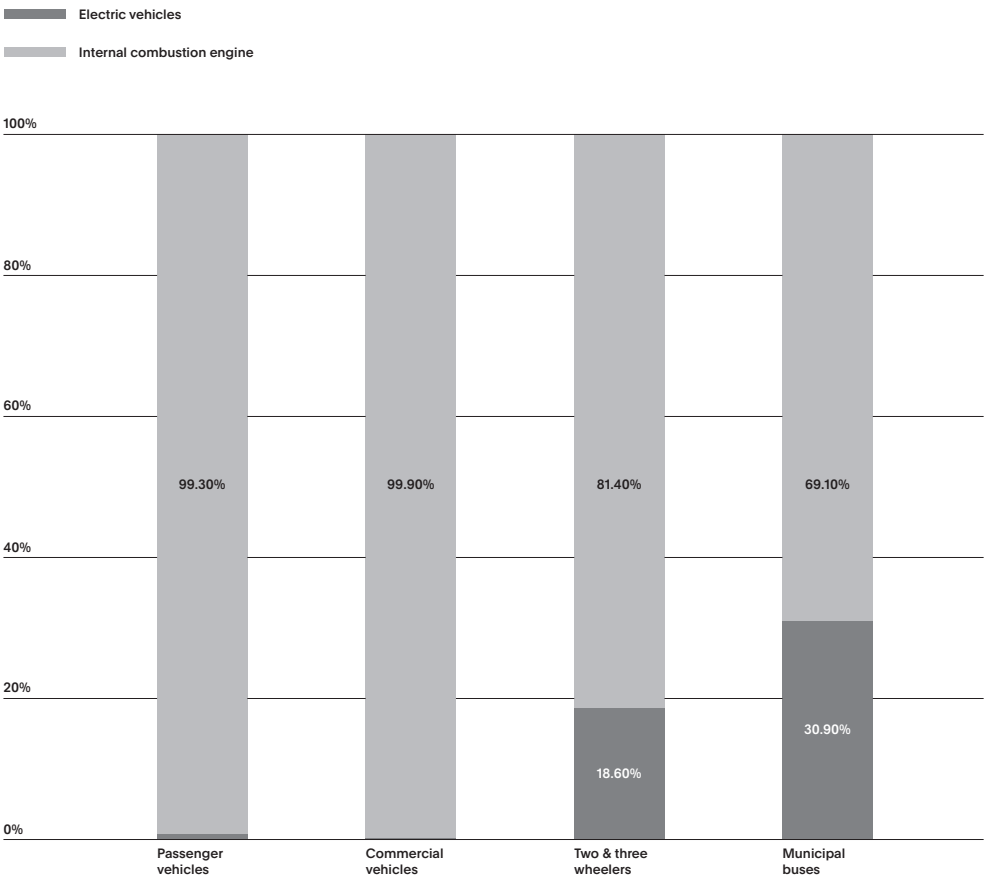
Early adopters and concerned citizens alone won't get us to net zero. To guarantee a market swing to electric vehicles, we'll need *better* performance at comparable prices. In this context, **the green premium is a rough measure of the difficulty of each problem**—of how far we have to go to reach net zero, whether for electric vehicles or food products or cement.

Our Cars KR (1.2) calls for electric vehicles to account for the majority of new vehicle sales by 2030—a big stretch by any reckoning. Thanks to enlightened public policy, the future we need is happening today in parts of Europe. Norway is already at 75 percent EV market share for new car sales. China has passed 5 percent to become the largest EV market in unit sales. In large Chinese cities, one of five cars sold are EVs. The United States, despite being home to Tesla, the world's largest maker of electric vehicles, is at no better than 2 percent.

Miles driven by electric vehicles lags across categories



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The big incumbent automakers can see the growth projections on the wall. Volkswagen is investing more than $85 billion in electrification by 2025. General Motors, Ford, and Hyundai are also placing big bets to electrify their fleets.

Our Buses and Trucks KR (1.3) focuses on two vehicle classes that get less attention than passenger cars, despite their outsize emissions. While buses and trucks represent 10 percent of the vehicles on the road, they generate 30 percent of the sector's global greenhouse gases.

Our Miles KR (1.4) ties most directly to emissions cuts. By focusing on total miles driven, it accounts for all vehicles on the road, from newly minted EVs to the oldest and dirtiest combustion vehicles. Globally, less than 1 percent of total passenger car miles were electric in 2020. Considering the sheer scale of the 13 trillion-plus miles driven worldwide each year, getting to 100 percent by 2050 will be an ambitious lift.

Our Planes KR (1.5) rallies the aviation industry to accelerate its adoption of sustainable aviation fuel. Our aim is for 20 percent of all airline miles to be flown with low-carbon fuels by 2025. Over a longer horizon, the industry will need to invent pathways to carbon-neutral flight with more efficient planes powered by synthetic fuels, electricity, or hydrogen.

Our Maritime KR (1.6) calls for more aggressive reductions in sea transport emissions by cargo and cruise ships. Heavy fuel oil generates large quantities of carbon dioxide and sulfur oxides. More than two thirds of these emissions are expelled within 250 miles of coastlines, exposing hundreds of millions of people to harmful pollutants.

Given the typical bulk carrier's fifteen-year life span, the maritime sector will be especially challenging to decarbonize. The path forward is to prod the industry to make or retrofit ships to be "zero-emissions ready" by using cleaner power sources. In the meantime, maritime emissions can be cut by slowing ships down, using more efficient engines, upgrading hulls and propulsion systems, and adding filters to catch those deadly small particles before they escape into the air.

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As Goes General Motors, So Goes America

In 1953, Charles Wilson, the chief executive of General Motors, was nominated by President Dwight Eisenhower to be Secretary of Defense. When Wilson made it clear he would not sell off his substantial holdings of GM stock, a U.S. senator reasonably asked about the potential for a conflict of interest. Wilson famously replied, "I cannot conceive of one because for years I thought what was good for our country was good for General Motors, and vice versa." Over the years, Wilson's statement (with some license) has been invoked both to praise and pillory GM and business in general. But there can be no doubt that America's largest automobile maker has significantly shaped the nation's economy, even its identity.

After a false start or two, General Motors has embraced its leadership role in developing zero-emission solutions. Back in 1996, the company rolled out the first commercial electric car, the EV1, with a 50-mile range. As *Wired* noted, it was "impractical, dinky, and entirely doomed." GM leased about a thousand EV1s, mostly in California, before recalling and destroying them.

It took fifteen years for the auto giant to try again with the Chevy Volt, a plug-in hybrid priced for the mid-market. In 2011, the Volt won *Motor Trend*'s Car of the Year Award. Over the next four years, it vied with the Nissan Leaf for honors as the top-selling plug-in in the United States. The 2016 model year brought another mid-market Chevrolet entry, the Bolt, an all-electric EV designed to compete with Tesla's Model 3.

Still, GM's EV production plans lagged behind Tesla and global rivals—until March 2020, when the company surprised everyone with a string of turnabout announcements that capitalized on the company's economies of scale. The good news began with a sneak peek at the Ultium, a high-energy, large-format, EV battery platform. In November 2020, the company announced a new lineup of thirty EV models to be introduced by 2025. Even more stunning was the plan set by chief executive Mary Barra for 2035: to end GM's 112-year history of making internal combustion cars.

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Mary Barra

It began with talking to customers across the country. We saw an inflection point in their view of EVs: *If it has the right range, and there's the right charging infrastructure, and the vehicle meets my needs, and I can afford it, I will consider it.*

We heard that everywhere. We came to believe we had a movement in the making. Given the importance of affordability, we also saw that GM had a critical role to play. If we want to electrify transportation, we've got to reach people who only buy one vehicle. It wouldn't be their family's second, third, or fourth vehicle. It would be their only one. So we decided to lead the transformation, and to do it at scale, worldwide.

It's a tremendous growth opportunity. We also want to supply EVs for zero-emissions autonomous ride-sharing and get the price down from three dollars a mile to one dollar a mile.

We developed an electric concept for potential use by the U.S. Defense Department. In commercial vehicles, we're selling electric delivery vans and last-mile solutions to FedEx Express and other fleets.

Ultimately, it's about execution. We have the know-how on our teams and in our plants. Electrification is now a core competency. We understand the customer. We have the resources to do this.

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But first, we need to keep innovating—to take more cost out of batteries, for instance. We also need full-scale charging infrastructure. We're talking with the Edison Electric Institute about energy management, including ways to shift charging to between 2:00 and 5:00 a.m., when rates are lowest. There's a lot of innovation that still needs to happen.

I read that a small city in California banned the building of gas stations. Just two years ago, that would have been unthinkable. But especially with the Biden administration's EV adoption goals, it's clear that we need to accelerate. And we need to do it equitably, so there's no divide. EVs must be for everyone. We can't leave anyone behind.

Being a leader starts with a strong focus on customers. Then you need to consider corporate responsibilities as they relate to climate change and equity. You need to be willing to do the right thing—and frankly, your employees expect it.

It's not a choice between stakeholder capitalism versus shareholder capitalism; they're inextricably linked. Our constituencies are our employees, our dealers, our suppliers, our local communities, and our government, as well as our shareholders and customers. In making decisions, we need to understand the implications for all those stakeholders. As I've found in my time in this role, you make better decisions when you're focused on the right mission.

You need to be willing to do the right thing—and frankly, your employees expect it.

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