

# A Parent's Guide to Countering Green Ideologies

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**STUDENTS LED  
ASTRAY BY  
ENVIRONMENTAL  
INDOCTRINATION**

### **A Michigan high school student**

contacted the Mackinac Center, asking for help with research on pollution and its impacts on the natural environment.

A biology class had led the student to believe the state was facing a growing problem with air pollution. The student's response was to propose forcing businesses to use less fossil fuel, stop using internal combustion engines, install more solar panels, and use more "bio-friendly factories and machines."

We thanked the student for reaching out and offered words of encouragement to continue working on these important energy and environmental policy issues. In response to the query, we offered a few thoughts on the student's proposal.

To begin, we needed to determine whether our air today is cleaner or dirtier than it was in the recent past. If it is more heavily polluted, students might be right to recommend higher costs and more stringent regulations to help with cleanup efforts. But if our air is

cleaner, imposing expensive new regulations could have far-reaching, negative social and economic impacts while delivering limited environmental benefits.

Although media headlines regularly trumpet stark and frightening stories about toxic air, EPA data demonstrates that Americans enjoy some of the best air quality in the world. From 1970 to 2021, levels of the six main pollutants tracked by the EPA — pollutants that can harm human health or damage property — have dropped by 78%. Those improvements have occurred despite the fact that we are driving more miles, we're using more energy, our economy is growing, and population is increasing. Additionally, the U.S. EPA reports that American "greenhouse gas emissions in 2020 were 21% below 2005 levels." (After accounting for sequestration from the land sector.) During the economic recession caused by the pandemic, the Energy Information Administration reported that CO<sub>2</sub> emissions decreased by 11%. While they increased by 7% as the economy rebounded, overall greenhouse gas emissions remained below 2019 levels.

Next we asked what it would cost to replace our existing machines and factories, or to transition to renewable energy sources — similar to a proposal made by New York Rep. Alexandria Ocasio-Cortez in her Green New Deal.

A 2022 McKinsey report on the transition to a net-zero economy estimated global costs of \$9.2 trillion annually to reach net-zero CO<sub>2</sub> emissions.

One study by the American Action Forum estimated the full Green New Deal would cost the American taxpayer as much \$93 trillion. But the predicted price drops to \$8.1 trillion if we only consider moving to a “low-carbon electricity grid” and “net zero emissions transportation system.” That transition would set each American household back about \$400 to \$500 per month over the next 10 years.

To answer this student’s question, we also needed to determine whether renewables could actually generate enough electricity to power all of our factories, machines and transportation. The U.S. Energy Information Administration reported that in 2020, Michigan residents and businesses relied on fossil fuels for over 61% of their electricity. Nuclear, an energy resource that does not emit CO<sub>2</sub> but which is pooh-poohed by many progressive green groups, provided over 28%. So to transition to a fully renewable electricity system, Michigan residents would need to spend tens of billions and carpet the state with wind turbines and solar panels, all in the effort to replace 89% of our electricity supply. Given current technology, that’s not even remotely feasible.

Lastly, we needed to determine whether renewable options are actually better for the environment than existing options. Not surprisingly, they drop the ball on this issue too.

Mark Mills of the Manhattan Institute discussed the high environmental costs of moving heavily to renewables in a 2019 Wall Street Journal essay. He noted that to build just one wind turbine, you need “900 tons of steel, 2,500 tons of concrete and 45 tons of nonrecyclable plastic.” Solar panels take even more materials. Mills pointed out that the switch would require us to greatly expand the mining and refining of metals and rare earth minerals, an idea which would encounter loud opposition from most environmental groups. As if that wasn’t enough, another study by Environmental Progress, a California-based environmental group, pointed out that “solar panels create 300 times more toxic waste per unit of energy than do nuclear power plants.”

The student’s proposal, then, misses the mark in three ways. First, Americans currently enjoy much cleaner air than we have in the past. Second, the overall costs of transitioning from our current system of energy to a renewable system would cause immense damage to the state’s economy, setting back families and small businesses. Third, switching our energy systems to use only renewables would do serious damage to the natural environment.

In every sense, the research materials this student relied on failed to provide accurate or balanced information, and it prompted proposals that would do far more harm than good. We were very glad to have received the email because it is clear that we all need to do a much better job of educating our youth. ■

Common

# MYTHCONCEPTIONS



The science on climate change is settled. There is nothing more to discuss about it.

Actually, there is a healthy and ongoing discourse over the science of global climate change. In fact, it's well past time that we have a full and independent review of the climate science that is driving energy and environmental policy.

But if it was true that the "science is settled," then we should not need to invest any more limited tax dollars into climate research. We would do far better to invest dollars into adaptation measures or efforts that address other environmental and health issues.

Renewable energy - primarily solar and wind - can replace nuclear and fossil fuels at an affordable cost.

While prices for renewable energy had been dropping for several years, they have experienced significant increases over the past few years. Both wind and solar prices have gone up by as much as 30-35% from 2021 to 2022. To make matters worse, there are several additional costs that wind and solar energy impose on the system. Those other costs are often overlooked, but wherever wind and solar make up more than a few percentage points of the electrical supply in an area, electricity prices jump rapidly.

Overall electricity prices go up because wind and solar energy are weather-dependent and unpredictable sources of energy — the sun doesn't shine and the wind doesn't blow 24/7. In fact, wind and solar have the ability to produce electricity only about 35% of the time and 20% of the time, respectively, something known as their "capacity factor." And there's no way to schedule the wind and sunlight we do receive for the times when we actually will need the electricity. When they don't produce electricity, we must use more reliable sources of energy — natural gas, nuclear, hydroelectric, or coal — to provide the always-on, or "baseload," electricity that we need.

Additionally, when we build new renewable generation facilities, we have to build new transmission lines to transport electricity to and from those turbines and solar arrays. We also are beginning to build battery backups that add to the costs as well. When all of these are added together, the actual price of renewable energy climbs significantly. For example, residential electricity prices in California, which relies heavily on solar, were over \$0.20 per kWh, in 2020, a 55% increase over the national average.

To make things worse, some states just don't have very good wind or solar resources. For example, according to the National Renewable Energy Labs, Michigan has some of the lowest global horizontal solar irradiance levels in the country. That means Michigan's geography and location, as well as its reliably cloudy weather, impact on the amount and intensity of the sun that shines here. So it takes more solar panels to produce the same amount of energy in Michigan than it does in California or Arizona. Alternately, a single solar panel in Michigan will produce less electricity, in a certain period of time, than one in more sunny states.

When it comes to wind energy, lower average wind speeds in Michigan mean that wind is one of the least reliable and least efficient energy options for that state.

Climate models show us that the world is warming beyond our worst fears.

Climate models are historically inaccurate, as shown by two scientists at the University of Alabama in Huntsville. Dr. Roy Spencer is principal research scientist and his colleague Dr. John Christy is a distinguished professor of atmospheric science and the director of the Earth System Science Center at the university. Spencer and Christy have compared the findings of more than 100 climate models with the real-world measurements of temperatures. The models, Spencer and Christy have concluded, consistently "run hot," or overpredict warming.

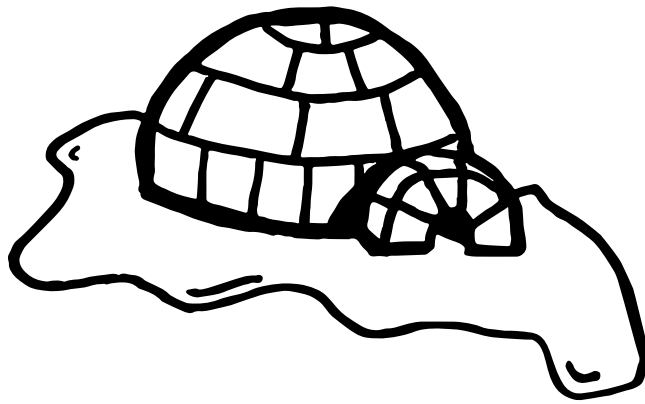
Climate change is an "existential crisis" or an "existential threat." We must drastically change our energy sources and cut our greenhouse gas emissions in the next ten to twelve years to avoid going beyond a climate "tipping point."

Respected climate scientists like Roy Spencer and John Christy have a different view. Spencer has bluntly stated: "There is no climate crisis. Even if all the warming we've seen in any observational data set is due to increasing CO<sub>2</sub> (carbon dioxide), which I don't believe it is, it's probably too small for any person to feel in their lifetime."

Even the UN's Intergovernmental Panel on Climate Change, or the IPCC, recognizes in its "Special Report: Global Warming of 1.5°C" that "Under the no-policy baseline scenario, temperature rises by 3.66°C by 2100, resulting in a global gross domestic product (GDP) loss of 2.6% (5–95% percentile range 0.5– 8.2%)." The IPCC is saying here that the extreme, almost unimaginably bad, worst-case scenario — arising from their "no-policy baseline scenario" — could lead to an 8.2% decrease in global GDP in the year 2100. While that would certainly mean an economic impact, it isn't an "end of the world" scenario.

But what about the polar bears? Aren't they going to go extinct from the effects of global warming?

Actually, polar bears are doing very well. The estimated population of the bears is about 39,000. This is about 4 to 6 times higher than the numbers that were estimated to exist in the 1960s.



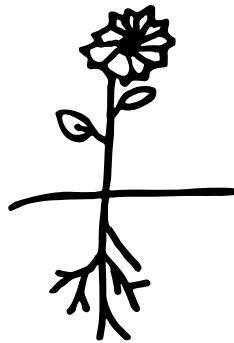
Global warming is causing a greater number of more intense hurricanes.

A September 2018 blog post by University of Alabama's Roy Spencer reported that "the average intensity of [the] 36 most costly storms has actually decreased." He also pointed out that, when considering all major hurricanes (Cat 3+), "there's no statistically significant trend ... and certainly a downward trend since the 1940s."



Energy sources like wind and solar can produce millions of jobs to replace the lost jobs in the fossil fuel and nuclear industries.

Green jobs are the antithesis of efficiency. If our green energy goal were to create the most jobs, we could hire millions of people to ride stationary bikes or run on treadmills to generate electricity. That might get the job done, but our electricity would be incredibly expensive. When it comes to energy, we should seek the biggest gain from the least amount of resources. We should measure energy by its output, not the size of its payroll.



We must abandon fossil fuels and nuclear power to ensure a safe natural environment for human life.

Buried in this argument is the assumption that the natural world is safe, and that, if it is unsafe, it is only because humans made it that way. But the natural world is, in many ways, unsafe for human life — think, for example, of winter in the northern United States. Humans make intelligent use of fossil fuels to create cheap and affordable energy, which is required to make much of the earth habitable for people.

We should reduce our impact on the climate by buying locally grown food and produce.

The amount of energy required to produce a crop depends on many factors, including soil condition or climate. In short, it may take you much more energy to produce a certain crop than it would require for someone at a distance to produce it and then ship it to you. As Pierre Desrochers and Hiroko Shimizu wrote in "The Locavore's Dilemma: In Praise of the 10,000-mile Diet," eating only locally grown food will result in "much more significant environmental damage" than the alternative.

We must keep temperature increases incredibly small.

William Nordhaus, the winner of the 2018 Nobel Prize in economics for his work on climate modeling, says our target should be 3.5 degrees C or less. Nordhaus argues that the 1.5 C target is simply "infeasible," as the cost of mitigating potential climate damage would be 10 times higher than the benefit. ■

*50 Reasons*  
***TO BE OPTIMISTIC***  
**ABOUT THE FUTURE**

WITH CONTRIBUTIONS BY AARON LEHMAN

Earth Day was first held on April 22, 1970. Throughout its relatively brief history, the holiday has had a consistent, urgent theme that is still echoed on the official Earth Day website: “Earth Day was a unified response to an environment in crisis — oil spills, smog, rivers so polluted they literally caught fire.”

The website goes on to claim that the celebration is credited with establishing the early environmental movement. That assertion may be more marketing than reality; the environmental movement harkens back to earlier conservationists who sounded alarms long before April 22, 1970. Aldo Leopold, for example, wrote his seminal work, “A Sand County Almanac: And Sketches Here and There,” in 1949.

But the specific details of the movement’s history are less important than the fact that those early conservationists had an important point. Right up to our recent past, we did not strive to understand how our actions affected our natural environment. As a result, our actions strained natural ecosystems — the Cuyahoga River did actually catch fire in 1969 — and people were right to begin looking for better ways to use and manage natural resources.

There are still active discussions about the proper policies we should employ to meet our environmental goals. But, today, very few (if any) people believe that we can pollute with impunity or would deny that we rely on our natural environment. So it is worthwhile to consider how meeting our needs in a more clean and efficient manner has markedly reduced our impacts on our environment and improved it.

To help with those considerations, we’ve put together a list of 50 ways markets and technology have helped reduce our impact, feed more of the planet’s population, and actively reverse past harms humans have caused to our environment.

## 1. NUTRITION

Many people in developing nations rely on rice as their primary food source. But a typical rice grain does not provide them with beta carotene, a healthful red-orange pigment found in many fruits and vegetables like carrots, and a material that our bodies naturally convert to Vitamin A. Some people who lack sufficient Vitamin A, especially small children and pregnant women, struggle with depressed immune response and blindness as a result. But through a gene-modifying technology, food scientists have developed crops like Golden Rice and Golden Promise barley. In rice, this technology effectively “turns on” two genes that naturally occur, allowing the rice grain to produce enough beta carotene to supply people with the Vitamin A they need. The presence of beta carotene also turns the rice grain a gold color – thus the name. The result: Millions of lives across the planet have been saved or improved. Sadly, however, this technology has encountered fierce opposition from anti-GMO activists and groups like Greenpeace.

## 2. DISEASE PREVENTION

Mosquitos that have been “bred [in a lab] to carry Wolbachia,” a bacteria that is common in insects but harmless to humans, are helping to reduce the spread of dengue fever in tropical nations. Researchers have not pinpointed the cause, but they do know the bacteria keep the disease from being transmitted when these insects bite. So the mosquitos may still be annoying, but their bite is not necessarily life-threatening anymore. As a side benefit, researchers report that the bacteria may also help reduce the number of mosquito eggs that hatch. One study of an Indonesian community reported a 76% decrease in the spread of dengue there since the release of Wolbachia-carrying mosquitoes in 2016.

## 3. FIGHTING WILDFIRE

New computing and mapping technologies are helping firefighters in their battle to reduce the costs and

impacts of wildfires. Where it used to take a day or more to prepare maps, we can now fly over a fire and have a detailed map in a few minutes. Supercomputers are also now able to combine meteorological, topographic and other data to predict the likelihood of a wildfire.

## 4. WILDFIRE 2.0

Building on the same theme, the amount of land affected by wildfire has gone down 25% since 2003. Improved mapping and satellite technology, along with far greater societal wealth, has given forest managers the ability to spot, target and extinguish fires before they can burn out of control. This is especially helpful in remote and thinly populated northern forests.

## 5. CHEAP, RELIABLE COMFORT

Since 1952, free-market innovations and improved efficiencies have decreased the price of air-conditioning by 97% for the average family. Many other household appliances that also help to reduce costs, reduce risks, and improve human well-being and comfort have experienced similar price declines over the same periods. According to the website HumanProgress.org, Walmart sells a 6,000 BTU air-conditioning unit (with a remote control) for \$178. Today an average blue-collar worker earns about \$32 an hour. That person, then, would have to work 5.56 hours to afford this appliance. In 1952, a 5,500 BTU unit cost about \$350 and the average blue-collar worker, earning \$1.72 an hour, would have had to work 203 hours to pay for a less efficient A/C. Workers today can enjoy a far better quality of life as they work fewer hours to afford what would have been luxury items a few decades ago. And the appliances they can purchase use far less energy today to do the same job. For example, the SEER rating (or seasonal energy efficiency ratio) of an air conditioner measures the amount of electricity that it uses to produce a given amount of cooling, expressed as a ratio. The

higher the rating, the more efficient the system. The Environmental and Energy Study Institute reports that minimum SEER ratings for home A/C units were between 8 and 10 in the late 1980s. In 2015, the average system had a minimum SEER rating of 14, and some more expensive systems can be as high as 23.

## 6. ABUNDANT FOOD

Green groups often quote academics like Thomas Malthus and Paul Ehrlich to warn that human populations will soon outstrip the Earth's ability to produce food, leaving billions to starve. In the real world, however, we're producing more food and feeding more people than ever before. Human populations increased from 5.588 billion in 1993 to 8 billion in 2022. However, worldwide global hunger, depicted by the Global Hunger Index (which tracks hunger on a global scale and ranks it from zero — no hunger — to 100 — extreme hunger) dropped from a “serious” value of 31.5 in 1994 to a “moderate” value of 17.2 in 2016. Sadly, the mix of a global pandemic, conflicts like Russian aggression in Ukraine, and restrictions on the development of reliable and affordable energy sources like natural gas, have forced progress on the GHI to a standstill. The 2022 edition of the Global Hunger Index report indicates a worldwide score of 19.1. The best way for world governments to resume improvements in the GHI and increase food production is to ensure the production and use of reliable forms of energy and fertilizers.

## 7. INCREASING WEALTH

Despite growing human populations, the number of people living in extreme poverty has decreased dramatically. The U.N.'s 2015 Millennium Development Goals Report notes that, “In 1990, nearly half of the population in the developing world lived on less than \$1.25 a day; that proportion dropped to 14% in 2015.” World Bank numbers mirror this report.

The World Bank explains that, in 2015, only 10% of the world's population experienced "extreme poverty," which they define as living on less than \$1.90/day. This means that 1.1 billion fewer people — a 36% reduction — live in extreme poverty than did in 1990.

## **8. LONGER LIVES**

Human life expectancy has also gone up significantly over the past several decades, primarily due to advances in medical science and agriculture, especially in the developing world. CDC statistics indicate that life expectancy in OECD countries has increased from 1980 to 2015. In the United States, average life expectancy at birth was 70.0 years for men and 77.4 for women in 1980. But by 2020, those numbers had increased to 74.2 and 79.9 years, respectively.

## **9. VACCINES WORK**

Improving medical technologies include the production and use of vaccines, which have eliminated or radically decreased the prevalence of many deadly diseases. The CDC estimates that, for children born between 1994 and 2013, vaccines will help to avoid more than 21 million hospitalizations and 732,000 deaths. Vaccines have already brought about a 79% reduction in measles-related deaths, essentially eradicated small pox, and ensured the US has been polio free since 1979. CDC predicts that widespread vaccine use will save \$1.38 trillion in total costs to society.

## **10. CHEAP, RELIABLE, AND CLEAN ENERGY**

One of the reasons we have the ability to clean our environment and produce better medicines and food is the easy availability of affordable, reliable and increasingly clean energy. The advent of improved exploration and fracking technologies means that, even though we're using more, we actually have far greater accessible reserves of natural gas and oil than we've ever had. EIA data indicates that while American

natural gas production has increased by more than 79% from 2007 to 2021, our proved reserves of natural gas have increased from 211 trillion cubic feet in 2006 to over 473 Tcf in 2020.

## **11. NATURAL GAS**

In the U.S., and around the world, we've been making good use of these fuels. Worldwide consumption of natural gas, the cleanest burning fossil fuel, has increased by more than 600% since 1965. Despite the increased use, prices for this essential fuel remain relatively low. Natural gas prices were at around \$4.40/million Btu in early 2022, compared to \$13.33 in June 2008. A clean burning and affordable fuel leads us to our next point.

## **12. CLEAN AIR**

While some may argue that increased use of fossil fuels entails more air pollution, our air is much cleaner today than it has been in the past several decades. EPA data show that national levels of the six "criteria air pollutants" tracked by federal regulators have decreased by an average of 78% from 1970 to 2020. Today all six of these pollutant levels are below the EPA's national standards.

## **13. SAFER VEHICLES**

We're using more energy to move ourselves around, but improved technologies in automobiles — air bags, stronger and lighter metal alloys, the addition of crumple zones, etc. — mean that the number of vehicle traffic fatalities has dropped dramatically: from a rate of 3.35 fatalities per 100 million vehicle miles traveled in 1975 to 1.36 in 2021.

## **14. MORE EFFICIENT**

At the same time as we are using more energy, our use of that energy is becoming far more efficient. In just one example, the Department of Energy reports that people

voluntarily switching to LED lighting will save the U.S. as much as \$30 billion and 348 terawatt-hours of electric power (compared with traditional incandescent lights). Those savings come (in part) from the fact that LEDs consume 75 percent less energy and last 25 times longer than incandescent bulbs.

## 15. CO<sub>2</sub> CAPTURE

We have repeatedly questioned the so-called consensus narrative on climate change. But for those who remain concerned that human-caused climate change presents a potentially catastrophic challenge to our continued survival, one new technology should provide you some comfort. This new technology, which is being developed by researchers at M.I.T., is much like a large battery that absorbs carbon dioxide from the air as it is being charged. It can then be discharged by releasing and capturing the CO<sub>2</sub>. The captured CO<sub>2</sub> gas can be used in medical or industrial processes and food production.

## 16. OZONE REPLENISHMENT

The ozone hole: In the early 1980s, scientists discovered that, each spring, a hole was opening in the ozone layer over the Antarctic due to destructive interactions between human-made chlorofluorocarbons and ozone in the stratosphere. The ozone layer is essential because it blocks a portion of the UV-B light that comes from the sun, protecting people, animals, and plants

from potentially damaging exposure to too much UV-B radiation. In 2019, NASA found that the ozone hole was the smallest ever recorded. When growing in the spring, the hole is as large as 8 million square miles, but in 2019, it reached a maximum size of 6.3 million square miles and then shrank down to less than 3.9 million square miles. While the size of the hole expanded to 9.5 million square miles in 2021, researchers reassured readers that this recent expansion is temporary and “does not mean the longer-term aim to close the ozone hole is off track.”

## 17. CO<sub>2</sub> IS PLANT FOOD

NASA also reports that, “From a quarter to half of Earth’s vegetated lands have shown significant greening over the last 35 years largely due to rising levels of atmospheric carbon dioxide.” Furthermore, the greening of the planet is benefitting developing nations the most. The research, a collaborative effort among 32 authors and 24 institutions in eight countries, found a 14% increase in green, leafy biomass, or plants, over the past three decades. They estimated that 70% of the increase is due to increased levels of CO<sub>2</sub> in the atmosphere.

## 18. GENETIC LIBRARY

To speed up responses to pathogens — pests and diseases — in agricultural crops, a genetic “library” has been created by researchers at the John Innes Centre in the U.K., with help from researchers in the U.S. and Australia. Together, they have developed a technique called AgRenSeq that uses genetic material from wild plants known to be resistant to a variety of pests and diseases. Researchers can insert the disease-resistant genes into domestic relatives and then speedily clone crops that have a defense against many pathogens the crops might encounter.

## 19. COSMIC CRISP APPLES

After being designed and bred for more than two decades, the ‘Cosmic Crisp’ apple is now being sold commercially. The apple has been in development since 1997, with generation after generation carefully selected to grow in all of Washington state’s microclimates. Even more impressive is the fact that, once picked, it can last up to a year in the refrigerator. So far, the new variety has been very popular; over 15 million individual trees have been planted across Washington state.

## 20. PESTICIDES

While they are often vilified, pesticides have been used for decades to protect crops and significantly increase yields in both industrial and smaller organic farming. When used properly, these pesticides can help reduce losses of fruits and vegetables by between 50% and 90%. That means more food is produced on fewer acres of land. Additionally, new technologies allow farmers to reduce overall pesticide use, while still maintaining productivity.

## 21. GEOSPATIAL TECHNOLOGY

This technology allows for more accurate pest detection and more effective and targeted use of pesticides. Additionally, as noted above, genetically engineered crops can now have built-in protection against pests and diseases. Both technologies help protect crops from predation, saving around \$60 billion in the U.S. from 2002 to 2008.

## 22. HEALTHIER, MORE PRODUCTIVE CROPS

The enset, a banana-like staple food crop that grows in a wide variety of conditions, is being genetically engineered by the International Institute of Tropical Agriculture and Ethiopian researchers to resist bacterial wilt. Scientists are sequencing the DNA of hundreds of varieties of enset to determine how best to spread the use of this beneficial crop to other areas of the world that need it the most.

## 23. AQUACULTURE

In eastern Indiana, AquaBounty Technologies is growing the first genetically modified salmon, “creating sustainable fishing and getting fresh seafood closer to consumers.” The company edited genes in Atlantic salmon so the fish grow to market size almost twice as fast as wild varieties. By isolating their operations in an inland setting, they can also reduce disease spread and address concerns about these fish influencing wild populations.

## 24. POLAR BEARS

Contrary to claims that accompanied a heart-wrenching 2017 video of a starving polar bear, the species is not being driven to extinction by climate change. In fact, according to The State of the Polar Bear 2021 report, prepared by Dr. Susan Crockford for the Global Warming Policy Foundation, the wild population has increased from about 5,000 in the 1950s to the current “global polar bear population [of] at least 32,000.”

**THE WILD POPULATION OF POLAR BEARS HAS INCREASED FROM ABOUT 5,000 IN 1950 TO THE CURRENT “GLOBAL POLAR BEAR POPULATION OF AT LEAST 32,000.”**

## 25. HALTING EXTINCTIONS

Scientists are working to halt the impending extinction of the northern white rhinoceros. The last remaining male of the species died of old age in 2018. But scientists preserved sperm from that individual and have harvested ten eggs from the remaining two females. A joint effort, involving the Ol Pejeta Conservancy, the Leibniz Institute for Zoo & Wildlife Research, Dvůr Králové Zoo in the Czech Republic, and the Kenya Wildlife Service, is using IVF to breed offspring. This extraordinary attempt may save the near-extinct species, and provide a ray of hope for other threatened and endangered species.

## 26. MOSQUITO CONTROL

Researchers at the University of Maryland teamed up with African colleagues to genetically modify a species of fungus that naturally infects the Anopheles mosquito. The modifications cause the fungus to produce a toxic venom once it is ingested by the mosquitos. In testing, researchers built a small, artificial village and enclosed it with mosquito netting. They added 1,500 mosquitos to a portion of the study area that contained the fungus. Within 45 days, only 13 mosquitos remained; 99% had succumbed to the fungus.

## 27. LAZARUS SPECIES

“Lazarus species” — more than 20 separate species that were thought to be extinct have been rediscovered, many in remote locations or deep beneath the ocean surface. One of these species is the small elephant of the Indonesian island of Java. This species survived because of the elephant trade in Asia decades ago; the tiny elephants were considered valuable by traders, so they were captured and bred in captivity before poachers could reach them.

## 28. LAZARUS RIVER

The Thames river and its tributaries in the United Kingdom appear to be showing a remarkable improvement in biodiversity and wildlife numbers, despite London becoming increasingly urban and populated. The U.K.’s Center for Ecology & Hydrology found that the river is “starting to reach levels one might expect to find in a river without any wastewater.” Modern sewage treatment systems, mixed with other technological improvements and restrictions on dumping pollutants, have allowed the river to revive. Considered biologically dead in 1957, the river system has regained 125 different species of fish, as well as many other plant and wildlife species. Recreational and commercial fisheries have returned.

## 29. RECOVERING ENDANGERED SPECIES

Even the progressive activists at the Center for Biological Diversity recognize that endangered species are doing much better in the United States than in earlier years. Their 2012 paper, “On Time, On Target” says that 90% of the species protected under the Endangered Species Act have been recovering at rates proposed in federal recovery plans. The center says that habitat preservation and captive-breeding programs have helped to increase the populations of sensitive species like the peregrine falcon, wood bison,

and sea otter, among others. Populations of several species, like the black-footed ferret or the El Segundo blue butterfly, have increased by several thousand percent. Of the bird populations covered by the Endangered Species Act, 85% have increased or stabilized.

### **30. FULL BELLIES**

The U.N.'s Millennium Goal #1 for 2015, announced in 2000, was to reduce by half the proportion of people who suffer from hunger. But the world actually met that target five years early! The New York Times and the U.N. annual hunger report both note that from 1990 to 2015, the number of people who lived in a state of hunger dropped by more than 200 million — from 991 million to 780 million.

### **31. IMPROVING PLANT PRODUCTIVITY**

Using science to improve food production has helped reduce hunger. One recent example comes from the Realizing Increased Photosynthetic Efficiency research project, in which researchers are taking the higher photosynthetic capacity of algae and inserting it into crop plants. Doing this allows these plants to convert CO<sub>2</sub> into sugar more efficiently and to better transform light energy into chemical energy. Together, these improvements could increase the productivity of plants by up to 60%, while also helping them use water more efficiently.

### **32. HIGHER CHILDHOOD SURVIVAL RATES**

Unicef reports that the worldwide mortality rate of children under five years old has been cut to less than half its 1990 total, dropping from 93 deaths per 1,000 live births, to 37 in 2020. And the number of children who died before reaching their fifth birthday dropped from 12.7 million in 1990 to about 5 million in 2020.

### **33. CONTROLLING HIV**

HIV.gov reports that thanks to new treatments and better education, the spread of HIV and AIDS has been reduced by about 31% since 2010. Additionally, the number of people living with HIV but receiving antiretroviral therapy increased from 800,000 in 2003 to 28.2 million in 2020.

### **34. CONTROLLING MALARIA**

W.H.O. numbers show that malaria-caused mortality dropped by 38% from 2000 to 2019, due to rapidly expanding interventions and better treatments. Sadly, the disruptions caused by the COVID-19 pandemic had a significant impact on the battle to limit the spread of malaria. Total cases jumped from 227 million in 2019 to 241 million in 2020. Global deaths increased from 558,000 in 2019 to 627,000 in 2020. The number of malaria deaths should resume their declines as we learn to live with SARS-CoV-2 virus.

## 35. MORE TREES — MORE FORESTS

Our World in Data reports that tree planting — or afforestation — and the natural expansion of forests have decreased the global rate of deforestation. The net loss of forests around the world has been reduced from an annual average of 7.8 million hectares in 1990 to 4.7 million hectares per year in the decade since 2010. Additionally, many developed nations are actually adding to their forested lands. For example, the United States increased its forested area by 153% from 1990 to 2010.

## 36. SAFE DRINKING WATER

The United Nation's Millennium Development Goals include one goal to reduce by half the proportion of people around the planet who lack "sustainable access to safe drinking water." Initially, the U.N. had hoped to meet that goal by 2015, but it was achieved five years ahead of schedule. Between 1990 and 2015, the percentage of people who obtained access to "improved drinking water sources" jumped from 76% to 90%.

## 37. SANITATION

In a related benefit, the U.N. also aimed to increase worldwide access to basic sanitation. From 1990 to 2015, 2.1 billion people gained access to improved sanitation. Since 1995, the percentage of worldwide population relying on unsafe sanitation dropped from 57% to 33%. Given the value of handwashing in reducing the spread of diseases and pathogens, continued improvement in this area is essential.

## 38. BATTERY PRICES

International Energy Agency data indicate that prices for lithium batteries, which are used for energy storage and in many electronic devices, have dropped significantly. From 2010 to 2018, utility scale battery prices decreased from approximately \$4,300/kWh

to \$1,600/kWh, a 63% decrease. The research firm BloombergNEF explains the price declines by noting that, "factory costs are falling thanks to improvements in manufacturing equipment and increased energy density at the cathode and cell level." Growing demand for lithium ion batteries for personal electronics, electric vehicles, and utility scale batteries is currently pushing prices for lithium and batteries up. It remains to be seen whether world governments will allow rapid permitting of lithium mines or other innovative battery technologies to help reduce prices.

## 39. BATTERIES 2.0

While they still face substantial barriers related to price, supply, and environmental impacts, lithium battery installations grew by 45% in 2018. The World Energy Council reports that pumped hydroelectric storage currently supplies over 96% of worldwide energy storage, but battery storage has the most potential for growth. They predict that "as much as 250 GW of energy storage [will be] installed by 2030," and that the costs of battery storage could drop by 50-66% by 2030.

## 40. SAVING HUMAN LIVES

Despite many frightening headlines about deaths from extreme weather, deaths from natural disasters have actually dropped significantly since 1900. In the early 20th century, annual deaths from natural disasters — earthquakes, famines, tornadoes, flooding, etc. — often exceeded one million. More recently, there are fewer than 20,000 annual deaths caused by natural disasters, a 98% reduction. Often this number is below 10,000, and has not gone over 500,000 since the 1960s. This dramatic decrease in deaths caused by natural disasters has occurred despite the addition of more than two billion people to the planet over the past 25 years.

## 41. ELECTRIFICATION

The global electrification rate has now reached 89%, as 153 million people gain access to electricity each year. Worldwide, the number of people who lack access to electricity dropped to 770 million in 2019. Once again, the COVID-19 pandemic has reversed this positive trend and some areas are seeing growing numbers without access to electricity. However, we expect numbers to resume their declines as we learn to live with the SARS-CoV-2 virus.

## 42. SAFER FISHING

Improved fishing methods have increased the fish catch off the coast of Mexico while also reducing the percent of sea turtles caught in fishing nets. Grupo Tortuguero is a coalition of groups in the region researching changes to fishing practices to reduce the bycatch and unintended deaths of sea turtles, while maintaining or increasing the fishing success of local fishers. Hanging lights on fishing nets decreases the number of turtles caught and increases the number of fish, for instance. Researchers from Duke University have found conservation efforts like these have led to a “90-percent reduction of sea turtles as bycatch since 1990.”

## 43. BIO-LOGGERS

Specialized devices that record animal behaviors and habitat conditions are playing a valuable role in wildlife and habitat conservation. Research published on Intechopen.com indicates that these devices use GPS and other instruments to track animal movement patterns and “measure the animals’ physiology, behavior, demographics, community interactions, and the environment [the] animal inhabits.” With improving technologies and reduced battery sizes, it is now possible to bio-log the activities of a broad range of organisms — from insects to blue whales.

## 44. CLEAN, BASELOAD ENERGY

Researchers at Michigan Tech University have created a process to clean and revivify coal-fired electricity generation plants that have been targeted for closure. Ezra Bar-Ziv’s research uses a process called “torrefaction” — heating biomass and plastic waste in oxygen-free conditions — to create what he calls “biocoal.” Bar-Ziv explains that, while they are still working on sourcing sufficient supplies of affordable biomass, he believes his process could keep existing baseload plants open, maintaining jobs and reducing overall emissions.

## 45. BREWING BEER WITH BURNT IRON

A family brewery, based in the Netherlands, has begun burning very finely ground iron powder to heat its brewing process. When burned, this inexpensive, easily transported and stored fuel can produce a great deal of heat. Where other heating processes produce various pollutants, this process is reported to produce heat and rust (iron oxide). The rust can be regenerated into iron powder using electricity and then reused in the heating process, with the claimed benefits for the fuel focusing on energy storage. It’s still very early in the development of this technology, but there are plans to expand to a 10 MW system by 2024 and to replace an existing coal-fired plant by 2030.

## 46. IDENTIFYING RARE SPECIES

Identifying rare species is becoming easier as Expeditionlab’s portable “GENE” field labs are moving the technical abilities of an established laboratory into a field setting. The GENE system allows field researchers to “extract, amplify, and sequence DNA” and has proven especially useful in remote areas. It can analyze the DNA of plants and animals to aid in the rapid identification of rare and hard-to-find species.

## 47. ARTIFICIAL REEFS

Artificial reefs are being built around the world in an attempt to encourage the growth of marine life and reverse the loss of coral reefs. As a result of reef-building efforts in Australia, 50 species of fish have moved onto one artificial reef, where only 12 had been before. While not all attempts to build artificial reefs are successful, the Florida Fish and Wildlife Conservation Commission reports that “more than 3,750 planned public artificial reefs have been placed in state and federal waters off Florida’s coast,” and many of those will succeed.

## 48. GREENER GREENHOUSES

Automated greenhouses are cheaper to run. Automation is allowing greenhouse operators to grow a wider variety of plants and produce a more consistent product year-round, regardless of location or outside climate. Contemporary greenhouses are increasingly tech-reliant, using LED grow-lights, sensors and computer automation to monitor and increase production. These newer technologies allow greenhouses to save on energy and production costs.

## 49. OYSTER CASTLES

The Chesapeake Bay Program, a partnership of government, academic, and nongovernmental organizations, was established to improve water quality, educate the public, and sustain the local economy. As part of its efforts, the program is working to rebuild oyster populations that declined due to, among other things, increased harvesting. Typically, oyster shells are sent to landfills after the oysters have been eaten. This practice actually reduces oyster populations because juvenile oyster larvae rely on the shells of their forebears to anchor and establish themselves. The Chesapeake Bay Program is building “living shorelines” made up of plants, sand, rock, and a mix of concrete and oyster shells as a way to provide

a habitat for juvenile oysters. As each new generation of oysters becomes established on these castles, the living shorelines will also help reduce shoreline erosion, improve water quality and restore wetlands.

## 50. TREE PLANTING WITH DRONES

Drones are now being used to speed up the planting process for trees and crops. One company that has developed drones, and the software to replant areas that have been logged or impacted by wildfire is called DroneSeed. Its specially equipped drones can plant up to 800 tree seed vessels per hour, compared to the entire day it takes an effective human tree planter to do the same work. Various agriculture startups have created drone systems that help to map out planting areas, improve crop spraying systems, monitor crop growth, and even “decrease planting costs by 85 percent,” according to work done by PricewaterhouseCoopers.

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Human ingenuity has developed amazing technologies and found numerous new ways to solve the environmental challenges we face. Whether these innovations help us find cheaper and cleaner energy sources, expand our ability to treat disease, decrease poverty, increase our access to food, stop species extinctions, or protect us from the impacts of natural disasters, their common element is the creative potential of the human mind being used to improve human health, well-being, and our environment.

Humanity is often wrongly maligned by green groups, elected officials, and the media as a necessarily destructive influence on our Earth. But our 50 examples demonstrate this is simply not the case. We have only published 50 reasons in this series, but the human mind has not yet begun to approach the limit of what it can achieve. ■

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**JASON HAYES** is the director of Environmental Policy for the Mackinac Center for Public Policy. The Environmental Policy Initiative focuses on improving the lives of Michigan's residents by first working to understand Michigan's unique natural features, and then promoting policies that will balance the state's environmental health and economic vigor.

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