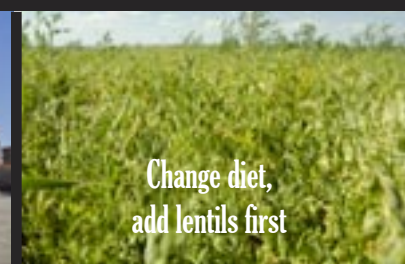
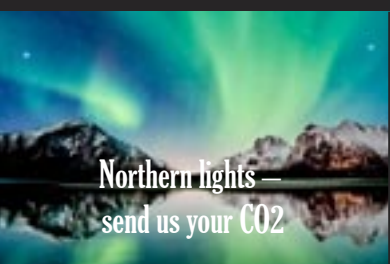


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Girl in a medical mask on the street during the coronavirus epidemic in Russia. Photo credit: vperemen.com

Change before we have to

GIANNI SERRA
ONE

This time it is not business as usual. Empty streets, no people, no cars, clear blue skies, producing less, consuming less, reinventing habits, schedule and priorities. It looks like fiction, but it is real. And global. What happens next door is also happening thousands of miles away. Not even wars have exposed so many distant countries all around the world on such an equal basis. Iran after China, Italy after Iran, Spain after Italy, the US after Spain, Britain after the US, India after all. Countries and people: princes, dignitaries, footballers, workers, men and women, the old and the young. All exposed.

We needed the coronavirus to show that everything can change and that everything can be changed. And very quickly. On December 31 last year, China alerted the World Health Organisation (WHO) to several cases of atypical pneumonia in Wuhan. The day after the city's Huanan Seafood Wholesale Market was shut down. A few weeks later, we are talking of a global pandemic, that has spread to at least 170 countries and territories.

Extreme situations need extreme measures. Despite being so close to China, Singapore managed to be one step ahead of the coronavirus. On March 24 the cases in the country were 558, more than half imported, 17 patients in critical condition and two victims out of a population of 5.6 million people. A stark contrast with Lombardy, an Italian region of 10 million people, which had registered in the same period a total of 32,346 cases, 1,236 in critical condition and 4,474 deaths. There is a difference here and not a minor one.

Singapore took note of what was happening in China and acted. The government did not react to an out-of-control situation but tried to prevent it. Whereas Italy, just like the rest of the world, was under the illusion that coronavirus was one of those things that will never happen or only happen to others. Some tried to deny the coronavirus matter, then to dismiss it, then debunk it, and only when there was no alternative they had to face reality. Misjudgement, wrong assumptions and the fear to lose consensus prevented many governments from acting in advance. All warning signs ignored. Only when the scale and the nature of the coronavirus issue were fully realised, measures came into play. Unfortunately, it was too little, too late for too many. Now, please replace in the above lines coronavirus with climate change. **ONE**

Northern lights

— send us your CO2

The coal mining companies still backing CCS as representing a clean future for their product have become somewhat isolated from the rest of the CCS community. Why?

TOBY LOCKWOOD

ONE

In March, a consortium of oil giants Equinor, Shell, and Total finished drilling an exploratory well off the coast of Norway. This time not searching for oil or gas, but in the hope of sending CO2 to be permanently stored in the porous rocks below the North Sea.

Dubbed the 'Northern Lights project', this venture forms part of Norway's flagship carbon capture and storage (CCS) project – a technology that Norway helped pioneer in Europe at the Sleipner offshore gas platform in 1996, but has since struggled to progress. In 2018, the Norwegian government agreed to help fund full engineering and design studies for a new 'full-scale CCS project'.

This time, the CO2 is to be captured from a cement plant and a waste-to-energy facility near Oslo. Led by the oil and gas consortium, Northern Lights encompasses the business of transporting the greenhouse gas from these industrial sites to the offshore platform for injection into the seabed. And this is where Norway is forging an entirely new approach in CCS. Instead of using pipelines for the whole journey, liquefied CO2 will first be collected by ships which will take the gas north along the coast to a storage point near Bergen. From there, an undersea pipeline pumps the greenhouse gas around another 100 km west, out to the new injection site.

The idea of using ship transportation is aimed at creating a flexible, standalone business for storing CO2, which

could expand to collecting emissions from industrial sites all around northern Europe. The CO2 from the two Norwegian projects alone – around 400 thousand tonnes per year each – is not large enough or dependable enough to justify investment in such costly infrastructure, so this bigger picture is essential to the project's financial success.

The pipeline and storage have initially been sized to accommodate 1.5 million tonnes of CO2 per year, and there are plans for a second phase to take capacity to 3.5 million tonnes per year if all goes according to plan. In order to meet this expansion target, the consortium is currently talking to over 30 companies around Europe who are interested in sending their CO2 to Northern Lights.

So how do these companies plan to make money out of storing CO2? Like other waste disposal businesses, the idea is to charge emitting industries for taking the CO2 off their hands, at a rate which Equinor think could be in the range of 35-50 euros per tonne by 2030. This business model is indicative of a global trend in CCS, in which projects have moved away from attempting to capture, transport, and store CO2 all on their own, towards the creation

of separate entities for transport and storage – often set up by the oil and gas companies which have the necessary engineering expertise.

Unlike the Norwegian concept, other propositions on the table tend to be based around heavily indu-

The CO2 is to be captured from a cement plant and a waste-to-energy facility near Oslo. Led by the oil and gas consortium, Northern Lights encompasses the business of transporting the greenhouse gas from these industrial sites to the offshore platform for injection into the seabed.

Skagsanden beach, Flakstad, Norway.
Photo credit: Unsplash/Johny Goerend



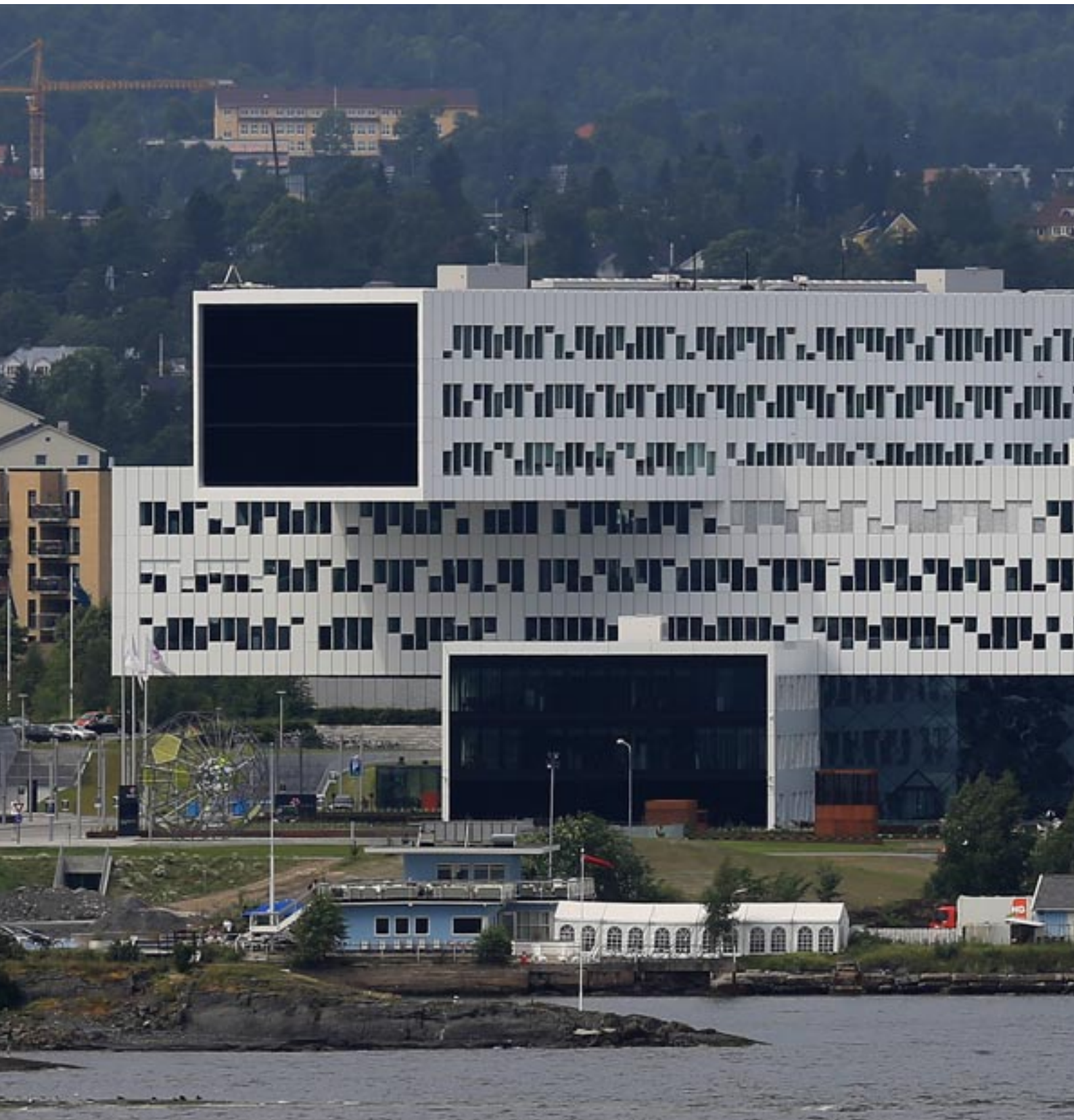
ustrialised areas, such as the Port of Rotterdam in the Netherlands or the Teesside and Humberside regions of the UK.

There is greater uncertainty about how the emitters will pay the fee for this service. Ultimately, it will need to be covered by climate policies which could raise the value of their production – be that power, cement, steel, or chemicals – enough to cover the cost of both capturing CO₂ and paying for storage.

These policies are still very much under development across Europe, although promising ideas include guaranteed power

prices and a premium for low-carbon products. However, it is clear there is a lot of interest from industries concerned about their long-term viability in a low-carbon world, and providing this simple ‘you pay, we’ll take it away’ solution certainly removes a lot of the barriers faced by earlier attempts at large-scale CCS.

A fundamental problem with building this kind of infrastructure is that it is a risky prospect for the private sector, when success depends on CO₂ capture projects emerging to fill the store. On the other hand, many capture projects won’t go ahead until they know the store is there. Known as the ‘chic-



ken and egg' problem, this often requires government intervention to resolve.

In this case, the Norwegian government has already helped fund the exploration well, and is planning to invest heavily in the initial infrastructure. From then on, 'Big Oil' is expected to make the business profitable. Critics of this approach question the idea of handing over assets to polluting companies to help them make more money out of 'cleaning up their mess'.

A more coercive approach would be to require fossil fuel pro-

ducers to store some fraction of the carbon they extract; but for now, oil and gas companies appear to be holding the cards.

With the drilling tests completed, an investment decision from the Northern Lights consortium is expected sometime this spring. Still, everything will depend on the decision of the Norwegian government later in the year. If the project gets the greenlight, construction is expected to take three years, and be operational in 2024. It may not be long before we see CO2 tankers sailing our seas. **ONE**

Equinor headquarter at Fornebu, Oslo (Norway).
Photo credit: Hans A. Rosbach



Sustainable urban planning makes smarter cities

EUSEBIO LORIA

ONE

The world is moving away from traditional energy sources towards more efficient and smarter energy systems. The Smart City concept is not new anymore, and it's slowly gaining traction.

The 'smart' concept has evolved from technology-driven progress towards social values. There is now a clear shift from the vision of a city supported and organised by innovative digital systems to one aiming at providing social inclusion, quality of life and sustainable development.

Nowadays, smartness relates to urban planning, sustainable energy, transport strategies and also social integration. Quality of life is increasingly playing a more substantial role in citizens' aspirations, and there is already a call-to-action to build modern, technological but also inclusive and dynamic cities. Singapore tops the new 'citizen-centric' smart city list, according to the IMD Smart City Index 2019, a gauge of "smartness" that emphasises how citizens perceive the efforts to make their city smarter, balancing "economic and technological aspects" with "human dimensions".

In 2007 Austrian professor Rudolf Giffinger explained the smart city as a well performing city that is forward-looking way in six dimensions - economy, people, governance, mobility, environment and life.

Many European projects share this vision and focus on the re-definition of urban areas according to the Clean Energy Package for all Europeans. This approach pays special attention to energy efficiency improvements of the heritage building stock. Buildings account for 40% of the total energy consumption in the European Union, 33% of CO₂ emissions and 70% of the continent's overall energy consumption.

The Concerto program, started in 2005 and funded by the European Research Framework Programme, opened the doors of Europe to energy efficiency and sustainability. More than 3,000

high-performance new buildings built (1.75 million m²), 376 kt CO₂ emission reductions per year (7 kt CO₂ in new buildings), a 1.326 GWh reduction in non-renewable primary energy demand per year.

The Opteemal program [Optimised Energy Efficient Design Platform for refurbishment at district level], which started in 2015, aims to overcome barriers related to the design of retrofitted efficient buildings and districts with the engagement of all stakeholders within a collaborative and cost-effective approach. Experience shows that, in a local urban context, knowledge sharing has a crucial role in supporting participants - homeowners, companies, policymakers - in the energy retrofitting and building renovation industries.

In the wake of this experience, Sotacarbo Sustainable Energy Research Centre, based in Carbonia, Italy, is implementing a tool to support the renovation and energy efficiency improvement of the local urban building heritage. The device - whose acronym "Auree" derives from the Italian translation of Urban Abacus of Building Energy performance - is based on a Web - GIS GeoBlog portal aimed at sharing data and information on local building heritage to involve a full group of stakeholders. The tool - to be tested and validated on Carbonia city - facilitates the improvement of citizen and stakeholders awareness. It will be used by real stakeholders to carry out an energy-efficient retrofitting design.

The peculiarity of the project is that it is in the context of a small city developed around the Serbariu former coal mine. In Carbonia there is a high percentage (40%) of historic buildings built before 1950, 96% of which are still in use today, mainly for residential purposes (86%). The challenge will be to release Carbonia from its strong architectural constraint and to combine the preservation of historical heritage with the concepts of efficiency and smartness. **ONE**



The flexible virtues of PtX

ALICE MASILI
ONE

The Power of X – not talking here about the Marvel mutant superheroes, but about technologies that can help us to fight climate change.

Southwestern Iceland, 2011: the George Olah plant marks a milestone for CO₂ utilisation from carbon capture and storage. We finally have the first industrial-scale power-to-x (PtX) facility, able to exploit carbon dioxide waste gas for the production of renewable methanol. PtX technologies are often described as crucial for reducing CO₂ emissions, given their suitability for combining energy from renewable sources and captured CO₂ that leads to a potential carbon-neutral fuel life cycle.

But what's behind these terms? And can they contribute to climate neutrality?

The analysis and insights collected by the International Energy Agency (IEA) in the World Energy Outlook 2019 highlighted an ever-greater gap between the promise of energy for all and the sad reality of almost one billion people still with no access to electricity.

The scientific evidence is clear on the need for faster cuts in greenhouse gas emissions, but expectations of rapid energy transitions based on renewable energies, collide with hard facts. And energy systems highly dependent on fossil fuels are still real today.

The World Energy Outlook shows a few scenarios that explore different possible futures, the actions - or inactions - that determine them and the interconnections. The current policy scenario shows that energy demand is expected to rise



by 1.3% every year in the next two decades, leading to the damaging combination of an unstoppable growth of energy-related emissions and energy insecurity. The transition to a more sustainable energy system needs to include low emission energy supply technologies such as renewable energy sources (RES). In recent years, RES technologies have made significant progress in the technical and economic fields with a substantial increase in installed capacity.

However, the natural intermittency of most forms renewable energy slows down their large-scale implementation. This behaviour afflicts the balancing of the overall electrical system. When energy production exceeds demand, you need technologies that allow both the accumulation of the excess energy produced, and its reuse. This is precisely where PtX technologies come into play.

PtX can convert electricity (power) into other forms of energy (X) through reversible chemical reactions. A classic example of PtX is the electrolysis of water for hydrogen production. According to the Future of Hydrogen report, published by the IEA in June 2019, the supply of hydrogen to industrial users is a global business. To meet the growing demand and to ensure that its production does not increase CO₂ emissions, the electrical energy for the reaction must come from renewable sources.

Green hydrogen, produced by renewables, is a fundamental building block for the production of synthetic fuels. It can react with CO₂ to produce methane, methanol and dimethyl ether. This reaction is called hydrogenation. The carbon required for the synthesis process can be obtained from recycled CO₂, for example, captured from abundant sources such as fossil fuel power plants or from the air itself. These carbon

capture and utilisation (CCU) methods see CO₂ as a resource, not as a waste.

Conversion of hydrogen to the most convenient forms of liquid and gaseous energy carrier facilitates long distance transportation and extended periods of storage, with minimal or no losses. Besides, all synthetic fuels can fit directly into existing infrastructure (e.g., filling stations and the gas network) without facing high costs, technical barriers or changes in habit.

A positive impact is expected not only in transport but also in many other sectors, where synthetic fuels can be used as final carriers of energy and raw materials: industry, electricity production, heating, chemical raw materials, fuel cells. Being able to create a carbon dioxide capture unit next to a fuel production site, thereby exploiting the distribution network already in place, would reduce production costs and would bring synthetic fuel costs into closer alignment with conventional fuels.

The first laboratory-scale power-to-gas plant, for the production of methane from hydrogen, as built in Japan in 1996. Nowadays, Europe leads the sector mainly thanks to Germany, Denmark, the Netherlands and Switzerland.

CO₂ methanation projects are mostly taking place in Germany; due to the transition of the country towards a renewable energy system, associated with a growing demand for chemical storage of electricity and the need to compensate the intermittent supply of wind and solar energy. According to the German Energy Agency (Dena) the implementation of PtG technologies in Germany would lead to a 55% reduction by 2030 and 80-95% in the long term. **ONE**



The Nesjavellir Geothermal Power Plant in Þingvellir, Iceland.
Photo credit: Gretar Ívarsson/ILRI/Stevie Mann



Electrifying buildings and cars can rein in electric rates

MOHIT CHHABRA
Nrdc.org

Electricity prices stand to rise in California because of wildfire costs—but converting more of the state's buildings and vehicles to electricity generated from low-cost renewable resources could help limit these increases and help keep electrical energy affordable.

This conclusion comes from a new journal article I co-authored with Catherine Hay that examines how electricity prices could be affected by two major factors: increased droughts and heat exacerbated by climate change. These conditions increase the risk of wildfires in California, requiring costly safety upgrades to the electricity system to avoid sparking. The costs of these safety upgrades increase California's electric rates because utilities pass these costs on to customers.

Meanwhile, the state needs to move toward large-scale efficient electrification of buildings and transportation to help meet its goal to become carbon neutral by 2045. Clean electricity generated from carbon-free resources like wind and solar is the key to the low-carbon economy that California is aiming for. This is because once electricity is low-carbon, Californians can then further reduce carbon by powering their cars, water heaters, and space heating appliances with clean electricity instead of polluting fossil fuels. But mass electrification will be a hard pill to swallow for customers if electricity rates skyrocket, sticking them with utility bills they can't afford. Our analysis shows that this won't be the case.

By 2030, rather than a 28 percent increase in electric rates over historical trends due to the additional cost of wildfires, the rise in rates can be curtailed to only 9 percent through smart electrification.

Our study was specific to residential customers in PG&E's service territory; those homes whose electricity flows through the poles and wires that PG&E owns and opera-

tes. However, our conclusions apply to all utilities in California: wildfire-related spending will put upward pressure on rates, but it can be counteracted through efficient electrification.

Study Findings

Liability for the recent deadly wildfires in Northern California drove utility Pacific Gas & Electric Co. (PG&E) to bankruptcy and a subsequent reorganization. The utility says it will spend more than \$3 billion in the near term to upgrade infrastructure and prepare for future liability claims and pay its fair share to develop a statewide \$21 billion safety fund to deal with any future wildfires. Those costs will be reflected in the rates the utilities charge customers for future service.

In our study, recently published in *The Electricity Journal*, we set out to answer three questions: How the costs described above, which enable PG&E to (1) compensate for the 2017 Northern California and the 2018 Camp wildfires, (2) mitigate future wildfires and (3) create a safety fund to deal with future wildfires, will affect PG&E's average residential electricity rates in the coming decade. We collectively refer to these costs as "wildfire-related costs" in this blog. How building and transportation electrification could counteract rate increases; What all of this means for residential utility customers' monthly bills.

Before we answer the first question, let's establish what PG&E rates would be if the 2017 and 2018 wildfires hadn't occurred. By analyzing historical data, we estimate that rates would have risen to 32 cents per kilowatt-hour in 2030, up from 23 cents per kilowatt-hour in 2018. In our study, we estimate that average residential electricity rates will rise an additional 9 cents per kilowatt-hour through 2030 due to wildfire-related costs, increasing the PG&E average residential electric rate to 41 cents per kilowatt-hour.



Windmills from the Tehachapi windfarm, California. Photo credit: Alexandre Buisse

But we also found that this increase in electric rates can be curtailed to only 35 cents per kilowatt-hour in 2030 through proactive electrification of buildings and transportation—only 3 cents more than what it would've been if the wildfires never occurred. That's because additional electricity sales from adding new electric load on the grid puts downward pressure on electric rates. Utility spending to build, maintain and operate the electric grid are largely fixed costs that form a large portion of our electric rates; the amount we pay our utilities to buy or produce the actual electricity on our behalf is much smaller in comparison.

Generally, increasing the total amount of electricity sales helps to spread the utility's fixed costs over a larger sales base, which reduces the price of each unit of electricity sold to customers. This is akin to what happens when you spread the same amount of peanut butter over a larger slice of bread; there is less peanut butter in every bite. The answer to how much bigger the slice of bread in our analysis should be—i.e., how much additional electricity consumption from proactive electrification that our study assumes—is 18 percent.

This estimate comes from a California Energy Commission report that, among other things, figured out how much electrification is needed to meet California's 2045 carbon-neutrality goals. (Read my paper to better understand how the amount of electric sales impact electric rates!)

Finally, we found that electrifying buildings and transportation at this pace through 2030 makes electrification more appealing for all Californians by keeping electricity affordable. The average PG&E residential customer would save \$28 a month on electric bills in 2030 compared to a future

without this proactive electrification. This result applies to all customers, those who move off fossil fuels to electricity along with those who don't. The average PG&E customer, who uses around 500 kilowatt-hours per month, pays approximately \$115 a month for electricity. This average customer would pay around \$160 a month in 2030 due to rate increases in line with historical trends. With wildfire-related costs, this customer could see electricity bills rise to \$210 a month. But with efficient electrification in line with our state's climate goals, that increase can be curtailed to \$175.

Let's not forget that Californians can go even further to keep their electric bills affordable by embracing energy efficiency! It's also important to remember that not switching to electricity from gas isn't a good option for Californians because residential gas rates are expected to increase steeply. This is because reduction in gas use due to higher temperatures, driven by climate change, combined with the eye-popping expense of maintaining gas infrastructure creates, means that these increasing infrastructure costs will need to be recovered from declining gas sales.

The results of this study are good news for Californians. By decarbonizing the state's buildings and transportation, we can clean up sectors that currently account for 60 percent of the state's greenhouse gas emissions. And we can make electricity more affordable in the process, saving residential customers hundreds of dollars a year.

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Change diet, add lentils first

Changing our diets will give the agricultural system the incentives to make the necessary changes needed to stop climate change.

By LENORE HITCHLER
ONE

Climate change must be stopped before it stops us! How can we do this? We must evolve from a fossil-fuel driven economy to a more sustainable one. Many industries burn vast amounts of fossil fuels. The result is an increase in greenhouse gases which contribute to global climate change.

The agricultural system produces 26% of greenhouse gas emissions. This was cited in the journal *Science* in an article titled “Reducing Food’s Environmental Impacts Through Producers and Consumers.” Therefore, massive modifications must occur in the manner in which food is produced and distributed. Changing our diets will give the agricultural system the incentives to make the necessary changes needed to stop climate change.

Dietary modification is such a broad topic that it advantageous to highlight one specific adjustment. Adding lentils to our diet is a great start which can ultimately lead to changes in the agricultural system. Lentils are pulses. According to the United Nations Food and Agriculture Organization (FAO), “pulses are a type of leguminous crop that are harvested sole for the dry seed.”

The online *Your Dictionary* states that legumes are: *Any of a large number of eudicot plants belonging to the family Fabaceae (or Leguminosae). Their characteristic fruit is a seed pod. Legumes live in a symbiotic relationship with bacteria in structures called nodules on their roots. These bacteria are able to take nitrogen from the air, which is in a form that plants cannot use, and convert it into compounds that the plants can*

use. Lentils, therefore, do not require synthetic fertilizers manufactured from fossil fuels which results in a lower carbon footprint.

Yantai Gan, a research scientist specializing in alternative crops and diversification at the Agriculture and Agri-Food at Canada’s Research Centre, studied the relationship between lentils and soil fertility. He found that lentils and their root bacteria provide between 50 and 80 pounds of nitrogen per acre. He also found that nitrogen at spring planting was 44% higher in soil previously planted in lentils. The FAO reports that rotating pulses with cereal crops results in higher yields of cereals amounting to 1.5 tonnes more per hectare.

Besides not requiring fossil fuel-based fertilizer, lentil crops do not rely on energy-intensive irrigation. Thus, the carbon footprint for one kilogram (kg) of lentils is only 0.9 kg of carbon dioxide (CO₂) equivalent. This includes emissions before they leave the farm, transport, wholesale and retail operations, cooking and waste disposal. In comparison, the equivalent carbon footprint for one kg of beef is 27 kg of CO₂ equivalent. Cheese is 13.5 kg, pork is 12.1 kg, and chicken is 6.9 kg. In fact, according to the FAO, 14.5% of annual greenhouse gasses are caused by livestock production.

Sujatha Bergen, policy analyst at the Natural Resources Defense Council, states that: “We’ve estimated that if Americans were to cut a



Lentils growing in field. Beach, North Dakota (USA).
Photo credit: USDA Natural Resources Conservation Service

quarter-pound of beef from their diet a week – that’s the average of a hamburger – it’d be like taking 10 million cars off the road for a year.”

There are other negative environmental consequences of raising livestock. Wayne Martindale and Caroline Wood, PhD researcher in plant biology, discuss this in *The Conversation*, an online news source. They state that: “livestock farming requires huge amounts of water and land for grazing and feed production, taking up an estimated 70% of all agricultural land and 27% of the human water footprint.”

The authors of the piece in *The Conversation* add that: “Pulses are also highly water-efficient; for each gram of protein, the average global water footprint of pulses is only 34% that of pork and 17% of beef. Gan found that lentils are ideally suited for semiarid areas. Meanwhile, the carbon footprint of pulses is less than half that of winter wheat and on average 48 times lower than the equivalent weight of British beef cattle.”

Substituting lentils for meat is something that in-

dividuals can easily do to lower their carbon footprint. Lentils can be stored for a long time and do not need to be refrigerated prior to cooking, thus lowering their carbon footprint during storage. According to *CookingLight* magazine, lentils can be soaked to shorten cooking time, further reducing consumption of fuel and production of greenhouse gases. Lentils also cook faster than other legumes too. They can be frozen, and when people are tired and hungry, they can quickly reheat them and combine them with whatever is on hand rather than going out to a fast food chain. Their versatility can help reduce food waste. For example, they can be mixed with various leftovers thus decreasing the amount of edible food that might otherwise be wasted and thrown away.

Unfortunately, there are some significant downsides to lentils. Meat and dairy products are very popular, and it is extremely difficult to change people’s food preferences. Consuming lentils without any herbs and spices is not very appealing as lentils by themselves have very little flavor. Red lentils turn very mushy when cooked, and many

people are turned off by their texture as eating them is like eating a bland pudding.

However, our new food pallet does not have to be boring, bland, and bereft of flavor. Fortunately, various ingredients can enhance the taste of lentils. They are very versatile and can be consumed as a hot cereal, in salads, main dishes, including soups, stews, veggie burgers and loaves, sweet and sour dishes, stuffed peppers, casseroles, and side dishes. They can even be sweetened and used as an ingredient in desserts, including brownies.

Lentils can also be used to produce a highly nutritious flour. According to the writers of *The Power of Pulses*, lentil flour can be used in breads, cookies, and cakes, as well as thickeners for soups and sauces. The authors add that “Mixing pulse flour with brown rice flour or another gluten-free grain, such as amaranth, provides a complete and delicious protein.”

Lentils can even be used to produce a nutritious pasta. Dietitian Rachel Warren, M.S., R.D., stated in Consumer Reports that pasta made from lentils is higher in protein and fiber than wheat-based pasta. As an added bonus, lentil-based pasta is gluten-free.

The history of the consumption of lentils is long and extensive. Lentils are associated with many countries and historical figures found throughout ancient history. For thousands of years, lentils have been consumed along with barley and wheat. Scientists believe that the cultivation of lentils began in central Asia. Lentils have been found throughout the area surrounding the Mediterranean.

Evidence of lentil crops dating from ten thousand years ago has been found on the banks of the Euphrates river in what is now northern Syria. Lentils were consumed in Greece as early as 6000 BC. Hippocrates used lentils in his medical practice. The Greek playwright Aristophanes called

lentil soup the “sweetest of delicacies.”

Lentils arrived in Egypt around 2000 BC. Remains of a lentil puree were found in a tomb in Thebes dating from around 1750 BC.

Moreover, lentils were cited in the Old Testament. In Genesis 25, Esau sold his brother Jacob his birthright for a “pottage of lentils.” In 2 Samuel, a field of lentils was invaded by the Philistines. Shammah stood in the middle of the field, vanquished the Philistines, and the crop was saved. In Ezekiel 4, God commanded him to “Take wheat and barley, beans and lentils, millet and spelt; put them in a storage jar and use them to make bread for yourself.”

In India, lentils were cultivated as early as 2500 BC. Lentil dishes of all types are found throughout India and regional areas specialize in their own unique recipes.

Ancient Rome also utilized lentils. Apicius wrote the first Roman cookbook 2000 years ago. He included a chapter on legumes which featured recipes for lentils with mussels, chestnuts or spices. Even though generally considered food for the lower classes, lentils were found at Roman banquets. *The Rerum Rusticarum*, 37 BC, was a publication that included the value of pulses

for supplying nourishment. The obelisk in front of St. Peter’s Basilica in Vatican City was transported by ship from Egypt cushioned by 2.8 million pounds of red lentils.

In India, lentils were cultivated as early as 2500 BC. Lentil dishes of all types are found throughout India and regional areas specialize in their own unique recipes. The word *dahl* or *daal* refers to either lentils or dried split pulses such as lentils, peas, and beans. Indian dishes frequently combine lentils and rice along with various herbs and spices. According to Kavita Mehta, founder of the web-based Indian Foods Co., lentils are consumed in some form at least twice a day in “any self-respecting Indian household.”

In England, because of food shortages during World War I, English cooks used lentils to make cheese and lentil savories. Isaac Hepworth, English blog writer, wrote about his grandmother’s recipe,

which included cheese, lentils, breadcrumbs, onions, and a little oil. Karen Burns Booth in her blog, *Lavender and Lovage*, wrote about the cheese and lentil sandwich filling recipe that she found in the English publication, *People's Friend* from World War I. This recipe also included cheese, lentils, breadcrumbs, onions, oil, plus the addition of parsley. Another recipe for lentils was included in *Victory in the Kitchen: Wartime Recipes* from World War II published by the Imperial War Museum in England.

During World War II, legumes, including lentils, were also utilized in the United States as an alternative to meat. Food shortages and rations led to the publication of the General Foods Corporation titled *Recipes For Today* in 1943. This booklet provided creative ways to prepare meals, using many General Foods products. They included a recipe for bean, pea, or lentil soup.

Various lentil dishes are also currently found in north African countries such as Egypt, Morocco, Ethiopia, and Middle Eastern countries. Lentils are also found in modern France, Italy, Greece, and Turkey. The ubiquity of lentils is further shown by the fact that the word for the lens of the eye comes from the Latin word for lentil. This is because eye lenses are similar in shape to lentils, being wide in the middle and narrowed at the ends.

As well as having an essential body part named after them, lentils provide important nutrients for the whole body. Unfortunately, according to the US Food and Drug Administration (FDA) lentils do not contain the complete protein that is necessary for a healthy diet. Lentils lack the amino acids methionine and cystine. If a person consumed no other proteins, it would be detrimental to their health. Fortunately, methionine and cystine are found in grains. Therefore, consuming rice or other grains along with lentils provides a complete protein. Of course, cooking rice requires energy use.

However, according to the article "Effect of Moisture Content on Cooking Time of Rice" published by the *Proceedings of the Manufacturing &*

Industrial Engineering Symposium, soaking rice considerably reduces cooking time. This results in less greenhouse gases.

Rice Pilaf served with lentils make a terrific basis for a meal which would provide a complete protein, vitamins and minerals along with plenty of fiber. Besides providing protein, lentils contain vitamins, minerals, and fiber. This might explain why the *Nurses Health Study* found that women who ate lentils or other pulses two or more times a week reduced their frequency of breast cancer by 24%.

Additional healthy advantages of consuming lentils are provided by Tallene Hacatoryan, M.S., R.D. She states that eating a diet high in fiber increases weight loss and lowers the risk of heart disease. Folate and magnesium are found in lentils, and they contribute to heart health. Research has shown that lentils reduce both blood glucose and cholesterol levels. Furthermore, lentils are a good source of omega-3 fatty acids, which have an anti-inflammatory effect. Folic acid found in lentils helps the body maintain new cells and prevents the changes in DNA that can lead to cancer.

There are even more health advantages of lentils. Sharon O'Brien, M.S., R.D. states: "Lentils are rich in polyphenols. These are a category of health-promoting phytochemicals. Some of the polyphenols in lentils, such as procyanidin and flavanols, are known to have strong antioxidant, anti-inflammatory and neuroprotective effects. In addition, when tested in the lab, the polyphenols in lentils were able to stop cancer cell growth, especially on cancerous skin cells. The polyphenols in lentil may also play a part in improving blood sugar levels."

Also, lentils do not contain either cholesterol or gluten. Another advantage of lentils is that they are very inexpensive. This is especially important for impoverished countries and the poor in wealthy countries. Of course, merely consuming lentils is not going to stop climate change. However, increasing the use of lentils will help slow it down. Additionally, lentil consumption will improve both the health of people and the environment. **ONE**

Why are climate-conscious cities often the least affordable?

NATHANAEL JOHNSON

Grist.org

Cities can do a lot to stop climate change. They can fill their streets with electric buses, pass strict efficiency rules for its buildings, and switch to powering the place with clean energy.

But there's a problem that mayors rarely mention when touting their green cred. The cities striving to go green tend to be the priciest, pushing all but the affluent into carbon-spewing commutes. Think New York, London, and, of course, San Francisco.

Most of San Francisco's electricity comes from a nuclear plant, solar panels, and other forms of clean energy, meaning that eighty-five percent of the energy powering the city's network of electric buses and trains is carbon-free. It recently barred people from driving on the main drag, Market Street, allowing bicycles and transit to flow freely.

The city pays residents to put solar panels on their homes. But boy do you have to pay to get into this garden of delights: \$1.2 million for the median home. As a result, the area has seen a 170 percent increase in the number of people commuting more than an hour and a half since 2005.

All that driving has California's climate efforts stuck in traffic. To meet its climate goals, most experts say the state will need to build a lot more apartments near bus and train stops.

It's not just California or even the United States. As cities around the world expand to house some 2 billion new people by the end of the century, they'll have to decide: Will they grow up, grow out, or try to stop growing entirely and turn away immigrants?

California's coastal cities were true innovators in strategies to push people elsewhere. In his new book, Golden

Gates: Fighting for Housing in America, Connor Dougherty, an economics reporter at The New York Times who was raised in the Bay Area, puts the state's housing history under the microscope. Grist asked Dougherty how well-meaning environmentalists helped drive up housing costs, and what will reverse that trend.

This interview has been condensed and edited for clarity.

Q.First of all, what's behind the housing crisis in California?

A.Put simply, we do not have enough housing. And it costs too much to build the housing needed. California has the highest home prices in the country. We have some of the worst rents in the country. We have half the homeless population in the country, even though we have just one-twelfth the population. So, while this is a national problem, California has been exceptionally bad at dealing with it.

Q.Are homeless people moving to California or is the homeless problem simply related to the lack of homes?

A.It's absolutely related to a lack of homes. A lot of people want to say it's mental health or drug addiction, and obviously those things are related. But lots of people around the country struggle with drugs and mental health without ending up on the streets. So what's the variable that matters? It's the cost of housing.

Q.Do environmentalists share some blame for driving up housing prices?

A.So in the 1960s and '70s there was a transition around the first Earth Day where we saw the rise of suburban environmentalism. Some of that was really good:

The environmental justice movement has been amazing, and suburban environmentalism was a mass movement. Older conservationism was generally exclusive because only a certain type of person could go spend a bunch of time in nature.

It wasn't a bad movement — I don't think we'd be better off without Yosemite National Park — it just wasn't something moving majorities at the local level.

Because it was pretty inextricably tied to home values, as well as a general love of your neighborhood, environmentalism could move majorities.

Q. So that suburban environmentalism worked because people could see benefits in their own neighborhoods. They were also pushing for less housing nearby so there would be more room for birds.

A. Totally. I think that if somebody could know definitely that allowing higher density housing in their neighborhood would affect the arc of climate change they would make that sacrifice. But it's hard to see and hard to know.

Q. The green backlash against growth is also important. How did that emerge?

A. There was a postwar suburban boom and California, really Los Angeles, was the most exaggerated example of that. In the early days people were pretty apolitical; that is, the newcomers were not anti-newcomer. That started to change in the '70s. A bunch of books were published about how California was being ruined. One of those books was *The Destruction of California* by Raymond Dasmann.

He was an environmentalist, and he was very concerned about growth — as he should have been. They were trying to build freeways everywhere.

Today, saying we do not want to keep growing at this scale and that we do not want to keep chewing up land and creating more space for cars is not something anyone would disagree with. But there are also aspects of that movement we can question.

Dasmann basically posits that, if we don't plan for population growth, it won't happen. If we don't make California hospitable to people they will not come.

Presciently, he says, the only place I've seen this done successfully is wealthy cities like Santa Barbara. I read that and thought, "Wow!" That, ideology taken to its logical extreme means that all of California becomes Santa Barbara, where only the wealthy can afford a house.

Q. And it's not just greens. A big part of the housing crisis comes from people wanting to keep their neighborhoods white and affluent. How does that translate into re-

stricting homes?

A. All around the country there are rules to make lot sizes large, or prohibit multifamily buildings, which have the net effect of making housing more expensive. Though these rules were often explicitly racist when they were passed, I don't think they are as explicitly race motivated as they once were. But the net effect is the same, because of wealth inequality. I'm sure there are wonderful people who want to live in a diverse, multi-cultural suburb that is just generally wealthy and has all the same housing type.

Q. You write that one way to keep poor people out of a neighborhood is to incorporate as a city. Californian cities, starting with Lakewood in Los Angeles County, figured out how to do this by creating something called a contract city. What's that?

A. A contract city is a technology. It makes something expensive and time consuming simpler and easier — that is what technology does. In a contract city, instead of hiring departments they contract out city services — often to the county.

If you go to Lafayette, California today there are Lafayette police cars, but they are not really police, they are county sheriffs that are contracted to pretend that they are Lafayette police.

If you wanted to build a city and actually pay for a police department and a waste treatment plant you'd have to pay a lot of money for them.

So this innovation makes it cheaper for an area to gain the land-use power of a city to make housing more expensive. Rules like large-lot zoning ordinances that require people to buy three acres with their house have the effect of excluding poorer people who require more services.

Q. How do we fix this?

A. It's pretty simple, right? You can either make housing affordable by subsidizing it, or you can build more housing. You can do both and hopefully they work together. Step one in a solution is that we are talking about the problem. People are sick of living like this; they've accepted that the status quo is totally unacceptable. There are young people both on the tenant side [we should subsidize housing] and the YIMBY ["yes in my backyard" — let's build more] side choosing to spend their Wednesday evenings going to planning meetings. This alone is a huge amount of progress.

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Facing undeniable reality of Climate change, deniers now argue it's not that bad

SIMON CHANDLER

Truthout.org

Climate change denialism has a long history. Possibly the earliest clear example dates back to October 1959, when a researcher working for none other than Royal Dutch Shell published an article in *The New Scientist*. Acknowledging that an “immense” quantity of fossil fuel has been burned since the middle of the 19th century, he nonetheless argued that, “Nature’s carbon cycles are so vast that there seem few grounds for believing Man will upset the balance.” Since then, articles, books, and other materials denying or belittling the existence of anthropogenic climate disruption have only proliferated, particularly as industry-funded groups, such as the Global Climate Coalition and the George C. Marshall Institute, emerged in the 1980s.

Unfortunately for such lobbyists and think tanks, it became harder to operate as evidence for the human-made nature of climate change accumulated over the years, and as an increasingly unified scientific consensus solidified around such evidence. The Global Climate Coalition disbanded in 2001, following years of targeted pressure from environmental groups and campaigners, as well as the resulting exits of such members as BP, Shell and Ford. Likewise, the George C. Marshall Institute folded in 2015, having suffered the withdrawal of funding from such backers as Exxon-Mobil, which decided to publicly end its support of the Institute and certain other disinformation groups in 2008.

Superficially, the situation appears even worse for climate change denialism now than it did 20 or even 10 years ago. In July, as a study published in *Nature* demonstrated that the past few decades have witnessed “unprecedented” global temperature rises, it was estimated by climate researcher John Cook that the scientific consensus on climate change has now likely passed 99 percent. Cook had previously co-authored a famous 2013 article that found that 97 percent of

researchers who published work on climate change between 1991 and 2011 agreed that it was being caused by human activity, indicating the increasing coalescence of the science community around objective reality. Given that Cook has now suggested that the consensus is nearly 100 percent, the future doesn’t look bright for any corporation, lobby group, think tank or multimillionaire wanting to prevent the public from seeing the proverbial light.

However, not only is the history of climate denialism long, but it’s also constantly evolving. Because even if it’s no longer viable to openly and directly claim that human activity isn’t heating the Earth, organizations with an interest in maintaining the status quo of fossil fuels have nonetheless been finding more indirect and inventive ways of undermining the world’s growing concern for its own future.

It seems that since the emergence of Extinction Rebellion, Swedish teenager Greta Thunberg’s activism, worldwide climate strikes and an almost-complete scientific consensus, this new form of denialism has become more active than ever. But that’s not to say it’s become more successful, since what little evidence there is indicates a stubborn failure to sway minds.

Send in the Bots

In an age where social media has become the primary medium for the consumption of news and information, it’s no surprise to learn that climate denialism has relocated to Twitter, Facebook and YouTube. However, of the three major social media platforms, it’s Twitter that’s the most representative of the new kind of denialism. In contrast to simply offering a space for skeptical videos and content, what sets it apart are the legions of bots and fraudulent accounts it hosts. While Facebook makes it hard to set up a



Australia 2019: a koala amongst the flames. Photo credit: Creative commons

fake user account, Twitter has facilitated the existence of thousands (if not millions) of automated or astroturfed accounts — which in this case, deviously create the illusion of widespread support for the idea that anthropogenic climate change is either a lie or bad science.

In an age where social media has become the primary medium for news and information, it's no surprise that climate denialism has relocated to Twitter, Facebook and YouTube. In a study published in November 2018, researchers at Brown University found that bots were generating 20 percent of all posts on Twitter related to climate change. They examined a sample of 144,000 accounts discussing climate change on the platform, finding that about 23,000 of these were bots, and while this is already a high number, it's likely that bot activity has increased in more recent months, as a kind of reactionary counterattack against the growing momentum behind climate activism.

On the one hand, this has been the impression of climate scientists and activists operating on Twitter. Replying to a tweet of a user who'd complained about climate deniers "crawling out from everywhere today," renowned climatologist Michael E. Mann wrote in August that, "A lot of them are bots and paid trolls. It's the preferred method of warfare by the climate change denial/delay machine." Similarly, one active Twitter climate campaigner advised his followers to "be on the lookout for these new, low-follower accounts. There's been a BIG uptick in them in mid-2019."

It would of course be rash to place too much faith in these subjective impressions of increased activity, but there have also been more objective measures of surges, which tend to arise whenever the issue of climate change gains more airtime and acceptance. In early September, "climate change" became the most popular term being used by the 100,000 accounts tracked by Bot Sentinel, a tool which monitors suspect and automated Twitter users. It rose in visibility after CNN's Climate Crisis Town Hall on September 4, appearing in 700 separate mentions within the following 24-hour period.

It's hard to determine just who or what exactly is responsible for such spikes in activity. However, in speaking with Inside-Climate News (which originally broke the story above), climate scientist Mann suggested that the usual suspects are likely pulling the strings of the new legions of climate-denying bots, just as they were with the lobby groups and think tanks of yore. "I believe this is a concerted effort, likely by bad state actors and fossil fuel interests, to create disinformation, discord and division as we approach the all-important UN Summit and children's youth event later this month," he said.

Energy companies have in the recent past harnessed bots

and fake accounts to manufacture the veneer of public acceptance of their industry.

Mann provided no evidence for these specific claims, but there is at least an indication that energy companies have in the recent past harnessed bots and fake accounts to manufacture the veneer of public acceptance of their industry. In 2016, DeSmogBlog published an investigative report that concluded that the Midwest Alliance for Infrastructure Now (MAIN) had created at least 16 suspicious Twitter accounts to propagate a pro-Dakota Access Pipeline message. MAIN's members include, among others, the North Dakota Petroleum Council, Petroleum Marketers, and the South Dakota Petroleum and Propane Marketers Association, the latter of which currently counts ExxonMobil as an "energy associate."

The fact that such organizations likely involved themselves in manipulating online political discourse in the case of the Dakota Access Pipeline implies that similar groups may very well be involved in the current wave of online climate denialism. Because without any massively public leak and backlash, why stop with only one episode?

Undermining Rather Than Denying

But it isn't only the migration to social media and the simulation of public backing that characterizes modern climate denialism. Its other defining feature is that, rather than directly rejecting the thesis of human-made climate change, contemporary climate denialism has been increasingly fashioning indirect and tangential ways of undermining calls for significant action on renewables and carbon reduction. Often, these new "indirect" methods amount to little more than nitpicking with how the issue of climate change is being described or presented, or at best, calling into question the political motives of those advocating for action and reform.

As an example, both of these tendencies were on display in an article published by National Review on September 6, only two days after CNN's Climate Crisis Town Hall television special. Written by Jonah Goldberg of the American Enterprise Institute, it set its sights on disputing whether climate change really constitutes an existential threat, rather than merely a threat to our quality of life, while also criticizing certain Democrats for referring to it as an existential crisis. At the same time, it proffered the argument that Democrats (and likely other climate activists) don't really care about the issue, and instead "want to use it as an excuse to radically transform the American economy and political system along lines that have less to do with climate change and much to do with their ideological animosity to the status quo."

Data from Google Trends reveal that search phrases such as "global warming hoax" and "climate change hoax" aren't as

The anti-green lobby has adopted an even more novel, albeit occasionally more absurd, method. This additional tactic entails the argument that rising global temperatures won't actually be as bad as our best science indicates they'll be.

popular as they were a couple of years ago. It's interesting to raise the specter of funding here. According to SourceWatch and the investigative news site Sludge, National Review has received numerous donations over the past few years from the Charles Koch Foundation and the Lynde and Harry Bradley Foundation, both of which are highly active in supporting climate change skepticism. At the same time, it's worth noting that the American Enterprise Institute — of which author Goldberg holds the "Asness Chair in Applied Liberty" — has also been funded by the Lynde and Harry Bradley Foundation, with leaked documents revealing that the Institute received nearly \$2.5 million from the Foundation between 2011 and 2015 alone.

In other words, Goldberg's National Review article has the full weight of the fossil fuel lobby behind it, as do similar articles on climate change published in The American Spectator and The Daily Caller, to name two others. Yet aside from the weaponizing of pedantry and the practice of attacking the political motives of reformers, the anti-green lobby has also adopted an even more novel, albeit occasionally more absurd, method.

As witnessed by a ludicrous article published last year by Spiked, this additional tactic entails the argument that rising global temperatures won't actually be as bad as our best science indicates they'll be. In this article, author Rob Lyons responds to a recent paper published in PLOS One in which it's calculated that, in 2050, London's climate will be comparable to that of Barcelona today. "Given that most Brits spend all year saving up to have a week or two in the sun on the beaches in places like Barcelona," Lyons opines, "this is hardly the end of the world. In fact, it sounds great. It is a change that we will have to adapt to, of course, but it is surely something that we can cope with."

Once again, it's worth pointing out that Spiked has been funded by the Charles Koch Foundation. Likewise, other articles running with the "it-won't-be-so-bad" theme have also been published in such places as National Affairs and Reason, which have also received significant financial support from the Lynde and Harry Bradley Foundation, in the case of National Affairs, as well as the Koch Foundation and the Scaife Foundation, in the case of Reason.

Put simply, despite the fact that the fossil fuel lobby has withdrawn from the increasingly difficult challenge of claiming that climate change isn't anthropogenic, it's nevertheless as active and as insidious as it has ever been. Its tactics have changed to become more duplicitous, more indirect, more

tendentiously pedantic and more ad hominem (witness the regular personal attacks on climate activist Thunberg and Rep. Alexandria Ocasio-Cortez), and it's this change in approach that has enabled it to ramp up its denialism in recent months and years.

Declining Popularity

The question is, are the new methods of the denialism lobby effective? This is a tricky question to answer, because while the global political momentum appears to be moving in favor of those who want action on climate change, the keys to the White House — and to the Environmental Protection Agency — belong to people who either don't believe in anthropogenic climate disruption, or who simply want to find excuses not to act.

Still, in terms of shaping public opinion, it would appear that the new denialism hasn't been particularly successful. Data from Google Trends, for instance, reveal that search phrases such as "global warming hoax" and "climate change hoax" aren't as popular as they were a couple of years ago.

In 2017, the average popularity of "global warming hoax" as a search phrase in the U.S. was 26.9 (100 represents the peak popularity for a term). In 2019, the average for the same phrase was only 12.5, indicating that fewer people are now searching for evidence of a hoax than they were two years ago (in 2015, the average was 28.9, while in 2016 it was 27.7). Similarly, the average popularity of "climate change hoax" was 13.8 in 2017, while in 2019 its average was 12.9. This would indicate that fewer people today suspect or believe that climate change is fake.

This doesn't look good for the fossil fuel lobby. It would seem that rather than saving money in preparation for its industry's eventual eclipse, it's wasting millions (or billions) of dollars on surreptitious campaigns that aren't really providing polluters with much bang for their buck. It's likely that with the continuous accumulation of additional evidence of human-made climate change, and with the rising tide of political support for action on the issue, their attempts to covertly sway the public will only become more futile. Of course, as the long history of denialism shows, this won't stop them from trying to invent new ways of dissuading us from taking action to improve our future.

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Mexico City is proposing to build one of the world's largest urban parks. Will it serve as a climate adaptation example for other cities?

PAUL BIASCO

Ensia.com

An architect and officials are hoping that a huge park in Mexico City can restore the water systems of the region and serve as a model for others around the world

Walking along the edge of a seasonally dry lakebed on the eastern outskirts of Mexico City, there is near perfect silence except for the occasional airplane that flies overhead. These planes flying out of a nearby airport are a reminder of the estimated US\$13 billion international airport that had been planned and partially constructed on top of the seasonal wetlands native to this place.

Then, in 2018, Mexico's new president, Andrés Manuel López Obrador, canceled the project and moved forward with plans to construct what would be one of the world's largest urban parks instead. Experts from around the world hope the project, if successful, will serve as an example to other cities of what is possible in the fight against climate change.

Turning Back the Clock

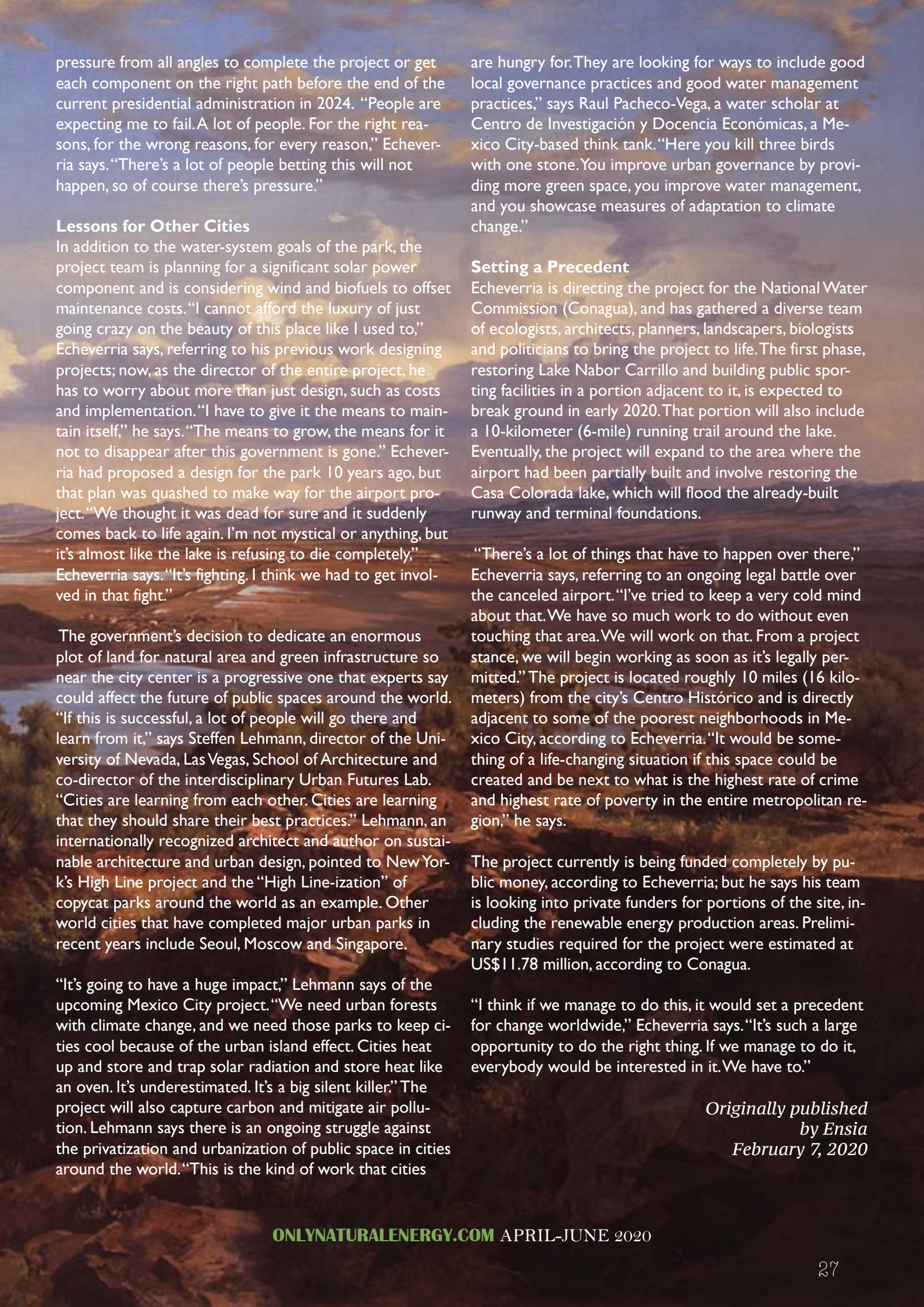
The size of the proposed park is nearly unfathomable from ground level, covering 12,300 hectares (30,394 acres) and stretching 16 kilometers (10 miles) from end to end. That's about the size of 36 New York Central Parks or more than twice the size of Manhattan.

The government and the architect behind the park, known as Parque Ecológico Lago de Texcoco, see great potential in the park — particularly in the face of mounting water shortages, floods and climate change. They view this mega project as one that could turn back the clock on disruptions to the region's water systems dating back to Hernán Cortés and the Spanish siege of Tenochtitlan in 1521. The region's lakes were the primary source of freshwater during Aztec times, but the Spanish drained the valley's lakes after they took over the city of Tenochtitlan. This forced an independent Mexico centuries later to construct hundreds of miles of pipes to

bring in roughly 30% of the city's water and to pump the rest from an underground aquifer. The city is now pumping water out of that aquifer twice as fast as water is returning via rainfall. On the other side of the equation, the city, which has been largely paved over, floods for months during the rainy season. "The problem is we cannot turn 500 years of history and go 180 degrees overnight," says Mexico City architect Iñaki Echeverría, executive director of the park project. "Very few times you are offered the possibility that can have an impact that can really change things. If we manage to do this, it changes the direction of the history of the city and the valley."

The project is designed to be constructed in the basin of the former Lake Texcoco, which dried as Mexico City expanded into a megacity of more than 20 million people over the past two millennia. The area has not been inhabited and has been off-limits to the public due to annual flooding and infrastructure issues. Echeverría is seeking to restore the vast majority of the area to its former state, including rejuvenating numerous lakes that were drained, as well as wetland areas. One of the goals of the project is to merge the concepts of public spaces and green infrastructure, providing hiking trails, sports courts and lakes for recreation, while bringing back the lakes to rebalance the Valley of Mexico's water system. That includes routing stormwater runoff into the wetlands and replenishing aquifers.

"This is really the only space that's left [in the city] and it's federal land and it's untapped," Echeverría says. "It was going to disappear. Right now there's a possibility to keep it, so we are really working hard to make this happen as soon as possible, to bring people here to understand that this is not a fantasy. This is something that can happen." The government hopes to open up the first section of the park project by 2021, according to Echeverría. The architect, who grew up in Mexico City, says he is feeling the



pressure from all angles to complete the project or get each component on the right path before the end of the current presidential administration in 2024. “People are expecting me to fail. A lot of people. For the right reasons, for the wrong reasons, for every reason,” Echeverria says. “There’s a lot of people betting this will not happen, so of course there’s pressure.”

Lessons for Other Cities

In addition to the water-system goals of the park, the project team is planning for a significant solar power component and is considering wind and biofuels to offset maintenance costs. “I cannot afford the luxury of just going crazy on the beauty of this place like I used to,” Echeverria says, referring to his previous work designing projects; now, as the director of the entire project, he has to worry about more than just design, such as costs and implementation. “I have to give it the means to maintain itself,” he says. “The means to grow, the means for it not to disappear after this government is gone.” Echeverria had proposed a design for the park 10 years ago, but that plan was quashed to make way for the airport project. “We thought it was dead for sure and it suddenly comes back to life again. I’m not mystical or anything, but it’s almost like the lake is refusing to die completely,” Echeverria says. “It’s fighting. I think we had to get involved in that fight.”

The government’s decision to dedicate an enormous plot of land for natural area and green infrastructure so near the city center is a progressive one that experts say could affect the future of public spaces around the world. “If this is successful, a lot of people will go there and learn from it,” says Steffen Lehmann, director of the University of Nevada, Las Vegas, School of Architecture and co-director of the interdisciplinary Urban Futures Lab. “Cities are learning from each other. Cities are learning that they should share their best practices.” Lehmann, an internationally recognized architect and author on sustainable architecture and urban design, pointed to New York’s High Line project and the “High Line-ization” of copycat parks around the world as an example. Other world cities that have completed major urban parks in recent years include Seoul, Moscow and Singapore.

“It’s going to have a huge impact,” Lehmann says of the upcoming Mexico City project. “We need urban forests with climate change, and we need those parks to keep cities cool because of the urban island effect. Cities heat up and store and trap solar radiation and store heat like an oven. It’s underestimated. It’s a big silent killer.” The project will also capture carbon and mitigate air pollution. Lehmann says there is an ongoing struggle against the privatization and urbanization of public space in cities around the world. “This is the kind of work that cities

are hungry for. They are looking for ways to include good local governance practices and good water management practices,” says Raul Pacheco-Vega, a water scholar at Centro de Investigación y Docencia Económicas, a Mexico City-based think tank. “Here you kill three birds with one stone. You improve urban governance by providing more green space, you improve water management, and you showcase measures of adaptation to climate change.”

Setting a Precedent

Echeverria is directing the project for the National Water Commission (Conagua), and has gathered a diverse team of ecologists, architects, planners, landscapers, biologists and politicians to bring the project to life. The first phase, restoring Lake Nabor Carrillo and building public sporting facilities in a portion adjacent to it, is expected to break ground in early 2020. That portion will also include a 10-kilometer (6-mile) running trail around the lake. Eventually, the project will expand to the area where the airport had been partially built and involve restoring the Casa Colorada lake, which will flood the already-built runway and terminal foundations.

“There’s a lot of things that have to happen over there,” Echeverria says, referring to an ongoing legal battle over the canceled airport. “I’ve tried to keep a very cold mind about that. We have so much work to do without even touching that area. We will work on that. From a project stance, we will begin working as soon as it’s legally permitted.” The project is located roughly 10 miles (16 kilometers) from the city’s Centro Histórico and is directly adjacent to some of the poorest neighborhoods in Mexico City, according to Echeverria. “It would be something of a life-changing situation if this space could be created and be next to what is the highest rate of crime and highest rate of poverty in the entire metropolitan region,” he says.

The project currently is being funded completely by public money, according to Echeverria; but he says his team is looking into private funders for portions of the site, including the renewable energy production areas. Preliminary studies required for the project were estimated at US\$11.78 million, according to Conagua.

“I think if we manage to do this, it would set a precedent for change worldwide,” Echeverria says. “It’s such a large opportunity to do the right thing. If we manage to do it, everybody would be interested in it. We have to.”

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Green ammonia could slash emissions from farming – and power ships of the future

BILL DAVID
The Conversation

For the past 100 years, a simple molecule has had an immensely positive impact on our world. Ammonia, which comprises three hydrogen atoms bonded to a single nitrogen atom, is widely used to make the fertilisers enable us to produce enough food for everyone on the planet. That makes it pretty much the most important molecule after water.

However, ammonia manufacturing is the world's third biggest industrial process emitter of carbon dioxide, creating half a billion tonnes of CO₂ each year – 1.8% of global CO₂ emissions.

My colleagues and I have just produced a report for the Royal Society that shows producing zero-carbon green ammonia could cut global carbon emissions by almost 2%. What's more, it could also store nation-scale amounts of renewable energy and power ships, trains and heavy-duty vehicles.

Ammonia is commonly produced by reacting methane with steam to produce hydrogen, and then reacting this with nitrogen from the air using what is known as the Haber-Bosch process. But the steam methane reforming also gives off carbon dioxide. In contrast, green ammonia is produced with hydrogen that has been separated from water using renewable electricity.

It's also possible to break ammonia back down into hydrogen and nitrogen, giving off energy in the process.

And it can be burned like fossil fuels such as diesel. This means ammonia can also be used as an energy store. The Rutherford Appleton Laboratory in Oxfordshire, UK, has a unique green ammonia demonstration system. It is powered by an on-site wind turbine and capable of producing up to 30kg of green ammonia a day. It can also feed green electricity back into the grid as required.

The challenge in making green ammonia production a viable alternative is bringing down the cost, of which 85% is electricity. In most parts of the world, renewable energy is still significantly more expensive than the methane used in conventional ammonia manufacturing.

However, the cost of electricity in areas with abundant renewable potential has decreased dramatically over the past decade, to around 1.7-3.4 GBP pence per kWh. This means you can produce green ammonia for around £220 per tonne.

This still isn't as cheap as the conventional process. But to keep using this method while reducing our emissions to net zero we would have to combine carbon capture and storage so the resulting CO₂ wouldn't enter the atmosphere. And that's when green ammonia can become cost competitive.

Zero-carbon fuel

Green ammonia also has the potential to address one of the biggest unsolved challenges in the race for net zero



Siemens Green Ammonia Demonstrator at the Rutherford Appleton Laboratory (Oxford, United Kingdom). Photo credit: Siemens

emissions: how do we create flexible zero-carbon fuel reserves that last for years in the way current fossil fuels do?

Ammonia is easily stored in large quantities as a liquid at modest pressures (between 10 and 15 times that of our atmosphere) or refrigerated to -33°C . In this form, the energy density is around half that of petrol and over ten times that of batteries.

What ammonia has over other potential fuel alternatives is that we already have a global manufacturing and distribution system in place because of its widespread use as a feedstock for fertilisers. There is also a comprehensive network of ports that handle ammonia at large scale so it could become a fuel for long-distance shipping with relative ease.

In fact, the international shipping industry has already proven the feasibility of using ammonia as a fuel in their largest ocean-going container ships. MAN Energy Solutions, a designer and manufacturer of marine engines, has announced that the first ammonia engine could be in operation by early 2022. This would also open up oppor-

tunities for green fuels for trains, heavy-duty freight and perhaps even zero-carbon aviation. Ammonia does present other challenges. The use of ammonia-based fertilisers contributes to global declines in biodiversity, widespread air quality problems and greenhouse gas emissions. New uses of ammonia must include effective measures to prevent any additional emissions.

Stringent controls that are already present at all current ammonia storage and relevant industrial sites, must be in place to ensure that the risks of ammonia release and the resulting formation of harmful nitrogen oxides (NO_x) are negligible.

What we need to do now is to research and demonstrate the potential of ammonia, from improving wind and solar power through optimising green ammonia production and storage. And we need to develop a comprehensive portfolio of ways of turning ammonia back into power when and where we need it.

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Analysis: Coronavirus has temporarily reduced China's CO₂ emissions by a quarter

As China battles one of the most serious virus epidemics of the century, the impacts on the country's energy demand and emissions are only beginning to be felt.

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[This article was updated on 4 March 2020 to include new data.]

Electricity demand and industrial output remain far below their usual levels across a range of indicators, many of which are at their lowest two-week average in several years. These include:

- Coal consumption at power plants was down 36%
- Operating rates for main steel products were down by more than 15%, while crude steel production was almost unchanged
- Coal throughput at the largest coal port fell 29%
- Coking plant utilization fell 23%
- Satellite-based NO₂ levels were 37% lower
- Utilization of oil refining capacity was lowered by 34%
- At their peak, flight cancellations were reducing global passenger aviation volumes by 10%, but the sector appears to be recovering, with global capacity down 5% on year in February as a whole.

All told, the measures to contain coronavirus have resulted in reductions of 15% to 40% in output across key industrial sectors.

This is likely to have wiped out a quarter or more of the country's CO₂ emissions over the past four weeks, the period when activity would normally have resumed after the Chinese new-year holiday.

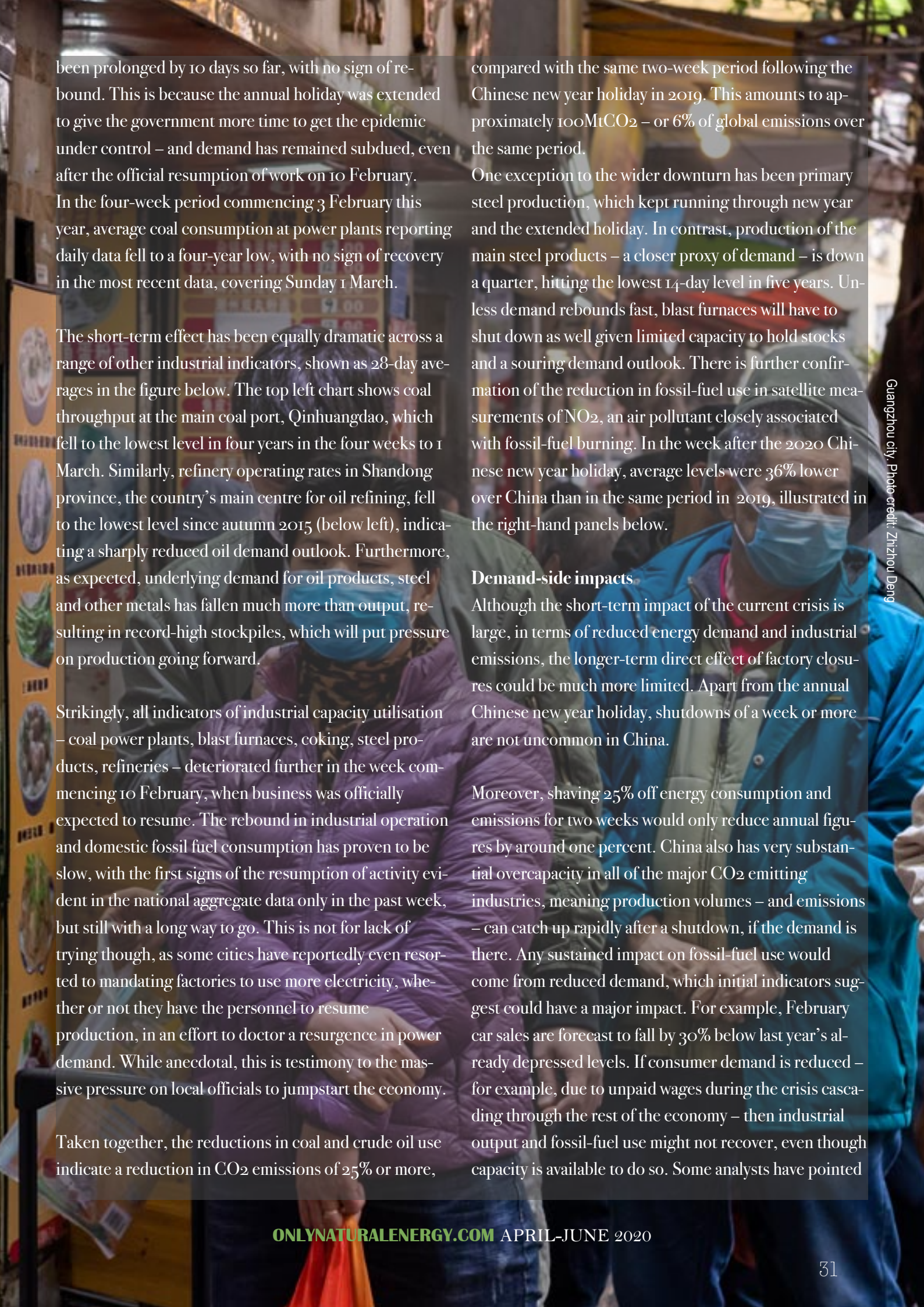
Over the same period in 2019, China released around 800m tonnes of CO₂ (MtCO₂), meaning the virus could have cut global emissions by 200MtCO₂ to date. The key question is whether the impacts are sustained, or if they will be offset – or even reversed – by the government response to the crisis. Initial analysis from the International Energy Agency (IEA) and Organization of the Petroleum Exporting Countries (OPEC) suggests the repercussions of the outbreak could shave up to half a percent off global oil demand in January–September this year.

However, the Chinese government's coming stimulus measures in response to the disruption could outweigh these shorter-term impacts on energy and emissions, as it did after the global financial crisis and the 2015 domestic economic downturn.

A country in shutdown

Every winter, during Chinese new year, the country closes down for a week, with shops and construction sites closing and most industries winding down operations. The holiday has a significant short-term impact on energy demand, industrial output and emissions. The blue lines on the chart below show how coal-fired power generation typically drops by an average of 50% in the 10 days following the eve of Chinese new year, marked as zero on the x-axis.

This year, shown in red, the usual fall in energy use has



been prolonged by 10 days so far, with no sign of rebound. This is because the annual holiday was extended to give the government more time to get the epidemic under control – and demand has remained subdued, even after the official resumption of work on 10 February. In the four-week period commencing 3 February this year, average coal consumption at power plants reporting daily data fell to a four-year low, with no sign of recovery in the most recent data, covering Sunday 1 March.

The short-term effect has been equally dramatic across a range of other industrial indicators, shown as 28-day averages in the figure below. The top left chart shows coal throughput at the main coal port, Qinhuangdao, which fell to the lowest level in four years in the four weeks to 1 March. Similarly, refinery operating rates in Shandong province, the country's main centre for oil refining, fell to the lowest level since autumn 2015 (below left), indicating a sharply reduced oil demand outlook. Furthermore, as expected, underlying demand for oil products, steel and other metals has fallen much more than output, resulting in record-high stockpiles, which will put pressure on production going forward.

Strikingly, all indicators of industrial capacity utilisation – coal power plants, blast furnaces, coking, steel products, refineries – deteriorated further in the week commencing 10 February, when business was officially expected to resume. The rebound in industrial operation and domestic fossil fuel consumption has proven to be slow, with the first signs of the resumption of activity evident in the national aggregate data only in the past week, but still with a long way to go. This is not for lack of trying though, as some cities have reportedly even resorted to mandating factories to use more electricity, whether or not they have the personnel to resume production, in an effort to doctor a resurgence in power demand. While anecdotal, this is testimony to the massive pressure on local officials to jumpstart the economy.

Taken together, the reductions in coal and crude oil use indicate a reduction in CO₂ emissions of 25% or more,

compared with the same two-week period following the Chinese new year holiday in 2019. This amounts to approximately 100MtCO₂ – or 6% of global emissions over the same period.

One exception to the wider downturn has been primary steel production, which kept running through new year and the extended holiday. In contrast, production of the main steel products – a closer proxy of demand – is down a quarter, hitting the lowest 14-day level in five years. Unless demand rebounds fast, blast furnaces will have to shut down as well given limited capacity to hold stocks and a souring demand outlook. There is further confirmation of the reduction in fossil-fuel use in satellite measurements of NO₂, an air pollutant closely associated with fossil-fuel burning. In the week after the 2020 Chinese new year holiday, average levels were 36% lower over China than in the same period in 2019, illustrated in the right-hand panels below.

Demand-side impacts

Although the short-term impact of the current crisis is large, in terms of reduced energy demand and industrial emissions, the longer-term direct effect of factory closures could be much more limited. Apart from the annual Chinese new year holiday, shutdowns of a week or more are not uncommon in China.

Moreover, shaving 25% off energy consumption and emissions for two weeks would only reduce annual figures by around one percent. China also has very substantial overcapacity in all of the major CO₂ emitting industries, meaning production volumes – and emissions – can catch up rapidly after a shutdown, if the demand is there. Any sustained impact on fossil-fuel use would come from reduced demand, which initial indicators suggest could have a major impact. For example, February car sales are forecast to fall by 30% below last year's already depressed levels. If consumer demand is reduced – for example, due to unpaid wages during the crisis cascading through the rest of the economy – then industrial output and fossil-fuel use might not recover, even though capacity is available to do so. Some analysts have pointed

to images of empty cities and cellphone factories as evidence for such an effect, although this might give an exaggerated idea of the impact. China's energy consumption is heavily dominated by energy-intensive industries and freight, with residential and commercial electricity consumption, private cars and so on playing a relatively minor role.

This is illustrated by the fact that Beijing experienced its second severe smog episode of the year last week, leaving many wondering where the pollution was coming from when most cars were off the road and most businesses were shut. As already noted above, steel blast furnaces in particular kept running throughout the extended holiday, while most power plants only shut a part of their boilers, at most. Instead, the single most important question on the demand side is the effect of the coronavirus outbreak on construction activity. The sector relies on migrant workers who might still be affected by restrictions on movement, enforced home quarantine and other measures for days or weeks, so resumption of operations is not straightforward.

The key factor determining the size of this impact is how fast things return to normal. Currently, Beijing is urging local governments to focus on getting the economy back on its feet. Chairman Xi himself has reportedly said that the coronavirus response outside the epicentre of the outbreak in Hubei province has gone too far, warning of damage to the economy and cautioning against more restrictive measures.

However, local governments continue to maintain and even tighten controls on movement and are encouraging businesses to stay shut. This suggests they are more wor-

ried about getting blamed for a new outbreak than about keeping the economy on ice for a few extra days or weeks. Beyond the disruptions caused by the measures to combat the virus on construction sites, apartment sales are certain to be affected for weeks, if not months, due to restrictions on movement. Lowered income is likely to prompt builders to slow down and refrain from starting new projects. If financial distress results in disruption to operations, the effect could be more profound and sustained.

The impacts on downstream demand have become even clearer, with real estate sales value forecast to fall as

much as 50% on the first quarter. The potential for wider financial disruption is clear as firms, local governments – and increasingly households – have high levels of debt. Lack of cashflow during the extended shutdown is likely to make some debt unserviceable, with the country's leading financial media

Caixin calling the virus “an existential threat” to small businesses. The issue is compounded by the widespread practice of firms taking on very short-term debt to finance long-term spending.

The measures taken by China and other countries to contain the virus are also having a dramatic impact on aviation volumes. The industry data provider OAG reports reductions of 50-90% in capacity on routes departing mainland China and a 60-70% reduction in domestic flights within the mainland over the past two weeks, compared with the week commencing 20 January.

Based on ICCT estimates (pdf), these flights were responsible for 17% of total CO₂ emissions from passenger aviation in 2018, implying that the on-going flight suspensions and cancellations have cut global CO₂ emis-

China's energy consumption is heavily dominated by energy-intensive industries and freight, with residential and commercial electricity consumption, private cars and so on playing a relatively minor role.

sions from passenger flights by around 11% (3Mt) in the past two weeks. (This is calculated by taking into account that flights arriving in China emit the same amount of CO₂ as flights departing from China, and have to be reduced in equal amount.)

Government response

The leadership in Beijing appears keenly aware of the financial risks. It has been calling on banks to roll over loans and local governments to cut rents and other costs for firms, as well as on brokerages to hold or buy stocks to keep share prices from tanking. Beyond the immediate interventions to avoid financial disruption, a forceful economic policy response is shaping up.

The background to this is that 2020 was to be the showcase year for China's economic accomplishments, marking the achievement of the goal of "building a moderately prosperous society", set a decade ago. Significantly lower GDP growth rates for the year would hardly fit the script.

The basic formula of Chinese economic policymaking is to take the projected growth in private consumption and net exports, and subtract them from the GDP growth target. The residual is the amount of debt-driven investment spending that is needed to hit the target.

Of these three GDP components, investment is by far the most CO₂-intensive, due to the energy used to make steel, cement, non-ferrous metals, glass and other basic construction materials. If the central government were to make up for a worse outlook on consumption and exports, then it could result in an increase in CO₂ emissions overall. There are already signs this could happen, with the Politburo calling recently for "active" stimulus, including speeding up large construction projects and increasing both bank lending and government spending.

The expectations of major stimulus spending are building up, with provinces reportedly preparing "wish lists" of projects to spend on, in preparation for a flood of money being available for such projects. A return to debt-fuelled stimulus spending runs counter to the go-

vernment's aim of rebalancing the economy towards consumption. Relaxing the GDP growth target for the year would give more space to reconcile the different objectives, but Xi has signalled that the country should stick to its targets "as of now".

The GDP growth target for 2020 will be officially set in the annual session of the National People's Congress, which normally takes place at the start of March, but appears likely to be delayed due to the virus outbreak. Another major uncertainty is that the initial statements about stimulus gave no indication of which sectors or what type of expenditure should be targeted. Targeting clean energy and energy efficiency investments would be a natural way to reconcile the perceived need to prop up economic growth with state-engineered spending and China's stated ambition to be a contributor to the fight against climate change.

The clean-energy sector is currently running well below capacity as investment in non-fossil energy sources and in electric vehicles slowed in 2019. Analysis of data from the China Electricity Council shows newly installed wind power capacity fell 4%, solar power capacity by 53%, hydropower by 53% and nuclear by 31% in the first 11 months of the year, while newly added thermal power capacity increased by 13%. After booming in the first half of the 2019, electric vehicle sales fell 32% year on year in the period from July to November.

Methodology

The estimated CO₂ reduction is based on fossil-fuel consumption data by sector and fuel for February 2019, and estimating year-on-year changes using sector activity indicators: daily coal consumption at power plants; coking plant; blast furnace and steel plant operating rates; and oil refinery operating rates. Residential fuel use is assumed to be unaffected. The estimate aligns with satellite-based NO₂ levels, which point to the possibility of an even larger reduction.

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Photo credit: نيمأ

NABLUS

Amman Street in the city of Nablus on March 25, 2020, is empty of people, in implementation of the mandatory quarantine decision due to the Corona virus pandemic in Palestine 2020.

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