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The Private-Public Nexus and Renewable Energy: United States, Germany, and China

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INTRODUCTION

From wood for campfires to uranium for nuclear power plants, humanity has struggled for thousands of years to harness energy to fuel its productivity. Where once we were capable of producing only enough energy to cook our food, humans are now capable of producing the energy needed to fuel complex machines like super computers or spacecraft. However, each new energy source poses new problems, oftentimes damaging the very environment where the energy source is created and used. Greenhouse gases that slowly increase the overall temperature of our planet are just the latest social cost imposed by dominant sources of energy.

The United Nations[1] and the National Aeronautics and Space Administration[2] report that there is a greater than 95% probability that human activity is responsible for warming Earth over the past 50 years. According to the most recent report of the Intergovernmental Panel on Climate Change (IPCC), we need to reduce emissions by 7.6% every year from 2020 to 2030 to avoid catastrophic damage.[3]

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1. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 4 (Rajendra K. Pachauri & Leo Meyer eds., 2015), https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf [https://perma.cc/WT8T-U9W7]. The qualifier "*extremely likely*" when used in this report is defined as a confidence level of 95-100%. *Id.* at 2 n.1.

2. *The Causes of Climate Change*, NASA, https://climate.nasa.gov/causes/ [https://perma.cc/VT92-Z8UF] (last visited Apr. 1, 2021).

3. *Climate Action: Key Findings*, UNITED NATIONS, https://www.un.org/en/climatechange/science/key-findings [https://perma.cc/ 59ZB-GS9Y] (last visited May 26, 2021); s*ee also* Masson-Delmotte et al., *Summary for Policymakers*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5°C: AN IPCC SPECIAL REPORT ON THE IMPACTS OF GLOBAL WARMING OF 1.5°C ABOVE PRE-INDUSTRIAL LEVELS AND RELATED GLOBAL GREENHOUSE GAS EMISSION PATHWAYS, IN THE CONTEXT OF STRENGTHENING THE GLOBAL RESPONSE TO THE THREAT OF CLIMATE CHANGE, SUSTAINABLE DEVELOPMENT, AND EFFORTS TO ERADICATE POVERTY (2018), https://www.ipcc.ch/

One especially promising focus for tackling this problem is solar energy. According to the U.S. Energy Information Administration, in the years 2014, 2015, and 2016, more than half of all additions to energy production methods in the United States were renewable energy technologies like wind turbines or solar power plants.[4] A study conducted by the National Renewable Energy Laboratory found that methods of renewable energy production using technology available today, if used in combination with a more flexible energy grid, are more than adequate to supply the U.S. with 80% of its expected electricity needs in the year 2050.[5] Are the United States and other countries making equivalent efforts to increase their renewable energy sectors? What is the role of legislation and governmental regulation in fueling the growth of renewable energy?

This Article focuses on solar energy, although developments in renewable energy sources (RES) often move in tandem as countries develop the political will to address the threat of climate change. Scientists try to alert us of the importance of moving quickly to greater reliance on solar energy and less on fossil fuels. According to the most recent report of the IPCC, we need to effectively halve our use of fossil fuels by 2030 to avoid catastrophic damage.[6]

But reacting to those warnings is not simply an engineering problem. As important as the cost-saving technologies associated with various RES are, the coordinated, collective policies necessary to make the shift away from fossil fuels await the political will to make the initial development expenditures and to pay the substantial psychological and political costs necessitated by the shift of resources. This Article examines the strategies

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site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf [https://perma.cc/F56N-TKBP].

4. Cara Marcy, *Renewable Generation Capacity Expected to Account for Most 2016 Capacity Additions*, U.S. ENERGY INFO. ADMIN. (Jan. 10, 2017), https://www.eia.gov/todayinenergy/detail.php?id=29492 [https://perma.cc/H8CB-HRYZ].

5. TRIEU MAI ET AL., NAT'L RENEWABLE ENERGY LAB., RENEWABLE ELECTRICITY FUTURES STUDY: EXECUTIVE SUMMARY, at iii (2012), https://www.nrel.gov/docs/fy13osti/52409-ES.pdf [https://perma.cc/JVR4-NSJY].

6. Johnathon Watts, *We Have 12 Years to Limit Climate Change Catastrophe, Warns UN*, GUARDIAN (Oct. 8, 2019) https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report [https://perma.cc/46XH-RFPG] (In this latest report, scientists warned that drastic changes were necessary to limit the temperature increase to 1.5°C. Failure to do so would lead to an increase in drought, floods, and extreme heat and poverty for millions of people. To meet this goal, carbon pollution would need to be cut by 45% by 2030.).

and adaptability pace reflected in the move to RES in the United States, Germany, and especially China.

I. THE PRIMACY OF SOLAR AMONG ALTERNATIVE RENEWABLE ENERGY SOURCES

In 2016, solar technology was the fastest growing source of new energy.[7] The International Energy Agency estimates that from 2017–2022, solar will have the largest annual capacity additions among all renewable energy sources, well above wind and hydro,[8] thereby making it a logical renewable on which to focus. But perhaps an even more important reason to focus on solar comes from a four-and-a-half-year study by researchers at the Lappeenranta-Lahti University of Technology as to how to best meet the goals of the Paris Climate Accord.[9] The conclusion of their research is that we need to function as much as possible on electricity generated by renewables, primarily solar.[10]

There are also practical reasons to focus on solar over wind. One difference is noise. Solar is silent, while wind turbines generate noise along with power, which may lead to people objecting to the installation of wind farms. Solar panels require much less maintenance than wind turbines. While you need to make sure your panels face the sun, it is much more difficult to find a place to install wind turbines.

Solar panels can pretty much be placed anywhere, from the ground to the tops of buildings, whereas wind turbines need to be at least 30 feet above anything within 500 feet, constraining their use in urban areas. Solar is much more predictable because there are so many more variables that

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7. Adam Vaughan, *Time to Shine: Solar Power is the Fastest Growing Source of New Energy*, GUARDIAN (Oct. 4, 2017), https://www.theguardian.com/environment/2017/oct/04/solar-power-renewables-international-energy-agency [https://perma.cc/594E-7MF6].

8. *Renewables 2017: Analysis and Forecasts to 2022*, INT'L ENERGY AGENCY (Oct. 2017), https://www.iea.org/reports/renewables-2017 [https://perma.cc/MX 8J-V5G5].

9. MANISH RAM ET AL., GLOBAL ENERGY SYSTEM BASED ON 100% RENEWABLE ENERGY: POWER, HEAT, TRANSPORT AND DESALINATION SECTORS (2019), http://energy watchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf [https://perma.cc/J2D4-J66U].

10. Steve Hanley, *Want to Limit Global Warming? Electrify Everything, Finds Study*, CLEANTECHNICA (Apr. 16, 2019), https://cleantechnica.com/2019/04/16/want-to-limit-global-warming-electrify-everything-finds-study/ [https://perma.cc/JD78-CQMA].

go into predicting what the average wind speed will be in a given location.[11]

II. RENEWABLE ENERGY IN THE UNITED STATES

According to the U.S. Energy Information Administration, in the years 2014, 2015, and 2016, more than half of all additions to energy production methods in the United States were renewable energy technologies like wind turbines or solar power plants.[12] The U.S. Department of Energy expects to see this trend continue once data is collected for the years 2017–2019.

Given that the U.S. has developed more methods of using renewable energy sources to produce energy and electricity than methods of using nonrenewable sources of energy like coal, oil, or natural gas, for the past four years, it is fair to say that the U.S. is slowly phasing out the nonrenewable energy market.

Additionally, a study conducted by the National Renewable Energy Laboratory found that methods of renewable energy production using technology currently available today are more than adequate to supply the U.S. with 80% of the electricity needed in the U.S. in the year 2050.[13] That kind of data tends to stall interest in RES because it pushes the threat beyond the lifespan of most voting Americans. Because the up-front research and development expenditures are so extensive, hopeful data, albeit based on questionable assumptions about future energy use, can weaken the fervor for increasing RES.

A. Typical Arguments Determining the Scope of Solar Energy in the United States

The question of whether to develop solar energy in the U.S. has been one of intense debate with several arguments either for or against the idea. One of the most-used arguments against solar energy is its large up-front costs.[14] Installing a photovoltaic (PV) solar panel, especially in a domestic

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11. *Wind vs. Solar*, SIMPLERAY, https://www.simpleray.com/resources-and-informations/wind-vs-solar [https://perma.cc/UXJ5-4EM6] (last visited Jan. 28, 2021).

12. Marcy, *supra* note 4.

13. MAI ET AL., *supra* note 5, at iii.

14. R. MARGOLIS & J. ZUBOY, NAT'L RENEWABLE ENERGY LAB., NONTECHNICAL BARRIERS TO SOLAR ENERGY USE: REVIEW OF RECENT LITERATURE 8 (2006), https://www.nrel.gov/docs/fy07osti/40116.pdf [https://perma.cc/A7J8-FTGA].

and/or consumer setting, can prove to be prohibitively expensive.[15] Some individuals also make the argument that producing a PV panel is too resource-intensive per unit of energy to be viable; PV panels require highly purified (and therefore expensive) silicon, boron, and phosphorous, as well as dyes such as titanium dioxide in some cases.[16]

Opponents of this argument contend that while solar may have once been rather expensive, production costs for solar panels have been plummeting in the last decade and are expected to continue becoming cheaper.[17] As solar technology advances and becomes more popular, solar panels benefit from economies of scale as well as increased efficiency, meaning the same square footage of solar panels can capture more energy and reduce the cost per watt.[18] The Chinese solar market (to be discussed extensively later) in particular is often cited as a success story because the Chinese have been able to slash costs through a combination of government subsidies, resource availability, domestic demand, and a unique supply chain system.[19]

Many proponents of solar energy also focus on its positive environmental impact. In 2017, the U.S. emitted 4.761 million metric tons of carbon dioxide—a greenhouse gas long known to heavily contribute to global warming[20]—from fuel combustion alone.[21] Generating energy from solar panels, however, produces no carbon dioxide or related greenhouse

15. CHRISTOPHER DYMOND, PV FOCUS GROUP REPORT 3 (2002), https://www.energytrust.org/wp-content/uploads/2016/11/02_PVFocusGroup.pdf [https://perma.cc/NN5G-6R9X].

16. Alex Epstein, *Jimmy Fallon Makes the World's Best Argument Against Solar and Wind Energy*, FORBES (Nov. 12, 2014), https://www.forbes.com/sites/alexepstein/2014/11/12/jimmy-fallon-makes-the-worlds-best-argument-against-solar-and-wind-energy/#5ef814932f4c [https://perma.cc/7W4X-JSMD].

17. DELOITTE CTR. FOR ENERGY SOLUTIONS, US SOLAR POWER GROWTH THROUGH 2040: EXPONENTIAL OR INCONSEQUENTIAL? 7 (2015), https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-er-solar-innovation-gro wth.pdf [https://perma.cc/9S3J-WATY].

18. *Id.*

19. Alan Goodrich et al., *Assessing the Drivers of Regional Trends in Solar Photovoltaic Manufacturing*, 6 ENERGY & ENVTL. SCI. 2811 (2013).

20. *See* Susan Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PROC. NAT'L ACAD. SCI. 1704 (2009).

21. INT'L ENERGY AGENCY, CO2 EMISSIONS FROM FUEL COMBUSTION HIGHLIGHTS 78 (2019), https://webstore.iea.org/co2-emissions-from-fuel-combustion-2019 [https://perma.cc/U24K-ZLN7].

gasses.[22] Those in favor of solar argue that not only would switching to solar lead to a cleaner and more sustainable environment, but also a healthier one: Some proponents estimate that the rate of heart attacks, asthma, and other cardiovascular and respiratory ailments could be reduced due to the lesser emissions of solar.[23]

Those who disagree with this stance often cite the argument that humans do not significantly contribute to global warming and therefore our aims to reduce emissions are a waste of time and resources.[24] This argument is essentially the same as the aforementioned cost argument as it contends that because fossil fuels are cheaper and more readily available than solar power and because the emissions of fossil fuels are largely irrelevant, we should continue using fossil fuels.[25]

Some people in favor of developing solar energy in the U.S. focus on its potential for job creation and the economic growth that follows. Advocates for this viewpoint sometimes argue that more jobs can be created through the solar energy market than the fossil fuels market.[26] Some estimate that as many as three million domestic jobs, most notably in manufacturing, could be created by developing a solar infrastructure and that this figure greatly overshadows the number of jobs lost in the resulting wane of the fossil fuels industry.[27]

Others, however, are skeptical of the alleged economic boom that would follow solar development.[28] Skeptics often claim that many of the jobs that would come with the solar market are low-paying, unproductive, clerical and administrative jobs, not the manufacturing jobs that solar advocates tout.[29] Another argument against the supposed solar boom is that it can only be accomplished through heavy government subsidy that

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22. M. Hosenuzzaman at al., *Global Prospects, Progress, Policies, and Environmental Impact of Solar Photovoltaic Power Generation*, 41 RENEWABLE & SUSTAINABLE ENERGY REVS. 284, 285 (2015).

23. *Id.* at 292.

24. Nigel Calder, *The Carbon Dioxide Thermometer and the Cause of Global Warming*, 10 ENERGY & ENV'T J. 1 (1999).

25. Alex Epstein, *Why Green Energy Means No Energy*, FORBES (Mar. 28, 2016, 1:49 PM), https://www.forbes.com/sites/alexepstein/2016/03/28/why-green-energy-means-no-energy/#490f613117dc [https://perma.cc/4AD8-ASP8].

26. Ehsanul Kabir et al., *Solar Energy: Potential and Future Prospects*, 82 RENEWABLE & SUSTAINABLE ENERGY REVS. 894 (2018).

27. Ken Zweibel, *A Solar Grand Plan*, SCI. AM., Jan. 2008, at 64 (2008).

28. Andrew Morriss et al., *Green Jobs Myths*, 16 MO. ENVTL. L. & POL'Y REV. 326 (2009).

29. *See generally id.*

makes solar competitive with fossil fuels, which subverts the free market by imposing slow and cumbersome government mandates.[30]

Solar energy, its opponents claim, simply can never meet today's energy demands on its own; thus, its forced substitution for our current energy sources is not only economically undesirable but will jeopardize meeting our energy needs as well.[31] The language of *forced* substitution has special resonance in the United States because few values are expressed with more passion in the United States than personal "liberty." State action tends to be seen as a threat to national identity, regardless of how democratically the governmental decision has been made.

B. The Slow Pace of Reaction to Climate Change in a Market Culture

Every country makes allocation and distribution decisions through a mixture of market and governmental decisions. The United States places primary reliance on the individual investment, consumption, and work decisions made by individuals interacting through millions of independent decisions. Those decisions are applauded as rational by the prevailing ideology in the United States.

This approach to organizing fundamental decisions depends for its moral legitimacy on the quality of information and forethought used by consumers, workers, and business leaders. The Pew Research Center found in its recent survey of public opinion in 26 countries that respondents in the United States ranked 20 out of 26 in viewing climate change as a major threat to human well-being.[32]

Compared to the United States, other developed countries seem to be investing just as much or more into their individual renewable energy sectors. In the year 2016, solar power capacity grew by nearly 50% of the total capacity for solar power all across the globe, with China accounting for nearly half of this expansion.[33]

For the first time ever, solar energy production growth surpassed that of any other source of fuel. These investments in renewable energy growth

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30. *Id.*

31. *Id.*

32. Moira Fagan & Christine Huang, *A Look at How People Around the World View Climate Change*, PEW RES. CTR. (Apr. 18, 2019), https://www.pewresearch.org/fact-tank/2019/04/18/a-look-at-how-people-around-the-world-view-climate-change/ [https://perma.cc/X7X5-5NSB].

33. *Solar Power Grew Faster Than Any Other Fuel in 2016, Opening a New Era for Solar Power*, INT'L ENERGY AGENCY (Oct. 4, 2017), https://www.iea.org/news/solar-pv-grew-faster-than-any-other-fuel-in-2016-opening-a-new-era-for-solar-power [https://perma.cc/8XR4-F4F6].

are the result of the Paris Agreement, an international treaty signed and ratified by 173 states who have all agreed to reduce their greenhouse gas emissions over the next several years.[34]

To try to pinpoint just where solar energy in the United States is headed, it is worth looking at the policies that shaped its use, from the Public Utility Regulatory Policies Act of 1978 (PURPA),[35] to the Energy Policy Act (EPAct) of 2005,[36] which altered PURPA to make it more practical for modern times.

Then-President of the United States Jimmy Carter introduced the National Energy Act, a collection of five bills with the ultimate goal of solving the problems left by the oil embargo, in 1978.[37] Section 210 of the Act introduced PURPA, with the hope of achieving two goals: (1) to reduce the U.S.'s dependence on foreign energy, namely crude oil and other fossil fuels; and (2) to promote alternative energy of all forms as viable sources of energy. PURPA gave solar energy, as well as many other forms of alternative energy, a fighting chance in the commercial realm.

That this Act was made possible by an unexpected oil embargo highlights the ability of the public sector to respond to emergencies *once the consequences affect the daily lives of the citizenry.* The Act first outlined the definition of "qualifying facilities," or those entities able to enjoy exemptions and benefits as outlined in the Act. In order to qualify for the exemptions and incentives, a facility's primary source of energy must come from some form of renewable energy, be it biomass, geothermal, or other forms such as solar energy.[38]

The qualifying facilities (QFs) then make up the whole of the market for energy, as the utility companies are now required to purchase their energy from the QFs. While this change in policy seems radical and prone

34. Paris Agreement under the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104.

35. Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95-617, 92 Stat. 3117.

36. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594.

37. The National Energy Act is the collective name for PURPA and four other acts: the Natural Gas Policy Act of 1978, Pub. L. No. 95–621, 92 Stat. 3350; the Energy Tax Act of 1978, Pub. L. No. 95–618, 92 Stat. 3174; the Powerplant and Industrial Fuel Use Act of 1978, Pub. L. No. 95–620, 92 Stat. 3289; and the National Energy Conservation Policy Act, Pub. L. No. 95–619, 92 Stat. 3206 (1978). *National Energy Act of 1978*, WHAT-WHEN-HOW, http://what-when-how.com/energy-engineering/national-energy-act-of-1978/ [https://perma.cc/UXW9-TGRW] (last visited Apr. 1, 2021).

38. Michael D. Hornstein & J.S. Gebhart Stoermer, *The Energy Policy Act of 2005: PURPA Reform, the Amendments, and Their Implications*, 27 ENERGY L.J. 25, 26 (2006).

to creating competition between facilities, one stipulation of this arrangement is that the QFs were to sell the energy for what is called an "avoided" cost; that is, the rates cannot be unfairly raised simply because the QFs now make up the only market in town. The cost must be equal to what the utility would charge anyone else. These qualifying facilities also were not allowed to discriminate against companies. If a company is looking to buy, a QF must be looking to sell, no questions asked.

The section that most of PURPA's opponents predictably took issue with was the mandatory purchase clause. Market cultures, in other words, prefer their mandates to be immersed in voluntary decisions because their ideology is tied to a visceral fear of state power. In their minds, the mandatory purchase clause not only discouraged, but disallowed competition in once-competitive markets.[39] When the EPAct was introduced in 2005, the mandatory purchase clause in PURPA was done away with, effectively re-allowing competition between QFs.[40]

One area of state action presents a particularly enticing reason to convert to solar energy—the multitude of incentives that can be made available for both residential and commercial facilities. On the federal level, for example, the 2008 federal bail-out bill extended a federal tax credit of 30% for residential and commercial installations through 2016.[41]

On the state level, states such as North Carolina, Oregon, Colorado, and Iowa have offered substantial tax credits to both residential and commercial plants producing renewable energy, especially solar.[42] North Carolina offers several tax credits for both the investment in and the construction of a renewable energy plant.[43] Oregon, another progressive

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39. *See* SCOTT HEMPLING ET AL., NAT'L RENEWABLE ENERGY LAB., RENEWABLE ENERGY PRICES IN STATE-LEVEL FEED-IN TARIFFS: FEDERAL LAW CONSTRAINTS AND POSSIBLE SOLUTIONS (2010), https://www.nrel.gov/docs/fy10osti/47408.pdf [https://perma.cc/CJZ3-MB5H]; David Grinlinton & LeRoy Paddock, *The Role of Feed-In Tariffs in Supporting the Expansion of Solar Energy Production,* 41 U. TOL. L. REV. 943 (2009).

40. Jonathan A. Lesser & Xuejuan Su, *Design of an Economically Efficient Feed-In Tariff Structure for Renewable Energy Development.*, 36 ENERGY POL'Y 981 (2008).

41. Emergency Economic Stabilization Act of 2008, Pub. L. No. 110-343, 122 Stat. 3765.

42. Vito A. Cosmo, Jr., *States Provide Tax Incentives for Investing in Alternative/Renewable Energy Products*, J. ST. TAX'N, Sept.–Oct. 2011, at 11, 12, 63.

43. For investment in a renewable energy-generating facility, a tax credit of 35% can be applied. N.C. GEN. STAT. ANN. § 105-129.16A(a) (Westlaw 2020). Depending on the size of the property, the ceiling for this credit ranges from $1,400 to $10,500 for a residential property, and up to $2.5 million for a commercial or industrial plant. N.C. GEN. STAT. ANN. § 105-129.16A(c)(1)–(2).

state in regards to alternative energy, introduced the Business Energy Tax Credit (BETC) to encourage the development of alternative energy facilities.[44] Colorado and Iowa offer tax exemptions for the components used in a facility's construction.[45]

The most solar-friendly state in the U.S. is predictably California. The state has classified solar energy as a utility, meaning it must be regulated as a public utility.[46] In other words, the rate of profit earned is limited by public sector values, rather than the private sector profit motive.

III. STATE ACTION AND SOLAR ENERGY IN GERMANY

Arguably, the history of renewable energy policy in Germany begins in 1974 with that nation's response to the first oil crisis of the early 1970s, a policy that initially emphasized reliance on nuclear energy and coal. Public policy has been the main driver in Germany's success with RES, not uniquely exceptional engineering. Germany's original response to the 1970's oil crisis was to increase the use of nuclear and coal energy production. The high cost of PV power has caused solar energy to be among the most expensive short-term alternatives. Market inducing programs were created to meet the high costs of PV implementation such

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Investors are also able to choose which tax he/she/they wish to apply this credit to, be it franchise, corporate or personal income, or, in the case of insurance companies, gross premiums. N.C. GEN. STAT. ANN. § 105-129.17(a). Tax credits for installation are 25% of the cost, to be taken in five equal installments, limited to 50% of the tax paid in a year. N.C. GEN. STAT. ANN. § 105-130.28.

44. The BETC gives the investor 10% of the certified cost of the facility for the first 2 years, and 5% of the certified cost for years three through five. OR. REV. STAT. ANN. § 315.354(1)(a), (c) (Westlaw 2020). The three requirements for qualification are: (1) the facility must be located in Oregon; (2) the facility must have received final certification from the Director of the Office of Energy; and (3) the taxpayer must be an eligible applicant under state law. OR. REV. STAT. ANN. § 469.205(1)(c); OR. ADMIN. R. 330-090-0120 (2020).

45. Colorado offers builders a 100% sales and use tax exemption on any and all components. COLO. REV. STAT. ANN. § 39-26-724(1)(a) (Westlaw 2020). Iowa offers similar exemptions on components for solar energy facilities. IOWA CODE ANN. § 423.3(90) (Westlaw 2020).

46. Section 216(e) of the California Public Utilities Code reads: "Any corporation or person engaged directly or indirectly in developing, producing, transmitting, distributing, delivering, or selling any form of heat derived from geothermal or solar resources or from cogeneration technology to any privately owned or publicly owned public utility, or to the public or any portion thereof, is not a public utility within the meaning of this section solely by reason of engaging in any of those activities." CAL. PUB. UTIL. CODE § 216(e) (Westlaw 2020).

as subsidized solar installation on top of schools. Greenpeace started programs to promote PV RES, as well as another program, "Cyrus installations," that garnered public support and drew in private firms due to the positive response of public opinion. This support eventually led to the proposal of the Eurosolar 100,000 roofs proposal. The German PV firms shifted their production facilities to the U.S., which led to Shell entering the German solar energy market with a 9.5-megawatt (MW) plant in Gelsenkirchen. These international partnerships led to increased pressure on German public authorities to support new market creation and increase public policy in this area.[47] In response to the Chernobyl disaster, however, Germany's energy policy shifted toward supporting and encouraging renewable energy sources.[48]

During the early 1990s, private citizens who subscribed to the solar roofing plan gained a 50% investment cost subsidy from the federal government and an additional 20% from the land government. At the end of the program, over 2,250 roofs had installed PV modes of energy

47. After the Chernobyl disaster, German support for Nuclear power decreased 70%. The price of wind RES was reduced by the feed in tax by 25% in 1990. Volkmar Lauber & Lutz Mez, *Renewable Electricity Policy in Germany, 1974 to 2005*, 26 BULL. SCI. TECH. & SOC'Y 105 (2006).

48. *Id.* at 105. Trade Unions after Chernobyl favored the phase out of nuclear power. In 1987 the then Chancellor of Germany Helmut Kohl declared climate change to be Germany's most important environmental issue. Under the framework of the Kyoto Protocol the German government pledged that it would reduce its greenhouse gas emissions by 40% while the rest of the European Union pledged 30%. Since the pledge to reduce emissions in 1990, Germany has decreased from 14,905 petajoules to 13,374 petajoules, according to AG Energiebilanzen, 2012. Carbon-dioxide emissions have been reduced from 1,042 million tons per year to 800 million tons per year, a 23% reduction since 1990. This reduction did not have a negative economic impact, as Germany maintained an average growth rate of 1.5% and the real gross domestic product rose 36%. Productivity of energy consumption rose 76% since 1990 from a total of 1.7 million Euros of GDP per ton of carbon dioxide emissions to 3 million Euros of GDP per ton of carbon dioxide emissions. Nuclear power as a percent of total energy expenditure dropped from supplying 11.2% of Germany's total energy in 1990 to 8.8% of Germany's total energy in 2011. RES increased from supplying 1.3% of Germany's total energy in 1990 to 11.5% according to AG Energiebilanzen 2012. RES supplied 20.1% of Germany's total electricity in 2012 with 24.5% being produced by lignite, 18.3% produced by hard coal and 17.6% produced by nuclear power. The large majority of Germany's power—over 50%—is used for heating and warm water, with an additional 30% of energy being used for transportation fuel consumption. Lutz Mez, *Germany's Merger of Energy and Climate Change Policy*, 68 BULL. ATOMIC SCIENTISTS 22, 29 (2006).

production.[49] During this same period a subsidized program of wind turbines was put in place that eventually led to a huge boom in wind production.[50]

Germany was clearly one of the first nations to recognize the importance of state action as a stimulus for alerting the private sector to profitable opportunities in RES. By the turn of the century, the need for public sector subsidies declined dramatically as private sector investors flocked to contracts with institutional and individual consumers. The subsidies that were so instrumental in jump-starting private investments stimulated cuts in the amounts paid by customers of renewable energy source generated grid electricity at rates of 35% to 10%.[51] These producers of RES electricity were not required to negotiate contracts with their customers and conduct other types of bureaucratic activity as part of their subsidy, thereby encouraging the use of these forms of RES. Additional governmental programs also provided large financial incentives to investors to finance wind and solar energy.[52]

The German government in the early part of the new century created new initiatives to push nonrenewable energy production out of the marketplace so that the new renewable energy firms would have a

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49. Mez, *supra* note 48, at 24.

50. Germany's goal to meet 38.6% of its energy consumption by 2020 with RES also included approximately 8.9% of biomass RES. Premium prices were paid for biological material that does not take away from natural areas such as roadside bark, forest residues and tree cutting residues. Residues included bark, black liquor, fiber sludge, wood chips, wood pellets and other paper residue. Biomass power plants currently use mostly waste wood, pulp, and residue from the paper industry. Biomass currently accounts for 9% of all electricity from RES and 2% for all gross electricity production. Philipp Sauter et al., *Impact of the Renewable Energy Sources Act in Germany on Electricity Produced with Solid Biofuels – Lessons Learned by Monitoring the Market Development*, 53 BIOMASS & BIOENERGY 162 (2013).

51. From 2000 to 2011, electricity from RES in Germany grew from 6.8% to 20.5%. From 2011 to 2012, German electricity from RES grew from 20.3% to 21.9%. The German per capita production of carbon dioxide dropped 22.4% from 1990 to 2008. The average American added 4.9 metric tons of carbon dioxide to the atmosphere, almost twice as much as the average German, a trend that has continued for two decades. In Germany today, private farmers own as much as 11% of all RES capacity in Germany while private individuals own as much as 51% of RES capacity in Germany overall. The "Big Four" German utilities own as much as 6.5 % of RES capacity. Will Boisvert, *Green Energy Bust in Germany*, DISSENT (Summer 2013), https://www.dissentmagazine.org/article/green-energy-bust-in-germany [https://perma.cc/FW63-T46T].

52. Lauber & Mez, *supra* note 47, at 106–07.

competitive advantage. Examples of these initiatives were an increase in the taxes on petrol, oil based products, and natural gas.[53] These are exactly the kinds of policies that would be greeted in the United States with a chorus of denunciations about state manipulation, coercion, and regulatory abuse.

As new RES technology develops, the new additional sunk costs required at regular intervals is similar to that of large-scale oil pipelines. This fact increases the incentives for private firms to switch the initial investment to newer technologies that will require fewer updates and lower the primary costs associated with startup.[54]

This expansion of the private German energy market gave German companies a first mover advantage and a continuous domestic German market of RES. This domestic market has allowed German firms to become experts at RES technology and to bring this technology to other countries to compete with foreign energy producers.

The German model of using substantial public sector incentives and infrastructure investments that make possible reductions in the cost of renewable energy offers an example of the constructive role the state can play in building entrepreneurial opportunities for private sector renewable energy firms. But this cooperation is made politically feasible in large part because such a large portion of the German population sees climate change as a serious threat to the flourishing of our species.

IV. THE ACCELERATED PACE OF SOLAR ENERGY PRODUCTION IN CHINA

A. Introduction

The staggering 1.2 billion residents in China consume more electricity than any country in the world.[55] China's reputation for burning fossil fuels is unmatched, burned into our memories by images of the polluted fog in

53. *Id.* at 150.

54. *Id.* at 150–51.

55. *China*, CIA WORLD FACTBOOK, https://www.cia.gov/the-world-factbook/countries/china/#energy [https://perma.cc/6PQ6-KDM4] (last updated May 4, 2021). The statistics are slightly outdated, but the numbers are not even close. China consumes 5.883 trillion kWh of electricity, almost 2 trillion kWh more than the second place United States at 3.902 kWh. *United States*, CIA WORLD FACTBOOK, https://www.cia.gov/the-world-factbook/countries/united-states/#energy [https://perma.cc/A2RD-CM8W] (last updated May 3, 2021).

Beijing. However, despite its reputation, China is the undisputed world leader in renewable energy production.[56]

B. The Growth of Renewable Energy in China

In the early 2000s, China launched a series of initiatives that would lead them to become the top renewable energy producer in 2017.[57] This section will briefly discuss the wind, hydro power, and solar PV markets and the role China has played in the growth of these markets.

1. Wind

The worldwide total installed capacity of wind power has grown exponentially in the 21st century. From 48 gigawatts (GW) in 2004, to 318 GW in 2013, and to 487 GW in 2016, wind power has proven to be an effective renewable resource.[58] Over the course of the last fifteen years, China has emerged as the leading producer in the wind industry.[59]

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56. RENEWABLE ENERGY POLICY NETWORK FOR THE 21ST CENTURY, RENEWABLES 2017 GLOBAL STATUS REPORT 25 (2017), https://www.ren21.net/wp-content/uploads/2019/05/GSR2017_Full-Report_English.pdf [https://perma.cc/3J3A-XRPQ] [hereinafter REN21 GLOBAL STATUS]. China has the highest total capacity of hydropower, wind power, and solar PV.

57. *See id.* (This exhaustive report, sponsored by the German government, UN Environment, and the Inter-American Development Bank (IDB), provides detailed, reliable statistics about the world renewable energy markets. The report measures the capacity added by countries in 2016 as well as their total production capacity at the end of 2016. Quite emphatically, the report illustrates the extent to which China dominates the renewable energy market. At the end of 2016, of the seven measured energy markets, China is leading in geothermal heat capacity, solar water heating collector capacity, wind power capacity, solar PV capacity, and hydropower capacity. They are second in bio-power generation and unranked in geothermal power capacity. In 2016, China invested more in renewable power and fuels than any other country in the world.).

58. RENEWABLE ENERGY POLICY NETWORK FOR THE 21ST CENTURY, THE FIRST DECADE: 2004–2014 (2014), https://www.ren21.net/Portals/0/documents/activities/Topical%20Reports/REN21_10yr.pdf [https://perma.cc/DWT6-D2DA] [hereinafter REN21 FIRST DECADE] (provides a comprehensive review of world renewable energy markets from 2004 to 2014).

59. *Id.* at 26 (China doubled their annual installment of wind capacity every year from 2004 to 2010. In 2014, China had more wind capacity than any country in the world.); *id.* at 88 (China increased wind power capacity by 23.4 GW in 2016. The next largest increase in 2016 was the United States, who built 8.2 GW of capacity. Currently, China has approximately twice the wind power capacity

2. Hydro Power

Hydro power, unlike wind and solar power, has a long history of power generation. Large-scale dams capable of producing a substantial amount of power have been around a long time, with the most notable project being the Hoover Dam, completed in 1936.[60] Due in part to the long history of hydro power development, the total installed capacity for hydro power has seen only modest growth over the course of the 21st century.[61]

The bulk of this 21st century growth can be attributed to China. In 2016, China contributed to over one-third of the added GW of total capacity in the hydropower industry.[62] Currently, China is the leader in hydropower capacity.[63] While hydropower generates over 50% of the world's renewable power capacity, a combination of wind and solar growth rates and concern about the impact of hydropower facilities on the environment suggest that the future of renewable energy lies elsewhere.[64]

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as the United States, their closest competitor, and over three times the capacity of Germany, their second closest competitor.).

60. *See generally History of Hoover*, ARIZ. POWER AUTHORITY, https://powerauthority.org/about-us/history-of-hoover/ [https://perma.cc/529X-CC2P] (last visited Apr. 1, 2021) (the Hoover Dam's initial purpose was flood control, but it now produces 2 GW of electricity a year).

61. REN21 FIRST DECADE, *supra* note 58, at 9 (Solar PV and wind power saw double-digit growth rates each year from 2004–2014. Solar PV skyrocketed 11,538% from 2004 to 2016 ([303 – 2.6]/2.6 = 115.53). Wind Power jumped 915% from 2004 to 2016 ([487 – 48]/48 = 9.148). Comparatively, hydro power grew by a total of only 53% from 2004 to 2016 ([1096 – 715]/715 = 0.532)).

62. REN21 GLOBAL STATUS, *supra* note 56, at 57.

63. *See id.* at 58 (China has 28% of installed GW total capacity for hydropower, a larger market share than the next three countries combined. Brazil, Canada, and the United States each have 9% of the market.).

64. *See id.* at 60; *see also* Eric Holthaus, *Hot Dam*, SLATE (June 1, 2015, 6:00 PM), https://slate.com/business/2015/06/the-future-of-hydroelectricity-its-not-good.html [https://perma.cc/V4GS-XZHN] (suggests that the impact of global warming makes hydro power less reliable). *But see* Chris Mooney & Brady Dennis, *The Surprisingly Bright Future of America's Forgotten Renewable Energy Source: Water*, WASH. POST (July 26, 2016, 2:41 PM), https://www.washingtonpost.com/news/energy-environment/wp/2016/07/26/the-surprisingly-bright-future-of-americas-overlooked-renewable-energy-source-water/ [https://perma.cc/PUX4-BXHG] (This article argues that hydro power's future does not lie in new dams but in renovating dams. They estimate hydro power could increase by 50 GW by 2050. While the article brings up an important point, 50 GW does not seem like a large enough increase to shoulder a substantial load in

3. Solar

The solar PV industry has grown at an unfathomable rate over the course of the last decade. In 2006, the world could produce 6 GW of electricity from solar PV systems. That number grew to 23 GW in 2009, 70 GW in 2011, 137 GW in 2013, 228 GW in 2015, and 303 GW in 2016.[65] China has led the way in these solar PV installations. In 2016, China installed 46% of new solar PV capacity.[66] Currently, China has over 75 GW of solar PV capacity, approximately 25% of the entire solar PV industry.[67]

The high growth was sparked by a combination of higher demand for renewable energy[68] and dramatic reductions in the cost of production, sparked by investment, innovation, and competition.[69] Despite large increases in demand, the prices of production for modules and inverters continue to decline substantially.[70] In other words, technological innovation and large-scale factory investments are more than meeting the increased demand stemming from more environmentally conscious populations.[71] China, as illustrated by their annual installed solar PV capacity, is largely responsible for the downward trend in prices.

Chinese solar PV manufacturers are dominating U.S. manufacturers.[72] The United States has long accused China of unfairly flooding the market

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the fight to make people more reliable on renewable energy, especially considering the stark increases in wind and solar PV capacities in 2016 alone.).

65. REN21 FIRST DECADE, *supra* note 58, at 9; REN21 GLOBAL STATUS, *supra* note 56, at 66.

66. REN21 GLOBAL STATUS, *supra* note 56, at 67.

67. *Id.*

68. *Id.* at 65.

69. *Id.*; *see generally* JEFFREY BALL ET AL., THE NEW SOLAR SYSTEM: CHINA'S EVOLVING SOLAR INDUSTRY AND ITS IMPLICATIONS FOR COMPETITIVE SOLAR POWER IN THE UNITED STATES AND THE WORLD (2017), https://law.stanford.edu/wp-content/uploads/2017/03/2017-03-20-Stanford-China-Report.pdf [https://perma.cc/3JNV-EKDJ] (outlining China's innovations in solar cell manufacturing and the competition that exists within China and around the world, and confirming the sinking solar PV costs that have coincided with the steep increase in demand for solar energy).

70. REN21 GLOBAL STATUS, *supra* note 56, at 69.

71. *Id.*

72. BALL ET AL., *supra* note 69, at 110 (In 2016, of the four major steps in solar-module manufacturing, Chinese companies are responsible for "52% of polysilicon manufacturing capacity, 81% of silicon-solar wafer manufacturing capacity, 59% of silicon-solar-cell manufacturing capacity, and 70% of crystalline-solar-module manufacturing capacity in the world.").

with solar PV equipment.[73] The United States, and many other countries, are claiming China is engaging in unfair trade because of the role the Chinese government has played in developing and subsidizing Chinese solar PV manufacturers (as will be discussed in the following section). In response, the European Union announced tariffs on Chinese solar panels in September of 2017.[74]

Donald Trump echoed these concerns, announcing a tariff on all solar modules and cells from China in early 2018.[75] While these tariffs are seen in a positive light among many domestic companies, certain American companies do not support the decision. For example, companies that install solar panels and consumers have both benefited from the cheap prices from Chinese manufacturers. These tariffs, therefore, have complex economic effects on the economies of affected nations.

The global impact of these tariffs is still unclear. Desperate for market share (and the jobs that come with it), countries will likely turn to public policy to gain a competitive edge.[76] The following section outlines the history of solar PV public policy in China—the undisputed leader in the industry—to help outline the public policy options these countries have moving forward.

C. The Impact of Public Policy on China's Solar Industry

The Chinese government first began addressing renewable energy development in the early 1980s, but the first impactful renewable energy legislation, however, was not passed until the early 2000s.[77] This early

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73. Emily Holden, *U.S. Setting Stage for Solar Trade War with China*, POLITICO (Dec. 15, 2017, 5:13 PM), https://www.politico.com/story/2017/12/15/trump-solar-power-china-trade-barriers-230854 [https://perma.cc/JYE4-VWZK].

74. Arthur Neslen, *Solar Industry Says EU Tariffs on Chinese Imports Will Raise Panel Prices*, GUARDIAN (Sept. 8, 2017, 7:16 AM), https://www.theguardian.com/environment/2017/sep/08/solar-industry-says-eu-tariffs-chinese-imports-will-raise-panel-prices [https://perma.cc/CST8-K7KX].

75. Dave Keating, *Trump Follows Europe's Lead with Chinese Solar Panel Tariffs*, FORBES (Jan. 23, 2018, 2:59 PM), https://www.forbes.com/sites/davekeating/2018/01/23/trump-follows-europes-lead-with-chinese-solar-panel-tariffs/?sh=637e2a4331a8 [https://perma.cc/NTZ4-FE7E].

76. Sufang Zhang et al., *The Erratic Path of the Low-Carbon Transition in China: Evolution of Solar PV Policy*, 67 ENERGY POL'Y 903 (2014).

77. *See* Qiang Zhi et al., *China's Solar Photovoltaic Policy: An Analysis Based on Policy Instruments,* 129 APPLIED ENERGY 308, 310 (2014). The paper describes the development of solar energy in China from the early 1980s to 2011. The authors cite the failure of pre-2000s policies to substantially impact on Chinese renewable energy development. High costs prevented the solar industry

21st century legislation pushed China towards becoming the leader in the solar PV industry.

These noteworthy pieces of legislation include *China's Tenth Five-Year Plan*, effective in 2001;[78] the *Renewable Energy Law of the People's Republic of China*, effective in 2006 and amended in 2009;[79] the *Golden Sun Program*, effective in 2009 and amended in 2011;[80] the *Interim Feed-in Tariff Law,* effective in 2010 but expired in 2013;[81] the *Twelfth Five-*

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from making any substantial progress. Due to the expenditures related to research and development, however, there might be some reason to believe that pre-2000s policy is partially responsible for the success of Chinese renewable energy today, although any impact the R&D expenditures had is immeasurable.

78. *See Policies Database*, INT'L ENERGY AGENCY, https://www.iea.org/policies?country=China%2CPeople%27s%20Republic%20Of%20China&topic=Renewable%20Energy [https://perma.cc/4ULD-XBHS] (last visited May 14, 2021) (skip to page 5 of the filtered policy list). This webpage provides an interactive map with an exhaustive list of regulations and laws passed by the Chinese government that have impacted the development of renewable energy in China. This law was the first major Chinese government initiative to address renewable energy. The plan offered tax incentives in the form of value added tax (VAT) cuts, primarily to wind and bio-energy projects, to the renewable energy industry. In 2001, the government aimed to increase solar PV capacity to a total of 53 MW by 2005, a number China failed to reach by a wide margin.

79. *Id.* (on page 4 of the filtered policy list). This law served as China's announcement to the world that China will make renewable energy a priority. The law places an emphasis on the development of electricity grid companies to more efficiently store and transfer renewable energy. Utility companies were unlikely to purchase renewable energy because of the cost, but this law helped shoulder the burden so that there would be at least some demand for renewable energy in China. The 2009 amendment gave the law more teeth, allowing the local governments to impose penalties on electricity grid companies who do not prioritize renewable energy and improve renewable energy related technologies. The 2009 amendment also allocated more funds for the research and development of improved electricity grid projects.

80. *Id*. This law is the first law that directly targeted the solar PV industry. The program provides substantial subsidies for solar PV projects, covering up to 50% of installation, transmission, and distribution costs for projects that are connected to the electricity grid. Solar PV projects that are off the grid could now get a subsidy for up to 70% of their installation cost.

81. *Id*. This law established China's first feed-in tariffs for solar PV energy. These feed-in tariffs incentivize solar PV energy producers to produce more energy by paying above market rate. The feed-in tariffs, a policy borrowed from Germany, proved to be an effective way to increase demand in the industry. A later law, the 2012 Renewable Energy Electricity Feed-in Tariff, gave subsidies to over 200 renewable energy projects in 2012 alone. China still uses feed-in tariffs to increase the demand for renewable energy.

Year Plan for National Strategic Emerging Industries, effective in 2012;[82] the *Solar Power Technology Development Twelfth Five-Year Special Plan*, effective in 2012;[83] and over twenty laws or regulations directly impacting the solar PV industry from 2013 to 2016.[84]

In China, policy is passed at the federal level and implemented by the local governments.[85] The legislation above, generally speaking, allocates funds to local governments for subsidies and research and development, changes tax policy to favor renewable energy consumption, and sets long-term goals that the local governments are told to meet. Given the striking number of laws and regulations passed by the Chinese government in the 21st century, and given the dynamic nature of these laws and regulations, the following discussion will largely avoid references to specific pieces of legislation in favor of a broader, more comprehensible picture of Chinese policy.

The following discussion is guided by the specific laws mentioned above and supported by the growing academic literature that analyzes the effectiveness of public policy in the Chinese solar PV industry.

Starting in the 2000s, early Chinese policy focused primarily on the development of large-scale manufacturing companies through policy

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82. *Id*. (on page 3 of the filtered policy list). This law targets a variety of renewable energy resources. The plan hopes to increase the efficiency of electricity grids that handle power that is generated from solar PV energy. Additionally, this law announced China's intent to establish more and better regulation to govern a now booming solar PV industry.

83. *Id*. This law focuses on decreasing costs of manufacturing and implementing solar PV systems. The law promotes the Chinese Ministry of Science and Technology to implement R&D initiatives that will help solve some of the problems the solar PV industry is facing.

84. *Id*. (see pages 1–3 of the filtered policy list). These laws cover almost every aspect of the industry. During this time, the Chinese government established a competitive bidding system to determine the winner of large solar PV projects, updated total capacity targets, altered the VAT cut incentive structure, launched a solar PV installation campaign in poor communities, altered feed-in tariff prices, and extended the length of feed-in tariffs until 2023. Collectively, these policies had an impact on the solar PV industry. But not one of these policies, unlike some of the policies before 2013, substantially altered the solar PV industry.

85. *See* Tain-Jy Chen, *The Development of China's Solar Photovoltaic Industry: Why Industrial Policy Failed*, 40 CAMBRIDGE J. ECON. 755 (2016) (Chen uses public policy surrounding the solar PV industry to critique the method the Chinese government uses to implement public policy. Chen outlines how the federal government and local governments interact to design and implement public policy.).

initiatives with supply-side characteristics.[86] Scholars debate whether supply-side policies were the most effective means of building the Chinese solar industry.[87] But despite this debate, one conclusion remains clear: Large-scale investment by the Chinese government in supply-side policy played an important role in the development of the most dominant solar PV manufacturing companies in the world.

By 2004, Chinese policy primarily consisted of supply-side policy meant to boost the growth of manufacturing companies. But in this same year, Germany passed the German Renewable Energy Act and established a feed-in tariff system,[88] a system that ultimately served as a model for the

86. *See* Qiang et al., *supra* note 77 (Qiang and the contributing authors make a key distinction between supply-side and demand-side policy. Demand-side policies, most notably feed-in tariffs, increase the demand for solar energy and expand the size of the market. On the other hand, supply-side policies, such as research and development and tax breaks, focus on developing and maintaining solar PV manufacturers and enhancing the quality of the product. The authors show how most of the early-2000s resources that were allocated to the solar PV industry were used to build the capacity of the Chinese manufacturing companies to meet global demand. Years later, China began to use more demand-side policies to build a large solar PV market within China.); *see also* BALL ET AL., *supra* note 69 (This comprehensive research is a study of China's solar industry with the goal of learning lessons from their successes and failures. This study confirms Qiang's findings that early Chinese solar PV policy focused heavily on the development of solar PV manufacturers rather than the development of a solar PV market.).

87. *See* Chen, *supra* note 85 (Chen argues that the policies the Chinese government implemented were effective in growing large-scale businesses, but they failed to grow the best businesses. The article illustrates an interesting problem with allowing local governments to implement subsidies. The result, Chen argues, is local government officials giving subsidies to the largest companies to increase, in turn increasing their likelihood of being re-elected. The companies become "too big to fail," and while they still compete against companies developed in other localities, the competition is not as good as the competition could be if it were developed more carefully. For example, a region in China could have a competitive advantage in producing a special piece of equipment. Instead of the market consisting of several companies competing, most of which are from this particular region, the current policy mechanism, while still resulting in several companies competing, would have only one company competing from the region with the competitive advantage.).

88. *See* Qiang, *supra* note 77, at 309 (Feed-in tariffs set a minimum price that utility companies must pay to private companies for renewable energy that is brought onto the electric grid. In China, these tariffs vary by region and technology. The tariffs provide long-term stability for investors.).

Chinese government.[89] The causation is not ironclad,[90] but 2004 does seem to serve as a turning point in Chinese solar PV policy. From 2005 onward, China launched a variety of demand-side initiatives that expanded the solar PV market in China. These demand-side initiatives allow Chinese companies to sell more renewable energy domestically.

One key policy that helped boost the demand for solar energy in China was the Golden Sun Program of 2009.[91] This program provided funding for the implementation of solar PV systems on buildings in China. Several other policies followed the Golden Sun Program to help expand access for Chinese homes and businesses to implement a small-scale, locally-distributed solar PV system.[92] But other demand-side policies pale in comparison to the crown jewel of solar PV public policy: feed-in tariffs. Taking a lesson from Germany, China began experimenting with feed-in tariffs as early as 2006.[93] In 2011, China developed their first nationwide feed-in tariff system.[94] The feed-in tariff system has been widely praised by scholars for its effectiveness.[95] While there have been several adjustments to the feed-in tariff system, China has used this system as the primary driver for increasing solar energy demand within the Chinese markets.

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89. *Id.* at 314 (Qiang argues that the German law helped stimulate the growth of the solar PV market. The law not only increased German demand, but its success sparked other countries to implement a similar feed-in tariff system.).

90. Perhaps increased concern about water and air pollution from the Chinese people is partly to blame. Demand-side policies do much more to impact energy consumption domestically, whereas supply-side policies increase the quantity demanded in all countries, not just China.

91. *See supra* note 80.

92. *See* Xingang Zhao et al., *Distributed Solar Photovoltaics in China: Policies and Economic Performance*, 88 ENERGY 572, 574–77 (2015) (for a list of several policies); *see* Sufang Zhang, *Analysis of DSPV (Distributed Solar PV) Power Policy in China*, 98 ENERGY 92, 93 (2016) ("Since the second half of 2012 China's DSPV market development strategy has witnessed a series of policy changes aimed at making DSPV power development an equal priority with LSPV power development.").

93. Qiang et al., *supra* note 77.

94. Zhang et al., *supra* note 76.

95. *See, e.g.*, Zhao et al., *supra* note 92, at 582 (one of the primary conclusions: FIT (feed-in tariffs) should be widely adopted for China's distributed PV currently); *see also* Sandy Rodrigues et al., *Economic Analysis of Photovoltaic Systems for the Residential Market under China's New Regulation*, 101 ENERGY POL'Y 467 (2017) (points out that feed-in tariffs are not as effective in boosting demand for small-scale, residential projects (DSPV), but it did still find that feed-in tariffs had a small impact on the payback period for residential installations).

Public policy has since followed the course set in 2011.[96] While the policies are consistently updated, there have been no substantial changes in the policy framework. Moving forward, China will likely begin to ease its manufacturers off government support as solar energy becomes more cost-effective. This would be a path similar to that followed by the Germans, but over a much shorter period of time.

D. An Evaluation of Chinese Public Policy

1. Is China a "Greener" Country?

The conclusion that emerges from the argument above is not necessarily that China is a "green" country. "China leads the world in producing renewable energy" is much different than "China leads the world in the incorporation of renewable energy." In fact, renewable energy made up 30.3% of China's energy consumption in 2000, but only 16.4% in 2011.[97] The good news is that China's percentage is back on the rise, however slightly, as renewable energy climbed to 17.1% of total energy consumption in 2014.[98] And we should be careful not to be unfair to China, as their per capita energy use rose from 898.987 kg of oil equivalent in 2000 to 2,236.73 kg of oil equivalent in 2014.[99] This per capita growth was accompanied by a growth in population from 1.2626 billion in 2000 to 1.3643 billion in 2014.[100]

In simpler terms, given the rate at which Chinese demand for energy consumption grew in the 21st century, it would have been nearly impossible for China's renewable energy use to keep the same pace. But as China's energy consumption demand levels off, and as China's renewable energy industries further develop, we can expect renewable

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96. *See* BALL ET AL., *supra* note 69 (This comprehensive report traces the development of solar energy policy in China to learn lessons for the United States. The findings in this report align closely with the story I describe above.).

97. *See Renewable Energy Consumption (% of Total Final Energy Consumption) – China*, WORLD BANK, https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?end=2015&locations=CN&start=1995&view=chart [https://perma.cc/MHP2-Q8YX] (last visited May 14, 2021).

98. *Id.*

99. *See Energy Use (kg of Oil Equivalent Per Capita) – China*, WORLD BANK, https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?locations=CN [https://perma.cc/BR49-96XL] (last visited Apr. 1, 2021).

100. *See Population, Total – China*, WORLD BANK, https://data.worldbank.org/indicator/SP.POP.TOTL?locations=CN [https://perma.cc/H887-VDBL] (last visited Apr. 1, 2021).

energy to contribute to an increasingly large proportion of China's total energy consumption.

2. What are the Goals of China's Solar PV Public Policy?

a. Early 2000s

There are undoubtedly multiple factors leading to the Chinese government's initial decision to heavily invest in their solar PV industry, but two factors carry the most weight. The first (and perhaps the most obvious) reason the Chinese government invested in the solar PV industry is to strengthen their economy. Renewable energy was and is a high growth industry, and China likely chose to divert resources to the industry in part because it had such a strong possibility of high growth.

Further, the early 2000s policies almost exclusively targeted the manufacturers (supply-side), suggesting the government was more concerned with growing businesses and creating jobs than consuming clean energy.[101] This long-term, business-focused strategy seems to have paid off.[102] The solar PV industry has grown astronomically in the 21st century, causing manufacturers to hire more people to meet the demand.[103]

For economic reasons alone, the Chinese government could have justified their renewable energy investments. But on closer examination, there seems to have been a more pressing reason that turned their focus to renewable energy: China was energy insecure.[104] This insecurity stemmed from a reliance on foreign energy, a rapidly growing population, a sharp increase in energy consumption per capita, and poor energy infrastructure.[105] These problems resulted in high energy prices (the

101. *See* GANG CHEN, CHINA'S CLIMATE POLICY 46 (2012) (Chen argues that business interests sparked China's initial investment in renewable energy).

102. The word "long-term" here is critical. It illustrates an advantage China has over many other countries. The Chinese government is not elected, allowing them to avoid the pressure politicians in democratic countries feel to get quick tangible results.

103. *See generally id.*; *see* REN21 GLOBAL STATUS, *supra* note 56, at 43 (China's renewable energy industry is responsible for 3.955 million jobs. Solar energy alone has 1.962 million workers).

104. *See* BO KONG, PAC. NW. NAT'L LAB., AN ANATOMY OF CHINA'S ENERGY INSECURITY AND ITS STRATEGIES (2005), https://www.pnnl.gov/main/publications/ external/technical_reports/pnnl-15529.pdf [https://perma.cc/392Y-9SWC].

105. *See* Emily T. Yeh & Joanna I. Lewis, *State Power and the Logic of Reform in China's Electricity Sector*, 77 PAC. AFF. 437, 439–40 (2004).

government is responsible for paying for those high prices) and widespread and frequent shortages.[106]

In response to these concerns, the Chinese government invested heavily in both renewable and nonrenewable energy.[107] The investments in both renewable and nonrenewable energy suggest the massive growth China experienced in the wind, hydro, and solar PV sectors is less about China shifting toward more renewable energy and more about China simply shifting toward more energy. The renewable sectors grew alongside coal and natural gas. China's renewable energy growth has dwarfed that of other countries because, at least in part, Chinese energy consumption has been growing at an equivalently rapid rate.[108]

While the two reasons given above are likely the biggest causes of the growth of China's solar PV industry, other factors, such as environmental benefits and geopolitical pressure, should not be entirely discounted.

b. 2008–Today

It is hard to say exactly when the Chinese people and government began to care about pollution. We do know that in 2008, the majority of people polled in China listed both air and water pollution as major concerns.[109] And in 2009, toward the end of Hu Jintao's tenure as the Chinese leader, Jintao began to express concerns about pollution in a speech to the UN.[110] In this speech, Jintao stated China's intention to move toward renewable energy. The UN speech and public poll show that by 2009 the Chinese government (at least officially) and people were beginning to align with the growing portion of people concerned about environmental issues throughout the world.

Years later, Xi Jinping, the Chinese leader who came to power in late 2012, moved China to align more closely with those sounding the alarm about climate change. A few months after he took office in 2013, Xi announced his intention to grow the economy in a more sustainable,

106. *Id.* at 447–48.

107. *See* KONG, *supra* note 104, at 29–32.

108. *See Energy Use (kg of Oil Equivalent Per Capita) – China*, *supra* note 99.

109. Richard Wike & Bridget Parker, *Corruption, Pollution, Inequality are Top Concerns in China*, PEW RES. CTR. (Sept. 24, 2015) http://www.pewglobal.org/2015/09/24/corruption-pollution-inequality-are-top-concerns-in-china/ [https://perma.cc/43NQ-2VM4].

110. *See* Zou Keyuan, *Building a 'Harmonious World': A Mission Impossible?*, 30 COPENHAGEN J. ASIAN STUD., no. 2, 2012, at 74, 75.

equitable, and environmentally-friendly manner.[111] He went so far as to claim that China's failure to grow the economy in this way was a "critical mistake" of the past.[112]

Xi showed a level of consistency with these concerns when he joined the Paris Agreement several years later. Taking one step further, Xi pleaded with U.S. President Donald Trump to stay in the agreement, speaking to the UN: "Man coexists with nature, which means that any harm to nature will eventually come back to haunt man. We hardly notice natural resources such as air, water, soil and blue sky when we have them. But we won't be able to survive without them." Xi's comments suggest that China's movement toward renewable energy comes from a genuine ethical concern about future generations and the environment, and that may be partially true. But there are other reasons Jinping would want to echo these kinds of sentiments on the world stage.

By taking a stand on climate change, Xi can help fulfill his long-stated desire to increase China's power in the world.[113] Investing heavily in renewable energy will help Xi reach his goal for three reasons. First, Xi's stance on climate change allows China to get closer to Europe.[114] Second, taking the lead in renewable energy will allow China to gain considerable influence over the direction of the energy industry in the future, assuming the energy industry continues to move in a greener direction.[115] Three,

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111. Damian Grammaticas, *China's New President Xi Jinping: A Man With a Dream*, BBC (Mar. 14, 2013), https://www.bbc.com/news/world-asia-china-21790384 [https://perma.cc/QP55-JH94].

112. *Id.*

113. *Id.* (the 2013 article clearly outlines Xi's intention of making China a world power); *see also* ASIAN INFRASTRUCTURE INV. BANK, https://www.aiib.org/en [https://perma.cc/2LTN-3BTH] (last visited Apr. 1, 2021). This bank is funding projects across the globe, promising to follow their motto of "lean, clean, and green." Western governments and institutions have expressed concern about the AAIB because of its capacity to compete with institutions like the World Bank, one mechanism the West likes to use to exert influence in the world. As their motto suggests, sustainable projects, including renewable energy, will be one of the bank's main focuses. The creation of this bank and the bank's deliberate consideration of renewable energy help support the claim that Xi is using their advantage in renewable energy production as a way to help China become a, or perhaps "the," world power.

114. *See* Tom Phillips, *China's Xi Says Paris Climate Deal Must Not Be Allowed to Fail*, GUARDIAN (Jan. 18, 2017), https://www.theguardian.com/world/2017/jan/19/chinas-xi-jinping-says-world-must-implement-paris-climate-deal [https://perma.cc/9XLZ-W8ZK].

115. *See* Chris G. Pope, *China Wants to Dominate the World's Green Energy Markets – Here's Why*, CONVERSATION (Jan. 12, 2018, 9:14 AM), https://thecon

establishing successful businesses in a massive, growing industry will help grow China's economy, increasing China's presence in world markets.

CONCLUSION

Whatever their deficits with respect to personal freedom and individual responsibility, nations with power predominantly centered in the hands of a few leaders can move with a rapidity denied to countries with a long tradition of antagonism to the state. It is unimaginable, for example, that the United States could move forward with targeted growth of RES resembling the multiplicity of subsidies and mandates the Chinese government was able to implement once they perceived climate change as a threat to their aspirations. Germany represents a middle ground between China and the United States in terms of an aggressive state stimulus for the development of solar energy. That middle ground is reflected in the willingness of the German government to draw back from its leadership role once it had made the foundational expenditures opening private sector profit opportunities to German entrepreneurs.

However, the cultural attitude toward a positive role for the state is not by itself a sufficient explanation for the relative growth of solar energy in a nation. Respect for science and the forecasts of its practitioners is also necessary for a robust public sentiment recognizing the imminent threat posed by climate change. Neither Germany nor China could have experienced solar energy development at the pace and success they demonstrated had the decision-makers in those countries possessed the same low regard that science endures in the United States.

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versation.com/china-wants-to-dominate-the-worlds-green-energy-markets-here s-why-89708 [https://perma.cc/GC4L-KJGN].