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HOW CAN THE UNITED STATES LEARN FROM FOREIGN COUNTRIES' TRANSPORT AND USE OF RENEWABLE POWER?

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Synopsis: This Article conducts a comparative analysis of energy transport system legislation and regulations between the United States and foreign countries, with an emphasis on renewable energy sources and

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comparisons between the United States and the European Union. Each energy source will use various countries as illustrative examples and discuss respective legislation and regulatory authority where applicable. The Article concludes that the United States should adopt a regional multi-terminal configuration transmission system, using high-voltage direct current, with connection to a smart grid, modeled after a proposed China-European Union energy transmission link, incentivized by state- and federal-level tax exemptions for renewable energy investments within the United States.

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Introduction

The United States should follow the example set by the European Union countries when it implemented clear regulations concerning renewable energy systems by adopting a federal renewable energy directive with a transparency platform, incentivized by state and federal-level tax exemptions for renewable energy investments within the United States. Additionally, the United States should look to China and the European Union as an example of regions with an electricity transmission model, specifically a regional multi-terminal configuration connected to a Smart Grid. The scope of this Article will focus on a comparative analysis of the types of renewable energy laws related to transport systems that work in foreign countries and how they can be implemented and enforced in the United States.

Part I of this Article will provide background and overview of both domestic and international energy and climate laws and agreements. Part II of this Article will explore nonrenewable energy sources, including modes of transportation, by highlighting certain petroleum exporting countries' oil and gas laws and regulations as illustrative examples. Part III of this Article will explore five sources of renewable energy and their respective storage methods, with illustrative examples of how countries use and transport different renewable energy sources, such as solar, wind, and hydropower. Part IV of this Article will address the challenges of transporting renewable energy in the United States, including storage and transmission. Finally, Part V of this Article will provide recommendations for creating a sustainable renewable energy transport system within the United States, including a discussion of any proposed legislation, action, and regulations concerning renewable energy transport systems.

I. Energy Laws, Agreements, And Regulations

A. United States

Energy and climate laws in the United States are regulated through cooperative federalism between the states and the federal government; there is no umbrella organization to oversee all energy sources and their respective transmission and storage needs. The Federal Water Power Act of 1920 created the Federal Power Commission.[1] As a result of the creation of the Department of Energy as an independent agency, the Federal Power Commission was retained and renamed as the Federal Energy Regulatory

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1. Fed. Water Power Act, 16 U.S.C. § 792 (1920).

Commission (hereinafter "FERC").[2] FERC, an independent agency within the Department of Energy, "regulates the interstate transmission of electricity, natural gas, and oil" in addition to reviewing non-federal hydropower projects.[3] The Energy Act of 2005 delegated certain responsibilities to FERC.[4] Among others, some of FERC's relevant responsibilities include regulating transmission and sale of electricity in interstate commerce, reviewing mergers and acquisitions, corporate transfers amongst electricity companies, and siting applications for electric transmission projects (under limited circumstances).[5] However, federal regulation of electricity is limited only to interstate service and sales.[6] The individual states have their own authority to regulate the retail service of electricity through their public utility commissions (hereinafter "PUCs").[7] States also regulate their own siting and facility planning processes.[8] In September 2018, FERC released its Strategic Plan, covering fiscal years 2018 through 2022, to address "significant changes in energy supply" and the "growth of new energy technologies."[9] Of its six objectives, one is to "promote safe, reliable, and secure infrastructure" in order to meet the nation's growing demand for energy.[10] Because FERC only regulates interstate electricity and "private, municipal, and state hydroelectric project"[11] facilities, the government should consider expanding its authority to cover all types of renewable energy sources. Additionally, part of this objective addresses permitting challenges for constructing new (and much needed) infrastructure. FERC's response to this difficult challenge is to "[p]rovide the public [with] more detailed, project-specific information"[12] and to "respond to energy infrastructure applications with timely and well-

2. Dep't of Energy Org. Act, 42 U.S.C. § 7101 (1977).

3. *What FERC Does*, FED. ENERGY REG.COMM'N, https://www.ferc.gov/about/ferc-does.asp (last visited May 8, 2019).

4. *Id.*; *see* Energy Policy Act, 42 U.S.C. § 13201 *et seq.* (2005).

5. *What FERC Does*, *supra* note 3.

6. *Id.*

7. *Electricity 101: How is electricity regulated?*, DEP'T OF ENERGY, https://www.energy.gov/oe/information center/educational-resources/electricity-101#p1 (last visited Mar. 23, 2019).

8. *Id.*

9. *Strategic Plan FY 2018—2022*, FED. ENERGY REG. COMM'N (Sept. 2018), at *v*, available at https://www.ferc.gov/about/strat-docs/FY-2018-FY-2022-strat-plan.pdf?csrt=17477395470162804595.

10. *Id.* at 9.

11. *What FERC Does*, *supra* note 3.

12. *Id.* at 10.

reasoned decisions," with the goal of reviewing proposals from application to decision within two years.[13]

The National Environmental Policy Act (hereinafter "NEPA")[14] establishes a "broad national framework for protecting [the] environment" by ensuring compliance with various environmental laws and regulations. Once a federal agency approves a proposal to take "major federal action,"[15] an environmental review under NEPA requires a three-step analysis.[16] The first step of the NEPA process analysis is a determination whether a categorical exclusion applies. A categorical exclusion is applicable where the federal action "does not, 'individually or cumulatively have a significant effect on the human environment.'"[17] The second step of the NEPA process analysis is to prepare an Environmental Assessment, which determines whether or not the proposed agency action has a significant impact.[18] The third step of the NEPA process analysis is two-fold: (1) if the Environmental Assessment concludes that there is no significant environmental impact, then a Finding of No Significant Impact is issued; and (2) if the Environmental Assessment concludes that there is a significant environmental impact, then a more rigorous, detailed Environmental Impact Statement is prepared.[19] Figure 1 is an illustrative example of the NEPA process.[20]

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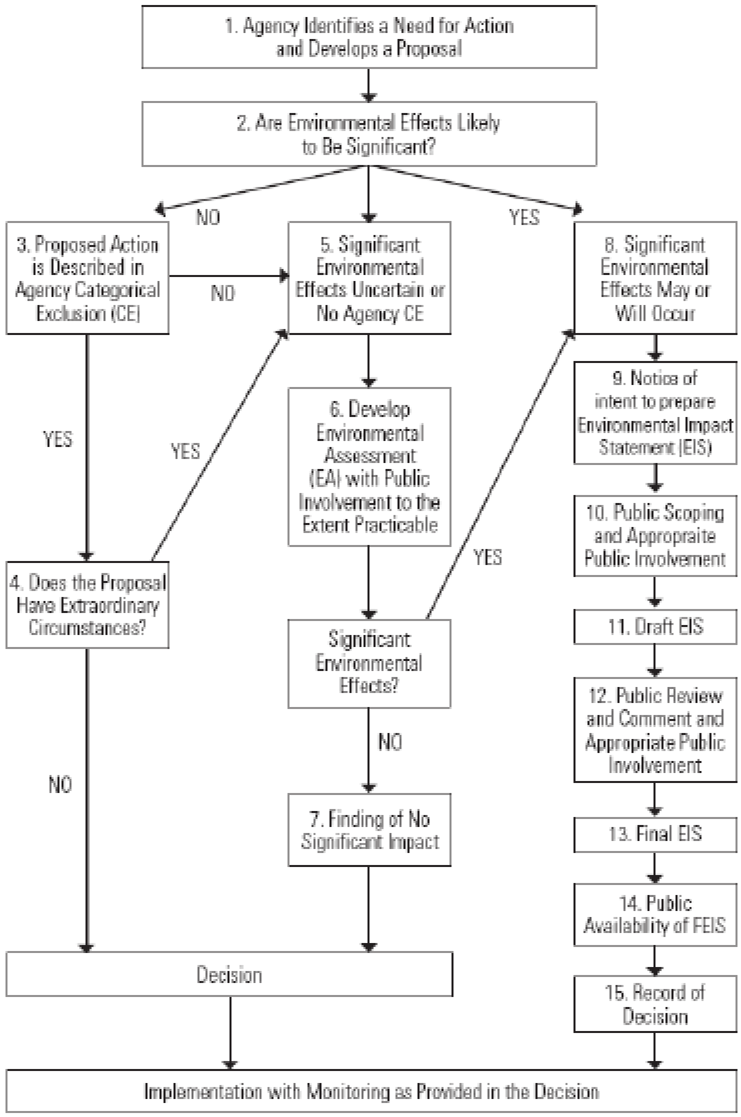
13. *Id.* at 12.
14. Nat'l Envtl. Policy Act, 42 U.S.C. § 4321 *et seq.* (1969) (hereinafter "NEPA").
15. *See* 40 C.F.R. § 1508.18 ("Major Federal action") (defining "action" and listing four categories of actions)
16. *NEPA Review Process,* ENVTL. PROT. AGENCY, https://www.epa.gov/nepa/national-environmental-policy-act review-process (last visited Mar. 23, 2019).
17. *Id.*; 40 C.F.R. § 1508.4.
18. *NEPA Review Process*, *supra* note 16.
19. *Id.*
20. NEPA Implementing Procs., 81 Fed. Reg. 61,200, 61,211 (Sept. 6, 2016).

Figure 1. The NEPA Process.



Congress amended the Energy Policy Act of 2005 to address and reevaluate energy production in the United States.[21] The Energy Policy Act of 2005 added emphasis on conservation and use of alternative energies,

21. See Energy Policy Act (2005), supra note 4; Energy Policy Act, 42 U.S.C. § 13201 et seq. (1992).

including renewable energy sources, nuclear power, and biofuels.[22] Additionally, the Act provides tax incentives and loan guarantees for technology innovation aimed at reducing greenhouse gas emissions.[23] The Act also calls for grant programs, testing initiatives, and tax incentives to promote the use of alternative fuels, with an end objective of reducing U.S. dependence on petroleum.[24]

B. International

In June 1992, Brazil hosted the United Nations Conference on Environment and Development (commonly referred to as the "Earth Summit") in Rio de Janeiro. The Earth Summit enabled world government leaders to come together to "rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet."[25] One way that was accomplished by the Summit was the initiative to seek alternative sources of energy "to replace the use of fossil fuels."[26] One of the key international agreements that emerged from the Earth Summit was the United Nations Framework Convention on Climate Change (hereinafter "UNFCCC").[27] The objective of the UNFCCC is to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[28] Part of this objective is to stabilize greenhouse gas emissions within a sufficient time frame.[29] The UNFCCC sets out non-binding commitments for the parties to the treaty, accounting for "common but differentiated responsibilities."[30] By acknowledging that the country-parties have differing responsibilities, the UNFCCC puts the onus on developed

22. *Laws & Regulations: Summary of the Energy Policy Act*, ENVTL. PROT. AGENCY, https://www.epa.gov/laws regulations/summary-energy-policy-act (last visited Mar. 20, 2019); *see also About EIA: Legislative Timeline*, U.S. ENERGY INFO. AGENCY, https://www.eia.gov/about/legislative_timeline.php (last visited Mar. 23, 2019).

23. *Id.*; *see* Energy Policy Act (2005), *supra* note 4.

24. *Alternative Fuels Data Center: Laws & Incentives*, DEP'T OF ENERGY, https://afdc.energy.gov/laws/key_legislation#epact05 (last visited Mar. 23, 2019).

25. *U.N. Conference on Env't & Dev. (1992)*, U.N., available at http://www.un.org/geninfo/bp/enviro.html (last visited Mar. 23, 2019).

26. *Id.*

27. U.N. Framework Convention on Climate Change, Mar. 12, 1994, 1771 U.N.T.S. 107 (hereinafter "UNFCCC"). The U.S. ratified the treaty on October 15, 1992.

28. *Id.* at art. 2.

29. *Id.*

30. *Id.* at art. 4(1).

countries to "tak[e] the lead in modifying longer-term trends in anthropogenic emissions."[31]

Three years after the UNFCCC took effect, parties to the UNFCCC met in Kyoto, Japan. The resulting agreement came to be known as the Kyoto Protocol,[32] which set binding emissions targets for developed countries. Under the Kyoto Protocol, Annex I Parties (mainly developed nations) have "quantified emission limitation and reduction commitments,"[33] aiming to reduce their respective greenhouse gas emissions to or below their respective 1990 greenhouse gas emissions percentage as a baseline.[34] These emission limitations and reductions target carbon dioxide (CO_2), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), and hydrofluorocarbons (HFCs)—some of the most common greenhouse gas emissions.[35]

In 2015, UNFCCC parties met together once again to continue establishing protocols and agreements toward limiting greenhouse gas emissions. The resulting agreement was the Paris Agreement.[36] Under the Paris Agreement, each country-party must establish mitigating mechanisms to reach the Agreement's objective goal.[37] The long-term objective of the Paris Agreement is to hold "the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels."[38]

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31. *Id.* at art. 4(2)(a).

32. Kyoto Protocol to the UNFCCC, Dec. 10, 1997, U.N. Doc. FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998) (hereinafter "Kyoto Protocol"). The U.S. did not ratify and dropped out in 2001.

33. *Id.* at art. 3.

34. *Id.* at art. 3(7).

35. *Id.* at Annex A.

36. Paris Agreement to the UNFCCC, Dec. 12, 2015, U.N. Doc. FCCC/CP/2015/L.9/Rev.1 (hereinafter the "Paris Agreement"). Former President Trump announced his intention to withdraw the U.S. from the Paris Agreement; however, the earliest the United States can withdraw is November 4, 2020, per Article 28.

37. *Id.* at art. 3.

38. *Id.* at art. 2(1)(a). The term "pre-industrial levels" is ambiguous as to the specified time period. Most researchers tend to use the period 1850–1900, while others suggest 1720–1800 might serve as a more accurate baseline. *See* Jonathan Amos, *Defining a true "pre-industrial" climate period*, BBC (Jan. 25, 2017), available at https://www.bbc.com/news/science-environment-38745937; Ed Hawkins et al., *Estimating Changes in Global Temperature Since Preindustrial Period*, 98 BULL. OF THE AM. METEOROLOGICAL SOC'Y 1841, 1846 (Oct. 9, 2017).

1. European Union Transmission Regulations

Electricity transmissions across Europe, or trans-European networks (hereinafter "TENs"), are regulated by the European Union under TEN-T (Trans-European Transport Networks)[39] and TEN-E (Trans-European Energy Networks)[40] regulations. An agreement known as the Maastricht Treaty established the objective of establishing and developing TENs in various areas, including energy transport.[41] Energy transport policy regarding necessary infrastructure is intended to eliminate bottlenecks and to improve operations between different modes of transmission and between regional and national transport systems.[42] TEN-T regulations also establish network "multimodal corridors" with the intent to implement modes of transmission onto one core network.[43] The agency that oversees TEN-T regulations is the Innovation and Networks Executive Agency,[44] which is tasked with a project named "Horizon 2020,"[45] which provides "support for research in the field of . . . smart, green and integrated transport."[46] The objectives of TEN-E regulations are to diversify sources of energy supply and to strengthen energy transmission lines with non-European Union countries as a way to incorporate energy transmission networks into EU Member States and to provide energy access for "island, landlocked and peripheral regions."[47]

The process of permitting all energy infrastructure within the European Union—both within an EU member state and for cross-border

39. Community guidelines for the development of the trans-European transport network (EC) No. 1692/96 of 9 Sept. 1996, 1996 O.J. (L 228) (hereinafter "TEN-T regulations").

40. Guidelines for trans-European energy infrastructure (EU) No. 347/2013 of 17 Apr. 2013, 2013 O.J. (L 115/39) (hereinafter "TEN-E regulations").

41. Treaty on European Union, July 29, 1992, 1992 O.J. (C 191) 1, 6.

42. *Trans-European Networks – guidelines*, EUROPEAN PARLIAMENT, available at http://www.europarl.europa.eu/factsheets/en/sheet/135/trans-european-networks-guidelines (last visited Mar. 24, 2019).

43. *Id.*

44. *Innovation & Networks Executive Agency: TEN-T*, EUR. COMM'N, available at https://ec.europa.eu/inea/en/ten-t (last visited Mar. 24, 2019).

45. *Innovation & Networks Executive Agency: Horizon 2020*, EUR. COMM'N, available at https://ec.europa.eu/inea/en/horizon-2020 (last visited Mar. 24, 2019). Horizon 2020 is currently looking into proposals for competitive low-carbon energy.

46. *Trans-European Networks – guidelines*, *supra* note 42.

47. *Id.*; *see* Decision (EC) No. 1364/2006 of 6 Sept. 2006, 2006 O.J. (L 262).

infrastructure—is done through a Project of Common Interest ("PCI").[48] PCIs are "key cross border infrastructure projects that link energy systems of EU countries."[49] The objectives of PCIs are to secure affordable and sustainable energy and to keep in accordance with the Paris Agreement's long-term goal of decarbonization.[50] The EU publishes a list of its current PCIs in a very detailed document, entitled "Technical Information on Projects of Common Interest." This document provides details on individual PCIs, including its location, project promoter, type of technology to be used, implementation status, and date of commission.[51] A prime example of a PCI is the proposed China-EU direct current transmission link.[52] In keeping with the objective of securing affordable and sustainable energy, this long distance power interconnection increases economic cooperation between China and European Union member states, as well as efficiently using renewable energy resources and generation capacities.

II. Non-Renewable Energy Sources

For centuries, fossil fuels have been and continue to be the primary source of energy consumption across the world. Fossil fuels are created over millions of years as a result of dead and decaying prehistoric organic matter, such as plant and animal matter.[53] The type of fossil fuelcreated depends on the combination of organic matter present, length of time buried beneath the ground, and the heat and pressure conditions the organic matter experienced.[54] This complex and time-consuming process is why these energy sources are referred to as "non-renewable" sources.[55] Coal, petroleum, and natural gas are the world's primary non-renewable energy

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48. *What are the Projects of Common Interest? How do they improve and modernise Europe's energy grid?*, EUR. COMM'N (Nov. 24, 2017), https://audiovisual.ec.europa.eu/en/video/I-147329.

49. *Projects of Common Interest*, EUR. COMM'N, available at https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest (last visited Mar. 24, 2019).

50. *Id.*

51. Technical Information on Projects of Common Interest, EUR. COMM'N (Nov. 24, 2017), available at https://ec.europa.eu/energy/sites/ener/files/technical_document_3rd_list_with_subheadings.pdf.

52. Discussion of the China-EU transmission link, *infra* Section V.A.

53. *Fossil*, DEP'T OF ENERGY, https://www.energy.gov/science-innovation/energy-sources/fossil (last visited Mar. 18, 2019).

54. *Id.*

55. *Fossil Energy Study Guide: Coal*, DEP'T OF ENERGY, *available at* https://www.energy.gov/sites/prod/files/Elem_Coal_Studyguide.pdf (last visited Mar. 18, 2019).

sources.[56] Fossil fuel consumption expanded greatly during the Industrial Revolution, powered by innovations in machinery, transportation, and mass production.[57]

More than three-quarters of the world's countries rely on fossil fuels as their primary energy sources. As of 2015, the global fossil fuel energy consumption was 79.676 percent, down nearly fifteen percent since 1960.[58] This Section will explore transmission of non-renewable energy sources, with an emphasis on methods of transmission in the United States and a few examples of oil and gas law from the Organization of Petroleum Exporting Countries (hereinafter "OPEC").

A. Methods of Transmission

Within the United States, transmission of petroleum products is regulated by individual states, while transmission of natural gas is regulated by the federal government.[59] The most common methods of fossil fuel transmission are by pipeline, by ship, or by rail. Pipelines are the primary method of transportation for both petroleum products and natural gas because of their efficiency and ability to move liquid products quickly.[60] Arguably, transmitting fossil fuels via pipeline is the most energy efficient; there is no need for additional transport using trucks or railway transport, thus resulting in a lower carbon footprint.[61] Ship transport is another method of transporting oil and gas; however, it is more conducive to oil transportation. Ships and barges have large capacities, enabling these vessels to transport vast quantities of oil and gas, which results in lower transport cost.[62] However, transporting natural gas via ships or barges becomes difficult. To transport natural gas via ship, it must first be

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56. *Fossil Fuels*, ENVTL. & ENERGY STUDY INST., https://www.eesi.org/topics/fossil-fuels/description (last visited Mar. 18, 2019).

57. *Fossil Energy Study Guide: Coal*, *supra* note 55; *Industrial Revolution*, HISTORY (Oct. 29, 2009) (last updated Jan. 10, 2019), https://www.history.com/topics/industrial-revolution/industrial-revolution.

58. *Fossil fuel energy consumption (% of total)*, THE WORLD BANK, https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?view=chart (last visited Mar. 18, 2019). 59 *See* Nat. Gas Act, 15 U.S.C. § 717 (1938).

59. *See* Nat. Gas Act, 15 U.S.C. § 717 (1938).

60. *Transporting Oil & Gas,* AM. PETROLEUM INST., https://www.api.org/oil-and-natural-gas/wells-to consumer/transporting-oil-natural-gas (last visited Mar. 24, 2019).

61. *Pipeline, Ship, or Rail: The Benefits and Needs of Different Oil and Gas Transport Methods*, STI GROUP (Feb. 2, 2016), https://setxind.com/midstream/pipeline-ship-rail-benefits-needs-different-oil-gas-transport-methods/.

62. *Id.*

converted and cooled into liquefied natural gas ("LNG"). LNG must be shipped in specialized LNG carriers, which are equipped with super-cooled cryogenic tanks.[63] Transporting natural gas via ship ultimately reverts to pipeline transmission, as the LNG is "regasified" at import terminals and transported via pipelines.[64] Still today, fossil fuels (especially coal) are transported via rail cars. Before pipelines became more interconnected across the country, rail transport was considered a "stopgap technique,"[65] transporting energy sources from one pipeline source to another. Railway transport continues to be a popular method due to the mass amount of fleet resources, long-standing infrastructure, and flexibility to adapt to market fluctuations.[66]

B. Oil and Gas Laws in Certain OPEC Countries

Unlike energy laws and regulations in the United States and European Union, oil and gas resources in certain OPEC countries are held and controlled by the government. Due to large petroleum reserves in the region, it is understandable why these countries rely heavily on nonrenewable resources as their primary source of energy.

1. Kingdom of Saudi Arabia

In 2014, the Kingdom of Saudi Arabia consumed 99.928 percent of its energy from fossil fuels.[67] Currently, the country has 263.2 billion barrels of oil reserves, as determined by a third party audit.[68] Saudi Arabia's constitution-like charter, The Basic Law of Saudi Arabia,[69] decrees all of

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63. *Natural Gas Explained: Liquefied Natural Gas*, U.S. ENERGY INFO. ADMIN. (July 13, 2018), https://www.eia.gov/energyexplained/index.php?page=natural_gas_lng.

64. *Id.*

65. *Pipeline, Ship, or Rail*, *supra* note 61.

66. *See id.*

67. *Saudi Arabia: Fossil fuel energy consumption (% of total)*, THE WORLD BANK, https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?locations=SA (last visited Mar. 24, 2019). The World Bank derives consumption statistics from the International Energy Agency, which reports consumption by kilotonne of oil equivalent (ktoe). *See Statistics – Saudi Arabia Total Final Consumption (TFC) by source*, INT'L ENERGY AGENCY, https://www.iea.org/statistics/?country=SAUDIARABI&year=2016&category=Energy%20consumption&indicator =TFCbySource&mode=chart&dataTable=BALANCES (last visited Apr. 15, 2019).

68. Ellen R. Wald, *Why It Matters How Much Oil Saudi Arabia Has*, FORBES (Jan. 9, 2019), https://www.forbes.com/sites/ellenrwald/2019/01/09/why-it-matters-how-much-oil-saudi-arabia has/#358a87b75137.

69. The Basic Law of Saudi Arabia, Royal Decree No. A/90 dated 27/8/1412 H (Mar. 1, 1992).

the country's oil and gas wealth be vested with the government. Saudi Arabia's regulatory body is the Ministry of Energy, Industry and Mineral Resources,[70] which is charged with developing and implementing the country's oil and gas policies.[71] Although the country has historically been heavily dependent on its oil reserves, both as an energy resource and as an economic driver, the Ministry of Energy, Industry and Mineral Resources launched an initiative entitled "Saudi Vision 2030."[72] The main objective of Saudi Vision 2030 is to diversify away from the country's dependence on hydrocarbons.[73] Through Saudi Vision 2030, Saudi Arabia hopes to become a "global investment powerhouse" by using its geographical location to connect Asia, Europe, and Africa for energy transmission.[74] The initiative expressly states the country is not "dependent solely on oil for [its] energy needs," and the country has many natural resources, such as gold, phosphate, uranium, and other minerals.[75]

2. Republic of Iraq

In 2014, the Republic of Iraq consumed 95.984 percent of its energy from fossil fuels.[76] As of 2017, the country has 147.233 billion barrels of crude oil reserves.[77] The country's laws regarding oil and gas are nebulous at best. Between the Constitution of Iraq,[78] the Federal Parliament, and the

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70. *Oil & Gas in the Kingdom of Saudi Arabia – An Overview (Client Publication),* SHEARMAN & STERLING LLP (Sept. 2016), available at https://www.shearman.com/~/media/Files/NewsInsights/Publications/2016/09/Saudi-Arabia Publications/Oil--Gas-in-the-Kingdom-of-Saudi-Arabia--An-Overview.pdf; *see Ministry of Energy, Industry & Mineral Resources,* Saudi National Portal, available at https://www.saudi.gov.sa/wps/portal/snp/pages/agencies/agencydetails/organization-AC160 (last visited Mar. 24, 2019)

71. *Oil & Gas in the Kingdom of Saudi Arabia*, *supra* note 70.

72. *Id.; see Forward*, Vision 2030, https://vision2030.gov.sa/en/foreword (last visited Mar. 24, 2019).

73. *Oil & Gas in the Kingdom of Saudi Arabia*, *supra* note 70.

74. *Forward*, Vision 2030, *supra* note 72.

75. *Id.*

76. *Iraq: Fossil fuel energy consumption (% of total)*, THE WORLD BANK, https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?locations=IQ (last visited Mar. 24, 2019); *see supra* note 67; *see also Statistics Iraq – Total Final Consumption (TFC) by source*, INT'L ENERGY AGENCY, https://www.iea.org/statistics/?country=IRAQ&year=2016&category=Energy%20consumption&indicator=TFCbySource&mode=chart&dataTable=BALANCES (last visited Apr. 15, 2019).

77. *Iraq Facts & Figures*, ORG. OF THE PETROLEUM EXPORTING COUNTRIES, https://www.opec.org/opec_web/en/about_us/164.htm (last visited Mar. 24, 2019).

78. Dustūr Jumḥūrīyat al-ʻIrāq [The Constitution of the Republic of Iraq] of 2005.

myriad of private contracts with international oil companies, Iraqi oil and gas law is a complicated mix.[79] The most relevant documents to the oil and gas legal framework in Iraq include the Constitution and proposed federal oil and gas laws, a proposed revenue sharing law, and interim revenue sharing agreements—between them, regulation of Iraqi oil and gas remains a "murky picture."[80] Of the 144 articles of the Constitution of Iraq, there are only two explicit oil and gas provisions. Article 111 states, "[o]il and gas are owned by all the people of Iraq in all the regions and governorates."[81] Article 112 makes a more obvious reference to Iraqi federal government oil and gas regulation by stating, "[t]he federal government, with the producing regional and governorate governments, shall together formulate the necessary strategic policies to develop oil and gas wealth in a way that achieves the highest benefit to the Iraqi people using the most advanced techniques of the market principles . . . ."[82] In 2007, Iraq attempted to pass a comprehensive oil and gas law, to no avail. The proposed federal law used language from Article 111 of the Constitution and attempted to come to a power-sharing agreement between the federal government and the various regions in Iraq.[83]

Unlike Saudi Arabia's Ministry of Energy, Industry and Mineral Resources, the Iraq Energy Institute takes a more protectionist view of its oil and gas industry, with no foreseeable plan concerning renewable energy transport systems. Currently, a key debate in the country is whether the demand for electricity (electric vehicles in particular) will encroach on the country's oil and gas industry. Energy forecasters view the debate surrounding transition to electricity as "underestimating technological innovation" in Iraq's oil and gas industry.[84]

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79. *Introduction to the Laws of Kurdistan, Iraq Working Paper Series: Oil & Gas Law of Iraq*, STANFORD LAW SCHOOL, 1, 3, available at https://law.stanford.edu/wp-content/uploads/2018/04/ILEI-Oil-and-Gas-Law.pdf (last visited Mar. 24, 2019).

80. *Id.* at 8.

81. Art. 111, The Constitution of the Republic of Iraq, *supra* note 78.

82. *Id.* at art. 112.

83. *Breakthrough in Iraq Oil Standoff*, BBC (Feb. 2, 2007), available at http://news.bbc.co.uk/2/hi/middle_east/6399257.stm.

84. Andreas De Vries & Salman Ghouri, *The Great Transition: Andreas De Vries & Salman Ghouri on the Future of Oil*, IRAQ ENERGY INST. (Mar. 3, 2019), available at https://iraqenergy.org/2019/03/03/2383-the-great-transition andreas-de-vries-salman-ghouri-on-future-of-oil/.

3. Islamic Republic of Iran

In 2014, the Islamic Republic of Iran consumed 99.023 percent of its energy from fossil fuels.[85] As of 2017, the country has 155.6 billion barrels of crude oil reserves.[86] Laws, regulations, and any activity regarding oil and gas are overseen by the Ministry of Petroleum of the Islamic Republic of Iran.[87] Within the Ministry are four sub-agencies: National Iranian Oil Company, National Iranian Gas Company, National Iranian Oil Refining and Distribution Company, and the National Petrochemical Company.[88] Of the countries listed in this Article as illustrative examples of dependency on hydrocarbons, Iran's perspective is the most aggressive. Like many other hydrocarbon-dependent countries, Iran also has an initiative entitled "Horizon 2025." This initiative, however, differs significantly from those of similar names. Iran's perspective is to remain "the second largest OPEC producer of crude oil," to acquire an international ranking as the second largest natural gas producer, and to create "the highest-value added from hydrocarbon resources in the country."[89] There is no mention of transitions toward electricity and renewable energy sources, which is a vast departure from many other countries' energy initiatives.

III. Renewables, Their Respective Storage and Transport Systems, and Foreign Countries' Regulations

Over recent decades, concerns about declining resources and increasing greenhouse gas emissions led countries to explore alternative methods of energy, such as energy from "renewable" sources. Renewable energy sources are sources of energy that can be replenished naturally,[90] unlike

85. *Iran: Fossil fuel energy consumption (% of total)*, THE WORLD BANK, https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?locations=IR (last visited Mar. 24, 2019); *see supra* note 67; *see also Statistics Iran, Islamic Republic of – Total Final Consumption (TFC) by source*, INT'L ENERGY AGENCY, https://www.iea.org/statistics/?country=IRAN&year=2016&category=Energy%20consumption&indicator=TFCbyS ource&mode=chart&dataTable=BALANCES (last visited Apr. 15, 2019).

86. *Iran Facts & Figures*, ORGANIZATION OF THE PETROLEUM EXPORTING COUNTRIES, https://www.opec.org/opec_web/en/about_us/163.htm (Mar. 24, 2019).

87. ESK Law Firm, *Oil and Gas Industry in Iran's Body of Law Post-Sanctions Strategy*, available at https://www.hg.org/legal-articles/oil-and-gas-industry-in-iran-s-body-of-law-post-sanctions-strategy-38249 (last visited Mar. 24, 2019).

88. *Id.*

89. *Id.*

90. *Renewable Energy Explained*, U.S. ENERGY INFO. ADMIN. (Jul. 13, 2018), https://www.eia.gov/energyexplained/?page=renewable_home.

finite nonrenewable energy sources. Most renewable energy sources do not produce carbon emissions, and as a result, are much cleaner.[91] The primary sources of renewable energy include biomass, hydropower, geothermal, wind, and solar.[92]

A global transition to renewable energy is imperative.[93] In November of 2018, a United States federal report and assessment on climate change warned of continued growing societal, economic, and natural resource loss without substantial efforts (both global and regional) to reduce greenhouse gas emissions by 2030.[94] The National Climate Assessment,[95] coupled with other multinational environmental agreements,[96] aims to reduce the global temperature in an effort to mitigate the effects of global warming. Fortunately, overall global renewable energy consumption has risen to 18.054 percent, up only one percent since 1990.[97] This Section will explore

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91. *See Energy & the Env't Explained: Where Greenhouse Gases Come From*, U.S. ENERGY INFO. ADMIN. (Jul. 20, 2018), https://www.eia.gov/energyexplained/index.php?page=environment_where_ghg_come_from. Biomass energy produces carbon emissions by its nature of burning non-fossilized organic plant and animal matter. *See infra* Section III.E.

92. *Renewable Energy Explained*, *supra* note 90.

93. *See* Patricia Espinosa, U.N. Climate Change Exec. Sec'y, Remarks on the 25th Anniversary of UNFCCC (Mar. 21, 2019), available at https://unfccc.int/news/unfccc-25th-anniversary-climate-action-is-more-urgent-than-ever ("Today, the urgency to address climate change has never been greater . . . . What we need now are results.").

94. *New federal climate assessment for U.S. released*, NAT'L OCEANIC & ATMOSPHERIC ASS'N (Nov. 23, 2018), https://www.noaa.gov/news/new-federal-climate-assessment-for-us-released; Alejandra Borunda, *Climate impacts grow, and U.S. must act, says new report*, NAT'L GEOGRAPHIC (Nov. 23, 2018), https://www.nationalgeographic.com/environment/2018/11/climate-change-US-report0/; *see* David Reidmiller et al., *Fourth National Climate Assessment Volume II: Impacts, Risks, and Adaption in the United States* (Nov. 23, 2018), *available at* https://nca2018.globalchange.gov (hereinafter "NCA4").

95. The National Climate Assessment was mandated by Congress with the Global Change Research Act of 1990. *See* 15 U.S.C. § 2921 *et seq*. Every four years, scientists from thirteen agencies compile a climate assessment, which serves as a reference tool for the President and Congress. *See* Doyle Rice, *U.S. impacts of climate change are intensifying, federal report says*, USA TODAY (Nov. 23, 2018), https://www.usatoday.com/story/news/nation/2018/11/23/climate-change-intensifying-economy-impacted-federal report-finds/2093291002/; Marshall Shepherd, *What Is The Nat'l Climate Assessment & Where Did It Come From?*, FORBES (Nov. 26, 2018), https://www.forbes.com/sites/marshallshepherd/2018/11/26/what-is-the-national-climate assessment-and-where-did-it-come-from/#6217ad93666e.

96. *See* Paris Agreement, *supra* note 36; Kyoto Protocol, *supra* note 32.

97. *Renewable energy consumption (% of total final energy consumption)*, THE WORLD BANK, https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?view=chart (last visited Mar. 18, 2019).

the primary renewable energy sources, their methods of storage and transmission, and highlight a country using each source and any related laws or regulations.

A. Solar

Solar energy is energy derived from solar radiation (commonly referred to as sun rays). Solar energy is created under enormous amounts of pressure through the fusion of hydrogen atoms into helium, thereby releasing energy.[98] On an average sunny day, one square meter of earth will receive roughly one kilowatt of energy.[99] Water is an effective way to store solar (heat) energy. As an illustrative example, if a swimming pool were to receive six hours of sunlight, the amount of water in that pool would receive around 288 kilowatts of energy, tenfold of what the average household in the United States uses in one day.[100]

Any place where hot days and abundant sunshine abound, fields of solar panels also abound. In the United States, the southernmost states are often referred to as the "Sun Belt." While often used as a moniker for those who migrate down from the colder northern states, the term "Sun Belt" is quite accurate for solar energy. The "belt" is a region around the world roughly following the thirty-sixth parallel circle of latitude, thirty-six degrees north of the equator. The aptly-named region receives fourteen hours and thirty-six minutes of sunlight on the longest day of the year[101] and nine hours and forty-three minutes of sunlight on the shortest day of the year.[102]

Solar energy is reflected off mirrors and concentrated into receivers that absorb the solar energy and turn it into heat.[103] Solar (or thermal) energy

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98. Catherine Boeckmann, *How Much Energy Does the Sun Produce?*, THE OLD FARMER'S ALMANAC (Mar. 26, 2009), https://www.almanac.com/content/how-much-energy-does-sun-produce#.

99. *How much power does the sun give us?*, SOLAR POWERED IN TORONTO, http://www.yourturn.ca/solar/solar power/how-much-power-does-the-sun-give-us/ (last visited Mar. 25, 2019).

100. *Id.*

101. *Duration of Daylight/Darkness Table for One Year*, U.S. NAVAL OBSERVATORY, available at https://aa.usno.navy.mil/cgi-bin/aa_durtablew.pl?form=2&year=2019&task=-1&place=&lon_sign=1&lon_deg=&lon_min=&lat_sign=1&lat_deg=36&lat_min=&tz=&tz_sign=-1 (last visited Mar. 25, 2019). The longest day of the year is referred to as the "summer solstice," which falls on June 21, 2019.

102. *Id.* The shortest day of the year is referred to as the "winter solstice," which falls on December 21, 2019.

103. *Solar Explained*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energy explained/index.php?page=solar_where (last visited Mar. 25, 2019).

storage methods can be divided into two categories: photovoltaic and thermal collectors. Photovoltaic collectors or cells "convert solar radiation directly into energy."[104] The term photovoltaic comes from the process of converting light (photons) into electricity (voltage).[105] Thermal collector storage methods include sensible heat storage, latent heat storage, and thermo-chemical storage. The most common thermal collection storage method is sensible heat storage, which uses a liquid or solid storage medium; this includes water, salt, sand, or rocks, which are then heated or cooled to store energy for transmission.[106] A benefit to this method of storage is the generated electricity can be transmitted after the sun has set, when there is no direct solar radiation to generate electricity. The preferred storage medium for sensible heat storage is molten salt, which can withstand temperatures of up to 1,050 °Fahrenheit.[107] As electricity is needed, the super-heated molten salt is dispatched through a steam generator, which generates and transmits electricity via a traditional steam turbine.[108] Figure 2[109] provides a simplified schematic of the process. In a latent heat storage method, the storage mediums are phase change materials, or materials that can convert from solid to liquid; this method allows the storage medium, such as water, to remain at relatively the same temperature throughout the process.[110] In a thermochemical storage method, certain chemical reactions are created to store energy.[111] Although this process is the most costly, the energy density is much higher.[112]

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104. *Energy Sources: Solar*, WORLD ENERGY COUNCIL, https://www.worldenergy.org/data/resources/resource/solar/ (last visited Mar. 25, 2019).

105. *Solar Photovoltaic Technology Basis,* NAT'L RENEWABLE ENERGY LAB., https://www.nrel.gov/research/re photovoltaics.html (last visited Mar. 25, 2019).

106. Abby L. Harvey, *The Latest in Thermal Energy Storage*, POWER MAGAZINE (Jul. 1, 2017), https://www.powermag.com/the-latest-in-thermal-energy-storage/?printmode=1.

107. *Id.*; *Molten Salt Energy Storage*, SOLAR RESERVE, https://www.solarreserve.com/en/technology/molten-salt energy-storage (last visited Mar. 25, 2019). As an added benefit, molten salt is environmentally friendly: its composite mixture of sodium nitrate and potassium nitrate allows it to be used as high-grade fertilizer if the storage plant is ever decommissioned. *Id.*

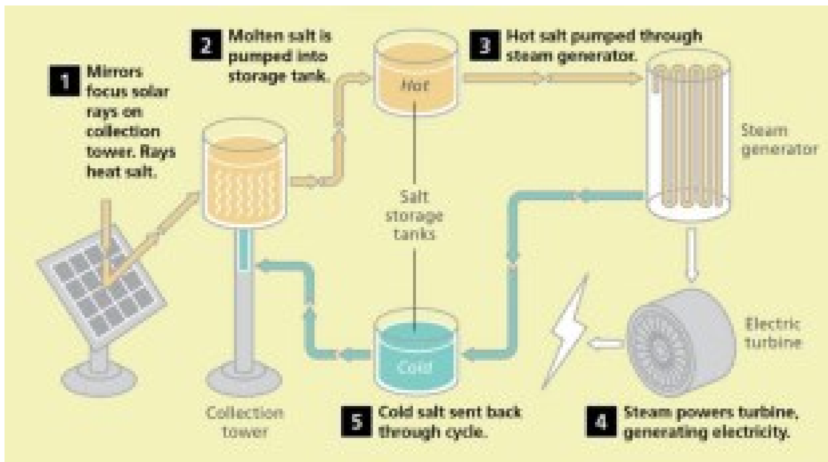
108. *Molten Salt Energy Storage*, *supra* at note 107.

109. Kari Lydersen, *9 Ways to Store Energy on the Grid*, DISCOVER (May 28, 2015), http://discovermagazine.com/2015/july-aug/26-power-stash.

110. Harvey, *supra* note 106; *Latent heat storage*, GLOBAL CCS INST., https://hub.globalccsinstitute.com/publications/strategic-research-priorities-cross-cutting-technology/33-latent-heat storage (last visited Mar. 25, 2019).

111. Harvey, *supra* note 106. The types of chemical reactions include dehydration (CaCl2 + 6H20), metalhydroxide/metaloxide (CaO + H20), and redox cycles of metaloxides

Figure 2. Sensible Heat Storage Method.



Currently, the world's largest solar farm is located in Morocco. The Noor Ouarzazate Solar Complex covers an area the size of 3,500 football fields and has a capacity of 580 megawatts, which is enough to power a city with a population of around 1.3 million, such as Dallas, Texas.[113] Morocco is an emerging country with one of the most ambitious energy targets in terms of percentage and timeframe. The country aimed to have forty-two percent of its energy come from renewable sources by 2020.[114]

(Mn_2O_3 + ½ O_2). *See* Christian Sattler & Antje Wörner, *Thermochemical Energy Storage*, DEP'T OF ENERGY (Jan. 8, 2013), available at https://www.energy.gov/sites/prod/files/2014/01/f6/tces_workshop_2013_sattler.pdf.

112. Harvey, *supra* note 106.

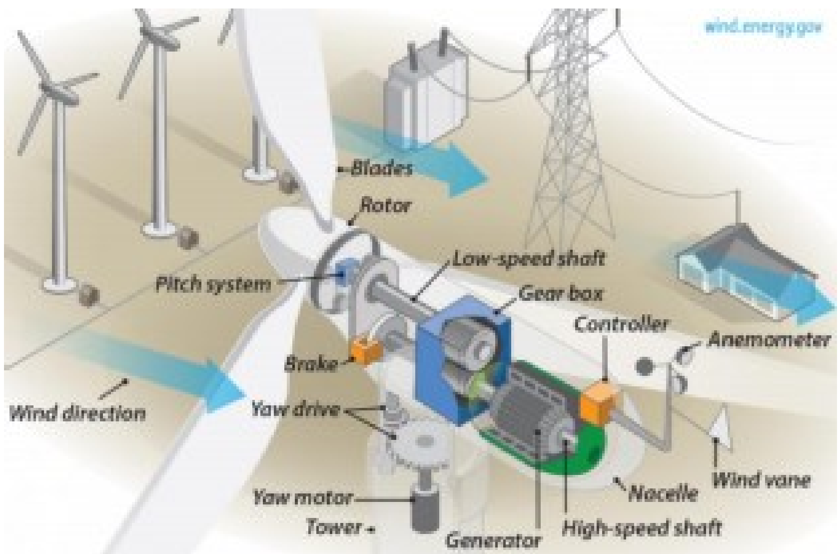
113. Nicki Shields & James Masters, *Morocco in the fast lane with world's largest concentrated solar farm*, CNN (Feb. 6, 2019), https://www.cnn.com/2019/02/06/motorsport/morocco-solar-farm-formula-e-spt-intl/index.html.

114. *Id.* As of January 2021, energy target updates have not been updated.

B. Wind

Wind power is generated from energy in moving air, caused by uneven heating and cooling conditions over the Earth's land. Wind energy is collected by the use of wind turbines, which use rotating blades to harness the wind's kinetic energy.[115] The blades, which are connected to a drive shaft, cause a generator to turn, creating electricity that is carried via cables to transmission lines.[116] While perhaps intuitive to think that wind turbines can be placed anywhere with windy conditions, the ideal locations for wind turbines are at high altitudes with open spaces, reducing windbreaks.[117] Figure 3[118] illustrates the components of a wind turbine.

Figure 3. The Inside of a Wind Turbine.



Wind turbines come in two forms: horizontal-axis turbines and vertical-axis turbines.[119] Horizontal-axis turbines are the most widely used and recognized. Standing at over 200 feet, they usually have three blades,

115. *Energy Explained: Wind*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/index.php?page=wind_home (last visited Mar. 25, 2019).
116. *Id.*
117. *Id.*
118. *The Inside of a Wind Turbine*, DEP'T OF ENERGY, https://www.energy.gov/eere/wind/inside-wind-turbine (last visited Mar. 25, 2019).
119. *Energy Explained: Wind*, *supra* note 115.

similar to an airplane propeller.[120] Taller turbines with longer blades are able to capture more of the wind's kinetic energy, thus generating more wind power electricity. Vertical-axis turbines are double-bladed, with the blades attached to a vertical rotor.[121] They are shorter and wider than horizontal-axis turbines and are not used frequently because they are less efficient. When numerous amounts of wind turbines are placed together, they create a wind farm. Wind farms are large clusters of turbines that can produce large amounts of electricity.[122]

Currently, the world's largest offshore wind farm[123] is the Walney Extension Wind Farm, located in the Irish Sea. The Walney Extension Wind Farm is comprised of 87 turbines that stand over 600 feet tall, with more than 186 miles of cables, and transmits electricity to England's national grid.[124] At capacity, the Walney Extension Wind Farm generates enough power for more than half a million homes and covers an area twice the size of Manhattan Island.[125] The Office of Gas and Electricity Markets ("Ofgem") is the United Kingdom's electricity regulator.[126] The Walney Extension Wind Farm, regulated by Ofgem, received its lease agreement from the Crown Estate[127] in 2010, and the project was completed in 2018.[128]

C. Hydropower

Hydropower is the world's leading source of renewable energy, supplying more than seventy percent of the world's renewable electricity.[129] Hydropower generates electricity from moving water, and swifter flowing

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120. *Id.*

121. *Id.*

122. *Id.*

123. The largest onshore wind farm is the Gansu Wind Farm (or Jiuquan Wind Power Base) in the western Gansu province in China.

124. Hilary Brueck, *The world's largest wind farm was just completed in the Irish Sea – and it's more than twice the size of Manhattan*, BUS. INSIDER (Sept. 13, 2018), https://www.businessinsider.com/largest-wind-farm-in-the-world 2018-9.

125. *Id.*

126. Ofgem, GOV.UK, https://www.gov.uk/government/organisations/ofgem (last visited Mar. 25, 2019).

127. The Crown Estate, now an independent commercial business created by Parliament, was traditionally comprised of lands belonging to the Crown. The Crown Estate is analogous to Federal land in the U.S.

128. *Walney Extension Project Summary*, Ørsted, available at https://walneyextension.co.uk/ (last visited Mar. 25, 2019).

129. *Energy Sources: Hydropower*, WORLD ENERGY COUNCIL, https://www.worldenergy.org/data/resources/resource/hydropower/ (last visited Mar. 25, 2019).

water generates more power and electricity.[130] Because hydropower only generates electricity when water is present, it is important to understand the water cycle; the amount of precipitation determines the amount of water available for producing electricity.[131] There are three categories of hydropower stations: (1) run of river stations, which generate hydropower electricity through the flow of a river; (2) reservoir stations, where hydropower electricity is generated through the release of stored water—such as water released from a damn; and (3) pumped storage stations, where water stored at a lower reservoir is pumped up to a higher reservoir to be released.[132] Hydropower electricity can also be generated through tidal power, wave power, and ocean thermal energy conversion.[133]

Currently, the world's largest hydropower stations are the Three Gorges Dam, located in the Hubei province of China, and the Itaipú Dam, located on the Paraná River bordering Brazil and Paraguay. The Three Gorges Dam began construction in 1993 and was not completed until 2006.[134] Three Gorges covers an area of approximately one million square kilometers and produces 451 billion cubic meters of water runoff annually.[135] In 2014, the Three Gorges Dam produced a record-breaking 98.8 terawatt-hours[136] before being surprised by the Itaipú Dam in 2017 (producing 101.3 terawatt-hours of electricity).[137]

D. Geothermal

Geothermal energy is constantly generated from the slow decay of radioactive particles within the Earth's core.[138] The temperature at the center of the Earth's core is roughly the same temperature as the surface of

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130. *Energy Explained: Hydropower*, U.S. ENERGY INFO. ADMIN, https://www.eia.gov/energyexplained/index.php?page=hydropower_home (last visited Mar. 25, 2019).

131. *Id.*

132. *Energy Sources: Hydropower*, *supra* note 129.

133. *Energy Explained: Hydropower*, *supra* note 130.

134. Yue Ma, *Three Gorges Dam*, STAN. UNIV. (Nov. 26, 2010), http://large.stanford.edu/courses/2010/ph240/ma2/.

135. *Three Gorges Dam Hydro Electric Power Plant, China*, POWER TECHNOLOGY, https://www.power technology.com/projects/gorges/ (last visited Mar. 25, 2019).

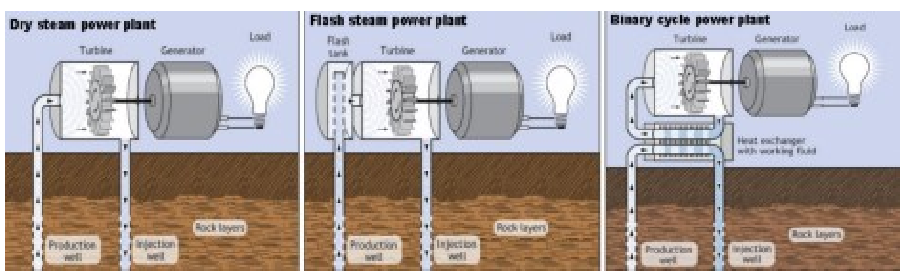
136. *Id.* One terawatt-hour is equal to 114 megawatts over a one-year period.

137. *Itaipú Ends 2016 with a Historic Production of 103.09 Million MWH*, ITAIPU BINACIONAL (Jan. 3, 2017), https://www.itaipu.gov.br/en/press-office/news/itaipu-ends-2016-historic-production-10309-million-mwh.

138. *Energy Explained: Geothermal*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/index.php?page=geothermal_home (last visited Mar. 25, 2019).

the Sun, some 10,800 °Fahrenheit.[139] There are two types of geothermal resources: convective hydrothermal resources, which requires a carrier such as water or steam, and dry rock resources.[140] Geothermal power plants run on high temperature hydrothermal resources from deep within the ground (up to two miles deep); the hot water or steam is drilled via an injection well and pumped to the surface, which then powers a turbine to generate electricity.[141] There are three types of geothermal power plants: (1) dry steam plants, which use steam directly from a reservoir; (2) flash steam plants, which convert high-pressure water from within the earth into steam; and (3) binary cycle power plants, which transfers heat energy from geothermal water to another liquid, which is then converted to steam to drive a generator.[142] Figure 4[143] illustrates the differences between geothermal power plants.

Figure 4. Geothermal Power Plants



Because most United States renewable power is focused on solar, wind, and hydro, the discussion of geothermal energy as a renewable energy source in the United States is outside the scope of this Article. However, Iceland provides an illustrative example. Iceland is a primary producer of geothermal energy: its geothermal facilities generate one-fourth of the country's electricity.[144] As of 2014, Iceland transitioned from energy reliance on coal and peat to reliance on "indigenous renewable resources,"

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139. *Id.*

140. *Energy Resources: Geothermal*, WORLD ENERGY COUNCIL, https://www.worldenergy.org/data/resources/resource/geothermal/ (last visited Mar. 25, 2019).

141. *See supra* note 138

142. *Id.*

143. *Id.*

144. *Geothermal*, NAT'L ENERGY AUTHORITY (ICE.), https://nea.is/geothermal (last visited Mar. 25, 2019).

including geothermal.[145] Iceland's geothermal resources are rich due to its geographical location. The country rests on the Mid-Atlantic ridge—the boundary between the North American and Eurasian tectonic plates.[146] As a result, there is a great amount of volcanic activity that is conducive to producing geothermal energy. Electricity is regulated in Iceland by its National Energy Authority, Orkustofnun. Similar to the United States, public land resources in Iceland belong to the state, and resources inside the ground attached to private land belong to the landowner.[147] Iceland's Act on Survey and Utilisation of Ground Resources[148] covers resources inside the ground and at the bottom of rivers, lakes, and the surrounding seas. Owners of electric power plants must submit technical details of the plant to the National Energy Authority, which shall be informed of the annual electricity generation.[149]

E. Biomass

Biomass is non-fossilized organic animal and plant material that contains stored solar energy. Plant biomass retains energy from the sun through the process of photosynthesis, so when biomass is burned, the stored chemical energy (glucose) is released as heat.[150] Types of biomass include wood, garbage, crops, alcohol fuels, and landfill gas.[151] Biogas materials such as wood or garbage can be burned directly for heat, while other biogas materials can be converted into biogas or biofuels and burned for energy.[152] Biomass energy is commonly used in industries which produce biomass material on site, such as the pulp and paper industry or food processing plants.[153] Liquid biofuels are being used as a decarbonization alternative to

145. *Id.*

146. *Geothermal: The Resource*, NAT'L ENERGY AUTHORITY (ICE.), https://nea.is/geothermal/the-resource/ (last visited Mar. 25, 2019).

147. *Geothermal: Legal & Regulatory Framework*, NAT'L ENERGY AUTHORITY (ICE.) https://nea.is/geothermal/legal and-regulatory-framework/ (last visited Mar. 25, 2019).

148. Act on Survey and Utilisation of Ground Resources, No. 57/1998 (Ice.).

149. *Id.*; *Geothermal: Legal & Regulatory Framework*, *supra* note 147.

150. *Energy Explained: Biomass*, U.S. ENERGY INFO. ADMIN, https://www.eia.gov/energyexplained/index.php?page=biomass_home (last visited Mar. 25, 2019).

151. *Introduction to Biomass (PowerPoint)*, NAT'L ENERGY ED. DEV. PROGRAM, available at https://www.need.org/biomassmaterials (last visited Mar. 25, 2019).

152. *See supra* note 150.

153. *Bioenergy and biofuels*, INT'L ENERGY AGENCY, https://www.iea.org/topics/renewables/bioenergy/ (last visited Mar. 25, 2019).

oil and gas.[154] While biomass energy accounts for less than one-tenth of the world's energy, long-term bioenergy is essential for a low-carbon system.

However, because biomass emits greenhouse gases, the use of biomass energy posits a complex question when compared to fossil fuels. But, the discussion of biomass energy as a renewable energy source is outside the scope of this Article, as most United States renewable power is focused on solar, wind, and hydro.

IV. Challenges of Transporting Renewables in the United States

A. Generation and Storage

According to FERC, energy storage is a "resource capable of receiving electric energy from the grid and storing it for later injection of electricity back to the grid."[155] Electricity storage does not involve the storage of electricity itself, "but rather the conversion of electricity into another form of energy . . . that is later converted back to electricity with minimal loss."[156] The only operational energy storage technologies that are currently deployed include "pumped hydro storage systems, compressed air storage, flywheels, and some electrochemical batteries."[157]

Current regulatory and market issues create barriers to entry for emerging energy storage technologies.[158] The main issues preventing the development of energy storage include: (1) newness of the technology; (2) categorization of storage for generation versus storage for transmission; (3) jurisdictional questions; (4) valuation of energy storage; (5) interconnections between energy storage systems; (6) cost allocation for storage and transmission; and (7) environmental concerns.[159]

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154. *Id.*

155. Order No. 841, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations & Independent System Operators*, 162 FERC ¶ 61, 127 at 29, 83 Fed. Reg. 9,580 (2018) (to be codified at 18 C.F.R. Part 35) (hereinafter "Order 841"). *See* David Schmitt & Glenn Sanford, *Energy Storage: Can We Get It Right?*, 39 ENERGY L. J. 447, 452 (Nov. 14, 2018).

156. *See* Schmitt & Sanford, 39 ENERGY L. J. 447, 451.

157. *Id.* at 455; *see* Dhruv Bhatnagar & Verne Loose, *Evaluating Utility Procured Electric Energy Storage Resources: A Perspective for State Electric Utility Regulators*, Sandia Report SAND2012-9422, SANDIA NAT'L LAB. 17 (Nov. 2012).

158. Schmitt & Sanford, *supra* note 155, at 475; *see* Notice of Proposed Rulemaking, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, [2016 Proposed Regs.] FERC Stats & Regs. ¶ 61,121, Fed. Reg. 9,580 (2016).

159. Schmitt & Sanford, 39 ENERGY L. J. 447, 475.

Energy storage is "new" in the sense that it has "not yet been widely adopted on the grid."[160] Because energy market rules were not designed with energy storage in mind, current energy market rules are out of alignment with the unique physical and operational characteristics of energy storage. Additionally, the current energy grid models and software are not able to handle the intricacies and complexities of energy storage, "such as its ability to deliver multiple services simultaneously."[161]

Currently, there is no uniform classification system for energy storage into the two traditional categories of generation and transmission. It is important to establish a legal definition for "energy storage" as a framework for an operational definition of "energy storage" for investment recovery cases.[162] Although "energy storage" does not fit neatly into federally or state-defined categorical definitions, energy storage can take the form of generation, load, or transmission.[163] Generation is "injecting energy into the grid or providing ancillary services," load is "withdrawing energy from the grid," and transmission is "transporting energy through time."[164] Another issue concerning categorization of energy storage is that FERC addresses the issue on a case-by-case basis.[165] This creates apprehension on the part of energy storage investment because the process is not an efficient, homogenous playing field.

Another issue concerning energy storage systems is whether they are regulated through federal or state authorities. This jurisdictional question is compounded by the complexities of how an energy storage company is structured and where on the grid the storage system is located.[166] If the transmission of electricity is either through interstate commerce or to the wholesale sale of electricity in interstate commerce, then FERC can exercise its federal jurisdiction; however, FERC does not regulate state and

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160. *Id.*

161. *Id.* at 476. S*ee generally* Andy Colthorpe, *Lack of Experience Holding Energy Storage Back as Non-Wires Alternative to T&D Spending*, NAVIGANT (Oct. 11, 2017), https://www.energy-storage.news/news/navigant-lack-of experience-holding-energy-storage-back-as-a-non-wires-alte.

162. Schmitt & Sanford, 39 ENERGY L. J. 447, 476.

163. *Id.*

164. *Id.*

165. *Id.* at 477.

166. *Id.* at 482. *See generally* David Pomper, *Pausing the Speed of Light: Rethinking the Basis for Federal Jurisdiction over Storage Services,* ELECTRICITYPOLICY.COM (2011), http://www.spiegelmcd.com/files/Pomper_merged_2011_11_15_02_26_56.pdf (last visited Mar. 26, 2019).

other federal power agencies.[167] According to FERC, states "would still have the authority to regulate retail services and the distribution grid."[168] FERC relies on the Supreme Court case *FERC v. Electric Power Supply Association* to assert its jurisdictional authority over wholesale market electricity regulation.[169]

Appropriately valuing energy storage is another unique challenge. Newer technologies for storage must "operate within existing market rules that were designed primarily around . . . fossil fuels."[170] "Value-stacking" also presents a valuation problem—combining multiple energy value streams into one system presents a financial risk to renewable energy investors that will continue until cost recovery systems are able to accurately price these "stacked benefits."[171] Additionally, the lack of an established and consistent revenue-generating model for value-stacked energy storage inhibits investment into this type of energy storage. A consistent valuation method must be reliable and show long-term success to "provide a return on capital investments for the projects to receive financing."[172] However, FERCissued a policy statement stating that stacked energy storage projects can obtain both market-based rates for generation and cost-recovery for transmission.[173]

Because energy storage cannot operate continuously at full capacity due to its unique technical and operating characteristics, it must first go through an "interconnectivity study process" under the Department of Energy's Energy Storage Program[174] as a way to "'ensure deliverability of energy and negotiate an interconnection agreement.'"[175] This process can take anywhere from one to three years,[176] which reduces energy storage advantages—energy storage can be put into commercial operation more

167. *See* 16 U.S.C. § 824(b)(1), (f) (2017).

168. Order No. 841 at 26.

169. *See FERC v. Electric Power Supply Ass'n*, 136 S. Ct. 760, 778–80 (2016).

170. Schmitt & Sanford, 39 ENERGY L. J. 447, 486.

171. *Id.* at 488. *See* Sydney Forrester et al., *Policy & Market Barriers to Energy Storage Providing Multiple Services*, 30 ELEC. J. 50, 51 (Nov. 2017).

172. Schmitt & Sanford, 39 ENERGY L. J. 447, 490.

173. *See* Policy Statement, *Utilization of Electric Storage Resources for Multiple Services When Receiving Cost-Based Rare Recovery*, 158 F.E.R.C. ¶ 61,501 (2017).

174. *Energy Storage*, DEP'T OF ENERGY, https://www.energy.gov/oe/activities/technology-development/energy-storage (last visited May 8, 2019).

175. Schmitt & Sanford, *supra* note 155, at 494 (quoting Buck Enderman et al., *Energy Storage Handbook*, K&L GATES 44 (2017), available at http://www.klgates.com/ePubs/Energy-Storage-Handbook-October2017/).

176. *Id.*

quickly, yet the lengthy interconnectivity process artificially reduces its speed. Currently the interconnectivity process uses a first-in-time method; however, this should be changed to a "first-ready, first-served approach," which would incentivize commercial operation priority.[177]

B. Transmission

As the regulatory framework currently stands, individual states manage their own procedures for siting transmissions lines. There is some regional cooperation and limited federal oversight, but ultimately the individual states interact with regional transmission organizations and independent system operators with regard to grid management.[178] While the need for new energy transmission infrastructure is necessary to meet increasing electricity demands, there remain obstacles associated with constructing multi-jurisdictional transmission systems. These obstacles include primary regulatory, at the state level for siting and permitting, "lack of robust federal authority or regional coordinating authority" when it comes to planning transmission infrastructure, and "difficulty in determining which electricity users should pay for new transmission lines."[179] Additionally, regional transmission organizations do not have authority of eminent domain, requiring the use of state eminent domain authority and potentially encountering "holdout" problems.[180] Regarding long-distance electricity transmission, smart grid developments[181] increases the efficiency of electricity transmission, enabling the integration of renewable energy sources into the electricity grid.[182]

V. Recommendations

A. Regional Multi-Terminal Configurations with Access to a Smart Grid

The United States should look to the proposed China to European Union electricity transmission link (hereinafter "China-EU transmission link") as a model for how to integrate multi regional electricity grids over long-range transmission lines. The China-EU transmission link is a proposed multi-

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177. Schmitt & Sanford, *supra* note 155, at 495.

178. Alexandra Klass & Elizabeth Wilson, *Interstate Challenges for Renewable Energy: A Federalism Mismatch*, 44 ENVTL. L. REP. 10705, 10706 (Aug. 2014).

179. *Id.* at 10706–07.

180. *Id.* at 10707.

181. Discussion of smart grid technologies, *infra* Section V.A.

182. Alexandra Klass, *Expanding the U.S. Transmission & Distribution Grid to Meet Deep Decarbonization Goals*, 47 ENVTL. L. REP. 10749, 10753 (Sept. 2017).

terminal configuration using high voltage direct current (HVDC). China launched this proposal in 2016 under its 2013 "One Belt, One Road" initiative.[183] The best analogy for this transmission link is to think of it as a digital silk road.

Most national electricity networks rely on alternating current. However, direct current is currently the best option for "large quantities of electricity transmitted over long distances"[184] because direct current is more stable than alternating current, allowing long transmission with low electricity loss.[185] Direct current runs continually in a single direction; however, it is not easy to convert direct current to different voltage levels.[186] On the other hand, alternating current can be converted into different voltage levels through a transformer, as the current alternates directions every few seconds.[187] Direct current is advantageous for the China-EU transmission link because of its better technical performances and reliability.[188]

Even though direct current is preferable for lengthy transmission lines, a continuous HVDC line would ultimately result in electricity loss. The solution proposed, then, is a multi-terminal configuration, connecting a thoroughfare of secondary transmission lines that inject or withdraw electricity while integrating various renewable energy sources along the proposed route, drawing from different regions' abundance of a particular renewable energy source.[189] A long, multi-terminal power interconnection spread over many regions and zones takes advantage of electricity demands of certain populations, as well as different sources of renewable energy that may be more prevalent in one region than another.[190] Demand for electricity depends on a number of factors, including the number of electric appliances present in a household, environmental conditions, time of year or season,

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183. Mircea Ardelean & Philip Minnebo, European Commission: JRC Science for Policy Report 2 (2017), *A China-EU electricity transmission link: Assessment of potential connecting countries and routes*, Publications Office of the European Union, *available at* https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/china-eu-electricity-transmission-link-assessment-potential-connecting-countries-and-routes (last visited May 8, 2019).

184. *Id.* at 1.

185. *The War of The Currents: AC vs. DC Power,* DEP'T OF ENERGY (Nov. 18, 2014), https://www.energy.gov/articles/war-currents-ac-vs-dc-power.

186. *Id.*

187. *Id.*

188. Ardelean & Minnebo, *supra* note 183, at 12–13.

189. *Id.* at 55.

190. *Id.*

and the presence of other power industries in the area.[191] Demand for electricity is not constant, however: there are peaks and troughs. As a result, a multi-terminal configuration would relieve the pressure on the electricity load by transmitting excess electricity to nearby places or remote locations.[192]

Drawbacks to constructing new electricity infrastructure include cost, community resistance, and lack of space. A solution to these problems would be to convert high voltage alternating current (HVAC) transmission lines into HVDC transmission lines: this would reduce the number of transmission lines and the amount of material used.[193] Converting HVAC to HVDC covers "changes to the conductor arrangement on the tower, the insulator assemblies and the configuration of the conductor;" that the changes are not made to towers or transmission lines.[194] For multiple-system transmission lines, as in the proposed China-EU transmission link, the HVAC to HVDC conversion procedure can be done in stages: first, direct current poles are placed on either side of a tower; second, the polarities are switched from alternating current to direct current.[195]

The China-EU transmission link posits three scenarios, all of which take distance, number of countries, and cost into consideration. The shortest route crosses six countries and requires a minimum of six converter terminals, for a total cost of 4 to 5 billion euros (€) for the converter terminals and €11 billion for transmission lines. The second short route crosses anywhere from eight to ten countries, as well as the Caspian and Black Seas. The cost of converters would rise to 6 to 8 billion euros and 10 billion euros for overhead transmission lines. For the Caspian and Black seas, submarine segments are necessary, which would cost an additional 5 to 6 billion euros. Finally, the longest route crosses eleven to thirteen countries, for a total cost of 7.5 to 9 billion euros for converter terminals and 17 billion euros for transmission lines.[196] In addition to cost consideration, geopolitical consideration must also be taken into account.

191. *Id.* at 57.
192. *Id.*
193. *Id.* at 80.
194. Michael Häusler, *Converting AC power lines to DC for higher transmission ratings*, 3 ABB REV. 4 (1997), available at https://library.e.abb.com/public/139412d24d16673fc1257b1a005b4ce8/04-11%20ENG%209703.pdf.
195. *Id.* at 7.
196. Ardelean & Minnebo, *supra* note 183, at 82.

For example, the more countries the route passes through, the more complex the permitting and licensing process becomes.[197]

Additionally, a U.S. regional multi-terminal transmission configuration could be connected with Smart Grid technology. Smart Grid technologies are "self-sufficient systems that can find solutions to problems quickly in an available system that reduces the workforce and targets sustainable, reliable, safe and quality electricity to all consumers."[198] A Smart Grid is an energy generation domain sharing information, such as energy supply and demand levels, with "the regional system operator, the power market, and the control center."[199] Like with most technology, a Smart Grid would be susceptible to data overload. Data density can be eliminated through the use of "multi-channel communication," with information networks splitting into zones or regions.[200] Intelligent network infrastructure covers "the management, the protection, the information and communication systems, the energy efficiency, the emissions, the power quality and the security of supply."[201] However, the "necessary equipment and infrastructure implementation is not available."[202] Figure 5[203] illustrates a Smart Grid framework.

197. *Id.* at 81.

198. Ramazan Bayindir et al., *Smart grid technologies and applications*, 66 RENEWABLE & SUSTAINABLE ENERGY REVS. 499 (Dec. 2016).

199. *Id.* at 500–501.

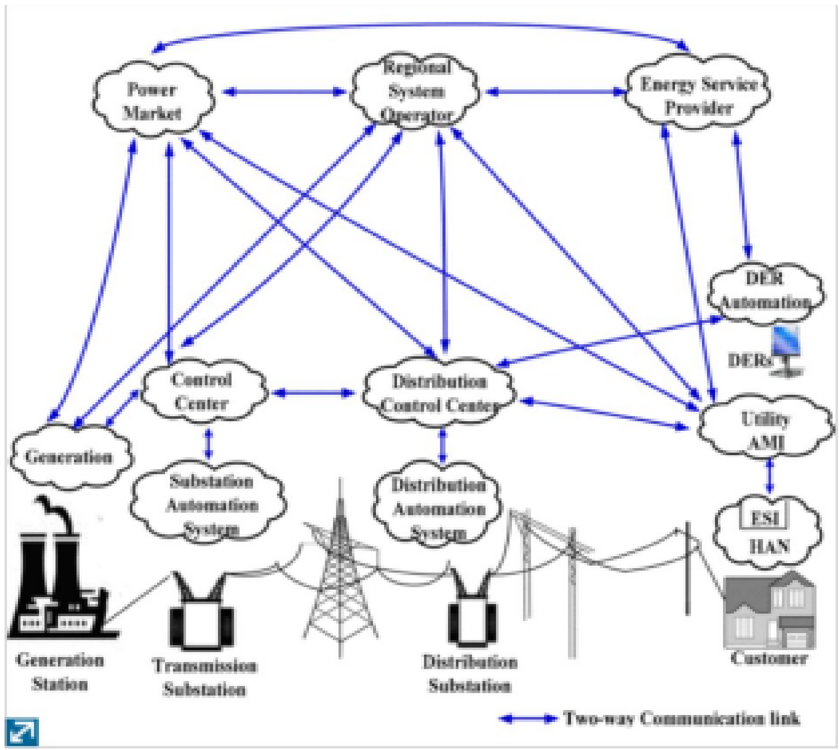
200. *Id.* at 500.

201. *Id.* at 502.

202. *Id.*

203. Palak Parikh et al., *Opportunities & Challenges of Wireless Communication Technologies for Smart Grid Applications*, Proceedings of Power Energy Soc. Gen. Meeting 2010 IEEE (July 25–29, 2010).

Figure 5. Smart Grid Framework.



B. Incentives

State and federal level tax exemptions for investment into alternative energy sources provide a strong financial incentive for the development of renewable energy transmission and storage. For example, Rhode Island allows a one hundred percent property tax exemption for "qualifying renewable energy systems and associated equipment used in residential and manufacturing facilities"[204] for renewable energy sources such as "direct solar radiation, wind, ocean, geothermal, small hydro, eligible biomass fuels, and fuel cells using renewable energy sources."[205] Similarly, Utah allows for sales tax exemptions for purchased or leased equipment used in alternative electric generation for resources such as nuclear fuel and waste

204. *Report of the Renewable Energy Subcommittee*, 38 ENERGY L.J. 1, 7 (Dec. 19, 2016) (citing 2016 R.I. Pub. Laws Ch. 163 (H.B. 8354A)).
205. *Id.* (citing 2016 R.I. Pub. Laws Ch. 163 (H.B. 8354A at 13)).

energy production, as well as "equipment used in renewable technologies like solar, wind, and geothermal."[206]

C. Proposed Actions in the United States

Over the years, there have been various proposed renewable energy legislations put forth in front of both houses of Congress. Unfortunately, most do not get very far. House Resolution 2746 was introduced on May 25, 2017, under the short title of "The American Renewable Energy and Efficiency Act."[207] The purpose of this resolution was "[t]o amend title VI of the Public Utility Regulatory Policies Act of 1978 to establish a Federal renewable electricity standard for retail electricity suppliers and a Federal energy efficiency resource standard for electricity and natural gas suppliers."[208] House Resolution 932 was introduced on January 30, 2019, under the short title of "The Renewable Certainty Act."[209] The purpose of this resolution is "[t]o authorize certain long-term contracts for Federal purchases of energy."[210] Senate Bill 520 was introduced on February 14, 2019, requesting that the Secretary of Energy "establish[s] an energy efficiency materials pilot program."[211]

In 2018, Former President Trump signed a bipartisan water infrastructure bill, establishing two government task forces to expedite the construction of electricity-producing hydropower systems.[212] The bill also addresses timelines for licensing and permitting. First, in converting conventional dams into hydropower electricity plants, FERC has 180 days to begin the process after licensing and permitting. Second, FERC will also expedite the construction of closed-loop storage energy projects to add electricity and more renewable energy sources to the grid. Decisions on construction of new facilities must be made in less than two years. The spending bill (6.1 billion dollars total) will be funded by the Department of Energy, which Former President Trump directed to sell off five million barrels of oil from the Strategic Petroleum Reserve by 2028.

206. *Id.* at 19; *see* UTAH CODE ANN. § 59-12-104 (47)(a) (West 2016).
207. H.R. 2746, 115th Cong. (May 25, 2017).
208. *Id.*
209. H.R. 932, 116th Cong. (Jan. 30, 2019)
210. *Id.*
211. S. 520, 116th Cong. (Feb. 14, 2019).
212. John Siciliano, *Trump just gave renewable energy a long-awaited victory*, WASH. EXAM'R (Oct. 23, 2018), https://www.washingtonexaminer.com/policy/energy/trump-just-gave-renewable-energy-a-long-awaited-victory.

Regarding the proposed regional multi-terminal transmission configuration, some states are beginning to propose or authorize multi-jurisdictional direct current transmission lines. In March 2019, Missouri regulators approved the Grain Belt Express transmission line, a 780-mile high-voltage power transmission line designed to deliver wind energy from the Midwest to the eastern power grid.[213] The project, which costs more than 2 billion dollars, had been rejected twice by the Missouri Public Service Commission following the opposition from some counties and individual landowners; however, following a Missouri Supreme Court decision,[214] the Missouri Public Service Commission reconsidered and approved the project. However, the Missouri House of Representatives voted to approve a bill limiting private companies' eminent domain authority for above-ground transmission lines.[215] Additionally, Direct Connect Development Company announced its proposal for an underground high-voltage direct current line called the SOO Green Renewable Rail Project.[216] The underground transmission line would transport wind energy from Iowa to the Greater Chicago Area along existing railroad rights-of-way.[217] A similar project, Rock Island Clean Line, was previously rejected due to proposed use of overhead transmission

213. David Lieb., *Missouri Regulators approve Midwest wind energy power line*, WASH. POST (Mar. 20, 2019), https://www.washingtonpost.com/business/missouri-regulators-approve-midwest-wind-energy-power line/2019/03/20/d105353c-4b31-11e9-8cfc-2c5d0999c21e_story.html?noredirect=on&utm_term=.383f6dca231d.

214. *Id.*; Grain Belt Express Clean Line, LLC v. Public Serv. Comm'n, 555 S.W.3d 469 (Mo. 2017) (holding that state regulators erred in denying the Grain Belt Express transmission line).

215. H.B. 1062, 100th Gen. Assemb., 1st Reg. Sess. (Mo. 2019). As of May 8, 2019, the Missouri Senate was unable to come to a vote on the same issue. *See Bill targeting wind energy line stalls in Missouri Senate*, WASH.POST (May 9, 2019), https://www.washingtonpost.com/national/energy-environment/bill-targeting-wind-energy-line-stalls-in missouri-senate/2019/05/09/342f589a-726f-11e9-9331-30bc5836f48e_story.html?utm_term=.0a2f115f648b.

216. Karen Graham, *Company proposes underground line to carry wind power to Chicago*, DIGITAL J. (Mar. 12, 2019), http://www.digitaljournal.com/business/company-proposes-underground-line-to-carry-wind-power-to chicago/article/545133; *see* The SOO Green Renewable Rail Project, http://www.soogreenrr.com (last visited Mar. 26, 2019).

217. Graham, *supra* note 216.

lines;[218] however, an underground transmission line could be operational as soon as 2024 if approved.[219]

Conclusion

The United States should follow the example of the European Union countries with clear implementing regulations concerning renewable energy systems by adopting a federal renewable energy directive with a transparency platform, incentivized by state and federal level tax exemptions for renewable energy investments within the United States. While there may not be practical application within the United States, in theory, the ideal proposal for renewable energy transport systems within the country is a regional, multi-terminal configuration coupled with conversion of alternating current electricity infrastructure to direct current electricity infrastructure. Proposed legislations on renewable energy seem to be gaining traction at both the state and federal level; however, the issue remains fiercely bipartisan and will continue to face legislative roadblocks.

218. *See generally* Ill. Landowners All., NFP v. Ill. Commerce Comm'n, 2017 IL 121302 (holding that state regulators improperly approved the Rock Island Clean Line project).
219. Graham, *supra* note 216.