Washington and Lee Journal of Energy, Climate, and the Environment

Volume 5 | Issue 1 Article 6

9-1-2013

"Turn on the Lights"—Sustainable Energy Investment and Regulatory Policy: Charting the Hydrokinetic Path for Pakistan

Nadia B. Ahmad
Sustainable Development Strategies Group

"Turn on the Lights"[1]—Sustainable Energy Investment and Regulatory Policy: Charting the Hydrokinetic Path for Pakistan

Nadia B. Ahmad*

Abstract

Hydrokinetic energy is an under-recognized, low-cost renewable technology that can be deployed in Pakistan through a robust national energy strategy and international investment schemes to tackle the country's acute energy crisis. This article will show how national and local laws can be amended to favor progress in the sustainable energy sector and achieve hydrokinetic energy production in Pakistan, which if actualized, would be nothing short of a game changer—strategically and environmentally. Despite current legal regimes that disfavor small scale hydroelectric power production, Pakistan and other less developed countries can adapt and deploy hydrokinetic technology through revamped investment laws, regulatory rules, and renewable energy tax reform.

Table of Contents

---

1. FUTURE, TURN ON THE LIGHTS (Epic Records 2012).

* Legal Fellow, Sustainable Development Strategies Group; LL.M. University of Denver Sturm College of Law; J.D. University of Florida Levin College of Law; B.A. University of California at Berkeley. This Article has benefited from feedback and questions by the faculty and participants at Harvard Law School's Institute for Global Law and Policy 2013 Workshop in Doha, Qatar. It has also been shaped by discussions at the 2012 Vail Global Energy Forum, the 2012 World Renewable Energy Forum, and the University of Denver's Second Annual Renewable Energy Law & Policy Summit: Driving the Development of Renewable Energy. The author thanks Luke Danielson, K.K. DuVivier, Annecoos Wiersema, Liaquat Ali Khan, Tayyab Mahmud, Dan Danielson, Usha Natarajan, Awang Ollong Kingsley, Luwam Dirar, Oluwakemi Ayanleye, Nurfadzilah Yahaya, Shazia Ahmad, and Rubina Ahmad for their comments on earlier drafts of this article. She also expresses her gratitude to Berta Esperanza Hernández-Truyol, Federico Cheever, Ved Nanda, Don Smith, Joan Policastri, Al Gasiewski, Terri Day, Cecilia Dalupan, Kristi Disney, Marketa Zubkova, and Lucy Daberkow, for their ideas and support. Special thanks to Akmal and Senan. This Article is dedicated to my parents and grandparents.

I. Introduction

> *The path towards sustainable energy sources will be long and sometimes difficult. But America cannot resist this transition; we must lead it.*[2]

In his second inaugural address, President Barack Obama ratcheted up the call for sustainable energy development.[3] Looking beyond America's own borders, it is important to consider energy projects in less developed countries (LDCs).[4] Among such prospects, Pakistan is arguably the most

---

2. President Barack Obama, Inaugural Address (Jan. 21, 2013), *available at* http://www.whitehouse.gov/the-press-office/2013/01/21/inaugural-address-president-barack-obama.

3. *See generally id*. (calling for America to lead the transition toward sustainable energy).

4. *See* Nino Marchetti, *Small Scale Renewable Energy in Developing Countries*, THE ENERGY COLLECTIVE (Feb. 24, 2012), http://theenergycollective.com/namarchetti/77475/small-scale-renewable-energy-and-informal-economy (addressing arguments for the use of renewable energy in developing

vital country for advancing U.S. security interests.[5] Pakistan's energy crisis is of concern not only to itself but also worldwide.[6] Having pledged over $30 billion in aid to Pakistan since 1948, the United States has overlooked the feasibility of nascent energy technologies to relieve the country's acute energy crisis.[7] As a part of the civilian assistance program to Pakistan, the U.S. Department of State and USAID recognized the need for alleviating energy poverty and creating sustainable energy options in Pakistan.[8] Until now, hydrokinetic energy was ignored as a solution to Pakistan's energy crisis.[9] The aim of this article is to furnish a preliminary framework for how this under-recognized, potentially low-cost renewable technology can be deployed in Pakistan through a robust national energy policy strategy and international investment schemes. Even though current legal regimes disfavor small-scale hydroelectric power production,[10] Pakistan and other similarly situated LDCs can adapt and deploy hydrokinetic technology through revamped renewable energy laws, rules, and tax reform.[11] This

---

countries) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

5. *See* INT'L SEC. ADVISORY BD., U.S. DEP'T OF STATE, PAKISTAN AND U.S. SECURITY STRATEGY 4 (2012), *available at* http://www.state.gov/t/avc/isab/199411.htm (detailing the critical nature of U.S.-Pakistani relations with respect to national security and the Department of State's strategic plan for working with Pakistan).

6. *See* Phillip Reeves, *Energy Crisis Cripples Pakistan's Economy*, NATIONAL PUBLIC RADIO (July 5, 2013, 3:50 PM), http://www.npr.org/templates/story/story.php?storyId=199114105 (describing Pakistan's energy crisis and the chronic power outages that affect its citizens) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

7. *See* SUSAN B. EPSTEIN & K. ALAN KRONSTADT, PAKISTAN: U.S. FOREIGN ASSISTANCE 2 (2012), *available at* http://www.fas.org/sgp/crs/row/R41856.pdf (reporting changes in U.S. foreign assistance for various security, energy, and stability needs in Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

8. *See* U.S. DEP'T OF STATE, CONGRESSIONAL BUDGET JUSTIFICATION: DEPARTMENT OF STATE OPERATIONS FISCAL YEAR 2013 141–42 (2013), *available at* http://www.state.gov/documents/organization/181061.pdf (describing the Bureau of Energy Resources plan to advance market and regulatory reforms in renewable energy on a global scale to help developing nations like Pakistan and Iraq).

9. *See* EPSTEIN & KRONSTADT, *supra* note 7, at 4 (discussing Pakistan's energy crisis and current plans to bolster renewable energy sources).

10. *See* Asad Umar, *The Role of the Private Sector in Pakistan's Energy Sector*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 141, 148 (Robert M. Hathaway, Bhumika Muchhala & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf (describing the legal and political barriers that obstruct the development of hydroelectric energy in Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

11. *See id.* at 148 ("Even though Pakistan has a large hydel potential, and several mega-storage and power generation projects have been identified and studied, this field

Article analyzes governance, regulatory, investment, and environmental law and policy in Pakistan for the use of hydrokinetic energy, a low-carbon, high-output energy alternative, which, if actualized, would be nothing short of a game changer both strategically and environmentally. This article will show how national, regional, provincial, and local laws can be amended to support progress in the sustainable energy sector and achieve hydrokinetic energy production in Pakistan.

Hydropower has historically been Pakistan's energy source of choice, accounting for one-third of the nation's electricity generation.[12] For that reason, the use of hydrokinetic energy would be an extension of the prevailing energy infrastructure and power grid system.[13] Hydrokinetic energy harnesses the power from the natural flow of water in streams and waves for electrical generation by using small turbines placed directly in the water.[14] While the engineering and design for hydrokinetic electricity generation are evolving, the potential is extraordinary in various LDCs by retooling energy, environmental, and investment laws.[15] Hydrokinetic energy can be among this millennium's major renewable energy sources with the right technological innovations and investment laws.[16] Although the methodology proposed in this article is country-specific, it can be expanded to other LDCs and restructured based on different national requirements, because many of the legal recommendations for supporting the sustainable energy growth are universal.[17]

---

remains marred in political controversy and disagreement amongst the provinces.").

12. *See* WORLD ENERGY COUNCIL, WORLD ENERGY TRILEMMA: 2012 WORLD ENERGY SUSTAINABILITY INDEX 85 (2012), *available at* http://www.worldenergy.org/documents/2012_energy_sustainability_index_vol_ii.pdf (discussing the different sources of energy in Pakistan and explaining the feasibility of alternative energy usage) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

13. *See id.* at 85 (explaining how Pakistan's preexisting hydropower infrastructure could make for a smooth transition to hydrokinetic energy).

14. U.S. DEP'T OF ENERGY, WIND AND WATER POWER PROGRAM FUNDING IN THE UNITED STATES: MARINE AND HYDROKINETIC ENERGY PROJECTS 3 (2012), *available at* http://www1.eere.energy.gov/water/pdfs/mhk_project_2011.pdf (defining hydrokinetic power and detailing various projects in the U.S.) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

15. *See* Marchetti, *supra* note 4 (explaining the potential for the development of hydrokinetic energy and the barriers that impede the process).

16. *See* U.S. DEP'T OF ENERGY, *supra* note 14, at 5 ("Although the marine and hydrokinetic (MHK) industry is at a relatively early stage of development compared to other renewable energy technologies (such as wind and solar power), the rivers, coasts, and oceans of the United States represent significant potential as a renewable energy resource.").

17. *See, e.g.*, Veronica B. Miller et al., *Hydrokinetic Power for Energy Access in Rural Ghana*, 36 RENEWABLE ENERGY 673, 676 (2011) (describing the use of hydrokinetic energy in Ghana).

Moreover, the deployment of hydrokinetic energy complements the United Nations Sustainable Energy for All initiative, which focuses on the necessary connection between clean energy development and defeating poverty.[18] This renewable energy development initiative is stimulated by fears of energy security and concerns that environmental degradation caused by conventional fossil fuels must be mitigated.[19] Pakistan has a significant amount of renewable energy resources in the form of solar, wind, geothermal, biomass, and hydropower.[20] These resources remain untapped.[21] Energy sources derived from extractive industries such as coal, oil, and gas may provide Pakistan with enough energy to power its electrical grid, but these fossil fuel sources are unreliable and unsustainable.[22] The current legal regime favors fossil fuels through government-backed subsidies and loan guarantees.[23] Having legal mandates, including a national renewable energy portfolio and renewable energy targets (RETs) to promote the diversity of energy sources, lays the foundation for a reliable electrical system.[24] Regulatory and governance

---

18. *See* BAN KI-MOON, SUSTAINABLE ENERGY FOR ALL: A VISION STATEMENT BY BAN KI-MOON SECRETARY GENERAL OF THE UNITED NATIONS 4 (2011), *available at* http://www.un.org/wcm/webdav/site/sustainableenergyforall/shared/Documents/SG_Sustainable_Energy_for_All_vision_final_clean.pdf (discussing the three goals of the Sustainable Energy for All initiative, including: "[(1) e]nsuring universal access to modern energy services. [(2) d]oubling the rate of improvement in energy efficiency. [(3) d]oubling the share of renewable energy in the global energy mix") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

19. *See id.* at 2–3 (discussing the global importance of energy and the reasons for the need of a change in energy policy); *see also* U.S. DEP'T OF ENERGY, WATER POWER PROGRAM: WATER POWER FOR A CLEAN ENERGY FUTURE 4 (2013), *available at* http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf (explaining the various environmental and economic benefits of developing water power) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

20. Saleem Shaikh, *Pakistan's Renewable Energy Awaits Tapping*, SCIDEV.NET (May 23, 2012), http://www.scidev.net/global/climate-change/news/pakistan-s-renewable-energy-awaits-tapping.html (discussing Pakistan's renewable energy resources) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

21. *See id.* ("Pakistan's massive, unexploited renewable energy sources, particularly hydroelectric and solar, can help plug its widening energy deficit and improve livelihoods.").

22. *See* Reeves, *supra* note 6 (explaining that the constant blackouts and outages in Pakistan are a result of the energy shortages throughout the country).

23. *See* Shahid Javed Burki, *The Weight of History: Pakistan's Energy Problem*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 35, 37–40 (Robert M. Hathaway, Bhumika Muchhala, & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf (discussing the make-up of the current energy system in Pakistan and the government's role in creating the current energy crisis) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

24. *See generally* Roger Bedard, Elec. Power Research Inst., Presented at the DOE Hydrokinetic Workshop: Hydrokinetic Energy "Lay of the Land" (Oct. 26, 2005) *available*

mechanisms to attract investment in alternative energy are necessary to make a next generation energy technology, like hydrokinetic energy, cost-competitive with existing renewables, and even conventional fossil fuels.[25] This article will also look at how the legal issues associated with intercorporate debt, corruption, and the lack of investment regimes bolster an increasing overreliance on fossil fuels that sideswipe and undermine environmental law reform and sustainable energy growth.[26]

This article consists of four parts. Part II of this article will discuss the shortage of energy in Pakistan and its root legal causes, the suitability of hydrokinetic energy for Pakistan, and what Islamabad policymakers can do by way of legal reform to promote hydrokinetic energy as a sustainable energy option. Parts III and IV turn toward legal impediments to implementation and specific policy measures for hydrokinetic energy investment regimes. Part V of this article will address law and policy measures for sustainable energy generation that have been successful internationally and how Pakistan can enhance its own laws to support international investment and sustainable development.

II. Status of Pakistan's Power Industry

Unreliable energy and power outages exacerbate Pakistan's economic and educational woes.[27] The energy crisis is sparked simultaneously by top-down issues at the federal government level and bottom-up factors such as the theft of electricity.[28] This inability to have

---

at http://hydropower.inel.gov/hydrokinetic_wave/pdfs/day1/01_overview.pdf (discussing the varieties of wave energy resources and conversion methods) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

25. *See infra* Part IV.B (discussing a variety of tax models that would promote investment in renewable alternative energy projects in Pakistan).

26. *See infra* Part III.A (addressing the problem of circular debt in Pakistan and the negative effects it has on the growth of reliable energy in Pakistan).

27. *See Energy Crisis Worse than Terrorism: Shahbaz Sharif,* NATION (June 18, 2012), http://www.nation.com.pk/pakistan-news-newspaper-daily-english-online/lahore/18-Jun-2012/energy-crisis-worse-than-terrorism-shahbaz-sharif (describing energy shortages that interfere with school and university schedules, as well as blackouts that impact factory production and hinder economic activity in other businesses) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT); s*ee also* Lakshman D. Guruswamy, *Sustainable Energy: A Preliminary Framework*, 38 IND. L. REV. 671, 674 (2005) ("Because the demand for oil and gas far exceeds the supply within those countries that rely most heavily upon them, these countries are compelled to import oil and gas from politically volatile parts of the world.").

28. *See* Reeves, *supra* note 6 ("Pakistan's public sector distribution and energy producing companies are hugely inefficient and afflicted by corruption and theft. A lot of people don't pay their electricity bills.").

dependable electricity creates geopolitical instability.[29] "Protesters in several towns in Punjab, Pakistan's wealthiest province, have smashed windshields, blocked roads, shut down markets, and set fires to the offices of parliamentarians and an electric utility. [Protestors] have clashed with police, who brought out handcuffs and tear gas and fired live rounds in the air."[30] Any solution for energy reliability and efficiency will require a strategy that looks at the energy crisis from a top-down and bottom-up perspective.[31] Employing a one-way energy strategy of top-down or bottom-up is not practical.[32] It has not worked in the United States and would be bound to fail in Pakistan as well.[33]

In the intervening time, the clean energy movement is sweeping across Europe, China, India, and Canada.[34] Renewable energy provides the hope of meeting energy consumption demand and increasing energy efficiency in South Asia, an area traditionally prone to blackouts, energy shortages, and aging energy infrastructure.[35] The need for energy in Pakistan is widespread.[36] The inability to turn on a light switch is of serious concern and typifies the condition of extreme poverty, class inequality, and

---

29. *See Pakistan's Energy Crisis: Power Politics,* THE ECONOMIST (May 21, 2012 7:05 PM), http://www.economist.com/blogs/banyan/2012/05/pakistan%E2%80%99s-energy-crisis ("Under the current government, the power sector has neared the top of a list of security, political and foreign-policy problems that includes some heavyweight contenders.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

30. *Id.*

31. *See, e.g.*, Kevin L. Doran, *Can the U.S. Achieve A Sustainable Energy Economy from the Bottom-Up? An Assessment of State Sustainable Energy Initiatives*, 7 VT. J. ENVTL. L. 3, 3 (2006) (explaining that America has not "achieved the ideal of a sustainable energy economy" on the national level despite the efforts of individual states).

32. *See id.* at 4 ("[W]ithout a uniform national regulatory regime, there is a risk that actors will engage in a 'race to the bottom' by locating in states that have not enacted stringent or any regulatory restrictions.").

33. *See generally id.* (discussing the failure of U.S. efforts to achieve sustainable energy because of a lack of both federal and state commitment to the project).

34. *See* discussion *infra* Part V.B (comparing hydrokinetic projects in the United Kingdom, Canada, India, Sri Lanka, Ghana, and China).

35. *See* Basharat Peer, *India Without Power*, THE NEW YORKER (Aug. 1, 2012), http://www.newyorker.com/online/blogs/newsdesk/2012/08/india-blackout-power-outage.html. ("[On July 30, 2012,] India underwent the largest power outage in its history. Six hundred million people were without power because of the collapse of the energy grid.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

36. *See* Mukhtar Ahmed, *Meeting Pakistan's Energy Needs, in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 17, 18–23 (Robert M. Hathaway, Bhumika Muchhala, & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf (discussing Pakistan's energy supply and demand).

lack of education, infrastructure disrepair, and lost hopes.[37] The reason Pakistan's energy woes take center stage is because of Pakistan's role in larger geopolitical conflicts.[38] In other Asian nations and throughout Africa, reliable energy is a cause for concern, but in Pakistan the lack of energy contributes to heightened anxiety because of increased violence, a deteriorating education system, rapid escalation of crime, rising health problems, and economic instability.[39] Having a dependable source of electricity would be a watershed moment for Pakistan and the surrounding region.[40]

Pakistan's energy industry is underdeveloped and highly inefficient. Only seventy-eight percent of its urban population and forty-six percent of rural people have access to electricity.[41] This disparity in electricity supply between urban centers and rural places is typical in LDCs.[42] Energy supply and access to energy is a concern to various sectors of the population.[43] Access to clean and reliable energy is the key for the stability and prosperity of Pakistan; the shutting down of production units contributes to unemployment and, in turn, to street crime and violence.[44] Since only sixty-two percent of the population has access to electricity, the sustained growth in consumption of electricity is also important.[45] Low electricity access rates correlate with low levels of social equity.[46]

---

37. *See Pakistan's Energy Crisis*, *supra* note 29 (explaining the broader political and social ramifications and causes of mass riots in response to power outages).

38. *See id.* (identifying Pakistan's government officials and their role in the energy crisis).

39. *See id.* ("Riots over power shortages in Pakistan are not new.").

40. *See* Shaikh, *supra* note 20 (describing how Pakistan's alternative energy sources await tapping).

41. *See* Denise Recheis, *Current Energy Crisis in Pakistan*, REEGLEBLOG (Dec. 1, 2011), http://blog.reegle.info/blog/current-energy-crisis-in-pakistan.htm ("Even though the country is blessed with energy resources, only seventy-eight percent of its urban population and forty-six percent of rural people have access to electricity.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

42. *See, e.g.*, Marchetti, *supra* note 4 ("Kenya's power grid does not reach the small farming village of Kiptusuri, making it difficult for local farmers to charge their cell phones.").

43. *See id.* (explaining the hardships associated with power outages).

44. *See Pakistan's Energy Crisis*, *supra* note 29 ("In the town of Vehari, rioters burned the offices of lawmakers belonging not only to a ruling coalition partner . . . but also the PML-N and the Pakistan Tehreek-e-Insaf, the party of Imran Khan, who positions himself as the country's only hope for change.").

45. World Energy Council, *supra* note 12, at 85.

46. *See id.* (explaining the relationship between energy access and societal factors in Pakistan).

Pakistan's power crisis has led to unannounced power cuts lasting as long as twelve hours in many areas of the country.[47] The energy crisis is expected to only worsen with demand projected to reach 50,000 megawatts (MW) by 2030, an amount which is three times higher than the supply presently available in the system.[48] Pakistan's energy problems have distinct causes, including the lack of integrated planning and forecasting, the absence of a central organization responsible for the energy sector, and an imbalanced energy mix.[49] The country has the potential to satisfy seventy-five percent of its energy needs through domestic resources, including oil, gas, and hydroelectricity production.[50]

Public discontent has grown at the perceived lack of tangible improvements in energy generation and distribution.[51] Businesses are forced to shut down for part of the week as a result of the energy deficit, forcing many into bankruptcy.[52] The power outages are a source of constant frustration.[53] Demand for electricity peaks in the summer at around 18,000 MW, "but power companies only manage to supply 13,000 to 14,000 MW."[54] For example, in the sacred month of Ramadan when Muslims fast from dawn to dusk, the inability to use central air conditioning units, ceiling fans, and other electrically-generated cooling devices can prove to be excruciating when temperatures approach 122 degrees Fahrenheit.[55]

---

47. *See* Recheis, *supra* note 41 ("Pakistan's power crisis has led to an acute electricity shortfall and unannounced power cuts of up to 12 hours in many areas of the country.").

48. *See, e.g.*, Navin Singh Khadka, *South Asia's Energy Crisis Demands Collective Action*, BBC NEWS (Aug. 12, 2012), http://www.bbc.co.uk/news/business-19107372 ("Pakistan's power crisis is going from bad to worse, with demand projected to reach 50,000 megawatts (MW) by 2030—three times more than the supply currently available in its system.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

49. Recheis, *supra* note 41.

50. *See id.* (describing Pakistan's potential to sustain its energy needs domestically).

51. *See id.* ("Access to clean and reliable energy is the key for the stability and prosperity of Pakistan; the fact that production units keep on shutting contributes to unemployment and in turn to street crime and violence.").

52. *See Lights Out: Pakistan's Energy Shortage*, THE ECONOMIST (Oct. 8, 2011), *available at* http://www.economist.com/node/21531495 ("Power shortages are estimated to slice some 3–4% of GDP.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

53. *See* Recheis, *supra* note 41 (describing the frustrations that lead to protests and riots in Pakistan).

54. *No End in Sight for Pakistan's Energy Crisis*, THE EXPRESS TRIBUNE (Aug. 8, 2012), http://tribune.com.pk/story/419175/no-end-in-sight-for-pakistans-energy-crisis/ (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

55. *See id.* (detailing the inconveniences of living without power in Pakistan during the summer months).

Pakistan's economic outlook has remained grim since 2008 because of its energy shortages.[56] Even though India also suffers energy shortages, India has invested in instituting national, state, and municipal level policies to improve its energy crisis.[57] Pakistan has recognized this predicament, but has not taken substantial affirmative steps to reduce foreign energy exports or expand its renewable energy sector.[58] Energy sustainability extends beyond economic analysis because reliable energy is "essential to sustaining the economy, maintaining organized and productive markets, and protecting individual survival."[59]

A. Energy Portfolio

In spite of the internal political dynamics and grim economic outlook, Pakistan is still a prime country for the deployment of hydrokinetic energy.[60] The country's specific wind, current, and water conditions are ideal for the production of hydrokinetic energy.[61] Those considerations along with the country's short and long-term energy needs are why hydrokinetic energy is well-suited as a sustainable energy option in Pakistan. An examination of Pakistan's energy portfolio shows how hydrokinetic energy can enter the mix and why the existing energy sources are inadequate.[62] This subsection will first examine conventional energy sources and then turn to advances in the renewable energy sector.

---

56. *See* Mohsin Khan & Shuja Nawaz, *Pakistan's Bleak Outlook Lightened by the Game-Changer with India*, EAST ASIA FORUM (Dec. 30, 2012), http://www.eastasiaforum.org/2012/12/30/pakistans-bleak-outlook-lightened-by-the-game-changer-with-india (describing inflation, deficits, and external imbalances caused by the energy crisis) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

57. *See* SUN-JOO AHN & DAGMAR GRACZYK, UNDERSTANDING ENERGY CHALLENGES IN INDIA: POLICIES, PLAYERS, AND ISSUES 21–23 (2012), *available at* https://www.iea.org/publications/freepublications/publication/India_study_FINAL_WEB.pdf (discussing India's 2008 Integrated Energy Policy which focuses on access to energy, energy security, and self-sufficiency) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

58. *See No End in Sight For Pakistan's Energy Crisis*, *supra* note 54 ("The government is keen to develop nuclear power as it tries to wean itself off expensive imported hydrocarbons—the country spends 7.5 percent of GDP on buying fuel, according to the Planning Commission.").

59. Irma S. Russell, *The Sustainability Principle in Sustainable Energy*, 44 TULSA L. REV. 121, 126 (2008).

60. *See No End in Sight For Pakistan's Energy Crisis*, *supra* note 54 ("The rivers and valleys of the mountainous north may offer more than 50,000 MW of untapped hydroelectric potential.").

61. *See id.* (discussing Pakistan's energy potential).

62. *See* Shaikh, *supra* note 20 (explaining the inadequacies in Pakistan's current energy resources).

Understanding the current state of the energy sector is necessary to understand the benefit that hydrokinetic energy provides to the energy portfolio. A diverse energy portfolio is fundamental for reliable and cost-effective energy.[63]

Power shortages are estimated to reduce three to four percent of Pakistan's GDP.[64] During 2008–09, the share of gas in the energy supply mix increased marginally to 48.3% from 47.5% in 2007–08, and stood at 30.2 million tons of oil equivalent (mtoe).[65] The growth in the use of oil supplies over the last few years was fueled by an increase in the consumption of furnace oil by the power sector due to a shortage of gas, as well as an inadequate supply of water for hydroelectricity generation.[66] In 2008–09 hydroelectricity declined slightly from 6.8 mtoe in 2007–08 to 6.6 mtoe.[67] Enhancing fuel efficiency would not only increase the electricity output from the available fuel sources, but also reduce prices by lowering the cost of production.[68]

Pakistan has been sought out for development projects in the past, but hydrokinetic energy is unique because it can be scaled to the circumstances of a given locality.[69] For example, in Karachi, Pakistan's largest city, hydrokinetic energy can be harnessed from the sea in large

---

63. *See id.* (suggesting that Pakistan should be drawing energy from diverse sources rather than relying solely on fossil fuels and other non-renewable sources).

64. *See Light's Out*, *supra* note 52 (noting that power shortages are adversely affecting Pakistani businesses, forcing them to shut down and potentially go bankrupt).

65. *See* Sumita Kumar, *Pakistan's Energy Security: Challenges and Options*, 34 STRATEGIC ANALYSIS, 912, 913 (2010) (describing the increase of gas as a share of the energy supply mix, and noting that "[t]he share of natural gas is the largest in Pakistan's energy consumption").

66. *See id.* at 913 (blaming increased furnace oil consumption and inadequate water supplies for Pakistan's increased reliance on oil).

67. *See id.* ("Hydro-electricity registered a slight decline and stood at 6.6 mtoe in 2008–2009 as compared to 6.8 mtoe in 2007–2008.")

68. *See Energy Report Points at Faults in Pakistani Systems*, THE NEWS (Aug. 27, 2012), http://www.thenews.com.pk/Todays-News-2-128444-Energy-report-points-at-faults-in-Pakistani-systems ("The report suggested that enhancing fuel efficiency (per unit generation) would not only help produce more electricity from the available fuel, but also help reduce power prices by bringing down the cost of production at cheaper rate.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT); *see also* Arshad H. Abbasi, *Pakistan Power Sector Outlook: Appraisal of the Karachi Electricity Supply Company (KESC)*, *in* POST PRIVATIZATION PERIOD, THE SUSTAINABLE DEVELOPMENT POLICY INST. (Arshad H. Abbasi & Fareeha Mehmood eds., 2012) (noting that energy efficiency would lead to saving "the scarce fiscal resources that the government spends on subsidizing the power sector").

69. *See* Burki, *supra* note 23, at 51 ("[T]he Indus River is longer than the Columbia, with a catchment area almost twice as large, but generates only half the amount of energy. The bulk of the 6,460 MW of electricity produced by the Indus system comes from two dams . . . on the Jhelum and . . . on the Indus.").

quantities with the requisite equipment, whereas in Gilgit or Multan hydrokinetic energy can be secured through rivers and streams from smaller community-based systems.[70]

Looking at the existing energy portfolio of Pakistan will show why it is depressed and how Pakistan can benefit from hydrokinetic energy. Hydrokinetic energy will not constitute a sizeable portion of the national energy portfolio; however, it can bridge the gaps in energy supply during peak and off-peak times, especially in rural areas and high population density areas along the Arabian Sea.[71] Breakthrough technologies impacting energy supply and demand will be necessary to address climate change, air quality, and energy security.[72] Understanding the inadequacies of current energy sources will show why a new energy source is critical in a nation suffering from an acute energy crisis.[73]

Natural gas is the number one energy source for Pakistan.[74] Pakistan consumes all the natural gas produced domestically, which amounts to nearly 968 billion cubic feet annually.[75] In 1952, natural gas was discovered in Baluchistan at the Sui field, a discovery that has since proved to be the country's largest gas reservoir.[76] Given the extent of onshore exploration activity within the country, it is highly unlikely that natural gas production is going to increase significantly in the foreseeable future.[77] In all probability, the production of natural gas will decline over the next couple of decades, even as demand increases for cheaper alternative fuels like coal and hydropower.[78] In the short term, Pakistan has

---

70. *See id.* (noting that different regions will require different systems to capture energy from different hydropower sources).

71. *See id.* (arguing the that Pakistan government will need to develop the political will to harness its hydroelectric potential).

72. *See* Gary E. Marchant, *Sustainable Energy Technologies: Ten Lessons from the History of Technology Regulation*, 18 WIDENER L.J. 831, 832 (2009) (explaining the need for innovation to solve global energy and environmental crises).

73. *See generally id.* (discussing the imperative of technological innovation in sustainable energy and the means to achieve it).

74. *See* Burki, *supra* note 23, at 40 (indicating in a chart that natural gas is and will likely remain Pakistan's primary source of energy).

75. *See* Kumar, *supra* note 65, at 913 ("Pakistan consumes all the domestic natural gas that it produces . . . .").

76. *See Sui Gas Field*, PAKISTAN PETROLEUM LIMITED, http://www.ppl.com.pk/content/sui-gas-field-overview (last visited Sept. 28, 2013) (noting the year of the field's discovery and that it entered service in 1955) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

77. *See* Kumar, *supra* note 65, at 913 (noting that it is unlikely that natural gas production will increase).

78. *See id*. ("Statistics show that in the year 2007–2008, the power sector was the largest consumer of gas (33.5% share), followed by the industrial sector (23.8%), household (18.1%), fertilizer (15.6%), transport (5.4%) and cement (0.9%).").

actively been pursuing the Iran-Pakistan Gas Pipeline Project and the Turkmenistan-Afghanistan-Pakistan-India Gas Pipeline Project to combat its energy shortages.[79] Over the long-term, natural gas use remains unclear.[80]

Because Pakistan's limited oil reserves cannot sustain its increasing energy demands, it imports oil.[81] The country, however, does have 944 million barrels of crude oil reserves that have been discovered, of which 680 million barrels have already been produced.[82] It is estimated that Pakistan has oil reserves of 300 million barrels.[83] Pakistan is dependent on West Asian countries for more than eighty percent of its oil and petroleum products.[84] Pakistan recently shelved plans to import petroleum product from India until 2014 due to variations in fuel environmental quality.[85] Moreover, the high carbon footprint of petroleum makes it an unattractive long-term energy strategy;[86] however, it is essential for immediate energy demands.[87]

---

79. *See Iranian Gas Will Flow In Pakistan from Dec 2014: Dr. Asim*, INT'L NEWS NETWORK (Sept. 5, 2012), http://www.onlinenews.com.pk/details.php?newsid=201604&catname=Business (discussing Pakistan's Minister for Petroleum and Natural Resources plans to import Iranian gas) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

80. *See id.* ("Demand for natural gas has outstripped supply in recent years, putting existing reserves under immense pressure.").

81. *See id*. (explaining Pakistan's dependence on oil imports).

82. PAKISTAN MINISTRY OF PETROLEUM AND NATURAL RESOURCES, FOSSIL FUELS OVERVIEW 2011, *available at* http://www.mpnr.gov.pk/gop/index.php?q=aHR0cDovLzE5Mi4xNjguNzAuMTM2L21wbnIvdXNlcmZpbGVzMS9maWxlL0ZPU1NJTCUyMEZVRUxTJTIwT1ZFUlZJRVctMjAxMS5wZGY%3D (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

83. *See* Kumar, *supra* note 65, at 914 ("While Pakistan's oil production is estimated to be about 60,000 barrels per day, of which approximately ninety-seven percent is crude oil, it consumes about 350,000 barrels of oil and various petroleum products per day.").

84. *Id.* Even though Pakistan witnessed vigorous oil exploration and development activity in the 1980s and 1990s, not many new oil fields became operational, therefore oil production has remained essentially flat. *Id.*

85. *See* Zafar Bhutta, *Pakistan Not to Import Fuel from India Before 2014*, INT'L HERALD TRIBUNE (Sept. 4, 2012), http://tribune.com.pk/story/430753/product-differences-pakistan-not-to-import-fuel-from-india-before-2014/ ("Pakistani refineries have been tasked to produce Euro-2 quality diesel till July 2014 and therefore the government wants to shelve the plan of oil trade with India till then.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

86. *See* Bikash Pandey, *Clean Energy Options for Rural Pakistan: Lessons from South Asia*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 167, 168 (Robert M. Hathaway, Bhumika Muchhala, & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf ("[T]he costs of environmental externalities from pollution are generally not included in the pricing

Following independence in 1947, coal comprised sixty percent of Pakistan's commercial energy consumption, but this share decreased when natural gas was discovered in 1952.[88] Discovery of large coal reserves in the Thar Desert in Sindh in the early 1990s, however, re-invigorated Pakistan's coal production and reliance.[89] The Thar reserves are estimated to contain 175 billion tons of coal.[90] This discovery has increased the potential role that coal will play in Pakistan's quest for energy self-reliance.[91] The coal mining industry in Pakistan is impeded by constraints, including the quality and quantity of coal, mining difficulties, organization problems, and investment risks.[92] Other issues, such as political instability, indecision, corruption, terrorism and security have also threatened coal exploration and production in the Thar Desert.[93] These reasons suggest that coal as a long-term energy source is unsustainable. Nonetheless, the Thar reserves are relatively close to population centers of Hyderabad and Karachi.[94] Experts have calculated that "135 to 175 billion tonnes of lignite

---

of power from conventional power generation.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

87. *See* Aram Zamgochian, *U.S. Chamber of Commerce Energy Overview for the Islamic Republic of Pakistan*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 157, 163 (Robert M. Hathaway, Bhumika Muchhala, & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf ("Net oil imports are projected to rise substantially as growth in demand outpaces increases in production.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

88. *See* Kumar, *supra* note 65, at 914 ("[S]oon after independence coal contributed to about 60 per cent of overall energy consumption, but this decreased with the discovery of gas in 1952.").

89. *See* PRIVATE POWER & INFRASTRUCTURE BOARD, PAKISTAN'S THAR COAL POWER GENERATION POTENTIAL 3 (2008), *available at* http://www.ppib.gov.pk/COAL%20BOOK.pdf (describing the effects of the Thar Coal discovery and Pakistan's plans to harness that resource) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

90. *Id.*

91. *See id.* (describing the impact of the Thar Desert discovery on Pakistan's energy independence).

92. *See* Siddharth Srivastava, *Pakistan's Thar Desert Coal Deposits*, ASIA SENTINEL (May 9, 2011), http://www.asiasentinel.com/econ-business/pakistans-thar-desert-coal-deposits/ 225 (describing the various problems with the coal industry in Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

93. *See id.* (noting the social problems that hamper the development of the Thar coal deposit).

94. *See* PRIVATE POWER & INFRASTRUCTURE BOARD, *supra* note 89, at 2 (describing the geographic location of the Thar Desert in relation to major cities).

coal can potentially be obtained from the Thar deposit, which can produce thousands of megawatts of electricity for decades."[95]

"Nuclear power provides about three percent of total electric power production in Pakistan."[96] The Pakistan Atomic Energy Commission operates two nuclear plants, Chashma-1 and Kanupp, which have an installed capacity of 300 MW and 125 MW respectively.[97] A third nuclear power plant, Chashma-2, was completed with the help of the China National Nuclear Corporation in 2011 and has an installed capacity of 325 MW.[98] The Pakistan Atomic Energy Commission hopes to increase the country's nuclear power generation capacity to 8,800 MW by 2030.[99] Nonetheless, concerns surrounding the safety and security of nuclear power plants may negatively impact the broad acceptance of nuclear energy.[100]

B. Renewable Energy Basket

Fossil fuels can generate enough energy to power Pakistan's electrical grid, but the permanency of these non-renewable fuel sources is speculative at best.[101] The establishment of a diverse energy portfolio is therefore essential. Diversity of assets is quintessential to an investment portfolio: a country should derive its electricity and power needs from a variety of generation sources, including the sun, wind, water, and

---

95. Amjad Agha, *Thar Coal—Pakistan's hope for energy self-sufficiency*, DAILY TIMES (May 22, 2012), http://www.dailytimes.com.pk/default.asp?page=2012\05\22\story_22-5-2012_pg7_17 (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

96. PAKISTAN ATOMIC ENERGY COMM'N, *Karachi Nuclear Power Complex*, CANDU OWNERS GROUPS, http://www.candu.org/paec.html (last visited Sept. 15, 2013) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

97. *See* Kumar, *supra* note 65, at 915 ("The two operational nuclear plants in Pakistan, Chashma-1 and Kanupp, have an installed capacity of 300 MW and 125 MW respectively, and are operated by the Pakistan Atomic Energy Commission.").

98. *See id.* (noting the assistance of the China National Nuclear Corporation).

99. *See id.* (stating the government's goal, and noting studies being conducted for the construction of additional nuclear plants).

100. *See* Chaim Braun, *Security Issues Related to Pakistan's Future Nuclear Power Program*, *in* PAKISTAN'S NUCLEAR FUTURE: WORRIES BEYOND WAR 277, 299 (Henry D. Kokolski, ed. 2008), *available at* http://iis-db.stanford.edu/pubs/22255/Braun_Security_Issues_Related_to_Pakistan_Future_Nulcear_Power_Program.pdf ("[S]afety-related events might cause severe social and economic implications on their own, and might precipitate further national security related actions by the government, or terrorist attacks trying to capitalize on the general unrest created by a safety event.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

101. *See* INTERNATIONAL NEWS NETWORK, *supra* note 79 (questioning the feasibility of meeting the needs of Pakistan's electricity grid with fossil fuels).

biomass.[102] Pakistan hopes to increase the use of renewable energy in the future, and for this purpose has set up the Alternative Energy Development Board (AEDB), which is working toward increasing renewably-sourced electricity from solar and wind projects.[103] In addition, Pakistan's Ministry of Science and Technology established the Pakistan Council of Renewable Energy Technologies (PCRET) by merging the National Institute of Silicon Technology (NIST) and the Pakistan Council for Appropriate Technologies (PCAT) in 2001.[104]

Pakistan's renewable energy sources—solar, wind, geothermal, biomass, and hydropower—have enormous potential. Electricity generation from renewable sources constitutes 32.8% of total power production, primarily from hydroelectric power.[105] The importance of alternative sources of energy like wind, solar, and biofuels has increased due to the massive rise in oil prices and ever-increasing energy demands.[106] As a result of the urgent demand for larger scale energy resources, it is critical for Pakistan to move from the planning stage of renewable energy implementation into a new dawn of implementation.[107] While some amount of planning must be deliberate and careful, a plan must be able to get off the ground.[108] Pakistanis have the necessary expertise in terms of engineering, science, construction, and design to grow the production, development, and harvesting of renewable energy.[109] Pakistan as a nation, however, lacks the regulatory planning, governance structures, and investment mechanisms to

---

102. *See generally* Ahmed, *supra* note 36 (discussing different energy portfolio mixes for Pakistan and their potential impacts).

103. *See* Burki, *supra* note 23, at 70 (describing the goals of the Alternative Energy Development Board).

104. *See Pakistan Council of Renewable Energy Technologies*, MINISTRY OF SCI. & TECH. GOV'T OF PAKISTAN, http://www.pcret.gov.pk/ [hereinafter PCRET] (last visited Sept. 15, 2013) ("[PCRET] was established by merging the National Institute of Silicon Technology (NIST) and the Pakistan Council for Appropriate Technologies (PCAT) on May 8, 2001.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

105. *See Abbasi*, *supra* note 68 (describing the percentage of power that renewable energy sources account for in Pakistan) There is debate as to whether large-scale hydroelectric power is considered a renewable energy source because of its environmental and social impacts. *Id.*

106. *See* Zamgochian, *supra* note 87 (describing the need for the development of renewable energy and the financial ramifications of dependency on nonrenewable resources).

107. *See id.* at 163 (discussing specific issues with Pakistan's energy policy).

108. *See generally id.* (outlining the structure of Pakistan's energy industry and resources).

109. *See, e.g.*, PCRET, *supra* note 104 (offering technical expertise to harness alternative energy).

incorporate renewable energy into mainstream energy sources.[110] Pakistan also lacks the ability to manage community expectations.[111] Moreover, decades of bureaucratic authoritarianism have led the way for local communities to have low regard for any government initiatives.[112] Because of this, any energy initiative is viewed with a raised eyebrow.

Pakistan will not only have to develop and implement sustainable technologies for accessing renewable energy, but it will also learn how to adopt new systems of energy governance and involve local and regional groups.[113] With a new generation of Pakistanis who have an eye on globalization and moving their country forward, radical change is possible. The national government and provincial governments will have to work together to create the change that is needed to herald a new and more vibrant Pakistan.[114]

In the interim, Pakistan has been developing a wind power energy project to address electricity supply problems since 2002.[115] Pakistan's geographic location with a coastline stretching over 1,046 kilometers provides the right conditions for the installation of wind turbines and the wind power potential of 50,000 MW.[116] There are, however, still concerns about how to supply remote areas with these new energy sources.[117] Working with the Chinese government, Pakistan established fourteen small wind power plants to generate electricity in the southern coastal region of Sindh and Balochistan, which previously had no access to electricity, because wind speeds are sufficient in hilly and coastal areas, which constitute a significant percentage of the terrain.[118]

---

110. *See* Burki, *supra* note 23, at 38 (describing the administrative and governmental flaws that prohibit alternative energy development).

111. *See* Reeves, *supra* note 6 ("Constant power outages are crippling Pakistan's economy and, as NPR's Philip Reeves reports, causing anger and frustration.").

112. *See id.* (noting the public skepticism toward government energy projects).

113. *See* Burki, *supra* note 23, at 39–40 (predicting Pakistan's progress in developing alternative energy).

114. *See id.* (explaining the need for cooperation from Pakistan's government to achieve the goal of harnessing alternative energy).

115. *Pakistan Looks to Wind Power*, BBC NEWS (Jan. 9, 2002), http://news.bbc.co.uk/2/hi/business/1750827.stm ("Pakistan is developing a wind power energy project, which could help solve some of the country's electricity supply problems.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

116. *Energy Report Points at Faults in Pakistani Systems*, *supra* note 68.

117. *See* BBC News, *supra* note 115 ("To supply electricity from the grid it is not even sometimes technically feasible, not to talk about economically feasible, to get back the revenues and for those areas definitely the renewable industry can play a part.").

118. *See id.* (discussing the wind power program with the Chinese government).

Solar energy is the best and most suitable form of renewable energy for Pakistan.[119] There is ample potential for generating solar power as two-thirds of Pakistan receives a good amount of sunlight—especially the central and southern parts of the country.[120] Solar energy would be well suited for Pakistan's sparsely populated regions: seventy percent of the population is divided among 50,000 villages far from the national grid.[121] Moreover, over thirty percent of generated power is lost in transmission, more than seven times the loss rate for proper transmission networks.[122] The lack of excess grid capacity limits the transmission of power from hydroelectric plants in the north to make up for demand shortfalls in the south.[123] Because connecting these villages to the national grid would be very costly, solar panels would more easily allow for distributed generation, a cost efficient and empowering solution to rural energy problems.[124]

Another viable renewable energy option is biofuels, which are a mixture of volatile, flammable hydrocarbons derived from plant material or animal waste that is used as fuel.[125] Pakistan is exploring both the options of bioethanol (from sugar) and cellulose-based ethanol.[126] Brazil is investing in Pakistan's biofuels sector with the aim of helping Pakistan

---

119. *See* Nisar Mahmood, *Solar, Wind and Geothermal Power Seen as Solutions to Energy Crisis*, THE NEWS (Nov. 28, 2011), http://www.thenews.com.pk/TodaysPrintDetail.aspx?ID=79794&Cat=7 (noting that scholars believe that Pakistan has a potential of generating 2.9 million megawatts electricity from the sun) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

120. *See Energy Report Points at Faults in Pakistani Systems*, *supra* note 68 (noting that, despite this potential, Pakistan's renewable generation capacity amounted to a paltry 180 MW between 2007 and 2008) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

121. *See* Riaz Haq, *Solar Energy for Sunny Pakistan*, HAQ'S MUSINGS (Feb. 27, 2009), http://www.riazhaq.com/2009/02/solar-energy-for-sunny-pakistan.html (stating that the Solar Energy Research Center produced a report indicating solar energy as the most suitable form of renewable energy) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

122. *See id.* (explaining problems with Pakistan's electric transmission infrastructure).

123. *See id.* ("[A] lack of spare high-voltage grid capacity limits the transmission of power from hydroelectric plants in the north to make up for shortfalls in the south.").

124. *See id.* (discussing the potential for solar power to benefit rural populations both economically and socially).

125. *See What are Biofuels?*, CORNELL UNIVERSITY GREEN CHOICES, http://www.greenchoices.cornell.edu/energy/biofuels/ (last visited Nov. 27, 2013) (defining biofuels) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

126. *See Energy Report Points at Faults in Pakistani Systems*, *supra* note 68 (stating that the existing sugar industry in Pakistan has the potential to produce more than 3,000 MW of electricity through co-generation).

through the current energy crisis.[127] It is estimated that manure from livestock could be used to generate upwards of 16.3 million cubic meters of biomes per day.[128]

In addition to the renewable energy sources discussed above, Pakistan also has an unrecognized potential for small-scale hydroelectric generation. Along with solar, wind, and biofuel projects, hydrokinetic energy has a future in Pakistan.[129] Despite success in small communities in other countries, hydrokinetic projects have stalled because of problems connecting to the national grid and difficulties with the large-scale adoption of technology.[130] Like hydrokinetic energy, Pakistan's wind and solar potential is undetermined.[131] Further empirical analysis will show the strong potential of renewable energy.[132] At this time, however, there is not enough data to quantify the potential energy production from renewable resources.[133] A unifying theme among renewable energy sources is that poor governance systems and legal incentives that facilitate fossil fuels are detrimental to renewable energy development.[134]

---

127. *See Brazil Ready to Invest in Energy Sector of Pakistan*, BUS. RECORDER (Mar. 9, 2011, 8:29 PM), http://www.brecorder.com/pakistan/business-a-economy/6352-brazil-ready-to-invest-in-energy-sector-of-pakistan.html ("[E]very possible help will be made to facilitate Pakistan to overcome the shortage of sugar. . . . [The Brazilian ambassador to Pakistan Alfredo Leoni] said that Brazil is ready to invest in energy sector which is the need of the hour as Pakistan has hit energy crisis recently.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

128. *See Pakistan Turns to Brazil and Biofuels in Light of Energy Crisis*, BIOFUELS DIGEST (Nov. 28, 2011), http://biofuelsdigest.com/bdigest/2011/11/28/pakistan-turns-to-brazil-and-biofuels-in-light-of-energy-crisis ("During a visit, Brazilian Ambassador Alfredo Leoni indicated that Brazil intends to invest in the ethanol and biofuel sectors . . . .") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

129. *See* Nadia Ahmad, *Shoring Up Power in Pakistan*, DAWN (June 6, 2013), http://beta.dawn.com/news/1019094/shoring-up-power-in-pakistan ("The use of small scale hydropower, including hydrokinetic energy, which harness power from the movements of waves and tides through underwater turbine, would be one of many potential energy sources to exploit.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

130. *See* Pandey, *supra* note 86, at 167–68 ("Although a number of successful projects have been demonstrated in small communities and for connection to the national grid, large scale adoption of the technology has not taken place.").

131. *See id.* at 168 *(*stating that Pakistan installed fifty towers of varying heights in the coastal areas of Sindh and Balochistan and in the desert of Balochistan to measure wind velocity).

132. *See id.* ("The potential for solar energy, although not yet determined, is also thought to be very good throughout the country.").

133. *See id.* at 167−68 (noting that Pakistan's hydro and wind power potential has not yet been fully measured).

134. *See id.* ("However, international experiences indicate that unless equal opportunities are made available to [renewable energy] as are enjoyed by conventional

Traditional hydroelectricity as a renewable energy resource is problematic because of environmental and social impacts associated with large dams.[135] The World Commission on Dams determined that "large-scale infrastructure projects such as dams can have devastating impacts on the lives and livelihoods of affected communities and ecosystems."[136] The "absence of adequate assessments and provisions being agreed to address these impacts" aggravate the harmful impacts of dams on communities and ecosystems.[137] Based on past experiences with flooding, and by watching natural and man-made disasters occur in neighboring India and within their own borders, the Pakistanis are justifiably cautious when considering dam projects.[138] Hydroelectric energy, though, is the second largest source of electricity in Pakistan and contributes 33.1% of total power generation in the country.[139] While Pakistan's hydroelectric generation potential is estimated to be 46,000 MW, only fourteen percent has been exploited.[140] Various hydropower projects are under review as they are cost-effective and serve as a reliable energy option.[141]

Historically dam projects in South Asia have been eyed with suspicion. For example, the construction of the Chandil Dam wreaked havoc in the Chaibbasa District in the Indian province of Bihar in 1991.[142] The trouble with dam projects in India, as in many LDCs, is that their designers and proponents are indifferent to the fate of the poor and tribal

---

energy (primarily thermal power from oil or coal), the establishment of renewable energy will be very difficult . . . .").

135. *See World Commission on Dams*, *in* DAMS AND DEVELOPMENT: A NEW FRAMEWORK FOR DECISION-MAKING 35, 75 (2000), *available at* http://www.internationalrivers.org/files/attached-files/world_commission_on_dams_final_report.pdf (noting that dams kill terrestrial plants and forests while displacing animals).

136. *Id.* at 199.

137. *Id.*

138. *See id.* at 112 (noting the impact of dams on grazing activities in pastoral communities in Pakistan).

139. *See* Kumar, *supra* note 65, at 914–21 (stating that the Water and Power Development Authority has control over the major hydroelectric plants, with the Tarbela plant being the largest with a 3,046 MW installed capacity, and that other operational plants include Mangla (1,000 MW), Warsak (240 MW), and Chashma (184 MW)).

140. *Id.*

141. *See* Abdul W. Bhutto, Aqeel A. Bazmi & Gholamreza Zahedi, *Greener Energy: Issues and Challenges for Pakistan—Hydel Power Perspective*, 16 RENEWABLE & SUSTAINABLE ENERGY REV. 2732, 2734 (2012) ("[N]umerous successful and mature projects have proved that, when carefully planned and executed, hydroelectric development can be reliable, cheap, economical and environment friendly . . . .").

142. *See* Mukul Sharma, *Project: One Night and Now What? in* LANDSCAPES AND LIVES: ENVIRONMENTAL DISPATCHES ON RURAL INDIA, 98, 98–99 (2001) (discussing the dramatic cost overruns and villages displaced as a result of the project).

populations.[143] Hydroelectricity is still seen as an attractive option because it provides water for irrigation and agriculture, storage capacity, flood control, and power generation.[144] Pakistan is also endowed with considerable water flow in the northern region, which has a comparatively sparse population.[145] Hydroelectric power is underutilized in Pakistan because of widespread public opposition to the construction of hydroelectric dams.[146] This public opposition and the lack of political consensus have also deterred water distribution efforts.[147]

The U.S. Congress allocated $280 million in new funding to support work on the Mangla Dam and Kurram Tangi Dam projects in Pakistan.[148] The World Bank initially funded this construction project, which was designed and supervised by the London-based firm of Binnie & Partners, but built by the Mangla Dam Contractors, a consortium of U.S. construction management firms that employed Pakistanis, Americans, British, Canadians, Germans, and Irish.[149] This project was a testament to international cooperation, but has since fallen by the wayside because of

---

143. *See id.* at 99 (noting the disconnect between those who advocated for the dam and those who were harmed by it).

144. *See* Kumar, *supra* note 65, at 912–24 (noting the added benefits of hydroelectric dams).

145. *See id.* (noting the abundance of water in Pakistan's sparsely populated north).

146. *See* Robert M. Hathaway, *Introduction*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY, 5, 5–6 (Robert M. Hathaway, Bhumika Muchhala & Michael Kugelman eds., 2007) *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf ("Meanwhile, widespread public opposition has significantly slowed the government's plans to build dams capable of generating electricity.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

147. *See* Sabira Qureshi, *Energy, Poverty Reduction and Equitable Development in Pakistan*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY, 57, 62 (Robert M. Hathaway, Bhumika Muchhala & Michael Kugelman eds., 2007) *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf ("Water distribution has also suffered from this lack of political consensus, which is stalling the development of major new hydropower development schemes.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

148. *See US Attaches Highest Priority to Pakistan's Energy Sector*, THE NEWS (July 4, 2013), http://www.thenews.com.pk/Todays-News-13-23886-US-attaches-highest-priority-to-Pakistans-energy-sector ("In mid-2012, Congress released $280 million in new assistance for Pakistan's energy sector; these funds will support projects at Mangla and Kurram Tangi 15.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

149. *See* J. DOMINIC MOLYNEUX & MICHAEL HIEATT, MANGLA DAM RAISING—PAKISTAN 1200 (2009), *available at* http://ussdams.com/proceedings/2012Proc/1199.pdf (noting that the project was designed and supervised by the U.K. firm Binnie & Partners (now Black & Veatch), and built by Mangla Dam Contractors) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

internal politicking, which is regrettably a trend for development projects in Pakistan.

Another significant hydroelectric project, which illustrates Islamabad's former prowess in construction and design, is the artificial reservoir of Rawal Lake.[150] The Rawal Dam helps fulfill the water needs for the cities of Rawalpindi and Islamabad, but the life of the dam expired in 2012.[151] These dams should be decommissioned and the funds should instead be used to develop hydrokinetic energy. The expiring Rawal Dam shows that the days of large-scale dams are numbered.[152] To continue funding large dam projects, which have been criticized by the World Commission on Dams, is reckless.[153]

III. Impediments to Implementation and Investment

This Part explores the barriers to investment and deployment of sustainable energy sources, specifically with respect to hydrokinetic energy projects in Pakistan. The first hurdle to harnessing renewable energy in Pakistan is overcoming the mindset that it is not possible to advance technologically in the innovation and policy arenas. Unemployment, inflation, and business closures, invariably caused by energy shortages, lead to lawlessness and anarchy.[154] A healthy dose of realism is essential to reset Pakistan's priorities with respect to electricity demands.[155] Businesses require a continuous supply of electricity to operate and complete orders

150. *See* Kalbe Ali, *Rawal Dam Life Expires This Year*, DAWN (Aug. 26, 2012), http://dawn.com/2012/08/26/rawal-dam-life-expires-this-year/ (noting that the dam's artificial reservoir covers 8.8 square kilometers near Islamabad) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

151. *See id.* ("The proposed life of small dams is 50 years, which ends in 2012.").

152. *See id.* (noting the expiration of the Rawal Dam).

153. *See World Commission on Dams*, *in* DAMS AND DEVELOPMENT: A NEW FRAMEWORK FOR DECISION-MAKING 35, 75 (2000) ("In the past, our unrestrained reliance upon large dam technology weighed down upon us . . . .") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

154. *See Entire Power Chain Must Be Streamlined*, NATION (Aug. 26, 2012), http://www.nation.com.pk/pakistan-news-newspaper-daily-english-online/business/26-Aug-2012/entire-power-chain-must-be-streamlined ("Unemployment, price-hikes, industrial closures always give birth to lawlessness and anarchy.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

155. *See id.* (noting that the government's willingness to give exemptions to "VIP entities" exacerbates the nation's energy problems).

within an established timeframe.[156] Energy shortages impede the Pakistani export industry from competing in international markets.[157]

A. Intercorporate Debt

A major deterrent of reliable energy generation and distribution in Pakistan is circular debt, otherwise known as intercorporate debt.[158] Intercorporate debt in Pakistan is estimated at an astonishing $880 million.[159] When public and private customers fail to pay their electricity bills, utilities cannot afford to pay fuel and operation costs, causing cascading defaults.[160] To eliminate or reduce this debt, the government should encourage initiatives for consumers to pay their bills in a timely fashion.[161] The government pays off a portion of this debt when power producers threaten to sue for loan defaults, but does not address problems that cause the debt.[162] Government officials say the energy crisis could be overcome by ending circular debt.[163] The Pakistan People's Party (PPP)

---

156. *See id.* ("[T]he industry needs continuous supply of electricity to keep the units operational and to complete the export orders well within the given timeframe . . . .").

157. *See id.* ("Pakistan had already lost a number of global markets and the new power cuts would further aggravate the situation . . . .").

158. *See* ELIZABETH MILLS, PAKISTAN'S ENERGY CRISIS 6 (2012), *available at* http://www.usip.org/sites/default/files/resources/PW79_Pakistans_Energy_Crisis.pdf (stating how circular debt is one of the largest issues facing Pakistan's energy policy, and detailing the specific struggles energy companies have encountered as a result) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

159. *See Pakistan's Energy Crisis*, *supra* note 29 ("This so-called 'circular debt,' currently about $880m, is an ongoing problem.").

160. *See* CHRIS TRIMBLE, NOBUO YOSHIDA & MOHAMMAD SAQIB, RETHINKING ELECTRICITY TARIFFS AND SUBSIDIES IN PAKISTAN, 3 (2011), *available at* http://www.indiaenvironmentportal.org.in/files/file/Rethinking%20Electricity%20Tariffs%20and%20Subsidies.pdf (finding that distribution companies cannot satisfy their power purchase cost obligations to power generation companies and that the power generation companies fail to pay fuel suppliers, who default on payments to refineries, gas producers, and international fuel suppliers).

161. *See* A. Rahim, *Tariff Increase and Circular Debt*, PAKISTAN TODAY (May 3, 2011), http://www.nation.com.pk/pakistan-news-newspaper-daily-english-online/letters/06-May-2012/tariff-increase-and-circular-debt (noting that increasing electricity tariffs may cause consumers to protest and refuse to pay their bills) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

162. *See Pakistan's Energy Crisis*, *supra* note 29 (noting that poor recovery of dues, electricity theft, transmission losses, reliance on imported oil and politically sensitive subsidies perpetuate intercorporate debt and utility revenue shortfalls).

163. *See Energy Crisis Can Be Overcome By Ending Circular Debt: Shahbaz*, PAKISTAN TODAY (June 18, 2012), http://www.pakistantoday.com.pk/2012/06/18/news/national/energy-crisis-can-be-overcome-by-ending-circular-debt-shahbaz ("Punjab Chief Minister Shahbaz Sharif . . . said

maintains that it gave 1.2 trillion rupees worth of subsidies to the power sector, supplemented the national grid by 3,500 MW, and initiated short-, medium-, and long-term strategic plans to resolve the energy crisis when they gained control of the government in March of 2008.[164] Critics question these assertions noting that, nearly five years later, Pakistan continues to undergo unsustainable load shedding everywhere from rural areas to urban centers like Lahore.[165]

B. Corruption

Corruption is another serious impediment to implementation of Pakistan's renewable energy standards.[166] Pakistan can overcome the technology gap with the appropriate funding and issues related to investment and regulation can be managed,[167] but overcoming corruption is crucial. As opposition leaders accused the Pakistani government of indulging in corruption, Transparency International's (TI) 2011 report on global corruption suggested that the Pakistani government may not be overly corrupt.[168] Pakistan's rank on the 2011 Index stood at 134, with forty-two countries ranking worse.[169] In 2012, Pakistan's rank slipped to

---

that the energy crisis could be overcome by ending circular debt.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

164. *See The Power Sector: the PM's Claims*, BUS. RECORDER (Aug. 24, 2012), http://www.brecorder.com/editorials/600:/1229985:the-power-sector-the-pms-claims/?date=2012-08-24 (paraphrasing the PPP's claims, and asserting that because "four-and-a-half years later the country continues to experience socio-economically unsustainable loadshedding" these claims must be examined) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

165. *See id.* (noting subsidies worth 1.2 trillion rupees were not used to eliminate the intercorporate debt or provide energy to the poor but instead used to remove the inter-DISCO tariff differential).

166. *See* Rizwan Ghani, *Solving Pakistan's Energy Crisis*, TECH. TIMES (Apr. 16, 2012), http://www.technologytimes.pk/2012/04/16/solving-pakistans-energy-crisis/ (discussing the deleterious impact that corruption has in economic terms and how Pakistan can move towards resolving the issue through banking reforms) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

167. *See* A. A. Khan, *Pakistan Puts Science Back on Its Development Agenda*, SCIDEVNET (Sept. 29 2009), http://www.scidev.net/global/mdgs/news/pakistan-puts-science-back-on-its-development-agenda.html (discussing Pakistan's commitment to science and technology development in renewable energy resources) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

168. *See Corruption Perceptions Index 2011*, TRANSPARENCY INTERNATIONAL, http://www.transparency.org/cpi2011/results (last visited Sept. 8, 2013) (ranking Pakistan 134th out of 176 countries based on their corruption) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

169. *See Corruption Perceptions Index 2012*, TRANSPARENCY INTERNATIONAL, http://www.transparency.org/cpi2012/results (last visited Sept. 8, 2013) (ranking Pakistan as

139, and government officials lambasted the methodology in the report and deemed the TI report baseless.[170] A government spokesperson noted that at the parliamentary level, the Public Accounts Committee (PAC) was actively working to monitor government expenditures for the first time in the country's history, and that it had recovered 180 billion rupees.[171] At the federal level, the National Accountability Bureau and Federal Investigation Agency were coordinating efforts as the Anti-Corruption Departments were performing at the provincial levels, all of which recovered embezzled funds and took action against those responsible for embezzling government funds.[172] Corruption in Pakistan poses a serious impediment to the successful development of sustainable energy projects.[173]

C. Lack of Investment Regimes

Countries considering the shift to renewables often do not have adequate incentives.[174] The majority of renewable energy technologies have yet to reach the point of market maturity and will require substantial continued innovation and research.[175] Moreover, without government incentives, the switch to renewable energy appears daunting—a match of David versus the Goliath of fossil fuels.[176] Ways to overcome investment regime hurdles through education will be discussed further in Part III.

139th on the Corruption Perceptions Index in the 2012 survey) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

170. *See Transparency International Report Baseless: Kaira*, DAWN (Dec. 8, 2012), http://dawn.com/2012/12/08/transparency-international-report-baseless-kaira/ (discussing criticism of the report) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

171. *See id.* ("Kaira said at parliamentary level, Public Accounts Committee (PAC) was actively working for the first time in the country's history. He said the PAC had recovered Rs180 billion . . . .").

172. *See id.* (explaining the recent success of Public Accounts Committee).

173. *See generally* CORRUPTION IN SOUTH ASIA; INDIA, PAKISTAN AND SRI LANKA (K. M. de Silva et al. eds., 2002) (discussing corruption in Pakistan and other nations in South Asia).

174. *See* Hannah Wiseman, *Expanding Regional Renewable Governance*, 35 HARV. ENVTL. L. REV. 477, 508–09 (2011) (citing the lack of accountability to individual regulators, conflicting solutions, and a preference for the status quo as reasons for the paucity of incentives).

175. *See* Felix Mormann, *Requirements for a Renewables Revolution*, 38 ECOLOGY L.Q. 903, 914–15 (2011) ("Most renewable energy technologies have not yet reached the stage of market maturity. The diversified portfolio of renewables favored by environmentalists and advocates of energy security will not be available without substantial research and innovation.").

176. *See id.* at 921 ("Even where the same permit requirements apply to renewable energy plants and fossil fuel plants, the burden of multiple and often duplicative administrative procedures tends to weigh much heavier on renewable energy plants.").

D. Overreliance on Fossil Fuels and Imported Energy

The Pakistani Sustainable Development Policy Institute concluded that the increased dependency on fossil fuel is the fundamental cause of the present energy crisis and the greatest hindrance towards financial sustainability.[177] The most sustainable and best solution to the energy crisis is low cost and sustainable hydroelectricity.[178] Because Pakistan is planning to import hydroelectricity from Tajikistan's Rogun Dam, it should consider developing its own hydroelectric industry.[179] The National Electricity Power Regulatory Authority (NEPRA) and water and power ministry never followed through with the plans to further develop Pakistani hydropower and transmit it to the Karachi Electricity Supply Company power system, which was envisioned during the construction phases of the Tarbela Dam in the 1960s.[180]

E. Considerations for Marine Biodiversity and Environmental Issues

Industry manufacturers of hydrokinetic technology assert that there is a minimal impact on biological diversity from hydrokinetic energy because the turbine spins at the same speed or less than the natural water flow and in the same direction of the water flow.[181] They claim to have determined that "little if any material adverse impact to marine life and expect zero impact on water quality as pertains to temperature, dissolved oxygen, or turbidity."[182] It is accepted, however, that definitive conclusions as to environmental impacts of these projects would require more detailed

---

177. *See* Mahmood, *supra* note 119 (discussing the Sustainable Development Policy Institute's report).

178. *See id.* ("Solar and hydel power [are] also the cheapest sources of energy.").

179. *See* Khalid Mustafa, *Import of Electricity to Weaken Pakistan's Hydropower Potential*, THE NEWS (July 16, 2013), http://www.thenews.com.pk/Todays-News-3-190061-Import-of-electricity-to-weaken-Pakistans-hydropower-potential (arguing that Pakistan ought to build two dams of its own instead of importing power from Tajikistan, which would weaken the country) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

180. *See Energy Report Points at Faults in Pakistani Systems*, *supra* note 68 (noting the original plan to transfer power to the Karachi Electricity Supply Company).

181. *See Hydrokinetic Power Barges*, ALTERNATIVE ENERGY (Aug. 18, 2009), http://www.alternative-energy-news.info/hydrokinetic-power-barges/ ("[T]hese power systems can be placed into sources of flowing water with minimal infrastructure or environmental impacts.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

182. *Id.*

analysis.[183] Even though there have not been many environmental impact studies of hydrokinetic technology, the U.S. Department of Energy has recognized that the environmental impact of new technologies could be significant and that it requires further study.[184] Hydrokinetic or ocean energy technologies extract energy from the water, which lowers wave height and current velocity; potentially altering sediment transport and the wave climate of nearby shorelines.[185] The environmental impacts of small-scale hydropower projects are a concern, but the environmental impact would not be as severe as the known environmental impacts of large hydropower projects.[186]

Hydrokinetic technologies derive electricity from a wave energy converter (WEC) device, a subsea pod, and subsea power transmission cables.[187] In a WEC design, the enclosed metallic structure of the WEC device and subsea pod designs could potentially serve as Faraday cages, shielding any electric field by an enclosure of conducting material.[188] The impact of electric and magnetic fields generated by hydrokinetic energy

---

183. *See* Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 633(b) (requiring the Department of Energy to prepare a report to Congress on the effects of marine and hydrokinetic projects).

184. *See generally* U.S. DEP'T OF ENERGY, REPORT TO CONGRESS: POTENTIAL ENVIRONMENTAL EFFECTS OF MARINE AND HYDROKINETIC ENERGY TECHNOLOGIES i (2008), *available at* www1.eere.energy.gov/water/pdfs/doe_eisa_633b.pdf ("[T]his report describes nine types of environmental effects that may occur and describes how monitoring and adaptive management principles might be employed to evaluate and mitigate those effects. There is no conclusive evidence that marine and hydrokinetic technologies will actually cause significant environmental impacts.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

185. *See id.* at 17 ("Operation of hydrokinetic or ocean energy technologies will extract energy from the water, which will reduce the height of waves or the velocity of currents in the local area. This loss of wave/current energy could, in turn, alter sediment transport and the wave climate of nearby shorelines.").

186. *See generally* S.A. Abbasi & Naseema Abbasi, *The Likely Adverse Environmental Impacts of Renewable Energy Sources*, 65 APPLIED ENERGY 121 (2000), *available at* http://www.aseanenvironment.info/Abstract/41013178.pdf ("[R]enewable energy sources are not the panacea they are popularly believed to be; indeed in some cases their adverse environmental impacts can be as strongly negative as the impacts of conventional energy sources.").

187. *See* CAMERON FISHER & MICHAEL SLATER, EFFECTS OF ELECTROMAGNETIC FIELDS ON MARINE SPECIES: A LITERATURE REVIEW 2 (2010), *available at* http://www.oregonwave.org/wp-content/uploads/1-Effects-of-electromagnetic-fields-on-marine-species-A-literature-review.pdf (explaining that that the subsea power transmission cables include the power cable exiting the bottom of each WEC and those cables from the subsea pod to a land-based substation).

188. *See id.* at 2 (describing the technical aspects of wave energy converters and their potential electromagnetic fields).

could have a serious impact on freshwater and marine biodiversity.[189] While the U.S. Department of Energy asserts that there is no conclusive evidence of significant environmental impact from hydrokinetic technologies,[190] impacts to tidal flow, current velocity, and the generation of electric and magnetic fields could have incremental impacts with serious long-term impacts on aquatic species.[191]

When evaluating environmental impacts from hydrokinetic energy sites, policy makers must consider the affected river habitat, the effect of water loss through evaporation, development along the river, and the accessibility of the site.[192] Issues arising from hydrokinetic technologies are similar to those posed by small dams, which officials have already started to examine in Pakistan.[193] With smaller dams, water storage is an issue that could lead to the construction of more low-head systems than anticipated.[194] Additionally, greenhouse gas (GHG) emissions are at least as likely from shallow reservoirs as from large reservoirs because of the potential for methane emissions.[195]

When the Massachusetts Renewable Energy Commission was considering hydrokinetic energy, it realized that it should avoid conducting redundant studies by using information available from conventional hydroelectricity research to reduce the cost of informed agency decision making.[196] Despite a friendly policy environment and modest investment in

---

189. *See id.* at 12–13 (summarizing the impacts of electromagnetic fields on aquatic species including effects on embryo development, geomagnetic navigation systems resulting in disorientation, and impaired food location).

190. *See* U.S. DEP'T OF ENERGY, REPORT TO CONGRESS, *supra* note 184, at i (noting the lack of known environmental harms and highlighting the need for further information and research to fully assess the environmental impacts).

191. *See generally id.* at 11–46 (describing potential environmental impacts of hydrokinetic technologies and suggesting mitigation measures for future projects).

192. *See* Abbasi, *supra* note 186, § 6.2 (asserting that the problems that result from a dispersed approach to energy generation are numerous and just as serious, per kilowatt generated, as those from more centralized hydropower generation).

193. *See generally* Naeem Ejaz et al., *Environmental Impacts of Small Dams on Agriculture and Ground Water Development: A Case Study of Khanpur Dam, Pakistan*, 10 PAK. J. ENGINEERING & APPLIED SCI. 45, 45–50 (2012) (summarizing a case study of the environmental impacts of small damns on crop production and water loss in areas of Pakistan).

194. *See* Abbasi, *supra* note 186, § 6.2 ("The problems of siltation and eutrofication are likely to be more serious with smaller and shallower bodies of water created by mini and micro projects.").

195. *See id.* (comparing shallow reservoirs for hydropower to paddy fields, known contributors of methane and other GHG emissions).

196. *See, e.g.*, Steve Amaral, Greg Allen & George Hecker, Presentation at the Annual MREC Technical Conference: Effects of Hydrokinetic Turbines on Aquatic Life: Turbine Passage and Fish Behavior (Oct. 15, 2009), *available at* http://www.mrec.umassd.edu/media/supportingfiles/mrec/agendasandpresentations/1stconfer

research and development, the permitting of tidal devices remains a considerable barrier to hydrokinetic power advancement in the United States.[197] In LDCs, the situation is much worse for research and development.[198]

One of the alternate ways to measure environmental impacts is through the use of a strategic environmental assessment (SEA), which is seen as a promising approach for determining the environmental effects of policy, plans and programs.[199] Used in developing and transitional countries, SEAs promote sustainable development by fostering openness and transparency in the decision-making process, and represent a more proactive approach to environmental assessments.[200]

IV. Creating an Attractive Investment Regime

Renewables cannot "rise above their paltry current market share" without changes in policy.[201] Policies must be implemented in order to attain the goals of reduced environmental damage and sustainability.[202] Policy changes are difficult to conceptualize by themselves.[203] It is easier to

---

ence/amaral_hk_fish_studies.pdf (presenting earlier research on the ecological effects of hydroelectric technologies including fish behavior and mortality) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

197. *See generally* BRIAN POLAGYE ET AL., U.S. DEPT. OF COMMERCE, ENVTL. EFFECTS OF TIDAL ENERGY DEV. 2 (2011), *available at* http://depts.washington.edu/nnmrec/workshop/docs/workshop_report_low_res.pdf (citing the environmental impact analysis of the permitting process as one of the top three barriers to tidal development).

198. *See* UNITED NATIONS CONFERENCE ON TRADE AND DEV., GLOBALIZATION OF R&D AND DEVELOPING COUNTRIES, PROCEEDINGS OF THE EXPERT MEETING 3 (2005), *available at* http://unctad.org/en/Docs/iteiia20056_en.pdf ("[M]any developing countries have fared moderately in growth and welfare creation because their R&D efforts have remained underfund and delinked from the private sector.").

199. *See* HUSSEIN ABAZA, RON BISSET, & BARRY SADLER, ENVIRONMENTAL IMPACT ASSESSMENT AND STRATEGIC ENVIRONMENTAL ASSESSMENT: TOWARDS AN INTEGRATED APPROACH 85 (2004), *available at* http://www.unep.ch/etu/publications/textONUbr.pdf (outlining the key elements to a successful integrated environmental assessment approach through SEA).

200. *See id.* (highlighting the use of SEA to review projects with significant known environmental impacts, such as macroeconomic policies, investment, trade and development programs, energy, transport and other sector plans).

201. PAUL KOMOR, RENEWABLE ENERGY POLICY 4–6 (2004).

202. *See id.* at 11 (noting that these goals will remain unobtainable without direct policy intervention).

203. *See id.* at 59 (commenting that although renewable energy costs more than fossil fuel based energy, the environmental benefits of renewable energy makes positive policy changes worthwhile for their long-term benefits).

look at policy changes in a broader development context.[204] Policy changes must account for globalization and the growth of renewable energy in the global marketplace.[205] In order for attractive investment regimes to exist for hydrokinetic energy development, it is important to consider the causes of globalization.[206] Pressure on companies by both consumers and competitors has forced innovation and upgrades to the quality of existing goods and services.[207] High costs for research and development are forcing companies to downgrade the scope of their value-added activities and to seek out wider markets to create strategic alliances and networks to combine their competencies.[208] In the energy sector, the impact of globalization and a wider international market will open avenues for competition and collaboration.[209]

A. Education to Transition to Renewables

Pakistan's greatest asset is its youth, the next generation of visionaries who can hope and work for a better Pakistan. The brightest young minds are located in university campuses across the country, including the Lahore University of Management Sciences, the University of Punjab, Aga Khan University, University of Peshawar, University of Engineering and Technology, Quaid-i-Azam University, the National University of Sciences and Technology, and others.[210] Scientists and engineers can develop the technology for hydrokinetic energy, but the lack

---

204. *See generally id.* (discussing the natural tension between policy intervention and developing markets).

205. *See* FRANKFURT SCHOOL-UNEP CENTRE, GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2013 20 (2013), *available at* http://www.unep.org/pdf/GTR-UNEP-FS-BNEF2.pdf (noting a dramatic growth of investment in renewable energy sources in developing nations, showing strong market growth in areas with rising power demands and ample renewable resources) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

206. *See* THE NEW GLOBALISM AND DEVELOPING COUNTRIES 2 (John H. Dunning & Khalil A. Hamdani, eds., 1997) (noting the rise of transnational corporations and the broadening economic interdependence of nations, creating a "borderless" global economy).

207. *See id.* at 15 (analyzing the effects of globalization on markets in both developed and developing nations).

208. *See id.* at 40 (noting that by working together, firms can exploit their own competencies both effectively and speedily in an effort to adapt to the globalizing economy).

209. *See* FRANKFURT SCHOOL-UNEP CENTRE, *supra* note 205, at 5 (explaining that a globalizing energy sector opens "a world of opportunity for billions of people" and can lead to massive investment opportunities, stimulating the global economy, and creating jobs).

210. *See generally* RANKING WEB OF WORLD UNIVERSITIES, PAKISTAN, *available at* http://www.webometrics.info/en/Asia/Pakistan%20 (last visited Nov. 7, 2013) (listing Pakistan's top universities) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

of outside funding and the low level of research and development in the energy sector will contribute to the risk of slow renewable energy development.[211] The level of innovation required for a timely transition to renewable sources of energy is also costly.[212]

The Electric Power Research Institute estimates that wave energy could create ten percent of the United States' energy with the significant wave resources along U.S. coasts.[213] Harvard University, through support from a private foundation, analyzed policy measures for energy technology innovation policy, called the Energy Research, Development, Demonstration, & Deployment (ERD3) Policy Project.[214] Similar research has not been completed in Pakistan. The federal government of Pakistan or a private foundation in collaboration with a research university must fund a study to prepare a comprehensive set of policy recommendations for development and deployment of low-carbon energy technologies.

B. Externalities, Tax Credits, Tariffs, and Tender Schemes

The International Energy Agency's report, *Taxing Energy: Why and How*, indicates that Organisation for Economic Co-operation and Development (OECD) countries are concerned with "security of energy supply" in the form of "self-sufficiency, wartime capability, minimization of adjustment lags, reduced import dependency (especially oil dependency),

---

211. *See* Felix Mormann, *Requirements for a Renewables Revolution*, 38 ECOLOGY L.Q. 903, 915 (2011) (showing that spillover effects, general market failures, and the dominance of the prevailing energy regime contribute to the energy sector's low level of research and development investment in renewables and discourages industry research and development efforts).

212. *See id.* at 943 (arguing that government funding for research, development, and demonstration must be increased to a more significant level to meet the recommendations of various governmental and intergovernmental agencies).

213. *See* ERPI TECHNICAL REPORT: MAPPING AND ASSESSMENT OF THE UNITED STATES OCEAN WAVE ENERGY RESOURCE 7-1 (2011), *available at* http://www1.eere.energy.gov/water/pdfs/mappingandassessment.pdf (calculating the potential wave energy resources in the United States to be approximately 2,640 TWh, or ten percent of the total annual U.S. energy consumption) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

214. *See Energy Research, Development, Demonstration, & Deployment (ERD3) Policy Project*, BELFER CTR. FOR SCI. & INT'L AFFAIRS, HARVARD UNIV., http://belfercenter.hks.harvard.edu/project/10/energy_technology_innovation_policy.html?page_id=213 (last visited Sept. 16, 2013) ("The development of comprehensive policy recommendations for a greatly expanded U.S. federal energy-technology endeavor will require, amongst other things, a study of the effectiveness of past and current U.S. energy-technology innovation policies and programs, assessing the innovation system as a whole: from basic energy research to early deployment and widespread diffusion.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

and price stability."[215] The International Energy Agency's report considers the externalities of existing energy systems.[216] LDCs can also learn from the OECD model for energy taxing because OECD countries are more attuned to energy concerns and have established tax and investment regimes to address issues of energy security.[217] Tax credits incentivize investment in renewable energy technology.[218] Feed-in tariffs offer renewable energy generators subsidized rates for power sold into the grid.[219] Tender schemes allow regulators to solicit bids from the private sector for contracts, which set the amount of energy to be produced, and its source.[220] Thus, there are a wide variety of ways to incentivize investment in renewable energy through tax schemes.

C. Infrastructure Improvements

Renewable energy can be harvested and used locally, allowing consumers to function independently of a conventional energy grid.[221] Renewable energy lends itself to a system of distributed generation which does not rely heavily on centralized power plants or fuel supply chains normally associated with fossil fuels.[222] This is a great benefit for Pakistan, where low and disperse demand in rural areas make the cost of extending high-voltage transmission lines uneconomical.[223]

---

215. INTERNATIONAL ENERGY AGENCY, TAXING ENERGY: WHY AND HOW 137 (1993).

216. *See id.* (explaining how new forms of energy generation internalize current energy generation externalities such cost of pollution abatement and inefficiencies of existing technologies).

217. *See id*. at 138 (describing efforts of OECD nations to reduce oil consumption and limit vulnerability in response to the rise of oil prices in the 1970s).

218. *See* Mormann, *supra* note 211, at 940 (discussing investments in renewable power plants through investment tax credits or tax credits for the production of electricity from renewables as possible ways to incentivize investments in renewable energy).

219. *See id.* at 951 (cautioning that feed-in tariff schemes, that have proven successful drivers of renewables deployment in Europe, may face regulatory hurdles in other countries, such as the United States).

220. *See id.* at 940 (adding that tender schemes, as with feed-in tariffs, require relatively complex regulatory frameworks).

221. *See* Darrell Blakeway, *Energy Autonomy: Getting Serious About Renewable Energy,* 29 ENERGY L.J. 217, 222 (2008) (reviewing HERMANN SCHEER, ENERGY AUTONOMY: THE ECONOMIC, SOCIAL, AND TECHNOLOGICAL CASE FOR RENEWABLE ENERGY (2007)) (contrasting locally-produced energy with the expansive global supply and transmission chains often associated with fossil fuels).

222. *See id.* ("[R]eliance on extensive national transmission grid systems and support from large central station power plants becomes less necessary, and ultimately dispensable.").

223. *See* Mashael Yazdanie, Renewable Energy in Pakistan: Policy Strengths, Challenges & the Path Forward, Energy Economics & Policy*,* 11 (June 2, 2010) (unpublished term paper), *available at*

Another issue with the wide-spread adoption of renewable energy technologies is that they are naturally decentralized and Pakistan's current electric power system was designed as a centralized system.[224] Newer forms of energy generation, like hydrokinetic energy, are at odds with the conventional centralized transmission system.[225] Centralized grid extensions can no longer be expected to reach all remaining communities unconnected to electricity grids because long distances and low demand make this approach cost prohibitive for rural areas.[226] Village level mini-grids in the form of wind turbines, small-scale hydropower or diesel generators "may provide a more cost effective alternative, especially for compact, high-density settlements."[227]

Conventional energy producers will not finance its competition, so only when investment decisions for renewable energy are independent of the conventional energy business will there be serious economic competition from renewable energy.[228] Decentralizing energy generation will create the possibility of decentralizing other aspects of the economy and limit the more harmful effects in the developing globalization of the economy.[229] Greater reliance on either cogeneration or dispersed renewable energy sources will decentralize the sources of power, improving electrical transmission and network efficiency.[230]

---

http://www.cepe.ethz.ch/education/termpapers/Yazdanie.pdf (illustrating the steep costs associated with even minor energy line construction projects in rural areas) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

224. *See id.* (recognizing that the infrastructure requirements of a decentralized means of energy production vary from those of centralized energy systems, which require existing system to be reconstituted for renewable energy projects).

225. *See* Blakeway, *supra* note 221, at 222 (arguing that renewable energy sources do not require traditional centralized systems, but function better through a distributed system within local communities).

226. *See* Dorothy Lele, *Social and Gender Issues in Pakistan's Energy Sector, in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY, 79, 85 (Robert M. Hathaway, Bhumika Muchhala & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf (noting that gas-turbine electricity generation challenges the notion that a centralized utility system is required for energy) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

227. *See id.* at 85 (adding the additional benefits of a decentralized system of more user accountability, easily assignable repair responsibility, proximity of decision-making to the users, and reliability as a backup to a centralized power grid).

228. *See* Blakeway, *supra* note 221, at 223 (citing further the "tremendous political . . . influence" that conventional energy has compared to renewable energy).

229. *See id.* at 224 (suggesting the constructive role that international organizations may play in this decentralization).

230. *See* Steven Ferrey, *Exit Strategy: State Legal Discretion to Environmentally Sculpt the Deregulating Electric Environment*, 26 HARV. ENVTL. L. REV. 109, 116 (2002) (arguing that centralized power sources are unreliable while smaller power sources that are deployed

D. Real Property and IP Regulation and Enforcement Concerns

Land is often integral to renewable energy production, but property rights and the division of ownership over a parcel may prevent its efficient use.[231] Multiple individuals or institutions may claim different property rights to a single parcel, and renewable energy projects routinely stretch over multiple parcels of land.[232] Overlapping local groups may also have a stake in negotiations, further complicating the governance of land rights in a region and stifling the development of such projects.[233]

Traditional government research subsidies have generated relatively few advances in combating climate change, and it is particularly difficult to fuel substantial policy and technological innovation through grants, controls, and regulatory measures.[234] Patent awards have value,[235] but provide too little incentives for the scale of innovation needed.[236] Innovation prizes may provide better incentives for addressing the climate policy challenge because they can encourage the dramatic technological breakthroughs necessary to enable reductions in greenhouse gases.[237]

Renewable entrepreneurs should have rights to their intellectual property in the form of licensing.[238] To reach this goal, Pakistan should establish technology transfer offices at universities and other research

---

in modular form are closes to the user of the electricity and this improves reliability and efficiency).

231. *See* Wiseman, *supra* note 174, at 482 (recognizing the limitations of use by a renewable energy developer without resolving these competing ownership and leasing hurdles).

232. *See id.* (noting the multiple property rights claims that may be made on a single parcel of land, and the challenge that this poses to renewable energy development).

233. *See id.* at 499−506 (noting the complexities that can create an "anticommons" that limits the ability to efficiently develop a renewable parcel).

234. *See generally* Jonathan H. Adler, *Eyes on A Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 HARV. ENVTL. L. REV. 1, 3–4 (2011) (discussing the lack of innovation that results from both traditional government research subsidies and regulatory-driven technology advances).

235. *See id.* at 13 (showing how the patent system encourages innovation from unforeseen sources, drawing from a wider pool of ideas and potential innovators).

236. *See id.* at 42 (concluding that there are currently no economic incentives to develop technologies to achieve advances in the climate change arena, specifically there are no economic incentives focused towards reducing greenhouse gas emissions or removing existing carbon from the atmosphere).

237. *See id.* at 4 ("Prizes are particularly well-suited for the climate policy challenge because the threat of global warming cannot be reduced by any meaningful degree without dramatic technological breakthroughs that enable reductions in atmospheric concentrations of GHGs, and traditional innovation tools are inadequate.").

238. *See* Mormann, *supra* note 211, at 942 (highlighting the idea of a "socially optimal" level of intellectual property protection to incentivize renewable energy entrepreneurs).

institutions to cooperate with private industry to narrow the gap between ideas and commercial execution.[239]

E. National Level Policy Strategy

The combining of Pakistan's Water and Power Development Authority (WAPDA) and the Petroleum and Natural Resources Ministry (PNRM) could create a single energy ministry to oversee and regulate national level power issues.[240] The WAPDA was established in 1958 in an era when nearly all of Pakistan's electricity was generated by dams.[241] An integrated approach for energy generation would combine the water and power ministry with the petroleum and natural resources ministry to improve efficiency.[242] Doing away with these competing bureaucracies would lead to greater management and innovation.[243]

A single energy ministry is more aptly suited to tackle issues of energy efficiency, especially as they relate to line losses. Line losses in Pakistan stand at around nineteen percent, considerably higher than in other countries such as Israel and Sri Lanka.[244] Iraq and Israel have managed to lower their line losses, and Argentina has cut down its line losses from twenty-four percent in 1992 to eleven percent in 2007.[245]

Another strategy to consider is the creation of a national renewable energy portfolio. A mandatory renewable portfolio standard (RPS) in concert with renewable energy certificates (REC) allows power producers

---

239. *See id.* (discussing the benefits of creating technology transfer offices).

240. *See* Farooq Tirmizi, *Comment: Time to Create an 'Energy Ministry,'* THE EXPRESS TRIBUNE (Aug. 24, 2012), http://tribune.com.pk/story/425448/comment-time-to-create-an-energy-ministry/ (calling for an integrated approach for the management of all energy systems within the nation's competing bureaucracies and to oversee the nation's energy infrastructure) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

241. *See id.* (noting the formation and reach of the WAPDA).

242. *See id.* (showing that considering all energy sources allows for broader management strategies and takes into account both cost and capacity).

243. *See id.* (identifying the United States Department of Energy as an example of a nationally unified energy regulator for the entire power grid of the country).

244. *See Electric Power Transmission and Distribution Losses (% of Output)*, THE WORLD BANK, http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS (last visited Sept. 6, 2013) (indicating an average of three percent in Israel and 14.6% in Sri Lanka for the same year) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT). Although Pakistan has experienced slight declines in line losses since 2008, the average between 2008 and 2010 stood at nineteen percent. *Id*.

245. *See id.* (collecting global data on electric transmission losses, including "line losses," to show trends and comparisons). While Iraq has shown line losses nearing fifty percent, it has shown a downward trend from forty-nine percent to thirty-seven percent in 2010. *Id.*

to harness renewables to sell their electricity and the corresponding green certificates and earn more than the market rate for electricity alone.[246] A national RPS has been debated in the United States.[247] This same strategy can be implemented in Pakistan. Pakistan's Alternative Energy Development Board could work with existing micro-finance institutions to support sustainable energy projects.[248]

NEPRA (National Electric Power Regulatory Authority) was established under the NEPRA Act of 1997[249] to be an autonomous regulatory agency that ensured the "transparent and judicious economic regulation in the energy sector."[250] NEPRA also sought to ensure fair competition and protections for the consumer, producer, and distributor.[251] However, the NEPRA Act of 1997 needs to be amended to improve the performance measures of distribution companies.[252] Maintenance of all distribution transformers and pole-mounted substations is inadequate.[253] Energy companies in Pakistan need to increase load monitoring, and undertake a host of proactive reforms in order to improve the cost and reliability of the nation's power supply."[254]

---

246. *See* Anna Bergek & Staffan Jacobsson, *Are Tradable Green Certificates a Cost-Efficient Policy Driving Technical Change or a Rent-Generating Machine? Lessons from Sweden 2003–2008*, 38 ENERGY POL'Y 1255, 1256 (2010) (listing Belgium, Sweden, and the United Kingdom as early adopters of Renewable Energy Certificates).

247. *See* Joshua P. Fershee, *Moving Power Forward: Creating A Forward-Looking Energy Policy Based on a National RPS*, 42 CONN. L. REV. 1405, 1407 (2010) (providing an overview of the key issues and challenges facing a potential federal-level RPS, and discussing the pitfalls of state-by-state regulation).

248. *See* Pandey, *supra* note 86, at 181–82 (providing examples of micro-finance structures allowing rural consumers to purchase solar home systems in Bangladesh and Sri Lanka).

249. NEPRA Act No. XL of 1997, *available at* http://www.nepra.org.pk/legislation.htm (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

250. *The Challenges in Implementing Power Sector Reforms*, BUS. AND FIN. REV. (Oct. 18, 2010), http://jang.com.pk/thenews/oct2010-weekly/busrev-18-10-2010/p3.htm (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

251. *See id.* (establishing regulations for the generation, transmission, and distribution of electric power).

252. *See Energy Report Points at Faults in Pakistani Systems*, SUSTAINABLE DEV. POL. INST. (Aug. 12, 2012), http://www.sdpi.org/policy_outreach/news_details771.html (discussing needed changes to the NEPRA Act) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

253. *See id.* (explaining how the transformers are overloaded and burn out at the rate of twelve percent annually).

254. *See id.* (discussing reforms that would improve the energy sector in Pakistan).

V. The Case for Hydrokinetic Investment in Pakistan

This Part will provide an overview of technology behind hydrokinetic energy and regulatory mechanisms for its innovation and deployment. As countries like Canada, India, and the United Kingdom are already harvesting wave energy, examinations of their regulatory and policy schemes will be used to analyze how hydrokinetic energy can be deployed in LDCs.[255] First generation hydropower is extremely controversial because of its environmental effects, but wind, solar, and hydropower contribute a minimal amount of CO_2 to the atmosphere and are not directly linked to climate change.[256] Like other renewable energy forms, hydrokinetic technology is moving beyond the research and development stage.[257] Renewable energy sources must be competitive to ultimately succeed in the marketplace.[258] The ideal business model for energy development would not require tax incentives, regulatory control, or legal safeguards, but the deployment of hydrokinetic technology in Pakistan would require subsidies to kick-start the business.[259]

It is a myth that renewables require higher subsidies than fossil fuels, which are also highly subsidized.[260] Development of renewable

---

255. *See* Anders Jansson, *Renewable Energy Can Bring Security of Energy Supply*, ENERGY HARVESTING J. (Aug. 30, 2013), http://www.energyharvestingjournal.com/articles/renewable-energy-can-bring-security-of-energy-supply-00005759.asp (noting that tidal energy harvesting shows promise for poorer and isolated nations) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

256. *See* Komor, *supra* note 201, at 4–6 (explaining how hydropower-fueled facilities produce no direct emission—such as oxides, carbon monoxide, sulfur oxides, or particulates—and therefore do not contribute to local or regional air quality problems).

257. *See* PEW CTR. ON GLOBAL CLIMATE CHANGE, HYDROKINETIC ELECTRIC POWER GENERATION 4 (2011), *available at* http://www.c2es.org/docUploads/HydrokineticElectricPowerGeneration_0.pdf (discussing the current status of hydrokinetic generation globally) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

258. *See* Komor, *supra* note 201, at 12 (noting that "markets create a complex set of forces that help ensure a technology meets the needs of users" and that market forces "cannot be duplicated by policy").

259. *See id*. at 11–12 (explaining that subsidies are already used for fossil fuels and the implementation of renewable energy would only require a "policy change, rather than new policy intervention").

260. *See* K.K. DUVIVIER, THE RENEWABLE ENERGY READER 8–9 (2011) ("A common myth is that renewable energy development requires inordinate government subsidies. In fact, every single energy resource in the United States has enjoyed, and continues to enjoy, government subsidies."). Pakistan also heavily subsidizes its fossil fuels. *See* Mehreen Khan, *Energy Subsidies Cripple Pakistan Economy, Says Study*, ENERGY SOURCE (July 27, 2011), http://blogs.ft.com/energy-source/2011/07/27/energy-subsidies-cripple-pakistan-economy-says-study/#axzz2eDNu8aS6 (explaining how Pakistan spent nearly $3.5 billion subsidizing

energy without government subsidies is unrealistic and bound to fail.[261] The impetus to slow down rates of climate change and decrease environmental degradation caused by fossil fuel use would provide ample support for arguments in favor of economic incentives to develop this renewable energy.[262] While accelerated production of domestic natural gas and coal and importation of foreign petroleum can provide short- and medium-term solutions to Pakistan's energy crisis, sustainable energy production is a long-term solution for the country's continued growth.[263]

Studies indicate that small-scale hydropower, once fully developed, could increase present rates of hydropower generation by up to 200% in the United States.[264] Similar water sources exist in Pakistan. Primary water sources include rainfall, glaciers, rivers, surface water, and groundwater.[265] Rainfall in Pakistan varies in magnitude, timing, and geographic distribution, with almost two-thirds of the rainfall occurring during the summer.[266] Even though rainfall is relatively low, heavy rainfall periods coincide with high summer temperatures,[267] which would allow hydrokinetic energy to be used to counter energy shortfalls at those times.[268]

---

the power sector in the fiscal year ending in June 2011) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

261. *See* Melissa Powers, *Sustainable Energy Subsidies*, 43 ENVTL. L. REV. 211, 215 (2013) ("[I]f [renewable energy sources] operated on an equal footing with fossil fuels, subsidies would not be necessary. Advocates of renewable power thus view a lack of competitiveness as the underlying rationale for subsidization.").

262. *See id.* at 214 (discussing how opponents of energy subsidies "ignore the urgency of climate change").

263. *See* Khurram Baig, *Energy Mix: Despite Multiple Options, Pakistan Should Not Give Up on Hydel*, THE EXPRESS TRIBUNE (June 30, 2013), http://tribune.com.pk/story/570486/energy-mix-despite-multiple-options-pakistan-should-not-give-up-on-hydel/ (describing the biggest barrier to hydropower in Pakistan as a lack of political will and consensus) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

264. *See* Gina S. Warren, *Hydropower: It's a Small World After All*, 91 NEB. L. REV. 925, 957 (2013) (discussing the increase in production of small-scale hydroelectric projects).

265. *See* PAK. WATER GATEWAY, WATER SOURCES OF PAKISTAN, *available at* http://cms.waterinfo.net.pk/pdf/wr.pdf (describing the primary water sources of Pakistan and explaining that the primary sources of rainfall are monsoons and western disturbances) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

266. *See id.* at 2 (discussing the seasonal variance in the rainfall in Pakistan).

267. *See id.* at 1 (explaining how Pakistan's rainy season is concentrated in the summer months).

268. *See Maine Deploys First U.S. Commercial, Grid-Connected Tidal Energy Project*, ENERGY.GOV (July 24, 2012), http://energy.gov/articles/maine-deploys-first-us-commercial-grid-connected-tidal-energy-project (explaining how tidal energy can be used to combat energy shortfalls) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

The Indus River irrigates the Indus Basin through its major tributaries, which flow through valleys parallel to the mountains of the High Himalayas and into the country's plains, eventually leading to the tidal delta near the Arabian Sea.[269] The Indus River System consists of the Indus River, Kabul River, Jhelum River, Chenab River, Ravi River, Setluj River, and Beas River.[270] Aside from the Indus River, the fast-flowing Kabul and Swat Rivers, irrigation canals in the Punjab and Sindh provinces, and tidal currents in the Arabian Sea each provide strong potential for hydrokinetic electricity.[271] A more remarkable potential exists in Pakistan's glacier-fed mountain streams, which are normally difficult to access and lack the traditional power grid association.[272] These mountain streams hold 16,000 MW of potential electricity.[273] In Pakistan, as elsewhere, future water needs surpass the total potential energy supply,[274] so the need to reduce the water losses can be accomplished through improved irrigation efficiency, construction of water reservoirs, and the adoption of artificial ground water recharge techniques to integrate the rain and excess flood water into depleted aquifers.[275]

Relations between India and Pakistan impact the development of hydrokinetic energy resources because of access to the Indus River.[276] This tension between the two neighboring nations further illustrates the need for Pakistan to seek alternate forms of energy sources.[277] To achieve successful

---

269. *See* Allah Bakhsh Sufi et al., *Integrated Water Resource Management in Pakistan*, Pakistan Engineering Congress, 37 (Working Paper No. 286), *available at* http://pecongress.org.pk/images/upload/books/4-Intergrated%20Water%20Resource%20Management%20in%20Pakistan%20%284%29.pdf (describing the flow of the Indus River) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

270. *See id.* (discussing the Indus River system).

271. *See Wind Power and Solar Energy in Pakistan,* REVE (Feb. 23, 2012), http://www.evwind.es/2012/02/23/wind-power-and-solar-energy-in-pakistan/16771/ (describing the untapped potential of regional water sources) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

272. *See id.* (discussing the alternative water sources that Pakistan has to offer).

273. *See id.* (noting the generative potential for glacial mountain streams in Pakistan, and noting the unique benefits of smaller mini-hydel projects).

274. *See* DAVID MITCHELL ET AL., CONNECTING THE DROPS: AN INDUS BASIN ROADMAP FOR CROSS-BORDER WATER RESEARCH, DATA SHARING AND POLICY COORDINATION 3 (2013), *available at* http://www.stimson.org/images/uploads/research-pdfs/connecting_the_drops_stimson.pdf (discussing the increased demand on the Indus River Basin and noting that the water of the Basin already is completely allocated) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

275. *See* Sufi et al., *supra* note 269, at 42. (explaining water loss abatement techniques).

276. *See* MITCHELL, *supra* note 274, at 22 (describing the history between India and Pakistan and the conflict over the Indus River Basin).

277. *See* Aziz Nayani, *Pakistan's New Big Threat Isn't Terrorism—It's Water*, THE ATLANTIC (July 19, 2013),

agriculture, public health, and economic development, access to river water is crucial.[278] The Indus Water Treaty of 1960 divided six major river systems between the two nations.[279] However, allegations of India diverting water upstream fuel tensions between the countries because half of Pakistan's population is involved in agriculture and more than ninety percent of the country is dependent on water from the Indus river.[280] With India also suffering from energy shortages,[281] hydroelectricity ranks high on India's list of priorities.[282] The long-standing water dispute between Pakistan and India can be resolved amicably through the Indus Water Treaty once India, the holder of the upper riparian rights, recognizes Pakistan's water crisis.[283]

Given such high stakes, there is a high potential for water-based conflict in the future if water becomes scarce.[284] As recently as April 2012, officials in Pakistan and India expressed a willingness to negotiate on

---

http://www.theatlantic.com/international/archive/2013/07/pakistans-new-big-threat-isnt-terrorism-its-water/277970/ (explaining that Pakistan can look outside of the situation with India to solve its water shortage issues) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

278. *See* James Kraska, *Sustainable Development Is Security: The Role of Transboundary River Agreements as a Confidence Building Measure (CBM) in South Asia*, 28 YALE J. INT'L L. 465, 481 (2003) ("International drainage basins link riparian states into a common and interdependent freshwater system that connects the agriculture, industry, energy, and transportation sectors into an integrated regional unit.").

279. *See* Indus Waters Treaty, India-Pak., Sept. 19, 1960, 419 U.N.T.S. 125 (giving Pakistan access to the Indus, Jhelum and Chenab rivers while India received access to the Sutlej, the Beas and Ravi rivers).

280. *See* Syed Mansur Hashim, *Going to War Over Water*, DAILY STAR (Aug. 28, 2012), http://www.thedailystar.net/newDesign/news-details.php?nid=247288 (describing the history of Pakistan and India fighting over the Indus River Basin) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

281. *See* Sam Tranum, *India-Pakistan Energy Cooperation Could Get Boost Under Sharif*, WORLD POL. REV. (June 25, 2013), http://www.worldpoliticsreview.com/articles/13049/india-pakistan-energy-cooperation-could-get-boost-under-sharif (explaining that, despite required power outages, India's energy situation is better off than Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

282. *See* Hashim, *supra* note 280 (concluding that India will focus on hydroelectricity because of energy shortages).

283. *See* Shoaib-ur-Rehman Siddiqui, *IWT Key to Resolve Pak-India Water Issue*, BUS. RECORDER (Nov. 21, 2012), http://www.brecorder.com/pakistan/general-news/91794.html (explaining how the Indus River Treaty solves the water dispute but it is up to India to abide by the treaty conditions) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

284. *See* Hashim, *supra* note 280 ("Populations will continue to grow. There will be more pressure on supply. Factor in climate change and faster glacial melt . . . . That means much more will be at stake. So you could have a perfect storm which conceivably could be some sort of trigger.").

energy related issues;[285] however, Pakistani officials are hesitant to import Indian oil.[286] Yet talks to establish an electricity transmission line to carry power between Amritsar and Lahore are ongoing.[287] South Asia lags behind other regions in the world in energy trade and regional integration.[288] In South Asia, deployment of sustainable energy is less a matter of technology and more about easing regional tensions between Pakistan and India.[289] As a result of the nations' contentious history, it is difficult to foresee any future agreements.[290] The disparity between the economies of Pakistan and India is related, in part, to energy infrastructure and policy.[291] While India has forged ahead with renewable energy, corruption, bureaucracy, and poor energy policy have soured Pakistan's attempt at entering the renewable energy revolution.[292] Pakistan's Water and Power Minister assured the Prime Minister Raja Pervez Ashraf that all necessary measures were being pursued for optimal energy generation to reduce the unmet demand.[293] Additionally, the Prime Minister recommended that hydropower projects be

---

285. *See India-Pakistan: Slow Progress in Trade Talks for Petroleum, Power*, THE ECON. TIMES (Aug. 26, 2012), http://articles.economictimes.indiatimes.com/2012-08-26/news/33402426_1_diesel-imports-india-and-pakistan-petrol-and-power (describing proposed talks between Pakistan and India for India to export petroleum to Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

286. *See id.* (noting concerns about an overreliance on oil from India).

287. *See* Vivek Katju, *Jumping Into a Power Deal with Pakistan is No Guarantee of Improved Relations*, DAILY MAIL ONLINE INDIA (June 18, 2013), http://www.dailymail.co.uk/indiahome/article-2344050/Jumping-power-deal-Pakistan-guarantee-improved-relations.html (noting the progress of talks between India and Pakistan for the Amritsar-Lahore line) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

288. *See* Khadka, *supra* note 48 (quoting the regional director of the South Asian Regional Initiative for Energy, who asserted that South Asia lags behind in regional power integration).

289. *See id.* (explaining that geopolitical issues are more significant than market and technology barriers in cross-border energy trading).

290. *See id.* ("[U]nless South Asian governments really want to solve their differences, the region's power crisis looks set to become perennial.").

291. *See A Survey of India and Pakistan: Sorry States*, THE ECONOMIST (May 20, 1999), http://www.economist.com/node/205915 (comparing the economies of India and Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

292. *See* Shaheryar Mirza, *An Inconvenient Truth: 'Pakistan Still Has a Long Way to Go With Regard to Green Energy'*, THE EXPRESS TRIBUNE (June 6, 2012), http://tribune.com.pk/story/389250/an-inconvenient-truth-pakistan-still-has-a-long-way-to-go-with-regard-to-green-energy/ (explaining that wind energy in Pakistan is twice as expensive as wind energy in India) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

293. *See Entire Power Chain Must Be Streamlined*, *supra* note 154 (describing the meeting between the two leaders and the assurances from the Water and Power Minister).

given high priority.[294] Hydropower should be the alternative energy of choice in Pakistan's future. By using hydrokinetic energy, Pakistan would be able to utilize its existing energy infrastructure to harness the renewable energy technology, as has been done elsewhere.[295]

A. Technology behind Hydrokinetic Energy

Hydrokinetic energy generates power by using submerged or partially submerged turbines that are moved by flowing water to generate electricity.[296] This form of power generation allows power systems to be placed into flowing water with minimal harm to infrastructure or the environment.[297] Hydrokinetic turbines should be situated in deep, strong flowing rivers or downstream from existing hydropower stations, where electric transmission facilities are located.[298]

Capturing the energy contained in waves may have the greatest potential for energy production.[299] The movement of ocean waves is driven by winds and is influenced undersea topography.[300] The promise of harnessing waves to generate power comes from both resource availability and advances in technology.[301] While no authoritative studies have been done on hydrokinetic energy in Pakistan, it is promising to look at potentials in places like the United States where studies indicate that "[e]xtracting only fifteen percent of the energy in U.S. coastal waves would

---

294. *See id.* (noting the Prime Minister's stated concern for the country's water and electricity needs).

295. *See e.g.*, Tony Kryzanowski, *More Minnesota Water Power*, ENERG (Sept. 2009), http://www.altenerg.com/back_issues/index.php-content_id=201.htm (noting that hydrokinetic energy projects can be implemented using existing infrastructure) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

296. *See How Hydrokinetic Energy Works*, UNION OF CONCERNED SCIENTISTS (Apr. 28, 2008), http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-hydrokinetic-energy-works.html ("Hydrokinetic technologies produce renewable electricity by harnessing the kinetic energy of a body of water, the energy that results from its motion.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

297. *See id.* ("[I]nitial studies indicate that these [environmental] impacts are likely to be minimal where appropriate care has been taken in site selection and project design.").

298. *See* Hydrokinetic Power Barges, *supra* note 181 (describing typical locations for hydrokinetic barge setups).

299. *See* UNION OF CONCERNED SCIENTISTS, *supra* note 296 (discussing various potential hydrokinetic energy sources).

300. *See id.* (discussing the causes of wave motion and tides).

301. *See id.* (noting the reasons that hydrokinetic power is now viable).

generate as much electricity as currently produced at conventional hydroelectric dams."[302]

Experts have recognized that small-scale hydropower is an attractive renewable solution for Pakistan.[303] Nonetheless, development of small-scale hydropower remains the domain of the provincial governments.[304] Small-scale hydropower is flexible to engineering redesign, or removal if necessary.[305] When policymakers discussed small-scale hydropower, they did not explore the option of hydrokinetic energy per se.[306] In Pakistan, of the estimated 50,000 MW in hydropower potential, only 4,800 MW has been developed over the last fifty years, and only through mega-hydel plants.[307] Hydrological surveys of northern Pakistan revealed "numerous small streams and waterfalls . . . having sufficient potential for electricity generation through micro-hydroelectric power plants."[308] A number of public and private-sector organizations are investing in the development of hydroelectric plants in a range of sizes.[309] A 2005 report by the Commission on Science and Technology for Sustainable Development in the South points out the tremendous potential for energy

---

302. *Id.*

303. *See* Saleem H. Ali, *Resolving Environmental Conflicts in Pakistan's Energy Policy*, *in* FUELING THE FUTURE: MEETING PAKISTAN'S ENERGY NEEDS IN THE 21ST CENTURY 185, 192–93 (Robert M. Hathaway, Bhumika Muchhala & Michael Kugelman eds., 2007), *available at* http://www.wilsoncenter.org/sites/default/files/Asia_FuelingtheFuture_rptmain.pdf (explaining that small-scale dams are more flexible and are promising for smaller water sources in Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

304. *See* Quazi Asif, *Can Provinces Handle the 18th Amendment?*, PAKISTAN TODAY (July 22, 2011), http://www.pakistantoday.com.pk/2011/07/22/city/karachi/can-provinces-handle-the-18th-amendment/ (explaining that the local provinces have the constitutional delegation of authority to establish power generation units) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

305. *See* UNION OF CONCERNED SCIENTISTS, *supra* note 296 (explaining the construction of hydrokinetic energy mechanisms).

306. *See* Ann-Kathrin Schneider, *Fast Track Power Generation*, INT'L RIVERS (Sept. 2008), http://www.internationalrivers.org/resources/fast-track-power-generation-1834 (describing how calls for large hydropower projects drown out smaller scale projects) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

307. *See* Nayyer Alam Zaigham & Zeeshan Alam Nayyer, *Prospects of Renewable Energy Sources in Pakistan*, *in* RENEWABLE ENERGY TECHS. AND SUSTAINABLE DEV. 65, 68–70 (2005), *available at* http://www.tawanai.com/wp-content/uploads/2008/12/RenewEnerPakistan-NAZ.pdf (explaining that the potential for hydropower in Pakistan is recognized but not utilized).

308. *Id.* at 68.

309. *See id.* (noting entities that are investing in hydropower projects).

development from waterfalls in Pakistan.[310] Other potential rivers to exploit for hydrokinetic energy development are the Kunhar and Chitral.[311] Moreover, "[w]hile aggregate hydropower capacity from these rivers might not ostensibly match the potential from large projects, the overall efficiency in distribution systems can often make them more attractive."[312]

Hydrokinetic energy can be an optimal renewable energy source in the national energy portfolio.[313] Discussions on the national and regional levels should coordinate so as to effectively make use of this renewable energy source.[314] The feasibility of hydrokinetic energy as a renewable energy source in Pakistan has been the subject of a cursory discussion, and the development programs at the World Bank should consider it more seriously.[315] Clusters of turbines can be strategically placed to harness wave energy.[316] This budding technology can be successfully deployed in Pakistan through an appropriate governance strategy, energy investment policy and regulatory regimes.[317]

The funding for hydrokinetic energy projects can come from national and international sources.[318] International development funds, such

---

310. *See id.* at 68–70 (explaining the potential for utilizing Pakistan's water resource for energy generation). "For example, the Punjab province has an extensive network of irrigation canals, and at many sites, small waterfalls are available, which can be exploited to employ low-head high-discharge hydropower plants." *Id.* at 69.

311. *See* Ali, *supra* note 303, at 192–93 (identifying other rivers as potential small rivers for generating power).

312. *Id.* at 193.

313. *See* Jonathan Fahey, *Renewable Energy Growth Is Rising Around The World, IEA Says*, The HUFFINGTON POST (June 26, 2013), http://www.huffingtonpost.com/2013/06/26/renewable-energy-growth_n_3504265.html ("Non-hydroelectric sources such as wind, solar, geothermal and energy derived from plants are also expected to grow quickly, but they contribute a far smaller amount of energy to the global mix [than hydroelectric sources].") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

314. *See* Asif, *supra* note 304 (explaining how oil and gas in Pakistan is now under joint federal and state ownership).

315. *See Mapping the Renewable Energy Revolution*, WORLD BANK (June 17, 2013), http://www.worldbank.org/en/news/feature/2013/06/17/mapping-the-energy-revolution (explaining that the World Bank is working with countries like Pakistan to produce informational data and support other activities) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

316. *See Wind Power and Solar Energy in Pakistan*, *supra* note 271 (explaining the effectiveness of clustering hydrokinetic turbines).

317. *See id.* (noting that the only limits on the use of alternative energy are "our ability to innovate, organize, and educate," and discussing potential for hydropower in Pakistan).

318. *See, e.g.*, RENEWABLE ENERGY ALASKA PROJECT, EMERGING ENERGY TECHNOLOGY: A GLOBAL OPPORTUNITY FOR ALASKA 5, *available at* http://www.legis.state.ak.us/basis/get_documents.asp?session=26&docid=7917 (listing state, national, and international funds for alternative energy) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

as those in Sweden, New Zealand, the United Kingdom, and the United States can provide funding for hydrokinetic energy research and project development.[319] The Swedish International Development Cooperation Agency (SIDA) is a governmental agency which offers technical assistance and funding throughout the world by channeling its resources through non-governmental organizations (NGOs), multilateral cooperation, and the EU.[320] SIDA is interested in promoting "international development cooperation" rather than simply providing "assistance."[321]

Small-scale hydroelectric development is a more sustainable option than large-scale dams.[322] Barriers to the introduction, development, and implementation of hydrokinetic energy in Pakistan includes costs, technology, permitting, local community involvement, a generalized shift in the country's energy strategy and outlook, and investment regimes.[323] As with any renewable technology, the hurdles are now less about the science, and more about policy, law, and governance structure.[324] The impact of hydrokinetic energy projects must be evaluated in both fresh and salt water.[325] Offshore renewable energy projects affect coastal ecosystems because a single development may have an ecological footprint extending

---

319. *See* KPMG, TAX AND INCENTIVES FOR RENEWABLE ENERGY (2012), *available at* http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/taxes-incentives-renewable-energy-2012.pdf (providing a survey of alternative energy taxes and incentives from twenty-three countries) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

320. *See generally Our Mission,* SWEDISH INT'L DEV. COOP. AGENCY, http://www.sida.se/English (last visited Nov. 3, 2013) (describing the purpose and function of the organization) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

321. *See id.* (noting the focus on cooperation). SIDA supports over 2,000 projects in over 100 countries. *Id.*

322. *See Micro-Hydro Power*, PRACTICAL ACTION, http://practicalaction.org/micro-hydro-power-3 (explaining that micro-hydro power systems do not dam rivers like large-scale hydropower and therefore do less damage to the environment) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

323. *See* Rina Saeed Khan, *The Untapped Blessing of Hydropower*, DAWN (July 23, 2013), http://dawn.com/news/1031357/the-untapped-blessing-of-hydropower (explaining that Pakistan's hydropower potential will not be realized without changes in government priorities and funding techniques) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

324. *See* Khurram Baig, *supra* note 263 (describing the biggest barrier to hydropower in Pakistan as a lack of political will and consensus).

325. *See* Louis Bergeron, *Stanford Researchers Use River Water and Salty Ocean Water to Generate Electricity*, STANFORD NEWS (Mar. 28, 2011), http://news.stanford.edu/news/2011/march/saline-rechargeable-battery-032811.html (describing a new system that can be placed where fresh water rivers meet ocean water to create energy using a chemical reaction) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

several square miles.[326] Scientists have noted that these developments require "proper consideration of any potential impact on the ecosystem at appropriate spatial and temporal scales."[327] Meanwhile, the present understanding of human impact on the coastal environment is "limited and piecemeal."[328]

Technologies that seek to generate energy from waves and currents are called hydrokinetic energy conversion devices, and generally either convert wave motion energy or tap water movement through rotating devices.[329] Although all such devices are still being developed, some fully permitted pilot devices have been deployed in developed countries.[330] The industry is rapidly progressing and hopes to build commercial scale projects in the coming decade.[331] The use of narrow blades and near two-dimensional waterflow, the turbine movement can be modeled using a "blade element momentum theory."[332] There are numerous promising configurations within each of these technology categories, and the lack of a clear leader today emphasizes the need to support further engineering studies and pilot deployments to establish the most cost-effective and environmentally sound options.[333]

Hydrokinetic power barges are designed for use in river and ocean currents with a horizontal axis turbine, which is mounted on a catamaran type hull and submerged into the water.[334] Such barges are easy to use because of their quick assembly and slow turbine rotation speed.[335] "The barge on which the turbines are mounted . . . is able to cope with fluctuations in water levels, substantial velocity increases, and direct

---

326. *See* Andrew B. Gill, *Offshore Renewable Energy: Ecological Implications of Generating Electricity in the Coastal Zone*, 42 J. APPLIED ECO. 605, 605–15 (2005) (explaining that a single development can have an ecological impact over a large area).

327. *Id.* at 606.

328. *Id.*

329. *See* UNION OF CONCERNED SCIENTISTS, *supra* note 296 (discussing the categorization of hydrokinetic energy projects).

330. *See id.* (discussing the state of the industry).

331. *See id.* (discussing the goal of building commercial scale "wave parks" and turbine arrays).

332. W.M.J. Batten et al., *Hydrodynamics of Marine Current Turbines*, 31 RENEWABLE ENERGY 249, 255 (2006).

333. *See Research and Development*, NAT'L HYDROPOWER ASS'N, http://www.hydro.org/tech-and-policy/policy-priorities/researcg-development/ (last visited Nov. 3, 2013) (describing the potential of hydropower and explaining that continued investment and research is crucial for its success) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

334. *See* Hydrokinetic Power Barges, *supra* note 181 (describing how hydrokinetic power barges utilize currents to create electricity).

335. *See id.* (stating that these barges can be assembled locally according to provided design plans and drawings).

impacts from large and fast-moving debris, . . . the only flow parameter that would decrease power output would be a decrease in the flow rate of the water . . . ."[336]

B. Representative Hydrokinetic Energy Projects

A number of countries are already investing in Pakistan's energy sector. Therefore Pakistan should consider seeking specific investment in hydrokinetic energy production and development. For example, Argentina is actively promoting technology transfer between Argentinean and Pakistani companies in the energy sector in the area of compressed natural gas.[337] The United States is additionally providing funds to support improvement of the Mangla Dam and infrastructure and due diligence report on the Kurram Tangi Dam project.[338] The United States seeks to invest in high-impact projects aimed at increasing Pakistan's energy resources and helping power sector institutions more effectively meet the country's energy needs.[339]

Instead of improvements to large-scale hydroelectric projects, the United States should consider investing in hydrokinetic pilot projects. Assistance from the U.S. government could help Pakistan also develop a regulatory framework similar to what exists in the United States for renewable energy projects. For example, the Federal Energy Regulatory Commission (FERC) in the United States has developed a set of norms for licensing hydrokinetic pilot projects, which are used to "test new, hydrokinetic technology devices; to determine the appropriate sites for hydrokinetic projects; and to gather information on environmental and other effects of the devices."[340] Project review occurs under FERC's existing

---

336. *Id.*

337. *See Argentina Helping Pakistan Fight Energy Crisis*, DAILY TIMES (Aug. 18, 2012), http://www.dailytimes.com.pk/default.asp?page=2012\08\18\story_18-8-2012_pg5_2 (discussing Argentina's efforts to combat Pakistan's energy deficiencies) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

338. *See* PPI, *US Releases $280m for Pakistan's Energy Projects*, DAWN (Aug. 3, 2012), http://dawn.com/2012/08/03/us-releases-280m-for-pakistans-energy-projects/ (reporting on the U.S. Congress releasing $280 million in assistance to support Pakistan's energy sector) (last visited Sept. 23, 2013) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

339. *See id.* (announcing that funds from the United States will support improvements to Mangla Dam and infrastructure support and due diligence work on the Kurram Tangi Dam project).

340. *See* FED. ENERGY REGULATORY COMM'N, LICENSING HYDROKINETIC PILOT PROJECTS 2 (Apr. 14, 2008), *available at* http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics/pdf/white_paper.pdf (providing guidance as part of the

authority and regulations.[341] Once a license is granted, the developer can collect revenue from generating electricity while still testing.[342] The United States is still experimenting with hydrokinetic technology for its own use because the technological feasibility of commercial hydrokinetic energy production is still only in the development stage.[343]

Tidal stream energy converter projects are planned or in use in the East River of New York City, the Juan de Fuca Strait off the southern coast of Vancouver Island in Canada, and the arctic seas of northern Norway as well as in Scotland, Russia, South Korea, and India.[344] In Strangford Lough in Northern Ireland, a 1.2 MW tidal stream energy converter became operational in 2008, the largest in the world at the time.[345] These energy development projects are motivated by "the desire for energy supply security and concerns with the environmental impacts of fossil fuel combustion."[346]

The technical complexities of hydrokinetic power generation aside, the regulatory and administrative support afforded to hydropower is key to its successful development and implementation.[347] The following subsections will illustrate how hydrokinetic energy projects are being deployed in both developed nations and LDCs. Understanding and conceptualizing the legal and regulatory framework for how other nations have explored hydrokinetic energy as a renewable energy source will illustrate the potential for investment and development in Pakistan.

Commission's ongoing effort to support the advancement and orderly development of innovative hydrokinetic technologies).

341. *See id.* at 4 (noting that FERC seeks to adapt existing rules and grant waivers rather than drafting new rules).

342. *See id.* ("When granted, a license would allow the developer to realize a revenue stream from generating while testing and would provide for Commission enforcement of license conditions.").

343. *See* Rachael Salcido, *Siting Offshore Hydrokinetic Energy Projects: A Comparative Look at Wave Energy Regulation in the Pacific Northwest*, 5 GOLDEN GATE U. ENVTL. L.J. 109, 112 (2011) (considering the approaches that Oregon, California, and Washington have taken to address the need for additional renewable energy while also undertaking a shift to comprehensive ocean management).

344. *See generally* J. Blanchfield, et al., *Tidal Stream Power Resource Assessment for Masset Sound, Haida Gwaii*, 222 J. POWER & ENERGY 485, 485–92 (2008) (presenting a case study of the power potential of a tidal stream connecting a bay to the open ocean).

345. *See id.* (noting when the converter entered service).

346. *Id.*

347. *See* Hon. Jon Wellinghoff, James Pederson & David L. Morenoff, *Facilitating Hydrokinetic Energy Development Through Regulatory Innovation*, 29 ENERGY L.J. 397, 399 (2008) (discussing how implementing a regulatory framework increases the potential for hydrokinetic energy).

1. United Kingdom

The United Kingdom, the former colonial ruler of pre-partition India, has been a forerunner in hydrokinetic energy.[348] The British government has provided infrastructure support to Pakistan.[349] Seeking technological know-how and reviewing the United Kingdom's regulatory mechanisms for hydrokinetic energy would be constructive. Developments in wind turbine technology and off-shore oil exploitation have made marine energy generation economically feasible.[350] The predictability and energy potential of harnessing tidal energy outweigh the difficulties of harnessing this energy source.[351] The Sustainable Energy Research Group at the University of Southampton in the United Kingdom is a pioneer in the development and design of marine current energy converters that extract energy from tidal flows.[352] Several of the group's research projects have dealt with issues of designing marine current energy converters, which essentially look like an "underwater wind turbine."[353] The European Marine Energy Centre (EMEC) in Scotland tests commercial scale wave and tidal technologies and seeks to develop performance standards and best practices for commercial scale marine energy projects.[354]

---

348. *See Hydrokinetic and Ocean Energy,* PR NEWS WIRE (Feb. 9, 2012), http://www.prnewswire.com/news-releases/hydrokinetic-and-ocean-energy-139004879.html ("Countries that have strong marine resources, such as the United Kingdom, the United States, Australia, South Korea, and Portugal, have committed to supporting the industry in some capacity—with the United Kingdom being the clear leader.") (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

349. *See Case Study: Building Bridges to Re-connect Cut-off Communities in Pakistan*, GOV.UK (June 6, 2012), https://www.gov.uk/government/case-studies/building-bridges-to-re-connect-cut-off-communities-in-pakistan (demonstrating the British support for infrastructure projects in Pakistan) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

350. *See Tidal Energy: Harnessing the Tides*, UNIVERSITY OF SOUTHAMPTON, http://www.southampton.ac.uk/energy_futures/research/marine_energy.page (last visited Nov. 2, 2013) (discussing advancements that have made marine energy feasible) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

351. *See id.* ("Although the marine environment is harsh, the energy available is more predictable and far denser than that available from wind.").

352. *See id.* ("Southampton's Sustainable Energy Research Group is at the forefront of the development and design of marine current energy converters that extract energy from tidal flows.").

353. *See id.* (discussing some of the University of Southampton's marine energy projects).

354. *See* EMEC, ENVIRONMENTAL IMPACT ASSESSMENT (EIA) GUIDANCE FOR DEVELOPERS AT THE EUROPEAN MARINE ENERGY CENTRE 1, 1–15 (2005), *available at* http://hydropower.inel.gov/hydrokinetic_wave/pdfs/day3/4_final_emec_procedure.pdf (demonstrating that the EMEC seeks to ensure the marine energy industry considers environmental implications of its projects and technologies in the early stages of design and

2. Canada

Canada is another leader in hydrokinetic energy and could prove to be a substantial ally for Pakistan in creating a hydrokinetic program of its own.[355] The Nova Scotian government aims to derive ten percent of its energy supply from tidal and wave energy.[356] This level of ambition in terms of the percentage of hydrokinetic energy generated overall correlates with wave, wind, and water conditions of Nova Scotia.[357] While Pakistan may not have the same potential hydrokinetic energy as Nova Scotia, it can model renewable energy targets optimistically based on its level of production capacity and scale. The government of Nova Scotia has set the target as part of its vow to reduce fossil fuel consumption.[358] The Fundy Ocean Research Centre for Energy, a government and privately funded testing facility, began work on developing test devices in 2012.[359] But even in Canada, internal election politics may impede the generation of tidal energy.[360]

4. Sri Lanka

Sri Lanka's development of hydrokinetic energy is particularly striking. In Sri Lanka legislative and policy actions were undertaken by the national government to create investment options for renewable

---

development for the purposes of best practice is being carried forward into commercial scale developments) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

355. *See Energy*, GOV'T OF CANADA, http://www.canadainternational.gc.ca/china-chine/bilateral_relations_bilaterales/Energy (last modified Sept. 9, 2013) (stating that hydropower accounts for ninety-seven percent of Canada's renewable electricity generation and nearly thirteen percent of the global production of hydropower) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

356. *See Nova Scotia Unveils Plan to Have Tidal Energy Meet 10 Percent of Its Energy Needs,* RENEWABLE ENERGY MAG. (May 16, 2012), http://www.renewableenergymagazine.com/article/nova-scotia-unveils-plan-to-have-tidal (reporting on Nova Scotia's energy department's plan to have tidal energy meet ten percent of its energy needs) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

357. *See id.* ("Nova Scotia is well-placed to become global player in this emerging energy industry.").

358. *See id.* (discussing Nova Scotia's plan to generate more tidal energy).

359. *See id.* (describing the Centre's work on tidal energy).

360. *See* Derek Wong, *Will Canada's Election Reshape Its Climate Policy Landscape?*, THE ENERGY COLLECTIVE (May 4, 2011), http://theenergycollective.com/derekwong/56907/federal-election-reshapes-canada-s-climate-policy-landscape (discussing the impact of the recent election on Canadian energy policy) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

technology.[361] In 1997 the Energy Services Delivery (ESD) promoted a host of private renewable energy projects, and drew financing through banks and micro-finance institutions with assistance from the World Bank and the GEF.[362] Based on the success of the ESD project, a new project—the Renewable Energy for Rural Economic Development (RERED)—is now underway, with the two institutions financing hydropower projects for the Sri Lankan grid.[363] Over 100 hydro projects have been installed in villages, and 80,000 solar home systems have been sold commercially.[364] The growth of small hydropower and solar home systems in Sri Lanka can be attributed to projects financed by the World Bank and GEF.[365] One of the participating credit institutions working with the World Bank and GEF on this program is a leading micro-finance agency in Sri Lanka, and the RERED program constitutes thirty percent of its lending portfolio.[366]

5. Ghana

The government of Ghana began financing its renewable energy and energy efficiency products from taxes on oil in the mid-1980s.[367] Ghana adopted a national energy policy for 2006 to 2020, in which it hoped to achieve fifteen percent penetration of rural electrification through decentralized renewable energy by 2015, expanding to double that amount five years later.[368] The policy also plans to receive twenty percent of its energy from renewable sources by 2020.[369] While there is no present policy or regulatory framework to assist hydrokinetic renewable energy investment, sites have been identified for small hydrokinetic energy projects.[370] While these sites have not historically been used, the Parliament

---

361. *See On-Grid Renewable Energy Development*, SRI LANKA SUSTAINABLE ENERGY AUTHORITY, *available at* www.energy.gov.lk/pdf/guideline/Grid_Renewable.pdf (July 2011) (outlining Sri Lanka's renewable energy financing process) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

362. *See* Pandey, *supra* note 86, at 178. (highlighting how the International Development Association of the World Bank and the GEF implemented the projects from 1997–2002 with $19.70 credit lines).

363. *See id.* (discussing the joint hydropower project of RERED and ESD).

364. *See id.* (discussing the success of the project).

365. *See id.* at 181 (noting that the success of the project in Sri Lanka can be attributed to the World Bank and GEF).

366. *See id.* at 181 (noting the important relationship between micro-finance and small scale renewable energy development).

367. *See* Veronica B. Miller et al., *Hydrokinetic Power for Energy Access in Rural Ghana*, 36 RENEWABLE ENERGY 671, 672 (2011) ("Since the mid-1980s, the Ghanaian government has been financing projects using small levies on petroleum products.").

368. *See id.* (noting the adoption of a strategic national energy plan).

369. *See id.* (discussing the plan's renewable energy goals).

370. *See id.* (noting the existence of potential hydrokinetic sites).

of Ghana is setting forth new policies for use of these sites.[371] Pakistan can look to Ghana as an example of how to set renewable energy targets.

6. China

Pakistan should consider steps to further improve its alliance with China for the purposes of energy production. Pakistan's current alliance with China is already proving fruitful through Chinese investments in Pakistani infrastructure.[372] While there are countries other than Pakistan that will be able to better utilize hydrokinetic energy and develop technology, Pakistan is an ideal place to use this technology because of the acute need for energy.[373] China's hydroelectric resources are estimated to be the largest in the world.[374] The Chinese excel in engineering and harvesting energy from non-fossil fuel sources.[375] China's future energy economy and its burgeoning population depend on its ability to become a leader in seeking out better alternatives to fossil fuels.[376] Sustainable energy is the thumping heart of China's future and continued growth.[377] If Pakistan's government and civil society can collaborate with the Chinese architects of water energy and Chinese urban planners, Pakistan will be one step closer to having sustainable energy sources.

---

371. *See id.* (discussing the unique potential benefits from hydrokinetic power in rural Ghana).

372. *See* Hans Spross, *China Increases Investment in Pakistan*, DW (July 11, 2013) http://www.dw.de/china-increases-investment-in-pakistan/a-16942100 (reporting on China's increased investment in Pakistani infrastructure) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

373. *See* WORLD ENERGY COUNCIL, *supra* note 12 (discussing the unmet demand for electricity in Pakistan).

374. *See* Robert W. Gee et al., *China's Power Sector: Global Economic and Environmental Implications*, 28 ENERGY L.J. 421, 431 (2007) (stating that China's total hydroelectric potential is estimated at 300,000 MW, two-thirds of which is in the remote southwestern quadrant of the country).

375. *See China Outpacing Rest of World in Natural Resource Use,* UNITED NATIONS ENVT'L PROGRAMME (Aug. 2, 2013), http://www.unep.org/newscentre/default.aspx?DocumentID=2723&ArticleID=9584 (reporting on China's surge ahead of the rest of the world in material consumption, but also its improvements in resource efficiency) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

376. *See* Michael Lelyveld, *Multiple Motives Drive China's Plans to Cut Number of Coal Mines*, RADIO FREE ASIA (Oct. 28, 2013), http://www.rfa.org/english/commentaries/energy_watch/coal-10282013110022.html (describing China's move away from coal for energy generation) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

377. *See id.* ("The government's recently-announced five-year action plan to fight smog in China's cities relies on reducing coal use in surrounding areas.").

C. International Collaboration

International organizations can play a constructive role in developing a contemporary renewable energy regime.[378] The international community should collaborate "to keep the energy question alive by developing it further in the mainstream agenda."[379] A sustainable energy future cannot be actualized without new international instruments.[380] The United Nations "Sustainable Energy for All" initiative is a highly ambitious, virtually impossible tripartite goal to provide: 1) universal access to modern energy services, 2) doubled rates of energy efficiency, and 3) doubled shares of renewable energy in the global energy mix by 2030.[381] The focus on renewable energy sources is driven primarily by fears of climate change and long-term aspirations for sustainable energy.[382] UN Secretary-General Ban Ki-moon promotes the push for sustainable energy enterprises.[383] The Sustainable Energy for All initiative realizes the central role energy plays in development.[384] As a leading voice for eco-efficiency, the United Nations Division on Sustainable Development under the Department of Economic and Social Affairs, has made it a goal to: 1) "[f]acilitate intergovernmental negotiations, consensus-building and decision-making[;]" 2) "[p]rovide technical assistance, expert advice and capacity building to support developing countries and countries with economies in transition in their efforts to achieve sustainable development;" 3) "[f]acilitate inter-agency and inter-organizational cooperation, exchange and sharing of information, and catalyze joint activities and partnerships within the United Nations system and with other international organizations, governments and civil society groups in support of sustainable development;" 4) "[p]romote and facilitate monitoring and evaluation of, and reporting on, the implementation of sustainable

---

378. *See* Blakeway, *supra* note 221, at 224 (exploring ways that the international community can enact policies to foster renewable energy development).

379. Jenny Sin-hang Ngai, *Energy as a Human Right in Armed Conflict: A Question of Universal Need, Survival, and Human Dignity*, 37 BROOK. J. INT'L L. 579, 621 (2012).

380. Lakshman D. Guruswamy, *Energy, Environment & Sustainable Development*, 8 CHAP. L. REV. 77, 78 (2005) (noting that sustainable energy requires international agreements dealing with "science and technology (S&T), trade and investment (T&I), research and development (R&D), technology transfer, and [sustainable development]").

381. *See* KI-MOON, *supra* note 18, at 4 (enumerating the "three linked objectives" that "underpin the goal of achieving sustainable energy for all by 2030").

382. *See id.* at 5 (exploring the threat of climate change and the imperative for clean energy).

383. *See id.* at 4 (outlining his goals in support of sustainable energy).

384. *See id.* at 8 ("Proper incentives are needed to . . . spur innovation to drive down the cost curve, invest in business-led solutions, and satisfy demand.").

development at the national, regional and international levels;" and 5) "[u]ndertake in-depth strategic analyses to provide policy advice."[385]

The United Nations' priorities appear hefty, but the central goals are negotiation, exchange of innovation, and appreciation for the process of cultivating and fostering sustainable development principles.[386] The United Nations' sustainable development goals align with and assist state development goals.[387] Market-oriented policies pursued by national governments and regional authorities have favored liberalization and deregulation of markets, privatization of state-owned enterprises, and the removal of structural distortions.[388] These changes have worked to enhance cross-border corporate integration.[389]

Legal instruments regarding sustainable development share certain legal principles. For the purposes of sustainable energy and international investment, it is helpful to consider these principles broadly to establish a framework for legal and policy changes.[390] International norms are not self-executing and many nations must enact their own national environmental law to give domestic force to multilateral environmental agreements and international environmental norms.[391] Beyond these internationally encouraged norms, far larger bodies of environmental norms are independently enacted within each nation.[392] International society lacks the sort of hierarchical decision-structures that are responsible for law making

---

385. *About*, UN ECONOMIC AND SOCIAL DEV., DIV. FOR SUSTAINABLE DEV., Priority Activities for the Division to Achieve These Goals, United Nations Department of Social and Economic Affairs, http://sustainabledevelopment.un.org/content/dsd/dsd/dsd_index.shtml (last visited Oct. 28, 2013) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

386. *See id.* (outlining the division's goals).

387. *See id.* (noting that the United Nations' goals seek sustainable development through cooperation on international, regional, and state levels).

388. *See* THE NEW GLOBALISM AND DEVELOPING COUNTRIES, *supra* note 206, at 15 (discussing changes that have promoted direct foreign investment).

389. *See id.* at 2 (discussing the rise of global economic interdependence).

390. *See* ROLAND KLÄGER, FAIR AND EQUITABLE TREATMENT IN INT'L INVESTMENT LAW 199–200 (2011) (explaining that the International Law Association (ILA) recognized seven principles of concern for sustainable development by analyzing treaty regimes, tribunal decisions and other international legal practices).

391. *See* Nicholas A. Robinson, *Enforcing Environmental Norms: Diplomatic and Judicial Approaches*, 26 HASTINGS INT'L & COMP. L. REV. 387, 397 (2003) (discussing the enforcement of environmental laws and its importance in attaining the international objective of sustainable development).

392. *See id.* (discussing the different legal means of reaching international environmental goals).

and implementation at the domestic level.[393] No central legislative organ exists at the international level. While treaties and custom remain the dominant paradigms of international norms, they are not the only forms available.[394]

Another area to consider is international investment agreements (IIA), which are treaties that address issues related to cross-border investments.[395] The deployment of hydrokinetic energy requires international investment for development. Investment treaties are aimed at creating institutions that back up an international market economy in which capital flows are more efficiently allocated while protecting and promoting investment flows in bilateral relationships.[396] Investment treaties have a larger constitutional function for providing a legal framework for international investment activities.[397] For the most part, international investment law is designed to grant protection for foreign investments instead of regulating access to foreign countries and allowing the free circulation of capital.[398] Investment treaties seek to protect foreign investor's assets in the host country and account for the reality of financing and structuring foreign investment activities through several layers of companies in various jurisdictions.[399] International investment law, like general international law, should address the concept of International Corporate Social Responsibility (ICSR) in the development of laws, rules, procedures, and decision-making.[400]

---

393. *See* Alhaji B.M. Marong, *From Rio to Johannesburg: Reflections on the Role of International Legal Norms in Sustainable Development*, 16 GEO. INT'L ENVTL. L. REV. 21, 52 (2003) (discussing the role of international legal norms in sustainable development).

394. *See id.* ("[W]hereas treaties and custom continue to be the prime constructs of international norms, other legal forms do exist.").

395. *See International Investment Agreements*, UNCTAD, http://unctad.org/en/Pages/DIAE/International%20Investment%20Agreements%20(IIA)/International-Investment-Agreements-(IIAs).aspx (last visited Sept. 23, 2013) (defining International Investment Agreements) (on file with the WASHINGTON AND LEE JOURNAL OF ENERGY, CLIMATE, AND THE ENVIRONMENT).

396. *See* STEPHAN W. SCHILL, THE MULTILATERALIZATION OF INTERNATIONAL INVESTMENT LAW 17 (2009) (discussing that attempts to develop a theory of international investment law are complicated by the numerous, largely bilateral treaties that are enforced by arbitral panels on a case-by-case basis).

397. *See id.* (noting that investment treaties are not intended to operate as private law contracts that order the relationship between a limited number of parties and contain the exchange of specific transactions).

398. *See id.* (discussing the structure of international law).

399. *See id.* at 200 (discussing the protection that investment treaties afford to investors).

400. *See* Peter Muchlinski, *Corporate Social Responsibility*, *in* THE OXFORD HANDBOOK OF INTERNATIONAL INVESTMENT LAW, 637, 643–45 (Peter Muchlinski ed., 2008) (citing UNCTAD, *The Social Responsibility of Transnational Corporations* (1999); UNCTAD, *World Investment Report 1999* (1999) ch. XII; UNCTAD, *World Investment*

Of the many justifications (legal, humanitarian, strategic) for encouraging sustainable development in Pakistan by the United States, the most compelling justification is the strategic justification.[401] In addition to the humanitarian aid provided, the endowment of aid can serve a national self-interest. Providing aid for Pakistan's energy sector is consistent with and furthers U.S. national security interests.[402] It is in the U.S.'s national interest to promote sustainable energy in Pakistan and assist in alleviating implementation and investment hurdles.

VI. Conclusion

While the future of renewable energy for Pakistan remains uncertain, hydrokinetic energy could be harnessed to combat Pakistan's energy woes with the appropriate technology and policy momentum. The solution is to leverage regulation and policy to promote this future energy idea. The technology and investment will follow. Islamabad policymakers and politicians easily balk at innovation because they believe it cannot be accomplished in Pakistan because of the enormous levels of corruption, government waste, and nepotism. Or, they boast about the potential for innovation in their country and fail to actualize this potential. In a country founded on zeal for self-determination, but tangled in bureaucratic and geopolitical tussles, this innovation in the energy industry is critical. Pakistan needs only to look at its neighbors, India and China, to see the potential of hydrokinetic energy. The United Nations has raised the stakes for developing nations vying for sustainable development opportunities. Pakistan should not wait for developed countries to take charge, but should lead the way on its own.

Report 2003 (2003); UNCTAD, *Social Responsibility*, Series on Issues in International Investment Agreements (2001)) (noting that ICSR obligations are "the *quid pro quo* for the protection of investors and investments under international investment protection agreements and international economic rules such as of the WTO").

401. *See* Royal C. Gardener & Ezequiel Lugo, *Official Development Assistance: Toward Funding Sustainability*, *in* AGENDA FOR A SUSTAINABLE AMERICA 399, 399 (John C. Dernbach ed., 2009) ("While legal and moral rationales might provide reasons for the United States to provide foreign assistance that encourages sustainable development, a strategic rationale consistent with the national security interests of the United States is the most compelling justification.").

402. *See id.* at 401 (explaining that the ramifications of weak and failed states can extend beyond a country's borders).