Notes & Comments

Energy Justice: Achieving Stability in Oil-Producing African Nations

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ABSTRACT

In 2010, the United States imported approximately fifteen percent of its oil from West Africa—mainly from Nigeria, Angola, Algeria, and Equitorial Guinea—and that percentage is expected to increase steadily. The Cheney Report encourages American oil companies to increase their African investments and stresses the importance of securing African oil to insulate the United States against supply disruption caused by Middle Eastern strife. However, many oil-producing African nations face the challenges of corruption, poverty, and the extensive involvement of foreign companies and governments. In order for Africa to be a stable source of oil, the United States needs to help reduce conflict, and it has a moral obligation to ensure that oil development helps raise individual living standards in the region. While many international organizations like the Organization of the Petroleum Exporting Countries and the African Union; frameworks like the Extractive Industries Transparency Initiative; and treaties like the African Growth and Opportunities Act, have sought to improve stability, there is still a great deal of work to be done. Using Energy Justice principles and providing simple technologies

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to individuals is one means to approach stabilizing oil-producing nations. Bottom-up assistance is integral to creating stronger, more stable societies by empowering individuals, and it can help ensure that oil-producing African nations are valuable American trading partners for years to come. This article discusses the specific problems oil-producing African nations face, how these problems are currently being addressed, and how Energy Justice provides a new approach to achieving long-term solutions.

I. INTRODUCTION

The United States has identified West Africa as critical to its energy security in the years to come. Currently, the United States imports fifteen percent of its oil from West Africa, mainly from Nigeria, Angola, Algeria, and Equatorial Guinea,[1] and while overall crude imports declined in recent years because of the economic downturn, the percentage of oil imports from Africa is expected to increase steadily.[2] The emphasis on developing African oil is highlighted by the Cheney Report,[3] which encourages American oil companies to increase their African investments and stresses the importance of securing African oil to insulate the United States against supply disruption caused by Middle Eastern strife.[4]

In order to "promote U.S. strategic objectives" and to "strengthen stability and security in the region," the United States maintains a strong military presence in West and Central Africa.[5] There is no doubt that a strong military presence has helped secure oil supplies. But it is not a lasting solution. In order to achieve energy security, the United States needs to help the oil-producing countries of West and Central Africa

1. U.S. Energy Information Administration, Crude Oil and Total Petroleum Imports Top 15 Countries, November 2010 Import Highlights, *available at* http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/company_level_imports/current/import.html (last visited Feb. 20, 2011).

2. Richard Dowden, *Only Obama could Say it to Africa*, HAMILTON SPECTATOR, July 16, 2009 [hereinafter Dowden]; Charles Corey, *Reforming African Economies Continue to Reap Benefits*, AMERICA.GOV, Sept. 2, 2009.

3. NAT'L ENERGY POLICY GRP., RELIABLE, AFFORDABLE, AND ENVIRONMENTALLY SOUND ENERGY FOR AMERICA'S FUTURE (May 2001), *available at* http://www.wtrg.com/EnergyReport/National-Energy-Policy.pdf.

4. Michael Klare & Daniel Volman, *The African 'Oil Rush' and US* National *Security*, 27 THIRD WORLD Q. 609, 612 (2006).

5. Lauren Ploch, *Africa Command: U.S. Strategic Interests and the Role of the U.S. Military in Africa*, CONG. RESEARCH SERV. RL34003 (July 28, 2009) *available at* http://ncseonline.org/NLE/CRs/abstract.cfm?NLEid=1874.

achieve stability from the bottom up,[6] using energy justice principles[7] to raise the living standards of the poorest people in the region.

This Article will first address the challenges that oil wealth can present. For countries with weak or failing governments, oil wealth can be a curse that ultimately fuels corruption and does nothing to improve the quality of life within the country. Next, the Article will examine the specific challenges facing oil-producing African nations. These include widespread corruption, poverty, and the involvement of foreign companies and governments. Then, current stabilization efforts are examined. These include actions by international organizations, like the Organization of the Petroleum Exporting Countries ("OPEC") and the African Union ("AU"), frameworks, like the Extractive Industries Transparency Initiative, and treaties, like the African Growth and Opportunities Act. Next, the Article will examine other international efforts, like militarization and sanctions, and whether they can effectively rein in rogue governments to create stable nations. These efforts meet some needs of oil-producing African nations but do not address the needs of the people within these countries at a micro-level. Therefore, this Article suggests using simple technologies to provide individuals access to energy without having to create a complete energy grid in each country. Ultimately, the Article concludes that assisting people from the bottom up is integral to creating strong governments and stable societies that will ensure Africa is a valuable trading partner for years to come.

II. OIL WEALTH OFTEN EXACERBATES CORRUPTION, POVERTY, AND VIOLENCE

The "curse of oil" is frequently discussed by economists to explain why oil rich nations "often grow more slowly, more corruptly, less equitably, more violently and with more authoritarian governments than others do."[8] Currently, oil-producing nations are host to one-third of the world's civil wars, due in large part to the internal conflicts that oil

6. "Bottom up" development is development that starts at the individual or local level instead of at the institutional or country level.

7. Energy justice is based on the concept that access to energy is critical to "economic and social development," and that simple, sustainable technologies can help provide this much needed energy to the approximately two billion people currently living in energy poverty. WORLD ENERGY JUSTICE, http://www.worldenergyjustice.org (last visited Mar. 17, 2011).

8. Alex Perry, *Africa's Oil Dreams*, TIME, May 31, 2007, http://www.time.com/time/magazine/article/0,9171,1626751,00.html.

wealth causes.[9] It has been recognized that oil wealth can create conflict in three primary ways: economic instability caused by fluctuating oil prices, support of insurgencies through black market sales or extortion, and encouragement of separatism because of wealth imbalance.[10] All three of these avenues to conflict are made possible by the economic and social imbalance that large oil revenues can create, and are exacerbated by the boom and bust cycles of energy development.[11]

However, oil wealth does not always create conflict. In fact, for oil-rich nations with stable governments, oil wealth rarely creates conflict. Since 1970, half of all oil-producing states have managed to remain conflict-free.[12] "Governments that limit corruption and put their windfalls to good use rarely face unrest."[13] Both Canada and Norway are among the highest oil-producing countries in the world,[14] and neither has suffered from increased conflict as a result. This can largely be attributed to the fact that both countries have strong governments, educated populations, and diversified economies.[15] Unfortunately, African oil-producing nations tend to have less-educated populations, lower average incomes, struggling economies, and governments with less law enforcement and higher rates of corruption. This instability threatens the reliability of African oil production.

III. THE CHALLENGES OF ENERGY DEVELOPMENT IN AFRICA

The "curse of oil" certainly seems to have come true for some African countries. Persistent poverty and corruption are the most obvious problems.[16] In addition, outside interests have played a major role in oil development. Both international corporations and other countries have affected oil development, often to the disadvantage of the local peoples. Providing bottom-up support using energy justice principles would be one way to help people participate in energy development.

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9. Michael L. Ross, *Blood Barrels*, FOREIGN AFFAIRS, May–June 2008 at 2, 2.

10. *Id.* at 4.

11. *See id.*

12. *Id.*

13. *Id.*

14. CENTRAL INTELLIGENCE AGENCY, CIA World Fact Book (2010), *available at* https://www.cia.gov/library/publications/the-world-factbook.html.

15. Ross, *supra* note 9, at 3.

16. *Corruption Perceptions Index 2009*, TRANSPARENCY INTERNATIONAL (2009), http://www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table (last visited Feb. 20, 2011).

A. Corruption's Effect on African Oil Nations

Nigeria provides a prime example of how corruption can affect oil development. Oil makes up around seventy percent of all government revenues in Nigeria and is the largest portion of its gross domestic product.[17] However, despite the country's rich deposits of natural resources, two-thirds of Nigerians live in poverty.[18] The Nigerian states were created in the 1960s and at that time enjoyed the benefits of their oil resources.[19] But as time went by, the federal government took title to oil resources through decree and cut regional entitlement to benefits down to almost nothing.[20] As a result, the Niger Delta, a region with extremely abundant oil reserves, was one of the poorest and least -regions in the country by the mid-1990s.[21]

In addition to economic impacts, many oil-producing regions of Nigeria have suffered the environmental consequences of oil development. Oil companies have spilled more than 1.5 million tons of oil in the Niger Delta over a fifty-year period, creating large-scale pollution problems.[22] Both environmental degradation and disenfranchisement have caused unrest amongst Nigerians, leading to widespread economic and social-political instability, which has hampered oil production. "Instability in the country's Niger Delta region has reduced output periodically by as much as twenty-five percent."[23] World oil prices have been affected by Nigerian political developments and by periodic attacks on pipelines and other oil facilities in the Delta.[24] Thus, achieving social stability and ensuring the government is accountable to its people can add stability to both local and global energy markets.

Gabon provides another example of how a corrupt government can destabilize oil-producing nations. Gabon has long been an oil-producing nation. However, due to corruption, oil revenues have been consistently distributed to a small number of individuals, creating a large income gap between the rich and the poor.[25] Gabon is ranked only ninety-third out of

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17. Augustine Ikelegbe, *The Economy of Conflict in the Oil Rich Niger Delta Region of Nigeria*, 14 NORDIC J. AFR. STUD. 208, 208 (2005).

18. Perry, *supra* note 8.

19. Ikelegbe, *supra* note 17, at 214.

20. *Id.*

21. *Id.*

22. Perry, *supra* note 8.

23. Ploch, *supra* note 5, at 13.

24. *Id.*

25. Andy Denwood, *Gabon's Oil Boom Hangover*, BBC NEWS, Oct. 11, 2004, *available at* http://news.bbc.co.uk/2/hi/africa/3733578.stm; *see also* Perry, *supra* note 8.

182 countries on the Human Development Index,[26] and one hundred seventieth out of 200 countries for unemployment.[27] Oil production in Gabon peaked in 1997 and has been declining since that time.[28] As oil production declines, Gabon will become increasingly vulnerable to economic instability because its government has put little effort into developing the non-energy sector.[29]

Angola also suffers from government corruption and unequal distribution of revenues. Angola's easy outward transfer of funds has gained approval from the United States, but more money leaves Angola every year than goes in.[30] In 2004, a Human Rights Watch report "claimed that $4.22 billion in oil revenues went missing between 1997 and 2002."[31] Meanwhile, the Angolan elites that have helped facilitate extraction by western petrochemical companies have enjoyed great financial benefits,[32] yet, two-thirds of the country's population lives on less than two dollars a day.[33] Transparency International ranked Angola 162 out of 180 countries on their corruption perception index, highlighting just how severe Angola's corruption problem is.[34]

Overcoming government corruption is a major obstacle for achieving security and justice, but failure to distribute wealth is not the only problem. If people had better access to energy themselves, they would be empowered to play an active role in the government and economy. Access to energy is a critical component in enabling people to help themselves through education, better standards of living, and increased productivity.[35] In his July 11, 2009 speech to the Ghanaian

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26. UNITED NATIONS DEVELOPMENT PROGRAMME, HUMAN DEVELOPMENT INDEX (HDI) – 2010 RANKINGS (2010), http://hdr.undp.org/en/statistics/; Human Development Report 2010 – Country Fact Sheets – Gabon, *available at* http://hdrstats.undp.org/en/countries/profiles/GAB.html (last visited Feb. 26, 2011).

27. CIA WORLD FACTBOOK, https://www.cia.gov/library/publications/the-world-factbook/index.html; Country Comparisons, Unemployment, CIA WORLD FACTBOOK *available at* https://www.cia.gov/library/publications/the-world-factbook/rankorder/2129rank.html (last visited Feb. 26, 2011).

28. *Gabon Energy Profile*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/countries/country-data.cfm?fips=GB#undefined (last visited Feb. 26, 2011).

29. *See* Ludvig Söderling, *After the Oil: Challenges Ahead in Gabon*, 15 J. AFR. ECON. 117 (2005).

30. David Sogge, *Angola 'Failed' yet 'Successful'* 9 (Fundación Para Les Relacions Internacionales Y El Diálogo Exterior, Working Paper No. 81, Apr. 2009).

31. Perry, *supra* note 8.

32. *Id.* at 24.

33. *Rising Angola; Oil, Glorious Oil*, ECONOMIST, Jan. 28, 2010.

34. *Corruption Perceptions Index 2009*, *supra* note 16.

35. THE WORLD BANK GROUP, ENERGY SECURITY ISSUES 3 (2005).

Parliament, President Obama further emphasized the strong role that African citizens need to play in achieving stability for their countries. "The world will be what you make of it. You have the power to hold your leaders accountable, and to build institutions that serve the people."[36] Access to energy would create an opportunity for more African citizens to "hold their leaders accountable" and "build institutions," ultimately creating stronger societies.

B. Poverty's Effect on African Oil Nations

Poverty is one of the underlying causes of social and economic instability and has long been a factor inhibiting development in Africa. The prevalence of poverty in Sub-Saharan Africa is well documented and has been extreme for decades.[37] Out of the 719 million people living in Sub-Saharan Africa, around half live on less than one dollar per day.[38] Estimates are that 200 million Africans do not have access to health care or proper hygiene, forty-seven percent do not have access to safe drinking water, and, in some places, access to any kind of electricity is non-existent.[39] Without these basic necessities, people do not have the tools they need to develop socially and economically, causing widespread poverty that can lead to internal conflict.[40] The cost of a conflict depends on its severity, but often conflicts can destroy years of social development and economic growth.[41]

In order to overcome poverty, people's basic needs have to be addressed.[42] Neither international aid nor wealthy governments have provided solutions to widespread poverty. There are many international organizations devoted to providing aid to Africa. However, after years of aid, many countries still remain underdeveloped, demonstrating that financial assistance alone is unlikely to overcome pervasive poverty.[43] Even when countries achieve macro-economic growth, poverty can still

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36. Remarks by the President to the Ghanaian Parliament, July 11, 2009, *available at* http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-to-the-Ghanaian-Parliament (last visited Feb. 20, 2011) [hereinafter Obama].

37. *See* Brian-Vincent Ikejiaku, *The Relationship Between Poverty, Conflict and Development*, 2 J. OF SUSTAINABLE DEV. 15, 15 (2009).

38. *Id.*

39. *Id.*

40. *Id.* at 16.

41. *Id.* at 18.

42. *See* Ikejiaku, *supra* note 37.

43. *See* Nathan Andrews, *Foreign Aid and Development In Africa: What the Literature Says and What the Reality Is*, 1 J. OF AFR. STUD. & DEV. 8 (2009).

be widespread.[44] Oil-producing countries in Africa are an example of this: while their governments become rich from oil sales, the benefits are ultimately slow to trickle down to the people at large, and poverty is still a major concern.

Energy is one of the keys to unlocking the potential of a country, and more attention should be paid to providing simple technology for renewable energy in the short run with an eye on developing energy networks for the future. "Energy increases poor people's productivity and incomes; lighting and power improve their health and education and help them connect to the global market."[45] The link between energy and improved education is especially important because there is a strong correlation between poverty and lack of education.[46] Studies have shown that providing basic education can help alleviate poverty through increased civic participation.[47] However, if current trends are allowed to continue, over 1.4 billion people will still lack electricity in 2030, which is only 200 million fewer than presently do.[48] In short, access to energy empowers people to make bottom-up improvements in their societies and stabilize their countries.

C. The Effect of Multinational and Foreign Oil Companies

Governments are partially to blame for instability and poverty, but international corporations play a large part as well. Foreign oil companies have been major players in the development of African oil. Companies from the United States alone devoted around $40 billion to West and Central African oil operations between 1995 and 2005.[49] This kind of heavy foreign investment has helped destabilize governments. "National sovereignty has been eroded in many respects by the growing trend of corporate globalization, including dramatic increases in international flows of private capital and the sheer size and scope of

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44. *Id.* at 14.

45. THE WORLD BANK GROUP, *supra* note 35.

46. *See* Servaas van der Berg, *Poverty and Education*, UNESCO International Institute for Educational Planning, Education Policy Series, http://www.iiep.unesco.org/fileadmin/user_upload/Info_Services_Publications/pdf/2009/EdPol10.pdf.

47. Jon Lauglo, *Engaging with Adults: The Case for Increased Support to Adult Basic Education in Sub-Saharan Africa* 7 (The World Bank, African Development Working Paper Series, Feb. 2001), *available at* http://eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED470365&ERICExtSearch_SearchType_0=no&accno=ED470365.

48. THE WORLD BANK GROUP, *supra* note 35.

49. Sandra T. Barnes, *Global Flows: Terror, Oil, and Strategic Philanthropy*, 48 AFR. STUD. REV. 1, 4 (2005).

multinational corporations."[50] Generally, there is no connection between the companies and the people living in the oil-producing region, which can lead to resentment within the country and may prevent companies from investing more in the local people. Shell Oil, for example, has admitted that its development activities in Nigeria lead, "inadvertently," to increased poverty, corruption, and conflict in that country.[51]

In some instances, especially in Nigeria, conflicts between locals and foreign companies have become violent. "[I]n 2002, a large group of Ijaw women occupied Chevron oil refineries in Warri, demanding company investments and jobs for local inhabitants. . . . According to Amnesty International, oil-related deaths in the Niger Delta in 2003 and 2004 were 680 and over 1,000 respectively."[52] In July of 2009, pipelines operated by oil companies Shell and Agip were attacked by the Movement for the Emancipation of the Niger Delta ("MEND"),[53] causing "a production loss of about 24,000 barrels per day."[54] Almost inevitably, disenfranchised peoples who suffer the consequences of oil and gas development without enjoying any of the benefits are responsible for these attacks.[55]

Some companies have recognized that it is in their best interest to help stabilize local communities and governments to prevent disruptive conflicts.[56] In accomplishing this task both local governments and oil companies should maintain transparency in order to regain local peoples' trust. Instead, many oil companies have been involved in providing illegal payments to government officials instead of correcting local

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50. CENTER FOR INT'L ENVTL. L., ONE SPECIES, ONE PLANET: ENVIRONMENTAL JUSTICE AND SUSTAINABLE DEVELOPMENT 21 (2002), *available at* http://www.ciel.org/Publications/OneSpecies_OnePlanet.pdf (last visited Feb. 20, 2011).

51. *How Deep is Corruption in Africa?*, BBC NEWS (June 18, 2004), *available at* http://news.bbc.co.uk/2/hi/africa/3819027.stm.

52. PAUL M. LUBECK, MICHAEL J. WATTS, & RONNIE LISPCHUTZ, CENTER FOR INT'L POL'Y, CONVERGENT INTERESTS: U.S. ENERGY SECURITY AND THE "SECURING" OF NIGERIAN DEMOCRACY 8 (2007) [hereinafter NIGERIAN DEMOCRACY].

53. MEND is a militant group focused on attacking oil companies to achieve a greater share of oil revenues for the locals who suffer the environmental consequences of resource development in the Niger Delta. *MEND: The Niger Delta's Umbrella Militant Group*, COUNCIL ON FOREIGN RELATIONS (2007), *available at* http://www.cfr.org/nigeria/mend-niger-deltas-umbrella-militant-group/p12920 (last visited Feb. 26, 2011).

54. Randy Fabi, *Nigerian Rebels Attack Oil Pipelines, Cut Output*, REUTERS, July 9, 2009, *available at* http://uk.reuters.com/article/2009/07/09/uk-nigeria-delta-attack-idUKTRE56749420090709.

55. NIGERIAN DEMOCRACY, *supra* note 52.

56. Barnes, *supra* note 49, at 4; *see also How Deep is Corruption in Africa?*, *supra* note 51 (Shell expressing the idea that volatility and conflict in Nigeria have made it difficult to operate).

problems.[57] More often then not, multinational companies have sought to pacify locals and create safer working conditions by extending monetary benefits.[58] But this has simply created more violence and more incentives for locals to extort money from oil companies.[59] Without transparency, corporations will continue to be at odds with local communities, and violence will continue to hamper development.

Finally, foreign oil companies have been responsible for a great deal of environmental damage, which causes a number of problems for local individuals. For example, many farming communities in the Niger Delta have lost their farmland because of environmental degradation.[60] While there have been some legal successes for polluted communities,[61] environmental laws and enforcement tend to be less stringent in developing countries, making it harder for local communities to receive compensation for their injuries.[62] Ultimately, multinational and foreign companies have not encouraged stability among Africa's oil-producing countries but have often exacerbated their problems.

D. The Impact of Other Countries

In addition to being mindful of the destabilizing effects companies can have in Africa, the United States also needs to be aware of the effects other countries have on African stability. Many countries are interested in African oil, creating another potential source of conflict in the region. Other countries seeking to acquire African oil include China, France, Britain, India, Russia, South Korea, Turkey, Brazil, Malaysia, and Australia.[63] Unfortunately, the surge of companies and countries from around the world getting involved in African oil production has lead to the decline of living standards within those countries, despite the fact that neighboring countries seem to be faring better.[64]

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57. Barnes, *supra* note 49, at 4.

58. Ikelegbe, *supra* note 17, at 216.

59. *Id.* at 216–17.

60. Gabriel Eweje, *Environmental Costs and Responsibilities Resulting from Oil Exploitation in Developing Countries: The Case of the Niger Delta of Nigeria*, 69 J. BUS. ETHICS 27, 34 (2006).

61. *See id.* at 30 (discussing a 2006 Nigerian federal court decision against Shell upholding a Nigeria National assembly resolution that ordered the company to pay $1.5 billion in compensation to Ijaw communities whose environment was devastated by the oil company's exploration activities).

62. *Id.* at 28.

63. Chris Nwachukwu Okeke, *The Second Scramble for Africa's Oil and Mineral Resources: Blessing or Curse?*, 42 INT'L LAW 193, 199 (2008).

64. *Id.*

China, in particular, could increase instability in West and Central African oil-producing nations. Between 2000 and 2005 China's overall trade with Africa was around $50 billion, and it has continued to grow at a steady rate.[65] At the same time, China "fiercely repudiates the increasingly powerful notion that outside interference into the domestic affairs of a state can be legitimate,"[66] and, therefore, is willing to deal with corrupt African governments. While Western policies towards oil development in Africa have historically been less than ideal, "there is virtually no way around the conclusion that China's massive return to Africa presents a negative political development"[67] that is unlikely to create lasting stability.

> China's involvement in Africa has received negative criticism from various sectors of the international community. The strongest of those criticisms is in regard to Chinese business and trade relations with a country like Sudan whose actions in the southern part of Darfur left a bad taste in the mouth of many people in the world.[68]

Because China's fuel demands are steadily increasing, and it does not attach conditions to its trade relationships with African countries, it is providing corrupt governments with an attractive alternative to trading with the United States and other Western nations.[69] As a result, it is not clear that Western countries will be able to create positive change and stability in Africa by putting pressure on the governments of oil-producing African nations to curb corruption and improve living standards. Instead, the United States should consider measures that directly benefit the people living within African oil-producing nations.

IV. CURRENT APPROACHES TO STABILIZATION: INTERGOVERNMENTAL ORGANIZATIONS, TREATIES, AND FRAMEWORKS.

There are already a number of on-going efforts to stabilize African nations. The United States currently provides aid to forty-seven African countries through the United States Agency for International Development ("USAID").[70] In addition, development opportunities are

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65. *Id.* at 198.

66. Denis M. Tull, *China's Engagement in Africa: Scope, Significance and Consequences*, 44 MODERN AFR. STUD. 459, 476 (2006).

67. *Id*. at 476.

68. Okeke *supra* note 63, at 198.

69. *See generally* Tull, *supra* note 66.

70. *Overview of U.S. Foreign Assistance to Africa*, USAID, http://www.usaid.gov/

provided through the United States African Development Foundation[71] and the African Growth Opportunity Act.[72] OPEC, while mainly concerned with the stability of the oil and gas market, also has a fund to provide assistance for developing nations.[73] However, none of these efforts focus on providing access to energy as a primary goal or objective. The AU has taken steps toward addressing African energy problems, but it is not clear how effective its efforts have been.

Ultimately, aid alone is not enough.[74] "The fact that 2 billion people live in energy poverty, despite the implementation of a wide range of grant- and loan-based programmes in the developing world, is the most compelling evidence that a new approach is needed."[75] Though there are some stability benefits that accrue from U.S. aid efforts, and the Extractive Industries Transparency Initiative ("EITI") has been able to move countries toward more open and honest governance,[76] these efforts have not solved the problem of poverty in Africa. Working to provide energy for African citizens will not only lead to a direct increase in living standards, but will also increase the success of aid, finance, and transparency initiatives by empowering people to participate more fully in their societies.[77] This Section will examine some of the frameworks, aid organizations, and treaties that are already in place and consider their effectiveness.

A. African Efforts to Stabilize Oil Producing Regions

The AU's Convention of the African Energy Commission ("CAEC") acknowledged the irony of African energy problems, noting that despite vast energy potential, many African countries lack the

locations/sub-saharan_africa/ (last visited Feb. 20, 2011).

71. *USADF – Foreign Assistance That Works*, AFRICAN DEVELOPMENT FOUNDATION, http://www.adf.gov/ (last visited Feb. 20, 2011).

72. *Background*, AFRICAN GROWTH AND OPPORTUNITY ACT, http://www.agoa.gov/agoalegislation/index.asp (last visited Feb. 20, 2011).

73. *See About OFID*, OPEC FUND FOR INTERNATIONAL DEVELOPMENT, http://www.ofid.org/about/vision_mission.aspx (last visited Feb. 20, 2011).

74. *See* Andrews, *supra* note 43.

75. Randall Spalding-Fecher, Harald Winkler & Stanford Mwakasonda, *Energy and the World Summit on Sustainable Development: What Next?*, 33 ENERGY POL'Y 99, 100 (2005).

76. *EITI Benefits*, EXTRACTIVE INDUSTRIES TRANSPARENCY INITIATIVE, http://eiti.org/eiti/benefits (last visited Feb. 20, 2011).

77. *See* Ambuj D. Sagar, *Alleviating Energy Poverty for the World's Poor*, 33 ENERGY POL'Y 1367, 1370 (2005); *see also* Lauglo, *supra* note 47.

energy infrastructure to pursue industrial development.[78] "[I]n year 2000 alone, Ethiopia, Kenya, Malawi, Nigeria, and Tanzania faced unprecedented power rationing which adversely affected their economies."[79] Africa has plentiful energy resources, but they are largely inaccessible to the people living in West and Central Africa because their energy infrastructure is insufficient.[80] CAEC recognized the importance of meeting Africa's energy needs and that a coordinated effort of African countries would be required to do so.[81] To that end, CAEC established the Convention of the African Energy Commission ("AFREC") in 2001.[82] AFREC's main goals are to "ensure, coordinate and harmonize the protection, preservation, development and the rational exploitation, marketing and integration of the energy resources of the African continent."[83]

Since 2001, progress toward achieving those goals has been slow. AFREC did not actually launch until 2008.[84] Currently, there is little available literature about AFREC and its progress. In addition, because its goals are mainly production- and market-oriented, providing access to energy for those living in energy poverty is unlikely to be a priority.[85] Because AFREC will play an important role in creating stable energy supplies in oil-producing African countries, it is in the United States' best interest to support it. But thus far, AFREC's focus has been on producers and the world market; not on solving energy poverty problems in Africa.

B. The African Growth Opportunity Act

The African Growth Opportunity Act ("AGOA") was established in

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78. Convention of the African Energy Commission, Pmbl., July 11, 2001, *available at* http://www.africa-union.org/root/au/Documents/Treaties/Text/CONVENTION%20-%20AFREC.pdf (last visited Feb. 20, 2011) [hereinafter African Energy Commission].

79. STEPHEN KAREKEZI, INSTITUT DE L'ENERGIE ET DE L'ENVIRONNEMENT DE LA FRANCOPHONIE [IEPF], RENEWABLES IN AFRICA – MEETING THE ENERGY NEEDS OF THE POOR, www.afrepren.org (search for "Renewables in Africa-Meeting the Energy Needs of the Poor").

80. *Transforming Africa's Infrastructure*, THE WORLD BANK, Nov. 12, 2009, http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:22386904~pagePK:146736~piPK:146830~theSitePK:258644,00.html.

81. African Energy Commission, *supra* note 78.

82. *Id*. at art. 2 § 1.

83. *History and Objective*, AFRICAN ENERGY COMMISSION, http://afrec.mem-algeria.org/en/index.htm (last visited Feb. 26, 2011).

84. *Id.*

85. *Id.*

2000 to expand Sub-Saharan African countries' access to the United States market.[86] Currently there are forty-one African countries that qualify for the program.[87] The main benefit of the program is extension of duty-free exporting to eligible countries.[88] The Act was originally written to be in place for eight years but has been extended until 2015.[89] It was most recently amended by the Bush administration through the African Investment Incentive Act of 2006—AGOA IV.[90] Those amendments mainly expand AGOA provisions to various textiles.[91]

While AGOA provides opportunities to further trade and support African exports, there are questions as to how effective it has been at helping African countries.[92] Out of all the exports that can be directly traced to AGOA, 95.7 percent have come from the energy sector, especially from oil.[93] There is no doubt that the AGOA has been good for trade between the United States and Africa, which has grown dramatically since the creation of the Act.[94] But for oil-producing African nations it is not clear that these benefits are reaching the poor. In addition, it is still much more expensive for African countries to access the international energy market because of energy poverty and the accompanying lack of infrastructure, like transport, telecommunications, and electricity.[95] Therefore, while the AGOA has been good for trade between Africa and the United States overall, it has not been an effective tool to alleviate energy poverty.

C. United States African Development Foundation

The United States African Development Foundation ("USADF")

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86. African Growth Opportunity Act, *Homepage*, AGOA.INFO, http://www.agoa.info/ (last visited May 24, 2011).

87. *Id.*

88. *Id.*

89. *Id.*

90. *Summary of Africa Investment Incentive Act of 2006—AGOA IV*, AGOA.GOV, http://www.agoa.gov/agoa_legislation/agoa_legislation4.html (last visited Feb. 20, 2011).

91. *See* African Investment Incentive Act of 2006, H.R. 6111 109th Cong. § 6002 (2006).

92. Mwangi Kimenyi, *African Growth and Opportunity Act: A Case of Vanishing Benefits*, THE BROOKINGS INST., (July 30, 2009) http://www.brookings.edu/opinions/2009/0730_agoa_kimenyi.aspx.

93. *Id.*

94. Greg Mills, *The U.S. and Africa: Prisoners of a Paradigm?*, CURRENT HIST. 225, 226 (May 2008).

95. Paul Brenton & Mombert Hoppe, *The African Growth and Opportunity Act, Exports, and Development in Sub-Saharan Africa* 19 (World Bank Policy Research Working Paper No. 3996, 2006).

provides aid to "rural cooperatives, small scale food processors, and to other small- and medium-size businesses."[96] USADF seeks to increase efficiency by bypassing African governments and funding communities directly.[97] To qualify under this program, companies must be 100 percent African-owned, be a legally recognized African entity (or be in the process of becoming one), demonstrate productive potential, be committed to helping their community, and be able to account for the use of USADF funds.[98] There are currently more than 300 projects funded by USADF in twenty African countries.[99]

USADF is one of the most helpful sources of aid for people living in energy poverty because it focuses on giving small loans to "microentrepreneurs."[100] This provides aid to those who most need it to establish a business and become economically productive. Unfortunately, because renewable energy technologies, like solar, are expensive to make, they do not provide a feasible product that microentrepreneurs could make and use locally to overcome energy poverty in their own communities. In addition, USADF loans are not available to non-African companies, even those that work closely with African organizations or businesses.[101] As a result, while USADF is an important aid organization that helps improve quality of life from the bottom up, it is not the best tool to help alleviate energy poverty.

D. Organization of the Petroleum Exporting Countries

Nigeria, Angola, Libya, and Algeria are the only African nations in the Organization of the Petroleum Exporting Countries ("OPEC").[102] OPEC serves as an international governing body for oil-producing nations, but its interests are mainly financial. The countries eligible to join OPEC are vaguely defined in its governing statute as "[a]ny . . . country with a substantial net export of crude petroleum, which has fundamentally similar interest to those of Member Countries."[103] After

96. AFRICAN DEVELOPMENT FOUNDATION, CONGRESSIONAL BUDGET JUSTIFICATION FISCAL YEAR 2011 16 (Mar. 5, 2010), http://www.adf.gov/documents/CBJ/CURRENTCBJ.pdf.

97. *Id.* at 31.

98. *Id.* at 29.

99. *Id.* at 17.

100. Curt Tarnoff & Marian Leonardo Lawson, *Foreign Aid: An Introduction to U.S. Programs and Policy*, CONG. RES. SERVICE 7-5700, 27 (Apr. 9, 2009).

101. AFRICAN DEVELOPMENT FOUNDATION *supra* note 96, at 29.

102. *Brief History*, OPEC, http://www.opec.org/opec_web/en/about_us/24.htm (last visited Feb. 20, 2011).

103. OPEC Statute 2008, art. 7(C), *available at* http://www.opec.org/pec_web/

meeting the eligibility requirements, admittance is determined by a vote of member countries.[104] The statute does not list a country's human rights record, governing standards, transparency, or environmental quality standards for oil and gas development as criteria or considerations for admittance.[105]

There may be some distinct stability benefits for oil-producing countries who join OPEC. The organization was established with the goal of maintaining "orderly oil markets with stable prices and to promote the economic development of its member states."[106] However, when OPEC was created in the 1960s, oil and gas prices were relatively stable. It is unclear whether membership in OPEC today—with increasing demand, declining supplies, and a more volatile market—helps foster development in member countries.[107]

OPEC has tried to encourage development through the OPEC Fund for International Development.[108] In 2008, African countries received almost $4 billion in loans from the OPEC Fund for International Development.[109] Unfortunately, member states are not eligible to receive money from this fund, leaving some of Africa's biggest oil-producing nations—Nigeria, Angola, Libya, and Algeria—at a disadvantage.[110] Ultimately, because of its heavy focus on market stability for oil supplies, OPEC does little to alleviate energy poverty in Africa.

E. Extractive Industries Transparency Initiative

The Extractive Industries Transparency Initiative ("EITI") is an international agreement conceived at the 2002 Sustainable Development Summit in Johannesburg.[111] The purpose of EITI is to increase public access to information regarding the impact of the oil industry on national

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tatic_files_project/media/downloads/publications/OS.pdf.

104. *Id.*

105. *See generally* OPEC Statute 2008, *supra* note 103, at arts 7–8.

106. Jose Noguera & Rowena Pecchecnino, *OPEC and the International Oil Market: Can a Cartel Fuel the Engine of Economic Development?*, 25 INT'L. J. INDUS. ORG. 187, 189 (2007).

107. *See id.*

108. *See OFID at a Glance*, OFID, http://www.ofid.org/about/about.aspx (last visited Feb. 20, 2011).

109. THE OPEC FUND FOR INTERNATIONAL DEVELOPMENT, ANNUAL REPORT 2008 20 (2008), *available at* http://www.ofid.org/publications/PDF/AR_2008/AR_2008_Engl.pdf.

110. *Id.* at 2.

111. Peter Eigen, *Fighting Corruption in a Global Economy: Transparency Initiatives in the Oil and Gas Industry*, 29 HOUS. J. INT'L L. 327, 334 (2007).

governments and economies. The EITI process is voluntary, and implementation is left up to individual countries.[112] Incentive to implement the program comes from improved international image, investor confidence, and, hopefully, social and economic stability.[113] Since its inception, G8[114] leaders have specifically endorsed it,[115] five countries have reached compliance, and about thirty countries are candidates to be compliant.[116]

The EITI has six primary criteria: publish oil revenues received by the government; subject payments and revenues to independent audits; appoint an independent administrator to monitor and comment on the audit process; extend transparency requirements to companies (including companies that are state-owned); engage civil society to design and monitor the transparency process; and develop a financially sustainable work plan to implement all these requirements, including timetables for implementation and measurable targets.[117] In addition, to reach compliant status, a country must complete EITI Validation.[118] That process entails an assessment by an independent "validator," who is selected by a "multi-stakeholder group" to gauge the country's progress and suggest areas that need improvement.[119] If a country meets all of the "indicator" standards, then it will reach validation.[120] If it does not reach validation but has made significant progress, it will continue to be a candidate country.[121] Candidate countries have two years to either reach validation or meet the standards for re-approval as a candidate country, and failing to do either will lead to revocation of candidacy.[122]

Despite the strong show of support for EITI, there are some complications to implementation and enforceability that may steer some

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112. *What is the EITI?*, EITI, http://eitransparency.org/eiti (last visited Feb. 20, 2011).

113. Eigen, *supra* note 111, at 338.

114. The Group of Eight ("G8") is the international economic forum for eight industrialized nations: the United States, the United Kingdom, France, Germany, Italy, Japan, Canada, and Russia. *Group of Eight*, ENCYCLOPEDIA BRITANNICA, http://www.britannica.com/EBchecked/topic/1014329/Group-of-Eight-G8 (last visited Mar. 21, 2011).

115. Eigen, *supra* note 111, at 338.

116. *Candidate Country*, EITI, http://eiti.org/countries/candidate (last visited Feb. 20, 2011).

117. *The EITI Principles and Criteria*, EITI, http://eiti.org/eiti/principles (last visited Feb. 20, 2011).

118. EITI INTERNATIONAL SECRETARIAT, EITI FACT SHEET (Nov. 25, 2010).

119. *Id.*

120. *Id.*

121. *Id.*

122. *Id.*

governments away, which raises questions as to its effectiveness.[123] First, although the initiative is voluntary for each country, compliance is contingent upon the willingness of private companies based in each country to observe the reporting and disclosure requirements.[124] Companies will likely resist mandatory reporting and disclosure requirements, making EITI difficult to implement. Second, the requirement that civil society be involved in the process could force governments to make significant shifts in public policy.[125] Monitoring governments to make sure they comply with this requirement in good faith could be very difficult.[126] The EITI program has potential and may make strides towards open, honest, and stable governments in oil-producing African nations, but whether it can be efficiently implemented has yet to be seen.

Ultimately, the existing frameworks, treaties, and aid organizations have many positive aspects, but they have not solved the problem of energy poverty in Africa. While, AGOA was established in 2000 and AFREC was established in 2002, not much progress has been made in the last decade. In order to successfully address energy poverty in Africa, a different approach will have to be taken.

V. ADDITIONAL INTERNATIONAL ACTIONS

In addition to the aforementioned organizations, other potential means of facilitating stability in oil-producing African countries are sanctions and militarization. Although these two international tools are often employed to control unstable areas and governments, there are major doubts about their effectiveness in stabilizing governments and economies. For example, sanctions are especially unpredictable because they only work if the entire international community upholds them. This Section will discuss militarization and sanctions as international efforts to create stability in Africa and the reasons that each is an ineffective tool for creating stability within a country from the bottom up.

A. Militarization

Both the UN and the United States have been involved in

123. *See* Eigen, *supra* note 111, at 342–44.

124. *Id.* at 337.

125. *Id.* at 343.

126. *See id.* (discussing the arrest of two civil society coalition members in the Republic of Congo).

peacekeeping missions for decades. The United States created the African Command ("AFRICOM") in February 2007.[127] Among AFRICOM's objectives is securing the Niger Delta from social and political instability to protect oil production as the United States looks to reduce its dependence on Middle Eastern oil.[128] In addition, the United States is focusing military efforts on offshore drilling operations in the Gulf of Guinea.[129] But U.S. military objectives in Africa are not limited to protecting and securing the oil supplies; counterterrorism is also a major focus. "Terrorist attacks on the U.S. embassies in Dar es Salaam, Tanzania and Nairobi, Kenya in 1998, on targets in Mombasa, Kenya in 2002 and more recently in Algeria, Mauritania, Morocco, and Somalia have highlighted the threat of violent extremism in the region."[130] After the terrorist attacks of September 11, 2001, the strategic approach to West Africa shifted from primarily peacekeeping missions to counterterrorism and energy security.[131]

The U.S. military presence in Africa is a limited tool for addressing oil-fueled conflicts, and it has undesirable consequences. In fact, "[i]n light of a long history of active Islamist politics and periodic revolts against governments in the region," and hostility toward American military efforts throughout the Islamic world, the U.S. military presence may encourage support of radical Islam.[132] Therefore, the United States should seek other means of stabilizing African nations where possible, and energy justice provides just such a possibility.

The UN currently has sixteen peacekeeping missions throughout the world, seven of which are in Africa.[133] Between 1992 and 2007, the number of UN peacekeeping missions in Africa grew at twice the rate of peacekeeping missions in the rest of the world.[134] The UN has the most efficient peacekeeping forces in the world, but it is reluctant to deploy troops unless a comprehensive peace agreement is already in place.[135] As a result, the UN and AU have developed a structure wherein the AU Security Council initially deploys troops to quell unrest in the area, then

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127. Ploch, *supra* note 5, at 1.

128. *Id.* at 13–14.

129. *Id.* at 14.

130. *Id.* at 15.

131. NIGERIAN DEMOCRACY, *supra* note 52, at 1.

132. *Id.* at 14.

133. *U.N. Peacekeeping Operations, Background Notes Jan. 31 2010*, UN.ORG, http://www.un.org/en/peacekeeping/bnote.htm (last visited Feb. 20, 2011).

134. Assefaw Bariagaber, *United Nations Peace Missions in Africa: Transformations and Determinants*, 38 J. BLACK STUD. 830, 832 (2008).

135. Cedric De Coning, *The Future of Peacekeeping in Africa*, 3 CONFLICT TRENDS 6, 6 (2006).

a complex UN peacekeeping operation follows.[136] AU involvement in security operations is a good sign for the future of security on the continent. But despite the UN's lengthy presence in Africa, it has not been able to create lasting stability in many regions, as demonstrated by continued poverty and corruption.

Militarization does a great deal to stabilize volatile regions and quell violence. However, because it is a forceful, top down method of dealing with instability, it often fails to achieve lasting peace. In order to create lasting stability in African nations a different approach is warranted.

B. Sanctions

Sanctions are a common international tool used to deal with rogue governments. The UN sanctioned a number of African countries throughout the 1990s and 2000s.[137] The United States also applies sanctions frequently, most notably against Iraq. However, sanctions have not proven to be effective.[138] Governments are often unresponsive to them, and sanctions can cause severe hardship to civilians.[139] For oil-producing African nations with corrupt governments, sanctions are liable to create more hardship than good.

One of the biggest obstacles to effective sanctions is international cooperation. The UN imposes sanctions through the Security Council, which is made up of the five permanent members—China, France, the Russian Federation, the United Kingdom, and the United States—and ten non-permanent members of the UN who serve on a term basis.[140] In order for the UN to impose sanctions, all five permanent members must support it.[141] Because obtaining unanimous support from these five members—some of the top oil consumers—is difficult, using UN sanctions to rein in corrupt governments in oil-producing African nations is unrealistic. Notably, China is both a permanent member of the UN Security Council and is competing with other nations for African oil, so it does not have a strong interest in sanctioning African governments.[142]

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136. *Id.*; Bariagaber, *supra* note 134, at 842.

137. Alex Vines, *Monitoring UN Sanctions in Africa: The Role of Panels of Experts*, *in* VERIFICATION YEARBOOK 2003, at 247 (T. Findlay, ed., 2004).

138. *See* Toby Dodge, *The Failure of Sanctions and the Evolution of International Policy Towards Iraq, 1990-2003*, 3 CONTEMP. ARAB AFF. 83 (2010).

139. Margaret Doxey, *Reflections on the Sanctions Decade and Beyond*, 64 INT'L J. 539, 543 (2008–2009).

140. *Membership of the Security Council*, UN.ORG, http://www.un.org/sc (last visited Feb. 20, 2010).

141. *Id*.

142. *See generally* Okeke, *supra* note 63.

And the Chinese government has demonstrated that it will not hesitate to prevent UN sanctions; China blocked proposed sanctions against Sudan for war crimes committed in Darfur.[143]

If the United States were to attempt to sanction oil-producing African countries, success would not be likely because of the amount of international interest in African oil. China provides the main obstacle to effective sanctions. China has shown willingness to do business with some of the most internationally criticized governments, like Sudan, whose actions with regard to the conflict in Darfur have been widely condemned.[144] By not attaching strings to trade, China is trying "to cultivate the favor of governments in oil-producing states and, by extension, obtain privileged access and opportunities for its companies."[145] That creates an appealing trade alternative for African governments tired of dealing with Western demands.[146] But because China does not consider human rights or government accountability in its dealings with oil-producing African nations, it counteracts Western pressure for government reform. Therefore, it is unlikely that the United States can create positive change in oil-producing African nations using sanctions.

VI. ENERGY JUSTICE PRINCIPLES

Energy justice is the key to stability in oil-producing West African countries. "Energy justice calls for the dissemination and distribution of [appropriate sustainable energy technologies] to the [energy poor], and the mainstreaming of women."[147] Achieving energy justice is a way to approach a number of international concerns at once. Environmental degradation, poor health, the availability of fresh water and food, and human rights are all important social issues tied to poverty that achieving energy justice could help alleviate. The underlying goal of energy justice is to provide people with tools that they can use to help themselves and thereby create stronger social, economic, and political structures.

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143. Carmel Davis, *AFRICOM's Relationship to Oil, Terrorism, and China*, 53 ORBIS 122, 128 (2009).

144. Okeke, *supra* note 63, at 198.

145. Tull, *supra* note 66, at 469.

146. *Id.* at 466–67.

147. WORLD ENERGY JUSTICE, http://worldenergyjustice.org/ (last visited Feb. 20, 2011); LAKSHMAN GURUSWAMY, THE NEED FOR ENERGY JUSTICE 3 (2009), *available at* http://cees.colorado.edu/ej_whitepaper.pdf.

A. Technologies

Energy justice focuses on simple technologies that are easy to distribute and require no access to an electricity grid. Eventually, the goal of the global community, and especially developed nations, should be to help developing nations create energy grids. Africa provides an especially good opportunity to bypass traditional energy development to clean fuel technologies, for as President Obama has recognized, "[a]cross Africa, there is bountiful wind and solar power; geothermal energy and biofuels."[148] But setting up clean technology grids is a long-term goal requiring a good deal of time and money. In the mean time, the global community should help people living in the poorest areas of the world gain access to a basic level of energy. It would be particularly advantageous for the United States to collaborate with oil-producing nations because it could help stabilize those countries, making them more reliable trading partners.[149]

There are a number of companies in the United States that are already working on solutions for energy justice in Africa. One such company is Elephant Energy.[150] It provides solar flashlights to rural communities in Namibia.[151] Each flashlight has a solar rechargeable battery that lasts up to fifteen hours, multiple settings, a hook mechanism by which it can be hung from the ceiling, and a durable exterior. The energy is simple, yet provides a great benefit to the owner.[152] It is inexpensive, renewable, and easy to use, yet provides families with hours of light that extends the productive hours of the day, which allows them to study and work after the sun goes down.[153] Other companies that provide similar technologies are D.light Design (which produces solar lamps) and Tough Stuff (which has a line of solar products like lamps and chargers).[154]

Another kind of technology that is very important for achieving energy justice is clean-burning cookstoves. One of the major problems in

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148. Dowden, *supra* note 2.

149. *See* NIGERIAN DEMOCRACY, *supra* note 52.

150. *Technology for the Developing World*, ELEPHANTENERGY, http://elephantenergy.org/ (last visited Feb. 20, 2011).

151. *Solar Light Project*, ELEPHANTENERGY, http://elephantenergy.org/SolarLightProject.html (last visited Feb. 20, 2011).

152. *The Importance of Light*, BOGOLIGHT, http://www.bogolight.com/Articles.asp?ID=6 (last visited Feb. 20, 2011).

153. *Id.*

154. *See* DLIGHTDESIGN, http://www.dlightdesign.com/home_global.php (last visited Feb. 20, 2011); TOUGHSTUFF, http://www.toughstuffonline.org/ (last visited Feb. 20, 2011).

the developing world is access to clean-cooking technology. According to the World Health Organization ("WHO"), "more than three billion people worldwide continue to depend on solid fuels, including biomass fuels (wood, dung, agricultural residues) and coal, for their energy needs."[155] WHO estimates that over 1.6 million people die every year from indoor air pollution caused by smoke from indoor cooking fires.[156]

While some areas of the world have made progress in deterring traditional "dirty" cooking methods, many Africans still cook using traditional methods.[157] The problem is growing in some African regions. "In sub-Saharan Africa, the reliance on biomass fuels appears to be growing as a result of population growth and the unavailability of, or increases in the price of, alternatives such as kerosene and liquid petroleum gas."[158] Providing access to clean-burning cookstoves can help solve this problem, which will in turn improve the health of thousands of women and children. Currently available cookstoves are fuel-efficient, using up to seventy percent less wood than traditional open fire stoves.[159] Additional benefits of these stoves include the fact that they are "simple and very low-maintenance, and . . . can be manufactured locally, using local materials, and adapted to meeting local cooking customs."[160] These cookstoves could immediately impact African populations and potentially save thousands of lives each year.

In addition to reducing indoor air pollution, many cookstoves that are currently available or under development convert biomass fuel into biochar. Biochar is a charcoal-like product created through pyrolosis—controlled burning with a limited supply of oxygen—of biomasses.[161] Biochar is a "[p]orous substance with high water- and air-holding capacity; sustainable habitat for some microbes and plant growth, good material for soil amendment, absorption of chemicals and humidity

155. *Indoor Air Pollution Takes a Heavy Toll on Health*, WORLD HEALTH ORGANIZATION, Apr. 30, 2007, *available at* http://www.who.int/mediacentre/news/notes/2007/np20/en.

156. *Indoor Air Pollution and Health*, WORLD HEALTH ORGANIZATION (June 2005), http://www.who.int/mediacentre/factsheets/fs292/en/.

157. *Energy Access, Security, Key to Reducing Poverty*, THE WORLD BANK (May 28, 2006), http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:20935616~pagePK:64257043~piPK:437376~theSitePK:4607,00.html.

158. *Id.*

159. *Forest-saving Stoves Programs*, TREESWATERPEOPLE, http://www.treeswaterpeople.org/stoves/stove_intro.htm (last visited Feb. 20, 2011).

160. *Id.*

161. *What is Biochar?*, BIOCHAR-INTERNATIONAL, http://www.biochar-international.org/biochar (last visited Feb. 20, 2011).

control."[162] The heat released in the conversion of biofuels to biochar can be used to cook food. The resulting char can be mixed back into the soil to make terra preta (or "super soil").[163] Using char to create terra preta is old technology. Indigenous peoples in the Amazonian region of South America used it to improve crop production.[164] Biochar "acts as a fertilizer, it improves structural properties of soil and reduces weed and pest problems."[165]

Worldwide, approximately 2.5 billion people get their livelihoods from farming.[166] This includes about sixty-five percent of the population of sub-Saharan Africa.[167] Because of the high reliance on agriculture, and the ability of biochar to act as a fertilizer, cookstoves that both burn cleanly and produce biochar can serve a double purpose. As an additional benefit, biochar has the potential to sequester carbon dioxide, one of the predominant greenhouse gases.[168] Currently, many of the companies that make clean-burning cookstoves design them so that they will also create biochar.[169] Some good examples are Worldstove[170] and Terra Preta Pot.[171] The International Biochar Initiative has been working on projects to provide stoves for people around the world and provides detailed information about the benefits of biochar cookstoves and biochar generally as a soil additive.[172]

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162. MAKOTO OGAWA, EFFECTS OF SOIL MICROBIAL FERTILITY BY CHARCOAL IN SOIL, at 5, *available at* http://www.eprida.com/eacu/PDF%20Files/MOgawa.pdf.

163. *See Biochar Use in Soils*, BIOCHAR-INTERNATIONAL, http://www.biochar-international.org/biochar/soils (last visited Feb. 20, 2011).

164. *Terra Preta*, FOODSOVEREIGNTY, http://www.foodsovereignty.org/new/terrapreta_en.php#top (last visited Feb. 20, 2011).

165. Johannes Lehmann, John Gaunt, & Marco Rondon, *Bio-char Sequestration in Terrestrial Ecosystems – A Review*, 11 MITIGATION & ADAPTATION STRATEGIES FOR GLOBAL CHANGE 403, 407–09 (2006) [hereinafter Lehmann].

166. VREDESEILANDEN, A CONVIENT TRUTH: FAMILY FARMERS CAN FEED THE WORLD, *available at* http://veco.vredeseilanden.org/files/docs/actueel/1_EN_Family%20Farmers%20can%20save%20the%20world%20%20%20%20A%20convenient%20truth.pdf.

167. Stephanie Hanson, *African Agriculture*, COUNCIL ON FOREIGN RELATIONS, May 28, 2008, http://www.cfr.org/publication/16352/ (last visited Feb. 20, 2011).

168. Lehmann, *supra* note 165, at 404–05.

169. *See generally What is Biochar?*, *supra* note 161; *Small Scale Biochar Production Methods*, BIOCHAR INFO, http://www.biochar.info/biochar.biochar-production-methods.cfml (last visited Feb. 20, 2011).

170. *About Us*, WOODSTOVE, http://worldstove.com/ (last visited Feb. 20, 2011).

171. *Small Scale Biochar Production*, *supra* note 169.

172. *Policy*, BIOCHAR-INTERNATIONAL, http://www.biochar-international.org/policy (last visited Feb. 20, 2011).

B. Why Providing Energy Justice Technologies Can Make a Big Difference

Successful countries have healthy and educated women.[173] In contrast, many of the poorest regions in the world lack significant economic contributions from women. These regions place heavy demands on women to maintain families and homes, which prevents women from engaging in economic activities.[174] Women in these regions also face educational disadvantages.[175]

Energy justice can provide the opportunity for women to make contributions to the economy,[176] which has been shown to reduce violence within a society.[177] For instance, fuel-efficient cookstoves reduce household duties, such as cooking and wood gathering, giving women more time to pursue other activities. In addition, flashlights and lamps extend the productive hours of the day, which women can use to develop economic opportunities. Small loan programs have allowed women to create businesses, which in turn give them the ability to support their families and communities.[178] Achieving stability in oil-producing African nations will require improvements in the health and well-being of women. Energy justice is a possible means of accomplishing this task by helping women gain better opportunities.

Children are another major demographic that will benefit from energy justice technologies. In addition to the hundreds of thousands of children who die every year because of indoor air pollution,[179] children without access to electricity face significant limitations. There are almost 38 million children in sub-Saharan Africa who are primary school-age but do not attend school.[180] In the poorest regions, children often work

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173. Nicholas D. Kristof & Sheryl WuDunn, *The Women's Crusade*, N.Y. TIMES, Aug. 23, 2009, http://www.nytimes.com/2009/08/23/magazine/23Women-t.html?_r=1&scp=5&sq=Women's%20rights&st=cse.

174. *See* Dep't of Econ. & Soc. Affairs, Div. for the Advancement of Women, *2009 World Survey on the Role of Women in Development, Women's Control Over Economic Resources and Access to Financial Resources, Including Microfinance*, vii, U.N. Doc. ST/ESA/326 (2009) [hereinafter Women in Development].

175. *United Nations Girls' Education Initiative*, UNICEF.ORG, http://www.unicef.org/girlseducation/index_44871.html (last visited Feb. 20, 2011).

176. *See* Women in Development, *supra* note 174.

177. *See* Kristof & WuDunn, *supra* note 173 (stating that societies where women have larger contributions to the economy are less violent).

178. *See id*.

179. *Indoor Air Pollution Takes a Heavy Toll on Health*, *supra* note 155.

180. MILLENNIUM DEVELOPMENT GOALS GAP TASK FORCE, THE MILLENNIUM DEVELOPMENT GOALS REPORT 2008, at 13 (2008), *available at* http://www.un.org/millenniumgoals/pdf/The%20Millennium%20Development%20Goals

with their parents during the day to take care of necessities and cannot do school-work after the sun goes down because they do not have enough light.[181] With solar lights, children are able to study more every day. Achieving higher educational levels leads to more stable and economically successful societies.[182]

C. Getting Energy Justice Technologies to the People

The most obvious way to increase the distribution of simple energy technologies is through the USADF. However, that is only available to companies and enterprises that are 100 percent African owned,[183] cutting out possible funding for companies like Trees Water People and Elephant Energy, which are based in the United States. There are numerous other potential options, but just two will be considered here.

First, the United States could look to provide energy technologies as part of the AFRICOM mission, shifting some of the focus from militarization to humanitarian efforts. AFRICOM's main objectives are to promote "an environment congenial to the United States," to counter Chinese influence, and to contain terrorist groups in the region.[184] Enhancing domestic stability is key to achieving those objectives, as it ultimately reduces the chance of war and encourages stronger economies.[185] Working on energy justice objectives is, therefore, in line with AFRICOM goals. In addition, it may soften the military image of the mission and lessen its emphasis on occupation, making it more humanitarian in scope. With the current state of terrorism, and U.S. presence in Iraq and Afghanistan, a less aggressive military approach in Africa could help reduce anti-U.S. sentiment and terrorist recruiting in that region.[186]

Another way the United States could encourage energy justice is to help American companies provide technologies to oil-producing African nations. Because the energy poor do not have the financial means to access renewable technologies, they need outside assistance to do so. Elephant Energy, for example, relies on charitable donations from Americans: individuals buy two solar flashlights and send either one or both to Africa where they are given to village entrepreneurs to market to

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%20Report%202008.pdf.

181. *Id.*

182. *See* Lauglo, *supra* note 47.

183. AFRICAN DEVELOPMENT FOUNDATION, *supra* note 96, at 25.

184. Davis, *supra* note 143, at 132; NIGERIAN DEMOCRACY, *supra* note 52, at 2.

185. Davis, *supra* note 143, at 130.

186. *See generally* Davis, *supra* note 143.

their communities.[187] These small efforts do make a difference, but the United States government could dramatically expand the scope and benefits of current energy justice efforts by offering funding assistance through tax breaks for small renewable manufactures, tax credits for working towards clean energy solutions for the world, or some similar mechanism.

D. Beyond Simple Technology: The Grid

In addition to simple technologies, the United States should help provide infrastructure that connects people to the energy grid. Over the last decade, China has worked on a number of projects in Africa, including creating roads, railways, dams, and power plants, among other things, that are viewed by the Chinese government as "goodwill projects" to help gain the support of African leaders.[188] This is an area that the United States and other Western nations have not gotten involved with in any significant way.[189] Working to expand energy grids would be one way that the United States government could support energy justice in oil-producing African nations. This effort would also build goodwill in these countries and ultimately create more secure states and stronger alliances with the United States, which would help secure the United States' energy future.

Since over seventy percent of Africa's population currently lives without access to any kind of modern energy,[190] the United States has the opportunity to help build infrastructure from scratch. Therefore, modern grid technologies can be used up front. One key technology is ultra-high voltage ("UHV") power lines.[191] These power lines are more efficient than regular lines, allowing power to be transported great distances with relatively little energy loss.[192] They also minimize the effect on the environment by reducing the number of energy transmission corridors.[193] Thus, using this technology offers numerous benefits.

Installing UHV lines could provide incentives for remote rural areas of Africa, which have high concentrations of undeveloped solar and wind

187. *Solar Light Project*, *supra* note 151.

188. *Id.*

189. *Id.*

190. THE WORLD BANK GROUP, *supra* note 35.

191. *Energy Efficient Ultra High Voltage: the Future of Electricity Transmission*, IEC-TECH NEWS, March 2007, http://electronics.ihs.com/news/articles/iec-uhv-electricity-transmission.htm.

192. *Id.*

193. *Id.*

energy, to implement and invest in cleaner technologies.[194] Because of their ability to carry energy efficiently over vast distances, UHV lines make it feasible to transport renewable energy in a cost-efficient way.[195] If rural areas of Africa were able to develop renewable technology, they could not only power their own cities, but they could sell energy back to the grid and earn money. This would be a boon for both rural communities and for international climate change efforts because energy development would be clean and sustainable.

Clearly, there are still obstacles to developing infrastructure required to connect all areas of rural Africa to a grid. The International Energy Agency estimates that it would cost $8 billion per year for twenty-five years in order to address the energy needs of all developing and middle-income countries throughout the world, of which African nations are a large share.[196] However, a more comprehensive grid should be part of the vision for Africa's energy future, in combination with simple solar and other renewable technologies that can provide energy for the most remote locations. If the United States backs efforts to alleviate energy poverty, it will strengthen its relationship with African nations. By doing so, the United States will help create stronger societies from the bottom up, ending corruption and providing stable trading partners far into the future.

VII. CONCLUSION

Oil supplies are decreasing and will continue to do so. The United States "can no longer afford to face every task with nothing but a hammer at its disposal."[197] Ideally, the United States will develop alternative sources of energy that will end its dependence on fossil fuels, but many decades will pass before this nation accomplishes such a feat. In the mean time, the United States government has recognized that Africa will be an important source of oil for years to come. In order for Africa to provide a stable source of oil—unlike the Middle East—the United States needs to help reduce conflict in oil-producing West African countries. Troops alone will not do this. In order to achieve stability, countries need help from the bottom up. Conventions and charters will do little to balance inequities without attending to the pressing needs of

194. David Winning, *Going the Distance*, WALL STREET JOURNAL, Apr. 27, 2009, http://online.wsj.com/article/SB124050430247148607.html.

195. *Id.*

196. *Id.*

197. John J. Hamre & Gordon R. Sullivan, *Toward Postconflict Reconstructions*, 25 THE WASH. Q. 85, 95 (2002).

the people. As President Obama eloquently noted, "Africa's future is up to Africans," but the United States should be there every step of the way,[198] not just because it will benefit directly from securing Africa's oil market, but because the United States has an ethical obligation to ensure that the oil it imports helps support the people of the countries from which it came.

198. Obama, *supra* note 36.

Articles

Energy Poverty: Can We Make Modern Energy Access Universal?

Focus on Financing Appropriate Sustainable Energy Technologies

Raffaella Centurelli*

ABSTRACT

Today billions of people lack access to the most basic energy services, electricity, and clean cooking facilities; and worse, this situation is set to change very little over the next twenty years, actually deteriorating in some respects. This is shameful and unacceptable. The ambitious goals that have been set to eradicate extreme poverty can never be fully realized without acknowledging and confronting this fact. The international community has long been aware of the close relationship between development and access to modern energy services,

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but there is no Millennium Development Goal ("MDG") specifically related to energy. To help support action and policy making in this area, the International Energy Agency ("IEA"), the United Nations Development Programme ("UNDP"), and the United Nations Industrial Development Organisation have pooled their resources and expertise to produce a report entitled: "Energy Poverty–How to make modern energy access universal?"[1] that was presented on September 21, 2010, on the sidelines of the United Nations Millennium Development Goals Summit in New York. As one of the analysts who carried out the study, and as one of the authors of the report, I am delighted to present the key findings of the work in this article, with a special focus on financing appropriate sustainable energy technologies to achieve universal access to modern energy services.

Table of Contents

1. INTERNATIONAL ENERGY AGENCY, WORLD ENERGY OUTLOOK: HOW TO MAKE MODERN ENERGY ACCESS UNIVERSAL? (2010), *available at* http://www.worldenergyoutlook.org/docs/weo2010/weo2010_poverty.pdf [hereinafter IEA ENERGY OUTLOOK].

I. THE CHALLENGE OF ENERGY ACCESS TODAY

Securing the energy supply and curbing energy's contribution to climate change are often referred to as the two overriding challenges faced by the energy sector on the road to a sustainable future.[2] But another key strategic challenge for the energy sector exists, one that requires immediate and focused attention by governments and the international community: the challenge of energy access.[3]

The numbers are striking. Today, 1.4 billion people—over twenty percent of the global population—lack access to electricity.[4] More than 85% of people lacking access to modern forms of energy live in rural areas of Sub-Saharan Africa or South Asia. The greatest challenge is indeed in Sub-Saharan Africa, where today only thirty-one percent of the population has access to electricity, the lowest level in the world. Residential electricity consumption in Sub-Saharan Africa, excluding South Africa, is roughly equivalent to consumption in New York. In other words, the 19.5 million inhabitants of New York consume in a year roughly the same quantity of electricity, 40 TWh, as the 791 million people of Sub-Saharan Africa.

Further, 2.7 billion people—some forty percent of the global population—rely on the traditional use of biomass for cooking.[5] Worse, our projections suggest that the problem will persist and even deepen in the longer term.[6] In our New Policies Scenario, a scenario that takes account of broad policy commitments that have already been announced, but which has no specific universal energy access goals, 1.2 billion people still lack access to electricity in 2030, eighty-seven percent of whom live in rural areas.[7] Most of them will be living in Sub-Saharan Africa, India, and other developing Asian countries (excluding China).[8] In the same scenario, the number of people relying on the traditional use of biomass for cooking *increases* to 2.8 billion in 2030, eighty-two

2. IEA ENERGY OUTLOOK, *supra* note 1, at 8.

3. *Id.*

4. *Id.* at 9.

5. *Id. See* Table 1 *infra*. The traditional use of biomass refers to the basic technology used, such as a three-stone fire or inefficient cookstove, not the resource itself. The number of people relying on the traditional use of biomass is based on survey and national data sources and refers to those households where biomass is the primary fuel for cooking. While the analysis in this report focuses on biomass, it is important to note that, in addition to the number of people relying on biomass for cooking, some 400 million people, mostly in China, rely on coal for cooking. This is a highly polluting fuel when used in traditional stoves and has serious health implications.

6. *See* IEA ENERGY OUTLOOK, *supra* note 1, at 9.

7. *Id.*

8. *Id.*

percent of whom are in rural areas.[9]

Table 1: Number of people without access to electricity and relying on the traditional use of biomass, 2009 (figures are in the millions)[10]

	Number of people lacking access to electricity	Number of people relying on the traditional use of biomass for cooking
Africa	587	657
Sub-Saharan Africa	*585*	*653*
Developing Asia	799	1 937
China	*8*	*423*
India	*404*	*855*
Other Asia	387	659
Latin America	31	85
Developing countries*	1 438	2 679
World**	1 441	2 679

*Includes Middle East countries. **Includes OECD and transition economies.

II. THE LINK BETWEEN ENERGY AND DEVELOPMENT

Lack of access to modern energy services, here defined as household access to electricity and clean cooking facilities (i.e. clean cooking fuels and stoves, advanced biomass cookstoves and biogas systems) is a serious hindrance to economic and social development and must be overcome if the UN MDGs are to be achieved.[11]

Access to modern forms of energy is essential for the provision of clean water, sanitation, and healthcare.[12] It also provides developmental benefits through the provision of reliable and efficient lighting, heating, cooking, mechanical power, transportation, and telecommunication

9. *Id.*
10. IEA ENERGY OUTLOOK, *supra* note 1, at 9.
11. *See id.* at 8, n.1.
12. *Id.* at 11.

services.[13] The international community has long been aware of the close correlation between income levels and access to modern energy.[14] Not surprisingly, countries with a large proportion of the population living on an income of less than two dollars per day tend to have low electrification rates and a high proportion of the population relying on traditional biomass.[15]

As incomes increase, access to electricity increases at a faster rate than access to modern cooking fuels.[16] This is largely because governments give higher priority to electrification, even though access to both electricity and clean cooking facilities is essential to success in eradicating the worst effects of poverty and putting poor communities on the path to development.[17]

13. *Id.*

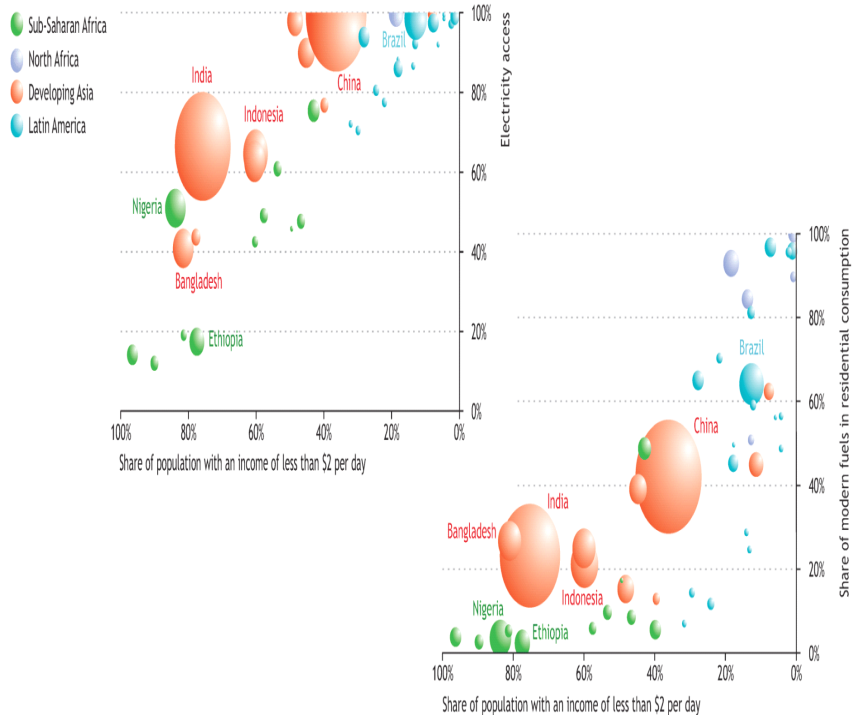
14. *Id.*

15. *Id.*

16. IEA ENERGY OUTLOOK, *supra* note 1, at 11. *See* Figure 1 *infra*.

17. IEA ENERGY OUTLOOK, *supra* note 1, at 11. In many countries, there is a lack of awareness of the health and socio-economic impacts of the use of biomass for cooking. Despite the demonstrable health consequences associated with current cooking practices in many developing countries, access to clean cooking facilities has received very little high-level attention, and, not surprisingly, very little progress has been made. Adequate training and support services have been lacking, as has the market research necessary to determine the concerns of the women who would be using the stoves and their different cooking habits.

Figure 1: Household income and access to electricity and modern fuels in developing countries[18]



Note: The size of the bubble is proportional to population.

III. Energy Habits in the Poorest Households and Health Implications

The adverse consequences of the use of traditional forms of energy on health, economic development, and the environment can be understood by looking at a case study: the example of the use of traditional biomass for cooking. Currently, devices for cooking with biomass are mostly three-stone fires, traditional mud stoves, or metal, cement, and pottery or brick stoves with no operating chimneys or hoods.[19] The high moisture content of the biomass resources used, and the low efficiency of the combustion process, produce dangerous levels

18. *Id.* at 12.
19. *Id.* at 13.

of smoke, particularly when food is cooked indoors.[20] The efficiency of biomass can be increased through provision of improved stoves and enhanced ventilation.[21] Adding chimneys to stoves with low combustion efficiency can itself be a useful improvement, as long as the chimney is kept clean and maintained.[22] However, often there is some leakage into the room and the smoke is merely vented outside the house and will, in part, re-enter the dwelling, so this option is not as effective as a change to clean fuels or advanced biomass stoves.[23] Experience suggests that in order for biomass gasifiers for cooking to consistently achieve emissions close to those of liquefied petroleum gas ("LPG") stoves, the stove requires assisted air flow by use of a fan.[24] Ventilation of the home (i.e., eaves spaces and larger, opened windows and doors) can contribute to reducing household air pollution but alone is unlikely to make a substantial difference if there is a highly polluting indoor source.[25]

Candles or kerosene/diesel lanterns generally provide lighting in low-income households in developing countries.[26] Candles and low-efficiency lanterns emit smoke.[27] Kerosene lamps produce better light, but they are uncomfortably hot in a tropical climate and they can be difficult to light.[28] Use of kerosene also imposes health risks through fires and children drinking fuel stored in soft drink bottles, and there is emerging evidence of links with tuberculosis and cancer.[29] Switching to electricity eliminates these risks and increases efficiency. A paraffin wax candle has an intensity (in lumens) of one and an efficiency (lumen per Watt) of 0.01, while a 15-Watt fluorescent bulb has an intensity of 600 and efficiency of forty.[30] There has been much recent success in the dissemination of compact fluorescent light bulbs ("CFLs") in many developing countries.[31] High-quality CFLs are four to five times more efficient than incandescent bulbs and last much longer.[32] Large-scale deployment of CFLs can help reduce peak electricity needs and

20. *Id.* at 13, box 1.
21. *Id.*
22. *Id.*
23. *Id.*
24. *Id.*
25. *Id.*
26. *Id.*
27. *Id.*
28. *Id.*
29. *Id.*
30. *Id.*
31. *Id.*
32. *Id.*

ameliorate infrastructure shortages.[33]

As a consequence of the pollutants emitted by traditional stoves with no chimneys, pollution levels inside households cooking with biomass are often many times higher than typical outdoor levels, even those in highly polluted cities.[34] The World Health Organization estimates that more than 1.45 million people die prematurely each year from household air pollution due to inefficient biomass combustion.[35] A significant portion of these are young children, who spend many hours each day breathing smoke pollution from the cookstove.[36] Today, the number of premature deaths from household air pollution is greater than the number of premature deaths from malaria or tuberculosis.[37]

Using World Health Organization projections for premature deaths to 2030,[38] the annual number of premature deaths over the projection period from the indoor use of biomass is expected to *increase* in the New Policies Scenario unless there is targeted action to deal with the problem.[39] By 2030, over 1.5 million people would die every year due to the effects of breathing smoke from poorly combusted biomass fuels.[40] This is more than 4,000 people per day.[41] By contrast, the World Health Organization expects the number of premature deaths from malaria, tuberculosis, or HIV/AIDS to decline over the same period.[42]

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33. *Id.*

34. *Id.* at 13.

35. *Id.*

36. *Id.*

37. *Id. See* Figure 2 *infra*.

38. The estimations for premature deaths are based on Colin D. Mathers & Dejan Loncar, *Projections of Global Mortality and Burden of Disease from 2002 to 2030*, 3 PLoS Medicine 2012 (November 2006); WORLD HEALTH ORGANIZATION [WHO], THE GLOBAL BURDEN OF DISEASE: 2004 UPDATE (2008), *available at* http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf [hereinafter WHO, GLOBAL BURDEN]; Kirk R. Smith et al., *Indoor air pollution from household use of solid fuels*, *in* COMPARATIVE QUANTIFICATION OF HEALTH RISKS: GLOBAL AND REGIONAL BURDEN OF DISEASE ATTRIBUTABLE TO SELECTED MAJOR RISK FACTORS (M. Ezzati et al., eds., 2004); WORLD HEATH ORGANIZATION, ENVIRONMENTAL BURDEN OF DISEASE SERIES, NO. 4: INDOOR SMOKE FROM SOLID FUELS: ASSESSING THE ENVIRONMENTAL BURDEN OF DISEASE AT THE NATIONAL AND LOCAL LEVELS (2004), *available at* http://www.who.int/quantifying_ehimpacts/publications/en/Indoorsmoke.pdf [hereinafter WHO, ENVIRONMENTAL BURDEN].

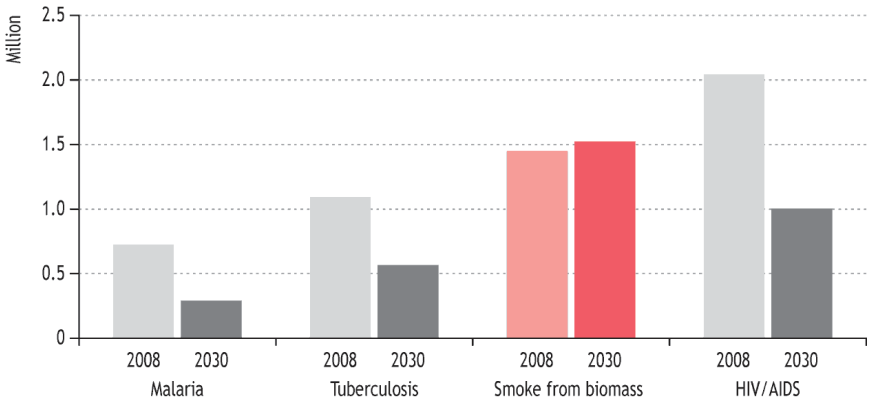
39. IEA ENERGY OUTLOOK, *supra* note 1, at 13.

40. *Id.*

41. *Id.*

42. *Id.*

Figure 2: Premature annual deaths from household air pollution and other diseases[43]



Furthermore, in developing regions in which households are heavily reliant on biomass, women and children are generally responsible for fuel collection, a time-consuming and exhausting task.[44] Women can suffer serious long-term physical damage from strenuous work without sufficient recuperation.[45] This risk, as well as the hazards of falls, snakebites, or human assault, rises steeply the farther from home women have to walk.[46] Children also spend time collecting fuel, which is time they do not spend in school or studying in the home. Inefficient and unsustainable cooking practices also have serious implications for the environment, such as land degradation and local and regional air pollution.[47] In cities where households are primarily reliant on wood or wood-based charcoal for cooking, there is local deforestation in the surrounding areas.[48]

IV. THE IMPORTANCE OF MODERN ENERGY IN ACHIEVING THE MILLENNIUM DEVELOPMENT GOALS

Eight Millennium Development Goals ("MDGs"), adopted in 2000,

43. *Id.* at 14 (citing Mathers & Loncar, *supra* note 38; WHO, GLOBAL BURDEN, *supra* note 38; Smith et al., *supra* note 38; WHO, ENVIRONMENTAL BURDEN, *supra* note 38).

44. *Id.*

45. *Id.*

46. *Id.*

47. *Id.*

48. *Id.*

were designed to eradicate extreme poverty and hunger by 2015. Energy can contribute to the achievement of each of these goals:

Goal 1: ***Eradicate extreme poverty and hunger***. Access to modern energy facilitates economic development by providing more efficient and healthier means to undertake basic household tasks and means to undertake productive activities more generally, often more cheaply than by using the inefficient substitutes such as candles and batteries. Modern energy can power water pumping, providing drinking water and increasing agricultural yields through the use of machinery and irrigation.

Goal 2: ***Achieve universal primary education***. In impoverished communities children commonly spend significant time gathering fuel wood, fetching water, and cooking. Access to improved cooking fuels or technologies facilitates school attendance. Electricity is important for education because it facilitates communication, particularly through information technology, but also by the provision of such basic needs as lighting.

Goal 3: ***Promote gender equality and empower women***. Improved access to electricity and modern fuels reduces the physical burden associated with carrying wood and frees up valuable time, especially for women, widening their employment opportunities. In addition, street lighting improves the safety of women and girls at night, allowing them to attend night schools and participate in community activities.

Goals 4, 5, and 6: ***Reduce child mortality; Improve maternal health; and combat HIV/AIDS, malaria and other diseases***. Most staple foods require cooking, and reducing household air pollution through improved cooking fuels and stoves decrease the risk of respiratory infections, chronic obstructive lung disease and lung cancer (when coal is used). Improved access to energy allows households to boil water, thus reducing the incidence of waterborne diseases. Improved access advances communication and transport services, which are critical for emergency health care. Electricity and modern energy services support the functioning of health clinics and hospitals.

Goal 7: ***Ensure environmental sustainability***. Modern cooking fuels and more efficient cookstoves can relieve pressures on the environment caused by the unsustainable use of biomass. The promotion of low-carbon renewable energy is congruent with the protection of the environment locally and globally, whereas the unsustainable exploitation of fuelwood causes local deforestation, soil degradation, and erosion. Using cleaner energy also reduces greenhouse-gas emissions and global warming.

Goal 8: ***Develop a global partnership for development***. Electricity is necessary to power information and communications technology

applications. Even if MDGs contain no goal specifically related to energy, and there are no targets or indicators associated with the MDGs that would enable governments and the international community to monitor progress towards universal access, recent high-level international forums have recognized the importance of energy access in development paths.[49]

In spring 2010, the summary report and recommendation of the UN Advisory Group on Energy and Climate Change ("AGECC") entitled, "Energy for a sustainable future" called for adoption of the goal of universal access to modern energy services by 2030.[50] More recently, on November 26, 2010, the UN General Assembly, with resolution A/C.2/65/L.42, declared 2012 the "International Year of Sustainable Energy for All," opening the way for an enhanced engagement of the international community towards the goal of universal energy access.

V. TOWARDS UNIVERSAL ACCESS TO MODERN ENERGY

In the last decades, many countries have made notable progress in improving access to electricity and clean cooking facilities. Succeeding in the impressive effort of providing electricity for over 500 million rural people in ten years, China reached near universal access to electricity around the year 2000 and is making substantial progress in the delivery of access to modern cooking fuels.[51] In Angola and Congo, where the share of the population with electricity access and access to modern cooking fuels has expanded, most of the achievement has come from urban areas.[52] While there has been progress on both fronts in Bangladesh, Sri Lanka, and Vietnam, more progress has been made in household electrification than in the provision of access to modern cooking fuels.[53]

Despite the positive trend registered in the recent past in many countries, today more than 1.4 billion people worldwide lack access to

49. IEA, ENERGY OUTLOOK, *supra* note 1, at 15, box 2.

50. *See* SECRETARY-GENERAL'S ADVISORY GROUP ON ENERGY AND CLIMATE CHANGE, ENERGY FOR A SUSTAINABLE FUTURE (2010), *available at* http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGECC%20summary%20report%5B1%5D.pdf (The Advisory Group on Energy and Climate Change (AGECC), a committee set up by UN Secretary-General Ban Ki-moon, is charged with assessing the global energy situation and incorporating this into international climate change talks).

51. *See* IEA, ENERGY OUTLOOK, *supra* note 1, at 18, 20, 32.

52. *Id.* at 32.

53. *Id.*

electricity,[54] and about 2.7 billion people rely for cooking primarily on biomass, including wood, charcoal, tree leaves, crop residues, and animal dung, used in inefficient devices.[55]

Although electrification and access to clean cooking fuels will progress over the period to 2030, the need for energy will grow as the population increases. Under the projected New Policies Scenario, without additional, dedicated policies, in 2030 there will still be 1.2 billion people lacking access,[56] and the number of people relying on the traditional use of biomass will increase to about 2.8 billion.[57]

54. *Id.* at 16.
55. *Id.* at 20.
56. *Id.* at 17.
57. *Id.* at 21. *See* Table 2 *infra*.

Table 2: Number of people without access to electricity and relying on the traditional use of biomass in the New Policies Scenario (Figures in the millions)[58]

	People lacking electricity access			People relying on biomass		
	2009	2015	2030	2009	2015	2030
Africa	587	636	654	657	745	922
Sub-Saharan Africa	585	635	652	653	741	918
Developing Asia	799	725	545	1937	1944	1769
China	8	5	0	423	393	280
India	404	389	293	855	863	780
Other Asia	387	331	252	659	688	709
Latin America	31	25	10	85	85	79
Developing countries*	1438	1404	1213	2679	2774	2770
World**	1441	1406	1213	2679	2774	2770

*Includes Middle East countries. **Includes OECD and transition economies.

To address this unsustainable and unacceptable future, and to illustrate what would be required to achieve universal access to modern energy services, the IEA developed the Universal Modern Energy Access Case ("UMEAC"). This case quantifies the number of people who need to gain access to modern energy services and the scale of the investments required by 2030. It includes interim targets for 2015 related to the achievement of the MDGs.

The energy targets adapted for 2015 are consistent with the achievement of the first MDG: eradicating extreme poverty. No more than one billion people should be without access to electricity by that date and no more than 1.7 billion should still be using traditional biomass

58. *See* IEA ENERGY OUTLOOK, *supra* note 1, at 16–21 (The 2010 edition of the *World Energy Outlook* sets out three scenarios. The Current Policies Scenario takes into consideration only those policies and measures that had been formally adopted by mid-2010; the New Policies Scenario takes account of broad policy commitments that have already been announced; while the 450 Scenario assumes a pathway to 2035 with the objective of limiting the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million of CO_2-equivalent).

for cooking on open fires or primitive stoves.[59] The relationship between poverty and modern energy access has been derived from a cross-country analysis covering 100 countries and the projections are based on regression analyses, which are applied to each region.[60]

Table 3: Targets in the Universal Modern Energy Access Case[61]

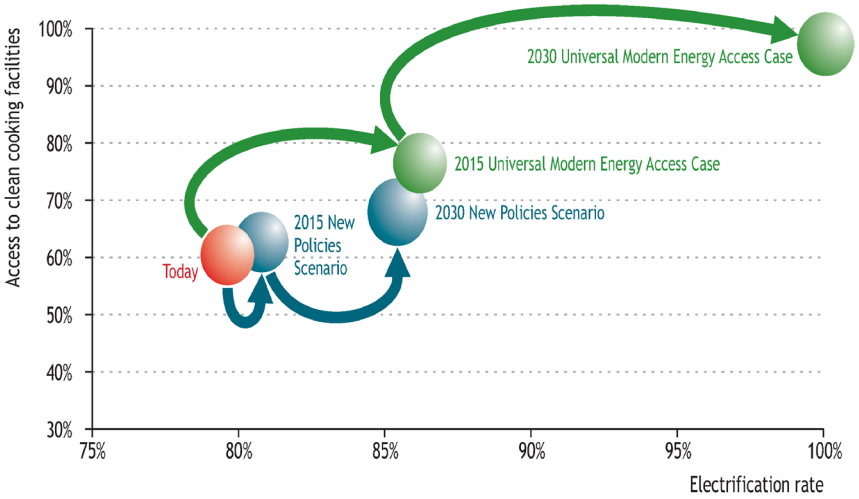
	2015		2030	
	Rural	Urban	Rural	Urban
Access to electricity	Provide 257 million people with electricity access	100% access to grid	100% access, of which 30% connected to the grid and 70% either mini-grid (75%) or off-grid (25%)	100% access to grid
Access to clean cooking facilities	Provide 800 million people with access to LPG stoves (30%), biogas systems (15%) or advanced biomass cookstoves (55%)	Provide 200 million people with access to LPG stoves	100% access, of which 30% provided with LPG stoves, 15% with biogas systems, and 55% with advanced biomass cookstoves	100% access to LPG stoves

Note: LPG stoves are used as a proxy for modern cooking stoves, including kerosene, biofuels, gas, and electric stoves. Advanced biomass cookstoves are biomass gasifier-operated cooking stoves that run on solid biomass, such as wood chips and briquettes. Biogas systems include biogas-fired stoves.

59. IEA, ENERGY OUTLOOK, *supra* note 1, at 16. *See* Table 3 *infra*.
60. IEA, ENERGY OUTLOOK, *supra* note 1, at 16.
61. *Id.*

IEA's analysis shows that, compared to the projections in the New Policies Scenario, in order to achieve the stated interim goals by 2015, an additional 395 million people need to be provided with electricity[62] and an additional 1 billion provided with access to clean cooking facilities.[63] These are demanding targets. As shown in Figure 3, in the New Policies Scenario they will not be achieved, even by 2030. For 2030, the UMEAC calculates what would be involved in achieving the more ambitious goal of universal access to modern energy services. Beyond the achievement of the interim 2015 target, this translates into the provision of electricity to an additional 800 million people and giving an additional 1.7 billion people access to clean cooking fuels in 2016–2030.[64]

Figure 3: Access to modern energy services in the New Policies Scenario (NPS) and Universal Modern Energy Access Case (UMEAC)[65]



A. Sustainable Technologies Options and Investment Needs

Universal access to modern energy can be achieved with the use of appropriate sustainable technologies. The IEA's UMEAC scenario explores the different options for providing access to electricity and clean cooking facilities.

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62. IEA ENERGY OUTLOOK, *supra* note 1, at 16.
63. *Id.*
64. *Id.*
65. *Id.* at 17.

1. Universal Access to Electricity

When modeling a scenario for universal access to electricity, the first step is to assess the extent of the additional generating capacity required to bring electricity to everyone by 2030. In order to do so, the IEA made assumptions about minimum levels of consumption at both the rural and urban level: rural households are assumed to consume at least 250 kWh per year and urban households 500 kWh per year.[66] Such assumptions are in line with the minimum electricity consumption of one kWh per day per household (or 365 kWh per year per household) set by the Indian rural electrification scheme.[67] In rural areas, this level of consumption could provide for the use of a floor fan, two compact fluorescent light bulbs, and a radio for about five hours per day.[68] In urban areas, consumption could also include a television and another appliance, such as an efficient refrigerator or a computer.[69] In the IEA model, household consumption rises every year over the projection period, until reaching the national average.[70]

In this way, the IEA estimated that a total incremental electricity output of around 950 TWh would be needed by 2030.[71] This additional electricity generation represents 2.9% of the nearly 33,000 TWh generated worldwide in 2030 in the New Policies Scenario.[72] To generate this additional electricity output would require a generating capacity of 250 GW.[73]

Various options for supplying this electricity need to be considered, including on-grid, mini-grid,[74] and isolated off-grid connections.[75] To ensure the most suitable technology option for providing electricity access, the IEA scenario takes into account the key variable of consumer density: the cost per MWh. When delivered through an established grid, the cost per MWh is cheaper than that through mini-grids or off-grid systems, but the cost of extending the grid to sparsely populated areas can be very high, and long distance transmission systems have high technical losses.[76] This results in grid extension in rural areas that is

66. IEA ENERGY OUTLOOK, *supra* note 1, at 19.
67. *Id.*
68. *Id.*
69. *Id.*
70. *Id.*
71. *Id.*
72. *Id.*
73. *Id.*
74. Mini-grids are village- and district-level networks with loads of up to 500 kW.
75. IEA ENERGY OUTLOOK, *supra* note 1, at 19.
76. *Id.* at 23.

often not cost effective.[77] Small, stand-alone renewable energy technologies can often meet the electricity needs of rural communities more cheaply and have the potential to displace costly diesel-based power generation options.[78]

Specific technologies have their advantages and limitations as well. Solar photovoltaic ("PV") is attractive as a source of electric power to provide basic services such as lighting and clean drinking water.[79] For greater load demand, mini-hydro or biomass technologies may offer a better solution, though PV should not be ruled out of consideration as system prices are decreasing—a trend which can be expected to continue in the years to come.[80] Moreover, PV can also be easily injected in variable quantities into existing power systems.[81] Wind energy represents a good (and available) cost-competitive resource, with mini-wind prices below those of PV.[82] Wind energy systems are capable of providing a significant amount of power, including motive power.[83] One of the main advantages of renewable energy sources, particularly for household-scale applications, is their comparatively low running costs (fuel costs are zero), but their high upfront costs demand new and innovative financial tools to encourage uptake.[84] To combine these different sources of energy in a power system supplying a mini-grid is probably the most promising approach to rural electrification.[85]

Thus, grid extension will contribute to part of the solution, but decentralized options have an important role to play when grid extension is too expensive. These decentralized options will provide the bulk of the additional connections over the projection period, as illustrated by Table 4.

Table 4: Generation requirements for universal electricity access, 2030 (TWh)[86]

	On-grid	**Mini-grid**	**Isolated off-grid**	**Total**

77. *Id.* at 23, box 3.
78. *Id.*
79. *Id.*
80. *Id.*
81. *Id.*
82. *Id.*
83. *Id.*
84. *Id.*
85. *Id.*
86. IEA ENERGY OUTLOOK, *supra* note 1, at 19.

Africa	196	187	80	463
Sub-Saharan Africa	*195*	*187*	*80*	*462*
Developing Asia	173	206	88	468
China	*1*	*1*	*0*	*2*
India	*85*	*112*	*48*	*245*
Other Asia	*87*	*94*	*40*	*221*
Latin America	6	3	1	10
Developing countries*	379	399	171	949
World**	**380**	**400**	**172**	**952**

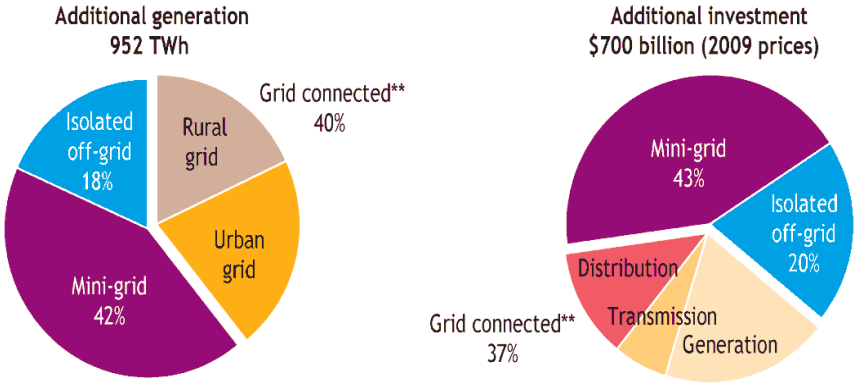
*Includes Middle East countries. **Includes OECD and transition economies.

The IEA estimated that universal electricity access would require a total investment of $700 billion over the period 2010–2030, or an annual investment of $33 billion.[87] This additional power-sector investment is equivalent to just five percent of the average annual global investment under the power sector in the New Policies Scenario, and only one-fifth of the annual investment required in China's power sector over the projection period.[88]

As rural areas account for the bulk of additional household electrification, decentralized solutions make up most of the investment over the projection period (see Figure 4). The bulk of investment for electrification by 2030 is incurred in Sub-Saharan Africa and Developing Asia, with both regions requiring cumulative investment of $340 billion.[89] Electrifying all households in India will require $180 billion over the next two decades.[90]

87. *Id.* at 24.
88. *Id.*
89. *Id.*
90. *Id.*

Figure 4: Incremental electricity generation and investment for universal electricity access, 2010-2030[91]



**Includes generation, transmission and distribution for both urban and rural grids.

2. Universal Access to Clean Cooking Facilities

The sustainable technology options for providing access to clean cooking facilities are: LPG stoves, advanced biomass cookstoves, and biogas systems.[92]

In this scenario, technology allocations are derived from assumptions regarding the most likely technology solution in each region—given resource availability and government policies and measures. Advanced biomass cookstoves, with emissions and efficiencies similar to those of LPG stoves, are assumed to cost forty-five dollars.[93] The cost of a biogas digester is assumed to be $400—the middle of the range of estimated costs for household biogas systems.[94] An LPG stove and canister is assumed to cost sixty dollars.[95] Infrastructure, distribution, and fuel costs are not included in the investment costs.[96] It is also assumed that each household retains one stove or biogas system over the projection period, thus replacement costs are not included.[97]

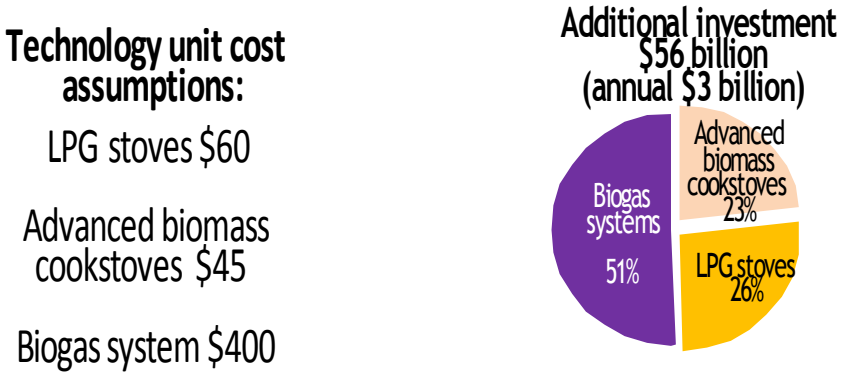
Universal access to clean cooking facilities could be achieved

91. *Id.* at 25.
92. *See id.* at 21.
93. *Id.* at 26.
94. *Id.*
95. *Id. See* Figure 5 *infra*.
96. IEA ENERGY OUTLOOK, *supra* note 1, at 26.
97. *Id.*

through an additional cumulative investment of an estimated $56 billion in 2010–2030.[98] Of this investment, thirty-eight percent is required from 2010 to 2015.[99] Over the entire projection period, fifty-one percent of the cumulative investment goes to biogas systems in rural areas, twenty-three percent to advanced biomass cookstoves in rural areas, and twenty-six percent to LPG stoves in both rural and urban areas.[100] The average additional annual investment over the period to 2030 is $2.6 billion.[101] Additional cumulative investment between 2010 and2030 of some $16 billion is required in China, $14 billion in India, and $10 billion in other developing Asian countries.[102] Further, the necessary cumulative investment from 2010 to 2030 is $14 billion in Sub-Saharan Africa.[103] Developing Asia accounts for eighty percent of the total $28 billion investment needed for biogas systems, while China alone accounts for fifty percent of the total.[104] In rural areas of Sub-Saharan Africa, over sixty percent of the 645 million people that need to gain access to clean cooking facilities from 2010–2030 are provided with advanced biomass cookstoves and the remainder with LPG stoves and biogas systems.[105] In rural areas of China, fifty-five percent of the target population is provided with biogas systems—fifteen percent with advanced biomass cookstoves and the remainder with LPG stoves.[106]

98. *Id.* at 25.
99. *Id.*
100. *Id.*
101. *Id.*
102. *Id.*
103. *Id.* at 26.
104. IEA ENERGY OUTLOOK, *supra* note 1, at 26.
105. *Id.*
106. *Id.*

Figure 5: Technological options and investment for universal access to clean cooking facilities, 2010–2030[107]



B. Global Implication of Universal Modern Energy Access

Achieving universal electricity access would have a modest impact on energy-related CO_2 emissions.[108] Compared with the New Policies Scenario, global energy-related CO_2 emissions in the UMEAC increase by just 0.8% by 2030, or around two percent of current OECD emissions (Figure 6).[109]

Expanding household access to modern fuels would inevitably increase global demand for these fuels—notably oil—but only by a small amount.[110] In this scenario, 730 million people switch to LPG stoves by 2030.[111] Assuming average LPG consumption of twenty-two kilograms per person per year,[112] total world oil product demand by 2030 would be 900,000 barrels per day ("mb/d") higher than under the New Policies

107. Original chart created by the author.

108. IEA ENERGY OUTLOOK, *supra* note 1, at 19.

109. *Id.*

110. *Id.* at 22.

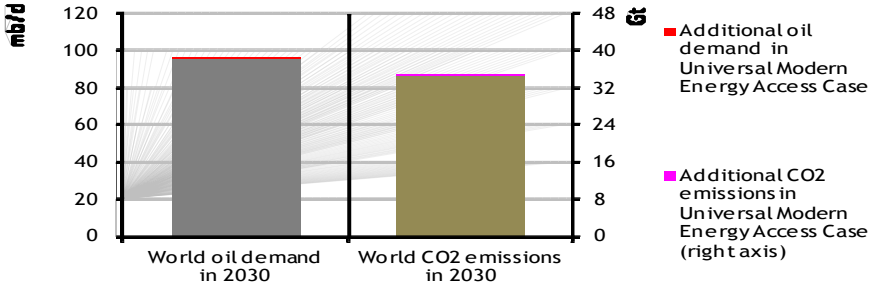
111. *Id.*

112. A weighted average based on WHO data for developing country households currently using LPG.

Scenario.[113] This represents 0.9% of the projected ninety-six mb/d of global oil demand in 2030.[114] The additional oil demand associated with access to LPG in the UMEAC is roughly equivalent to five percent of oil demand in the United States today.[115]

The impact on greenhouse-gas emissions by switching to advanced biomass technologies or LPG is very difficult to quantify because of the diversity of factors involved, including the particular fuels, the types of stoves, whether the biomass used is replaced by new planting, and whether a sustainable forestry management program is in place.[116] But it is widely accepted that improved stoves and greater conversion efficiency would reduce emissions.[117]

Figure 6: Global implications for CO_2 emissions and oil demand in the UMEAC, 2030[118]



VI. FINANCING OPTIONS FOR UNIVERSAL MODERN ENERGY ACCESS

Financing the $756 billion needed to provide universal access to modern energy services from 2010–2030, which works out to be $36 billion per year, is a major challenge.[119] So far, investments have been far below needs, especially in Sub-Saharan Africa.[120] Investments in

113. IEA ENERGY OUTLOOK, *supra* note 1, at 22.
114. *Id.*
115. *Id.*
116. *Id.*
117. *Id.*
118. Original chart created by the author.
119. IEA ENERGY OUTLOOK, *supra* note 1, at 22.
120. *Id.*

electrification have been greater than in clean cooking facilities.[121]

All available sources of finance will need to be tapped, including international funds; public/private partnerships; bank finance at multilateral, bilateral, and local levels; microfinance; loans; and targeted subsidies.[122] The financing mechanism adopted will need to be matched to the particular characteristics of the financing need. For example, the financial mechanisms appropriate to electrification differ according to the scale of the project and also differ from those required to expand access to clean cooking facilities.

The public sector can be expected to fund the costs of creating the necessary enabling environment.[123] Indeed, governments need to establish appropriate policies, regulations, and institutions.[124] Governments will often need to finance the relatively large investments, such as additional generating capacity and transmission links.[125] Indeed, in most developing countries, upfront public investment in developing national and local capacity is the most important ingredient in creating an environment that encourages the private sector to assume at least part of the risk.[126] This is because private investors want to ensure that a commercial return can be reliably earned on their investment.[127] Investment costs, which fall to consumers, are in a different category. Households will need loans (often on concessionary terms), lease financing (to convert unaffordable high initial investment costs into affordable operating costs), grants, and even initial operating subsidies.[128]

Local public banks, as well as bilateral and multilateral agencies, will remain important sources of finance.[129] However, those institutions are unlikely to be in a position to provide the level of financing necessary to promote universal access to modern energy services.[130] Existing energy programs and funds, such as the Renewable Energy and Energy Efficiency Fund ("REEF"), the Climate Investment Funds administered by the World Bank and implemented jointly with other development

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121. *Id.*

122. *Id.* at 26.

123. *Id.*

124. *Id.*

125. *Id.*

126. *Id.* at 26–27.

127. *Id.* at 27.

128. *Id.*

129. *Id.* (citing WORLD BANK GROUP, ASSESSMENT OF THE IMPACT OF THE CRISIS ON NEW PPI PROJECTS – UPDATE 5: NEW PRIVATE INFRASTRUCTURE ACTIVITY IN DEVELOPING COUNTRIES RECOVERED SELECTIVELY IN THE THIRD QUARTER OF 2009 (2010)).

130. *Id.*

banks,[131] the Global Environment Facility, and GTZ's Energising Development can be utilized to administer and distribute finances, but will need to be scaled-up significantly.[132]

Oil and gas-exporting countries have a source of financing that is not available to importing countries.[133] *World Energy Outlook 2008* estimated that the cost of providing electricity and LPG stoves and canisters to those households without access in the ten largest oil and gas-exporting countries in Sub-Saharan Africa would be roughly equivalent to only 0.4% of the governments' cumulative take from hydrocarbon exports through to 2030.[134] Such resource wealth offers a significant opportunity for economic development and poverty alleviation, if managed effectively.[135] In order to ensure effective management, greater efficiency of revenue allocation and greater accountability in the use of public funds are both important.[136]

Long-term financing for rural electrification is important. From the outset, financial provisions should extend long-term (five to ten years) support for the system under contracts providing also for maintenance and upgrading.[137] Efforts should be made to direct usage, at least partially, towards the development of productive activities, to generate funds to cover the costs, particularly maintenance, once the support arrangements have come to an end.[138]

At least part of rural electrification should serve economic development activities as a means to generate revenue for maintenance and other operating costs with a view to the end of the support. In one innovative scheme, the user pays only part of the tariff and the rest is covered by the government. This type of subsidy is focused on people with low consumption. Some countries have given support to private developers through rural electrification funds or developed local co-operatives, owned by consumers. Smart subsidy schemes to provide electricity to rural households, such as output-based aid subsidies, have also been developed in some countries.

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131. *Id. See also*, WORLD BANK CLEAN TECHNOLOGY FUND, PILOT PROGRAM FOR CLIMATE RESILIENCE (2008), *available at* http://www.climateinvestmentfunds.org/cif/ppcr; WORLD BANK CLEAN TECHNOLOGY FUND, SCALING UP RENEWABLE ENERGY PROGRAM IN LOW INCOME COUNTRIES (2009), *available at* http://www.climateinvestmentfunds.org /cif/srep.

132. *Id.*

133. *Id.*

134. *Id.*

135. *Id.*

136. *Id.*

137. *Id.*

138. *Id.*

In contrast to investments for electrification, which are mainly funded by governments and institutional investors, cooking services involve products which are paid for by the consumer.[139] The cost of an improved cookstove ranges from a few dollars to forty-five dollars (or in some cases considerably more).[140] Where improved combustion leads to substantial, demonstrable reductions in global warming emissions, these costs may be offset by carbon financing through the Clean Development Mechanism or other mechanisms generating carbon credits.[141] To support the uptake of clean cooking facilities, governments and donors need to invest in public awareness campaigns regarding the health and other benefits of clean cooking practices.[142]

Microfinance has proved particularly valuable to poor women.[143] They tend to obtain better credit ratings than men and highly value the improvements that can be made to the quality of family life.[144] In Bangladesh, for example, women have been shown to default on loans far less often than men.[145] In many cases, however, the scale of microfinance is insufficient to make large inroads into energy poverty.[146]

Because the amount of energy delivered from traditional technologies, such as a three-stone fires and kerosene/diesel lanterns, is much lower than that from modern services, such as electricity, poorer households spend a much higher share of their income on energy services.[147] A study of rural energy use in Bangladesh found that, for example, the cost of each kilolumen-hour from incandescent light bulbs or fluorescent tubes is less than two percent of the cost of comparable lighting services from kerosene lamps.[148] Accordingly, access to electricity can reduce total household energy costs dramatically, if upfront costs related to the connection are made affordable.[149] In

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139. *Id.* The provision of cookstoves by themselves is not enough for universal access. The supply chain, including distribution and production, of stoves and fuels, including biomass, also needs to be considered.

140. *Id.*

141. IEA ENERGY OUTLOOK, *supra* note 1, at 27. The Gold Standard Foundation, an international non-profit organization based in Switzerland, operates a certification scheme for Gold Standard carbon credits.

142. *Id.*

143. *Id.*

144. *Id.*

145. *Id.*

146. *Id.*

147. *Id.* at 34.

148. *Id.* (citing M. Asaduzzaman, Douglas F. Barnes & Shahidur R. Khandker, *Restoring Balance: Bangladesh's Rural Energy Realities*, *in* WORLD BANK WORKING PAPER NO. 181, at 41 (2009)).

149. *Id.*

addition, successful energy efficiency initiatives reduce electricity demand, which has the secondary benefit that existing generation plants can be used to supply new households, thereby reducing the need for capacity additions.[150]

The poor often need to allocate a disproportionately high share of household budgets to energy services,[151] so the poorest populations accordingly need distinct forms of help even though their per capita consumption is low.[152] To address this, there is a long history of using subsidies to assist affordability.[153] But ensuring that the benefits are provided only to the people most in need is difficult; and a contribution by the consumer is critical to successful uptake.[154] Households that pay for even a small fraction of the cost of modern energy services, whether it is an electricity connection, advanced biomass, or LPG cookstove or biogas digester, are more likely to provide for maintenance and operating costs.[155] Upfront costs for connections to the electricity grid or for fuel canisters and clean cooking stoves can still remain too high for the poor and, in the most extreme cases, there may be no alternative to subsidizing initially even a proportion of operating costs.[156] One example, promoted by the EU-PV working group on developing countries is a Regulatory Purchase Tariff for off-grid electrification.[157] Under this tariff, the user pays only part of the tariff cost and the government pays the rest.[158] This type of subsidy is focused on people with low consumption.[159]

VII. THE WAY FORWARD

How can countries embark on a dynamic path that will eventually lead to universal access to modern energy services?[160] Experience shows that success can be achieved in a variety of ways. Cambodia, Mali, and Madagascar have given support to private developers through rural

150. *Id.*

151. *Id.* at 28 (citing Energy Sector Management Assistance Programme, U.N. Development Programme, U.N. Millenium Project & World Bank, *Energy Services for the Millennium Development Goals,* 17–18 (2005)).

152. *Id.*

153. *Id.*

154. *Id.*

155. *Id.*

156. *Id.*

157. *Id.*

158. *Id.*

159. *Id.*

160. *Id.* at 35.

electrification funds.[161] Bangladesh and Nepal have developed local cooperatives owned by consumers.[162] Smart subsidy schemes to provide electricity to rural households, such as "output-based aid" subsidies, have been developed in some countries, *e.g.*, Senegal and Mozambique, and a similar approach has been used in Colombia to connect poor households to natural gas services.[163] In Mali, multifunctional platform[164] projects have been developed to provide mechanical power, and their success has led to similar programs being adopted in other African countries, such as Burkina Faso, Ghana, Guinea, and Senegal.[165] To meet overall universal modern energy access objectives, however, these approaches need to be scaled-up significantly and applied more widely.[166]

Increasing access to modern energy services requires, first, the integration of energy access into national development strategies, preferably with support from the UN system.[167] Strong and sustainable financial, institutional, and technology frameworks must be set up and capacity building undertaken at the local and regional levels with the goal of developing the capacity of national and local organizations, the private sector, and communities themselves to provide appropriate energy technologies and services.[168] In Nepal, for example, well over half of the total program implementation costs to provide micro-hydropower and improved cooking stoves were dedicated to capacity development.[169] Setting national goals and targets is important, but it is not enough without carefully monitoring progress.[170]

Greater regional cooperation can prevent unnecessary expansion of

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161. *Id.*

162. *Id.*

163. *Id.*

164. The multifunctional platform is built around a diesel engine, which can also run off jatropha oil. It can power various tools, such as a cereal mill, husker, alternator, battery charger, pump, welding and carpentry equipment, *etc*. It can also generate electricity and be used to distribute water.

165. *Id.* at 35–36.

166. *Id.* at 36; *see generally* U.N. DEVELOPMENT PROGRAMME [UNDP] & ALTERNATIVE ENERGY PROMOTION CENTRE, CAPACITY DEVELOPMENT IN SCALING UP DECENTRALIZED ENERGY ACCESS PROGRAMMES: LESSONS FROM NEPAL ON ITS ROLE, COSTS AND FINANCING (2010) [hereinafter UNDP & AEPC]; UNDP, *Expanding Access to Modern Energy Services. Replicating, scaling up and mainstreaming at the local level: Lessons from community-based energy initiatives*, U.N. Sales No.E.06.III.B.24 (2006) [hereinafter UNDP, 2006].

167. *Id.*

168. *Id.*

169. *Id.* (citing UNDP & AEPC, *supra* note 166, at 16).

170. *Id.*

electricity generation capacity in the future.[171] Coordination within a country and between regional governments can greatly enhance the efficacy of electricity projects and contribute to wider benefits.[172] In Africa for example, regional power pools appear to make a valuable contribution to regional integration, which is widely perceived as one of the best engines of Africa's development.[173]

About half of developing countries have set up electricity access targets at the national, rural and/or urban level.[174] Objectives vary among countries. While some countries, such as Bangladesh, Bhutan, Botswana, Ghana, India, Nepal, South Africa, and Swaziland aim to reach universal access within the next five to seventeen years, others have defined intermediate goals, such as Malawi and Rwanda, that aim to achieve thirty percent and thirty-five percent electrification rates respectively by 2020.[175] Both Laos and Indonesia have a target to electrify ninety percent of the population by 2020; in Indonesia, this involves expanding access to some two million new subscribers each year.[176] Cambodia has a target to increase its rural electrification rate from twelve percent today to seventy percent by 2030.[177] Troublingly, very few developing countries have set targets for access to modern cooking fuels or improved cookstoves or have set targets for reducing the share of the population relying on traditional biomass.[178]

171. *Id.*
172. *Id.*
173. *Id.*
174. IEA ENERGY OUTLOOK, *supra* note 1, at 36.
175. *Id.*
176. *Id.*
177. *Id.*
178. *Id. See* Table 5 *infra*.

Table 5: Number of developing countries with energy access targets[179]

	Developing countries (total)	*of which*: Sub-Saharan Africa
Electricity	68	35
Modern fuels	17	13
Improved cookstoves	11	7
Mechanical power	5	5

Note: Based on UNDP's classification of developing countries.

Despite the demonstrable health consequences associated with current cooking practices in many developing countries, access to clean cooking facilities has received very little high-level attention, and, not surprisingly, very little progress has been made in the past.[180] Adequate training and support services have been lacking, together with the market research necessary to determine the various concerns and cooking habits of the women who would be using the stoves.[181] Things are now moving. Governments are becoming aware of the limitations of policies that encourage switching to liquid cooking fuels, such as LPG, and are putting in place strategies to increase the use of advanced biomass cookstoves and biogas systems.[182] The heightened awareness of the need to improve the use of biomass for cooking is driven by different factors among countries.[183] The most important include high oil prices and the global recession, as well as unreliable supplies of liquid fuels and the illegal diversion of LPG and kerosene to the industry and transport sectors.[184]

At the international level a big step forward has been taken recently. Last September, the UN Foundation launched the "Global Alliance for Clean Cookstoves"[185] with a goal of 100 million homes to adopt clean

179. IEA ENERGY OUTLOOK, *supra* note 1, at 36.

180. *Id.*

181. *Id.*

182. *Id.* at 37.

183. *Id.* at 37, n.28.

184. *Id.*

185. U.N. Foundation, *Global Alliance for Clean Cookstoves*, *available at* http://cleancookstoves.org/the-alliance.

and efficient stoves and fuels by 2020.[186] The Alliance's mission is to help overcome the market barriers that currently impede the production, deployment, and use of clean cookstoves in the developing world.[187]

VIII. CONCLUSION

Bringing electricity to the 1.2 billion people who would otherwise not have access to it by 2030 would require an additional cumulative investment of $700 billion from 2010–2030, or $33 billion per year.[188] In addition, in order to achieve universal access to clean cooking facilities for some 2.8 billion people, an additional cumulative investment of some $56 billion would be required from 2010–2030, or $2.6 billion per year.[189] Thus, a $36 billion investment per year would be required to achieve universal access to electricity and clean cooking facilities by 2030.[190]

This will surely be a major challenge, but the numbers need to be put into context. The annual investment required over the next two decades to achieve universal access to modern energy services is only around 0.06% of the average annual global GDP.[191] Furthermore, in 2009 countries spent nearly ten times this amount—or $312 billion—on fossil-fuel subsidies.[192] Furthermore, as the IEA estimated in the WEO 2008, the cost of achieving universal access in the ten largest oil and gas-exporting countries in sub-Saharan Africa is equivalent to only 0.4% of the governments' cumulative oil and gas revenues through to 2030.[193] Finally, this year the IEA estimated that adding just 0.3 cents per kWh—only 1.8% of the current price—to electricity tariffs in OECD countries would fully fund the additional investment needed for universal electricity access.[194]

Relatively high investment needs are neither the sole nor the biggest barrier to universal access to modern energy services. Recognition by the international community and by national governments of the urgency of

186. *Id.*

187. *Id.*

188. IEA ENERGY OUTLOOK, *supra* note 1, at 17.

189. *Id.*

190. *Id.*

191. *Id.* at 22.

192. *Energy Subsidies*, INTERNATIONAL ENERGY AGENCY, *available at* http://www.worldenergyoutlook.org/ subsidies.asp (last visited Feb. 25, 2011).

193. INTERNATIONAL ENERGY AGENCY, WORLD ENERGY OUTLOOK 2008, *available at* http://www.worldenergyoutlook.org/2008.asp (last visited Feb. 25, 2011).

194. IEA ENERGY OUTLOOK, *supra* note 1, at 24.

the need, and long-term policy commitment as part of strategic development plans, are necessary conditions to achieve universal modern energy access.[195]

Effective environmental management cannot be excluded from energy and development concerns.[196] Preventing irreversible damage to the global climate will require decarbonization of the world's energy system.[197] For developing countries, however, difficult choices have to be made in allocating scarce resources among pressing development needs, and climate change is often viewed as a long-term concern that must be traded off against short-term priorities.[198] While the poorest developing countries are not major contributors to climate change, their populations suffer acutely from its effects.[199] For net oil-importing developing countries in particular, rising and volatile prices have amplified the challenge of expanding energy access and have put an extra burden on fiscal budgets.[200] In a high-energy price and climate-conscious world, it makes sense for governments tackling the energy poverty challenge to choose a course consistent with long-term sustainable development goals, rather than choose the energy technologies and mixes used by OECD countries in the 1950s and 1960s.[201]

National development plans need to provide for the creation of strong institutional, regulatory, and legal frameworks and financing from all available sources—including the private sector.[202] Appropriate technological choices need to be factored in.[203] A robust set of indicators for measuring energy poverty and for tracking progress in a country's transition to the use of modern energy is needed to provide a rigorous analytical basis for policy-making.[204] International aid will be needed to subsidize investments in the production and distribution of both electricity and clean cooking fuels for capacity building and in creating an institutional system that integrates these different areas over the long-

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195. *Id.* at 37.

196. *Id.* at 14.

197. *Id.*

198. *Id.*

199. *Id.*

200. *Id.*

201. IEA ENERGY OUTLOOK, *supra* note 1, at 14

202. *Id.* at 37.

203. *Id.*

204. *Id.* (citing Morgan Bazilian *et al., Measuring Energy Access: Supporting a Global Target*, *in* Earth Institute Working Paper, at 19 (2010), *available at* http://modi.mech.columbia.edu/files/measuring_ energy_poverty merge_8_A_3.pdf).

term, while simultaneously addressing climate change.[205] International development organizations can support research, design, and development of appropriate technologies.[206] Promising approaches include reliance on renewable energy in rural applications and the use of locally-produced bioenergy to generate electricity.[207] International development organizations should take the lead in collecting, compiling, and sharing knowledge and in developing tools and indicators to measure progress.[208]

Prioritizing energy access as a key driver of social and economic development is a first step towards universal modern energy access.[209] The way forward will require:

- ❖ Commitment from the international community to the objective of achieving universal access to electricity and to clean cooking facilities by 2030;
- ❖ Establishment of national goals for access to modern energy services, supported by specific plans, targets, systematic monitoring, and the use of appropriate indicators; and,
- ❖ Creation of adequate and sustainable financial, institutional, and technology frameworks.[210]

Moving forward, the goal is to place energy and poverty at the head of the international agenda.

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205. *Id.*

206. *Id.*

207. *Id.*

208. *Id.*

209. *Id.* at 38.

210. *Id.* An important outstanding piece of analysis that is required is to identify how best to raise and administer the financing to deliver energy access to those in need. There should be a special excerpt of the 2011 World Energy Outlook that presents a new architecture for financing universal modern energy access. This study will benefit from an expert-level meeting hosted by the IEA in Paris in May 2011, which will bring together experts from across private/public financial institutions, and national/international governmental and non-governmental organizations that work on energy and development. We will present our analysis to a special high-level meeting hosted by the Government of Norway in Oslo in October 2011 in the presence of top representatives from Governments and international institutions.

18,000 Americans Without Electricity: Illuminating and Solving the Navajo Energy Crisis

David Tarasi, Christian Alexander, Julie Nania, Bob Gregory, Naree Chan, and Doug Vilsack

ABSTRACT

According to the most recent estimate, approximately 18,000 households on the Navajo Nation do not have access to electricity. This article examines the current lack of electricity in many households on the Navajo Nation as well as the suitability of small-scale solar lighting technologies as a way to counter this problem. Over the past year, members of Eagle Energy conducted research on the Navajo Nation in order to assess the energy needs of the Navajo people as well as the suitability of solar lighting technologies to meet these needs. During the initial research, baseline energy use surveys were distributed, as well as demonstration models of small-scale solar lighting technologies. After research, participants had an opportunity to use the lights and to give their opinions on the technology. This research found that there were still a significant number of Navajo homes without access to electricity. Additionally, the research shows that these households could benefit from the use of solar lighting technologies to bridge the gap between a complete lack of electricity and grid electrification.

I. INTRODUCTION

A. Elephant Energy's Presence in Namibia and on the Navajo Indian Reservation

Elephant Energy is a non-profit organization based in the United States that seeks to provide appropriate sustainable energy technologies ("ASETs") to people living without electricity. Elephant Energy was founded in August 2008 with an initial pilot project in the Caprivi Region of Namibia in southern Africa. The organization expanded its operations after determining that small-scale solar technologies were of great benefit to rural households in Namibia. Since 2008, Elephant Energy has provided ASETs to over one thousand households in rural Namibia through a variety of market-based mechanisms.

Elephant Energy is now in the process of developing a micro-franchise model for the distribution of ASETs in Namibia that will allow local entrepreneurs to market products in their village areas. The first Elephant Energy Shop was established in October 2010 and, with its affiliated rural entrepreneurs, provides access to ASETs for the over 70,000 inhabitants of the Caprivi Region while also serving as a model for Elephant Energy to expand into other areas of rural Namibia.

In 2010, with the help of a modest grant from the University of Colorado and support from Dine CARE, a non-profit dedicated to solving energy and environmental issues on the Navajo Indian Reservation ("Navajo Nation"), Elephant Energy expanded its reach to the Navajo Nation, located in the southwestern United States. The Navajo Solar Light Project involved trips to the Navajo Nation in August, October, and November 2010 by volunteers and students at the University of Colorado Law School to determine whether the ASETs utilized by Elephant Energy were appropriate solutions for the Navajo Nation. Initial findings indicate that the 18,000 households on the Navajo Nation that lack access to electricity could greatly benefit from the increased availability of solar-powered lights, like those that Elephant Energy offers in Namibia, as well as larger-scale solar-powered lighting systems. Elephant Energy has rebranded its operations on the Navajo Nation, working under the name "Eagle Energy." Eagle Energy follows the same strategy used in Namibia with the flexibility to make changes necessary for the specific conditions of the Navajo Nation.

1. Background: The Navajo Nation

The Navajo Nation is a Native American reservation located in northeastern Arizona, southeastern Utah, and northwestern New Mexico. The Nation is divided into five agencies, with eighteen to thirty-one chapters in each agency. It covers a land area of over 26,000 square miles, making it larger than each of the ten smallest U.S. states, with a total population of approximately180,462 people.[1]

Despite being located in the United States, the Navajo Nation suffers from extreme poverty. According to the 2000 census, 42.9 percent of residents of the Navajo Nation lived below the poverty level, meaning they had an income of less than $8,350 per year.[2] The proportion of impoverished people was more than four times the average poverty level in the United States. In addition, 21.4 percent of Navajo families lacked plumbing,[3] and 62.6 percent lacked basic telephone service.[4]

B. Electricity Issues on the Navajo Nation

In addition to extreme poverty, many Navajo households do not have access to electricity. Although the census does not collect data on household electrification, it is conservatively estimated that around 18,000 of the 48,000 households on the Navajo Nation lack electricity.[5] This poses a number of significant problems for those families without electricity, including lack of access to adequate lighting, heating, and refrigeration. Alternatives to grid-tied electricity, like kerosene for lighting, diesel generation for electricity, and wood stoves for home heating, are often expensive, dangerous, unhealthy, and insufficient.[6]

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1. TRIB CHOUDHARY, NAVAJO NATION DATA FROM US CENSUS 2000 1 (2000), *available at* http://www.navajobusiness.com/pdf/NNCensus/Census2000.pdf.

2. *Id*.

3. NAVAJO NATION REGIONAL PARTNERSHIP COUNCIL, NAVAJO NATION, 2010 NEEDS AND ASSETS REPORT 23 (2010), a*vailable at* http://www.azftf.gov/WhoWeAre/Board/Documents/Sept27,10%20Board%20Materials/Attachment_11l_Navajo%20Nation%20_NA_2010%20RPT.pdf.

4. Maria Martha Chavez & Scout Bittle, *Providing Facilities and Support to Digitally Isolated Communities* 5 (CAPE Working Paper, 2008), *available at* http://www.publicagenda.org/files/pdf/CAPE%20Working%20Paper%20Providing%20Support%20to%20Digitally%20Isolated%20Communities.pdf

5. CHOUDHARY, *supra* note 1, at 1.

6. E. Muller, R. D. Diab, M. Binedell & R. Hounsome, *Health Risk Assessment of Kerosene Usage in an Informal Settlement in Durban, South Africa*, 37 ATMOSPHERIC

There are many reasons for the lack of access to electricity on the Navajo Nation, including geographic isolation, high poverty levels, and legal and political pressures.

1. Geographic Issues

One of the main causes for the lack of access to electricity in the Navajo Nation is the geographic isolation of many chapters,[7] and of individual households within each chapter. The Navajo Nation is slightly larger than West Virginia, but it has one-tenth the population spread across the same area.[8] This means that most of its communities are located a significant distance from each other, requiring long power distribution lines to bridge these gaps. In addition to the distance between Navajo communities, individual households are often located relatively far apart from each other. Even if a community has access to electricity, only some households may have electricity, while others just down the road are out of reach of the current power distribution lines.

The modern electrical grid system is designed to effectively serve large concentrations of people in specific populous areas. When many people are spread out over a vast area, the system is no longer efficient, and it becomes too expensive to extend power lines over the large distances between each home.[9] In addition to being geographically isolated, much of the terrain of the Navajo Nation is rugged and without roads. This makes transporting the equipment to build new power lines very difficult, which further increases the cost of installing traditional infrastructure.

2. Economic Issues

Although geographic isolation limits the Navajo Nation's access

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ENV'T 2015 (2003) (discussing dangers of kerosene); W. E. Pierson, J. Q. Koenig, & E. J. Bardana, *Potential Adverse Health Effects of Wood Smoke*, 151 WEST J. MED. 339 (1989) (discussing dangers of woodsmoke); *see, e.g.*, J.G. Vera, *Options for Rural Electrification in Mexico*, 7 ENERGY CONVERSION 426 (1992) (discussing dangers of diesel).

7. A chapter is a discrete local governmental entity within the Navajo Nation. The Navajo Nation is made up of 110 such chapters.

8. *See* NAVAJO TRIBAL UTIL. AUTH., *available at* http://ntua.com (last visited Mar. 26, 2011).

9. *Frequently Asked Questions on NTUA's Solar Energy Program,* NAVAJO TRIBAL UTIL. AUTH., http://www.ntua.com/solar/FAQs.html (last visited Jul. 29, 2011) [hereinafter *NTUA's Solar Energy Program*].

to energy, economics play a role as well. As noted above, the cost of extending power lines in the rugged terrain of the Navajo Nation is extremely high. The average cost to extend a line a single mile is about $27,000.[10] Due to the isolated nature of many Navajo households the cost of the line extension cannot be split over many customers because any given line extension may only reach a few additional customers.

Additionally, despite the large reserves of natural resources for energy production located on the Navajo Nation, the Navajo Tribal Utility Authority ("NTUA") does not operate any of its own power plants, so it is required to purchase electricity from other utility providers.[11] About fifty percent of NTUA's revenues go to purchasing electricity from other suppliers, increasing the cost to its consumers and limiting its funding for new power lines.[12]

Cost is also an issue for households that want to use large-scale photovoltaic systems to generate electricity. Very few households on the Navajo Nation can afford the large up-front cost of a photovoltaic system. The NTUA has a leasing program for two-kilowatt photovoltaic systems, which generate enough electricity to power home lighting, television, and small appliances, but are not an equal replacement for grid electricity.[13] Although this program exists, adoption has been extremely low.[14] The monthly cost is still high, and the supply is relatively low. The program requires a fifteen-year lease at a rate of $95 per month, with an $85 initial fee.[15] Only 200 households are currently leasing such systems.[16]

3. Legal/Political Issues

Legal issues have also slowed electricity development on the Navajo Nation. In 1966, a land dispute between the Navajo and Hopi tribes halted all development on over 1.5 million acres of land in the western portion of the Navajo Nation.[17] During the "Bennett Freeze," no

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10. *Id.*

11. *Frequently Asked Questions on NTUA's Energy Prices*, NAVAJO TRIBAL UTIL. AUTH., http://www.ntua.com/FAQs/FAQs.html (last visited Jul. 29, 2011).

12. *Id.*

13. *NTUA's Solar Energy Program, supra* note 9.

14. *Id.*

15. *Id.*

16. *NTUA's Renewable Energy Program Welcome*, NAVAJO TRIBAL UTIL. AUTH., http://www.ntua.com/solar/solarinfo.html (last visited Mar. 26, 2011).

17. Josh D. Moore, *Recent Developments: Justice Too Long Delayed on the Navajo Reservation: The "Bennet Freeze" as a Case Study in Government Treatment of Native*

new housing could be built, no roads or schools could be constructed, and the building of electrical infrastructure was outlawed in that area.[18] The development freeze was enacted to prevent either tribe from taking ownership of the land, but it also had the effect of forcing the residents of the area to live in poverty for the past forty years.[19] They have been unable to develop any new infrastructure or even make repairs to their homes.[20]

Although the ban was lifted in 2006, the damage done by the freeze remains. Of the 8,000 residents of the area, only ten percent have running water, and only three percent have electricity.[21] The infrastructure needed to run power lines is largely lacking, as are roads needed for new construction.[22] Although a bill was recently put before Congress to create a trust fund to help develop the former Bennett Freeze area,[23] it will be years before the area can reach a level of home electrification even equal to the rest of the Navajo Nation.

Many elderly Navajo have lived their entire lives without electricity and with a constant promise from the NTUA that electricity will be coming soon. As a result, many people have lost hope that they will ever be provided electrical services. One woman interviewed by Eagle Energy volunteers said she had been promised electricity by the end of the year, but it had been fifteen years of the same response without any progress. Despite a clear wish for electrification, many Navajo communities have no choice but to burn kerosene and wait.

II. BENEFITS OF SOLAR TECHNOLOGIES

Eagle Energy, operating under its original "Elephant Energy" brand, has been supplying affordable, small-scale solar lighting technologies to rural Namibians for the last three years. In both Namibia and the Navajo Nation, many homes lack electricity because they are located in rural areas where grid electrification does not make economic sense. Like Namibia, the Navajo Nation also has world-class solar

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Americans, 6 HARV. HUM. RTS. J. 222, 222 (1993).

18. *Id.* at 225.

19. 155 CONG. REC. S44, 55 (daily ed. Jan. 6, 2009) (statement of Sen. McCain).

20. *Id.*

21. 150 Cong. Rec. 20,343 (2004) (statement of Rep. Renzi).

22. *Id*.

23. Former Bennett Freeze Area Development Act, H.R. 6525, 111th Cong. (2009–10).

energy resources, making it an ideal location for solar energy production. New Mexico and Arizona have abundant sunshine, and receive some of the highest levels of solar radiation in the United States.[24]

Eagle Energy's small-scale solar technologies are ideal for Navajo Nation residents living in rural areas that are not likely to receive grid electricity in the near future. Eagle Energy is currently distributing six different solar lighting technologies on the Navajo Nation, including the D.Light Kiran, Sun King Lantern, ToughStuff solar panel and light, Nokero solar light bulb, and the large and mini BOGO light. All of these technologies use small solar panels to charge rechargeable batteries that power LED bulbs. Some of the lights are designed as flashlights, some as lanterns, and some can also be used to charge cell phones.[25]

These ASETs provide a quality source of lighting, allowing people to work and learn when they previously were forced to live in the dark or pay a high price for illumination via kerosene or propane. At a cost of $25 to $35, Eagle Energy's lights are not much more expensive than a kerosene lantern, and incur no additional monthly cost after purchase.[26] Furthermore, solar technologies provide health benefits by reducing indoor air pollution, and they help protect the environment by decreasing greenhouse gas emissions when compared with the use of kerosene lanterns.[27]

A. Economic Benefits

Eagle Energy's solar-powered lights provide a distinct economic advantage compared to kerosene and propane-fueled lanterns because they do not require users to buy multiple replacement fuel canisters per month. Although solar-powered lights come with rechargeable batteries that must be replaced after one or two years, the five-dollar cost is negligible compared to replacement fuel canisters.

Cost is also an issue for families that currently have access to grid electricity. With the high poverty levels that exist on the Navajo Nation,

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24. *See Photovoltaic Solar Resources of the United States*, NAT'L RENEWABLE ENERGY LAB., http://www.nrel.gov/gis/images/map_pv_national_lo-res.jpg (last visited Mar. 26, 2011).

25. Doug Vilsack, *Appropriate Sustainable Energy Technologies Product Catalog*, ELEPHANT ENERGY, http://www.elephantenergy.org/uploads/EECatalog.pdf (last visited Mar. 26, 2011).

26. *Id.*

27. *See, e.g.*, Craig Bain, Crystal Ballentine et al., *Navajo Electrification for Sustainable Development: The Potential Economic and Social Benefits*, 28 AM. INDIAN CULTURE & RESEARCH J. 67 (2004).

many who have access to grid-tied electricity cannot afford their monthly bills. Many Navajo families interviewed by Eagle Energy volunteers expressed an interest in solar-powered lighting technologies as a way to lower their monthly electricity bills.

B. Health Benefits

Solar Lanterns also provide a health benefit over the kerosene lanterns commonly used by the Navajo Nation. Although the health impacts caused by using fuel lighting is an understudied field, a recent article in the International Journal of Indoor Environment and Health attempted to quantify the risk. The authors found that vendors using simple kerosene lanterns were exposed to particulate matter concentrations significantly greater than the amount present in the ambient air.[28] Such exposure can present long-term health risks.[29] The article concluded that the best solution to combat this problem is the use of solar LED lighting.[30]

C. Educational and Productivity Benefits

Solar lighting technologies also provide an increased quality of light, which can benefit educational quality. Candles and kerosene lanterns provide a low-quality light source, making it difficult for children to read and do homework. Eagle Energy's solar technologies provide high-quality light, allowing children to read and do schoolwork after dark. Additionally, children who grow up using solar lights may be more prone to learn about the technology and come up with innovative ideas and uses for it. Solar lighting technologies can also provide a benefit to people without electricity who work from home, allowing them to work after dark at a lower cost compared to kerosene lanterns.

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28. J. Apple et al., *Characterization of Particulate Matter Size Distributions and Indoor Concentrations From Kerosene and Diesel Lamps*, 20 INDOOR AIR 399, 406 (2010).

29. *Id.* at 407.

30. *Id.* at 410.

D. CO2 Emission Benefits

Kerosene lanterns also produce CO2 emissions, causing harm to the environment. The average kerosene lantern, when used for four hours per night, produces over 100 Kg of CO2 emissions per year.[31] Assuming that each of the 18,000 households on the Navajo Nation has just one lantern and uses it for four hours per night, the net greenhouse gas emissions reduction from kerosene lanterns on the Navajo Nation would be over 1.8 million Kgs per year.[32] For reference, this is equal to driving over four million miles in the average car. Replacing these lanterns with solar-powered lighting technologies would eliminate these harmful emissions.

III. PROJECT METHODOLOGY

Eagle Energy's Navajo Solar Light Project ("Pilot Project") contained three phases. First, Eagle Energy located specific Navajo communities and determined what these communities' energy needs were and whether Eagle Energy's technologies were appropriate for addressing at least some of these needs. Second, Eagle Energy surveyed volunteer households from the community about their general energy usage and needs and distributed a total of 100 solar-powered lights of six different types to volunteer households (two different types to each household). Finally, Eagle Energy followed up with survey questions about the participants' use of these technologies. These three phases roughly correspond with three trips made by Eagle Energy's Colorado-based volunteers, which spanned a three-month period from August to November 2010. During this time, Eagle Energy's locally stationed partner in the Pilot Project, Melton Martinez, also conducted work in the communities with the help of Dine CARE.

A. Phase I: Locate Communities and Determine Need

Eagle Energy chose four communities in the Eastern Agency of the Navajo Nation to partner with for the first phase of the Pilot Project.

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31. Evan Mills, *The Specter of Fuel-Based Lighting*, 308 SCIENCE 1263, 1263 (2005).

32. This does not take into account the GHG emissions created by the manufacturing of solar lights and shipping to the Navajo Nation.

The Baca, Thoreau, Pinedale, and Mariano Lake Chapters were selected. Eagle Energy decided to focus on these communities, located in the area near Thoreau and Grants, New Mexico, due to previous connections with local community activists in the area and the proximity to Eagle Energy volunteers in Colorado.

1. Information on the Four Partner Chapters

Thoreau Chapter: According to the 2000 census, Thoreau chapter had 1,450 residents living in 415 households.[33] The median household income was $22,366, with one-third of all families below the poverty line.[34] Nearly 50 percent of families lacked telephone service, and 64 percent used wood for home heating.[35]

Baca Chapter: In 2000, Baca chapter had 889 members living in 206 households.[36] 44.5 percent of families lived below the poverty line, with a median household income of $17,708.[37] Over 68 percent of families used wood for home heating, and 49.1 percent lacked telephone service.[38]

Pinedale Chapter: In 2000, Pinedale chapter had 1,129 residents living in 293 households.[39] Over 48 percent of families lived below the poverty line, with a median income of $13,040.[40] 77 percent of families used wood for heating fuel, and seventy-two percent lacked telephone service.[41]

Mariano Lake Chapter: According to the 2000 census, Mariano

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33. LSR Innovations, *Thoreau Selected Characteristics from Census 2000* (Nov. 2003), *available at* http://thoreau.nndes.org/ cms/kunde/rts/thoreaunndesorg/docs/429390975-09-28-2004-11-12-59u.pdf.

34. *Id*.

35. *Id*.

36. LSR Innovations, *Baca Selected Characteristics From Census 2000* (Nov. 2003), *available at* http://baca.nndes.org/ cms/kunde/rts/bacanndesorg/docs/429390542-09-28-2004-10-52-51a.pdf.

37. *Id*.

38. *Id*.

39. LSR Innovations, *Pinedale Selected Characteristics From Census 2000* (Nov. 2003), *available at* http://pinedale.nndes.org/ cms/kunde/rts/pinedalenndesorg/docs/429390815-09-28-2004-11-05-06e.pdf.

40. *Id*.

41. *Id*.

Lake had 870 families in 260 households.[42] The median household income was $10,625, with 40 percent of families living below the poverty line.[43] More than 73 percent of families used wood for heating fuel and 68.8 percent of families lacked telephone service.[44]

2. Exploration & Orientation Trip

Eagle Energy's initial trip was designed to fulfill two key purposes. First, we wanted to find suitable partner chapters, and second, we wanted to determine whether our solar technologies were appropriate for the Navajo nation. After visiting multiple chapters and homes without electricity, we decided to partner with the four chapters profiled above.

Throughout the meetings and home visits, participants were very supportive of the idea of increasing access to small-scale solar technologies. Participants noted that many members of these communities are without access to electricity and that other forms of lighting, including kerosene and propane lanterns, flashlights, and car battery-charged lights are either expensive, dangerous, or both. Participants also noted that even those with access to electricity might benefit from solar lights because it could help reduce their electricity costs. Based on these meetings, we decided that Eagle Energy's solar lighting technologies would make a strong positive impact on the Navajo Nation.

B. Phase II: Survey Households on General Energy Use and Distribute Solar Lights

Eagle Energy staged a second trip in October 2010 after determining the geographic focus of the Pilot Project and confirming that Eagle Energy's proposal could adequately address real energy needs. The purpose of this trip was to gather specific data on the energy needs of the communities and distribute a small batch of solar-powered lights. Eagle

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42. LSR Innovations, *Mariano Lake Selected Characteristics From Census 2000* (Nov. 2003), *available at* http://marianolake.nndes.org/cms/kunde/rts/marianolakenndesorg/docs/ 429390776-09-28-2004-11-03-14e.pdf.

43. *Id.*

44. *Id.*

Energy conducted three separate public meetings at the Thoreau, Baca and Pinedale chapter houses.

At these meetings Eagle Energy distributed solar lights and surveys to measure the energy uses and needs on the Navajo Nation. Eagle Energy representatives made clear that they would be conducting a follow-up visit roughly a month later to gather survey data from participating households.

The first survey was designed to obtain baseline data. It was conducted when the lights were distributed, and consisted of ten questions regarding each household's general energy use and needs beyond just lighting. The baseline energy use survey also asked for more specific information about household members, including number of people living in the household, their ages, etc. This survey was written in English, although Eagle Energy provided translation to those who felt more comfortable communicating in Navajo. Overall, Eagle Energy gathered baseline energy use surveys from twenty-nine households. All participants who filled out a general energy use survey were given lights, making the total number of distributed lights during the trip fifty-eight. At the conclusion of the trip, the remaining lights (forty-two total) were given to Mr. Martinez to distribute along with additional surveys.

C. Phase III: Follow-up Trip and Survey on Solar Light Use

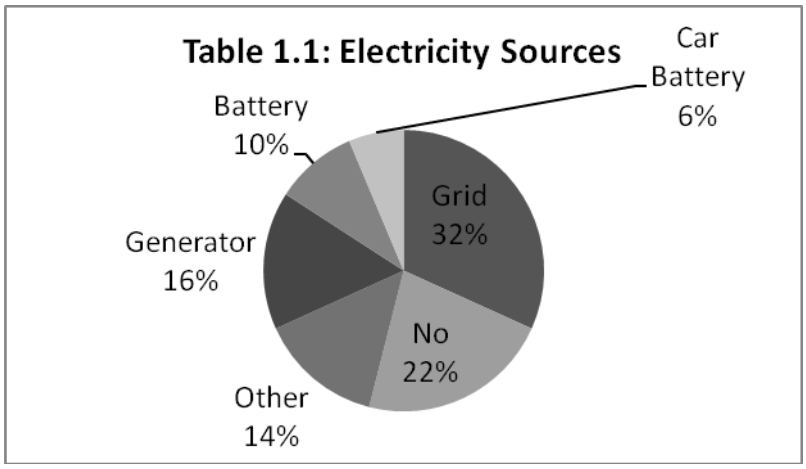
The main purpose of Eagle Energy's third trip to the Navajo Nation was to collect follow up surveys and meet with some of the families who received lights during phase II. The results from this trip are discussed below. During this trip, Eagle Energy's resolution for funding solar lights at Pinedale chapter was presented and passed. Despite current funding issues, this resolution was important because it showed buy-in from the chapter.

IV. RESULTS AND DISCUSSION

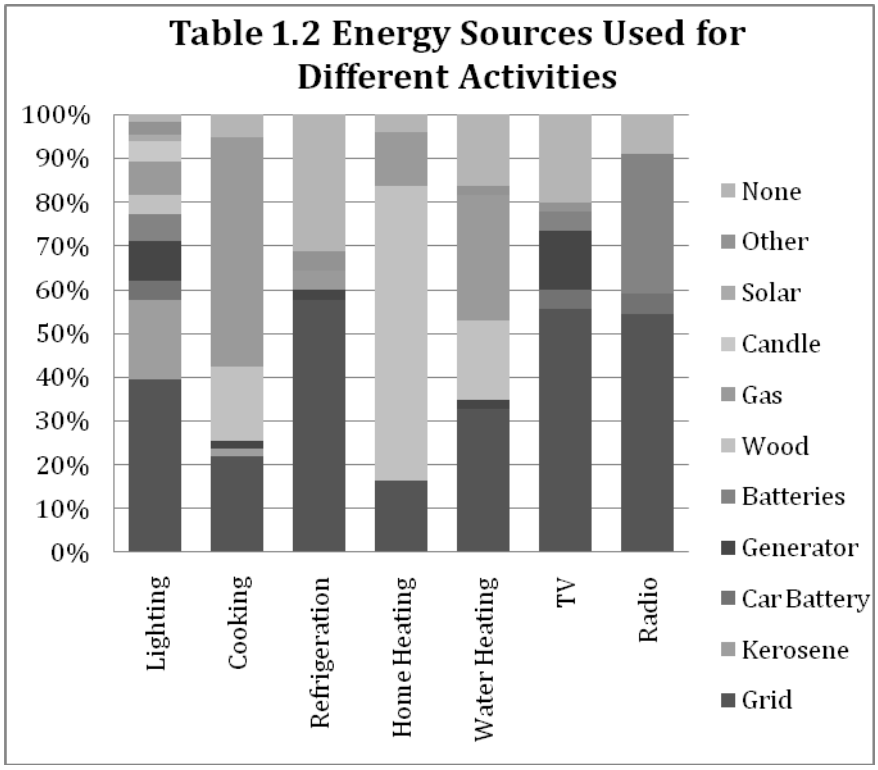
A. Baseline Energy Use Survey Results

The baseline surveys Eagle Energy collected on the second trip illustrate energy needs and usages of families in rural areas on the Navajo Nation. These surveys also collected information about the energy sources used for specific activities, as well as the average amount spent on varying energy sources per month.

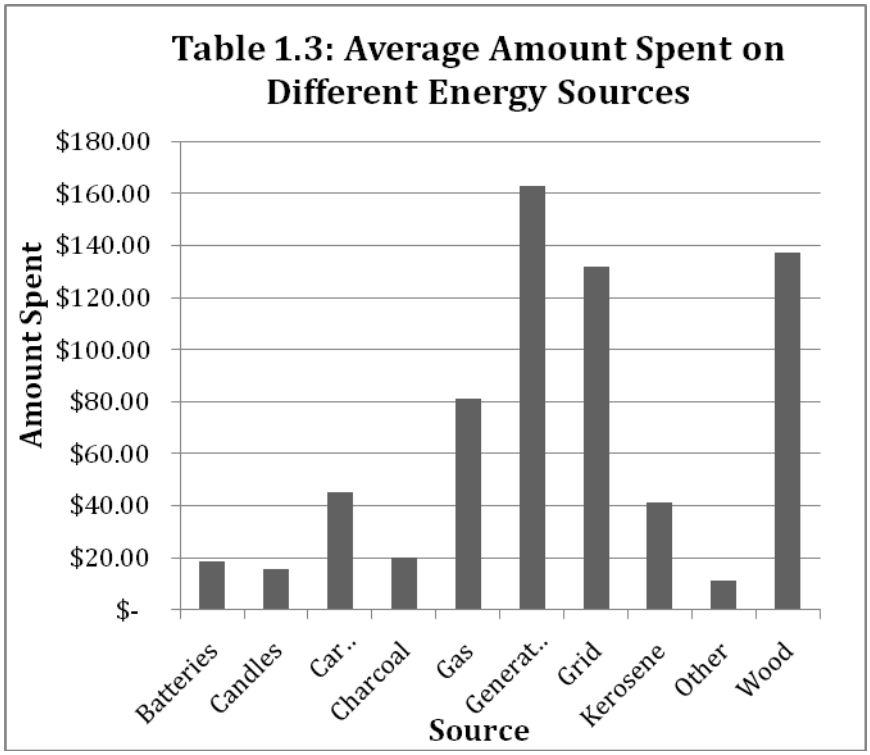
The baseline survey showed the severe lack of access to electricity in the four-chapter area. Only forty-three percent of the people surveyed had access to grid electricity, thirty-four percent were using generators or batteries, and thirty percent had no access to electricity at all. Table 1.1 shows access to electricity by energy source.



The baseline energy use survey also recorded the activities performed with each source of electricity. Table 1.2 shows the sources of electricity for each of these uses.



The baseline survey also recorded the average amount spent on different electricity sources per month. Table 1.3 shows the average spent per household during the month prior to filling out the survey in October and November 2010.



B. Follow-Up Survey Results

Pilot Project participants used six varieties of Eagle Energy's solar-powered lights for one month, providing valuable information on the suitability of small-scale solar lighting technologies on the Navajo Nation by filling out follow-up surveys. Participants found many uses for the lights, including some tasks that were impossible to complete with the limited array of energy products currently available on the Navajo Nation. Table 2.1 represents the activities that each solar-powered light was used for, and table 2.2 shows the tasks the lights made possible that were not previously possible.

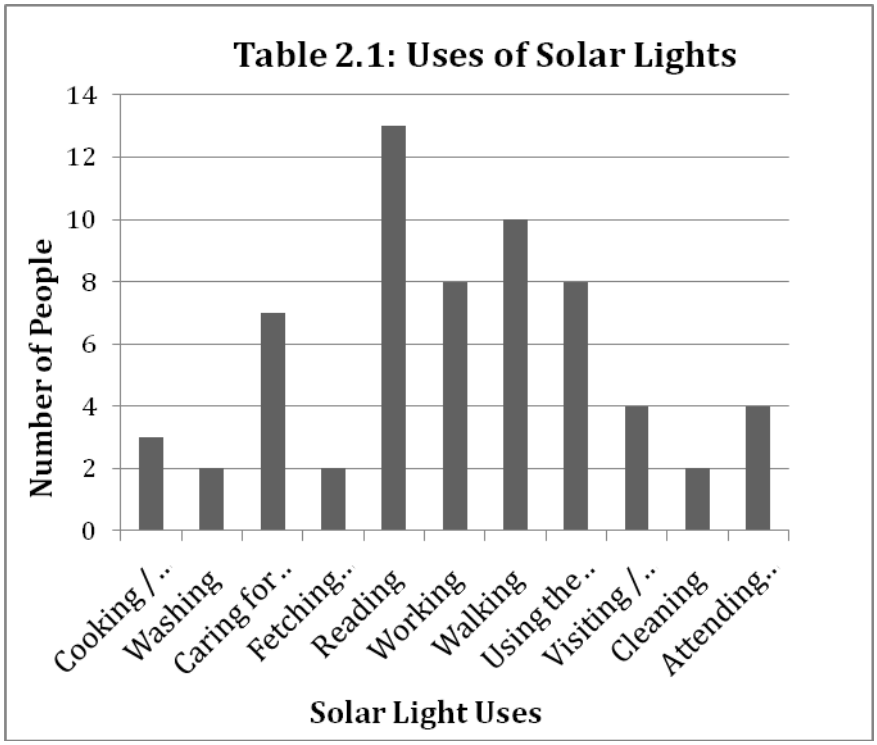


Table 2.1: Uses of Solar Lights
Number of People
14
12
10
8
6
4
2
0
Cooking /..
Washing
Caring for ..
Fetching..
Reading
Working
Walking
Using the..
Visiting /..
Cleaning
Attending..
Solar Light Uses

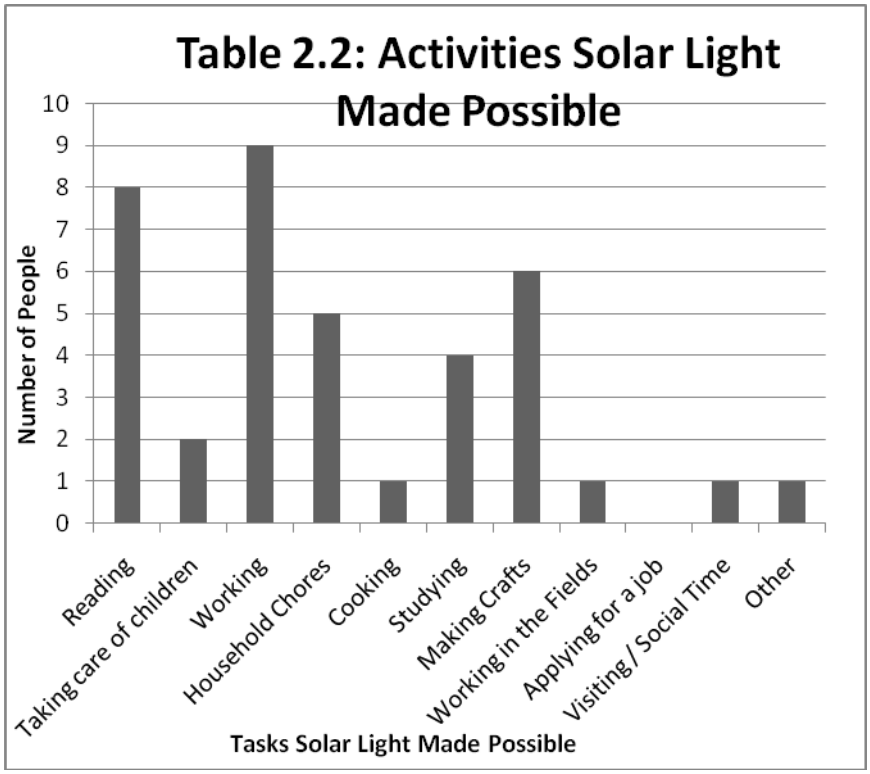
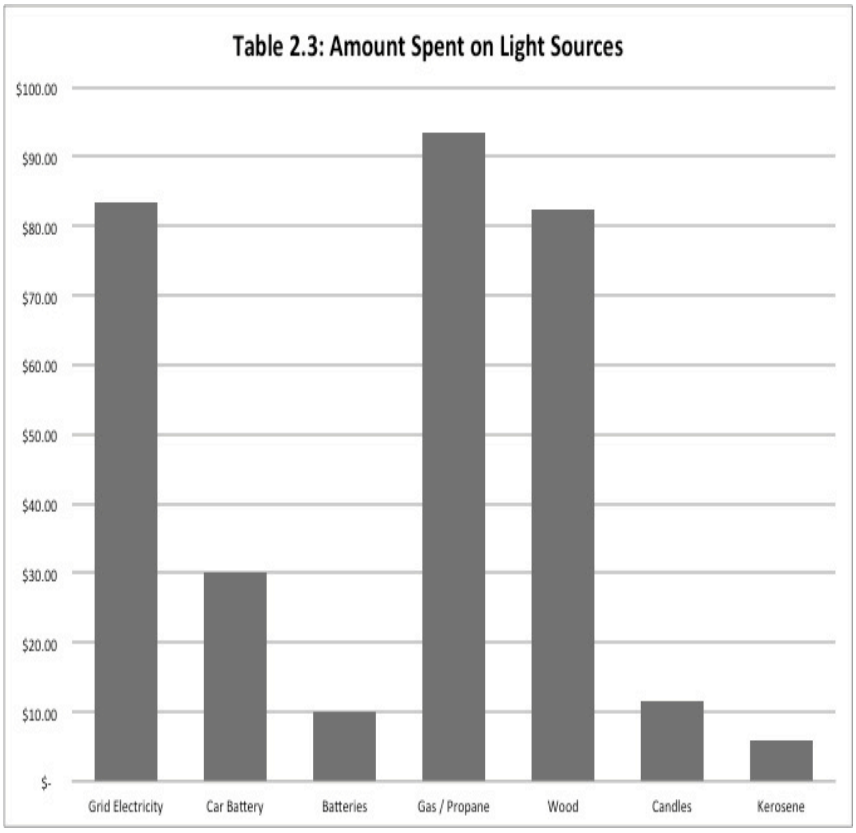
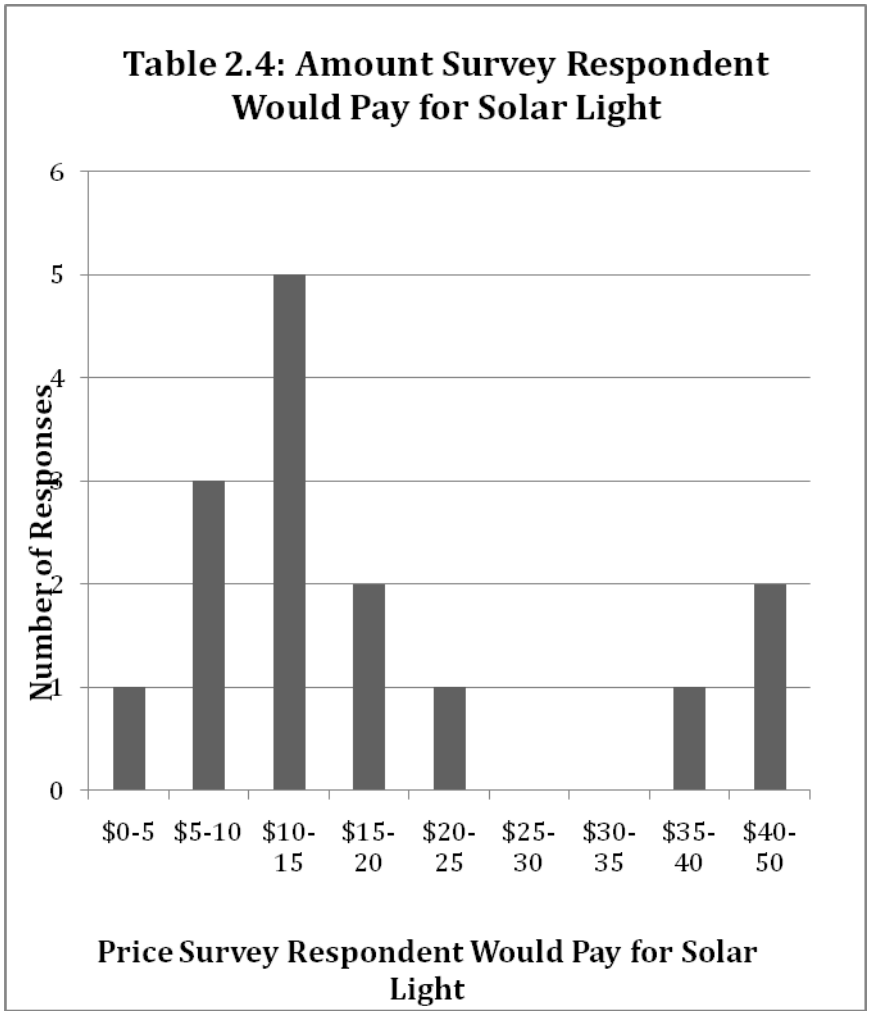


Table 2.2: Activities Solar Light Made Possible
Number of People
10
9
8
7
6
5
4
3
2
1
0
Reading
Taking care of children
Working
Household Chores
Cooking
Studying
Making Crafts
Working in the Fields
Applying for a job
Visiting / Social Time
Other
Tasks Solar Light Made Possible

The follow-up survey also showed the economic benefits of Eagle Energy's solar lighting technologies. The survey respondents reported the amount of money they spent on lighting and the amount the solar lights saved them during the month of the pilot project. Table 2.3 shows the average amount of money spent on various lighting products during the month before using solar lights. After using the lights, users reported an average savings of $36.88 for the month.



The surveys also showed that the solar-powered lights provided by Eagle Energy are quality products that are appropriate for the Navajo Nation. The survey respondents all found the lights very easy to use, and all of the lights worked properly over the course of the pilot project. The Pilot Project participants expressed an interest in paying for more lights in the future, with an average response of about $15 being the price that people would be willing to pay. Table 2.4 shows the amounts people said they would be willing to pay to purchase these lights.



C. Pilot Project Data Analysis

The results of the baseline and follow-up surveys make several points clear. First, there continues to be a severe lack of access to electricity in the Northeast corner of the Navajo Nation. Most Navajo families surveyed used a mix of fuels to meet their daily energy needs, instead of relying on only a gas line and electricity, as is common elsewhere in the United States. These sources of energy are extremely expensive, costing families far more per month than they would spend to receive a similar amount of energy through an electric line. Many Navajo families rely on car batteries or generators to run lights and appliances. Other households do not have access to batteries or generators and must

make do with zero electricity while paying high prices for kerosene, propane, and wood to meet their energy needs.

Second, the surveys show that Eagle Energy's small-scale solar-powered lighting technologies are appropriate for use on the Navajo Nation and can make a difference in people's lives. All survey respondents found uses for the light as a replacement for their customary lighting products, such as candles, kerosene, and propane. Many respondents were also able to accomplish tasks that were impossible with other forms of lighting. For example, one respondent said the solar light allowed him to continue his welding business after dark because he no longer had to use his generator for lighting. Another respondent said she was able to continue her intricate beadwork at night due to the higher quality light provided by the solar lantern. In addition, many respondents commented on the solar lights quality and ease of use.

Finally, the surveys show that it makes economic sense to offer small-scale solar-powered lights for sale on the Navajo Nation. The large amount spent on inefficient and poor quality lighting products and fuels, such as kerosene and propone lanterns, makes it clear that $25 to $35 solar-powered lights are a cost effective alternative. In addition, people expressed a willingness to pay the higher up-front cost for a solar-powered light in order to avoid continuously paying for kerosene, propane, and batteries.

V. CONCLUSIONS AND FUTURE PLANNING

It is clear from the results of the Pilot Project that there remains a lack of access to electricity on the Navajo Nation and that Eagle Energy's ASETs can be used to meet the energy needs of Navajo families at a basic level. In preparation for a project expansion, Eagle Energy Project must set goals, study distribution strategies, strengthen and expand partnerships, and increase marketing and outreach efforts.

Eagle Energy must determine which ASETs are best suited to meet the energy needs of the rural Navajo people. Although all of the tested solar-powered lights were useful, other technologies may be more appropriate, including: brighter solar-powered lights, larger solar home systems, efficient cookstoves, portable solar chargers, and others.

Going forward, Eagle Energy must continue to ensure that its partner chapters buy into its mission. Passing chapter resolutions is an important first step in community involvement, but additional relationships with community leaders and other local Navajo organizations must be formed if Eagle Energy is to have an enduring

impact on the Navajo Nation.

While giving away solar-powered lights was necessary to gather data during the Pilot Project, Eagle Energy does not plan to give solar-powered lights away in the future. Similar to its work as "Elephant Energy" in Namibia, Eagle Energy plans to conduct a feasibility/market study to determine if a market-based distribution model for small-scale solar-powered lights is economically viable, including sales via swap markets, established shops, rural salespeople, mail orders, and chapter house sales. Using market-based distribution will allow Eagle Energy to more effectively distribute solar technologies while also creating jobs on the Navajo Nation.

Although market-based product distribution is preferred, many elderly Navajo people have very little money and could be difficult to reach via a sales model. As a result, Eagle Energy plans to continue to work with the Baca, Pinedale, Mariano Lake, and Thoreau Chapters to purchase a stock of solar-powered lights for sale to community members for full price or for a price subsidized by the Chapters. Subsidized or free lights would then be available only through the Chapters for the elderly and sick.

Eagle Energy also plans to continue its strong outreach efforts by partnering with local schools and community groups on the Navajo Nation. Eagle Energy volunteers will develop educational materials and strategies to inform Navajo people about the benefits of renewable energy, especially the economic benefits of using solar-powered lights instead of expensive kerosene, propane, and batteries.

Finally, the Eagle Energy team ended 2010 with an ambitious goal to eradicate kerosene use on the Navajo Nation in the next five years with the help of their Navajo partners. In 2010, Eagle Energy demonstrated the $25 solar-powered alternative to the $25,000 power line. In 2011 it continues to work to bring light to the 18,000 families on the Navajo Nation without electricity and provide them with the technology many Americans take for granted.

How Can the Rural Energy Poor Obtain Appropriate Sustainable Energy Technologies?

Michael Waggoner*

ABSTRACT

Solutions to a current serious problem for the rural energy poor might best be found at least in part in older practices.

The problem comes from cooking over open fires, impairing the health of the cook and of others in her family, using fuel so inefficiently as to threaten forests, and releasing soot that contributes to global warming. Small, cheap, reliable cooking stoves could address these issues, improving health by reducing smoke and exhausting it through a chimney and thus away from the cook, using fuel more efficiently so that less needs to be gathered, and more completely burning the fuel so that less soot is released.

Older practices may most effectively put such stoves into the hands of the rural energy poor: Traveling merchants once sold small tools in rural areas. More recently they have sold cellular phones, and now they can sell the stoves. They might also sell water filters and other small appliances, reducing costs by spreading them over more products. A problem here is that many developing nation governments are bureaucratic, unfriendly to business, or even corrupt, and these barriers to commerce hurt the energy poor. Reforming markets and politics, while of course important to people in business, is also important to those needing better access to energy.

The U.S. has a long tradition of county agricultural extension agents serving as a bridge between farms and ranches, on the one hand, and agricultural universities on the other. The agricultural universities are in

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touch with industries serving agriculture such as those selling fertilizer, pesticides, seed, and tractors. The agent transmits information both ways, telling the colleges and thus industry of problems on the farms and telling the farmers of new solutions. This model would be useful in transmitting the new technology of the efficient stoves, providing a neutral alternative to the self-interested traveling merchants. These agents might be hired from among the well-educated people in the developing nations who at present are finding it difficult to obtain suitable employment.

INTRODUCTION

One should separate urban areas from rural areas when addressing the problem of getting appropriate sustainable energy technologies ("ASETs") to the energy poor. Rural as well as urban areas need to develop and to deploy ASETs, both to provide the energy needed for improved standards of living and to minimize greenhouse gas emissions. For urban areas, large-scale projects such as wind or solar farms, biomass- or nuclear-fueled thermal electric generators, or geothermal may be most appropriate. These technologies are being developed.[1] They may be deployed because the dense populations of urban areas make such projects practical, and current low interest rates, when added to subsidies and tax credits, make constructing such projects affordable. Governments and large corporations may be required to raise the capital and to provide the organization needed for such projects. For rural areas, however, it may be appropriate to develop different technologies and to deploy them in different ways, using social and economic institutions different from those used in urban areas.

The article examines two traditional institutions appropriate for the deployment of the new technologies of ASETs in rural areas, institutions that should also help with the improvement of the ASETs technologies. The first institution is the peddler or traveling salesperson; the second is the local agricultural extension agent. The ASET in focus will be primarily the cooking stove, although the analysis will also apply to similar small-scale and inexpensive ASETs such as water filters, irrigation pumps, etc. Some of these ASETs may also be appropriate in energy-poor urban areas, where cooking may be done over small fires and where the water may be unsafe to drink, but the focus will be on the rural energy poor.

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1. *See, e.g.*, Larry Greenemeier, *Winds of Change Blow Renewable Energy Across Latin America*, SCI. AM., July 2, 2010, *available at* http://www.scientificamerican.com/article.cfm?id=wind-power-colombia-guajira.

COOKING PROBLEMS

Let us begin with a major problem of the rural energy poor: cooking. Most of the rural energy poor cook with biomass such as wood or dried animal dung. So long as new biomass grows as fast as old biomass is burned—and unfortunately, this too often is not the case—such cooking contributes nothing to the excess of carbon dioxide ("CO_2") that threatens our planet with climate change or global warming. Biomass cooking nonetheless imposes very great costs. Cooking over an open fire exposes the cook to inhalation of the products of incomplete combustion. Breathing this harmful air is a leading cause of premature death among the rural energy poor, ranking only slightly behind bad water[2] and HIV/AIDS.[3] Furthermore, the cook, often a wife and mother, may carry her children or keep them close as part of her mothering duties, thus also exposing them to the unhealthy air.

Open-air cooking imposes additional costs beyond its harm to the health of those doing the cooking and others nearby. Open fires use fuel inefficiently, so they require large quantities of fuel,[4] which means that the rural poor must gather more wood. This gathering risks destruction of nearby forests, which are important to the local community. Forests provide wood, fiber, and food and are important parts of the ecosystem. They also protect against soil erosion and help to average out the water resources by storing rain and snowmelt in the root systems so water will be available in drier seasons.[5] As nearby forests are cut, fuel gatherers must go farther in search of fuel, distracting them from education and other economically productive activities, and sometimes exposing them to risks from human and animal predators.

Cooking with biomass fuels need not contribute to net CO_2

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2. Sabaleel Nandy, Gen. Manager, Water Purifier Bus., Tata Chem. Ltd., Story of the Swach Water Filter, Presentation at the University of Colorado Law School Energy Justice Conference (Nov. 5, 2010), *available at* http://lawweb.colorado.edu/events/mediaDetails.jsp?id=3000.

3. Lupita Motoya & Christian L'Orange, Cooking, Presentation at the University of Colorado Law School Energy Justice Conference (Nov. 5, 2010), *available at* http://lawweb.colorado.edu/events/mediaDetails.jsp?id=3000.

4. *See, e.g.*, *Energy Savers, Your Home, Wood and Pellet Heating*, U.S. DEP'T OF ENERGY, ENERGY EFFICIENCY AND RENEWABLE ENERGY, http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12570 (last updated Feb. 9, 2011) (under the section titled "Types of Wood- and Pellet-Burning Appliances, High-efficiency Fireplaces and Fireplace Inserts") ("[T]raditional open masonry fireplaces should not be considered heating devices" because they are so energy inefficient).

5. Gordon W. Stuart & Pamela J. Edwards, *Concepts About Forests and Water,* 23 NAT'L J. APPLIED FORESTRY 11 (2006), *available at* http://www.fs.fed.us/ne/newtown_square/publications/other_publishers/OCR/ne_2006_stuart001.pdf.

emissions, so long as the forests are maintained, so that the CO_2 emitted in cooking is counterbalanced by the CO_2 taken up by growing forests and other plants. However, in many areas, gathering fuel for biomass cooking contributes to the net reduction in forests and other vegetation.[6] If the forests and other biomass sources are not replaced as fast as they are consumed, biomass cooking will contribute to net CO_2 emissions and thus to climate change.

Perhaps a more serious contribution to global warming from biomass cooking is the emission of soot. The tiny black carbon particles in the smoke of incomplete biomass combustion—in addition to being very dangerous when inhaled—absorb heat from solar radiation when released into the environment, thus contributing to global warming generally.[7] Because black-colored objects absorb energy and white-colored objects reflect energy, black carbon deposited into the air generally absorbs the energy that white clouds would reflect, and black carbon deposited onto the landscape in colder areas absorbs the energy that white snowfields and white glacial ice would normally reflect. Thus, carbon soot deposits on glaciers may add to the destruction of glaciers, not only indirectly by increasing global temperatures, but also directly by making a glacier absorb more heat from the sun.[8] The retreat of glaciers, in addition to being a symptom of global warming, reduces a glacier's ability to even out seasonal stream flow by storing water in the form of ice and releasing it slowly into streams as it melts.[9]

Thus, open-air biomass cooking creates problems by harming the health of the cook and people nearby. It also leads to deforestation,

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6. Fuel wood gathering and non-timber forest products usage by subsistence farmers are estimated to cause six percent of net deforestation. U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, INVESTMENT AND FINANCIAL FLOWS TO ADDRESS CLIMATE CHANGE 81 (Oct. 2007) (see Table IV-35), *available at* http://unfccc.int/resource/docs/publications/financial_flows.pdf.

7. David E. Steitz, Rob Gutro, Krishna Ramanujan & Mary Tobin, *Black Soot and Snow: A Warmer Combination*, NASA, (Dec. 22, 2003), http://www.nasa.gov/home/hqnews/2003/dec/HQ_03420_black_soot.html.

8. Adam Volland, *Black Carbon Deposits on Himalayan Ice Threaten Earth's "Third Pole"*, NASA, (Dec. 14, 2009), http://www.nasa.gov/topics/earth/features/carbon-pole.html.

9. Press Release, Univ. of Cal., Santa Barbara, Scientists Find That Debris on Certain Himalayan Glaciers May Prevent Melting (Jan. 24, 2011), *available at* http://www.ia.ucsb.edu/pa/display.aspx?pkey=2406, *citing* Dirk Scherler, Bodo Bookhagen & Manfred R. Strecker, *Spatially Variable Response of Himalayan Glaciers to Climate Change Affected by Debris Cover*, 4 NATURE GEOSCI. 156 (Jan. 23, 2011), *available at* http://www.nature.com/ngeo/journal/vaop/ncurrent/full/ngeo1068.html ("Retreating glaciers, and thus a reduction of seasonal water storage in this region, have a large impact on hundreds of millions of people living in the downstream section of these rivers").

which contributes to global warming.

COOKING SOLUTIONS

A possible solution to these problems is to increase the use of enclosed cookstoves. Enclosing the fire increases cooking efficiency and reduces pollutants in smoke—heat retained close to the fire cooks food more quickly, and smoke held near the flames combusts more thoroughly. Cookstoves therefore improve the efficiency of biomass combustion, protecting the cook's health, the forests nearby, and the planet and its glaciers. Benjamin Franklin recognized the increased efficiency of stoves compared to open fires over 300 years ago.[10]

It is possible to increase cooking efficiency by replacing an open fire with a stove made from brick, cement, clay, stone, etc. Many of the energy poor may already be taking these approaches.[11] However, various outreach and educational efforts may be able to help more people use these materials. It may be possible to increase employment in rural areas as those trained to work with these materials are paid to build stoves for their friends and neighbors. But these materials may not be readily available to many of the energy poor, and even if they are, they may not be the best materials for making cook-friendly stoves. These materials may be most efficient for building ovens, with the stove's thermal mass retaining the heat for baking or roasting after the fire has burned out. They would not be efficient, however, for frying or boiling because they cannot quickly transfer energy.

An alternative could be durable and inexpensive cook stoves that could be mass-produced and sold to the rural energy poor. They would have to be small and light so that they could be easily transported in areas with less developed road or river transportation. The history of similar selling success is both recent and old.

BRINGING TECHNOLOGY TO THE PEOPLE

In older times, simple tools and farm implements were sold by traveling salespeople and later in small stores.[12] As time went on, similar

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10. I. BERNARD COHEN, BENJAMIN FRANKLIN'S SCIENCE 200-11 (2nd prtg. 1996).

11. See the discussion of building and selling more efficient cookstoves in Guatemala in Tina Rosenberg, *When Microcredit Won't Do,* N.Y. TIMES, Jan. 31, 2011, *available at* http://opinionator.blogs.nytimes.com/2011/01/31/when-microcredit-wont-do/.

12. James W. Baker, *The Yankee Peddler*, JABEZ CORNER, http://www.jabezcorner.com/jbz/jbz-peddlers.html (last updated July 28, 2010).

sales techniques were used for more sophisticated and expensive equipment. Starting with the recent successes, cellular phones have been broadly sold in energy poor areas.[13] Once the needed electromagnetic spectrum was allocated to cellular phones, sales increased even in quite rural areas.[14] In fact, much of the world may never see substantial hard-wired phone networks because of the success of cellular phones. While the manufacture of cellular phones and the creation and operation of networks require large organizations (public or private), the selling of the phones themselves has been largely decentralized.

The techniques that sold axes and sewing machines in older times and cellular phones more recently could be used to sell cookstoves. These techniques might also be used to sell inexpensive and reliable products such as water filters[15] or irrigation pumps for which the energy poor have needs similar to the need for safe and efficient stoves. Later, these techniques might be used for more sophisticated products such as photovoltaics or wind generators. Indeed, traveling vendors could use their time more efficiently and increase revenue if they had a broad array of products that could be brought to the rural poor at one time.

In the developed world and even in developing urban areas, the consumer often goes to a commercial area or a store with a broad spectrum of products, but the rural energy poor often lack the transportation and roads needed to get to such stores. The traveling seller could, during each trip, deliver what would take many trips by individual rural villagers. Repeat visits to the village allow the traveling seller to sell parts, new applications, and different products and also to keep in touch with prior customers who may have repair issues or may need guidance on proper use of older products. Networks of such traveling sellers might be operated by new small-scale entrepreneurs, by retail businesses already operating in the energy poor country, by

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13. *See, e.g.,* Nicholas Kristof, *Buying Rice—With Your Cell Phone*, N.Y. TIMES, Dec. 4, 2010, *available at* http://kristof.blogs.nytimes.com/2010/12/04/buying-rice-with-your-cell-phone/; *see also M-PESA Mobile Money*, CONSULTATIVE GROUP TO ASSIST THE POOR, http://www.cgap.org/p/site/c/media/?play=1.9.45741 (last visited Feb. 2, 2011) (a video on use of cell phones for money transactions).

14. *See A Special Report on Telecoms in Emerging Markets, Eureka Moments*, ECONOMIST, Sept. 24, 2009, *available at* http://www.economist.com/node/14483872; *The Mother of Invention*, ECONOMIST, Sept. 24, 2009, *available at* http://www.economist.com/node/14483880. The process of allocating spectrum in the U.S. (presumably somewhat similar to that in other nations) is described in Dylan Loeb McClain, *Directing Traffic in the Radio Spectrum's Crowded Neighborhood*, N.Y. TIMES, Feb. 24, 2000, *available at* http://www.nytimes.com/2000/02/24/technology/ directing-traffic-in-the-radio-spectrum-s-crowded-neighborhood.html?scp=3&sq= electromagnetic%20spectrum&st=Search.

15. Nandy, *supra* note 2.

nongovernmental organizations, or by international commercial companies.

The important point is that many of the needs of the rural energy poor might best be served through market activities—this has been the case from the age of new axes to the age of cellular phones. Although such market forces as carbon taxes and cap-and-trade are major tools for those concerned about the environment and climate change, perhaps reformers should turn their focus to the operation of traditional markets for goods and services, rather than the more exotic and abstract markets that operate under cap-and-trade. Perhaps Adam Smith and private enterprise deserve a larger place in environmental reform.[16] Meetings on environmental reform are heavily attended by experts from the social sciences and hard sciences, including economists, political scientists, physicists, biochemists, and engineers. How many attendees are from business schools, people who can talk about design, marketing, finance, and warranties? How many are from mass merchants such as Coca-Cola and Wal-Mart?[17] How many are from extenders of credit, whether micro lending or bankcards? There is something crass and rough about markets, and few would seriously doubt that markets need such infrastructure as courts, regulations, and laws of contracts, property, creditors' remedies, and bankruptcy. But markets are great at making technology available, at bridging the gap between what technology can do, and what end users want and need.

Despite the substantial benefits that markets produce, in much of the world—particularly in the energy poor nations—there are many barriers to the creation and operation of small- and medium-sized businesses.[18] One may speculate as to why these barriers exist.[19] Some governments may follow the mercantilist beliefs that dominated thought about public finance before Adam Smith.[20] Authoritarian regimes desiring to control all power may fear economic power centers as much as they fear political or religious rivals. Some nations may operate under systems of crony capitalism, under which a few large enterprises friendly

16. Adam Smith's THE WEALTH OF NATIONS (1776) is regarded by many as the foundation of modern market economics.

17. The representative from Tata, the conglomerate founded in India that has grown to be a major worldwide economic force, contributed significantly to this conference.

18. *See, e.g.*, INT'L FIN. CORP. & WORLD BANK, DOING BUSINESS 2011, MAKING A DIFFERENCE FOR ENTREPRENEURS 4 (Nov. 4, 2010), *available at* http://www.doingbusiness.org/reports/doing-business/doing-business-2011 (the Executive Summary provides the ranking of nations for their ease of doing business, a list where many of the energy poor are ranked as less hospitable).

19. *Id.*

20. See note 16, *supra*.

to the regime dominate the economy and are protected by the regime from competition.[21] Various nations may have serious corruption problems that delay and increase the cost of starting and operating businesses. Whatever the causes of the hostile business conditions in many of the energy poor nations, that hostility is imposing serious costs on the people and the environment of that nation.

ANOTHER LINK BETWEEN TECHNOLOGY AND THE END-USER

United States history includes another powerful influence on the process of getting technology to end-users: the cooperation between land-grant universities and local Cooperative Extension System Offices for the purpose of improving farming and ranching.[22] We are well aware of the technological progress in cars, computers, planes, and telecommunications. Perhaps further back in our consciousness are the revolutions in applying technology to agriculture.

The agricultural revolution has many components that together have allowed much less labor to produce much more food, fiber, etc. Chemical analysis allows better determination of what fertilizer or other soil enhancement may be appropriate.[23] Water use has been extensively studied and is increasingly well-understood,[24] even though the relatively water-rich United States lags behind such drier areas as Israel in the efficient use of water.[25] Crops have been improved by careful selection,[26]

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21. *See, e.g.*, Kareem Fahim, Michael Slackman & David Rohde, *Egypt's Ire Turns to Confidant of Mubarak's Son*, N.Y. TIMES, Feb. 7, 2011, at A1, *available at* http://www.nytimes.com/2011/02/07/world/middleeast/07corruption.html?scp=1&sq=%22crony%20capitalism%22&st=cse ("While hard facts are difficult to come by, Egyptians watching the rise of a moneyed class widely believe that self-dealing, crony capitalism and corruption are endemic."); Thomas L. Friedman, *The $110 Billion Question*, N.Y. TIMES, Mar. 6, 2011, at WK12, *available at* http://www.nytimes.com/2011/03/06/opinion/06friedman.html?_r=2&scp=21&sq=corruption,%20development&st=cse ("[O]ne reason for the rebellion in Egypt and protests in Jordan was the in-your-face corruption and crony capitalism that everyone in the public knew about.").

22. *See Cooperative Extension System Offices*, NAT'L INST. OF FOOD AND AGRIC., U.S. DEP'T OF AGRIC., http://www.csrees.usda.gov/Extension/index.html (last updated Dec. 14, 2010).

23. *See generally* VACLAV SMIL, ENRICHING THE EARTH: FRITZ HABER, CARL BOSCH, AND THE TRANSFORMATION OF WORLD FOOD PRODUCTION (2004).

24. *Irrigation Techniques*, U.S. GEOLOGICAL SERVICE, WATER SCIENCE FOR SCHOOLS, *available at* http://ga.water.usgs.gov/edu/irmethods.html (last modified Mar. 30, 2011).

25. Andrew Martin, *Can Israel Find the Water It Needs?*, N.Y. TIMES, Aug. 10, 2008, at BU7, *available at* http://www.nytimes.com/2008/08/10/business/worldbusiness/

later by hybridization,[27] and more recently by genetic modification.[28] Methods to control pests and weeds have been improved.[29] Contour plowing became the norm, and in many areas no-till farming is practiced.[30] Harvesting techniques seek to better preserve freshness and to protect against contamination and decay.[31]

These techniques have been developed, improved, and implemented through extensive collaboration among the agricultural colleges, farmers, and ranchers via the extension offices.[32] Agents who staff the extension offices are local residents who know the community and are known by the community. These agents transmit information from the farmers such as new problems, new solutions, or difficulties with old solutions. Going the other direction, these agents transmit information from the agricultural colleges to the farmers. The developers of better equipment, fertilizers, herbicides, pesticides, seeds, etc., use this communication system in both directions.

The new technologies for the rural energy poor might benefit from a communications system similar to that developed in the United

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10feed.html?ref=irrigation ("Israel has always been considered to be at the forefront of water efficiency in agriculture.").

26. Paul Voosen, *Molecular Breeding Makes Crops Hardier and More Nutritious,* SCI. AM., Dec. 21, 2009, *available at* http://www.scientificamerican.com/article.cfm?id=molecular-breeding-crops-genetics-rice-soy-corn-wheat.

27. Keith Schneider, *Science Debates Using Tools To Redesign Life*, N.Y. TIMES, June 8, 1987, at A17, *available at* http://www.nytimes.com/1987/06/08/us/science-debates-using-tools-to-redesign-life.html?scp=7&sq=crop%20hybridization&st=cse ("The genetic traits of plants and animals have been manipulated for centuries. But until now animal breeding and the hybridization of crop plants have been slow, cumbersome and difficult.").

28. *See* David Biello, *Can Genetically Modified Crops Feed the World?*, SCI. AM., April 16, 2009, *available at* http://www.scientificamerican.com/podcast/episode.cfm?id=can-genetically-modified-crops-feed-09-04-16.

29. Emily Laber-Warren, *Green Chemistry: Scientists Devise New 'Benign by Design' Drugs, Paints, Pesticides and More*, SCI. AM., May 28, 2010, *available at* http://www.scientificamerican.com/article.cfm?id=green-chemistry-benign-by-design.

30. John R. Huggins & John P. Reganold, *No-Till: How Farmers Are Saving the Soil by Parking Their Plows*, SCI. AM., June 30, 2008, *available at* http://www.scientificamerican.com/article.cfm?id=no-till.

31. Jan Ellen Speigel, *An Enduring Summer Treat, Improved by Science*, N.Y. TIMES, July 30, 2010, *available at* http://www.nytimes.com/2010/08/01/nyregion/01dinect.html?scp=8&sq=improved%20harvesting&st=cse ("Using plastic on the ground and covers on rows of selected fields, he is widely credited with harvesting the earliest corn in New England.").

32. See the website for the National Institute of Food and Agriculture (the former Cooperative State Research, Education, and Extension Service ("CSREES")), U.S. DEPARTMENT OF AGRICULTURE, http://www.csrees.usda.gov/qlinks/extension.html, on which the following discussion is based.

States, linking colleges with extension offices with those living in remote, small villages. A cookstove must be designed for its fuel, with different equipment required in stoves that burn animal dung, charcoal, coal, dried grass or twigs, hardwood, softwood, etc. The cookstove must be designed for the kind of cooking its users want, whether it be baking or boiling, frying or roasting, etc. The users of the stove must know how to use it and for what, to avoid the risk of carbon monoxide poisoning or accidental fires. If the climate permits, outdoor cooking reduces the risks of fire to the dwelling and of carbon monoxide poisoning. In harsher climates, a chimney may be required for safety, and in general chimneys increase the efficiency of stoves.[33] But chimneys must be well-designed and maintained.

Sustainable technologies that appear simple might actually require users to have continued contact with people who are familiar with the technology. A water filter might be effective at removing organic materials, but ineffective with ionic salts, or vice versa, and the filtering element is likely to need cleaning or changing. A water pump may need cleaning or replacement of seals, and if it is powered by an electric motor or internal combustion engine still more maintenance will be required. More sophisticated equipment for solar- or wind-generated electricity is likely to require periodic upkeep. Improvements are expected in these technologies, leading to the need to replace machines made with the old technology before their useful lives are over. While these issues should also be covered by the traveling salespeople discussed above under "Cooking Solutions," it will be valuable to have back-up from neutral agricultural extension agents.

In many energy-poor parts of the world, educated people are unable to find employment that suits their training.[34] This may be due to the fact that energy-poor countries lack the jobs or niches in which educated people can use their skills. Every professor and student may want to become an Oxford don, but the world demands relatively few purveyors of such services. Having those people use their skills to help transmit knowledge back and forth between universities and the energy poor might be the most gainful use of their education, and it might beneficially encourage the universities to employ more useful problem solving as opposed to some of the very abstract academic issues upon

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33. Because the air inside the chimney is warmer and thus lighter than the outside air, the air in the chimney rises. The rising air in the chimney draws more fresh air into the fire, aiding the combustion process, much as blowing on a campfire makes the campfire burn more intensely.

34. *See, e.g.*, Josh Chin, *Value of a Chinese College Degree: $44?*, CHINA REAL TIME REPORT, Nov. 22, 2010, *available at* http://blogs.wsj.com/chinarealtime/2010/11/22/value-of-a-chinese-college-degree-44/#.

which higher education too often fixates with great redundancy. Of course there is a need for and utility in pure research, but there is also a need for practical applications of theory to bridge the gap between the theory-rich and the energy-poor.

CONCLUSION

Getting appropriate sustainable energy technologies into the hands of the rural energy poor might best be done through the activities of traveling salespeople—they have brought cellular phones and plows to the rural poor. Alternatively or in addition, colleges might work with extension offices located in rural energy poor areas, much as they have long provided practical information transfer in U.S. agriculture. Colleges can provide appropriate sustainable energy technologies, skills, and knowledge to the rural energy poor, and the energy poor can return feedback about the success of these technologies. Supplementary benefits of this approach would be to orient the colleges away from pure theory and toward more practical activities, and to provide a more useful and reasonably compensated outlet for the abilities of their students.