

Building Opportunities and Partnerships in Zambia, Africa

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ABSTRACT:

This paper explores opportunities in Zambia, Africa for the U.S. and other developed nations to extend building technologies that can potentially reduce global greenhouse gas emissions and also support mutual economic development and environmental quality benefits. About ninety percent of the agrarian population in Zambia live in buildings constructed of wooden sticks and native grasses. Energy for these homes is primarily limited to wood and charcoal for heating and cooking. The countryside and ambient air are tainted by smoke from smoldering wood from production of charcoal for local and export markets. Cooking and heating appliances are extremely primitive, inefficient, and unhealthy. Opportunities exist to develop building technologies that use cleaner burning coal briquets for fuel, improve efficiency of cooking stoves, improve conditions for human health, construct more energy-efficient buildings, and stimulate economic development. External financial and technical support for such development would yield investor benefits including market entry or expansion in a resource rich developing county, low capital investment costs, low labor costs, and greenhouse gas mitigation and offset opportunities. Zambia is too rich in natural and human resources to be so poor. Building infrastructure and community development can establish a foundation for sustainable economic development and environmental quality for the whole world to enjoy.

Introduction

Last December in Kyoto, Japan, the U.S. engaged in negotiations related to international participation in global climate change agreements. One critical issue for the U.S. was that “meaningful participation of developing countries” be included in the agreement. The agreement failed to provide specific details defining meaningful participation of developing countries, but it did open the door for a market based approach for international emissions trading among private companies, developed countries, and developing countries. This paper provides a basis for U.S. companies to explore investment opportunities in the Republic of Zambia, and it outlines opportunities for the Zambian Government to take advantage of valuable resources they can bring to the global climate change negotiation table. There are potential energy-efficiency, economic, and environmental benefits from such collaboration.

The Kyoto agreement, subject to ratification by the U.S. Senate, would provide the opportunity for U.S. companies to purchase less expensive greenhouse gas emission permits from other companies or countries that have more emission capacity than they need to meet emission targets. The trade of emission permits can be a win-win for both parties because it allows more economical achievement of emission levels by one party for an equitable share of financial support for the other party. This mechanism is more fully developed in the concept of “joint implementation” introduced in the 1992 U.N. Framework Convention on Climate Change. Specific joint implementation mechanisms are not fully accepted by all potential parties to the Convention, but they are being negotiated. The U.S. Senate may not ratify the treaty until such

mechanisms are outlined to the extent that Congressional constituency in U.S. industry can clearly recognize benefits in Senate ratification.

Dealing equitably with international partners in remediating global climate change problems presents new opportunities for developed countries to not only gain from emission permit trading but also to gain by extending technology assistance in developing markets. The U.S. is currently formulating alternative "Road Maps" for reaching U.S. carbon reduction targets established by the Kyoto protocol. Numerous new building technologies reduce greenhouse gas emissions and provide energy-efficiency savings and other air and water quality improvements. Technologies that work in U.S. culture may not apply in underdeveloped countries like Zambia. Each developing country brings unique characteristics to the negotiation table where investment opportunities must be carefully evaluated, but rewards can be significant in terms of benefits for all parties.

Overview of Business and Social Conditions in a Country Needing Assistance

One of the poorest countries in the world, Zambia lies in Central Africa and covers an area slightly larger than Texas with a population of 9.1 million. Forty two percent live in cities where they have migrated to escape rural poverty conditions and find a source of income by working in industry. The rate of urbanization is estimated at 3.5 percent per year. This has significant affects on natural resource utilization and social adjustments in the vicinity of cities. In rural areas primitive agriculture is the primary occupation and source of survival. Of the total land area, 56% is suitable for agriculture, but presently only about 20% is being so used. Forests, covering 66% of the total land area, are very important as a source of food including fruits, vegetables, mushrooms, roots, edible insects, and secondary products like honey and beeswax. The climate is tropical and there are four distinct seasons; namely winter from June to August, pre-rainy season from September to October, rainy season from November to March, and the post-rainy season during April and May. Annual rainfall for the last 30 years has averaged at about 1000 mm, but during the past 10 years it has averaged only 974 mm which is significantly less than the 30 year average. Droughts do occur and are recently occurring more frequently and with greater severity. Both climate and water availability directly affect the health and welfare of Zambian people and wildlife resources. About 8% of the total land area is set aside for National Parks which are preserved for wildlife and other natural resource conservation. Zambia's National Parks are the largest in all of Africa.

Figure 1. illustrates the relative sectoral share of contributions to gross domestic product (GDP) in 1990. Zambia has experienced a major trend towards a decrease in economic growth over the past 20 years. Agriculture is the only sector which exhibits a positive average growth rate over the past 10 years. The mining sector, the backbone of the economy in past years, peaked in the early 1970s and continues to decline which forces a decline in transportation and industry sectors. The services sector has experienced a premature surge due to the loss of employment in mining which forces the population to resort to subsistence agriculture and trade for survival. The growth in agriculture was stimulated by government policy designed to ensure national food security, increase employment and income and ensure the agricultural base is maintained and improved. The policy emphasized increases in sustainable industrial exports and set forth a \$300 million Agricultural Sector Investment Program funded by donor countries. Agriculture is considered by the Government to be the major "engine of growth" for the future. Given the poor

performance of the economy, Zambia has had to rely on donor financing and an increasing national debt to provide social services. The future of the economy is dependent on the success of a Structural Adjustment Program initiated by the government in 1990 and the policy of opening up the economy for foreign investment.

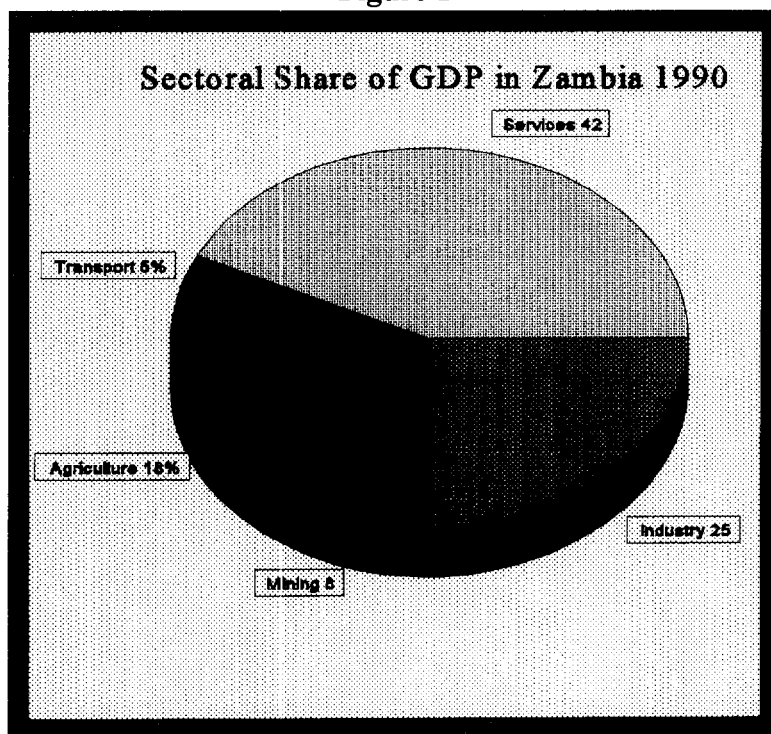
About ninety percent of the agrarian population in Zambia live in buildings constructed of wooden sticks and native grasses. Some rural buildings are constructed of bricks with a sheet metal roof held down by large rocks. Rural people live in and are organized by tribes that

maintain control of a limited area of land on which they survive. Energy for these homes is mostly limited to wood and charcoal for heating and cooking. Cooking, and heating appliances and the “buildings” are extremely primitive, inefficient, and unhealthy. Lighting consists of candles and rarely kerosine lanterns. A mere 12 % of the households throughout Zambia have electricity. Wood fuels provide the main energy source in the residential sector. Ambient air in the rural areas and in cities is tainted by smoke from wood burning and open-air charcoal production and use.

In cities, buildings are primarily constructed with brick and are not unlike buildings in the U.S. The infrastructure was built forty or fifty years ago with revenues and affluence in connection with the copper mining industry that flourished when Zambia was a British territory and up until the mid 1970s when the price of copper suffered a severe decline worldwide. The demise of the copper industry caused government and its revenues to reduce city infrastructure to a growing state of depression. By the late 1980s it had fallen into the deepest debt of all African countries. Unemployment and underemployment were and still remain a serious national problem. Per capita annual income is currently about \$350.00 which is equivalent to about half what it was when Zambia first gained independence in 1964.

The capital city shows evidence of a once affluent economy that invested wisely in urban infrastructure to the extent that the capital city, Lusaka, earned its distinction as “The Garden City”. With declining economy over the past two decades or more, the influence of a declining economy has left its currently visible mark. The streets, sidewalks, storm drains, parks, and buildings that had been professionally designed and constructed are severely broken and in disrepair. The storm drains are full with household trash, some of which is burned in place, and sediment from accelerated soil erosion. Flowering trees that had once beautifully lined the streets on both sides are suffering, many of them prematurely dead or dying due to dry conditions, soil

Figure 1



erosion, trash burning, and disease. With exceptions noted, many of the buildings show lack of investment in normal maintenance. Street vending, in sidewalks, parks and wherever, is a livelihood of underemployed people trying their best to survive by selling a variety of household goods, food, and clothing.

In spite of poverty conditions, Zambia is famed for its huge protected wilderness and parks covering about 8% of the land area where there is habitat for one of the most diverse species of animals in Africa. The famous Victoria Falls in Livingstone is an important natural feature for a relatively undeveloped tourism industry. Zambian Government can establish policies that provide favorable environment for tourism industry and ensure that transportation and accommodation infrastructure can meet growing demands of international travelers. Safari excursions, canoeing, rafting, and walking trips are organized by knowledgeable wildlife experts and guides. Most accommodations for travelers are currently small scale, have not yet been widely marketed, and are located in rural areas rather than in the cities, although there are excellent accommodations in Lusaka. Zambians are friendly, courteous, intelligent, hard working, and resourceful people. Most of the population speaks both English and native African.

Emissions Inventory

Making charcoal from the forest and gathering wood is a popular occupation, because wood is effectively “free for the taking” and charcoal brings a relatively high price in both local markets and in export to nearby countries. Zambia has resources to generate over 6,000 mega watts of electric power from hydro-electric facilities. It has installed capacity of only 1,630 mega watts of which only 1,020 are being used. Electricity, generated primarily by hydropower provides only 13% of the total energy demand. Firewood and charcoal provide almost 70% of the total energy demand. The rate of household electrification is constrained by inability of a poor population to pay for distribution facilities. About 87% of all households in both rural and urban areas use wood or charcoal for cooking. Table 1. shows the relative share of carbon emissions resulting from various activities.

Table 1. Summary of Carbon Dioxide Emission in Zambia, 1990

Sector	Source	Carbon dioxide (000 m. tons)
Fossil Energy - Solid	Coal	853.3
	Coke	86.5
Fossil Energy - Liquid	Gasoline	357.2
	Kerosene	134.27
	Diesel	861.64
	LPG	4.38
	LSG	20.5
	Jet fuel	171.03
	Heavy fuel oil	289.65

Sector	Source	Carbon dioxide (000 m. tons)
	Refinery	77
	Fossil Energy sub total:	2,855.47
Industry:	Cement production	210
	Glass production	1.9
	Lime production	120
	Fertilizer production	40
	Industry sub total:	371.9
Land use emissions:	Forest clearing	44,604.4
	On-site decay (oxidation)	4,686.26
	Off-site burning for fuel	10,096.08
Land use sequestrations:	Uptake-nat. regeneration	(122,235.78)
	Uptake-forest plantations	(678.20)
	Land use sub total:	(63,527)
Net CO₂ Emissions:	emissions - sequestration:	(60,299)

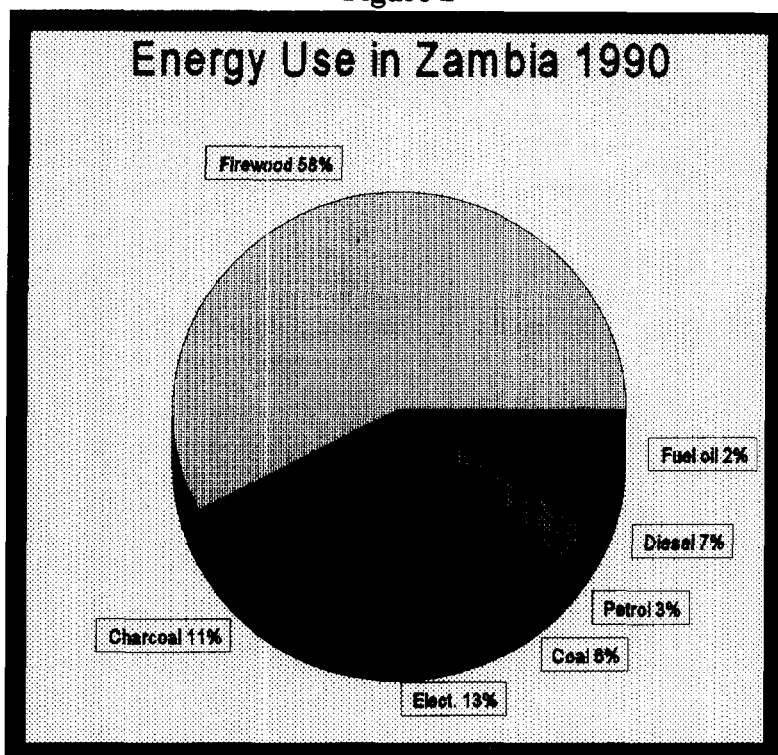
*Calculated using Intergovernmental Panel on Climate Change guidelines and default factors. Figures do not constitute absolute emissions.

Zambia is an overall net sink for carbon dioxide by about 60 metric tons per year. The high sequestration rate of native forests is due to the high rate of forest regeneration. The main carbon sink is regrowth of forests following temporary forest clearing, farming the cleared areas for a few years, and then abandoning cultivated lands that are either regenerated naturally or are planted. Zambia's emission inventory includes no carbon sequestration by urban trees, but it is probably insignificant compared to the high rate of sequestration and forest growth in rural areas. The average sequestration rate from forests is about 2.5 metric tons per hectare per year.

High harvest pressure on forest resources as a source of household fuel prevents the forest from becoming potentially more valuable which is a major policy issue. The lost value is becoming increasingly obvious with accelerated soil erosion, flooding, water quality and quantity problems, air pollution, local climate deterioration, and detriments to tourism and building industries. The Zambian Government recognizes the importance of the issue and is making efforts to expand use of electricity, introduce alternative sources of fuel, and promote distributed generation facilities with the intention of reducing the excessively high rate of rural deforestation that is leading Zambia into even poorer condition.

Commercial buildings and industry are the primary users of electricity which is generated primarily from hydroelectric sources within the country. Power generated from coal which is in plentiful supply, with known reserves of 30 million tons, accounts for only 6 per cent of total energy consumption. About 90 percent of coal energy is used in the copper mining and commerce industry. Use of electricity in both residential and commercial sectors is primarily limited by the high cost of conventional distribution lines to potential users, most of whom simply cannot afford the price. Figure 2. illustrates the high percentage of energy demand share produced from sources other than fossil fuel. The combined use of firewood, charcoal, and hydroelectric is 82%.

Figure 2



Vulnerability to Climate Change

Africa is the continent most susceptible to sustaining damage to natural and social systems due to impacts of projected climate changes. Natural and social systems in Zambia are particularly sensitive to climate change because drought combined with a barely surviving and fragile agricultural economy with widespread poverty all add up to a limited ability to adapt to adversity. Zambia is prone to recurrent droughts and following flood events that cause severe erosion and loss of soil productivity. Deterioration of climate has far reaching effects in terms of trade, agricultural productivity, forest ecosystem changes, water resources, human health, population movements, wildlife habitat, and other associated social and physical stresses. A series of vulnerability and adaptation assessment reports prepared by the Environmental Council of Zambia in cooperation with the U.S. Country Studies Program documents these effects

Global climate change issues can leave countries like Zambia vulnerable to the impact of investors from developed countries that would take unfair advantage of investment opportunity in a country fragile and sensitive to mismanagement and improper use of available resources. The lack of sufficient government policies to deal with big industry investing in carbon, natural resources, human resources, and other benefits could become a vulnerability problem.

Mitigation Strategies in the Building Sector

Country Studies assessments in Zambia were used to identify and evaluate optional strategies that would support national economic development and provide cost effective contribution to achieving international climate change goals. Various strategies considered in the mitigation analysis are listed in Table 2.

Table 2. Global Climate Change Mitigation Strategies in Zambia

Proposed option	Penetration level in 2010	cost \$/m.ton CO ₂ eq.	Sector
Replace pipeline diesel pumps	1 project (900kW)	(97.02)	Utility
Replace remote generators	1 replacement (8MW)	(93.58)	Utility
Reduced tillage farming	reduce by 200 tractors	(89.00)	Industry
Residential charcoal to coal	100,000 households	(0.29)	Buildings
Charcoal production efficiency	50,000 batches	(0.11)	Utility
Improved cook stoves	500,000 improved stoves	.38	Buildings
Extend household electric	300,000 households	9.33	Buildings
Cement production efficiency	1 plant	61.03	Industry
Electric boilers	150 boilers	101.15	Industry
Building industry development	unknown	unknown	Buildings
community improvements to support tourism	unknown	unknown	Buildings

*Negative (costs) indicate savings through improved efficiency. Positive costs indicate implementation would require external funds investment to gain CO₂ reduction and other benefits.

Extension of Household Electrification. Perhaps the most significant proposal to improve economic development while also contributing to reducing greenhouse gas emissions is extension of house hold electrification. Only 12% of the population has household electricity. Hydro-electric sources generate less than built capacity and area currently developed at much less than full potential. The forest resource is being depleted due to household cooking with wood and charcoal while a healthy forest resource could be more valuable for other purposes. Barriers that this opportunity faces are: costs to extend electric lines to homes in remote and dispersed areas, home occupants inability to pay for electricity, costs of connecting service to the buildings, and costs of electric lighting and cooking appliances. Penetration of electricity into the residential sector will depend largely on growth in income levels of potential customers and Zambia Electric Service Company's (ZESCO) plans for investing in such extensions. The cost to connect 20,000 customers per year is about \$6 million. The goal is to electrify 300,000 residences by 2010 and 600,000 by 2030 which is about 6 times the current level of service. The estimated cost per ton of carbon from this option is about \$9.33 per ton.

Household fuel shift from Wood Charcoal to Coal Briquettes. Charcoal is a primary source of household energy in urban low income groups not able to afford electricity and also in rural areas where future electric service may not be available in the near term. Coal briquettes made

of waste coal dust fines, sawdust, and molasses would be manufactured in an industrial plant capable of producing 200,000 tons of coal briquettes in 2010 and two plants in 2030 to produce 400,000 tons. The manufacture, sale, and use of coal briquettes would displace the production, sale, and use of wood charcoal while reducing utilization pressure on the forest resource. This should not reduce sequestration capacity of the forest in the immediate future. It would utilize coal fine wastes that are currently a source of methane emissions due to spontaneous oxidation in mine wastes. It would reduce on-site biomass burning emissions from charcoal production which include CO₂, CH₄, and CO. Employment opportunity would change shift from wood charcoal production in the forest to jobs in coal briquette manufacturing. Coal briquettes could be more efficiently exported than charcoal.

Improved Household Cooking Stoves. Local research has studied and designed improved cook stoves that are 50% more efficient than existing stoves that have an efficiency of only about 10%. Manufacturing and marketing the new stoves would save fuel, cut down on carbon emissions, improve air quality, improve residential human health conditions, and provide new employment opportunity in this proposed building appliance industry. This option would also help reduce pressure on forest resources for a variety of benefits already described. The cost of the new stove model is equivalent to the cost of the older model and would be culturally acceptable since it is similar to what is already in use.

Other Options Considered. A variety of other options are being proposed that would indirectly affect buildings and the building industry. Converting cement production from wet to dry process would save energy and reduce greenhouse gas emissions. Replacing remote diesel electricity generators with utility lines connecting communities to the national electricity grid would displace the burning of diesel fuel, but costs for connection lines is estimated at \$105 million. International gas pipeline pumping stations in Zambia are currently fired by diesel fuel and could be converted to electric pumps for significant greenhouse gas savings, but again the cost for distributing electricity to these 2 sites in Zambia is about \$1.0 million. Alternative farming techniques such as low tillage systems could also be used to reduce tractor emissions and soil oxidation losses, but the pesticides required are expensive and there are not many tractors in use at the present time.

Options Not Considered. Urban infrastructure improvements and development of the tourism industry would bring international travelers with money to Zambia, provide employment opportunity in the services sector, and help build a foundation for economic development and financial security. The remnants of affluence remain in the cities as well as in the minds of citizens who previously experienced “The Garden City”. Substantial redevelopment investments are needed and an internal source of capital from agriculture will be much longer in coming although Zambia has the climate, soil, and manpower to become a significant source of food for much of South Central Africa. The private tourism industry investment encouraged by the Government could provide a source of capital needed to jump start the economy, provide local service jobs, and take advantage of the Natural Parks. The national parks, wildlife resources, cultural heritage, and human resources could be the foundation for an extremely lucrative tourism industry that would bring in capital needed to support a growing economy and ultimately lead to a growing building industry and the ability on the part of residents to pay for a higher standard of living.

Discussion

Solutions to achieving prosperity in Zambia are complex and deeply rooted in social, cultural, and political experience. Looking at buildings as individual structures will not alone lead to better buildings or even an energy efficient economy. There are other systems that enter into the formula. The proposed mitigation options in the building sector do not appear to have as high a payback on investment as do options in the utility and agricultural sectors. Capital in Zambia is simply unavailable for making even the best of investments. Even these high pay back utility and agricultural investments rely on financial help from outside investors. Many of the options considered show that investing in greenhouse gas reduction benefits would also yield calculated financial savings from efficiency gains. Curtailment of charcoal production and household wood burning activities may be a sound option for protecting the forest resources. In the long term a better managed forest resource could support a forest products and building industry along with taking advantage of the higher value uses of the forests. Even electrification of households using hydro power as a source of energy is unsustainable in the absence of an ability to pay for service.

Any investment in improving living conditions in Zambia and its contribution to the Global Climate Change issue must carefully support practical and cost effective means to achieve a sustainable inflow of financial capital while also protecting its remaining most valuable resources. Successful strategies would encourage change to grow out of a continuation of current practices and cultural values. Strategies should be feasible, affordable, cost effective, practical, and acceptable.

The joint implementation concept can be a win-win for both Zambia and private industry investors. Zambia's interest in implementing options to promote economic development or provide an inflow of capital might complement the interest of potential investors in the opportunity to buy a net surplus of carbon emission credits at a cost lower than can be purchased elsewhere. U.S. industry investors must weigh carefully the opportunity to invest in domestic improvements in the U.S. to achieve carbon reduction and related benefits against the opportunity to invest in benefits for developing countries. There is the question of how can developed countries best help developing countries? Assistance in the form of food and money may not be as good as sending industrial development and resource efficiency technology that will help them be able to help themselves grow as a nation.

Prioritizing greenhouse gas emission options that also provide for economic development may not be the sole basis for assessing net savings or immediate return on investment. Using foreign grant funds to install electric utility lines to households that cannot afford to pay for electricity may not be as effective as investing in tourism or other industries that establish jobs in the services sector and build a foundation for households that eventually will be able to pay on a sustainable basis for electricity, building appliances, and ultimately better buildings in more stable communities.

Recommendations

1. Zambia should consider preparing an analysis of the option of developing tourism as a proposed strategy for global climate change mitigation that would utilize its existing resources to generate a source of outside revenue, provide employment opportunities in the services sector, and offset carbon emissions in developed countries. The natural,

cultural, and human resources might be effectively developed to support tourism industry as a sound option for developing a source of both immediate and sustainable inflow of capital for developing an energy-efficient economy.

2. U.S. private industry should consider investigating advantages of market expansion opportunities in Zambia that would support implementation of energy-efficient building technologies, provide for cleaner fuel, more efficient stoves, better constructed buildings, improved human health conditions, and more sustainable communities. Financial and technical support for such improvements could yield stakeholder benefits including market entry or expansion in a resource rich developing county, low capital investment costs, low labor costs, and greenhouse gas mitigation offset opportunities.

3. Private industry should consider evaluating potential benefits of collaborations with developing countries in order to economically achieve U.S. greenhouse gas emission targets and build support for Senate ratification of the Kyoto protocol.

Conclusions

Zambia is too rich in natural and human resources to be so poor. Building infrastructure and community development can use available resources as a foundation for sustainable development quality of life for the whole world to enjoy. This country has only 12 percent of its population using electricity, 90 percent of electricity generated by hydro power facilities operating at 30 percent of capacity, productive soil and climate, a population with the remaining memory and vision for economic success, the largest National Parks in all of Africa, a net surplus of carbon sinks, and the opportunity to technically avoid many of the mistakes made by already developed countries. If the U.S. road map for carbon reductions fails to lead the way to collaboration with Zambia, other developed countries with investment bound industry may discover the opportunity first. Taken separately or together energy-efficiency, emissions trading, international collaboration, and economic development can lead to excellent business investments for an American energy-efficient economy.

Acknowledgments

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